An Impasse-driven Model of a New Result on Learning in Problem Solving

Randolph M. Jones
Eric S. Fleischman
Computer Science Department
Colby College

Learning to Solve Problems

- A typical approach
  - Lectures on the topic
  - Reading on the topic
  - Examine some worked examples
  - Practice on some problems
  - Test on some problems
- Success is measured by performance on the final tests

The Self-Explanation Effect

(Chi, Bassok, Lewis, Reimann, and Glaser, 1989)

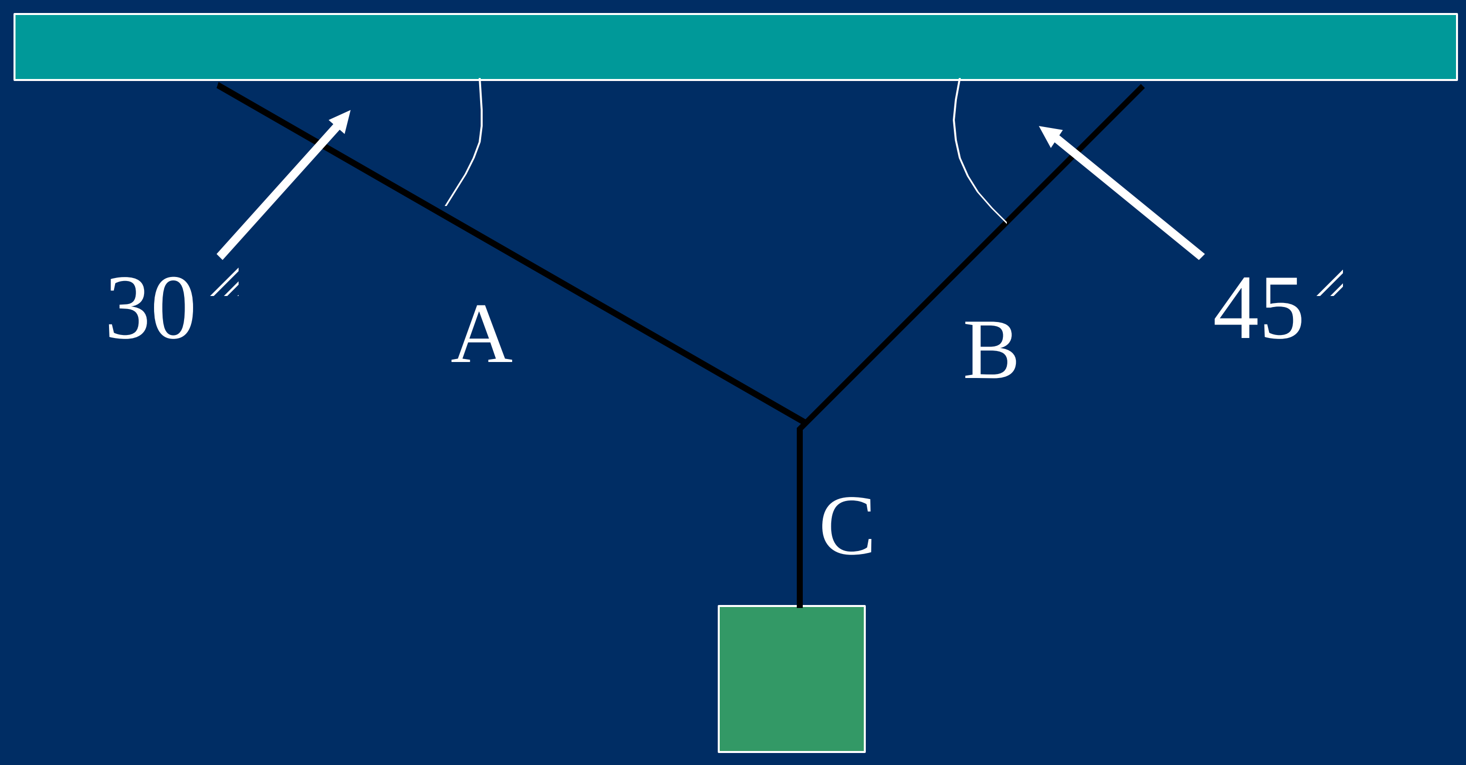
- Good learners utter many more self-explanations than poor learners
- Good learners utter more accurate self-monitoring statements
- Good learners refer to chapter examples much less often than poor learners
- Good learners have better focus when looking up examples

The Fading Effect

(Renkl, Atkinson, & Maier, 2000)

- Post-test scores are higher when students work incrementally faded examples than if they receive only worked examples and problems.

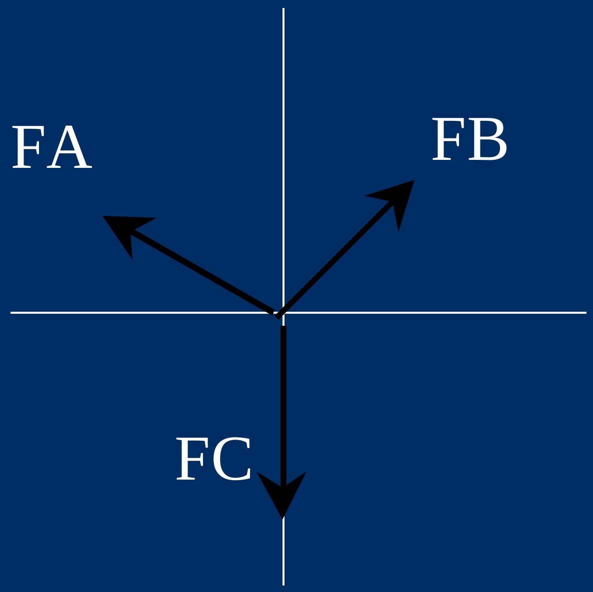
A Typical Problem



What is the magnitude of each force?

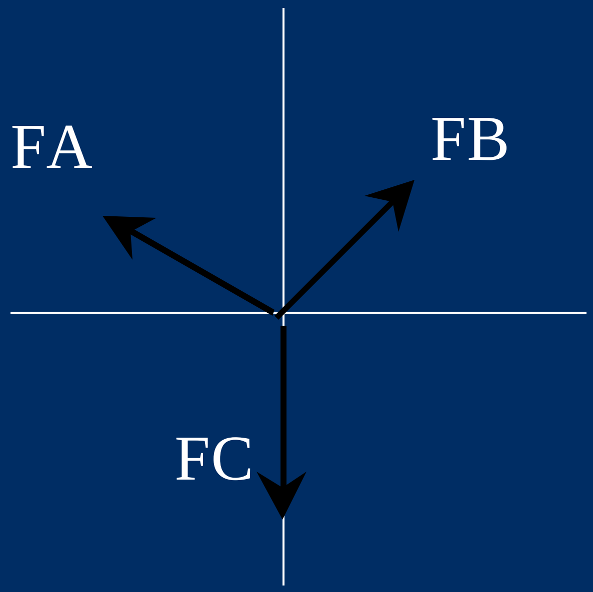
A Typical Example

- Let the knot be "the body"
- FA, FB, FC are all the forces acting on the body
- The body is at rest, so FA+FB+FC=0
- By projection, $FA_X+FB_X=0$
- By projection, $FA_Y+FB_Y+FC_Y=0$
- $FA_X = -FA \cos 30° = -0.8666FA$
- Etc.

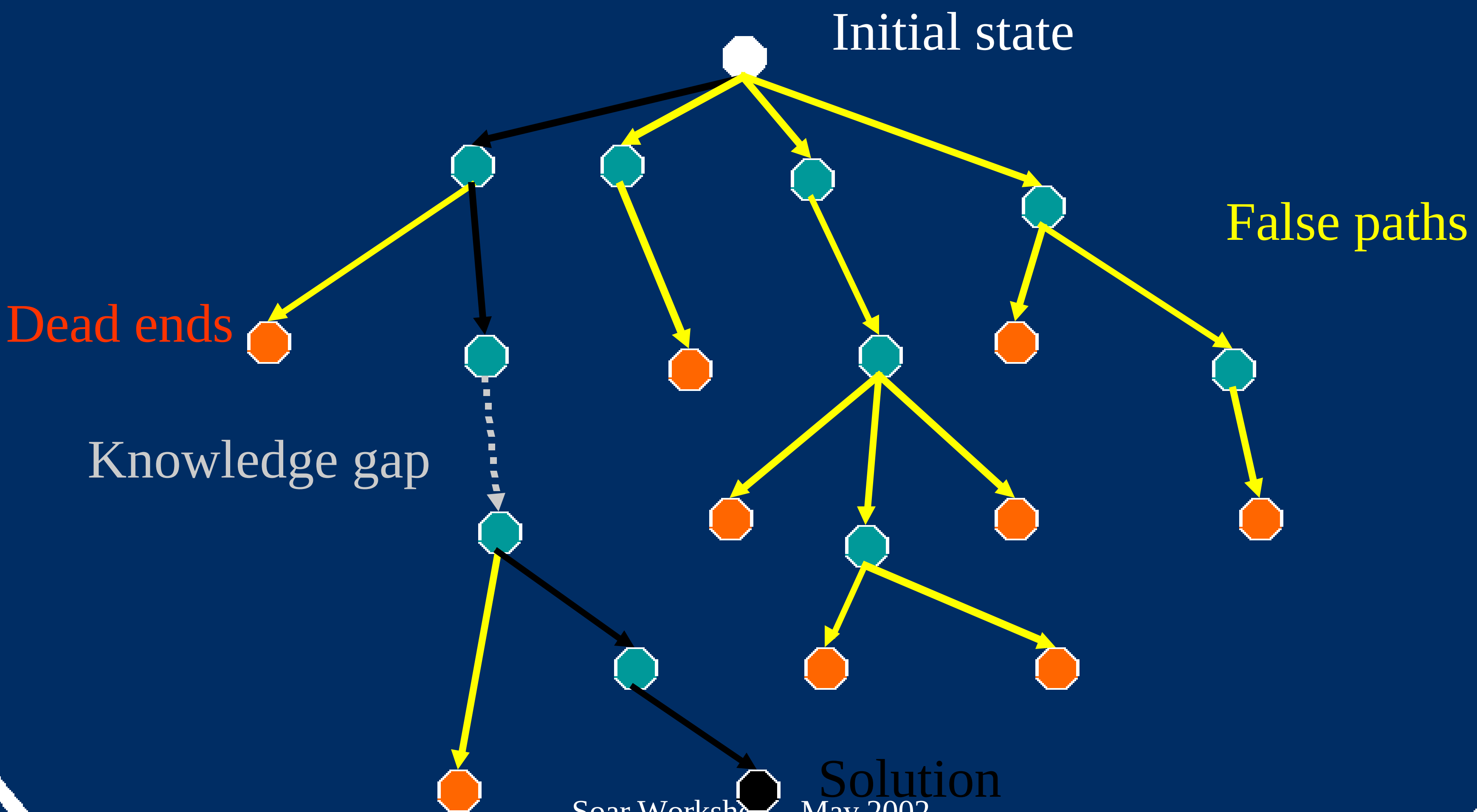


A Faded Example

- Let the knot be “the body”
- FA, FB, FC are all the forces acting on the body
- The body is at rest, so FA+FB+FC=0
- By projection, $FA_X+FB_X=0$
- By projection, $FA_Y+FB_Y+FC_Y=0$
- INSERT NEXT STEP HERE



Impasse-Driven Learning From Constrained Problems



Cascade and Self-Explanation

- Self-explainers are good solvers because:
  - They have the opportunity to learn new rules while self-explaining
  - They store traces of their example-explaining, which can guide search while solving problems
  - They patch the right gaps
  - Neither learning mechanism alone is sufficient
  - The learning mechanisms interact
- BUT
  - We do not know why students sometimes choose not to self-explain

The Cascade Story for Fading

- Improved performance occurs when a student is able to patch the right gaps
- Fading must somehow help this happen
- Two possibilities:
  - Students are forced to focus on faded portions of examples, thus exposing gaps
  - Knowledge tuning in the right places can help guide gap-finding in later problem solving

Cascade's Predictions

- Impasses and self-explanation should occur more frequently in faded portions of examples
- Improved performance should correlate with resolved impasses and *useful* self-explanation
- Improved performance should not correlate with impasse-free fading or *useless* self-explanation
- Improvement from fading should *not* occur in the absence of resolved impasses (during self-explanation) or appropriately faded analogies

Results and Benefits

- Initial protocol studies on newly collected data suggest that our predictions are correct
- If Cascade is right (or even partially right), we can use it to:
  – Evaluate curricula of faded examples and problems
  – Predict performance on particular problem sets from particular example sets
  – Target individual knowledge chunks for learning
  – Guide the construction of faded examples aimed at those targets

What's Soar Got to Do With It?

- Cascade incorporates two learning mechanisms
  - Specialization of general knowledge in the face of a problem-solving impasse
  - Automatic pairing and storage of goals with solution steps, for later use by analogy
- Soar is well suited for both of these types of learning