CASTS: A System for Collaborating Among Students, Teachers and Software

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S-CASTS is a research program aimed at investigating the use of models of collaboration in the augmentation of existing, flexible software tools for mathematics education. This poster reports on the development of algorithms for recognizing students' plans when interacting with such pedagogical systems, and for presenting this information to teachers and researchers in the educational sciences. It is a first step towards building a collaborative pedagogic agent that will support students in their problem-solving and teachers in their analysis of students' modeling and understanding of statistical data.

S-CASTS

Goal: To create a system that collaborates with teachers in understanding how their students use pedagogical software to solve data and probability problems.

The Computer System and Teachers play Complementary Roles

System: plan recognition, milestone recognition, and analysis of student activities.

Teachers: pedagogical decisions based on the system's analysis.
Our study uses TinkerPlots [Key Curriculum Press]

- A commercial system used world-wide to teach students in grades 4-8 about data analysis and probability.
- Students use a toolkit to actively model and analyze stochastic events.
- Basic objects shown below: sampler, table and plot.

### Challenges for a Teacher in the Computer Lab

How do students construct TinkerPlots models?
How do they explore multiple models, operating on several simultaneously?
How do they use the models they create to analyze data?
What common mistakes do they make?

Screen snapshots don't show any details of students' problem-solving.

### A Sample Problem: The RAIN Problem

There is a 75% chance of rain each day.

What is the probability that it rains for the next 4 consecutive days?

End Result of One Student’s Session

There are many ways to solve the RAIN problem in TinkerPlots
Plan Recognition: What does the system need?

- A user log representing the actions the student has taken using the software
- A representation of ideal solutions (recipes) for solving a problem.
- Algorithms that use recipes to match user log to solutions, and recognize the plan the student was following.

Challenges

Ideally designed pedagogical systems are flexible, allowing students to explore and experiment with different approaches towards solving the problem, and to perform actions in relatively free order.

Traditional plan recognition assumes a goal-oriented, perfect user that does not make mistakes.

Our algorithms need to capture users that are pursuing multiple, interleaving plans, or that are confused about which plan to take.

Specifying a Recipe: Basic Actions

Basic actions are rudimentary, involving a single click or keystroke.

Specifying a Recipe: Complex Actions

Complex actions are abstract; they are composed of other complex and basic actions.
Recipes

A recipe for a complex action includes a set of (complex and basic) sub-actions for completing the complex action.

Two possible recipes for creating a device to solve RAIN

Plans

A plan for a complex action is a hierarchy of recipes towards completing that complex action.

Empirical Evaluation of Plan Recognition

Subjects:
- 12 adults, varied educational backgrounds
- Training: 30 minute TinkerPlots tutorial
- 4 statistical problems

Evaluation of TinkerPlots plans:
- Domain expert's set of gold standard recipes.
- Compared algorithm output to subject's "true" plan
- Correctly identified plans in all cases where the log registration was complete (40 out of 43 instances).
“Milestone” recognition

- Milestones mark important transition points in students’ use of TinkerPlots that provide information to teachers.
- Examples of milestones: RUN a particular sampler, COLLECT data in a given table, DRAG an attribute from a table to an axis of a graph.
- Unlike plans, milestones are displayed in chronological order; there is no hierarchical structure of milestones.

Aggregate class work

To make pedagogical decisions, teachers want to know how the entire class performed. The third type of information a teacher can get is an aggregate view of the strategies individual members of the class followed.

Future Directions

- Design a graphical user interface for teachers to explore plans, milestones and aggregate information about their students
- Work with other types of data analysis problems using TinkerPlots
- Extend analysis techniques to other kinds of pedagogical software
- Use logging and analysis tools for research on the development of statistical reasoning