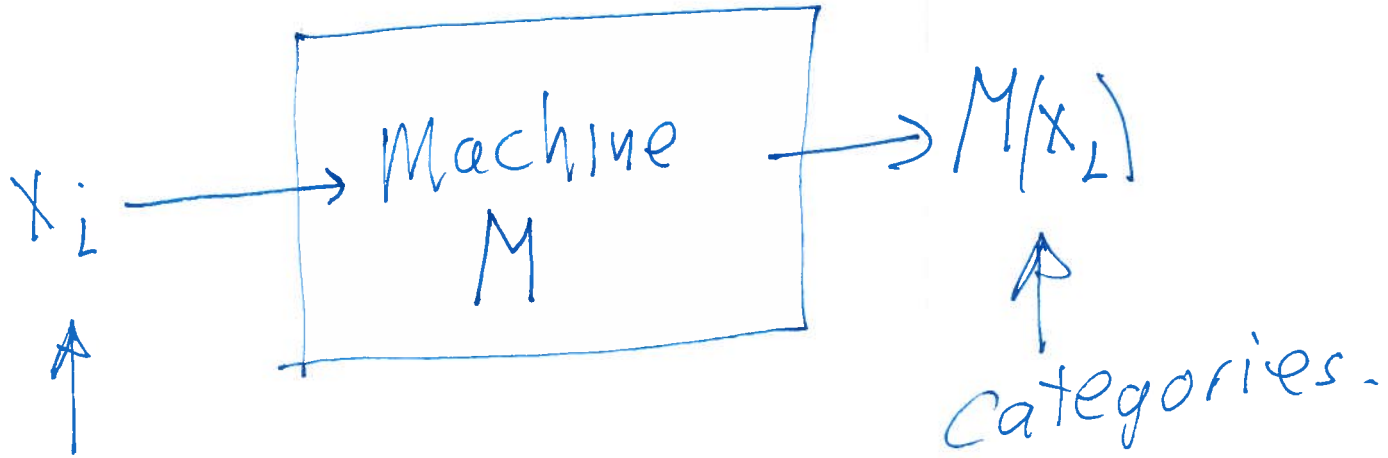
Machine Learning - Some examples



bit maps of hand written numerals 16 x 16 matrix

10 categories
0, 1, ..., 9

x_i Input

has correct output y_i

So WANT $y_i = M(x_i)$ correct answer

How build M?

Rule based expert system – deterministic, fixed

New idea

M depends on parameters m and can learn by adjusting m

Given $\vec{x}_1, \ldots, \vec{x}_n$ training data, $\vec{y}_1, \ldots, \vec{y}_n$ correct output

Pick m_1, initial parameters

for $i = 1$ to n

$x_i \rightarrow M_{m_i}(x_i)$

adjust m_i to shrink $|M_{m_i}(x_i) - y_i| = \text{error}_i$

end

- M_{m_n} then used on new data and see how it does.
- NOTE: OFTEN MULTIPLE x_i are processed before adjusting m.

What form should the machine take

- Popular and successful structure is neural net — many variants
  - First version
  - explain later what motivates this choice.

K-level net

$$M_2(x) = F_K \circ F_{K-1} \circ \dots \circ F_1(x)$$

each $F_i(x, A_i, \vec{b}_i)$ A_L is matrix

A_i: weights

$\vec{b}_i$: bias

$$= \sigma(A_i \vec{x} + \vec{b}_i)$$

σ: activation function

$\sigma(y) =$ 

$\sigma(y_1, y_2, \ldots, y_n) = (\sigma(y_1), \ldots, \sigma(y_n))$

vectorized version

Deep feed forward neural net

many layers or functions F_i