Constraint satisfaction problem

- constraint satisfaction problem (CSP):
  - a set of n variables X
  - a domain D_i for each variable x_i in X
  - a set of constraints restricting the feasibility of the tuples $(x_0, x_1, \ldots, x_{n-1}) \in D_0 \times \ldots \times D_{n-1}$
- solution: an assignment of value to each variable so that every constraint is satisfied
  - no objective function → not an optimization problem

Example: *n* queens problem as a CSP

- problem: place n queens on a $n \times n$ chessboard so that they do not threat one another
- CSP formulation
  - variables: x_i for each row i
  - domain: $D_i = \{ 1, 2, \ldots, n \}$
  - constraints:
    - $x_i \neq x_j$
    - $x_i - x_j \neq i - j$
    - $x_j - x_i \neq i - j$

Fuzzy constraint satisfaction problem

- fuzzy constraint satiscation problem (FCSP) is a five-tuple $P = \langle V, C_\mu, W, T, U \rangle$
  - V: variables
  - U: universes (domains) for the variables
  - C_μ: constraints as membership functions
  - W: weighting scheme
  - T: aggregation function

Dog Eat Dog: Modelling the criteria as fuzzy sets

- if the visual observation of the enemy is reliable, then avoid the enemy
- if the visual observation of the prey is reliable, then chase the prey
- if the olfactory observation of the pond is reliable, then go to the pond
- if the visual observation of the enemy is reliable, then stay in the centre of the play field

Dog Eat Dog: Weighting the criteria importances

- fuzzy criterion C_i has a weight $w_i \in [0, 1]$
  - a greater value w_i corresponds to a greater importance
- the weighted value from the implication $w_i \rightarrow C_i$
  - classical definition $(A \rightarrow B \Leftrightarrow \neg A \vee B)$: $\min\{ (1 - w_i), C_i \}$
  - Yager's weighting scheme: the weighted membership value:

$$\mu_{C^w}(x) = \begin{cases} 1, \text{ if } \mu(x) = 0 \text{ and } w = 0 \\ (\mu_C(x))^w, \text{ otherwise} \end{cases}$$

Dog Eat Dog: Aggregating the criteria

- aggregator should have compensatory properties
- the effect of a poorly satisfied criterion is not so drastic
- mean-based operators instead of conjunction
  - ordered weighted averaging (OWA)

Ordered weighted averaging (OWA)

- weight sequence $W = (w_0, w_1, \ldots, w_{n-1})^T$
  - $\forall w_i \in [0, 1]$ and $\Sigma w_i = 1$
- $F(a_0, a_1, \ldots, a_{n-1}) = \Sigma w_j b_j$
  - b_j is the $(j+1)$th largest element of the sequence $A = \langle a_0, a_1, \ldots, a_{n-1} \rangle$
- by setting the weight sequence we can get
  - conjunction: $W = \{ 0, 0, \ldots, 1 \} = \min\{A\}$
  - disjunction: $W = \{ 1, 0, \ldots, 0 \} = \max\{A\}$
  - average: $W = \{1/n, 1/n, \ldots, 1/n\}$
- soft-and operator: $w_i = 2(i + 1) / (n(n + 1))$
  - example: $n = 4$, $W = \{ 0.1, 0.2, 0.3, 0.4 \}$

Outroduction

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 (in Turku)
  1. October 15, 2007
  2. November 19, 2007
  3. December 18, 2007
- check the exact times and places at **http://www.it.utu.fi/opetus/tentit/**
- remember to enrol! **https://ssl.utu.fi/nettiopsu/**

Examinations (cont'd)

- questions
  - based on both lectures and the textbook
  - 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

Follow-up course: Multiplayer Computer Games

- focus: networking in computer games
- credits: 5 cp (3 cu)
- schedule:
  - October 29 – November 29, 2007
  - Mondays 2–4 p.m., Wednesdays 4–6 p.m., and Thursdays 2–4 p.m.
- web page: **http://www.iki.fi/smed/mcg**

My two cents

- software construction practices: game programming is no longer a reservate for wizards, nerds and geeks
- off-the-shelf components: gfx cards, 3d engines, animation tools, audio, AI, networking…
- deeper games: human-like bots, interactive stories
- untapped markets: not every game buyer is (nor even wants to be) familiar with current game genres
- independent game publishing: war against apathy!
- new (academically) educated generation of game developers is coming!