

MuJoCo UI Exercise

MuJoCo Workshop: XML Editing Exercises

Exercise 1: Modify Model Appearance

Task: Change the left leg ("thigh_left" and "shin_left") color to red.

Hint:

- Locate the `geom` elements corresponding to `thigh_left` and `shin_left`.
- Modify their `material` or `rgba` values.

Solution:

```
<geom name="thigh_left" fromto="0 0 0 0 -.01 -.34" class="thigh" material="left_leg_material"/>
<geom name="shin_left" fromto="0 0 0 0 0 -.3" class="shin" material="left_leg_material"/>

<asset>
  <material name="left_leg_material" rgba="1 0 0 1"/>
</asset>
```

Exercise 2: Add a New Geometry

Task: Add a blue spherical decoration (size 0.05) to the top of the head.

Hint:

- Add a new `geom` within the `head` body.
- Set `type="sphere"` and position it slightly above the head.

Solution:

```
<body name="head" pos="0 0 .19">
  <geom name="head" type="sphere" size=".09"/>
```

```
<geom name="decoration" type="sphere" size=".05" pos="0 0 .
1" rgba="0 0 1 1"/>
</body>
```

Exercise 3: Add a Sensor

Task: Add a touch sensor to the left foot and display its value during runtime.

Hint:

- Add a `sensor` element of `type="touch"` linked to a `geom` in the `foot_left` body.
- Use Python or other runtime scripts to access sensor data.

Solution:

```
<body name="foot_left" pos="0 0 -.39">
  <joint name="ankle_y_left" class="ankle_y"/>
  <joint name="ankle_x_left" class="ankle_x" axis="-1 0 -.5"/
>
  <geom name="foot1_left" class="foot1"/>
  <geom name="foot2_left" class="foot2"/>
  <sensor name="touch_sensor_left" type="touch" site="foot1_l
eft"/>
</body>
```

Runtime Script (Python):

```
import mujoco_py

model = mujoco_py.load_model_from_path("your_model.xml")
sim = mujoco_py.MjSim(model)

while True:
    sim.step()
    print("Touch sensor value:", sim.data.sensordata)
```

Exercise 4: Modify Camera View

Task: Change the default position of the "side" camera to `(0, -5, 2)`.

Hint:

- Locate the `camera` element named `side` and adjust its `pos` attribute.

Solution:

```
<camera name="side" pos="0 -5 2" xyaxes="1 0 0 0 1 2" mode="t
rackcom"/>
```

Exercise 5: Add Joint Range Limits

Task: Limit the range of the left knee joint ("knee_left") to `-90` to `0` degrees.

Hint:

- Modify the `joint` element corresponding to `knee_left`.
- Adjust the `range` attribute.

Solution:

```
<joint name="knee_left" pos="0 0 .02" axis="0 -1 0" range="-9
0 0" class="knee"/>
```

Exercise 6: Add a Light Source

Task: Add a spotlight above the model at position `(0, 0, 3)` with a yellow color.

Hint:

- Add a `light` element in the `worldbody` section.
- Set its `pos` and `diffuse` attributes.

Solution:

```
<light name="yellow_spotlight" pos="0 0 3" diffuse="1 1 0.5"
specular="0.2 0.2 0.2" cutoff="45"/>
```

Exercise 7: Create a New Keyframe

Task: Add a new keyframe for a pose where the model tilts to the left.

Hint:

- Add a `key` element in the `keyframe` section.
- Adjust the `qpos` values to create the desired pose.

Solution:

```
<keyframe>
  <key name="tilt_left" qpos="0 0 1
                        1 0 0 0
                        -0.2 0.1 0
                        -0.2 -0.1 -0.3 -1.2 -0.5 -0.1
                        -0.1 0 -0.2 -1.0 -0.3 -0.1
                        0.2 -0.1 -0.8 0.0 0.1 0.2"/>
</keyframe>
```

Appendix: Source XML for exercise

```
<!-- Copyright 2021 DeepMind Technologies Limited
```

```

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```

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WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express
```

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```
-->

<mujoco model="Humanoid">
  <option timestep="0.005"/>

  <visual>
    <map force="0.1" zfar="30"/>
    <rgba haze="0.15 0.25 0.35 1"/>
    <global offwidth="2560" offheight="1440" elevation="-20" azimuth="30"/>
  </visual>

  <statistic center="0 0 0.7"/>

  <asset>
    <texture type="skybox" builtin="gradient" rgb1=".3 .5 .7" rgb2=".7 .6 .5"/>
    <texture name="body" type="cube" builtin="flat" mark="cross" scale="1000" >
    <material name="body" texture="body" texuniform="true" rgba="0.9 0.9 0.9 1"/>
    <texture name="grid" type="2d" builtin="checker" width="512" height="512" >
    <material name="grid" texture="grid" texrepeat="1 1" texuniform="true" >
  </asset>

  <default>
    <motor ctrllimited="true" ctrlrange="-1 1" ctrlgain="1000"/>
    <default class="body">
      <!-- geoms -->
      <geom type="capsule" condim="1" friction=".7" solimp=".9" solbrd=".01" >
      <default class="thigh">
        <geom size=".06"/>
      </default>
      <default class="shin">
        <geom fromto="0 0 0 0 0 -.3" size=".049"/>
      </default>
      <default class="foot">
```

```

    <geom size=".027"/>
    <default class="foot1">
        <geom fromto="- .07 -.01 0 .14 -.03 0"/>
    </default>
    <default class="foot2">
        <geom fromto="- .07 .01 0 .14 .03 0"/>
    </default>
</default>
<default class="arm_upper">
    <geom size=".04"/>
</default>
<default class="arm_lower">
    <geom size=".031"/>
</default>
<default class="hand">
    <geom type="sphere" size=".04"/>
</default>

<!-- joints -->
<joint type="hinge" damping=".2" stiffness="1" armature="
<default class="joint_big">
    <joint damping="5" stiffness="10"/>
    <default class="hip_x">
        <joint range="-30 10"/>
    </default>
    <default class="hip_z">
        <joint range="-60 35"/>
    </default>
    <default class="hip_y">
        <joint axis="0 1 0" range="-150 20"/>
    </default>
    <default class="joint_big_stiff">
        <joint stiffness="20"/>
    </default>
</default>
<default class="knee">

```

```

    <joint pos="0 0 .02" axis="0 -1 0" range="-160 2"/>
  </default>
  <default class="ankle">
    <joint range="-50 50"/>
    <default class="ankle_y">
      <joint pos="0 0 .08" axis="0 1 0" stiffness="6"/>
    </default>
    <default class="ankle_x">
      <joint pos="0 0 .04" stiffness="3"/>
    </default>
  </default>
  <default class="shoulder">
    <joint range="-85 60"/>
  </default>
  <default class="elbow">
    <joint range="-100 50" stiffness="0"/>
  </default>
</default>
</default>

<worldbody>
  <geom name="floor" size="0 0 .05" type="plane" material="gr">
  <light name="spotlight" mode="targetbodycom" target="torso">
  <body name="torso" pos="0 0 1.282" childclass="body">
    <light name="top" pos="0 0 2" mode="trackcom"/>
    <camera name="back" pos="-3 0 1" xyaxes="0 -1 0 1 0 2" mode="trackcom">
    <camera name="side" pos="0 -3 1" xyaxes="1 0 0 0 1 2" mode="trackcom">
    <freejoint name="root"/>
    <geom name="torso" fromto="0 -.07 0 0 .07 0" size=".07"/>
    <geom name="waist_upper" fromto="-.01 -.06 -.12 -.01 .06 .12" size=".06"/>
    <body name="head" pos="0 0 .19">
      <geom name="head" type="sphere" size=".09"/>
      <camera name="egocentric" pos=".09 0 0" xyaxes="0 -1 0 1 0 2" mode="trackcom">
    </body>
    <body name="waist_lower" pos="-.01 0 -.26">
      <geom name="waist_lower" fromto="0 -.06 0 0 .06 0" size=".06"/>
    </body>
  </body>

```

```

<joint name="abdomen_z" pos="0 0 .065" axis="0 0 1" range="0 3.14159" type="revolute">
<joint name="abdomen_y" pos="0 0 .065" axis="0 1 0" range="0 3.14159" type="revolute">
<body name="pelvis" pos="0 0 -.165">
  <joint name="abdomen_x" pos="0 0 .1" axis="1 0 0" range="0 3.14159" type="revolute">
  <geom name="butt" fromto="- .02 -.07 0 -.02 .07 0" size="0.01 0.01 0.01" class="butt">
  <body name="thigh_right" pos="0 -.1 -.04">
    <joint name="hip_x_right" axis="1 0 0" class="hip_x"/>
    <joint name="hip_z_right" axis="0 0 1" class="hip_z"/>
    <joint name="hip_y_right" class="hip_y"/>
    <geom name="thigh_right" fromto="0 0 0 0 .01 -.34" class="thigh">
    <body name="shin_right" pos="0 .01 -.4">
      <joint name="knee_right" class="knee"/>
      <geom name="shin_right" class="shin"/>
      <body name="foot_right" pos="0 0 -.39">
        <joint name="ankle_y_right" class="ankle_y"/>
        <joint name="ankle_x_right" class="ankle_x" axis="1 0 0"/>
        <geom name="foot1_right" class="foot1"/>
        <geom name="foot2_right" class="foot2"/>
      </body>
    </body>
  </body>
</body>
<body name="thigh_left" pos="0 .1 -.04">
  <joint name="hip_x_left" axis="-1 0 0" class="hip_x"/>
  <joint name="hip_z_left" axis="0 0 -1" class="hip_z"/>
  <joint name="hip_y_left" class="hip_y"/>
  <geom name="thigh_left" fromto="0 0 0 0 -.01 -.34" class="thigh">
  <body name="shin_left" pos="0 -.01 -.4">
    <joint name="knee_left" class="knee"/>
    <geom name="shin_left" fromto="0 0 0 0 0 -.3" class="shin">
    <body name="foot_left" pos="0 0 -.39">
      <joint name="ankle_y_left" class="ankle_y"/>
      <joint name="ankle_x_left" class="ankle_x" axis="1 0 0"/>
      <geom name="foot1_left" class="foot1"/>
      <geom name="foot2_left" class="foot2"/>
    </body>
  </body>
</body>

```



```

        </body>
    </body>
</body>
<body name="upper_arm_right" pos="0 -.17 .06">
    <joint name="shoulder1_right" axis="2 1 1" class="shoulder1"/>
    <joint name="shoulder2_right" axis="0 -1 1" class="shoulder2"/>
    <geom name="upper_arm_right" fromto="0 0 0 .16 -.16 -.16" class="upper_arm"/>
    <body name="lower_arm_right" pos=".18 -.18 -.18">
        <joint name="elbow_right" axis="0 -1 1" class="elbow"/>
        <geom name="lower_arm_right" fromto=".01 .01 .01 .17 -.17 -.17" class="lower_arm"/>
        <body name="hand_right" pos=".18 .18 .18">
            <geom name="hand_right" zaxis="1 1 1" class="hand"/>
        </body>
    </body>
</body>
</body>
<body name="upper_arm_left" pos="0 .17 .06">
    <joint name="shoulder1_left" axis="-2 1 -1" class="shoulder1"/>
    <joint name="shoulder2_left" axis="0 -1 -1" class="shoulder2"/>
    <geom name="upper_arm_left" fromto="0 0 0 .16 .16 -.16" class="upper_arm"/>
    <body name="lower_arm_left" pos=".18 .18 -.18">
        <joint name="elbow_left" axis="0 -1 -1" class="elbow"/>
        <geom name="lower_arm_left" fromto=".01 -.01 .01 .17 .17 .17" class="lower_arm"/>
        <body name="hand_left" pos=".18 -.18 .18">
            <geom name="hand_left" zaxis="1 -1 1" class="hand"/>
        </body>
    </body>
</body>
</body>
</worldbody>

<contact>
    <exclude body1="waist_lower" body2="thigh_right"/>
    <exclude body1="waist_lower" body2="thigh_left"/>
</contact>

<tendon>

```

```

    <fixed name="hamstring_right" limited="true" range="-0.3 2">
      <joint joint="hip_y_right" coef=".5"/>
      <joint joint="knee_right" coef="-.5"/>
    </fixed>
    <fixed name="hamstring_left" limited="true" range="-0.3 2">
      <joint joint="hip_y_left" coef=".5"/>
      <joint joint="knee_left" coef="-.5"/>
    </fixed>
  </tendon>

  <actuator>
    <motor name="abdomen_z" gear="40" joint="abdomen_z"/>
    <motor name="abdomen_y" gear="40" joint="abdomen_y"/>
    <motor name="abdomen_x" gear="40" joint="abdomen_x"/>
    <motor name="hip_x_right" gear="40" joint="hip_x_right"/>
    <motor name="hip_z_right" gear="40" joint="hip_z_right"/>
    <motor name="hip_y_right" gear="120" joint="hip_y_right"/>
    <motor name="knee_right" gear="80" joint="knee_right"/>
    <motor name="ankle_y_right" gear="20" joint="ankle_y_right"/>
    <motor name="ankle_x_right" gear="20" joint="ankle_x_right"/>
    <motor name="hip_x_left" gear="40" joint="hip_x_left"/>
    <motor name="hip_z_left" gear="40" joint="hip_z_left"/>
    <motor name="hip_y_left" gear="120" joint="hip_y_left"/>
    <motor name="knee_left" gear="80" joint="knee_left"/>
    <motor name="ankle_y_left" gear="20" joint="ankle_y_left"/>
    <motor name="ankle_x_left" gear="20" joint="ankle_x_left"/>
    <motor name="shoulder1_right" gear="20" joint="shoulder1_right"/>
    <motor name="shoulder2_right" gear="20" joint="shoulder2_right"/>
    <motor name="elbow_right" gear="40" joint="elbow_right"/>
    <motor name="shoulder1_left" gear="20" joint="shoulder1_left"/>
    <motor name="shoulder2_left" gear="20" joint="shoulder2_left"/>
    <motor name="elbow_left" gear="40" joint="elbow_left"/>
  </actuator>

  <keyframe>
    <!--

```

The values below are split into rows for readability:

torso position
torso orientation
spinal
right leg
left leg
arms

-->

<key name="squat"

qpos="0 0 0.596
0.988015 0 0.154359 0
0 0.4 0
-0.25 -0.5 -2.5 -2.65 -0.8 0.56
-0.25 -0.5 -2.5 -2.65 -0.8 0.56
0 0 0 0 0 0"/>

<key name="stand_on_left_leg"

qpos="0 0 1.21948
0.971588 -0.179973 0.135318 -0.0729076
-0.0516 -0.202 0.23
-0.24 -0.007 -0.34 -1.76 -0.466 -0.0415
-0.08 -0.01 -0.37 -0.685 -0.35 -0.09
0.109 -0.067 -0.7 -0.05 0.12 0.16"/>

<key name="prone"

qpos="0.4 0 0.0757706
0.7325 0 0.680767 0
0 0.0729 0
0.0077 0.0019 -0.026 -0.351 -0.27 0
0.0077 0.0019 -0.026 -0.351 -0.27 0
0.56 -0.62 -1.752
0.56 -0.62 -1.752"/>

<key name="supine"

qpos="-0.4 0 0.08122
0.722788 0 -0.69107 0
0 -0.25 0
0.0182 0.0142 0.3 0.042 -0.44 -0.02
0.0182 0.0142 0.3 0.042 -0.44 -0.02

```
0.186 -0.73 -1.73  
0.186 -0.73 -1.73"/>  
</keyframe>  
</mujoco>
```