Heuristics

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Very Large Graphs

- Consider how you could traverse and search in an extremely large graph.
- Specifically, suppose we are trying to reach a specific vertex, our *goal*.
- Despite its efficiency, Dijkstra's may prove unsuitable, as it needs to process each vertex and edge.
- If $|V| > 10^8$ or $|E| > 10^8$ then the program will be slow.
- For example, lets look at RúnaHeimur

RúnaHeimur

- The task asks you to solve a sliding puzzle of $N \times M$ tiles.
- The state of the puzzle can be represented with a permutation of size $N \times M$, as is done in the statement.
- The transitions between states are encoded as swaps of digits.
- Solving the problem is simple with a graph algorithm.
- DFS or BFS would determine a path to the solved state, if one exists.
- Number of states is $\mathcal{O}\left((NM)!\right)$.
- Linear time and memory is too much.

RúnaHeimur

- Some states are further from the solved state than others.
- Need some way of knowing how far we are from the solution.
- We can't know for sure, so take a guess.
- For a vertex v, define a function $h(v)$ to represent the guess
- Let $g(v)$ be the distance from the source
- Run an algorithm similar to Dijkstra's where vertices are selected by $f(v) = g(v) + h(v)$ instead.

- How to define $h(v)$? This is our heuristic function
- Number of inversions in the permutation
- Number of misplaced tiles
- Sum of Manhattan distance to correct positions
- Many options available.
- Some of these are *admissable* heuristics, meaning they will find the shortest path instead of some path.

A* and IDA*

- This method is known as A* and is often used as a simple pathfinding algorithm.
- Memory usage can be high.
- With a branching factor is b and max depth is d then the complexity is $\mathcal{O}(b^d$.
- Iterative Deepening DFS is a version of DFS where the depth is bounded. If the algorithm fails then the bound is increased.
- This is done to similar performance and results as BFS but with less memory complexity.
- Iterative Deppening A* is similar, the bound is on the value of $f(v)$ instead of depth.