

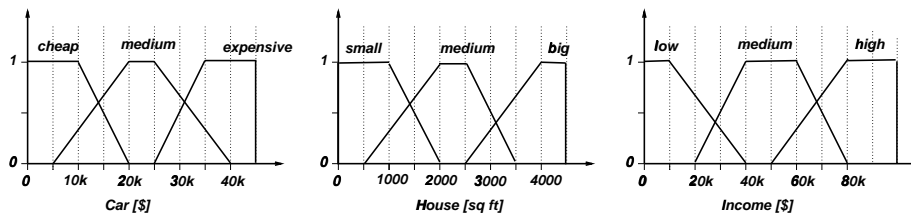
CSE 6392 - Reasoning with Uncertainty

Homework 1- Fall 2006

Due Date: Sep. 28 2006, 7:00 pm

Fuzzy Logic

1. A Fuzzy logic inference system is used to infer the income of a person. The income is assumed here to be related to the value of the car and to the size of the house the person owns (this system is by no means assumed to be realistic). The inference system uses three linguistic variables (*Car*, *House*, and *Income*). Each of these can belong to three possible sets (*cheap*, *medium*, and *expensive* for *Car* ; *small*, *medium*, and *big* for *House* ; *low*, *medium*, and *high* for *Income*). The following are the corresponding membership functions:



The controller uses the following fuzzy rules:

- if *Car* is *cheap* and *House* is *small* then *Income* is *low*
- if *Car* is *medium* and *House* is *medium* then *Income* is *medium*
- if *Car* is *cheap* and *House* is *big* then *Income* is *medium*
- if *Car* is *expensive* and *House* is *small* then *Income* is *medium*
- if *Car* is *expensive* and *House* is *big* then *Income* is *high*

Calculate the resulting score membership functions and defuzzified income value for a car value of \$ 16.000 and a house with 1.200 square feet using the Mamdani inference system introduced in class.

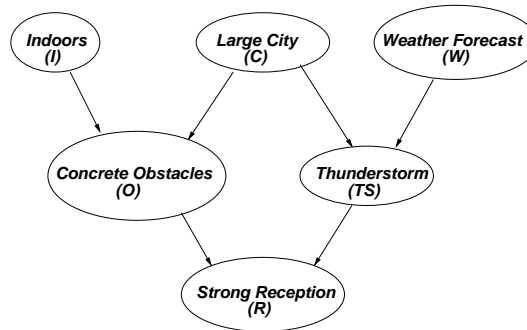
Probabilities

2. The probability of a defective microchip is 0.05. There are a number of tests that can be performed to determine if the chip is functioning correctly. The first test detects 80% of all defects while the second can determine 75% of all defects including 80% of all defects that are also determined by the first test. Neither one of the tests returns an error if the chip is correct. How high is the probability that a chip is defective despite both tests coming back negative ?
3. For a lottery a ball is drawn at random from a box. After each draw the ball is put back into the box. You are told that the box contains either 1 green (*G*), 1 red (*R*), and 2 blue (*B*) balls or 1 green, 2 red, and 1 blue ball. Use an iterated Bayesian network to determine the probability of there being 2 red balls

after observing the sequence $R G R G B R$. Show the probabilities after each iteration (i.e. after each observation).

Bayesian Networks

4. Below is a probabilistic network to assess the probability of good radio reception. The goal is to use the available information about the receiver's location and the weather forecast to predict the probability of a good reception. According to this model, the probability of a good reception (R) depends on the presence of obstacles (O) and thunderstorms (TS). These, in turn, depend on the location (C and I) and on the weather forecast (W).



Use the following conditional probabilities to determine the conditional probabilities of good reception for the scenarios $C \wedge I \wedge W$, $C \wedge \neg I \wedge \neg TS$ and for the case where no observations are available.

$$R : P(R | O \wedge TS) = 0.2$$

$$P(R | O \wedge \neg TS) = 0.4$$

$$P(R | \neg O \wedge TS) = 0.5$$

$$P(R | \neg O \wedge \neg TS) = 0.8$$

$$O : P(O | I \wedge C) = 0.7$$

$$P(O | I \wedge \neg C) = 0.4$$

$$P(O | \neg I \wedge C) = 0.5$$

$$P(O | \neg I \wedge \neg C) = 0.1$$

$$TS : P(TS | C \wedge W) = 0.6$$

$$P(TS | C \wedge \neg W) = 0.05$$

$$P(TS | \neg C \wedge W) = 0.5$$

$$P(TS | \neg C \wedge \neg W) = 0.1$$

$$I : P(I) = 0.6$$

$$C : P(C) = 0.7$$

$$W : P(W) = 0.2$$

Dempster Shafer Beliefs

5. Use a Dempster Shafer belief system to determine the beliefs for the lottery of problem 3. ($W = \{B_R, B_B\}$, $B_R =$ biased towards red, $B_B =$ being biased towards blue). ($W = \{B_R, B_B\}$). In particular, determine the beliefs and plausibilities for the two sequences $R G R G B R$ and $R B G R B B$. Show the beliefs after every update using the mass density functions below to represent the evidence.¹
- Set the mass densities for the evidence to the conditional probabilities of the particular biased sets given the color of ball drawn.
 - Repeat the experiments with a simplified evidence function where evidence 0.1 is added to configuration B_x and no evidence is given to the other configuration if a ball of color x is drawn.

¹Rather than computing all the values by hand it might be simpler to write a short program to compute the mass densities, beliefs, and plausibilities.