Necessary Installations

```
!pip install gym
!apt-get install python-opengl -y
!apt install xvfb -y

!pip install gym[atari]

!pip install pyvirtualdisplay
!pip install piglet
```

```
Requirement already satisfied: gym in /usr/local/lib/python3.10/dist-
packages (0.25.2)
Requirement already satisfied: numpy>=1.18.0 in
/usr/local/lib/python3.10/dist-packages (from gym) (1.23.5)
Requirement already satisfied: cloudpickle>=1.2.0 in
/usr/local/lib/python3.10/dist-packages (from gym) (2.2.1)
Requirement already satisfied: gym-notices>=0.0.4 in
/usr/local/lib/python3.10/dist-packages (from gym) (0.0.8)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
E: Unable to locate package python-opengl
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  libfontenc1 libxfont2 libxkbfile1 x11-xkb-utils xfonts-base xfonts-
encodings xfonts-utils
  xserver-common
The following NEW packages will be installed:
  libfontenc1 libxfont2 libxkbfile1 x11-xkb-utils xfonts-base xfonts-
encodings xfonts-utils
  xserver-common xvfb
0 upgraded, 9 newly installed, 0 to remove and 32 not upgraded.
Need to get 7,814 kB of archives.
After this operation, 11.9 MB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu jammy/main amd64 libfontenc1
amd64 1:1.1.4-1build3 [14.7 kB]
Get:2 http://archive.ubuntu.com/ubuntu jammy/main amd64 libxfont2
amd64 1:2.0.5-1build1 [94.5 kB]
Get:3 http://archive.ubuntu.com/ubuntu jammy/main amd64 libxkbfile1
amd64 1:1.1.0-1build3 [71.8 kB]
Get:4 http://archive.ubuntu.com/ubuntu jammy/main amd64 x11-xkb-utils
amd64 7.7+5build4 [172 kB]
Get:5 http://archive.ubuntu.com/ubuntu jammy/main amd64 xfonts-
encodings all 1:1.0.5-0ubuntu2 [578 kB]
Get:6 http://archive.ubuntu.com/ubuntu jammy/main amd64 xfonts-utils
amd64 1:7.7+6build2 [94.6 kB]
```

```
Get:7 http://archive.ubuntu.com/ubuntu jammy/main amd64 xfonts-base
all 1:1.0.5 [5,896 kB]
Get:8 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64
xserver-common all 2:21.1.4-2ubuntu1.7~22.04.8 [28.6 kB]
Get:9 http://archive.ubuntu.com/ubuntu jammy-updates/universe amd64
xvfb amd64 2:21.1.4-2ubuntu1.7~22.04.8 [863 kB]
Fetched 7,814 kB in 1s (5,405 kB/s)
Selecting previously unselected package libfontenc1:amd64.
(Reading database ... 121730 files and directories currently
installed.)
Preparing to unpack .../0-libfontenc1_1%3a1.1.4-1build3_amd64.deb ...
Unpacking libfontenc1:amd64 (1:1.1.4-1build3) ...
Selecting previously unselected package libxfont2:amd64.
Preparing to unpack .../1-libxfont2_1%3a2.0.5-1build1_amd64.deb ...
Unpacking libxfont2:amd64 (1:2.0.5-1build1) ...
Selecting previously unselected package libxkbfile1:amd64.
Preparing to unpack .../2-libxkbfile1_1%3a1.1.0-1build3_amd64.deb ...
Unpacking libxkbfile1:amd64 (1:1.1.0-1build3) ...
Selecting previously unselected package x11-xkb-utils.
Preparing to unpack .../3-x11-xkb-utils_7.7+5build4_amd64.deb ...
Unpacking x11-xkb-utils (7.7+5build4) ...
Selecting previously unselected package xfonts-encodings.
Preparing to unpack .../4-xfonts-encodings_1%3a1.0.5-
0ubuntu2_all.deb ...
Unpacking xfonts-encodings (1:1.0.5-0ubuntu2) ...
Selecting previously unselected package xfonts-utils.
Preparing to unpack .../5-xfonts-utils_1%3a7.7+6build2_amd64.deb ...
Unpacking xfonts-utils (1:7.7+6build2) ...
Selecting previously unselected package xfonts-base.
Preparing to unpack .../6-xfonts-base_1%3a1.0.5_all.deb ...
Unpacking xfonts-base (1:1.0.5) ...
Selecting previously unselected package xserver-common.
Preparing to unpack .../7-xserver-common_2%3a21.1.4-
2ubuntu1.7~22.04.8_all.deb ...
Unpacking xserver-common (2:21.1.4-2ubuntu1.7~22.04.8) ...
Selecting previously unselected package xvfb.
Preparing to unpack .../8-xvfb_2%3a21.1.4-2ubuntu1.7~22.04.8_amd64.deb
...
Unpacking xvfb (2:21.1.4-2ubuntu1.7~22.04.8) ...
Setting up libfontenc1:amd64 (1:1.1.4-1build3) ...
Setting up xfonts-encodings (1:1.0.5-0ubuntu2) ...
Setting up libxkbfile1:amd64 (1:1.1.0-1build3) ...
Setting up libxfont2:amd64 (1:2.0.5-1build1) ...
Setting up x11-xkb-utils (7.7+5build4) ...
Setting up xfonts-utils (1:7.7+6build2) ...
Setting up xfonts-base (1:1.0.5) ...
Setting up xserver-common (2:21.1.4-2ubuntu1.7~22.04.8) ...
Setting up xvfb (2:21.1.4-2ubuntu1.7~22.04.8) ...
Processing triggers for man-db (2.10.2-1) ...
```

```
Processing triggers for fontconfig (2.13.1-4.2ubuntu5) ...
Processing triggers for libc-bin (2.35-0ubuntu3.4) ...
/sbin/ldconfig.real: /usr/local/lib/libtbbbind.so.3 is not a symbolic
link

/sbin/ldconfig.real: /usr/local/lib/libtbb.so.12 is not a symbolic
link

/sbin/ldconfig.real: /usr/local/lib/libtbbbind_2_0.so.3 is not a
symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbmalloc.so.2 is not a
symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbbind_2_5.so.3 is not a
symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbmalloc_proxy.so.2 is not a
symbolic link

Requirement already satisfied: gym[atari] in
/usr/local/lib/python3.10/dist-packages (0.25.2)
Requirement already satisfied: numpy>=1.18.0 in
/usr/local/lib/python3.10/dist-packages (from gym[atari]) (1.23.5)
Requirement already satisfied: cloudpickle>=1.2.0 in
/usr/local/lib/python3.10/dist-packages (from gym[atari]) (2.2.1)
Requirement already satisfied: gym-notices>=0.0.4 in
/usr/local/lib/python3.10/dist-packages (from gym[atari]) (0.0.8)
Collecting ale-py~=0.7.5 (from gym[atari])
  Downloading ale_py-0.7.5-cp310-cp310-
manylinux_2_17_x86_64.manylinux2014_x86_64.whl (1.6 MB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.6/1.6 MB 7.2 MB/s eta
0:00:00
ent already satisfied: importlib-resources in
/usr/local/lib/python3.10/dist-packages (from ale-py~=0.7.5-
>gym[atari]) (6.1.1)
Installing collected packages: ale-py
Successfully installed ale-py-0.7.5
Collecting pyvirtualdisplay
  Downloading PyVirtualDisplay-3.0-py3-none-any.whl (15 kB)
Installing collected packages: pyvirtualdisplay
Successfully installed pyvirtualdisplay-3.0
Collecting piglet
  Downloading piglet-1.0.0-py2.py3-none-any.whl (2.2 kB)
Collecting piglet-templates (from piglet)
  Downloading piglet_templates-1.3.0-py3-none-any.whl (67 kB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 67.5/67.5 kB 1.2 MB/s eta
0:00:00
ent already satisfied: pyparsing in /usr/local/lib/python3.10/dist-
packages (from piglet-templates->piglet) (3.1.1)
```

```
Requirement already satisfied: attrs in
/usr/local/lib/python3.10/dist-packages (from piglet-templates-
>piglet) (23.2.0)
Requirement already satisfied: astunparse in
/usr/local/lib/python3.10/dist-packages (from piglet-templates-
>piglet) (1.6.3)
Requirement already satisfied: markupsafe in
/usr/local/lib/python3.10/dist-packages (from piglet-templates-
>piglet) (2.1.4)
Requirement already satisfied: wheel<1.0,>=0.23.0 in
/usr/local/lib/python3.10/dist-packages (from astunparse->piglet-
templates->piglet) (0.42.0)
Requirement already satisfied: six<2.0,>=1.6.1 in
/usr/local/lib/python3.10/dist-packages (from astunparse->piglet-
templates->piglet) (1.16.0)
Installing collected packages: piglet-templates, piglet
Successfully installed piglet-1.0.0 piglet-templates-1.3.0
```

To activate virtual display we need to run a script once for training an agent, as follows:

```
from pyvirtualdisplay import Display
display = Display(visible=0, size=(1400, 900))
display.start()
```

```
<pyvirtualdisplay.display.Display at 0x7f7f5db74ca0>
```

```
# This code creates a virtual display to draw game images on.
# If you are running locally, just ignore it
import os
if type(os.environ.get("DISPLAY")) is not str or
len(os.environ.get("DISPLAY"))==0:
    !bash ../xvfb start
    %env DISPLAY=:1

import gym
from gym import logger as gymlogger
from gym.wrappers.record_video import RecordVideo
gymlogger.set_level(40) # error only
import tensorflow as tf
import numpy as np
import random
import matplotlib
import matplotlib.pyplot as plt
%matplotlib inline
import math
import glob
import io
import base64
from IPython.display import HTML
```

```
from IPython import display as ipythondisplay

"""
Utility functions to enable video recording of gym environment and
displaying it
To enable video, just do "env = wrap_env(env)""
"""

def show_video():
  mp4list = glob.glob('video/*.mp4')
  if len(mp4list) > 0:
    mp4 = mp4list[0]
    video = io.open(mp4, 'r+b').read()
    encoded = base64.b64encode(video)
    ipythondisplay.display(HTML(data='''<video alt="test" autoplay
                loop controls style="height: 400px;">
                <source src="data:video/mp4;base64,{0}"
type="video/mp4" />
             </video>'''.format(encoded.decode('ascii'))))
  else:
    print("Could not find video")


def wrap_env(env):
  env = RecordVideo(env, './video')
  return env
```

#Pendulum

- Here the environment is the space where the pendulum is present in.
- The observation space is the (x,y) coordinates of the pendulum's free end and its angular velocity.
- The action is torque applied to free end of the pendulum.
- The goal is to apply the action until the pendulum reaches the upright position

```
env = gym.make('Pendulum-v1')
env = wrap_env(env)
observation = env.reset()

total_reward = 0

while True:
  env.render()

  # your agent goes here
  action = env.action_space.sample()   # take a random action
  observation, reward, done, info = env.step(action)
```

```
  # print(reward)
  total_reward+=reward

  if done:
    break;

env.close()
show_video()
print(total_reward)
```

```
<IPython.core.display.HTML object>
```

```
-1570.4869482878873
```

```
env = gym.make("Pendulum-v1")

total_reward = 0
num_episodes = 1000  # Number of episodes to run

for episode in range(num_episodes):
    obs = env.reset()
    episode_reward = 0

    while True:
        action = env.action_space.sample()  # Random action
        obs, reward, done, _ = env.step(action)
        episode_reward += reward

        if done:
            break

    total_reward += episode_reward

average_reward = total_reward / num_episodes
print(f'Average total reward over {num_episodes} episodes:',
average_reward)
```

```
Average total reward over 1000 episodes: -1231.157219497855
```

Here, the maximum reward is achieved when pedulum is upright position (when zero torque and zero velocity is applied) , that time the reward is 0 based on the formula: r = -(theta2 + 0.1 * theta_dt2 + 0.001 * torque2)