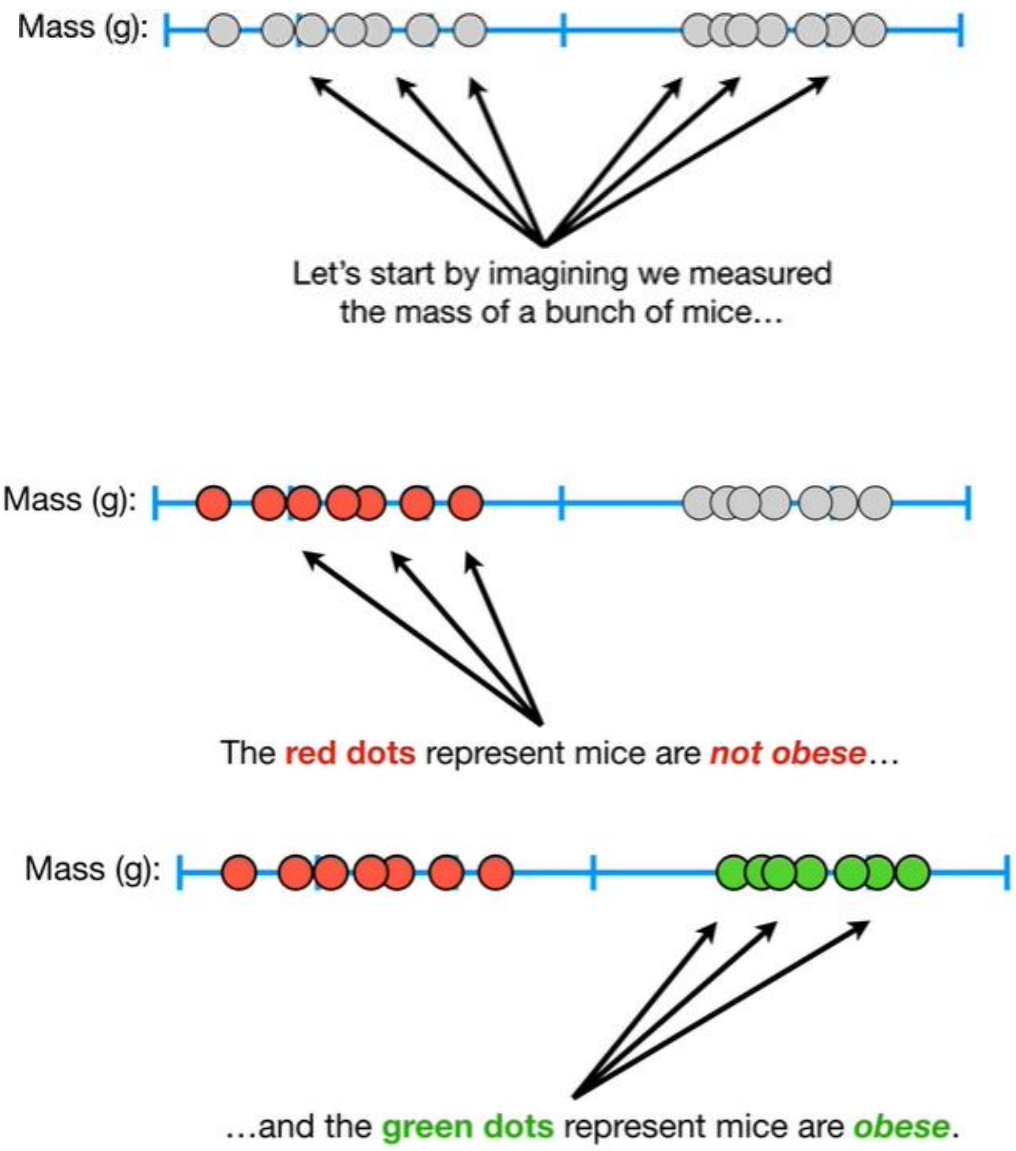
Introduction to Support Vector Machines

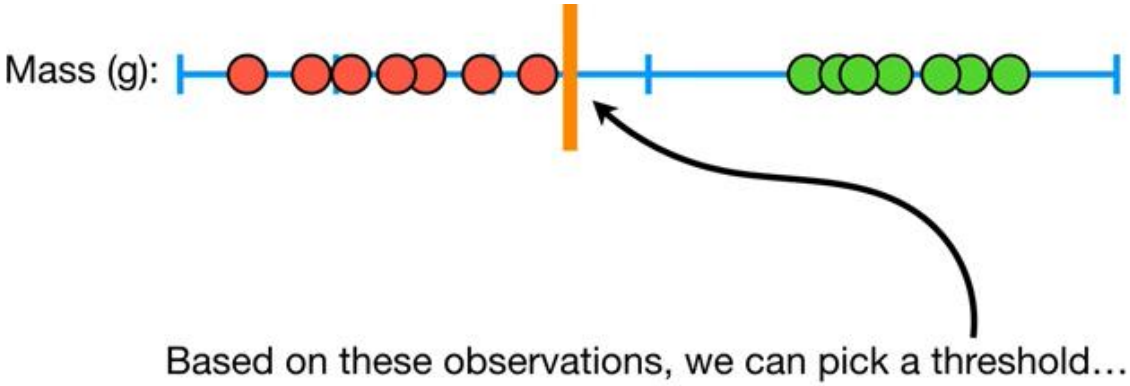
Support Vector Machine (SVM)

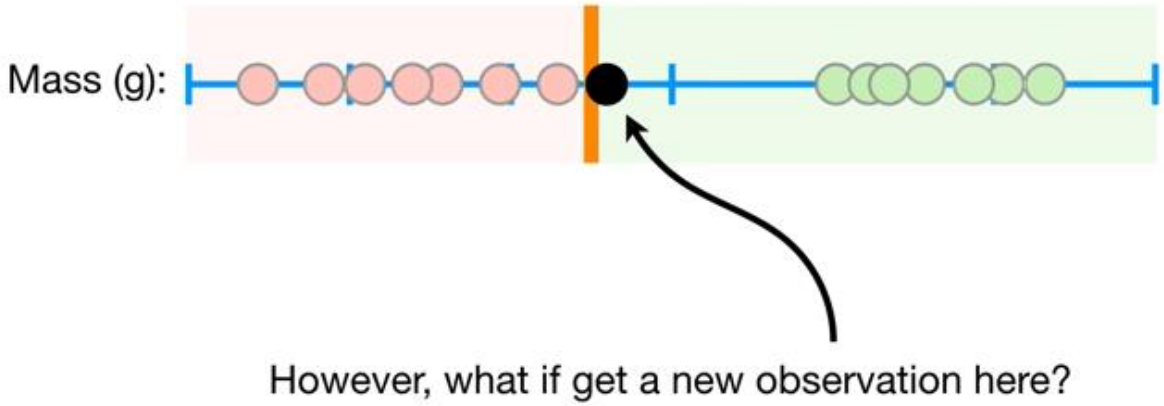
- SVM is a supervised machine learning algorithm that can be used for both classification or regression problem.
- In the SVM algorithm, we plot each data item as a point in n-dimensional space (where n is a number of features you have) with the value of each feature being the value of a particular coordinate.
- Then, we perform classification by finding the hyper-plane that differentiates the two classes very well.

SVM

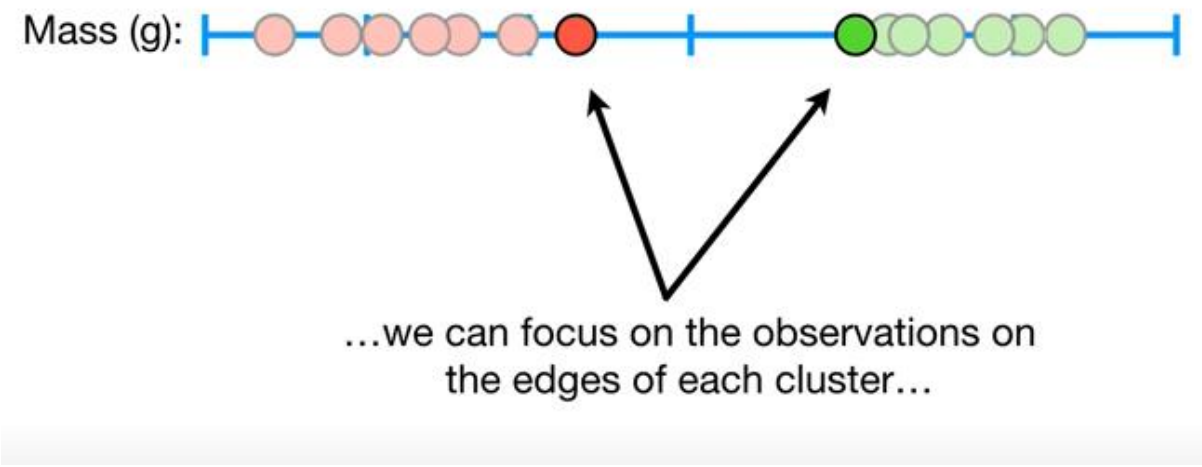

Mass (g):
Let's start by imagining we measured
the mass of a bunch of mice…
Mass (g):
The red dots represent mice are not obese…
Mass (g):
…and the green dots represent mice are obese.

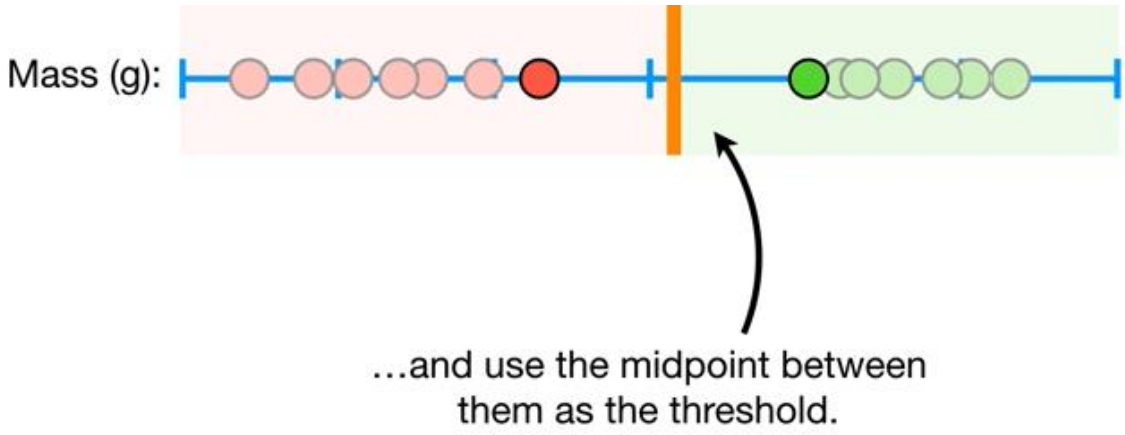
SVM


Mass (g):
Based on these observations, we can pick a threshold…

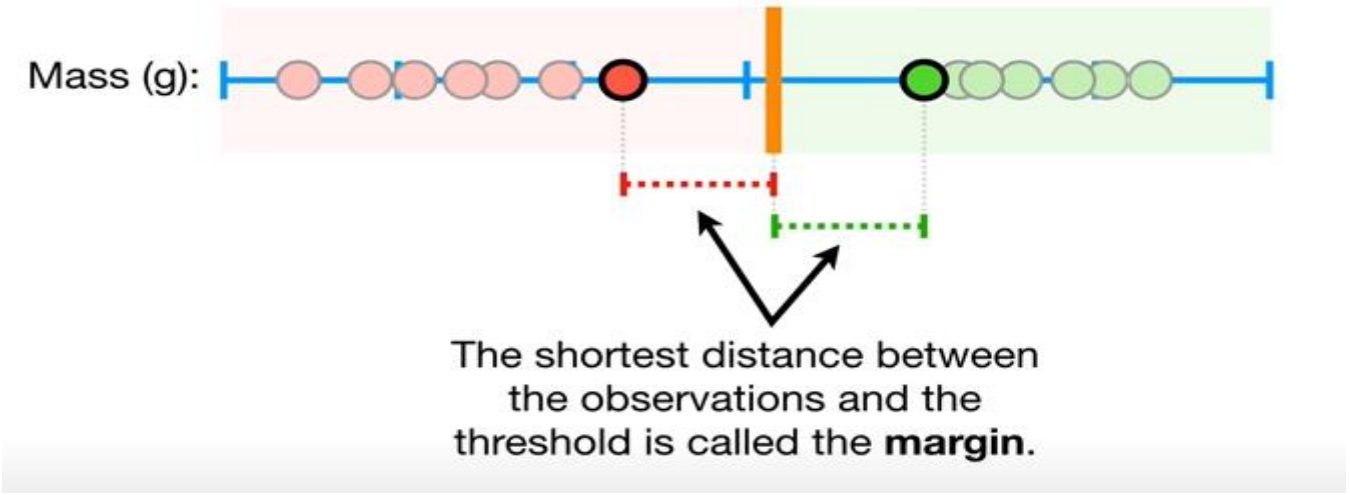

Mass (g):
However, what if get a new observation here?

SVM

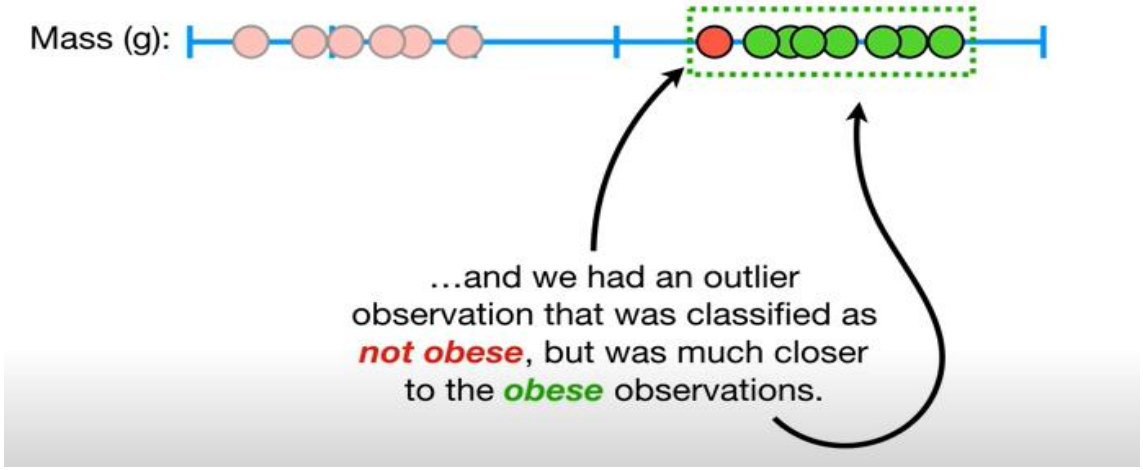

Mass (g):
…we can focus on the observations on
the edges of each cluster…


Mass (g):
…and use the midpoint between
them as the threshold.

SVM



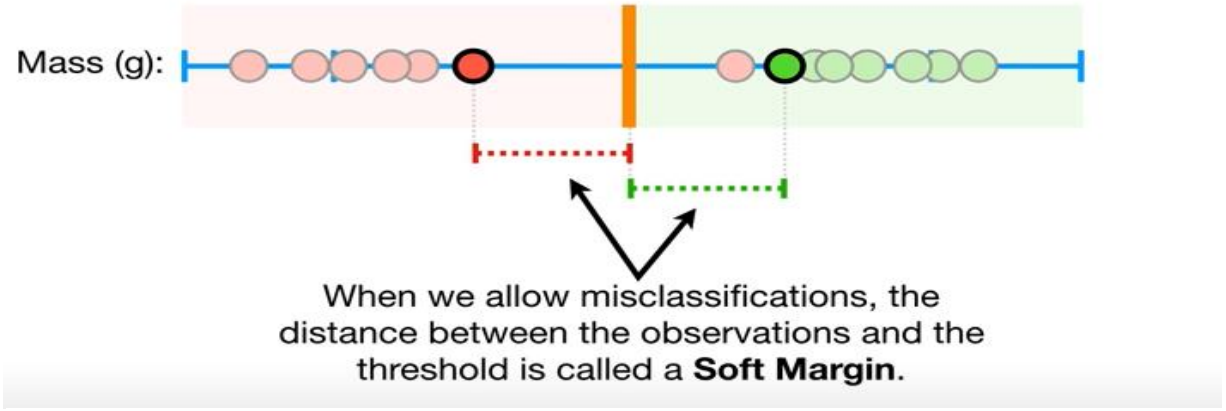
Using margin with maximum distance for classification, called Maximum Margin Classifier

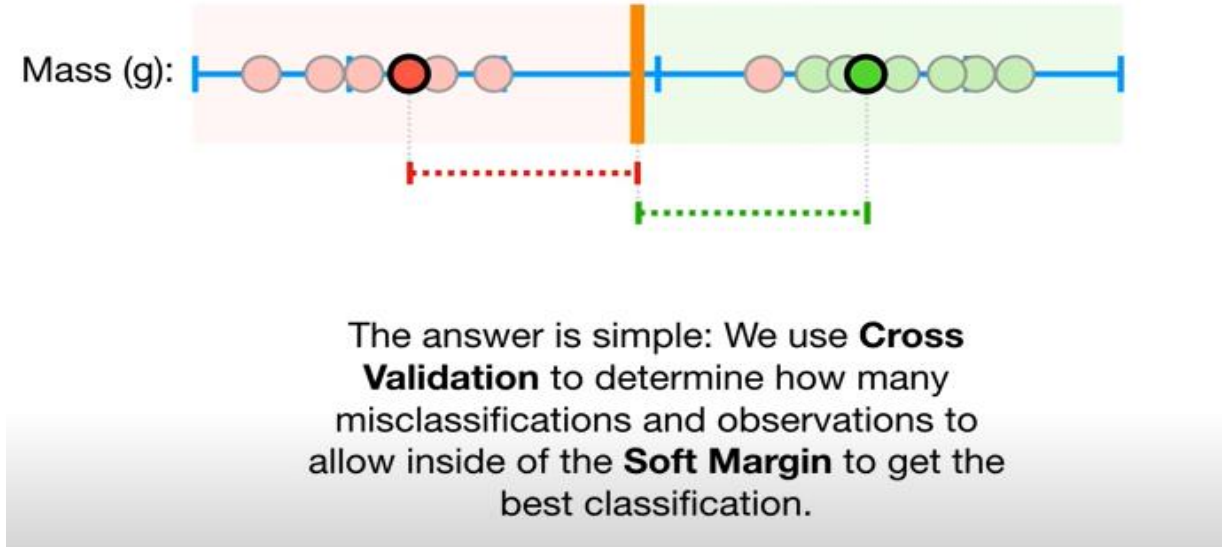


So **Maximal Margin Classifiers** are *super sensitive to outliers* in the training data and that makes them pretty lame.

SVM

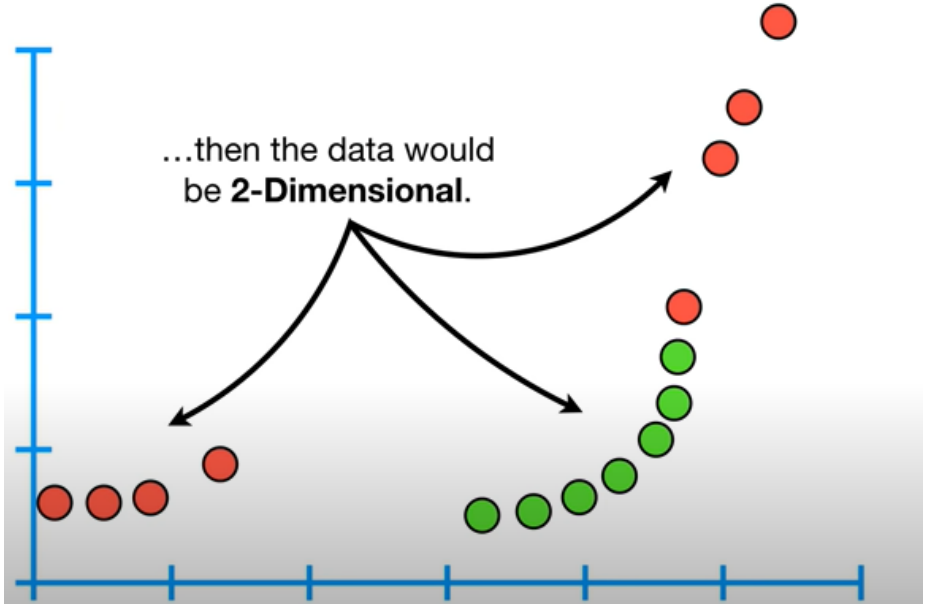
Choose a threshold that allows misclassifications. This s example of Bias-Variance Trandeoff.



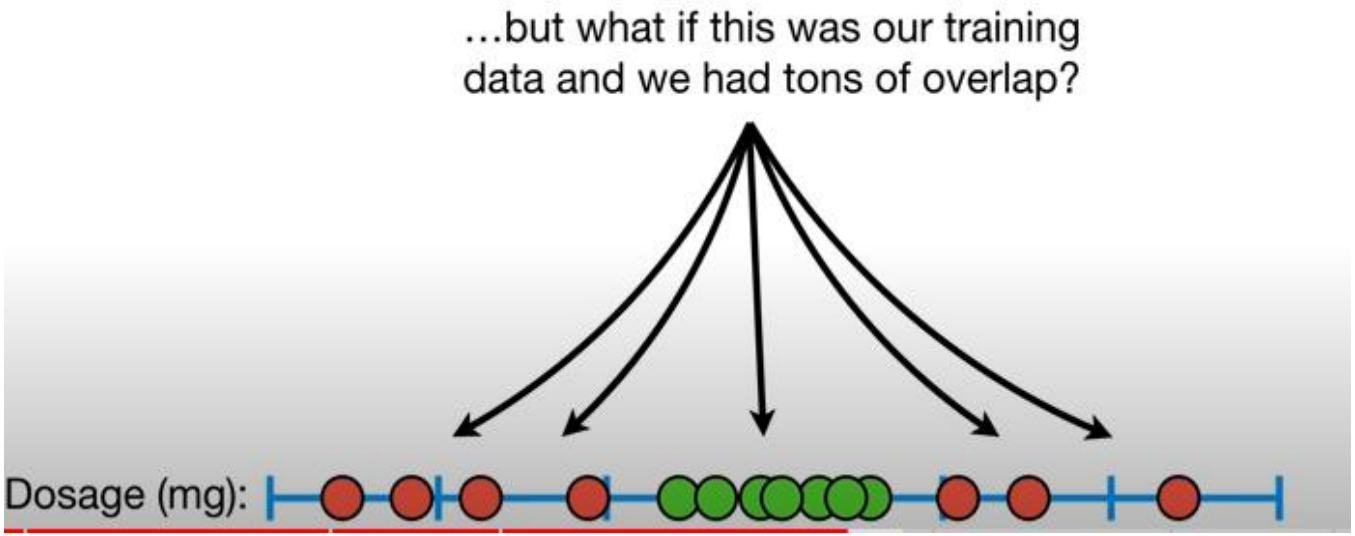


SVM

- **When we use Soft Magin for classifier, we call it Support Vector Classifiers.**
- **For Two dimensional data, Margin will be a Line**
- **For High dimensional data, Margin will be a plane or Hyperplane**

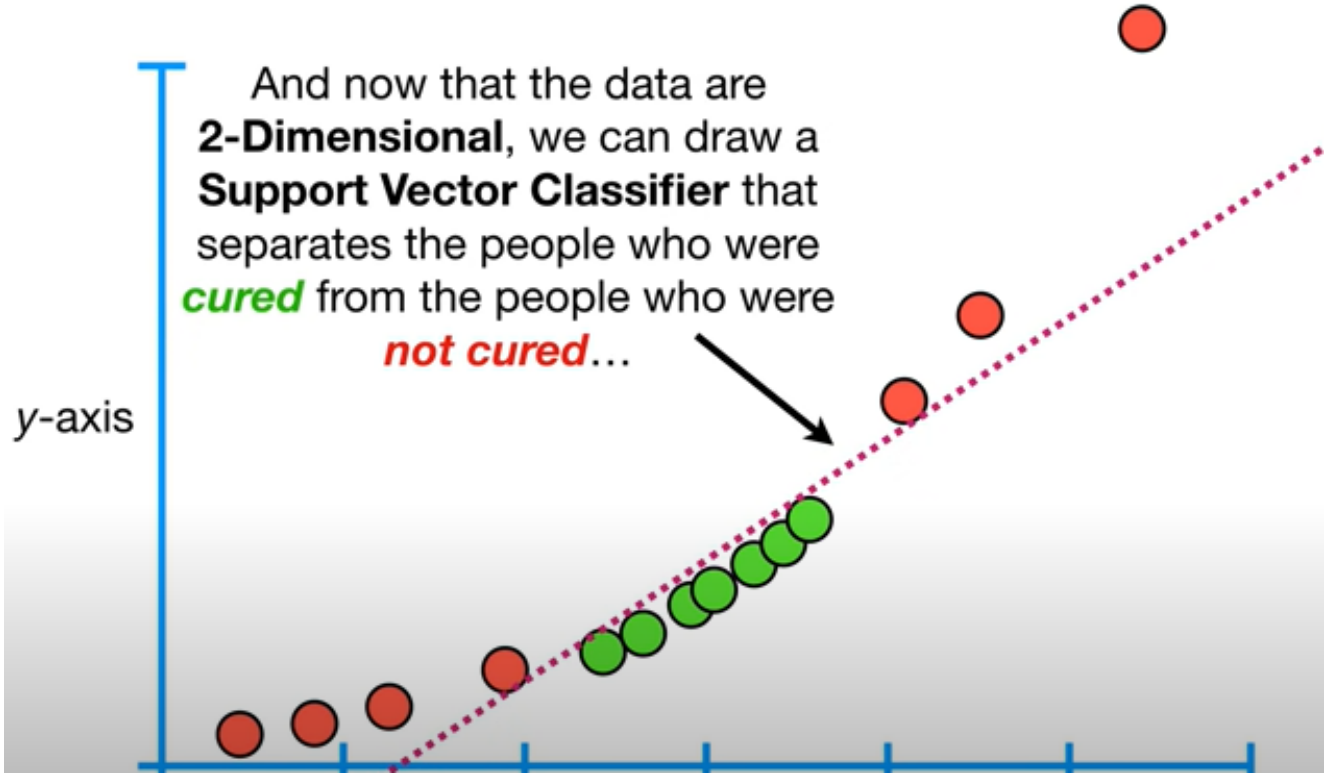


SVM



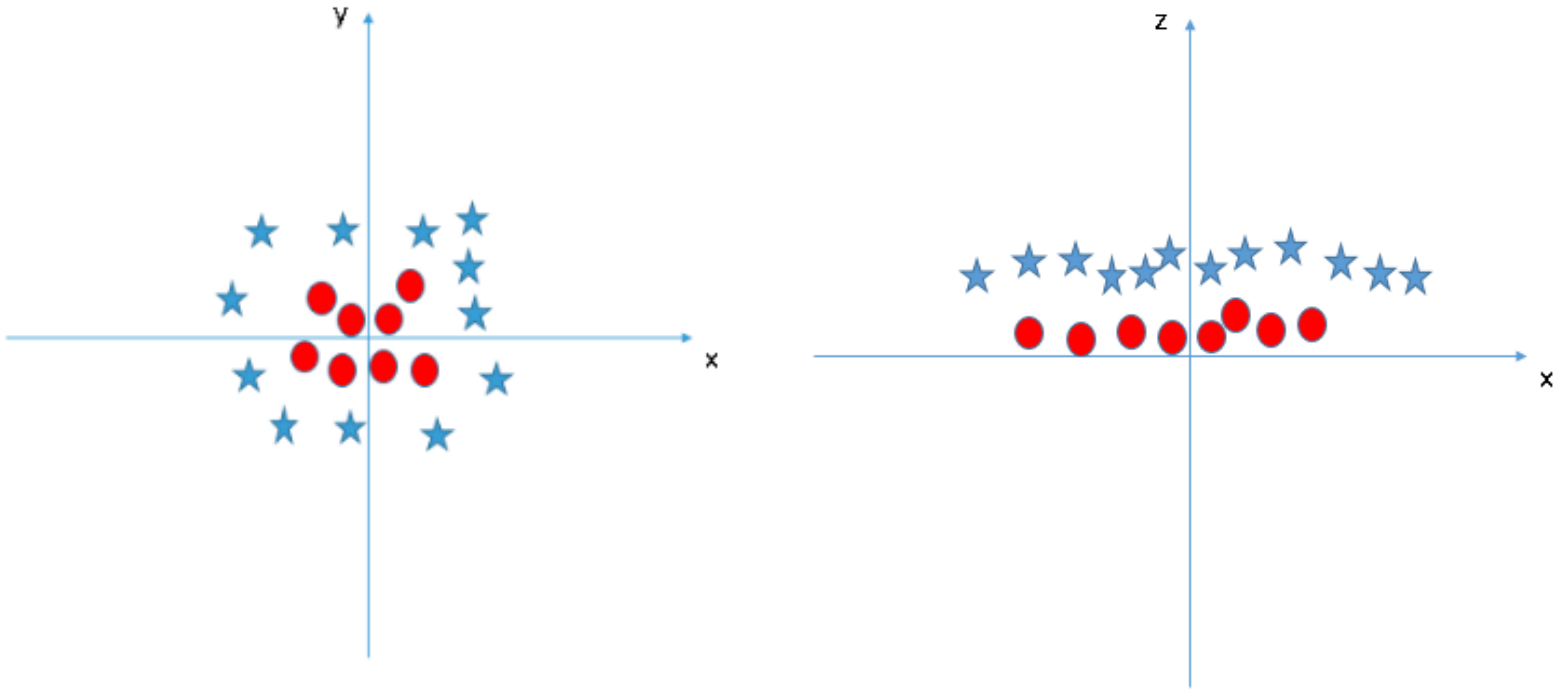
Support Vector Machine: Add an axis ‘y’ which will be Dosage^2

Support Vector Machine



1. **Start data in low dimension**
2. **Move data in higher dimension**
3. **Find Support Vector Classifier that separate data in higher space into different classes.**

Support Vector Machine: Another Example



SVM solves this problem by introducing additional feature. Here, we will add a new feature z=x^2+y^2. Now, let's plot the data points on axis x and z:

Support Vector Machine

How to determine higher dimensional space??

SVM uses **Kernal Functions** to find classifier in higher dimensions. SVM kernel is a function that takes low dimensional input space and transforms it to a higher dimensional space i.e. it converts not separable problem to separable problem. It is mostly useful in non-linear separation problem.

- Examples:
  - Polynomial Kernal with degree d
  - Radial Kernal or Radial Basis Function (RBF)