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ITCS 3153: Introduction to Artificial Intelligence
In-class assignment
Introduction to utility theory

1. Economists often use an exponential utility function for money: $U(x) = -e^{x/R}$, where R is a positive constant representing an individual's risk tolerance. As R (measured in same units as x) becomes larger, the individual becomes less risk-averse.

   Assume Mary has an exponential utility function with R=$500. Mary is given the choice between receiving $500 with certainty (probability 1) or participating in a lottery which has a 60% probability of winning $5000 and a 40% probability of winning nothing. Assuming Mary acts rationally, which option should she choose? Show how you derive your answer.

If Mary takes $500:

$U(500) = -2.71$

So $EU(A) = 1(-2.71)$

$= \boxed{-2.71}$

The other option

$U(5000) = -22026.5$
$U(0) = -1$
$EU(A) = -22026.5(.6) +$
$\qquad + 1(.4)$
$\qquad = -13216.3$

choose to take the $500
since we get higher returns.

2. Consider a student who has the choice to buy or not buy a textbook for a course. We'll model this as a decision problem with one Boolean decision node, B, indicating whether the agent chooses to buy the book, and two Boolean chance nodes, M, indicating whether the student has mastered the material in the book, and P, indicating whether the student passes the course. Of course, there is also a utility node, U. A certain student has an additive utility function: 0 for not buying the book and -$100 for buying it; and $2000 for passing the course and 0 for not passing. The student's conditional probability estimates are:

   $P(p|b, m) = 0.9$ $P(m|b) = 0.9$
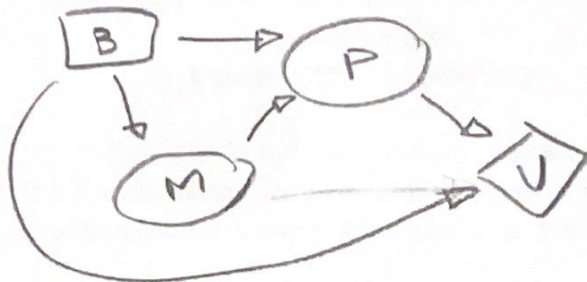 $P(p|b, \neg m) = 0.5$ $P(m|\neg b) = 0.7$
   $P(p|\neg b, m) = 0.8$
   $P(p|\neg b, \neg m) = 0.3$

a) Draw the decision network for this problem. Remember that decision nodes are rectangles, chance nodes are ovals, and utility nodes are diamonds.

b) Compute the expected utility of buying the book and of not buying it.

$P(p|\neg b) = P(p|\neg b, m) +$
$\qquad\qquad P(p|\neg b, \neg m)$

$= P(m|\neg b) P(p|\neg b, m) +$
$\qquad P(\neg m|\neg b) P(p|\neg b, \neg m)$

$= (.7)(.8) + (.3)(.3) = .65$

$2000 (.65) = \boxed{1300}$

$P(p|b) = P(p|b, m) + P(p|b, \neg m)$
$\quad = P(m|b) P(p|b, m) + P(\neg m|b)$
$\qquad\qquad\qquad\qquad\qquad P(p|b, \neg m)$
$\quad = (.9)(.9) + (.1)(.5) = .86$

$\quad = (.9)(.1) + (.1)(.5) = .14$

$1900 (.86) - 100 (.14)$
$\qquad\qquad = \boxed{1620}$

c) Acting rationally, what choice should the student make?

BUY THE TEXTBOOK :)