

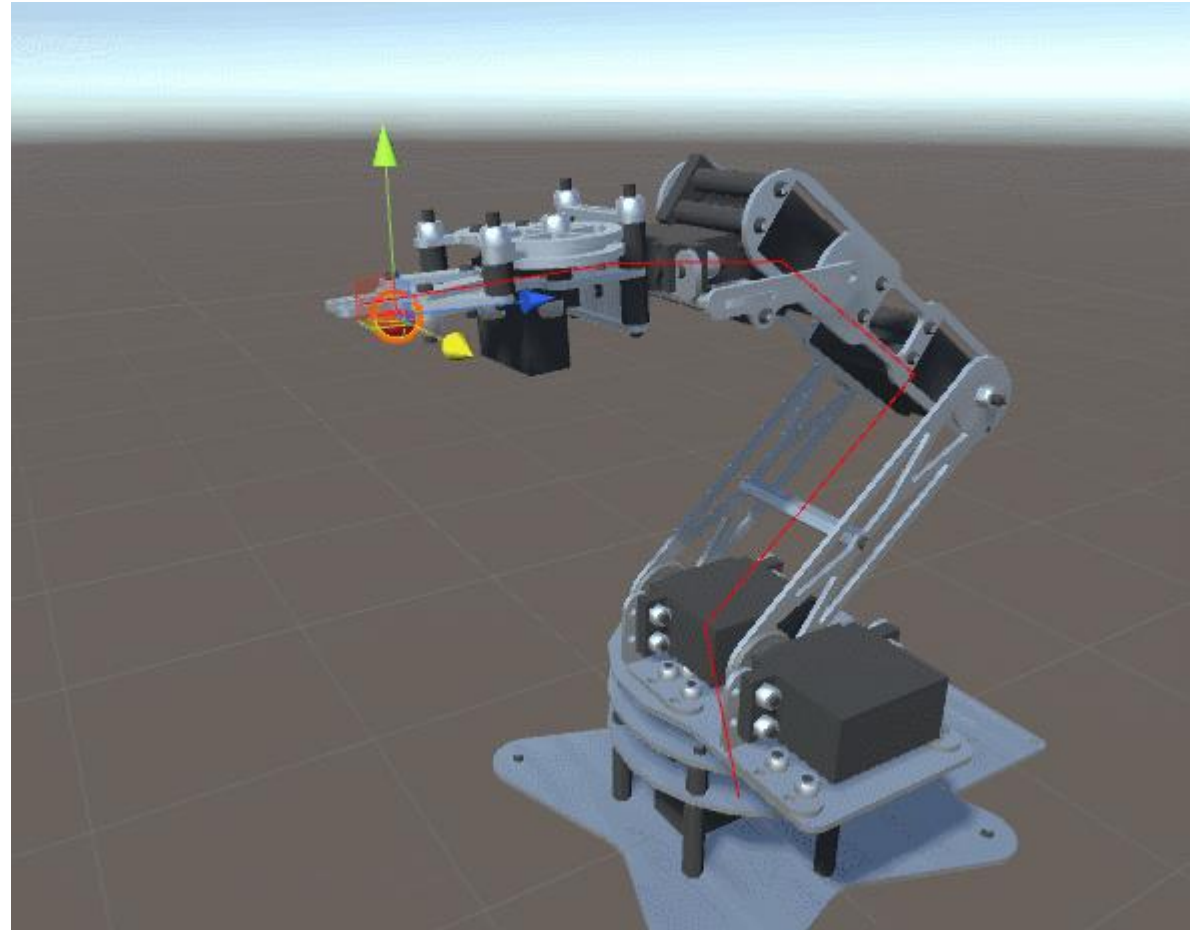
# Animation Foundations

## 08. Direct Kinematics Exercises



# Last week

- Axis angle rotations in practice
- Quaternion rotation
  - Making a rotation
  - Finding a rotation offset
  - Maintaining a rotation offset
  - Removing a rotation offset



# Exercise 5 (last weeks)

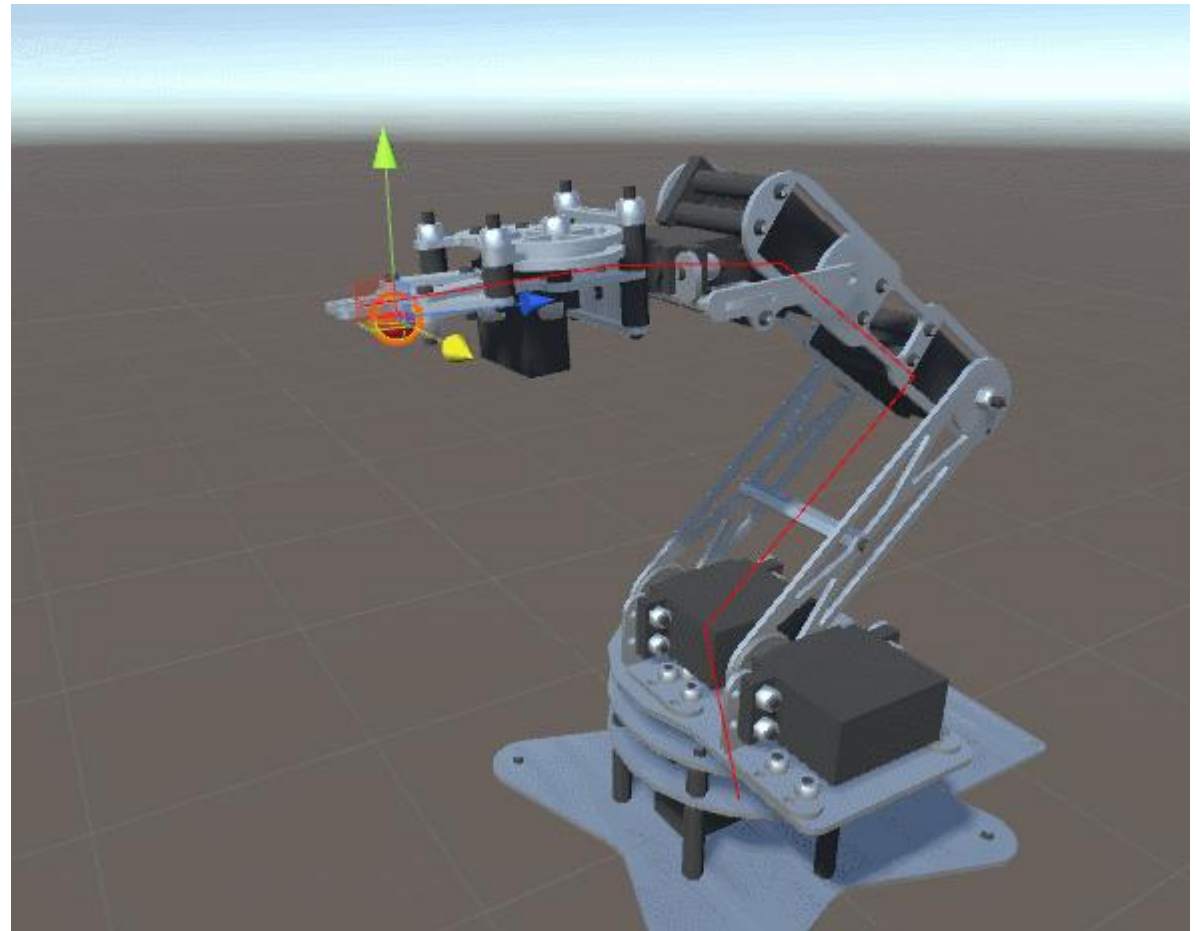
Write your own Quaternion class that:

- Always keeps values normal
- Can multiply quaternions
- Can invert quaternions
- Can convert from axis angle
- Can convert to axis angle
- Optionally, gives a warning if it is rotating more than  $180^\circ$

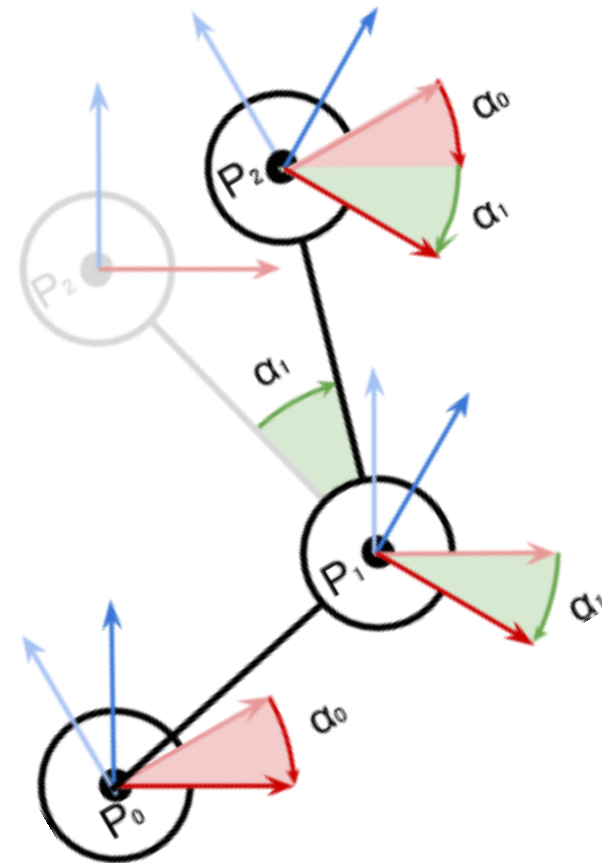
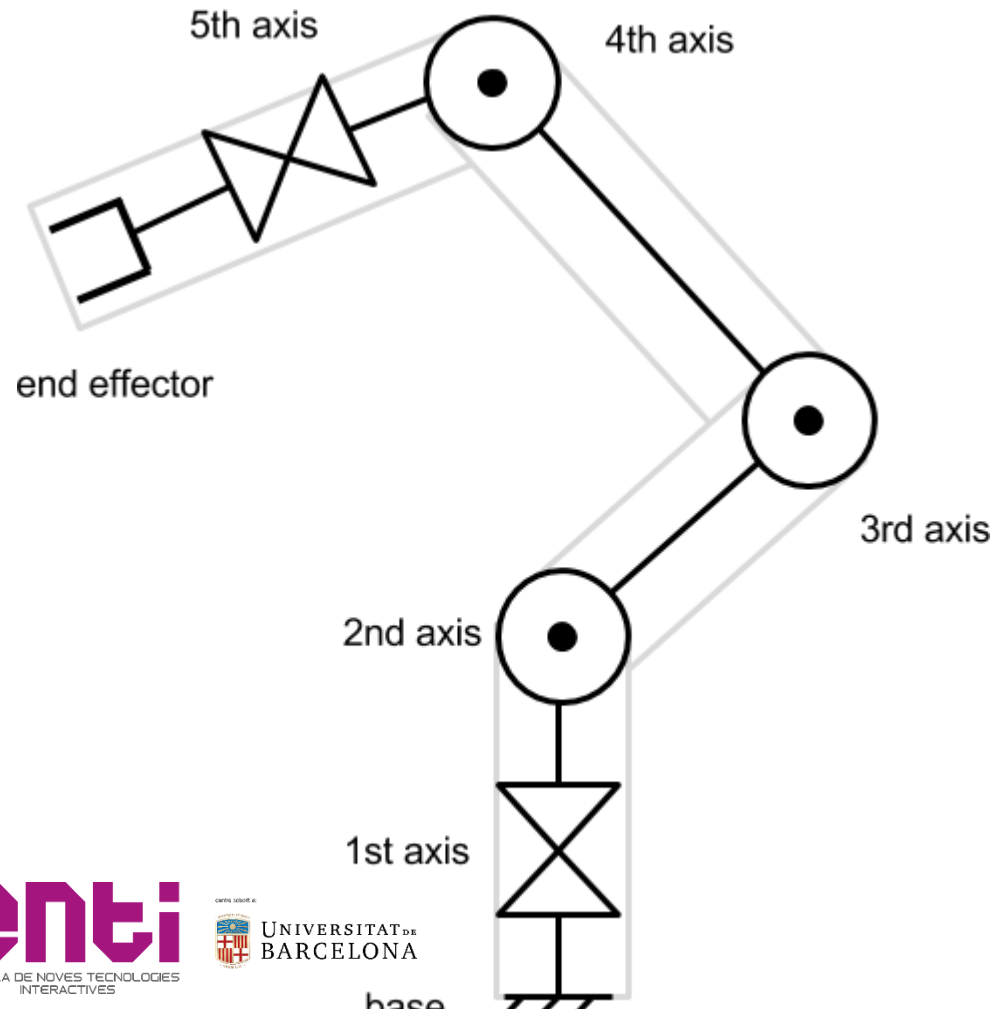
- Check that exercise 4 still Works when using it

# Outline for next weeks

- Forward Kinematics
- Constraints
- Inverse Kinematics (IK)
  - Cyclic Coordinate Descent
  - Fabric
  - Gradient Descent
- IK with constraints



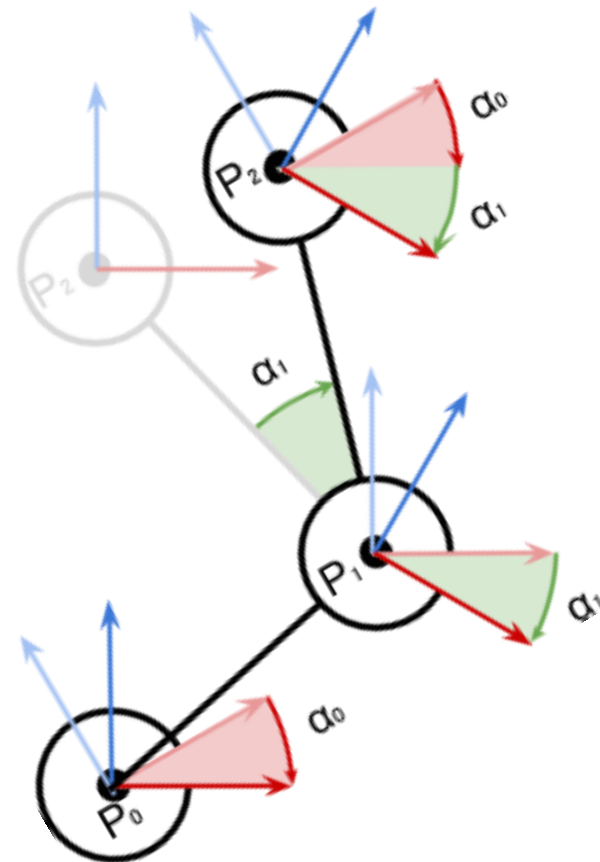
# Direct Kinematics



# Direct Kinematics. Exercise 1

Find position endeffector in 2D  
depending on:

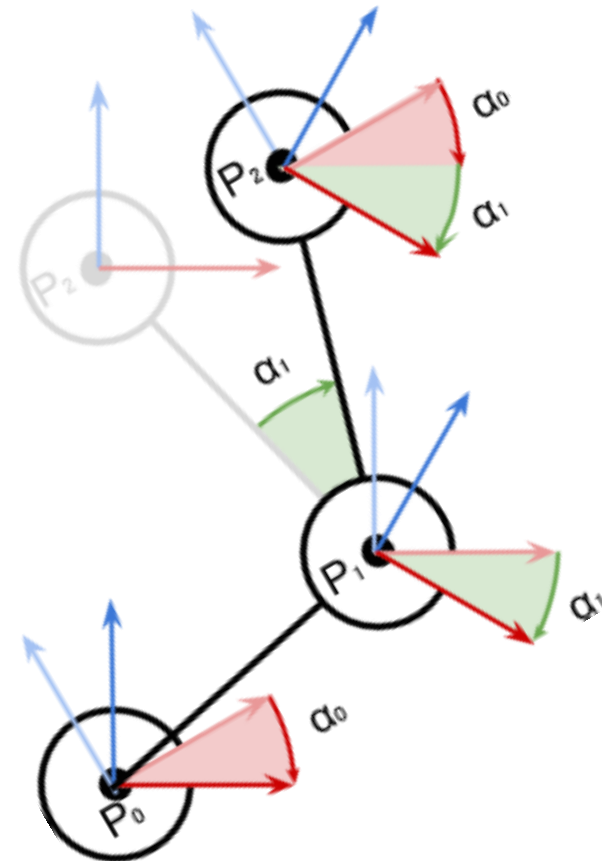
- $\alpha_0$
- $\alpha_1$
- $\alpha_2$



# Direct Kinematics. Exercise 2

Generalize Exercise 1 to 3D

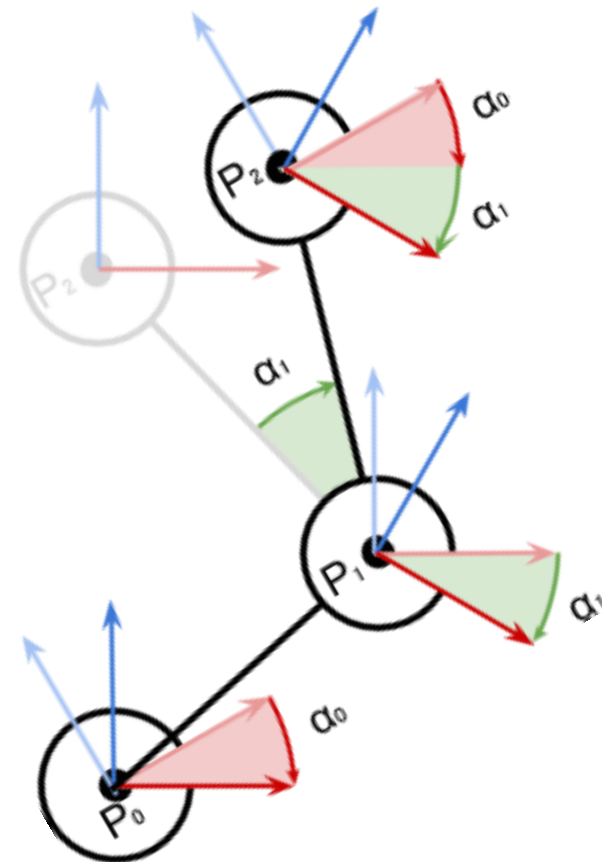
- Assume only 1 axis of rotation per joint
- What 3D rotation method do you use?



# Direct Constraints. Exercise 3

Make a function that constrains the angle of rotation to a maximum value `MaxAngle`

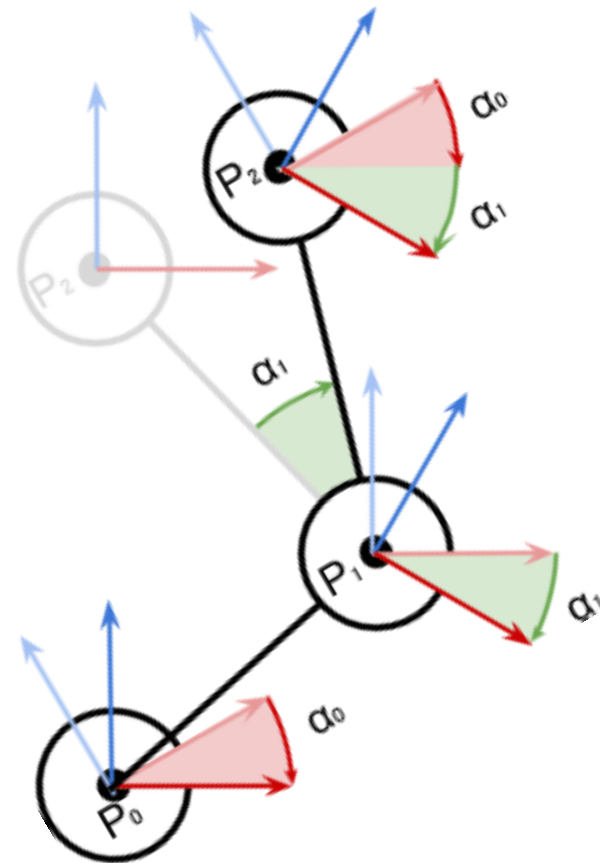
Complete the script `angleConstraints` in the project provided





# Direct Constraints. Exercise 4

Add a minimum angle as a constraint MinAngle



# Direct Constraints. Exercise 5

Reproduce exercises 1 to 4 with your own Quaternion class.

