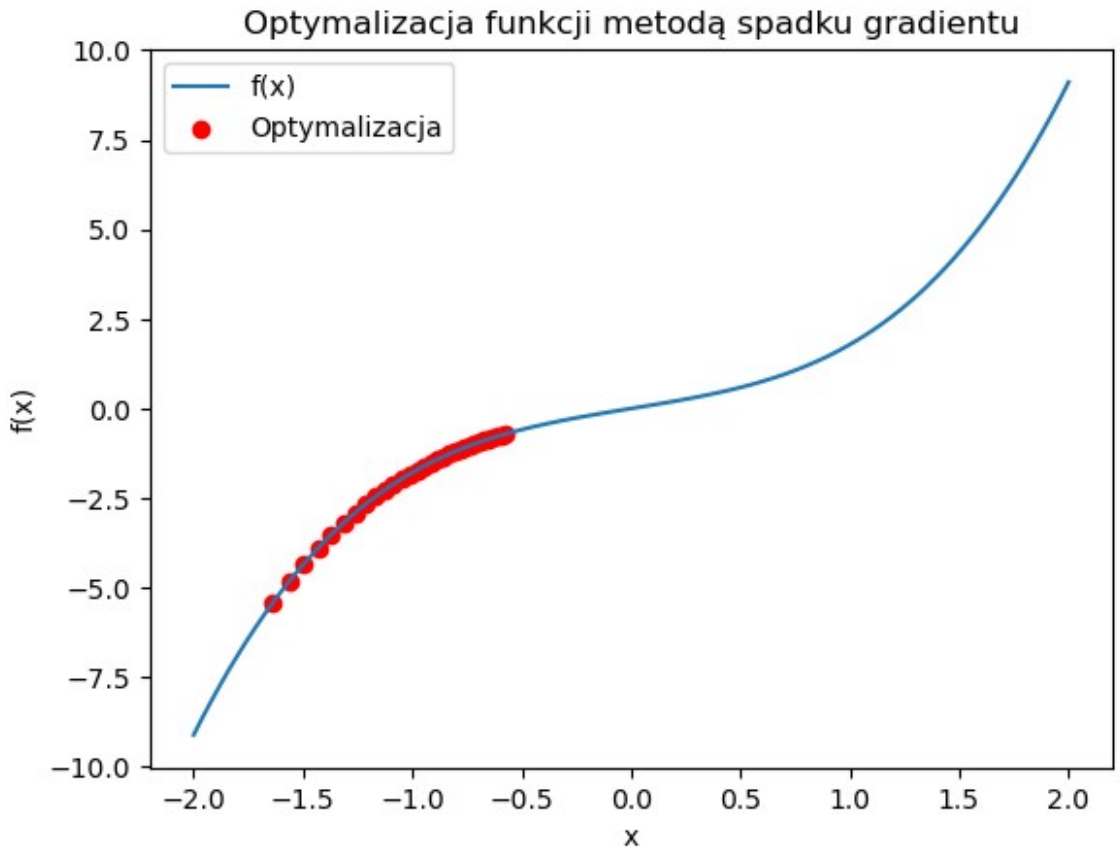
```
pip install torch torchvision

Requirement already satisfied: torch in c:\hubert\programy\anaconda\
lib\site-packages (2.6.0)
Requirement already satisfied: torchvision in c:\hubert\programy\
anaconda\lib\site-packages (0.21.0)
Requirement already satisfied: filelock in c:\hubert\programy\
anaconda\lib\site-packages (from torch) (3.13.1)
Requirement already satisfied: typing-extensions>=4.10.0 in c:\hubert\
programy\anaconda\lib\site-packages (from torch) (4.11.0)
Requirement already satisfied: networkx in c:\hubert\programy\
anaconda\lib\site-packages (from torch) (3.2.1)
Requirement already satisfied: jinja2 in c:\hubert\programy\anaconda\
lib\site-packages (from torch) (3.1.4)
Requirement already satisfied: fsspec in c:\hubert\programy\anaconda\
lib\site-packages (from torch) (2024.3.1)
Requirement already satisfied: setuptools in c:\hubert\programy\
anaconda\lib\site-packages (from torch) (69.5.1)
Requirement already satisfied: sympy==1.13.1 in c:\hubert\programy\
anaconda\lib\site-packages (from torch) (1.13.1)
Requirement already satisfied: mpmath<1.4,>=1.1.0 in c:\hubert\
programy\anaconda\lib\site-packages (from sympy==1.13.1->torch)
(1.3.0)
Requirement already satisfied: numpy in c:\hubert\programy\anaconda\
lib\site-packages (from torchvision) (1.26.4)
Requirement already satisfied: pillow!=8.3.*,>=5.3.0 in c:\hubert\
programy\anaconda\lib\site-packages (from torchvision) (10.3.0)
Requirement already satisfied: MarkupSafe>=2.0 in c:\hubert\programy\
anaconda\lib\site-packages (from jinja2->torch) (2.1.3)
Note: you may need to restart the kernel to use updated packages.

pip install tensorflow

Requirement already satisfied: tensorflow in c:\hubert\programy\
anaconda\lib\site-packages (2.18.0)
Requirement already satisfied: tensorflow-intel==2.18.0 in c:\hubert\
programy\anaconda\lib\site-packages (from tensorflow) (2.18.0)
Requirement already satisfied: absl-py>=1.0.0 in c:\hubert\programy\
anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow)
(2.1.0)
Requirement already satisfied: astunparse>=1.6.0 in c:\hubert\
programy\anaconda\lib\site-packages (from tensorflow-intel==2.18.0-
>tensorflow) (1.6.3)
Requirement already satisfied: flatbuffers>=24.3.25 in c:\hubert\
programy\anaconda\lib\site-packages (from tensorflow-intel==2.18.0-
>tensorflow) (25.1.24)
Requirement already satisfied: gast!=0.5.0,!=0.5.1,!=0.5.2,>=0.2.1 in
c:\hubert\programy\anaconda\lib\site-packages (from tensorflow-
intel==2.18.0->tensorflow) (0.6.0)
Requirement already satisfied: google-pasta>=0.1.1 in c:\hubert\
```

```
programy\anaconda\lib\site-packages (from tensorflow-intel==2.18.0-
>tensorflow) (0.2.0)
Requirement already satisfied: libclang>=13.0.0 in c:\hubert\programy\
anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow)
(18.1.1)
Requirement already satisfied: opt-einsum>=2.3.2 in c:\hubert\
programy\anaconda\lib\site-packages (from tensorflow-intel==2.18.0-
>tensorflow) (3.4.0)
Requirement already satisfied: packaging in c:\hubert\programy\
anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow)
(23.2)
Requirement already satisfied: protobuf!=4.21.0,!=4.21.1,!=4.21.2,!
=4.21.3,!=4.21.4,!=4.21.5,<6.0.0dev,>=3.20.3 in c:\hubert\programy\
anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow)
(3.20.3)
Requirement already satisfied: requests<3,>=2.21.0 in c:\hubert\
programy\anaconda\lib\site-packages (from tensorflow-intel==2.18.0-
>tensorflow) (2.32.2)
Requirement already satisfied: setuptools in c:\hubert\programy\
anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow)
(69.5.1)
Requirement already satisfied: six>=1.12.0 in c:\hubert\programy\
anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow)
(1.16.0)
Requirement already satisfied: termcolor>=1.1.0 in c:\hubert\programy\
anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow)
(2.5.0)
Requirement already satisfied: typing-extensions>=3.6.6 in c:\hubert\
programy\anaconda\lib\site-packages (from tensorflow-intel==2.18.0-
>tensorflow) (4.11.0)
Requirement already satisfied: wrapt>=1.11.0 in c:\hubert\programy\
anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow)
(1.14.1)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in c:\hubert\
programy\anaconda\lib\site-packages (from tensorflow-intel==2.18.0-
>tensorflow) (1.70.0)
Requirement already satisfied: tensorboard<2.19,>=2.18 in c:\hubert\
programy\anaconda\lib\site-packages (from tensorflow-intel==2.18.0-
>tensorflow) (2.18.0)
Requirement already satisfied: keras>=3.5.0 in c:\hubert\programy\
anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow)
(3.8.0)
Requirement already satisfied: numpy<2.1.0,>=1.26.0 in c:\hubert\
programy\anaconda\lib\site-packages (from tensorflow-intel==2.18.0-
>tensorflow) (1.26.4)
Requirement already satisfied: h5py>=3.11.0 in c:\hubert\programy\
anaconda\lib\site-packages (from tensorflow-intel==2.18.0->tensorflow)
(3.11.0)
Requirement already satisfied: ml-dtypes<0.5.0,>=0.4.0 in c:\hubert\
```

```
programy\anaconda\lib\site-packages (from tensorflow-intel==2.18.0-
>tensorflow) (0.4.1)
Requirement already satisfied: wheel<1.0,>=0.23.0 in c:\hubert\
programy\anaconda\lib\site-packages (from astunparse>=1.6.0-
>tensorflow-intel==2.18.0->tensorflow) (0.43.0)
Requirement already satisfied: rich in c:\hubert\programy\anaconda\
lib\site-packages (from keras>=3.5.0->tensorflow-intel==2.18.0-
>tensorflow) (13.3.5)
Requirement already satisfied: namex in c:\hubert\programy\anaconda\
lib\site-packages (from keras>=3.5.0->tensorflow-intel==2.18.0-
>tensorflow) (0.0.8)
Requirement already satisfied: optree in c:\hubert\programy\anaconda\
lib\site-packages (from keras>=3.5.0->tensorflow-intel==2.18.0-
>tensorflow) (0.14.0)
Requirement already satisfied: charset-normalizer<4,>=2 in c:\hubert\
programy\anaconda\lib\site-packages (from requests<3,>=2.21.0-
>tensorflow-intel==2.18.0->tensorflow) (2.0.4)
Requirement already satisfied: idna<4,>=2.5 in c:\hubert\programy\
anaconda\lib\site-packages (from requests<3,>=2.21.0->tensorflow-
intel==2.18.0->tensorflow) (3.7)
Requirement already satisfied: urllib3<3,>=1.21.1 in c:\hubert\
programy\anaconda\lib\site-packages (from requests<3,>=2.21.0-
>tensorflow-intel==2.18.0->tensorflow) (2.2.2)
Requirement already satisfied: certifi>=2017.4.17 in c:\hubert\
programy\anaconda\lib\site-packages (from requests<3,>=2.21.0-
>tensorflow-intel==2.18.0->tensorflow) (2024.8.30)
Requirement already satisfied: markdown>=2.6.8 in c:\hubert\programy\
anaconda\lib\site-packages (from tensorboard<2.19,>=2.18->tensorflow-
intel==2.18.0->tensorflow) (3.4.1)
Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0
in c:\hubert\programy\anaconda\lib\site-packages (from
tensorboard<2.19,>=2.18->tensorflow-intel==2.18.0->tensorflow) (0.7.2)
Requirement already satisfied: werkzeug>=1.0.1 in c:\hubert\programy\
anaconda\lib\site-packages (from tensorboard<2.19,>=2.18->tensorflow-
intel==2.18.0->tensorflow) (3.0.3)
Requirement already satisfied: MarkupSafe>=2.1.1 in c:\hubert\
programy\anaconda\lib\site-packages (from werkzeug>=1.0.1-
>tensorboard<2.19,>=2.18->tensorflow-intel==2.18.0->tensorflow)
(2.1.3)
Requirement already satisfied: markdown-it-py<3.0.0,>=2.2.0 in c:\
hubert\programy\anaconda\lib\site-packages (from rich->keras>=3.5.0-
>tensorflow-intel==2.18.0->tensorflow) (2.2.0)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in c:\hubert\
programy\anaconda\lib\site-packages (from rich->keras>=3.5.0-
>tensorflow-intel==2.18.0->tensorflow) (2.15.1)
Requirement already satisfied: mdurl~=0.1 in c:\hubert\programy\
anaconda\lib\site-packages (from markdown-it-py<3.0.0,>=2.2.0->rich-
>keras>=3.5.0->tensorflow-intel==2.18.0->tensorflow) (0.1.0)
Note: you may need to restart the kernel to use updated packages.
```

```python
import numpy as np
import matplotlib.pyplot as plt
import tensorflow as tf
from sklearn import datasets
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Input, Conv2D, Flatten,
MaxPooling2D
from tensorflow.keras.utils import to_categorical

# 1. Optymalizacja f(x) = arctan(x) + x^3 metodą spadku gradientu
def f(x):
    return np.arctan(x) + x**3

def grad_f(x):
    return (1 / (1 + x**2)) + 3*x**2

# Gradient Descent
x_init = np.random.uniform(-2, 2)
learning_rate = 0.01
iterations = 30
x_vals = [x_init]

for _ in range(iterations):
    grad = grad_f(x_vals[-1])
    if np.abs(grad) > 1e6:
        break
    x_new = x_vals[-1] - learning_rate * grad
    x_vals.append(x_new)

x_plot = np.linspace(-2, 2, 100)
plt.plot(x_plot, f(x_plot), label='f(x)')
plt.scatter(x_vals, f(np.array(x_vals)), color='red',
label='Optymalizacja')
plt.legend()
plt.xlabel("x")
plt.ylabel("f(x)")
plt.title("Optymalizacja funkcji metodą spadku gradientu")
plt.show()
```




```
pip install scikit-learn
```

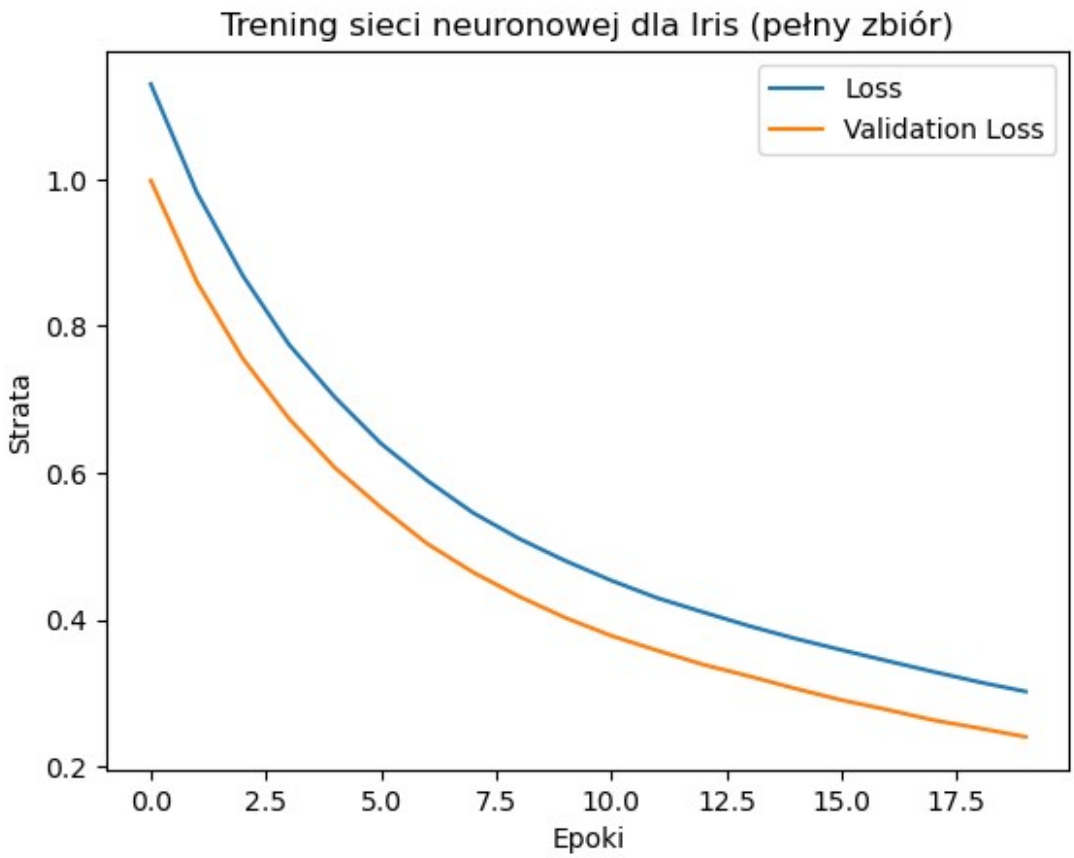
```
Requirement already satisfied: scikit-learn in c:\hubert\programy\
anaconda\lib\site-packages (1.4.2)
Requirement already satisfied: numpy>=1.19.5 in c:\hubert\programy\
anaconda\lib\site-packages (from scikit-learn) (1.26.4)
Requirement already satisfied: scipy>=1.6.0 in c:\hubert\programy\
anaconda\lib\site-packages (from scikit-learn) (1.13.1)
Requirement already satisfied: joblib>=1.2.0 in c:\hubert\programy\
anaconda\lib\site-packages (from scikit-learn) (1.4.2)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\hubert\
programy\anaconda\lib\site-packages (from scikit-learn) (2.2.0)
Note: you may need to restart the kernel to use updated packages.
```

```
# 2. Sieć neuronowa do klasyfikacji pełnego zbioru Iris
from sklearn import datasets
dataset = datasets.load_iris()
X, y = dataset.data, dataset.target

X_train, X_test, y_train, y_test = train_test_split(X, y,
test_size=0.2, random_state=42)
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
```

```
X_test = scaler.transform(X_test)

y_train = to_categorical(y_train, 3)
y_test = to_categorical(y_test, 3)

model = Sequential([
    Input(shape=(4,)),
    Dense(16, activation='relu'),
    Dense(3, activation='softmax')
])

model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])
history = model.fit(X_train, y_train, epochs=20, batch_size=5,
verbose=1, validation_data=(X_test, y_test))

# Wizualizacja procesu uczenia
plt.plot(history.history['loss'], label='Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.xlabel("Epoki")
plt.ylabel("Strata")
plt.legend()
plt.title("Trening sieci neuronowej dla Iris (pełny zbiór)")
plt.show()
```

```
Epoch 1/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 1s 8ms/step - accuracy: 0.3387 - loss:
1.2487 - val_accuracy: 0.3667 - val_loss: 0.9982
Epoch 2/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.4142 - loss:
1.0361 - val_accuracy: 0.5333 - val_loss: 0.8601
Epoch 3/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.5744 - loss:
0.9506 - val_accuracy: 0.6667 - val_loss: 0.7555
Epoch 4/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.6275 - loss:
0.8232 - val_accuracy: 0.7000 - val_loss: 0.6741
Epoch 5/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.6289 - loss:
0.7130 - val_accuracy: 0.7333 - val_loss: 0.6069
Epoch 6/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.6522 - loss:
0.6551 - val_accuracy: 0.7667 - val_loss: 0.5529
Epoch 7/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7161 - loss:
0.6355 - val_accuracy: 0.8333 - val_loss: 0.5037
Epoch 8/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7940 - loss:
0.5418 - val_accuracy: 0.8667 - val_loss: 0.4646
Epoch 9/20
```

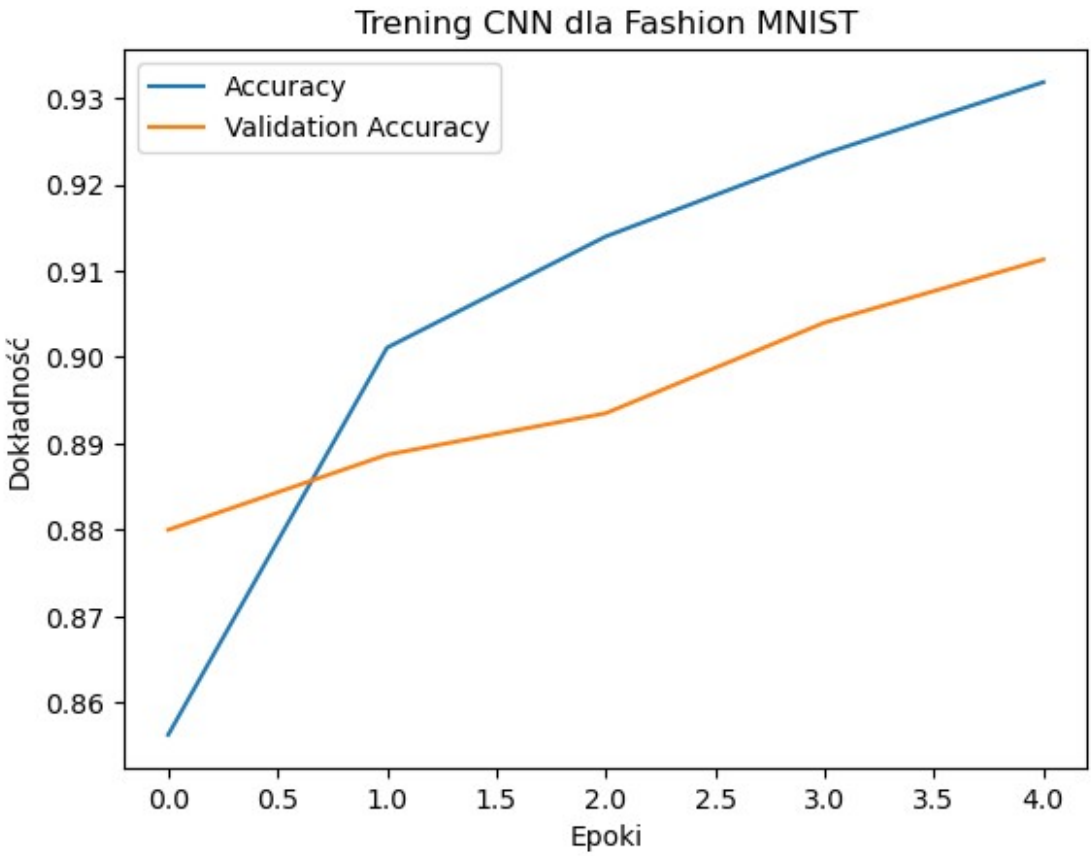
```
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.7964 - loss:
0.5126 - val_accuracy: 0.8667 - val_loss: 0.4317
Epoch 10/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8199 - loss:
0.4537 - val_accuracy: 0.8667 - val_loss: 0.4028
Epoch 11/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8209 - loss:
0.4470 - val_accuracy: 0.8667 - val_loss: 0.3782
Epoch 12/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8456 - loss:
0.4334 - val_accuracy: 0.9000 - val_loss: 0.3581
Epoch 13/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8509 - loss:
0.4144 - val_accuracy: 0.9333 - val_loss: 0.3388
Epoch 14/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8204 - loss:
0.4011 - val_accuracy: 0.9333 - val_loss: 0.3230
Epoch 15/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8672 - loss:
0.3776 - val_accuracy: 0.9333 - val_loss: 0.3062
Epoch 16/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8957 - loss:
0.3425 - val_accuracy: 0.9333 - val_loss: 0.2906
Epoch 17/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.9086 - loss:
0.3078 - val_accuracy: 0.9333 - val_loss: 0.2773
Epoch 18/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.9210 - loss:
0.2816 - val_accuracy: 0.9333 - val_loss: 0.2632
Epoch 19/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.8771 - loss:
0.3260 - val_accuracy: 0.9667 - val_loss: 0.2521
Epoch 20/20
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 2ms/step - accuracy: 0.9408 - loss:
0.2848 - val_accuracy: 0.9667 - val_loss: 0.2405
```




```
# 3. Sieć CNN dla Fashion MNIST
fashion_mnist = tf.keras.datasets.fashion_mnist
(x_train, y_train), (x_test, y_test) = fashion_mnist.load_data()

x_train, x_test = x_train / 255.0, x_test / 255.0
x_train = x_train.reshape(-1, 28, 28, 1)
x_test = x_test.reshape(-1, 28, 28, 1)

y_train = to_categorical(y_train, 10)
y_test = to_categorical(y_test, 10)

cnn_model = Sequential([
    Input(shape=(28,28,1)),
    Conv2D(32, (3,3), activation='relu'),
    MaxPooling2D((2,2)),
    Flatten(),
    Dense(64, activation='relu'),
    Dense(10, activation='softmax')
])

cnn_model.compile(optimizer='adam', loss='categorical_crossentropy',
metrics=['accuracy'])
cnn_history = cnn_model.fit(x_train, y_train, epochs=5, batch_size=32,
```

```
validation_data=(x_test, y_test))

# Wizualizacja treningu CNN
plt.plot(cnn_history.history['accuracy'], label='Accuracy')
plt.plot(cnn_history.history['val_accuracy'], label='Validation
Accuracy')
plt.xlabel("Epoki")
plt.ylabel("Dokładność")
plt.legend()
plt.title("Trening CNN dla Fashion MNIST")
plt.show()
```

```
Epoch 1/5
1875/1875 ━━━━━━━━━━━━━━━━━━━━ 5s 2ms/step - accuracy: 0.8093 - loss:
0.5498 - val_accuracy: 0.8800 - val_loss: 0.3350
Epoch 2/5
1875/1875 ━━━━━━━━━━━━━━━━━━━━ 4s 2ms/step - accuracy: 0.8982 - loss:
0.2837 - val_accuracy: 0.8887 - val_loss: 0.2958
Epoch 3/5
1875/1875 ━━━━━━━━━━━━━━━━━━━━ 4s 2ms/step - accuracy: 0.9146 - loss:
0.2362 - val_accuracy: 0.8935 - val_loss: 0.2903
Epoch 4/5
1875/1875 ━━━━━━━━━━━━━━━━━━━━ 4s 2ms/step - accuracy: 0.9254 - loss:
0.2049 - val_accuracy: 0.9040 - val_loss: 0.2584
Epoch 5/5
1875/1875 ━━━━━━━━━━━━━━━━━━━━ 4s 2ms/step - accuracy: 0.9350 - loss:
0.1775 - val_accuracy: 0.9113 - val_loss: 0.2588
```


Trening CNN dla Fashion MNIST
Accuracy
Validation Accuracy
Dokładność
Epoki
0.93
0.92
0.91
0.90
0.89
0.88
0.87
0.86
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0