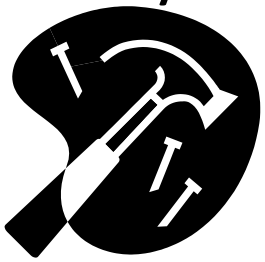
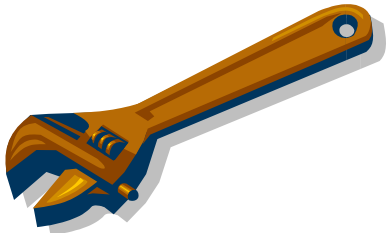
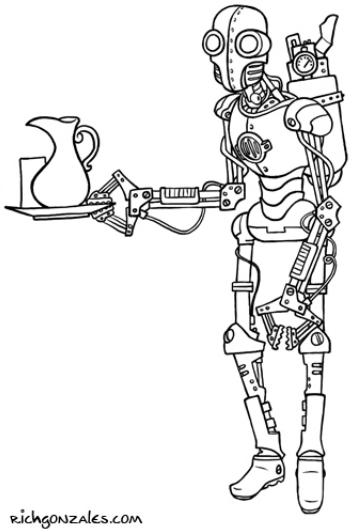
One Reason for Integrated Intelligences

- Today's model: Software as tool


The problems we are facing are getting harder
We're not getting any smarter

- Tomorrow's model: Software as collaborator

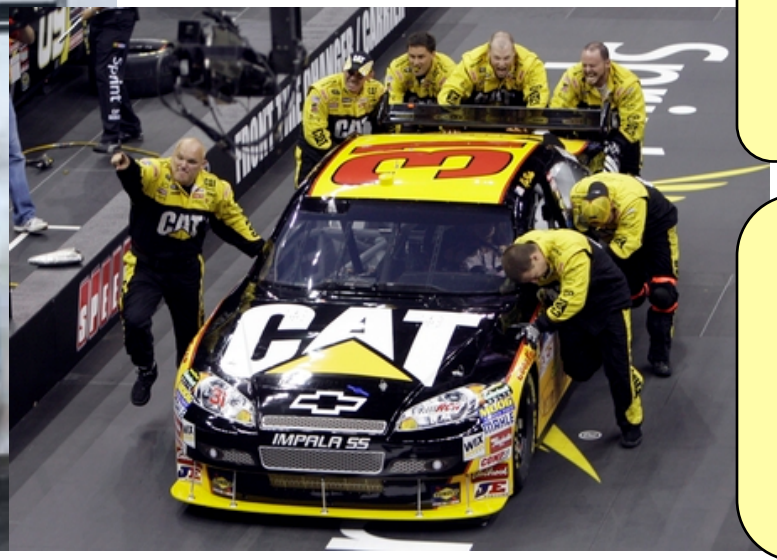


Another Reason: Understanding how Minds Work

Unified Theories of Cognition (Newell, 1990)

TIME SCALE OF HUMAN ACTION

Scale (sec)	Time Units	System	World (theory)
10^{7}	months		
10^{6}	weeks		**SOCIAL BAND**
10^{5}	days		
10^{4}	hours	Task	
10^{3}	10 min	Task	**RATIONAL BAND**
10^{2}	minutes	Task	
10^{1}	10 sec	Unit task	
10^{0}	1 sec	Operations	**COGNITIVE BAND**
10^{-1}	100 ms	Deliberate act	
10^{-2}	10 ms	Neural circuit	
10^{-3}	1 ms	Neuron	**BIOLOGICAL BAND**
10^{-4}	100 μs	Organelle	



Today's AI systems can be fast and effective

But they are carefully designed for narrow niches, maintained by highly trained personnel

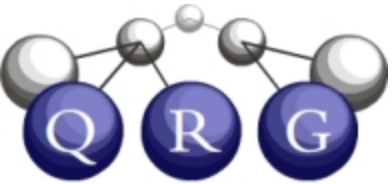
What if AI systems were as robust, trainable, and taskable as dogs?

Q R G

NORTHWESTERN UNIVERSITY · 1851 ·

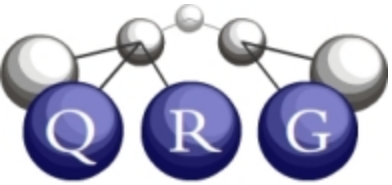
Summaries of One-pagers

- Organisms
  - Deliberative autonomy (Aha)
  - Data efficient learning (Chai)
  - Self-awareness (de Kleer)
  - Forms of intergration (Fischer, Laird, Rosenbloom)
  - Interactive task learning (Chai, Laird)
- Knowledge
  - Commonsense (Chai,de Kleer, Muller)
  - Causality (Chai, de Kleer, Hunter)
  - Metaknowledge (de Kleer, Leake)
  - About people (Chai, Oh, Wilson)



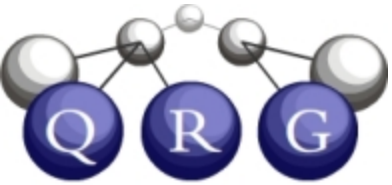
More summaries

- Communication
  - Semantic perception (aha)
  - Grounding language (Chai, Oh)
  - Multimodal interaction (Chai, Coman, Oh, Wilson, Woolf)
- Use Scenarios
  - Life partners, DevOps (Aha)
  - Customer Service (Coman, Muller)
  - Design (de Kleer)
  - Assistants for comp. Sustainability (Fischer)
  - Eldercare (Oh, Wilson)
  - Mentor for everyone (Woolf)



Arcs of Progress

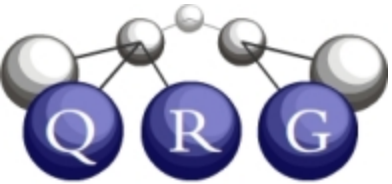
- Stretch goals to excite the imagination
- End state: 2040
- Identify milestones along the way
- Analysis of capabilities



2050 Goal

- AI tutors, coaches, partners, and mentors that support people who want to learn any area of science, at any level, any time

- One of the proposed tests in a suite to replace the Turing Test (AAAI 2015)
  - Daunting challenge
  - Clear benefits to society
  - Science Learning & Teaching Working Group: Ken Forbus, Peter Clark, Chen Liang, Nina N., Christian Lebiere, Gabor Melli, Jim Spohrer, Melanie Swan



There are Never Enough People to Help with Education

- Not enough teachers
- Not enough tutors
- Not enough teammates
- Not available when you need them
  - Finishing homework at 3am the night before it is due
- Not for as long as you need them
- Don't know you like friends and family do
  - Shared experiences as a source of examples

Vision: AI Assistants for Learning Science

Now: CogSketch, Companions, PSLC, Cyc, IBM's Watson, Semantic Web, new sensors… Provide individual technologies and initial architectures

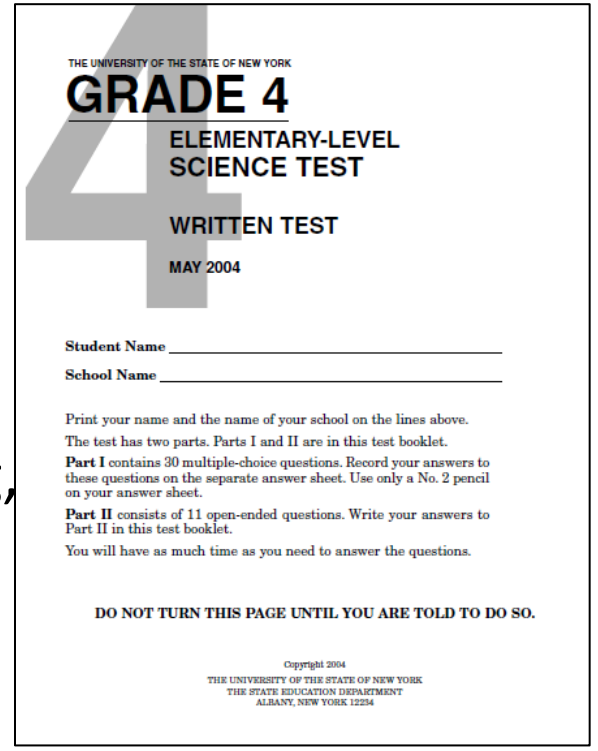
Multimodal Science Learners:
AIs that can learn science from people via reading, dialogue, sketching, and vision.
Barriers: Learning at scale, interactively, at human-like rates. Fluent communication.

Multimodal Science Tutors:
AIs that can help people learn science.

2050: AI tutors, coaches, & mentors that support people who want to learn any area of science, at any level, any time.

Dimension: Knowledge & Reasoning

- Depth of expertise
- Breadth of coverage
- Current state
  - 8th grade science tests, > 700 teams using statistical NLP and deep learning, 60% = best score
  - 4th grade science tests, AI2's Aristo, statistical NLP + some reasoning, 70%
  - Multiple choice, no diagram



THE UNIVERSITY OF THE STATE OF NEW YORK

GRADE 4

ELEMENTARY-LEVEL SCIENCE TEST

WRITTEN TEST

MAY 2004

Student Name _____

School Name _____

Print your name and the name of your school on the lines above.

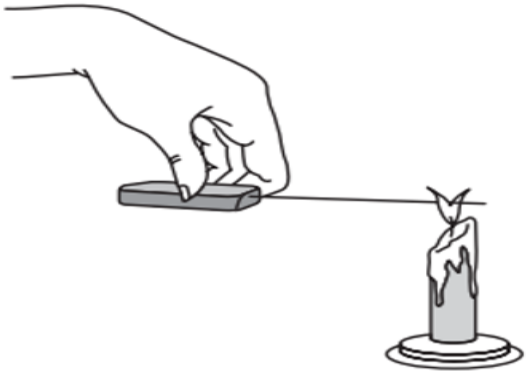
The test has two parts. Parts I and II are in this test booklet.

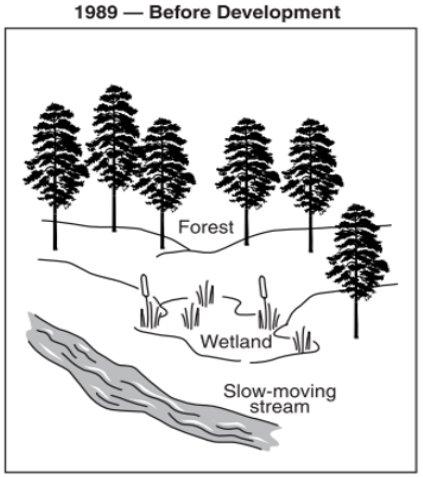
Part I contains 30 multiple-choice questions. Record your answers to these questions on the separate answer sheet. Use only a No. 2 pencil on your answer sheet.

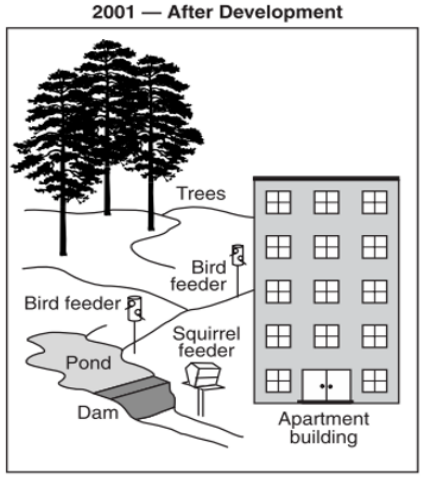
Part II consists of 11 open-ended questions. Write your answers to Part II in this test booklet.

You will have as much time as you need to answer the questions.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

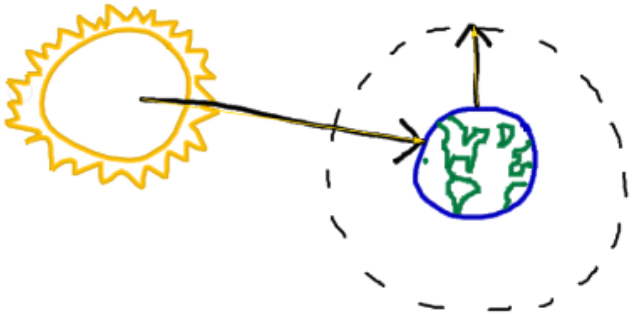


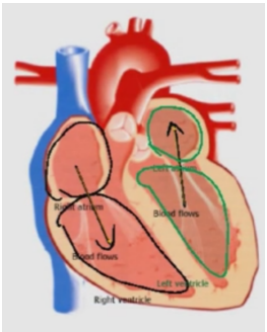


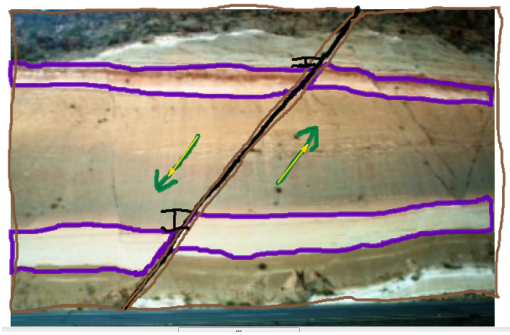


Dimension: Learning

- How easily can systems be instructed?
  - Human students don't need millions of examples to learn algebra (or anything else)
- Learning by reading
  - Vary by grade levels
  - Multimodal: Diagrams are essential
- Interactive knowledge capture
  - Already can provide educational value, if students can learn by teaching AIs

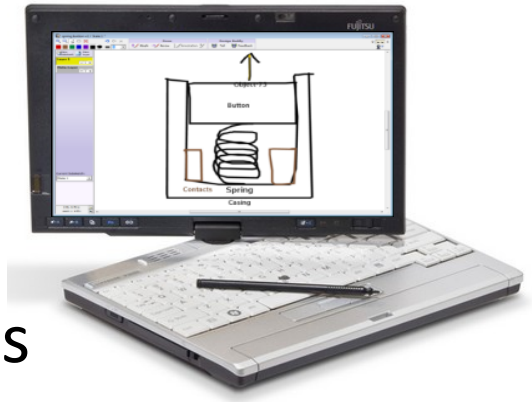




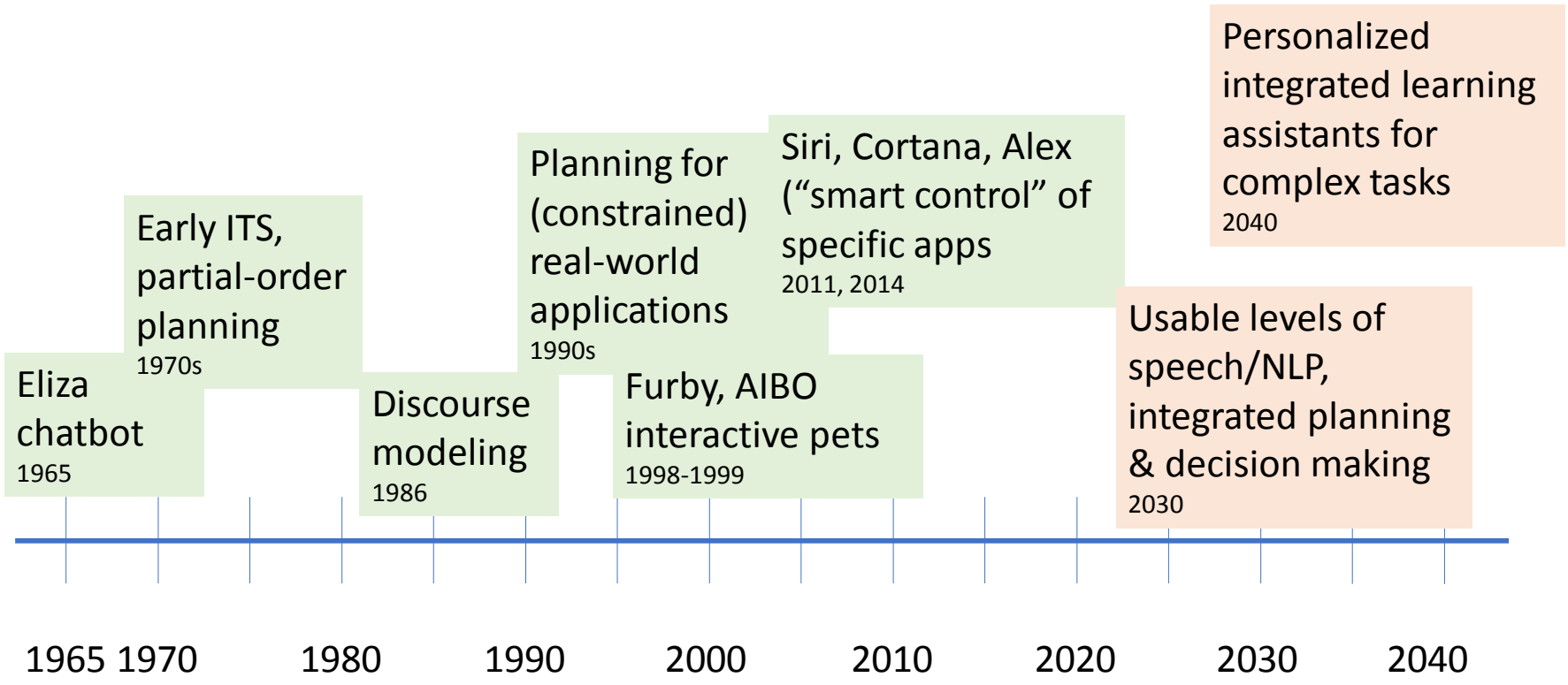


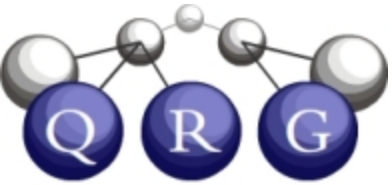
Dimension: Communications

- Teaching, mentoring, coaching…
- Multiple modalities
  - Language, sketching, gesture
- Ability to learn rapidly from students
  - True Socratic dialogs
  - Software needs to keep up with culturally relevant examples
- Build up relationships over weeks, months, years



Personal Assistant Arc





What might you worry about?