Lecture 17: Clustering and density estimation

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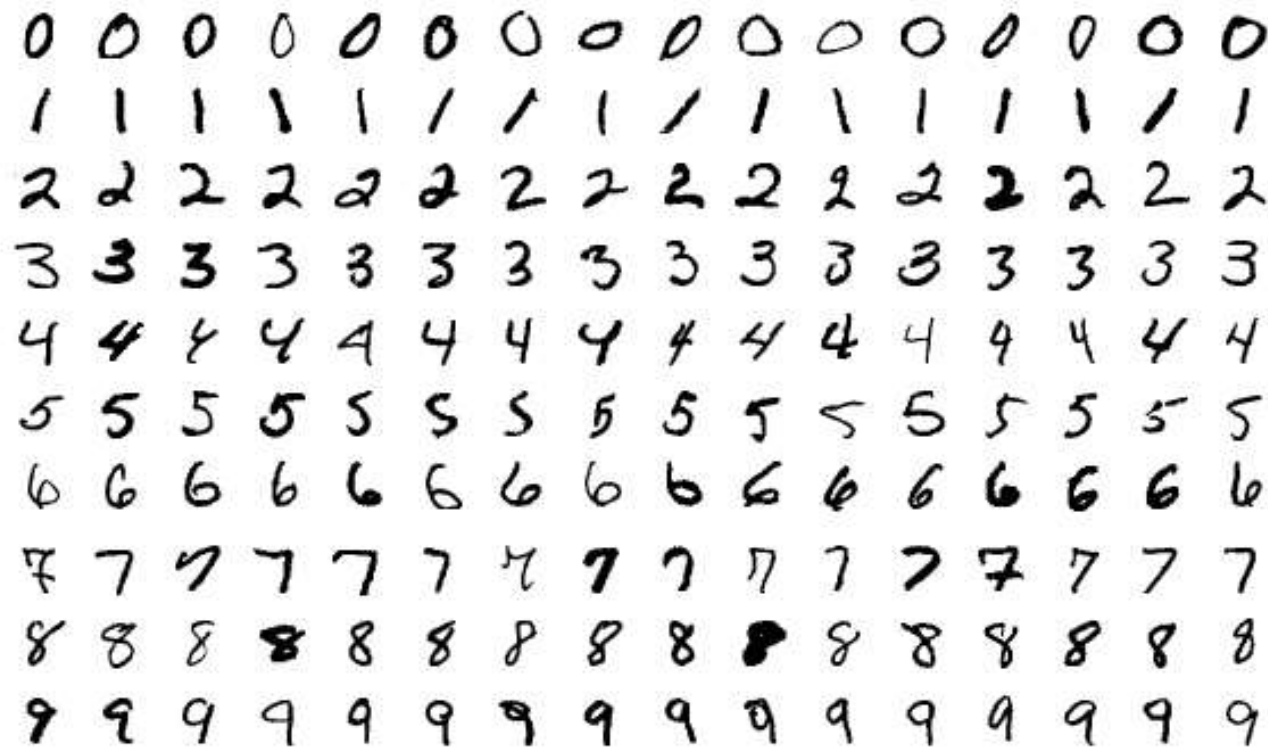# What is unsupervised learning?

Unsupervised Learning

Your are given n observations:

$$\mathbf{x}_{1:n} = \{\mathbf{x}_1, \ldots, \mathbf{x}_n\}$$

(inputs, features, …)
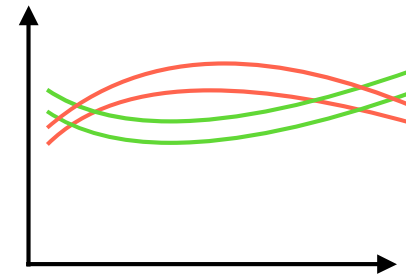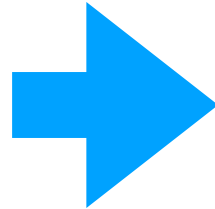
Problem: Find patterns/structure in the data.

Classic clustering example: MNIST dataset without labels

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Example of unsupervised learning in engineering context

Engineering system

Timeseries of sensor data

How many different operating faults can occur?

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Example of density estimation in engineering/scientific context

Experimental measurements of inputs to engineering model

Estimated probability density
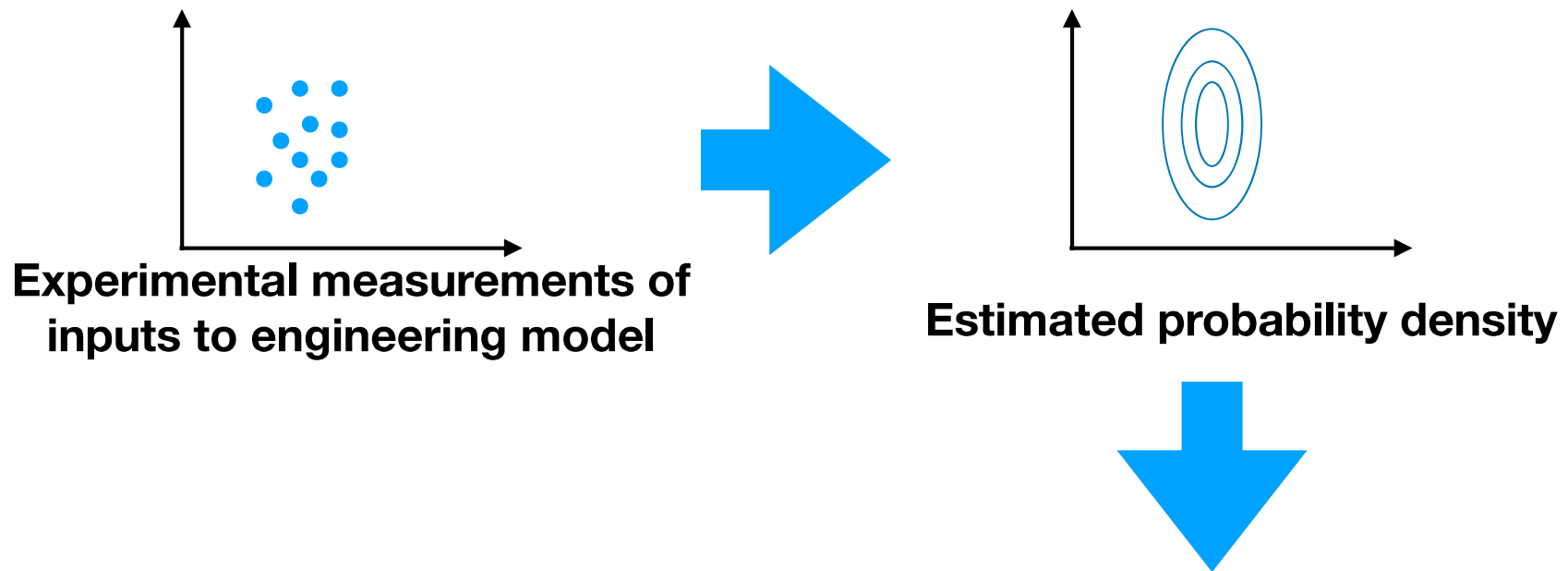
Uncertainty propagation through engineering/scientific model.

Example of clustering in scientific context

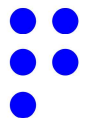Q: How many different galaxies are there in this picture?

https://astrobiology.nasa.gov/news/15000-galaxies-in-one-image/

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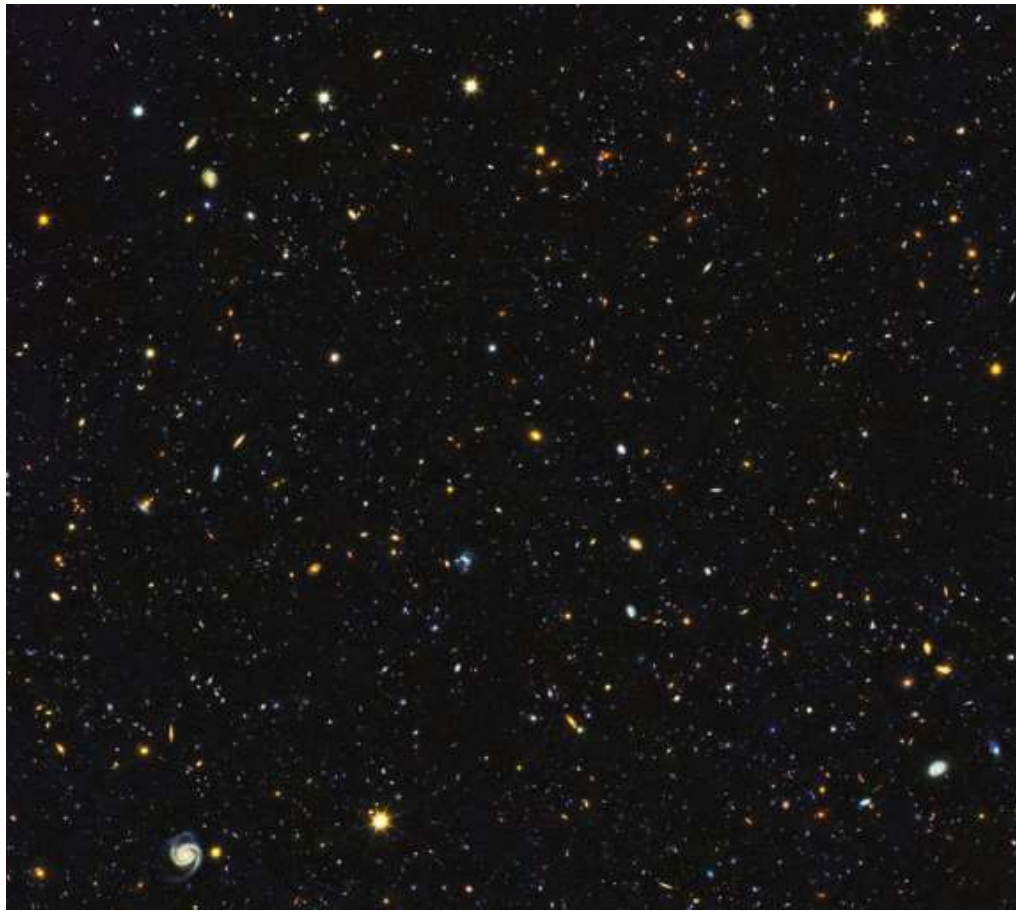
Particle identification

Q : What are the locations of the particles?
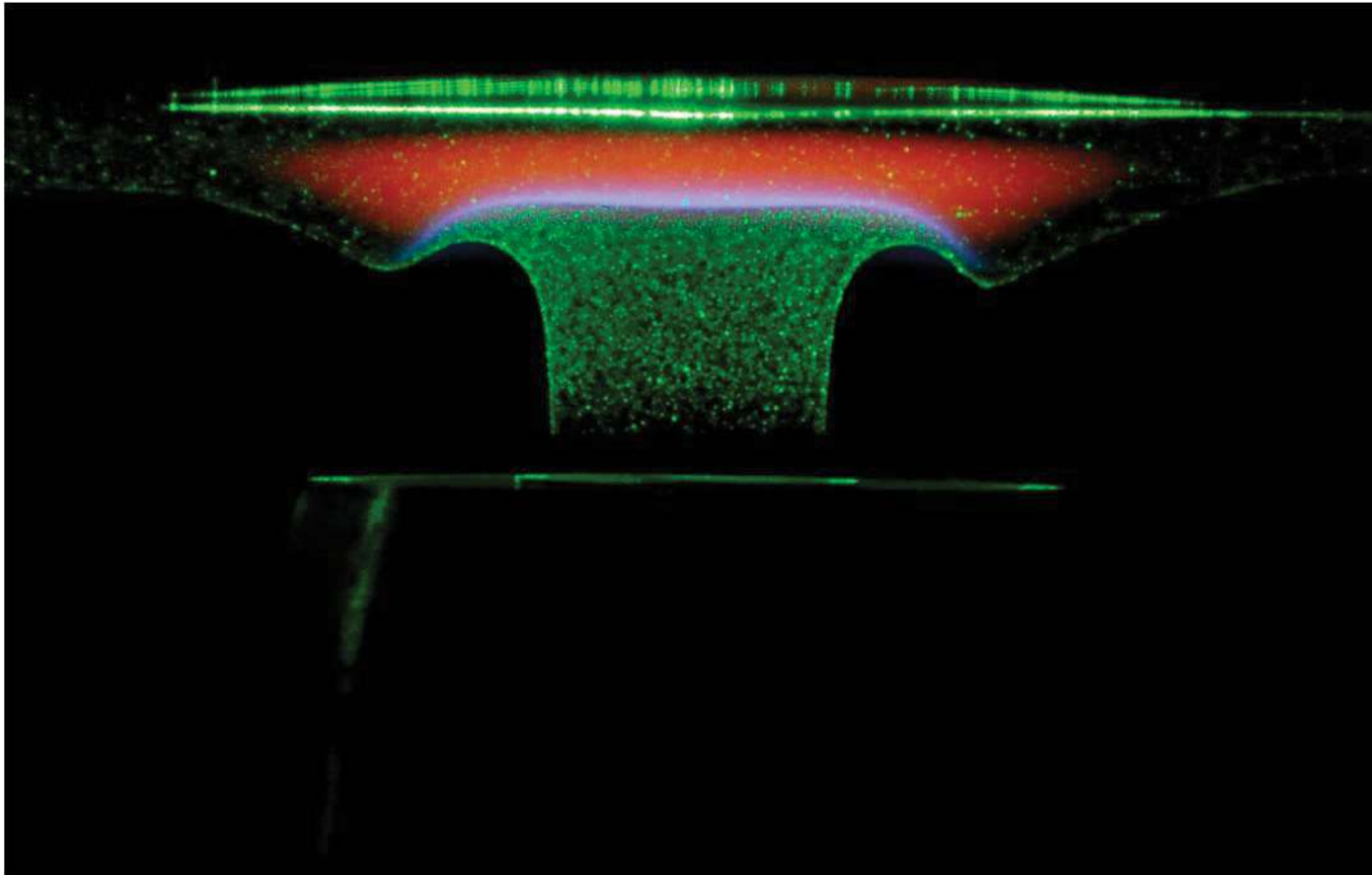
A methane stagnation flame; flow seeded with 1 micron Al2O3 particles, illuminated by green light sheet (wavelength 532 nm) for particle image velocimetry.

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