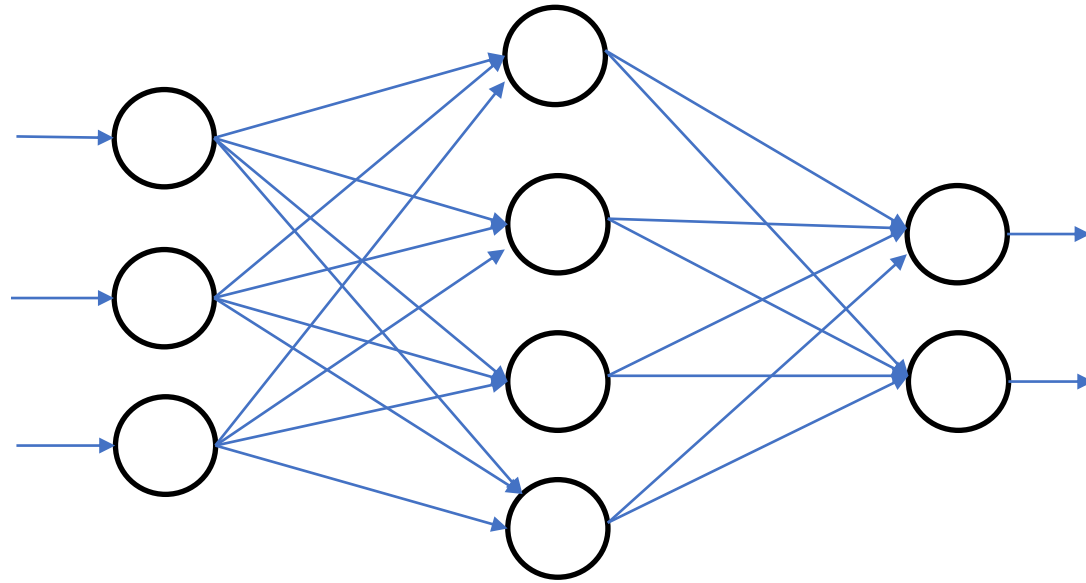


Lesson 8:

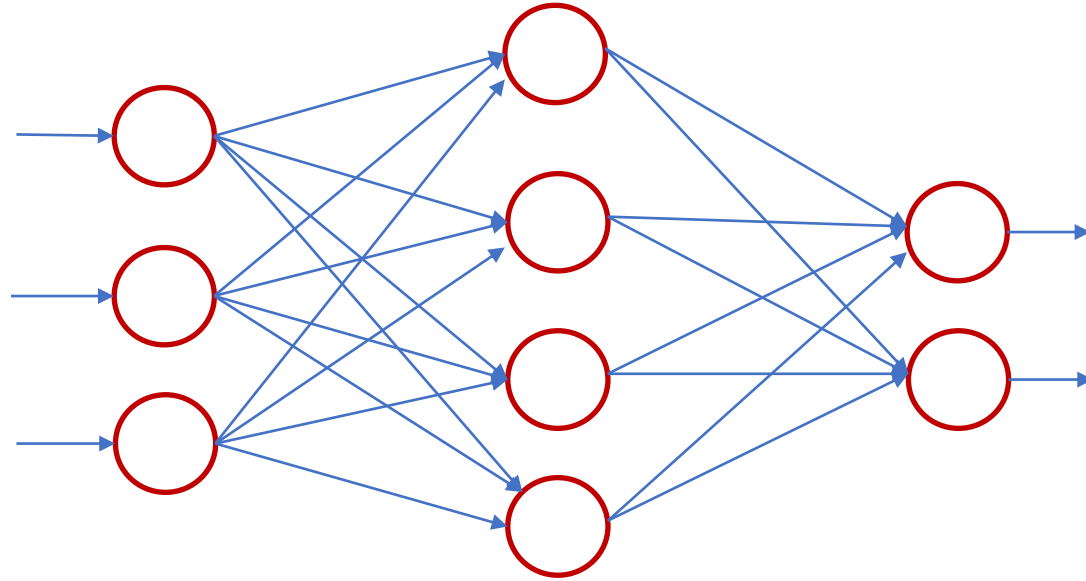
Neural Network: Terminologies and a Toy Example

Terminologies in Artificial Neural Network

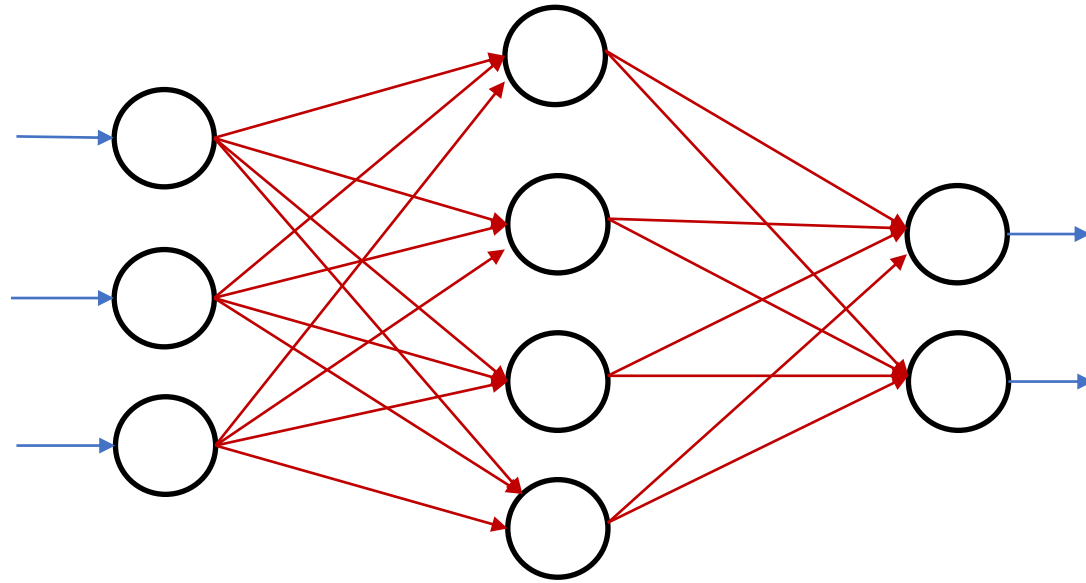


Terminologies in Artificial Neural Network

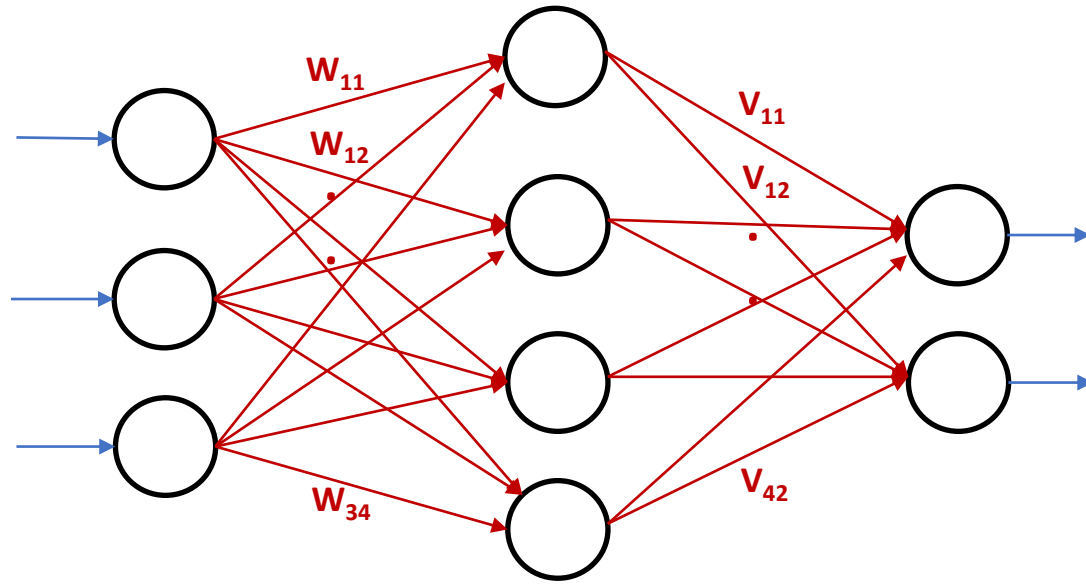
Nodes/Neurons

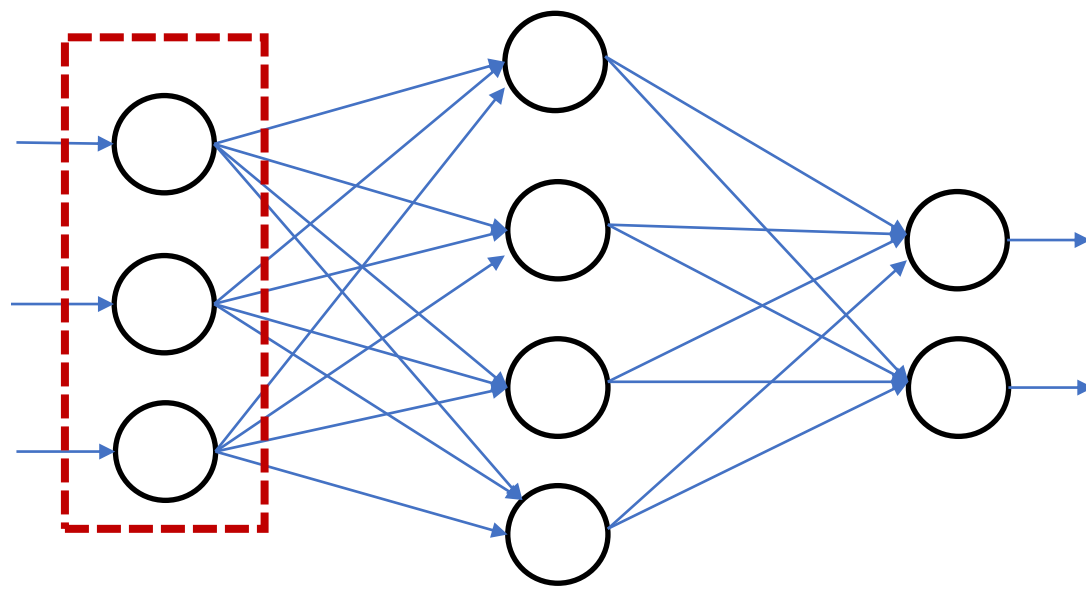


Connections/Dendrites

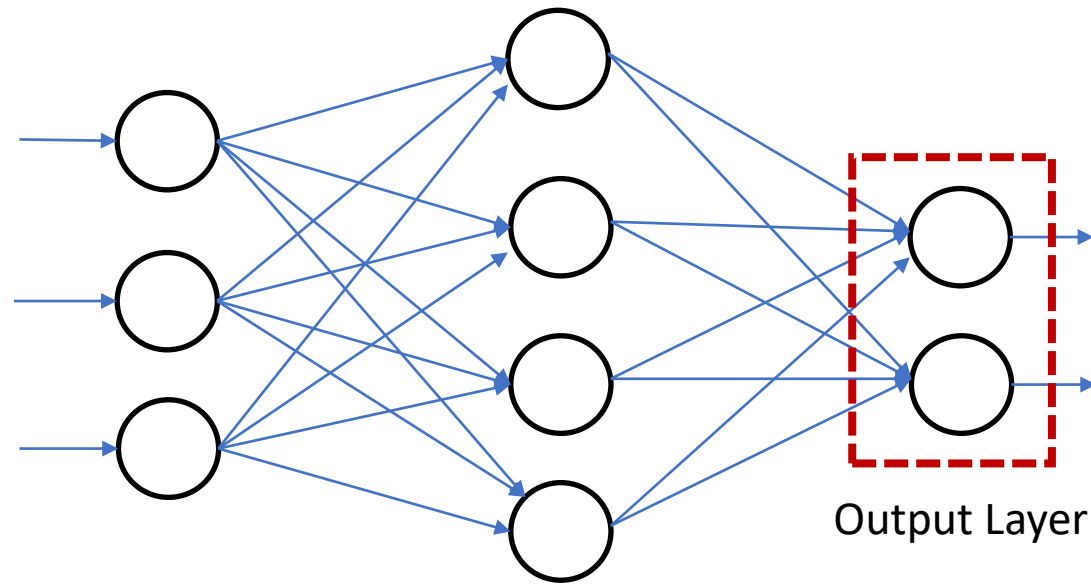


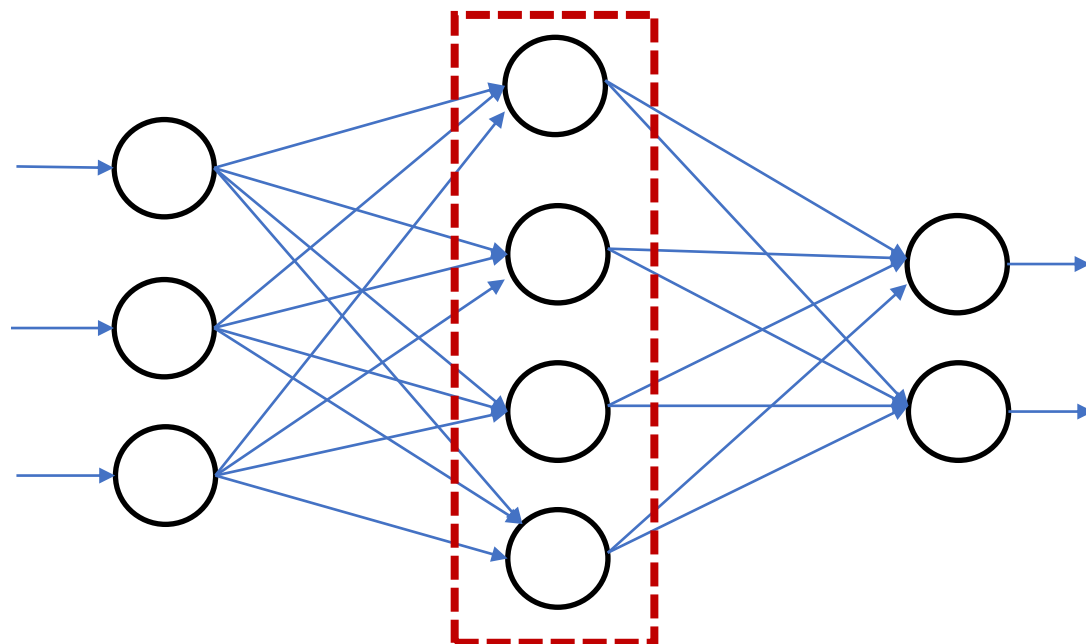
Weights/Synapses



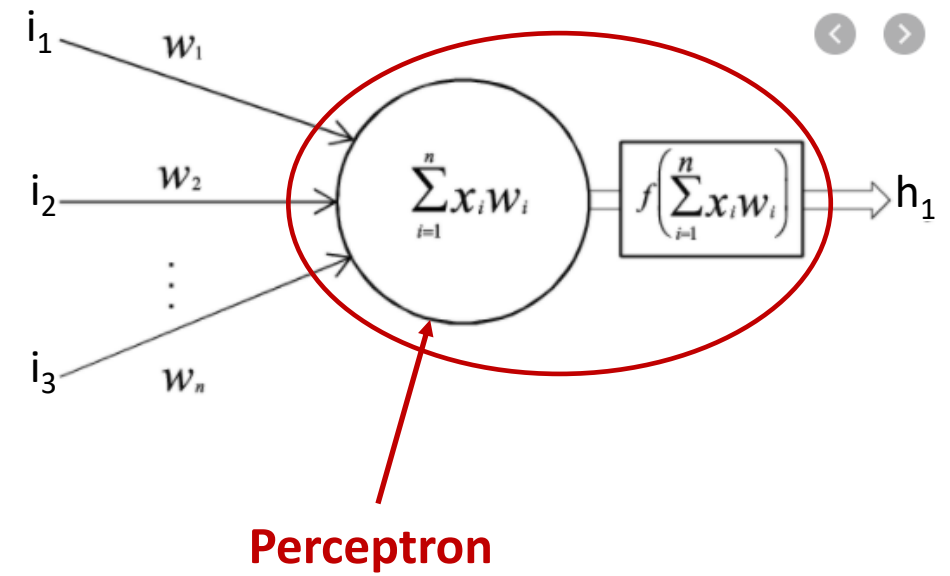
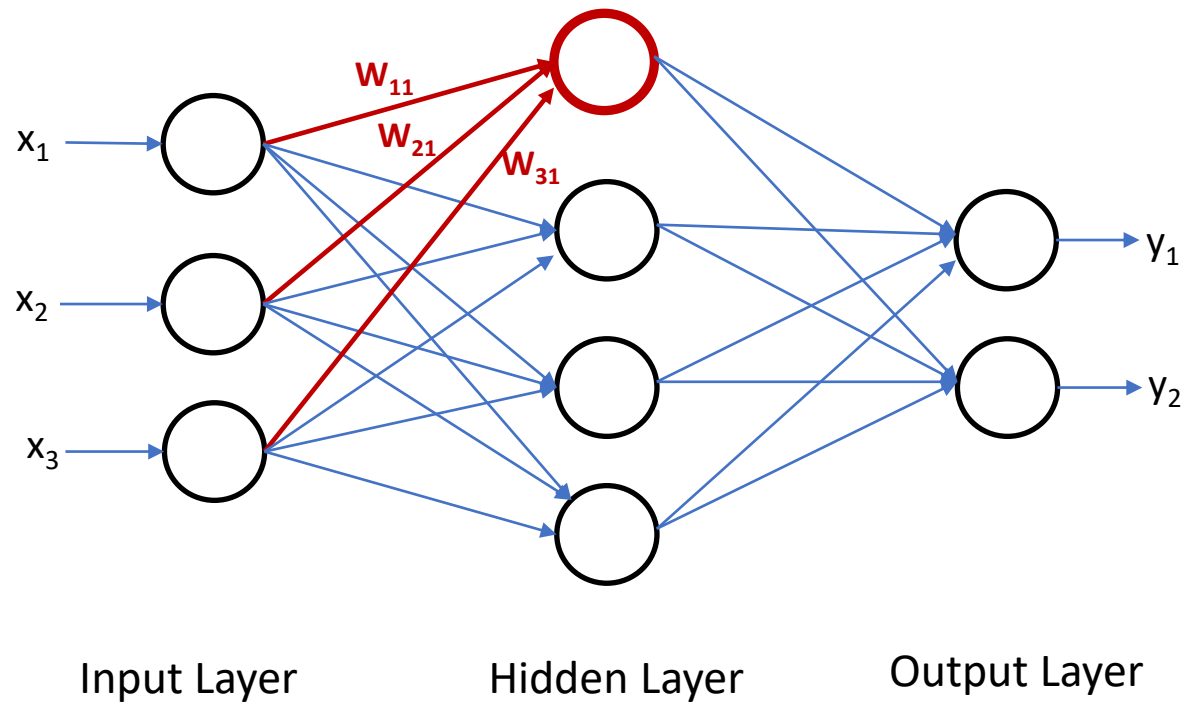


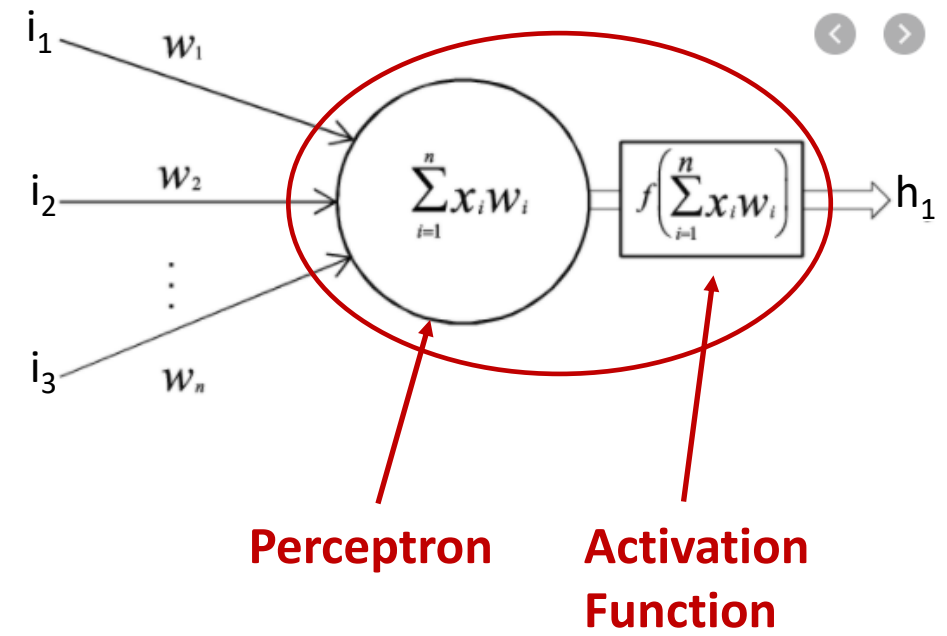
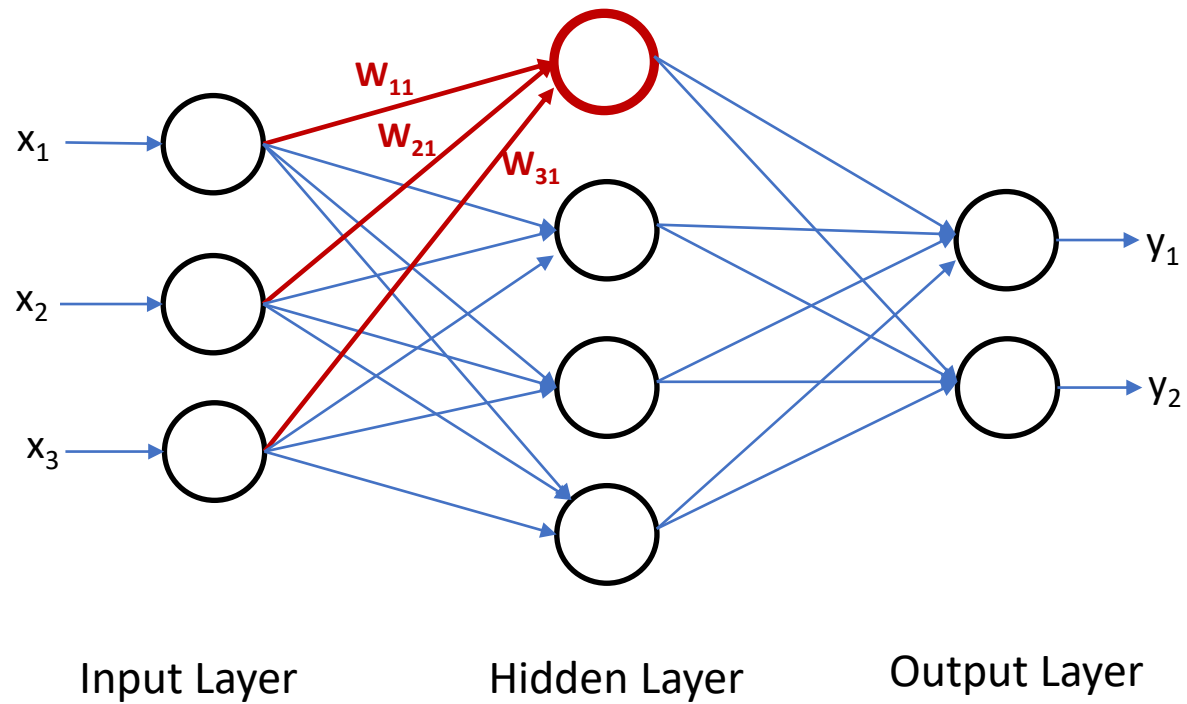
Input Layer



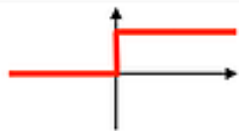
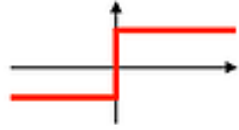
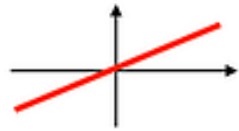
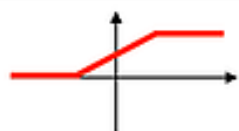
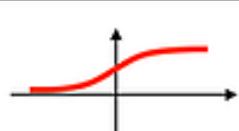
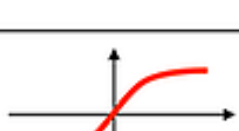


Hidden Layer

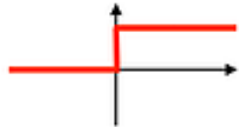
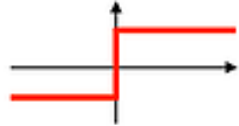
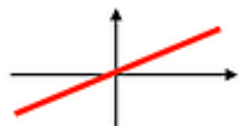
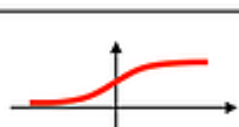
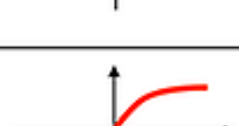
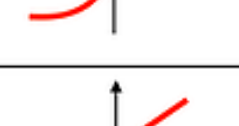




Activation Functions

Activation function	Equation	Example	1D Graph
Unit step (Heaviside)	$\phi(z) = \begin{cases} 0, & z < 0, \\ 0.5, & z = 0, \\ 1, & z > 0, \end{cases}$	Perceptron variant	
Sign (Signum)	$\phi(z) = \begin{cases} -1, & z < 0, \\ 0, & z = 0, \\ 1, & z > 0, \end{cases}$	Perceptron variant	
Linear	$\phi(z) = z$	Adaline, linear regression	
Piece-wise linear	$\phi(z) = \begin{cases} 1, & z \geq \frac{1}{2}, \\ z + \frac{1}{2}, & -\frac{1}{2} < z < \frac{1}{2}, \\ 0, & z \leq -\frac{1}{2}, \end{cases}$	Support vector machine	
Logistic (sigmoid)	$\phi(z) = \frac{1}{1 + e^{-z}}$	Logistic regression, Multi-layer NN	
Hyperbolic tangent	$\phi(z) = \frac{e^z - e^{-z}}{e^z + e^{-z}}$	Multi-layer Neural Networks	
Rectifier, ReLU (Rectified Linear Unit)	$\phi(z) = \max(0, z)$	Multi-layer Neural Networks	
Rectifier, softplus	$\phi(z) = \ln(1 + e^z)$	Multi-layer Neural Networks	

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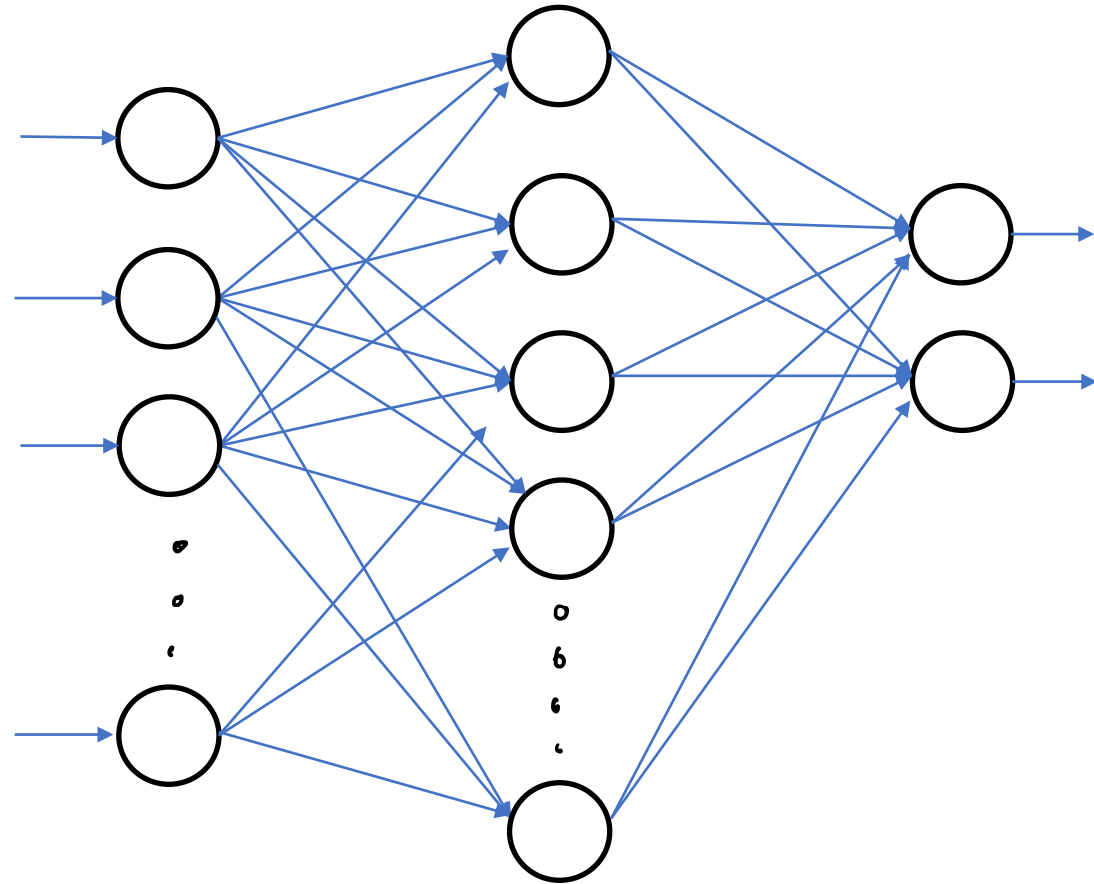
A Toy Example



60x60=3600



60x60=3600



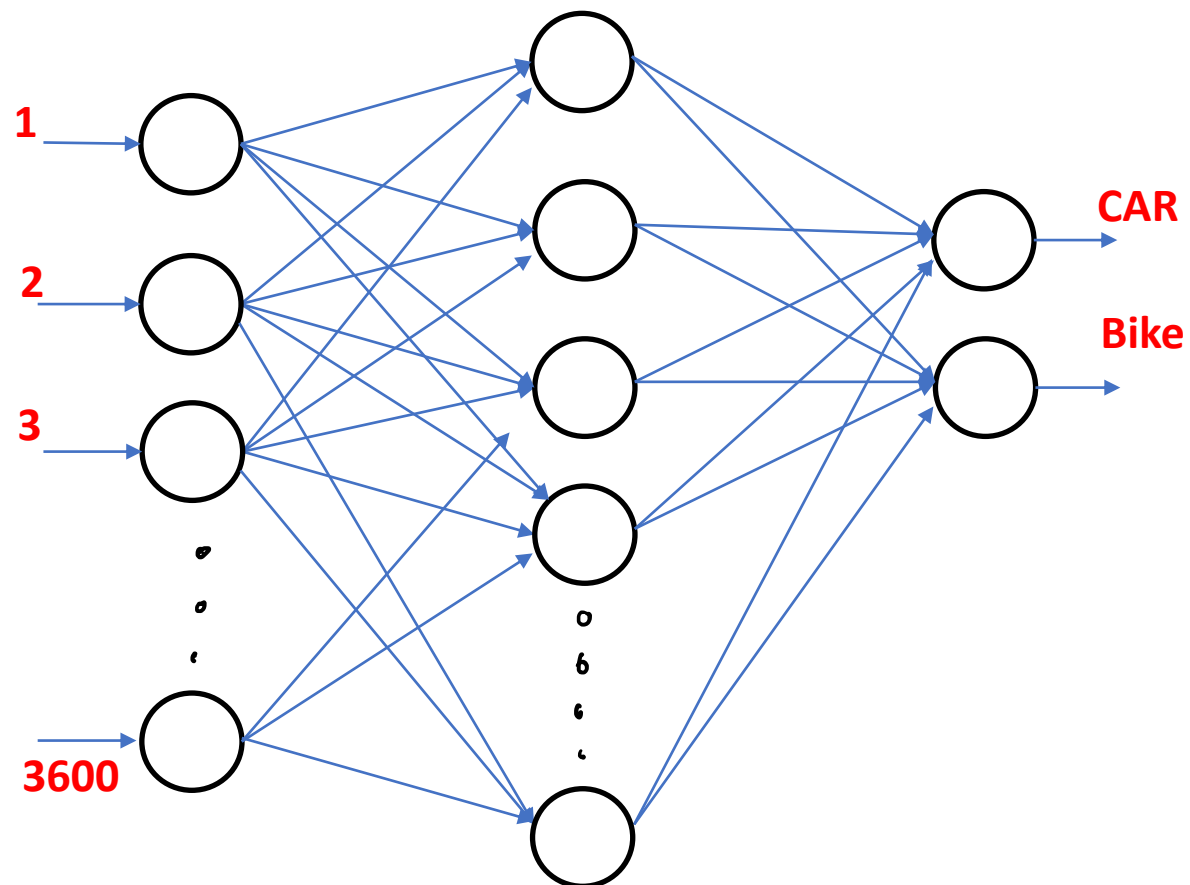
A Toy Example



60x60=3600



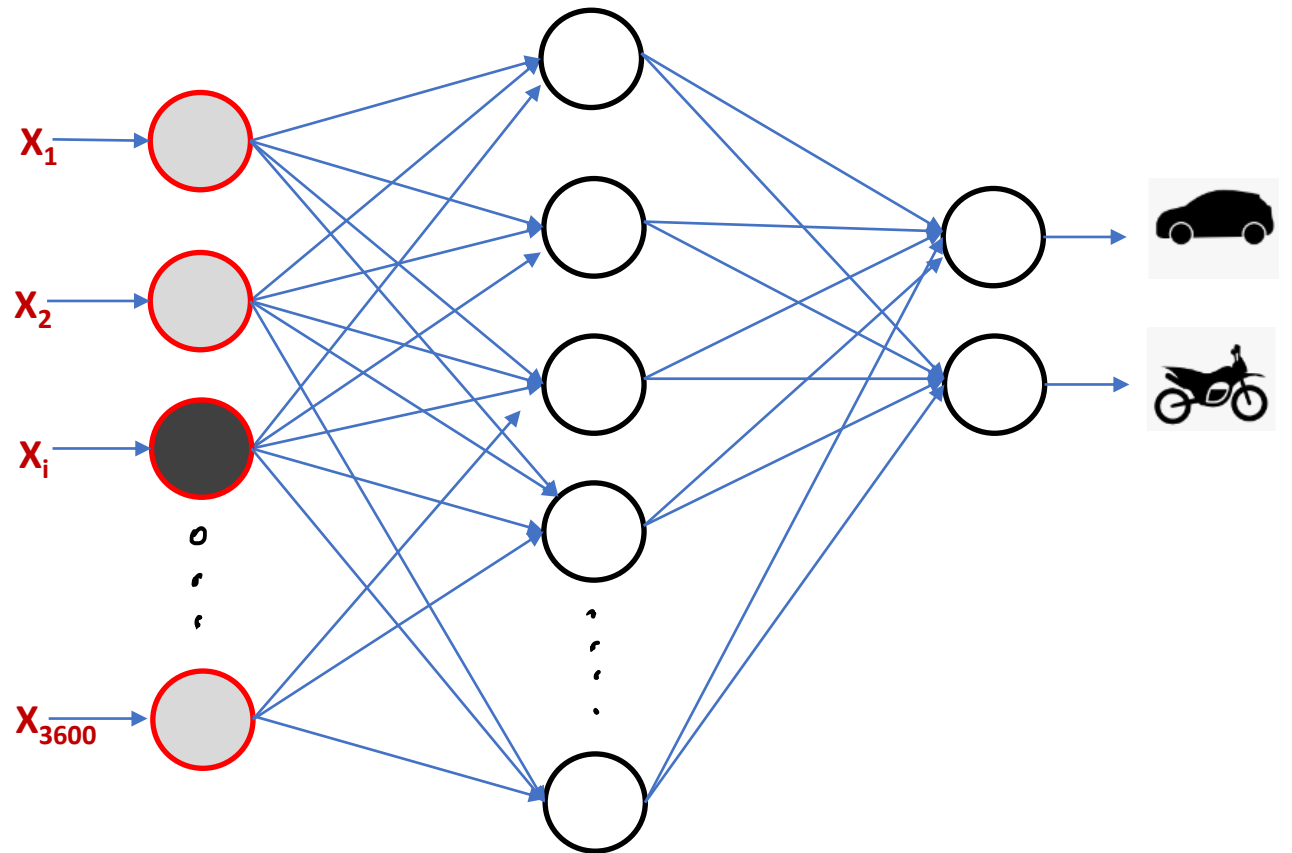
60x60=3600



A Toy Example



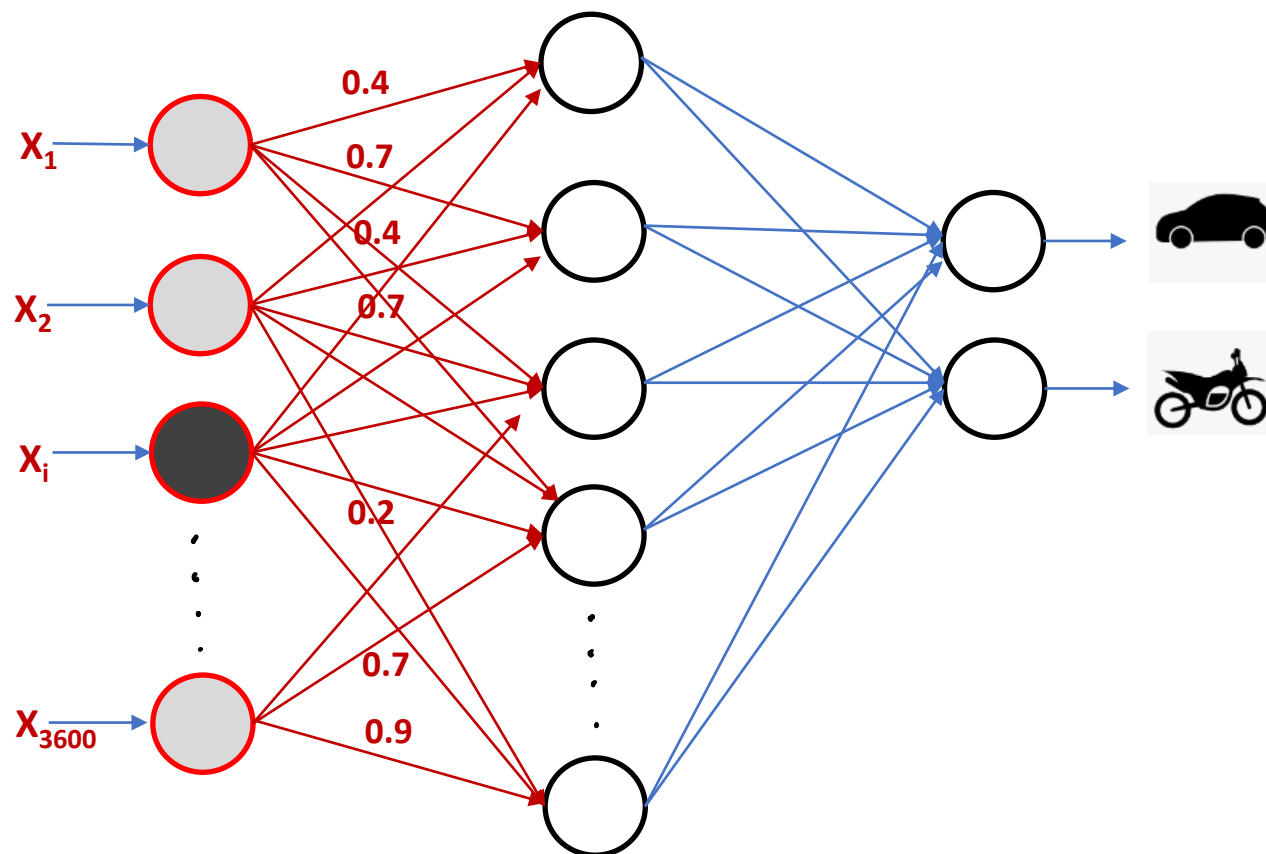
$60 \times 60 = 3600$



A Toy Example



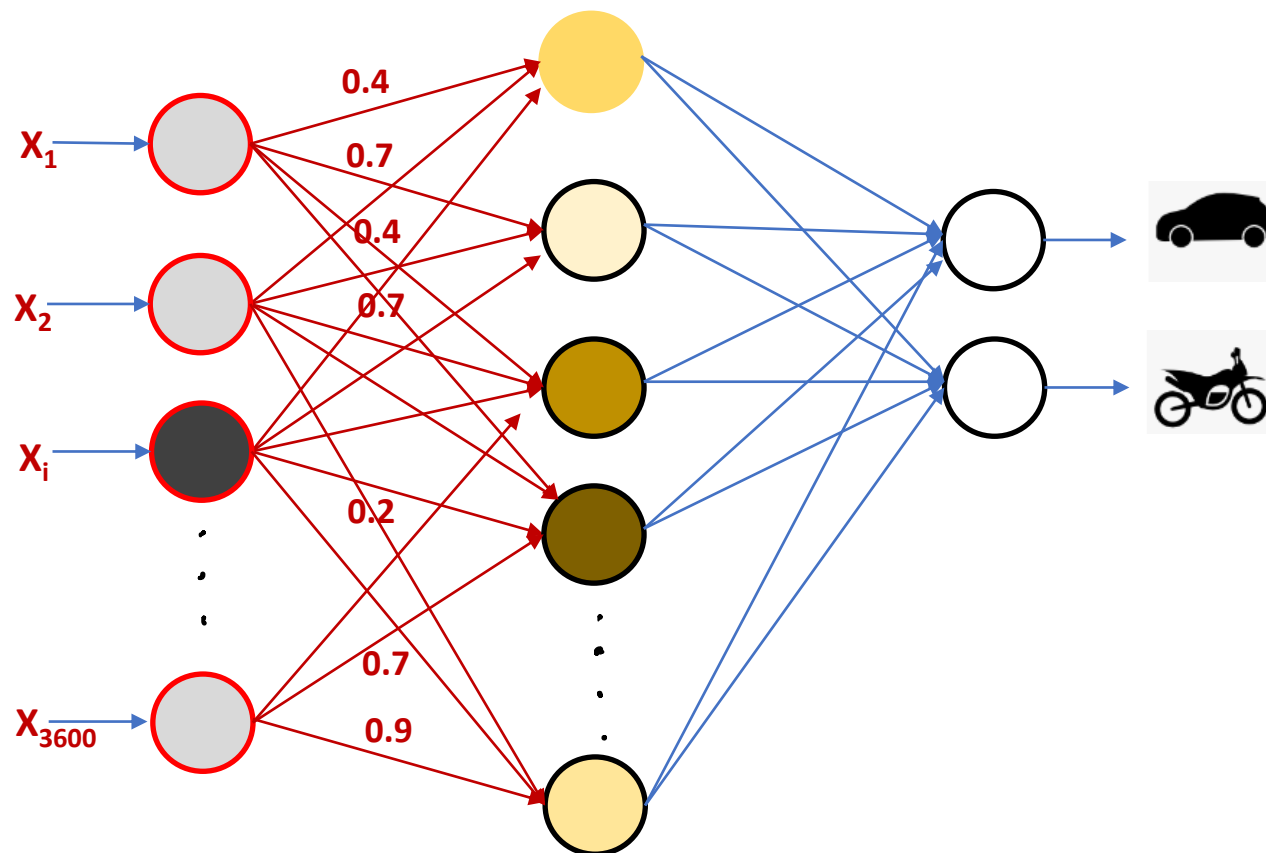
$60 \times 60 = 3600$



A Toy Example



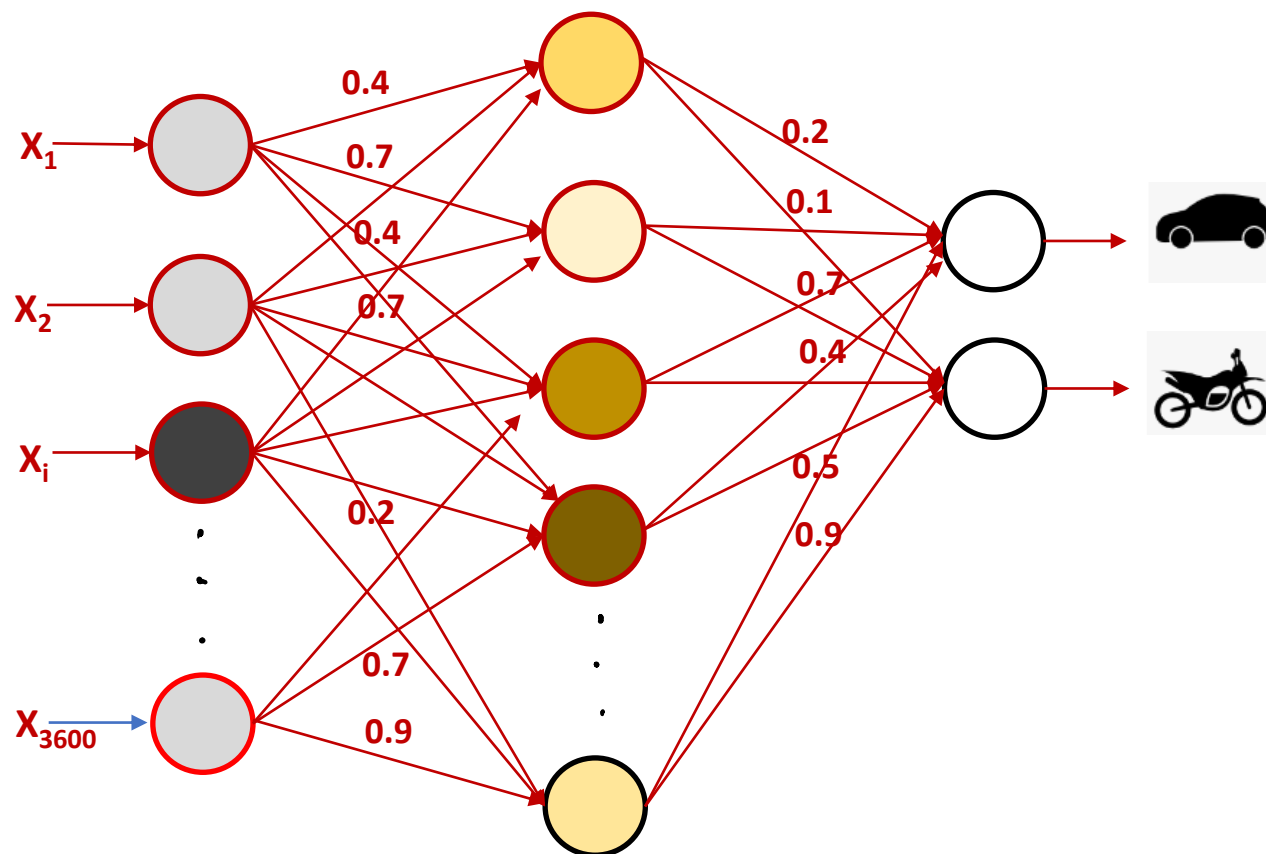
60x60=3600



A Toy Example



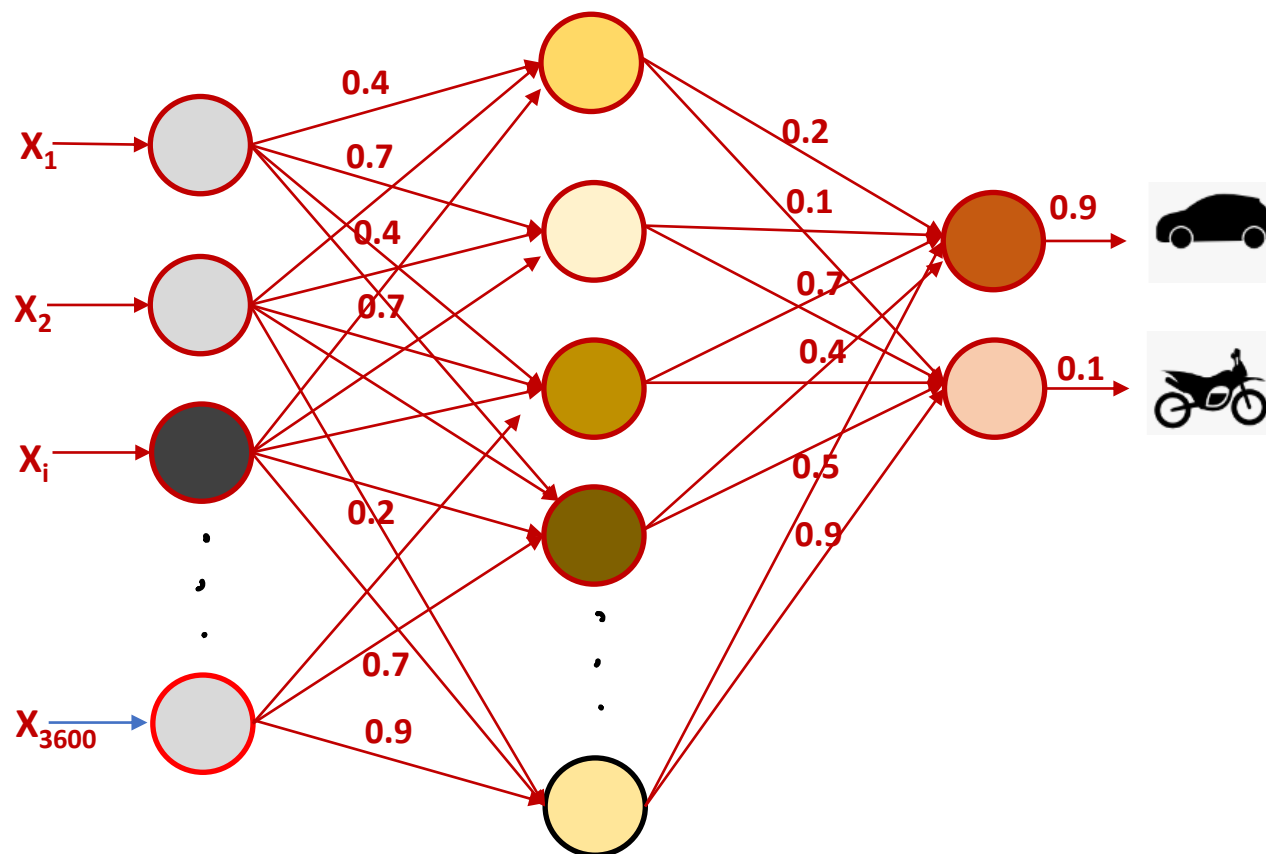
60x60=3600



A Toy Example



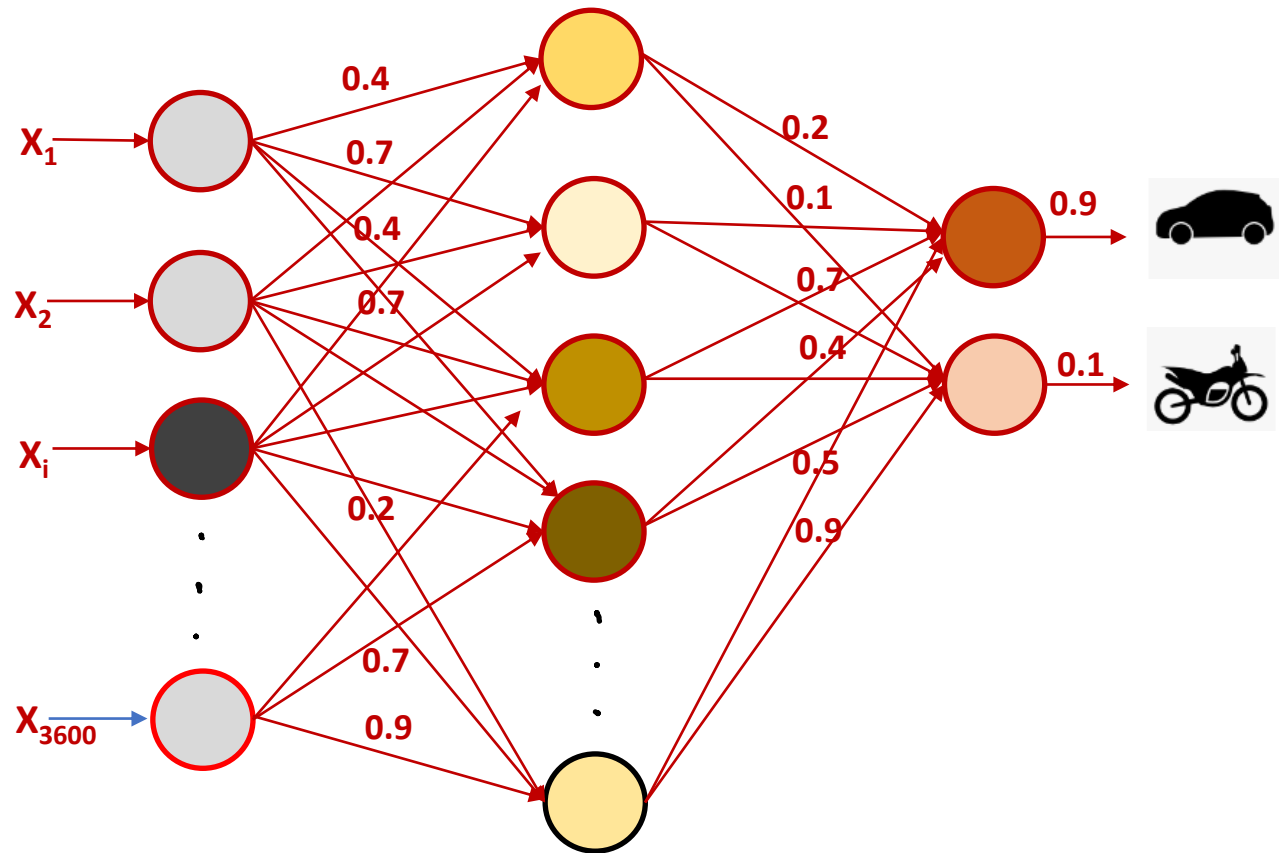
60x60=3600



A Toy Example



60x60=3600

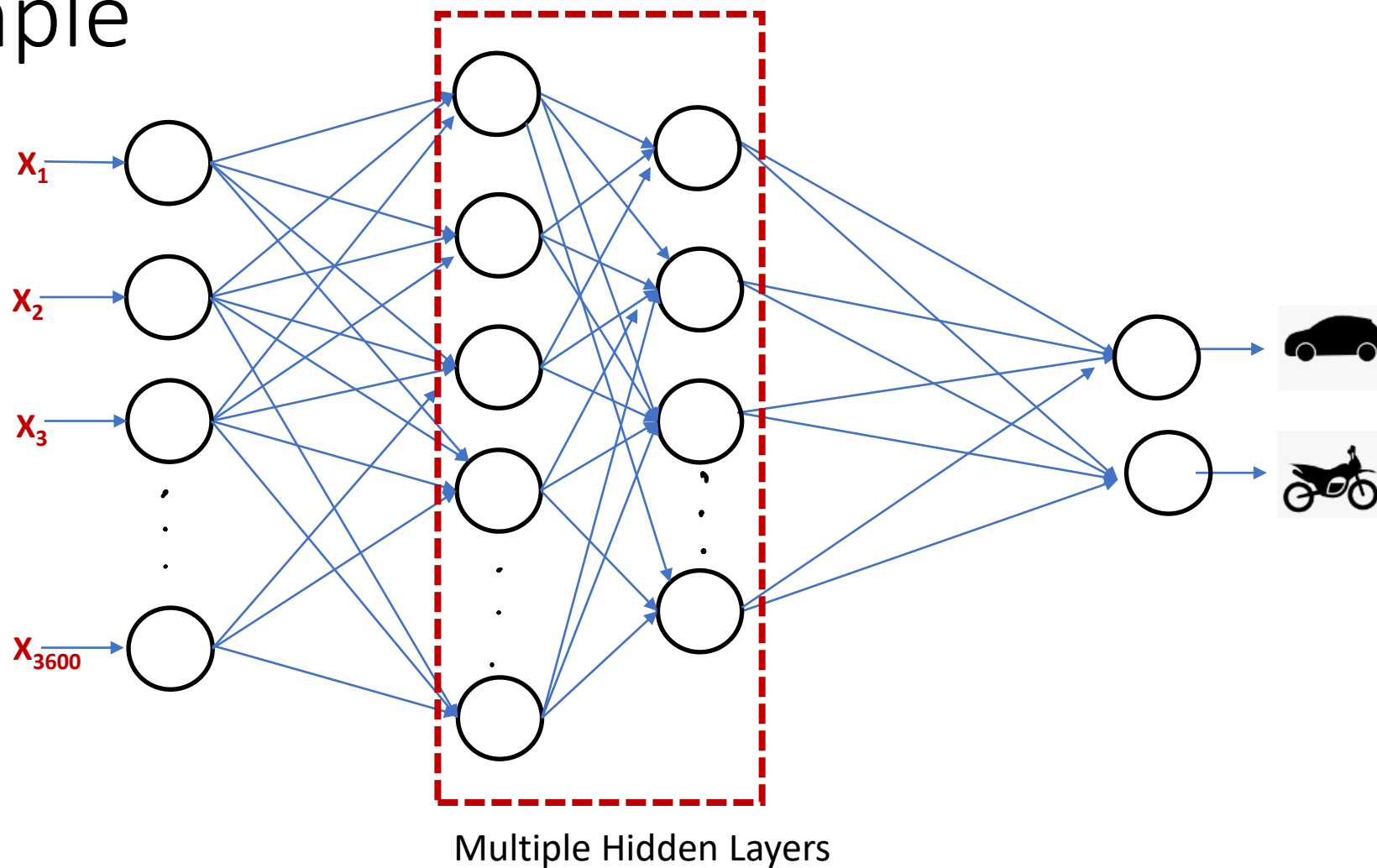


Forward pass

A Toy Example



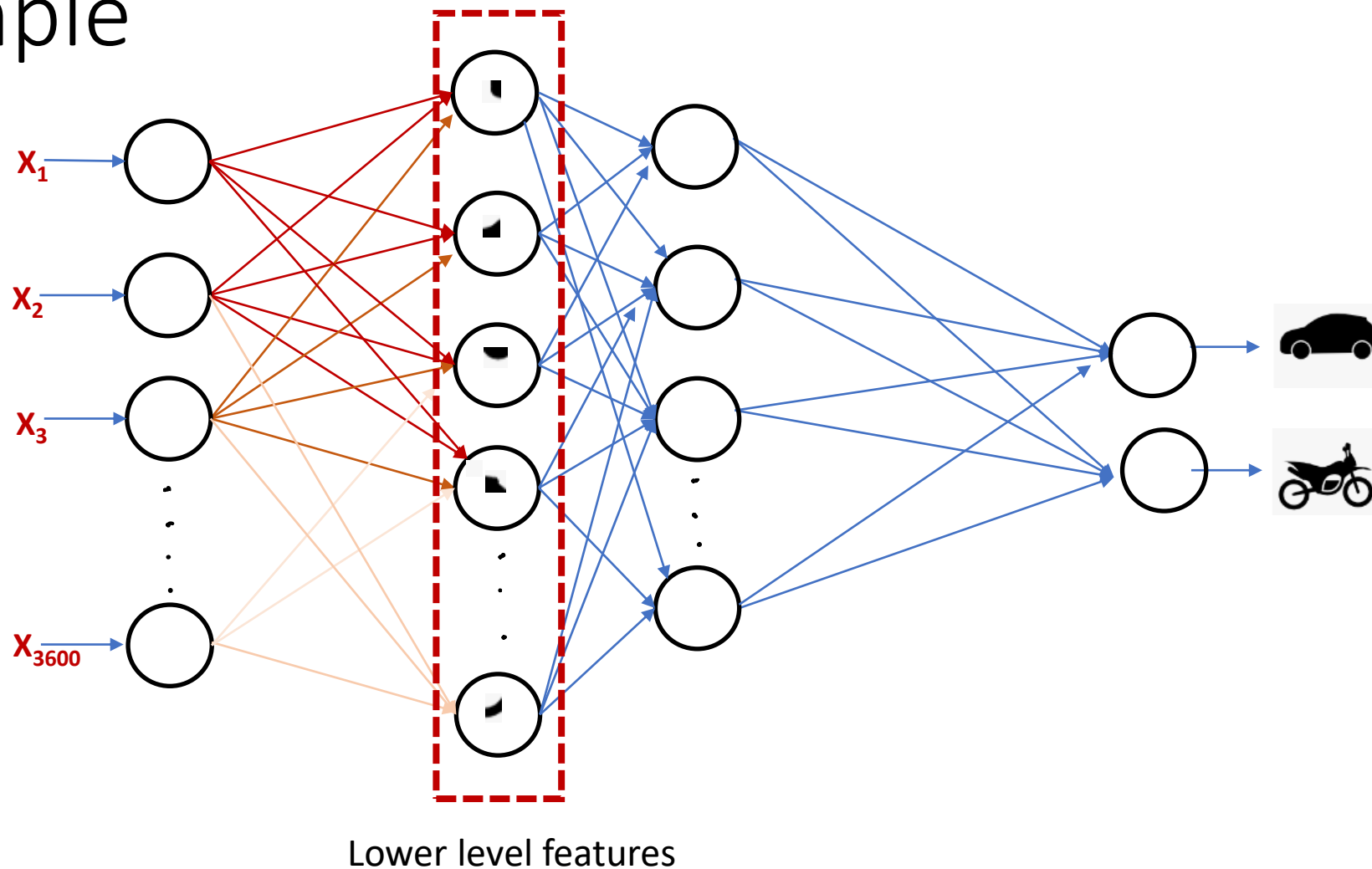
$60 \times 60 = 3600$



A Toy Example



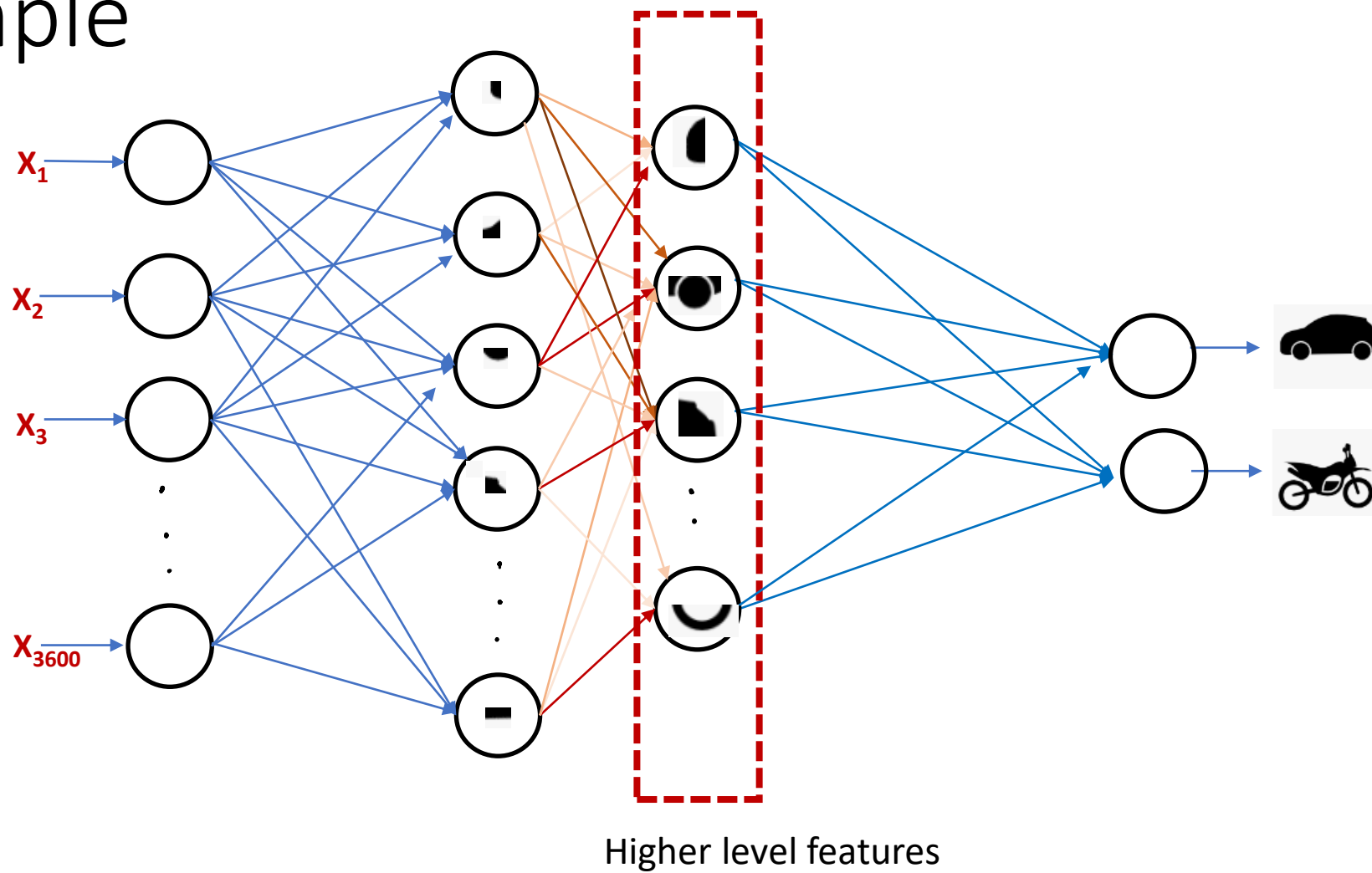
$60 \times 60 = 3600$



A Toy Example



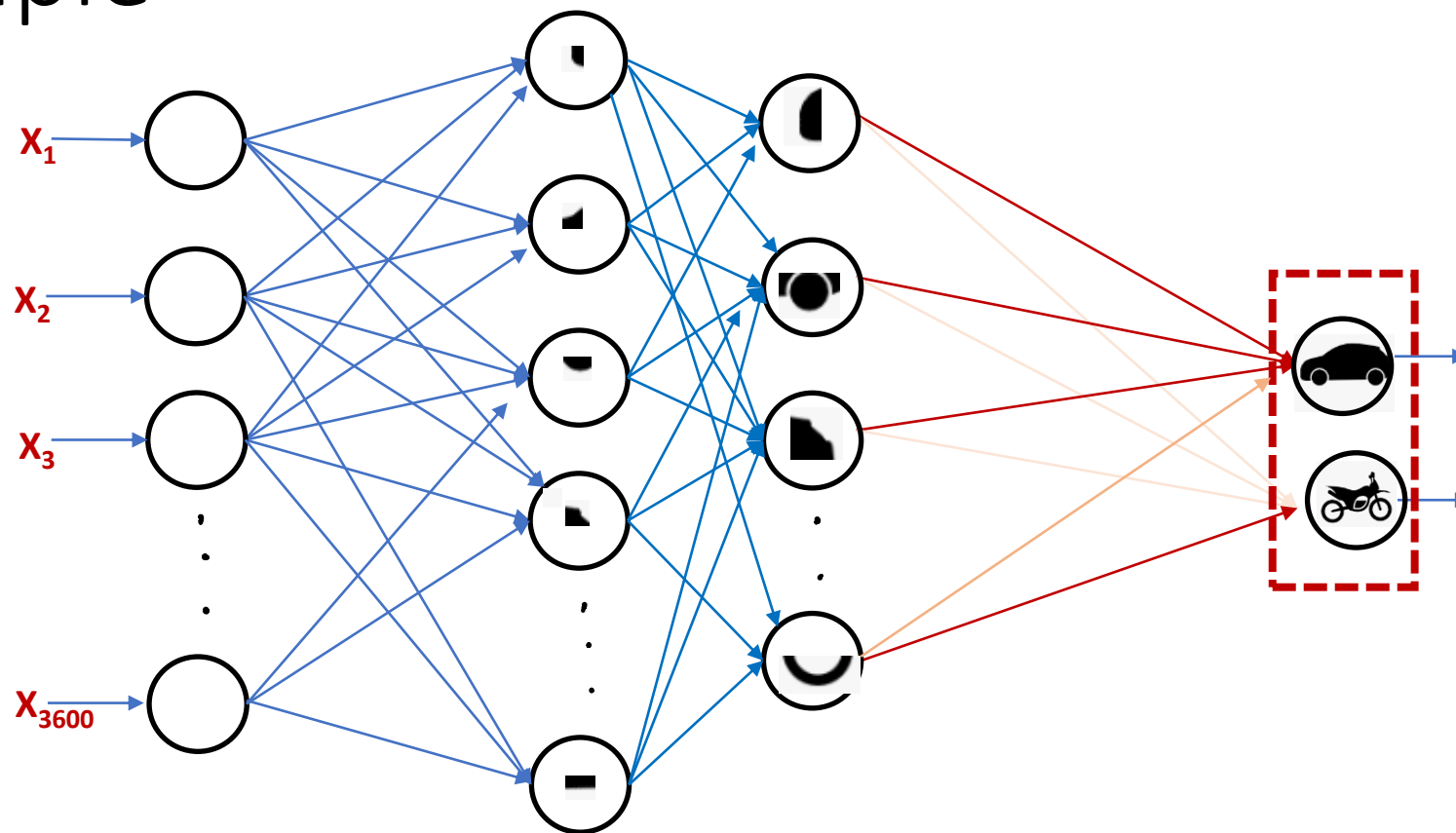
$60 \times 60 = 3600$



A Toy Example



$60 \times 60 = 3600$



Higher level features