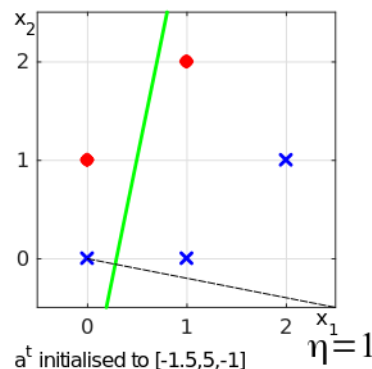


## Sequential Perceptron Learning Algorithm

- Initialise  $\mathbf{a}$  to arbitrary solution and select learning rate
- Until convergence (all samples correctly classified)
- ➔ For each sample,  $\mathbf{y}_k$ , in the dataset in turn
  - If  $\mathbf{y}_k$  is misclassified:
 
$$\mathbf{a} \leftarrow \mathbf{a} + \eta \omega'_k \mathbf{y}_k$$

Example:

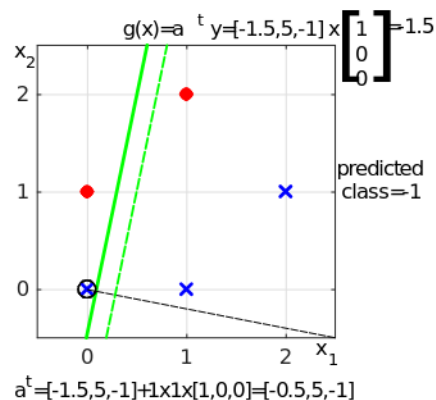
$\mathbf{x}^T$	class
[0,0]	1
[1,0]	1
[2,1]	1
[0,1]	-1
[1,2]	-1



## Sequential Perceptron Learning Algorithm

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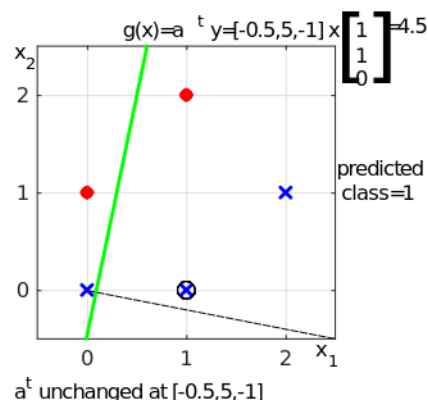
Example:



## Sequential Perceptron Learning Algorithm

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Example:



## Sequential Perceptron Learning Algorithm

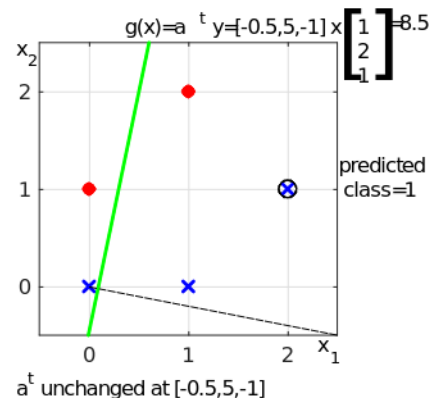
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## Sequential Perceptron Learning Algorithm

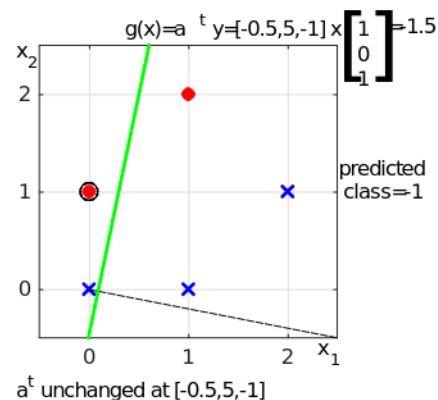
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## Sequential Perceptron Learning Algorithm

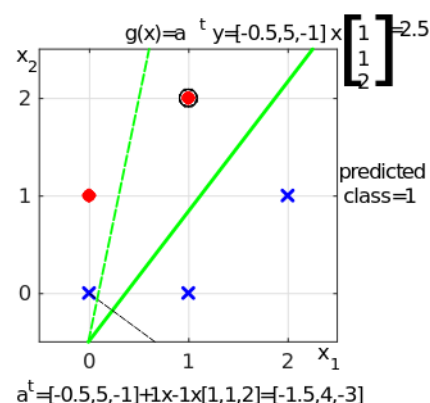
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Example:



## Sequential Perceptron Learning Algorithm

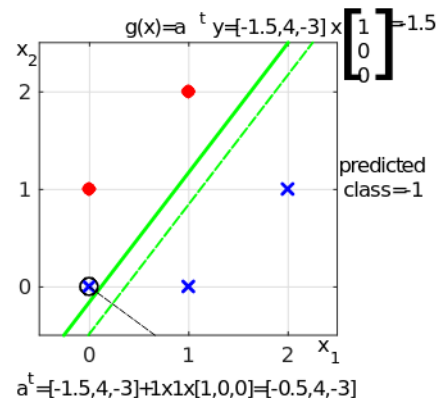
- Initialise  $\mathbf{a}$  to arbitrary solution
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➔ For each sample,  $\mathbf{y}_k$ , in the dataset in turn

- If  $\mathbf{y}_k$  is misclassified:

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Example:



## Sequential Perceptron Learning Algorithm

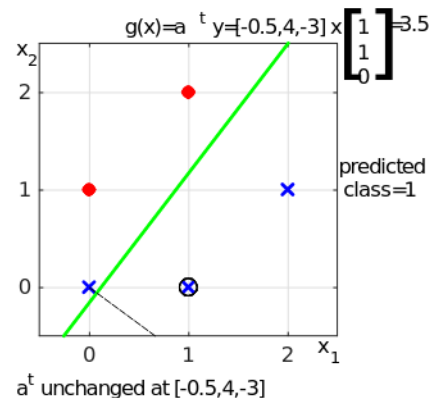
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Example:



## Sequential Perceptron Learning Algorithm

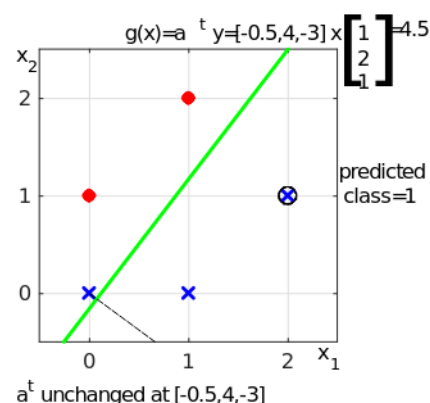
- Initialise  $\mathbf{a}$  to arbitrary solution
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Example:



## Sequential Perceptron Learning Algorithm

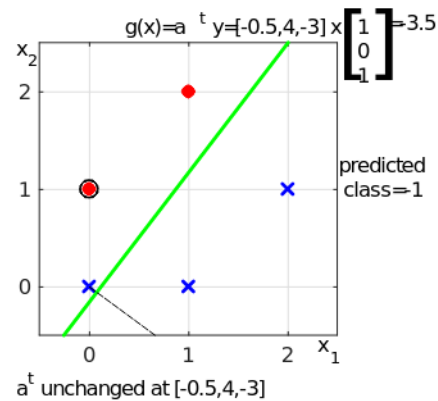
- Initialise  $\mathbf{a}$  to arbitrary solution
- Until convergence (all samples correctly classified)

➔ For each sample,  $\mathbf{y}_k$ , in the dataset in turn

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Example:



## Sequential Perceptron Learning Algorithm

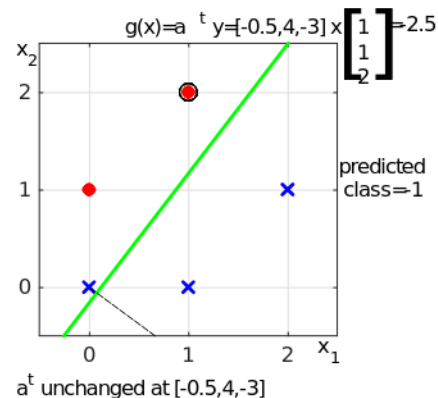
- Initialise  $\mathbf{a}$  to arbitrary solution
- Until convergence (all samples correctly classified)

➔ For each sample,  $\mathbf{y}_k$ , in the dataset in turn

- If  $\mathbf{y}_k$  is misclassified:

$$\mathbf{a} \leftarrow \mathbf{a} + \eta \omega'_k \mathbf{y}_k$$

Example:



## Sequential Perceptron Learning Algorithm

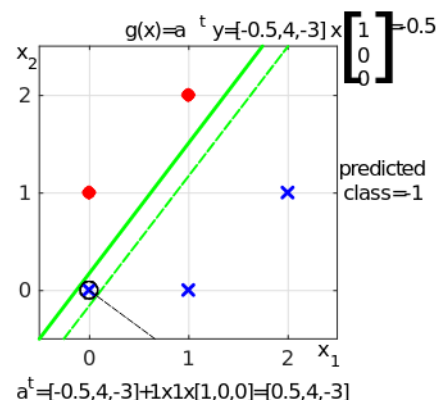
- Initialise  $\mathbf{a}$  to arbitrary solution
- Until convergence (all samples correctly classified)

➔ For each sample,  $\mathbf{y}_k$ , in the dataset in turn

- If  $\mathbf{y}_k$  is misclassified:

$$\mathbf{a} \leftarrow \mathbf{a} + \eta \omega'_k \mathbf{y}_k$$

Example:

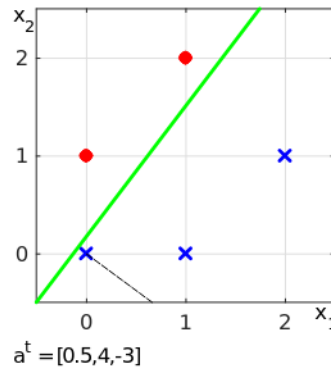


## Sequential Perceptron Learning Algorithm

- Initialise  $\mathbf{a}$  to arbitrary solution and select learning rate
- **Until convergence (all samples correctly classified)**
- ➔ For each sample,  $\mathbf{y}_k$ , in the dataset in turn
  - If  $\mathbf{y}_k$  is misclassified:
 
$$\mathbf{a} \leftarrow \mathbf{a} + \eta \omega'_k \mathbf{y}_k$$

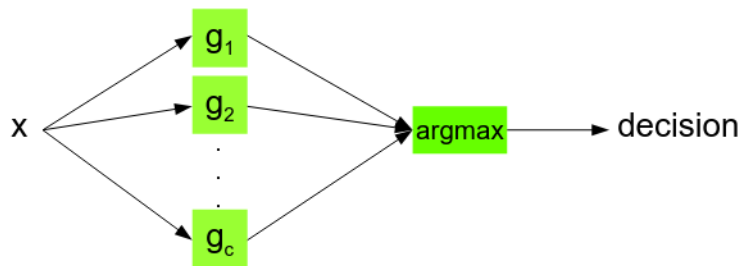
Example:

$\mathbf{x}^T$	class	$g(\mathbf{x})$
[0,0]	1	0.5
[1,0]	1	4.5
[2,1]	1	5.5
[0,1]	-1	-2.5
[1,2]	-1	-1.5



## Multiclass Perceptron Learning Algorithm

Assign feature vector  $\mathbf{x}$  to class  $\omega_j$  if:  $g_j(\mathbf{x}) > g_i(\mathbf{x}) \quad \forall i \neq j$



If classification is wrong, adjust weights of discriminant functions:

- move weights for required class towards input
- move weights of wrongly selected class away from input

## Multiclass Perceptron Learning Algorithm

- Set value of hyper-parameter ( $\eta$ )
- For each possible class,  $c$ , initialise  $\mathbf{a}_c$  to arbitrary solution
- ➔ For each sample,  $(\mathbf{y}_k, \omega_k)$  in the dataset in turn
  - Classify:  $c' = \operatorname{argmax}_c g_c(\mathbf{x}_k)$
  - If  $\mathbf{y}_k$  is misclassified (i.e.  $c' \neq \omega_k$ )
    - Move  $\mathbf{a}_{\omega_k}$  towards  $\mathbf{y}_k$ :  $\mathbf{a}_{\omega_k} \leftarrow \mathbf{a}_{\omega_k} + \eta \mathbf{y}_k$
    - Move  $\mathbf{a}_{c'}$  away from  $\mathbf{y}_k$ :  $\mathbf{a}_{c'} \leftarrow \mathbf{a}_{c'} - \eta \mathbf{y}_k$