**Explain why problem formulation must follow goal formulation**

Because in goal formulation, we decide the things and aspect we want. So without goal formulation, we don’t know what should be include in our problem.

**The textbook says that we would not consider problems with negative path costs. In this exercise, we explore this in more depth. 5 points]**

**(a) Suppose that actions can have arbitrarily large negative costs; explain why this possibility would force any optimal algorithm to explore the entire state space.**

If the actions can have arbitrarily large negative costs, then any optimal algorithm need to explore the entire state space because if for a two path tree, for path1, the first part of actions a1, is optimal than the a2 of path2. If the algorithm don’t explore the entire state space, it will choose path1. However, if the actions of the first part, in the rest of actions, because actions can have arbitrarily negative costs. Add a2 and a2Rest, the total value may less than the total value of a1+a1Rest. Then actually path 2 is the optimal path. So the algorithm need to explore the entire state space.

**(b) Does it help if we insist that step costs must be greater than or equal to some negative constant c? Consider both trees and graphs.**

No. Suppose c is -1. For path 1 we have n actions with value 0. And for path 2, in the first part have n/2 actions with value 1, and the second part n/2 +1 actions with value -1. We still need to check the entire state space to determine the optimal way.

**(c) Suppose that there is a set of operators that form a loop, so that executing the set in some order results in no net change to the state. If all of these operators have negative cost, what does this imply about the optimal behavior for an agent in such an environment?**

Then this agent may work forever since results have no net change and all operators have negative costs, then it will become negative infinity.

**(d) One can easily imagine operators with high negative cost, even in domains such as route finding. For example, some stretches of a road might have such beautiful scenery as to far outweigh the normal costs in terms of time and fuel. Explain, in precise terms, within the context of state-space search, why humans do not drive around scenic loops indefinitely, and explain how to define the state space and operators for route finding so that artificial agents can also avoid looping.**

For example, if a path has beautiful scenery and negative cost 5. In ideal situation, we would keep driving around this scenic and loop forever. However, in real world, as humans, the cost of that scenery may not always the same. After we have been traveled once, the cost may increase because we are lack interest of that place. In real world we won’t drive around the same place over and over. So humans don’t drive around scenic loops indefinitely.

For artificial agents part, we can just easily adjust the agent function, including the number of passes of a path as a factor to dealing with the path cost. As the number of time increase, the path cost increase . Then the artificial agents are able to avoid looping as well.

**(e) Can you think of a real domain in which step costs are such as to cause looping?**

Everyday I’ll brush my teeth. Although doing this will takes sometimes and also I need to buy toothbrush and toothpaste. However, it has a negative cost because I have to brush and protect my teeth. So I will ignore the time and money using on this can keep brushing my teeth everyday.

**Exercise 2**

**1. Formulate the problem precisely, making only those distinctions necessary to ensure a valid solution. Draw a diagram of the complete state space (without repeated states). [4 points]**

See diagram.pdf

**2. Implement and solve the problem optimally using an appropriate search algorithm. Is it a good idea to check for repeated states? [9 points]**

See python files

**3. Why do you think people (humans) have a hard time solving this puzzle, given that the state space is so simple?**

Although each step is easy. But the whole sequence is not that short. It’s easy to expand the action from a frontier but It’s hard to keep the whole diagram in mind. And people have to always pay attention to both banks of the river, let the number of missionaries always larger on both side. So there are many information that we have to remember all the time. And there are also some illegal actions to mislead us. As a result, people would have a hard time solving this puzzle.