Heuristic Search

- Chapter 2: state-space search, combinatorial explosion, heuristic search, branch-and-bound, problem characteristics.
- Read chapter 3 (skip section 3.4): hill climbing, simulated annealing, A* search, admissible heuristics, constraint satisfaction, means-ends analysis.

Traveling Salesperson (TSP)

- Input: completely connected graph with weights on the edges.
- Each node is a city.
- Goal: visit a subset of the cities exactly once, and return home.
- Solution: shortest weight path that accomplishes goal.

TSP Solutions

- Generate-n-test?
  - 3!=6. 10!=3,628,800. 25!=?
  - Combinatorial explosion = exponential.
  - What's bigger 2^n or n!?
- Breadth-first-search?
- Branch-n-bound: keep track of the shortest path found so far. How does that help?
- Any suggestions?

Heuristics

- Heuristic=a technique for (hopefully) improving the efficiency of search.
  - Benefit: explore fewer states.
  - Cost: compute heuristic.
- *Complete* heuristic: always returns goal state if exhaustive search would have.
- *Admissible* heuristic: always find optimal path.

Nearest Neighbor Heuristic

- Heuristic is typically used to order the nodes to be expanded (priority queue).
- TSP: of the cities not yet visited, repeatedly choose the closest one to the current city.
- Time complexity?
- Quality of tour?

Heuristic Functions

- Heuristic: state → number.
- **TSP**: sum of distance traveled so far.
- **Chess**: material advantage.
- **Tic-Tac-Toe:** 1 for each row in which we could win and in which we already have one piece + 2 for each such row where we have 2 pieces.

Simulated Annealing

- Well known technique to escape local maxima (minima).
- Idea: with some probability P make a suboptimal move.
- Keep reducing P over time.
- Rate of change of P is called “annealing schedule”.