IMGD 3000 - Technical Game Development I: Path-finding AI in Games

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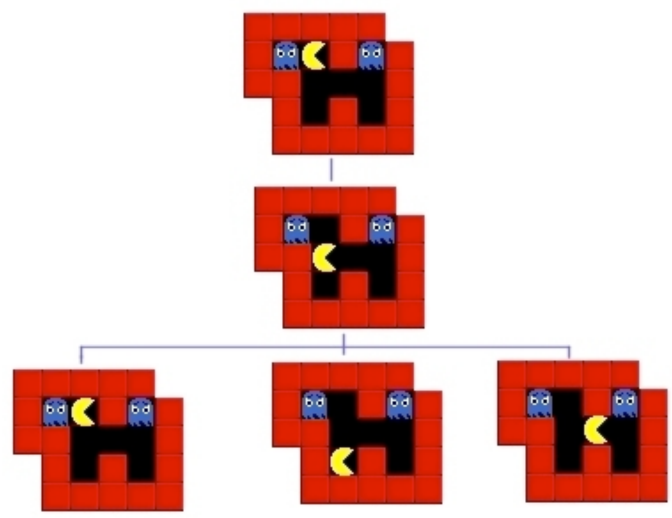
Motivation

- Path-finding
  - A common thing we want to do with NPCs
- But, what is it?
  - Given a start position/state, find a "good" path to a goal position/state
  - Could be a walking/flying path
  - Could be a solution sequence for a puzzle
- Examples
  - Find a path from one place to another, avoiding obstacles
  - Solve an "Eight-Piece" puzzle

A* Algorithm High-Level

- Given:
  - Start state
  - Goal state
  - List of candidate states (nodes): OPEN
  - List of nodes we have tried: CLOSED
- Visit each successor
  - Compute the cost
  - Estimate distance to goal
  - Update cost based on current path



Estimating Cost: F = G + H

- We assign to each node
  - G: the movement cost to get from start to here
  - H: the estimated cost to get from here to goal
  - F: the sum of G and H
- We sort OPEN by lower F value
  - Explore "cheaper" possibilities first
- Choosing a good ***heuristic*** for H is important

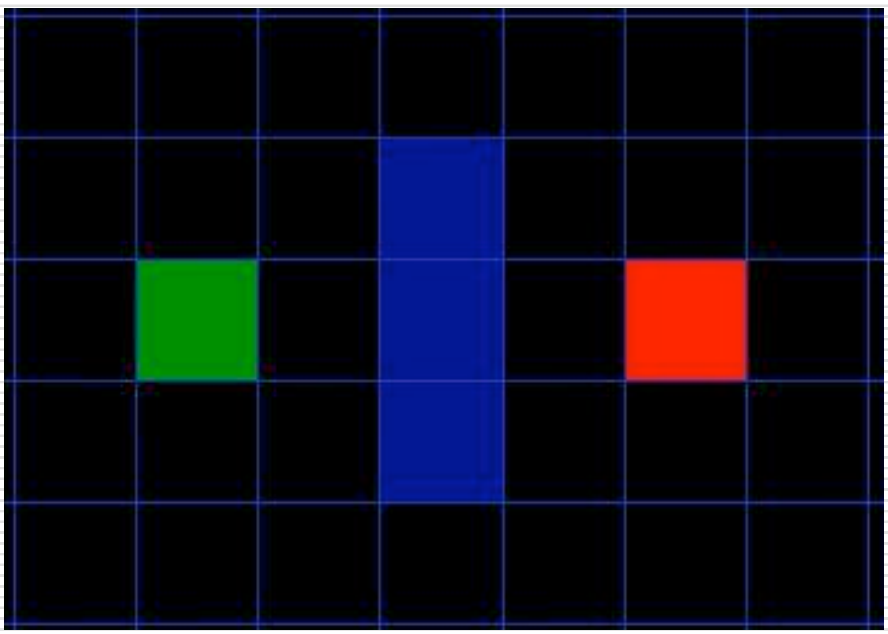
A* Algorithm Pseudocode

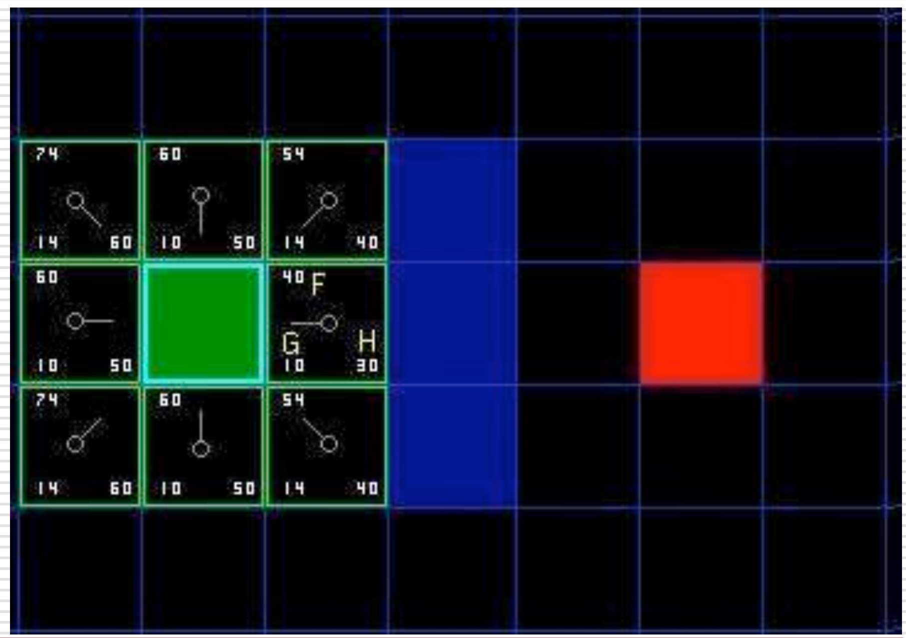
```
Create a node containing the goal state node_goal
Create a node containing the start state node_start
Put node_start on the OPEN list
while the OPEN list is not empty  {
   Get the node off the OPEN list with the lowest f and call it node_cur
   if node_cur is the same state as node_goal // We have found the solution!
       break from the while loop
   Generate each state node_succ that can come after node_cur
   for each node_succ of node_cur  {
       Set the cost of node_succ to be the cost of node_cur plus the cost to get to node_succ from node_cur
       find node_succ on the OPEN list
       if node_succ is on the OPEN list but the existing one is as good or better
           discard this successor and continue // Other path to node_succ is better.
       if node_succ is on the CLOSED list but the existing one is as good or better
           discard this successor and continue  // Other path to node_succ is better
       Remove occurrences of node_succ from OPEN and CLOSED
       Set the parent of node_succ to node_cur
       Set h to be the estimated distance to node_goal // Using the heuristic function
       Add node_succ to the OPEN list // We'll check this later
   }
   Add node_cur to the CLOSED list  // We're done processing this node
}
```

A* Algorithm Dissection

- Green: Start
- Red: Goal
- Blue: Barrier

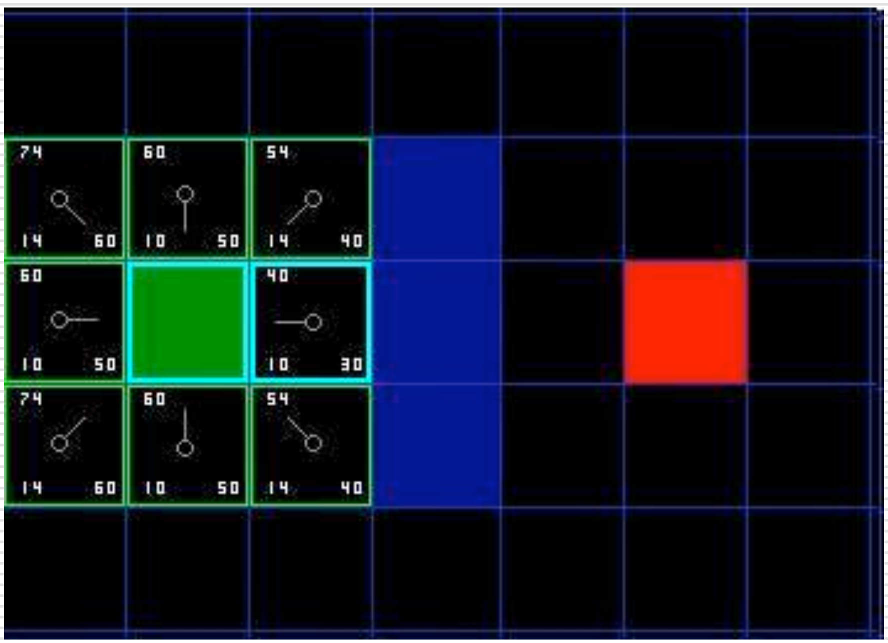
- G: 10 vert/horiz,
  14 diag.
- H: Manhattan distance * 10

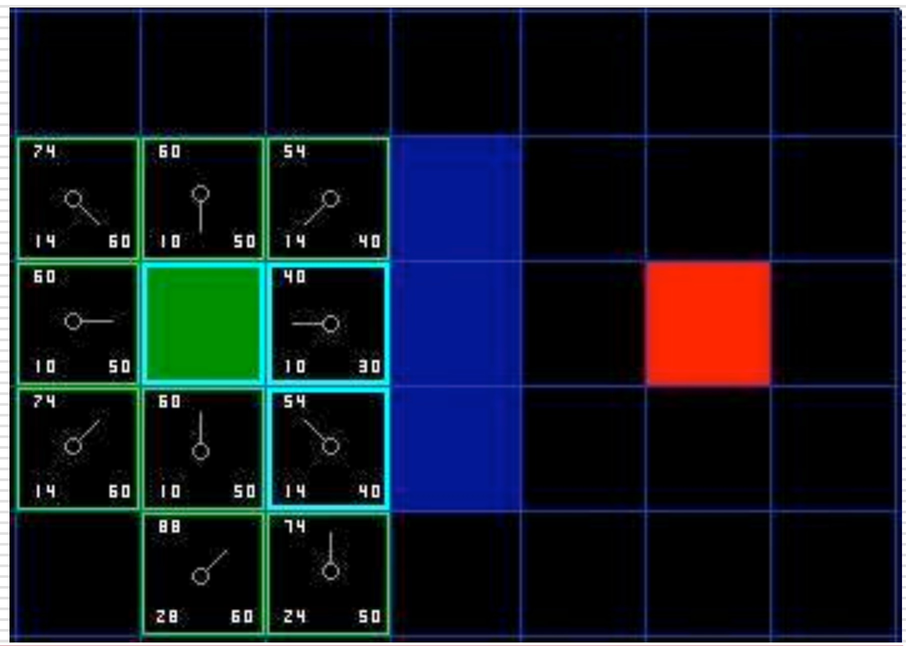




A* Algorithm (cont.)

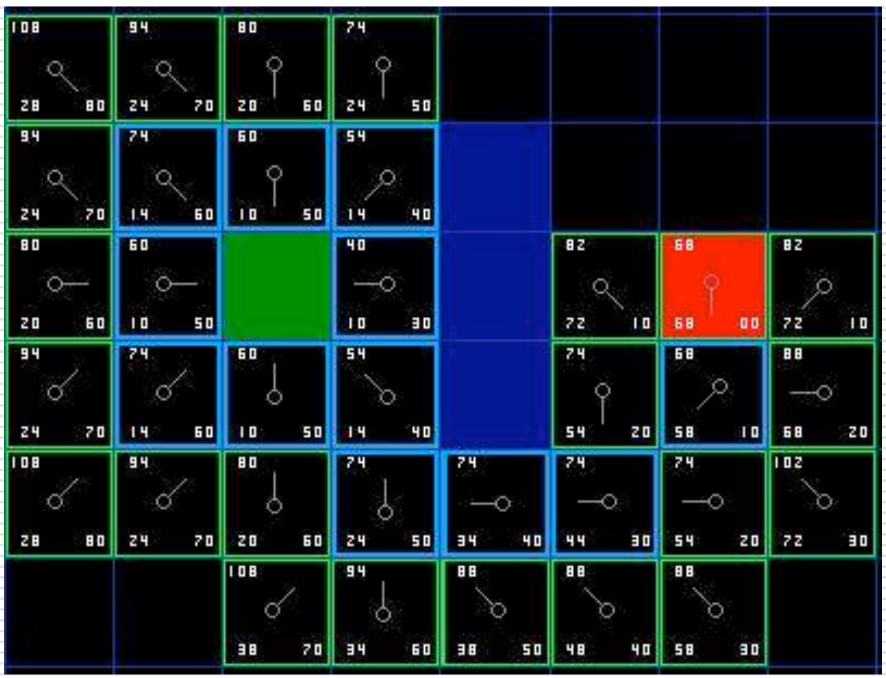
- Now check for the low F value in OPEN
  - In this case NE = SE = 54, so choose SE
- Going directly to SE is cheaper than E->SE
  - Leave start as the parent of SE, and iterate

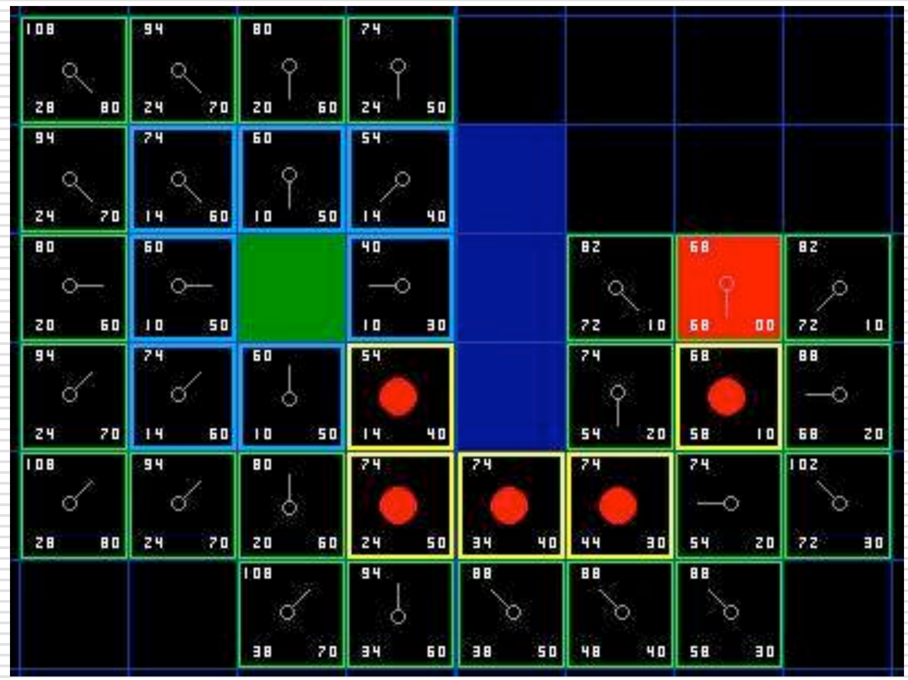




A* Algorithm (cont.)

- Keep iterating until we reach goal, and OPEN is empty
- Follow the parent links to get short path





Choosing a Distance Heuristic (H)

- Any graph-search algorithm is ***admissible*** if it always returns an optimal solution
- A* is only admissible if we never overestimate H
  - H too big: NO guarantee of shortest path, but it will be quick!
  - H = 0: Always gets the optimal path, but will search large space (breadth first)

Examples

- http://www.antimodal.com/astar/
- Now let's do one!

References

- "Steering Behaviors For Autonomous Characters" by Craig Reynolds
  - http://www.red3d.com/cwr/steer/
- "A* Algorithm Tutorial" by Justin Heyes-Jones
  - http://www.geocities.com/jheyesjones/astar.html
- "A* Pathfinding for Beginners" by Patrick Lester
  - http://www.gamedev.net/reference/articles/article2003.asp