

E9 205 Machine Learning for Signal Processing

Introduction to Real World Signals

03-08-2016



Overview

- ❖ What are the typical real-world signals
- ❖ What is learning
- ❖ Why should we attempt learning of such signals
- ❖ Roadmap of the course

Real World Signals

- ❖ Signal in general is a function $f : X \rightarrow V$
- ❖ Real World Signals
 - ❖ which we see everyday everywhere
 - ❖ Text, Speech, Image, Videos...
 - ❖ DNA sequence, financial data, weather parameters, neural spike train...
 - ❖ Belonging to / generated by certain category of events.

Real World Signals

- ❖ Types of signals- Continuous and Discrete
- ❖ Observations from real world signals
 - ❖ Information may not be uniform.
 - ❖ Cannot be modeled deterministically.
 - ❖ Affected by noise, sensing equipments.
 - ❖ Missing or hidden variables.

Real World Signals - Examples

- ❖ Text data
 - ❖ Discrete sequence of items

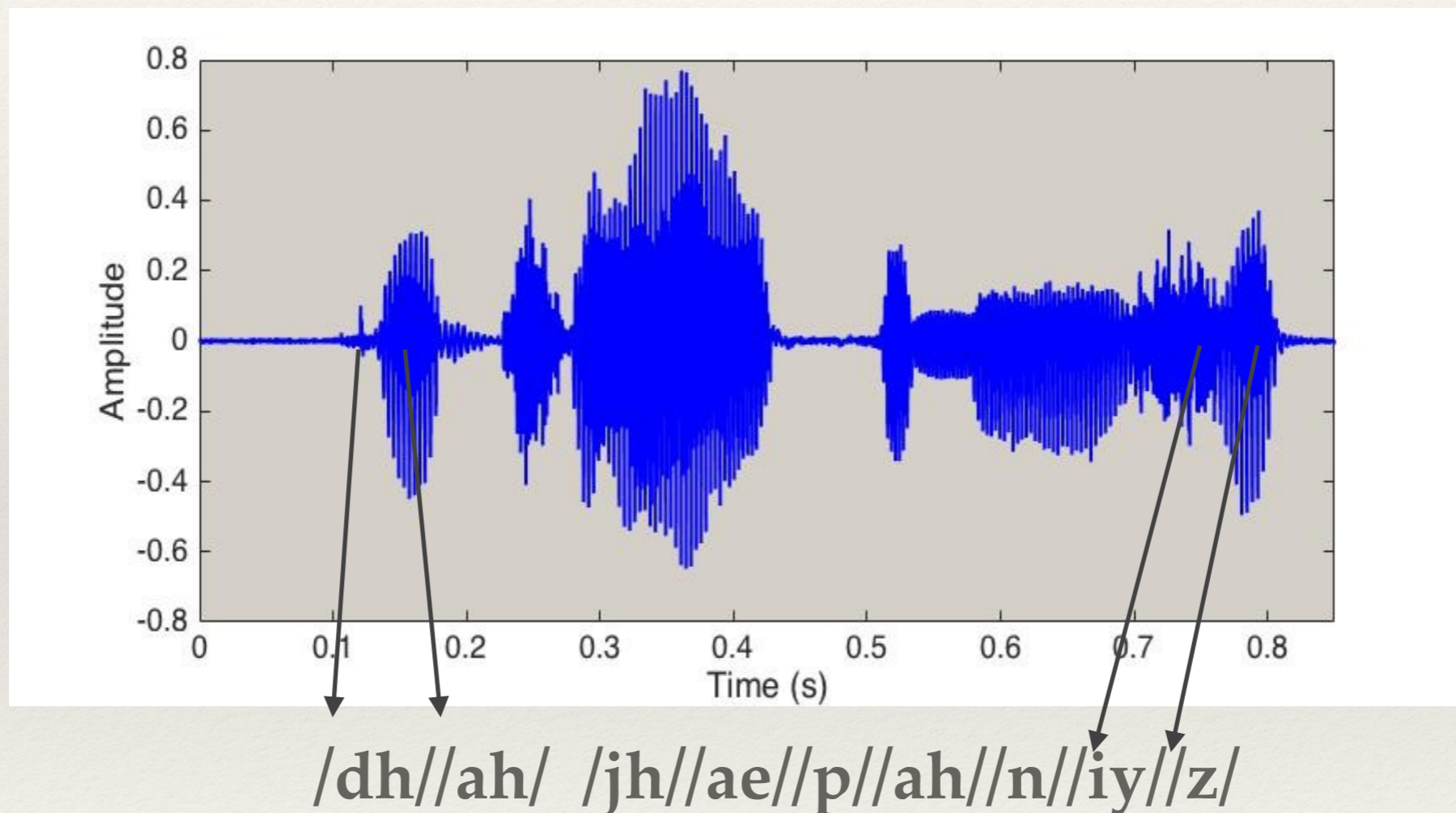
In the last 29 years, sir has never ever said 'well played' to me because he thought I would get complacent and I would stop working hard.

Items - [In] [the] [last] [29] [years]

- ❖ Some items carry more **importance** than others.

Real World Signals - Examples

❖ Speech data



❖ Phonetic units - underlying hidden variables.

Real World Signals - Examples

- ❖ Images



- ❖ Measurement artifacts - noise.

Patterns in Real World Signals

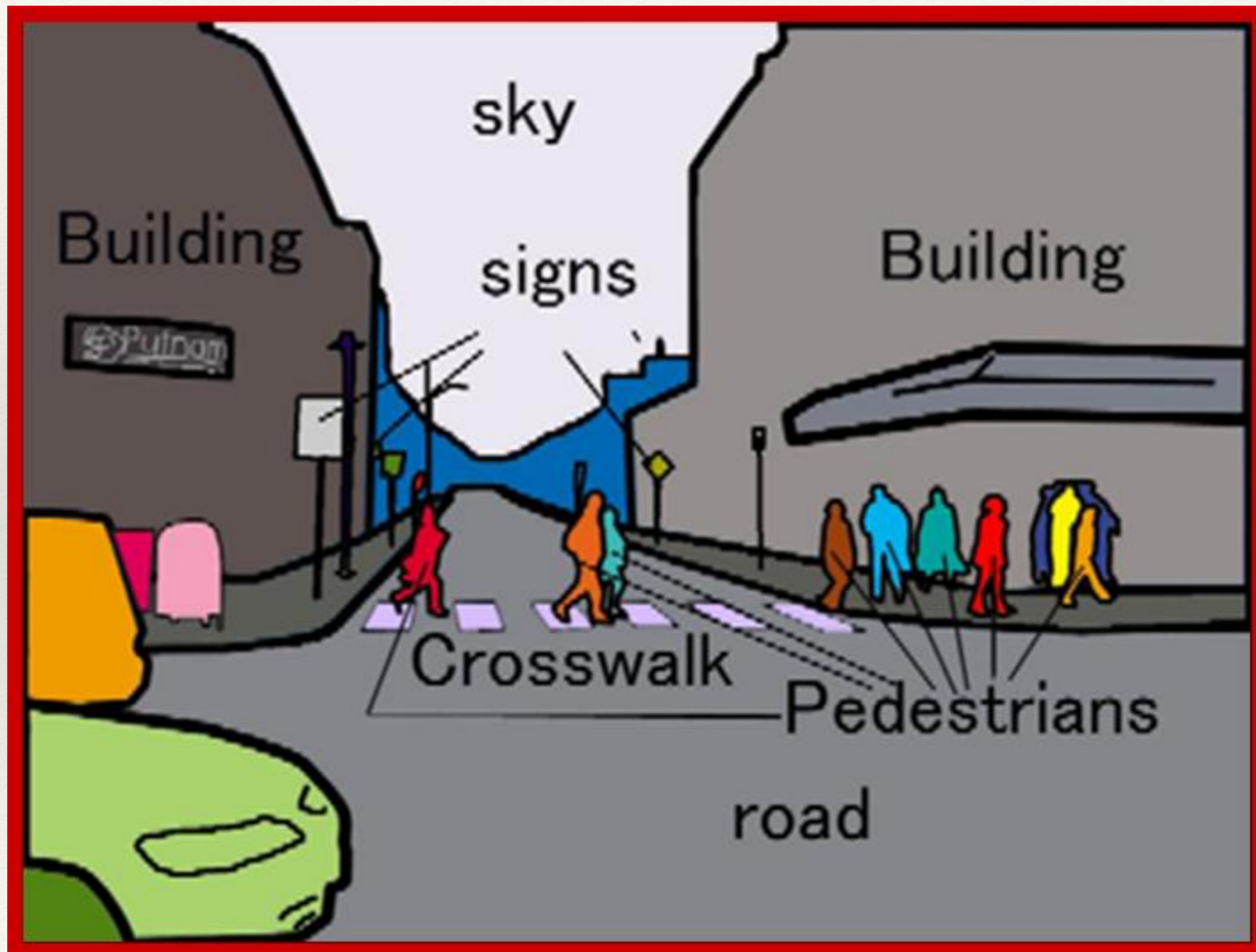
- ❖ Patterns in real world signals
 - ❖ Caused by various generation processes in the real-world signals.
 - ❖ Hidden from the observation.
 - ❖ Value patterns and geometric patterns.
 - ❖ May be hierarchical in nature.
 - ❖ Manifested as pure patterns or transformed / distorted versions.

What is Learning

- ❖ Learning
 - ❖ Process of describing or uncovering the pattern.
 - ❖ Understanding the physical process of generation.
 - ❖ Generalization for prediction, classification, decision making.
 - ❖ Using the data to learn the underlying pattern.
- ❖ Humans are **fundamentally trained** to learn and recognize patterns.

What is Learning

Object
Recognition



What is Learning

Facial Identification



Topic Summarization

The Karnataka government is planning to start an aviation school to help students from lower economic and rural backgrounds become pilots.

Machine Learning

- ❖ Machine Learning
 - ❖ Automatic discovery of patterns.
 - ❖ Motivated by human capabilities to process real world signals.
 - ❖ Mimicking / Extending / Replacing human functions.
 - ❖ Branch of artificial intelligence.
 - ❖ Classification and Regression.

Machine Learning - Examples

Domain Identification - Blog v/s Chat ?

“I tried these Butterscotch Muffins today and they turned out so good. I had half the pack of butterscotch chips that I bought long back so wanted to use it up.”

"Hey, it's Geoff from yesterday. How's it going?
Hi there. Don't wanna bother you long, but
you saw this video?"

Machine Learning - Examples

Did a Human or Machine write this ?

“A shallow magnitude 4.7 earthquake was reported Monday morning five miles from Westwood, California, according to the U.S. Geological Survey. The temblor occurred at 6:25 AM, Pacific time at a depth of 5.0 miles.”

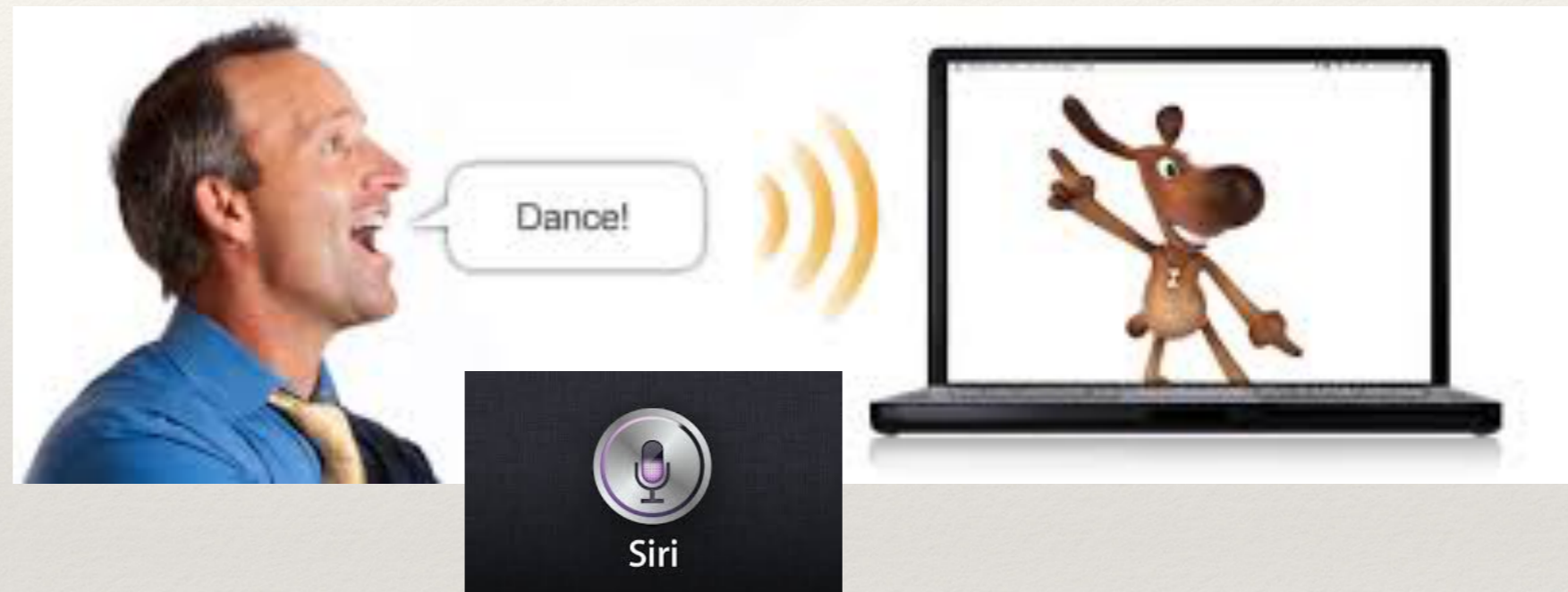
“Kitty couldn’t fall asleep for a long time. Her nerves were strained as two tight strings, and even a glass of hot wine, that Vronsky made her drink, did not help her. Lying in bed she kept going over and over that monstrous scene at the meadow.”

<http://www.nytimes.com/interactive/2015/03/08/opinion/sunday/algorithm-human-quiz.html>



Machine Learning - Examples

Speech Recognition

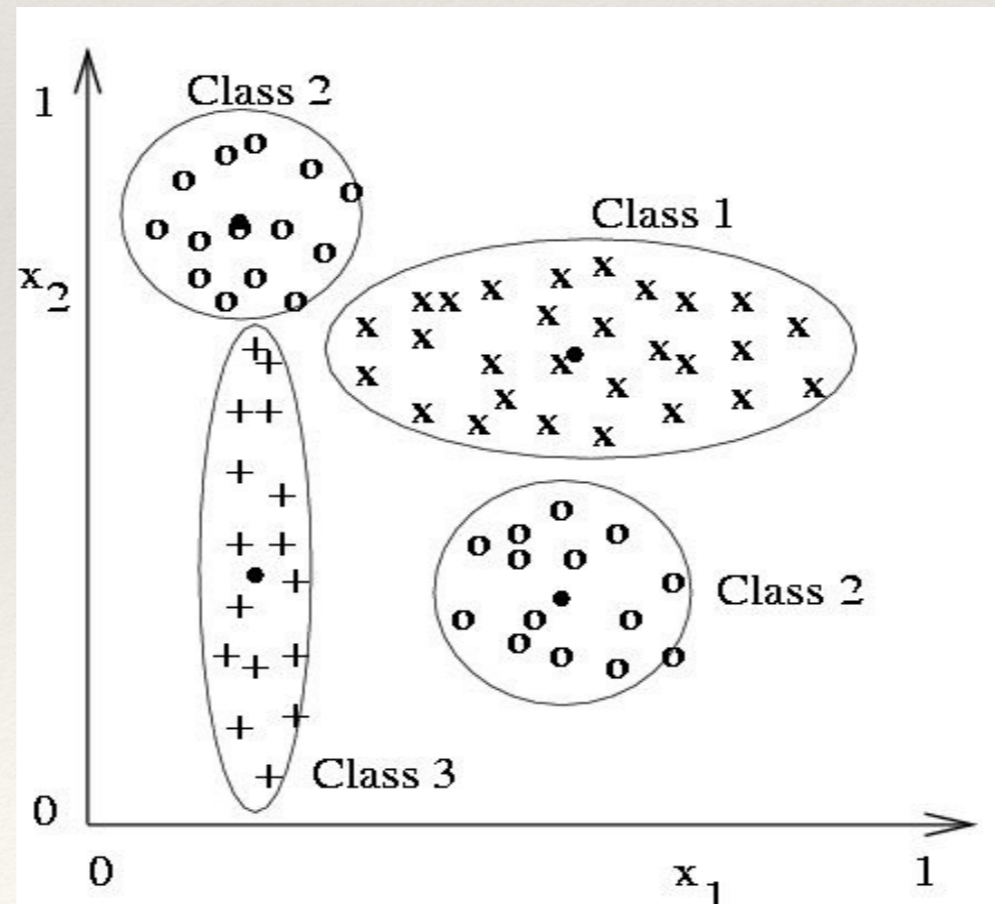


Sound Synthesis

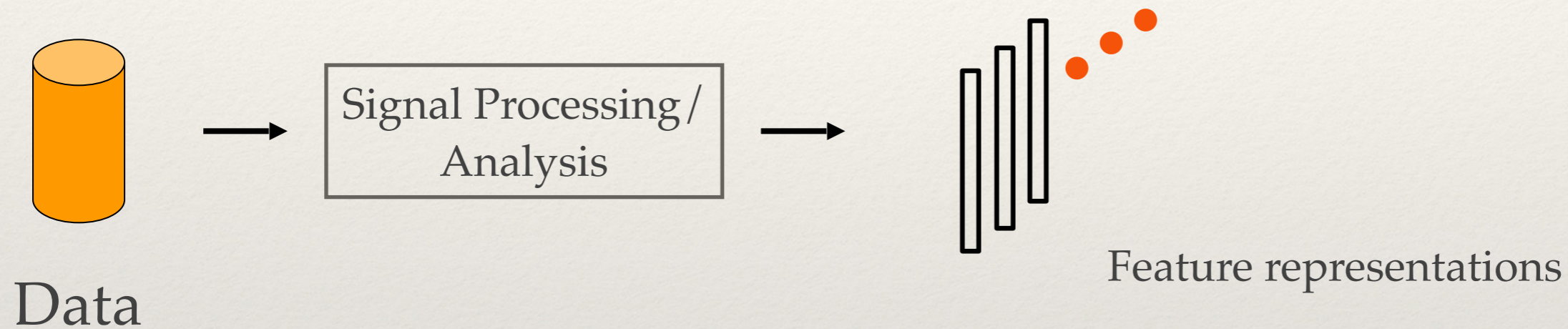
<http://news.mit.edu/2016/artificial-intelligence-produces-realistic-sounds-0613>

Machine Learning

- ❖ Traditional approaches to Machine Learning
 - ❖ Rule and heuristic based methodologies
 - ❖ Using small amounts of data.
- ❖ Recently, most problems are addressed as statistical pattern recognition problem with big data.

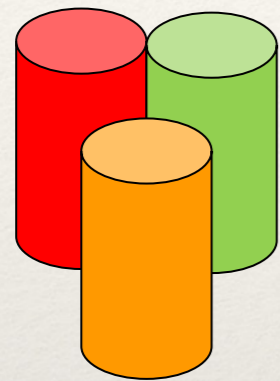


Course Roadmap



- ❖ Feature Extraction from Text, Speech, Image / Video signals.
- ❖ Dealing with noise and unwanted redundancies.
- ❖ Bio-inspired processing.

Course Roadmap



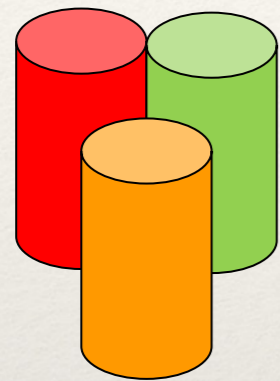
→ Features →

Models for Pattern
Recognition

Data Set

- ❖ Modeling the generation of data
 - ❖ Gaussian, Mixture Gaussian, Hidden Markov Models etc.
- ❖ Modeling the separation of data
 - ❖ Support Vector Machines, Deep Neural Networks etc.

Course Roadmap



Data Set

→ Features →

Models for Pattern Recognition

- ❖ Things between features and pattern recognitions
 - ❖ Feature selection, dimensionality reduction, adaptation.
 - ❖ Representation learning.