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
- Daily '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 (or preferably) perfect
  - "things" are not always creatures
- Follow (the game's) natural laws
  - and avoid cheating
- Characters should be aware
Game AI (or is it AL?)

- 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

PDP-1

Chess
History - 1980

- **1960's**
  - First computer games
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- **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, and (in 2001) 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 to AI
  - and physics ...
- 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

- In Sweden
  - +39%/year on average (2006-2014)
  - 12.5 bilj SEK turnover in 2016 (+7%)
  - Most of the (282) companies make +
  - 4291 employees (+550 in 2016)
  - 20-30% of the best games (various lists) were developed in Sweden
2000- BIG industry

- Internationally
  - 2.2 bilj players
  - 108 bilj USD (predicted sales 2017)
  - +56% growth over the last 5 years
  - Mobile games have 42% of the market

- Tough competition ("10 most sold games cover 80% of the market")

- Typical game project: 2 years, 70 people, 20+ milj 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)

Variants: "α-β-pruning" and "expectimax"
Finite State Machines

Pacman ghost (red)

- Ghost Exits Center Room
- Pellet Wears Off
- Player Eats Pellet
- Run From Player
- Rise
  - Eyes Travel Back to Center
  - Die
- Player Dies
- Player Respawns
- Move Randomly
### A* Algorithm

Distance from S + estimated distance to G

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Reinforcement Learning
Best ≠ shortest
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 (a la MENACE)
  - Director level AI
- Evolutionary methods
  - genetic algorithms and PSO
- Neural networks
  - in game development, but not often in game
MENACE

Plate 1. The original matchbox version of MENACE
AI in various game types

- Board games
- Role playing games
- Strategy games
- Racing games
- Platform and sports 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

The Elder Scrolls IV: Oblivion (2006)
Town behaviour

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)
Strategy games

Civilization III (2001)
Action games (FPS, TPS)

- Enemies
- Cooperative agents
- Weapons
- Attention
  - requires perception
    - requires a good physics engine
- Pathfinding
- Spatial reasoning
- Anticipation

Action games (Attention)

Thief 3: Deadly Shadows (2004)
Racing games

Forza Motorsport (2005)
Racing games

- Track AI
  - Neural networks (CMR2)
- Traffic (including pedestrians)
- Physics
- Tuning NPCs and vehicle parameters
  - Genetic algorithms
  - Particle swarm optimization
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 (1989)

Prince of Persia: The Two Thrones (2005)
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?
  - Dedicated cores?
  - From simulated to real worlds (robotics)
Robocup (Aibo league)

Clips from German Open 2002
Recommended reading

http://aigamedev.com