Assignment 4

CSE 473 – Introduction to Artificial Intelligence, University of Washington, Spring 2010.

Due Monday, May 3, at 5:00 PM.

The assignment has two parts. In the first part you'll get more familiar with heuristic search methods. In the second part, you'll apply logic to the representation of knowledge and solution of problems.

Part I. Heuristic Search.

1. A* search (30 points). Consider the map of France (with distances) shown in class and in the reading. (a) Find the shortest route from Nantes to Nice. (b) Propose two new heuristics for this problem. At least one of them must be admissible. (c) Give an argument why the admissible one is admissible. (d) Is the other also admissible? Why or why not? (e) Add two more options to the Python program that implement search in this map, corresponding to A* search with each of your new heuristics. (f) Compare the performance of these heuristics with: (i) uniform cost search, and (ii) A* search with the longitude-difference heuristic (built-in). (g) If one were to change the source and destination for the problem, what are the extremes of good and bad performance of your heuristic (choose the admissible one or either if they are both admissible) in comparison with the longitude-difference heuristic?

2. Genetic search (15 points). Select either problem A or problem B and then work out a formulation of genetic search for solving instances of the problem.

> Problem A: Layout. A set of artistic photos is to be arranged on a web page. Assume the goal is to place n images on a page of a given width w and with height as small as possible such at all n images (which are rectangular and whose widths and heights are given but vary from one photo to another) are placed on the page with no images overlapping or going off the page.
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> Problem B: Scheduling. A set of course offerings by a department is to make use of the rooms in a particular building and to respect certain constraints that certain pairs of courses should not meet at the same time. When a course is scheduled for a room, the expected enrollment for the course must not exceed the room capacity.

Be sure to explain how each of the following aspects figures into your formulation: (a) representation of "individuals" (i.e., states), (b) a suitable crossover operator, (c) a suitable mutation operator, and (d) a suitable fitness function.

3. Constraints (10 points). Express the following type of puzzle as a constraint satisfaction problem, identifying the set of variables, set of domains for the variables, and set of constraints.

> A *Prime k-in-a-row puzzle on an m by n board* is the problem of placing k tokens on an m by n board (whose squares are numbered 1 through m*n in "raster-scan order" -- left-to-right and top-to-bottom) such that the k tokens form a line horizontally, vertically, or diagonally, and each token falls on a prime number.

Part 2. Propositional and Predicate Logic in AI.

4. Propositional encoding for resolution (15 points). Translate the following passage into a set of propositional calculus formulas, using the given propositional variables and their given meanings. Express your translation as a syllogism.

The passage:

"Either Lisbeth had control of Mikael's laptop or Mikael was dreaming. The list of phone numbers had been changed and Mikael had not done it. If Lisbeth controlled the computer and Mikael had not changed the phone numbers, then Lisbeth must have done it. If Mikael was wide awake then he certainly was not dreaming. Mikael was wide awake. Therefore, Lisbeth must have changed the list of phone numbers."

Proposition symbols and assigned meanings:

P1: Lisbeth had control of Mikael's laptop.
P2: Mikael was dreaming.
P3: The list of phone numbers had been changed.
P4: Mikael had changed the list of phone numbers.
P5: Lisbeth must have changed the list of phone numbers.
P6: Mikael was wide awake.

Give three examples of inferences you made about the meanings of words or phrases in the passage in order to arrive at your formulation. For example, the laptop is a computer, so that P1 is not only the representation for the first part of the first sentence, but also the first part of the third sentence.

5. Propositional resolution (10 points). Convert the statements in the syllogism above to clause form, and then prove the syllogism using only one inference rule: resolution.

6. Predicate calculus encoding and resolution (20 points). Consider the following passage. Express this information in the predicate calculus (10 points).

> "Wolfgang is in New York and needs to fly from New York to Frankfurt in order to get home. (He only flies nonstop.) If a volcano is erupting between two continents then flights between those continents are not available. The continent of New York (JFK) is North America. The continent of Frankfurt (FRA) is Europe. Someone who needs to fly from A to B to get home cannot get home unless flights from A to B are available. Eyjafjallajokull lies between North America and Europe. Eyjafjallajokull is erupting."

Use predicate calculus resolution to show that Wolfgang cannot get home (10 points).

Updates and Corrections, as necessary, to this assignment will be posted in GoPost. This sheet may also be updated.