Pattern Recognition

From Curve Fitting to Generalization
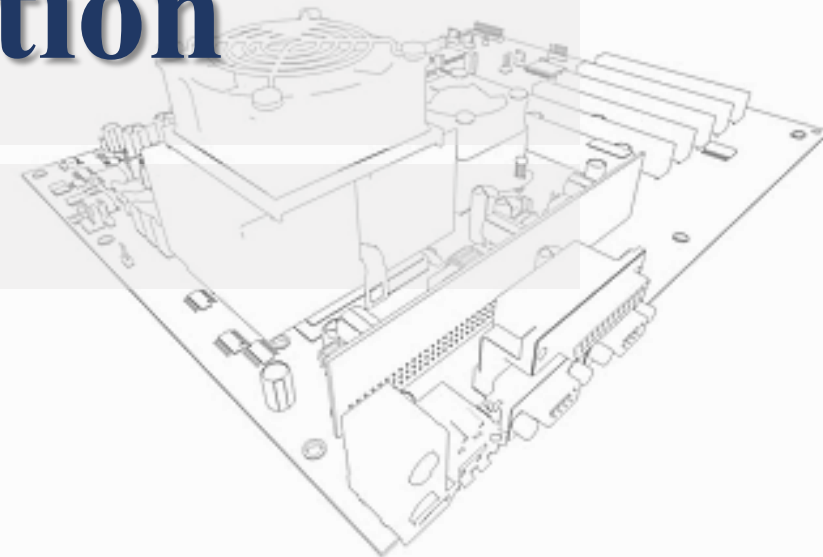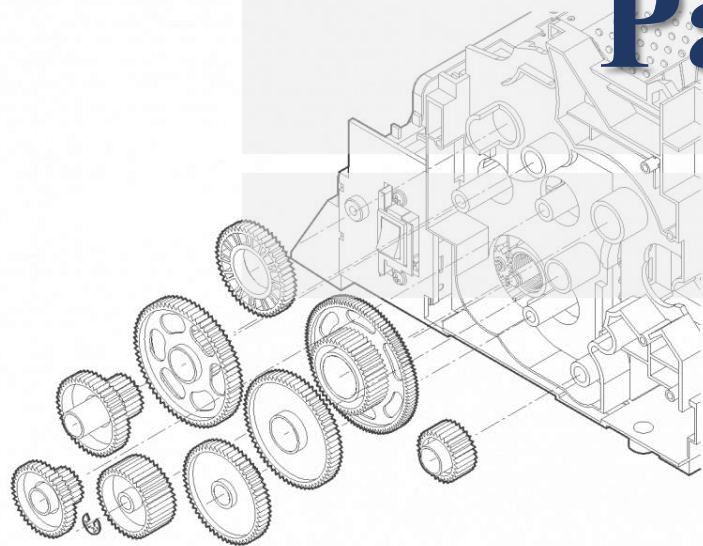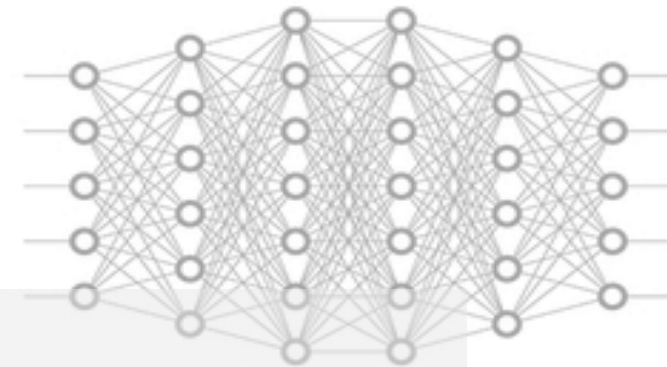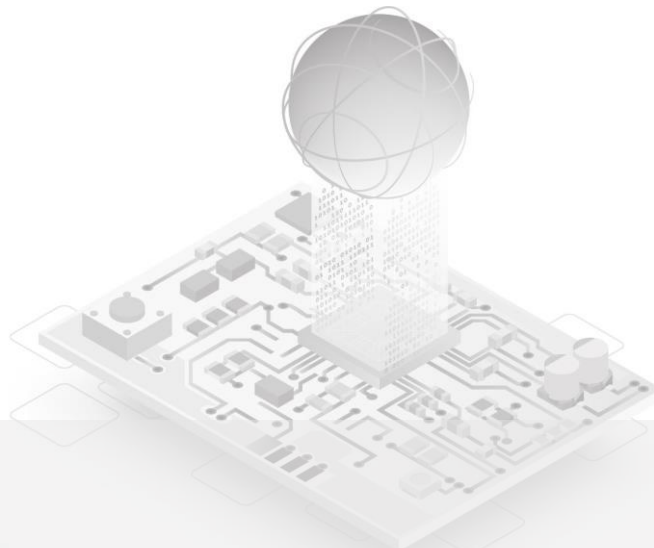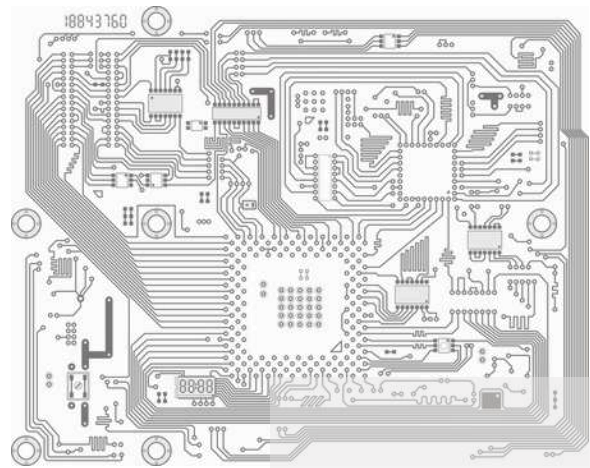
Case Study
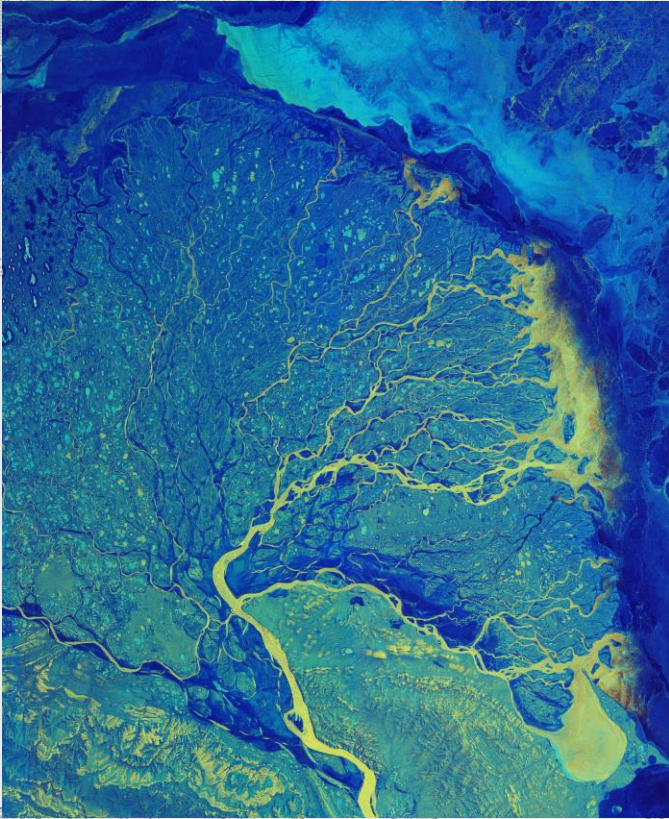
Rhine Delta
Pic Credit: European Space Agency

Ganges Delta in India & Bangladesh
Pic Credit: NASA

River System / Fluvial Networks – Can you predict this pattern

Types of images

**Raster**
- JPEG format
- PNG format

XML Based 2D vector image format
- Support Vector Graphics (SVG)

Point Cloud
- LAS
- DOT

Other format
- Voxel (3d printing)

Support Vector Graphics

Code Credit: YouTube channel **Dev ED**. Learn to build SVG Animation with CSS

Point Cloud

Pointcloud

x: 0.6227932   person
y: −0.5543099
z: 1.160986
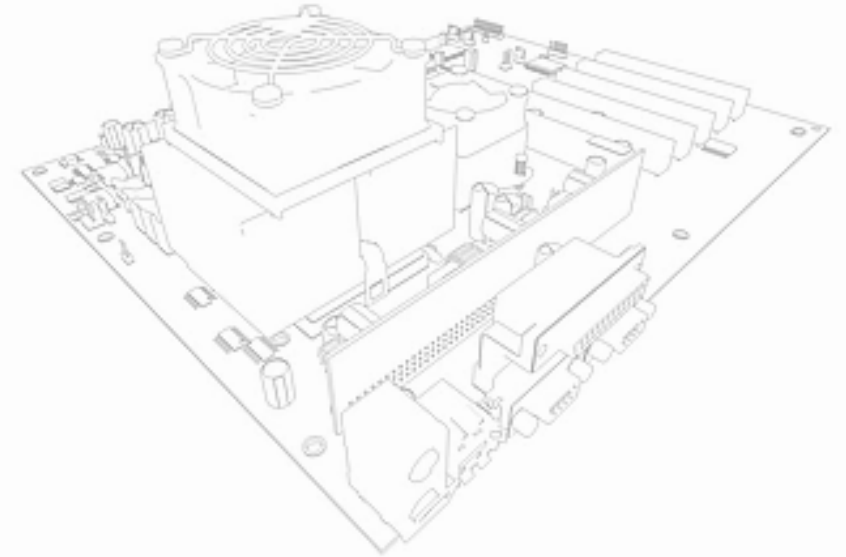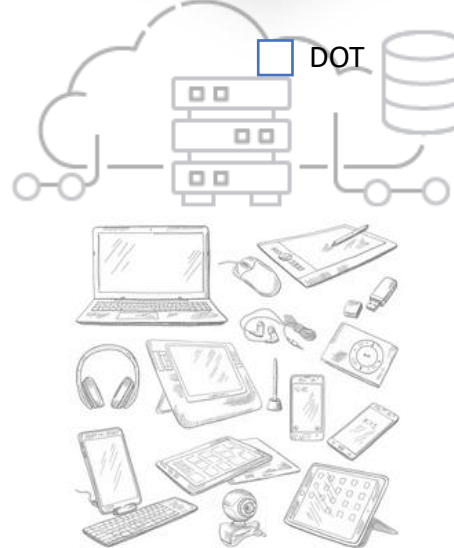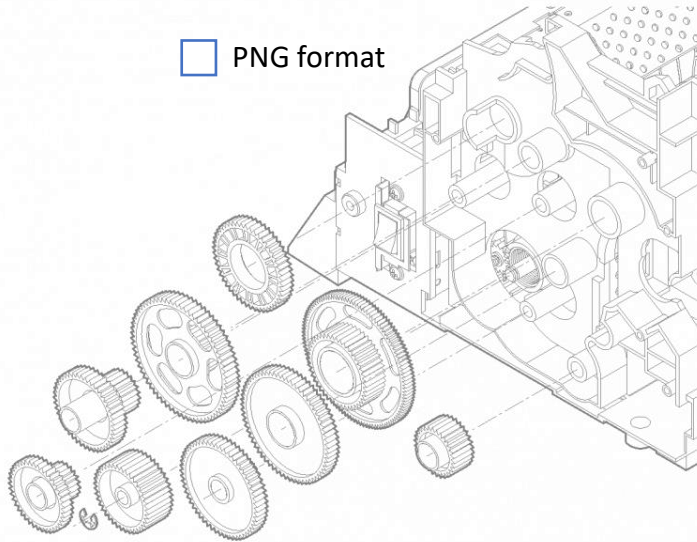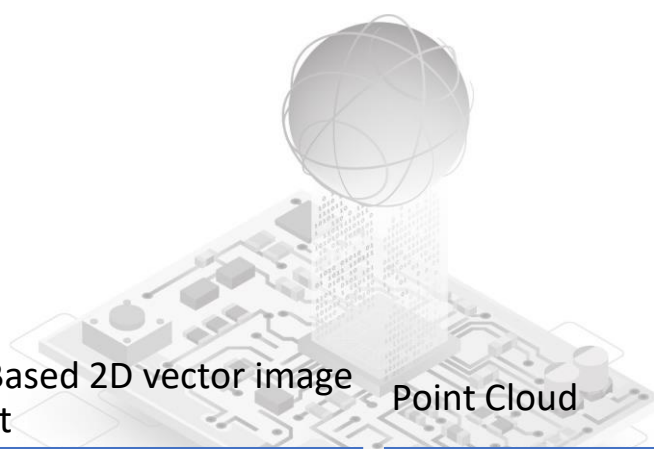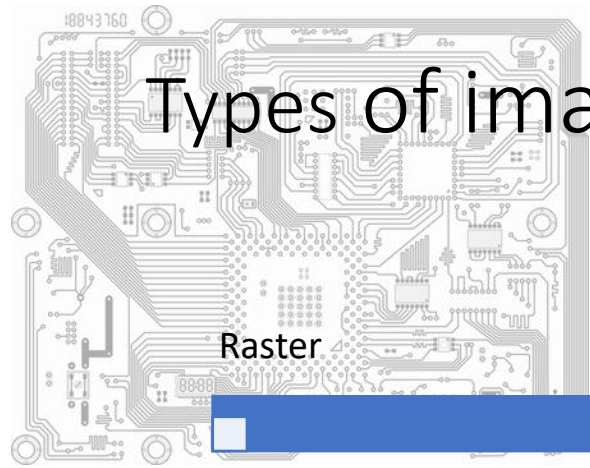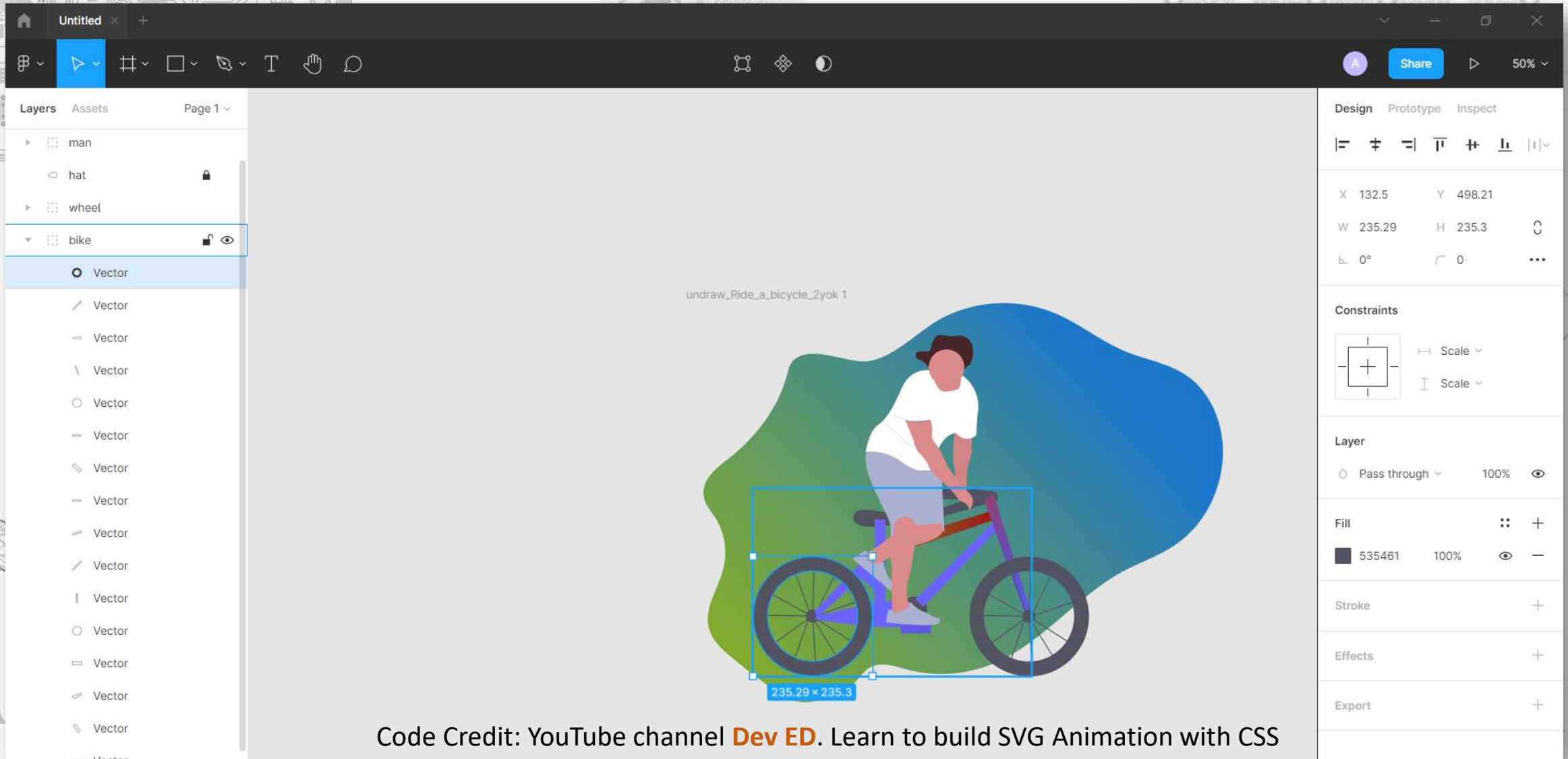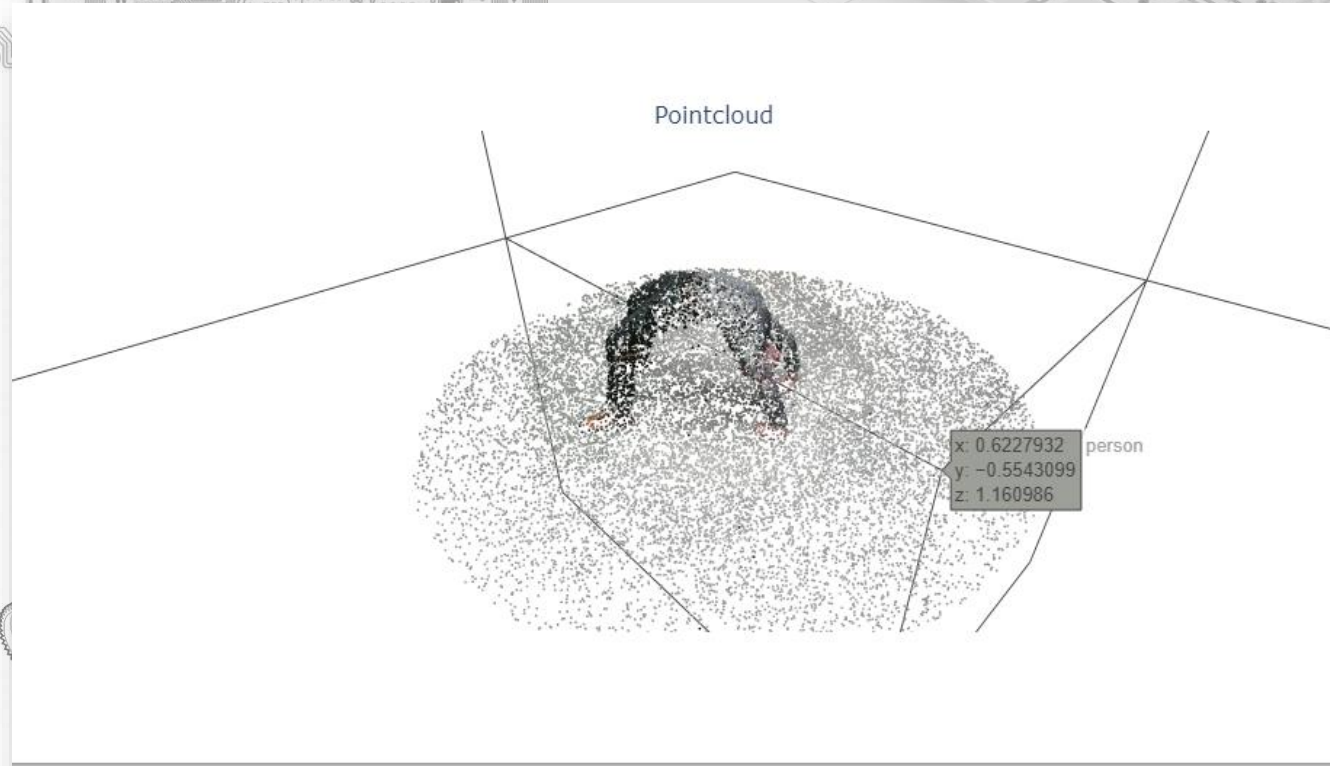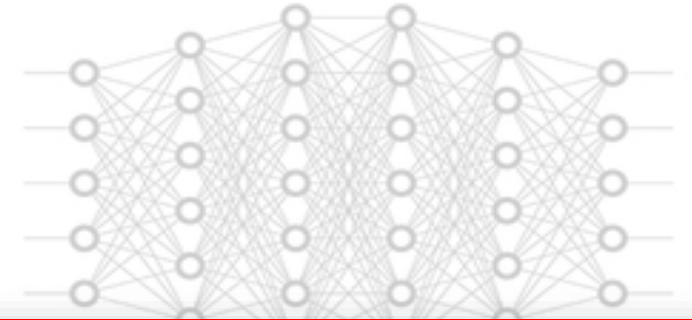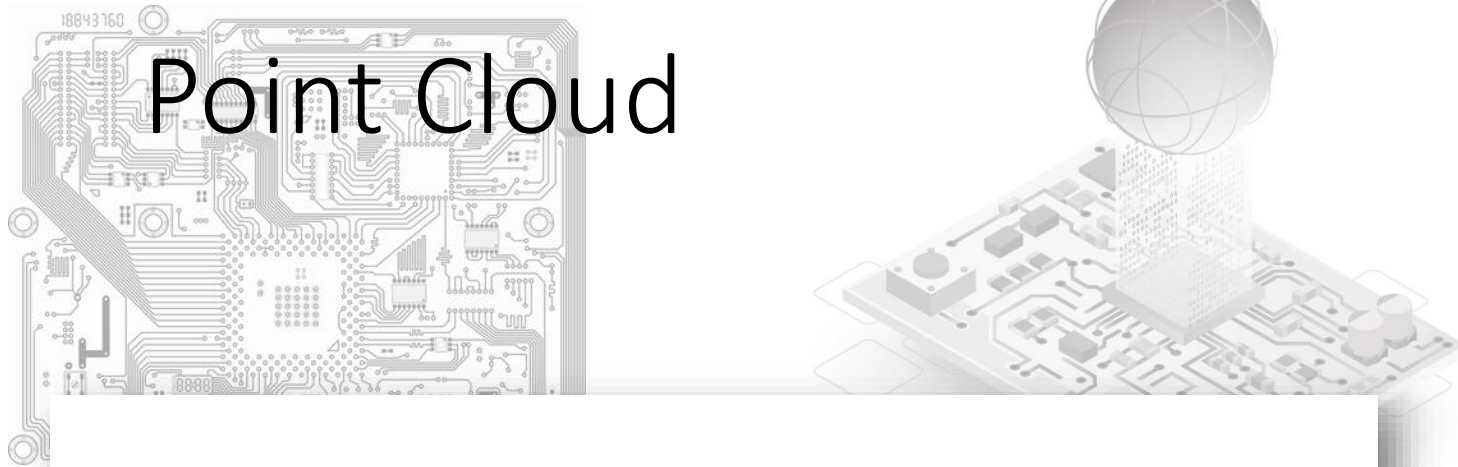
Mandelbrot Set – Demo

$$z_{n+1} = z_n^2 + c$$

Escape Time Algorithm
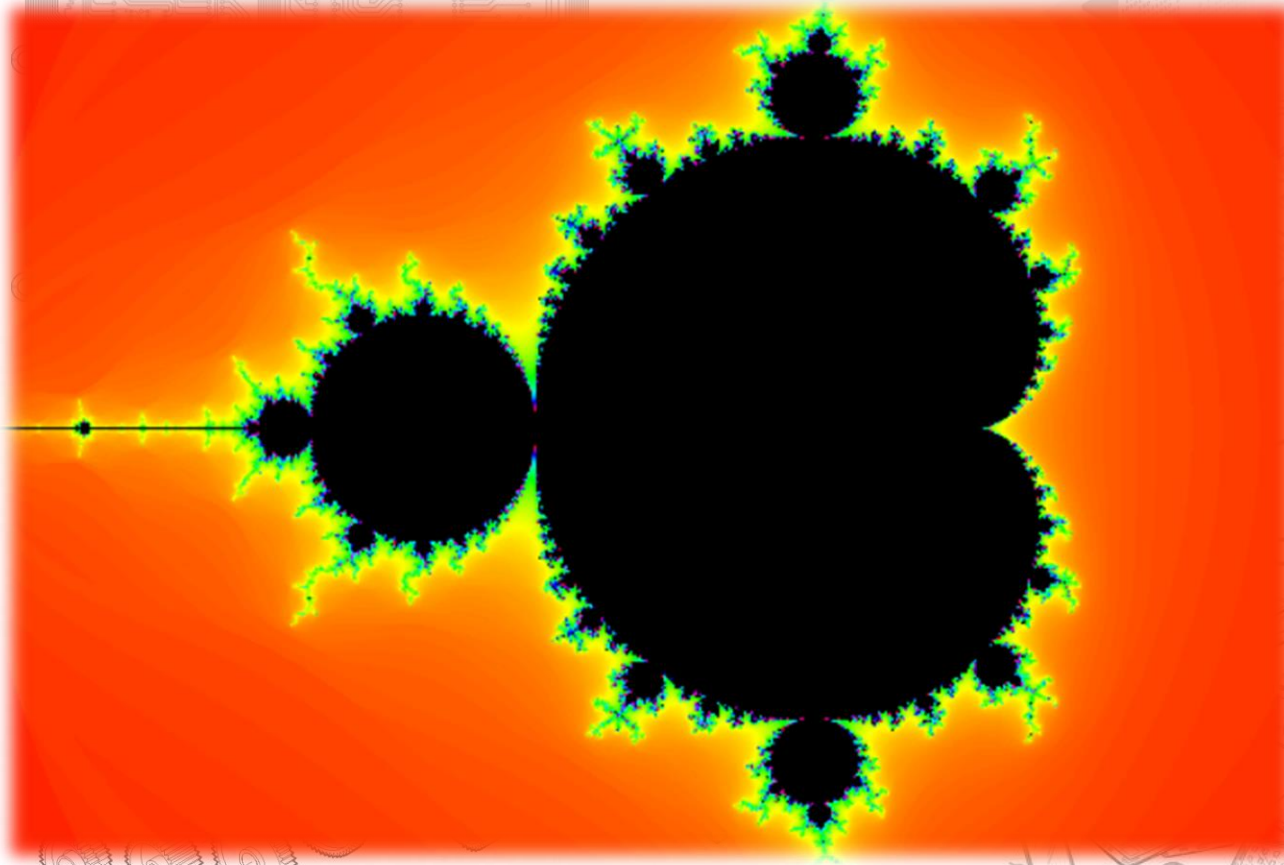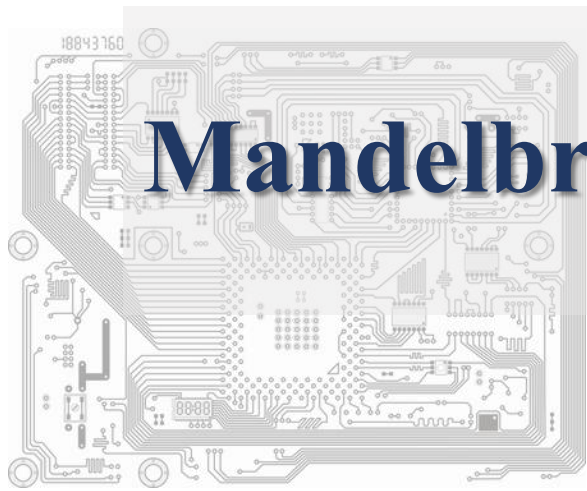
Mandelbrot Set
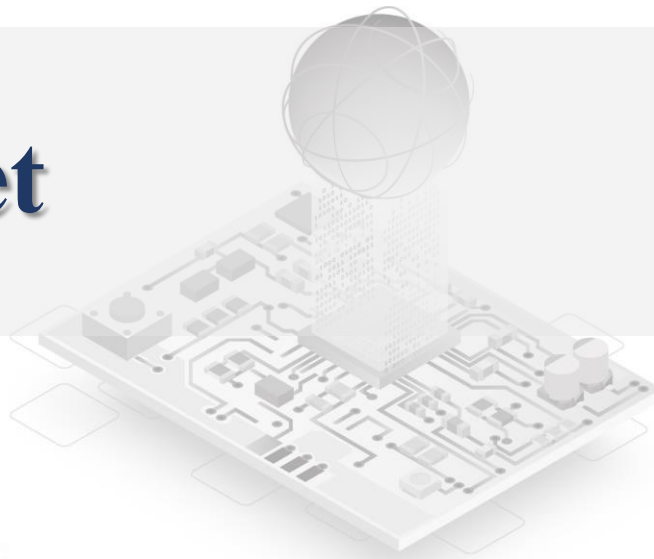
Simple equation can create complex system where exact pattern can't be predicted easily (or may be can't be predicted at all)

Chaos: Small Changes can have large impact on system

Causality: Which factor influences outcome may not be clear

Pattern Recognition : Trying to sub divide the field (Demo)

Feature Engineering

Curve Fitting

Optimization

Traditional

Modern

- Generalization
- Optimization
- Self Organization
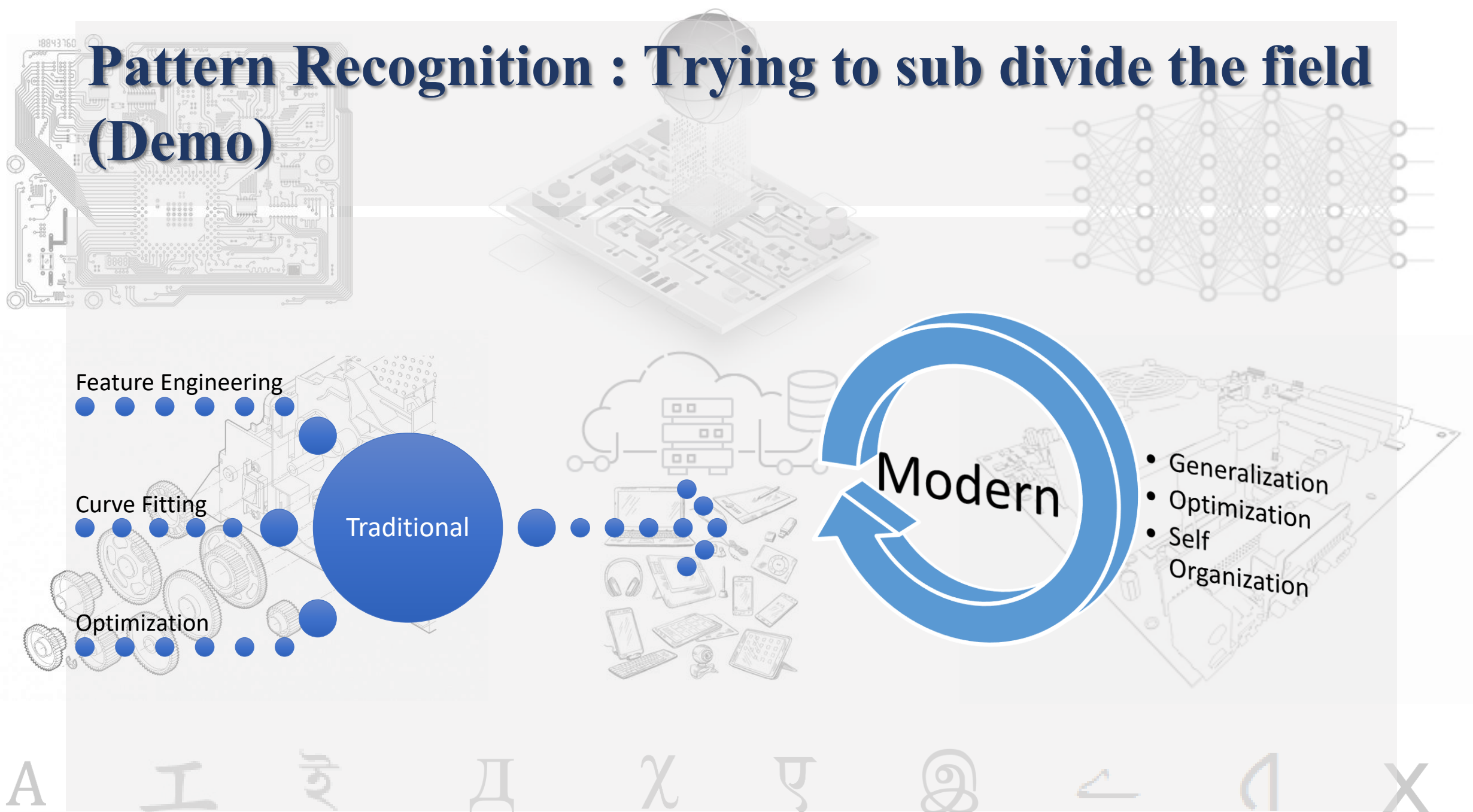
Where is the Boundary??

Kernel trick (Credit Wikipedia)

REGRESSION WITH 100 POINTS

$y = -5E-13x^6 + 1E-09x^5 - 1E-06x^4 + 0.0008x^3 - 0.1894x^2 + 20.392x - 419.66$
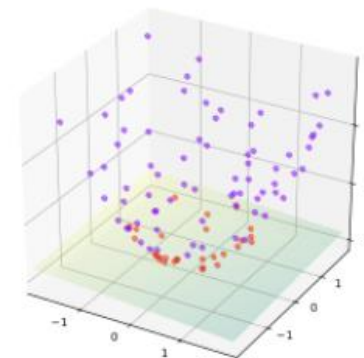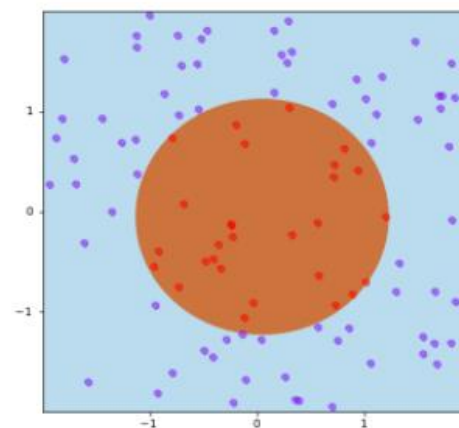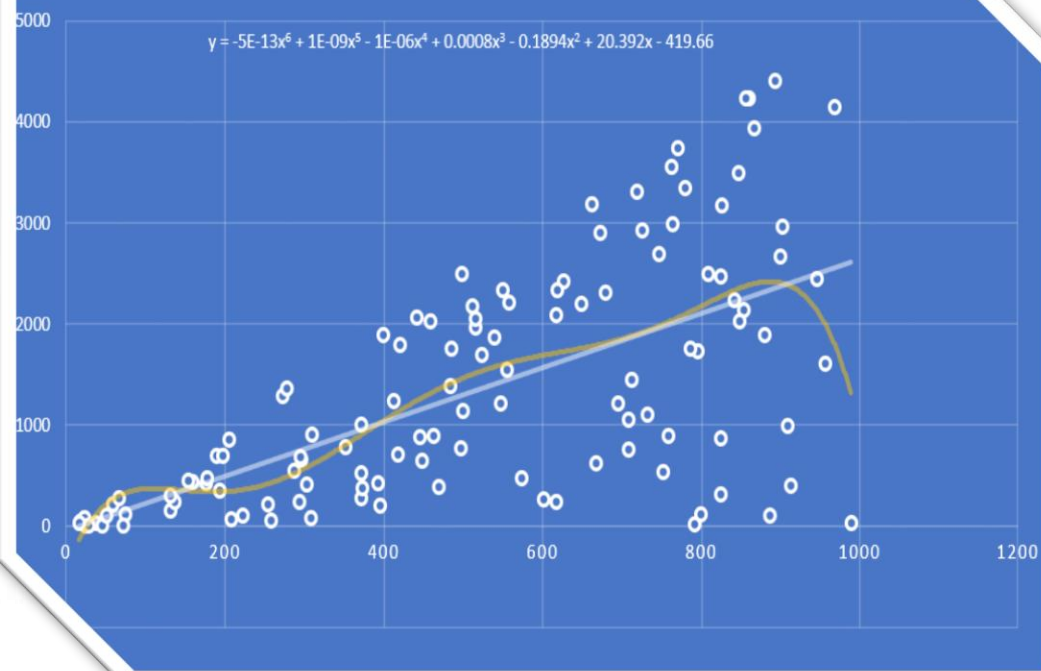
SVM with kernel given by $\varphi((a, b)) = (a, b, a^2 + b^2)$ and thus $K(\mathbf{x}, \mathbf{y}) = \mathbf{x} \cdot \mathbf{y} + \|\mathbf{x}\|^2 \|\mathbf{y}\|^2$. The training points are mapped to a 3-dimensional space where a separating hyperplane can be easily found.

Hyperparameter Tunning (Guessing Game)
When to use which Model ??

ML Work Flow

Start by guessing best hypothesis in hypothesis space.

Check how good the guess is.

Update

Repeat till you have data or run out of money

What was your Hypothesis space/ Inductive bias / Data Set

Learn lots of features

Multi class problem : Ensemble Methods(Gradient boosting), Random Forest

Non linear two class problem: Support Vector machine

Probabilistic – Bayesian Learning

Polynomial function- linear classifier

Deep Learning: ANN + Mixture of many areas

Bayes' Rule

I am absolutely BEGGING everyone to PLEASE learn Bayes' rule. Please!

CNBC @CNBC · Jul 31

CDC says 74% of people infected in Massachusetts Covid outbreak were fully vaccinated cnb.cx/2TL4AIv

3:28 AM · Jul 31, 2021 · Twitter Web App

240 Retweets   **35** Quote Tweets   **2,241** Likes

probability a hypothesis is true given the evidence

probability a hypothesis is true (before any evidence is present)

probability of seeing the evidence if the hypothesis is true

$$P(H/E) = \frac{P(H)\, P(E/H)}{P(E)}$$

probability of observing the evidence

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Pic credit: https://www.gaussianwaves.com/2021/04/bayes-theorem/