AI in Computer Games

why, where and how

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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)

**1990's**

- FPS and RTS games
- Games about/with evolution and learning (Creatures, 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 multiplayer
- 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 52bilj USD 2009 (greater than the music industry: 37bilj)
  - 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**

- Strategic/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)

MAX

MIN

MAX 5 1 3 17 42 7

A*

Distance from S + estimated distance to G

Finite State Machines

Pacman ghost (red)

Reinforcement Learning
Best ≠ shortest

Store knowledge in objects instead of in the characters

- not thirsty, warm
- Easier to know what is relevant
- Easier to add new objects later
- Attributed to Will Wright (Sims)

Smart terrain

Machine Learning?

- Game characters are short lived
- Learning requires many attempts

  Keep it simple!

- Probabilistic methods (MENACE)
- 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
- Strategic 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

Racing games
- 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