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CRN At-A-Glance

2017 CRA Taulbee Survey: Another Year of Record Undergrad Enrollment; Doctoral Degree Production Steady While Master's Production Rises Again

This article and the accompanying figures and tables present the results from the 47th annual CRA Taulbee Survey. The survey, conducted annually by the Computing Research Association, documents trends in student enrollment, degree production, employment of graduates, and faculty salaries in academic units in the United States and Canada that grant the Ph.D. in computer science (CS), computer engineering (CE), or information (I). Most of these academic units are departments, but some are colleges or schools of information or computing. In this report, we will use the term "department" to refer to the unit offering the program.

See page 2 for full article.

Expanding the Pipeline: 2018 CRA-W Grad Cohort for Women Inspires Attendees to Persist in Computing

On April 13-14, more than 400 women graduate students in computing from more than 150 institutions converged on San Francisco, CA, for the 2018 CRA-W Graduate Cohort for Women (CRA-W Grad Cohort). Throughout the two-day workshop, professional connections were made, new friendships were formed, and mentoring relationships with senior researchers were established. CRA-W organizes this workshop as part of its mission to increase the success and participation of women in computing research.

See page 58 for article.

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2017 CRA Taulbee Survey

Another Year of Record Undergrad Enrollment; Doctoral Degree Production Steady While Master's Production Rises Again

By Stuart Zweben and Betsy Bizot

This article and the accompanying figures and tables present the results from the 47th annual CRA Taulbee Survey[1]. The survey, conducted annually by the Computing Research Association, documents trends in student enrollment, degree production, employment of graduates, and faculty salaries in academic units in the United States and Canada that grant the Ph.D. in computer science (CS), computer engineering (CE), or information (I)[2]. Most of these academic units are departments, but some are colleges or schools of information or computing. In this report, we will use the term "department" to refer to the unit offering the program.

CRA gathers survey data during the fall. Responses received by February 9, 2018 are included in the analysis. The period covered by the data varies from table to table. Degree production and enrollment (Ph.D., Master's, and Bachelor's) refer to the previous academic year (2016-17). Data for new students in all categories refer to the current academic year (2017-18). Projected student production and information on faculty salaries are also for the current academic year; salaries are those effective January 1, 2018.

We surveyed a total of 281 Ph.D.-granting departments; we received salary responses from 171 and main survey responses from 168, for a total of 181 departments responding to one or both parts of the survey. This is similar to last year's 183 respondents, although the overall response rate of 64 percent is lower than last year's 68 percent. The response rates from CE and Canadian departments in particular continue to be low. The U.S. CS response rate of 77 percent is, as usual, the highest of all of the categories, although it also dropped from last year's 80 percent. Figure 1 shows the history of the survey's response rates. Response rates are inexact because some departments provide only partial data, and some institutions provide a single joint response for multiple departments. Thus, in some tables the number of departments shown as reporting will not equal the overall total number of respondents shown in Figure 1 for that category of department.

To account for the changes in response rate, we will comment not only on aggregate totals but also on averages per department reporting or data from those departments that responded to both 2016 and 2017 surveys. This is a more meaningful indication of the one-year changes affecting the data.

Departments that responded to the survey were sent preliminary results about faculty salaries in December 2017; these results included additional distributional information not contained in this report. The CRA Board views this as a benefit of participating in the survey.

Degree, enrollment, and faculty salary data for the U.S CS departments are stratified according to: a) whether the institution is public or private; and b) the tenure-track faculty size of the reporting department. The faculty size strata deliberately overlap, so that data from most departments affect multiple strata. This may be especially useful to departments near the boundary of one stratum. Salary data is also stratified according to the population of the locale in which the institution is located[3]. These stratifications allow our readers to see multiple views of important data, and hopefully gain new insights from them. In addition to tabular presentations of data, we will use "box and whisker" diagrams to show medians, quartiles, and the range between the 10th and 90th percentile data points.

For the first time this year, we requested information about supported master's students. The information collected is comparable to that about supported doctoral students, which we have been collecting and reporting for many years. The results are reported in the section on Graduate Student Support. Also in this year's report, we provide a summary of course-level enrollment data. We began collecting this in last year's survey to monitor continuing changes after the publication of the Generation-CS report. This data helps us understand enrollment trends at a somewhat finer level of detail than the aggregated data we have been gathering previously.

We thank all of the respondents to this year's questionnaire. The participating departments are listed at the end of this article. CRA member respondents will again be given the opportunity to obtain certain survey information for a self-selected peer group. Instructions for doing this will be emailed to all such departments.

Figure 1. Number of Respondents to the Taulbee Survey

Year	US CS Depts.	US CE Depts.	Canadian	US Information	Total
1995	110/133 (83%)	9/13 (69%)	11/16 (69%)		130/162 (80%)
1996	98/131 (75%)	8/13 (62%)	9/16 (56%)		115/160 (72%)
1997	111/133 (83%)	6/13 (46%)	13/17 (76%)		130/163 (80%)
1998	122/145 (84%)	7/19 (37%)	12/18 (67%)		141/182 (77%)
1999	132/156 (85%)	5/24 (21%)	19/23 (83%)		156/203 (77%)
2000	148/163 (91%)	6/28 (21%)	19/23 (83%)		173/214 (81%)
2001	142/164 (87%)	8/28 (29%)	23/23 (100%)		173/215 (80%)
2002	150/170 (88%)	10/28 (36%)	22/27 (82%)		182/225 (80%)
2003	148/170 (87%)	6/28 (21%)	19/27 (70%)		173/225 (77%)
2004	158/172 (92%)	10/30 (33%)	21/27 (78%)		189/229 (83%)
2005	156/174 (90%)	10/31 (32%)	22/27 (81%)		188/232 (81%)
2006	156/175 (89%)	12/33 (36%)	20/28 (71%)		188/235 (80%)
2007	155/176 (88%)	10/30 (33%)	21/28 (75%)		186/234 (79%)
2008	151/181 (83%)	12/32 (38%)	20/30 (67%)	9/19 (47%)	192/264 (73%)
2009	147/184 (80%)	13/31 (42%)	16/30 (53.3%)	12/20 (60%)	188/265 (71%)
2010	150/184 (82%)	12/30 (40%)	18/29 (62%)	15/22 (68%)	195/265 (74%)
2011	142/185 (77%)	13/31 (42%)	13/30 (43%)	16/21 (76%)	184/267 (69%)
2012	152/189 (80%)	11/32 (34%)	14/30 (47%)	16/26 (62%)	193/277 (70%)
2013	144/188 (77%)	10/30 (33%)	14/26 (54%)	11/22 (50%)	179/266 (67%)
2014	143/188 (76%)	13/31 (42%)	12/26 (46%)	13/19 (68%)	181/268 (68%)
2015	146/190 (77%)	8/32 (25%)	12/26 (46%)	12/18 (67%)	178/266 (67%)
2016	150/188 (80%)	8/33 (24%)	11/26 (42%)	14/21 (67%)	183/268 (68%)
2017	148/192 (77%)	8/35 (23%)	11/30 (37%)	14/24 (58%)	181/281 (64%)

Doctoral Degree Production, Enrollment, and Employment

(Tables D1-D10; Figures D1-D6)

Degree Production

On a per department basis, doctoral degree production held steady in 2016-17. This year's respondents produced 13.1 degrees per U.S. CS department, and 12.4 degrees per department overall. This compares with 12.9 and 12.3, respectively, reported last year. Fewer departments reported their Ph.D. production this year, so Table D1 shows 1,834 degrees produced in 2016-17 compared with 1,888 in 2015-16.

Among all departments reporting both this year and last year, the number of total doctoral degrees increased by 1.2 percent. Among U.S. CS departments reporting both years, the increase was 0.8 percent.

Women received 18.3 percent of CS doctoral degrees and 19.3 percent of all doctoral computing degrees (Table D2). Both values represent an increase from last year. The CS percentage is the same as it was two years ago. The ethnicity profile of CS doctoral graduates is similar to what it has been for the past two years, except that the proportion of resident Asians increased this year while the proportion of Non-resident Aliens decreased, each between one and two percentage points. The percentage of CS doctoral graduates who were American Indian or Alaska Native, Black or African American, Native Hawaiian/Pacific Islander, Hispanic, or Multiracial Non-Hispanic totaled less than 3 percent again this year. CE and I degree areas also reported a decreased percentage of Non-resident Alien doctoral graduates, following an increase last year. These areas each had a corresponding increase in the proportion of degrees going to resident Asians and Whites.

2017 CRA Taulbee Survey *(continued)*

As we have found in previous years, Non-resident Aliens again comprised a higher percentage of the CS female doctoral graduates than they did CS male graduates, while Whites comprised a lower percentage of the female graduates as compared with male graduates. However, this year the difference is only one percentage point for both Non-resident Aliens and Whites, so the distribution of CS doctoral graduates relative to ethnicity is virtually the same for men and women (Table D9).

Doctoral Program Enrollment

Among programs that reported both years, total doctoral enrollment increased by 3.0 percent. If only U.S. computer science departments are considered, the increase was 3.7 percent (Table 1). For the second straight year, total doctoral enrollment by gender is more diverse compared with last year in all department areas (CS, CE, and I). The overall fraction of current doctoral students who are women is 22.1 percent, versus 21.6 percent last year (Table D7). The fraction of doctoral

Table D1. PhD Production and Pipeline by Department Type

Department Type	# Depts	PhDs Awarded		PhDs Next Year		Passed Qualifier		Passed Thesis (if dept has)		
		#	Avg/ Dept	#	Avg/ Dept	#	Avg/ Dept	#	# Dept	Avg/ Dept
US CS Public	93	1,166	13.1	1,300	14.0	1,384	16.3	940	73	11.8
US CS Private	31	391	13.0	538	17.4	497	15.5	213	24	8.8
US CS Total	124	1,557	13.1	1,838	14.8	1,881	16.1	1,153	97	11.1
US CE	7	59	8.4	94	13.4	151	30.2	135	5	28.9
US Info	13	78	6.5	125	9.6	110	8.5	89	11	8.0
Canadian	11	140	14.0	155	14.1	82	10.3	89	7	12.8
Grand Total	93	1,834	12.4	2,212	14.3	2,224	15.6	1,466	120	12.0

Table D2. PhDs Awarded by Gender

	CS		CE		I		Total	
Male	1,298	81.7%	98	89.1%	78	60.9%	1,474	80.7%
Female	291	18.3%	12	10.9%	50	39.1%	353	19.3%
Total Known Gender	1,589		110		128		1,827	
Gender Unknown	3		0		4		7	
Grand Total	1,592		110		132		1,834	

Table D3. PhDs Awarded by Ethnicity

	CS		CE		I		Total	
Nonresident Alien	891	62.3%	54	55.7%	42	35.0%	987	59.9%
Amer Indian or Alaska Native	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Asian	130	9.1%	16	16.5%	12	10.0%	158	9.6%
Black or African-American	10	0.7%	0	0.0%	8	6.7%	18	1.1%
Native Hawaiian/Pac Islander	1	0.1%	0	0.0%	1	0.8%	2	0.1%
White	371	25.9%	24	24.7%	48	40.0%	443	26.9%
Multiracial, not Hispanic	4	0.3%	1	1.0%	2	1.7%	7	0.4%
Hispanic, any race	24	1.7%	2	2.1%	7	5.8%	33	2.0%
Total Residency & Ethnicity Known	1,431		97		120		1,648	
Resident, ethnicity unknown	91		1		4		96	
Residency unknown	70		12		8		90	
Grand Total	1,592		110		139		1,834	

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Table D4. Employment of New PhD Recipients By Specialty

	Artificial Intelligence	Computing Education	Databases / Information Retrieval	Graphics/Visualization	Hardware/Architecture	High-Performance Computing	Human-Computer Interaction	Informatics: Biomedical/ Other Science	Information Science	Information Systems	Networks	Operating Systems	Programming Languages/ Compilers	Robotics/Vision	Scientific/ Numerical Computing	Security / Information Assurance	Social Computing/ Social Informatics	Software Engineering	Theory and Algorithms	Other	Total	
North American PhD Granting Depts.																						
Tenure-track	22	3	11	2	5	4	12	5	10	5	8	2	2	2	0	14	0	9	2	11	129	9.1%
Researcher	2	0	0	1	0	1	3	2	1	1	2	3	2	0	1	4	0	1	1	2	27	1.9%
Postdoc	28	1	8	10	4	2	1	6	3	2	7	2	12	12	1	12	1	4	15	20	151	10.7%
Teaching Faculty	7	5	4	1	4	3	5	2	3	0	4	0	1	1	1	3	0	3	0	7	54	3.8%
North American, Other Academic																						
Other CS/CE/I Dept.	1	0	3	1	0	0	3	1	2	0	3	0	1	1	0	4	0	2	3	7	32	2.3%
Non-CS/CE/I Dept	0	0	0	0	0	0	0	2	3	0	0	1	0	0	0	0	0	0	0	1	7	0.5%
North American, Non-Academic																						
Industry	116	2	57	48	45	38	34	22	4	11	62	29	28	54	5	58	8	77	37	106	841	59.4%
Government	2	0	0	2	1	3	1	0	2	1	1	1	0	0	1	7	1	2	0	4	29	2.0%
Self-Employed	8	0	1	1	1	1	2	0	2	0	0	2	0	0	0	1	0	1	0	0	20	1.4%
Unemployed	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	3	0.2%
Other	1	0	0	1	0	0	0	1	2	0	0	0	1	0	2	3	2	2	0	7	22	1.6%
Total Inside North America																						
	188	11	84	67	60	52	61	41	32	20	87	40	47	71	11	106	12	101	59	165	1,315	92.8%
Outside North America																						
Ten-Track in PhD	2	0	3	1	0	1	4	1	5	0	1	1	0	0	1	2	0	3	2	4	31	2.2%
Researcher in PhD	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	4	0.3%
Postdoc in PhD	6	0	0	0	1	0	3	0	0	1	1	0	0	0	0	1	0	1	3	1	18	1.3%
Teaching in PhD	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	3	0	1	7	0.5%
Other Academic	1	0	0	0	1	0	1	0	0	0	1	0	1	0	0	1	1	1	0	0	8	0.6%
Industry	5	0	2	3	0	0	2	0	0	1	2	0	1	1	0	1	1	1	1	3	24	1.7%
Government	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	5	0.4%
Self-Employed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Unemployed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Other	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	1	5	0.4%
Total Outside NA	15	1	7	5	3	1	11	1	6	3	7	1	2	1	1	5	3	11	7	11	102	7.2%
Total with Employment Data, Inside North America plus Outside North America																						
	203	12	91	72	63	53	72	42	38	23	94	41	49	72	12	111	15	112	66	176	1,417	
Employment Type & Location Unknown																						
	43	2	19	21	16	5	11	7	2	5	17	7	2	8	3	9	2	14	18	206	417	
Grand Total	246	14	110	93	79	58	83	49	40	28	111	48	51	80	15	120	17	126	84	382	1,834	

students who are not either Non-resident Aliens, Asian, or White remains below 5 percent overall and also within CS programs (Table D8).

As has been true in previous years, Non-resident Aliens comprise a higher percentage of the enrolled women than they do the enrolled men, and Whites comprise a lower percentage of enrolled women. This year, resident Asians comprise a higher percentage of enrolled Asian women than they do Asian men; last year, these percentages were similar.

Among those pursuing I degrees, 58 percent of the men and 61 percent of the women are Non-resident Aliens or Resident Asians. Last year these percentages were 59 and 54, respectively. This year, Whites comprise a higher percentage of men than they do women among those pursuing I degrees; last year, the reverse was true (Table D10).

At U.S. CS departments, the average number of students per department who passed qualifier exams in 2016-17 was 16.1. For the past three years, this average was between 13.9 and 14.3. Both public and private

Table D4a. Detail of Industry Employment

	Artificial Intelligence	Computing Education	Databases / Information Retrieval	Graphics/Visualization	Hardware/Architecture	High-Performance Computing	Human-Computer Interaction	Informatics: Biomedica/ Other Science	Information Science	Information Systems	Networks	Operating Systems	Programming Languages/ Compilers	Robotics/Vision	Scientific/ Numerical Computing	Security / Information Assurance	Social Computing/ Social Informatics	Software Engineering	Theory and Algorithms	Other	Total		
Inside North America																							
Research	82	1	21	20	27	14	20	14	3	6	21	12	15	40	3	24	2	34	17	23	28	427	50.8%
Non-Research	18	1	29	20	16	22	12	6	1	1	27	15	11	6	1	23	6	39	9	17	12	292	34.7%
Postdoctorate	0	0	2	1	0	2	0	1	0	0	4	1	2	1	1	2	0	0	4	3	2	26	3.1%
Type Not Specified	16	0	5	7	2	0	2	1	0	4	10	1	0	7	0	9	0	4	7	17	4	96	11.4%
Total Inside NA	116	2	57	48	45	38	34	22	4	11	62	29	28	54	5	58	8	77	37	60	46	841	
Outside North America																							
Research	3	0	2	3	0	0	2	0	0	0	0	0	0	1	0	0	0	0	1	0	1	13	54.2%
Non-Research	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	1	1	1	0	1	1	8	33.3%
Postdoctorate	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Type Not Specified	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	12.5%
Total Outside NA	5	0	2	3	0	0	2	0	0	1	2	0	1	1	0	1	1	1	1	1	2	24	

Table D5. New PhD Students by Department Type

	CS				CE				I				Total	
Department Type	**New Admit**	**MS to PhD**	**Total**	**Avg. per Dept.**	**New Admit**	**MS to PhD**	**Total**	**Avg. per Dept.**	**New Admit**	**MS to PhD**	**Total**	**Avg. per Dept.**	**Total**	**Avg. per Dept**
US CS Public	1,668	135	1,803	18.8	112	3	115	7.2	84	0	84	10.5	2,002	20.6
US CS Private	781	61	842	24.1	12	1	13	2.6	17	1	18	6.0	873	24.9
US CS Total	2,449	196	2,645	20.2	124	4	128	6.1	101	1	102	9.3	2,875	21.8
US CE	0	0	0	0.0	56	35	91	13.0	0	0	0	0.0	91	13.0
US Information	9	0	9	9.0	0	0	0	0.0	126	5	131	9.4	140	10.0
Canadian	141	17	158	14.4	0	0	0	0.0	0	0	0	0.0	158	14.4
Grand Total	2,599	213	2,812	19.7	180	39	219	7.8	227	6	233	9.3	3,264	19.9

Table D5a. New PhD Students from Outside North America

Department Type	CS	CE	I	Total New Outside	Total New	% outside North America
US CS Public	1,226	88	44	1,358	2,002	67.8%
US CS Private	488	8	14	510	873	58.4%
Total US CS	1,714	96	58	1,868	2,875	65.0%
US CE	0	61	0	61	91	67.0%
US Info	4	0	72	76	140	54.3%
Canadian	101	0	0	101	158	63.9%
Grand Total	1,819	157	130	2,106	3,264	64.5%

Table D6. PhD Enrollment by Department Type

Department Type	# Depts	CS		CE		I		Total	
US CS Public	99	9,336	66.2%	511	66.2%	410	66.2%	10,257	66.2%
US CS Private	36	3,353	24.2%	81	24.2%	165	24.2%	3,599	24.2%
Total US CS	135	12,689	90.3%	592	90.3%	575	90.3%	13,856	90.3%
US CE	6	0	0.1%	549	0.1%	0	0.1%	549	0.1%
US Info	14	37	0.2%	0	0.2%	652	0.2%	689	0.2%
Canadian	11	832	9.3%	25	9.3%	0	9.3%	857	9.3%
Grand Total	166	13,558		1,166		1,227		15,951	

Table D7. PhD Enrollment by Gender

	CS		CE		I		Total	
Male	10,251	78.9%	957	82.1%	669	60.7%	11,877	77.9%
Female	2,734	21.1%	208	17.9%	434	39.3%	3,376	22.1%
Total Known Gender	12,985		1,165		1,103		15,253	
Gender Unknown	573		1		124		698	
Grand Total	13,558		1,166		1,227		15,951	

Table D8. PhD Enrollment by Ethnicity

	CS		CE		I		Total	
Nonresident Alien	8,058	64.3%	750	68.1%	507	46.7%	9,315	63.2%
Amer Indian or Alaska Native	22	0.2%	0	0.0%	3	0.3%	25	0.2%
Asian	1069	8.5%	99	9.0%	108	9.9%	1276	8.7%
Black or African-American	170	1.4%	17	1.5%	54	5.0%	241	1.6%
Native Hawaiian/Pac Islander	32	0.3%	0	0.0%	0	0.0%	32	0.2%
White	2,884	23.0%	194	17.6%	371	34.2%	3,449	23.4%
Multiracial, not Hispanic	73	0.6%	18	1.6%	12	1.1%	103	0.7%
Hispanic, any race	233	1.9%	24	2.2%	31	2.9%	288	2.0%
Total Known	12,541		1,102		1,086		14,729	
Resident, ethnicity unknown	565		17		21		603	
Residency unknown	452		47		120		619	
Grand Total	13,558		1,166		1,227		15,951	

Table D9. PhDs Awarded by Gender and Ethnicity, From 154 Departments

	CS					CE					I					Ethnicity Totals	
	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Total	%
Nonresident Alien	727	164	0	62	63	48	6	0	55	60	33	9	0	46	19	987	59.9
Amer Indian or Alaska Native	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0.0
Asian	103	27	0	9	10	15	1	0	17	10	6	6	0	8	13	158	9.6
Black or African-American	6	4	0	1	2	0	0	0	0	0	3	5	0	4	10	18	1.1
Native Hawaiian/ Pac Islander	1	0	0	0	0	0	0	0	0	0	0	1	0	0	2	2	0.1
White	307	64	0	26	25	21	3	0	24	30	26	22	0	36	46	443	26.9
Multiracial, not Hispanic	4	0	0	0	0	1	0	0	1	0	2	0	0	3	0	7	0.4
Hispanic, any race	22	2	0	2	1	2	0	0	2	0	2	5	0	3	10	33	2.0
Total Res & Ethnicity Known	1,170	261	0	0	0	87	10	0			72	48	0			1,648	
Resident, ethnicity unknown	76	15	0			1	0	0			2	2	0			96	
Not Reported (N/R)	52	15	3			10	2	0			4	0	4			90	
Gender Totals	1,298	291	3			98	12	0			78	50	4			1,834	
%	81.7%	18.3%				89.1%	10.9%				60.9%	39.1%					
* % of M and % of F columns are the percent of that gender who are of the specified ethnicity, of those whose ethnicity is known																	

Table D10. PhD Enrollment by Gender and Ethnicity, From 164 Departments Providing Breakdown Data

	CS					CE					I					Ethnicity Totals	
	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Total	%
Nonresident Alien	6,125	1,689	244	64	66	627	123	0	69	62	303	193	11	49	52	9,315	63.2%
Amer Indian or Alaska Native	18	3	1	0	0	0	0	0	0	0	2	1	0	0	0	25	0.2%
Asian	783	249	37	8	10	75	24	0	8	12	58	32	5	9	9	1276	8.7%
Black or African-American	107	58	5	1	2	12	5	0	1	3	24	21	2	4	6	241	1.6%
Native Hawaiian/ Pac Islander	21	11	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0.2%
White	2,273	495	116	24	19	153	41	0	17	21	207	107	28	34	29	3,449	23.4%
Multiracial, not Hispanic	52	17	4	1	1	16	2	0	2	1	7	4	1	1	1	103	0.7%
Hispanic, any race	181	43	9	2	2	20	4	0	2	2	14	12	2	2	3	288	2.0%
Total Res & Ethnicity Known	9,560	2,565	416			903	199				615	370	49			14,729	
Resident, ethnicity unknown	448	106	11			17	0				16	4	1			603	
Not Reported (N/R)	243	63	146			37	9				24	22	74			619	
Gender Totals	10,251	2,734	573			957	208				669	434	124			15,951	
%	78.9%	21.1%				82.1%	17.9%				60.7%	39.3%	0 %			0.0%	
* % of M and % of F columns are the percent of that gender who are of the specified ethnicity, of those whose ethnicity is known																	

Figure D1. PhD Production

CRA Taulbee Survey 2017

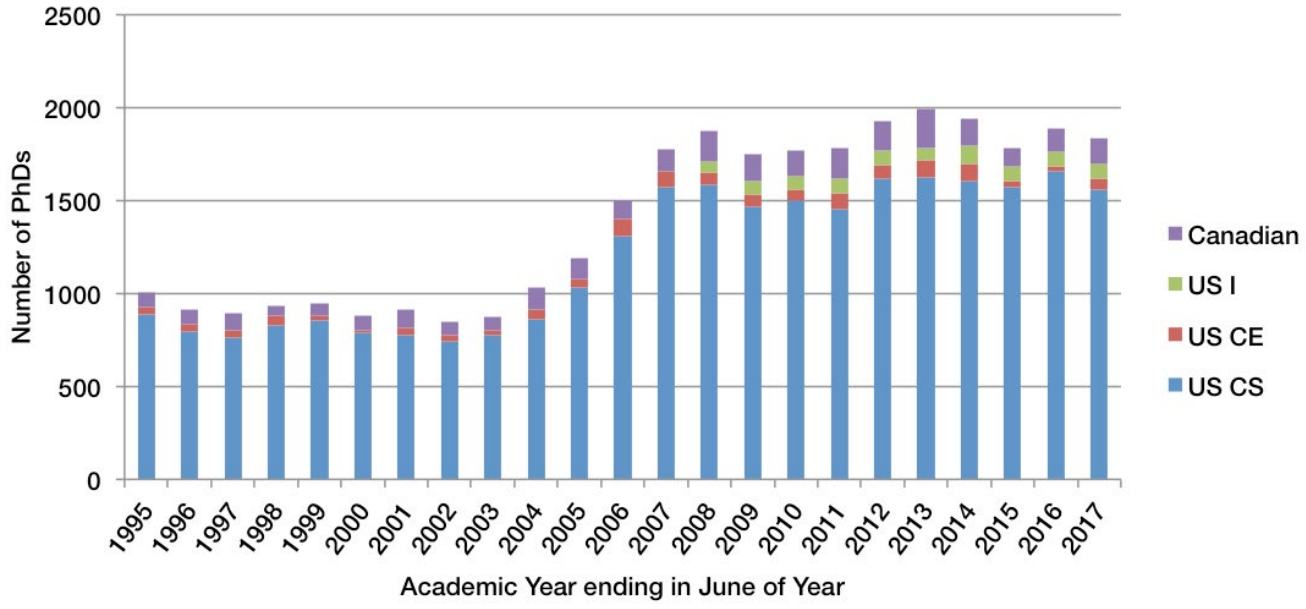


Figure D2. Nonresident Aliens as Fraction of PhD Enrollments

CRA Taulbee Survey 2017

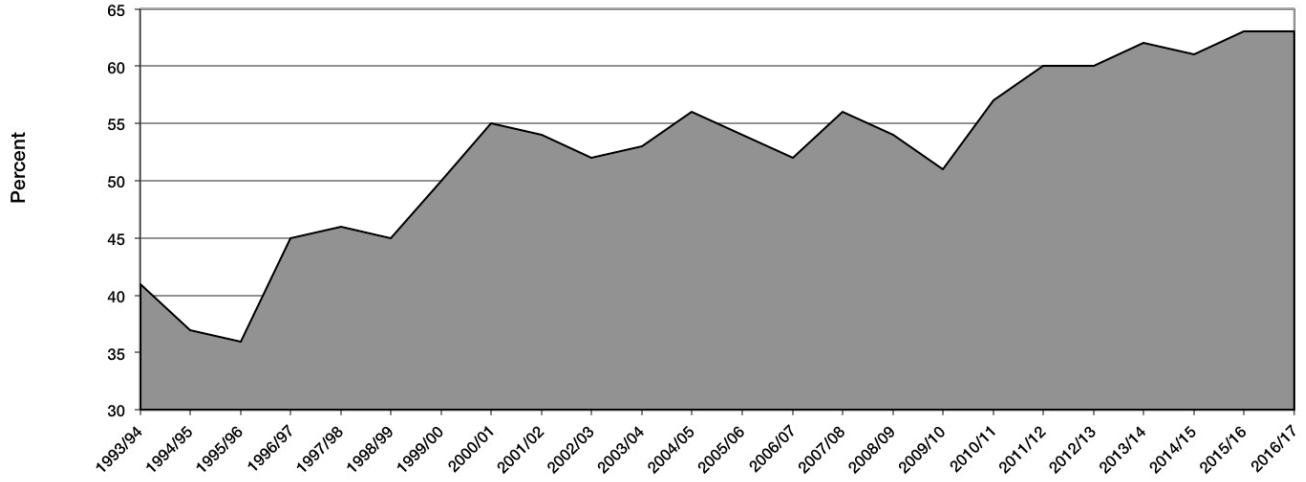


Figure D3. PhD Degrees Granted by Tenure-Track Size

CRA Taulbee Survey 2017

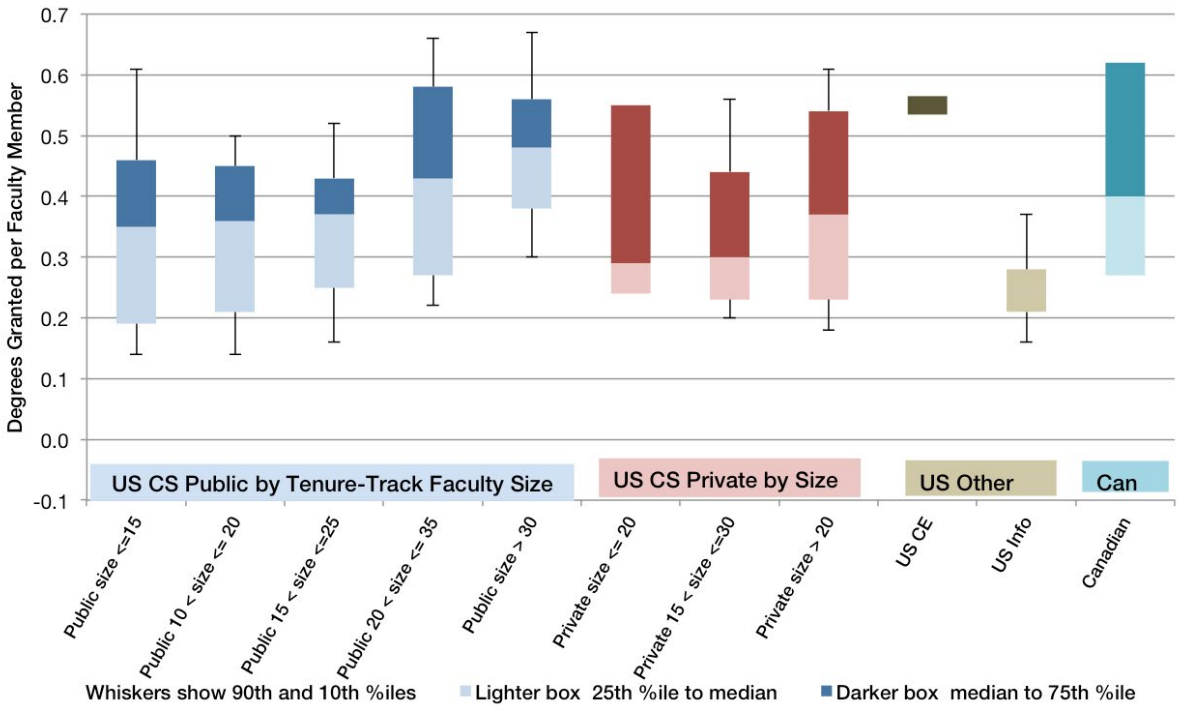


Figure D4. PhD Enrollment Normalized by Tenure-Track Size

CRA Taulbee Survey 2017

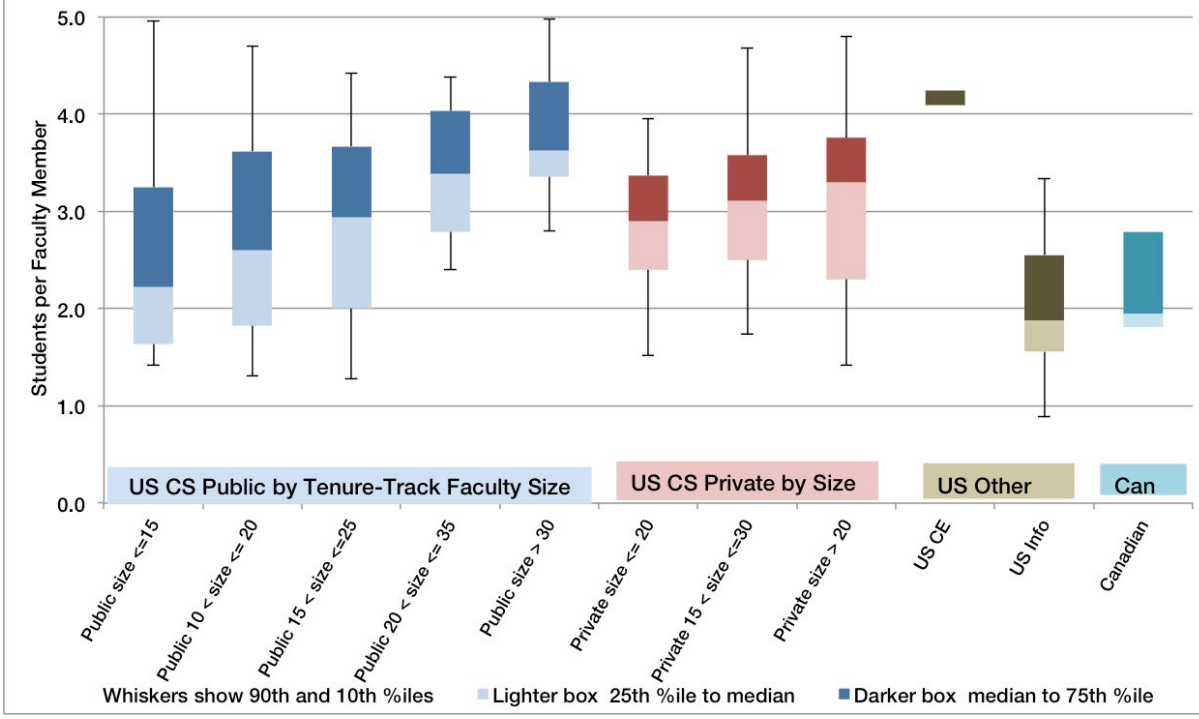


Figure D5. CS Pipeline corrected for year of entry

CRA Taulbee Survey 2017

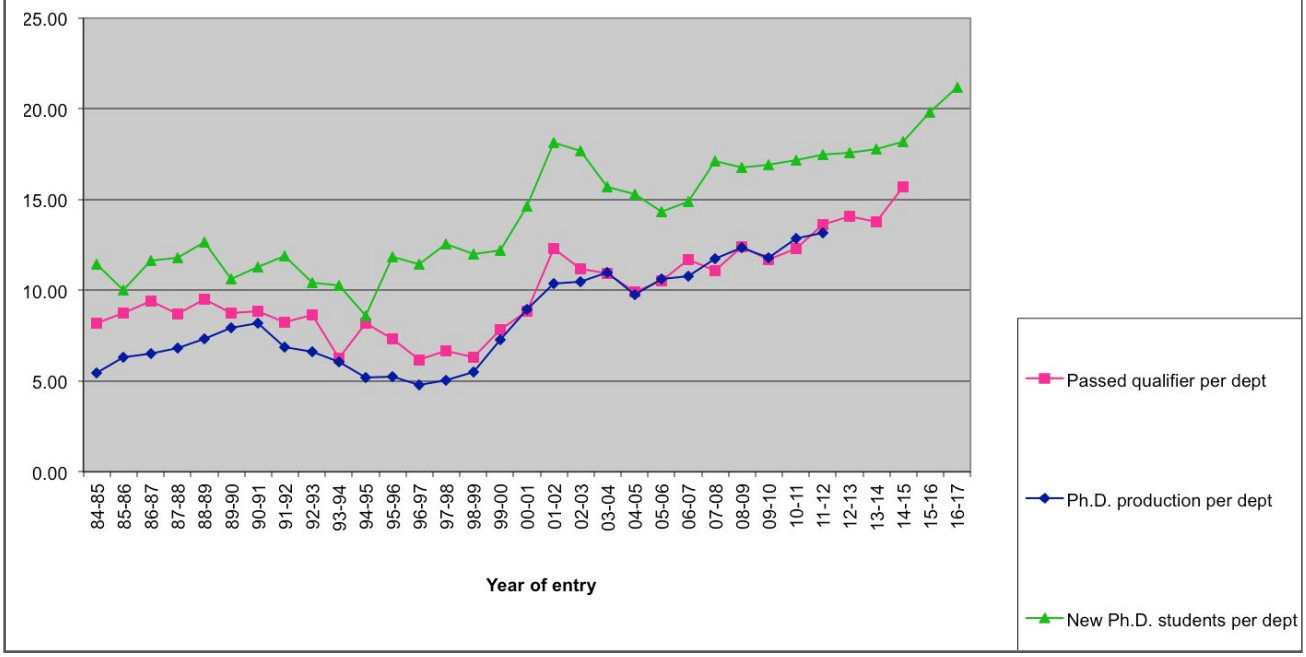
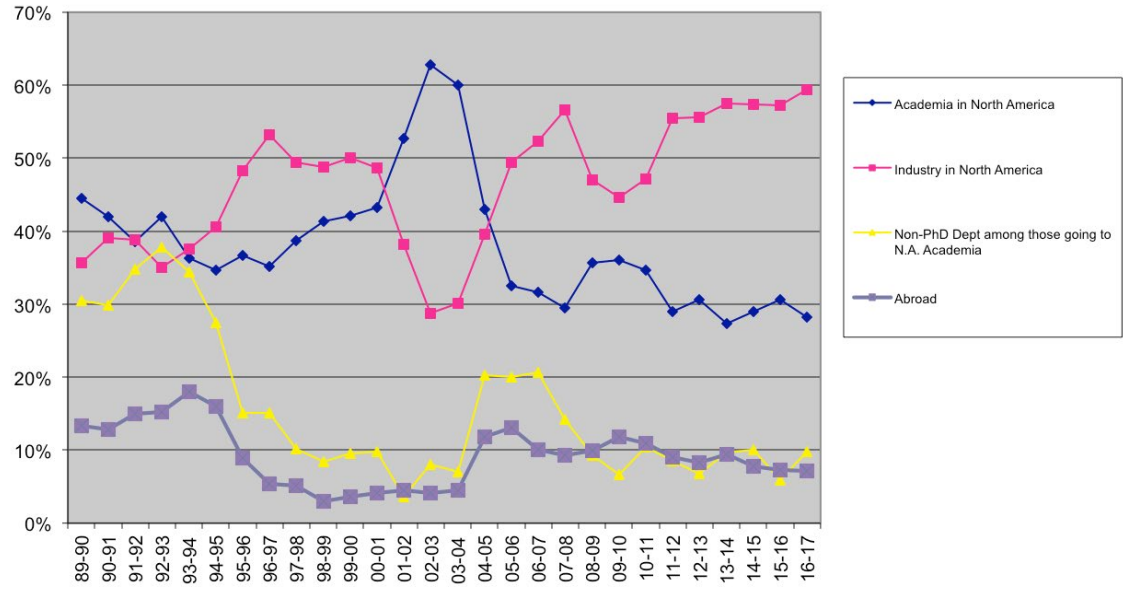


Figure D6. Employment Trends for New Ph.D.s

CRA Taulbee Survey 2017



institutions reported increases. The average number per U.S. CS department who passed thesis candidacy exams in 2016-17 (most, but not all, departments have such exams) increased slightly from 2015-16, mainly due to increases at private institutions (Table D1).

The number of new Ph.D. students per department reporting increased this year compared with those from last year's reporting departments (Tables 1 and D5) in CS, CE and Canadian departments. There was somewhat of a decrease in I departments. Among all departments that reported both years, the number of new Ph.D. students increased 3.9 percent. If only U.S. CS departments that reported both years are considered, the increase was 4.1 percent.

The proportion of new doctoral students from outside North America rose this year to 64.5% from 62.0% last year. There were increases in all categories of departments, while last year there were decreases in all categories of departments (Table D5a).

Figure D5 shows a graphical view of the Ph.D. pipeline for U.S. computer science and Canadian departments, the main producers of CS doctoral degrees. The data in this graph are normalized by the number of reporting departments. The graph offsets the qualifier data by two years from the data for new students, and offsets the graduation data by five years from the data for new students.

These data have been useful in estimating the timing of changes in production rates. The graph suggests small growth in doctoral production during the next two years. However, departments are forecasting a double-digit percent increase in production during 2017-18 (Table D1). Last year's optimistic departmental production forecast was not realized.

Ph.D. Employment

Figure D6 shows the employment trend of new Ph.D.s in academia and industry within North America, those taking employment outside of North America, and those going to academia in North America who took positions in departments other than Ph.D.-granting CS and CE departments. Table D4 shows a more detailed breakdown of the employment data for new Ph.D.s. The percentage of new Ph.D.s who took positions in North American industry was 59.4 percent, an increase from the 57.2 percent reported last year. Among those doctoral graduates who went to North American industry and for whom the type of industry position was known, about 57 percent took research positions (Table D4a). This is lower than the 60 percent reported in 2016, but the same as the percentage in 2015. This year, definitive data was provided for 89 percent of the graduates who went to North American industry, slightly less than the 91 percent last year.

Table 1. Degree Production and Enrollment Change From Previous Year

	Total						Only Departments Responding Both Years					
	US CS Only			All Departments			US CS Only			All Departments		
PhDs	**2016**	**2017**	**% chg**	**2016**	**2017**	**% chg**	**2016**	**2017**	**% chg**	**2016**	**2017**	**% chg**
PhD Awarded	1,655	1,557	-5.9%	1,888	1,834	-2.9%	1,444	1,456	0.8%	1,633	1,653	1.2%
#Units PhD Awd	128	119	-7.0%	154	148	-3.9%	108	108		129	129	
PhD Enrollment	13,243	13,856	4.6%	15,093	15,951	5.7%	12,836	13,310	3.7%	14,467	14,901	3.0%
#Units PhD Enr	134	135	0.7%	164	166	1.2%	126	126		152	152	
New PhD Enroll	2,672	2,875	7.6%	2,996	3,264	8.9%	2,604	2,710	4.1%	2,902	3,014	3.9%
#Units New PhD	130	132	1.5%	161	164	1.9%	120	120		147	147	
Bachelor's	**2016**	**2017**	**% chg**	**2016**	**2017**	**% chg**	**2016**	**2017**	**% chg**	**2016**	**2017**	**% chg**
BS Awarded	20,709	24,291	17.3%	25,508	29,587	16.0%	19,980	23,577	18.0%	24,125	28,178	16.8%
#Units BS Awd	131	131	0.0%	156	157	0.6%	123	123		146	146	
BS Enrollment	114,607	127,739	11.5%	136,589	153,610	12.5%	109,510	121,371	10.8%	130,903	141,670	8.2%
#Units BS Enr	131	131	0.0%	155	160	3.2%	123	123		145	145	
New BS Majors	27,266	30,734	12.7%	32,216	35,902	11.4%	26,011	27,139	4.3%	30,541	31,704	3.8%
#Units New BS	112	113	0.9%	137	138	0.7%	101	101		123	123	
BS Enroll/Dept	874.9	975.1	11.5%	881.2	960	9.0%	890	986.8	10.8%	902.8	977	8.2%

2017 CRA Taulbee Survey *(continued)*

After a two-year rise, the percentage of Ph.D. graduates who took North American academic jobs fell in 2016-17 to 28.2 from 30.7 last year. However, the percentage of graduates taking tenure-track positions in North American doctoral-granting computing departments rose slightly, from to 9.0 in 2015-16 to 9.8 in 2016-17. The percentage taking positions in North American non-Ph.D.-granting computing departments jumped from 1.6 percent in last year's report to 2.8 percent, while the percentage taking North American academic postdoctoral positions fell from 14.3 percent to 10.7 percent.

Among those whose employment is known, the proportion of Ph.D. graduates who were reported taking positions outside of North America was 7.2 percent, similar to last year's reported value. In 2016-17, 24 percent of those employed outside of North America went to industry. This is similar to the percentage reported for 2014-15, but lower than the 28 percent reported for 2015-16. About 30 percent went to tenure-track academic positions, similar to last year's 33 percent, while approximately 18 percent went to academic postdoctoral positions, compared with 15 percent last year. Of the doctoral graduates who went to non-North American industry positions, there was a much greater balance between research and non-research positions than was the case last year. Last year, the positions were in research by more than a three-to-one margin, while this year the positions still favored research, but by less than two-to-one. Definitive data was provided for 88 percent of these graduates.

When academic and industry postdocs are combined, the result is that 13.8 percent of 2016-17 doctoral graduates whose employment was known took some type of postdoctoral position. This is lower than the 16.6 percent reported last year. Thirteen percent of these were industry postdocs, an increase over last year's 8 percent, indicating that academic postdocs were the basis for the overall decline.

The unemployment rate for new Ph.D.s again this year was below 1 percent. In 2016-17, 22.7 percent of new Ph.D.s' employment status was unknown; in 2015-16 it was 20.6 percent. The lack of information about the employment of more than one in five graduates may skew the real overall percentages for certain employment categories.

Table D4 also indicates the areas of specialty of new Ph.D.s. Artificial intelligence/machine learning, software engineering, security/information assurance, networks, and databases are the most popular areas of specialization for doctoral graduates, in that order. These five areas comprise almost 39 percent of all the doctoral degrees produced in 2016-17. The hardware/architecture, HCI, and HPC areas showed decent increases in degree production. There are many Ph.D.s categorized as "other," which includes "unknown." It is unclear how many of these are really "other" and how many were just not categorized.

Table M1. Master's Degrees Awarded by Department Type

Department Type	# Depts	CS		CE		I		Total	
US CS Public	97	7,388	56.7%	372	40.9%	1,005	30.4%	8,765	50.8%
US CS Private	35	5,095	39.1%	81	8.9%	534	16.2%	5,710	33.1%
Total US CS	132	12,483	95.8%	453	49.8%	1,539	46.6%	14,475	83.9%
US CE	6	0	0.0%	448	49.2%	0	0.0%	448	2.6%
US Info	12	39	0.3%	0	0.0%	1,763	53.4%	1,802	10.4%
Canadian	11	515	4.0%	9	1.0%	0	0.0%	524	3.0%
Grand Total	161	13,037		910		3,302		17,249	

Table M2. Master's Degrees Awarded by Gender

	CS		CE		I		Total	
Male	8,956	73.9%	710	78.0%	1,690	54.3%	11,356	70.4%
Female	3,162	26.1%	200	22.0%	1,422	45.7%	4,784	29.6%
Total Known Gender	12,118		910		3,112		16,140	
Gender Unknown	919		0		190		1,109	
Grand Total	13,037		910		3,302		17,249	

Table M3. Master's Degrees Awarded by Ethnicity

	CS		CE		I		Total	
Nonresident Alien	8,813	73.8%	675	76.1%	1,589	49.9%	11,077	69.2%
Amer Indian or Alaska Native	23	0.2%	0	0.0%	2	0.1%	25	0.2%
Asian	921	7.7%	41	4.6%	252	7.9%	1,214	7.6%
Black or African-American	111	0.9%	9	1.0%	137	4.3%	257	1.6%
Native Hawaiian/Pac Island	3	0.0%	1	0.1%	2	0.1%	6	0.0%
White	1,842	15.4%	126	14.2%	1,040	32.7%	3,008	18.8%
Multiracial, not Hispanic	62	0.5%	10	1.1%	58	1.8%	130	0.8%
Hispanic, any race	173	1.4%	25	2.8%	102	3.2%	300	1.9%
Total Residency & Ethnicity Known	11,948		887		3,182		16,017	
Resident, ethnicity unknown	307		12		89		408	
Residency unknown	782		11		31		824	
Grand Total	13,037		910		3,302		17,249	

Table M4. Master's Degrees Expected Next Year by Department Type

Department Type	# Depts	CS		CE		I		Total	
US CS Public	89	5,863	54.7%	163	26.4%	504	19.0%	6,530	46.7%
US CS Private	31	4,305	40.1%	102	16.5%	405	15.3%	4,812	34.4%
Total US CS	120	10,168	94.8%	265	42.9%	909	34.3%	11,342	81.0%
US CE	6	0	0.0%	343	55.5%	0	0.0%	343	2.5%
US Info	11	35	0.3%	0	0.0%	1,744	65.7%	1,779	12.7%
Canadian	11	523	4.9%	10	1.6%	0	0.0%	533	3.8%
Grand Total	148	10,726		618		2,653		13,997	

Table M5. New Master's Students by Department Type

Department Type	CS			CE			I			Total			Outside North America	
	Total	# Depts	Avg. per Dept.	Total	# Depts	Avg. per Dept.	Total	# Depts	Avg. per Dept.	Total	# Depts	Avg. per Dept.	# Depts	%
US CS Public	7,994	96	83.3	301	17	17.7	797	10	79.7	9,092	96	94.7	5,714	62.8%
US CS Private	4,176	33	126.5	99	5	19.8	366	5	73.2	4,641	33	140.6	3,016	65.0%
Total US CS	12,170	129	94.3	400	22	18.2	1,163	15	77.5	13,733	129	106.5	8,730	63.6%
US CE	0	0	0.0	382	6	63.7	0	0	0.0	382	6	63.7	297	77.7%
US Info	18	1	18.0	0	0	0.0	1,651	12	137.6	1,669	12	139.1	714	42.8%
Canadian	679	11	61.7	9	1	9.0	0	0	0.0	688	11	62.5	295	42.9%
Grand Total	12,867	141	91.3	791	29	27.3	2,814	27	104.2	16,472	158	104.3	10,036	60.9%

Master's and Bachelor's Degree Production and Enrollments

This section reports data about enrollment and degree production for master's and bachelor's programs in the doctoral-granting departments. Although the absolute number of degrees and enrolled students reported herein only reflect departments that offer the doctoral degree, the trends observed in the master's and bachelor's data from these departments tend to strongly reflect trends in the larger population of programs that offer such degrees.

Master's

(Tables M1-M8; Figures M1-M2)

On a per department basis, CS master's degree production in U.S. CS departments rose over 19 percent in 2016-17; this follows approximately 17 and 25 percent increases in the previous two years. Both public and private departments again reported large increases.

Table M6. Total Master's Enrollment by Department Type

Department Type	CS			CE			I			Total		
	Total	# Depts	Avg. per Dept.	Total	# Depts	Avg. per Dept.	Total	# Depts	Avg. per Dept.	Total	# Depts	Avg. per Dept.
US CS Public	16,425	96	171.1	769	21	36.6	2,325	14	166.1	19,519	96	203.3
US CS Private	10330	34	303.8	322	6	53.7	1938	6	323.0	12590	35	359.7
Total US CS	26,755	130	205.8	1,091	27	40.4	4,263	20	213.2	32,109	131	245.1
US CE	0	0	0.0	974	7	139.1	0	0	0.0	974	7	139.1
US Info	74	1	74.0	0	0	0.0	4095	12	341.3	4169	12	347.4
Canadian	1237	11	112.5	27	1	27.0	0	0	0.0	1264	11	114.9
Grand Total	28,066	142	197.6	2,092	35	59.8	8,358	32	261.2	38,516	161	239.2

Table M7. Masters Degrees Awarded by Gender and Ethnicity, From 163 Departments Providing Breakdown Data

	CS					CE					I					Ethnicity Totals	
	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Total	%
Nonresident Alien	6,094	2,462	257	71	81	514	161	0	74	83	923	595	71	57	43	11,077	69.2
Amer Indian or Alaska Native	13	10	0	0	0	0	0	0	0	0	1	1	0	0	0	25	0.2
Asian	641	272	8	7	9	31	10	0	5	5	137	109	6	8	8	1214	7.6
Black or African-American	87	24	0	1	1	8	1	0	1	1	68	61	8	4	4	257	1.6
Native Hawaiian/ Pac Islander	3	0	0	0	0	1	0	0	0	0	1	0	1	0	0	6	0.0
White	1,579	250	13	18	8	110	16	0	16	8	436	529	75	27	38	3,008	18.8
Multiracial, not Hispanic	51	9	2	1	0	8	2	0	1	1	19	34	5	1	3	130	0.8
Hispanic, any race	139	32	2	2	1	22	3	0	3	2	46	49	7	3	4	300	1.9
Total Res & Ethnicity Known	8,607	3,059	282			694	193	0			1,631	1,378	173			16,017	
Resident, ethnicity unknown	228	61	18			8	4	0			47	42	0			408	
Not Reported (N/R)	121	42	619			8	3	0			12	2	17			824	
Gender Totals	8,956	3,162	919			710	200	0			1,690	1,422	190			17,249	
%	73.9%	26.1%				78.0%	22.0%				54.3%	45.7%					

* % of M and % of F columns are the percent of that gender who are of the specified ethnicity, of those whose ethnicity is known

Table M8. Masters Enrollment by Gender and Ethnicity, From 162 Departments Providing Breakdown Data

	CS					CE					I					Ethnicity Totals	
	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Total	%
Nonresident Alien	11,231	5,183	196	61	78	1,082	354	83	73	82	1,864	1,298	94	50	40	21,385	61.5
Amer Indian or Alaska Native	16	3	0	0	0	1	0	0	0	0	1	4	2	0	0	27	0.1
Asian	1793	620	18	10	9	81	27	0	5	6	319	205	16	9	6	3,079	8.9
Black or African-American	341	81	2	2	1	22	4	0	2	1	232	182	19	6	6	883	2.5
Native Hawaiian/ Pac Islander	5	1	0	0	0	0	0	0	0	0	3	8	0	0	0	17	0.0
White	4,335	661	78	24	10	236	33	1	16	8	1,098	1,349	171	29	42	7,962	22.9
Multiracial, not Hispanic	191	38	2	1	1	6	6	0	0	1	50	65	4	1	2	362	1.0
Hispanic, any race	532	95	9	3	1	63	10	0	4	2	166	140	21	4	4	1,036	3.0
Total Res & Ethnicity Known	18,444	6,682	305			1,491	434	84			3,733	3,251	327			34,751	
Resident, ethnicity unknown	950	258	12			15	3	1			217	162	14			1632	
Not Reported (N/R)	715	230	470			27	16	21			1	0	653			2,133	
Gender Totals	20,109	7,170	787			1,533	453	106			3,951	3,413	994			38,516	
%	73.7%	26.3%				77.2%	22.8%				53.7%	46.3%					
* % of M and % of F columns are the percent of that gender who are of the specified ethnicity, of those whose ethnicity is known																	

Overall production of master's degrees in the CE and Information areas also rose in 2015-16. Canadian departments showed a decline in master's production (Table M1).

The proportion of female graduates among CS master's degree recipients rose from 25.2 percent to 26.1 percent. The CE area also showed a small increase in gender diversity. The overall percentage of master's degrees to women increased only 0.2 to 29.6 percent, due to a drop in the I area from 47.9 percent to 45.7 percent (Table M2).

In CS, 73.8 percent of master's degrees went to Non-resident Aliens, a dip from the 75.6 percent in 2015-16. The CE area showed a bit of an increase, from 73.6 percent to 76.1 percent, while in the Information area, the percentage of the master's recipients that were Non-resident Aliens remained steady at 49.9 percent. The CS decline in non-resident Alien percentage was offset by slight gains by Whites and resident Asians. The percentage of master's recipients among American Indian/ Alaska Native, Black/African-American, Native Hawaiian/Pacific Islander, Hispanic, and Multiracial in CS was approximately 3 percent in 2016-17, similar to that reported last year. This percentage dropped in the I area from 10.6 percent to 9.5 percent (Table M3).

Non-resident Aliens again comprised a much larger proportion of female CS and CE degree recipients than male CS and CE degree recipients, while Whites again comprised a larger percentage of male CS and CE degree recipients than female CS and CE degree recipients (Table M7). In the I area, Non-resident Aliens again comprised a larger percentage of male master's graduates than female master's graduates, and Whites comprised a smaller fraction of male master's graduates than female master's graduates. The current enrollment breakdown by gender and ethnicity (Table M8) suggests that these observations will continue to be reflected in master's recipients in the near future.

The average number of new master's students enrolled in U.S. CS departments rose again this year, from 89.1 to 106.5. Once again, U.S. CS departments at both public and private institutions experienced increases (Table M5).

The fraction of new master's students in U.S. CS departments that is reported to be from outside North America dropped to 63.6 percent in 2017-18 from 67.5 percent in 2016-17 (Table M5). The fraction of new master's students at U.S. CS institutions is approximately at the level from 2015-16. This year's decrease was in departments at public institutions; private institutions showed an increase from 60.8 percent

Figure M1. Master's Degrees Granted by Tenure-Track Size

CRA Taulbee Survey 2017

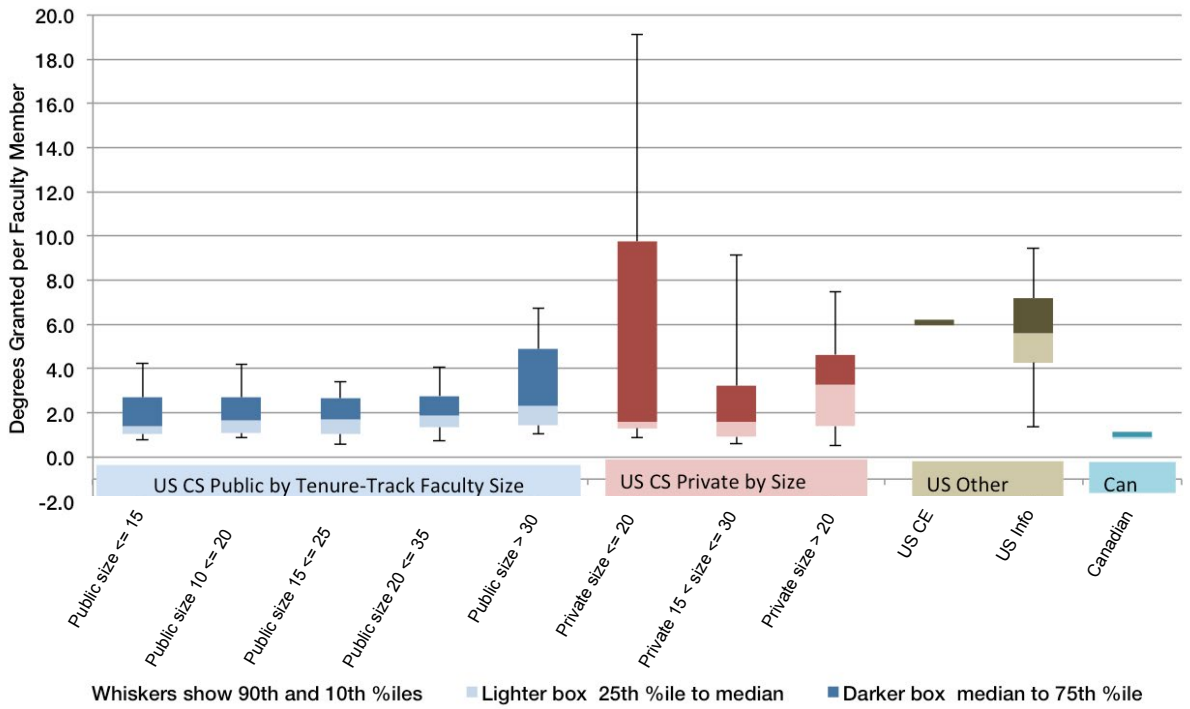
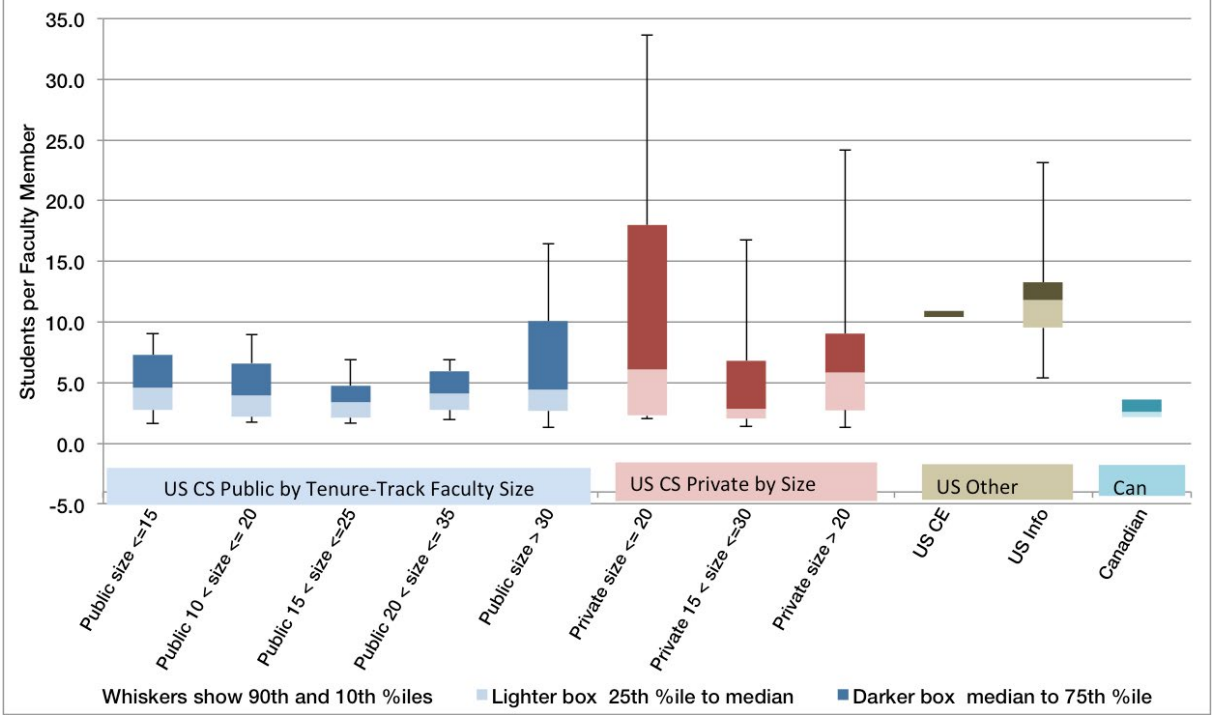


Figure M2. Master's Enrollment Normalized by Tenure-Track Size

CRA Taulbee Survey 2017



to 65.0 percent. At U.S. Information departments, the fraction of new master's students from outside North America dropped from 49.3 percent to 42.8 percent, following a large increase last year.

Bachelor's

(Tables 1, B1-B8; Figures B1-B4)

Bachelor's degree production continues its upward trend, with double-digit percentage increases for the fourth consecutive year. Overall degree production, aggregated across all three areas of computing, is 15.3 percent higher at this year's reporting departments than it was at last year's reporting departments. In U.S. CS departments, the increase is 17.3 percent. When considering only those departments that reported both years, the increase was 16.8 percent for all departments and 18.0 percent for U.S. CS departments (Table 1). When only the CS area is considered, bachelor's degree production per department increased 21.2 percent at U.S. CS departments, and it increased 17.1 percent among all reporting departments (Table B1).

Figure B1 shows the trend in total computing bachelor's degree production since 1995 for all departments reporting to the Taulbee

Table B1. Bachelor's Degrees Awarded by Department Type

Department Type	# Depts	CS		CE		I		Total	
US CS Public	96	15,345	68.7%	1,910	64.5%	1,869	43.6%	19,124	64.6%
US CS Private	35	4,562	20.4%	277	9.4%	328	7.7%	5,167	17.5%
Total US CS	131	19,907	89.1%	2,187	73.9%	2,197	51.3%	24,291	82.1%
US CE	6	0	0.0%	756	25.5%	0	0.0%	756	2.6%
US Info	10	129	0.6%	0	0.0%	1,738	40.6%	1,867	6.3%
Canadian	10	2,307	10.3%	17	0.6%	349	8.1%	2,673	9.0%
Grand Total	157	22,343		2,960		4,284		29,587	

Table B2. Bachelor's Degrees Awarded by Gender

	CS		CE		I		Total	
Male	17,252	81.0%	2,551	87.4%	3,159	75.0%	22,962	80.8%
Female	4,036	19.0%	369	12.6%	1,054	25.0%	5,459	19.2%
Total Known Gender	21,288		2,920		4,213		28,421	
Gender Unknown	1,055		40		71		1,166	
Grand Total	22,343		2,960		4,284		29,587	

Table B3. Bachelor's Degrees Awarded by Ethnicity

	CS		CE		I		Total	
Nonresident Alien	2,205	12.5%	344	13.7%	304	8.2%	2,853	12.0%
Amer Indian or Alaska Native	42	0.2%	20	0.8%	21	0.6%	83	0.3%
Asian	4,564	25.9%	602	24.0%	629	16.9%	5,795	24.3%
Black or African-American	547	3.1%	88	3.5%	258	6.9%	893	3.7%
Native Hawaiian/Pac Islander	45	0.3%	4	0.2%	49	1.3%	98	0.4%
White	8,402	47.6%	1,174	46.8%	1,893	51.0%	11,469	48.1%
Multiracial, not Hispanic	511	2.9%	64	2.5%	159	4.3%	734	3.1%
Hispanic, any race	1,322	7.5%	215	8.6%	401	10.8%	1,938	8.1%
Total Residency & Ethnicity Known	17,638		2,511		3,714		23,863	
Resident, ethnicity unknown	1,385		69		127		1,581	
Residency unknown	3,320		380		443		4,143	
Grand Total	22,343		2,960		4,284		29,587	

Table B4. Bachelor's Degrees Expected Next Year by Department Type

Department Type	# Depts	CS		CE		I		Total	
US CS Public	88	15,261	63.9%	1,793	61.9%	1,471	45.9%	18,525	61.7%
US CS Private	31	5,103	21.4%	325	11.2%	230	7.2%	5,658	18.9%
Total US CS	119	20,364	85.2%	2,118	73.1%	1,701	53.0%	24,183	80.6%
US CE	6	0	0.0%	728	25.1%	0	0.0%	728	2.4%
US Info	10	140	0.6%	0	0.0%	1,506	47.0%	1,646	5.5%
Canadian	10	3,393	14.2%	51	1.8%	0	0.0%	3,444	11.5%
Grand Total	145	23,897		2,897		3,207		30,001	

Table B5. New Bachelor's Students by Department Type

	CS				CE				I				Total	
Department Type	Major	Pre-Major	# Depts	Avg. Major /Dept	Total	Pre-Major	# Depts	Avg. Major /Dept	Total	Pre-Major	# Depts	Avg. Major /Dept	Total Major	Avg. Major /Dept
US CS Public	20,457	7,467	87	235.1	2,468	956	27	91.4	1,111	408	19	58.5	24,036	276.3
US CS Private	6,004	1,691	26	230.9	334	55	8	41.8	360	13	5	72.0	6,698	257.6
US CS Total	26,461	9,158	113	234.2	2,802	1,011	35	80.1	1,471	421	24	61.3	30,734	272.0
US CE	0	0	0	0.0	707	356	6	117.8	0	0	0	0.0	707	117.8
US Information	275	0	1	275.0	0	0	0	0.0	885	132	10	88.5	1,160	116.0
Canadian	3,301	1,123	9	366.8	0	0	0	0.0	0	0	0	0.0	3,301	366.8
Grand Total	30,037	10,281	123	244.2	3,509	1,367	41	85.6	2,356	553	34	69.3	35,902	260.2

Table B6. Total Bachelor's Enrollment by Department Type

	CS				CE				I				Total	
Department Type	Major	Pre-Major	# Depts	Avg. Major /Dept	Total	Pre-Major	# Depts	Avg. Major /Dept	Total	Pre-Major	# Dept	Avg. Major /Dept	Total Major	Avg. Major /Dept
US CS Public	81,200	17,215	96	845.8	9,699	1,830	33	293.9	8,905	738	23	387.2	99,804	1039.6
US CS Private	25,087	3,169	34	737.9	1,085	113	10	108.5	1,763	90	6	293.8	27,935	798.1
US CS Total	106,287	20,384	130	817.6	10,784	1,943	43	250.8	10,668	828	29	367.9	127,739	975.1
US CE	0	0	0	0.0	4,210	1,089	7	601.4	0	0	0	0.0	4,210	601.4
US Info	799	0	1	799.0	0	0	0	0.0	5,335	1,346	12	444.6	6,134	511.2
Canadian	13,503	3,515	10	1350.3	175	0	1	175.0	1,849	0	1	1849.0	15,527	1552.7
Grand Total	120,589	23,899	141	855.2	9,699	1,830	33	293.9	17,852	2,174	42	425.0	153,610	960.1

Survey. Double-digit percentage increases in CS bachelor's degree production are likely to continue for the next few years based on current enrollments.

For the tenth consecutive year, there was an increase in the number of new undergraduate computing majors despite the capacity pressures facing departments. This year's respondents reported 11.4 percent more new majors, with an average of 10.6 percent more per department than did last year's respondents (Table B5). The increase is only 3.8 percent when considering only those departments reporting both this year and last year. Among U.S. computer science departments, the increase was 12.7 percent overall (11.8 percent per department), and 4.3 percent among departments reporting both this year and last year. If only increases in new CS majors at U.S. CS departments are considered, the average

Table B7. Bachelors Degrees Awarded by Gender and Ethnicity, From 156 Departments Providing Breakdown Data

	CS					CE					I					Ethnicity Totals	
	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Total	%
Nonresident Alien	1,673	529	3	12	17	289	55	0	13	17	202	102	0	7	11	2,853	12.0
Amer Indian or Alaska Native	34	8	0	0	0	15	5	0	1	2	11	10	0	0	1	83	0.3
Asian	3,415	1,104	29	24	35	494	105	3	23	32	427	202	0	15	22	5,795	24.3
Black or African-American	448	93	5	3	3	72	16	0	3	5	185	73	0	7	8	893	3.7
Native Hawaiian/ Pac Islander	38	7	0	0	0	3	1	0	0	0	45	4	0	2	0	98	0.4
White	7,143	1,110	57	50	35	1,053	113	8	49	35	1,500	393	0	54	43	11,469	48.1
Multiracial, not Hispanic	361	147	3	3	5	54	10	0	3	3	104	54	1	4	6	734	3.1
Hispanic, any race	1,082	200	7	8	6	191	20	4	9	6	325	76	0	12	8	1,938	8.1
Total Res & Ethnicity Known	14,194	3,198	104			2,171	325	15			2,799	914	1			23,863	
Resident, ethnicity unknown	839	251	2			60	9	0			99	26	2			1,581	
Not Reported (N/R)	1,867	504	949			320	35	25			261	114	68			4,143	
Gender Totals	17,252	4,036	1,055			2,551	369	40			3,159	1,054	71			29,587	
%	81.0%	19.0%				87.4%	12.6%				75.0%	25.0%					

* % of M and % of F columns are the percent of that gender who are of the specified ethnicity, of those whose ethnicity is known

Table B8. Bachelors Enrollment by Gender and Ethnicity, From 155 Departments Providing Breakdown Data

	CS					CE					I					Ethnicity Totals	
	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Total	%
Nonresident Alien	8,063	2,641	30	11	17	1,297	260	4	12	14	609	236	19	5	8	13,437	11.4
Amer Indian or Alaska Native	230	56	0	0	0	21	6	0	0	0	37	16	2	0	1	372	0.3
Asian	15,933	5,180	139	23	32	2,501	612	14	24	33	1,954	754	144	17	24	28,374	24.0
Black or African-American	2,997	803	21	4	5	426	118	9	4	6	900	301	127	8	10	5,945	5.0
Native Hawaiian/ Pac Islander	149	54	0	0	0	33	9	21	0	1	27	5	0	0	0	305	0.3
White	34,069	5,347	348	48	33	4,704	614	45	45	33	5,824	1,347	118	52	43	54,129	45.7
Multiracial, not Hispanic	2,142	537	21	3	3	355	64	13	3	3	346	127	22	3	4	3,753	3.2
Hispanic, any race	7,014	1,381	41	10	9	1,140	195	15	11	10	1,537	342	43	14	11	12,030	10.2
Total Res & Ethnicity Known	70,597	15,999	600			10,477	1,878	121			11,234	3,128	475			118,345	
Resident, ethnicity unknown	3,862	1,498	2,360			345	55	1			429	96	3			9,951	
Not Reported (N/R)	11,235	3,251	6,049			2,041	244	7			1,422	694	371			25,314	
Gender Totals	89,847	21,733	9,009			12,863	2,177	129			13,085	3,918	849			153,610	
%	80.5%	19.5%				85.5%	14.5%				77.0%	23.0%					

* % of M and % of F columns are the percent of that gender who are of the specified ethnicity, of those whose ethnicity is known

Table B9. Undergraduate Representative Course Enrollments 2015-2017, Department-Level Percentiles

Number of Students Reported				% Who Are Majors				% Who Are Women				% URM at Non-MSI			
Intro-Level for Non Majors															
(N=54)	2015	2016	2017	(N=37)	2015	2016	2017	(N=33)	2015	2016	2017	(N=23)	2015	2016	2017
25	74	77	76.75	25	0.9	0.4	0.3	25	26.6	26.1	33.4	25	11.1	8.8	12.0
50	182	207.5	210	50	3.5	3.5	2.7	50	38.6	38.2	40.6	50	15.9	12.5	15.8
75	347	382.5	343	75	16.6	16.6	11.9	75	49.7	45.8	48.0	75	22.9	23.8	23.7
Intro for Majors															
(N=55)	2015	2016	2017	(N=39)	2015	2016	2017	(N=33)	2015	2016	2017	(N=22)	2015	2016	2017
25	185	193	221	25	22.4	15.2	20.4	25	16.7	17.1	18.0	25	9.2	9.1	8.5
50	286	299	314	50	44.8	41.9	36.5	50	20.6	21.9	22.2	50	12.9	15.1	15.8
75	454	436	489	75	60.3	56.5	73.7	75	32.7	36.3	35.8	75	20.3	21.2	21.5
Mid-Level															
(N=54)	2015	2016	2017	(N=40)	2015	2016	2017	(N33)	2015	2016	2017	(N=21)	2015	2016	2017
25	85.75	107	113.5	25	45.2	43.5	39.0	25	13.2	14.5	15.1	25	7.4	8.2	9.5
50	134.5	151.5	176.5	50	62.2	60.8	57.2	50	17.4	20.0	19.2	50	12.6	11.3	13.6
75	260.25	294.25	355.75	75	81.7	86.1	83.2	75	25.1	26.7	28.1	75	17.8	18.6	20.8
Upper-Level															
(N=52)	2015	2016	2017	(N=38)	2015	2016	2017	(N=31)	2015	2016	2017	(N=21)	2015	2016	2017
25	56	54.5	67.25	25	60.9	69.3	63.5	25	8.8	10.8	11.5	25	3.6	4.0	7.0
50	100.5	123.5	132.5	50	82.0	82.2	86.5	50	14.1	16.0	17.6	50	10.2	8.9	10.8
75	186	194	191.5	75	95.4	97.6	96.3	75	23.9	23.1	29.9	75	18.0	20.2	19.4

Figure B1. BS Production (CS & CE)

CRA Taulbee Survey 2017

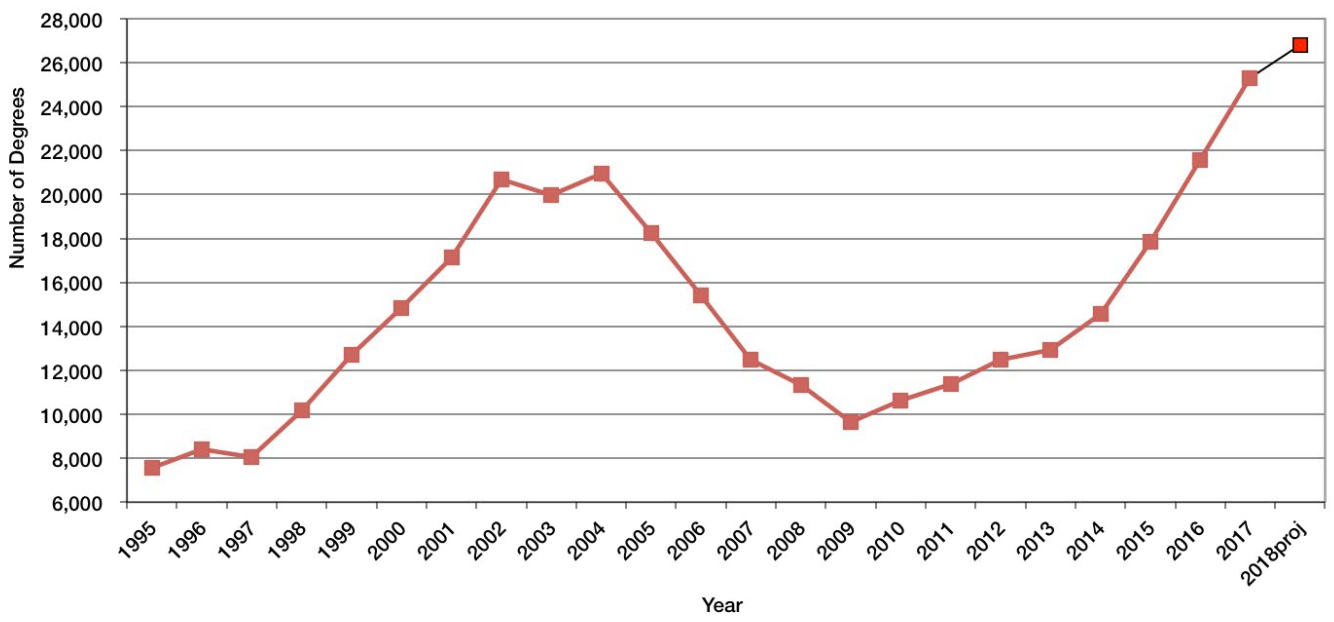


Figure B2. Newly Declared Undergraduate Majors: CS, CE, and I (beginning in 2008)

CRA Taulbee Survey 2017

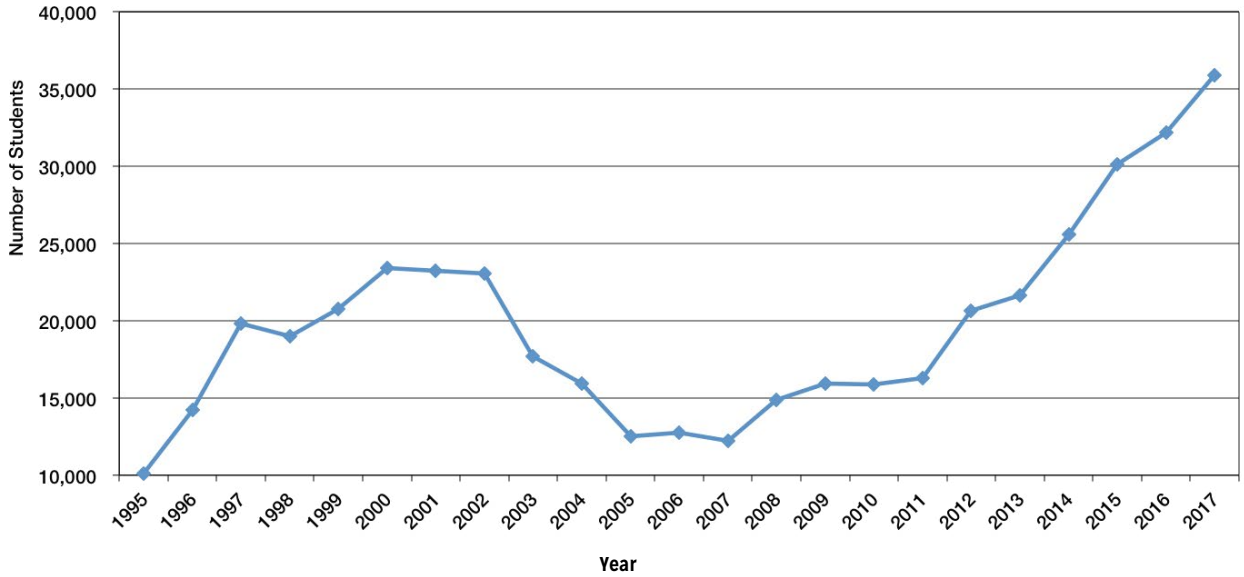


Figure B3. Bachelor's Degrees Granted by Tenure-Track Size

CRA Taulbee Survey 2017

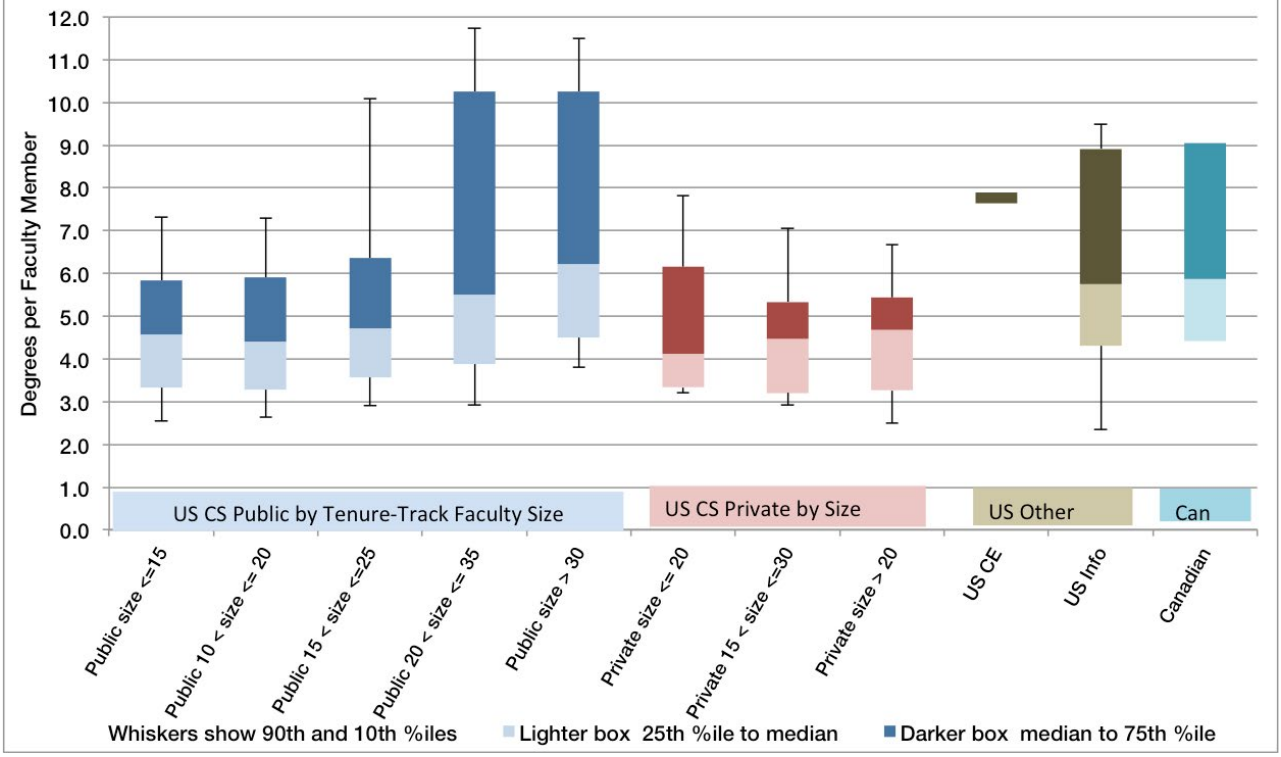


Figure B4. Bachelor's Enrollment Normalized by Tenure-Track Size

CRA Taulbee Survey 2017

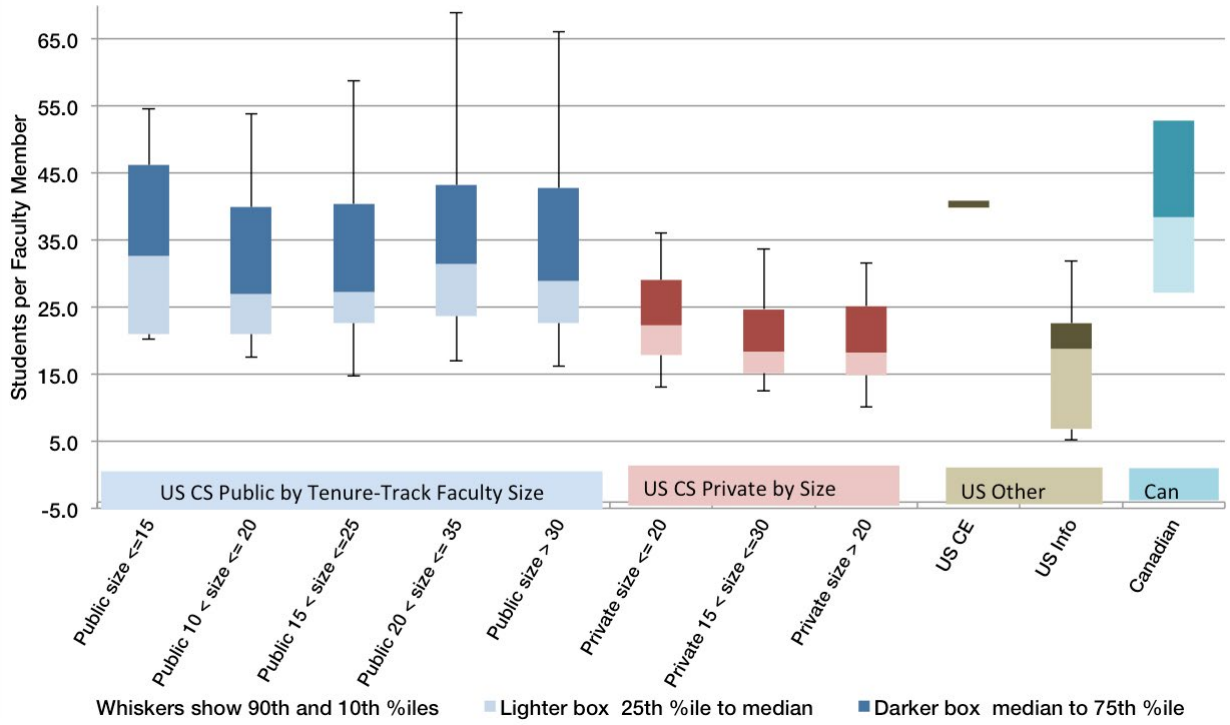


Figure B5. Average New and Continuing CS Majors per Academic Unit (U.S. CS Programs Only)

CRA Taulbee Survey 2017

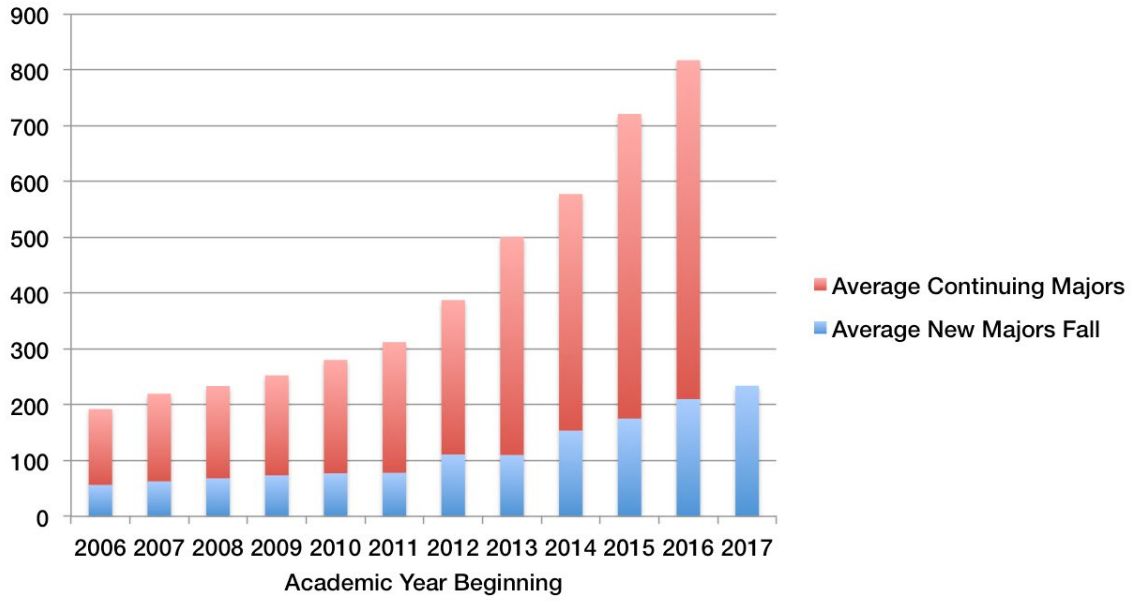


Table F1. Actual and Anticipated Faculty Size by Position and Department Type

	Actual		Projected				Expected 2-Yr Growth	
	2017-2018		2018-2019		2019-2020			
US CS Public	Total	Average	Total	Average	Total	Average	#	%
TenureTrack	2,970	30.0	3,161	31.9	3,264	33.0	294	9.9%
Teaching	707	8.2	763	9.0	812	9.6	105	14.9%
Research	258	5.0	277	5.2	296	5.5	38	14.7%
Postdoc	311	6.2	345	6.5	367	7.2	56	18.0%
Total	4,236	42.8	4,538	45.8	4,730	47.8	494	11.7%
US CS Private								
TenureTrack	1,206	33.5	1,280	35.5	1,358	37.7	152	12.6%
Teaching	240	8.3	274	9.4	299	10.3	59	24.6%
Research	150	8.3	157	8.7	170	9.4	20	13.3%
Postdoc	256	10.7	277	11.5	302	12.6	46	18.0%
Total	1,848	51.3	1,986	55.2	2,128	59.1	280	15.2%
All US CS								
TenureTrack	4,176	30.9	4,441	32.9	4,622	34.2	446	10.7%
Teaching	947	8.2	1,037	9.1	1,111	9.7	164	17.3%
Research	408	5.8	434	6.1	466	6.5	58	14.2%
Postdoc	567	7.7	622	8.1	669	8.9	102	18.0%
Total	6,084	45.1	6,524	48.3	6,858	50.8	774	12.7%
US CE								
TenureTrack	105	15.0	109	15.6	110	15.7	5	4.8%
Teaching	21	3.4	22	3.6	22	3.7	1	4.8%
Research	1	0.6	2	1.0	3	1.3	2	200.0%
Postdoc	6	2.1	8	2.7	10	3.2	4	66.7%
Total	132	18.9	140	20.0	144	20.6	12	9.1%
US I								
TenureTrack	356	25.4	379	27.1	397	28.4	41	11.5%
Teaching	141	10.8	155	11.9	168	12.9	27	19.1%
Research	16	2.6	17	2.8	19	3.1	3	18.8%
Postdoc	34	3.4	41	4.1	45	4.5	11	32.4%
Total	545	38.9	590	42.1	627	44.8	82	15.0%
Canadian								
TenureTrack	422	38.3	446	40.5	464	42.2	42	10.0%
Teaching	72	6.5	74	6.7	76	6.9	4	5.6%
Research	8	4.0	11	3.7	11	3.7	3	37.5%
Postdoc	83	10.4	92	11.5	96	12.0	13	15.7%
Total	584	53.1	622	56.5	646	58.7	62	10.6%
Grand Total								
TenureTrack	5,059	30.3	5,375	32.2	5,593	33.5	534	10.6%
Teaching	1,180	8.1	1,287	8.9	1,376	9.6	196	16.6%
Research	432	5.4	464	5.7	498	6.0	66	15.3%
Postdoc	691	7.3	763	7.8	819	8.5	128	18.5%
Total	7,345	44.0	7,876	47.2	8,275	49.6	930	12.7%

increase is 11.4 percent per department. Figure B2 illustrates the trend in the total number of newly declared computing undergraduate majors as reported in the Taulbee Survey. Total undergraduate enrollment in computing majors among U.S. CS departments (i.e., the sum of the number of majors in CS, CE, and I at these departments) increased 11.5 percent (also 11.5 percent per department) when all respondents are compared, and increased 10.8 percent among U.S. CS departments reporting both this year and last year. Total enrollment per department increased in all three computing areas (CS, CE, and I) (Table B6).

Per-department averages smooth out comparisons from year to year when there are differences in the number of reporting departments, but the averages include both very large and very small departments. Figures B3 and B4 show the distribution of number of degrees awarded (Figure B3) and total enrollment (Figure B4) per tenured or tenure-track faculty member, in department size groupings for the U.S. CS departments. Larger departments, both public and private, produce more bachelor's degrees per tenure-track faculty member than do smaller departments. Departments from private institutions enroll fewer bachelor's students per tenure-track faculty as faculty size increases. Departments from public institutions have a less clear relationship between faculty size and enrollment per tenure-track faculty member.

The enrollment increases in CS are of particular interest to our community. This year's Taulbee Survey data shows that the per-department enrollment of CS bachelor's majors in U.S. CS departments increased by 13.3 percent over last year. While understandably lower than the 24.8 percent reported last year, this increase is formidable given the sustained growth surge of more than decade and the capacity barriers that have caused several departments to limit entrance into the major. Figure B5 shows the enrollment trend from Taulbee Survey data since this surge began. The average enrollment per U.S. CS department has increased over 300 percent during this period; that is, it has more than quadrupled. For the past four years, it has exceeded the previous peak reached during the dot-com enrollment surge.

Another view of bachelor's enrollments can be gleaned from CS course-level data. Such data was first reported in CRA's Generation-CS report for the fall terms in 2005, 2010 and 2015. The Taulbee Survey began collecting follow-up data in the 2016 survey, and now does so annually. Table B9 shows the three-year enrollment trends for the four types of courses for which data is collected. Only those departments are included that reported data for each of the three years. The data indicate that, between fall 2015 and fall 2017, median enrollment in the introductory course for CS majors, a representative mid-level course, and a representative upper-level course each increased. The percentage increases were 9.8%, 31.2% and 31.8%, respectively. The table further

Table F2. Vacant Positions 2016-2017 by Position and Department Type

	Tried to fill	Filled
US CS Public		
TenureTrack	307	261
Teaching	167	147
Research	51	52
Postdoc	79	103
Total	604	563
US CS Private		
TenureTrack	127	99
Teaching	52	44
Research	21	21
Postdoc	90	88
Total	290	252
All US CS		
TenureTrack	434	360
Teaching	219	191
Research	72	73
Postdoc	169	191
Total	894	815
US CE		
TenureTrack	11	10
Teaching	11	11
Research	8	8
Postdoc	5	5
Total	35	34
US I		
TenureTrack	18	19
Teaching	15	14
Research	1	2
Postdoc	18	17
Total	52	50
Canadian		
TenureTrack	46	33
Teaching	12	10
Research	0	1
Postdoc	2	28
Total	59	71
Grand Total		
TenureTrack	509	421
Teaching	257	226
Research	81	84
Postdoc	194	241
Total	1,040	970

shows that the median percent of non-majors in both the introductory course for majors and the mid-level course increased during this period (as indicated by decreasing median percentages of majors). There are fewer data points for the representation of women and under-represented minority groups, and as yet no clear trends to report for the data we have obtained.

Gender diversity among bachelor's graduates in CS improved again this year, with women comprising 19.0 percent of the 2016-17 graduates, compared to 17.9 percent in 2015-16. In CE, the percentage of women among bachelor's graduates was steady at 12.6 percent and the percentage of women among I graduates rose from 22.9 percent to 25.0 percent (Table B2). The percentage of CS bachelor's degrees awarded to Whites again declined from 50.3 percent in 2015-16 to 47.6 percent in

Table F2a. Reasons Positions Left Unfilled

Reason	# Reported	% of Reasons
Didn't find a person who met our hiring goals*	19	14.3%
Offers turned down	69	51.9%
Technically vacant, not filled for admin reasons	3	2.3%
Hiring in progress	37	27.8%
Other	5	3.8%
Total Reasons Provided	133	
***What hiring goals could not be met?**		**# Given**
Specific specialty area not found (no two the same)		7
Poor qualifications for teaching faculty		2
Not right qualifications or complement to current faculty		4

Table F3. Gender of Newly Hired Faculty

	Tenure-Track		Teaching		Research		Postdoc		Total	
Male	313	79.2%	104	67.5%	28	66.7%	111	74.5%	556	75.1%
Female	82	20.8%	50	32.5%	14	33.3%	38	25.5%	184	24.9%
Unknown	1		0		0		8		9	
Total	396		154		42		157		749	

Table F4. Ethnicity of Newly Hired Faculty

	Tenure-Track		Teaching		Research		Postdoc		Total	
Nonresident Alien	47	13.5%	14	10.4%	3	7.9%	46	32.2%	110	16.6%
American Indian / Alaska Native	1	0.3%	1	0.7%	0	0.0%	3	2.1%	5	0.8%
Asian	102	29.4%	15	11.1%	13	34.2%	30	21.0%	160	24.1%
Black or African-American	6	1.7%	1	0.7%	1	2.6%	2	1.4%	10	1.5%
Native Hawaiian/ Pacific Islander	1	0.3%	0	0.0%	0	0.0%	0	0.0%	1	0.2%
White	145	41.8%	82	60.7%	18	47.4%	41	28.7%	286	43.1%
Multiracial, not Hispanic	1	0.3%	0	0.0%	0	0.0%	3	2.1%	4	0.6%
Hispanic, any race	9	2.6%	6	4.4%	1	2.6%	2	1.4%	18	2.7%
Resident, race/ethnic unknown	35	10.1%	16	11.9%	2	5.3%	16	11.2%	69	10.4%
Total known residency	347		135		38		143		663	
Residency Unknown	49		19		3		14		86	
Total	396		154		42		157		732	

2016-17, while the percentage awarded to Asians was up slightly, from 25.3 percent to 25.9 percent. The percentage awarded to Non-resident Aliens rose from 10.4 percent to 12.5 percent. Changes in other ethnicity categories were less than 1 percent in CS. In aggregate across the three areas of computing, 48.1 percent of the graduates were White, 24.3 percent Asian, 12.0 percent Non-resident Aliens, and 15.6 percent all other ethnicity categories combined. However, in I programs, the other ethnicity categories accounted for approximately 24 percent of the graduates (Table B3).

In all three computing areas (CS, CE, and I), Resident Asians and Non-resident Aliens once again comprise a larger fraction of female enrollment than male enrollment, while Whites comprise a larger fraction of male enrollment than female enrollment (Table B8). Table B7 indicates that the same comparisons hold true for degree awardees.

Table F5. Faculty Losses

Died	5
Retired	80
Took Academic Position Elsewhere	85
Took Nonacademic Position	26
Remained, but Changed to Part Time	12
Other	20
Unknown	6
Total	234

Faculty Demographics[4]

(Tables F1-F9; Figure F1)

Table F1 shows the current and anticipated sizes, in FTE, for tenure-track, teaching, and research faculty, and postdocs. The total tenure-track faculty count in U.S. CS departments increased by 5.2 percent over last year, and the average tenure-track faculty size increased by 5.1 percent. Both of these values are larger increases than last year (2.3 and 4.6 percent, respectively). In U.S. CS departments, the average number of teaching faculty increased from 7.7 to 8.2 (6.5 percent vs 11.6 percent last year) and the average number of research faculty is 5.8, vs 5.7 last year. The average number of postdocs increased from 6.5 to 7.7. Canadian, CE, and I departments have much more volatile data due to the small number of departments reporting in each of these categories.

Table F6. Gender of Current Faculty

	Full		Associate		Assistant		Teaching		Research		Postdoc		Total	
Male	2,051	84.9%	997	77.2%	920	76.8%	914	73.1%	360	80.0%	607	80.4%	5,849	79.5%
Female	365	15.1%	294	22.8%	278	23.2%	336	26.9%	90	20.0%	148	19.6%	1,511	20.5%
Unknown	66		28		21		38		4		35		192	
Total	2,482		1,319		1,219		1,288		454		790		7,552	

Table F7. Ethnicity of Current Faculty

	Full		Associate		Assistant		Teaching		Research		Postdoc		Total	
Nonresident Alien	22	1.0%	7	0.6%	139	12.6%	40	3.5%	59	13.9%	217	31.6%	484	7.1%
American Indian / Alaska Native	1	0.0%	4	0.3%	3	0.3%	2	0.2%	1	0.2%	0	0.0%	11	0.2%
Asian	609	26.9%	357	30.9%	327	29.6%	120	10.4%	73	17.2%	168	24.5%	1,654	24.4%
Black or African-American	22	1.0%	31	2.7%	35	3.2%	34	3.0%	2	0.5%	8	1.2%	132	1.9%
Native Hawaiian / Pacific Islander	1	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.1%	2	0.0%
White	1,447	63.9%	637	55.1%	511	46.2%	846	73.5%	258	60.8%	216	31.5%	3,915	57.7%
Multiracial, not Hispanic	11	0.5%	10	0.9%	10	0.9%	7	0.6%	1	0.2%	6	0.9%	45	0.7%
Hispanic, any race	44	1.9%	32	2.8%	21	1.9%	39	3.4%	15	3.5%	13	1.9%	164	2.4%
Resident, race/ethnic unknown	107	4.7%	79	6.8%	60	5.4%	63	5.5%	15	3.5%	57	8.3%	381	5.6%
Total known residency	2,264		1,157		1,106		1,151		424		686		6,788	
Residency Unknown	218		162		113		137		30		104		764	
Total	2,482		1,319		1,219		1,288		454		790		7,552	

Table F8. Current Tenured and Tenure-Track Faculty by Gender and Ethnicity, From 159 Departments

	Full Professor					Associate Professor					Assistant Professor					Ethnicity Totals	
	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Total	%
Nonresident Alien	17	5	0	1	2	7	0	0	1	0	104	29	0	13	12	168	3.9
Amer Indian or Alaska Native	1	0	0	0	0	2	2	0	0	1	1	2	0	0	1	8	0.2
Asian	525	78	0	29	25	256	98	0	31	38	250	77	0	32	30	1,293	30.2
Black or African-American	18	3	0	1	1	20	11	0	3	4	21	14	0	3	6	88	2.1
Native Hawaiian/ Pac Islander	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.0
White	1,220	220	0	67	70	495	137	1	61	54	385	123	0	49	49	2,595	60.6
Multiracial, not Hispanic	11	0	0	1	0	8	2	0	1	1	7	3	0	1	1	31	0.7
Hispanic, any race	33	10	0	2	3	27	5	0	3	2	16	5	0	2	2	97	2.3
Total Res & Ethnicity Known	1,826	316	0			815	255	1			784	253	0			4,281	
Resident, ethnicity unknown	83	20	0			59	17	0			43	13	0			246	
Not Reported (N/R)	126	26	66			113	22	27			82	10	21			493	
Gender Totals	2,051	365	66			997	294	28			920	278	21			5,020	
%	84.9%	15.1%				77.2%	22.8%				76.8%	23.2%					

* %M and %F columns are the percent of that gender who are of the specified ethnicity, of those whose ethnicity is known

Table F9. Current Non-Tenure-Track Faculty and Postdoctorates by Gender and Ethnicity, From 160 Departments

	Non-Tenure-Track Teaching					Non-Tenure-Track Research					Postdoctorates					Ethnicity Totals	
	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Male	Fem	N/R	% of M*	% of F*	Total	%
Nonresident Alien	29	8	0	4	3	43	13	0	13	17	184	31	0	36	26	316	15
Amer Indian or Alaska Native	1	1	0	0	0	0	1	0	0	1	0	0	0	0	0	3	0
Asian	78	41	0	10	14	59	14	0	18	18	137	31	0	27	26	361	17
Black or African-American	22	12	0	3	4	0	2	0	0	3	4	4	0	1	3	44	2
Native Hawaiian/ Pac Islander	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0
White	620	218	0	79	75	212	45	0	65	57	172	44	0	34	37	1,320	62
Multiracial, not Hispanic	5	2	0	1	1	1	0	0	0	0	3	3	0	1	3	14	1
Hispanic, any race	31	8	0	4	3	10	4	0	3	5	8	5	0	2	4	67	3
Total Res & Ethnicity Known	786	290	0			325	79	0			508	119	0			2,126	
Resident, ethnicity unknown	40	17	0			10	4	0			46	11	0			135	
Not Reported (N/R)	71	28	38			20	6	4			51	18	35			271	
Gender Totals	914	336	38			360	90	4			607	148	35			2,532	
%	73.1%	26.9%				80.0%	20.0%				80.4%	19.6%					

* %M and %F columns are the percent of that gender who are of the specified ethnicity, of those whose ethnicity is known

While the increases in both tenure-track and teaching faculty are no doubt welcome, they again lag the increases in undergraduate student enrollment, as reported in an earlier section. Figure F1 illustrates the comparative changes in enrollment and faculty since 2006, when the current enrollment surge began. This figure updates with recent years' data a figure from the Generation-CS report. Keeping instructional resources apace of enrollment increases remains a continuing challenge to the doctoral-granting departments.

As noted in previous Taulbee reports, Canadian universities, on average, have several more tenure-track faculty members per department than do U.S. universities, while U.S. I and CE departments, on average, are somewhat smaller than U.S. CS departments. The observations about U.S. CE and I departments may reflect the fact that we ask departments to report only computing-related faculty, so departments with Library Science or EE programs may report only part of their faculty.

Among U.S. CS departments, those at private universities have more of each category of faculty, including postdocs, than do those at public universities on average. However, there now is little difference in the average number of teaching faculty at publics and privates. The average tenure-track size at private universities rose from 30.9 to 33.5 while the average number of teaching faculty declined from 8.7 to 8.3. At the public universities, both the average tenure-track size and the average teaching faculty size increased. The specific set of departments reporting from one year to the next can impact these figures.

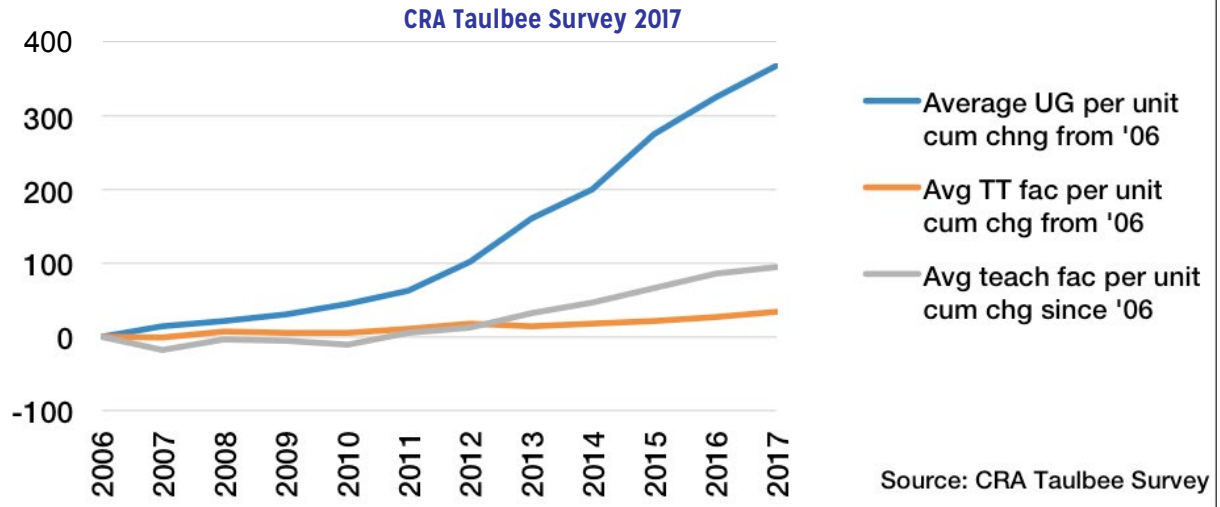
Table F2 summarizes faculty hiring this past year. The success rate for hiring tenure-track faculty at U.S. CS departments rose quite a bit this year, from 72.7 percent last year to 82.9 percent this year. The success rate among departments at public universities was higher than that at private universities (85.2 percent vs 78.0 percent). Again this year, Canadian departments had lower success rates, on average, than did U.S. CS, CE, and I departments. In aggregate across all types of departments, the tenure-track hiring success rate increased from 71.9 percent to 82.7 percent.

Among those hired into all categories of academic positions (tenure-track, teaching faculty, research faculty, and postdoc) for 2016-17, 24.9 percent were women, similar to last year's percentage (Table F3). However, among those newly hired into tenure-track positions, the proportion of women declined from 24.3 percent last year to 20.8 percent this year. This year's figure is still slightly higher than that of two years ago. The percentage of positions going to women in each of the teaching faculty, research faculty, and postdoctoral positions rose as compared with those reported last year. Both the percentage of women among new tenure-track faculty hires and among newly hired faculty overall are once again higher than the percentage of new female Ph.D.s produced this past year.

Among new tenure-track faculty, the fraction who are White again declined slightly, from 43.8 percent to 41.8 percent, while the fraction who are Non-resident Alien or Asian new hires declined from 47.7 percent to 42.9 percent. This year, there was a larger fraction of new hires who are residents with unknown race. Once again, Whites dominated the newly hired teaching faculty, with Asians and Non-resident Aliens accounting for much of the remainder (and an even larger part of the remainder than was the case last year). Among research faculty, Whites comprised 47.4 percent of new hires, while Non-resident Aliens or resident Asians in aggregate comprised 42.1

Figure F1. Comparative Change in Majors and Instructional Resources per Unit

CRA Taulbee Survey 2017



percent of new hires. Both figures are higher than those reported last year. Among postdoc new hires, Whites comprised 28.7 percent, compared to 29.3 percent last year, while Non-resident Aliens and resident Asians collectively comprised 53.2 percent compared with 62.1 percent last year. Note, however, that the fraction of new postdocs who are residents with ethnicity unknown is greater than that reported last year (Table F4).

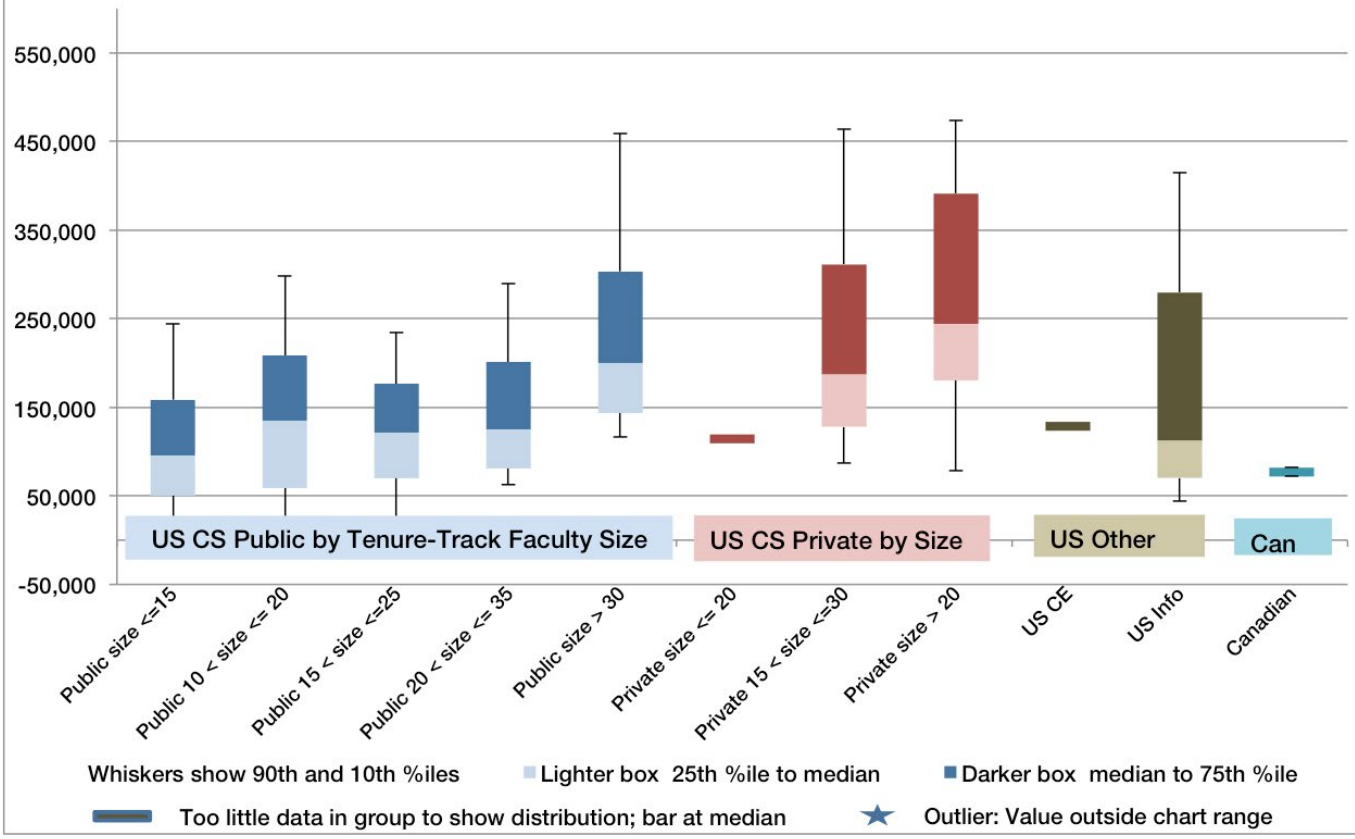
Since 2015, the Taulbee Survey has been collecting information on the number of new faculty hires who had been postdocs in the previous year. In 2015, the departments reporting to the survey hired 233 new assistant professors. Of those, 78 (33 percent) had received their Ph.D. in the previous academic year, and 72 (31 percent) had previously been in a postdoc. In 2016, 279 new assistant professors were hired, 87 of whom were new Ph.D.s (31 percent) and 86 of whom were recent postdocs (also 31 percent). In 2017, 298 new assistant professors were hired, 91 of whom (31 percent) were new Ph.D.s and 63 of whom (21 percent) were recent postdocs. The percent of new hires who are new Ph.D.s has been relatively constant, but this year, the percent who were recent postdocs dropped quite a bit. This suggests that more of the new

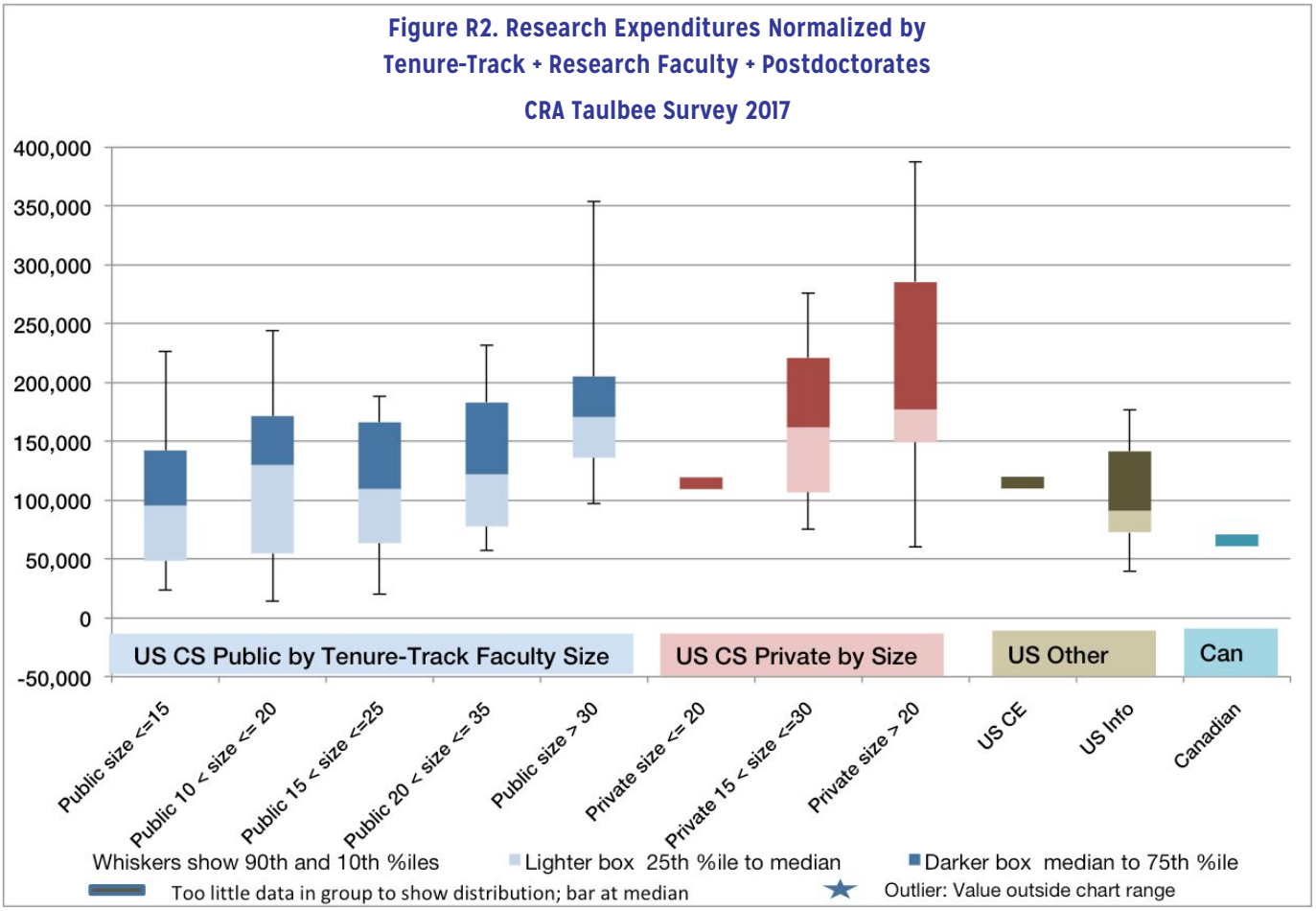
Table R1. Total Expenditure from External Sources for Computing Research

Department Type	# Depts	10th	25th	50th	75th	90th
US CS Public	85	$501,735	$1,957,603	$4,054,147	$7,983,775	$17,096,345
US CS Private	26	$1,996,536	$3,190,845	$7,466,028	$11,814,182	$18,864,715
US CE	6		$1,180,526	$2,090,478	$2,978,273	
US Information	13	$1,081,357	$2,078,548	$2,808,247	$3,913,548	$4,925,074
Canadian	6		$754,225	$1,871,107	$5,624,497	

Figure R1. Research Expenditures Normalized by Tenure-Track Size

CRA Taulbee Survey 2017





assistant professor hires are coming from other institutions or from industry. From other data in the Taulbee Survey, we note that a greater percentage of new doctoral graduates have been taking teaching faculty positions. It is possible that some of these are short-term, full-time appointments at the institution in which the student graduated, prior to taking a tenure-track position elsewhere. However, we have no definitive data to support this conjecture.

There were fewer faculty losses reported this year as compared with last year (Table F5). Reported deaths, retirements and faculty taking non-academic positions each were lower than last year, while movement from one academic position to another was comparable to last year.

The proportion of women at the full and associate professor ranks rose slightly from those reported last year, while the proportion at the assistant professor level dropped slightly (Table F6). There was a slight increases in the proportion of women among research faculty, while there was a slight decrease in the proportion of women among teaching faculty and postdocs. This is the reverse of what happened last year, but is the same as what happened two years ago. Whites, Asians, and Non-resident Aliens dominate each category of faculty members (Table F7).

Among the 163 departments who report gender by ethnicity breakdowns (which represents the vast majority of departments), Whites again comprised a greater percentage of female full professors than they do male full professors, while the reverse is true at the associate professor level. Asians comprise a greater percentage of male full professors than they do female full professors while the reverse is true at the associate professor level (Table F8).

For next year, U.S. CS departments forecast an average 6.5 percent growth in tenure-track faculty and 11.0 percent growth in teaching faculty. They also forecast an average 5.2 percent growth in postdocs. The departments missed last year's expectations for both tenure-track and research faculty hiring. They exceeded their expectations for postdoc hiring.

Non-Tenure-Track Teaching Faculty

The 2016 Taulbee Survey contained several questions about non-tenure-track teaching faculty to help CRA decide what, if anything, the survey should collect differently about those faculty.

The majority of responding units (61 percent) were interested in having the Taulbee Survey provide more fine-grained information about non-tenure-track teaching faculty. To further probe the landscape of teaching faculty, CRA formed a special committee that conducted a targeted survey about teaching faculty during fall of 2017. The results of this survey are now being analyzed and are expected to inform the 2018 Taulbee Survey.

Research Expenditures

(Table R1; Figures R1-R2)

Table R1 shows the distribution of departments' total research expenditure (including indirect costs or "overhead" as stated on project budgets) from external sources of support. Figures R1 and R2 show the per capita expenditure, where capitation is computed two ways. The first (Figure R1) is relative to the number of tenure-track faculty members. The second (Figure R2) is relative to research faculty and postdocs as well as tenure-track faculty. Canadian levels are shown in Canadian dollars.

Table G1. Doctoral Students Supported as Full-Time Students by Department Type

		On Institutional Funds						On External Funds						Total
Department Type	# Dept	Teaching Assistants		Research Assistants		Full-Support Fellows		Teaching Assistants		Research Assistants		Full-Support Fellows		
US CS Public	93	3,188.1	39.5%	1,034.0	12.8%	412.5	5.1%	13.4	0.2%	3,198.6	39.7%	217.5	2.7%	8,064.1
US CS Private	32	1,126.0	29.4%	432.0	11.3%	271.0	7.1%	10.0	0.3%	1,870.0	48.7%	127.0	3.3%	3,836.0
US CS Total	125	4,314.1	36.3%	1,466.0	12.3%	683.5	5.7%	23.4	0.2%	5,068.6	42.6%	344.5	2.9%	11,900.1
US CE	6	143.0	41.2%	152.0	43.8%	11.0	3.2%	0.0	0.0%	41.0	11.8%	0.0	0.0%	347.0
US I	14	204.3	38.9%	64.8	12.3%	30.0	5.7%	0.2	0.0%	204.7	39.0%	21.0	4.0%	525.0
Canadian	9	307.5	52.8%	95.0	16.3%	6.0	1.0%	0.0	0.0%	174.0	29.9%	0.0	0.0%	582.5
Grand Total	154	4,968.9	37.2%	1,777.8	13.3%	730.5	5.5%	23.6	0.2%	5,488.3	41.1%	365.5	2.7%	13,354.6

Table G1a. Master's Students Supported as Full-Time Students by Department Type

		On Institutional Funds						On External Funds						Total
Department Type	# Dept	Teaching Assistants		Research Assistants		Full-Support Fellows		Teaching Assistants		Research Assistants		Full-Support Fellows		
US CS Public	72	1,400.7	67.6%	196.8	9.5%	7.0	0.3%	5.0	0.2%	417.1	20.1%	47.0	2.3%	2,073.5
US CS Private	18	100.0	63.7%	29.0	18.5%	3.0	1.9%	1.0	0.6%	19.0	12.1%	5.0	3.2%	157.0
US CS Total	90	1,500.7	67.3%	225.8	10.1%	10.0	0.4%	6.0	0.3%	436.1	19.6%	52.0	2.3%	2,230.5
US CE	7	44.0	65.7%	21.0	31.3%	0.0	0.0%	0.0	0.0%	2.0	3.0%	0.0	0.0%	67.0
US I	10	61.2	34.5%	18.6	10.5%	47.0	26.5%	1.8	1.0%	47.0	26.5%	2.0	1.1%	177.5
Canadian	7	338.5	59.6%	77.0	13.6%	7.0	1.2%	0.0	0.0%	145.0	25.6%	0.0	0.0%	567.5
Grand Total	114	1,944	63.9%	342	11.3%	64	2.1%	8	0.3%	630	20.7%	54	1.8%	3,043

Table G1b. Master's Students Eligibility for Assistantship Support

	# Depts	% of Depts
All master's students are eligible for assistantships	83	59.7%
No master's students are eligible for assistantships	18	12.9%
Students in some master's programs but not others are eligible for assistantships	25	18.0%
Other*	13	9.4%
*Other responses divided between individual student qualifications (e.g. GPA or training) and department needs or resources (research needs, funds availability)		

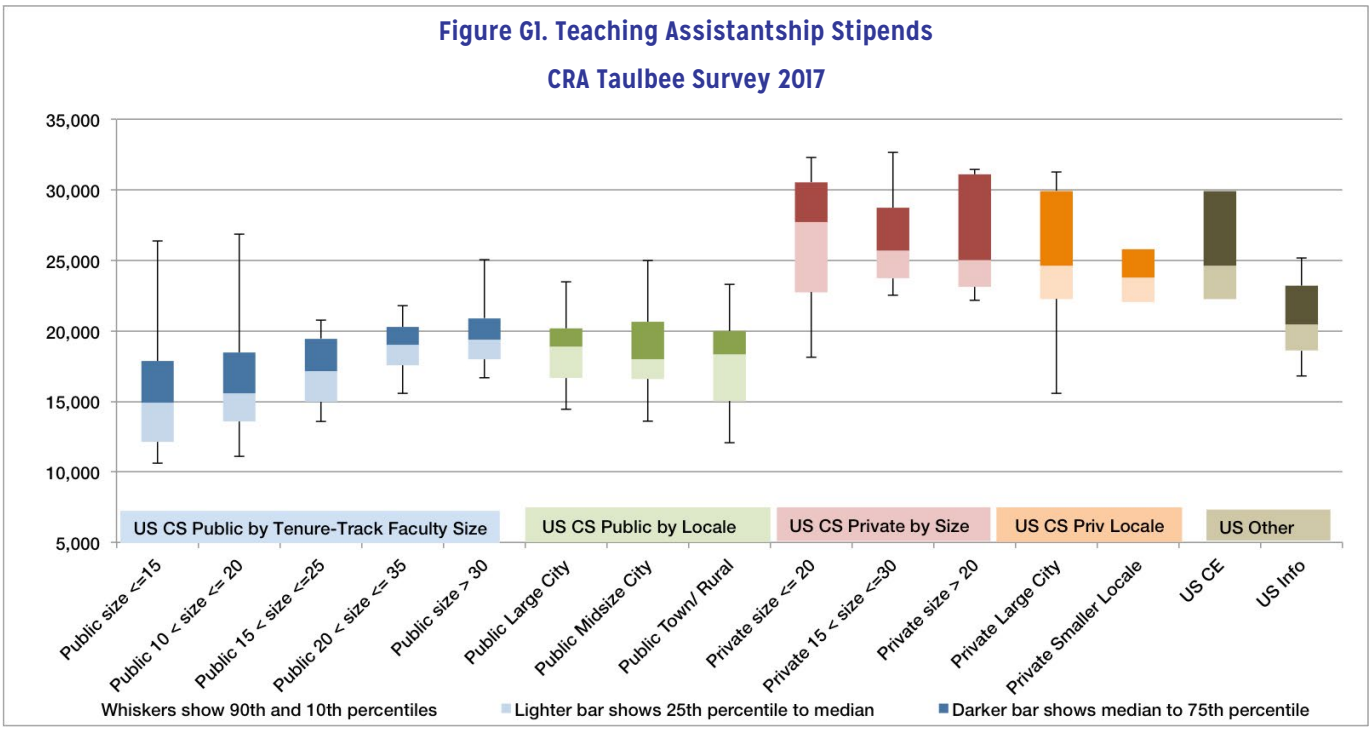


Table G2. Fall 2017 Academic-Year Graduate Stipends by Department Type and Support Type

Teaching Assistantships						
		Percentiles of Department Averages				
Department Type	**# Depts**	**10th**	**25th**	**50th**	**75th**	**90th**
US CS Public	94	$12,045	$15,648	$18,498	$20,199	$23,966
US CS Private	25	$18,540	$22,050	$24,225	$27,333	$31,270
US CE	7		$15,291	$18,000	$19,876	
US Info	11	$16,783	$18,113	$20,520	$23,339	$25,369
Canadian	8		$5,175	$14,005	$17,937	

Research Assistantships						
		Percentiles of Department Averages				
Department Type	**# Depts**	**10th**	**25th**	**50th**	**75th**	**90th**
US CS Public	94	$13,943	$16,196	$19,085	$21,430	$25,218
US CS Private	33	$20,880	$22,440	$25,029	$29,532	$31,004
US CE	7		$17,835	$18,864	$19,971	
US Information	12	$17,240	$20,100	$21,813	$23,024	$23,535
Canadian	6		$7,785	$12,819	$20,225	

Full-Support Fellows						
		Percentiles of Department Averages				
Department Type	**# Depts**	**10th**	**25th**	**50th**	**75th**	**90th**
US CS Public	60	$14,925	$20,000	$23,000	$27,243	$32,500
US CS Private	32	$22,541	$23,940	$26,011	$30,742	$32,450
US CE	3			$25,000		
US Information	9		$20,399	$24,000	$29,827	
Canadian	4			$18,192		

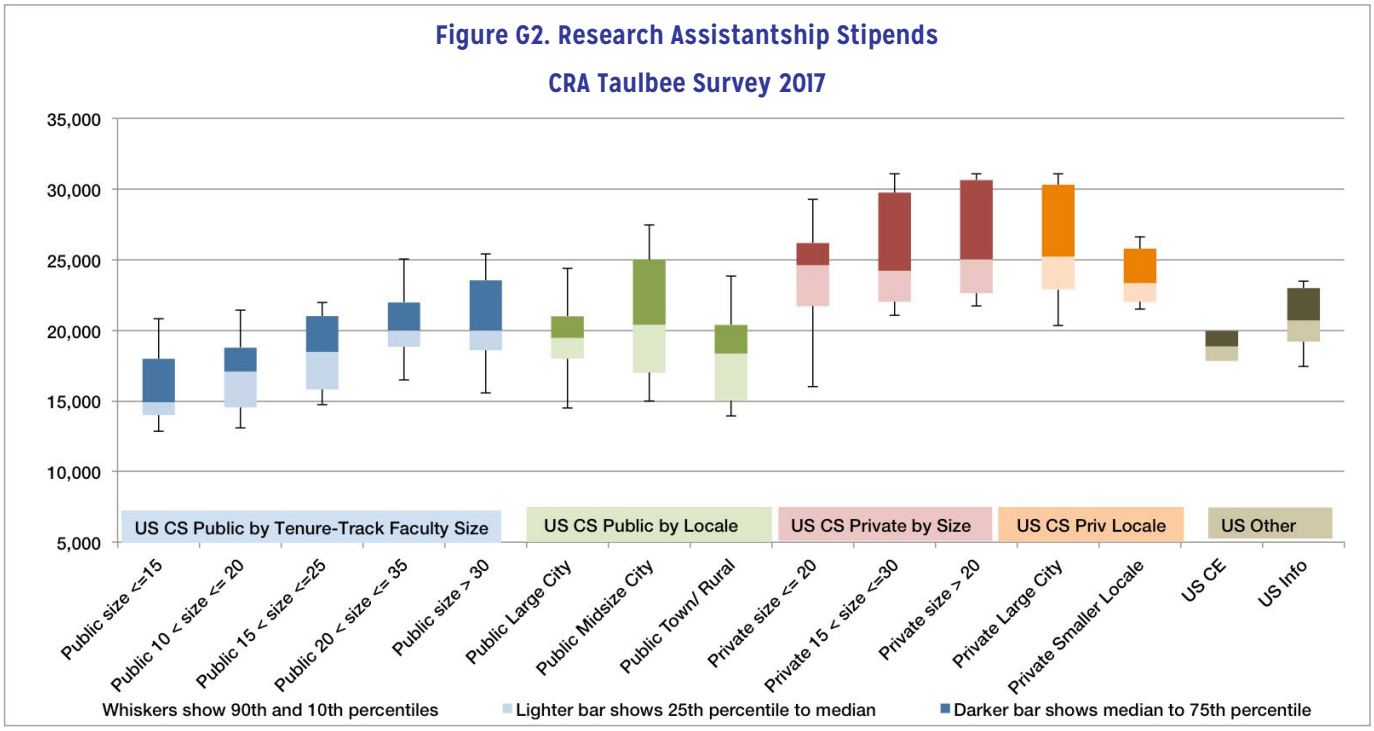


Figure G2. Research Assistantship Stipends
CRA Taulbee Survey 2017
35,000
30,000
25,000
20,000
15,000
10,000
5,000
US CS Public by Tenure-Track Faculty Size
US CS Public by Locale
US CS Private by Size
US CS Priv Locale
US Other
Public size <=15
Public 10 < size <= 20
Public 15 < size <=25
Public 20 < size <= 35
Public size > 30
Public Large City
Public Midsize City
Public Town/ Rural
Private size <= 20
Private 15 < size <=30
Private size > 20
Private Large City
Private Smaller Locale
US CE
US Info
Whiskers show 90th and 10th percentiles
Lighter bar shows 25th percentile to median
Darker bar shows median to 75th percentile

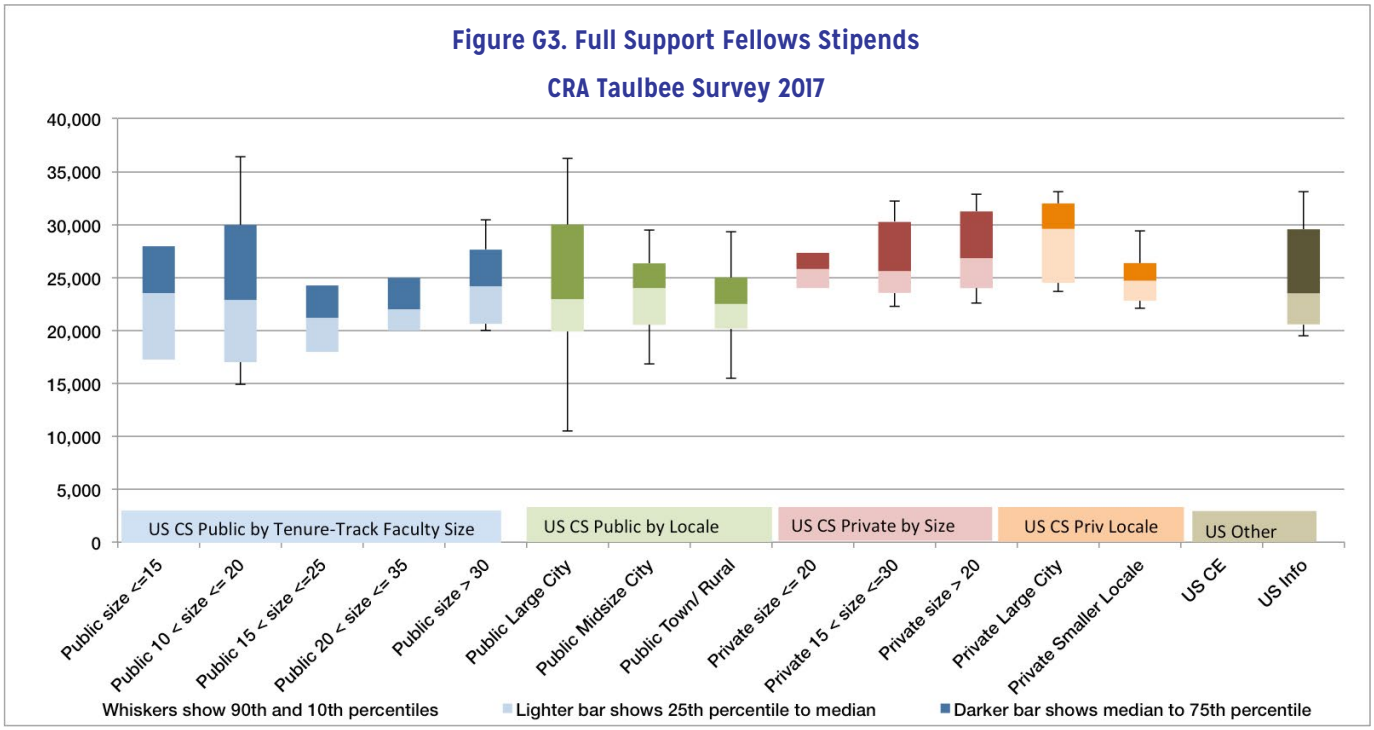


Figure G3. Full Support Fellows Stipends
CRA Taulbee Survey 2017
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
US CS Public by Tenure-Track Faculty Size
US CS Public by Locale
US CS Private by Size
US CS Priv Locale
US Other
Public size <=15
Public 10 < size <= 20
Public 15 < size <=25
Public 20 < size <= 35
Public size > 30
Public Large City
Public Midsize City
Public Town/ Rural
Private size <= 20
Private 15 < size <=30
Private size > 20
Private Large City
Private Smaller Locale
US CE
US Info
Whiskers show 90th and 10th percentiles
Lighter bar shows 25th percentile to median
Darker bar shows median to 75th percentile

Overall median research expenditures for 2016-17 at U.S. CS public departments increased 8.7 percent in comparison with 2015-16. At U.S. CS departments in private institutions, median expenditures rose 19.6 percent. The direction of change at private universities was the reverse of what was experienced last year. The median research expenditure at U.S. CS departments in private institutions remains considerably higher that of public institutions. Median expenditures at U.S. I departments was within one-half of one percent of last year's figure, and that for Canadian departments was one percent higher than last year. The sample size for I departments and Canadian departments is small, which makes these comparisons subject to more volatility.

The U.S. CS data show a tendency for larger departments to have more external funding per capita than smaller departments. This holds for departments at both public and private institutions.

Graduate Student Support

(Tables G1-G2; Figures G1-G3)

Table G1 shows the number of doctoral students supported as full-time students as of fall 2017, further categorized as teaching assistants (TAs), research assistants (RAs), and full-support fellows. In the past, the heading for this table read "Graduate Students Supported as Full-Time Students by Department Type". In fact, this table only reported responses to a question that was about support of doctoral students, and has been renamed accordingly. The table also shows the split between those on institutional vs. external funds. The average number of TAs on institutional funds in U.S. CS departments dropped slightly from last year's value, from 35.3 to 34.5. Public universities reported a slight decrease, while the average at private universities rose by 7.9 percent after declining by a similar percentage last year. The reported values at private universities have been somewhat volatile in recent years. Since there are fewer of them, compared with public universities, they are more sensitive to the specific units reporting in a given year. The small number of CE, I, and Canadian departments also make these comparative averages subject to volatility.

The average number of RAs on external funding was slightly lower at public and slightly higher at private U.S. CS departments, while the average number of RAs supported on institutional funds declined at private universities and rose at publics. The average number of full-support fellows on internal funds dropped slightly in U.S. CS public departments and rose at U.S. private departments. The average number of

Table S1. Nine-month Salaries, 141 Responses of 192 US CS Departments, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	113	117	123	138	111	129	138	137	107	52	48
Indiv	673	518	714	1,992	404	562	1,024	1,028	848	289	425
10	$134,404	$124,614	$120,732	$124,517	$99,151	$102,139	$100,004	$89,327	$66,015	$60,754	$47,891
25	$152,091	$142,483	$132,108	$143,451	$105,687	$109,353	$108,597	$95,440	$70,906	$74,157	$50,000
50	$173,987	$165,230	$149,469	$159,958	$114,204	$120,595	$117,505	$103,014	$80,102	$92,228	$57,159
75	$193,929	$191,967	$168,729	$179,071	$127,500	$130,397	$128,569	$111,085	$91,852	$122,020	$62,378
90	$216,805	$213,326	$188,049	$197,867	$138,611	$142,850	$140,675	$120,516	$103,122	$150,085	$69,066

Table S2. Nine-month Salaries, 103 Responses of 139 US CS Public (All Public), Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	81	83	93	101	84	95	101	100	77	36	34
Indiv	447	374	521	1,404	300	400	742	748	567	184	203
10	$130,839	$118,948	$119,475	$122,317	$98,224	$100,192	$99,707	$88,598	$63,269	$51,975	$47,747
25	$147,991	$137,913	$129,424	$142,178	$102,250	$108,756	$106,568	$93,584	$69,692	$71,000	$49,807
50	$167,790	$159,207	$144,760	$155,652	$111,643	$118,108	$114,581	$99,176	$77,226	$84,503	$54,249
75	$186,554	$179,282	$162,209	$171,320	$122,500	$125,331	$124,261	$107,128	$85,445	$109,169	$59,602
90	$199,575	$196,250	$175,351	$183,118	$132,129	$134,392	$136,236	$113,557	$97,200	$122,479	$63,139

full-support fellows on external funds increased at U.S. CS departments in both public and private universities.

This year, for the first time, we also requested information about supported master's students. The results are shown in Table G1a.While 37.4 percent of doctoral student support is for TAs, 64.2 percent of master's student support is for TAs. Conversely, 54.4 percent of doctoral student support is for RAs, while 32.0 percent of master's student support is for RAs. Among the 90 U.S. CS departments that provided master's support data, the average number of TAs per department on institutional funds is 16.7, which is about half the level reported above for doctoral student support per department. However, since there are only about ¾ as many U.S. CS departments reporting master's support data, one should be careful when trying to compare these two averages.

Table G2 shows the distribution of stipends for TAs, RAs, and full-support fellows. U.S. CS data are further broken down in this table by public and private institution. Figures G1-G3 further break down the U.S. CS data by size of department and by geographic location of the university.

The median TA salaries at U.S. CS departments increased 3.0 percent at public universities and increased 1.1 percent at private universities. Median salaries of RAs rose 2.2 percent at public universities and 0.7 percent at private universities. For full-support fellows, median salaries rose 3.9 percent at U.S. public universities and 1.3 percent at U.S. private universities.

Median stipends are higher at private U.S. CS departments, compared with public U.S. CS departments, in each of the three stipend categories. Stipends at U.S. I schools fall in between those at public and private U.S. CS departments. These relationships are unchanged from previous years.

At U.S. CS departments in public institutions, larger departments have higher salaries than do smaller departments for both TAs and RAs. Stipends in U.S. CS departments at private institutions do not exhibit a clear relationship based on department size for RAs, but for TAs, stipends are lower at larger departments.

Table S3. Nine-month Salaries, 38 Responses of 53 US CS Private (All Private), Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	32	34	30	37	27	34	37	37	30	16	14
Indiv	226	144	193	588	104	162	282	280	281	105	222
10	$148,797	$134,032	$140,007	$140,051	$106,399	$106,751	$107,454	$101,096	$76,896	$73,824	$57,470
25	$164,928	$147,968	$155,716	$160,936	$109,316	$121,079	$117,007	$103,862	$81,170	$93,582	$61,102
50	$198,716	$191,491	$172,029	$184,034	$122,784	$131,888	$128,015	$112,525	$92,378	$138,789	$65,136
75	$218,000	$221,125	$193,762	$204,459	$136,724	$144,234	$143,289	$123,150	$100,616	$157,024	$68,007
90	$238,456	$253,604	$205,195	$221,400	$146,813	$153,837	$149,849	$128,419	$112,708	$161,890	$69,148

Table S4. Nine-month Salaries, 23 Responses of US CS Public With <=15 Tenure-Track Faculty, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	14	11	19	22	18	20	23	22	15	2	1
Indiv	38	16	35	95	52	47	108	72	53		
10	$116,617	$100,778	$111,988	$115,400	$95,380	$94,915	$94,594	$85,001	$57,306		
25	$126,804	$115,522	$114,138	$119,132	$99,016	$99,231	$98,838	$87,070	$61,247		
50	$136,190	$118,593	$121,311	$126,624	$100,083	$103,243	$102,327	$90,436	$66,199		
75	$152,100	$129,333	$128,423	$143,435	$109,792	$109,539	$109,088	$94,361	$73,359		
90	$171,945	$145,288	$151,497	$151,194	$127,965	$122,503	$122,118	$98,379	$78,387		

Faculty Salaries

(Tables S1-S21; Figures S1-S9)

Each department was asked to report individual (but anonymous) faculty salaries if possible; otherwise, the department was requested to provide the mean salary for each rank (full, associate, and assistant professors and non-tenure-track teaching faculty, research faculty, and post-doctorates) and the number of persons at each rank. The salaries are those in effect on January 1, 2018 for U.S. departments; nine-month salaries are reported in U.S. dollars. For Canadian departments, twelve-month salaries are reported in Canadian dollars. Respondents were asked to include salary supplements such as salary monies from endowed positions.

U.S. CS data are reported in Tables S1-S16 and in the box and whiskers diagrams. Data for CE, I, Canadian, and new Ph.D.s are reported in Tables S17-S20. The tables and diagrams contain distributional data (first decile, quartiles, and ninth decile) computed from the department averages only. Thus, for example, a table row labeled "50" or the median line in a diagram is the median of the averages for the departments that reported within the stratum (the number of such departments reporting is shown in the "depts" row). Therefore, it is not a true median of all of the salaries.

We also report salary data for senior faculty based on time in rank, for more meaningful comparison of individual or departmental faculty salaries with national averages. We report associate professor salaries for time in rank of 7 years or less, and of more than 7 years. For full professors, we report time in rank of 7 years or less, 8 to 15 years, and more than 15 years.

Those departments reporting salary data were provided a summary report in December 2017. Those departments that provided individual salaries were additionally provided more comprehensive distributional information based on these individual salaries. This year, 70 percent of those reporting salary data provided salaries at the individual level.

The remainder of this section summarizes the basic report provided in December 2017 to all departments that provided salary data. The

Table S5. Nine-month Salaries, 38 Responses of US CS Public With 10 < Tenure-Track Faculty <=20, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	27	25	32	37	32	34	37	35	25	5	7
Indiv	82	62	85	243	86	85	186	135	114	25	16
10	$114,463	$108,741	$113,099	$117,105	$94,099	$95,886	$95,922	$86,000	$57,086		
25	$129,319	$118,580	$120,095	$125,425	$99,106	$101,700	$99,918	$89,205	$61,671		$48,163
50	$145,683	$134,613	$132,791	$143,028	$102,542	$108,756	$107,786	$93,654	$71,792	$62,000	$50,000
75	$161,775	$149,500	$148,896	$153,799	$110,551	$120,040	$114,154	$98,319	$76,451		$57,070
90	$181,204	$173,452	$162,041	$164,918	$115,746	$124,938	$120,956	$100,995	$83,138		

Table S6. Nine-month Salaries, 31 Responses of US CS Public With 15 < Tenure-Track Faculty <=25, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	23	26	27	30	25	28	29	29	22	7	9
Indiv	79	85	103	278	68	78	157	134	107	31	19
10	$132,783	$120,708	$122,644	$137,494	$95,776	$100,375	$99,551	$91,322	$58,774		
25	$145,047	$134,985	$132,791	$140,747	$102,001	$109,038	$105,900	$94,442	$69,732	$53,817	$50,000
50	$160,044	$152,479	$142,012	$151,234	$109,254	$114,562	$112,737	$98,187	$73,664	$76,000	$54,325
75	$174,560	$179,489	$149,129	$165,187	$114,136	$121,188	$117,616	$101,333	$78,958	$117,636	$59,814
90	$192,454	$190,506	$168,558	$172,557	$121,961	$125,586	$124,723	$110,528	$91,497		

Table S7. Nine-month Salaries, 29 Responses of US CS Public With 20 < Tenure-Track Faculty <=35, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	24	28	29	29	24	28	28	29	20	11	10
Indiv	106	99	154	361	87	106	197	203	125	26	28
10	$141,945	$143,095	$123,727	$138,580	$101,525	$104,542	$104,470	$93,622	$69,154	$37,923	$48,221
25	$152,536	$152,489	$132,039	$148,241	$107,808	$109,919	$110,524	$96,325	$69,662	$71,199	$49,807
50	$170,016	$170,156	$145,299	$162,766	$114,170	$117,531	$117,059	$99,868	$76,032	$88,592	$55,336
75	$188,041	$182,599	$164,985	$175,445	$121,316	$125,671	$124,224	$107,496	$82,332	$105,211	$59,340
90	$195,629	$204,215	$168,999	$181,027	$127,500	$133,703	$128,507	$113,601	$92,452	$113,712	$64,540

Table S8. Nine-month Salaries, 38 Responses of US CS Public With Tenure-Track Faculty >30, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	36	36	36	38	31	36	38	38	33	24	21
Indiv	298	247	315	905	138	232	392	460	362	139	173
10	$157,977	$145,474	$134,751	$152,683	$106,849	$111,916	$113,051	$98,295	$70,606	$67,899	$45,042
25	$168,740	$155,907	$143,442	$158,470	$115,862	$119,814	$116,789	$103,166	$79,307	$74,157	$51,844
50	$181,869	$166,889	$158,063	$170,200	$121,001	$125,670	$124,886	$107,251	$84,590	$90,086	$54,828
75	$193,892	$185,752	$167,158	$180,782	$129,952	$134,386	$134,720	$112,268	$92,189	$109,169	$58,964
90	$215,402	$202,628	$177,983	$190,600	$138,611	$138,178	$140,382	$115,159	$102,855	$125,981	$61,010

data reported below, and the accompanying tables, were updated to reflect a small amount of data provided after the deadline for the December report.

Salaries at private institutions tend to be higher than those at public institutions for all faculty types (Tables S2 and S3). This pattern is consistent with data from previous years.

When viewed relative to faculty size (Figures S1-S7), salaries at each tenure-track rank tend to be higher for larger departments at both public and private institutions. This pattern is consistent with last year's pattern. Salaries for teaching faculty exhibit this pattern at private institutions and, for the most part, also at public institutions.

When viewed relative to type of locale (also Figures S1-S7), public institution salaries appear to be generally lower in smaller locales than in mid-size or large cities for all tenure-track faculty ranks and for teaching faculty, Private institution salaries also exhibit this behavior except for full professors in rank 8-15 years.

Our analysis of faculty salary changes from one year to the next uses only those departments that reported both years; otherwise, the departments that reported during only one year can skew the comparison. Because some departments that reported both years provided only aggregate salaries for their full and associate professors during one year and in the other year reported them by years in rank, we only report salary changes for all full professors and for all associate professors in the year-to-year comparison. Table S21 shows, by type of faculty and type of department, the change in the median of the average salaries from departments that reported both years (the number of departments being compared is indicated in parentheses in each column heading). Using the cell showing full professors at U.S. CS departments as an example, the table indicates that the median of the 124 average salaries for full professors was 2.4 percent higher in 2017 than was the median of the average full professor salaries in 2016 from these same 124 departments.

When interpreting these changes, it is important to remember the effect that promotions have on the departmental data from

Table S9. Nine-month Salaries, 15 Responses of US CS Private With <=20 Tenure-Track Faculty, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank n		Teach	Research	Postdoc
Depts	11	13	11	14	11	13	14	14	10	3	2
Indiv	37	29	32	101	22	33	60	48	38		
10	$130,076	$132,213	$140,037	$124,771	$100,025	$104,282	$101,058	$96,840	$76,102		
25	$151,143	$133,790	$148,601	$147,796	$107,067	$106,526	$108,018	$101,869	$80,270		
50	$163,728	$152,435	$169,014	$169,014	$114,585	$120,688	$118,008	$106,128	$83,103		
75	$176,403	$194,150	$181,625	$183,401	$125,536	$131,775	$127,511	$117,850	$89,591		
90	$206,690	$222,479	$198,359	$193,657	$130,268	$139,268	$132,918	$123,402	$95,506		

Table S10. Nine-month Salaries, 18 Responses of US CS Private With 15 < Tenure-Track Faculty <=30, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	15	15	14	17	11	15	17	18	14	9	7
Indiv	82	51	66	210	22	41	72	109	74	33	58
10	$162,620	$150,783	$145,376	$162,279	$107,829	$120,176	$114,594	$102,940	$77,339		
25	$170,398	$169,630	$155,998	$170,701	$114,317	$122,487	$119,000	$104,772	$80,361	$111,400	$61,120
50	$183,850	$191,967	$170,280	$183,581	$122,784	$132,000	$128,642	$111,634	$92,057	$137,518	$62,008
75	$207,106	$214,373	$192,655	$203,454	$133,223	$146,613	$140,247	$124,909	$109,537	$141,667	$67,996
90	$230,439	$234,937	$214,487	$213,029	$134,105	$153,561	$148,241	$127,170	$121,960		

Table S11. Nine-month Salaries, 23 Responses of US CS Private With Tenure-Track Faculty >20, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	21	21	19	23	16	21	23	23	20	13	12
Indiv	189	115	161	487	82	129	222	232	243	99	216
10	$165,924	$147,396	$144,191	$153,344	$107,728	$122,250	$115,368	$103,646	$77,257	$73,643	$57,118
25	$183,850	$172,010	$156,876	$177,308	$116,159	$129,392	$122,480	$108,855	$84,235	$98,899	$61,182
50	$205,973	$197,960	$174,714	$194,490	$133,303	$140,295	$137,381	$113,662	$97,052	$140,060	$66,984
75	$235,233	$228,729	$197,971	$216,785	$146,118	$148,740	$145,405	$124,764	$108,010	$157,793	$68,401
90	$240,269	$259,830	$219,477	$224,481	$152,142	$171,200	$155,229	$130,329	$115,455	$163,956	$69,189

Table S12. Nine-month Salaries, 38 Responses of US CS Public In Large City or Suburbs, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	35	34	36	38	34	37	38	37	28	16	13
Indiv	205	166	193	566	128	171	304	294	238	95	89
10	$142,424	$132,706	$126,324	$142,726	$100,455	$107,511	$104,902	$93,448	$69,504	$51,975	$45,634
25	$157,153	$144,013	$133,610	$148,363	$107,609	$111,753	$110,991	$98,187	$72,037	$67,348	$48,325
50	$172,781	$159,452	$144,827	$159,037	$116,100	$118,701	$117,055	$103,014	$79,493	$104,943	$52,979
75	$186,083	$180,804	$163,450	$172,172	$127,500	$127,148	$127,821	$107,718	$87,070	$113,178	$56,958
90	$208,145	$200,032	$173,702	$186,543	$132,129	$135,509	$137,455	$113,900	$92,977	$133,368	$59,793

Table S13. Nine-month Salaries, 25 Responses of US CS Public In Midsize City or Suburbs, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	21	19	21	24	18	23	24	23	17	9	6
Indiv	127	93	157	386	64	93	166	159	139	39	36
10	$135,953	$114,421	$125,000	$137,257	$100,060	$106,496	$102,331	$92,029	$63,479		
25	$152,867	$135,356	$140,581	$145,251	$105,383	$111,904	$110,708	$95,217	$69,692	$73,642	
50	$173,987	$164,693	$151,471	$159,563	$111,358	$120,170	$115,341	$101,084	$79,000	$83,685	$54,983
75	$192,881	$170,555	$164,913	$173,191	$117,609	$126,910	$124,689	$110,592	$88,644	$115,100	
90	$194,825	$192,022	$176,383	$185,927	$137,364	$135,088	$138,294	$118,383	$111,889		

Table S14. Nine-month Salaries, 39 Responses of US CS Public in Small City, Town, or Rural, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	25	30	36	39	31	34	38	39	31	11	15
Indiv	115	115	171	452	102	135	265	294	189	50	78
10	$121,826	$118,345	$114,138	$118,830	$97,208	$98,043	$98,069	$85,267	$61,671	$68,000	$47,897
25	$138,166	$133,496	$121,130	$126,624	$99,437	$101,700	$101,704	$89,272	$66,760	$73,165	$51,396
50	$151,542	$157,567	$137,832	$147,969	$107,199	$112,369	$109,811	$96,325	$74,213	$75,458	$54,828
75	$180,019	$179,034	$158,140	$162,396	$117,941	$124,668	$121,625	$99,919	$84,725	$86,871	$60,412
90	$190,053	$197,450	$170,794	$177,601	$126,538	$129,300	$127,394	$109,133	$91,956	$92,284	$62,852

Table S15. Nine-month Salaries, 25 Responses of US CS Private in Large City or Suburbs, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	22	23	24	25	19	25	25	24	21	11	8
Indiv	123	102	160	401	86	121	215	195	240	78	154
10	$141,061	$135,116	$139,830	$139,771	$107,467	$111,772	$111,034	$100,602	$77,218	$77,629	
25	$164,128	$148,123	$153,024	$167,631	$112,694	$120,688	$118,222	$106,523	$81,443	$105,150	$61,139
50	$204,449	$191,015	$170,280	$184,034	$128,287	$132,000	$128,642	$115,148	$94,755	$141,667	$65,460
75	$216,070	$221,174	$190,087	$203,454	$136,724	$144,512	$144,994	$125,552	$98,186	$157,281	$68,401
90	$238,456	$267,333	$202,117	$219,849	$149,254	$153,561	$150,533	$130,288	$107,247	$165,334	

Table S16. Nine-month Salaries, 13 Responses of US CS Private in Other than Large City, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	10	11	6	12	8	9	12	13	9	5	6
Indiv	103	42	33	187	18	41	67	85	41	27	68
10	$153,312	$134,595		$146,954			$104,113	$103,283			
25	$168,310	$157,323		$158,563	$106,916	$124,700	$113,015	$103,862	$81,079		
50	$189,471	$192,706	$180,803	$185,537	$117,064	$129,776	$123,705	$111,820	$89,907	$114,052	$64,396
75	$217,288	$217,024		$205,873	$127,419	$142,759	$140,259	$118,256	$110,300		
90	$237,723	$228,729		$221,880			$142,990	$122,359			

Table S17. Nine-month Salaries, 8 Responses of 35 US Computer Engineering Departments, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	5	6	6	8	5	7	8	8	5	1	3
Indiv	26	15	28	77	16	27	49	27	19	0	0
10											
25				$150,943		$108,959	$109,878	$94,125			
50	$186,903	$165,184	$132,624	$172,792	$114,052	$111,573	$120,319	$98,500	$77,915		
75				$183,667		$117,033	$124,967	$105,548			
90											

Table S18. Nine-month Salaries, 14 Responses of 24 US Information Departments, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	11	13	12	14	10	14	14	14	13	5	6
Indiv	33	55	62	151	42	93	135	137	109	17	31
10	$138,603	$131,607	$124,507	$140,778	$95,752	$96,788	$95,403	$83,635	$73,922		
25	$156,674	$145,438	$143,136	$148,582	$101,953	$106,333	$106,333	$92,870	$78,718		
50	$176,408	$159,207	$148,075	$164,306	$115,800	$118,028	$119,457	$100,671	$90,953	$79,977	$56,141
75	$193,204	$183,027	$156,561	$172,478	$125,205	$138,546	$138,134	$106,370	$103,304		
90	$199,984	$197,404	$172,154	$192,851	$138,956	$143,546	$142,240	$114,724	$135,420		

Table S19. Twelve-month Salaries, 9 Responses of 30 Canadian Departments, Percentiles from Department Averages

	Full Professor				Associate			Assistant	Non-Tenure Track		
	In rank 16+ yrs	In rank 8-15 yrs	In rank 0-7 years	All years in rank	In rank 8+ years	In rank 0-7 years	All years in rank		Teach	Research	Postdoc
Depts	9	8	9	9	9	7	9	9	6	3	4
Indiv	57	50	56	163	64	37	101	51	59		45
10											
25	$167,307	$166,529	$145,915	$170,603	$142,851	$127,311	$134,901	$100,653			
50	$205,063	$176,028	$157,979	$176,965	$151,064	$144,960	$148,775	$118,994	$120,506		$55,525
75	$210,452	$197,717	$188,592	$197,802	$173,843	$163,028	$168,398	$132,508			
90											

Table S20. Nine-month Salaries for New PhDs (Twelve-month for Canadian)

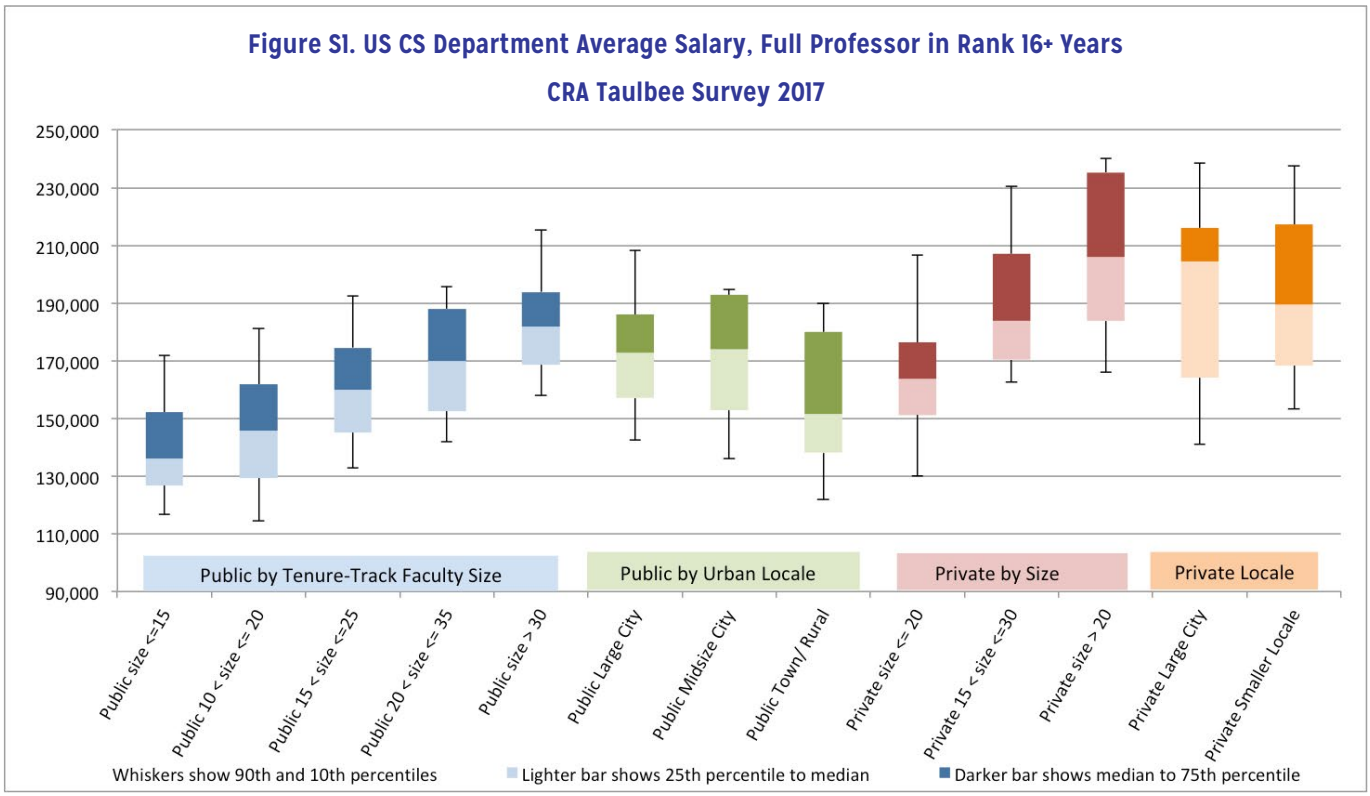
	US (CS, CE, and Info Combined)				Canadian			
	Tenure-Track	Non-ten Teaching	Non-ten Research	Postdoc	Tenure-Track	Non-ten Teaching	Non-ten Research	Postdoc
Depts	81	27	8	28	4	1	1	3
Indiv	151	37	11	132	15	2	2	17
10	$90,000	$64,500	$60,000	$43,436				
25	$95,200	$72,500	$65,421	$50,689				
50	$102,504	$78,000	$68,333	$59,000	$120,000			
75	$110,000	$90,000	$72,750	$67,425				
90	$114,400	$97,221	$84,999	$67,425				

one year to the next, since a promotion causes an individual faculty member to move from one rank to another. Thus, a department with a small number of faculty members in a particular rank can have its average salary in that rank change appreciably (in either direction) by a single promotion to or from that rank. Departures via resignation or retirement also impact these figures, particularly in the non-tenure-track categories. Because of the small number of Canadian, CE, and I departments reporting, the values in those columns are considerably more volatile; this is evident in several of the entries in Table S21.

For new Ph.D.s in tenure-track positions at U.S. CS, CE, and I school departments (Table S20) the median of the averages was $102,504, an increase of 2.5 percent vs. last year. There were not enough new tenure-track faculty salaries from Canadian institutions last year to report any salary distribution data, so year-to-year comparisons cannot be made.

Table S21. Change in Salary Median for Departments that Reported in Both 2016 and 2017

	U.S. CS	U.S. CE	U.S. I	Canadian
Departments	133	8	13	8
Full Profs	1.3%	5.5%	2.6%	-1.8%
Assoc. Profs.	3.5%	1.8%	4.3%	1.5%
Asst. Profs.	1.5%	-2.5%	2.5%	5.4%
Non-ten-track teaching faculty	2.8%	-4.3%	4.5%	
Research faculty	2.4%		0.2%	
Post doctorates	3.9%	0.5%	-3.2%	1.7%



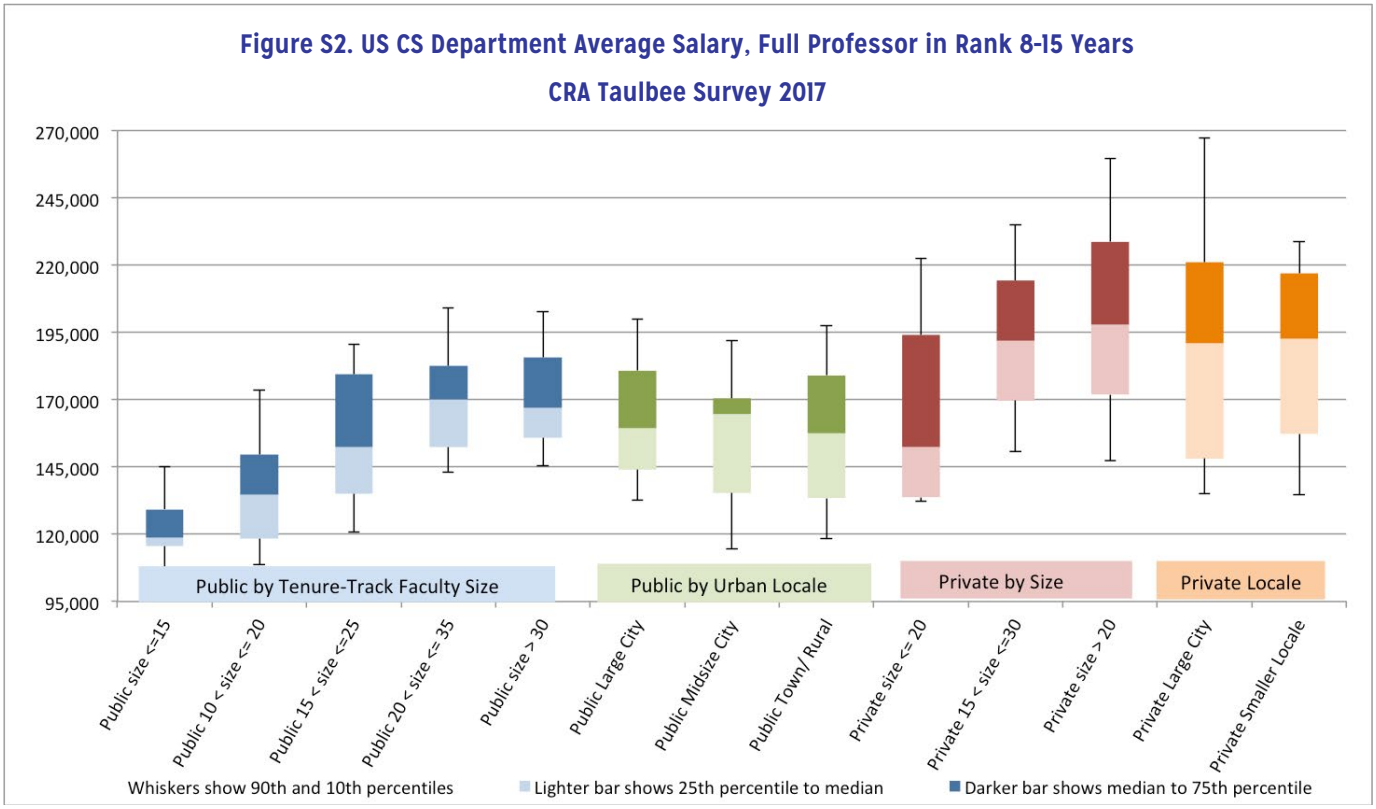


Figure S2. US CS Department Average Salary, Full Professor in Rank 8-15 Years
CRA Taulbee Survey 2017
270,000
245,000
220,000
195,000
170,000
145,000
120,000
95,000
Public by Tenure-Track Faculty Size
Public by Urban Locale
Private by Size
Private Locale
Public size <=15
Public 10 < size <= 20
Public 15 < size <=25
Public 20 < size <= 35
Public size > 30
Public Large City
Public Midsize City
Public Town/ Rural
Private size <= 20
Private 15 < size <=30
Private size > 20
Private Large City
Private Smaller Locale
Whiskers show 90th and 10th percentiles
Lighter bar shows 25th percentile to median
Darker bar shows median to 75th percentile

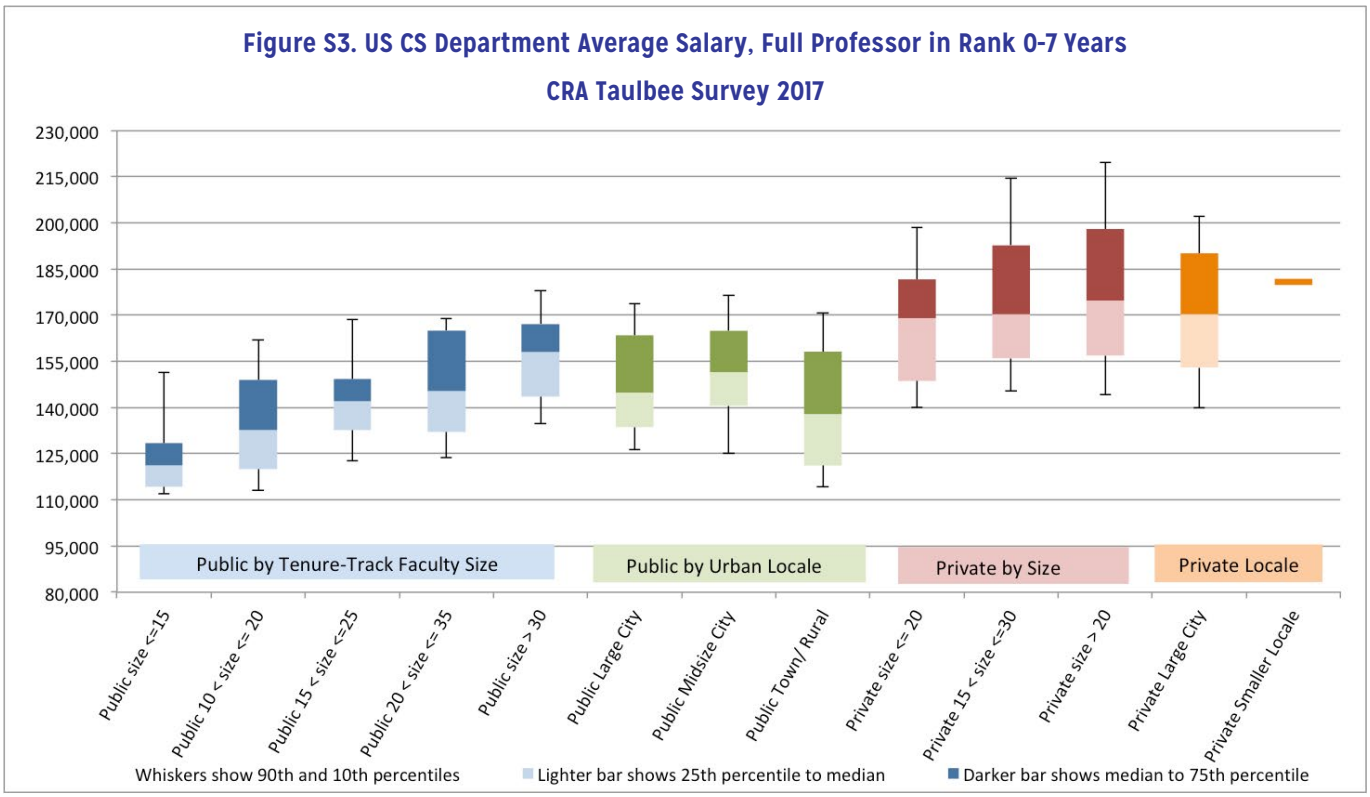


Figure S3. US CS Department Average Salary, Full Professor in Rank 0-7 Years
CRA Taulbee Survey 2017
230,000
215,000
200,000
185,000
170,000
155,000
140,000
125,000
110,000
95,000
80,000
Public by Tenure-Track Faculty Size
Public by Urban Locale
Private by Size
Private Locale
Public size <=15
Public 10 < size <= 20
Public 15 < size <=25
Public 20 < size <= 35
Public size > 30
Public Large City
Public Midsize City
Public Town/ Rural
Private size <= 20
Private 15 < size <=30
Private size > 20
Private Large City
Private Smaller Locale
Whiskers show 90th and 10th percentiles
Lighter bar shows 25th percentile to median
Darker bar shows median to 75th percentile

Figure S4. US CS Department Average Salary, Associate Professor in Rank 8+ Years

CRA Taulbee Survey 2017

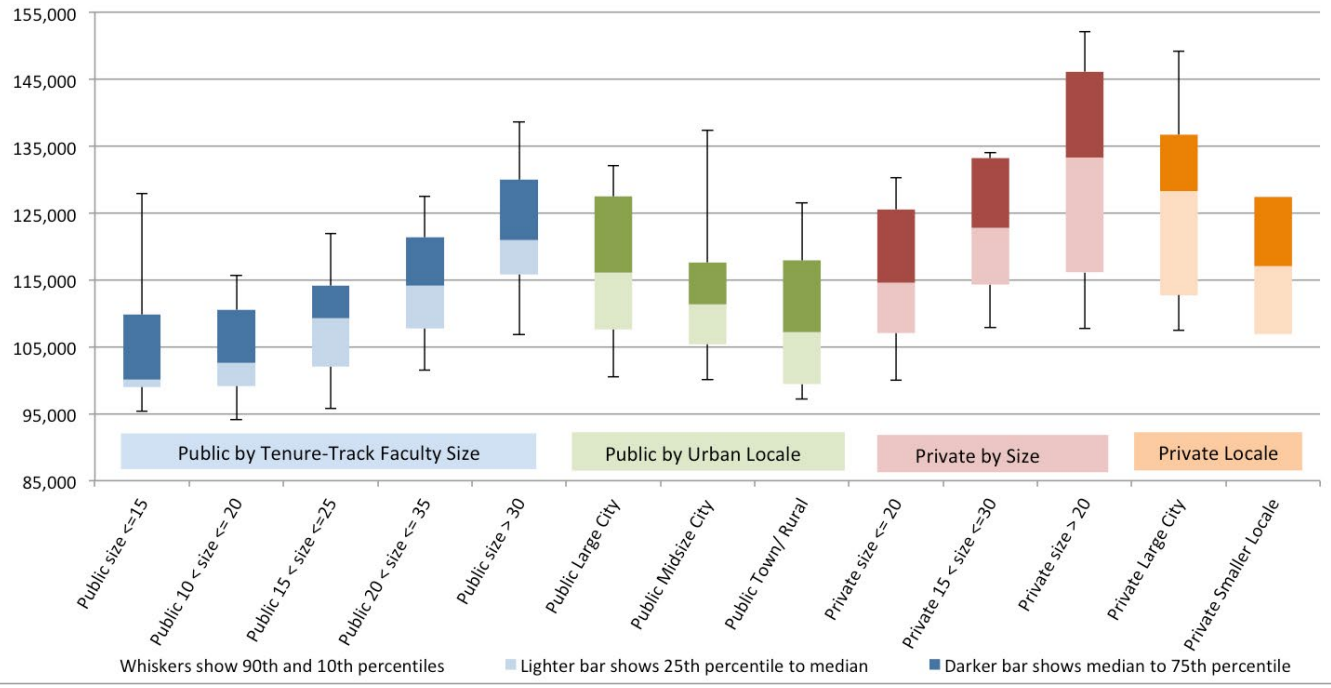


Figure S5. US CS Department Average Salary, Associate Professor in Rank 0-7 Years

CRA Taulbee Survey 2017

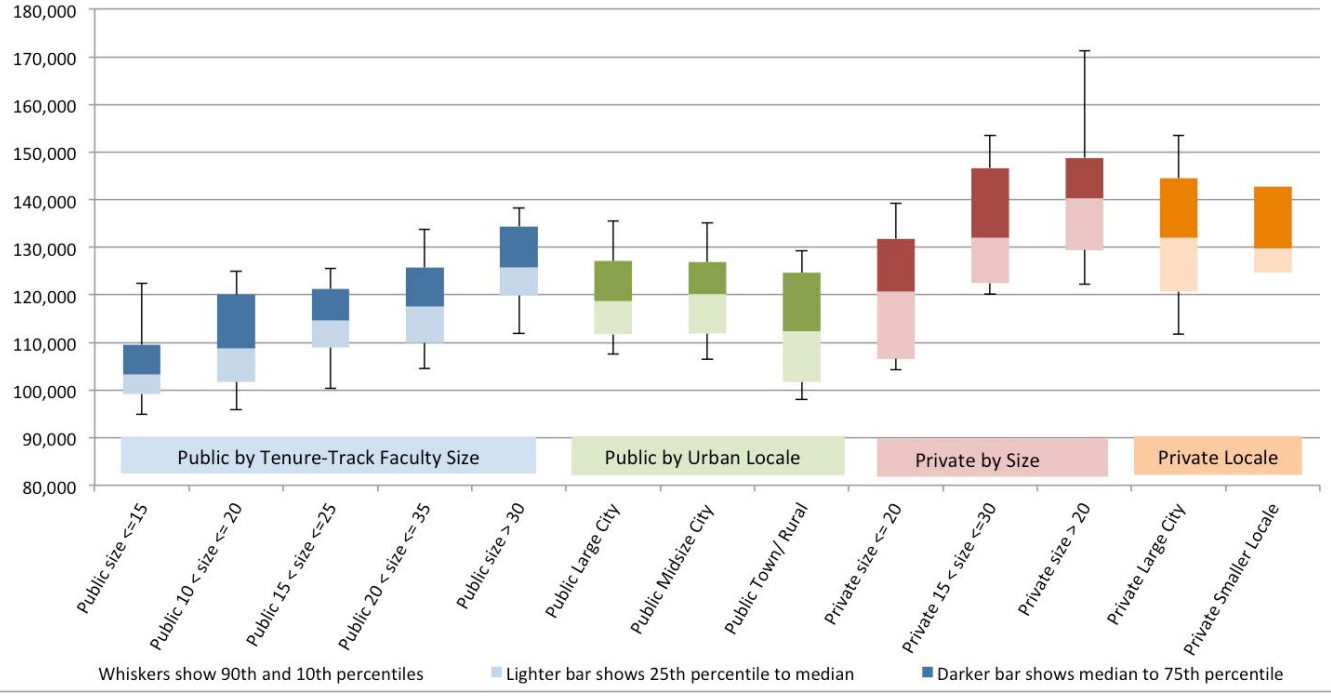


Figure S6. US CS Department Average Salary, Assistant Professor

CRA Taulbee Survey 2017

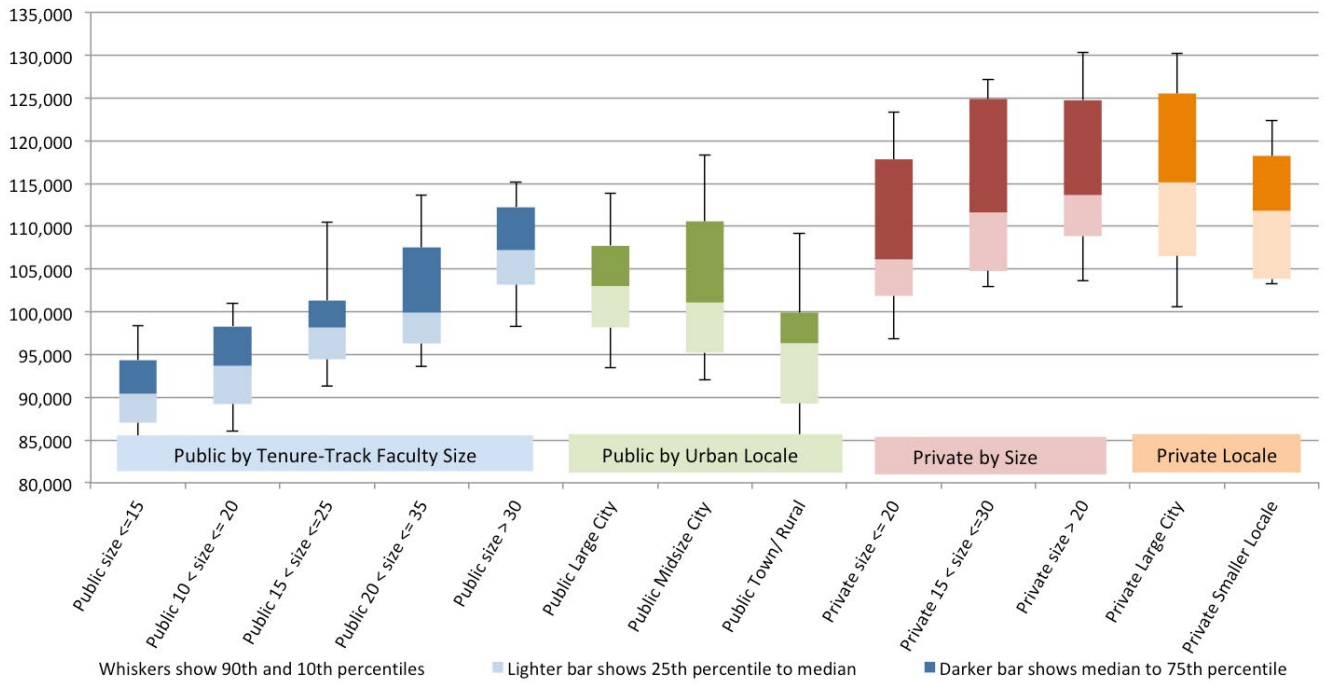


Figure S7. US CS Department Average Salary, Non-Tenure Track Teaching Faculty

CRA Taulbee Survey 2017

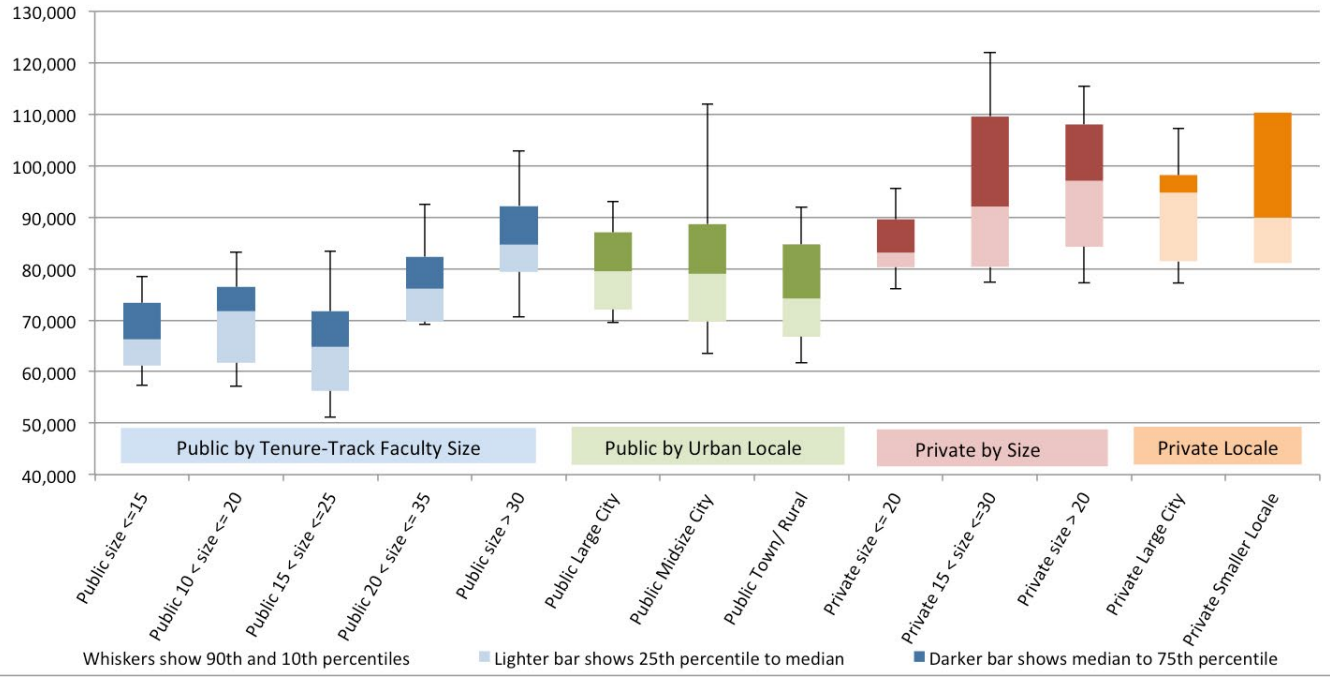
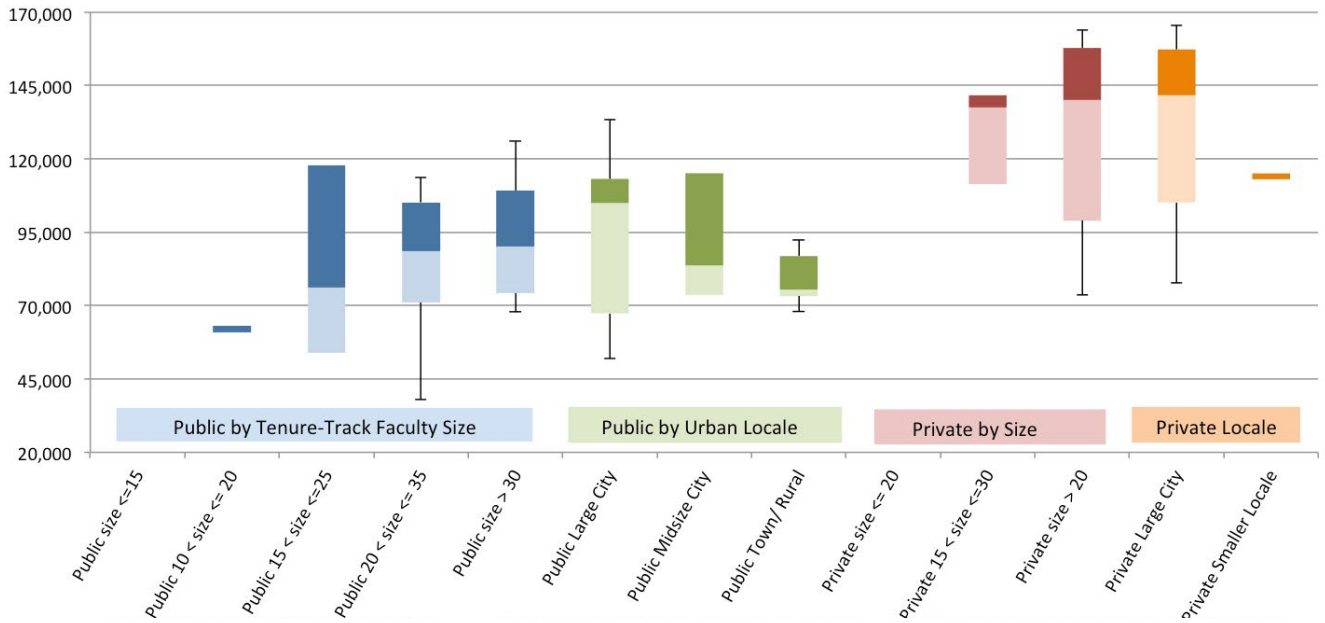


Figure S8. US CS Department Average Salary, Non-Tenure Track Research Faculty

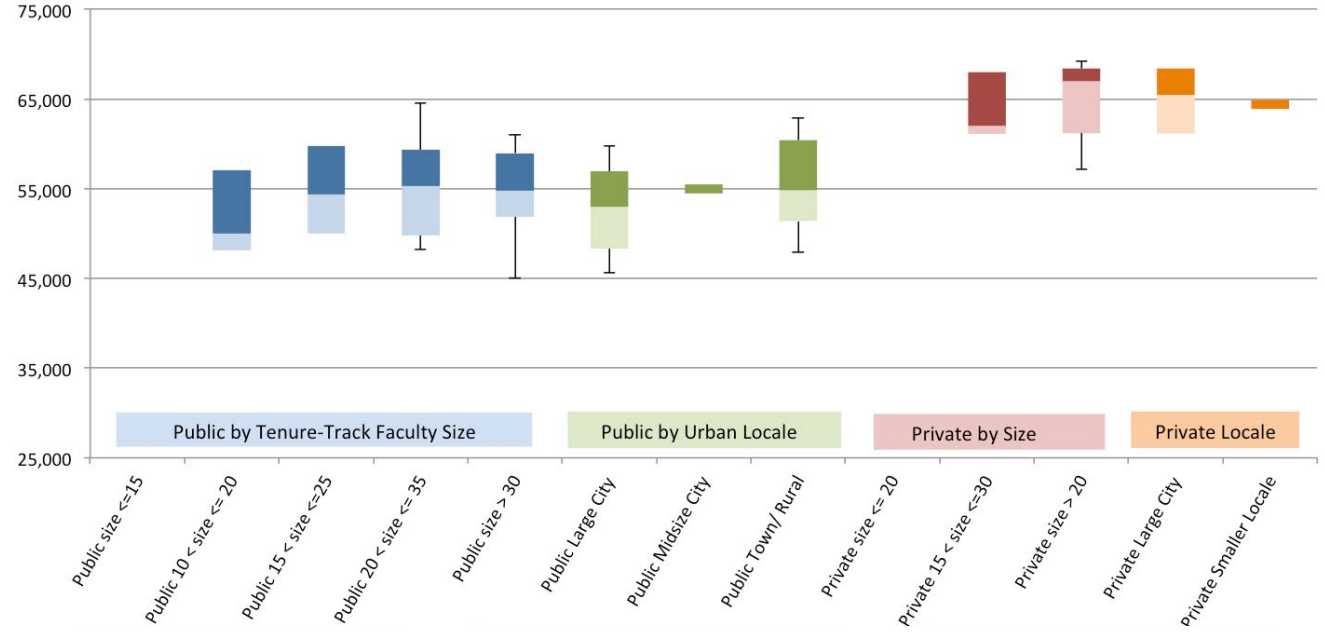
CRA Taulbee Survey 2017



Whiskers show 90th and 10th percentiles | Lighter bar shows 25th percentile to median | Darker bar shows median to 75th percentile

Figure S9. US CS Department Average Salary, Postdoctorates

CRA Taulbee Survey 2017



Whiskers show 90th and 10th percentiles | Lighter bar shows 25th percentile to median | Darker bar shows median to 75th percentile

Concluding Observations

Once again, undergraduate enrollments in U.S. doctoral-granting computer science programs increased, as did the number of new students in the departments' graduate programs at both the master's and doctoral levels. While there also were increases in the number of tenure-track and teaching faculty, these increases continue to not keep pace with the increases in students. Next year, as part of the Department Profiles section of the Taulbee Survey that runs every three years, we intend to gather updated information about how departments are coping with this situation.

Participating CS, CE, I and Canadian Departments

*(Departments marked with * have participated in all 5 of the most recent Taulbee surveys)*

U.S. CS Public (109): Arizona State*, Auburn*, Binghamton, Clemson*, College of William & Mary*, Colorado School of Mines*, Colorado State*, Florida International*, George Mason*, Georgia Tech*, Georgia State, Indiana*, Iowa State*, Kansas State*, Kent State*, Michigan State*, Michigan Technological University, Mississippi State*, Missouri University of Science and Technology, Montana State*, Naval Postgraduate School*, New Jersey Institute of Technology, New Mexico State, North Carolina State*, North Dakota State*, Ohio State*, Ohio*, Oklahoma State*, Old Dominion, Oregon State, Pennsylvania State*, Portland State*, Purdue*, Rutgers, Southern Illinois (Carbondale), Stony Brook (SUNY)*, Texas A&M*, Texas Tech, University at Buffalo, Universities of: Alabama (Birmingham* and Tuscaloosa*), Arizona, Arkansas*, Arkansas at Little Rock*, California (Berkeley*, Davis*, Irvine*, Los Angeles, Riverside*, San Diego, Santa Barbara*, and Santa Cruz*), Central Florida*, Colorado (Boulder)*, Connecticut, Delaware*, Florida*, Georgia*, Houston*, Idaho, Illinois (Chicago* and Urbana-Champaign*), Iowa*, Kansas*, Kentucky, Louisiana at Lafayette*, Maryland (College Park* and Baltimore County*), Massachusetts (Amherst*, Boston*, and Lowell), Memphis, Michigan*, Minnesota*, Nebraska (Omaha and Lincoln*), Nevada (Las Vegas and Reno*), New Hampshire*, New Mexico, North Carolina (Chapel Hill* and Charlotte*), North Dakota, North Texas*, Oklahoma*, Oregon*, Pittsburgh, Rhode Island*, South Carolina*, South Florida*, Southern Mississippi, Tennessee (Knoxville)*, Texas (Arlington, Austin*, Dallas*, and El Paso*), Utah*, Vermont, Virginia*, Washington*, Wisconsin (Madison* and Milwaukee), Wyoming, Virginia Commonwealth, Virginia Tech*, Washington State*, Wayne State, Western Michigan, and Wright State.

U.S. CS Private (40): Boston University*, Brandeis, Brown, Carnegie Mellon*, Case Western Reserve*, Clarkson, Columbia, Cornell*, DePaul*, Drexel*, Duke*, Emory, George Washington, Georgetown, Harvard, Illinois Institute of Technology, Johns Hopkins*, Lehigh*, MIT*, New York University*, Northeastern*, Northwestern, Polytechnic*, Princeton*, Rensselaer*, Rice, Rochester Institute of Technology*, Stanford*, Stevens Institute of Technology, Toyota Technological Institute at Chicago*, Tufts*, Universities of: Chicago*, Notre Dame, Pennsylvania*, Rochester*, Southern California*, and Tulsa*, Washington in St. Louis*, Worcester Polytechnic Institute*, and Yale.

U.S. CE (8): Iowa State, North Carolina State*, Northeastern, Universities of: California (Santa Cruz), Central Florida*, Illinois (Urbana-Champaign), New Mexico*, and Southern California.

U.S. Information (15): Cornell*, Drexel*, Florida State, Indiana*, Penn State*, Syracuse, Universities of: California (Berkeley)*, Colorado (Boulder), Illinois (Urbana-Champaign), Maryland (College Park ISchool and Baltimore County*), Michigan*, North Carolina (Chapel Hill)*, Pittsburgh*, and Washington*.

Canadian (11): Concordia*, McGill, Simon Fraser*, Universities of: British Columbia*, Calgary*, Manitoba*, Toronto*, Victoria*, Waterloo, Western Ontario, and York*.

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[1]The title of the survey honors Orrin E. Taulbee of the University of Pittsburgh, who conducted these surveys for the Computer Science Board until 1984, with retrospective annual data going back to 1970.

[2]Information (I) programs included here are Information Science, Information Systems, Information Technology, Informatics, and related disciplines with a strong computing component. Surveys were sent to CRA members, the CRA Deans group members, and participants in the iSchools Caucus (*www.ischools.org*) who met the criteria of granting Ph.D.s and being located in North America. Other I programs who meet these criteria and would like to participate in the survey in future years are invited to contact *survey@cra.org* for inclusion.

[3]Classification of the population of an institution's locale is in accordance with the Carnegie Classification database. Large cities are those with population >= 250,000. Mid-size cities have population between 100,000 and 250,000. Town/rural populations are less than 100,000.

[4]All faculty tables: The survey makes no distinction between faculty specializing in CS vs. CE programs. Every effort is made to minimize the inclusion of faculty in electrical engineering who are not computer engineers.

Should NSF CISE Implement a No-Deadlines Approach?

CRA
Computing Research Association

Our friends at the National Science Foundation (NSF) have asked for research community input on a proposed policy change to eliminate/reduce deadlines for core programs in the CISE Directorate.

The question comes as two other directorates at the Foundation – the Directorate for Geosciences (GEO) and the Directorate for Biological Sciences (BIO) – have announced they will implement a "no-deadline" full-proposal mechanism for receiving and reviewing proposals submitted to core programs. A Dear Colleague Letter released by the BIO directorate explains their plan:

> *In order to promote interdisciplinary research that crosses biological scales and traverses current divisional boundaries, BIO will implement a "no-deadline," full-proposal mechanism for receiving and reviewing proposals submitted to core programs....*
>
> *By accepting proposals at any time, investigators will have greater opportunities to prepare their proposals, build strong collaborations, and think more creatively, thereby resulting in more complex, interdisciplinary projects that have the potential to dramatically advance biological science. We anticipate that the elimination of deadlines will reduce the burden on institutions and the community by expanding the submission period over the course of the year, in contrast to the previous fixed yearly deadlines.*

Given the increased pressures on securing federal funding and, in some cases, reduced capacity for grant management at computing research institutions, do you think the Computer & Information Science & Engineering (CISE) Directorate should follow the lead of the BIO and GEO directorates and consider eliminating or reducing deadlines for proposal submissions? What positive or negative impact could such a shift have on our community?

Please fill out this informal, non-scientific survey and let us know. We'll collect responses through May 15th and then share the collective feedback with NSF.

Envisioning the Future of CERP

By Burçin Tamer, Director of CERP and Heather Wright, Associate Director of CERP

CRA's Center for Evaluating the Research Pipeline (CERP) recently underwent staffing changes when former Director Jane Stout left the CRA. Burçin Tamer, Ph.D., is now the Director of CERP and Heather Wright is the Associate Director. Under their leadership, CERP will extend its reach as a resource for the computing community through its Data Buddies Project, evaluation services, and other activities. Heather and Burçin are both excited to make contributions to the computing community and drive the broader mission of CRA to facilitate the development of strong, diverse talent in the field.

CERP as a Resource for the Computing Community

CERP's main goal is to be a valuable resource for the computing community. It has an extensive data collection infrastructure and uses their data to perform evaluation, provide evidence-based recommendations, and contribute knowledge to the computing community at large. With the goal of increasing responsiveness to the computing community, the center will further develop services based on the community's needs and make resources publicly and widely available.

The Data Buddies Project

CERP collects survey data from undergraduate and graduate students through the Data Buddies Project. The project currently includes 99 colleges and universities that volunteer as a network to reach computing students across the United States and Canada. The institutions distribute a survey link on behalf of CERP to all students affiliated with computing degree programs within their departments. With minimal-to-no burden on the departments that distribute the Data Buddies survey, the center is able to collect nearly 20,000 responses from students each year.

Once data collection through the project concludes, volunteer departments receive a customized annual report that provides several unique features. These reports include an executive "Your Institution at a Glance" page that visualizes some of the key variables for each institution. Additionally, the reports provide aggregated data tables comparing students from their institution against students from similar institutions. Finally, two additional chapters compare the institution's students by gender and race/ethnicity presented alongside the comparison of similar institutions' students by gender and race/ethnicity. These reports allow departments to not only learn about their students but also explore how their students' experiences measure against those from similar institutions.

The Data Buddies Project also provides an opportunity to formulate a longitudinal data collection process through which CERP obtains data at multiple time points from students who agree to participate in the study. These data are invaluable for understanding the progression of students' academic careers.

Is your department involved with Data Buddies? Contribute to this project and start receiving your own customized report by volunteering here!

Envisioning the Future *(continued)*

Evaluation Services

CERP has an extensive number of evaluation services that can provide specific recommendations to clients seeking to improve their programs for participants at all career stages (i.e., undergraduates, graduate students, postdocs, career professionals, and faculty members). The center evaluates programs using a diverse set of methods, including formative assessment, pretest-posttest design, comparative evaluation, and quasi-experimental design. Data collected through Data Buddies provides a unique opportunity to produce these comparative and quasi-experimental evaluations.

CERP currently provides evaluative assessment of webinars, stand-alone workshops, conference workshops, formal Research Experience for Undergraduates programs, fellowship programs, Living-Learning-Communities, and professional development seminars. Examples of evaluation reports are available here.

Do you have a program you would like CERP to evaluate? Contact CERP here!

Other Activities

In addition to collecting survey data and providing program evaluation services, the center engages in a number of other activities. CERP's data and analysis results are shared with the broader community through an interactive data visualization page and monthly infographics in *Computing Research News*. Furthermore, CERP uses its data resources and social science skills to make scholarly contributions to CS education research.

The center also has the capacity to provide data and research services beyond the available survey data. To date, it has responded to requests for empirical information on the state of computing education, designed and implemented data collection strategies to address specific research and evaluation needs, and served as a consulting body for social science research design.

What would you like to see in CERP's future infographics? Submit your ideas here!

Support

CERP's work is supported through National Science Foundation awards CNS-1246649 and DUE-1431112, and direct CRA contributions.

About the CERP Team

Burçin Tamer is the Director of CERP. She is responsible for overall operations and manages CERP's data resources and infrastructure as well as analysis activities. Her work provides social science support to the computing community's efforts for broadening participation.

Burçin joined CRA as a Research Scientist at CERP in May 2015 and has been Director since April 2018. Prior to joining CRA, she completed her doctoral training in Political Science and Women's Studies in 2015 at Pennsylvania State University, where she also received her Master of Arts degree in Political Science. At Penn State, she worked as a researcher on several large scale projects for which she designed and implemented data collection processes, performed analyses, and contributed to dissemination activities.

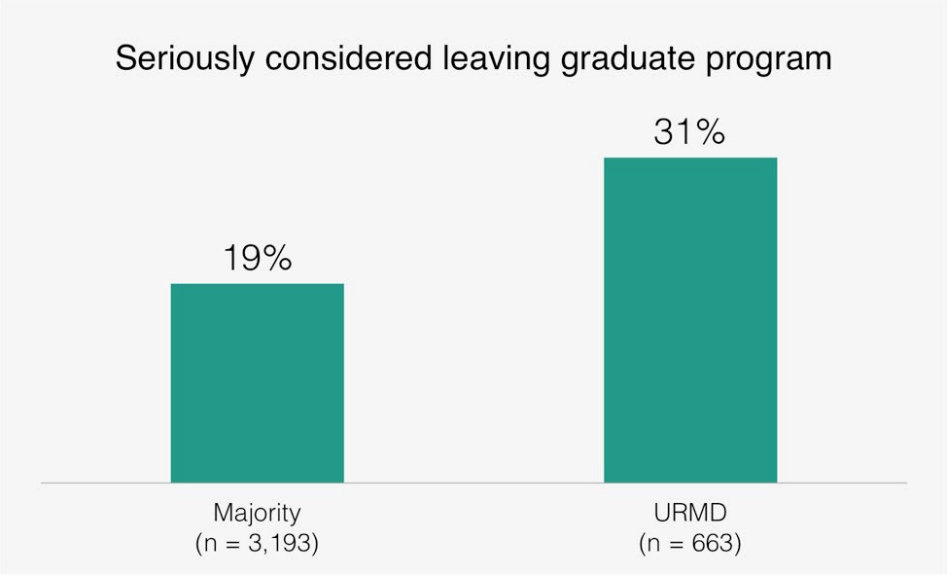
As Associate Director, **Heather Wright** leads CERP's evaluation efforts for programs aimed at broadening participation in computing-related fields. Heather also manages CERP's Data Buddies Project, a national survey initiative that collects data from undergraduate and graduate students across the United States and Canada. Heather holds a B.S. in Sociology and two minors in Technical & Business Writing and Women's Studies. She has been with the CRA since 2013.

Want to receive more updates about CERP? Subscribe to their newsletter!

About 1 in 3 Underrepresented Minority Students and Students with Disabilities (URMD) Reported Thinking About Leaving Their Graduate Program

CERP
Computing Research Association
Evaluation

By Burçin Tamer, CERP Director



This chart presents survey data from graduate students collected during the fall 2017 semester. Students were asked whether they have seriously considered leaving their program during their academic career to date. Compared to White and Asian students (Majority), who are considered the racial and ethnic majority in computing fields, students who are members of underrepresented racial and ethnic groups and students with disabilities (URMD) were 1.5 times more likely to report having seriously considered leaving their graduate program.

Broadening participation in computing requires efforts that go beyond recruiting a diverse group of students. Retaining these students is what ensures a sustainable increase in diversity across the board. While retention is an issue to consider for all students, it is particularly pertinent for students who are not in the majority in the discipline, as these students tend to face a variety of obstacles that may adversely affect their persistence in their programs.

Providing strong support structures and opportunities for networking is an important component of retaining URMD students (as well as women). For instance, CRA organized the inaugural URMD Grad Cohort Workshop on March 16-17, 2018. These types of events bring together students to form supportive relationships, network with their peers and professionals in their area, and gain insights about various professional development topics.

Notes:

The survey data used in this chart were collected during the fall 2017 by Center for Evaluating the Research Pipeline (CERP) via The Data Buddies Project. The sample includes 3,856 Master's and Ph.D. students who are in a computing related field. The difference between the proportions of URMD and majority students who reported having seriously considered leaving their graduate program was tested using a z-test and is statistically significant at $p \leq .05$ level.

Underrepresented minority (URM) students include students who identify as African American/Black, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, Arab/Middle Eastern/Persian, and Mexican American/Chicano/Puerto Rican/Other Latino. *Students with disabilities* include students who reported having at least one type of disability (auditory, intellectual, mental illness, mobility/orthopedic, speech/language, specific learning disability, and visual). *Majority* includes racial/ethnic groups who are in the majority in computing, which are White/Caucasian, East Asian, Southeast Asian, South Asian, and Other Asian.

This analysis is brought to you by the CRA's Center for Evaluating the Research Pipeline (CERP). CERP provides social science research and comparative evaluation for the computing community. Subscribe to the CERP newsletter here.

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CCC Announces New Council Members

By CCC Staff

The **Computing Research Association** (CRA), in consultation with the **National Science Foundation** (NSF), has appointed four new members to the **Computing Community Consortium** (CCC) Council:

- **Ian Foster, Argonne National Laboratory**
- **David C. Parkes, Harvard University**
- **Ronitt Rubinfeld, Massachusetts Institute of Technology**
- **Suresh Venkatasubramanian, University of Utah**

Beginning July 1, the new members will each serve three-year terms. The **CCC Council** is comprised of 20 members who have expertise in diverse areas of computing. They are instrumental in leading CCC's **visioning programs,** which help catalyze and enable ideas for future computing research. Members serve staggered three-year terms that rotate every July.

The CCC and CRA thank those Council members whose terms end on June 30 for their exceptional dedication and service to the CCC and to the broader computing research community:

- **Cynthia Dwork, Harvard University**
- **Katherine Yelick, University of California at Berkeley**
- **Elizabeth Churchill,** Google

This July **Mark D. Hill** from the **University of Wisconsin-Madison** will become Chair and **Liz Bradley** from the **University of Colorado Boulder** will become the Vice Chair. **Beth Mynatt** from **Georgia Tech** will become the Past Chair.

The CCC encourages participation from all members of the computing research community in our various activities. Each fall, the CCC issues a call for proposals for visioning activities. Each spring, the CCC issues a call for nominations for Council members effective the following July. For more information, please visit the **CCC website** or contact Dr. Ann W. Drobnis, CCC Director, at **adrobnis@cra.org.**

Full Bios of New CCC Council Members

Ian Foster is Distinguished Fellow and director of the Data Science and Learning Division at Argonne National Laboratory. He is also the Arthur Holly Compton Distinguished Service Professor of Computer Science at the University of Chicago. Ian received a BSc (Hons I) degree from the University of Canterbury, New Zealand, and a PhD from Imperial College, United Kingdom, both in computer science. His research deals with distributed, parallel, and data-intensive computing technologies, and innovative applications of those technologies to scientific problems in such domains as climate change and biomedicine. His Globus software is widely used in national and international cyberinfrastructures. Foster is a fellow of the American Association for the Advancement of Science, the Association for Computing Machinery, and the British Computer Society. His awards include the Global Information Infrastructure Next Generation award, the British Computer Society's Lovelace Medal, the IEEE's Kanai award, and honorary doctorates from the University of Canterbury, New Zealand, and the Mexican Center for Research and Advanced Studies of the National Polytechnic Institute (CINVESTAV). He was a co-founder of Univa, Inc., a company established to deliver grid and cloud computing solutions.

New Council Members *(continued)*

David C. Parkes is the George F. Colony Professor of Computer Science in the Paulson School of Engineering and Applied Sciences at Harvard University, where he founded the EconCS research group and leads research with a focus on artificial intelligence, machine learning, and economics. He is co-director of the Harvard University Data Science Initiative, a faculty co-lead for planning the expansion of the Paulson school into the Allston campus, and was Area Dean for Computer Science, 2013-2017. Parkes served on the inaugural panel of the "Stanford 100 Year Study on Artificial Intelligence," co-organized the 2016 OSTP Workshop on "AI for Social Good," and served as chair of the ACM Special Interest Group on Electronic Commerce (2011-16). Parkes is Fellow of the Association for the Advancement of Artificial Intelligence (AAAI), and recipient of the 2017 ACM/SIGAI Autonomous Agents Research Award, the NSF Career Award, the Alfred P. Sloan Fellowship, the Thouron Scholarship, and the Roslyn Abramson Award for Teaching. Parkes has degrees from the University of Oxford and the University of Pennsylvania, serves on several international scientific advisory boards, and is a technical advisor to a number of start-ups.

Ronitt Rubinfeld is a professor in the Department of Electrical Engineering and Computer Science and a member of the Computer Science and Artificial Intelligence Laboratory at MIT. Ronitt is also on the faculty of the Computer Science Department at Tel Aviv University. Ronitt's main research area is the study of algorithms which run in sublinear time. Ronitt received her PhD from the University of California, Berkeley in 1991. Prior to her position at MIT, Ronitt was on the faculty at Cornell University and at NEC Research Labs. She was an ONR Young Investigator, a Sloan Research Fellow, the 1995 Cornell Association for Computer Science Undergraduates Faculty of the Year, and a recipient of the Cornell College of Engineering Teaching Award. Ronitt has given an invited lecture at the International Congress of Mathematicians in 2006, and is an ACM Fellow.

Suresh Venkatasubramanian is a professor at the University of Utah. His background is in algorithms and computational geometry, as well as data mining and machine learning. His current research interests lie in algorithmic fairness, and more generally the problem of understanding and explaining the results of black box decision procedures. Suresh received a CAREER award from the NSF for his work in the geometry of probability, as well as a test-of-time award at ICDE 2017 for his work in privacy. His research on algorithmic fairness has received press coverage across North America and Europe, including NPR's Science Friday, NBC, and CNN, as well as in other media outlets. He is a member of the board of the ACLU in Utah, and is a member of New York City's Failure to Appear Tool (FTA) Research Advisory Council.

Learn more about the CCC Council and its members on our webpage!

John Hennessy and David Patterson Share ACM Turing Award

CCC
Computing Community Consortium
Catalyst

By Mark D. Hill

The following is from the ACM SIGARCH Computer Architecture Today Blog by CCC Vice Chair Mark D. Hill, the John P. Morgridge Professor and Gene M. Amdahl Professor of Computer Sciences at the University of Wisconsin-Madison.

ACM recently announced that computer scientists John Hennessy and David Patterson have shared the 2017 ACM Turing Award with the official citation, ***"For pioneering a systematic, quantitative approach to the design and evaluation of computer architectures with enduring impact on the microprocessor industry."*** The Turing Award is the highest award in computer science. It is given for "lasting and major technical importance to the computer field" and has been compared to a Nobel Prize, whose categories pre-date our field. ACM's formal press release is available here.

Hennessy & Patterson will present their public Turing lecture at the International Symposium on Computer Architecture (ISCA) in Los Angeles, CA on Monday, June 4, 2018. The abstract for the lecture is at the end of this blog post. FYI: I have known Hennessy and Patterson since the 1980s and Patterson was my Ph.D. co-advisor.

For this blog, I complement ACM's press release with a story–necessarily oversimplified–for how Hennessy & Patterson's work fundamentally changed and accelerated computer architecture work. First, the background. From the beginning to the late 1960s, computer architecture was in a "golden" pioneer era when, instruction set architecture, instruction level parallelism, and caches were discovered. The next phase–until early 1980s–was an era with many computer architecture proposals often supported with incomplete metrics (e.g., MFLOPS or MIPS) and qualitative arguments. Progress during this interregnum was slower.

Hennessy & Patterson ushered in multiple eras in which quantitative methods drove progress, wherein new ideas were judged experimentally on whether they systematically improved end-to-end metrics (e.g., time/program = instructions/program×cycles/instruction×time/cycle). Idea development required more rigor and more time, but the field began to move much faster because we built upon each other more systematically. Quantitative methods flourished first in the instruction-level parallelism era until early 2000s and then in multicore era to the early 2010s. Now we are experiencing a new heterogeneous era–with CPUs augmented with graphics processing units and a sea of other accelerators–whose rich possibilities will enable another golden age of computer architecture, provided good quantitative methods are developed and applied following the tenets and inspiration of Turing Laureates John Hennessy and David Patterson.

The abstract for Hennessy & Patterson's Turing lecture follows.

A New Golden Age for Computer Architecture:

Domain-Specific Hardware/Software Co-Design, Enhanced Security, Open Instruction Sets, and Agile Chip Development

John Hennessy and David Patterson

June 4, 2018

In the 1980s, Mead and Conway [1] democratized chip design and high-level language programming surpassed assembly language programming, which made instruction set advances viable. Innovations like RISC, superscalar, multilevel caches, and speculation plus compiler advances (especially in register allocation) ushered in a Golden Age of computer architecture, when performance increased annually by 60%. In the later 1990s and 2000s, architectural innovation decreased, so performance came primarily from higher clock rates and larger caches. The ending of Dennard Scaling and Moore's Law also slowed this path; single core performance improved only 3% last year! In addition to poor performance gains of modern microprocessors, Spectre

recently demonstrated timing attacks that leak information at high rates [2].

We're on the cusp of another Golden Age that will significantly improve cost, performance, energy, and security. These architecture challenges are even harder given that we've lost the exponentially increasing resources provided by Dennard scaling and Moore's law. We've identified areas that are critical to this new age:

- **Hardware/Software Co-Design for High-Level and Domain-Specific Languages**

Advanced programming languages like Python and domain-specific languages like TensorFlow have dramatically improved programmer productivity by increasing software reuse and by raising the level of abstraction. Whereas compiler-architecture co-design delivered gains of about three in the 1980s for C compilers and RISC architectures, new advances could create compilers and *domain-specific architectures* [3] (DSAs) that deliver tenfold or more jumps [4] in this new Golden Age.

- **Enhancing Security**

We've made tremendous gains in information technology (IT) in the past 40 years, but if security is a war, we're losing it. Thus far, architects have been asked for little beyond page-level protection and supporting virtual machines. The very definition of computer architecture ignores timing, yet Spectre shows that attacks that can determine timing of operations can leak supposedly protected data. It's time for architects to redefine computer architecture and treat security as a first class citizen to protect data from timing attacks, or at worst reduce information leaks to a trickle.

- **Free and Open Architectures and Open-Source Implementations**

Progress on these issues likely will require changes to the instruction set architecture (ISA), which is problematic for proprietary ISAs. For tall challenges like these, we want *all* the best minds to work on them, not only the engineers who work for the ISA owners. Thus, a free and open ISA such as RISC-V can be a boon to researchers [5] because:

- Many people in many organizations can innovate simultaneously using RISC-V.
- The ISA is designed for modularity and extensions.
- It comes with a complete software stack, including compilers, operating systems, and debuggers, which are open source and thus also modifiable.
- This modern ISA is designed to work for any application, from cloud-level servers down to mobile and IoT devices.
- RISC-V is driven by a 100-member foundation [6] that ensures its long-term stability and evolution.

Unlike the past, open ISAs are viable because many engineers for a wide range of products are designing SOCs by incorporating IP and because ARM has demonstrated that IP works for ISAs.

An open architecture also enables open-source processor designs for both FPGAs and real chips, so architects can innovate by modifying an existing RISC-V design and its software stack. While FPGAs run at perhaps only 100 MHz, that is fast enough to run trillions of instructions or to be deployed on the Internet to test a security feature against real attacks. Given the plasticity of FPGAs, the RISC-V ecosystem enables experimental investigations of novel features that can be deployed, evaluated, and iterated in days rather than in years. That vision requires more IP than CPUs, such as GPUs, neural network accelerators, DRAM controllers, and PCIe controllers [7]. The stability of process nodes due to the ending of Moore's Law make this goal easier than in the past. This necessity opens a path for architects to have impact by contributing open-source components much as their software colleagues do for databases and operating systems.

- **Agile Chip Development**

As the focus of innovation in architecture shifts from the general-purpose CPU to domain-specific and heterogeneous processors, we will need to achieve major breakthroughs in design time and cost (as happened for VLSI in the 1980s). Small teams should be able to design chips, tailored for a specific domain or application. This will require that hardware design become much more efficient, and more like modern software design.

Unlike the "waterfall" development process of giant chips by large companies, Agile development process [8] allows small groups to iterate designs of working but incomplete prototypes for small chips. Fortuitously, the same programming language advances that improved reuse of software have been incorporated in recent hardware design languages, which makes hardware design and reuse easier.

While one can stop at layout for a research paper, building real chips is inspiring for everyone in a project, and is the only way to verify important characteristics like timing and energy consumption. The good news is that today TMSC will deliver 100 small test chips in the latest technology for only $30,000 [9]. Thus, virtually all projects can afford real chips as final validation of innovation as well as to enjoy the satisfaction of seeing your ideas work in silicon.

We believe the deceleration of performance gains for standard microprocessors, the opportunities in high-level, domain-specific languages and security, the freeing of architects from the chains of proprietary ISAs, and (ironically) the ending of Dennard scaling and Moore's law will lead to another Golden Age for architecture. Aided by an open-source ecosystem, agily developed prototypes will demonstrate advances and thereby accelerate commercial adoption. We envision the same rapid improvement as in the last Golden Age, but this time in cost, energy, and security as well in performance.

What an exciting time to be a computer architect!

[1] Mead, Carver, and Lynn Conway. *Introduction to VLSI systems*. Addison-Wesley, 1980

[2] Hill, Mark. "A Primer on the Meltdown & Spectre Hardware Security Design Flaws and their Important Implications," Computer Architecture Today Blog, February 15, 2018, https://www.sigarch.org/ a-primer-on-the-meltdown-spectre-hardware-security-design-flaws-and -their-important-implications/

[3] Hennessy, John L., and David A. Patterson. "Domain Specific Architectures" in *Computer architecture: a quantitative approach*. Sixth Edition, Elsevier, 2018.

[4] Jouppi, Norman P., Cliff Young, Nishant Patil, David Patterson, et al. "In-datacenter performance analysis of a Tensor Processing Unit." In Proc. *44th Annual International Symposium on Computer Architecture*, pp. 1-12. ACM, 2017.

[5] Ceze, Luis, Mark Hill, Karthikeyan Sankaralingam, and Thomas Wenisch. "Democratizing Design for FutureComputing Platforms," June 26, 2017, www.cccblog.org/2017/06/26/democratizing-design-for-future-computing-platforms/

[6] www.riscv.org.

[7] DARPA, Broad Agency Announcement, "Electronics Resurgence Initiative," September 13, 2017.

[8] Lee, Yunsup, Andrew Waterman, Henry Cook, Brian Zimmer, et al. "An agile approach to building RISC-V microprocessors." *IEEE Micro* 36, no. 2 (2016): 8-20.

[9] Patterson, David and Borivoje Nikolić, "Agile Design for Hardware, Parts I, II, III," *EE Times*, July 27 to August 3, 2015.

Expanding the Pipeline: 2018 CRA-W Grad Cohort for Women Inspires Attendees to Persist in Computing

CRA-W
Computing Research Association
Women

By Shar Steed, CRA Communications Specialist

On April 13-14, more than 400 women graduate students in computing from more than 150 institutions converged on San Francisco, CA, for the 2018 CRA-W Graduate Cohort for Women (CRA-W Grad Cohort). Throughout the two-day workshop, professional connections were made, new friendships were formed, and mentoring relationships with senior researchers were established. CRA-W organizes this workshop as part of its mission to increase the success and participation of women in computing research.

This Year's Workshop

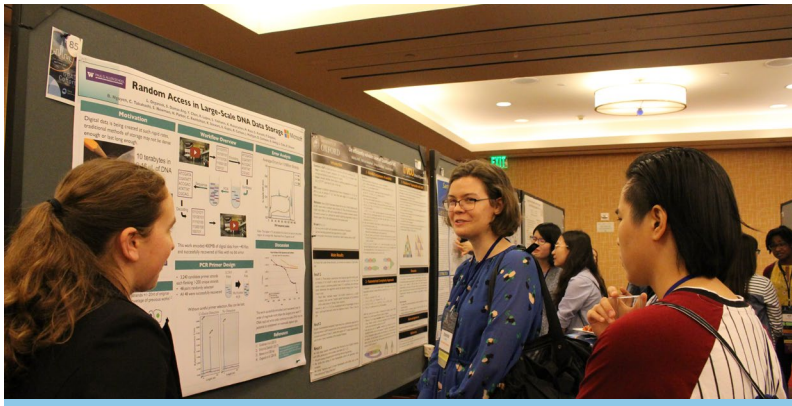
During the presentations and informal networking opportunities, participants received advice on navigating their graduate education and gained relevant insights on a wide range of topics that included networking effectively, whether to get a Master's or a Ph.D., finding an advisor and developing an effective working relationship, finding a research topic, preparing your thesis proposal and becoming a Ph.D., publishing your research, presentation and other verbal communication skills, building your professional persona, balancing graduate school with your personal life, M.S. career opportunities and job search, industry vs. academic research positions, and Ph.D. academic and non-academic career paths and job search. One session also provided perspectives from Grad Cohort alumnae. In an inspiring keynote presentation, Maria Klawe, president of Harvey Mudd College, shared her life story, describing her career path and detailing hurdles she had to overcome and obstacles she still faces every day.

The plenary session on Strategies for Human-Human Interaction was another event highlight. The speakers—Jamika Burge, Capital One; Lori Clarke, University of Massachusetts Amherst; and Margaret Martonosi, Princeton University—encouraged students to stand up for themselves, bring up issues to an advisor, and look for allies. Even though the CRA-W Grad Cohort has grown to more than 400 participants, the environment is still very welcoming and supportive. During this session (and several others), attendees felt comfortable opening up to the group and lined up to share their stories about facing challenges and about positive outcomes that came out of difficult situations.

After the Friday afternoon poster session, the energy among the attendees remained high for a reception sponsored by Microsoft Research. The DJ spun a variety of music and participants, speakers, sponsors, and staff enjoyed dancing and socializing with friends, old and new.

The Need for More Women in Computing

Women are underrepresented at all stages of the computing research career pipeline, and that is why events like the CRA-W Graduate Cohort for Women, which brings together those who may feel isolated, are crucial to supporting the creation of a diverse pipeline of the computing field. It's important to encourage women to stay the course and complete their graduate training. In testimonials collected after the workshop, a resounding theme was the participants' renewed motivation to complete their Ph.D. And CRA's Center for Evaluating the Research Pipeline (CERP) has data that supports this:



"[At Grad Cohort], the session about being a woman in computing changed my life. I thought I was the only one dealing with this pressure and it is so helpful. Now I understand that differences will always be there and that my job is learning how to succeed in that environment. The session about self-confidence is another session that I will never forget; understanding that a successful career can be accompanied with failures motivates me to stand up even when I feel that I can't." – Grad Cohort participant, 2012

Thank You, Sponsors

The 2018 CRA-W Grad Cohort Workshop was made possible through generous contributions by CRA, Microsoft Research, Association for Computing Machinery, National Science Foundation, Google, Intel Corporation, Department of Energy, a private foundation, Facebook, ACM SIGACT, ACM SIGAI, ACM SIGARCH, ACM SIGCHI, ACM SIGCOMM, ACM SIGCSE, ACM SIGGRAPH, ACM SIGHPC, ACM SIGIR, ACM SIGMICRO, ACM SIGOPS, ACM SIGPLAN, ACM SIGSOFT, Bloomberg, IBM, IEEE Computer Society, Snowflake, Whova, and, in some cases, department funds from participating universities and institutions. Please join us in thanking them for their kind support.

CRA-W Accepting Proposals for Collaborative Research Experience for Undergraduates: May 18 Deadline

CRA-W
Computing Research Association
Women

We encourage you to participate in CRA-W's Collaborative Research Experience for Undergraduates (CREU) program, which is **now accepting applications through May 18.** CREU is an undergraduate research program that provides research stipends to teams of students working on research projects under the guidance of a mentor at their home institutions. Students supported by CREU collaborate with each other and with their mentors during the academic year and, in some cases, the following summer. Students are strongly encouraged to present their CREU research at national or regional conferences. The program provides travel funds to support such participation and past CREU participants have found such activities to be extremely valuable.

This is a great opportunity for your students to become involved in computing research and engage in the research community. Please forward this opportunity to your students and fellow faculty members, who may be interested in participating in this program.

Students and faculty may submit proposals at: https://cra.org/cra-w/creu/

If you have any questions or comments regarding this program, please feel free to contact creu@cra.org.

CRA CONFERENCE 2018 at snowbird

CRA Computing Research Association

July 16-18

PROGRAM UPDATE

Monday, July 16

2:00 – 7:00 pm **Registration**

3:00 – 5:30 pm **New Chairs Workshop**
Co-chairs: Greg Hager, Johns Hopkins University, and Andrew Sears, Penn State

6:00 – 7:00 pm **Welcome Reception**

7:00 – 9:00 pm **Dinner/Awards Presentations/After Dinner Speech**

Welcome from the Conference Chairs
Kim Hazelwood, Facebook, and Vivek Sarkar, Georgia Tech

Awards Presentations
Distinguished Service and A. Nico Habermann Awards
Susan Davidson, University of Pennsylvania, and Andrew Bernat, CRA

CRA-E Faculty Mentoring Awards
Susanne Hambrusch, Purdue University

Plenary Talk
David Patterson, University of California – Berkeley and Google

Tuesday, July 17

6:00 am – 6:30 pm **Registration**

7:00 am **Breakfast**

8:30 am – 10:00 am **Plenary Panel**

Diversity in Leadership

Chair: Carla Brodley, Northeastern University

Speakers: Michelle Craig, University of Toronto, Shinder Dhillon, Microsoft, Ayanna Howard, Georgia Tech, Diane Levitt, Cornell Tech, Mark Taguchi, Management Leadership for Tomorrow, and Ruth Watkins, University of Utah

Much of the effort of the Conference at Snowbird community has focused on increasing the diversity of our students across all stages of the academic pipeline with some efforts post Ph.D. The focus of this panel of industry and academic experts is on the challenges and opportunities in retaining diverse employees. And further, on efforts to ensure leadership paths in industry and academia of diverse members of staff/faculty. In short, our focus will be on efforts to ensure that diversity does not stop at "bringing diversity in the door" – put another way, people go where they are invited and stay where they are welcomed.

10:00 am **Break**

10:30 am – noon **Parallel Tracks**

Increasing Diversity in Computing is Easier Than You Think: Some Small Steps that Make a Big Difference

Chair: Mary Hall, University of Utah

Speakers: Richard Ladner, University of Washington, and Manuel Pérez Quiñones

This panel will consider a number of common questions that colleges and universities face in trying to increase diversity of the population of computing students. The discussion will focus on the types of programs and activities that may be in reach for most academic units, and particularly for units that feel they are currently not doing enough to increase diversity and retain a diverse student population. The following questions are representative of the intended discussion.

- What programs are widely used and proven successful for recruitment, development and retention of diverse student populations in undergraduate computer science programs?
- Depending on type of institution, what are low-cost, low-effort programs that a unit can undertake?
- In universities where the entire student population is not very diverse, how can a unit create a community for students from underrepresented groups?
- Students from different underrepresented groups have unique needs. What are things a unit should think about in creating a welcoming environment for all students?
- What are examples of ways that a unit can partner with other institutions to create a diverse student pipeline?

Tuesday, July 17 *(continued)*

10:30 am – noon **Parallel Tracks *(continued)***

Growing a CS Department into a School/College of Computing
Chair: Chris Johnson, University of Utah
Speakers: Farnam Jahanian, Carnegie Mellon University, and Ruth Watkins, University of Utah
As computing continues to grow by tremendous leaps and bounds and to permeate universities' intellectual landscape, many department chairs are finding their programs have outgrown, or are outgrowing, the confines of their current locations in colleges of engineering or science. Discussions are taking place in many departments about exploring the possibility of expanding to a school or college of computing (or a similar name). In this panel, we have gathered a set of Provosts from Universities who have successfully made the transition from a Department of Computer Science to a College of Computing. The panelists will discuss the benefits of becoming a College of Computing, as well as, the challenges Departments face in making a successful transition to a College.

Department Rankings
Chair: H.V. Jagadish, University of Michigan
Speakers: Emery Berger, University of Massachusetts-Amherst, Kathryn McKinley and Kuansan Wang, Microsoft
Department rankings matter, whether we like it or not. Our community suffers when these rankings are performed poorly by external parties who may have limited understanding of our field. This is the case, even though we all understand that ranking reduces complex multi-attribute entities to a single number. This panel will describe some ways forward that are recently being explored.

Noon – 1:30 pm **Lunch**

1:30 – 3:00 pm **Parallel Tracks**

Improving Faculty Recruiting in the Computing Community
Co-chairs: Shashi Shekhar, University of Minnesota, and Josep Torrellas, University of Illinois at Urbana-Champaign
Speakers: Michael Franklin, University of Chicago, Juan Gilbert, University of Florida, Brian Noble, University of Michigan, Jennifer Rexford, Princeton University, and Craig Wills, Worcester Polytechnic Institute
Faculty recruiting challenges are on the minds of many computing research members. In this session, the panelists will discuss faculty recruiting challenges faced by departmental leadership (e.g., low yield), faculty members (e.g., multiple candidates per week), and faculty candidates (e.g., many strong candidates not getting academic interviews). It will also assess the needs, if any, for computing research community action.

Using CRA Data to Improve Your Department and Inform Decision Making
Co-chairs: Betsy Bizot, CRA, and Burçin Tamer, CRA
Speakers: James Allan, University of Massachusetts-Amherst, Tracy Camp, Colorado School of Mines, Thu Nguyen, Rutgers University, and Cal Ribbens, Virginia Tech
This session will discuss two of CRA's data sources: the Taulbee Survey and the Data Buddies Project. Attendees will learn how these data sources are distinct yet complementary and gain a better understanding of the information available from each in published reports and departmental comparison reports. Speakers will describe how departments have made use of these data, and discuss issues of individual and departmental privacy and the tradeoffs of survey length, comprehensiveness, and response rate. A portion of the session will be devoted to getting feedback on how Taulbee and Data Buddies can be of better use to the community.

Program Update *(continued)*

Tuesday, July 17 *(continued)*

1:30 – 3:00 pm **Parallel Tracks**

Augmenting, Not Replacing, People

Chair: Ann Drobnis, CRA

Speakers: Greg Hager, Johns Hopkins University, Monica Lam, Stanford, and Jenna Wiens, University of Michigan

Artificial intelligence (AI) technologies are rapidly maturing into tools that are impacting our everyday lives. However, contrary to popular conception, most of these tools will not be autonomous, stand-alone systems, but rather will manifest as human assistants and augmentations. While autonomous driving is featured in the headlines, the short-term impact of advances in this field will be increased safety, comfort, and convenience, with the driver still at the wheel. New technologies in healthcare will not replace doctors, but will leverage their skill and judgement by providing super-human augmentations for eyes, hands, and intellect. As more robots move onto the manufacturing floor, they are most likely to function as ever-smarter programmable tools, and will still require human coworkers to teach them new tasks and to do those elements that are simply too hard to automate. Meanwhile, the scope of AI personal assistants continues to broaden in terms of their impact on different aspects of human interactions. This session explores these themes, emphasizing in particular the areas where AI and people will work together to do what neither can do alone.

3:00 pm **Break**

3:30 – 5:00 pm **Networking Activities**

6:30 – 9:00 pm **Dinner**

After Dinner Talks – Computing Research Futures

Chair: Mark Hill, University of Wisconsin-Madison

Muddied Waters: Online Disinformation During Crisis Events

Speaker: Kate Starbird, University of Washington

Recent public attention and debate around "fake news" has highlighted the growing challenge of determining information veracity online. This is a complex and dynamic problem at the intersection of technology, human cognition, and human behavior—i.e. our strategies and heuristics for making sense of information may make us vulnerable, within online spaces, to absorbing and passing along misinformation. Increasingly, it appears that certain actors are intentionally exploiting these vulnerabilities, spreading intentional misinformation—or *disinformation*—for various purposes, including geopolitical goals. Drawing on research conducted on online rumors in the context of crisis response, this talk explores what alternative narratives (or "conspiracy theories") of crisis events reveal about "fake news", political propaganda, and disinformation online.

Program Update *(continued)*

Tuesday, July 17 *(continued)*

6:30 – 9:00 pm **Dinner**

Machine Learning for Science

Speaker: Kathy Yelick, University of California, Berkeley, and Lawrence Berkeley National Laboratory

While machine learning is revolutionizing many areas of computer science, it is also impacting the theory and practice of physical, energy and life sciences. But the challenges and opportunities in these domains are somewhat different. First, science requires the need to interpret and generalize models and to explain behavior in a manner consistent with physical laws. Second, the scaling problems go beyond large data sets and include very large models and machines, leveraging the access to systems and expertise in high performance computing. Third, the data may be highly complex, and may have a low signal to noise ratio, come from highly optimized sensors, or involve multi-modal data from different experiments or simulations. We expect progress in "ML for Science" will benefit these other disciplines, but will also provide feedback to aid in the power and understanding of machine learning more broadly.

Wednesday, July 18

6:00 am – 6:30 pm **Registration**

7:00 am **Breakfast**

8:30 – 10:00 am **Plenary Session**

Plenary Speaker: Raquel Urtasun, University of Toronto and Uber Advanced Technologies Group

10:00 am **Break**

10:30 am – Noon **Parallel Tracks**

Self-driving Cars: When Will They Become Mainstream?

Speakers: Raj Rajkumar, Carnegie Mellon University, Maarten Sierhuis, Nissan, and Raquel Urtasan, University of Toronto and Uber Advanced Technologies Group

Program Update *(continued)*

Wednesday, July 18 *(continued)*

10:30 am – Noon **Parallel Tracks**

Booming Faculty: Opportunities and Challenges

Chair: Laura Haas, University of Massachusetts – Amherst

Speakers: Carla Brodley, Northeastern University, Juan Gilbert, University of Florida, Elizabeth Jessup, University of Colorado, Boulder, and Dean Tullsen, UC San Diego

To cope with the rapid growth of student enrollments, many departments have been scrambling to rapidly grow their faculty. This panel will look at a number of questions raised by this rapid growth, among them:

- How can we navigate the transition from small(ish) to big(ger), and the impacts on processes (e.g., faculty meetings, hiring committees, annual review processes)?
- How can political issues from the rapid growth of one department or college in a time of budget pressures be avoided or reduced?
- How are departments coping with the additional pressure explosive growth is putting on space?
- What are the needs for additional staff to support the growth in faculty, and how are departments handling them?
- How are departments preserving collegiality, and growing or maintaining diversity as they expand?
- How are we supporting faculty research in a time of shrinking federal budgets but rising faculty numbers?
- How can we recruit sufficient high quality graduate students and deal with the additional pressures these growing numbers cause?

Diversity in Research Conferences: Spotlight and Brainstorming Solutions

Co-chairs: Sarita Adve, University of Illinois at Urbana-Champaign, and Kathryn McKinley, Google

Noon – 1:30 pm **Lunch**

1:30 – 3:00 pm **Parallel Tracks**

Recruiting, Retaining, and Advancing Teaching Faculty

Co-chairs: Dan Grossman, University of Washington and Penny Rheingans, University of Maryland Baltimore County

Speakers: Carla Brodley, Northeastern University, Michelle Craig, University of Toronto, Kevin Skadron, University of Virginia, and Ross Whitaker, University of Utah

This panel will address questions being considered by the CRA ad hoc committee on the role of teaching faculty in computing units at research universities, and in particular how administrative leaders (in particular chairs) can improve the effectiveness and satisfaction of teaching faculty. Topics are likely to include:

- What are best practices for the role of teaching faculty?
- What can CRA data tell us about the role of teaching faculty across institutions currently?
- What are the common challenges for recruiting/retaining/advancing teaching faculty and how can they be met?
- What unique perspectives do teaching faculty themselves have on these topics and how can administrative leaders better understand those perspectives?

Program Update *(continued)*

Wednesday, July 18 *(continued)*

1:30 – 3:00 pm **Parallel Tracks**

New Models for Industrial Research in CS

Co-chairs: Brent Hailpern, IBM and Joe Sventek, University of Oregon

Speakers: Maria Ebling, Medaptive Health, Maarten Sierhuis, Nissan, and Norm Whitaker, Microsoft

Companies large and small are experimenting with new models for industrial research in computer science. Some old labs have disappeared, others are re-inventing themselves, while new labs have sprung up outside the traditional IT industry. This panel will attempt to answer the following questions:

- Why change the model? What is broken and how do the new models fix the problem?
- Do students require different academic preparation to succeed (in both academia and industry)?
- Do these models enhance the ability for researchers to migrate between industry and academia? Is there a viable career path for researchers keeping one foot in an academic job and the other in industrial research?
- Do the traditional models of measuring impact (publications, citations, professional society participation and awards) still matter?

Increasing Social Responsibility in Computing Professionals — What Should CS Departments and Labs Do?

Chair: Moshe Vardi, Rice University

Speakers: Barbara Grosz, Harvard University, Vijay Kumar, University of Pennsylvania, Illah Nourbakhsh, Carnegie Mellon University, and Ellen Zegura, Georgia Tech

A profound shift in the public view of computing has taken place recently. Computing was traditionally viewed as a source of innovation, economic growth, good jobs, and cool gadgets. In the past few months, one reads in the mainstream media descriptions of Silicon Valley as "tax-avoiding, job-killing, soul-sucking machine" and of cyberspace as "a dark and lawless realm where malevolent actors ranging from Russian trolls to pro-ISIS Twitter users could work with impunity to subvert the institutional foundations of democracy." Computing today is one of the greatest forces driving societal change, and computing professionals must accept their share of social responsibility. The question to computer science departments and labs is "What specifically should we do to address this challenging responsibility?" The panel will present several points of view on how to respond to the social-responsibility challenge from both the research perspective and the education perspective.

3:30 – 5:00 pm **Making a Federal Case for Computing Plenary**

Speaker: Peter Harsha, CRA

5:00 pm **Break**

6:30 pm **Dinner**

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Updates on NSF CISE Leadership

By Jim Kurose, Assistant Director of the National Science Foundation (NSF) for Computer and Information Science and Engineering (CISE), and Erwin Gianchandani, Deputy Assistant Director of NSF for CISE

We are delighted to provide an update on recent leadership changes within the National Science Foundation's (NSF) Directorate for Computer & Information Science & Engineering (CISE) over the last several months:

- In the Office of Advanced Cyberinfrastructure (OAC), **Dr. Manish Parashar** joined CISE in February 2018 as the Office Director. Manish joined NSF from Rutgers, the State University of New Jersey, where he is a Distinguished Professor and was the founding Director of the Rutgers Discovery Informatics Institute and the Applied Software Systems Laboratory. Manish served as Program Director in the then-Office of Cyberinfrastructure from 2009 to 2011.
- Dr. Balasubramanian "Bala" Kalyanasundaram, Professor and recent Chair of Computer Science at Georgetown University, rejoined CISE as the Acting Division Director for Computing and Communication Foundations (CCF) in March 2018. Bala previously served as program director in CCF and led the CISE-wide Exploiting Parallelism and Scalability program. Bala is providing the scientific expertise essential to the continued success of the CCF division and will ensure a smooth transition in leadership as the search for the next CCF DD continues and concludes.
- Dr. Thyagarajan "Thyaga" Nandagopal has been appointed as the Deputy Division Director in CCF. Thyaga has been with NSF/CISE since February 2012, and until his transition to CCF, he managed the wireless research portfolio, including the **Platforms for Advanced Wireless Research (PAWR) program,** within the CISE Division of Computer and Network Systems.
- We recently **announced** that Dr. Henry Kautz will join as the Division Director for Information and Intelligent Systems (IIS) on June 11, 2018. Henry is joining from the University of Rochester, where he is Professor and Founding Director of the Georgen Institute for Data Science.
- We are delighted **Irene Qualters,** who previously served as OAC Office Director (and ACI Division Director) since April 2014, will continue as a Senior Science Advisor in CISE. Irene will continue to contribute to strategic leadership and stewardship of new directions for CISE activities, particularly for the "Big Ideas for Future NSF Investment" in Major Research Equipment and Facilities Construction and Midscale Infrastructure; and will help sustain the Nation's leadership in advanced computing through interagency and public-private partnerships, as articulated in the **National Strategic Computing Initiative (NSCI).**
- In addition, Howard Wactlar, from Carnegie Mellon University, who has served as the Acting Division Director for IIS since February 2017, will continue in CISE as a Senior Advisor upon Henry's arrival. Howard previously led IIS from 2010 to 2014. During his recent time at NSF, he has provided leadership for the Big Idea, Future of Work at the Human-Technology Frontier and has also led a major revision of the NSF-wide Cyberlearning for Work at the Human-Technology Frontier program, transitioning its focus toward continuous education and adult retraining in the face of emerging technologies, such as artificial intelligence.

We also want to acknowledge Dr. S. Rao Kosaraju, who returned to Johns Hopkins University earlier this year after serving as the Division Director for CCF since January 2014. Rao demonstrated tremendously thoughtful and effective leadership for CCF, CISE, and the broader computing research community.

While we highlight changes to our leadership team here, we want to also express that we are incredibly appreciative of all those who serve in CISE more generally! Indeed, many of our scientific staff come from the community and are on temporary leave from their home institutions, **serving through Intergovernmental Personnel Act (IPA) assignments.** These rotators help ensure important connections to the broader research community.

We invite you to get involved as well! You can serve on panels, participate in workshops, and serve on advisory committees. Even more, consider an IPA assignment at NSF or at another federal agency. To learn more about the life of computing researchers in policy roles in DC, see the **CRN column *CS in DC*.**

By serving at NSF, you can help to continue NSF's stellar track record for advancing transformative research through our investments in people, ideas, and infrastructure. We promise it'll be an interesting and rewarding experience!

Dan Reed Named Senior Vice President for Academic Affairs at the University of Utah

CRA
Computing Research Association

(Photo by: Tom Jorgensen/University of Iowa)

Former CRA Board Chair Dan Reed has been named senior vice president for academic affairs at the University of Utah. Reed is currently on the faculty at the University of Iowa and will begin his new position on July 1.

From the University of Utah announcement:

> *"Dan is an exceptional addition to the university's leadership team and the thought leadership of our state," said university President Ruth V. Watkins. "He is a talented scholar and administrator and the perfect fit in our efforts to become one of the country's premier public universities. I look forward to working closely with him in the years ahead."*

Click here to read the full news release.

Professional Opportunities

Brown University

Brown DSI-Tripods Postdoctoral Research Associate

The Data Science Initiative (DSI) at Brown University seeks applications for non-tenure track faculty positions with a start date of July 1, 2018. These are one-year positions, potentially renewable for a second year. Candidates are required to have received a Ph.D. degree or equivalent by the start of this appointment.
There will be teaching opportunities in mathematics, statistics, and data science courses at the undergraduate and/or Masters level. Responsibilities include active engagement in DSI activities. Successful candidates will contribute to the data science research activities of the NSF-TRIPODS Phase 1 Institute, which include (but are not limited to) geometry and topology of data, causal and model-based inference, and data analysis on massive graphs and networks.

To apply, please use Interfolio (*https://apply.interfolio.com/49651*) and submit the relevant materials (cover sheet, curriculum vitae, a concise description of research and teaching interests, and three letters of recommendation. Applications will be considered until the position(s) are filled but we strongly encourage the candidates to submit complete applications (including reference letters) by April 6, 2018 for full consideration). Inquiries should be sent electronically to *dsi-info@brown.edu.*

Brown University is committed to fostering a diverse and inclusive academic global community; as an EEO/AA employer, Brown considers applicants for employment without regard to, and does not discriminate on the basis of, gender, race, protected veteran status, disability, or any other legally protected status.

Bryn Mawr College

Lecturer or Visiting Assistant Professor

The Department of Computer Science at Bryn Mawr College invites applications for a full-time, one-year position in Computer Science starting August 2018. An advanced degree (completed Ph.D. preferred, but ABD or Master's is acceptable) in Computer Science is required. For more details on the position, please visit the Interfolio link below.

To apply, submit a cover letter; curriculum vitae; sample syllabi of courses able to offer and course evaluations from past courses (if available); together with two letters of reference via Interfolio at: *https://apply.interfolio.com/50115.*

Review of applications will begin immediately and continue until position is filled.

The Citadel

Tenure-Track Position in Computer Science

The *Department of Mathematics and Computer Science* invites applications for a tenure-track faculty position in computer science at the Assistant Professor level beginning August 2018. Minimum qualifications include an earned Ph.D. in computer science and a commitment to excellence in teaching, research, and service. In addition, candidates should display the core values of The Citadel: honor, duty, and respect. Candidates from all areas of computer science are encouraged to apply, especially those with strong backgrounds in cybersecurity.

Located in beautiful Charleston, S.C., *The Citadel* is a fully accredited, public, comprehensive, co-educational college with a student body of 2300 undergraduate and 1000 evening and graduate students. **The Citadel has been designated as a National Center of Academic Excellence in Cyber Defense Education by National Security Agency and Department of Homeland Security.** The Department of Mathematics and Computer Science has 16 full-time faculty members covering the areas of mathematics, statistics, and computer science. The department offers B.S. in computer science, M.S. in computer and information science, a graduate certificate in cybersecurity, and minors in computer programming, management information systems, and cybersecurity. Teaching responsibilities include undergraduate courses in computer science for majors and minors and graduate-level courses in our joint Master of Science program with the College of Charleston. A normal teaching load is nine-twelve hours per week with small class sizes.

The Citadel supports faculty scholarship and professional development. Internal funding is available for research,

development, and travel. Salary and fringe benefits are competitive, and other benefits include convenient parking and access to the Citadel Beach House located on the Isle of Palms.

Applicants should submit a letter of application, curriculum vita, copies of transcripts, a statement of teaching philosophy, a statement of research plan, and at least three letters of recommendation with at least one that addresses applicant's teaching. All application materials should be submitted online at The Citadel Careers web site, ***http://careers.pageuppeople.com/743/cw/en/job/495434/assistant-professor-in-computer-science.*** If you have any questions or concerns while applying at the Citadel Careers web site, please call The Citadel's Human Resources Office at 843-953-6922.

Questions about the position may be directed to Dr. Shankar M. Banik, *Chair, Computer Science Search Committee, Department of Mathematics and Computer Science, The Citadel, 171 Moultrie Street, Charleston, SC 29409,* phone: 843-953-5039, or email: ***shankar.banik@citadel.edu.*** Review of applications will begin on March 1, 2018, and will continue until the position is filled.

Applications from women and minorities are especially encouraged. The Citadel is an affirmative action/equal opportunity employer actively committed to ensuring diversity in all campus employment.

Georgetown University

Graduate Program Director, Department of Computer Science

The ***Department of Computer Science*** at ***Georgetown University*** seeks a Graduate Program Director to manage and provide administrative support for our graduate programs. The program currently supports roughly 40 MS students and 25 PhD students and is expected to grow over time

Responsibilities include but are not limited to:

- advertising the programs
- recruiting students for the Master's and PhD positions
- managing admissions for Master's students
- managing student visits and orientations
- advising students
- tracking student progress
- professional networking

The Program Director will teach one class each academic year in support of the department.

This position will report directly to the Chair of the Department. The person hired will work closely with and complement the role of the Director of Graduate Studies, who leads graduate curricular activities and PhD admissions. The Program Director will interact with the graduate committee on issues related to admissions and policy decision and will also work with the administrative officer in computer science and staff in the Graduate School of Arts Sciences to ensure that different needs of the students are met.

The position requires a PhD in Computer Science or closely related area. A minimum of 3 years in CS education is required. The successful applicant will have good interpersonal and administrative skills and be dedicated to excellence in graduate computer science education.

Please follow this link to see the full job description and to apply.

Georgetown University is an Equal Opportunity/Affirmative Action Employer fully dedicated to achieving a diverse faculty and staff. All qualified applicants are encouraged to apply and will receive consideration for employment without regard to race, color, religion, national origin, age, sex (including pregnancy, gender identity and expression, and sexual orientation), disability status, protected veteran status, or any other characteristic protected by law.

For questions, contact Clay Shields (***clay@georgetown.edu***) at 202-687-2004.

Johns Hopkins University

Teaching Track Faculty

The Whiting School of Engineering at Johns Hopkins University seeks applicants for a full-time teaching position in the area of engineering computation and programming. This is a career-oriented, renewable appointment that is responsible for the development and delivery of introductory computing courses to undergraduate students from majors throughout the university. Teaching faculty members are also encouraged to engage in departmental

and university service and may have advising responsibilities. Opportunities to teach upper-level and graduate level courses may also be available, depending on the candidate's background. Extensive grading support is given to all instructors. The Schools of Engineering and of Arts and Sciences have a well-established non-tenure track career path for full-time teaching faculty culminating in the rank of Teaching Professor.

Johns Hopkins is a private university known for its commitment to academic excellence and research. The teaching faculty member will be appointed in the academic department within the Whiting School of Engineering that most closely aligns with their academic background. See the school webpages at *https://engineering.jhu.edu/* for additional information about the school, including undergraduate programs and current course descriptions.

Applicants for the position must have a Masters degree or Ph.D. in Computer Science, Computer Science Education, Engineering Education or an engineering discipline in a closely related field, demonstrated excellence in and commitment to teaching, and excellent communication skills. Candidates with experience teaching programming in C, C++, Java, Python or MATLAB are preferred.

Applicants should apply using the online application *https://apply.interfolio.com/49117.* Please submit a cover letter, curriculum vitae, teaching statement, and recent teaching evaluations. Three letters of reference will also be required. Letter writer information should be provided in the application. Applications will be evaluated on a rolling basis. Questions should be directed to *WSELecSearch@jhu.edu.*

The Johns Hopkins University is committed to active recruitment of a diverse faculty and student body. The University is an Affirmative Action/Equal Opportunity Employer of women, minorities, protected veterans and individuals with disabilities and encourages applications from these and other protected group members. Consistent with the University's goals of achieving excellence in all areas, we will assess the comprehensive qualifications of each applicant.

The Whiting School of Engineering is committed to building a diverse educational environment.

Johns Hopkins University

Head, Department of Computer Science

The Whiting School of Engineering at Johns Hopkins University (*https://engineering.jhu.edu/*) invites nominations and applications for the role of Head of the Department of Computer Science. This is an outstanding opportunity for an accomplished scholar with leadership experience, in collaboration with a growing faculty and an enterprising dean, to further strengthen an exceptional department at the nation's first research university. Important opportunities for impact include continued expansion of the breadth, depth, and intensity of research and education in the Department; recruiting and retaining outstanding faculty and students; increasing the diversity of faculty, students, and staff; broadening the Department's engagement with industry as well as with other departments, centers, and institutes in the University; increasing gift and grant support; and ensuring that degree programs are in the forefront of their fields. The means to these ends, the measures of success, and the prioritization of activities designed to achieve them are matters the Head will define in collaboration with the faculty and the Dean.

Established in 1986, the Department of Computer Science (CS) has grown to become one of the largest departments in the Whiting School. It currently has 29 full-time tenured and tenure-track faculty members, three full-time teaching faculty, 11 full-time and adjunct research faculty members, over 450 undergraduate students pursuing a first or second major, and approximately 250 graduate students. The annual research budget has grown to over $20M per year, and the research portfolio includes hundreds of papers appearing at top conferences and journals. The CS website is *https://www.cs.jhu.edu.*

Serving a renewable five-year term, the Head will be appointed as a full-time tenured faculty member in CS and will be encouraged to remain active in research, though strategic leadership of the Department will be his/her top priority. S/he will be a distinguished computer scientist and proven leader who can inspire and collaborate with faculty, staff, and students and who will work proactively

with the Dean, other WSE department leaders, and leaders of academic and research units across and beyond Hopkins. Successful applicants will evidence the intellectual distinction, entrepreneurial creativity, collaborative spirit, transparency, inclusiveness, and creativity that characterize the School's culture, along with the scholarly credentials required for appointment as full professor.

The Whiting School of Engineering has engaged Opus Partners to support the recruitment of the CS Department Head. Applicants should submit a single PDF containing a letter of interest outlining their research and leadership experience, their CV, and a two- to three-page statement of research interests to *laura.jenks@opuspartners.net.* Nominations, recommendations, expressions of interest, and inquiries should go to the same address. Applications received by July 31, 2018 will receive full consideration. Every effort will be made to ensure candidate confidentiality.

The Whiting School of Engineering and the Department of Computer Science are committed to building a diverse educational environment, and women and minorities are strongly encouraged to apply. The Johns Hopkins University is an equal opportunity employer and does not discriminate on the basis of gender, marital status, pregnancy, race, color, ethnicity, national origin, age, disability, religion, sexual orientation, gender identity or expression, veteran status, other legally protected characteristics or any other occupationally irrelevant criteria. The University promotes Affirmative Action for minorities, women, individuals who are disabled, and veterans. Johns Hopkins University is a drug-free, smoke-free workplace.

King's College

Visiting Assistant Professor of Computer Science

King's College anticipates an opening for a visiting Assistant Professor of Computer Science starting Fall 2018. Candidates must hold an advanced degree, preferably a Ph.D., in Computer Science from an accredited institution by the start date. Teaching experience preferred. The successful candidate will teach a broad range of computer science courses as well as introductory courses to non-majors. Normal teaching load is 12 hours per semester. Primary interest and commitment must be to quality instruction and to formally training and mentoring young computer scientists.

To apply, send one *.pdf file containing a letter of interest, CV, teaching philosophy (two-page maximum length), transcripts, and three letters of professional reference to *hrjobs@kings.edu.* Review of applications will begin immediately and continue until the position is filled.

King's College is a private, Catholic, teaching college of the liberal arts and sciences and pre-professional programs sponsored by the Congregation of Holy Cross. It serves over 2400 full-time and part-time graduate and undergraduate students. A rigorous core curriculum provides the foundation for all majors. The College is located near downtown Wilkes-Barre, on the edge of the Pocono Mountains. King's is committed to recruiting a diverse faculty and student body and welcomes applications from persons of traditionally under-represented groups. EOE *www.kings.edu*

MIT Lincoln Laboratory

Cryptography Researcher

Our Secure, Resilient Systems and Technology Group is looking for a Cryptography Researcher. We are looking for someone to provide expertise in theoretical and applied cryptography and lead research in the areas of cryptographic algorithms and protocols.

For a full description, please go to: *https://careers.ll.mit.edu/job/Cryptography-Researcher-MA/463250800/*

NEC Laboratories America

Researcher and Senior Associate Researcher – Data Science & Systems Research

The Data Science & Systems Research Department of **NEC Laboratories America** aims to build novel big data solutions and service platforms that simplify complex computer systems management, and to develop new information technology that supports innovative applications, from big data analytics to the Internet of Things.

Our research is both experimental and theoretical, covering many domains in data science and system research, such as: time series mining, graph mining, deep learning, text mining, anomaly detection, signal processing, cloud computing, data centers, software-defined networking and streaming processing.

The goal of our research is to fully understand the dynamics of big data from complex systems, retrieve patterns to profile them and build innovative solutions to help end user managing those systems. We have built a number of analytic engines and system solutions to process and analyze big data and support various applications in detection, prediction and optimization. Our research leads to both award-winning NEC products and publications in top conferences.

Our group is looking for Researchers and Senior Associate Researchers to work in the areas of artificial intelligence, machine learning and data mining. The ideal candidate must have expertise in one of the above areas, and can develop algorithms to analyze massive data and build innovative applications. He/she must have a PhD in CS/CE with a strong publication record in at least one of the following areas:

- Machine learning and AI (Especially neural networks and deep learning)
- Text mining and information retrieval
- Time series analysis and prediction
- Graph and information network mining
- Data mining and statistical learning
- Large scale optimization and learning
- Signal processing, image processing and computer vision

NEC Labs is located in Princeton, NJ, home of the Princeton University and one of New Jersey's most beautiful and idyllic towns. The area offers many exciting cultural, entertainment and outdoor activities. The office is minutes away from Princeton University and an hour from New York, Philadelphia, and the Atlantic Ocean.

For more information about NEC labs, access ***http://www.nec-labs.com/***, and submit your CV and research statement through our career center at ***https://www.appone.com/MainInfoReq.asp?R_ID=1802426.***

EOE-M/F/D/V

NYU Abu Dhabi

Assistant Instructor
Computer Science

New York University has established a campus in Abu Dhabi, United Arab Emirates, and invites applications for an Assistant Instructor position in the field of Computer Science. We encourage applicants with experience in teaching of Computer Science undergraduate courses. A B.Sc. in Computer Science or a B.Eng. in Computer Engineering is required. Candidates with a Masters degree in Computer Science, Computer Engineering, or related fields are encouraged to apply, and those who have a Ph.D. in Computer Science, Computer Engineering, or related fields will also be considered in special cases.

The Assistant Instructor will support NYU Abu Dhabi's education mission by assisting in the instruction of the Computer Science courses that are part of the Computer Science undergraduate curriculum. The instructor will also be responsible for taking part in departmental activities and responsibilities, and providing assistance with the preparation, development, instruction, and assessment of recitations and labs. During January Term and Summer Term, Assistant Instructors will support teaching and research through a variety of activities that may include research with a faculty member or conducting instructional enhancement projects, or both. Instructors undergo training during the last two weeks of August each academic year. Salaries are extremely competitive with a generous benefits package, and appointments are for two to three years with the opportunity to renew. The Assistant Instructor is also expected to acquire, set up, and maintain hardware and software computing equipment required for teaching and research in Computer Science, as well as provide instrumentation support for faculty and students regarding research projects. The Assistant Instructor is expected to test-drive new equipment and software, and liaison with the main IT department regarding collaborative projects. It is desirable for the Assistant Instructor to have experience in areas such as hosting systems, networking, virtualization, databases, solid modeling, and distributed systems.

Applicants should submit a resume, teaching statement, cover letter, and three letters of reference in PDF format to be considered. Please visit our website at: *https://apply.interfolio.com/49110* for instructions and other information on how to apply. Applications are open until filled. If you have any questions, please e-mail *nyuad.science@nyu.edu*

About NYUAD:
NYU Abu Dhabi is a degree-granting research university with a fully integrated liberal arts and science undergraduate program in the Arts, Sciences, Social Sciences, Humanities, and Engineering. NYU Abu Dhabi, NYU New York, and NYU Shanghai, form the backbone of NYU's global network university, an interconnected network of portal campuses and academic centers across six continents that enable seamless international mobility of students and faculty in their pursuit of academic and scholarly activity. This global university represents a transformative shift in higher education, one in which the intellectual and creative endeavors of academia are shaped and examined through an international and multicultural perspective. As a major intellectual hub at the crossroads of the Arab world, NYUAD serves as a center for scholarly thought, advanced research, knowledge creation, and sharing, through its academic, research, and creative activities.

UAE Nationals are encouraged to apply.

NYU Shanghai

Postdoc Position in Human-Computer Interaction and Computer Music

Earliest Starting date: May, 2018

ONE postdoctoral position is available at the Music X Lab in the School of Computer Science and Engineering at New York University, Shanghai Campus, China. The project is haptic guidance for flute tutoring, which aims to develop a novel haptic approach to help people learn flute (instruments in general) much more efficient than traditional methods. The project is a collaboration between New York University, Dartmouth College, and Carnegie Mellon University. It includes 3D modeling, mechanical engineering, user study design, and computer music algorithm design for instrument tutoring. The position will be one year with possibility of an extension pending performance and funding.

The post-doc will be responsible to develop new haptic hardware and design haptic guidance techniques to effectively lead human motions via mechanical control. (The first prototype has just been accepted by a top computer music conference NIME; the arXiv version is at *https://arxiv.org/abs/1803.06625*.) The post-doc will also coordinate the work of graduate and undergraduate team members. A strong background is required in human-computer interaction. The candidate should also be family with rapid prototyping tools, such as 3d-printing, fabrication, and Arduino. Strong experiences are preferred in either mechanical engineering, circuit design, or computer music.

Applications should be sent by email (to Dr. Gus Xia, *gxia@nyu.edu*) with subject "Postdoc at Music X Lab_YOURNAME". The email should include:

1. A comprehensive CV
2. Expected date of availability
3. Contact Information for at least two references.

Oklahoma State University

Visiting Assistant Professor

Applications are invited for one Visiting Assistant Professor position for the 2018-2019 academic year, August 2018 to May 2019. The position is contingent upon availability of funds.

The Oklahoma State University (OSU) Computer Science Department is seeking applications from candidates in all areas of Computer Science. Candidates with teaching experience and knowledge of the Java programming language will be given preference. An earned Ph.D. in Computer Science or a closely-related field from an accredited institution is required at the time of appointment. The position is for the main OSU campus in Stillwater; however, duties may be assigned in either the OSU-Stillwater campus, the OSU satellite campus in Tulsa, or both.

The OSU Computer Science Department (*http://www.cs.okstate.edu/*) is strongly committed to excellence in research, teaching, and outreach. The Department offers the B.S., M.S., and Ph.D. degrees in Computer Science and has a Graduate Certificate Program in Big Data Analytics.

The Department also offers courses to students at remote sites using interactive video and the Internet. There are currently about 276 undergraduate students and about 75 graduate students enrolled in the Department.

To apply, visit: *http://cs.okstate.edu/VAP_Search-2018-2019*

For full consideration, applications should be received by May 11, 2018; however, applications will be considered until the position has been filled.

OSU is an AA/EEO/E-Verify Employer

Postdoctoral Scholar, Software Systems Security Lab

We're seeking several researchers and postdoctoral scholars, broadly in the area of software and systems security, formal methods, and programming languages.
See details at: **http://apptrkr.com/1194384**

CAMPUS SECURITY CRIME STATISTICS: For more about safety at Penn State, and to review the Annual Security Report which contains information about crime statistics and other safety and security matters, please go to http://www.police.psu.edu/clery/, which will also provide you with detail on how to request a hard copy of the Annual Security Report.

Penn State is an equal opportunity, affirmative action employer, and is committed to providing employment opportunities to all qualified applicants without regard to race, color, religion, age, sex, sexual orientation, gender identity, national origin, disability or protected veteran status.

Princeton University

Computer Science Lecturer

The Department of Computer Science seeks applications from outstanding individuals who share our strong commitment to undergraduate education to join our teaching faculty for full and part-time Lecturer positions.

Computer Science is enjoying record popularity at Princeton, and opportunities abound to engage with our outstanding students at many levels. Our large undergraduate courses are the shared responsibility of a team of faculty and graduate assistants. A successful candidate for this position will participate in such a team at the outset. Job responsibilities can also include teaching upper-level courses, advising undergraduate research, curriculum development, state-of-the-art software technology development, data analytics, outreach to under-represented groups, and online content development.

Research and scholarship in CS education or in any area of CS is also encouraged. An advanced degree in computer science, or related field, is required (PhD preferred).

Applications must include a cover letter, curriculum vitae, teaching statement, material relevant to evaluating the applicant's teaching abilities and research accomplishments, and contact information for at least three references. To apply, please submit a cover letter, CV, and contact information for three references to *https://puwebp.princeton.edu/AcadHire/apply/application.xhtml?listingId=6401.*

This position is subject to the University's background check policy.

Purdue University

Assistant/Associate Professor of Practice Positions

The Department of Computer Science at Purdue University is soliciting applications for Professor of Practice positions at the Assistant or Associate Professor level to begin Fall 2018. These are newly created positions offering three- to five-year appointments that are renewable based on satisfactory performance for faculty with primary responsibilities in teaching and service. Applicants should hold a PhD in computer science or a related field, or a BS degree in computer science or a related discipline and commensurate experience in teaching or industry. Applicants should be committed to excellence in teaching, and should have the ability to teach a broad collection of core courses in the undergraduate curriculum. Applicants will

The School of Information at the University of California, Berkeley seeks applications for a pool of part-time, non-tenure track lecturers to teach courses in Information. Screening of applicants is ongoing and will continue as needed. The number of positions varies from semester to semester, depending on the needs of the school. Positions may range from 17% to 35% time.

Applicants will be selected from this pool for the 2018-19 academic year (including summer semester), when there is curricular need. Positions typically start at the beginning of the semester, and appointments may be renewable based on need, funding, and performance.

Responsibilities

We are seeking outstanding lecturers who can teach courses in our Master's of Information Management and Systems program. In addition to teaching responsibilities, general duties include holding office hours, assigning grades, advising students, and preparing course materials.

Basic Qualifications

The minimum qualifications required to be an applicant are an advanced degree (Master's or Ph.D. or equivalent degree) or at least five years of relevant professional experience in a technical, social science, or interdisciplinary field such as Information, Information Science, Statistics, Computer Science, Engineering, Political Science, Sociology, Law, or Economics required at time of application.

Additional Qualifications

The Information Management lecturer will have teaching experience in at least one of the following core areas:

- Information Management
- International Economics and Policy
- User-centered Design
- Data Analysis and Visualization
- Other Areas of Information Systems and Services

Preferred qualifications include: a record of superior academic or professional performance; the ability to be self-directed with broadly-defined limits on assignments; excellent communication skills, both oral and written; and a demonstrated ability to interact efficiently with diverse people in a highly multidisciplinary environment.

Salary

The salary per course will be determined by level of education and experience (in teaching, research, and practice).

The School of Information is interested in candidates who will contribute to diversity and equal opportunity in higher education through their teaching or other related areas. If the candidate has made contributions to this area, we recommend they submit a statement addressing past and/or potential contributions.

UC Berkeley has an excellent benefits package as well as a number of policies and programs to support employees as they balance work and family, if applicable.

To apply, please go to the following link: **http://apptrkr.com/1192482**

Applicants should submit a Cover Letter, a Curriculum Vitae, and a Statement of Teaching Interest/Experience/Approach, and provide contact information only for three (3) references. Please indicate which MIMS class(es) you are qualified to teach in the Statement of Teaching Interest/Experience/Approach. Optionally, applicants may provide a Statement of Research and up to three (3) PDF copies of recent publications, as well as a Statement of Contributions to Diversity (statement addressing past and/or potential contributions to diversity through teaching or other related areas).

Letters of reference will only be solicited for finalists. All letters will be treated as confidential per University of California policy and California state law. Please refer potential referees, including when letters are provided via a third party (i.e., dossier service or career center), to the UC Berkeley statement of confidentiality (http://apo.berkeley.edu/evalltr.html) prior to submitting their letters.

This pool will remain open until March 11, 2019 to accommodate course needs and new applicants. Appointments are made for three semesters per year: fall, spring, and summer. If you wish to remain in the pool after March 11, 2019 you will need to reapply.

Please note: The use of a lecturer pool does not guarantee that an open position exists. See the review date specified in AP Recruit to learn whether the school is currently reviewing applications for a specific position. If there is no future review date specified, your application may not be considered at this time.

Please direct questions to: **dean@ischool.berkeley.edu**

The University of California is an Equal Opportunity/Affirmative Action Employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, national origin, disability, age or protected veteran status. For the complete University of California nondiscrimination and affirmative action policy see: http://policy.ucop.edu/doc/4000376/NondiscrimAffirmAct.

also be expected to develop and supervise project courses for undergraduates. Review of applications and candidate interviews will begin on April 1, 2018, and will continue until the positions are filled.

The Department of Computer Science offers a stimulating and nurturing educational environment with thriving undergraduate and graduate programs and active research programs in most areas of computer science. Additional information about the department is available at *http://www.cs.purdue.edu.* Salary and benefits will be competitive.

Postdoctoral Scholar - Information and Cybersecurity - School of Information

The School of Information at the University of California, Berkeley seeks applications for multiple Postdoctoral Scholars, in the area of Information and Cybersecurity, at 100% time, to help teach in, build, and be an integral part of our web-based Master's of Information and Cybersecurity program (cybersecurity.berkeley.edu).

The number of positions varies from semester to semester, depending on the needs of the School. Positions typically start in January, May, and August, and appointments may be renewed based on need, funding, and performance.

This is a full-time, one- or two-year, renewable, postdoctoral position.

The position will include teaching sections in our online Master's program, research collaboration, and participation in the intellectual community at the School of Information and on the Berkeley campus.

Basic qualifications: A Ph.D. or equivalent degree is required at time of application or the completion of all degree requirements except the dissertation at the time of application.

Additional Qualifications: A Ph.D. or equivalent degree is required by the date of hire.

Successful candidates will have earned a doctoral degree in a relevant technical, social science, or interdisciplinary field such as Information, Information Science, Cybersecurity, Statistics, Computer Science, Engineering, Political Science, Sociology, Law, or Economics. The Information and Cybersecurity postdoc will have teaching and research experience in at least one of the following core areas or course offerings:

- Cybersecurity Legal, Political, and Economic Context
- Cryptography
- Secure Programming
- Network Security
- Usable Privacy and Security
- Managing Cyber Risk
- Privacy Engineering
- Operating System Security
- Cloud Security
- Mobile Security
- Web Security

Please indicate in your Statement of Teaching which class(es) you believe you are qualified to teach.

Preferred qualifications include a record of superior academic or professional performance; the ability to be self-directed with broadly-defined limits on assignments; excellent communication skills, both oral and written; and a demonstrated ability to interact effectively with diverse people in a highly multidisciplinary environment.

Salary: Starting salaries are typically in the range of $60,000 to $65,000 per year and commensurate with qualifications and experience.

The School of Information is interested in candidates who will contribute to diversity and equal opportunity in higher education through their teaching or other related areas. If the candidate has made contributions to this area, we recommend they submit a statement addressing past and/or potential contributions.

To apply, please go to the following link: **http://apptrkr.com/1203808**

Applicants should submit a Cover Letter, a Curriculum Vitae, a Statement of Teaching Interests/Experience/Approach, a Short Statement of Research Interests/Experience/Approach, and a PDF copy of recent publication. Optionally, applicants may provide Course Evaluations, up to two (2) additional PDF copies of recent publications, as well as a Statement of Contributions to Diversity (statement addressing past and/or potential contributions to diversity through teaching or other related areas).

All letters of reference will be treated as confidential per University of California policy and California State law. Please arrange for letters of recommendation to be uploaded directly by recommenders. Please refer potential referees, including when letters are provided via a third party (i.e., dossier service or career center), to the UC Berkeley statement of confidentiality:

http://apo.berkeley.edu/evalltr.html prior to submitting their letters.

This pool will remain open until April 9, 2019 to accommodate course needs and new applicants. Appointments are made for three starts per year: fall, spring, and summer. If you wish to remain in the pool after April 9, 2019 you will need to reapply.

Please direct questions to dean@ischool.berkeley.edu.

The University of California is an Equal Opportunity/Affirmative Action Employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, national origin, disability, age or protected veteran status. For the complete University of California nondiscrimination and affirmative action policy see:

https://policy.ucop.edu/doc/4000376/DiscriminatioHarassmentAffirmAction.

About The I School

UC Berkeley's newest school, the School of Information (I School), was created in 1994 to address one of society's most compelling challenges: the need to organize and make sense of the abundance of information that we can now collect, store, and share without regard for cost or distance. The way we organize, represent, govern, and make sense of this information will shape our ability to achieve public as well as private goals.

The I School educates professionals and scholars to understand the problems and possibilities of information, to develop models of information practice, and to design useful and usable information applications, services, and solutions. This requires insights from diverse fields. Our faculty includes scholars and professionals with deep expertise in information and computer science, social sciences, management, law, design, and policy, as well as related fields.

We offer professional master's degrees and an academic doctoral degree. Our on-campus master's program (MIMS) trains students for careers as information professionals and emphasizes small classes and project-based learning. Our MICS program prepares cybersecurity leaders with the technical skills and contextual knowledge necessary to develop solutions for complex cybersecurity challenges. Our web-based master's program (MIDS) is the first and only degree available completely online to train data science professionals. Our Ph.D. program equips scholars to contribute to knowledge and to the policies that influence the organization, use, and sharing of information.

Our graduates work at well-known Bay Area companies that include Apple, Google, Facebook, Salesforce, Twitter, and LinkedIn, as well as at nonprofits like Kaiser Permanente and established businesses like Wells Fargo and Chevron. Many of our graduates take advantage of the opportunity to get in on the ground floor to create or work for start-ups.

The University of California is an Equal Opportunity/Affirmative Action Employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, national origin, disability, age or protected veteran status. For the complete University of California nondiscrimination and affirmative action policy see: http://policy.ucop.edu/doc/4000376/NondiscrimAffirmAct.

Purdue University's Department of Computer Science is committed to advancing diversity in all areas of faculty effort, including scholarship, instruction, and engagement. Candidates should address at least one of these areas in their cover letter, indicating their past experiences, current interests or activities, and/or future goals to promote a climate that values diversity, and inclusion.

Applicants are strongly encouraged to apply online at ***https://hiring.science.purdue.edu.*** Alternately hard-copy applications may be sent to: Professor of Practice Search Chair, Department of Computer Science, 305 N. University St., Purdue University, West Lafayette IN 47907. A background check will be required for employment.

Purdue University is an EEO/AA employer. All individuals, including minorities, women, individuals with disabilities, and veterans are encouraged to apply.

St Cloud State University

Assistant/Associate Professor Position

St Cloud State University, CSIT department, seeks candidates for one-year fixed-term Assistant/Associate Professor position(s) to teach a variety of courses. At least an MS degree with an emphasis in Cybersecurity is required. ABDs may apply. Applicant review begins in late April/early May 2018; open until filled.

To apply, visit ***http://agency.governmentjobs.com/stcloudstate/default.cfm***

University of Colorado Boulder

High Assistant, Associate and Full T/TT Position in Data Mining, Machine Learning, Information Retrieval or Information Visualization

The recently established Department of Information Science at the University of Colorado Boulder seeks outstanding candidates for a tenure line faculty appointment at all ranks, though assistant candidates must have at least 3 years in rank. Successful candidates will help shape the future of Information Science—as a Department and as a discipline. The Department takes a progressive computational, social and humanistic approach to Information Science, focusing on human–data interaction in all its diverse forms and contexts.

We seek candidates who work in data mining, machine learning, information retrieval or information visualization. Successful candidates will take a strong role in the organizational and intellectual life of the department. Applications are being reviewed as received for starting dates of Fall 2018 or Spring 2019.

The University of Colorado is an Equal Opportunity Employer committed to building a diverse workforce. We encourage applications from women, racial and ethnic minorities, individuals with disabilities, and veterans. For more information and to apply, see ***https://cu.taleo.net/careersection/2/jobdetail.ftl?job=12894&lang=en.***

University of Maryland

Assistant/Associate/Full Professor

The Department of Computer Science at the University of Maryland, College Park, MD, USA is recruiting to fill two endowed professorship funded through a generous gift from Capital One with start dates on or after July 1, 2018. The openings are not restricted to any rank and outstanding candidates at all levels are encouraged to apply. Successful applicants will also be given joint appointments with the University of Maryland Institute for Advanced Computer Studies (UMIACS), a multi-disciplinary research institute.

Exceptional candidates in ***Machine Learning, Data Science, and Cybersecurity*** are being sought. Applicants working at the boundary of computer science and other disciplines are also encouraged to apply, and may be considered for joint positions with other departments or institutes on campus. A candidate should indicate in their cover letter if they might be interested in such a joint appointment.

The department is committed to building a diverse faculty and it especially encourages applications from women and underrepresented minorities. In addition, candidates who have experience engaging with a diverse range of faculty, staff, and students and contributing to a climate of inclusivity are encouraged to discuss their perspectives on these subjects in their application materials.

Interested candidates should apply on-line at ***https://ejobs.umd.edu*** AND at ***http://hiring.cs.umd.edu/capitalone/*** in order to receive consideration. Search under Faculty for position #123708. The review of applications the process will continue until the positions are filled. Candidates will be prompted when submitting applications to submit a cover letter, a *curriculum vitae*, research and teaching statements, and provide contact information for at least four references. Questions about these positions can be directed to the faculty recruitment committee at: ***capitalonesearch@cs.umd.edu.***

The Department of Computer Science at the University of Maryland is consistently ranked among the top-15 nationally. It is one of the largest departments in the country, with approximately 50 full-time tenured and tenure-track faculty covering a wide variety of research areas and over 200 doctoral students drawn from top undergraduate programs nationally and internationally. In 2018 the department is slated to occupy its new state-of-the-art facility, the ***Brendan Iribe Center for Computer Science and Innovation,*** which is currently under ***construction.*** Additional information about the Department of Computer Science and UMIACS is available at ***http://www.cs.umd.edu*** and at ***http://www.umiacs.umd.edu.*** To learn more about the Iribe Center, please visit: ***http://csctr.cs.umd.edu.***

The University of Maryland, College Park, was founded in 1856 and is the flagship institution in the University System of Maryland. Its 1,250 acre College Park campus is minutes away from Washington, D.C., the nexus of the nation's legislative, executive, and judicial centers. This unique proximity to business and technology leaders, federal departments and agencies, and a myriad of research organizations, embassies, think tanks, cultural centers, and non- profit organizations offers unique opportunities for engagement for faculty and students.

The University of Maryland, College Park, an equal opportunity/affirmative action employer, complies with all applicable federal and state laws and regulations regarding nondiscrimination and affirmative action; all qualified applicants will receive consideration for employment. The University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, national origin, physical or mental disability, protected veteran status, age, gender identity or expression, sexual orientation, creed, marital status, political affiliation, personal appearance, or on the basis of rights secured by the First Amendment, in all aspects of employment, educational programs and activities, and admissions.

Apply Here: ***http://www.Click2Apply.net/wz24dmttmf2wyc5k***

The University of Pittsburgh

Multiple Non-Tenure Track Positions

The University of Pittsburgh (Pitt) recently created a new School of Computing and Information (SCI) to be the nexus of computing and information at Pitt. SCI has many openings for non-tenure track positions that offer careers and paths for advancement in teaching across a spectrum of areas, which includes rethinking curricula to reflect emerging concepts, conducting research, and developing activities for the deep entwinement of new skills in computing and information into other disciplines. Such programs are essential to train polymaths who understand and apply the abstractions that unite disciplines. As SCI transitions to a four-year school and creates new undergraduate and graduate degree programs, individuals filling these openings will have the chance to develop and teach curricula in many areas, including computer science, information science, information culture, and data stewardship. In addition, we are seeking individuals with competencies and experience in cybersecurity for an anticipated new institute for professional education. SCI's leadership, faculty, and staff value the importance of and need for diversity and inclusion within computing and information. Candidates from underrepresented populations, as well as those experienced with diverse students and commitments to inclusion are especially encouraged to apply for these openings.

Full application instructions are available from ***http://www.sci.pitt.edu/recruiting.*** A MS is required and a PhD is strongly preferred. The review of applications is ongoing. The anticipated start date is August 2018. Questions about the search may be emailed to ***sci-recruit@pitt.edu.***

The University of Pittsburgh is an affirmative action and equal opportunity employer and does not discriminate on the basis of age, color, disability, gender, gender identity, marital status, national or ethnic origin, race, religion, sexual orientation, or veteran status.

University of Sydney

Senior Lecturer / Associate Professor in Security
School of Information Technologies
Faculty of Engineering and Information Technologies
Reference no. 653/0417B

About the opportunity

The School of Information Technologies (SIT) invites applications from outstanding candidates for a continuing Senior Lecturer or Associate Professor position (Level C or D) in Security starting immediately. The level of appointment will be commensurate with qualifications and experience.

About you

To be successful, you will have a PhD in computer science, or a closely related discipline. You must show evidence of excellent research achievements in one of more areas of computer security and the ability to publish your research in highly-ranked outlets. A strong commitment to teaching and learning is required as well as evidence of ability to lecture and prepare new teaching material. You will be expected to teach a range of computer science and security related courses.

All applications must be submitted via the University of Sydney careers website. Visit *sydney.edu.au/recruitment* and search by the reference number for more information and to apply.

Closing date: 11:30pm 22 April 2018 (Sydney time)

University of Virginia

Postdoctoral Research Associate

The Center for Research on Intelligent Storage and Processing in Memory within the Department of Computer Science at the University of Virginia seeks candidates for a postdoctoral research associate, for a term of up to three years, to pursue and support research on hardware, software, and applications driving the state of the art in memory and storage systems. The candidate will join a team of multiple faculty and a large group of PhD students working in this area, spanning the departments of Computer Science and Electrical & Computer Engineering. The incumbent will report to Prof. Kevin Skadron, but will have the opportunity to collaborate broadly, and will also have opportunities to help in leadership of the Center.

The responsibilities of this position consist of leading and publishing an independent research project, helping advise other graduate students in the Center, helping prepare technical presentations, reports, and proposals, and identifying/leading new research opportunities. In helping coordinate center-wide activities, the research associate will have guidance and support from Prof. Skadron, as well as support of the Center staff.

The successful candidate will have a strong research record in computer architecture relevant to memory or storage systems, be self-directed, exhibit leadership skills, select appropriate research problems and techniques, exhibit strong writing and communication skills, be able to mentor graduate students, and be able to work with other teams.

The candidate must have completed all requirements for a PhD by the start date for the position. The start date is flexible.

To apply, visit *https://jobs.virginia.edu* and search for posting 0623071. Complete a Candidate Profile online; attach a cover letter, curriculum vitae, a one-page letter of research interest, and contact information for three professional references.

Questions regarding the position can be directed to Kevin Skadron at *skadron@virginia.edu.*

With one of the highest graduation rates of minority undergraduate students and one of the highest percentages of women engineering students among public universities, the University of Virginia is fundamentally committed to increasing the diversity of its faculty and staff. The University of Virginia is an affirmative action and equal opportunity employer. We welcome nominations of and applications from women, members of minority groups, veterans and individuals with disabilities. We also welcome others who would bring additional dimensions of diversity to the university's research and teaching mission. We believe diversity is excellence expressing itself through every person's perspectives and lived experiences.

UPENN

Non-Tenure Stream Track Positions

The University of Pittsburgh (Pitt) recently created a new School of Computing and Information (SCI) to be the nexus of computing and information at Pitt. SCI has many openings for non-tenure track positions that offer careers and paths for advancement in teaching across a spectrum of areas, which includes rethinking curricula to reflect emerging concepts, conducting research, and developing activities for the deep entwinement of new skills in computing and information into other disciplines. Such programs are essential to train polymaths who understand and apply the abstractions that unite disciplines. As SCI transitions to a four-year school and creates new undergraduate and graduate degree programs, individuals filling these openings will have the chance to develop and teach curricula in many areas, including computer science, information science, information culture, and data stewardship. In addition, we are seeking individuals with competencies and experience in cybersecurity for an anticipated new institute for professional education. SCI's leadership, faculty, and staff value the importance of and need for diversity and inclusion within computing and information. Candidates from underrepresented populations, as well as those experienced with diverse students and commitments to inclusion are especially encouraged to apply for these openings.

Worcester Polytechnic Institute

Teaching Professor (Open Rank), Computer Science

Looking for faculty colleagues who engage deeply in both teaching and research within a curriculum that embraces student projects and independent learning? Consider joining the faculty at WPI . The Computer Science Department is actively seeking applicants for one or more full-time, non-tenure-track positions for the Fall of 2018. Depending on background, appointments may be as a Teaching Professor or Instructor.Applicants with professional experience are encouraged to apply and may be appointed as a Professor of Practice. Appointments may be for multiple years and are renewable.

Principal Duties and Responsibilities

The department is interested in applicants with teaching and project advising expertise in all areas of Computer Science, but is particularly interested in applicants with experience in introductory Computer Science, Systems, Programming Languages and Software Engineering. The successful candidate will teach and advise projects at the undergraduate and possibly graduate levels as well as be a contributing member of a collegial department with over 30 full-time faculty members.

Junior-year projects involving the interaction of society and technology, Senior-year projects in the major, graduate students and a number of computing-related degree programs make the WPI Computer Science Department a rewarding environment for candidates interested in teaching and project advising.

Position Requirements

Candidates should have an advanced degree in Computer Science or a closely related field, and the potential for excellence in teaching and project advising.

Questions about the hiring process should be sent to recruit@cs.wpi.edu. More information about the positions and instructions for applying are available at http://web.cs.wpi.edu/facultyhire/. You will need to include a teaching statement, vitae and contact information for at least three references.

To apply, visit: **http://apptrkr.com/1206172**. Review of applications will begin effective immediately and continue until the positions are filled.

Founded in 1865, WPI is one of the nation's first technological universities. A highly selective private university located within an hour of Boston, WPI is consistently ranked among the top 60 research institutions by US News & World Report. The university is home to an innovative and intensive project-based curriculum that empowers students with the knowledge and skills to address real world problems around the globe, an approach repeatedly cited for excellence by The Fiske Guide to Colleges and The Princeton Review.

Located in the heart of New England, WPI is surrounded by cultural and recreational opportunities. The UMass Medical Center, a large number of technology companies and many colleges and universities are located in the immediate area making it ideal for two-career families.

We are an Equal Opportunity Employer and do not discriminate against applicants due to age, race, color, religion, sex, sexual orientation, gender identity, national origin, veteran status or disability. We are looking for individuals who value creativity, diversity, inclusion, and collaboration. A pre-employment criminal records check is required.

GREAT MINDS at WORK

Full application instructions are available from *http://www.sci.pitt.edu/recruiting*. A MS is required and a PhD is strongly preferred. The review of applications is ongoing. The anticipated start date is August 2018. Questions about the search may be emailed to *sci-recruit@pitt.edu.*

The University of Pittsburgh is an affirmative action and equal opportunity employer and does not discriminate on the basis of age, color, disability, gender, gender identity, marital status, national or ethnic origin, race, religion, sexual orientation, or veteran status.

Vassar College

1-Yr. and 2-Yr. Visiting Assistant Professor of Computer Science

The Department of Computer Science at Vassar College invites applications for a one- and a two-year position at the rank of Visiting Assistant Professor beginning Fall semester 2018. Vassar College is an affirmative action and equal opportunity employer with a strong commitment to increasing the diversity of the campus community and the curriculum, and promoting an environment of equality, inclusion, and respect for difference. Candidates who can contribute to this goal through their teaching, research, advising, and other activities are encouraged to identify their strengths and experiences in this area. Individuals from groups whose underrepresentation in the American professoriate has been severe and longstanding are particularly encouraged to apply.

A commitment to excellence in undergraduate teaching and research is expected. The Ph.D. in Computer Science is required. Strong candidates in all areas of Computer Science are encouraged to apply. Teaching responsibilities will include introductory, intermediate, and upper level courses. The expected teaching load will be one lecture-plus-lab course and one lecture-only course per semester.

To apply, please visit *https://employment.vassar.edu/applicants/Central?quickFind=52494* to link to the posting for this position. Candidates should submit a letter of application, a CV, a statement of teaching experience and philosophy, a statement of research experience, a candidate diversity statement highlighting contributions to and/or future plans for promoting diversity and inclusion through teaching, research and/or professional involvements, an unofficial graduate transcript, and three (3) letters of recommendation, at least one of which directly addresses teaching. Additional information on candidate diversity statements can be found at *http://deanofthefaculty.vassar.edu/positions/candidate-diversity-statement.html*

For further inquiries, email *csFacSearch@vassar.edu.*

Review of applications will begin on May 1stand will continue until all positions are filled. Please direct any questions about the position to Luke Hunsberger, Acting Chair of the Computer Science Department (*hunsberger@vassar.edu*).

Virginia Tech

Research Assistant Professor / Postdoctoral Research Associate / Research Associate

Virginia Tech (*https://vt.edu/*), founded in 1872 as a land-grant institution, is currently ranked as a Top 25 Public University by US News & World Report (USNWR) and a Top 25 Public Research University by the National Science Foundation. The Department of Electrical and Computer Engineering (ECE; *https://ece.vt.edu/*)'s graduate programs are ranked in the Top 20 by USNWR.

ECE's Systems Software Research Group (SSRG; *http://www.ssrg.ece.vt.edu/*) has multiple research positions available in the category of Research Assistant Professor, Postdoctoral Associate, and Research Associate. The positions involve conducting research in the areas of operating systems, virtualization, programming languages, compilers, and formal methods, and their intersection across different projects. Projects in operating systems involve developing innovative operating systems for emerging multicore platforms, in particular those with heterogeneous instruction sets, from node-scale (e.g., ARM/x86, CPU/GPU/FPGAs) to rack-scale (e.g., Scale-out processors, Firebox). Virtualization projects involve designing hypervisor systems with significantly reduced attack surface and strong degree of isolation in untrusted, publicly available cloud computing environments. Projects in languages and compilers involve designing domain-specific languages that automatically generate parsers for OS/

hypervisor input handling, following the language-theoretic security paradigm. Projects in formal methods involve verifying machine code through de-compilation, instruction-set-architecture formalization (e.g., x86, ARMv8), and reasoning about program behaviors, all inside theorem provers (e.g., Isabelle/HOL). A cross-cutting theme across projects is to understand how to build software systems that are scalable, energy-efficient, reliable, and secure.

More details about the position, research projects, etc, can be found at: *http://www.ssrg.ece.vt.edu/positions.html*

Position-specific responsibilities, minimum required qualifications, and details on how to apply are available at:

- Research Assistant Professor: *https://listings.jobs.vt.edu/postings/68372*
- Postdoctoral Associate: *https://listings.jobs.vt.edu/postings/63862*
- Research Associate: *https://listings.jobs.vt.edu/postings/63883*

Interested applicants are strongly encouraged to contact Prof. Binoy Ravindran (*binoy@vt.edu*) for any questions.