Robot Morphology

Laboratori 1: **Robot Morphology**

Grup 11- Estudiants:

- **Pol Casacuberta Gil**
- **Marta Granero i Martí**

Link: https://drive.matlab.com/sharing/b8a7f88a-dcb6-4c09-a328-ba6c7e737807

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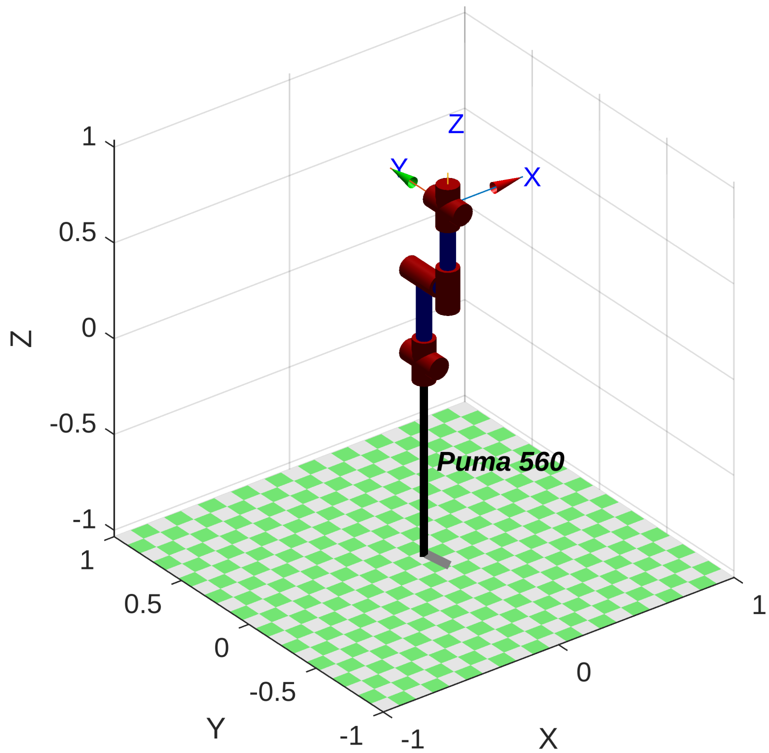
6R Robot. Puma 560

Before start the exercise see the videos:

https://youtu.be/ArzP7rh4_9Q

Call the Wired Robot object and plot it

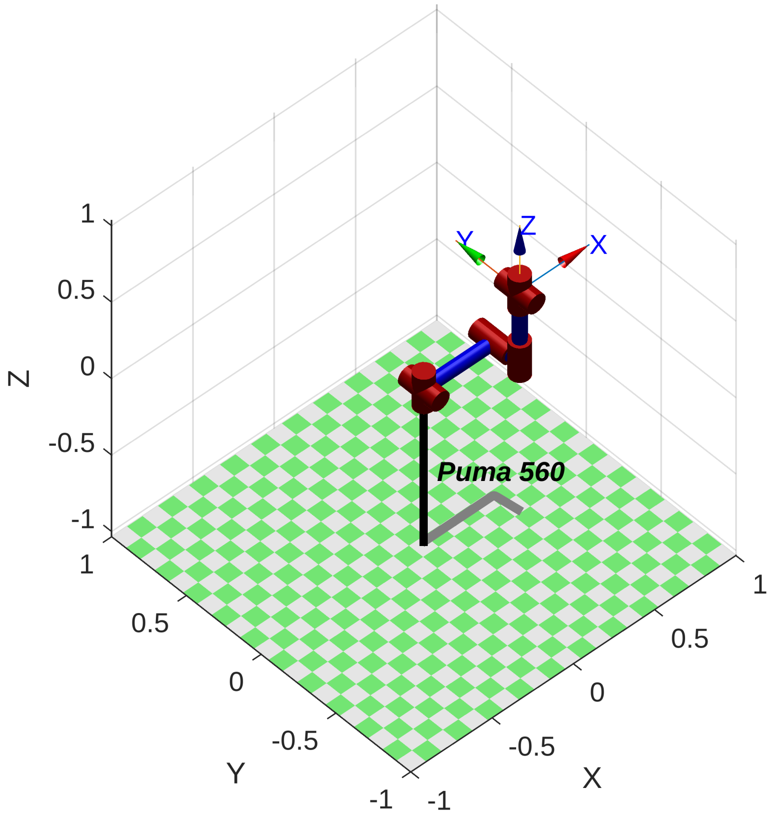
```
close all
clear
mdl_puma560 % Invoque the puma object from the RTB
p560.plot(qr) % qz is the joint vector 1x6. Try qr, qn, any within the limits
```



Work with the wire model and change the point of view.

See: https://es.mathworks.com/help/matlab/creating_plots/setting-the-viewpoint-with-azimuth-and-elevation.html

```
close all
p560.plot(qz)
view([-42.61 46.25])
```



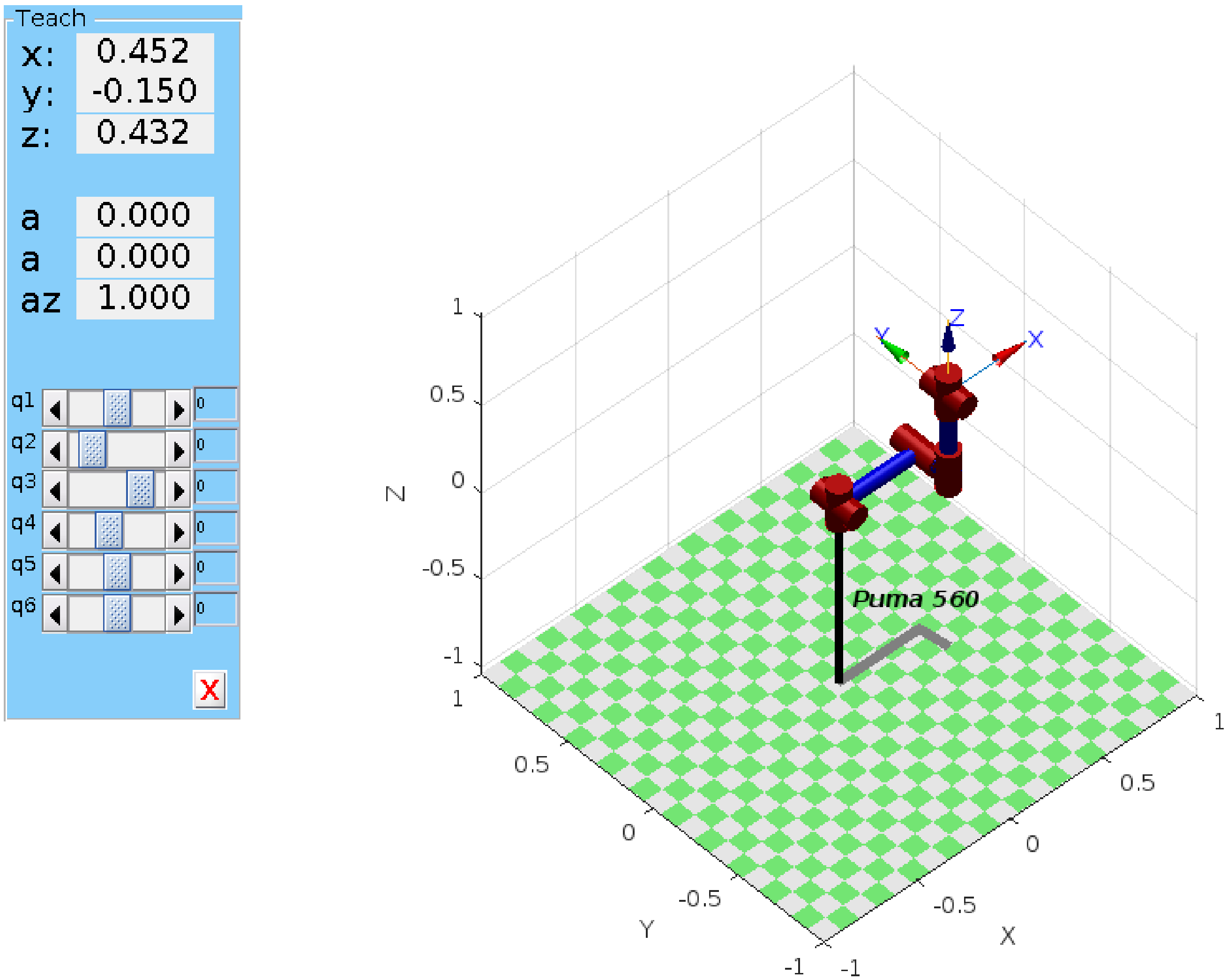
Play with the teach

Modify the joint angle [q1q2 q3 q4 q5 q6]). It is a kind of Joystick.

Pay attention to [x y z].

[ax ay az] are no relevant for the exercise.

```
p560.teach('approach')
```



Moving the Robot

```
clear all
close all
mdl_puma560
```

Declare a joint motion by adding rows

```
Q=zeros(100,6); % at the moment no motion
```

See the Joint 1 limits

```
q1_limits=p560.links(1, 1).qlim
```

```
q1_limits = 1×2
   -2.7925    2.7925
```

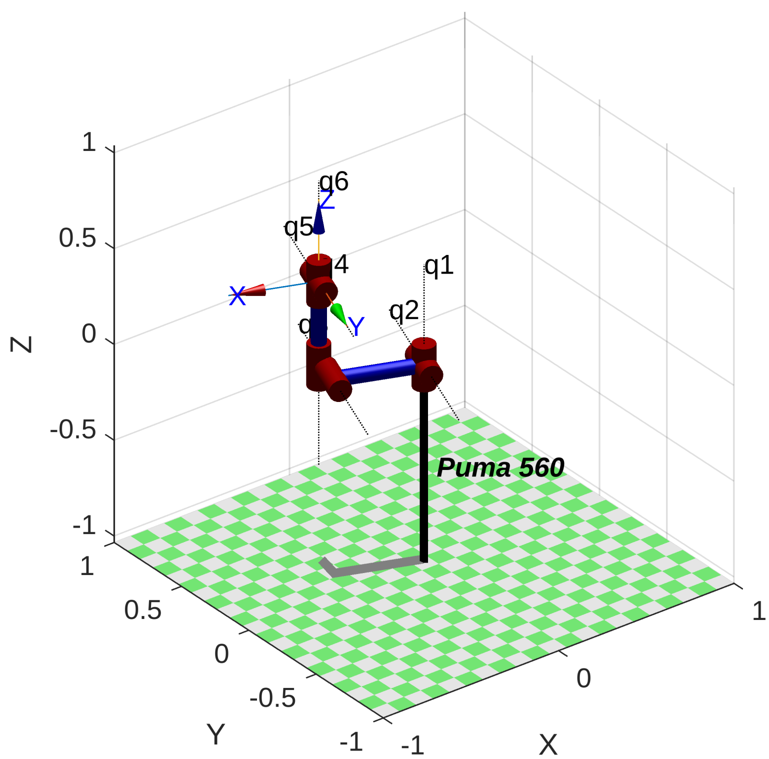
Build the joint's motion. Firts only Joint #1

```
q1=linspace(q1_limits(1),q1_limits(2),100)';
Q=[q1 Q(:,2:6)]
```

```
Q = 100×6
   -2.7925         0         0         0         0         0
   -2.7361         0         0         0         0         0
   -2.6797         0         0         0         0         0
   -2.6233         0         0         0         0         0
   -2.5669         0         0         0         0         0
   -2.5105         0         0         0         0         0
   -2.4540         0         0         0         0         0
   -2.3976         0         0         0         0         0
   -2.3412         0         0         0         0         0
   -2.2848         0         0         0         0         0
      ⋮
```

Plotting

```
p560.plot(Q,'jaxes')
```



Play with the plot options

Moving two joints. See above

```
q2_limits=p560.links(1, 2).qlim
```

```
q2_limits = 1×2
   -0.7854    3.9270
```

```
q2=linspace(q2_limits(1),q2_limits(2),100)';
Q12=[q1 q2 Q(:,3:6)];
```

Options: Add a trail to see the trajectory, display the join axis, make biger or smaller the robot

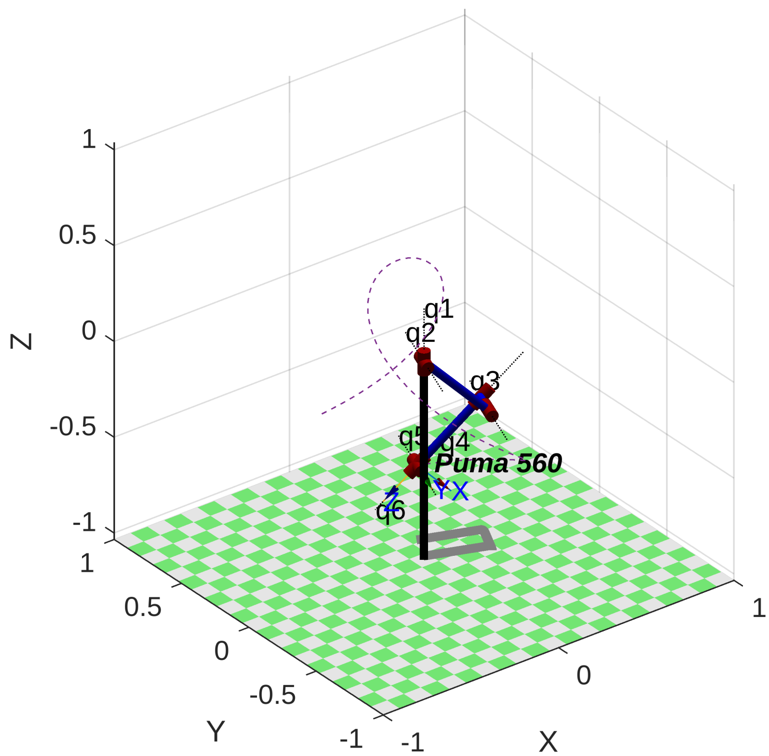
Visit the RTB manual.pdf at:

https://atenea.upc.edu/pluginfile.php/3871049/mod_resource/content/3/robot.pdf

or

https://petercorke.com/toolboxes/robotics-toolbox/

```
close all
mdl_puma560
p560.plot(Q12,'trail','--','jaxes','zoom',2) %% Play outside the mlx file to see it: co
```



Play with other options to get familiar with. You must! becouse all along the course it will be necesary

Recovering End efector position

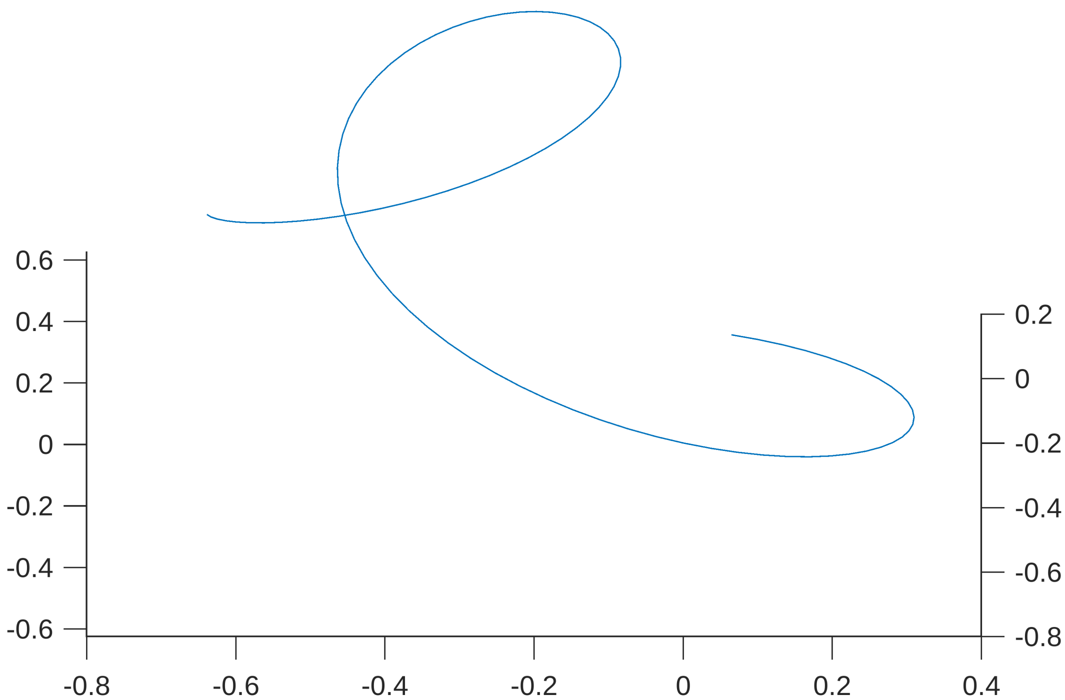
Use function 'fkine' for recovering the finger tips of the robot

```
T=p560.fkine(Q12); % Forward Kinematic to be explained. Given Theta's (q's) obtain the
ft=[T.t] % to gert only the position
```

```
ft = 3×100
```

```
   -0.6386   -0.6335   -0.6251   -0.6135   -0.5990   -0.5817   -0.5618   -0.5397 ...
   -0.0728   -0.1086   -0.1436   -0.1772   -0.2092   -0.2393   -0.2672   -0.2928
   -0.0144    0.0154    0.0451    0.0747    0.1042    0.1334    0.1623    0.1909
```

```
figure
plot3(ft(1,:),ft(2,:), ft(3,:))
view(0,40)
```



Working area

```
clear all
close all
mdl_puma560
q2_limits=p560.links(1, 2).qlim
```

```
q2_limits = 1×2
   -0.7854    3.9270
```

```
q2=linspace(q2_limits(1),q2_limits(2),100)';
Q= [zeros(100,1) linspace(q2_limits(1),q2_limits(2),100)' zeros(100,4) ]
```

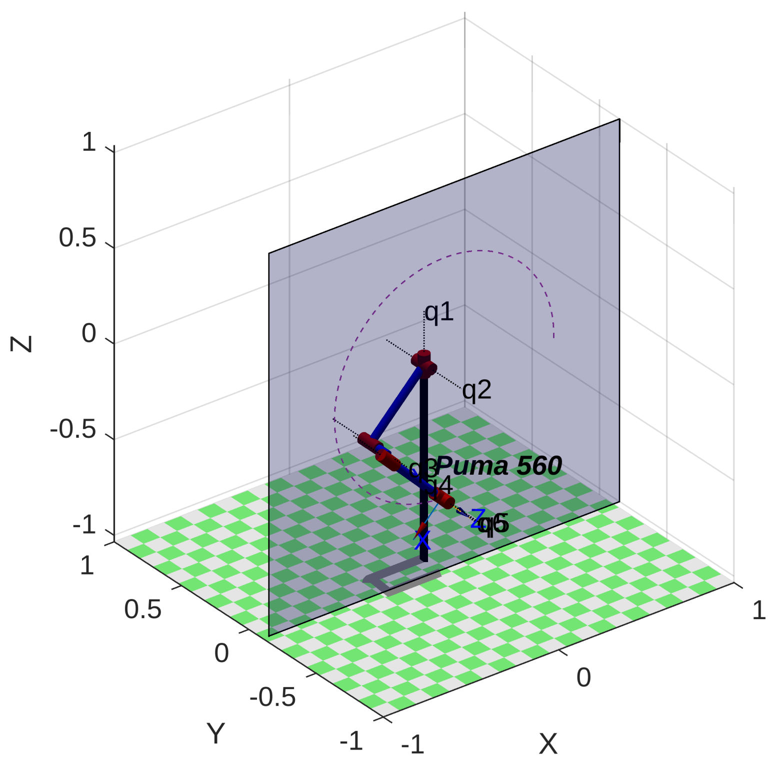
```
Q = 100×6
         0   -0.7854         0         0         0         0
         0   -0.7378         0         0         0         0
         0   -0.6902         0         0         0         0
         0   -0.6426         0         0         0         0
         0   -0.5950         0         0         0         0
         0   -0.5474         0         0         0         0
```

```
         0   -0.4998         0         0         0         0
         0   -0.4522         0         0         0         0
         0   -0.4046         0         0         0         0
         0   -0.3570         0         0         0         0
      ⋮
```

```
p560.plot(Q,'trail','--','jaxes','zoom',2)
T=p560.fkine(Q);
ft=[T.t]
```

```
ft = 3×100
    0.6250    0.6250    0.6235    0.6207    0.6164    0.6108    0.6037    0.5953 ···
   -0.1501   -0.1501   -0.1501   -0.1501   -0.1501   -0.1500   -0.1500   -0.1500
   -0.0144    0.0154    0.0451    0.0747    0.1042    0.1334    0.1623    0.1909
```

```
hold on
v = [-1 -0.1501 -1 ; 1 -0.1501 -1 ; 1 -0.1501 1; -1 -0.1501 1];
f = [1 2 3 4];
patch('Faces',f,'Vertices',v,'FaceColor','blue','FaceAlpha',.3)
```



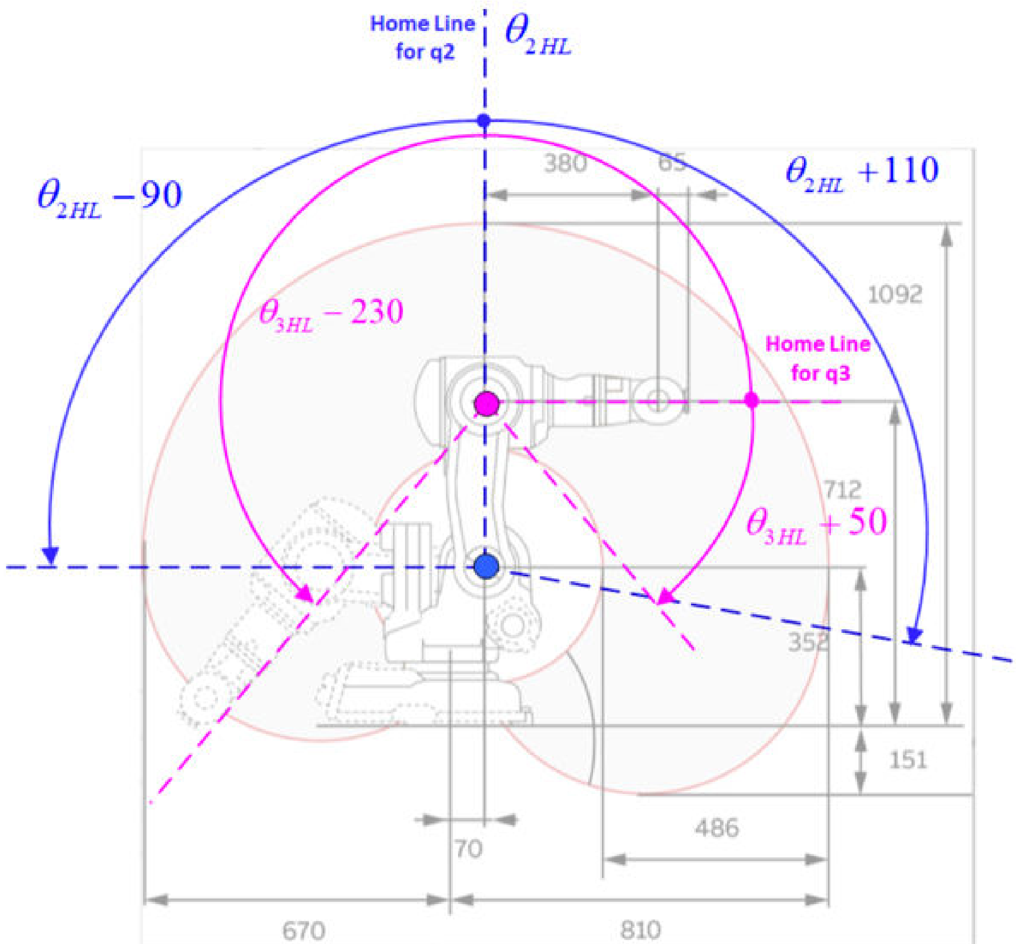
IRB140 exercise

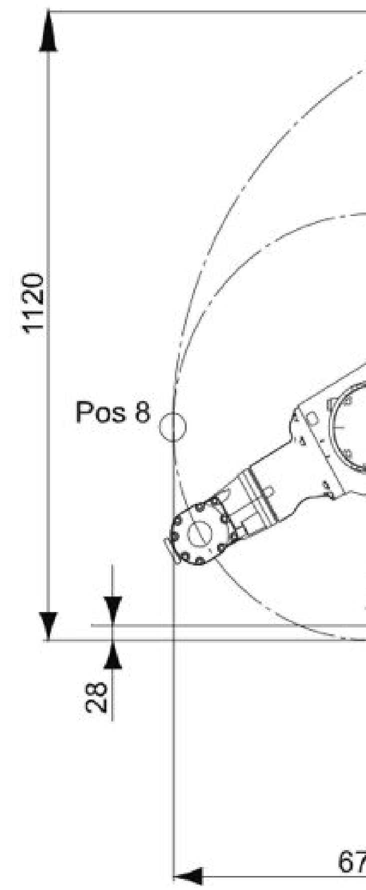
Fill the table

Understand the numbers that appears in the following table and fill/create a matrix with the irb140RTB angles.

Pay attention to home position of the ABB Drawing and the wired model of the RTB

					ABB_Drawing			R
Pose		X posion	Z position		Axis-2	Axis-3		Axi
0		450	712		0	0		
1		70	1092		0	-90		
2		314	421		0	50		
3		765	99		110	-90		
6		1	596		-90	50		
7		218	558		110	-230		
8		-670	352		-90	-90		





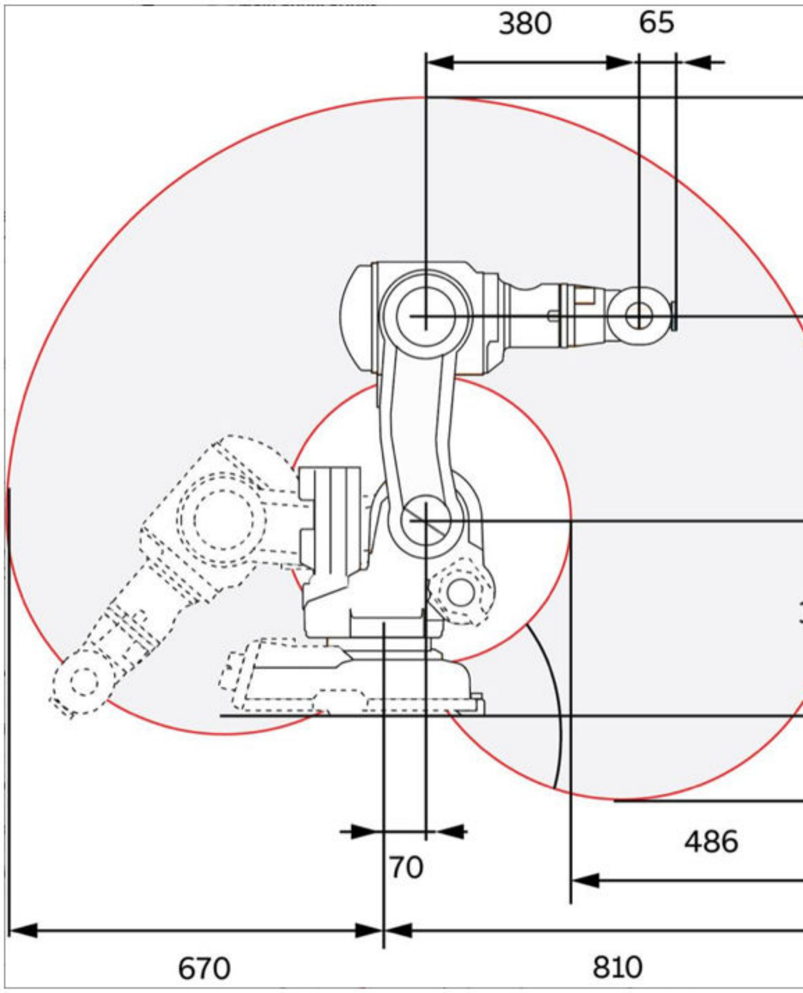

```
%Tabla de poses con valores de los ángulos de q2 y q3
pose = {'Pose 0'; 'Pose 1'; 'Pose 2'; 'Pose 3'; 'Pose 6'; 'Pose 7'; 'Pose 8'};
q2 = [-90; -90; -90; 20; -180; 20; -180];
q3 = [180; 90; 230; 90; 230; -50; 90];
```

```
T = table(pose, q2, q3);

disp(T);
```

```
       pose         q2      q3
    ___________    ____    ____

    {'Pose 0'}      -90     180
    {'Pose 1'}      -90      90
    {'Pose 2'}      -90     230
    {'Pose 3'}       20      90
    {'Pose 6'}     -180     230
    {'Pose 7'}       20     -50
    {'Pose 8'}     -180      90
```

Draw the work space

Get a joint sequence movement to recover the work space as shown in the figure. See video rb140_WS_Solution.mp4.




```
%Cargamos el modelo del robot IRB140
clear
close all
```

```
mdl_irb140
```

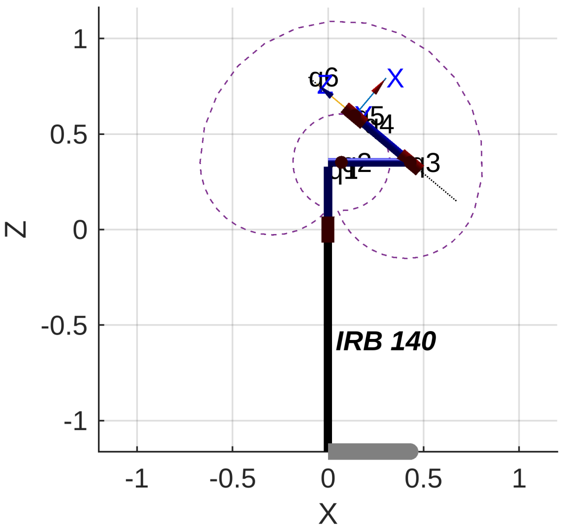
```
robot =

IRB 140 [ABB]:: 6 axis, RRRRRR, stdDH, slowRNE
+---+-----------+-----------+-----------+-----------+-----------+
| j |     theta |         d |         a |     alpha |    offset |
+---+-----------+-----------+-----------+-----------+-----------+
|  1|         q1|      0.352|       0.07|    -1.5708|          0|
|  2|         q2|          0|       0.36|          0|          0|
|  3|         q3|          0|          0|     1.5708|          0|
|  4|         q4|       0.38|          0|    -1.5708|          0|
|  5|         q5|          0|          0|     1.5708|          0|
|  6|         q6|          0|          0|          0|          0|
+---+-----------+-----------+-----------+-----------+-----------+
```

```
steps = 15;
q2 = [-180 20 20 -180 -180 0];
q3 = [230 230 90 90 -50 -50];
n = numel(q2);
% matriz de ceros Q la usamos para guardar la secuencia de ángulos de articulación
% para todo el movimiento del brazo del robot
Q = zeros(steps*(n-1), 6);

degrees = [q2' q3']
```

```
degrees = 6×2
  -180   230
    20   230
    20    90
  -180    90
  -180   -50
     0   -50
```

```
ini_q2 = deg2rad(degrees(1,1));
ini_q3 = deg2rad(degrees(1,2));

%Interpolamos entre los ángulos iniciales y finales de q2 y q3.
idx = 1;
for i = 2:n
    end_q2 = deg2rad(degrees(i,1));
    end_q3 = deg2rad(degrees(i,2));
    %llenamos las filas de la matriz Q con los valores interpolados
    %mediante la función linspace
    Q(idx:idx+ steps-1,2) = linspace(ini_q2, end_q2, steps)';
    Q(idx:idx+ steps-1,3) = linspace(ini_q3, end_q3, steps)';
    idx = idx + steps;

    ini_q2 = end_q2;
    ini_q3 = end_q3;
end

%Mostramos la trayectoria del robot
```

```
irb140.plot(Q,'trail','--','jaxes','zoom',2, 'view',[0 0])
```



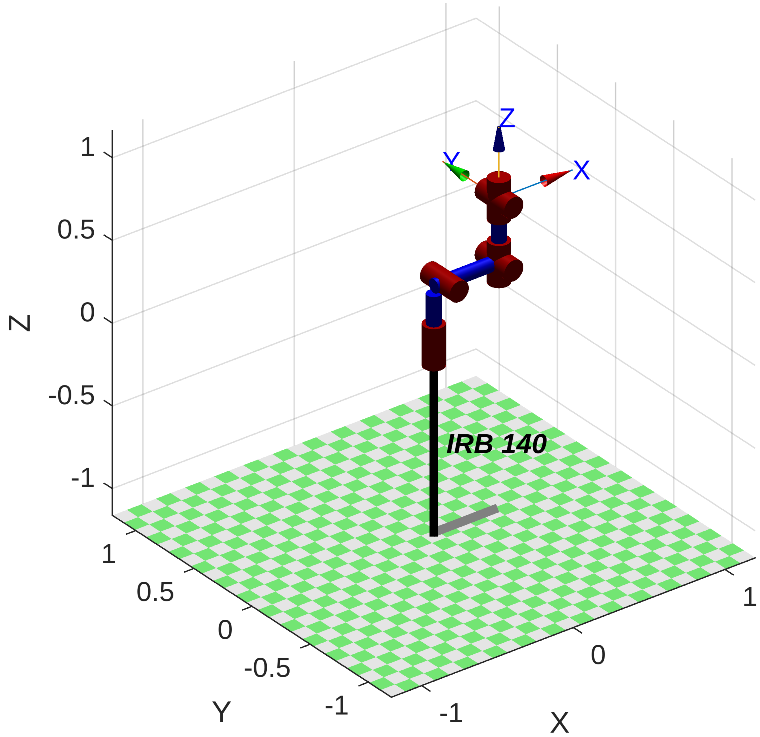
Invoque IRB140

```
clear
close all
mdl_irb140
```

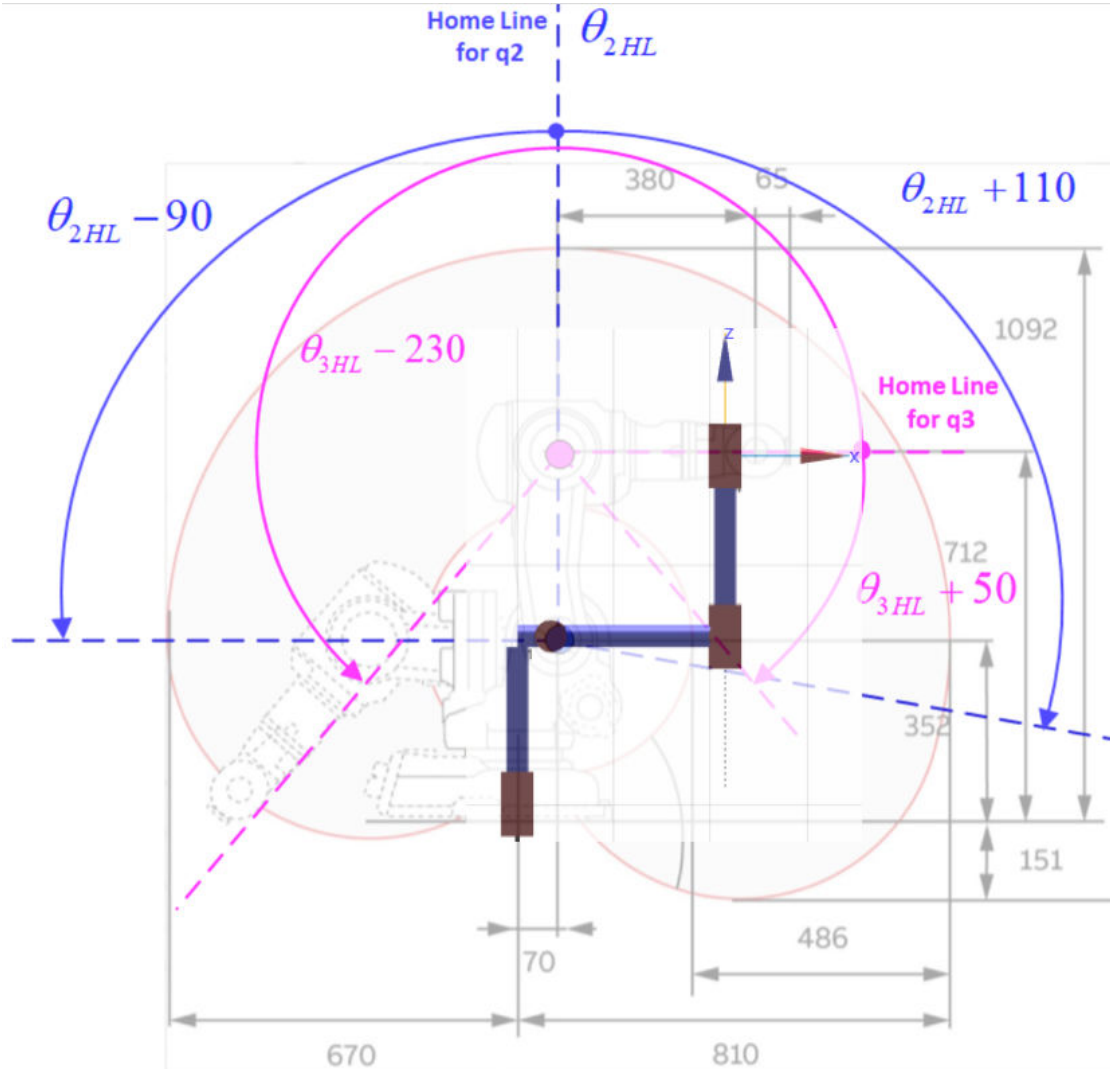
```
robot = 

IRB 140 [ABB]:: 6 axis, RRRRRR, stdDH, slowRNE
+---+-----------+-----------+-----------+-----------+-----------+
| j |     theta |         d |         a |     alpha |    offset |
+---+-----------+-----------+-----------+-----------+-----------+
|  1|         q1|      0.352|       0.07|    -1.5708|          0|
|  2|         q2|          0|       0.36|          0|          0|
|  3|         q3|          0|          0|     1.5708|          0|
|  4|         q4|       0.38|          0|    -1.5708|          0|
|  5|         q5|          0|          0|     1.5708|          0|
|  6|         q6|          0|          0|          0|          0|
+---+-----------+-----------+-----------+-----------+-----------+
```

Plot the IRB

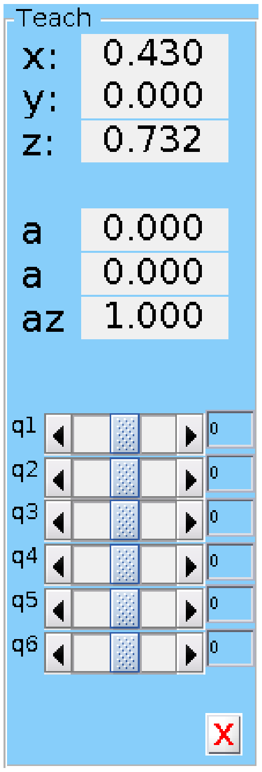
```
irb140.plot(qz)
```

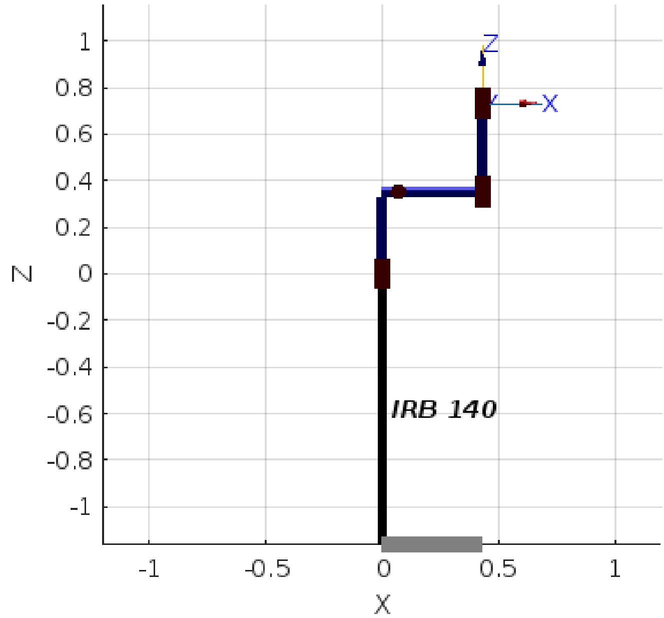


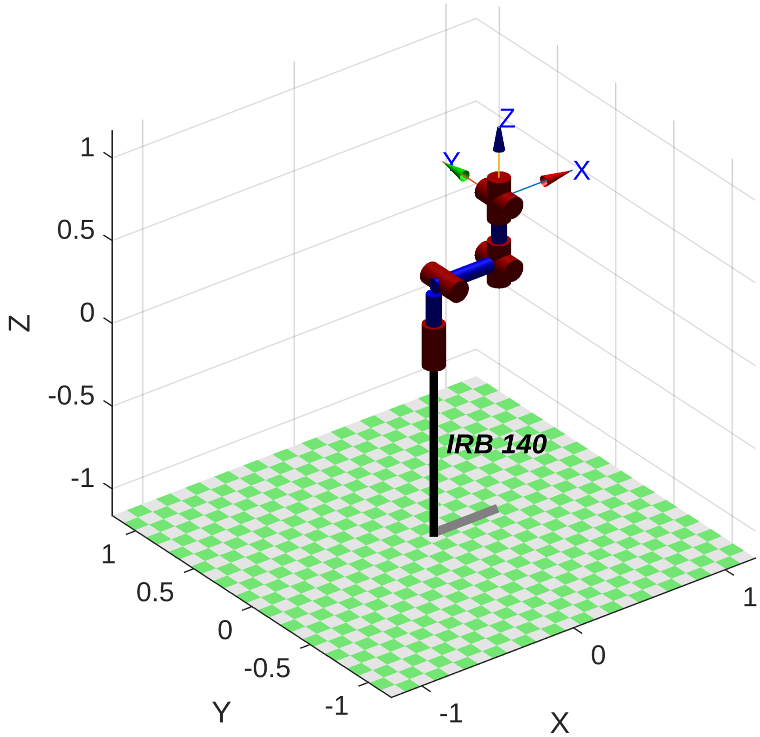
To think about




```
figure
irb140.plot(qz,'zoom',2, 'view',[0 0])
irb140.teach('approach')
```


Teach
x: 0.430
y: 0.000
z: 0.732
a 0.000
a 0.000
az 1.000
q1 0
q2 0
q3 0
q4 0
q5 0
q6 0
X


Z
X
IRB 140
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1
-0.5
0
0.5
1
X



Z
1
0.5
0
-0.5
-1
Y
1
0.5
0
-0.5
-1
X
-1
0
1
IRB 140