

## ✓ Soft Actor-Critic (SAC)

```
!apt-get install -y libgl1-mesa-dev
```

```

Selecting previously unselected package libegl-dev:amd64.
Preparing to unpack .../2-libegl-dev_1.4.0-1_amd64.deb ...
Unpacking libegl-dev:amd64 (1.4.0-1) ...
Selecting previously unselected package libgles1:amd64.
Preparing to unpack .../3-libgles1_1.4.0-1_amd64.deb ...
Unpacking libgles1:amd64 (1.4.0-1) ...
Selecting previously unselected package libgles-dev:amd64.
Preparing to unpack .../4-libgles-dev_1.4.0-1_amd64.deb ...
Unpacking libgles-dev:amd64 (1.4.0-1) ...
Selecting previously unselected package libopengl-dev:amd64.
Preparing to unpack .../5-libopengl-dev_1.4.0-1_amd64.deb ...
Unpacking libopengl-dev:amd64 (1.4.0-1) ...
Selecting previously unselected package libglvnd-core-dev:amd64.
Preparing to unpack .../6-libglvnd-core-dev_1.4.0-1_amd64.deb ...
Unpacking libglvnd-core-dev:amd64 (1.4.0-1) ...
Selecting previously unselected package libglvnd-dev:amd64.
Preparing to unpack .../7-libglvnd-dev_1.4.0-1_amd64.deb ...
Unpacking libglvnd-dev:amd64 (1.4.0-1) ...
Selecting previously unselected package libgl1-mesa-dev:amd64.
Preparing to unpack .../8-libgl1-mesa-dev_23.2.1-1ubuntu3.1~22.04.2_amd64.deb ...
Unpacking libgl1-mesa-dev:amd64 (23.2.1-1ubuntu3.1~22.04.2) ...
Setting up libglvnd-core-dev:amd64 (1.4.0-1) ...
Setting up libgles1:amd64 (1.4.0-1) ...
Setting up libglx-dev:amd64 (1.4.0-1) ...
Setting up libopengl-dev:amd64 (1.4.0-1) ...
Setting up libgl-dev:amd64 (1.4.0-1) ...
Setting up libegl-dev:amd64 (1.4.0-1) ...
Setting up libgles-dev:amd64 (1.4.0-1) ...
Setting up libglvnd-dev:amd64 (1.4.0-1) ...
Setting up libgl1-mesa-dev:amd64 (23.2.1-1ubuntu3.1~22.04.2) ...
Processing triggers for libc-bin (2.35-0ubuntu3.4) ...
/sbin/ldconfig.real: /usr/local/lib/libtcm.so.1 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/libtcm_debug.so.1 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/libtbbbind.so.3 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_loader.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_adapter_level_zero.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbmalloc_proxy.so.2 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/libtbb.so.12 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_adapter_opencl.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libumf.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libhwloc.so.15 is not a symbolic link

```

```
!apt-get install -y libgl1-mesa-glx
```

```

Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following NEW packages will be installed:
  libgl1-mesa-glx
0 upgraded, 1 newly installed, 0 to remove and 49 not upgraded.
Need to get 5,584 B of archives.
After this operation, 74.8 kB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu jammy-updates/universe amd64 libgl1-mesa-glx amd64 23.0.4-0ubuntu1~22.04.1 [5,584 B]
Fetched 5,584 B in 0s (38.6 kB/s)
Selecting previously unselected package libgl1-mesa-glx:amd64.
(Reading database ... 123717 files and directories currently installed.)

```

```
Preparing to unpack .../libgl1-mesa-glx_23.0.4-0ubuntu1~22.04.1_amd64.deb ...
Unpacking libgl1-mesa-glx:amd64 (23.0.4-0ubuntu1~22.04.1) ...
Setting up libgl1-mesa-glx:amd64 (23.0.4-0ubuntu1~22.04.1) ...
```

```
!apt-get install -y libglew-dev
```



```
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  libglu1-mesa libglu1-mesa-dev
The following NEW packages will be installed:
  libglew-dev libglu1-mesa libglu1-mesa-dev
0 upgraded, 3 newly installed, 0 to remove and 49 not upgraded.
Need to get 663 kB of archives.
After this operation, 4,058 kB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu jammy/main amd64 libglu1-mesa amd64 9.0.2-1 [145 kB]
Get:2 http://archive.ubuntu.com/ubuntu jammy/main amd64 libglu1-mesa-dev amd64 9.0.2-1 [231 kB]
Get:3 http://archive.ubuntu.com/ubuntu jammy/universe amd64 libglew-dev amd64 2.2.0-4 [287 kB]
Fetched 663 kB in 1s (1,105 kB/s)
Selecting previously unselected package libglu1-mesa:amd64.
(Reading database ... 123723 files and directories currently installed.)
Preparing to unpack .../libglu1-mesa_9.0.2-1_amd64.deb ...
Unpacking libglu1-mesa:amd64 (9.0.2-1) ...
Selecting previously unselected package libglu1-mesa-dev:amd64.
Preparing to unpack .../libglu1-mesa-dev_9.0.2-1_amd64.deb ...
Unpacking libglu1-mesa-dev:amd64 (9.0.2-1) ...
Selecting previously unselected package libglew-dev:amd64.
Preparing to unpack .../libglew-dev_2.2.0-4_amd64.deb ...
Unpacking libglew-dev:amd64 (2.2.0-4) ...
Setting up libglu1-mesa:amd64 (9.0.2-1) ...
Setting up libglu1-mesa-dev:amd64 (9.0.2-1) ...
Setting up libglew-dev:amd64 (2.2.0-4) ...
Processing triggers for libc-bin (2.35-0ubuntu3.4) ...
/sbin/ldconfig.real: /usr/local/lib/libtcm.so.1 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/libtcm_debug.so.1 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/libtbbbind.so.3 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_loader.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_adapter_level_zero.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbmalloc_proxy.so.2 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/libtbb.so.12 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_adapter_ocl.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libumf.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libhwloc.so.15 is not a symbolic link
```

```
!apt-get install -y xvfb
```



```

Unpacking xserver-common (2:21.1.4-2ubuntu1.7~22.04.12) ...
Selecting previously unselected package xvfb.
Preparing to unpack .../8-xvfb_2%3a21.1.4-2ubuntu1.7~22.04.12_amd64.deb ...
Unpacking xvfb (2:21.1.4-2ubuntu1.7~22.04.12) ...
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 (2:21.1.4-2ubuntu1.7~22.04.12) ...
Setting up xvfb (2:21.1.4-2ubuntu1.7~22.04.12) ...
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/libtcm.so.1 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/libtcm_debug.so.1 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/libtbbbind.so.3 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_loader.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_adapter_level_zero.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libtbbmalloc_proxy.so.2 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/libtbb.so.12 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_adapter_opencl.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libumf.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libhwloc.so.15 is not a symbolic link

```

```
!apt-get install -y libosmesa6-dev
```

```

📁 Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  libosmesa6
The following NEW packages will be installed:
  libosmesa6 libosmesa6-dev
0 upgraded, 2 newly installed, 0 to remove and 49 not upgraded.
Need to get 3,130 kB of archives.
After this operation, 12.7 MB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libosmesa6 amd64 23.2.1-1ubuntu3.1~22.04.2 [3,121 kB]
Get:2 http://archive.ubuntu.com/ubuntu jammy-updates/main amd64 libosmesa6-dev amd64 23.2.1-1ubuntu3.1~22.04.2 [8,984 kB]
Fetched 3,130 kB in 2s (1,890 kB/s)
Selecting previously unselected package libosmesa6:amd64.
(Reading database ... 124308 files and directories currently installed.)
Preparing to unpack .../libosmesa6_23.2.1-1ubuntu3.1~22.04.2_amd64.deb ...
Unpacking libosmesa6:amd64 (23.2.1-1ubuntu3.1~22.04.2) ...
Selecting previously unselected package libosmesa6-dev:amd64.
Preparing to unpack .../libosmesa6-dev_23.2.1-1ubuntu3.1~22.04.2_amd64.deb ...
Unpacking libosmesa6-dev:amd64 (23.2.1-1ubuntu3.1~22.04.2) ...
Setting up libosmesa6:amd64 (23.2.1-1ubuntu3.1~22.04.2) ...
Setting up libosmesa6-dev:amd64 (23.2.1-1ubuntu3.1~22.04.2) ...
Processing triggers for libc-bin (2.35-0ubuntu3.4) ...
/sbin/ldconfig.real: /usr/local/lib/libtcm.so.1 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/libtcm_debug.so.1 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/libtbbbind.so.3 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_loader.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_adapter_level_zero.so.0 is not a symbolic link

```

```

/sbin/ldconfig.real: /usr/local/lib/libtbbmalloc_proxy.so.2 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/libtbb.so.12 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libur_adapter_opencl.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libumf.so.0 is not a symbolic link

/sbin/ldconfig.real: /usr/local/lib/libhwloc.so.15 is not a symbolic link

```

```
!apt-get install -y software-properties-common
```

```

🔄 Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
software-properties-common is already the newest version (0.99.22.9).
0 upgraded, 0 newly installed, 0 to remove and 49 not upgraded.

```

```
!apt-get install -y patchelf
```

```

🔄 Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following NEW packages will be installed:
  patchelf
0 upgraded, 1 newly installed, 0 to remove and 49 not upgraded.
Need to get 72.1 kB of archives.
After this operation, 186 kB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu jammy/universe amd64 patchelf amd64 0.14.3-1 [72.1 kB]
Fetched 72.1 kB in 1s (115 kB/s)
Selecting previously unselected package patchelf.
(Reading database ... 124327 files and directories currently installed.)
Preparing to unpack .../patchelf_0.14.3-1_amd64.deb ...
Unpacking patchelf (0.14.3-1) ...
Setting up patchelf (0.14.3-1) ...
Processing triggers for man-db (2.10.2-1) ...

```

```
!pip install free-mujoco-py
```

```

🔄 Collecting free-mujoco-py
  Downloading free_mujoco_py-2.1.6-py3-none-any.whl.metadata (586 bytes)
Collecting Cython<0.30.0,>=0.29.24 (from free-mujoco-py)
  Downloading Cython-0.29.37-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.manylinux_2_24_x86_64.whl.metadata
Requirement already satisfied: cffi<2.0.0,>=1.15.0 in /usr/local/lib/python3.10/dist-packages (from free-mujoco-py) (1
Collecting fasteners==0.15 (from free-mujoco-py)
  Downloading fasteners-0.15-py2.py3-none-any.whl.metadata (2.6 kB)
Collecting glfw<2.0.0,>=1.4.0 (from free-mujoco-py)
  Downloading glfw-1.12.0-py2.py27.py3.py30.py31.py32.py33.py34.py35.py36.py37.py38-none-manylinux2014_x86_64.whl.meta
Requirement already satisfied: imageio<3.0.0,>=2.9.0 in /usr/local/lib/python3.10/dist-packages (from free-mujoco-py)
Requirement already satisfied: numpy<2.0.0,>=1.21.3 in /usr/local/lib/python3.10/dist-packages (from free-mujoco-py) (
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-packages (from fasteners==0.15->free-mujoco-py) (
Collecting monotonic>=0.1 (from fasteners==0.15->free-mujoco-py)
  Downloading monotonic-1.6-py2.py3-none-any.whl.metadata (1.5 kB)
Requirement already satisfied: pycparser in /usr/local/lib/python3.10/dist-packages (from cffi<2.0.0,>=1.15.0->free-mu
Requirement already satisfied: pillow>=8.3.2 in /usr/local/lib/python3.10/dist-packages (from imageio<3.0.0,>=2.9.0->f
Downloading free_mujoco_py-2.1.6-py3-none-any.whl (14.1 MB)
14.1/14.1 MB 93.1 MB/s eta 0:00:00
Downloading fasteners-0.15-py2.py3-none-any.whl (23 kB)
Downloading Cython-0.29.37-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.manylinux_2_24_x86_64.whl (1.9 MB)
1.9/1.9 MB 85.8 MB/s eta 0:00:00
Downloading glfw-1.12.0-py2.py27.py3.py30.py31.py32.py33.py34.py35.py36.py37.py38-none-manylinux2014_x86_64.whl (203 k
203.7/203.7 kB 19.0 MB/s eta 0:00:00
Downloading monotonic-1.6-py2.py3-none-any.whl (8.2 kB)
Installing collected packages: monotonic, glfw, fasteners, Cython, free-mujoco-py
  Attempting uninstall: Cython
    Found existing installation: Cython 3.0.11
    Uninstalling Cython-3.0.11:
      Successfully uninstalled Cython-3.0.11
Successfully installed Cython-0.29.37 fasteners-0.15 free-mujoco-py-2.1.6 glfw-1.12.0 monotonic-1.6

```

```
!pip install gym==0.25.2
```

```

Requirement already satisfied: gym==0.25.2 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==0.25.2) (1.26.4)
Requirement already satisfied: cloudpickle>=1.2.0 in /usr/local/lib/python3.10/dist-packages (from gym==0.25.2) (3.1.0)
Requirement already satisfied: gym-notices>=0.0.4 in /usr/local/lib/python3.10/dist-packages (from gym==0.25.2) (0.0.8)

```

```
!pip install pytorch-lightning
```

```

Collecting pytorch-lightning
  Downloading pytorch_lightning-2.4.0-py3-none-any.whl.metadata (21 kB)
Requirement already satisfied: torch>=2.1.0 in /usr/local/lib/python3.10/dist-packages (from pytorch-lightning) (2.5.0)
Requirement already satisfied: tqdm>=4.57.0 in /usr/local/lib/python3.10/dist-packages (from pytorch-lightning) (4.66)
Requirement already satisfied: PyYAML>=5.4 in /usr/local/lib/python3.10/dist-packages (from pytorch-lightning) (6.0.2)
Requirement already satisfied: fsspec>=2022.5.0 in /usr/local/lib/python3.10/dist-packages (from fsspec[http]>=2022.5)
Collecting torchmetrics>=0.7.0 (from pytorch-lightning)
  Downloading torchmetrics-1.5.2-py3-none-any.whl.metadata (20 kB)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packages (from pytorch-lightning) (24)
Requirement already satisfied: typing-extensions>=4.4.0 in /usr/local/lib/python3.10/dist-packages (from pytorch-lightning)
Collecting lightning-utilities>=0.10.0 (from pytorch-lightning)
  Downloading lightning_utilities-0.11.8-py3-none-any.whl.metadata (5.2 kB)
Requirement already satisfied: aiohttp!=4.0.0a0,!=4.0.0a1 in /usr/local/lib/python3.10/dist-packages (from fsspec[http]
Requirement already satisfied: setuptools in /usr/local/lib/python3.10/dist-packages (from lightning-utilities>=0.10.0)
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from torch>=2.1.0->pytorch-lightning)
Requirement already satisfied: networkx in /usr/local/lib/python3.10/dist-packages (from torch>=2.1.0->pytorch-lightning)
Requirement already satisfied: Jinja2 in /usr/local/lib/python3.10/dist-packages (from torch>=2.1.0->pytorch-lightning)
Requirement already satisfied: sympy==1.13.1 in /usr/local/lib/python3.10/dist-packages (from torch>=2.1.0->pytorch-lightning)
Requirement already satisfied: mpmath<1.4, >=1.1.0 in /usr/local/lib/python3.10/dist-packages (from sympy==1.13.1->torch)
Requirement already satisfied: numpy>1.20.0 in /usr/local/lib/python3.10/dist-packages (from torchmetrics>=0.7.0->pytorch-lightning)
Requirement already satisfied: aiohappyeyeballs>=2.3.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp!=4.0.0a0,!=4.0.0a1)
Requirement already satisfied: aiosignal>=1.1.2 in /usr/local/lib/python3.10/dist-packages (from aiohttp!=4.0.0a0,!=4.0.0a1)
Requirement already satisfied: attrs>=17.3.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp!=4.0.0a0,!=4.0.0a1)
Requirement already satisfied: frozenlist>=1.1.1 in /usr/local/lib/python3.10/dist-packages (from aiohttp!=4.0.0a0,!=4.0.0a1)
Requirement already satisfied: multidict<7.0, >=4.5 in /usr/local/lib/python3.10/dist-packages (from aiohttp!=4.0.0a0,!=4.0.0a1)
Requirement already satisfied: yarl<2.0, >=1.12.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp!=4.0.0a0,!=4.0.0a1)
Requirement already satisfied: async-timeout<5.0, >=4.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp!=4.0.0a0,!=4.0.0a1)
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.10/dist-packages (from Jinja2->torch>=2.1.0->pytorch-lightning)
Requirement already satisfied: idna>=2.0 in /usr/local/lib/python3.10/dist-packages (from yarl<2.0, >=1.12.0->aiohttp!=4.0.0a0,!=4.0.0a1)
Requirement already satisfied: propcache>=0.2.0 in /usr/local/lib/python3.10/dist-packages (from yarl<2.0, >=1.12.0->aiohttp!=4.0.0a0,!=4.0.0a1)
  Downloading pytorch_lightning-2.4.0-py3-none-any.whl (815 kB)
      815.2/815.2 kB 22.4 MB/s eta 0:00:00
  Downloading lightning_utilities-0.11.8-py3-none-any.whl (26 kB)
  Downloading torchmetrics-1.5.2-py3-none-any.whl (891 kB)
      891.4/891.4 kB 49.9 MB/s eta 0:00:00
Installing collected packages: lightning-utilities, torchmetrics, pytorch-lightning
Successfully installed lightning-utilities-0.11.8 pytorch-lightning-2.4.0 torchmetrics-1.5.2

```

```
!pip install optuna
```

```

Collecting optuna
  Downloading optuna-4.0.0-py3-none-any.whl.metadata (16 kB)
Collecting alembic>=1.5.0 (from optuna)
  Downloading alembic-1.14.0-py3-none-any.whl.metadata (7.4 kB)
Collecting colorlog (from optuna)
  Downloading colorlog-6.9.0-py3-none-any.whl.metadata (10 kB)
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages (from optuna) (1.26.4)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packages (from optuna) (24.1)
Requirement already satisfied: sqlalchemy>=1.3.0 in /usr/local/lib/python3.10/dist-packages (from optuna) (2.0.36)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-packages (from optuna) (4.66.6)
Requirement already satisfied: PyYAML in /usr/local/lib/python3.10/dist-packages (from optuna) (6.0.2)
Collecting Mako (from alembic>=1.5.0->optuna)
  Downloading Mako-1.3.6-py3-none-any.whl.metadata (2.9 kB)
Requirement already satisfied: typing-extensions>=4 in /usr/local/lib/python3.10/dist-packages (from alembic>=1.5.0->optuna)
Requirement already satisfied: greenlet!=0.4.17 in /usr/local/lib/python3.10/dist-packages (from sqlalchemy>=1.3.0->optuna)
Requirement already satisfied: MarkupSafe>=0.9.2 in /usr/local/lib/python3.10/dist-packages (from Mako->alembic>=1.5.0->optuna)
  Downloading optuna-4.0.0-py3-none-any.whl (362 kB)
      362.8/362.8 kB 8.2 MB/s eta 0:00:00
  Downloading alembic-1.14.0-py3-none-any.whl (233 kB)
      233.5/233.5 kB 10.0 MB/s eta 0:00:00
  Downloading colorlog-6.9.0-py3-none-any.whl (11 kB)
  Downloading Mako-1.3.6-py3-none-any.whl (78 kB)
      78.6/78.6 kB 5.2 MB/s eta 0:00:00
Installing collected packages: Mako, colorlog, alembic, optuna
Successfully installed Mako-1.3.6 alembic-1.14.0 colorlog-6.9.0 optuna-4.0.0

```

```
!pip install gym-robotics
```

◀ ▶

```

➡ Collecting pyvirtualdisplay
   Downloading PyVirtualDisplay-3.0-py3-none-any.whl.metadata (943 bytes)
   Downloading PyVirtualDisplay-3.0-py3-none-any.whl (15 kB)
   Installing collected packages: pyvirtualdisplay
   Successfully installed pyvirtualdisplay-3.0

```

Requirement already satisfied: PyOpenGL in /usr/local/lib/python3.10/dist-packages (3.1.7)

◀ ▶

```
↳ <pyvirtualdisplay.display.Display at 0x79ac93687eb0>
```

```

import copy
import gym
import torch
import itertools
import random

import numpy as np
import torch.nn.functional as F

from collections import deque, namedtuple
from IPython.display import HTML
from base64 import b64encode

from torch import nn
from torch.utils.data import DataLoader
from torch.utils.data.dataset import IterableDataset
from torch.optim import AdamW
from torch.distributions.normal import Normal

from pytorch_lightning import LightningModule, Trainer

from gym.wrappers import RecordVideo, RecordEpisodeStatistics, \
    FilterObservation, FlattenObservation

device = 'cuda' if torch.cuda.is_available() else 'cpu'
num_gpus = torch.cuda.device_count()

```

⚠ /usr/local/lib/python3.10/dist-packages/gym/envs/registration.py:307: DeprecationWarning: The package name gym\_robotic  
fn()

```

def display_video(episode=0):
    video_file = open(f'/content/videos/rl-video-episode-{episode}.mp4', "r+b").read()
    video_url = f"data:video/mp4;base64,{b64encode(video_file).decode()}"
    return HTML(f"<video width=600 controls><source src='{video_url}'></video>")

```

## ✓ Create the replay buffer

```

class ReplayBuffer:

    def __init__(self, capacity):
        self.buffer = deque(maxlen=capacity)

    def __len__(self):
        return len(self.buffer)

    def append(self, experience):
        self.buffer.append(experience)

    def sample(self, batch_size):
        return random.sample(self.buffer, batch_size)

```

```

class RLDataset(IterableDataset):

    def __init__(self, buffer, sample_size=400):
        self.buffer = buffer
        self.sample_size = sample_size

    def __iter__(self):
        for experience in self.buffer.sample(self.sample_size):
            yield experience

```

## ✓ Create the environment

```

def create_environment(name, render_mode=None):
    env = gym.make(name, render_mode=render_mode)
    env = FilterObservation(env, ['observation', 'desired_goal'])
    env = FlattenObservation(env)

```

```
env = RecordVideo(env, video_folder='./videos', episode_trigger=lambda x: x % 50 == 0)
env = RecordEpisodeStatistics(env)
return env
```

## ✓ Update the target network

```
def polyak_average(net, target_net, tau=0.01):
    for qp, tp in zip(net.parameters(), target_net.parameters()):
        tp.data.copy_(tau * qp.data + (1 - tau) * tp.data)
```

## ✓ Create the Deep Q-Network

```
class DQN(nn.Module):

    def __init__(self, hidden_size, obs_size, out_dims):
        super().__init__()
        self.net = nn.Sequential(
            nn.Linear(obs_size + out_dims, hidden_size),
            nn.ReLU(),
            nn.Linear(hidden_size, hidden_size),
            nn.ReLU(),
            nn.Linear(hidden_size, 1),
        )

    def forward(self, state, action):
        if isinstance(state, np.ndarray):
            state = torch.from_numpy(state).to(device)
        if isinstance(action, np.ndarray):
            action = torch.from_numpy(action).to(device)
        in_vector = torch.hstack((state, action))
        return self.net(in_vector.float())
```

## ✓ Create the gradient policy

```
class GradientPolicy(nn.Module):

    def __init__(self, hidden_size, obs_size, out_dims, max):
        super().__init__()

        self.max = torch.from_numpy(max).to(device)

        self.net = nn.Sequential(
            nn.Linear(obs_size, hidden_size),
            nn.ReLU(),
            nn.Linear(hidden_size, hidden_size),
            nn.ReLU()
        )
        self.linear_mu = nn.Linear(hidden_size, out_dims)
        self.linear_std = nn.Linear(hidden_size, out_dims)
        # self.linear_log_std = nn.Linear(hidden_size, out_dims)

    def forward(self, obs):
        if isinstance(obs, np.ndarray):
            obs = torch.from_numpy(obs).to(device)
        x = self.net(obs.float())
        mu = self.linear_mu(x)
        std = self.linear_std(x)
        std = F.softplus(std) + 1e-3

        dist = Normal(mu, std)
        action = dist.rsample()
        log_prob = dist.log_prob(action)
        log_prob = log_prob.sum(dim=-1, keepdim=True)
        log_prob -= (2 * (np.log(2) - action - F.softplus(-2*action))).sum(dim=-1, keepdim=True)

        action = torch.tanh(action) * self.max
        return action, log_prob
```



## ✓ Soft actor-critic algorithm

```

class SAC(LightningModule):

    def __init__(self, env_name, capacity=100_000, batch_size=256, lr=1e-3,
                 hidden_size=256, gamma=0.99, loss_fn=F.smooth_l1_loss, optim=AdamW,
                 samples_per_epoch=1_000, tau=0.05, alpha=0.02, epsilon=0.05):

        super().__init__()

        self.env = create_environment(env_name, render_mode="rgb_array")

        obs_size = self.env.observation_space.shape[0]
        action_dims = self.env.action_space.shape[0]
        max_action = self.env.action_space.high

        self.q_net1 = DQN(hidden_size, obs_size, action_dims)
        self.q_net2 = DQN(hidden_size, obs_size, action_dims)
        self.policy = GradientPolicy(hidden_size, obs_size, action_dims, max_action)

        self.target_policy = copy.deepcopy(self.policy)
        self.target_q_net1 = copy.deepcopy(self.q_net1)
        self.target_q_net2 = copy.deepcopy(self.q_net2)

        self.buffer = ReplayBuffer(capacity=capacity)

        self.save_hyperparameters()

        self.automatic_optimization = False

        while len(self.buffer) < self.hparams.samples_per_epoch:
            print(f"{len(self.buffer)} samples in experience buffer. Filling...")
            self.play_episodes()

    @torch.no_grad()
    def play_episodes(self, policy=None):
        obs = list(self.env.reset())
        obs = np.array(obs[0])
        #print(obs)
        done = False

        while not done:
            if policy and random.random() > self.hparams.epsilon:
                action, _ = self.policy(obs)
                action = action.cpu().numpy()
            else:
                action = self.env.action_space.sample()

            step_output = self.env.step(action)
            if len(step_output) == 5:
                next_obs, reward, terminated, truncated, info = step_output
                # Combine terminated and truncated to align with the original 'done' logic.
                done = terminated or truncated
            else:
                next_obs, reward, done, info = step_output

            #print(type(obs), "o")
            #print(type(action), "a")
            #print(type(reward), "r")
            #print(type(done), "d")
            #print(type(next_obs), "no")
            exp = (obs, action, reward, done, next_obs)
            self.buffer.append(exp)
            obs = next_obs

        def forward(self, x):
            output = self.policy(x)
            return output

        def configure_optimizers(self):
            q_net_parameters = itertools.chain(self.q_net1.parameters(), self.q_net2.parameters())

```

```

q_net_optimizer = self.hparams.optim(q_net_parameters, lr=self.hparams.lr)
policy_optimizer = self.hparams.optim(self.policy.parameters(), lr=self.hparams.lr)
return [q_net_optimizer, policy_optimizer]

def train_dataloader(self):
    dataset = RLDataset(self.buffer, self.hparams.samples_per_epoch,)
    #print(dataset)
    dataloader = DataLoader(
        dataset=dataset,
        batch_size=self.hparams.batch_size,
    )
    #print(dataloader)
    return dataloader

def training_step(self, batch, batch_idx):
    states, actions, rewards, dones, next_states = batch
    #print(type(states),"s")
    #print(type(actions))
    #print(type(rewards))
    #print(type(dones))
    #print(type(next_states))

    rewards = rewards.unsqueeze(1)
    dones = dones.unsqueeze(1)

    # Optimize Q-networks
    opt_q, opt_policy = self.optimizers() # Access optimizers
    opt_q.zero_grad() # Zero gradients for Q-networks optimizer

    action_values1 = self.q_net1(states, actions)
    action_values2 = self.q_net2(states, actions)

    target_actions, target_log_probs = self.target_policy(next_states)

    next_action_values = torch.min(
        self.target_q_net1(next_states, target_actions),
        self.target_q_net2(next_states, target_actions)
    )
    next_action_values[dones] = 0.0

    expected_action_values = rewards + self.hparams.gamma * (next_action_values - self.hparams.alpha * target_log_probs)

    q_loss1 = self.hparams.loss_fn(action_values1, expected_action_values)
    q_loss2 = self.hparams.loss_fn(action_values2, expected_action_values)

    q_loss_total = q_loss1 + q_loss2

    self.log("episode/Q-Loss", q_loss_total)

    self.manual_backward(q_loss_total) # Manually backpropagate the loss
    opt_q.step() # Update Q-network parameters

    # Optimize Policy
    opt_policy.zero_grad() # Zero gradients for policy optimizer

    actions, log_probs = self.policy(states)

    action_values = torch.min(
        self.q_net1(states, actions),
        self.q_net2(states, actions)
    )

    policy_loss = (self.hparams.alpha * log_probs - action_values).mean()
    self.log("episode/Policy Loss", policy_loss)

    self.manual_backward(policy_loss) # Manually backpropagate the loss
    opt_policy.step()

def on_train_epoch_end(self):
    self.play_episodes(policy=self.policy)

    polyak_average(self.q_net1, self.target_q_net1, tau=self.hparams.tau)
    polyak_average(self.q_net2, self.target_q_net2, tau=self.hparams.tau)
    polyak_average(self.policy, self.target_policy, tau=self.hparams.tau)

```

```
self.log("episode/episode_return", self.env.return_queue[-1])
```

```
# Start tensorboard.
!rm -r /content/lightning_logs/
!rm -r /content/videos/
%load_ext tensorboard
%tensorboard --logdir /content/lightning_logs/
```

```
rm: cannot remove '/content/lightning_logs/': No such file or directory
rm: cannot remove '/content/videos/': No such file or directory
```

TensorBoard

TIME SERIES

SCALARS

HPARAMS

INACTIVE

Filter tags (regex)

All

Scalars

Image

Histogram

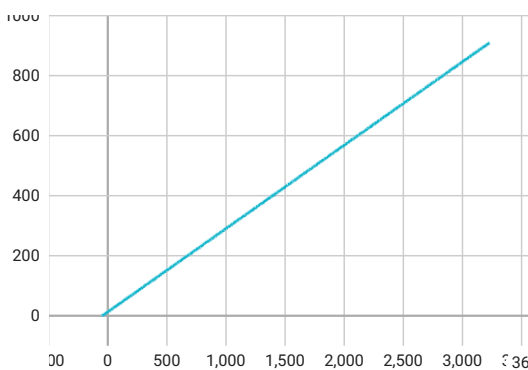
Settings

episode 3 cards

version_1	-2.4275	-2.0973	3,519	4.374 min
-----------	---------	---------	-------	-----------

epoch

epoch



Run	Smoothed	Value	Step	Relative
version_1	907.7201	909	3,639	4.546 min

hp\_metric

```
import pytorch_lightning as pl
import warnings
warnings.filterwarnings('ignore')
```

```
algo = SAC('FetchReachDense-v1', lr=1e-3, alpha=0.002, tau=0.1)
```

```
trainer = pl.Trainer(
    accelerator="gpu" if num_gpus else "cpu", # Use 'gpu' if num_gpus is greater than 0, otherwise use 'cpu'
    devices=1, # Specify the number of GPUs or 'auto' for automatic detection
    max_epochs=2000,
    log_every_n_steps=10
)
```

```
trainer.fit(algo)
```

```

0 samples in experience buffer. Filling...
Moviepy - Building video /content/videos/rl-video-episode-0.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-0.mp4

Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-0.mp4
50 samples in experience buffer. Filling...
100 samples in experience buffer. Filling...
150 samples in experience buffer. Filling...
200 samples in experience buffer. Filling...
250 samples in experience buffer. Filling...
300 samples in experience buffer. Filling...
350 samples in experience buffer. Filling...
400 samples in experience buffer. Filling...
450 samples in experience buffer. Filling...
500 samples in experience buffer. Filling...
550 samples in experience buffer. Filling...
600 samples in experience buffer. Filling...
650 samples in experience buffer. Filling...
700 samples in experience buffer. Filling...
750 samples in experience buffer. Filling...
800 samples in experience buffer. Filling...
850 samples in experience buffer. Filling...
INFO:pytorch_lightning.utilities.rank_zero:GPU available: True (cuda), used: True
INFO:pytorch_lightning.utilities.rank_zero:TPU available: False, using: 0 TPU cores
INFO:pytorch_lightning.utilities.rank_zero:HPU available: False, using: 0 HPUs
INFO:pytorch_lightning.accelerators.cuda:LOCAL_RANK: 0 - CUDA_VISIBLE_DEVICES: [0]
900 samples in experience buffer. Filling...
950 samples in experience buffer. Filling...
INFO:pytorch_lightning.callbacks.model_summary:
  | Name          | Type          | Params | Mode
  |-----|-----|-----|-----|
0 | q_net1         | DQN           | 70.7 K | train
1 | q_net2         | DQN           | 70.7 K | train
2 | policy         | GradientPolicy | 71.4 K | train
3 | target_policy  | GradientPolicy | 71.4 K | train
4 | target_q_net1  | DQN           | 70.7 K | train
5 | target_q_net2  | DQN           | 70.7 K | train
  |-----|-----|-----|-----|
425 K   Trainable params
0       Non-trainable params
425 K   Total params
1.702   Total estimated model params size (MB)
44      Modules in train mode
0       Modules in eval mode

Epoch 1999:
Moviepy - Building video /content/videos/rl-video-episode-50.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-50.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|██████    | 20/53 [00:00<00:00, 198.84it/s, now=None]
t: 75%|██████████ | 40/53 [00:00<00:00, 191.06it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-50.mp4
Moviepy - Building video /content/videos/rl-video-episode-100.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-100.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 36%|██████    | 19/53 [00:00<00:00, 185.97it/s, now=None]
t: 72%|██████████ | 38/53 [00:00<00:00, 174.54it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-100.mp4
Moviepy - Building video /content/videos/rl-video-episode-150.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-150.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 32%|██████    | 17/53 [00:00<00:00, 167.26it/s, now=None]
t: 66%|██████████ | 35/53 [00:00<00:00, 173.17it/s, now=None]
t: 100%|██████████| 53/53 [00:00<00:00, 140.56it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-150.mp4
Moviepy - Building video /content/videos/rl-video-episode-200.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-200.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 40%|██████    | 21/53 [00:00<00:00, 202.53it/s, now=None]
t: 79%|██████████ | 42/53 [00:00<00:00, 192.19it/s, now=None]

```

```
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-200.mp4
Moviepy - Building video /content/videos/rl-video-episode-250.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-250.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|███      | 20/53 [00:00<00:00, 192.71it/s, now=None]
t: 75%|██████   | 40/53 [00:00<00:00, 182.06it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-250.mp4
Moviepy - Building video /content/videos/rl-video-episode-300.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-300.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 34%|███      | 18/53 [00:00<00:00, 173.63it/s, now=None]
t: 70%|██████   | 37/53 [00:00<00:00, 181.83it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-300.mp4
Moviepy - Building video /content/videos/rl-video-episode-350.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-350.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|███      | 20/53 [00:00<00:00, 199.02it/s, now=None]
t: 75%|██████   | 40/53 [00:00<00:00, 191.79it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-350.mp4
Moviepy - Building video /content/videos/rl-video-episode-400.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-400.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|███      | 20/53 [00:00<00:00, 191.90it/s, now=None]
t: 75%|██████   | 40/53 [00:00<00:00, 185.82it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-400.mp4
Moviepy - Building video /content/videos/rl-video-episode-450.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-450.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 19%|██       | 10/53 [00:00<00:00, 93.11it/s, now=None]
t: 40%|████     | 21/53 [00:00<00:00, 99.24it/s, now=None]
t: 60%|██████   | 32/53 [00:00<00:00, 100.52it/s, now=None]
t: 81%|██████   | 43/53 [00:00<00:00, 97.75it/s, now=None]
t: 100%|███████ | 53/53 [00:00<00:00, 78.87it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-450.mp4
Moviepy - Building video /content/videos/rl-video-episode-500.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-500.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 23%|██       | 12/53 [00:00<00:00, 111.73it/s, now=None]
t: 45%|████     | 24/53 [00:00<00:00, 97.52it/s, now=None]
t: 66%|██████   | 35/53 [00:00<00:00, 98.88it/s, now=None]
t: 85%|██████   | 45/53 [00:00<00:00, 89.78it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-500.mp4
Moviepy - Building video /content/videos/rl-video-episode-550.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-550.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|███      | 20/53 [00:00<00:00, 193.52it/s, now=None]
t: 75%|██████   | 40/53 [00:00<00:00, 189.18it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-550.mp4
Moviepy - Building video /content/videos/rl-video-episode-600.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-600.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|███      | 20/53 [00:00<00:00, 193.20it/s, now=None]
t: 75%|██████   | 40/53 [00:00<00:00, 177.95it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-600.mp4
Moviepy - Building video /content/videos/rl-video-episode-650.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-650.mp4
```

```
t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 19%|██       | 10/53 [00:00<00:00, 96.69it/s, now=None]
t: 38%|████     | 20/53 [00:00<00:00, 94.33it/s, now=None]
t: 57%|██████   | 30/53 [00:00<00:00, 95.82it/s, now=None]
t: 75%|████████ | 40/53 [00:00<00:00, 94.83it/s, now=None]
t: 94%|█████████| 50/53 [00:00<00:00, 76.07it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-650.mp4
Moviepy - Building video /content/videos/rl-video-episode-700.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-700.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|████     | 20/53 [00:00<00:00, 196.37it/s, now=None]
t: 75%|████████ | 40/53 [00:00<00:00, 177.19it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-700.mp4
Moviepy - Building video /content/videos/rl-video-episode-750.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-750.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 40%|████     | 21/53 [00:00<00:00, 201.63it/s, now=None]
t: 79%|████████ | 42/53 [00:00<00:00, 192.35it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-750.mp4
Moviepy - Building video /content/videos/rl-video-episode-800.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-800.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 34%|████     | 18/53 [00:00<00:00, 178.05it/s, now=None]
t: 70%|████████ | 37/53 [00:00<00:00, 181.19it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-800.mp4
Moviepy - Building video /content/videos/rl-video-episode-850.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-850.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|████     | 20/53 [00:00<00:00, 196.65it/s, now=None]
t: 75%|████████ | 40/53 [00:00<00:00, 189.58it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-850.mp4
Moviepy - Building video /content/videos/rl-video-episode-900.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-900.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 30%|████     | 16/53 [00:00<00:00, 153.96it/s, now=None]
t: 66%|████████ | 35/53 [00:00<00:00, 171.64it/s, now=None]
t: 100%|█████████| 53/53 [00:00<00:00, 145.08it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-900.mp4
Moviepy - Building video /content/videos/rl-video-episode-950.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-950.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 34%|████     | 18/53 [00:00<00:00, 176.90it/s, now=None]
t: 70%|████████ | 37/53 [00:00<00:00, 181.56it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-950.mp4
Moviepy - Building video /content/videos/rl-video-episode-1000.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1000.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 21%|██       | 11/53 [00:00<00:00, 102.85it/s, now=None]
t: 42%|████     | 22/53 [00:00<00:00, 101.49it/s, now=None]
t: 64%|████████ | 34/53 [00:00<00:00, 106.20it/s, now=None]
t: 85%|█████████| 45/53 [00:00<00:00, 99.44it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1000.mp4
Moviepy - Building video /content/videos/rl-video-episode-1050.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1050.mp4

t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 19%|██       | 10/53 [00:00<00:00, 95.75it/s, now=None]
t: 38%|████     | 20/53 [00:00<00:00, 95.43it/s, now=None]
```

```
t: 50%|██████| | 20/53 [00:00<00:00, 93.41it/s, now=None]
t: 57%|██████| | 30/53 [00:00<00:00, 93.02it/s, now=None]
t: 75%|██████| | 40/53 [00:00<00:00, 94.72it/s, now=None]
t: 94%|██████| | 50/53 [00:00<00:00, 79.79it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1050.mp4
Moviepy - Building video /content/videos/rl-video-episode-1100.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1100.mp4

t: 0%| | | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|██████| | 20/53 [00:00<00:00, 194.44it/s, now=None]
t: 75%|██████| | 40/53 [00:00<00:00, 187.64it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1100.mp4
Moviepy - Building video /content/videos/rl-video-episode-1150.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1150.mp4

t: 0%| | | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|██████| | 20/53 [00:00<00:00, 194.28it/s, now=None]
t: 75%|██████| | 40/53 [00:00<00:00, 189.40it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1150.mp4
Moviepy - Building video /content/videos/rl-video-episode-1200.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1200.mp4

t: 0%| | | 0/53 [00:00<?, ?it/s, now=None]
t: 36%|██████| | 19/53 [00:00<00:00, 187.05it/s, now=None]
t: 72%|██████| | 38/53 [00:00<00:00, 185.21it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1200.mp4
Moviepy - Building video /content/videos/rl-video-episode-1250.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1250.mp4

t: 0%| | | 0/53 [00:00<?, ?it/s, now=None]
t: 40%|██████| | 21/53 [00:00<00:00, 203.67it/s, now=None]
t: 79%|██████| | 42/53 [00:00<00:00, 194.95it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1250.mp4
Moviepy - Building video /content/videos/rl-video-episode-1300.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1300.mp4

t: 0%| | | 0/53 [00:00<?, ?it/s, now=None]
t: 36%|██████| | 19/53 [00:00<00:00, 186.72it/s, now=None]
t: 72%|██████| | 38/53 [00:00<00:00, 185.74it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1300.mp4
Moviepy - Building video /content/videos/rl-video-episode-1350.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1350.mp4

t: 0%| | | 0/53 [00:00<?, ?it/s, now=None]
t: 36%|██████| | 19/53 [00:00<00:00, 188.14it/s, now=None]
t: 72%|██████| | 38/53 [00:00<00:00, 185.34it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1350.mp4
Moviepy - Building video /content/videos/rl-video-episode-1400.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1400.mp4

t: 0%| | | 0/53 [00:00<?, ?it/s, now=None]
t: 32%|██████| | 17/53 [00:00<00:00, 167.87it/s, now=None]
t: 68%|██████| | 36/53 [00:00<00:00, 177.72it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1400.mp4
Moviepy - Building video /content/videos/rl-video-episode-1450.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1450.mp4

t: 0%| | | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|██████| | 20/53 [00:00<00:00, 196.10it/s, now=None]
t: 75%|██████| | 40/53 [00:00<00:00, 191.07it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1450.mp4
Moviepy - Building video /content/videos/rl-video-episode-1500.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1500.mp4
```

```
t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|███      | 20/53 [00:00<00:00, 192.29it/s, now=None]
t: 75%|██████    | 40/53 [00:00<00:00, 185.16it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1500.mp4
Moviepy - Building video /content/videos/rl-video-episode-1550.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1550.mp4
```

```
t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 21%|██       | 11/53 [00:00<00:00, 96.36it/s, now=None]
t: 40%|████      | 21/53 [00:00<00:00, 92.08it/s, now=None]
t: 58%|██████    | 31/53 [00:00<00:00, 93.73it/s, now=None]
t: 77%|███████   | 41/53 [00:00<00:00, 94.90it/s, now=None]
t: 96%|████████  | 51/53 [00:00<00:00, 74.34it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1550.mp4
Moviepy - Building video /content/videos/rl-video-episode-1600.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1600.mp4
```

```
t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 17%|██       | 9/53 [00:00<00:00, 83.27it/s, now=None]
t: 38%|████      | 20/53 [00:00<00:00, 94.47it/s, now=None]
t: 57%|██████    | 30/53 [00:00<00:00, 95.92it/s, now=None]
t: 77%|███████   | 41/53 [00:00<00:00, 99.03it/s, now=None]
t: 96%|████████  | 51/53 [00:00<00:00, 79.42it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1600.mp4
Moviepy - Building video /content/videos/rl-video-episode-1650.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1650.mp4
```

```
t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 40%|████      | 21/53 [00:00<00:00, 201.99it/s, now=None]
t: 79%|███████   | 42/53 [00:00<00:00, 193.09it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1650.mp4
Moviepy - Building video /content/videos/rl-video-episode-1700.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1700.mp4
```

```
t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|████      | 20/53 [00:00<00:00, 199.28it/s, now=None]
t: 75%|██████    | 40/53 [00:00<00:00, 189.86it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1700.mp4
Moviepy - Building video /content/videos/rl-video-episode-1750.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1750.mp4
```

```
t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|████      | 20/53 [00:00<00:00, 195.97it/s, now=None]
t: 75%|██████    | 40/53 [00:00<00:00, 186.81it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1750.mp4
Moviepy - Building video /content/videos/rl-video-episode-1800.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1800.mp4
```

```
t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|████      | 20/53 [00:00<00:00, 190.40it/s, now=None]
t: 75%|██████    | 40/53 [00:00<00:00, 175.36it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1800.mp4
Moviepy - Building video /content/videos/rl-video-episode-1850.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1850.mp4
```

```
t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|████      | 20/53 [00:00<00:00, 196.43it/s, now=None]
t: 75%|██████    | 40/53 [00:00<00:00, 185.81it/s, now=None]
Moviepy - Done !
Moviepy - video ready /content/videos/rl-video-episode-1850.mp4
Moviepy - Building video /content/videos/rl-video-episode-1900.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1900.mp4
```

```
t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|████      | 20/53 [00:00<00:00, 193.86it/s, now=None]
t: 75%|██████    | 40/53 [00:00<00:00, 188.39it/s, now=None]
Moviepy - Done !
```



```
Moviepy - video ready /content/videos/rl-video-episode-1900.mp4
Moviepy - Building video /content/videos/rl-video-episode-1950.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-1950.mp4
```

```
t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|███      | 20/53 [00:00<00:00, 192.32it/s, now=None]
t: 75%|██████   | 40/53 [00:00<00:00, 187.81it/s, now=None]
Moviepy - Done !

Moviepy - video ready /content/videos/rl-video-episode-1950.mp4
Moviepy - Building video /content/videos/rl-video-episode-2000.mp4.
Moviepy - Writing video /content/videos/rl-video-episode-2000.mp4
```

```
t: 0%|          | 0/53 [00:00<?, ?it/s, now=None]
t: 38%|███      | 20/53 [00:00<00:00, 190.94it/s, now=None]
t: 75%|██████   | 40/53 [00:00<00:00, 171.02it/s, now=None]
Moviepy - Done !

Moviepy - video ready /content/videos/rl-video-episode-2000.mp4
INFO:pytorch_lightning.utilities.rank_zero:`Trainer.fit` stopped: `max_epochs=2000` reached.
```

```
display_video(episode=2000)
```



0:02 / 0:02