First round of natural intelligence, a prelude to artificial intelligence

COSC 418 Artificial Intelligence, August 28, 2006

Dr. Gene B. Chase

If our brain were simple enough for us to understand it,
it would be too simple for us to [use it to] understand it.
—A. R. Luria[1]

I'd prefer for this first time around that you didn't read up on solutions to "your" question anywhere, but just rely on your wits. I have avoided in some cases giving the usual name for the problem to make it less likely that you will find a solution elsewhere. I have a metaquestion for you: Do these questions below have anything in common?

1. Sudoku. Attached is a Sudoku puzzle. Can you solve it? Tell us how you did it. Can you tell a computer how you did it?

2. Tic-tac-toe. Play a game against a person. Play a game against a computer. (There are lots of them around. For example: www-cse.uta.edu/~cook/ai1/lectures/applets/ttt/TicTacToe.html). Can you tell a computer how to play tic-tac-toe?

3. Figure 6.14 on p. 190 of your text with n=4 boxes. Convince yourself that there is a win for the first player when n=4. What is the first player's strategy when n is even to assure a win? What is the second player's strategy for a win when n is odd? Can you tell a computer how to win? Tell us how to win.

4. Noyes Chapman's "15 puzzle" took American gamespeople by storm in the 1880s, shortly after he patented it. Here is an applet for you to play the game. www.cut-the-knot.org/pythagoras/fifteen.shtml Can you solve it? Could you tell a computer how to solve it? Half of the random starting configurations are impossible to solve. Tell us why. At this web site, you can play the "8-puzzle," a simpler variation. Are there hints from solving that one that can help us to solve the 15-puzzle? Tell us how to solve the 8-puzzle. (Or even the 15-puzzle if you can.)

(Until this year, 2006, very intelligent folks like puzzle expert Martin Gardner believed that this puzzle was created by Sam Loyd (not "Lloyd," although internet searches will find it spelled both ways). The 15 Puzzle earned Loyd a lot of money as a popularizer of it. Here is where I learned about Chapman's priority: mathworld.wolfram.com/15Puzzle.html .)

5. Parking Zone is a 15-puzzle-like game, with an applet for it located here: www.microgames.info/game_info.php?products_id=241 I think that it is easier than the 15-puzzle. Could you tell a computer how to solve it? Tell us how to solve it.

6. Missionaries and Cannibals. Here is a version of the famous "missionary and cannibals" game. www.plastelina.net/games/game2.html If you are using Firefox, then you better look at just the Flash file plastelina.net/games/loginpageG2.swf since Firefox doesn't seem to scale the file correctly, and Internet Explorer does. Can you solve it for three missionaries and three cannibals? n missionaries and n cannibals? Can you tell us how you did it? Could you tell a computer how to do it?

(I thank Susanna Epp for pointing me to the site. See her web site under "A sampling of websites": condor.depaul.edu/~sepp/ I thank my son Tim for suggesting that we look at the Flash file directly.)

7. The cabbage-goat-wolf puzzle is so easy to solve that I'm going to give you the puzzle in French so that you can't read the instructions. Tell us how to solve it. perso.orange.fr/jeux.lulu/html/loupChe/loupChe1.htm If you get stuck, you can find a link to the English instructions at Susanna Epps's web site mentioned in Question #6 above.

8. Left hand rule for escaping from a maze. Someone told you that if you are ever lost in a maze which has an exit, just put your hand against the wall to the left and follow it around until you come to the exit. Does this rule work? If so, tell us why; if not, tell us when it does.

9. Maps. From Messiah College (1 College Ave, Grantham PA 17027) to York, PA, try maps.yahoo.com, maps.google.com, and mapquest.com. Do you get the same directions? Are they accurate? Tell us why or why not? Hint: The correct directions to York, PA, are to go East on Route 114 to 382; go South on 382 to I-81. Then (as all the sites say) continue South to York. What rules do you think that the various map sites are using? [Route 114 is called Market Street in Mechanicsburg, Lisburn Road between here and Lisburn, Hodgstown Road west of Mechanicsburg, and so on.]

10. Clustering. I assign grades based on what you earn, not on "grading on a curve." But suppose that I wanted to assign grades to our class using the following rule. Group the grades into two piles, which I'll call for the sake of convenience A and C. Put the highest grade in the A pile; put the lowest grade in the C pile. Now put all of the rest of the grades in one of the two piles, one at a time, depending on **whether the grade is "similar" (more like) the other grades in the pile so far.**

(a) What letter would your rule assign to the grades under each of the following scenarios?

Case 1:

70 75 76 76 80 85 90 91 91 93 93 93

Case 2:

70 71 72 79 80 86 92 93 93 93 93 93

Case 3:

70 71 72 73 74 82 83 89 90 91 92 93

Defend your reasons for what rule you used to call grades "similar."

(b) Repeat this with the same grades, but now try to assign three letter grades, A, B, and C. Does your reasoning work if there were four grades to assign, A, B, C, D?

11. Logic. Richard Nixon was a Republican. Richard Nixon was a Quaker. Quakers are pacifists. Republicans are not pacifists. What reasoning will you do to make all of those three sentences true?

12. Winning at games. There are two players. Let's call them O and E. They simultaneously display one or two fingers. Let the total number of fingers displayed be f. If f is odd, O collects f dollars from E. If f is even, E collects f dollars from O.

(a) Who will win in the long run? What strategy would you play if you were O? What strategy would you play if you were E? Write a short computer program to try out a variety of strategies (perhaps using random numbers to simulate the players), and tell us what the program predicts that the best strategy will be.

(b) Find the best strategy if O and E display one, two, or three fingers.

Although this is a game (as we will define it in our course), games can be very serious. Are there biological weapons being developed in Iraq? An inspector chooses a day to inspect a facility; the facility operator chooses a day to hide all the weapons. The inspector wins if the days are different; the

facility operator wins if the days are the same. This is an application of the study of two-person games.

(c) What's the best strategy for playing the game rock-paper-scissors? What is the best strategy for playing the game rock-paper-scissors-fire-water? (For a definition of the game, see Exercise 17.10 on p. 648, but don't do the exercise.)

13. Maximum number of packages. Suppose my grocer has 75 pounds (1200 ounces) of cashews and 120 pounds (1920 ounces) of peanuts. He wants to sell two kinds of one-pound (16 oz.) packages: low-grade packages with 4 oz. cashews, and 12 oz. peanuts; and high-grade packages with 8 oz. of each.

(a) What is the largest number of packages that can be made (x+y)? Hint: If x is the number of packages of low-grade mix and y is the number of packages of high-grade mix, then 4x+8y must be the number of ounces of *cashews* in those packages, and it can't be more than the grocer has. What represents the number of *peanuts* in those packages? Can you draw a picture showing all possible values permitted for x and y on a plane?

(b) Now find my grocer's largest profit P = \$0.25 x + \$0.45 y, which assumes that he makes 25 cents on each low-grade package of nuts and 45 cents on each high-grade package of nuts. Use your picture and trial and error, if you need to.

14. Goal seeking in Microsoft Excel. In an Excel spreadsheet, put a number, say 2.0, in cell A1. Put the formula `=exp(-(A1^2))` in another cell, say A2. You will see the value of the formula, 0.0183, appear in A2. Now click on A2 and select from the menu **Tools | Goal Seek** and set the value of A2 to 0.3, and tell Excel to change A1 to make A2 to be 0.3.

(a) What value of x will make $\exp(-x^2)$ have the value 0.3? How do you think that Excel does this? Now set up the value of A1 to be 2 again, and repeat this process, but this time having the goal value of A2 be 1.0. Do you get a different message? But now just set up the starting value of A1 to be 0.0. Do you see that A2 is in fact 1.0 if A1 is 0.0? How do you explain what Excel did now? Drawing the graph of $y=\exp(-x^2)$ might help.

(b) Here is a second problem in this category, one that I used last month to discuss my retirement plans with my financial advisor. This time put principal \$240.00 in cell A1; inflation rate 3% in A2; years 22 in A3, and put in A4 the formula `=A1/(1+A2)^A3`. You should see the answer \$125.25 in A4 (if formatted as currency), meaning that \$240.00 in today's dollars will only be worth \$125.25 in today's dollars after 22 years, if annual inflation is compounded at 3% per year. Let Excel goal-seek to do a what-if calculation to ask how much you would have to start with (in cell A1) to end up with \$240.00 (in A4) instead of \$125.25. The function y = principal/(1+inflation)^years actually allows you to play "what if" games with the other two variables, inflation and years. Do any examples give the same problems that you found in Part (a) of this question? This time the graph is four-dimensional, but you can hold one of the three independent variables constant and graph (say in Derive) the function of the other two. Does drawing the graph help?

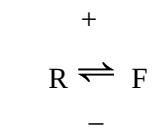
15. Goal seeking. Like Question #11 about Nixon above, this is intentionally vague. In a room is a banana hanging from the ceiling, a monkey, and a box. Your goal is to keep the monkey from going hungry. The monkey cannot reach the banana. The monkey can climb on the box, in which case the monkey can reach the banana. Give a precise set of "if ... then" rules like "if box under banana then monkey gets on box" that will guarantee that the monkey does not go hungry if it is at all possible. What kinds of assumptions did you make? For example, did you assume that the box was under the banana? Did you assume that the monkey could move the box? Did you assume that a monkey is not hungry just because he's holding a banana?

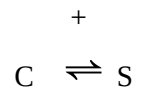
16. Filtering email. (a) Without researching any further, how would *you* decide between spam and good email? How do you think that spam filters like SpamAssassin do it?

(b) Research how filtering works, and be prepared to tell us.

17. Psychological model. Consider the program `HumanPsychology.java` that I distributed in class. How could you improve on it as a psychological model?

18. Modeling feedback. Here at the right is a way to draw the situation between rabbits and their natural predators, foxes. We take the diagram to mean that the more rabbits there are, the more (+) foxes there will be, but the more foxes there are the fewer (–) rabbits there will be. The diagram is sometimes called a "signed digraph" because we put either + or – on each arc of a directed graph. We call this situation **negative** feedback, and the result is **stable** much like an air conditioner control is stable. In the air conditioning case, R means room temperature and F means thermostat reading. As the temperature R goes up, the thermostat F goes up (+), but as the thermostat reading F goes up, the air conditioner kicks in to cool the room temperature R, so R goes down (–).





At left is an example of **positive** feedback, taken from public policy. If C is the cost of a public works project, and S is the satisfaction of the taxpayers who received the public works project, then the more that the project cost, C, the more satisfied, S, the recipients will be, and the more satisfied they are, the more elected officials will spend on public works. Thus the signed digraph looks like at right, and the whole thing spirals out of control, in an **unstable** way.

(a) Attached to this handout are three more examples of signed digraphs taken from a book by Fred S. Roberts. I have removed the signs from the arcs. Put reasonable signs on the first one and discuss whether there is negative feedback (good) anywhere in the model, or positive feedback (bad).

For the psychological model written in Java referenced in Question #17 above draw a signed digraph involving H, standing for increased hitting of someone, and B, standing for anger. Do you think that this is a positive or negative feedback loop? What does Proverbs 15:1 have to say about that?

(b) Repeat for the other two signed digraphs on the attachment.

19. Scheduling building a car.

A shop is supposed to assemble two cars. For one car, it take 30 minutes to add the engine, 30 minutes to add the wheels, and 10 minutes to inspect it; for the other car, it take 60 minutes to add the engine, 15 minutes to add the wheels, and 10 minutes to inspect it.

(a) Assume that there is only one station at which each of the activities can take place. How fast can the job be completed?

(b) Assume that there are unlimited stations for each activity, adding engine, wheels, and inspecting. How fast can the job be completed?

(c) Distributed with this packet is a schedule for planning a conference. The times are not written in for which the activities should take place, and furthermore there are three times for each activity: fastest estimate, slowest estimate, and best estimate (that is, most probable amount of time). Fill in reasonable values for the times, and say how fast a conference can be planned under those circumstances.

20. Scheduling students. If you have several classes needed for graduation take and several times at which classes are offered that you need for graduation, what will you do to plan your schedule? What kinds of problems can arise? Can you tell a computer how to schedule classes to allow majors to be completed by all students who enroll in the major?

21. Language generation. Write a Computer Science paper by visiting www.pdos.lcs.mit.edu/scigen and using at least your own name as one of the authors. Skim the resulting paper, including the references to see which papers "you" wrote that were cited there.

(a) How (without peeking) do you suppose this was done?

(b) Now looking at the files in the folder q:\InsturctorFiles\Chase_Gene\ai\scigen how do you suppose this was done?

22. Captcha. Check out www.captcha.net especially running esp-pix and gimpy at the links on that page. Could you create a computer program to do what you are able to do at those sites? Why or why not?

23. Guess my function game. We are going to play this game together as a class. After we do, then what kinds of functions do you think you could program a computer to guess?

24. Brain-Eye-Hands game. We are going to play this game together as a class. After we do, then what kinds of tasks would be easy or hard for this kind of feedback control system?

25. The triangular block on the attachment page. Can this figure be made out of wood? Why or why not? Can you tell a computer which figures can or cannot be made out of wood?

26. Answering natural language questions. Is MIT Professor Boris Katz's site Start start.csail.mit.edu/ better than Ask Jeeves www.ask.com ? Why or why not? Is there an advantage to using www.dogpile.com which combines several engines? Why or why not? What is TextMap trying to do that the others are not? isi.edu/natural-language/projects/TextMap
Try a question like "Who authored the Declaration of Independence?" for example. Or for a harder one, "What percentage of Miami, Florida, population is Latino?" Is the answer 55.32 or 65.76%?
In each case, was the sentence analyzed correctly? Open the link "View Analysis of Question" in the top pane in another window after you submit the question to find out. Be patient here. This engine is slow.