NPTEL ONLINE CERTIFICATION COURSES

Course Name: Deep Learning

Faculty Name: Prof. Prabir Kumar Biswas
Department : E & ECE, IIT Kharagpur

Topic

Lecture 01: Introduction

CONCEPTS COVERED

Concepts Covered:

- Deep Learning: An Introduction
- Descriptors/ Feature Vectors
- Machine Learning vs. Deep Learning
- Discriminative/ Generative Model
- Challenges
- Power of Deep Learning

What is learning?

Image Source: Internet

Can You Recognize these Pictures ?

- If Yes, How do you Recognize it?

Image Source: Internet

Origin of Machine Learning?

…..Lies in very early efforts of understanding Intelligence.

- What is Intelligence?
- It can be defined as the ability to comprehend; to understand and profit from experience.
- Capability to acquire and Apply Knowledge.

Image Source: Internet

Learning?
2300 Years ago….

- Plato (427-347 BC)
- The concept of Abstract Ideas are known to us a priori, through a Mystic connection with world.
- He concluded that ability to think is found in *a priori* knowledge of the concepts.

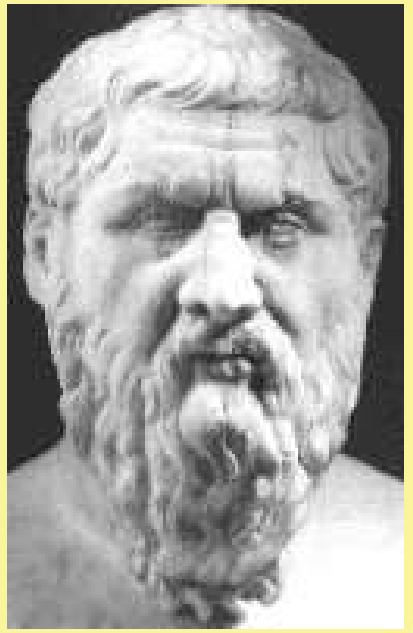

Image Source: Internet

Learning?

Plato's Pupil…

- Aristotle (384-322 BC)
- Criticized his Teacher's Theory

as it is not taking into account

the important aspect

--- An ability to Learn or Adapt to changing world.

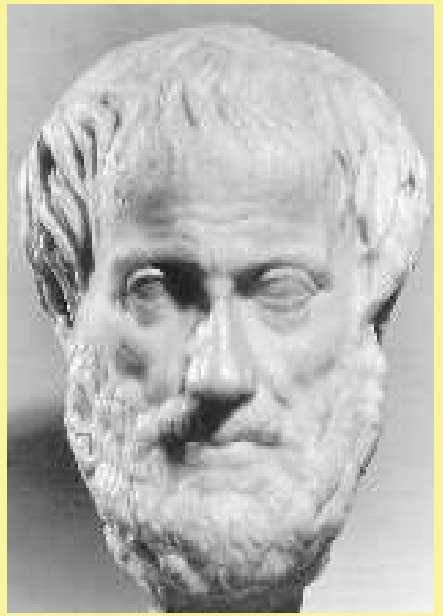

Image Source: Internet

Descriptors/ Feature Vectors

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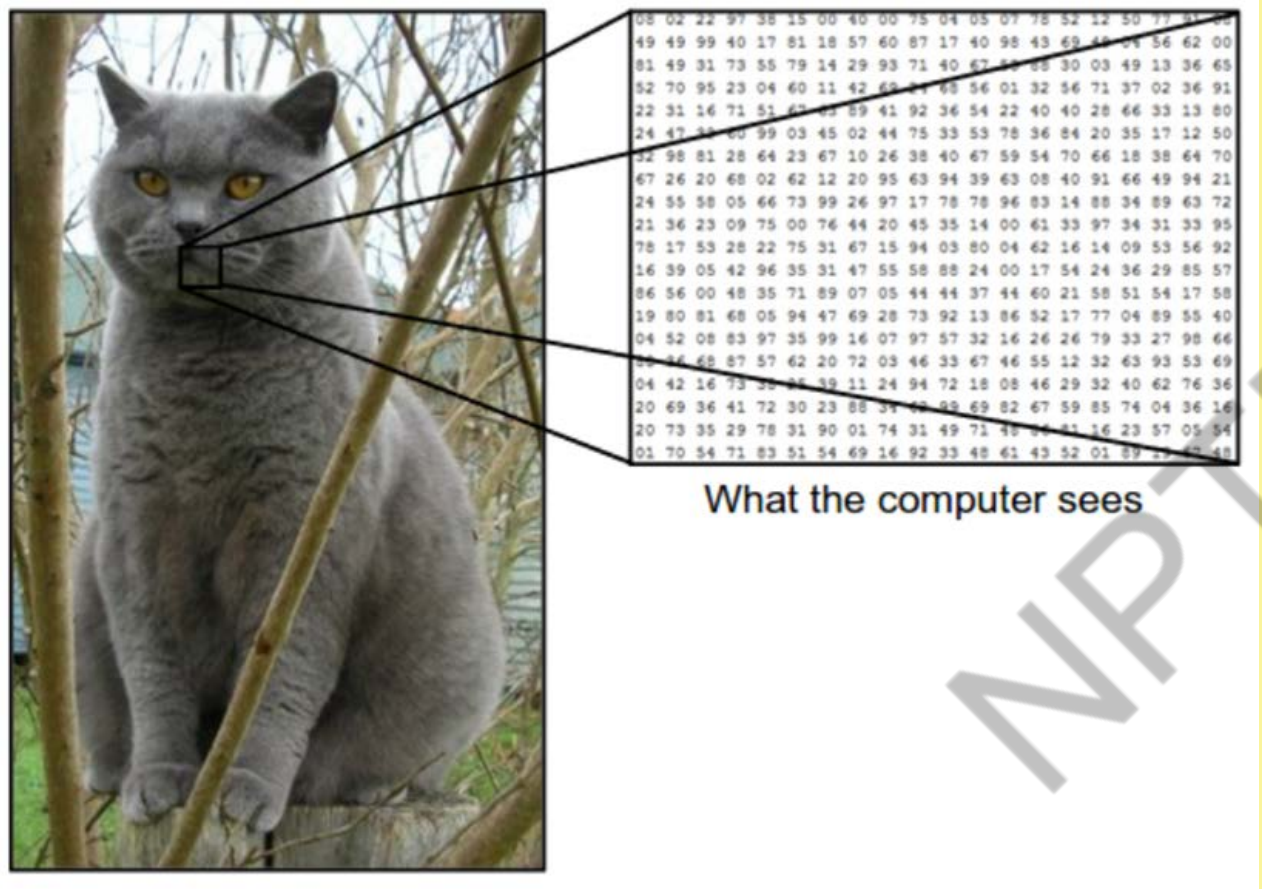

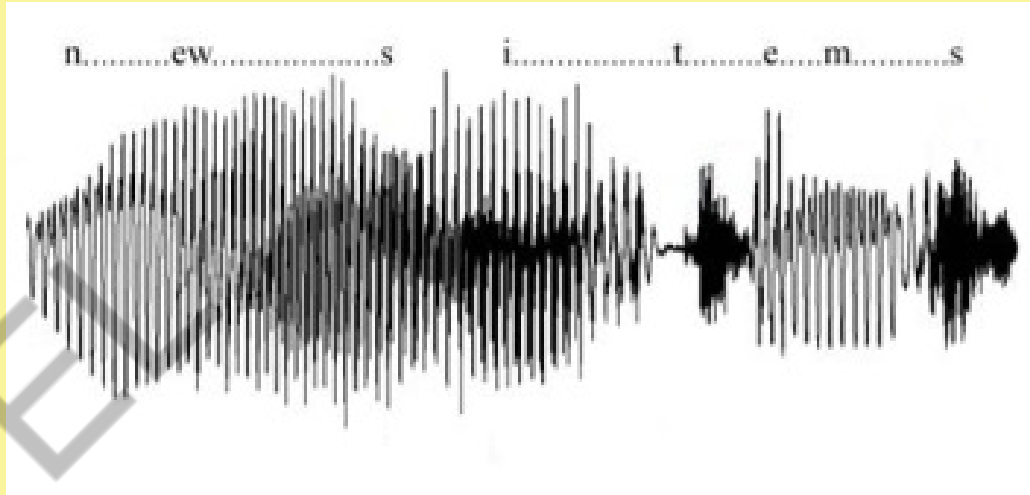

Image Source: Internet

Descriptors/ Feature Vectors

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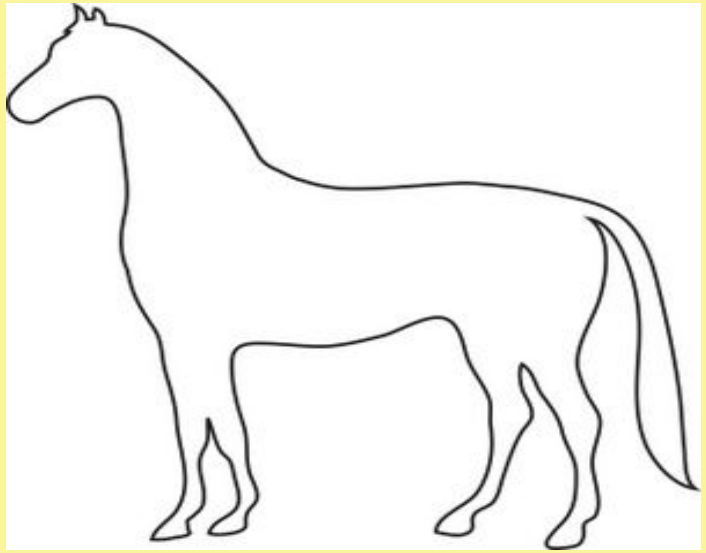
Descriptors/ Feature Vectors



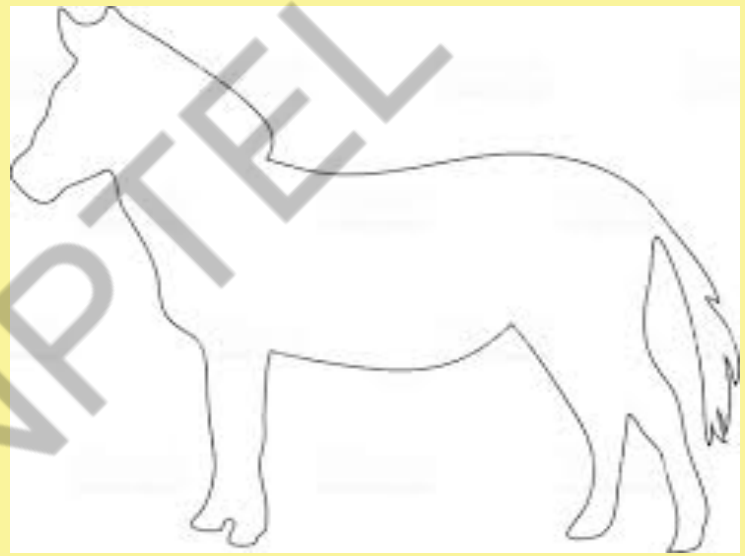


Image Source: Internet

Descriptors/ Feature Vectors

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Machine Learning
vs
Deep Learning

Image Source: Internet

Discriminative vs. Generative Model

Image Source: Internet

Discriminative Model


Cat


Dog


Dog


Cat


Cat


Dog

$x_i \sim P(x)$

P (X)

Error Backprop

Learning Algorithm (θ)

Loss

Predicted	**P (Y | X)**
Cat	Cat
Cat	Dog
Dog	Cat

Image Source: Internet

Generative Model

"What I can not create, I do not understand."

- Richard Feynman

- Collect a large amount of data in some domain
- Train a model to generate data like it.

Challenges

Image Source: Internet

Viewing Angle

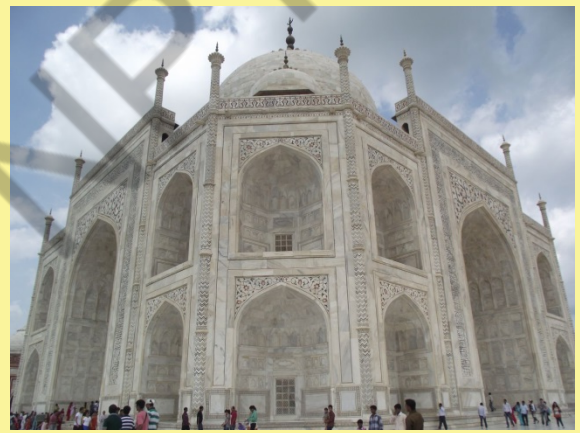


Image Source: Internet

Pose

Image Source: Internet

Illumination

Image Source: Internet

Intraclass Variation

Image Source: Internet

Distortion and Occlusion

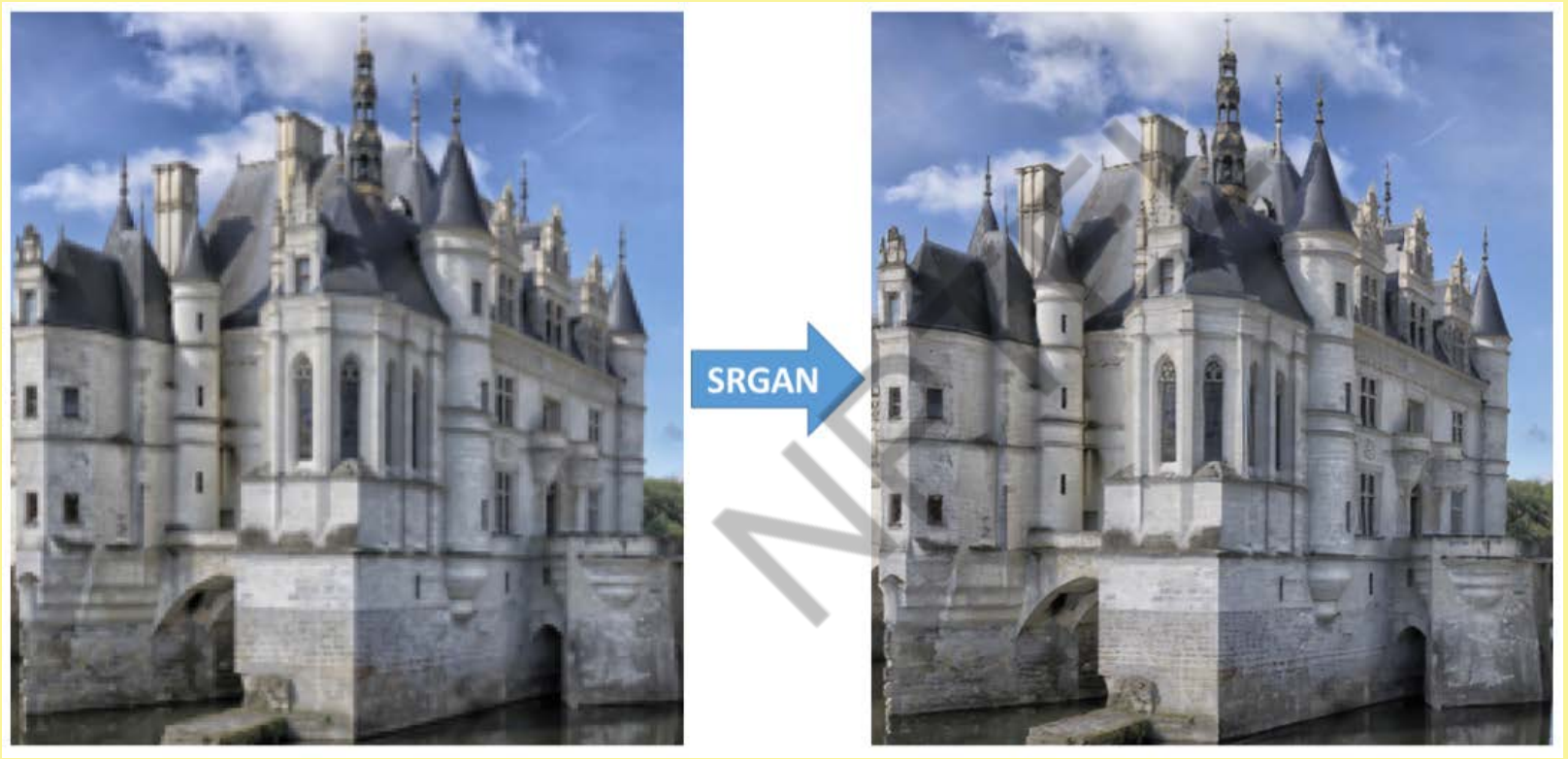
Image Source: Internet

Power of Deep Learning

High Resolution Image Synthesis*

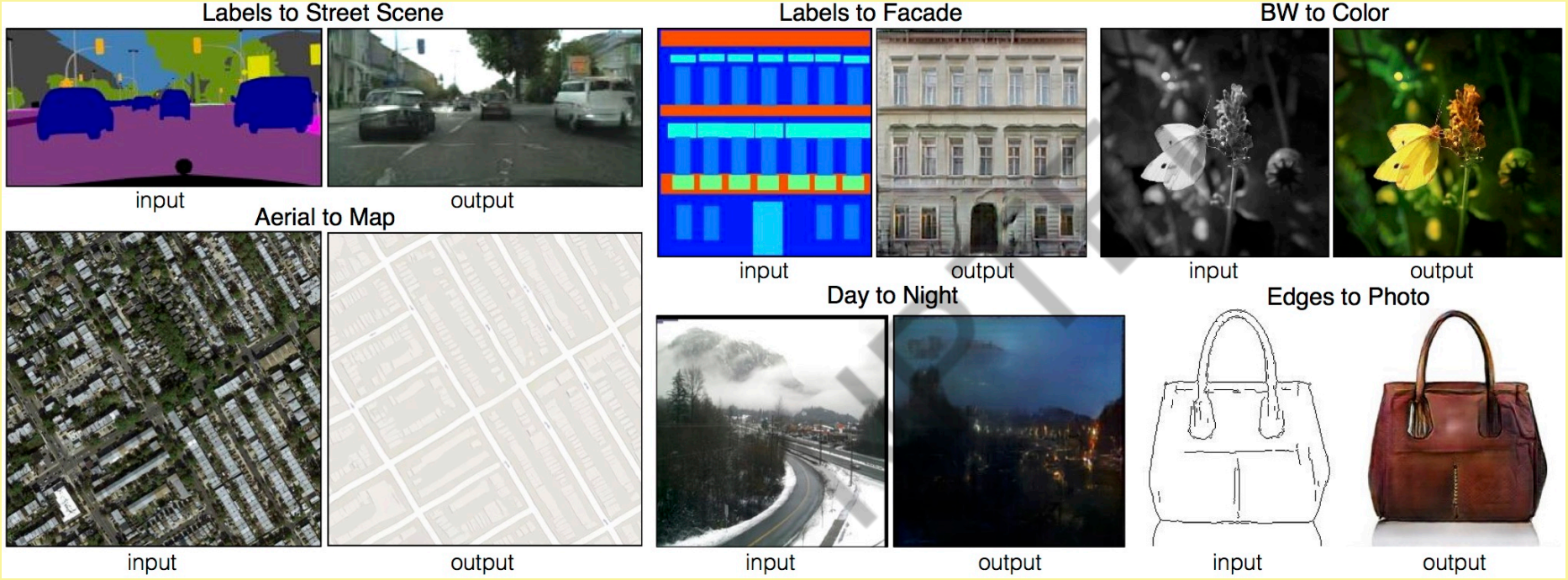
** Karras, Tero, Timo Aila, Samuli Laine, and Jaakko Lehtinen. "Progressive growing of gans for improved quality, stability, and variation." ICLR, 2018.*

Image Super resolution*



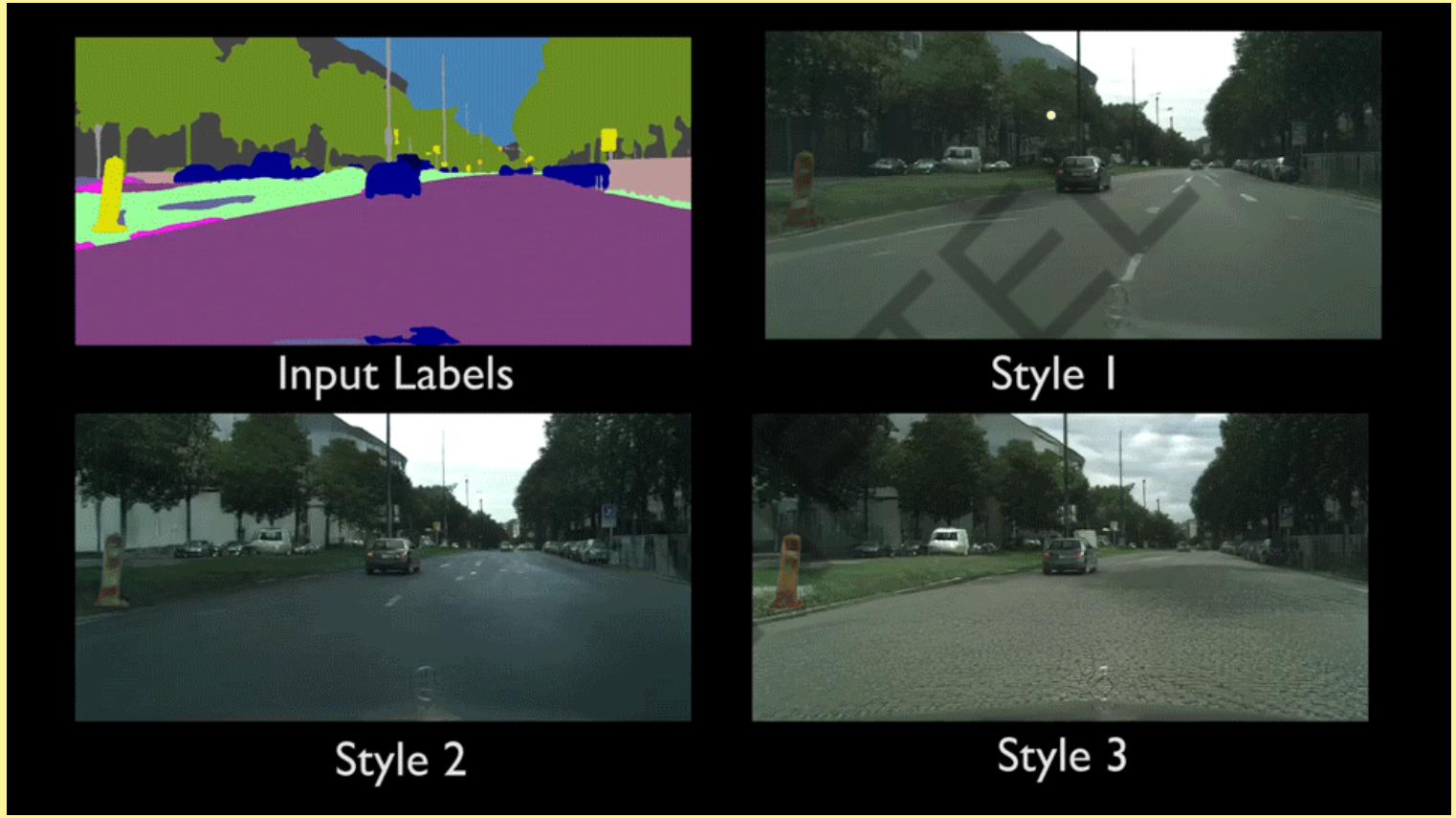
*Ledig et al.. "Photo-Realistic Single Image Super-Resolution Using a Generative Adversarial Network" CVPR 2016

Image to Image Translation*



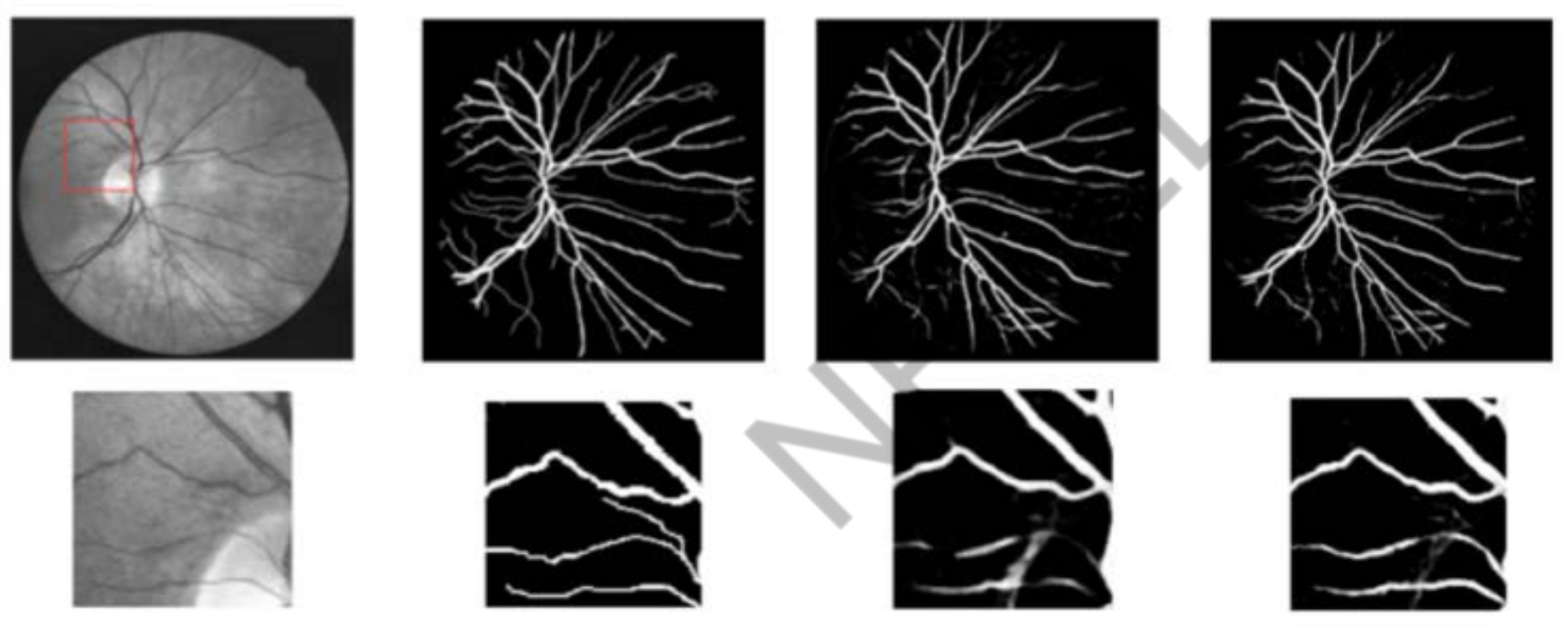
*Isola, Phillip, Jun-Yan Zhu, Tinghui Zhou, and Alexei A. Efros. "Image-to-image translation with conditional adversarial networks." *CVPR, 2017*

Video to Video Translation*



*Wang, Ting-Chun, Ming-Yu Liu, Jun-Yan Zhu, Guilin Liu, Andrew Tao, Jan Kautz, and Bryan Catanzaro. "Video-to-video synthesis." *NeurIPS, 2018*

Medical Image Processing



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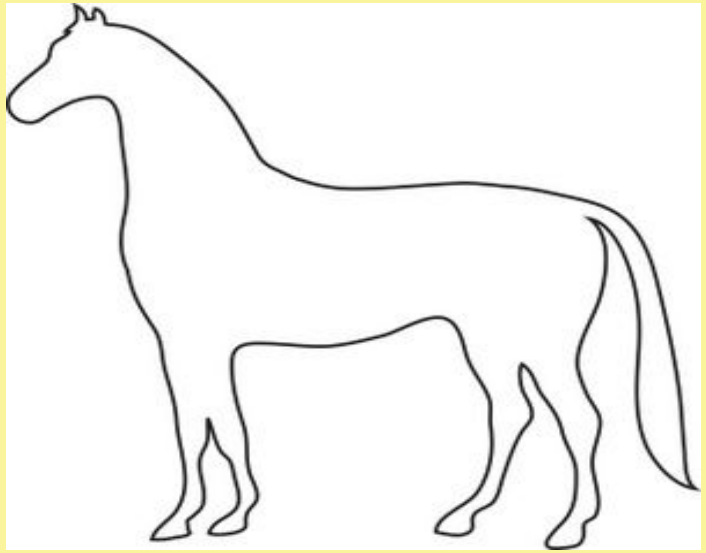
Topic

Lecture 02: Feature Vector

Descriptors/ Feature Vectors

Image Source: Internet

Descriptors/ Feature Vectors



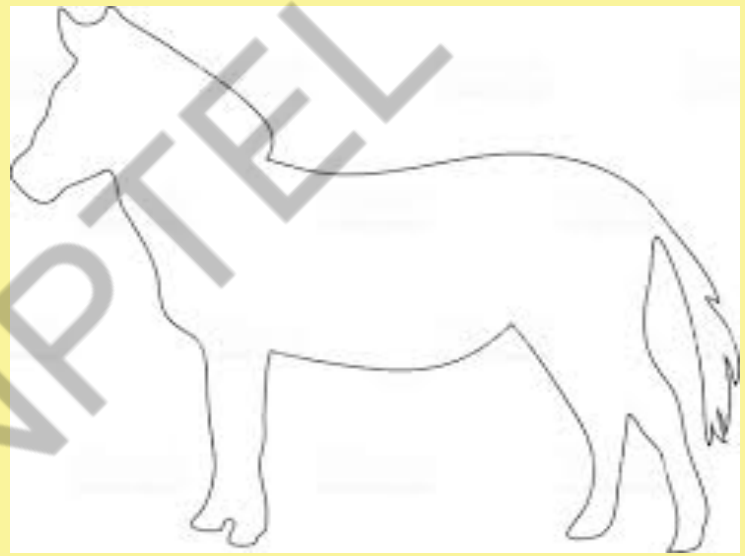


Image Source: Internet

Descriptors/ Feature Vectors

Image Source: Internet

CONCEPTS COVERED

Concepts Covered: Descriptors/ Features

- Visual Signals
  - Boundary Features
  - Region Features
- Audio Signals

Boundary Descriptors

Shape Feature/ Polygonal Representation

Signature

Fourier Descriptor

Statistical Moments

Region Descriptors

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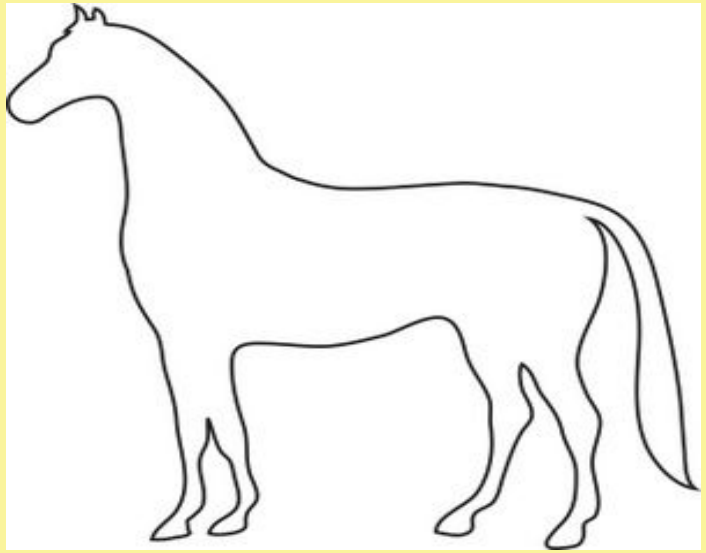
Topic

Lecture 03: Region Descriptors

Descriptors/ Feature Vectors

Image Source: Internet

Descriptors/ Feature Vectors



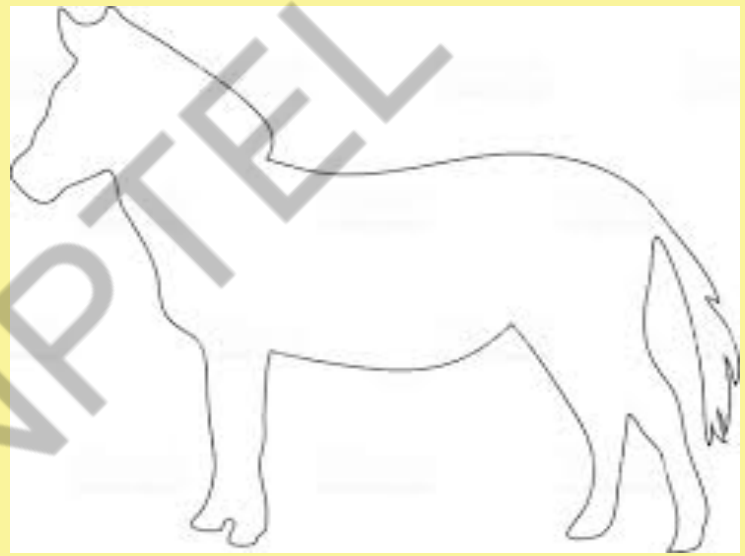


Image Source: Internet

Descriptors/ Feature Vectors

Image Source: Internet

CONCEPTS COVERED

Concepts Covered: Descriptors/ Features

- Visual Signals
  - Boundary Features
  - Region Features
- Audio Signals

Region Descriptors

Intensity Descriptor

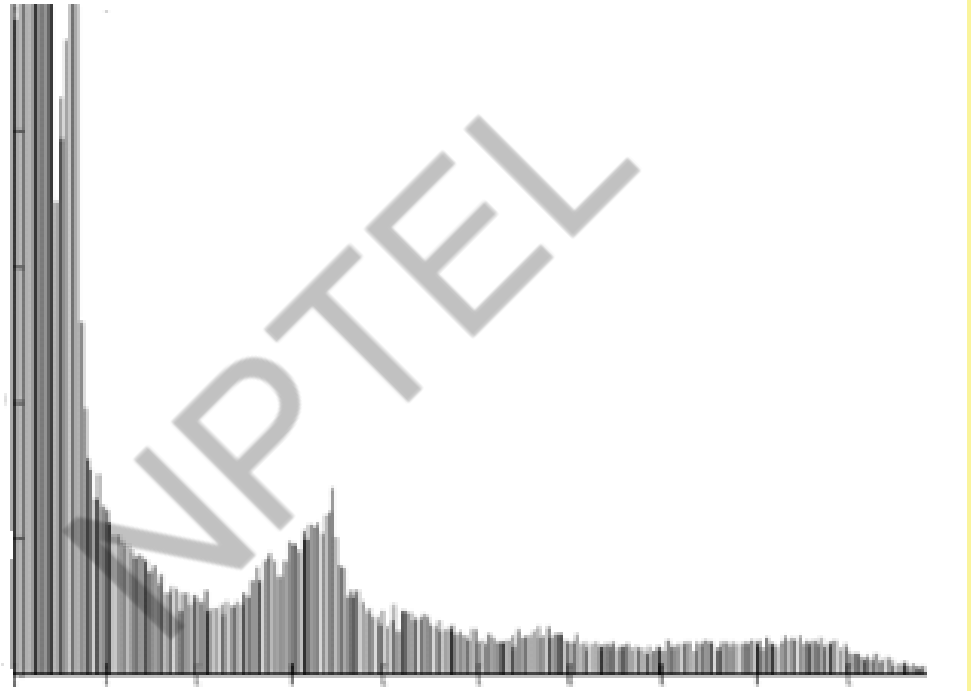


Image Source: Internet

Intensity Descriptor

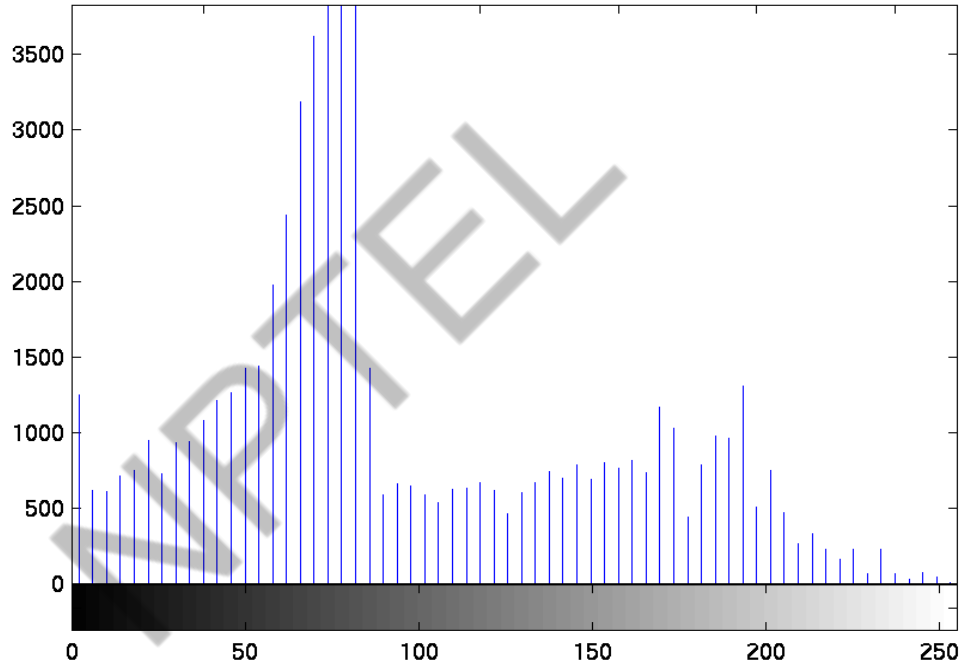


Image Source: Internet

Colour Feature

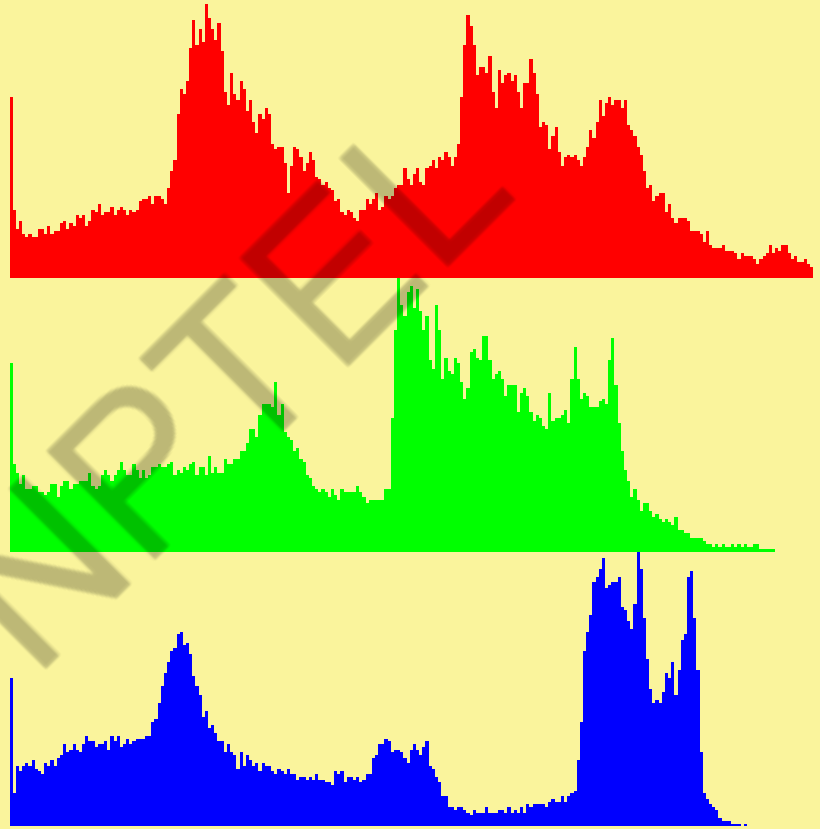
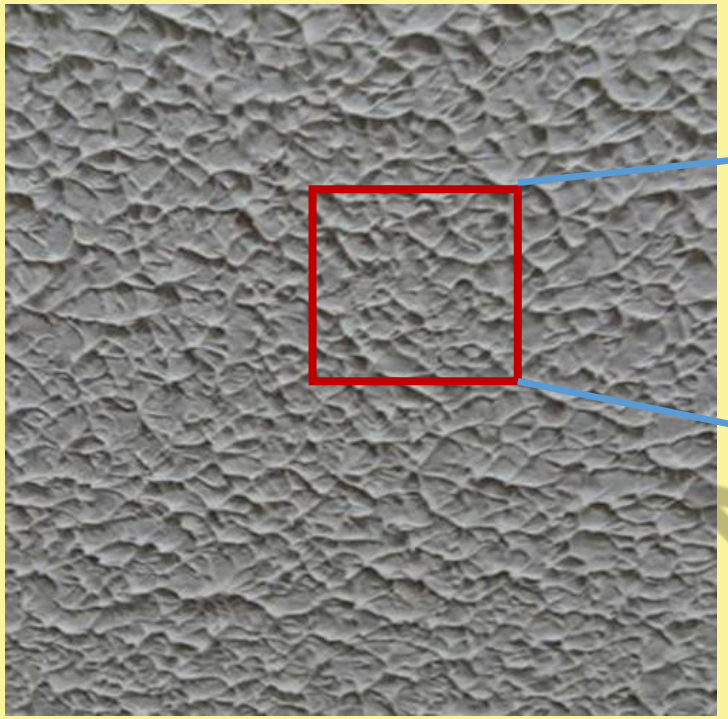


Image Source:https://billmill.org/the_histogram.html

Texture Descriptors

Pixel Domain/ Co-occurrence Matrix



150	100	115	109	112	100	145	140
110	112	120	135	125	120	132	133
152	99	129	130	122	135	98	100
147	138	142	95	108	136	110	125
99	127	149	138	138	129	108	129
128	125	139	115	120	145	137	131
146	159	150	130	147	139	143	127
140	120	128	98	100	106	115	119

Pixel Domain/ Co-occurrence Matrix

10	9	7	9	5	8	11	9
6	5	15	12	4	6	3	2
9	3	2	10	6	8	4	5
8	2	4	3	7	5	6	1
2	0	11	8	10	9	8	2
8	4	7	1	6	0	7	6
2	3	8	9	11	6	3	9
7	2	8	8	6	12	6	7

Co-occurrence matrix based descriptors

Maximum Probability $\max_{i,j}(c_{ij})$

Element Difference Moment $\sum_i \sum_j (i-j)^k C_{i,j}$

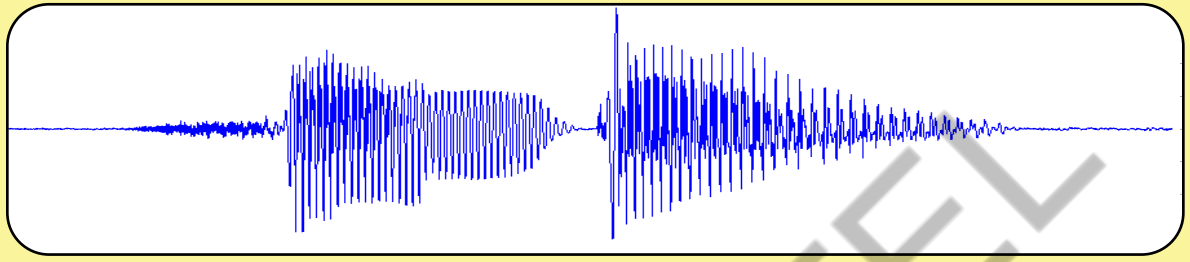
Inverse Element Difference Moment $\sum_i \sum_j C_{i,j} / (i-j)^k \qquad i \neq j$

Uniformity $\sum_i \sum_i C_{ij}^2$

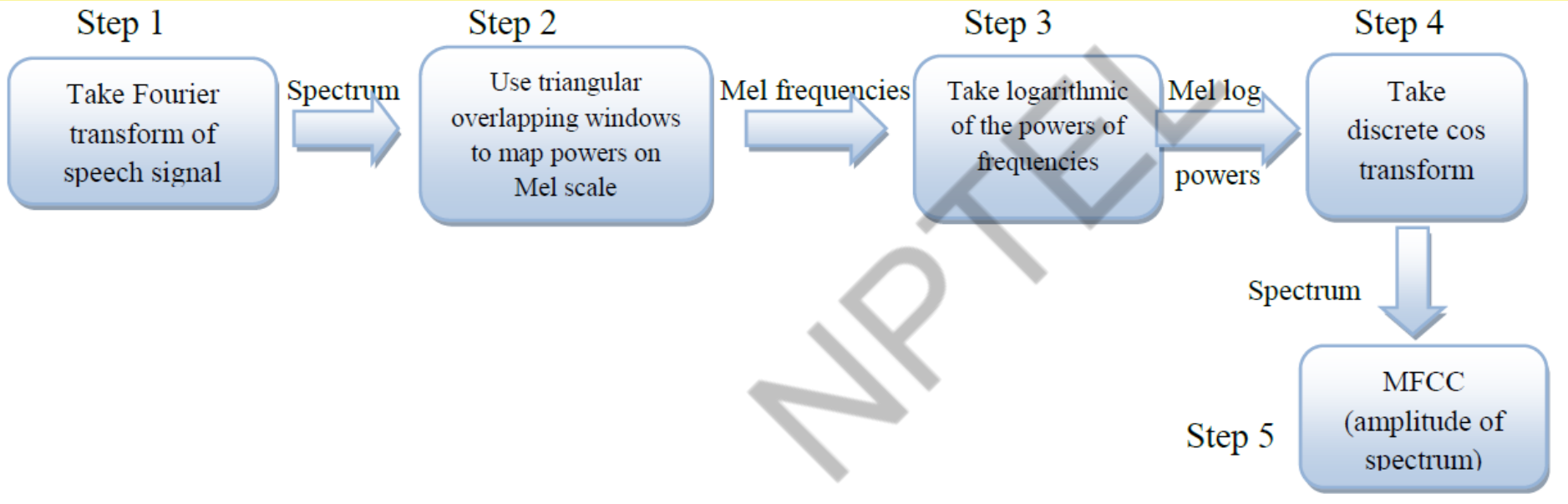
Entropy $-\sum_i \sum_j c_{ij} \log_2 C_{ij}$

Audio

Time Domain Feature - LPC



Spectral Domain- MFCC



Traditional Machine Learning vs. Deep Learning

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Department : Electronics and Electrical Communication Engineering

Topic

Lecture 04: Bayesian Learning

CONCEPTS COVERED

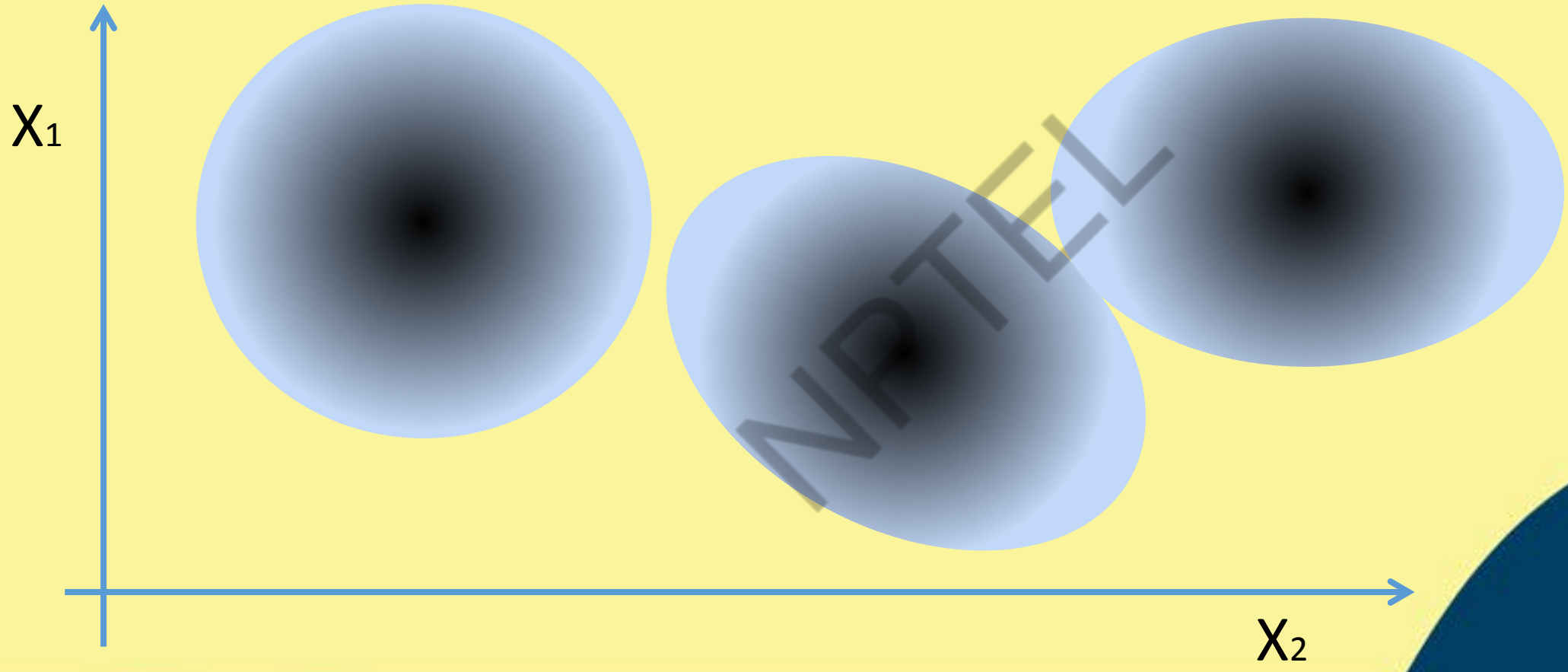
Concepts Covered:

- Feature Space Representation
- Bayes Rule
- Bayes Minimum Error Classifier
- Bayes Minimum Risk Classifier

Feature Space Representation

Image Source: Internet

Feature Space Representation



Feature Space Representation

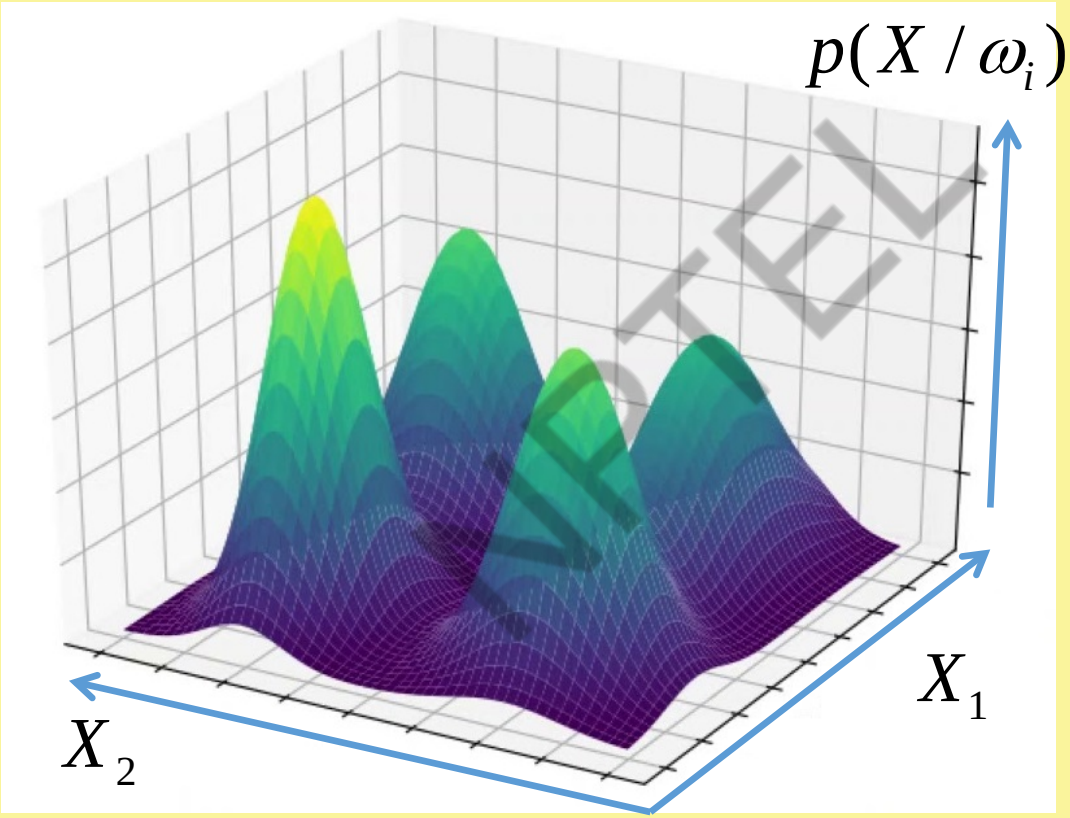


Image Source: Internet

Bayesian Learning

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Course Name: Deep Learning

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Department : Electronics and Electrical Communication Engineering

Topic

Lecture 05: Bayes Minimum Risk Classifier

CONCEPTS COVERED

Concepts Covered:

- Feature Space Representation
- Bayes Rule
- Bayes Minimum Error Classifier
- Bayes Minimum Risk Classifier

Feature Space Representation

Image Source: Internet

Feature Distribution

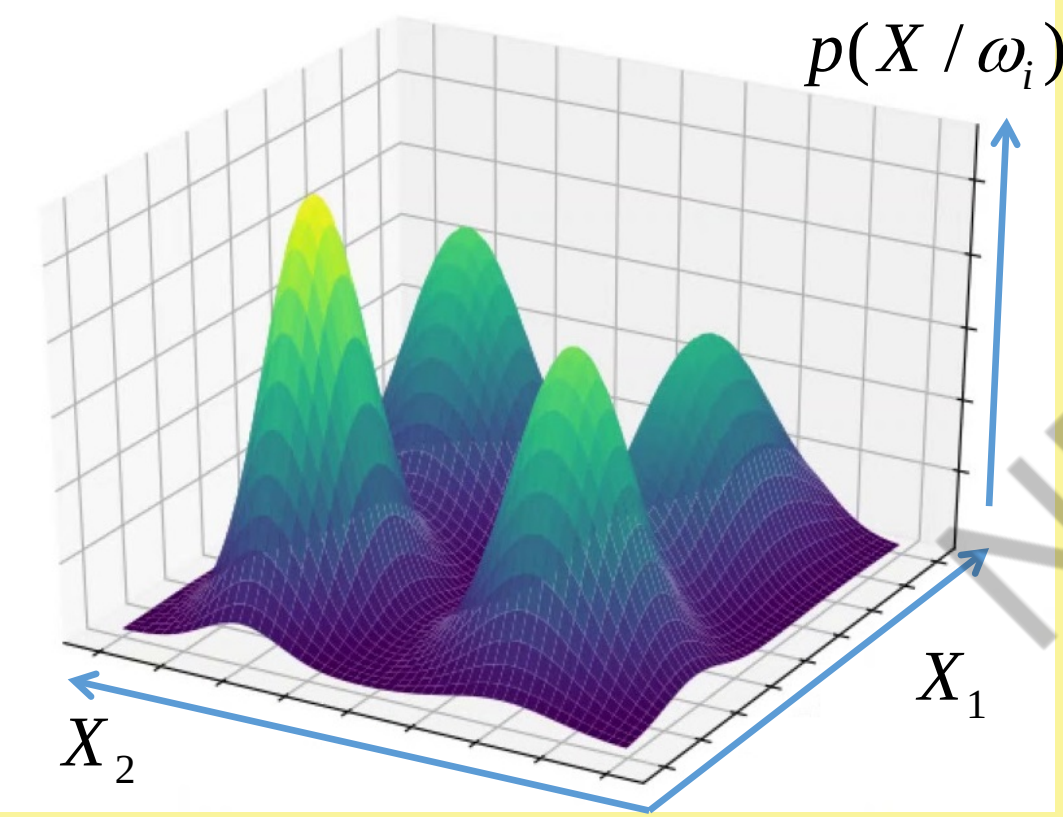

Image Source: Internet

Bayes Minimum Error Classification

Bayes Minimum Risk Classification

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