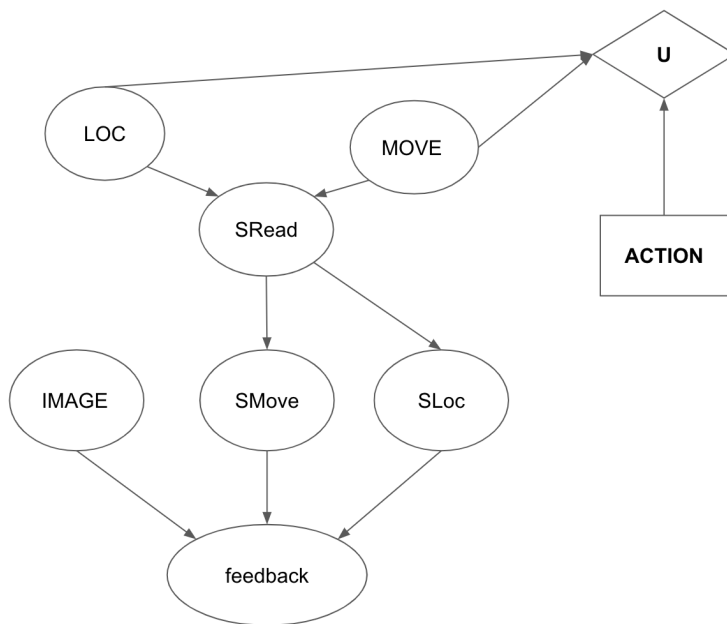


Q1. Vehicle Perception Indication

A vehicle is trying to identify the situation of the world around it using a set of sensors located around the vehicle.

Each sensor reading (SRead) is based off of an object's location (LOC) and an object's movement (MOVE). The sensor reading will then produce various values for its predicted location (SLoc) and predicted movement (SMove). The user will receive these readings, as well as the the image (IMAGE) as feedback.

- (a) The vehicle takes an action, and we assign some utility to the action based on the object's location and movement. Possible actions are MOVE TOWARDS, MOVE AWAY, and STOP. Suppose the decision network faced by the vehicle is the following.

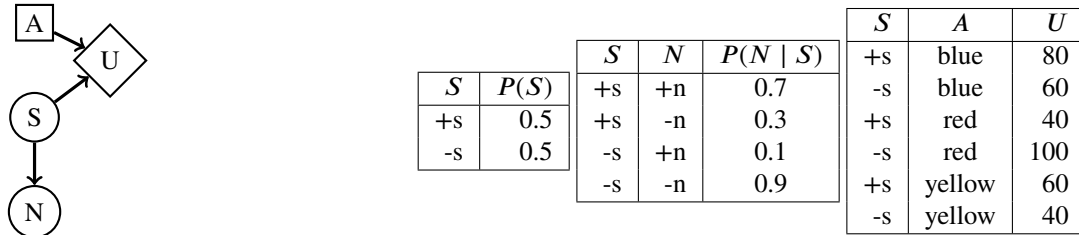


- (i) Based on the diagram above, which of the following **could possibly be true**?
- VPI (Image) = 0
 - VPI (SRead) < 0
 - VPI (SMove, SRead) > VPI (SRead)
 - VPI (Feedback) = 0
 - None of the above
- (ii) Based on the diagram above, which of the following **must necessarily be true**?
- VPI (Image) = 0
 - VPI (SRead) = 0
 - VPI (SMove, SRead) = VPI (SRead)
 - VPI (Feedback) = 0
 - None of the above

Q2. [Optional] Dressed to Impress

- (a) Alice is invited to a party tonight which is said to be once-in-a-lifetime. However, this mysterious party doesn't publicize who is going and thus Alice has no idea whether the size S of the party will be large ($S = +s$) or tiny ($S = -s$). The size can affect the noise N outside the party, and it will either be noisy ($N = +n$) or quiet ($N = -n$). Alice has three dresses: blue, red and yellow. Each dress will have a different utility for her depending on the size of the party. Let's help her decide which will be best!

We have the following decision network, where circles are chance nodes, squares are decision nodes, and diamonds are utility nodes:



- (i) What is the expected utility of wearing each dress, with both S and N unobserved?

- $EU(A=\text{blue}) =$ _____
- $EU(A=\text{red}) =$ _____
- $EU(A=\text{yellow}) =$ _____

What is Alice's maximum expected utility?

- $MEU(\{\}) =$ _____

- (ii) Suppose Alice observes that the party is quiet, $N = -n$. Compute the following conditional probabilities with this observation:

- $P(+s | -n) =$ _____
- $P(-s | -n) =$ _____

What is the expected utility of wearing each dress?

- $EU(A=\text{blue} | N = -n) =$ _____
- $EU(A=\text{red} | N = -n) =$ _____
- $EU(A=\text{yellow} | N = -n) =$ _____

What is Alice's maximum expected utility given that $N = -n$?

- $MEU(\{N=-n\}) =$ _____

- (iii) Construct a formula for $VPI(N)$ for the given network. To decouple this problem from your work above, use any of the symbolic terms from the following list (rather than plugging in numeric values):

$P(+n | +s)$, $P(+n | -s)$, $P(-n | +s)$, $P(-n | -s)$, $P(+n)$, $P(-n)$, $P(+s)$, $P(-s)$,
 $MEU(\{\})$, $MEU(\{N = +n\})$, $MEU(\{N = -n\})$

- $VPI(N) =$ _____

3 Decision Trees

You are a geek who hates sports. Trying to look cool at a party, you join a discussion that you believe to be about football and basketball. You gather information about the two main subjects of discussion, but still cannot figure out what sports they play.

Sport	Position	Name	Height	Weight	Age	College
?	Guard	Charlie Ward	6'02"	185	41	Florida State
?	Defensive End	Julius Peppers	6'07"	283	32	North Carolina

Fortunately, you have brought your CS 188 notes along, and will build some classifiers to determine which sport is being discussed. You come across a pamphlet from the Atlantic Coast Conference Basketball Hall of Fame, as well as an Oakland Raiders team roster, and create the following table:

Sport	Position	Name	Height	Weight	Age	College
Basketball	Guard	Michael Jordan	6'06"	195	49	North Carolina
Basketball	Guard	Vince Carter	6'06"	215	35	North Carolina
Basketball	Guard	Muggsy Bogues	5'03"	135	47	Wake Forest
Basketball	Center	Tim Duncan	6'11"	260	35	Oklahoma
Football	Center	Vince Carter	6'02"	295	29	Oklahoma
Football	Kicker	Tim Duncan	6'00"	215	33	Oklahoma
Football	Kicker	Sebastian Janikowski	6'02"	250	33	Florida State
Football	Guard	Langston Walker	6'08"	345	33	California

2.1 Entropy

Before we get started, let's review the concept of entropy.

(b) Give the definition of entropy for an arbitrary probability distribution $P(X)$.

(c) Draw a graph of entropy $H(X)$ vs. $P(X = 1)$ for a binary random variable X .

(d) What is the entropy of the distribution of Sport in the training data? What about Position?

(i) You may have noticed that the testing data has a value for Position that is missing in training data. What could we do in this case?