

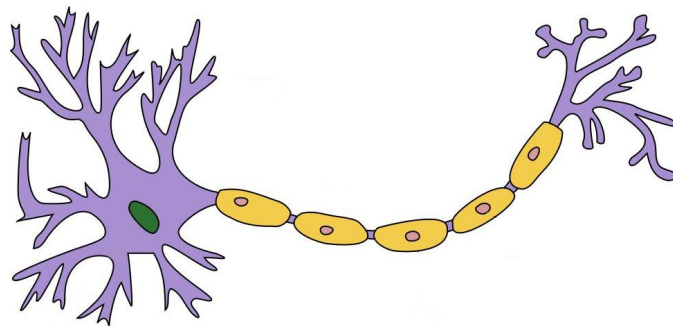
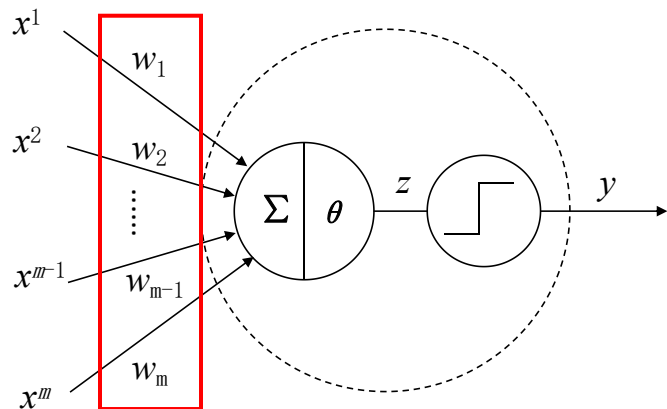


12.3 多层神经网络



12.3.1 多层神经网络模型

M-P神经元



权值向量 W 是固定的，不能够自动学习和更新



感知机训练法则

$$w_i^{(k+1)} = w_i^{(k)} + \Delta w_i$$

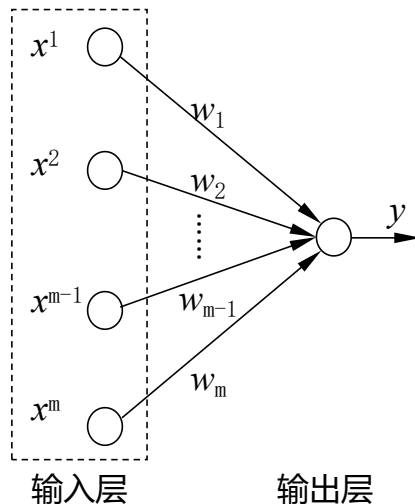
$$\Delta w_i = \eta (y - \hat{y}) x_i$$

y : 训练样例的标记

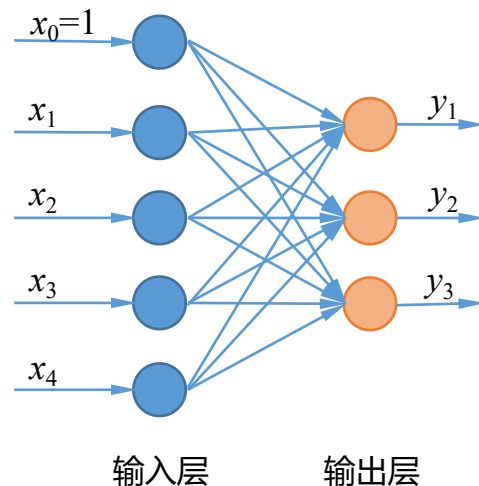
\hat{y} : 感知机的输出

$\eta \in (0,1)$: 学习率

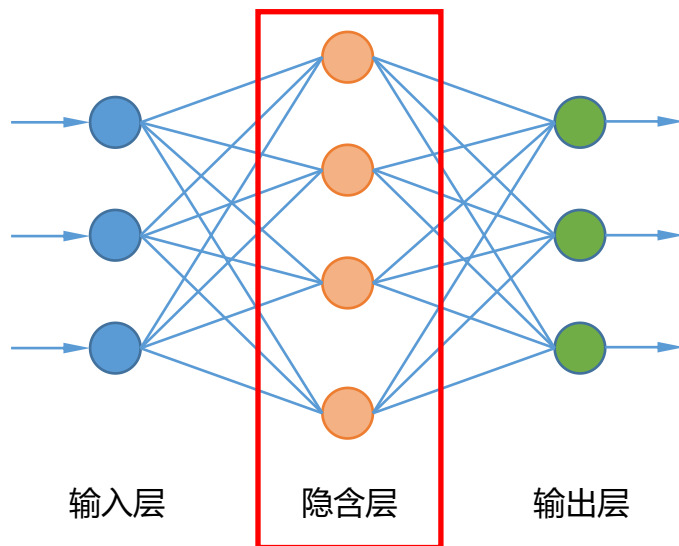
感知机：线性二分类



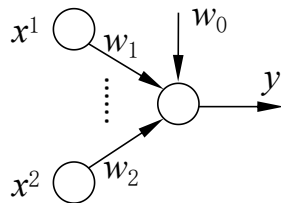
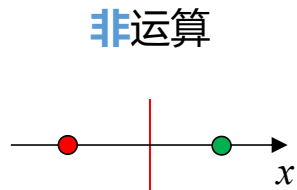
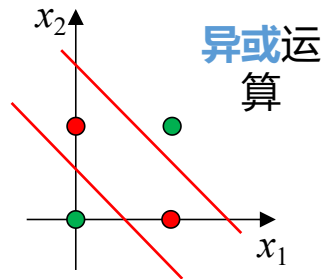
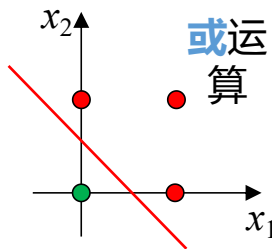
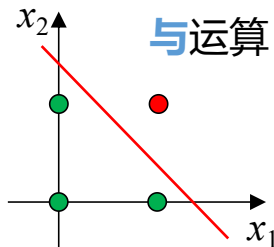
多分类：设置多个输出节点



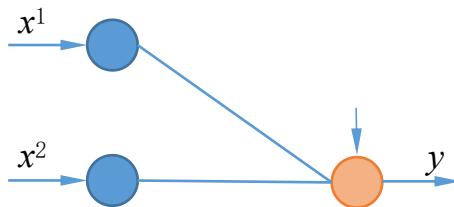
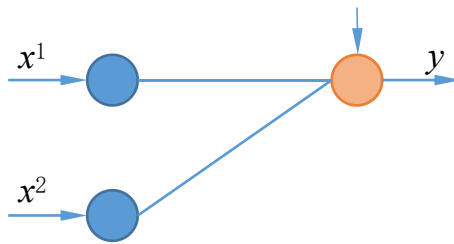
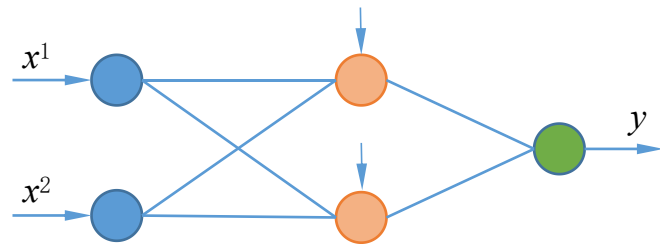
□ 多层神经网络



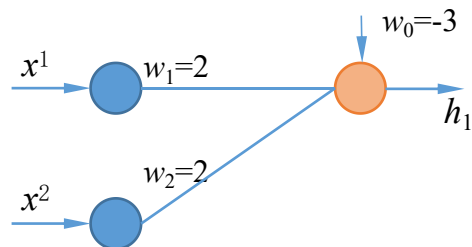
线性分类器



■ 异或问题



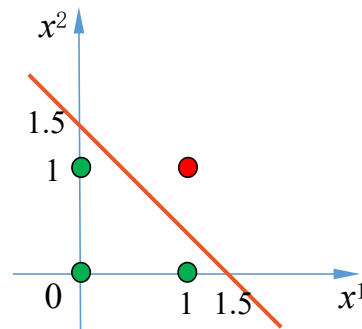
12.3.1 多层神经网络模型



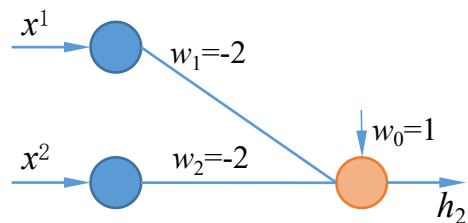
$$z_1 = 2x^1 + 2x^2 - 3$$

$$h_1 = \text{step}(2x^1 + 2x^2 - 3) = \underline{x^1 x^2}$$

(x^1, x^2)	z_1	h_1
(0, 0)	-3	0
(0, 1)	-1	0
(1, 0)	-1	0
(1, 1)	1	1



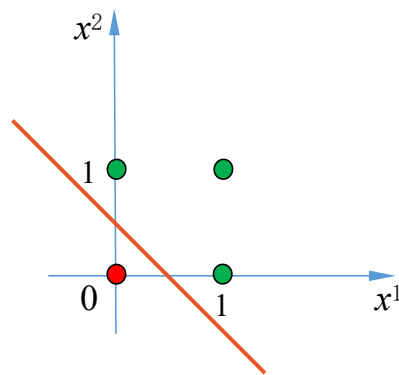
12.3.1 多层神经网络模型



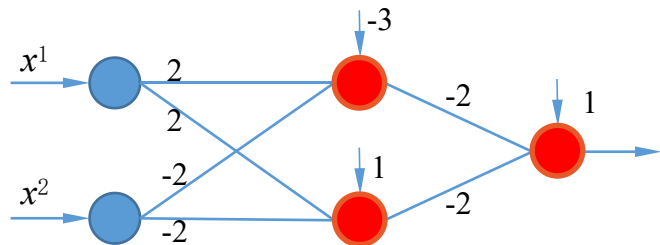
$$z_2 = -2x^1 - 2x^2 + 1$$

$$h_2 = \text{step}(-2x^1 - 2x^2 + 1) = \overline{x^1 + x^2}$$

(x^1, x^2)	z_2	h_2
(0, 0)	1	1
(0, 1)	-1	0
(1, 0)	-1	0
(1, 1)	-3	0



12.3.1 多层神经网络模型



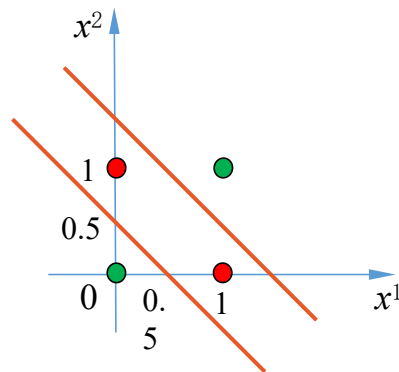
每个神经元**3**个模型参数: w_1, w_2, w_0

3个神经元共**9**个模型参数

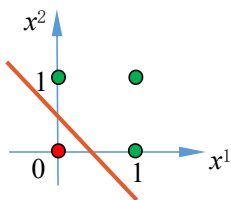
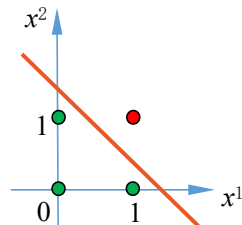
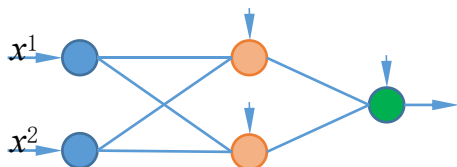
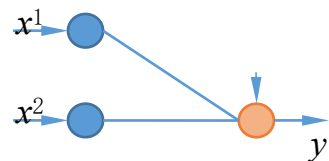
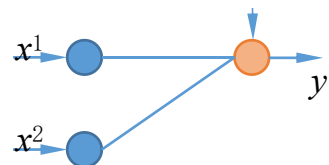
$$z = -2h_1 - 2h_2 + 1$$

$$y = \text{step}(-2x^1 - 2x^2 + 1)$$

(x^1, x^2)	h_1	h_2	y
(0, 0)	0	1	0
(0, 1)	0	0	1
(1, 0)	0	0	1
(1, 1)	1	0	0



12.3.1 多层神经网络模型



(x^1, x^2)	h_1	h_2	y
(0, 0)	0	1	0
(0, 1)	0	0	1
(1, 0)	0	0	1
(1, 1)	1	0	0

$$h_1 = x^1 x^2$$

$$h_2 = \overline{x^1 + x^2}$$

$$\overline{h_1 + h_2} = \overline{x^1 x^2 + x^1 + x^2}$$

$$= \overline{x^1 x^2} (\overline{x^1 + x^2})$$

$$= (\overline{x^1} + \overline{x^2}) (\overline{x^1 + x^2})$$

$$= (\overline{x^1} + \overline{x^2}) \overline{x^1} + (\overline{x^1} + \overline{x^2}) \overline{x^2}$$

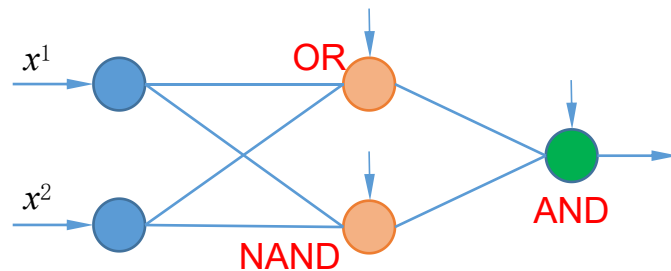
$$= \overline{x^1} \overline{x^2} + \overline{x^1} \overline{x^2}$$

$$= \underline{\overline{x^1} \oplus \overline{x^2}}$$

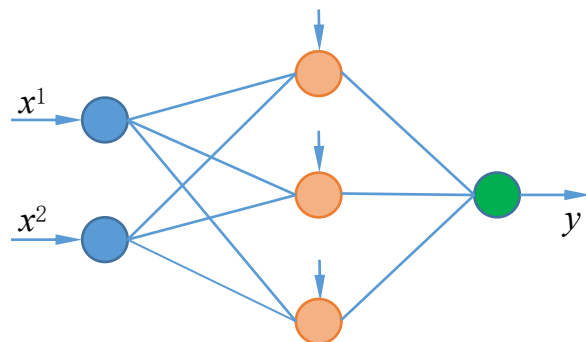
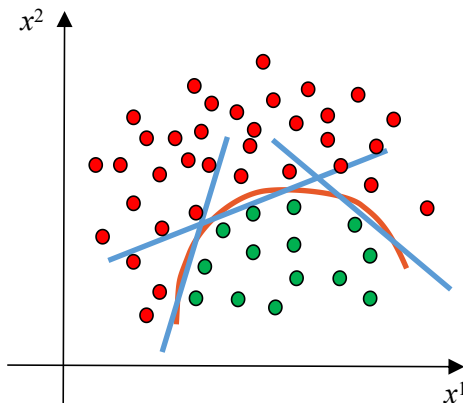
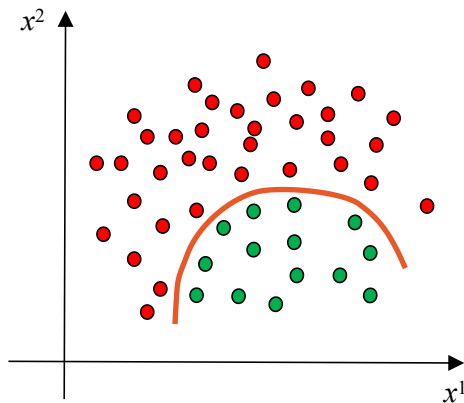


12.3.1 多层神经网络模型

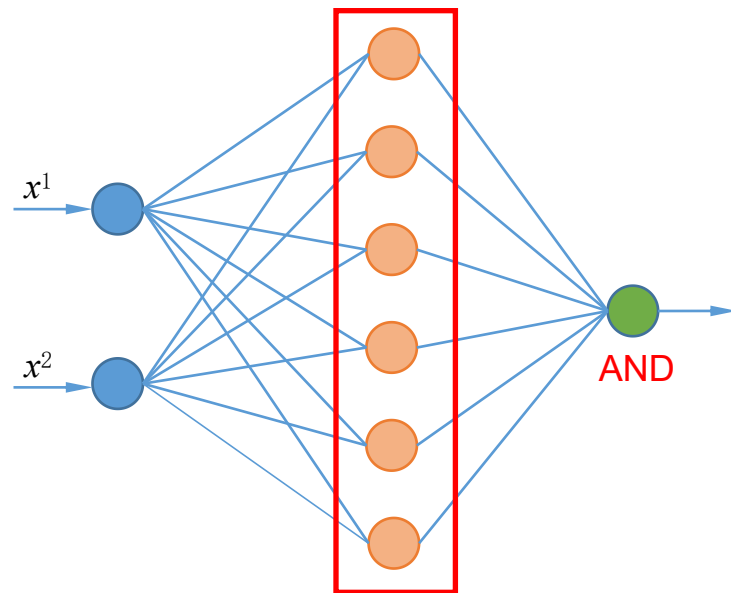
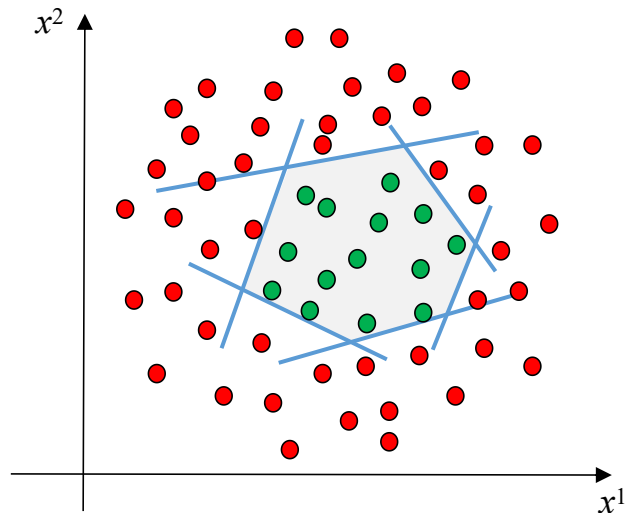
(x^1, x^2)	OR	NAND	AND
$(0, 0)$	0	1	0
$(0, 1)$	1	1	1
$(1, 0)$	1	1	1
$(1, 1)$	1	0	0



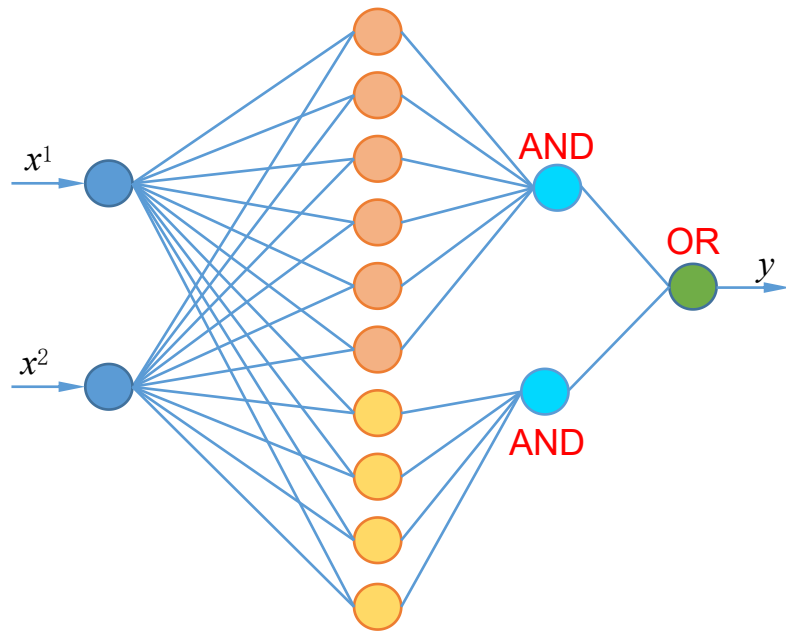
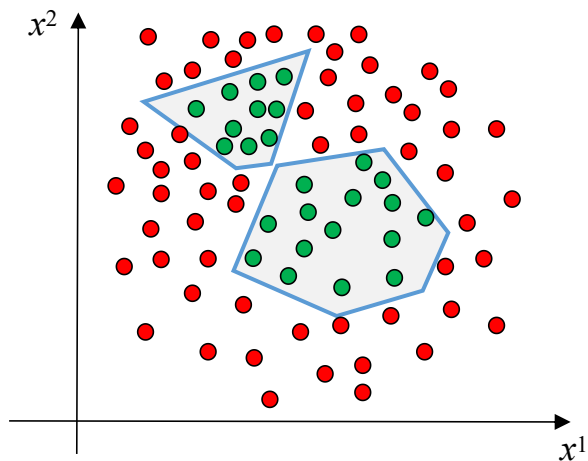
12.3.1 多层神经网络模型



12.3.1 多层神经网络模型



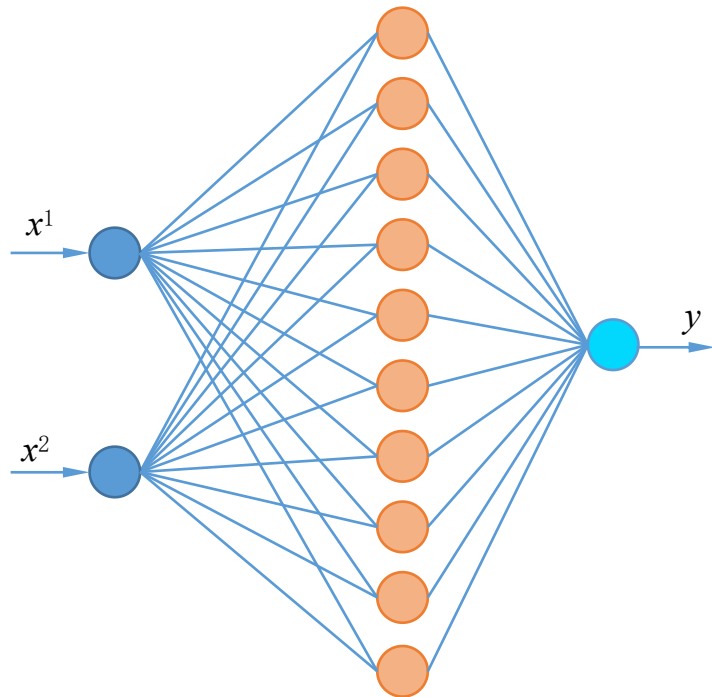
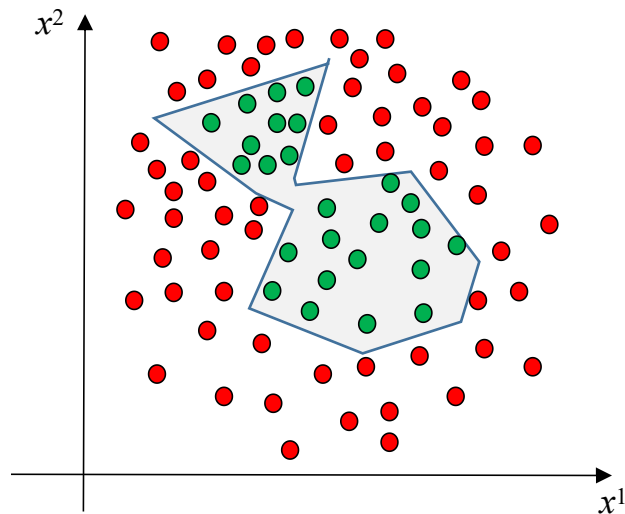
12.3.1 多层神经网络模型



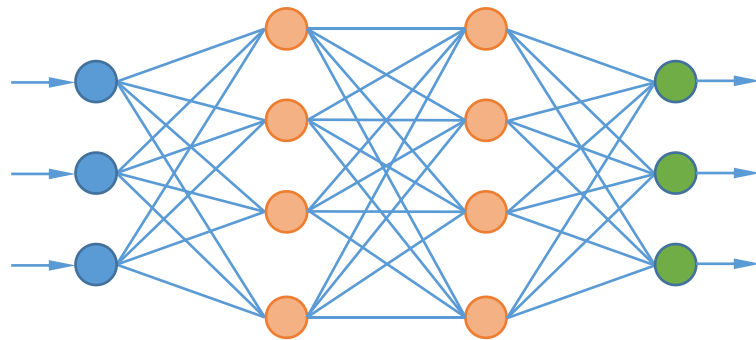
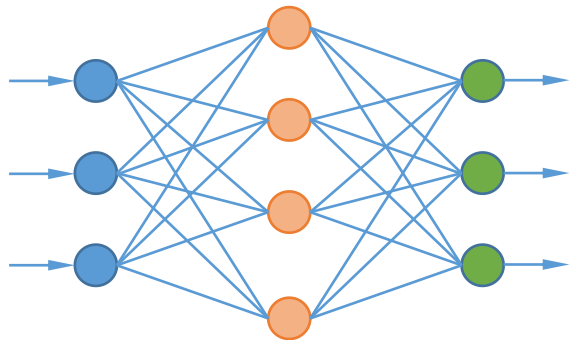
如果神经网络中有**足够的隐含层**，每个隐含层中有**足够多的神经元**，神经网络就可以表示**任意复杂函数**或**空间分布**



12.3.1 多层神经网络模型



□ 前馈神经网络 (Feedforward Neural Networks)



- 每层神经元只与**前一层**的神经元相连
- 处于**同一层**的神经元之间**没有连接**
- 各层间**没有反馈**，不存在跨层连接



□ 全连接网络 (Full Connected Network)

