



NPTEL ONLINE CERTIFICATION COURSES

Course Name: Deep Learning

Faculty Name: Prof. P. K. Biswas

Department : E & ECE, IIT Kharagpur

Topic

Lecture 11: Support Vector Machine

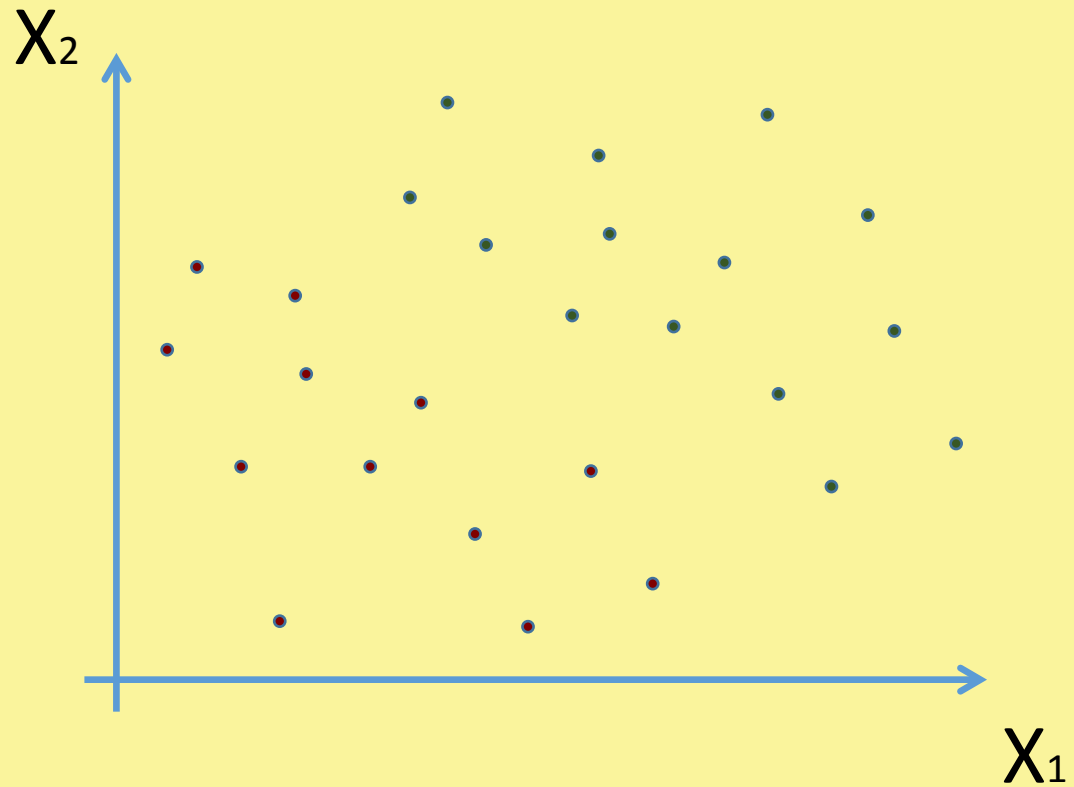
CONCEPTS COVERED

Concepts Covered:

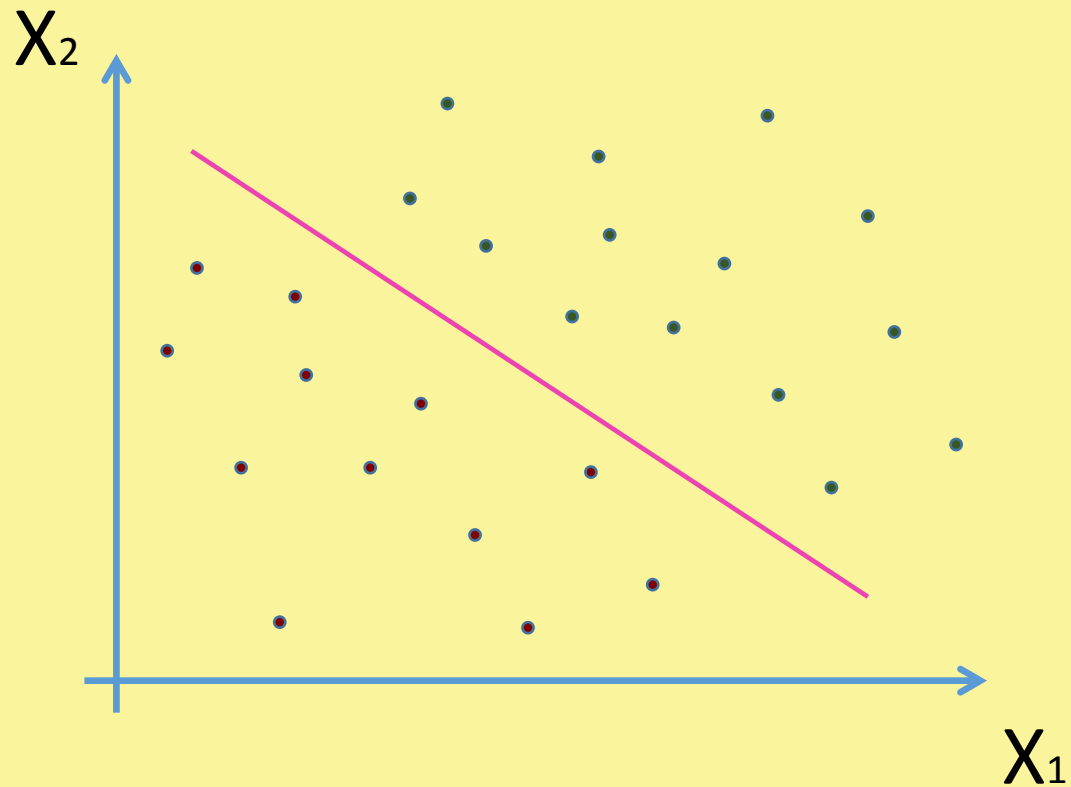
- ☐ Linear Discriminator
- ☐ Perceptron Algorithm
- ☐ Support Vector Machine (SVM)



Linear Classifier – 2 Class Problem



Linear Classifier – 2 Class Problem



$$a^t X + b = 0$$

$$\text{For } X \in \omega_1 : a^t X + b > 0$$

$$\text{For } X \in \omega_2 : a^t X + b < 0$$



Linear Classifier – 2 Class Problem

$$a^t X + b = 0 \Rightarrow a^t X = 0$$

$$a = \begin{bmatrix} a_1 \\ a_2 \\ \vdots \\ a_d \\ b \end{bmatrix} \quad X = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_d \\ 1 \end{bmatrix}$$

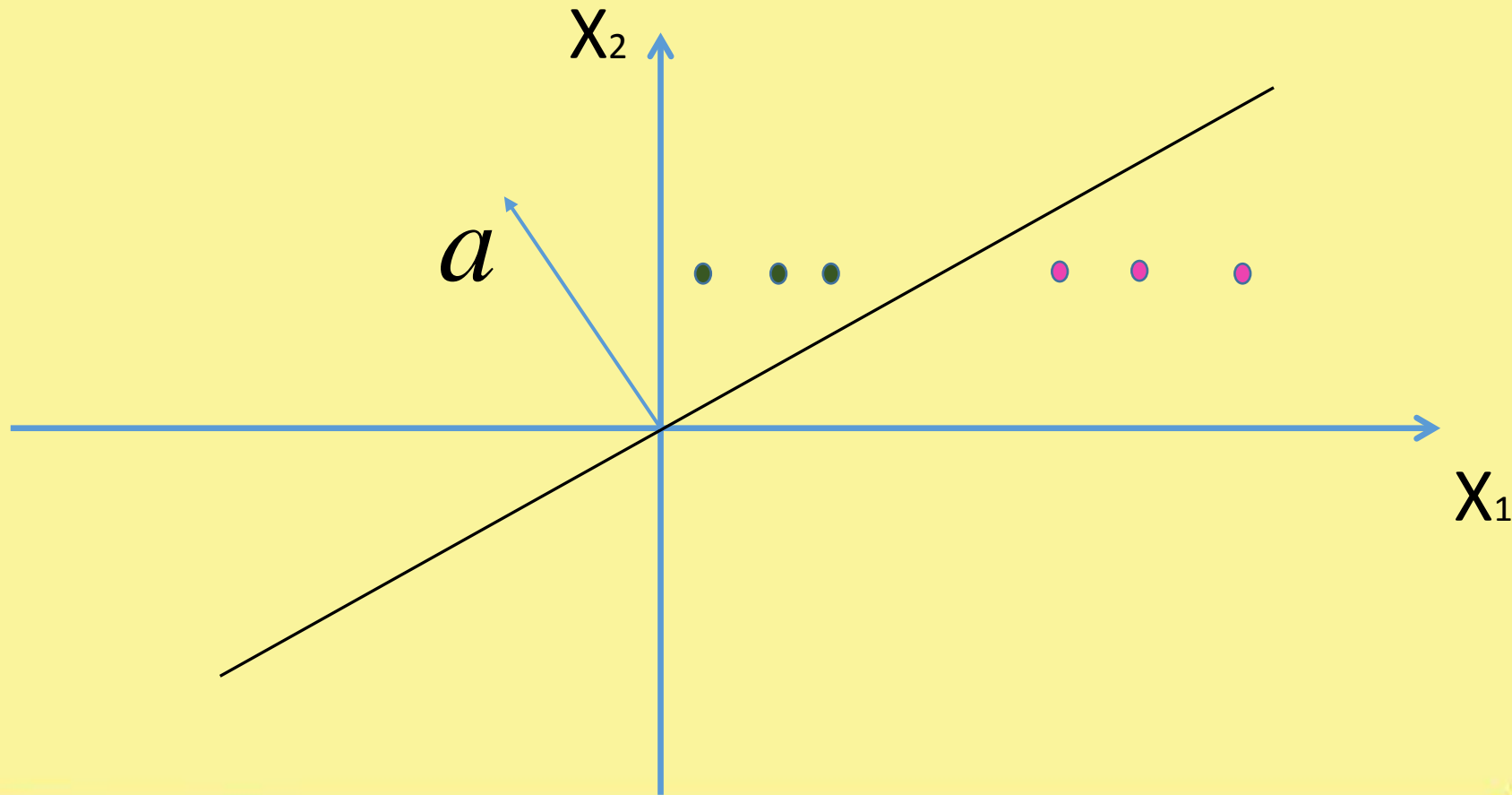
Classification Rule

$$\text{For } Y \in \omega_1 : a^t X > 0$$

$$\text{For } Y \in \omega_2 : a^t X < 0$$



Linear Classifier – 2 Class Problem



Linear Classifier – 2 Class Problem

Negating all X from $\omega_2 : X \leftarrow -X$

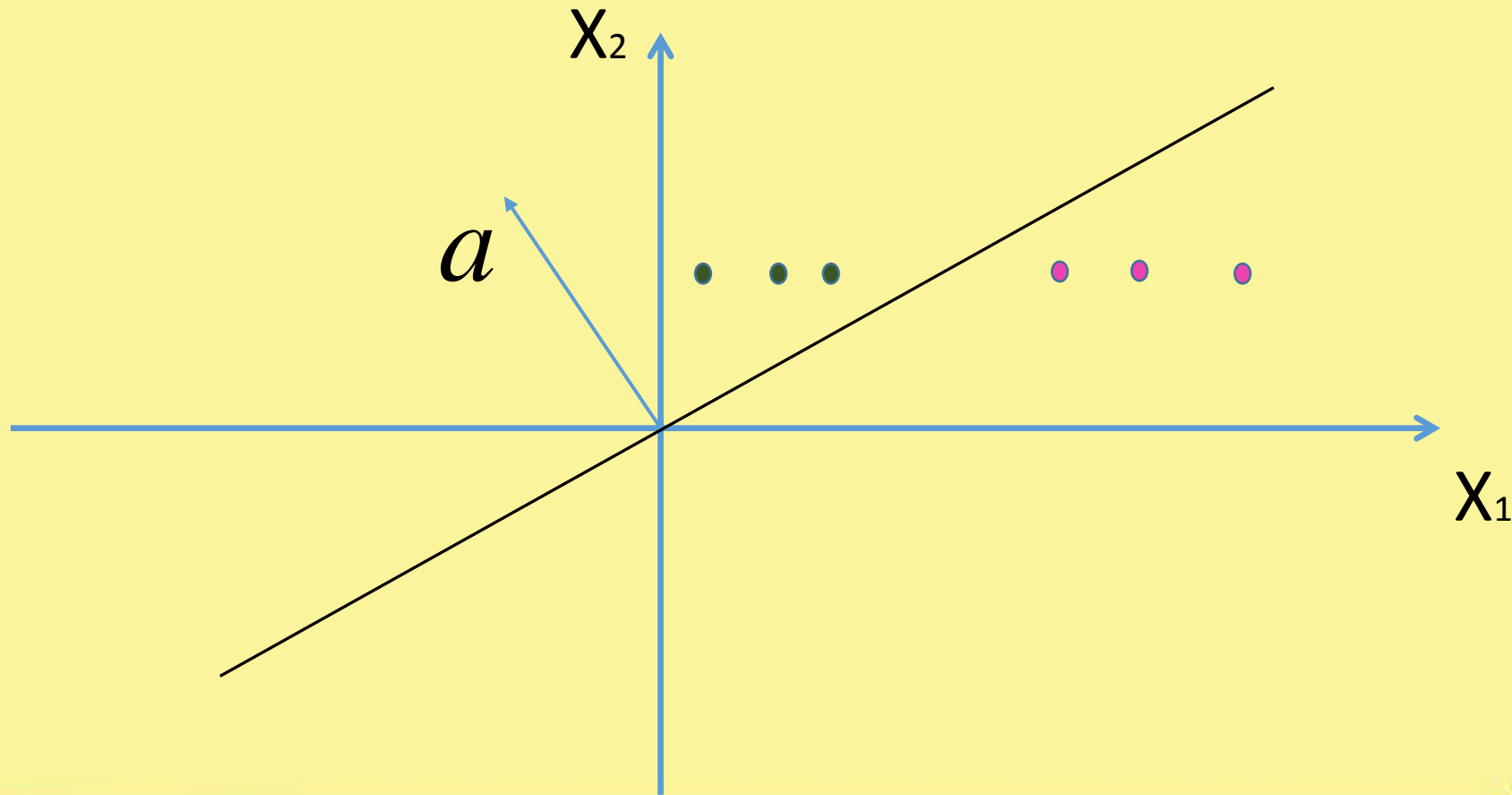
Classification Rule: $a^t X > 0$

If $a^t X < 0$; for any X irrespective of class

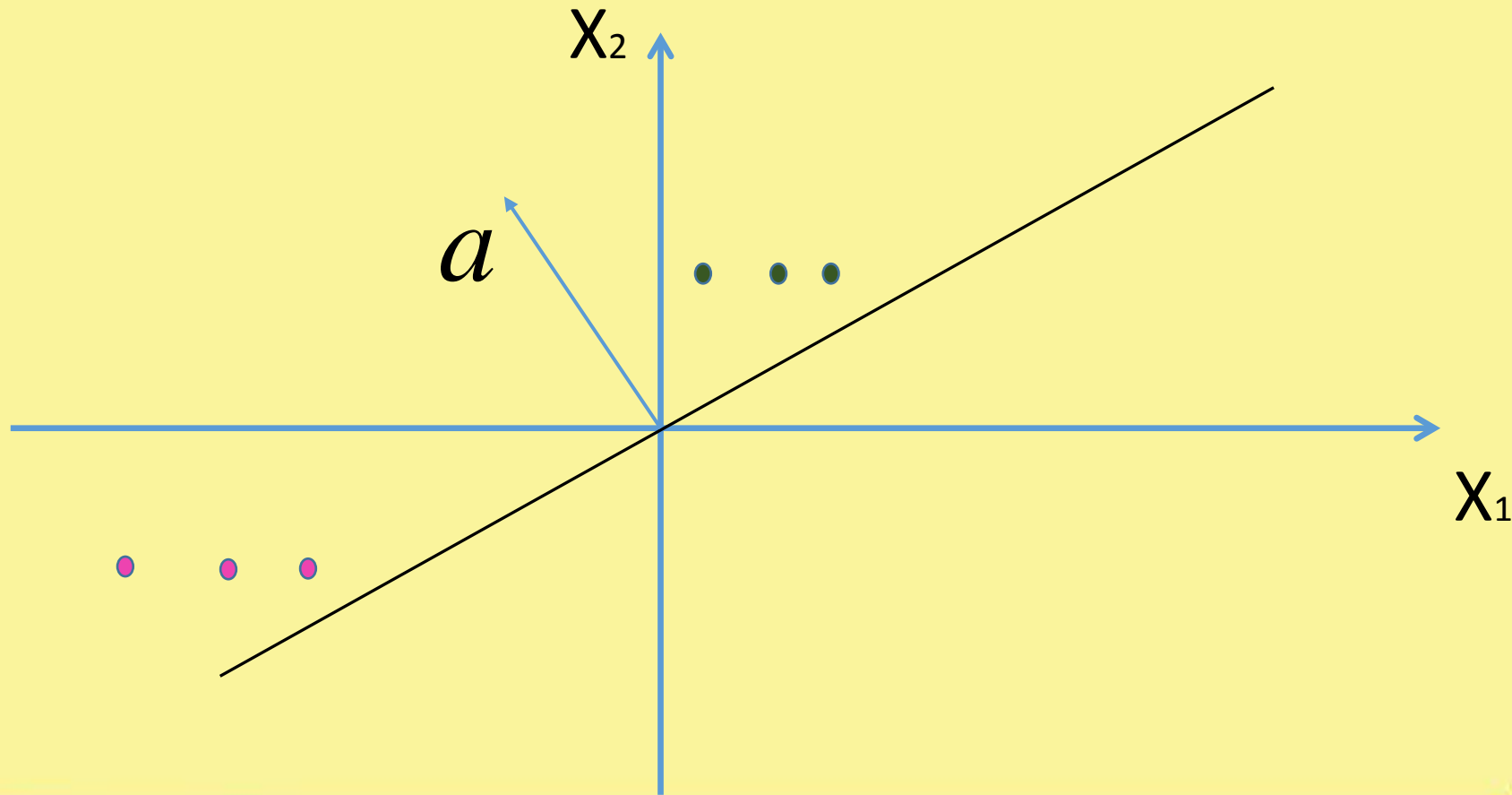
\Rightarrow "a" misclassifies that particular X



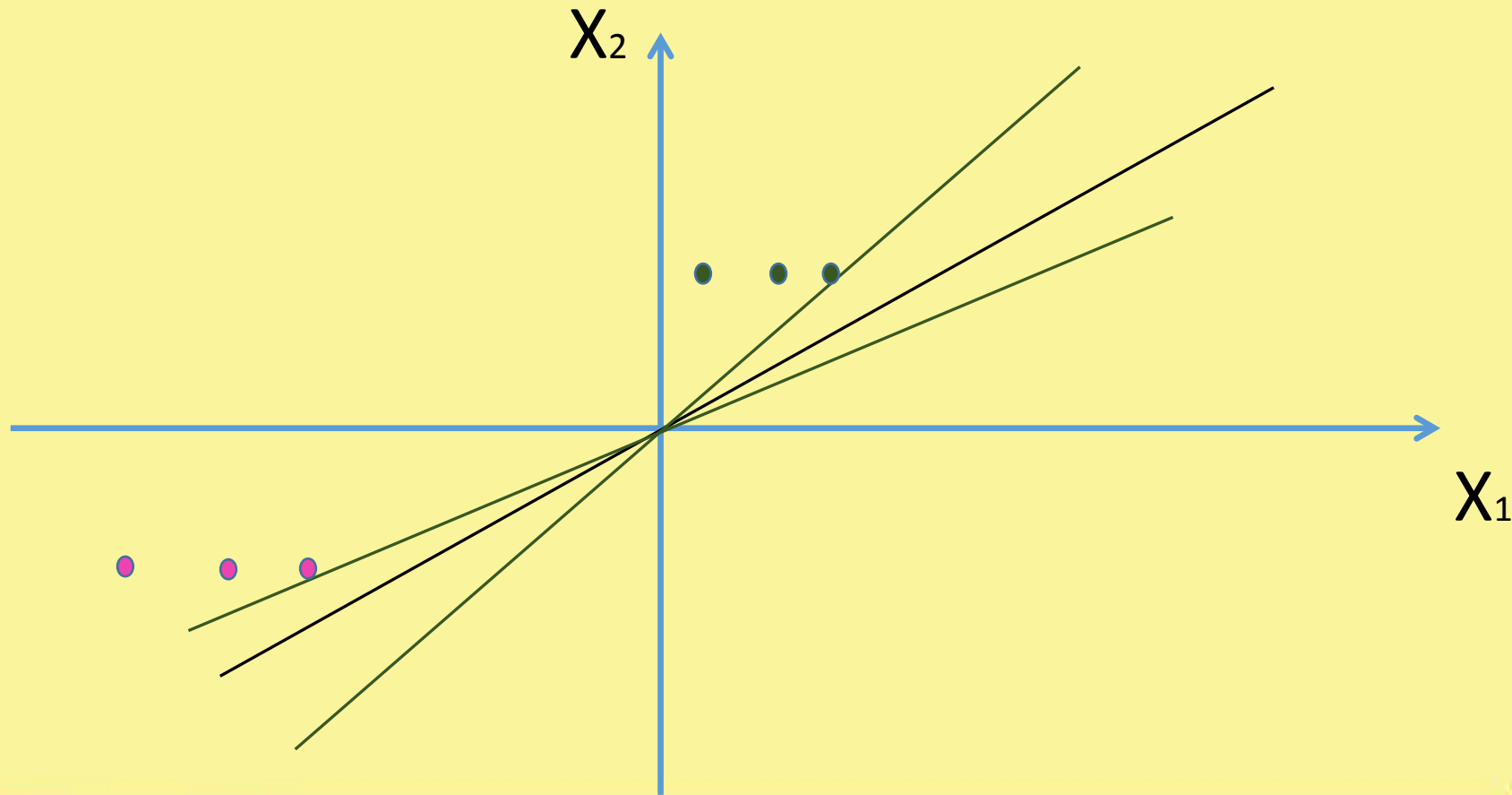
Linear Classifier – 2 Class Problem



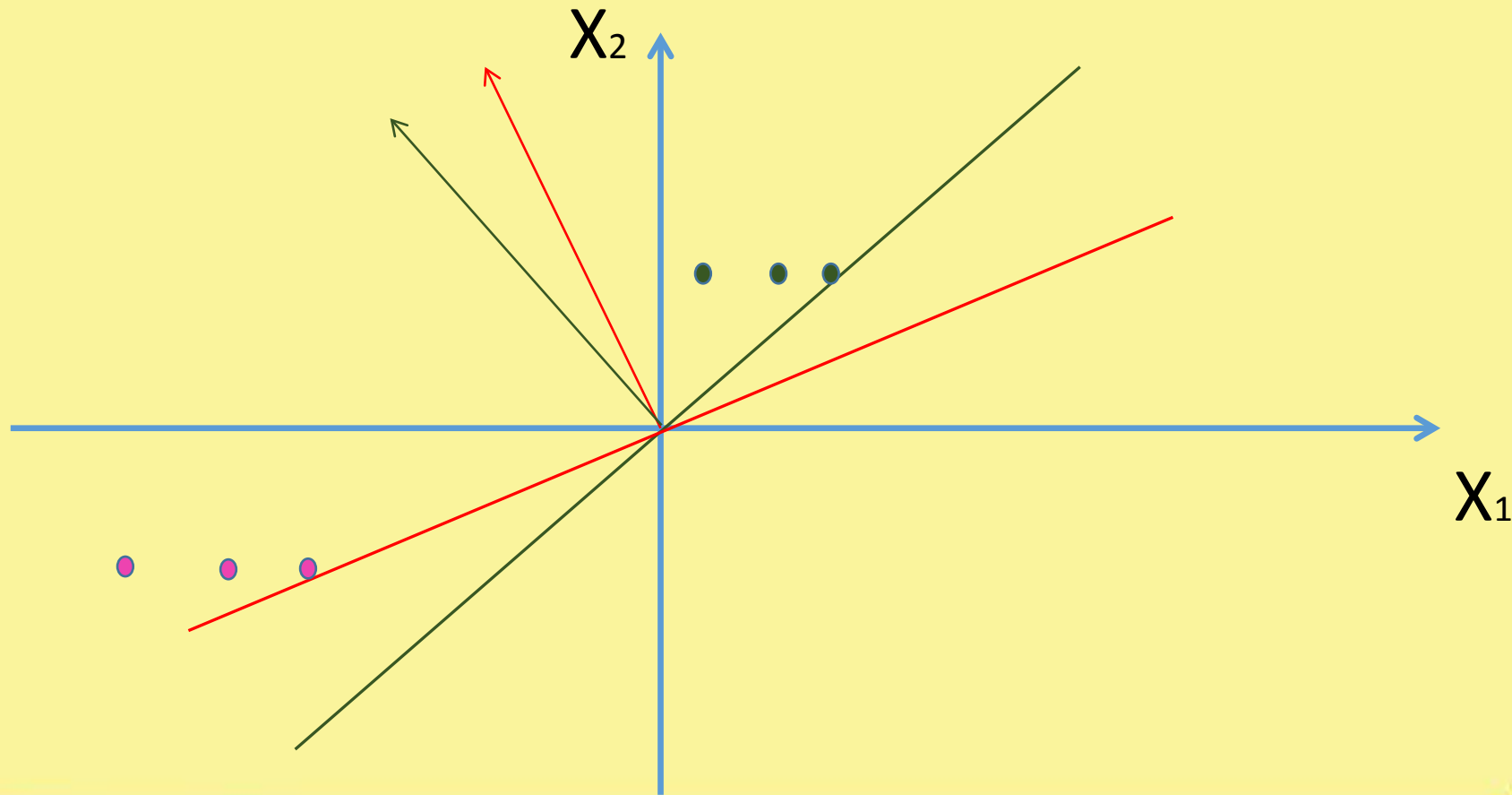
Linear Classifier – 2 Class Problem



Linear Classifier – 2 Class Problem



Linear Classifier – 2 Class Problem



Linear Classifier – Learning

Any "a" misclassifies $X \Rightarrow a^t X < 0$

This leads to an error: $J_P(a) = \sum_{\forall Y: \text{misclassified}} -a^t X$

Follow Gradient Descent Algorithm

$$a \leftarrow a - \eta \nabla_a J_P(a)$$



Linear Classifier – Learning

Perceptron Criteria

$$J_p(a) = \sum_{\forall X: \text{misclassified}} -a^t X \Rightarrow \nabla_a J_p(a) = - \sum_{\forall X: \text{misclassified}} X$$

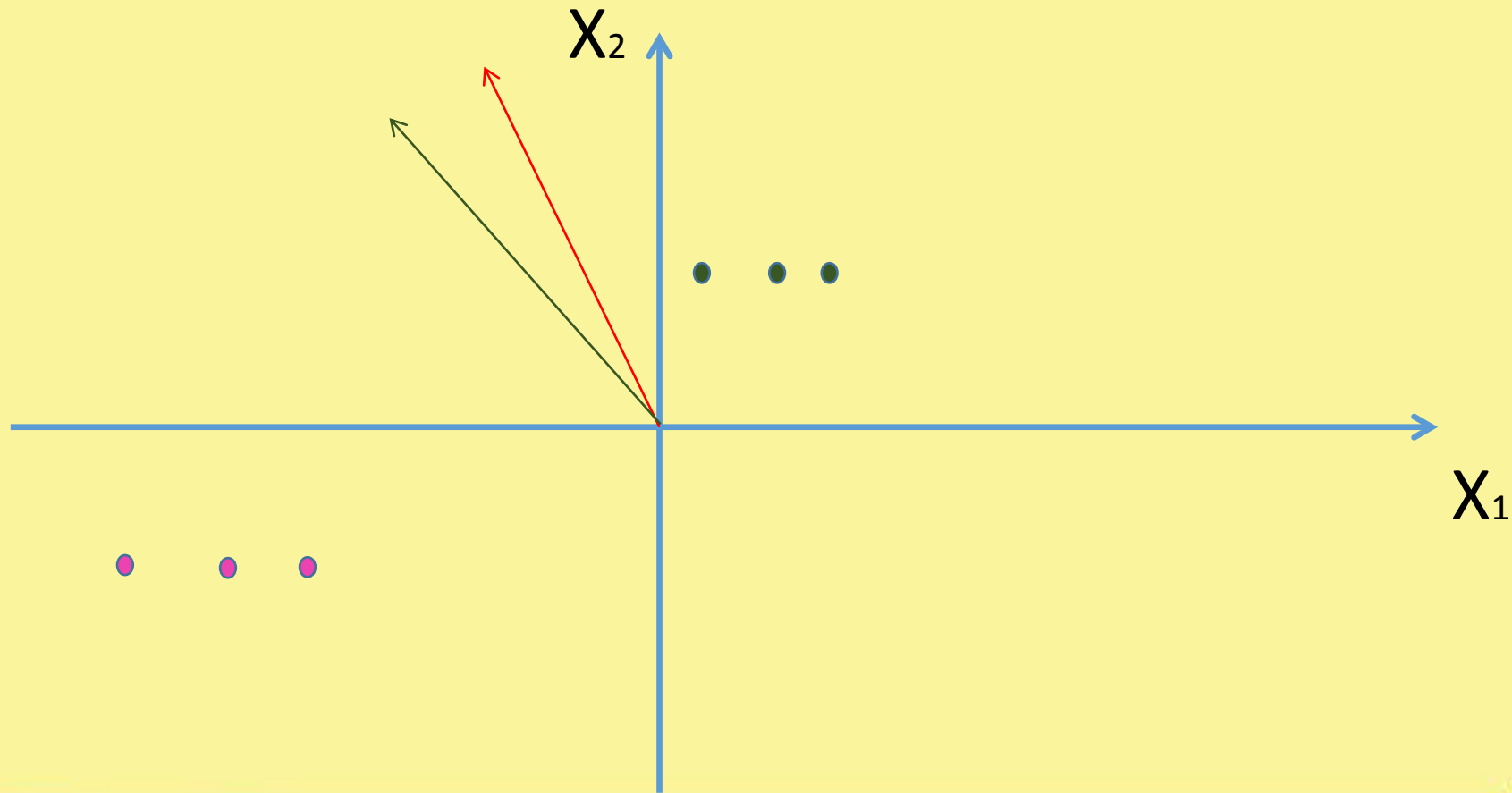
Weight Updation Rule

$$a(0) \leftarrow \text{Random}$$

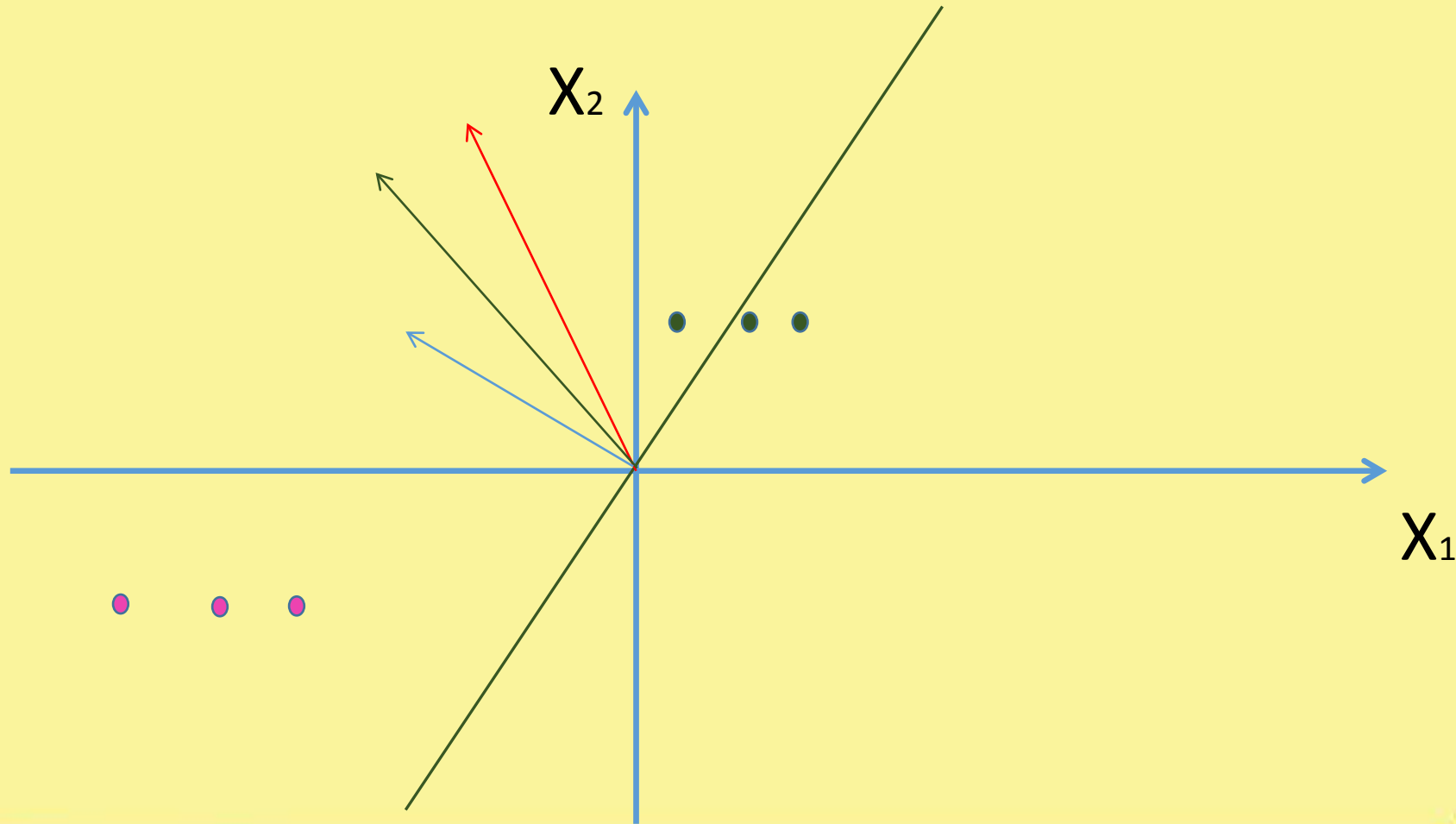
$$a(k+1) \leftarrow a(k) + \eta \sum_{\forall X: \text{Misclassified}} X$$



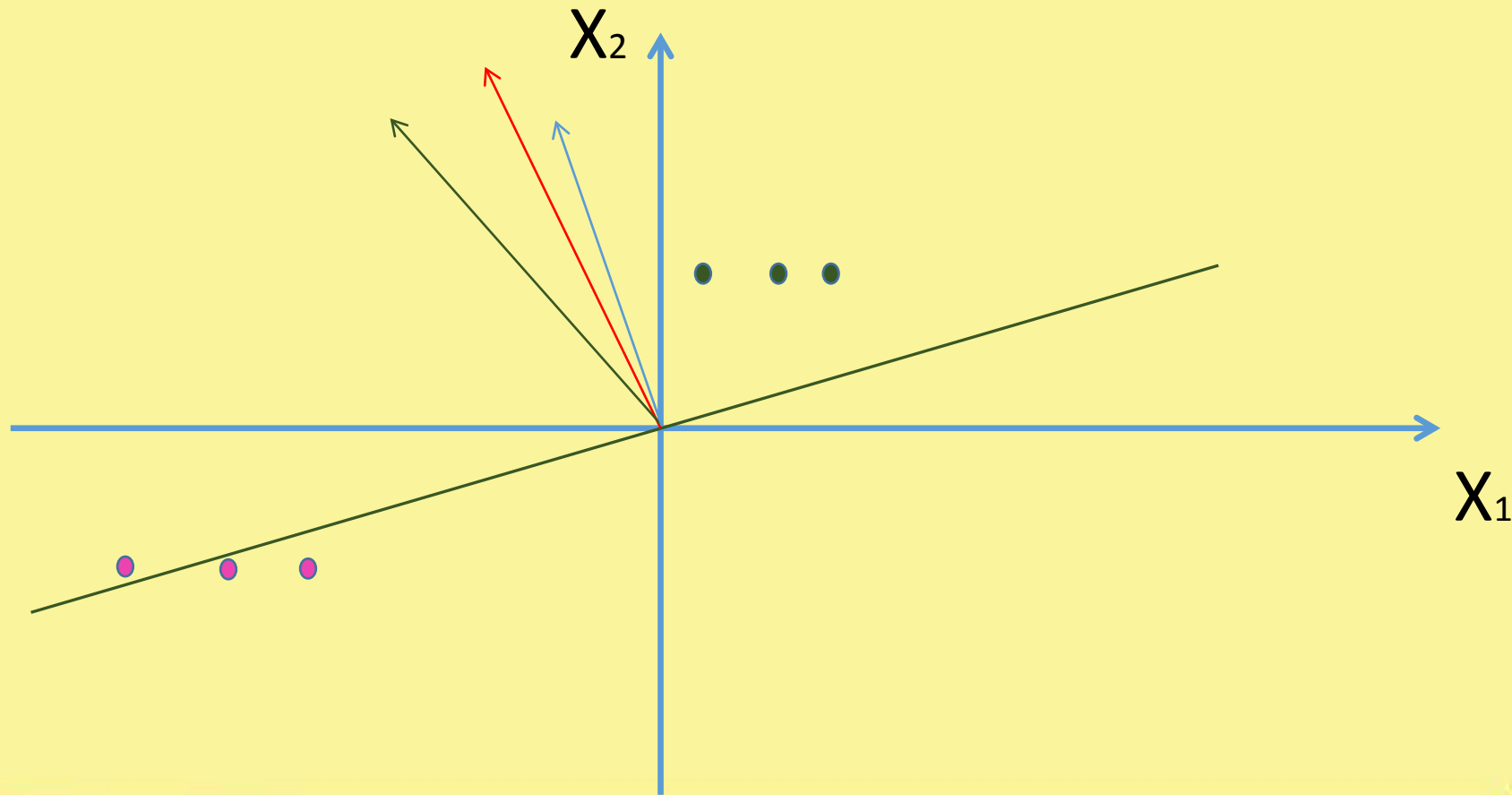
Linear Classifier – 2 Class Problem



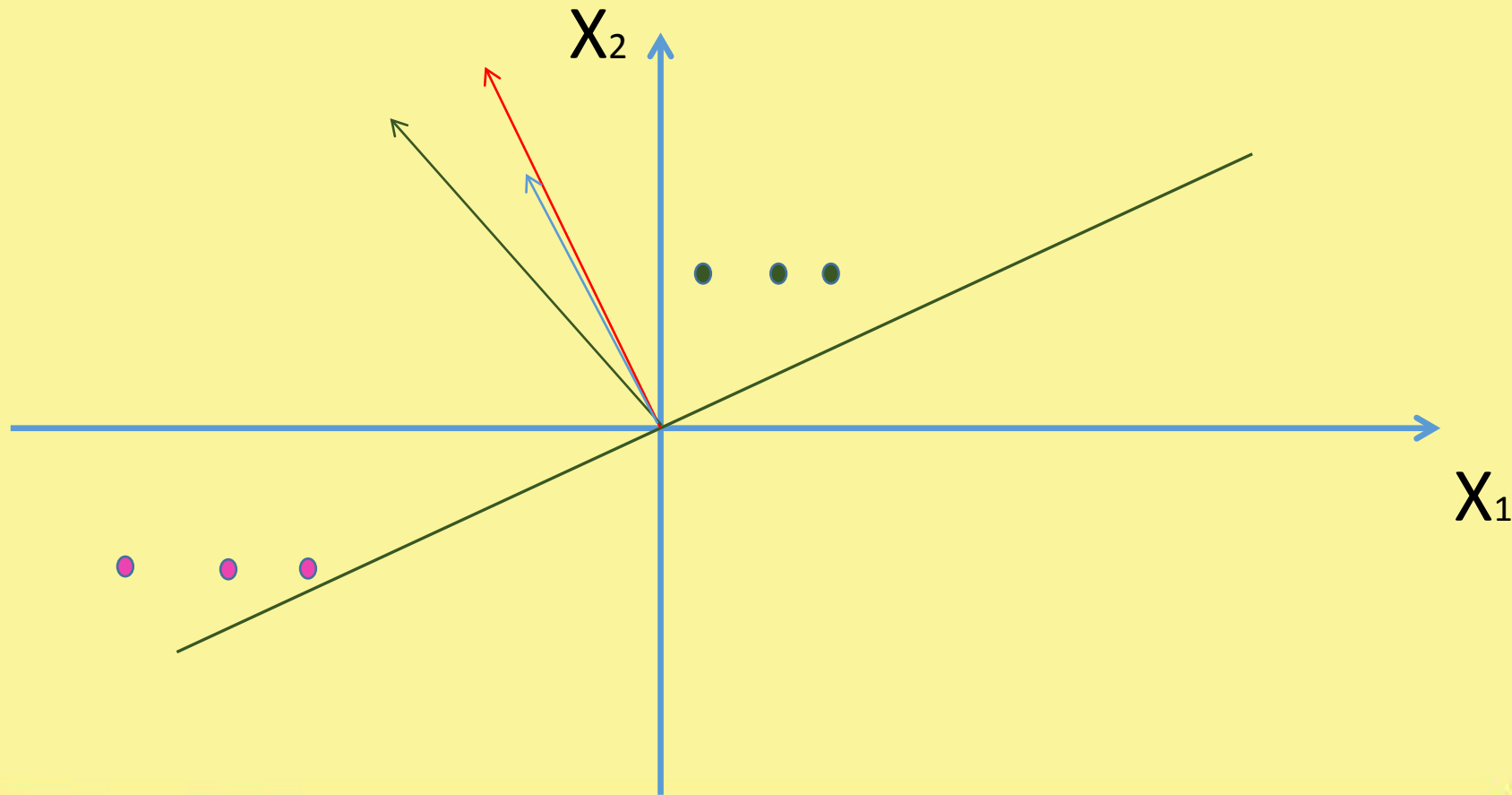
Linear Classifier – 2 Class Problem



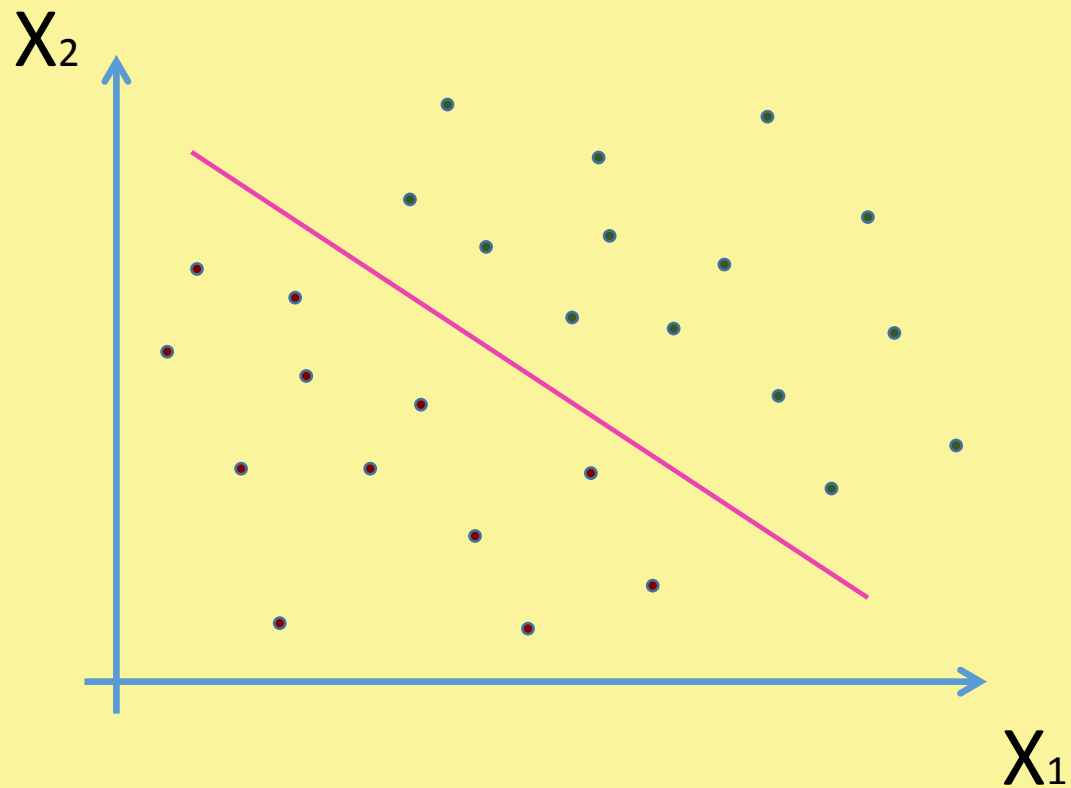
Linear Classifier – 2 Class Problem



Linear Classifier – 2 Class Problem



Support Vector Machine



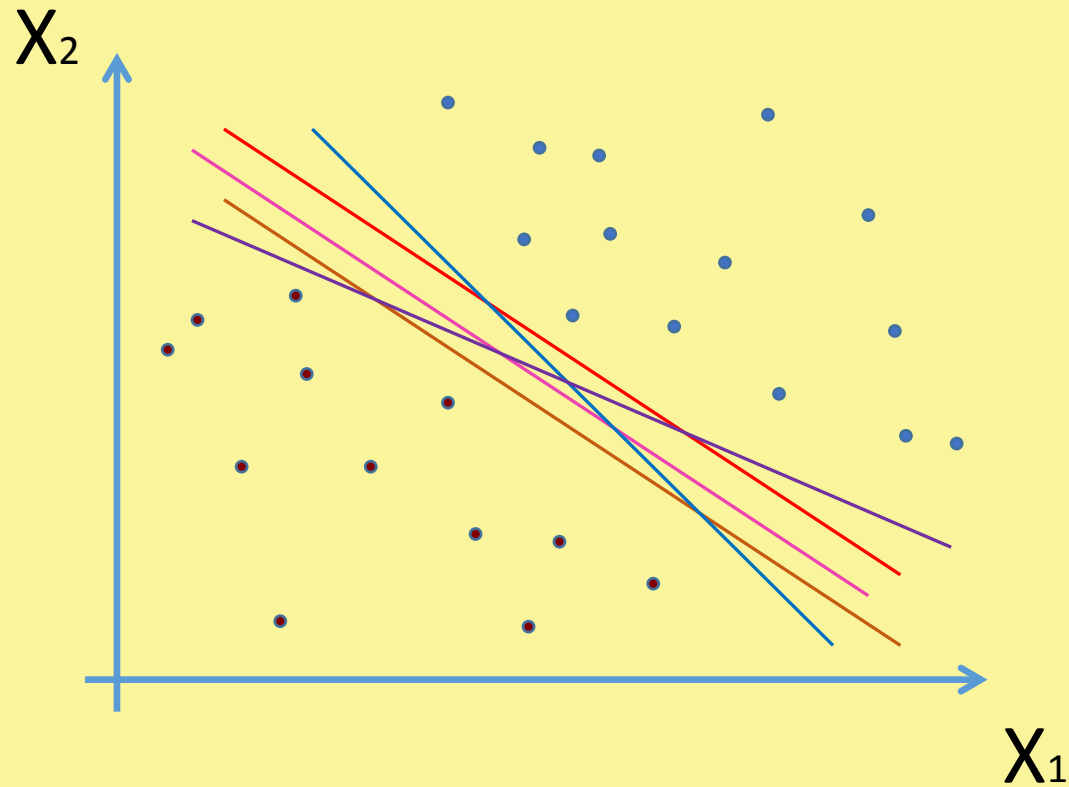
$$a^t X + b = 0$$

$$\text{For } X \in \omega_1 : a^t X + b > 0$$

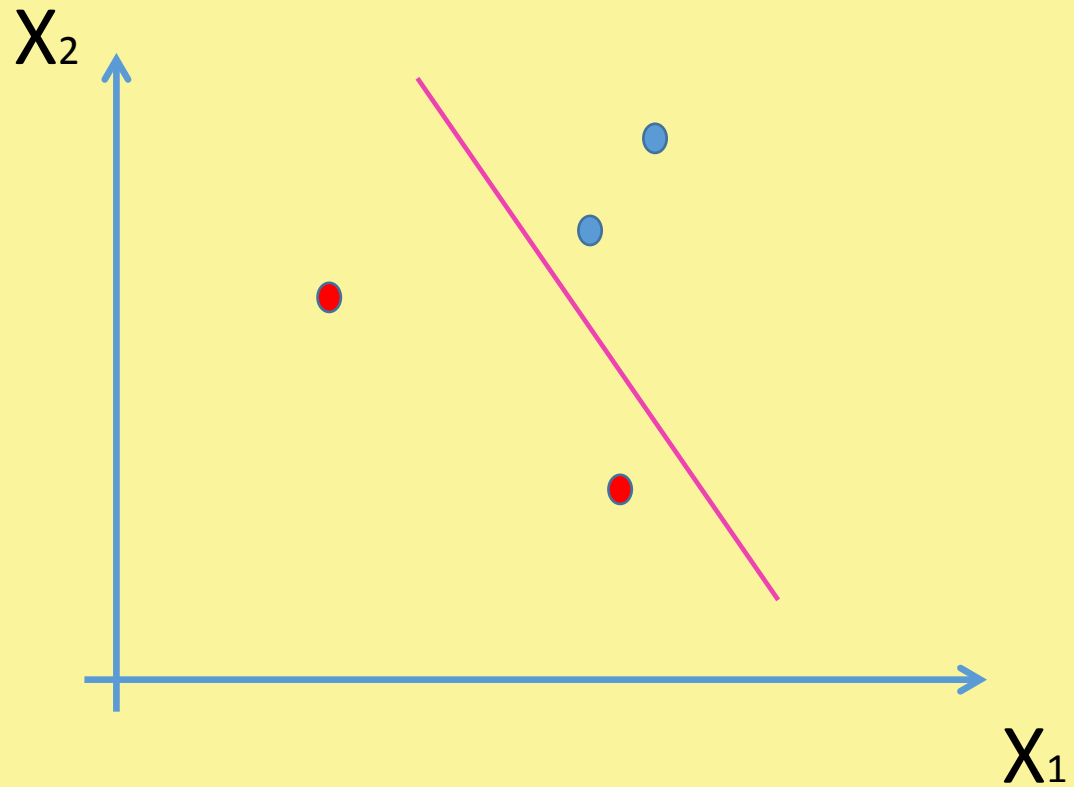
$$\text{For } X \in \omega_2 : a^t X + b < 0$$



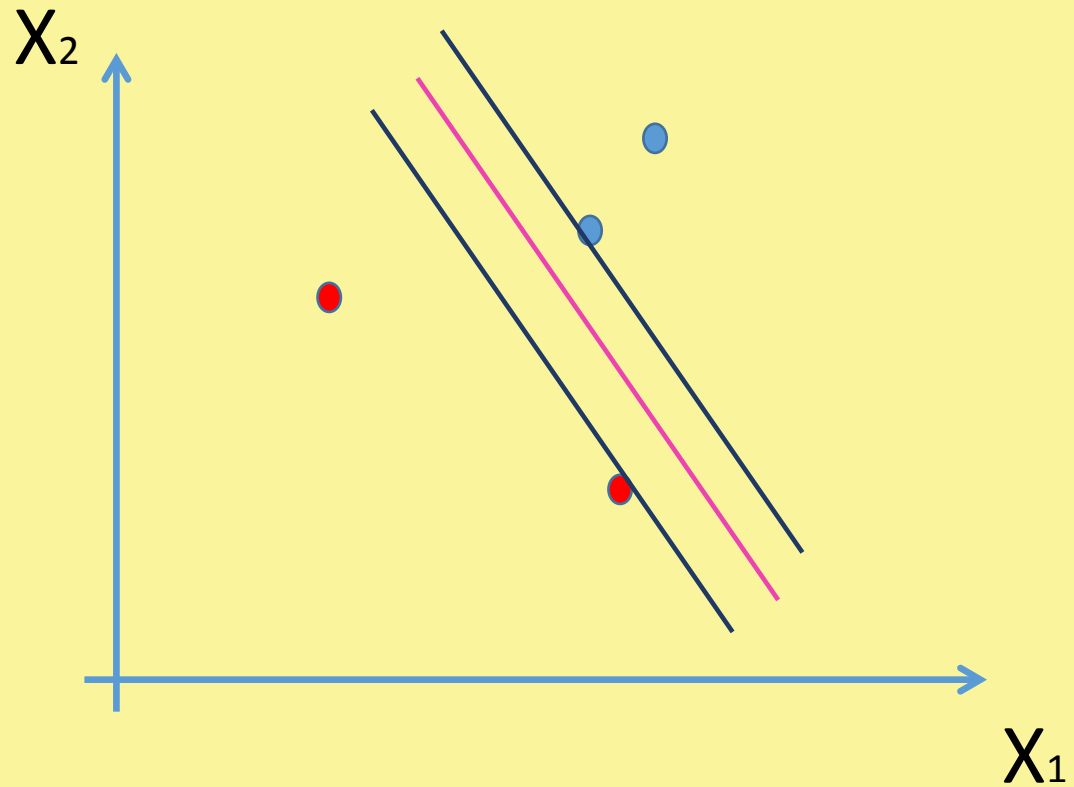
Support Vector Machine



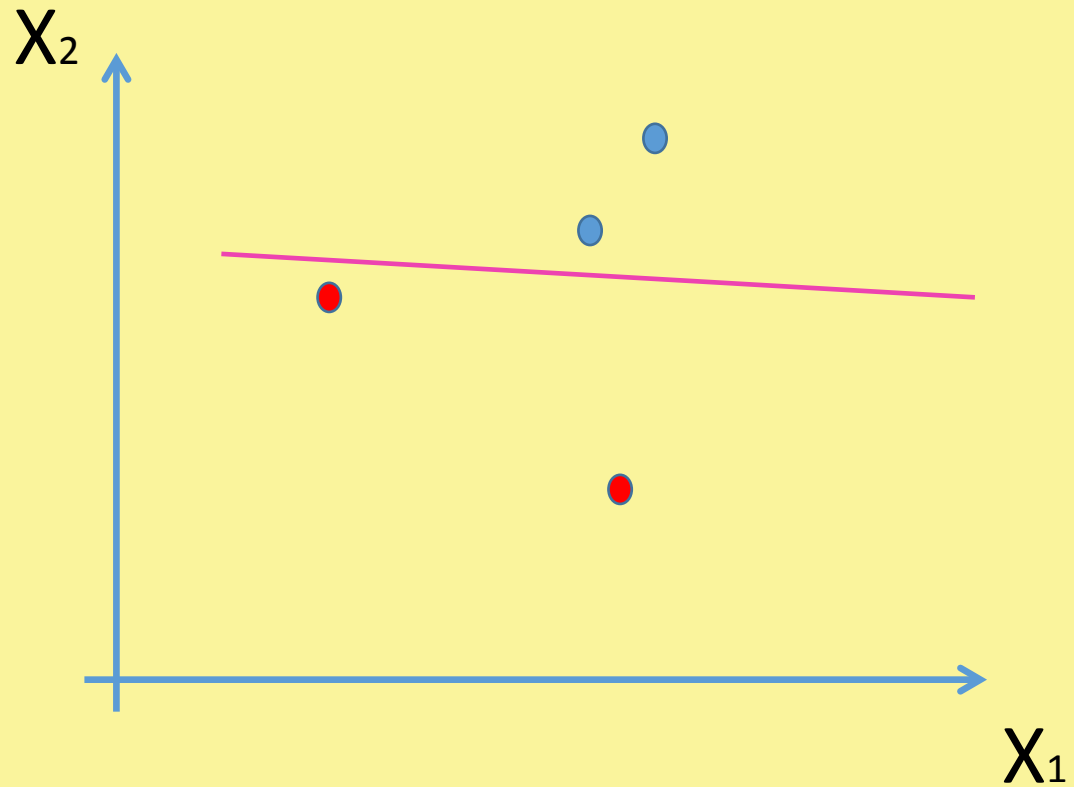
Support Vector Machine



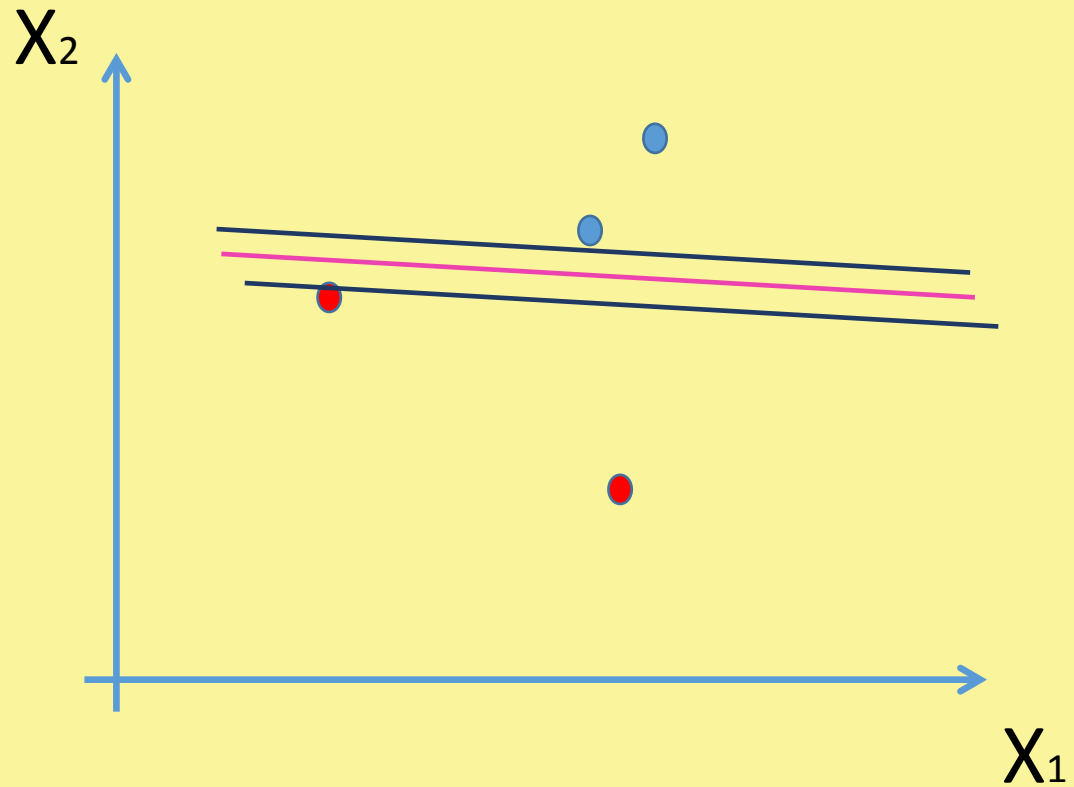
Support Vector Machine



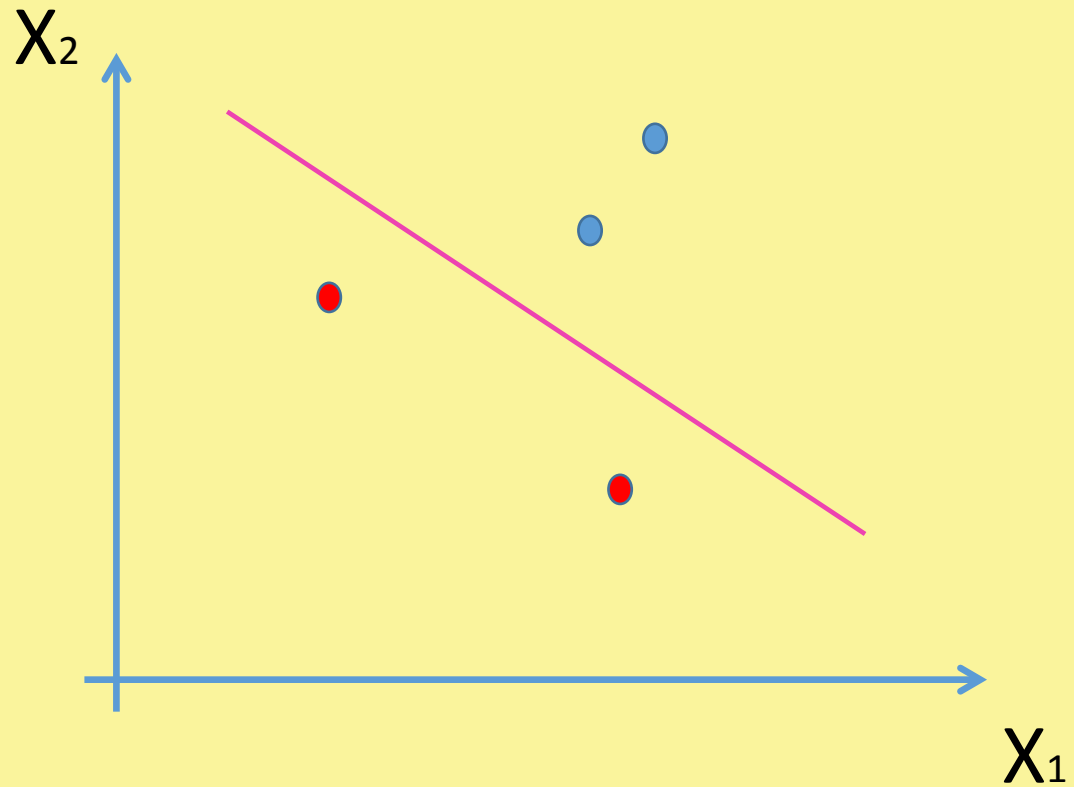
Support Vector Machine



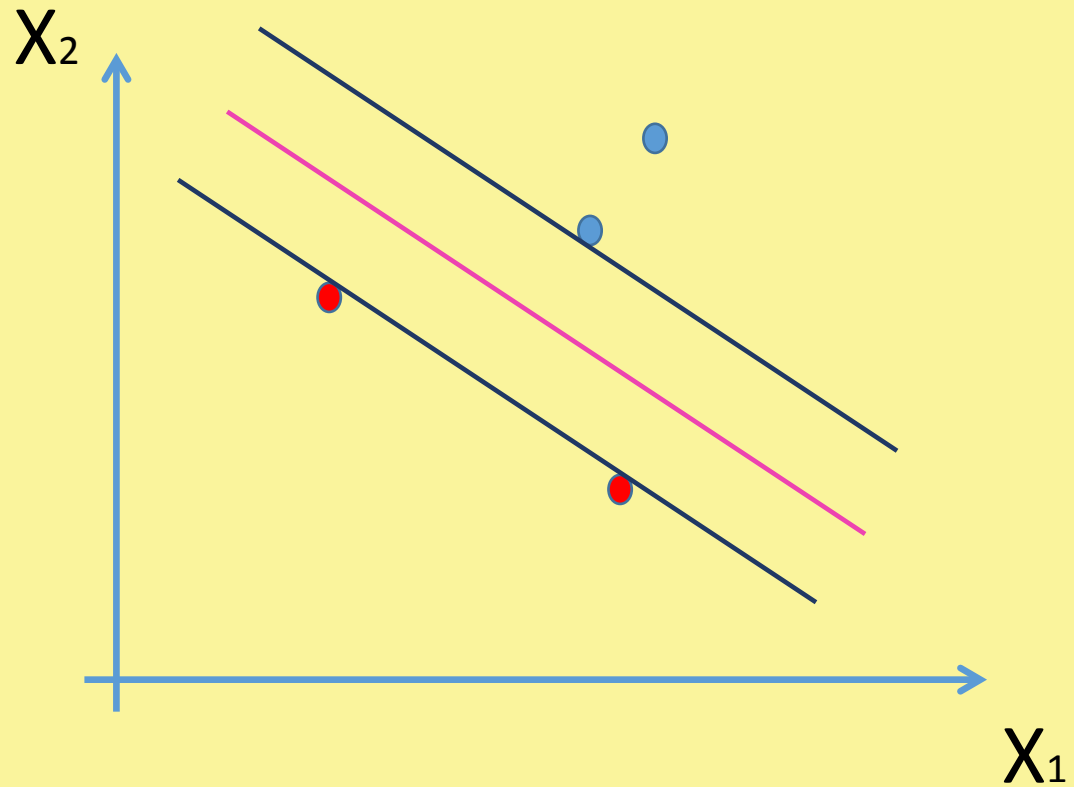
Support Vector Machine



Support Vector Machine



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*Thank
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