Job or Academics ?

IT Projects or Research ?

#$%& ?

(what, when, where….I do not know)

Where??

TCS, Wipro, Mindtree, Infosys

(You know better than me!!)

GE, research

IBM, IRL

Microsoft research

TCS Innovation Lab

Google

Yahoo

Fractals

Factset

Infosys

……

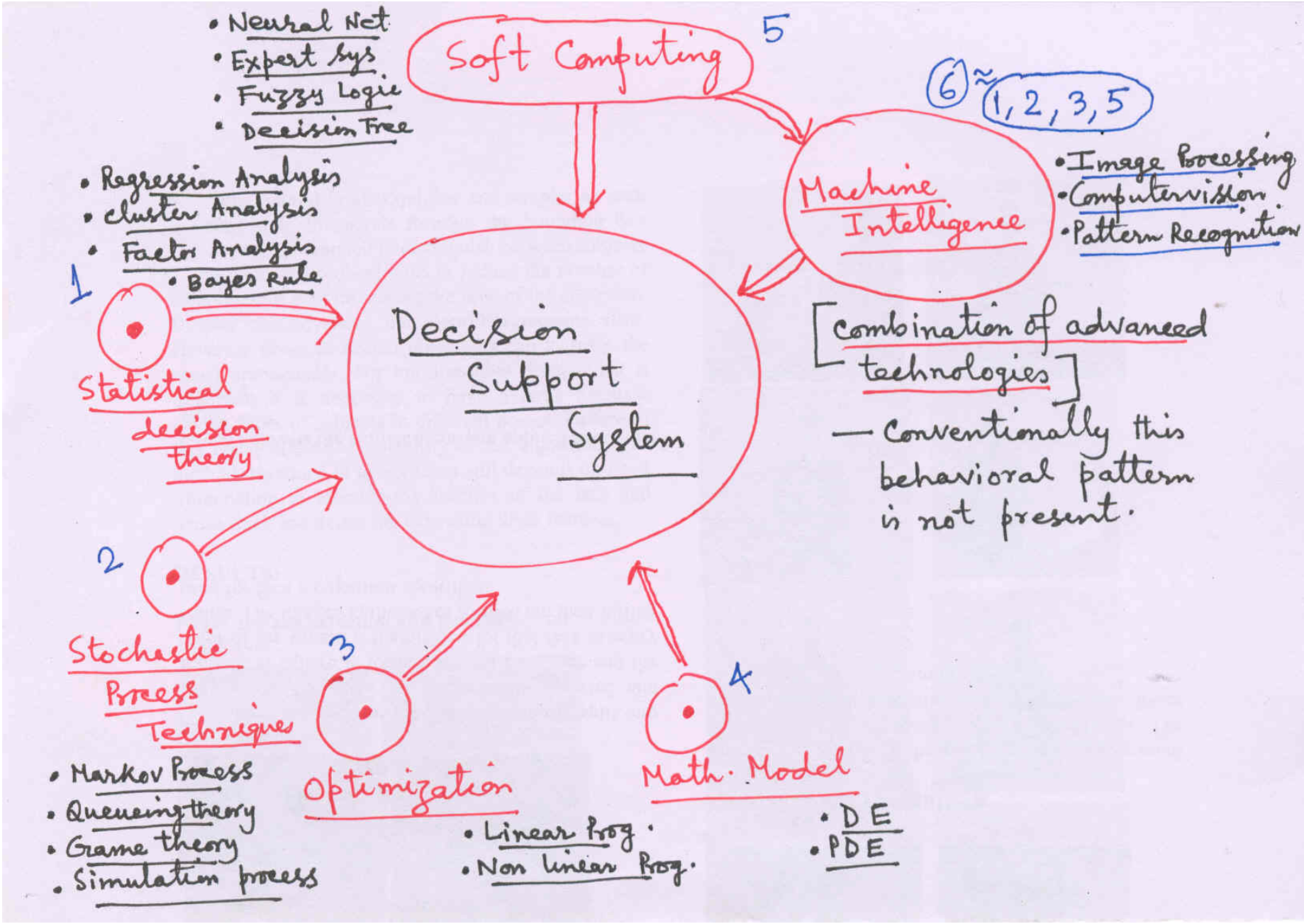
Machine Intelligence/Learning concern with designing and developing of algorithms that allow machines, essentially computers, to evolve realistic or human like behavior based on the empirical data available.

Combining advanced technologies to trace the intrinsic conventional behavioral pattern of the system. Suggesting realistic/intelligent/robust decisions about the system.

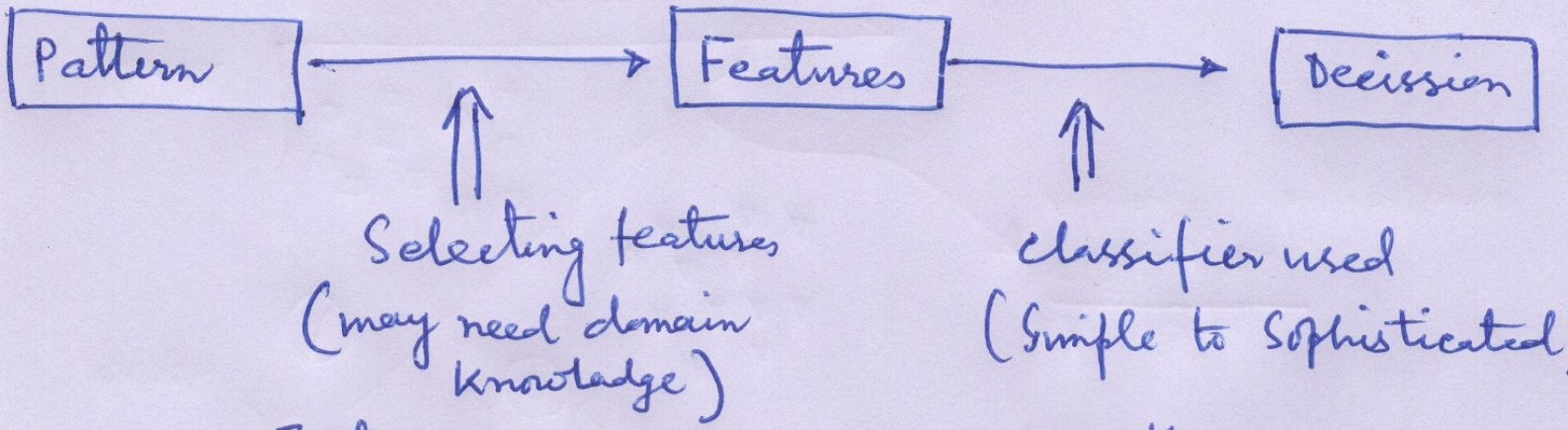
Can lead to Artificial Intelligence and more often make use of many concepts of artificial intelligence.

Possibly leading towards emerging a new branch of study called "Soft Computing"
– Decisions are not Hard (yes/no) rather Soft and enabling users to decide the final decision.

Could be included in the broad spectrum of Decision Support System.


• Neural Net
• Expert Sys
• Fuzzy Logic
• Decision Tree
Soft Computing
5
6 ≈ 1, 2, 3, 5
Machine Intelligence
• Image Processing
• Computervision
• Pattern Recognition
• Regression Analysis
• cluster Analysis
• Factor Analysis
• Bayes Rule
1
Statistical decision theory
Decision Support System
[combination of advanced technologies]
— Conventionally this behavioral pattern is not present.
2
Stochastic Process Techniques
• Markov Process
• Queueing theory
• Game theory
• Simulation process
3
Optimization
• Linear Prog.
• Non linear Prog.
4
Math. Model
• DE
• PDE

PATTERN RECOGNITION

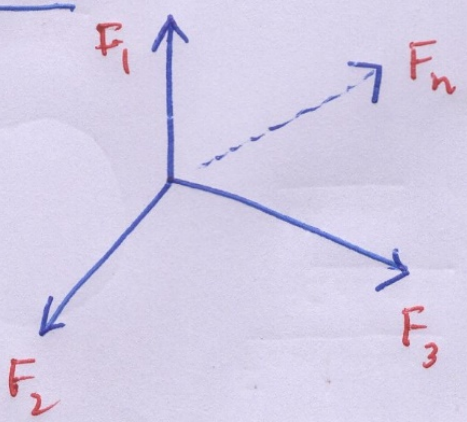


Pattern	Features F_1	F_2	-----	F_n	class level
1	f_{11}	f_{12}	....	f_{1n}	C_1
2	f_{21}	f_{22}	....	f_{2n}	C_2
3					
⋮					
m	f_{m1}	f_{m2}	-----	f_{mn}	C_m

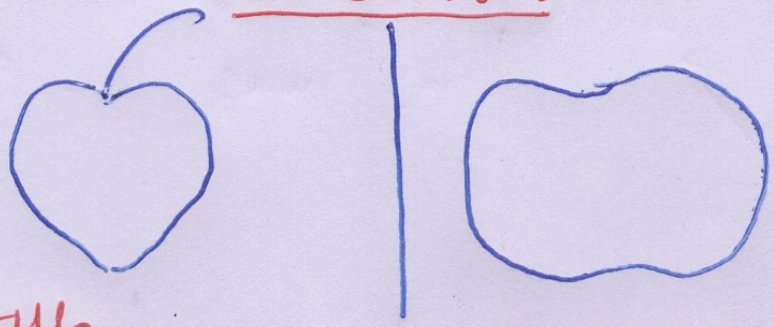
Each pattern

$\underline{X}_i \in \mathbb{R}^n$, $\underline{X}_i = \{f_{i1} f_{i2} \cdots f_{in}\}$

A data point in the n-dimensional space.



Example :



Features

colour , skin texture

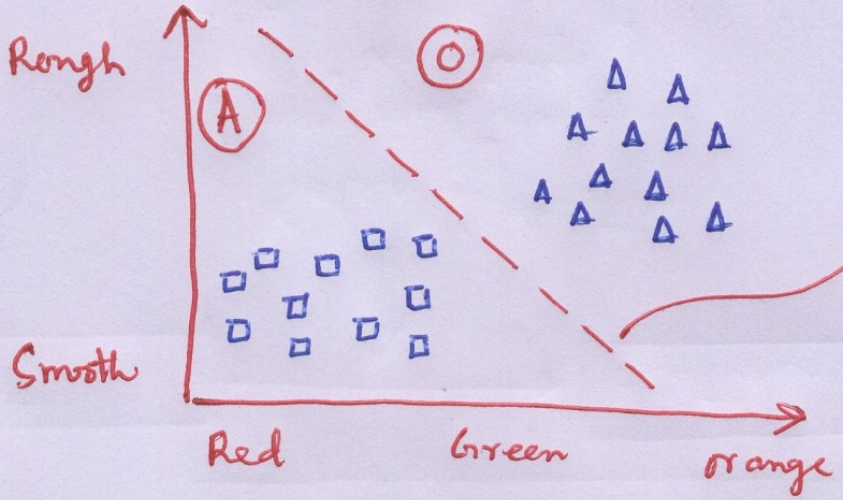
shape , Taste , smell

..... (n such features)

Consider only two features namely colour and skin texture

Options for colour → Red, ----, brown, ----, Green, ---- Shafran, -- orange

Skin Texture → smooth, ---- little rough, ---- , rough



classifier

Finding this separating hyperplane

Data → Learn (Parameters of the classifier ≡ separating hyperplane) → Test (New data without class information) with the learned classifier

Two class, Two Features

	F_1	F_2	Class
$\underline{X}_1$	f_{11}	f_{12}	1
$\underline{X}_2$	f_{21}	f_{22}	2
⋮			⋮
X_m	f_{m1}	f_{m2}	1

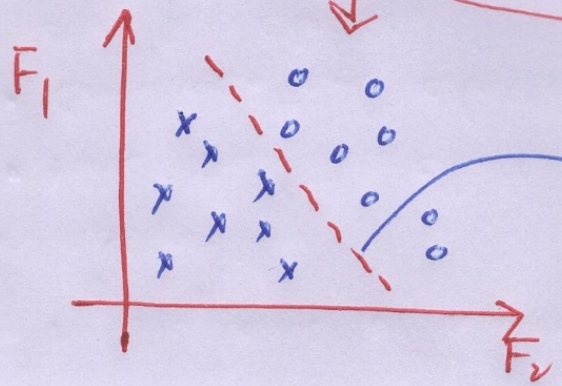
⟹

all class-1

	F_1	F_2	class
Y_1			1
Y_2			1
⋮			⋮
Y_{m_1}			1

all class-2

	F_1	F_2	class
Z_1			2
Z_2			2
⋮			⋮
Z_{m_1}			2

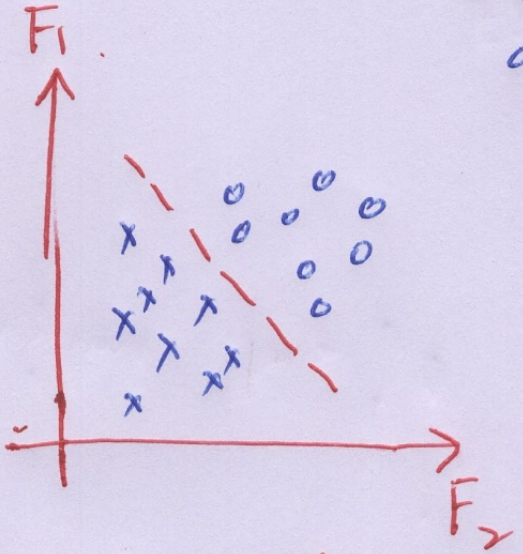


→ Learn the separating hyperplane for the data given.

Is the separating hyperplane is always linear?

→ Not necessarily

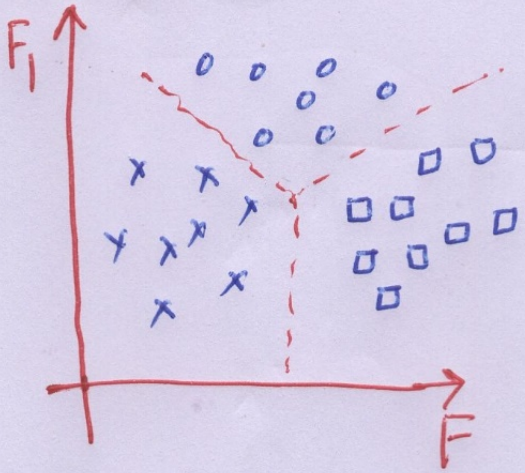
- More than two classes
- Complecated classes even if there are two classes



Simple classifier

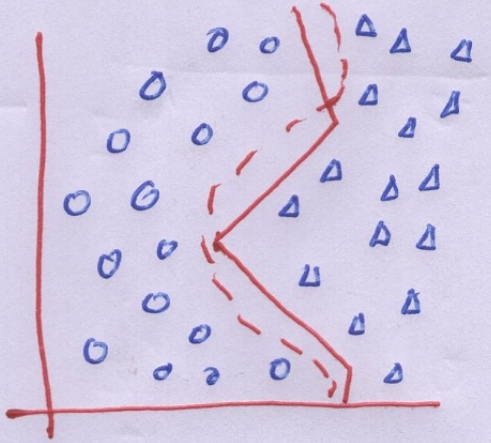
Example

Bayesclas NN, NB classifier



- More than two classes
- Piecewise linear separating hyperplane

Ex Bayesclassifier
NN
NB classifier



- Two classes
- Nolinear separating hyperplane or piecewise linear

Ex Neural Networks

LP Detection

Recognition J V 5 0 5 2

POWER OF 3

LAKSHMI AJAY
Times News Network

With a GDP that can cause envy to a nation, Gujarat is on a roll with the three most coveted cities of the state competing head on with each other in the growth race. Surat has averaged 11.5 per cent annualised growth between 2001-02 and 2006-07 and Ahmedabad City region (Ahmedabad and Gandhinagar districts) at 10.1 per cent with Vadodara at 9.8 per cent.

Rini Dhumal, artist:
Since we have a lot of industrial areas like Kalol, Halol and Nandesari around Vadodara, I think industrially the city has a lot going for it. The chemical, plastic and oil units in Vadodara have made it a hub for these industries. I feel sad that even Ahmedabad has surpassed us in infrastructure and growth.

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Ramayana goes to Hollywood

Ashok Banker's *Ramayana* is being made into a Hollywood series, which will be high on special effects and star presence

PURNIMA SHARMA
Times News Network

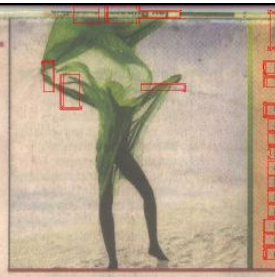
It was his love for mythology that led Ashok Banker to dabble in *Ramayana*, which is now being adapted on celluloid by Hollywood. Says the reticent writer, "The talks actually started way back in 2006. Before that too, there had been some tentative enquiries. A studio wanted to make three films on the *Ramayana* in both English and Hindi, to be shot in India." But Ashok decided to sell an offer to Ben Kingsley. "Being of Indian origin, he had the most exciting vision. Ben had wanted to fly down with Nicole Kidman to speak to me about it," he laughs.

Ashok Banker

Now, of course, with the film being planned to go on the floors by the middle of this year, the cast and crew are being decided. "Some major names — both from Hollywood and Bollywood — are expected to be part of it. I've no idea if Nicole would be in it, though I think she'll make a great Surpanakha. Even Daniel Craig's agent has called up to say that he'd be interested. And if I had my way, I'd like him to do Ravana, since he has a very brutish and powerful presence. I'd want the baddies to be played by Westerners and Indians to play the 'human' ones," he says.

However, the latest is that Ben Kingsley is no longer producing the film, "though a major Hollywood production studio is backing it. But, he's evinced interest in playing Vishwamitra or Ravana. I want him to be Vibhishana," adds Ashok.

Ask him what sets his version of the epic apart, and he says, "My retelling is for the people who have a modern sensibility, who speak in the idiom of today and have a fascination for past history. I've thrown in words used in our normal language that people can relate to." But will a Western audience relate to the *Ramayana*? "Despite my retelling in the modern idiom, it is entirely Indian. My *Ramayana* will be realistic and heavy on special effects. The filmmakers are keen to catch the fantasy of the film audiences," says Ashok.



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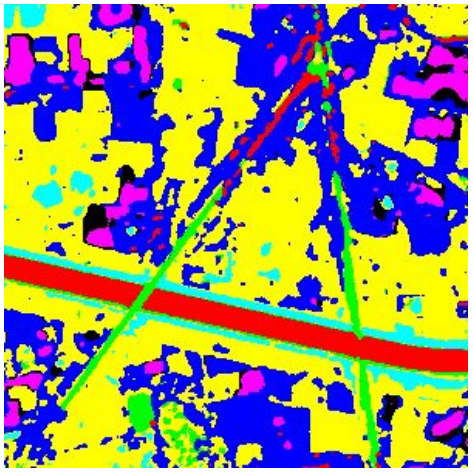
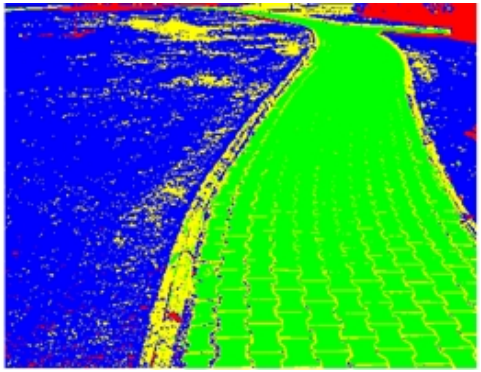
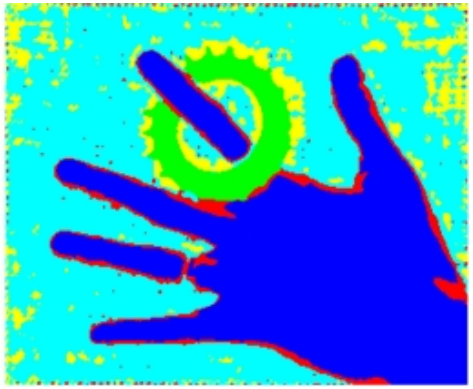
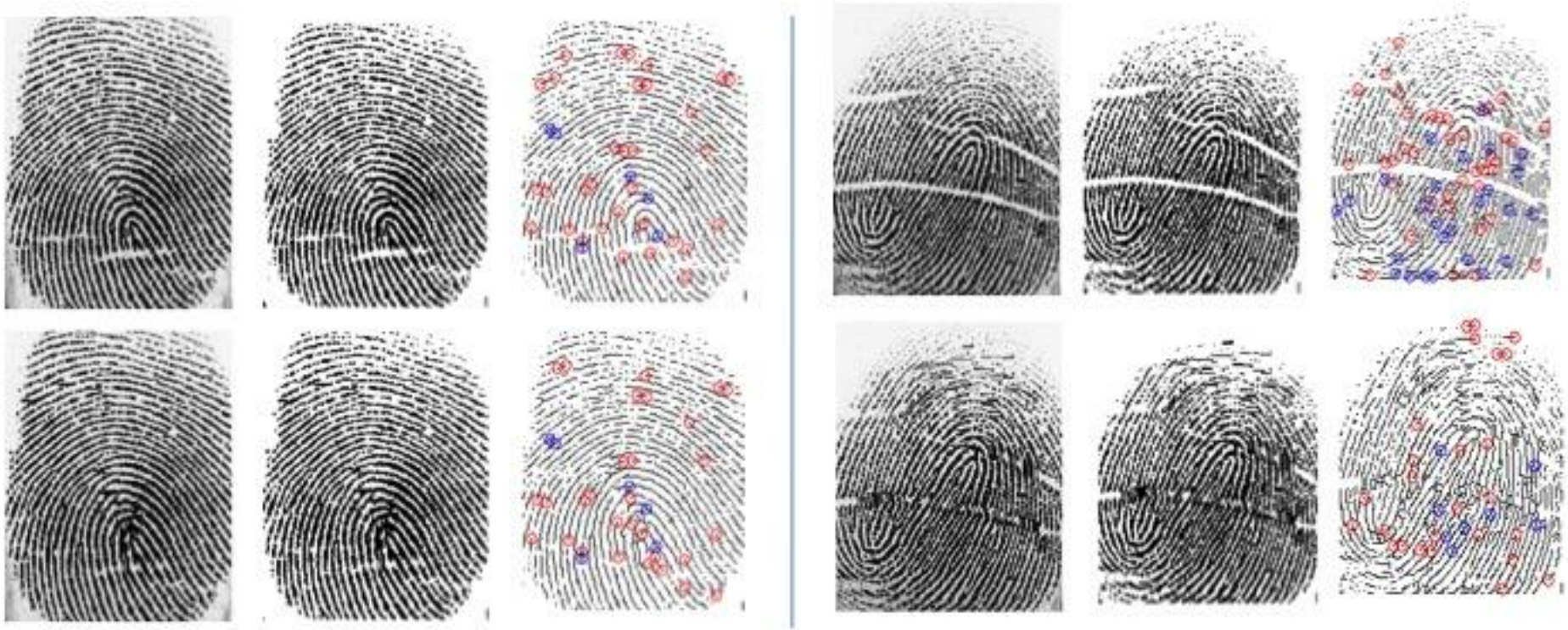








For each image, its enhanced image, binarization of both images, and extracted minutiae.

?

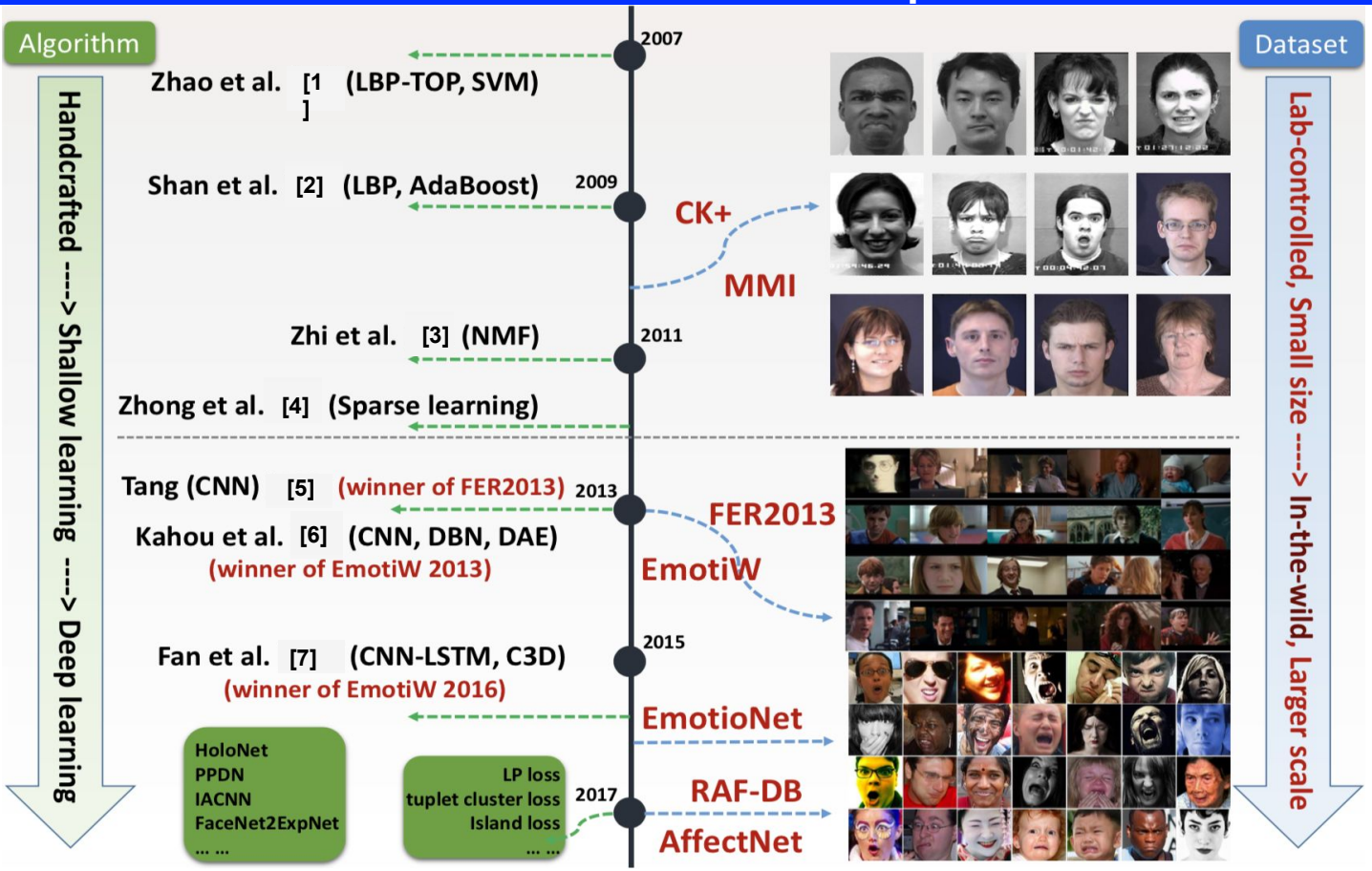
A test face

Database of face images
(model faces)

D

Face identified

FER Data Bases and Techniques



[1] G. Zhao and M. Pietikainen, "Dynamic texture recognition using local binary patterns with an application to facial expressions," *IEEE transactions on pattern analysis and machine intelligence*, vol. 29, no. 6, pp. 915–928, 2007.

[2] C. Shan, S. Gong, and P. W. McOwan, "Facial expression recognition based on local binary patterns: A comprehensive study," *Image and Vision Computing*, vol. 27, no. 6, pp. 803–816, 2009.

[3] R. Zhi, M. Flierl, Q. Ruan, and W. B. Kleijn, "Graph-preserving sparse nonnegative matrix factorization with application to facial expression recognition," *IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics)*, vol. 41, no. 1, pp. 38–52, 2011.

[4] L. Zhong, Q. Liu, P. Yang, B. Liu, J. Huang, and D. N. Metaxas, "Learning active facial patches for expression analysis," in *Computer Vision and Pattern Recognition (CVPR), 2012 IEEE Conference on*. IEEE, 2012, pp. 2562–2569.

[5] Y. Tang, "Deep learning using linear support vector machines," *arXiv preprint arXiv:1306.0239*, 2013.

[6] S. E. Kahou, C. Pal, X. Bouthillier, P. Froumenty, C ¸ . Gu ̈lc ̧ehre, R. Memisevic, P. Vincent, A. Courville, Y. Bengio, R. C. Ferrari *et al.*, "Combining modality specific deep neural networks for emotion recognition in video," in *Proceedings of the 15th ACM on International conference on multimodal interaction*. ACM, 2013, pp. 543–550.

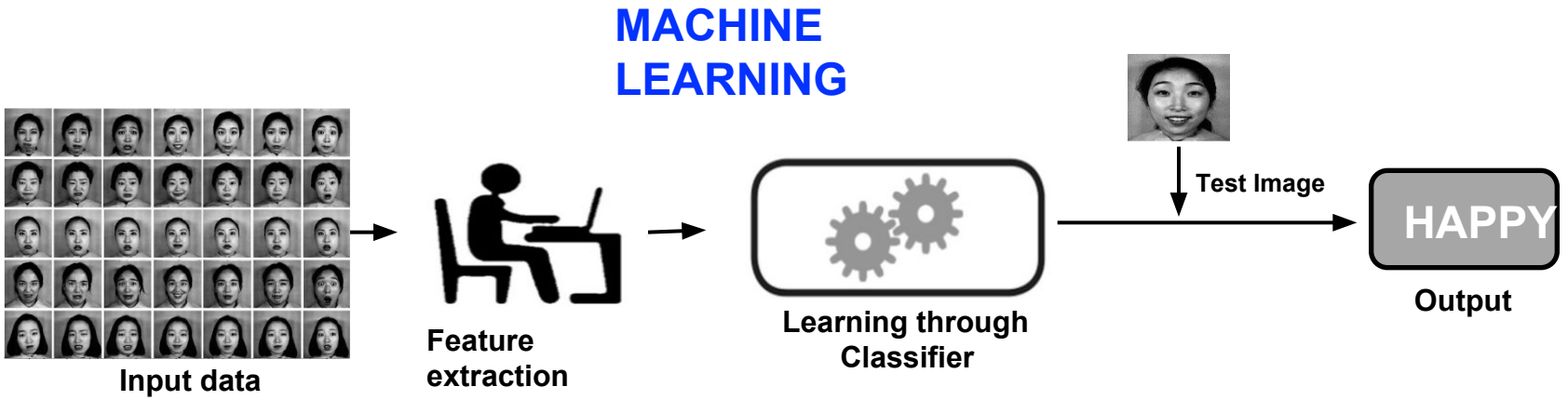
[7] Y. Fan, X. Lu, D. Li, and Y. Liu, "Video-based emotion recognition using cnn-rnn and c3d hybrid networks," in *Proceedings of the 18th ACM International Conference on Multimodal Interaction*. ACM, 2016, pp. 445–450.

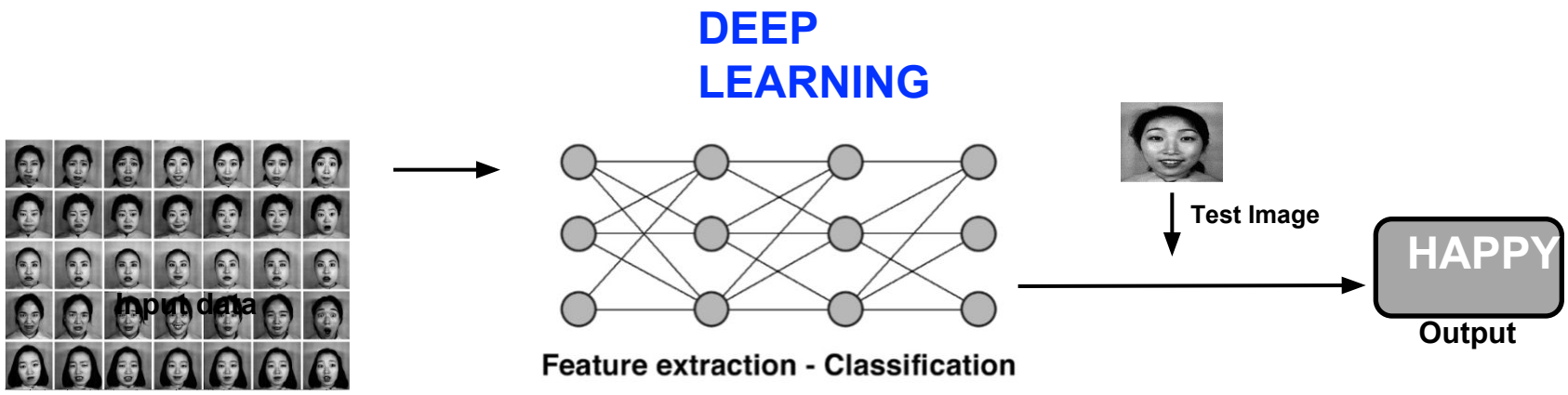
Ting Zhang. Facial expression recognition based on deep learning: A survey. In *International Conference on Intelligent and Interactive*
Systems and Applications, pages 345–352. Springer, 2017.

What is Face/Facial Expression Recognition ?

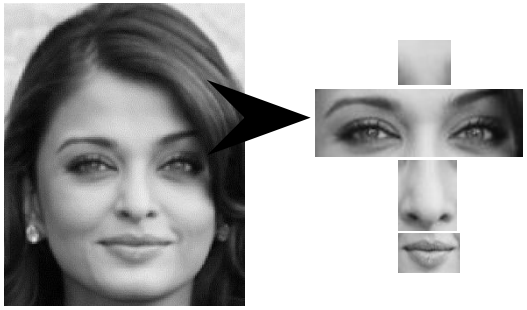
- A machine learning subfield of learning **representations** of data. Exceptional effective at **learning patterns**.
- Deep learning algorithms attempt to learn (multiple levels of) representation by using a **hierarchy of multiple layers**

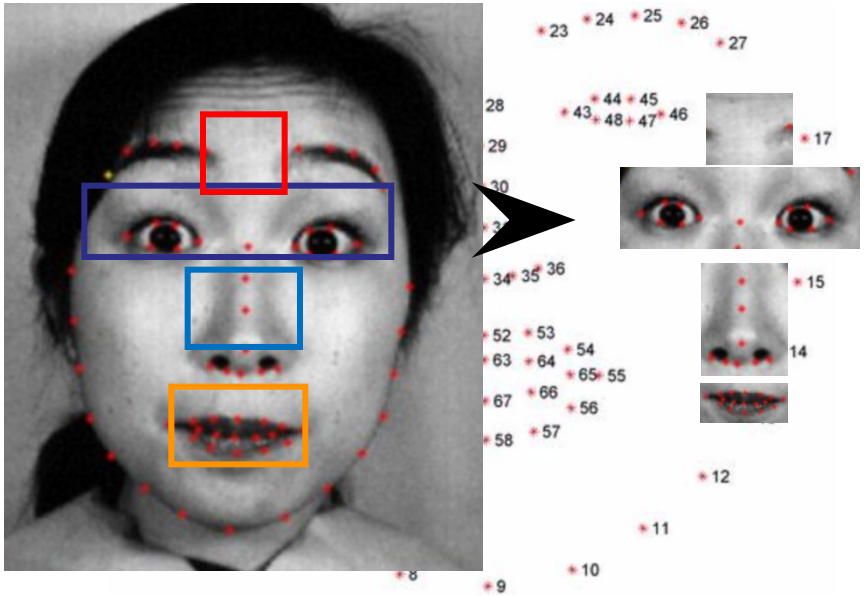
  If you provide the system **tons of information**, it begins to understand it and respond in useful ways.





Physical Analysis and Modular face (Detection of facial parts)



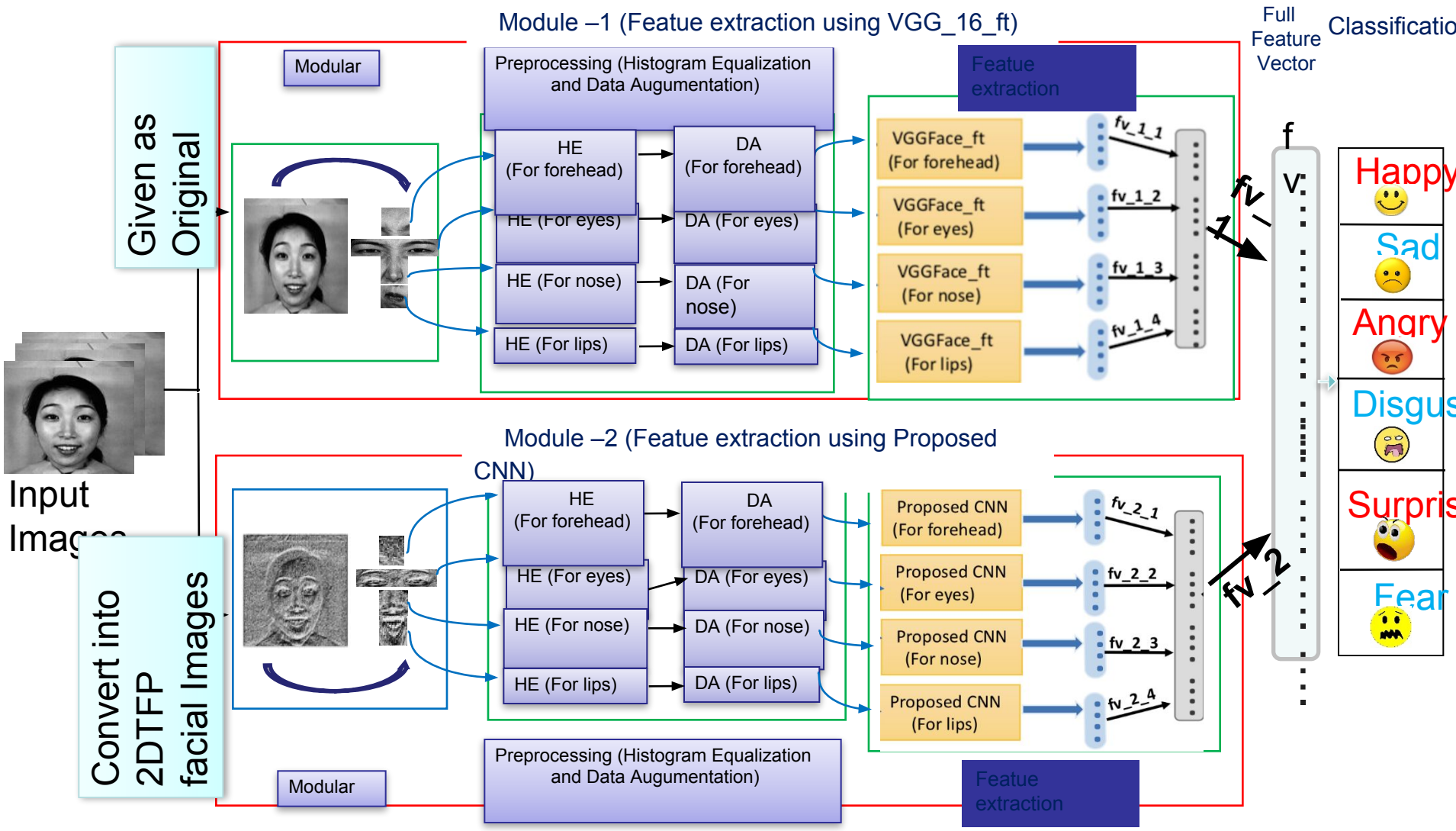


It seems forehead, eyes, nose and lips are more informative for identifying a person.

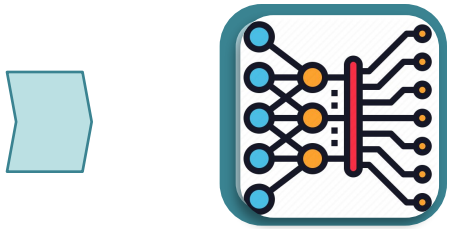
[8] Christos Sagonas, Georgios Tzimiropoulos, Stefanos Zafeiriou, and Maja Pantic. 300 faces in- the-wild challenge: The first facial landmark localization challenge. In Proceedings of the IEEE International Conference on Computer Vision Workshops, pages 397–403, 2013.

2DNN : Double channel based deep neural network

Proposed Architecture

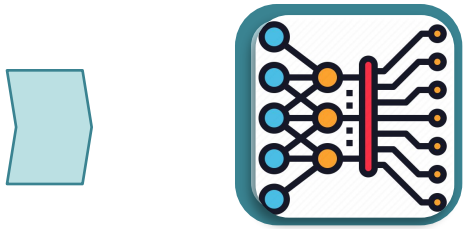


Face Anti-Spoofing



REAL

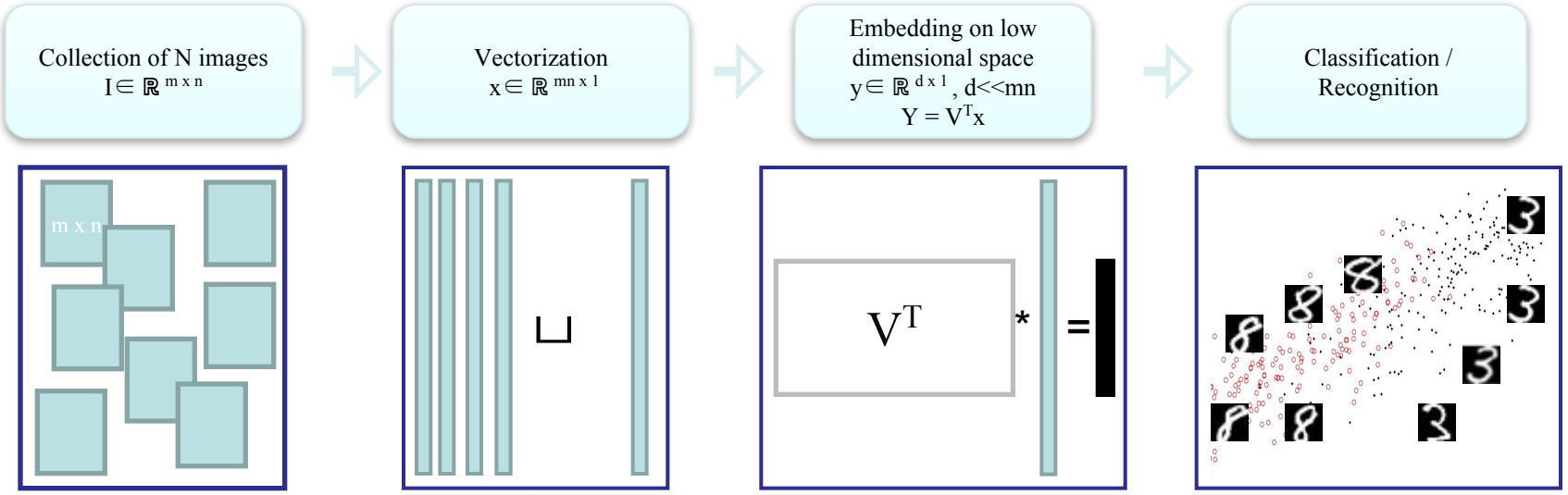
SPOOF



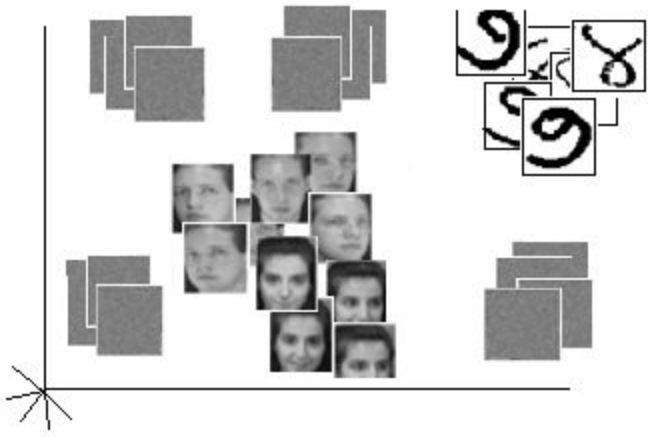
REAL

SPOOF

Dimensionality Reduction for Pattern Recognition



Possibilities = $256^{mn} = (2^8)^{mn}$



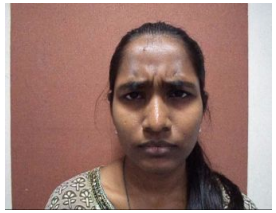
- Curse of dimensionality[1]
- In the ***mn***-dimensional space, these images are not evenly/widely spaced, rather reside compactly.
- Machine learning algorithms find it difficult to identify patterns in these images in such a high dimensional space.
- Representation of images in lower dimensional space is highly sought.

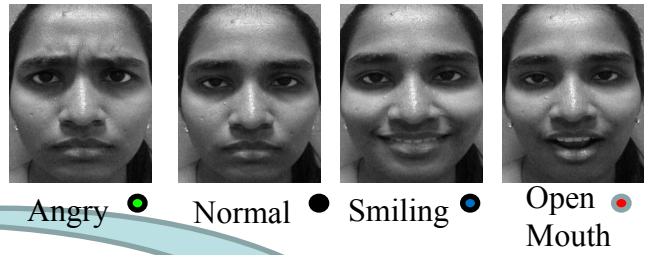
[1] D. L. Donoho, "Aide-memoire. high-dimensional data analysis: The curses and blessings of dimensionality," 2000

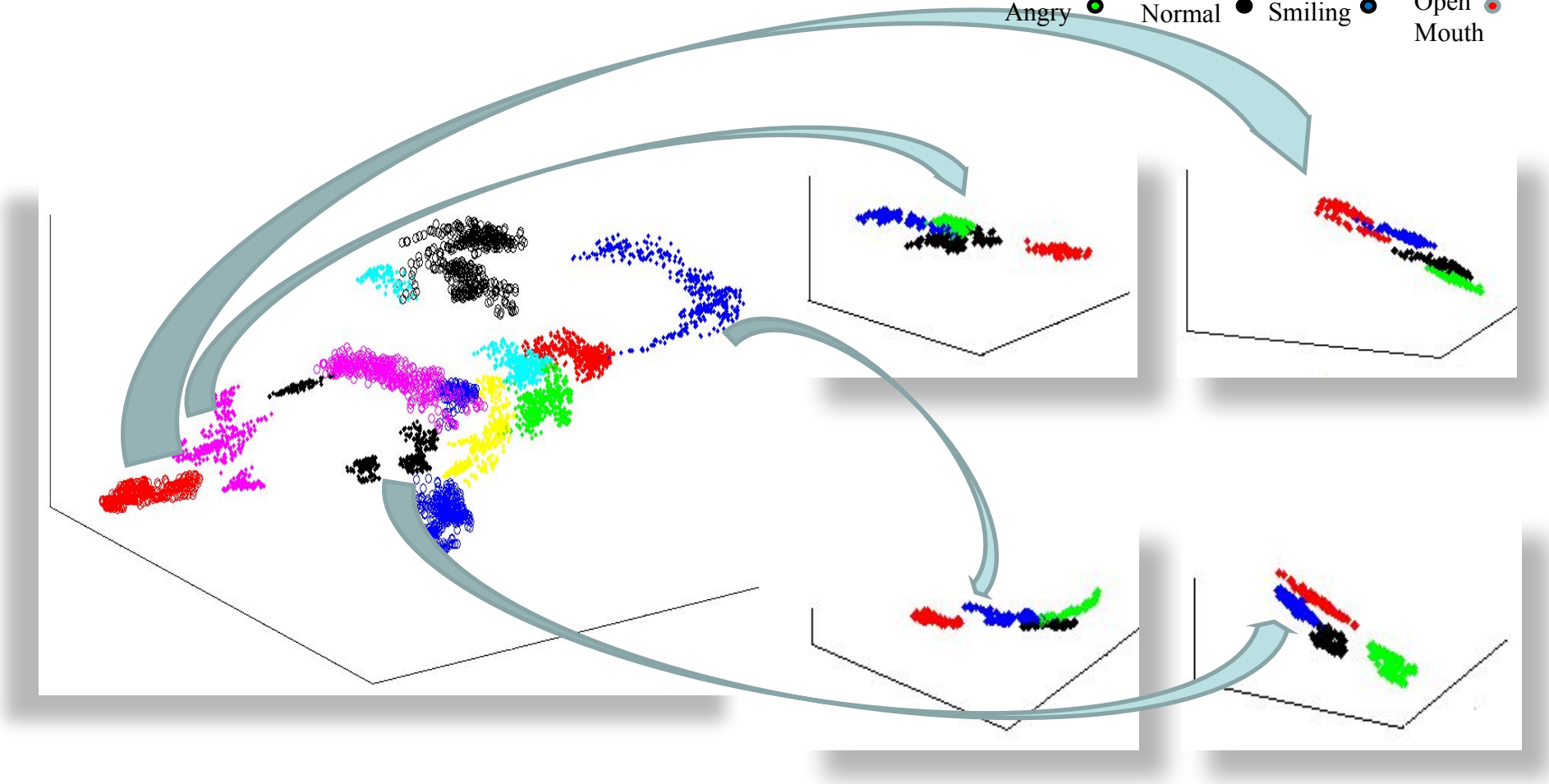
DAIICT Video Dataset

Can we identify 1. *The person*, 2. *The Facial expression* at a time?

- A video dataset of 11 subjects having 4 different facial expressions was generated.
- Subjects were asked to change their facial expression.

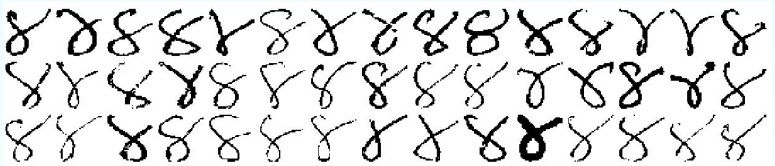






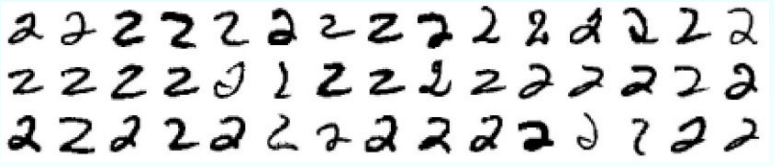
Some of the Handwritten Numerals database [3] [4] [5]

Devnagari numerals database
Nearly 1800 images each



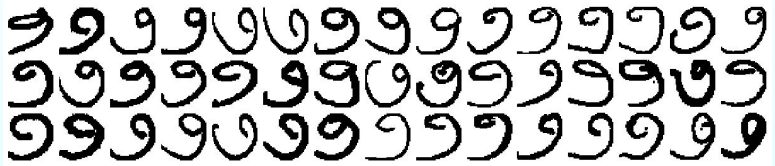
randomly selected few samples of digit 4

MNIST digit database
Nearly 7000 images each



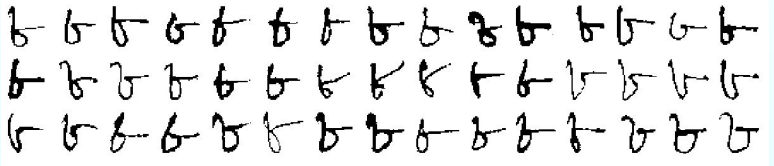
randomly selected few samples of digit 2

Gujarati numerals database
Nearly 1300 images each



randomly selected few samples of digit 7

Bangla numerals database
Nearly 2400 images each



randomly: selected few samples of digit 8

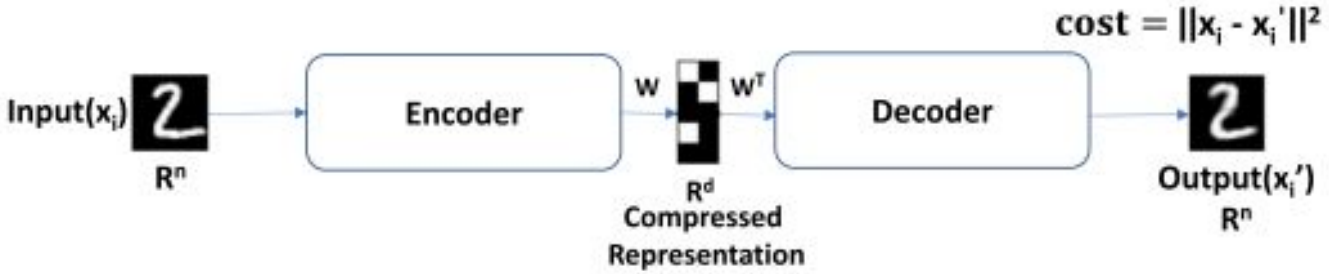
Handwritten text or numerals have a huge variations in terms of shape, stroke width, orientations and pattern. Thus makes a good dataset for image recognition experiments.

[3] Mukesh M. Goswami and Suman K. Mitra "Offline Handwritten Gujarati Numeral Recognition using Low-Level Strokes" *International Journal of Applied Pattern Recognition (IJAPR),* Inderscience Publication, Vol 2, No. 4, pp 353-379, 2016.

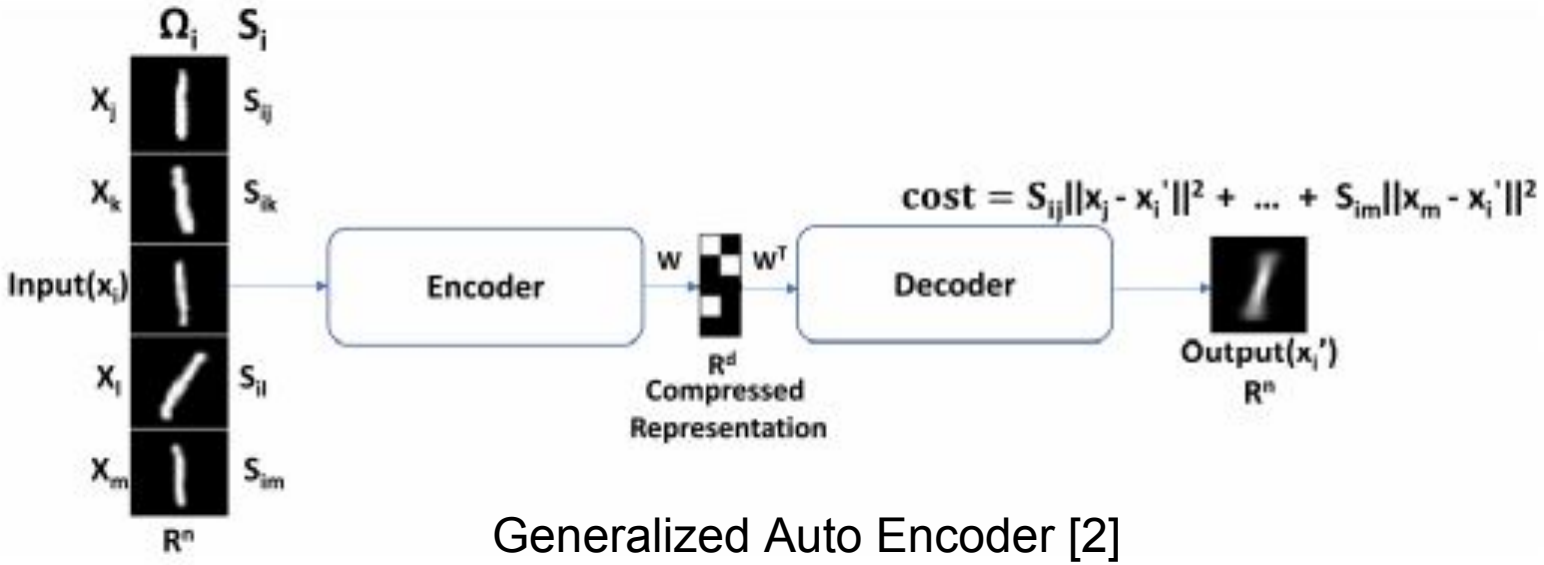
[4] Ravi Nagar, Suman K Mitra, "Feature extraction based on stroke orientation estimation technique for handwritten numeral", Eighth International Conference on Advances in Pattern Recognition (ICAPR), 2015.

[5] U. Bhattacharya and B. Chaudhuri, "Databases for research on recognition of handwritten characters of indian scripts," in Proceedings of 8th International Conference on Document Analysis and Recognition. IEEE, 2005, pp. 789– 793.

Deep Generalized Auto Encoder



- Self-supervised learning, thus the word "Auto" in Auto Encoder.
- Cost function for training the Auto Encoder
- Auto-Encoder with linear activation is equivalent to PCA



Generalized Auto Encoder [2]

[2] Wang, Wei, et al. "Generalized autoencoder: A neural network framework for dimensionality reduction." *Proceedings of the IEEE conference on computer vision and pattern recognition workshops*. 2014.

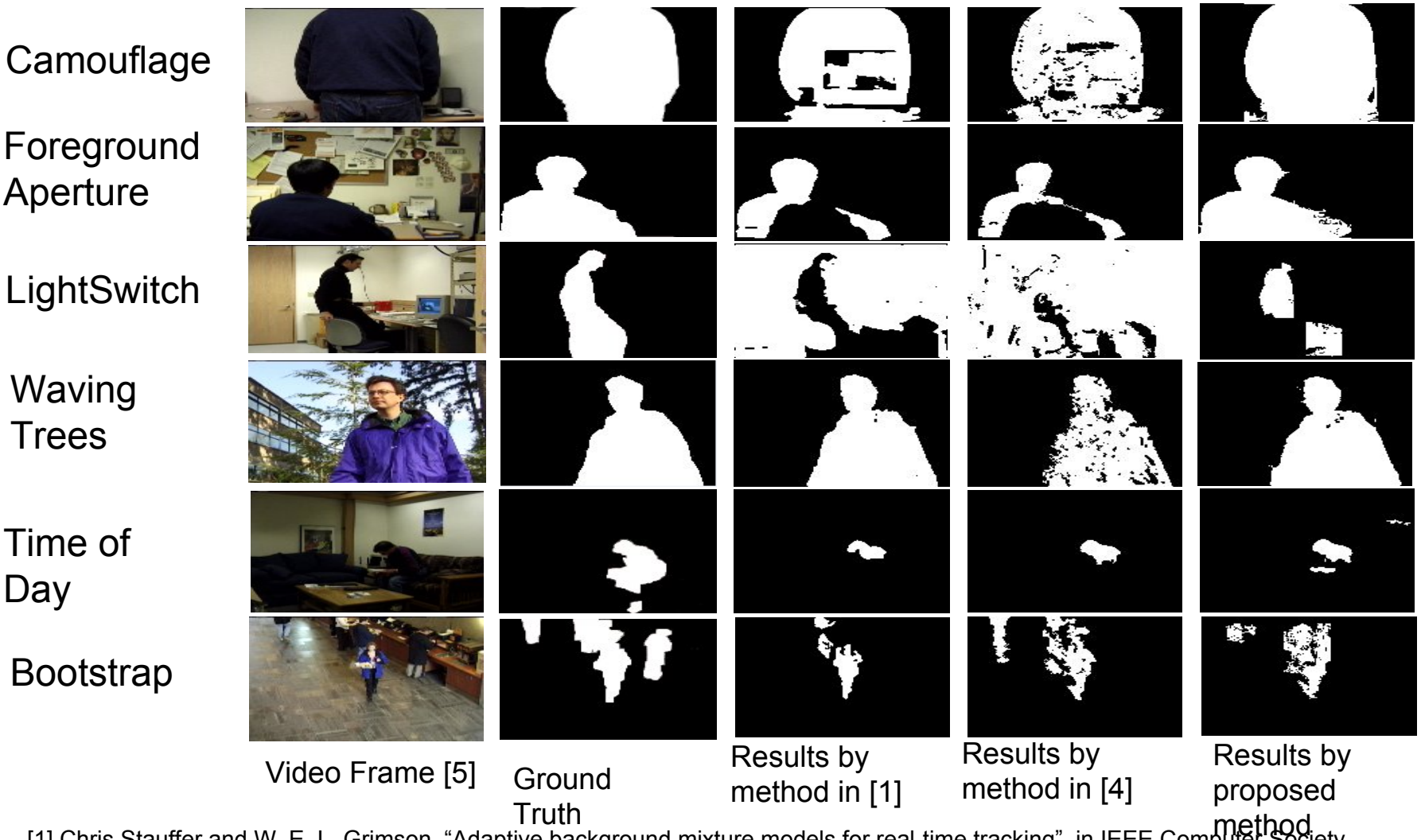
Image Quality Assessment

- Digital images are susceptible to various type of distortions due to:
  - •Image acquisition - different ways of capturing, camera quality and positioning
  - •Various processing stages in the camera pipeline before storage
  - •Compression - storage and fast transmission
  - •Transmission and reproduction
  - •Artificial image processing and editing

Clean Image **QS: 0** | White Noise **QS: 41.17** | Gaussian Blur **QS: 52.47** | Fast Fading **QS: 54.17** | JP2K Compression **QS: 56.27**

- The best way to quantify visual image quality is through subjective evaluation by human observers which is expensive, time consuming and inconvenient.
- A technology that imitates the ability of humans to judge perceptual quality of image without any prior information about it is called **Blind Image Quality Assessment**.
- Certain statistical properties of natural images get modified in the presence of various distortions. We have studied these natural image statistics (NSS) in Two Dimensional Orthogonal Locality Preserving Projection (2D-OLPP) domain.
- Various statistical features have been identified and designed which reflect the distortion in the images.
- Perceptual quality of image is predicted by quantifying the deviation between NSS features in the 2D-OLPP domain of the pristine images and the image in concern.

Object Background segmentation using GMM



[1] Chris Stauffer and W. E. L. Grimson, “Adaptive background mixture models for real-time tracking”, in IEEE Computer Society Conf. Computer Vision and Pattern Recognition,vol. 2,1999.
[4] M. Haque, M. Murshed, M. Paul, “A Hybrid Object Detection Technique from Dynamic Background Using Gaussian Mixture Models”, in IEEE 10th Workshop, Multimedia Signal Processing, 2008.
[5] Kentaro Toyama, John Krumm, Barry Brumitt, Brian Meyers, "Wallower: Principles and Practice of Background Maintenance", Seventh International Conference on Computer Vision, September 1999, Kerkyra, Greece, pp. 255-261, IEEE Computer Society Press.

Stroke Feature Extraction in Printed Gujarati Text

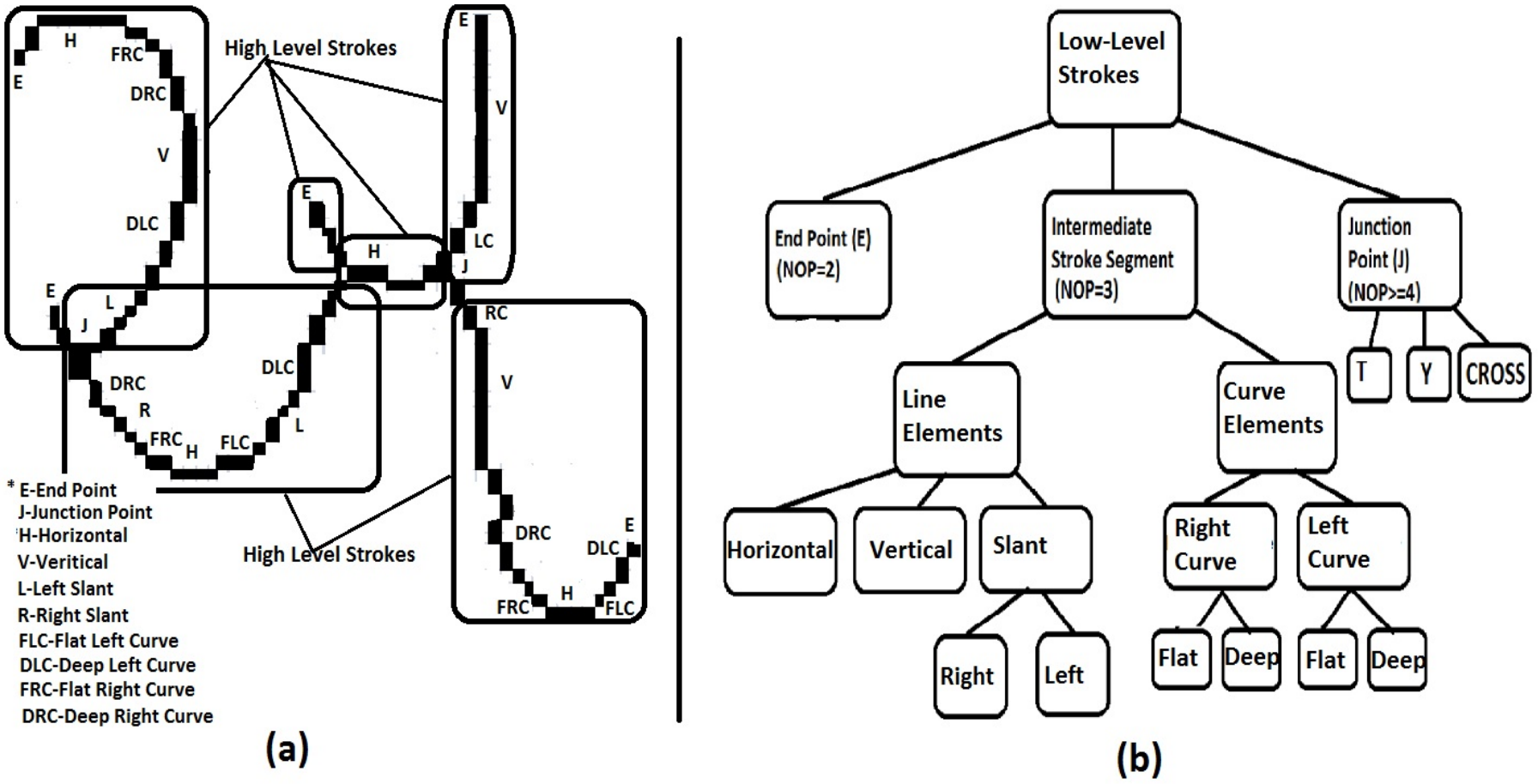


Figure 1. (a) Formation of Character as set of High-level strokes described by some sequence of Low-level stroke (b) Categorization of Low-level strokes based.

Classification of Printed Gujarati Text using Low-level Stroke

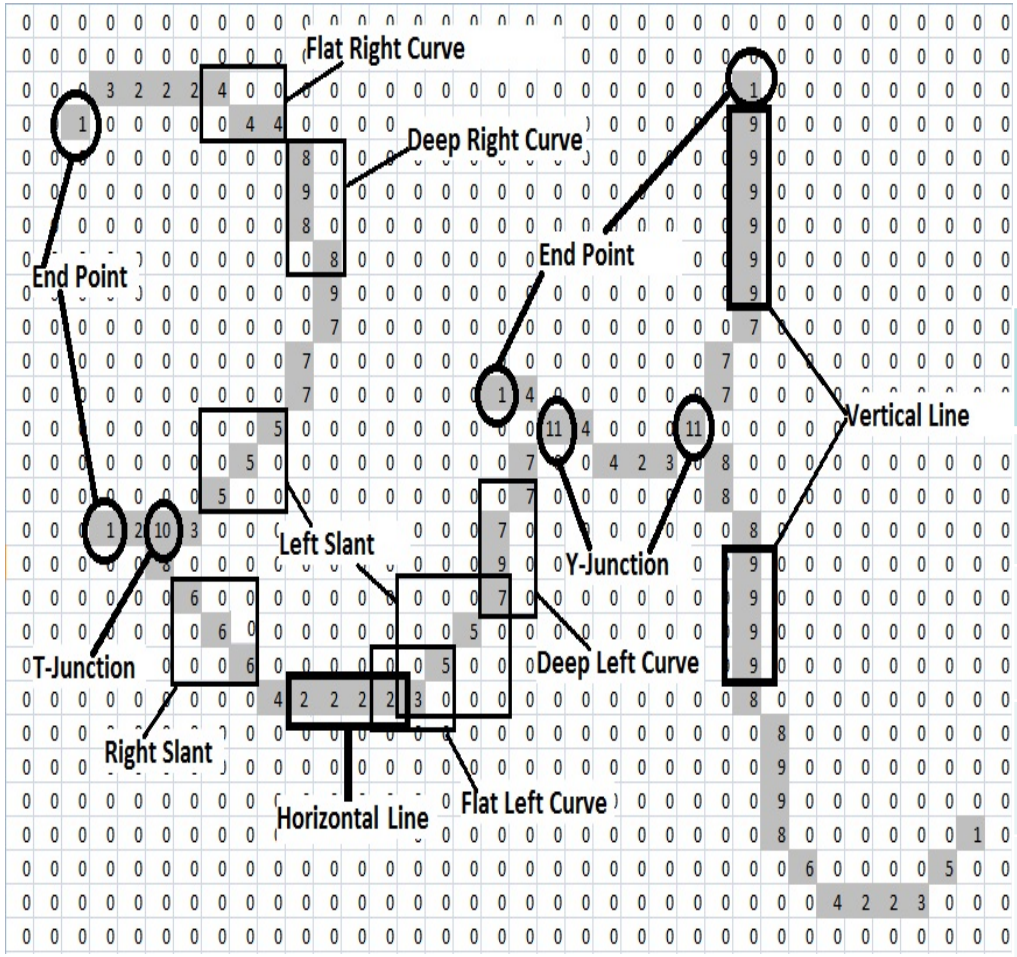


Figure 2. Sample output of Low-level stroke extraction Algorithm

Table 1. Performance comparison of HLLS with DEF, CC and HoG on book, newspaper and laser printed symbol databases

Database	DEF[1]	CC[2]	HoG[3]	HLLS[4]
BOOKDB	99.20	98.90	99.43	**99.48**
LASERDB	95.46	98.40	**99.38**	99.22
NEWSDB	95.63	94.97	**96.80**	96.91
ALL	97.46	96.78	98.09	**98.13**

[1]Directional Element Features; [2]Chaincode; [3]Histogram of Oriented Gradients; [4]Histogram of Low-level Strokes

Extraction of High-Level Strokes form Printed Gujarati Text

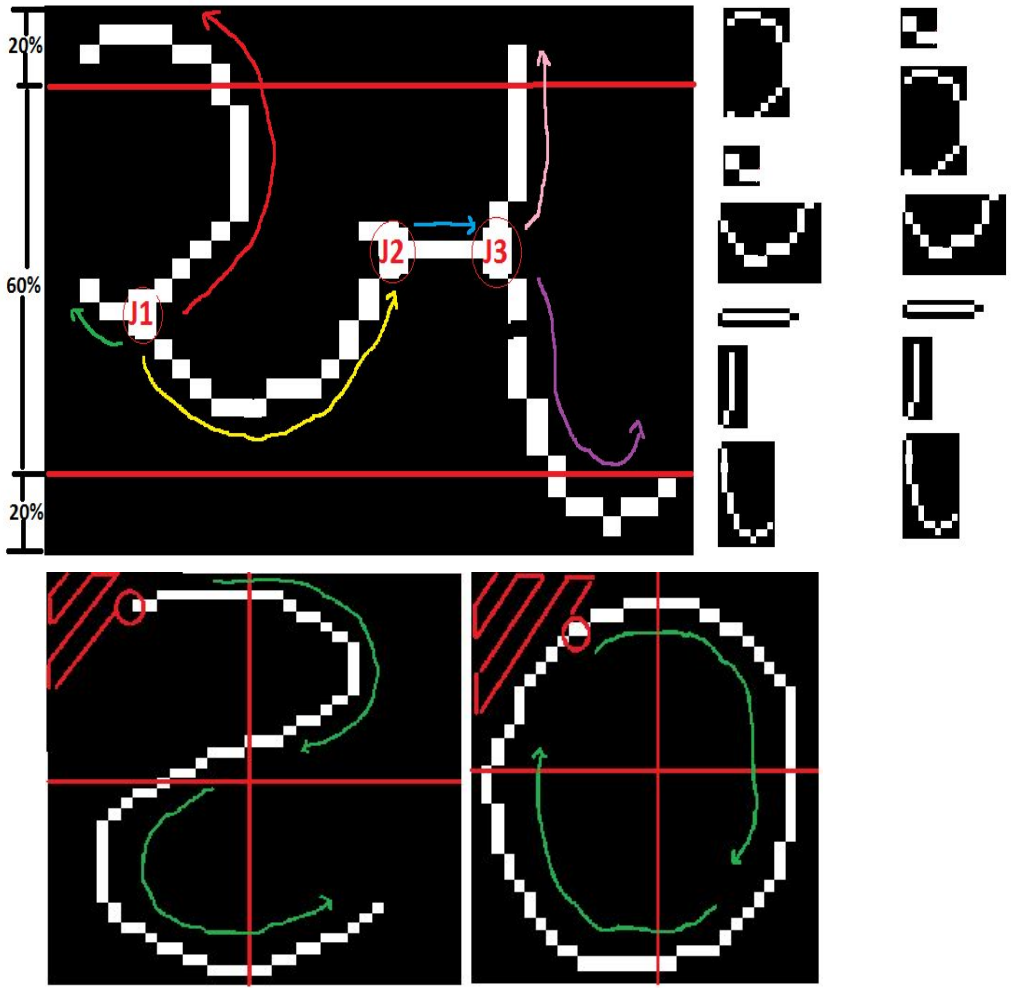


Figure 3. High-level Stroke Extraction from Printed

High-Level Stroke Extraction Algorithm.

1. Scan the middle region of Character in left to right order to Get list of Junction Point

2. For Each junction point in list

2.1. scan junction point neighborhood to get starting point of each stroke

2.2. scan each stroke using contour tracing algorithm from starting point until either end point or another junction point is not reached

2.3. combine low-level stroke with direction information to get sequence of directional low-level stroke

3. If a character does not have junction point then use first end-point or object-pixel in zigzag order from top-left quadrant of character image.

3.1. use step 2.2 and 2.3 to get sequence of directional low-level stroke

Identification of High-Level Strokes and Application to Printed Gujarati Text Recog.

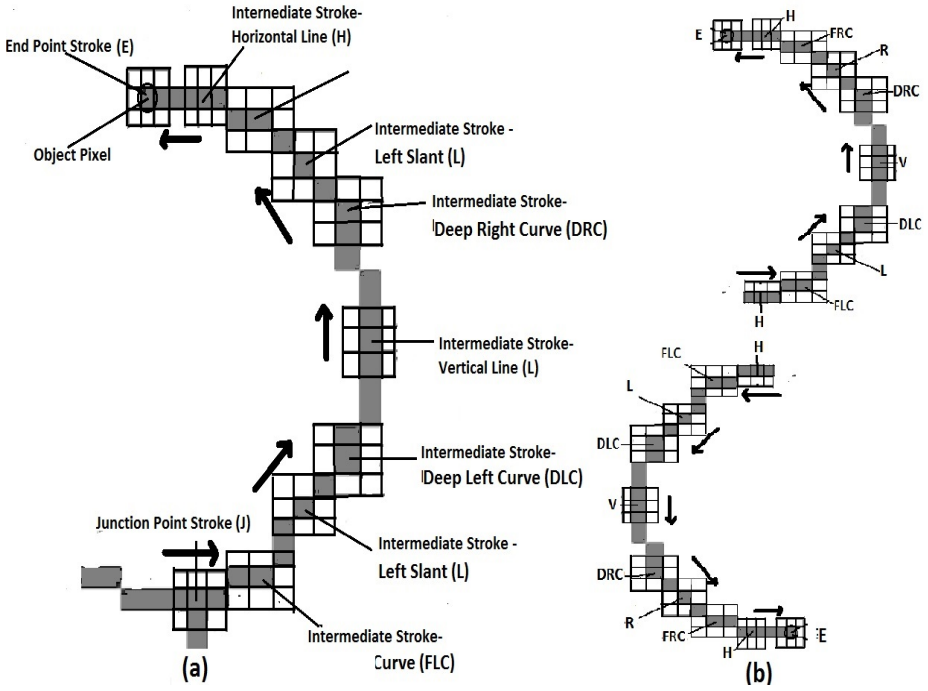


Table 2. High-level Stroke Identification Result on book, laser and newspaper symbol dataset

Models	Average Test Accuracy on Labeled Stroke Dataset
CRF[1]	97.79
FA[2]	95.46
HHM[3]	85.61

[1]Condinational Random Field; [2] Finitie Automata; [3]Hidden Markov Model;

Table 2. Printed Character Classification using High-Level Stroke Features Labeled using CRF

Database	BOOK	LASER	NEWS	All
Naïve Bayes	95.08	90.01	81.76	92.93
HHM[3]	98.01	93.77	**92.89**	**97.45**

Handwritten Word Segmentation

Challenges of handwritten Words

Joint Characters

Different Character Size

Multiple Writing Styles

Skew

The proposed segmentation method uses connected component on the input image and feeds the patches of connected component to the trained object detection model Faster RCNN.

Input

Connected Component patches

Final Segmented Output