# Classification of Power Quality disturbances by various Machine Learning techniques in Distributed Generated systems

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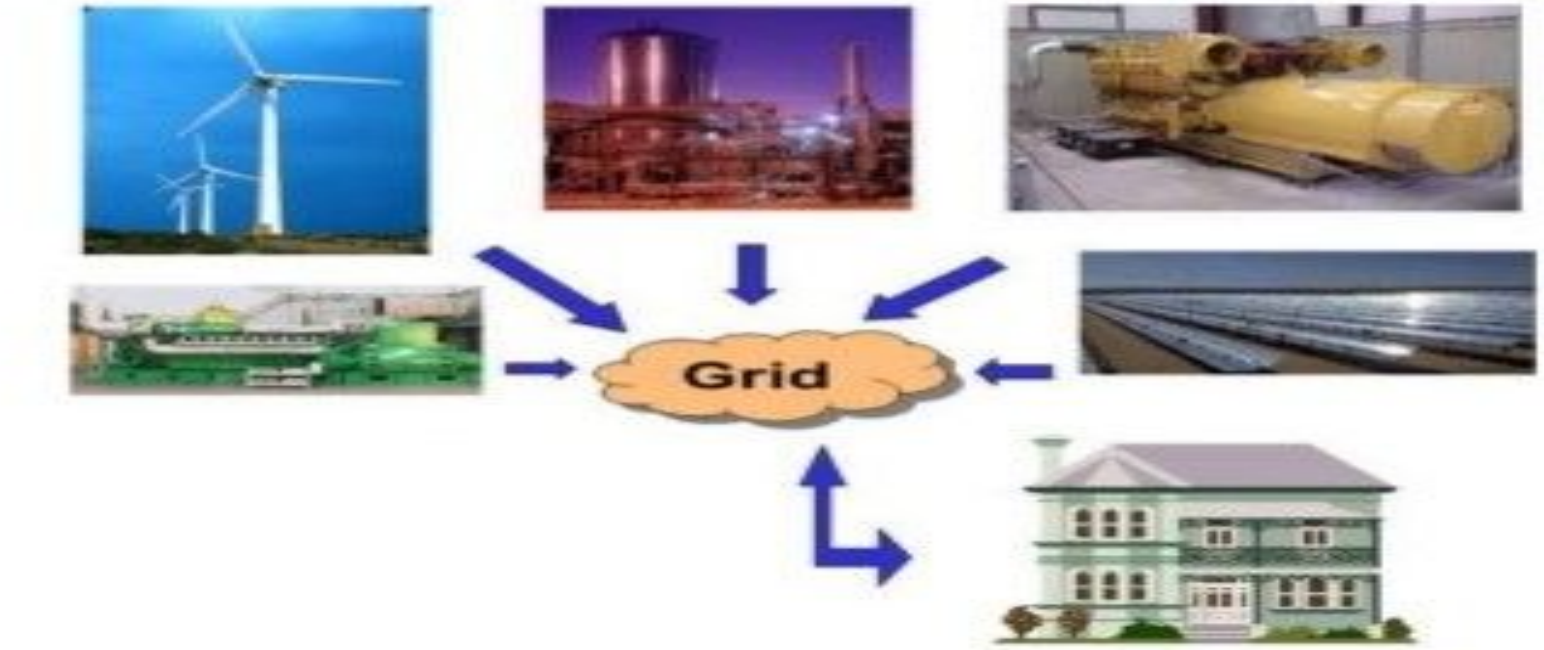
IIIT-Bh

# INTRODUCTION

## Distribution System



# WHY DG

?

1. Associated with green form of energy

2. Environment friendly.

3. Uses smaller sized generator that does typical central Station plant .

4. Wind system and solar (Photovoltaic systems).

...

5. It can generate electricity from many small energy resources .

6. Reduces number of power lines .

7. Reduces amount of energy lost in transmitting electricity

8. Reduces cost of transmission line and the losses

## RESURGENCE OF DG

1) The original power system consist of relatively small generators configured in isolated island, used DG that model gave way to the present centralized system because of economies of scale.
2) There was a desire of sequester electricity generation facilities away from population centers for environmental reason and locate them closer to the sources of fuel and water.

## PRESPECTIVES OF DG BENEFITS

1) End user perspective.
2) Distribution utility perspective.
3) Commercial power procedure perspective.

# Disadvantages

- Power Quality
- Cost of operation and maintenance
- Long term reliability of units
- Interconnection

# Power quality issues

- Voltage sag
- Voltage swell
- Harmonics
- Voltage regulation
- Islanding
- Flicker
- Interruptions

# FEATURE EXTRACTION TECHNIQUES

- Wavelet transform
- S- transform
- Hyperbolic s- transform
- Principal component analysis

# Statistical features of a signal

1. Entropy
2. Energy
3. RMS
4. Mean
5. Standard deviation
6. Kurtosis
7. Skewness
8. Diff b/w max and min

PQ Disturbance

# CLASSIFICATION

**CLASSIFICATION**

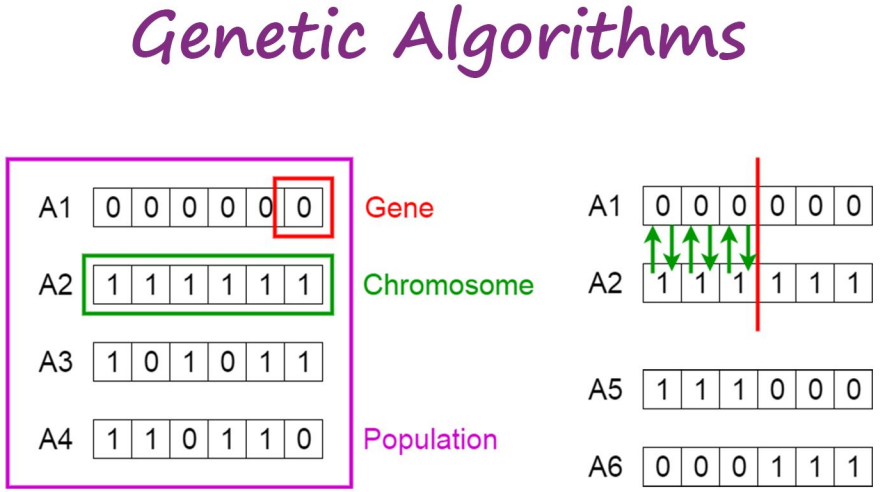
It is the problem of identifying to which a set of categories ,a new observations belongs, on the basis of training set of data whose category membership is known .

- Some of the soft computing methods are

- ANN ( Artificial Neural Network)
- SVM(  Support vector machine)
- Decision tree
- Random forest
- Fuzzy and Neuro-Fuzzy

# GENETIC ALGORITHM

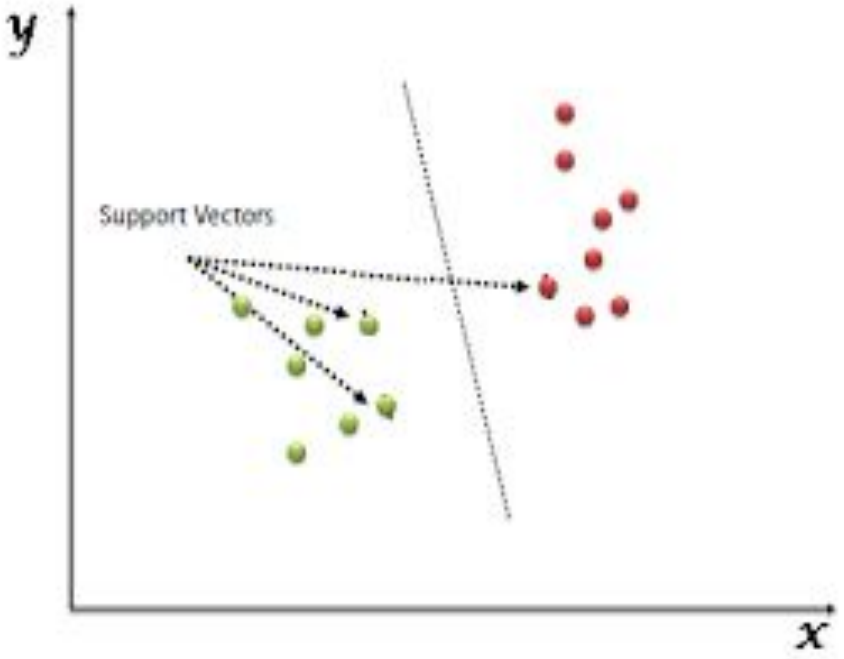
Solves both constrained and unconstrained optimization problems that is based on natural selection,



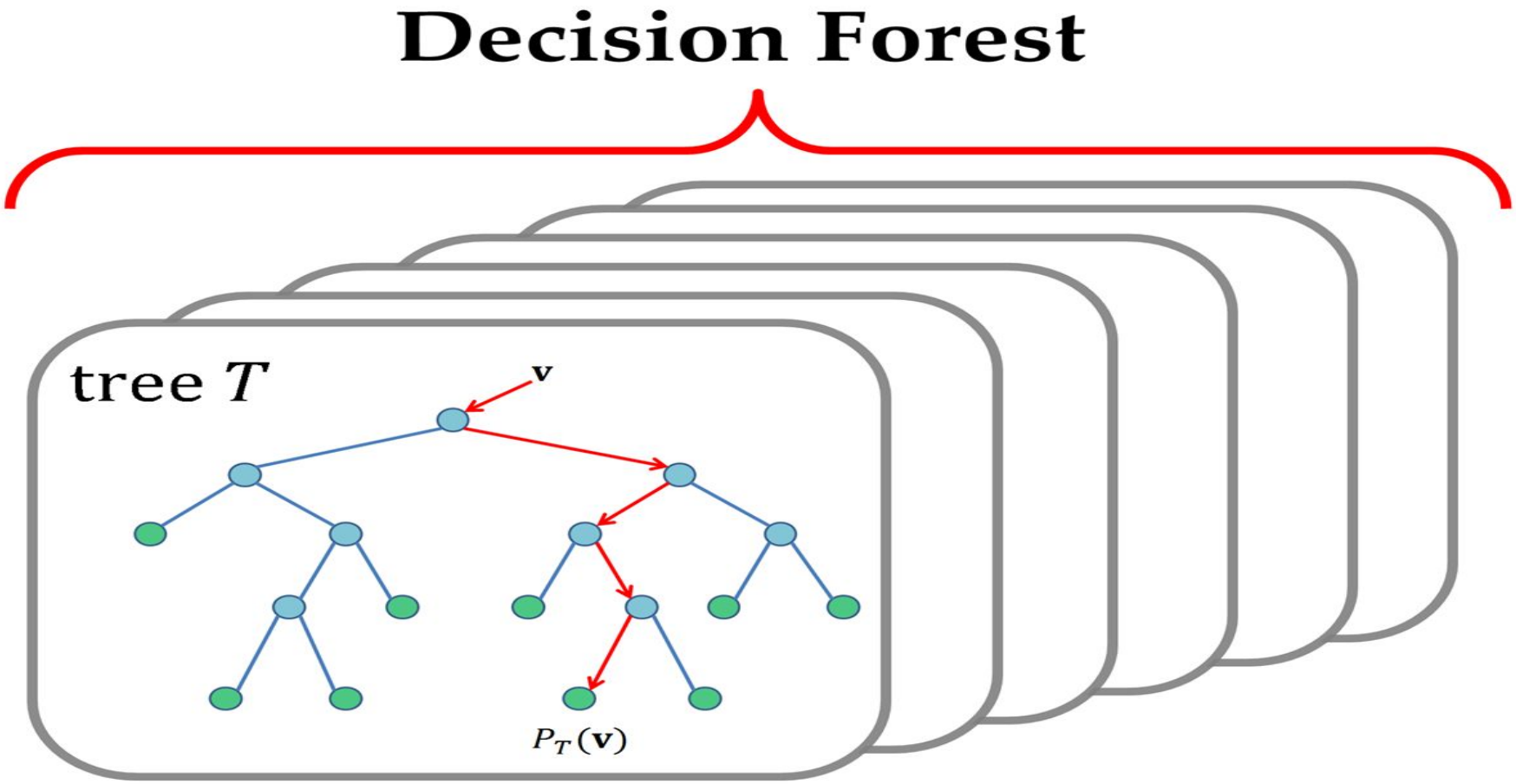
# SVM

Supervised machine learning  algo .

Classification or Regression challenge .



# DT

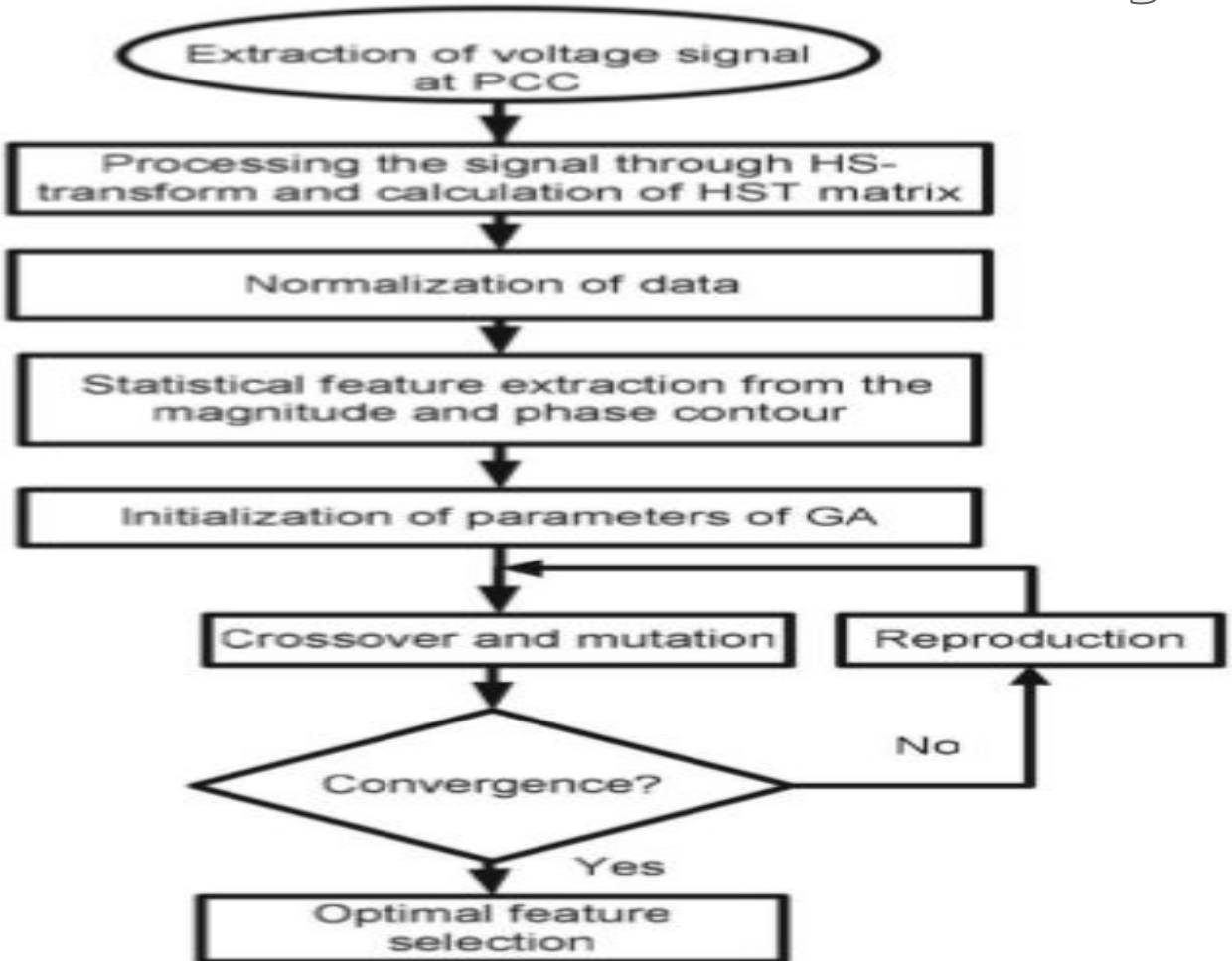


# PROBLEM STATEMENT

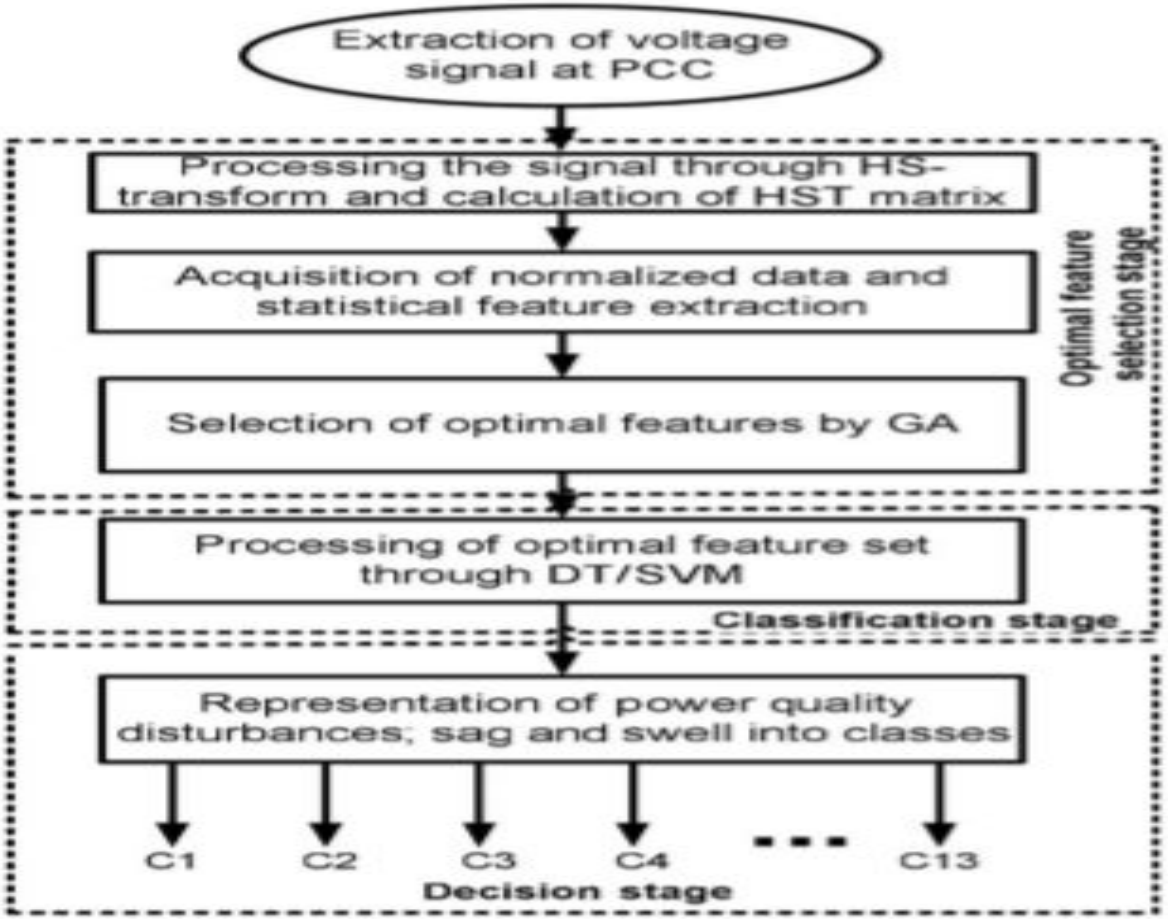
? The dimension of the total data set has to be reduced. To achieve this, features have to be extracted from the measured signal.
? The computational complexity of the prediction and learning process has to be reduced and the prediction accuracy has to be enhanced.
? Redundant features are to be removed and optimal features are to be selected from the total feature set.
? Accuracy is to be found out for PQ distubance classification under different circumstances .

# General approach to problem statement

# optimal feature selection by GA



# Classification strategy using SVM/DT



# SIMULATION RESULTS

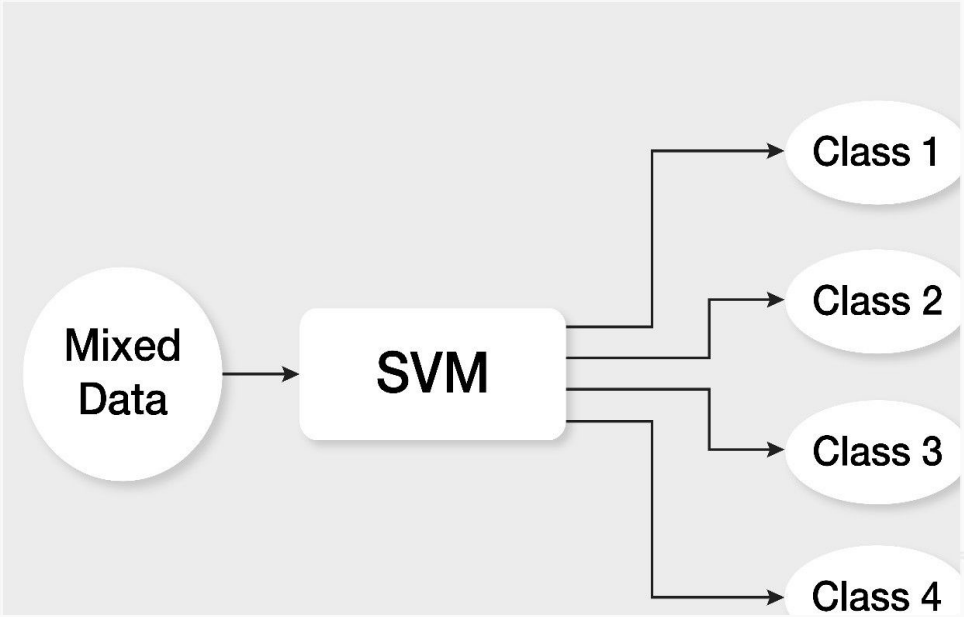
# SVM

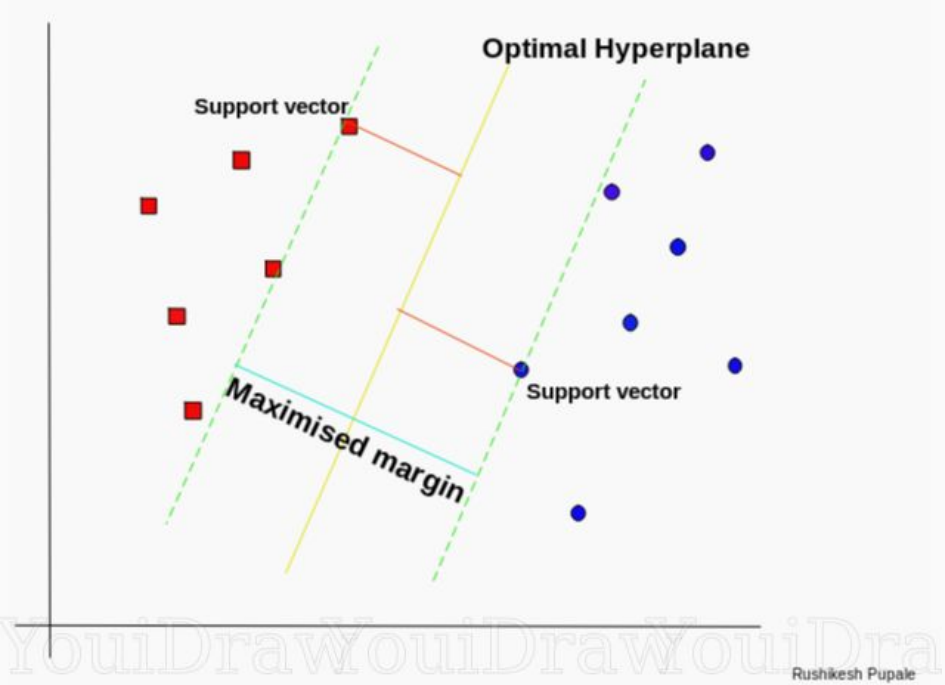
Support Vector Machine” (SVM) is a supervised machine learning algorithm which can be used for both classification or regression challenges .

Plot each data item as a point in n-dimensional space (where n is number of features you have

classification by finding the hyper-plane that differentiate the classes .

# HOW SVM WORKS ?



# CLASSIFICATION RESULTS

**Gamma = 0.4-0.6**

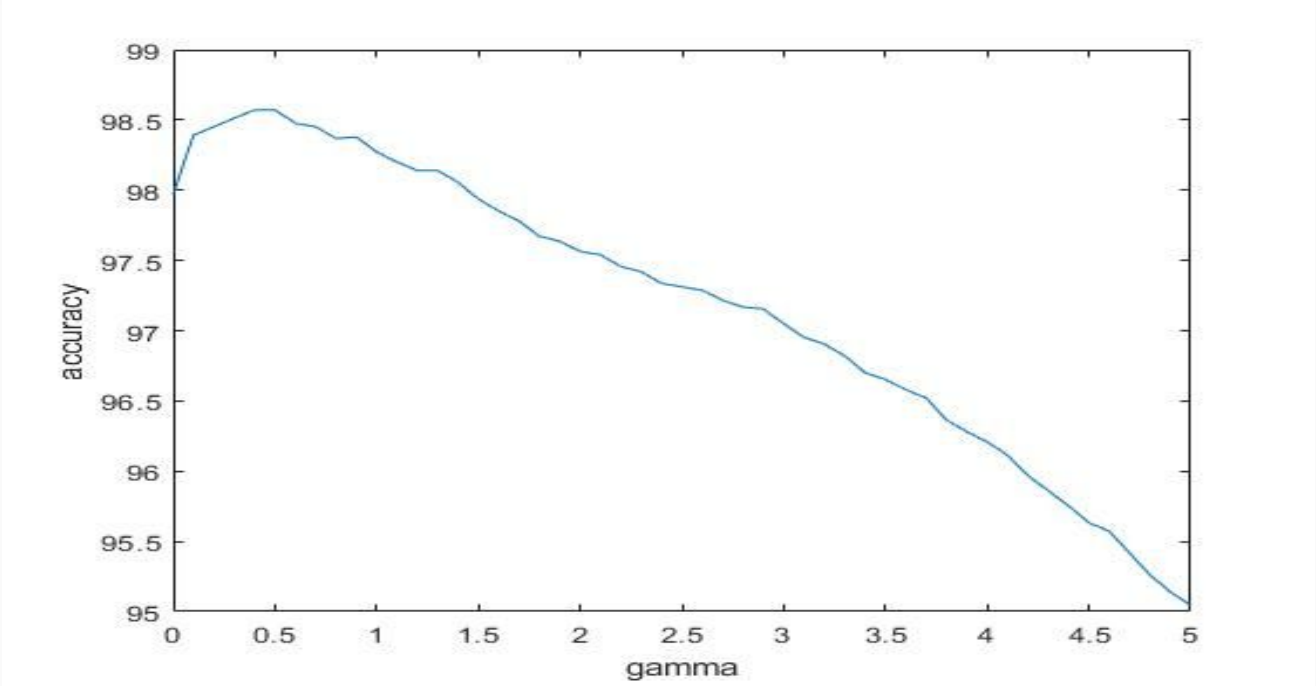
| Class Type | No. of samples | Accuracy |
|---|---|---|
| Sag | 10000 | 94.5% |
| Swell | 10000 | 99.87% |
| Interruption | 10000 | 100% |
| Harmonics | 10000 | 100% |
| Flicker | 10000 | 98.4% |
| Overall | 50000 | 98.57% |

# CLASSIFICATION RESULTS

Gamma = 5

| Class Type | No. of samples | Accuracy |
|---|---|---|
| Sag | 10000 | 90.86% |
| Swell | 10000 | 97.6% |
| Interruption | 10000 | 98.2% |
| Harmonics | 10000 | 98.2% |
| Flicker | 10000 | 92.9% |
| Overall | 50000 | 95.2% |

# Accuracy vs gamma (10000 samples)



# CLASSIFICATION RESULTS

**Gamma = 0.15-0.2**

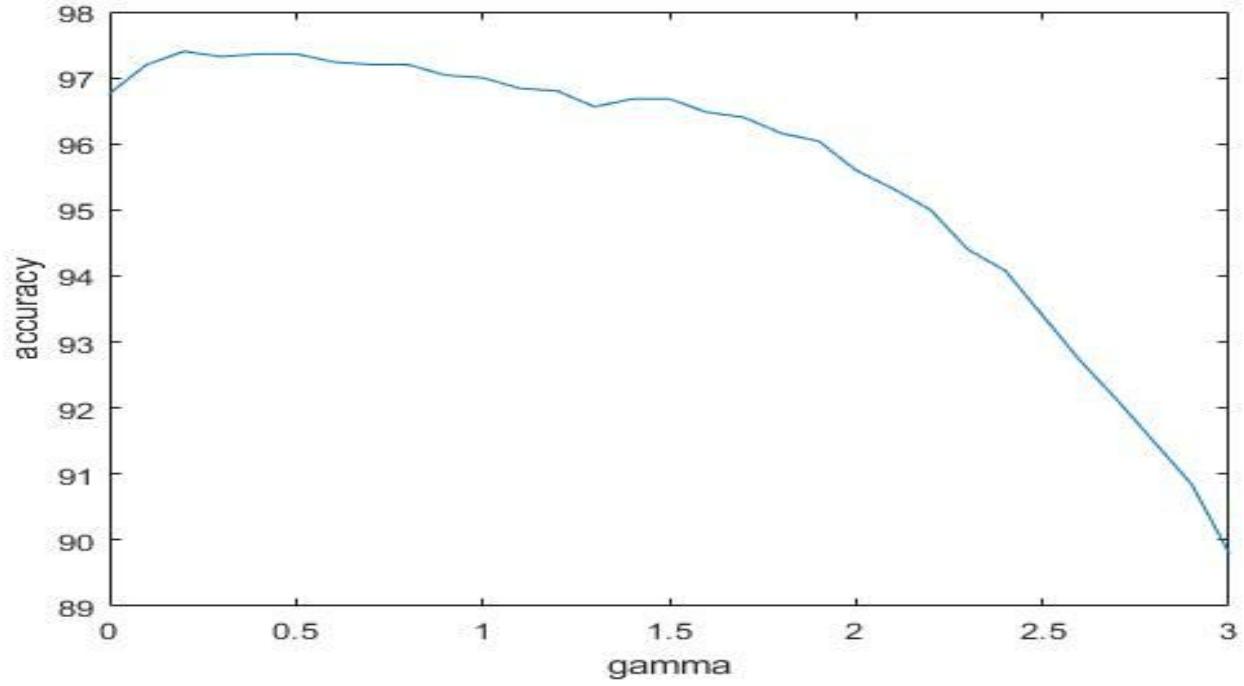
| Class Type | No. of samples | Accuracy |
|---|---|---|
| Sag | 3000 | 93.6% |
| Swell | 3000 | 98.4% |
| Interruption | 3000 | 100% |
| Harmonics | 3000 | 100% |
| Flicker | 3000 | 97.4% |
| Overall | 15000 | 98.57% |

# CLASSIFICATION RESULTS

Gamma = 3

| Class Type | No. of samples | Accuracy |
|---|---|---|
| Sag | 3000 | 84.9% |
| Swell | 3000 | 89% |
| Interruption | 3000 | 93% |
| Harmonics | 3000 | 92.7% |
| Flicker | 3000 | 90% |
| Overall | 15000 | 89.9% |

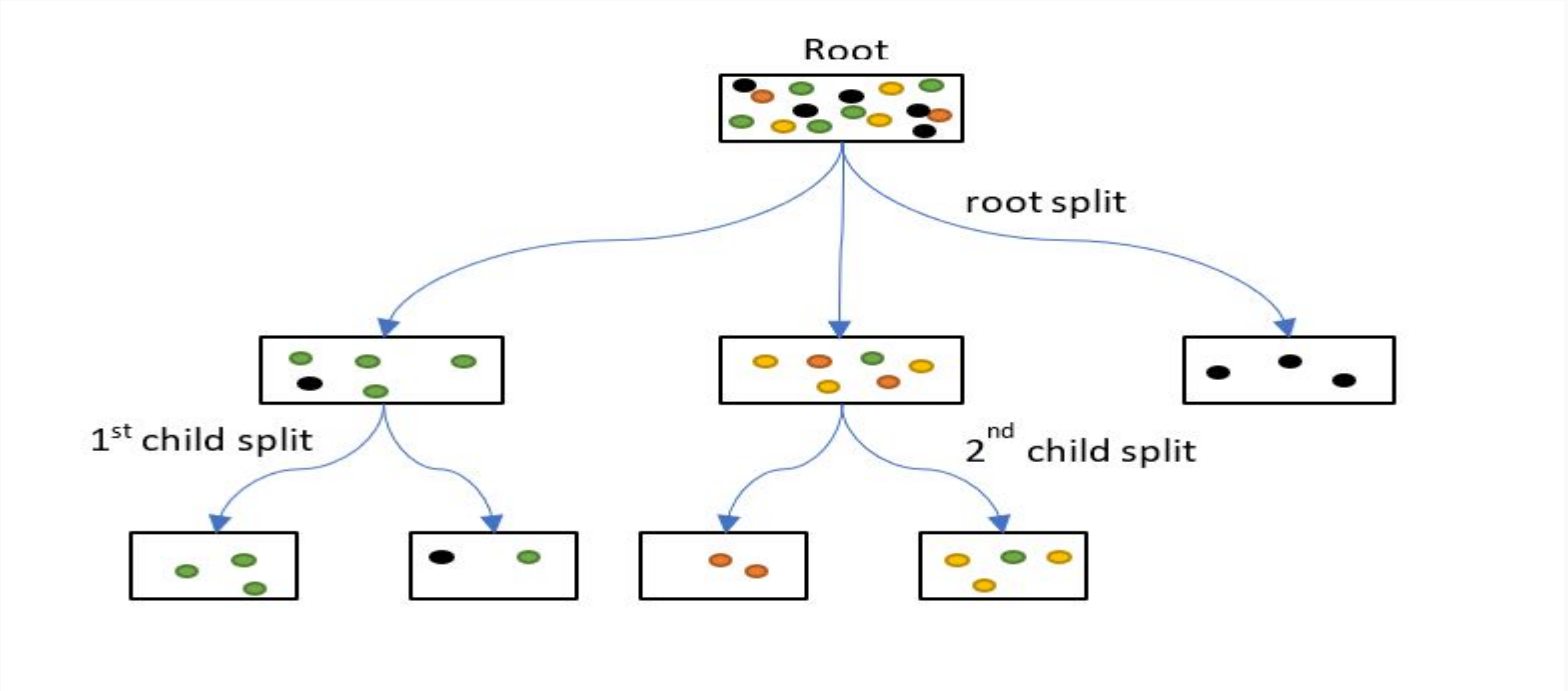
# Accuracy vs gamma (3000 samples)



# Decision Tree

A decision tree is a decision support tool that uses a **t**ree-like graph or model of decisions and their possible consequences, including chance event outcomes, resource costs, and utility. It is one way to display an algorithm that only contains conditional control statements

# HOW DT WORKS ?



# CLASSIFICATION RESULTS

| Class Type | No. of samples | Accuracy |
|---|---|---|
| Sag | 10000 | 94.3% |
| Swell | 10000 | 87.6% |
| Interruption | 10000 | 90.5% |
| Harmonics | 10000 | 85.6% |
| Flicker | 10000 | 94.3% |
| Overall | 50000 | 92.3% |

# CONCLUSION

- Normalization is must for SVM
- SVM showed better accuracy than DT .
- Accuracy increases with increase in no. of samples or variation of gamma Parameter .
- Genetic algorithm optimises the redundant and less important features .
- Wavelet packet transform is used to extract features .
- Further db4 was used with 4-level decomposition.
- By application of better hardware accuracy for both the techniues can be increased .

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# FUTURE SCOPE

- Different ML techniques like LSTM,random Forest can be used-compared to present work .
- Different transform techniques can be used for comparision .
- We can check the accuracy under different circumstances like noise signal or harmonics is induced .

# REFERENCES


1. P. Ray, N. Kishor, and S. Mohanty, “Islanding and power quality disturbance detection in grid connected hybrid power system using wavelet and S-transform,” IEEE Trans. Smart Grid, vol. 3, no. 3, pp. 1082–1094, Sep. 2012.
2. P.K. DashandM.V.Chilukuri, “HybridS-transformandKalman filtering approach for detection and measurement of short duration disturbances in power networks,”IEEE Trans.Instrum.Meas.,vol.53,no.2,pp.588–594, Apr. 2004.
3. S. Mishra, C. Bhende, and B. Panigrahi, “Detection and classification of power quality disturbances using S-transform and probabilistic neural network,” IEEE Trans. Power Del., vol. 23,no. 1,pp. 280–287, Jan. 2008

4. Aleksandar Milchevski, Dimitar Taskovski Faculty of electrical engineering and IT, Cyril and Methodius University – Skopje Adv. Signal Process. 2012

5. Sung min.tai ho“Classification for distributed Systems using ANN” Journal of Electrical and electronics (2011) .pp 76-88

6. Spect and Donald F “Probabalistic Neural Networks and Adaline techniques for classification” .Neural Networks.IEEE Transaction (2012)

7. Abe Koji, Ohba Satoshi, Iwamoto S.new load frequency control method suitable for large penetration of wind power generations and Energy Storage systems” IEEE trans Proc 2009:1–6 .

8. P. Ray, S. Mohanty, and N. Kishor, “Disturbance detection in grid connected Distributed generation system using wavelet and S-transform,”Elect. Power Syst. Res.,vol. 81, no. 3, pp. 805–819, Mar. 2011.

# Thank you

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