1 Exercise *(k-nearest Neighbor (4p))*

Mrs.A who studies Cognitive Science is looking for a T-shirt for her boyfriend, whose weight is about 80 kg and 177 cm tall. Please help her to find the right T-shirt size using simple k-Nearest Neighbor and Euclidean distance. To be certain, pick k=1,3 and 5.

Distances of $x = (177, 80)$ to each other data point:

$$
\begin{aligned}
d(x, x_1) &= \sqrt{(177-188)^2 + (80-100)^2} &&= \sqrt{521} = 22.8254 \\
d(x, x_2) &= \sqrt{(177-178)^2 + (80-108)^2} &&= \sqrt{785} = 28.0178 \\
d(x, x_3) &= \sqrt{(177-170)^2 + (80-50)^2} &&= \sqrt{949} = 30.8058 \\
d(x, x_4) &= \sqrt{(177-180)^2 + (80-86)^2} &&= 3\sqrt{5} = 6.7082 \\
d(x, x_5) &= \sqrt{(177-193)^2 + (80-70)^2} &&= 2\sqrt{89} = 18.868 \\
d(x, x_6) &= \sqrt{(177-182)^2 + (80-61)^2} &&= \sqrt{386} = 19.6469 \\
d(x, x_7) &= \sqrt{(177-187)^2 + (80-70)^2} &&= 10\sqrt{2} = 14.1421 \\
d(x, x_8) &= \sqrt{(177-173)^2 + (80-93)^2} &&= \sqrt{185} = 13.6015 \\
d(x, x_9) &= \sqrt{(177-172)^2 + (80-80)^2} &&= 5 \\
d(x, x_{10}) &= \sqrt{(177-185)^2 + (80-92)^2} &&= 4\sqrt{13} = 14.4222 \\
d(x, x_{11}) &= \sqrt{(177-174)^2 + (80-80)^2} &&= 3 \\
d(x, x_{12}) &= \sqrt{(177-174)^2 + (80-70)^2} &&= \sqrt{109} = 10.4403
\end{aligned}
$$

Since we are dealing with discrete valued output, we take the target value that occurs most often among the k nearest neighbors as the target value for x.

- $k = 1$-nearest neighbors:
  $x_{11} = (174, 80), t_{11} = XL$
  Choose $t = XL$.

- $k = 3$-nearest neighbors:
  $x_{11} = (174, 80), t_{11} = XL$
  $x_9 = (172, 80), t_9 = XL$
  $x_4 = (180, 86), t_4 = M/L$
  Choose $t = XL$.

- $k = 5$-nearest neighbors:
  $x_{11} = (174, 80), t_{11} = XL$
  $x_9 = (172, 80), t_9 = XL$

$x_4 = (180, 86), t_4 = M/L$
$x_{12} = (174, 70), t_{12} = M/L$
$x_8 = (173, 93), t_8 = XL$
Choose $t = XL$.

2 Exercise *(RBF (8p))*

1. Discuss RBF network and MLP in different aspects e.g. input and output dimension, extrapolation, lesion tolerance and advantages of each network.

2. The training of RBF network concerns three parts. The first step is to find suitable centers or input weights, ξ. Explain in detail how to find these input weights.

3. Write down another basis function which has the property $\Phi(r) \to 0$ as $|r| \to \infty$ and one example a of basis function which has property: $\Phi(r) \to \infty$ as $|r| \to \infty$.

3 Exercise *(SOM (8p))*

1. Explain

   (a) the meaning of topology preservation:

   (b) the properties of the topology function:

   (c) measuring similarity in SOM:

2. How to avoid that the later training phases forcefully pull the entire map towards a new pattern?

3. Briefly discuss at least three applications of SOM in different aspects.