AI in Games

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Sources

- http://www.science4all.org/article/advanced-game-theory-overview/
- http://www.alanturing.net/turing_archive/pages/Reference%20Articles/BriefHistofComp.html
- https://deepmind.com/blog/alphago-zero-learning-scratch/
Overview

- Context
- A history of AI in Games
- Strategies for AI in Games
- Examples
- Game Development View
- Final remarks
Context

- How is AI used in games?
  - Creating human-like opponents or behaviors
    - Chess
    - Fighting Games
  - Solving Games
    - Complete Information Games (Chess)
    - Incomplete Knowledge Games (Poker)

A simplified poker game tree.

Source: http://www.science4all.org/article/advanced-game-theory-overview/

Source: https://upload.wikimedia.org/wikipedia/commons/thumb/5/55/ChessCastlingMovie_en.svg/210px-ChessCastlingMovie_en.svg.png
Context

- How is gamification useful in AI research?
  - Games provide a user-friendly framework for testing AI.
    - Genetic Algorithms
    - Machine Learning

Source: http://www.goatstream.com/research/papers/SA2013/
A history of AI in Games

- **Heuristic AI** (simple rule following, not genuine intelligence)
  - In 1951, AI was used to beat the game Nim (A math strategy game)
  - In 1972, Pong was released
    - AI played as an opponent
  - More and more advanced Heuristic AIs developed as computing power became more available
    - Almost every video game uses Heuristic AI in some way

- **True AI**
  - More recently, advanced AI techniques such as ML, RL, NN have been used in Game Dev.
    - Improving motion control (ML)
    - Design and Balance of Games (2012) (ML)
Heuristic AI in games

- The simplest version of AI
- Rule following
- A simple Pong AI implementation:

```java
private void updatePaddlePosition() {
    int direction = EQUATOR - ball.getY();
    if (direction < 0) {
        paddle.setDirection(Direction.DOWN);
    } else if (direction > 0) {
        paddle.setDirection(Direction.UP);
    } else {
        paddle.stop();
    }
}
```
AI in fighting games

Like Street Fighters V or KOF

AI in fighting games

- AI level difficulty – based on the AI’s frequency of decision making
  - Easy AI:
    - Less desire to defend or attack
    - Limited Combos
  - Hard AI:
    - Increased desire to move
    - Higher level combo
Fan made AI

- Usually designed using the concept of **counter-measure**
Fan made AI

- Designed with individual characters in mind
- Optimize play of each character
- Create best counters to enemy moves
  - choose moves which have no penalty

EX: When character A jumps, but has no skill that can hit character B in time, character B, using fan-made AI, counters with dragon punch.

- Similar to Deep Blue AI in Chess
Source: Touhou 12.3 東方非想天則 ～ 超弩級ギニョルの謎を追え Screenshot
Why have AI in fighting games?

- Default AI: Helps new players to get started
- Fan-made AI: Helps high-level players practice specific counters against different characters
- AI is critical to supporting players in fighting games
AI in collection trading card games

- Used in HearthStone and Magic the Gathering
- Increases enjoyment/difficulty
- Lightweight
- Incomplete implementation

Source: https://edge.alluremedia.com.au/m/k/2016/03/cardgen2.png
Something Else...

Source: https://deepmind.com/blog/alphago-zero-learning-scratch/

AlphaGo Zero
- reinforcement learning
- playing games against itself

Is such advanced AI needed?
AI in Game Development

Game Design:
- Progressive Gameplay
- Emergent Gameplay

AI Framework:
- FSM (Finite State Machine)
- DT (Decision Tree)
- BT (Behavior Tree)

- No more if/else
- Let’s try LINQ!
  - brief and easier to read

In “Designing Emergent AI”

Behavior Tree In Game Development

- What are BTs?
- How are BTs used?
- Opening UE4...

Source: Unreal Engine 4 Screenshot
Incomplete Information Game Solving AI

- Incomplete information games are games played with incomplete information
  - Rock / Paper / Scissors
  - Poker
- Game theory can be used to find optimal (Nash Equilibrium) solutions
  - Rock / Paper / Scissors: Randomly select each \( \frac{1}{3} \) of the time
  - Poker: ... extremely complicated
    - Hand selection
    - Check/Call/Fold/Bet/Raise
    - Accounting for position
    - Bet sizing
    - Optimal Value: Bluff ratio
- Attempts to Solve Poker:
  - Neural Networks, Repetitive Play (Brute force-esque)
Incomplete Information Game Solving AI

- Libratus (2017)
  - First Poker program to outperform professional HUNL specialists
    - Over a sample of 120,000 hands (a reasonable sample size)
    - Win-rate of 14.7 BB / 100 hands (extremely high)
  - Does not have a fixed strategy
    - Procedurally generates a strategy
    - "Learns" the best hands to use as bluffs, value bets
      - Considers "removal effects" (Holding a card makes it impossible for opponent to hold)
    - Follows game theory concepts (Balance, optimal Value:Bluff)
    - Randomization (in hand selection, hand play, bet sizing)
  - Creators are looking for applications in Cybersecurity, business negotiation, and medicine
Closing remarks

- AI is constantly being used to improve the enjoyment in video games
  - Started with simple rule following
  - Now we see Machine Learning being used

Source:

Source: Touhou 12.3 Screenshot
Closing remarks

- AI is advancing rapidly
  - 1980s Chess, 2015 Go, 2017 HUNL Poker
  - In more complex incomplete information games, human thinking still holds an edge
  - This edge will continue to shrink as more AI is developed
  - Will AI ever be able to beat any human at any strategy game?

Source: http://www.onlinepokeracademy.com/img/pokerstars_screen5.jpg
Closing remarks

- Games are used to advance AI algorithms
  - Efficient for testing
    - Define clear objectives
  - Applications of gamified AI: cybersecurity, business, medicine

Source: