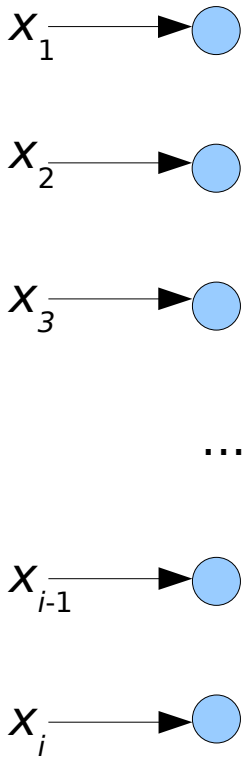
Introduction to Artificial Intelligence

Jaderick P. Pabico
Institute of Computer Science, College of Arts and Sciences
University of the Philippines Los Baños, College 4031, Laguna

CMSC 170 – Introduction to AI
2nd Semester 2009-2010

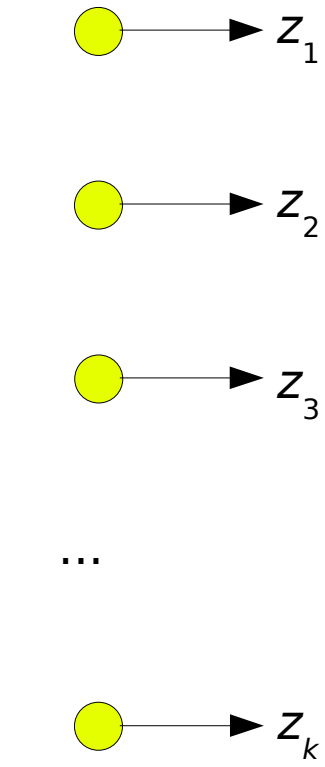
Neural Networks

- Number of inputs = *i*



Neural Networks

- Number of outputs = k

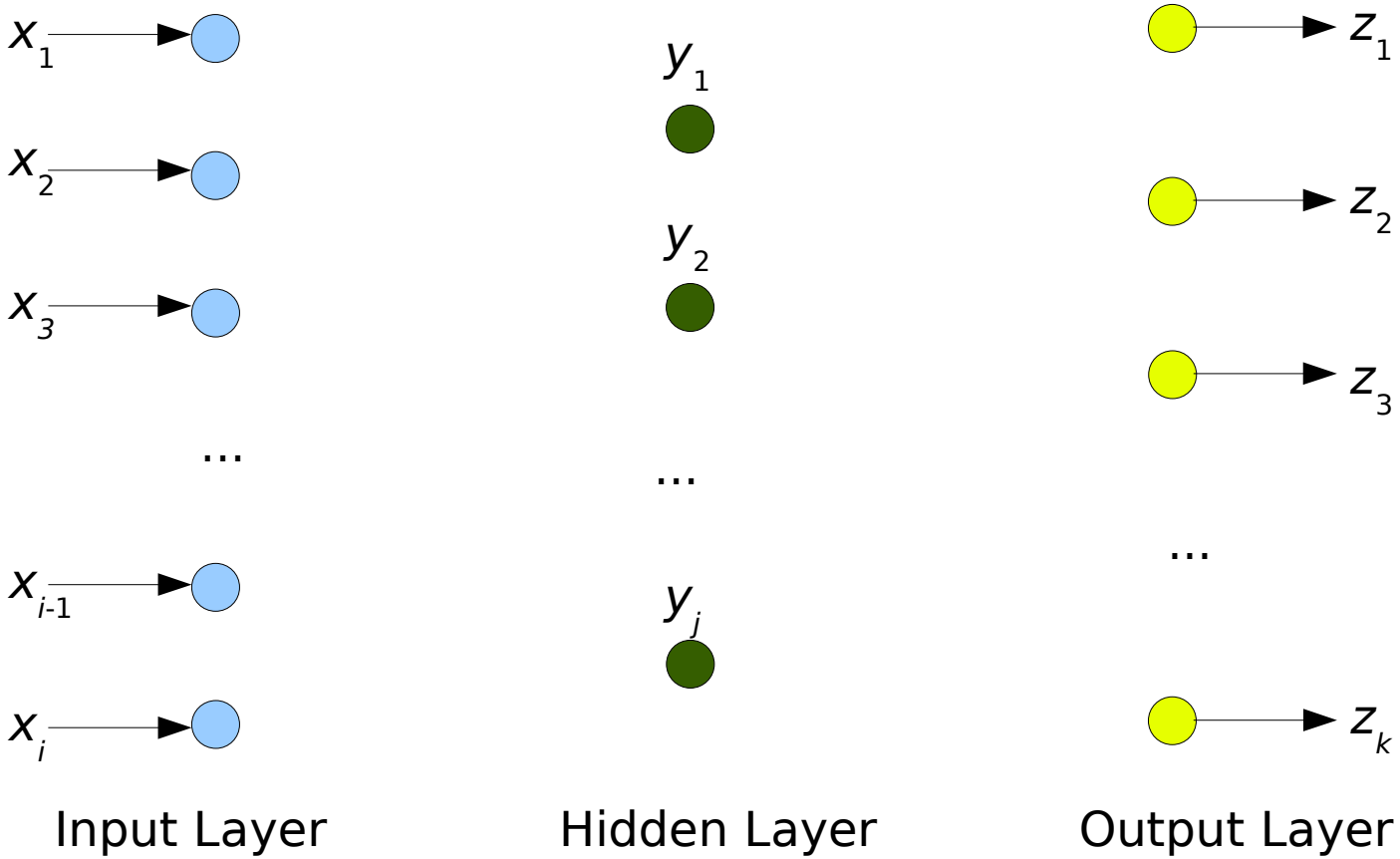


Neural Networks

- How do we get from input to output?

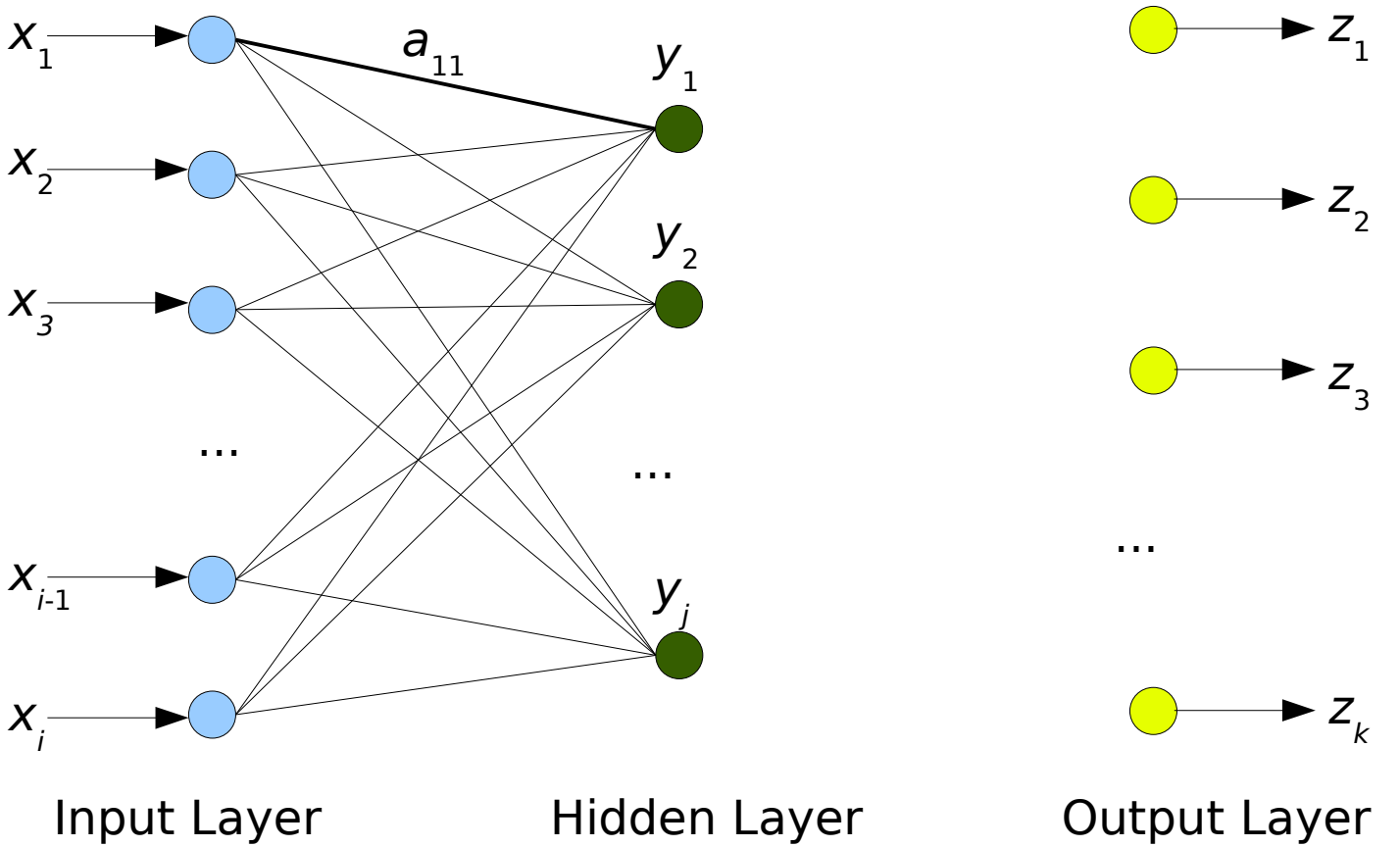
Neural Networks

- Hidden layer: number of nodes = j



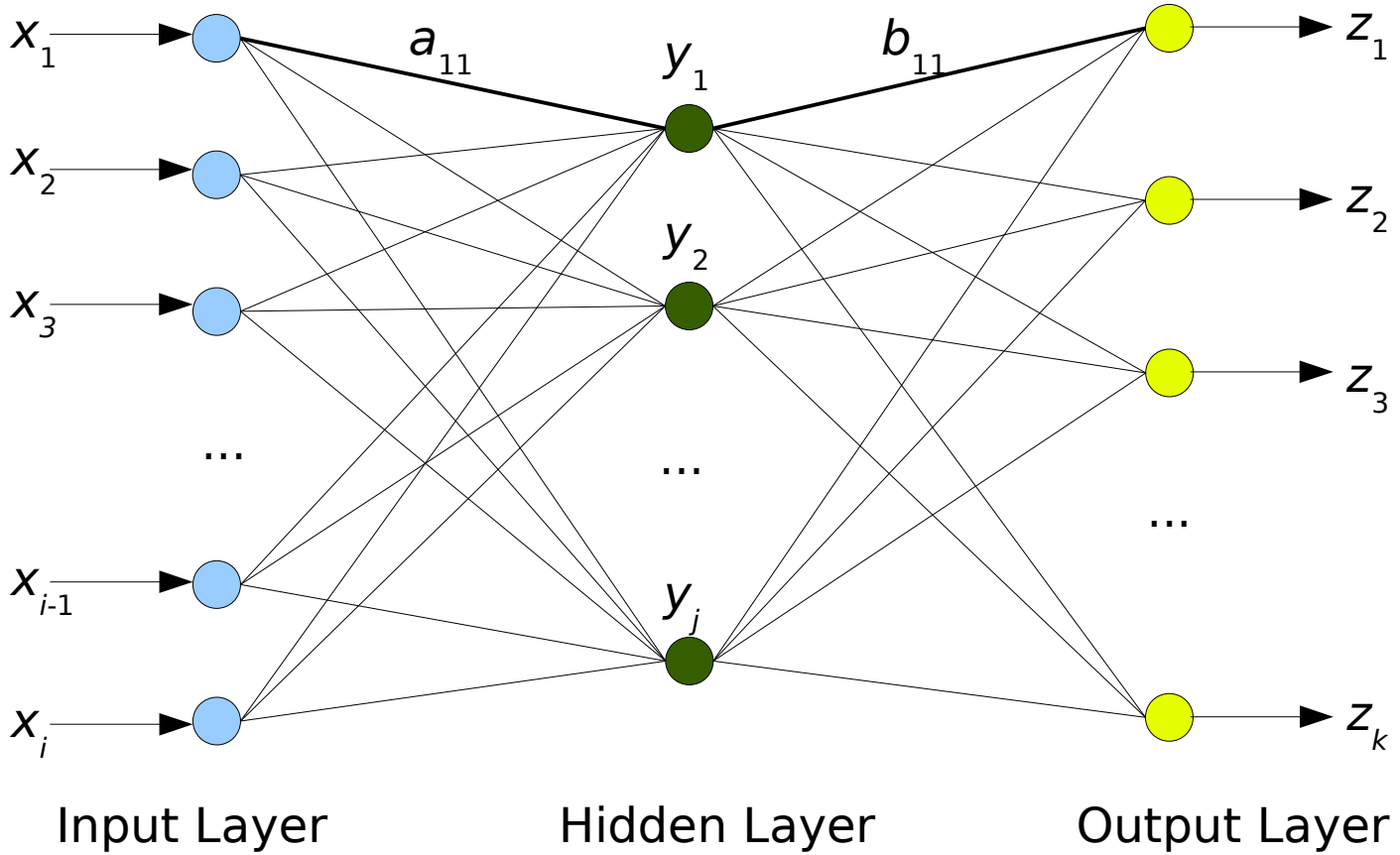
Neural Networks

- Nodes at input layer are connected to nodes at hidden layer



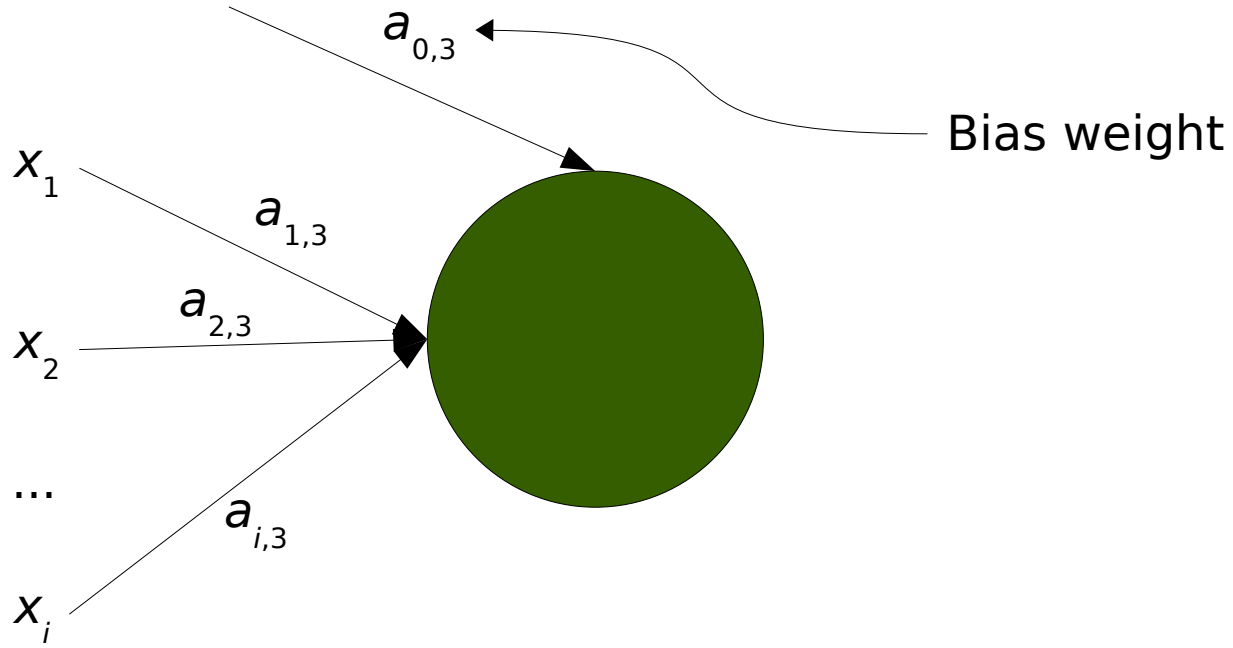
Neural Networks

- Nodes at hidden layer are connected to nodes at output layer



Neural Networks

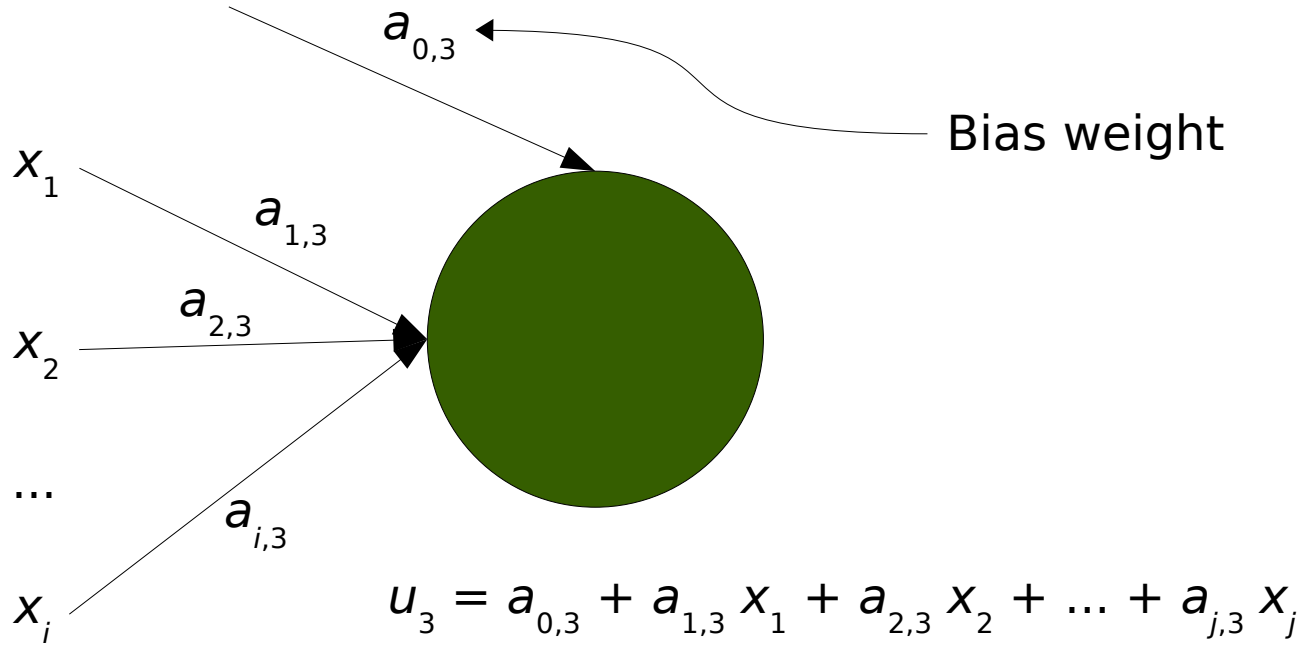
- A node at the hidden layer (3rd node)



x are inputs, *a* are weights

Neural Networks

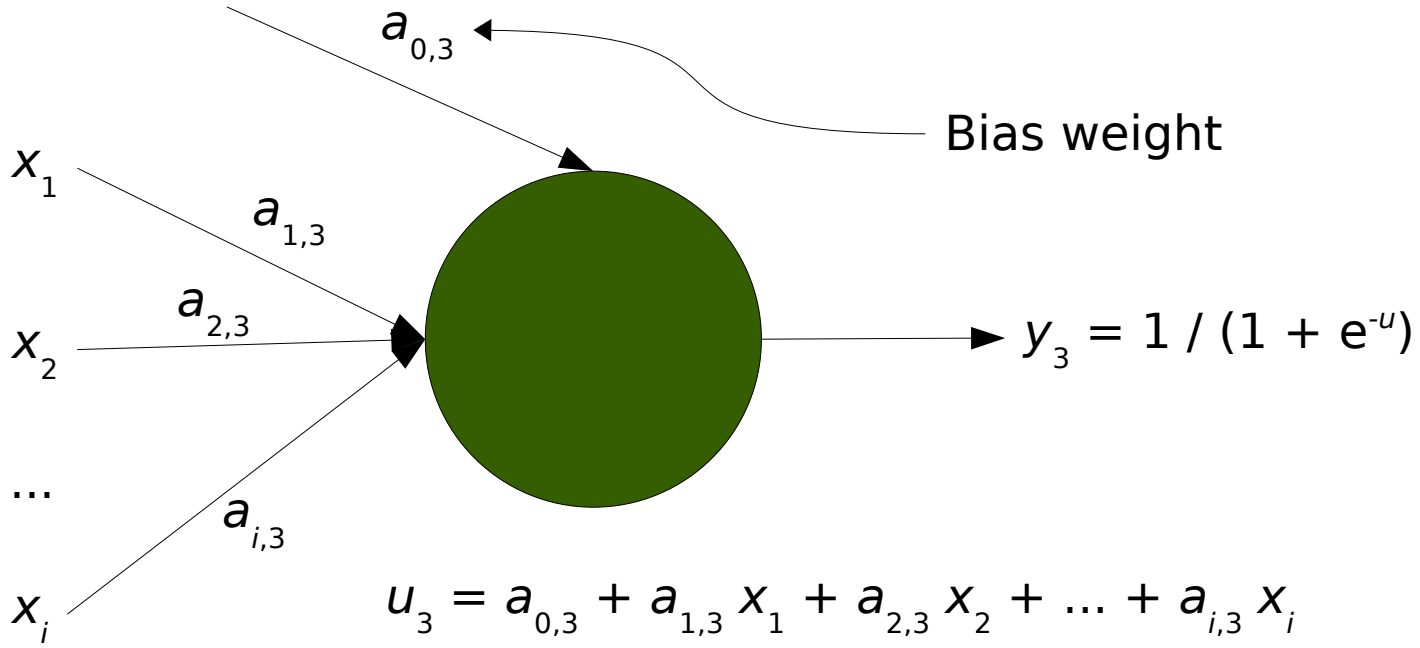
- A node at the hidden layer (3rd node)



x are inputs, *a* are weights

Neural Networks

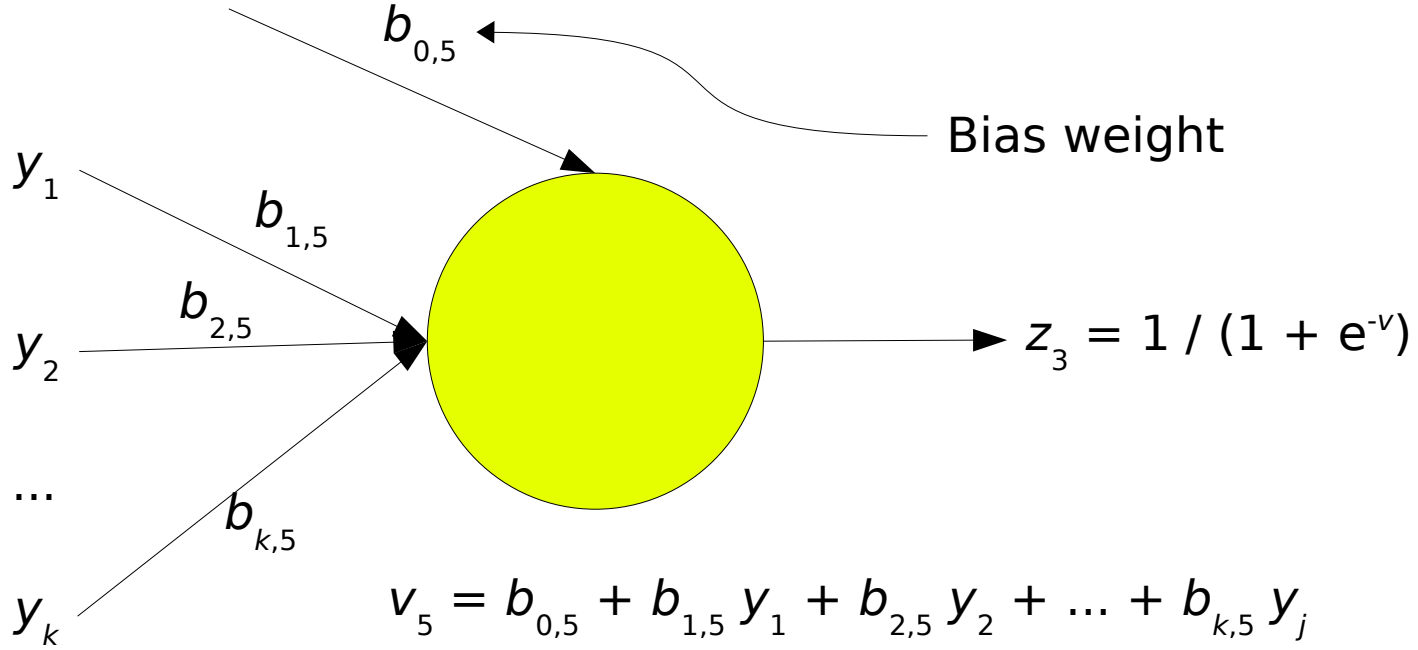
- A node at the hidden layer (3rd node)



x are inputs, *a* are weights

Neural Networks

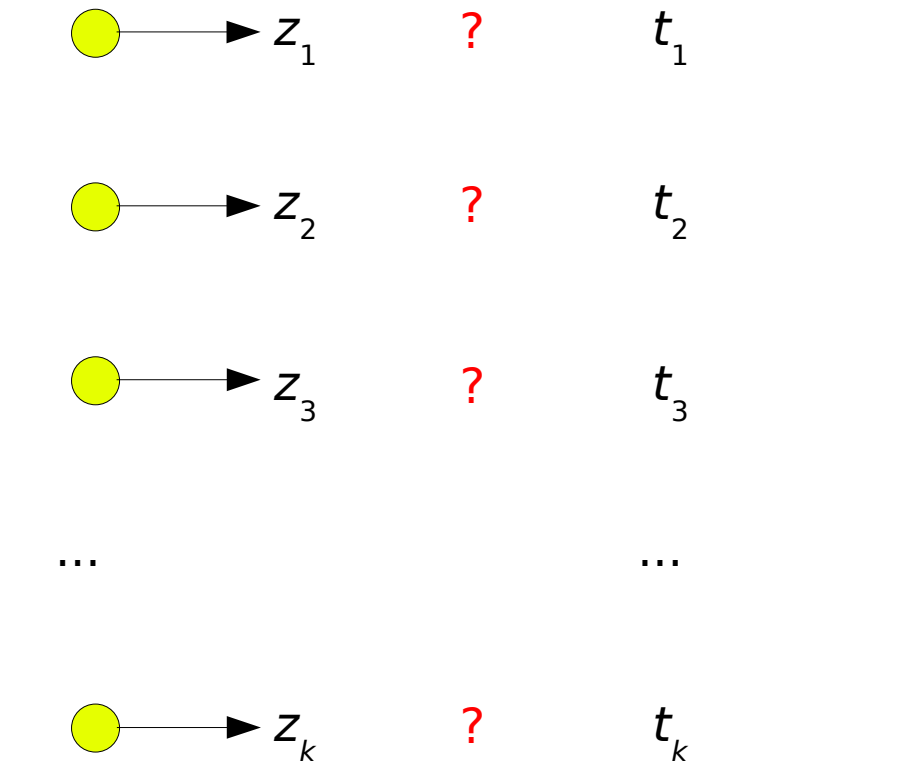
- A node at the output layer (5th node)



y are outputs from the hidden nodes, *b* are weights

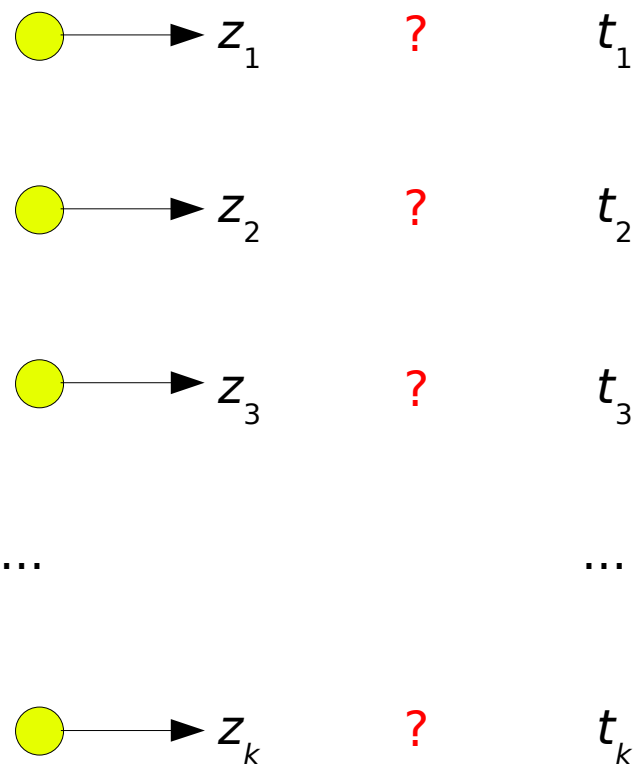
Neural Networks

- The output layer is compared to the target values



Neural Networks

- The difference between z and t is the error e



$$e_1 = z_1 - t_1$$

$$e_2 = z_2 - t_2$$

$$e_3 = z_3 - t_3$$

...

$$e_k = z_k - t_k$$

Error

Neural Networks

- The error *E* contributed by the *k*th output is therefore:

$$dE/dz_k = z_k - t_k$$

Neural Networks

- The *k*th output with respect to the *k*th *v*:

$$dz_k/dv_k = z_k (1 - z_k)$$

Neural Networks

- Therefore, the error *E* contributed by the *k*th *v* is:

$$dE/dv_k =$$

$$dE/dz_k \times dz_k/dv_k =$$

$$(z_k - t_k)\, z_k\, (1 - z_k)$$

Neural Networks

- The value of v_k with respect to $b_{j,k}$ is:

$$dv_k/db_{0,k} = 1$$

For bias weight

$$dv_k/db_{j,k} = y_j$$

Neural Networks

- The value of v_k with respect to y_j is:

$$dv_k/dy_j = b_{j,k}$$

Neural Networks

- Therefore, the error E contributed by $b_{j,k}$ is:

$$dE/db_{j,k} =$$

$$dE/dz_k \times dz_k/dv_k \times dv_k/db_{j,k}$$

Neural Networks

- And the error E contributed by y_j is:

$$dE/dy_j =$$

$$dE/dz_k \times dz_k/dv_k \times dv_k/dy_j$$

Neural Networks

- The value of y_j with respect to u_j is:

$$dy_j/du_j = y_j (1 - y_j)$$

Neural Networks

- The value of u_j with respect to $a_{i,j}$ is:

$$\mathrm{d}u_j/\mathrm{d}a_{0,j} = 1$$

For bias weight

$$\mathrm{d}u_j/\mathrm{d}a_{i,j} = x_i$$

Neural Networks

- Assignment:

$$dE/du_j = ?$$

$$dE/da_{i,j} = ?$$