# Curricula and Metrics to Investigate Human-Like Learning 

Jacob Beal, Paul Robertson, Robert Laddaga BBN Technologies
AAAI Symposium on Learning From Humans March, 2009

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


## What's needed to learn from humans?

- Embodied/grounded High quality Sunsoty data Creation of new representations
- Many different cognitive specialists
- More parallel compuze tracking Metaco Fance recognition
- Spelke principles/core knowledge
- Ecologically valid reasoning Visual representations
- Shared experiences w. teacher

Cueing from natural language

- Sheer quantity of background knowledge
- Autonomy of learner Learning by intervention Natural language understanding Social cueing


## What's needed to learn from humans?

Large common-sense fact collection

- Embodiod diorreund fed fee dom
- Embodied/grounqeomputational High quality sensory dabta Intuitive pedagogy computational power of neurons
 arsace recognition



 Quantum effects in micrợubumes

- Skeerr mivantiparse maphreresentation and computation
 Good 酸eboosingited chersural language understanding


## 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.


## 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 $22^{\text {nd }}$
- Feedback round: July $25^{\text {th }}$
- First BL Cup competition: September $26^{\text {th }}$
- Other participation (e.g. curriculum design, base learner code) is invited as well http://dsl.bbn.com/BL/ oblp@bbn.com
Help us help build the community!

