CS 387: GAME AI

INTRODUCTION TO GAME AI

3/29/2016

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Class website:
CS 387

- **Focus**: artificial intelligence techniques for computer games.
- **Goal**: cover basic and advanced AI techniques used in commercial games:
  - Platformers
  - Shooters
  - Racing games
  - Board games
  - Strategy games
  - RPG games
  - Rogue-likes
Outline

- Structure of the course
- Intro to Game AI
- Examples of Game AI
- Course Scope
- Projects
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Structure of the Course

• Individual projects
  • For each project, I will give you a small game engine.
  • You will have to implement an AI technique in it.
  • You turn in the code, a small report and demo your project in class.

• Exams:
  • Midterm
  • Final
Grading

- Projects: 50%
- Midterm: 20%
- Final: 20%
- Attendance and class participation: 10%
Miscelania

• Prerequisites:
  • CS 380 (Artificial Intelligence)
  • C++ / Java programming

• Book:
  • “Artificial Intelligence for Games” (Millington & Funge)
  • But I will use materials from other sources to complement topics not covered by the book.
  • For example, for PCG I use: http://www.pcgbook.com

• If you have doubts about any AI technique:
  • “Artificial Intelligence: A Modern Approach” (Russell & Norvig)
  • “Machine Learning: A Probabilistic Perspective” (Kevin Murphy)
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Artificial Intelligence
We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire.

The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves.

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What is Game AI?

- Artificial Intelligence for Computer Games
- Different from traditional AI

Traditional AI: Optimality, efficiency

Game AI: Fun, artificial “stupidity”
What is Game AI?

• Intersection of games and AI:

• Two (three) main communities working on it:
  • Academics:
    • Artificial Intelligence community: how can games help us have better AI (AI centric)
    • Computer Game scholars: how can AI help us have better/more interesting/new forms of games? (Games centric)
  • Game industry:
    • Their goal is to make games that sell more units (games centric)
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Examples of Game AI

“Pac-Man” (1980)
First ever video game to feature AI
AI: finite state machine
Examples of Game AI

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First ever video game to feature AI
AI: finite state machine
First Ever Game to Feature AI?
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- Dr. NIM from the 1960s?
  https://www.youtube.com/watch?v=9KABcmczPdg
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- “El Ajedrecista”, 1921 (Leonardo Torres y Quevedo)
Examples of Game AI

Chess

AI needs to provide a collection of difficulty levels.

Only one: hardest (to be played only against grand-masters), falls into the realm of traditional AI.
Examples of Game AI

“The Secret of Monkey Island”
“And Then There Were None”

Dialogues, storytelling
Examples of Game AI

“Left 4 Dead 2”

AI Director adjusts game pace to ensure desired dramatic effects
Examples of Game AI

“Black & White”

Uses machine learning to simulate a learning creature
Examples of Game AI

“Starcraft II”
Strategy, planning, path-finding, economics, etc.
Examples of Game AI

“Spelunky”

Procedural content generation
Types of Game AI

- **Inside** the game:
  - Character control
  - Director (drama management)

- **During** game development:
  - Help in behavior/content design

- **After** game deployment:
  - Analysis of game data
Types of Game AI

- **Inside** the game:
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Covered in this course
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Course Scope

- Movement and Steering
- Pathfinding
- Decision Making
- Tactical and Strategic Reasoning
- Board Games
- Procedural Content Generation
- Machine Learning
Course Scope

- Movement and Steering
  - Platform games
  - Racing games
- Pathfinding
- Decision Making
- Tactical and Strategic Reasoning
- Board Games
- Procedural Content Generation
- Machine Learning
Course Scope

• Movement and Steering
• Pathfinding
  • Dijkstra
  • A*
  • A* variants for computer games

• Decision Making
• Tactical and Strategic Reasoning
• Board Games
• Procedural Content Generation
• Machine Learning
Course Scope

• Movement and Steering
• Pathfinding
• Decision Making
  • Decision trees
  • Finite State Machines
  • Behavior Trees
• Tactical and Strategic Reasoning
• Board Games
• Procedural Content Generation
• Machine Learning
Course Scope

• Movement and Steering
• Pathfinding
• Decision Making
• Tactical and Strategic Reasoning
  • Rule-based Systems
  • Waypoints and Influence Maps
• Board Games
• Procedural Content Generation
• Machine Learning
Course Scope

- Movement and Steering
- Pathfinding
- Decision Making
- Tactical and Strategic Reasoning
- Board Games
  - Minimax
  - Montecarlo Tree Search

- Procedural Content Generation
- Machine Learning
Course Scope

- Movement and Steering
- Pathfinding
- Decision Making
- Tactical and Strategic Reasoning
- Board Games
- Procedural Content Generation
  - Search-based content generation
  - Tile-based content generation
  - Machine-learning-based content generation
- Machine Learning
Course Scope

• Movement and Steering
• Pathfinding
• Decision Making
• Tactical and Strategic Reasoning
• Board Games
• Procedural Content Generation
• Machine Learning
  • Supervised learning in games
  • Reinforcement learning in games
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Projects

- Individual projects

- I will give you a list of 5, and you have to pick 3:
  - Steering behavior
  - Pathfinding
  - Behavior Trees
  - Strategic decision making
  - Procedural Content Generation

- Goal of each project: implement a specific Game AI algorithm in the game engine provided

- Deliverables:
  - Source code.
  - Small report
  - Present your project in class.
Projects

- Projects are due 2 weeks after the lecture in which their topic is covered.
  - Via learn.drexel.edu

- Submit:
  - Your source code (please document your code appropriately):
  - A short description of what you did (2 pages max).

- In addition to those deadlines, you will demo your projects in class in special sessions (week 5 and week 10).
Projects

- Project demos:
  - You will prepare a short video (3 minutes max)
    - The video will be sent to the instructor prior to demoing in class:
    - You can submit a youtube link, DropBox link, Google Drive link, etc.
  - Demo presentations:
    - In class in special sessions (week 5 and week 10).
    - You will stand and present the video in front of the whole class (3 minutes max)
  - The demos are due the night before the day they are demoed in class (I need time for setting them up and verifying I can play them)
Project Grading

• Projects are a big part of your grade: 50/100 points
• Each project is graded in a 100 point scale:
  • You lose 10 points per each date it is submitted late (even if it’s one second late)
  • You can lose up to 50 points for late submission (after that, no more points are lost)
  • The in-class presentation is worth 20 points. So, you can choose not to present, but you will lose 20 points.
  • Only one project (project 5) has extra credit.
• You only need to do 3 projects:
  • If you do more than 3, only the 3 with the highest grade will be used for your final grade (but you are welcome to do all of them if you are interested!)
Project 1: Steering Behaviors

- Implement steering behaviors (explained week 2)
- Game Engine:
  - Simple car driving (Java)
Project 2: Pathfinding

- Implement A* in a RTS Game
- Game Engine: S3 (Java)
Project 3: Scripting

- Implement a Behavior Tree

- Game Engine:
  - Mario (Java, with bindings for other languages)
Project 4: Strategic Decision Making

- Implement a rule-based AI to play an RTS Game
- Game Engine: microRTS(Java)
Project 5: Procedural Content Generation

- Implement an automatic map generator
- Game Engine: A4Engine (JavaScript)
Projects

• After the lecture in each of the topics relevant to each project, I will describe the project in more detail:

  • Project 1: Content covered week 2 (due week 4)
  • Project 2: Content covered week 3 (due week 5)
  • Project 3: Content covered week 4 (due week 6)
  • Project 4: Content covered week 7 (due week 9)
  • Project 5: Content covered week 8 (due week 10)
Summary

• Class structure:
  • 3 projects (choose out of 5)
  • Mindterm/final
  • Check class website

• Game AI combines traditional AI plus design
Next Class

• How do the game engine and the AI component communicate?