Automated Analysis of Students' Responses to Short-Answer Physics Questions

Christopher M. Nakamura, Dean Zollman
Kansas State University Physics Department

Sytil K. Murphy
Shepherd University Physics Department

Michael Christel and Scott Stevens
Carnegie Mellon University Entertainment Technology Center

AAPT Winter National Meeting 2012 Ontario, CA
February 08, 2012

This work is supported in part by U.S. National Science Foundation under grant numbers REC-0632587 and REC-0632657

All images and photographs created by C.M. Nakamura unless otherwise indicated

Project Goals

Pathway Active Learning Environment

• Develop an interactive online synthetic tutor
  – Targeted at high school & intro college physics students
  – Designed for supplemental instruction at home
  – Investigates interactive multimedia lessons and tutors

• Seek to exploit benefits of human tutoring
  – Interaction is mostly student-centered
  – Students must build explanations
  – Students must challenge their explanations

Active Learning Environment

Key Functions

• Lesson Activities

• Synthetic Tutor (SI)

The System

• Three lessons cover Newton’s Laws

• Uses 3-stage Learning Cycle

• Focuses both on calculation and concepts

3 Karplus (1977)
Active Learning Environment

The System

• Collects a lot of lesson responses

• Can’t provide response-specific feedback

Can we use responses we have to provide feedback?
Analysis Procedure

Data Set 1
Response 1
Response 2
Response 3
Response 4
Response N

Manual grouping of responses by ideas expressed

Groups of Responses
Group 1
Group 2

Automatic extraction of data features

Feature List

Machine Learning Algorithm

Trained Model

* Here a Feature List is a list of all the words in the response set.

Analysis Procedure

Tool used: Summarization IDE: 4. Rosé et al. (2008)

Results

• Process has shown promise (~60-75% match rate)
• Further results are mixed (50%-90%); work is ongoing
• Larger groups match better
• Approach reveals coherence; also divergence
• Properties of good lesson problems?

5. Nakamura et. al (2011)
Response Prediction

• Relationships may reveal common response patterns
• Response patterns could indicate constructive or non-constructive usage

Student Pathways
Conclusions

- Investigating ways to provide automated feedback in a synthetic tutoring system
- Machine learning provided promising results; more analysis is needed
- Looking for connections across activities and concepts

The End

Thank you.

For more information: cnakamur@phys.ksu.edu
References


