Game AI

CS 4730 – Computer Game Design

Some slides courtesy Tiffany Barnes, NCSU

The Loop of Life

- Games are driven by a game loop that performs a series of tasks every frame
- Some games have separate loops for the front and and the game itself
- Other games have a unified main loop

The Game Loop

- Tasks
  - Handling time
  - Gathering player input
  - Networking
  - Simulation
  - Collision detection and response
  - Object updates
  - Rendering
  - Other miscellaneous tasks

The Game Loop

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  - **Simulation**
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  - Rendering
  - Other miscellaneous tasks

What all do you have to simulate?

- Physics
- Environments
- Lighting
- Sounds
- Behaviors

Some Terms To Know

- AI: Artificial Intelligence – does not have to mean perfect human-like intelligence!
- Turing Test: Can a normal user tell the difference between interacting with a computer and a person
- NPC: Non-Player Character – any thing in the world that needs to be modeled, can make decisions, and can potentially have player interaction

Discussion

- How good should the AI be?

Discussion

- Are people more fun than NPCs? Why?

AI vs. Game AI

- Modern AI research is more in genetic algorithms and neural networks
- This isn't really an option for game AI (right now)
  - We value efficiency over complexity
  - Too much other stuff to do in the game loop!
  - AI for us just has to be "good enough" to be fun
- We will look at three main AI roles:
  - State-based behavior, planning/strat, pathfinding

What Makes "Good AI"?

- Perceived by user as challenging
  - Cruel, but fair!
- User is surprised by the game
  - but later understands why
- Feeling that reality will provide answers
  - able to make progress solving problem
- What games have used AI effectively?

The Bar To Reach

- Have you failed in your attempt to create a game if your NPCs can't pass the Turing Test?
- NO! Of course not!
- Sometimes NPCs can pass the Turing Test in very specific circumstances
  - Computer chess player
- Sometimes NPCs will never pass the Turing Test and we're okay with that!
  - Koopa Troopas in Super Mario Bros. 3

"Good Enough"

- Your AI needs to be "good enough for the player to be challenged…"
- And "bad enough for the player to have fun…"
- Games are often played to escape from reality
- Playing against an AI that's "too good" is incredibly frustrating
- Imagine a computer player of Othello or Scrabble that ONLY took optimal moves

The AI Loop

- Given the changes to the environment, what should the NPC do?
- Cognition of the NPC
  - Perception (processing the state of the environment) or “Sense”
  - Decision making (decide what to do based on perception) or “Plan”
  - Control (update NPC one time step) or “Act”

Perception

- The NPC's estimation of game-related information
- Includes perceived strategies of PCs
- Identifies most important factors for the NPC to respond to
- Think of it as the NPCs "attention span"

Decision Making

- Determining a course of action for this time step for this particular state of the game
- Usually requires a trade off between accuracy of the decision and speed of computation
- Computer COULD simulate out several steps to make a "better" decision, but at a cost of speed and potentially "fun"

Control

- Adjusting the appropriate variables of the NPC to carry out the decision made
  - Steering or throttle in a racing game
  - Crouching or taking a shot in an FPS
  - Using a potion or casting a spell in an RPG

The Sum Of The Parts

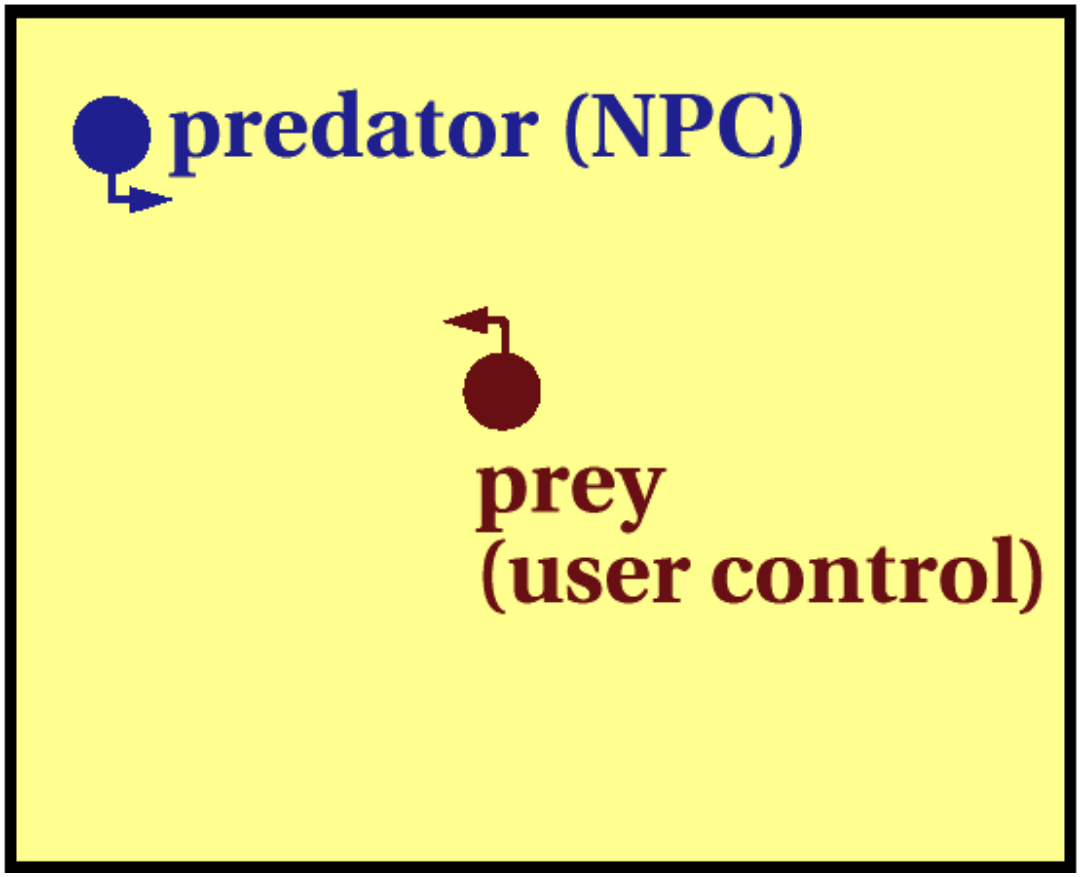
- The sum of all these parts makes up the AI of an NPC
- It can be incredibly complex
  - Large fight in a tactical shooter
- It can be pattern based
  - Behaviors of a sentry in Metal Gear Solid
  - Behaviors of any boxer in Punch Out
- It can be … well, stupid
  - Goombas or Koopas in Super Mario Bros. 3

Pong AI

- What is the challenge in creating the AI for Pong?

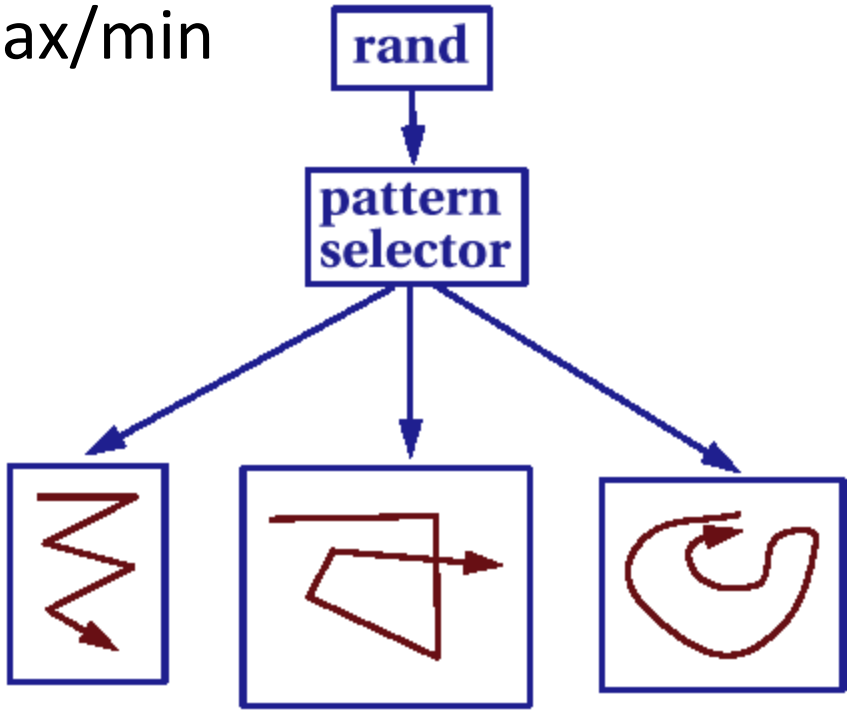
Chase/Evade

- Consider a very simple AI task
- Algorithm for the predator?



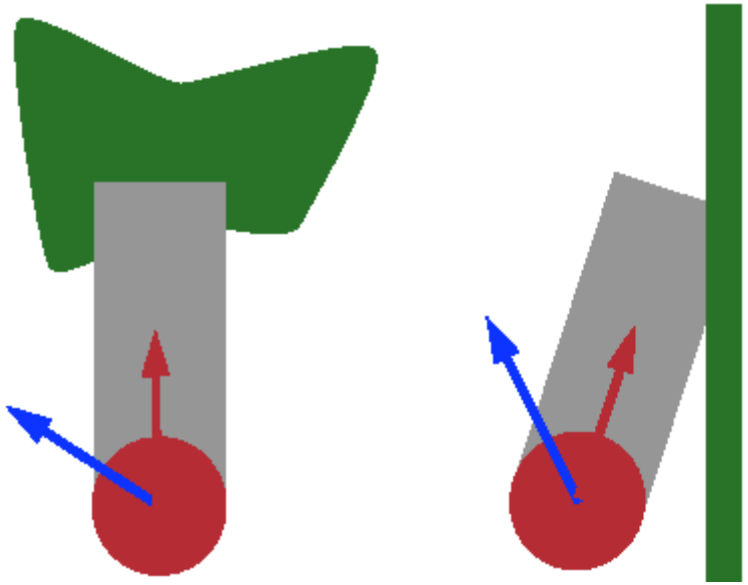
Enhancements to Chase

- Speed Control
  - Velocity, Acceleration max/min
  - Limited turning Radius
- Randomness
  - Moves
  - Patterns



Steering Behaviors

- Pursue
- Evade
- Wander
- Obstacle Avoidance
- Wall/Path following
- Queuing
- Combine behaviors with weights
- What could go wrong?



AI Strategies

- Reaction vs. Deliberation
- When having the NPC make a decision, how much thought goes into the next move?
- How is the AI different in:
  - Frozen Synapse
  - Kingdom Hearts
  - Civilization
  - Halo

AI Strategies

- Reaction-Based
  - Fast, but limited capabilities
- Implementations
  - Finite-State Machines
  - Rule-Based Systems
  - Set Pattern

AI Strategies

- Deliberation-Based
  - Much slower, but more adaptable
- Implementations
  - A* / Dijkstra
  - Roadmaps
  - Genetic Algorithms

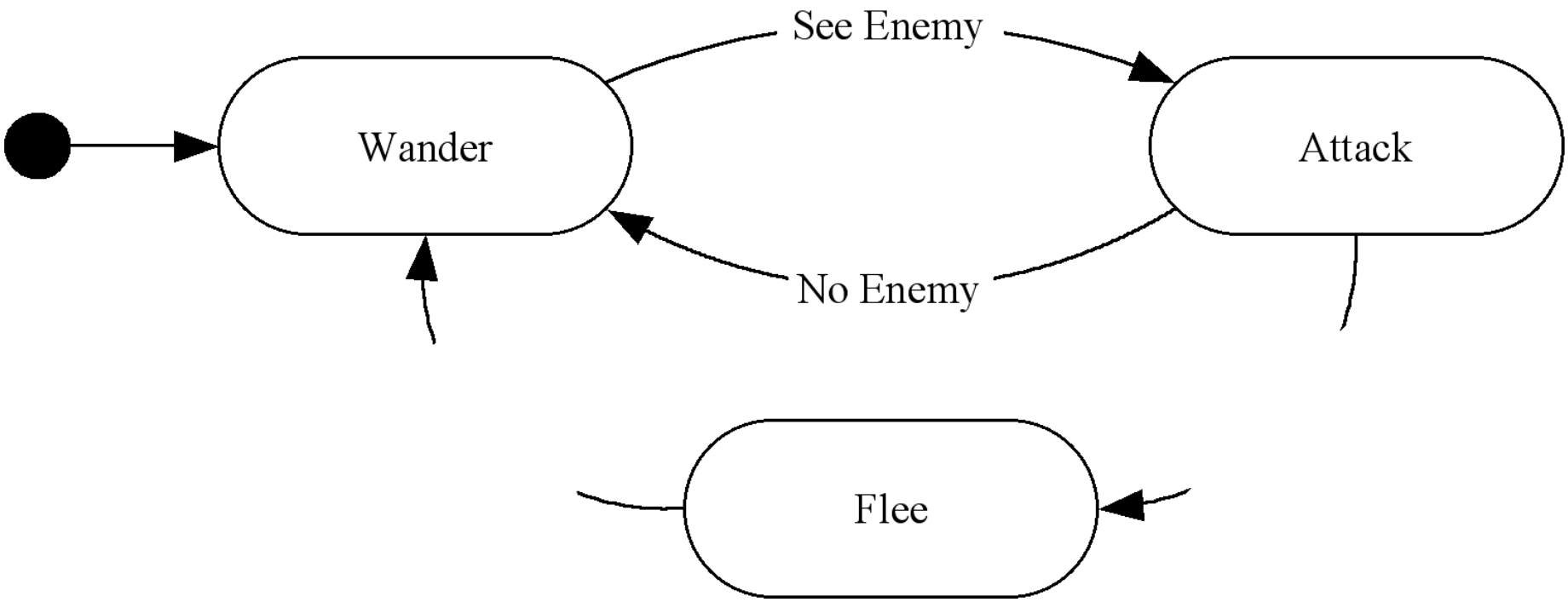
Set Pattern

- Describe the AI behavior of a Koopa Troopa
  - Or any other bad guy from SMB3

Finite-State Machines

- An abstract construct for determining the behavior of an NPC
- Any given behavior state is represented along with rules for transitioning between states
- The standard bad guys in Metal Gear Solid are excellent examples of this

Switch FSM



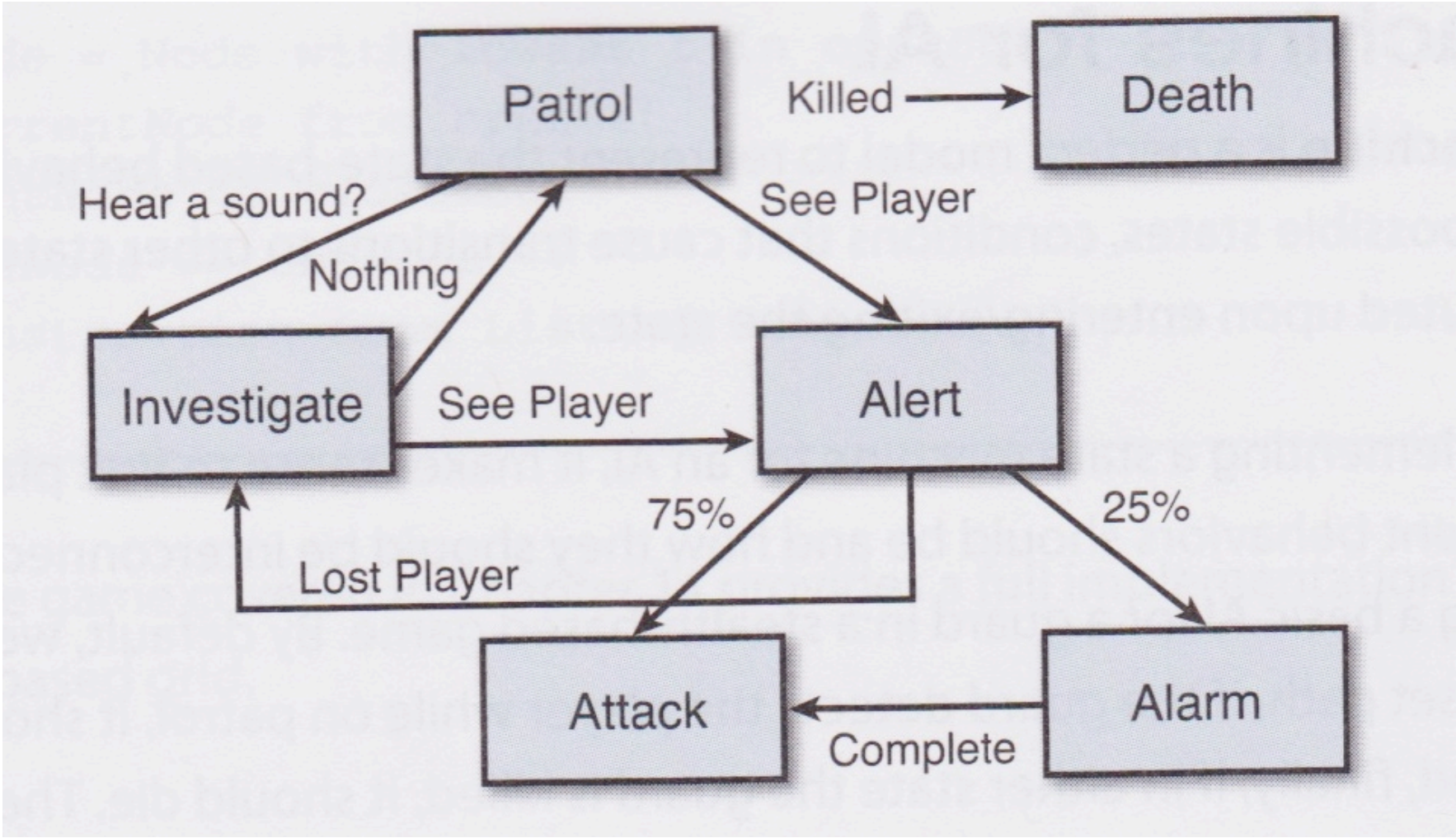
Switch FSM

```
void RunLogic( int * state ) {
    switch( state )
    {
        case 0:  //Wander
            Wander();
            if( SeeEnemy() )     { *state = 1; }
            break;

        case 1:  //Attack
            Attack();
            if( LowOnHealth() ) { *state = 2; }
            if( NoEnemy() )      { *state = 0; }
            break;

        case 2:  //Flee
            Flee();
            if( NoEnemy() )      { *state = 0; }
            break;
    }
}
```

Switch FSM

- Within each state can be more complex AI
- In Metal Gear Solid, when an enemy sees you, they follow you as long as you are “discovered”
- When the discovery period expires, the enemies return to their previous state, which is set pattern

More Advanced FSM



Problems with State Machines

- Too Predictable
  - Sometimes a good thing, sometimes not
- Limited
  - Can have a very small set of options available at any one time

Probabilistic FSMs

- We can change the personality of an NPC by adjusting the state probabilities

	Aggressive	Passive
Attack	50%	5%
Evade	5%	60%
Random	10%	10%
Flock	20%	20%
Pattern	15%	5%

Probabilistic FSMs

- Other aspects:
  - Sight
  - Memory
  - Curiosity
  - Fear
  - Anger
  - Sadness
  - Sociability
- Modify probabilities on the fly?

Goal Based

- The NPC has a central goal to achieve and a set of operations it can use
- It will selectively choose an operation based on which will get it closer to the goal at that moment
- Goal could be nearly anything
  - A particular score
  - Health of the PC