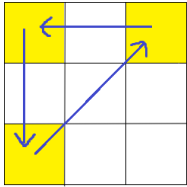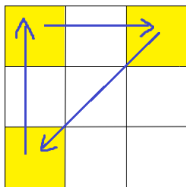# Group Theory using Rubik's cube

Sheet 2
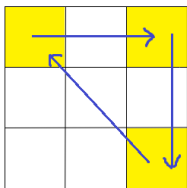
In the session, we saw that the move URU'L'UR'U'L made the corner cubies in the top layer move in the following cycle: (U' denotes inverse of U)
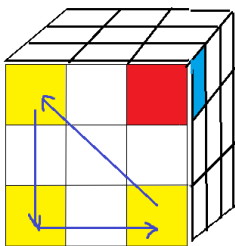

1. Find the moves which will make the top-layer corner cubies move in the following cycles:
a) Reverse direction

b) Fixing the corner <u>ful</u> and shifting the other corners in a loop

c) Moving the corners in the front face instead of the top face

2. The previous challenge involves moving three corner cubies lying on the same face. E.g (<u>fur</u>   <u>ful</u>   <u>fdr</u>). Can you shift three corner cubies not lying on the same face?
   That is, you need to create a cycle such that <u>fur</u> → <u>ful</u> → <u>fbr</u> → <u>fur</u>, leaving the rest of the cube unchanged.

3. Find the order & cycle decomposition of the move FRUF'R'U'. Observe its patterns.

4. Find a move that achieves the following

a) Creates a cycle of 3 edge cubies on the same face, without affecting rest of the cube.

b) Creates a cycle of 3 edge cubies not on the same face, without affecting rest of the cube.

c) Swaps 1 pair of corner cubies, without affecting rest of the cube.

d) Swaps 1 pair of edge cubies, without affecting rest of the cube.

e) Changes the orientation but not position of exactly 1 pair of corner cubies, without affecting rest of the cube.

f) Changes the orientation but not position of exactly 1 pair of edge cubies, without affecting rest of the cube.