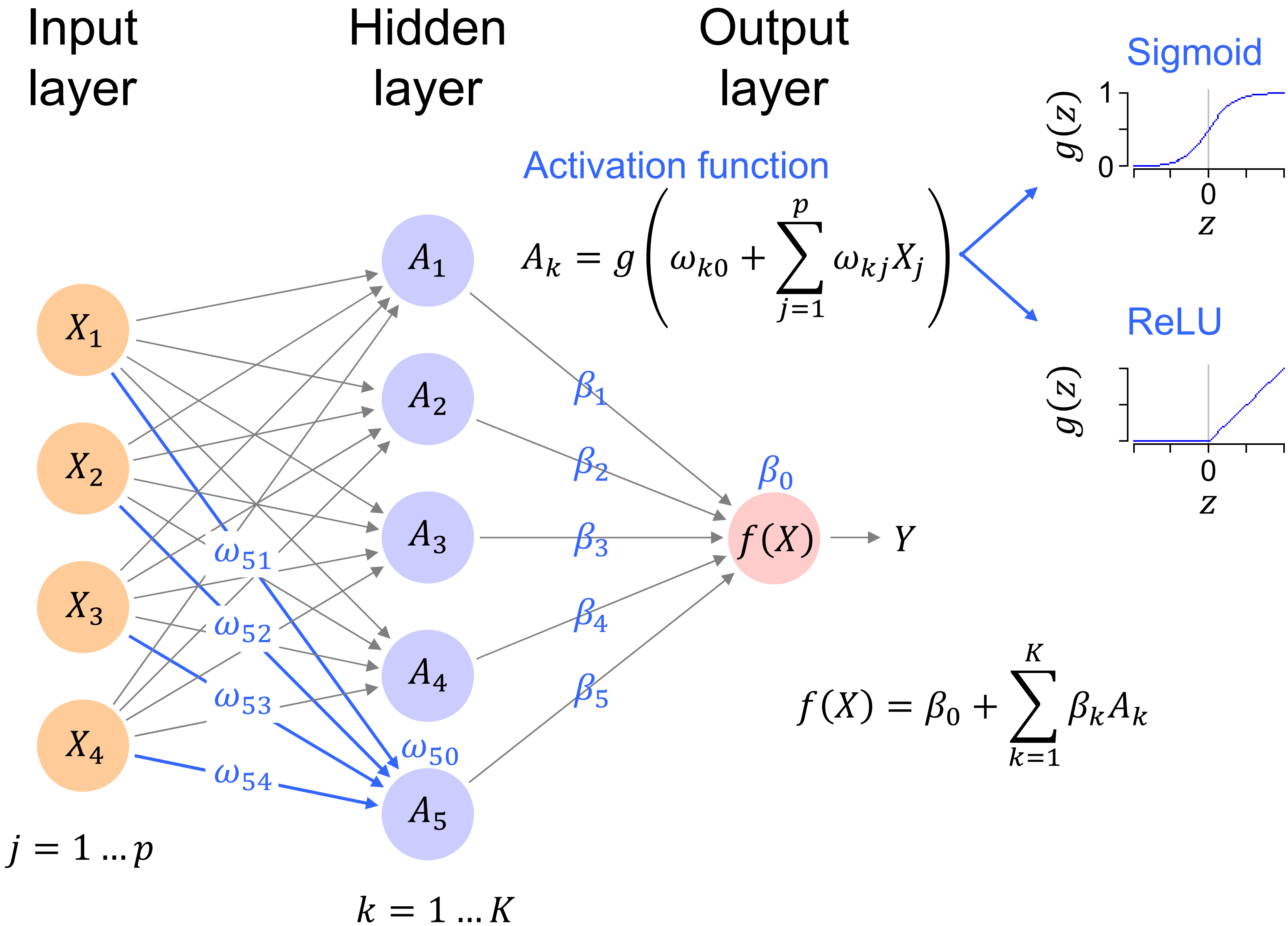
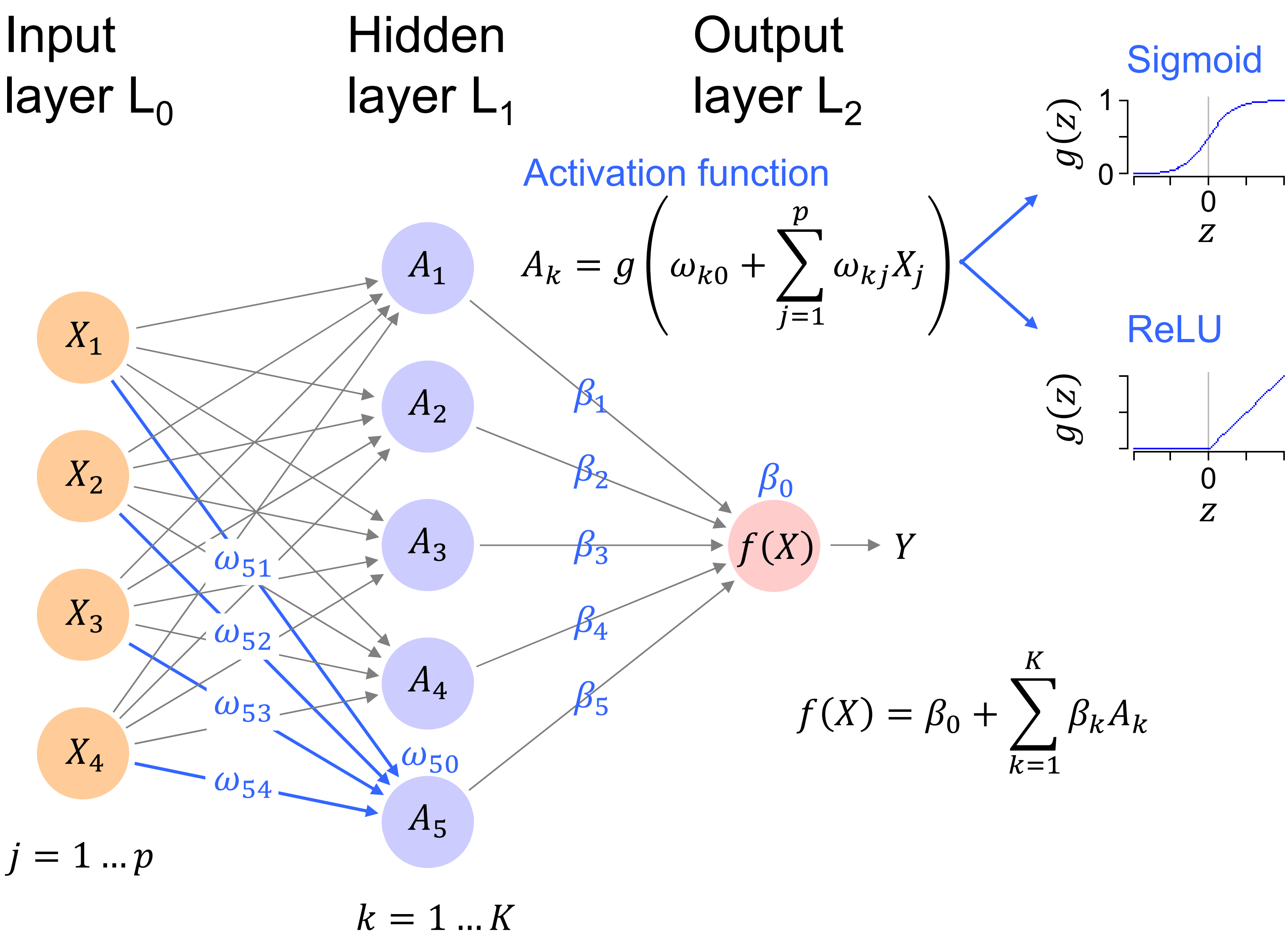
Single layer NN (generalizing)



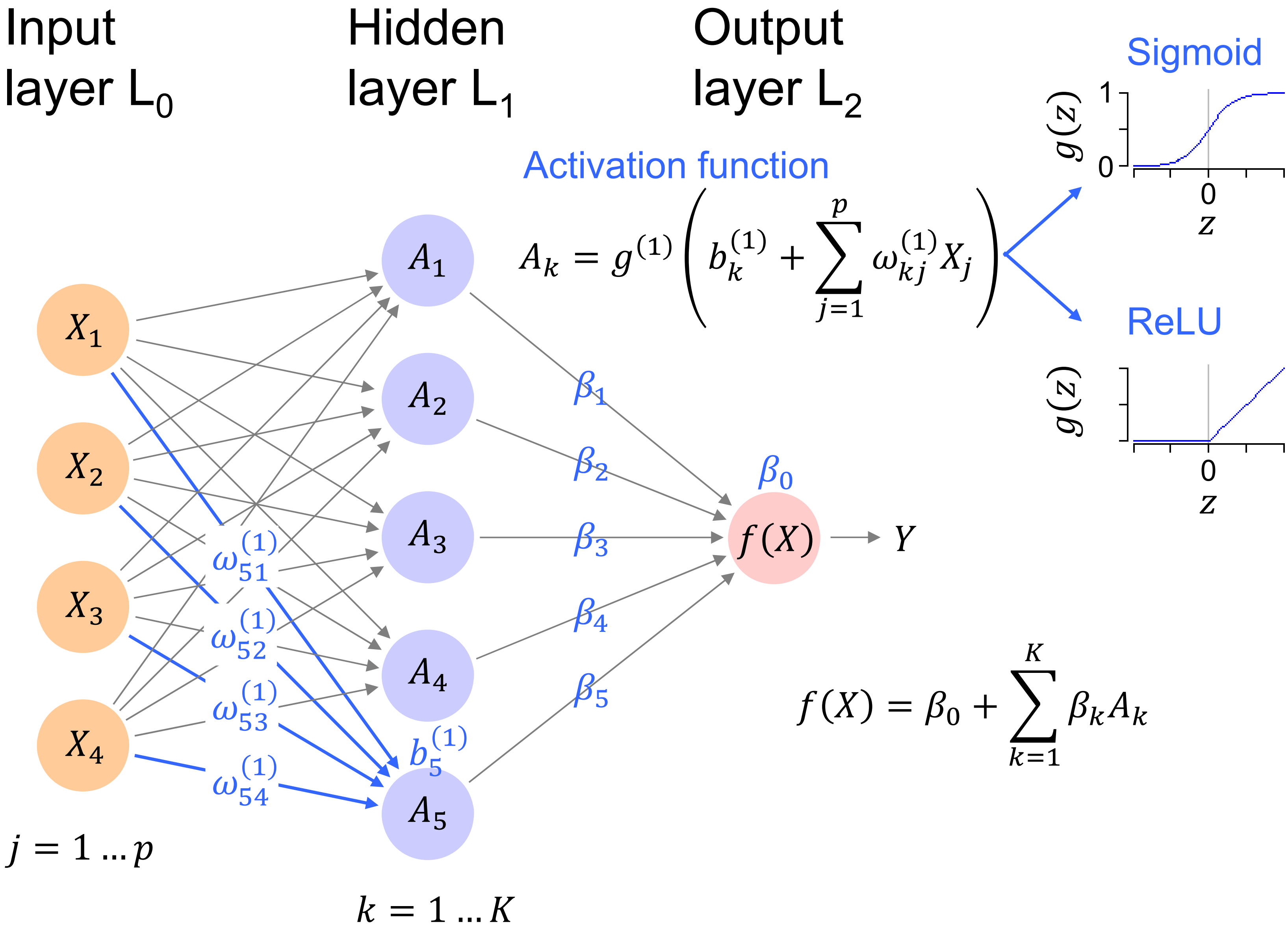
$$A_k = g\left(\omega_{k0} + \sum_{j=1}^{p} \omega_{kj} X_j\right)$$

$$f(X) = \beta_0 + \sum_{k=1}^{K} \beta_k A_k$$

Single layer NN (generalizing)



Single layer NN (generalizing)

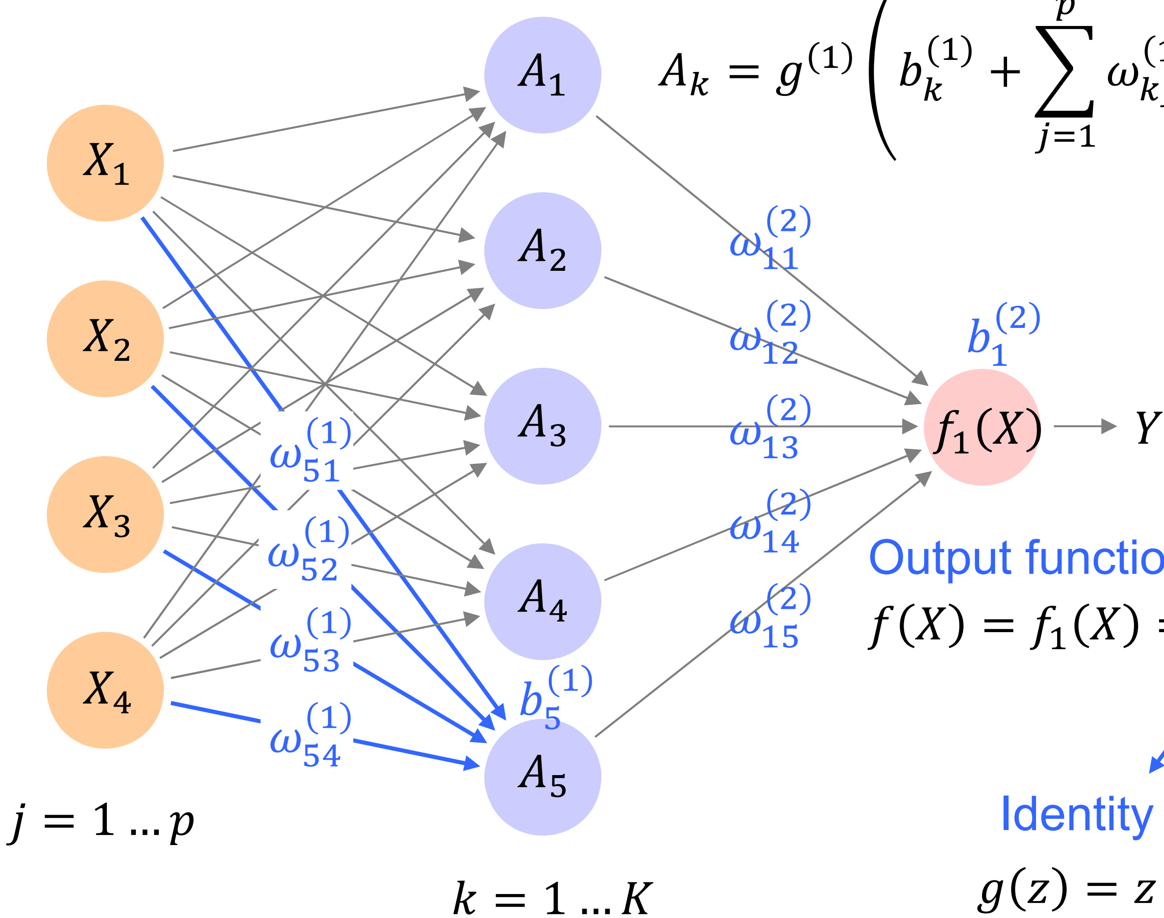


$$A_k = g^{(1)}\left(b_k^{(1)} + \sum_{j=1}^{p} \omega_{kj}^{(1)} X_j\right)$$

$$f(X) = \beta_0 + \sum_{k=1}^{K} \beta_k A_k$$

Single layer NN (generalizing)

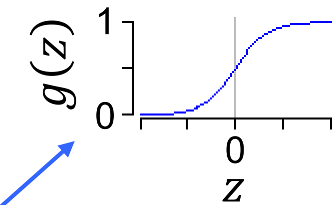
Input layer L_0 | Hidden layer L_1 | Output layer L_2



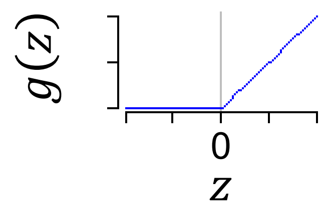
Activation function

$$A_k = g^{(1)}\left(b_k^{(1)} + \sum_{j=1}^{p} \omega_{kj}^{(1)} X_j\right)$$

Sigmoid



ReLU



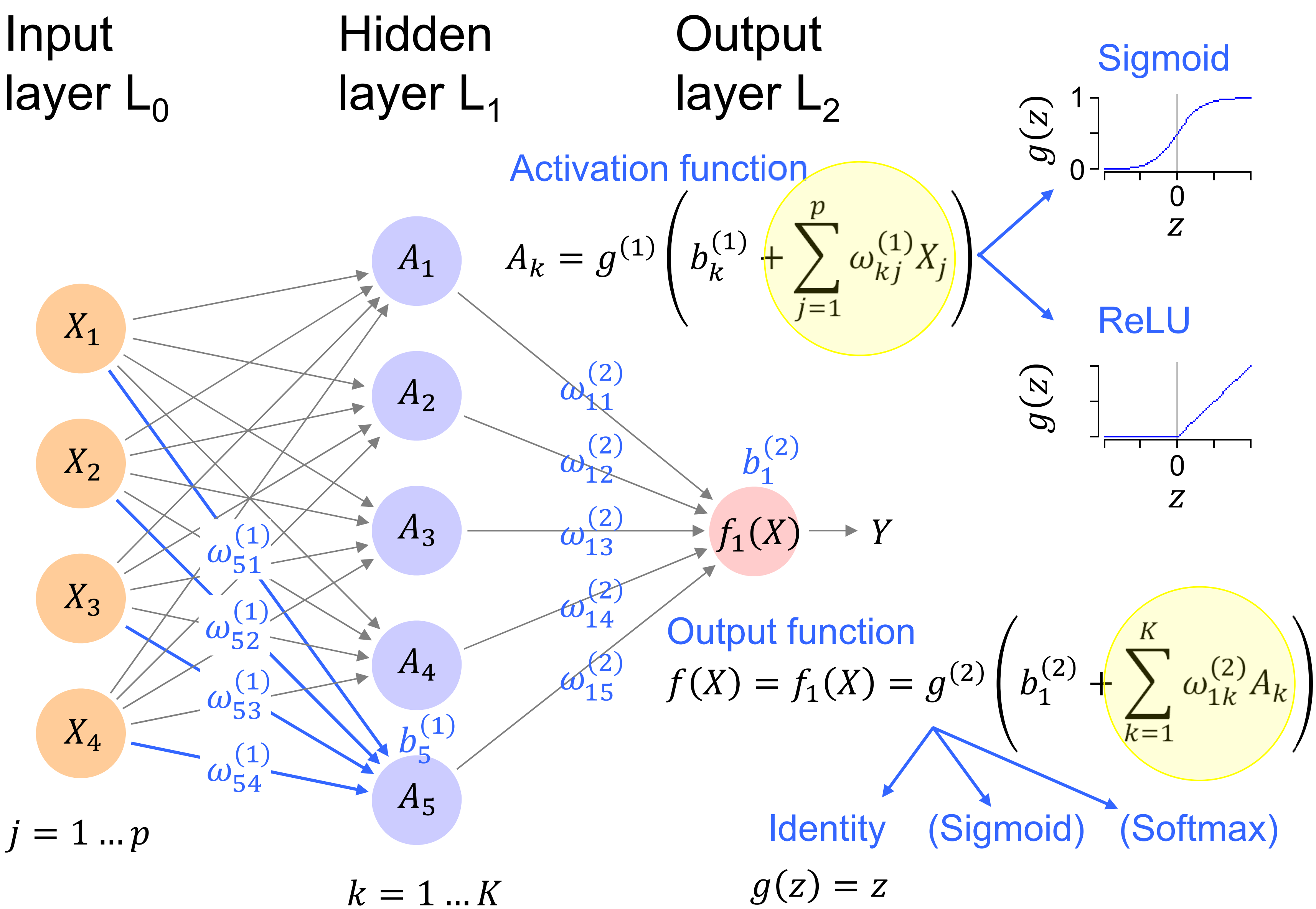
Output function

$$f(X) = f_1(X) = g^{(2)}\left(b_1^{(2)} + \sum_{k=1}^{K} \omega_{1k}^{(2)} A_k\right)$$

Identity (Sigmoid) (Softmax)

$g(z) = z$

Single layer NN (generalizing)



Single layer NN (generalizing)

$$\sum_{j=1}^{p} \omega_{kj}^{(1)} X_j$$

multiply down columns
then add across rows

$$\begin{array}{ccccccc}
\omega_{k1} & & \omega_{k2} & & \omega_{k3} & & \omega_{k4} \\
* & + & * & + & * & + & * \\
X_1 & & X_2 & & X_3 & & X_4
\end{array}$$

data rows
i = 1...n

$$\begin{array}{cccc}
x_{11} & x_{12} & x_{13} & x_{14} \\
x_{21} & x_{22} & x_{23} & x_{24} \\
\vdots & \vdots & \vdots & \vdots \\
x_{n1} & x_{n2} & x_{n3} & x_{n4}
\end{array}$$

data columns
j = 1...p

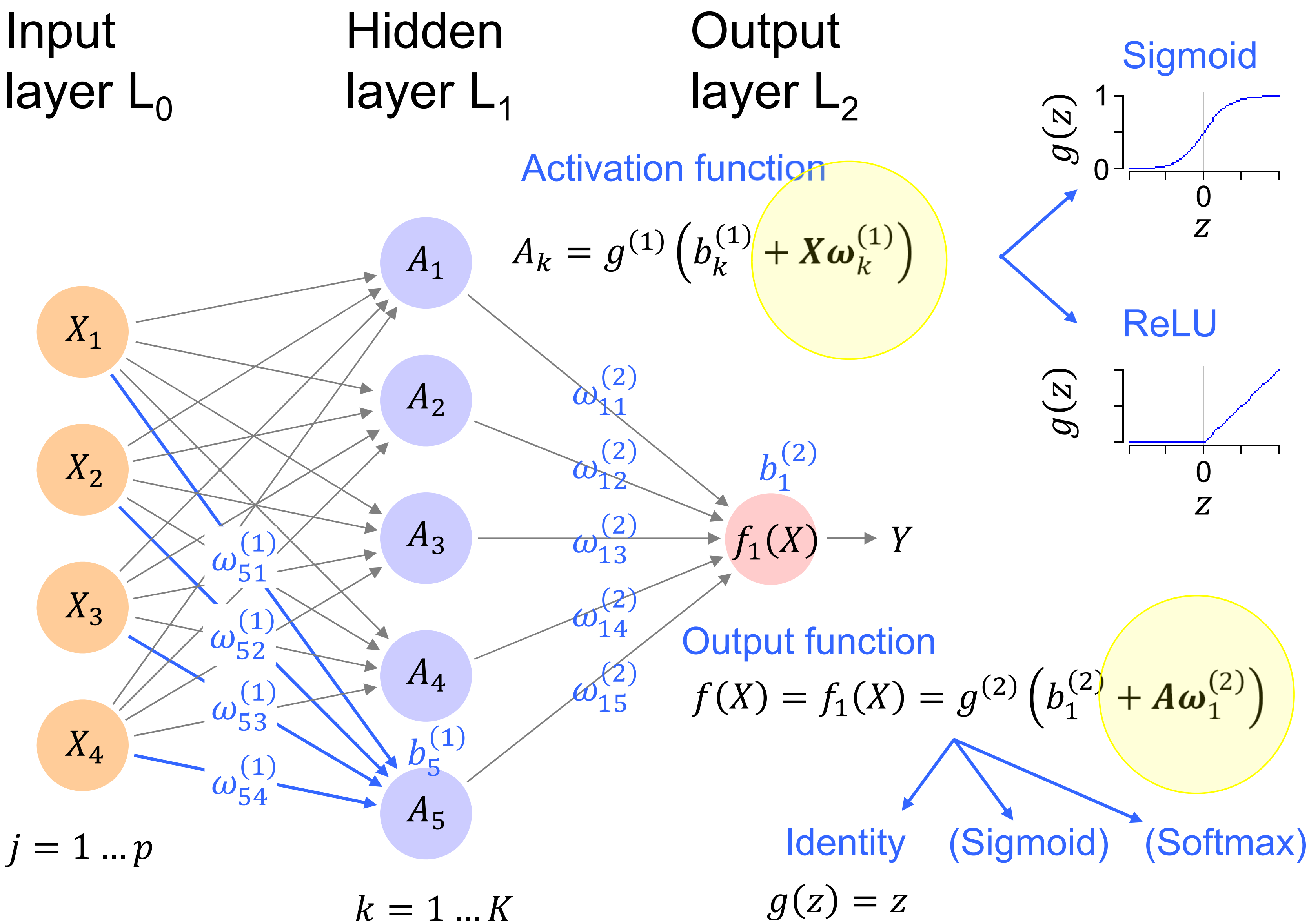
Matrix multiplication

$$\boldsymbol{X\omega}_k$$

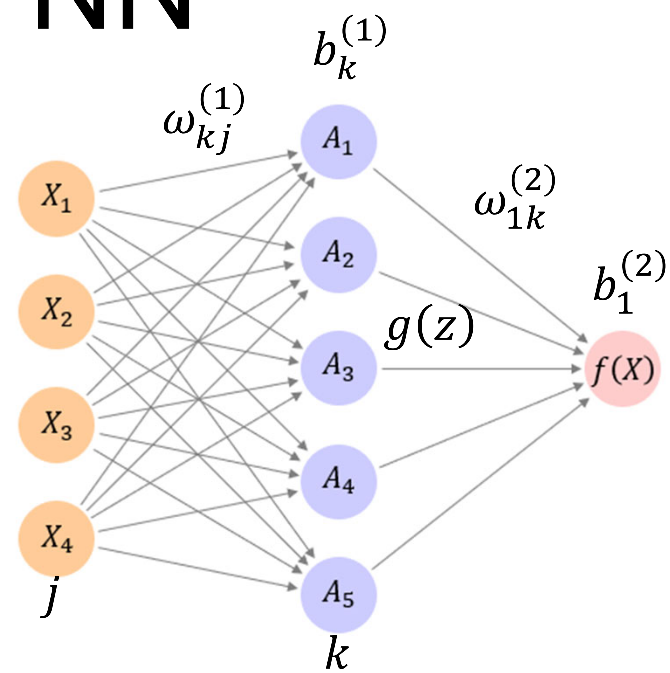
n x p   p x 1

R: `x %*% w`

Single layer NN (generalizing)



Single layer NN



Model algorithm

define $g(z)$

load and prepare x_j

set K

set $\omega_{kj}^{(1)}$, $b_k^{(1)}$, $\omega_{1k}^{(2)}$, $b_1^{(2)}$

for each activation unit k in 1:K

calculate linear predictor: $z_k = b_k^{(1)} + \boldsymbol{X}\boldsymbol{\omega}_k^{(1)}$

calculate nonlinear activation: $A_k = g(z_k)$

calculate linear model: $f(x) = b_1^{(2)} + \boldsymbol{A}\boldsymbol{\omega}_1^{(2)}$

return $f(x)$