

## Perceptron Learning Worksheet

Algorithm:

1. Initialize starting weights randomly
2. Do until you want to stop (*typically when accuracy is good enough or weights stop changing*):
  - a. for each training example (x, y):
    - i. use NN to get prediction of  $h(x)$
    - ii. if  $h(x)$  differs from y, update all weights:
    - iii.  $w[i] = w[i] + (y - h(x)) * x[i]$
  - b. compute accuracy over entire training data = (# predicted correctly)/(# of training examples)

Training data (XOR)

| x1 | x2 | y |
|----|----|---|
| 0  | 0  | 0 |
| 0  | 1  | 1 |
| 1  | 0  | 1 |
| 1  | 1  | 0 |

| Epoch | Starting weights |    |    | Example   |    |    |   | Weighted sum | Predict $h(x)$ | Error $y - h(x)$ | Updated weights |    |    |
|-------|------------------|----|----|-----------|----|----|---|--------------|----------------|------------------|-----------------|----|----|
|       | w0               | w1 | w2 | x0 (bias) | x1 | x2 | y |              |                |                  | w0              | w1 | w2 |
| 1     | 1                | 2  | 3  | 1         | 0  | 0  | 0 |              |                |                  |                 |    |    |
| 1     |                  |    |    | 1         | 0  | 1  | 1 |              |                |                  |                 |    |    |
| 1     |                  |    |    | 1         | 1  | 0  | 1 |              |                |                  |                 |    |    |
| 1     |                  |    |    | 1         | 1  | 1  | 0 |              |                |                  |                 |    |    |
| 2     |                  |    |    | 1         | 0  | 0  | 0 |              |                |                  |                 |    |    |
| 2     |                  |    |    | 1         | 0  | 1  | 1 |              |                |                  |                 |    |    |
| 2     |                  |    |    | 1         | 1  | 0  | 1 |              |                |                  |                 |    |    |
| 2     |                  |    |    | 1         | 1  | 1  | 0 |              |                |                  |                 |    |    |
| 3     |                  |    |    | 1         | 0  | 0  | 0 |              |                |                  |                 |    |    |
| 3     |                  |    |    | 1         | 0  | 1  | 1 |              |                |                  |                 |    |    |
| 3     |                  |    |    | 1         | 1  | 0  | 1 |              |                |                  |                 |    |    |
| 3     |                  |    |    | 1         | 1  | 1  | 0 |              |                |                  |                 |    |    |