AI in Computer Games
why, where and how

Who am I?
- Lecturer at Uppsala University, Dept. of information technology
- AI, machine learning and natural computation
- Gamer since 1980

AI in Computer Games
- Goals
- History
- Common issues and methods
- Issues in various game categories

Goals
- Games are entertainment!
- Important that things behave naturally
  - not necessarily perfect
  - "things" are not always creatures
- Follow (the game's) natural laws
  - and avoid cheating
- Characters should be aware

Game A(I?)
- Academic AI is usually concerned with making rational decisions
  - Searching for the optimal solution
- Game AI is more often about
  - Artificial Life
  - Believable behaviour
    - including stupidity!
    - realistic physics
  - Game balancing
    - challenging, but not unbeatable opponents

History -1980
- 1960's
  - First computer games
    - SpaceWar! (PDP-1, for two human players) (1962)
    - Board games (e.g. chess) against the machine
### History -1980

- **1960's**
  - First computer games
    - SpaceWar! (PDP-1, for two human players) (1962)
    - Board games (e.g. chess) against the machine
- **1970's**
  - Pong (early arcade game) (1972)
  - Computer controlled opponents
  - Space Invaders (1978)
  - Predefined patterns, no awareness
  - "AI" takes 1-2% of CPU

### 1980's

- Pac-Man (1980)
  - aware opponents with personality
- A computer beats a master chess player (1983)
- First fighting games
- Adventure games
  - Dungeon, Zork, ...
- First MORPG (MUD)
- Space Invaders

### 1990's

- FPS and RTS games
- Games about/with evolution and learning (Creatures, and (later) Black&White)
- Deep Blue beats Kasparov (1997)
- Graphic cards take the load off the CPU
- AI takes 10-35% of CPU

### 2000-

- Focus shift from single- to multipler
- Focus shift from graphics towards AI
- Large part of the code is AI code
- often made from scratch for each game
- Less cheating
- Characters are more aware
  - thanks to better physics engines
- Characters collaborate better

### 2000- BIG industry

- Estimated worth 67bilj USD 2010
  - more than music sales+concerts
- Sales +150% in Sweden 2000-2009
  - GNP +15% in the same period
- 7.4milj games sold in Sweden 2009
- Tough competition: 10 most sold games cover 80% of the market
- Typical game project: 2 years, 70 people, 20milj USD (+ marketing)

### Typical Game AI topics

- Strategical/tactical decisions
  - Against or with you
  - Search for best counter action
  - adaptivity
- Director level AI
- Simulation
  - of natural behaviour
  - for animation (e.g. bird flocks)
- Shortest path problems
Why is Game AI hard? (what makes it interesting to CompSci)
- Huge state space
- Huge action space
- Multiple tasks
  - on different levels of abstraction
  - of different types
- Non-deterministic
  - post-conditions difficult to set
  - makes planning difficult
- Often real time

Some common methods
- Minimax
  - logic games, search for best counter action
- Finite State Machines (FSM)
  - Behaviour
- A*
  - For shortest path problems
- Particle methods
  - Simulation of flocks, smoke, water, grass,...
- Smart terrain

Minimax (counter actions)

Finite State Machines
Pacman ghost (red)

A* 
Distance from S + estimated distance to G

Reinforcement Learning
Best ≠ shortest

Civilization III

Smart terrain
- Store knowledge in objects instead of in the characters
  - drink me! ➔ not thirsty, warm
- Easier to know what is relevant
- Easier to add new objects later
- Attributed to Will Wright (Sims)

Machine Learning?
- Game characters are short lived
- Learning requires many attempts
  
  **Keep it simple!**
  
  - Probabilistic methods (MENACE)
    - Director level AI
  - Evolutionary methods
    - genetic algorithms and PSO
  - Neural networks
    - in game development, but not in the game

MENACE

AI in various game types
- Board games
- Role playing games
- Strategy games
- Platform and sports games
- Racing games

Board games
- Discrete time / turn based
- Often deterministic
- AI is in the opponent
- AI goal is non-typical (for games)
  - usually strives for optimality
- Tree search
- Library
- Reinforcement learning
Role Playing and Adventure
- AI in enemies, bosses, party members and other NPCs, ...
- Scripting, FSMs, Messaging
- Role Playing ≠ Combat
  - combat oriented games are simpler to make
- Conversations (grammar machines)
- Quest generators
- Towns

Town behaviour
- Need-based system
  - Needs (e.g. hunger, business, …)
  - Actions (e.g. eating, trading, …)
  - "Need pathfinding"
- Problems
  - Finding people
  - Unwanted interaction between NPCs

Strategy games
- AI heavy (on both sides)
- Shortest path problems
- Strategical decisions
- Tactical decisions
- Town building and resource management
  - planning
  - Indigenous life
  - Reconnaissance (fog-of-war)
  - Diplomacy
  - Know thy enemy (observe and adapt)

Action games (FPS, TPS)
- Enemies
- Cooperative agents
- Weapons
- Attention
  - requires perception
    - requires a good physics engine
- Pathfinding
- Spatial reasoning
- Anticipation
**Action games (FPS, TPS)**

- **Platforms and sports**
  - Platform games
    - In 3D, since 1996 (Mario 64)
    - Camera problems
  - Sports games
    - Camera problems (harder)
    - Cooperation
    - Game balance can be difficult
    - Learning

**Platforms and sports**

- Prince of Persia
- Prince of Persia: The Two Thrones

**Racing games**

- Forza Motorsport (2005)
- Track AI
  - Neural networks (CMR2)
  - Traffic (including pedestrians)
  - Physics
- Tuning NPCs and vehicle parameters
  - Genetic algorithms
  - Particle swarm optimization

**Conclusion**

- Making realistic games requires more than good graphics
- Computer controlled characters must behave
  - Naturally
  - Reasonably intelligent, without cheating
- Graphics has dedicated hardware
  - More processing power available to AI
- In the future
  - Dedicated AI cards?
  - Combined AI/Physics/Graphics cards?
  - Multicore processors
  - Knowledge transfer from games to robotics
Robocup (Aibo league)

Recommended reading

http://aigamedev.com