Algorithms for Computer Games

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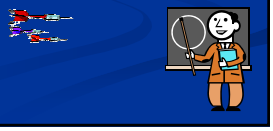
Course syllabus

- credits: 4 cp (2 cu)
- prerequisites
  - fundamentals of algorithms and data structures (see Cormen et al., *Introduction to Algorithms*)
  - knowledge in programming (e.g., with Java)
- assessment
  - examination only (no exercises)

Lectures

- Tuesdays and Wednesdays, 12–2 p.m.
- September 6 – October 18, 2005
- Datacity, Auditorium



Examinations 1(3)

- examination dates (to be confirmed)
  1. October 26, 2005
     - N.B. lecture examination, 12:00–14:00
  2. ?? (possibly November 2005)
  3. ?? (possibly January 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/**

Examinations 2(3)

- if you are *not* a student of University of Turku, you must register to receive the credits
- further instructions are available at **http://www.tucs.fi/education/courses/participating_courses.php**

Examinations 3(3)

- 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

Web page

http://staff.cs.utu.fi/staff/jouni.smed/a4cg/

- news and announcements
- slides, code examples, additional material
- corrections to the lecture notes

Follow-up course: Multiplayer Computer Games

- focus: networking in computer games
- credits: 4 cp (2 cu)
- schedule:
  - November 1 – December 15, 2005
  - Tuesdays 2–4 p.m. and Thursdays 12–2 p.m.
- web page:
  http://staff.cs.utu.fi/staff/jouni.smed/mcg/

Lecture notes

- J. Smed & H. Hakonen: *Algorithms and Networking for Computer Games*, 2005
- paper copies are distributed in the lectures
- no electronic version! (don't even ask)
- errata can be found in the course web page

Let's play a game: Bonus on grades

- find error or suggest improvements on the lecture notes
- first one to send gets point(s); check the existing errata!
- among those who receive *at least* 10 points:
  - student with most points gets 0.5 bonus on the examination points
  - the next best three get 0.25 bonus on the examination points
- scoring:
  - 1 point – error in text
  - 2 points – error in equation or code
  - 4 points – bug in code or improvement on a method

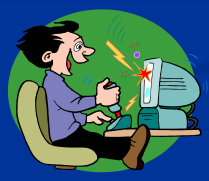
How to submit erratum

- e-mail to **jouni.smed@cs.utu.fi**
- use the subject prefix 'a4cg'
- give page and line numbers
  - negative line number indicates numbering from the bottom up
- list the errors and the possible corrections
- remember to include your full name and student number

The small print: The submitted corrections can be used freely in the subsequent editions without further notice.

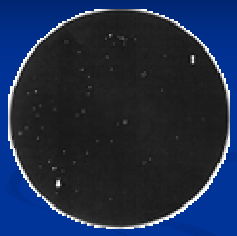
(If you can read this, you don't need new glasses.)

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! ARRRGGGHHH!!,' 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 1Plays at Spacewar", *Decuscope*, 1(1):2–4, April 1962

...and then...

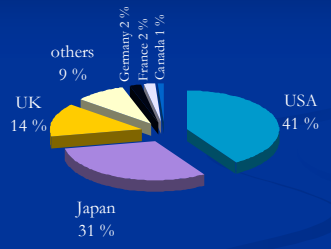
- 1962: *Spacewar*
- 1971: Nutting: *Computer Space*
- 1972: Atari: *Pong*
- 1978: Midway: *Space Invaders*
- 1979: Roy Trubshaw: *MUD*
- 1980: Namco: *Pac-Man*
- 1981: Nintendo: *Donkey Kong*
- 1983: Commodore 64
- 1985: Alexei Pajitnov: *Tetris*
- 1989: Nintendo Game Boy
- 1993: id Software: *Doom*
- 1994: Sony Playstation
- 1997: Origin: *Ultima Online*
- 2001: Microsoft Xbox

…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 %

sources: PriceWaterhouseCoopers, NPD Funworld

Game industry geographically



source: GDAA Game Industry Fact Sheet, 2003

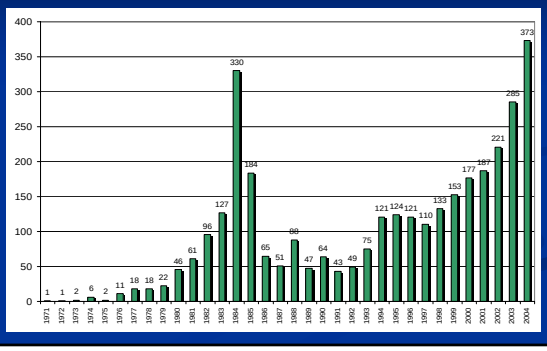
Top 20 game publishers

ranking criteria:
- annual revenue
- game reviews and revenue
- developer polls

	Publisher	G$
1.	Electronic Arts	2.96
2.	Microsoft Game Studios	.64
3.	Sony Computer Ent.	1.78
4.	THQ	.64
5.	Ubisoft	.62
6.	Eidos Interactive	.25
7.	Activision	.95
8.	Take-Two Interactive	1.03
9.	Atari	.47
10.	Nintendo	2.10
11.	Vivendi Universal Games	.72
12.	Codemasters	.14
13.	Acclaim	.14
14.	Sega	.59
15.	Konami	.89
16.	Square Enix	.60
17	Midway Games	.09
18.	Koei	.27
19.	Empire Interactive	.05
20.	Namco	.20

source: *Game Developer*, Oct. 2004

Articles containing 'computer game' according to the Inspec database



source: Inspec, Aug. 2005

Academic sources

- journals
  - *Journal of Intelligent Games & Simulation* (2002–)
  - *Journal of Game Development* (2004–)
- conferences
  - Computers & Games, CG (biannually 1998–)
  - Game-On Conference on Simulation and AI in Computer Games, GAME-ON (annually 2000–)
  - Application and Development of Computer Games, ADCOG (annually 2001–)
  - NetGames (annually 2002–)

…and many more…

Practitioners' sources

- books
  - *Game Programming Gems* series (four volumes)
  - *AI Game Programming Wisdom* series (two volumes)
- journals
  - *Game Developer* (1994–)
  - *Gamasutra*, **http://www.gamasutra.com**
- conferences
  - Game Developers Conference, GDC (annually 1988–)

…and many more…

IGDA: Curriculum framework

- humanistic perspective
  - critical game studies
  - games and society
- technical perspective
  - game design
  - game programming
  - visual design
  - audio design
  - interactive storytelling
- administrative perspective
  - game production
  - business of gaming

source: **http://www.igda.org/academia**

Game programming

IGDA: "Aspects of traditional Computer Science — modified to address the technical aspects of gaming."

- mathematical and algorithmic methods
- modelling
- multimedia programming (graphics and audio)
- artificial intelligence
- networking and distributed computing
- software construction, prototyping and testing

Algorithmic problems in computer games

- graphics and audio
  - 3D rendering
  - camera movements
  - adaptive audio
- simulation and modelling
  - game engines
- multiplayer networking
  - protocols and security
  - resource distribution
- artificial intelligence (AI)
  - computer-controlled actors

a shift of interest

Intention of this cource

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

Contents

Topics 1(2)

- Introduction
  - how to decompose and construct computer games?
- Random Numbers
  - if computers are deterministic, how to achieve indeterminism at all?
- Tournaments
  - how to form a tournament for a set of contestants to solve their ranking?

Topics 2(2)

- Game Trees
  - given time and resources, how to solve perfect information games?
- Path Finding
  - observing the geography of the game world, how to get from one place to another?
- Decision-Making
  - being a synthetic participant on a game, how to interact?

§1 Introduction

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

First, a thought game

- what features are common to all games?

1. players
2. rules
3. goals
4. opponents
5. representation

Definition for 'play'

'[Play] is an activity which proceeds within certain limits of time and space, in a visible order, according to rules freely accepted, and outside the sphere of necessity or material utility. The play-mood is one of rapture and enthusiasm, and is sacred or festive in accordance with the occasion. A feeling of exaltation and tension accompanies the action, mirth and relaxation follow.'

— Johan Huizinga, *Homo Ludens*

Definition for 'game'

'a universal form of recreation generally including any activity engaged in for diversion or amusement and often establishing a situation that involves a contest or rivalry'

— *Encyclopædia Britannica*

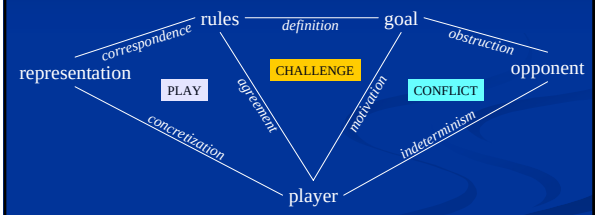
'Etymology: Middle English, from Old English *gamen;* akin to Old High German *gaman* amusement'

— *Merriam-Webster Dictionary*

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 rivarly
- representation: concretizes the game

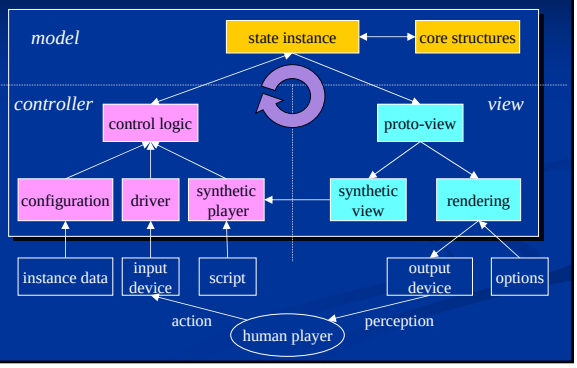
Components, relationships and aspects of a game



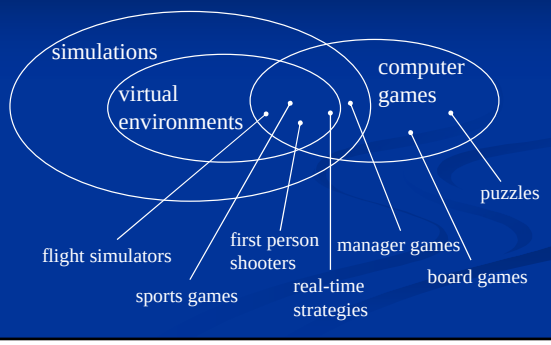
Definition for 'computer game'

- 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

Model-View-Controller



Simulations vs. computer games



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*)