AI in Computer Games

why, where and how

Olle Gällmo

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

PDP-1

Chess

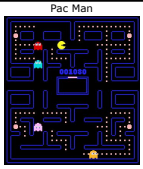
History -1980

- 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


Pong

Space Invaders


1980's

Pac Man


- 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)

Tekken 3


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


Doom


Dune 2


Black & White

2000-

- Computer games is a **big** industry
  - A game project: 2 years, 8-15 million USD
  - Swedish market up 34% in 2008 (23% in USA)
- Less cheating in AI
- Characters are more aware
- Characters collaborate better
- Focus shift from graphics towards AI
  - Large part of the code is AI code
    (often made from scratch for each game, now how good is that?)

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?

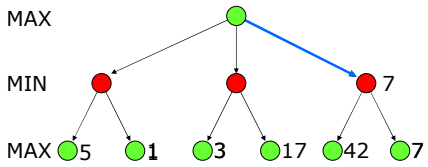
(what makes it interesting to CompSci)

- Huge state space
- Huge action space
- Multiple tasks
  - on different levels of abstraction
  - of different types
- Non-deterministic
  - makes planning difficult
    - post-conditions difficult to set
- 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

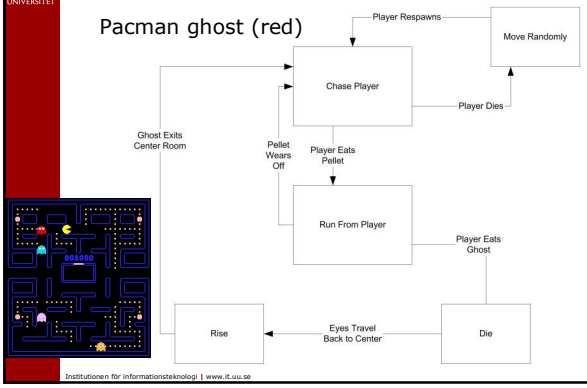
Minimax (counter actions)



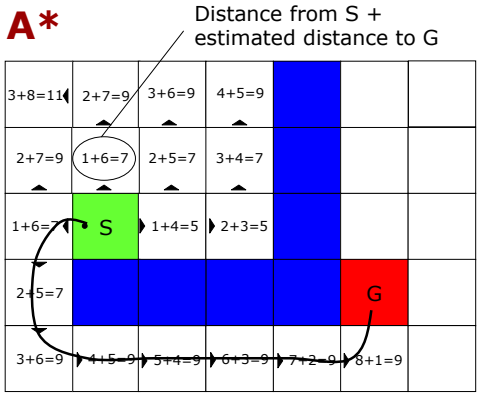
Variants:"α-β-pruning" and "expectimax"

Finite State Machines

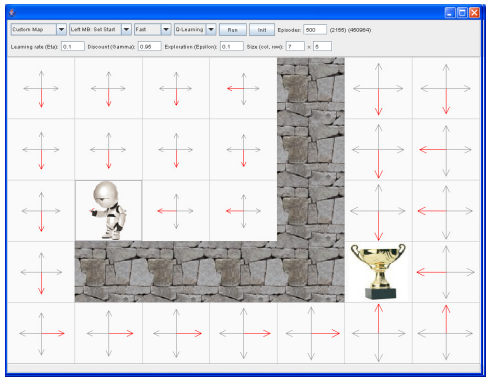
Pacman ghost (red)



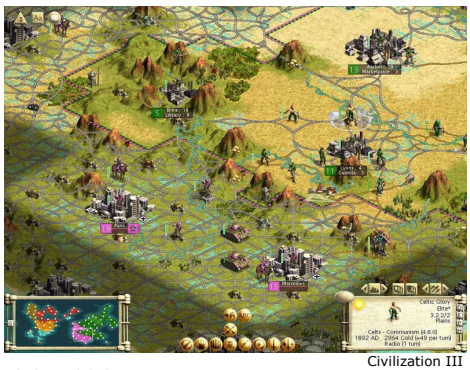
A*



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)
- Evolutionary methods
  - genetic algorithms and PSO
- Neural networks
  - in game development, but not in the game

MENACE

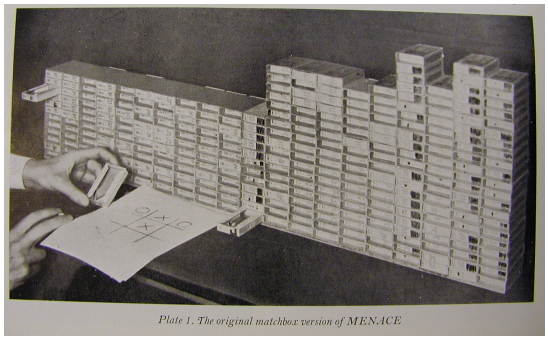


Plate 1. The original matchbox version of MENACE

AI in various game types

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

Board games

Chess

- 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

The Elder Scrolls IV: Oblivion

- 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

Balmora, in The Elder Scrolls III: Morrowind

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

Civilization III

- 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

Action games (FPS, TPS)

Half Life 2

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

Action games (FPS, TPS)

Thief 3: Deadly Shadows

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

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 avilable to AI
- In the future
  - Dedicated AI cards?
  - Combined AI/Physics/Graphics cards?
  - Multicore processors
  - Knowledge transfer from games to robotics

Robocup (Aibo league)