Rapid Development of Human Expertise

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The Challenge

Solve problems that
– All expert people
– all massive computer architectures
cannot solve by themselves
Symbiotic Human-Computer Computing architecture
Solving Hard Problems with Human-Computer Symbiosis

Coadaptation (Optimization):
1. People → Experts
2. Interaction → Optimal problem solving tools

Games are an ideal vehicle of coadaptation
People → Experts

1. Infinite Curriculum
   – Thought Process Language Analysis
2. Optimal Actions through Learning Ecosystem
   – Learners
   – Groups
   – Teachers
3. Optimize for the Meta and Non-cognitive skills
   – Persistence
   – Thinking outside of the box
Signs of Promise
Proteins
Proteins

MQIFVKTLTGKTILEVEPSDTIE...
Proteins

MQIFVKTLTGKITLEVEPSDTIE...

Sequence 3D Structure
Proteins

MQIFVKTLTGKTILEVEPSDTIE...
MGKYDKQIDLSTVDLKKLRVKEL...
KPVSLSYRCPCRFESHVARANV...

Sequence → 3D Structure
Proteins

Sequence:

- MKTLYDLPIVLRNLPEDLVLEK...
- SMGTAERVKIVVEHLGVDA...
- GPLGSDQYIVVNGAPVIPSAKV...

3D Structure:

- EASY
- HARD
Proteins

Sequence:
- MKTLYDLPIVLRNL_PEDLVLEK...
- SMSDTAERVKKIVVEHLGVDAL...
- GPLGSDQYIVVN GAPVIPSASKV...

3D Structure:
- ?
- ?
- ?

EASY

HARD
Training refinement

Level completion percentage

Date

One Small Clash
Swing It Around
Hide the Hydrophobic
Shake It Off
Close the Gap
When Backbones Collide
Twin Pack
Nudge It Along
Triple Packed
Sheets Together
Lonely Sheets
Sheets and Ladders
Lock and Lower
Turn It Down
The Right Rotation
Flippin' Sheets
Rubber Band Reversal
Linear trend (R.B.R. only)
Training refinement

![Graph showing level completion percentage over dates]

- Level completion percentage
Training refinement

Level completion percentage

Date

Level completion percentage

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Linear trend (R.B.R. only)
Training refinement

![Graph showing level completion percentage over dates for various tasks](image)

- **Level completion percentage**
- **Date**
- **Tasks**:
  - One Small Clash
  - Twin Pack
  - Lock and Lower
  - Swing It Around
  - Nudge It Along
  - Turn It Down
  - Hide the Hydrophobic
  - Triple Packed
  - The Right Rotation
  - Shake It Off
  - Sheets Together
  - Flippin’ Sheets
  - Close the Gap
  - Lonely Sheets
  - Rubber Band Reversal
  - When Backbones Collide
  - Sheets and Ladders
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Level completion percentage vs Date for various activities:

- One Small Clash
- Twin Pack
- Swing It Around
- Nudge It Along
- Hide the Hydrophobic
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- Shake It Off
- Sheets Together
- Close the Gap
- Lonely Sheets
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Training refinement
Comparison to Algorithm

Better energy

Closer to native

Player solutions
Top player path
Algorithm solutions
Foldit Video Gamers Join the Fight Against Ebola Virus

Several vaccines are already in the pipeline to counter the devastating threat posed by the Ebola virus in Africa, but game players are using a collaborative puzzle program called Foldit to help look for new treatments. The online game, which was created by University of Washington researchers in 2008, enlists players to find the best ways to twist virtual protein molecules into the desired shapes.
Very broad appeal

Prior knowledge of biochemistry

- None
- High school / Basic
- One undergraduate course
- Majored in biology or similar
- PhD in chemistry or organic chemistry
- PhD in biochemistry 30 years ago
- Professionally involved
Social Expertise

- Group sharing and collaboration
- Peer review and iteration
- Multiple paths to skill and success
- Social praise and feedback
- Self-specialization
- Collective Intelligence
Creativity
Drug Design
Small Molecules
Accelerating Neuroscience
Neuronal Reconstruction

Goal: can we produce high quality reconstructions at scale by developing novices?
Neuron Ontology Reconstruction
Rapid Content Mastery
Algebra Mastery in Elementary School

3 equations without errors with behaviors that indicate fluency

\( ax + b = c + \frac{d}{e} \)

\( \frac{abx}{b} + c + c + 0 = d + yz \)

\( b - \frac{c}{x} = c + d - c \)
Washington Algebra Challenge

We did it!

TOTAL EFFORT: 6 months 28 days 2 hours

KIDS ARE STILL PLAYING:

EQUATIONS SOLVED:

TOTAL EFFORT:

429,053

7m 20d 07

Winners Announced!

This year’s Washington State Algebra Challenge was a fantastic success. Not only did we exceed our original goal of 250,000 equations, but we had participation from a total of 4,132 students representing public and private schools, home school programs, and after school groups. Check out the winners by clicking the button below!

VIEW WINNERS!
En uforglemmelig matematikkt ime!

We did it!

EQUATIONS: 644,936

TOTAL EFFORT: 9 months 29 days 22 hours

KIDS ARE STILL PLAYING:

EQUATIONS SOLVED: 697,292

TOTAL EFFORT: 10m 25d 13

Congratulations!

Over 6000 students completed over 600,000 equations – most of those during the first 5 days! Total student playing time reached almost 10 full months (24 hour per day)! An amazing effort by all. Quite a few classrooms achieved over 95% mastery and all the students were exposed to (and hopefully excited by) the conceptual ideas involved in solving algebraic equations. Thanks to all who participated.
Norway Challenge

• 8 million equations
• Almost 10% of school ready kids now have the concept mastered
• 42% of all work is done in after school hours
Teacher Effects
Student Effects
K-12 Deployment

• ½ Million students / grade
  – Math and ELA

• 200 million first generation learners in India
  – basic numeracy and literacy
Learned Lessons

• Infinitely adaptive experience
• Optimize the entire ecosystem
• Optimize individuals not outcomes
• Collective Social Intelligence
• Coevolution
People → Experts

1. Infinite Curriculum
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