Task IV: Quantum Generative Adversarial Network (QGAN)

You will explore how best to apply a quantum generative adversarial network (QGAN) to solve a High Energy Data analysis issue, more specifically, separating the signal events from the background events.

You should use the Google Cirq and Tensorflow Quantum (TFQ) libraries for this task.

A set of input samples (simulated with Delphes) is provided in NumPy NPZ format [Download Input].

In the input file, there are only 100 samples for training and 100 samples for testing so it won't take much computing resources to accomplish this task. The signal events are labeled with 1 while the background events are labeled with 0.

Be sure to show that you understand how to fine tune your machine learning model to improve the performance. The performance can be evaluated with classification accuracy or Area Under ROC Curve (AUC).

In [ ]:
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!pip install tensorflow==2.7.0
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Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/publi
c/simple/
Collecting tensorflow==2.7.0
  Downloading tensorflow-2.7.0-cp39-cp39-manylinux2010_x86_64.whl (489.7 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 489.7/489.7 MB 1.9 MB/s eta 0:00:00
Collecting keras-preprocessing>=1.1.1
  Downloading Keras_Preprocessing-1.1.2-py2.py3-none-any.whl (42 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 42.6/42.6 KB 2.1 MB/s eta 0:00:00
Collecting tensorflow-estimator<2.8,~=2.7.0rc0
  Downloading tensorflow_estimator-2.7.0-py2.py3-none-any.whl (463 kB)
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Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.21.0 in /usr/local/lib/pyth
on3.9/dist-packages (from tensorflow==2.7.0) (0.32.0)
Requirement already satisfied: gast<0.5.0,>=0.2.1 in /usr/local/lib/python3.9/dist-package
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Collecting keras<2.8,>=2.7.0rc0
  Downloading keras-2.7.0-py2.py3-none-any.whl (1.3 MB)
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Requirement already satisfied: protobuf>=3.9.2 in /usr/local/lib/python3.9/dist-packages
(from tensorflow==2.7.0) (3.20.3)
Requirement already satisfied: wheel<1.0,>=0.32.0 in /usr/local/lib/python3.9/dist-package
s (from tensorflow==2.7.0) (0.40.0)
Requirement already satisfied: wrapt>=1.11.0 in /usr/local/lib/python3.9/dist-packages (fr
om tensorflow==2.7.0) (1.14.1)
Collecting flatbuffers<3.0,>=1.12
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Requirement already satisfied: termcolor>=1.1.0 in /usr/local/lib/python3.9/dist-packages
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Requirement already satisfied: tensorboard~=2.6 in /usr/local/lib/python3.9/dist-packages
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Requirement already satisfied: google-pasta>=0.1.1 in /usr/local/lib/python3.9/dist-packag
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Requirement already satisfied: astunparse>=1.6.0 in /usr/local/lib/python3.9/dist-packages
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Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0 in /usr/local/lib/pyth
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Requirement already satisfied: markdown>=2.6.8 in /usr/local/lib/python3.9/dist-packages
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Requirement already satisfied: google-auth<3,>=1.6.3 in /usr/local/lib/python3.9/dist-pack
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Requirement already satisfied: setuptools>=41.0.0 in /usr/local/lib/python3.9/dist-package
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Requirement already satisfied: werkzeug>=1.0.1 in /usr/local/lib/python3.9/dist-packages
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Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /usr/local/lib/python3.
9/dist-packages (from tensorboard~=2.6->tensorflow==2.7.0) (0.4.6)
Requirement already satisfied: pyasn1-modules>=0.2.1 in /usr/local/lib/python3.9/dist-pack
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Requirement already satisfied: requests-oauthlib>=0.7.0 in /usr/local/lib/python3.9/dist-p
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1)
Requirement already satisfied: importlib-metadata>=4.4 in /usr/local/lib/python3.9/dist-pa
ckages (from markdown>=2.6.8->tensorboard~=2.6->tensorflow==2.7.0) (6.1.0)
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/python3.9/dist-
packages (from requests<3,>=2.21.0->tensorboard~=2.6->tensorflow==2.7.0) (2.0.12)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /usr/local/lib/python3.9/dist-pack
ages (from requests<3,>=2.21.0->tensorboard~=2.6->tensorflow==2.7.0) (1.26.15)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.9/dist-package
s (from requests<3,>=2.21.0->tensorboard~=2.6->tensorflow==2.7.0) (2022.12.7)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.9/dist-packages (fro
m requests<3,>=2.21.0->tensorboard~=2.6->tensorflow==2.7.0) (3.4)
Requirement already satisfied: MarkupSafe>=2.1.1 in /usr/local/lib/python3.9/dist-packages
(from werkzeug>=1.0.1->tensorboard~=2.6->tensorflow==2.7.0) (2.1.2)
Requirement already satisfied: zipp>=0.5 in /usr/local/lib/python3.9/dist-packages (from i
mportlib-metadata>=4.4->markdown>=2.6.8->tensorboard~=2.6->tensorflow==2.7.0) (3.15.0)
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in /usr/local/lib/python3.9/dist-packa
ges (from pyasn1-modules>=0.2.1->google-auth<3,>=1.6.3->tensorboard~=2.6->tensorflow==2.7.
0) (0.4.8)
Requirement already satisfied: oauthlib>=3.0.0 in /usr/local/lib/python3.9/dist-packages
(from requests-oauthlib>=0.7.0->google-auth-oauthlib<0.5,>=0.4.1->tensorboard~=2.6->tensor
flow==2.7.0) (3.2.2)
Installing collected packages: tensorflow-estimator, keras, flatbuffers, keras-preprocessi
ng, tensorflow
  Attempting uninstall: tensorflow-estimator
    Found existing installation: tensorflow-estimator 2.12.0
    Uninstalling tensorflow-estimator-2.12.0:
      Successfully uninstalled tensorflow-estimator-2.12.0
  Attempting uninstall: keras
    Found existing installation: keras 2.12.0
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    Uninstalling keras-2.12.0:
      Successfully uninstalled keras-2.12.0
  Attempting uninstall: flatbuffers
    Found existing installation: flatbuffers 23.3.3
    Uninstalling flatbuffers-23.3.3:
      Successfully uninstalled flatbuffers-23.3.3
  Attempting uninstall: tensorflow
    Found existing installation: tensorflow 2.12.0
    Uninstalling tensorflow-2.12.0:
      Successfully uninstalled tensorflow-2.12.0
Successfully installed flatbuffers-2.0.7 keras-2.7.0 keras-preprocessing-1.1.2 tensorflow-
2.7.0 tensorflow-estimator-2.7.0
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In [ ]:

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!pip install tensorflow-quantum==0.7.2
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Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/publi
c/simple/
Collecting tensorflow-quantum==0.7.2
  Downloading tensorflow_quantum-0.7.2-cp39-cp39-manylinux_2_12_x86_64.manylinux2010_x86_6
4.whl (10.5 MB)
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Collecting protobuf==3.17.3
  Downloading protobuf-3.17.3-cp39-cp39-manylinux_2_5_x86_64.manylinux1_x86_64.whl (1.0 M
B)
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Collecting sympy==1.8
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Collecting cirq-google>=0.13.1
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Collecting googleapis-common-protos==1.52.0
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Collecting cirq-core==0.13.1
  Downloading cirq_core-0.13.1-py3-none-any.whl (1.6 MB)
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Collecting google-api-core==1.21.0
  Downloading google_api_core-1.21.0-py2.py3-none-any.whl (90 kB)
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Collecting google-auth==1.18.0
  Downloading google_auth-1.18.0-py2.py3-none-any.whl (90 kB)
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Collecting networkx~=2.4
  Downloading networkx-2.8.8-py3-none-any.whl (2.0 MB)
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Requirement already satisfied: matplotlib~=3.0 in /usr/local/lib/python3.9/dist-packages
(from cirq-core==0.13.1->tensorflow-quantum==0.7.2) (3.7.1)
Requirement already satisfied: sortedcontainers~=2.0 in /usr/local/lib/python3.9/dist-pack
ages (from cirq-core==0.13.1->tensorflow-quantum==0.7.2) (2.4.0)
Requirement already satisfied: typing-extensions in /usr/local/lib/python3.9/dist-packages
(from cirq-core==0.13.1->tensorflow-quantum==0.7.2) (4.5.0)
Requirement already satisfied: tqdm in /usr/local/lib/python3.9/dist-packages (from cirq-c
ore==0.13.1->tensorflow-quantum==0.7.2) (4.65.0)
Requirement already satisfied: pandas in /usr/local/lib/python3.9/dist-packages (from cirq
-core==0.13.1->tensorflow-quantum==0.7.2) (1.4.4)
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core==0.13.1->tensorflow-quantum==0.7.2) (1.10.1)
Requirement already satisfied: numpy~=1.16 in /usr/local/lib/python3.9/dist-packages (from
cirq-core==0.13.1->tensorflow-quantum==0.7.2) (1.22.4)
Collecting duet~=0.2.0
  Downloading duet-0.2.7-py3-none-any.whl (28 kB)
Requirement already satisfied: requests<3.0.0dev,>=2.18.0 in /usr/local/lib/python3.9/dist
-packages (from google-api-core==1.21.0->tensorflow-quantum==0.7.2) (2.27.1)
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Requirement already satisfied: setuptools>=34.0.0 in /usr/local/lib/python3.9/dist-packages (from google-api-core==1.21.0->tensorflow-quantum==0.7.2) (67.6.1)
Requirement already satisfied: six>=1.10.0 in /usr/local/lib/python3.9/dist-packages (from google-api-core==1.21.0->tensorflow-quantum==0.7.2) (1.16.0)
Requirement already satisfied: pytz in /usr/local/lib/python3.9/dist-packages (from google-api-core==1.21.0->tensorflow-quantum==0.7.2) (2022.7.1)
Requirement already satisfied: rsa<5,>=3.1.4 in /usr/local/lib/python3.9/dist-packages (from google-auth==1.18.0->tensorflow-quantum==0.7.2) (4.9)
Collecting cachetools<5.0,>=2.0.0
  Downloading cachetools-4.2.4-py3-none-any.whl (10 kB)
Requirement already satisfied: pyasn1-modules>=0.2.1 in /usr/local/lib/python3.9/dist-packages (from google-auth==1.18.0->tensorflow-quantum==0.7.2) (0.2.8)
Requirement already satisfied: mpmath>=0.19 in /usr/local/lib/python3.9/dist-packages (from sympy==1.8->tensorflow-quantum==0.7.2) (1.3.0)
Requirement already satisfied: proto-plus>=1.20.0 in /usr/local/lib/python3.9/dist-packages (from cirq-google>=0.13.1->tensorflow-quantum==0.7.2) (1.22.2)
Collecting google-api-core[grpc]<2.0.0dev,>=1.14.0
  Downloading google_api_core-1.34.0-py3-none-any.whl (120 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 120.2/120.2 KB 9.9 MB/s eta 0:00:00
Collecting cirq-google>=0.13.1
  Downloading cirq_google-1.0.0-py3-none-any.whl (576 kB)
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  Downloading cirq_google-0.15.0-py3-none-any.whl (641 kB)
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  Downloading cirq_google-0.14.1-py3-none-any.whl (541 kB)
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  Downloading cirq_google-0.14.0-py3-none-any.whl (541 kB)
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  Downloading cirq_google-0.13.1-py3-none-any.whl (437 kB)
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Collecting google-api-core[grpc]<2.0.0dev,>=1.14.0
  Downloading google_api_core-1.33.2-py3-none-any.whl (115 kB)
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  Downloading google_api_core-1.33.1-py3-none-any.whl (115 kB)
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  Downloading google_api_core-1.33.0-py3-none-any.whl (115 kB)
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  Downloading google_api_core-1.32.0-py2.py3-none-any.whl (93 kB)
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  Downloading google_api_core-1.31.6-py2.py3-none-any.whl (93 kB)
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  Downloading google_api_core-1.31.5-py2.py3-none-any.whl (93 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 93.3/93.3 KB 10.7 MB/s eta 0:00:00
  Downloading google_api_core-1.31.4-py2.py3-none-any.whl (93 kB)
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  Downloading google_api_core-1.31.3-py2.py3-none-any.whl (93 kB)
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  Downloading google_api_core-1.30.0-py2.py3-none-any.whl (93 kB)
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  Downloading google_api_core-1.29.0-py2.py3-none-any.whl (93 kB)
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  Downloading google_api_core-1.28.0-py2.py3-none-any.whl (92 kB)
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  Downloading google_api_core-1.26.3-py2.py3-none-any.whl (93 kB)
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  Downloading google_api_core-1.26.2-py2.py3-none-any.whl (93 kB)
```

```
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     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 92.0/92.0 KB 10.5 MB/s eta 0:00:00
  Downloading google_api_core-1.22.4-py2.py3-none-any.whl (91 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 91.7/91.7 KB 10.6 MB/s eta 0:00:00
  Downloading google_api_core-1.22.3-py2.py3-none-any.whl (91 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 91.2/91.2 KB 10.9 MB/s eta 0:00:00
  Downloading google_api_core-1.22.2-py2.py3-none-any.whl (91 kB)
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  Downloading google_api_core-1.22.1-py2.py3-none-any.whl (91 kB)
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  Downloading google_api_core-1.22.0-py2.py3-none-any.whl (91 kB)
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Requirement already satisfied: grpcio<2.0dev,>=1.29.0 in /usr/local/lib/python3.9/dist-pac
kages (from google-api-core==1.21.0->tensorflow-quantum==0.7.2) (1.53.0)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.9/dist-packages (fro
m matplotlib~=3.0->cirq-core==0.13.1->tensorflow-quantum==0.7.2) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.9/dist-packages
(from matplotlib~=3.0->cirq-core==0.13.1->tensorflow-quantum==0.7.2) (4.39.3)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.9/dist-packages
(from matplotlib~=3.0->cirq-core==0.13.1->tensorflow-quantum==0.7.2) (23.0)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.9/dist-packages
(from matplotlib~=3.0->cirq-core==0.13.1->tensorflow-quantum==0.7.2) (3.0.9)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.9/dist-packages
(from matplotlib~=3.0->cirq-core==0.13.1->tensorflow-quantum==0.7.2) (1.4.4)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.9/dist-packages
(from matplotlib~=3.0->cirq-core==0.13.1->tensorflow-quantum==0.7.2) (1.0.7)
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.9/dist-packa
ges (from matplotlib~=3.0->cirq-core==0.13.1->tensorflow-quantum==0.7.2) (2.8.2)
Requirement already satisfied: importlib-resources>=3.2.0 in /usr/local/lib/python3.9/dist
-packages (from matplotlib~=3.0->cirq-core==0.13.1->tensorflow-quantum==0.7.2) (5.12.0)
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.9/dist-packages (fr
om matplotlib~=3.0->cirq-core==0.13.1->tensorflow-quantum==0.7.2) (8.4.0)
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in /usr/local/lib/python3.9/dist-packa
ges (from pyasn1-modules>=0.2.1->google-auth==1.18.0->tensorflow-quantum==0.7.2) (0.4.8)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /usr/local/lib/python3.9/dist-pack
ages (from requests<3.0.0dev,>=2.18.0->google-api-core==1.21.0->tensorflow-quantum==0.7.2)
(1.26.15)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.9/dist-package
s (from requests<3.0.0dev,>=2.18.0->google-api-core==1.21.0->tensorflow-quantum==0.7.2) (2
022.12.7)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.9/dist-packages (fro
m requests<3.0.0dev,>=2.18.0->google-api-core==1.21.0->tensorflow-quantum==0.7.2) (3.4)
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/python3.9/dist-
packages (from requests<3.0.0dev,>=2.18.0->google-api-core==1.21.0->tensorflow-quantum==0.
7.2) (2.0.12)
Requirement already satisfied: zipp>=3.1.0 in /usr/local/lib/python3.9/dist-packages (from
importlib-resources>=3.2.0->matplotlib~=3.0->cirq-core==0.13.1->tensorflow-quantum==0.7.2)
(3.15.0)
Installing collected packages: sympy, protobuf, networkx, duet, cachetools, googleapis-com
mon-protos, google-auth, google-api-core, cirq-core, cirq-google, tensorflow-quantum
  Attempting uninstall: sympy
```

```
    Found existing installation: sympy 1.11.1
    Uninstalling sympy-1.11.1:
      Successfully uninstalled sympy-1.11.1
  Attempting uninstall: protobuf
    Found existing installation: protobuf 3.20.3
    Uninstalling protobuf-3.20.3:
      Successfully uninstalled protobuf-3.20.3
  Attempting uninstall: networkx
    Found existing installation: networkx 3.0
    Uninstalling networkx-3.0:
      Successfully uninstalled networkx-3.0
  Attempting uninstall: cachetools
    Found existing installation: cachetools 5.3.0
    Uninstalling cachetools-5.3.0:
      Successfully uninstalled cachetools-5.3.0
  Attempting uninstall: googleapis-common-protos
    Found existing installation: googleapis-common-protos 1.59.0
    Uninstalling googleapis-common-protos-1.59.0:
      Successfully uninstalled googleapis-common-protos-1.59.0
  Attempting uninstall: google-auth
    Found existing installation: google-auth 2.17.0
    Uninstalling google-auth-2.17.0:
      Successfully uninstalled google-auth-2.17.0
  Attempting uninstall: google-api-core
    Found existing installation: google-api-core 2.11.0
    Uninstalling google-api-core-2.11.0:
      Successfully uninstalled google-api-core-2.11.0
ERROR: pip's dependency resolver does not currently take into account all the packages tha
t are installed. This behaviour is the source of the following dependency conflicts.
tensorflow-hub 0.13.0 requires protobuf>=3.19.6, but you have protobuf 3.17.3 which is inc
ompatible.
tensorboard 2.12.0 requires protobuf>=3.19.6, but you have protobuf 3.17.3 which is incomp
atible.
pydata-google-auth 1.7.0 requires google-auth<3.0dev,>=1.25.0; python_version >= "3.6", bu
t you have google-auth 1.18.0 which is incompatible.
proto-plus 1.22.2 requires protobuf<5.0.0dev,>=3.19.0, but you have protobuf 3.17.3 which
is incompatible.
pandas-gbq 0.17.9 requires google-api-core!=2.0.*,!=2.1.*,!=2.2.*,!=2.3.0,<3.0.0dev,>=1.3
1.5, but you have google-api-core 1.21.0 which is incompatible.
pandas-gbq 0.17.9 requires google-auth>=1.25.0, but you have google-auth 1.18.0 which is i
ncompatible.
google-cloud-translate 3.8.4 requires google-api-core[grpc]!=2.0.*,!=2.1.*,!=2.2.*,!=2.3.
*,!=2.4.*,!=2.5.*,!=2.6.*,!=2.7.*,<3.0.0dev,>=1.32.0, but you have google-api-core 1.21.0
which is incompatible.
google-cloud-translate 3.8.4 requires protobuf!=3.20.0,!=3.20.1,!=4.21.0,!=4.21.1,!=4.21.
2,!=4.21.3,!=4.21.4,!=4.21.5,<5.0.0dev,>=3.19.5, but you have protobuf 3.17.3 which is inc
ompatible.
google-cloud-storage 2.7.0 requires google-api-core!=2.0.*,!=2.1.*,!=2.2.*,!=2.3.0,<3.0.0d
ev,>=1.31.5, but you have google-api-core 1.21.0 which is incompatible.
google-cloud-storage 2.7.0 requires google-auth<3.0dev,>=1.25.0, but you have google-auth
1.18.0 which is incompatible.
google-cloud-language 2.6.1 requires google-api-core[grpc]!=2.0.*,!=2.1.*,!=2.2.*,!=2.3.
*,!=2.4.*,!=2.5.*,!=2.6.*,!=2.7.*,<3.0.0dev,>=1.32.0, but you have google-api-core 1.21.0
which is incompatible.
google-cloud-language 2.6.1 requires protobuf!=3.20.0,!=3.20.1,!=4.21.0,!=4.21.1,!=4.21.
2,!=4.21.3,!=4.21.4,!=4.21.5,<5.0.0dev,>=3.19.5, but you have protobuf 3.17.3 which is inc
ompatible.
google-cloud-firestore 2.7.3 requires google-api-core[grpc]!=2.0.*,!=2.1.*,!=2.10.*,!=2.2.
*,!=2.3.*,!=2.4.*,!=2.5.*,!=2.6.*,!=2.7.*,!=2.8.*,!=2.9.*,<3.0.0dev,>=1.34.0, but you have
google-api-core 1.21.0 which is incompatible.
google-cloud-firestore 2.7.3 requires protobuf!=3.20.0,!=3.20.1,!=4.21.0,!=4.21.1,!=4.21.
2,!=4.21.3,!=4.21.4,!=4.21.5,<5.0.0dev,>=3.19.5, but you have protobuf 3.17.3 which is inc
ompatible.
google-cloud-datastore 2.11.1 requires google-api-core[grpc]!=2.0.*,!=2.1.*,!=2.10.*,!=2.
```

```
2.*,!=2.3.*,!=2.4.*,!=2.5.*,!=2.6.*,!=2.7.*,!=2.8.*,!=2.9.*,<3.0.0dev,>=1.34.0, but you ha
ve google-api-core 1.21.0 which is incompatible.
google-cloud-datastore 2.11.1 requires protobuf!=3.20.0,!=3.20.1,!=4.21.0,!=4.21.1,!=4.21.
2,!=4.21.3,!=4.21.4,!=4.21.5,<5.0.0dev,>=3.19.5, but you have protobuf 3.17.3 which is inc
ompatible.
google-cloud-core 2.3.2 requires google-api-core!=2.0.*,!=2.1.*,!=2.2.*,!=2.3.0,<3.0.0dev,
>=1.31.6, but you have google-api-core 1.21.0 which is incompatible.
google-cloud-core 2.3.2 requires google-auth<3.0dev,>=1.25.0, but you have google-auth 1.1
8.0 which is incompatible.
google-cloud-bigquery 3.4.2 requires google-api-core[grpc]!=2.0.*,!=2.1.*,!=2.2.*,!=2.3.0,
<3.0.0dev,>=1.31.5, but you have google-api-core 1.21.0 which is incompatible.
google-cloud-bigquery 3.4.2 requires protobuf!=3.20.0,!=3.20.1,!=4.21.0,!=4.21.1,!=4.21.
2,!=4.21.3,!=4.21.4,!=4.21.5,<5.0.0dev,>=3.19.5, but you have protobuf 3.17.3 which is inc
ompatible.
google-cloud-bigquery-storage 2.19.1 requires google-api-core[grpc]!=2.0.*,!=2.1.*,!=2.10.
*,!=2.2.*,!=2.3.*,!=2.4.*,!=2.5.*,!=2.6.*,!=2.7.*,!=2.8.*,!=2.9.*,<3.0.0dev,>=1.34.0, but
you have google-api-core 1.21.0 which is incompatible.
google-cloud-bigquery-storage 2.19.1 requires protobuf!=3.20.0,!=3.20.1,!=4.21.0,!=4.21.
1,!=4.21.2,!=4.21.3,!=4.21.4,!=4.21.5,<5.0.0dev,>=3.19.5, but you have protobuf 3.17.3 whi
ch is incompatible.
google-api-python-client 2.70.0 requires google-api-core!=2.0.*,!=2.1.*,!=2.2.*,!=2.3.0,<
3.0.0dev,>=1.31.5, but you have google-api-core 1.21.0 which is incompatible.
google-api-python-client 2.70.0 requires google-auth<3.0.0dev,>=1.19.0, but you have googl
e-auth 1.18.0 which is incompatible.
firebase-admin 5.3.0 requires google-api-core[grpc]<3.0.0dev,>=1.22.1; platform_python_imp
lementation != "PyPy", but you have google-api-core 1.21.0 which is incompatible.
Successfully installed cachetools-4.2.4 cirq-core-0.13.1 cirq-google-0.13.1 duet-0.2.7 goo
gle-api-core-1.21.0 google-auth-1.18.0 googleapis-common-protos-1.52.0 networkx-2.8.8 prot
obuf-3.17.3 sympy-1.8 tensorflow-quantum-0.7.2
```

Implementation of QGAN

In [ ]:

```
import tensorflow as tf
import tensorflow_quantum as tfq
```

In [ ]:

```
import cirq
import sympy
import numpy as np

# visualization tools
%matplotlib inline
import matplotlib.pyplot as plt
from cirq.contrib.svg import SVGCircuit
```

In [ ]:

```
import numpy as np

# Load the dataset
with np.load('QIS_EXAM_200Events (1).npz', allow_pickle=True) as data:
    train_data = data["training_input"].item()
    test_data = data["test_input"].item()

train_inputs = np.concatenate([train_data[key] for key in train_data.keys()], axis=0)
test_inputs = np.concatenate([test_data[key] for key in test_data.keys()], axis=0)

train_labels = np.concatenate([np.zeros(len(train_data[key])) + int(key) for key in train_
test_labels = np.concatenate([np.zeros(len(test_data[key])) + int(key) for key in test_dat

# Sanity check
```

```
(100, 5) (100,)
(100, 5) (100,)
```

In [ ]:
```
x_train=train_inputs
x_test=test_inputs
```

In [ ]:
```
y_train=train_labels
y_test=test_labels
```

In [ ]:
```
# Checking the minimum and maximum value of the features
print("Minimum value of the feature",x_train.min(),"------>", "Maximum value of the featu
print("Minimum value of the feature",x_test.min(),"------>","Maximum value of the feature"
```

```
Minimum value of the feature -0.9999305803064449 ------> Maximum value of the feature 0.93
44843617214956
Minimum value of the feature -0.9997083749335067 ------> Maximum value of the feature 0.93
4061853011746
```

In [ ]:
```
# convert label format from 1/0 to 1/-1
y_train = tf.keras.utils.to_categorical(y_train)*2-1
y_test = tf.keras.utils.to_categorical(y_test)*2-1

y_train = np.concatenate((y_train, np.ones((len(y_train), 1))), axis=1)
y_test = np.concatenate((y_test, np.ones((len(y_test), 1))), axis=1)

print(y_train.shape, y_test.shape)
```

```
(100, 3) (100, 3)
```

Generate quantum data from the dataset with amplitude encoding.

In [ ]:
```
def generate_data(X, qubits):
    quantum_data = []
    # iterate through data samples
    for sample in X:
        circuit = cirq.Circuit()
        # iterate through sample's features
        for bit in range(len(sample)):
            # calculate amplitude for encoding
            amplitude = np.sin(sample[bit] * np.pi / 2)
            circuit.append(cirq.X(qubits[bit])**amplitude)

        quantum_data.append(circuit)
    return quantum_data
```

Let us now visualise the angle encoding circuit for the first sample of each label in the collection.*italicised text*

In [ ]:
```
qubits = cirq.GridQubit.rect(1, 5)
train_quantum_data = tfq.convert_to_tensor(generate_data(x_train, qubits))
test_quantum_data = tfq.convert_to_tensor(generate_data(x_test, qubits))
```

In [ ]:
```
from cirq.contrib.svg import svg
from IPython.display import SVG

# Get the circuit and convert it to an SVG image
label_one_circuit = tfq.from_tensor(train_quantum_data)[y_train[:, 0] == 1][0]
circuit1 = (SVGCircuit(label_one_circuit))
```

```
with open('circuit1.png', 'w') as f:
    f.write(str(circuit1))

circuit1
```

```
WARNING:matplotlib.font_manager:findfont: Font family 'Arial' not found.
WARNING:matplotlib.font_manager:findfont: Font family 'Arial' not found.
WARNING:matplotlib.font_manager:findfont: Font family 'Arial' not found.
WARNING:matplotlib.font_manager:findfont: Font family 'Arial' not found.
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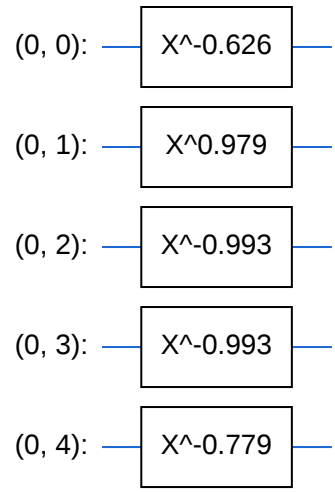
```

Out[ ]:



Now Constructs a quantum circuit in Cirq that performs a rotation of the qubit state on the Bloch sphere about the X, Y, and Z axes, with rotation angles given by the values in `symbols`.**bold text**

In [ ]:

```
def make_rotation_circuit(bit, symbols):
    return cirq.Circuit(
        cirq.X(bit)**symbols[0],
        cirq.Y(bit)**symbols[1],
        cirq.Z(bit)**symbols[2])
```

In [ ]:

```
def make_two_qubit_unitary_circuit(qubits, symbols):
    """
    Constructs a quantum circuit in Cirq that creates an arbitrary two-qubit
    unitary operation using the given rotation angles in `symbols`.
    """
    circuit = cirq.Circuit()
    circuit += make_rotation_circuit(qubits[0], symbols[0:3])
    circuit += make_rotation_circuit(qubits[1], symbols[3:6])
    circuit += [cirq.ZZ(*qubits)**symbols[6]]
    circuit += [cirq.YY(*qubits)**symbols[7]]
    circuit += [cirq.XX(*qubits)**symbols[8]]
    circuit += make_rotation_circuit(qubits[0], symbols[9:12])
    circuit += make_rotation_circuit(qubits[1], symbols[12:])
    return circuit
```

In [ ]:

```
def generator(qubits, symbols, layer=1):
    circuit = cirq.Circuit()

    # Applies random rotations around the y-axis of the Bloch sphere to a list of qubits u
    num_qubits = len(qubits)
    gles = np.random.normal(loc=0, scale=np.pi/3, size=num_qubits // 2)
```

```python
    for i in range(num_qubits // 2):
        circuit += cirq.ry(random_angles[i])(qubits[i])

    for i in range(layer):
    # Apply a unitary layer to the qubits
        for j, qubit in enumerate(qubits):
            # Compute the index range for the symbols associated with this qubit
            symbol_start_idx = 3*j + 3*i*len(qubits)
            symbol_end_idx = 3*(j+1) + 3*i*len(qubits)

            # Apply a rotation circuit to the qubit using the specified symbols
            rotation_circuit = make_rotation_circuit(qubit, symbols[symbol_start_idx:symbo
            circuit += rotation_circuit



        # entangling layer
        for j in range(len(qubits)):
            if j != (len(qubits)-1):
                circuit += cirq.CNOT(qubits[j], qubits[j+1])
            else:
                pass

    # Construct the final unitary for the data qubits
    final_unitary_symbols = symbols[-(3*int(len(qubits)/2)):]
    for i in range(int(len(qubits)/2)):
        circuit += make_rotation_circuit(qubits[i], final_unitary_symbols[3*i : 3*(i+1)])
    return circuit
```

In [ ]:

```python
# params total: (3*features*2)*layer params + (3*features) final params
circuit3=SVGCircuit(generator(cirq.GridQubit.rect(1, 10), sympy.symbols('generator:105'),
with open('circuit2.png', 'w') as f:
    f.write(str(circuit3))

circuit3
```

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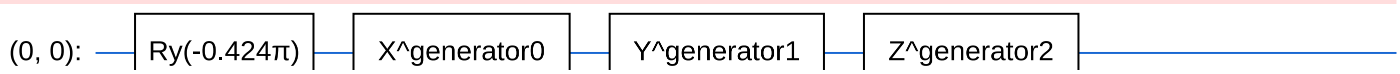
```

Out[ ]:



Constructs a discriminator circuit in Cirq that applies a series of Hadamard gates to the data qubits, followed by a series of unitary and entangling layers that depend on the values in `symbols`, and a final unitary layer on the output qubits. The number of layers can be specified using the `layers` parameter.

In [ ]:

```
def discriminator(data_qubits, output_qubits, symbols, layer=1):
    """
    Constructs a Cirq circuit for a quantum discriminator that performs a series
    of operations on the input `data_qubits` and output `output_qubits`, with the
    rotation angles determined by the values in `symbols`, and the number of
    layer specified by `layer`.
    """
    circuit = cirq.Circuit()

    # Hadamard layer for data qubits
    for qubit in data_qubits:
        circuit += cirq.H(qubit)

    # Apply unitary and entangling layer
    all_qubits = data_qubits + output_qubits
    for layer in range(layer):
        for i, qubit in enumerate(all_qubits):
            symbols_layer_i = symbols[3*i + 3*len(all_qubits)*layer : 3*(i+1) + 3*len(all_
            circuit += make_rotation_circuit(qubit, symbols_layer_i)

        for i in range(len(all_qubits) - 1):
            circuit += cirq.CNOT(all_qubits[i], all_qubits[i+1])
```

```python
    # Apply final unitary for output qubits
    symbols_final_unitary = symbols[-(3*len(output_qubits)):]
    for i, qubit in enumerate(output_qubits):
        circuit += make_rotation_circuit(qubit, symbols_final_unitary[3*i : 3*(i+1)])

    return circuit
```

In [ ]:

```python
qubits = cirq.GridQubit.rect(1, 5+3)
# params total: (3 * (features + (total_number_of_class + 1)))*layer + 3*(total_number_of_
circuit4=SVGCircuit(discriminator(qubits[0:5], qubits[5:], sympy.symbols('discriminator:57
with open('circuit4.png', 'w') as f:
    f.write(str(circuit4))

circuit4
```

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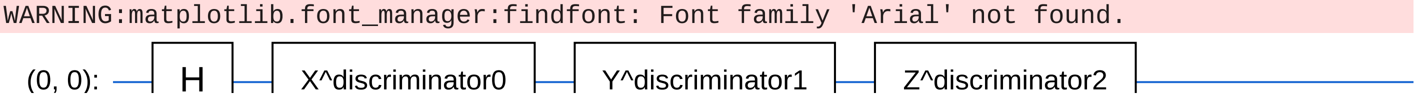
Out[ ]:



In [ ]:

```
def create_gen_disc_circuit(symbols_gen, symbols_disc, qubits, total_number_of_features, t
    """
    Constructs a quantum circuit in Cirq that combines a generator and a discriminator ci

    Args:
        symbols_gen (list): A list of symbols for the generator circuit.
        symbols_disc (list): A list of symbols for the discriminator circuit.
        qubits (list): A list of qubits used in the circuit.
        total_number_of_features (int): The number of input features.
        total_number_of_class (int): The number of output classes.
```

Loading [MathJax]/extensions/Safe.js

```
        generator_layers (int): The number of layers in the generator circuit. Default is
        discriminator_layers (int): The number of layers in the discriminator circuit. Def

    Returns:
        A Cirq circuit that represents the generator and discriminator circuits combined.
    """
    # Create a circuit with the given qubits
    circuit = cirq.Circuit()
    # Create a list of qubits for the generator and discriminator circuits
    gen_qubits = qubits[:len(qubits)-(total_number_of_class+1)]
    disc_qubits = qubits[len(qubits)-(total_number_of_class+1):]

    # Add the generator circuit to the circuit
    gen_circuit = generator(gen_qubits, symbols_gen, layer=generator_layers)
    circuit += gen_circuit

    # Add the discriminator circuit to the circuit
    disc_circuit = discriminator(disc_qubits[:int(len(disc_qubits)/2)], disc_qubits[int(le
    circuit += disc_circuit

    return circuit
```

In [ ]:

```
# model fix parameters
total_number_of_class = 2
total_number_of_features = 5
generator_layers = 4
discriminator_layers = 4
```

In [ ]:

```
count_of_generator_par = (3*total_number_of_features*2)*generator_layers + (3*total_numbe
count_of_discriminator_par = (3*(total_number_of_features + total_number_of_class + 1))*di

print(count_of_generator_par, count_of_discriminator_par)
```

```
135 105
```

In [ ]:

```
# trainable parameters
symbols_gen = sympy.symbols('gen0:' + str(count_of_generator_par))
symbols_disc = sympy.symbols('disc0:' + str(count_of_discriminator_par))

# qubits
qgan_qubits = cirq.GridQubit.rect(1, total_number_of_features*2 + total_number_of_class +
```

In [ ]:

```
def calculate_discriminator_loss(y_true, y_pred, c_weight=0.5, epsilon=1e-10):
    """
    Computes the loss for a binary discriminator model that takes in a 2D input array
    of shape (batch_size, 3) and outputs a scalar value.

    The discriminator loss is a combination of binary cross-entropy loss for the
    discriminator output and categorical cross-entropy loss for the classifier output.
    The weight given to the categorical cross-entropy loss is controlled by the `c_weight`
    argument.

    Args:
        y_true (tf.Tensor): The true labels with shape (batch_size, 3).
        y_pred (tf.Tensor): The predicted labels with shape (batch_size, 3).
        c_weight (float): The weight given to the categorical cross-entropy loss.
        epsilon (float): A small value used for numerical stability.

    Returns:
        The combined loss value as a scalar tf.Tensor object.
```

```
    """
    d_true = (y_true[:, 2] + 1) / 2
    d_pred = (y_pred[:, 2] + 1) / 2

    d_loss = -1 * (tf.math.log(d_pred + epsilon) * d_true +
                   tf.math.log(1 - d_pred + epsilon) * (1 - d_true))
    d_loss = tf.reduce_mean(d_loss)

    c_true = (y_true[:, :2] + 1) / 2
    c_pred = (y_pred[:, :2] + 1) / 2

    d_true_size = tf.cast(tf.shape(tf.where(tf.equal(d_true, 1)))), dtype=tf.float32)[0] +

    c_loss = tf.reduce_sum(tf.keras.losses.CategoricalCrossentropy(reduction='none')(c_tru

    return (1 - c_weight) * d_loss + c_weight * c_loss
```

In [ ]:

```
@tf.function
def custom_acc(y_true, y_pred):
    """
    Computes a custom accuracy metric for a binary classification problem with
    two classes. The first two columns of the input tensors contain the real
    class probabilities, and the third column contains the binary label (+1 or -1).
    """
    y_true_bin = (y_true[:, 2] + 1) / 2  # convert binary labels to 0/1
    y_pred_bin = (y_pred[:, 2] + 1) / 2

    y_true_cls = tf.argmax(y_true[:, :2], axis=1)  # extract true class labels
    y_pred_cls = tf.argmax(y_pred[:, :2], axis=1)  # extract predicted class labels

    correct = tf.cast(y_true_cls == y_pred_cls, tf.float32) * y_true_bin

    num_positives = tf.cast(tf.size(tf.where(y_true_bin == 1)), dtype=tf.float32) + 1e-10
    acc = tf.reduce_sum(correct) / num_positives

    return acc
```

In [ ]:

```
# discriminator model

def discriminator_model(weights_disc):
    disc_readout_operators = [cirq.Z(qgan_qubits[-(total_number_of_class+1) + q]) for q in

    data_input = tf.keras.Input(shape=(), dtype=tf.dtypes.string)

    qdiscriminator_layers = tfq.layers.PQC(discriminator(qgan_qubits[:int((len(qgan_qubits
                 qgan_qubits[len(qgan_qubits)-(total_number_of_class+1):], weights_disc,
                 disc_readout_operators, name='qdiscriminator_layers')(data_input)

    quantum_disc_model = tf.keras.Model(inputs=[data_input], outputs=[qdiscriminator_layer

    # Compile the model
    quantum_disc_model.compile(optimizer=tf.keras.optimizers.Adam(learning_rate=0.001),
                  loss=calculate_discriminator_loss,
                  metrics=[custom_acc]
                   )

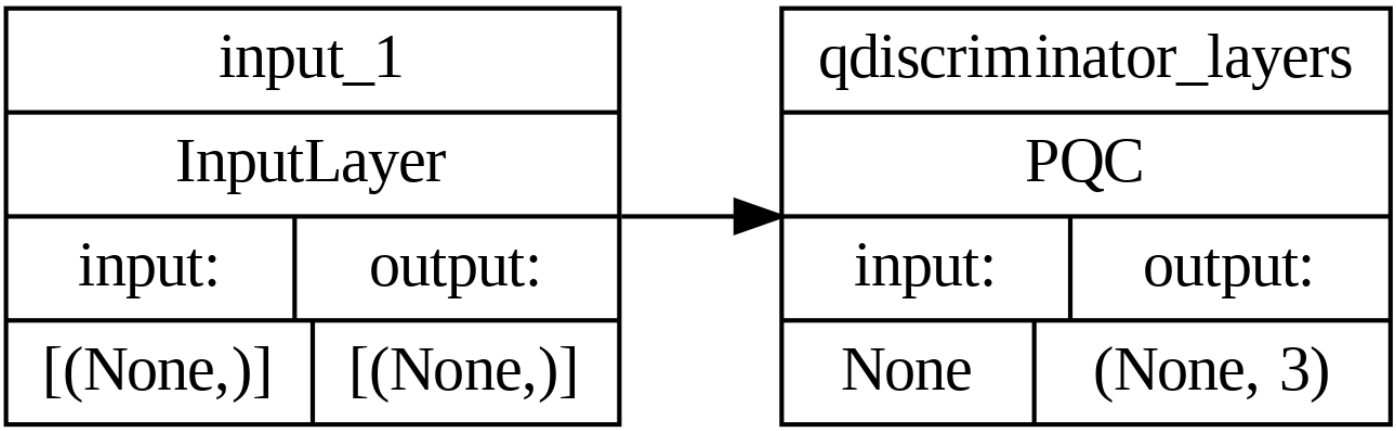
    return quantum_disc_model
```

In [ ]:

```
quantum_disc_model = discriminator_model(symbols_disc)
```

In [ ]:
```
tf.keras.utils.plot_model(quantum_disc_model,show_shapes=True,show_layer_names=True,rankdi
```

Out[ ]:



In [ ]:
```
def gen_loss(y_true, y_pred):
    y_pred = (y_pred + 1)/2
    return tf.reduce_mean((-1)*tf.math.log(y_pred), axis=0)
```

In [ ]:
```
# generator-discriminator pair model

def generator_model(symbols_gen, weights_disc):
    gen_readout_operators = cirq.Z(qgan_qubits[-1])

    data_input = tf.keras.Input(shape=(), dtype=tf.dtypes.string)

    qgenerator_layers = tfq.layers.PQC(create_gen_disc_circuit(symbols_gen, weights_disc,
                                qgan_qubits, total_number_of_features, total_number_of_
                                gen_readout_operators, name='qgenerator_layers')(data_in

    quantum_gen_model = tf.keras.Model(inputs=[data_input], outputs=[qgenerator_layers])

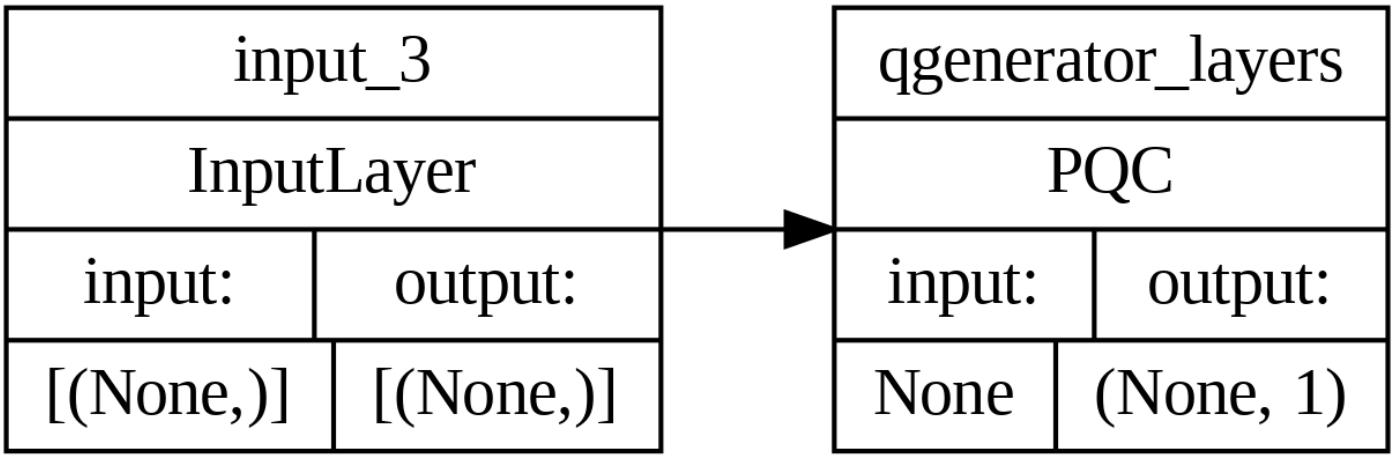
    # Compile the model
    quantum_gen_model.compile(optimizer=tf.keras.optimizers.Adam(learning_rate=0.001),
                      loss=gen_loss)

    return quantum_gen_model
```

In [ ]:
```
quantum_gen_model = generator_model(symbols_gen, quantum_disc_model.get_weights()[0])
```

In [ ]:
```
tf.keras.utils.plot_model(quantum_gen_model,show_shapes=True,show_layer_names=True,rankdir
```

Out[ ]:



In [ ]:

```
import cirq

def generate_quantum_data(X):
    """
    Generate quantum data for a given dataset.

    :param X: input data as a list of samples
    :return: quantum data as a list of Cirq circuits
    """
    quantum_data = []
    # iterate through data samples
    for x in X:
        # create an empty circuit
        circuit = cirq.Circuit()
        # add quantum gates and operations to the circuit
        # ...
        # append the completed circuit to the list of quantum data
        quantum_data.append(circuit)

    return quantum_data
```

In [ ]:

```
identity_data = tfq.convert_to_tensor(generate_quantum_data(x_train))
identity_label = np.zeros((len(identity_data),))

# Sanity check
print(len(identity_data), identity_label.shape)
```

```
100 (100,)
```

The generate_unique_fake_data() will generate fake quantum data using circuit

In [ ]:

```
def generate_unique_fake_data(input_data, num_qubits, symbols, layer=1):


    # create an empty list to store the generated circuits
    quantum_circuits = []

    # iterate through input data
    for sample in input_data:

        # generate a quantum circuit using the generator function with the specified qubit
        circuit = generator(qubits[:2*len(sample)], symbols, layer=layer)

        # add the generated circuit to the list of quantum circuits
        quantum_circuits.append(circuit)
```

```
    # return the list of generated quantum circuits
    return quantum_circuits
```

We must produce the labels for the false quantum data once we have created the fake quantum data. Because the class labels are not necessary for false data, these labels may be constructed simply as an array of zeros. Because all of the samples are fraudulent, they will all receive a -1 for the fake/real label.

In [ ]:

```
fake_data = tfq.convert_to_tensor(generate_unique_fake_data(x_train, qgan_qubits, quantum_
y_true_fake = np.zeros((len(fake_data), total_number_of_class+1))
y_true_fake[:, 2] += (-1)

y_true_fake.shape
```

Out[ ]:

```
(100, 3)
```

Now lets plot the fake quantum data circuit for the first two samples generated.

In [ ]:

```
circuit5=SVGCircuit(tfq.from_tensor(fake_data)[0])
with open('circuit5.svg', 'w') as f:
    f.write(str(circuit5))

circuit5
```

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```

Out[ ]:

In [ ]:

```
circuit6=SVGCircuit(tfq.from_tensor(fake_data)[1])
with open('circuit6.svg', 'w') as f:
    f.write(str(circuit6))

circuit6
```

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```

Out[ ]:

Train the Model

In [ ]:

```
# Model initialization
qdisc_model = discriminator_model(symbols_disc)
qgen_model = generator_model(symbols_gen, qdisc_model.get_weights()[0])
```

In [ ]:

```
def checkpoints(cycle):
    gen_model_cp = tf.keras.callbacks.ModelCheckpoint(
        filepath='./model_save/cp_generator_' + str(cycle) + '.h5',
        save_weights_only=True,
        monitor='loss',
        mode='min',
        save_best_only=True)

    disc_model_cp = tf.keras.callbacks.ModelCheckpoint(
        filepath='./model_save/cp_disc_' + str(cycle) + '.h5',
        save_weights_only=True,
        monitor='custom_accuracy',
        mode='max',
        save_best_only=True)

    return gen_model_cp, disc_model_cp
```

Fit the Generator Model

In [ ]:

```
def train_qgen(epochs, batch, verbose):
    history = quantum_gen_model.fit(x=identity_data,y=identity_label,batch_size=batch,epoc
    return history
```

Fit the Discriminator Model

In [ ]:

```
def train_qdisc(epochs, batch, verbose):
    history = quantum_disc_model.fit(x=gen_data_train,y=y_gen_train,batch_size=batch,epoch
    return history
```

In [ ]:

```
w1 = quantum_disc_model.get_weights()[0]
w2 = quantum_gen_model.get_weights()[0]
```

In [ ]:

```
# re-declare the generator model using the discriminator's weights
quantum_gen_model = generator_model(symbols_gen, quantum_disc_model.get_weights()[0])
generator_model, disc_model_cp = checkpoints(cycle=1)
```

In [ ]:

```
!mkdir model_save
```

In [ ]:

```
num_epochs = 1000
batch_size = 100
```

```
verbose = 1
H = train_qgen(num_epochs, batch_size, verbose)
```

```
Epoch 1/1000
1/1 [==============================] - 3s 3s/step - loss: 0.6910
Epoch 2/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6862
Epoch 3/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6815
Epoch 4/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6769
Epoch 5/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6725
Epoch 6/1000
1/1 [==============================] - 4s 4s/step - loss: 0.6682
Epoch 7/1000
1/1 [==============================] - 4s 4s/step - loss: 0.6640
Epoch 8/1000
1/1 [==============================] - 3s 3s/step - loss: 0.6600
Epoch 9/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6560
Epoch 10/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6522
Epoch 11/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6485
Epoch 12/1000
1/1 [==============================] - 3s 3s/step - loss: 0.6449
Epoch 13/1000
1/1 [==============================] - 4s 4s/step - loss: 0.6414
Epoch 14/1000
1/1 [==============================] - 4s 4s/step - loss: 0.6379
Epoch 15/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6345
Epoch 16/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6312
Epoch 17/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6279
Epoch 18/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6247
Epoch 19/1000
1/1 [==============================] - 3s 3s/step - loss: 0.6215
Epoch 20/1000
1/1 [==============================] - 4s 4s/step - loss: 0.6183
Epoch 21/1000
1/1 [==============================] - 3s 3s/step - loss: 0.6152
Epoch 22/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6121
Epoch 23/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6090
Epoch 24/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6059
Epoch 25/1000
1/1 [==============================] - 2s 2s/step - loss: 0.6029
Epoch 26/1000
1/1 [==============================] - 4s 4s/step - loss: 0.5999
Epoch 27/1000
1/1 [==============================] - 4s 4s/step - loss: 0.5969
Epoch 28/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5940
Epoch 29/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5910
Epoch 30/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5881
Epoch 31/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5852
```

```
Epoch 32/1000
1/1 [==============================] - 3s 3s/step - loss: 0.5824
Epoch 33/1000
1/1 [==============================] - 4s 4s/step - loss: 0.5795
Epoch 34/1000
1/1 [==============================] - 3s 3s/step - loss: 0.5767
Epoch 35/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5739
Epoch 36/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5711
Epoch 37/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5684
Epoch 38/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5656
Epoch 39/1000
1/1 [==============================] - 3s 3s/step - loss: 0.5629
Epoch 40/1000
1/1 [==============================] - 4s 4s/step - loss: 0.5602
Epoch 41/1000
1/1 [==============================] - 3s 3s/step - loss: 0.5576
Epoch 42/1000
1/1 [==============================] - 4s 4s/step - loss: 0.5549
Epoch 43/1000
1/1 [==============================] - 4s 4s/step - loss: 0.5523
Epoch 44/1000
1/1 [==============================] - 3s 3s/step - loss: 0.5497
Epoch 45/1000
1/1 [==============================] - 4s 4s/step - loss: 0.5471
Epoch 46/1000
1/1 [==============================] - 3s 3s/step - loss: 0.5446
Epoch 47/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5421
Epoch 48/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5396
Epoch 49/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5371
Epoch 50/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5346
Epoch 51/1000
1/1 [==============================] - 4s 4s/step - loss: 0.5322
Epoch 52/1000
1/1 [==============================] - 4s 4s/step - loss: 0.5298
Epoch 53/1000
1/1 [==============================] - 3s 3s/step - loss: 0.5274
Epoch 54/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5250
Epoch 55/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5227
Epoch 56/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5203
Epoch 57/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5180
Epoch 58/1000
1/1 [==============================] - 4s 4s/step - loss: 0.5157
Epoch 59/1000
1/1 [==============================] - 4s 4s/step - loss: 0.5135
Epoch 60/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5112
Epoch 61/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5090
Epoch 62/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5067
Epoch 63/1000
1/1 [==============================] - 2s 2s/step - loss: 0.5045
```

```
Epoch 64/1000
1/1 [==============================] - 3s 3s/step - loss: 0.5023
Epoch 65/1000
1/1 [==============================] - 4s 4s/step - loss: 0.5001
Epoch 66/1000
1/1 [==============================] - 3s 3s/step - loss: 0.4979
Epoch 67/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4958
Epoch 68/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4936
Epoch 69/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4915
Epoch 70/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4893
Epoch 71/1000
1/1 [==============================] - 3s 3s/step - loss: 0.4872
Epoch 72/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4851
Epoch 73/1000
1/1 [==============================] - 3s 3s/step - loss: 0.4830
Epoch 74/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4809
Epoch 75/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4788
Epoch 76/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4768
Epoch 77/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4747
Epoch 78/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4727
Epoch 79/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4707
Epoch 80/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4686
Epoch 81/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4666
Epoch 82/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4646
Epoch 83/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4627
Epoch 84/1000
1/1 [==============================] - 3s 3s/step - loss: 0.4607
Epoch 85/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4587
Epoch 86/1000
1/1 [==============================] - 3s 3s/step - loss: 0.4568
Epoch 87/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4549
Epoch 88/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4530
Epoch 89/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4511
Epoch 90/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4492
Epoch 91/1000
1/1 [==============================] - 3s 3s/step - loss: 0.4473
Epoch 92/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4455
Epoch 93/1000
1/1 [==============================] - 3s 3s/step - loss: 0.4436
Epoch 94/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4418
Epoch 95/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4400
```

```
Epoch 96/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4382
Epoch 97/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4364
Epoch 98/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4347
Epoch 99/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4329
Epoch 100/1000
1/1 [==============================] - 3s 3s/step - loss: 0.4312
Epoch 101/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4295
Epoch 102/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4278
Epoch 103/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4262
Epoch 104/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4245
Epoch 105/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4229
Epoch 106/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4213
Epoch 107/1000
1/1 [==============================] - 3s 3s/step - loss: 0.4197
Epoch 108/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4181
Epoch 109/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4166
Epoch 110/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4151
Epoch 111/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4136
Epoch 112/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4121
Epoch 113/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4107
Epoch 114/1000
1/1 [==============================] - 3s 3s/step - loss: 0.4093
Epoch 115/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4079
Epoch 116/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4065
Epoch 117/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4051
Epoch 118/1000
1/1 [==============================] - 2s 2s/step - loss: 0.4038
Epoch 119/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4025
Epoch 120/1000
1/1 [==============================] - 4s 4s/step - loss: 0.4012
Epoch 121/1000
1/1 [==============================] - 3s 3s/step - loss: 0.4000
Epoch 122/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3987
Epoch 123/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3975
Epoch 124/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3963
Epoch 125/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3951
Epoch 126/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3939
Epoch 127/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3928
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```
Epoch 128/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3916
Epoch 129/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3905
Epoch 130/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3894
Epoch 131/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3883
Epoch 132/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3872
Epoch 133/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3862
Epoch 134/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3851
Epoch 135/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3841
Epoch 136/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3830
Epoch 137/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3820
Epoch 138/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3810
Epoch 139/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3800
Epoch 140/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3790
Epoch 141/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3780
Epoch 142/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3770
Epoch 143/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3761
Epoch 144/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3751
Epoch 145/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3741
Epoch 146/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3732
Epoch 147/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3722
Epoch 148/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3712
Epoch 149/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3703
Epoch 150/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3693
Epoch 151/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3684
Epoch 152/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3674
Epoch 153/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3665
Epoch 154/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3655
Epoch 155/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3646
Epoch 156/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3636
Epoch 157/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3627
Epoch 158/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3617
Epoch 159/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3607
```

```
Epoch 160/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3598
Epoch 161/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3588
Epoch 162/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3578
Epoch 163/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3568
Epoch 164/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3559
Epoch 165/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3549
Epoch 166/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3539
Epoch 167/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3529
Epoch 168/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3518
Epoch 169/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3508
Epoch 170/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3498
Epoch 171/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3488
Epoch 172/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3477
Epoch 173/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3467
Epoch 174/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3456
Epoch 175/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3445
Epoch 176/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3435
Epoch 177/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3424
Epoch 178/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3413
Epoch 179/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3402
Epoch 180/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3391
Epoch 181/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3380
Epoch 182/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3369
Epoch 183/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3358
Epoch 184/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3347
Epoch 185/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3336
Epoch 186/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3325
Epoch 187/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3313
Epoch 188/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3302
Epoch 189/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3291
Epoch 190/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3280
Epoch 191/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3269
```

```
Epoch 192/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3258
Epoch 193/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3247
Epoch 194/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3236
Epoch 195/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3225
Epoch 196/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3214
Epoch 197/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3204
Epoch 198/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3193
Epoch 199/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3183
Epoch 200/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3172
Epoch 201/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3162
Epoch 202/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3152
Epoch 203/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3142
Epoch 204/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3132
Epoch 205/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3122
Epoch 206/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3113
Epoch 207/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3103
Epoch 208/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3094
Epoch 209/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3085
Epoch 210/1000
1/1 [==============================] - 3s 3s/step - loss: 0.3076
Epoch 211/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3067
Epoch 212/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3058
Epoch 213/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3049
Epoch 214/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3041
Epoch 215/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3033
Epoch 216/1000
1/1 [==============================] - 4s 4s/step - loss: 0.3025
Epoch 217/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3017
Epoch 218/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3009
Epoch 219/1000
1/1 [==============================] - 2s 2s/step - loss: 0.3002
Epoch 220/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2994
Epoch 221/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2987
Epoch 222/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2980
Epoch 223/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2973
```

```
Epoch 224/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2966
Epoch 225/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2960
Epoch 226/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2953
Epoch 227/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2947
Epoch 228/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2941
Epoch 229/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2935
Epoch 230/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2929
Epoch 231/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2924
Epoch 232/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2918
Epoch 233/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2913
Epoch 234/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2908
Epoch 235/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2903
Epoch 236/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2898
Epoch 237/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2893
Epoch 238/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2889
Epoch 239/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2884
Epoch 240/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2880
Epoch 241/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2875
Epoch 242/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2871
Epoch 243/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2867
Epoch 244/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2863
Epoch 245/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2859
Epoch 246/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2856
Epoch 247/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2852
Epoch 248/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2849
Epoch 249/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2845
Epoch 250/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2842
Epoch 251/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2838
Epoch 252/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2835
Epoch 253/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2832
Epoch 254/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2829
Epoch 255/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2826
```

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Epoch 256/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2823
Epoch 257/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2820
Epoch 258/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2817
Epoch 259/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2814
Epoch 260/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2812
Epoch 261/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2809
Epoch 262/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2806
Epoch 263/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2804
Epoch 264/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2801
Epoch 265/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2799
Epoch 266/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2796
Epoch 267/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2794
Epoch 268/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2791
Epoch 269/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2789
Epoch 270/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2787
Epoch 271/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2785
Epoch 272/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2782
Epoch 273/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2780
Epoch 274/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2778
Epoch 275/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2776
Epoch 276/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2774
Epoch 277/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2772
Epoch 278/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2770
Epoch 279/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2768
Epoch 280/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2766
Epoch 281/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2764
Epoch 282/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2762
Epoch 283/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2760
Epoch 284/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2758
Epoch 285/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2756
Epoch 286/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2754
Epoch 287/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2752
```

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Epoch 288/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2751
Epoch 289/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2749
Epoch 290/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2747
Epoch 291/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2745
Epoch 292/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2744
Epoch 293/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2742
Epoch 294/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2740
Epoch 295/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2739
Epoch 296/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2737
Epoch 297/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2735
Epoch 298/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2734
Epoch 299/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2732
Epoch 300/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2730
Epoch 301/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2729
Epoch 302/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2727
Epoch 303/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2726
Epoch 304/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2724
Epoch 305/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2723
Epoch 306/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2721
Epoch 307/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2720
Epoch 308/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2718
Epoch 309/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2717
Epoch 310/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2715
Epoch 311/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2714
Epoch 312/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2712
Epoch 313/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2711
Epoch 314/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2709
Epoch 315/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2708
Epoch 316/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2706
Epoch 317/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2705
Epoch 318/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2704
Epoch 319/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2702
```

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Epoch 320/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2701
Epoch 321/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2699
Epoch 322/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2698
Epoch 323/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2697
Epoch 324/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2695
Epoch 325/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2694
Epoch 326/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2693
Epoch 327/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2691
Epoch 328/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2690
Epoch 329/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2689
Epoch 330/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2687
Epoch 331/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2686
Epoch 332/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2685
Epoch 333/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2683
Epoch 334/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2682
Epoch 335/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2681
Epoch 336/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2679
Epoch 337/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2678
Epoch 338/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2677
Epoch 339/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2675
Epoch 340/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2674
Epoch 341/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2673
Epoch 342/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2671
Epoch 343/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2670
Epoch 344/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2669
Epoch 345/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2667
Epoch 346/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2666
Epoch 347/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2665
Epoch 348/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2663
Epoch 349/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2662
Epoch 350/1000
1/1 [==============================] - 5s 5s/step - loss: 0.2661
Epoch 351/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2659
```

```
Epoch 352/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2658
Epoch 353/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2657
Epoch 354/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2655
Epoch 355/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2654
Epoch 356/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2653
Epoch 357/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2651
Epoch 358/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2650
Epoch 359/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2648
Epoch 360/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2647
Epoch 361/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2646
Epoch 362/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2644
Epoch 363/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2643
Epoch 364/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2642
Epoch 365/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2640
Epoch 366/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2639
Epoch 367/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2637
Epoch 368/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2636
Epoch 369/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2635
Epoch 370/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2633
Epoch 371/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2632
Epoch 372/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2630
Epoch 373/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2629
Epoch 374/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2627
Epoch 375/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2626
Epoch 376/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2624
Epoch 377/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2623
Epoch 378/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2622
Epoch 379/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2620
Epoch 380/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2619
Epoch 381/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2617
Epoch 382/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2616
Epoch 383/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2614
```

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Epoch 384/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2613
Epoch 385/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2611
Epoch 386/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2610
Epoch 387/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2608
Epoch 388/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2606
Epoch 389/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2605
Epoch 390/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2603
Epoch 391/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2602
Epoch 392/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2600
Epoch 393/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2599
Epoch 394/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2597
Epoch 395/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2596
Epoch 396/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2594
Epoch 397/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2592
Epoch 398/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2591
Epoch 399/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2589
Epoch 400/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2588
Epoch 401/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2586
Epoch 402/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2584
Epoch 403/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2583
Epoch 404/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2581
Epoch 405/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2580
Epoch 406/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2578
Epoch 407/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2576
Epoch 408/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2575
Epoch 409/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2573
Epoch 410/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2572
Epoch 411/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2570
Epoch 412/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2568
Epoch 413/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2567
Epoch 414/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2565
Epoch 415/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2563
```

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Epoch 416/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2562
Epoch 417/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2560
Epoch 418/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2558
Epoch 419/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2557
Epoch 420/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2555
Epoch 421/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2554
Epoch 422/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2552
Epoch 423/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2550
Epoch 424/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2549
Epoch 425/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2547
Epoch 426/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2545
Epoch 427/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2544
Epoch 428/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2542
Epoch 429/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2541
Epoch 430/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2539
Epoch 431/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2537
Epoch 432/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2536
Epoch 433/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2534
Epoch 434/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2533
Epoch 435/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2531
Epoch 436/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2529
Epoch 437/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2528
Epoch 438/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2526
Epoch 439/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2525
Epoch 440/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2523
Epoch 441/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2522
Epoch 442/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2520
Epoch 443/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2519
Epoch 444/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2517
Epoch 445/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2515
Epoch 446/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2514
Epoch 447/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2512
```

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Epoch 448/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2511
Epoch 449/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2509
Epoch 450/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2508
Epoch 451/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2506
Epoch 452/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2505
Epoch 453/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2503
Epoch 454/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2502
Epoch 455/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2500
Epoch 456/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2499
Epoch 457/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2497
Epoch 458/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2496
Epoch 459/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2495
Epoch 460/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2493
Epoch 461/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2492
Epoch 462/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2490
Epoch 463/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2489
Epoch 464/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2488
Epoch 465/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2486
Epoch 466/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2485
Epoch 467/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2483
Epoch 468/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2482
Epoch 469/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2481
Epoch 470/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2479
Epoch 471/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2478
Epoch 472/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2477
Epoch 473/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2475
Epoch 474/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2474
Epoch 475/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2473
Epoch 476/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2471
Epoch 477/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2470
Epoch 478/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2469
Epoch 479/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2467
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Epoch 480/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2466
Epoch 481/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2465
Epoch 482/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2464
Epoch 483/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2462
Epoch 484/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2461
Epoch 485/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2460
Epoch 486/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2459
Epoch 487/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2457
Epoch 488/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2456
Epoch 489/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2455
Epoch 490/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2454
Epoch 491/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2453
Epoch 492/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2452
Epoch 493/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2450
Epoch 494/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2449
Epoch 495/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2448
Epoch 496/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2447
Epoch 497/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2446
Epoch 498/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2445
Epoch 499/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2444
Epoch 500/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2443
Epoch 501/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2441
Epoch 502/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2440
Epoch 503/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2439
Epoch 504/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2438
Epoch 505/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2437
Epoch 506/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2436
Epoch 507/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2435
Epoch 508/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2434
Epoch 509/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2433
Epoch 510/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2432
Epoch 511/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2431
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Epoch 512/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2430
Epoch 513/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2429
Epoch 514/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2428
Epoch 515/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2427
Epoch 516/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2426
Epoch 517/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2425
Epoch 518/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2424
Epoch 519/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2424
Epoch 520/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2423
Epoch 521/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2422
Epoch 522/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2421
Epoch 523/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2420
Epoch 524/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2419
Epoch 525/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2418
Epoch 526/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2417
Epoch 527/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2417
Epoch 528/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2416
Epoch 529/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2415
Epoch 530/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2414
Epoch 531/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2413
Epoch 532/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2413
Epoch 533/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2412
Epoch 534/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2411
Epoch 535/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2410
Epoch 536/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2409
Epoch 537/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2409
Epoch 538/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2408
Epoch 539/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2407
Epoch 540/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2407
Epoch 541/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2406
Epoch 542/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2405
Epoch 543/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2404
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Epoch 544/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2404
Epoch 545/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2403
Epoch 546/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2402
Epoch 547/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2402
Epoch 548/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2401
Epoch 549/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2400
Epoch 550/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2400
Epoch 551/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2399
Epoch 552/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2399
Epoch 553/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2398
Epoch 554/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2397
Epoch 555/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2397
Epoch 556/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2396
Epoch 557/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2396
Epoch 558/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2395
Epoch 559/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2395
Epoch 560/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2394
Epoch 561/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2393
Epoch 562/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2393
Epoch 563/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2392
Epoch 564/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2392
Epoch 565/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2391
Epoch 566/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2391
Epoch 567/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2390
Epoch 568/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2390
Epoch 569/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2389
Epoch 570/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2389
Epoch 571/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2388
Epoch 572/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2388
Epoch 573/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2388
Epoch 574/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2387
Epoch 575/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2387
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Epoch 576/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2386
Epoch 577/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2386
Epoch 578/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2385
Epoch 579/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2385
Epoch 580/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2385
Epoch 581/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2384
Epoch 582/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2384
Epoch 583/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2383
Epoch 584/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2383
Epoch 585/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2383
Epoch 586/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2382
Epoch 587/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2382
Epoch 588/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2381
Epoch 589/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2381
Epoch 590/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2381
Epoch 591/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2380
Epoch 592/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2380
Epoch 593/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2380
Epoch 594/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2379
Epoch 595/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2379
Epoch 596/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2379
Epoch 597/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2378
Epoch 598/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2378
Epoch 599/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2377
Epoch 600/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2377
Epoch 601/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2377
Epoch 602/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2377
Epoch 603/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2376
Epoch 604/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2376
Epoch 605/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2376
Epoch 606/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2375
Epoch 607/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2375
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Epoch 608/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2375
Epoch 609/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2374
Epoch 610/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2374
Epoch 611/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2374
Epoch 612/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2374
Epoch 613/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2373
Epoch 614/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2373
Epoch 615/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2373
Epoch 616/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2372
Epoch 617/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2372
Epoch 618/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2372
Epoch 619/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2372
Epoch 620/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2371
Epoch 621/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2371
Epoch 622/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2371
Epoch 623/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2370
Epoch 624/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2370
Epoch 625/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2370
Epoch 626/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2370
Epoch 627/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2369
Epoch 628/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2369
Epoch 629/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2369
Epoch 630/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2369
Epoch 631/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2368
Epoch 632/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2368
Epoch 633/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2368
Epoch 634/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2368
Epoch 635/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2368
Epoch 636/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2367
Epoch 637/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2367
Epoch 638/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2367
Epoch 639/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2367
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Epoch 640/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2366
Epoch 641/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2366
Epoch 642/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2366
Epoch 643/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2366
Epoch 644/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2365
Epoch 645/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2365
Epoch 646/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2365
Epoch 647/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2365
Epoch 648/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2365
Epoch 649/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2364
Epoch 650/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2364
Epoch 651/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2364
Epoch 652/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2364
Epoch 653/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2363
Epoch 654/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2363
Epoch 655/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2363
Epoch 656/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2363
Epoch 657/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2363
Epoch 658/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2362
Epoch 659/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2362
Epoch 660/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2362
Epoch 661/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2362
Epoch 662/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2362
Epoch 663/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2361
Epoch 664/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2361
Epoch 665/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2361
Epoch 666/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2361
Epoch 667/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2361
Epoch 668/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2360
Epoch 669/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2360
Epoch 670/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2360
Epoch 671/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2360
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Epoch 672/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2360
Epoch 673/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2359
Epoch 674/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2359
Epoch 675/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2359
Epoch 676/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2359
Epoch 677/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2359
Epoch 678/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2358
Epoch 679/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2358
Epoch 680/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2358
Epoch 681/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2358
Epoch 682/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2358
Epoch 683/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2358
Epoch 684/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2357
Epoch 685/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2357
Epoch 686/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2357
Epoch 687/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2357
Epoch 688/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2357
Epoch 689/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2356
Epoch 690/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2356
Epoch 691/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2356
Epoch 692/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2356
Epoch 693/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2356
Epoch 694/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2356
Epoch 695/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2355
Epoch 696/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2355
Epoch 697/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2355
Epoch 698/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2355
Epoch 699/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2355
Epoch 700/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2354
Epoch 701/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2354
Epoch 702/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2354
Epoch 703/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2354
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Epoch 704/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2354
Epoch 705/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2354
Epoch 706/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2353
Epoch 707/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2353
Epoch 708/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2353
Epoch 709/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2353
Epoch 710/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2353
Epoch 711/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2353
Epoch 712/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2352
Epoch 713/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2352
Epoch 714/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2352
Epoch 715/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2352
Epoch 716/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2352
Epoch 717/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2352
Epoch 718/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2351
Epoch 719/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2351
Epoch 720/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2351
Epoch 721/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2351
Epoch 722/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2351
Epoch 723/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2350
Epoch 724/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2350
Epoch 725/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2350
Epoch 726/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2350
Epoch 727/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2350
Epoch 728/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2350
Epoch 729/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2349
Epoch 730/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2349
Epoch 731/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2349
Epoch 732/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2349
Epoch 733/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2349
Epoch 734/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2349
Epoch 735/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2348
```

```
Epoch 736/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2348
Epoch 737/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2348
Epoch 738/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2348
Epoch 739/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2348
Epoch 740/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2348
Epoch 741/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2347
Epoch 742/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2347
Epoch 743/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2347
Epoch 744/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2347
Epoch 745/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2347
Epoch 746/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2347
Epoch 747/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2346
Epoch 748/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2346
Epoch 749/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2346
Epoch 750/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2346
Epoch 751/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2346
Epoch 752/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2346
Epoch 753/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2345
Epoch 754/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2345
Epoch 755/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2345
Epoch 756/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2345
Epoch 757/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2345
Epoch 758/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2345
Epoch 759/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2344
Epoch 760/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2344
Epoch 761/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2344
Epoch 762/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2344
Epoch 763/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2344
Epoch 764/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2344
Epoch 765/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2344
Epoch 766/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2343
Epoch 767/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2343
```

```
Epoch 768/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2343
Epoch 769/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2343
Epoch 770/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2343
Epoch 771/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2343
Epoch 772/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2342
Epoch 773/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2342
Epoch 774/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2342
Epoch 775/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2342
Epoch 776/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2342
Epoch 777/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2342
Epoch 778/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2341
Epoch 779/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2341
Epoch 780/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2341
Epoch 781/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2341
Epoch 782/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2341
Epoch 783/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2341
Epoch 784/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2340
Epoch 785/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2340
Epoch 786/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2340
Epoch 787/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2340
Epoch 788/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2340
Epoch 789/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2340
Epoch 790/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2339
Epoch 791/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2339
Epoch 792/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2339
Epoch 793/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2339
Epoch 794/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2339
Epoch 795/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2339
Epoch 796/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2338
Epoch 797/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2338
Epoch 798/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2338
Epoch 799/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2338
```

```
Epoch 800/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2338
Epoch 801/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2338
Epoch 802/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2337
Epoch 803/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2337
Epoch 804/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2337
Epoch 805/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2337
Epoch 806/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2337
Epoch 807/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2337
Epoch 808/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2336
Epoch 809/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2336
Epoch 810/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2336
Epoch 811/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2336
Epoch 812/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2336
Epoch 813/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2336
Epoch 814/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2336
Epoch 815/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2335
Epoch 816/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2335
Epoch 817/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2335
Epoch 818/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2335
Epoch 819/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2335
Epoch 820/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2335
Epoch 821/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2334
Epoch 822/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2334
Epoch 823/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2334
Epoch 824/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2334
Epoch 825/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2334
Epoch 826/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2334
Epoch 827/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2333
Epoch 828/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2333
Epoch 829/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2333
Epoch 830/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2333
Epoch 831/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2333
```

```
Epoch 832/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2333
Epoch 833/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2332
Epoch 834/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2332
Epoch 835/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2332
Epoch 836/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2332
Epoch 837/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2332
Epoch 838/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2332
Epoch 839/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2331
Epoch 840/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2331
Epoch 841/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2331
Epoch 842/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2331
Epoch 843/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2331
Epoch 844/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2331
Epoch 845/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2331
Epoch 846/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2330
Epoch 847/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2330
Epoch 848/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2330
Epoch 849/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2330
Epoch 850/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2330
Epoch 851/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2330
Epoch 852/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2329
Epoch 853/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2329
Epoch 854/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2329
Epoch 855/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2329
Epoch 856/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2329
Epoch 857/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2329
Epoch 858/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2328
Epoch 859/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2328
Epoch 860/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2328
Epoch 861/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2328
Epoch 862/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2328
Epoch 863/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2328
```

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Epoch 864/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2328
Epoch 865/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2327
Epoch 866/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2327
Epoch 867/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2327
Epoch 868/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2327
Epoch 869/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2327
Epoch 870/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2327
Epoch 871/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2326
Epoch 872/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2326
Epoch 873/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2326
Epoch 874/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2326
Epoch 875/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2326
Epoch 876/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2326
Epoch 877/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2325
Epoch 878/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2325
Epoch 879/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2325
Epoch 880/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2325
Epoch 881/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2325
Epoch 882/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2325
Epoch 883/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2325
Epoch 884/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2324
Epoch 885/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2324
Epoch 886/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2324
Epoch 887/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2324
Epoch 888/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2324
Epoch 889/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2324
Epoch 890/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2323
Epoch 891/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2323
Epoch 892/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2323
Epoch 893/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2323
Epoch 894/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2323
Epoch 895/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2323
```

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Epoch 896/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2323
Epoch 897/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2322
Epoch 898/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2322
Epoch 899/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2322
Epoch 900/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2322
Epoch 901/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2322
Epoch 902/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2322
Epoch 903/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2321
Epoch 904/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2321
Epoch 905/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2321
Epoch 906/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2321
Epoch 907/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2321
Epoch 908/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2321
Epoch 909/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2320
Epoch 910/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2320
Epoch 911/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2320
Epoch 912/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2320
Epoch 913/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2320
Epoch 914/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2320
Epoch 915/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2320
Epoch 916/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2319
Epoch 917/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2319
Epoch 918/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2319
Epoch 919/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2319
Epoch 920/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2319
Epoch 921/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2319
Epoch 922/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2318
Epoch 923/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2318
Epoch 924/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2318
Epoch 925/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2318
Epoch 926/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2318
Epoch 927/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2318
```

```
Epoch 928/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2318
Epoch 929/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2317
Epoch 930/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2317
Epoch 931/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2317
Epoch 932/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2317
Epoch 933/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2317
Epoch 934/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2317
Epoch 935/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2316
Epoch 936/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2316
Epoch 937/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2316
Epoch 938/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2316
Epoch 939/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2316
Epoch 940/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2316
Epoch 941/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2315
Epoch 942/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2315
Epoch 943/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2315
Epoch 944/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2315
Epoch 945/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2315
Epoch 946/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2315
Epoch 947/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2315
Epoch 948/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2314
Epoch 949/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2314
Epoch 950/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2314
Epoch 951/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2314
Epoch 952/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2314
Epoch 953/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2314
Epoch 954/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2313
Epoch 955/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2313
Epoch 956/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2313
Epoch 957/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2313
Epoch 958/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2313
Epoch 959/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2313
```

```
Epoch 960/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2312
Epoch 961/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2312
Epoch 962/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2312
Epoch 963/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2312
Epoch 964/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2312
Epoch 965/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2312
Epoch 966/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2311
Epoch 967/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2311
Epoch 968/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2311
Epoch 969/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2311
Epoch 970/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2311
Epoch 971/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2311
Epoch 972/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2310
Epoch 973/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2310
Epoch 974/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2310
Epoch 975/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2310
Epoch 976/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2310
Epoch 977/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2310
Epoch 978/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2309
Epoch 979/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2309
Epoch 980/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2309
Epoch 981/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2309
Epoch 982/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2309
Epoch 983/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2309
Epoch 984/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2308
Epoch 985/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2308
Epoch 986/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2308
Epoch 987/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2308
Epoch 988/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2308
Epoch 989/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2307
Epoch 990/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2307
Epoch 991/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2307
```

```
Epoch 992/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2307
Epoch 993/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2307
Epoch 994/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2307
Epoch 995/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2306
Epoch 996/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2306
Epoch 997/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2306
Epoch 998/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2306
Epoch 999/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2306
Epoch 1000/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2305
```

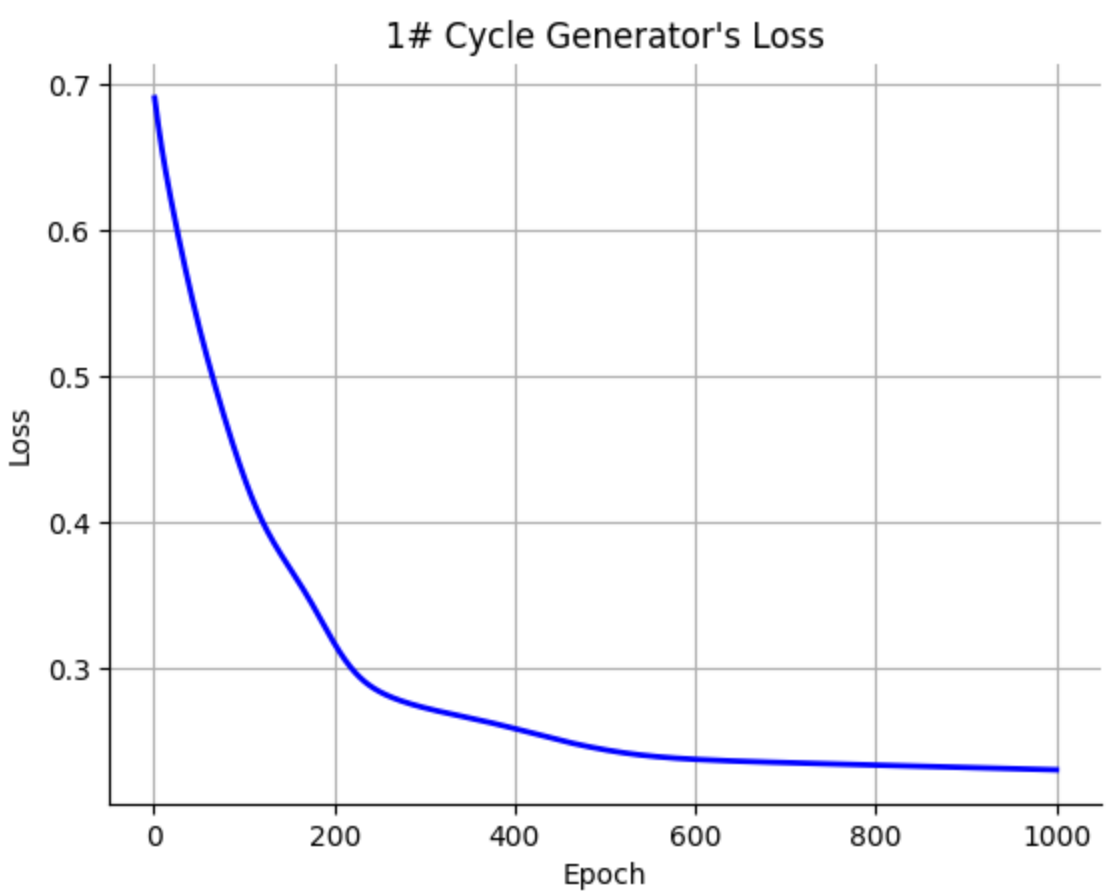
In [ ]:

```python
import matplotlib.pyplot as plt

# Get the data
loss = H.history['loss']
epochs = range(1, len(loss) + 1)

# Customize the plot
fig, ax = plt.subplots()
ax.plot(epochs, loss, color='blue', linestyle='-', linewidth=2)
ax.set_xlabel('Epoch')
ax.set_ylabel('Loss')
ax.set_title("1# Cycle Generator's Loss")
ax.grid(True)
ax.spines['top'].set_visible(False)
ax.spines['right'].set_visible(False)

# Show the plot
plt.show()
```



We can observe that the loss value decreases throughout training, indicating that the generator effectively deceive the discriminator.

In [ ]:

```
gen_data_train = tfq.convert_to_tensor(generate_data(x_train, qgan_qubits) + generate_unic
gen_data_test = tfq.convert_to_tensor(generate_data(x_test, qgan_qubits) + generate_unique

y_gen_train = np.concatenate((y_train, y_true_fake), axis = 0)
y_gen_test = np.concatenate((y_test, y_true_fake), axis = 0)

print(len(gen_data_train), len(gen_data_test))
print(y_gen_train.shape, y_gen_test.shape)
```

```
200 200
(200, 3) (200, 3)
```

In [ ]:

```
# Fit the Discriminator Model
H = train_qdisc(200, 64, 1)
```

```
Epoch 1/200
4/4 [==============================] - 8s 2s/step - loss: 0.7191 - custom_accuracy: 0.7197
- val_loss: 0.5548 - val_custom_accuracy: 0.3511
Epoch 2/200
4/4 [==============================] - 5s 1s/step - loss: 0.7172 - custom_accuracy: 0.6523
- val_loss: 0.5516 - val_custom_accuracy: 0.3511
Epoch 3/200
4/4 [==============================] - 4s 1000ms/step - loss: 0.7096 - custom_accuracy: 0.
6473 - val_loss: 0.5488 - val_custom_accuracy: 0.3763
Epoch 4/200
4/4 [==============================] - 4s 1s/step - loss: 0.7010 - custom_accuracy: 0.6631
- val_loss: 0.5457 - val_custom_accuracy: 0.3559
Epoch 5/200
4/4 [==============================] - 7s 2s/step - loss: 0.7058 - custom_accuracy: 0.6330
- val_loss: 0.5427 - val_custom_accuracy: 0.3559
```

```
4/4 [==============================] - 5s 1s/step - loss: 0.6956 - custom_accuracy: 0.6420
- val_loss: 0.5403 - val_custom_accuracy: 0.3559
Epoch 7/200
4/4 [==============================] - 4s 1s/step - loss: 0.6861 - custom_accuracy: 0.6571
- val_loss: 0.5377 - val_custom_accuracy: 0.3559
Epoch 8/200
4/4 [==============================] - 5s 1s/step - loss: 0.6859 - custom_accuracy: 0.6919
- val_loss: 0.5352 - val_custom_accuracy: 0.3559
Epoch 9/200
4/4 [==============================] - 8s 2s/step - loss: 0.6823 - custom_accuracy: 0.5340
- val_loss: 0.5329 - val_custom_accuracy: 0.3559
Epoch 10/200
4/4 [==============================] - 4s 987ms/step - loss: 0.6790 - custom_accuracy: 0.6
151 - val_loss: 0.5309 - val_custom_accuracy: 0.3559
Epoch 11/200
4/4 [==============================] - 4s 1s/step - loss: 0.6684 - custom_accuracy: 0.5797
- val_loss: 0.5291 - val_custom_accuracy: 0.3559
Epoch 12/200
4/4 [==============================] - 6s 2s/step - loss: 0.6729 - custom_accuracy: 0.5136
- val_loss: 0.5275 - val_custom_accuracy: 0.3559
Epoch 13/200
4/4 [==============================] - 6s 1s/step - loss: 0.6650 - custom_accuracy: 0.6126
- val_loss: 0.5262 - val_custom_accuracy: 0.3559
Epoch 14/200
4/4 [==============================] - 4s 1s/step - loss: 0.6651 - custom_accuracy: 0.6778
- val_loss: 0.5248 - val_custom_accuracy: 0.3559
Epoch 15/200
4/4 [==============================] - 4s 1s/step - loss: 0.6686 - custom_accuracy: 0.5179
- val_loss: 0.5235 - val_custom_accuracy: 0.3559
Epoch 16/200
4/4 [==============================] - 6s 2s/step - loss: 0.6608 - custom_accuracy: 0.5490
- val_loss: 0.5223 - val_custom_accuracy: 0.3559
Epoch 17/200
4/4 [==============================] - 7s 1s/step - loss: 0.6538 - custom_accuracy: 0.7691
- val_loss: 0.5211 - val_custom_accuracy: 0.3559
Epoch 18/200
4/4 [==============================] - 4s 968ms/step - loss: 0.6570 - custom_accuracy: 0.6
814 - val_loss: 0.5198 - val_custom_accuracy: 0.3559
Epoch 19/200
4/4 [==============================] - 4s 982ms/step - loss: 0.6483 - custom_accuracy: 0.7
066 - val_loss: 0.5184 - val_custom_accuracy: 0.3559
Epoch 20/200
4/4 [==============================] - 7s 2s/step - loss: 0.6481 - custom_accuracy: 0.6756
- val_loss: 0.5172 - val_custom_accuracy: 0.3559
Epoch 21/200
4/4 [==============================] - 5s 1s/step - loss: 0.6444 - custom_accuracy: 0.7346
- val_loss: 0.5159 - val_custom_accuracy: 0.3559
Epoch 22/200
4/4 [==============================] - 4s 1s/step - loss: 0.6472 - custom_accuracy: 0.7421
- val_loss: 0.5145 - val_custom_accuracy: 0.3559
Epoch 23/200
4/4 [==============================] - 4s 1s/step - loss: 0.6380 - custom_accuracy: 0.7168
- val_loss: 0.5134 - val_custom_accuracy: 0.3559
Epoch 24/200
4/4 [==============================] - 8s 2s/step - loss: 0.6360 - custom_accuracy: 0.6540
- val_loss: 0.5125 - val_custom_accuracy: 0.3559
Epoch 25/200
4/4 [==============================] - 4s 1s/step - loss: 0.6397 - custom_accuracy: 0.6553
- val_loss: 0.5118 - val_custom_accuracy: 0.3559
Epoch 26/200
4/4 [==============================] - 4s 1s/step - loss: 0.6261 - custom_accuracy: 0.7324
- val_loss: 0.5115 - val_custom_accuracy: 0.3520
Epoch 27/200
4/4 [==============================] - 5s 1s/step - loss: 0.6285 - custom_accuracy: 0.6930
```

```
- val_loss: 0.5109 - val_custom_accuracy: 0.3520
Epoch 28/200
4/4 [==============================] - 7s 2s/step - loss: 0.6263 - custom_accuracy: 0.6395
- val_loss: 0.5103 - val_custom_accuracy: 0.3520
Epoch 29/200
4/4 [==============================] - 4s 1s/step - loss: 0.6235 - custom_accuracy: 0.6801
- val_loss: 0.5100 - val_custom_accuracy: 0.3520
Epoch 30/200
4/4 [==============================] - 4s 1s/step - loss: 0.6208 - custom_accuracy: 0.7087
- val_loss: 0.5098 - val_custom_accuracy: 0.3520
Epoch 31/200
4/4 [==============================] - 6s 2s/step - loss: 0.6252 - custom_accuracy: 0.6611
- val_loss: 0.5095 - val_custom_accuracy: 0.3520
Epoch 32/200
4/4 [==============================] - 6s 2s/step - loss: 0.6274 - custom_accuracy: 0.5282
- val_loss: 0.5096 - val_custom_accuracy: 0.3520
Epoch 33/200
4/4 [==============================] - 4s 989ms/step - loss: 0.6151 - custom_accuracy: 0.6
827 - val_loss: 0.5099 - val_custom_accuracy: 0.3520
Epoch 34/200
4/4 [==============================] - 4s 1s/step - loss: 0.6171 - custom_accuracy: 0.7362
- val_loss: 0.5101 - val_custom_accuracy: 0.3520
Epoch 35/200
4/4 [==============================] - 8s 2s/step - loss: 0.6051 - custom_accuracy: 0.7991
- val_loss: 0.5101 - val_custom_accuracy: 0.3520
Epoch 36/200
4/4 [==============================] - 7s 2s/step - loss: 0.6084 - custom_accuracy: 0.6866
- val_loss: 0.5098 - val_custom_accuracy: 0.3520
Epoch 37/200
4/4 [==============================] - 4s 973ms/step - loss: 0.6081 - custom_accuracy: 0.7
239 - val_loss: 0.5093 - val_custom_accuracy: 0.3520
Epoch 38/200
4/4 [==============================] - 4s 995ms/step - loss: 0.6112 - custom_accuracy: 0.6
330 - val_loss: 0.5087 - val_custom_accuracy: 0.3520
Epoch 39/200
4/4 [==============================] - 6s 2s/step - loss: 0.6041 - custom_accuracy: 0.6933
- val_loss: 0.5087 - val_custom_accuracy: 0.3520
Epoch 40/200
4/4 [==============================] - 6s 2s/step - loss: 0.6000 - custom_accuracy: 0.7855
- val_loss: 0.5084 - val_custom_accuracy: 0.3520
Epoch 41/200
4/4 [==============================] - 4s 1s/step - loss: 0.6014 - custom_accuracy: 0.7218
- val_loss: 0.5079 - val_custom_accuracy: 0.3520
Epoch 42/200
4/4 [==============================] - 4s 1s/step - loss: 0.5984 - custom_accuracy: 0.5594
- val_loss: 0.5075 - val_custom_accuracy: 0.3325
Epoch 43/200
4/4 [==============================] - 6s 2s/step - loss: 0.6006 - custom_accuracy: 0.7897
- val_loss: 0.5073 - val_custom_accuracy: 0.3151
Epoch 44/200
4/4 [==============================] - 6s 1s/step - loss: 0.6050 - custom_accuracy: 0.4982
- val_loss: 0.5072 - val_custom_accuracy: 0.3016
Epoch 45/200
4/4 [==============================] - 4s 994ms/step - loss: 0.6030 - custom_accuracy: 0.6
228 - val_loss: 0.5075 - val_custom_accuracy: 0.2977
Epoch 46/200
4/4 [==============================] - 4s 997ms/step - loss: 0.5971 - custom_accuracy: 0.6
188 - val_loss: 0.5074 - val_custom_accuracy: 0.2977
Epoch 47/200
4/4 [==============================] - 6s 2s/step - loss: 0.5904 - custom_accuracy: 0.6235
- val_loss: 0.5071 - val_custom_accuracy: 0.2977
Epoch 48/200
4/4 [==============================] - 6s 1s/step - loss: 0.5913 - custom_accuracy: 0.7031
- val_loss: 0.5067 - val_custom_accuracy: 0.2977
```

```
Epoch 49/200
4/4 [==============================] - 4s 1s/step - loss: 0.5935 - custom_accuracy: 0.6535
- val_loss: 0.5061 - val_custom_accuracy: 0.2977
Epoch 50/200
4/4 [==============================] - 4s 1s/step - loss: 0.5809 - custom_accuracy: 0.7093
- val_loss: 0.5054 - val_custom_accuracy: 0.3047
Epoch 51/200
4/4 [==============================] - 6s 2s/step - loss: 0.5875 - custom_accuracy: 0.5178
- val_loss: 0.5047 - val_custom_accuracy: 0.3047
Epoch 52/200
4/4 [==============================] - 6s 1s/step - loss: 0.5941 - custom_accuracy: 0.5477
- val_loss: 0.5046 - val_custom_accuracy: 0.3047
Epoch 53/200
4/4 [==============================] - 4s 1s/step - loss: 0.5856 - custom_accuracy: 0.6259
- val_loss: 0.5044 - val_custom_accuracy: 0.3047
Epoch 54/200
4/4 [==============================] - 4s 999ms/step - loss: 0.5882 - custom_accuracy: 0.7
042 - val_loss: 0.5043 - val_custom_accuracy: 0.3047
Epoch 55/200
4/4 [==============================] - 6s 2s/step - loss: 0.5933 - custom_accuracy: 0.6113
- val_loss: 0.5038 - val_custom_accuracy: 0.3047
Epoch 56/200
4/4 [==============================] - 5s 1s/step - loss: 0.5837 - custom_accuracy: 0.6479
- val_loss: 0.5031 - val_custom_accuracy: 0.3047
Epoch 57/200
4/4 [==============================] - 4s 1s/step - loss: 0.5765 - custom_accuracy: 0.6293
- val_loss: 0.5023 - val_custom_accuracy: 0.3047
Epoch 58/200
4/4 [==============================] - 4s 988ms/step - loss: 0.5769 - custom_accuracy: 0.6
186 - val_loss: 0.5017 - val_custom_accuracy: 0.3047
Epoch 59/200
4/4 [==============================] - 7s 2s/step - loss: 0.5832 - custom_accuracy: 0.6736
- val_loss: 0.5014 - val_custom_accuracy: 0.2977
Epoch 60/200
4/4 [==============================] - 5s 1s/step - loss: 0.5679 - custom_accuracy: 0.6427
- val_loss: 0.5014 - val_custom_accuracy: 0.2977
Epoch 61/200
4/4 [==============================] - 4s 1s/step - loss: 0.5734 - custom_accuracy: 0.5436
- val_loss: 0.5017 - val_custom_accuracy: 0.2977
Epoch 62/200
4/4 [==============================] - 4s 1s/step - loss: 0.5784 - custom_accuracy: 0.6683
- val_loss: 0.5021 - val_custom_accuracy: 0.2977
Epoch 63/200
4/4 [==============================] - 7s 2s/step - loss: 0.5583 - custom_accuracy: 0.5090
- val_loss: 0.5020 - val_custom_accuracy: 0.2977
Epoch 64/200
4/4 [==============================] - 5s 989ms/step - loss: 0.5764 - custom_accuracy: 0.5
782 - val_loss: 0.5023 - val_custom_accuracy: 0.3016
Epoch 65/200
4/4 [==============================] - 4s 952ms/step - loss: 0.5726 - custom_accuracy: 0.7
538 - val_loss: 0.5023 - val_custom_accuracy: 0.2947
Epoch 66/200
4/4 [==============================] - 5s 1s/step - loss: 0.5664 - custom_accuracy: 0.6858
- val_loss: 0.5019 - val_custom_accuracy: 0.2977
Epoch 67/200
4/4 [==============================] - 7s 2s/step - loss: 0.5618 - custom_accuracy: 0.6982
- val_loss: 0.5014 - val_custom_accuracy: 0.2977
Epoch 68/200
4/4 [==============================] - 4s 1s/step - loss: 0.5580 - custom_accuracy: 0.6460
- val_loss: 0.5007 - val_custom_accuracy: 0.2977
Epoch 69/200
4/4 [==============================] - 4s 1s/step - loss: 0.5625 - custom_accuracy: 0.5310
- val_loss: 0.5005 - val_custom_accuracy: 0.3047
Epoch 70/200
```

```
4/4 [==============================] - 5s 1s/step - loss: 0.5627 - custom_accuracy: 0.6076
- val_loss: 0.5009 - val_custom_accuracy: 0.2977
Epoch 71/200
4/4 [==============================] - 7s 2s/step - loss: 0.5578 - custom_accuracy: 0.7122
- val_loss: 0.5012 - val_custom_accuracy: 0.2977
Epoch 72/200
4/4 [==============================] - 4s 1s/step - loss: 0.5578 - custom_accuracy: 0.5867
- val_loss: 0.5015 - val_custom_accuracy: 0.2977
Epoch 73/200
4/4 [==============================] - 4s 989ms/step - loss: 0.5597 - custom_accuracy: 0.6
903 - val_loss: 0.5018 - val_custom_accuracy: 0.2977
Epoch 74/200
4/4 [==============================] - 6s 2s/step - loss: 0.5446 - custom_accuracy: 0.6463
- val_loss: 0.5015 - val_custom_accuracy: 0.2977
Epoch 75/200
4/4 [==============================] - 6s 2s/step - loss: 0.5581 - custom_accuracy: 0.6246
- val_loss: 0.5008 - val_custom_accuracy: 0.2977
Epoch 76/200
4/4 [==============================] - 4s 1s/step - loss: 0.5389 - custom_accuracy: 0.7276
- val_loss: 0.4994 - val_custom_accuracy: 0.2977
Epoch 77/200
4/4 [==============================] - 4s 1s/step - loss: 0.5415 - custom_accuracy: 0.7185
- val_loss: 0.4982 - val_custom_accuracy: 0.2977
Epoch 78/200
4/4 [==============================] - 6s 2s/step - loss: 0.5455 - custom_accuracy: 0.6354
- val_loss: 0.4969 - val_custom_accuracy: 0.2977
Epoch 79/200
4/4 [==============================] - 7s 2s/step - loss: 0.5438 - custom_accuracy: 0.5968
- val_loss: 0.4954 - val_custom_accuracy: 0.2977
Epoch 80/200
4/4 [==============================] - 6s 2s/step - loss: 0.5358 - custom_accuracy: 0.7452
- val_loss: 0.4944 - val_custom_accuracy: 0.3016
Epoch 81/200
4/4 [==============================] - 5s 1s/step - loss: 0.5443 - custom_accuracy: 0.5519
- val_loss: 0.4933 - val_custom_accuracy: 0.3112
Epoch 82/200
4/4 [==============================] - 7s 2s/step - loss: 0.5378 - custom_accuracy: 0.7860
- val_loss: 0.4921 - val_custom_accuracy: 0.3481
Epoch 83/200
4/4 [==============================] - 4s 982ms/step - loss: 0.5285 - custom_accuracy: 0.7
367 - val_loss: 0.4906 - val_custom_accuracy: 0.3403
Epoch 84/200
4/4 [==============================] - 4s 1s/step - loss: 0.5303 - custom_accuracy: 0.6900
- val_loss: 0.4891 - val_custom_accuracy: 0.2977
Epoch 85/200
4/4 [==============================] - 5s 1s/step - loss: 0.5230 - custom_accuracy: 0.6552
- val_loss: 0.4884 - val_custom_accuracy: 0.2977
Epoch 86/200
4/4 [==============================] - 7s 2s/step - loss: 0.5280 - custom_accuracy: 0.6113
- val_loss: 0.4883 - val_custom_accuracy: 0.2977
Epoch 87/200
4/4 [==============================] - 4s 987ms/step - loss: 0.5398 - custom_accuracy: 0.5
999 - val_loss: 0.4879 - val_custom_accuracy: 0.2977
Epoch 88/200
4/4 [==============================] - 4s 984ms/step - loss: 0.5178 - custom_accuracy: 0.7
058 - val_loss: 0.4876 - val_custom_accuracy: 0.2630
Epoch 89/200
4/4 [==============================] - 6s 2s/step - loss: 0.5164 - custom_accuracy: 0.6408
- val_loss: 0.4873 - val_custom_accuracy: 0.2860
Epoch 90/200
4/4 [==============================] - 6s 2s/step - loss: 0.5268 - custom_accuracy: 0.5326
- val_loss: 0.4872 - val_custom_accuracy: 0.2860
Epoch 91/200
4/4 [==============================] - 4s 998ms/step - loss: 0.5223 - custom_accuracy: 0.5
```

```
903 - val_loss: 0.4872 - val_custom_accuracy: 0.3286
Epoch 92/200
4/4 [==============================] - 4s 975ms/step - loss: 0.5276 - custom_accuracy: 0.8
005 - val_loss: 0.4864 - val_custom_accuracy: 0.3403
Epoch 93/200
4/4 [==============================] - 6s 2s/step - loss: 0.5161 - custom_accuracy: 0.8041
- val_loss: 0.4849 - val_custom_accuracy: 0.3442
Epoch 94/200
4/4 [==============================] - 6s 2s/step - loss: 0.5122 - custom_accuracy: 0.8137
- val_loss: 0.4836 - val_custom_accuracy: 0.3442
Epoch 95/200
4/4 [==============================] - 4s 1s/step - loss: 0.5061 - custom_accuracy: 0.8131
- val_loss: 0.4827 - val_custom_accuracy: 0.3442
Epoch 96/200
4/4 [==============================] - 4s 984ms/step - loss: 0.5122 - custom_accuracy: 0.7
652 - val_loss: 0.4822 - val_custom_accuracy: 0.3442
Epoch 97/200
4/4 [==============================] - 6s 2s/step - loss: 0.5052 - custom_accuracy: 0.8126
- val_loss: 0.4812 - val_custom_accuracy: 0.3442
Epoch 98/200
4/4 [==============================] - 6s 1s/step - loss: 0.4944 - custom_accuracy: 0.7587
- val_loss: 0.4807 - val_custom_accuracy: 0.3442
Epoch 99/200
4/4 [==============================] - 4s 1s/step - loss: 0.4978 - custom_accuracy: 0.8109
- val_loss: 0.4811 - val_custom_accuracy: 0.3442
Epoch 100/200
4/4 [==============================] - 4s 988ms/step - loss: 0.5112 - custom_accuracy: 0.7
792 - val_loss: 0.4806 - val_custom_accuracy: 0.3442
Epoch 101/200
4/4 [==============================] - 6s 2s/step - loss: 0.4966 - custom_accuracy: 0.7382
- val_loss: 0.4794 - val_custom_accuracy: 0.3442
Epoch 102/200
4/4 [==============================] - 5s 1s/step - loss: 0.5026 - custom_accuracy: 0.8155
- val_loss: 0.4785 - val_custom_accuracy: 0.2964
Epoch 103/200
4/4 [==============================] - 4s 972ms/step - loss: 0.4987 - custom_accuracy: 0.6
629 - val_loss: 0.4784 - val_custom_accuracy: 0.2817
Epoch 104/200
4/4 [==============================] - 4s 1s/step - loss: 0.5007 - custom_accuracy: 0.8090
- val_loss: 0.4777 - val_custom_accuracy: 0.2817
Epoch 105/200
4/4 [==============================] - 7s 2s/step - loss: 0.5081 - custom_accuracy: 0.6727
- val_loss: 0.4781 - val_custom_accuracy: 0.2747
Epoch 106/200
4/4 [==============================] - 5s 1s/step - loss: 0.4805 - custom_accuracy: 0.7308
- val_loss: 0.4783 - val_custom_accuracy: 0.2747
Epoch 107/200
4/4 [==============================] - 4s 1s/step - loss: 0.4917 - custom_accuracy: 0.8192
- val_loss: 0.4793 - val_custom_accuracy: 0.2747
Epoch 108/200
4/4 [==============================] - 4s 1s/step - loss: 0.4912 - custom_accuracy: 0.7102
- val_loss: 0.4802 - val_custom_accuracy: 0.2747
Epoch 109/200
4/4 [==============================] - 7s 2s/step - loss: 0.4907 - custom_accuracy: 0.7714
- val_loss: 0.4797 - val_custom_accuracy: 0.2747
Epoch 110/200
4/4 [==============================] - 5s 1s/step - loss: 0.4720 - custom_accuracy: 0.7723
- val_loss: 0.4785 - val_custom_accuracy: 0.2747
Epoch 111/200
4/4 [==============================] - 4s 1s/step - loss: 0.5015 - custom_accuracy: 0.7323
- val_loss: 0.4773 - val_custom_accuracy: 0.2747
Epoch 112/200
4/4 [==============================] - 4s 1s/step - loss: 0.4908 - custom_accuracy: 0.6926
- val_loss: 0.4763 - val_custom_accuracy: 0.2747
```

```
Epoch 113/200
4/4 [==============================] - 7s 2s/step - loss: 0.4956 - custom_accuracy: 0.6201
- val_loss: 0.4746 - val_custom_accuracy: 0.2747
Epoch 114/200
4/4 [==============================] - 5s 1s/step - loss: 0.4961 - custom_accuracy: 0.5530
- val_loss: 0.4712 - val_custom_accuracy: 0.2747
Epoch 115/200
4/4 [==============================] - 4s 976ms/step - loss: 0.4805 - custom_accuracy: 0.8
218 - val_loss: 0.4693 - val_custom_accuracy: 0.2708
Epoch 116/200
4/4 [==============================] - 5s 1s/step - loss: 0.4764 - custom_accuracy: 0.7037
- val_loss: 0.4692 - val_custom_accuracy: 0.2708
Epoch 117/200
4/4 [==============================] - 7s 2s/step - loss: 0.4891 - custom_accuracy: 0.6871
- val_loss: 0.4689 - val_custom_accuracy: 0.2708
Epoch 118/200
4/4 [==============================] - 4s 995ms/step - loss: 0.4967 - custom_accuracy: 0.7
298 - val_loss: 0.4675 - val_custom_accuracy: 0.2708
Epoch 119/200
4/4 [==============================] - 4s 990ms/step - loss: 0.4893 - custom_accuracy: 0.7
801 - val_loss: 0.4656 - val_custom_accuracy: 0.2708
Epoch 120/200
4/4 [==============================] - 5s 1s/step - loss: 0.4826 - custom_accuracy: 0.6795
- val_loss: 0.4641 - val_custom_accuracy: 0.2708
Epoch 121/200
4/4 [==============================] - 7s 2s/step - loss: 0.4895 - custom_accuracy: 0.7264
- val_loss: 0.4630 - val_custom_accuracy: 0.2708
Epoch 122/200
4/4 [==============================] - 4s 1s/step - loss: 0.4837 - custom_accuracy: 0.7135
- val_loss: 0.4623 - val_custom_accuracy: 0.2708
Epoch 123/200
4/4 [==============================] - 5s 1s/step - loss: 0.4838 - custom_accuracy: 0.8082
- val_loss: 0.4610 - val_custom_accuracy: 0.2708
Epoch 124/200
4/4 [==============================] - 8s 2s/step - loss: 0.4677 - custom_accuracy: 0.7069
- val_loss: 0.4601 - val_custom_accuracy: 0.2708
Epoch 125/200
4/4 [==============================] - 7s 2s/step - loss: 0.4691 - custom_accuracy: 0.7167
- val_loss: 0.4588 - val_custom_accuracy: 0.2708
Epoch 126/200
4/4 [==============================] - 4s 993ms/step - loss: 0.4823 - custom_accuracy: 0.7
346 - val_loss: 0.4575 - val_custom_accuracy: 0.2708
Epoch 127/200
4/4 [==============================] - 4s 988ms/step - loss: 0.4680 - custom_accuracy: 0.7
310 - val_loss: 0.4570 - val_custom_accuracy: 0.2708
Epoch 128/200
4/4 [==============================] - 6s 2s/step - loss: 0.4839 - custom_accuracy: 0.7909
- val_loss: 0.4560 - val_custom_accuracy: 0.2708
Epoch 129/200
4/4 [==============================] - 6s 1s/step - loss: 0.4971 - custom_accuracy: 0.7729
- val_loss: 0.4555 - val_custom_accuracy: 0.2708
Epoch 130/200
4/4 [==============================] - 4s 986ms/step - loss: 0.4722 - custom_accuracy: 0.8
054 - val_loss: 0.4555 - val_custom_accuracy: 0.2708
Epoch 131/200
4/4 [==============================] - 4s 995ms/step - loss: 0.4668 - custom_accuracy: 0.8
083 - val_loss: 0.4572 - val_custom_accuracy: 0.2708
Epoch 132/200
4/4 [==============================] - 6s 2s/step - loss: 0.4737 - custom_accuracy: 0.7191
- val_loss: 0.4592 - val_custom_accuracy: 0.2708
Epoch 133/200
4/4 [==============================] - 6s 1s/step - loss: 0.4522 - custom_accuracy: 0.8205
- val_loss: 0.4603 - val_custom_accuracy: 0.2708
Epoch 134/200
```

```
4/4 [==============================] - 4s 1s/step - loss: 0.4749 - custom_accuracy: 0.7749
- val_loss: 0.4618 - val_custom_accuracy: 0.2708
Epoch 135/200
4/4 [==============================] - 4s 998ms/step - loss: 0.4640 - custom_accuracy: 0.7
228 - val_loss: 0.4631 - val_custom_accuracy: 0.2708
Epoch 136/200
4/4 [==============================] - 6s 2s/step - loss: 0.4784 - custom_accuracy: 0.7221
- val_loss: 0.4625 - val_custom_accuracy: 0.2708
Epoch 137/200
4/4 [==============================] - 6s 1s/step - loss: 0.4551 - custom_accuracy: 0.7078
- val_loss: 0.4616 - val_custom_accuracy: 0.2708
Epoch 138/200
4/4 [==============================] - 4s 978ms/step - loss: 0.4757 - custom_accuracy: 0.7
498 - val_loss: 0.4614 - val_custom_accuracy: 0.2708
Epoch 139/200
4/4 [==============================] - 4s 993ms/step - loss: 0.4612 - custom_accuracy: 0.7
125 - val_loss: 0.4613 - val_custom_accuracy: 0.2708
Epoch 140/200
4/4 [==============================] - 7s 2s/step - loss: 0.4674 - custom_accuracy: 0.7096
- val_loss: 0.4607 - val_custom_accuracy: 0.2708
Epoch 141/200
4/4 [==============================] - 5s 1s/step - loss: 0.4630 - custom_accuracy: 0.7130
- val_loss: 0.4593 - val_custom_accuracy: 0.2708
Epoch 142/200
4/4 [==============================] - 4s 1s/step - loss: 0.4503 - custom_accuracy: 0.7967
- val_loss: 0.4584 - val_custom_accuracy: 0.2708
Epoch 143/200
4/4 [==============================] - 4s 1s/step - loss: 0.4765 - custom_accuracy: 0.6405
- val_loss: 0.4585 - val_custom_accuracy: 0.2708
Epoch 144/200
4/4 [==============================] - 7s 2s/step - loss: 0.4531 - custom_accuracy: 0.8071
- val_loss: 0.4586 - val_custom_accuracy: 0.2708
Epoch 145/200
4/4 [==============================] - 5s 995ms/step - loss: 0.4557 - custom_accuracy: 0.7
131 - val_loss: 0.4586 - val_custom_accuracy: 0.2708
Epoch 146/200
4/4 [==============================] - 4s 988ms/step - loss: 0.4763 - custom_accuracy: 0.7
634 - val_loss: 0.4572 - val_custom_accuracy: 0.2708
Epoch 147/200
4/4 [==============================] - 5s 1s/step - loss: 0.4532 - custom_accuracy: 0.7350
- val_loss: 0.4552 - val_custom_accuracy: 0.2708
Epoch 148/200
4/4 [==============================] - 7s 2s/step - loss: 0.4611 - custom_accuracy: 0.6726
- val_loss: 0.4529 - val_custom_accuracy: 0.2708
Epoch 149/200
4/4 [==============================] - 4s 1s/step - loss: 0.4575 - custom_accuracy: 0.6720
- val_loss: 0.4515 - val_custom_accuracy: 0.2708
Epoch 150/200
4/4 [==============================] - 4s 1s/step - loss: 0.4574 - custom_accuracy: 0.7968
- val_loss: 0.4505 - val_custom_accuracy: 0.2708
Epoch 151/200
4/4 [==============================] - 5s 1s/step - loss: 0.4394 - custom_accuracy: 0.7271
- val_loss: 0.4507 - val_custom_accuracy: 0.2708
Epoch 152/200
4/4 [==============================] - 7s 2s/step - loss: 0.4563 - custom_accuracy: 0.6835
- val_loss: 0.4508 - val_custom_accuracy: 0.2708
Epoch 153/200
4/4 [==============================] - 4s 1s/step - loss: 0.4566 - custom_accuracy: 0.6904
- val_loss: 0.4495 - val_custom_accuracy: 0.2708
Epoch 154/200
4/4 [==============================] - 4s 1s/step - loss: 0.4610 - custom_accuracy: 0.7307
- val_loss: 0.4480 - val_custom_accuracy: 0.2708
Epoch 155/200
4/4 [==============================] - 6s 2s/step - loss: 0.4563 - custom_accuracy: 0.7577
```

```
- val_loss: 0.4466 - val_custom_accuracy: 0.2708
Epoch 156/200
4/4 [==============================] - 6s 2s/step - loss: 0.4522 - custom_accuracy: 0.7472
- val_loss: 0.4463 - val_custom_accuracy: 0.2708
Epoch 157/200
4/4 [==============================] - 4s 993ms/step - loss: 0.4509 - custom_accuracy: 0.7
327 - val_loss: 0.4460 - val_custom_accuracy: 0.2708
Epoch 158/200
4/4 [==============================] - 4s 1s/step - loss: 0.4591 - custom_accuracy: 0.8045
- val_loss: 0.4452 - val_custom_accuracy: 0.2708
Epoch 159/200
4/4 [==============================] - 6s 2s/step - loss: 0.4554 - custom_accuracy: 0.7033
- val_loss: 0.4452 - val_custom_accuracy: 0.2708
Epoch 160/200
4/4 [==============================] - 6s 1s/step - loss: 0.4497 - custom_accuracy: 0.7294
- val_loss: 0.4451 - val_custom_accuracy: 0.2708
Epoch 161/200
4/4 [==============================] - 4s 989ms/step - loss: 0.4641 - custom_accuracy: 0.6
836 - val_loss: 0.4451 - val_custom_accuracy: 0.2708
Epoch 162/200
4/4 [==============================] - 4s 968ms/step - loss: 0.4632 - custom_accuracy: 0.6
797 - val_loss: 0.4455 - val_custom_accuracy: 0.2708
Epoch 163/200
4/4 [==============================] - 6s 2s/step - loss: 0.4517 - custom_accuracy: 0.7139
- val_loss: 0.4454 - val_custom_accuracy: 0.2708
Epoch 164/200
4/4 [==============================] - 6s 1s/step - loss: 0.4435 - custom_accuracy: 0.7390
- val_loss: 0.4459 - val_custom_accuracy: 0.2708
Epoch 165/200
4/4 [==============================] - 4s 1s/step - loss: 0.4612 - custom_accuracy: 0.8047
- val_loss: 0.4463 - val_custom_accuracy: 0.2708
Epoch 166/200
4/4 [==============================] - 4s 1s/step - loss: 0.4415 - custom_accuracy: 0.6798
- val_loss: 0.4469 - val_custom_accuracy: 0.2708
Epoch 167/200
4/4 [==============================] - 7s 2s/step - loss: 0.4550 - custom_accuracy: 0.7159
- val_loss: 0.4463 - val_custom_accuracy: 0.2708
Epoch 168/200
4/4 [==============================] - 8s 2s/step - loss: 0.4432 - custom_accuracy: 0.8012
- val_loss: 0.4462 - val_custom_accuracy: 0.2708
Epoch 169/200
4/4 [==============================] - 5s 1s/step - loss: 0.4468 - custom_accuracy: 0.7957
- val_loss: 0.4468 - val_custom_accuracy: 0.2708
Epoch 170/200
4/4 [==============================] - 4s 977ms/step - loss: 0.4492 - custom_accuracy: 0.5
593 - val_loss: 0.4477 - val_custom_accuracy: 0.2708
Epoch 171/200
4/4 [==============================] - 5s 1s/step - loss: 0.4492 - custom_accuracy: 0.8130
- val_loss: 0.4479 - val_custom_accuracy: 0.2708
Epoch 172/200
4/4 [==============================] - 6s 2s/step - loss: 0.4514 - custom_accuracy: 0.6891
- val_loss: 0.4478 - val_custom_accuracy: 0.2708
Epoch 173/200
4/4 [==============================] - 4s 1s/step - loss: 0.4370 - custom_accuracy: 0.7175
- val_loss: 0.4480 - val_custom_accuracy: 0.3212
Epoch 174/200
4/4 [==============================] - 4s 994ms/step - loss: 0.4516 - custom_accuracy: 0.8
180 - val_loss: 0.4482 - val_custom_accuracy: 0.3442
Epoch 175/200
4/4 [==============================] - 6s 2s/step - loss: 0.4419 - custom_accuracy: 0.7073
- val_loss: 0.4476 - val_custom_accuracy: 0.3442
Epoch 176/200
4/4 [==============================] - 6s 2s/step - loss: 0.4359 - custom_accuracy: 0.8175
- val_loss: 0.4468 - val_custom_accuracy: 0.3442
```

```
Epoch 177/200
4/4 [==============================] - 4s 1s/step - loss: 0.4396 - custom_accuracy: 0.7414
- val_loss: 0.4467 - val_custom_accuracy: 0.3442
Epoch 178/200
4/4 [==============================] - 4s 1s/step - loss: 0.4408 - custom_accuracy: 0.7569
- val_loss: 0.4467 - val_custom_accuracy: 0.3442
Epoch 179/200
4/4 [==============================] - 6s 2s/step - loss: 0.4354 - custom_accuracy: 0.7725
- val_loss: 0.4471 - val_custom_accuracy: 0.3442
Epoch 180/200
4/4 [==============================] - 6s 1s/step - loss: 0.4444 - custom_accuracy: 0.8102
- val_loss: 0.4471 - val_custom_accuracy: 0.3442
Epoch 181/200
4/4 [==============================] - 4s 959ms/step - loss: 0.4549 - custom_accuracy: 0.7
581 - val_loss: 0.4472 - val_custom_accuracy: 0.3442
Epoch 182/200
4/4 [==============================] - 4s 1s/step - loss: 0.4442 - custom_accuracy: 0.7396
- val_loss: 0.4467 - val_custom_accuracy: 0.3442
Epoch 183/200
4/4 [==============================] - 6s 2s/step - loss: 0.4390 - custom_accuracy: 0.8147
- val_loss: 0.4450 - val_custom_accuracy: 0.3442
Epoch 184/200
4/4 [==============================] - 6s 1s/step - loss: 0.4482 - custom_accuracy: 0.6978
- val_loss: 0.4444 - val_custom_accuracy: 0.3442
Epoch 185/200
4/4 [==============================] - 4s 980ms/step - loss: 0.4475 - custom_accuracy: 0.8
168 - val_loss: 0.4448 - val_custom_accuracy: 0.3442
Epoch 186/200
4/4 [==============================] - 4s 1s/step - loss: 0.4379 - custom_accuracy: 0.8167
- val_loss: 0.4455 - val_custom_accuracy: 0.3442
Epoch 187/200
4/4 [==============================] - 6s 2s/step - loss: 0.4445 - custom_accuracy: 0.6608
- val_loss: 0.4464 - val_custom_accuracy: 0.3442
Epoch 188/200
4/4 [==============================] - 6s 1s/step - loss: 0.4359 - custom_accuracy: 0.7360
- val_loss: 0.4469 - val_custom_accuracy: 0.3442
Epoch 189/200
4/4 [==============================] - 4s 1s/step - loss: 0.4560 - custom_accuracy: 0.7005
- val_loss: 0.4469 - val_custom_accuracy: 0.3442
Epoch 190/200
4/4 [==============================] - 4s 992ms/step - loss: 0.4493 - custom_accuracy: 0.7
021 - val_loss: 0.4466 - val_custom_accuracy: 0.3442
Epoch 191/200
4/4 [==============================] - 7s 2s/step - loss: 0.4426 - custom_accuracy: 0.8175
- val_loss: 0.4466 - val_custom_accuracy: 0.3442
Epoch 192/200
4/4 [==============================] - 5s 1s/step - loss: 0.4322 - custom_accuracy: 0.7376
- val_loss: 0.4467 - val_custom_accuracy: 0.3442
Epoch 193/200
4/4 [==============================] - 4s 1s/step - loss: 0.4342 - custom_accuracy: 0.6993
- val_loss: 0.4475 - val_custom_accuracy: 0.3442
Epoch 194/200
4/4 [==============================] - 4s 1s/step - loss: 0.4267 - custom_accuracy: 0.8146
- val_loss: 0.4486 - val_custom_accuracy: 0.3442
Epoch 195/200
4/4 [==============================] - 7s 2s/step - loss: 0.4342 - custom_accuracy: 0.7769
- val_loss: 0.4495 - val_custom_accuracy: 0.3442
Epoch 196/200
4/4 [==============================] - 5s 1s/step - loss: 0.4347 - custom_accuracy: 0.7508
- val_loss: 0.4489 - val_custom_accuracy: 0.3442
Epoch 197/200
4/4 [==============================] - 4s 989ms/step - loss: 0.4296 - custom_accuracy: 0.7
349 - val_loss: 0.4477 - val_custom_accuracy: 0.3442
Epoch 198/200
```

```
4/4 [==============================] - 5s 1s/step - loss: 0.4367 - custom_accuracy: 0.7776
- val_loss: 0.4467 - val_custom_accuracy: 0.3442
Epoch 199/200
4/4 [==============================] - 7s 2s/step - loss: 0.4414 - custom_accuracy: 0.7584
- val_loss: 0.4453 - val_custom_accuracy: 0.3442
Epoch 200/200
4/4 [==============================] - 4s 998ms/step - loss: 0.4329 - custom_accuracy: 0.7
620 - val_loss: 0.4446 - val_custom_accuracy: 0.3442
```

In [ ]:

```python
import matplotlib.pyplot as plt

# Define the style of the plot
plt.style.use('seaborn-darkgrid')

# Create a new figure with custom size
fig, ax = plt.subplots(figsize=(8, 6))

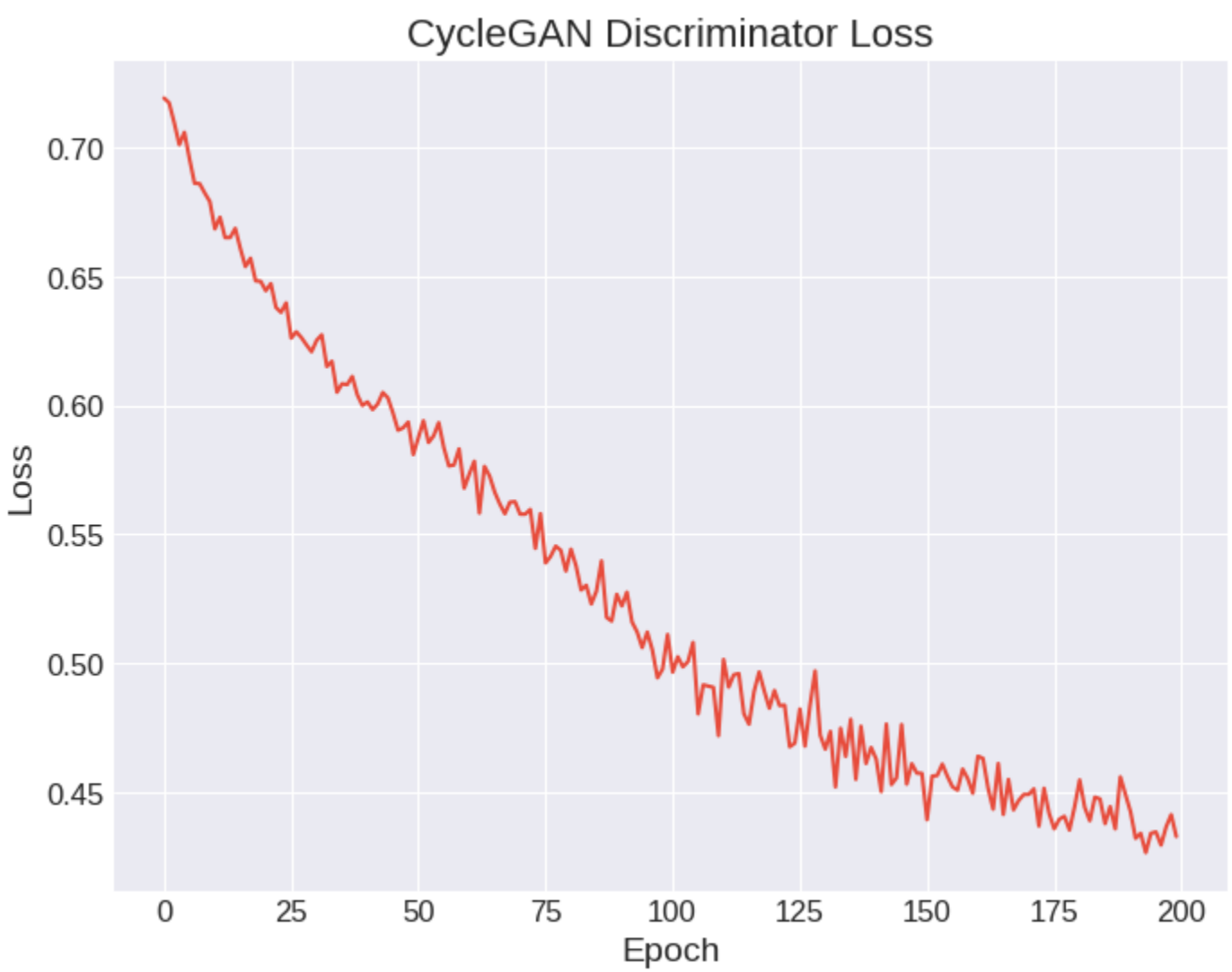
# Plot the loss data with a specific color and linestyle
ax.plot(H.history['loss'], color='#E74C3C', linestyle='-')

# Add labels and title to the plot
ax.set_xlabel('Epoch', fontsize=14)
ax.set_ylabel('Loss', fontsize=14)
ax.set_title("CycleGAN Discriminator Loss", fontsize=16)

# Customize the tick labels
ax.tick_params(axis='both', labelsize=12)

# Show the plot
plt.show()
```

```
<ipython-input-52-c3a1e95b5c0a>:4: MatplotlibDeprecationWarning: The seaborn styles shippe
d by Matplotlib are deprecated since 3.6, as they no longer correspond to the styles shipp
ed by seaborn. However, they will remain available as 'seaborn-v0_8-<style>'. Alternativel
y, directly use the seaborn API instead.
  plt.style.use('seaborn-darkgrid')
```



In [ ]:

```
import matplotlib.pyplot as plt

# set the figure size
fig = plt.figure(figsize=(8,6))

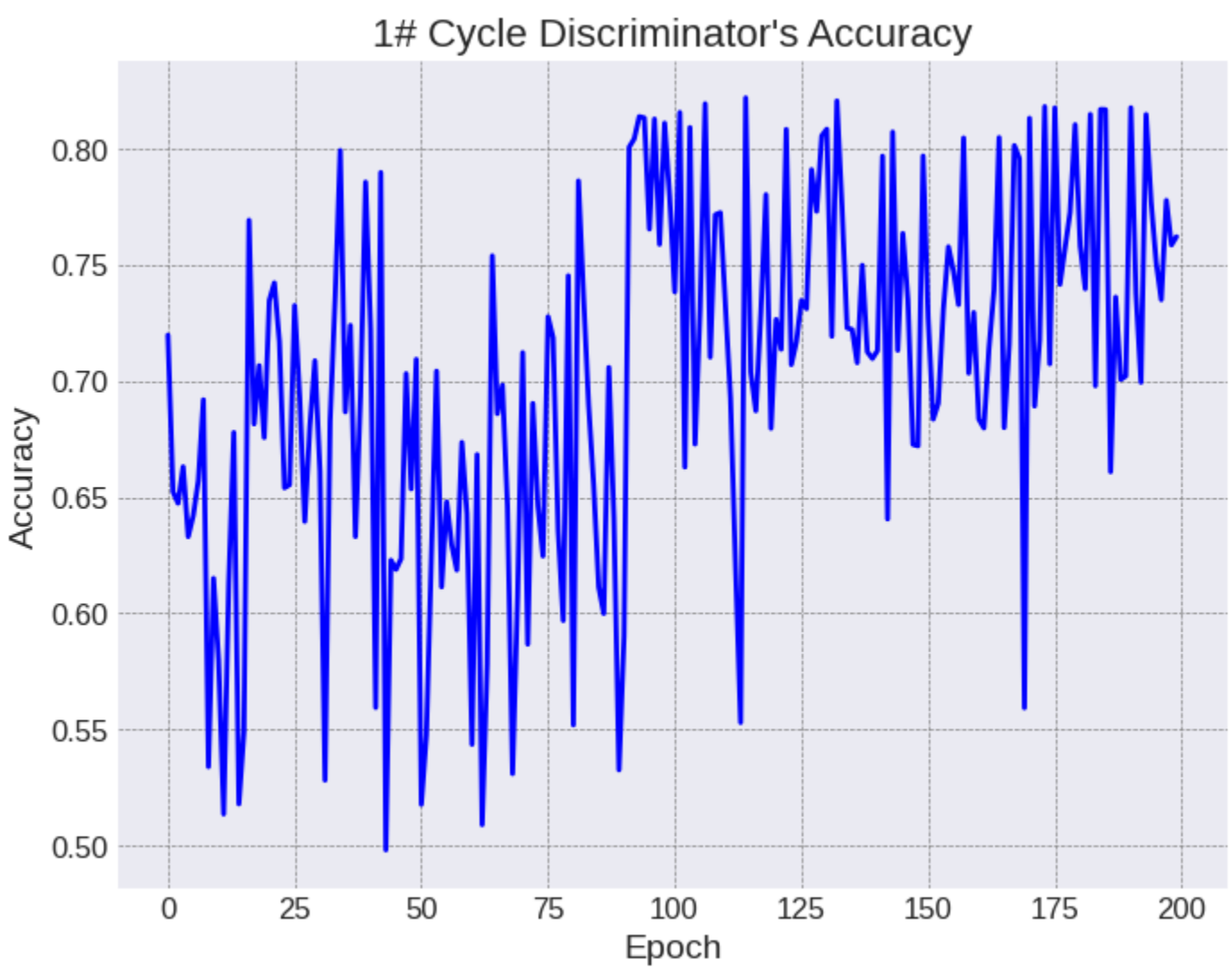
# plot the data
plt.plot(H.history['custom_accuracy'], color='blue', linewidth=2)

# set the axis labels and title
plt.xlabel('Epoch', fontsize=14)
plt.ylabel('Accuracy', fontsize=14)
plt.title("1# Cycle Discriminator's Accuracy", fontsize=16)

# customize the tick labels
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)

# customize the grid
plt.grid(color='gray', linestyle='--', linewidth=0.5)

# show the plot
plt.show()
```



In [ ]:
```
custom_acc(np.array(y_gen_test, dtype=np.float32), qdisc_model.predict(gen_data_test))
```

Out[ ]:
```
<tf.Tensor: shape=(), dtype=float32, numpy=0.71>
```

In [ ]:
```
best_qdisc_weights = qdisc_model.get_weights()[0]
best_qgen_weights = qgen_model.get_weights()[0]
qgen_model = generator_model(symbols_gen, qdisc_model.get_weights()[0])

qgen_model.get_layer('qgen_layer').set_weights([best_qgen_weights])
qdisc_model.get_layer('qdisc_layer').set_weights([best_qdisc_weights])
```

In [ ]:
```
gen_model_cp, disc_model_cp = checkpoints(cycle=2)
```

In [ ]:
```
# Fit the Generator Model
H = train_qgen(1000, 100, 1)
```

```
Epoch 1/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2767
Epoch 2/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2767
Epoch 3/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2767
Epoch 4/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2767
```

```
1/1 [==============================] - 8s 8s/step - loss: 0.2767
Epoch 6/1000
1/1 [==============================] - 8s 8s/step - loss: 0.2767
Epoch 7/1000
1/1 [==============================] - 5s 5s/step - loss: 0.2767
Epoch 8/1000
1/1 [==============================] - 8s 8s/step - loss: 0.2767
Epoch 9/1000
1/1 [==============================] - 7s 7s/step - loss: 0.2767
Epoch 10/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2767
Epoch 11/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2767
Epoch 12/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2767
Epoch 13/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2767
Epoch 14/1000
1/1 [==============================] - 6s 6s/step - loss: 0.2767
Epoch 15/1000
1/1 [==============================] - 7s 7s/step - loss: 0.2767
Epoch 16/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2767
Epoch 17/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2767
Epoch 18/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2767
Epoch 19/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2767
Epoch 20/1000
1/1 [==============================] - 5s 5s/step - loss: 0.2767
Epoch 21/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2767
Epoch 22/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2767
Epoch 23/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2767
Epoch 24/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2767
Epoch 25/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2767
Epoch 26/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2767
Epoch 27/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2767
Epoch 28/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2766
Epoch 29/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2766
Epoch 30/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2766
Epoch 31/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2766
Epoch 32/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2766
Epoch 33/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2766
Epoch 34/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2766
Epoch 35/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2766
Epoch 36/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2766
Epoch 37/1000
```

```
1/1 [==============================] - 2s 2s/step - loss: 0.2766
Epoch 38/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2766
Epoch 39/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2766
Epoch 40/1000
1/1 [==============================] - 5s 5s/step - loss: 0.2766
Epoch 41/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2766
Epoch 42/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2766
Epoch 43/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2766
Epoch 44/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2766
Epoch 45/1000
1/1 [==============================] - 5s 5s/step - loss: 0.2766
Epoch 46/1000
1/1 [==============================] - 6s 6s/step - loss: 0.2766
Epoch 47/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2766
Epoch 48/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2766
Epoch 49/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2766
Epoch 50/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2766
Epoch 51/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2766
Epoch 52/1000
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1/1 [==============================] - 2s 2s/step - loss: 0.2750
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Epoch 703/1000
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Epoch 704/1000
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Epoch 705/1000
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Epoch 708/1000
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Epoch 709/1000
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Epoch 741/1000
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1/1 [==============================] - 4s 4s/step - loss: 0.2747
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Epoch 800/1000
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Epoch 805/1000
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1/1 [==============================] - 2s 2s/step - loss: 0.2746
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Epoch 808/1000
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Epoch 881/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2745
Epoch 882/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2745
Epoch 883/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2745
Epoch 884/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2745
Epoch 885/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2745
Epoch 886/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2745
Epoch 887/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2745
Epoch 888/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2745
Epoch 889/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2745
Epoch 890/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2745
Epoch 891/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2745
Epoch 892/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 893/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2744
Epoch 894/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 895/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 896/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 897/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 898/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 899/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 900/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2744
Epoch 901/1000
```

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1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 902/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 903/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 904/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 905/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 906/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 907/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 908/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 909/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 910/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 911/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2744
Epoch 912/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 913/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 914/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 915/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 916/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 917/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 918/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2744
Epoch 919/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 920/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 921/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 922/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 923/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 924/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 925/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2744
Epoch 926/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 927/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2744
Epoch 928/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 929/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 930/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 931/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 932/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 933/1000
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1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 934/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2744
Epoch 935/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 936/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 937/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 938/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 939/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 940/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2744
Epoch 941/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 942/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 943/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 944/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2744
Epoch 945/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2743
Epoch 946/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2743
Epoch 947/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2743
Epoch 948/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 949/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 950/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 951/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 952/1000
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Epoch 953/1000
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1/1 [==============================] - 2s 2s/step - loss: 0.2743
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1/1 [==============================] - 2s 2s/step - loss: 0.2743
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1/1 [==============================] - 2s 2s/step - loss: 0.2743
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Epoch 960/1000
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Epoch 961/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2743
Epoch 962/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2743
Epoch 963/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2743
Epoch 964/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 965/1000
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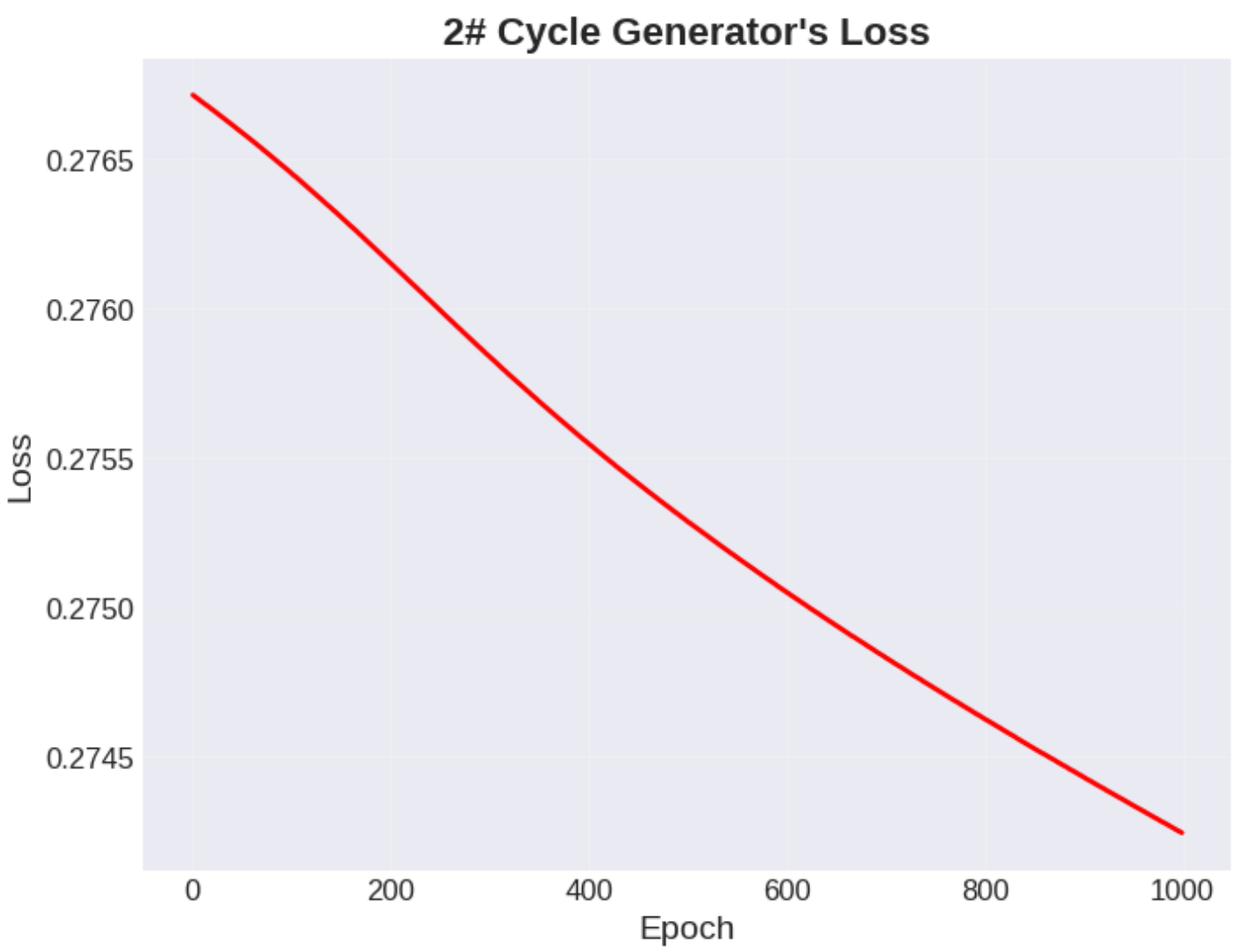
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 966/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2743
Epoch 967/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2743
Epoch 968/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 969/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 970/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 971/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 972/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2743
Epoch 973/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2743
Epoch 974/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2743
Epoch 975/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 976/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 977/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 978/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 979/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2743
Epoch 980/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2743
Epoch 981/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2743
Epoch 982/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 983/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 984/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 985/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 986/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2743
Epoch 987/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2743
Epoch 988/1000
1/1 [==============================] - 3s 3s/step - loss: 0.2743
Epoch 989/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 990/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 991/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 992/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 993/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2743
Epoch 994/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2743
Epoch 995/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 996/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 997/1000
```

```
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 998/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2743
Epoch 999/1000
1/1 [==============================] - 2s 2s/step - loss: 0.2742
Epoch 1000/1000
1/1 [==============================] - 4s 4s/step - loss: 0.2742
```

In [ ]:

```python
import matplotlib.pyplot as plt

# Get the data for the plot
loss = H.history['loss']

# Set the figure size and create the plot
plt.figure(figsize=(8,6))
plt.plot(loss, color='red', linewidth=2)

# Set the title and axis labels
plt.title("2# Cycle Generator's Loss", fontsize=16, fontweight='bold')
plt.xlabel('Epoch', fontsize=14)
plt.ylabel('Loss', fontsize=14)

# Customize the tick labels
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)

# Customize the grid lines
plt.grid(alpha=0.2)

# Show the plot
plt.show()
```



In [ ]:

```
# Generate Real + Fake Data

gen_data_train = tfq.convert_to_tensor(generate_data(x_train, qgan_qubits) + generate_unic
gen_data_test = tfq.convert_to_tensor(generate_data(x_test, qgan_qubits) + generate_unique

y_gen_train = np.concatenate((y_train, y_true_fake), axis = 0)
y_gen_test = np.concatenate((y_test, y_true_fake), axis = 0)

print(len(gen_data_train), len(gen_data_test))
print(y_gen_train.shape, y_gen_test.shape)
```

```
200 200
(200, 3) (200, 3)
```

In [ ]:

```
# Fit the Discriminator Model
H = train_qdisc(250, 64, 1)
```

```
Epoch 1/250
4/4 [==============================] - 5s 1s/step - loss: 0.4444 - custom_accuracy: 0.7559
- val_loss: 0.4466 - val_custom_accuracy: 0.3442
Epoch 2/250
4/4 [==============================] - 4s 1s/step - loss: 0.4359 - custom_accuracy: 0.7049
- val_loss: 0.4469 - val_custom_accuracy: 0.3442
Epoch 3/250
4/4 [==============================] - 5s 1s/step - loss: 0.4340 - custom_accuracy: 0.7323
- val_loss: 0.4474 - val_custom_accuracy: 0.3442
Epoch 4/250
4/4 [==============================] - 7s 2s/step - loss: 0.4467 - custom_accuracy: 0.7319
- val_loss: 0.4481 - val_custom_accuracy: 0.3442
```

```
Epoch 5/250
4/4 [==============================] - 4s 1s/step - loss: 0.4367 - custom_accuracy: 0.8168
- val_loss: 0.4487 - val_custom_accuracy: 0.3442
Epoch 6/250
4/4 [==============================] - 4s 998ms/step - loss: 0.4468 - custom_accuracy: 0.6
839 - val_loss: 0.4493 - val_custom_accuracy: 0.3442
Epoch 7/250
4/4 [==============================] - 6s 2s/step - loss: 0.4468 - custom_accuracy: 0.6504
- val_loss: 0.4489 - val_custom_accuracy: 0.3442
Epoch 8/250
4/4 [==============================] - 5s 1s/step - loss: 0.4378 - custom_accuracy: 0.7643
- val_loss: 0.4483 - val_custom_accuracy: 0.3520
Epoch 9/250
4/4 [==============================] - 4s 1s/step - loss: 0.4273 - custom_accuracy: 0.8185
- val_loss: 0.4483 - val_custom_accuracy: 0.3442
Epoch 10/250
4/4 [==============================] - 4s 989ms/step - loss: 0.4388 - custom_accuracy: 0.8
182 - val_loss: 0.4490 - val_custom_accuracy: 0.3442
Epoch 11/250
4/4 [==============================] - 7s 2s/step - loss: 0.4269 - custom_accuracy: 0.7683
- val_loss: 0.4501 - val_custom_accuracy: 0.3442
Epoch 12/250
4/4 [==============================] - 5s 1s/step - loss: 0.4233 - custom_accuracy: 0.8140
- val_loss: 0.4509 - val_custom_accuracy: 0.3442
Epoch 13/250
4/4 [==============================] - 4s 989ms/step - loss: 0.4394 - custom_accuracy: 0.7
577 - val_loss: 0.4517 - val_custom_accuracy: 0.3442
Epoch 14/250
4/4 [==============================] - 5s 1s/step - loss: 0.4457 - custom_accuracy: 0.6922
- val_loss: 0.4521 - val_custom_accuracy: 0.3442
Epoch 15/250
4/4 [==============================] - 7s 2s/step - loss: 0.4355 - custom_accuracy: 0.8162
- val_loss: 0.4521 - val_custom_accuracy: 0.3442
Epoch 16/250
4/4 [==============================] - 4s 1s/step - loss: 0.4169 - custom_accuracy: 0.8242
- val_loss: 0.4532 - val_custom_accuracy: 0.3442
Epoch 17/250
4/4 [==============================] - 4s 990ms/step - loss: 0.4512 - custom_accuracy: 0.7
515 - val_loss: 0.4544 - val_custom_accuracy: 0.3442
Epoch 18/250
4/4 [==============================] - 6s 2s/step - loss: 0.4328 - custom_accuracy: 0.7397
- val_loss: 0.4547 - val_custom_accuracy: 0.3442
Epoch 19/250
4/4 [==============================] - 6s 1s/step - loss: 0.4336 - custom_accuracy: 0.8146
- val_loss: 0.4540 - val_custom_accuracy: 0.3442
Epoch 20/250
4/4 [==============================] - 4s 969ms/step - loss: 0.4451 - custom_accuracy: 0.7
628 - val_loss: 0.4537 - val_custom_accuracy: 0.3442
Epoch 21/250
4/4 [==============================] - 4s 1s/step - loss: 0.4142 - custom_accuracy: 0.8167
- val_loss: 0.4533 - val_custom_accuracy: 0.3442
Epoch 22/250
4/4 [==============================] - 6s 2s/step - loss: 0.4470 - custom_accuracy: 0.6624
- val_loss: 0.4535 - val_custom_accuracy: 0.3442
Epoch 23/250
4/4 [==============================] - 5s 1s/step - loss: 0.4366 - custom_accuracy: 0.7426
- val_loss: 0.4538 - val_custom_accuracy: 0.3442
Epoch 24/250
4/4 [==============================] - 4s 994ms/step - loss: 0.4276 - custom_accuracy: 0.8
096 - val_loss: 0.4544 - val_custom_accuracy: 0.3442
Epoch 25/250
4/4 [==============================] - 4s 1s/step - loss: 0.4424 - custom_accuracy: 0.7373
- val_loss: 0.4541 - val_custom_accuracy: 0.3442
Epoch 26/250
```

```
4/4 [==============================] - 8s 2s/step - loss: 0.4424 - custom_accuracy: 0.7486
- val_loss: 0.4529 - val_custom_accuracy: 0.3442
Epoch 27/250
4/4 [==============================] - 7s 2s/step - loss: 0.4296 - custom_accuracy: 0.8193
- val_loss: 0.4511 - val_custom_accuracy: 0.3442
Epoch 28/250
4/4 [==============================] - 4s 1s/step - loss: 0.4460 - custom_accuracy: 0.8106
- val_loss: 0.4498 - val_custom_accuracy: 0.3442
Epoch 29/250
4/4 [==============================] - 4s 1s/step - loss: 0.4327 - custom_accuracy: 0.8125
- val_loss: 0.4488 - val_custom_accuracy: 0.3442
Epoch 30/250
4/4 [==============================] - 6s 2s/step - loss: 0.4365 - custom_accuracy: 0.8158
- val_loss: 0.4485 - val_custom_accuracy: 0.3442
Epoch 31/250
4/4 [==============================] - 5s 1s/step - loss: 0.4284 - custom_accuracy: 0.7007
- val_loss: 0.4486 - val_custom_accuracy: 0.3442
Epoch 32/250
4/4 [==============================] - 4s 1s/step - loss: 0.4327 - custom_accuracy: 0.8173
- val_loss: 0.4489 - val_custom_accuracy: 0.3442
Epoch 33/250
4/4 [==============================] - 4s 1s/step - loss: 0.4261 - custom_accuracy: 0.6825
- val_loss: 0.4493 - val_custom_accuracy: 0.3442
Epoch 34/250
4/4 [==============================] - 7s 2s/step - loss: 0.4402 - custom_accuracy: 0.8140
- val_loss: 0.4490 - val_custom_accuracy: 0.3442
Epoch 35/250
4/4 [==============================] - 4s 981ms/step - loss: 0.4381 - custom_accuracy: 0.7
270 - val_loss: 0.4488 - val_custom_accuracy: 0.3442
Epoch 36/250
4/4 [==============================] - 4s 979ms/step - loss: 0.4307 - custom_accuracy: 0.8
123 - val_loss: 0.4486 - val_custom_accuracy: 0.3442
Epoch 37/250
4/4 [==============================] - 5s 1s/step - loss: 0.4306 - custom_accuracy: 0.8182
- val_loss: 0.4488 - val_custom_accuracy: 0.3442
Epoch 38/250
4/4 [==============================] - 7s 2s/step - loss: 0.4207 - custom_accuracy: 0.6647
- val_loss: 0.4494 - val_custom_accuracy: 0.3442
Epoch 39/250
4/4 [==============================] - 4s 976ms/step - loss: 0.4373 - custom_accuracy: 0.8
196 - val_loss: 0.4497 - val_custom_accuracy: 0.3442
Epoch 40/250
4/4 [==============================] - 4s 984ms/step - loss: 0.4500 - custom_accuracy: 0.8
127 - val_loss: 0.4498 - val_custom_accuracy: 0.3442
Epoch 41/250
4/4 [==============================] - 5s 2s/step - loss: 0.4368 - custom_accuracy: 0.8174
- val_loss: 0.4499 - val_custom_accuracy: 0.3442
Epoch 42/250
4/4 [==============================] - 6s 1s/step - loss: 0.4418 - custom_accuracy: 0.8083
- val_loss: 0.4503 - val_custom_accuracy: 0.3442
Epoch 43/250
4/4 [==============================] - 4s 1s/step - loss: 0.4312 - custom_accuracy: 0.7221
- val_loss: 0.4501 - val_custom_accuracy: 0.3442
Epoch 44/250
4/4 [==============================] - 4s 1s/step - loss: 0.4348 - custom_accuracy: 0.7572
- val_loss: 0.4489 - val_custom_accuracy: 0.3442
Epoch 45/250
4/4 [==============================] - 6s 2s/step - loss: 0.4394 - custom_accuracy: 0.8165
- val_loss: 0.4476 - val_custom_accuracy: 0.3442
Epoch 46/250
4/4 [==============================] - 5s 1s/step - loss: 0.4353 - custom_accuracy: 0.7551
- val_loss: 0.4469 - val_custom_accuracy: 0.3442
Epoch 47/250
4/4 [==============================] - 4s 995ms/step - loss: 0.4361 - custom_accuracy: 0.8
```

```
156 - val_loss: 0.4465 - val_custom_accuracy: 0.3442
Epoch 48/250
4/4 [==============================] - 4s 1s/step - loss: 0.4370 - custom_accuracy: 0.7691
- val_loss: 0.4468 - val_custom_accuracy: 0.3442
Epoch 49/250
4/4 [==============================] - 7s 2s/step - loss: 0.4241 - custom_accuracy: 0.8164
- val_loss: 0.4470 - val_custom_accuracy: 0.3442
Epoch 50/250
4/4 [==============================] - 4s 961ms/step - loss: 0.4364 - custom_accuracy: 0.7
254 - val_loss: 0.4473 - val_custom_accuracy: 0.3442
Epoch 51/250
4/4 [==============================] - 4s 1s/step - loss: 0.4480 - custom_accuracy: 0.7658
- val_loss: 0.4469 - val_custom_accuracy: 0.3442
Epoch 52/250
4/4 [==============================] - 5s 1s/step - loss: 0.4453 - custom_accuracy: 0.7741
- val_loss: 0.4459 - val_custom_accuracy: 0.3442
Epoch 53/250
4/4 [==============================] - 7s 2s/step - loss: 0.4318 - custom_accuracy: 0.7708
- val_loss: 0.4445 - val_custom_accuracy: 0.3442
Epoch 54/250
4/4 [==============================] - 4s 1s/step - loss: 0.4330 - custom_accuracy: 0.8170
- val_loss: 0.4435 - val_custom_accuracy: 0.3442
Epoch 55/250
4/4 [==============================] - 4s 999ms/step - loss: 0.4284 - custom_accuracy: 0.6
984 - val_loss: 0.4435 - val_custom_accuracy: 0.3442
Epoch 56/250
4/4 [==============================] - 5s 1s/step - loss: 0.4442 - custom_accuracy: 0.6806
- val_loss: 0.4436 - val_custom_accuracy: 0.3442
Epoch 57/250
4/4 [==============================] - 6s 1s/step - loss: 0.4385 - custom_accuracy: 0.7657
- val_loss: 0.4434 - val_custom_accuracy: 0.3442
Epoch 58/250
4/4 [==============================] - 4s 965ms/step - loss: 0.4445 - custom_accuracy: 0.7
418 - val_loss: 0.4428 - val_custom_accuracy: 0.3442
Epoch 59/250
4/4 [==============================] - 4s 989ms/step - loss: 0.4288 - custom_accuracy: 0.8
125 - val_loss: 0.4429 - val_custom_accuracy: 0.3442
Epoch 60/250
4/4 [==============================] - 6s 2s/step - loss: 0.4324 - custom_accuracy: 0.7064
- val_loss: 0.4430 - val_custom_accuracy: 0.3442
Epoch 61/250
4/4 [==============================] - 5s 1s/step - loss: 0.4409 - custom_accuracy: 0.6857
- val_loss: 0.4423 - val_custom_accuracy: 0.3442
Epoch 62/250
4/4 [==============================] - 4s 1s/step - loss: 0.4267 - custom_accuracy: 0.7399
- val_loss: 0.4417 - val_custom_accuracy: 0.3442
Epoch 63/250
4/4 [==============================] - 4s 985ms/step - loss: 0.4501 - custom_accuracy: 0.7
261 - val_loss: 0.4417 - val_custom_accuracy: 0.3442
Epoch 64/250
4/4 [==============================] - 7s 2s/step - loss: 0.4416 - custom_accuracy: 0.8094
- val_loss: 0.4412 - val_custom_accuracy: 0.3442
Epoch 65/250
4/4 [==============================] - 5s 1s/step - loss: 0.4373 - custom_accuracy: 0.7394
- val_loss: 0.4412 - val_custom_accuracy: 0.3442
Epoch 66/250
4/4 [==============================] - 4s 996ms/step - loss: 0.4520 - custom_accuracy: 0.7
014 - val_loss: 0.4410 - val_custom_accuracy: 0.3442
Epoch 67/250
4/4 [==============================] - 5s 1s/step - loss: 0.4381 - custom_accuracy: 0.8061
- val_loss: 0.4403 - val_custom_accuracy: 0.3442
Epoch 68/250
4/4 [==============================] - 7s 2s/step - loss: 0.4336 - custom_accuracy: 0.8084
- val_loss: 0.4397 - val_custom_accuracy: 0.3442
```

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Epoch 69/250
4/4 [==============================] - 4s 1s/step - loss: 0.4267 - custom_accuracy: 0.7409
- val_loss: 0.4396 - val_custom_accuracy: 0.3442
Epoch 70/250
4/4 [==============================] - 4s 989ms/step - loss: 0.4491 - custom_accuracy: 0.5
853 - val_loss: 0.4399 - val_custom_accuracy: 0.3442
Epoch 71/250
4/4 [==============================] - 5s 1s/step - loss: 0.4308 - custom_accuracy: 0.7419
- val_loss: 0.4398 - val_custom_accuracy: 0.3442
Epoch 72/250
4/4 [==============================] - 6s 2s/step - loss: 0.4271 - custom_accuracy: 0.8185
- val_loss: 0.4397 - val_custom_accuracy: 0.3442
Epoch 73/250
4/4 [==============================] - 4s 993ms/step - loss: 0.4368 - custom_accuracy: 0.8
189 - val_loss: 0.4399 - val_custom_accuracy: 0.3442
Epoch 74/250
4/4 [==============================] - 4s 997ms/step - loss: 0.4350 - custom_accuracy: 0.7
111 - val_loss: 0.4400 - val_custom_accuracy: 0.3442
Epoch 75/250
4/4 [==============================] - 6s 2s/step - loss: 0.4415 - custom_accuracy: 0.6827
- val_loss: 0.4394 - val_custom_accuracy: 0.3442
Epoch 76/250
4/4 [==============================] - 6s 1s/step - loss: 0.4388 - custom_accuracy: 0.8151
- val_loss: 0.4384 - val_custom_accuracy: 0.3442
Epoch 77/250
4/4 [==============================] - 6s 2s/step - loss: 0.4416 - custom_accuracy: 0.7408
- val_loss: 0.4376 - val_custom_accuracy: 0.3442
Epoch 78/250
4/4 [==============================] - 7s 2s/step - loss: 0.4398 - custom_accuracy: 0.7638
- val_loss: 0.4370 - val_custom_accuracy: 0.3442
Epoch 79/250
4/4 [==============================] - 6s 1s/step - loss: 0.4308 - custom_accuracy: 0.7480
- val_loss: 0.4366 - val_custom_accuracy: 0.3442
Epoch 80/250
4/4 [==============================] - 4s 968ms/step - loss: 0.4346 - custom_accuracy: 0.6
374 - val_loss: 0.4367 - val_custom_accuracy: 0.3442
Epoch 81/250
4/4 [==============================] - 4s 1s/step - loss: 0.4155 - custom_accuracy: 0.7266
- val_loss: 0.4366 - val_custom_accuracy: 0.3442
Epoch 82/250
4/4 [==============================] - 6s 2s/step - loss: 0.4340 - custom_accuracy: 0.7576
- val_loss: 0.4365 - val_custom_accuracy: 0.3442
Epoch 83/250
4/4 [==============================] - 5s 1s/step - loss: 0.4347 - custom_accuracy: 0.6806
- val_loss: 0.4369 - val_custom_accuracy: 0.3442
Epoch 84/250
4/4 [==============================] - 4s 964ms/step - loss: 0.4344 - custom_accuracy: 0.7
240 - val_loss: 0.4370 - val_custom_accuracy: 0.3442
Epoch 85/250
4/4 [==============================] - 4s 1s/step - loss: 0.4197 - custom_accuracy: 0.8128
- val_loss: 0.4369 - val_custom_accuracy: 0.3442
Epoch 86/250
4/4 [==============================] - 7s 2s/step - loss: 0.4264 - custom_accuracy: 0.7714
- val_loss: 0.4368 - val_custom_accuracy: 0.3442
Epoch 87/250
4/4 [==============================] - 4s 1s/step - loss: 0.4281 - custom_accuracy: 0.8086
- val_loss: 0.4367 - val_custom_accuracy: 0.3442
Epoch 88/250
4/4 [==============================] - 4s 1s/step - loss: 0.4127 - custom_accuracy: 0.8186
- val_loss: 0.4371 - val_custom_accuracy: 0.3442
Epoch 89/250
4/4 [==============================] - 5s 1s/step - loss: 0.4300 - custom_accuracy: 0.7387
- val_loss: 0.4378 - val_custom_accuracy: 0.3442
Epoch 90/250
```

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4/4 [==============================] - 6s 2s/step - loss: 0.4286 - custom_accuracy: 0.5871
- val_loss: 0.4391 - val_custom_accuracy: 0.3442
Epoch 91/250
4/4 [==============================] - 4s 1s/step - loss: 0.4185 - custom_accuracy: 0.6978
- val_loss: 0.4402 - val_custom_accuracy: 0.3442
Epoch 92/250
4/4 [==============================] - 4s 1s/step - loss: 0.4311 - custom_accuracy: 0.6797
- val_loss: 0.4417 - val_custom_accuracy: 0.3442
Epoch 93/250
4/4 [==============================] - 6s 2s/step - loss: 0.4321 - custom_accuracy: 0.7392
- val_loss: 0.4422 - val_custom_accuracy: 0.3442
Epoch 94/250
4/4 [==============================] - 5s 1s/step - loss: 0.4310 - custom_accuracy: 0.7772
- val_loss: 0.4417 - val_custom_accuracy: 0.3442
Epoch 95/250
4/4 [==============================] - 4s 1s/step - loss: 0.4192 - custom_accuracy: 0.7225
- val_loss: 0.4406 - val_custom_accuracy: 0.3442
Epoch 96/250
4/4 [==============================] - 4s 1s/step - loss: 0.4295 - custom_accuracy: 0.8121
- val_loss: 0.4398 - val_custom_accuracy: 0.3442
Epoch 97/250
4/4 [==============================] - 7s 2s/step - loss: 0.4395 - custom_accuracy: 0.8110
- val_loss: 0.4395 - val_custom_accuracy: 0.3442
Epoch 98/250
4/4 [==============================] - 4s 969ms/step - loss: 0.4309 - custom_accuracy: 0.7
059 - val_loss: 0.4391 - val_custom_accuracy: 0.3442
Epoch 99/250
4/4 [==============================] - 4s 989ms/step - loss: 0.4306 - custom_accuracy: 0.7
407 - val_loss: 0.4385 - val_custom_accuracy: 0.3442
Epoch 100/250
4/4 [==============================] - 5s 1s/step - loss: 0.4335 - custom_accuracy: 0.8162
- val_loss: 0.4374 - val_custom_accuracy: 0.3442
Epoch 101/250
4/4 [==============================] - 7s 2s/step - loss: 0.4270 - custom_accuracy: 0.7687
- val_loss: 0.4371 - val_custom_accuracy: 0.3442
Epoch 102/250
4/4 [==============================] - 4s 985ms/step - loss: 0.4339 - custom_accuracy: 0.8
173 - val_loss: 0.4372 - val_custom_accuracy: 0.3442
Epoch 103/250
4/4 [==============================] - 4s 986ms/step - loss: 0.4400 - custom_accuracy: 0.8
071 - val_loss: 0.4378 - val_custom_accuracy: 0.3442
Epoch 104/250
4/4 [==============================] - 6s 2s/step - loss: 0.4198 - custom_accuracy: 0.8117
- val_loss: 0.4379 - val_custom_accuracy: 0.3442
Epoch 105/250
4/4 [==============================] - 6s 1s/step - loss: 0.4290 - custom_accuracy: 0.7687
- val_loss: 0.4379 - val_custom_accuracy: 0.3442
Epoch 106/250
4/4 [==============================] - 4s 1s/step - loss: 0.4189 - custom_accuracy: 0.7281
- val_loss: 0.4378 - val_custom_accuracy: 0.3442
Epoch 107/250
4/4 [==============================] - 4s 1s/step - loss: 0.4194 - custom_accuracy: 0.6993
- val_loss: 0.4383 - val_custom_accuracy: 0.3442
Epoch 108/250
4/4 [==============================] - 6s 2s/step - loss: 0.4248 - custom_accuracy: 0.7069
- val_loss: 0.4388 - val_custom_accuracy: 0.3442
Epoch 109/250
4/4 [==============================] - 5s 1s/step - loss: 0.4322 - custom_accuracy: 0.8200
- val_loss: 0.4382 - val_custom_accuracy: 0.3442
Epoch 110/250
4/4 [==============================] - 4s 1s/step - loss: 0.4291 - custom_accuracy: 0.6876
- val_loss: 0.4381 - val_custom_accuracy: 0.3442
Epoch 111/250
4/4 [==============================] - 4s 1s/step - loss: 0.4137 - custom_accuracy: 0.8107
```

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- val_loss: 0.4379 - val_custom_accuracy: 0.3442
Epoch 112/250
4/4 [==============================] - 7s 2s/step - loss: 0.4242 - custom_accuracy: 0.8164
- val_loss: 0.4386 - val_custom_accuracy: 0.3442
Epoch 113/250
4/4 [==============================] - 4s 1s/step - loss: 0.4195 - custom_accuracy: 0.7705
- val_loss: 0.4393 - val_custom_accuracy: 0.3442
Epoch 114/250
4/4 [==============================] - 4s 1s/step - loss: 0.4399 - custom_accuracy: 0.7175
- val_loss: 0.4393 - val_custom_accuracy: 0.3442
Epoch 115/250
4/4 [==============================] - 5s 1s/step - loss: 0.4221 - custom_accuracy: 0.8121
- val_loss: 0.4390 - val_custom_accuracy: 0.3442
Epoch 116/250
4/4 [==============================] - 6s 2s/step - loss: 0.4225 - custom_accuracy: 0.8185
- val_loss: 0.4393 - val_custom_accuracy: 0.3442
Epoch 117/250
4/4 [==============================] - 4s 999ms/step - loss: 0.4231 - custom_accuracy: 0.7
746 - val_loss: 0.4403 - val_custom_accuracy: 0.3442
Epoch 118/250
4/4 [==============================] - 4s 1s/step - loss: 0.4270 - custom_accuracy: 0.7370
- val_loss: 0.4406 - val_custom_accuracy: 0.3442
Epoch 119/250
4/4 [==============================] - 6s 2s/step - loss: 0.4409 - custom_accuracy: 0.8137
- val_loss: 0.4409 - val_custom_accuracy: 0.3442
Epoch 120/250
4/4 [==============================] - 6s 1s/step - loss: 0.4333 - custom_accuracy: 0.5822
- val_loss: 0.4412 - val_custom_accuracy: 0.3442
Epoch 121/250
4/4 [==============================] - 4s 1s/step - loss: 0.4353 - custom_accuracy: 0.5864
- val_loss: 0.4411 - val_custom_accuracy: 0.3442
Epoch 122/250
4/4 [==============================] - 4s 998ms/step - loss: 0.4159 - custom_accuracy: 0.7
429 - val_loss: 0.4410 - val_custom_accuracy: 0.3442
Epoch 123/250
4/4 [==============================] - 6s 2s/step - loss: 0.4295 - custom_accuracy: 0.8056
- val_loss: 0.4410 - val_custom_accuracy: 0.3442
Epoch 124/250
4/4 [==============================] - 5s 1s/step - loss: 0.4323 - custom_accuracy: 0.7586
- val_loss: 0.4405 - val_custom_accuracy: 0.3442
Epoch 125/250
4/4 [==============================] - 4s 972ms/step - loss: 0.4315 - custom_accuracy: 0.7
338 - val_loss: 0.4398 - val_custom_accuracy: 0.3442
Epoch 126/250
4/4 [==============================] - 4s 1s/step - loss: 0.4271 - custom_accuracy: 0.7695
- val_loss: 0.4391 - val_custom_accuracy: 0.3442
Epoch 127/250
4/4 [==============================] - 7s 2s/step - loss: 0.4249 - custom_accuracy: 0.7618
- val_loss: 0.4380 - val_custom_accuracy: 0.3442
Epoch 128/250
4/4 [==============================] - 7s 2s/step - loss: 0.4109 - custom_accuracy: 0.8152
- val_loss: 0.4376 - val_custom_accuracy: 0.3442
Epoch 129/250
4/4 [==============================] - 5s 1s/step - loss: 0.4301 - custom_accuracy: 0.8156
- val_loss: 0.4373 - val_custom_accuracy: 0.3442
Epoch 130/250
4/4 [==============================] - 7s 2s/step - loss: 0.4442 - custom_accuracy: 0.7174
- val_loss: 0.4368 - val_custom_accuracy: 0.3442
Epoch 131/250
4/4 [==============================] - 5s 1s/step - loss: 0.4176 - custom_accuracy: 0.8180
- val_loss: 0.4363 - val_custom_accuracy: 0.3442
Epoch 132/250
4/4 [==============================] - 4s 1s/step - loss: 0.4173 - custom_accuracy: 0.8147
- val_loss: 0.4364 - val_custom_accuracy: 0.3442
```

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Epoch 133/250
4/4 [==============================] - 5s 1s/step - loss: 0.4434 - custom_accuracy: 0.8118
- val_loss: 0.4362 - val_custom_accuracy: 0.3442
Epoch 134/250
4/4 [==============================] - 7s 2s/step - loss: 0.4262 - custom_accuracy: 0.8135
- val_loss: 0.4358 - val_custom_accuracy: 0.3442
Epoch 135/250
4/4 [==============================] - 4s 999ms/step - loss: 0.4332 - custom_accuracy: 0.8
067 - val_loss: 0.4356 - val_custom_accuracy: 0.3442
Epoch 136/250
4/4 [==============================] - 4s 1s/step - loss: 0.4230 - custom_accuracy: 0.8138
- val_loss: 0.4361 - val_custom_accuracy: 0.3442
Epoch 137/250
4/4 [==============================] - 6s 2s/step - loss: 0.4200 - custom_accuracy: 0.7734
- val_loss: 0.4366 - val_custom_accuracy: 0.3442
Epoch 138/250
4/4 [==============================] - 6s 1s/step - loss: 0.4229 - custom_accuracy: 0.7600
- val_loss: 0.4363 - val_custom_accuracy: 0.3442
Epoch 139/250
4/4 [==============================] - 4s 1s/step - loss: 0.4240 - custom_accuracy: 0.8118
- val_loss: 0.4364 - val_custom_accuracy: 0.3442
Epoch 140/250
4/4 [==============================] - 4s 979ms/step - loss: 0.4337 - custom_accuracy: 0.8
099 - val_loss: 0.4362 - val_custom_accuracy: 0.3442
Epoch 141/250
4/4 [==============================] - 6s 2s/step - loss: 0.4197 - custom_accuracy: 0.7680
- val_loss: 0.4356 - val_custom_accuracy: 0.3442
Epoch 142/250
4/4 [==============================] - 5s 1s/step - loss: 0.4298 - custom_accuracy: 0.5663
- val_loss: 0.4351 - val_custom_accuracy: 0.3442
Epoch 143/250
4/4 [==============================] - 4s 1s/step - loss: 0.4317 - custom_accuracy: 0.7691
- val_loss: 0.4356 - val_custom_accuracy: 0.3442
Epoch 144/250
4/4 [==============================] - 4s 1s/step - loss: 0.4324 - custom_accuracy: 0.6640
- val_loss: 0.4356 - val_custom_accuracy: 0.3442
Epoch 145/250
4/4 [==============================] - 7s 2s/step - loss: 0.4175 - custom_accuracy: 0.8160
- val_loss: 0.4359 - val_custom_accuracy: 0.3442
Epoch 146/250
4/4 [==============================] - 4s 1s/step - loss: 0.4277 - custom_accuracy: 0.7023
- val_loss: 0.4364 - val_custom_accuracy: 0.3442
Epoch 147/250
4/4 [==============================] - 4s 984ms/step - loss: 0.4302 - custom_accuracy: 0.7
723 - val_loss: 0.4364 - val_custom_accuracy: 0.3442
Epoch 148/250
4/4 [==============================] - 6s 2s/step - loss: 0.4377 - custom_accuracy: 0.7334
- val_loss: 0.4358 - val_custom_accuracy: 0.3442
Epoch 149/250
4/4 [==============================] - 6s 1s/step - loss: 0.4330 - custom_accuracy: 0.7513
- val_loss: 0.4356 - val_custom_accuracy: 0.3442
Epoch 150/250
4/4 [==============================] - 4s 1s/step - loss: 0.4284 - custom_accuracy: 0.7688
- val_loss: 0.4352 - val_custom_accuracy: 0.3442
Epoch 151/250
4/4 [==============================] - 4s 970ms/step - loss: 0.4329 - custom_accuracy: 0.8
328 - val_loss: 0.4344 - val_custom_accuracy: 0.3442
Epoch 152/250
4/4 [==============================] - 6s 2s/step - loss: 0.4241 - custom_accuracy: 0.7052
- val_loss: 0.4344 - val_custom_accuracy: 0.3442
Epoch 153/250
4/4 [==============================] - 5s 1s/step - loss: 0.4460 - custom_accuracy: 0.8091
- val_loss: 0.4337 - val_custom_accuracy: 0.3442
Epoch 154/250
```

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4/4 [==============================] - 4s 1s/step - loss: 0.4262 - custom_accuracy: 0.7674
- val_loss: 0.4331 - val_custom_accuracy: 0.3442
Epoch 155/250
4/4 [==============================] - 4s 1s/step - loss: 0.4236 - custom_accuracy: 0.8173
- val_loss: 0.4328 - val_custom_accuracy: 0.3442
Epoch 156/250
4/4 [==============================] - 7s 2s/step - loss: 0.4142 - custom_accuracy: 0.7233
- val_loss: 0.4329 - val_custom_accuracy: 0.3442
Epoch 157/250
4/4 [==============================] - 5s 996ms/step - loss: 0.4277 - custom_accuracy: 0.8
186 - val_loss: 0.4328 - val_custom_accuracy: 0.3442
Epoch 158/250
4/4 [==============================] - 4s 1s/step - loss: 0.4322 - custom_accuracy: 0.7405
- val_loss: 0.4327 - val_custom_accuracy: 0.3442
Epoch 159/250
4/4 [==============================] - 5s 1s/step - loss: 0.4244 - custom_accuracy: 0.7395
- val_loss: 0.4321 - val_custom_accuracy: 0.3442
Epoch 160/250
4/4 [==============================] - 7s 2s/step - loss: 0.4365 - custom_accuracy: 0.8149
- val_loss: 0.4317 - val_custom_accuracy: 0.3442
Epoch 161/250
4/4 [==============================] - 4s 1s/step - loss: 0.4184 - custom_accuracy: 0.8152
- val_loss: 0.4318 - val_custom_accuracy: 0.3442
Epoch 162/250
4/4 [==============================] - 4s 1s/step - loss: 0.4336 - custom_accuracy: 0.7527
- val_loss: 0.4320 - val_custom_accuracy: 0.3442
Epoch 163/250
4/4 [==============================] - 6s 2s/step - loss: 0.4220 - custom_accuracy: 0.8116
- val_loss: 0.4323 - val_custom_accuracy: 0.3442
Epoch 164/250
4/4 [==============================] - 6s 1s/step - loss: 0.4248 - custom_accuracy: 0.7406
- val_loss: 0.4325 - val_custom_accuracy: 0.3442
Epoch 165/250
4/4 [==============================] - 4s 1s/step - loss: 0.4317 - custom_accuracy: 0.7694
- val_loss: 0.4328 - val_custom_accuracy: 0.3442
Epoch 166/250
4/4 [==============================] - 4s 1s/step - loss: 0.4216 - custom_accuracy: 0.8179
- val_loss: 0.4329 - val_custom_accuracy: 0.3442
Epoch 167/250
4/4 [==============================] - 6s 2s/step - loss: 0.4275 - custom_accuracy: 0.7355
- val_loss: 0.4335 - val_custom_accuracy: 0.3442
Epoch 168/250
4/4 [==============================] - 5s 1s/step - loss: 0.4228 - custom_accuracy: 0.6842
- val_loss: 0.4339 - val_custom_accuracy: 0.3442
Epoch 169/250
4/4 [==============================] - 4s 1s/step - loss: 0.4160 - custom_accuracy: 0.8120
- val_loss: 0.4341 - val_custom_accuracy: 0.3442
Epoch 170/250
4/4 [==============================] - 4s 1s/step - loss: 0.4067 - custom_accuracy: 0.8181
- val_loss: 0.4349 - val_custom_accuracy: 0.3442
Epoch 171/250
4/4 [==============================] - 7s 2s/step - loss: 0.4229 - custom_accuracy: 0.7375
- val_loss: 0.4363 - val_custom_accuracy: 0.3442
Epoch 172/250
4/4 [==============================] - 4s 1s/step - loss: 0.4308 - custom_accuracy: 0.6949
- val_loss: 0.4376 - val_custom_accuracy: 0.3442
Epoch 173/250
4/4 [==============================] - 4s 986ms/step - loss: 0.4327 - custom_accuracy: 0.6
605 - val_loss: 0.4388 - val_custom_accuracy: 0.3442
Epoch 174/250
4/4 [==============================] - 5s 1s/step - loss: 0.4320 - custom_accuracy: 0.8105
- val_loss: 0.4399 - val_custom_accuracy: 0.3442
Epoch 175/250
4/4 [==============================] - 6s 2s/step - loss: 0.4261 - custom_accuracy: 0.7604
```

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- val_loss: 0.4406 - val_custom_accuracy: 0.3442
Epoch 176/250
4/4 [==============================] - 4s 1s/step - loss: 0.4153 - custom_accuracy: 0.7577
- val_loss: 0.4410 - val_custom_accuracy: 0.3442
Epoch 177/250
4/4 [==============================] - 4s 1s/step - loss: 0.4164 - custom_accuracy: 0.7684
- val_loss: 0.4410 - val_custom_accuracy: 0.3442
Epoch 178/250
4/4 [==============================] - 6s 2s/step - loss: 0.4183 - custom_accuracy: 0.6633
- val_loss: 0.4409 - val_custom_accuracy: 0.3442
Epoch 179/250
4/4 [==============================] - 7s 2s/step - loss: 0.4347 - custom_accuracy: 0.8146
- val_loss: 0.4405 - val_custom_accuracy: 0.3442
Epoch 180/250
4/4 [==============================] - 6s 1s/step - loss: 0.4100 - custom_accuracy: 0.8112
- val_loss: 0.4406 - val_custom_accuracy: 0.3442
Epoch 181/250
4/4 [==============================] - 5s 1s/step - loss: 0.4377 - custom_accuracy: 0.7003
- val_loss: 0.4407 - val_custom_accuracy: 0.3442
Epoch 182/250
4/4 [==============================] - 6s 1s/step - loss: 0.4272 - custom_accuracy: 0.7436
- val_loss: 0.4409 - val_custom_accuracy: 0.3442
Epoch 183/250
4/4 [==============================] - 4s 1s/step - loss: 0.4168 - custom_accuracy: 0.8156
- val_loss: 0.4406 - val_custom_accuracy: 0.3442
Epoch 184/250
4/4 [==============================] - 4s 1s/step - loss: 0.4261 - custom_accuracy: 0.7690
- val_loss: 0.4410 - val_custom_accuracy: 0.3442
Epoch 185/250
4/4 [==============================] - 6s 2s/step - loss: 0.4230 - custom_accuracy: 0.7313
- val_loss: 0.4413 - val_custom_accuracy: 0.3442
Epoch 186/250
4/4 [==============================] - 5s 1s/step - loss: 0.4263 - custom_accuracy: 0.7721
- val_loss: 0.4410 - val_custom_accuracy: 0.3442
Epoch 187/250
4/4 [==============================] - 4s 1s/step - loss: 0.4062 - custom_accuracy: 0.7629
- val_loss: 0.4410 - val_custom_accuracy: 0.3442
Epoch 188/250
4/4 [==============================] - 4s 999ms/step - loss: 0.4339 - custom_accuracy: 0.7
572 - val_loss: 0.4407 - val_custom_accuracy: 0.3442
Epoch 189/250
4/4 [==============================] - 7s 2s/step - loss: 0.4156 - custom_accuracy: 0.7261
- val_loss: 0.4404 - val_custom_accuracy: 0.3442
Epoch 190/250
4/4 [==============================] - 5s 1s/step - loss: 0.4141 - custom_accuracy: 0.8193
- val_loss: 0.4398 - val_custom_accuracy: 0.3442
Epoch 191/250
4/4 [==============================] - 4s 1s/step - loss: 0.4433 - custom_accuracy: 0.8137
- val_loss: 0.4395 - val_custom_accuracy: 0.3442
Epoch 192/250
4/4 [==============================] - 5s 1s/step - loss: 0.4297 - custom_accuracy: 0.7519
- val_loss: 0.4391 - val_custom_accuracy: 0.3442
Epoch 193/250
4/4 [==============================] - 7s 2s/step - loss: 0.4315 - custom_accuracy: 0.8134
- val_loss: 0.4384 - val_custom_accuracy: 0.3442
Epoch 194/250
4/4 [==============================] - 4s 977ms/step - loss: 0.4443 - custom_accuracy: 0.7
701 - val_loss: 0.4377 - val_custom_accuracy: 0.3442
Epoch 195/250
4/4 [==============================] - 4s 1s/step - loss: 0.4174 - custom_accuracy: 0.8138
- val_loss: 0.4365 - val_custom_accuracy: 0.3442
Epoch 196/250
4/4 [==============================] - 6s 2s/step - loss: 0.4289 - custom_accuracy: 0.8138
- val_loss: 0.4360 - val_custom_accuracy: 0.3442
```

```
Epoch 197/250
4/4 [==============================] - 6s 1s/step - loss: 0.4361 - custom_accuracy: 0.7235
- val_loss: 0.4358 - val_custom_accuracy: 0.3442
Epoch 198/250
4/4 [==============================] - 4s 1s/step - loss: 0.4297 - custom_accuracy: 0.8114
- val_loss: 0.4351 - val_custom_accuracy: 0.3442
Epoch 199/250
4/4 [==============================] - 4s 998ms/step - loss: 0.4527 - custom_accuracy: 0.7
531 - val_loss: 0.4344 - val_custom_accuracy: 0.3442
Epoch 200/250
4/4 [==============================] - 6s 2s/step - loss: 0.4268 - custom_accuracy: 0.7678
- val_loss: 0.4337 - val_custom_accuracy: 0.3442
Epoch 201/250
4/4 [==============================] - 5s 1s/step - loss: 0.4387 - custom_accuracy: 0.7666
- val_loss: 0.4330 - val_custom_accuracy: 0.3442
Epoch 202/250
4/4 [==============================] - 4s 1s/step - loss: 0.4347 - custom_accuracy: 0.7577
- val_loss: 0.4325 - val_custom_accuracy: 0.3442
Epoch 203/250
4/4 [==============================] - 4s 1s/step - loss: 0.4326 - custom_accuracy: 0.7347
- val_loss: 0.4318 - val_custom_accuracy: 0.3442
Epoch 204/250
4/4 [==============================] - 6s 2s/step - loss: 0.4375 - custom_accuracy: 0.7695
- val_loss: 0.4309 - val_custom_accuracy: 0.3442
Epoch 205/250
4/4 [==============================] - 5s 1s/step - loss: 0.4249 - custom_accuracy: 0.8077
- val_loss: 0.4299 - val_custom_accuracy: 0.3442
Epoch 206/250
4/4 [==============================] - 4s 993ms/step - loss: 0.4182 - custom_accuracy: 0.7
537 - val_loss: 0.4291 - val_custom_accuracy: 0.3442
Epoch 207/250
4/4 [==============================] - 4s 996ms/step - loss: 0.4376 - custom_accuracy: 0.7
305 - val_loss: 0.4280 - val_custom_accuracy: 0.3442
Epoch 208/250
4/4 [==============================] - 7s 2s/step - loss: 0.4278 - custom_accuracy: 0.8164
- val_loss: 0.4269 - val_custom_accuracy: 0.3442
Epoch 209/250
4/4 [==============================] - 5s 1s/step - loss: 0.4252 - custom_accuracy: 0.7535
- val_loss: 0.4266 - val_custom_accuracy: 0.3442
Epoch 210/250
4/4 [==============================] - 4s 989ms/step - loss: 0.4306 - custom_accuracy: 0.7
574 - val_loss: 0.4267 - val_custom_accuracy: 0.3442
Epoch 211/250
4/4 [==============================] - 5s 1s/step - loss: 0.4212 - custom_accuracy: 0.8165
- val_loss: 0.4271 - val_custom_accuracy: 0.3442
Epoch 212/250
4/4 [==============================] - 7s 2s/step - loss: 0.4307 - custom_accuracy: 0.7060
- val_loss: 0.4275 - val_custom_accuracy: 0.3442
Epoch 213/250
4/4 [==============================] - 4s 1s/step - loss: 0.4220 - custom_accuracy: 0.6991
- val_loss: 0.4275 - val_custom_accuracy: 0.3442
Epoch 214/250
4/4 [==============================] - 4s 997ms/step - loss: 0.4227 - custom_accuracy: 0.8
122 - val_loss: 0.4268 - val_custom_accuracy: 0.3442
Epoch 215/250
4/4 [==============================] - 6s 2s/step - loss: 0.4337 - custom_accuracy: 0.7560
- val_loss: 0.4264 - val_custom_accuracy: 0.3442
Epoch 216/250
4/4 [==============================] - 6s 1s/step - loss: 0.4290 - custom_accuracy: 0.8126
- val_loss: 0.4262 - val_custom_accuracy: 0.3442
Epoch 217/250
4/4 [==============================] - 4s 1s/step - loss: 0.4246 - custom_accuracy: 0.6834
- val_loss: 0.4259 - val_custom_accuracy: 0.3442
Epoch 218/250
```

```
4/4 [==============================] - 4s 986ms/step - loss: 0.4385 - custom_accuracy: 0.8
117 - val_loss: 0.4252 - val_custom_accuracy: 0.3442
Epoch 219/250
4/4 [==============================] - 6s 2s/step - loss: 0.4363 - custom_accuracy: 0.7574
- val_loss: 0.4242 - val_custom_accuracy: 0.3442
Epoch 220/250
4/4 [==============================] - 5s 1s/step - loss: 0.4367 - custom_accuracy: 0.7388
- val_loss: 0.4233 - val_custom_accuracy: 0.3442
Epoch 221/250
4/4 [==============================] - 4s 1s/step - loss: 0.4325 - custom_accuracy: 0.6987
- val_loss: 0.4225 - val_custom_accuracy: 0.3442
Epoch 222/250
4/4 [==============================] - 4s 1s/step - loss: 0.4364 - custom_accuracy: 0.7728
- val_loss: 0.4221 - val_custom_accuracy: 0.3442
Epoch 223/250
4/4 [==============================] - 7s 2s/step - loss: 0.4289 - custom_accuracy: 0.8079
- val_loss: 0.4216 - val_custom_accuracy: 0.3442
Epoch 224/250
4/4 [==============================] - 5s 1s/step - loss: 0.4151 - custom_accuracy: 0.8157
- val_loss: 0.4216 - val_custom_accuracy: 0.3442
Epoch 225/250
4/4 [==============================] - 4s 1s/step - loss: 0.4403 - custom_accuracy: 0.7696
- val_loss: 0.4213 - val_custom_accuracy: 0.3442
Epoch 226/250
4/4 [==============================] - 5s 1s/step - loss: 0.4220 - custom_accuracy: 0.7030
- val_loss: 0.4212 - val_custom_accuracy: 0.3442
Epoch 227/250
4/4 [==============================] - 6s 2s/step - loss: 0.4379 - custom_accuracy: 0.8105
- val_loss: 0.4212 - val_custom_accuracy: 0.3442
Epoch 228/250
4/4 [==============================] - 4s 972ms/step - loss: 0.4441 - custom_accuracy: 0.8
111 - val_loss: 0.4210 - val_custom_accuracy: 0.3442
Epoch 229/250
4/4 [==============================] - 4s 1s/step - loss: 0.4445 - custom_accuracy: 0.8074
- val_loss: 0.4209 - val_custom_accuracy: 0.3442
Epoch 230/250
4/4 [==============================] - 5s 1s/step - loss: 0.4431 - custom_accuracy: 0.8051
- val_loss: 0.4207 - val_custom_accuracy: 0.3442
Epoch 231/250
4/4 [==============================] - 7s 2s/step - loss: 0.4251 - custom_accuracy: 0.8082
- val_loss: 0.4205 - val_custom_accuracy: 0.3442
Epoch 232/250
4/4 [==============================] - 6s 1s/step - loss: 0.4225 - custom_accuracy: 0.8104
- val_loss: 0.4207 - val_custom_accuracy: 0.3442
Epoch 233/250
4/4 [==============================] - 5s 1s/step - loss: 0.4442 - custom_accuracy: 0.7557
- val_loss: 0.4206 - val_custom_accuracy: 0.3442
Epoch 234/250
4/4 [==============================] - 6s 2s/step - loss: 0.4339 - custom_accuracy: 0.7416
- val_loss: 0.4207 - val_custom_accuracy: 0.3442
Epoch 235/250
4/4 [==============================] - 4s 976ms/step - loss: 0.4382 - custom_accuracy: 0.7
033 - val_loss: 0.4211 - val_custom_accuracy: 0.3442
Epoch 236/250
4/4 [==============================] - 4s 974ms/step - loss: 0.4412 - custom_accuracy: 0.8
073 - val_loss: 0.4218 - val_custom_accuracy: 0.3442
Epoch 237/250
4/4 [==============================] - 6s 2s/step - loss: 0.4380 - custom_accuracy: 0.7695
- val_loss: 0.4221 - val_custom_accuracy: 0.3442
Epoch 238/250
4/4 [==============================] - 6s 1s/step - loss: 0.4289 - custom_accuracy: 0.7748
- val_loss: 0.4225 - val_custom_accuracy: 0.3442
Epoch 239/250
4/4 [==============================] - 4s 970ms/step - loss: 0.4327 - custom_accuracy: 0.8
```

```
073 - val_loss: 0.4226 - val_custom_accuracy: 0.3442
Epoch 240/250
4/4 [==============================] - 4s 978ms/step - loss: 0.4424 - custom_accuracy: 0.8
084 - val_loss: 0.4221 - val_custom_accuracy: 0.3442
Epoch 241/250
4/4 [==============================] - 6s 2s/step - loss: 0.4316 - custom_accuracy: 0.7634
- val_loss: 0.4217 - val_custom_accuracy: 0.3442
Epoch 242/250
4/4 [==============================] - 5s 1s/step - loss: 0.4271 - custom_accuracy: 0.8096
- val_loss: 0.4219 - val_custom_accuracy: 0.3442
Epoch 243/250
4/4 [==============================] - 4s 1s/step - loss: 0.4273 - custom_accuracy: 0.7389
- val_loss: 0.4227 - val_custom_accuracy: 0.3442
Epoch 244/250
4/4 [==============================] - 4s 1s/step - loss: 0.4289 - custom_accuracy: 0.7591
- val_loss: 0.4235 - val_custom_accuracy: 0.3442
Epoch 245/250
4/4 [==============================] - 9s 2s/step - loss: 0.4329 - custom_accuracy: 0.7572
- val_loss: 0.4244 - val_custom_accuracy: 0.3442
Epoch 246/250
4/4 [==============================] - 5s 1s/step - loss: 0.4217 - custom_accuracy: 0.7577
- val_loss: 0.4253 - val_custom_accuracy: 0.3442
Epoch 247/250
4/4 [==============================] - 4s 1s/step - loss: 0.4265 - custom_accuracy: 0.8183
- val_loss: 0.4261 - val_custom_accuracy: 0.3442
Epoch 248/250
4/4 [==============================] - 6s 2s/step - loss: 0.4273 - custom_accuracy: 0.6943
- val_loss: 0.4272 - val_custom_accuracy: 0.3442
Epoch 249/250
4/4 [==============================] - 5s 1s/step - loss: 0.4431 - custom_accuracy: 0.7415
- val_loss: 0.4283 - val_custom_accuracy: 0.3442
Epoch 250/250
4/4 [==============================] - 4s 1s/step - loss: 0.4377 - custom_accuracy: 0.8131
- val_loss: 0.4288 - val_custom_accuracy: 0.3442
```

In [ ]:

```python
import matplotlib.pyplot as plt

# Define colors for the graph
line_color = '#0077c8'
bg_color = '#f7f7f7'

# Create the figure and axes objects
fig, ax = plt.subplots()

# Set the background color of the plot area
fig.patch.set_facecolor(bg_color)
ax.set_facecolor(bg_color)

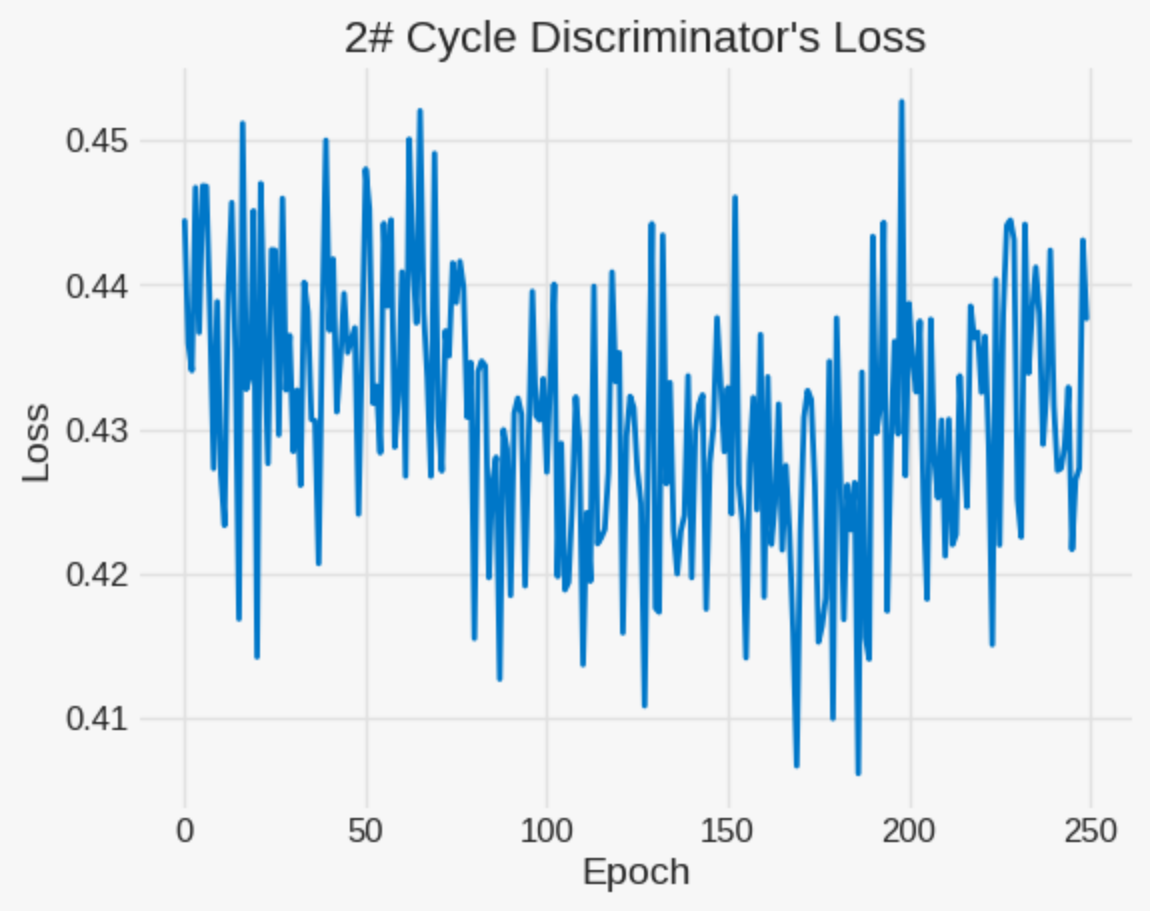
# Plot the loss data
ax.plot(H.history['loss'], color=line_color, linewidth=2)

# Set the axis labels and title
ax.set_xlabel('Epoch', fontsize=14)
ax.set_ylabel('Loss', fontsize=14)
ax.set_title("2# Cycle Discriminator's Loss", fontsize=16)

# Customize the tick labels
ax.tick_params(axis='both', which='major', labelsize=12, color=line_color)
ax.tick_params(axis='both', which='minor', labelsize=10, color=line_color)

# Customize the grid lines
ax.grid(color='#e1e1e1', linestyle='-', linewidth=1)
```

```
# Show the plot
```



In [ ]:

```
import matplotlib.pyplot as plt

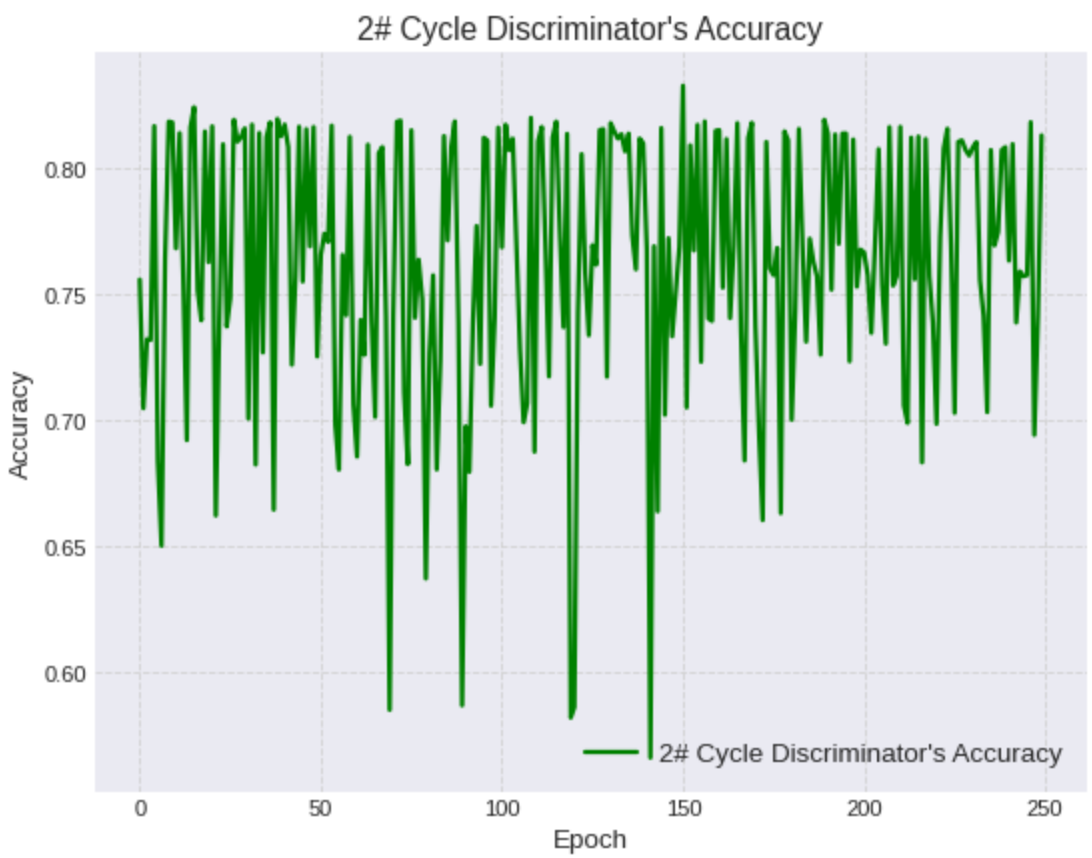
# Define the figure size and dpi
fig = plt.figure(figsize=(8, 6), dpi=80)

# Plot the data
plt.plot(H.history['custom_accuracy'], color='green', linewidth=2, label="2# Cycle Discri

# Add title, axis labels and legend
plt.title("2# Cycle Discriminator's Accuracy", fontsize=14)
plt.xlabel('Epoch', fontsize=12)
plt.ylabel('Accuracy', fontsize=12)
plt.legend(loc='lower right', fontsize=12)

# Customize the tick labels and grid
plt.xticks(fontsize=10)
plt.yticks(fontsize=10)
plt.grid(color='lightgrey', linestyle='--')

# Show the plot
plt.show()
```



In [ ]:
```
custom_acc(np.array(y_gen_test, dtype=np.float32), qdisc_model.predict(gen_data_test))
```

Out[ ]:
```
<tf.Tensor: shape=(), dtype=float32, numpy=0.71>
```

In [ ]:
```
best_qdisc_weights = qdisc_model.get_weights()[0]
best_qgen_weights = qgen_model.get_weights()[0]
qgen_model = generator_model(symbols_gen, qdisc_model.get_weights()[0])

qgen_model.get_layer('qgen_layer').set_weights([best_qgen_weights])
qdisc_model.get_layer('qdisc_layer').set_weights([best_qdisc_weights])
```

In [ ]:
```
gen_model_cp, disc_model_cp = checkpoints(cycle=3)
```

In [ ]:
```
# Fit the Generator Model
H = train_qgen(500, 100, 1)
```

```
Epoch 1/500
1/1 [==============================] - 3s 3s/step - loss: 0.6238
Epoch 2/500
1/1 [==============================] - 2s 2s/step - loss: 0.6188
Epoch 3/500
1/1 [==============================] - 2s 2s/step - loss: 0.6139
Epoch 4/500
1/1 [==============================] - 4s 4s/step - loss: 0.6092
Epoch 5/500
1/1 [==============================] - 4s 4s/step - loss: 0.6047
Epoch 6/500
1/1 [==============================] - 2s 2s/step - loss: 0.6003
Epoch 7/500
1/1 [==============================] - 2s 2s/step - loss: 0.5960
Epoch 8/500
1/1 [==============================] - 2s 2s/step - loss: 0.5919
```

```
Epoch 9/500
1/1 [==============================] - 2s 2s/step - loss: 0.5878
Epoch 10/500
1/1 [==============================] - 2s 2s/step - loss: 0.5838
Epoch 11/500
1/1 [==============================] - 4s 4s/step - loss: 0.5798
Epoch 12/500
1/1 [==============================] - 4s 4s/step - loss: 0.5759
Epoch 13/500
1/1 [==============================] - 2s 2s/step - loss: 0.5721
Epoch 14/500
1/1 [==============================] - 2s 2s/step - loss: 0.5683
Epoch 15/500
1/1 [==============================] - 2s 2s/step - loss: 0.5645
Epoch 16/500
1/1 [==============================] - 2s 2s/step - loss: 0.5607
Epoch 17/500
1/1 [==============================] - 2s 2s/step - loss: 0.5570
Epoch 18/500
1/1 [==============================] - 4s 4s/step - loss: 0.5533
Epoch 19/500
1/1 [==============================] - 4s 4s/step - loss: 0.5497
Epoch 20/500
1/1 [==============================] - 2s 2s/step - loss: 0.5460
Epoch 21/500
1/1 [==============================] - 2s 2s/step - loss: 0.5424
Epoch 22/500
1/1 [==============================] - 2s 2s/step - loss: 0.5388
Epoch 23/500
1/1 [==============================] - 2s 2s/step - loss: 0.5352
Epoch 24/500
1/1 [==============================] - 3s 3s/step - loss: 0.5317
Epoch 25/500
1/1 [==============================] - 4s 4s/step - loss: 0.5282
Epoch 26/500
1/1 [==============================] - 3s 3s/step - loss: 0.5247
Epoch 27/500
1/1 [==============================] - 2s 2s/step - loss: 0.5213
Epoch 28/500
1/1 [==============================] - 2s 2s/step - loss: 0.5180
Epoch 29/500
1/1 [==============================] - 2s 2s/step - loss: 0.5147
Epoch 30/500
1/1 [==============================] - 2s 2s/step - loss: 0.5114
Epoch 31/500
1/1 [==============================] - 3s 3s/step - loss: 0.5083
Epoch 32/500
1/1 [==============================] - 4s 4s/step - loss: 0.5052
Epoch 33/500
1/1 [==============================] - 3s 3s/step - loss: 0.5022
Epoch 34/500
1/1 [==============================] - 2s 2s/step - loss: 0.4992
Epoch 35/500
1/1 [==============================] - 2s 2s/step - loss: 0.4964
Epoch 36/500
1/1 [==============================] - 2s 2s/step - loss: 0.4936
Epoch 37/500
1/1 [==============================] - 2s 2s/step - loss: 0.4909
Epoch 38/500
1/1 [==============================] - 4s 4s/step - loss: 0.4883
Epoch 39/500
1/1 [==============================] - 4s 4s/step - loss: 0.4858
Epoch 40/500
1/1 [==============================] - 3s 3s/step - loss: 0.4834
```

```
Epoch 41/500
1/1 [==============================] - 2s 2s/step - loss: 0.4811
Epoch 42/500
1/1 [==============================] - 2s 2s/step - loss: 0.4788
Epoch 43/500
1/1 [==============================] - 2s 2s/step - loss: 0.4767
Epoch 44/500
1/1 [==============================] - 2s 2s/step - loss: 0.4746
Epoch 45/500
1/1 [==============================] - 4s 4s/step - loss: 0.4726
Epoch 46/500
1/1 [==============================] - 4s 4s/step - loss: 0.4707
Epoch 47/500
1/1 [==============================] - 2s 2s/step - loss: 0.4689
Epoch 48/500
1/1 [==============================] - 3s 3s/step - loss: 0.4671
Epoch 49/500
1/1 [==============================] - 4s 4s/step - loss: 0.4654
Epoch 50/500
1/1 [==============================] - 4s 4s/step - loss: 0.4637
Epoch 51/500
1/1 [==============================] - 4s 4s/step - loss: 0.4621
Epoch 52/500
1/1 [==============================] - 3s 3s/step - loss: 0.4606
Epoch 53/500
1/1 [==============================] - 2s 2s/step - loss: 0.4591
Epoch 54/500
1/1 [==============================] - 2s 2s/step - loss: 0.4577
Epoch 55/500
1/1 [==============================] - 2s 2s/step - loss: 0.4563
Epoch 56/500
1/1 [==============================] - 2s 2s/step - loss: 0.4549
Epoch 57/500
1/1 [==============================] - 3s 3s/step - loss: 0.4536
Epoch 58/500
1/1 [==============================] - 4s 4s/step - loss: 0.4524
Epoch 59/500
1/1 [==============================] - 3s 3s/step - loss: 0.4511
Epoch 60/500
1/1 [==============================] - 2s 2s/step - loss: 0.4500
Epoch 61/500
1/1 [==============================] - 2s 2s/step - loss: 0.4488
Epoch 62/500
1/1 [==============================] - 2s 2s/step - loss: 0.4476
Epoch 63/500
1/1 [==============================] - 2s 2s/step - loss: 0.4465
Epoch 64/500
1/1 [==============================] - 3s 3s/step - loss: 0.4454
Epoch 65/500
1/1 [==============================] - 4s 4s/step - loss: 0.4444
Epoch 66/500
1/1 [==============================] - 3s 3s/step - loss: 0.4433
Epoch 67/500
1/1 [==============================] - 2s 2s/step - loss: 0.4423
Epoch 68/500
1/1 [==============================] - 2s 2s/step - loss: 0.4413
Epoch 69/500
1/1 [==============================] - 2s 2s/step - loss: 0.4403
Epoch 70/500
1/1 [==============================] - 2s 2s/step - loss: 0.4393
Epoch 71/500
1/1 [==============================] - 4s 4s/step - loss: 0.4383
Epoch 72/500
1/1 [==============================] - 4s 4s/step - loss: 0.4374
```

```
Epoch 73/500
1/1 [==============================] - 3s 3s/step - loss: 0.4365
Epoch 74/500
1/1 [==============================] - 2s 2s/step - loss: 0.4356
Epoch 75/500
1/1 [==============================] - 2s 2s/step - loss: 0.4347
Epoch 76/500
1/1 [==============================] - 2s 2s/step - loss: 0.4338
Epoch 77/500
1/1 [==============================] - 2s 2s/step - loss: 0.4329
Epoch 78/500
1/1 [==============================] - 4s 4s/step - loss: 0.4321
Epoch 79/500
1/1 [==============================] - 4s 4s/step - loss: 0.4313
Epoch 80/500
1/1 [==============================] - 2s 2s/step - loss: 0.4304
Epoch 81/500
1/1 [==============================] - 2s 2s/step - loss: 0.4296
Epoch 82/500
1/1 [==============================] - 2s 2s/step - loss: 0.4288
Epoch 83/500
1/1 [==============================] - 2s 2s/step - loss: 0.4281
Epoch 84/500
1/1 [==============================] - 2s 2s/step - loss: 0.4273
Epoch 85/500
1/1 [==============================] - 4s 4s/step - loss: 0.4266
Epoch 86/500
1/1 [==============================] - 4s 4s/step - loss: 0.4258
Epoch 87/500
1/1 [==============================] - 2s 2s/step - loss: 0.4251
Epoch 88/500
1/1 [==============================] - 2s 2s/step - loss: 0.4244
Epoch 89/500
1/1 [==============================] - 2s 2s/step - loss: 0.4237
Epoch 90/500
1/1 [==============================] - 2s 2s/step - loss: 0.4230
Epoch 91/500
1/1 [==============================] - 3s 3s/step - loss: 0.4223
Epoch 92/500
1/1 [==============================] - 4s 4s/step - loss: 0.4217
Epoch 93/500
1/1 [==============================] - 4s 4s/step - loss: 0.4210
Epoch 94/500
1/1 [==============================] - 2s 2s/step - loss: 0.4204
Epoch 95/500
1/1 [==============================] - 2s 2s/step - loss: 0.4198
Epoch 96/500
1/1 [==============================] - 2s 2s/step - loss: 0.4191
Epoch 97/500
1/1 [==============================] - 2s 2s/step - loss: 0.4185
Epoch 98/500
1/1 [==============================] - 3s 3s/step - loss: 0.4179
Epoch 99/500
1/1 [==============================] - 4s 4s/step - loss: 0.4173
Epoch 100/500
1/1 [==============================] - 3s 3s/step - loss: 0.4168
Epoch 101/500
1/1 [==============================] - 2s 2s/step - loss: 0.4162
Epoch 102/500
1/1 [==============================] - 2s 2s/step - loss: 0.4156
Epoch 103/500
1/1 [==============================] - 2s 2s/step - loss: 0.4151
Epoch 104/500
1/1 [==============================] - 2s 2s/step - loss: 0.4145
```

```
Epoch 105/500
1/1 [==============================] - 3s 3s/step - loss: 0.4140
Epoch 106/500
1/1 [==============================] - 4s 4s/step - loss: 0.4135
Epoch 107/500
1/1 [==============================] - 3s 3s/step - loss: 0.4129
Epoch 108/500
1/1 [==============================] - 2s 2s/step - loss: 0.4124
Epoch 109/500
1/1 [==============================] - 2s 2s/step - loss: 0.4119
Epoch 110/500
1/1 [==============================] - 2s 2s/step - loss: 0.4114
Epoch 111/500
1/1 [==============================] - 2s 2s/step - loss: 0.4109
Epoch 112/500
1/1 [==============================] - 4s 4s/step - loss: 0.4104
Epoch 113/500
1/1 [==============================] - 4s 4s/step - loss: 0.4099
Epoch 114/500
1/1 [==============================] - 3s 3s/step - loss: 0.4095
Epoch 115/500
1/1 [==============================] - 2s 2s/step - loss: 0.4090
Epoch 116/500
1/1 [==============================] - 2s 2s/step - loss: 0.4085
Epoch 117/500
1/1 [==============================] - 2s 2s/step - loss: 0.4081
Epoch 118/500
1/1 [==============================] - 2s 2s/step - loss: 0.4076
Epoch 119/500
1/1 [==============================] - 4s 4s/step - loss: 0.4072
Epoch 120/500
1/1 [==============================] - 4s 4s/step - loss: 0.4067
Epoch 121/500
1/1 [==============================] - 2s 2s/step - loss: 0.4063
Epoch 122/500
1/1 [==============================] - 2s 2s/step - loss: 0.4059
Epoch 123/500
1/1 [==============================] - 2s 2s/step - loss: 0.4054
Epoch 124/500
1/1 [==============================] - 2s 2s/step - loss: 0.4050
Epoch 125/500
1/1 [==============================] - 2s 2s/step - loss: 0.4046
Epoch 126/500
1/1 [==============================] - 4s 4s/step - loss: 0.4042
Epoch 127/500
1/1 [==============================] - 4s 4s/step - loss: 0.4038
Epoch 128/500
1/1 [==============================] - 2s 2s/step - loss: 0.4034
Epoch 129/500
1/1 [==============================] - 2s 2s/step - loss: 0.4030
Epoch 130/500
1/1 [==============================] - 2s 2s/step - loss: 0.4027
Epoch 131/500
1/1 [==============================] - 2s 2s/step - loss: 0.4023
Epoch 132/500
1/1 [==============================] - 3s 3s/step - loss: 0.4019
Epoch 133/500
1/1 [==============================] - 4s 4s/step - loss: 0.4016
Epoch 134/500
1/1 [==============================] - 4s 4s/step - loss: 0.4012
Epoch 135/500
1/1 [==============================] - 2s 2s/step - loss: 0.4008
Epoch 136/500
1/1 [==============================] - 2s 2s/step - loss: 0.4005
```

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Epoch 137/500
1/1 [==============================] - 2s 2s/step - loss: 0.4002
Epoch 138/500
1/1 [==============================] - 2s 2s/step - loss: 0.3998
Epoch 139/500
1/1 [==============================] - 3s 3s/step - loss: 0.3995
Epoch 140/500
1/1 [==============================] - 4s 4s/step - loss: 0.3991
Epoch 141/500
1/1 [==============================] - 3s 3s/step - loss: 0.3988
Epoch 142/500
1/1 [==============================] - 2s 2s/step - loss: 0.3985
Epoch 143/500
1/1 [==============================] - 2s 2s/step - loss: 0.3982
Epoch 144/500
1/1 [==============================] - 2s 2s/step - loss: 0.3979
Epoch 145/500
1/1 [==============================] - 4s 4s/step - loss: 0.3976
Epoch 146/500
1/1 [==============================] - 4s 4s/step - loss: 0.3973
Epoch 147/500
1/1 [==============================] - 4s 4s/step - loss: 0.3970
Epoch 148/500
1/1 [==============================] - 4s 4s/step - loss: 0.3967
Epoch 149/500
1/1 [==============================] - 2s 2s/step - loss: 0.3964
Epoch 150/500
1/1 [==============================] - 2s 2s/step - loss: 0.3961
Epoch 151/500
1/1 [==============================] - 2s 2s/step - loss: 0.3958
Epoch 152/500
1/1 [==============================] - 2s 2s/step - loss: 0.3955
Epoch 153/500
1/1 [==============================] - 2s 2s/step - loss: 0.3953
Epoch 154/500
1/1 [==============================] - 4s 4s/step - loss: 0.3950
Epoch 155/500
1/1 [==============================] - 4s 4s/step - loss: 0.3947
Epoch 156/500
1/1 [==============================] - 2s 2s/step - loss: 0.3945
Epoch 157/500
1/1 [==============================] - 2s 2s/step - loss: 0.3942
Epoch 158/500
1/1 [==============================] - 2s 2s/step - loss: 0.3940
Epoch 159/500
1/1 [==============================] - 2s 2s/step - loss: 0.3937
Epoch 160/500
1/1 [==============================] - 3s 3s/step - loss: 0.3934
Epoch 161/500
1/1 [==============================] - 4s 4s/step - loss: 0.3932
Epoch 162/500
1/1 [==============================] - 3s 3s/step - loss: 0.3930
Epoch 163/500
1/1 [==============================] - 2s 2s/step - loss: 0.3927
Epoch 164/500
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Epoch 165/500
1/1 [==============================] - 2s 2s/step - loss: 0.3923
Epoch 166/500
1/1 [==============================] - 2s 2s/step - loss: 0.3920
Epoch 167/500
1/1 [==============================] - 3s 3s/step - loss: 0.3918
Epoch 168/500
1/1 [==============================] - 4s 4s/step - loss: 0.3916
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Epoch 169/500
1/1 [==============================] - 3s 3s/step - loss: 0.3913
Epoch 170/500
1/1 [==============================] - 2s 2s/step - loss: 0.3911
Epoch 171/500
1/1 [==============================] - 2s 2s/step - loss: 0.3909
Epoch 172/500
1/1 [==============================] - 2s 2s/step - loss: 0.3907
Epoch 173/500
1/1 [==============================] - 2s 2s/step - loss: 0.3905
Epoch 174/500
1/1 [==============================] - 4s 4s/step - loss: 0.3903
Epoch 175/500
1/1 [==============================] - 4s 4s/step - loss: 0.3901
Epoch 176/500
1/1 [==============================] - 3s 3s/step - loss: 0.3899
Epoch 177/500
1/1 [==============================] - 2s 2s/step - loss: 0.3897
Epoch 178/500
1/1 [==============================] - 2s 2s/step - loss: 0.3895
Epoch 179/500
1/1 [==============================] - 2s 2s/step - loss: 0.3893
Epoch 180/500
1/1 [==============================] - 2s 2s/step - loss: 0.3891
Epoch 181/500
1/1 [==============================] - 4s 4s/step - loss: 0.3889
Epoch 182/500
1/1 [==============================] - 4s 4s/step - loss: 0.3887
Epoch 183/500
1/1 [==============================] - 2s 2s/step - loss: 0.3885
Epoch 184/500
1/1 [==============================] - 2s 2s/step - loss: 0.3883
Epoch 185/500
1/1 [==============================] - 2s 2s/step - loss: 0.3882
Epoch 186/500
1/1 [==============================] - 2s 2s/step - loss: 0.3880
Epoch 187/500
1/1 [==============================] - 2s 2s/step - loss: 0.3878
Epoch 188/500
1/1 [==============================] - 4s 4s/step - loss: 0.3876
Epoch 189/500
1/1 [==============================] - 4s 4s/step - loss: 0.3875
Epoch 190/500
1/1 [==============================] - 2s 2s/step - loss: 0.3873
Epoch 191/500
1/1 [==============================] - 2s 2s/step - loss: 0.3871
Epoch 192/500
1/1 [==============================] - 2s 2s/step - loss: 0.3869
Epoch 193/500
1/1 [==============================] - 2s 2s/step - loss: 0.3868
Epoch 194/500
1/1 [==============================] - 3s 3s/step - loss: 0.3866
Epoch 195/500
1/1 [==============================] - 4s 4s/step - loss: 0.3865
Epoch 196/500
1/1 [==============================] - 3s 3s/step - loss: 0.3863
Epoch 197/500
1/1 [==============================] - 2s 2s/step - loss: 0.3861
Epoch 198/500
1/1 [==============================] - 2s 2s/step - loss: 0.3860
Epoch 199/500
1/1 [==============================] - 2s 2s/step - loss: 0.3858
Epoch 200/500
1/1 [==============================] - 2s 2s/step - loss: 0.3857
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Epoch 201/500
1/1 [==============================] - 3s 3s/step - loss: 0.3855
Epoch 202/500
1/1 [==============================] - 4s 4s/step - loss: 0.3854
Epoch 203/500
1/1 [==============================] - 3s 3s/step - loss: 0.3852
Epoch 204/500
1/1 [==============================] - 2s 2s/step - loss: 0.3851
Epoch 205/500
1/1 [==============================] - 2s 2s/step - loss: 0.3849
Epoch 206/500
1/1 [==============================] - 2s 2s/step - loss: 0.3848
Epoch 207/500
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Epoch 209/500
1/1 [==============================] - 4s 4s/step - loss: 0.3844
Epoch 210/500
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Epoch 211/500
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Epoch 212/500
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Epoch 213/500
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Epoch 214/500
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Epoch 215/500
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Epoch 216/500
1/1 [==============================] - 4s 4s/step - loss: 0.3834
Epoch 217/500
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Epoch 218/500
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Epoch 223/500
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Epoch 226/500
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Epoch 227/500
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Epoch 228/500
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Epoch 229/500
1/1 [==============================] - 4s 4s/step - loss: 0.3818
Epoch 230/500
1/1 [==============================] - 4s 4s/step - loss: 0.3817
Epoch 231/500
1/1 [==============================] - 2s 2s/step - loss: 0.3816
Epoch 232/500
1/1 [==============================] - 2s 2s/step - loss: 0.3815
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Epoch 233/500
1/1 [==============================] - 2s 2s/step - loss: 0.3814
Epoch 234/500
1/1 [==============================] - 2s 2s/step - loss: 0.3812
Epoch 235/500
1/1 [==============================] - 3s 3s/step - loss: 0.3811
Epoch 236/500
1/1 [==============================] - 4s 4s/step - loss: 0.3810
Epoch 237/500
1/1 [==============================] - 4s 4s/step - loss: 0.3809
Epoch 238/500
1/1 [==============================] - 2s 2s/step - loss: 0.3808
Epoch 239/500
1/1 [==============================] - 2s 2s/step - loss: 0.3807
Epoch 240/500
1/1 [==============================] - 2s 2s/step - loss: 0.3806
Epoch 241/500
1/1 [==============================] - 4s 4s/step - loss: 0.3805
Epoch 242/500
1/1 [==============================] - 4s 4s/step - loss: 0.3803
Epoch 243/500
1/1 [==============================] - 4s 4s/step - loss: 0.3802
Epoch 244/500
1/1 [==============================] - 3s 3s/step - loss: 0.3801
Epoch 245/500
1/1 [==============================] - 2s 2s/step - loss: 0.3800
Epoch 246/500
1/1 [==============================] - 2s 2s/step - loss: 0.3799
Epoch 247/500
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Epoch 248/500
1/1 [==============================] - 2s 2s/step - loss: 0.3797
Epoch 249/500
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Epoch 250/500
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Epoch 251/500
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Epoch 252/500
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Epoch 253/500
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Epoch 254/500
1/1 [==============================] - 2s 2s/step - loss: 0.3791
Epoch 255/500
1/1 [==============================] - 2s 2s/step - loss: 0.3790
Epoch 256/500
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Epoch 257/500
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Epoch 258/500
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Epoch 262/500
1/1 [==============================] - 2s 2s/step - loss: 0.3782
Epoch 263/500
1/1 [==============================] - 4s 4s/step - loss: 0.3781
Epoch 264/500
1/1 [==============================] - 4s 4s/step - loss: 0.3780
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Epoch 265/500
1/1 [==============================] - 2s 2s/step - loss: 0.3779
Epoch 266/500
1/1 [==============================] - 2s 2s/step - loss: 0.3778
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Epoch 269/500
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Epoch 270/500
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Epoch 271/500
1/1 [==============================] - 4s 4s/step - loss: 0.3773
Epoch 272/500
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Epoch 273/500
1/1 [==============================] - 2s 2s/step - loss: 0.3771
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Epoch 279/500
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Epoch 280/500
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Epoch 282/500
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Epoch 283/500
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Epoch 297/500
1/1 [==============================] - 4s 4s/step - loss: 0.3746
Epoch 298/500
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Epoch 302/500
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Epoch 329/500
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Epoch 330/500
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Epoch 335/500
1/1 [==============================] - 2s 2s/step - loss: 0.3702
Epoch 336/500
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Epoch 337/500
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Epoch 360/500
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Epoch 361/500
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Epoch 390/500
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1/1 [==============================] - 2s 2s/step - loss: 0.3639
Epoch 392/500
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Epoch 393/500
1/1 [==============================] - 4s 4s/step - loss: 0.3638
Epoch 394/500
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Epoch 399/500
1/1 [==============================] - 2s 2s/step - loss: 0.3632
Epoch 400/500
1/1 [==============================] - 4s 4s/step - loss: 0.3631
Epoch 401/500
1/1 [==============================] - 4s 4s/step - loss: 0.3631
Epoch 402/500
1/1 [==============================] - 2s 2s/step - loss: 0.3630
Epoch 403/500
1/1 [==============================] - 2s 2s/step - loss: 0.3629
Epoch 404/500
1/1 [==============================] - 2s 2s/step - loss: 0.3628
Epoch 405/500
1/1 [==============================] - 2s 2s/step - loss: 0.3627
Epoch 406/500
1/1 [==============================] - 3s 3s/step - loss: 0.3626
Epoch 407/500
1/1 [==============================] - 4s 4s/step - loss: 0.3625
Epoch 408/500
1/1 [==============================] - 3s 3s/step - loss: 0.3625
Epoch 409/500
1/1 [==============================] - 2s 2s/step - loss: 0.3624
Epoch 410/500
1/1 [==============================] - 2s 2s/step - loss: 0.3623
Epoch 411/500
1/1 [==============================] - 2s 2s/step - loss: 0.3622
Epoch 412/500
1/1 [==============================] - 2s 2s/step - loss: 0.3621
Epoch 413/500
1/1 [==============================] - 3s 3s/step - loss: 0.3621
Epoch 414/500
1/1 [==============================] - 4s 4s/step - loss: 0.3620
Epoch 415/500
1/1 [==============================] - 3s 3s/step - loss: 0.3619
Epoch 416/500
1/1 [==============================] - 2s 2s/step - loss: 0.3618
Epoch 417/500
1/1 [==============================] - 2s 2s/step - loss: 0.3618
Epoch 418/500
1/1 [==============================] - 2s 2s/step - loss: 0.3617
Epoch 419/500
1/1 [==============================] - 2s 2s/step - loss: 0.3616
Epoch 420/500
1/1 [==============================] - 4s 4s/step - loss: 0.3615
Epoch 421/500
1/1 [==============================] - 4s 4s/step - loss: 0.3615
Epoch 422/500
1/1 [==============================] - 2s 2s/step - loss: 0.3614
Epoch 423/500
1/1 [==============================] - 2s 2s/step - loss: 0.3613
Epoch 424/500
1/1 [==============================] - 2s 2s/step - loss: 0.3612
```

```
Epoch 425/500
1/1 [==============================] - 2s 2s/step - loss: 0.3612
Epoch 426/500
1/1 [==============================] - 3s 3s/step - loss: 0.3611
Epoch 427/500
1/1 [==============================] - 4s 4s/step - loss: 0.3610
Epoch 428/500
1/1 [==============================] - 3s 3s/step - loss: 0.3609
Epoch 429/500
1/1 [==============================] - 2s 2s/step - loss: 0.3609
Epoch 430/500
1/1 [==============================] - 2s 2s/step - loss: 0.3608
Epoch 431/500
1/1 [==============================] - 2s 2s/step - loss: 0.3607
Epoch 432/500
1/1 [==============================] - 2s 2s/step - loss: 0.3607
Epoch 433/500
1/1 [==============================] - 4s 4s/step - loss: 0.3606
Epoch 434/500
1/1 [==============================] - 4s 4s/step - loss: 0.3605
Epoch 435/500
1/1 [==============================] - 4s 4s/step - loss: 0.3604
Epoch 436/500
1/1 [==============================] - 4s 4s/step - loss: 0.3604
Epoch 437/500
1/1 [==============================] - 2s 2s/step - loss: 0.3603
Epoch 438/500
1/1 [==============================] - 2s 2s/step - loss: 0.3602
Epoch 439/500
1/1 [==============================] - 2s 2s/step - loss: 0.3602
Epoch 440/500
1/1 [==============================] - 2s 2s/step - loss: 0.3601
Epoch 441/500
1/1 [==============================] - 4s 4s/step - loss: 0.3600
Epoch 442/500
1/1 [==============================] - 4s 4s/step - loss: 0.3600
Epoch 443/500
1/1 [==============================] - 3s 3s/step - loss: 0.3599
Epoch 444/500
1/1 [==============================] - 2s 2s/step - loss: 0.3598
Epoch 445/500
1/1 [==============================] - 2s 2s/step - loss: 0.3598
Epoch 446/500
1/1 [==============================] - 2s 2s/step - loss: 0.3597
Epoch 447/500
1/1 [==============================] - 2s 2s/step - loss: 0.3596
Epoch 448/500
1/1 [==============================] - 4s 4s/step - loss: 0.3596
Epoch 449/500
1/1 [==============================] - 4s 4s/step - loss: 0.3595
Epoch 450/500
1/1 [==============================] - 3s 3s/step - loss: 0.3594
Epoch 451/500
1/1 [==============================] - 2s 2s/step - loss: 0.3594
Epoch 452/500
1/1 [==============================] - 2s 2s/step - loss: 0.3593
Epoch 453/500
1/1 [==============================] - 2s 2s/step - loss: 0.3592
Epoch 454/500
1/1 [==============================] - 2s 2s/step - loss: 0.3592
Epoch 455/500
1/1 [==============================] - 4s 4s/step - loss: 0.3591
Epoch 456/500
1/1 [==============================] - 4s 4s/step - loss: 0.3591
```

```
Epoch 457/500
1/1 [==============================] - 2s 2s/step - loss: 0.3590
Epoch 458/500
1/1 [==============================] - 2s 2s/step - loss: 0.3589
Epoch 459/500
1/1 [==============================] - 2s 2s/step - loss: 0.3589
Epoch 460/500
1/1 [==============================] - 2s 2s/step - loss: 0.3588
Epoch 461/500
1/1 [==============================] - 3s 3s/step - loss: 0.3587
Epoch 462/500
1/1 [==============================] - 4s 4s/step - loss: 0.3587
Epoch 463/500
1/1 [==============================] - 4s 4s/step - loss: 0.3586
Epoch 464/500
1/1 [==============================] - 2s 2s/step - loss: 0.3586
Epoch 465/500
1/1 [==============================] - 2s 2s/step - loss: 0.3585
Epoch 466/500
1/1 [==============================] - 2s 2s/step - loss: 0.3584
Epoch 467/500
1/1 [==============================] - 2s 2s/step - loss: 0.3584
Epoch 468/500
1/1 [==============================] - 3s 3s/step - loss: 0.3583
Epoch 469/500
1/1 [==============================] - 4s 4s/step - loss: 0.3583
Epoch 470/500
1/1 [==============================] - 3s 3s/step - loss: 0.3582
Epoch 471/500
1/1 [==============================] - 2s 2s/step - loss: 0.3582
Epoch 472/500
1/1 [==============================] - 2s 2s/step - loss: 0.3581
Epoch 473/500
1/1 [==============================] - 2s 2s/step - loss: 0.3580
Epoch 474/500
1/1 [==============================] - 2s 2s/step - loss: 0.3580
Epoch 475/500
1/1 [==============================] - 4s 4s/step - loss: 0.3579
Epoch 476/500
1/1 [==============================] - 4s 4s/step - loss: 0.3579
Epoch 477/500
1/1 [==============================] - 3s 3s/step - loss: 0.3578
Epoch 478/500
1/1 [==============================] - 2s 2s/step - loss: 0.3578
Epoch 479/500
1/1 [==============================] - 2s 2s/step - loss: 0.3577
Epoch 480/500
1/1 [==============================] - 2s 2s/step - loss: 0.3576
Epoch 481/500
1/1 [==============================] - 2s 2s/step - loss: 0.3576
Epoch 482/500
1/1 [==============================] - 4s 4s/step - loss: 0.3575
Epoch 483/500
1/1 [==============================] - 4s 4s/step - loss: 0.3575
Epoch 484/500
1/1 [==============================] - 2s 2s/step - loss: 0.3574
Epoch 485/500
1/1 [==============================] - 2s 2s/step - loss: 0.3574
Epoch 486/500
1/1 [==============================] - 2s 2s/step - loss: 0.3573
Epoch 487/500
1/1 [==============================] - 2s 2s/step - loss: 0.3573
Epoch 488/500
1/1 [==============================] - 3s 3s/step - loss: 0.3572
```

```
Epoch 489/500
1/1 [==============================] - 4s 4s/step - loss: 0.3572
Epoch 490/500
1/1 [==============================] - 4s 4s/step - loss: 0.3571
Epoch 491/500
1/1 [==============================] - 2s 2s/step - loss: 0.3571
Epoch 492/500
1/1 [==============================] - 2s 2s/step - loss: 0.3570
Epoch 493/500
1/1 [==============================] - 2s 2s/step - loss: 0.3570
Epoch 494/500
1/1 [==============================] - 2s 2s/step - loss: 0.3569
Epoch 495/500
1/1 [==============================] - 3s 3s/step - loss: 0.3568
Epoch 496/500
1/1 [==============================] - 4s 4s/step - loss: 0.3568
Epoch 497/500
1/1 [==============================] - 3s 3s/step - loss: 0.3567
Epoch 498/500
1/1 [==============================] - 2s 2s/step - loss: 0.3567
Epoch 499/500
1/1 [==============================] - 2s 2s/step - loss: 0.3566
Epoch 500/500
1/1 [==============================] - 2s 2s/step - loss: 0.3566
```

In [ ]:

```python
import matplotlib.pyplot as plt

# Define the figure size and resolution
fig = plt.figure(figsize=(8, 6), dpi=120)

# Set the font size for the labels
plt.rcParams.update({'font.size': 14})

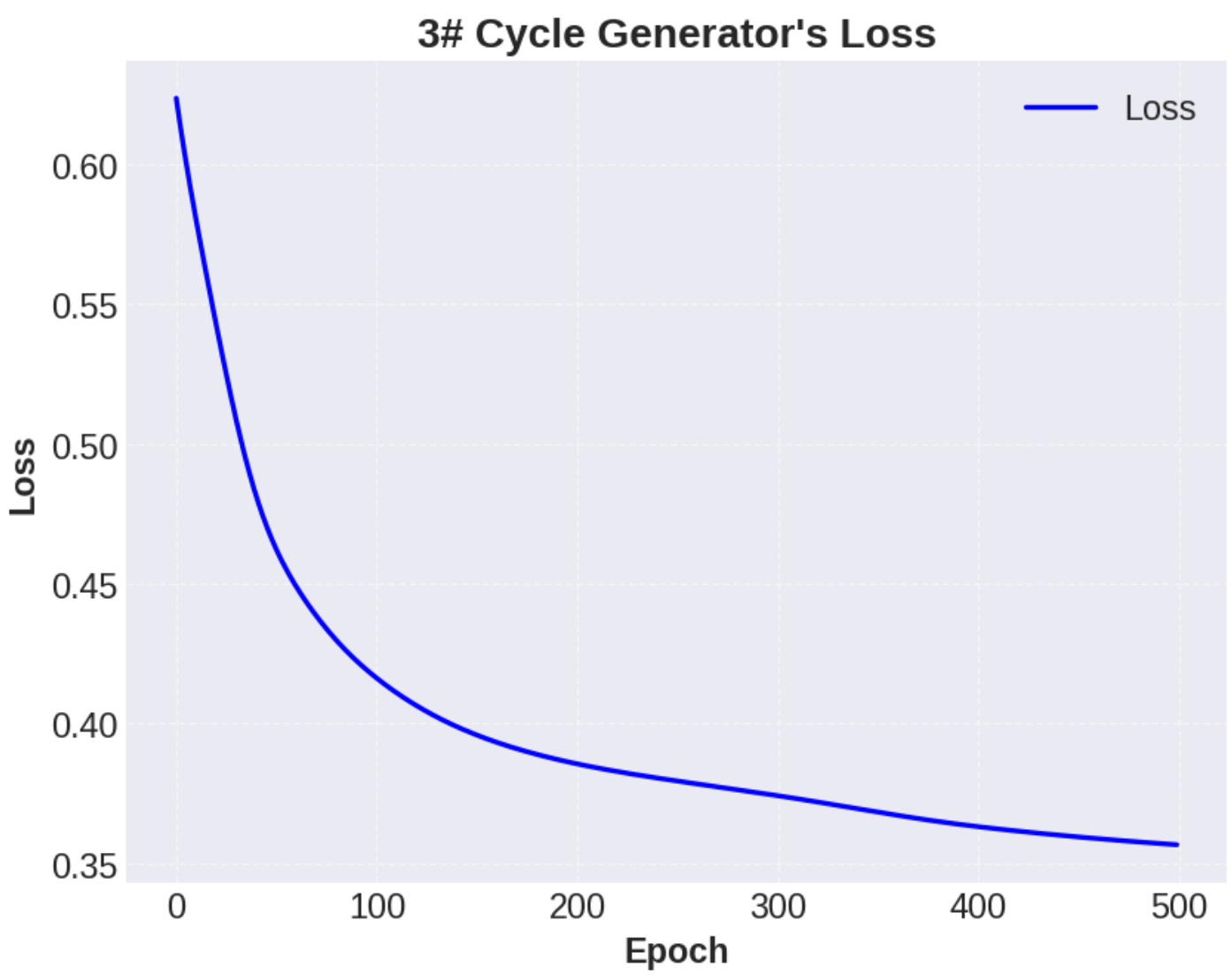
# Plot the loss values
plt.plot(H.history['loss'], color='blue', linewidth=2)

# Add a grid
plt.grid(True, linestyle='--', alpha=0.5)

# Set the x and y axis labels and title
plt.xlabel('Epoch', fontweight='bold')
plt.ylabel('Loss', fontweight='bold')
plt.title("3# Cycle Generator's Loss", fontweight='bold')

# Add a legend
plt.legend(['Loss'], loc='upper right')

# Show the plot
plt.show()
```



In [ ]:

```
# Generate Real + Fake Data

gen_data_train = tfq.convert_to_tensor(generate_data(x_train, qgan_qubits) + generate_unic
gen_data_test = tfq.convert_to_tensor(generate_data(x_test, qgan_qubits) + generate_unique

y_gen_train = np.concatenate((y_train, y_true_fake), axis = 0)
y_gen_test = np.concatenate((y_test, y_true_fake), axis = 0)

print(len(gen_data_train), len(gen_data_test))
print(y_gen_train.shape, y_gen_test.shape)
```

```
200 200
(200, 3) (200, 3)
```

In [ ]:

```
# Change the C_weight
C_weight = 0.8
```

In [ ]:

```
# Fit the Discriminator Model
H = train_qdisc(250, 64, 1)
```

```
Epoch 1/250
4/4 [==============================] - 4s 1s/step - loss: 0.4429 - custom_accuracy: 0.7392
- val_loss: 0.4437 - val_custom_accuracy: 0.3442
Epoch 2/250
4/4 [==============================] - 7s 2s/step - loss: 0.4421 - custom_accuracy: 0.7789
- val_loss: 0.4439 - val_custom_accuracy: 0.3442
```

```
Epoch 3/250
4/4 [==============================] - 5s 1s/step - loss: 0.4410 - custom_accuracy: 0.7322
- val_loss: 0.4437 - val_custom_accuracy: 0.3442
Epoch 4/250
4/4 [==============================] - 4s 1s/step - loss: 0.4486 - custom_accuracy: 0.8146
- val_loss: 0.4434 - val_custom_accuracy: 0.3442
Epoch 5/250
4/4 [==============================] - 5s 1s/step - loss: 0.4371 - custom_accuracy: 0.7547
- val_loss: 0.4438 - val_custom_accuracy: 0.3442
Epoch 6/250
4/4 [==============================] - 7s 2s/step - loss: 0.4388 - custom_accuracy: 0.7017
- val_loss: 0.4439 - val_custom_accuracy: 0.3442
Epoch 7/250
4/4 [==============================] - 7s 2s/step - loss: 0.4318 - custom_accuracy: 0.7266
- val_loss: 0.4444 - val_custom_accuracy: 0.3442
Epoch 8/250
4/4 [==============================] - 6s 1s/step - loss: 0.4350 - custom_accuracy: 0.7708
- val_loss: 0.4446 - val_custom_accuracy: 0.3442
Epoch 9/250
4/4 [==============================] - 6s 2s/step - loss: 0.4383 - custom_accuracy: 0.7351
- val_loss: 0.4449 - val_custom_accuracy: 0.3442
Epoch 10/250
4/4 [==============================] - 4s 1s/step - loss: 0.4337 - custom_accuracy: 0.7643
- val_loss: 0.4446 - val_custom_accuracy: 0.3442
Epoch 11/250
4/4 [==============================] - 4s 968ms/step - loss: 0.4424 - custom_accuracy: 0.7
700 - val_loss: 0.4446 - val_custom_accuracy: 0.3442
Epoch 12/250
4/4 [==============================] - 6s 2s/step - loss: 0.4428 - custom_accuracy: 0.8162
- val_loss: 0.4442 - val_custom_accuracy: 0.3442
Epoch 13/250
4/4 [==============================] - 6s 1s/step - loss: 0.4447 - custom_accuracy: 0.7567
- val_loss: 0.4443 - val_custom_accuracy: 0.3442
Epoch 14/250
4/4 [==============================] - 4s 1s/step - loss: 0.4344 - custom_accuracy: 0.8075
- val_loss: 0.4443 - val_custom_accuracy: 0.3442
Epoch 15/250
4/4 [==============================] - 4s 1s/step - loss: 0.4433 - custom_accuracy: 0.7255
- val_loss: 0.4438 - val_custom_accuracy: 0.3442
Epoch 16/250
4/4 [==============================] - 7s 2s/step - loss: 0.4453 - custom_accuracy: 0.7733
- val_loss: 0.4431 - val_custom_accuracy: 0.3442
Epoch 17/250
4/4 [==============================] - 5s 1s/step - loss: 0.4439 - custom_accuracy: 0.8109
- val_loss: 0.4427 - val_custom_accuracy: 0.3442
Epoch 18/250
4/4 [==============================] - 4s 1s/step - loss: 0.4391 - custom_accuracy: 0.7531
- val_loss: 0.4422 - val_custom_accuracy: 0.3442
Epoch 19/250
4/4 [==============================] - 5s 1s/step - loss: 0.4342 - custom_accuracy: 0.7260
- val_loss: 0.4420 - val_custom_accuracy: 0.3442
Epoch 20/250
4/4 [==============================] - 7s 2s/step - loss: 0.4460 - custom_accuracy: 0.6993
- val_loss: 0.4415 - val_custom_accuracy: 0.3442
Epoch 21/250
4/4 [==============================] - 4s 1s/step - loss: 0.4429 - custom_accuracy: 0.7412
- val_loss: 0.4412 - val_custom_accuracy: 0.3442
Epoch 22/250
4/4 [==============================] - 4s 1s/step - loss: 0.4349 - custom_accuracy: 0.8180
- val_loss: 0.4411 - val_custom_accuracy: 0.3442
Epoch 23/250
4/4 [==============================] - 7s 2s/step - loss: 0.4472 - custom_accuracy: 0.8090
- val_loss: 0.4415 - val_custom_accuracy: 0.3442
Epoch 24/250
```

```
4/4 [==============================] - 5s 1s/step - loss: 0.4307 - custom_accuracy: 0.7455
- val_loss: 0.4418 - val_custom_accuracy: 0.3442
Epoch 25/250
4/4 [==============================] - 4s 1s/step - loss: 0.4265 - custom_accuracy: 0.7612
- val_loss: 0.4419 - val_custom_accuracy: 0.3442
Epoch 26/250
4/4 [==============================] - 4s 1s/step - loss: 0.4545 - custom_accuracy: 0.8098
- val_loss: 0.4415 - val_custom_accuracy: 0.3442
Epoch 27/250
4/4 [==============================] - 7s 2s/step - loss: 0.4484 - custom_accuracy: 0.8125
- val_loss: 0.4411 - val_custom_accuracy: 0.3442
Epoch 28/250
4/4 [==============================] - 4s 1s/step - loss: 0.4356 - custom_accuracy: 0.8185
- val_loss: 0.4417 - val_custom_accuracy: 0.3442
Epoch 29/250
4/4 [==============================] - 4s 971ms/step - loss: 0.4626 - custom_accuracy: 0.7
709 - val_loss: 0.4429 - val_custom_accuracy: 0.3442
Epoch 30/250
4/4 [==============================] - 5s 1s/step - loss: 0.4350 - custom_accuracy: 0.8129
- val_loss: 0.4434 - val_custom_accuracy: 0.3442
Epoch 31/250
4/4 [==============================] - 6s 2s/step - loss: 0.4378 - custom_accuracy: 0.7020
- val_loss: 0.4437 - val_custom_accuracy: 0.3442
Epoch 32/250
4/4 [==============================] - 4s 1s/step - loss: 0.4278 - custom_accuracy: 0.7054
- val_loss: 0.4438 - val_custom_accuracy: 0.3442
Epoch 33/250
4/4 [==============================] - 4s 1s/step - loss: 0.4302 - custom_accuracy: 0.8142
- val_loss: 0.4440 - val_custom_accuracy: 0.3442
Epoch 34/250
4/4 [==============================] - 6s 2s/step - loss: 0.4333 - custom_accuracy: 0.8148
- val_loss: 0.4442 - val_custom_accuracy: 0.3442
Epoch 35/250
4/4 [==============================] - 6s 1s/step - loss: 0.4235 - custom_accuracy: 0.8160
- val_loss: 0.4446 - val_custom_accuracy: 0.3442
Epoch 36/250
4/4 [==============================] - 4s 998ms/step - loss: 0.4366 - custom_accuracy: 0.7
666 - val_loss: 0.4448 - val_custom_accuracy: 0.3442
Epoch 37/250
4/4 [==============================] - 4s 1s/step - loss: 0.4381 - custom_accuracy: 0.7286
- val_loss: 0.4448 - val_custom_accuracy: 0.3442
Epoch 38/250
4/4 [==============================] - 7s 2s/step - loss: 0.4285 - custom_accuracy: 0.8141
- val_loss: 0.4445 - val_custom_accuracy: 0.3442
Epoch 39/250
4/4 [==============================] - 5s 1s/step - loss: 0.4263 - custom_accuracy: 0.8204
- val_loss: 0.4451 - val_custom_accuracy: 0.3442
Epoch 40/250
4/4 [==============================] - 4s 1s/step - loss: 0.4293 - custom_accuracy: 0.6861
- val_loss: 0.4456 - val_custom_accuracy: 0.3442
Epoch 41/250
4/4 [==============================] - 5s 1s/step - loss: 0.4439 - custom_accuracy: 0.8104
- val_loss: 0.4452 - val_custom_accuracy: 0.3442
Epoch 42/250
4/4 [==============================] - 6s 2s/step - loss: 0.4348 - custom_accuracy: 0.8098
- val_loss: 0.4445 - val_custom_accuracy: 0.3442
Epoch 43/250
4/4 [==============================] - 4s 1s/step - loss: 0.4339 - custom_accuracy: 0.7696
- val_loss: 0.4441 - val_custom_accuracy: 0.3442
Epoch 44/250
4/4 [==============================] - 4s 1s/step - loss: 0.4250 - custom_accuracy: 0.7366
- val_loss: 0.4443 - val_custom_accuracy: 0.3442
Epoch 45/250
4/4 [==============================] - 6s 2s/step - loss: 0.4409 - custom_accuracy: 0.8116
```

```
- val_loss: 0.4450 - val_custom_accuracy: 0.3442
Epoch 46/250
4/4 [==============================] - 6s 1s/step - loss: 0.4421 - custom_accuracy: 0.8052
- val_loss: 0.4456 - val_custom_accuracy: 0.3442
Epoch 47/250
4/4 [==============================] - 4s 1s/step - loss: 0.4305 - custom_accuracy: 0.7724
- val_loss: 0.4457 - val_custom_accuracy: 0.3442
Epoch 48/250
4/4 [==============================] - 4s 969ms/step - loss: 0.4388 - custom_accuracy: 0.7
526 - val_loss: 0.4452 - val_custom_accuracy: 0.3442
Epoch 49/250
4/4 [==============================] - 7s 2s/step - loss: 0.4233 - custom_accuracy: 0.8159
- val_loss: 0.4445 - val_custom_accuracy: 0.3442
Epoch 50/250
4/4 [==============================] - 5s 1s/step - loss: 0.4373 - custom_accuracy: 0.8149
- val_loss: 0.4441 - val_custom_accuracy: 0.3442
Epoch 51/250
4/4 [==============================] - 4s 1s/step - loss: 0.4328 - custom_accuracy: 0.6990
- val_loss: 0.4437 - val_custom_accuracy: 0.3442
Epoch 52/250
4/4 [==============================] - 4s 1s/step - loss: 0.4350 - custom_accuracy: 0.8206
- val_loss: 0.4432 - val_custom_accuracy: 0.3442
Epoch 53/250
4/4 [==============================] - 7s 2s/step - loss: 0.4267 - custom_accuracy: 0.8137
- val_loss: 0.4433 - val_custom_accuracy: 0.3442
Epoch 54/250
4/4 [==============================] - 4s 989ms/step - loss: 0.4283 - custom_accuracy: 0.8
078 - val_loss: 0.4437 - val_custom_accuracy: 0.3442
Epoch 55/250
4/4 [==============================] - 4s 1s/step - loss: 0.4308 - custom_accuracy: 0.7570
- val_loss: 0.4445 - val_custom_accuracy: 0.3442
Epoch 56/250
4/4 [==============================] - 5s 1s/step - loss: 0.4325 - custom_accuracy: 0.7791
- val_loss: 0.4449 - val_custom_accuracy: 0.3442
Epoch 57/250
4/4 [==============================] - 6s 2s/step - loss: 0.4422 - custom_accuracy: 0.7579
- val_loss: 0.4440 - val_custom_accuracy: 0.3442
Epoch 58/250
4/4 [==============================] - 4s 1s/step - loss: 0.4189 - custom_accuracy: 0.7271
- val_loss: 0.4433 - val_custom_accuracy: 0.3442
Epoch 59/250
4/4 [==============================] - 5s 1s/step - loss: 0.4350 - custom_accuracy: 0.6939
- val_loss: 0.4428 - val_custom_accuracy: 0.3442
Epoch 60/250
4/4 [==============================] - 8s 2s/step - loss: 0.4328 - custom_accuracy: 0.7430
- val_loss: 0.4427 - val_custom_accuracy: 0.3442
Epoch 61/250
4/4 [==============================] - 6s 1s/step - loss: 0.4426 - custom_accuracy: 0.8121
- val_loss: 0.4422 - val_custom_accuracy: 0.3442
Epoch 62/250
4/4 [==============================] - 4s 1s/step - loss: 0.4261 - custom_accuracy: 0.7411
- val_loss: 0.4421 - val_custom_accuracy: 0.3442
Epoch 63/250
4/4 [==============================] - 4s 1s/step - loss: 0.4245 - custom_accuracy: 0.7723
- val_loss: 0.4426 - val_custom_accuracy: 0.3442
Epoch 64/250
4/4 [==============================] - 6s 2s/step - loss: 0.4345 - custom_accuracy: 0.7671
- val_loss: 0.4429 - val_custom_accuracy: 0.3442
Epoch 65/250
4/4 [==============================] - 5s 1s/step - loss: 0.4434 - custom_accuracy: 0.7535
- val_loss: 0.4427 - val_custom_accuracy: 0.3442
Epoch 66/250
4/4 [==============================] - 4s 1s/step - loss: 0.4125 - custom_accuracy: 0.8178
- val_loss: 0.4430 - val_custom_accuracy: 0.3442
```

```
Epoch 67/250
4/4 [==============================] - 4s 1s/step - loss: 0.4260 - custom_accuracy: 0.8158
- val_loss: 0.4440 - val_custom_accuracy: 0.3442
Epoch 68/250
4/4 [==============================] - 7s 2s/step - loss: 0.4205 - custom_accuracy: 0.8189
- val_loss: 0.4456 - val_custom_accuracy: 0.3442
Epoch 69/250
4/4 [==============================] - 5s 1s/step - loss: 0.4284 - custom_accuracy: 0.7549
- val_loss: 0.4468 - val_custom_accuracy: 0.3442
Epoch 70/250
4/4 [==============================] - 4s 964ms/step - loss: 0.4486 - custom_accuracy: 0.6
844 - val_loss: 0.4472 - val_custom_accuracy: 0.3442
Epoch 71/250
4/4 [==============================] - 5s 1s/step - loss: 0.4241 - custom_accuracy: 0.8250
- val_loss: 0.4470 - val_custom_accuracy: 0.3442
Epoch 72/250
4/4 [==============================] - 7s 2s/step - loss: 0.4194 - custom_accuracy: 0.8131
- val_loss: 0.4478 - val_custom_accuracy: 0.3442
Epoch 73/250
4/4 [==============================] - 4s 1s/step - loss: 0.4382 - custom_accuracy: 0.8154
- val_loss: 0.4488 - val_custom_accuracy: 0.3442
Epoch 74/250
4/4 [==============================] - 4s 1s/step - loss: 0.4243 - custom_accuracy: 0.7416
- val_loss: 0.4497 - val_custom_accuracy: 0.3442
Epoch 75/250
4/4 [==============================] - 6s 2s/step - loss: 0.4171 - custom_accuracy: 0.7259
- val_loss: 0.4501 - val_custom_accuracy: 0.3442
Epoch 76/250
4/4 [==============================] - 6s 1s/step - loss: 0.4243 - custom_accuracy: 0.6841
- val_loss: 0.4501 - val_custom_accuracy: 0.3442
Epoch 77/250
4/4 [==============================] - 4s 1s/step - loss: 0.4371 - custom_accuracy: 0.7095
- val_loss: 0.4494 - val_custom_accuracy: 0.3442
Epoch 78/250
4/4 [==============================] - 4s 964ms/step - loss: 0.4407 - custom_accuracy: 0.7
400 - val_loss: 0.4482 - val_custom_accuracy: 0.3442
Epoch 79/250
4/4 [==============================] - 6s 2s/step - loss: 0.4241 - custom_accuracy: 0.8169
- val_loss: 0.4476 - val_custom_accuracy: 0.3442
Epoch 80/250
4/4 [==============================] - 5s 1s/step - loss: 0.4320 - custom_accuracy: 0.8115
- val_loss: 0.4478 - val_custom_accuracy: 0.3442
Epoch 81/250
4/4 [==============================] - 4s 984ms/step - loss: 0.4327 - custom_accuracy: 0.7
611 - val_loss: 0.4474 - val_custom_accuracy: 0.3442
Epoch 82/250
4/4 [==============================] - 4s 1s/step - loss: 0.4219 - custom_accuracy: 0.7258
- val_loss: 0.4469 - val_custom_accuracy: 0.3442
Epoch 83/250
4/4 [==============================] - 7s 2s/step - loss: 0.4199 - custom_accuracy: 0.8182
- val_loss: 0.4466 - val_custom_accuracy: 0.3442
Epoch 84/250
4/4 [==============================] - 4s 1s/step - loss: 0.4143 - custom_accuracy: 0.8206
- val_loss: 0.4471 - val_custom_accuracy: 0.3442
Epoch 85/250
4/4 [==============================] - 4s 1s/step - loss: 0.4165 - custom_accuracy: 0.7602
- val_loss: 0.4482 - val_custom_accuracy: 0.3442
Epoch 86/250
4/4 [==============================] - 5s 1s/step - loss: 0.4400 - custom_accuracy: 0.7016
- val_loss: 0.4488 - val_custom_accuracy: 0.3442
Epoch 87/250
4/4 [==============================] - 6s 2s/step - loss: 0.4300 - custom_accuracy: 0.7400
- val_loss: 0.4500 - val_custom_accuracy: 0.3442
Epoch 88/250
```

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4/4 [==============================] - 4s 1s/step - loss: 0.4427 - custom_accuracy: 0.6471
- val_loss: 0.4508 - val_custom_accuracy: 0.3442
Epoch 89/250
4/4 [==============================] - 4s 1s/step - loss: 0.4170 - custom_accuracy: 0.7174
- val_loss: 0.4513 - val_custom_accuracy: 0.3442
Epoch 90/250
4/4 [==============================] - 6s 2s/step - loss: 0.4199 - custom_accuracy: 0.5775
- val_loss: 0.4511 - val_custom_accuracy: 0.3442
Epoch 91/250
4/4 [==============================] - 5s 1s/step - loss: 0.4422 - custom_accuracy: 0.8149
- val_loss: 0.4505 - val_custom_accuracy: 0.3442
Epoch 92/250
4/4 [==============================] - 4s 1s/step - loss: 0.4448 - custom_accuracy: 0.7654
- val_loss: 0.4494 - val_custom_accuracy: 0.3442
Epoch 93/250
4/4 [==============================] - 4s 1s/step - loss: 0.4207 - custom_accuracy: 0.8131
- val_loss: 0.4482 - val_custom_accuracy: 0.3442
Epoch 94/250
4/4 [==============================] - 7s 2s/step - loss: 0.4174 - custom_accuracy: 0.8139
- val_loss: 0.4479 - val_custom_accuracy: 0.3442
Epoch 95/250
4/4 [==============================] - 5s 1s/step - loss: 0.4157 - custom_accuracy: 0.7681
- val_loss: 0.4479 - val_custom_accuracy: 0.3442
Epoch 96/250
4/4 [==============================] - 4s 1s/step - loss: 0.4146 - custom_accuracy: 0.8173
- val_loss: 0.4477 - val_custom_accuracy: 0.3442
Epoch 97/250
4/4 [==============================] - 5s 1s/step - loss: 0.4329 - custom_accuracy: 0.7674
- val_loss: 0.4480 - val_custom_accuracy: 0.3442
Epoch 98/250
4/4 [==============================] - 7s 2s/step - loss: 0.4313 - custom_accuracy: 0.7782
- val_loss: 0.4476 - val_custom_accuracy: 0.3442
Epoch 99/250
4/4 [==============================] - 4s 990ms/step - loss: 0.4289 - custom_accuracy: 0.7
006 - val_loss: 0.4464 - val_custom_accuracy: 0.3442
Epoch 100/250
4/4 [==============================] - 4s 1s/step - loss: 0.4352 - custom_accuracy: 0.7754
- val_loss: 0.4457 - val_custom_accuracy: 0.3442
Epoch 101/250
4/4 [==============================] - 6s 2s/step - loss: 0.4200 - custom_accuracy: 0.7576
- val_loss: 0.4445 - val_custom_accuracy: 0.3442
Epoch 102/250
4/4 [==============================] - 6s 1s/step - loss: 0.4114 - custom_accuracy: 0.7751
- val_loss: 0.4434 - val_custom_accuracy: 0.3442
Epoch 103/250
4/4 [==============================] - 4s 964ms/step - loss: 0.4273 - custom_accuracy: 0.7
268 - val_loss: 0.4423 - val_custom_accuracy: 0.3442
Epoch 104/250
4/4 [==============================] - 4s 1s/step - loss: 0.4167 - custom_accuracy: 0.8087
- val_loss: 0.4416 - val_custom_accuracy: 0.3442
Epoch 105/250
4/4 [==============================] - 6s 2s/step - loss: 0.4288 - custom_accuracy: 0.8119
- val_loss: 0.4412 - val_custom_accuracy: 0.3442
Epoch 106/250
4/4 [==============================] - 5s 1s/step - loss: 0.4280 - custom_accuracy: 0.8146
- val_loss: 0.4408 - val_custom_accuracy: 0.3442
Epoch 107/250
4/4 [==============================] - 4s 1s/step - loss: 0.4003 - custom_accuracy: 0.8230
- val_loss: 0.4413 - val_custom_accuracy: 0.3442
Epoch 108/250
4/4 [==============================] - 5s 1s/step - loss: 0.4278 - custom_accuracy: 0.7310
- val_loss: 0.4429 - val_custom_accuracy: 0.3442
Epoch 109/250
4/4 [==============================] - 7s 2s/step - loss: 0.4189 - custom_accuracy: 0.7771
```

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- val_loss: 0.4434 - val_custom_accuracy: 0.3442
Epoch 110/250
4/4 [==============================] - 4s 1s/step - loss: 0.4133 - custom_accuracy: 0.7431
- val_loss: 0.4430 - val_custom_accuracy: 0.3442
Epoch 111/250
4/4 [==============================] - 4s 1s/step - loss: 0.4061 - custom_accuracy: 0.8068
- val_loss: 0.4427 - val_custom_accuracy: 0.3442
Epoch 112/250
4/4 [==============================] - 6s 2s/step - loss: 0.4236 - custom_accuracy: 0.8121
- val_loss: 0.4424 - val_custom_accuracy: 0.3442
Epoch 113/250
4/4 [==============================] - 7s 2s/step - loss: 0.4222 - custom_accuracy: 0.7756
- val_loss: 0.4419 - val_custom_accuracy: 0.3442
Epoch 114/250
4/4 [==============================] - 5s 1s/step - loss: 0.4195 - custom_accuracy: 0.6964
- val_loss: 0.4407 - val_custom_accuracy: 0.3442
Epoch 115/250
4/4 [==============================] - 4s 1s/step - loss: 0.4141 - custom_accuracy: 0.6935
- val_loss: 0.4407 - val_custom_accuracy: 0.3442
Epoch 116/250
4/4 [==============================] - 5s 1s/step - loss: 0.4258 - custom_accuracy: 0.7358
- val_loss: 0.4422 - val_custom_accuracy: 0.3442
Epoch 117/250
4/4 [==============================] - 7s 2s/step - loss: 0.4170 - custom_accuracy: 0.8104
- val_loss: 0.4439 - val_custom_accuracy: 0.3442
Epoch 118/250
4/4 [==============================] - 4s 1s/step - loss: 0.4402 - custom_accuracy: 0.7590
- val_loss: 0.4448 - val_custom_accuracy: 0.3442
Epoch 119/250
4/4 [==============================] - 4s 989ms/step - loss: 0.4193 - custom_accuracy: 0.8
146 - val_loss: 0.4451 - val_custom_accuracy: 0.3442
Epoch 120/250
4/4 [==============================] - 6s 2s/step - loss: 0.4197 - custom_accuracy: 0.8100
- val_loss: 0.4451 - val_custom_accuracy: 0.3442
Epoch 121/250
4/4 [==============================] - 6s 1s/step - loss: 0.4151 - custom_accuracy: 0.8156
- val_loss: 0.4445 - val_custom_accuracy: 0.3442
Epoch 122/250
4/4 [==============================] - 4s 998ms/step - loss: 0.4272 - custom_accuracy: 0.7
279 - val_loss: 0.4431 - val_custom_accuracy: 0.3442
Epoch 123/250
4/4 [==============================] - 4s 1s/step - loss: 0.4118 - custom_accuracy: 0.8129
- val_loss: 0.4411 - val_custom_accuracy: 0.3442
Epoch 124/250
4/4 [==============================] - 6s 2s/step - loss: 0.4069 - custom_accuracy: 0.7054
- val_loss: 0.4397 - val_custom_accuracy: 0.3442
Epoch 125/250
4/4 [==============================] - 5s 1s/step - loss: 0.4096 - custom_accuracy: 0.7639
- val_loss: 0.4379 - val_custom_accuracy: 0.3442
Epoch 126/250
4/4 [==============================] - 4s 985ms/step - loss: 0.4154 - custom_accuracy: 0.8
230 - val_loss: 0.4368 - val_custom_accuracy: 0.3442
Epoch 127/250
4/4 [==============================] - 4s 1s/step - loss: 0.4303 - custom_accuracy: 0.7226
- val_loss: 0.4368 - val_custom_accuracy: 0.3442
Epoch 128/250
4/4 [==============================] - 7s 2s/step - loss: 0.4197 - custom_accuracy: 0.7598
- val_loss: 0.4355 - val_custom_accuracy: 0.3442
Epoch 129/250
4/4 [==============================] - 4s 1s/step - loss: 0.4263 - custom_accuracy: 0.8070
- val_loss: 0.4340 - val_custom_accuracy: 0.3442
Epoch 130/250
4/4 [==============================] - 4s 997ms/step - loss: 0.4216 - custom_accuracy: 0.7
007 - val_loss: 0.4328 - val_custom_accuracy: 0.3442
```

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Epoch 131/250
4/4 [==============================] - 5s 1s/step - loss: 0.4151 - custom_accuracy: 0.7661
- val_loss: 0.4315 - val_custom_accuracy: 0.3442
Epoch 132/250
4/4 [==============================] - 6s 2s/step - loss: 0.4114 - custom_accuracy: 0.7031
- val_loss: 0.4302 - val_custom_accuracy: 0.3442
Epoch 133/250
4/4 [==============================] - 4s 994ms/step - loss: 0.4229 - custom_accuracy: 0.7
663 - val_loss: 0.4289 - val_custom_accuracy: 0.3442
Epoch 134/250
4/4 [==============================] - 4s 1s/step - loss: 0.3942 - custom_accuracy: 0.7308
- val_loss: 0.4280 - val_custom_accuracy: 0.3442
Epoch 135/250
4/4 [==============================] - 6s 2s/step - loss: 0.4168 - custom_accuracy: 0.7394
- val_loss: 0.4274 - val_custom_accuracy: 0.3442
Epoch 136/250
4/4 [==============================] - 6s 1s/step - loss: 0.3967 - custom_accuracy: 0.7537
- val_loss: 0.4274 - val_custom_accuracy: 0.3442
Epoch 137/250
4/4 [==============================] - 4s 999ms/step - loss: 0.4220 - custom_accuracy: 0.7
333 - val_loss: 0.4270 - val_custom_accuracy: 0.3442
Epoch 138/250
4/4 [==============================] - 4s 994ms/step - loss: 0.4108 - custom_accuracy: 0.8
125 - val_loss: 0.4274 - val_custom_accuracy: 0.3442
Epoch 139/250
4/4 [==============================] - 7s 2s/step - loss: 0.4170 - custom_accuracy: 0.8137
- val_loss: 0.4279 - val_custom_accuracy: 0.3442
Epoch 140/250
4/4 [==============================] - 5s 1s/step - loss: 0.4190 - custom_accuracy: 0.7700
- val_loss: 0.4285 - val_custom_accuracy: 0.3442
Epoch 141/250
4/4 [==============================] - 4s 1s/step - loss: 0.4086 - custom_accuracy: 0.8154
- val_loss: 0.4289 - val_custom_accuracy: 0.3442
Epoch 142/250
4/4 [==============================] - 5s 1s/step - loss: 0.4163 - custom_accuracy: 0.8153
- val_loss: 0.4293 - val_custom_accuracy: 0.3442
Epoch 143/250
4/4 [==============================] - 7s 2s/step - loss: 0.4205 - custom_accuracy: 0.7394
- val_loss: 0.4293 - val_custom_accuracy: 0.3442
Epoch 144/250
4/4 [==============================] - 4s 1s/step - loss: 0.4184 - custom_accuracy: 0.7408
- val_loss: 0.4287 - val_custom_accuracy: 0.3442
Epoch 145/250
4/4 [==============================] - 4s 1s/step - loss: 0.4066 - custom_accuracy: 0.8286
- val_loss: 0.4279 - val_custom_accuracy: 0.3442
Epoch 146/250
4/4 [==============================] - 6s 2s/step - loss: 0.4067 - custom_accuracy: 0.8149
- val_loss: 0.4276 - val_custom_accuracy: 0.3442
Epoch 147/250
4/4 [==============================] - 6s 1s/step - loss: 0.3942 - custom_accuracy: 0.5715
- val_loss: 0.4281 - val_custom_accuracy: 0.3442
Epoch 148/250
4/4 [==============================] - 4s 1s/step - loss: 0.4143 - custom_accuracy: 0.7429
- val_loss: 0.4290 - val_custom_accuracy: 0.3442
Epoch 149/250
4/4 [==============================] - 4s 1s/step - loss: 0.4127 - custom_accuracy: 0.6968
- val_loss: 0.4287 - val_custom_accuracy: 0.3442
Epoch 150/250
4/4 [==============================] - 7s 2s/step - loss: 0.4168 - custom_accuracy: 0.7763
- val_loss: 0.4284 - val_custom_accuracy: 0.3442
Epoch 151/250
4/4 [==============================] - 5s 1s/step - loss: 0.3995 - custom_accuracy: 0.8088
- val_loss: 0.4275 - val_custom_accuracy: 0.3442
Epoch 152/250
```

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4/4 [==============================] - 4s 1s/step - loss: 0.4075 - custom_accuracy: 0.7769
- val_loss: 0.4265 - val_custom_accuracy: 0.3442
Epoch 153/250
4/4 [==============================] - 6s 2s/step - loss: 0.4114 - custom_accuracy: 0.8162
- val_loss: 0.4254 - val_custom_accuracy: 0.3442
Epoch 154/250
4/4 [==============================] - 6s 2s/step - loss: 0.3902 - custom_accuracy: 0.8177
- val_loss: 0.4251 - val_custom_accuracy: 0.3442
Epoch 155/250
4/4 [==============================] - 4s 999ms/step - loss: 0.4126 - custom_accuracy: 0.8
153 - val_loss: 0.4252 - val_custom_accuracy: 0.3442
Epoch 156/250
4/4 [==============================] - 4s 1s/step - loss: 0.3957 - custom_accuracy: 0.6842
- val_loss: 0.4258 - val_custom_accuracy: 0.3442
Epoch 157/250
4/4 [==============================] - 6s 2s/step - loss: 0.4315 - custom_accuracy: 0.7341
- val_loss: 0.4255 - val_custom_accuracy: 0.3442
Epoch 158/250
4/4 [==============================] - 5s 1s/step - loss: 0.4036 - custom_accuracy: 0.7010
- val_loss: 0.4258 - val_custom_accuracy: 0.3442
Epoch 159/250
4/4 [==============================] - 4s 1s/step - loss: 0.3930 - custom_accuracy: 0.8151
- val_loss: 0.4269 - val_custom_accuracy: 0.3442
Epoch 160/250
4/4 [==============================] - 4s 1s/step - loss: 0.4072 - custom_accuracy: 0.7367
- val_loss: 0.4276 - val_custom_accuracy: 0.3442
Epoch 161/250
4/4 [==============================] - 7s 2s/step - loss: 0.4104 - custom_accuracy: 0.7700
- val_loss: 0.4274 - val_custom_accuracy: 0.3442
Epoch 162/250
4/4 [==============================] - 4s 1s/step - loss: 0.3897 - custom_accuracy: 0.7580
- val_loss: 0.4273 - val_custom_accuracy: 0.3442
Epoch 163/250
4/4 [==============================] - 4s 1s/step - loss: 0.4134 - custom_accuracy: 0.6637
- val_loss: 0.4269 - val_custom_accuracy: 0.3442
Epoch 164/250
4/4 [==============================] - 5s 1s/step - loss: 0.4018 - custom_accuracy: 0.8149
- val_loss: 0.4263 - val_custom_accuracy: 0.3442
Epoch 165/250
4/4 [==============================] - 8s 2s/step - loss: 0.3938 - custom_accuracy: 0.8147
- val_loss: 0.4261 - val_custom_accuracy: 0.3442
Epoch 166/250
4/4 [==============================] - 6s 1s/step - loss: 0.4001 - custom_accuracy: 0.8155
- val_loss: 0.4259 - val_custom_accuracy: 0.3442
Epoch 167/250
4/4 [==============================] - 4s 1s/step - loss: 0.3973 - custom_accuracy: 0.8188
- val_loss: 0.4259 - val_custom_accuracy: 0.3442
Epoch 168/250
4/4 [==============================] - 6s 2s/step - loss: 0.3782 - custom_accuracy: 0.8130
- val_loss: 0.4264 - val_custom_accuracy: 0.3442
Epoch 169/250
4/4 [==============================] - 6s 1s/step - loss: 0.4236 - custom_accuracy: 0.7370
- val_loss: 0.4267 - val_custom_accuracy: 0.3442
Epoch 170/250
4/4 [==============================] - 4s 1s/step - loss: 0.3947 - custom_accuracy: 0.7734
- val_loss: 0.4268 - val_custom_accuracy: 0.3442
Epoch 171/250
4/4 [==============================] - 4s 1s/step - loss: 0.4038 - custom_accuracy: 0.8178
- val_loss: 0.4262 - val_custom_accuracy: 0.3442
Epoch 172/250
4/4 [==============================] - 7s 2s/step - loss: 0.3966 - custom_accuracy: 0.7607
- val_loss: 0.4256 - val_custom_accuracy: 0.3442
Epoch 173/250
4/4 [==============================] - 5s 1s/step - loss: 0.4095 - custom_accuracy: 0.8024
```

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- val_loss: 0.4248 - val_custom_accuracy: 0.3442
Epoch 174/250
4/4 [==============================] - 4s 1s/step - loss: 0.4029 - custom_accuracy: 0.7582
- val_loss: 0.4239 - val_custom_accuracy: 0.3442
Epoch 175/250
4/4 [==============================] - 5s 1s/step - loss: 0.3927 - custom_accuracy: 0.8149
- val_loss: 0.4238 - val_custom_accuracy: 0.3442
Epoch 176/250
4/4 [==============================] - 7s 2s/step - loss: 0.4244 - custom_accuracy: 0.8149
- val_loss: 0.4244 - val_custom_accuracy: 0.3442
Epoch 177/250
4/4 [==============================] - 4s 980ms/step - loss: 0.4084 - custom_accuracy: 0.7
603 - val_loss: 0.4249 - val_custom_accuracy: 0.3442
Epoch 178/250
4/4 [==============================] - 4s 1s/step - loss: 0.4052 - custom_accuracy: 0.8106
- val_loss: 0.4255 - val_custom_accuracy: 0.3442
Epoch 179/250
4/4 [==============================] - 5s 1s/step - loss: 0.3988 - custom_accuracy: 0.8114
- val_loss: 0.4257 - val_custom_accuracy: 0.3442
Epoch 180/250
4/4 [==============================] - 6s 2s/step - loss: 0.3938 - custom_accuracy: 0.7693
- val_loss: 0.4257 - val_custom_accuracy: 0.3442
Epoch 181/250
4/4 [==============================] - 4s 1s/step - loss: 0.4160 - custom_accuracy: 0.8121
- val_loss: 0.4251 - val_custom_accuracy: 0.3442
Epoch 182/250
4/4 [==============================] - 4s 1s/step - loss: 0.3944 - custom_accuracy: 0.8139
- val_loss: 0.4246 - val_custom_accuracy: 0.3442
Epoch 183/250
4/4 [==============================] - 7s 2s/step - loss: 0.4101 - custom_accuracy: 0.6907
- val_loss: 0.4239 - val_custom_accuracy: 0.3442
Epoch 184/250
4/4 [==============================] - 5s 1s/step - loss: 0.4128 - custom_accuracy: 0.7570
- val_loss: 0.4231 - val_custom_accuracy: 0.3442
Epoch 185/250
4/4 [==============================] - 4s 1s/step - loss: 0.3891 - custom_accuracy: 0.8165
- val_loss: 0.4229 - val_custom_accuracy: 0.3442
Epoch 186/250
4/4 [==============================] - 4s 981ms/step - loss: 0.4148 - custom_accuracy: 0.7
253 - val_loss: 0.4224 - val_custom_accuracy: 0.3442
Epoch 187/250
4/4 [==============================] - 7s 2s/step - loss: 0.4081 - custom_accuracy: 0.7391
- val_loss: 0.4215 - val_custom_accuracy: 0.3442
Epoch 188/250
4/4 [==============================] - 5s 1s/step - loss: 0.4008 - custom_accuracy: 0.7765
- val_loss: 0.4203 - val_custom_accuracy: 0.3442
Epoch 189/250
4/4 [==============================] - 4s 1s/step - loss: 0.3974 - custom_accuracy: 0.6961
- val_loss: 0.4189 - val_custom_accuracy: 0.3442
Epoch 190/250
4/4 [==============================] - 5s 1s/step - loss: 0.4073 - custom_accuracy: 0.7402
- val_loss: 0.4176 - val_custom_accuracy: 0.3442
Epoch 191/250
4/4 [==============================] - 7s 2s/step - loss: 0.3951 - custom_accuracy: 0.7400
- val_loss: 0.4169 - val_custom_accuracy: 0.3442
Epoch 192/250
4/4 [==============================] - 4s 1s/step - loss: 0.4014 - custom_accuracy: 0.8169
- val_loss: 0.4172 - val_custom_accuracy: 0.3442
Epoch 193/250
4/4 [==============================] - 4s 977ms/step - loss: 0.4113 - custom_accuracy: 0.7
718 - val_loss: 0.4177 - val_custom_accuracy: 0.3442
Epoch 194/250
4/4 [==============================] - 6s 2s/step - loss: 0.3877 - custom_accuracy: 0.8172
- val_loss: 0.4179 - val_custom_accuracy: 0.3442
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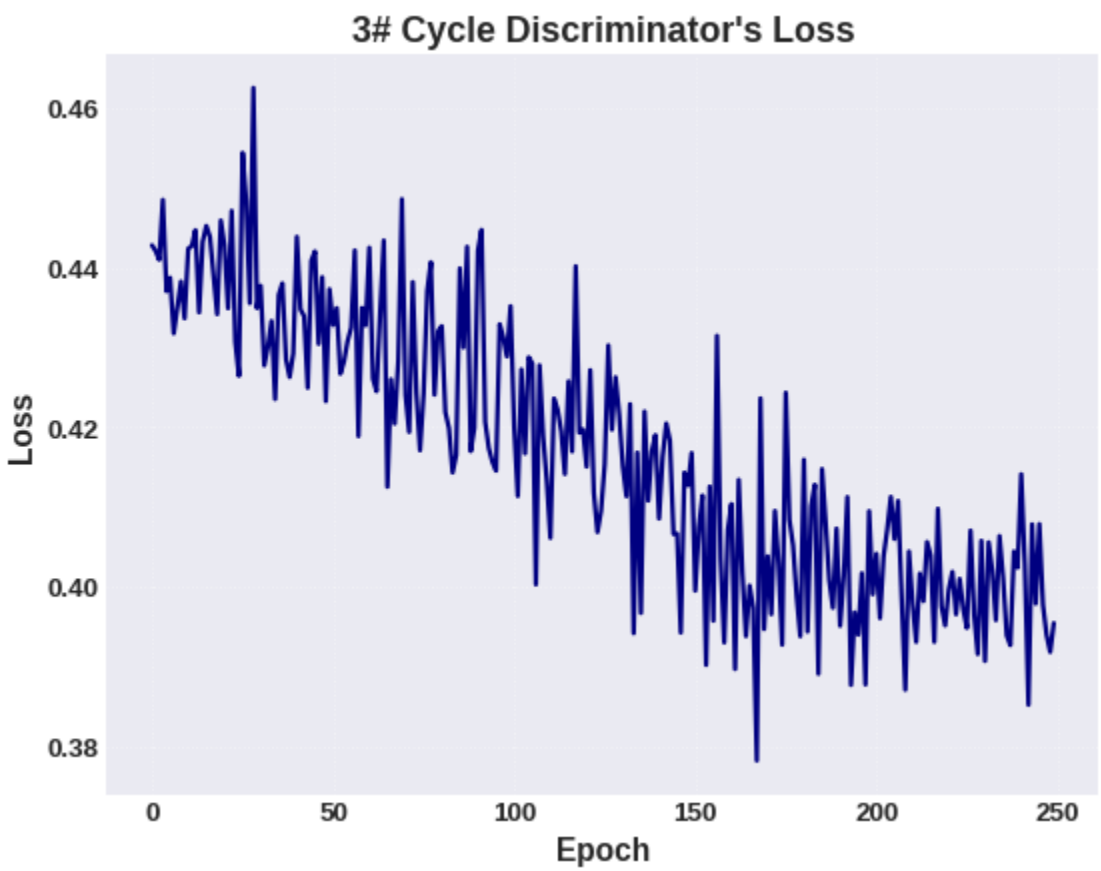
Epoch 195/250
4/4 [==============================] - 6s 1s/step - loss: 0.3968 - custom_accuracy: 0.6990
- val_loss: 0.4185 - val_custom_accuracy: 0.3442
Epoch 196/250
4/4 [==============================] - 4s 1s/step - loss: 0.3940 - custom_accuracy: 0.7678
- val_loss: 0.4190 - val_custom_accuracy: 0.3442
Epoch 197/250
4/4 [==============================] - 4s 1s/step - loss: 0.4017 - custom_accuracy: 0.8129
- val_loss: 0.4188 - val_custom_accuracy: 0.3442
Epoch 198/250
4/4 [==============================] - 7s 2s/step - loss: 0.3877 - custom_accuracy: 0.8143
- val_loss: 0.4191 - val_custom_accuracy: 0.3442
Epoch 199/250
4/4 [==============================] - 5s 1s/step - loss: 0.4095 - custom_accuracy: 0.7650
- val_loss: 0.4190 - val_custom_accuracy: 0.3442
Epoch 200/250
4/4 [==============================] - 4s 1s/step - loss: 0.3991 - custom_accuracy: 0.7536
- val_loss: 0.4187 - val_custom_accuracy: 0.3442
Epoch 201/250
4/4 [==============================] - 5s 1s/step - loss: 0.4042 - custom_accuracy: 0.7489
- val_loss: 0.4180 - val_custom_accuracy: 0.3442
Epoch 202/250
4/4 [==============================] - 7s 2s/step - loss: 0.3961 - custom_accuracy: 0.7728
- val_loss: 0.4169 - val_custom_accuracy: 0.3442
Epoch 203/250
4/4 [==============================] - 4s 1s/step - loss: 0.4038 - custom_accuracy: 0.7245
- val_loss: 0.4153 - val_custom_accuracy: 0.3442
Epoch 204/250
4/4 [==============================] - 4s 1s/step - loss: 0.4072 - custom_accuracy: 0.7658
- val_loss: 0.4135 - val_custom_accuracy: 0.3442
Epoch 205/250
4/4 [==============================] - 6s 2s/step - loss: 0.4113 - custom_accuracy: 0.6839
- val_loss: 0.4121 - val_custom_accuracy: 0.3442
Epoch 206/250
4/4 [==============================] - 6s 1s/step - loss: 0.4060 - custom_accuracy: 0.6740
- val_loss: 0.4107 - val_custom_accuracy: 0.3442
Epoch 207/250
4/4 [==============================] - 4s 989ms/step - loss: 0.4108 - custom_accuracy: 0.7
743 - val_loss: 0.4092 - val_custom_accuracy: 0.3442
Epoch 208/250
4/4 [==============================] - 4s 1s/step - loss: 0.3985 - custom_accuracy: 0.7679
- val_loss: 0.4082 - val_custom_accuracy: 0.3442
Epoch 209/250
4/4 [==============================] - 7s 2s/step - loss: 0.3871 - custom_accuracy: 0.8126
- val_loss: 0.4080 - val_custom_accuracy: 0.3442
Epoch 210/250
4/4 [==============================] - 5s 1s/step - loss: 0.4044 - custom_accuracy: 0.7002
- val_loss: 0.4089 - val_custom_accuracy: 0.3442
Epoch 211/250
4/4 [==============================] - 4s 985ms/step - loss: 0.3979 - custom_accuracy: 0.6
844 - val_loss: 0.4097 - val_custom_accuracy: 0.3442
Epoch 212/250
4/4 [==============================] - 5s 1s/step - loss: 0.3931 - custom_accuracy: 0.8136
- val_loss: 0.4099 - val_custom_accuracy: 0.3442
Epoch 213/250
4/4 [==============================] - 6s 2s/step - loss: 0.4017 - custom_accuracy: 0.7612
- val_loss: 0.4099 - val_custom_accuracy: 0.3442
Epoch 214/250
4/4 [==============================] - 4s 996ms/step - loss: 0.3982 - custom_accuracy: 0.8
095 - val_loss: 0.4099 - val_custom_accuracy: 0.3442
Epoch 215/250
4/4 [==============================] - 4s 996ms/step - loss: 0.4056 - custom_accuracy: 0.8
172 - val_loss: 0.4101 - val_custom_accuracy: 0.3442
Epoch 216/250
```

```
4/4 [==============================] - 6s 2s/step - loss: 0.4039 - custom_accuracy: 0.8115
- val_loss: 0.4101 - val_custom_accuracy: 0.3442
Epoch 217/250
4/4 [==============================] - 8s 2s/step - loss: 0.3931 - custom_accuracy: 0.8147
- val_loss: 0.4106 - val_custom_accuracy: 0.3442
Epoch 218/250
4/4 [==============================] - 6s 1s/step - loss: 0.4098 - custom_accuracy: 0.8134
- val_loss: 0.4112 - val_custom_accuracy: 0.3442
Epoch 219/250
4/4 [==============================] - 5s 1s/step - loss: 0.3975 - custom_accuracy: 0.8078
- val_loss: 0.4117 - val_custom_accuracy: 0.3442
Epoch 220/250
4/4 [==============================] - 7s 2s/step - loss: 0.3951 - custom_accuracy: 0.7250
- val_loss: 0.4119 - val_custom_accuracy: 0.3442
Epoch 221/250
4/4 [==============================] - 4s 1s/step - loss: 0.3997 - custom_accuracy: 0.6973
- val_loss: 0.4126 - val_custom_accuracy: 0.3442
Epoch 222/250
4/4 [==============================] - 4s 1000ms/step - loss: 0.4019 - custom_accuracy: 0.
7097 - val_loss: 0.4141 - val_custom_accuracy: 0.3442
Epoch 223/250
4/4 [==============================] - 6s 2s/step - loss: 0.3965 - custom_accuracy: 0.7391
- val_loss: 0.4155 - val_custom_accuracy: 0.3442
Epoch 224/250
4/4 [==============================] - 6s 1s/step - loss: 0.4010 - custom_accuracy: 0.8120
- val_loss: 0.4174 - val_custom_accuracy: 0.3442
Epoch 225/250
4/4 [==============================] - 4s 1s/step - loss: 0.3972 - custom_accuracy: 0.7054
- val_loss: 0.4195 - val_custom_accuracy: 0.3442
Epoch 226/250
4/4 [==============================] - 4s 1s/step - loss: 0.3948 - custom_accuracy: 0.8150
- val_loss: 0.4212 - val_custom_accuracy: 0.3442
Epoch 227/250
4/4 [==============================] - 7s 2s/step - loss: 0.4071 - custom_accuracy: 0.8192
- val_loss: 0.4218 - val_custom_accuracy: 0.3442
Epoch 228/250
4/4 [==============================] - 5s 1s/step - loss: 0.3965 - custom_accuracy: 0.7123
- val_loss: 0.4211 - val_custom_accuracy: 0.3442
Epoch 229/250
4/4 [==============================] - 4s 1s/step - loss: 0.3916 - custom_accuracy: 0.8170
- val_loss: 0.4204 - val_custom_accuracy: 0.3442
Epoch 230/250
4/4 [==============================] - 5s 1s/step - loss: 0.4058 - custom_accuracy: 0.8079
- val_loss: 0.4197 - val_custom_accuracy: 0.3442
Epoch 231/250
4/4 [==============================] - 7s 2s/step - loss: 0.3907 - custom_accuracy: 0.7035
- val_loss: 0.4194 - val_custom_accuracy: 0.3442
Epoch 232/250
4/4 [==============================] - 4s 1000ms/step - loss: 0.4056 - custom_accuracy: 0.
8166 - val_loss: 0.4190 - val_custom_accuracy: 0.3442
Epoch 233/250
4/4 [==============================] - 4s 1s/step - loss: 0.4021 - custom_accuracy: 0.5815
- val_loss: 0.4189 - val_custom_accuracy: 0.3442
Epoch 234/250
4/4 [==============================] - 6s 2s/step - loss: 0.3958 - custom_accuracy: 0.8131
- val_loss: 0.4193 - val_custom_accuracy: 0.3442
Epoch 235/250
4/4 [==============================] - 6s 1s/step - loss: 0.4064 - custom_accuracy: 0.7386
- val_loss: 0.4195 - val_custom_accuracy: 0.3442
Epoch 236/250
4/4 [==============================] - 4s 1s/step - loss: 0.4011 - custom_accuracy: 0.7678
- val_loss: 0.4194 - val_custom_accuracy: 0.3442
Epoch 237/250
4/4 [==============================] - 4s 1s/step - loss: 0.3939 - custom_accuracy: 0.8153
```

```
- val_loss: 0.4191 - val_custom_accuracy: 0.3442
Epoch 238/250
4/4 [==============================] - 6s 2s/step - loss: 0.3927 - custom_accuracy: 0.7603
- val_loss: 0.4192 - val_custom_accuracy: 0.3442
Epoch 239/250
4/4 [==============================] - 5s 1s/step - loss: 0.4044 - custom_accuracy: 0.7548
- val_loss: 0.4188 - val_custom_accuracy: 0.3442
Epoch 240/250
4/4 [==============================] - 4s 1s/step - loss: 0.4024 - custom_accuracy: 0.8097
- val_loss: 0.4173 - val_custom_accuracy: 0.3442
Epoch 241/250
4/4 [==============================] - 4s 963ms/step - loss: 0.4141 - custom_accuracy: 0.7
697 - val_loss: 0.4157 - val_custom_accuracy: 0.3442
Epoch 242/250
4/4 [==============================] - 7s 2s/step - loss: 0.4028 - custom_accuracy: 0.7639
- val_loss: 0.4137 - val_custom_accuracy: 0.3442
Epoch 243/250
4/4 [==============================] - 5s 1s/step - loss: 0.3852 - custom_accuracy: 0.8155
- val_loss: 0.4124 - val_custom_accuracy: 0.3442
Epoch 244/250
4/4 [==============================] - 4s 979ms/step - loss: 0.4078 - custom_accuracy: 0.6
649 - val_loss: 0.4119 - val_custom_accuracy: 0.3442
Epoch 245/250
4/4 [==============================] - 5s 1s/step - loss: 0.3979 - custom_accuracy: 0.7331
- val_loss: 0.4117 - val_custom_accuracy: 0.3442
Epoch 246/250
4/4 [==============================] - 7s 2s/step - loss: 0.4079 - custom_accuracy: 0.8112
- val_loss: 0.4110 - val_custom_accuracy: 0.3442
Epoch 247/250
4/4 [==============================] - 4s 1s/step - loss: 0.3978 - custom_accuracy: 0.7271
- val_loss: 0.4102 - val_custom_accuracy: 0.3442
Epoch 248/250
4/4 [==============================] - 4s 998ms/step - loss: 0.3940 - custom_accuracy: 0.7
264 - val_loss: 0.4094 - val_custom_accuracy: 0.3442
Epoch 249/250
4/4 [==============================] - 6s 2s/step - loss: 0.3918 - custom_accuracy: 0.7392
- val_loss: 0.4094 - val_custom_accuracy: 0.3442
Epoch 250/250
4/4 [==============================] - 6s 1s/step - loss: 0.3954 - custom_accuracy: 0.8144
- val_loss: 0.4100 - val_custom_accuracy: 0.3442
```

In [ ]:

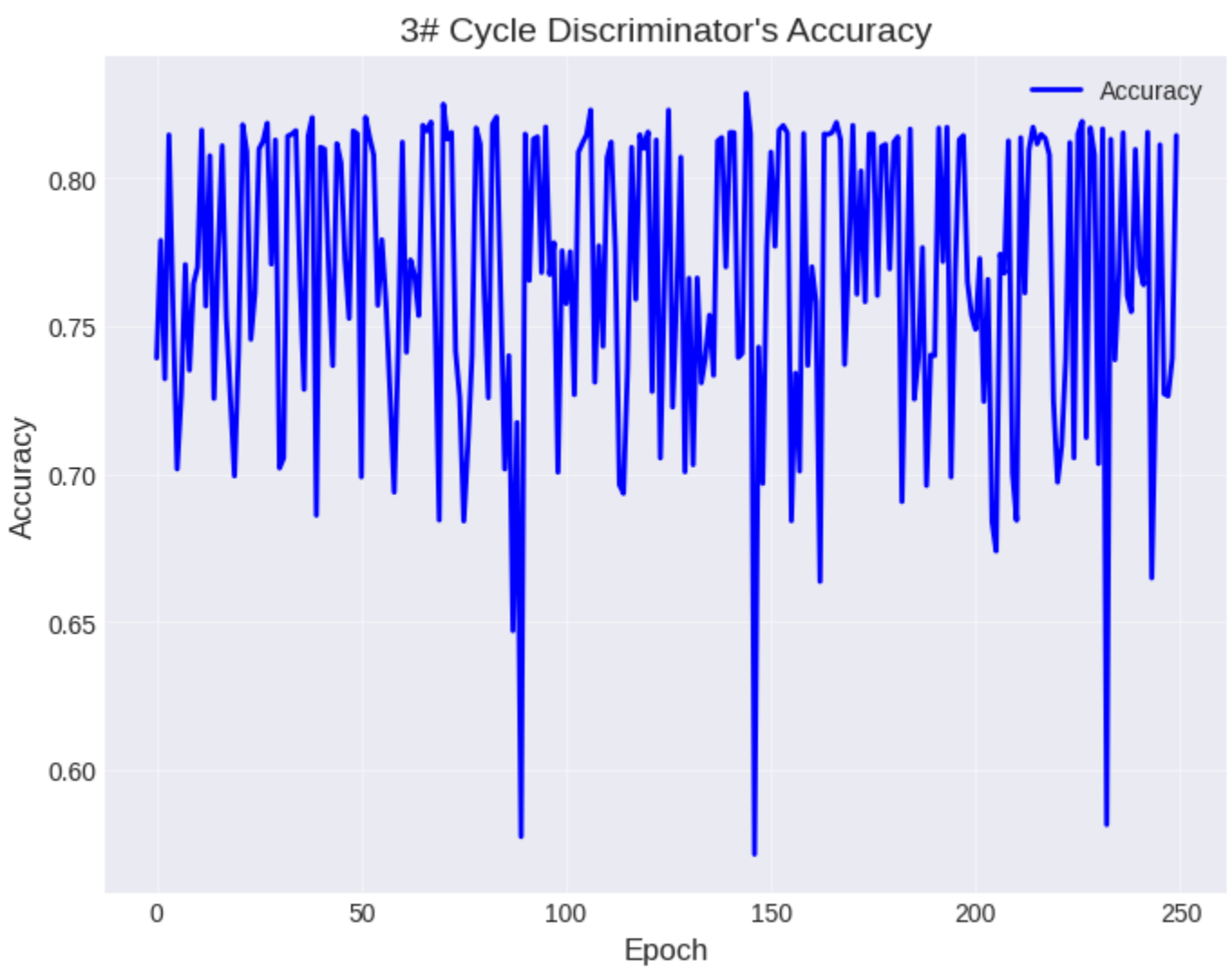
```python
import matplotlib.pyplot as plt

# Define figure size and dpi
fig = plt.figure(figsize=(8,6), dpi=80)

# Plot the loss curve
plt.plot(H.history['loss'], linewidth=2, color='navy')

# Set the axis labels and title
plt.xlabel('Epoch', fontsize=14, fontweight='bold')
plt.ylabel('Loss', fontsize=14, fontweight='bold')
plt.title("3# Cycle Discriminator's Loss", fontsize=16, fontweight='bold')

# Customize the tick labels and grid
plt.xticks(fontsize=12, fontweight='bold')
plt.yticks(fontsize=12, fontweight='bold')
plt.grid(linestyle='dotted', alpha=0.5)

# Show the plot
plt.show()
```



In [ ]:

```python
import matplotlib.pyplot as plt

# Set the style
plt.style.use('seaborn-darkgrid')

# Create the figure and axes objects
fig, ax = plt.subplots(figsize=(8, 6))

# Plot the data
ax.plot(H.history['custom_accuracy'], color='blue', linewidth=2)

# Add labels and title
ax.set_xlabel('Epoch', fontsize=12)
ax.set_ylabel('Accuracy', fontsize=12)
ax.set_title("3# Cycle Discriminator's Accuracy", fontsize=14)

# Set the tick size and font size
ax.tick_params(axis='both', labelsize=10)

# Add grid lines and legend
ax.grid(alpha=0.4)
ax.legend(['Accuracy'], fontsize=10)

# Show the plot
plt.show()
```

```
<ipython-input-73-7f91d6975e76>:4: MatplotlibDeprecationWarning: The seaborn styles shipped by Matplotlib are deprecated since 3.6, as they no longer correspond to the styles shipped by seaborn. However, they will remain available as 'seaborn-v0_8-<style>'. Alternatively, directly use the seaborn API instead.
  plt.style.use('seaborn-darkgrid')
```



In [ ]:
```
custom_acc(np.array(y_gen_test, dtype=np.float32), qdisc_model.predict(gen_data_test))
```

Out[ ]:
```
<tf.Tensor: shape=(), dtype=float32, numpy=0.71>
```

In [ ]:
```
best_qdisc_weights = qdisc_model.get_weights()[0]
best_qgen_weights = qgen_model.get_weights()[0]
qgen_model = generator_model(symbols_gen, qdisc_model.get_weights()[0])

qgen_model.get_layer('qgen_layer').set_weights([best_qgen_weights])
qdisc_model.get_layer('qdisc_layer').set_weights([best_qdisc_weights])
```

In [ ]:
```
gen_model_cp, disc_model_cp = checkpoints(cycle=4)
```

In [ ]:
```
# Fit the Generator Model
H = train_qgen(150, 100, 1)
```

```
Epoch 1/150
1/1 [==============================] - 3s 3s/step - loss: 0.6619
Epoch 2/150
1/1 [==============================] - 2s 2s/step - loss: 0.6565
Epoch 3/150
1/1 [==============================] - 2s 2s/step - loss: 0.6512
Epoch 4/150
1/1 [==============================] - 4s 4s/step - loss: 0.6459
```

```
1/1 [==============================] - 4s 4s/step - loss: 0.6407
Epoch 6/150
1/1 [==============================] - 2s 2s/step - loss: 0.6356
Epoch 7/150
1/1 [==============================] - 2s 2s/step - loss: 0.6306
Epoch 8/150
1/1 [==============================] - 2s 2s/step - loss: 0.6258
Epoch 9/150
1/1 [==============================] - 2s 2s/step - loss: 0.6211
Epoch 10/150
1/1 [==============================] - 3s 3s/step - loss: 0.6165
Epoch 11/150
1/1 [==============================] - 4s 4s/step - loss: 0.6122
Epoch 12/150
1/1 [==============================] - 4s 4s/step - loss: 0.6080
Epoch 13/150
1/1 [==============================] - 2s 2s/step - loss: 0.6040
Epoch 14/150
1/1 [==============================] - 2s 2s/step - loss: 0.6001
Epoch 15/150
1/1 [==============================] - 2s 2s/step - loss: 0.5964
Epoch 16/150
1/1 [==============================] - 2s 2s/step - loss: 0.5929
Epoch 17/150
1/1 [==============================] - 3s 3s/step - loss: 0.5895
Epoch 18/150
1/1 [==============================] - 4s 4s/step - loss: 0.5863
Epoch 19/150
1/1 [==============================] - 3s 3s/step - loss: 0.5832
Epoch 20/150
1/1 [==============================] - 2s 2s/step - loss: 0.5802
Epoch 21/150
1/1 [==============================] - 2s 2s/step - loss: 0.5773
Epoch 22/150
1/1 [==============================] - 2s 2s/step - loss: 0.5746
Epoch 23/150
1/1 [==============================] - 2s 2s/step - loss: 0.5719
Epoch 24/150
1/1 [==============================] - 4s 4s/step - loss: 0.5693
Epoch 25/150
1/1 [==============================] - 4s 4s/step - loss: 0.5668
Epoch 26/150
1/1 [==============================] - 3s 3s/step - loss: 0.5644
Epoch 27/150
1/1 [==============================] - 2s 2s/step - loss: 0.5620
Epoch 28/150
1/1 [==============================] - 2s 2s/step - loss: 0.5597
Epoch 29/150
1/1 [==============================] - 2s 2s/step - loss: 0.5574
Epoch 30/150
1/1 [==============================] - 2s 2s/step - loss: 0.5552
Epoch 31/150
1/1 [==============================] - 4s 4s/step - loss: 0.5529
Epoch 32/150
1/1 [==============================] - 4s 4s/step - loss: 0.5508
Epoch 33/150
1/1 [==============================] - 3s 3s/step - loss: 0.5486
Epoch 34/150
1/1 [==============================] - 3s 3s/step - loss: 0.5465
Epoch 35/150
1/1 [==============================] - 4s 4s/step - loss: 0.5444
Epoch 36/150
1/1 [==============================] - 4s 4s/step - loss: 0.5424
Epoch 37/150
```

```
1/1 [==============================] - 4s 4s/step - loss: 0.5403
Epoch 38/150
1/1 [==============================] - 4s 4s/step - loss: 0.5383
Epoch 39/150
1/1 [==============================] - 2s 2s/step - loss: 0.5364
Epoch 40/150
1/1 [==============================] - 2s 2s/step - loss: 0.5344
Epoch 41/150
1/1 [==============================] - 2s 2s/step - loss: 0.5325
Epoch 42/150
1/1 [==============================] - 2s 2s/step - loss: 0.5306
Epoch 43/150
1/1 [==============================] - 3s 3s/step - loss: 0.5287
Epoch 44/150
1/1 [==============================] - 4s 4s/step - loss: 0.5269
Epoch 45/150
1/1 [==============================] - 3s 3s/step - loss: 0.5251
Epoch 46/150
1/1 [==============================] - 2s 2s/step - loss: 0.5233
Epoch 47/150
1/1 [==============================] - 2s 2s/step - loss: 0.5215
Epoch 48/150
1/1 [==============================] - 2s 2s/step - loss: 0.5197
Epoch 49/150
1/1 [==============================] - 2s 2s/step - loss: 0.5179
Epoch 50/150
1/1 [==============================] - 3s 3s/step - loss: 0.5161
Epoch 51/150
1/1 [==============================] - 4s 4s/step - loss: 0.5144
Epoch 52/150
1/1 [==============================] - 3s 3s/step - loss: 0.5126
Epoch 53/150
1/1 [==============================] - 2s 2s/step - loss: 0.5109
Epoch 54/150
1/1 [==============================] - 2s 2s/step - loss: 0.5091
Epoch 55/150
1/1 [==============================] - 2s 2s/step - loss: 0.5074
Epoch 56/150
1/1 [==============================] - 2s 2s/step - loss: 0.5056
Epoch 57/150
1/1 [==============================] - 4s 4s/step - loss: 0.5039
Epoch 58/150
1/1 [==============================] - 4s 4s/step - loss: 0.5021
Epoch 59/150
1/1 [==============================] - 3s 3s/step - loss: 0.5004
Epoch 60/150
1/1 [==============================] - 2s 2s/step - loss: 0.4986
Epoch 61/150
1/1 [==============================] - 2s 2s/step - loss: 0.4968
Epoch 62/150
1/1 [==============================] - 2s 2s/step - loss: 0.4951
Epoch 63/150
1/1 [==============================] - 2s 2s/step - loss: 0.4933
Epoch 64/150
1/1 [==============================] - 4s 4s/step - loss: 0.4916
Epoch 65/150
1/1 [==============================] - 4s 4s/step - loss: 0.4898
Epoch 66/150
1/1 [==============================] - 3s 3s/step - loss: 0.4881
Epoch 67/150
1/1 [==============================] - 2s 2s/step - loss: 0.4864
Epoch 68/150
1/1 [==============================] - 2s 2s/step - loss: 0.4847
Epoch 69/150
```

```
1/1 [==============================] - 2s 2s/step - loss: 0.4830
Epoch 70/150
1/1 [==============================] - 2s 2s/step - loss: 0.4813
Epoch 71/150
1/1 [==============================] - 4s 4s/step - loss: 0.4796
Epoch 72/150
1/1 [==============================] - 4s 4s/step - loss: 0.4779
Epoch 73/150
1/1 [==============================] - 2s 2s/step - loss: 0.4763
Epoch 74/150
1/1 [==============================] - 2s 2s/step - loss: 0.4746
Epoch 75/150
1/1 [==============================] - 2s 2s/step - loss: 0.4730
Epoch 76/150
1/1 [==============================] - 2s 2s/step - loss: 0.4714
Epoch 77/150
1/1 [==============================] - 3s 3s/step - loss: 0.4699
Epoch 78/150
1/1 [==============================] - 4s 4s/step - loss: 0.4683
Epoch 79/150
1/1 [==============================] - 3s 3s/step - loss: 0.4668
Epoch 80/150
1/1 [==============================] - 2s 2s/step - loss: 0.4653
Epoch 81/150
1/1 [==============================] - 2s 2s/step - loss: 0.4638
Epoch 82/150
1/1 [==============================] - 2s 2s/step - loss: 0.4624
Epoch 83/150
1/1 [==============================] - 2s 2s/step - loss: 0.4609
Epoch 84/150
1/1 [==============================] - 3s 3s/step - loss: 0.4595
Epoch 85/150
1/1 [==============================] - 4s 4s/step - loss: 0.4581
Epoch 86/150
1/1 [==============================] - 4s 4s/step - loss: 0.4568
Epoch 87/150
1/1 [==============================] - 2s 2s/step - loss: 0.4554
Epoch 88/150
1/1 [==============================] - 2s 2s/step - loss: 0.4541
Epoch 89/150
1/1 [==============================] - 2s 2s/step - loss: 0.4528
Epoch 90/150
1/1 [==============================] - 2s 2s/step - loss: 0.4516
Epoch 91/150
1/1 [==============================] - 3s 3s/step - loss: 0.4503
Epoch 92/150
1/1 [==============================] - 4s 4s/step - loss: 0.4491
Epoch 93/150
1/1 [==============================] - 3s 3s/step - loss: 0.4479
Epoch 94/150
1/1 [==============================] - 2s 2s/step - loss: 0.4468
Epoch 95/150
1/1 [==============================] - 2s 2s/step - loss: 0.4456
Epoch 96/150
1/1 [==============================] - 2s 2s/step - loss: 0.4445
Epoch 97/150
1/1 [==============================] - 2s 2s/step - loss: 0.4434
Epoch 98/150
1/1 [==============================] - 3s 3s/step - loss: 0.4423
Epoch 99/150
1/1 [==============================] - 4s 4s/step - loss: 0.4412
Epoch 100/150
1/1 [==============================] - 3s 3s/step - loss: 0.4401
Epoch 101/150
```

```
1/1 [==============================] - 2s 2s/step - loss: 0.4391
Epoch 102/150
1/1 [==============================] - 2s 2s/step - loss: 0.4380
Epoch 103/150
1/1 [==============================] - 2s 2s/step - loss: 0.4370
Epoch 104/150
1/1 [==============================] - 2s 2s/step - loss: 0.4360
Epoch 105/150
1/1 [==============================] - 4s 4s/step - loss: 0.4350
Epoch 106/150
1/1 [==============================] - 4s 4s/step - loss: 0.4340
Epoch 107/150
1/1 [==============================] - 3s 3s/step - loss: 0.4330
Epoch 108/150
1/1 [==============================] - 2s 2s/step - loss: 0.4320
Epoch 109/150
1/1 [==============================] - 2s 2s/step - loss: 0.4310
Epoch 110/150
1/1 [==============================] - 2s 2s/step - loss: 0.4301
Epoch 111/150
1/1 [==============================] - 2s 2s/step - loss: 0.4291
Epoch 112/150
1/1 [==============================] - 4s 4s/step - loss: 0.4281
Epoch 113/150
1/1 [==============================] - 4s 4s/step - loss: 0.4272
Epoch 114/150
1/1 [==============================] - 3s 3s/step - loss: 0.4262
Epoch 115/150
1/1 [==============================] - 2s 2s/step - loss: 0.4253
Epoch 116/150
1/1 [==============================] - 2s 2s/step - loss: 0.4243
Epoch 117/150
1/1 [==============================] - 2s 2s/step - loss: 0.4234
Epoch 118/150
1/1 [==============================] - 2s 2s/step - loss: 0.4225
Epoch 119/150
1/1 [==============================] - 4s 4s/step - loss: 0.4216
Epoch 120/150
1/1 [==============================] - 4s 4s/step - loss: 0.4206
Epoch 121/150
1/1 [==============================] - 2s 2s/step - loss: 0.4197
Epoch 122/150
1/1 [==============================] - 2s 2s/step - loss: 0.4188
Epoch 123/150
1/1 [==============================] - 2s 2s/step - loss: 0.4179
Epoch 124/150
1/1 [==============================] - 2s 2s/step - loss: 0.4171
Epoch 125/150
1/1 [==============================] - 3s 3s/step - loss: 0.4162
Epoch 126/150
1/1 [==============================] - 4s 4s/step - loss: 0.4153
Epoch 127/150
1/1 [==============================] - 4s 4s/step - loss: 0.4145
Epoch 128/150
1/1 [==============================] - 2s 2s/step - loss: 0.4136
Epoch 129/150
1/1 [==============================] - 2s 2s/step - loss: 0.4128
Epoch 130/150
1/1 [==============================] - 2s 2s/step - loss: 0.4119
Epoch 131/150
1/1 [==============================] - 2s 2s/step - loss: 0.4111
Epoch 132/150
1/1 [==============================] - 3s 3s/step - loss: 0.4103
Epoch 133/150
```

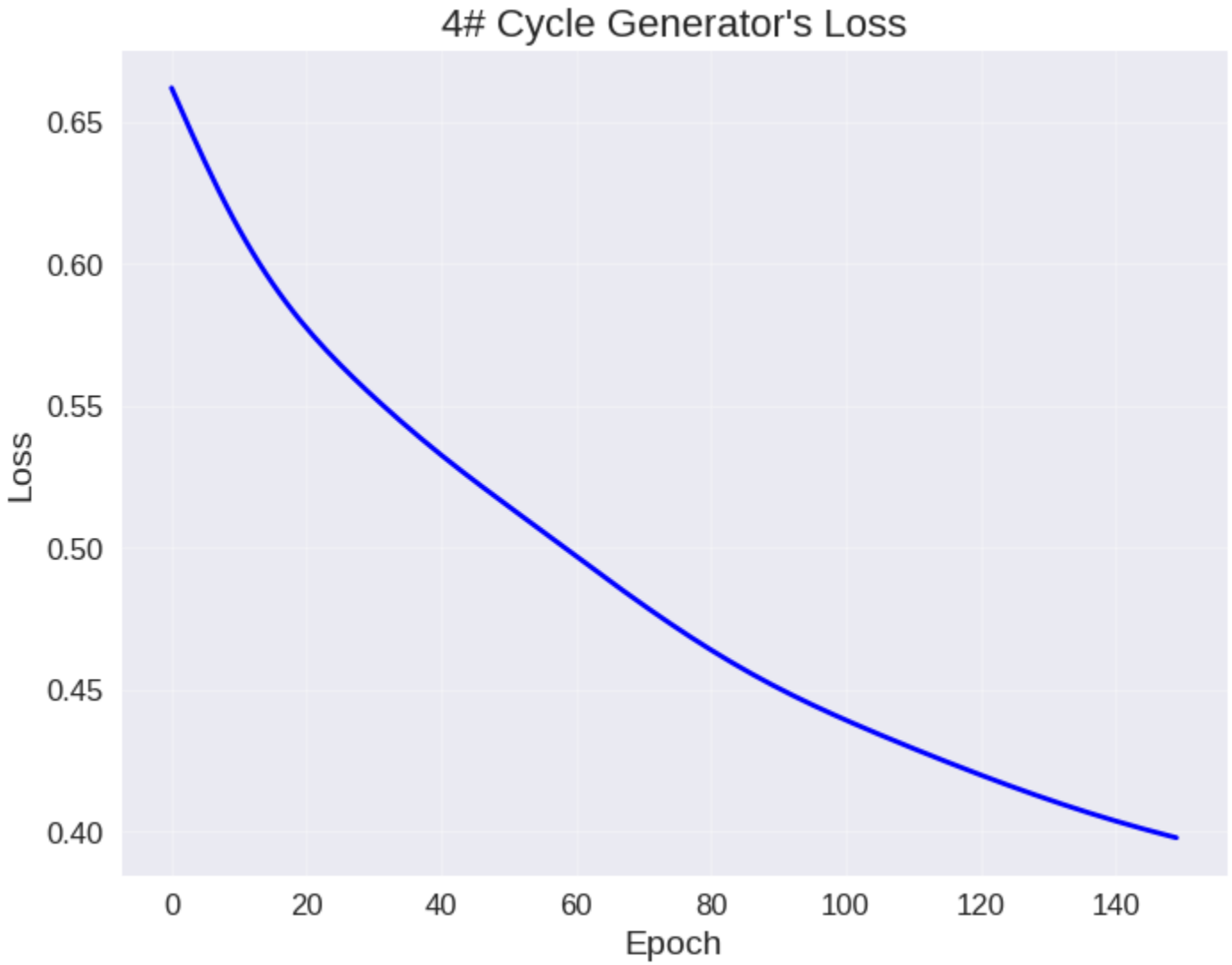
```
1/1 [==============================] - 4s 4s/step - loss: 0.4095
Epoch 134/150
1/1 [==============================] - 4s 4s/step - loss: 0.4087
Epoch 135/150
1/1 [==============================] - 4s 4s/step - loss: 0.4080
Epoch 136/150
1/1 [==============================] - 3s 3s/step - loss: 0.4072
Epoch 137/150
1/1 [==============================] - 2s 2s/step - loss: 0.4064
Epoch 138/150
1/1 [==============================] - 2s 2s/step - loss: 0.4057
Epoch 139/150
1/1 [==============================] - 2s 2s/step - loss: 0.4050
Epoch 140/150
1/1 [==============================] - 2s 2s/step - loss: 0.4042
Epoch 141/150
1/1 [==============================] - 4s 4s/step - loss: 0.4035
Epoch 142/150
1/1 [==============================] - 4s 4s/step - loss: 0.4028
Epoch 143/150
1/1 [==============================] - 2s 2s/step - loss: 0.4021
Epoch 144/150
1/1 [==============================] - 2s 2s/step - loss: 0.4015
Epoch 145/150
1/1 [==============================] - 2s 2s/step - loss: 0.4008
Epoch 146/150
1/1 [==============================] - 2s 2s/step - loss: 0.4001
Epoch 147/150
1/1 [==============================] - 3s 3s/step - loss: 0.3995
Epoch 148/150
1/1 [==============================] - 4s 4s/step - loss: 0.3989
Epoch 149/150
1/1 [==============================] - 4s 4s/step - loss: 0.3983
Epoch 150/150
1/1 [==============================] - 2s 2s/step - loss: 0.3976
```

In [ ]:

```python
import matplotlib.pyplot as plt

# Set the style of the plot
plt.style.use('seaborn')

# Create a figure object and set the figure size
fig = plt.figure(figsize=(8, 6))

# Plot the loss values
plt.plot(H.history['loss'], linewidth=2, color='blue')

# Set the x-axis and y-axis labels
plt.xlabel('Epoch', fontsize=14)
plt.ylabel('Loss', fontsize=14)

# Set the title of the plot
plt.title("4# Cycle Generator's Loss", fontsize=16)

# Customize the tick marks and grid lines
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.grid(alpha=0.3)

# Show the plot
plt.show()
```

```
<ipython-input-78-5ac7956f0154>:4: MatplotlibDeprecationWarning: The seaborn styles shippe
b are deprecated since 3.6, as they no longer correspond to the styles shipp
```

```
ed by seaborn. However, they will remain available as 'seaborn-v0_8-<style>'. Alternativel
y, directly use the seaborn API instead.
  plt.style.use('seaborn')
```



In [ ]:
```
# Generate Real + Fake Data

gen_data_train = tfq.convert_to_tensor(generate_data(x_train, qgan_qubits) + generate_unic
gen_data_test = tfq.convert_to_tensor(generate_data(x_test, qgan_qubits) + generate_unique

y_gen_train = np.concatenate((y_train, y_true_fake), axis = 0)
y_gen_test = np.concatenate((y_test, y_true_fake), axis = 0)

print(len(gen_data_train), len(gen_data_test))
print(y_gen_train.shape, y_gen_test.shape)
```

```
200 200
(200, 3) (200, 3)
```

In [ ]:
```
# Change the C_weight
C_weight = 0.95
```

In [ ]:
```
# Fit the Discriminator Model
H = train_qdisc(250, 64, 1)
```

```
Epoch 1/250
4/4 [==============================] - 6s 1s/step - loss: 0.4177 - custom_accuracy: 0.8030
- val_loss: 0.4060 - val_custom_accuracy: 0.3442
```

```
4/4 [==============================] - 4s 1s/step - loss: 0.3898 - custom_accuracy: 0.7333
- val_loss: 0.4055 - val_custom_accuracy: 0.3442
Epoch 3/250
4/4 [==============================] - 4s 1s/step - loss: 0.3981 - custom_accuracy: 0.8116
- val_loss: 0.4053 - val_custom_accuracy: 0.3442
Epoch 4/250
4/4 [==============================] - 7s 2s/step - loss: 0.3928 - custom_accuracy: 0.6699
- val_loss: 0.4051 - val_custom_accuracy: 0.3442
Epoch 5/250
4/4 [==============================] - 5s 1s/step - loss: 0.3881 - custom_accuracy: 0.8042
- val_loss: 0.4047 - val_custom_accuracy: 0.3442
Epoch 6/250
4/4 [==============================] - 4s 983ms/step - loss: 0.3971 - custom_accuracy: 0.7
796 - val_loss: 0.4038 - val_custom_accuracy: 0.3442
Epoch 7/250
4/4 [==============================] - 4s 1s/step - loss: 0.3988 - custom_accuracy: 0.7024
- val_loss: 0.4026 - val_custom_accuracy: 0.3442
Epoch 8/250
4/4 [==============================] - 7s 2s/step - loss: 0.3901 - custom_accuracy: 0.8156
- val_loss: 0.4019 - val_custom_accuracy: 0.3442
Epoch 9/250
4/4 [==============================] - 4s 1s/step - loss: 0.3882 - custom_accuracy: 0.7578
- val_loss: 0.4016 - val_custom_accuracy: 0.3442
Epoch 10/250
4/4 [==============================] - 4s 1s/step - loss: 0.3923 - custom_accuracy: 0.7410
- val_loss: 0.4018 - val_custom_accuracy: 0.3442
Epoch 11/250
4/4 [==============================] - 5s 1s/step - loss: 0.3792 - custom_accuracy: 0.7601
- val_loss: 0.4023 - val_custom_accuracy: 0.3442
Epoch 12/250
4/4 [==============================] - 6s 2s/step - loss: 0.3942 - custom_accuracy: 0.7571
- val_loss: 0.4029 - val_custom_accuracy: 0.3442
Epoch 13/250
4/4 [==============================] - 4s 1s/step - loss: 0.3970 - custom_accuracy: 0.5764
- val_loss: 0.4026 - val_custom_accuracy: 0.3442
Epoch 14/250
4/4 [==============================] - 4s 1s/step - loss: 0.3950 - custom_accuracy: 0.7248
- val_loss: 0.4019 - val_custom_accuracy: 0.3442
Epoch 15/250
4/4 [==============================] - 6s 2s/step - loss: 0.3837 - custom_accuracy: 0.7269
- val_loss: 0.4010 - val_custom_accuracy: 0.3442
Epoch 16/250
4/4 [==============================] - 5s 1s/step - loss: 0.3903 - custom_accuracy: 0.8102
- val_loss: 0.3999 - val_custom_accuracy: 0.3442
Epoch 17/250
4/4 [==============================] - 4s 981ms/step - loss: 0.3990 - custom_accuracy: 0.7
676 - val_loss: 0.3987 - val_custom_accuracy: 0.3442
Epoch 18/250
4/4 [==============================] - 4s 1s/step - loss: 0.3891 - custom_accuracy: 0.8107
- val_loss: 0.3978 - val_custom_accuracy: 0.3442
Epoch 19/250
4/4 [==============================] - 8s 2s/step - loss: 0.4008 - custom_accuracy: 0.8056
- val_loss: 0.3966 - val_custom_accuracy: 0.3442
Epoch 20/250
4/4 [==============================] - 4s 1s/step - loss: 0.3905 - custom_accuracy: 0.8136
- val_loss: 0.3951 - val_custom_accuracy: 0.3442
Epoch 21/250
4/4 [==============================] - 4s 987ms/step - loss: 0.4039 - custom_accuracy: 0.8
175 - val_loss: 0.3937 - val_custom_accuracy: 0.3442
Epoch 22/250
4/4 [==============================] - 6s 2s/step - loss: 0.3923 - custom_accuracy: 0.7406
- val_loss: 0.3930 - val_custom_accuracy: 0.3442
Epoch 23/250
4/4 [==============================] - 6s 2s/step - loss: 0.3884 - custom_accuracy: 0.7368
```

```
- val_loss: 0.3924 - val_custom_accuracy: 0.3442
Epoch 24/250
4/4 [==============================] - 4s 991ms/step - loss: 0.3964 - custom_accuracy: 0.7
679 - val_loss: 0.3925 - val_custom_accuracy: 0.3442
Epoch 25/250
4/4 [==============================] - 4s 1s/step - loss: 0.3844 - custom_accuracy: 0.8154
- val_loss: 0.3923 - val_custom_accuracy: 0.3442
Epoch 26/250
4/4 [==============================] - 6s 2s/step - loss: 0.3891 - custom_accuracy: 0.8170
- val_loss: 0.3925 - val_custom_accuracy: 0.3442
Epoch 27/250
4/4 [==============================] - 5s 1s/step - loss: 0.3830 - custom_accuracy: 0.7599
- val_loss: 0.3928 - val_custom_accuracy: 0.3442
Epoch 28/250
4/4 [==============================] - 4s 965ms/step - loss: 0.4014 - custom_accuracy: 0.7
424 - val_loss: 0.3929 - val_custom_accuracy: 0.3442
Epoch 29/250
4/4 [==============================] - 4s 1s/step - loss: 0.3829 - custom_accuracy: 0.6893
- val_loss: 0.3931 - val_custom_accuracy: 0.3442
Epoch 30/250
4/4 [==============================] - 7s 2s/step - loss: 0.4129 - custom_accuracy: 0.7069
- val_loss: 0.3926 - val_custom_accuracy: 0.3442
Epoch 31/250
4/4 [==============================] - 4s 1s/step - loss: 0.3919 - custom_accuracy: 0.8144
- val_loss: 0.3918 - val_custom_accuracy: 0.3442
Epoch 32/250
4/4 [==============================] - 4s 1s/step - loss: 0.3922 - custom_accuracy: 0.8137
- val_loss: 0.3917 - val_custom_accuracy: 0.3442
Epoch 33/250
4/4 [==============================] - 5s 1s/step - loss: 0.3908 - custom_accuracy: 0.7606
- val_loss: 0.3919 - val_custom_accuracy: 0.3442
Epoch 34/250
4/4 [==============================] - 6s 2s/step - loss: 0.4033 - custom_accuracy: 0.8144
- val_loss: 0.3914 - val_custom_accuracy: 0.3442
Epoch 35/250
4/4 [==============================] - 4s 998ms/step - loss: 0.3950 - custom_accuracy: 0.7
575 - val_loss: 0.3909 - val_custom_accuracy: 0.3442
Epoch 36/250
4/4 [==============================] - 4s 1s/step - loss: 0.3783 - custom_accuracy: 0.8196
- val_loss: 0.3906 - val_custom_accuracy: 0.3442
Epoch 37/250
4/4 [==============================] - 6s 2s/step - loss: 0.3865 - custom_accuracy: 0.7500
- val_loss: 0.3908 - val_custom_accuracy: 0.3442
Epoch 38/250
4/4 [==============================] - 6s 1s/step - loss: 0.3819 - custom_accuracy: 0.8103
- val_loss: 0.3914 - val_custom_accuracy: 0.3442
Epoch 39/250
4/4 [==============================] - 4s 1s/step - loss: 0.3871 - custom_accuracy: 0.7408
- val_loss: 0.3923 - val_custom_accuracy: 0.3442
Epoch 40/250
4/4 [==============================] - 4s 1s/step - loss: 0.4129 - custom_accuracy: 0.6991
- val_loss: 0.3939 - val_custom_accuracy: 0.3442
Epoch 41/250
4/4 [==============================] - 8s 2s/step - loss: 0.3834 - custom_accuracy: 0.7687
- val_loss: 0.3959 - val_custom_accuracy: 0.3442
Epoch 42/250
4/4 [==============================] - 7s 2s/step - loss: 0.3995 - custom_accuracy: 0.8102
- val_loss: 0.3972 - val_custom_accuracy: 0.3442
Epoch 43/250
4/4 [==============================] - 4s 1s/step - loss: 0.3891 - custom_accuracy: 0.7364
- val_loss: 0.3977 - val_custom_accuracy: 0.3442
Epoch 44/250
4/4 [==============================] - 5s 1s/step - loss: 0.4109 - custom_accuracy: 0.7568
- val_loss: 0.3972 - val_custom_accuracy: 0.3442
```

```
Epoch 45/250
4/4 [==============================] - 7s 2s/step - loss: 0.3831 - custom_accuracy: 0.6852
- val_loss: 0.3961 - val_custom_accuracy: 0.3442
Epoch 46/250
4/4 [==============================] - 4s 1s/step - loss: 0.3835 - custom_accuracy: 0.7256
- val_loss: 0.3949 - val_custom_accuracy: 0.3442
Epoch 47/250
4/4 [==============================] - 4s 988ms/step - loss: 0.3942 - custom_accuracy: 0.7
285 - val_loss: 0.3942 - val_custom_accuracy: 0.3442
Epoch 48/250
4/4 [==============================] - 6s 2s/step - loss: 0.3873 - custom_accuracy: 0.7601
- val_loss: 0.3939 - val_custom_accuracy: 0.3442
Epoch 49/250
4/4 [==============================] - 6s 1s/step - loss: 0.3899 - custom_accuracy: 0.8102
- val_loss: 0.3934 - val_custom_accuracy: 0.3442
Epoch 50/250
4/4 [==============================] - 4s 998ms/step - loss: 0.3946 - custom_accuracy: 0.8
121 - val_loss: 0.3925 - val_custom_accuracy: 0.3442
Epoch 51/250
4/4 [==============================] - 4s 995ms/step - loss: 0.3919 - custom_accuracy: 0.7
727 - val_loss: 0.3915 - val_custom_accuracy: 0.3442
Epoch 52/250
4/4 [==============================] - 7s 2s/step - loss: 0.3818 - custom_accuracy: 0.7630
- val_loss: 0.3909 - val_custom_accuracy: 0.3442
Epoch 53/250
4/4 [==============================] - 5s 1s/step - loss: 0.3922 - custom_accuracy: 0.7427
- val_loss: 0.3907 - val_custom_accuracy: 0.3442
Epoch 54/250
4/4 [==============================] - 4s 1s/step - loss: 0.3956 - custom_accuracy: 0.7752
- val_loss: 0.3901 - val_custom_accuracy: 0.3442
Epoch 55/250
4/4 [==============================] - 4s 1s/step - loss: 0.3903 - custom_accuracy: 0.7393
- val_loss: 0.3896 - val_custom_accuracy: 0.3442
Epoch 56/250
4/4 [==============================] - 7s 2s/step - loss: 0.3855 - custom_accuracy: 0.8160
- val_loss: 0.3898 - val_custom_accuracy: 0.3442
Epoch 57/250
4/4 [==============================] - 4s 1s/step - loss: 0.3897 - custom_accuracy: 0.6636
- val_loss: 0.3903 - val_custom_accuracy: 0.3442
Epoch 58/250
4/4 [==============================] - 4s 997ms/step - loss: 0.4078 - custom_accuracy: 0.8
082 - val_loss: 0.3901 - val_custom_accuracy: 0.3442
Epoch 59/250
4/4 [==============================] - 5s 1s/step - loss: 0.4013 - custom_accuracy: 0.8065
- val_loss: 0.3898 - val_custom_accuracy: 0.3442
Epoch 60/250
4/4 [==============================] - 6s 2s/step - loss: 0.3896 - custom_accuracy: 0.6489
- val_loss: 0.3895 - val_custom_accuracy: 0.3442
Epoch 61/250
4/4 [==============================] - 4s 1s/step - loss: 0.3919 - custom_accuracy: 0.7514
- val_loss: 0.3889 - val_custom_accuracy: 0.3442
Epoch 62/250
4/4 [==============================] - 4s 984ms/step - loss: 0.4020 - custom_accuracy: 0.7
803 - val_loss: 0.3883 - val_custom_accuracy: 0.3442
Epoch 63/250
4/4 [==============================] - 6s 2s/step - loss: 0.3853 - custom_accuracy: 0.7337
- val_loss: 0.3876 - val_custom_accuracy: 0.3442
Epoch 64/250
4/4 [==============================] - 6s 1s/step - loss: 0.3952 - custom_accuracy: 0.8136
- val_loss: 0.3870 - val_custom_accuracy: 0.3442
Epoch 65/250
4/4 [==============================] - 4s 1s/step - loss: 0.3916 - custom_accuracy: 0.7550
- val_loss: 0.3862 - val_custom_accuracy: 0.3442
Epoch 66/250
```

```
4/4 [==============================] - 4s 1s/step - loss: 0.3913 - custom_accuracy: 0.7253
- val_loss: 0.3856 - val_custom_accuracy: 0.3442
Epoch 67/250
4/4 [==============================] - 7s 2s/step - loss: 0.3917 - custom_accuracy: 0.8101
- val_loss: 0.3848 - val_custom_accuracy: 0.3442
Epoch 68/250
4/4 [==============================] - 5s 1s/step - loss: 0.3912 - custom_accuracy: 0.8174
- val_loss: 0.3845 - val_custom_accuracy: 0.3442
Epoch 69/250
4/4 [==============================] - 4s 1s/step - loss: 0.3874 - custom_accuracy: 0.7388
- val_loss: 0.3845 - val_custom_accuracy: 0.3442
Epoch 70/250
4/4 [==============================] - 5s 1s/step - loss: 0.3957 - custom_accuracy: 0.8136
- val_loss: 0.3845 - val_custom_accuracy: 0.3442
Epoch 71/250
4/4 [==============================] - 7s 2s/step - loss: 0.3808 - custom_accuracy: 0.6975
- val_loss: 0.3848 - val_custom_accuracy: 0.3442
Epoch 72/250
4/4 [==============================] - 4s 1s/step - loss: 0.3995 - custom_accuracy: 0.7000
- val_loss: 0.3853 - val_custom_accuracy: 0.3442
Epoch 73/250
4/4 [==============================] - 4s 1s/step - loss: 0.3908 - custom_accuracy: 0.7693
- val_loss: 0.3855 - val_custom_accuracy: 0.3442
Epoch 74/250
4/4 [==============================] - 6s 2s/step - loss: 0.3992 - custom_accuracy: 0.7001
- val_loss: 0.3853 - val_custom_accuracy: 0.3442
Epoch 75/250
4/4 [==============================] - 6s 1s/step - loss: 0.3847 - custom_accuracy: 0.6529
- val_loss: 0.3852 - val_custom_accuracy: 0.3442
Epoch 76/250
4/4 [==============================] - 4s 976ms/step - loss: 0.3983 - custom_accuracy: 0.7
422 - val_loss: 0.3854 - val_custom_accuracy: 0.3442
Epoch 77/250
4/4 [==============================] - 4s 1s/step - loss: 0.3883 - custom_accuracy: 0.8137
- val_loss: 0.3854 - val_custom_accuracy: 0.3442
Epoch 78/250
4/4 [==============================] - 6s 2s/step - loss: 0.3920 - custom_accuracy: 0.7745
- val_loss: 0.3855 - val_custom_accuracy: 0.3442
Epoch 79/250
4/4 [==============================] - 5s 1s/step - loss: 0.3804 - custom_accuracy: 0.8104
- val_loss: 0.3851 - val_custom_accuracy: 0.3442
Epoch 80/250
4/4 [==============================] - 4s 1s/step - loss: 0.3836 - custom_accuracy: 0.7053
- val_loss: 0.3848 - val_custom_accuracy: 0.3442
Epoch 81/250
4/4 [==============================] - 4s 1s/step - loss: 0.3787 - custom_accuracy: 0.8123
- val_loss: 0.3844 - val_custom_accuracy: 0.3442
Epoch 82/250
4/4 [==============================] - 7s 2s/step - loss: 0.3948 - custom_accuracy: 0.8079
- val_loss: 0.3838 - val_custom_accuracy: 0.3442
Epoch 83/250
4/4 [==============================] - 4s 1s/step - loss: 0.3738 - custom_accuracy: 0.7377
- val_loss: 0.3837 - val_custom_accuracy: 0.3442
Epoch 84/250
4/4 [==============================] - 4s 990ms/step - loss: 0.3954 - custom_accuracy: 0.6
846 - val_loss: 0.3837 - val_custom_accuracy: 0.3442
Epoch 85/250
4/4 [==============================] - 5s 1s/step - loss: 0.3845 - custom_accuracy: 0.7264
- val_loss: 0.3834 - val_custom_accuracy: 0.3442
Epoch 86/250
4/4 [==============================] - 6s 2s/step - loss: 0.3801 - custom_accuracy: 0.7548
- val_loss: 0.3830 - val_custom_accuracy: 0.3442
Epoch 87/250
4/4 [==============================] - 4s 1s/step - loss: 0.3892 - custom_accuracy: 0.8142
```

```
- val_loss: 0.3831 - val_custom_accuracy: 0.3442
Epoch 88/250
4/4 [==============================] - 4s 1s/step - loss: 0.3898 - custom_accuracy: 0.8129
- val_loss: 0.3835 - val_custom_accuracy: 0.3442
Epoch 89/250
4/4 [==============================] - 6s 2s/step - loss: 0.3876 - custom_accuracy: 0.7711
- val_loss: 0.3839 - val_custom_accuracy: 0.3442
Epoch 90/250
4/4 [==============================] - 6s 1s/step - loss: 0.3987 - custom_accuracy: 0.6655
- val_loss: 0.3837 - val_custom_accuracy: 0.3442
Epoch 91/250
4/4 [==============================] - 4s 1s/step - loss: 0.3853 - custom_accuracy: 0.7674
- val_loss: 0.3842 - val_custom_accuracy: 0.3442
Epoch 92/250
4/4 [==============================] - 4s 1s/step - loss: 0.3830 - custom_accuracy: 0.7021
- val_loss: 0.3844 - val_custom_accuracy: 0.3442
Epoch 93/250
4/4 [==============================] - 7s 2s/step - loss: 0.3861 - custom_accuracy: 0.7078
- val_loss: 0.3842 - val_custom_accuracy: 0.3442
Epoch 94/250
4/4 [==============================] - 6s 1s/step - loss: 0.3898 - custom_accuracy: 0.8113
- val_loss: 0.3839 - val_custom_accuracy: 0.3442
Epoch 95/250
4/4 [==============================] - 7s 2s/step - loss: 0.4030 - custom_accuracy: 0.7403
- val_loss: 0.3832 - val_custom_accuracy: 0.3442
Epoch 96/250
4/4 [==============================] - 7s 2s/step - loss: 0.3932 - custom_accuracy: 0.7595
- val_loss: 0.3831 - val_custom_accuracy: 0.3442
Epoch 97/250
4/4 [==============================] - 4s 1s/step - loss: 0.3828 - custom_accuracy: 0.8160
- val_loss: 0.3838 - val_custom_accuracy: 0.3442
Epoch 98/250
4/4 [==============================] - 4s 1s/step - loss: 0.3819 - custom_accuracy: 0.8121
- val_loss: 0.3846 - val_custom_accuracy: 0.3442
Epoch 99/250
4/4 [==============================] - 6s 2s/step - loss: 0.3827 - custom_accuracy: 0.7033
- val_loss: 0.3856 - val_custom_accuracy: 0.3442
Epoch 100/250
4/4 [==============================] - 6s 1s/step - loss: 0.3863 - custom_accuracy: 0.7577
- val_loss: 0.3874 - val_custom_accuracy: 0.3442
Epoch 101/250
4/4 [==============================] - 4s 1s/step - loss: 0.3872 - custom_accuracy: 0.8159
- val_loss: 0.3882 - val_custom_accuracy: 0.3442
Epoch 102/250
4/4 [==============================] - 4s 987ms/step - loss: 0.3898 - custom_accuracy: 0.7
235 - val_loss: 0.3884 - val_custom_accuracy: 0.3442
Epoch 103/250
4/4 [==============================] - 6s 2s/step - loss: 0.3779 - custom_accuracy: 0.5688
- val_loss: 0.3881 - val_custom_accuracy: 0.3442
Epoch 104/250
4/4 [==============================] - 5s 1s/step - loss: 0.3802 - custom_accuracy: 0.8135
- val_loss: 0.3885 - val_custom_accuracy: 0.3442
Epoch 105/250
4/4 [==============================] - 4s 1s/step - loss: 0.3871 - custom_accuracy: 0.7391
- val_loss: 0.3889 - val_custom_accuracy: 0.3442
Epoch 106/250
4/4 [==============================] - 4s 1s/step - loss: 0.3847 - custom_accuracy: 0.8136
- val_loss: 0.3898 - val_custom_accuracy: 0.3442
Epoch 107/250
4/4 [==============================] - 7s 2s/step - loss: 0.3845 - custom_accuracy: 0.6995
- val_loss: 0.3910 - val_custom_accuracy: 0.3442
Epoch 108/250
4/4 [==============================] - 4s 1s/step - loss: 0.3744 - custom_accuracy: 0.8188
- val_loss: 0.3928 - val_custom_accuracy: 0.3442
```

```
Epoch 109/250
4/4 [==============================] - 4s 1s/step - loss: 0.3982 - custom_accuracy: 0.8057
- val_loss: 0.3941 - val_custom_accuracy: 0.3442
Epoch 110/250
4/4 [==============================] - 5s 1s/step - loss: 0.3982 - custom_accuracy: 0.7605
- val_loss: 0.3947 - val_custom_accuracy: 0.3442
Epoch 111/250
4/4 [==============================] - 6s 2s/step - loss: 0.3871 - custom_accuracy: 0.7257
- val_loss: 0.3949 - val_custom_accuracy: 0.3442
Epoch 112/250
4/4 [==============================] - 4s 997ms/step - loss: 0.3903 - custom_accuracy: 0.7
392 - val_loss: 0.3950 - val_custom_accuracy: 0.3442
Epoch 113/250
4/4 [==============================] - 4s 1s/step - loss: 0.3884 - custom_accuracy: 0.8080
- val_loss: 0.3951 - val_custom_accuracy: 0.3442
Epoch 114/250
4/4 [==============================] - 6s 2s/step - loss: 0.3889 - custom_accuracy: 0.7365
- val_loss: 0.3952 - val_custom_accuracy: 0.3442
Epoch 115/250
4/4 [==============================] - 6s 1s/step - loss: 0.3903 - custom_accuracy: 0.8094
- val_loss: 0.3948 - val_custom_accuracy: 0.3442
Epoch 116/250
4/4 [==============================] - 4s 1s/step - loss: 0.3981 - custom_accuracy: 0.6602
- val_loss: 0.3944 - val_custom_accuracy: 0.3442
Epoch 117/250
4/4 [==============================] - 4s 1s/step - loss: 0.3834 - custom_accuracy: 0.8032
- val_loss: 0.3948 - val_custom_accuracy: 0.3442
Epoch 118/250
4/4 [==============================] - 6s 2s/step - loss: 0.4066 - custom_accuracy: 0.6846
- val_loss: 0.3947 - val_custom_accuracy: 0.3442
Epoch 119/250
4/4 [==============================] - 5s 1s/step - loss: 0.3826 - custom_accuracy: 0.8122
- val_loss: 0.3943 - val_custom_accuracy: 0.3442
Epoch 120/250
4/4 [==============================] - 4s 988ms/step - loss: 0.3809 - custom_accuracy: 0.7
834 - val_loss: 0.3935 - val_custom_accuracy: 0.3442
Epoch 121/250
4/4 [==============================] - 5s 1s/step - loss: 0.3795 - custom_accuracy: 0.7080
- val_loss: 0.3927 - val_custom_accuracy: 0.3442
Epoch 122/250
4/4 [==============================] - 7s 2s/step - loss: 0.3970 - custom_accuracy: 0.8175
- val_loss: 0.3917 - val_custom_accuracy: 0.3442
Epoch 123/250
4/4 [==============================] - 4s 1s/step - loss: 0.3917 - custom_accuracy: 0.8135
- val_loss: 0.3906 - val_custom_accuracy: 0.3442
Epoch 124/250
4/4 [==============================] - 4s 1s/step - loss: 0.3848 - custom_accuracy: 0.7382
- val_loss: 0.3896 - val_custom_accuracy: 0.3442
Epoch 125/250
4/4 [==============================] - 5s 2s/step - loss: 0.3927 - custom_accuracy: 0.5765
- val_loss: 0.3898 - val_custom_accuracy: 0.3442
Epoch 126/250
4/4 [==============================] - 6s 1s/step - loss: 0.3866 - custom_accuracy: 0.8050
- val_loss: 0.3912 - val_custom_accuracy: 0.3442
Epoch 127/250
4/4 [==============================] - 4s 1s/step - loss: 0.3881 - custom_accuracy: 0.7705
- val_loss: 0.3910 - val_custom_accuracy: 0.3442
Epoch 128/250
4/4 [==============================] - 4s 993ms/step - loss: 0.3854 - custom_accuracy: 0.8
214 - val_loss: 0.3904 - val_custom_accuracy: 0.3442
Epoch 129/250
4/4 [==============================] - 6s 2s/step - loss: 0.3841 - custom_accuracy: 0.8172
- val_loss: 0.3901 - val_custom_accuracy: 0.3442
Epoch 130/250
```

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4/4 [==============================] - 5s 1s/step - loss: 0.3891 - custom_accuracy: 0.7373
- val_loss: 0.3901 - val_custom_accuracy: 0.3442
Epoch 131/250
4/4 [==============================] - 4s 978ms/step - loss: 0.4012 - custom_accuracy: 0.8
169 - val_loss: 0.3899 - val_custom_accuracy: 0.3442
Epoch 132/250
4/4 [==============================] - 4s 1s/step - loss: 0.3940 - custom_accuracy: 0.7571
- val_loss: 0.3898 - val_custom_accuracy: 0.3442
Epoch 133/250
4/4 [==============================] - 7s 2s/step - loss: 0.3671 - custom_accuracy: 0.8158
- val_loss: 0.3901 - val_custom_accuracy: 0.3442
Epoch 134/250
4/4 [==============================] - 4s 1s/step - loss: 0.3960 - custom_accuracy: 0.7579
- val_loss: 0.3905 - val_custom_accuracy: 0.3442
Epoch 135/250
4/4 [==============================] - 4s 1s/step - loss: 0.3800 - custom_accuracy: 0.8141
- val_loss: 0.3909 - val_custom_accuracy: 0.3442
Epoch 136/250
4/4 [==============================] - 5s 1s/step - loss: 0.3870 - custom_accuracy: 0.7567
- val_loss: 0.3912 - val_custom_accuracy: 0.3442
Epoch 137/250
4/4 [==============================] - 6s 2s/step - loss: 0.3900 - custom_accuracy: 0.7685
- val_loss: 0.3910 - val_custom_accuracy: 0.3442
Epoch 138/250
4/4 [==============================] - 4s 1s/step - loss: 0.3847 - custom_accuracy: 0.7464
- val_loss: 0.3902 - val_custom_accuracy: 0.3442
Epoch 139/250
4/4 [==============================] - 4s 1s/step - loss: 0.3880 - custom_accuracy: 0.7344
- val_loss: 0.3897 - val_custom_accuracy: 0.3442
Epoch 140/250
4/4 [==============================] - 7s 2s/step - loss: 0.3891 - custom_accuracy: 0.7643
- val_loss: 0.3895 - val_custom_accuracy: 0.3442
Epoch 141/250
4/4 [==============================] - 5s 1s/step - loss: 0.3782 - custom_accuracy: 0.7314
- val_loss: 0.3888 - val_custom_accuracy: 0.3442
Epoch 142/250
4/4 [==============================] - 4s 1s/step - loss: 0.3734 - custom_accuracy: 0.8174
- val_loss: 0.3883 - val_custom_accuracy: 0.3442
Epoch 143/250
4/4 [==============================] - 4s 1s/step - loss: 0.3916 - custom_accuracy: 0.7679
- val_loss: 0.3878 - val_custom_accuracy: 0.3442
Epoch 144/250
4/4 [==============================] - 7s 2s/step - loss: 0.3877 - custom_accuracy: 0.6640
- val_loss: 0.3875 - val_custom_accuracy: 0.3442
Epoch 145/250
4/4 [==============================] - 4s 1s/step - loss: 0.3864 - custom_accuracy: 0.6637
- val_loss: 0.3880 - val_custom_accuracy: 0.3442
Epoch 146/250
4/4 [==============================] - 4s 1s/step - loss: 0.3884 - custom_accuracy: 0.7705
- val_loss: 0.3890 - val_custom_accuracy: 0.3442
Epoch 147/250
4/4 [==============================] - 5s 1s/step - loss: 0.3826 - custom_accuracy: 0.8143
- val_loss: 0.3892 - val_custom_accuracy: 0.3442
Epoch 148/250
4/4 [==============================] - 8s 2s/step - loss: 0.3977 - custom_accuracy: 0.6994
- val_loss: 0.3890 - val_custom_accuracy: 0.3442
Epoch 149/250
4/4 [==============================] - 6s 1s/step - loss: 0.3838 - custom_accuracy: 0.7629
- val_loss: 0.3889 - val_custom_accuracy: 0.3442
Epoch 150/250
4/4 [==============================] - 4s 996ms/step - loss: 0.3831 - custom_accuracy: 0.8
171 - val_loss: 0.3891 - val_custom_accuracy: 0.3442
Epoch 151/250
4/4 [==============================] - 5s 1s/step - loss: 0.3856 - custom_accuracy: 0.8148
```

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- val_loss: 0.3889 - val_custom_accuracy: 0.3442
Epoch 152/250
4/4 [==============================] - 6s 2s/step - loss: 0.3904 - custom_accuracy: 0.8116
- val_loss: 0.3881 - val_custom_accuracy: 0.3442
Epoch 153/250
4/4 [==============================] - 4s 1s/step - loss: 0.3900 - custom_accuracy: 0.8142
- val_loss: 0.3874 - val_custom_accuracy: 0.3442
Epoch 154/250
4/4 [==============================] - 4s 1s/step - loss: 0.3931 - custom_accuracy: 0.7664
- val_loss: 0.3871 - val_custom_accuracy: 0.3442
Epoch 155/250
4/4 [==============================] - 6s 2s/step - loss: 0.4014 - custom_accuracy: 0.6965
- val_loss: 0.3868 - val_custom_accuracy: 0.3442
Epoch 156/250
4/4 [==============================] - 6s 1s/step - loss: 0.3853 - custom_accuracy: 0.7268
- val_loss: 0.3868 - val_custom_accuracy: 0.3442
Epoch 157/250
4/4 [==============================] - 4s 1s/step - loss: 0.3897 - custom_accuracy: 0.8072
- val_loss: 0.3867 - val_custom_accuracy: 0.3442
Epoch 158/250
4/4 [==============================] - 4s 1s/step - loss: 0.3949 - custom_accuracy: 0.8117
- val_loss: 0.3867 - val_custom_accuracy: 0.3442
Epoch 159/250
4/4 [==============================] - 6s 2s/step - loss: 0.3807 - custom_accuracy: 0.8125
- val_loss: 0.3871 - val_custom_accuracy: 0.3442
Epoch 160/250
4/4 [==============================] - 5s 1s/step - loss: 0.3806 - custom_accuracy: 0.6651
- val_loss: 0.3872 - val_custom_accuracy: 0.3442
Epoch 161/250
4/4 [==============================] - 4s 1s/step - loss: 0.3862 - custom_accuracy: 0.7382
- val_loss: 0.3866 - val_custom_accuracy: 0.3442
Epoch 162/250
4/4 [==============================] - 4s 1s/step - loss: 0.3908 - custom_accuracy: 0.6842
- val_loss: 0.3855 - val_custom_accuracy: 0.3442
Epoch 163/250
4/4 [==============================] - 7s 2s/step - loss: 0.3907 - custom_accuracy: 0.7649
- val_loss: 0.3847 - val_custom_accuracy: 0.3442
Epoch 164/250
4/4 [==============================] - 4s 988ms/step - loss: 0.4001 - custom_accuracy: 0.8
036 - val_loss: 0.3840 - val_custom_accuracy: 0.3442
Epoch 165/250
4/4 [==============================] - 4s 1s/step - loss: 0.3868 - custom_accuracy: 0.8154
- val_loss: 0.3837 - val_custom_accuracy: 0.3442
Epoch 166/250
4/4 [==============================] - 5s 1s/step - loss: 0.3880 - custom_accuracy: 0.7582
- val_loss: 0.3840 - val_custom_accuracy: 0.3442
Epoch 167/250
4/4 [==============================] - 6s 2s/step - loss: 0.3854 - custom_accuracy: 0.8141
- val_loss: 0.3836 - val_custom_accuracy: 0.3442
Epoch 168/250
4/4 [==============================] - 4s 1s/step - loss: 0.3846 - custom_accuracy: 0.8165
- val_loss: 0.3830 - val_custom_accuracy: 0.3442
Epoch 169/250
4/4 [==============================] - 4s 991ms/step - loss: 0.3976 - custom_accuracy: 0.8
155 - val_loss: 0.3826 - val_custom_accuracy: 0.3442
Epoch 170/250
4/4 [==============================] - 6s 2s/step - loss: 0.3878 - custom_accuracy: 0.8150
- val_loss: 0.3821 - val_custom_accuracy: 0.3442
Epoch 171/250
4/4 [==============================] - 6s 1s/step - loss: 0.3886 - custom_accuracy: 0.7253
- val_loss: 0.3819 - val_custom_accuracy: 0.3442
Epoch 172/250
4/4 [==============================] - 4s 1s/step - loss: 0.3789 - custom_accuracy: 0.7416
- val_loss: 0.3814 - val_custom_accuracy: 0.3442
```

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Epoch 173/250
4/4 [==============================] - 4s 1s/step - loss: 0.3866 - custom_accuracy: 0.7572
- val_loss: 0.3809 - val_custom_accuracy: 0.3442
Epoch 174/250
4/4 [==============================] - 6s 2s/step - loss: 0.3797 - custom_accuracy: 0.8195
- val_loss: 0.3805 - val_custom_accuracy: 0.3442
Epoch 175/250
4/4 [==============================] - 5s 1s/step - loss: 0.3938 - custom_accuracy: 0.7360
- val_loss: 0.3804 - val_custom_accuracy: 0.3442
Epoch 176/250
4/4 [==============================] - 4s 976ms/step - loss: 0.3901 - custom_accuracy: 0.7
607 - val_loss: 0.3803 - val_custom_accuracy: 0.3442
Epoch 177/250
4/4 [==============================] - 4s 1s/step - loss: 0.3920 - custom_accuracy: 0.7469
- val_loss: 0.3804 - val_custom_accuracy: 0.3442
Epoch 178/250
4/4 [==============================] - 7s 2s/step - loss: 0.3963 - custom_accuracy: 0.8110
- val_loss: 0.3807 - val_custom_accuracy: 0.3442
Epoch 179/250
4/4 [==============================] - 5s 1s/step - loss: 0.3868 - custom_accuracy: 0.7689
- val_loss: 0.3809 - val_custom_accuracy: 0.3442
Epoch 180/250
4/4 [==============================] - 4s 1s/step - loss: 0.3846 - custom_accuracy: 0.7470
- val_loss: 0.3808 - val_custom_accuracy: 0.3442
Epoch 181/250
4/4 [==============================] - 6s 2s/step - loss: 0.3838 - custom_accuracy: 0.7412
- val_loss: 0.3809 - val_custom_accuracy: 0.3442
Epoch 182/250
4/4 [==============================] - 6s 1s/step - loss: 0.3790 - custom_accuracy: 0.8191
- val_loss: 0.3809 - val_custom_accuracy: 0.3442
Epoch 183/250
4/4 [==============================] - 4s 1s/step - loss: 0.3869 - custom_accuracy: 0.7646
- val_loss: 0.3818 - val_custom_accuracy: 0.3442
Epoch 184/250
4/4 [==============================] - 4s 1s/step - loss: 0.3954 - custom_accuracy: 0.7582
- val_loss: 0.3822 - val_custom_accuracy: 0.3442
Epoch 185/250
4/4 [==============================] - 6s 2s/step - loss: 0.3918 - custom_accuracy: 0.8144
- val_loss: 0.3825 - val_custom_accuracy: 0.3442
Epoch 186/250
4/4 [==============================] - 5s 1s/step - loss: 0.3823 - custom_accuracy: 0.6982
- val_loss: 0.3827 - val_custom_accuracy: 0.3442
Epoch 187/250
4/4 [==============================] - 4s 1s/step - loss: 0.3946 - custom_accuracy: 0.5841
- val_loss: 0.3829 - val_custom_accuracy: 0.3442
Epoch 188/250
4/4 [==============================] - 4s 1s/step - loss: 0.3827 - custom_accuracy: 0.8131
- val_loss: 0.3828 - val_custom_accuracy: 0.3442
Epoch 189/250
4/4 [==============================] - 7s 2s/step - loss: 0.3978 - custom_accuracy: 0.6629
- val_loss: 0.3826 - val_custom_accuracy: 0.3442
Epoch 190/250
4/4 [==============================] - 4s 982ms/step - loss: 0.3899 - custom_accuracy: 0.7
683 - val_loss: 0.3826 - val_custom_accuracy: 0.3442
Epoch 191/250
4/4 [==============================] - 4s 1s/step - loss: 0.3895 - custom_accuracy: 0.8119
- val_loss: 0.3822 - val_custom_accuracy: 0.3442
Epoch 192/250
4/4 [==============================] - 5s 1s/step - loss: 0.3900 - custom_accuracy: 0.7650
- val_loss: 0.3815 - val_custom_accuracy: 0.3442
Epoch 193/250
4/4 [==============================] - 6s 2s/step - loss: 0.3850 - custom_accuracy: 0.8145
- val_loss: 0.3807 - val_custom_accuracy: 0.3442
Epoch 194/250
```

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4/4 [==============================] - 4s 1s/step - loss: 0.3860 - custom_accuracy: 0.7642
- val_loss: 0.3802 - val_custom_accuracy: 0.3442
Epoch 195/250
4/4 [==============================] - 4s 1s/step - loss: 0.3896 - custom_accuracy: 0.8162
- val_loss: 0.3795 - val_custom_accuracy: 0.3442
Epoch 196/250
4/4 [==============================] - 6s 2s/step - loss: 0.3924 - custom_accuracy: 0.7389
- val_loss: 0.3792 - val_custom_accuracy: 0.3442
Epoch 197/250
4/4 [==============================] - 5s 1s/step - loss: 0.3917 - custom_accuracy: 0.8159
- val_loss: 0.3796 - val_custom_accuracy: 0.3442
Epoch 198/250
4/4 [==============================] - 4s 999ms/step - loss: 0.3772 - custom_accuracy: 0.7
062 - val_loss: 0.3802 - val_custom_accuracy: 0.3442
Epoch 199/250
4/4 [==============================] - 4s 1s/step - loss: 0.3854 - custom_accuracy: 0.7710
- val_loss: 0.3807 - val_custom_accuracy: 0.3442
Epoch 200/250
4/4 [==============================] - 7s 2s/step - loss: 0.3834 - custom_accuracy: 0.7287
- val_loss: 0.3810 - val_custom_accuracy: 0.3442
Epoch 201/250
4/4 [==============================] - 7s 2s/step - loss: 0.3881 - custom_accuracy: 0.7687
- val_loss: 0.3811 - val_custom_accuracy: 0.3442
Epoch 202/250
4/4 [==============================] - 5s 1s/step - loss: 0.3901 - custom_accuracy: 0.7512
- val_loss: 0.3806 - val_custom_accuracy: 0.3442
Epoch 203/250
4/4 [==============================] - 6s 2s/step - loss: 0.3887 - custom_accuracy: 0.8124
- val_loss: 0.3798 - val_custom_accuracy: 0.3442
Epoch 204/250
4/4 [==============================] - 6s 1s/step - loss: 0.3851 - custom_accuracy: 0.8128
- val_loss: 0.3796 - val_custom_accuracy: 0.3442
Epoch 205/250
4/4 [==============================] - 4s 1s/step - loss: 0.3904 - custom_accuracy: 0.7673
- val_loss: 0.3796 - val_custom_accuracy: 0.3442
Epoch 206/250
4/4 [==============================] - 4s 1s/step - loss: 0.3838 - custom_accuracy: 0.7030
- val_loss: 0.3797 - val_custom_accuracy: 0.3442
Epoch 207/250
4/4 [==============================] - 6s 2s/step - loss: 0.3882 - custom_accuracy: 0.8146
- val_loss: 0.3800 - val_custom_accuracy: 0.3442
Epoch 208/250
4/4 [==============================] - 5s 1s/step - loss: 0.3850 - custom_accuracy: 0.7690
- val_loss: 0.3804 - val_custom_accuracy: 0.3442
Epoch 209/250
4/4 [==============================] - 4s 1s/step - loss: 0.3953 - custom_accuracy: 0.7371
- val_loss: 0.3805 - val_custom_accuracy: 0.3442
Epoch 210/250
4/4 [==============================] - 4s 1s/step - loss: 0.3851 - custom_accuracy: 0.8128
- val_loss: 0.3812 - val_custom_accuracy: 0.3442
Epoch 211/250
4/4 [==============================] - 7s 2s/step - loss: 0.3880 - custom_accuracy: 0.7102
- val_loss: 0.3823 - val_custom_accuracy: 0.3442
Epoch 212/250
4/4 [==============================] - 4s 1s/step - loss: 0.3851 - custom_accuracy: 0.6509
- val_loss: 0.3841 - val_custom_accuracy: 0.3442
Epoch 213/250
4/4 [==============================] - 4s 1s/step - loss: 0.3803 - custom_accuracy: 0.7573
- val_loss: 0.3850 - val_custom_accuracy: 0.3442
Epoch 214/250
4/4 [==============================] - 5s 1s/step - loss: 0.3828 - custom_accuracy: 0.8138
- val_loss: 0.3852 - val_custom_accuracy: 0.3442
Epoch 215/250
4/4 [==============================] - 6s 1s/step - loss: 0.3904 - custom_accuracy: 0.5766
```

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- val_loss: 0.3851 - val_custom_accuracy: 0.3442
Epoch 216/250
4/4 [==============================] - 4s 1s/step - loss: 0.3817 - custom_accuracy: 0.8094
- val_loss: 0.3847 - val_custom_accuracy: 0.3442
Epoch 217/250
4/4 [==============================] - 4s 1s/step - loss: 0.4036 - custom_accuracy: 0.8165
- val_loss: 0.3840 - val_custom_accuracy: 0.3442
Epoch 218/250
4/4 [==============================] - 6s 2s/step - loss: 0.3921 - custom_accuracy: 0.7567
- val_loss: 0.3835 - val_custom_accuracy: 0.3442
Epoch 219/250
4/4 [==============================] - 5s 1s/step - loss: 0.3907 - custom_accuracy: 0.7559
- val_loss: 0.3832 - val_custom_accuracy: 0.3442
Epoch 220/250
4/4 [==============================] - 4s 973ms/step - loss: 0.3974 - custom_accuracy: 0.7
572 - val_loss: 0.3827 - val_custom_accuracy: 0.3442
Epoch 221/250
4/4 [==============================] - 4s 1s/step - loss: 0.3766 - custom_accuracy: 0.7292
- val_loss: 0.3823 - val_custom_accuracy: 0.3442
Epoch 222/250
4/4 [==============================] - 7s 2s/step - loss: 0.3750 - custom_accuracy: 0.8168
- val_loss: 0.3821 - val_custom_accuracy: 0.3442
Epoch 223/250
4/4 [==============================] - 4s 1s/step - loss: 0.3833 - custom_accuracy: 0.8110
- val_loss: 0.3824 - val_custom_accuracy: 0.3442
Epoch 224/250
4/4 [==============================] - 4s 995ms/step - loss: 0.3895 - custom_accuracy: 0.8
138 - val_loss: 0.3825 - val_custom_accuracy: 0.3442
Epoch 225/250
4/4 [==============================] - 5s 1s/step - loss: 0.3894 - custom_accuracy: 0.7578
- val_loss: 0.3826 - val_custom_accuracy: 0.3442
Epoch 226/250
4/4 [==============================] - 7s 2s/step - loss: 0.3841 - custom_accuracy: 0.8111
- val_loss: 0.3829 - val_custom_accuracy: 0.3442
Epoch 227/250
4/4 [==============================] - 4s 984ms/step - loss: 0.3953 - custom_accuracy: 0.7
686 - val_loss: 0.3829 - val_custom_accuracy: 0.3442
Epoch 228/250
4/4 [==============================] - 4s 1s/step - loss: 0.3845 - custom_accuracy: 0.8096
- val_loss: 0.3827 - val_custom_accuracy: 0.3442
Epoch 229/250
4/4 [==============================] - 6s 2s/step - loss: 0.3914 - custom_accuracy: 0.7569
- val_loss: 0.3827 - val_custom_accuracy: 0.3442
Epoch 230/250
4/4 [==============================] - 6s 2s/step - loss: 0.3760 - custom_accuracy: 0.6655
- val_loss: 0.3829 - val_custom_accuracy: 0.3442
Epoch 231/250
4/4 [==============================] - 4s 1s/step - loss: 0.3903 - custom_accuracy: 0.7698
- val_loss: 0.3828 - val_custom_accuracy: 0.3442
Epoch 232/250
4/4 [==============================] - 4s 996ms/step - loss: 0.3925 - custom_accuracy: 0.7
539 - val_loss: 0.3823 - val_custom_accuracy: 0.3442
Epoch 233/250
4/4 [==============================] - 7s 2s/step - loss: 0.3905 - custom_accuracy: 0.7618
- val_loss: 0.3821 - val_custom_accuracy: 0.3442
Epoch 234/250
4/4 [==============================] - 5s 1s/step - loss: 0.3813 - custom_accuracy: 0.8165
- val_loss: 0.3818 - val_custom_accuracy: 0.3442
Epoch 235/250
4/4 [==============================] - 4s 988ms/step - loss: 0.3882 - custom_accuracy: 0.7
725 - val_loss: 0.3818 - val_custom_accuracy: 0.3442
Epoch 236/250
4/4 [==============================] - 5s 1s/step - loss: 0.3902 - custom_accuracy: 0.7179
- val_loss: 0.3821 - val_custom_accuracy: 0.3442
```

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Epoch 237/250
4/4 [==============================] - 7s 2s/step - loss: 0.3848 - custom_accuracy: 0.7388
- val_loss: 0.3825 - val_custom_accuracy: 0.3442
Epoch 238/250
4/4 [==============================] - 4s 1s/step - loss: 0.3875 - custom_accuracy: 0.8194
- val_loss: 0.3830 - val_custom_accuracy: 0.3442
Epoch 239/250
4/4 [==============================] - 4s 1s/step - loss: 0.3794 - custom_accuracy: 0.7376
- val_loss: 0.3837 - val_custom_accuracy: 0.3442
Epoch 240/250
4/4 [==============================] - 5s 1s/step - loss: 0.3872 - custom_accuracy: 0.8165
- val_loss: 0.3842 - val_custom_accuracy: 0.3442
Epoch 241/250
4/4 [==============================] - 6s 2s/step - loss: 0.3813 - custom_accuracy: 0.8129
- val_loss: 0.3853 - val_custom_accuracy: 0.3442
Epoch 242/250
4/4 [==============================] - 4s 1s/step - loss: 0.3851 - custom_accuracy: 0.7690
- val_loss: 0.3862 - val_custom_accuracy: 0.3442
Epoch 243/250
4/4 [==============================] - 4s 1s/step - loss: 0.3843 - custom_accuracy: 0.7570
- val_loss: 0.3863 - val_custom_accuracy: 0.3442
Epoch 244/250
4/4 [==============================] - 6s 2s/step - loss: 0.3888 - custom_accuracy: 0.7286
- val_loss: 0.3859 - val_custom_accuracy: 0.3442
Epoch 245/250
4/4 [==============================] - 5s 1s/step - loss: 0.3870 - custom_accuracy: 0.7599
- val_loss: 0.3848 - val_custom_accuracy: 0.3442
Epoch 246/250
4/4 [==============================] - 4s 1s/step - loss: 0.3777 - custom_accuracy: 0.8230
- val_loss: 0.3838 - val_custom_accuracy: 0.3442
Epoch 247/250
4/4 [==============================] - 4s 1s/step - loss: 0.3817 - custom_accuracy: 0.8137
- val_loss: 0.3838 - val_custom_accuracy: 0.3442
Epoch 248/250
4/4 [==============================] - 7s 2s/step - loss: 0.3946 - custom_accuracy: 0.6488
- val_loss: 0.3836 - val_custom_accuracy: 0.3442
Epoch 249/250
4/4 [==============================] - 4s 1s/step - loss: 0.3823 - custom_accuracy: 0.7565
- val_loss: 0.3835 - val_custom_accuracy: 0.3442
Epoch 250/250
4/4 [==============================] - 4s 1s/step - loss: 0.3949 - custom_accuracy: 0.8107
- val_loss: 0.3832 - val_custom_accuracy: 0.3442
```
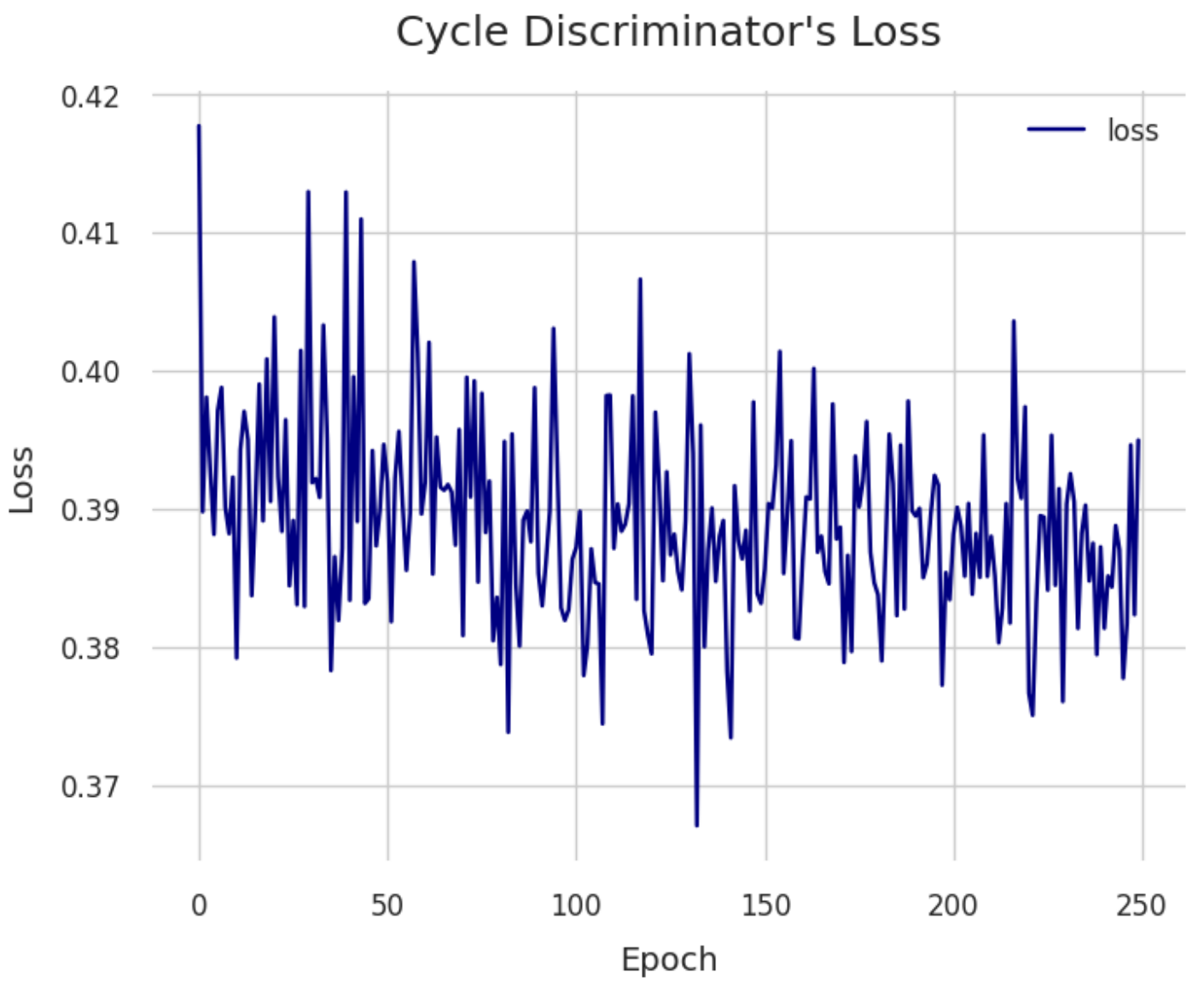

In [ ]:

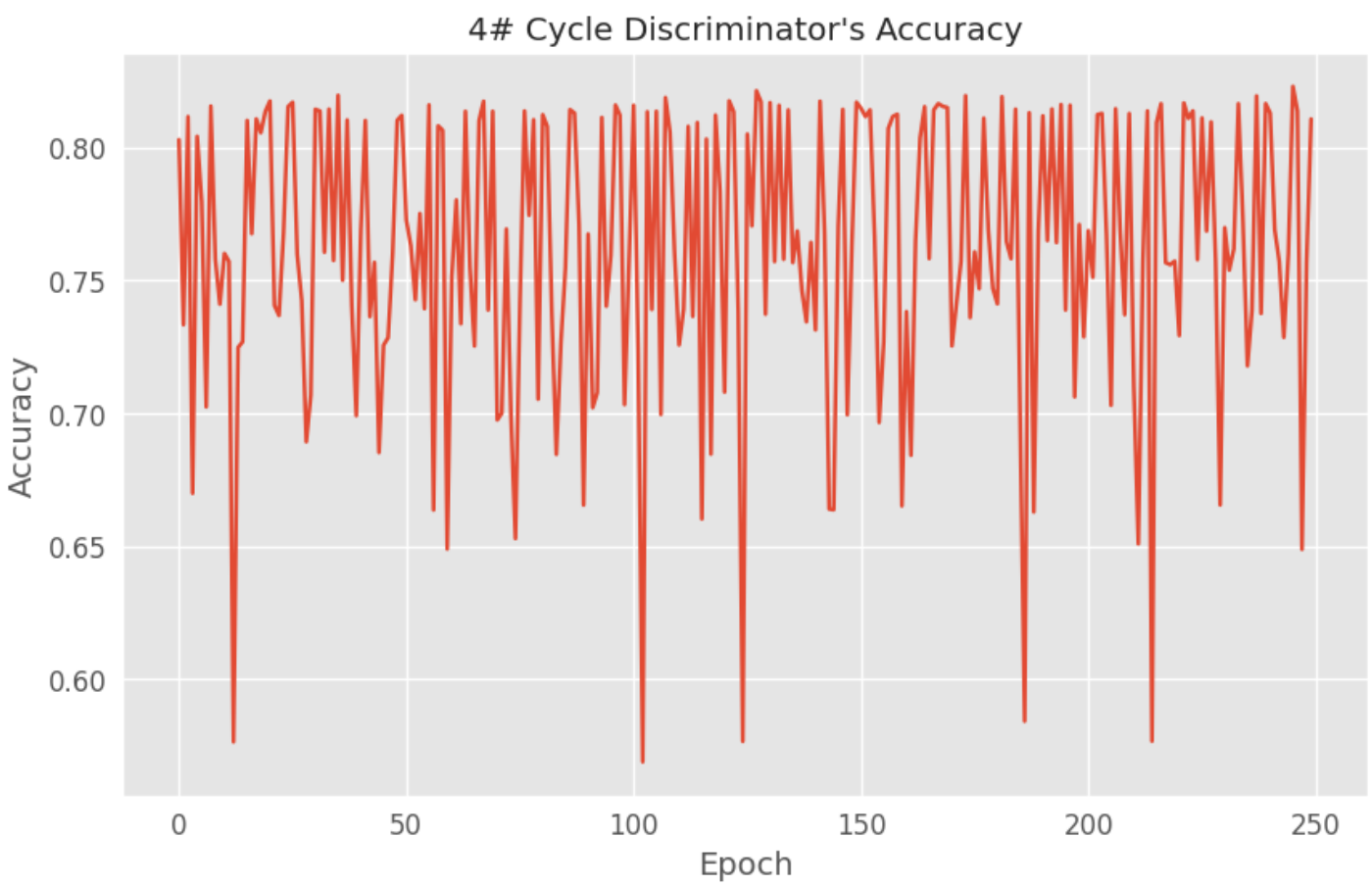
```python
import matplotlib.pyplot as plt
import seaborn as sns

sns.set_style("whitegrid")  # set the style of the plot

# create a figure and axis object
fig, ax = plt.subplots(figsize=(8, 6))

# plot the loss values
ax.plot(H.history['loss'], color='navy')

# set the labels and title
ax.set_xlabel('Epoch', fontsize=14, labelpad=10)
ax.set_ylabel('Loss', fontsize=14, labelpad=10)
ax.set_title("Cycle Discriminator's Loss", fontsize=18, pad=20)

# customize the ticks
ax.tick_params(axis='both', which='major', labelsize=12, length=6, width=1.5)
ax.tick_params(axis='both', which='minor', labelsize=12, length=4, width=1)

# spines on the top and right sides
```

```
ax.spines['top'].set_visible(False)
ax.spines['right'].set_visible(False)

# add a legend
ax.legend(['loss'], loc='upper right', fontsize=12)

# display the plot
plt.show()
```



In [ ]:

```
plt.plot(H.history['custom_accuracy'])
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.title("4# Cycle Discriminator's Accuracy")
plt.show()
```



In [ ]:
```
custom_accuracy(np.array(y_gen_test, dtype=np.float32), qdisc_model.predict(gen_data_test)
```

Out[ ]:
```
<tf.Tensor: shape=(), dtype=float32, numpy=0.71>
```

Fifth Cycle

In [ ]:
```
best_qdisc_weights = qdisc_model.get_weights()[0]
best_qgen_weights = qgen_model.get_weights()[0]
qgen_model = generator_model(symbols_gen, qdisc_model.get_weights()[0])

qgen_model.get_layer('qgen_layer').set_weights([best_qgen_weights])
qdisc_model.get_layer('qdisc_layer').set_weights([best_qdisc_weights])
```

In [ ]:
```
gen_model_cp, disc_model_cp = checkpoints(cycle=5)
```

In [ ]:
```
C_weight = 1.0
```

In [ ]:
```
# Fit the Discriminator Model
history = qdisc_model.fit(x=train_quantum_data,y=y_train,batch_size=32,epochs=250,verbose=
```

```
Epoch 1/250
4/4 [==============================] - 1s 376ms/step - loss: 0.4749 - custom_accuracy: 0.7
031 - val_loss: 0.4899 - val_custom_accuracy: 0.7734
Epoch 2/250
4/4 [==============================] - 1s 333ms/step - loss: 0.4576 - custom_accuracy: 0.7
031 - val_loss: 0.4659 - val_custom_accuracy: 0.7734
Epoch 3/250
4/4 [==============================] - 1s 327ms/step - loss: 0.4322 - custom_accuracy: 0.7
```

```
578 - val_loss: 0.4391 - val_custom_accuracy: 0.7734
Epoch 4/250
4/4 [==============================] - 1s 329ms/step - loss: 0.4062 - custom_accuracy: 0.7
578 - val_loss: 0.4139 - val_custom_accuracy: 0.7734
Epoch 5/250
4/4 [==============================] - 1s 332ms/step - loss: 0.3820 - custom_accuracy: 0.8
125 - val_loss: 0.3928 - val_custom_accuracy: 0.7734
Epoch 6/250
4/4 [==============================] - 1s 326ms/step - loss: 0.3613 - custom_accuracy: 0.8
125 - val_loss: 0.3750 - val_custom_accuracy: 0.7734
Epoch 7/250
4/4 [==============================] - 1s 213ms/step - loss: 0.3444 - custom_accuracy: 0.7
578 - val_loss: 0.3607 - val_custom_accuracy: 0.7734
Epoch 8/250
4/4 [==============================] - 1s 192ms/step - loss: 0.3304 - custom_accuracy: 0.7
031 - val_loss: 0.3490 - val_custom_accuracy: 0.7734
Epoch 9/250
4/4 [==============================] - 1s 221ms/step - loss: 0.3192 - custom_accuracy: 0.8
125 - val_loss: 0.3396 - val_custom_accuracy: 0.7734
Epoch 10/250
4/4 [==============================] - 1s 211ms/step - loss: 0.3104 - custom_accuracy: 0.7
578 - val_loss: 0.3323 - val_custom_accuracy: 0.7734
Epoch 11/250
4/4 [==============================] - 1s 255ms/step - loss: 0.3032 - custom_accuracy: 0.7
578 - val_loss: 0.3267 - val_custom_accuracy: 0.7734
Epoch 12/250
4/4 [==============================] - 1s 379ms/step - loss: 0.2976 - custom_accuracy: 0.7
031 - val_loss: 0.3220 - val_custom_accuracy: 0.7734
Epoch 13/250
4/4 [==============================] - 1s 364ms/step - loss: 0.2931 - custom_accuracy: 0.7
578 - val_loss: 0.3182 - val_custom_accuracy: 0.7734
Epoch 14/250
4/4 [==============================] - 1s 341ms/step - loss: 0.2896 - custom_accuracy: 0.7
578 - val_loss: 0.3151 - val_custom_accuracy: 0.7734
Epoch 15/250
4/4 [==============================] - 1s 342ms/step - loss: 0.2870 - custom_accuracy: 0.8
125 - val_loss: 0.3128 - val_custom_accuracy: 0.7734
Epoch 16/250
4/4 [==============================] - 1s 386ms/step - loss: 0.2846 - custom_accuracy: 0.8
125 - val_loss: 0.3109 - val_custom_accuracy: 0.7734
Epoch 17/250
4/4 [==============================] - 2s 440ms/step - loss: 0.2827 - custom_accuracy: 0.7
031 - val_loss: 0.3094 - val_custom_accuracy: 0.7734
Epoch 18/250
4/4 [==============================] - 1s 376ms/step - loss: 0.2813 - custom_accuracy: 0.7
031 - val_loss: 0.3083 - val_custom_accuracy: 0.7734
Epoch 19/250
4/4 [==============================] - 1s 404ms/step - loss: 0.2800 - custom_accuracy: 0.7
578 - val_loss: 0.3072 - val_custom_accuracy: 0.7734
Epoch 20/250
4/4 [==============================] - 1s 354ms/step - loss: 0.2791 - custom_accuracy: 0.7
578 - val_loss: 0.3059 - val_custom_accuracy: 0.7734
Epoch 21/250
4/4 [==============================] - 1s 330ms/step - loss: 0.2784 - custom_accuracy: 0.8
125 - val_loss: 0.3049 - val_custom_accuracy: 0.7734
Epoch 22/250
4/4 [==============================] - 1s 338ms/step - loss: 0.2776 - custom_accuracy: 0.7
031 - val_loss: 0.3043 - val_custom_accuracy: 0.7734
Epoch 23/250
4/4 [==============================] - 1s 228ms/step - loss: 0.2770 - custom_accuracy: 0.8
125 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 24/250
4/4 [==============================] - 1s 213ms/step - loss: 0.2765 - custom_accuracy: 0.7
031 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
```

```
Epoch 25/250
4/4 [==============================] - 1s 208ms/step - loss: 0.2761 - custom_accuracy: 0.7
578 - val_loss: 0.3024 - val_custom_accuracy: 0.7734
Epoch 26/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2760 - custom_accuracy: 0.8
125 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 27/250
4/4 [==============================] - 1s 209ms/step - loss: 0.2756 - custom_accuracy: 0.7
578 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 28/250
4/4 [==============================] - 1s 213ms/step - loss: 0.2757 - custom_accuracy: 0.7
578 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 29/250
4/4 [==============================] - 1s 208ms/step - loss: 0.2748 - custom_accuracy: 0.8
125 - val_loss: 0.3024 - val_custom_accuracy: 0.7734
Epoch 30/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2746 - custom_accuracy: 0.7
578 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 31/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2744 - custom_accuracy: 0.8
125 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 32/250
4/4 [==============================] - 1s 216ms/step - loss: 0.2747 - custom_accuracy: 0.7
031 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 33/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2745 - custom_accuracy: 0.8
125 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 34/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2745 - custom_accuracy: 0.8
125 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 35/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2744 - custom_accuracy: 0.7
578 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 36/250
4/4 [==============================] - 1s 313ms/step - loss: 0.2742 - custom_accuracy: 0.7
578 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 37/250
4/4 [==============================] - 1s 370ms/step - loss: 0.2742 - custom_accuracy: 0.7
578 - val_loss: 0.3019 - val_custom_accuracy: 0.7734
Epoch 38/250
4/4 [==============================] - 1s 341ms/step - loss: 0.2743 - custom_accuracy: 0.7
578 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 39/250
4/4 [==============================] - 1s 334ms/step - loss: 0.2742 - custom_accuracy: 0.8
125 - val_loss: 0.3024 - val_custom_accuracy: 0.7734
Epoch 40/250
4/4 [==============================] - 1s 325ms/step - loss: 0.2743 - custom_accuracy: 0.7
578 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 41/250
4/4 [==============================] - 1s 330ms/step - loss: 0.2742 - custom_accuracy: 0.7
031 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 42/250
4/4 [==============================] - 1s 314ms/step - loss: 0.2739 - custom_accuracy: 0.7
578 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 43/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2740 - custom_accuracy: 0.7
578 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 44/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2739 - custom_accuracy: 0.6
484 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 45/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2742 - custom_accuracy: 0.8
125 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 46/250
```

```
4/4 [==============================] - 1s 198ms/step - loss: 0.2740 - custom_accuracy: 0.7
578 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
Epoch 47/250
4/4 [==============================] - 1s 193ms/step - loss: 0.2738 - custom_accuracy: 0.7
578 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 48/250
4/4 [==============================] - 1s 192ms/step - loss: 0.2738 - custom_accuracy: 0.8
125 - val_loss: 0.3034 - val_custom_accuracy: 0.7734
Epoch 49/250
4/4 [==============================] - 1s 216ms/step - loss: 0.2738 - custom_accuracy: 0.7
578 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
Epoch 50/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2739 - custom_accuracy: 0.7
578 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 51/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2739 - custom_accuracy: 0.8
125 - val_loss: 0.3032 - val_custom_accuracy: 0.7734
Epoch 52/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2738 - custom_accuracy: 0.7
031 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 53/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2736 - custom_accuracy: 0.7
578 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 54/250
4/4 [==============================] - 1s 194ms/step - loss: 0.2736 - custom_accuracy: 0.7
578 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 55/250
4/4 [==============================] - 1s 209ms/step - loss: 0.2736 - custom_accuracy: 0.7
578 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 56/250
4/4 [==============================] - 1s 327ms/step - loss: 0.2735 - custom_accuracy: 0.7
578 - val_loss: 0.3029 - val_custom_accuracy: 0.7734
Epoch 57/250
4/4 [==============================] - 1s 372ms/step - loss: 0.2736 - custom_accuracy: 0.7
578 - val_loss: 0.3034 - val_custom_accuracy: 0.7734
Epoch 58/250
4/4 [==============================] - 1s 337ms/step - loss: 0.2734 - custom_accuracy: 0.8
125 - val_loss: 0.3040 - val_custom_accuracy: 0.7734
Epoch 59/250
4/4 [==============================] - 1s 332ms/step - loss: 0.2736 - custom_accuracy: 0.8
125 - val_loss: 0.3043 - val_custom_accuracy: 0.7734
Epoch 60/250
4/4 [==============================] - 1s 327ms/step - loss: 0.2736 - custom_accuracy: 0.7
578 - val_loss: 0.3045 - val_custom_accuracy: 0.7734
Epoch 61/250
4/4 [==============================] - 1s 333ms/step - loss: 0.2735 - custom_accuracy: 0.7
578 - val_loss: 0.3049 - val_custom_accuracy: 0.7734
Epoch 62/250
4/4 [==============================] - 1s 314ms/step - loss: 0.2738 - custom_accuracy: 0.8
125 - val_loss: 0.3055 - val_custom_accuracy: 0.7734
Epoch 63/250
4/4 [==============================] - 1s 209ms/step - loss: 0.2738 - custom_accuracy: 0.7
031 - val_loss: 0.3059 - val_custom_accuracy: 0.7734
Epoch 64/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2738 - custom_accuracy: 0.8
125 - val_loss: 0.3062 - val_custom_accuracy: 0.7734
Epoch 65/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2738 - custom_accuracy: 0.7
578 - val_loss: 0.3062 - val_custom_accuracy: 0.7734
Epoch 66/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2737 - custom_accuracy: 0.6
484 - val_loss: 0.3061 - val_custom_accuracy: 0.7734
Epoch 67/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2737 - custom_accuracy: 0.7
```

```
578 - val_loss: 0.3063 - val_custom_accuracy: 0.7734
Epoch 68/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2737 - custom_accuracy: 0.7
578 - val_loss: 0.3068 - val_custom_accuracy: 0.7734
Epoch 69/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2738 - custom_accuracy: 0.8
125 - val_loss: 0.3070 - val_custom_accuracy: 0.7734
Epoch 70/250
4/4 [==============================] - 1s 211ms/step - loss: 0.2738 - custom_accuracy: 0.7
031 - val_loss: 0.3071 - val_custom_accuracy: 0.7734
Epoch 71/250
4/4 [==============================] - 1s 215ms/step - loss: 0.2738 - custom_accuracy: 0.7
578 - val_loss: 0.3074 - val_custom_accuracy: 0.7734
Epoch 72/250
4/4 [==============================] - 1s 213ms/step - loss: 0.2739 - custom_accuracy: 0.7
578 - val_loss: 0.3073 - val_custom_accuracy: 0.7734
Epoch 73/250
4/4 [==============================] - 1s 212ms/step - loss: 0.2739 - custom_accuracy: 0.7
031 - val_loss: 0.3066 - val_custom_accuracy: 0.7734
Epoch 74/250
4/4 [==============================] - 1s 210ms/step - loss: 0.2738 - custom_accuracy: 0.7
031 - val_loss: 0.3064 - val_custom_accuracy: 0.7734
Epoch 75/250
4/4 [==============================] - 1s 210ms/step - loss: 0.2737 - custom_accuracy: 0.7
578 - val_loss: 0.3065 - val_custom_accuracy: 0.7734
Epoch 76/250
4/4 [==============================] - 1s 368ms/step - loss: 0.2736 - custom_accuracy: 0.7
578 - val_loss: 0.3066 - val_custom_accuracy: 0.7734
Epoch 77/250
4/4 [==============================] - 1s 352ms/step - loss: 0.2737 - custom_accuracy: 0.7
578 - val_loss: 0.3066 - val_custom_accuracy: 0.7734
Epoch 78/250
4/4 [==============================] - 1s 336ms/step - loss: 0.2737 - custom_accuracy: 0.7
031 - val_loss: 0.3063 - val_custom_accuracy: 0.7734
Epoch 79/250
4/4 [==============================] - 1s 325ms/step - loss: 0.2736 - custom_accuracy: 0.7
578 - val_loss: 0.3058 - val_custom_accuracy: 0.7734
Epoch 80/250
4/4 [==============================] - 1s 333ms/step - loss: 0.2735 - custom_accuracy: 0.7
578 - val_loss: 0.3051 - val_custom_accuracy: 0.7734
Epoch 81/250
4/4 [==============================] - 1s 329ms/step - loss: 0.2733 - custom_accuracy: 0.8
125 - val_loss: 0.3046 - val_custom_accuracy: 0.7734
Epoch 82/250
4/4 [==============================] - 1s 258ms/step - loss: 0.2733 - custom_accuracy: 0.7
578 - val_loss: 0.3041 - val_custom_accuracy: 0.7734
Epoch 83/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2731 - custom_accuracy: 0.7
031 - val_loss: 0.3039 - val_custom_accuracy: 0.7734
Epoch 84/250
4/4 [==============================] - 1s 211ms/step - loss: 0.2731 - custom_accuracy: 0.7
578 - val_loss: 0.3037 - val_custom_accuracy: 0.7734
Epoch 85/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2731 - custom_accuracy: 0.7
031 - val_loss: 0.3032 - val_custom_accuracy: 0.7734
Epoch 86/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2732 - custom_accuracy: 0.7
578 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 87/250
4/4 [==============================] - 1s 210ms/step - loss: 0.2733 - custom_accuracy: 0.7
578 - val_loss: 0.3033 - val_custom_accuracy: 0.7734
Epoch 88/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2736 - custom_accuracy: 0.7
578 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
```

```
Epoch 89/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2736 - custom_accuracy: 0.8
125 - val_loss: 0.3037 - val_custom_accuracy: 0.7734
Epoch 90/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2735 - custom_accuracy: 0.7
031 - val_loss: 0.3037 - val_custom_accuracy: 0.7734
Epoch 91/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2731 - custom_accuracy: 0.7
031 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
Epoch 92/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2727 - custom_accuracy: 0.7
578 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 93/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2734 - custom_accuracy: 0.7
578 - val_loss: 0.3034 - val_custom_accuracy: 0.7734
Epoch 94/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2740 - custom_accuracy: 0.8
125 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 95/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2743 - custom_accuracy: 0.7
578 - val_loss: 0.3037 - val_custom_accuracy: 0.7734
Epoch 96/250
4/4 [==============================] - 1s 371ms/step - loss: 0.2743 - custom_accuracy: 0.8
125 - val_loss: 0.3039 - val_custom_accuracy: 0.7734
Epoch 97/250
4/4 [==============================] - 1s 354ms/step - loss: 0.2742 - custom_accuracy: 0.7
031 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
Epoch 98/250
4/4 [==============================] - 1s 330ms/step - loss: 0.2740 - custom_accuracy: 0.8
125 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 99/250
4/4 [==============================] - 1s 330ms/step - loss: 0.2736 - custom_accuracy: 0.8
125 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 100/250
4/4 [==============================] - 1s 333ms/step - loss: 0.2733 - custom_accuracy: 0.7
031 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 101/250
4/4 [==============================] - 1s 330ms/step - loss: 0.2732 - custom_accuracy: 0.7
031 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 102/250
4/4 [==============================] - 1s 255ms/step - loss: 0.2731 - custom_accuracy: 0.7
578 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 103/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 104/250
4/4 [==============================] - 1s 216ms/step - loss: 0.2729 - custom_accuracy: 0.7
031 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 105/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2729 - custom_accuracy: 0.8
125 - val_loss: 0.3000 - val_custom_accuracy: 0.7734
Epoch 106/250
4/4 [==============================] - 1s 214ms/step - loss: 0.2729 - custom_accuracy: 0.7
578 - val_loss: 0.2997 - val_custom_accuracy: 0.7734
Epoch 107/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2729 - custom_accuracy: 0.7
578 - val_loss: 0.2994 - val_custom_accuracy: 0.7734
Epoch 108/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2729 - custom_accuracy: 0.7
031 - val_loss: 0.2989 - val_custom_accuracy: 0.7734
Epoch 109/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2730 - custom_accuracy: 0.7
578 - val_loss: 0.2988 - val_custom_accuracy: 0.7734
Epoch 110/250
```

```
4/4 [==============================] - 1s 202ms/step - loss: 0.2730 - custom_accuracy: 0.8
125 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 111/250
4/4 [==============================] - 1s 192ms/step - loss: 0.2730 - custom_accuracy: 0.7
578 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 112/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2732 - custom_accuracy: 0.6
484 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 113/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2736 - custom_accuracy: 0.7
031 - val_loss: 0.2985 - val_custom_accuracy: 0.7734
Epoch 114/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2731 - custom_accuracy: 0.7
578 - val_loss: 0.2988 - val_custom_accuracy: 0.7734
Epoch 115/250
4/4 [==============================] - 1s 231ms/step - loss: 0.2730 - custom_accuracy: 0.7
578 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 116/250
4/4 [==============================] - 1s 362ms/step - loss: 0.2730 - custom_accuracy: 0.8
125 - val_loss: 0.2989 - val_custom_accuracy: 0.7734
Epoch 117/250
4/4 [==============================] - 1s 356ms/step - loss: 0.2730 - custom_accuracy: 0.7
578 - val_loss: 0.2987 - val_custom_accuracy: 0.7734
Epoch 118/250
4/4 [==============================] - 1s 328ms/step - loss: 0.2731 - custom_accuracy: 0.6
484 - val_loss: 0.2985 - val_custom_accuracy: 0.7734
Epoch 119/250
4/4 [==============================] - 1s 332ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.2988 - val_custom_accuracy: 0.7734
Epoch 120/250
4/4 [==============================] - 1s 338ms/step - loss: 0.2730 - custom_accuracy: 0.7
578 - val_loss: 0.2991 - val_custom_accuracy: 0.7734
Epoch 121/250
4/4 [==============================] - 1s 336ms/step - loss: 0.2731 - custom_accuracy: 0.7
031 - val_loss: 0.2992 - val_custom_accuracy: 0.7734
Epoch 122/250
4/4 [==============================] - 1s 221ms/step - loss: 0.2731 - custom_accuracy: 0.8
125 - val_loss: 0.2993 - val_custom_accuracy: 0.7734
Epoch 123/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2730 - custom_accuracy: 0.7
578 - val_loss: 0.2994 - val_custom_accuracy: 0.7734
Epoch 124/250
4/4 [==============================] - 1s 194ms/step - loss: 0.2729 - custom_accuracy: 0.8
125 - val_loss: 0.2992 - val_custom_accuracy: 0.7734
Epoch 125/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2728 - custom_accuracy: 0.8
125 - val_loss: 0.2992 - val_custom_accuracy: 0.7734
Epoch 126/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2728 - custom_accuracy: 0.7
031 - val_loss: 0.2992 - val_custom_accuracy: 0.7734
Epoch 127/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.2997 - val_custom_accuracy: 0.7734
Epoch 128/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2727 - custom_accuracy: 0.8
125 - val_loss: 0.2999 - val_custom_accuracy: 0.7734
Epoch 129/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 130/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2727 - custom_accuracy: 0.7
578 - val_loss: 0.3006 - val_custom_accuracy: 0.7734
Epoch 131/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2727 - custom_accuracy: 0.7
```

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578 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 132/250
4/4 [==============================] - 1s 216ms/step - loss: 0.2727 - custom_accuracy: 0.7
031 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 133/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2726 - custom_accuracy: 0.7
578 - val_loss: 0.3003 - val_custom_accuracy: 0.7734
Epoch 134/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2727 - custom_accuracy: 0.7
031 - val_loss: 0.2996 - val_custom_accuracy: 0.7734
Epoch 135/250
4/4 [==============================] - 1s 276ms/step - loss: 0.2728 - custom_accuracy: 0.8
125 - val_loss: 0.2993 - val_custom_accuracy: 0.7734
Epoch 136/250
4/4 [==============================] - 1s 363ms/step - loss: 0.2729 - custom_accuracy: 0.7
578 - val_loss: 0.2992 - val_custom_accuracy: 0.7734
Epoch 137/250
4/4 [==============================] - 1s 407ms/step - loss: 0.2729 - custom_accuracy: 0.8
125 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 138/250
4/4 [==============================] - 1s 323ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.2989 - val_custom_accuracy: 0.7734
Epoch 139/250
4/4 [==============================] - 1s 338ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.2987 - val_custom_accuracy: 0.7734
Epoch 140/250
4/4 [==============================] - 1s 325ms/step - loss: 0.2727 - custom_accuracy: 0.6
484 - val_loss: 0.2986 - val_custom_accuracy: 0.7734
Epoch 141/250
4/4 [==============================] - 1s 333ms/step - loss: 0.2726 - custom_accuracy: 0.8
125 - val_loss: 0.2988 - val_custom_accuracy: 0.7734
Epoch 142/250
4/4 [==============================] - 1s 213ms/step - loss: 0.2727 - custom_accuracy: 0.7
578 - val_loss: 0.2992 - val_custom_accuracy: 0.7734
Epoch 143/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2727 - custom_accuracy: 0.7
578 - val_loss: 0.2996 - val_custom_accuracy: 0.7734
Epoch 144/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2728 - custom_accuracy: 0.7
031 - val_loss: 0.3000 - val_custom_accuracy: 0.7734
Epoch 145/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2729 - custom_accuracy: 0.8
125 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 146/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 147/250
4/4 [==============================] - 1s 193ms/step - loss: 0.2728 - custom_accuracy: 0.7
031 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 148/250
4/4 [==============================] - 1s 211ms/step - loss: 0.2728 - custom_accuracy: 0.8
125 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 149/250
4/4 [==============================] - 1s 214ms/step - loss: 0.2730 - custom_accuracy: 0.7
031 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 150/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2727 - custom_accuracy: 0.7
031 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 151/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2726 - custom_accuracy: 0.8
125 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 152/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2724 - custom_accuracy: 0.7
031 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
```

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Epoch 153/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2724 - custom_accuracy: 0.7
031 - val_loss: 0.3019 - val_custom_accuracy: 0.7734
Epoch 154/250
4/4 [==============================] - 1s 207ms/step - loss: 0.2724 - custom_accuracy: 0.7
031 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 155/250
4/4 [==============================] - 1s 379ms/step - loss: 0.2728 - custom_accuracy: 0.8
125 - val_loss: 0.3038 - val_custom_accuracy: 0.7734
Epoch 156/250
4/4 [==============================] - 1s 384ms/step - loss: 0.2729 - custom_accuracy: 0.8
125 - val_loss: 0.3047 - val_custom_accuracy: 0.7734
Epoch 157/250
4/4 [==============================] - 1s 336ms/step - loss: 0.2731 - custom_accuracy: 0.7
578 - val_loss: 0.3052 - val_custom_accuracy: 0.7734
Epoch 158/250
4/4 [==============================] - 1s 330ms/step - loss: 0.2732 - custom_accuracy: 0.7
578 - val_loss: 0.3052 - val_custom_accuracy: 0.7734
Epoch 159/250
4/4 [==============================] - 1s 335ms/step - loss: 0.2734 - custom_accuracy: 0.7
578 - val_loss: 0.3051 - val_custom_accuracy: 0.7734
Epoch 160/250
4/4 [==============================] - 1s 334ms/step - loss: 0.2733 - custom_accuracy: 0.7
578 - val_loss: 0.3047 - val_custom_accuracy: 0.7734
Epoch 161/250
4/4 [==============================] - 1s 277ms/step - loss: 0.2734 - custom_accuracy: 0.8
125 - val_loss: 0.3042 - val_custom_accuracy: 0.7734
Epoch 162/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2731 - custom_accuracy: 0.7
578 - val_loss: 0.3039 - val_custom_accuracy: 0.7734
Epoch 163/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2730 - custom_accuracy: 0.7
578 - val_loss: 0.3041 - val_custom_accuracy: 0.7734
Epoch 164/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.3041 - val_custom_accuracy: 0.7734
Epoch 165/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2726 - custom_accuracy: 0.8
125 - val_loss: 0.3041 - val_custom_accuracy: 0.7734
Epoch 166/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2727 - custom_accuracy: 0.7
031 - val_loss: 0.3038 - val_custom_accuracy: 0.7734
Epoch 167/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2724 - custom_accuracy: 0.7
578 - val_loss: 0.3033 - val_custom_accuracy: 0.7734
Epoch 168/250
4/4 [==============================] - 1s 194ms/step - loss: 0.2727 - custom_accuracy: 0.7
578 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 169/250
4/4 [==============================] - 1s 216ms/step - loss: 0.2726 - custom_accuracy: 0.7
578 - val_loss: 0.3029 - val_custom_accuracy: 0.7734
Epoch 170/250
4/4 [==============================] - 1s 206ms/step - loss: 0.2727 - custom_accuracy: 0.7
578 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 171/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2733 - custom_accuracy: 0.7
578 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 172/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2735 - custom_accuracy: 0.7
031 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 173/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2732 - custom_accuracy: 0.7
031 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 174/250
```

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4/4 [==============================] - 1s 202ms/step - loss: 0.2732 - custom_accuracy: 0.6
484 - val_loss: 0.3024 - val_custom_accuracy: 0.7734
Epoch 175/250
4/4 [==============================] - 1s 371ms/step - loss: 0.2734 - custom_accuracy: 0.8
125 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 176/250
4/4 [==============================] - 1s 364ms/step - loss: 0.2731 - custom_accuracy: 0.7
578 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 177/250
4/4 [==============================] - 1s 327ms/step - loss: 0.2729 - custom_accuracy: 0.8
125 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 178/250
4/4 [==============================] - 1s 332ms/step - loss: 0.2729 - custom_accuracy: 0.7
578 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 179/250
4/4 [==============================] - 1s 326ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 180/250
4/4 [==============================] - 1s 341ms/step - loss: 0.2724 - custom_accuracy: 0.7
578 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 181/250
4/4 [==============================] - 1s 258ms/step - loss: 0.2726 - custom_accuracy: 0.7
578 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 182/250
4/4 [==============================] - 1s 205ms/step - loss: 0.2727 - custom_accuracy: 0.8
125 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 183/250
4/4 [==============================] - 1s 205ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 184/250
4/4 [==============================] - 1s 206ms/step - loss: 0.2729 - custom_accuracy: 0.8
125 - val_loss: 0.3037 - val_custom_accuracy: 0.7734
Epoch 185/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2729 - custom_accuracy: 0.7
578 - val_loss: 0.3041 - val_custom_accuracy: 0.7734
Epoch 186/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2729 - custom_accuracy: 0.8
125 - val_loss: 0.3041 - val_custom_accuracy: 0.7734
Epoch 187/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2729 - custom_accuracy: 0.7
578 - val_loss: 0.3038 - val_custom_accuracy: 0.7734
Epoch 188/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2729 - custom_accuracy: 0.7
578 - val_loss: 0.3032 - val_custom_accuracy: 0.7734
Epoch 189/250
4/4 [==============================] - 1s 211ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.3029 - val_custom_accuracy: 0.7734
Epoch 190/250
4/4 [==============================] - 1s 205ms/step - loss: 0.2727 - custom_accuracy: 0.8
125 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 191/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2725 - custom_accuracy: 0.7
578 - val_loss: 0.3024 - val_custom_accuracy: 0.7734
Epoch 192/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2727 - custom_accuracy: 0.8
125 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 193/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2724 - custom_accuracy: 0.8
125 - val_loss: 0.3015 - val_custom_accuracy: 0.7734
Epoch 194/250
4/4 [==============================] - 1s 242ms/step - loss: 0.2724 - custom_accuracy: 0.7
578 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 195/250
4/4 [==============================] - 1s 365ms/step - loss: 0.2724 - custom_accuracy: 0.7
```

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578 - val_loss: 0.3015 - val_custom_accuracy: 0.7734
Epoch 196/250
4/4 [==============================] - 1s 366ms/step - loss: 0.2724 - custom_accuracy: 0.7
578 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 197/250
4/4 [==============================] - 1s 336ms/step - loss: 0.2723 - custom_accuracy: 0.7
578 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 198/250
4/4 [==============================] - 1s 332ms/step - loss: 0.2724 - custom_accuracy: 0.7
031 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 199/250
4/4 [==============================] - 1s 334ms/step - loss: 0.2724 - custom_accuracy: 0.7
031 - val_loss: 0.3008 - val_custom_accuracy: 0.7734
Epoch 200/250
4/4 [==============================] - 1s 330ms/step - loss: 0.2727 - custom_accuracy: 0.7
578 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 201/250
4/4 [==============================] - 1s 212ms/step - loss: 0.2727 - custom_accuracy: 0.7
578 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 202/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2731 - custom_accuracy: 0.8
125 - val_loss: 0.3000 - val_custom_accuracy: 0.7734
Epoch 203/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2730 - custom_accuracy: 0.7
578 - val_loss: 0.2999 - val_custom_accuracy: 0.7734
Epoch 204/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2727 - custom_accuracy: 0.8
125 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 205/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2726 - custom_accuracy: 0.5
938 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 206/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2724 - custom_accuracy: 0.7
578 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 207/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2727 - custom_accuracy: 0.8
125 - val_loss: 0.3008 - val_custom_accuracy: 0.7734
Epoch 208/250
4/4 [==============================] - 1s 212ms/step - loss: 0.2723 - custom_accuracy: 0.7
031 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 209/250
4/4 [==============================] - 1s 216ms/step - loss: 0.2724 - custom_accuracy: 0.7
578 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 210/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2724 - custom_accuracy: 0.8
125 - val_loss: 0.3011 - val_custom_accuracy: 0.7734
Epoch 211/250
4/4 [==============================] - 1s 216ms/step - loss: 0.2725 - custom_accuracy: 0.7
578 - val_loss: 0.3012 - val_custom_accuracy: 0.7734
Epoch 212/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2723 - custom_accuracy: 0.7
578 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 213/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2724 - custom_accuracy: 0.7
578 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 214/250
4/4 [==============================] - 1s 333ms/step - loss: 0.2722 - custom_accuracy: 0.6
484 - val_loss: 0.3006 - val_custom_accuracy: 0.7734
Epoch 215/250
4/4 [==============================] - 1s 364ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.3003 - val_custom_accuracy: 0.7734
Epoch 216/250
4/4 [==============================] - 1s 337ms/step - loss: 0.2727 - custom_accuracy: 0.7
578 - val_loss: 0.3001 - val_custom_accuracy: 0.7734
```

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Epoch 217/250
4/4 [==============================] - 1s 335ms/step - loss: 0.2726 - custom_accuracy: 0.8
125 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 218/250
4/4 [==============================] - 1s 340ms/step - loss: 0.2725 - custom_accuracy: 0.7
578 - val_loss: 0.3006 - val_custom_accuracy: 0.7734
Epoch 219/250
4/4 [==============================] - 1s 331ms/step - loss: 0.2723 - custom_accuracy: 0.7
031 - val_loss: 0.3008 - val_custom_accuracy: 0.7734
Epoch 220/250
4/4 [==============================] - 1s 311ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3008 - val_custom_accuracy: 0.7734
Epoch 221/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2723 - custom_accuracy: 0.6
484 - val_loss: 0.3006 - val_custom_accuracy: 0.7734
Epoch 222/250
4/4 [==============================] - 1s 208ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 223/250
4/4 [==============================] - 1s 206ms/step - loss: 0.2726 - custom_accuracy: 0.8
125 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 224/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2732 - custom_accuracy: 0.7
578 - val_loss: 0.3003 - val_custom_accuracy: 0.7734
Epoch 225/250
4/4 [==============================] - 1s 220ms/step - loss: 0.2734 - custom_accuracy: 0.7
578 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 226/250
4/4 [==============================] - 1s 220ms/step - loss: 0.2732 - custom_accuracy: 0.8
125 - val_loss: 0.3000 - val_custom_accuracy: 0.7734
Epoch 227/250
4/4 [==============================] - 1s 205ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.3000 - val_custom_accuracy: 0.7734
Epoch 228/250
4/4 [==============================] - 1s 205ms/step - loss: 0.2725 - custom_accuracy: 0.7
031 - val_loss: 0.3000 - val_custom_accuracy: 0.7734
Epoch 229/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2726 - custom_accuracy: 0.8
125 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 230/250
4/4 [==============================] - 1s 229ms/step - loss: 0.2726 - custom_accuracy: 0.7
031 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 231/250
4/4 [==============================] - 1s 205ms/step - loss: 0.2724 - custom_accuracy: 0.7
578 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 232/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2724 - custom_accuracy: 0.7
578 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 233/250
4/4 [==============================] - 1s 244ms/step - loss: 0.2724 - custom_accuracy: 0.7
578 - val_loss: 0.2997 - val_custom_accuracy: 0.7734
Epoch 234/250
4/4 [==============================] - 1s 379ms/step - loss: 0.2724 - custom_accuracy: 0.8
125 - val_loss: 0.2991 - val_custom_accuracy: 0.7734
Epoch 235/250
4/4 [==============================] - 1s 348ms/step - loss: 0.2724 - custom_accuracy: 0.7
578 - val_loss: 0.2988 - val_custom_accuracy: 0.7734
Epoch 236/250
4/4 [==============================] - 1s 343ms/step - loss: 0.2723 - custom_accuracy: 0.7
578 - val_loss: 0.2984 - val_custom_accuracy: 0.7734
Epoch 237/250
4/4 [==============================] - 1s 333ms/step - loss: 0.2727 - custom_accuracy: 0.7
578 - val_loss: 0.2984 - val_custom_accuracy: 0.7734
Epoch 238/250
```

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4/4 [==============================] - 1s 339ms/step - loss: 0.2726 - custom_accuracy: 0.7
578 - val_loss: 0.2987 - val_custom_accuracy: 0.7734
Epoch 239/250
4/4 [==============================] - 1s 329ms/step - loss: 0.2728 - custom_accuracy: 0.8
125 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 240/250
4/4 [==============================] - 1s 220ms/step - loss: 0.2726 - custom_accuracy: 0.7
578 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 241/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2726 - custom_accuracy: 0.7
578 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 242/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2724 - custom_accuracy: 0.6
484 - val_loss: 0.2992 - val_custom_accuracy: 0.7734
Epoch 243/250
4/4 [==============================] - 1s 206ms/step - loss: 0.2723 - custom_accuracy: 0.8
125 - val_loss: 0.2996 - val_custom_accuracy: 0.7734
Epoch 244/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 245/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2722 - custom_accuracy: 0.7
578 - val_loss: 0.3008 - val_custom_accuracy: 0.7734
Epoch 246/250
4/4 [==============================] - 1s 208ms/step - loss: 0.2723 - custom_accuracy: 0.7
578 - val_loss: 0.3012 - val_custom_accuracy: 0.7734
Epoch 247/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2722 - custom_accuracy: 0.7
031 - val_loss: 0.3012 - val_custom_accuracy: 0.7734
Epoch 248/250
4/4 [==============================] - 1s 206ms/step - loss: 0.2722 - custom_accuracy: 0.7
578 - val_loss: 0.3012 - val_custom_accuracy: 0.7734
Epoch 249/250
4/4 [==============================] - 1s 217ms/step - loss: 0.2722 - custom_accuracy: 0.6
484 - val_loss: 0.3015 - val_custom_accuracy: 0.7734
Epoch 250/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3019 - val_custom_accuracy: 0.7734
```

In [ ]:

```
# Fit the Discriminator Model for another 250 epochs
history = qdisc_model.fit(x=train_quantum_data,
                          y=y_train,
                          batch_size=32,
                          epochs=250,
                          verbose=1,
                          callbacks=[disc_model_cp],
                          validation_data=(test_quantum_data, y_test)
                          )
```

```
Epoch 1/250
4/4 [==============================] - 1s 211ms/step - loss: 0.2723 - custom_accuracy: 0.7
578 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 2/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 3/250
4/4 [==============================] - 1s 359ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3019 - val_custom_accuracy: 0.7734
Epoch 4/250
4/4 [==============================] - 1s 364ms/step - loss: 0.2722 - custom_accuracy: 0.6
484 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 5/250
4/4 [==============================] - 1s 333ms/step - loss: 0.2723 - custom_accuracy: 0.7
```



```
: 0.3015 - val_custom_accuracy: 0.7734
```

```
Epoch 6/250
4/4 [==============================] - 1s 340ms/step - loss: 0.2723 - custom_accuracy: 0.7
578 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 7/250
4/4 [==============================] - 1s 333ms/step - loss: 0.2723 - custom_accuracy: 0.8
125 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 8/250
4/4 [==============================] - 1s 339ms/step - loss: 0.2723 - custom_accuracy: 0.8
125 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 9/250
4/4 [==============================] - 1s 300ms/step - loss: 0.2723 - custom_accuracy: 0.8
125 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 10/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2721 - custom_accuracy: 0.8
125 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 11/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 12/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2720 - custom_accuracy: 0.7
578 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 13/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2721 - custom_accuracy: 0.6
484 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
Epoch 14/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2725 - custom_accuracy: 0.8
125 - val_loss: 0.3042 - val_custom_accuracy: 0.7734
Epoch 15/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2725 - custom_accuracy: 0.7
578 - val_loss: 0.3047 - val_custom_accuracy: 0.7734
Epoch 16/250
4/4 [==============================] - 1s 215ms/step - loss: 0.2726 - custom_accuracy: 0.8
125 - val_loss: 0.3050 - val_custom_accuracy: 0.7734
Epoch 17/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2724 - custom_accuracy: 0.6
484 - val_loss: 0.3050 - val_custom_accuracy: 0.7734
Epoch 18/250
4/4 [==============================] - 1s 205ms/step - loss: 0.2723 - custom_accuracy: 0.8
125 - val_loss: 0.3046 - val_custom_accuracy: 0.7734
Epoch 19/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2723 - custom_accuracy: 0.7
578 - val_loss: 0.3043 - val_custom_accuracy: 0.7734
Epoch 20/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2723 - custom_accuracy: 0.8
125 - val_loss: 0.3042 - val_custom_accuracy: 0.7734
Epoch 21/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3042 - val_custom_accuracy: 0.7734
Epoch 22/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3039 - val_custom_accuracy: 0.7734
Epoch 23/250
4/4 [==============================] - 1s 369ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3034 - val_custom_accuracy: 0.7734
Epoch 24/250
4/4 [==============================] - 1s 362ms/step - loss: 0.2720 - custom_accuracy: 0.8
125 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 25/250
4/4 [==============================] - 1s 332ms/step - loss: 0.2725 - custom_accuracy: 0.7
578 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 26/250
4/4 [==============================] - 1s 335ms/step - loss: 0.2724 - custom_accuracy: 0.7
578 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 27/250
```

```
4/4 [==============================] - 1s 322ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 28/250
4/4 [==============================] - 1s 341ms/step - loss: 0.2723 - custom_accuracy: 0.7
031 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 29/250
4/4 [==============================] - 1s 265ms/step - loss: 0.2722 - custom_accuracy: 0.7
031 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
Epoch 30/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2721 - custom_accuracy: 0.7
031 - val_loss: 0.3037 - val_custom_accuracy: 0.7734
Epoch 31/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2720 - custom_accuracy: 0.8
125 - val_loss: 0.3046 - val_custom_accuracy: 0.7734
Epoch 32/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2724 - custom_accuracy: 0.8
125 - val_loss: 0.3051 - val_custom_accuracy: 0.7734
Epoch 33/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2728 - custom_accuracy: 0.7
578 - val_loss: 0.3052 - val_custom_accuracy: 0.7734
Epoch 34/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2728 - custom_accuracy: 0.8
125 - val_loss: 0.3049 - val_custom_accuracy: 0.7734
Epoch 35/250
4/4 [==============================] - 1s 194ms/step - loss: 0.2729 - custom_accuracy: 0.8
125 - val_loss: 0.3043 - val_custom_accuracy: 0.7734
Epoch 36/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2729 - custom_accuracy: 0.7
031 - val_loss: 0.3040 - val_custom_accuracy: 0.7734
Epoch 37/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2729 - custom_accuracy: 0.7
578 - val_loss: 0.3045 - val_custom_accuracy: 0.7734
Epoch 38/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2731 - custom_accuracy: 0.7
031 - val_loss: 0.3047 - val_custom_accuracy: 0.7734
Epoch 39/250
4/4 [==============================] - 1s 214ms/step - loss: 0.2733 - custom_accuracy: 0.7
031 - val_loss: 0.3046 - val_custom_accuracy: 0.7734
Epoch 40/250
4/4 [==============================] - 1s 206ms/step - loss: 0.2733 - custom_accuracy: 0.8
125 - val_loss: 0.3042 - val_custom_accuracy: 0.7734
Epoch 41/250
4/4 [==============================] - 1s 225ms/step - loss: 0.2734 - custom_accuracy: 0.8
125 - val_loss: 0.3039 - val_custom_accuracy: 0.7734
Epoch 42/250
4/4 [==============================] - 1s 375ms/step - loss: 0.2735 - custom_accuracy: 0.7
031 - val_loss: 0.3032 - val_custom_accuracy: 0.7734
Epoch 43/250
4/4 [==============================] - 2s 409ms/step - loss: 0.2736 - custom_accuracy: 0.7
578 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 44/250
4/4 [==============================] - 2s 382ms/step - loss: 0.2746 - custom_accuracy: 0.8
125 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 45/250
4/4 [==============================] - 1s 383ms/step - loss: 0.2746 - custom_accuracy: 0.6
484 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 46/250
4/4 [==============================] - 1s 361ms/step - loss: 0.2749 - custom_accuracy: 0.7
031 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 47/250
4/4 [==============================] - 1s 366ms/step - loss: 0.2750 - custom_accuracy: 0.7
578 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 48/250
4/4 [==============================] - 1s 359ms/step - loss: 0.2748 - custom_accuracy: 0.7
```

```
578 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 49/250
4/4 [==============================] - 1s 363ms/step - loss: 0.2742 - custom_accuracy: 0.6
484 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 50/250
4/4 [==============================] - 1s 375ms/step - loss: 0.2737 - custom_accuracy: 0.7
578 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 51/250
4/4 [==============================] - 1s 357ms/step - loss: 0.2731 - custom_accuracy: 0.7
578 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 52/250
4/4 [==============================] - 1s 252ms/step - loss: 0.2726 - custom_accuracy: 0.8
125 - val_loss: 0.3029 - val_custom_accuracy: 0.7734
Epoch 53/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2727 - custom_accuracy: 0.8
125 - val_loss: 0.3034 - val_custom_accuracy: 0.7734
Epoch 54/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2726 - custom_accuracy: 0.7
578 - val_loss: 0.3037 - val_custom_accuracy: 0.7734
Epoch 55/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2727 - custom_accuracy: 0.7
031 - val_loss: 0.3042 - val_custom_accuracy: 0.7734
Epoch 56/250
4/4 [==============================] - 1s 211ms/step - loss: 0.2725 - custom_accuracy: 0.7
031 - val_loss: 0.3048 - val_custom_accuracy: 0.7734
Epoch 57/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2723 - custom_accuracy: 0.8
125 - val_loss: 0.3045 - val_custom_accuracy: 0.7734
Epoch 58/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2724 - custom_accuracy: 0.8
125 - val_loss: 0.3044 - val_custom_accuracy: 0.7734
Epoch 59/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2724 - custom_accuracy: 0.7
578 - val_loss: 0.3041 - val_custom_accuracy: 0.7734
Epoch 60/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2723 - custom_accuracy: 0.8
125 - val_loss: 0.3033 - val_custom_accuracy: 0.7734
Epoch 61/250
4/4 [==============================] - 1s 205ms/step - loss: 0.2722 - custom_accuracy: 0.6
484 - val_loss: 0.3029 - val_custom_accuracy: 0.7734
Epoch 62/250
4/4 [==============================] - 1s 216ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 63/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2722 - custom_accuracy: 0.7
578 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 64/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2721 - custom_accuracy: 0.7
031 - val_loss: 0.3024 - val_custom_accuracy: 0.7734
Epoch 65/250
4/4 [==============================] - 1s 224ms/step - loss: 0.2721 - custom_accuracy: 0.7
031 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 66/250
4/4 [==============================] - 1s 370ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 67/250
4/4 [==============================] - 1s 349ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 68/250
4/4 [==============================] - 1s 329ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3019 - val_custom_accuracy: 0.7734
Epoch 69/250
4/4 [==============================] - 1s 342ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
```

```
Epoch 70/250
4/4 [==============================] - 1s 331ms/step - loss: 0.2722 - custom_accuracy: 0.7
031 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 71/250
4/4 [==============================] - 1s 337ms/step - loss: 0.2721 - custom_accuracy: 0.8
125 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
Epoch 72/250
4/4 [==============================] - 1s 258ms/step - loss: 0.2720 - custom_accuracy: 0.8
125 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 73/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2722 - custom_accuracy: 0.7
031 - val_loss: 0.3039 - val_custom_accuracy: 0.7734
Epoch 74/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3037 - val_custom_accuracy: 0.7734
Epoch 75/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2721 - custom_accuracy: 0.8
125 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
Epoch 76/250
4/4 [==============================] - 1s 210ms/step - loss: 0.2720 - custom_accuracy: 0.7
578 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 77/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2719 - custom_accuracy: 0.7
578 - val_loss: 0.3034 - val_custom_accuracy: 0.7734
Epoch 78/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 79/250
4/4 [==============================] - 1s 214ms/step - loss: 0.2720 - custom_accuracy: 0.7
578 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
Epoch 80/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2723 - custom_accuracy: 0.7
031 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 81/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2723 - custom_accuracy: 0.8
125 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 82/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2722 - custom_accuracy: 0.7
578 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 83/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2722 - custom_accuracy: 0.7
031 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 84/250
4/4 [==============================] - 1s 209ms/step - loss: 0.2722 - custom_accuracy: 0.7
031 - val_loss: 0.3001 - val_custom_accuracy: 0.7734
Epoch 85/250
4/4 [==============================] - 1s 277ms/step - loss: 0.2726 - custom_accuracy: 0.7
578 - val_loss: 0.2996 - val_custom_accuracy: 0.7734
Epoch 86/250
4/4 [==============================] - 1s 370ms/step - loss: 0.2722 - custom_accuracy: 0.6
484 - val_loss: 0.3000 - val_custom_accuracy: 0.7734
Epoch 87/250
4/4 [==============================] - 1s 346ms/step - loss: 0.2723 - custom_accuracy: 0.8
125 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 88/250
4/4 [==============================] - 1s 336ms/step - loss: 0.2725 - custom_accuracy: 0.8
125 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 89/250
4/4 [==============================] - 1s 335ms/step - loss: 0.2726 - custom_accuracy: 0.7
031 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 90/250
4/4 [==============================] - 1s 340ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 91/250
```

```
4/4 [==============================] - 1s 338ms/step - loss: 0.2720 - custom_accuracy: 0.7
031 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 92/250
4/4 [==============================] - 1s 210ms/step - loss: 0.2720 - custom_accuracy: 0.7
578 - val_loss: 0.3019 - val_custom_accuracy: 0.7734
Epoch 93/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2722 - custom_accuracy: 0.7
031 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 94/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2721 - custom_accuracy: 0.8
125 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 95/250
4/4 [==============================] - 1s 208ms/step - loss: 0.2720 - custom_accuracy: 0.6
484 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 96/250
4/4 [==============================] - 1s 207ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 97/250
4/4 [==============================] - 1s 190ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 98/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2722 - custom_accuracy: 0.7
031 - val_loss: 0.3033 - val_custom_accuracy: 0.7734
Epoch 99/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 100/250
4/4 [==============================] - 1s 192ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 101/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 102/250
4/4 [==============================] - 1s 207ms/step - loss: 0.2723 - custom_accuracy: 0.8
125 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 103/250
4/4 [==============================] - 1s 210ms/step - loss: 0.2720 - custom_accuracy: 0.7
578 - val_loss: 0.3038 - val_custom_accuracy: 0.7734
Epoch 104/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2720 - custom_accuracy: 0.8
125 - val_loss: 0.3039 - val_custom_accuracy: 0.7734
Epoch 105/250
4/4 [==============================] - 1s 325ms/step - loss: 0.2720 - custom_accuracy: 0.8
125 - val_loss: 0.3043 - val_custom_accuracy: 0.7734
Epoch 106/250
4/4 [==============================] - 1s 363ms/step - loss: 0.2722 - custom_accuracy: 0.7
578 - val_loss: 0.3049 - val_custom_accuracy: 0.7734
Epoch 107/250
4/4 [==============================] - 1s 336ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3047 - val_custom_accuracy: 0.7734
Epoch 108/250
4/4 [==============================] - 1s 333ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3041 - val_custom_accuracy: 0.7734
Epoch 109/250
4/4 [==============================] - 1s 330ms/step - loss: 0.2720 - custom_accuracy: 0.8
125 - val_loss: 0.3042 - val_custom_accuracy: 0.7734
Epoch 110/250
4/4 [==============================] - 1s 390ms/step - loss: 0.2719 - custom_accuracy: 0.7
578 - val_loss: 0.3042 - val_custom_accuracy: 0.7734
Epoch 111/250
4/4 [==============================] - 1s 301ms/step - loss: 0.2719 - custom_accuracy: 0.8
125 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
Epoch 112/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2718 - custom_accuracy: 0.8
```

```
125 - val_loss: 0.3032 - val_custom_accuracy: 0.7734
Epoch 113/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3029 - val_custom_accuracy: 0.7734
Epoch 114/250
4/4 [==============================] - 1s 217ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3029 - val_custom_accuracy: 0.7734
Epoch 115/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 116/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2719 - custom_accuracy: 0.7
031 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 117/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2719 - custom_accuracy: 0.7
578 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 118/250
4/4 [==============================] - 1s 220ms/step - loss: 0.2720 - custom_accuracy: 0.7
031 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 119/250
4/4 [==============================] - 1s 214ms/step - loss: 0.2719 - custom_accuracy: 0.8
125 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 120/250
4/4 [==============================] - 1s 208ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 121/250
4/4 [==============================] - 1s 215ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 122/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 123/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2719 - custom_accuracy: 0.7
578 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 124/250
4/4 [==============================] - 1s 223ms/step - loss: 0.2719 - custom_accuracy: 0.7
031 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 125/250
4/4 [==============================] - 1s 374ms/step - loss: 0.2719 - custom_accuracy: 0.8
125 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 126/250
4/4 [==============================] - 1s 353ms/step - loss: 0.2719 - custom_accuracy: 0.7
578 - val_loss: 0.3024 - val_custom_accuracy: 0.7734
Epoch 127/250
4/4 [==============================] - 1s 333ms/step - loss: 0.2718 - custom_accuracy: 0.7
031 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
Epoch 128/250
4/4 [==============================] - 1s 334ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3034 - val_custom_accuracy: 0.7734
Epoch 129/250
4/4 [==============================] - 1s 331ms/step - loss: 0.2720 - custom_accuracy: 0.7
578 - val_loss: 0.3039 - val_custom_accuracy: 0.7734
Epoch 130/250
4/4 [==============================] - 1s 332ms/step - loss: 0.2719 - custom_accuracy: 0.7
031 - val_loss: 0.3041 - val_custom_accuracy: 0.7734
Epoch 131/250
4/4 [==============================] - 1s 218ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3043 - val_custom_accuracy: 0.7734
Epoch 132/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2721 - custom_accuracy: 0.8
125 - val_loss: 0.3045 - val_custom_accuracy: 0.7734
Epoch 133/250
4/4 [==============================] - 1s 217ms/step - loss: 0.2721 - custom_accuracy: 0.7
031 - val_loss: 0.3044 - val_custom_accuracy: 0.7734
```

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Epoch 134/250
4/4 [==============================] - 1s 206ms/step - loss: 0.2723 - custom_accuracy: 0.7
578 - val_loss: 0.3034 - val_custom_accuracy: 0.7734
Epoch 135/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 136/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2716 - custom_accuracy: 0.8
125 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 137/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3011 - val_custom_accuracy: 0.7734
Epoch 138/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2717 - custom_accuracy: 0.8
125 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 139/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2717 - custom_accuracy: 0.7
578 - val_loss: 0.3003 - val_custom_accuracy: 0.7734
Epoch 140/250
4/4 [==============================] - 1s 221ms/step - loss: 0.2719 - custom_accuracy: 0.7
578 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 141/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3006 - val_custom_accuracy: 0.7734
Epoch 142/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 143/250
4/4 [==============================] - 1s 210ms/step - loss: 0.2721 - custom_accuracy: 0.7
031 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 144/250
4/4 [==============================] - 1s 321ms/step - loss: 0.2717 - custom_accuracy: 0.6
484 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 145/250
4/4 [==============================] - 1s 375ms/step - loss: 0.2720 - custom_accuracy: 0.6
484 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 146/250
4/4 [==============================] - 1s 342ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3039 - val_custom_accuracy: 0.7734
Epoch 147/250
4/4 [==============================] - 1s 325ms/step - loss: 0.2719 - custom_accuracy: 0.7
578 - val_loss: 0.3046 - val_custom_accuracy: 0.7734
Epoch 148/250
4/4 [==============================] - 1s 328ms/step - loss: 0.2720 - custom_accuracy: 0.8
125 - val_loss: 0.3046 - val_custom_accuracy: 0.7734
Epoch 149/250
4/4 [==============================] - 1s 329ms/step - loss: 0.2719 - custom_accuracy: 0.7
031 - val_loss: 0.3049 - val_custom_accuracy: 0.7734
Epoch 150/250
4/4 [==============================] - 1s 313ms/step - loss: 0.2719 - custom_accuracy: 0.7
578 - val_loss: 0.3054 - val_custom_accuracy: 0.7734
Epoch 151/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3055 - val_custom_accuracy: 0.7734
Epoch 152/250
4/4 [==============================] - 1s 210ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3055 - val_custom_accuracy: 0.7734
Epoch 153/250
4/4 [==============================] - 1s 206ms/step - loss: 0.2724 - custom_accuracy: 0.8
125 - val_loss: 0.3052 - val_custom_accuracy: 0.7734
Epoch 154/250
4/4 [==============================] - 1s 194ms/step - loss: 0.2721 - custom_accuracy: 0.7
031 - val_loss: 0.3051 - val_custom_accuracy: 0.7734
Epoch 155/250
```

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4/4 [==============================] - 1s 196ms/step - loss: 0.2722 - custom_accuracy: 0.7
031 - val_loss: 0.3046 - val_custom_accuracy: 0.7734
Epoch 156/250
4/4 [==============================] - 1s 217ms/step - loss: 0.2725 - custom_accuracy: 0.7
578 - val_loss: 0.3041 - val_custom_accuracy: 0.7734
Epoch 157/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2725 - custom_accuracy: 0.8
125 - val_loss: 0.3038 - val_custom_accuracy: 0.7734
Epoch 158/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2725 - custom_accuracy: 0.8
125 - val_loss: 0.3037 - val_custom_accuracy: 0.7734
Epoch 159/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2726 - custom_accuracy: 0.6
484 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
Epoch 160/250
4/4 [==============================] - 1s 210ms/step - loss: 0.2722 - custom_accuracy: 0.7
031 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 161/250
4/4 [==============================] - 1s 210ms/step - loss: 0.2715 - custom_accuracy: 0.7
578 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
Epoch 162/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2717 - custom_accuracy: 0.7
578 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 163/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2715 - custom_accuracy: 0.8
125 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 164/250
4/4 [==============================] - 1s 366ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 165/250
4/4 [==============================] - 1s 362ms/step - loss: 0.2720 - custom_accuracy: 0.7
578 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 166/250
4/4 [==============================] - 1s 332ms/step - loss: 0.2717 - custom_accuracy: 0.7
031 - val_loss: 0.3029 - val_custom_accuracy: 0.7734
Epoch 167/250
4/4 [==============================] - 1s 401ms/step - loss: 0.2717 - custom_accuracy: 0.7
031 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 168/250
4/4 [==============================] - 1s 328ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 169/250
4/4 [==============================] - 1s 345ms/step - loss: 0.2719 - custom_accuracy: 0.8
125 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 170/250
4/4 [==============================] - 1s 264ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 171/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 172/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2722 - custom_accuracy: 0.7
031 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 173/250
4/4 [==============================] - 1s 207ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3038 - val_custom_accuracy: 0.7734
Epoch 174/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2719 - custom_accuracy: 0.7
578 - val_loss: 0.3049 - val_custom_accuracy: 0.7734
Epoch 175/250
4/4 [==============================] - 1s 196ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3064 - val_custom_accuracy: 0.7734
Epoch 176/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2721 - custom_accuracy: 0.7
```

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578 - val_loss: 0.3077 - val_custom_accuracy: 0.7734
Epoch 177/250
4/4 [==============================] - 1s 206ms/step - loss: 0.2721 - custom_accuracy: 0.7
031 - val_loss: 0.3081 - val_custom_accuracy: 0.7734
Epoch 178/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2724 - custom_accuracy: 0.8
125 - val_loss: 0.3081 - val_custom_accuracy: 0.7734
Epoch 179/250
4/4 [==============================] - 1s 208ms/step - loss: 0.2730 - custom_accuracy: 0.7
578 - val_loss: 0.3082 - val_custom_accuracy: 0.7734
Epoch 180/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2727 - custom_accuracy: 0.8
125 - val_loss: 0.3075 - val_custom_accuracy: 0.7734
Epoch 181/250
4/4 [==============================] - 1s 215ms/step - loss: 0.2726 - custom_accuracy: 0.7
578 - val_loss: 0.3065 - val_custom_accuracy: 0.7734
Epoch 182/250
4/4 [==============================] - 1s 207ms/step - loss: 0.2725 - custom_accuracy: 0.8
125 - val_loss: 0.3053 - val_custom_accuracy: 0.7734
Epoch 183/250
4/4 [==============================] - 1s 290ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3043 - val_custom_accuracy: 0.7734
Epoch 184/250
4/4 [==============================] - 1s 366ms/step - loss: 0.2720 - custom_accuracy: 0.7
578 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
Epoch 185/250
4/4 [==============================] - 1s 341ms/step - loss: 0.2720 - custom_accuracy: 0.7
031 - val_loss: 0.3033 - val_custom_accuracy: 0.7734
Epoch 186/250
4/4 [==============================] - 1s 334ms/step - loss: 0.2719 - custom_accuracy: 0.8
125 - val_loss: 0.3034 - val_custom_accuracy: 0.7734
Epoch 187/250
4/4 [==============================] - 1s 331ms/step - loss: 0.2719 - custom_accuracy: 0.8
125 - val_loss: 0.3038 - val_custom_accuracy: 0.7734
Epoch 188/250
4/4 [==============================] - 1s 333ms/step - loss: 0.2717 - custom_accuracy: 0.6
484 - val_loss: 0.3038 - val_custom_accuracy: 0.7734
Epoch 189/250
4/4 [==============================] - 1s 322ms/step - loss: 0.2719 - custom_accuracy: 0.7
031 - val_loss: 0.3037 - val_custom_accuracy: 0.7734
Epoch 190/250
4/4 [==============================] - 1s 215ms/step - loss: 0.2717 - custom_accuracy: 0.7
578 - val_loss: 0.3039 - val_custom_accuracy: 0.7734
Epoch 191/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2718 - custom_accuracy: 0.7
031 - val_loss: 0.3045 - val_custom_accuracy: 0.7734
Epoch 192/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3049 - val_custom_accuracy: 0.7734
Epoch 193/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3052 - val_custom_accuracy: 0.7734
Epoch 194/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3053 - val_custom_accuracy: 0.7734
Epoch 195/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2717 - custom_accuracy: 0.7
578 - val_loss: 0.3053 - val_custom_accuracy: 0.7734
Epoch 196/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2717 - custom_accuracy: 0.6
484 - val_loss: 0.3056 - val_custom_accuracy: 0.7734
Epoch 197/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2717 - custom_accuracy: 0.7
578 - val_loss: 0.3055 - val_custom_accuracy: 0.7734
```

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Epoch 198/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2721 - custom_accuracy: 0.8
125 - val_loss: 0.3049 - val_custom_accuracy: 0.7734
Epoch 199/250
4/4 [==============================] - 1s 215ms/step - loss: 0.2719 - custom_accuracy: 0.7
031 - val_loss: 0.3042 - val_custom_accuracy: 0.7734
Epoch 200/250
4/4 [==============================] - 1s 208ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3032 - val_custom_accuracy: 0.7734
Epoch 201/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2724 - custom_accuracy: 0.8
125 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 202/250
4/4 [==============================] - 1s 215ms/step - loss: 0.2722 - custom_accuracy: 0.7
578 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 203/250
4/4 [==============================] - 1s 349ms/step - loss: 0.2719 - custom_accuracy: 0.7
578 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 204/250
4/4 [==============================] - 1s 359ms/step - loss: 0.2715 - custom_accuracy: 0.8
125 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 205/250
4/4 [==============================] - 1s 332ms/step - loss: 0.2715 - custom_accuracy: 0.7
578 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 206/250
4/4 [==============================] - 1s 344ms/step - loss: 0.2716 - custom_accuracy: 0.8
125 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 207/250
4/4 [==============================] - 1s 327ms/step - loss: 0.2717 - custom_accuracy: 0.7
031 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 208/250
4/4 [==============================] - 1s 330ms/step - loss: 0.2717 - custom_accuracy: 0.7
578 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 209/250
4/4 [==============================] - 1s 318ms/step - loss: 0.2716 - custom_accuracy: 0.7
578 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 210/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 211/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 212/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2715 - custom_accuracy: 0.7
578 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 213/250
4/4 [==============================] - 1s 210ms/step - loss: 0.2719 - custom_accuracy: 0.7
578 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 214/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2717 - custom_accuracy: 0.7
578 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 215/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2717 - custom_accuracy: 0.7
578 - val_loss: 0.3038 - val_custom_accuracy: 0.7734
Epoch 216/250
4/4 [==============================] - 1s 219ms/step - loss: 0.2719 - custom_accuracy: 0.8
125 - val_loss: 0.3032 - val_custom_accuracy: 0.7734
Epoch 217/250
4/4 [==============================] - 1s 198ms/step - loss: 0.2716 - custom_accuracy: 0.8
125 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 218/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2715 - custom_accuracy: 0.8
125 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 219/250
```

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4/4 [==============================] - 1s 201ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 220/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2714 - custom_accuracy: 0.7
578 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 221/250
4/4 [==============================] - 1s 205ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 222/250
4/4 [==============================] - 1s 200ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 223/250
4/4 [==============================] - 1s 356ms/step - loss: 0.2716 - custom_accuracy: 0.8
125 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 224/250
4/4 [==============================] - 1s 381ms/step - loss: 0.2715 - custom_accuracy: 0.7
031 - val_loss: 0.3011 - val_custom_accuracy: 0.7734
Epoch 225/250
4/4 [==============================] - 1s 326ms/step - loss: 0.2713 - custom_accuracy: 0.8
125 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 226/250
4/4 [==============================] - 1s 332ms/step - loss: 0.2714 - custom_accuracy: 0.7
578 - val_loss: 0.3015 - val_custom_accuracy: 0.7734
Epoch 227/250
4/4 [==============================] - 1s 336ms/step - loss: 0.2715 - custom_accuracy: 0.7
578 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 228/250
4/4 [==============================] - 1s 400ms/step - loss: 0.2715 - custom_accuracy: 0.8
125 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 229/250
4/4 [==============================] - 1s 252ms/step - loss: 0.2714 - custom_accuracy: 0.7
578 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 230/250
4/4 [==============================] - 1s 204ms/step - loss: 0.2714 - custom_accuracy: 0.6
484 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 231/250
4/4 [==============================] - 1s 211ms/step - loss: 0.2713 - custom_accuracy: 0.8
125 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 232/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2714 - custom_accuracy: 0.7
578 - val_loss: 0.3033 - val_custom_accuracy: 0.7734
Epoch 233/250
4/4 [==============================] - 1s 210ms/step - loss: 0.2717 - custom_accuracy: 0.7
578 - val_loss: 0.3042 - val_custom_accuracy: 0.7734
Epoch 234/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.3038 - val_custom_accuracy: 0.7734
Epoch 235/250
4/4 [==============================] - 1s 215ms/step - loss: 0.2715 - custom_accuracy: 0.7
578 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 236/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 237/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 238/250
4/4 [==============================] - 1s 197ms/step - loss: 0.2714 - custom_accuracy: 0.7
031 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 239/250
4/4 [==============================] - 1s 202ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 240/250
4/4 [==============================] - 1s 199ms/step - loss: 0.2715 - custom_accuracy: 0.7
```

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578 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 241/250
4/4 [==============================] - 1s 195ms/step - loss: 0.2716 - custom_accuracy: 0.7
031 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 242/250
4/4 [==============================] - 1s 325ms/step - loss: 0.2715 - custom_accuracy: 0.7
578 - val_loss: 0.3011 - val_custom_accuracy: 0.7734
Epoch 243/250
4/4 [==============================] - 1s 366ms/step - loss: 0.2718 - custom_accuracy: 0.7
031 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 244/250
4/4 [==============================] - 1s 344ms/step - loss: 0.2716 - custom_accuracy: 0.7
578 - val_loss: 0.3011 - val_custom_accuracy: 0.7734
Epoch 245/250
4/4 [==============================] - 1s 333ms/step - loss: 0.2717 - custom_accuracy: 0.8
125 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 246/250
4/4 [==============================] - 1s 328ms/step - loss: 0.2720 - custom_accuracy: 0.8
125 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 247/250
4/4 [==============================] - 1s 335ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 248/250
4/4 [==============================] - 1s 338ms/step - loss: 0.2721 - custom_accuracy: 0.8
125 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 249/250
4/4 [==============================] - 1s 201ms/step - loss: 0.2721 - custom_accuracy: 0.7
578 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 250/250
4/4 [==============================] - 1s 203ms/step - loss: 0.2722 - custom_accuracy: 0.8
125 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
```

In [ ]:

```
# Fit the Discriminator Model for another 500 epochs
history = qdisc_model.fit(x=train_quantum_data,
                          y=y_train,
                          batch_size=32,
                          epochs=500,
                          verbose=1,
                          callbacks=[disc_model_cp],
                          validation_data=(test_quantum_data, y_test)
                          )
```

```
Epoch 1/500
4/4 [==============================] - 1s 357ms/step - loss: 0.2722 - custom_accuracy: 0.7
578 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 2/500
4/4 [==============================] - 1s 366ms/step - loss: 0.2720 - custom_accuracy: 0.7
578 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 3/500
4/4 [==============================] - 1s 339ms/step - loss: 0.2716 - custom_accuracy: 0.7
578 - val_loss: 0.3019 - val_custom_accuracy: 0.7734
Epoch 4/500
4/4 [==============================] - 1s 340ms/step - loss: 0.2716 - custom_accuracy: 0.7
031 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 5/500
4/4 [==============================] - 1s 334ms/step - loss: 0.2715 - custom_accuracy: 0.8
125 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 6/500
4/4 [==============================] - 1s 353ms/step - loss: 0.2715 - custom_accuracy: 0.6
484 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 7/500
4/4 [==============================] - 1s 260ms/step - loss: 0.2716 - custom_accuracy: 0.8
125 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
```

```
4/4 [==============================] - 1s 199ms/step - loss: 0.2716 - custom_accuracy: 0.8
125 - val_loss: 0.3032 - val_custom_accuracy: 0.7734
Epoch 9/500
4/4 [==============================] - 1s 198ms/step - loss: 0.2715 - custom_accuracy: 0.7
578 - val_loss: 0.3032 - val_custom_accuracy: 0.7734
Epoch 10/500
4/4 [==============================] - 1s 197ms/step - loss: 0.2715 - custom_accuracy: 0.7
578 - val_loss: 0.3032 - val_custom_accuracy: 0.7734
Epoch 11/500
4/4 [==============================] - 1s 195ms/step - loss: 0.2715 - custom_accuracy: 0.8
125 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 12/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2717 - custom_accuracy: 0.8
125 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 13/500
4/4 [==============================] - 1s 214ms/step - loss: 0.2717 - custom_accuracy: 0.7
578 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 14/500
4/4 [==============================] - 1s 216ms/step - loss: 0.2717 - custom_accuracy: 0.7
578 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 15/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 16/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2714 - custom_accuracy: 0.7
578 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 17/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3024 - val_custom_accuracy: 0.7734
Epoch 18/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 19/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2714 - custom_accuracy: 0.7
031 - val_loss: 0.3024 - val_custom_accuracy: 0.7734
Epoch 20/500
4/4 [==============================] - 1s 250ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 21/500
4/4 [==============================] - 1s 363ms/step - loss: 0.2717 - custom_accuracy: 0.7
031 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 22/500
4/4 [==============================] - 1s 349ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.3006 - val_custom_accuracy: 0.7734
Epoch 23/500
4/4 [==============================] - 1s 327ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 24/500
4/4 [==============================] - 1s 329ms/step - loss: 0.2719 - custom_accuracy: 0.7
578 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 25/500
4/4 [==============================] - 1s 332ms/step - loss: 0.2720 - custom_accuracy: 0.7
578 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 26/500
4/4 [==============================] - 1s 329ms/step - loss: 0.2723 - custom_accuracy: 0.8
125 - val_loss: 0.3011 - val_custom_accuracy: 0.7734
Epoch 27/500
4/4 [==============================] - 1s 248ms/step - loss: 0.2719 - custom_accuracy: 0.8
125 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 28/500
4/4 [==============================] - 1s 219ms/step - loss: 0.2716 - custom_accuracy: 0.8
125 - val_loss: 0.3019 - val_custom_accuracy: 0.7734
Epoch 29/500
4/4 [==============================] - 1s 197ms/step - loss: 0.2712 - custom_accuracy: 0.7
```

```
578 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 30/500
4/4 [==============================] - 1s 195ms/step - loss: 0.2720 - custom_accuracy: 0.7
031 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
Epoch 31/500
4/4 [==============================] - 1s 197ms/step - loss: 0.2713 - custom_accuracy: 0.8
125 - val_loss: 0.3042 - val_custom_accuracy: 0.7734
Epoch 32/500
4/4 [==============================] - 1s 216ms/step - loss: 0.2713 - custom_accuracy: 0.7
578 - val_loss: 0.3049 - val_custom_accuracy: 0.7734
Epoch 33/500
4/4 [==============================] - 1s 211ms/step - loss: 0.2713 - custom_accuracy: 0.8
125 - val_loss: 0.3057 - val_custom_accuracy: 0.7734
Epoch 34/500
4/4 [==============================] - 1s 209ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.3066 - val_custom_accuracy: 0.7734
Epoch 35/500
4/4 [==============================] - 1s 192ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3071 - val_custom_accuracy: 0.7734
Epoch 36/500
4/4 [==============================] - 1s 197ms/step - loss: 0.2718 - custom_accuracy: 0.8
125 - val_loss: 0.3070 - val_custom_accuracy: 0.7734
Epoch 37/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2718 - custom_accuracy: 0.7
031 - val_loss: 0.3070 - val_custom_accuracy: 0.7734
Epoch 38/500
4/4 [==============================] - 1s 195ms/step - loss: 0.2716 - custom_accuracy: 0.7
031 - val_loss: 0.3065 - val_custom_accuracy: 0.7734
Epoch 39/500
4/4 [==============================] - 1s 210ms/step - loss: 0.2715 - custom_accuracy: 0.7
578 - val_loss: 0.3055 - val_custom_accuracy: 0.7734
Epoch 40/500
4/4 [==============================] - 1s 270ms/step - loss: 0.2712 - custom_accuracy: 0.7
578 - val_loss: 0.3037 - val_custom_accuracy: 0.7734
Epoch 41/500
4/4 [==============================] - 1s 368ms/step - loss: 0.2711 - custom_accuracy: 0.7
578 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 42/500
4/4 [==============================] - 1s 385ms/step - loss: 0.2713 - custom_accuracy: 0.7
578 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 43/500
4/4 [==============================] - 2s 502ms/step - loss: 0.2717 - custom_accuracy: 0.7
031 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 44/500
4/4 [==============================] - 2s 427ms/step - loss: 0.2717 - custom_accuracy: 0.7
578 - val_loss: 0.2983 - val_custom_accuracy: 0.7734
Epoch 45/500
4/4 [==============================] - 1s 367ms/step - loss: 0.2716 - custom_accuracy: 0.7
578 - val_loss: 0.2984 - val_custom_accuracy: 0.7734
Epoch 46/500
4/4 [==============================] - 1s 365ms/step - loss: 0.2718 - custom_accuracy: 0.7
578 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 47/500
4/4 [==============================] - 1s 384ms/step - loss: 0.2713 - custom_accuracy: 0.7
578 - val_loss: 0.2993 - val_custom_accuracy: 0.7734
Epoch 48/500
4/4 [==============================] - 1s 366ms/step - loss: 0.2712 - custom_accuracy: 0.7
578 - val_loss: 0.2996 - val_custom_accuracy: 0.7734
Epoch 49/500
4/4 [==============================] - 1s 337ms/step - loss: 0.2712 - custom_accuracy: 0.7
031 - val_loss: 0.2996 - val_custom_accuracy: 0.7734
Epoch 50/500
4/4 [==============================] - 1s 335ms/step - loss: 0.2714 - custom_accuracy: 0.6
484 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
```

```
Epoch 51/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2713 - custom_accuracy: 0.7
578 - val_loss: 0.2988 - val_custom_accuracy: 0.7734
Epoch 52/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2713 - custom_accuracy: 0.7
031 - val_loss: 0.2983 - val_custom_accuracy: 0.7734
Epoch 53/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2711 - custom_accuracy: 0.6
484 - val_loss: 0.2979 - val_custom_accuracy: 0.7734
Epoch 54/500
4/4 [==============================] - 1s 211ms/step - loss: 0.2712 - custom_accuracy: 0.7
578 - val_loss: 0.2975 - val_custom_accuracy: 0.7734
Epoch 55/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2716 - custom_accuracy: 0.7
578 - val_loss: 0.2972 - val_custom_accuracy: 0.7734
Epoch 56/500
4/4 [==============================] - 1s 215ms/step - loss: 0.2717 - custom_accuracy: 0.6
484 - val_loss: 0.2966 - val_custom_accuracy: 0.7734
Epoch 57/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2721 - custom_accuracy: 0.8
125 - val_loss: 0.2966 - val_custom_accuracy: 0.7734
Epoch 58/500
4/4 [==============================] - 1s 217ms/step - loss: 0.2719 - custom_accuracy: 0.8
125 - val_loss: 0.2969 - val_custom_accuracy: 0.7734
Epoch 59/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2717 - custom_accuracy: 0.6
484 - val_loss: 0.2973 - val_custom_accuracy: 0.7734
Epoch 60/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2715 - custom_accuracy: 0.8
125 - val_loss: 0.2972 - val_custom_accuracy: 0.7734
Epoch 61/500
4/4 [==============================] - 1s 378ms/step - loss: 0.2716 - custom_accuracy: 0.8
125 - val_loss: 0.2973 - val_custom_accuracy: 0.7734
Epoch 62/500
4/4 [==============================] - 1s 360ms/step - loss: 0.2714 - custom_accuracy: 0.6
484 - val_loss: 0.2977 - val_custom_accuracy: 0.7734
Epoch 63/500
4/4 [==============================] - 1s 342ms/step - loss: 0.2712 - custom_accuracy: 0.8
125 - val_loss: 0.2984 - val_custom_accuracy: 0.7734
Epoch 64/500
4/4 [==============================] - 1s 340ms/step - loss: 0.2714 - custom_accuracy: 0.7
578 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 65/500
4/4 [==============================] - 1s 334ms/step - loss: 0.2714 - custom_accuracy: 0.7
031 - val_loss: 0.2992 - val_custom_accuracy: 0.7734
Epoch 66/500
4/4 [==============================] - 1s 331ms/step - loss: 0.2710 - custom_accuracy: 0.8
125 - val_loss: 0.2985 - val_custom_accuracy: 0.7734
Epoch 67/500
4/4 [==============================] - 1s 252ms/step - loss: 0.2710 - custom_accuracy: 0.8
125 - val_loss: 0.2983 - val_custom_accuracy: 0.7734
Epoch 68/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2709 - custom_accuracy: 0.7
578 - val_loss: 0.2983 - val_custom_accuracy: 0.7734
Epoch 69/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2710 - custom_accuracy: 0.7
578 - val_loss: 0.2982 - val_custom_accuracy: 0.7734
Epoch 70/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2712 - custom_accuracy: 0.7
031 - val_loss: 0.2987 - val_custom_accuracy: 0.7734
Epoch 71/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2708 - custom_accuracy: 0.8
125 - val_loss: 0.2998 - val_custom_accuracy: 0.7734
Epoch 72/500
```

```
4/4 [==============================] - 1s 202ms/step - loss: 0.2706 - custom_accuracy: 0.8
125 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 73/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2712 - custom_accuracy: 0.6
484 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 74/500
4/4 [==============================] - 1s 198ms/step - loss: 0.2704 - custom_accuracy: 0.7
031 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 75/500
4/4 [==============================] - 1s 210ms/step - loss: 0.2708 - custom_accuracy: 0.7
031 - val_loss: 0.2993 - val_custom_accuracy: 0.7734
Epoch 76/500
4/4 [==============================] - 1s 197ms/step - loss: 0.2710 - custom_accuracy: 0.7
578 - val_loss: 0.2987 - val_custom_accuracy: 0.7734
Epoch 77/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2711 - custom_accuracy: 0.7
031 - val_loss: 0.2981 - val_custom_accuracy: 0.7734
Epoch 78/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2713 - custom_accuracy: 0.8
125 - val_loss: 0.2972 - val_custom_accuracy: 0.7734
Epoch 79/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2711 - custom_accuracy: 0.8
125 - val_loss: 0.2970 - val_custom_accuracy: 0.7734
Epoch 80/500
4/4 [==============================] - 1s 260ms/step - loss: 0.2709 - custom_accuracy: 0.7
578 - val_loss: 0.2971 - val_custom_accuracy: 0.7734
Epoch 81/500
4/4 [==============================] - 1s 365ms/step - loss: 0.2710 - custom_accuracy: 0.7
578 - val_loss: 0.2974 - val_custom_accuracy: 0.7734
Epoch 82/500
4/4 [==============================] - 1s 342ms/step - loss: 0.2708 - custom_accuracy: 0.8
125 - val_loss: 0.2976 - val_custom_accuracy: 0.7734
Epoch 83/500
4/4 [==============================] - 1s 328ms/step - loss: 0.2709 - custom_accuracy: 0.8
125 - val_loss: 0.2980 - val_custom_accuracy: 0.7734
Epoch 84/500
4/4 [==============================] - 1s 329ms/step - loss: 0.2708 - custom_accuracy: 0.8
125 - val_loss: 0.2984 - val_custom_accuracy: 0.7734
Epoch 85/500
4/4 [==============================] - 1s 332ms/step - loss: 0.2708 - custom_accuracy: 0.8
125 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 86/500
4/4 [==============================] - 1s 324ms/step - loss: 0.2711 - custom_accuracy: 0.8
125 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 87/500
4/4 [==============================] - 1s 240ms/step - loss: 0.2708 - custom_accuracy: 0.8
125 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 88/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2708 - custom_accuracy: 0.7
578 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 89/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2709 - custom_accuracy: 0.7
031 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 90/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2715 - custom_accuracy: 0.7
578 - val_loss: 0.3044 - val_custom_accuracy: 0.7734
Epoch 91/500
4/4 [==============================] - 1s 194ms/step - loss: 0.2721 - custom_accuracy: 0.8
125 - val_loss: 0.3055 - val_custom_accuracy: 0.7734
Epoch 92/500
4/4 [==============================] - 1s 196ms/step - loss: 0.2722 - custom_accuracy: 0.7
031 - val_loss: 0.3054 - val_custom_accuracy: 0.7734
Epoch 93/500
4/4 [==============================] - 1s 219ms/step - loss: 0.2719 - custom_accuracy: 0.7
```

```
578 - val_loss: 0.3049 - val_custom_accuracy: 0.7734
Epoch 94/500
4/4 [==============================] - 1s 212ms/step - loss: 0.2717 - custom_accuracy: 0.7
578 - val_loss: 0.3049 - val_custom_accuracy: 0.7734
Epoch 95/500
4/4 [==============================] - 1s 198ms/step - loss: 0.2715 - custom_accuracy: 0.8
125 - val_loss: 0.3052 - val_custom_accuracy: 0.7734
Epoch 96/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.3051 - val_custom_accuracy: 0.7734
Epoch 97/500
4/4 [==============================] - 1s 198ms/step - loss: 0.2713 - custom_accuracy: 0.6
484 - val_loss: 0.3052 - val_custom_accuracy: 0.7734
Epoch 98/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2712 - custom_accuracy: 0.8
125 - val_loss: 0.3050 - val_custom_accuracy: 0.7734
Epoch 99/500
4/4 [==============================] - 1s 197ms/step - loss: 0.2710 - custom_accuracy: 0.8
125 - val_loss: 0.3045 - val_custom_accuracy: 0.7734
Epoch 100/500
4/4 [==============================] - 1s 265ms/step - loss: 0.2710 - custom_accuracy: 0.8
125 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
Epoch 101/500
4/4 [==============================] - 1s 366ms/step - loss: 0.2706 - custom_accuracy: 0.7
578 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 102/500
4/4 [==============================] - 1s 356ms/step - loss: 0.2705 - custom_accuracy: 0.7
578 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 103/500
4/4 [==============================] - 1s 333ms/step - loss: 0.2709 - custom_accuracy: 0.7
578 - val_loss: 0.3006 - val_custom_accuracy: 0.7734
Epoch 104/500
4/4 [==============================] - 1s 333ms/step - loss: 0.2713 - custom_accuracy: 0.8
125 - val_loss: 0.2999 - val_custom_accuracy: 0.7734
Epoch 105/500
4/4 [==============================] - 1s 336ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.2995 - val_custom_accuracy: 0.7734
Epoch 106/500
4/4 [==============================] - 1s 333ms/step - loss: 0.2714 - custom_accuracy: 0.8
125 - val_loss: 0.2994 - val_custom_accuracy: 0.7734
Epoch 107/500
4/4 [==============================] - 1s 221ms/step - loss: 0.2712 - custom_accuracy: 0.7
578 - val_loss: 0.2997 - val_custom_accuracy: 0.7734
Epoch 108/500
4/4 [==============================] - 1s 212ms/step - loss: 0.2710 - custom_accuracy: 0.7
578 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 109/500
4/4 [==============================] - 1s 196ms/step - loss: 0.2711 - custom_accuracy: 0.7
031 - val_loss: 0.3003 - val_custom_accuracy: 0.7734
Epoch 110/500
4/4 [==============================] - 1s 216ms/step - loss: 0.2709 - custom_accuracy: 0.8
125 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 111/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2710 - custom_accuracy: 0.8
125 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 112/500
4/4 [==============================] - 1s 224ms/step - loss: 0.2709 - custom_accuracy: 0.8
125 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 113/500
4/4 [==============================] - 1s 197ms/step - loss: 0.2708 - custom_accuracy: 0.8
125 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 114/500
4/4 [==============================] - 1s 195ms/step - loss: 0.2710 - custom_accuracy: 0.7
578 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
```

```
Epoch 115/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2709 - custom_accuracy: 0.7
578 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 116/500
4/4 [==============================] - 1s 212ms/step - loss: 0.2708 - custom_accuracy: 0.7
578 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 117/500
4/4 [==============================] - 1s 198ms/step - loss: 0.2709 - custom_accuracy: 0.7
578 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 118/500
4/4 [==============================] - 1s 214ms/step - loss: 0.2707 - custom_accuracy: 0.7
578 - val_loss: 0.3029 - val_custom_accuracy: 0.7734
Epoch 119/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2709 - custom_accuracy: 0.8
125 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 120/500
4/4 [==============================] - 1s 307ms/step - loss: 0.2707 - custom_accuracy: 0.7
578 - val_loss: 0.3032 - val_custom_accuracy: 0.7734
Epoch 121/500
4/4 [==============================] - 1s 366ms/step - loss: 0.2706 - custom_accuracy: 0.7
578 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 122/500
4/4 [==============================] - 1s 338ms/step - loss: 0.2707 - custom_accuracy: 0.7
578 - val_loss: 0.3042 - val_custom_accuracy: 0.7734
Epoch 123/500
4/4 [==============================] - 1s 341ms/step - loss: 0.2707 - custom_accuracy: 0.6
484 - val_loss: 0.3049 - val_custom_accuracy: 0.7734
Epoch 124/500
4/4 [==============================] - 1s 329ms/step - loss: 0.2711 - custom_accuracy: 0.8
125 - val_loss: 0.3054 - val_custom_accuracy: 0.7734
Epoch 125/500
4/4 [==============================] - 1s 332ms/step - loss: 0.2714 - custom_accuracy: 0.7
031 - val_loss: 0.3057 - val_custom_accuracy: 0.7734
Epoch 126/500
4/4 [==============================] - 1s 317ms/step - loss: 0.2721 - custom_accuracy: 0.8
125 - val_loss: 0.3068 - val_custom_accuracy: 0.7734
Epoch 127/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2722 - custom_accuracy: 0.7
031 - val_loss: 0.3066 - val_custom_accuracy: 0.7734
Epoch 128/500
4/4 [==============================] - 1s 211ms/step - loss: 0.2715 - custom_accuracy: 0.8
125 - val_loss: 0.3055 - val_custom_accuracy: 0.7734
Epoch 129/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2711 - custom_accuracy: 0.7
578 - val_loss: 0.3043 - val_custom_accuracy: 0.7734
Epoch 130/500
4/4 [==============================] - 1s 197ms/step - loss: 0.2704 - custom_accuracy: 0.8
125 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 131/500
4/4 [==============================] - 1s 210ms/step - loss: 0.2703 - custom_accuracy: 0.7
578 - val_loss: 0.3032 - val_custom_accuracy: 0.7734
Epoch 132/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2703 - custom_accuracy: 0.7
578 - val_loss: 0.3034 - val_custom_accuracy: 0.7734
Epoch 133/500
4/4 [==============================] - 1s 198ms/step - loss: 0.2705 - custom_accuracy: 0.7
578 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 134/500
4/4 [==============================] - 1s 211ms/step - loss: 0.2701 - custom_accuracy: 0.8
125 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 135/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2702 - custom_accuracy: 0.7
031 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 136/500
```

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4/4 [==============================] - 1s 204ms/step - loss: 0.2703 - custom_accuracy: 0.8
125 - val_loss: 0.3029 - val_custom_accuracy: 0.7734
Epoch 137/500
4/4 [==============================] - 1s 198ms/step - loss: 0.2705 - custom_accuracy: 0.6
484 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
Epoch 138/500
4/4 [==============================] - 1s 212ms/step - loss: 0.2704 - custom_accuracy: 0.8
125 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 139/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2703 - custom_accuracy: 0.8
125 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 140/500
4/4 [==============================] - 1s 373ms/step - loss: 0.2702 - custom_accuracy: 0.7
578 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 141/500
4/4 [==============================] - 1s 363ms/step - loss: 0.2701 - custom_accuracy: 0.7
578 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 142/500
4/4 [==============================] - 1s 337ms/step - loss: 0.2701 - custom_accuracy: 0.6
484 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 143/500
4/4 [==============================] - 1s 326ms/step - loss: 0.2700 - custom_accuracy: 0.7
031 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 144/500
4/4 [==============================] - 1s 327ms/step - loss: 0.2705 - custom_accuracy: 0.8
125 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 145/500
4/4 [==============================] - 1s 326ms/step - loss: 0.2707 - custom_accuracy: 0.7
578 - val_loss: 0.3033 - val_custom_accuracy: 0.7734
Epoch 146/500
4/4 [==============================] - 1s 264ms/step - loss: 0.2705 - custom_accuracy: 0.7
031 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
Epoch 147/500
4/4 [==============================] - 1s 196ms/step - loss: 0.2704 - custom_accuracy: 0.7
578 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 148/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2703 - custom_accuracy: 0.8
125 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 149/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2704 - custom_accuracy: 0.8
125 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 150/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2703 - custom_accuracy: 0.7
031 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 151/500
4/4 [==============================] - 1s 194ms/step - loss: 0.2701 - custom_accuracy: 0.8
125 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 152/500
4/4 [==============================] - 1s 215ms/step - loss: 0.2701 - custom_accuracy: 0.7
578 - val_loss: 0.3015 - val_custom_accuracy: 0.7734
Epoch 153/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2698 - custom_accuracy: 0.8
125 - val_loss: 0.3015 - val_custom_accuracy: 0.7734
Epoch 154/500
4/4 [==============================] - 1s 214ms/step - loss: 0.2700 - custom_accuracy: 0.7
578 - val_loss: 0.3018 - val_custom_accuracy: 0.7734
Epoch 155/500
4/4 [==============================] - 1s 212ms/step - loss: 0.2700 - custom_accuracy: 0.8
125 - val_loss: 0.3012 - val_custom_accuracy: 0.7734
Epoch 156/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2699 - custom_accuracy: 0.7
578 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 157/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2698 - custom_accuracy: 0.7
```

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031 - val_loss: 0.3003 - val_custom_accuracy: 0.7734
Epoch 158/500
4/4 [==============================] - 1s 198ms/step - loss: 0.2697 - custom_accuracy: 0.7
031 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 159/500
4/4 [==============================] - 1s 236ms/step - loss: 0.2697 - custom_accuracy: 0.7
578 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 160/500
4/4 [==============================] - 1s 365ms/step - loss: 0.2699 - custom_accuracy: 0.7
031 - val_loss: 0.3019 - val_custom_accuracy: 0.7734
Epoch 161/500
4/4 [==============================] - 1s 357ms/step - loss: 0.2699 - custom_accuracy: 0.8
125 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
Epoch 162/500
4/4 [==============================] - 1s 332ms/step - loss: 0.2699 - custom_accuracy: 0.7
031 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
Epoch 163/500
4/4 [==============================] - 1s 331ms/step - loss: 0.2699 - custom_accuracy: 0.8
125 - val_loss: 0.3039 - val_custom_accuracy: 0.7734
Epoch 164/500
4/4 [==============================] - 1s 340ms/step - loss: 0.2699 - custom_accuracy: 0.8
125 - val_loss: 0.3042 - val_custom_accuracy: 0.7734
Epoch 165/500
4/4 [==============================] - 1s 327ms/step - loss: 0.2701 - custom_accuracy: 0.7
031 - val_loss: 0.3043 - val_custom_accuracy: 0.7734
Epoch 166/500
4/4 [==============================] - 1s 254ms/step - loss: 0.2699 - custom_accuracy: 0.8
125 - val_loss: 0.3041 - val_custom_accuracy: 0.7734
Epoch 167/500
4/4 [==============================] - 1s 213ms/step - loss: 0.2698 - custom_accuracy: 0.7
578 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
Epoch 168/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2698 - custom_accuracy: 0.7
578 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 169/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2698 - custom_accuracy: 0.7
578 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 170/500
4/4 [==============================] - 1s 214ms/step - loss: 0.2698 - custom_accuracy: 0.8
125 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 171/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2697 - custom_accuracy: 0.7
578 - val_loss: 0.3024 - val_custom_accuracy: 0.7734
Epoch 172/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2699 - custom_accuracy: 0.7
578 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 173/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2698 - custom_accuracy: 0.8
125 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 174/500
4/4 [==============================] - 1s 212ms/step - loss: 0.2699 - custom_accuracy: 0.8
125 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 175/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2698 - custom_accuracy: 0.8
125 - val_loss: 0.3015 - val_custom_accuracy: 0.7734
Epoch 176/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2699 - custom_accuracy: 0.7
578 - val_loss: 0.3019 - val_custom_accuracy: 0.7734
Epoch 177/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2698 - custom_accuracy: 0.7
578 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
Epoch 178/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2700 - custom_accuracy: 0.8
125 - val_loss: 0.3038 - val_custom_accuracy: 0.7734
```

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Epoch 179/500
4/4 [==============================] - 1s 272ms/step - loss: 0.2704 - custom_accuracy: 0.7
578 - val_loss: 0.3046 - val_custom_accuracy: 0.7734
Epoch 180/500
4/4 [==============================] - 1s 367ms/step - loss: 0.2706 - custom_accuracy: 0.8
125 - val_loss: 0.3055 - val_custom_accuracy: 0.7734
Epoch 181/500
4/4 [==============================] - 1s 344ms/step - loss: 0.2707 - custom_accuracy: 0.7
578 - val_loss: 0.3057 - val_custom_accuracy: 0.7734
Epoch 182/500
4/4 [==============================] - 1s 335ms/step - loss: 0.2707 - custom_accuracy: 0.8
125 - val_loss: 0.3051 - val_custom_accuracy: 0.7734
Epoch 183/500
4/4 [==============================] - 1s 329ms/step - loss: 0.2705 - custom_accuracy: 0.7
578 - val_loss: 0.3041 - val_custom_accuracy: 0.7734
Epoch 184/500
4/4 [==============================] - 1s 392ms/step - loss: 0.2699 - custom_accuracy: 0.7
578 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
Epoch 185/500
4/4 [==============================] - 1s 334ms/step - loss: 0.2698 - custom_accuracy: 0.8
125 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 186/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2698 - custom_accuracy: 0.7
578 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 187/500
4/4 [==============================] - 1s 196ms/step - loss: 0.2698 - custom_accuracy: 0.8
125 - val_loss: 0.3011 - val_custom_accuracy: 0.7734
Epoch 188/500
4/4 [==============================] - 1s 197ms/step - loss: 0.2695 - custom_accuracy: 0.8
125 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 189/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2695 - custom_accuracy: 0.8
125 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 190/500
4/4 [==============================] - 1s 196ms/step - loss: 0.2695 - custom_accuracy: 0.7
578 - val_loss: 0.3015 - val_custom_accuracy: 0.7734
Epoch 191/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2694 - custom_accuracy: 0.8
125 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 192/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2697 - custom_accuracy: 0.7
031 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 193/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2699 - custom_accuracy: 0.7
578 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 194/500
4/4 [==============================] - 1s 209ms/step - loss: 0.2699 - custom_accuracy: 0.7
031 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 195/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2698 - custom_accuracy: 0.6
484 - val_loss: 0.3029 - val_custom_accuracy: 0.7734
Epoch 196/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2700 - custom_accuracy: 0.8
125 - val_loss: 0.3029 - val_custom_accuracy: 0.7734
Epoch 197/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2697 - custom_accuracy: 0.7
578 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 198/500
4/4 [==============================] - 1s 198ms/step - loss: 0.2697 - custom_accuracy: 0.7
031 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 199/500
4/4 [==============================] - 1s 297ms/step - loss: 0.2694 - custom_accuracy: 0.7
578 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 200/500
```

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4/4 [==============================] - 1s 371ms/step - loss: 0.2696 - custom_accuracy: 0.7
578 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 201/500
4/4 [==============================] - 1s 343ms/step - loss: 0.2696 - custom_accuracy: 0.7
031 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 202/500
4/4 [==============================] - 1s 330ms/step - loss: 0.2698 - custom_accuracy: 0.7
578 - val_loss: 0.3003 - val_custom_accuracy: 0.7734
Epoch 203/500
4/4 [==============================] - 1s 325ms/step - loss: 0.2697 - custom_accuracy: 0.7
578 - val_loss: 0.3011 - val_custom_accuracy: 0.7734
Epoch 204/500
4/4 [==============================] - 1s 332ms/step - loss: 0.2696 - custom_accuracy: 0.7
578 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 205/500
4/4 [==============================] - 1s 341ms/step - loss: 0.2693 - custom_accuracy: 0.7
578 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
Epoch 206/500
4/4 [==============================] - 1s 215ms/step - loss: 0.2698 - custom_accuracy: 0.7
578 - val_loss: 0.3029 - val_custom_accuracy: 0.7734
Epoch 207/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2696 - custom_accuracy: 0.7
031 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 208/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2696 - custom_accuracy: 0.7
578 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 209/500
4/4 [==============================] - 1s 210ms/step - loss: 0.2694 - custom_accuracy: 0.7
578 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 210/500
4/4 [==============================] - 1s 212ms/step - loss: 0.2693 - custom_accuracy: 0.8
125 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 211/500
4/4 [==============================] - 1s 198ms/step - loss: 0.2694 - custom_accuracy: 0.7
031 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 212/500
4/4 [==============================] - 1s 198ms/step - loss: 0.2693 - custom_accuracy: 0.7
578 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 213/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2692 - custom_accuracy: 0.7
578 - val_loss: 0.3033 - val_custom_accuracy: 0.7734
Epoch 214/500
4/4 [==============================] - 1s 215ms/step - loss: 0.2692 - custom_accuracy: 0.7
578 - val_loss: 0.3040 - val_custom_accuracy: 0.7734
Epoch 215/500
4/4 [==============================] - 1s 213ms/step - loss: 0.2692 - custom_accuracy: 0.7
031 - val_loss: 0.3040 - val_custom_accuracy: 0.7734
Epoch 216/500
4/4 [==============================] - 1s 196ms/step - loss: 0.2692 - custom_accuracy: 0.7
578 - val_loss: 0.3043 - val_custom_accuracy: 0.7734
Epoch 217/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2691 - custom_accuracy: 0.8
125 - val_loss: 0.3050 - val_custom_accuracy: 0.7734
Epoch 218/500
4/4 [==============================] - 1s 214ms/step - loss: 0.2692 - custom_accuracy: 0.8
125 - val_loss: 0.3058 - val_custom_accuracy: 0.7734
Epoch 219/500
4/4 [==============================] - 1s 373ms/step - loss: 0.2694 - custom_accuracy: 0.6
484 - val_loss: 0.3066 - val_custom_accuracy: 0.7734
Epoch 220/500
4/4 [==============================] - 1s 370ms/step - loss: 0.2696 - custom_accuracy: 0.7
578 - val_loss: 0.3068 - val_custom_accuracy: 0.7734
Epoch 221/500
4/4 [==============================] - 1s 344ms/step - loss: 0.2696 - custom_accuracy: 0.8
```

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125 - val_loss: 0.3071 - val_custom_accuracy: 0.7734
Epoch 222/500
4/4 [==============================] - 1s 332ms/step - loss: 0.2696 - custom_accuracy: 0.8
125 - val_loss: 0.3073 - val_custom_accuracy: 0.7734
Epoch 223/500
4/4 [==============================] - 1s 329ms/step - loss: 0.2697 - custom_accuracy: 0.7
578 - val_loss: 0.3071 - val_custom_accuracy: 0.7734
Epoch 224/500
4/4 [==============================] - 1s 326ms/step - loss: 0.2696 - custom_accuracy: 0.8
125 - val_loss: 0.3074 - val_custom_accuracy: 0.7734
Epoch 225/500
4/4 [==============================] - 1s 286ms/step - loss: 0.2695 - custom_accuracy: 0.7
578 - val_loss: 0.3076 - val_custom_accuracy: 0.7734
Epoch 226/500
4/4 [==============================] - 1s 215ms/step - loss: 0.2696 - custom_accuracy: 0.8
125 - val_loss: 0.3081 - val_custom_accuracy: 0.7734
Epoch 227/500
4/4 [==============================] - 1s 221ms/step - loss: 0.2699 - custom_accuracy: 0.7
578 - val_loss: 0.3086 - val_custom_accuracy: 0.7734
Epoch 228/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2701 - custom_accuracy: 0.8
125 - val_loss: 0.3092 - val_custom_accuracy: 0.7734
Epoch 229/500
4/4 [==============================] - 1s 211ms/step - loss: 0.2704 - custom_accuracy: 0.7
578 - val_loss: 0.3092 - val_custom_accuracy: 0.7734
Epoch 230/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2705 - custom_accuracy: 0.8
125 - val_loss: 0.3091 - val_custom_accuracy: 0.7734
Epoch 231/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2703 - custom_accuracy: 0.8
125 - val_loss: 0.3079 - val_custom_accuracy: 0.7734
Epoch 232/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2701 - custom_accuracy: 0.7
578 - val_loss: 0.3070 - val_custom_accuracy: 0.7734
Epoch 233/500
4/4 [==============================] - 1s 214ms/step - loss: 0.2699 - custom_accuracy: 0.7
578 - val_loss: 0.3059 - val_custom_accuracy: 0.7734
Epoch 234/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2696 - custom_accuracy: 0.7
578 - val_loss: 0.3038 - val_custom_accuracy: 0.7734
Epoch 235/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2692 - custom_accuracy: 0.7
578 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 236/500
4/4 [==============================] - 1s 198ms/step - loss: 0.2688 - custom_accuracy: 0.7
031 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 237/500
4/4 [==============================] - 1s 195ms/step - loss: 0.2691 - custom_accuracy: 0.7
578 - val_loss: 0.3003 - val_custom_accuracy: 0.7734
Epoch 238/500
4/4 [==============================] - 1s 223ms/step - loss: 0.2690 - custom_accuracy: 0.8
125 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 239/500
4/4 [==============================] - 1s 377ms/step - loss: 0.2693 - custom_accuracy: 0.8
125 - val_loss: 0.3011 - val_custom_accuracy: 0.7734
Epoch 240/500
4/4 [==============================] - 1s 361ms/step - loss: 0.2691 - custom_accuracy: 0.7
578 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 241/500
4/4 [==============================] - 1s 325ms/step - loss: 0.2688 - custom_accuracy: 0.8
125 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 242/500
4/4 [==============================] - 1s 343ms/step - loss: 0.2690 - custom_accuracy: 0.7
031 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
```

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Epoch 243/500
4/4 [==============================] - 1s 335ms/step - loss: 0.2688 - custom_accuracy: 0.7
578 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 244/500
4/4 [==============================] - 1s 335ms/step - loss: 0.2686 - custom_accuracy: 0.8
125 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 245/500
4/4 [==============================] - 1s 261ms/step - loss: 0.2688 - custom_accuracy: 0.7
031 - val_loss: 0.3024 - val_custom_accuracy: 0.7734
Epoch 246/500
4/4 [==============================] - 1s 215ms/step - loss: 0.2688 - custom_accuracy: 0.7
578 - val_loss: 0.3024 - val_custom_accuracy: 0.7734
Epoch 247/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2689 - custom_accuracy: 0.8
125 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 248/500
4/4 [==============================] - 1s 207ms/step - loss: 0.2690 - custom_accuracy: 0.8
125 - val_loss: 0.3027 - val_custom_accuracy: 0.7734
Epoch 249/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2691 - custom_accuracy: 0.7
578 - val_loss: 0.3035 - val_custom_accuracy: 0.7734
Epoch 250/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2694 - custom_accuracy: 0.7
578 - val_loss: 0.3041 - val_custom_accuracy: 0.7734
Epoch 251/500
4/4 [==============================] - 1s 208ms/step - loss: 0.2693 - custom_accuracy: 0.8
125 - val_loss: 0.3039 - val_custom_accuracy: 0.7734
Epoch 252/500
4/4 [==============================] - 1s 213ms/step - loss: 0.2689 - custom_accuracy: 0.7
578 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 253/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2687 - custom_accuracy: 0.8
125 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 254/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2685 - custom_accuracy: 0.7
031 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 255/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2688 - custom_accuracy: 0.7
031 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 256/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2684 - custom_accuracy: 0.7
031 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 257/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2685 - custom_accuracy: 0.7
578 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 258/500
4/4 [==============================] - 1s 252ms/step - loss: 0.2686 - custom_accuracy: 0.8
125 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 259/500
4/4 [==============================] - 1s 376ms/step - loss: 0.2685 - custom_accuracy: 0.7
578 - val_loss: 0.2996 - val_custom_accuracy: 0.7734
Epoch 260/500
4/4 [==============================] - 1s 350ms/step - loss: 0.2685 - custom_accuracy: 0.7
578 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 261/500
4/4 [==============================] - 1s 341ms/step - loss: 0.2688 - custom_accuracy: 0.8
125 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 262/500
4/4 [==============================] - 1s 330ms/step - loss: 0.2688 - custom_accuracy: 0.7
578 - val_loss: 0.2988 - val_custom_accuracy: 0.7734
Epoch 263/500
4/4 [==============================] - 1s 329ms/step - loss: 0.2694 - custom_accuracy: 0.7
578 - val_loss: 0.2981 - val_custom_accuracy: 0.7734
Epoch 264/500
```

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4/4 [==============================] - 1s 343ms/step - loss: 0.2697 - custom_accuracy: 0.8
125 - val_loss: 0.2976 - val_custom_accuracy: 0.7734
Epoch 265/500
4/4 [==============================] - 1s 214ms/step - loss: 0.2697 - custom_accuracy: 0.7
578 - val_loss: 0.2973 - val_custom_accuracy: 0.7734
Epoch 266/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2695 - custom_accuracy: 0.8
125 - val_loss: 0.2972 - val_custom_accuracy: 0.7734
Epoch 267/500
4/4 [==============================] - 1s 213ms/step - loss: 0.2695 - custom_accuracy: 0.7
578 - val_loss: 0.2974 - val_custom_accuracy: 0.7734
Epoch 268/500
4/4 [==============================] - 1s 219ms/step - loss: 0.2690 - custom_accuracy: 0.8
125 - val_loss: 0.2981 - val_custom_accuracy: 0.7734
Epoch 269/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2689 - custom_accuracy: 0.6
484 - val_loss: 0.2989 - val_custom_accuracy: 0.7734
Epoch 270/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2686 - custom_accuracy: 0.7
031 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 271/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2685 - custom_accuracy: 0.8
125 - val_loss: 0.2988 - val_custom_accuracy: 0.7734
Epoch 272/500
4/4 [==============================] - 1s 215ms/step - loss: 0.2691 - custom_accuracy: 0.7
578 - val_loss: 0.2987 - val_custom_accuracy: 0.7734
Epoch 273/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2686 - custom_accuracy: 0.7
031 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 274/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2687 - custom_accuracy: 0.7
578 - val_loss: 0.2985 - val_custom_accuracy: 0.7734
Epoch 275/500
4/4 [==============================] - 1s 211ms/step - loss: 0.2688 - custom_accuracy: 0.7
578 - val_loss: 0.2975 - val_custom_accuracy: 0.7734
Epoch 276/500
4/4 [==============================] - 1s 211ms/step - loss: 0.2691 - custom_accuracy: 0.7
031 - val_loss: 0.2971 - val_custom_accuracy: 0.7734
Epoch 277/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2691 - custom_accuracy: 0.8
125 - val_loss: 0.2971 - val_custom_accuracy: 0.7734
Epoch 278/500
4/4 [==============================] - 1s 373ms/step - loss: 0.2688 - custom_accuracy: 0.7
031 - val_loss: 0.2974 - val_custom_accuracy: 0.7734
Epoch 279/500
4/4 [==============================] - 1s 357ms/step - loss: 0.2687 - custom_accuracy: 0.7
578 - val_loss: 0.2971 - val_custom_accuracy: 0.7734
Epoch 280/500
4/4 [==============================] - 1s 331ms/step - loss: 0.2689 - custom_accuracy: 0.8
125 - val_loss: 0.2969 - val_custom_accuracy: 0.7734
Epoch 281/500
4/4 [==============================] - 1s 332ms/step - loss: 0.2688 - custom_accuracy: 0.7
578 - val_loss: 0.2970 - val_custom_accuracy: 0.7734
Epoch 282/500
4/4 [==============================] - 1s 338ms/step - loss: 0.2686 - custom_accuracy: 0.7
578 - val_loss: 0.2972 - val_custom_accuracy: 0.7734
Epoch 283/500
4/4 [==============================] - 1s 343ms/step - loss: 0.2687 - custom_accuracy: 0.7
031 - val_loss: 0.2978 - val_custom_accuracy: 0.7734
Epoch 284/500
4/4 [==============================] - 1s 396ms/step - loss: 0.2686 - custom_accuracy: 0.7
578 - val_loss: 0.2980 - val_custom_accuracy: 0.7734
Epoch 285/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2687 - custom_accuracy: 0.8
```

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125 - val_loss: 0.2977 - val_custom_accuracy: 0.7734
Epoch 286/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2689 - custom_accuracy: 0.7
578 - val_loss: 0.2976 - val_custom_accuracy: 0.7734
Epoch 287/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2689 - custom_accuracy: 0.7
578 - val_loss: 0.2973 - val_custom_accuracy: 0.7734
Epoch 288/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2694 - custom_accuracy: 0.7
031 - val_loss: 0.2967 - val_custom_accuracy: 0.7812
Epoch 289/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2699 - custom_accuracy: 0.8
125 - val_loss: 0.2962 - val_custom_accuracy: 0.7812
Epoch 290/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2706 - custom_accuracy: 0.7
031 - val_loss: 0.2962 - val_custom_accuracy: 0.7812
Epoch 291/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2703 - custom_accuracy: 0.7
578 - val_loss: 0.2962 - val_custom_accuracy: 0.7812
Epoch 292/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2703 - custom_accuracy: 0.7
578 - val_loss: 0.2964 - val_custom_accuracy: 0.7812
Epoch 293/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2695 - custom_accuracy: 0.8
125 - val_loss: 0.2969 - val_custom_accuracy: 0.7812
Epoch 294/500
4/4 [==============================] - 1s 207ms/step - loss: 0.2694 - custom_accuracy: 0.7
578 - val_loss: 0.2980 - val_custom_accuracy: 0.7734
Epoch 295/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2685 - custom_accuracy: 0.7
578 - val_loss: 0.2991 - val_custom_accuracy: 0.7734
Epoch 296/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2683 - custom_accuracy: 0.7
578 - val_loss: 0.3003 - val_custom_accuracy: 0.7734
Epoch 297/500
4/4 [==============================] - 1s 304ms/step - loss: 0.2683 - custom_accuracy: 0.7
578 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 298/500
4/4 [==============================] - 1s 376ms/step - loss: 0.2682 - custom_accuracy: 0.7
578 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 299/500
4/4 [==============================] - 1s 353ms/step - loss: 0.2683 - custom_accuracy: 0.8
125 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 300/500
4/4 [==============================] - 1s 336ms/step - loss: 0.2682 - custom_accuracy: 0.7
578 - val_loss: 0.3034 - val_custom_accuracy: 0.7734
Epoch 301/500
4/4 [==============================] - 1s 394ms/step - loss: 0.2682 - custom_accuracy: 0.7
578 - val_loss: 0.3037 - val_custom_accuracy: 0.7734
Epoch 302/500
4/4 [==============================] - 1s 339ms/step - loss: 0.2682 - custom_accuracy: 0.7
578 - val_loss: 0.3047 - val_custom_accuracy: 0.7734
Epoch 303/500
4/4 [==============================] - 1s 302ms/step - loss: 0.2684 - custom_accuracy: 0.8
125 - val_loss: 0.3057 - val_custom_accuracy: 0.7734
Epoch 304/500
4/4 [==============================] - 1s 220ms/step - loss: 0.2686 - custom_accuracy: 0.7
031 - val_loss: 0.3059 - val_custom_accuracy: 0.7734
Epoch 305/500
4/4 [==============================] - 1s 215ms/step - loss: 0.2687 - custom_accuracy: 0.7
578 - val_loss: 0.3063 - val_custom_accuracy: 0.7734
Epoch 306/500
4/4 [==============================] - 1s 218ms/step - loss: 0.2687 - custom_accuracy: 0.8
125 - val_loss: 0.3069 - val_custom_accuracy: 0.7734
```

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Epoch 307/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2689 - custom_accuracy: 0.8
125 - val_loss: 0.3073 - val_custom_accuracy: 0.7734
Epoch 308/500
4/4 [==============================] - 1s 222ms/step - loss: 0.2689 - custom_accuracy: 0.8
125 - val_loss: 0.3076 - val_custom_accuracy: 0.7734
Epoch 309/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2690 - custom_accuracy: 0.8
125 - val_loss: 0.3082 - val_custom_accuracy: 0.7734
Epoch 310/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2693 - custom_accuracy: 0.7
031 - val_loss: 0.3081 - val_custom_accuracy: 0.7734
Epoch 311/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2688 - custom_accuracy: 0.7
578 - val_loss: 0.3067 - val_custom_accuracy: 0.7734
Epoch 312/500
4/4 [==============================] - 1s 210ms/step - loss: 0.2687 - custom_accuracy: 0.7
031 - val_loss: 0.3063 - val_custom_accuracy: 0.7734
Epoch 313/500
4/4 [==============================] - 1s 222ms/step - loss: 0.2686 - custom_accuracy: 0.8
125 - val_loss: 0.3058 - val_custom_accuracy: 0.7734
Epoch 314/500
4/4 [==============================] - 1s 214ms/step - loss: 0.2684 - custom_accuracy: 0.7
031 - val_loss: 0.3048 - val_custom_accuracy: 0.7734
Epoch 315/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2684 - custom_accuracy: 0.7
031 - val_loss: 0.3043 - val_custom_accuracy: 0.7734
Epoch 316/500
4/4 [==============================] - 1s 279ms/step - loss: 0.2682 - custom_accuracy: 0.7
031 - val_loss: 0.3034 - val_custom_accuracy: 0.7734
Epoch 317/500
4/4 [==============================] - 1s 375ms/step - loss: 0.2681 - custom_accuracy: 0.7
578 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 318/500
4/4 [==============================] - 1s 344ms/step - loss: 0.2686 - custom_accuracy: 0.7
578 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 319/500
4/4 [==============================] - 1s 346ms/step - loss: 0.2688 - custom_accuracy: 0.7
578 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 320/500
4/4 [==============================] - 1s 395ms/step - loss: 0.2686 - custom_accuracy: 0.7
031 - val_loss: 0.3001 - val_custom_accuracy: 0.7734
Epoch 321/500
4/4 [==============================] - 1s 337ms/step - loss: 0.2686 - custom_accuracy: 0.7
578 - val_loss: 0.2992 - val_custom_accuracy: 0.7734
Epoch 322/500
4/4 [==============================] - 1s 333ms/step - loss: 0.2686 - custom_accuracy: 0.6
484 - val_loss: 0.2989 - val_custom_accuracy: 0.7734
Epoch 323/500
4/4 [==============================] - 1s 219ms/step - loss: 0.2685 - custom_accuracy: 0.8
125 - val_loss: 0.3003 - val_custom_accuracy: 0.7734
Epoch 324/500
4/4 [==============================] - 1s 371ms/step - loss: 0.2677 - custom_accuracy: 0.7
578 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 325/500
4/4 [==============================] - 1s 362ms/step - loss: 0.2680 - custom_accuracy: 0.8
125 - val_loss: 0.3028 - val_custom_accuracy: 0.7734
Epoch 326/500
4/4 [==============================] - 1s 333ms/step - loss: 0.2683 - custom_accuracy: 0.8
125 - val_loss: 0.3043 - val_custom_accuracy: 0.7734
Epoch 327/500
4/4 [==============================] - 1s 345ms/step - loss: 0.2685 - custom_accuracy: 0.7
578 - val_loss: 0.3051 - val_custom_accuracy: 0.7734
Epoch 328/500
```

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4/4 [==============================] - 1s 332ms/step - loss: 0.2686 - custom_accuracy: 0.7
578 - val_loss: 0.3052 - val_custom_accuracy: 0.7734
Epoch 329/500
4/4 [==============================] - 1s 342ms/step - loss: 0.2688 - custom_accuracy: 0.6
484 - val_loss: 0.3051 - val_custom_accuracy: 0.7734
Epoch 330/500
4/4 [==============================] - 1s 218ms/step - loss: 0.2686 - custom_accuracy: 0.8
125 - val_loss: 0.3040 - val_custom_accuracy: 0.7734
Epoch 331/500
4/4 [==============================] - 1s 251ms/step - loss: 0.2685 - custom_accuracy: 0.7
578 - val_loss: 0.3031 - val_custom_accuracy: 0.7734
Epoch 332/500
4/4 [==============================] - 1s 365ms/step - loss: 0.2684 - custom_accuracy: 0.8
125 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 333/500
4/4 [==============================] - 1s 355ms/step - loss: 0.2678 - custom_accuracy: 0.7
578 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 334/500
4/4 [==============================] - 1s 343ms/step - loss: 0.2679 - custom_accuracy: 0.7
031 - val_loss: 0.3001 - val_custom_accuracy: 0.7734
Epoch 335/500
4/4 [==============================] - 1s 337ms/step - loss: 0.2679 - custom_accuracy: 0.8
125 - val_loss: 0.2999 - val_custom_accuracy: 0.7734
Epoch 336/500
4/4 [==============================] - 1s 332ms/step - loss: 0.2681 - custom_accuracy: 0.7
578 - val_loss: 0.2999 - val_custom_accuracy: 0.7734
Epoch 337/500
4/4 [==============================] - 1s 327ms/step - loss: 0.2678 - custom_accuracy: 0.7
578 - val_loss: 0.3008 - val_custom_accuracy: 0.7734
Epoch 338/500
4/4 [==============================] - 1s 266ms/step - loss: 0.2680 - custom_accuracy: 0.7
031 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 339/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2681 - custom_accuracy: 0.7
578 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 340/500
4/4 [==============================] - 1s 210ms/step - loss: 0.2682 - custom_accuracy: 0.7
578 - val_loss: 0.3013 - val_custom_accuracy: 0.7734
Epoch 341/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2678 - custom_accuracy: 0.7
031 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 342/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2679 - custom_accuracy: 0.7
031 - val_loss: 0.2996 - val_custom_accuracy: 0.7734
Epoch 343/500
4/4 [==============================] - 1s 209ms/step - loss: 0.2679 - custom_accuracy: 0.6
484 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 344/500
4/4 [==============================] - 1s 209ms/step - loss: 0.2681 - custom_accuracy: 0.6
484 - val_loss: 0.2980 - val_custom_accuracy: 0.7734
Epoch 345/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2682 - custom_accuracy: 0.8
125 - val_loss: 0.2977 - val_custom_accuracy: 0.7812
Epoch 346/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2684 - custom_accuracy: 0.7
578 - val_loss: 0.2979 - val_custom_accuracy: 0.7812
Epoch 347/500
4/4 [==============================] - 1s 222ms/step - loss: 0.2684 - custom_accuracy: 0.8
125 - val_loss: 0.2980 - val_custom_accuracy: 0.7734
Epoch 348/500
4/4 [==============================] - 1s 210ms/step - loss: 0.2683 - custom_accuracy: 0.7
578 - val_loss: 0.2985 - val_custom_accuracy: 0.7734
Epoch 349/500
4/4 [==============================] - 1s 207ms/step - loss: 0.2679 - custom_accuracy: 0.8
```

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125 - val_loss: 0.2993 - val_custom_accuracy: 0.7734
Epoch 350/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2680 - custom_accuracy: 0.7
031 - val_loss: 0.3000 - val_custom_accuracy: 0.7734
Epoch 351/500
4/4 [==============================] - 1s 291ms/step - loss: 0.2681 - custom_accuracy: 0.7
578 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 352/500
4/4 [==============================] - 1s 374ms/step - loss: 0.2681 - custom_accuracy: 0.7
031 - val_loss: 0.2999 - val_custom_accuracy: 0.7734
Epoch 353/500
4/4 [==============================] - 1s 353ms/step - loss: 0.2679 - custom_accuracy: 0.7
578 - val_loss: 0.2995 - val_custom_accuracy: 0.7734
Epoch 354/500
4/4 [==============================] - 1s 326ms/step - loss: 0.2680 - custom_accuracy: 0.8
125 - val_loss: 0.2986 - val_custom_accuracy: 0.7734
Epoch 355/500
4/4 [==============================] - 1s 352ms/step - loss: 0.2680 - custom_accuracy: 0.7
578 - val_loss: 0.2984 - val_custom_accuracy: 0.7734
Epoch 356/500
4/4 [==============================] - 1s 355ms/step - loss: 0.2680 - custom_accuracy: 0.7
031 - val_loss: 0.2983 - val_custom_accuracy: 0.7734
Epoch 357/500
4/4 [==============================] - 1s 344ms/step - loss: 0.2681 - custom_accuracy: 0.8
125 - val_loss: 0.2978 - val_custom_accuracy: 0.7734
Epoch 358/500
4/4 [==============================] - 1s 217ms/step - loss: 0.2682 - custom_accuracy: 0.7
578 - val_loss: 0.2975 - val_custom_accuracy: 0.7734
Epoch 359/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2681 - custom_accuracy: 0.7
031 - val_loss: 0.2981 - val_custom_accuracy: 0.7734
Epoch 360/500
4/4 [==============================] - 1s 217ms/step - loss: 0.2679 - custom_accuracy: 0.8
125 - val_loss: 0.2989 - val_custom_accuracy: 0.7734
Epoch 361/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2678 - custom_accuracy: 0.8
125 - val_loss: 0.2994 - val_custom_accuracy: 0.7734
Epoch 362/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2679 - custom_accuracy: 0.7
578 - val_loss: 0.2996 - val_custom_accuracy: 0.7734
Epoch 363/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2676 - custom_accuracy: 0.7
578 - val_loss: 0.2996 - val_custom_accuracy: 0.7734
Epoch 364/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2682 - custom_accuracy: 0.7
578 - val_loss: 0.2996 - val_custom_accuracy: 0.7734
Epoch 365/500
4/4 [==============================] - 1s 210ms/step - loss: 0.2682 - custom_accuracy: 0.7
578 - val_loss: 0.2999 - val_custom_accuracy: 0.7734
Epoch 366/500
4/4 [==============================] - 1s 211ms/step - loss: 0.2683 - custom_accuracy: 0.8
125 - val_loss: 0.3001 - val_custom_accuracy: 0.7734
Epoch 367/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2682 - custom_accuracy: 0.7
031 - val_loss: 0.2999 - val_custom_accuracy: 0.7734
Epoch 368/500
4/4 [==============================] - 1s 209ms/step - loss: 0.2682 - custom_accuracy: 0.8
125 - val_loss: 0.2998 - val_custom_accuracy: 0.7734
Epoch 369/500
4/4 [==============================] - 1s 197ms/step - loss: 0.2685 - custom_accuracy: 0.8
125 - val_loss: 0.2998 - val_custom_accuracy: 0.7734
Epoch 370/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2684 - custom_accuracy: 0.8
125 - val_loss: 0.3000 - val_custom_accuracy: 0.7734
```

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Epoch 371/500
4/4 [==============================] - 1s 381ms/step - loss: 0.2679 - custom_accuracy: 0.8
125 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 372/500
4/4 [==============================] - 1s 368ms/step - loss: 0.2678 - custom_accuracy: 0.7
578 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 373/500
4/4 [==============================] - 1s 345ms/step - loss: 0.2680 - custom_accuracy: 0.7
578 - val_loss: 0.3012 - val_custom_accuracy: 0.7734
Epoch 374/500
4/4 [==============================] - 1s 338ms/step - loss: 0.2679 - custom_accuracy: 0.7
578 - val_loss: 0.3015 - val_custom_accuracy: 0.7734
Epoch 375/500
4/4 [==============================] - 1s 330ms/step - loss: 0.2683 - custom_accuracy: 0.8
125 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 376/500
4/4 [==============================] - 1s 334ms/step - loss: 0.2678 - custom_accuracy: 0.7
578 - val_loss: 0.3024 - val_custom_accuracy: 0.7734
Epoch 377/500
4/4 [==============================] - 1s 273ms/step - loss: 0.2678 - custom_accuracy: 0.7
031 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 378/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2678 - custom_accuracy: 0.7
031 - val_loss: 0.3015 - val_custom_accuracy: 0.7734
Epoch 379/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2678 - custom_accuracy: 0.7
031 - val_loss: 0.3015 - val_custom_accuracy: 0.7734
Epoch 380/500
4/4 [==============================] - 1s 218ms/step - loss: 0.2677 - custom_accuracy: 0.7
031 - val_loss: 0.3008 - val_custom_accuracy: 0.7734
Epoch 381/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2680 - custom_accuracy: 0.8
125 - val_loss: 0.3005 - val_custom_accuracy: 0.7734
Epoch 382/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2680 - custom_accuracy: 0.7
578 - val_loss: 0.3006 - val_custom_accuracy: 0.7734
Epoch 383/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2676 - custom_accuracy: 0.7
578 - val_loss: 0.3003 - val_custom_accuracy: 0.7734
Epoch 384/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2676 - custom_accuracy: 0.7
031 - val_loss: 0.2998 - val_custom_accuracy: 0.7734
Epoch 385/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2677 - custom_accuracy: 0.7
578 - val_loss: 0.2997 - val_custom_accuracy: 0.7734
Epoch 386/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2679 - custom_accuracy: 0.7
578 - val_loss: 0.2998 - val_custom_accuracy: 0.7734
Epoch 387/500
4/4 [==============================] - 1s 223ms/step - loss: 0.2679 - custom_accuracy: 0.7
578 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 388/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2678 - custom_accuracy: 0.6
484 - val_loss: 0.3003 - val_custom_accuracy: 0.7734
Epoch 389/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2677 - custom_accuracy: 0.7
578 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 390/500
4/4 [==============================] - 1s 268ms/step - loss: 0.2676 - custom_accuracy: 0.7
578 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 391/500
4/4 [==============================] - 1s 363ms/step - loss: 0.2675 - custom_accuracy: 0.7
578 - val_loss: 0.3015 - val_custom_accuracy: 0.7734
Epoch 392/500
```

```
4/4 [==============================] - 1s 353ms/step - loss: 0.2676 - custom_accuracy: 0.7
578 - val_loss: 0.3012 - val_custom_accuracy: 0.7734
Epoch 393/500
4/4 [==============================] - 1s 331ms/step - loss: 0.2676 - custom_accuracy: 0.7
031 - val_loss: 0.3006 - val_custom_accuracy: 0.7734
Epoch 394/500
4/4 [==============================] - 1s 334ms/step - loss: 0.2677 - custom_accuracy: 0.7
578 - val_loss: 0.2999 - val_custom_accuracy: 0.7734
Epoch 395/500
4/4 [==============================] - 1s 342ms/step - loss: 0.2681 - custom_accuracy: 0.7
578 - val_loss: 0.2992 - val_custom_accuracy: 0.7812
Epoch 396/500
4/4 [==============================] - 1s 329ms/step - loss: 0.2680 - custom_accuracy: 0.7
578 - val_loss: 0.2991 - val_custom_accuracy: 0.7734
Epoch 397/500
4/4 [==============================] - 1s 275ms/step - loss: 0.2679 - custom_accuracy: 0.7
578 - val_loss: 0.2986 - val_custom_accuracy: 0.7812
Epoch 398/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2681 - custom_accuracy: 0.7
578 - val_loss: 0.2977 - val_custom_accuracy: 0.7812
Epoch 399/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2681 - custom_accuracy: 0.7
031 - val_loss: 0.2973 - val_custom_accuracy: 0.7812
Epoch 400/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2689 - custom_accuracy: 0.8
125 - val_loss: 0.2969 - val_custom_accuracy: 0.7812
Epoch 401/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2691 - custom_accuracy: 0.8
125 - val_loss: 0.2966 - val_custom_accuracy: 0.7812
Epoch 402/500
4/4 [==============================] - 1s 217ms/step - loss: 0.2691 - custom_accuracy: 0.7
578 - val_loss: 0.2966 - val_custom_accuracy: 0.7812
Epoch 403/500
4/4 [==============================] - 1s 212ms/step - loss: 0.2689 - custom_accuracy: 0.7
578 - val_loss: 0.2963 - val_custom_accuracy: 0.7812
Epoch 404/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2688 - custom_accuracy: 0.7
578 - val_loss: 0.2964 - val_custom_accuracy: 0.7812
Epoch 405/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2686 - custom_accuracy: 0.8
125 - val_loss: 0.2974 - val_custom_accuracy: 0.7734
Epoch 406/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2685 - custom_accuracy: 0.7
578 - val_loss: 0.2987 - val_custom_accuracy: 0.7734
Epoch 407/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2677 - custom_accuracy: 0.7
031 - val_loss: 0.2990 - val_custom_accuracy: 0.7734
Epoch 408/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2682 - custom_accuracy: 0.7
031 - val_loss: 0.2986 - val_custom_accuracy: 0.7734
Epoch 409/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2679 - custom_accuracy: 0.8
125 - val_loss: 0.2983 - val_custom_accuracy: 0.7734
Epoch 410/500
4/4 [==============================] - 1s 294ms/step - loss: 0.2681 - custom_accuracy: 0.8
125 - val_loss: 0.2987 - val_custom_accuracy: 0.7734
Epoch 411/500
4/4 [==============================] - 1s 362ms/step - loss: 0.2678 - custom_accuracy: 0.7
031 - val_loss: 0.2991 - val_custom_accuracy: 0.7734
Epoch 412/500
4/4 [==============================] - 1s 344ms/step - loss: 0.2675 - custom_accuracy: 0.7
031 - val_loss: 0.2992 - val_custom_accuracy: 0.7734
Epoch 413/500
4/4 [==============================] - 1s 340ms/step - loss: 0.2672 - custom_accuracy: 0.7
```

```
578 - val_loss: 0.2991 - val_custom_accuracy: 0.7734
Epoch 414/500
4/4 [==============================] - 1s 340ms/step - loss: 0.2678 - custom_accuracy: 0.7
031 - val_loss: 0.2993 - val_custom_accuracy: 0.7812
Epoch 415/500
4/4 [==============================] - 1s 338ms/step - loss: 0.2690 - custom_accuracy: 0.8
125 - val_loss: 0.2997 - val_custom_accuracy: 0.7812
Epoch 416/500
4/4 [==============================] - 1s 327ms/step - loss: 0.2694 - custom_accuracy: 0.6
484 - val_loss: 0.2999 - val_custom_accuracy: 0.7812
Epoch 417/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2693 - custom_accuracy: 0.7
578 - val_loss: 0.3008 - val_custom_accuracy: 0.7812
Epoch 418/500
4/4 [==============================] - 1s 209ms/step - loss: 0.2688 - custom_accuracy: 0.7
578 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 419/500
4/4 [==============================] - 1s 209ms/step - loss: 0.2675 - custom_accuracy: 0.7
031 - val_loss: 0.3036 - val_custom_accuracy: 0.7734
Epoch 420/500
4/4 [==============================] - 1s 216ms/step - loss: 0.2680 - custom_accuracy: 0.7
578 - val_loss: 0.3050 - val_custom_accuracy: 0.7734
Epoch 421/500
4/4 [==============================] - 1s 207ms/step - loss: 0.2680 - custom_accuracy: 0.7
578 - val_loss: 0.3052 - val_custom_accuracy: 0.7734
Epoch 422/500
4/4 [==============================] - 1s 211ms/step - loss: 0.2682 - custom_accuracy: 0.7
031 - val_loss: 0.3059 - val_custom_accuracy: 0.7734
Epoch 423/500
4/4 [==============================] - 1s 212ms/step - loss: 0.2681 - custom_accuracy: 0.8
125 - val_loss: 0.3057 - val_custom_accuracy: 0.7734
Epoch 424/500
4/4 [==============================] - 1s 208ms/step - loss: 0.2681 - custom_accuracy: 0.7
578 - val_loss: 0.3060 - val_custom_accuracy: 0.7734
Epoch 425/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2684 - custom_accuracy: 0.7
578 - val_loss: 0.3066 - val_custom_accuracy: 0.7734
Epoch 426/500
4/4 [==============================] - 1s 223ms/step - loss: 0.2683 - custom_accuracy: 0.7
578 - val_loss: 0.3058 - val_custom_accuracy: 0.7734
Epoch 427/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2681 - custom_accuracy: 0.6
484 - val_loss: 0.3044 - val_custom_accuracy: 0.7734
Epoch 428/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2677 - custom_accuracy: 0.7
031 - val_loss: 0.3048 - val_custom_accuracy: 0.7734
Epoch 429/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2680 - custom_accuracy: 0.7
578 - val_loss: 0.3046 - val_custom_accuracy: 0.7734
Epoch 430/500
4/4 [==============================] - 1s 370ms/step - loss: 0.2678 - custom_accuracy: 0.8
125 - val_loss: 0.3051 - val_custom_accuracy: 0.7734
Epoch 431/500
4/4 [==============================] - 1s 368ms/step - loss: 0.2680 - custom_accuracy: 0.8
125 - val_loss: 0.3060 - val_custom_accuracy: 0.7734
Epoch 432/500
4/4 [==============================] - 1s 352ms/step - loss: 0.2683 - custom_accuracy: 0.6
484 - val_loss: 0.3061 - val_custom_accuracy: 0.7734
Epoch 433/500
4/4 [==============================] - 1s 342ms/step - loss: 0.2682 - custom_accuracy: 0.7
031 - val_loss: 0.3053 - val_custom_accuracy: 0.7734
Epoch 434/500
4/4 [==============================] - 1s 329ms/step - loss: 0.2679 - custom_accuracy: 0.7
578 - val_loss: 0.3057 - val_custom_accuracy: 0.7734
```

```
Epoch 435/500
4/4 [==============================] - 1s 345ms/step - loss: 0.2680 - custom_accuracy: 0.8
125 - val_loss: 0.3068 - val_custom_accuracy: 0.7734
Epoch 436/500
4/4 [==============================] - 1s 295ms/step - loss: 0.2685 - custom_accuracy: 0.7
578 - val_loss: 0.3079 - val_custom_accuracy: 0.7734
Epoch 437/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2691 - custom_accuracy: 0.7
578 - val_loss: 0.3091 - val_custom_accuracy: 0.7734
Epoch 438/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2695 - custom_accuracy: 0.7
031 - val_loss: 0.3097 - val_custom_accuracy: 0.7734
Epoch 439/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2695 - custom_accuracy: 0.8
125 - val_loss: 0.3093 - val_custom_accuracy: 0.7734
Epoch 440/500
4/4 [==============================] - 1s 219ms/step - loss: 0.2694 - custom_accuracy: 0.7
578 - val_loss: 0.3086 - val_custom_accuracy: 0.7734
Epoch 441/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2692 - custom_accuracy: 0.7
578 - val_loss: 0.3078 - val_custom_accuracy: 0.7734
Epoch 442/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2687 - custom_accuracy: 0.7
578 - val_loss: 0.3058 - val_custom_accuracy: 0.7734
Epoch 443/500
4/4 [==============================] - 1s 216ms/step - loss: 0.2679 - custom_accuracy: 0.8
125 - val_loss: 0.3040 - val_custom_accuracy: 0.7734
Epoch 444/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2676 - custom_accuracy: 0.6
484 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 445/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2673 - custom_accuracy: 0.8
125 - val_loss: 0.3021 - val_custom_accuracy: 0.7734
Epoch 446/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2673 - custom_accuracy: 0.7
578 - val_loss: 0.3017 - val_custom_accuracy: 0.7734
Epoch 447/500
4/4 [==============================] - 1s 202ms/step - loss: 0.2672 - custom_accuracy: 0.7
578 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 448/500
4/4 [==============================] - 1s 208ms/step - loss: 0.2675 - custom_accuracy: 0.7
578 - val_loss: 0.3004 - val_custom_accuracy: 0.7812
Epoch 449/500
4/4 [==============================] - 1s 246ms/step - loss: 0.2678 - custom_accuracy: 0.7
578 - val_loss: 0.2995 - val_custom_accuracy: 0.7812
Epoch 450/500
4/4 [==============================] - 1s 368ms/step - loss: 0.2683 - custom_accuracy: 0.7
578 - val_loss: 0.2993 - val_custom_accuracy: 0.7812
Epoch 451/500
4/4 [==============================] - 1s 363ms/step - loss: 0.2682 - custom_accuracy: 0.7
031 - val_loss: 0.2989 - val_custom_accuracy: 0.7812
Epoch 452/500
4/4 [==============================] - 1s 345ms/step - loss: 0.2681 - custom_accuracy: 0.8
125 - val_loss: 0.2990 - val_custom_accuracy: 0.7812
Epoch 453/500
4/4 [==============================] - 1s 342ms/step - loss: 0.2680 - custom_accuracy: 0.8
125 - val_loss: 0.2992 - val_custom_accuracy: 0.7812
Epoch 454/500
4/4 [==============================] - 1s 359ms/step - loss: 0.2678 - custom_accuracy: 0.7
031 - val_loss: 0.2995 - val_custom_accuracy: 0.7734
Epoch 455/500
4/4 [==============================] - 1s 329ms/step - loss: 0.2676 - custom_accuracy: 0.7
578 - val_loss: 0.3000 - val_custom_accuracy: 0.7734
Epoch 456/500
```

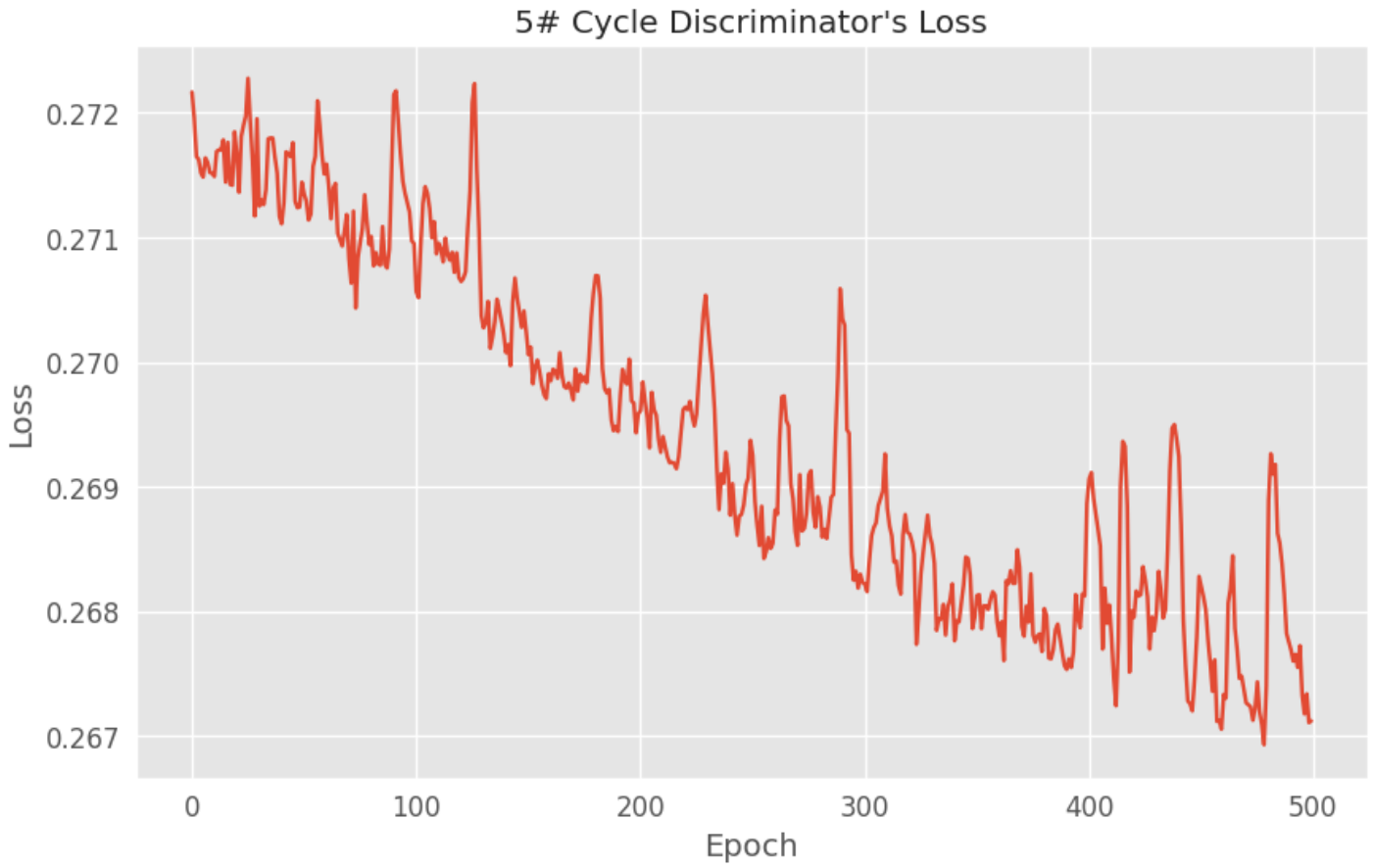
```
4/4 [==============================] - 1s 259ms/step - loss: 0.2674 - custom_accuracy: 0.7
578 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 457/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2676 - custom_accuracy: 0.7
031 - val_loss: 0.3009 - val_custom_accuracy: 0.7734
Epoch 458/500
4/4 [==============================] - 1s 210ms/step - loss: 0.2671 - custom_accuracy: 0.8
125 - val_loss: 0.3006 - val_custom_accuracy: 0.7734
Epoch 459/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2671 - custom_accuracy: 0.7
578 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 460/500
4/4 [==============================] - 1s 215ms/step - loss: 0.2671 - custom_accuracy: 0.7
031 - val_loss: 0.3004 - val_custom_accuracy: 0.7734
Epoch 461/500
4/4 [==============================] - 1s 208ms/step - loss: 0.2673 - custom_accuracy: 0.7
031 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 462/500
4/4 [==============================] - 1s 213ms/step - loss: 0.2673 - custom_accuracy: 0.8
125 - val_loss: 0.3025 - val_custom_accuracy: 0.7734
Epoch 463/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2681 - custom_accuracy: 0.6
484 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
Epoch 464/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2682 - custom_accuracy: 0.7
578 - val_loss: 0.3023 - val_custom_accuracy: 0.7734
Epoch 465/500
4/4 [==============================] - 1s 207ms/step - loss: 0.2684 - custom_accuracy: 0.6
484 - val_loss: 0.3014 - val_custom_accuracy: 0.7734
Epoch 466/500
4/4 [==============================] - 1s 223ms/step - loss: 0.2679 - custom_accuracy: 0.7
578 - val_loss: 0.3010 - val_custom_accuracy: 0.7734
Epoch 467/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2677 - custom_accuracy: 0.7
031 - val_loss: 0.3001 - val_custom_accuracy: 0.7734
Epoch 468/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2675 - custom_accuracy: 0.8
125 - val_loss: 0.3000 - val_custom_accuracy: 0.7734
Epoch 469/500
4/4 [==============================] - 1s 358ms/step - loss: 0.2675 - custom_accuracy: 0.7
578 - val_loss: 0.2997 - val_custom_accuracy: 0.7734
Epoch 470/500
4/4 [==============================] - 1s 364ms/step - loss: 0.2674 - custom_accuracy: 0.7
578 - val_loss: 0.2999 - val_custom_accuracy: 0.7734
Epoch 471/500
4/4 [==============================] - 1s 332ms/step - loss: 0.2673 - custom_accuracy: 0.7
031 - val_loss: 0.3002 - val_custom_accuracy: 0.7734
Epoch 472/500
4/4 [==============================] - 1s 347ms/step - loss: 0.2673 - custom_accuracy: 0.8
125 - val_loss: 0.3006 - val_custom_accuracy: 0.7734
Epoch 473/500
4/4 [==============================] - 1s 340ms/step - loss: 0.2672 - custom_accuracy: 0.8
125 - val_loss: 0.3011 - val_custom_accuracy: 0.7734
Epoch 474/500
4/4 [==============================] - 1s 336ms/step - loss: 0.2671 - custom_accuracy: 0.8
125 - val_loss: 0.3015 - val_custom_accuracy: 0.7734
Epoch 475/500
4/4 [==============================] - 1s 319ms/step - loss: 0.2672 - custom_accuracy: 0.7
578 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 476/500
4/4 [==============================] - 1s 221ms/step - loss: 0.2674 - custom_accuracy: 0.7
578 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 477/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2672 - custom_accuracy: 0.6
```

```
484 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
Epoch 478/500
4/4 [==============================] - 1s 199ms/step - loss: 0.2671 - custom_accuracy: 0.7
031 - val_loss: 0.3007 - val_custom_accuracy: 0.7734
Epoch 479/500
4/4 [==============================] - 1s 204ms/step - loss: 0.2669 - custom_accuracy: 0.7
578 - val_loss: 0.3001 - val_custom_accuracy: 0.7734
Epoch 480/500
4/4 [==============================] - 1s 212ms/step - loss: 0.2674 - custom_accuracy: 0.7
578 - val_loss: 0.2996 - val_custom_accuracy: 0.7812
Epoch 481/500
4/4 [==============================] - 1s 207ms/step - loss: 0.2689 - custom_accuracy: 0.8
125 - val_loss: 0.2997 - val_custom_accuracy: 0.7812
Epoch 482/500
4/4 [==============================] - 1s 207ms/step - loss: 0.2693 - custom_accuracy: 0.7
578 - val_loss: 0.3001 - val_custom_accuracy: 0.7812
Epoch 483/500
4/4 [==============================] - 1s 201ms/step - loss: 0.2691 - custom_accuracy: 0.7
578 - val_loss: 0.3003 - val_custom_accuracy: 0.7812
Epoch 484/500
4/4 [==============================] - 1s 215ms/step - loss: 0.2692 - custom_accuracy: 0.7
578 - val_loss: 0.3007 - val_custom_accuracy: 0.7812
Epoch 485/500
4/4 [==============================] - 1s 207ms/step - loss: 0.2686 - custom_accuracy: 0.7
578 - val_loss: 0.3008 - val_custom_accuracy: 0.7812
Epoch 486/500
4/4 [==============================] - 1s 203ms/step - loss: 0.2685 - custom_accuracy: 0.7
578 - val_loss: 0.3009 - val_custom_accuracy: 0.7812
Epoch 487/500
4/4 [==============================] - 1s 205ms/step - loss: 0.2684 - custom_accuracy: 0.7
031 - val_loss: 0.3007 - val_custom_accuracy: 0.7812
Epoch 488/500
4/4 [==============================] - 1s 253ms/step - loss: 0.2681 - custom_accuracy: 0.7
578 - val_loss: 0.3010 - val_custom_accuracy: 0.7812
Epoch 489/500
4/4 [==============================] - 1s 388ms/step - loss: 0.2678 - custom_accuracy: 0.7
578 - val_loss: 0.3013 - val_custom_accuracy: 0.7812
Epoch 490/500
4/4 [==============================] - 1s 351ms/step - loss: 0.2678 - custom_accuracy: 0.8
125 - val_loss: 0.3011 - val_custom_accuracy: 0.7812
Epoch 491/500
4/4 [==============================] - 1s 343ms/step - loss: 0.2677 - custom_accuracy: 0.7
578 - val_loss: 0.3012 - val_custom_accuracy: 0.7812
Epoch 492/500
4/4 [==============================] - 1s 339ms/step - loss: 0.2676 - custom_accuracy: 0.8
125 - val_loss: 0.3015 - val_custom_accuracy: 0.7812
Epoch 493/500
4/4 [==============================] - 1s 329ms/step - loss: 0.2677 - custom_accuracy: 0.6
484 - val_loss: 0.3015 - val_custom_accuracy: 0.7812
Epoch 494/500
4/4 [==============================] - 1s 334ms/step - loss: 0.2676 - custom_accuracy: 0.7
031 - val_loss: 0.3013 - val_custom_accuracy: 0.7812
Epoch 495/500
4/4 [==============================] - 1s 250ms/step - loss: 0.2677 - custom_accuracy: 0.7
578 - val_loss: 0.3016 - val_custom_accuracy: 0.7812
Epoch 496/500
4/4 [==============================] - 1s 206ms/step - loss: 0.2673 - custom_accuracy: 0.7
578 - val_loss: 0.3020 - val_custom_accuracy: 0.7734
Epoch 497/500
4/4 [==============================] - 1s 200ms/step - loss: 0.2672 - custom_accuracy: 0.8
125 - val_loss: 0.3026 - val_custom_accuracy: 0.7734
Epoch 498/500
4/4 [==============================] - 1s 222ms/step - loss: 0.2673 - custom_accuracy: 0.5
938 - val_loss: 0.3030 - val_custom_accuracy: 0.7734
```

```
Epoch 499/500
4/4 [==============================] - 1s 220ms/step - loss: 0.2671 - custom_accuracy: 0.8
125 - val_loss: 0.3022 - val_custom_accuracy: 0.7734
Epoch 500/500
4/4 [==============================] - 1s 209ms/step - loss: 0.2671 - custom_accuracy: 0.6
484 - val_loss: 0.3016 - val_custom_accuracy: 0.7734
```

In [ ]:

```
plt.plot(history.history['loss'])
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.title("5# Cycle Discriminator's Loss")
plt.show()
```



In [ ]:

```
qdisc_model.save_weights('./model_save/disc_final.h5')
qgen_model.save_weights('./model_save/gen_final.h5')
```

In [ ]:

```
qdisc_model.load_weights('./model_save/disc_final.h5')
```

In [ ]:

```
from sklearn.metrics import roc_auc_score

print("Training Accuracy:", custom_acc(np.array(y_train, dtype=np.float32), qdisc_model.pr
print("Testing Accuracy", custom_acc(np.array(y_test, dtype=np.float32), qdisc_model.predi

print("Training AUC:", roc_auc_score(np.argmax(((y_train+1)/2)[:, :2], axis=1), (((qdisc_m
print("Testing AUC:", roc_auc_score(np.argmax(((y_test+1)/2)[:, :2], axis=1), (((qdisc_mod
```

```
Training Accuracy: 0.76
Testing Accuracy 0.71
Training AUC: 0.8496
Testing AUC: 0.7824
```

This project proposes and trains a QGAN architecture. At the completion of the training procedure, the discriminator had 0.76 training accuracy and 0.71 testing accuracy, as well as 0.8496 training AUC and 0.7824 testing AUC. Because there are so many moving pieces in a QGAN architecture, choosing the proper parameters and regulating the adversarial game are the most difficult portions of training a QGAN model. While the ansatz is fixed in this project, evaluating a fresh ansatz for both the generator and discriminator may result in improved performance in the future.

In [ ]:
```
from google.colab import files
files.download("/content/model_save.zip")
```

In [ ]:
```

```