COMPSCI 777 S2 C
Game Technology

Burkhard Wünsche[1], Jarno van der Linden[1], Ute Loerch[2], Hans Guesgen[2], Patricia Riddle[2]

[1]*Division for Biomedical Imaging & Visualization*

[2]*Artificial Intelligence Group*

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

IMPORTANT ANNOUNCEMENT

Departmental Policy on Cheating on Assignments

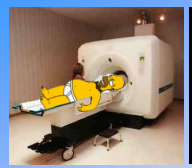
1. ***The Computer Science Department uses many ways to check that the work students submit for marking is their own and was not produced by, or copied from, someone else. In particular, for most programming assignments, the department uses a program comparison program to automatically compare all submissions from students. Also Turnitin.com may be used on essays and reports. This detects similarity to online material and submitted works in its own database.***
2. ***All assignments where plagiarism is detected are checked for similarity by the course supervisor or another suitable person associated with the course.***
3. ***All assignments deemed to be too similar are automatically allocated a zero mark.***
4. ***All students who submitted these assignments are entered in the duplicate assignment register.***
5. ***A standard email (see below) is sent to these students.***
6. ***Repeat offenders may be referred to the University Disciplinary Committee.***

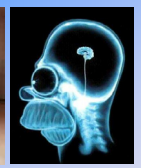
For more details see http://www.cs.auckland.ac.nz/CheatingPolicy.html

Who is Burkhard?

- Born in München (Germany)

- Studied in Kaiserslautern (Germany)
- PhD in Biomedical Visualization



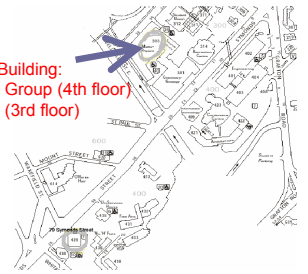


- Research Interests:
  - Computer Graphics, Biomedical Imaging, Scientific Visualization, Geometric Modelling, Computer-Aided Geometric Design, Game Technology, Simulation Algorithms, Information Visualization.

COMPSCI 777 Game Technology Lecturers

- Burkhard Wuensche (Supervisor) (burkhard@cs.auckland.ac.nz)
  Building 303, Room 490
  Office hours: Thursday 2-4pm
- Jarno van der Linden (jvan006@cs.auckland.ac.nz)
  Building 303, Room 496
  Office hours: TBA
- Ute Loerch (ute@cs.auckland.ac.nz)
  Building 303, Room 388
  Office hours: TBA
- Hans Guesgen (hans@cs.auckland.ac.nz)
  Building 303, Room 379
  Office hours: TBA
- Patricia Riddle (pat@cs.auckland.ac.nz)
  Building 303, Room 392
  Office hours: TBA

Science Building:
Graphics Group (4th floor)
AI Group (3rd floor)



COMPSCI 777 - Game Technology Lectures

Lectures:

Day	Time	Room
Tuesday	12-1pm	Rm 279
Thursday	12-1pm	Rm 279
Friday	12-1pm	Rm 279

COMPSCI 777 - Game Technology Exam

Exam: 60% of final mark

Date: Saturday, 6th November, 2.15pm
(subject to change)

COMPSCI 777 Game Technology - Assignments

Worth 40% of total marks – split between Computer Graphics & AI

Assignment 1 – worth 6⅔ % of final mark, Due date: probably 9th August
(see assignment handout for details)

Late hand in: 1 day after the due date (5% penalty)
No assignments accepted after the 'late day'.

There will probably be 4-6 assignments in total!

COMPSCI 777Game Technology Course Description

An advanced course looking at some of the computer graphics and artificial intelligence technology involved in computer games.

Typical topics are: an introduction to the gaming industry; commercial modelling and animation software; maximizing graphics performance, including such techniques as visibility preprocessing, multiple levels of detail, space subdivision, fast collision detection, direct programming of the graphics card; AI for computer games, including decision trees, rule-based systems, path planning, flocking behaviours, intelligent agents; research issues, such as physically-based modelling, terrain generation, computer learning.

Textbooks & Reference Books

- **OpenGL**
  - Edward Angel, "OpenGL, A Primer", Addison Wesley Longman, 2002.
  - OpenGL Architecture Review Board (Mason Woo, Jackie Neider, Tom Davis), "OpenGL Programming Guide", Second or Third Edition, Addison Wesley Longman.
- **Windows Programming**
  - Prosise, "Programming Windows with MFC"
  - Petzold, "Programming Windows"
  - Richter, "Advanced Windows"
- **3D Computer Graphics**
  - Hill, F.S., "Computer Graphics using Open GL", 2nd ed., Prentice Hall, 2001
  - Edward Angel, "Interactive Computer Graphics, A Top-Down Approach with OpenGL", Third Edition, Addison Wesley Longman, 2003

Textbooks & Reference Books (cont'd)

- **Game Web Sites**
  - GameTutorials.com: http://www.gametutorials.com/
  - Gamasutra: http://www.gamasutra.com/
  - FlipCode.com: http://www.flipcode.com/
  - GameDeveloper.net: http://www.gamedev.net/
  - Game Industry News: http://www.gameindustry.com/
- **Game Development Associations**
  - IGDA (Intl. Game Developers Assoc.): http://www.igdn.com/
  - NZGDA (NZ Game Developers Assoc.): http://www.nzgda.com/
  - IGDA Auckland Student Chapter: http://auckland.igda.org.nz/

COMPSCI 777 - Game Technology

Part 1 (weeks 1-2) - Burkhard

TOPICS:

1. Introduction to Computer Games
2. The Game Industry
3. Game Development
4. Game Engine Design
5. Game Engine Programming with OpenGL under Windows

COMPSCI 777 - Game Technology

Part 2 (weeks 3-4) - Ute

TOPICS (subject to change):

1. The evolution of Game AI
2. Finite State Machines and Computer Games
3. Game Trees
4. Using N-Gram Statistical Models to Predict Player Behaviour
5. Practical Natural Language Learning for Games

COMPSCI 777 - Game Technology

Part 3 (weeks 5-8) - Jarno

TOPICS (subject to change):

1. Visibility preprocessing
2. Multiple levels of detail
3. Space subdivision
4. Fast collision detection
5. Direct programming of the graphics card

COMPSCI 777 - Game Technology

Part 4/5 (weeks 9-12) – Hans / Pat

TOPICS (subject to change):

1. A*- Pathplanning
2. Simplified 3D Movement and Pathfinding
3. Fuzzy Logic for Games
4. Flocking: A simple Technique for Simulating Group Behaviour
5. A Neural Net Primer
6. Aspects of Genetic Programming applied to a Games

1. Introduction to Computer Games

1.1 What are Computer Games?

1.2 Genres

1.3 History of Computer Games

1.1. What are Computer Games?

electronic game

also called ***computer game*** *or* ***video game*** any interactive game operated by computer circuitry. The machines, or "platforms," on which **electronic games** are played include general-purpose shared and personal computers, arcade consoles, video consoles connected to home television sets, and handheld game machines. The term video game can be used to represent the totality of these formats, or it can refer more specifically only to **games** played on devices with video displays: television and arcade consoles.

From: *Encyclopædia Britannica* Online

What are Computer Games? (cont'd)

(Multiplayer) Computer Game

⇳

Highly-interactive (Collaborative) Virtual Environment

© 1999-2003 Sony Computer Entertainment America, Everquest homepage, URL: http://eqlive.station.sony.com

1.2 Genres

- Action Games
- Adventure Games
- Role Playing Games (RPG)
  - Massive Multiplayer Online RPG (MMORPG)
- Simulation Game
- Strategy Games
  - Real-time Strategy Games (RTS)
- Puzzle Games
- Sport Games
- Survival-Horror Games

Perspectives

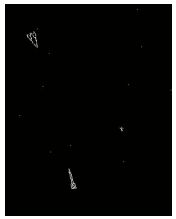
- First Person Shooter (FPS)
- Third Person Shooter (TPS)

1.3. History of Computer Games

- "Tennis for Two" (1958)
  - By William A. Higinbotham
  - Created on an oscilloscope

© http://www.osti.gov/accomplishments/images/video.jpg

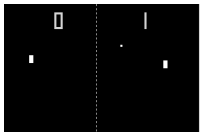
- Space War (Massachusetts Institute of Technology, 1961)
  - First documented computer game
  - developed for the PDP-1 at MIT



© http://www.wheels.org/spacewar/

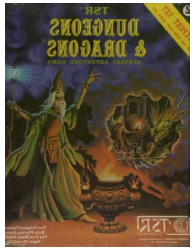
History of Computer Games (cont'd)

- Pong (1972)
  - Videogame
  - Manufacturer: Atari
  - Predictable, easy to learn



© WebMagic Inc., Killer list of video games, URL: http://www.klov.com.

- Adventure (Will Crowther/ Don Woods, 1972/1976)
  - First adventure/simulation game
- Dungeons & Dragons (Gary Gygax & Alex Arneson, 1974)
  - Started the Role Playing Game (RPG) industry
  - Best selling RPG game (20 million players as of 2004)
  - Influenced by Lord of the Rings, Greek & Norse mythology etc.



© 2004 Farlex Inc., TheFreeDictionary.com

History of Computer Games (cont'd)

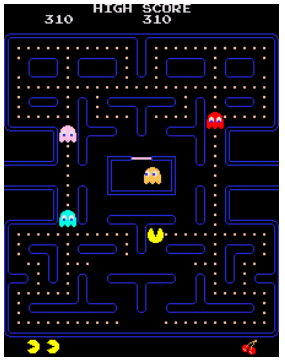
- Space Invader (1978)
  - Videogame
  - Manufacturer: Bally Midway, Taito Corporation

© WebMagic Inc., Killer list of video games, URL: http://www.klov.com.

1970's: Video arcades spreading from Japan to America.

History of Computer Games (cont'd)

- Pac Man (1980)
  - Videogame
  - Creator: Toru Iwatani
  - Manufacturer: Namco
  - Trivia:
    - The single most popular game of all time!!
    - The game spawned an animated series on ABC that lasted two seasons (from 1982 to 1984).
    - The game's hero was born from a pan of pizza with one slice missing!,
    - The game was, at first, called *Puckman*.
    - The American rights were to go to Atari originally, but they turned them down, saying the game was too easy.

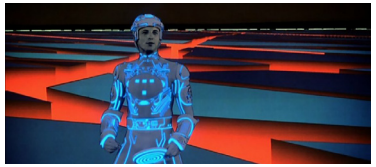


© WebMagic Inc., Killer list of video games, URL: http://www.klov.com.

History of Computer Games (cont'd)

- 1982
  - Walt Disney releases the movie 'Tron'
  - Peak of arcade games

© 2004 Walt Disney Corp. / Mythric Studios, http://www.tron-sector.com



- 1983
  - Console and Video game crash
    - But revival in late 80's by Nintendo
  - Increase of computer games on PC's

History of Computer Games (cont'd)

- Elite (Acornsoft, 1983)
  - Polygonal 3D Graphics
  - Newtonian Physics

© Simon Challands 1996-2003, http://elite.acornarcade.com/ims/arcscrn/police.gif

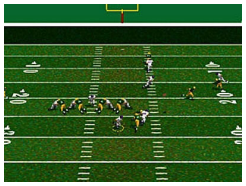
- Tetris (Alex Pajitnov, 1985)
  - Used by Nintendo for GameBoy

- Final Fantasy (Squaresoft / Hironobu Sakaguchi, 1987)
  - One of the most influential video game franchises ever
  - Menu-based role playing game

© 2004 Farlex Inc., TheFreeDictionary.com, http://encyclopedia.thefreedictionary.com/Final%20Fantasy%201

History of Computer Games (cont'd)

- John Madden Football (Electronic Arts, 1988)
  - Start of EA's American Football series
  - Interesting article about the game's production:
    - http://www.designersnotebook.com/Online_Articles/Putting_Madden_in_Madden/body_putting_madden_in_madden.htm



© 1995-2004 Muze Inc., http://www.rottentomatoes.com/g/JohnMaddenFootball-704754/images.php#screenshots

- SimCity (Maxis, 1989)
  - Real-time strategy / simulation game
  - New paradigm (no win/loose)
  - Predecessor of "The Sims" (2000) - the most successful computer game of all times.

History of Computer Games (cont'd)

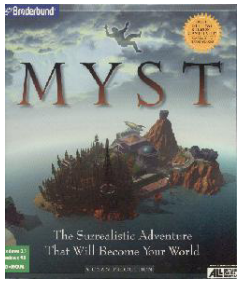
- Super Mario 3 (Nintendo, 1990)
  - Best selling video game until that date

© 2004 Farlex Inc., TheFreeDictionary.com

- Civilization (MicroProse, 1991)
  - most successful and most celebrated turn-based strategy game of all time
- Wolfenstein 3D (ID Software, 1992)
  - First Person Shooter game
  - Originally released as shareware
  - Predecessor of DOOM & Quake

History of Computer Games (cont'd)

- Myst (Broderbund, 1993)
  - Best selling video game for a decade (9 mil. copies)
  - Created by Robyn and Rand Miller (1991-1993)
  - Graphic adventure computer game
  - Originally developed on Apple Macintosh computers as one large colour HyperCard stack.
  - Articles:
    - The making of Myst III – Exile: http://www.myst3.com/html/insidelook2.html
    - Guerrillas in the Myst - Wired Magazine's 1994 article about the creation of Myst: http://www.wired.com/wired/archive/2.08/myst_pr.html
    - *Exploring Myst's Brave New World* - Wired Magazine 2003 interview with Rand Miller: http://www.wired.com/wired/archive/11.06/play_pr.html

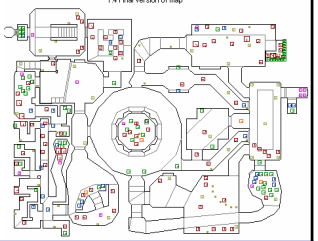


© 2004 Farlex Inc., TheFreeDictionary.com

History of Computer Games (cont'd)

- DOOM (ID Software, 1993)
  - One of the most influential games of all times
  - Inspired by *Alien* and *Evil Dead* movies
  - Multiplayer mode, 1st with *Death match* over network
  - Multiple level-of-details
  - BSP trees
  - Non-perpendicular walls
  - Varying light levels
  - Interactive scene components
  - Online article about the DOOM rendering engine: http://encyclopedia.thefreedictionary.com/technology%20of%20DOOM
  - Sourcecode: http://www.3ddownloads.com/showfile.php3?file_id=7430

© 2004 Farlex Inc., TheFreeDictionary.com



History of Computer Games (cont'd)

- Tomb Raider (Eidos Interactive, 1996)
  - (Cubic) 3D world
  - Third Person Shooter (TPS) game
  - Puzzles + combat

© http://www.tombraiders.net/katie/tr2lara.html

© 2000-2004 Gamekult.com, http://www.gamekult.com/tout/jeux/images/ME0000437670

- Quake (ID Software, 1996)
  - World created as true 3D space
  - Kick started graphics card revolution (GLQuake)
  - Quake engine
  - Light maps & real-time light sources
  - Easy to modify (QuakeC) -> "mods"
  - Responsible for "*machinima*" phenomenon

History of Computer Games (cont'd)

- Unreal (Epic Games, 1998)
  - Unreal engine
  - New benchmark for 3D graphics
  - 4-5 years development!

© 1998 Michael Breeden.

© 2004 Farlex Inc., TheFreeDictionary.com

- Half-life (Valve Software,1998)
  - Based on a modified quake engine
  - Heralded for it's storyline
  - Base for the multi-player mod "Counter Strike"

History of Computer Games (cont'd)

- Ultima Online (Origin Systems / EA, 1997)
  - First popular massively multiplayer computer game
  - 150000 online users by February 2000

© 2004 Electronic Arts Corp., http://www.uo.com

- Lineage (NCsoft (South Korea), 1998)
  - Commercially most successful massively multiplayer online role playing game (MMORPG) ever
  - More than 4 million subscribers (mostly South Korea)

© 2004 NCsoft Corp., http://www.lineage.com/

- EverQuest (Verant Interactive / Sony, 1999)
  - Leading MMORPG in US and Europe: 450000 subscribers in 2004

© 1999-2003 Sony, http://eqlive.station.sony.com

History of Computer Games (cont'd)

- The Sims (Maxis, 2000)
  - Most successful PC game in history
  - Strategy / Simulation computer game
  - Uses an agent based artificial life program
  - 50% female gamers
  - Dec. 2002 "The Sims Online'
    - "like an enormous chat room full of boring people"

© 2001 Electronic Arts Corp., http://thesims.ea.com

- Lineage 2 (NCsoft, 2003)
  - Unreal engine for 3D graphics

The Future of Computer Games

Soon coming to a theatre near you …

- Half-life 2
  - Advanced physics engine
  - Emotional and behavioural responses
- Doom 3
- The Matrix Online

The Future of Computer Games (cont'd)

Soon coming to a theatre near you …

- The Sims 2
  - Full 3D
  - Characters will age and have genetic traits which are passed on to children
- Unreal 3 Engine
  - Requires DirectX9 equipped PC
  - Supports per-pixel lighting and rendering techniques
  - Dynamic shadowing

2. The Game Industry

2.1 Industry Overview

2.2 Industry Sectors

2.3 Game Markets

2.4 Companies

2.5 How to "break in"?

2.1 Industry Overview

- Revenue in 2001
  - Console Sales: 9.02 billion US$
  - Peripheral Sales: 4.17 billion US$
  - Software Sales: 28.84 billion US$
- Revenue for Computer Games overtook revenue from movies in 2001
- Fastest growing software sector
  - >60% in the next decade
  - Average salary of game developers: 35,000-70,000 US$
- Challenges
  - Crisis of creativity
  - Increasing average age of gamers (29 years)
  - Increase of production costs / project size / license costs
  - Outsourcing
  - Software piracy

2.2 Industry Sectors

- Game Developers / Publishers / Distributors
- Contractors
- Technology Providers
  - Animation Software, Modelling Software, Plug-Ins, Sound recording, …
- Game Hardware Manufacturer
  - Consoles, Accessories, Simulators (e.g. for racing cars), …
- Education & Training
- Research

2.3 Game Markets

- PC games
- Console games
  - PlayStation 2, Xbox, GameCube
- Arcade Games
- Online market
  - Examples:
    - Half-life: No.1 online action game for PCs
    - Battle.net (Blizzard Entertainment) has >11 mil. Active accounts

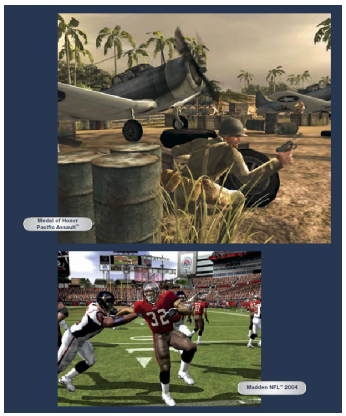
2.4 Game Companies (Developers/ Publishers)

- Electronic Arts (USA)
- Vivendi Universal Games (France)
- Eidos (Britain)
- Ubisoft (France)
- Infograme/Atari (France)
- Acclaim Entertainment (USA)
- Bioware (Canada)
- Sony Entertainment (Japan)
- Take 2 Games (USA)
- ID Software (USA)
- Epic Games (USA)
- Activision (USA)
- …. Sidhe Interactive (New Zealand)

Game Companies (cont'd)

Electronic Arts

- Revenue (2004): € 2.957 billion
- Net Income: $ 577 mil.
- 4800 employees worldwide
- Development Studios
  - USA, Canada, Japan, England.
- Leading franchises (>5 mil. copies):
  - The Sims, Need for Speed, Medal of Honor, FIFA Soccer, The Lord of the Rings, Madden NFL Football



© 2004 Electronic Arts, 2004 Annual Report, http://media.corporate-ir.net/media_files/irol/88/88189/reports/2004AR.pdf

Game Companies (cont'd)

Vivendi Universal Games

- Revenue (2003): € 571 mil.
- Operating Loss: € 201 mil.
- 1985 employees
- Labels:
  - Blizzard Entertainment, Coxtel, Fox Interactive, Sierra Entertainment, Knowledge Adventure, Massive Entertainment
- Leading franchises:
  - Diabolo, Half-Life, Warcraft, StarCraft, The Simpsons
- Best-selling titles 2003
  - The Simpsons: Hit & Run, The Hulk, Warcraft III: The Frozen Throne

© 2003 Vivendi Universal, 2003 Annual Review, URL:: http://www.vivendiuniversal.com/vu/en/files/brochure_2003_ang.pdf

Game Companies (cont'd)

Sidhe Interactive

- "Sidhe" is Gaelic for "faerie folk"
- Established in 1997 in Wellington
- Revenue: 3-4 million in 2003
- 30-35 employees
- Managing Director: Mario Wynand
- Worked on the games:
  - O'Neill Championship Surfer (PlayStation)
  - Barbie Beach Vacation (PC)
  - Barbie Sparkling Ice Show (PC)
  - Adidas Football Fever (PC)
  - Jimmy Neutron: Jet Fusion (PS2/GC)
  - Hoyle Majestic Chess (PC)
  - Rugby League (PS2/Xbox/PC).

http://www.gamespot.com.au/xbox/reviews/0,2000027235,39115709,00.htm

2.5 How to "break in"

- Determine your skills and interests
- Study relevant subjects (see job requirements)
- Get experience
- Develop "people skills"
- Make contacts
- Keep informed
- Create a portfolio of your work (artists/animators)

Positions

- Example - Epic Games advertised in July 2004 the following positions:
  - Character Modellers / Skinners
  - High-Res Modeller
  - Concept Artist
  - FX Artist
  - Level Designers
  - Gameplay Programmers
  - Tools Programmers
  - Texture Artist
  - Production Assistant
- Other fields
  - Testing, AI/Scripting, Sound Design, Animation, Game Design, Backstory/Dialogue

Job Requirements

- Example: Sidhe Interactive's advertisement for a programmer (July 2004) lists the following skills:
  - University Computer Science degree or equivalent
  - Strong C++ programming and math skills
  - Understanding of object oriented design and programming techniques
  - Comfortable working in a managed team environment
  - Able to work well under pressure and to tight deadlines
  - Good communication skills
  - Professional game development experience desirable but not required
  - Knowledge of AI, 3D graphics, sound, or physics principles beneficial
  - Experience in large, team based software projects preferred