CSC421 Intro to Artificial Intelligence

UNIT 19:
Uncertainty

Midterm Review

- $E \wedge L \rightarrow \neg N \wedge \neg M$
- Number of possible models ?
- How many models are there for which sentence is false ?
- Prove using model checking that the above sentence is not entailed by $E \rightarrow \neg N$

Why uncertainty ?

- Laziness: too much work to completely cover every possible expection
- Theoretical ignorance
- Practical ignorance: missing evidence, noisy observations, unexpected changes
- Probability is the primary formalism for dealing with uncertainty
- Degree of belief (sentence is true or false)
  - There is a pit at square (2,2)
- Alternative:
  - Fuzzy Logic – degree of truth
  - “This towel is wet”

Problem I

- Three closed doors one of which hides the car of your dreams. Behind each of the other two goats. You will choose a door and win whatever is behind it. You decide on a door and announce your choice, whereas the hosts opens one of the other two doors and reveals a goat. He then asks if you would like to switch you choice or not. What should you do ?

Probability

- Primitive instictive probability
  - Dark clouds today mean rain is likely since it has rained in the past when the clouds had that look
- Formal theory
  - 17-century
  - Correspondance between B. Pascal and P. Fermat
  - Gambling

- Pervasive in all sciences. Knowledge of probability is critical for any CS practitioner.

Sample Spaces

- A = {(1,6), (2,5), (3,4), (4,3), (5,2), (6,1)}
- Rolling a seven with a pair of dice
- Experiment gives rise to sample space
- Discrete sample spaces (infinite but countable)
- Probability distribution = associating each of the discrete outcomes with a number between 0 and 1. The sum of all the outcomes must add up to 1.
- Car-goat
  - Assume you switch
  - S = {(1,2,3,L), (1, 3, 2, L), (2, 3, 1, W), (3, 2, 1, W)}
  - Door you choose, door hosts opens, door you switch to

Problem II

- “The king comes from a family of two children. What is the probability that the other child is his sister ?

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- (B,B), (B,G), (G,B), (G,G)
- U = one child is a girl
- V one child is the king
- P(U/V) = 2/3
- Not “what is the probability a person's sibling is a sister”

Making decisions under uncertainty

- Suppose I believe the following:
  - P(30min gets me there on time) = 0.04
  - P(1 hr gets me there on time) = 0.70
  - P(24 hrs gets me there on time) = 0.98
- Which action to choose ?
- Depends on my preferences
- Utility theory = represent preferences
- Decision theory = utility theory + probability theory

Probability Basics

- Set Ω – the sample space
- $\omega \in \Omega$ is a sample point/atomic event, outcome, possible world
- Probability space/model is a sample space with an assignment $P(\Omega)$ for every point
  - $0 <= P(\omega) <= 1$
  - $\sum P(\omega) = 1$
- An event is a subset of Ω

Random Variables

- A random variable is a function from sample points to some range e.g the reals or booleans
  - e.g. Odd(1) = true
- P induces a probability distribution for any r.v X
- P(Odd = true) = P(1) + P(3) + P(5) = ½
- How can you rewrite the above example for the general case ?

Propositions

- This of a proposition as the event (set of sample points) where the proposition is true
- Given boolen random variables A, B
  - Event a = set of sample points where $A(\omega) = 1$
- Often in AI sample points are defined by the values of a set of random variables i.e., the sample space is the Cartesian product of the ranges of the variables
- With boolean variables sample point = propositional logic model
  - A = true, B = false