Homework-2

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CS 6375 - Machine Learning

(1) given, $x = 4.2$

$x = 4$ is the nearest sample from the training data.

Therefore, the test sample with $x = 4.2$ is classified into

label B.

(2) According to 2-NN

$x_i = 4.2$

$x = 4, \quad |x_i - x_i| = 0.2$

$x = 5 \quad |x - x_i| = 0.8$

As They are the closest two neighbors, according to the distances the $x = 4.2$ has **label = B.**

(3) $x = 4.2$, 3NN.

Using the euclidean norm.

$x = 3, \quad |3 - 4.2| = 1.2$

$x = 4, \quad |4 - 4.2| = 0.2$

$x = 5, \quad |5 - 4.2| = 0.8$

$x = 6, \quad |6 - 4.2| = 1.8$

The closest neighbors are $x = 3, 4, 5$, There are two labels with A and one B. Therefore, for $x = 4.2$, **label is A.**

(4) Estimating error for 1-NN by leave-one-out cross validation.

given ~~for~~ Leaving out $x = 0$

The closest neighbor to $x = 0$ is $x = 1$, label A

classification of $x = 0$ is A.

Leaving out $x = 1$

The closest neighbors $x = 1, 2$

classification of $x = 1$ is A

Leaving out $x = 2$

The closest neighbor is $x = 1, 3$

classification of 2 is A.

Leaving out $x = 3$

The closest neighbor is $x = 2, 4$

classification of $x = 3$ is B which is error

Leaving out $x = 4$

The closest neighbor is $x = 3, 5$

classification of $x = 4$ is A which is an error

Leaving out $x = 5$

closest neighbors is $x = 4, 6$

classification of $x = 5$ is B which is an error

Leaving out $x = 6$

closest neighbor is $x = 5, 7$

classification A.

Leaving out $x = 7$

closest neighbor $x = 6, 8$

classification A

Leaving out $x = 8$

closest neighbors x = 7, 9.
classification B · It is an error.

Leaving out x = 9

closest neighbors · x = 8, 10
classification A · It is an error.

Leaving out x = 10

closest neighbor x = 9, 11
classification B.

Leaving out x = 11

closest neighbor x = 10, 12
classification B.

Leaving out x = 12

closest neighbor x = 11, 13
classification A. It is an error

Leaving out x = 13

closest neighbor x = 12, 14
classification B. It is an error.

Leaving out x = 14

closest neighbor x = 13, 15
classification A. It is an error.

Leaving out x = 15

closest neighbor x = 14, 16
classification. B.

Leaving out x = 16

closest neighbor = 15, 17.
classification B

Leaving out x = 17

closest neighbor = 16
classification B.

Estimation of error = $\frac{8}{18}$

(5) Leave one out cross validation for 2NN

Leave x : 0

closest neighbors x = 1, 2

classification A

Leave x = 1

closesest neighbors x = 0, 2

classification A

Leave x = 2

closest neighbors x = 1, 3.

classification A.

Leave x = 3

closest neighbors x = 2, 4

classification : B. It is an error

Leave x = 4

closest neighbors x = 3, 5

classification A. It is an error

Leave x = 5

closest neighburs x = 4, 6

classification B It is an error.

Leave x = 6

closest neighbors x = 5, 7

classification A.

Leave x = 7

closest neighbors x = 6, 8

classification A.

Leave x = 8

closest neighbors x = 7, 9 classification B. It is an error

Leave x : 9

closest neighbors x : 8, 10 · classification B. It is an error.

Leave x : 10

closest neighbors x : 9, 11 · classification B.

Leave x : 11

closest neighbors x : 10, 12 · classification B.

Leave x : 12

closest neighbors x : 11, 13 classification A. It is an error.

Leave x : 13

closest neighbors x : 12, 14 . classification B · It is an error

Leave x : 14

closest neighbors x : 13, 15 · classification A . It is an error

Leave x : 15

closest neighbors x : 14, 16 . classification B

Leave x : 16

classification B

Leave x : 17

closest neighbors x : 15, K

classification B

No. of errors : $\frac{8}{18}$

(6) For a 3-NN.

Leave x : 9

closest neighbors : 1, 2, 3

classification : A.

Leave x=1

closest neighbors = 0, 2 3

classification = A.

Leave x=2

closest neighbor 0, 1, 3, 4

Since 0, 4 are equally distant. Taking 4 so error is maximized

classification: A.

Leave 3

closest neighbor 2, 4, 1, 5

classification A.

Leave out x=4

Neighbors: 3, 5, 2

classification A. It is an error

Leave out x=5

Naghbors: 4, 6, 3

classification: A.

Leave x=6

Neighbors 5, 7, 4

classification A.

Leave x=7

Neighbors. 6, 8, 9

classification A.

Leave x=8

Neighbor. 7, 9, 10

classification B. It is an error.

Leave x=9

Neighbors = 8, 10, 7

classification A. It is an error.

Leave x=10

Neighbors. 9, 11, 8. classification B

Leave out x=11

Neighbors: 10, 12, 13 · classification B.

Leave out x=12

Neighbors · 11, 13, 14 · classification B.

Leave out x=13

Neighbors · 12, 14, 11 · classification B · it is an error

Leave out x=14

Neighbors : 13, 15, 12 classification B.

Leave out x=15

Neighbors : 14, 16, 13 · classification B.

Leave out x=16

Neighbors · 15, 17, 14 · classification B

Leave out x=17

Neighbors 14, 15, 16 · classification B.

Estimation of error = $\frac{4}{18}$

(4) 4-NN

Leave out x=0

Neighbors : 1, 2, 3, 4 · classification : A

Leave out x=1

Neighbors · 0, 2, 3, 4 classification A

Leave out x=2

classification A

Leave out x=3

classification A.

Leave out x=4

Neighbors : 3, 5, 6, 2 . classification A/B. It is an error

Leave out x=5

Neighbors : 4, 6, 7, 3 · classification A

Leave out x=6

Neighbors : 5, 7, 8, 4. classification D

Leave out x=7

Neighbors : 6, 8, 9, 5 classification D.

Leave out x=8

Neighbors : 7, 9, 10, 6 · classification B. It is an error

Leave out x=9

Neighbors : 8, 10, 7, 11 · classification A . It is an error.

Leave out x=10

Neighbors : 9, 11, 12, 8 · classification B

Leave out x=11

Neighbors : 10, 12, 9, 13 · classification B.

Leave out x=12

Neighbors : 11, 13, 14, 10. classification B

Leave out x=13

Neighbors : 12, 14, 11, 15 classification : B . It's an error

Leave out x=14

Neighbors : 13, 15, 16, 12 · classification B

Leave out x=15

Neighbors : 14, 16, 13, 17 classification B.

Leave out $x = 16$

classification B

Leave out $x = 17$

classification B.

Estimated error $\frac{4}{18}$

(8) 17-NN

Leave out x=0

classification B. Its an error.

Leave out x=1

classification B. Its an error

Leave out x=2

classification . B . Its an error

Leave out x=3

classification B. Its an error.

Leave out x=4

classification A Its an error

Leave out x=5

classification B . Its an error.

Leave out x=6

Classification B Its an error

Its the same case for x=7 to x=17

∴ Estimated error = $\frac{18}{18}$