

Wallfollow

September 16, 2024

1 wall follow

Casen er fra 2.semester: - https://eaaa.instructure.com/courses/17030/files/982828?module_item_id=522476

Løsningsmodellen er inspireret af Tensorflow in 10 min.. -
https://www.youtube.com/watch?v=6_2hzRopPbQ&t=5s

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\ea23itek\3semester\kunstig-intelligens\ai\lib\site-  
packages (24.2)
```

```
Requirement already satisfied: pandas in  
c:\users\chr_v\documents\ea23itek\3semester\kunstig-intelligens\ai\lib\site-  
packages (2.2.2)
```

```
Requirement already satisfied: numpy>=1.22.4 in  
c:\users\chr_v\documents\ea23itek\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\ea23itek\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\ea23itek\3semester\kunstig-intelligens\ai\lib\site-  
packages (from pandas) (2024.2)
```

```
Requirement already satisfied: tzdata>=2022.7 in  
c:\users\chr_v\documents\ea23itek\3semester\kunstig-intelligens\ai\lib\site-
```

packages (from pandas) (2024.1)
 Requirement already satisfied: six>=1.5 in
 c:\users\chr_v\documents\ea23itek\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\ea23itek\3semester\kunstig-intelligens\ai\lib\site-
 packages (1.5.1)
 Requirement already satisfied: numpy>=1.19.5 in
 c:\users\chr_v\documents\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\3semester\kunstig-intelligens\ai\lib\site-
 packages (from scikit-learn) (3.5.0)
 Requirement already satisfied: tensorflow in
 c:\users\chr_v\documents\ea23itek\3semester\kunstig-intelligens\ai\lib\site-
 packages (2.17.0)
 Requirement already satisfied: tensorflow-intel==2.17.0 in
 c:\users\chr_v\documents\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (1.26.4)
Requirement already satisfied: matplotlib in
c:\users\chr_v\documents\ea23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (3.9.2)
Requirement already satisfied: contourpy>=1.0.1 in
c:\users\chr_v\documents\ea23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (1.3.0)
Requirement already satisfied: cycler>=0.10 in
c:\users\chr_v\documents\ea23itek\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\ea23itek\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\ea23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (1.4.5)
Requirement already satisfied: numpy>=1.23 in
c:\users\chr_v\documents\ea23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (1.26.4)
Requirement already satisfied: packaging>=20.0 in
c:\users\chr_v\documents\ea23itek\3semester\kunstig-intelligens\ai\lib\site-
packages (from matplotlib) (24.1)
Requirement already satisfied: pillow>=8 in
c:\users\chr_v\documents\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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\ea23itek\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

```
[46]: import pandas as pd

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

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

print(X)
```

	afstand
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10

4 Byg efter bedste fornemmelse et neuralt netværk

```
[47]: 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=2, 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\ea23itek\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

```
[48]: import numpy as np  
  
X_train = np.asarray(X).astype('float32')  
y_train = np.asarray(Y).astype('float32')
```

6 Og træn med disse data

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

```
Epoch 1/200  
1/1          1s 709ms/step - loss:  
0.9824  
Epoch 2/200  
1/1          0s 35ms/step - loss:  
0.9346  
Epoch 3/200  
1/1          0s 57ms/step - loss:  
0.8884  
Epoch 4/200  
1/1          0s 90ms/step - loss:  
0.8439  
Epoch 5/200  
1/1          0s 69ms/step - loss:  
0.8010  
Epoch 6/200  
1/1          0s 58ms/step - loss:  
0.7597  
Epoch 7/200  
1/1          0s 75ms/step - loss:  
0.7200  
Epoch 8/200  
1/1          0s 77ms/step - loss:  
0.6819  
Epoch 9/200  
1/1          0s 75ms/step - loss:  
0.6455  
Epoch 10/200  
1/1          0s 71ms/step - loss:
```

```

0.6106
Epoch 11/200
1/1      0s 76ms/step - loss:
0.5772
Epoch 12/200
1/1      0s 93ms/step - loss:
0.5454
Epoch 13/200
1/1      0s 80ms/step - loss:
0.5149
Epoch 14/200
1/1      0s 73ms/step - loss:
0.4858
Epoch 15/200
1/1      0s 63ms/step - loss:
0.4580
Epoch 16/200
1/1      0s 76ms/step - loss:
0.4314
Epoch 17/200
1/1      0s 68ms/step - loss:
0.4060
Epoch 18/200
1/1      0s 73ms/step - loss:
0.3817
Epoch 19/200
1/1      0s 80ms/step - loss:
0.3585
Epoch 20/200
1/1      0s 96ms/step - loss:
0.3364
Epoch 21/200
1/1      0s 55ms/step - loss:
0.3153
Epoch 22/200
1/1      0s 73ms/step - loss:
0.2953
Epoch 23/200
1/1      0s 61ms/step - loss:
0.2763
Epoch 24/200
1/1      0s 64ms/step - loss:
0.2583
Epoch 25/200
1/1      0s 65ms/step - loss:
0.2413
Epoch 26/200
1/1      0s 68ms/step - loss:

```



```

0.2254
Epoch 27/200
1/1      0s 64ms/step - loss:
0.2104
Epoch 28/200
1/1      0s 68ms/step - loss:
0.1964
Epoch 29/200
1/1      0s 93ms/step - loss:
0.1834
Epoch 30/200
1/1      0s 85ms/step - loss:
0.1713
Epoch 31/200
1/1      0s 65ms/step - loss:
0.1601
Epoch 32/200
1/1      0s 75ms/step - loss:
0.1498
Epoch 33/200
1/1      0s 64ms/step - loss:
0.1402
Epoch 34/200
1/1      0s 86ms/step - loss:
0.1315
Epoch 35/200
1/1      0s 66ms/step - loss:
0.1235
Epoch 36/200
1/1      0s 65ms/step - loss:
0.1162
Epoch 37/200
1/1      0s 76ms/step - loss:
0.1095
Epoch 38/200
1/1      0s 64ms/step - loss:
0.1034
Epoch 39/200
1/1      0s 57ms/step - loss:
0.0979
Epoch 40/200
1/1      0s 48ms/step - loss:
0.0929
Epoch 41/200
1/1      0s 90ms/step - loss:
0.0884
Epoch 42/200
1/1      0s 56ms/step - loss:

```

```

0.0843
Epoch 43/200
1/1      0s 84ms/step - loss:
0.0807
Epoch 44/200
1/1      0s 73ms/step - loss:
0.0775
Epoch 45/200
1/1      0s 65ms/step - loss:
0.0746
Epoch 46/200
1/1      0s 64ms/step - loss:
0.0721
Epoch 47/200
1/1      0s 76ms/step - loss:
0.0699
Epoch 48/200
1/1      0s 80ms/step - loss:
0.0679
Epoch 49/200
1/1      0s 86ms/step - loss:
0.0663
Epoch 50/200
1/1      0s 64ms/step - loss:
0.0648
Epoch 51/200
1/1      0s 68ms/step - loss:
0.0636
Epoch 52/200
1/1      0s 66ms/step - loss:
0.0626
Epoch 53/200
1/1      0s 66ms/step - loss:
0.0617
Epoch 54/200
1/1      0s 61ms/step - loss:
0.0609
Epoch 55/200
1/1      0s 57ms/step - loss:
0.0603
Epoch 56/200
1/1      0s 91ms/step - loss:
0.0598
Epoch 57/200
1/1      0s 59ms/step - loss:
0.0594
Epoch 58/200
1/1      0s 64ms/step - loss:

```

```

0.0590
Epoch 59/200
1/1      0s 80ms/step - loss:
0.0587
Epoch 60/200
1/1      0s 73ms/step - loss:
0.0584
Epoch 61/200
1/1      0s 67ms/step - loss:
0.0582
Epoch 62/200
1/1      0s 65ms/step - loss:
0.0580
Epoch 63/200
1/1      0s 67ms/step - loss:
0.0579
Epoch 64/200
1/1      0s 57ms/step - loss:
0.0578
Epoch 65/200
1/1      0s 77ms/step - loss:
0.0576
Epoch 66/200
1/1      0s 64ms/step - loss:
0.0575
Epoch 67/200
1/1      0s 61ms/step - loss:
0.0574
Epoch 68/200
1/1      0s 82ms/step - loss:
0.0573
Epoch 69/200
1/1      0s 66ms/step - loss:
0.0572
Epoch 70/200
1/1      0s 67ms/step - loss:
0.0571
Epoch 71/200
1/1      0s 85ms/step - loss:
0.0570
Epoch 72/200
1/1      0s 81ms/step - loss:
0.0569
Epoch 73/200
1/1      0s 64ms/step - loss:
0.0568
Epoch 74/200
1/1      0s 54ms/step - loss:

```

```

0.0567
Epoch 75/200
1/1      0s 69ms/step - loss:
0.0565
Epoch 76/200
1/1      0s 65ms/step - loss:
0.0564
Epoch 77/200
1/1      0s 65ms/step - loss:
0.0562
Epoch 78/200
1/1      0s 64ms/step - loss:
0.0561
Epoch 79/200
1/1      0s 63ms/step - loss:
0.0559
Epoch 80/200
1/1      0s 66ms/step - loss:
0.0558
Epoch 81/200
1/1      0s 59ms/step - loss:
0.0556
Epoch 82/200
1/1      0s 56ms/step - loss:
0.0554
Epoch 83/200
1/1      0s 51ms/step - loss:
0.0553
Epoch 84/200
1/1      0s 58ms/step - loss:
0.0551
Epoch 85/200
1/1      0s 59ms/step - loss:
0.0549
Epoch 86/200
1/1      0s 68ms/step - loss:
0.0548
Epoch 87/200
1/1      0s 62ms/step - loss:
0.0546
Epoch 88/200
1/1      0s 52ms/step - loss:
0.0544
Epoch 89/200
1/1      0s 65ms/step - loss:
0.0543
Epoch 90/200
1/1      0s 56ms/step - loss:

```

```

0.0541
Epoch 91/200
1/1      0s 51ms/step - loss:
0.0539
Epoch 92/200
1/1      0s 65ms/step - loss:
0.0538
Epoch 93/200
1/1      0s 76ms/step - loss:
0.0536
Epoch 94/200
1/1      0s 81ms/step - loss:
0.0535
Epoch 95/200
1/1      0s 48ms/step - loss:
0.0533
Epoch 96/200
1/1      0s 41ms/step - loss:
0.0532
Epoch 97/200
1/1      0s 41ms/step - loss:
0.0530
Epoch 98/200
1/1      0s 95ms/step - loss:
0.0529
Epoch 99/200
1/1      0s 49ms/step - loss:
0.0527
Epoch 100/200
1/1      0s 41ms/step - loss:
0.0526
Epoch 101/200
1/1      0s 71ms/step - loss:
0.0524
Epoch 102/200
1/1      0s 64ms/step - loss:
0.0523
Epoch 103/200
1/1      0s 65ms/step - loss:
0.0521
Epoch 104/200
1/1      0s 74ms/step - loss:
0.0520
Epoch 105/200
1/1      0s 72ms/step - loss:
0.0519
Epoch 106/200
1/1      0s 66ms/step - loss:

```

```

0.0517
Epoch 107/200
1/1      0s 87ms/step - loss:
0.0516
Epoch 108/200
1/1      0s 64ms/step - loss:
0.0515
Epoch 109/200
1/1      0s 64ms/step - loss:
0.0513
Epoch 110/200
1/1      0s 40ms/step - loss:
0.0512
Epoch 111/200
1/1      0s 33ms/step - loss:
0.0511
Epoch 112/200
1/1      0s 43ms/step - loss:
0.0509
Epoch 113/200
1/1      0s 65ms/step - loss:
0.0508
Epoch 114/200
1/1      0s 58ms/step - loss:
0.0507
Epoch 115/200
1/1      0s 48ms/step - loss:
0.0505
Epoch 116/200
1/1      0s 28ms/step - loss:
0.0504
Epoch 117/200
1/1      0s 50ms/step - loss:
0.0503
Epoch 118/200
1/1      0s 40ms/step - loss:
0.0501
Epoch 119/200
1/1      0s 47ms/step - loss:
0.0500
Epoch 120/200
1/1      0s 48ms/step - loss:
0.0499
Epoch 121/200
1/1      0s 32ms/step - loss:
0.0498
Epoch 122/200
1/1      0s 29ms/step - loss:

```

```

0.0496
Epoch 123/200
1/1      0s 41ms/step - loss:
0.0495
Epoch 124/200
1/1      0s 39ms/step - loss:
0.0494
Epoch 125/200
1/1      0s 31ms/step - loss:
0.0492
Epoch 126/200
1/1      0s 38ms/step - loss:
0.0491
Epoch 127/200
1/1      0s 55ms/step - loss:
0.0490
Epoch 128/200
1/1      0s 65ms/step - loss:
0.0489
Epoch 129/200
1/1      0s 109ms/step - loss:
0.0487
Epoch 130/200
1/1      0s 56ms/step - loss:
0.0486
Epoch 131/200
1/1      0s 36ms/step - loss:
0.0485
Epoch 132/200
1/1      0s 57ms/step - loss:
0.0484
Epoch 133/200
1/1      0s 57ms/step - loss:
0.0482
Epoch 134/200
1/1      0s 68ms/step - loss:
0.0481
Epoch 135/200
1/1      0s 56ms/step - loss:
0.0480
Epoch 136/200
1/1      0s 52ms/step - loss:
0.0479
Epoch 137/200
1/1      0s 50ms/step - loss:
0.0477
Epoch 138/200
1/1      0s 33ms/step - loss:

```

```

0.0476
Epoch 139/200
1/1      0s 32ms/step - loss:
0.0475
Epoch 140/200
1/1      0s 32ms/step - loss:
0.0474
Epoch 141/200
1/1      0s 40ms/step - loss:
0.0473
Epoch 142/200
1/1      0s 51ms/step - loss:
0.0471
Epoch 143/200
1/1      0s 76ms/step - loss:
0.0470
Epoch 144/200
1/1      0s 65ms/step - loss:
0.0469
Epoch 145/200
1/1      0s 66ms/step - loss:
0.0468
Epoch 146/200
1/1      0s 48ms/step - loss:
0.0466
Epoch 147/200
1/1      0s 65ms/step - loss:
0.0465
Epoch 148/200
1/1      0s 60ms/step - loss:
0.0464
Epoch 149/200
1/1      0s 40ms/step - loss:
0.0463
Epoch 150/200
1/1      0s 44ms/step - loss:
0.0462
Epoch 151/200
1/1      0s 32ms/step - loss:
0.0461
Epoch 152/200
1/1      0s 32ms/step - loss:
0.0459
Epoch 153/200
1/1      0s 55ms/step - loss:
0.0458
Epoch 154/200
1/1      0s 48ms/step - loss:

```



```

0.0457
Epoch 155/200
1/1      0s 44ms/step - loss:
0.0456
Epoch 156/200
1/1      0s 92ms/step - loss:
0.0455
Epoch 157/200
1/1      0s 41ms/step - loss:
0.0453
Epoch 158/200
1/1      0s 48ms/step - loss:
0.0452
Epoch 159/200
1/1      0s 44ms/step - loss:
0.0451
Epoch 160/200
1/1      0s 32ms/step - loss:
0.0450
Epoch 161/200
1/1      0s 32ms/step - loss:
0.0449
Epoch 162/200
1/1      0s 36ms/step - loss:
0.0448
Epoch 163/200
1/1      0s 34ms/step - loss:
0.0446
Epoch 164/200
1/1      0s 33ms/step - loss:
0.0445
Epoch 165/200
1/1      0s 32ms/step - loss:
0.0444
Epoch 166/200
1/1      0s 40ms/step - loss:
0.0443
Epoch 167/200
1/1      0s 32ms/step - loss:
0.0442
Epoch 168/200
1/1      0s 40ms/step - loss:
0.0441
Epoch 169/200
1/1      0s 36ms/step - loss:
0.0440
Epoch 170/200
1/1      0s 32ms/step - loss:

```

```

0.0438
Epoch 171/200
1/1      0s 40ms/step - loss:
0.0437
Epoch 172/200
1/1      0s 35ms/step - loss:
0.0436
Epoch 173/200
1/1      0s 32ms/step - loss:
0.0435
Epoch 174/200
1/1      0s 32ms/step - loss:
0.0434
Epoch 175/200
1/1      0s 40ms/step - loss:
0.0433
Epoch 176/200
1/1      0s 32ms/step - loss:
0.0432
Epoch 177/200
1/1      0s 49ms/step - loss:
0.0431
Epoch 178/200
1/1      0s 40ms/step - loss:
0.0429
Epoch 179/200
1/1      0s 104ms/step - loss:
0.0428
Epoch 180/200
1/1      0s 41ms/step - loss:
0.0427
Epoch 181/200
1/1      0s 49ms/step - loss:
0.0426
Epoch 182/200
1/1      0s 54ms/step - loss:
0.0425
Epoch 183/200
1/1      0s 56ms/step - loss:
0.0424
Epoch 184/200
1/1      0s 57ms/step - loss:
0.0423
Epoch 185/200
1/1      0s 36ms/step - loss:
0.0422
Epoch 186/200
1/1      0s 56ms/step - loss:

```

```
0.0421
Epoch 187/200
1/1      0s 57ms/step - loss:
0.0419
Epoch 188/200
1/1      0s 26ms/step - loss:
0.0418
Epoch 189/200
1/1      0s 33ms/step - loss:
0.0417
Epoch 190/200
1/1      0s 33ms/step - loss:
0.0416
Epoch 191/200
1/1      0s 34ms/step - loss:
0.0415
Epoch 192/200
1/1      0s 33ms/step - loss:
0.0414
Epoch 193/200
1/1      0s 33ms/step - loss:
0.0413
Epoch 194/200
1/1      0s 40ms/step - loss:
0.0412
Epoch 195/200
1/1      0s 34ms/step - loss:
0.0411
Epoch 196/200
1/1      0s 32ms/step - loss:
0.0410
Epoch 197/200
1/1      0s 32ms/step - loss:
0.0409
Epoch 198/200
1/1      0s 32ms/step - loss:
0.0408
Epoch 199/200
1/1      0s 100ms/step - loss:
0.0406
Epoch 200/200
1/1      0s 46ms/step - loss:
0.0405
```

[49]: <keras.src.callbacks.history.History at 0x1f285d0a730>

7 plot resultatet

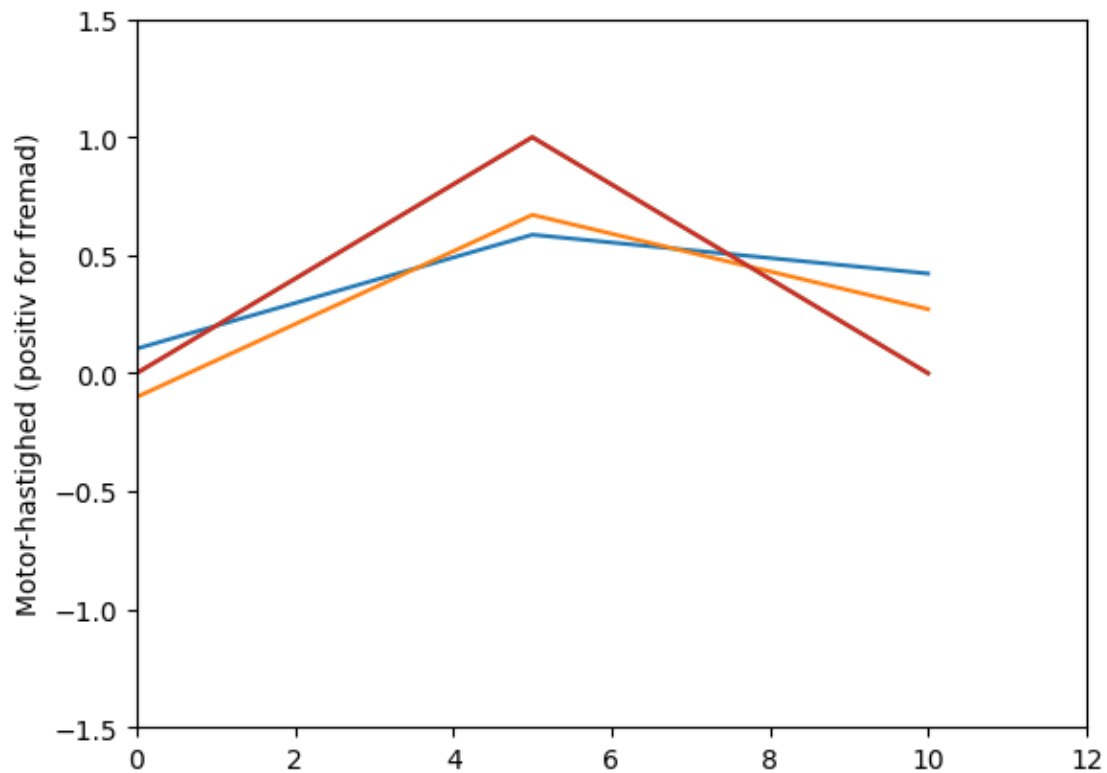
```
[51]: import matplotlib.pyplot as plt

test_afstand = pd.Series([0,5,10])  # x-aksen (lineær op til 20)

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(Y)                          # Y er træningsdata for output (rød og grøn)
plt.ylabel('Motor-hastighed (positiv for fremad)')
plt.axis((0, 12, -1.5, 1.5))
plt.show()
```

1/1

0s 49ms/step

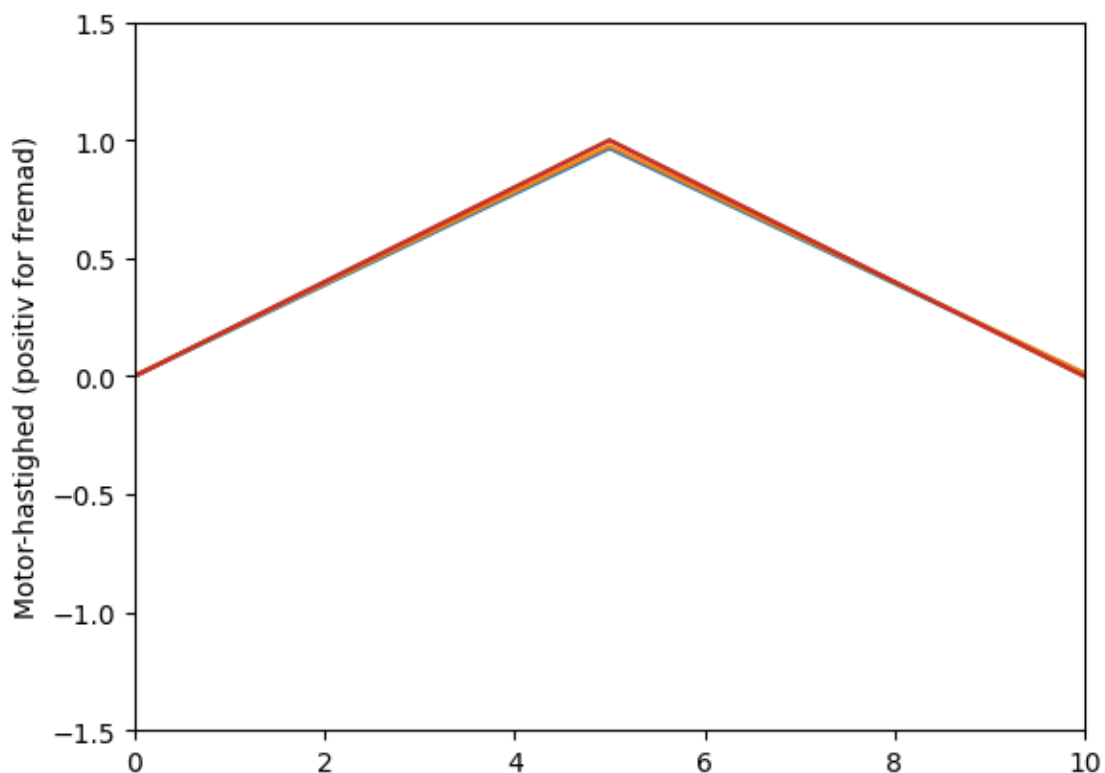


8 mere træning, og plot

```
[52]: model.fit(X_train, y_train, epochs=7000, batch_size=30, 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(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 24ms/step



```
[55]: a = model.predict(np.array([5,11]))
```

WARNING:tensorflow:6 out of the last 16 calls to <function TensorFlowTrainer.make_predict_function.<locals>.one_step_on_data_distributed at 0x000001F285C6DAF0> triggered tf.function retracing. Tracing is expensive and the excessive number of tracings could be due to (1) creating @tf.function repeatedly in a loop, (2) passing tensors with different shapes, (3) passing Python objects instead of tensors. For (1), please define your @tf.function outside of the loop. For (2), @tf.function has reduce_retracing=True option that

can avoid unnecessary retracing. For (3), please refer to
https://www.tensorflow.org/guide/function#controlling_retracing and
https://www.tensorflow.org/api_docs/python/tf/function for more details.
1/1 0s 66ms/step

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

```
[[ 0.9657984  0.97625846]
 [-0.13744454 -0.14670902]]
```

```
[ ]:
```