OOB

- Capstone/Reports
  - Code and reports due Thursday night, 11:55p
  - Exam period for EVERYONE. 2:50p-5:40p, here.
  - Bring 2 copies of written reports
- Please do CIOS: http://gatech.smartevals.com
  - Fear not: access granted to me 5 days after grades due
  - Please complete. I take them seriously and use them to improve my methods
  - Should only take 10 to 15 minutes, tops.

Game AI: Recap

2016-07-26

Game AI: The set of algorithms, representations, tools, and tricks that support the creation and management of real-time digital experiences

Motivations

- gain a breadth of understanding of the toolbox of AI approaches employed in digital games
- focus on applied knowledge within the context of digital games
- understand how a game design can be brought into existence through the application of algorithms that are often thought of as intelligent

Learning Objectives

Students in this course will:

1. … gain a breadth of understanding of current issues and techniques in academic and industry game AI.
2. … have hands-on experience in working with different game technologies and incorporating AI programming techniques within those technologies.
3. … be capable of implementing some of the most common Game AI techniques used in industry today
4. … better understand the relationship between game AI and aesthetics, narrative, and player experience
5. … have an understanding of and appreciate the distinctions between artificial intelligence techniques adopted by the computer game industry and those being pursued in research labs and non-games related industries

What is…

- GAI?
  - Set of tricks and techniques to bring about a particular game design.
  - Goals include:
    - enhancing the player's engagement, enjoyment, and experience
      - End behavior is the target
      - Do better than random
    - doing things the player or designer cannot do or don't want to do
      - replace real people when they are unwilling or unavailable to play
      - aid for designers and developers
    - making the entities, opponents, agents, companions, etc. in games **appear** intelligent
    - believable characters / looking convincing
- A Game?
  - A system of rules and a goal and agency.

How/Why distinct from “academic AI”

- Good game AI == matching right behaviors to right algorithms
- Product is the target, not clever coding – ends justify means. FUN
- Illusion of intelligence
- “Magic Circle” (Rules of play: game design fundamentals)
- Elegance in simplicity & the complexity fallacy
- Quality control & resource limits
- Fun vs smart: goal is not always to beat the player
- Optimal/rational is rarely the right thing to do

Common “GAI” Tricks

- Move before firing – no cheap shots
- Be visible
- Have horrible aim (being Rambo is fun)
- Miss the first time
- Attack “kung fu” style
- Warn the player
- Tell the player what you are doing (especially companions)
- React to own mistakes
- Pull back at the last minute
- Intentional vulnerabilities or predictable patterns

Liden, “Artificial Stupidity: The Art of Intentional Mistakes”. *AI Game Programming Wisdom*.

Common “GAI” Techniques

- Path planning, obstacle avoidance
  - Tile-based graph (“grid navigation”)
  - Path Networks / Points of Visibility NavGraph
  - Expanded Geometry
  - NavMesh
- Decision making
  - Finite state machines
  - Trigger systems
  - Decision & Behavior trees
  - Rule-based systems
  - Planning
  - Reactive Planning
  - Blackboards
- Command hierarchies—strategic, tactical, individual combat
- Action prediction
- Search
  - Precompute: Dijkstra & Floyd-Warshall
  - Live: A*, Hierarchical A*, RTA*, RTA* + lookahead, D* lite
  - Large: Genetic Algorithms, MCTS, Hill Climbing, alpha-beta pruning, expectiminimax
- (Kinematic & Steering) Movement
  - Emergent behavior—flocking, crowds
  - Steering, Flocking, Formations
  - Terrain analysis—finding resource, ambush points
- Smart environ’s, Scripting, Trigger systems
- Designer intent
  - Dynamic difficulty adjustment
  - Drama management
- Procedural Content Generation
- Player Models: Robin, Bartle, Yee

Learning in GAI?

- Potential to (in principle)…
  - Adapt to each player
  - Provide consistent challenge
  - Produce more believable characters
  - Reduce effort to create game-specific AI
- In practice
  - Falls short, and not for want of trying
  - Hype more attractive than reality
  - Not widely used → **Reproducibility & QA**

- Advice: Be aware of the hype
  - Unpredictability motivates curbing learning ability
  - Often impossible to avoid learning "wrong" thing
  - Behavior might fulfill goals but make terrible gameplay
  - Cake/Eat: ↑ learning flexibility == ↓ control gameplay
  - Overfitting vs Generalization
- Sol'n: **Constrain** learning task (e.g. cover pts)
  - Problem decomposition (again!)

Communication in Decision Making?

- Lens: Multi-agent system
  - Collection of collaborative agents
  - Communicate & cooperate
  - Retain autonomy
  - Need for negotiation / mutually acceptable agreements (cooperative problem solving)
- Reasoning decomposition: distributed expertise
  - Problems too large for single / centralized agent
  - Reactive agents rarely communicate / collaborate
  - Problem independence, partial result sharing
- Hope: Sum greater than parts

- Distributed Decision Making:

1. Decompose the task
2. Allocate subtasks to “experts”
3. Await task accomplishment
4. Synthesize & Arbitrate results

Information sharing needed for most/all!

Design-time vs Run-time PCG?

- Design time: Speed up design of static content
  - # of unique objects in the world
  - Players expect non-repetitive
  - Game dev times now 100s of man-years with huge design teams
  - Cost savings big motivation
  - RISKS: quality (designer) control, stupidity, magic circle

- Run-time: customization, dynamic adjustment
  - Players are different: Preferences for pace + playstyle
    - Moderate challenge levels (e.g. help avoid getting stuck)
    - Adjust to play style
    - Detect/avoid player exploits
  - When to use run-time PCG
    - When decisions can only be made at run-time
    - When pre-compute exceeds storage/memory limits
    - Replayability; story/quest generation; pacing;
  - Optimization problem
    - What is the set of content that delivers the optimal experience to the player given individual differences?

Game AI By Genre

- FPS
  - Movement
  - Decision making
  - Perception
  - Pathfinding
  - Tactical AI (e.g. Halo)
  - Drama management (e.g. L4D)
- Driving Game
  - Movement & Steering Behaviors
  - Pathfinding
  - Tactics
- Sports
  - Physics (projectile) prediction
  - Playbooks and Content Creation
    - Formation movement
    - Expert knowledge
- RTS
  - Pathfinding
  - Group movement
  - Tactical & Strategic AI
  - Decision making
- Turn-based
  - Similar to RTS AI
  - Timing: AI at disadvantage
  - Player assistance
    - Automation of repetitive tasks
    - Automation of decision-making

Game Oscars: GAI Topics for last 4 years ?

- AI directors & Designer intent
- Planners (HTN and otherwise)
- Open-world systems
- Scale, large numbers active
- Prolonged interaction
- Persistent enemies
- PCG
- NPC personalities & memories
- AI with survival instinct
- Evolutionary algorithms
- Reinforcement learning
- Neural networks
- Interactive fiction
- Behavior Trees
- Smart worlds/objects
- Crowds
- Believable movement
- MCTS
- PCG
- Player models and dynamic difficulty

Takeaways

- Simplicity & speed
- Non-determinism (& random seed)
- Inform player about what is going on and why
- Hierarchies help
- Heuristics help
- Illusion of intelligence
- Search
- (Graphs & other) Models

- “Everything should be as simple as possible, but not simpler.” – Einstein
- Occam (of Razor fame – parsimony, economy, succinctness in logic/problem-solving)
  - “Entities should not be multiplied more than necessary”
  - “Of two competing theories or explanations, all other things being equal, the simpler one is to be preferred.”
- Mikhail Kalashnikov (of AK-47 fame)
  - “All that is complex is not useful. All that is useful is simple.”
- “Perfect is the enemy of good”
  - https://en.wikipedia.org/wiki/Perfect_is_the_enemy_of_good

Thank you! Candid feedback welcome (can do anonymously)