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Artificial Intelligence and The Complexity

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Hendri Karisma

- Sr. Research and Development Engineer at blibli.com (PT. Global Digital Niaga)
- Rnd Team for Data Science
- Before working for Fraud Detection System. Current working in Dynamic Recommendation System.
- Research area : deep learning, recommendation system, fraud detection system, econometrics, stochastic methods, social media analysis, and natural language processing.

Definition of Informatics

"Automation of Information" –

Prof. Dr. Ing. Iping Supriana

What is Artificial Intelligence?

- S. Rusel and P. Norvig, Artificial Intelligence in Modern Approach

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

Acting Humanly

- Computer would need to possess the following capabilities :
  - Natural Language Processing
  - Knowledge Representation
  - Automated Reasoning
  - Machine Learning
- Turing test :
  - Computer vision : perceive objects
  - Robotics : manipulate objects and move

Thinking Humanly: The Cognitive modeling approach

- We need to get inside the actual workings of human minds :
  - **Introspection**, trying to catch our own thoughts as they go by
  - **Psychological experiments**, observing a person in action
  - **Brain imaging**, observing the brain in action

Thinking Rationally: The “laws of thought” approach

- By 1965, programs existed that could, in principle, solve any solvable problem described in logical notation. (Although if no solution exists, the program might loop forever.)
- Logicist tradition within artificial intelligence hopes to build on such programs to create intelligent systems.
- There are two main obstacles to this approach :
  - First, it is not easy to take informal knowledge and state it in the formal terms required by logical notation, particularly when the knowledge is less than 100% certain.
  - Second, there is a big difference between solving a problem “in principle” and solving it in practice.

Acting Rationally: The rational agent approach

- An agent is just something that acts
- **Computer agents** are expected to do more:
  - operate autonomously
  - perceive their environment
  - persist over a prolonged time period
  - adapt to change, and create and pursue goals.
- Making correct inferences is sometimes part of being a rational agent, On the other hand, correct inference is not all of rationality; in some situations, there is no provably correct thing to do, but something must still be done.

The Foundations of AI

- **Philosophy**
  - Can formal rules be used to draw valid conclusions?
  - How does the mind arise from a physical brain
  - Where does knowledge come from?
  - How does knowledge lead to action?
- **Mathematics**
  - What are the formal rules to draw valid conclusions?
  - What can be computed?
  - How do we reason with uncertain information?
- **Economics**
  - How should we make decisions so as to max payoff?
  - How should we do this when others may not go along
  - How should we do this when the payoff may be far in the future?
- **Neuroscience**
  - How do brains process information?
- **Psychology**
  - How do humans and animals think and act?
- **Computer engineering**
  - How can we build an efficient computer?
- **Linguistics**
  - How does language relate to thougt?

Problem Solving agent

- Searching for solution
- Knowledge Base and Planning
- Reasoning
- Learning

Searching for solution

- Uninformed search strategies :
  - Breadth-first search
  - Deep-first search
  - Depth-limited search
  - Iterative Deepening depth-first search
  - Bidirectional search
- Informed (Heuristic) search strategies :
  - Greedy best-first search
  - A* search (minimizing the total estimated solution cost)
  - Memory-bounded heuristic search
- Local Search Algorithms and Optimization Problems
- Local Search in Continuous Spaces
- Searching with Non-deteministic Actions
- Searching with Partial Observation
- Online search agents and unknown environments
- Adversarial search (Mathematical Game Theory)
- Constraint Satisfaction Problems

Knowledge base and planning

- Planners that are are used in the real world for planning and scheduling the oper- ations of spacecraft, factories, and military campaigns are more complex.
- Three Approachment :
  - Searching based problem solving
  - Hybrid logical agent
  - Classical planning using planning graph

Reasoning

- Explain how to build network models to reason under uncertainty according to the laws of probability theory.
- Representing knowledge in an uncertain domain Bayesian or Probabilistic Reasoning.
- Probabilistic Reasoning over time
- Examples : Hidden Markov Models, Kalman filters, and dynamic Bayesian networks (which include hidden Markov models and Kalman filters as special cases)

Learning

- An agent is learning if it improves its performance on future tasks after making observations about the world.
- Why would we want an agent to learn?
  - The designers cannot anticipate all possible situations that the agent might find itself in
  - The designers cannot anticipate all changes over time; a program designed to predict tomorrow's stock market prices must learn to adapt when conditions change from boom to bust.
  - Sometimes human programmers have no idea how to program a solution themselves

Learning

- Inductive
  - Machine Learning
- Deductive
  - Expert system

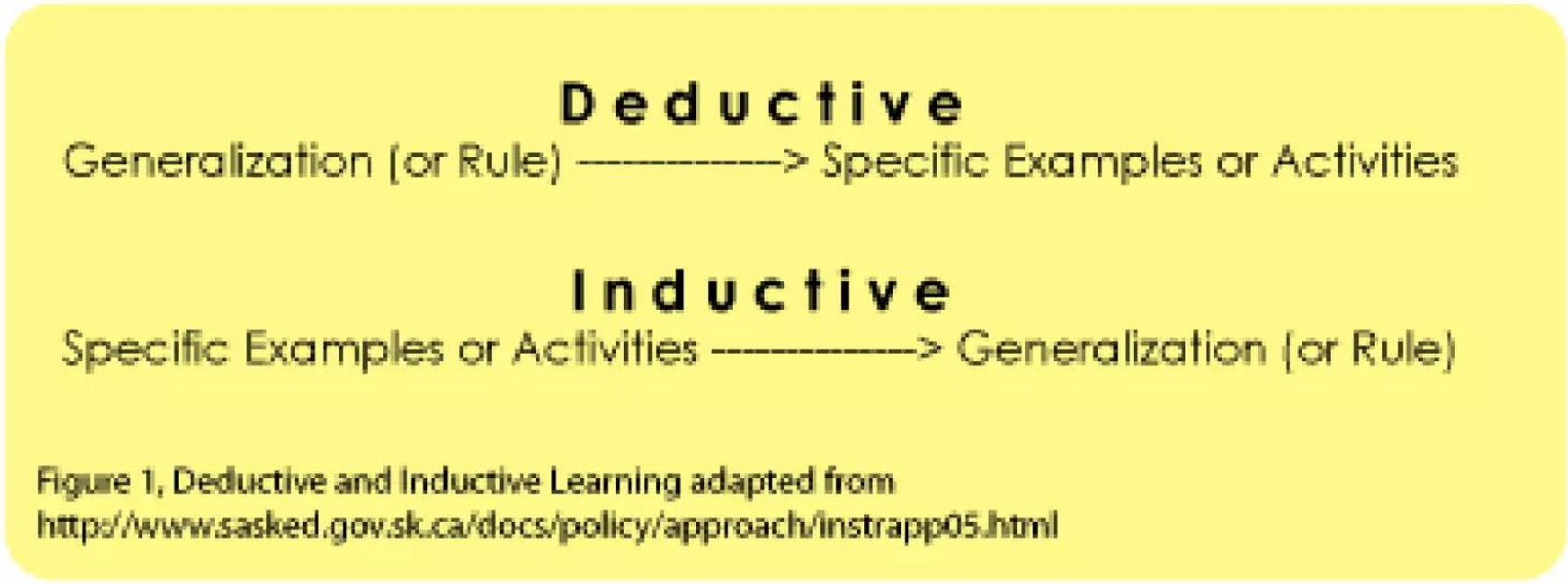


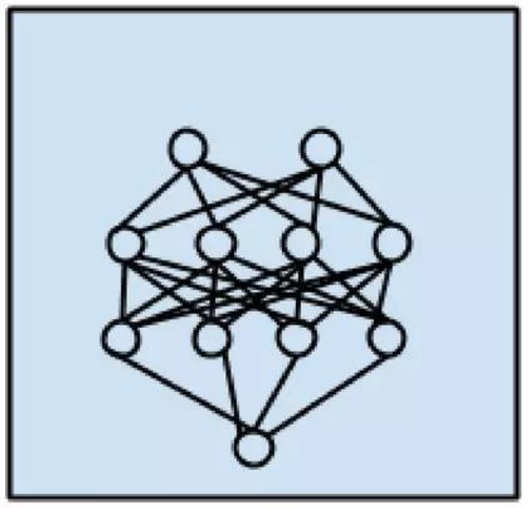
Figure 1, Deductive and Inductive Learning adapted from
http://www.sasked.gov.sk.ca/docs/policy/approach/instrapp05.html

Machine Learning Definition

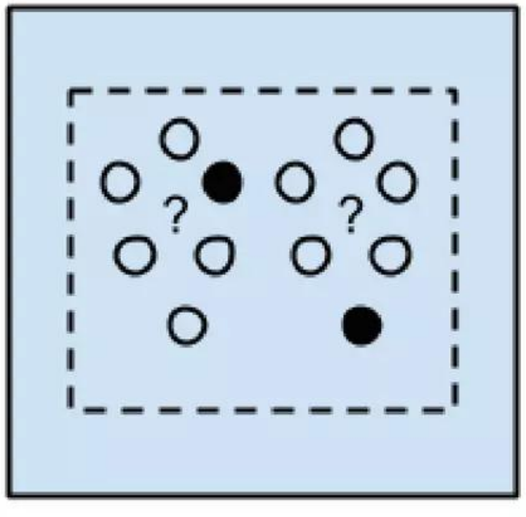
"A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E." – Prof. Tom Mitchel

Machine Learning #1

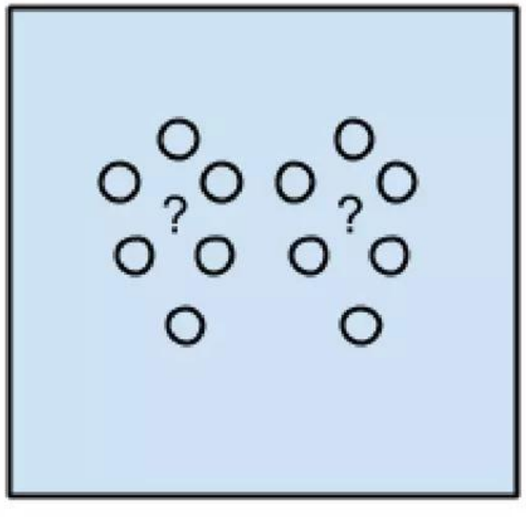
- Supervised
- Unsupervised
- Reinforcement Learning
- Semi-Supervised
- Deep Learning



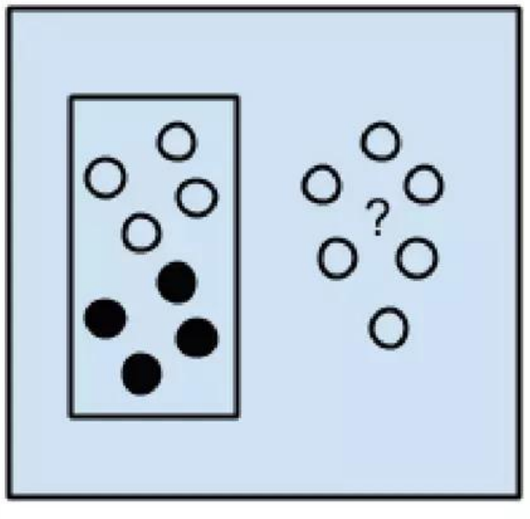
Deep Learning Algorithms



Semi-supervised Learning Algorithms

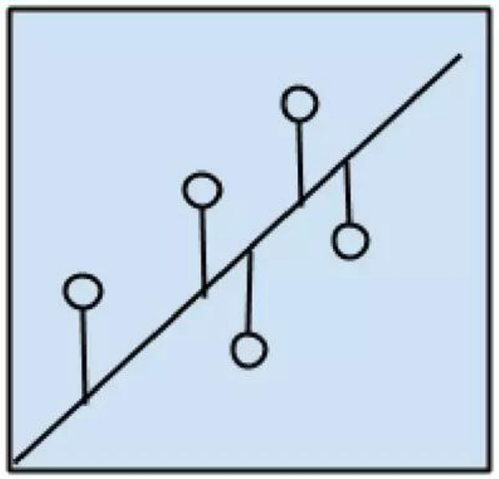


Unsupervised Learning Algorithms

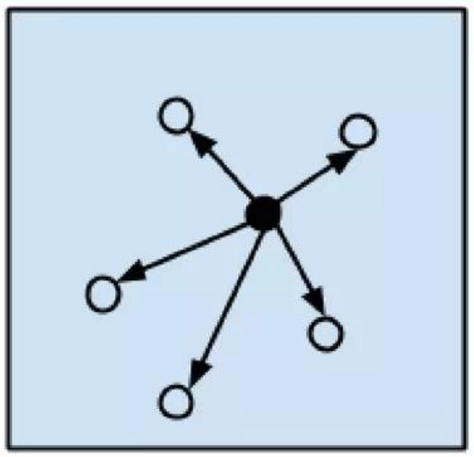


Supervised Learning Algorithms

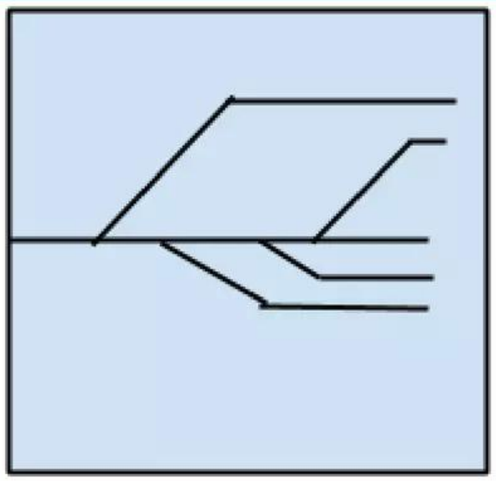
Machine Learning #2



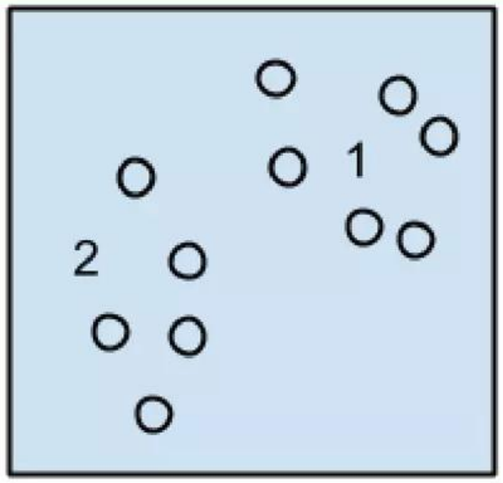
Regression Algorithms



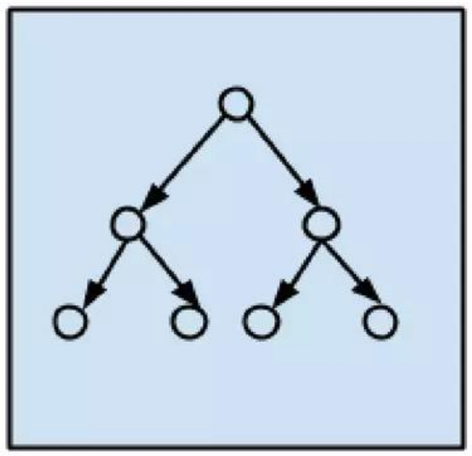
Instance-based Algorithms



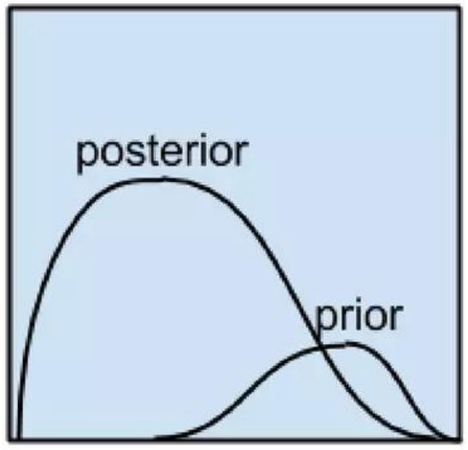
Regularization Algorithms



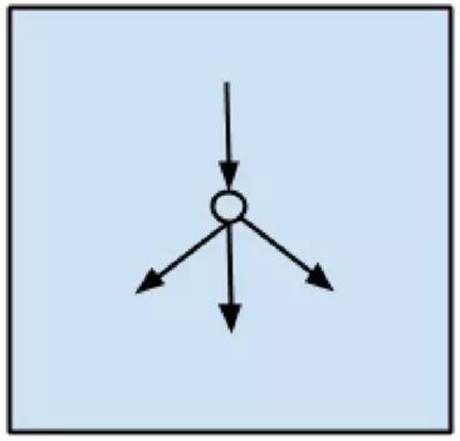
Clustering Algorithms



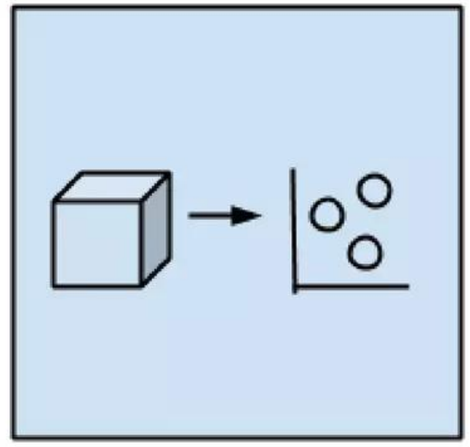
Decision Tree Algorithms



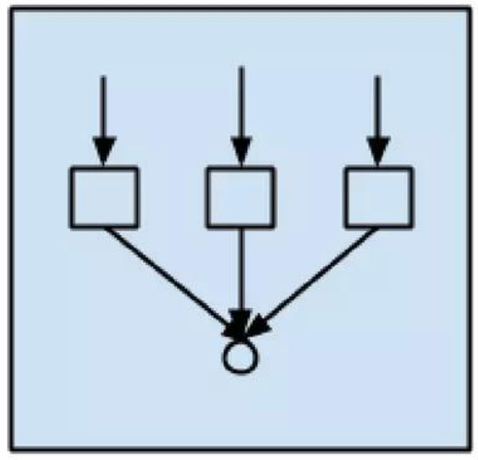
Bayesian Algorithms



Artificial Neural Network Algorithms

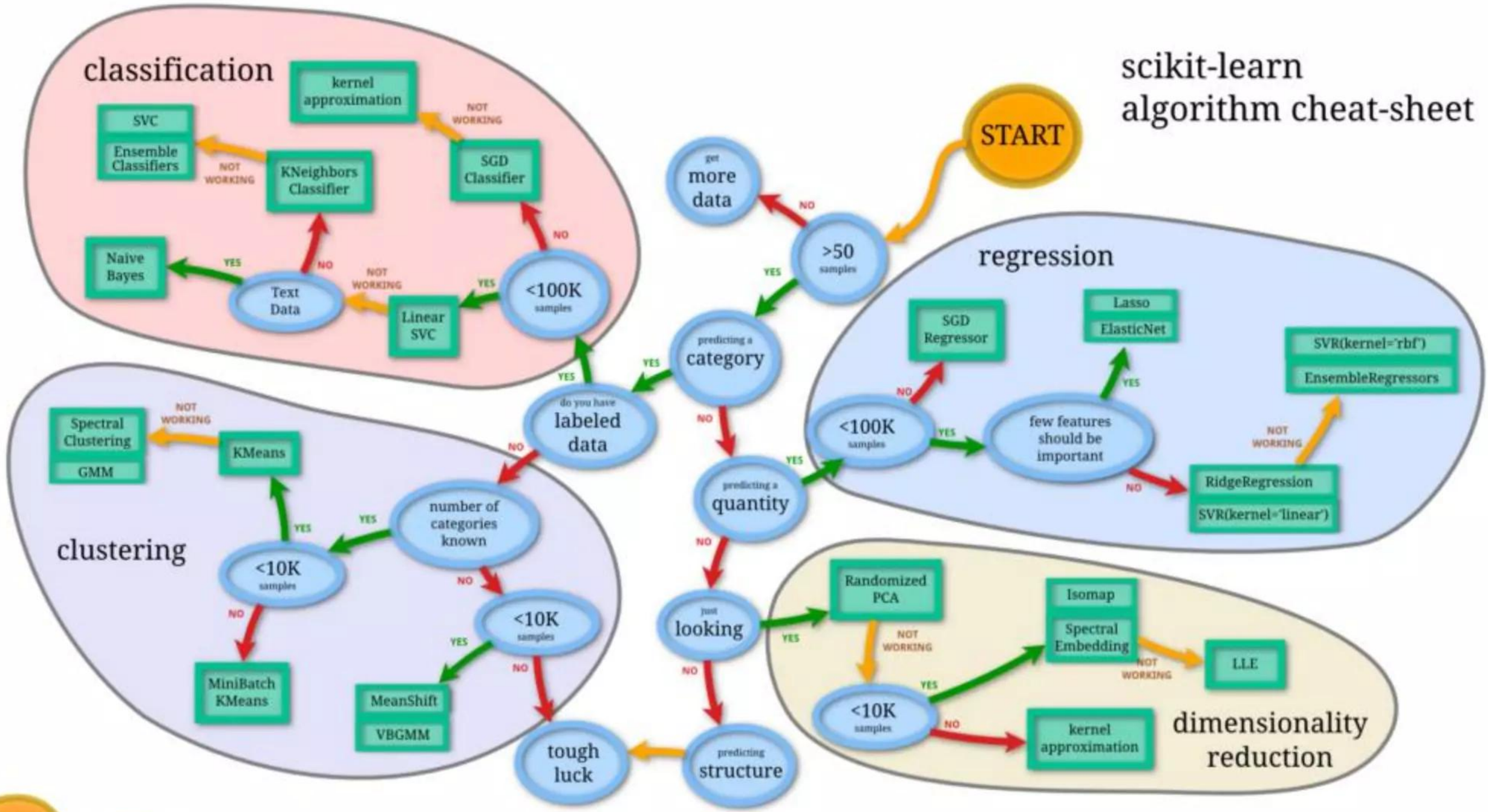


Dimensional Reduction Algorithms



Ensemble Algorithms

Machine Learning Taxonomy #1



Machine Learning Taxonomy #2

Machine Learning: Algorithm Cheat Sheet

START

CLUSTERING

No → **K-means**

Predict future data points?

Yes

Predict categories or values?

Categories

ANOMALY DETECTION

Yes → **One-class SVM**

No → **PCA-based anomaly**

Yes → <100K data points or >100 features?

Values

REGRESSION

Yes → **Ordinal regression**

Data in rank-ordered categories?

No

Yes → **Poisson regression**

Predict event counts?

No

Distribution → **Fast forest quantile regression**

Predict single values or a distribution?

Single values

Close enough → **Linear regression**

Linear approximation okay?

No

Yes → Prefer explainable class boundaries

Decision forest regression

If you have overlapping features, try:

Boosted decision tree regression

No

Neural network regression

If your data points are statistically independent, try:

Bayesian linear regression

MULTI-CLASS CLASSIFICATION

>2 → Two categories or more than two?

2

One of the categories rare?

No → Choose a two-class classifier

Yes → Prefer classifier built from >1 two-class classifiers?

No → Prefer explainable class boundaries?

Yes → **One-v-All multiclass**

No → **Multiclass logistic regression**

Yes → Select one:
Multiclass decision forest
Muilticlass decision jungle

If you prefer performance over training time, and all features are numerical, try:

Multiclass neural network

TWO-CLASS CLASSIFICATION

Yes → <100K data points or >100 features

Two-class SVM

If the accuracy is good but you want it faster, try:

Locally Deep SVM

No

Speed → Prefer speed or accuracy?

Two-class averaged perception

Accuracy

No → Prefer explainable class boundaries?

Two-class logistic regression

If you prefer performance over training time, and all features are numerical, try:

Two-class neural network

If your data points are statistically independant, you can try:

Two-class Bayes point machine

Yes

Select one:
Two-class decision forest
Two-class decision jungle

If you have overlapping features, try:

Two-class boosted decision tree

Machine Learning Application in Business

MACHINE INTELLIGENCE 3.0

ENTERPRISE INTELLIGENCE

VISUAL
Orbital Insight, planet, clarifai, DEEPVISION, cortica, Sagacian, SPACE_KNOW, Captricity, netra, deepomatic

AUDIO
Gridspace, TalkIQ, nexidia, twilio, CAPIO, Expect Labs, Clover, Mobvoi, QuriousAI, popup archive

SENSOR
PREDIX, C3IoT, MAANA, Sentenai, PLANET OS, UPTAKE, IMUBIT, Preferred Networks, thingworx, KONUX, Alluvium

INTERNAL DATA
PRIMER, IBM WATSON, Cycorp, Palantir, ARIMO, Alation, sapho, Outlier, Digital Reasoning

MARKET
mattermark, Quid, DataFox, PREMISE, Bottlenose, MOTIVA, enigma, CB INSIGHTS, Tracxn, predata

ENTERPRISE FUNCTIONS

CUSTOMER SUPPORT
DigitalGenius, Kasisto, ELOQUENT, Wiseio, ACTIONIQ, zendesk, Preact, CLARABRIDGE

SALES
collective[i], 6sense, fuse|machines, AVISO, salesforce, INSIDE SALES.COM, clari, Zensight

MARKETING
MINTIGO, Lattice, RADIUS, LiftIgniter, PERSADO, brightfunnel, retention, MOTIVA, COGNICOR, AIRPR, msg.ai

SECURITY
CYLANCE, DARKTRACE, ZIMPERIUM, deepinstinct, Sentinel, DEMISTO, graphistry, drawbridge, SignalSense, AppZen

RECRUITING
textio, entelo, Wade & Wendy, hi, unitive, SpringRole, GIGSTER, HireVue

AUTONOMOUS SYSTEMS

GROUND NAVIGATION
drive.ai, AdasWorks, ZOOX, MOBILEYE, UBER, Google, TESLA, nuTonomy, Auro Robotics

AERIAL
SKYDIO, SHIELD AI, Airware, dji, LILY, DroneDeploy, pilot.ai, SKYCATCH

INDUSTRIAL
JAYBRIDGE, OSARO, CLEARPATH, fetch, KINDRED, HARVEST, rethink robotics

AGENTS

PERSONAL
amazon alexa, Cortana, Allo, facebook, Siri, Replika

PROFESSIONAL
butter.ai, pogo, SKIPFLAG, clara, x.ai, slack, talla, Zoom.ai, sudo

INDUSTRIES

AGRICULTURE
BLUE RIVER, mavrx, tule, TRACE GENOMICS, Pivot Bio, TerrAvion, AGRI-DATA, Descartes Labs, udio, abundant robotics

EDUCATION
KNEWTON, volley, gradescope, CTI, coursera, UDACITY, altschool

INVESTMENT
Bloomberg, sentient, iSENTIUM, KENSHO, alphasense, Dataminr, CEREBELLUM CAPITAL, Quandl

LEGAL
blueJ, BEAGLE, Everlaw, RAVEL, Seal, ROSS, LEGAL ROBOT

LOGISTICS
NAUTO, Acerta, PRETECKT, clearmetal, Routific, MARBLE, PITSTOP

INDUSTRIES CONT'D

MATERIALS
zymergen, Citrine, Eigen Innovations, SIGHT MACHINE, GINKGO BIOWORKS, nanotronics, CALCULARIO

RETAIL FINANCE
TALA, zestfinance, Lendo, earnest, Affirm, MIRADOR, wealthfront, Betterment

HEALTHCARE

PATIENT
PULSE, CareSkore, ZEPHYR HEALTH, IBM Watson Health, OncoRe, SENTRIAN, Atomwise, Numerate

IMAGE
BUTTERFLY, 3SCAN, ARTERYS, enlitic, BAYLABS, imagia, Google DeepMind

BIOLOGICAL
iCarbonX, color, GRAIL, deep genomics, RECURSION, LUMINIST, Numerate, Atomwise, verily, WHOLE BIOME

shivonzilis.com/MACHINEINTELLIGENCE · Bloomberg BETA

TECHNOLOGY STACK

AGENT ENABLERS
OCTANE.AI, howdy, MaluubA, KITT.AI, OpenAI Gym, Kasisto, AUTOMAT, semanticmachines

DATA SCIENCE
DOMINO, SPARKBEYOND, rapidminer, kaggle, DataRobot, yhat, AYASDI, data iku, seldon, yseop, bigml

MACHINE LEARNING
CognitiveScale, GoogleML, context relevant, Cycorp, HyperScience, narrologics, minds.ai, H2O.ai, SCALED INFERENCE, sparkcognition, loop, GEOMETRIC INTELLIGENCE, deepsense.io, reactive, skymind, bonsai

NATURAL LANGUAGE
agolo, AYLIEN, LEXALYTICS, Narrative Science, spaCy, LUMINOSO, cortical.io, MonkeyLearn

DEVELOPMENT
SIGOPT, HyperOpt, fuzzy.io, okite, rainforest, lobe, Anodot, Signifai, LAYER 6, bonsai

DATA CAPTURE
CrowdFlower, diffbot, CrowdAI, import.io, Paxata, DATASIFT, amazon mechanical turk, enigma, WorkFusion, DATALOGUE, TRIFACTA, parsehub

OPEN SOURCE LIBRARIES
Keras, Chainer, CNTK, TensorFlow, Caffe, H2O, DEEPLEARNING4J, theano, torch, DSSTNE, Scikit-learn, AzureML, neon, MXNet, DMTK, Spark, PaddlePaddle, WEKA

HARDWARE
KNUPATH, TENSTORRENT, Cirrascale, NVIDIA, intel nervana, Movidius, tensilica, GoogleTPU, 10^{26} Labs, Qualcomm, Cerebras, Isosemi

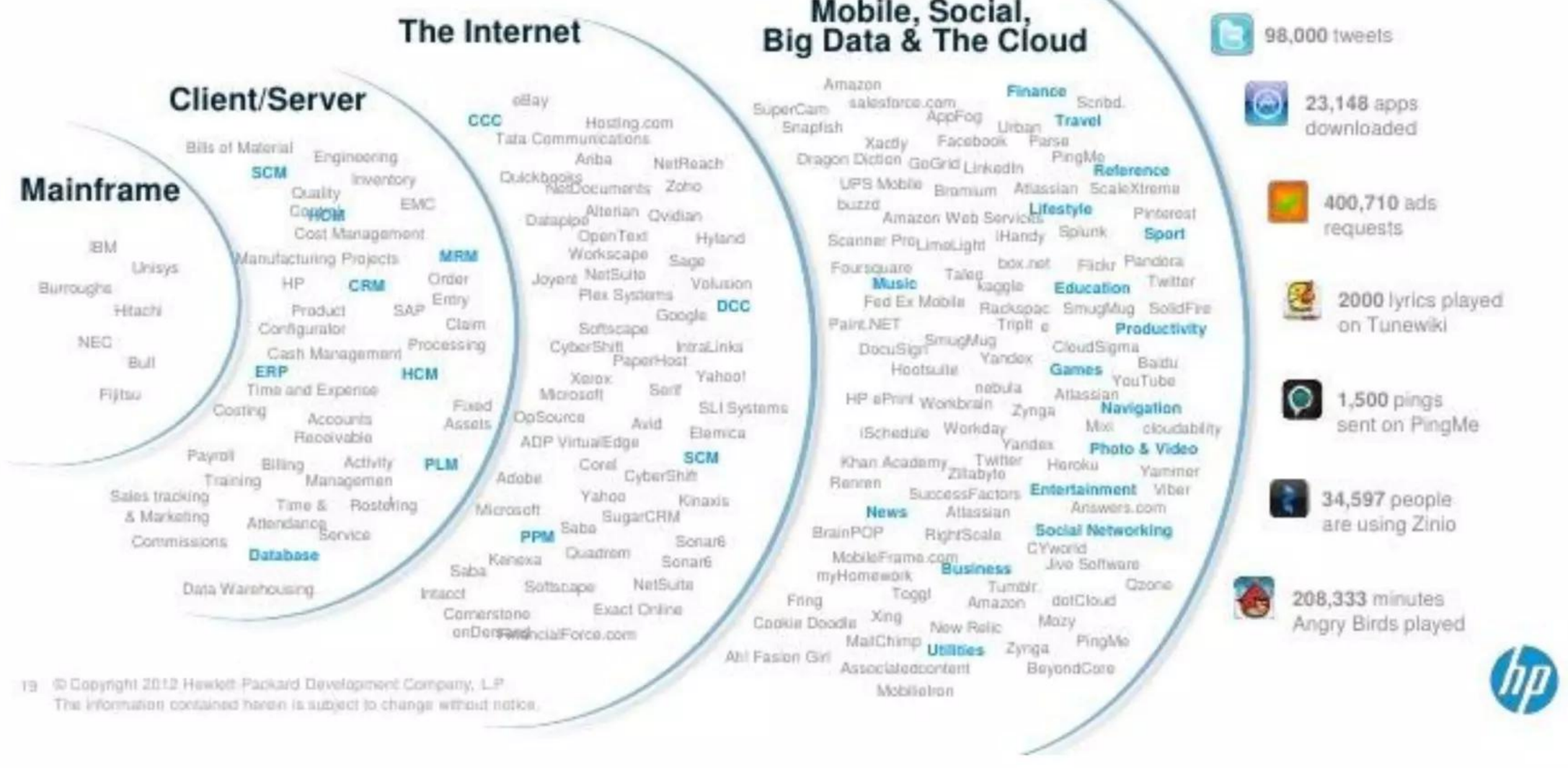
RESEARCH
OpenAI, maluuba, ELEMENT AI, vicarious, KNOGGIN, Numenta, Kimera Systems, Cogitai

Artificial Intelligence in Industry

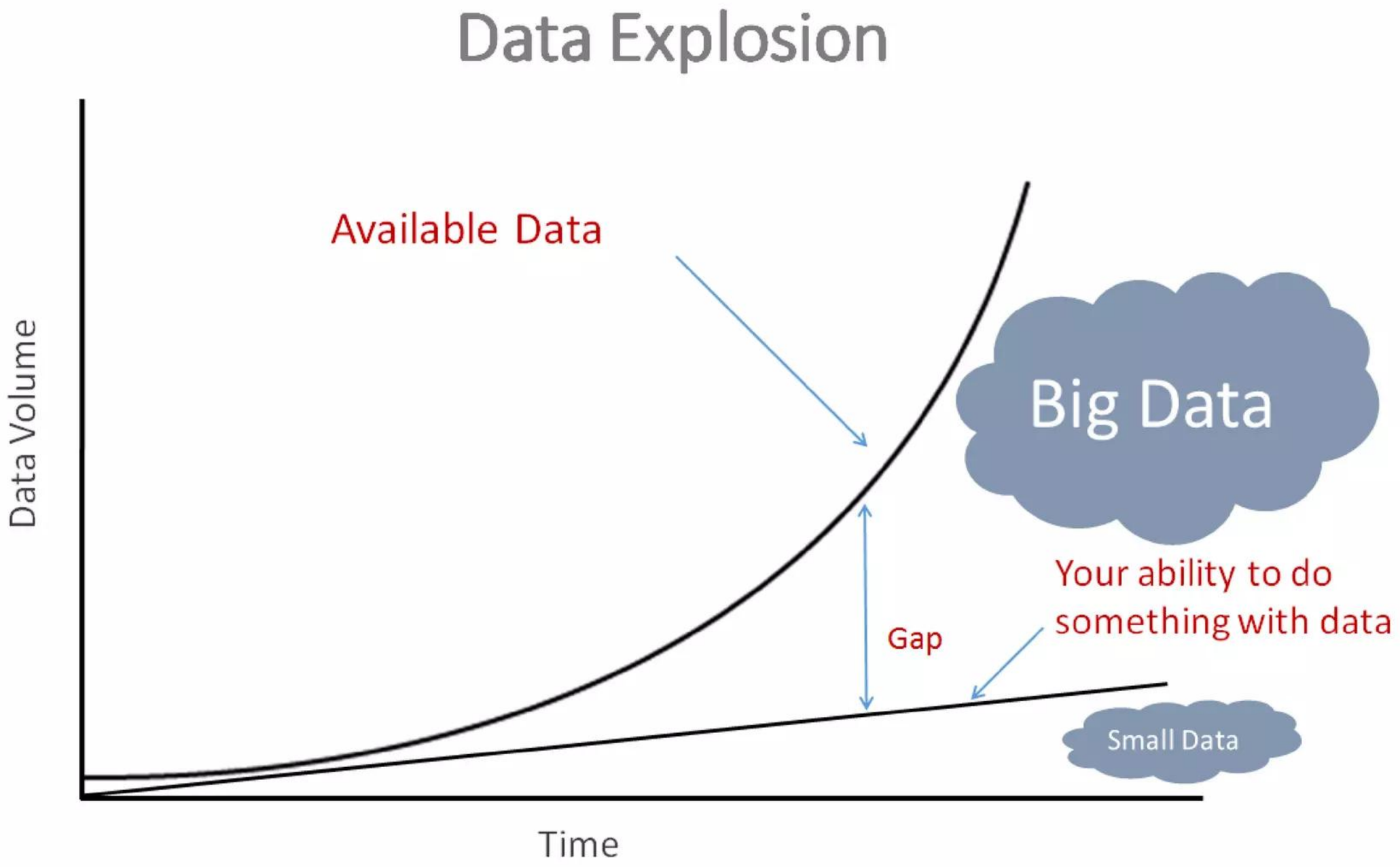
- **Fraud Detection System**
- **Dynamic Recommendation System and User Profiling**
- **Traveling Salesman Problem and Binpacking Problem for better warehouse management**
- Chatbot
- **Social Media Analysis**
  - Vocal users
  - Preprocessing for another approachment (add more features)
- Company condition forecasting
- Governance simulation

The Complexity #1

Accelerating Innovation & Change – every 60 seconds



The Complexity #2



The Complexity #3

- Big data : volume, variety, velocity, and veracity. (You might consider a fifth V, value.)
- Knowledge representation or the architecture of the model
- Unimplemented methods/algorithms in any libraries
- Stack of methods
- Data mostly unlabeled data
- Features Engineering (especially from unstructured data)
- Machines (Hardware)
- High Performance Computing

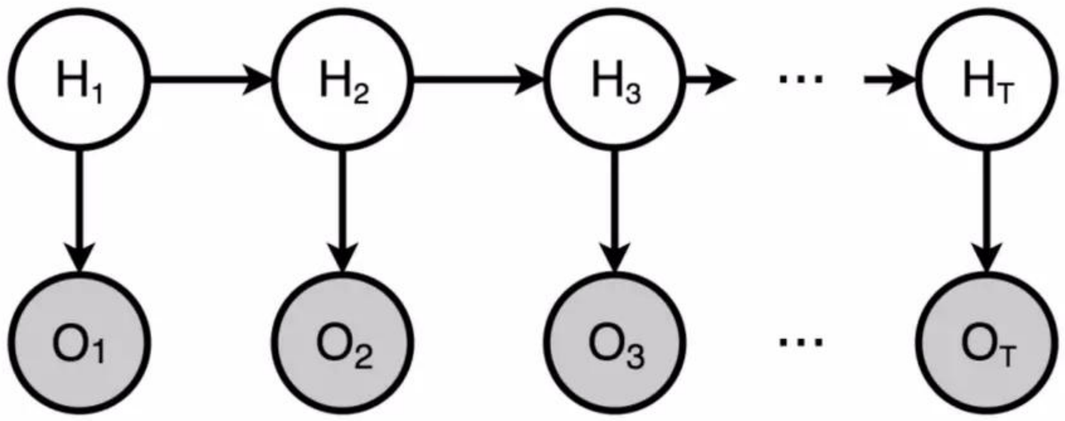
Big Data

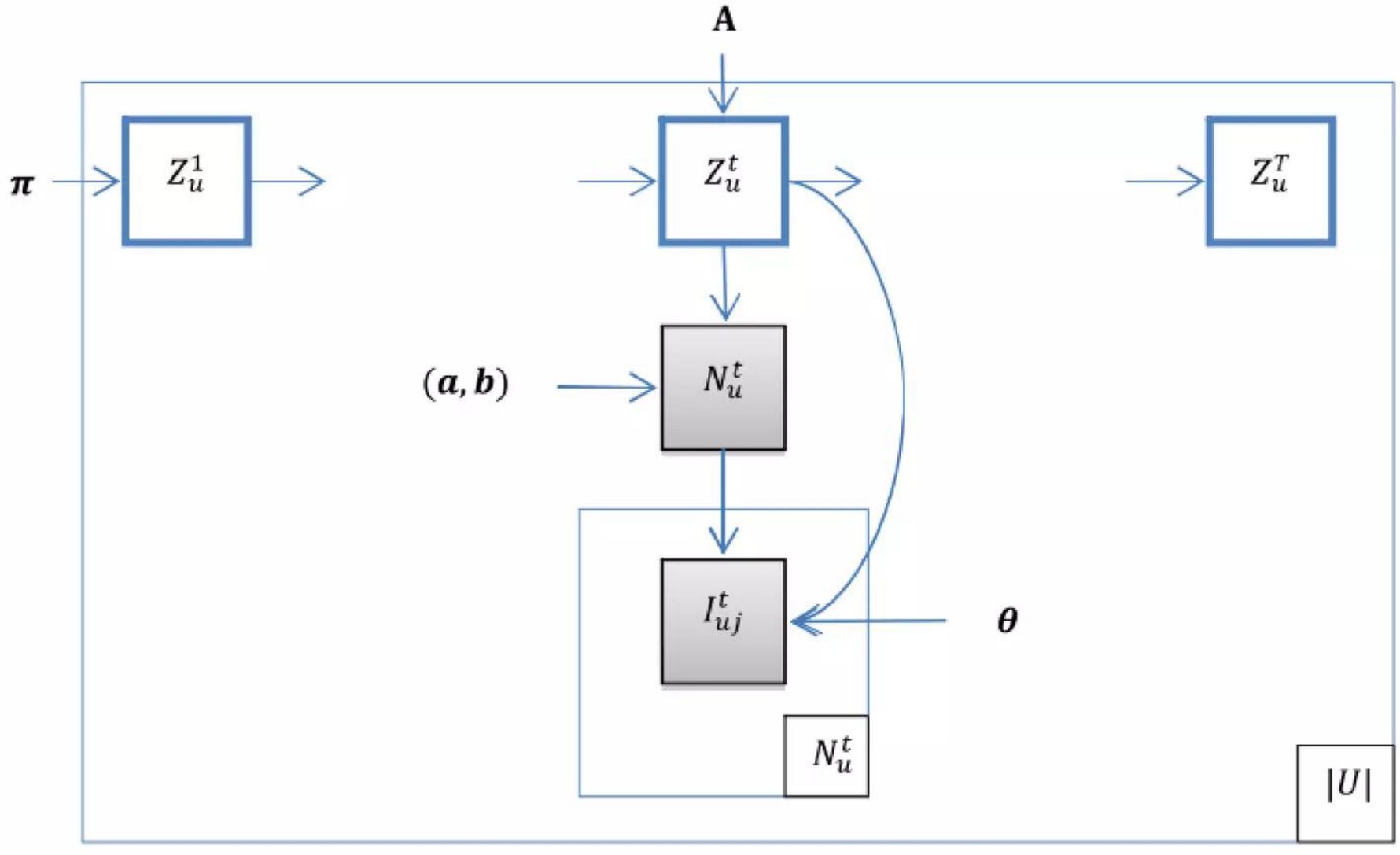
- **Data retrieving**: Big Query
- **Stream analytics**: software that can filter, aggregate, enrich, and analyze a high throughput of data from multiple disparate live data sources and in any data format.
- Data Sources: operational and functional systems, machine logs and sensors, Web and social and many other sources
- Data Platforms, Warehouses and Discovery Platforms: that enable the capture and management of data, and then – critically – its conversion into customer insights and, ultimately, action

Stack of Methods

- More complex methods and models
- Methods characteristic
- Methods behavior
- Methods customization
  - Ex. Semi-supervised, Deep learning, features engineering
  - Sample cases : our research in FDS and dynamic recommendation system

Dynamic Collaborative Filtering using HMM



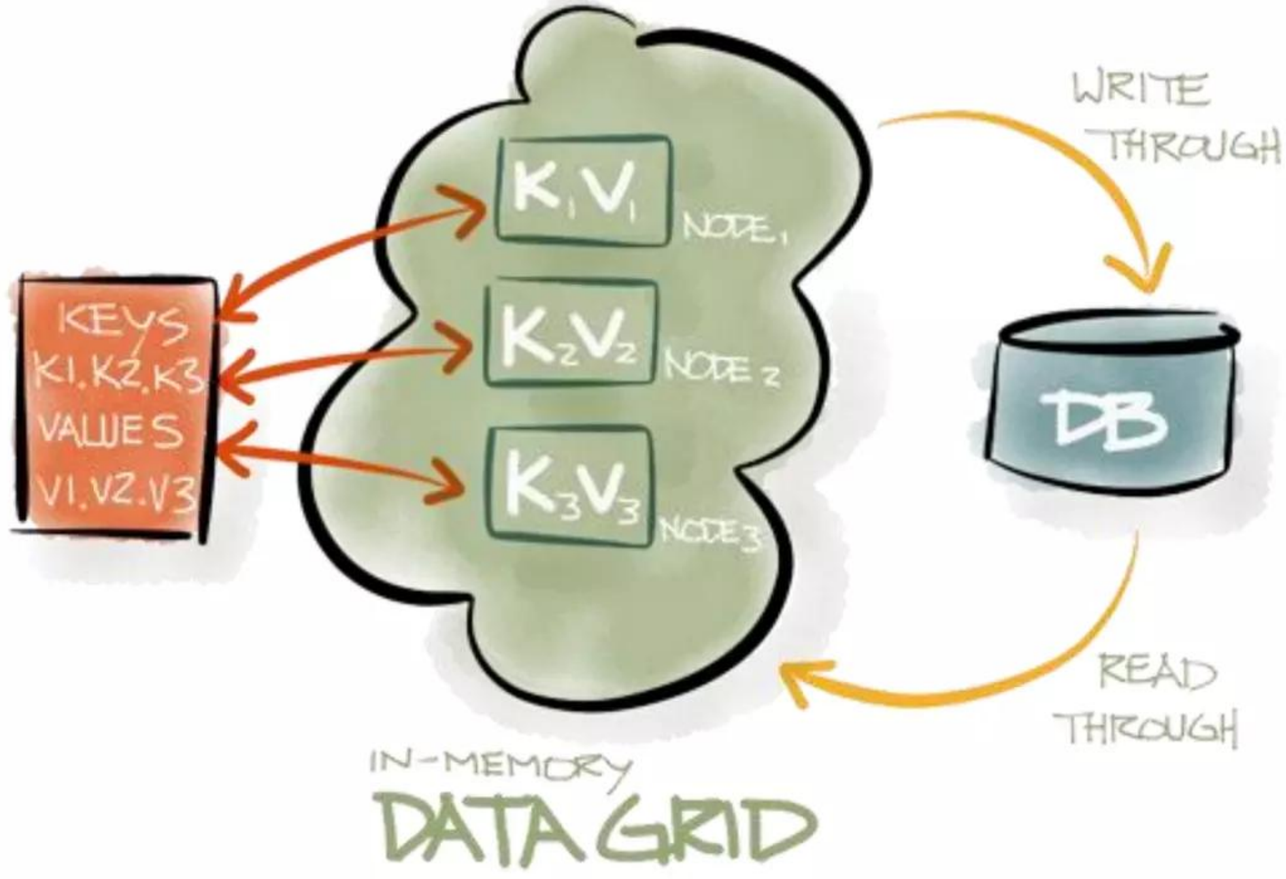


High Performance Computing

https://hadoop4usa.wordpress.com/2012/04/13/scale-out-up/

High Performance Computing #2

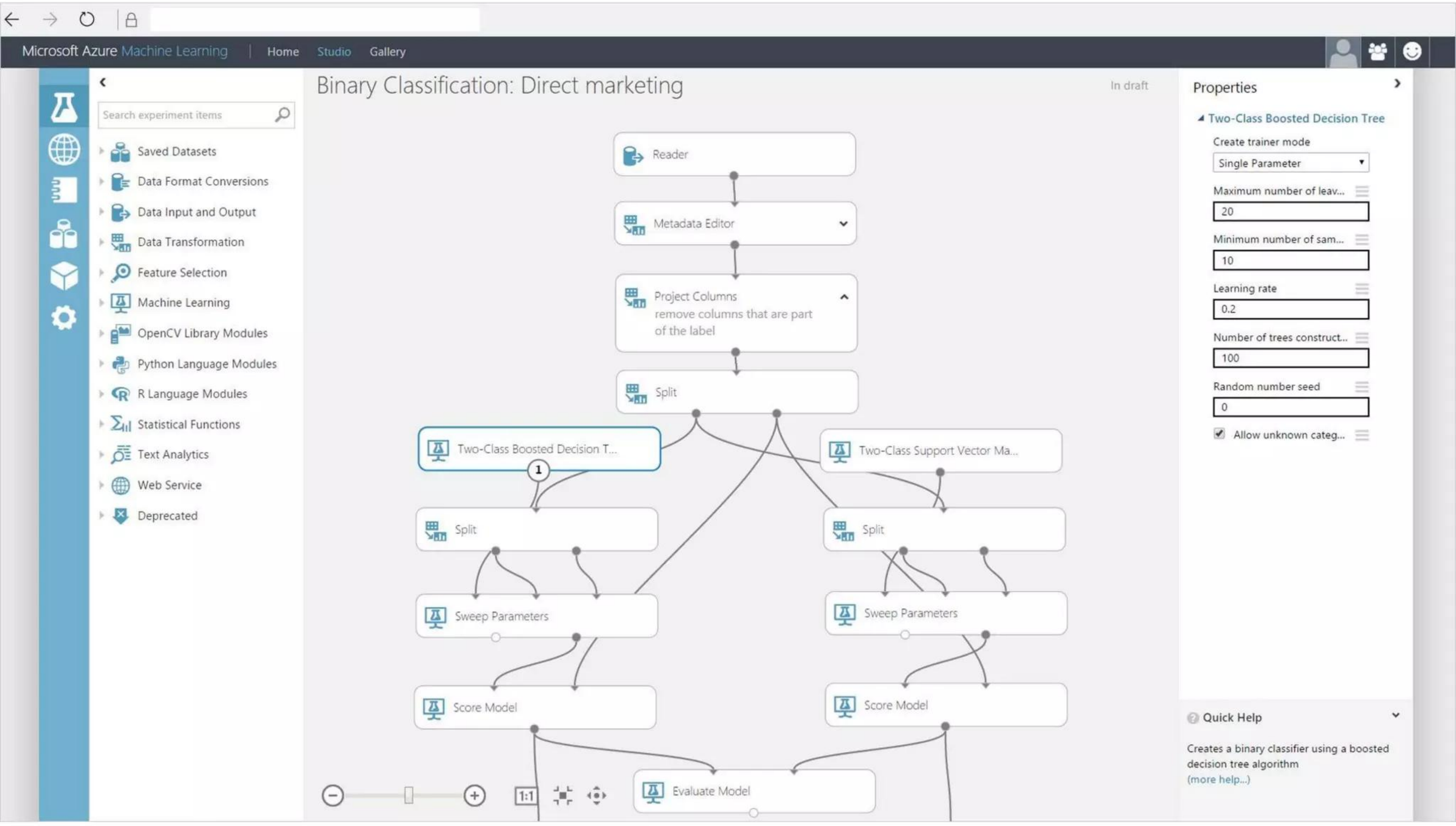
- **In-memory data fabric**: provides low-latency access and processing of large quantities of data by distributing data across the dynamic random access memory (DRAM), Flash, or SSD of a distributed computer system.



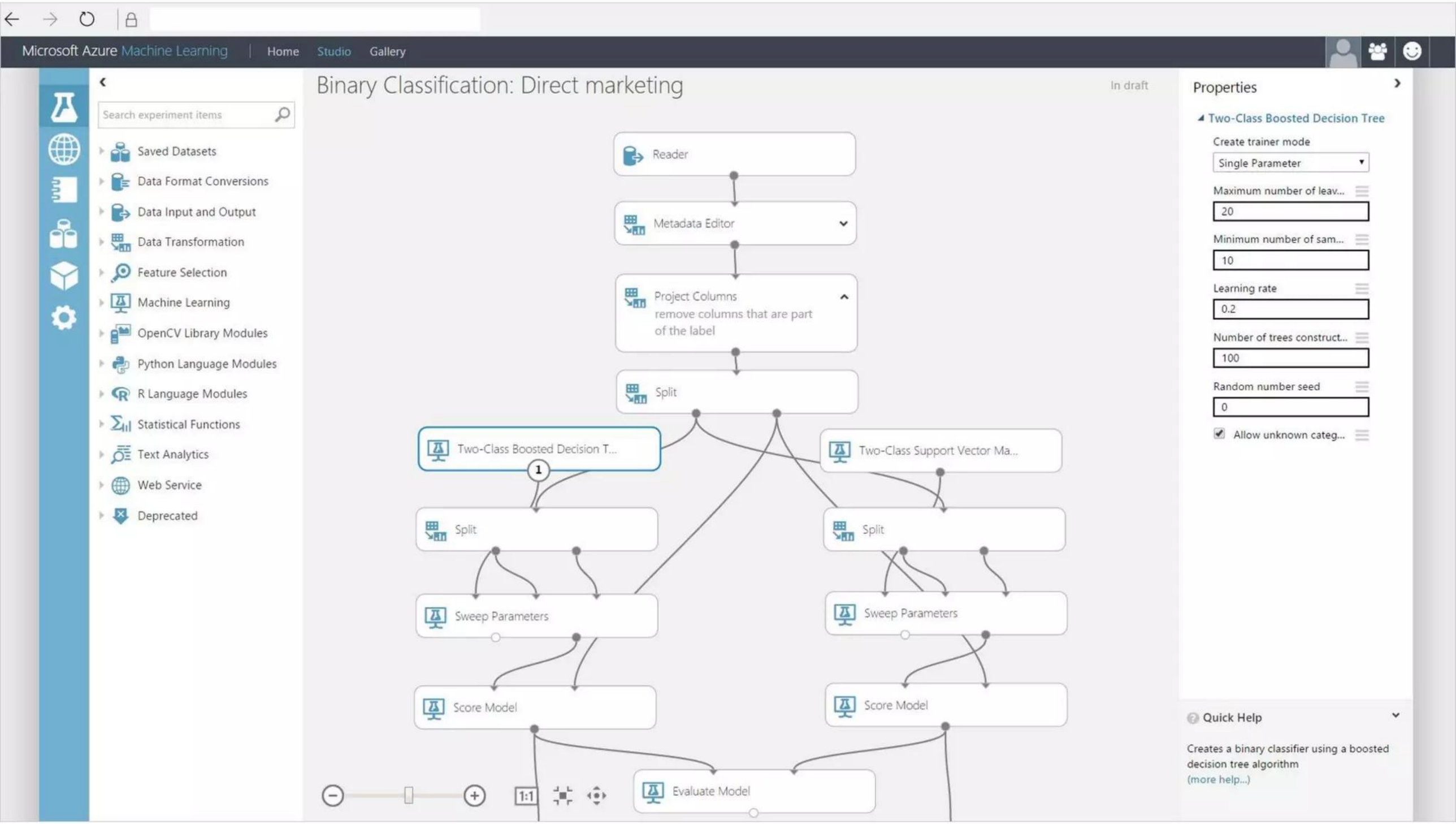
Machines

- **Cluster machine**
- **GPU machines (OpenCL and nvidia CUDA)**

Stack of Technologies

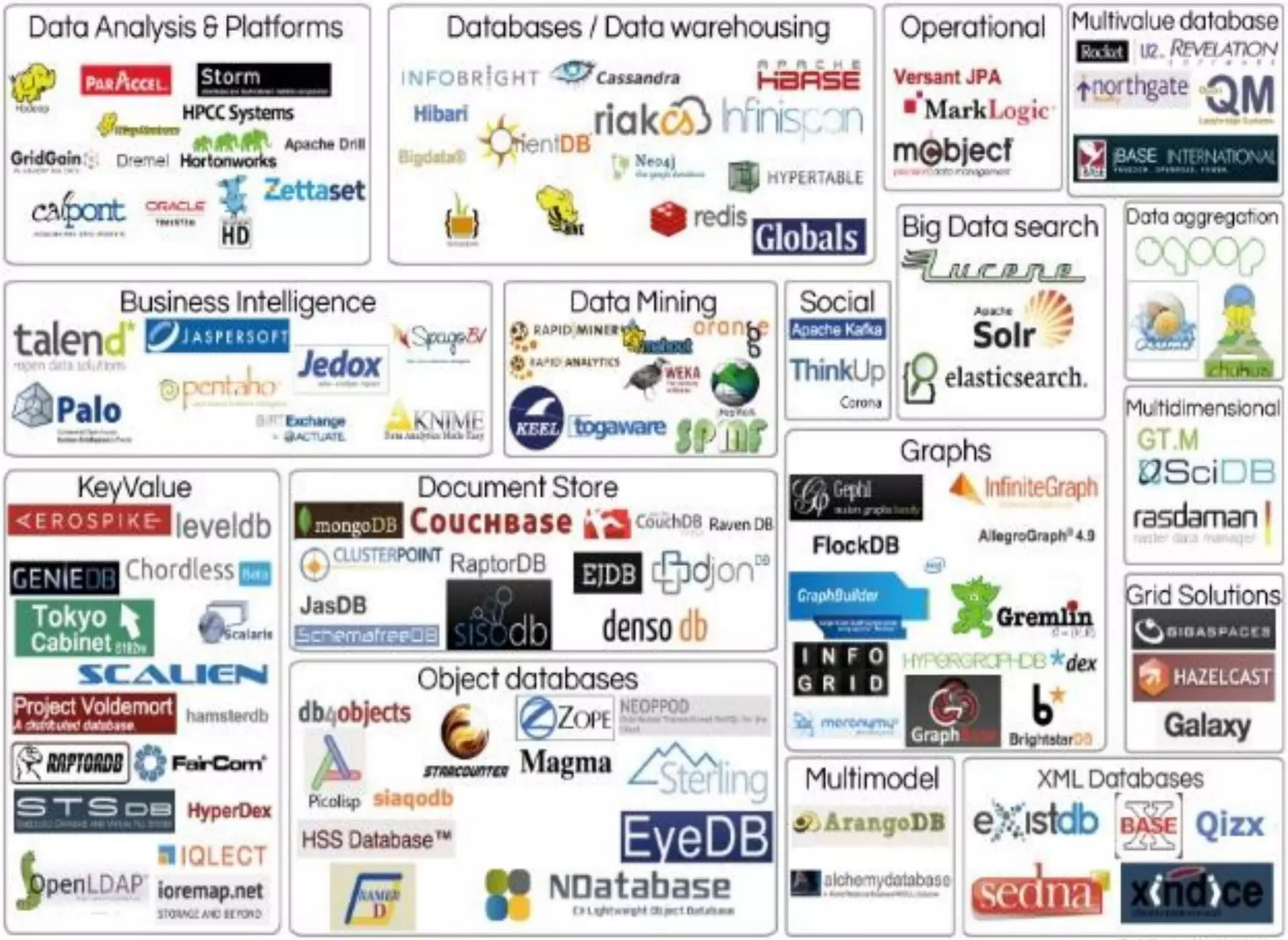


Stack of Technologies #2



Stack of Technologies #3

Stack of Technologies #4



Stack of Technologies #5

blibli.com BIG CHOICES BIG DEALS

IoT Sensors / Data Collection

Embedded

freeRTOS

THE C PROGRAMMING LANGUAGE

C++

Text

ASCII

UNICODE

CSV

<xml/>

{JSON}

Binary

BARCODE

QR

protobuf
Protocol Buffers

Data Transfer

Wired

SCI

USB

Ethernet

ETHERNET

Wireless

RFID

NFC

Wi-Fi

ZigBee

4GLTE

Bluetooth

S/W Protocols

FTP

http://

RESTful

Storage / Analytics

hadoop

APACHE HBASE

HIVE

Cassandra

amazon web services S3

mongoDB

redis

MapReduce

Spark

Flink

Visualization

D3

Google Maps

Google Developers CHARTS

sas THE POWER TO KNOW.

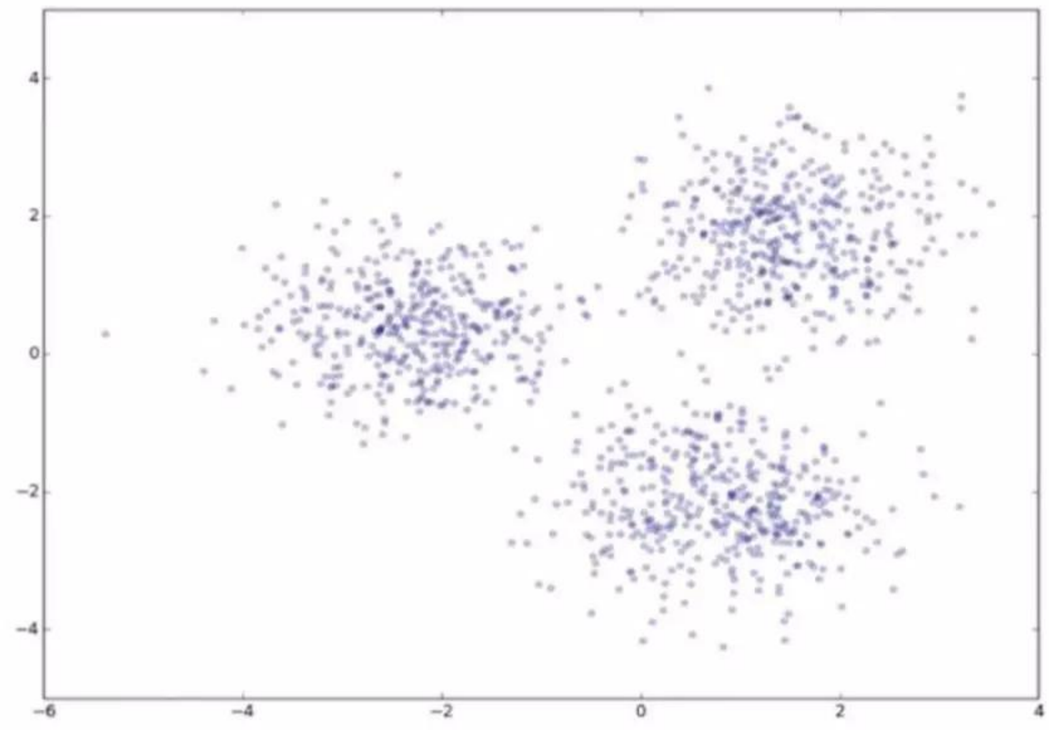
R

+ableau

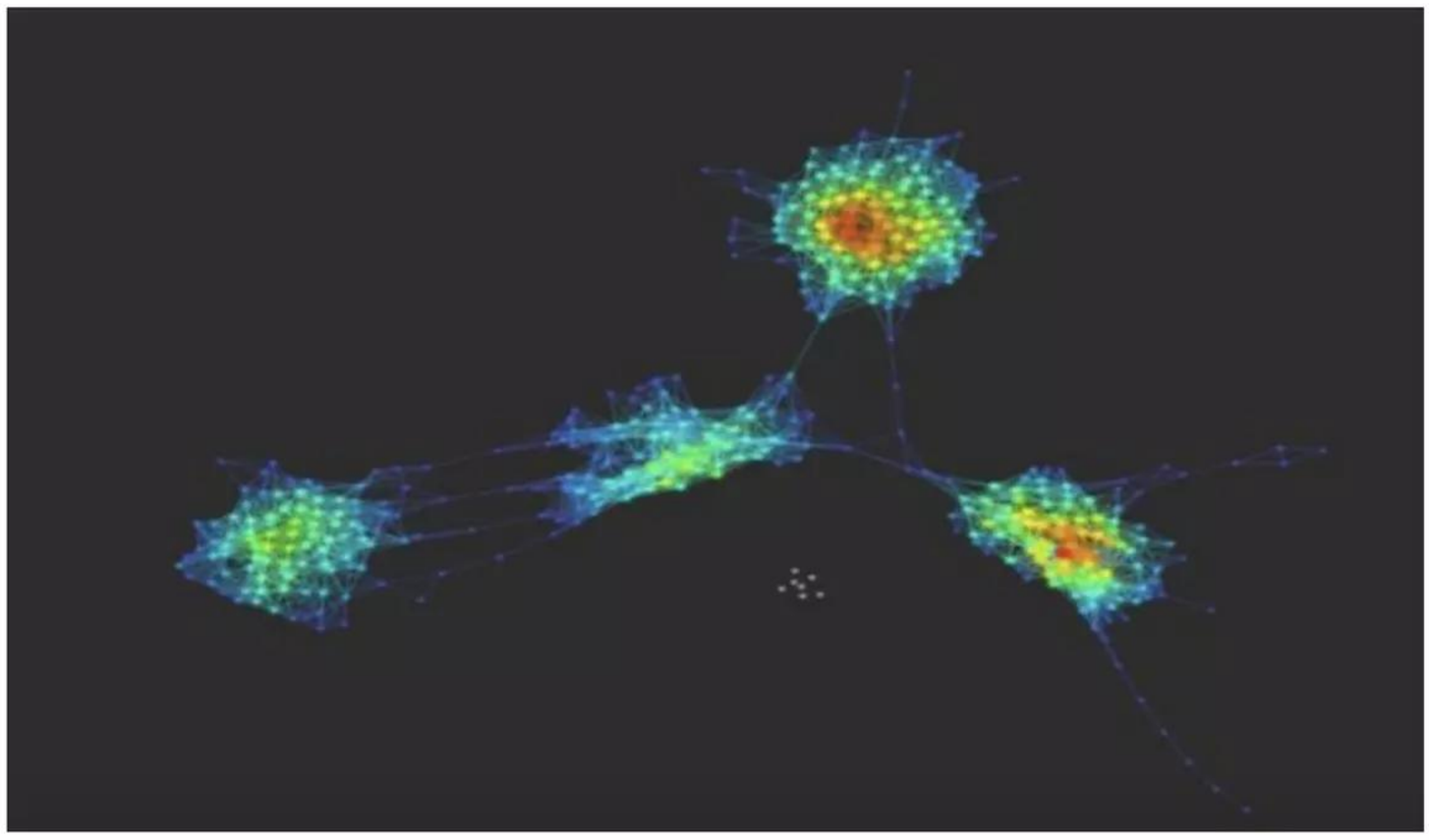
CARTODB

ANGULARJS by Google

Topological Data Analysis



- Coordinate invariance
- Deformation Invariance
- Compressed Representations



THANK YOU

Any question?