Curricula and Metrics to Investigate Human-Like Learning

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It's not what you know, it's how you learn it.
Context: Bootstrapped Learning Cup

- Contest that promotes LFH research
  - Open platform for curriculum development
  - Contributed domains for instruction
  - Base student, improved each year

Problem: How do we measure success?
What's needed to learn from humans?

- Embodied/grounded
- Many different cognitive specialists
- More parallel compute power
- Spelke principles/core knowledge
- Ecologically valid reasoning
- Shared experiences w. teacher
- Sheer quantity of background knowledge
- Autonomy of learner
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Intuitive physics
High quality sensory data
Creation of new representations
Face recognition
Metacognition
Learning how to learn
Visual representations
Cueing from natural language
Learning by intervention
Social cueing
Natural language understanding
Gaze tracking
What's needed to learn from humans?

- Embodied/grounded
- Many different cognitive specialists
- More parallel compute power
- Ecologically valid reasoning
- Spelke principles/core knowledge
- Sheer quantity of background knowledge
- Autonomy of learner
- Motor degrees of freedom
- Intuitive pedagogy
- Learning within a result to cause
- Gesture communication
- Better reinforcement learning
- Long training of genetics
- Sparsely connected algorithms we haven't discovered yet
- Robust short learning time
- Non-parametric learning
- Learning how to learn
- Crafting of new representations
- Motor imprecision
- High quality sensory data
- Computational power of neurons
- Creation of new representations
- Learning how to learn
- Non-Von Neumann architecture
- Robust short learning time
- Bayesian rationality
- Limbic motivation system
- Qualitative reasoning
- Visual representations
- Non-monotonic logic
- Visual representations
- Counterfactual reasoning
- Sparse graph representation and computation
- Concurrent learning of many things
- Synthesis of many things
- Story scripts
- Autonomy of learner
- Learning by intervention
- Good at inventing symbols
- Natural language understanding
- Social cueing
- Self-organized teachers
- Satisficing rather than optimization
- Large common-sense fact collection
- Bayesian rationality
- Learning how to learn
- Learning by intervention
- Good at inventing symbols
- Visual representations
- Intuitive physics
- High quality sensory data
- Computational power of neurons
- Creation of new representations
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- Social cueing
Which are really important?

Uh...
Spectrum Curriculum

- Pick one dimension to focus on
- Sequence of lessons along dimension
  - Incrementally move from hard to easy
- Test before first lesson, after each lesson

*It's not what you know, it's how you learn it.*
Dimension: Learner Autonomy

- Autonomy hypothesis:
  - Student is hypothesizing about environment
  - Teacher's actions provide disambiguating hints

- Implications:
  - Incorrect signals still help if they favor a hypothesis
  - Student is expected to fill in “obvious” gaps
  - Perceptible affordances will trigger learning w/o intervention from teacher
Example Spectrum: Out-Of-Bounds

- Many scattered points

Boolean function
Example Spectrum: Out-Of-Bounds

- Many scattered points
- Many border points

*Decision is a single boundary*
Example Spectrum: Out-Of-Bounds

- Many scattered points
- Many border points
- Cardinal border points

*Boundary is a rectangle*
Example Spectrum: Out-Of-Bounds

- Many scattered points
- Many border points
- Cardinal border points
- Opposite corner points

Rectangle is aligned w. cardinal axes
Example Spectrum: Out-Of-Bounds

- Many scattered points
- Many border points
- Cardinal border points
- Opposite corner points
- Hint line & 2 examples

Visible line is boundary of function
Example Spectrum: Out-Of-Bounds

- Many scattered points
- Many border points
- Cardinal border points
- Opposite corner points
- Hint line & 2 examples
- Hint line & 1 example

Other region has opposite value
Example Spectrum: Out-Of-Bounds

- Many scattered points
- Many border points
- Cardinal border points
- Opposite corner points
- Hint line & 2 examples
- Hint line & 1 example
- Hint line only.

*Inside is likely to be positive.*
Open Bootstrapped Learning Project

It’s not what you know, it’s how you learn it.

Teaching Computers
What if computers could learn anything that a human mentor could teach them?
- We wouldn’t need to write new software every time we wanted a new capability.
- Mentors wouldn’t need to be computer programmers.
- Computer systems could keep up with advances in technology, techniques, or tactics by learning new tricks.

The Project
The Bootstrapped Learning Project is a DARPA research program to develop ways for machines to learn from naive human teachers, through a mixture of normal human interactions, such as showing examples, correcting, and showing examples. Learn More.

The Bootstrapped Learning Cup
- Are you doing research in artificial intelligence, machine learning, or computer knowledge?
- Are you interested in pushing the state-of-the-art for how computers can learn?
- Do you want to help realize a future where regular people can teach computers in the same way that they mentor other people?

Here's your chance!
The Bootstrapped Learning Project is sponsoring a competition, open to any student or university research group. Starting with a baseline virtual student, your challenge will be to enhance its learning capabilities so that it's ready to be taught a simple game of virtual keepaway.

Your virtual student will compete with others to see who scores highest on a test after going through a set of tutorials on how to play keepaway. Then, these newly educated virtual students will play against each other, using the knowledge and skills learned during the tutorial.

Participants will get the opportunity to join the Bootstrapped Learning community, see early advances in natural instruction, and help shape the future research direction. Plus, you'll win recognition for your research group and your own programming skills. Sign up now for further competition notification. I'm interested.

Join the Competition
We're betting that some of you have great ideas about natural instruction and human-like learning for computers. Showcase your skills and research into machine learning at the first Bootstrapped Learning competition in September 2006. Join now, and your entry will be eligible for a preliminary feedback round in July.

To enter the competition, email us at ohbp@bbr.com

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Contest Structure

- Given: teaching system, base student
- Goal: improve student's ability to learn
- 6 RoboCup skill spectra
  - All teach a function by example + hints
  - One whole spectrum and easiest 1/3 of others are provided in advance
  - Taught concepts used by KeepAway player
- Two scores: spectra test integral, play-off
Beta Contest Codebase

- Java project, based on BAE/SRI BL framework
- Semi-competent base student
- Undergraduate level manuals
Looking for Participants!

- We need contestants!
  - Materials released: May 22\textsuperscript{nd}
  - Feedback round: July 25\textsuperscript{th}
  - First BL Cup competition: September 26\textsuperscript{th}
- Other participation (e.g. curriculum design, base learner code) is invited as well

http://dsl.bbn.com/BL/

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Help us help build the community!