opg_simple

September 16, 2024

1 Opgave

2 Installer libraries

[1]:
```
!python.exe -m pip install --upgrade pip

!pip install pandas

!pip install scikit-learn

!pip install tensorflow

!pip install numpy

!pip install matplotlib
```

```
Requirement already satisfied: pip in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (24.2)
Requirement already satisfied: pandas in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (2.2.2)
Requirement already satisfied: numpy>=1.22.4 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from pandas) (1.26.4)
Requirement already satisfied: python-dateutil>=2.8.2 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from pandas) (2.9.0.post0)
Requirement already satisfied: pytz>=2020.1 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from pandas) (2024.2)
Requirement already satisfied: tzdata>=2022.7 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from pandas) (2024.1)
Requirement already satisfied: six>=1.5 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from python-dateutil>=2.8.2->pandas) (1.16.0)
Requirement already satisfied: scikit-learn in
```

```
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (1.5.1)
Requirement already satisfied: numpy>=1.19.5 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from scikit-learn) (1.26.4)
Requirement already satisfied: scipy>=1.6.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from scikit-learn) (1.13.1)
Requirement already satisfied: joblib>=1.2.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from scikit-learn) (1.4.2)
Requirement already satisfied: threadpoolctl>=3.1.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from scikit-learn) (3.5.0)
Requirement already satisfied: tensorflow in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (2.17.0)
Requirement already satisfied: tensorflow-intel==2.17.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow) (2.17.0)
Requirement already satisfied: absl-py>=1.0.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (2.1.0)
Requirement already satisfied: astunparse>=1.6.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (1.6.3)
Requirement already satisfied: flatbuffers>=24.3.25 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (24.3.25)
Requirement already satisfied: gast!=0.5.0,!=0.5.1,!=0.5.2,>=0.2.1 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (0.6.0)
Requirement already satisfied: google-pasta>=0.1.1 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (0.2.0)
Requirement already satisfied: h5py>=3.10.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (3.11.0)
Requirement already satisfied: libclang>=13.0.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (18.1.1)
Requirement already satisfied: ml-dtypes<0.5.0,>=0.3.1 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (0.4.0)
Requirement already satisfied: opt-einsum>=2.3.2 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (3.3.0)
Requirement already satisfied: packaging in
```

```
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (24.1)
Requirement already satisfied:
protobuf!=4.21.0,!=4.21.1,!=4.21.2,!=4.21.3,!=4.21.4,!=4.21.5,<5.0.0dev,>=3.20.3
in c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (4.25.4)
Requirement already satisfied: requests<3,>=2.21.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (2.32.3)
Requirement already satisfied: setuptools in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (57.4.0)
Requirement already satisfied: six>=1.12.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (1.16.0)
Requirement already satisfied: termcolor>=1.1.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (2.4.0)
Requirement already satisfied: typing-extensions>=3.6.6 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (4.12.2)
Requirement already satisfied: wrapt>=1.11.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (1.16.0)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (1.66.1)
Requirement already satisfied: tensorboard<2.18,>=2.17 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (2.17.1)
Requirement already satisfied: keras>=3.2.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (3.5.0)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (0.31.0)
Requirement already satisfied: numpy<2.0.0,>=1.23.5 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorflow-intel==2.17.0->tensorflow) (1.26.4)
Requirement already satisfied: wheel<1.0,>=0.23.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from astunparse>=1.6.0->tensorflow-intel==2.17.0->tensorflow) (0.44.0)
Requirement already satisfied: rich in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from keras>=3.2.0->tensorflow-intel==2.17.0->tensorflow) (13.8.1)
Requirement already satisfied: namex in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from keras>=3.2.0->tensorflow-intel==2.17.0->tensorflow) (0.0.8)
```

```
Requirement already satisfied: optree in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from keras>=3.2.0->tensorflow-intel==2.17.0->tensorflow) (0.12.1)
Requirement already satisfied: charset-normalizer<4,>=2 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from requests<3,>=2.21.0->tensorflow-intel==2.17.0->tensorflow)
(3.3.2)
Requirement already satisfied: idna<4,>=2.5 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from requests<3,>=2.21.0->tensorflow-intel==2.17.0->tensorflow) (3.8)
Requirement already satisfied: urllib3<3,>=1.21.1 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from requests<3,>=2.21.0->tensorflow-intel==2.17.0->tensorflow)
(1.26.20)
Requirement already satisfied: certifi>=2017.4.17 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from requests<3,>=2.21.0->tensorflow-intel==2.17.0->tensorflow)
(2024.8.30)
Requirement already satisfied: markdown>=2.6.8 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorboard<2.18,>=2.17->tensorflow-intel==2.17.0->tensorflow)
(3.7)
Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorboard<2.18,>=2.17->tensorflow-intel==2.17.0->tensorflow)
(0.7.2)
Requirement already satisfied: werkzeug>=1.0.1 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from tensorboard<2.18,>=2.17->tensorflow-intel==2.17.0->tensorflow)
(3.0.4)
Requirement already satisfied: importlib-metadata>=4.4 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from markdown>=2.6.8->tensorboard<2.18,>=2.17->tensorflow-
intel==2.17.0->tensorflow) (8.4.0)
Requirement already satisfied: MarkupSafe>=2.1.1 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from werkzeug>=1.0.1->tensorboard<2.18,>=2.17->tensorflow-
intel==2.17.0->tensorflow) (2.1.5)
Requirement already satisfied: markdown-it-py>=2.2.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from rich->keras>=3.2.0->tensorflow-intel==2.17.0->tensorflow) (3.0.0)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from rich->keras>=3.2.0->tensorflow-intel==2.17.0->tensorflow)
(2.18.0)
Requirement already satisfied: zipp>=0.5 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from importlib-
```

```
metadata>=4.4->markdown>=2.6.8->tensorboard<2.18,>=2.17->tensorflow-
intel==2.17.0->tensorflow) (3.20.1)
Requirement already satisfied: mdurl~=0.1 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from markdown-it-py>=2.2.0->rich->keras>=3.2.0->tensorflow-
intel==2.17.0->tensorflow) (0.1.2)
Requirement already satisfied: numpy in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (1.26.4)
Requirement already satisfied: matplotlib in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (3.9.2)
Requirement already satisfied: contourpy>=1.0.1 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (1.3.0)
Requirement already satisfied: cycler>=0.10 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (4.53.1)
Requirement already satisfied: kiwisolver>=1.3.1 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (1.4.5)
Requirement already satisfied: numpy>=1.23 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (1.26.4)
Requirement already satisfied: packaging>=20.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (24.1)
Requirement already satisfied: pillow>=8 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (10.4.0)
Requirement already satisfied: pyparsing>=2.3.1 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (3.1.4)
Requirement already satisfied: python-dateutil>=2.7 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (2.9.0.post0)
Requirement already satisfied: importlib-resources>=3.2.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (6.4.4)
Requirement already satisfied: zipp>=3.1.0 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from importlib-resources>=3.2.0->matplotlib) (3.20.1)
Requirement already satisfied: six>=1.5 in
c:\users\chr_v\documents\eaa23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from python-dateutil>=2.7->matplotlib) (1.16.0)
```

3 Brug Panda til at læse (og vise) data fra csv-regnearket som indeholder træningsdata

[2]:
```
import pandas as pd

df = pd.read_csv('wall2.csv')

X = pd.get_dummies(df.drop(['motor'], axis=1)) #
Y = pd.get_dummies(df.drop(['afstand'], axis=1))

print(X)
```

```
    afstand
0       0.0
1       0.5
2       1.0
3       1.5
4       2.0
5       2.5
6       3.0
7       3.5
8       4.0
9       4.5
10      5.0
11      5.5
12      6.0
13      6.5
14      7.0
15      7.5
16      8.0
17      8.5
18      9.0
19      9.5
20     10.0
```

4 Byg efter bedste fornemmelse et neuralt netværk

[3]:
```
from tensorflow.keras.models import Sequential, load_model
from tensorflow.keras.layers import Dense

model = Sequential()
model.add(Dense(units=30, activation='tanh', input_dim=1))
 ↪                                    # 1 input til 30 neuroner i et␣
 ↪skjult lag
model.add(Dense(units=1, activation='linear'))  #sigmoid kan ikke bruges da␣
 ↪positiv og negativ signal ønskes            # (2) output
```

```
model.compile(loss="mean_squared_error", optimizer='Adam')#,␣
↪metrics='accuracy')  #sgd  loss='binary_crossentropy'/"mean_squared_error"
```

```
C:\Users\chr_v\Documents\eaa23itek\3semester\Kunstig-Intelligens\ai\lib\site-
packages\keras\src\layers\core\dense.py:87: UserWarning: Do not pass an
`input_shape`/`input_dim` argument to a layer. When using Sequential models,
prefer using an `Input(shape)` object as the first layer in the model instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

5 Konverter træningsdata til et array af float

[4]:
```
import numpy as np

X_train = np.asarray(X).astype('float32')
y_train = np.asarray(Y).astype('float32')
```

6 Og træn med disse data, og plot data

[5]:
```
model.fit(X_train, y_train, epochs=200, batch_size=20)
```

```
Epoch 1/200
2/2             1s 8ms/step - loss:
0.4412
Epoch 2/200
2/2             0s 8ms/step - loss:
0.3652
Epoch 3/200
2/2             0s 3ms/step - loss:
0.2972
Epoch 4/200
2/2             0s 8ms/step - loss:
0.2337
Epoch 5/200
2/2             0s 11ms/step - loss:
0.1873
Epoch 6/200
2/2             0s 8ms/step - loss:
0.1464
Epoch 7/200
2/2             0s 0s/step - loss:
0.1162
Epoch 8/200
2/2             0s 8ms/step - loss:
0.0903
Epoch 9/200
2/2             0s 0s/step - loss:
```

```
0.0765
Epoch 10/200
2/2             0s 8ms/step - loss:
0.0625
Epoch 11/200
2/2             0s 8ms/step - loss:
0.0566
Epoch 12/200
2/2             0s 8ms/step - loss:
0.0525
Epoch 13/200
2/2             0s 0s/step - loss:
0.0509
Epoch 14/200
2/2             0s 0s/step - loss:
0.0506
Epoch 15/200
2/2             0s 0s/step - loss:
0.0486
Epoch 16/200
2/2             0s 8ms/step - loss:
0.0525
Epoch 17/200
2/2             0s 8ms/step - loss:
0.0526
Epoch 18/200
2/2             0s 8ms/step - loss:
0.0517
Epoch 19/200
2/2             0s 0s/step - loss:
0.0519
Epoch 20/200
2/2             0s 0s/step - loss:
0.0510
Epoch 21/200
2/2             0s 8ms/step - loss:
0.0510
Epoch 22/200
2/2             0s 0s/step - loss:
0.0497
Epoch 23/200
2/2             0s 0s/step - loss:
0.0490
Epoch 24/200
2/2             0s 8ms/step - loss:
0.0476
Epoch 25/200
2/2             0s 0s/step - loss:
```

```
0.0482
Epoch 26/200
2/2             0s 0s/step - loss:
0.0480
Epoch 27/200
2/2             0s 8ms/step - loss:
0.0478
Epoch 28/200
2/2             0s 0s/step - loss:
0.0477
Epoch 29/200
2/2             0s 8ms/step - loss:
0.0450
Epoch 30/200
2/2             0s 8ms/step - loss:
0.0463
Epoch 31/200
2/2             0s 0s/step - loss:
0.0489
Epoch 32/200
2/2             0s 8ms/step - loss:
0.0503
Epoch 33/200
2/2             0s 0s/step - loss:
0.0515
Epoch 34/200
2/2             0s 8ms/step - loss:
0.0527
Epoch 35/200
2/2             0s 0s/step - loss:
0.0525
Epoch 36/200
2/2             0s 8ms/step - loss:
0.0507
Epoch 37/200
2/2             0s 9ms/step - loss:
0.0504
Epoch 38/200
2/2             0s 4ms/step - loss:
0.0515
Epoch 39/200
2/2             0s 0s/step - loss:
0.0496
Epoch 40/200
2/2             0s 8ms/step - loss:
0.0484
Epoch 41/200
2/2             0s 8ms/step - loss:
```

```
0.0467
Epoch 42/200
2/2             0s 0s/step - loss:
0.0451
Epoch 43/200
2/2             0s 10ms/step - loss:
0.0448
Epoch 44/200
2/2             0s 0s/step - loss:
0.0432
Epoch 45/200
2/2             0s 0s/step - loss:
0.0444
Epoch 46/200
2/2             0s 8ms/step - loss:
0.0433
Epoch 47/200
2/2             0s 8ms/step - loss:
0.0464
Epoch 48/200
2/2             0s 8ms/step - loss:
0.0476
Epoch 49/200
2/2             0s 8ms/step - loss:
0.0473
Epoch 50/200
2/2             0s 8ms/step - loss:
0.0481
Epoch 51/200
2/2             0s 0s/step - loss:
0.0516
Epoch 52/200
2/2             0s 8ms/step - loss:
0.0497
Epoch 53/200
2/2             0s 8ms/step - loss:
0.0481
Epoch 54/200
2/2             0s 8ms/step - loss:
0.0496
Epoch 55/200
2/2             0s 8ms/step - loss:
0.0496
Epoch 56/200
2/2             0s 8ms/step - loss:
0.0493
Epoch 57/200
2/2             0s 0s/step - loss:
```

```
0.0487
Epoch 58/200
2/2             0s 0s/step - loss:
0.0465
Epoch 59/200
2/2             0s 4ms/step - loss:
0.0472
Epoch 60/200
2/2             0s 8ms/step - loss:
0.0469
Epoch 61/200
2/2             0s 8ms/step - loss:
0.0491
Epoch 62/200
2/2             0s 12ms/step - loss:
0.0513
Epoch 63/200
2/2             0s 0s/step - loss:
0.0532
Epoch 64/200
2/2             0s 12ms/step - loss:
0.0509
Epoch 65/200
2/2             0s 0s/step - loss:
0.0540
Epoch 66/200
2/2             0s 0s/step - loss:
0.0503
Epoch 67/200
2/2             0s 10ms/step - loss:
0.0472
Epoch 68/200
2/2             0s 8ms/step - loss:
0.0450
Epoch 69/200
2/2             0s 0s/step - loss:
0.0431
Epoch 70/200
2/2             0s 8ms/step - loss:
0.0414
Epoch 71/200
2/2             0s 0s/step - loss:
0.0402
Epoch 72/200
2/2             0s 8ms/step - loss:
0.0375
Epoch 73/200
2/2             0s 3ms/step - loss:
```

```
0.0390
Epoch 74/200
2/2             0s 0s/step - loss:
0.0385
Epoch 75/200
2/2             0s 0s/step - loss:
0.0384
Epoch 76/200
2/2             0s 0s/step - loss:
0.0382
Epoch 77/200
2/2             0s 8ms/step - loss:
0.0378
Epoch 78/200
2/2             0s 0s/step - loss:
0.0381
Epoch 79/200
2/2             0s 0s/step - loss:
0.0380
Epoch 80/200
2/2             0s 8ms/step - loss:
0.0380
Epoch 81/200
2/2             0s 0s/step - loss:
0.0355
Epoch 82/200
2/2             0s 8ms/step - loss:
0.0379
Epoch 83/200
2/2             0s 516us/step - loss:
0.0359
Epoch 84/200
2/2             0s 0s/step - loss:
0.0372
Epoch 85/200
2/2             0s 8ms/step - loss:
0.0377
Epoch 86/200
2/2             0s 0s/step - loss:
0.0381
Epoch 87/200
2/2             0s 8ms/step - loss:
0.0379
Epoch 88/200
2/2             0s 1ms/step - loss:
0.0353
Epoch 89/200
2/2             0s 0s/step - loss:
```

```
0.0376
Epoch 90/200
2/2             0s 8ms/step - loss:
0.0368
Epoch 91/200
2/2             0s 0s/step - loss:
0.0365
Epoch 92/200
2/2             0s 6ms/step - loss:
0.0365
Epoch 93/200
2/2             0s 0s/step - loss:
0.0364
Epoch 94/200
2/2             0s 0s/step - loss:
0.0371
Epoch 95/200
2/2             0s 8ms/step - loss:
0.0373
Epoch 96/200
2/2             0s 8ms/step - loss:
0.0364
Epoch 97/200
2/2             0s 9ms/step - loss:
0.0366
Epoch 98/200
2/2             0s 8ms/step - loss:
0.0340
Epoch 99/200
2/2             0s 0s/step - loss:
0.0361
Epoch 100/200
2/2             0s 0s/step - loss:
0.0357
Epoch 101/200
2/2             0s 0s/step - loss:
0.0342
Epoch 102/200
2/2             0s 8ms/step - loss:
0.0350
Epoch 103/200
2/2             0s 8ms/step - loss:
0.0352
Epoch 104/200
2/2             0s 9ms/step - loss:
0.0350
Epoch 105/200
2/2             0s 0s/step - loss:
```

```
0.0347
Epoch 106/200
2/2             0s 8ms/step - loss:
0.0334
Epoch 107/200
2/2             0s 8ms/step - loss:
0.0347
Epoch 108/200
2/2             0s 8ms/step - loss:
0.0336
Epoch 109/200
2/2             0s 0s/step - loss:
0.0344
Epoch 110/200
2/2             0s 8ms/step - loss:
0.0348
Epoch 111/200
2/2             0s 0s/step - loss:
0.0348
Epoch 112/200
2/2             0s 0s/step - loss:
0.0351
Epoch 113/200
2/2             0s 8ms/step - loss:
0.0352
Epoch 114/200
2/2             0s 0s/step - loss:
0.0333
Epoch 115/200
2/2             0s 0s/step - loss:
0.0345
Epoch 116/200
2/2             0s 0s/step - loss:
0.0351
Epoch 117/200
2/2             0s 8ms/step - loss:
0.0363
Epoch 118/200
2/2             0s 8ms/step - loss:
0.0344
Epoch 119/200
2/2             0s 8ms/step - loss:
0.0343
Epoch 120/200
2/2             0s 0s/step - loss:
0.0330
Epoch 121/200
2/2             0s 8ms/step - loss:
```

```
0.0330
Epoch 122/200
2/2             0s 0s/step - loss:
0.0325
Epoch 123/200
2/2             0s 0s/step - loss:
0.0323
Epoch 124/200
2/2             0s 0s/step - loss:
0.0325
Epoch 125/200
2/2             0s 8ms/step - loss:
0.0327
Epoch 126/200
2/2             0s 8ms/step - loss:
0.0315
Epoch 127/200
2/2             0s 8ms/step - loss:
0.0328
Epoch 128/200
2/2             0s 0s/step - loss:
0.0345
Epoch 129/200
2/2             0s 8ms/step - loss:
0.0347
Epoch 130/200
2/2             0s 0s/step - loss:
0.0346
Epoch 131/200
2/2             0s 0s/step - loss:
0.0342
Epoch 132/200
2/2             0s 8ms/step - loss:
0.0337
Epoch 133/200
2/2             0s 0s/step - loss:
0.0334
Epoch 134/200
2/2             0s 0s/step - loss:
0.0336
Epoch 135/200
2/2             0s 8ms/step - loss:
0.0325
Epoch 136/200
2/2             0s 8ms/step - loss:
0.0340
Epoch 137/200
2/2             0s 8ms/step - loss:
```

```
0.0348
Epoch 138/200
2/2             0s 8ms/step - loss:
0.0338
Epoch 139/200
2/2             0s 0s/step - loss:
0.0342
Epoch 140/200
2/2             0s 0s/step - loss:
0.0316
Epoch 141/200
2/2             0s 0s/step - loss:
0.0315
Epoch 142/200
2/2             0s 11ms/step - loss:
0.0300
Epoch 143/200
2/2             0s 0s/step - loss:
0.0285
Epoch 144/200
2/2             0s 0s/step - loss:
0.0293
Epoch 145/200
2/2             0s 8ms/step - loss:
0.0305
Epoch 146/200
2/2             0s 8ms/step - loss:
0.0326
Epoch 147/200
2/2             0s 8ms/step - loss:
0.0346
Epoch 148/200
2/2             0s 0s/step - loss:
0.0346
Epoch 149/200
2/2             0s 8ms/step - loss:
0.0341
Epoch 150/200
2/2             0s 0s/step - loss:
0.0332
Epoch 151/200
2/2             0s 0s/step - loss:
0.0317
Epoch 152/200
2/2             0s 0s/step - loss:
0.0299
Epoch 153/200
2/2             0s 8ms/step - loss:
```

```
0.0301
Epoch 154/200
2/2             0s 7ms/step - loss:
0.0297
Epoch 155/200
2/2             0s 8ms/step - loss:
0.0301
Epoch 156/200
2/2             0s 8ms/step - loss:
0.0293
Epoch 157/200
2/2             0s 0s/step - loss:
0.0294
Epoch 158/200
2/2             0s 0s/step - loss:
0.0290
Epoch 159/200
2/2             0s 0s/step - loss:
0.0289
Epoch 160/200
2/2             0s 8ms/step - loss:
0.0288
Epoch 161/200
2/2             0s 8ms/step - loss:
0.0286
Epoch 162/200
2/2             0s 4ms/step - loss:
0.0287
Epoch 163/200
2/2             0s 0s/step - loss:
0.0289
Epoch 164/200
2/2             0s 0s/step - loss:
0.0287
Epoch 165/200
2/2             0s 8ms/step - loss:
0.0284
Epoch 166/200
2/2             0s 0s/step - loss:
0.0271
Epoch 167/200
2/2             0s 8ms/step - loss:
0.0285
Epoch 168/200
2/2             0s 8ms/step - loss:
0.0286
Epoch 169/200
2/2             0s 7ms/step - loss:
```

```
0.0285
Epoch 170/200
2/2             0s 8ms/step - loss:
0.0276
Epoch 171/200
2/2             0s 0s/step - loss:
0.0282
Epoch 172/200
2/2             0s 499us/step - loss:
0.0276
Epoch 173/200
2/2             0s 0s/step - loss:
0.0280
Epoch 174/200
2/2             0s 0s/step - loss:
0.0296
Epoch 175/200
2/2             0s 8ms/step - loss:
0.0310
Epoch 176/200
2/2             0s 8ms/step - loss:
0.0325
Epoch 177/200
2/2             0s 8ms/step - loss:
0.0333
Epoch 178/200
2/2             0s 8ms/step - loss:
0.0334
Epoch 179/200
2/2             0s 8ms/step - loss:
0.0337
Epoch 180/200
2/2             0s 0s/step - loss:
0.0316
Epoch 181/200
2/2             0s 0s/step - loss:
0.0299
Epoch 182/200
2/2             0s 0s/step - loss:
0.0279
Epoch 183/200
2/2             0s 8ms/step - loss:
0.0272
Epoch 184/200
2/2             0s 8ms/step - loss:
0.0273
Epoch 185/200
2/2             0s 8ms/step - loss:
```

```
0.0272
Epoch 186/200
2/2             0s 0s/step - loss:
0.0262
Epoch 187/200
2/2             0s 8ms/step - loss:
0.0269
Epoch 188/200
2/2             0s 0s/step - loss:
0.0271
Epoch 189/200
2/2             0s 0s/step - loss:
0.0266
Epoch 190/200
2/2             0s 0s/step - loss:
0.0270
Epoch 191/200
2/2             0s 0s/step - loss:
0.0262
Epoch 192/200
2/2             0s 0s/step - loss:
0.0272
Epoch 193/200
2/2             0s 8ms/step - loss:
0.0282
Epoch 194/200
2/2             0s 8ms/step - loss:
0.0288
Epoch 195/200
2/2             0s 0s/step - loss:
0.0298
Epoch 196/200
2/2             0s 8ms/step - loss:
0.0277
Epoch 197/200
2/2             0s 0s/step - loss:
0.0280
Epoch 198/200
2/2             0s 0s/step - loss:
0.0268
Epoch 199/200
2/2             0s 0s/step - loss:
0.0250
Epoch 200/200
2/2             0s 8ms/step - loss:
0.0259
```

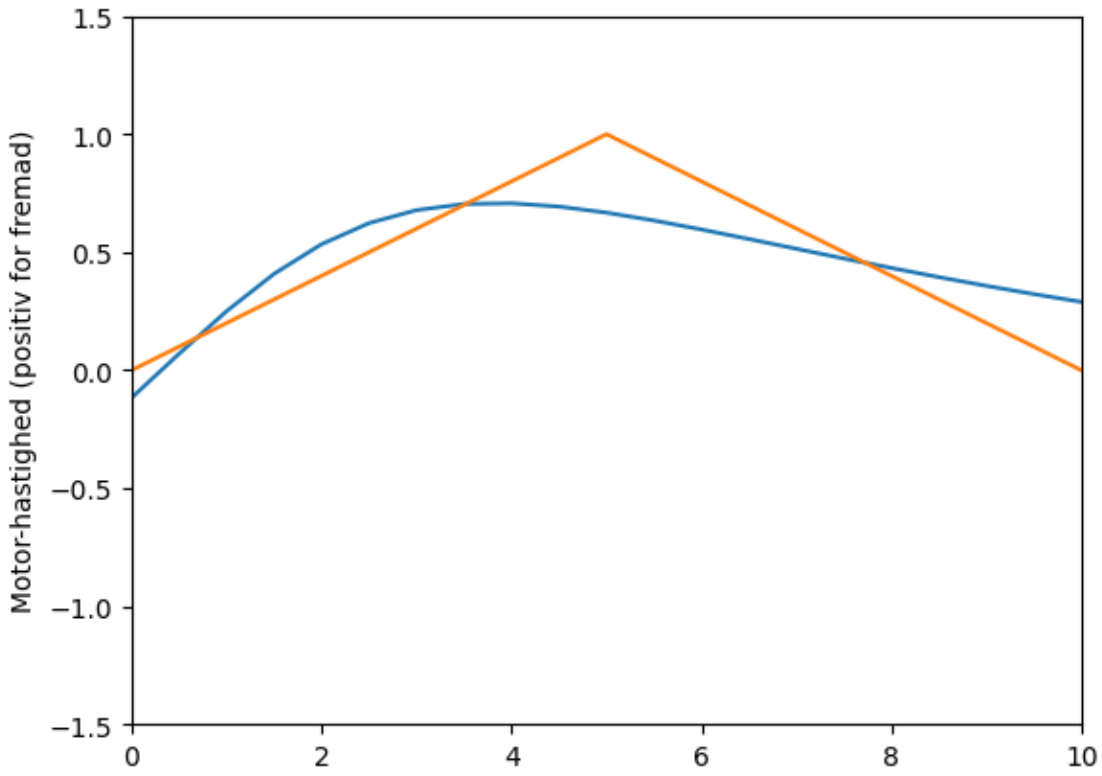
[5]: <keras.src.callbacks.history.History at 0x273a7ccf790>

[6]:
```
import matplotlib.pyplot as plt

test_afstand = np.array([0,0.5,1,1.5,2,2.5,3,3.5,4,4.5,5,5.5,6,6.5,7,7.5,8,8.
↪5,9,9.5,10])

b = model.predict(test_afstand)    #b  er de af netværket estimerede værdier␣
↪for højre og venstre -motor (2-dimensionelt)
plt.plot(test_afstand,b)           # her plottes b  (orange og blåtyrkis)
plt.plot(X, Y)                        # Y er træningsdata for output (rød og␣
↪grøn)
plt.ylabel('Motor-hastighed (positiv for fremad)')
plt.axis((0, 10, -1.5, 1.5))
plt.show()
```

```
1/1             0s 56ms/step
```



7 mere træning, og plot

[ ]:
```
model.fit(X_train, y_train, epochs=2000, batch_size=20, verbose=0)

b = model.predict(test_afstand)    #b  er de af netværket estimerede værdier␣
 ↪for højre og venstre -motor (2-dimensionelt)
plt.plot(test_afstand,b)           # her plottes b  (orange og blåtyrkis)
plt.plot(X,Y)                        # Y er træningsdata for output (rød og␣
 ↪grøn)
plt.ylabel('Motor-hastighed (positiv for fremad)')
plt.axis((0, 10, -1.5, 1.5))
plt.show()
```

[ ]:
```
a = model.predict(pd.Series([5,11]))
```

[ ]:
```
print(a)
```

[ ]:
```

```