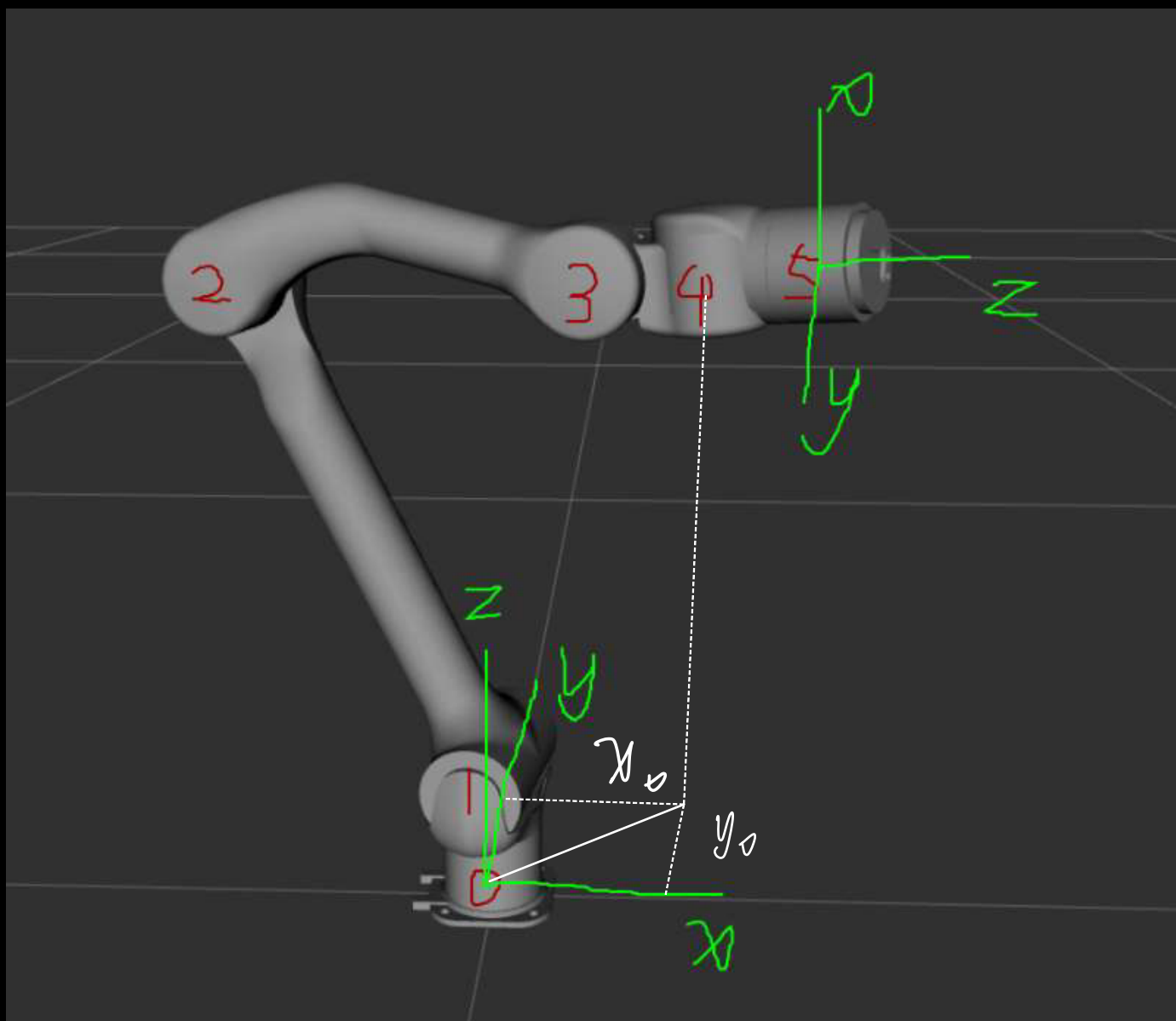


# 新构型机械臂逆运动学



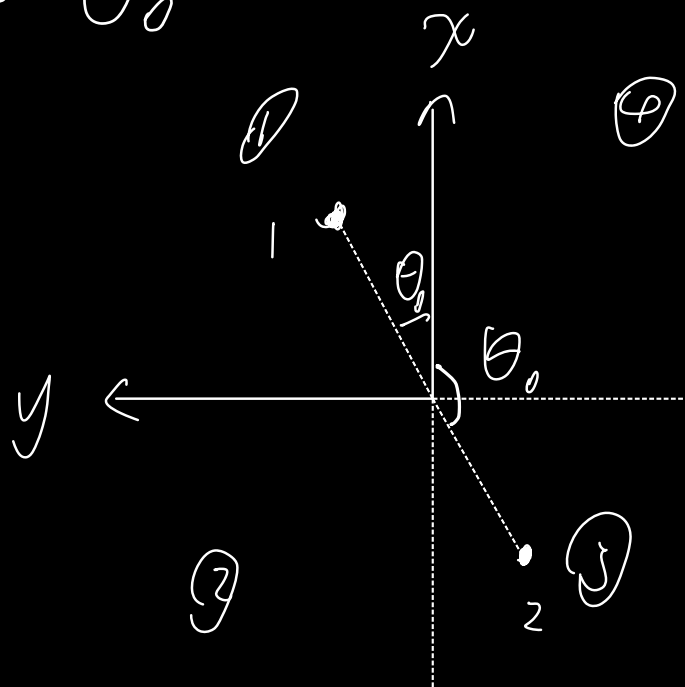
$$\text{atan2}(y, x) \sim -\pi \sim \pi$$

$$\arccos(\hat{Y}, \hat{X}) \sim 0 \sim \pi$$

$$\arcsin(\hat{Y}, \hat{X}) \sim -\frac{\pi}{2} \sim \frac{\pi}{2}$$

# 一、几何法推导逆运动学

① 求  $\theta_0$



1:  $\arctan z \rightarrow$  锐角  $\rightarrow \theta_0$

2:  $\text{atan2} \rightarrow$  钝角  $\rightarrow \theta_0$

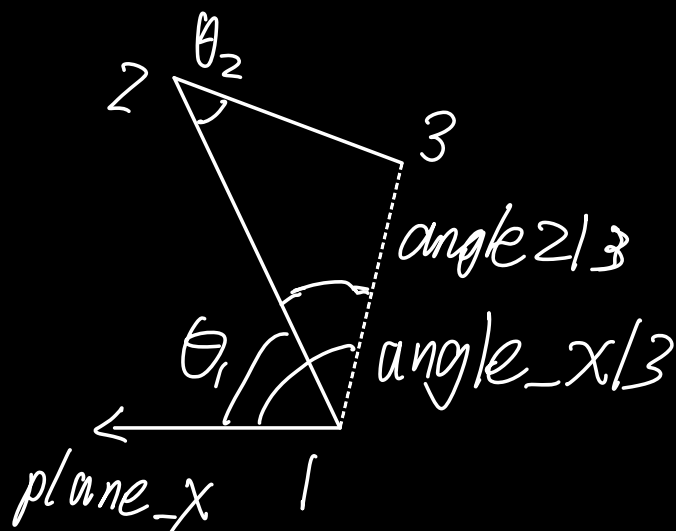
$$\theta_0[i] = \text{atan2}(y_0, x_0)$$

$$\theta_0[i] = fmod(\theta_0[i] - \pi, 2\pi) \quad \theta_0 > 0$$

$$\theta_0[i] = fmod(\theta_0[i] + \pi, 2\pi) \quad \theta_0 < 0$$

② 求  $\theta_1$  的关节角度

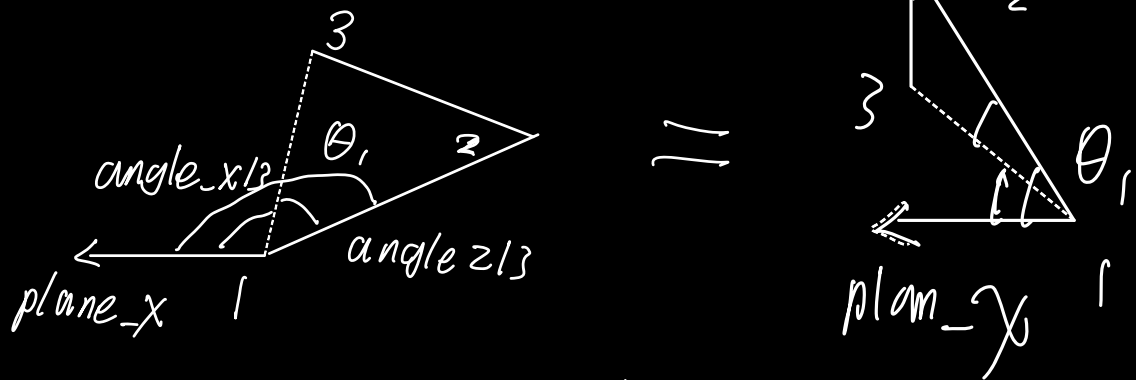
$\Rightarrow$  structure 1



$$\theta_1 = \text{angle\_x/3} - \text{angle\_2/3}$$

$$\theta_2 = \text{theta2bias} - \text{angle\_123}$$

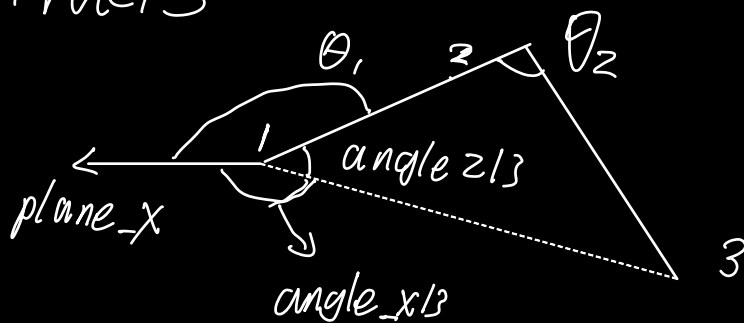
2) struct 2



$$\theta_1 = \text{angle\_x13} + \text{angle\_z13}$$

$$\theta_2 = \text{theta2Bias} - (2\pi - \text{angle123})$$

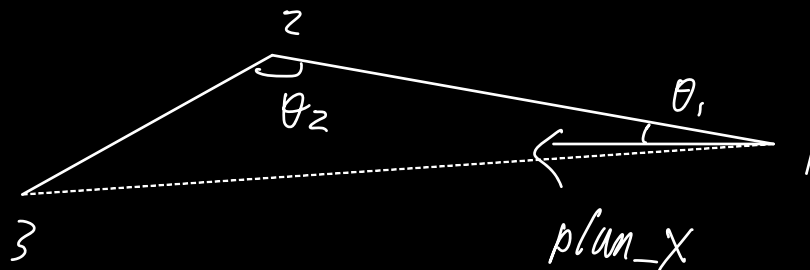
3) struct 3



$$\theta_1 = 2\pi - \text{angle\_x13} - \text{angle\_z13}$$

$$\theta_2 = \text{theta2Bias} - \text{angle123}$$

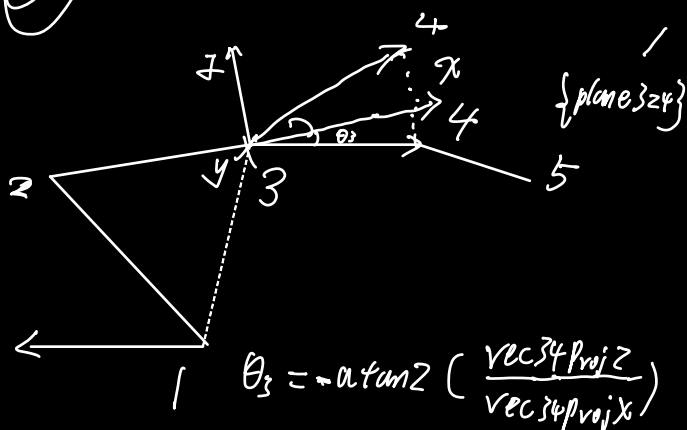
4) struct 4



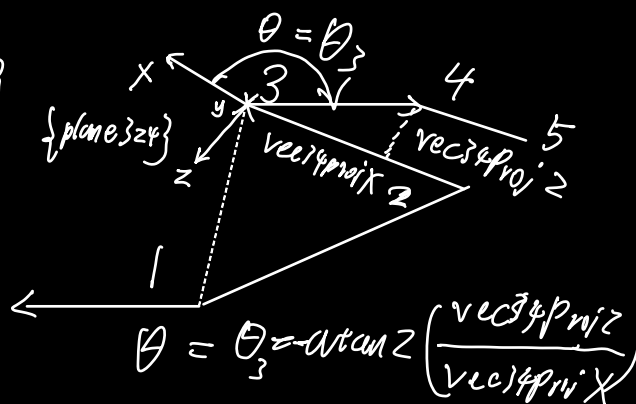
$$\theta_1 = \text{angle } 213 - \text{angle\_x}13$$

$$\theta_2 = \text{theta}213_{\text{axis}} - (2\pi - \text{angle}123)$$

③ 求  $\theta_3$



$$\theta_3 = \arctan 2 \left( \frac{\text{vec}34\text{proj}z}{\text{vec}34\text{proj}x} \right)$$



$$\theta = \theta_3 = \arctan 2 \left( \frac{\text{vec}34\text{proj}z}{\text{vec}34\text{proj}x} \right)$$

$$\text{plane}324x = R2.col(0)$$

$$\text{plane}324z = (\text{plane}324x \times \text{plane}1234y).normalized()$$

④ 最后两关节角度:  $\theta_4, \theta_5$

$$T_{45} \cdot T_{56} = T_{46}$$

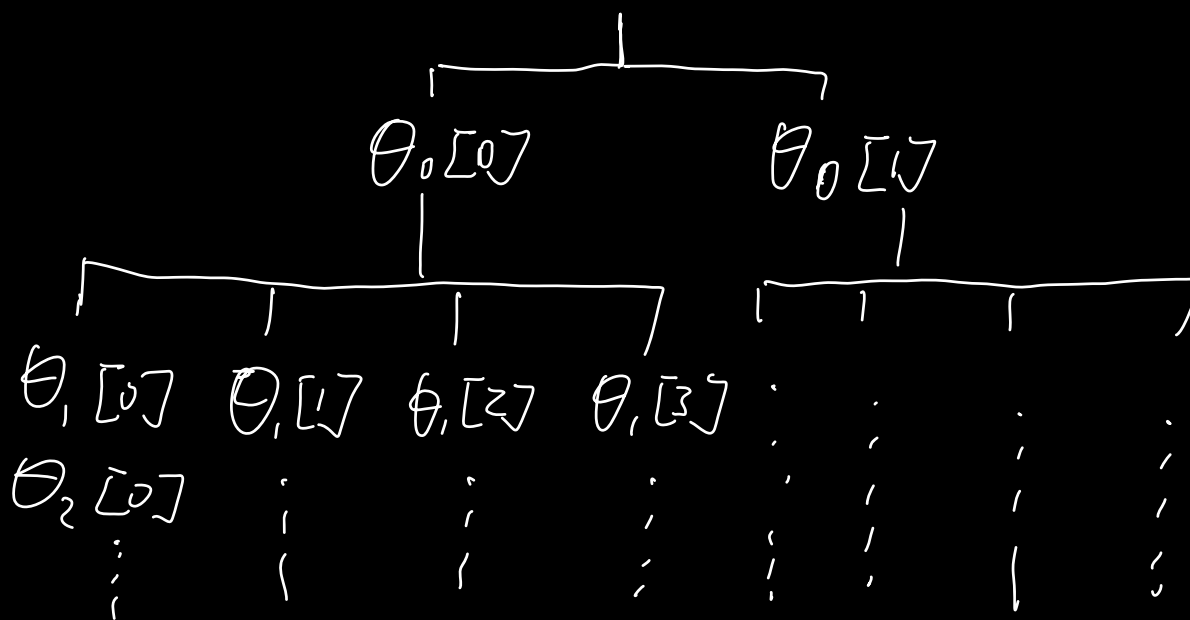
$$T_5^4 \cdot T_6^5 = T_6^4 \Rightarrow$$

$$T_4^{0-1} T_6^0 = T_0^4 \cdot T_6^4 = T_6^4$$

$$\underline{\underline{T_5^4 \cdot T_6^5 = T_4^{0-1} \cdot T_6^0 = T_6^4}}$$

⑤ 计算步骤图

8 种中构型

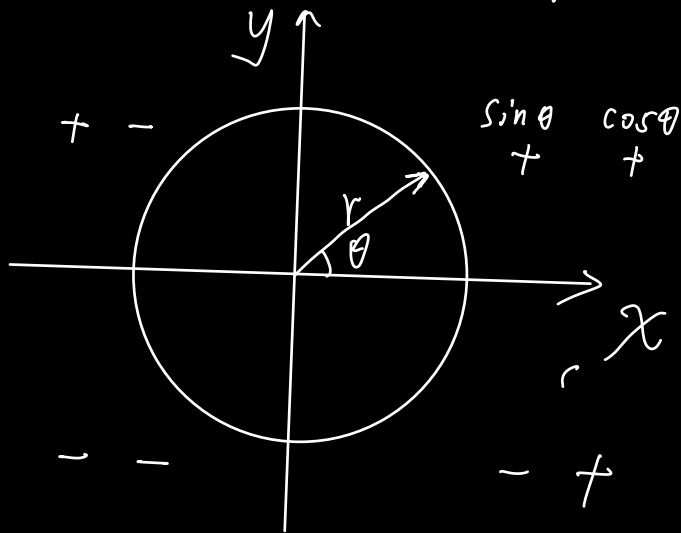


## 二、其它

### (1) 圆形轨迹

$$\text{position\_x} = \text{center\_x} + \text{radius} \cdot \sin(\theta)$$

$$\text{position\_y} = \text{center\_y} + \text{radius} \cdot \cos(\theta)$$



### (2) random number verify

C++中  $[0, 1]$  浮点数:  $\text{rand}() / \text{double}(\text{RAND\_MAX})$

eg.  $[a, b]$  random number  $\text{rand}$

$$a + \text{rand} \cdot (b - a)$$

(17)

end  
endMountPosLocal  
jointPos.at(5)

$$\text{jointPos.at}(5) = \text{PgPos} - \text{endMountPosLocal}$$