2-D — simple line say separate.
3-D — zaida dimensional say called hyperplane.

$W \cdot X + b = 0$

Support Vector Machines (SVM)

Ek aisa Linear Classification hy jo data ke 2 classes ke beech sb say behtr seedhi boundary (hyper plane) banata hy. Purpose is to set W (weight vector) and b (bias) like:

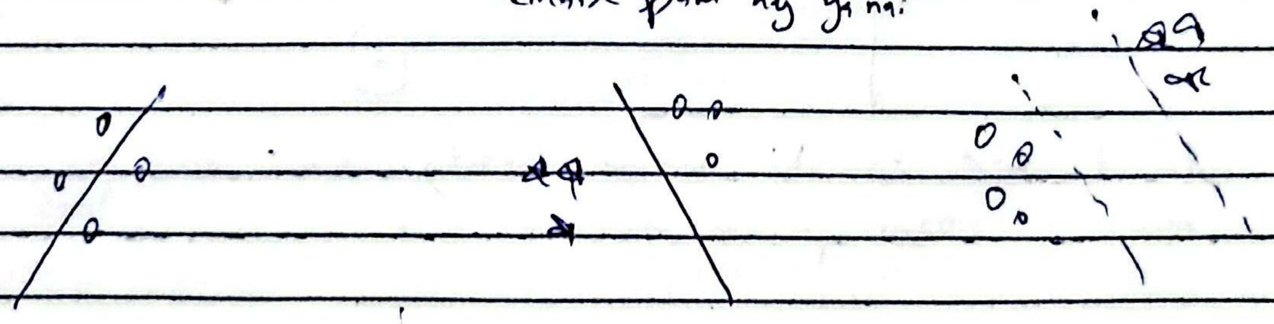
a) Dono classes ke sb points sahi taraf hoon.

b) Boundary say dono taraf ka margin sab say zaida hoo.

Example:- Hard margin →

- 2 classes kay beech road bechani hy.
- Middle line of road = hyper-plane
- 2 classes kay jo sib se qareeb waley points htay hain, we draw 2 straight lines. These lines just choo kr guzr jati hain. These are SVM. We calculate distances of these. More width of these 2 lines.
- Important because there is clear gap. new data can not go idhar-udhar like gett say dari side pr.
- Margin → Distance b/w hyperplanes and nearest data point of either class. SVM tries to maximize margin. No hit to point.

Linear Regression	Logistic Regression	SVM
• Supervised regression model	Supervised classification model.	Supervised machine learning algo
• e.g., 6 month baad house ki price?	e.g., fever hoga ya nai, Yes / No. email spam hy ya nai	



Simplest SVM machine called SVM machine

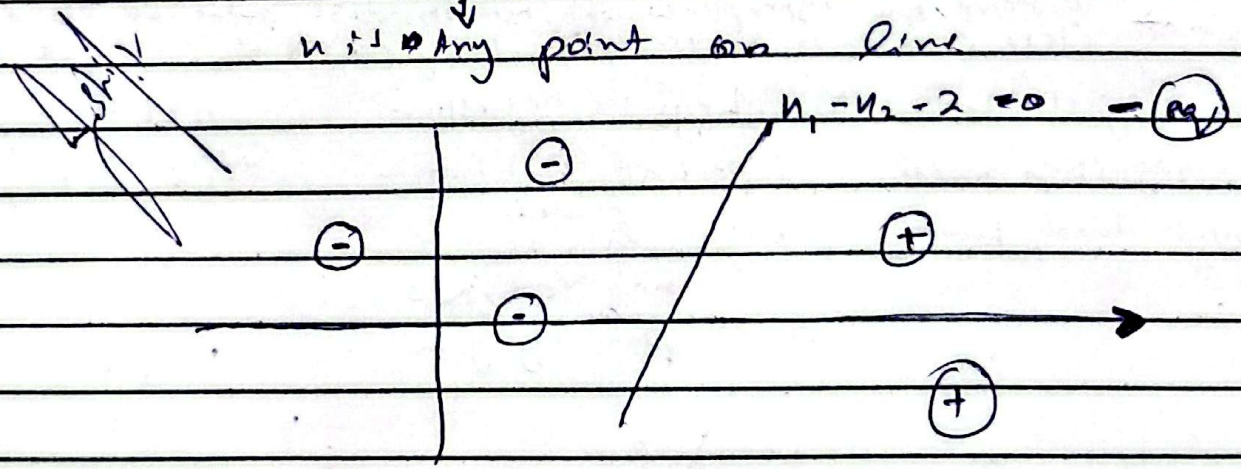
- Maximum margin classifier is linear classifier with maximum classifier.
  ⇓
  places hyperplane such that margin should be wide

- Why maximum margins?
  a) Easy to divide 2 classes by a large margin
  b) Sab say big margin se hyperplane thori si shift ho beh jaye to mis classify kam ho ga.
  c) Robust or strong as small portion of datasets are SVM. No effect on other data points.
  d) Experimentally it works very well.

- Finding MM classifier.?
  - Hyperplane ko define karney kay liye we need 2 things W and b (W → vector which perpendicular the hyperplane. b → number that shift hyperplane from origin)

$W.u + b = 0$

u is any point on line



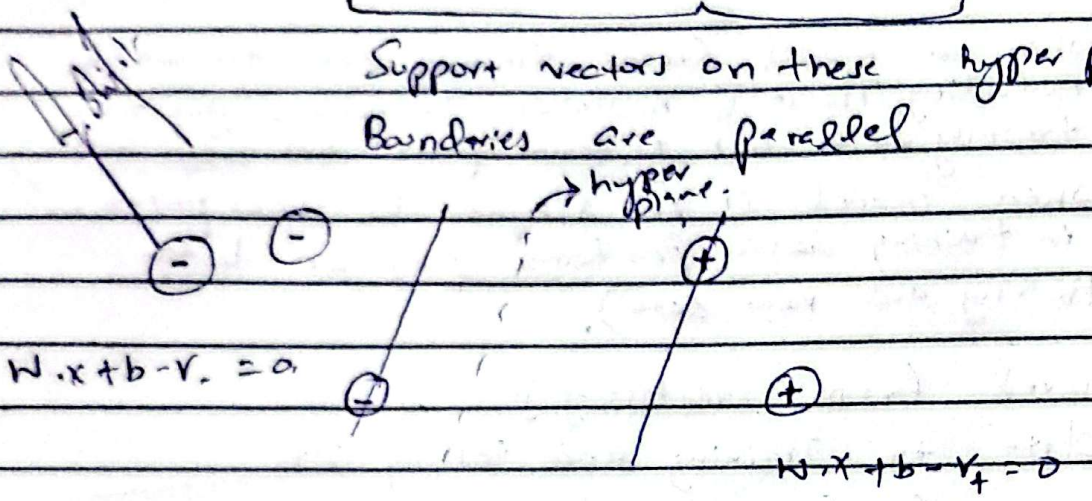
If u_1 and u_2 ki values satisfy karti hain eq ko tou wo line pr hain.

- For valid separating hyperplane, there are scalers $r_+ \geq 0$ and $r_- \geq 0$

$w.x + b + r_- = 0$ & $w.x + b - r_+ = 0$

Support vectors on these hyper planes.

Boundaries are parallel



- Centering hyperplane between boundaries.

If (w, b) are valid hyperplane. we can define new bias $b' = b + (r_- - r_+)/2$

new hyperplane $w.x + b' = 0$ will be exactly center.

- Hard Margin SVM → • When training data is perfectly linearly separable.
  - Any training point can not come in margin or on wrong side.
  - Margin is strict. so no compromise.
  - A little noise or overlap, model fails and model train nhi hta.
- Soft Margin SVM → • A little noisy data, we use soft margin.
  - margins are made flexible. Misclassifications can be there.
  - Classifier can make mistakes on trainig data
  - Each misclassification get an error which is minimized.

↓

parameter C which controls the balance.

Supervised → SVM, Linear Regression, logistic regression, decision trees.

Unsupervised → K-means, PCA.

- SVM normally handles 2 classes what if there are more classes.
  - one vs all classifiers
  - one vs one classifier
- Overfitting (When a model learns training data too well, including noise & mistakes. It works great on training data but performs poor on new data)
- Underfitting (When model is too simple to learn patterns in training data. Performs poor on both training and new data).

⇒ How to be saved from overfitting?

- Divide data to Training and testing set.
- Select that classifier which works good on test
- Model generalize & overfitting say bachate hy.