



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?

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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.

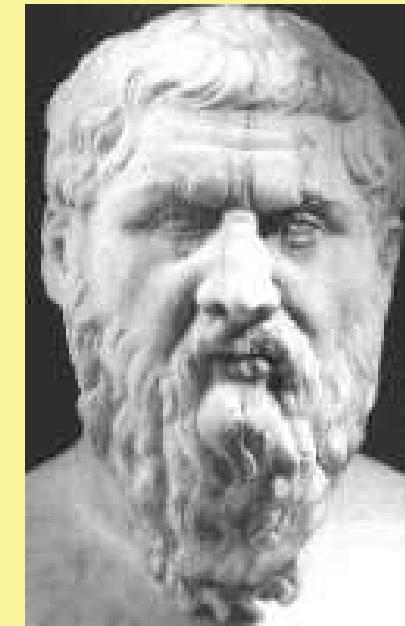


Image Source: Internet

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.

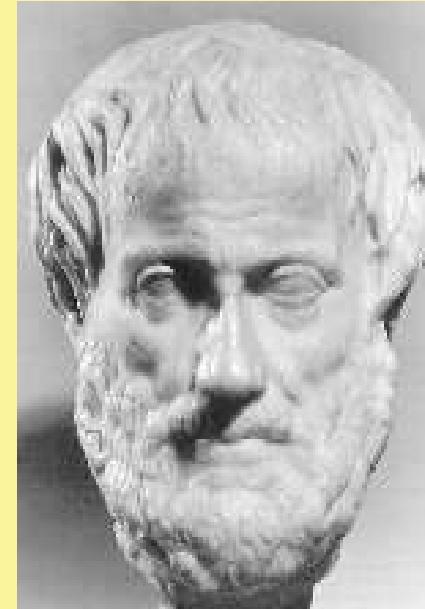
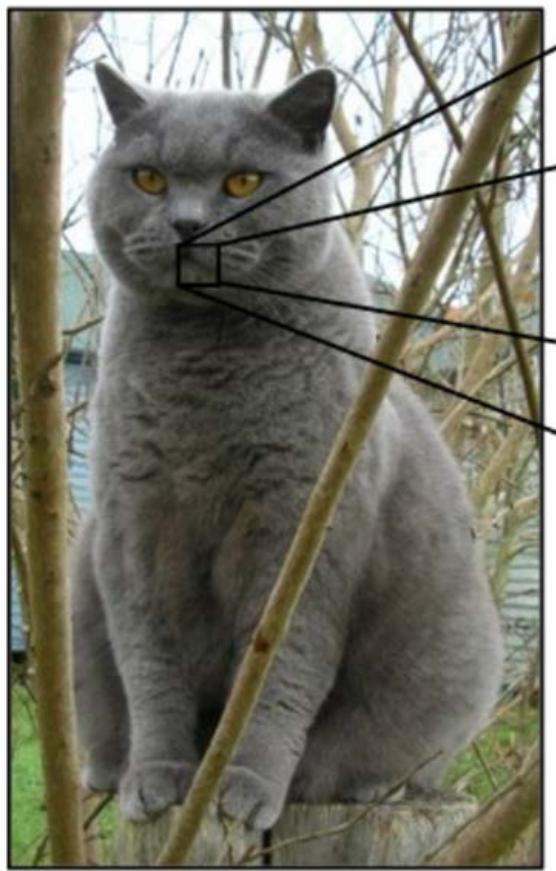


Image Source: Internet

Descriptors/ Feature Vectors



Image Source: Internet



What the computer sees

08	02	22	97	38	15	00	40	00	75	04	05	07	78	52	12	50	77	81	48
49	49	99	40	17	81	18	57	60	87	17	40	98	43	69	45	01	56	62	00
81	49	31	73	55	79	14	29	93	71	40	67	51	08	30	03	49	13	36	65
52	70	95	23	04	60	11	42	69	31	68	56	01	32	56	71	37	02	36	91
22	31	16	71	51	67	03	89	41	92	36	54	22	40	40	28	66	33	13	80
24	47	32	60	99	03	45	02	44	75	33	53	78	36	84	20	35	17	12	50
32	98	81	28	64	23	67	10	26	38	40	67	59	54	70	66	18	38	64	70
67	26	20	68	02	62	12	20	95	63	94	39	63	08	40	91	66	49	96	21
24	55	58	05	66	73	99	26	97	17	78	78	96	83	14	88	34	89	63	72
21	36	23	09	75	00	76	44	20	45	35	14	00	61	33	97	34	31	33	95
78	17	53	28	22	75	31	67	15	94	03	80	04	62	16	14	09	53	56	92
16	39	05	42	96	35	31	47	55	58	88	24	00	17	54	24	36	29	85	57
86	56	00	48	35	71	89	07	05	44	44	37	44	60	21	58	51	54	17	58
19	80	81	68	05	94	47	69	28	73	92	13	86	52	17	77	04	89	55	40
04	52	08	83	97	35	99	16	07	97	57	32	16	26	26	79	33	27	98	66
53	46	68	87	57	62	20	72	03	46	33	67	46	55	12	32	63	93	53	69
04	42	16	73	38	05	39	11	24	94	72	18	08	46	29	32	40	62	76	36
20	69	36	41	72	30	23	88	37	42	99	69	82	67	59	85	74	04	36	16
20	73	35	29	78	31	90	01	74	31	49	71	48	94	41	16	23	57	05	54
01	70	54	71	83	51	54	69	16	92	33	48	61	43	52	01	89	23	62	48

n.....ew.....s i.....t....e..m.....s

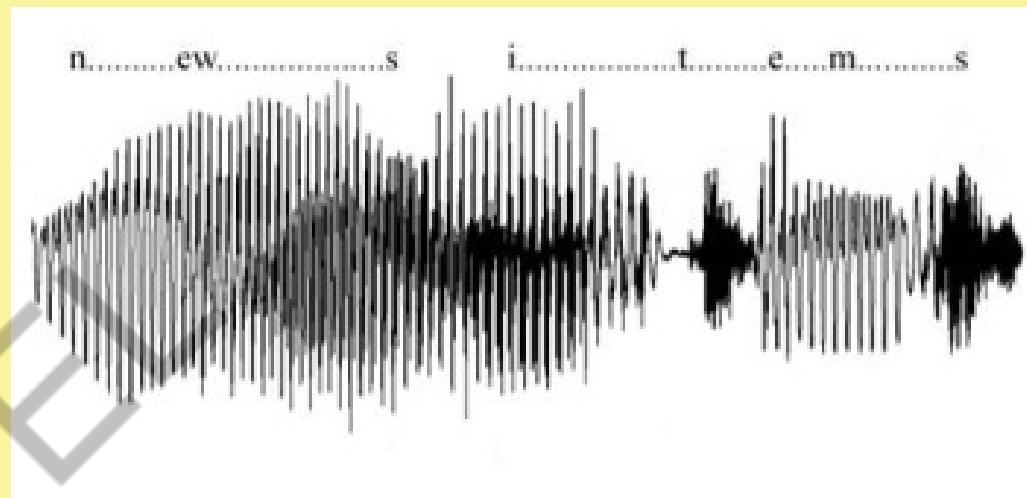


Image Source: Internet

Descriptors/ Feature Vectors



Image Source: Internet

Descriptors/ Feature Vectors

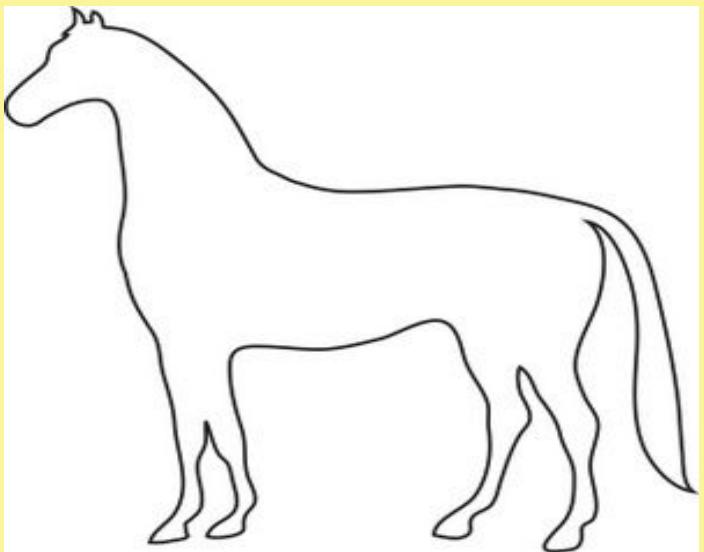


Image Source: Internet

Descriptors/ Feature Vectors



Image Source: Internet

Machine Learning vs Deep Learning



Image Source: Internet

Discriminative vs. Generative Model



Image Source: Internet

Discriminative Model



Cat



Dog



Dog



Cat



Cat



Dog

$P(X)$



$x_i \sim P(x)$

Error Backprop

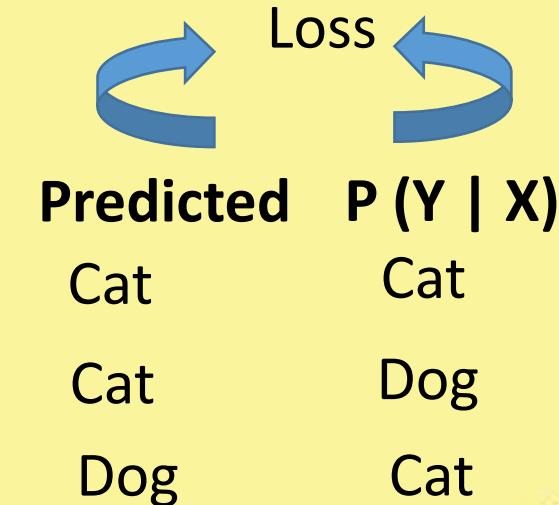
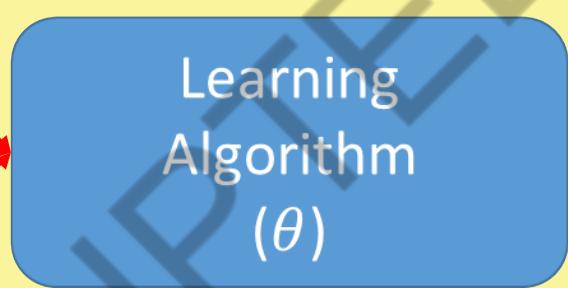


Image Source: Internet



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.



Challenge s

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Image Source: Internet

Viewing Angle

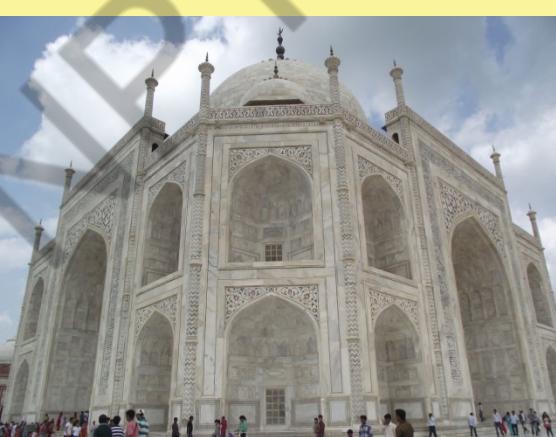


Image Source: Internet

Pose



Image Source: Internet

Illumination



Image Source: Internet

Intraclass Variation



Image Source: Internet

Distortion and Occlusion



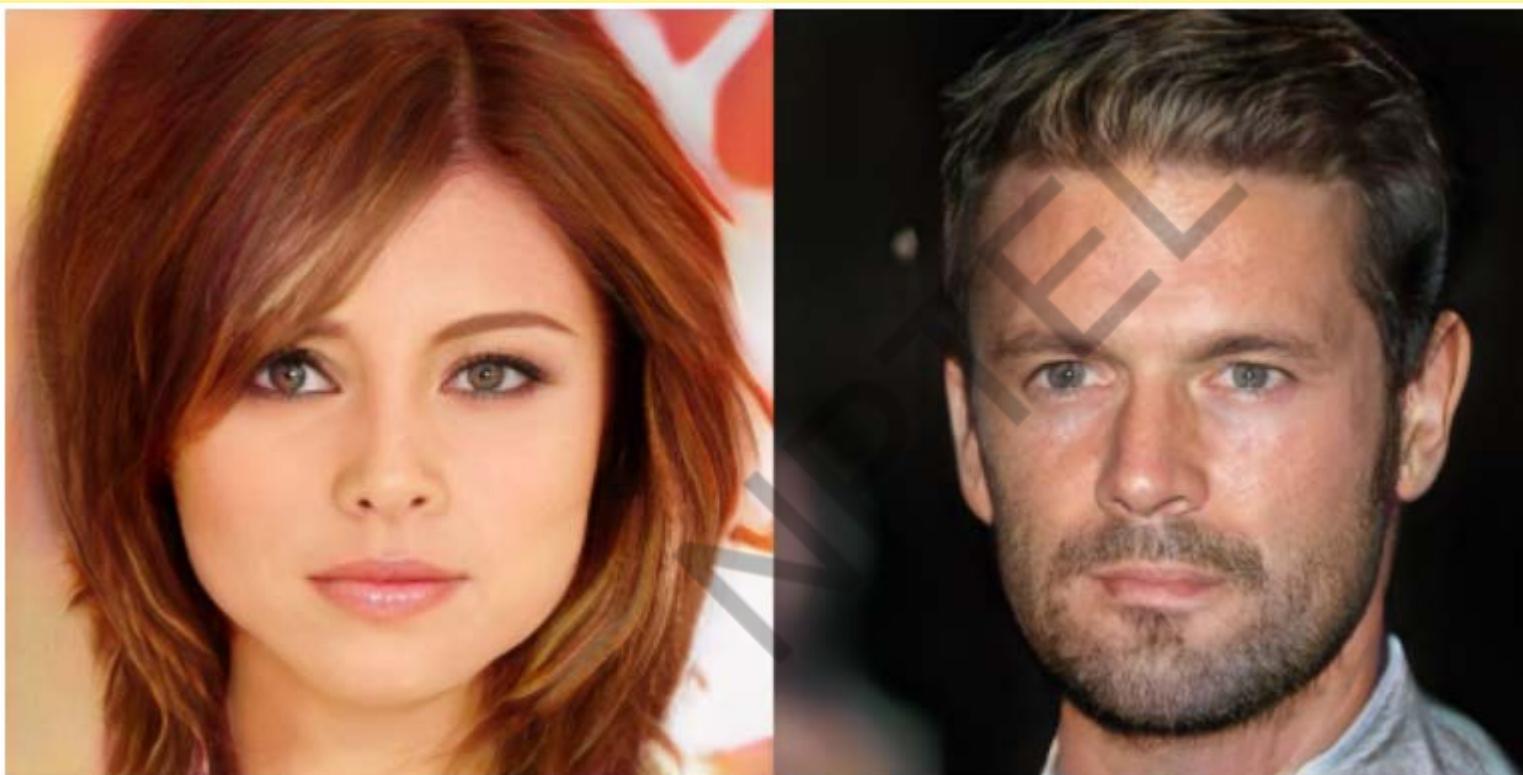
Image Source: Internet

Power of Deep Learning

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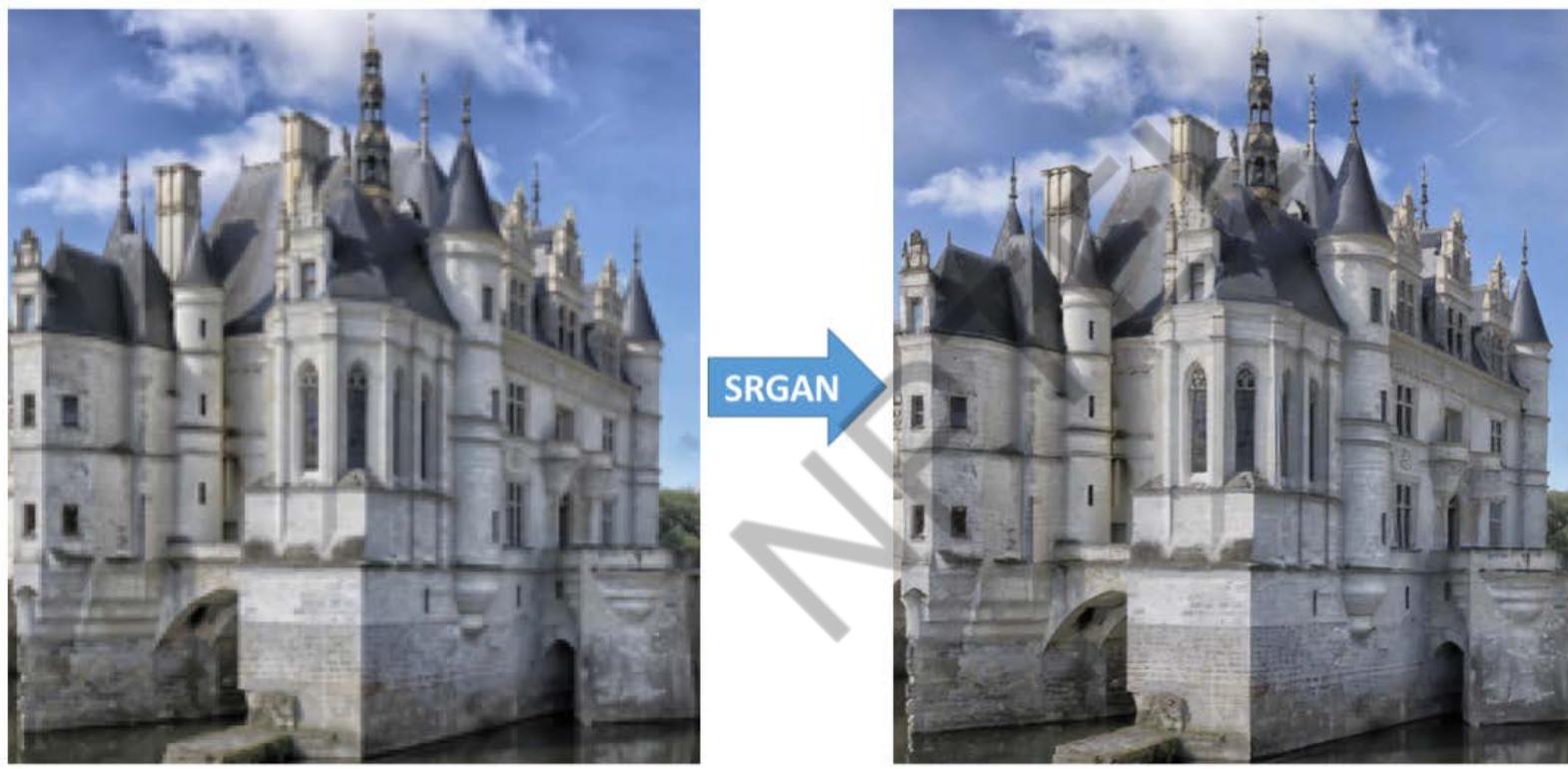


High Resolution Image Synthesis*



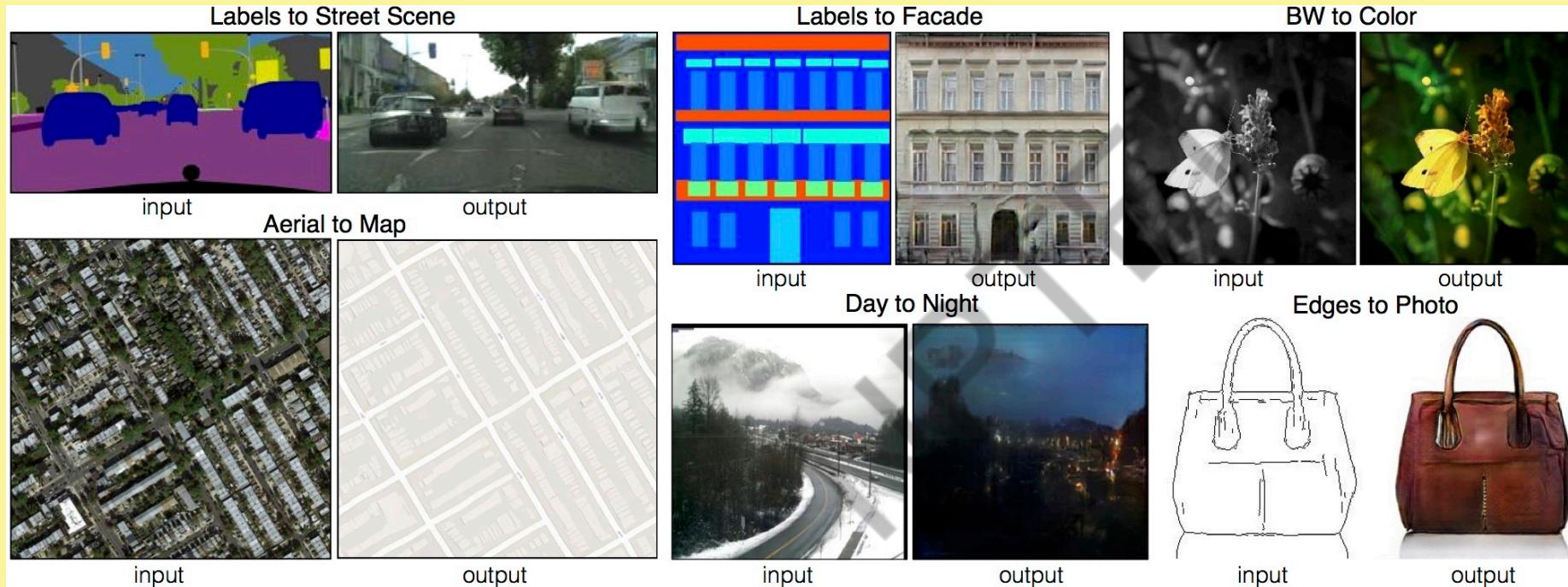
* Karras, Tero, Timo Aila, Samuli Laine, and Jaakko Lehtinen.
"Progressive growing of gans for improved quality, stability,
and variation." ICLR, 2018.

Image Super resolution*



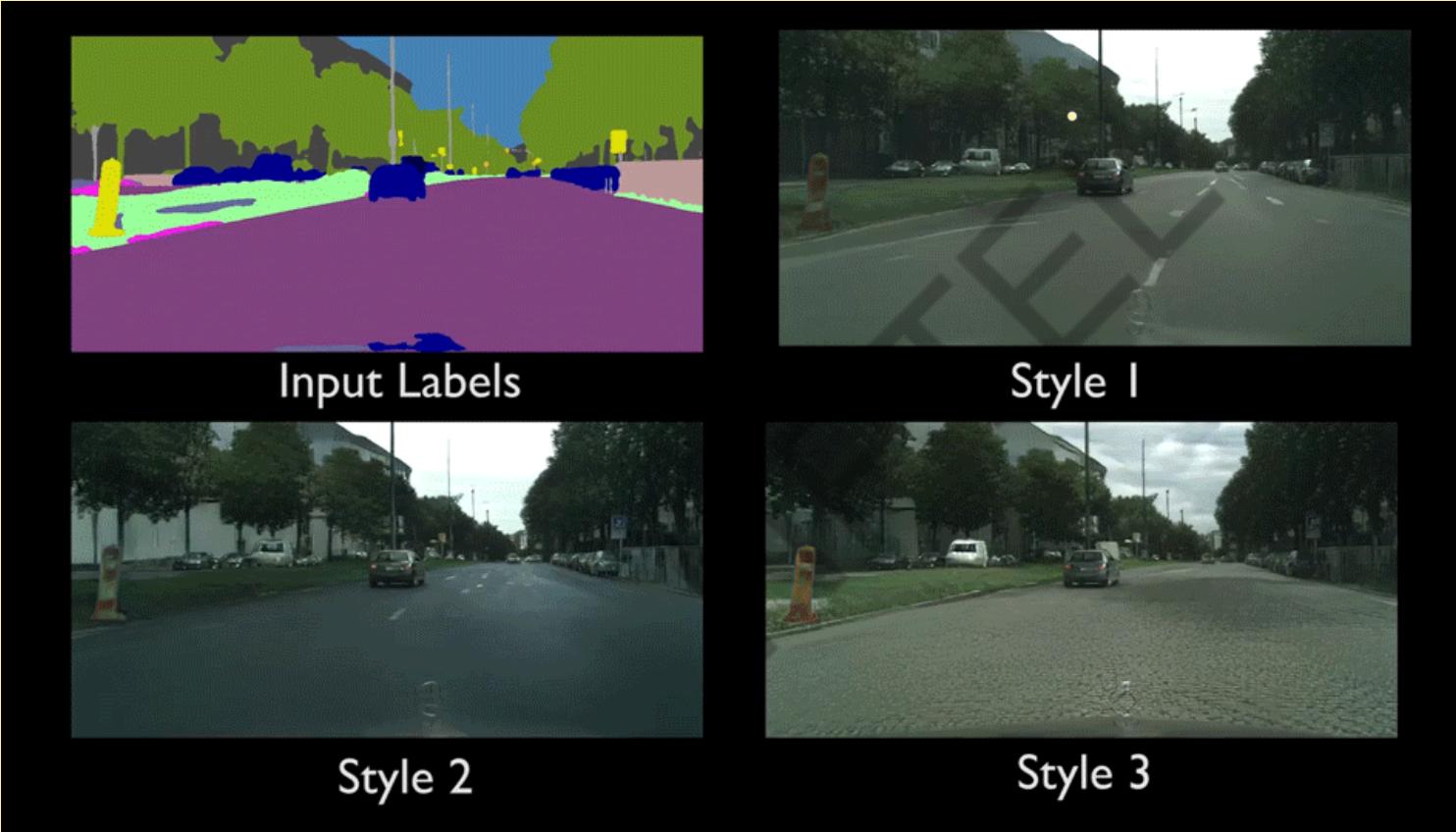
*Ledig et al.. "Photo-Realistic Single Image Super-Resolution Using a Generative Adversarial Network" CVPR 2016

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

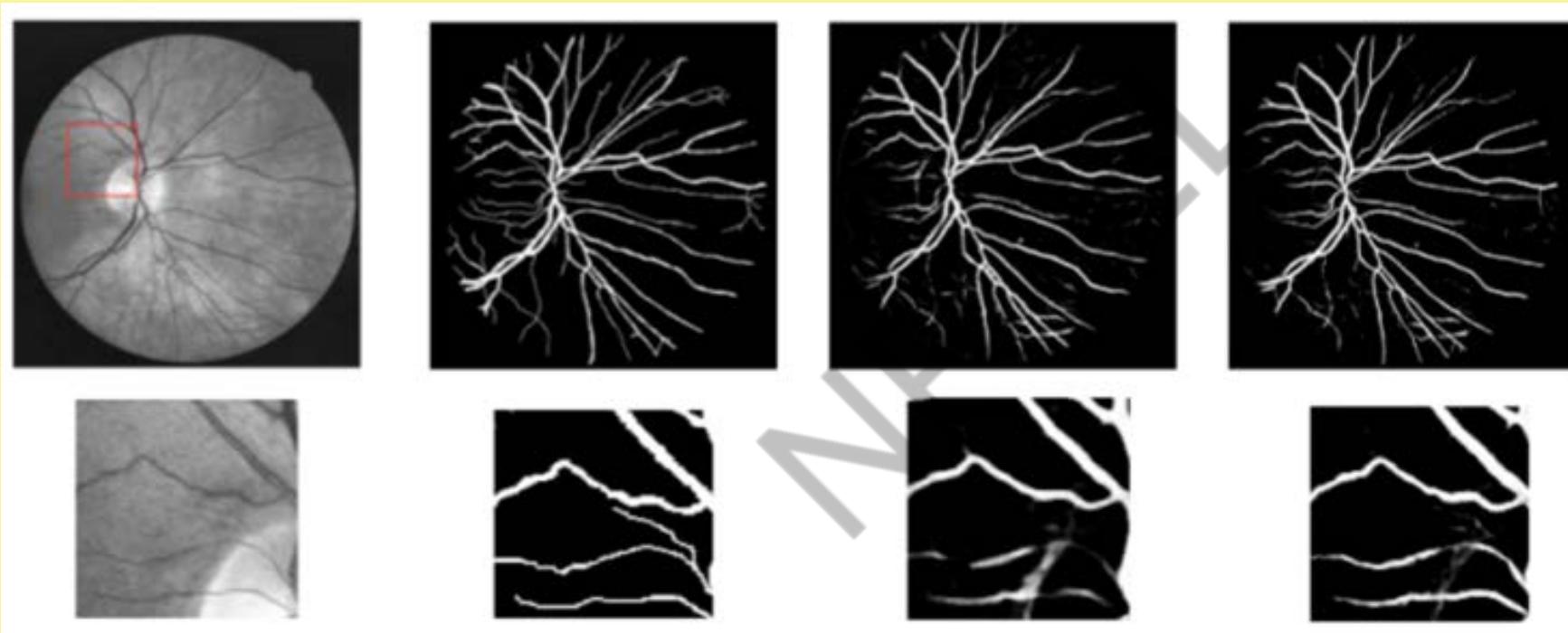
Video to Video Translation*



*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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*Thank
you*

A large, stylized "Thank you" message is written in black cursive script. The "T" and "y" are particularly prominent. A gold-colored fountain pen nib is shown writing the "u" in "you", with ink trailing off the end of the pen. The background behind the text is a light yellow color.



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Lecture 02: Feature Vector

Descriptors/ Feature Vectors



Image Source: Internet

Descriptors/ Feature Vectors

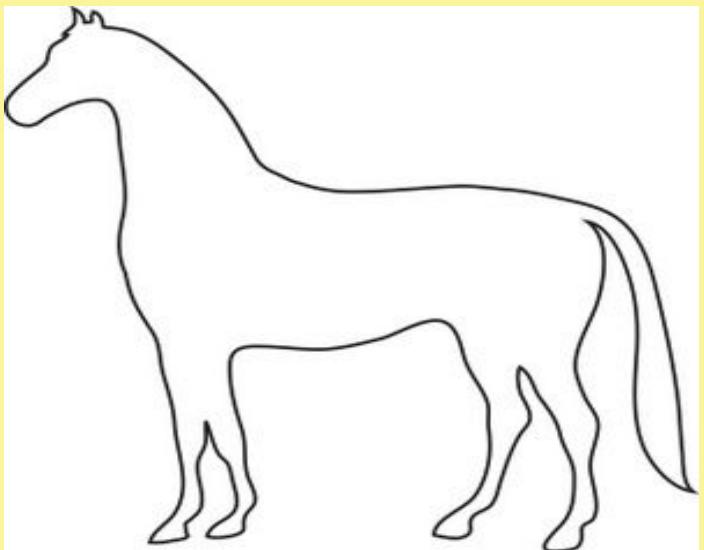


Image Source: Internet

Descriptors/ Feature Vectors



Image Source: Internet

CONCEPTS COVERED

Concepts Covered: Descriptors/ Features

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



Boundary Descriptors

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Shape Feature/ Polygonal Representation

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Signature

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Fourier Descriptor

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Statistical Moments

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Region Descriptors





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*Thank
you*

An illustration of a fountain pen with its nib pointing towards the right, as if writing the word "you" in cursive script. The pen is gold and black.



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Lecture 03: Region Descriptors

Descriptors/ Feature Vectors



Image Source: Internet

Descriptors/ Feature Vectors

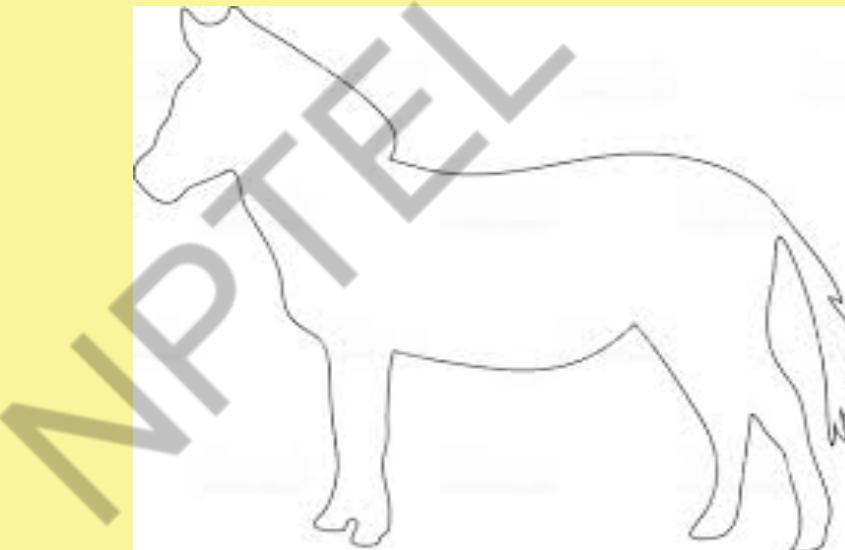
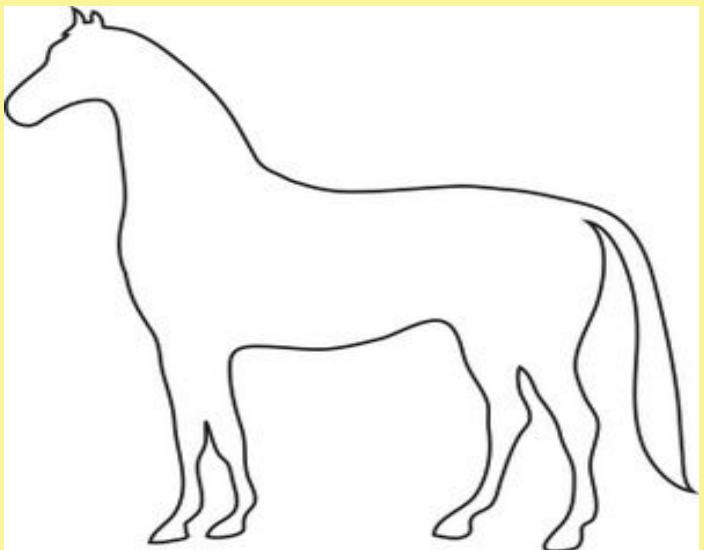


Image Source: Internet

Descriptors/ Feature Vectors



Image Source: Internet

CONCEPTS COVERED

Concepts Covered: Descriptors/ Features

Visual Signals

- ❖ Boundary Features

- ❖ Region Features

Audio Signals



Region Descriptors

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Intensity Descriptor

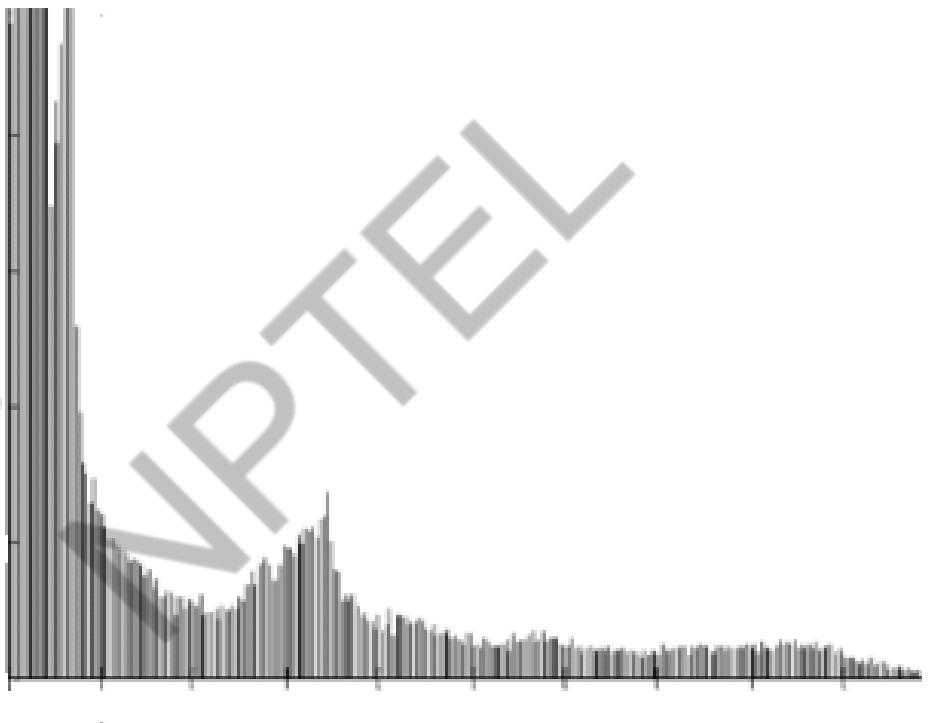
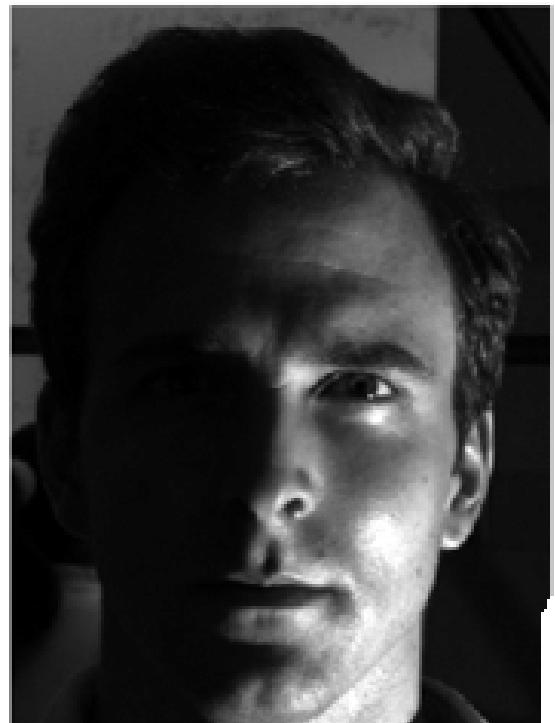


Image Source: Internet

Intensity Descriptor

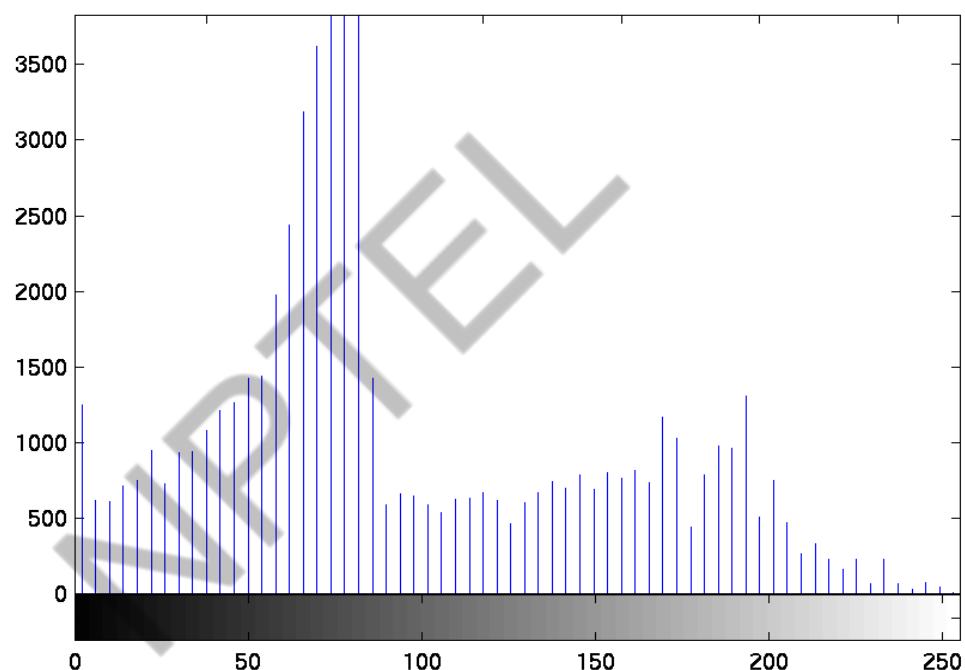
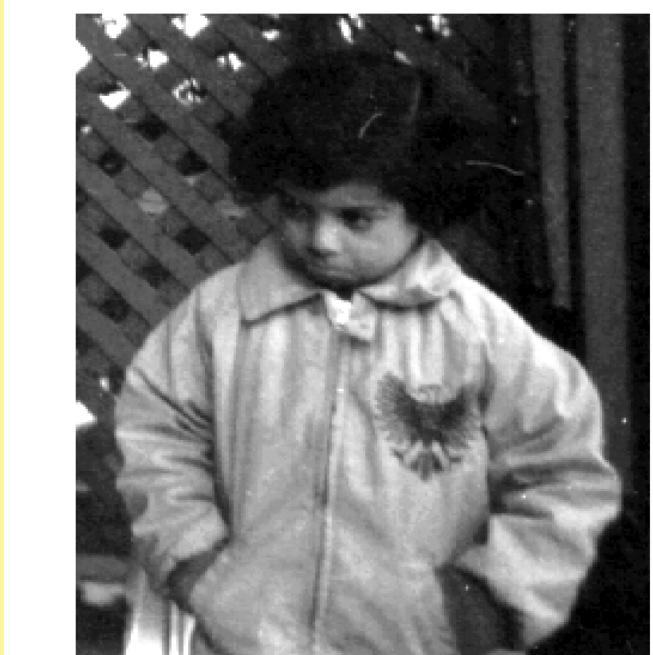


Image Source: Internet

Colour Feature

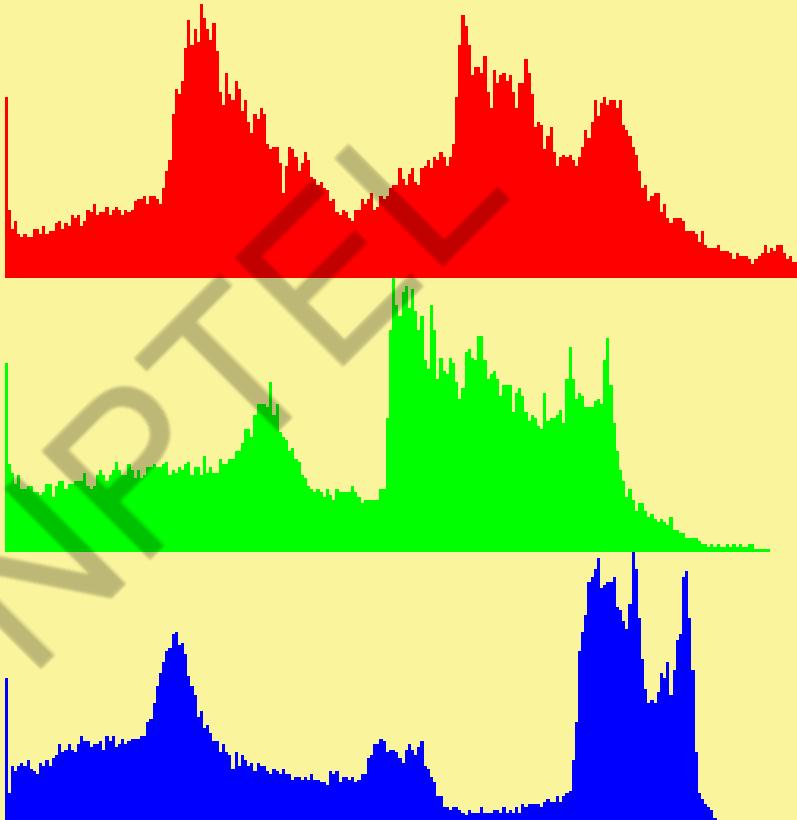
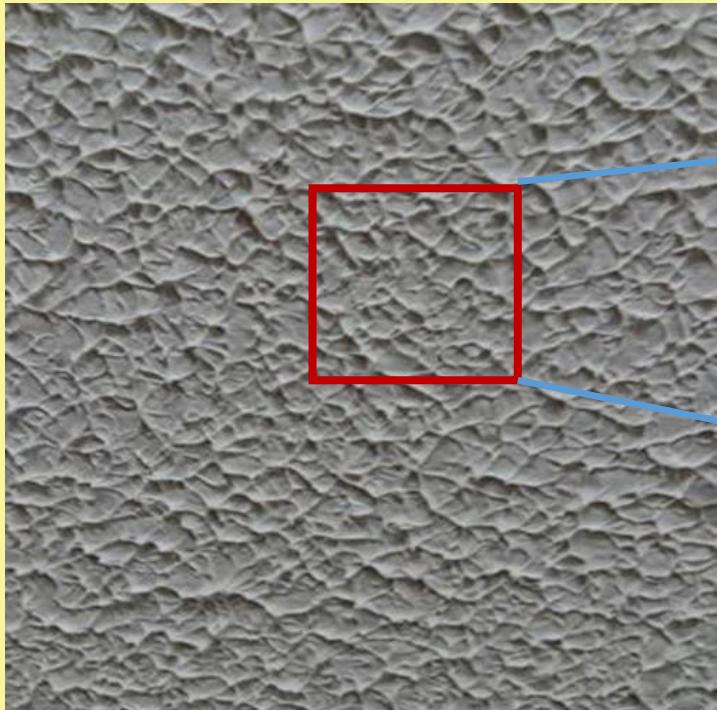


Image Source:https://billmill.org/the_histogram.html

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

$$\sum_i \sum_j C_{i,j} / (i - j)^k \quad i \neq j$$

Uniformity

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

Entropy

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

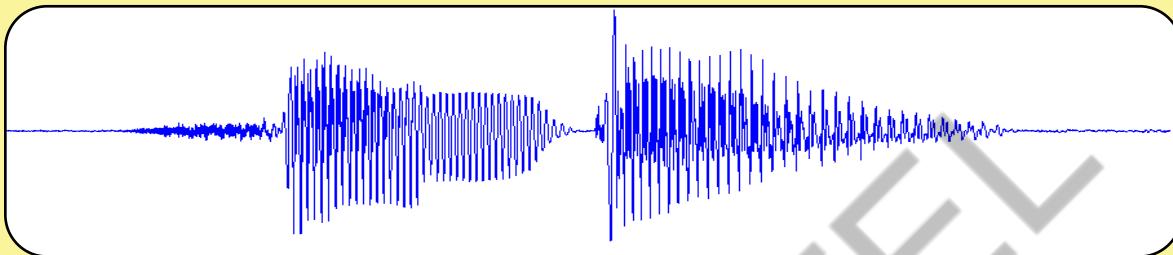


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Audio



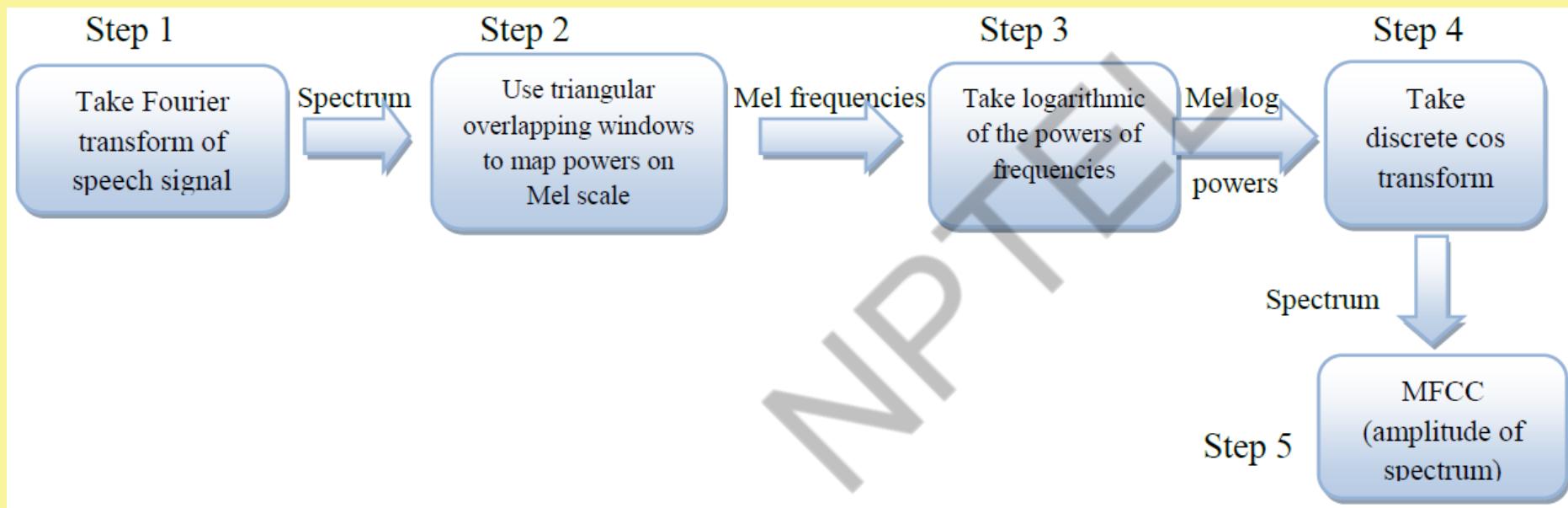
Time Domain Feature - LPC



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Spectral Domain- MFCC



Traditional Machine Learning vs. Deep Learning

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*Thank
you*

An illustration of a fountain pen with its nib pointing towards the right, as if it has just finished writing the word "you" in a cursive script. The pen is gold-colored with a black clip.



NPTEL ONLINE CERTIFICATION COURSES

Course Name: Deep Learning

Faculty Name: Prof. P. K. Biswas

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

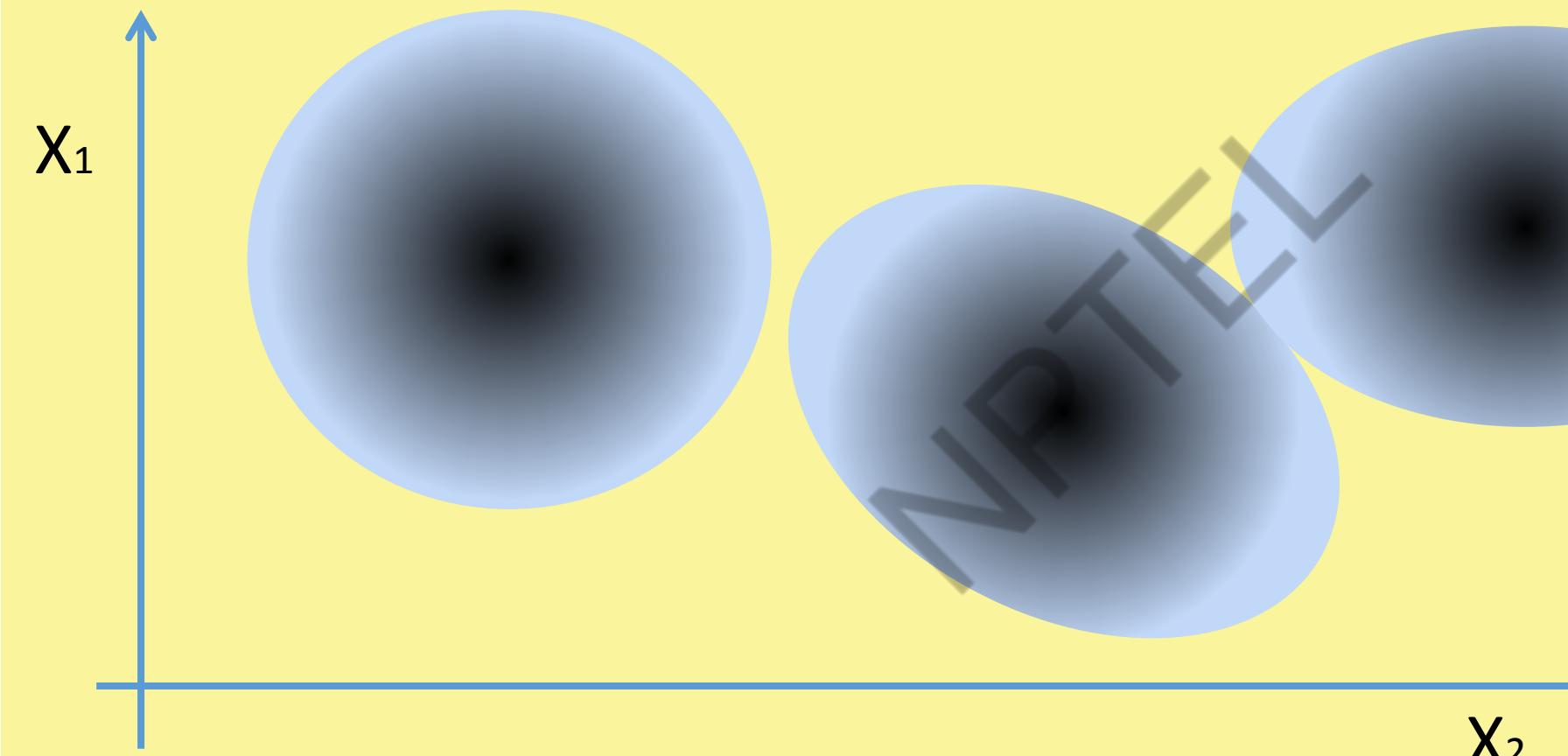


Feature Space Representation



Image Source: Internet

Feature Space Representation



Feature Space Representation

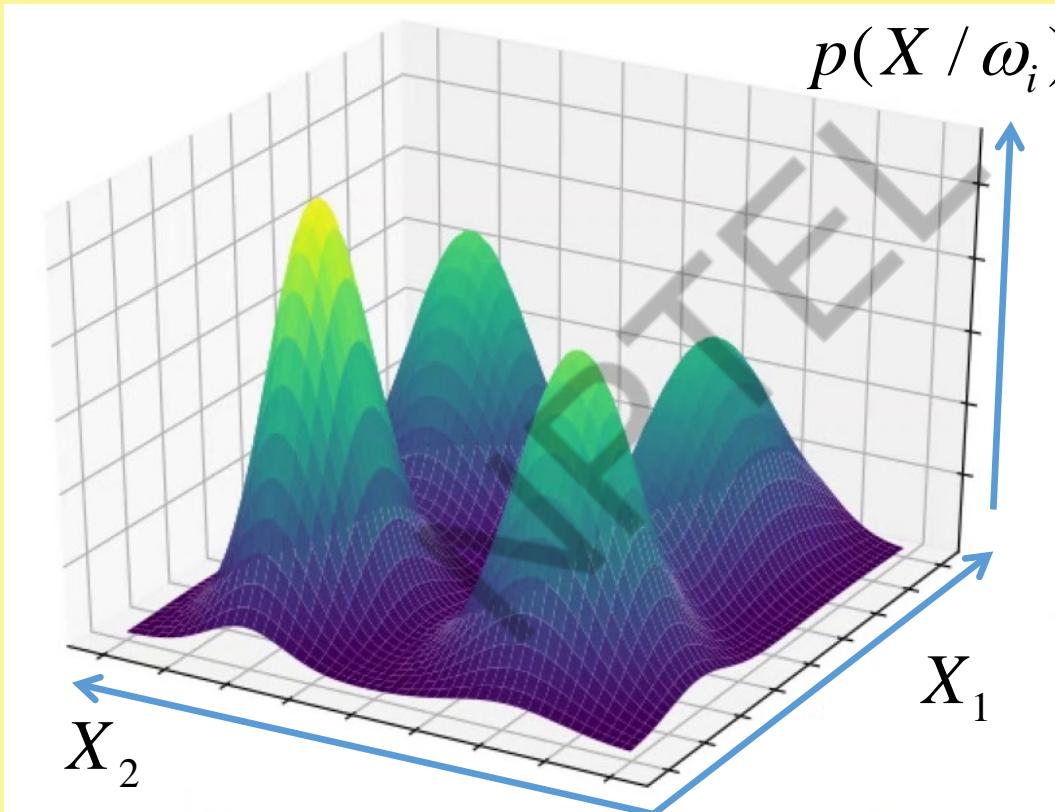


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Bayesian Learning

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Lecture 05: Bayes Minimum Risk Classifier

CONCEPTS COVERED

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- Feature Space Representation
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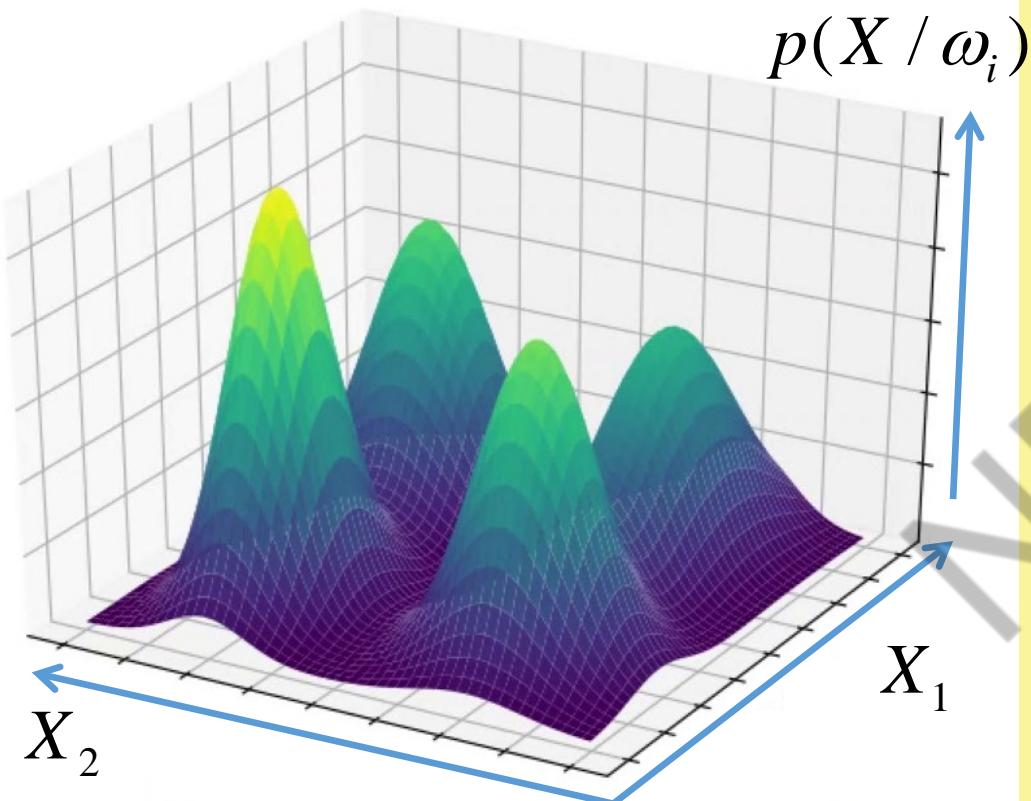


Feature Space Representation



Image Source: Internet

Feature Distribution



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Image Source: Internet

Bayes Minimum Error Classification

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Bayes Minimum Risk Classification

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*Thank
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