Basic Statistical Analysis

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Environment Settings

- A rectangle area is used whose dimension is 2 x 1.5 meters.
- A custom robot similar to an e-puck was used.
- The robot starts in the middle of the arena (Coordinates x= 1.00, y = 0.75, theta = 180).
- The robot moves in a random fashion way around the environment avoiding obstacles.
  - With probability p=0.01 it decides to turn to the left or to the right.
  - To decide the angle to the turn it selects a random angle between 1 and 30.
- The robot has 8 sensors that measure the distance between the robot and the walls.
- The simulator runs during 10 minutes in fast mode which is translated to around 12 hours of collected data.

About the experiments

- The coordinates of the robot (x, y, θ) and the sensor measurements $(s_1, s_2, \ldots, s_8)$
- Two datasets were collected: one with small noise in the sensor measurement and the other one with bigger noise.
- Some noise was introduced in the sensors measurements of the robot using the concept of lookup tables.
    - The first column of the table specifies the input distances.
    - The second column specifies the corresponding desired response values.
    - The third column indicates the desired standard deviation of the noise.
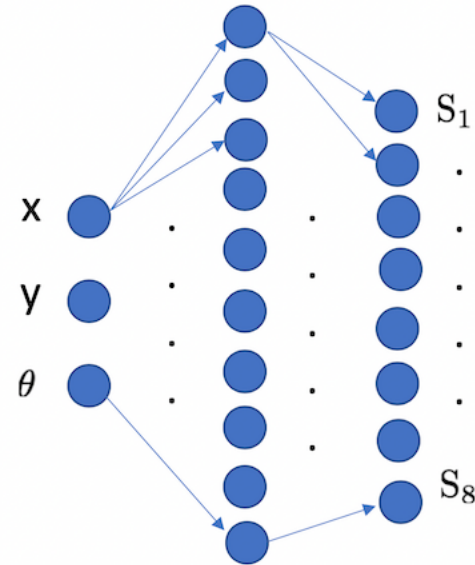- First experiment:

0	0	0.01
10	10	0.01

- Second experiment:

| 0	0	0.2
10	10	0.2

About the experiments

- Two models were fitted:
  - Random forest
    - Number of estimators: 5
    - Criterion: MSE
  - Neural Network
    - Activation of hidden layer: Relu.
    - Optimization: RMSprop
    - Loss: MSE
    - Metrics= MSE
    - Kfold = 5
    - Number of Epochs = 50

About the experiments

- First experiment:
  - 830 908 samples used for training
  - 276 969 samples used for testing

- Second experiment:
  - 444 000 samples used for training
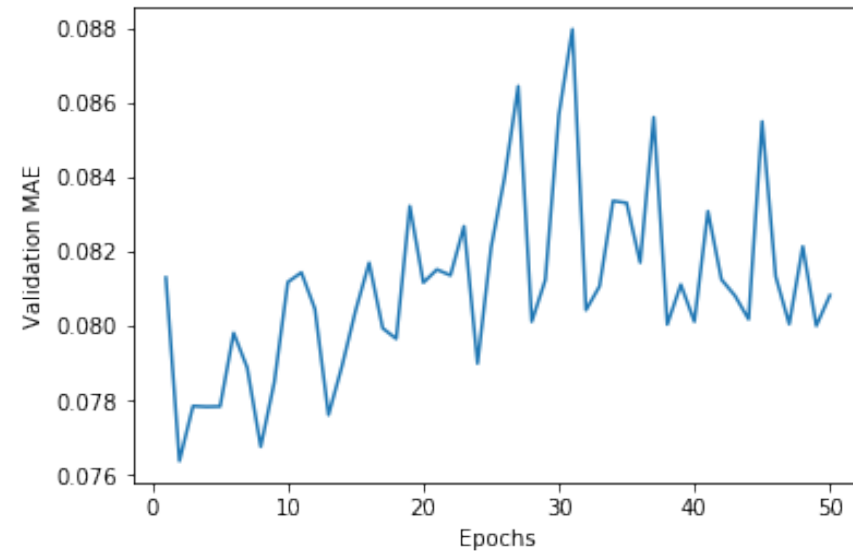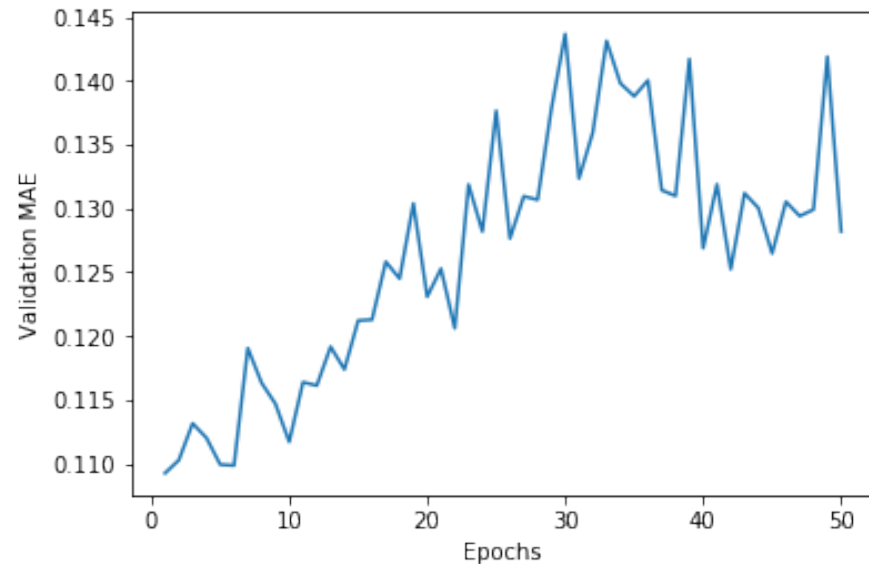 - 222 000 samples used for testing

Robot position estimation
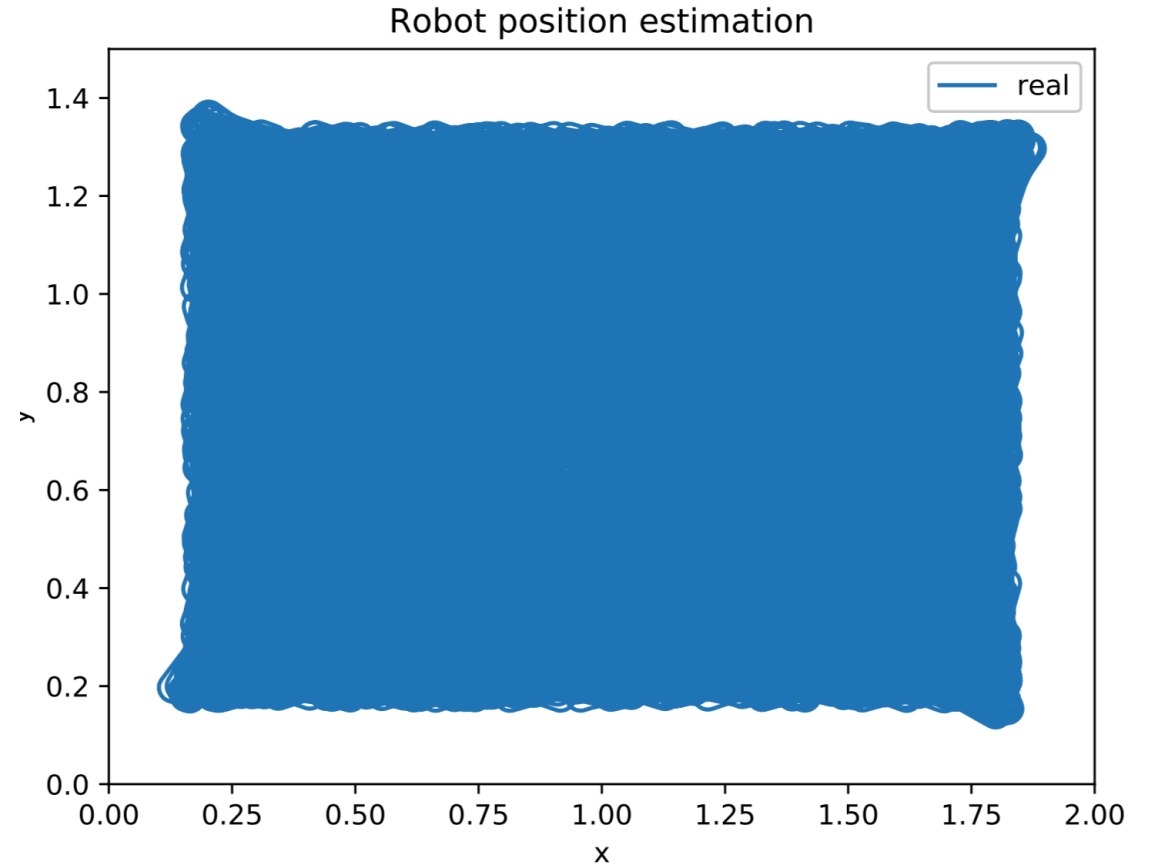
Results: Random Forest

	FIRST EXPERIMENT	SECOND EXPERIMENT
Feature Importance	x: 0.278818 y: 0.267225 θ: 0.453957	x: 0.294433 y: 0.231119 θ: 0.474448
R^2 score	0.99904	0.79538
Mean Absolute Error	0.00448	0.04404
Normalized Mean Square Error	0.00097	0.20584

$$NMSE = \frac{\sum_{i=1}^{N}(y_i - \widehat{y_i})}{N \, Var(Y)}$$

Results: Neural Network

	FIRST EXPERIMENT	SECOND EXPERIMENT
Normalized Mean Square Error	0.56075	0.56616

$$NMSE = \frac{\sum_{i=1}^{N}(y_i - \widehat{y_i})}{N\,Var(Y)}$$