

# Algorithms for Computer Games

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<http://www.iki.fi/smed>

## Course syllabus

- credits: 5 cp (3 cu)
- prerequisites
  - fundamentals of algorithms and data structures (e.g., Cormen et al., *Introduction to Algorithms*)
  - knowledge in programming (e.g., with Java)
- assessment
  - examination only (no exercises)

## Lectures

- Lecture times
  - Mondays 2–4 p.m. (except today)
  - Wednesdays 4–6 p.m.
  - Thursdays 2–4 p.m.
- September 10 – October 3, 2007
- Auditorium Alpha, ICT Building



## Examinations 1(3)

- examination dates (to be confirmed)
  1. ?? (possibly October 2007)
  2. ?? (possibly November 2007)
  3. ?? (possibly January 2008)
- check the exact times and places at <http://www.it.utu.fi/opetus/tentit/>
- remember to enroll! <https://ssl.utu.fi/nettiopsu/>

## Examinations 2(3)

- if you are studying in the Åbo Akademi University, you must register to the University of Turku to receive the credits

Further instructions are available at

<http://www.tucs.fi/>



## Examinations 3(3)

- 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

### Web page

<http://www.iki.fi/smed/a4cg>

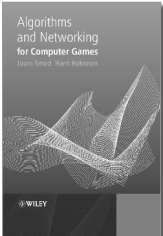
- news and announcements
- slides, code examples, additional material
- discussion forum

### 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>

### Textbook

- Jouni Smed & Harri Hakonen:  
*Algorithms and Networking for Computer Games*, John Wiley & Sons, 2006.
- <http://www.wiley.com/go/smed>




### Computer games



### In the beginning...


“If, when walking down the halls of MIT, you should happen to hear strange cries of ‘No! No! Turn! Fire! AARRGGGHHH!!,’ do not be alarmed. Another western is not being filmed—MIT students and others are merely participating in a new sport, SPACEWAR!”



D. J. Edwards & J. M. Graetz, “PDP-1 Plays at Spacewar”, *Decuscope*, 1(1):2–4, April 1962

### ...and then...

<ul style="list-style-type: none"> <li>■ 1962: <i>Spacewar</i></li> <li>■ 1971: Nutting: <i>Computer Space</i></li> <li>■ 1972: Atari: <i>Pong</i></li> <li>■ 1978: Midway: <i>Space Invaders</i></li> <li>■ 1979: Roy Trubshaw: <i>MUD</i></li> <li>■ 1980: Namco: <i>Pac-Man</i></li> <li>■ 1981: Nintendo: <i>Donkey Kong</i></li> <li>■ 1983: Commodore 64</li> </ul>	<ul style="list-style-type: none"> <li>■ 1985: Alexei Pajitnov: <i>Tetris</i></li> <li>■ 1989: Nintendo Game Boy</li> <li>■ 1993: id Software: <i>Doom</i></li> <li>■ 1994: Sony Playstation</li> <li>■ 1997: Origin: <i>Ultima Online</i></li> <li>■ 2001: Microsoft Xbox</li> <li>■ 2006: Nintendo Wii</li> </ul>
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### ...and now

- annual global revenue 2002:
  - computer games: 25 G€
  - film box office: 24 G€
- US revenue 2003:
  - computer games: 11.4 G\$
  - film box office: 8.3 G\$
- predictions for annual growth 2003–07:
  - computer game industry: 11.3 %
  - movie industry: 6.4 %

source: PriceWaterhouseCoopers, NPD Funworld

### Game industry geographically

source: GDDA Game Industry Fact Sheet, 2003

### Articles containing 'computer game' according to the Inspec database

source: Inspec, Aug. 2007

### Three academic perspectives to computer games

```

    graph TD
        GAME((GAME))
        subgraph Humanistic_perspective [Humanistic perspective]
            GD[Game design]
            subgraph GD_items [ ]
                GD_rules[rules]
                GD_graphics[graphics]
                GD_animation[animation]
                GD_audio[audio]
            end
        end
        subgraph Admin_business_perspective [Administrative/business perspective]
            GP[Game programming]
            subgraph GP_items [ ]
                GP_gfx[gfx & audio]
                GP_simulation[simulation]
                GP_networking[networking]
                GP_AI[AI]
            end
        end
        subgraph Software_development_perspective [Software development perspective]
            SD[Software development]
            subgraph SD_items [ ]
                SD_patterns[design patterns]
                SD_architectures[architectures]
                SD_testing[testing]
                SD_reuse[reuse]
            end
        end
        GD --- GAME
        GP --- GAME
        SD --- GAME
    
```

### Intention of this course

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

### Contents

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

### §1 Introduction

- definitions: play, game, computer game
- anatomy of computer games
- synthetic players
- multiplayer
- games and story-telling
- other game design considerations

### First, a thought game

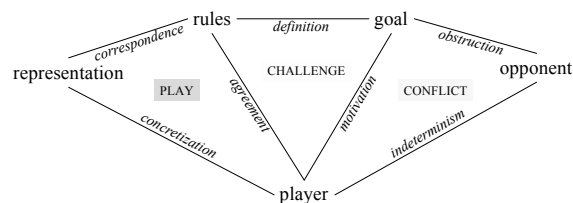
- what features are common to all games?



### Components of a game

- players: willing to participate for enjoyment, diversion or amusement
- rules: define limits of the game
- goals: gives a sense of purpose
- opponents: give arise to contest and rivalry
- representation: concretizes the game

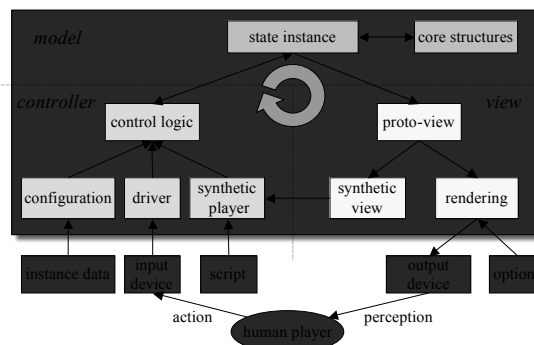
### Components, relationships and aspects of a game



### Definition for 'computer game'

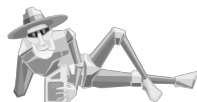
- a game that is carried out with the help of a computer program
  - roles:
    - coordinating the game process
    - illustrating the situation
    - participating as a player
- Model-View-Controller architectural pattern

### Model-View-Controller



### Synthetic players

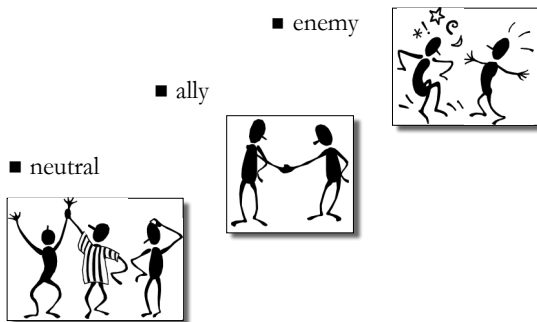
- synthetic player = computer-generated actor in the game
  - displays human-like features
  - has a stance towards the human player
- games are anthropocentric!



### Humanness

- human traits and characteristics
  - fear and panic (*Half-Life, Halo*)
- computer game comprising only synthetic players
  - semi-autonomous actors (*The Sims*)
  - fully autonomous actors (*Core War, AOE2*)

### Stance towards the player

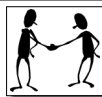


### Enemy



- provides challenge
  - opponent
- must demonstrate intelligent (or at least purposeful) behaviour
- cheating
  - quick-and-dirty methods
  - when the human player cannot observe enemy's actions

### Ally



- augmenting the user interface
  - hints and guides
- aiding the human player
  - reconnaissance officer
  - teammate, wingman
- should observe the human point of view
  - provide information in an accessible format
  - consistency of actions

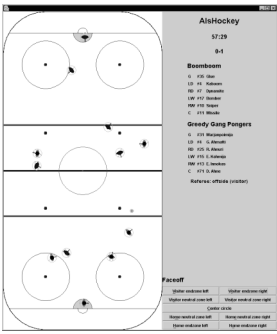
### Neutral



- commentator
  - highlighting events and providing background information
- camera director
  - choosing camera views, angles and cuts
- referee
  - judging the rule violations
- should observe the context and conventions

## Studying synthetic players: AIsHockey

- simplified ice hockey:
  - official IIHF rules
  - realistic measures and weights
  - Newtonian physics engine
- distributed system
  - client/server architecture
- implemented with Java
  - source code available (under BSD licence)



## Example: MyAI.java

```

import fi.utu.cs.hockey.ai.*;

public class MyAI extends AI implements Constants {
    public void react() {
        if (isPuckWithinReach()) {
            head(headingTo(0.0, THEIR_GOAL_LINE));
            brake(0.5);
            shoot(1.0);
            say(1050L);
        } else {
            head(headingTo(puck()));
            dash(1.0);
        }
    }
}
    
```

## Try it yourself!

- challenge: implement a team of autonomous collaborating synthetic players
- the platform and ready-to-use teams available at: <http://www.iki.fi/smed/aishockey>



## Multiplaying

- multiple human players sharing the same game
- methods:
  - divide the screen
  - divide the playtime
  - networking

All this and more in the follow-up course  
*Multiplayer Computer Games*  
starting October 29, 2007.

## Games and story-telling

- traditional, linear story-telling
  - events remain from time to time (almost) unchangeable
  - books, theatre, cinema
  - participant (reader, watcher) is passive
- interactive story-telling
  - events change and adapt to the choices the participant makes
  - computer games
  - participant (player) is active

## A story is always told to human beings

- story-telling is not about actions but reasons for actions
  - humans use a story (i.e., a narrative) to understand intentional behaviour
  - how can we model and generate this?
- story-telling is about humans
  - humans humanize the characters' behaviour and understand the story through themselves
  - how can we model and generate this?

### **Other game design considerations**

- customization
- tutorial
- profiles
- modification
- replaying

→ parameterization!