INFERRING USERS' CONTEXT FROM THEIR SMARTPHONE DATA

Speaker: Preeti Bhargava

Host: Lori Pollock

CRA-W Undergraduate Town Hall

September 28th, 2017

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About Me‡

Work Experience

- Current: Senior Research Engineer, Data Science, Lithium Technologies | Klout (2016 – present)
- Senior Member Technical Staff, Oracle India (2007 - 2010)

Education

- MS (2012) and PhD (2015), UMD, College Park
  - Advisor: Prof. Ashok Agrawala
- BE (2007), Delhi College of Engineering

PhD Internships

- Xerox PARC (2013)
- Samsung Research America (2014, 2015)

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PhD Research Focus‡

Dissertation: Proactive Context-aware Computing and Systems

Mobile and Ubiquitous Systems

- Locus (Mobiquitous'12, JLBS'15)
- RoverII (UbiComp' 12)
- SenseMe (Mobiquitous'14, EAI Endorsed Tran. on CASA 2016)
- TellMe (Mobiquitous'15)

Personalization and Recommender Systems

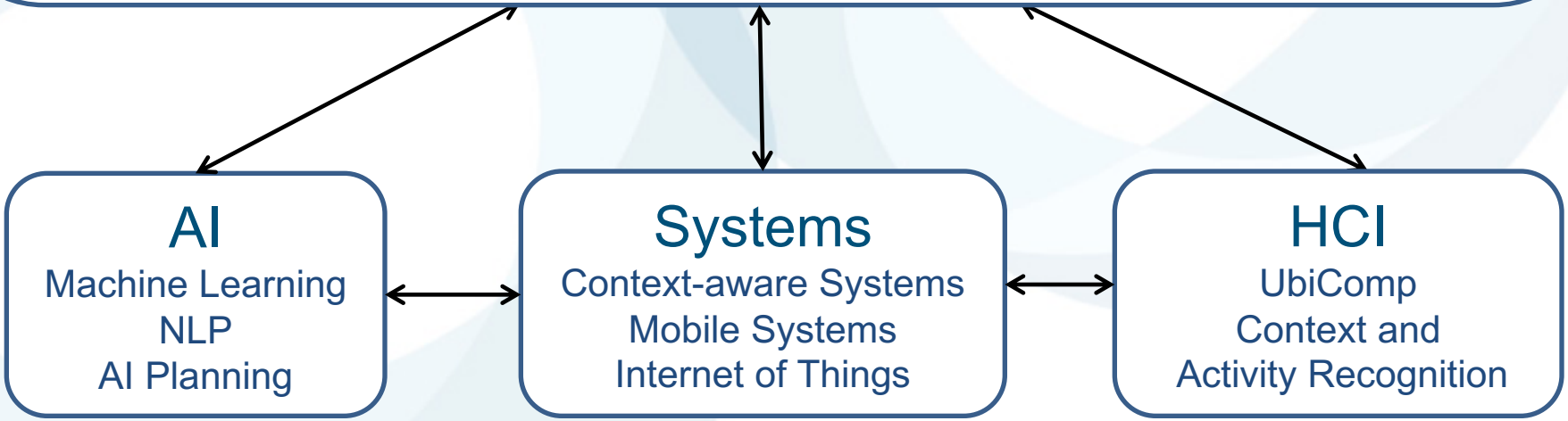
- User Interest Modeling from Facebook (IUI'15)
- Multi-dimensional collaborative recommendations (WWW'15)

User Modeling

- User Behavior Modeling from smartphone data collection (EAI Endorsed Tran. on CASA 2016)

Internet of Things

- ThingTalk



‡Pertinent papers, posters, talks etc. available at http://preetibhargava.info

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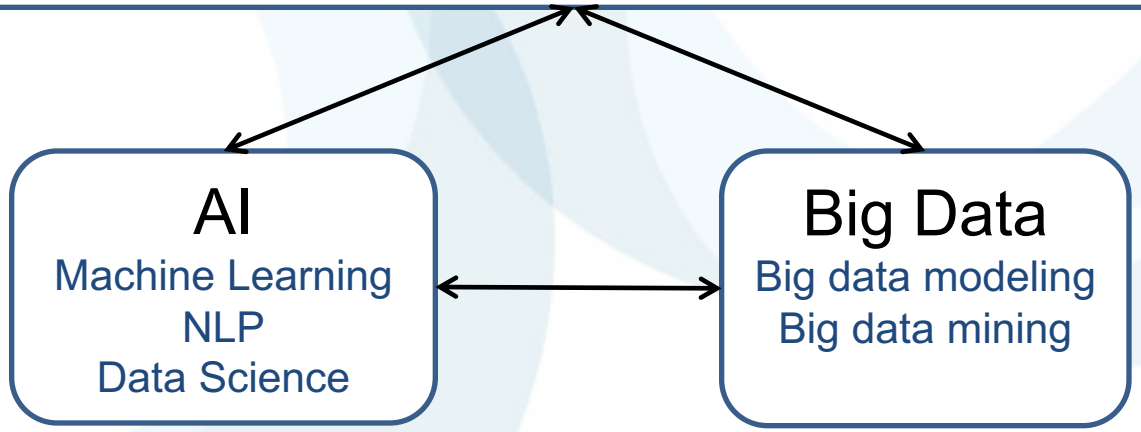
Current Research Focus‡

Extracting rich information from noisy user generated text on social media

- ❑ Densely Annotated Wikipedia Text (WWW 2017 workshop)
- ❑ Entity Disambiguation and Linking (WWW 2017 workshop)
- ❑ Lithium NLP (EMNLP 2017 workshop)
- ❑ Twitter Sentiment analysis (ICDM 2017 workshop)



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INFERRING USERS' CONTEXT FROM THEIR SMARTPHONE DATA

Preeti Bhargava

Senior Research Engineer, Data Science

Lithium Technologies | Klout

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Context and its dimensions

- "Any information that can be used to characterize the situation of an entity."
- Multiple dimensions of user's context:
  - Who is the user? What do we know about him? Preferences/Interests/Demographics/Mood
  - Where is the user? – Location
  - What is the user doing? - Activity
  - When? – Time
  - Who is the user with? - People around him

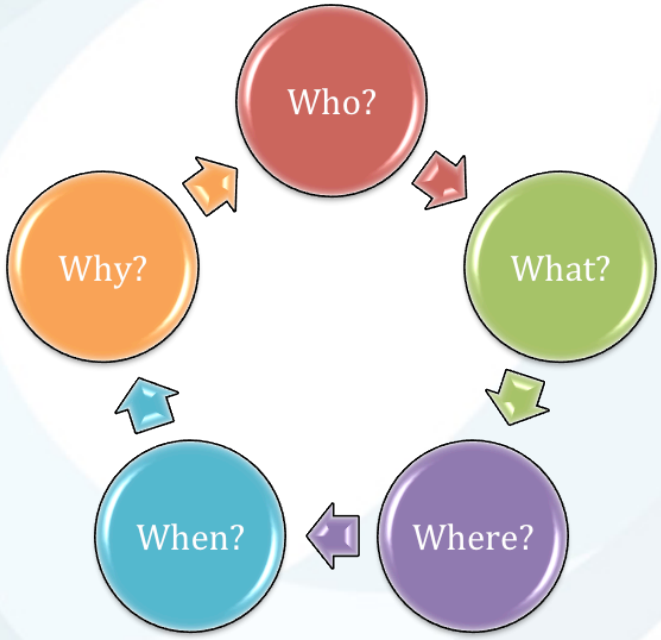

Image source: http://myparadigmshift.org/wp-content/uploads/2013/04/who-what-where-when-why.png

Modeling users' context from their smartphone data

Smartphones – ubiquitous and powerful

- Multitude of sensors - GPS, accelerometer, WiFi and cellular radio, gyroscope, camera, microphone etc.
- Come equipped with an increasing range of computational, storage and communication capabilities
- Can be used to:
  - infer several dimensions of user's context
  - deliver information to users
- Current talk will focus on 2 dimensions – location and activities

Poll question 1

How many sensors can you count on your smartphone?

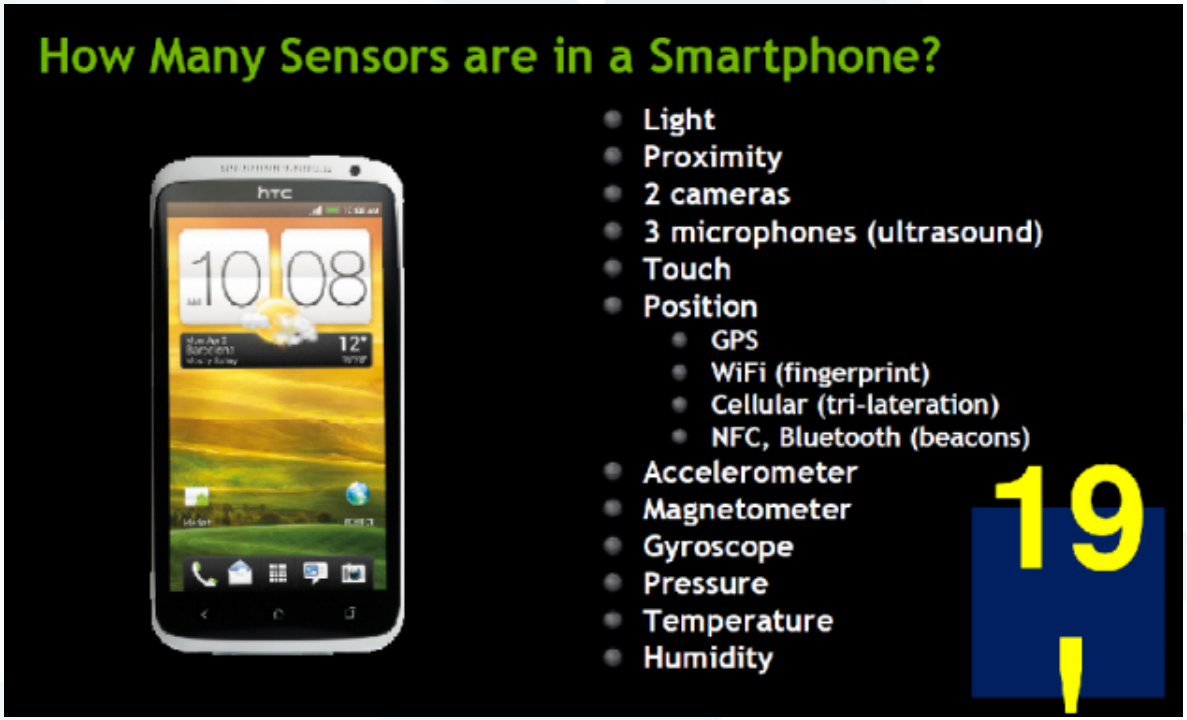

Image source: http://www.technologyace.com/technology/types-sensors-modern-smartphones/ (2013)

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Modeling users' context from their smartphone data (contd.)

Where is the user? ***Location***

- Outdoor localization – GPS
- Indoor localization – Wi-Fi, Bluetooth, RFID, NFC
- Alternative technologies exist but still several challenges
  - Low cost of deployment and maintenance
  - Accuracy vs Calibration effort tradeoff
  - Robustness to environmental changes
  - Multi-story environments - Floor determination

Indoor localization

Selected existing approaches and their limitations

- Wi-Fi Fingerprinting – RADAR (2000), Horus (2003)
  - Very accurate but…
  - Requires Wi-Fi Radio map calibration effort,
  - Expensive to set up and maintain,
  - Not robust to environmental changes
- Bluetooth bases solutions (iBeacon)
  - Need proprietary hardware
- Some works on Floor determination
  - User input (Active Campus (2002) , FTrack (2012))
  - Low accuracy GSM fingerprinting (Skyloc (2007))

Indoor localization (contd.)

My research work - Locus[‡]

- Calibration free, minimal set up, robust, room level accuracy
- Floor and location determination on the floor in multi-story buildings
- Uses knowledge of infrastructure – buildings, AP locations, room boundaries
- Deployed and tested on UMD campus (~220 buildings with ~4500 APs)
- Designed to enable several LBS such as indoor navigation and tracking in medical emergency scenarios

[‡] P. Bhargava, S.Krishnamoorthy, A.K.Nakshathri, M. Mah, A. Agrawala, *Locus: An indoor localization, tracking and navigation system for multi-story buildings using heuristics derived from Wi-Fi signal strength*, **MobiQuitous 2012**

[‡]P. Bhargava, S. Krishnamoorthy, A. Shrivastava, A.K. Nakshathri, M. Mah, A. Agrawala, *Locus: Robust and Calibration-free Indoor Localization, Tracking and Navigation for Multi-story Buildings,* **Journal of Location based Services, 2015**

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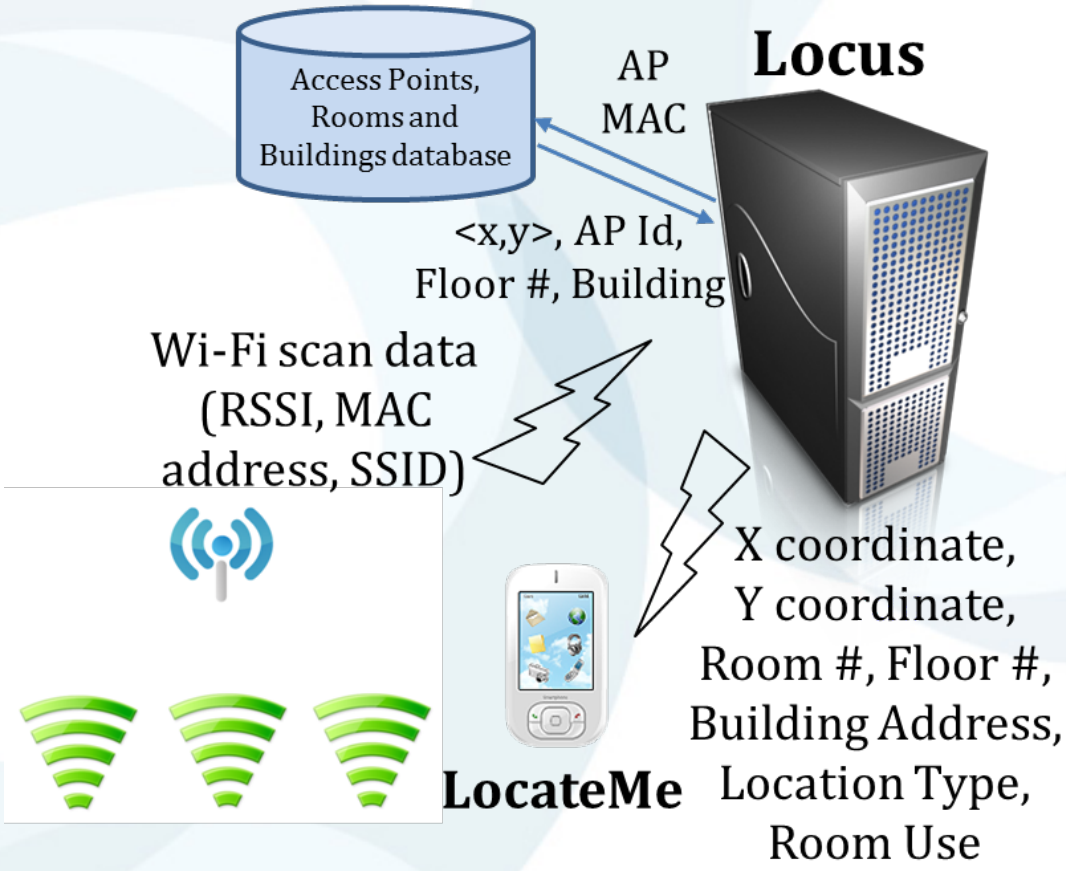
Indoor localization (contd.)

Locus System High Level Overview



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Indoor localization (contd.)

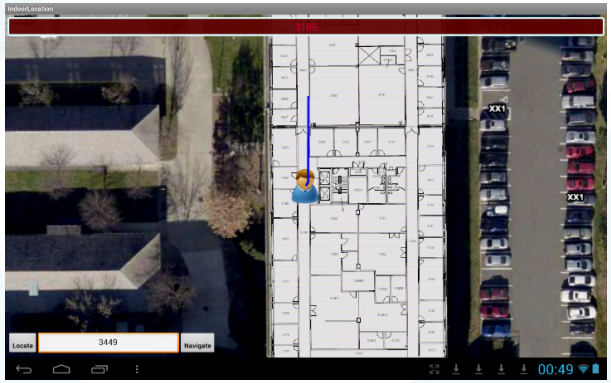
Locus Results and Benefits

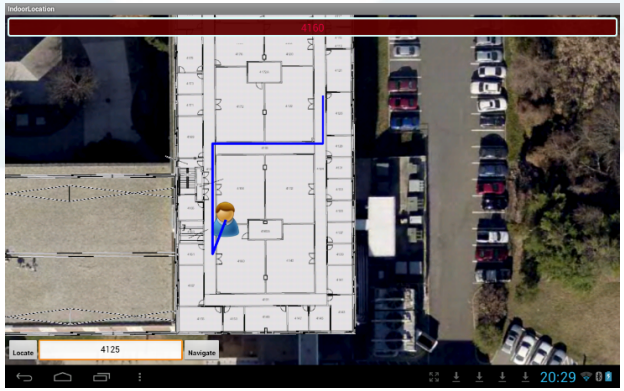
- Average Floor accuracy (% of correct floor estimations) > 95%
- Average Euclidean Location Error < 6.5m (Room level accuracy)
- One of the first calibration-free systems for floor and location determination in multi-story buildings
- Minimum setup, deployment and maintenance expenses
- Readily deployable
- Robust to environmental changes
- Relies on existing infrastructure and mobile device capabilities
- Scalable to buildings with any number of floors
- Low software and hardware complexity
- Designed to support multiple indoor location based context-aware applications

Indoor localization (contd.)

Applications of indoor localization systems

- Indoor Navigation
- Retail – coupons based on proximity
- Health care
  - Emergency scenarios
  - Tracking patients in a hospital
- Can you think of any?





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Modeling users' context from their smartphone data (contd.)

What is the user doing? ***Activity Recognition***

- In addition to location, context or situation of the user includes several dimensions - activities, environment, people around him
- Challenges in multi-dimensional context and activity recognition :
  - automated - embedded in ubiquitous devices
  - robust
  - power efficient
  - non-invasive manner
  - accurate
  - scalable
  - privacy preserving …

Context and Activity Recognition

Selected existing approaches and limitations

- Environmental context (Indoor/Outdoor detection)
  - IODetector
    - uses light and magnetic field sensors, and cell tower signals
    - dependency on device manufacturer
    - sensor output varies with time of the day and weather
- Physical Activity Recognition
  - CenceMe and Jigsaw
    - Latency and privacy challenges due to backend server
    - Some calibration required for accelerometer (gait, position, orientation)s

Context and Activity Recognition(contd.)

Existing approaches and limitations (Not exhaustive)

- Social Context Recognition
  - SenceMe – bluetooth and location sharing
    - Privacy invasion
- Device Activity Recognition
  - MFU, MRU apps

Context and Activity Recognition (contd.)

My research - SenseMe ‡

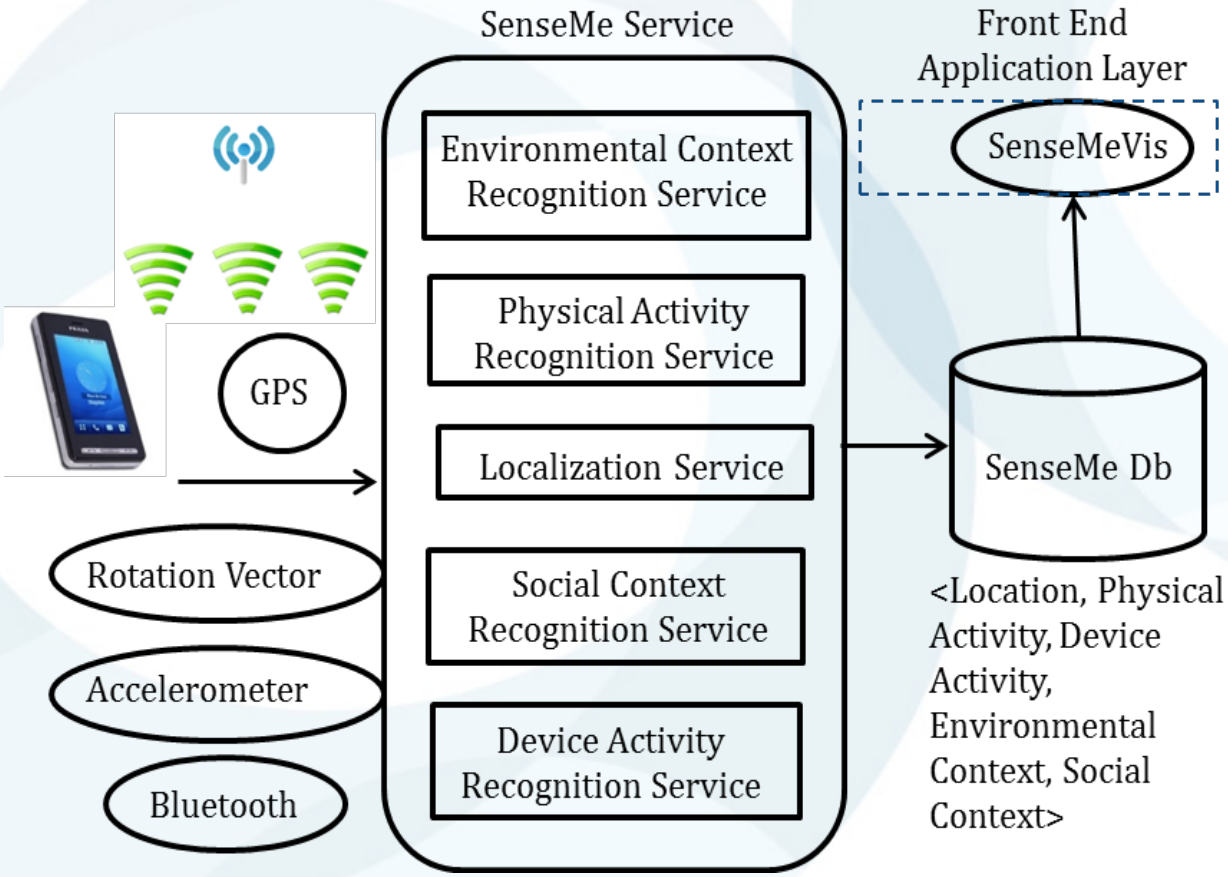
- SenseMe – On-device system that recognizes 5 dimensions of user's context:

Situation Dimension	Possible Values
Environmental context	{Indoor, Outdoor, Indoor-Outdoor}
Physical Activity	{Stationary, Walking, Running, In-vehicle}
Context-aware Location	Set of locations determined by Wi-Fi (indoors) or GPS (outdoors)
Device Activity	Task the user is engaged in on the device such as phone call or messaging
Social Context	Number of people around the user

‡ P. Bhargava, N. Gramsky, A. Agrawala, *SenseMe: A System for Continuous, On-Device, and Multi-dimensional Context and Activity Recognition*, **MobiQuitous 2014**

Context and Activity Recognition (contd.)

SenseMe architecture



<Indoor; Stationary; Phone Call; A.V. Williams Building, College Park; With 4 people>

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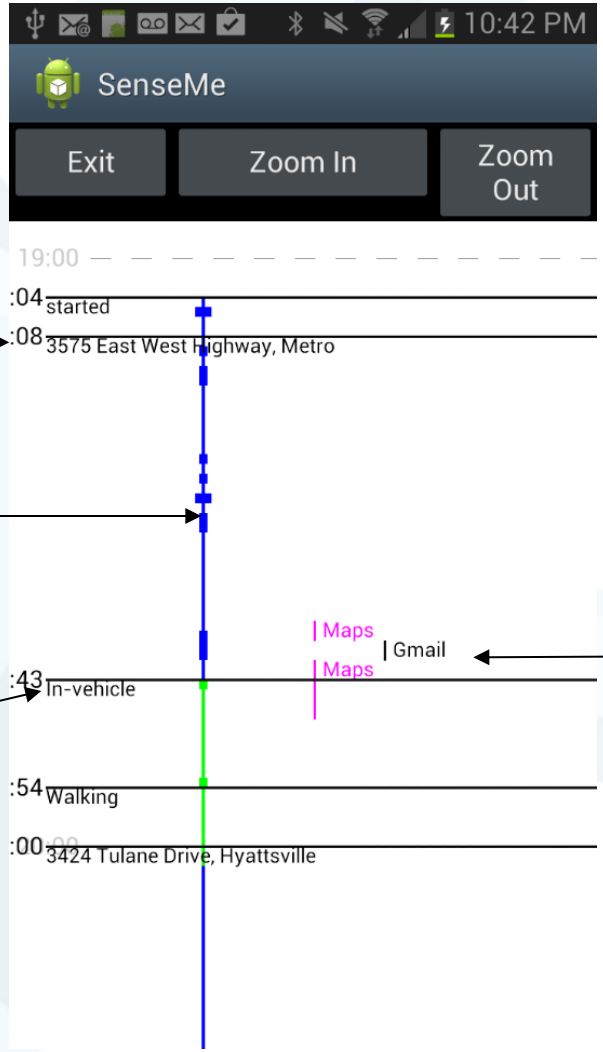
Context and Activity Recognition (contd.)

SenseMeVis



Context-aware location

Environmental and social context

Physical Activity

Device Activity

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Context and Activity Recognition (contd.)

SenseMe results

SenseMe service	Overall Accuracy (%)	Closest Baseline Accuracy (%)
Environmental Context Recognition	91.23	88
Physical Activity Recognition	95.75	95
Context-aware Localization	93.12	--
Device Activity Recognition	99.1	--
Social Context Recognition	87.5	--

Context and Activity Recognition (contd.)

SenseMe advantages

- Uses power conservation techniques - Suppression, Piggybacking and Adaptation to duty cycle GPS
- Calibration-free - Uses techniques that are agnostic to orientation, body position, time, weather etc. ,
- Scalable – tested with users having varied schedules and mobility patterns
- Device independent and universally applicable
- Minimum latency and Privacy preserving - All computation and processing carried out on device
- Non-invasive - runs in the background to collect and process user's data without the need for any intervention.

GRADUATE SCHOOL APPLICATION AND ADMISSION PROCESS - HOW TO GO FROM CS UNDERGRADUATE TO A PHD PROGRAM? WHAT DOES GRADUATE SCHOOL LOOK LIKE FOR CS?

Speaker: Preeti Bhargava

Host: Lori Pollock

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Getting involved in undergraduate research

Summary:

- Excellent UTH on Dec 1st 2016 by Katherine Sittig-Boyd
- Apply to CREU, DREU (CRA-W) programs in USA, DAAD in Europe
- Email professors
- Intern and try to publish your research
- Attend conferences –
  - Grace Hopper Conference research track
  - Lots of labs/companies in the career fair
- Maintain an updated webpage/portfolio

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Getting involved in undergraduate research (contd.)

Benefits :

- You realize whether you like research
- Gives you an edge when applying for graduate programs – demonstrates ability to conduct independent research
- Publications
- Recommendations from professors/supervisors

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How to go from CS undergraduate to a PhD program? (contd.)

Pick universities

- USNews is a good source
  - Overall and Discipline specific rankings – AI, Systems, HCI etc.
- Top 20-30 in your field (CS/EE)
- Check out specific departments and professors
- Shortlist about 10 schools
- Distribute MS and PhD applications

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How to go from CS undergraduate to a PhD program? (contd.)

Application materials (Covered in detail in a previous UTH on July 14 2016 by Tanya Amert)*

- ❑ General application
- ❑ SOP
- ❑ Recommendations
- ❑ Transcripts
- ❑ Test scores – GRE/TOEFL
- ❑ CV
- ❑ Fees

*Resources for applying to graduate school: http://preetibhargava.info/gradschool

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What does CS graduate school look like?

General Timeline

- Year 1 - 2 : Finish your coursework, find a research topic and an advisor
- Year 2 - 4 : Start your research and publish your work
- Year 3 : Qualifying exam (some schools require it)
- End of year 4 : Propose your thesis
- Year 5 - 6: Finish your research
- End of year 6 : Defend your thesis
- Have a plan (A and B) for these ~6 years!
- Disclaimers:
  - May vary across schools and departments
  - Very high level overview of milestones

CS PhD - Key milestones

Finding an advisor

- Guide for the rest of your graduate school journey – choose wisely!
- In your broad area of interest - read his/her papers
- Conducive working atmosphere and relationship
- Size of research group
- Funding
- Talk to other students

CS PhD - Key milestones (contd.)

Finding a research topic/problem

- That you like and that you can contribute to
  - Remember – your thesis should be a novel and significant contribution to CS!
- Read recently published papers – discuss with research group and advisor
- Take courses relevant to your research
- Attend conferences (find the top tier conferences in your area)
- Tips:
  - Many professors and researchers maintain a calendar of upcoming conferences and deadlines
  - Search for conferences rankings and find the top tier ones

CS PhD - Key milestones (contd.)

*Funding**

- Apply for scholarships or fellowships at your school
- Several government and private organizations and companies sponsor awards, scholarships and fellowships – NSF, DOE, Facebook, Microsoft, Google, IBM etc.
- Writing grant proposals (with your advisor) – really helps if you want to pursue an academic career
- Travel grants for conference attendance

*List of scholarships, fellowships and travel grants:
http://preetibhargava.info/resources-for-funding-grad-school

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CS PhD - Key milestones (contd.)

Publishing your work

- Write and publish papers - top tier conferences and journals
- Professors usually have a minimum requirement for their students
- Try to maintain a good cadence (~1-2 papers every year)
  - Less stressful
- Network and collaborate with other researchers in your field
  - Find them at conferences
  - Follow their work

CS PhD - Key milestones (contd.)

Internships

- Industry internships - Extremely useful for a career in industry
- Apply to academic labs and schools
- Try to find a project close to your PhD research
- Publish your work – can be possibly included in dissertation!
- 3 papers through PARC and SRA internships
  - International students in US: Make sure you take care of CPT/OPT requirements at school

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CS PhD - Key milestones (contd.)

Thesis proposal

- Formulate the problem that your research is addressing
- Have a story that ties everything together
- Propose your thesis – write it up and present to a committee!

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CS PhD - Key milestones (contd.)

Defend and apply for jobs

- Finish your thesis work
- Start applying for jobs before you defend
  - Less stressful
  - 2-3 months or more on average
- Academic – prepare your CV, research statement, go to the universities and present your work
  - Ask your advisor for guidance on where to apply for Post doc or assistant professor positions
- Industry – prepare your CV, apply to the teams and companies that interest you, ask friends to refer you for open positions, use LinkedIn effectively, interview
- References from advisor, internship mentors, professors

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Resources

Visit **CRA-W.org** for more resources for all levels of your career

Join our CRA-W mailing list, **CRA-W Updates**, by going to bit.ly/1McQCDd

Follow @CRAWomen to find out about upcoming events or programs

Don’t forget to take the feedback survey!

PLEASE COMPLETE FEEDBACK SURVEY

Survey URL:
http://bit.ly/2omKWfZ