

# 人工智能

## ——人工神经网络 I



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# Perceptron Learning Algorithm

- 对连续型属性做统一处理。
- 离散型属性需要转化为连续随机变量。
- 对于拥有 $d$ 个特征的  $\mathbf{x}=(x_1, x_2, \dots, x_d)$  , 计算它的带权“分数”。

如果  $\sum_{k=1}^d w_k x_k > threshold$  , 预测为+1(good)

如果  $\sum_{k=1}^d w_k x_k < threshold$  , 预测为-1(bad)

- $\mathbf{y}=\{+1(\text{good}), -1(\text{bad})\}$

$$h(\mathbf{x}) = \text{sign} \left( \left( \sum_{k=1}^d w_k x_k \right) - threshold \right)$$

# Perceptron Learning Algorithm

$$\begin{aligned}h(\mathbf{x}) &= \text{sign} \left( \left( \sum_{k=1}^d w_k x_k \right) - \text{threshold} \right) \\&= \text{sign} \left( \left( \sum_{k=1}^d w_k x_k \right) + \underbrace{(-\text{threshold})}_{w_0} \cdot \underbrace{(+1)}_{x_0} \right) \\&= \text{sign} \left( \sum_{j=0}^d w_j x_j \right) \\&= \text{sign} (\tilde{\mathbf{W}}^T \tilde{\mathbf{X}})\end{aligned}$$

$-y_i \tilde{\mathbf{w}}^T \tilde{\mathbf{x}}_i$  来衡量错误情况

# Perceptron Learning Algorithm

- 难点: 函数  $h(\mathbf{x})$  有无限多种可能
- 想法: 先初始化  $\mathbf{w}_{(0)}$ , 然后根据  $D$  来修正  $\mathbf{w}$ .
- For  $t = 0, 1, \dots$

- 找到  $\mathbf{w}_{(t)}$  预测错的数据  $(\mathbf{x}_{i(t)}, y_{i(t)})$

$$\text{sign}(\tilde{\mathbf{w}}_{(t)}^T \tilde{\mathbf{x}}_{i(t)}) \neq y_{i(t)} \quad \bar{y} \equiv -w^T x \cdot y = 1$$

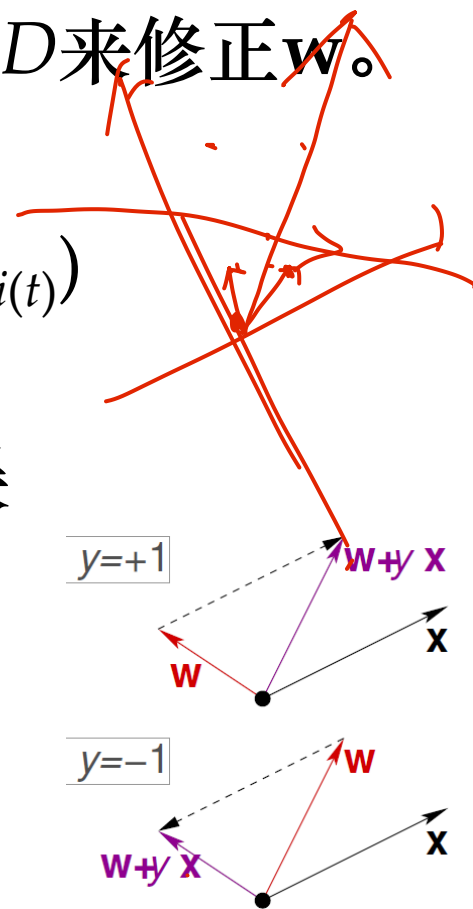
- (尝试) 用下面的方法修正错误

$$\tilde{\mathbf{w}}_{(t+1)} \leftarrow \tilde{\mathbf{w}}_{(t)} + y_{i(t)} \tilde{\mathbf{x}}_{i(t)} \quad \begin{matrix} w_{t+1} \\ = w_t - \eta \bar{y} \end{matrix}$$

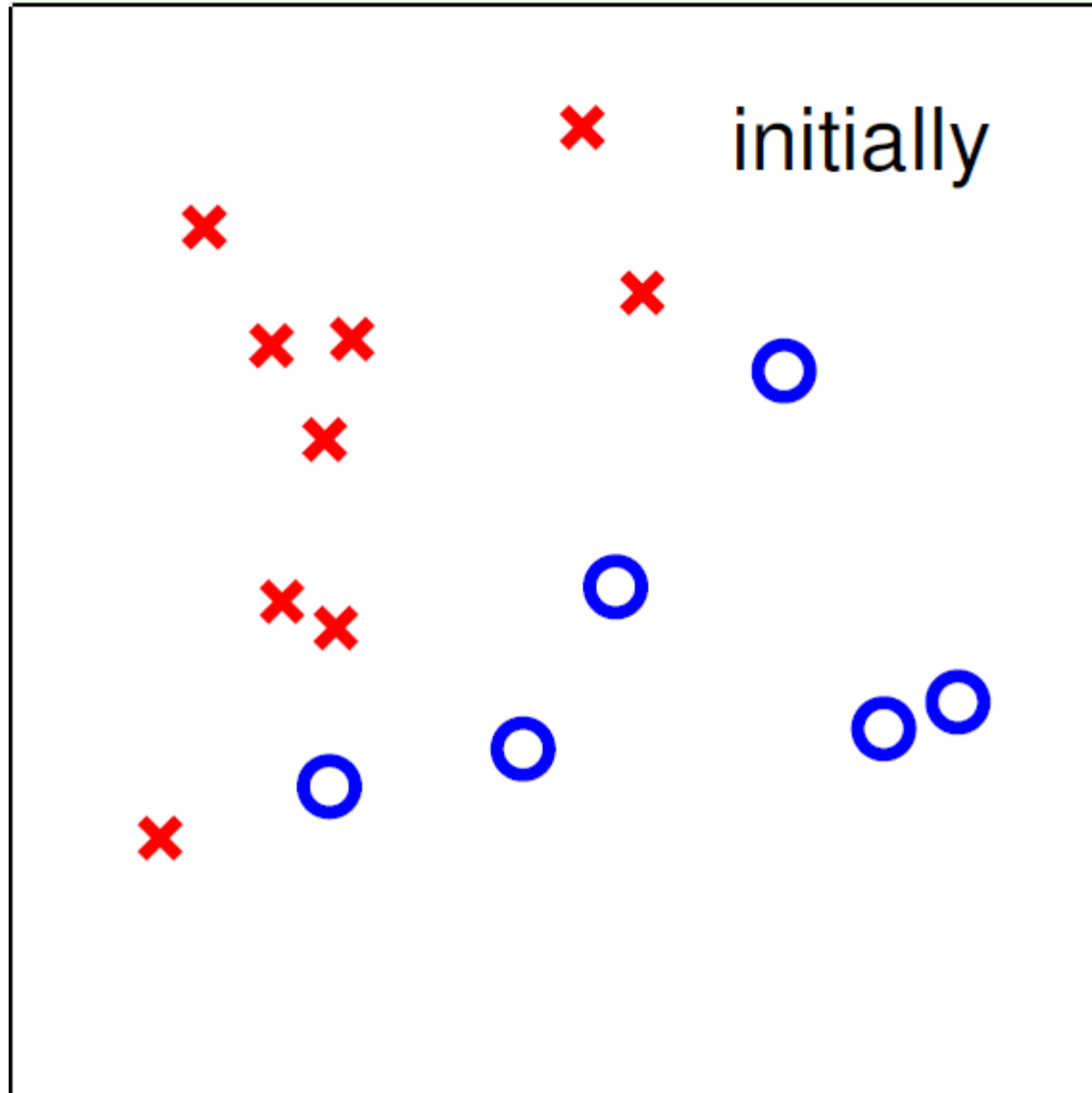
- 直到没有错误

- 返回最终的  $\mathbf{W}$  (called  $\mathbf{W}_{\text{PLA}}$ )

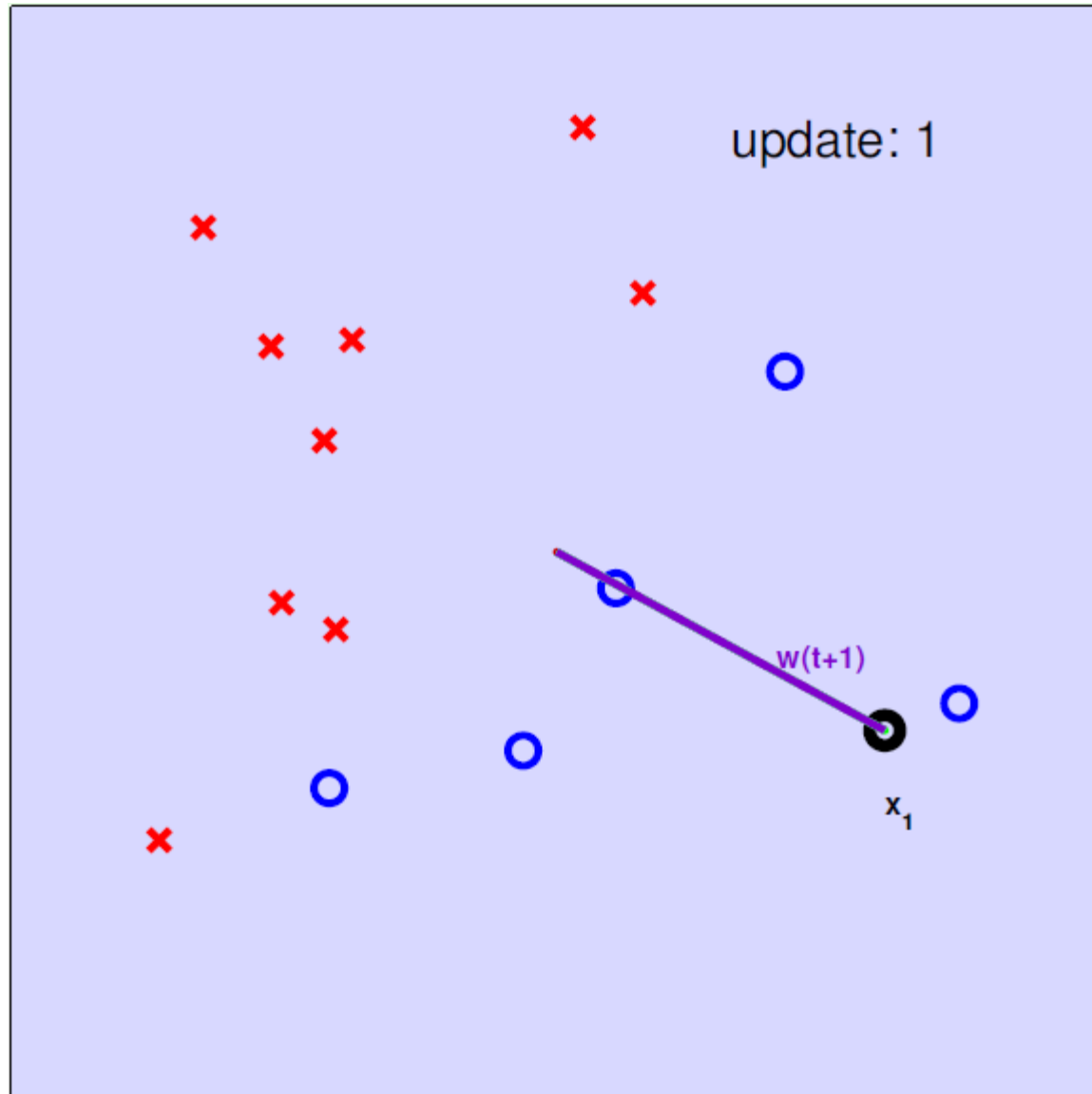
$w$  和分界线正交



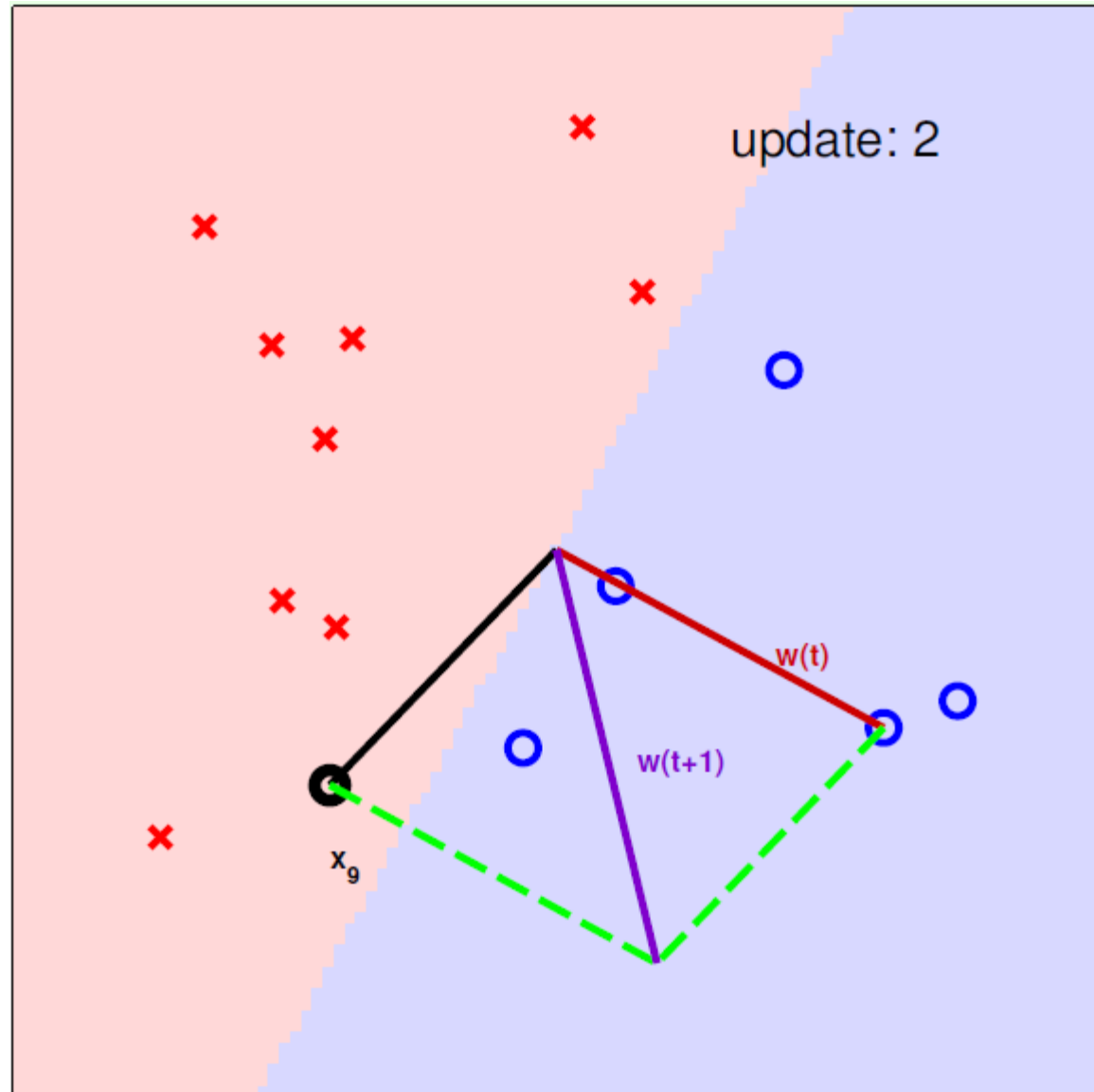
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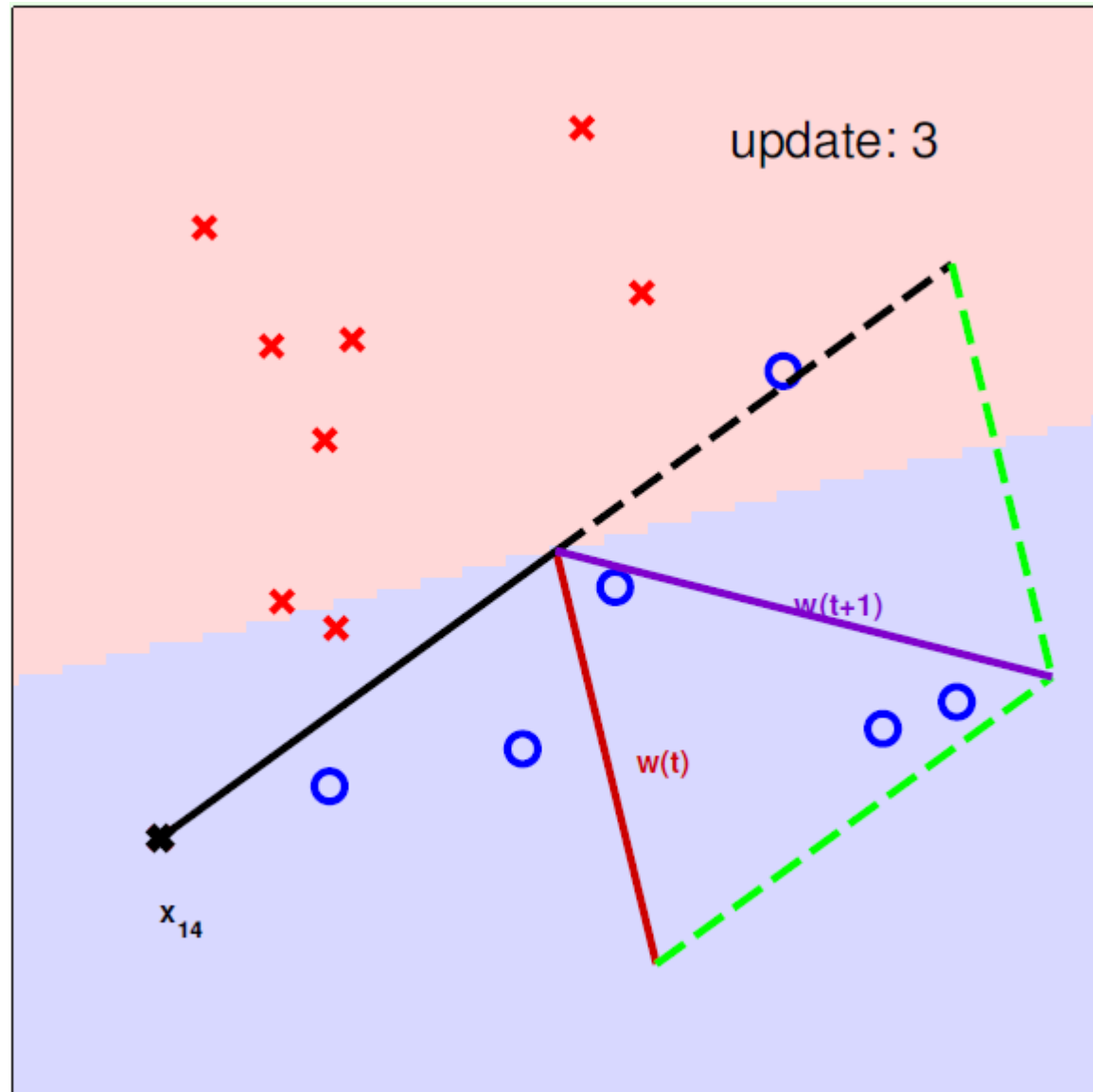
# Perceptron Learning Algorithm



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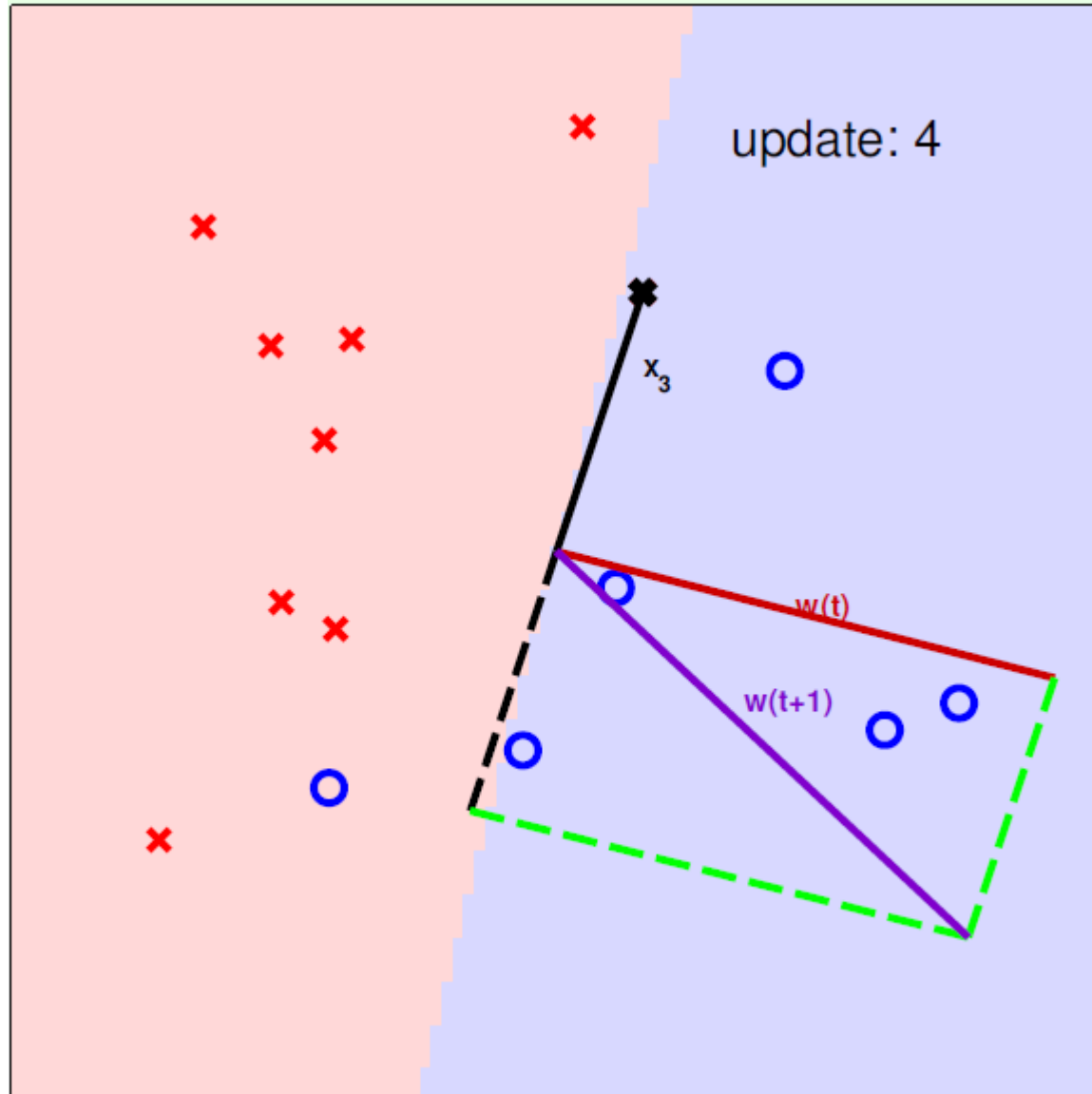


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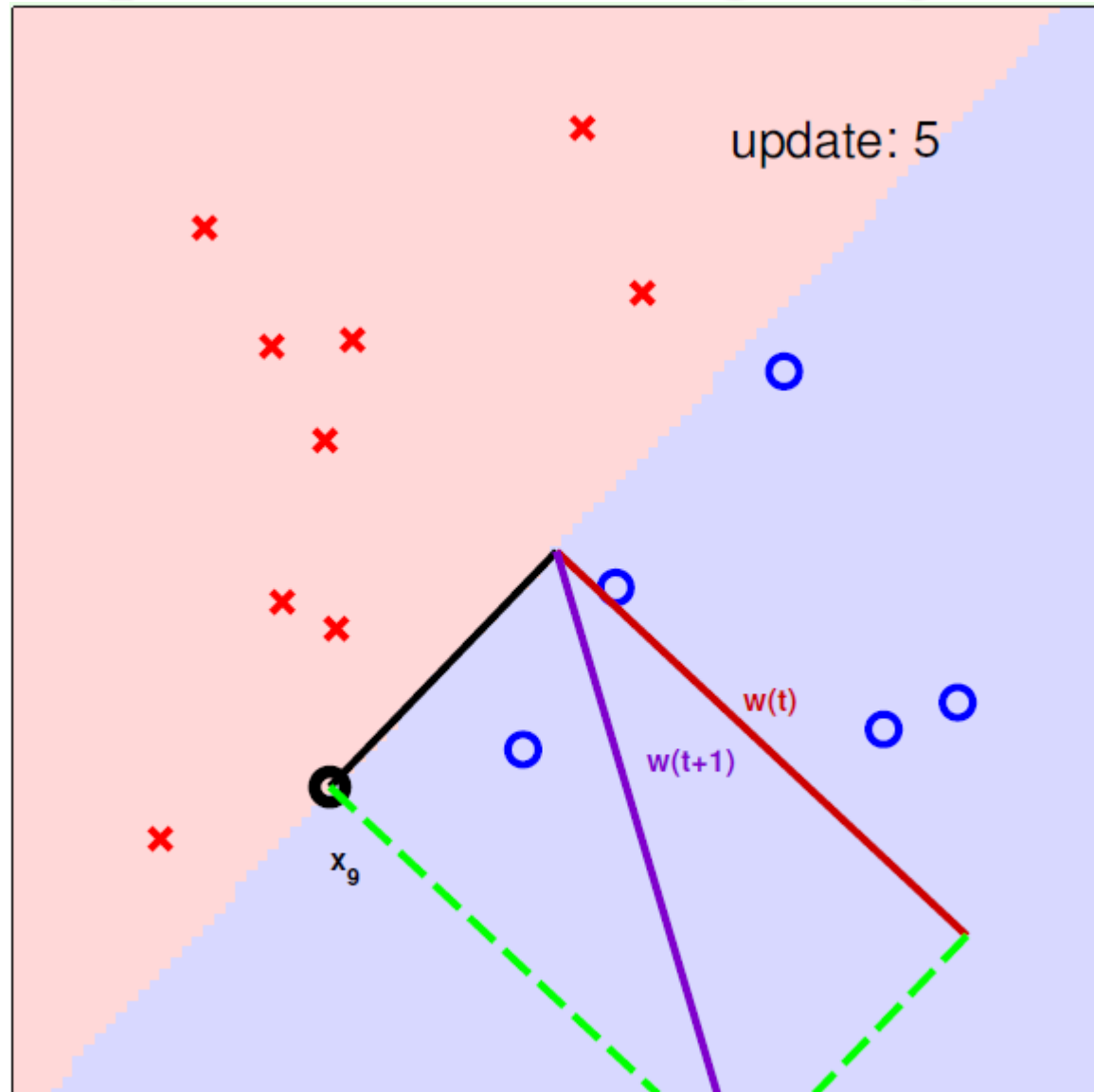




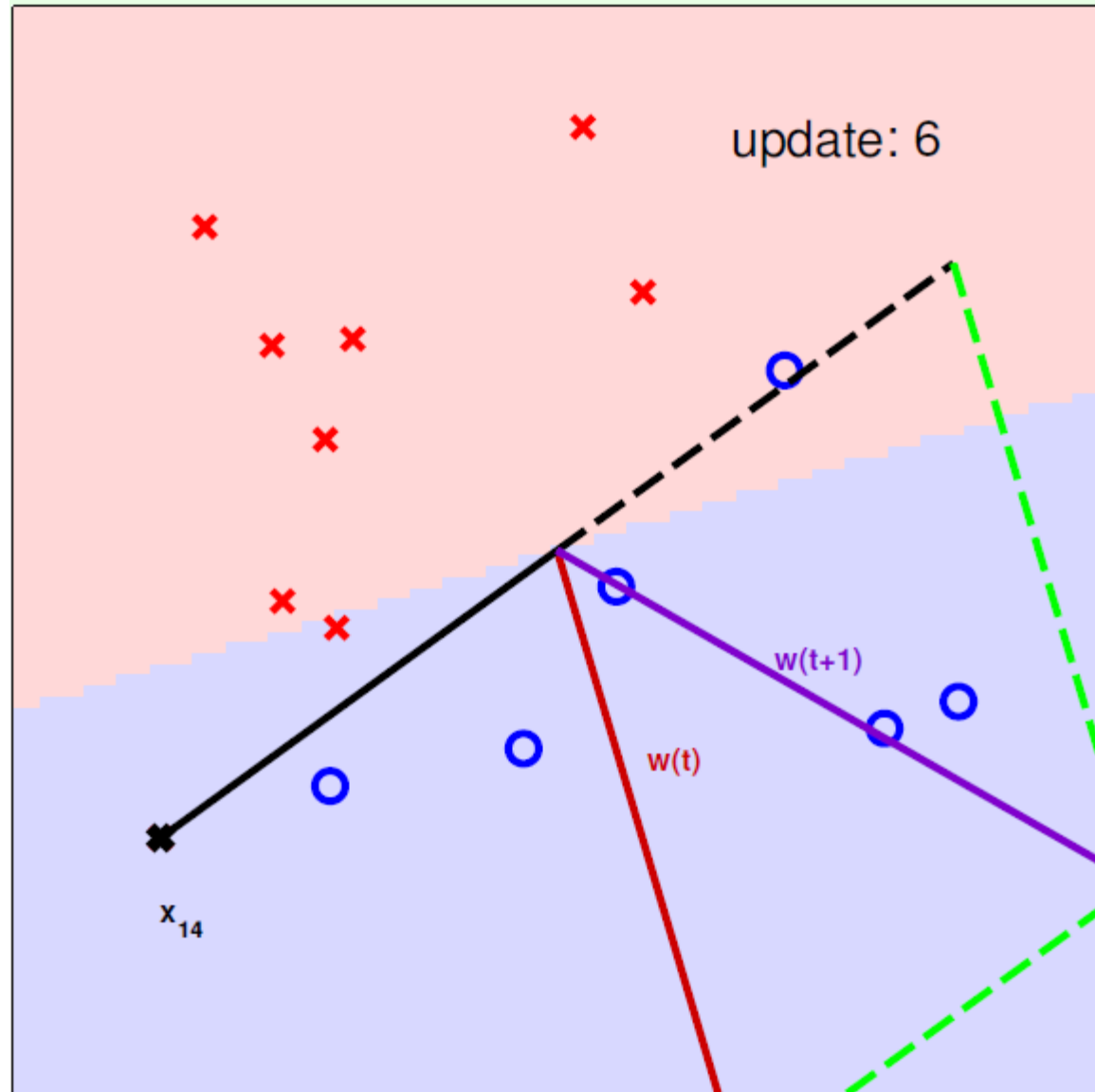
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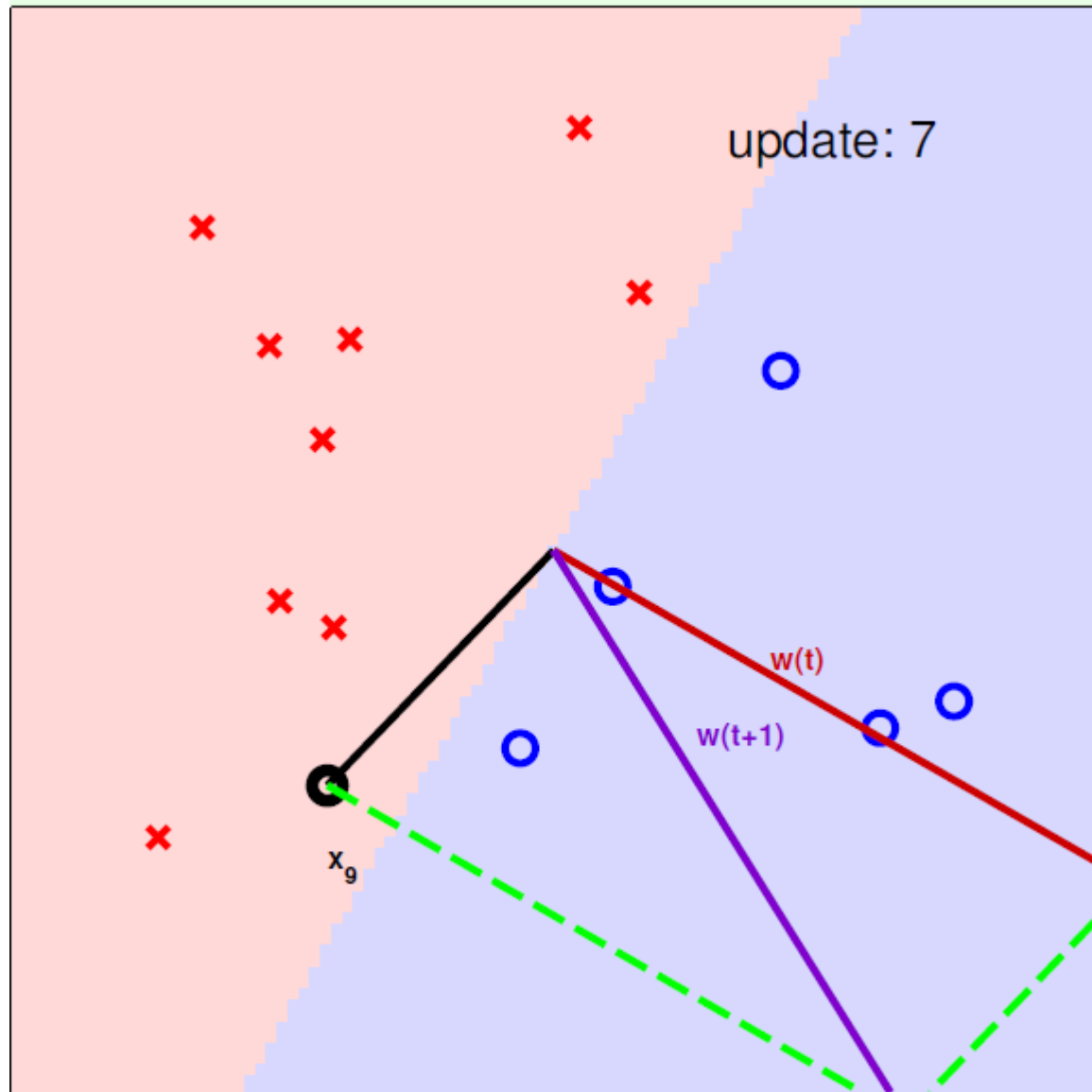
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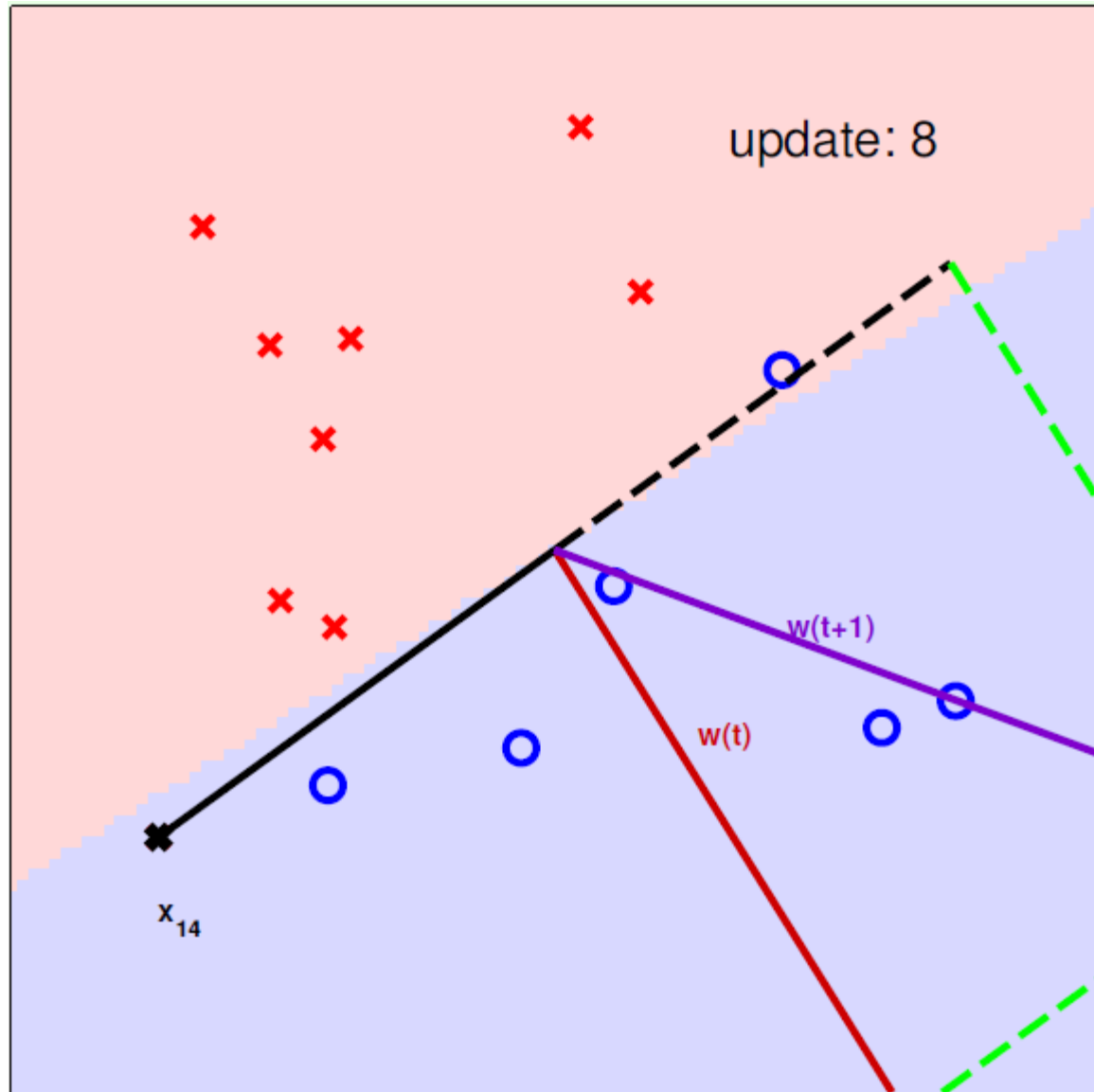
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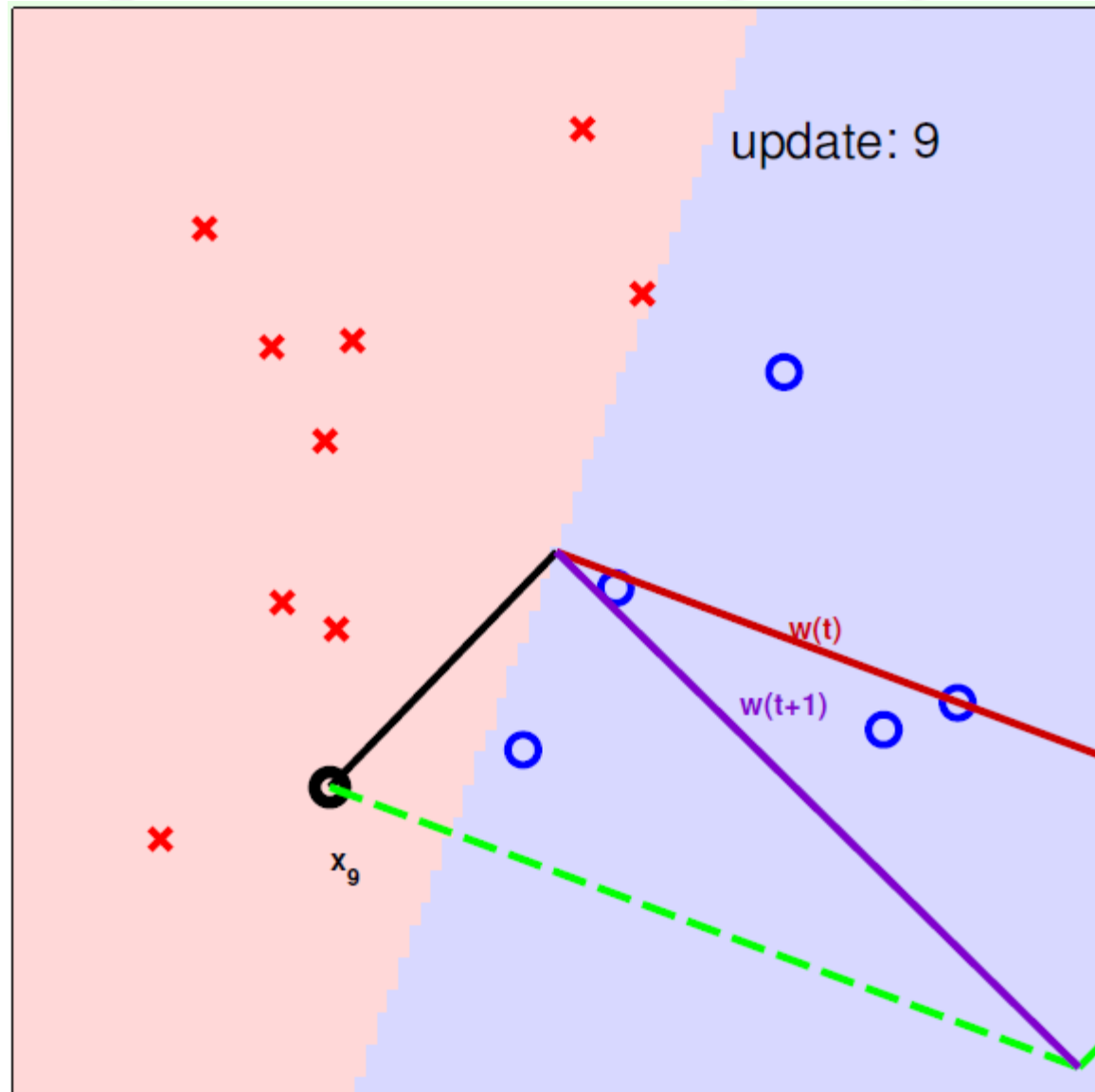
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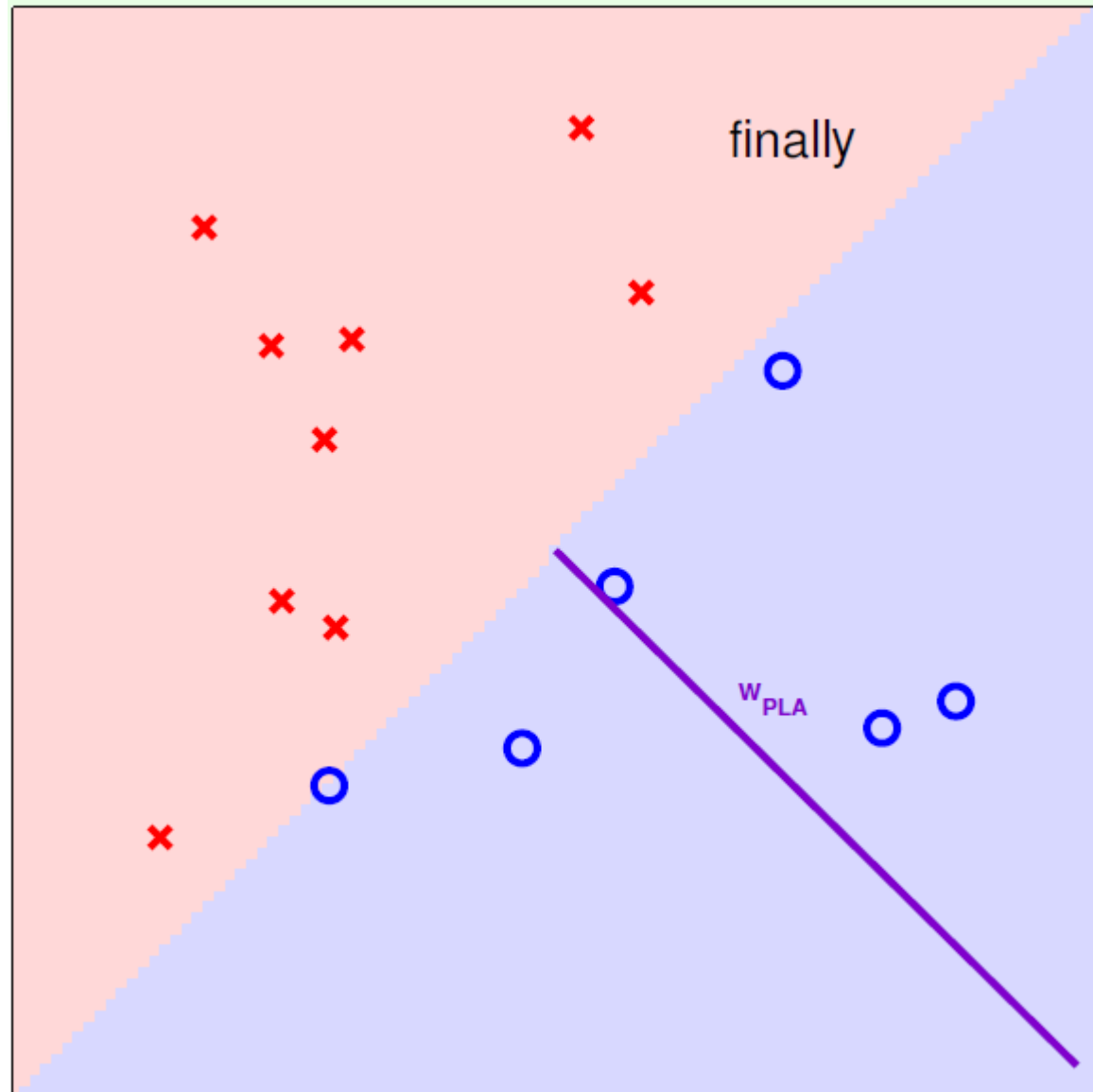
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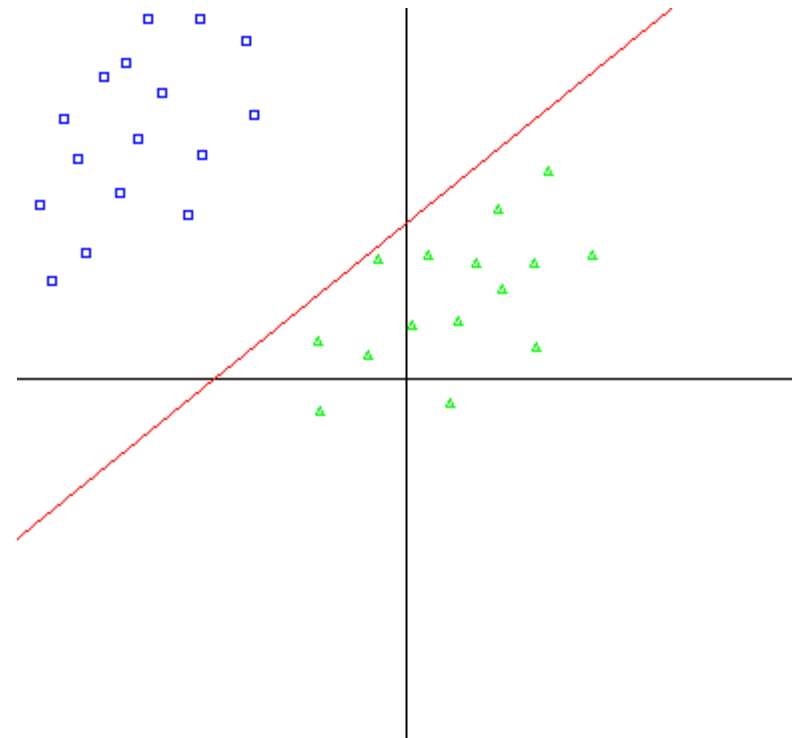
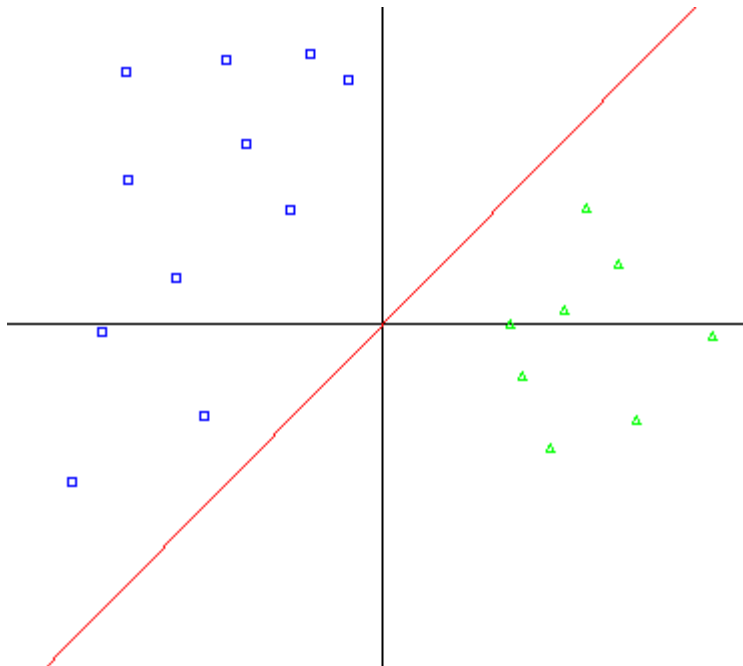
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# Perceptron Learning Algorithm

- 仅当存在某个超平面，能够正确划分所有数据时，PLA算法会收敛；而且，遍历数据的顺序不同，可能会导致结果不同，因此有多个解存在。

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