§7 Modelling Uncertainty

- probabilistic uncertainty
  - probability of an outcome
  - dice, shuffled cards
  - statistical reasoning
    - Bayesian networks, Dempster-Shafer theory
- possibilistic uncertainty
  - possibility of classifying object
  - *sorites* paradoxes
  - fuzzy sets

Bayes' theorem

- hypothesis H
- evidence E
- probability of the hypothesis $P(H)$
- probability of the evidence $P(E)$
- probability of the hypothesis based on the evidence
  $P(H|E) = (P(E|H) \cdot P(H)) / P(E)$

Example

- H — there is a bug in the code
- E — a bug is detected in the test
- $E|H$ — a bug is detected in the test given that there is a bug in the code
- $H|E$ — there is a bug in the code given that a bug is detected in the test

Example (cont'd)

- $P(H) = 0.10$
- $P(E|H) = 0.90$
- $P(E|\neg H) = 0.10$
- $P(E) = P(E|H) \cdot P(H) + P(E|\neg H) \cdot P(\neg H) = 0.18$
- from Bayes' theorem:
  $P(H|E) = 0.5$
- conclusion: a detected bug has fifty-fifty chance that it is not in the actual code

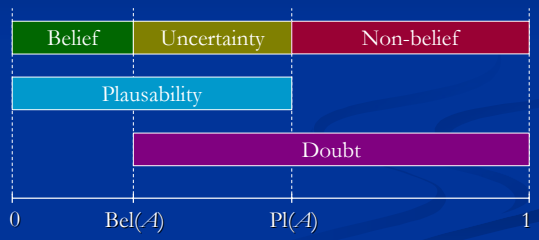
Bayesian networks

- describe cause-and-effect relationships with a directed graph
  - vertices = propositions or variables
  - edges = dependencies as probabilities
- propagation of the probabilities
- problems:
  - relationships between the evidence and hypotheses are known
  - establishing and updating the probabilities

Dempster-Shafer theory

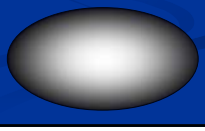
- belief about a proposition as an interval
  [belief, plausability] $\subseteq$ [0, 1]
- belief supporting A: Bel(A)
- plausability of A: Pl(A) = 1 − Bel($\neg A$)
- Bel(intruder) = 0.3, Pl(intruder) = 0.8
  - Bel(no intruder) = 0.2
  - 0.5 of the probability range is indeterminate

Belief interval

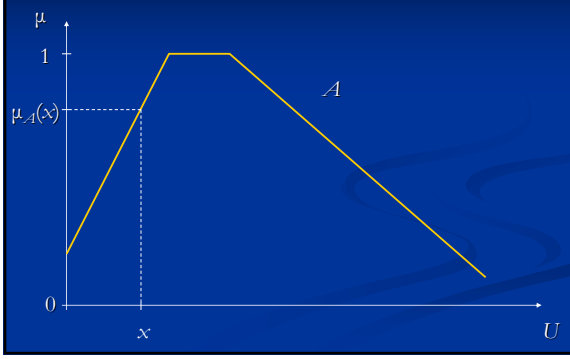


Fuzzy sets

- element x has a membership in the set A defined by a membership function $\mu_A(x)$
  - not in the set: $\mu_A(x) = 0$
  - fully in the set: $\mu_A(x) = 1$
  - partially in the set: $0 < \mu_A(x) < 1$



Membership function

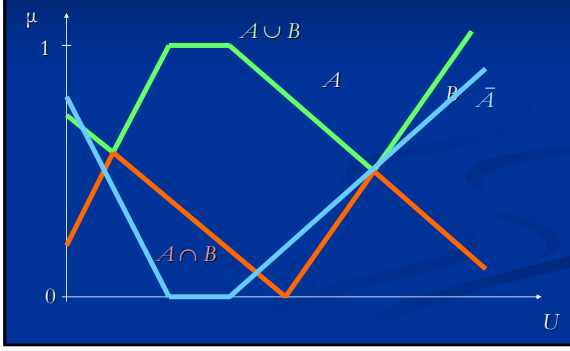


Fuzzy operations

- union: $\mu_C(x) = \max\{\mu_A(x), \mu_B(x)\}$
- intersection: $\mu_C(x) = \min\{\mu_A(x), \mu_B(x)\}$
- complement: $\mu_C(x) = 1 - \mu_A(x)$

- note: operations can be defined differently

Fuzzy operations (cont'd)



Uses for fuzzy sets

- approximate reasoning
- fuzzy constraint satisfaction problem
- fuzzy numbers
- almost any 'crisp' method can be fuzzified!

Outroduction

§1 Introduction
§2 Random Numbers
§3 Tournaments
§4 Game Trees
§5 Path Finding
§6 Decision-Making
§7 Modelling Uncertainty

The intention, huh?

- to provide a glance into the world of computer games as seen from the perspective of a computer scientist

Examinations

- examination dates (to be confirmed)
  1. October 26, 2005
     - N.B. lecture examination, 12:00–14:00
  2. November 21, 2005
  3. January 30, 2006
- check the exact times and places at **http://www.it.utu.fi/opetus/tentit/**
- remember to enrol! **https://www.it.utu.fi/kurssi-ilmo/**

Examination questions

- questions
  - based on both lectures and lecture notes
  - two questions, à 5 points
  - to pass the examination, at least 5 points (50%) are required
  - grade: $g = \lceil p - 5 \rceil$
  - questions are in English, but you can answer in English or in Finnish

My two cents

- software construction practices: will game programming remain the last reservate for wizards, nerds and geeks?
- off-the-shelf components: gfx cards, 3d engines, animation tools, audio, AI, networking…
- mobile platforms: location-based games
- untapped markets: not every game buyer is (nor even don't want to be) familiar with current game genres
- independent game publishing: war against apathy!
- technology breeds new ideas—or does it?