



THE HONG KONG  
POLYTECHNIC UNIVERSITY  
香港理工大學

INDUSTRIAL CENTRE  
工業中心

# Control and Automation IC2122 Robotics Lab with VREP

Instructor: Louis Wong

Industrial Centre

The Hong Kong Polytechnic University

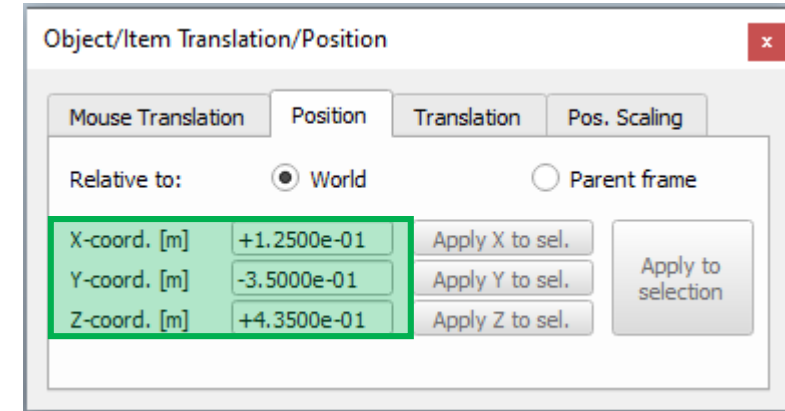
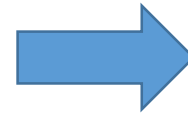
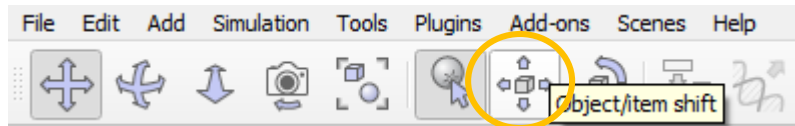
# V-REP Tools

- Object Position:

1. Select the object

2. Click

3. Position: X, Y, Z

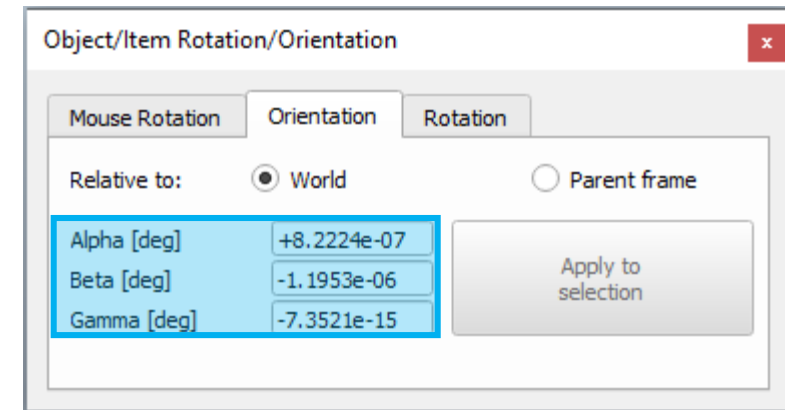
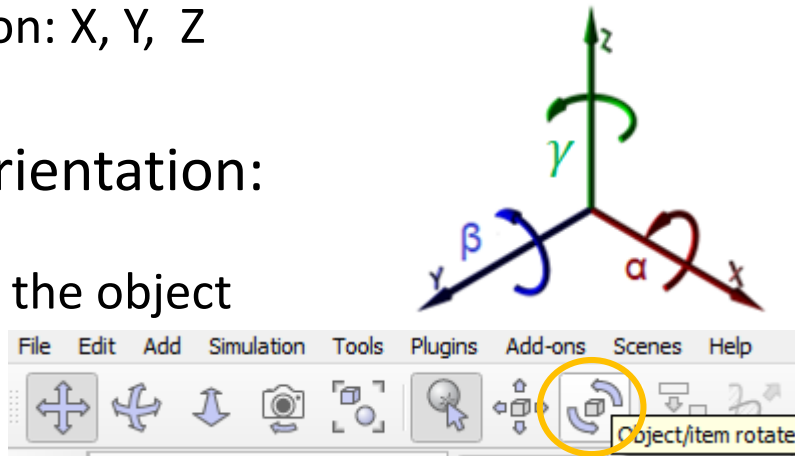


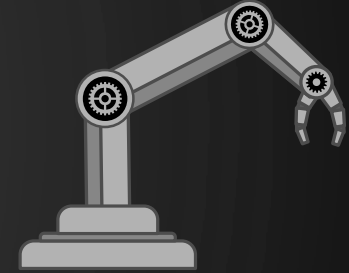
- Object Orientation:

1. Select the object

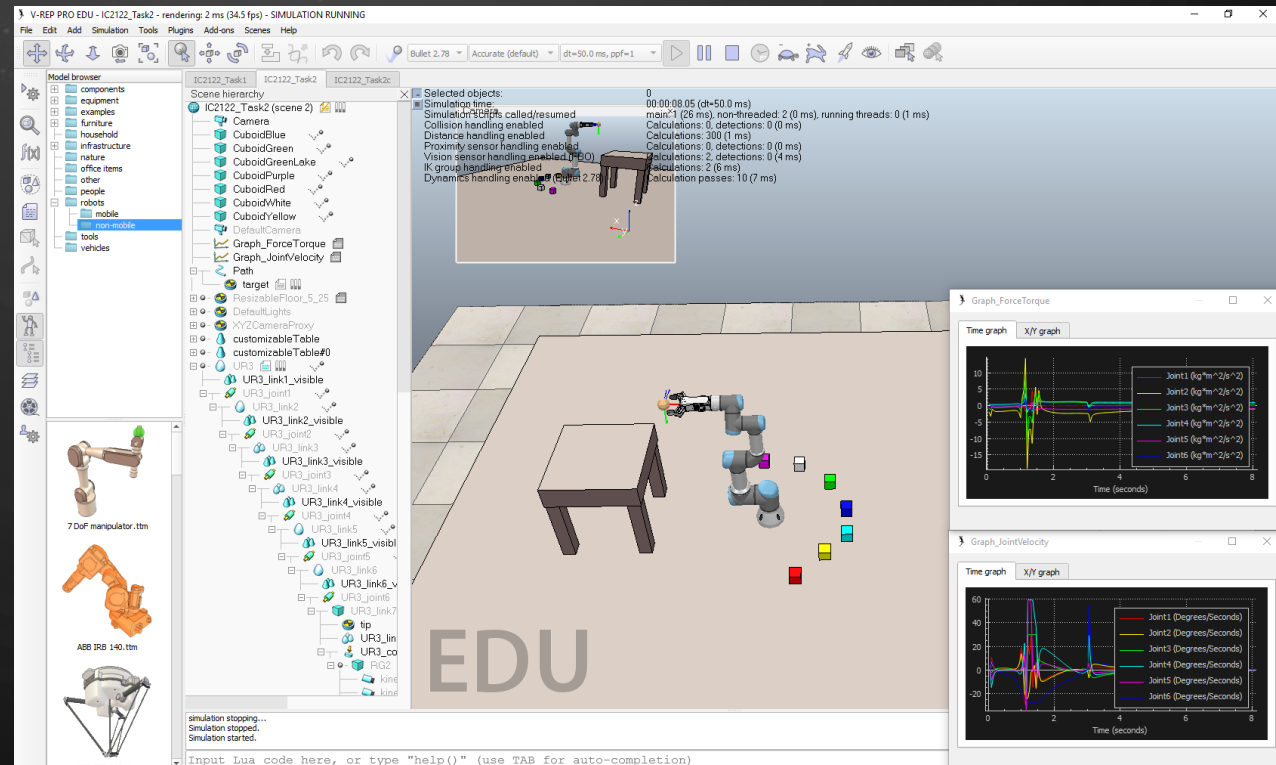
2. Click

3. Orientation: Alpha ( $\alpha$ ), Beta ( $\beta$ ), Gamma( $\gamma$ )





# Task 2: Inverse Kinematics



# Start-up – V-REP

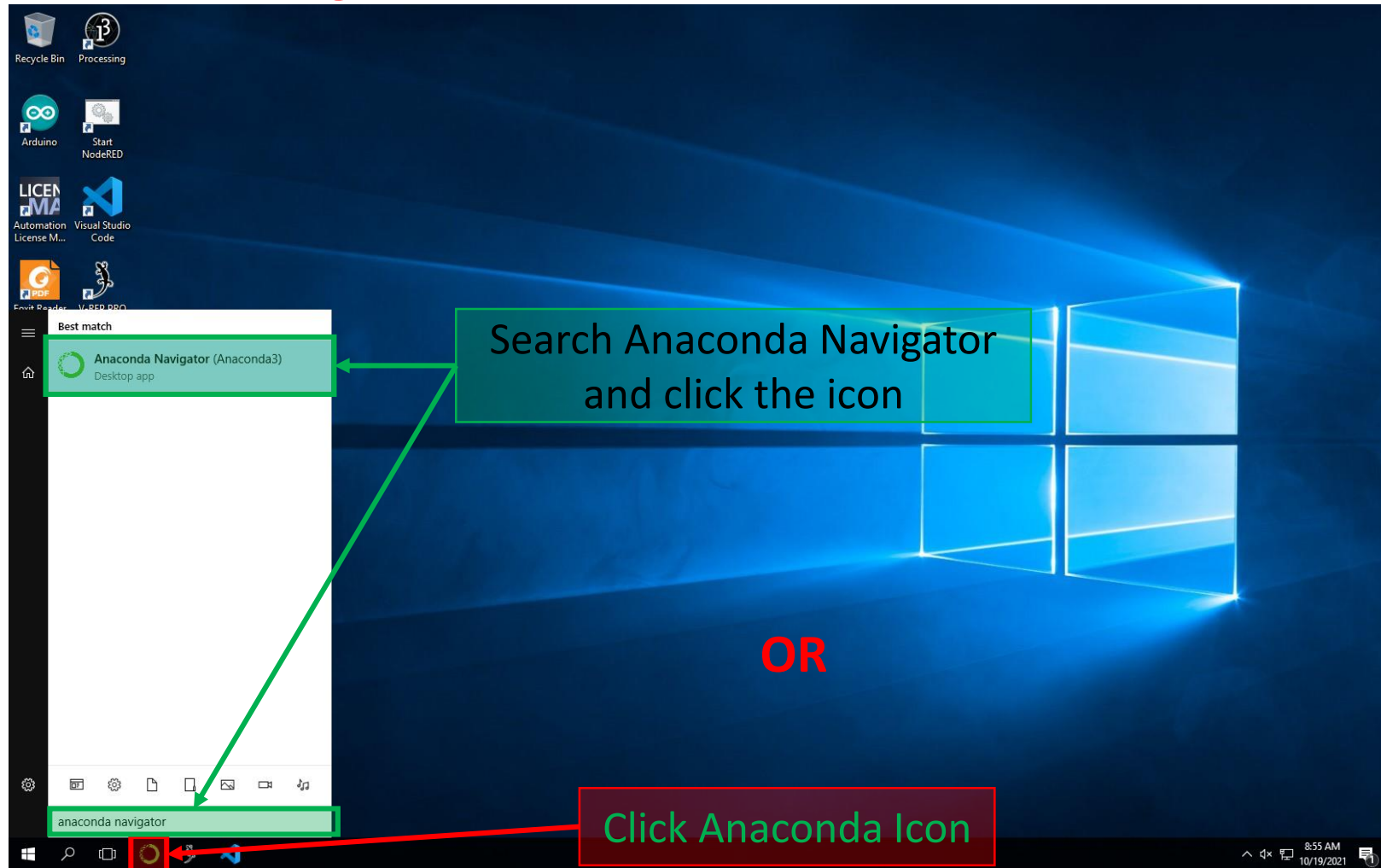
- Start the V-REP (Task2\_vrep.bat)

The screenshot shows a Windows File Explorer window titled 'IC2122-Robotics'. The address bar displays the path 'This PC > DATA (D:) > 01-Home > IoT > IC2122-Robotics'. A green box highlights the address bar, and a text box to its right contains the path 'D:\01-Home\IoT\IC2122-Robotics'. The left sidebar shows the navigation pane with 'This PC' selected. The main pane displays a list of files and folders. The file 'Task2\_vrep' is highlighted with a purple box. A purple arrow points from a text box labeled 'Double-Click' to the highlighted file.

Name	Date modified	Type	Size
Task1	10/18/2021 9:43 AM	File folder	
Task2	10/18/2021 9:43 AM	File folder	
Task3	10/18/2021 9:44 AM	File folder	
Task4	10/18/2021 9:42 AM	File folder	
IC2122_Task1_r4	10/18/2021 9:41 AM	Microsoft PowerP...	8,301 KB
IC2122_Task2_r4	10/18/2021 9:41 AM	Microsoft PowerP...	6,613 KB
IC2122_Task3_r3	10/18/2021 9:41 AM	Microsoft PowerP...	7,015 KB
IC2122_Task4_r2	10/18/2021 9:41 AM	Microsoft PowerP...	8,072 KB
IC21122-Robotics-Task1-2	10/11/2021 5:21 PM	Microsoft Word 9...	73 KB
IC21122-Robotics-Task3-4	10/12/2021 3:58 PM	Microsoft Word 9...	76 KB
README	9/23/2021 8:53 AM	Markdown Source...	8 KB
Task1_vrep	10/5/2021 9:55 AM	Windows Batch File	1 KB
Task2_vrep	10/5/2021 4:35 PM	Windows Batch File	1 KB
Task2c_vrep	10/5/2021 4:35 PM	Windows Batch File	1 KB
Task3_vrep	10/11/2021 11:30 ...	Windows Batch File	1 KB
Task4a_vrep	10/11/2021 11:31 ...	Windows Batch File	1 KB
Task4b_vrep	10/11/2021 11:31 ...	Windows Batch File	1 KB
Task4c_vrep	10/11/2021 11:31 ...	Windows Batch File	1 KB

# Start-up – Anaconda Navigator

- Start the **Anaconda Navigator** on Taskbar or search Windows

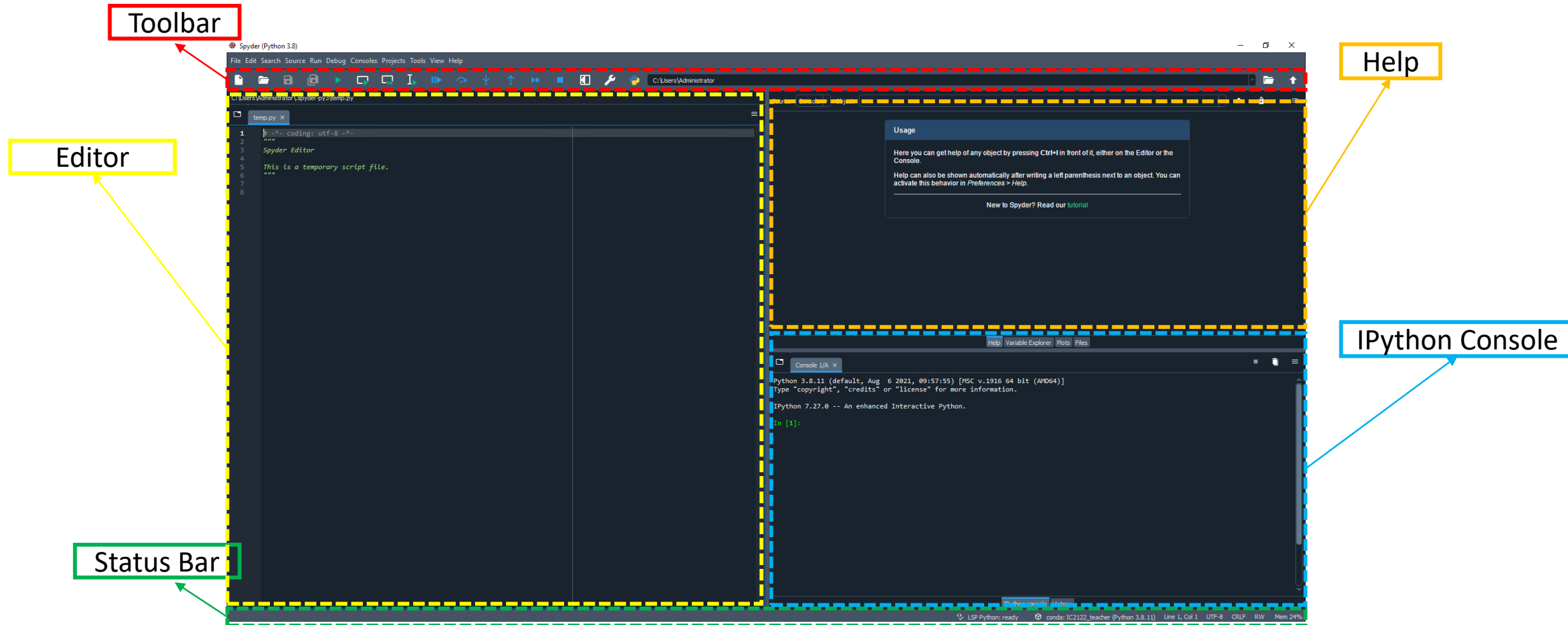


# Start-up – Spyder

- Launch Spyder

The screenshot displays the Anaconda Navigator application window. The interface includes a top menu bar with 'File' and 'Help', and a left sidebar with navigation options: 'Home' (highlighted with a blue box and callout 1), 'Environments', 'Learning', and 'Community'. The main area is titled 'Applications on' and features a dropdown menu for environment selection (callout 2) showing 'IC2122' and 'base (root)', with 'IC2122' selected (callout 3). Below the dropdown, four application cards are visible: 'Datalore', 'IBM Watson Studio Cloud', 'Qt Console', and 'Spyder'. The 'Spyder' card is highlighted with a yellow box and callout 4, showing its version '5.0.5' and a 'Launch' button. The 'Spyder' card also includes a description: 'Scientific PYTHON Development Environment. Powerful Python IDE with advanced editing, interactive testing, debugging and introspection features'.

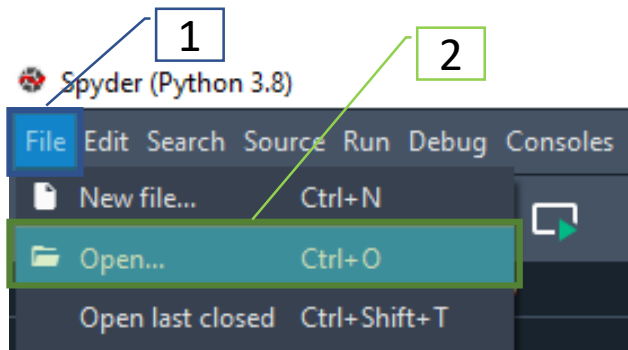
# Start-up – Spyder



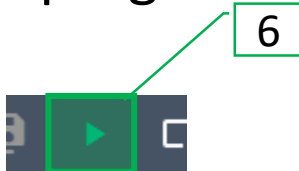


# Start-up – Spyder

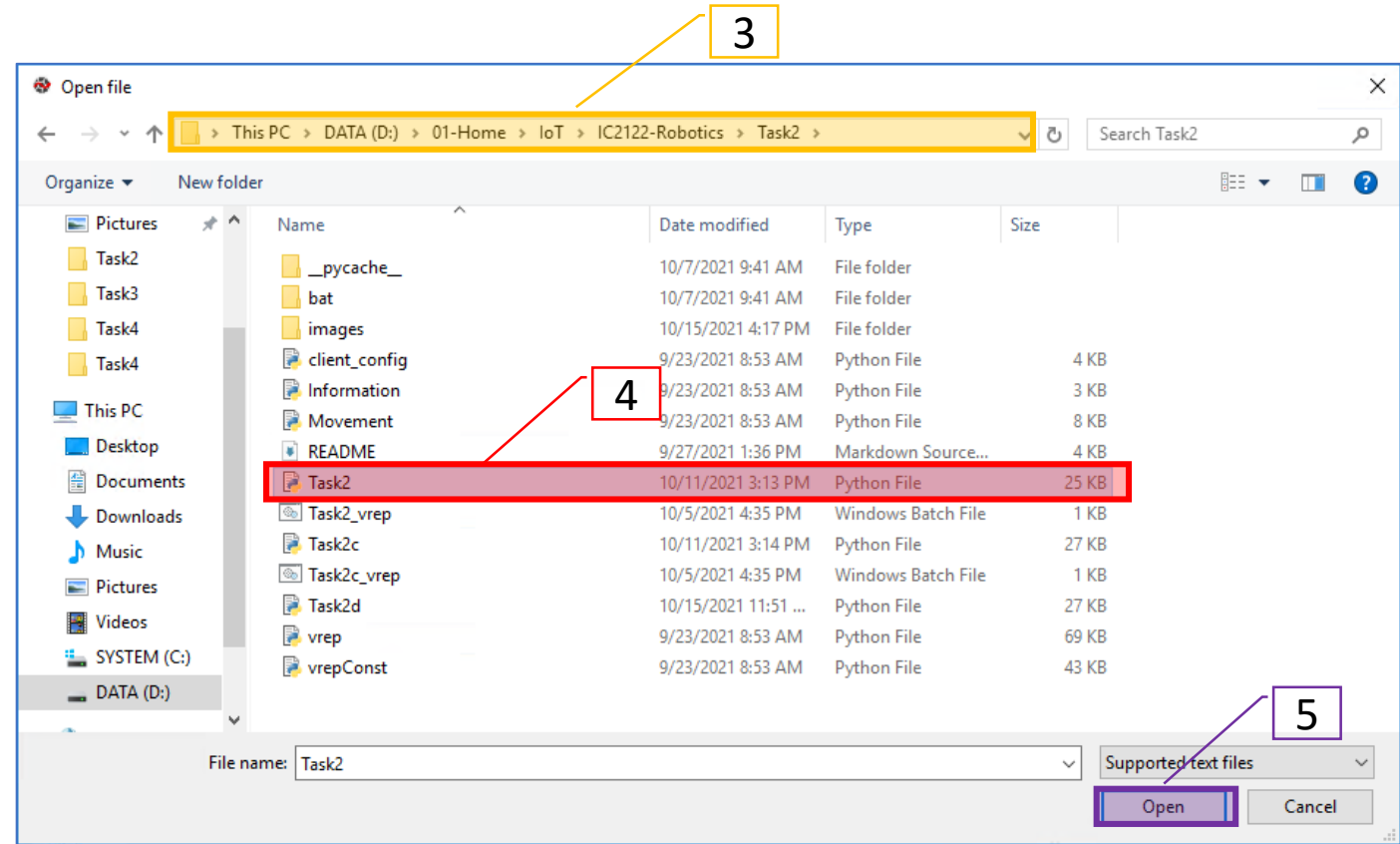
- **Open** Python file at editor



- **Run** the program at Spyder



D:\01-Home\IoT\IC2122-Robotics\Task2

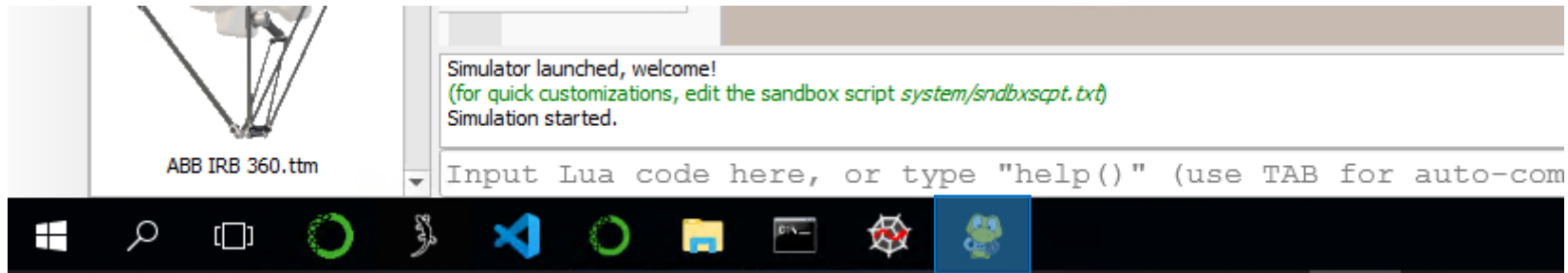




# Start-up – Control panel window

---

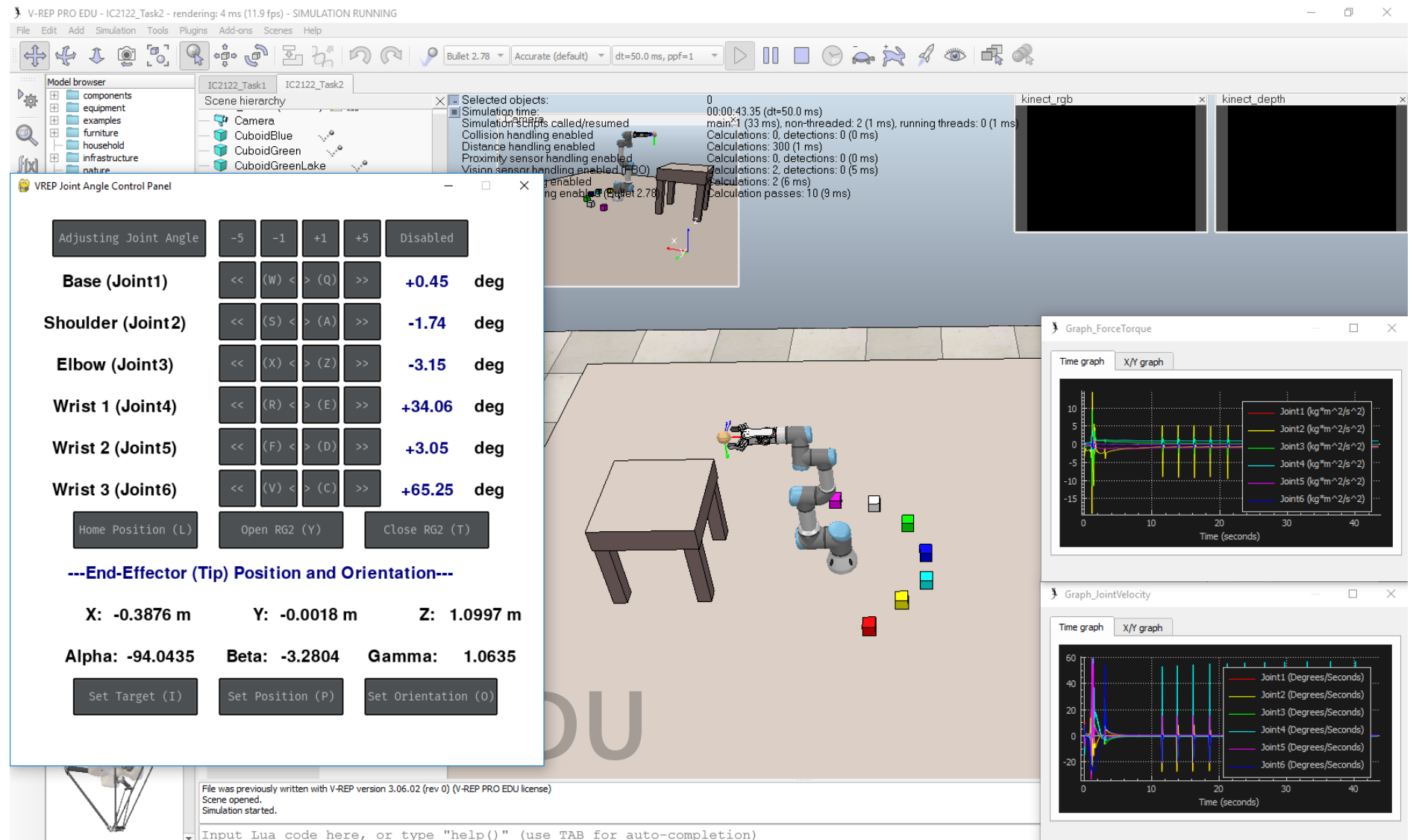
- Control panel window will be appeared after running the program
- After switching to the V-REP, the control panel window will be hidden
- **Click** the Control panel window icon to open it.



Click this icon

# Start-up

- V-REP interface:



# V-REP Joint Angle - Control Panel

- Target Configuration

1. Set Target (T)

(Input your value at Console)

- Set target Position (X, Y, Z)
- Set target Orientation (Alpha, Beta, Gamma)

```
Input Position X: 0.4
Input Position Y: 0
Input Position Z: 0.435
Input Orientation Alpha (in degree): 0
Input Orientation Beta (in degree): 90
Input Orientation Gamma (in degree): 180
```

Joint Angle configuration disabled

Home Position (T)    Open R02 (T)    Close R02 (T)

---End-Effector (Tip) Position and Orientation---

X: -0.0048 m    Y: 0.3887 m    Z: 1.1039 m

Alpha: 135.4654    Beta: -87.2704    Gamma: 50.8909

Set Target (I)

Set Position (P)

Set Orientation (O)

2. Set Position (P)

(Input your value at Console)

- Set target Position (X, Y, Z)

```
Input Position X: 0.4
Input Position Y: 0
Input Position Z: 0.435
```

3. Set Orientation (O)

(Input your value at Console)

- Set target Orientation (Alpha, Beta, Gamma)

```
Input Orientation Alpha (in degree): 0
Input Orientation Beta (in degree): 90
Input Orientation Gamma (in degree): 180
```

# V-REP Joint Angle – How to use "Set Target" button?

- How to use the "Set Target" button?

1. Click "Set Target" button



Step 1

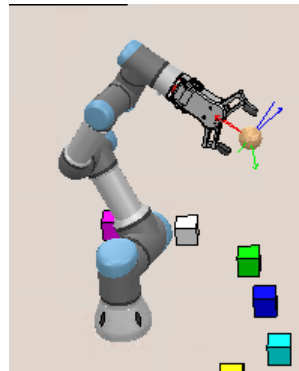
2. Switch to the Spyder IPython Console

3. Input **Position or Orientation** value

4. Press "Enter" to confirm the inputted value

5. Repeat above two steps  
(X, Y, Z, Alpha, Beta, Gamma)

6. The UR3 will be moved  
based on the setting



Step 6

Step 2

```
pygame 2.0.1 (SDL 2.0.14, Python 3.8.11)
Hello from the pygame community. https://www.pygame.org/contribute.html
Simulation started
connect successfully
Simulation start

Input Position X: 0.3
Input Position Y: 0
Input Position Z: 0.9
Input Orientation Alpha (in degree): 0
Input Orientation Beta (in degree): 43
Input Orientation Gamma (in degree): -169
```

Step 3&4

Step 5

# IC2122 – Task 2a

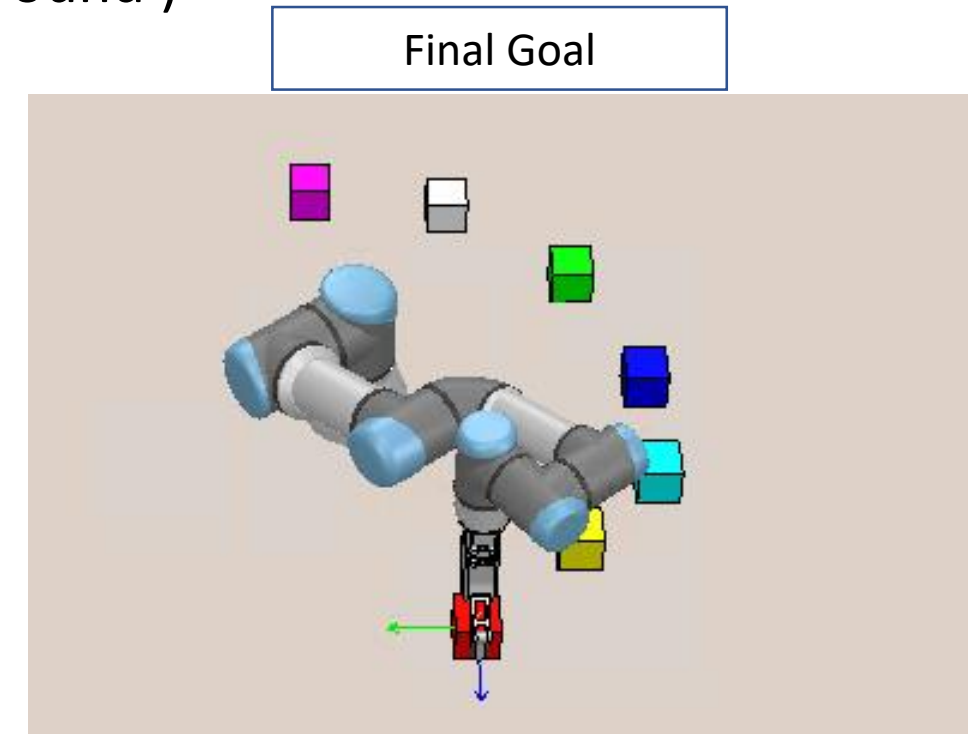


- Task 2a: **Move** the end-effector to the **RED** block using **Inverse Kinematics** and write down the procedure.
- (Remark: Adjust the end-effector **vertically** to the ground )

Red Block Position:	Position X	Position Y	Position Z
	0.125 m	-0.35 m	0.435 m

## Joint Angle

Base (Joint1)	<< (W) < > (Q) >>	+37.65 deg
Shoulder (Joint2)	<< (S) < > (A) >>	-70.57 deg
Elbow (Joint3)	<< (X) < > (Z) >>	-0.33 deg
Wrist 1 (Joint4)	<< (R) < > (E) >>	+162.7 deg
Wrist 2 (Joint5)	<< (F) < > (D) >>	-89.42 deg
Wrist 3 (Joint6)	<< (V) < > (C) >>	-142.32 deg



# IC2122 – Task 2b

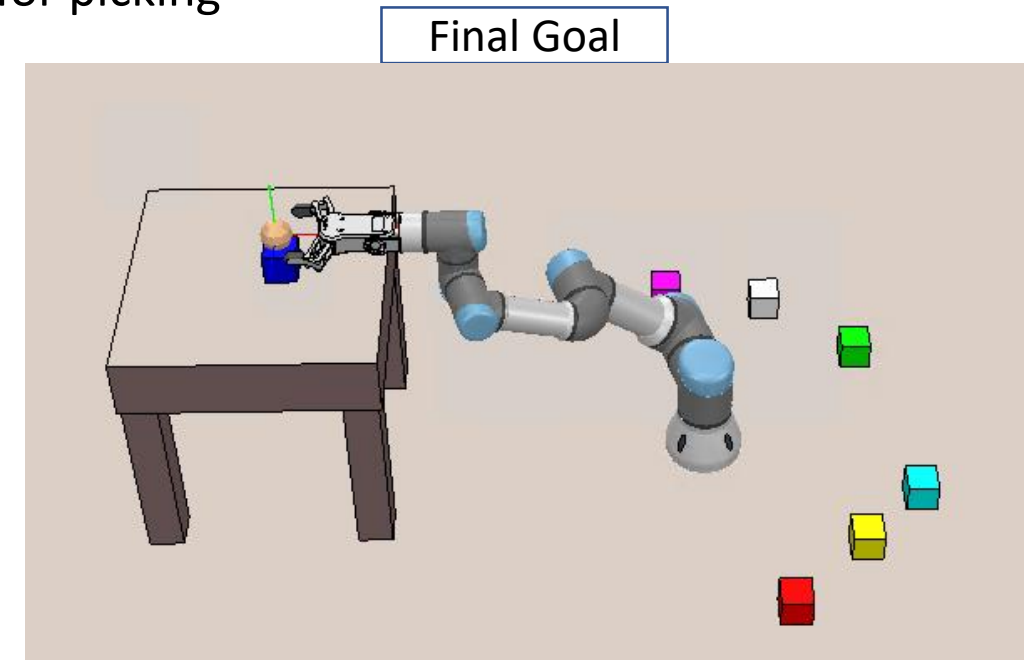
- Task 2b: **Pick** the **BLUE** block and **place** it on the table using **Inverse Kinematics** and write down the procedure.




(Remark: Make the end-effector **vertically** to the ground for picking and **horizontally** to the table for placing)

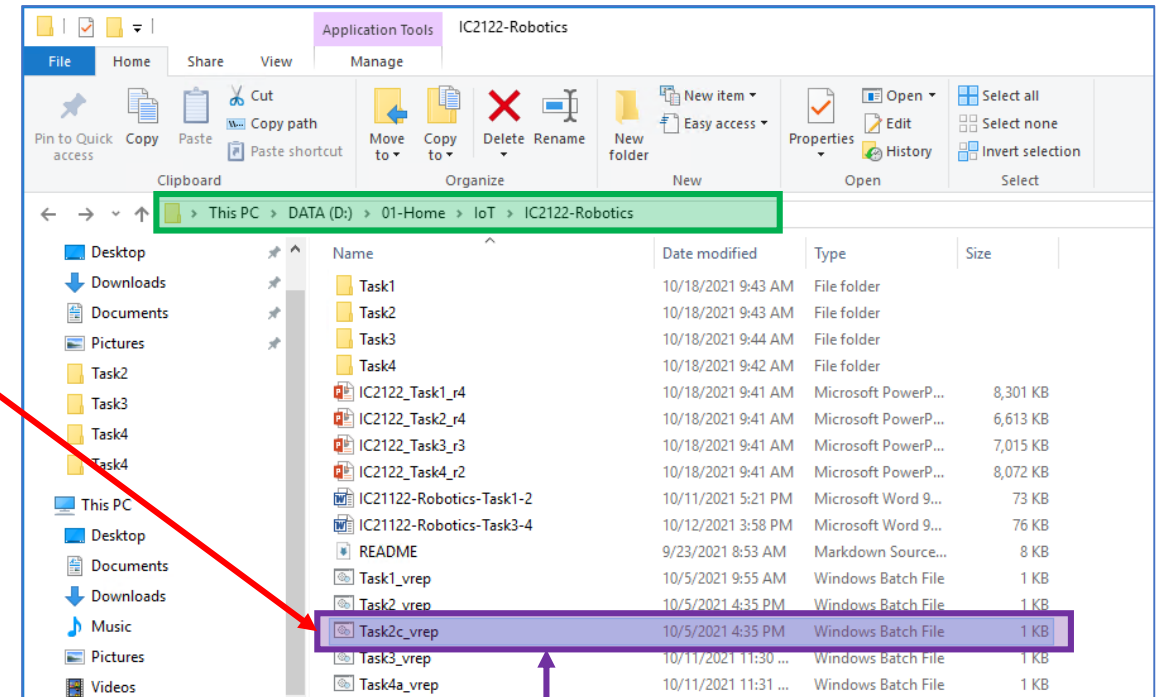
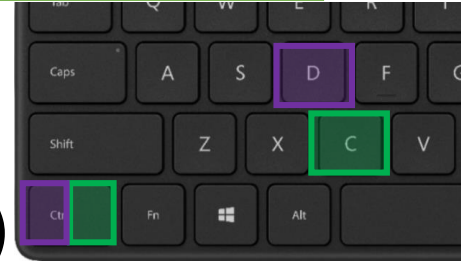
BLUE Block original Position:	Position X	Position Y	Position Z
	0.35 m	0.0225 m	0.435 m

BLUE Block final Position:	Position X	Position Y	Position Z
	$\approx -0.667$ m	$\approx 0$ m	0.846 m



# IC2122 – Task 2c

- **Stop** the program by **holding** “Ctrl” and **clicking** “C” (IPython console)
- **Open** a new console by **holding** “Ctrl” and **clicking** “D” (IPython console)
- **Close** the previous V-REP
- Start a new V-REP (**Task2c\_vrep.bat**)
- **Switch** to Spyder and **open** Tack2c.py  
(D:\01-Home\IoT\IC2122-Robotics\Task2)
- **Run** the program (Spyder) 

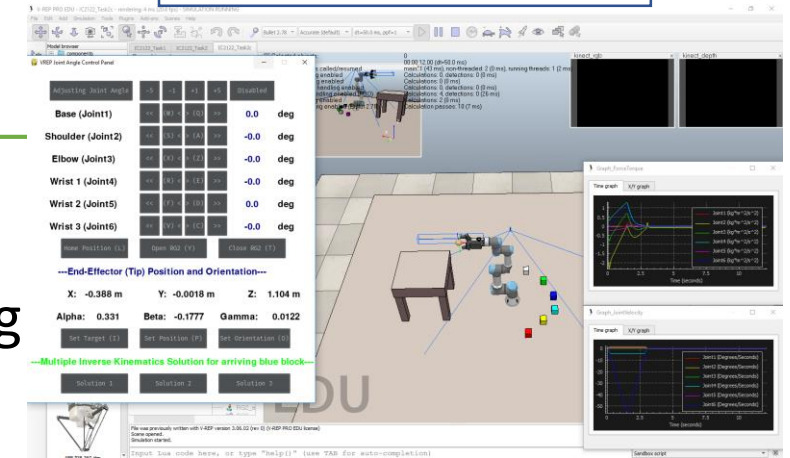


Double-Click



# IC2122 – Task 2c

## Task 2c interface



- Task 2c: **Moving** the end-effector to the **BLUE** block using

**Inverse Kinematics** often provides different solutions or approaches.

- a) **Observe** and **discuss** the below 3 solutions.

---Multiple Inverse Kinematics Solution for arriving blue block---

Solution 1

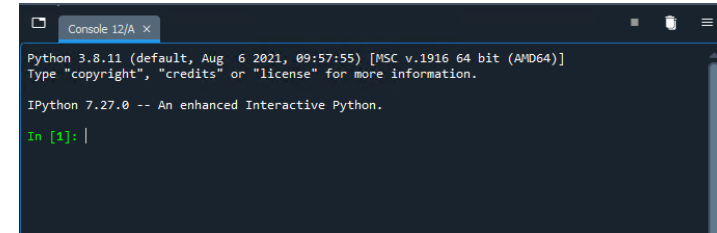
Solution 2

Solution 3

- b) **Suggest** the method to create the unique solution (e.g. guide)

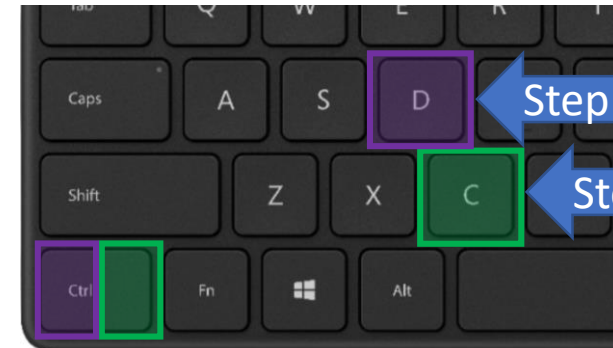
# Task2 – Troubleshoot

- Step 1: **Switch** to the Spyder IPython Console



← Step 1

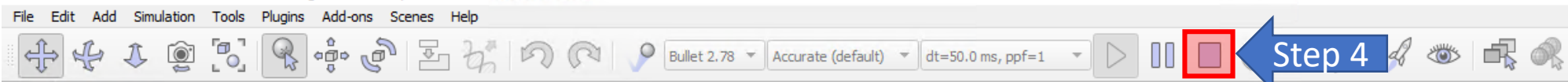
- Step 2: **Stop** the program by **holding** “Ctrl” and **clicking** “C”
- Step 3: **Open** a new console by **holding** “Ctrl” and **clicking** “D”
- Step 4: **Stop** the V-REP simulation



← Step 3

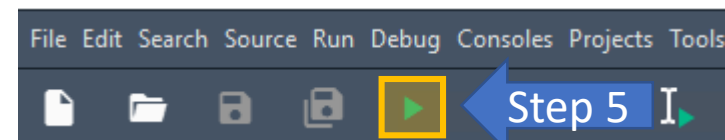
← Step 2

V-REP PRO EDU - IC2122\_Task1 - rendering: 2 ms (45.5 fps) - SIMULATION RUNNING



← Step 4

- Step 5: **Run** the program at Spyder

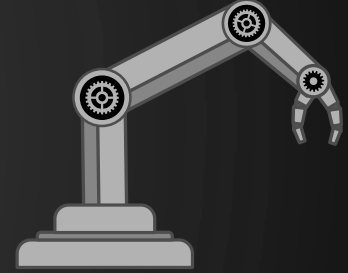


← Step 5



THE HONG KONG  
POLYTECHNIC UNIVERSITY  
香港理工大學

INDUSTRIAL CENTRE  
工業中心



# Q&A

