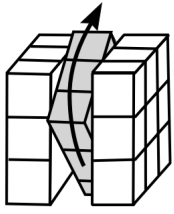


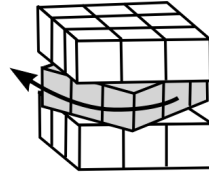
Chapter 19 - Rubik's Cube Beginnings

Notation & Terminology:

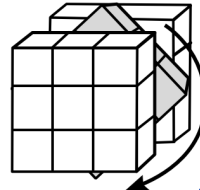
Slice Moves



$$M_R = M_L^{-1}$$

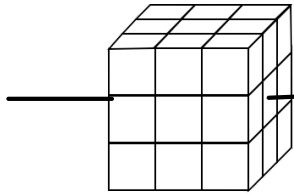


$$M_u = M_D^{-1}$$

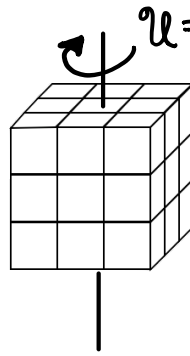


$$M_F = M_B^{-1}$$

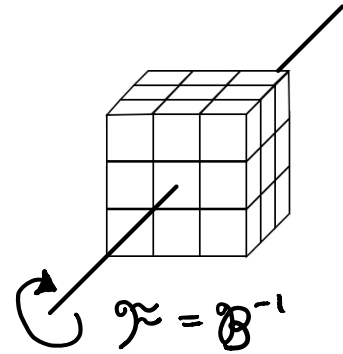
Whole Cube Moves:



$$R = L^{-1}$$



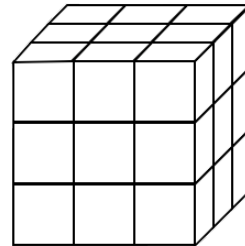
$$U = D^{-1}$$



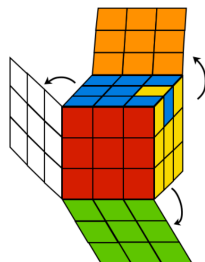
$$F = B^{-1}$$

Facet Notation:

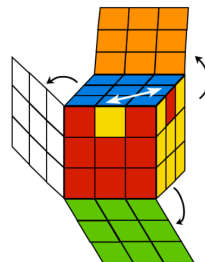
	ulb	ub	ubr								
	ul	U	ur								
	ufl	uf	urf								
lbu	lu	luf	flu	fu	fur	rfu	ru	rub	bru	bu	bul
lb	L	lf	fl	F	fr	rf	R	rb	br	B	bl
ldb	ld	lfd	fdl	fd	frd	rdf	rd	rbd	bdr	bd	bl
			dlf	df	dfr						
			dl	D	dr						
			dbl	db	drb						



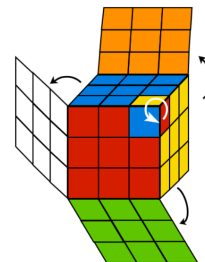
Impossible Moves:



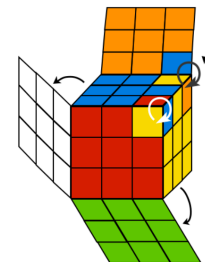
(a) single edge flip



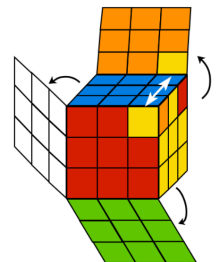
(b) edge swap



(c) single corner twist



(d) double corner twist in same direction

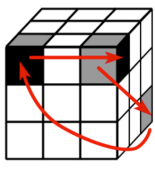


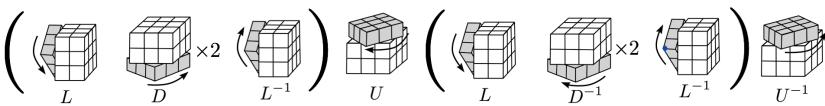
(e) corner swap

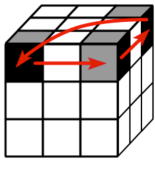
Figure 19.6: Five different configurations that are impossible to achieve.

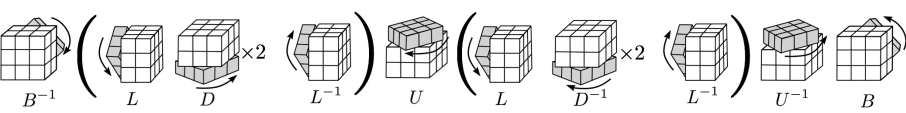
Catalog of Useful Moves :

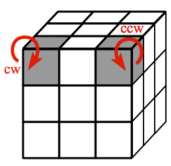
Corner Moves :

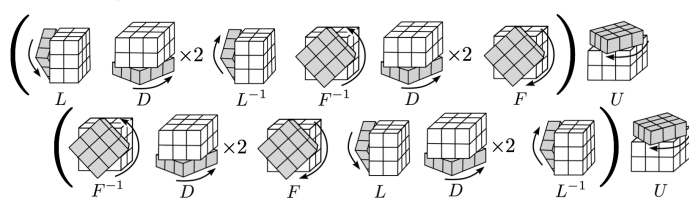
C1  $[LD^2L^{-1}, U] =$

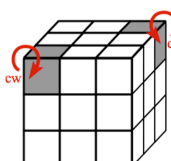


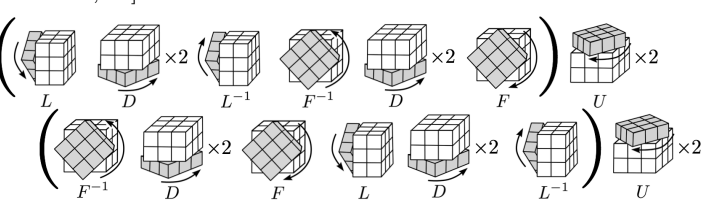
C1'  $B^{-1}[LD^2L^{-1}, U]B =$



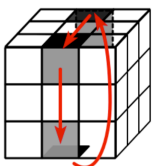
C2  $[LD^2L^{-1}F^{-1}D^2F, U] =$

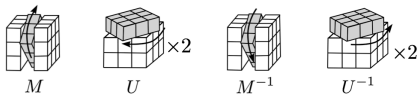



C2'  $[LD^2L^{-1}F^{-1}D^2F, U^2] =$

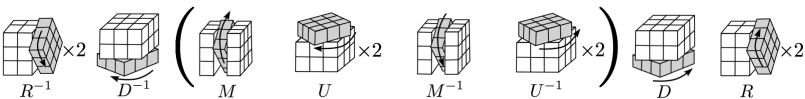


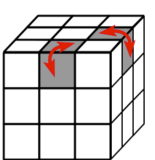
Edge Moves :

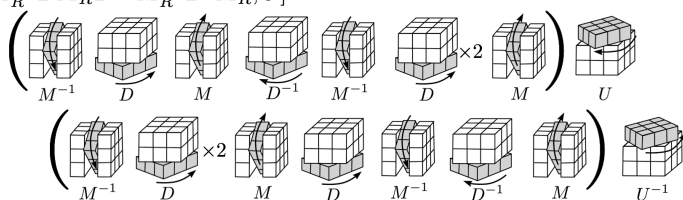
E1  $[M_R, U^2] =$

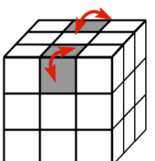


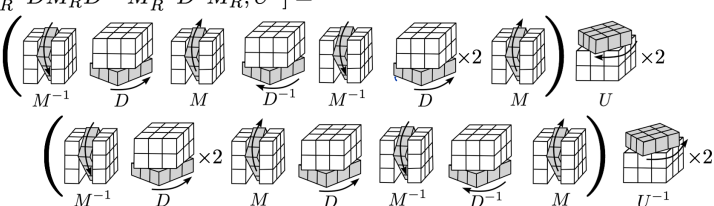
E1'  $R^{-2}D^{-1}[M_R, U^2]DR^2 =$



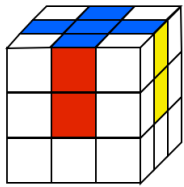
E2  $[M_R^{-1}DM_RD^{-1}M_R^{-1}D^2M_R, U] =$



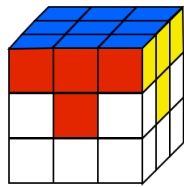
E2'  $[M_R^{-1}DM_RD^{-1}M_R^{-1}D^2M_R, U^2] =$



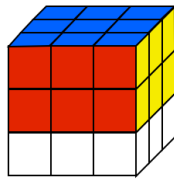
Strategy For Solution :



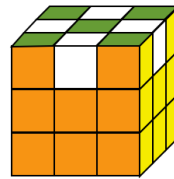
Step 1



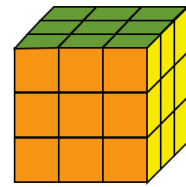
Step 2



Step 3



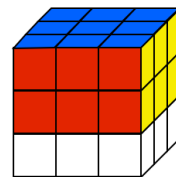
Step 4



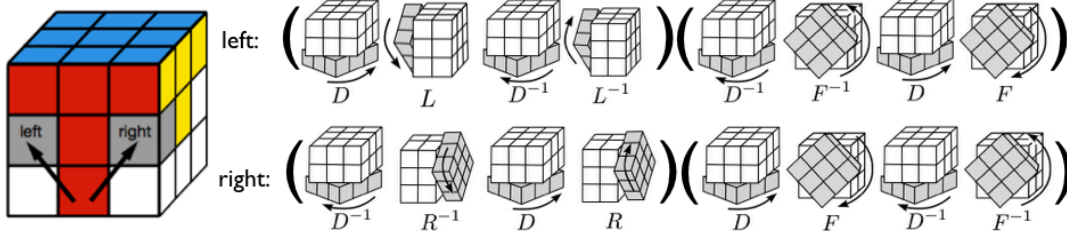
Step 5

Step 1 & 2 : Complete the up layer
 - first solve the corners
 - then solve the edges
 No special moves needed here, just move pieces around in the D layer and bring up to U layer using L, F, F⁻¹, R⁻¹ "elevators".

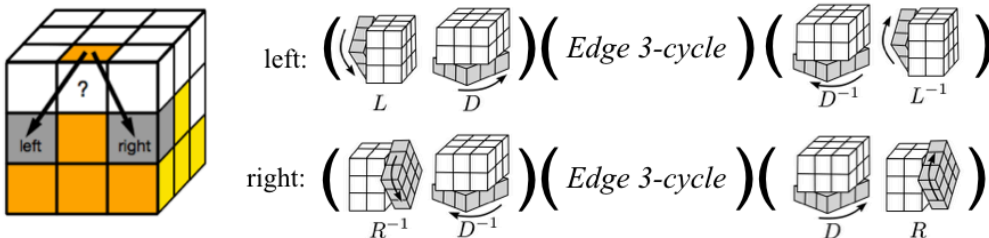
Step 3: Solve edges in the middle layer



Using Z-commutators :

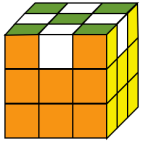


Using 3-cycles

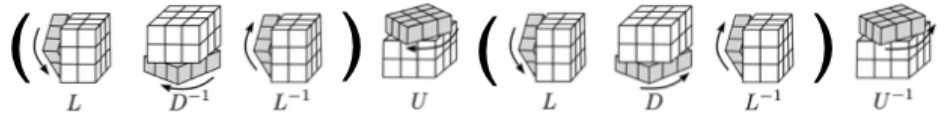


Last Layer : Flip cube over so last layer is now on top.

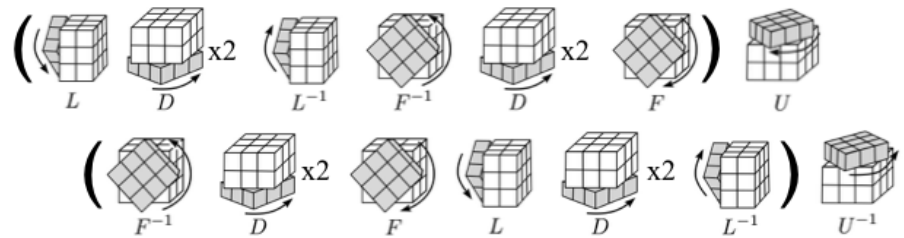
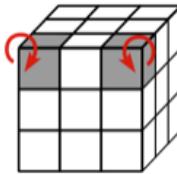
Step 4: Solve corners in the last layer.



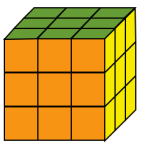
4(a) permute corners



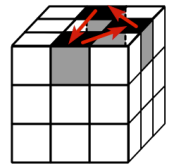
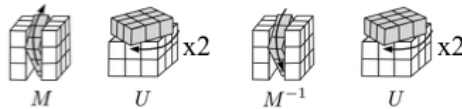
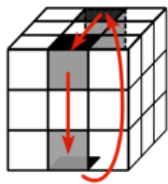
4(b) orient



Step 5: Solve edges in the last layer

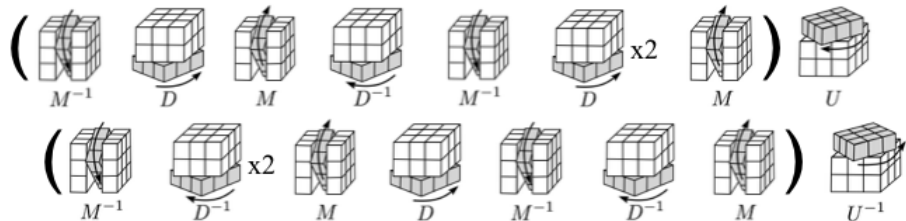
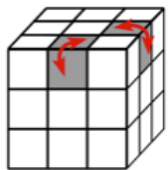


5(a) permute



$R' D' [M, u^2] D R$

5(b) orient



Summary guide available on course website:

<http://www.sfu.ca/~jtmulhol/math302/downloads/rc-5step-soln.pdf>

Example: Show the steps involved in solving the last layer.

