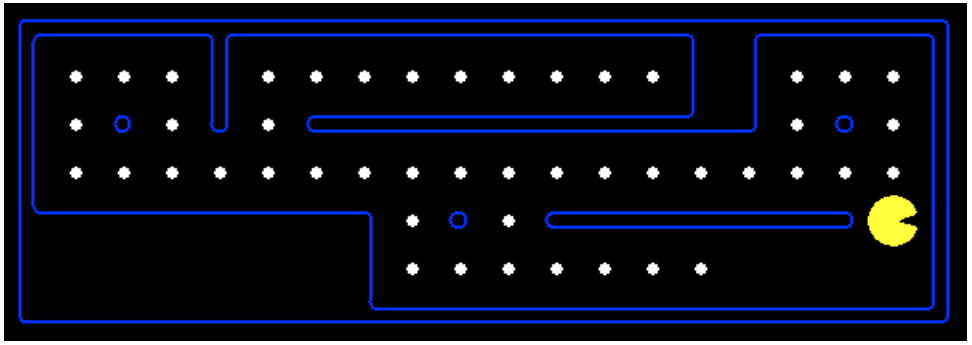
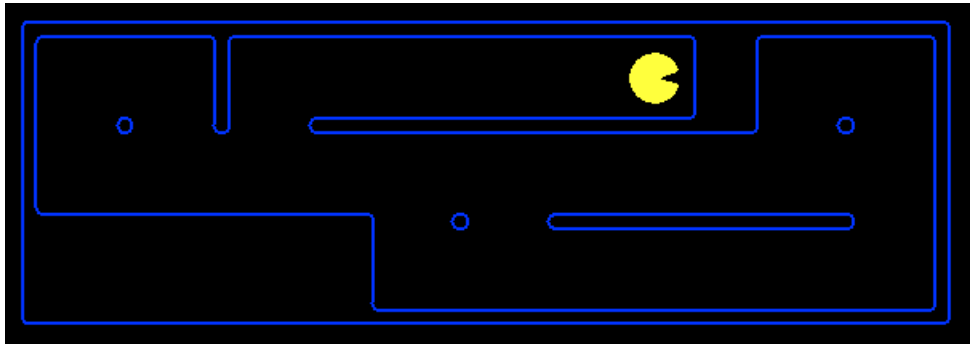
- Project 1: Constants
- Lab: Evals, Project 2
- Lab 8: due Friday @ midnight

Goal Based Agents

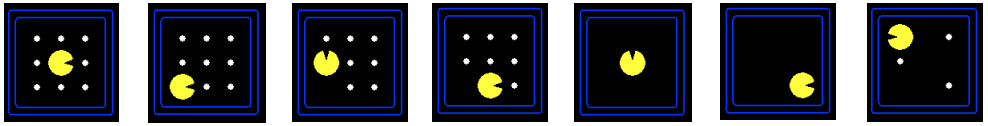
- Goal-based agents:
  - Plan ahead
  - Ask “what if”
  - Decisions based on (hypothesized) consequences of actions
  - Must have a model of how the world evolves in response to actions
  - Act on how the world WOULD BE



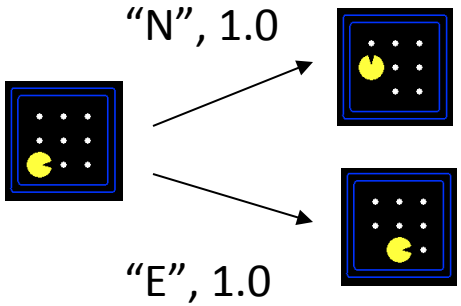


Search Problems

- A search problem consists of:
  - A state space

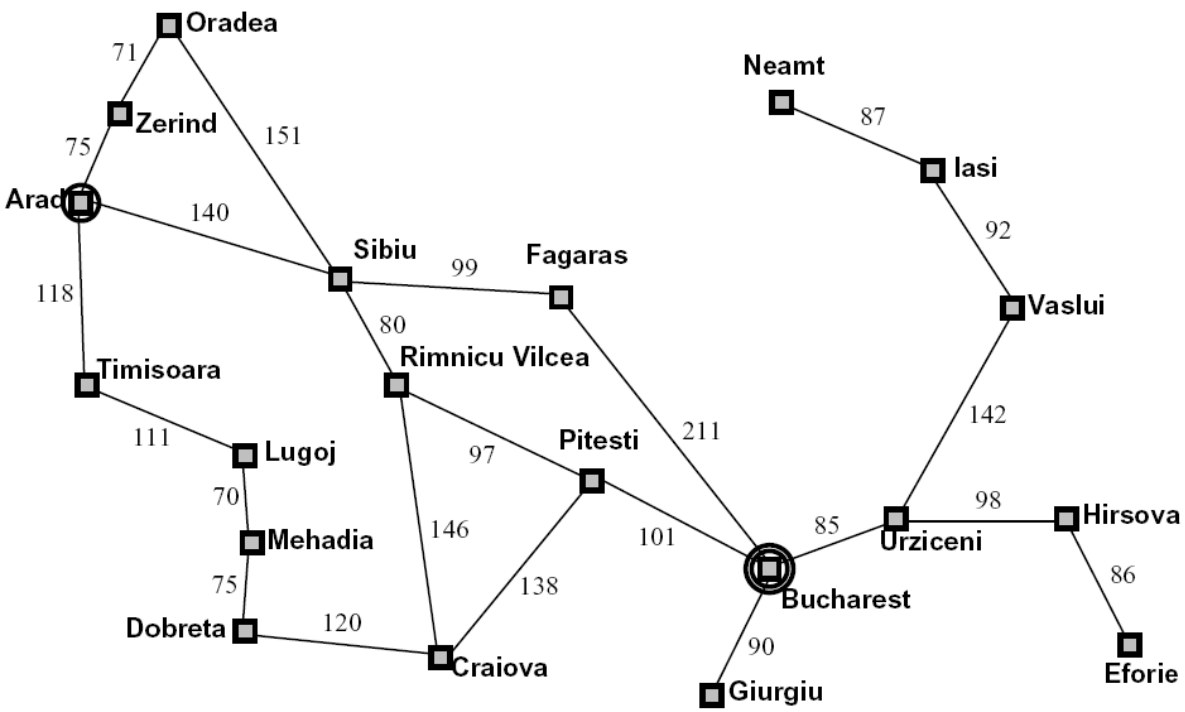


  - A successor function



  - A start state and a goal test
- A solution is a sequence of actions (a plan) which transforms the start state to a goal state

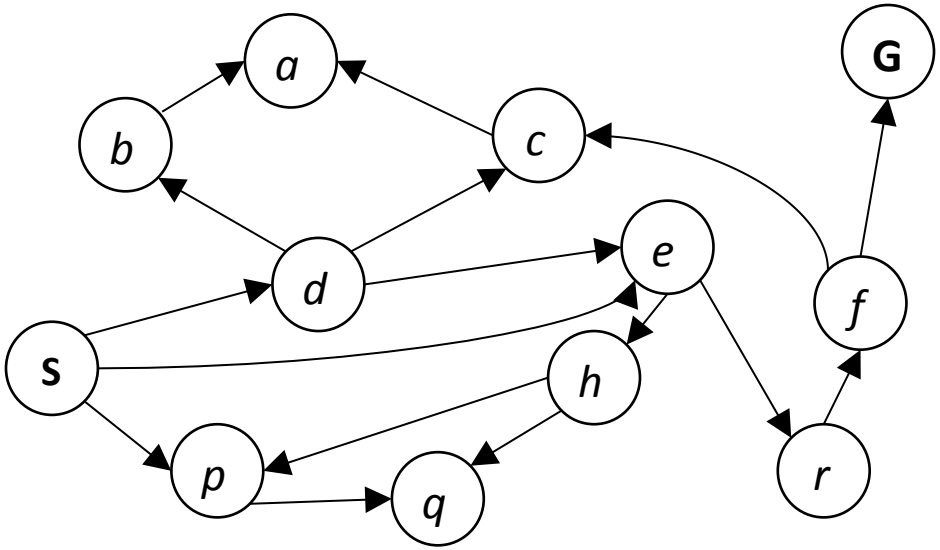
Example: Romania



- State space:
  - Cities
- Successor function:
  - Go to adj city with cost = dist
- Start state:
  - Arad
- Goal test:
  - Is state == Bucharest?
- Solution?

State Space Graphs

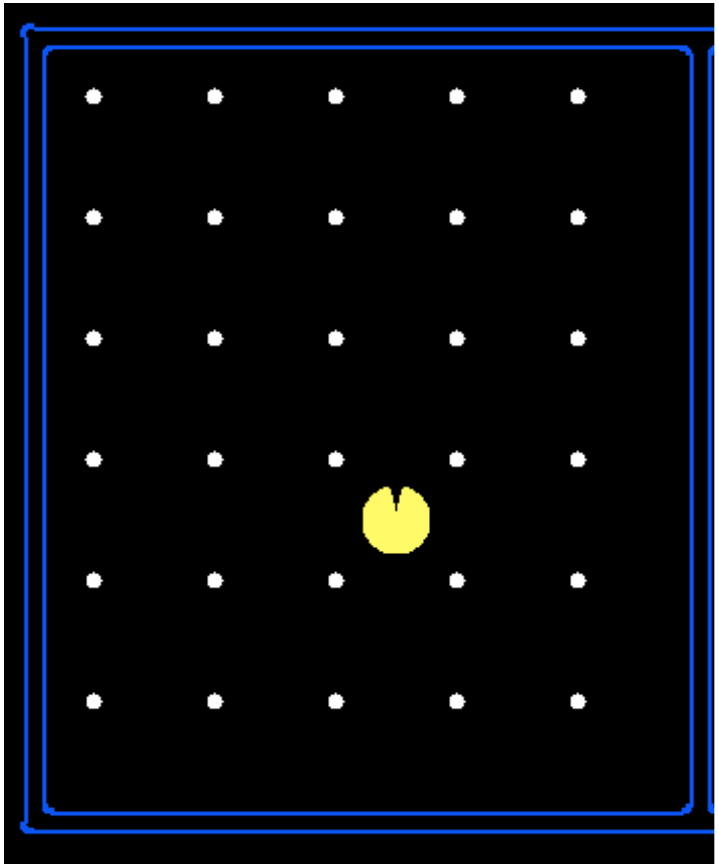
- State space graph: A mathematical representation of a search problem
  - For every search problem, there's a corresponding state space graph
  - The successor function is represented by arcs
- We can rarely build this graph in memory (so we don't)



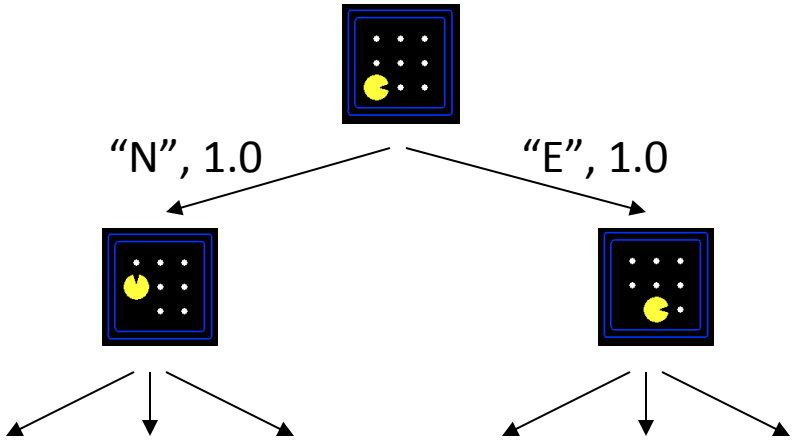
Ridiculously tiny search graph for a tiny search problem

State Space Sizes?

- Search Problem:
  Eat all of the food
- Pacman positions:
  10 x 12 = 120
- Food count: 30



Search Trees



- A search tree:
  - This is a "what if" tree of plans and outcomes
  - Start state at the root node
  - Children correspond to successors
  - Nodes contain states, correspond to PLANS to those states
  - For most problems, we can never actually build the whole tree

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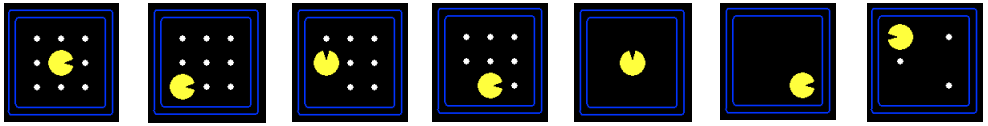
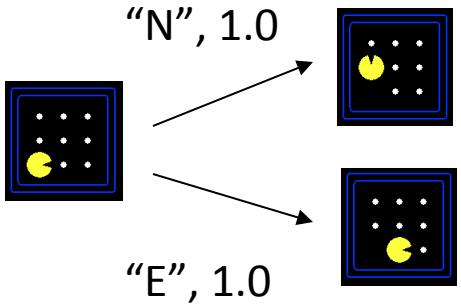


  - A successor function



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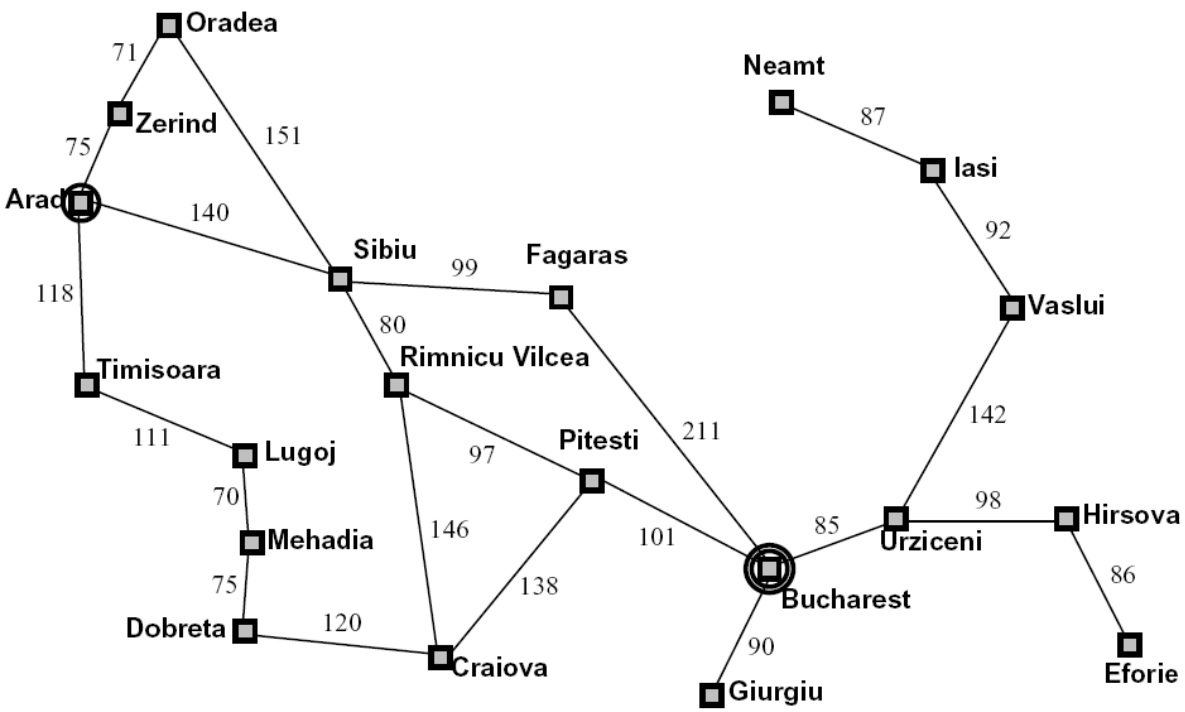

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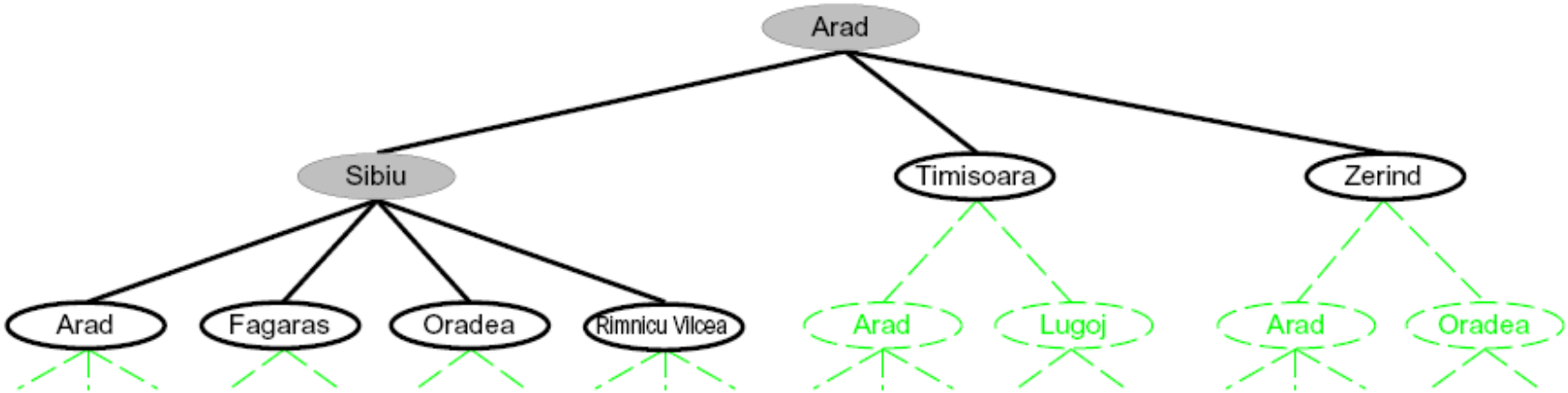
Another Search Tree



- Search:
  - Expand out possible plans
  - Maintain a fringe of unexpanded plans
  - Try to expand as few tree nodes as possible

General Tree Search

```
function TREE-SEARCH( problem, strategy) returns a solution, or failure
    initialize the search tree using the initial state of problem
    loop do
        if there are no candidates for expansion then return failure
        choose a leaf node for expansion according to strategy
        if the node contains a goal state then return the corresponding solution
        else expand the node and add the resulting nodes to the search tree
    end
```

- Important ideas:
  - Fringe
  - Expansion
  - Exploration strategy

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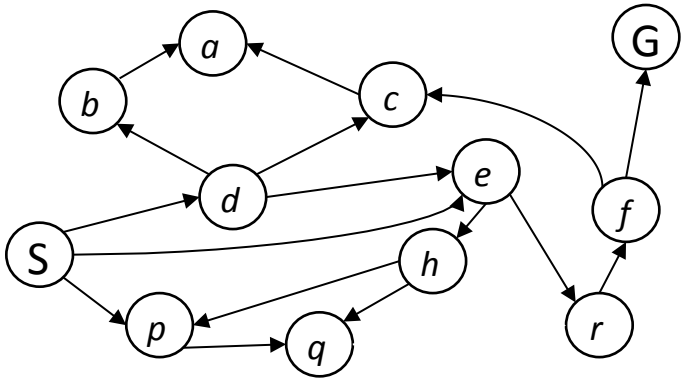
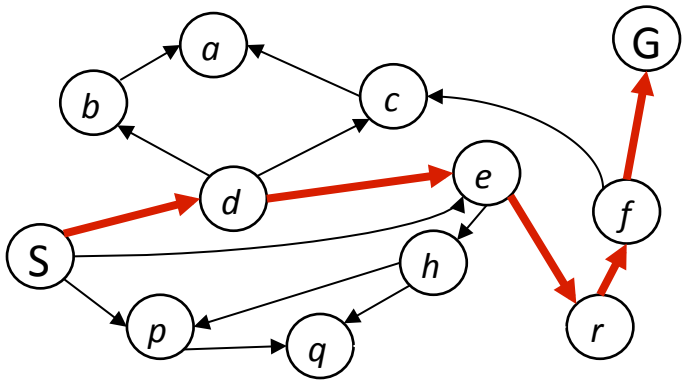
- Important ideas:
  - Fringe
  - Expansion
  - Exploration strategy

- Main question: which fringe nodes to explore?

Example: Tree Search

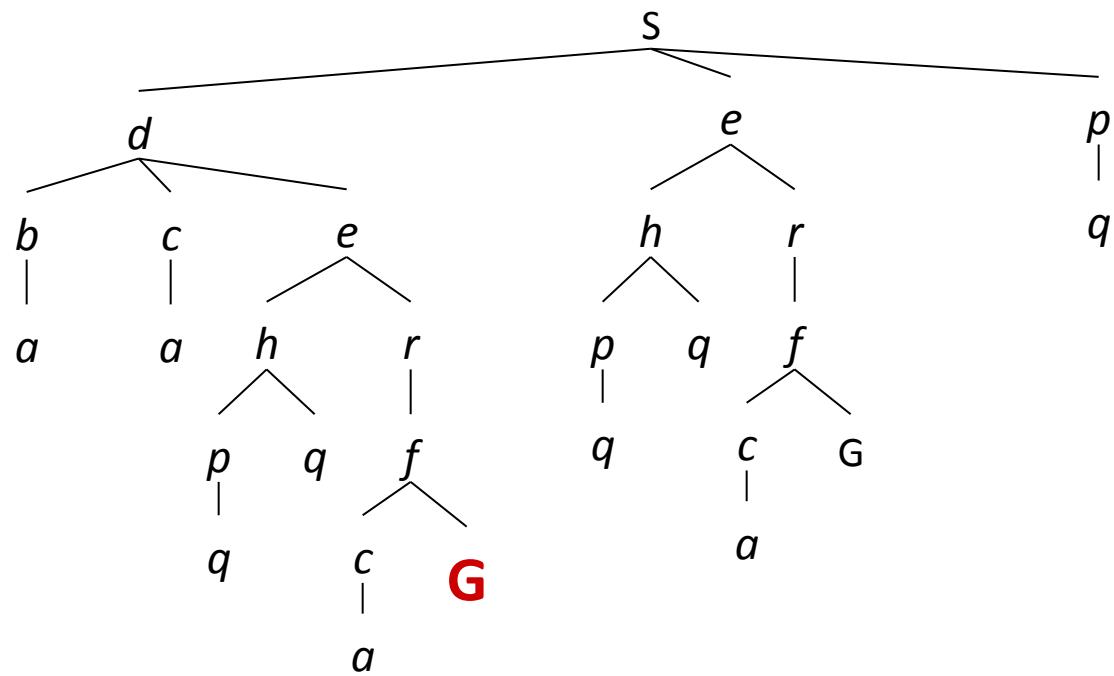


State Graphs vs. Search Trees



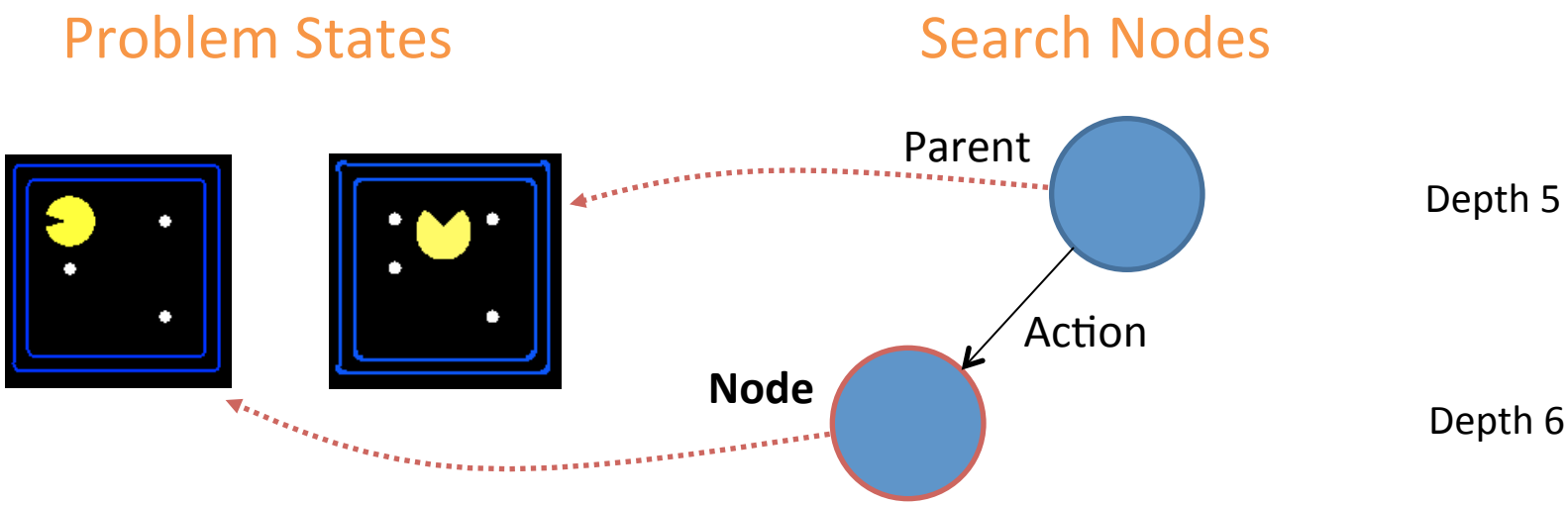
Each NODE in in the search tree is an entire PATH in the problem graph.

We construct both on demand – and we construct as little as possible.



States vs. Nodes

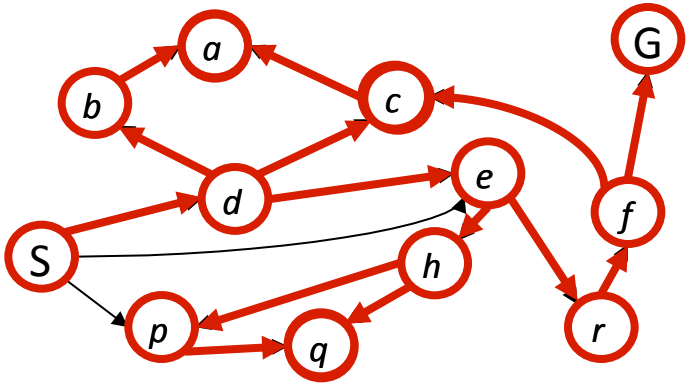
- Nodes in state space graphs are problem states
  - Represent an abstracted state of the world
  - Have successors, can be goal / non-goal, have multiple predecessors
- Nodes in search trees are plans
  - Represent a plan (sequence of actions) which results in the node's state
  - Have a problem state and one parent, a path length, a depth & a cost
  - The same problem state may be achieved by multiple search tree nodes

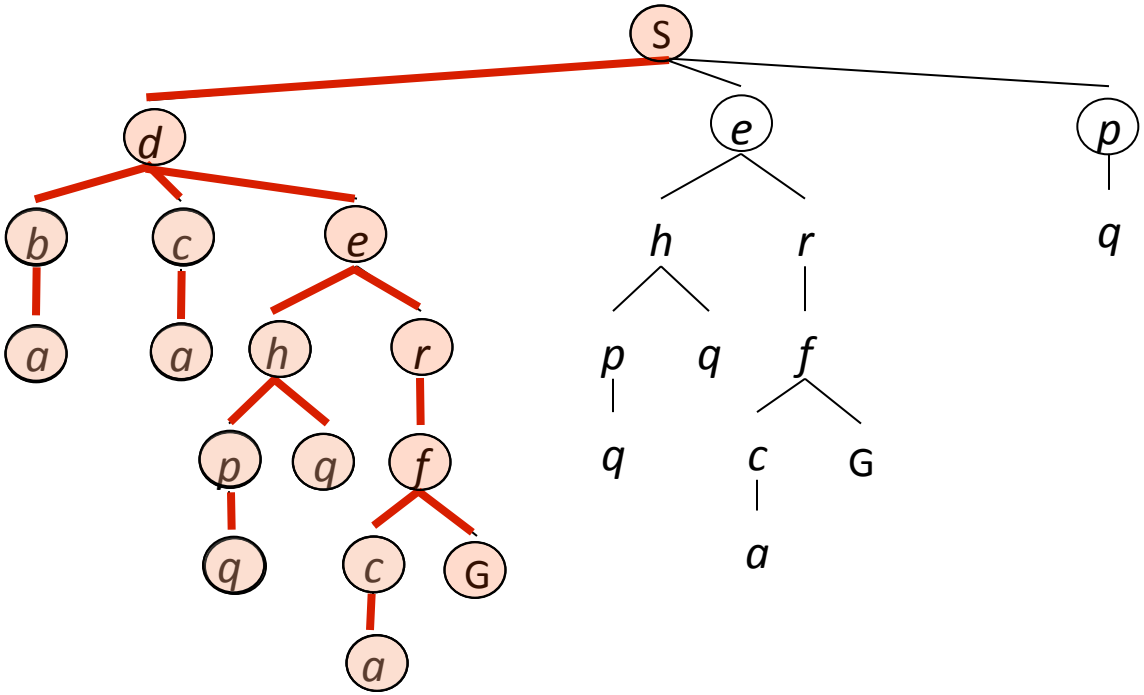


Depth First Search

Strategy: expand deepest node first

Implementation: Probably want to use recursion





Breadth First Search

Strategy: expand shallowest node first

Implementation: Fringe is a FIFO queue