CSC 480

Artificial Intelligence

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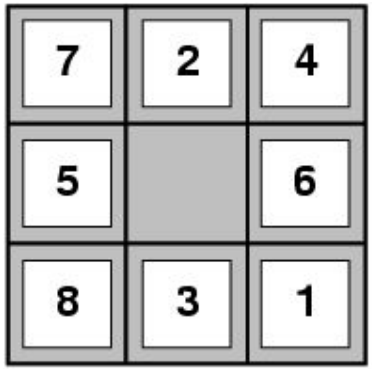
Fall 2018 - Cal Poly, San Luis Obispo

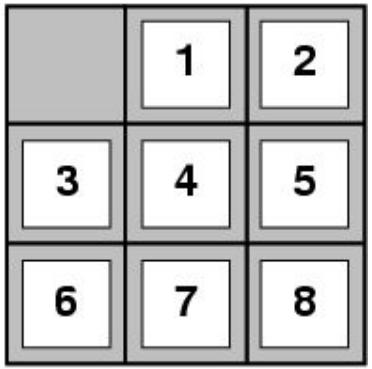
Problem Descriptions [1/4]

Sliding Tile Puzzle

- Objective: Get tiles in numerical order
- Move tile horizontally or vertically into empty space
- `WIDTH!/2` configurations



Start State

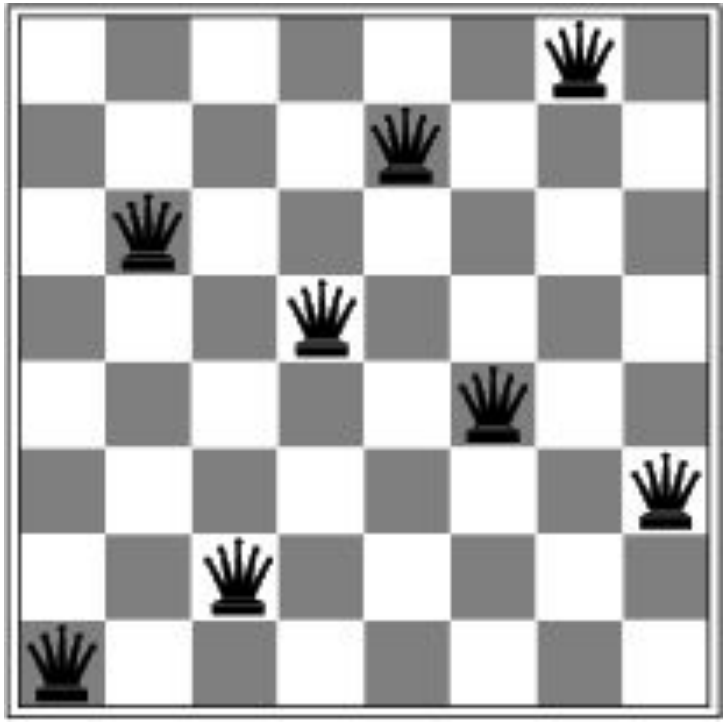


Goal State

Problem Descriptions [2/4]

N-Queens

- Objective: No attacking pairs
- Queens attack horizontally, vertically, diagonally
- Queens may be placed on any empty square
- `64!` configurations



Problem Descriptions [3/4]

Knuth's Problem

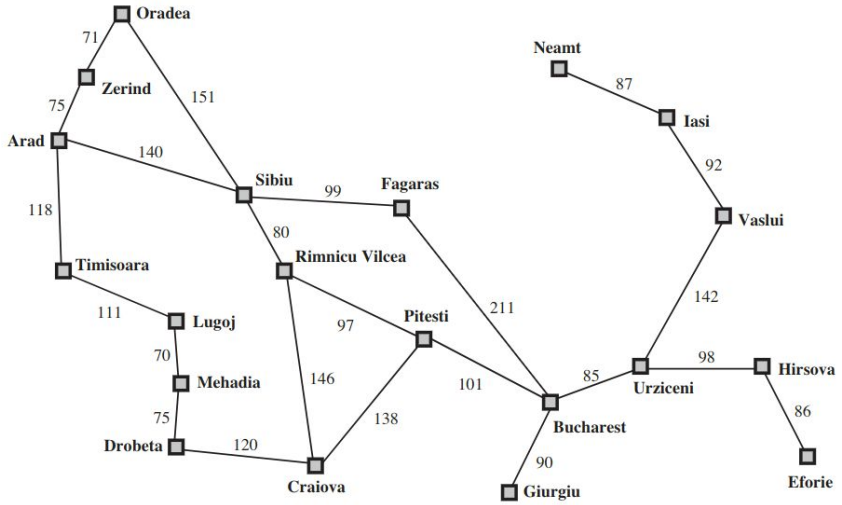
- Objective: Using `4` reach a specified integer using:
  - Factorial
  - Square root
  - Floor
- Infinite configurations

$$\left\lfloor \sqrt{\sqrt{\sqrt{\sqrt{(4!)!}}}} \right\rfloor = 5$$

Problem Descriptions [4/4]

Romania Travel Problem

- Objective: Get from Arad to Bucharest
- Cost of each action varies
- Ideally, find shortest route



Problem Solving

Components of a Problem

- Initial State
- Action Set
- Transition Model
- Goal Test
- Path Cost

Problem Solving: Initial State

Components of a Problem

- **Initial State**
- Action Set
- Transition Model
- Goal Test
- Path Cost

Starting point of problem

- Simplified description of state
- Only relevant properties used

Define problems where:

- Initial states known or not known in advance?
- Initial states not known at present?

Problem Solving: Action Set

Components of a Problem

- Initial State
- **Action Set**
- Transition Model
- Goal Test
- Path Cost

From any state, some set of actions must be available to proceed

Actions available may differ for different states

Define problems where:

- Action set is always/never same for all possible states

Problem Solving: Transition Model

Components of a Problem

- Initial State
- Action Set
- **Transition Model**
- Goal Test
- Path Cost

Problem must define outcome of an action in a particular state

Model represented as function:

```
Result(s, a) = s'
```

Problem Solving: Goal Test

Components of a Problem

- Initial State
- Action Set
- Transition Model
- **Goal Test**
- Path Cost

Determine whether solution found

- Test may be applied to frontier or explored states (depending on problem requirements)

Define problems where:

- Goal test is computationally expensive
- Multiple goals exist

Problem Solving: Path Cost

Components of a Problem

- Initial State
- Action Set
- Transition Model
- Goal Test
- **Path Cost**

Cost of solution, from initial state to goal state

Define problems where:

- Path cost is irrelevant to solution
- Cost is difficult to calculate

State Space

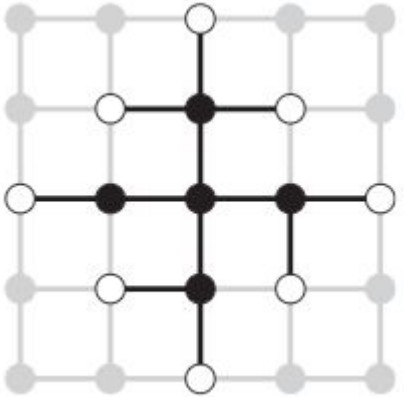
All reachable states from initial state make up the state space

Explored States

- States already visited by search algorithm

Frontier States

- Unexplored states adjacent to at least one explored state



- Black: Explored
- White: Frontier

Search

Find sequence of actions to go from initial state to goal state

- Path may or may not be relevant to solution
- Optimality may not be feasible

State space may have cycles

- Tree Search: Assume no cycles in state space
- Graph Search: Keep set of explored states to avoid cycles
  - "Algorithms that forget their history are doomed to repeat it."

Searches may be **informed** or **uninformed**