# CSE 4308 / CSE 5360 - *Artificial Intelligence I*

Homework 6- Fall 2013

Due Date: Dec. 9 2013, 5:00 pm

This assignment is optional and the final assignment grade will be the better of the average of the first 5 or of all 6 assignments. Problems marked with a * are required only for students in the graduate section (CSE 5360). They will be graded for extra credit for students of CSE 4308.

## Decision Networks

1. Consider the following system for an intelligent sprinkler system. The system has a moisture sensor that measures whether the ground is dry (the sensor is binary - T/F), a sensor that is hooked up to the weather forecast and receives a signal indicating whether the weather forecast predicts rain for the next 25 hours (again binary), and is connected to a clock that tells it what part of the day it is (3am-9am, 9am-3pm, 3pm-9pm, 9pm-3am). The moisture sensor is 95% accurate and the weather forecast is correct 80% of the time.

   The goal of the system is to not let the ground become dry for too long but also to preserve water (i.e. not to wet the lawn when it is raining in the next 24 hours. In addition, it is best to water the lawn in the morning and it is worst if it is watered around noon.

   a) Design a utility function that expresses the above preferences in terms of the random variables $Time$ (expressed in the same 4 discrete ranges as the clock input), $Dry\ Soil$ (which represents whether the soil is actually dry or not - note that this is different from the sensor since it is the actual dryness), and $Will\ Rain$ (which is again the actual fact whether it will rain or not; not the sensor reading).

   b) Use the AIspace decision network solver to build a decision network to control the sprinklers. To build this your network should contain the state notes from part $a)$, a node for each of the sensors from the description, as well as an action node (that has 2 states - sprinklers on or off), and a utility node to encode your utility function from part $a)$. Make all 3 state nodes parents of your action node and allow the AIspace system to optimize your policy. Submit the designed network in a .bif file and indicate the decision your network takes for the following cases: i) the moisture sensor reads false, the weather forecast predicts rain, and the time is between 3pm and 9pm, ii) the moisture sensor reads true, the forecast predicts rain, and the time is between 9am and 3pm, and iii) the moisture sensor reads false, the forecast predicts no rain, and the time is between 9am and 3pm.

## Fuzzy Logic

2. A Fuzzy logic control system is used to regulate the speed of a car. The speed depends on the distance of the car from another vehicle in front of it. The control system uses two linguistic variables ($distance$ and $speed$). Each of these can belong to three possible sets ($close$, $medium$, and $far$ for $distance$ - $slow$, $medium$, and $fast$ for $speed$). The following are the corresponding membership functions:
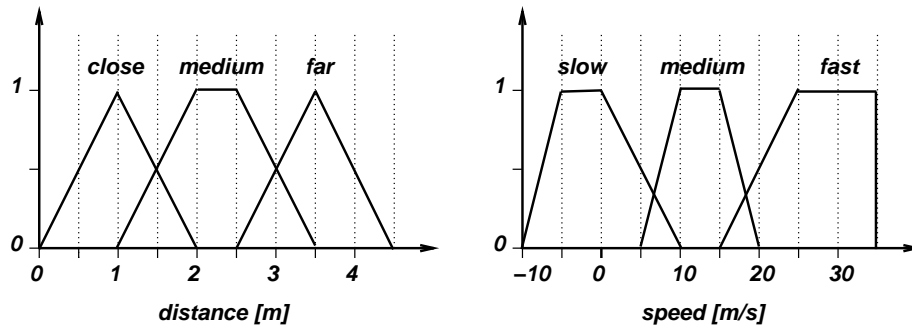
The controller uses the following fuzzy rules:

if $distance$ is $close$ then $speed$ is $slow$
if $distance$ is $medium$ then $speed$ is $medium$
if $distance$ is $far$ then $speed$ is $fast$
if $distance$ is $close$ then $speed$ is $slow$

Calculate the resulting velocity membership functions and defuzzified values for a distance of $1.5m$, $3m$, and $4m$ using a Mamdani inference system (i.e. $\mu_{A \vee B} = max(\mu_A, \mu_B)$, $\mu_{A \wedge B} = min(\mu_A, \mu_B)$, and coupled implication $A \rightarrow B = A \wedge B$)

## Genetic Algorithms

3. On a 5x5 grid the goal is to find a strategy that gets an agent as fast as possible from its starting point to a specific goal location. The agent knows what grid cell it is on and can perform one of 4 actions, "North", "South", "West", and "East".

    a)   Design a genome to solve this problem using a genetic algorithm.

    b)   Design and discuss an appropriate crossover and mutation operator for your genome choice from part $a$) as well as a fitness function for the given problem.

    c)*  Implement a simple genetic algorithm to solve the problem using your choices from parts $a$) and $b$).