Machine Learning Algorithms

kNN

Goal

In this chapter, we will understand the concepts of k-Nearest Neighbour (kNN) algorithm.

Theory

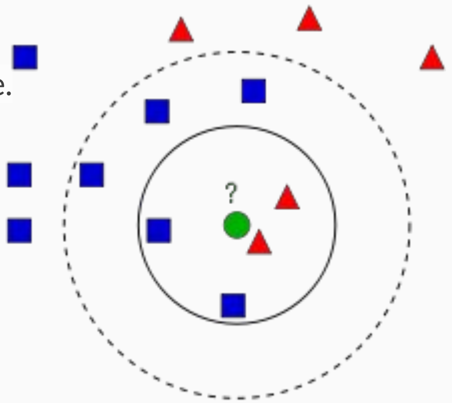
kNN is one of the simplest of classification algorithms available for supervised learning. The idea is to search for closest match of the test data in feature space. We will look into it with below image.

In the image, there are two families, Blue Squares and Red Triangles. We call each family as **Class**. Their houses are shown in their town map which we call feature space. *(You can consider a feature space as a space where all datas are projected. For example, consider a 2D coordinate space. Each data has two features, x and y coordinates. You can represent this data in your 2D coordinate space, right? Now imagine if there are three features, you need 3D space. Now consider N features, where you need N-dimensional space, right? This N-dimensional space is its feature space. In our image, you can consider it as a 2D case with two features).*

Now a new member comes into the town and creates a new home, which is shown as green circle.

He should be added to one of these Blue/Red families. We call that process, **Classification**.

What we do? Since we are dealing with kNN, let us apply this algorithm.



One method is to check who is his nearest neighbour. From the image, it is clear it is the Red Triangle family. So he is also added into Red Triangle. This method is called simply **Nearest Neighbour**, because classification depends only on the nearest neighbour.

But there is a problem with that. Red Triangle may be the nearest. But what if there are lot of Blue Squares near to him? Then Blue Squares have more strength in that locality than Red Triangle. So just checking nearest one is not sufficient. Instead we check some k nearest families. Then whoever is majority in them, the new guy belongs to that family. In our image, let's take k=3, ie 3 nearest families. He has two Red and one Blue (there are two Blues equidistant, but since k=3, we take only one of them), so again he should be added to Red family. But what if we take k=7? Then he has 5 Blue families and 2 Red families. Great!! Now he should be added to Blue family. So it all changes with value of k. More funny thing is, what if k = 4? He has 2 Red and 2 Blue neighbours. It is a tie !!! So better take k as an odd number. So this method is called **k-Nearest Neighbour** since classification depends on k nearest neighbours.

Again, in kNN, it is true we are considering k neighbours, but we are giving equal importance to all, right? Is it justice? For example, take the case of k=4. We told it is a tie. But see, the 2 Red families are more closer to him than the other 2 Blue families. So he is more eligible to be added to Red. So how do we mathematically explain that? We give some weights to each family depending on their distance to the new-comer. For those who are near to him get higher weights while those are far away get lower weights. Then we add total weights of each family separately. Whoever gets highest total weights, new-comer goes to that family. This is called **modified kNN**.

So what are some important things you see here?

- You need to have information about all the houses in town, right? Because, we have to check the distance from new-comer to all the existing houses to find the nearest neighbour. If there are plenty of houses and families, it takes lots of memory, and more time for calculation also.
- There is almost zero time for any kind of training or preparation.

Now let’s see it in OpenCV.