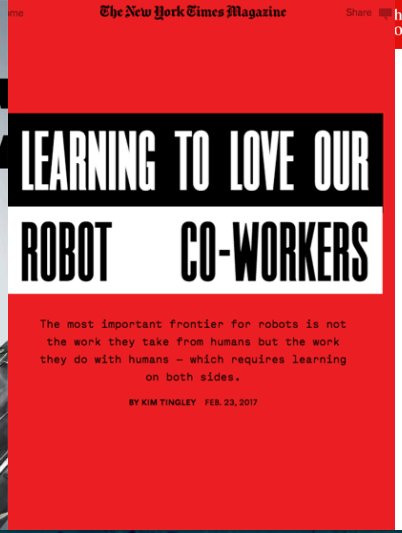
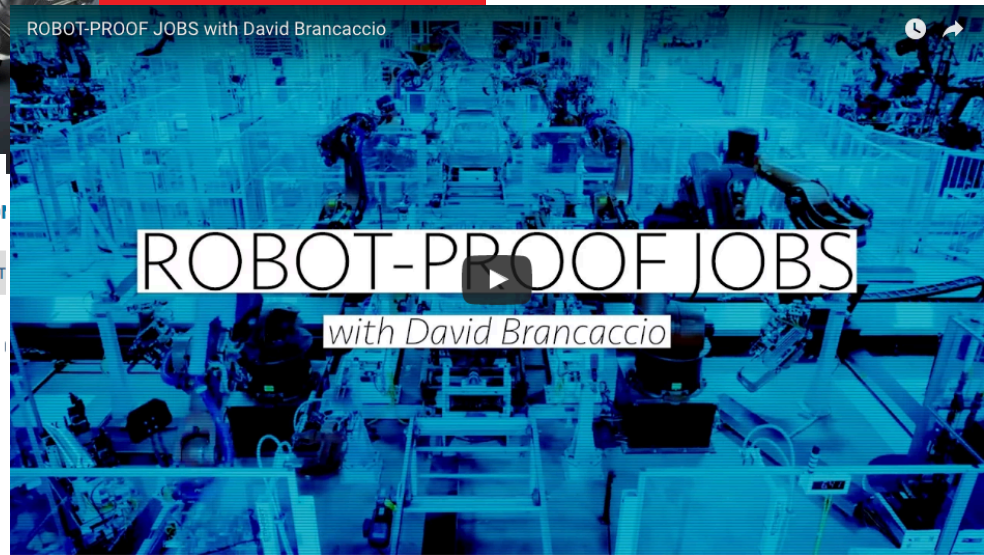
Academia + Industry to ACCELERATE Learning

Marti Hearst

UC Berkeley

BayLan 2018





THE CHRONICLE OF HIGHER EDUCATION NEWS OPINIO

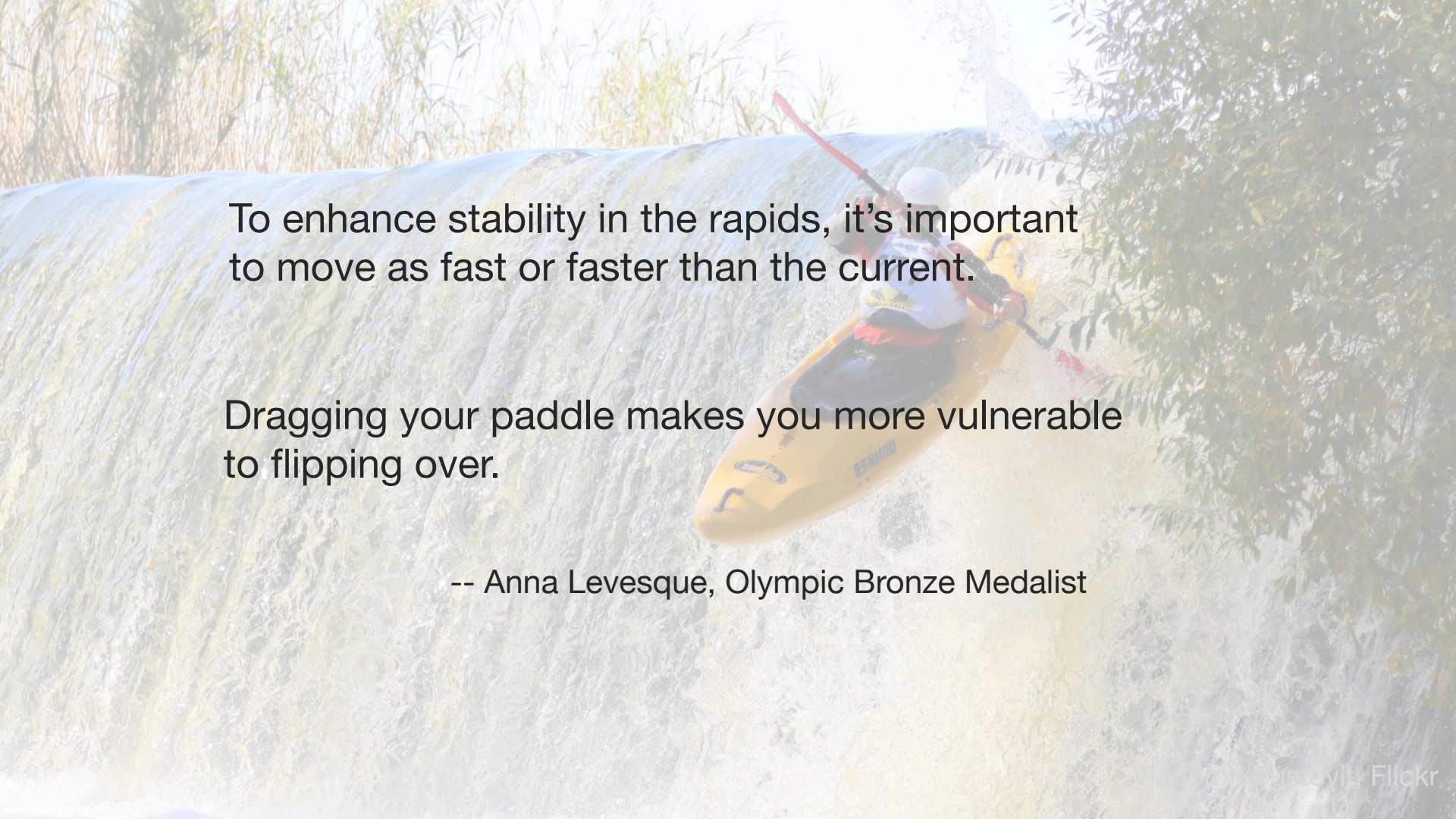
SECTIONS FEATURED: How to Train Effective Teachers What's New in Freshman Housing Your Daily Briefing T

COMMENTARY

Robot-Proof: How Colleges Can Keep People Relevant in the Workplace

By Joseph E. Aoun | JANUARY 27, 2016

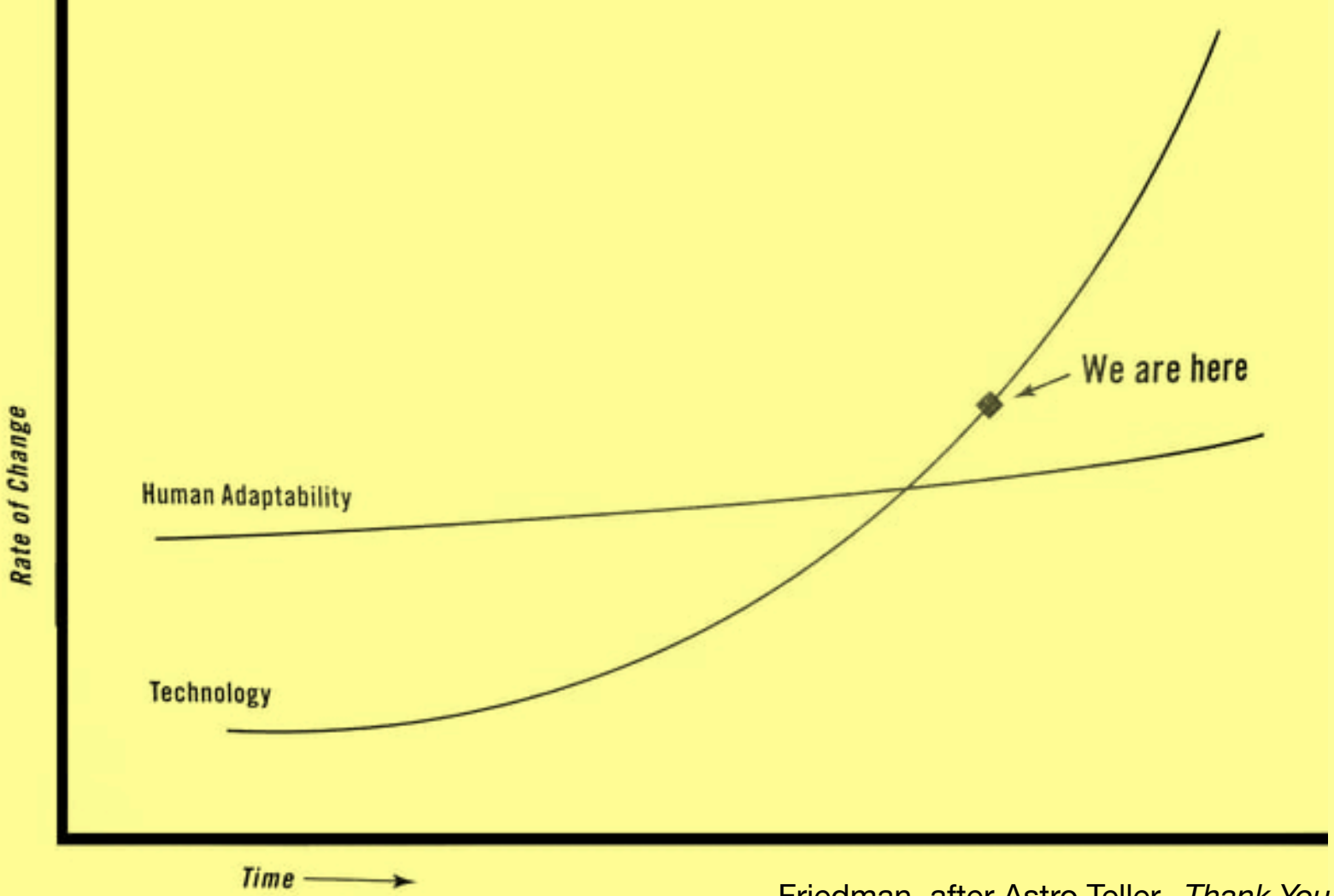
Vladomir Pustovit, Flickr



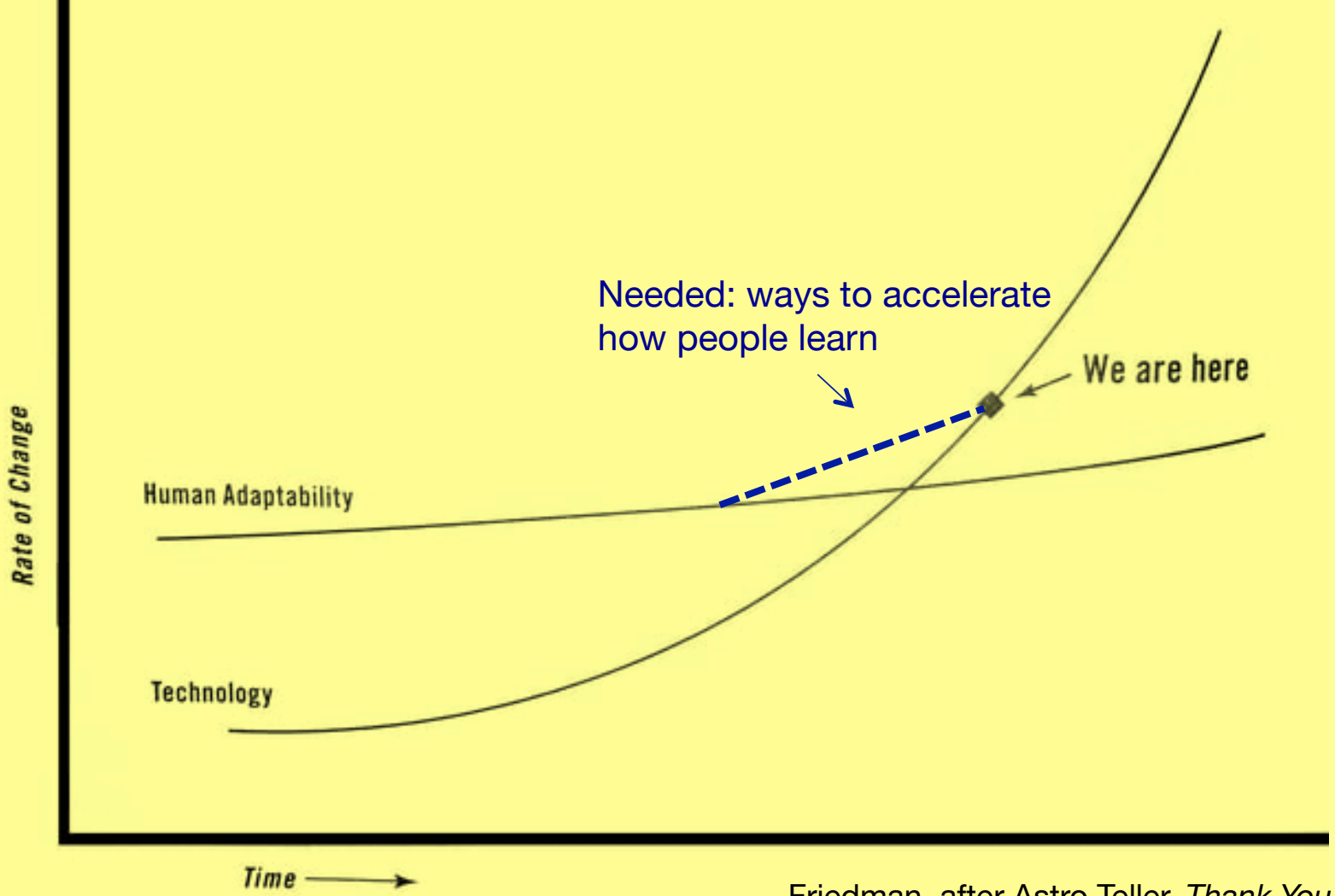
To enhance stability in the rapids, it's important to move as fast or faster than the current.

Dragging your paddle makes you more vulnerable to flipping over.

-- Anna Levesque, Olympic Bronze Medalist



Friedman, after Astro Teller, *Thank You For Being Late*



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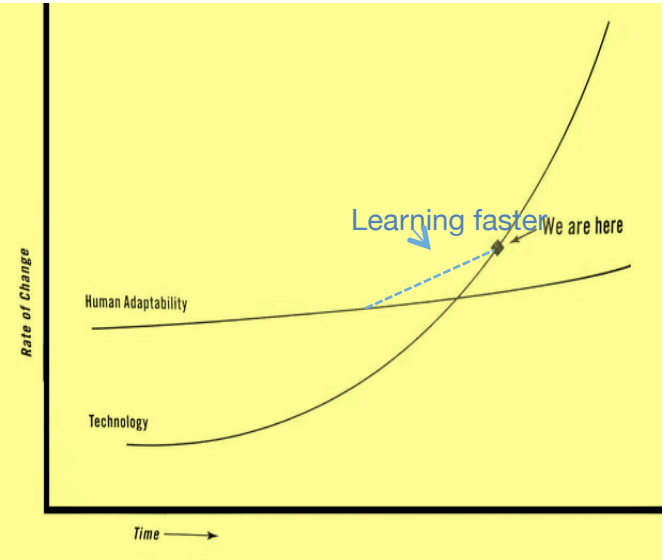


"There is a mismatch between the pace of change and our ability to develop the learning systems … that would enable citizens to get the most out of these accelerations and cushion their worst impacts."

We can apply features that drive technological innovation to figure out how to enhance human's adaptability.

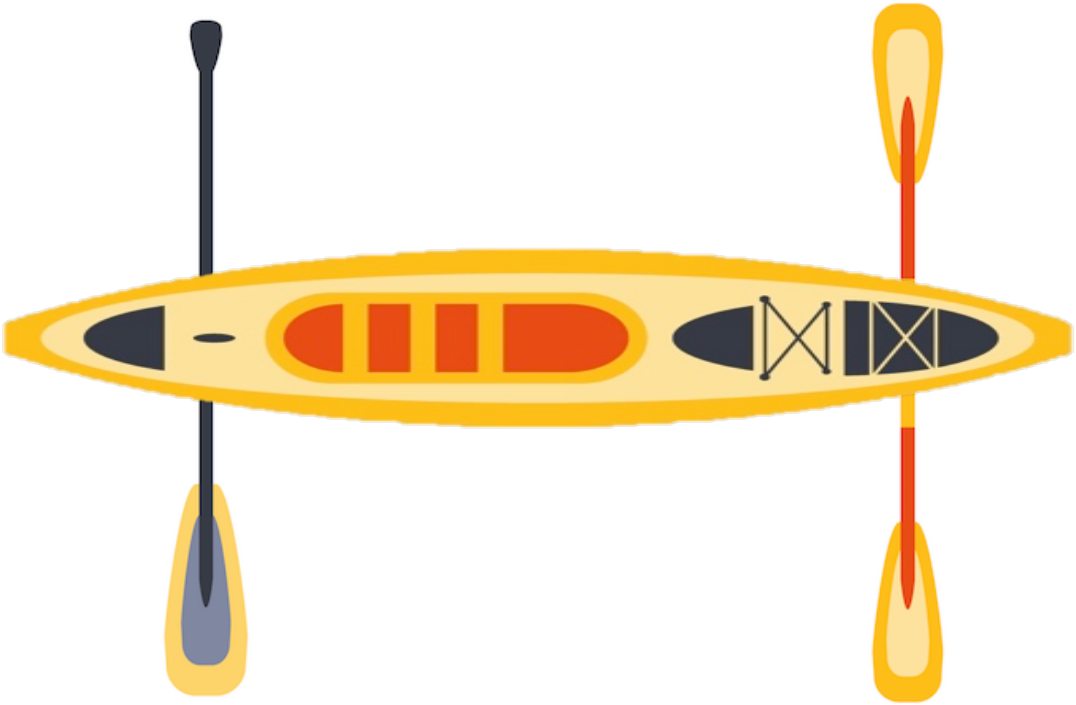
Friedman, *Thank You For Being Late*

Two Simultaneous Disruptions Related to Technology

Job Automation

Teaching/Learning Online

Both Should be Benefitting by the Mitigating Factor of AI



Job Automation

Teaching/Learning Online

The Challenge

- Although for decades technology has been changing the employment landscape, the change seems to be accelerating today.
- **One way** to address this is to help people help themselves by improving our methods for teaching and learning.
- **One method** for improving our teaching and learning is for AI to play a bigger role than it has to date.
- Can industry + academia working together make a **real breakthrough**?

EXAMPLE PAIN POINT: AUTOMATING FEEDBACK IN MOOCS

Pavel Pevzner

One-on-one education is best.

But we can't afford it, and if we could, there maybe are not enough tutors.

Instead, we should combine computers with teaching.

ISMB 2017 Keynote talk

Pavel Pevzner

Massive Adaptive Interactive Textbook

Online bioinformatics platform

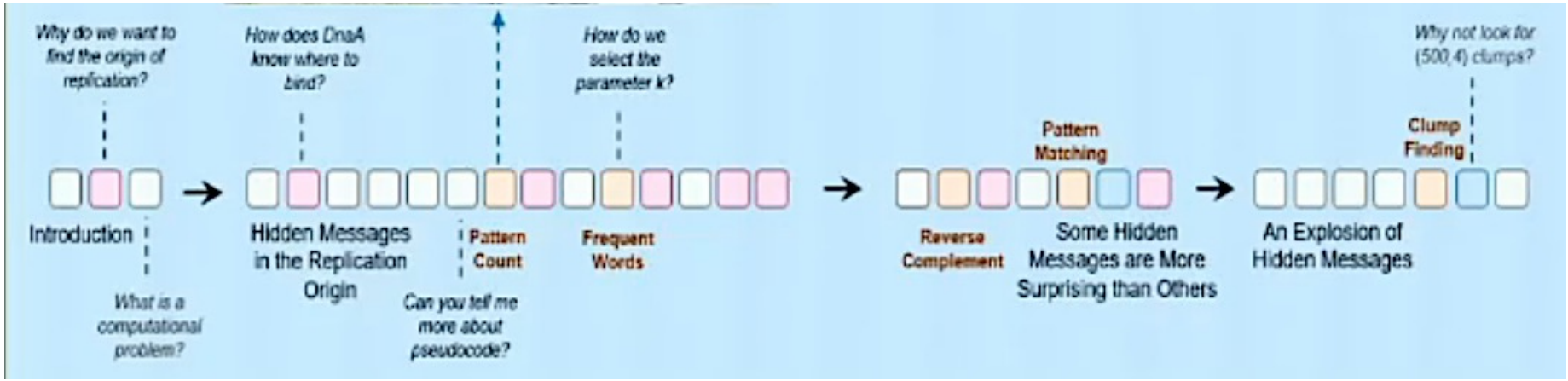
100+ autograded programming challenges

Stop and think exercises, code challenges, detours

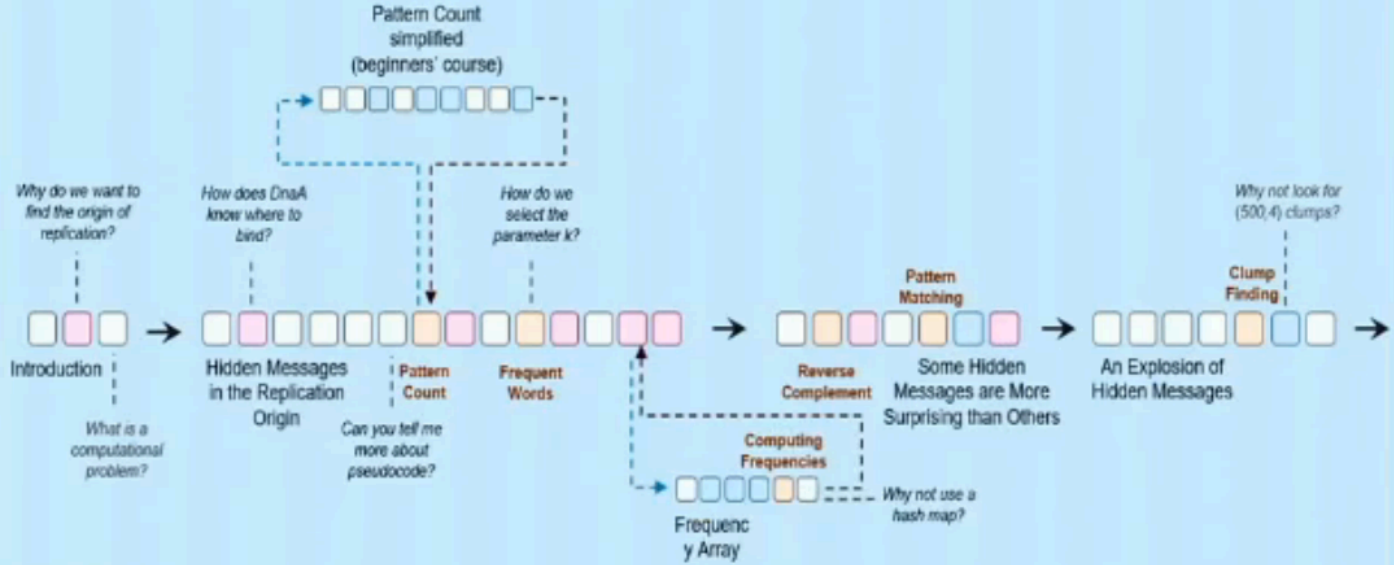
As soon as a student fails, they are directed to a new module to address the learning breakdown.

ISMB 2017 Keynote talk

Programs, Challenges, FAQs throughout

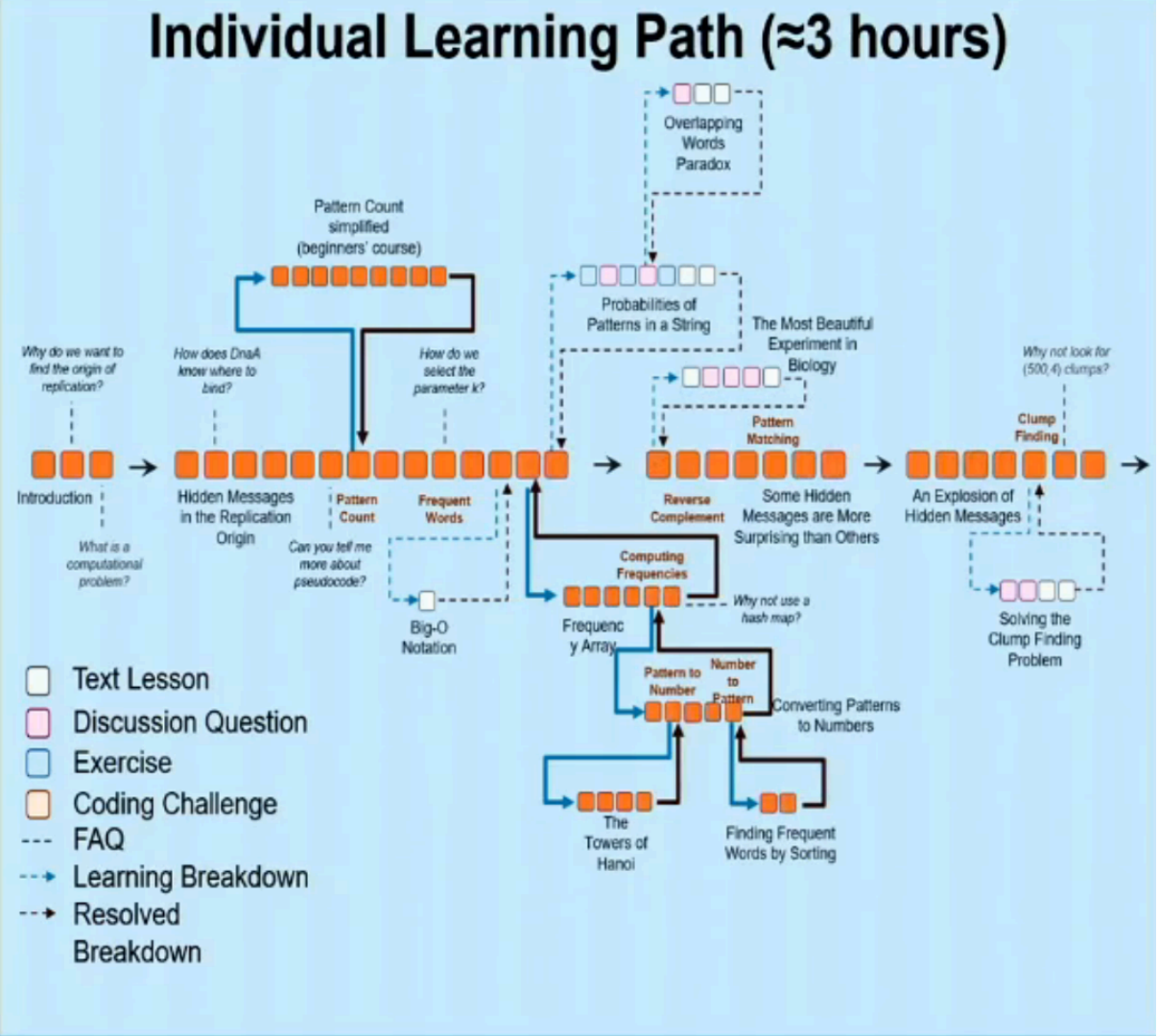


Pevzner ISMB 2017 Keynote talk



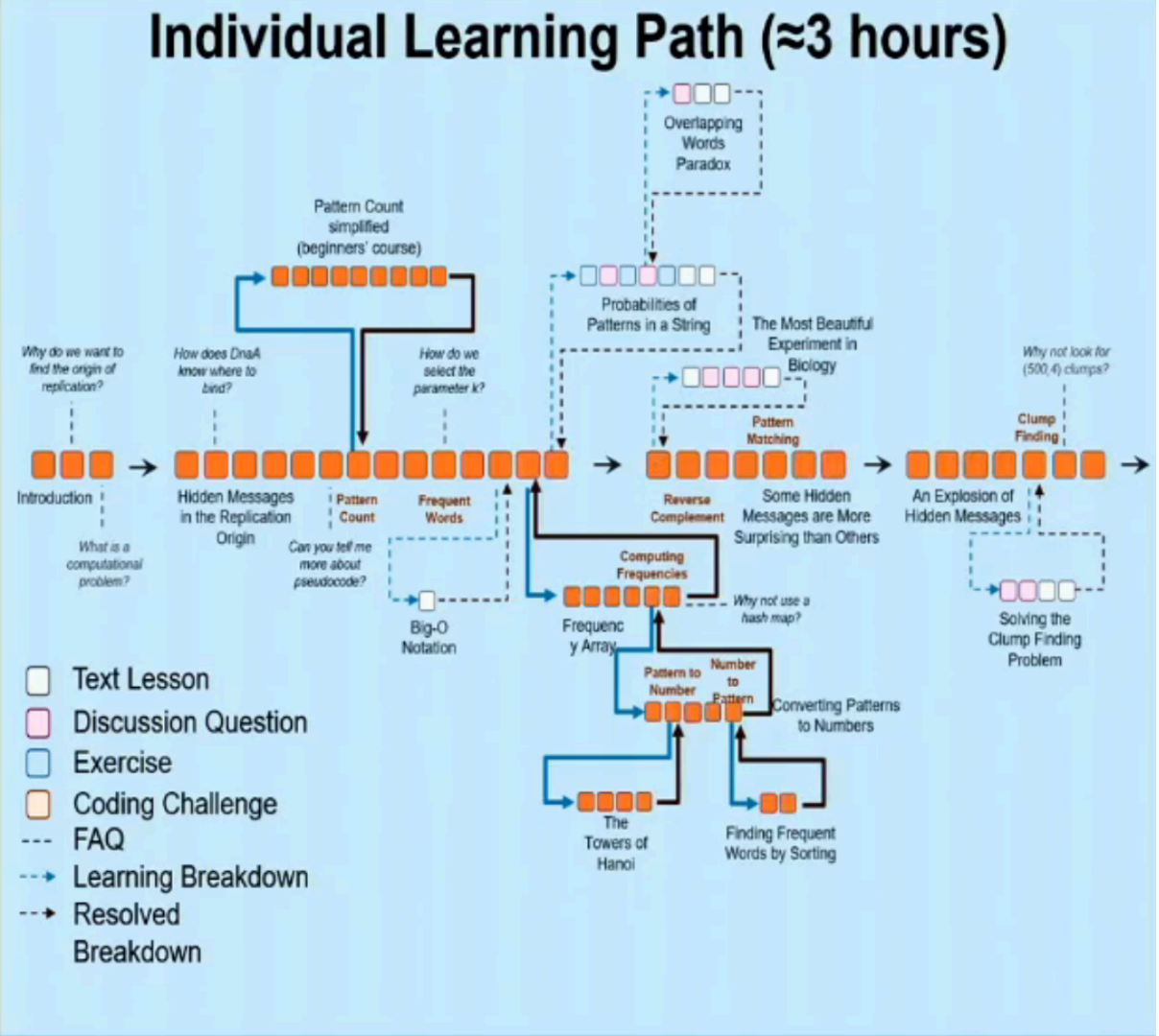
If a student makes an error, they are directed to a sub-branch to address the relevant misunderstanding.

Pevzner **ISMB 2017 Keynote talk**



With thousands of students taking the course, more and more unexpected errors are uncovered.

Pevzner **ISMB 2017 Keynote talk**



12 people and 7000 hours development time already!

Pevzner **ISMB 2017 Keynote talk**

Karthik Muralidharan

Developing Countries' Perspective

- Hardware-focused interventions for home or school seem to have no positive impact on learning outcomes
- Pedagogy-focused computer-aided learning programs that allow students to review grade-appropriate content at their own pace do better, but gains are modest (.1-.2)
- Interventions that deliver the largest gains appear to be those that use technology to also personalize instruction.

Muralidharan et al, CESifo Working Paper, No. 6328, 2017

Karthik Muralidharan

MindSpark Deployment in India

- 10 years of development
  - >45,000 test questions
  - >1M questions administered per day
- Can tailor suggestions to students
- Student errors are analyzed to refine suggestions
- This allows for identification of long-tail misconceptions
- Show .36 learning gain in math and .22 in Hindi in randomized controlled studies.
- HOWEVER all of this tailoring work has been done manually.

Muralidharan et al, CESifo Working Paper, No. 6328, 2017

Long Tail Student Misperceptions: Which Number is Larger?

“27 is larger than 3”

Long Tail Student Misperceptions: Which Number is Larger?

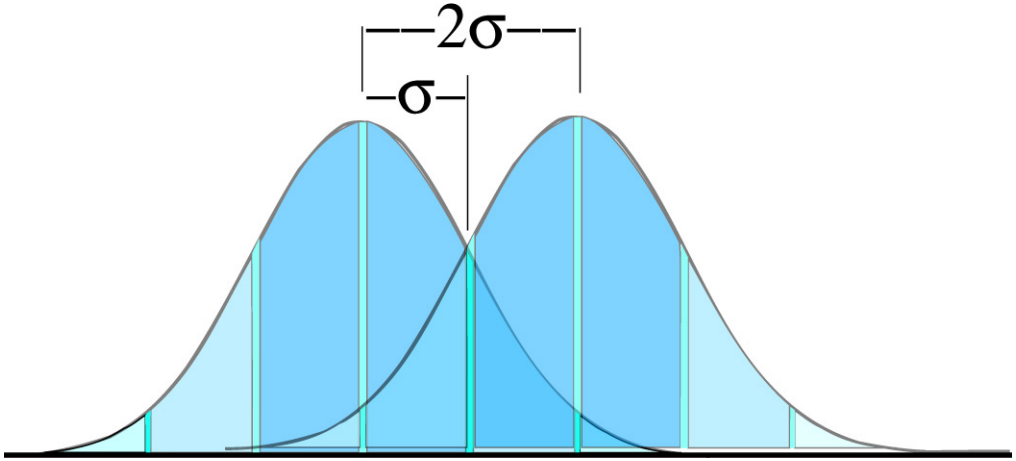
“1/27 is larger than 1/39”

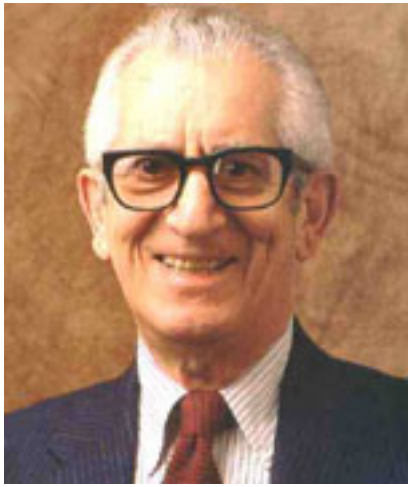
WE NEED TO ACCELERATE THIS: PEOPLE ARE DOING IT BY HAND!

THERE ARE MANY MORE EXAMPLES…

AN EARLIER CHALLENGE

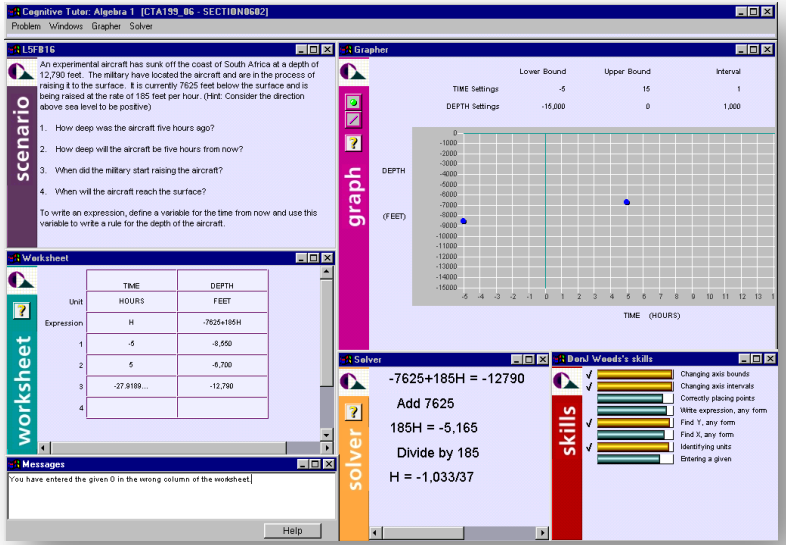
The average under tutoring [with mastery learning] was about two standard deviations above the average of the control. (Benjamin Bloom, 1984)*



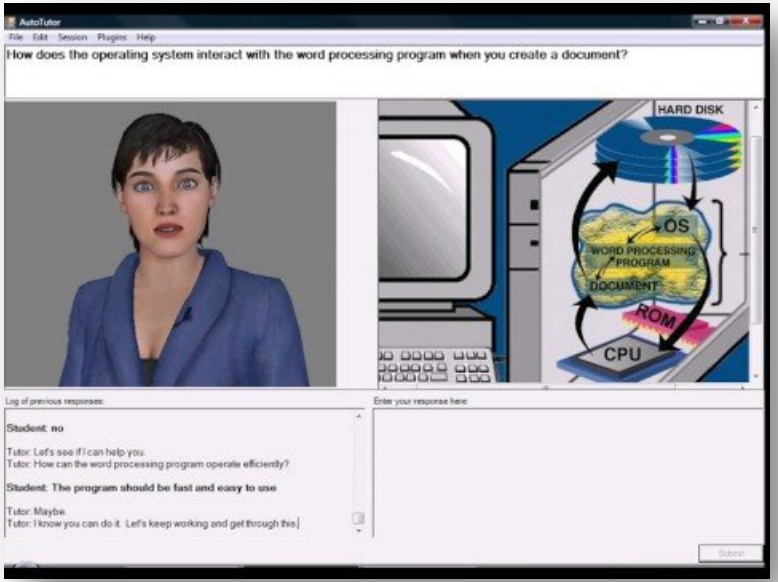


*Subsequent analysis suggests (a) these cases were outliers, and (b) mastery learning was more important than tutoring, but it was a motivating challenge problem!

Sophisticated Intelligent Tutoring Systems



Cognitive Tutor (Algebra)



Autotutor

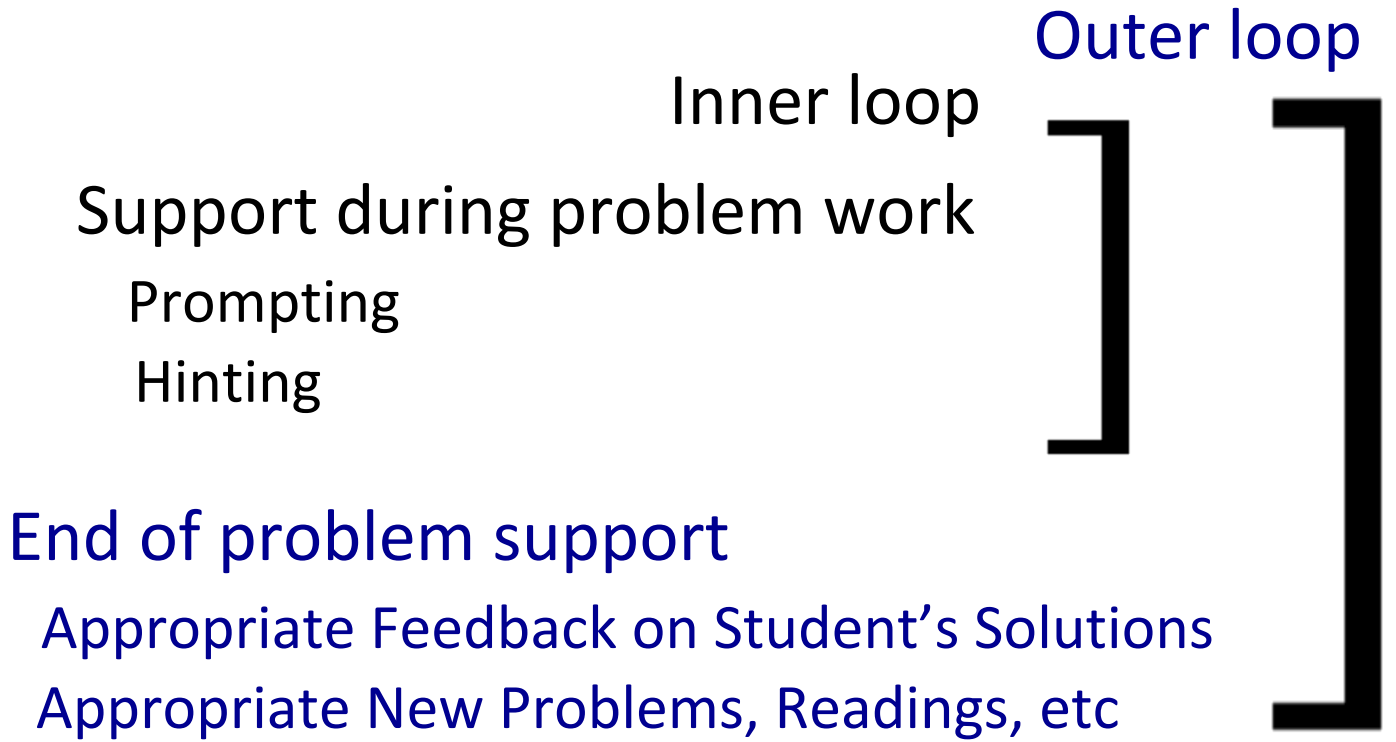
Tutoring Systems: Interactive Feedback Loops

Inner loop

Support during problem work

- Prompting
- Hinting

Tutoring Systems: Interactive Feedback Loops



Do Intelligent Tutoring Systems Work?

- Meta-meta-analysis (Kulik & Fletcher, Review of Educational Research, 2016)
  - Took into account important controlling factors
  - Found moderately strong positive effects (.4 - .6 typically)
  - An important factor was “adequacy of the program implementation”

  “The evaluations show that ITS’s typically raise student performance well beyond the level of conventional classes and even beyond the level achieved by students who receive instruction from… human tutors.”

WHY AREN'T INTELLIGENT TUTORING SYSTEMS DEPLOYED EVERYWHERE?

Claim: If There Were An Easy-to-Use Semi-Automated Way To Develop these Systems, People Would Use It

Why don’t we have good software for developing autograders, hint generators, etc, for every topic ?

Ryan Baker

"Stupid" Tutoring Systems, Intelligent Humans

The initial vision for intelligent tutoring systems involved powerful systems that would leverage rich user models to create complex learning interactions.

But the intelligent tutoring systems being used at scale today are much simpler.

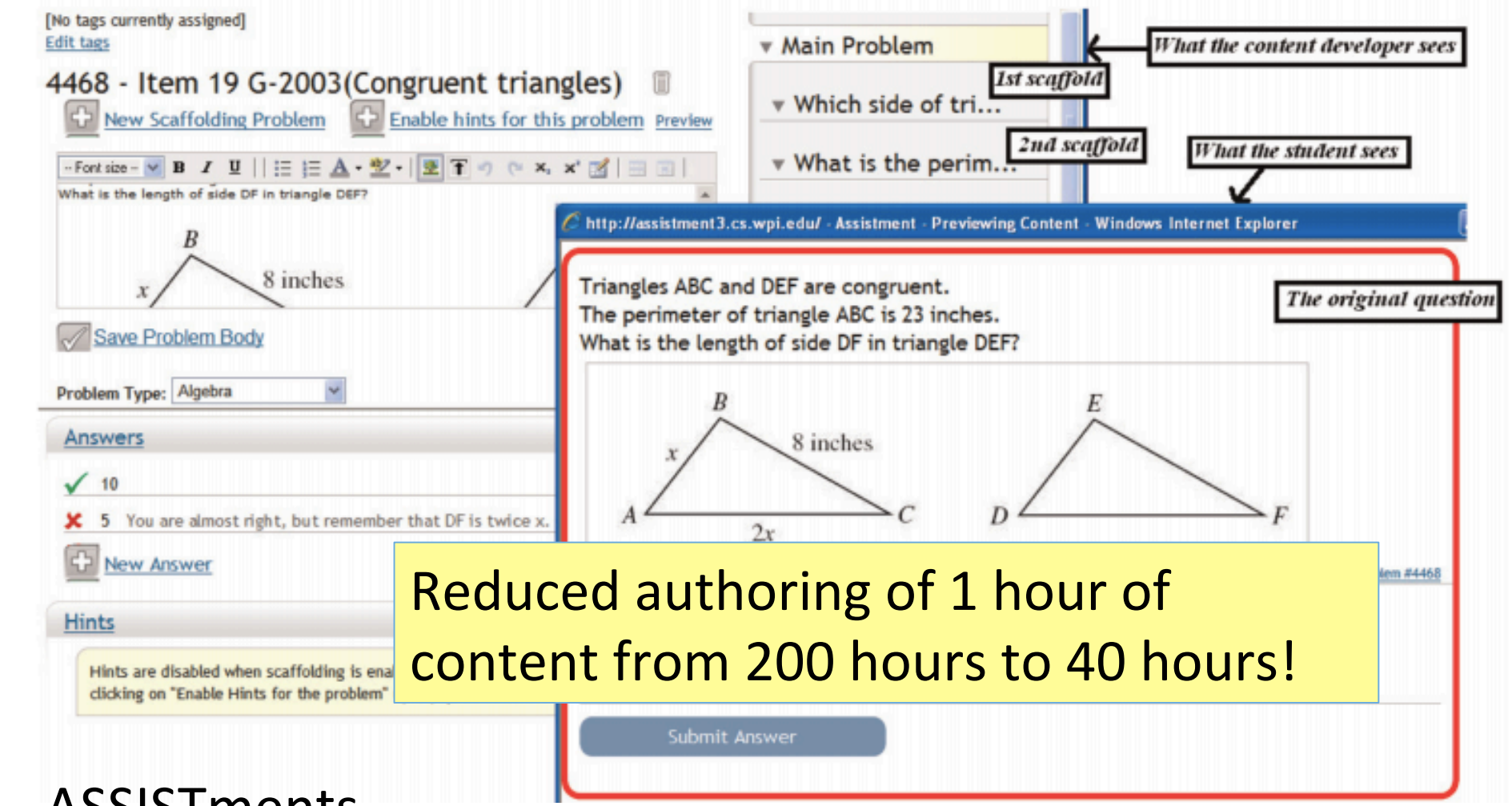
Baker, IJAIE 26 (2), 2016.

Ryan Baker

"Stupid" Tutoring Systems, Intelligent Humans

Perhaps we do not in fact need intelligent tutoring systems. Perhaps instead what we need, what we are already developing, is stupid tutoring systems. Tutors that do not, themselves, behave very intelligently. But tutors that are designed intelligently, and that leverage human intelligence.

Baker, IJAIE 26 (2), 2016.



Reduced authoring of 1 hour of content from 200 hours to 40 hours!

ASSISTments

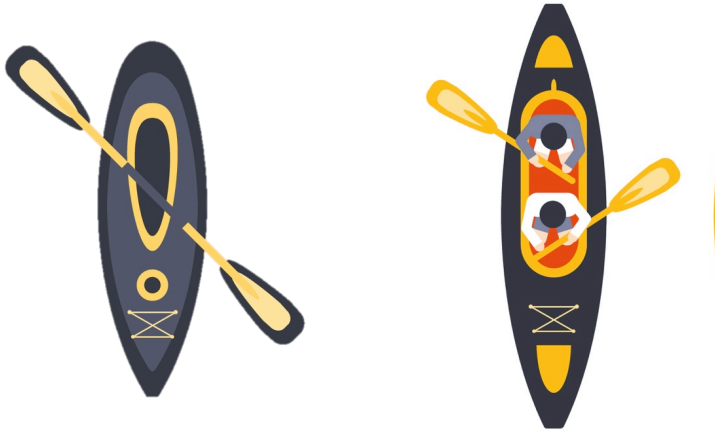
Raqqaz et al, IEEE Trans Learn Tech 2009

Learning:
The Ideal Laboratory for Core AI Problems

- Machine Learning
- Knowledge Representation
- Reasoning
- Natural Language Processing
- Image and Video Analysis
- Cognition
- Neuro-X

Opportunities for AI to Intersect with Learning

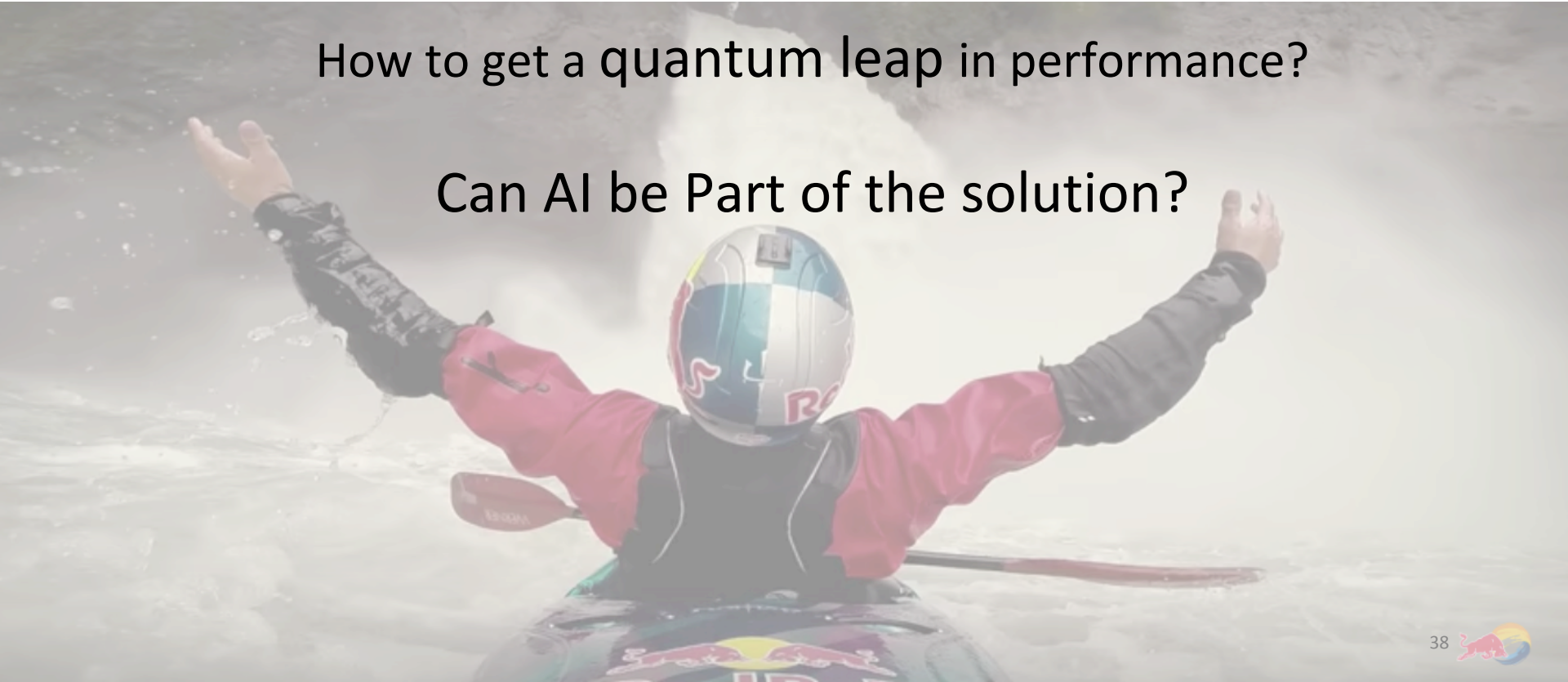
Generating Hints From Existing Rationales



Reproducing Peer Learning Online

MOONSHOT: Accelerate Learning

Moonshot: Accelerate Learning



How to get a quantum leap in performance?

Can AI be Part of the solution?

To Accelerate Human Learning Beyond What Is Possible Today

To reach 2-sigma goal,
Automation and expertise
Academia and industry together might be the key.

Thank you!

Marti Hearst
UC Berkeley