Adaptive Behavior for Fighting Game Characters

May 24, 2005

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Outline

- Motivation and Goal
- Requirements
- Game Architecture
- AI System
  - The Three Layers
  - The Two AI Model Types
- Conclusion and Future Work
- Demo *Alpha Fighter*

Motivation: Why Games?

- Games are relevant financially
  - Huge industry rivaling film industry
- Games are relevant academically
  - It's difficult!
    - Games are large projects
    - Games cover a wide area of CS
      - Graphics, AI, Physics, S/W Engineering, UI
    - Games must run in real-time

Motivation: Why Game AI?

- Common game AI techniques[3]:
  - FSMs, decision trees, A* path-finding
  - Developer defines all behavior
  - Leads to a static world
- Promising game AI techniques[4]:
  - Neural networks, genetic algorithms, etc.
  - Next step = machine learning
  - Developer defines rules
  - Emergent behavior, adaptation, dynamic world

Goal: 3D Fighting Game

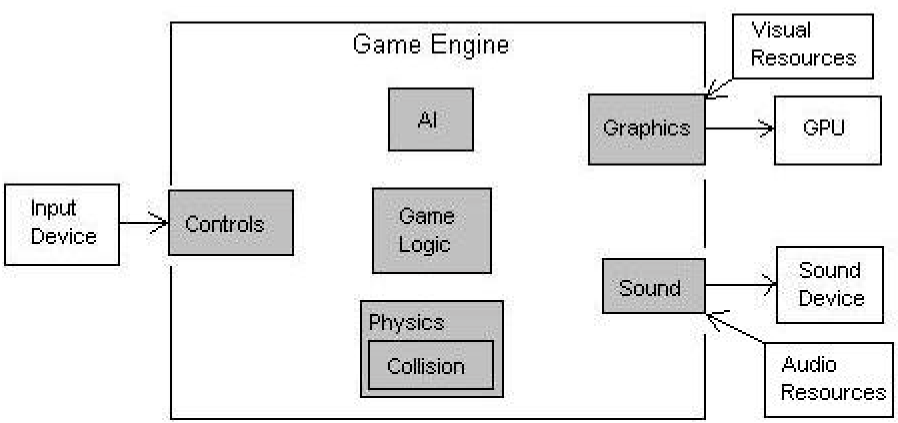
Alpha Fighter

Requirements

- Very simple game mechanics
  - Two playable characters
  - Simple and small set of fighting moves
  - Goal is just to beat your opponent
- Provides context to showcase adaptive AI
  - Non-player character (NPC) adapts to player
  - Provide extensibility

Game Architecture: Major Modules

- AI
- Physics
- Game logic
- Graphics
- Sound
- Controls

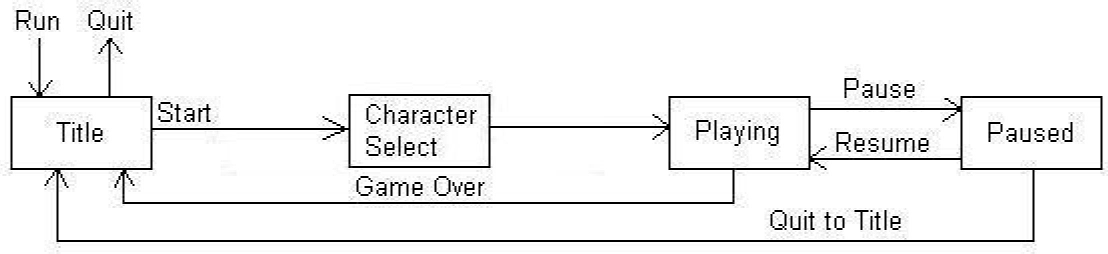


Game Architecture: Graphics, Sound, Controls

- Graphics: Direct3D
  - CGraphics class, CThing::render()
- Sound: DirectMusic and DirectSound
  - playSound(), playMusic()
- Controls: DirectInput
  - keyPressed(), keySingle(), etc.
  - processInput()

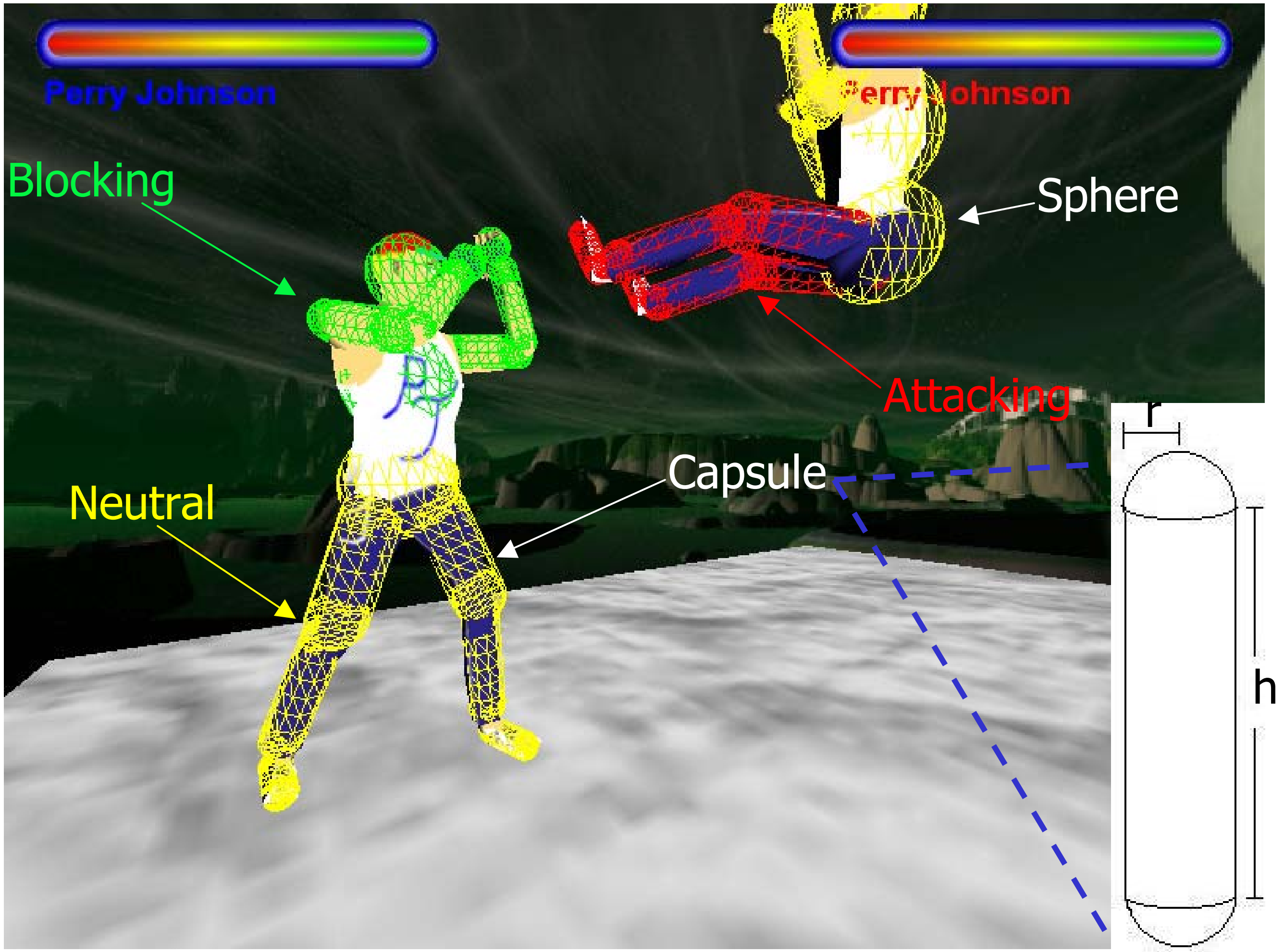
Game Architecture: Game Logic, Physics

- Game Flow

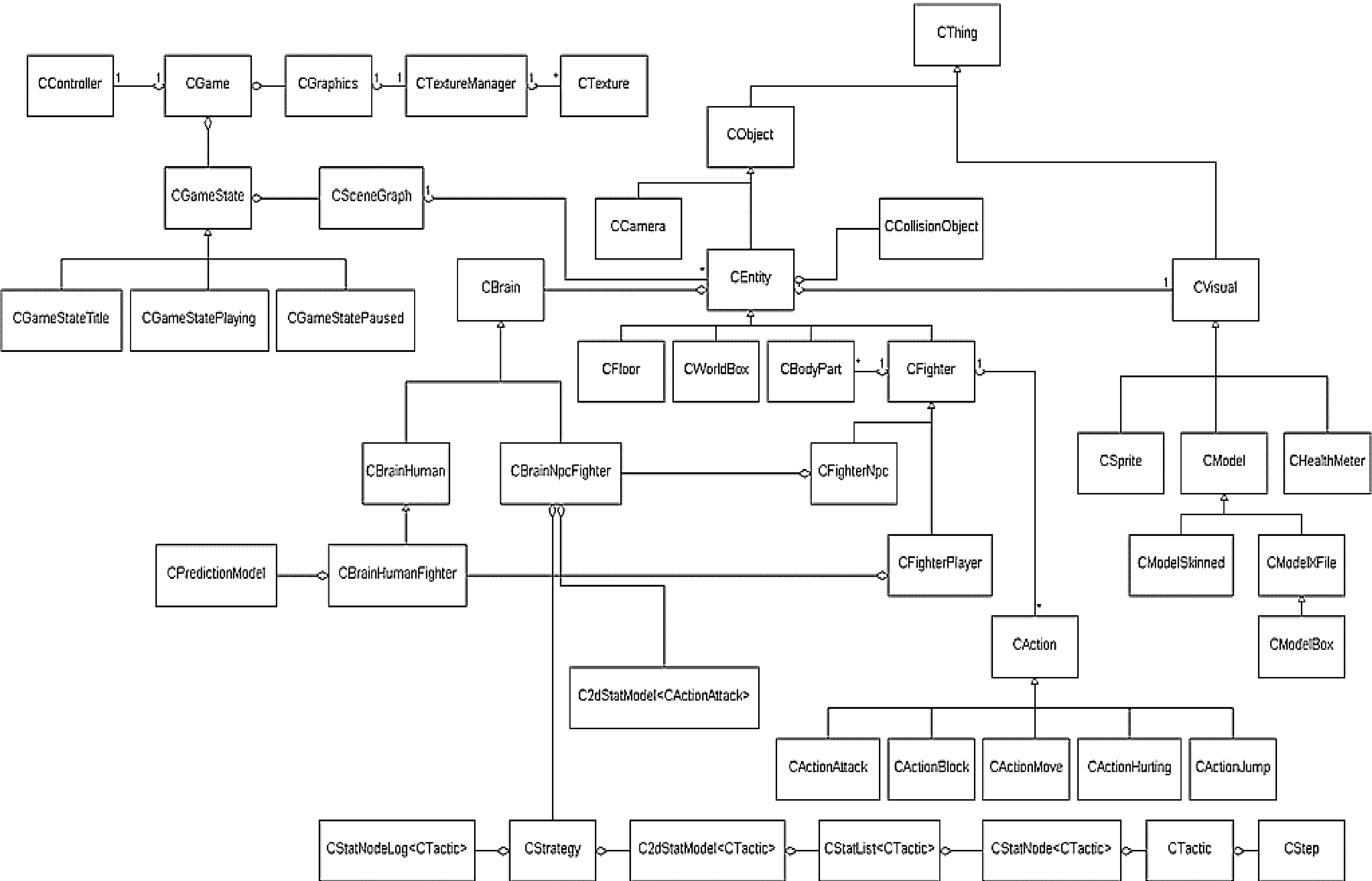


- Physics
  - Simple kinematics (pos, vel, acc)
  - Collision detection – spheres & capsules
  - Collision reaction – body part state

Game Architecture: Collision Detection/Reaction



UML Class Diagram

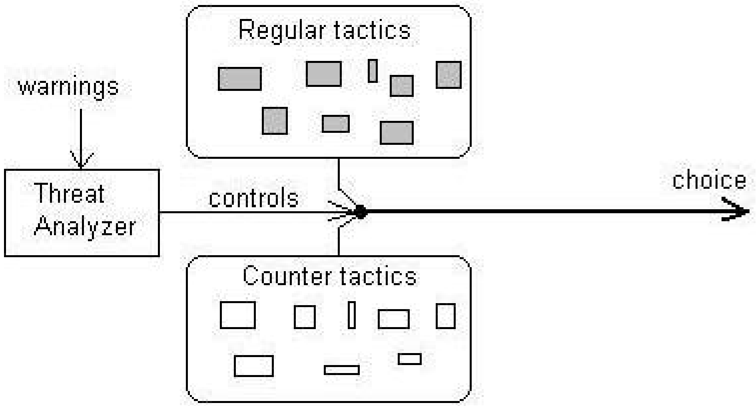


Game AI: The Three Layers[2]

- Strategic Layer
  - Choose attack set or defense set
- Tactical Layer
  - Choose a tactic from set decided above
- Operational Layer
  - Execute the tactic

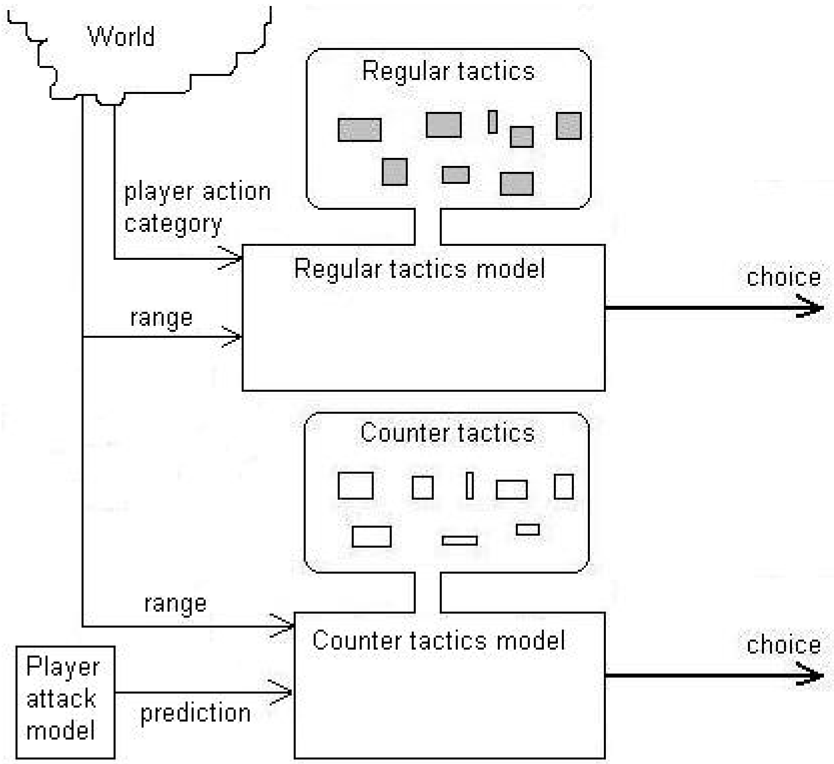
Game AI: Strategic Layer

- The only non-adaptive layer
- Normally offensive(regular tactics)
- Defense(counter) when “see” attack coming.
  - NPC does not know **which** attack it is.
  - Mimic reactionary behavior of human player.



Game AI: Tactical Layer

- AI models choose tactic from given set
- Based on a Matrix of Production Sets (described later)
- Note each takes two inputs as indices into the matrix



Game AI: Tactical Layer

- A Tactic is a sequence of Steps

- **Ex 1: Move within kicking range and attack**
- BEGIN_TACTIC Long_Attack 0(regular) 1(init points)
- MoveWithinRange 1(kicking)
- Attack
- END_TACTIC

- **Ex 2: Block for at most 2 seconds then attack**
- BEGIN_TACTIC Block_2_Attack 1(counter) 1
- Block 2 (max seconds, or until attacked)
- Attack
- END_TACTIC

Game AI: Operational Layer

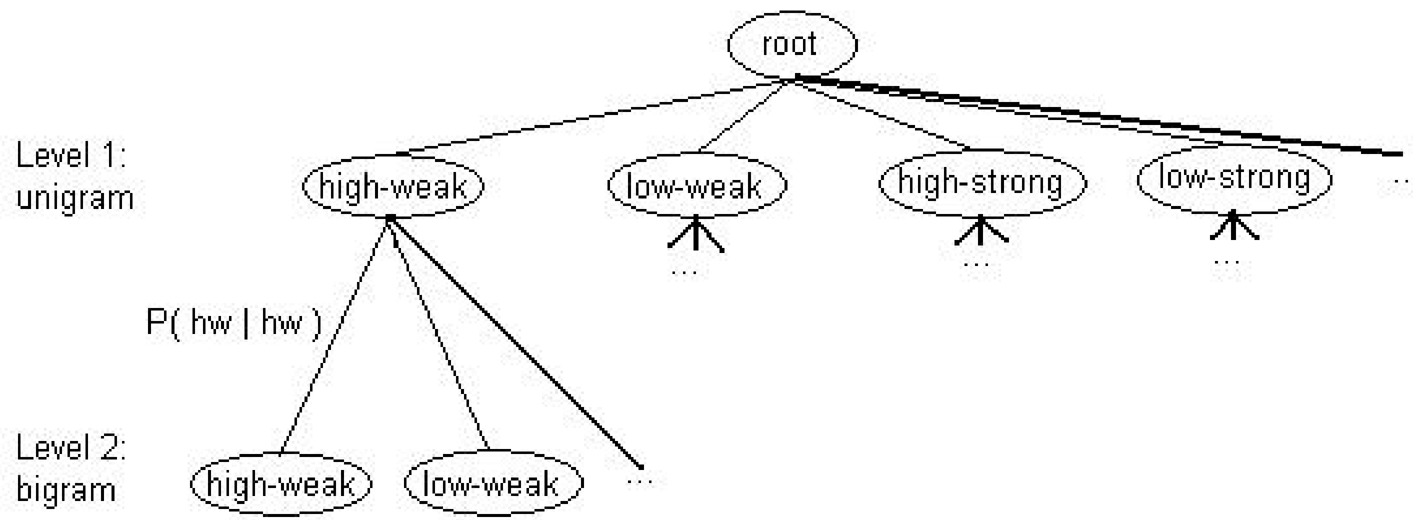
- Carries out details of a Step
  - Attack – Which attack to use?
    - Based on NPC Attack AI Model
  - Block – Block high or low?
    - Based on Player Attack AI Model
  - MoveWithinRange – How?
    - Based on simple conditional logic

Game AI: The Two Model Types

- HMM Tree Array
  - Used by Player Attack Model
  - Used for prediction
- Matrix of Sets
  - Used by Regular Tactics Model, Counter Tactics Model, and NPC Attack Model
  - Used for production

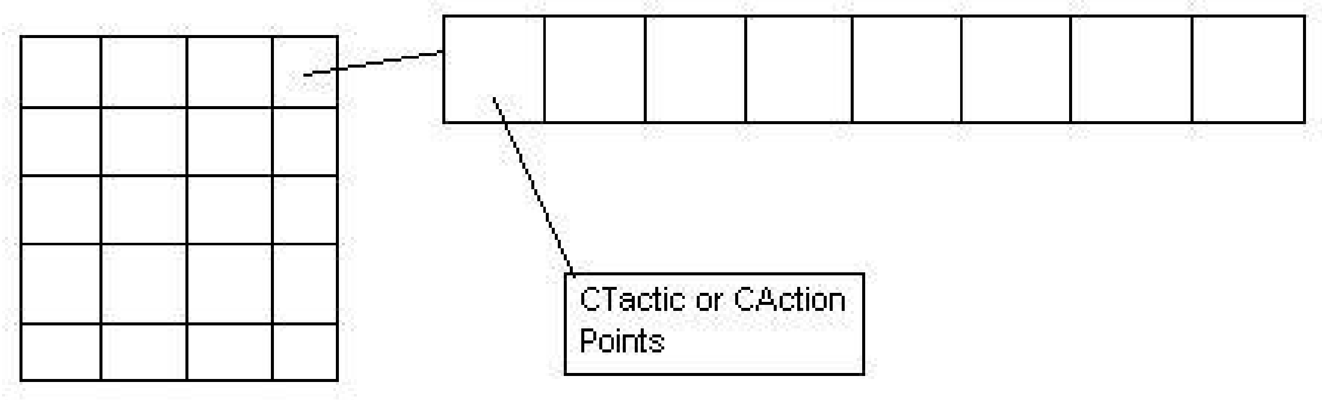
Game AI: HMM Tree Array[1]

- Level i contains n-gram of degree i.
- To predict: traverse to level n – 1 and pick most probable child.
- To learn: traverse to node at level n and add points.



Game AI: Matrix of Sets

- To produce (probabilistic production):
  - Find the set.
  - Pick random number r [0,sum of points in set].
  - Iterate through set until sum of points >= r.



Game AI: Matrix of Sets

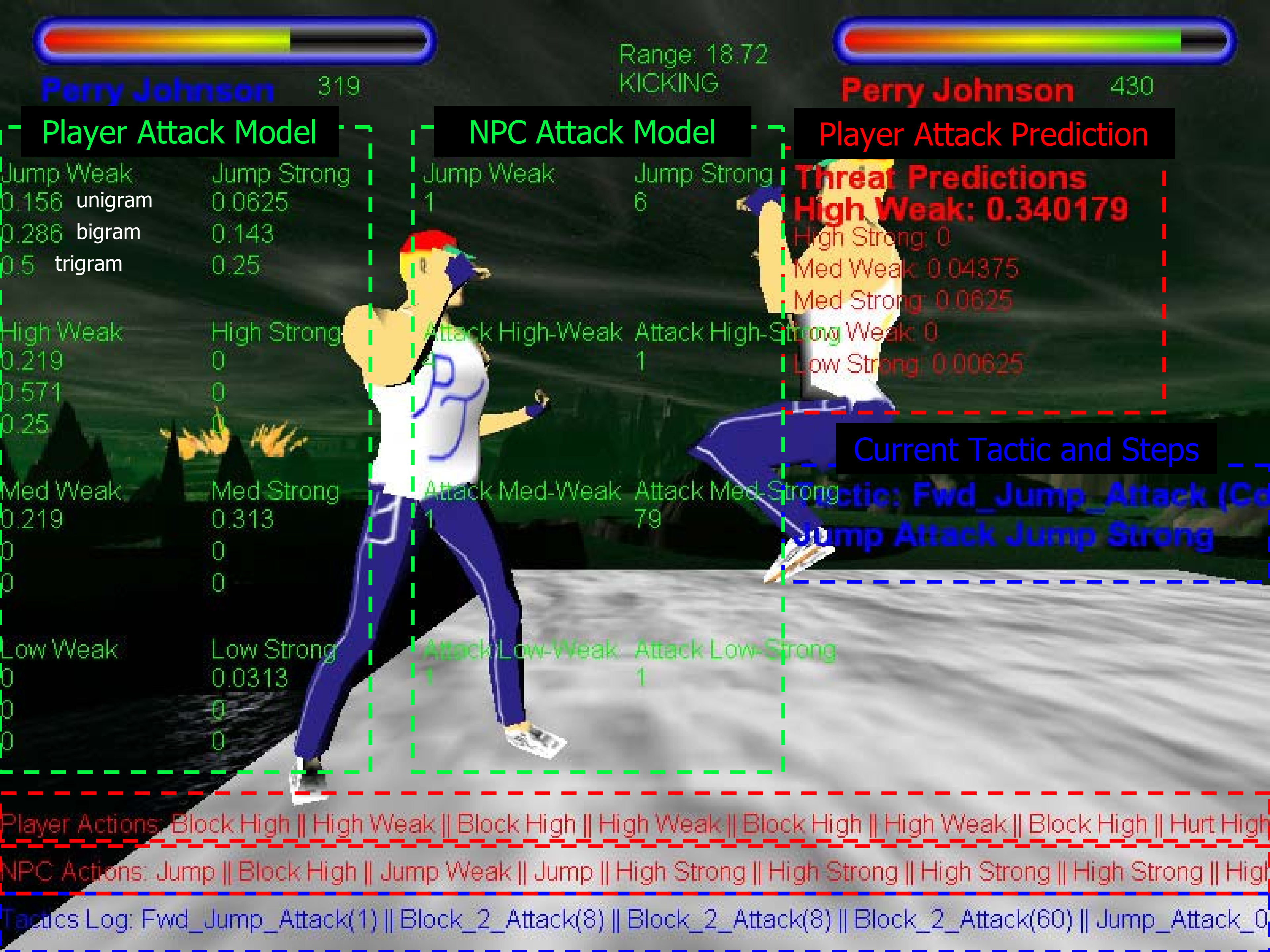
- To learn (reinforcement with discount):
  - Logs are kept of recent tactics/actions
  - On a reinforcing event:
    - (1) Adjust points of newest logged element by x
    - (2) Discount x by discount factor
    - (3) If x != 0 and more in log repeat (1) with next
    - Note points are integers so x != 0 makes sense.

Initial amount = -8
Falloff factor = 0.5

current	Tactic A	Tactic B	Tactic C	Tactic A	Tactic D	Tactic B	oldest
	-8	-4	-2	-1	0	0	

Game AI: Reinforcing Events

Event	*Reinforcement*
NPC hurts player	+ +
Player misses NPC	+
NPC misses player	–
Player hurts NPC	– –


Perry Johnson 319
Range: 18.72
KICKING
Perry Johnson 430
Player Attack Model
NPC Attack Model
Player Attack Prediction
Jump Weak
0.156 unigram
0.286 bigram
0.5 trigram
Jump Strong
0.0625
0.143
0.25
High Weak
0.219
0.571
0.25
High Strong
0
0
Med Weak
0.219
0
0
Med Strong
0.313
0
0
Low Weak
0
0
0
Low Strong
0.0313
0
0
Jump Weak
1
Jump Strong
6
Attack High-Weak
Attack High-Strong
1
Attack Med-Weak
1
Attack Med-Strong
79
Attack Low-Weak
1
Attack Low-Strong
1
Threat Predictions
High Weak: 0.340179
High Strong: 0
Med Weak: 0.04375
Med Strong: 0.0625
Low Strong: 0.00625
Current Tactic and Steps
Tactic: Fwd_Jump_Attack (Co
Jump Attack Jump Strong
Player Actions: Block High || High Weak || Block High || High Weak || Block High || High Weak || Block High || Hurt High
NPC Actions: Jump || Block High || Jump Weak || Jump || High Strong || High Strong || High Strong || High Strong || High
Tactics Log: Fwd_Jump_Attack(1) || Block_2_Attack(8) || Block_2_Attack(8) || Block_2_Attack(60) || Jump_Attack_0

References

[1] CHARNIAK, E. 1996. *Statistical Language Learning.* MIT Press, Cambridge, MA.

[2] KAUKORANTA, T., SMED, J., AND HAKONEN, H. 2004. Understanding pattern recognition methods. In *AI Game Programming Wisdom 2*, S. RABIN, Ed. Charles River Media, Hingham, MA, 579-589.

[3] RABIN, S. 2004. Common game AI techniques. In *AI Game Programming Wisdom 2*, S. RABIN, Ed. Charles River Media, Hingham, MA, 3-24.

[4] RABIN, S. 2004. Promising game AI techniques. In *AI Game Programming Wisdom 2*, S. RABIN, Ed. Charles River Media, Hingham, MA, 15-27.