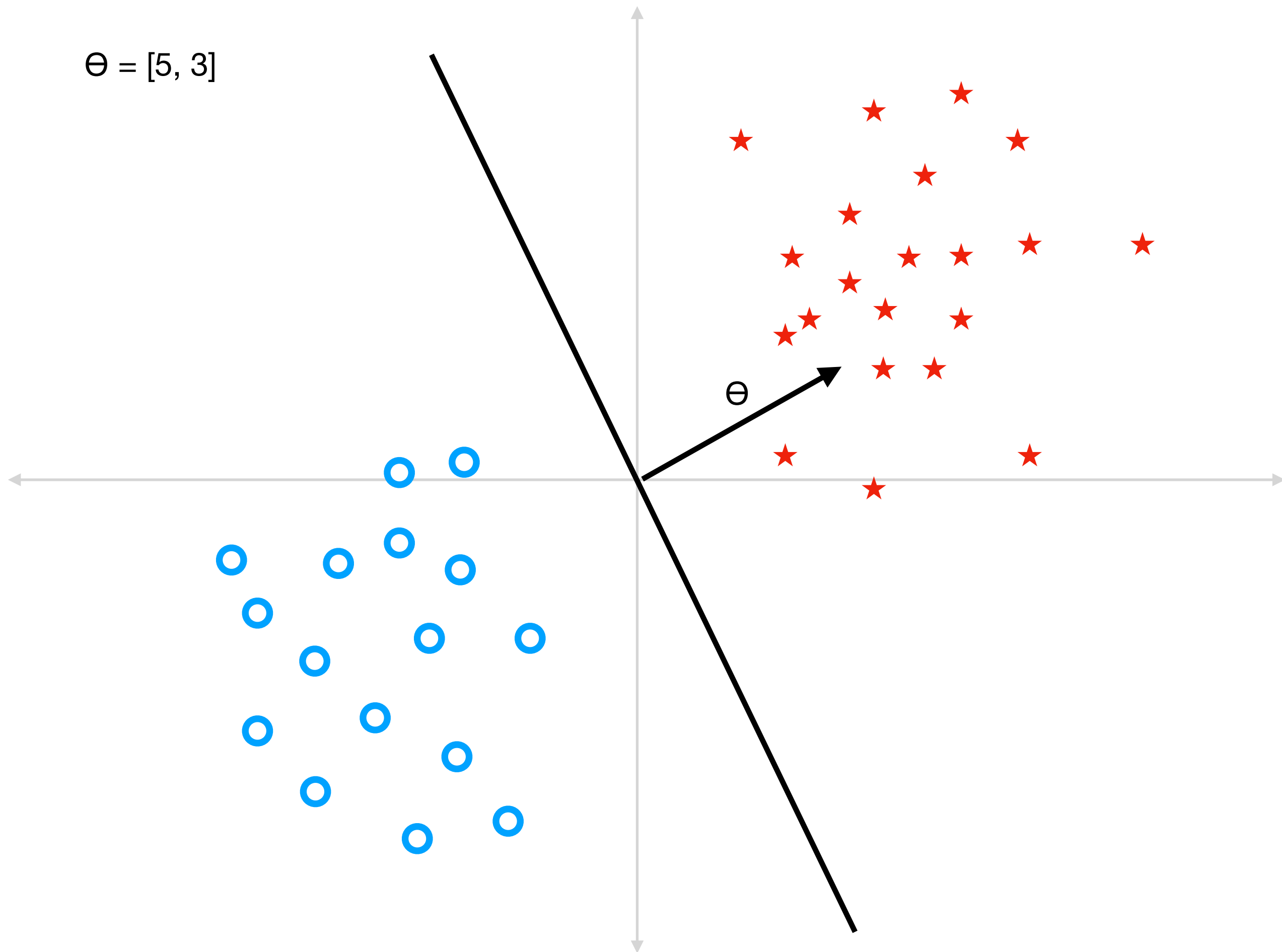


$$\Theta = [5, 3]$$

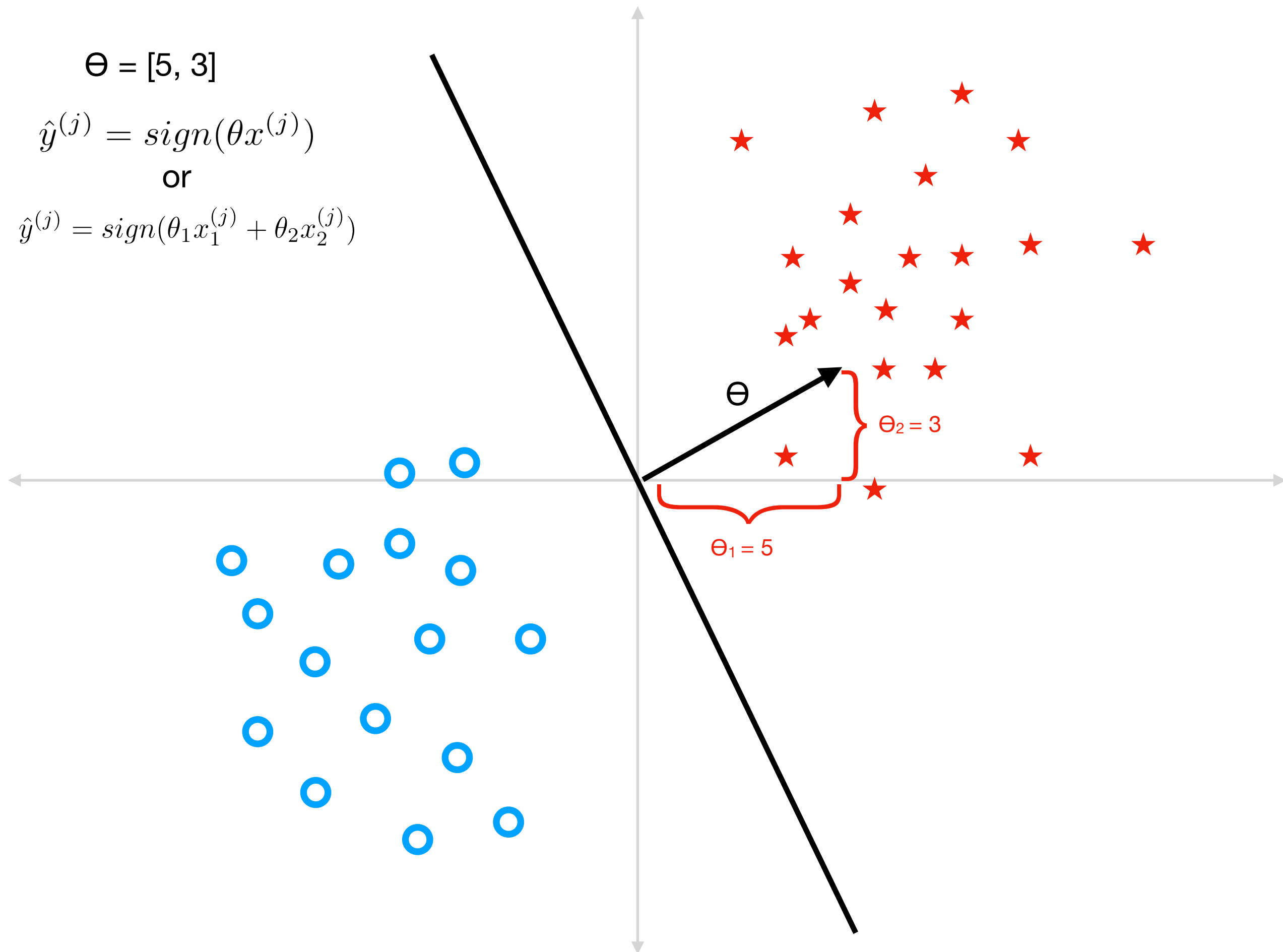


$$\Theta = [5, 3]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$

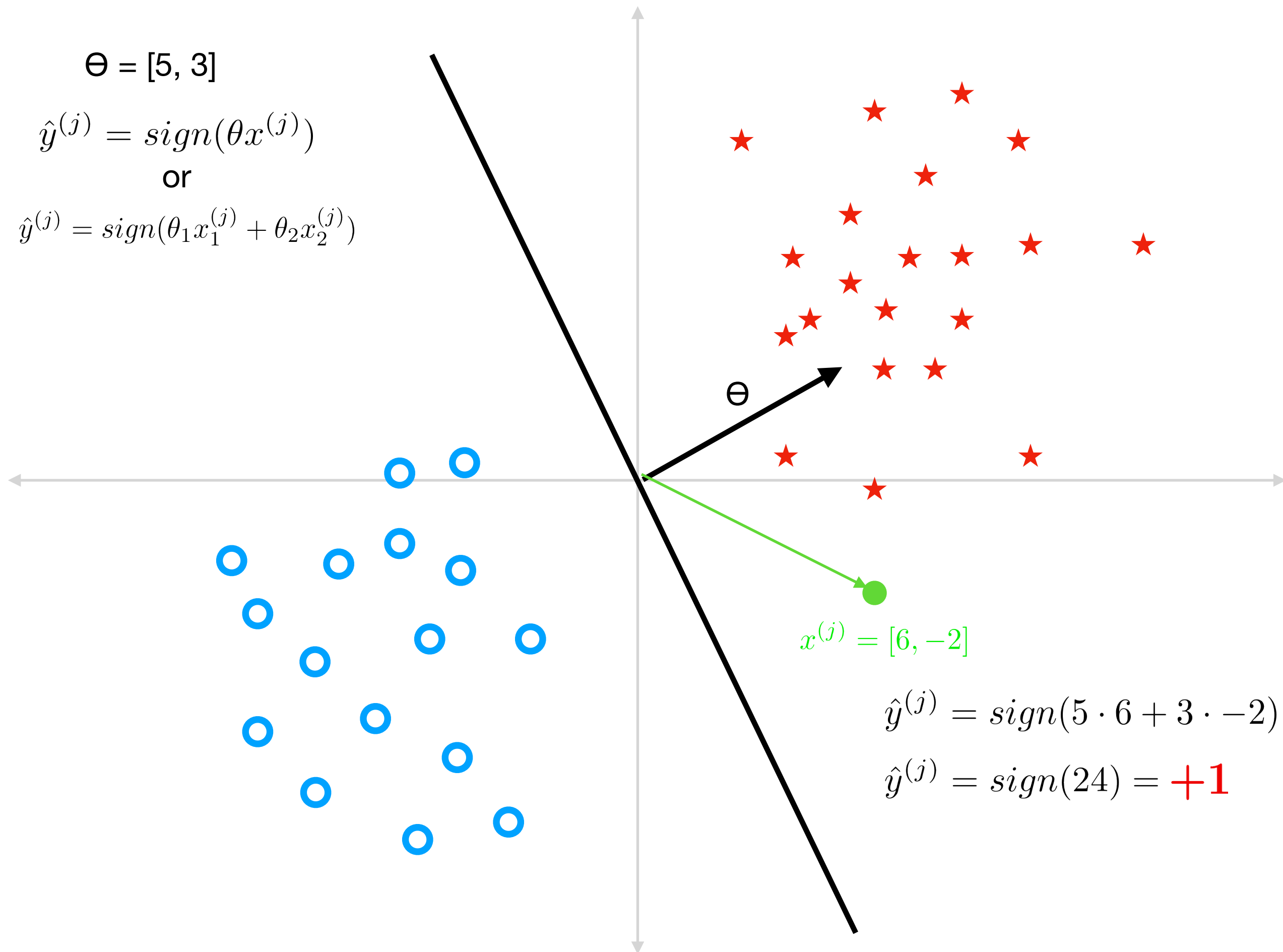


$$\Theta = [5, 3]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$



$$x^{(j)} = [6, -2]$$

$$\hat{y}^{(j)} = \text{sign}(5 \cdot 6 + 3 \cdot -2)$$

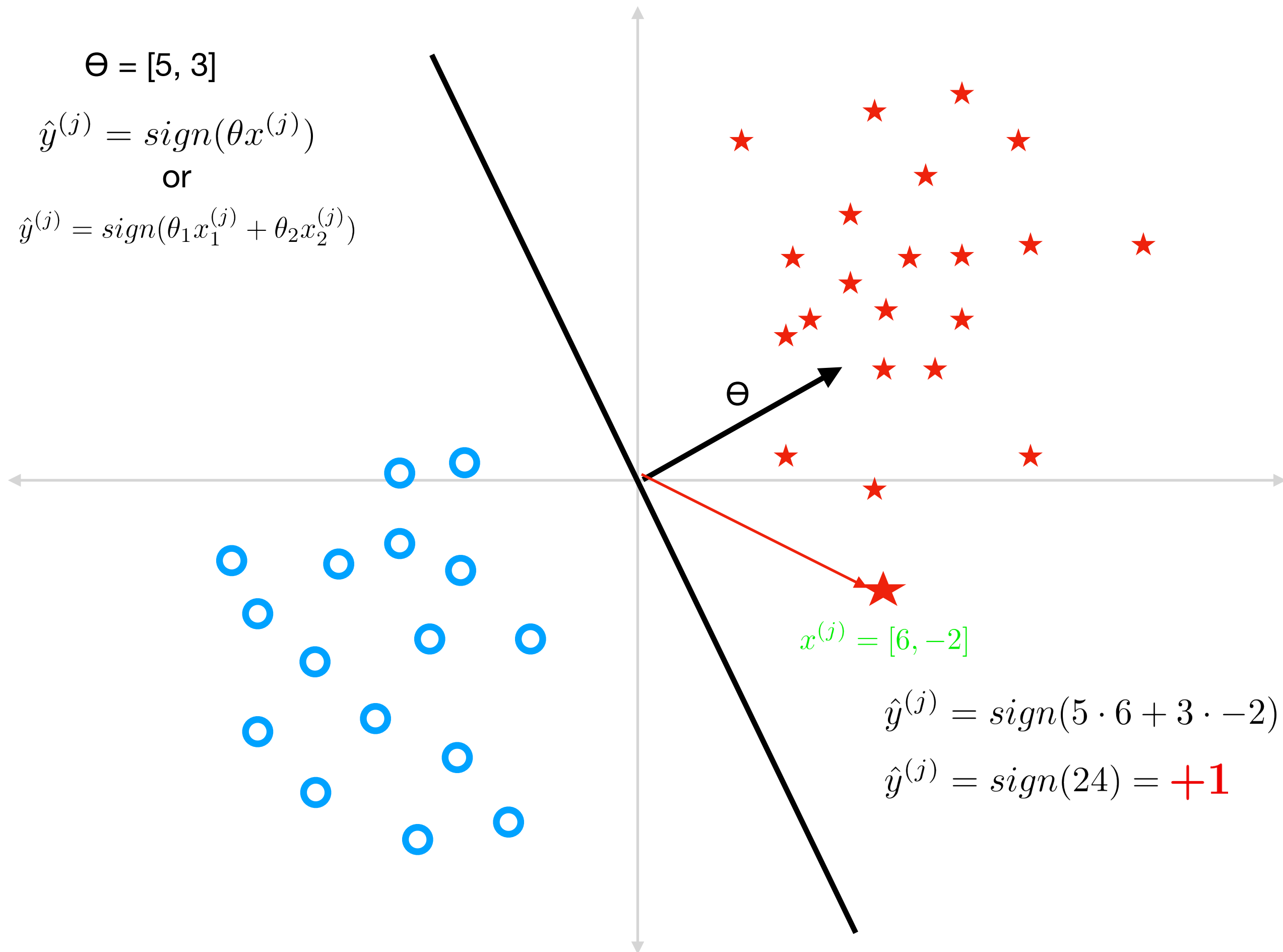
$$\hat{y}^{(j)} = \text{sign}(24) = +1$$

$$\Theta = [5, 3]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$



$$\hat{y}^{(j)} = \text{sign}(5 \cdot 6 + 3 \cdot -2)$$

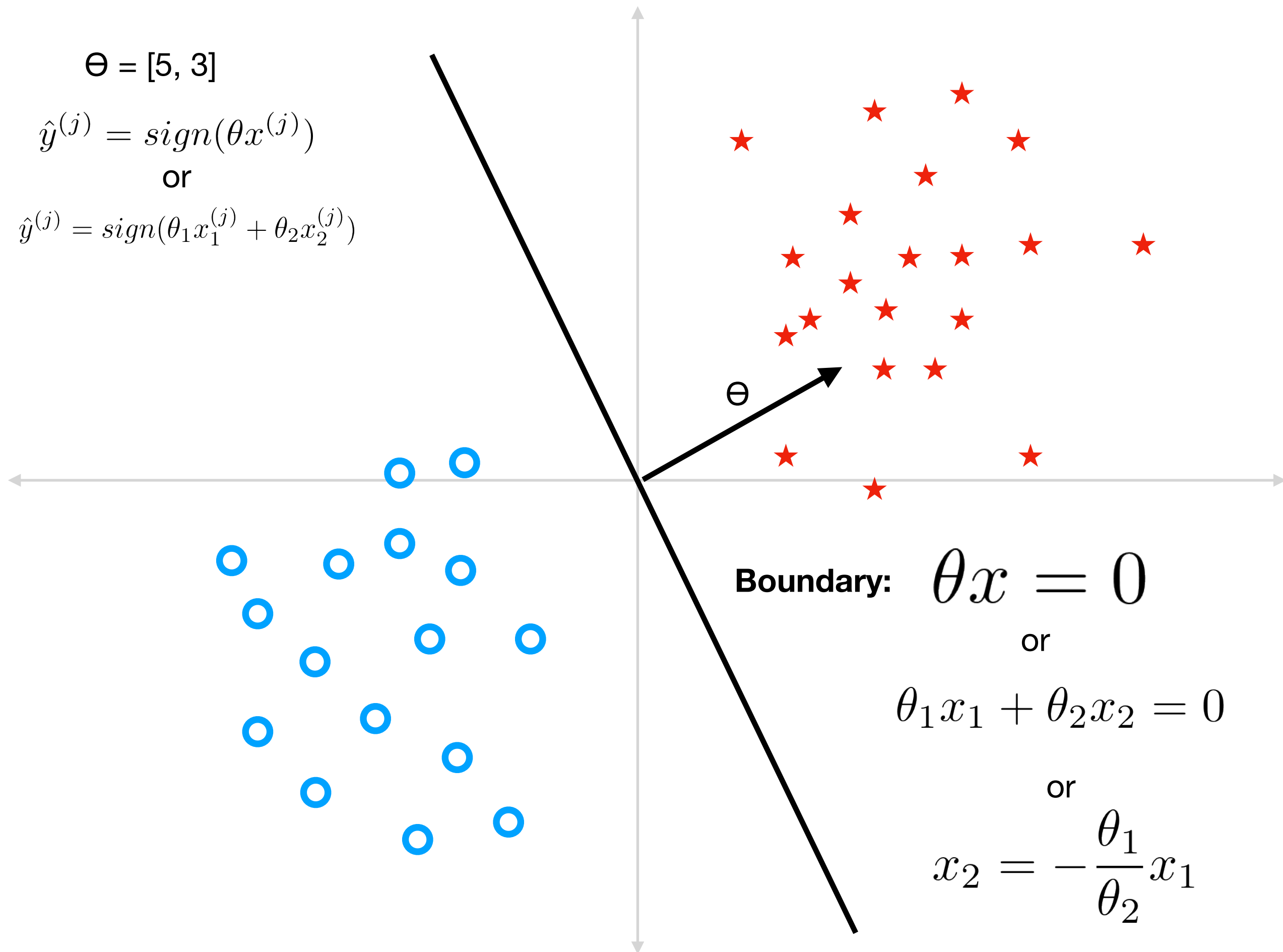
$$\hat{y}^{(j)} = \text{sign}(24) = +1$$

$$\Theta = [5, 3]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$

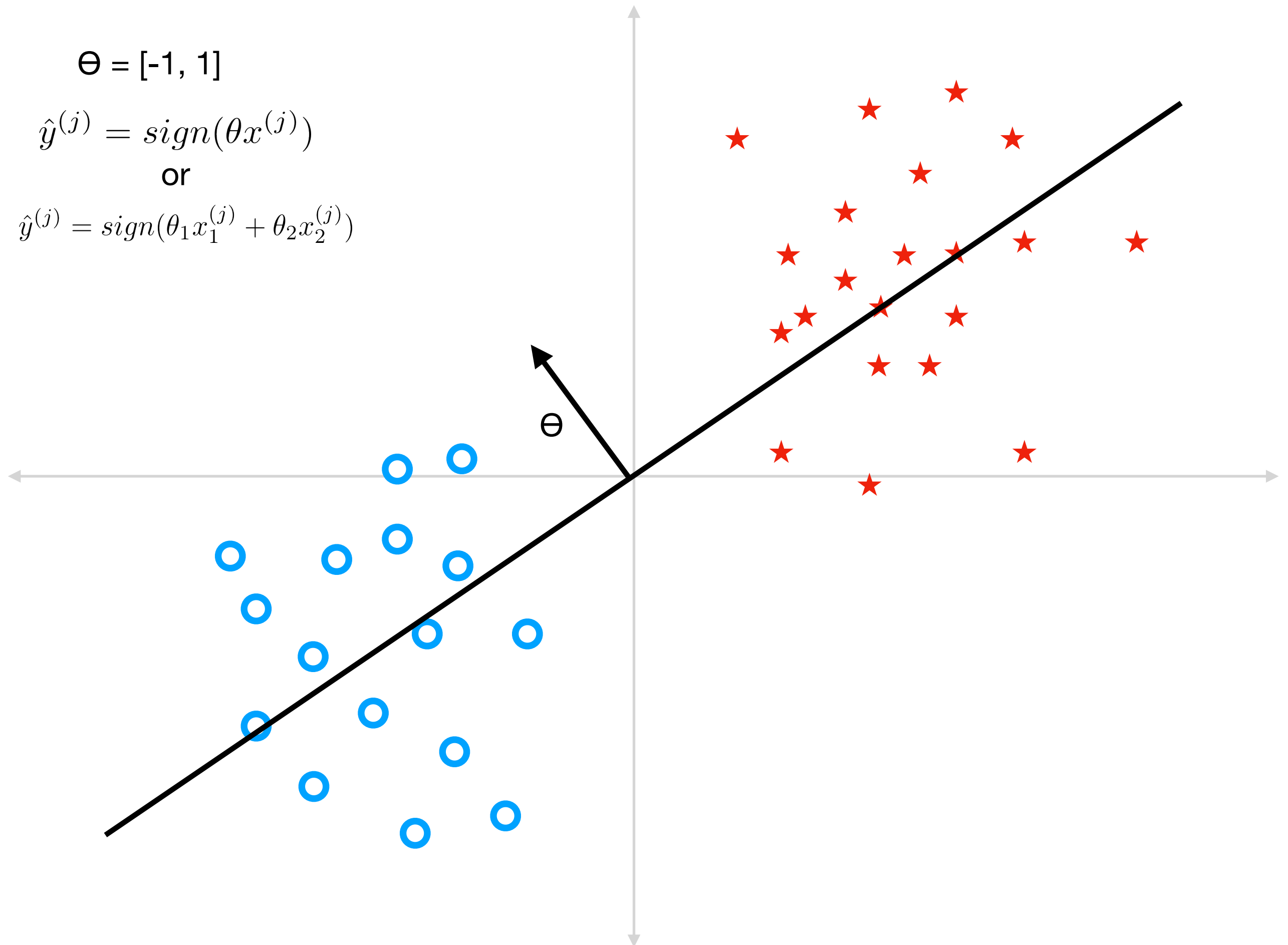


$$\Theta = [-1, 1]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$

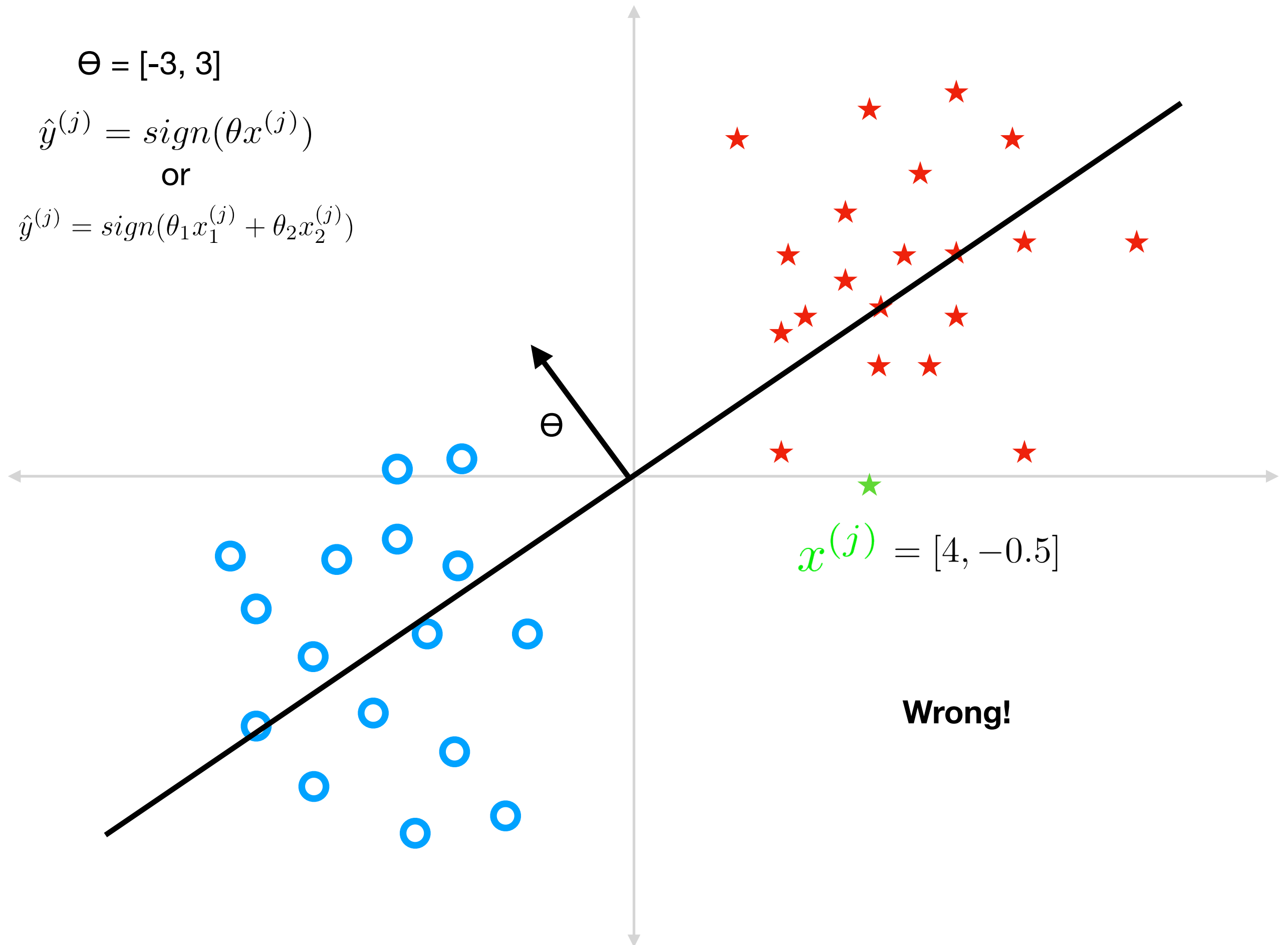


$$\Theta = [-3, 3]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$

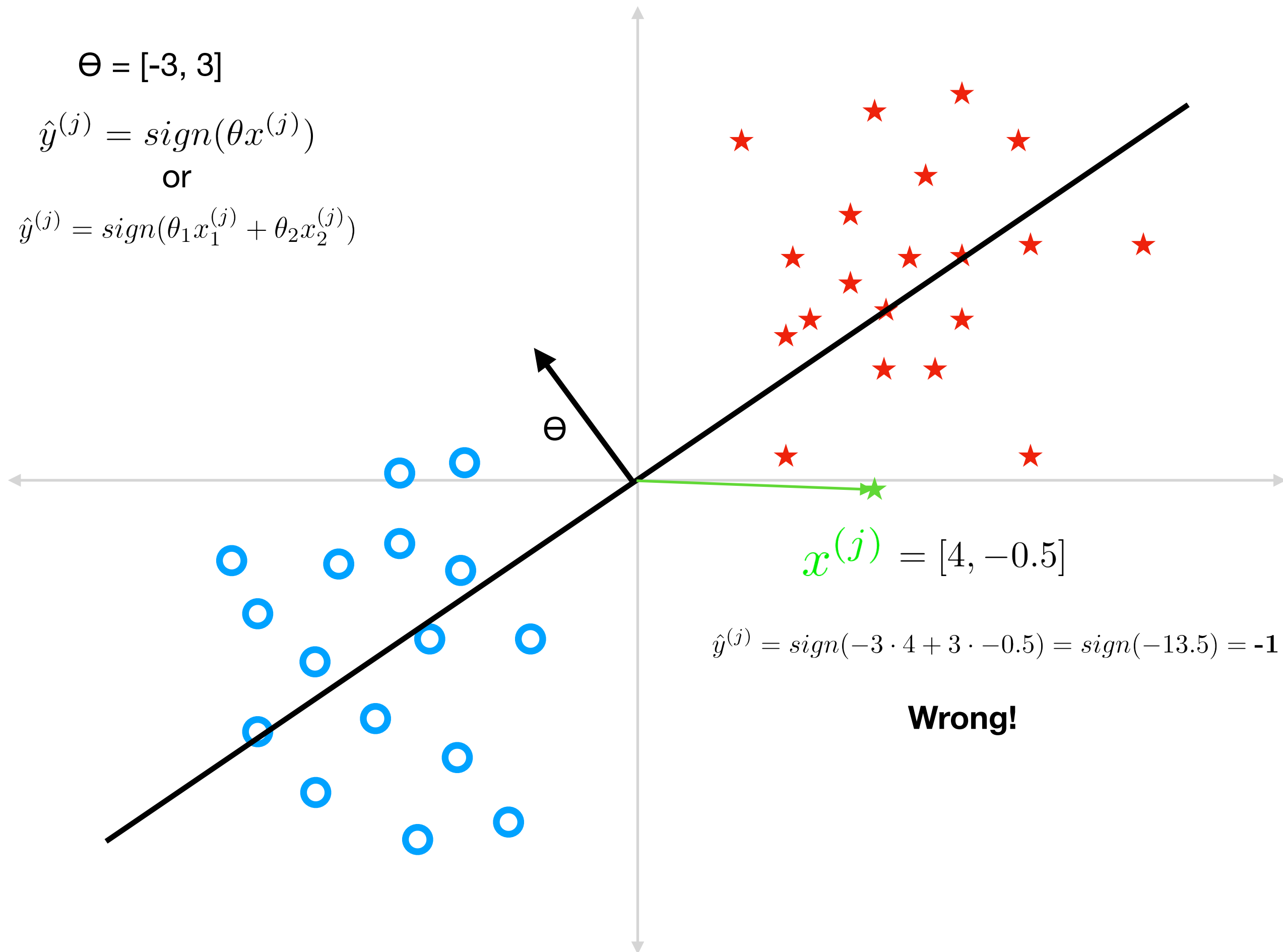


$$\Theta = [-3, 3]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$

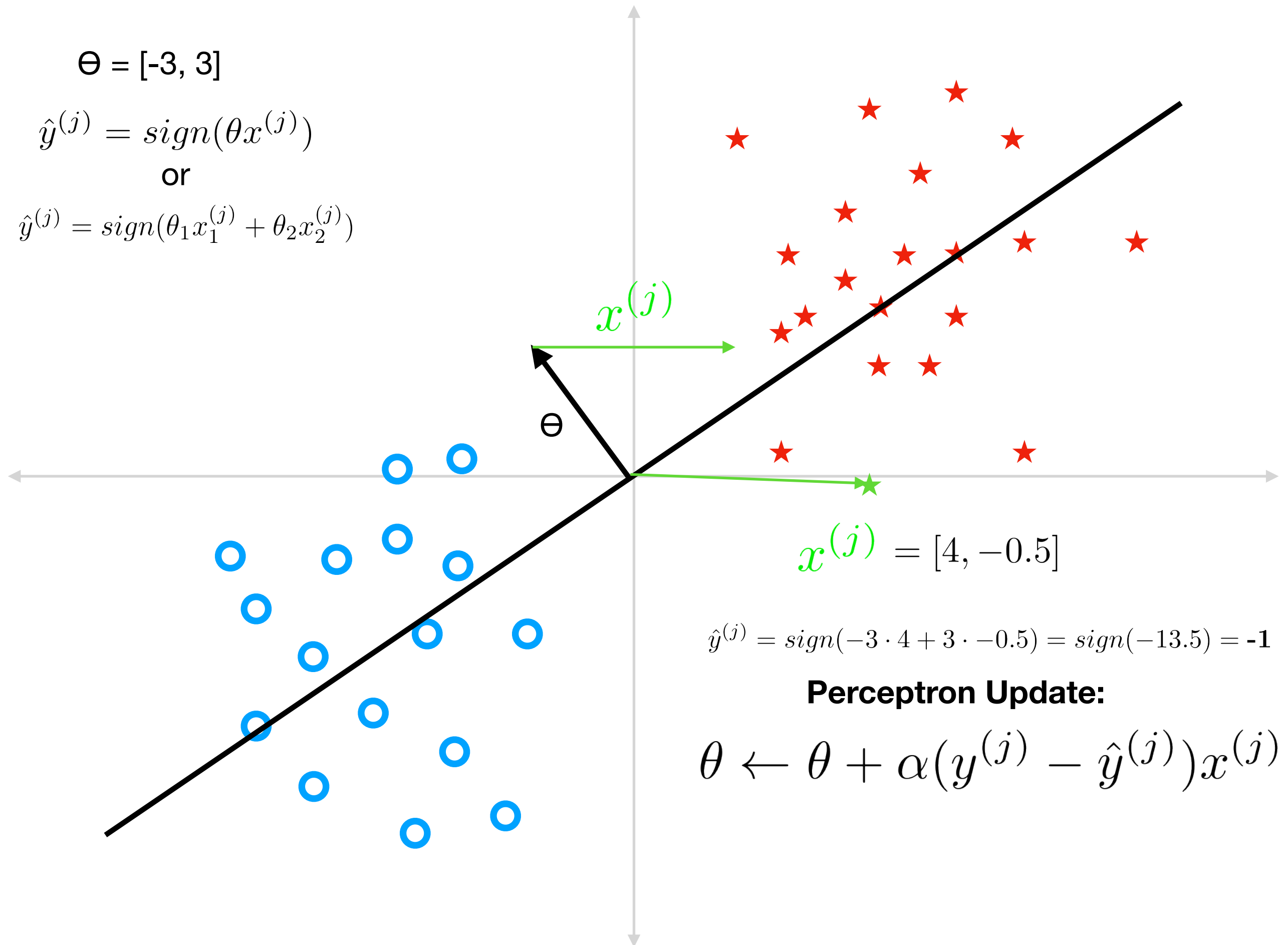


$$\Theta = [-3, 3]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$



$$x^{(j)} = [4, -0.5]$$

$$\hat{y}^{(j)} = \text{sign}(-3 \cdot 4 + 3 \cdot -0.5) = \text{sign}(-13.5) = -1$$

Perceptron Update:

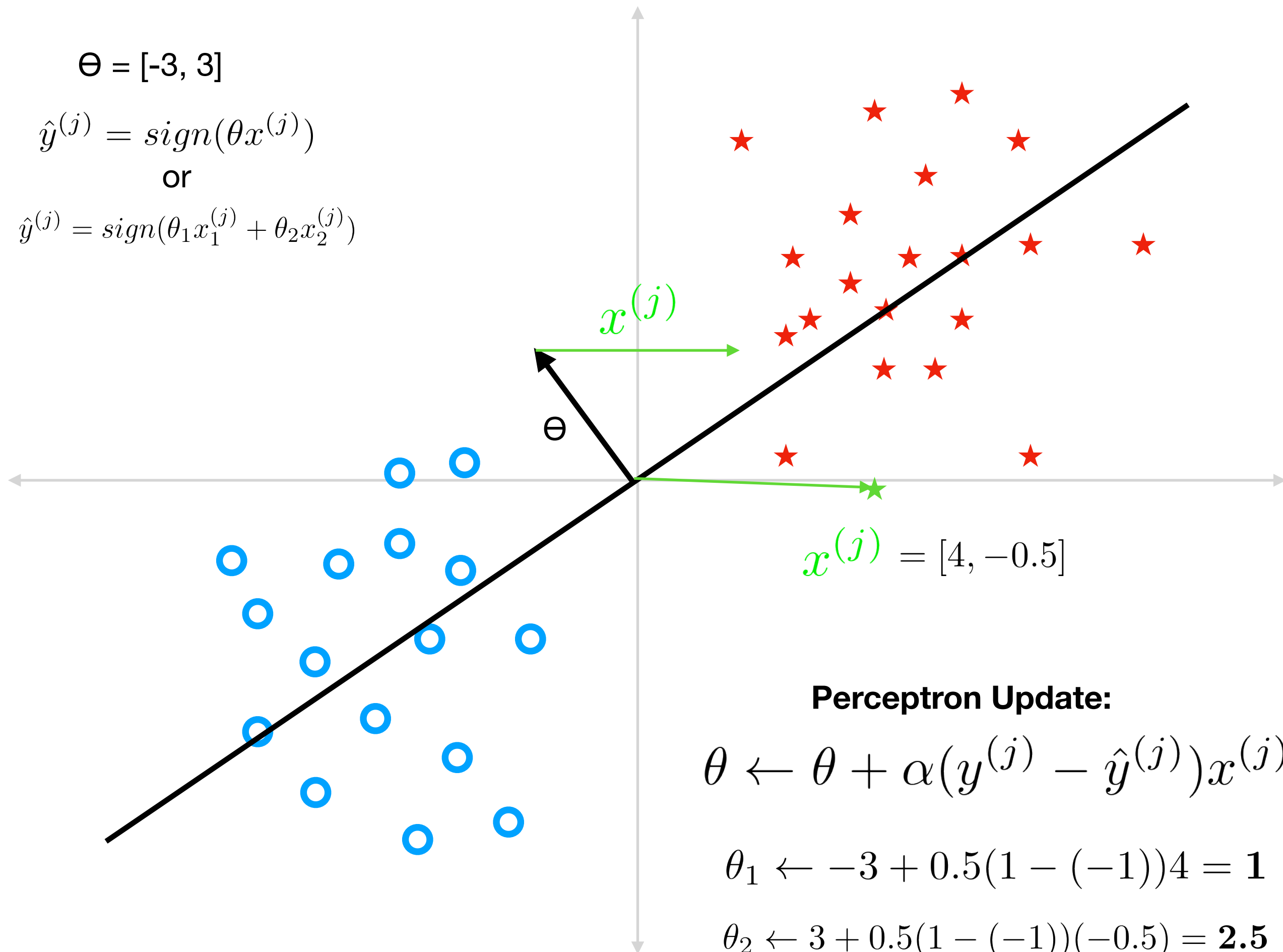
$$\theta \leftarrow \theta + \alpha(y^{(j)} - \hat{y}^{(j)})x^{(j)}$$

$$\Theta = [-3, 3]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$



Perceptron Update:

$$\theta \leftarrow \theta + \alpha(y^{(j)} - \hat{y}^{(j)})x^{(j)}$$

$$\theta_1 \leftarrow -3 + 0.5(1 - (-1))4 = \mathbf{1}$$

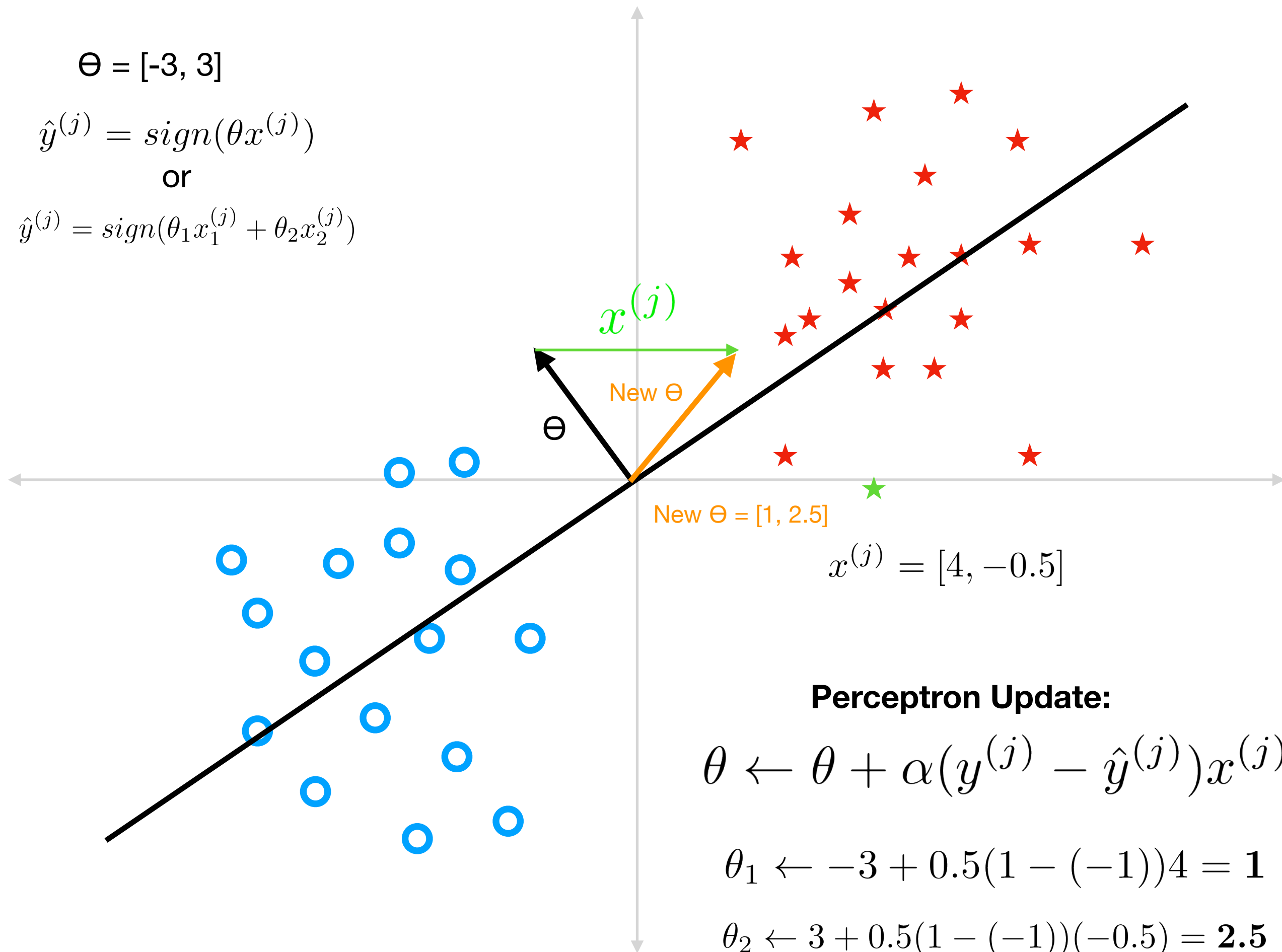
$$\theta_2 \leftarrow 3 + 0.5(1 - (-1))(-0.5) = \mathbf{2.5}$$

$$\Theta = [-3, 3]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$



Perceptron Update:

$$\theta \leftarrow \theta + \alpha(y^{(j)} - \hat{y}^{(j)})x^{(j)}$$

$$\theta_1 \leftarrow -3 + 0.5(1 - (-1))4 = \mathbf{1}$$

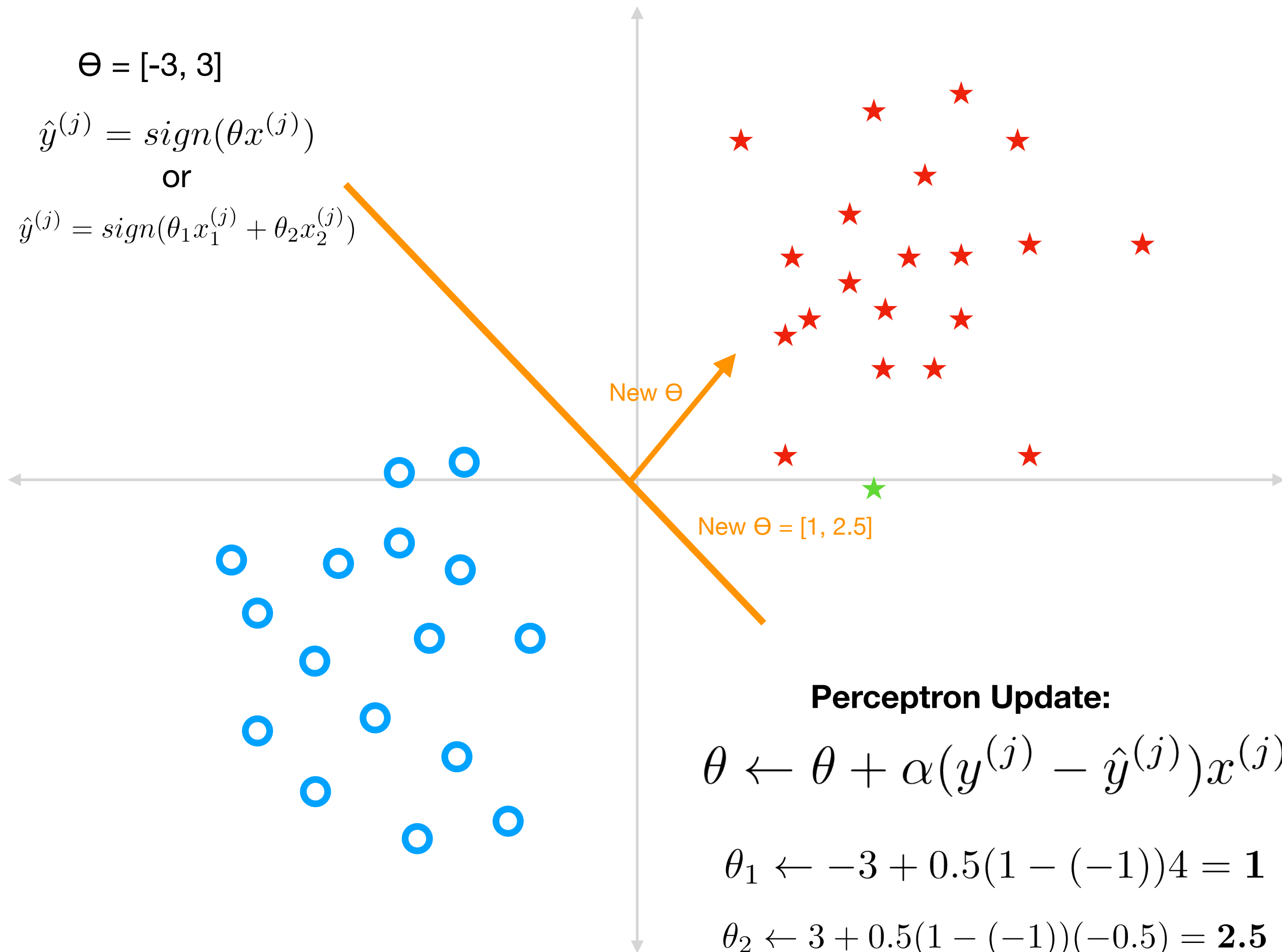
$$\theta_2 \leftarrow 3 + 0.5(1 - (-1))(-0.5) = \mathbf{2.5}$$

$$\Theta = [-3, 3]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$



Perceptron Update:

$$\theta \leftarrow \theta + \alpha(y^{(j)} - \hat{y}^{(j)})x^{(j)}$$

$$\theta_1 \leftarrow -3 + 0.5(1 - (-1))4 = \mathbf{1}$$

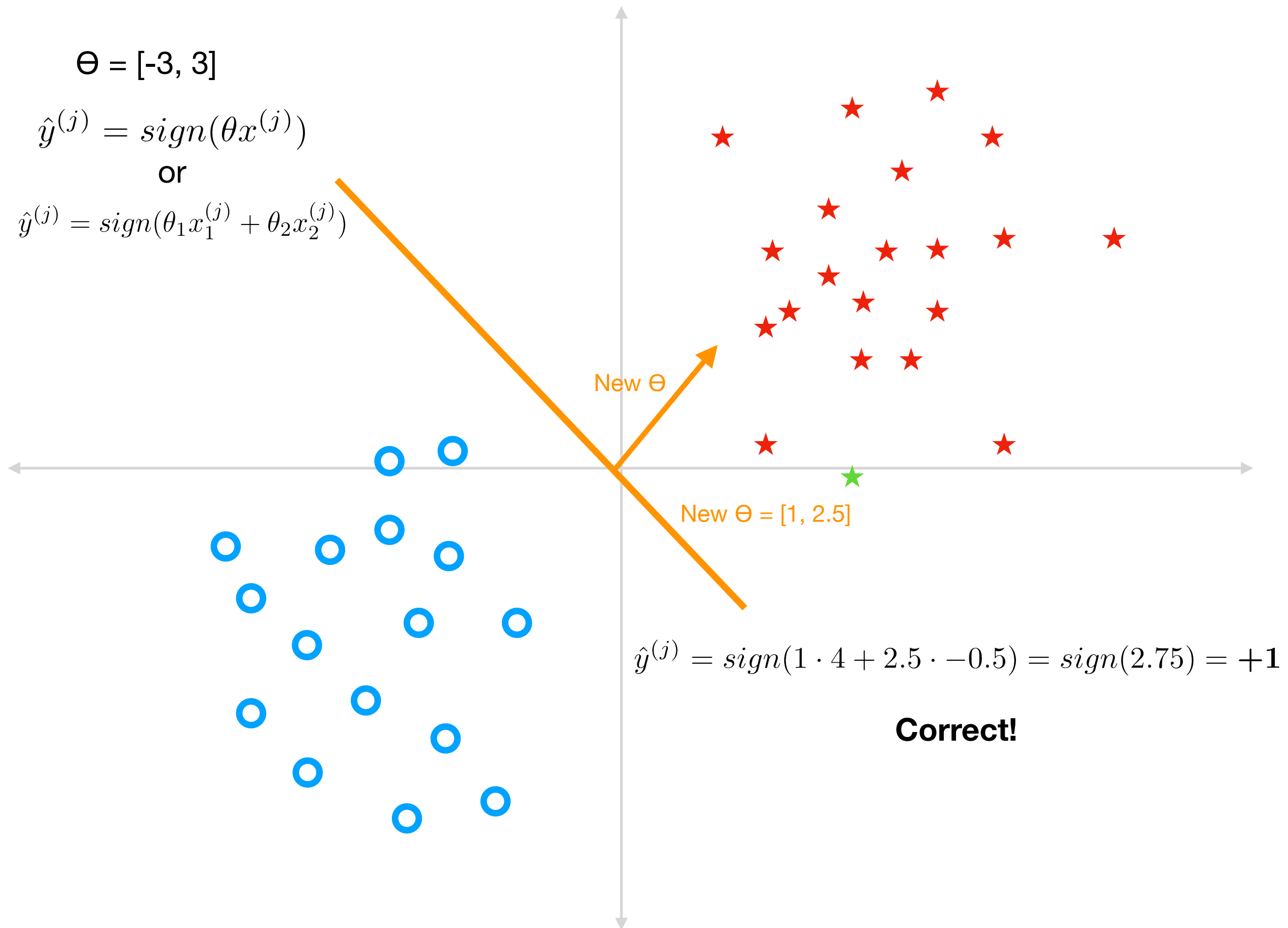
$$\theta_2 \leftarrow 3 + 0.5(1 - (-1))(-0.5) = \mathbf{2.5}$$

$$\Theta = [-3, 3]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$



$$\hat{y}^{(j)} = \text{sign}(1 \cdot 4 + 2.5 \cdot -0.5) = \text{sign}(2.75) = +1$$

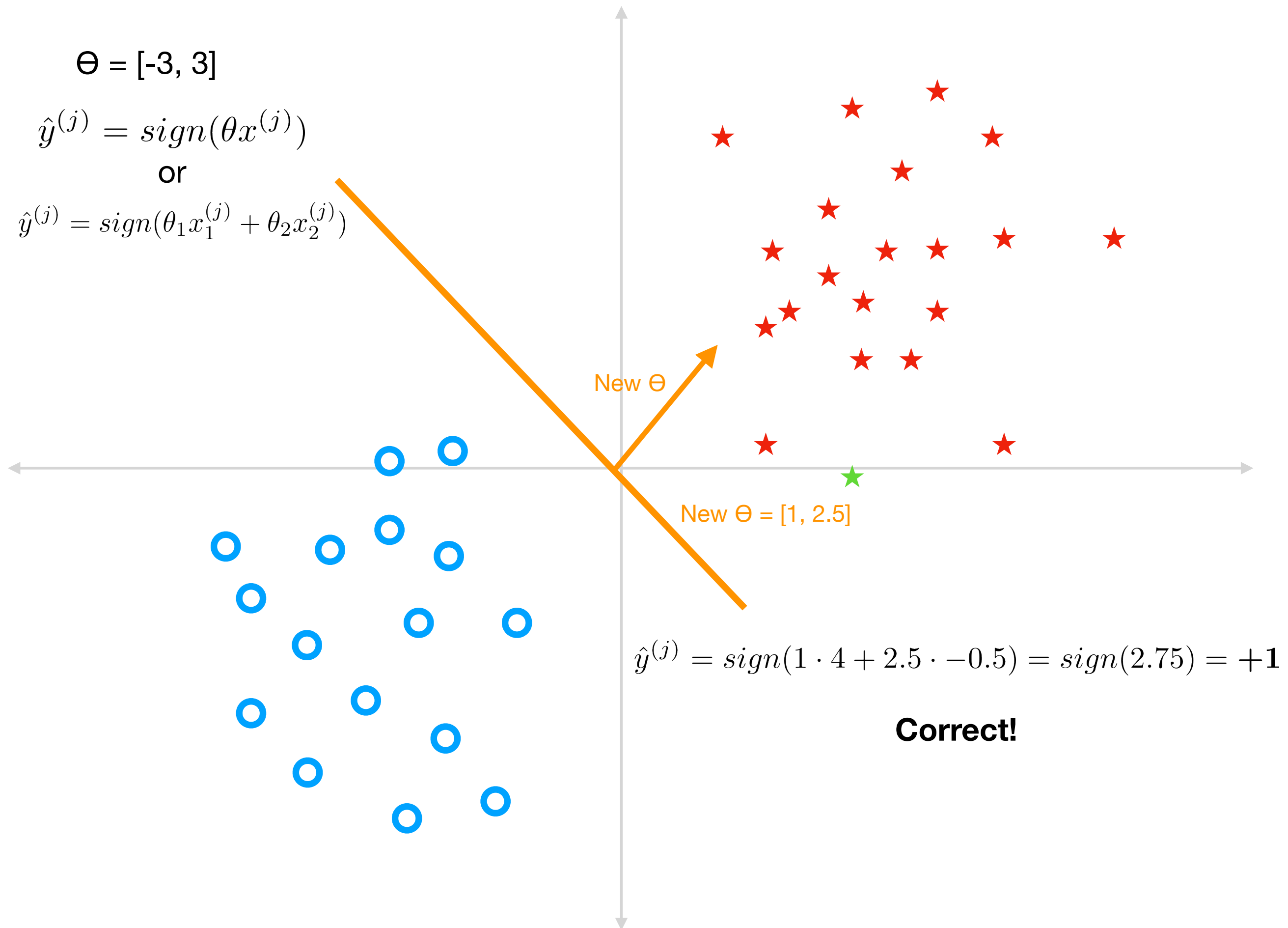
Correct!

$$\Theta = [-3, 3]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$

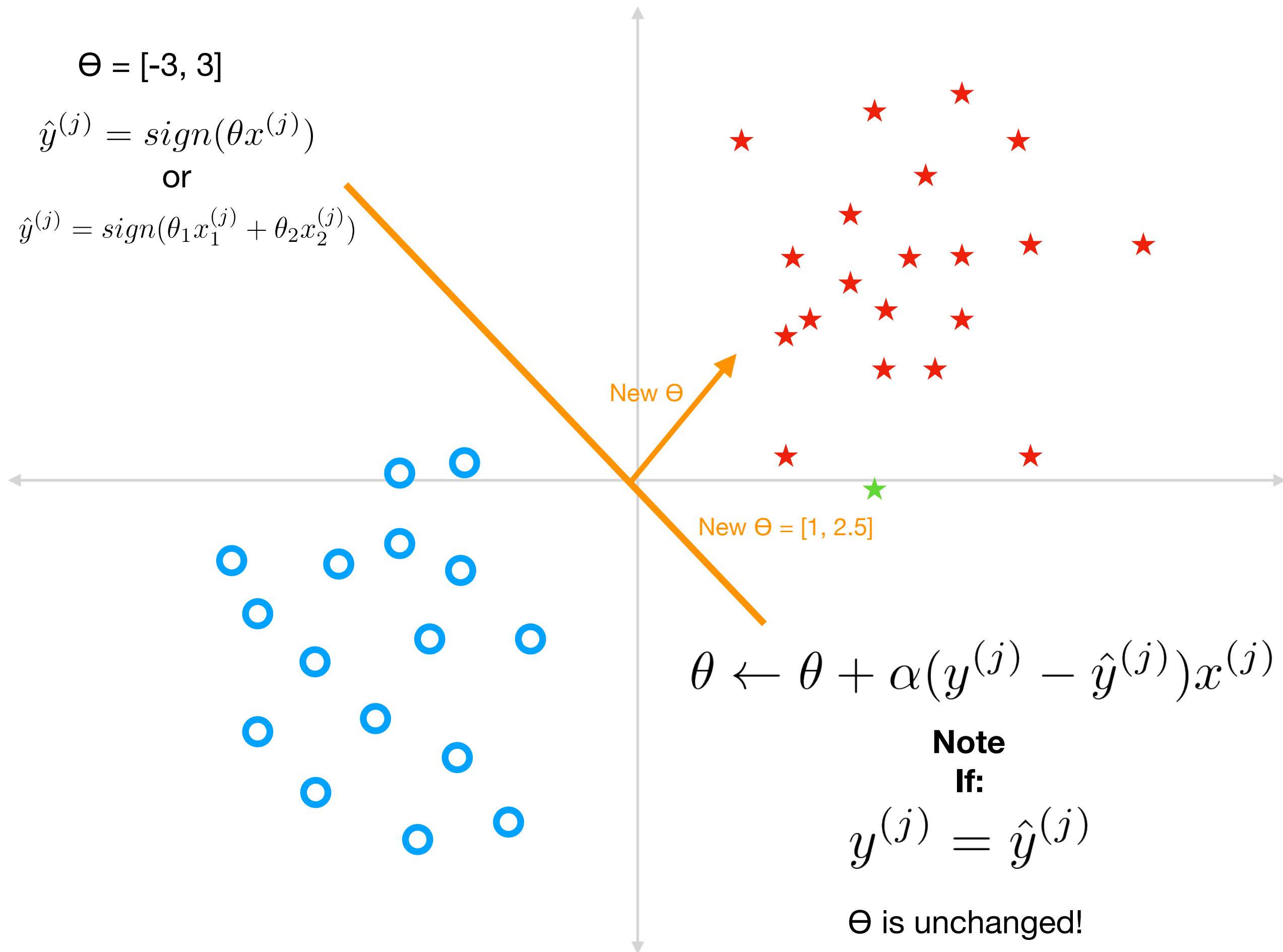


$$\Theta = [-3, 3]$$

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

or

$$\hat{y}^{(j)} = \text{sign}(\theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$



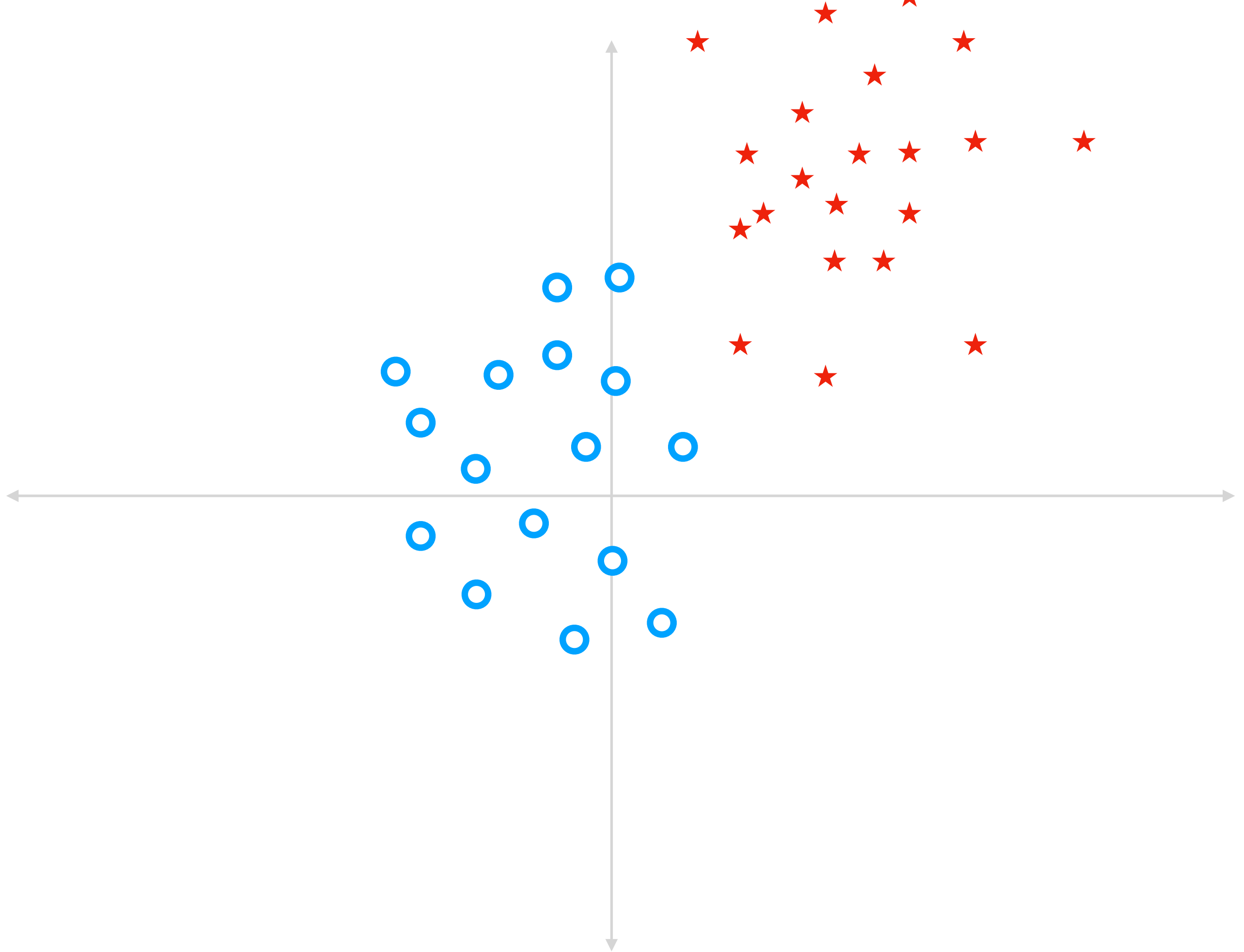
$$\theta \leftarrow \theta + \alpha(y^{(j)} - \hat{y}^{(j)})x^{(j)}$$

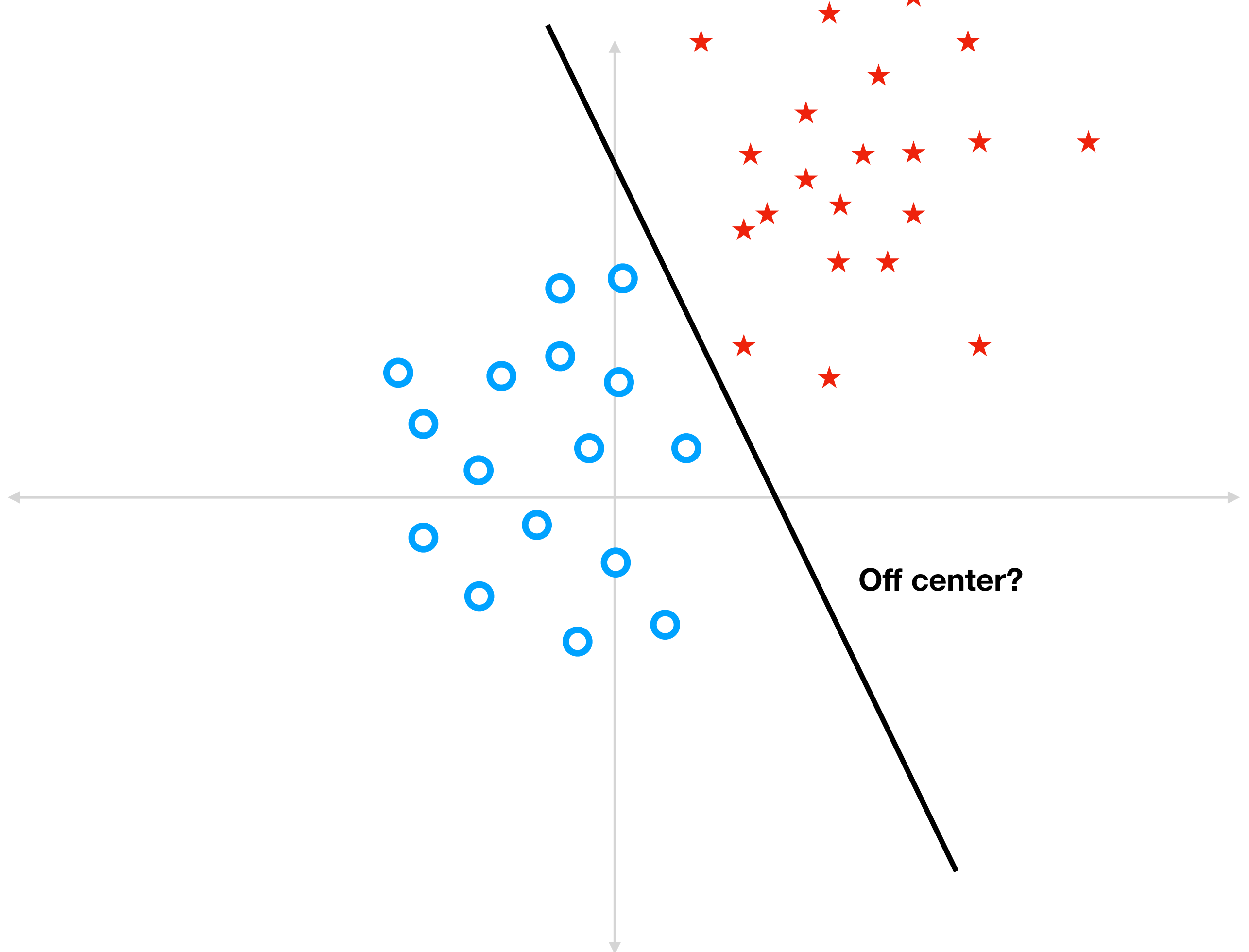
Note

If:

$$y^{(j)} = \hat{y}^{(j)}$$

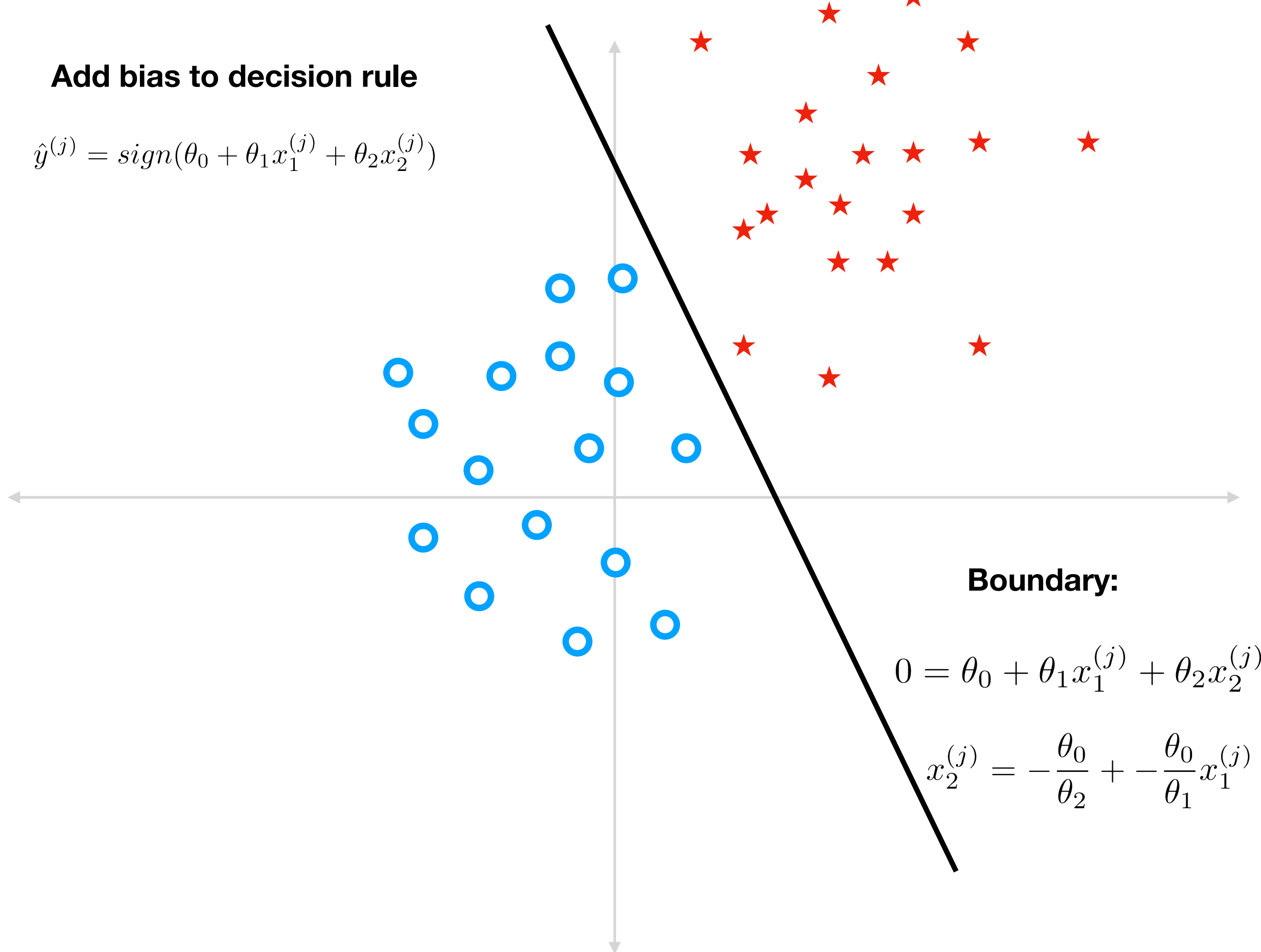
Θ is unchanged!





Add bias to decision rule

$$\hat{y}^{(j)} = \text{sign}(\theta_0 + \theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$



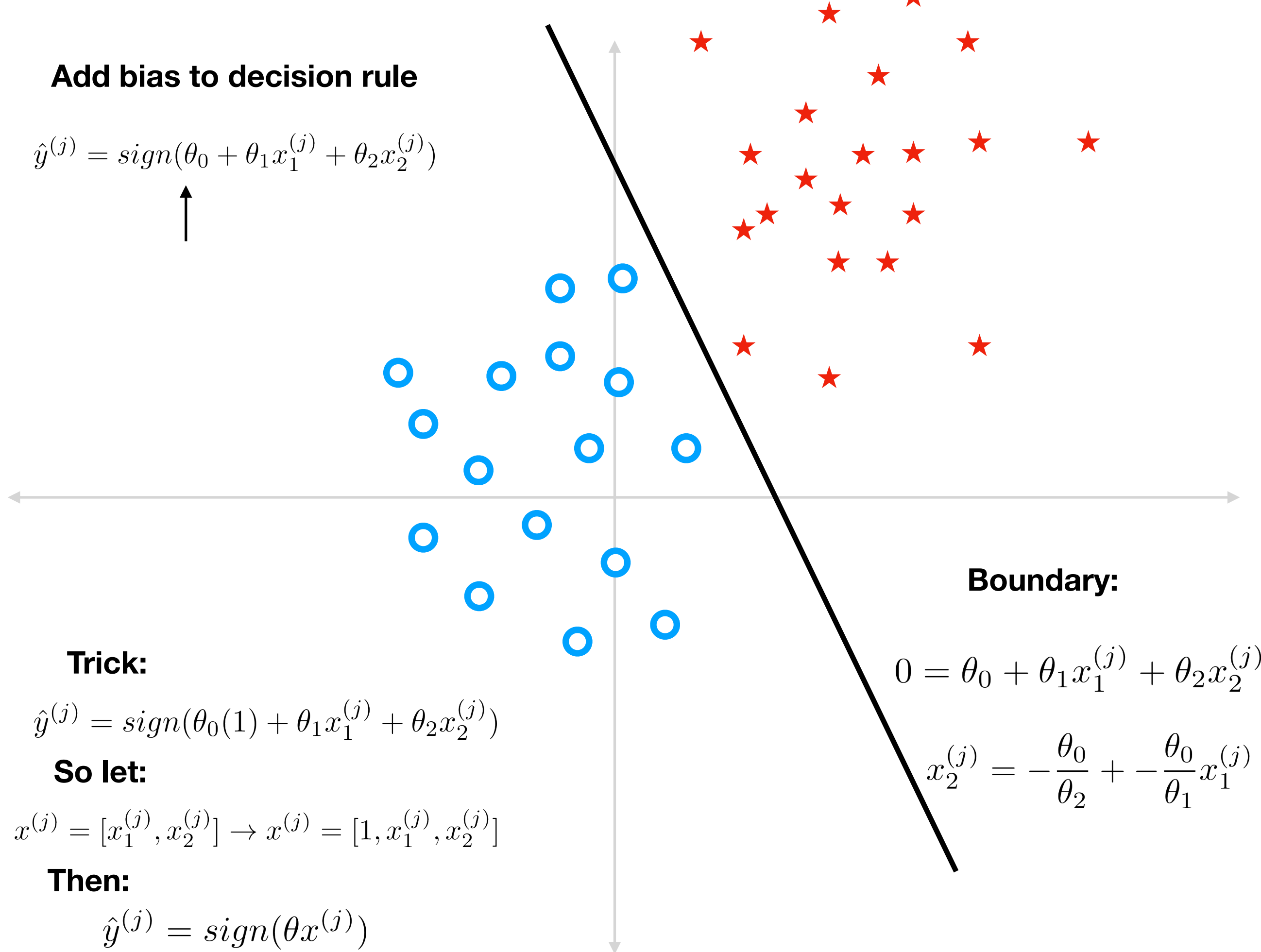
Boundary:

$$0 = \theta_0 + \theta_1 x_1^{(j)} + \theta_2 x_2^{(j)}$$

$$x_2^{(j)} = -\frac{\theta_0}{\theta_2} - \frac{\theta_1}{\theta_2} x_1^{(j)}$$

Add bias to decision rule

$$\hat{y}^{(j)} = \text{sign}(\theta_0 + \theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$



Boundary:

$$0 = \theta_0 + \theta_1 x_1^{(j)} + \theta_2 x_2^{(j)}$$

$$\hat{y}^{(j)} = \text{sign}(\theta_0(1) + \theta_1 x_1^{(j)} + \theta_2 x_2^{(j)})$$

So let:

$$x^{(j)} = [x_1^{(j)}, x_2^{(j)}] \rightarrow x^{(j)} = [1, x_1^{(j)}, x_2^{(j)}]$$

Then:

$$\hat{y}^{(j)} = \text{sign}(\theta x^{(j)})$$

$$x_2^{(j)} = -\frac{\theta_0}{\theta_2} + -\frac{\theta_0}{\theta_1} x_1^{(j)}$$