Loop Closure Equations

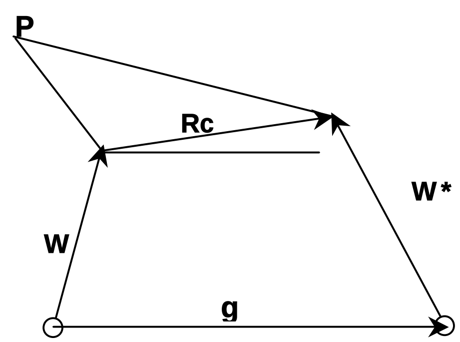
Position
Velocity
Acceleration

Position Analysis

Identify **driving link** and known quantities

Identify unknown values

Provide sufficient loops to solve for all unknowns.

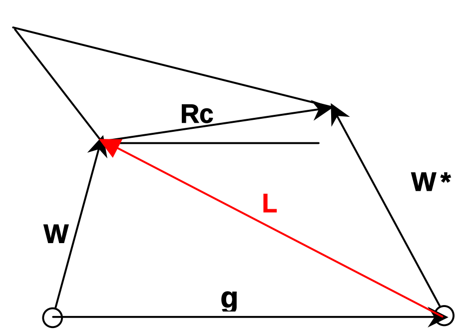


Assume W is driving

Known values, W, Z, Z*, W*, g, θw, θg

Unknown values, θ_{Rc}, θ_{W^*}

How can we find θ_{Rc}, θ_{W^*}?



Loop 1

$$\vec{W} = \vec{g} + \vec{L}$$
$$W\cos(q_W) - g\cos(q_g) = L\cos(u)$$
$$W\sin(q_W) - g\sin(q_g) = L\sin(u)$$
$$W^2 + g^2 - 2gW\cos(q_W - q_g) = L^2$$
$$L = \sqrt{W^2 + g^2 - 2gW\cos(q_W - q_g)}$$
$$u = \tan^{-1}\left(\frac{W\sin(q_W) - g\sin(q_g)}{W\cos(q_W) - g\cos(q_g)}\right)$$

Loop 2

$$\vec{L} + \vec{R}_c = \vec{W}*$$
$$L\cos(u) + R_c\cos(q_{RC}) = W*\cos(q_{W*})$$
$$L\sin(u) + R_c\sin(q_{RC}) = W*\sin(q_{W*})$$
$$L^2 + R^2{}_c + 2LR_c\cos(u - q_{RC}) = W*^2$$
$$\cos(u - q_{RC}) = \frac{W*^2 - L^2 - R^2{}_c}{2LR_c}$$
$$u - q_{RC} = \cos^{-1}\left(\frac{W*^2 - L^2 - R^2{}_c}{2LR_c}\right)$$
$$q_{RC} = u \pm \cos^{-1}\left(\frac{W*^2 - L^2 - R^2{}_c}{2LR_c}\right)$$
$$q_{W*} = \tan^{-1}\left(\frac{L\sin(u) + R_c\sin(q_{RC})}{L\cos(u) + R_c\cos(q_{RC})}\right)$$

All parameters are known.

How would you find the position of the coupler point, , for any value of θw?