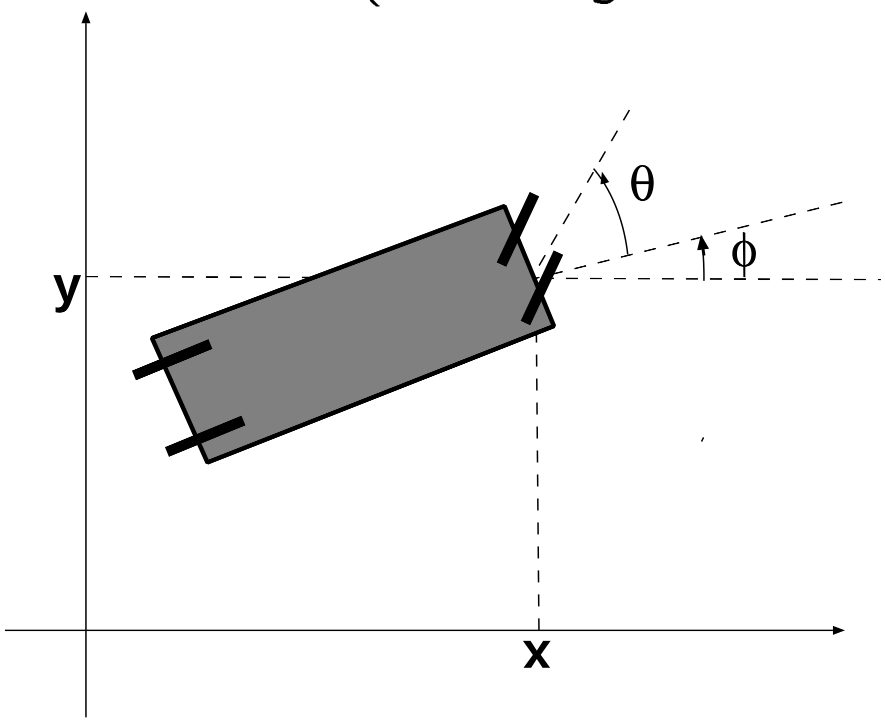
A CAR (following E. Nelson, 1967)



$$\dot{X} = u_d DRIVE(X) + u_s STEER(X)\,,$$

$$X = (x, y, \phi, \theta)^\dagger\,,$$

$$DRIVE = (\cos(\theta+\phi), \sin(\theta+\phi), \sin(\theta), 0)^\dagger\,,$$

$$STEER = (0, 0, 0, 1)^\dagger\,.$$

STEER: $\dot{\theta} = 1$
DRIVE: $\dot{x} = \cos(\theta + \phi)$, $\dot{y} = \sin(\theta + \phi)$,
$\dot{\phi} = \sin(\theta)$, $\dot{\theta} = 0$.

$$[STEER, DRIVE] = WRIGGLE$$

$$[WRIGGLE, DRIVE] = SLIDE$$

$$SLIDE = (-\sin\phi, \cos\phi, 0, 0)^{\dagger}\,,$$

$$WRIGGLE = SLIDE + ROTATE \ \ (\text{when } \ \theta = 0)\,,$$

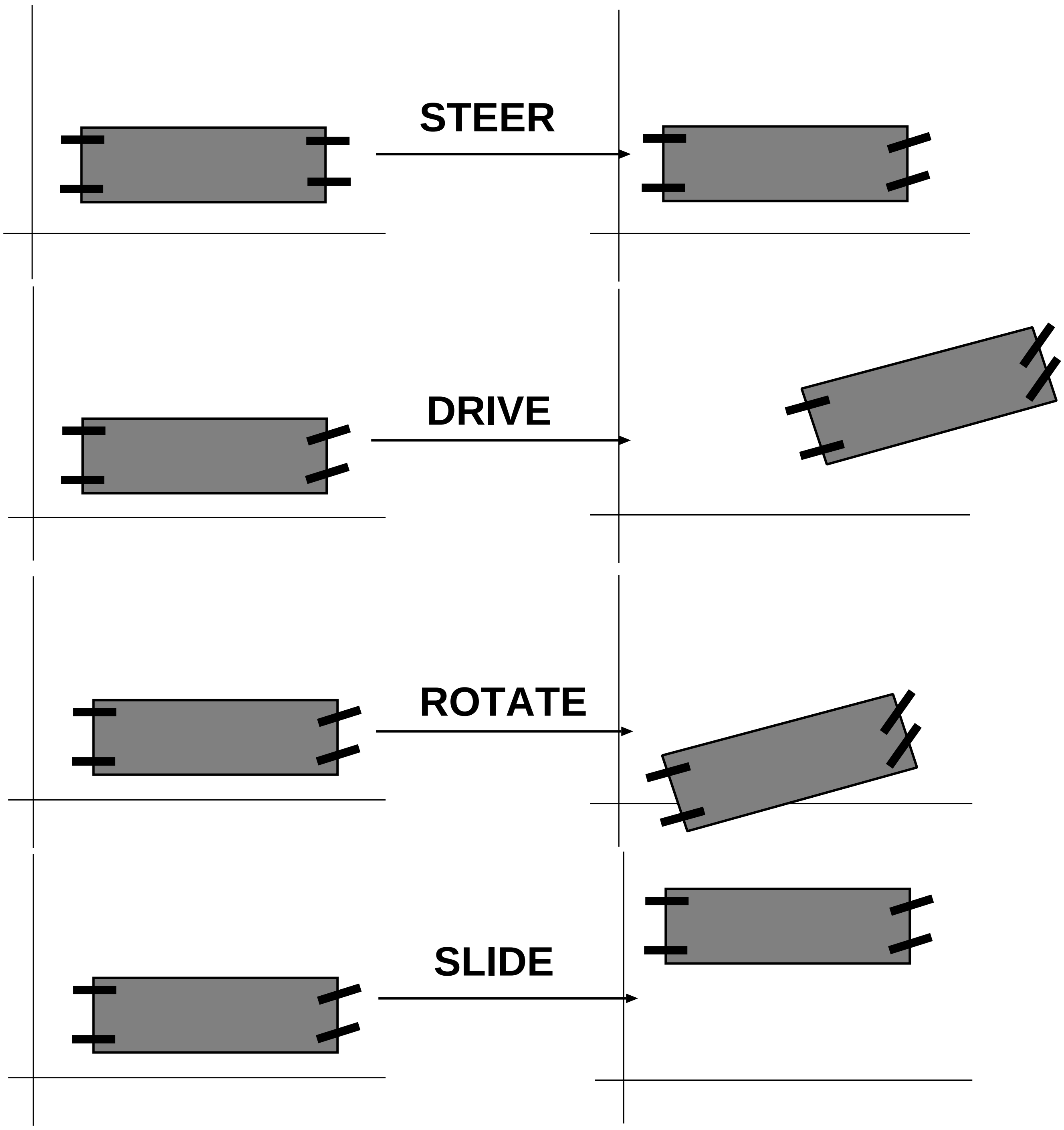
$$ROTATE = (0, 0, 1, 0)\,.$$

- The effect of WRIGGLE is attained by doing:

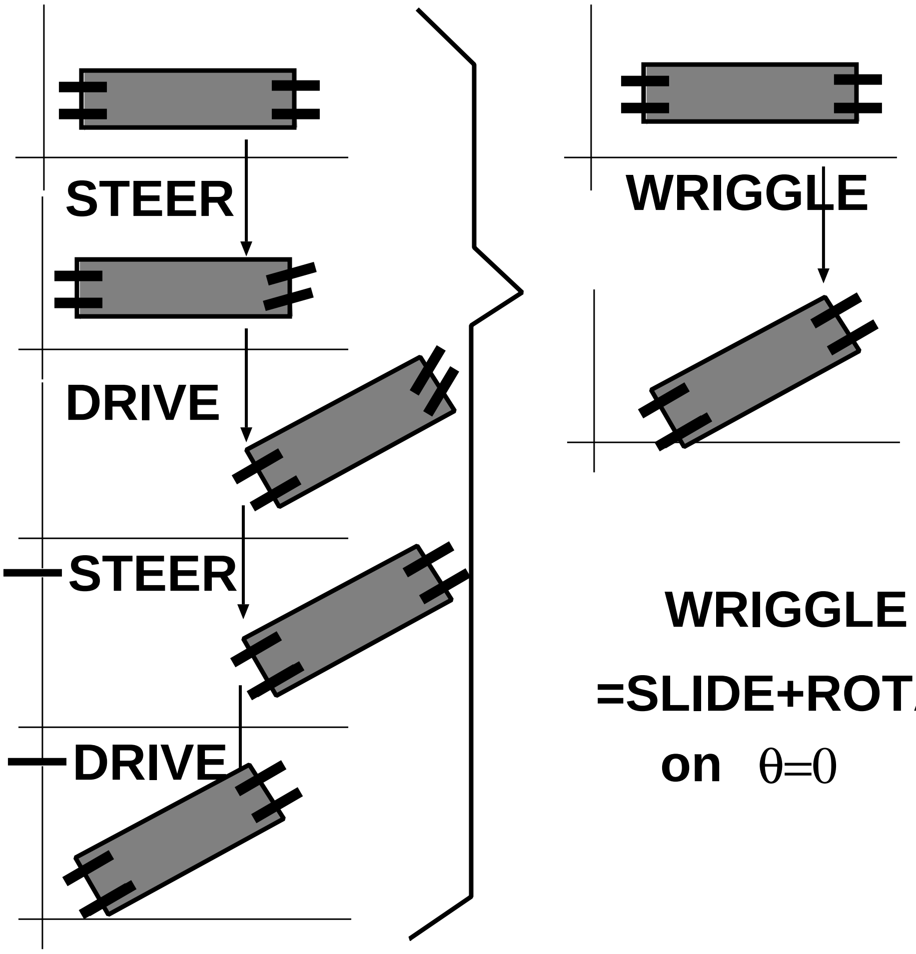
  STEER, DRIVE, -STEER, -DRIVE

- The effect of SLIDE is attained by doing:

  WRIGGLE, DRIVE, -WRIGGLE, -DRIVE


STEER
DRIVE
ROTATE
SLIDE

[STEER, DRIVE]= WRIGGLE



WRIGGLE

=SLIDE+ROTATE

on $\theta=0$

[WRIGGLE, DRIVE] = SLIDE