National University of Singapore
School of Computing

Semester 1, AY2023-24

CS4246/CS5446 AI Planning and Decision Making

Tutorial Week 6: DT and DA

Guidelines

You may discuss the content of the questions with your classmates. But everyone should work on and be ready to present ALL the solutions.

Problem 1: Basic Risky Decision

Note: This question is brought forward from the last week's tutorial to give you the context for the next problem

Richie Bean is trying to strike it big in the stock market during the economic downturn. He is considering buying some options to a very risky stock on a diamond mine in Africa. There is only a 10% chance that the stock price will rise if he exercises his options, but the payoff is \$200,000. It costs \$10,000 to buy and exercise the options. The alternative is not to buy at all, in which case Mr. Bean's profit is zero.

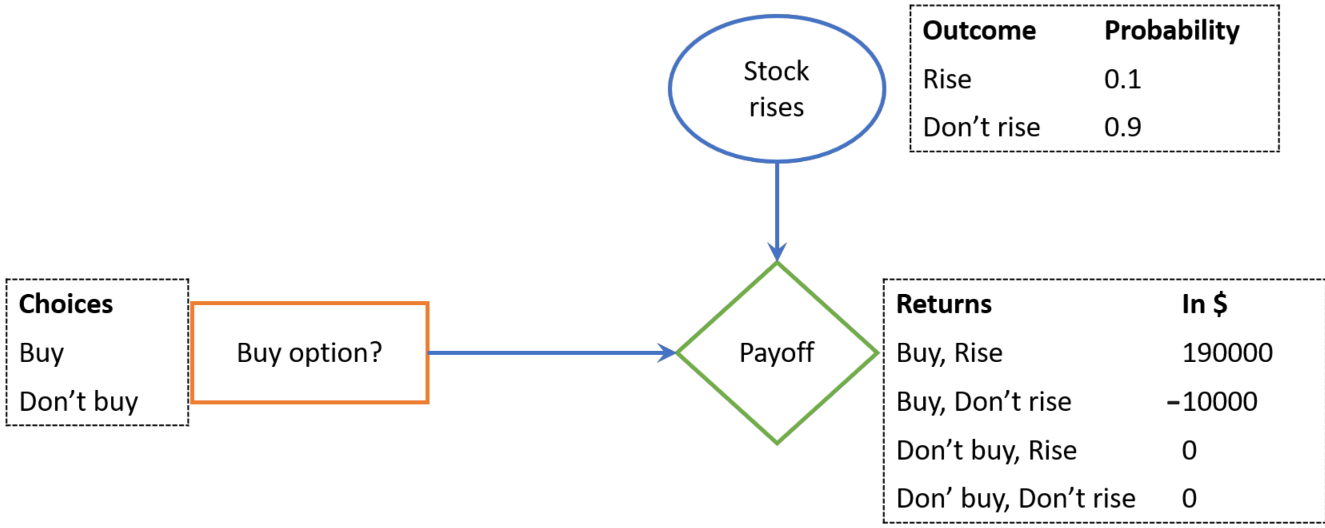
a. Draw an influence diagram to represent Mr. Bean's problem. Clearly indicate all the options/outcomes and numbers. Should he buy the options? Use the solution approaches mentioned in the lecture to substantiate your answer.

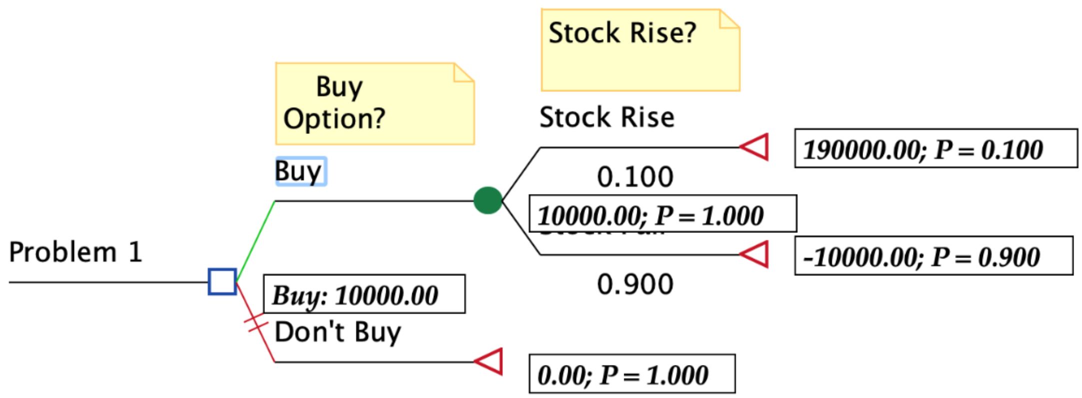
   Solution:

b. Draw an decision tree to represent Mr. Bean's problem. Clearly indicate all the options/outcomes and numbers. Should he buy the options? Show all the details in your decision tree.

   Solution:

   EMV for buy \$10000, don't buy \$0.





Problem 2: Value of Perfect Information

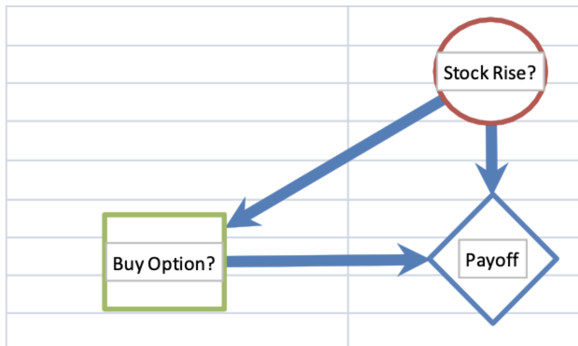
a. Represent the hypothetical situation where Mr. Bean will get perfect information before he makes the decision. How to represent this situation in an influence diagram? Clearly indicate all the options/outcomes and numbers.

Solution:

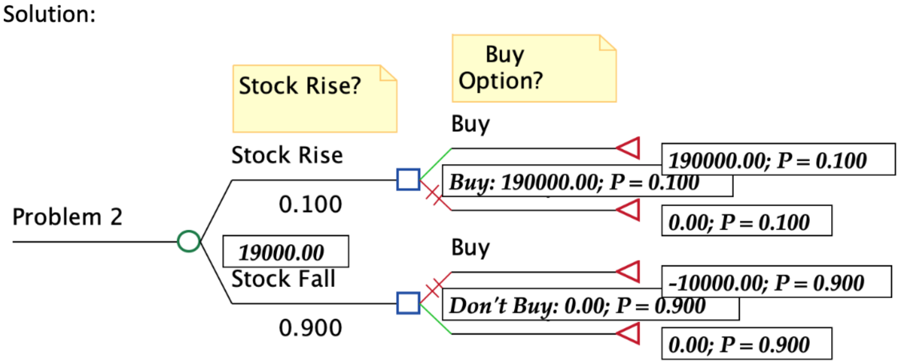
b. How to represent this situation in the decision tree? What is the expected value of the decision with perfect information?

Solution:

[Solution]: (Numbers should be shown as well, but are omitted here)



Solution:



EMV with perfect information is $19,000

EVPI = $19,000 - $10,000 = $9,000 ---- Max amount to pay for Perfect information

Problem 3: Scrooge and his nephews

Uncle Scrooge is deciding which of his three grand-nephews, Huey, Duey, and Louie, is going to inherit his wealth and business empire. To help him in his assessment, Uncle Scrooge sets up the following lottery, where the choice is between:
Option (A): Receiving \$4900 (with probability 1), OR
Option (B): participate in a lottery which has a 60% probability of winning \$7000 and a 40% probability of winning \$20.

a) Huey's utility function for wealth (money) x is represented by an exponential utility function: $U(x) = log_{10}(x)$, for all $x > 0$. Assuming that Huey would choose the option with the higher utility, which option would he choose?
Solution:
Huey would choose Option (A).
Option (A) utility = 3.69 (by plugging in the values)
Option (B) utility = 2.82.

b) Duey's utility function for wealth x is represented by $U(x) = \sqrt{x}$, for all $x > 0$. Assuming that Duey would choose the option with the higher utility, which option would he choose?
Solution:
Duey would choose Option (A).
Option (A) utility = 70
Option (B) utility = 51.98

c) Louie's utility function for wealth $x, \forall x > 0$ is represented by the following utility function

$$U(x) = \begin{cases} x, & 0 \leq x \leq 5000 \\ (10000 - x), & 5000 < x \leq 10000 \\ 10000, & x > 10000 \end{cases}$$

Assuming Louie would choose the option with the higher utility, which option would Louie choose?
Solution:
Louie would choose Option (A).
Option (A) utility = 4900
Option (B) utility = 1808

d) Uncle Scrooge Scrooge needs to choose a successor who is rational and reasonably risk averse, so that he can preserve and yet grow the business. After fully understanding each of their utility functions, which of Huey, Duey, and Luey would Uncle Scrooge consider to be his successor? There could be more than one choice.
Solution:
Risk averse means that the utility function is concave. When the second derivate of the function is negative, it is a concave function.

Both Huey and Duey's utility functions are rational and risk averse. However, Louie's utility function does not conform to monotonicity criteria, making him irrational.

Uncle Scrooge would select either Huey or Duey as his successor.