JAVA Assignment: Rubik's Cube

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1 The Rubik's Cube

A Rubik's Cube is a puzzle designed by Mr Rubik. In a Rubik's Cube, each of the faces is covered by colored stickers. In the initial setting, all the stickers of a face are of the same color and different colors are used for different faces. After performing some random twists, the aim of the game is to twist the cube until every side returns to be of a single color.

2 The Sequential Algorithm

The idea behind the sequential algorithm is simple. From a starting cube, we can twist it in each axis, row and direction (Figure 1). For each cube of size S, doing a twist, there are $6*(S\text{-}1)$ new possible cubes. In Figure 2, the exolution of the search is represented as a tree. It's easy to understand from the figure that there is a rapid growth of the tree, in fact at the tree level i there are $(6*(S\text{-}1))^i$ nodes (cubes). The used state space search strategy, is the **deepening depth-first search (IDDFS)**. A depth-limited search is run repeatedly, increasing the depth limit with each iteration until it reaches d, the depth of the shallowest goal state. When the bound is increased, the solution search starts again from the begin (the root), and continues until the bound level is reached. On each iteration, the algorithm visits the nodes in the search tree in the same order as depth-first search, but the cumulative order in which nodes are first visited is effectively breadth-first. The first 2 iterations of the algorithm, with the order of the cube's evaluation is shown in Figure 3.

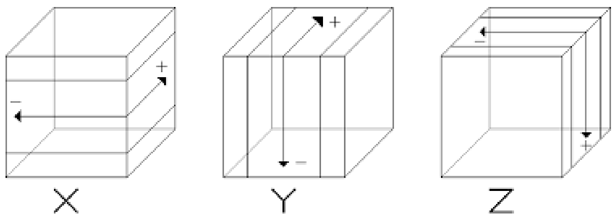


Figure 1: Possible directions and axis for twist of a 3d cube

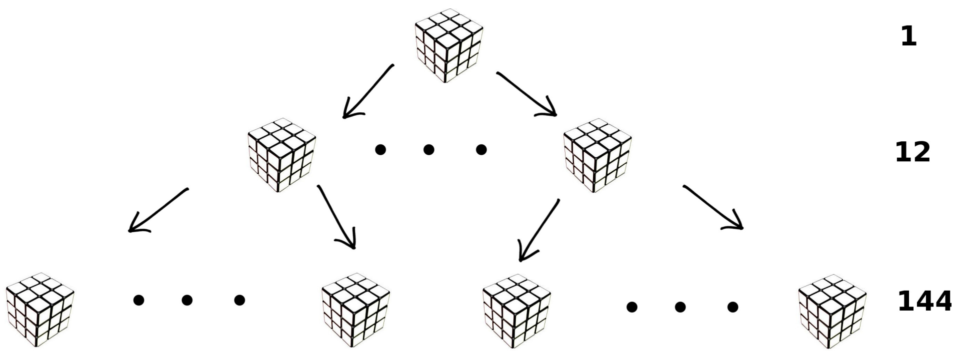


Figure 2: Rubik's Cube Solution Tree

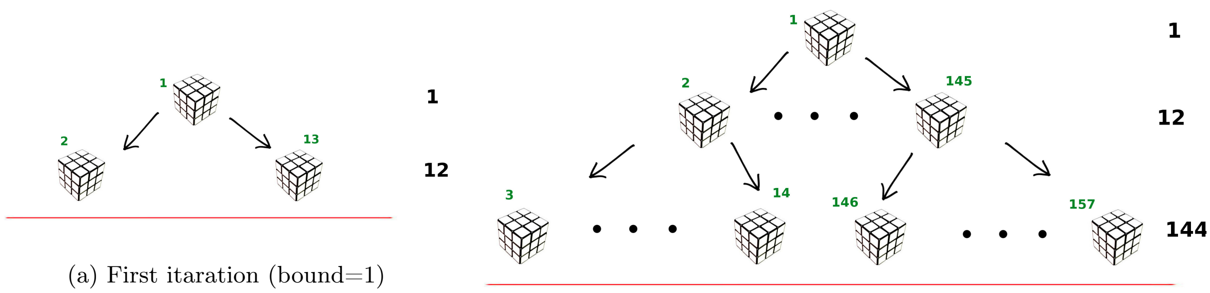
3 The Parallel Algorithm

$$\frac{(\sum_{i=0}^{m-z} n^i * \lfloor \frac{n^z}{k} \rfloor + \sum_{i=0}^{m-z} n^i) * 100}{(\sum_{i=0}^{m-z} n^i * \lfloor \frac{n^z}{k} \rfloor)} < 101 \quad (1)$$

$$\lfloor \frac{n^z}{k} \rfloor > 100 \quad (2)$$

$$\sum_{i=0}^{m-z} n^i * \lfloor \frac{n^z}{k} \rfloor \quad (3)$$

$$\sum_{i=0}^{m-z} n^i * \lfloor \frac{n^z}{k} \rfloor + \sum_{i=0}^{m-z} n^i \quad (4)$$



(a) First itaration (bound=1)

(b) Second itaration (bound=2)

Figure 3: The IDDFS Algorithm