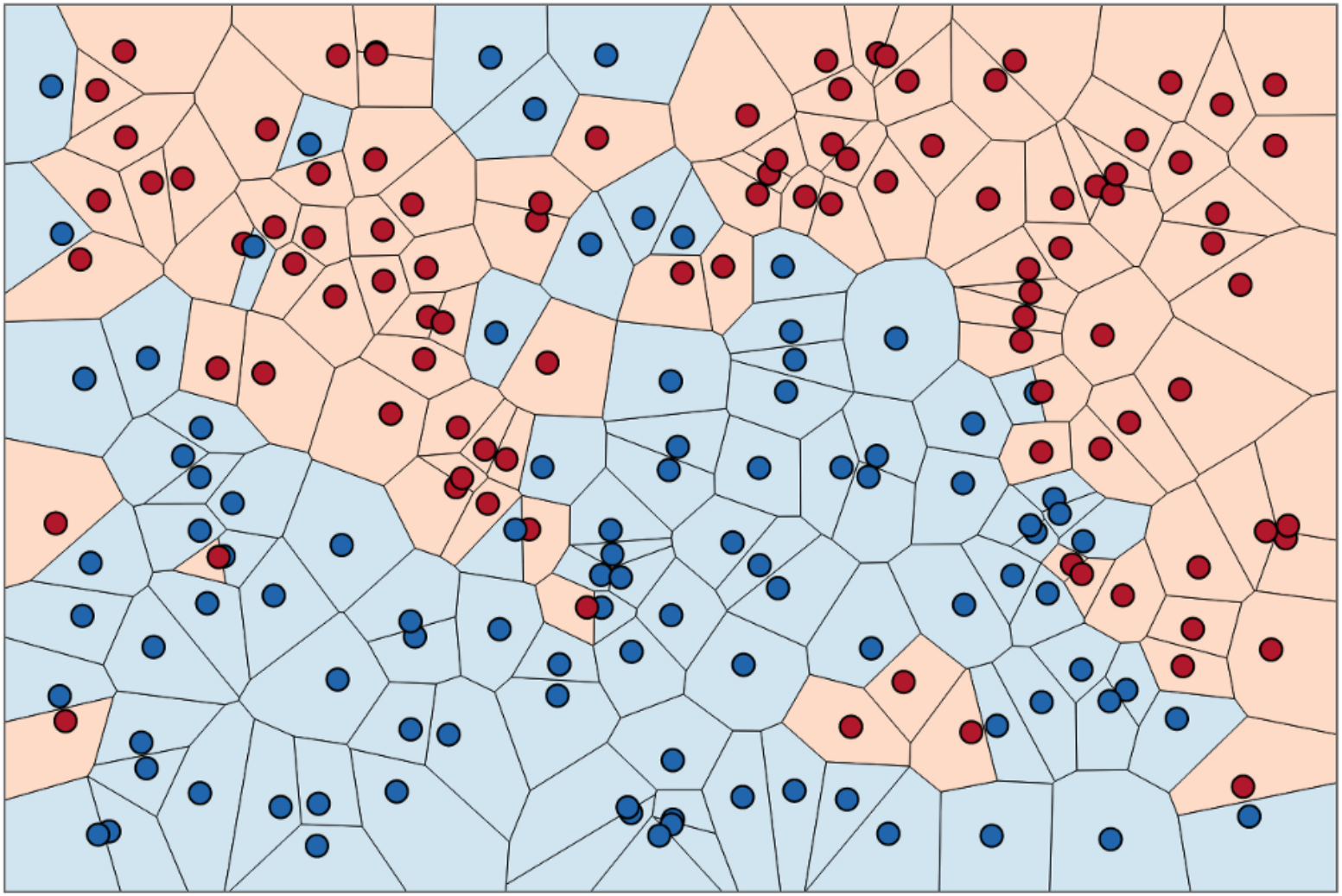
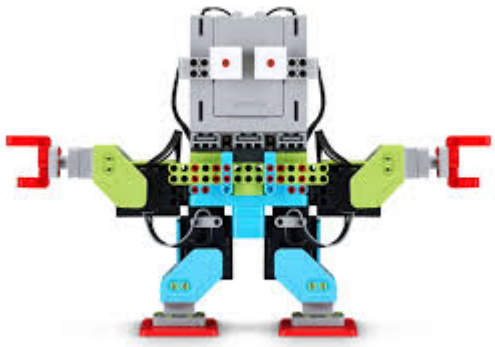


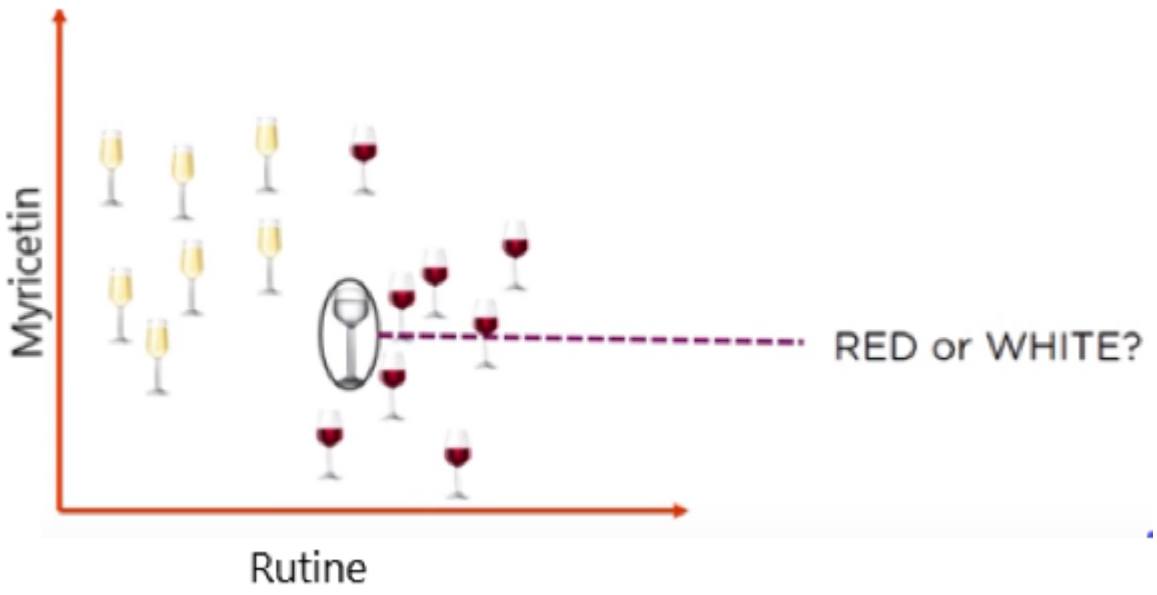
What is KNN?



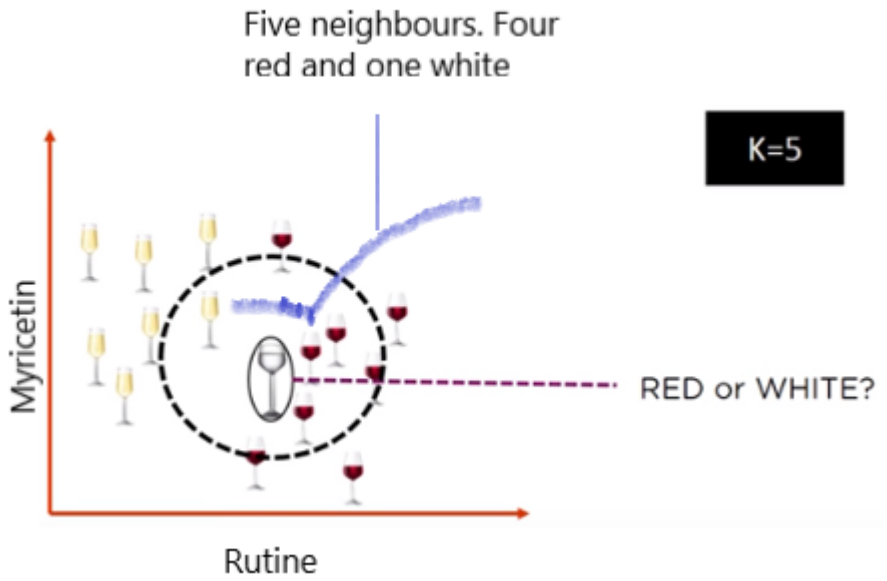
k-Nearest-Neighbor (k-NN) rule is a model-free data mining method that determines the categories based on majority vote.

K Nearest Neighbour is a simple algorithm that stores all the available cases and classifies the new data or case based on a similarity measure. It is mostly used to classifies a data point based on how its neighbours are classified.
Let's take below wine example. Two chemical components called Rutime and Myricetin. Consider a measurement of Rutine vs Myricetin level with two data points, Red and White wines. They have tested and where then fall on that graph based on how much Rutine and how much Myricetin chemical content present in the wines.

'k' in KNN is a parameter that refers to the number of nearest neighbours to include in the majority of the voting process. Suppose, if we add a new glass of wine in the dataset. We would like to know whether the new wine is red or white?



So, we need to find out what the neighbours are in this case. Let's say k = 5 and the new data point is classified by the majority of votes from its five neighbours and the new point would be classified as red since four out of five neighbours are red.



How shall I choose the value of 'k' in KNN Algorithm?

‘k’ in KNN algorithm is based on feature similarity choosing the right value of K is a process called parameter tuning and is important for better accuracy. Finding the value of k is not easy.

Few ideas on picking a value for ‘K’

1) Firstly, there is no physical or biological way to determine the best value for “K”, so we have to try out a few values before settling on one. We can do this by pretending part of the training data is “unknown”

2) Small values for K can be noisy and subject to the effects of outliers.

3) Larger values of K will have smoother decision boundaries which mean lower variance but increased bias.

4) Another way to choose K is though cross-validation. One way to select the cross-validation dataset from the training dataset. Take the small portion from the training dataset and call it a validation dataset, and then use the same to evaluate different possible values of K. This way we are going to predict the label for every instance in the validation set using with K equals to 1, K equals to 2, K

equals to 3.. and then we look at what value of K gives us the best performance on the validation set and then we can take that value and use that as the final set of our algorithm so we are minimizing the validation error.

5) In general, practice, choosing the value of **k** is **k = sqrt(N)** where **N** stands for the **number of samples in your training dataset**.

6) Try and keep the value of k odd in order to avoid confusion between two classes of data

How does KNN Algorithm works?

In the classification setting, the K-nearest neighbor algorithm essentially boils down to forming a majority vote between the K most similar instances to a given “unseen” observation. Similarity is defined according to a distance metric between two data points. A popular one is the Euclidean distance method

Euclidean $\sqrt{\sum_{i=1}^{k}(x_i - y_i)^2}$

Hamming distance is basically the number of locations where categorical variables differ.
Suppose the number of features measured on each experimental unit is 7.
The Hamming distance between:
10**1**1**1**01 and 1001001 is 2.
2**1**7**3**896 and 2233796 is 3.

> Other methods are *Manhattan, Minkowski, and Hamming distance* methods. *For categorical variables, the hamming distance must be used.*

Let’s take a small example. Age vs loan.

Customer	Age	Loan	Default
John	25	40000	N
Smith	35	60000	N
Alex	45	80000	N
Jade	20	20000	N
Kate	35	120000	N
Mark	52	18000	N
Anil	23	95000	Y
Pat	40	62000	Y
George	60	100000	Y
Jim	48	220000	Y
Jack	33	150000	Y
Andrew	48	142000	?

We need to predict Andrew default status by using Euclidean distance

We need to predict Andrew default status (Yes or No).

Customer	Age	Loan	Default	Euclidean distance
John	25	40000	N	1,02,000.00
Smith	35	60000	N	82,000.00
Alex	45	80000	N	62,000.00
Jade	20	20000	N	1,22,000.00
Kate	35	120000	N	22,000.00
Mark	52	18000	N	1,24,000.00
Anil	23	95000	Y	47,000.01
Pat	40	62000	Y	80,000.00
George	60	100000	Y	42,000.00
Jim	48	220000	Y	78,000.00
Jack	33	150000	Y	8,000.01
Andrew	**48**	**142000**	**?**	

First Step calculate the Euclidean distance dist(d) = Sq.rt $(x_1-y_1)^2 + (x_2-y_2)^2$
= Sq.rt$(48-25)^2 + (142000-40000)^2$
dist (d_1) = 1,02,000.

We need to calcuate the distance for all the datapoints

Calculate Euclidean distance for all the data points.

Customer	Age	Loan	Default	Euclidean distance	Minimum Euclidean Distance
John	25	40000	N	1,02,000.00	
Smith	35	60000	N	82,000.00	
Alex	**45**	**80000**	**N**	**62,000.00**	**5**
Jade	20	20000	N	1,22,000.00	
Kate	**35**	**120000**	**N**	**22,000.00**	**2**
Mark	52	18000	N	1,24,000.00	
Anil	**23**	**95000**	**Y**	**47,000.01**	**4**
Pat	40	62000	Y	80,000.00	
George	**60**	**100000**	**Y**	**42,000.00**	**3**
Jim	48	220000	Y	78,000.00	
Jack	**33**	**150000**	**Y**	**8,000.01**	**1**
Andrew	48	142000	?		

Let assume K = 5

Find minimum euclidean distance and rank in order (ascending)

In this case, 5 minimum euclidean distance. With k=5, there are two Default = N and three Default = Y out of five closest neighbors.

We can say Andrew default stauts is 'Y' (Yes)

With K=5, there are two Default=N and three Default=Y out of five closest neighbors. We can say default status for Andrew is 'Y' based on the major similarity of 3 points out of 5. (I am assuming K=5 only for example purpose here, since 5 is odd number)

> K-NN is also a lazy learner because it doesn't learn a discriminative function from the training data but "memorizes" the training dataset instead.

Pros of KNN

1. Simple to implement
2. Flexible to feature/distance choices
3. Naturally handles multi-class cases
4. Can do well in practice with enough representative data

Cons of KNN

1. Need to determine the value of parameter K (number of nearest neighbors)
2. Computation cost is quite high because we need to compute the distance of each query instance to all training samples.
3. Storage of data
4. Must know we have a meaningful distance function.

If you find any mistakes or improvements required, please feel free to comment below.

Reference:
https://stackoverflow.com/questions/11568897/value-of-k-in-k-nearest-neighbor-algorithm