# KNN Numerical Example (hand computation)

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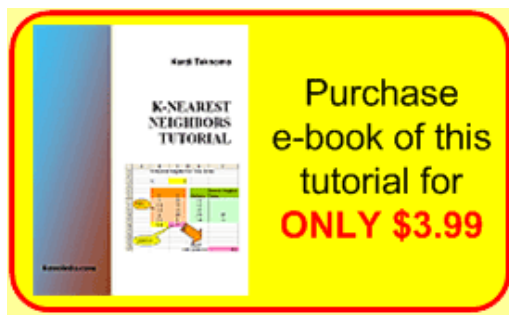
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## Numerical Exampe of K Nearest Neighbor Algorithm

Here is step by step on how to compute K-nearest neighbors KNN algorithm:

1. Determine parameter K = number of nearest neighbors
2. Calculate the distance between the query-instance and all the training samples

3. Sort the distance and determine nearest neighbors based on the K-th minimum distance
4. Gather the category $Y$ of the nearest neighbors
5. Use simple majority of the category of nearest neighbors as the prediction value of the query instance

We will use again the previous example (https://people.revoledu.com/kardi/tutorial/KNN/WhatisKNN.html) to calculate KNN by hand computation. If you want to download the MS excel companion of this tutorial, click here (https://people.revoledu.com/kardi/tutorial/KNN/purchase.html)

**Example**

We have data from the questionnaires survey (to ask people opinion) and objective testing with two attributes (acid durability and strength) to classify whether a special paper tissue is good or not. Here is four training samples

| X1 = Acid Durability (seconds) | X2 = Strength (kg/square meter) | Y = Classification |
|---|---|---|
| 7 | 7 | Bad |
| 7 | 4 | Bad |
| 3 | 4 | Good |
| 1 | 4 | Good |

Now the factory produces a new paper tissue that pass laboratory test with X1 = 3 and X2 = 7. Without another expensive survey, can we guess what the classification of this new tissue is?

*1. Determine parameter K = number of nearest neighbors*

Suppose use K = 3

*2. Calculate the distance between the query-instance and all the training samples*

Coordinate of query instance is (3, 7), instead of calculating the distance we compute square distance which is faster to calculate (without square root)

| X1 = Acid Durability (seconds) | X2 = Strength (kg/square meter) | **Square Distance to query instance (3, 7)** |
|---|---|---|
| 7 | 7 | $(7-3)^2 + (7-7)^2 = 16$ |
| 7 | 4 | $(7-3)^2 + (4-7)^2 = 25$ |
| 3 | 4 | $(3-3)^2 + (4-7)^2 = 9$ |
| 1 | 4 | $(1-3)^2 + (4-7)^2 = 13$ |

*3. Sort the distance and determine nearest neighbors based on the K-th minimum distance*

| X1 = Acid Durability (seconds) | X2 = Strength (kg/square meter) | Square Distance to query instance (3, 7) | Rank minimum distance | Is it included in 3-Nearest neighbors? |
|---|---|---|---|---|
| 7 | 7 | $(7-3)^2+(7-7)^2=16$ | 3 | **Yes** |
| 7 | 4 | $(7-3)^2+(4-7)^2=25$ | 4 | **No** |
| 3 | 4 | $(3-3)^2+(4-7)^2=9$ | 1 | **Yes** |
| 1 | 4 | $(1-3)^2+(4-7)^2=13$ | 2 | **Yes** |

*4. Gather the category $Y$ of the nearest neighbors.* Notice in the second row last column that the category of nearest neighbor (Y) is not included because the rank of this data is more than 3 (=K).

| X1 = Acid Durability (seconds) | X2 = Strength (kg/square meter) | Square Distance to query instance (3, 7) | Rank minimum distance | Is it included in 3-Nearest neighbors? | **Y = Category of nearest Neighbor** |
|---|---|---|---|---|---|
| 7 | 7 | $(7-3)^2+(7-7)^2=16$ | 3 | Yes | **Bad** |
| 7 | 4 | $(7-3)^2+(4-7)^2=25$ | 4 | No | **-** |
| 3 | 4 | $(3-3)^2+(4-7)^2=9$ | 1 | Yes | **Good** |
| 1 | 4 | $(1-3)^2+(4-7)^2=13$ | 2 | Yes | **Good** |

*5. Use simple majority of the category of nearest neighbors as the prediction value of the query instance*

We have 2 good and 1 bad, since 2>1 then we conclude that a new paper tissue that pass laboratory test with X1 = 3 and X2 = 7 is included in **Good** category.

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**Preferable reference for this tutorial is**

Teknomo, Kardi. K-Nearest Neighbors Tutorial. https:\\people.revoledu.com\kardi\tutorial\KNN\