Homework 5—Build a More Complex Cognitive Tutor
05-432/05-832 Personalized Online Learning, Fall 2018
Due: Fri, Nov 9, 11:59pm (via Canvas)
Maximum points: 70

This homework aims to let you "experience" the full power of rule-based cognitive modeling for purposes of personalizing instruction. You will build a rule-based tutor for a task domain for which building an example-tracing tutor is not feasible. You are asked to complete a cognitive model for a tutor about Mendelian genetics. Also, you get to build a tutor that, instead of supporting the usual problem-solving practice, supports a process of scientific experimentation and interpreting the results of the experiments (abductive reasoning).

The assignment offers an opportunity to learn about the following:

- Doing an analytical cognitive task analysis (you'll learn in class what we mean by that term)
- Designing your own working memory representation;
- Modeling steps with multiple rules;
- Linking the interface representation dynamically to the semantic representation of the problem, as opposed to statically;
- Creating a dynamic interface with a Nools tutor;
- Additional Nools constructs (e.g., not, exists, salience, and ways of dealing with slots that hold an array of values, rather than a single value).

This assignment must be carried out by students working in interdisciplinary pairs. If you decide to work as a pair, you are asked to submit a joint report (i.e., one report for the collaborating pair). The procedure for forming pairs and ensuring that each team is an interdisciplinary team will be discussed in class. Find below information for how to structure the roles within the team so each team member benefits maximally from the experience.

Grading criteria

- Have correct English rules been defined through cognitive task analysis?
- Does the tutor behave correctly?
    - The tutor should allow for self-crosses. I.e., crossing a strain with itself.
    - If there are multiple inferences that can be drawn after two strains have been crossed, they can be entered in any order.
    - The tutor should accept the next cross only when all key inferences from the previous cross have been entered.
    - The tutor should capture all possible solutions paths for the two problems that were provided (and problems of the same type).
    - You are not asked to attach hints or to implement bug rules (although in general, tutors should always have hints and often have bug rules).

- Has the model been documented adequately? (See below)
- Has the student team worked together effectively?

Resources downloadable from BlackBoard:

- Some background material for learning about the task domain
- A tutor interface
- Behavior graphs to be used for learning the task and testing the cognitive model (note: these graphs do not exhaustively enumerate all solution paths)
- **(To be provided later)** a partial model, together with commentary that gives suggestions for how to extend the partial model.

Step 1: Study the task domain and do some cognitive task analysis

Read the background materials in files "Declarative instruction.docx" and "MendelBackwardsV4.ppt". You might check if there are good Khan videos about this topic. Please share with the class if you find good ones! To get a feel fro the abductive reasoning process you will model, play with the provided example-tracing tutors (files "foxglove example tracing.brd" and "lupine example tracing.brd"). Use hints if needed – they only give the correct step, though, so for each inference that is made, make sure you understand why.

Once you have a good sense for the abductive reasoning processes supported by this tutor, conduct analytical cognitive task analysis.

1. so as to complete the table on p. 16 of MendelBackwardsV4.ppt – these rules capture specify the partial and full conclusions that can be drawn from the results of crossing two strains – based purely on the phenotypes of the two strains being crossed, and those of the offspring.
2. Also, study the rules on p. 17 and 18 – these rules capture inferences that combine from partial and full conclusions drawn from multiple crosses, including, critically, the last one.
3. Finally, as a way of planning/understanding your cognitive model, relate the steps/links in the given behavior graphs to the subgoals, described below.

The result of the cognitive task analysis should be English versions of rules, comparable to these shown in the slides, and in the Nools code that is provided as part of the homework.