An Evaluation of Uninformed and Informed Search Algorithms on the k-puzzle Problem
AY19/20 Semester 2 CS3243 Project 1, Group 37

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1 Problem Specification

Fix $n \in \mathbb{Z}_{\geq 2}$. Let $k = n^2 - 1$. A valid state v is a $n \times n$ array with the entries $v_{(x,y)}$ containing a permutation of the integers $[0, k]$. V is the set of valid states. Each valid state has a unique coordinate $e = (x_e, y_e)$ such that $v_e = 0$. Call v_e the empty cell of v. An initial state s is a valid state with $e = (n, n)$. The goal state g is where $g_{(x,y)} = (x-1)n + y$ for all $(x, y) \in (\mathbb{Z}_{[1,n]})^2$, except for $g_{(n,n)}$ which is 0. Let $A = \{\texttt{up} = (-1, 0), \texttt{down} = (1, 0), \texttt{left} = (0, -1), \texttt{right} = (0, 1)\}$ be the set of actions. The transition function $T : V \times A \to V$ is where $T(v, a) = v'$ with v' being identical to v except with $(v'_{e-a}, v'_e) = (v_e, v_{e-a})$.

The problem is to determine if g is reachable from a given initial state s, and if so, specify a sequence of actions $p \in A^*$ that leads from s to g.

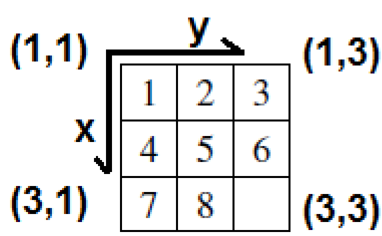

Fig. 1. The coordinate system and the goal state, in the case of $n = 3$.

2 Technical Analysis

2.1 [Uninformed Search]

Correctness [BLAH]

Efficiency Given any valid state, there are up to $|A| = 4$ possible actions. However, the initial state only has 2 possible actions, and every state thereafter has an action that backtracks and can thus be discounted, thus the maximum branching factor b of the problem space is $|A| - 1 = 3$. // This algorithm thus has $O(3^d)$ time and $O(3^d)$ space complexity.

2.2 [Informed Search]

Correctness [BLAH]

Efficiency [BLAH]

Heuristics

Heu1 The 3 heuristics should be distinct and non-trivial; for example, your heuristic should not be a constant, a simple linear transformation of other heuristics, or any simple function of another heuristic like a square root of another

Consistency/Admissibility: Your heuristic must be provably admissible, or (preferably) consistent. In either case you must formally prove this property. Note that consistency implies admissibility but not the other way around. Thus, if you show admissibility, you should provide a (preferably simple) counterexample where your heuristic violates consistency.

Heu2 [desc]

Heu3 [desc]

3 Experimental Setup

1. The goal of the experiments should be defined (including a rationale for the chosen algorithms and heuristics), and in particular the metrics designed/used should be justified
2. The entire experimental process should be clearly defined such that the experiments may be replicated

Table 1. Table captions should be placed above the tables.

Heading level	Example	Font size and style
Title (centered)	**Lecture Notes**	14 point, bold
1st-level heading	**1 Introduction**	12 point, bold
2nd-level heading	**2.1 Printing Area**	10 point, bold
3rd-level heading	**Run-in Heading in Bold.** Text follows	10 point, bold
4th-level heading	*Lowest Level Heading.* Text follows	10 point, italic

4 Results and Discussion

1. The results from your experimentation should be clearly summarised (you may include more detailed results in an Appendix, which would not count towards the given page limit – these will only be optionally viewed at the markers' discretion)
2. A concise discussion comparing the theoretical analysis and empirical results should be given to elucidate the effectiveness and efficiency of your implementations