INSTITUTE OF COMPUTER SCIENCE
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Identification of Fake GAN-Generated Images through Frequency Analysis and Machine Learning

CMSC 190 SPECIAL PROBLEM

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These people do not exist...

Images taken frome 140k fake and real images

Deception through AI

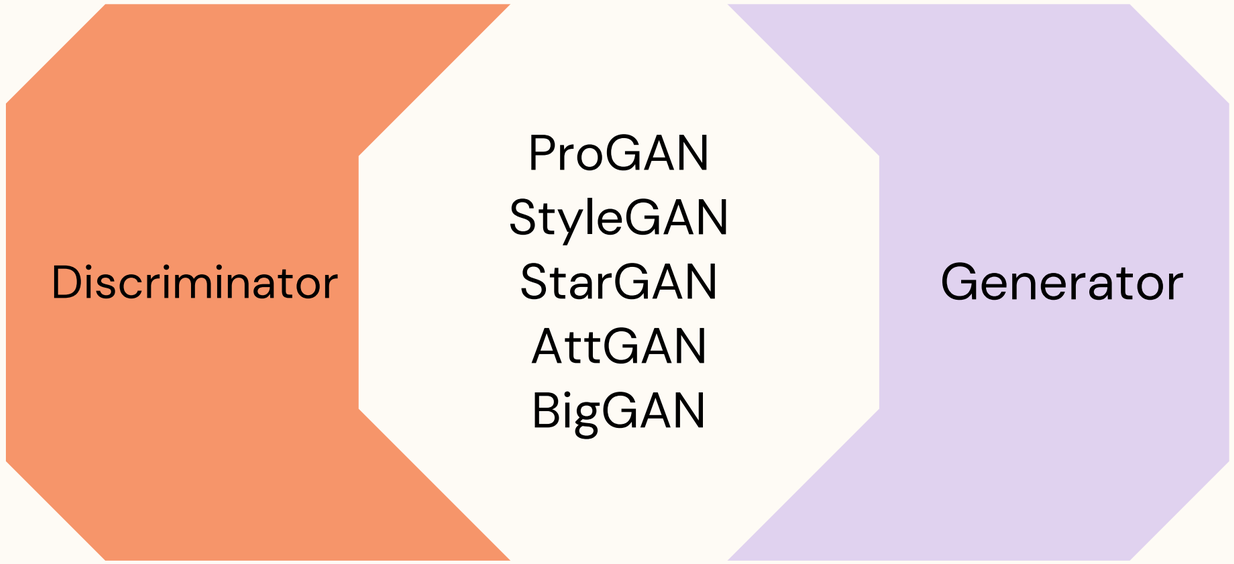
- Synthetic media generation through
  - Deepfake
  - Generative AI
- Fabrication of fake images, videos, and audios
- Deception of audiences
- Identity theft and defamation

Images taken frome 140k fake and real images

Anchors, reporters nagamit sa 'deepfake' ads

January 26, 2024 news report from TV Patrol

Generative Adversarial Networks



- Adversarial Training
- Hyper-realistic images
- Computationally expensive to train

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*As GANs continuously improve, the race for **more advance detectors** to discriminate fake from real images also calls for **enhanced strategies**, **robust methods**, and **innovative approaches** to stay ahead in the ongoing battle between generative models and detection mechanisms.*

GAN detection

Deep Learning and the use of CNNs

- High computational resources
- Complex Architectures

Concentrated on Fake Faces

- Diverse Fake Face Dataset
- FaceForensics++
- 140k Real and Fake Faces
- CelebA

Significance of the Study

Frequency Analysis

Discrete Cosine Transform

Discrete Wavelet Transform

+

Machine Learning

Support Vector Machine

Random Forest

GAN traces in different object classes

- Animals
- Vehicles
- General objects

Research Objectives

- Collect real and synthetic images from the ProGAN dataset.
- Apply DCT and DWT as pre-processing methods on the input images.
- Determine which spectral features can be used to classify fake from real images.
- Implement two classification models for this problem namely: (1)Support Vector Machine (SVM) and (2)Random Forest.
- Evaluate the accuracy of the classification models using the proposed methods.

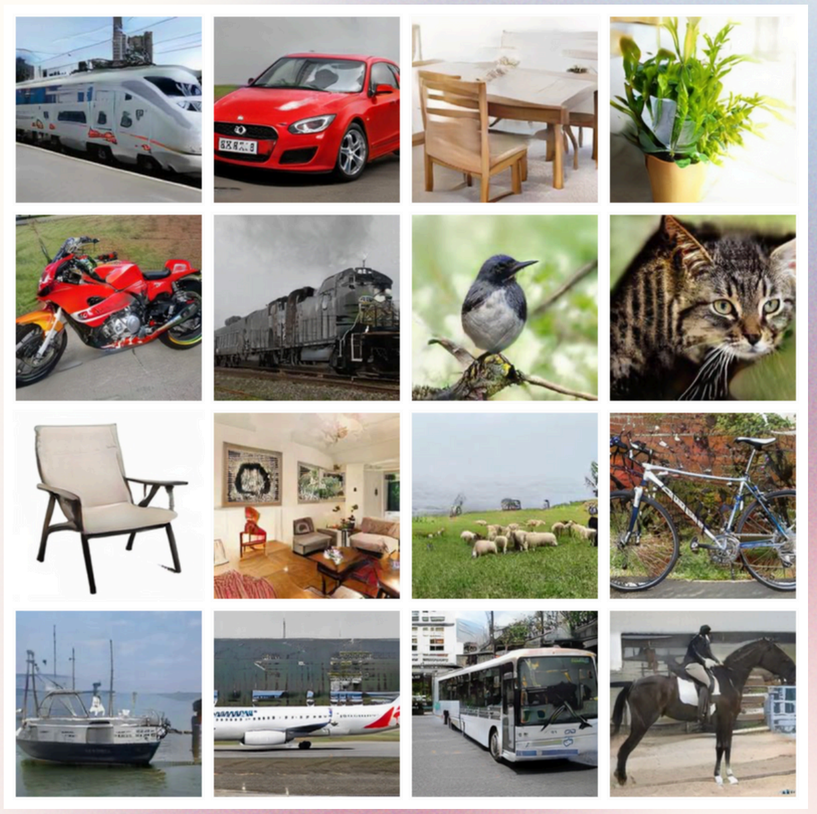
Methodology

Collect images from the **ProGAN** dataset with varying **subclasses**

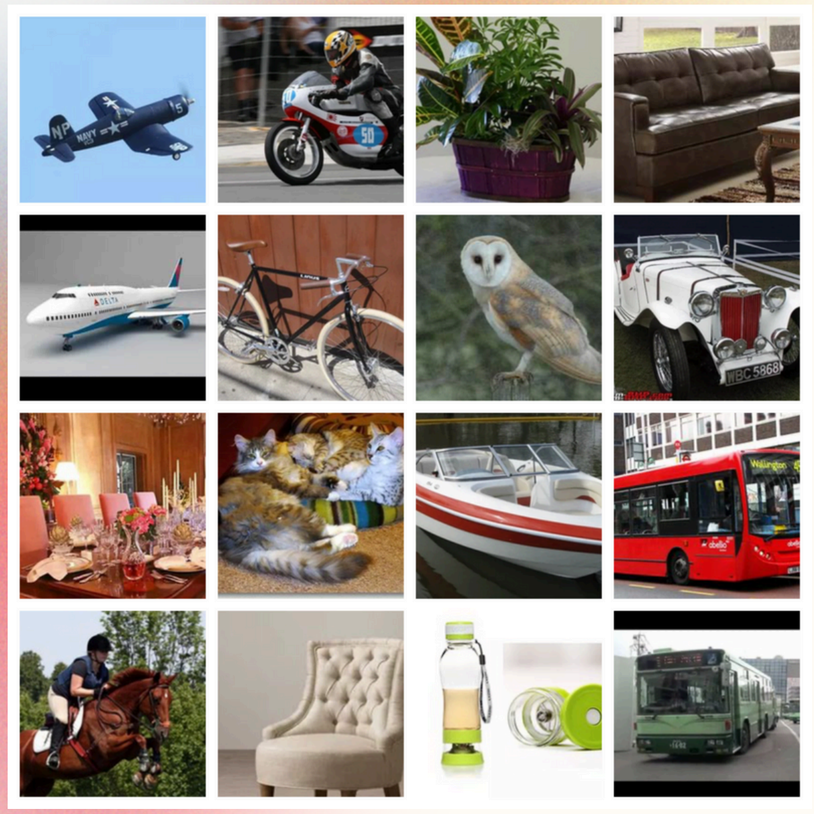
Apply **DCT** and **DWT** on images and determine which **spectral features** can be used to classify fake images

Classify the images using two classification models: **SVM** and **Random Forest**

Evaluate the **accuracy** of each classifcation model and the overall accuracy of the proposed solution

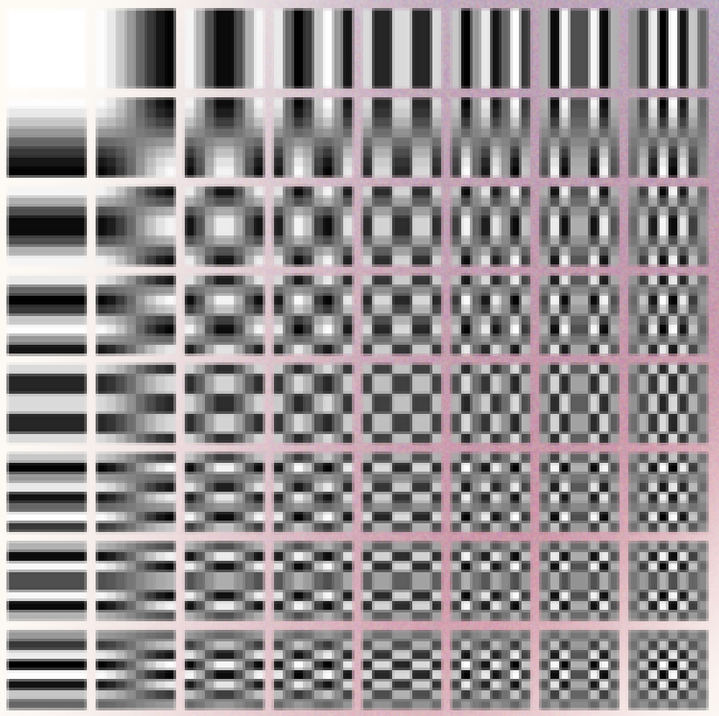


Fake Images from the ProGAN dataset



Real Images from the ProGAN dataset

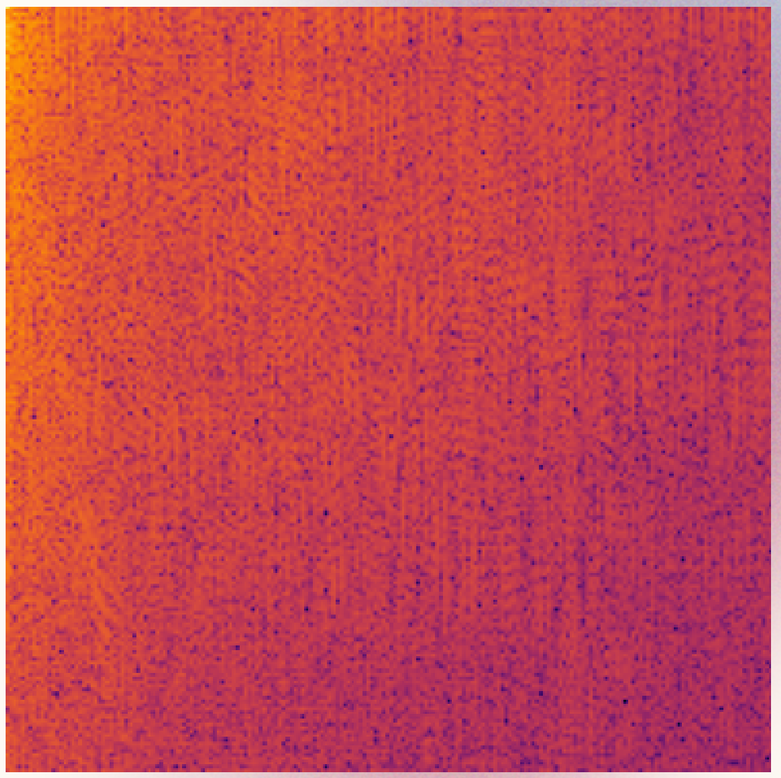
Discrete Cosine Transform



8 x 8 DCT Block

- Based on Fourier Transform
- Represent images as a sum of cosine waves
- Used in image compression algorithms
- Used in Frank et al. and Guidice et al.’s studies

Using SciPy for DCT



Log plot of DCT coeffiecients

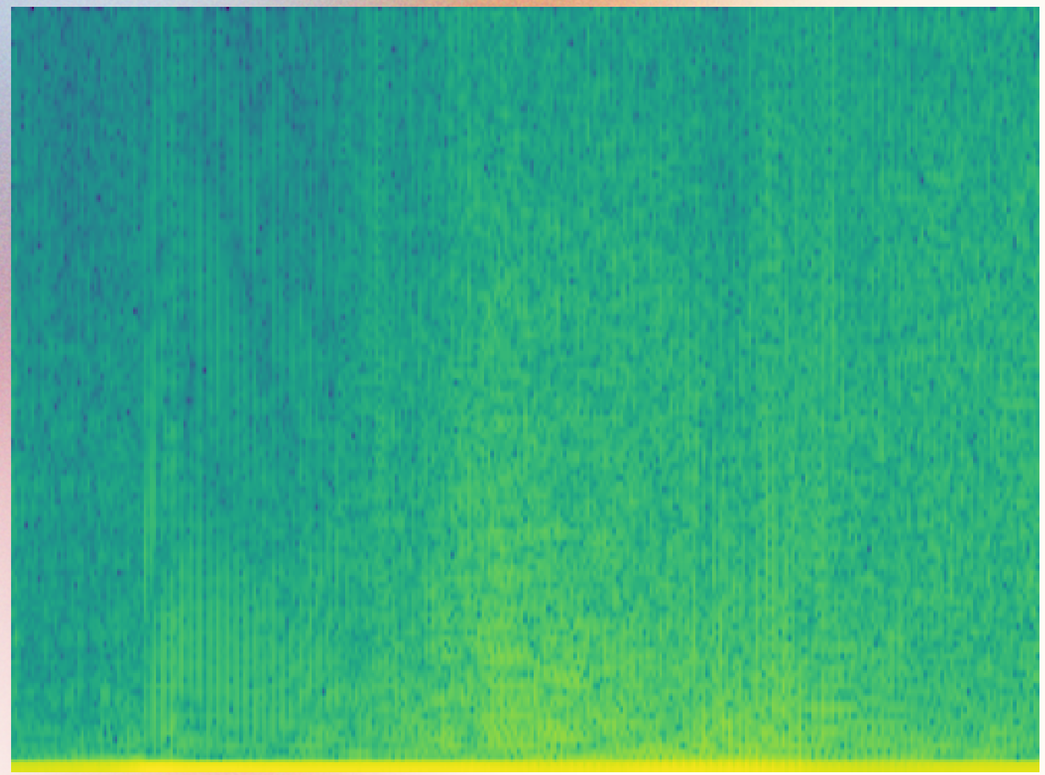
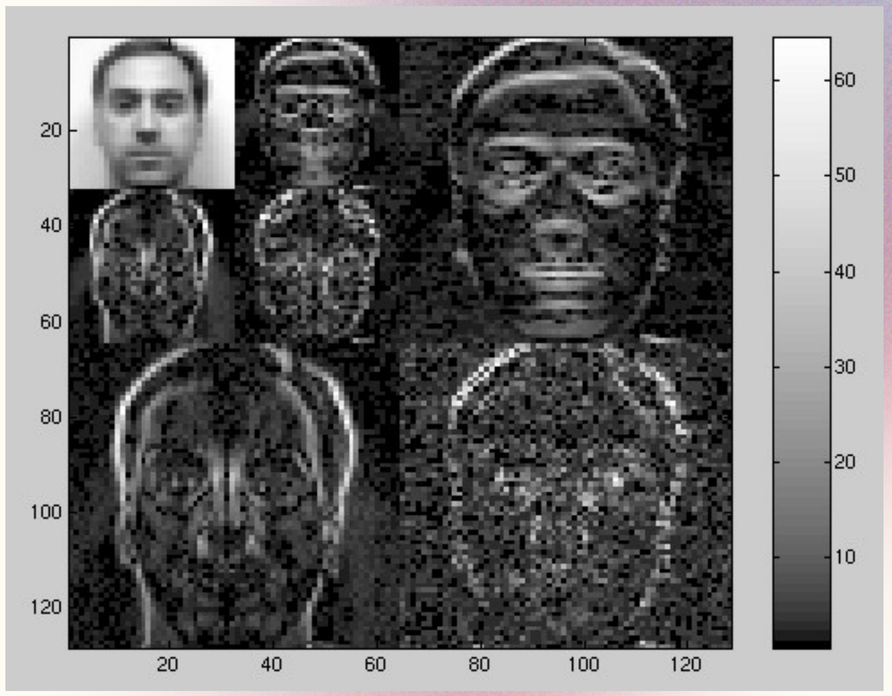


Image Spectrogram

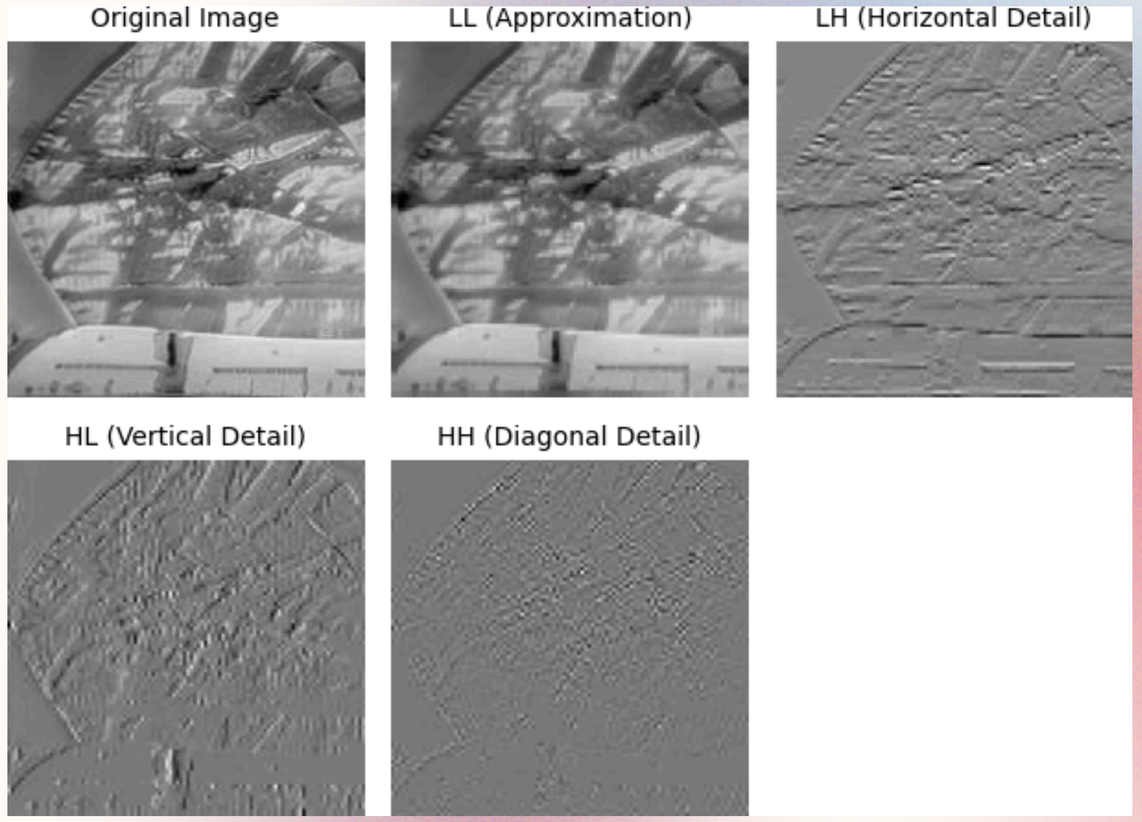
Discrete Wavelet Transform



Application of DWT on image processing

- Alternative to Fourier Transform
- Transforms image pixels to wavelets
- Multi-level frequency representation
- Used in Tang et al. and Liu et al.’s studies

DWT using PyWavelets



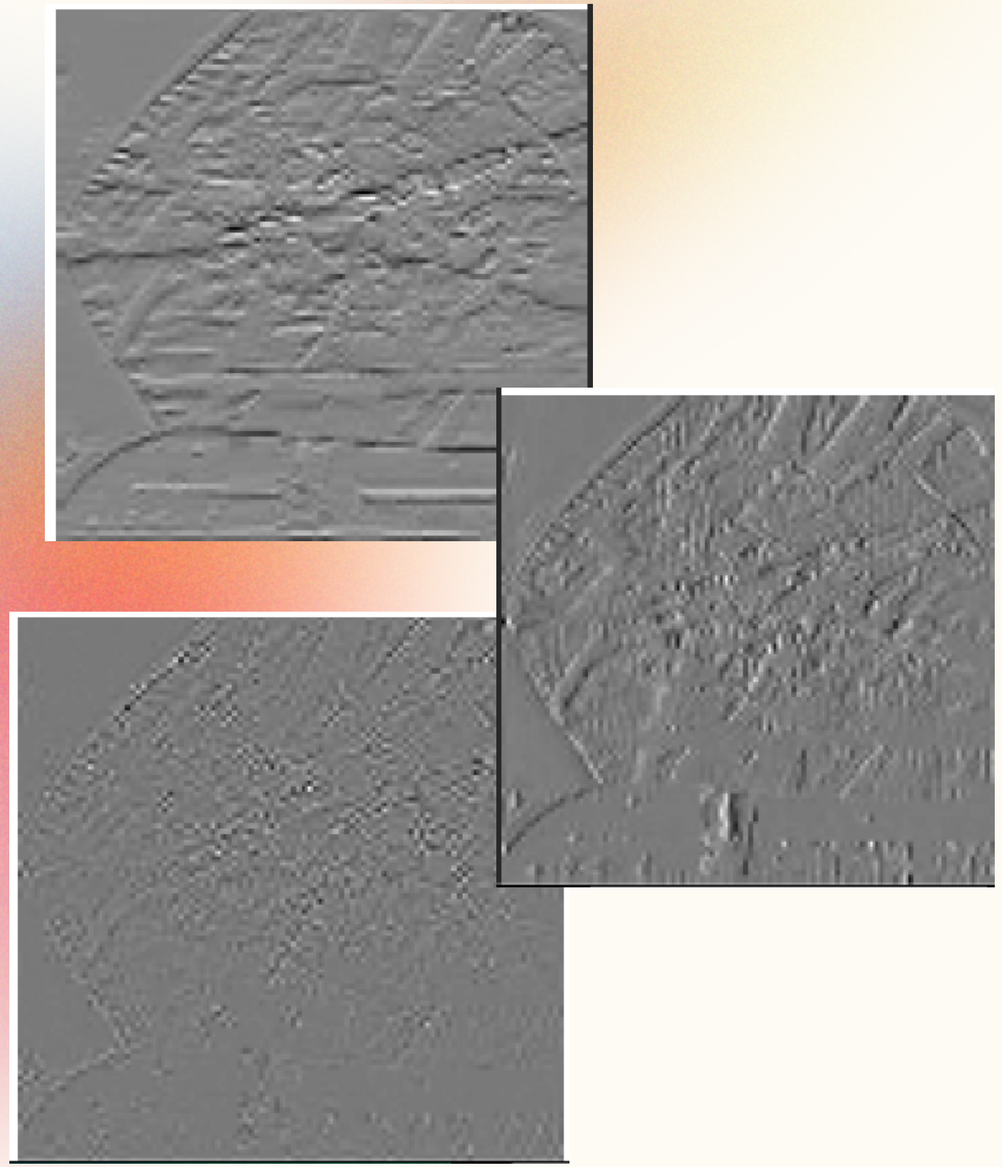
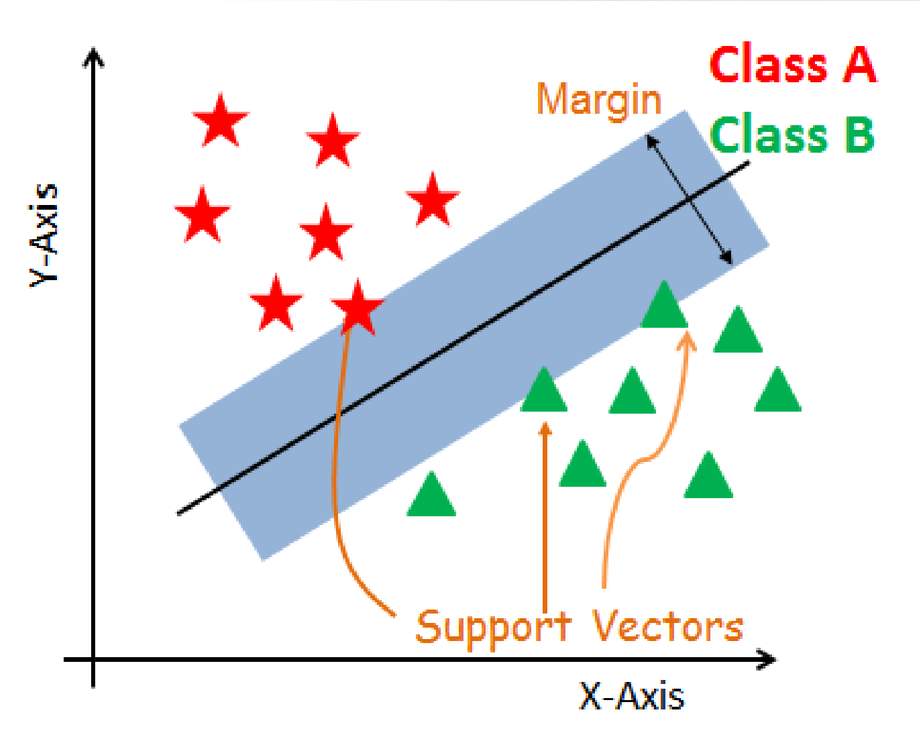
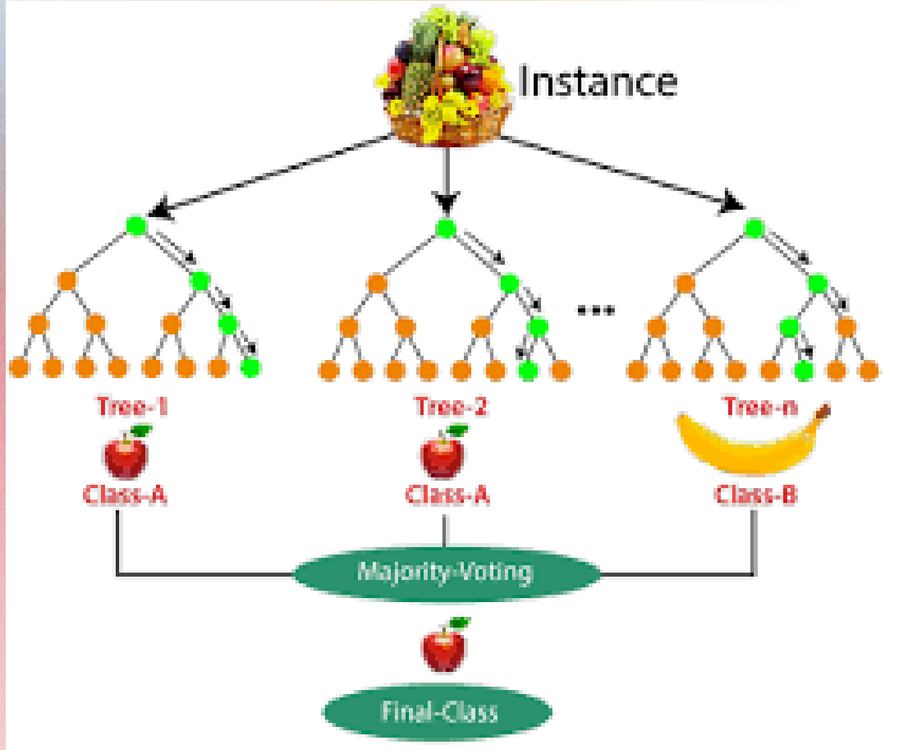


Image decomposition using DWT

Classification Models





Support Vector Machine

- High Dimensional Data
- Pattern Recognition
- Regression Analysis

Random Forest

- Decision Trees
- Overfitting
- Generalize

Sample Code & Initial Output