Cube Algorithm

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1 IndexCube

We are in need of class that represents a 3 by 3 rubiks cube. The IndexCube stores the state of the corners and edges seperately. KEk

1.1 Edge indices

The position of all edges is a permuation of 12 elements. Instead of using 12 integer to store the position of every edge we use one integer that stores the lexicographic index of the permuation. There are $\lceil \log_2(12!) \rceil = 29$ bits needed to store all possible indices and we use a 32 bit integer to store this value. We use the family of bijective functions $E_i : \{0, 1, ..., 11\} \rightarrow \{0, 1, ..., 11\}$ where $i \in \{0, 1, ..., 12! - 1\}$ is the lexicographic index of the permuation that E_i represents.

A 12 element permuation will be represented by the following 2 row matrix:

$$\begin{pmatrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 \\ x_0 & x_1 & x_2 & x_3 & x_4 & x_5 & x_6 & x_7 & x_8 & x_9 & x_{10} & x_{11} \end{pmatrix}$$

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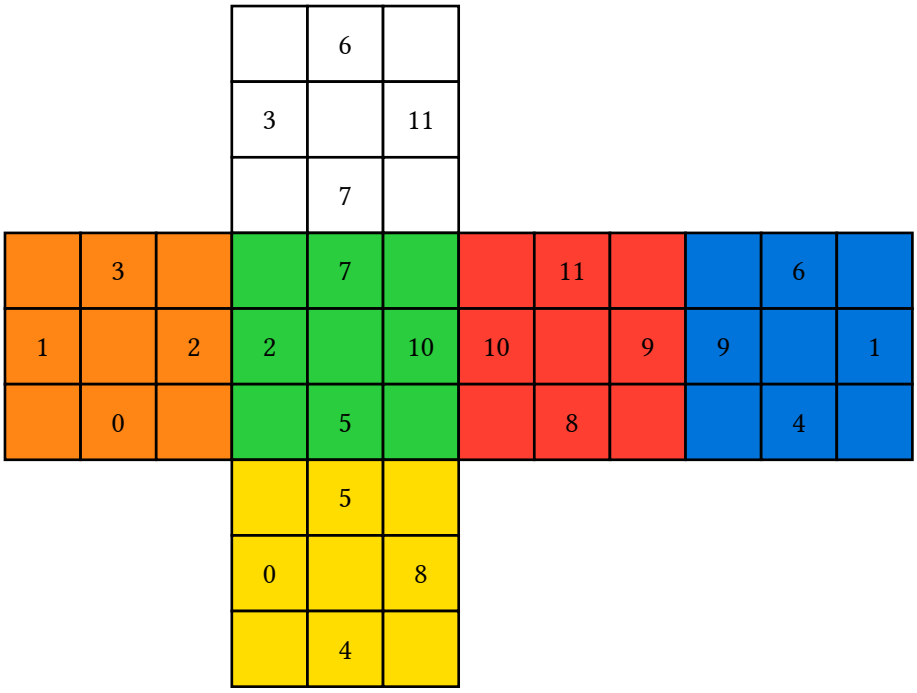
Every edge has to corrospond to an index between 1 and 12 now. We sort the edges by their x, y and z components on a right handed coordinate system with the green facing towards positive z and white facing towards positive y. In the following cube net the resulting indices can be seen.



The specific selection of indices will reduce the amount of space needed to store a matrix in discussed in section **KEK**. After the move L (90° clockwise rotation of the orange side) the permuation matrix has the following values:

$$\begin{pmatrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 \\ \mathbf{1} & \mathbf{3} & \mathbf{0} & \mathbf{2} & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 \end{pmatrix}$$

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Inverse (?)

$$\begin{pmatrix} 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 \\ \mathbf{2} & \mathbf{0} & \mathbf{3} & \mathbf{1} & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 \end{pmatrix}$$

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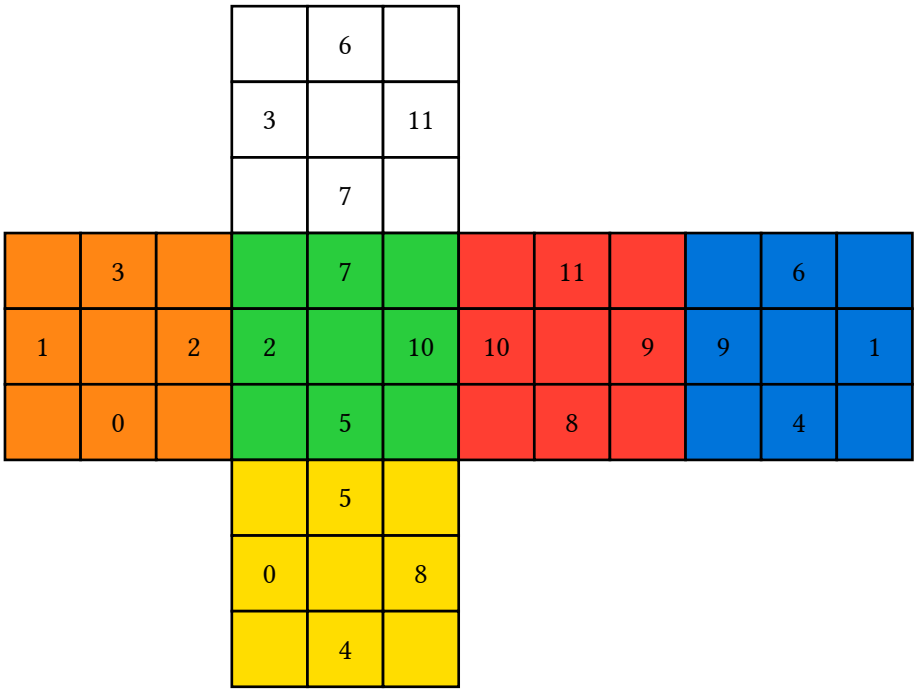

https://jperm.net/3x3/moves

Every edge has 2 possible orientations. To represent all edge orientation, 12 bits are needed which are stored into a single 16 bit integer.

The influence of the edge permuation to the edge orientation is defined as follows.

1.2 Corner indices