Python-Machine Learning

using Scikit-Learn package

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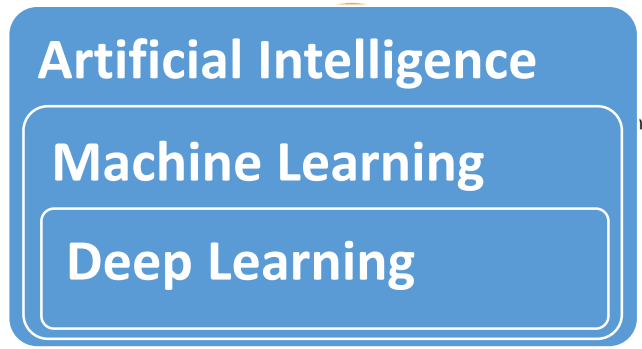
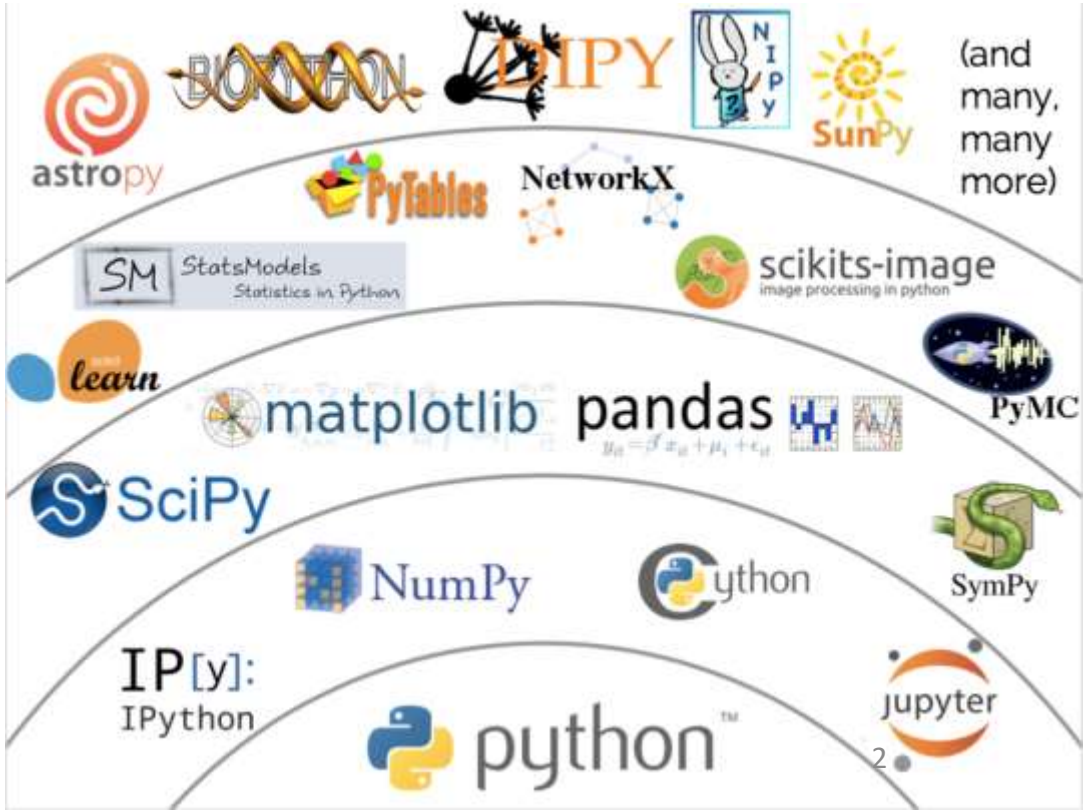
Agenda

- Introduction
- History, need
- Why Machine Learning Matters
- Type of ML-Supervised vs unsupervised
- Classification, Regression, Clustering
- Cheat sheet
- Machine learning flow





Introduction

- Machine learning is where computational and algorithmic skills of data science meet the statistical thinking of data science,
- The result is a collection of approaches to inference and data exploration that are *not about effective theory* so much as *effective computation*.
- Better to think of machine learning as a *means of building models of Data*
- Machine learning along with entire Data Science ecosystem is trying to make this mathematical, model-based "learning" as same as "learning" exhibited by the human brain.

- “A computer program is said to learn

  from experience *E* with respect to some class of tasks *T* and performance measure *P*

  if its performance at tasks in *T*, as measured by *P*, improves with experience *E*.” *by Tom M. Mitchell*

"~~Can machines think~~?"

is replaced with the question

"Can machines do what we (as thinking entities) can do?"

Alan Turing

Source : wikipedia

History

- Arthur Samuel, an American pioneer in the field of computer gaming and artificial intelligence, coined the term "Machine Learning" in 1959 while at IBM
- In earlier times scientist attempted to approach the problem with various symbolic methods, as well as what were then termed "neural networks“
- Probabilistic reasoning was also employed in various automated medical diagnosis programs

Why Machine Learning Matters

With the rise in big data, machine learning has become a key technique for solving problems in areas, such as:

- **Computational finance**, for credit scoring and algorithmic trading
- **Image processing and computer vision**, for face recognition, motion detection, and object detection
- **Computational biology**, for tumor detection, drug discovery, and DNA sequencing
- **Energy production**, for price and load forecasting
- **Automotive, aerospace, and manufacturing**, for predictive maintenance
- **Natural language processing**, for voice recognition applications

Source: Mathworks.com

Why Machine Learning is needed

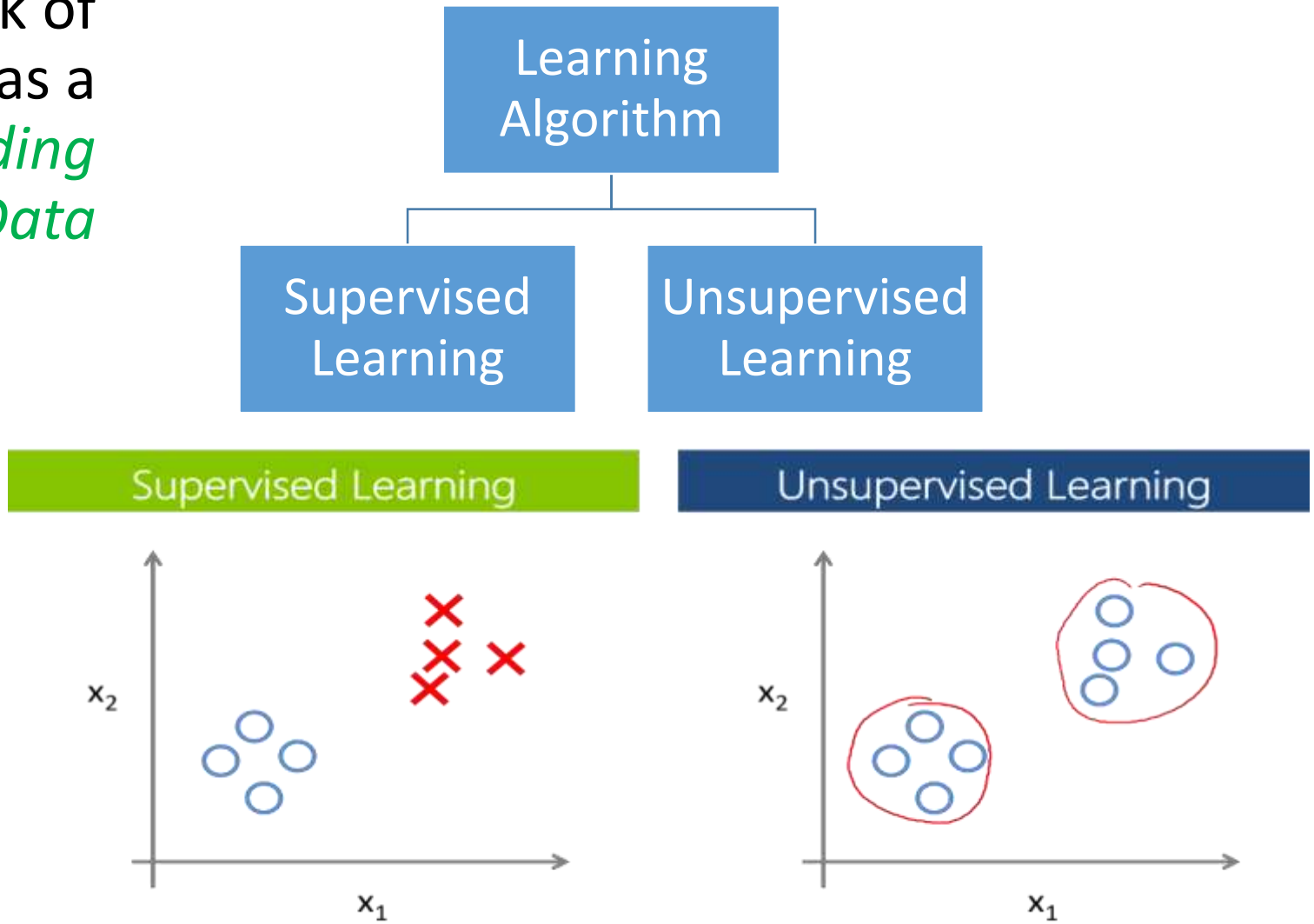
- If Programmer start making use cases / rules for complex system, then it will result in a large number of rules and exceptions.
- Machine Learning is needed in cases where humans cannot directly write a program to handle each and every case.
- So it's better to have a machine (~~rather than human~~) that learns from a large training set.

according to the definition earlier:

- Task (T): recognizing and classifying handwritten words within images
- Performance measure (P): percent of words correctly classified
- Training experience (E): a database of handwritten words with given classifications

Major Classes of Learning Algorithms

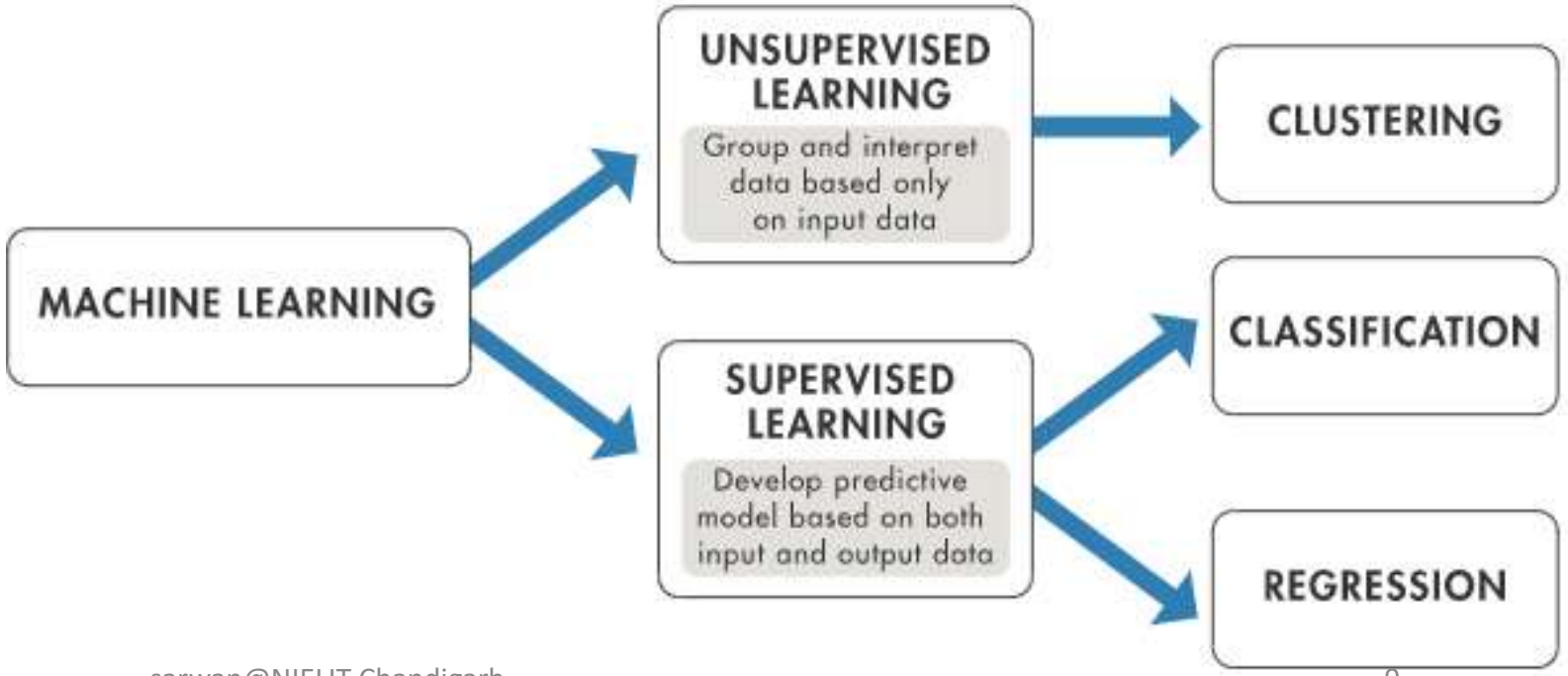
Better to think of machine learning as a *means of building models of Data*



Supervised learning

learning from exemplars

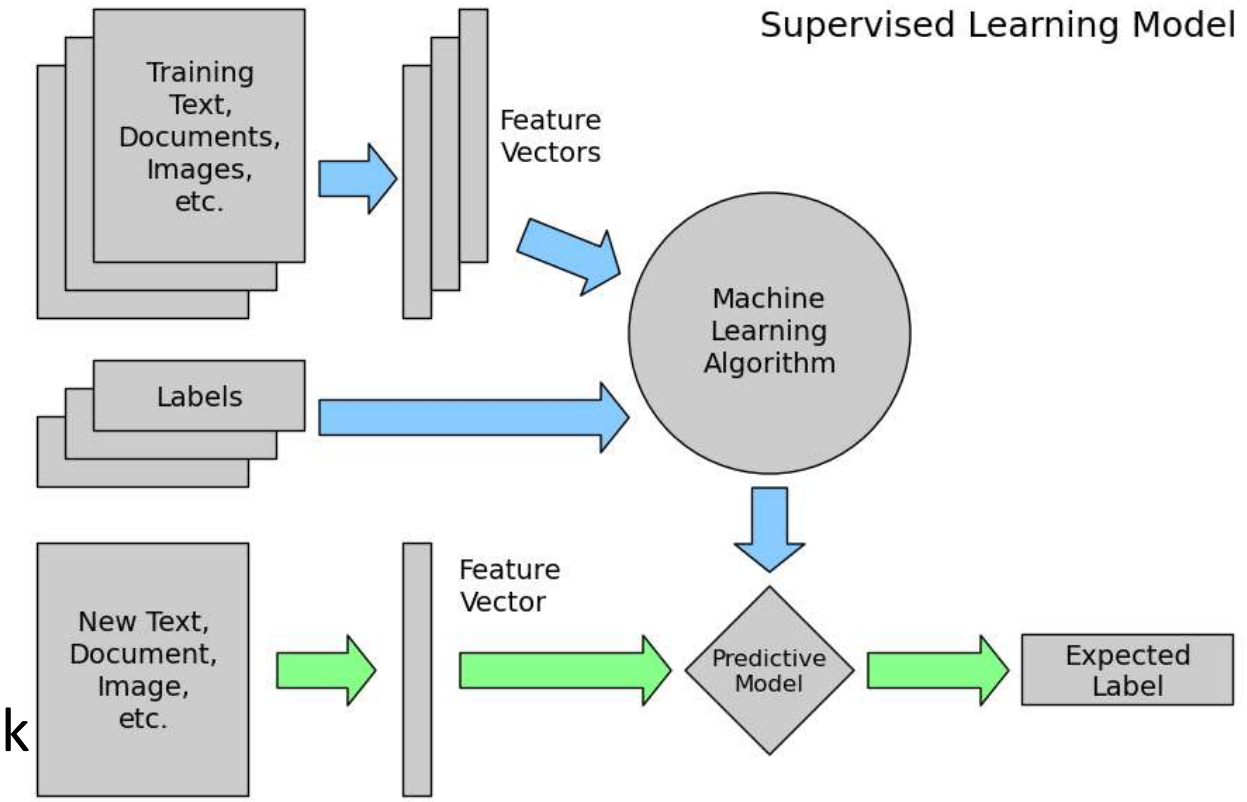
- The computer is presented with example inputs and their desired outputs, given by a "teacher", and the goal is to learn a general rule that maps inputs to outputs.
- The training process continues until the model achieves a desired level of accuracy on the training data. once this model is determined, it can be used to apply labels to new, unknown data.



Source : wikipedia

Supervised learning

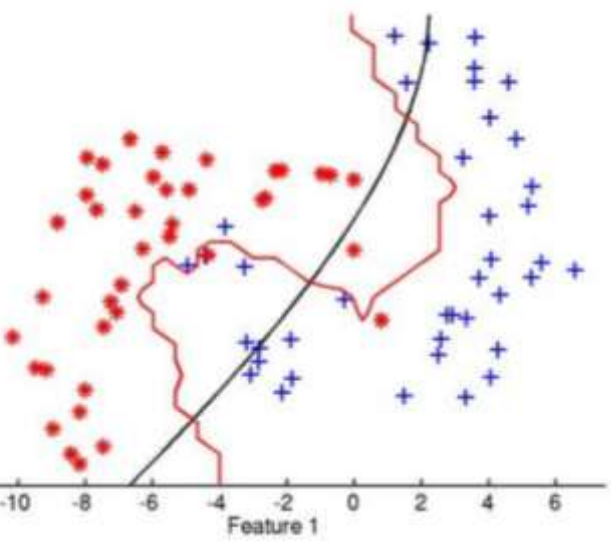
- Semi-supervised learning:
  - the computer is given only an incomplete training signal.
- Active learning:
  - the computer can only obtain training labels for a limited set of instances (based on a budget)
- Reinforcement learning:
  - training data (in form of rewards and punishments) is given only as feedback to the program's actions in a dynamic environment, such as driving a vehicle, game



Source : wikipedia

Supervised Learning: Classification Problems

- Consists of taking input vectors and deciding which of the N classes they belong to, based on training from exemplars of each class
- Find 'decision boundaries' that can be used to separate out the different classes.
- It is to decide which class the current input belongs to.



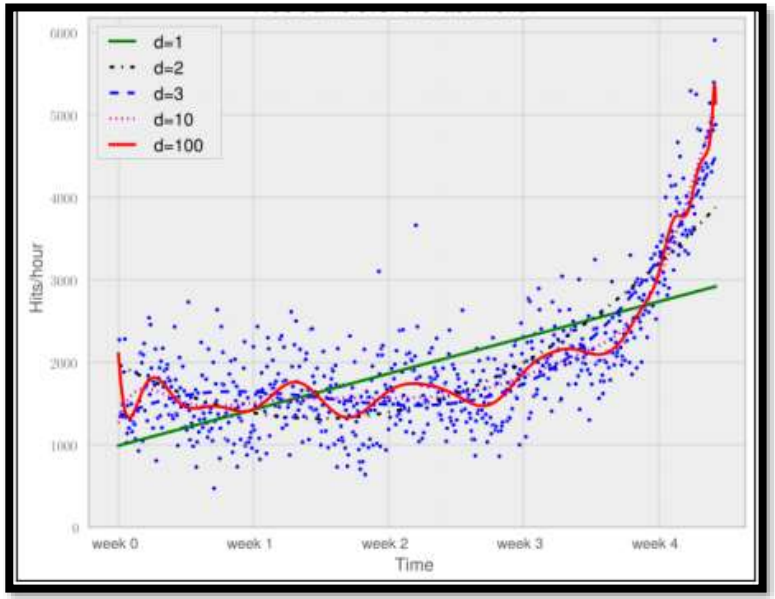
Supervised Learning

Classification Problems

Regression Problems

Supervised Learning: Regression Problems

- Given some data, you assume that those values come from some sort of function and try to find out what the function is.
- Try to fit a mathematical function that describes a curve, such that the curve passes as close as possible to all the data points.
- Regression is essentially a problem of function approximation or interpolation



Unsupervised learning

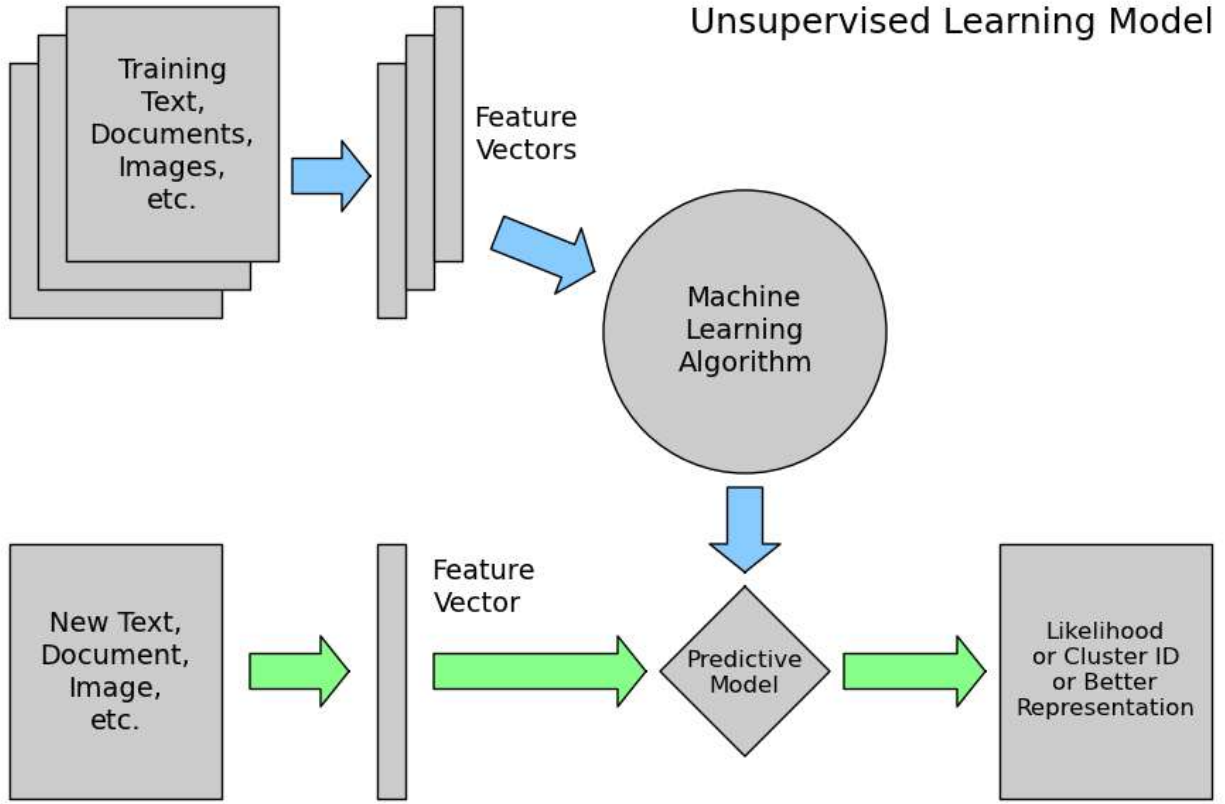
" letting the dataset speak for itself "

- No labels are given to the learning algorithm, leaving it on its own to find structure in its input. Unsupervised learning can be a goal in itself (discovering hidden patterns in data) or

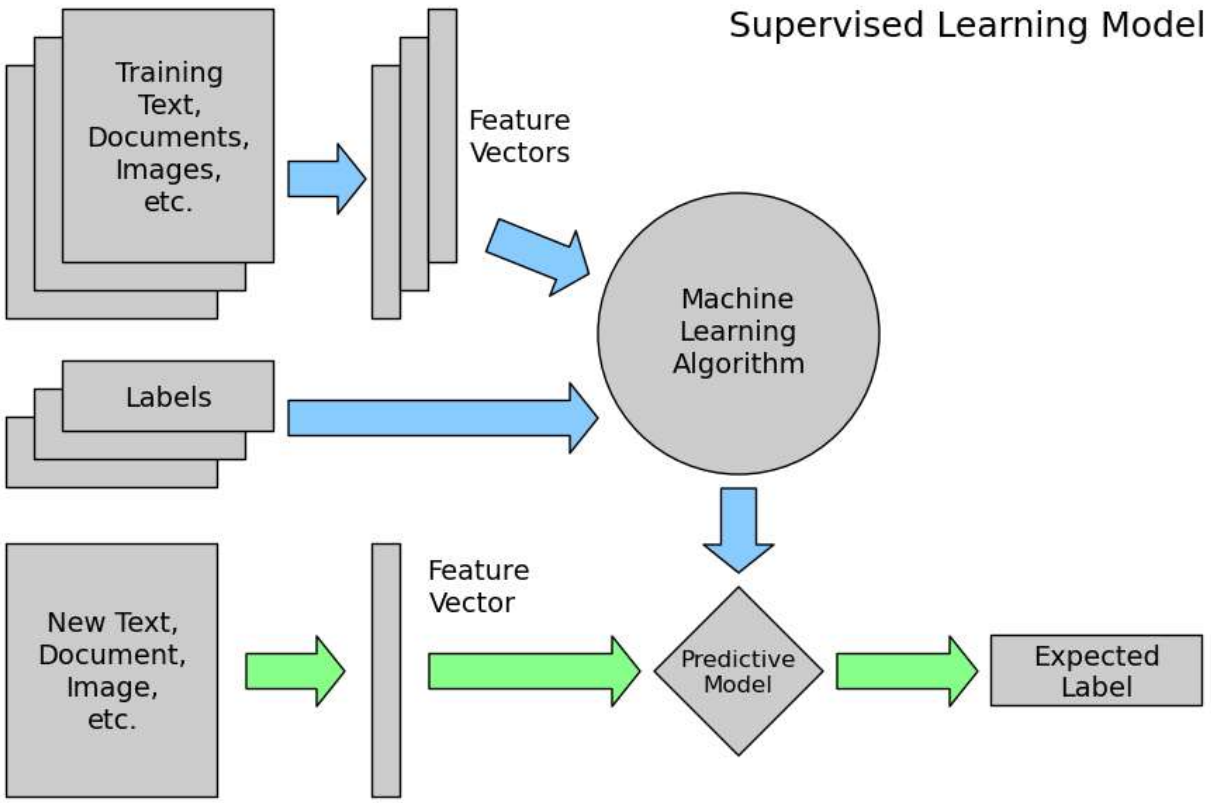
  a means towards an end (feature learning).
- It is used for clustering population in different groups, which is widely used for segmenting customers in different groups for specific intervention.
- These models include tasks such as clustering and dimensionality reduction.
  - Clustering algorithms identify distinct groups of data, while
  - Dimensionality reduction algorithms search for more succinct representations of the data.

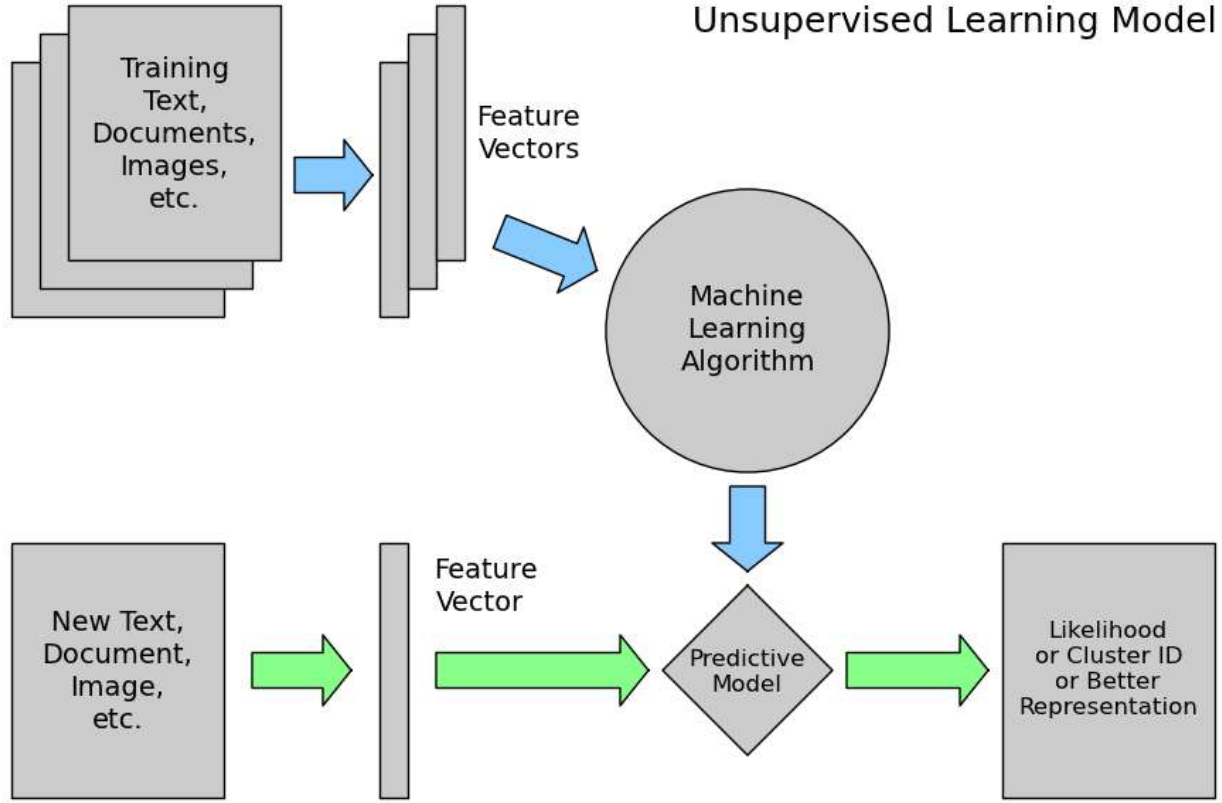
Unsupervised learning - Clustering

- The aim of unsupervised learning is to find clusters of similar inputs in the data without being explicitly told that some datapoints belong to one class and the other in other classes.
- The algorithm has to discover this similarity by itself

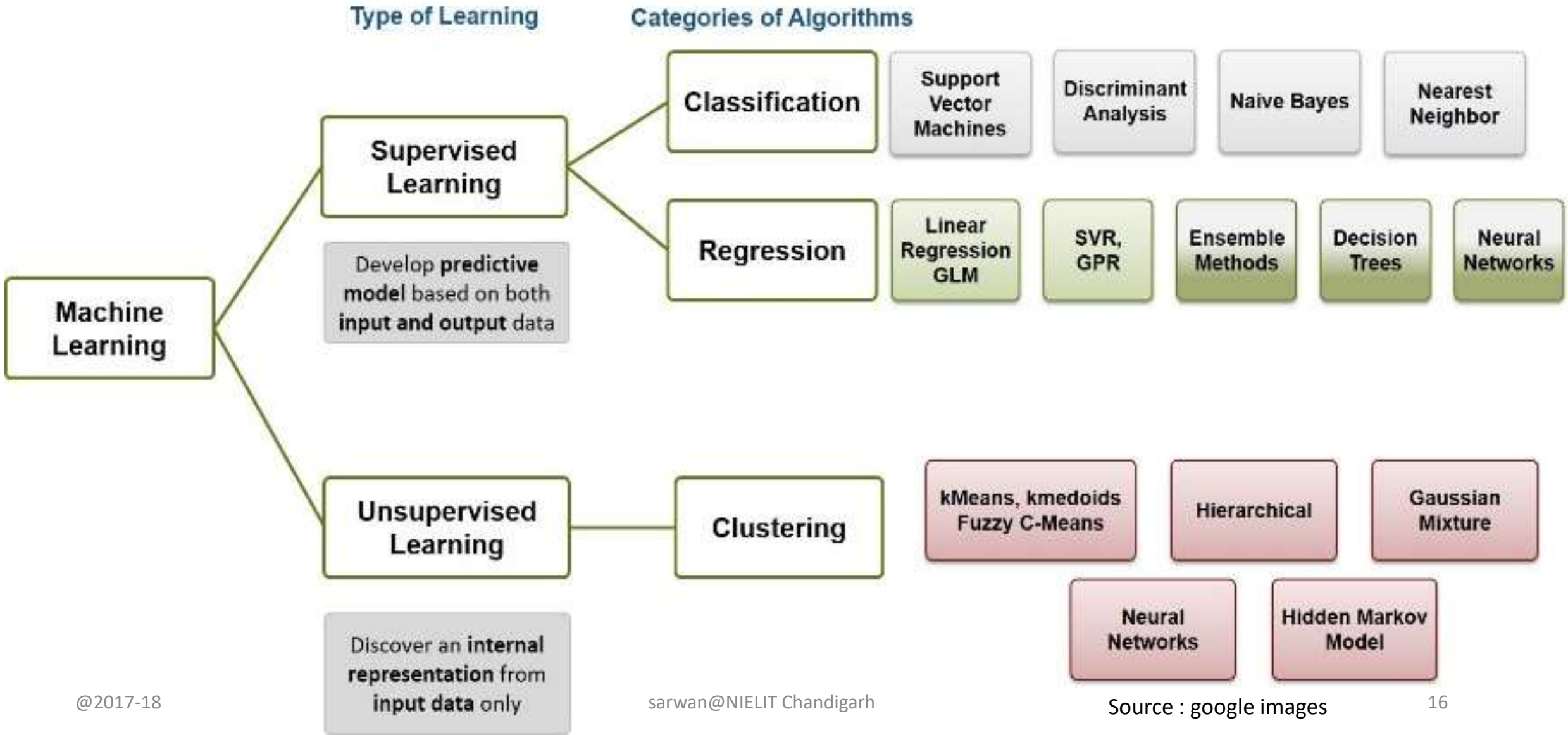


Supervised vs Unsupervised learning

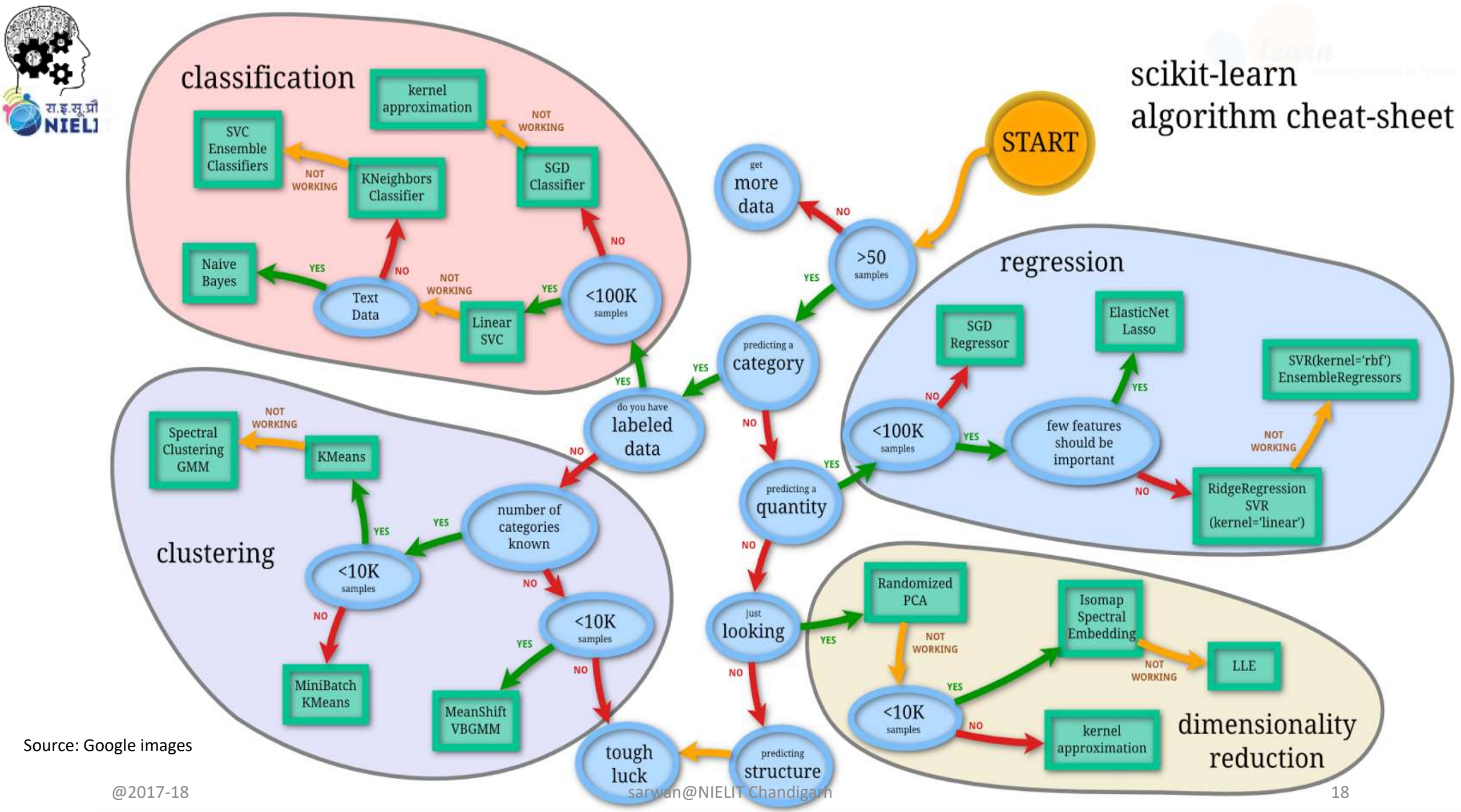




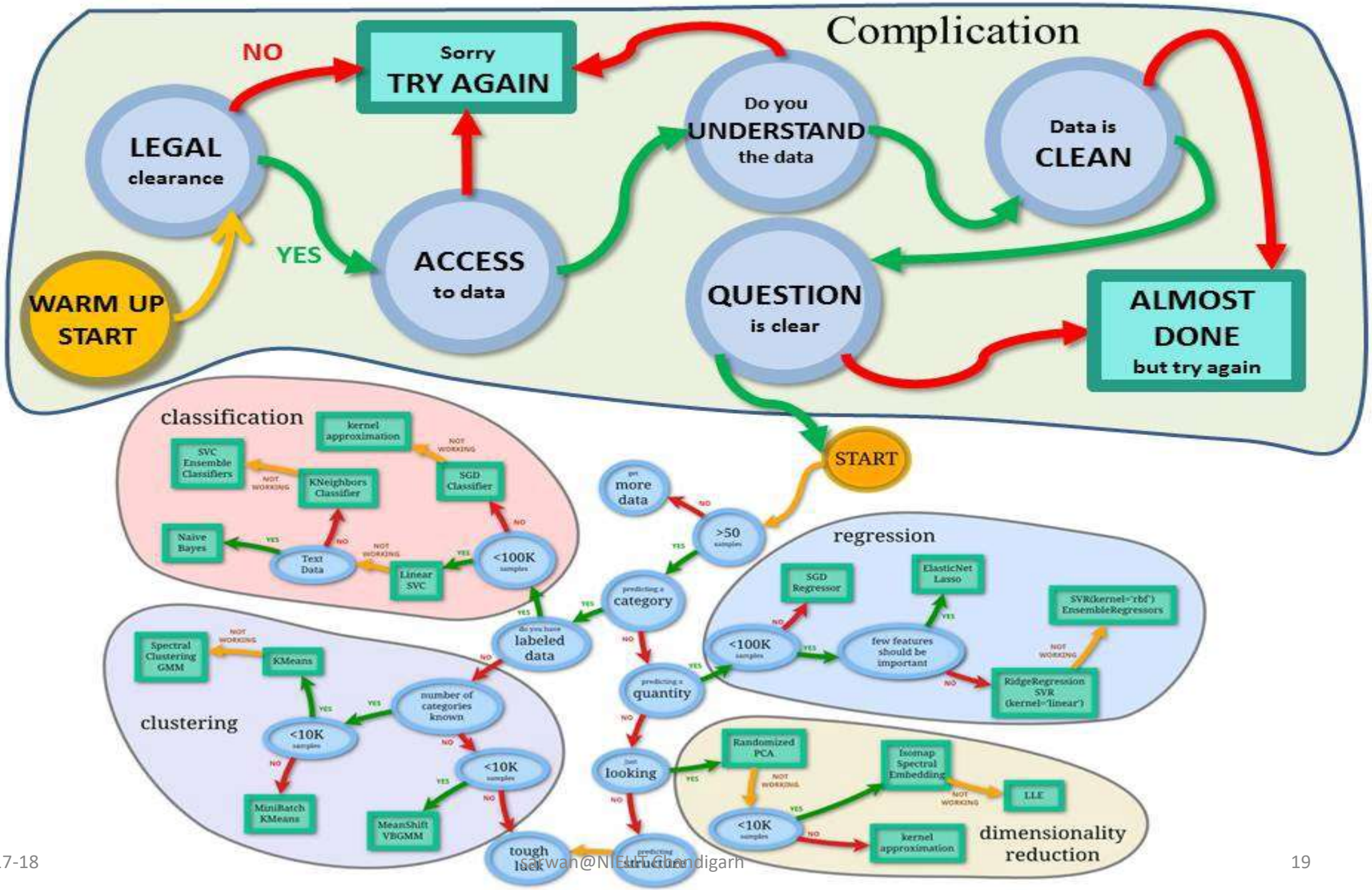
Category of Algorithms

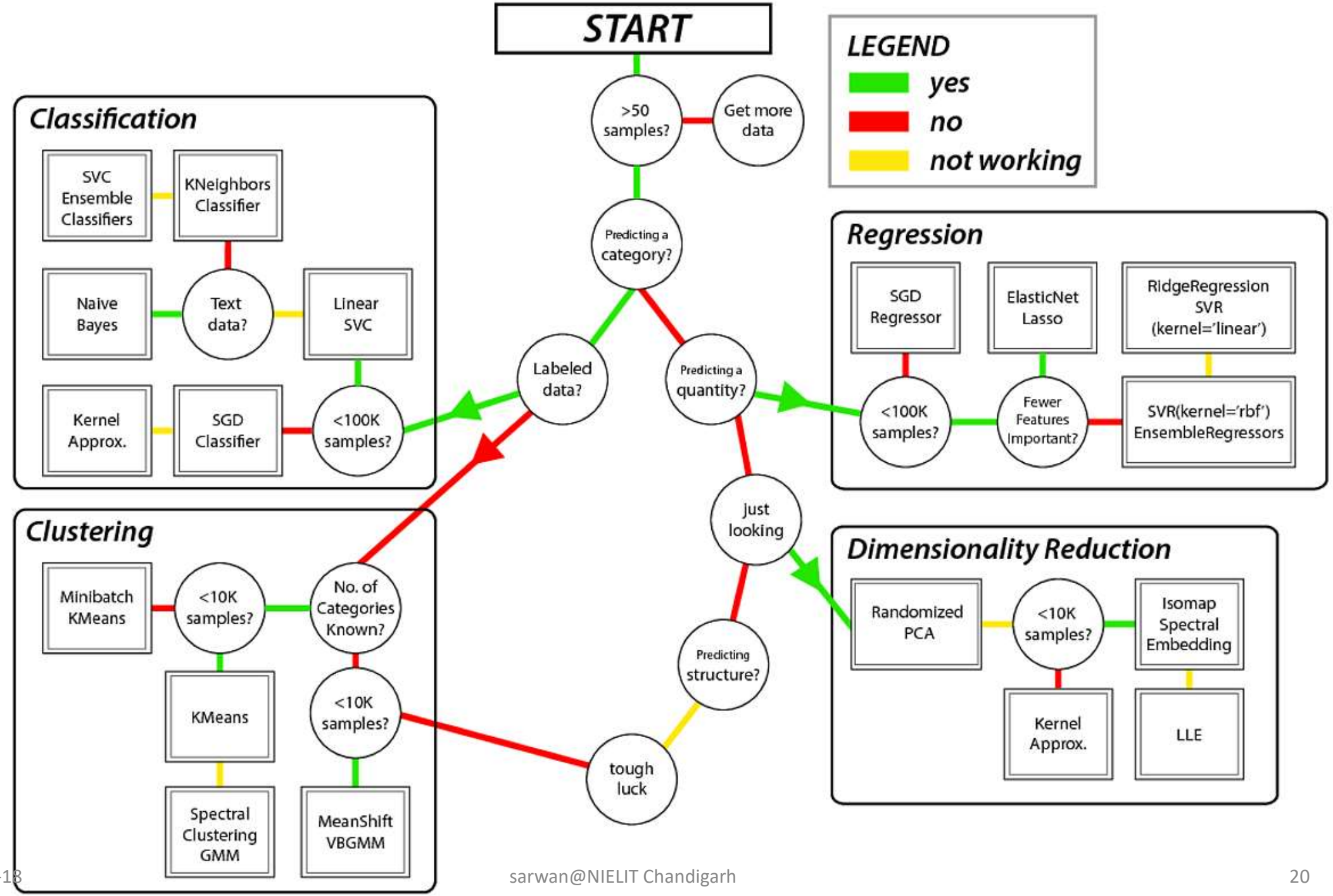


- Scikit-learn is probably the most useful library for machine learning in Python. It is on NumPy, SciPy and matplotlib, this library contains a lot of efficient tools for machine learning and statistical modeling including classification, regression, clustering and dimensionality reduction.
- Note that *scikit-learn is used to build models*. It should not be used for reading the data, manipulating and summarizing it. There are better libraries for that (e.g. NumPy, Pandas etc.)



Source: Google images


Complication
NO
Sorry
TRY AGAIN
LEGAL
clearance
YES
ACCESS
to data
Do you
UNDERSTAND
the data
Data is
CLEAN
WARM UP
START
QUESTION
is clear
ALMOST
DONE
but try again
START
classification
kernel approximation
NOT WORKING
SVC Ensemble Classifiers
NOT WORKING
KNeighbors Classifier
SGD Classifier
Naive Bayes
YES
Text Data
NO
NOT WORKING
Linear SVC
<100K samples
NO
YES
more data
NO
>50 samples
YES
predicting a category
YES
NO
do you have labeled data
NO
YES
regression
SGD Regressor
NO
ElasticNet Lasso
YES
SVR(kernel='rbf') EnsembleRegressors
<100K samples
YES
few features should be important
NOT WORKING
RidgeRegression SVR (kernel='linear')
NO
predicting a quantity
YES
NO
clustering
Spectral Clustering GMM
NOT WORKING
KMeans
number of categories known
YES
<10K samples
YES
NO
<10K samples
NO
YES
MiniBatch KMeans
MeanShift VBGMM
looking
YES
Randomized PCA
NOT WORKING
Isomap Spectral Embedding
NOT WORKING
LLE
<10K samples
YES
NO
kernel approximation
dimensionality reduction
NO
tough luck
predicting structure


START
>50 samples?
Get more data
Predicting a category?
Labeled data?
Predicting a quantity?
Just looking
Predicting structure?
tough luck
Classification
SVC Ensemble Classifiers
KNeighbors Classifier
Naive Bayes
Text data?
Linear SVC
Kernel Approx.
SGD Classifier
<100K samples?
Regression
SGD Regressor
ElasticNet Lasso
RidgeRegression SVR (kernel='linear')
<100K samples?
Fewer Features Important?
SVR(kernel='rbf') EnsembleRegressors
Clustering
Minibatch KMeans
<10K samples?
No. of Categories Known?
KMeans
<10K samples?
Spectral Clustering GMM
MeanShift VBGMM
Dimensionality Reduction
Randomized PCA
<10K samples?
Isomap Spectral Embedding
Kernel Approx.
LLE
LEGEND
yes
no
not working

Machine Learning Workflow

- No labels are given to the learning algorithm, leaving it on its own to find structure in its input. Unsupervised learning can be a goal in itself (discovering hidden patterns in data) or a means towards an end (feature learning).
- It is used for clustering population in different groups, which is widely used for segmenting customers in different groups for specific intervention.
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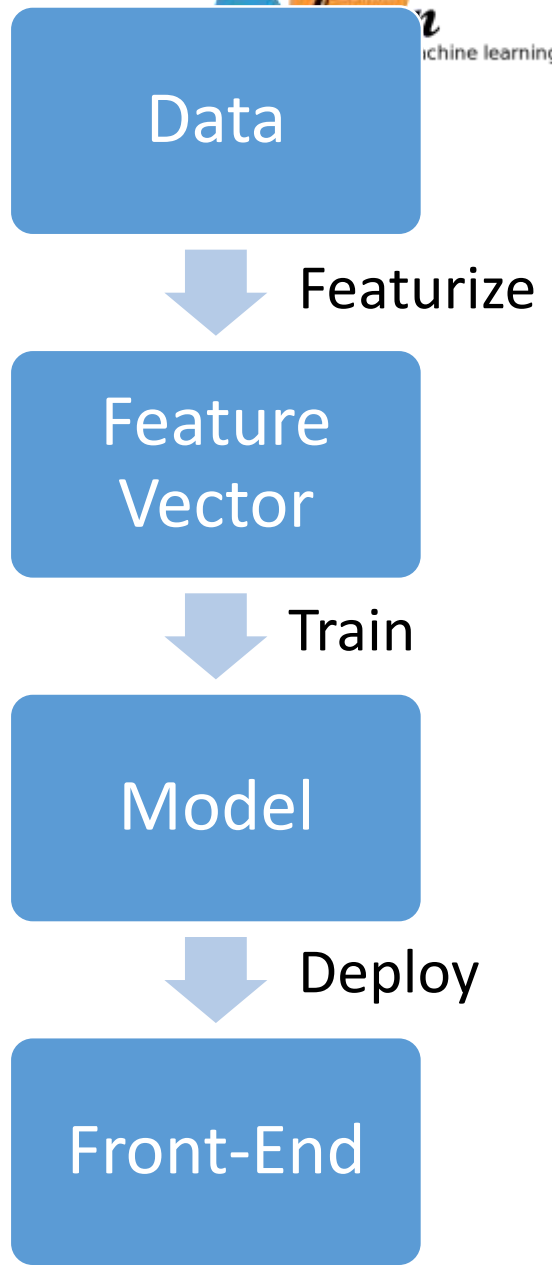

Where ML is used

- Separating SPAM email
- Categorizing post available on Internet by search engines.
- Autonomous Ground Vehicles
- Gaming
- IBM Watson- medical domain