

Artificial Intelligence Part II

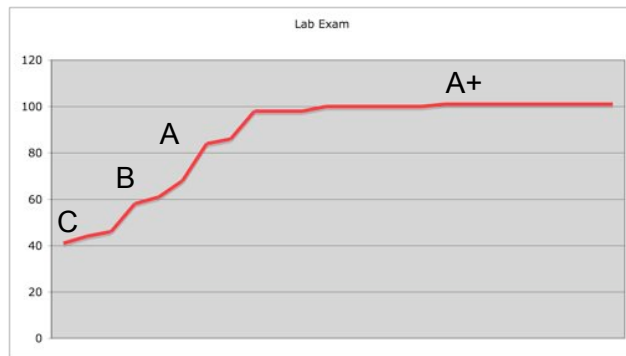
CMPUT 299
Winter 2006
March 2, 2006

Lecture Overview

- Lab Exam
- Pizza!
- Summary (Tuesday)
- Pathfinding
- Finite State Machines

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Lab Exam Scores



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Pizza!

- Get together with last semesters students
 - Advice session for project
- Next Tuesday (March 7)
- CSC 333, 5:00 pm
- RSVP to Nathan

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Algorithm

- A detailed set of actions to perform or accomplish some task
- Evaluate game algorithms according to:
 1. Does it meet our time constraints?
 2. Does it meet our memory constraints?
 3. Does it solve the task at hand?
 4. Does it do so in an acceptable/realistic manner?

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Describing Algorithms

- Three components to describing an algorithm
 - Actions
 - States
 - Transitions

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Finite State Machines (FSM)

- An algorithm for applying actions in states
- A computer can be described as a FSM
- Simple, but powerful

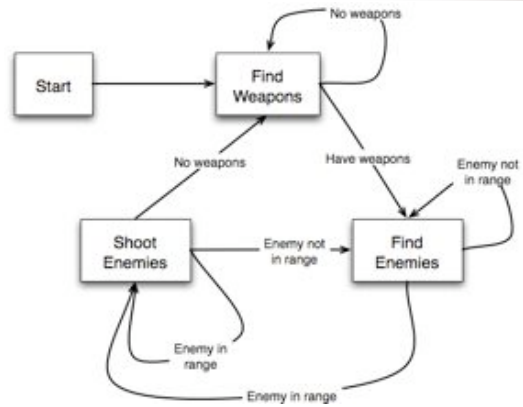
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FSM Example

- Simple first person shooter (FPS) state:
 - Do I have a weapon?
 - Am I near an enemy?
- FPS Actions
 - Find weapons
 - Find enemies
 - Shoot enemies

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Finite State Machine



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Exercise

- Trogdor - control knights
 - What are the actions?
 - What are the states?

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FSM Pros and Cons

- Pros:
 - How much time does it take to run a FSM?
 - How much memory does a FSM use?
 - Very simple to implement
- Cons
 - May be difficult to reproduce complex behavior
 - May be too predictable

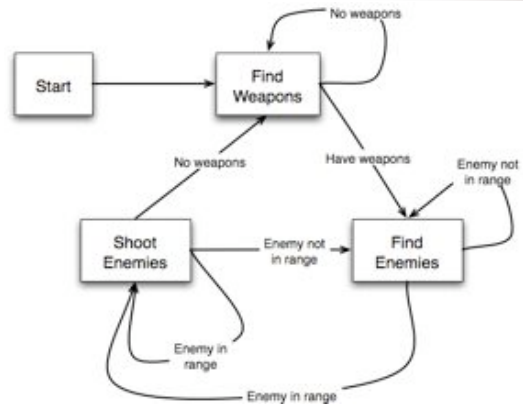
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Finite State Machines

- Can be built in two ways
 - Boxes are states or actions

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FSM 1



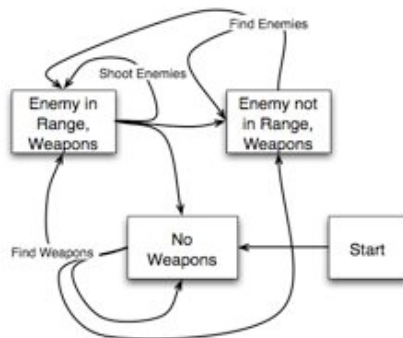
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Possible states

- Weapons / Enemies
 - Have Weapons, Near Enemies
 - Have Weapons, No Enemies
 - No Weapons, Near Enemies
 - No Weapons, No Enemies

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FSM 2



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Pacman



Pacman ghosts

- How are pacman ghosts controlled?

Simple Task Complexity

- How many paths are there through a grid?
 - Start at one corner
 - Travel to the other corner
 - How many possible paths are there?
- Actions, states, transitions?

2x2 Grid

	Goal
Start	

3x3 Grid

		Goal
Start		

4x4 Grid

			Goal
Start			

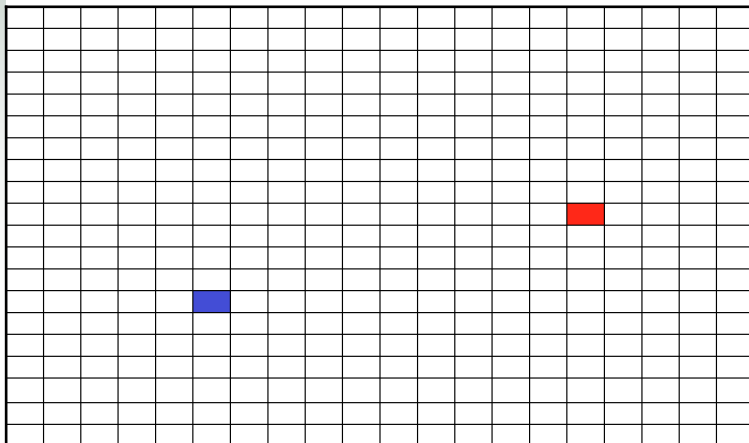
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How many paths?

Grid Size	# of paths
2x2	2
3x3	6
4x4	20
5x5	70
6x6	252
7x7	924
8x8	3432

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Pathfinding



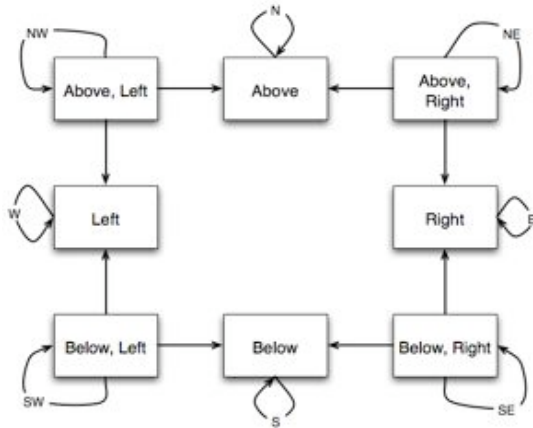
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FSM for grid problem

- What FSM can we use for grid pathfinding?
 - Actions:
 - N, S, E, W, NE, NW, SE, SW
 - States: (Goal Location)
 - Above (+ left/right)
 - Below (+ left/right)
 - Right
 - Left

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Pathfinding FSM



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Pathfinding

- Pathfinding is a global problem
 - Need global knowledge of the world to make correct choices
 - Easy for our visual systems to see this global information
- New approach
 - *Search algorithm*

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Grid-Based Pathfinding

- Given a start and goal in a grid
 - Compute all 1-step moves
 - Label with cost
 - Compute 2-step moves
 - Label with cost
 - Continue until goal is reached

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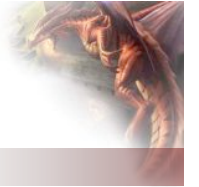
				Goal
Start				

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				Goal
1				
Start	1			

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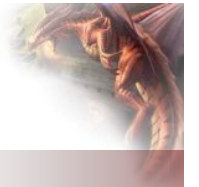
				Goal
2				
1	2			
Start	1	2		

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				Goal
3				
2	3			
1	2	3		
Start	1	2	3	

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4				Goal
3	4			
2	3	4		
1	2	3	4	
Start	1	2	3	4

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4	5			Goal
3	4	5		
2	3	4	5	
1	2	3	4	5
Start	1	2	3	4

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4	5	6		Goal
3	4	5	6	
2	3	4	5	6
1	2	3	4	5
Start	1	2	3	4

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4	5	6	7	Goal
3	4	5	6	7
2	3	4	5	6
1	2	3	4	5
Start	1	2	3	4

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Pathfinding

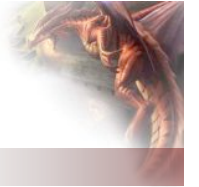
- Compute the cost to all locations
 - Time? Memory?
 - $\pi \cdot r^2$
 - Solves the problem
 - Will find the shortest path
- *Breadth-First Search*

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				Goal
	[Obstacle]			
			[Obstacle]	
Start				

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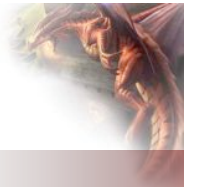
				Goal
	[Obstacle]			
1			[Obstacle]	
Start	1			

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				Goal
	[Obstacle]			
2				
1	2		[Obstacle]	
Start	1	2		

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				Goal
3	[Obstacle]			
2	3		[Obstacle]	
1	2	3		
Start	1	2	3	

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4				Goal
3				
2	3	4		
1	2	3		
Start	1	2	3	4

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4	5			Goal
3				
2	3	4		
1	2	3		5
Start	1	2	3	4

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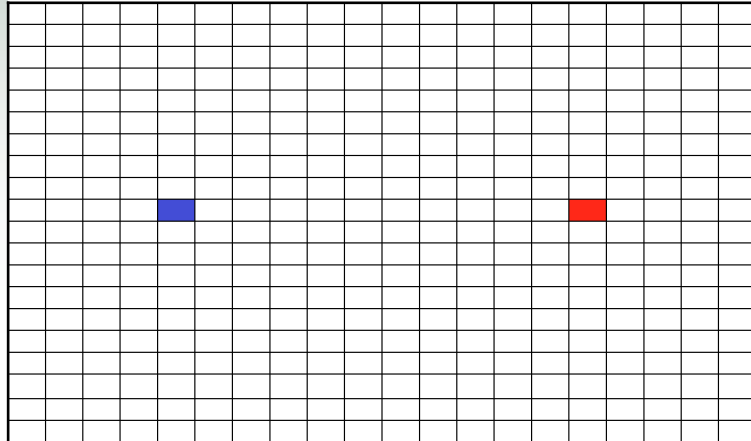
4	5	6		Goal
3				
2	3	4		6
1	2	3		5
Start	1	2	3	4

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4	5	6	7	Goal
3				7
2	3	4		6
1	2	3		5
Start	1	2	3	4

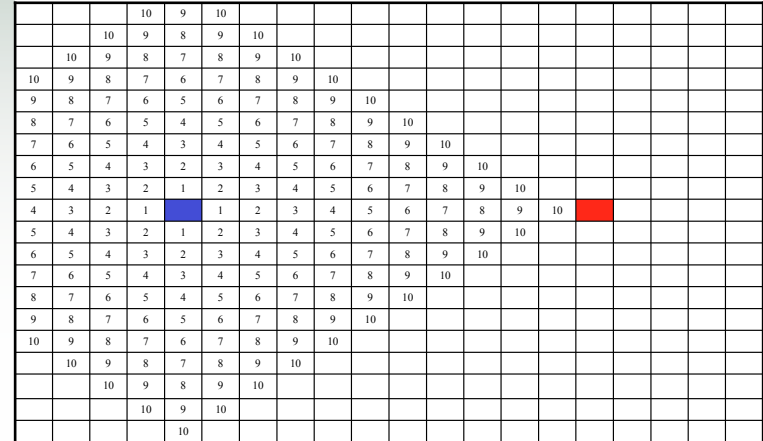
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What about...



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What about...



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Pathfinding

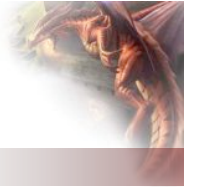
- In some cases we do much more work than the simpler algorithm
 - Avoid this by improving our algorithm
 - Consider the distance to the goal
 - Assuming no obstacles in the world

4	3	2	1	Goal
5	4	3	2	1
6	5	4	3	2
7	6	5	4	3
Start	7	6	5	4



4	3	2	1	Goal
5	4	3	2	1
6	5	4	3	2
7	6	5	4	3
Start	1+7	6	5	4

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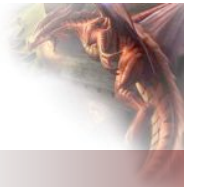
4	3	2	1	Goal
5	4	3	2	1
6	5	4	3	2
7	2+6	5	4	3
Start	1+7	6	5	4

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4	3	2	1	Goal
5	4	3	2	1
6	3+5	4	3	2
7	2+6	5	4	3
Start	1+7	6	5	4

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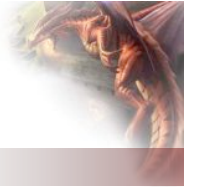
4	3	2	1	Goal
5	4	3	2	1
6	3+5	4+4	3	2
7	2+6	5	4	3
Start	1+7	6	5	4

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4	3	2	1	Goal
5	4	3	2	1
6	3+5	4+4	5+3	2
7	2+6	5	4	3
Start	1+7	6	5	4

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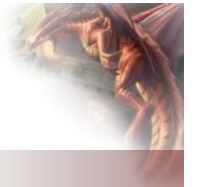
4	3	2	1	Goal
5	4	3	6+2	1
6	3+5	4+4	5+3	2
7	2+6	5	4	3
Start	1+7	6	5	4

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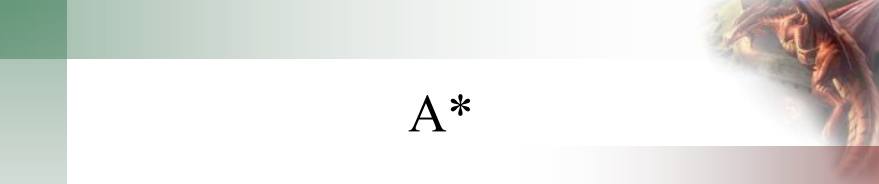
4	3	2	1	Goal
5	4	3	6+2	7+1
6	3+5	4+4	5+3	2
7	2+6	5	4	3
Start	1+7	6	5	4

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4	3	2	1	Goal
5	4	3	6+2	7+1
6	3+5	4+4	5+3	2
7	2+6	5	4	3
Start	1+7	6	5	4

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A*

- Standard game pathfinding algorithm is A*
 - Combines actual costs with cost estimates
 - In easy cases behaves the same as simple FSM
 - In complicated cases still finds optimal paths
- Many extensions by AI researchers
 - IDA*, SMA*, D*, HPA*, PRA* ...