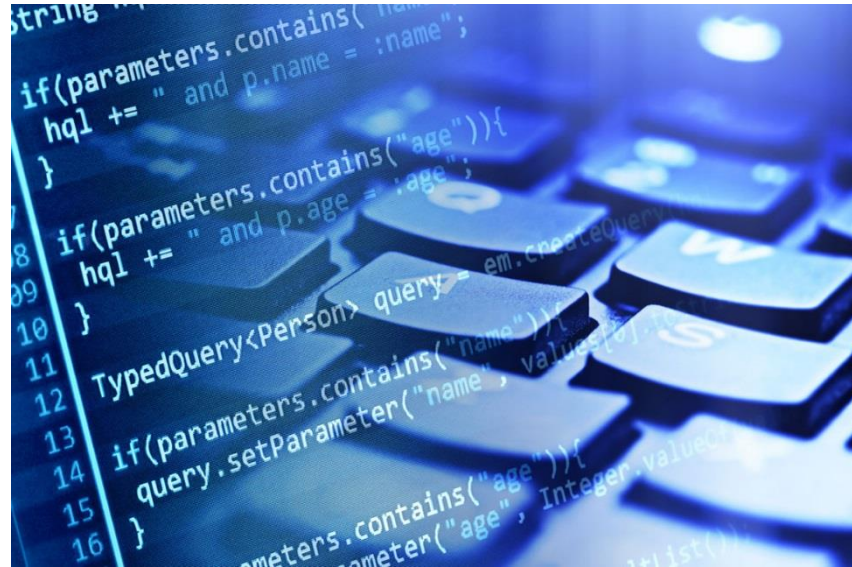


Application of Basis in Machine Learning

Hung-yi Lee

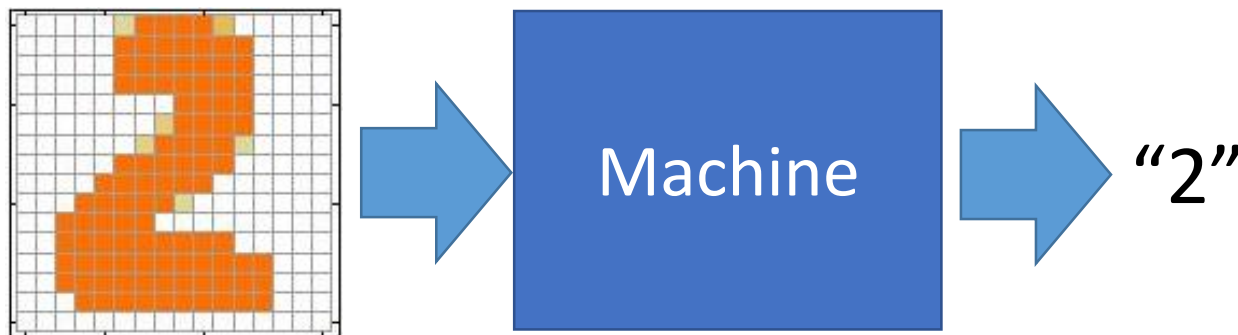
What is Machine Learning?



- You can ask computers to do lots of things for you.
- However, computer can only do what you ask it to do.
- Computer can never solve the problem you can't solve.

Example: Handwriting Digit Recognition

- One day, you are asked to write a program for handwriting digit recognition.



“1”:

--	--

.....

Hard to describe the
common pattern by rules

“2”:

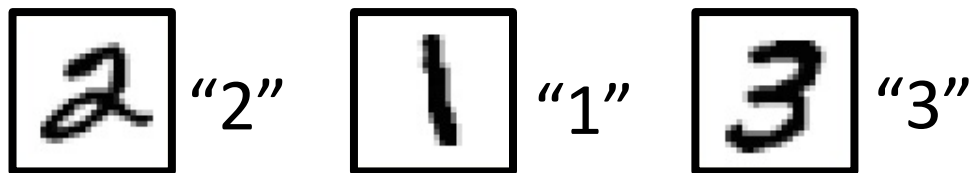
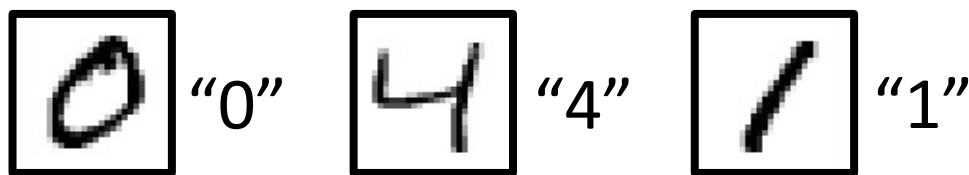
--	--

.....

Lots of exception.

Example: Handwriting Digit Recognition

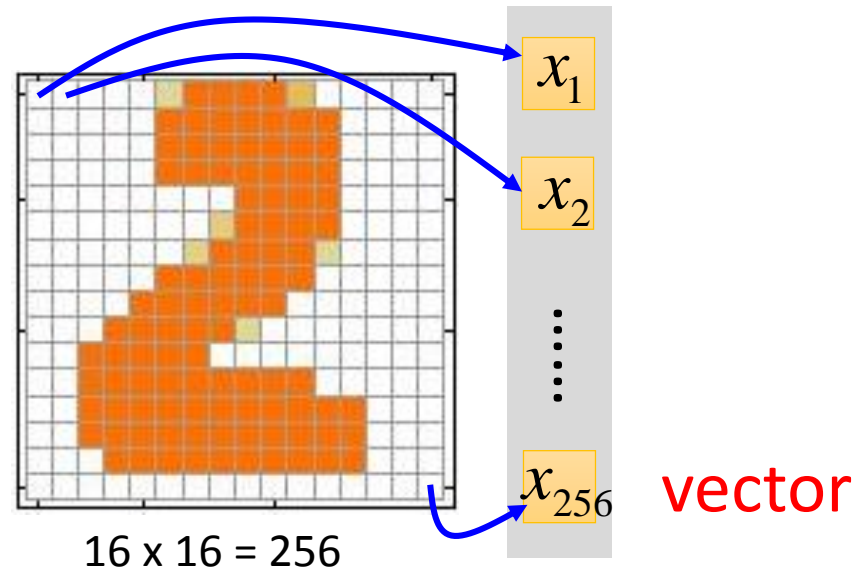
- Write a program for learning, and then teach the machine by some examples.



Example: Handwriting Digit Recognition

- What a machine see are pixels

Can we make the
input simpler?



16 x 16 = 256

Ink \rightarrow 1

No ink \rightarrow 0

Example: Handwriting Digit Recognition

$$x = c_1 u_1 + c_2 u_2 + \dots + c_n u_n$$

Pixels in a digit image

Basis for digit images

$$\begin{bmatrix} c_1 \\ c_2 \\ \vdots \\ c_n \end{bmatrix}$$

Represent a digit image (coordinate change)

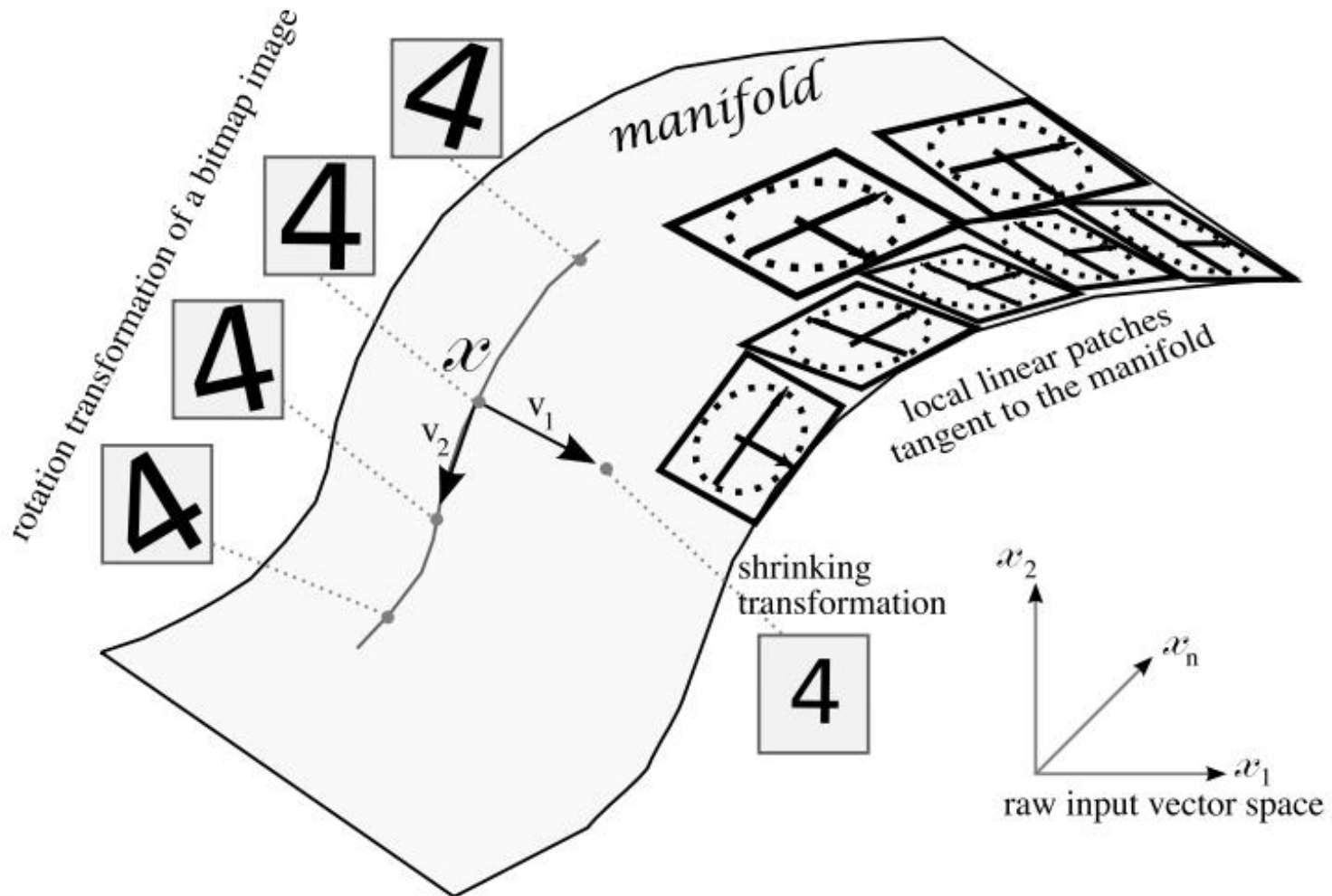
➤ If there are 16 X 16 pixels in an image, it is very possible that n is less than 16 x 16

➤ A random 16 x 16 image is not a digit.

➤ The dimension of the subspace of Handwriting Digits is much less than 256

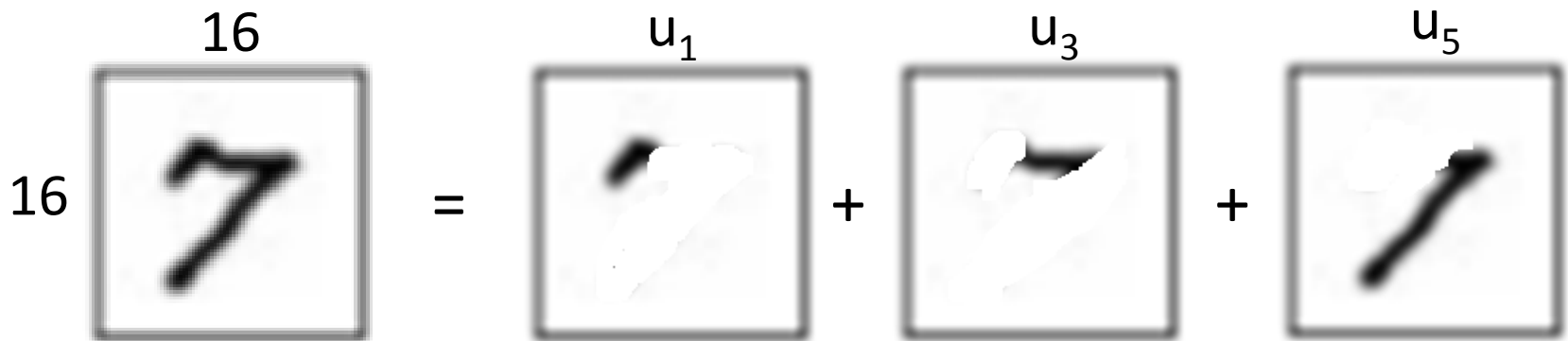
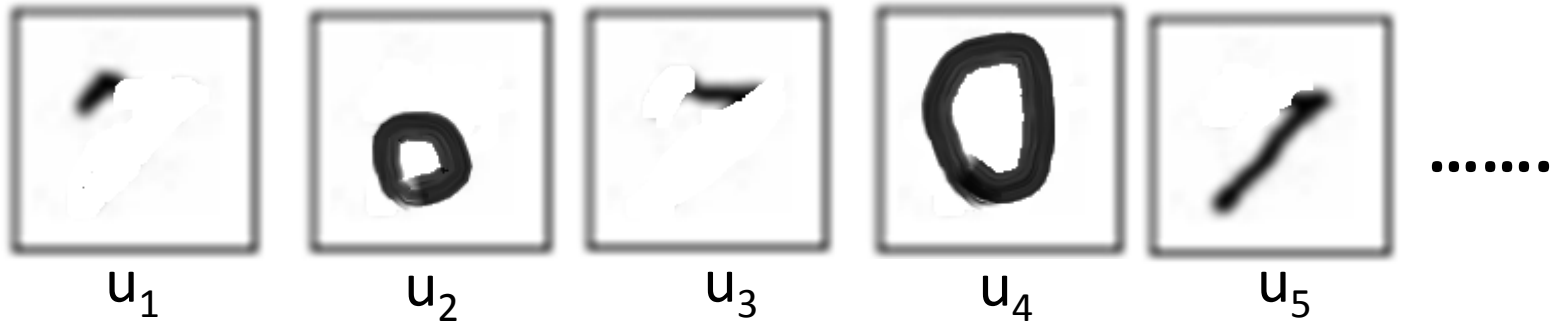


Example: Handwriting Digit Recognition



Example: Handwriting Digit Recognition

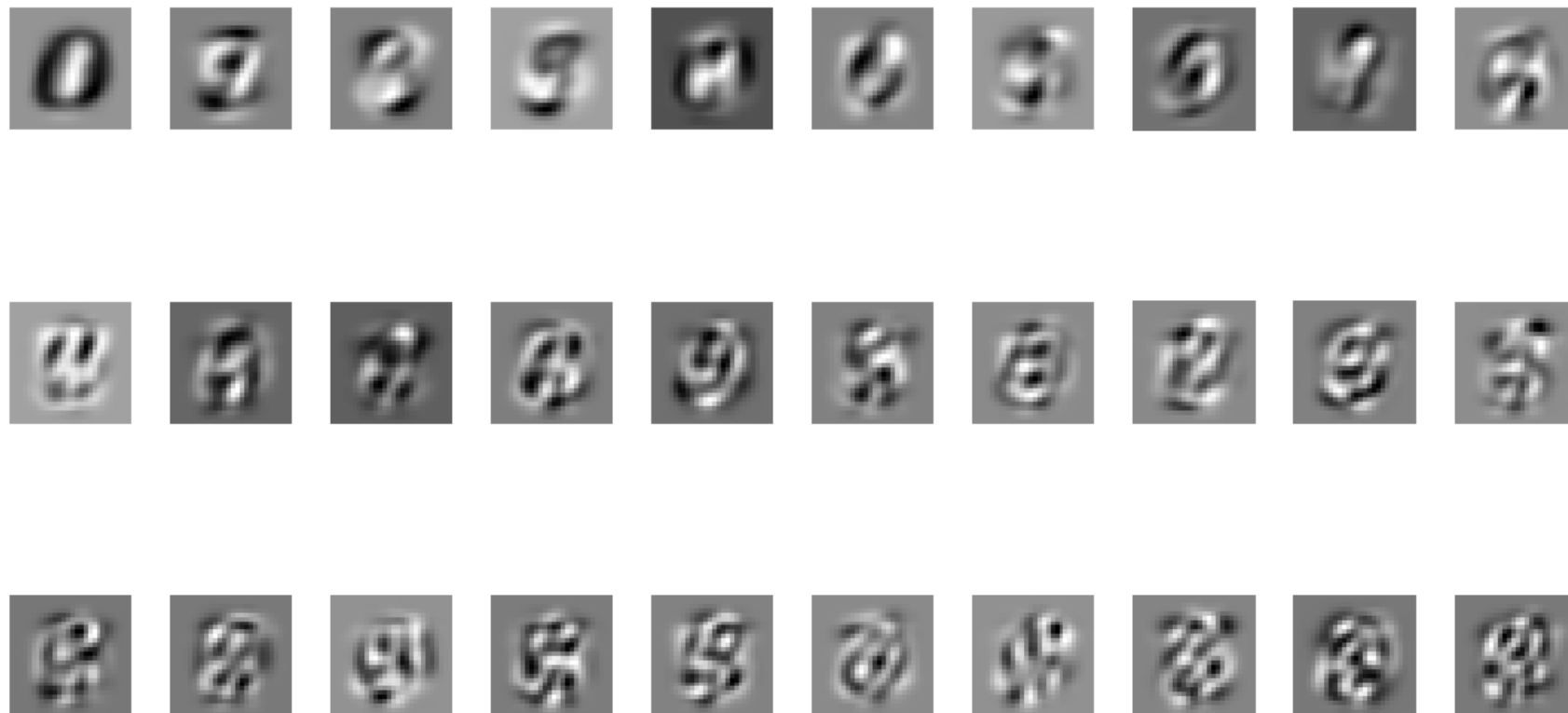
$$x = c_1 u_1 + c_2 u_2 + \dots + c_n u_n$$



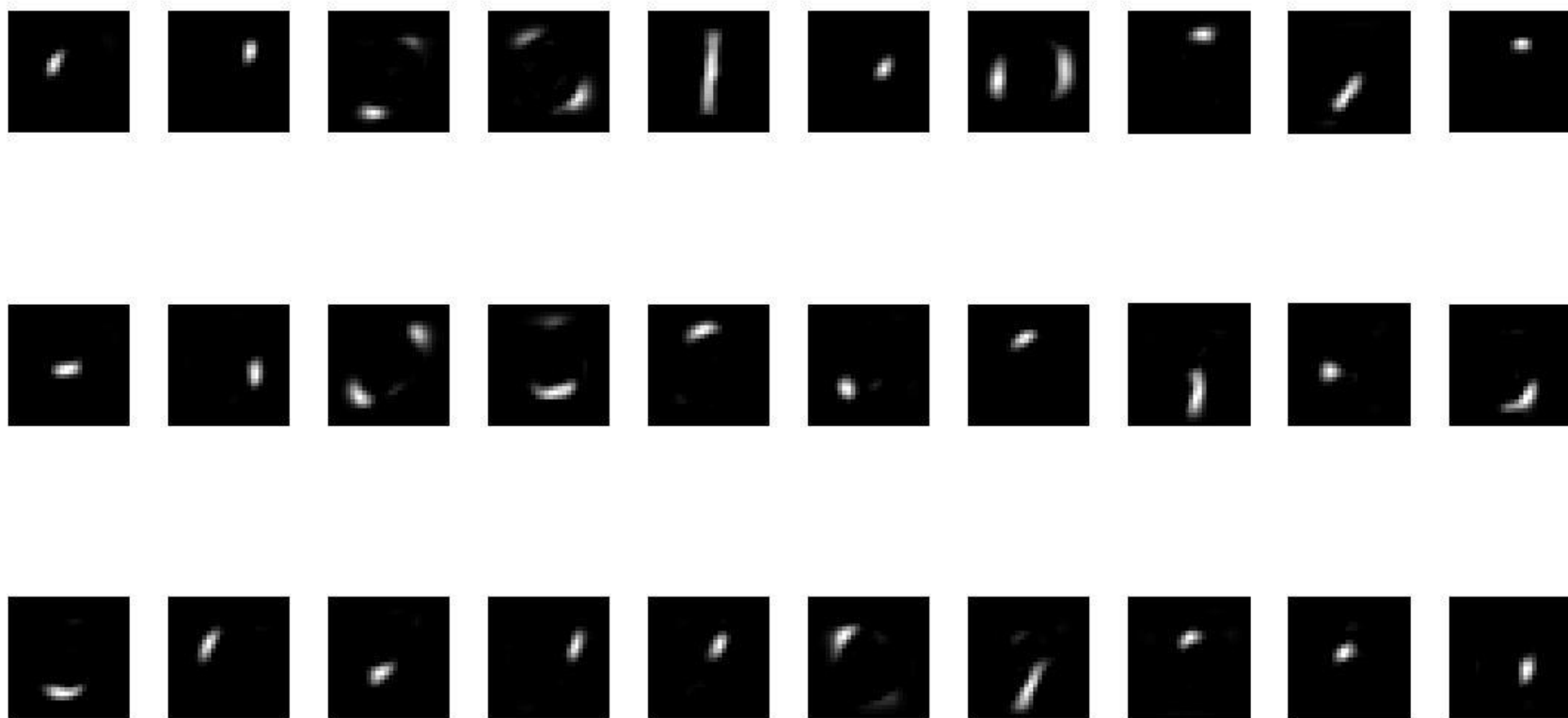
Represented by
16 X 16 = 256 pixels

[1 0 1 0 1 0]
(simpler representation)

PCA (Chapter 7.8 in textbook)



NMF



(strictly speaking, they do not form a basis)

Face Recognition

A →

B →



PCA (Chapter 7.8 in textbook)



NMF



(strictly speaking, they do not form a basis)