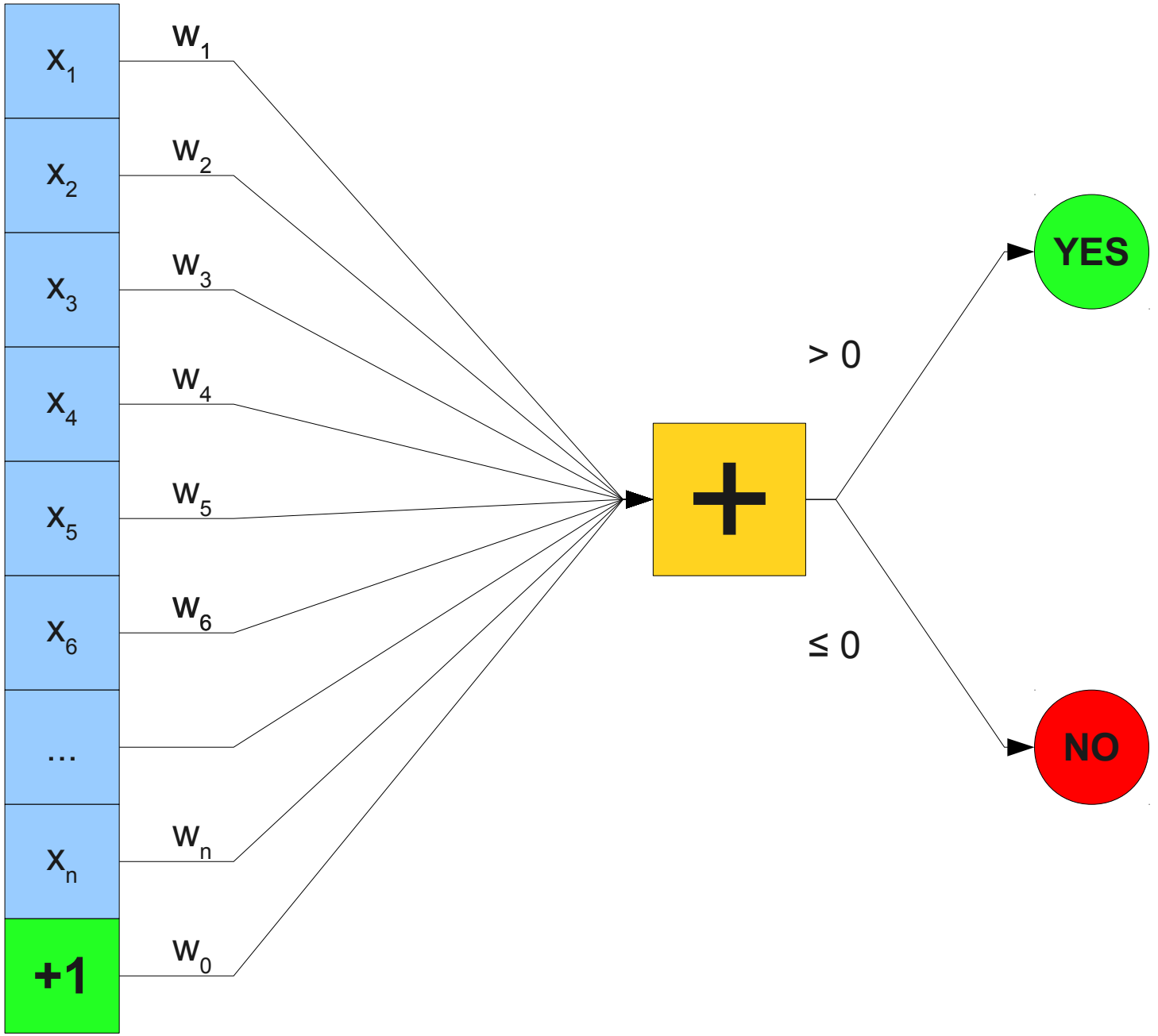
Machine Learning

CS Kickball!
4PM Today at FloMo Field

Evaluate this course on Axess!

Your comments really make a difference.

Introduction to Perceptrons


x1
x2
x3
x4
x5
x6
...
xn
+1
w1
w2
w3
w4
w5
w6
wn
w0
+
> 0
≤ 0
YES
NO

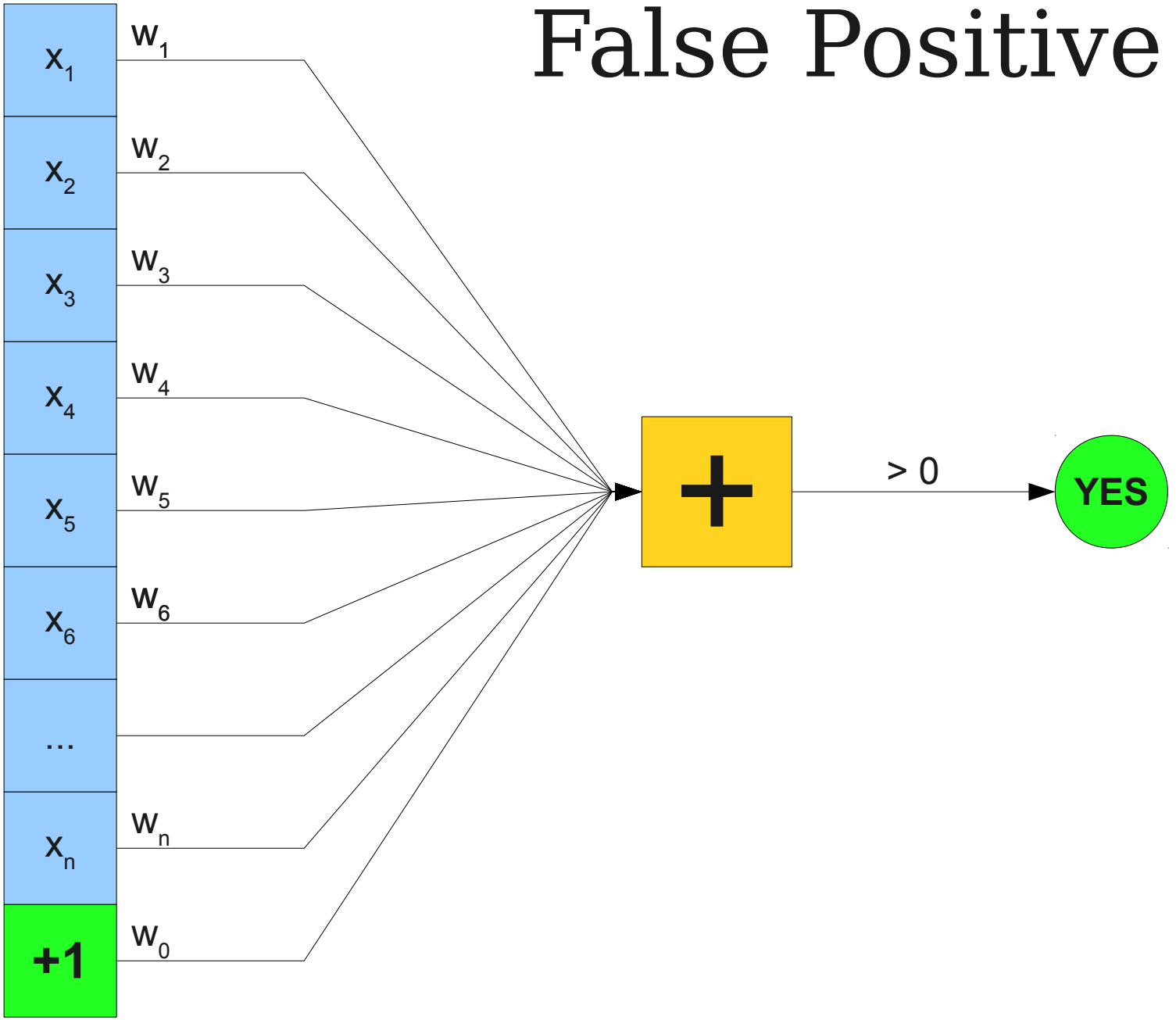
How do we choose good values for $w_0 \ldots w_n$?

One Approach

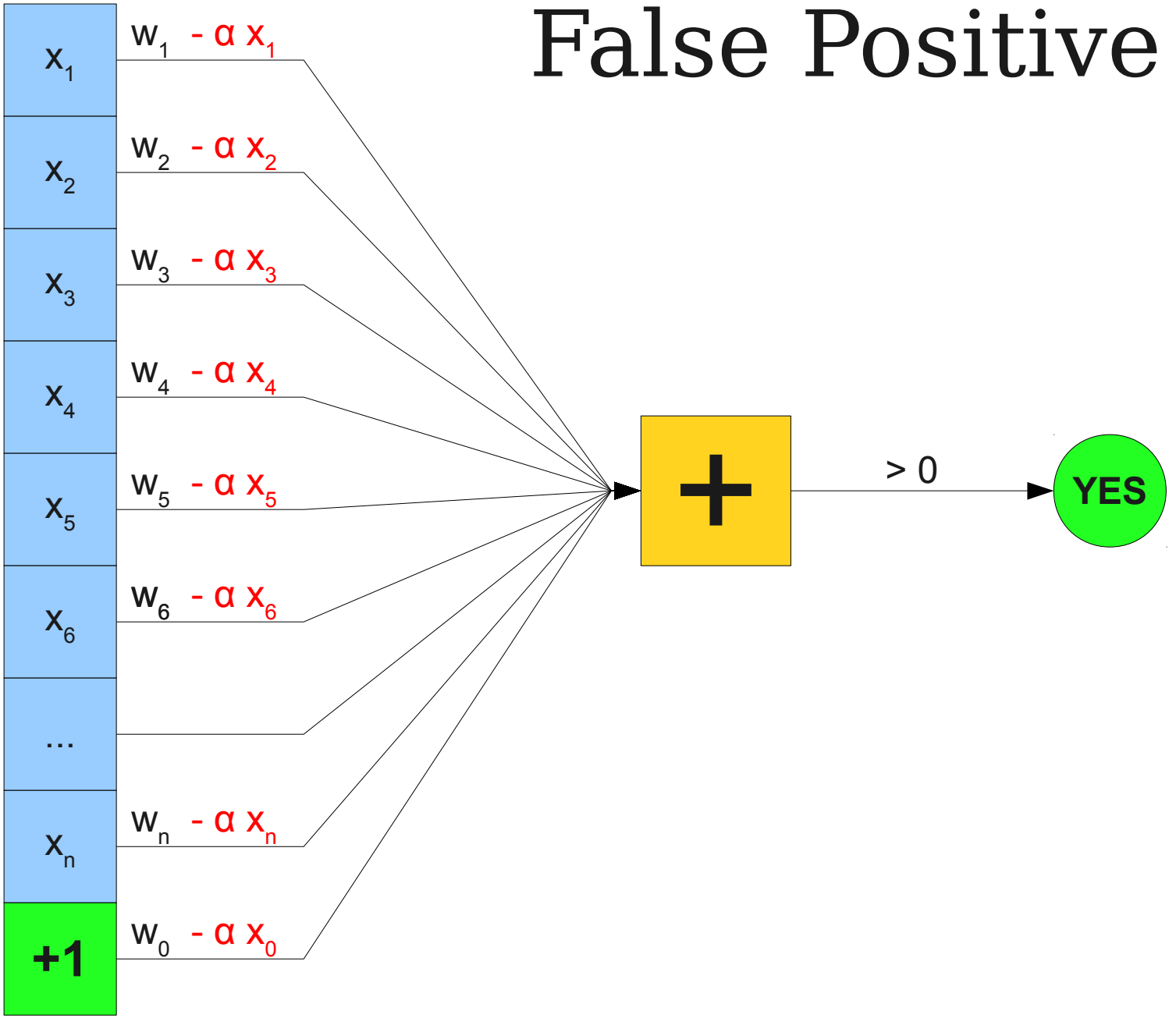
- **Train** the perceptron on valid data.
- For each data point:
  - Ask the perceptron what it thinks.
  - If correct, do nothing.
  - Otherwise, nudge w_0 … w_n in the right direction.
- Repeat until number of errors is “small enough.”
- Question: What kind of mistakes can we make?

False Positive

False Positive

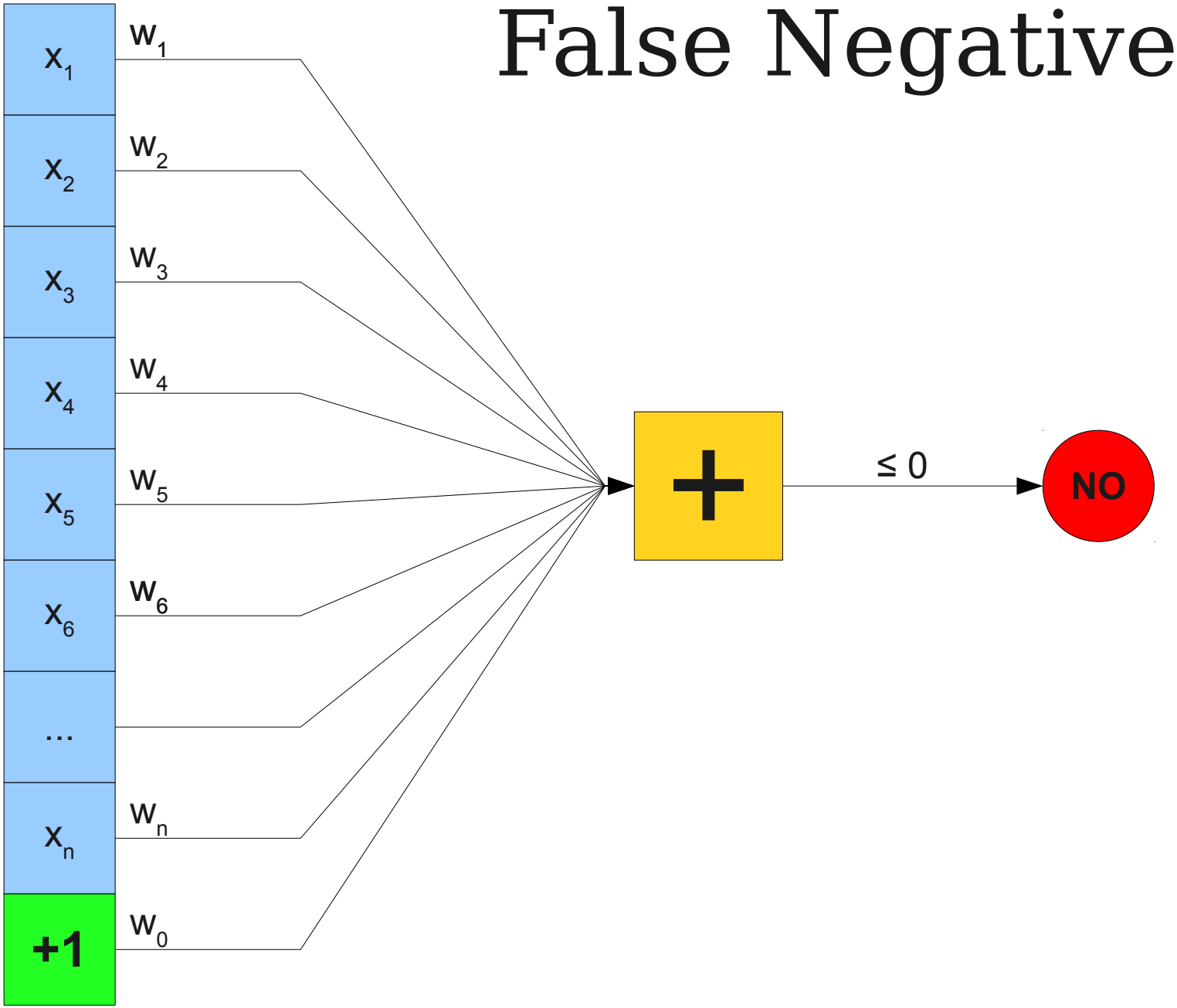


False Positive

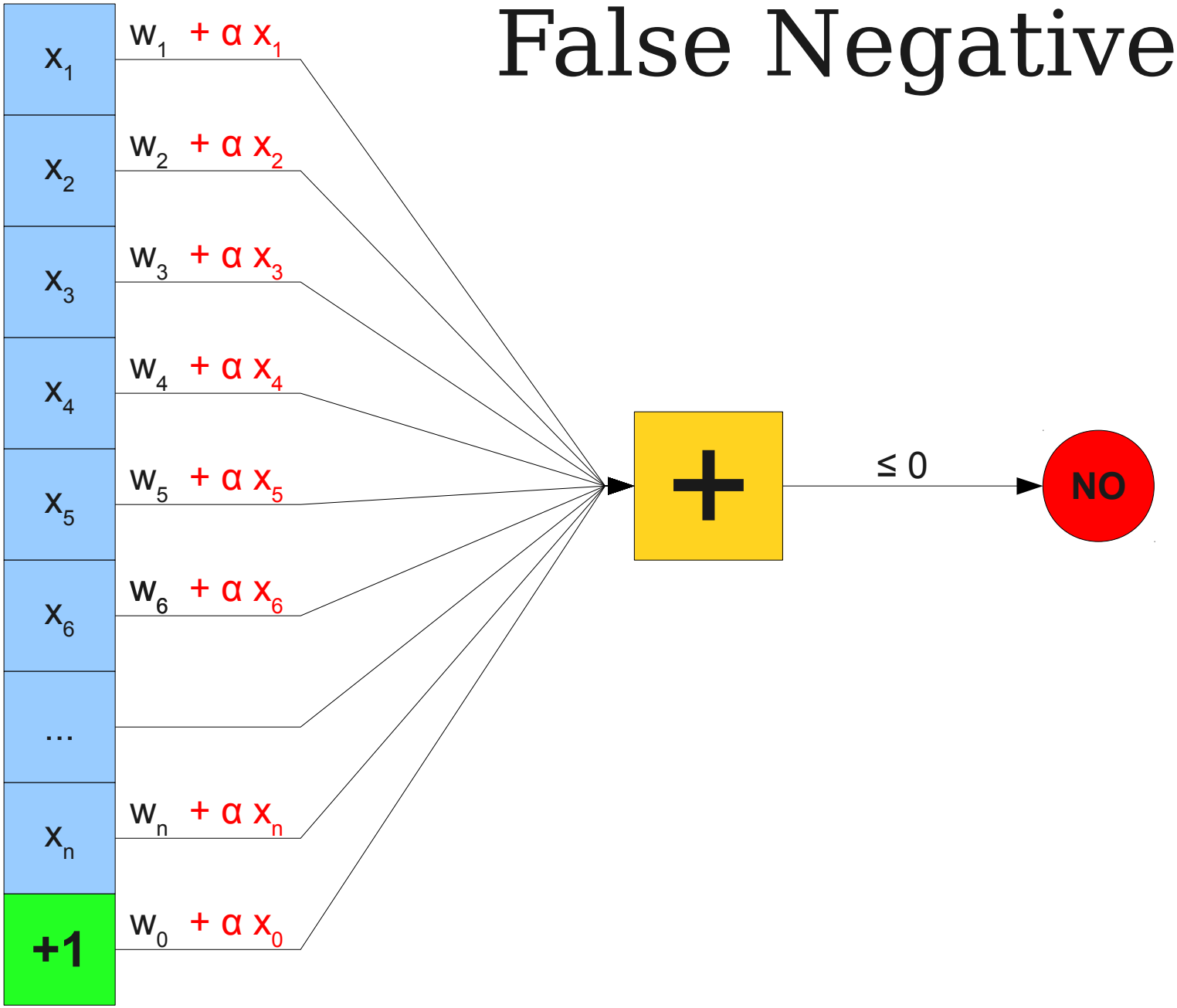


False Negative

False Negative



False Negative



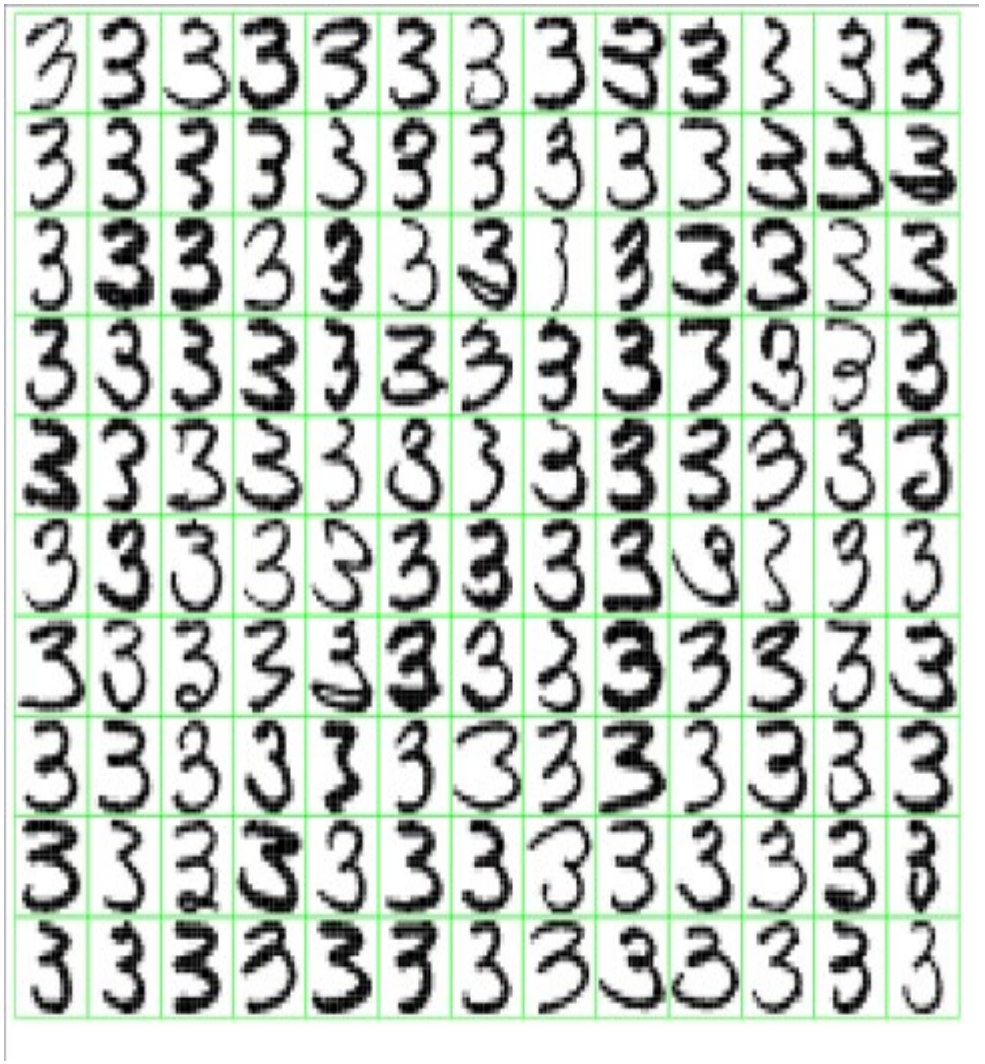
A Cute Math Trick

- For false positives, set $w_i = w_i - \alpha x_i$.
- For false negatives, set $w_i = w_i + \alpha x_i$.
- For correct answers, set $w_i = w_i$.
- Let “YES” be 1 and “NO” be 0.
- Consider the difference between **actual answer** and **perceptron guess**:
  - False positive: Actually NO, we say YES. Difference is -1.
  - False negative: Actually YES, we say NO. Difference is +1.
  - Correct answer: Both YES or both NO. Difference is 0.
- General update rule: $\mathbf{w_i = w_i + \alpha (real - guess) x_i}$.

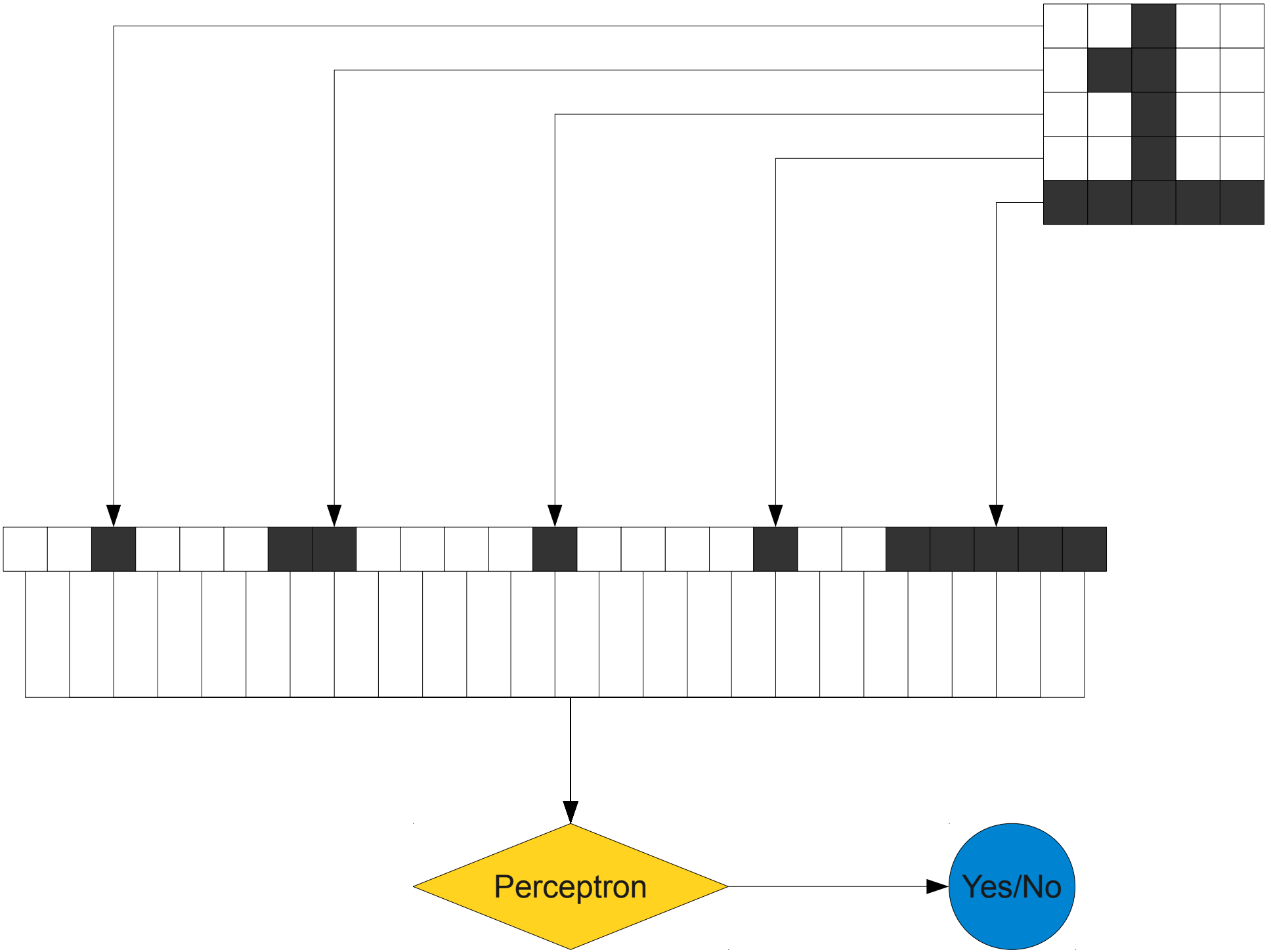
Perceptron Learning Algorithm

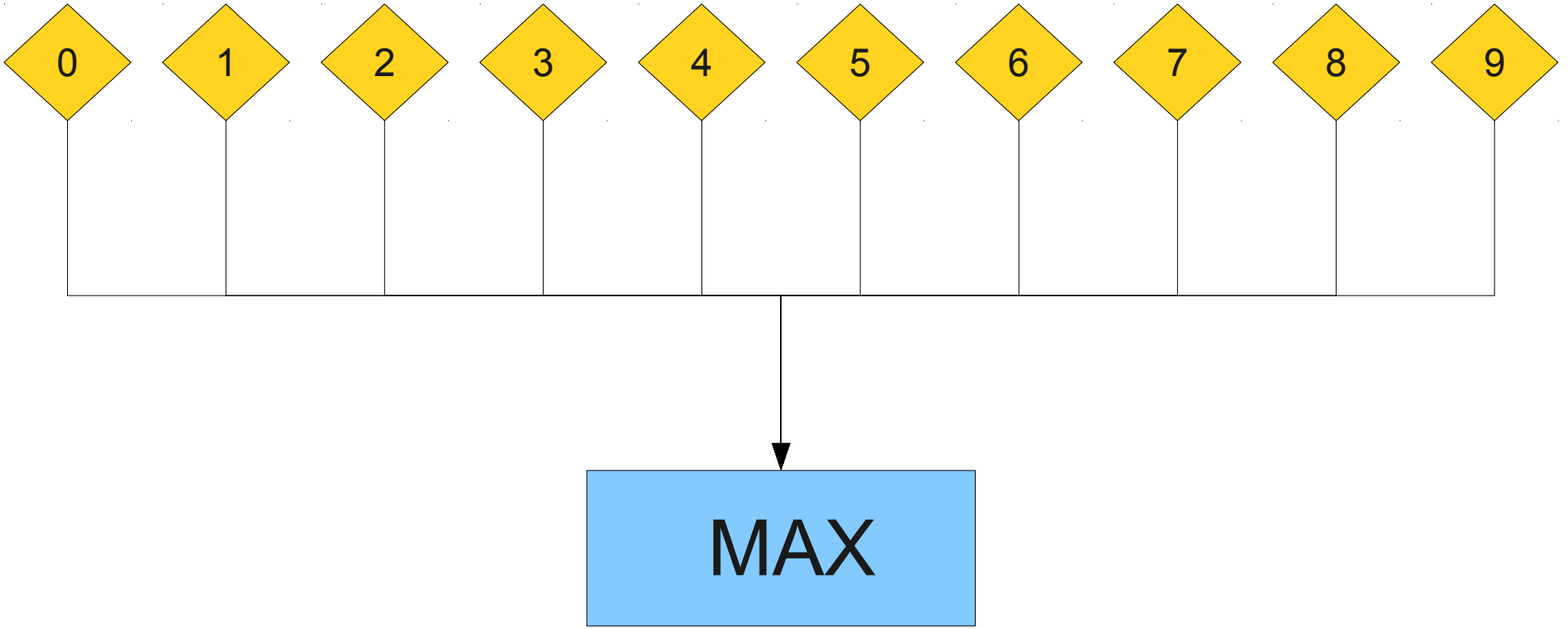
- Start with a random guess of each w_i.
- Repeat until perceptron is sufficiently accurate:
  - Choose a training example $(x_0, x_1, \ldots, x_n)$.
  - Let **real** be the real answer, **guess** be the perceptron's guess.
  - For each i, set $\mathbf{w_i := w_i + \alpha\ (real - guess)\ x_i}$
- Note: Use **batching** in practice.
  - Update everything all at once.

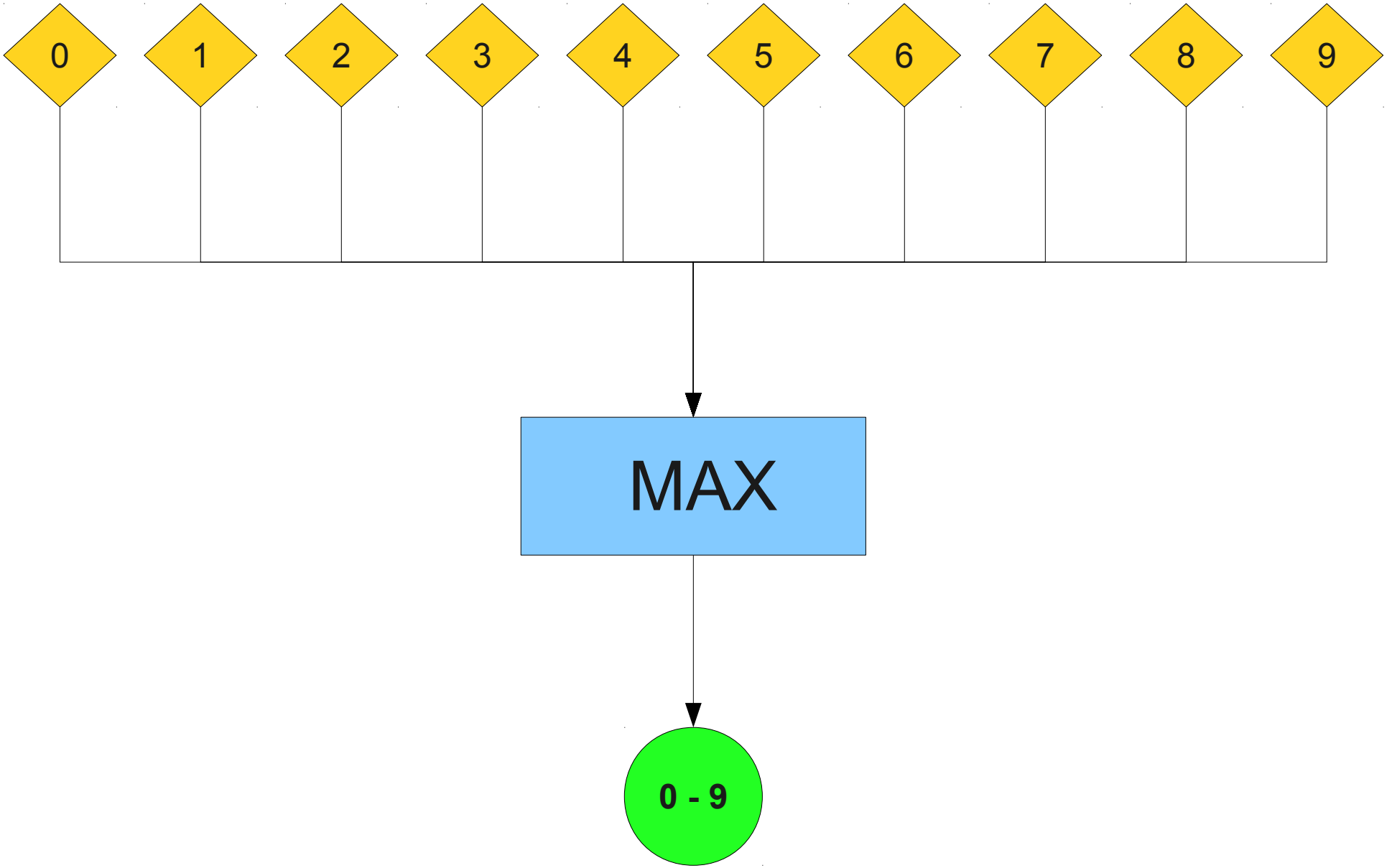
Application: Handwriting Analysis



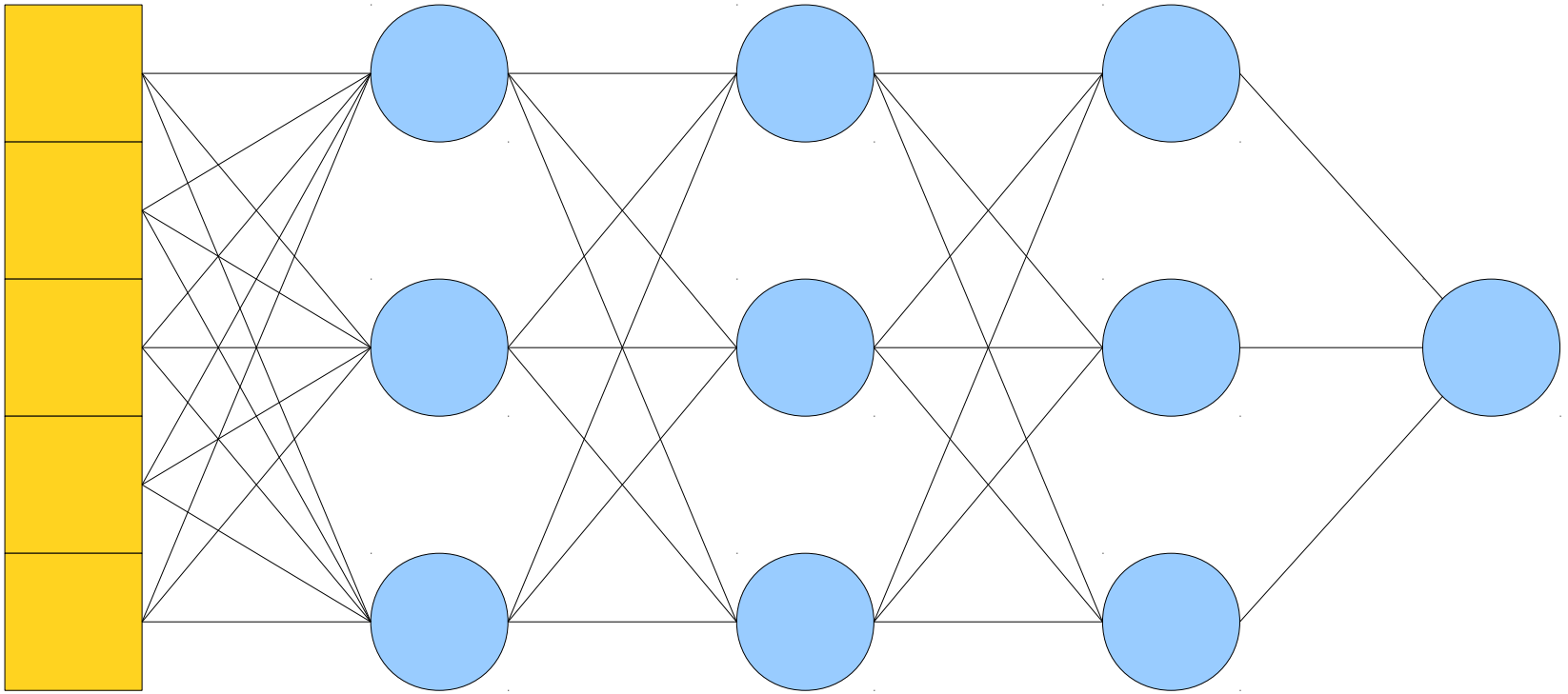
- Train a computer to recognize handwritten numbers 0 – 9.
- Large training and test set available (MNIST Handwritten Digit Database)


Perceptron
Yes/No


0
1
2
3
4
5
6
7
8
9
MAX


0
1
2
3
4
5
6
7
8
9
MAX
0 - 9

Combining Perceptrons



This is called a neural network.

Machine Learning

- Interesting in machine learning? Take CS109 and CS229!
- Many beautiful algorithms:
  - Naive Bayes classifiers (used in spam filtering).
  - Decision trees (used in hospitals for diagnostics).
  - Bayesian networks (used in cancer research to learn what causes tumors).