Oleksandr Romanko, Ph.D.
Senior Research Analyst, Risk Analytics, Watson Financial Services, IBM Canada
Adjunct Professor, University of Toronto

MIE1624H – Introduction to Data Science and Analytics

Lecture 1 – Introduction

University of Toronto
September 18, 2018

About me

Dr. Oleksandr Romanko

- Senior Research Analyst, Quantitative Research at Risk Analytics, Business Analytics, IBM, with the company since 2010
- Ph.D. in Computer Science from McMaster University
- Author of over 20 papers and reports
- Adjunct professor at University of Toronto and lecturer at McMaster University
- Research areas:
  - business analytics, operational research, optimization, finance
  - portfolio optimization, multi-objective optimization
  - market and credit risk modeling and optimization
  - numerical methods for risk management
  - design of numerical algorithms and their software implementation

🕮 Being an IBMer

IBM Centennial: A Century of Progress

2011

CTR changed its name to International Business Machines Corporation globally in 1924

CTR changes name in Canada to International Business Machines Company in 1917

1911

Incorporated on June 16, 1911 in US as the Computing Tabulating Recording Company

Making the world work better – pioneering the science

1969

1973

1981

2008

IBM Centennial: 100 Years of Innovation

A Snapshot of IBM Milestones

This June, IBM will reach a significant milestone—its 100th anniversary. Join us in taking a look back at just a few of the historical breakthroughs that have helped IBM shape the century and the company.

1900

1911

IBM was formed as the Computing Tabulating and Recording Company, or C-T-R, specializing in punch cards, commercial scales and clocks.

1923

IBM's punched card technology helped tackle large-scale projects like the U.S. Census.

1924

With global ambitions, the company renamed itself International Business Machines – today, it operates in 170 countries.

1930

1935

IBM pioneered training courses for women so they could work in technical positions traditionally filled by men.

1936

IBM worked with the U.S. government to start Social Security – the largest accounting project of its time.

1944

IBM's free-ton Automatic Sequence Controlled Calculator was the first machine to handle long calculations automatically.

1956

RAMAC (Random Access Method of Accounting and Control), the first magnetic hard disk drive, created the data storage industry.

1960

1961

The Selectric Typewriter was an instant design sensation, delighting typists for 25 years.

1962

IBM and American Airlines launched the world's first computer-driven airline reservation system, SABRE – which paved the way for online banking technology.

1964

The company made a big bet with the System/360 – this early mainframe ushered in the era of computer compatibility.

1969

IBM labs developed the magnetic stripe on credit cards – still ubiquitous on ID cards, drivers' licenses and ATM bank cards.

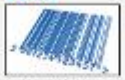
1969

IBM technology guided the Apollo mission to the moon – the company has played a part in the U.S. space program since the 1960s.

1971

IBM created the floppy disk, which made storage powerful and affordable – and the PC revolution possible.

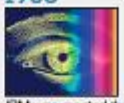
1973



Supermarkets started scanning UPC bar codes, invented by IBM. Today, they track everything from clothing to dairy cows.

1980

1980



IBM was granted the first patent for LASIK surgery technology – and continues to hold more U.S. patents than any company.

1981

The IBM Personal Computer launched the PC revolution, helping computers go mainstream beyond hobbyists and geeks.

1984

By the mid-'80s, IBM computers understood 5,000 spoken words at 95% accuracy; today, speech recognition is pervasive at home and on the road.

1986

IBM scientists won the Nobel Prize for the scanning tunnel microscope – which would eventually manipulate atoms to spell I-B-M.

1997

IBM's Deep Blue supercomputer defeated the best chess player in the world.

1997

IBM launched "eBusiness," turning the Internet into a tool for business and ushering in the future of electronic commerce.

2001

IBM invested $1 billion in Linux, spurring open source innovation that still reverberates around the world.

2011

Watson supercomputer can detect nuances in words, irony and riddles – and inspire new realms of search queries and artificial intelligence.

2008

Smarter Planet launched to improve how the world works – now smart buoys in Ireland's Galway Bay detect pollution, protect fish stock.

📖 Best Jobs

Profession

«Choose a **job you love**, and you will never have to work a day in your life.»

Confucius

«The only way to do great work is to **love what you do**. If you haven't found it yet, **keep looking**. Don't settle.»

Steve Jobs

Best jobs

Forbes / Tech / #BigData

FEB 25, 2016 @ 11:26 PM **14,811** VIEWS

Is Being A Data Scientist Really The Best Job In America?

Bernard Marr, CONTRIBUTOR

I write about big data, analytics and enterprise performance **FULL BIO**

Opinions expressed by Forbes Contributors are their own.

It's official – data scientist is the best job in America, according to users of online employment analysts Glassdoor.

Glassdoor's service allows employees to anonymously rate their jobs and their employers, awarding scores for how well they are paid, treated, and helped to advance in their careers.

glassdoor

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Interviews

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Employers | Try Free Job Postings

25 Best Jobs in America

2.5k Shares

Want a new job? Glassdoor is here to help, identifying the 25 Best Jobs in America for 2016. The jobs that make this list have the highest overall Glassdoor Job Score, determined by combining three key factors – number of job openings, salary and career opportunities rating. These jobs stand out across all three categories.

United States 2016

1

Data Scientist

Job Openings	1,736
Median Base Salary	$116,840
Career Opportunity	4.1
Job Score	4.7

2

Tax Manager

Job Openings	1,574
Median Base Salary	$108,000
Career Opportunity	3.9
Job Score	4.7

Big Data's Big Problem: Little Talent


Forbes

TECH | 1/18/2013 @ 10:18AM | 9,232 views

Combating the Big Data skills shortage


Harvard Business Review

THE MAGAZINE

October 2012

Data Scientist: The Sexiest Job of the 21st Century


THE CHRONICLE OF HIGHER EDUCATION

November 14, 2013

Home | News | Global | Opinion & Ideas | Facts & Figures | Blogs | Advice | Forums | Jobs | Search The Ch

Administration

August 14, 2013

IBM and Universities Team Up to Close a 'Big Data' Skills Gap

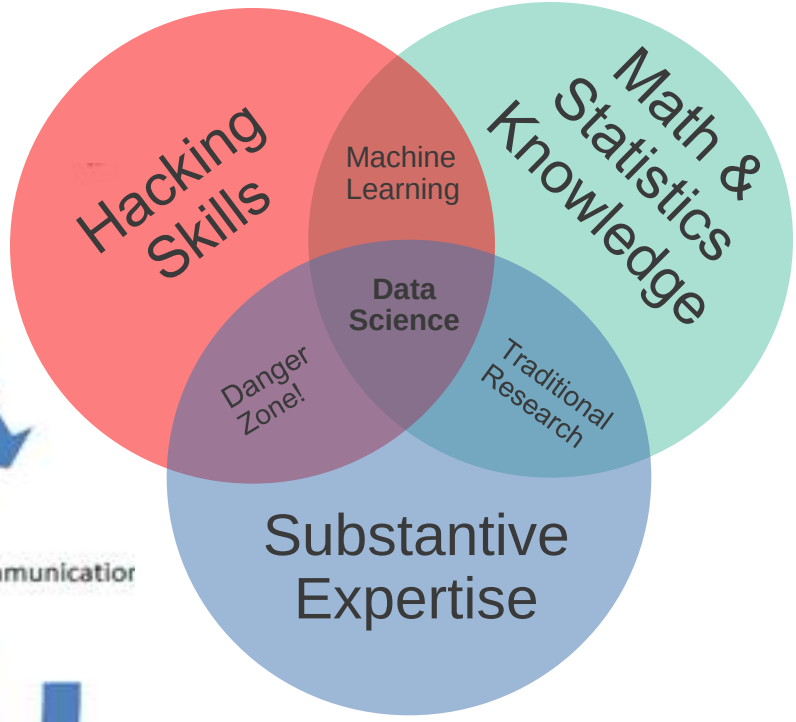

The Big Data & Analytics Hub

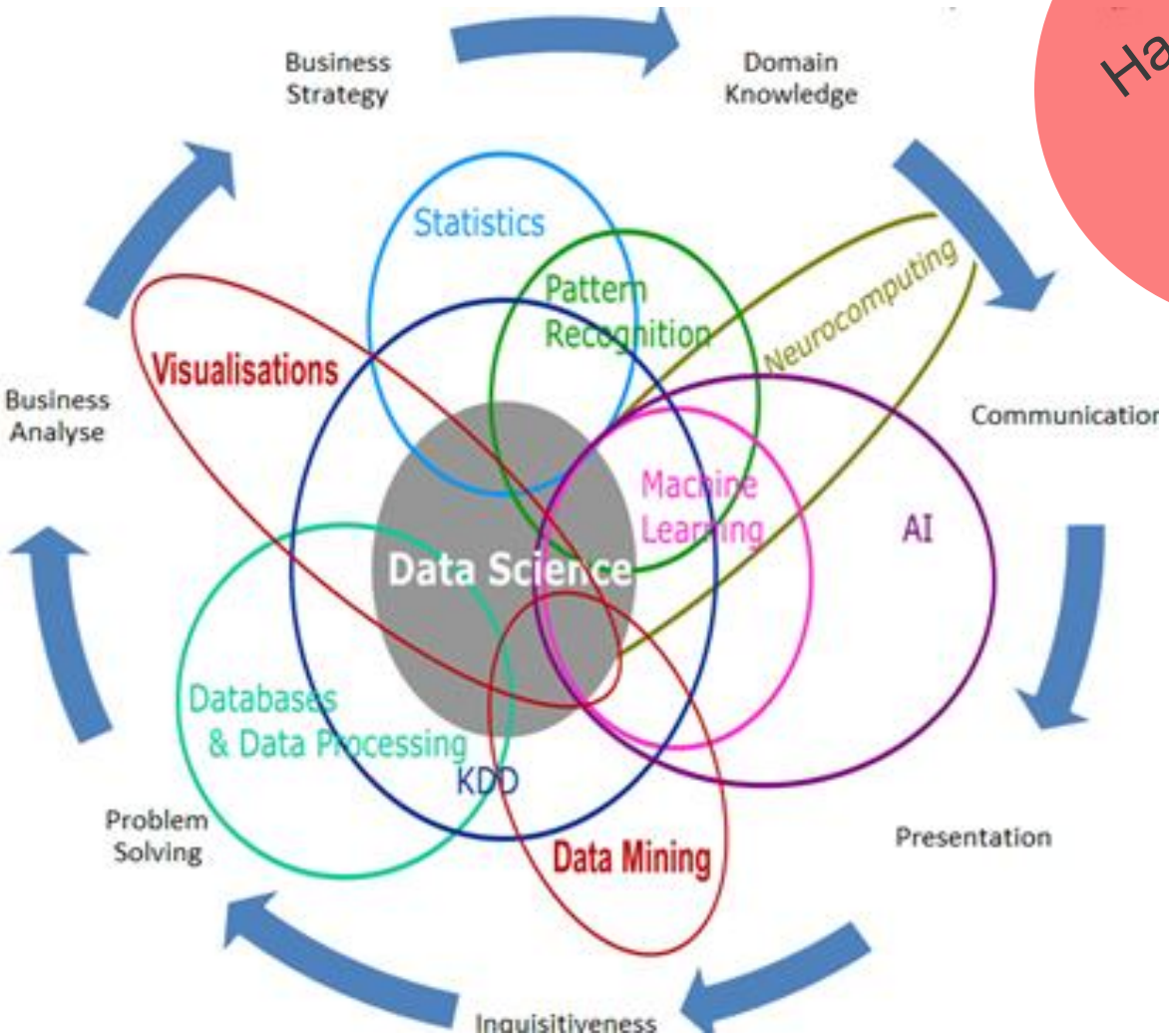
Blogs | Videos & Podcasts | Resources | Events | Around the Web | IBM Solutions

Data Scientist: Closing the Talent Gap

January 17, 2013

Data Science





📖 Analytics

What is analytics?

Analytics is the scientific process of deriving insights from data in order to make decisions

Descriptive Analytics
What has happened?

Predictive Analytics
What will happen?

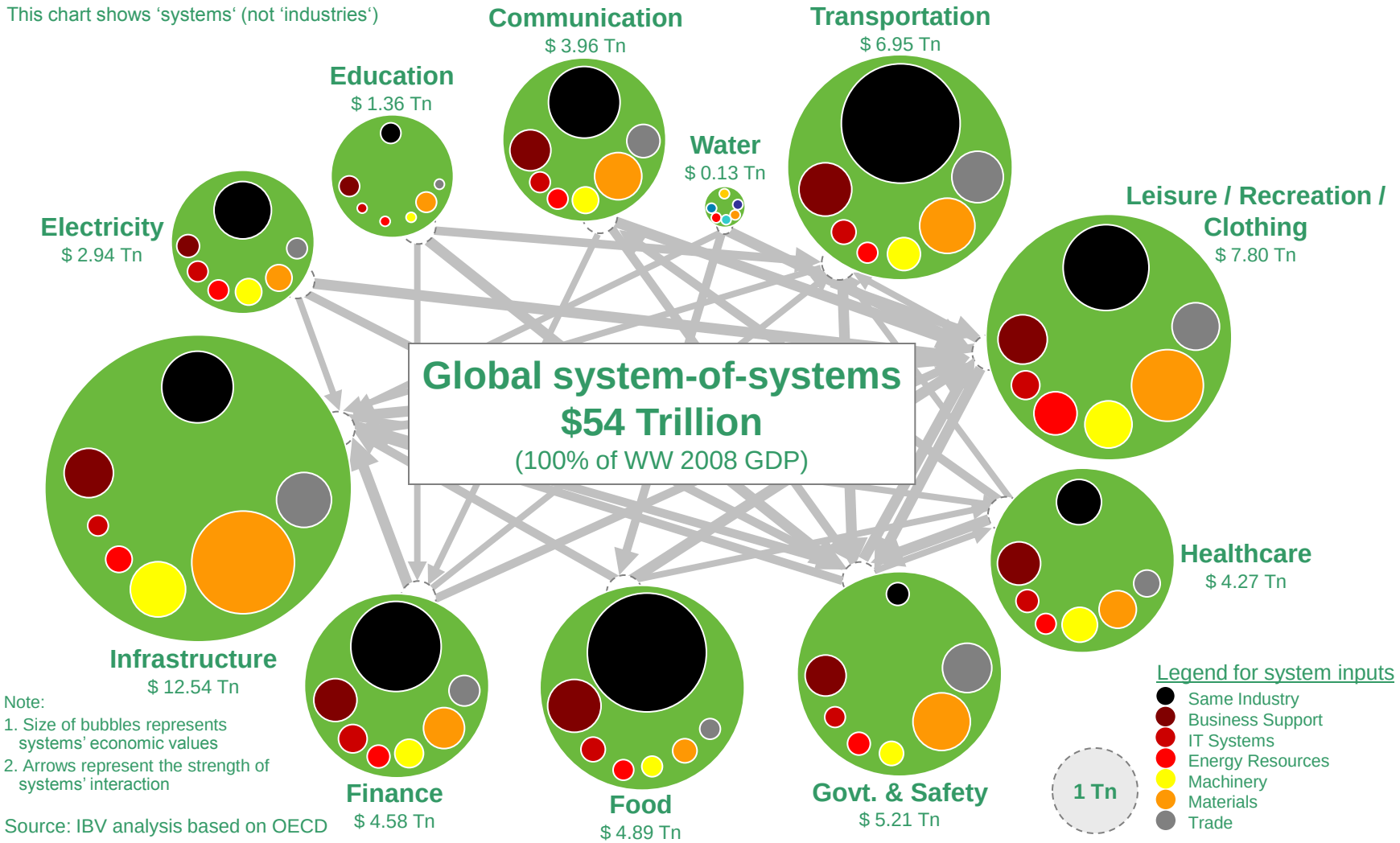
Prescriptive Analytics and Artificial Intelligence
What should we do?

Business Value

Operations research

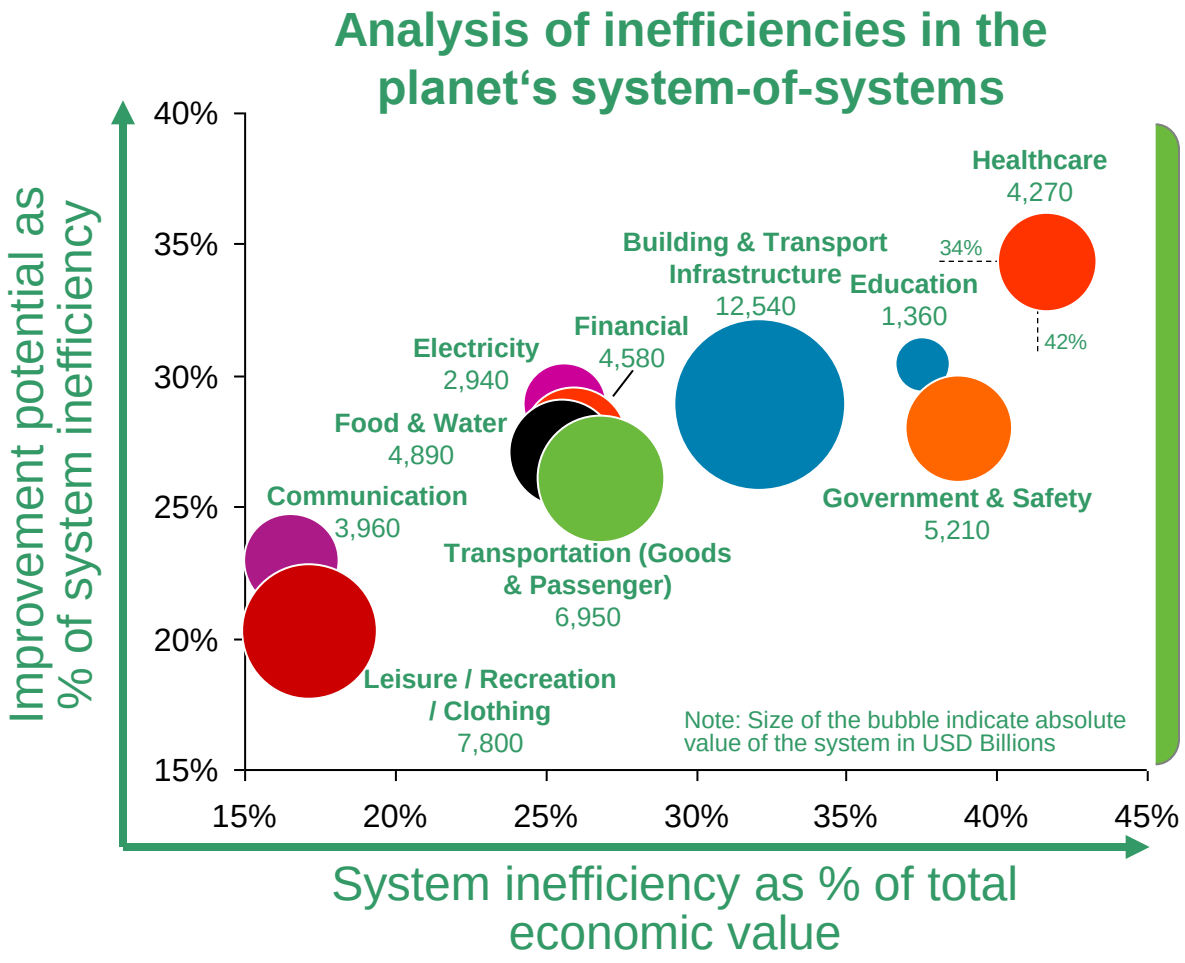
- **Operations Research** (O.R.) is the discipline of applying advanced analytical methods to help make better decisions
- Analytical techniques:
  - Simulation – giving you the ability to try out approaches and test ideas for improvement
  - Optimization – narrowing your choices to the very best when there are virtually innumerable feasible options and comparing them is difficult
  - Probability and Statistics – helping you measure risk, mine data to find valuable connections and insights, test conclusions, and make reliable forecasts
  - Mathematical Modeling – algorithms and software

Our planet is a complex, dynamic, highly interconnected $54 Trillion system-of-systems (OECD-based analysis)



Economists estimate, that all systems carry inefficiencies of up to $15 Tn, of which $4 Tn could be eliminated

This chart shows ‘systems‘ (not ‘industries‘)



Global economic value of

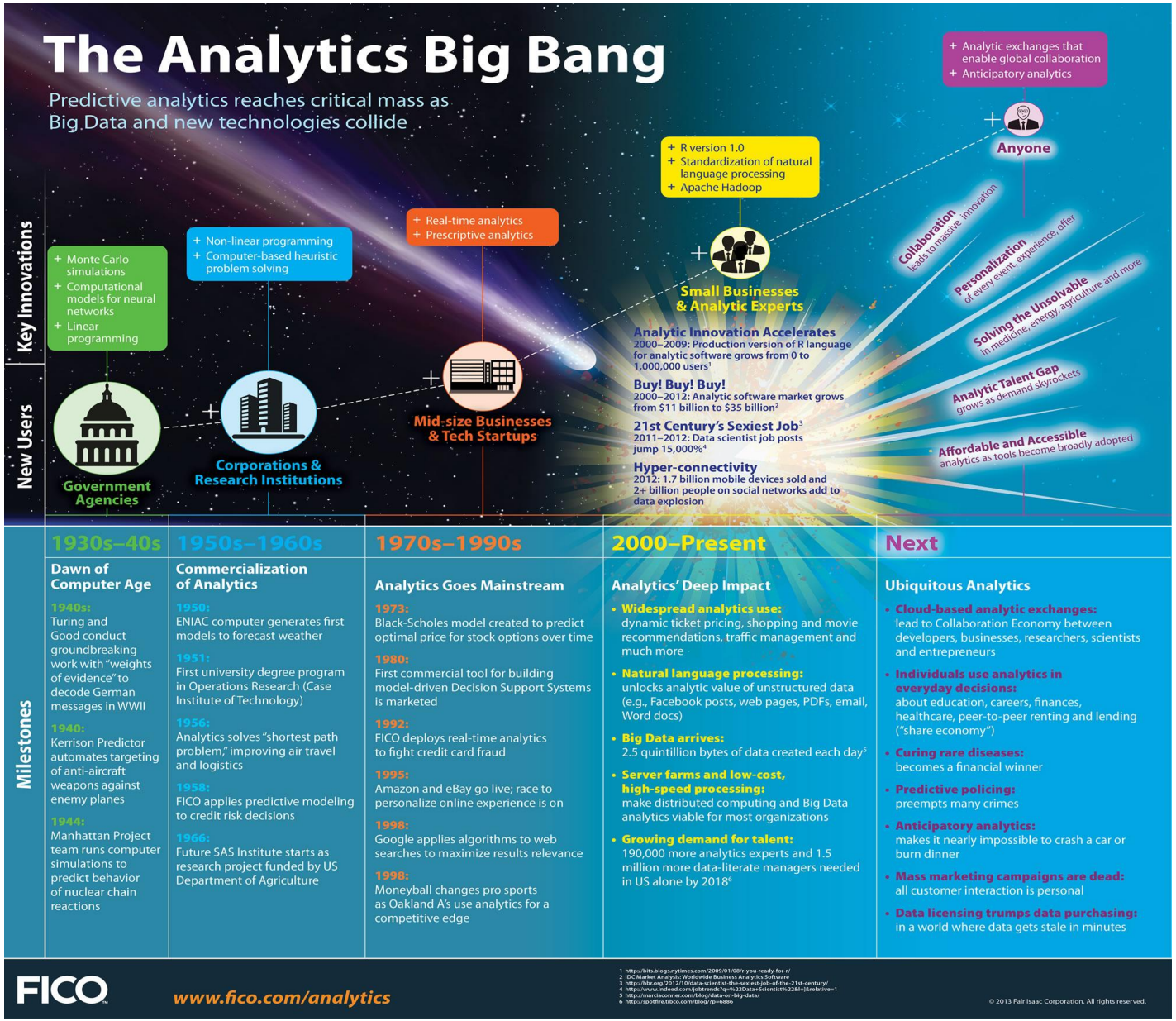
System-of-systems	**$54 Trillion** 100% of WW 2008 GDP
Inefficiencies	**$15 Trillion** 28% of WW 2008 GDP
Improvement potential	**$4 Trillion** 7% of WW 2008 GDP

How to read the chart:

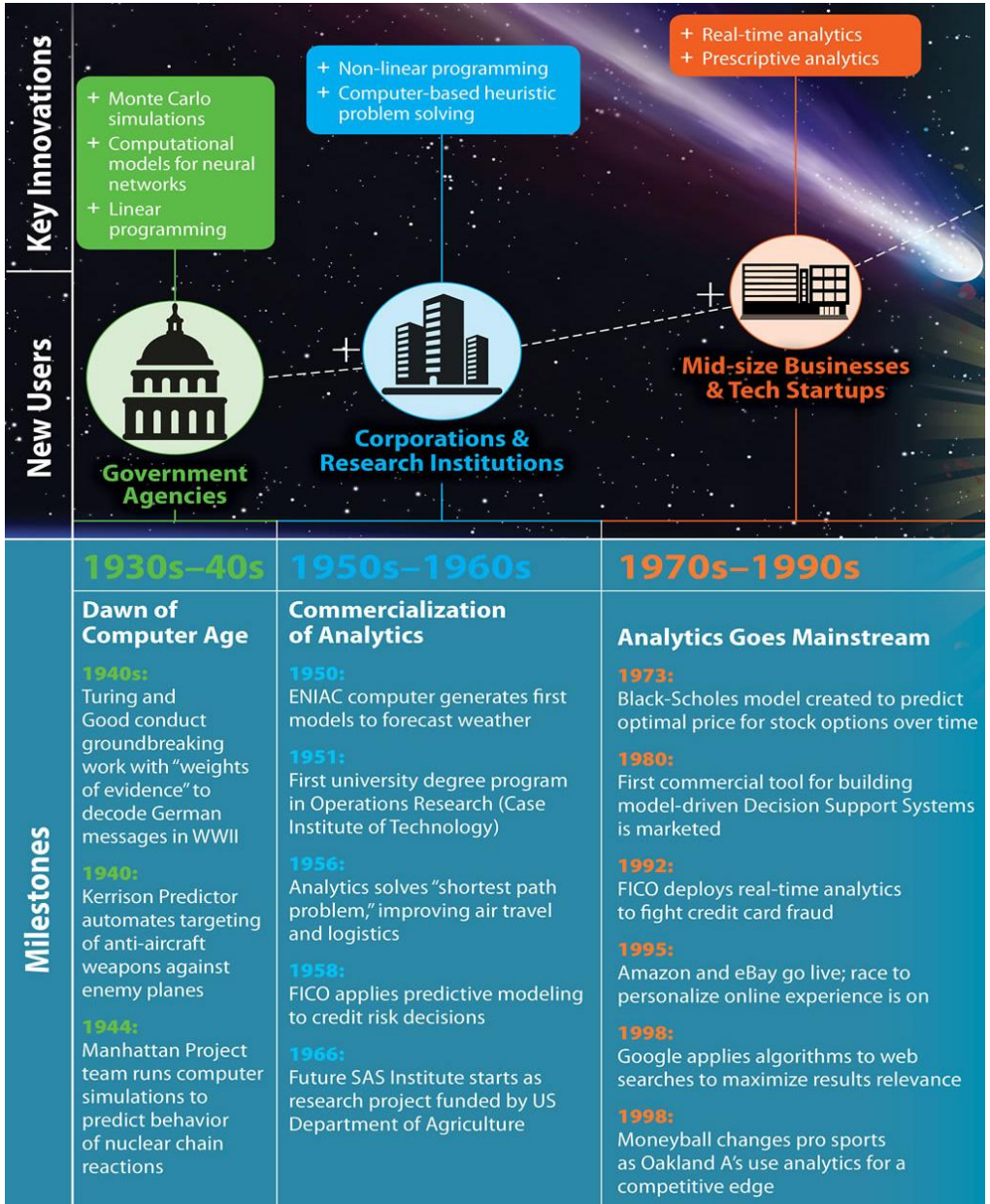
For example, the Healthcare system‘s value is $4,270B. It carries an estimated inefficiency of 42%. From that level of 42% inefficiency, economists estimate that ~34% can be eliminated (= 34% x 42%).

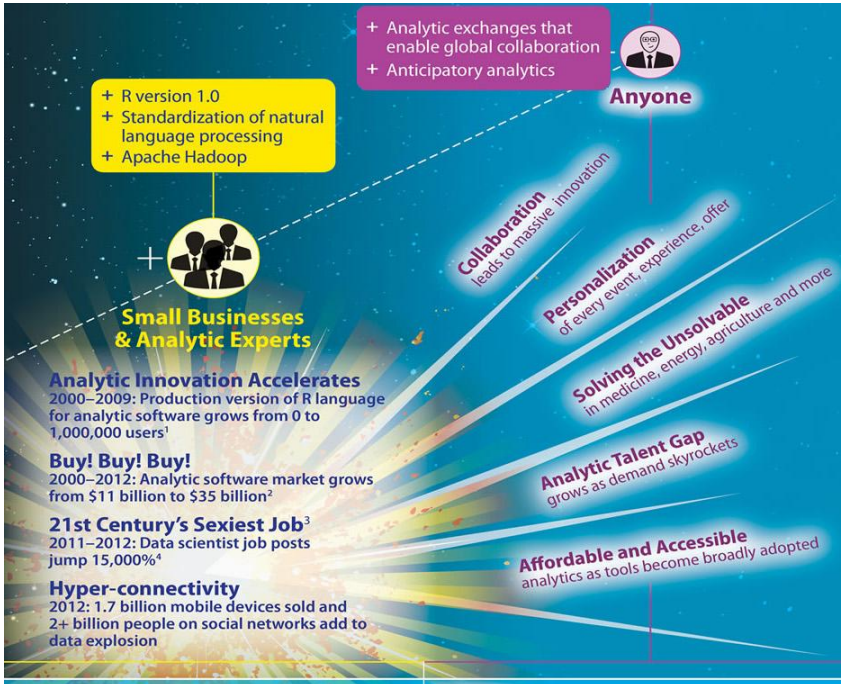
Source: IBM economists survey 2009; n= 480

History of analytics



History of business analytics





2000–Present

Analytics' Deep Impact

- **Widespread analytics use:** dynamic ticket pricing, shopping and movie recommendations, traffic management and much more
- **Natural language processing:** unlocks analytic value of unstructured data (e.g., Facebook posts, web pages, PDFs, email, Word docs)
- **Big Data arrives:** 2.5 quintillion bytes of data created each day[5]
- **Server farms and low-cost, high-speed processing:** make distributed computing and Big Data analytics viable for most organizations
- **Growing demand for talent:** 190,000 more analytics experts and 1.5 million more data-literate managers needed in US alone by 2018[6]

Next

Ubiquitous Analytics

- **Cloud-based analytic exchanges:** lead to Collaboration Economy between developers, businesses, researchers, scientists and entrepreneurs
- **Individuals use analytics in everyday decisions:** about education, careers, finances, healthcare, peer-to-peer renting and lending ("share economy")
- **Curing rare diseases:** becomes a financial winner
- **Predictive policing:** preempts many crimes
- **Anticipatory analytics:** makes it nearly impossible to crash a car or burn dinner
- **Mass marketing campaigns are dead:** all customer interaction is personal
- **Data licensing trumps data purchasing:** in a world where data gets stale in minutes

📖 Course Outline

Course summary

- **Course title:** Introduction to Data Science and Analytics

- **Course summary:** The objective of the course is to learn analytical models and overview quantitative algorithms for solving engineering and business problems. Data science or analytics is the process of deriving insights from data in order to make optimal decisions. It allows hundreds of companies and governments to save lives, increase profits and minimize resource usage. Considerable attention in the course is devoted to applications of computational and modeling algorithms to finance, risk management, marketing, health care, smart city projects, crime prevention, predictive maintenance, web and social media analytics, personal analytics, etc. We will show how various data science and analytics techniques such as basic statistics, regressions, uncertainty modeling, simulation and optimization modeling, data mining and machine learning, text analytics, artificial intelligence and visualizations can be implemented and applied using Python. Python and IBM Watson Analytics are modeling and visualization software used in this course. Practical aspects of computational models and case studies in Interactive Python are emphasized.

Course outline

Introduction to data science and analytics

- Data science concepts
- Application areas of quantitative modeling

Python programming, data science software

- Introduction to Python
- Comparison of Python, R and Matlab usage in data science

Basic statistics

- Random variables, sampling
- Distributions and statistical measures
- Hypothesis testing
- Statistics case studies in Ipython

Overview of linear algebra

- Linear algebra and matrix computations
- Functions, derivatives, convexity

Course outline

Modeling techniques, regression

- Mathematical modeling process
- Linear regression
- Logistic regression
- Regression case studies in IPython

Data visualization and visual analytics

- Visual analytics
- IBM Watson Analytics

Simulation modeling

- Random number generation
- Monte Carlo simulations
- Simulation case studies in Ipython

Optimization

- Overview of optimization algorithms
- Optimization case studies in IPython

Course outline

Data mining and machine learning

- Classification (decision trees)
- Clustering (K-means, Fuzzy C-means, Hierarchical Clustering, DBSCAN)
- Association rules
- Data mining case studies in IPython

Cognitive computing and artificial intelligence

- Text analytics
- Social media analytics
- Neural networks
- Spatio-temporal analytics
- Cognitive computing case studies in IPython

Storytelling based on analytics, analytical decision making

- Validating analytics
- Storytelling based on analytics
- Decision-making based on analytics

Assignments, exams and grading (tentative)

Assignment #1 – Solving an analytics problem in Python **(15%)**

- Individual assignment.

Assignment #2 – Solving an analytics problem in Python **(15%)**

- Individual assignment.

Course Project (Assignment #3 and Assignment #4) – Smart city analytics via machine learning and data analytics in Python **(30%)**

- Group project (groups of 6 students), the same groups as for In-Class Presentations.

In-Class Group Presentation **(15%)**

- Group presentations of up to 10 minutes are required to cover topics related to additional course materials and the course project.

Final Exam **(25%)**

- For the final exam you may be responsible for analyzing, computing and writing up a solution to case problems. Each solution must be completed individually.

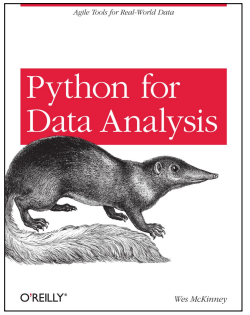
Notes

- If a student gets less than 50% mark at the Final Exam, her/his course mark will be reduced one letter grade down. E.g., a student got 14 pts (Assg 1) + 13 pts (Assg 2) + 28 pts (Course Project) + 14 pts (In-Class Presentation) + 12 pts (Final Exam) = 81 pts that corresponds to A- course mark, but because a student got 12 pts out of 25 pts at the Final Exam (less than 50%), the course mark will be reduced from A- to B+.

Course materials and readings

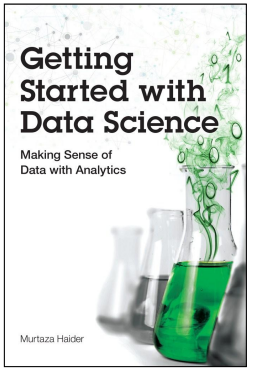
Required

- **Course slides** by O. Romanko and D. Rosu, 2017
  Quercus



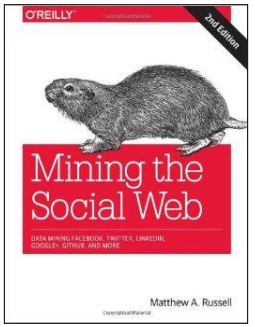
Optional

- **Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Ipython** by W. McKinney, 2012
  https://www.amazon.com/Python-Data-Analysis-Wrangling-IPython/dp/1449319793/



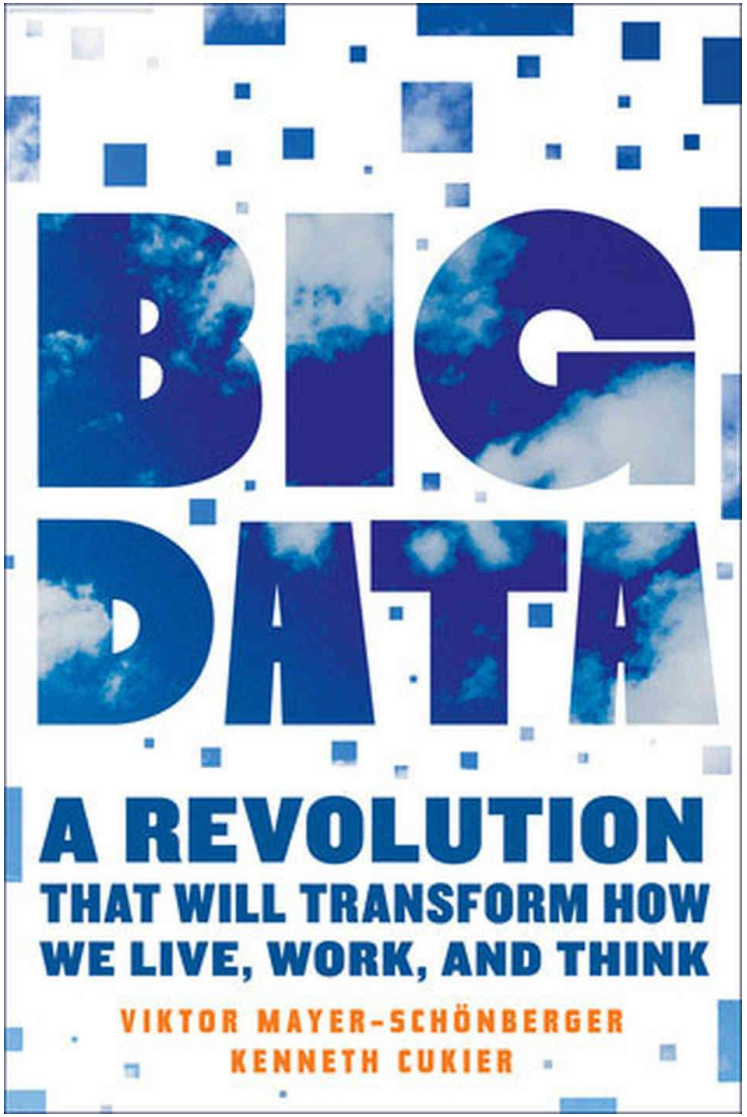
- **Getting Started with Data Science: Making Sense of Data with Analytics** by M. Haider, 2015
  https://www.amazon.com/Getting-Started-Data-Science-Analytics/dp/0133991024/

- **Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More** by M. Russell, 2013
  https://www.amazon.com/Mining-Social-Web-Facebook-LinkedIn/dp/1449367615/

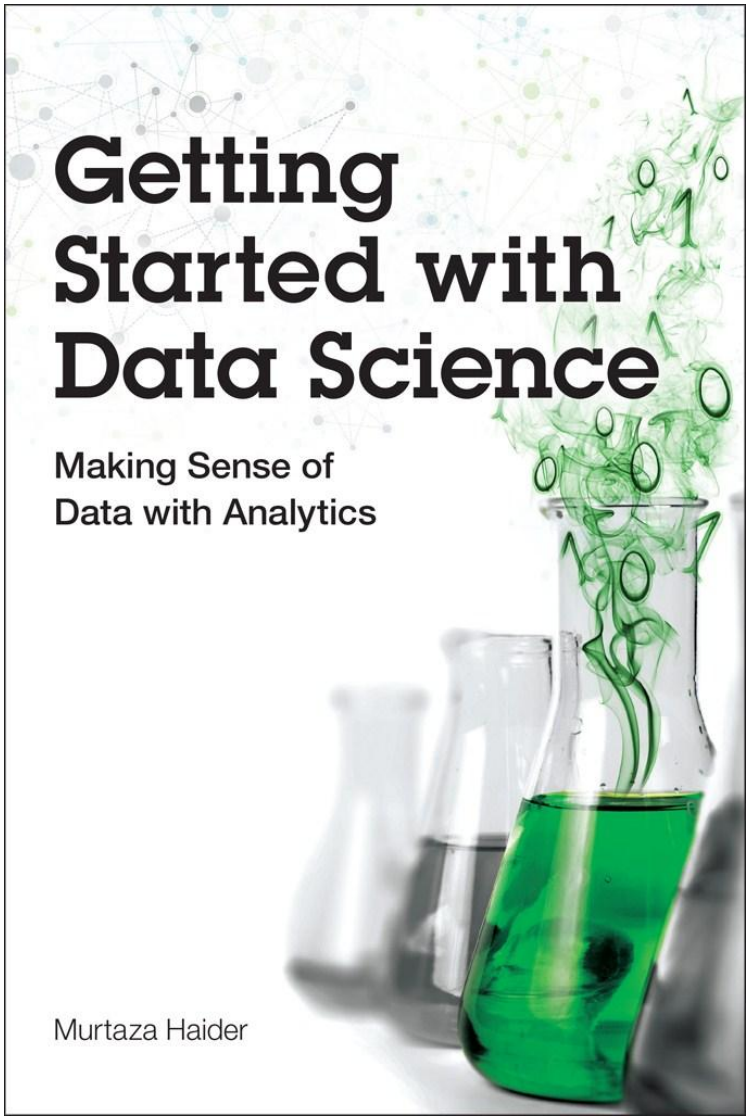


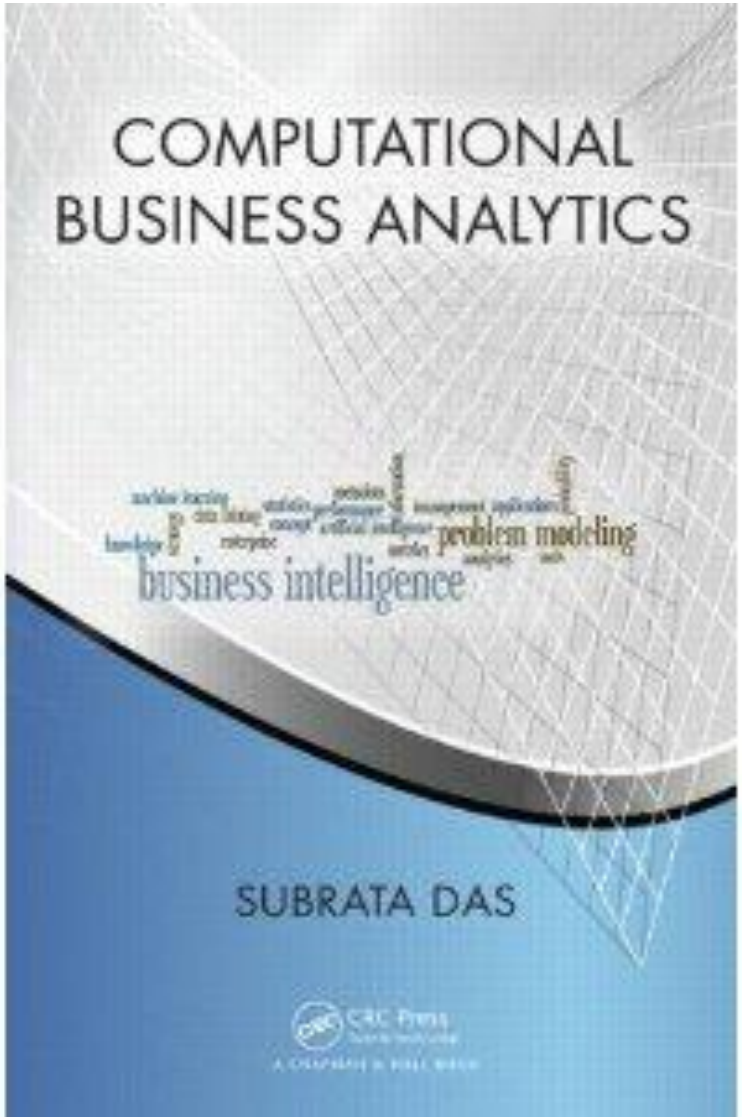
📖 Recommended Literature

Literature

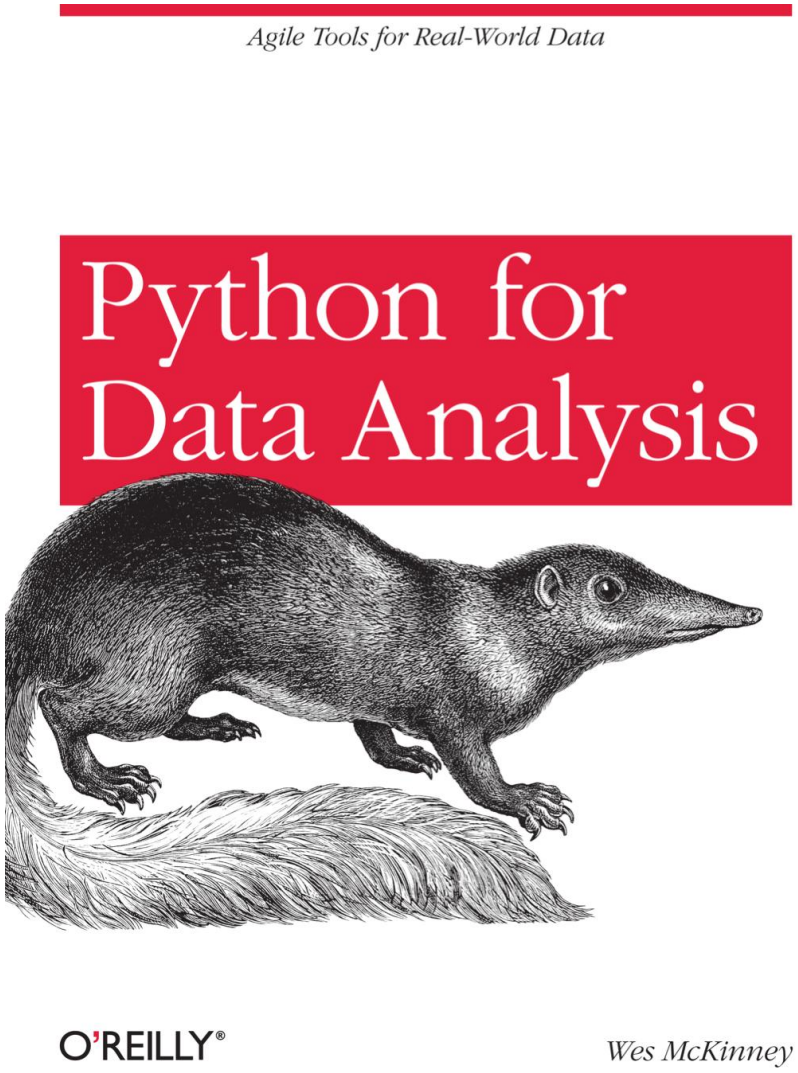

BIG
DATA
A REVOLUTION
THAT WILL TRANSFORM HOW
WE LIVE, WORK, AND THINK
VIKTOR MAYER-SCHÖNBERGER
KENNETH CUKIER

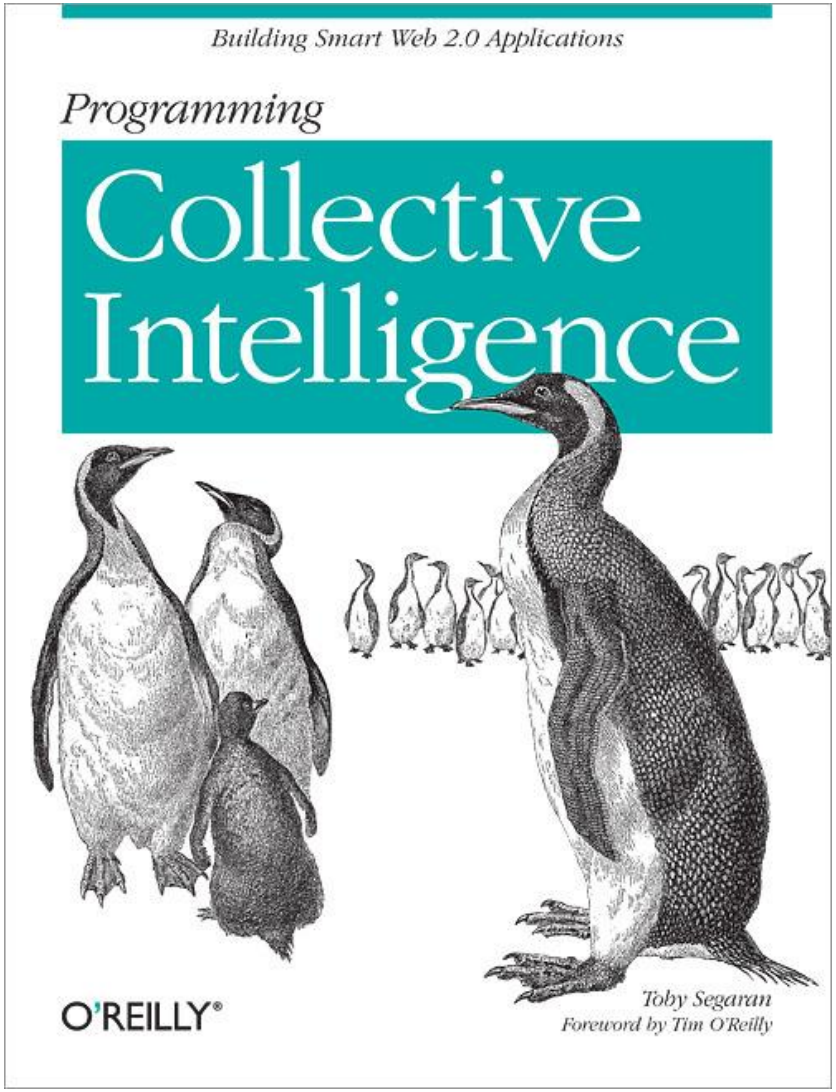
Literature


Getting Started with Data Science
Making Sense of Data with Analytics
Murtaza Haider

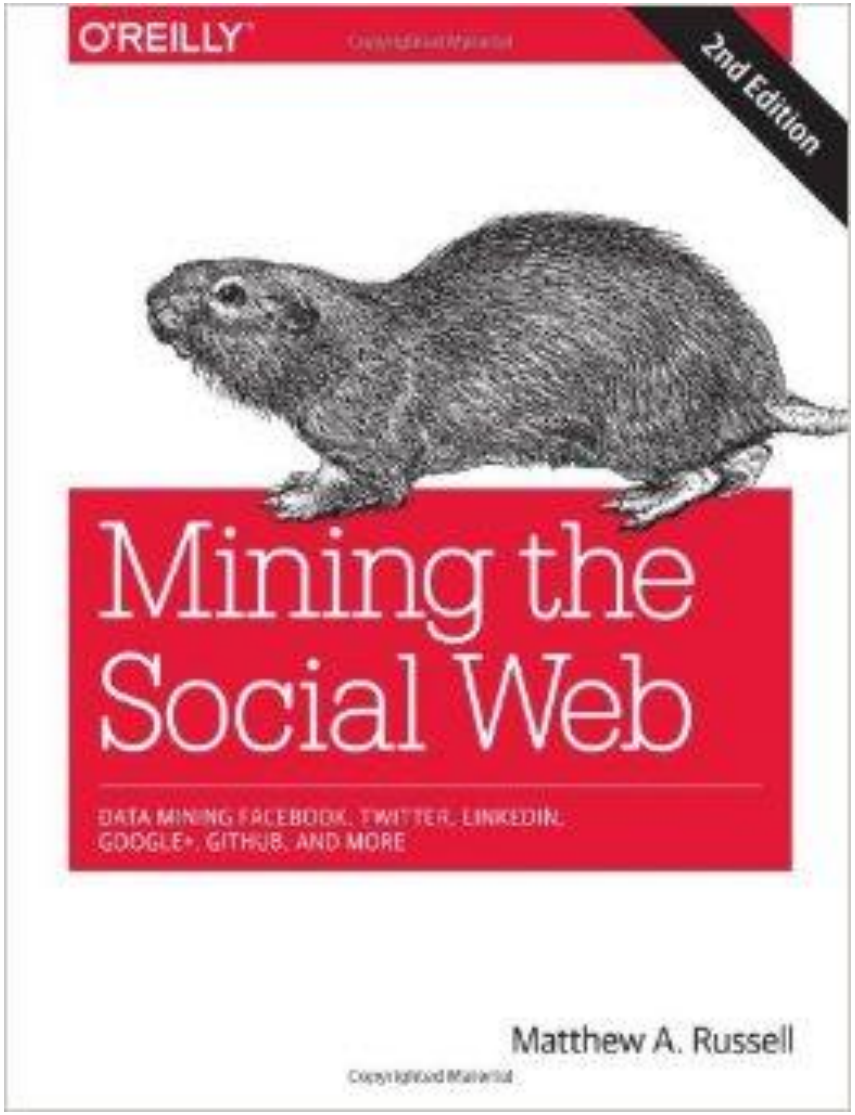

COMPUTATIONAL BUSINESS ANALYTICS
problem modeling
business intelligence
SUBRATA DAS
CRC Press

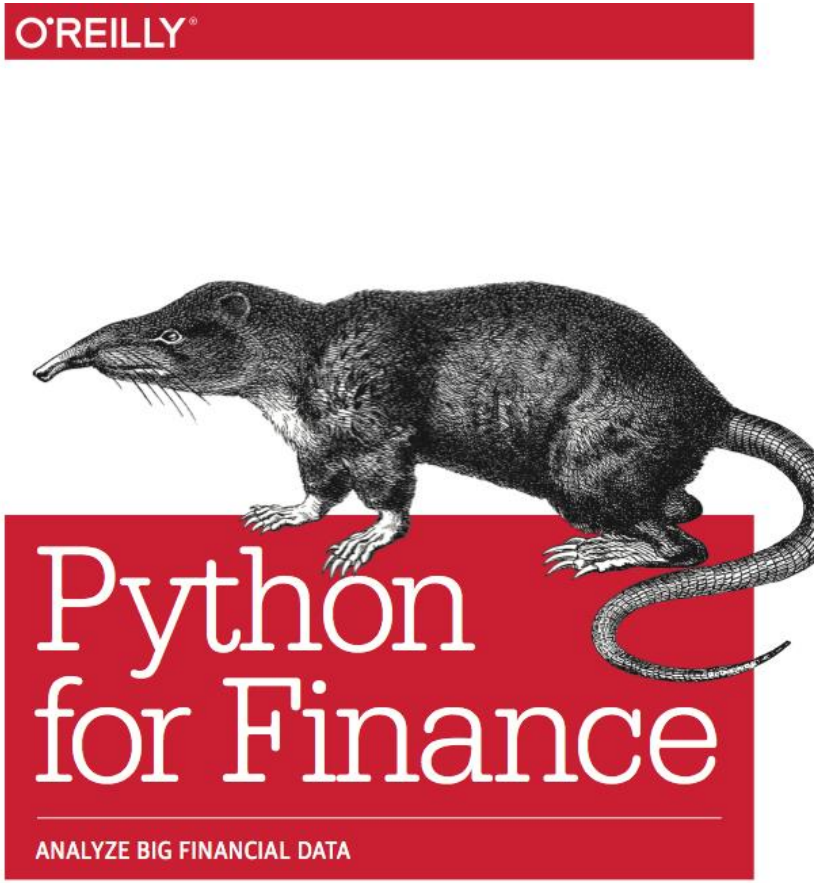
Literature


Agile Tools for Real-World Data
Python for Data Analysis
O'REILLY®
Wes McKinney


Building Smart Web 2.0 Applications
Programming
Collective Intelligence
O'REILLY®
Toby Segaran
Foreword by Tim O'Reilly

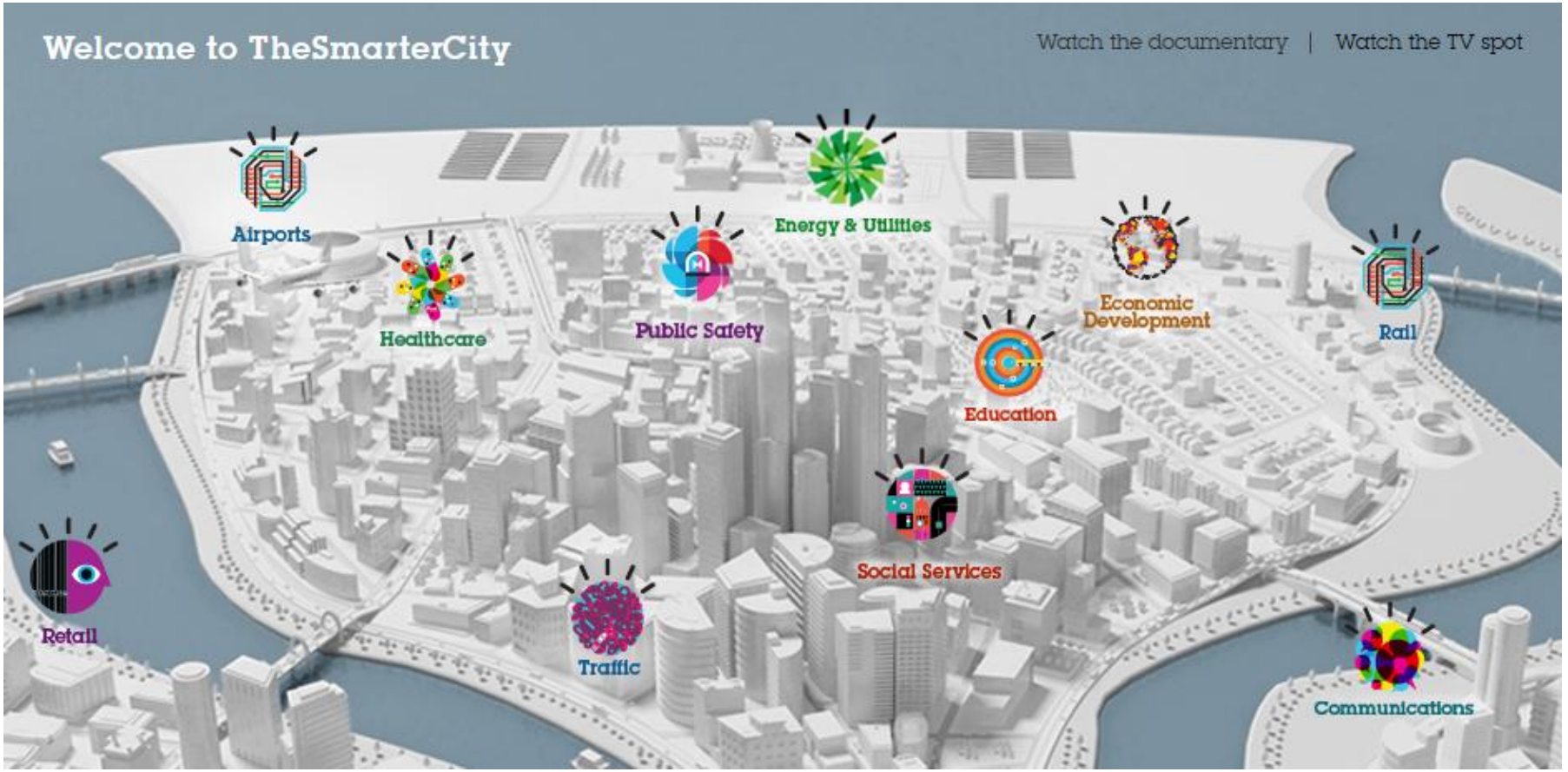
Literature


O'REILLY
2nd Edition
Mining the Social Web
DATA MINING FACEBOOK, TWITTER, LINKEDIN, GOOGLE+, GITHUB, AND MORE
Matthew A. Russell


O'REILLY
Python for Finance
ANALYZE BIG FINANCIAL DATA
Yves Hilpisch

📖 Analytics Examples

Smarter Cities



Use of camera phones at the Papal inauguration in 2005 and 2013

Data reveals hidden city dynamics

We can collect information from almost everything to make better decisions

30 billion

RFID tags embedded into our world and across entire ecosystems

1 billion

Camera phones in existence able to document accidents, damage, and crimes

85%

Of new automobiles will contain event data recorders collecting travel information

Instrumented Interconnected Intelligent

What is big data?

Big data *are datasets that grow so large that they become awkward to work with using on-hand database management tools.*

Difficulties include capture, storage, search, sharing, analytics, and visualizing.

Source: Wikipedia

Big social data

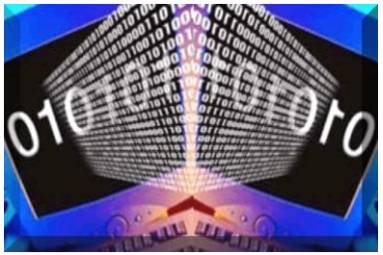
Applications of big data analytics

Smarter Healthcare

Multi-channel

Finance

Log Analysis



Homeland Security

Traffic Control

Telecom

Search Quality

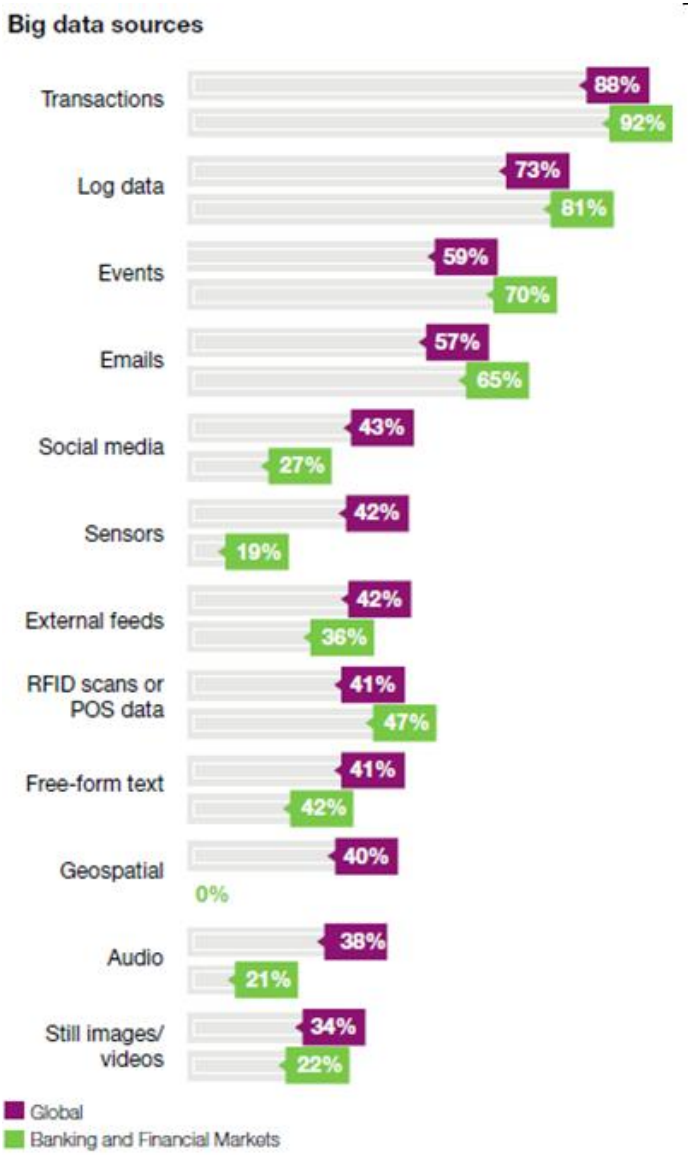
Manufacturing

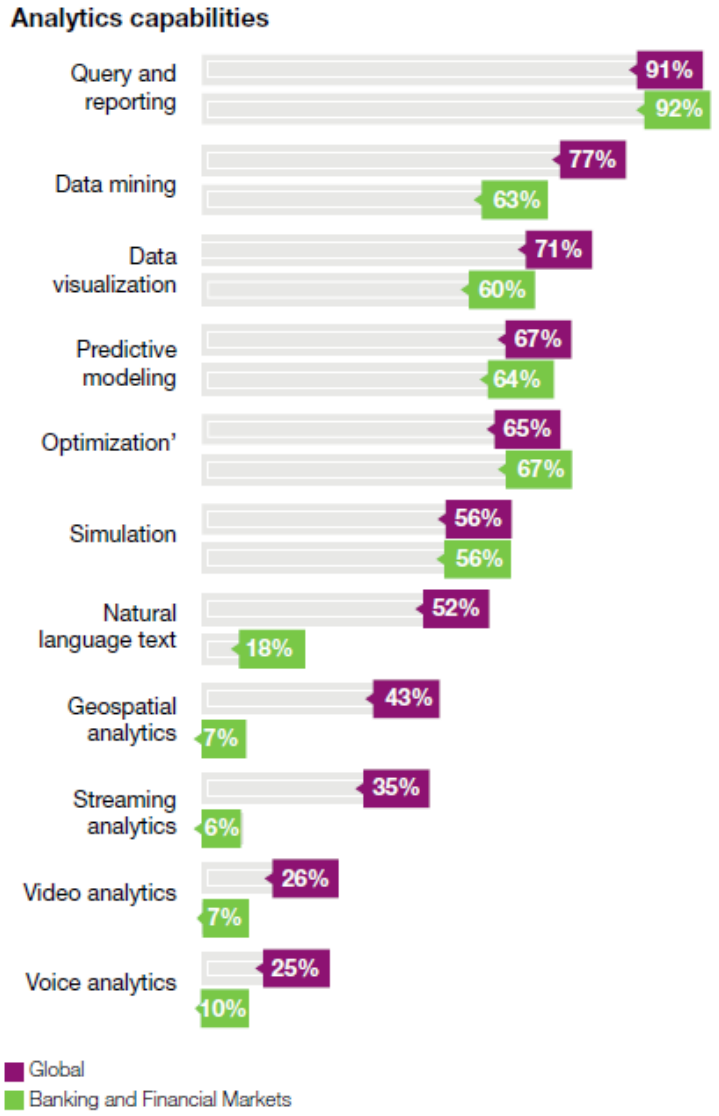
Trading Analytics

Fraud and Risk

Retail: Churn, NBO

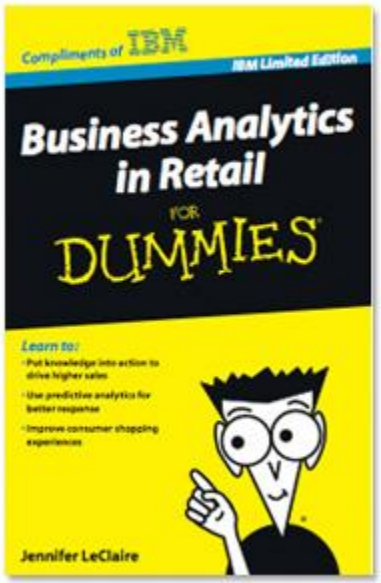
Use of Big Data globally and in the financial sector





Multiple responses accepted

Marketing analytics



Fitting room analytics

Good

SELA

Mango

Bad

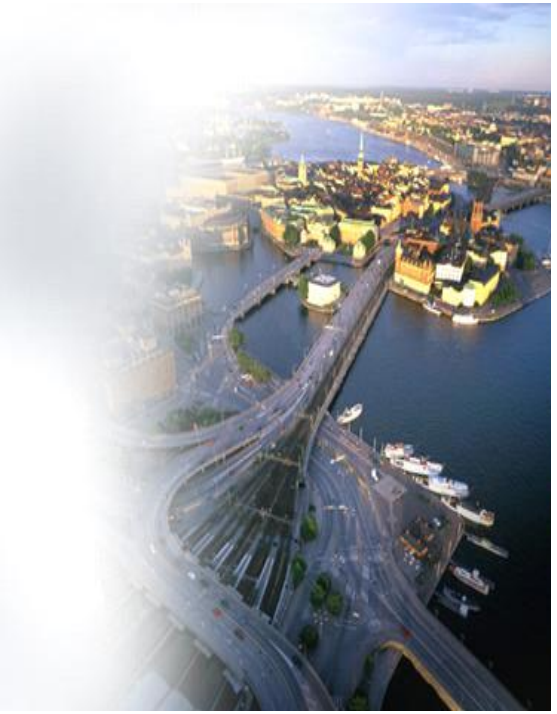
ZARA

New Yorker

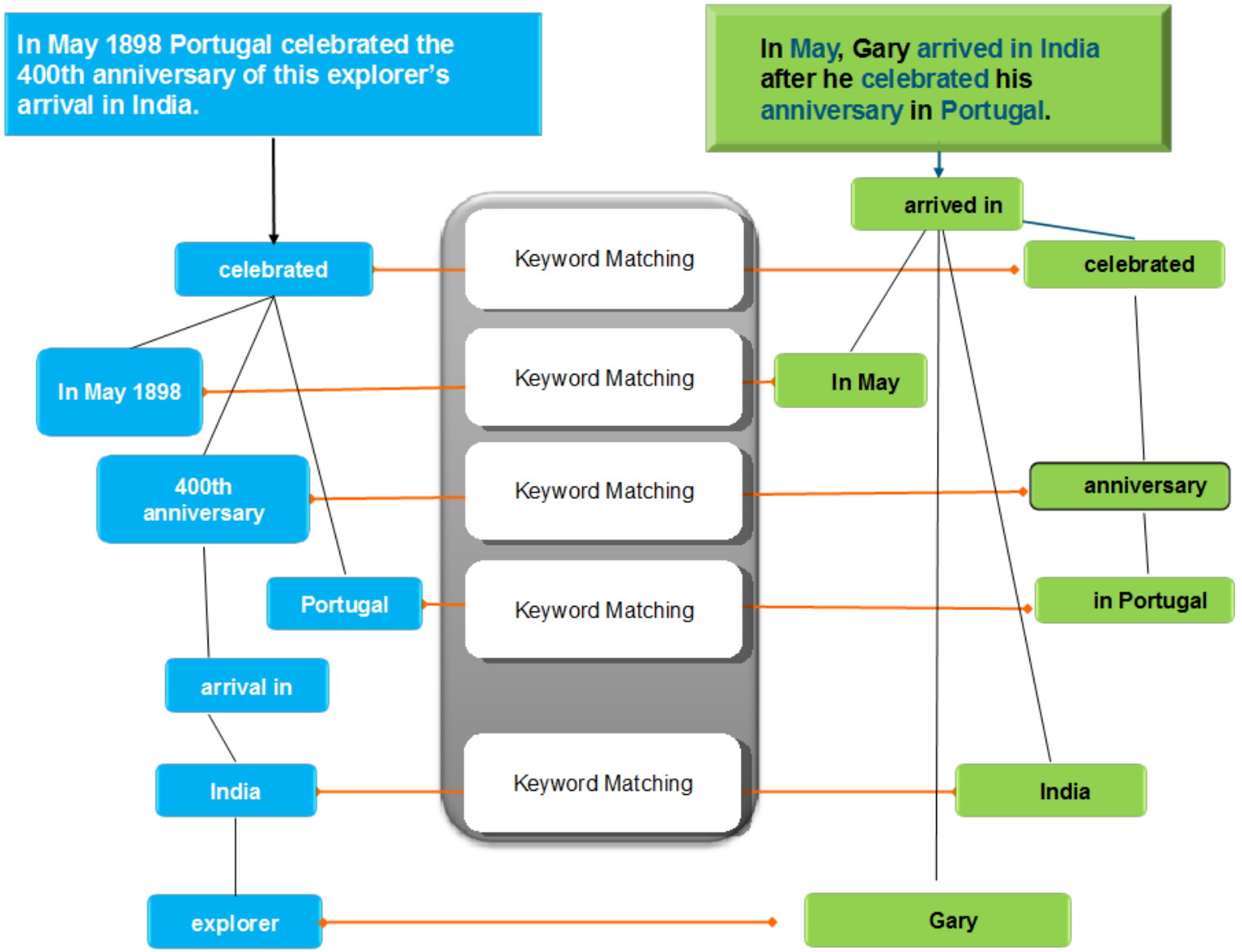
Source: Adme

Intelligent transport systems

- **Real time monitoring & forecasting of congestion in cities enables real time action to reduce traffic and emissions**
  - **Can charge drivers at point of use for access to city centers**
- **Stockholm Congestion Tax Project**
  - **Involves 18 barrier-free control points**
  - **Allows differentiated pricing by time of day, congestion level, and potentially emissions level**
  - **Results:**
    - **Traffic reduced by 100,000 vehicle passages per day (25%)**
    - **Public transportation passengers increased by 40,000 / day**
    - **Congestion during peak hours and CO_2 emissions were dramatically reduced**

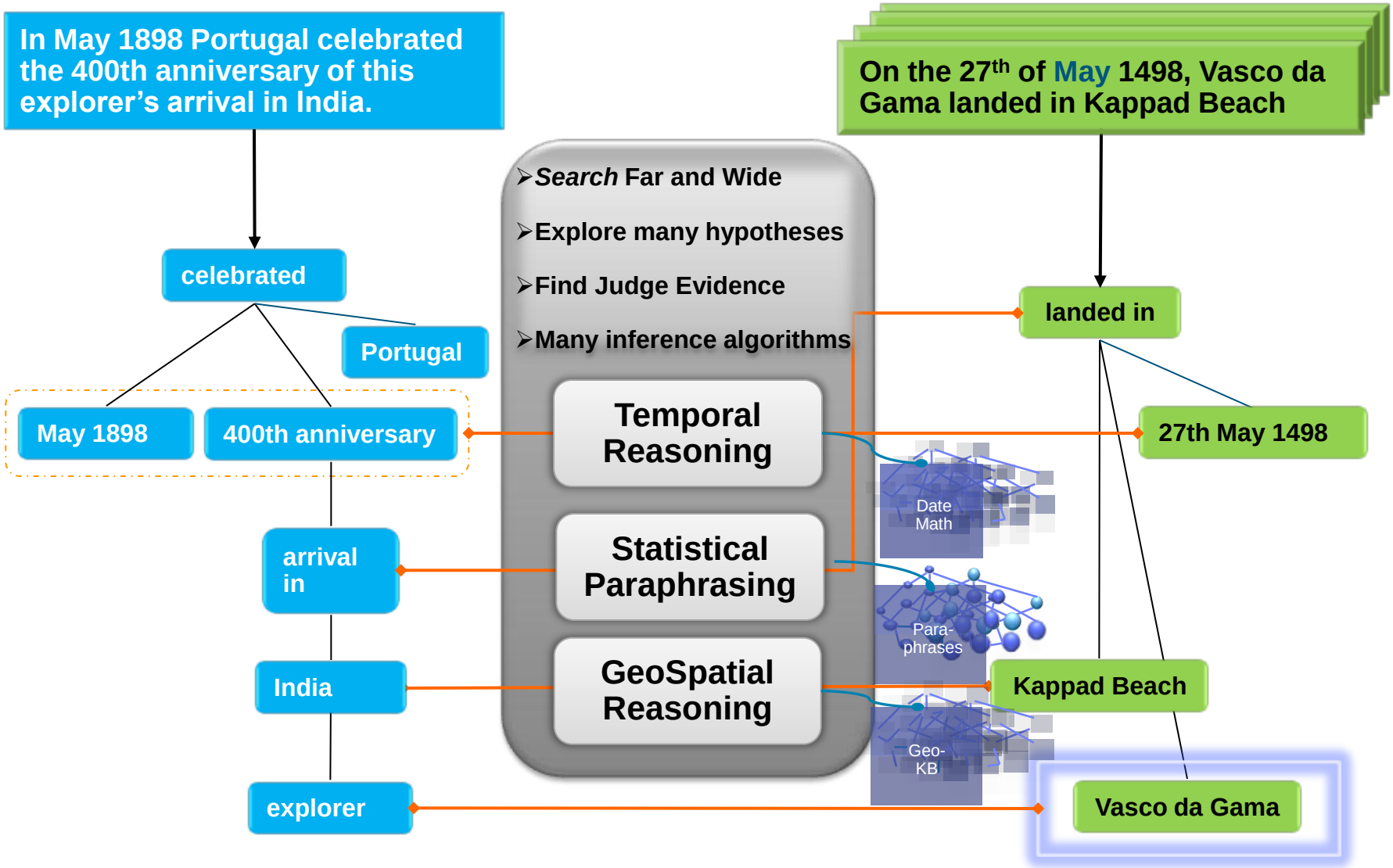


Artificial intelligence



Source: A Brief Overview and Thoughts for Healthcare Education and Performance Improvement by Watson Team

Artificial intelligence



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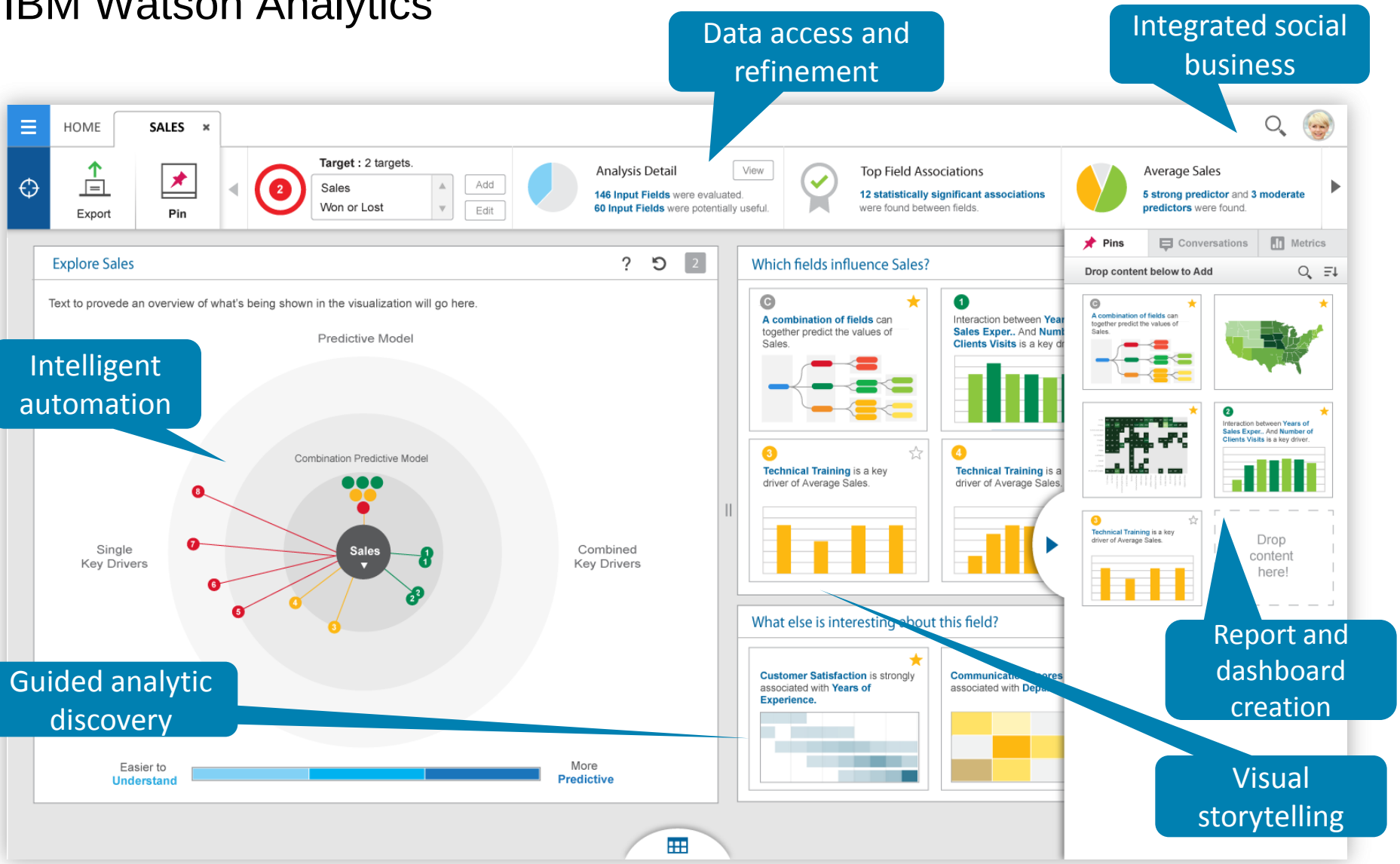
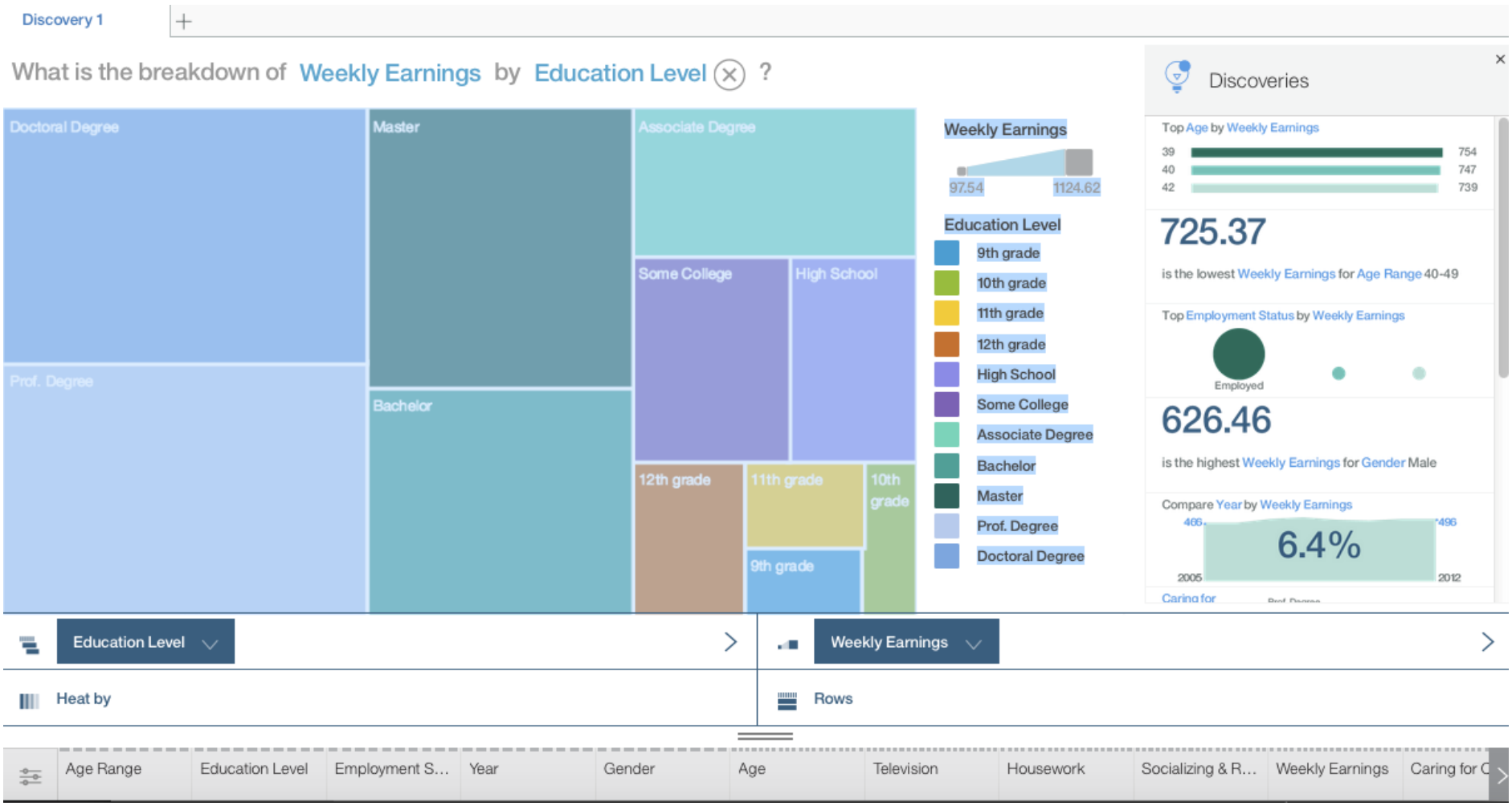
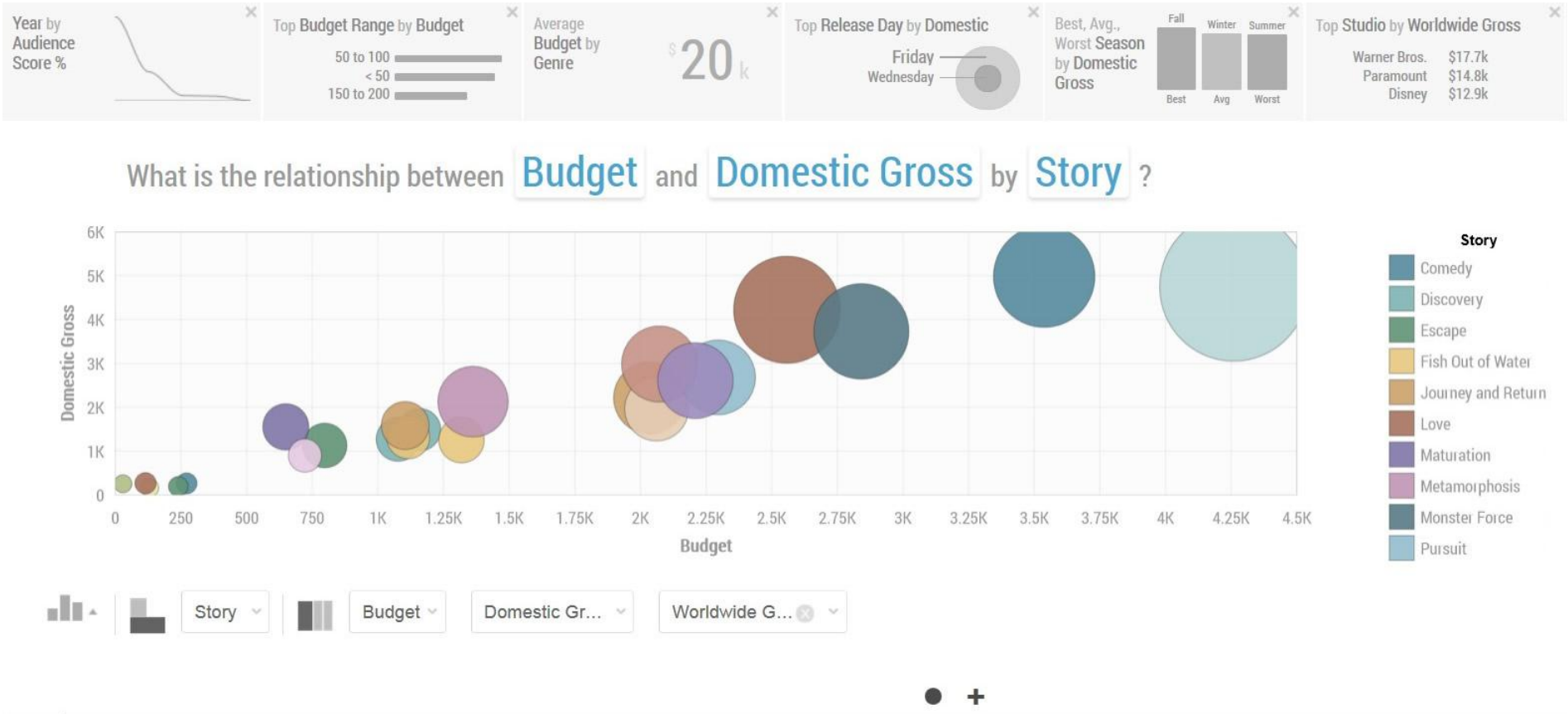
IBM Watson Analytics



IBM Watson Analytics – http://www.ibm.com/watson-analytics



IBM Watson Analytics – http://www.ibm.com/watson-analytics



IBM Debater

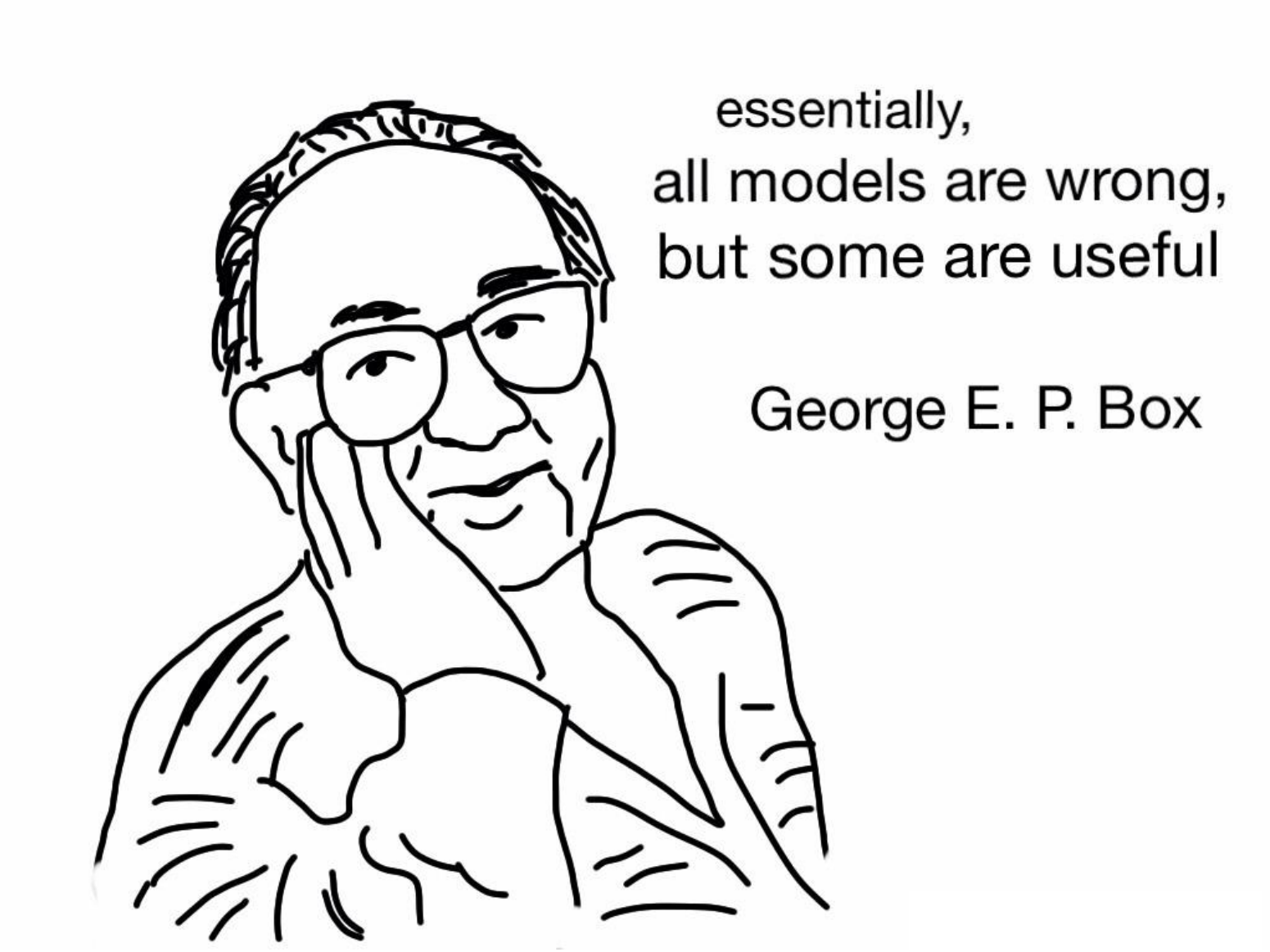
https://youtu.be/naQujxmg9gg

Modeling

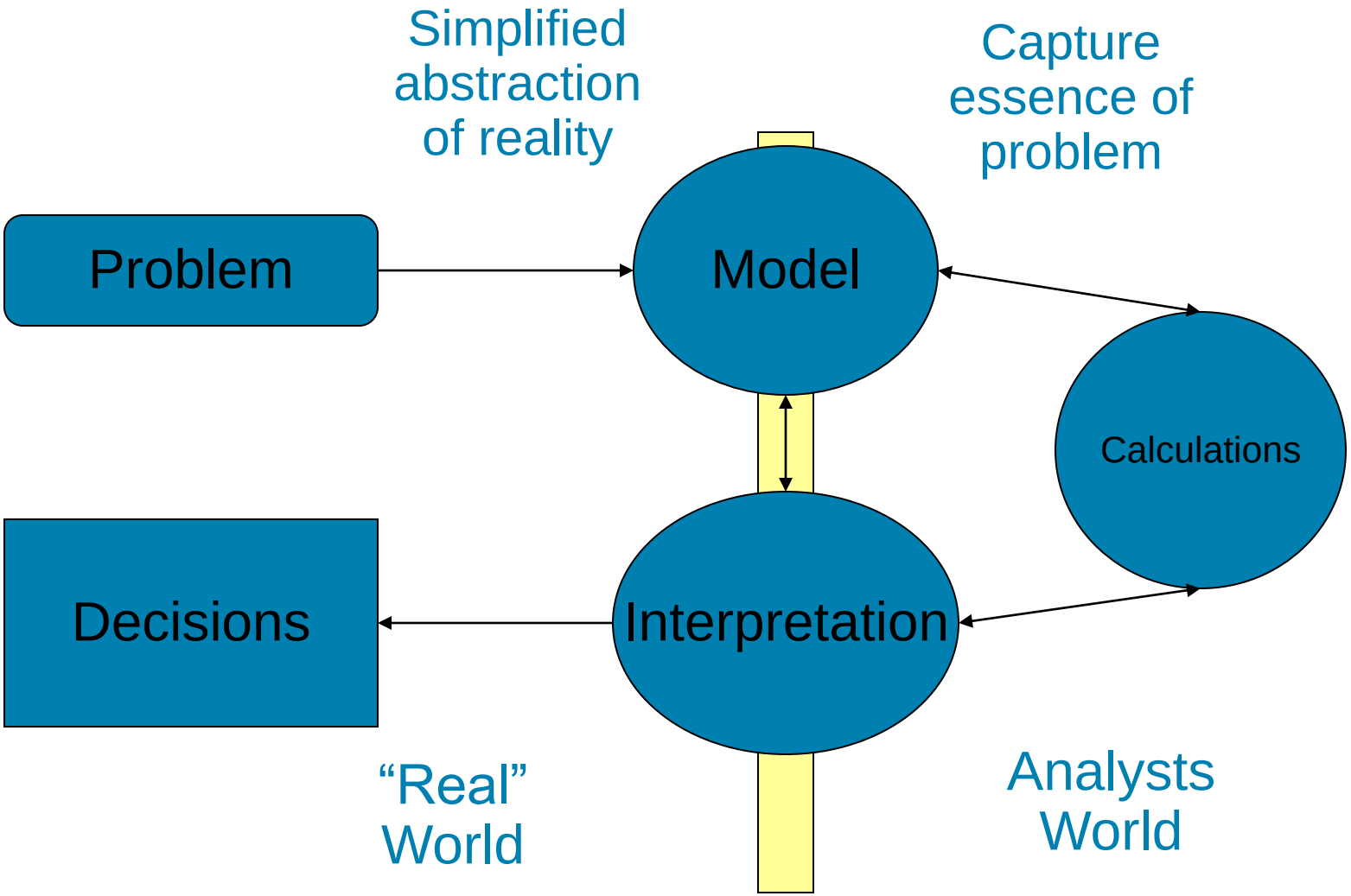
Questions that we can try to answer with models

- **Statistics** – exploratory analysis and hypothesis testing
  - ✓ Decisions made from samples
  - ✓ Hypothesis testing
- **Machine learning** – learning from examples
  - ✓ Supervised learning (prediction, classification)
  - ✓ Unsupervised learning (clustering, associations)
- **Artificial intelligence** – advanced analytics
  - ✓ Text analytics, social media analytics, NLP
  - ✓ Spatio-temporal analytics
  - ✓ Image and visual recognition
  - ✓ Reinforcement learning and autonomous systems
- **Modeling uncertainty** – what would happen in the future?
  - ✓ Monte Carlo simulations
- **Optimizing decisions** – what's best?
  - ✓ Optimization

Models


essentially,
all models are wrong,
but some are useful
George E. P. Box

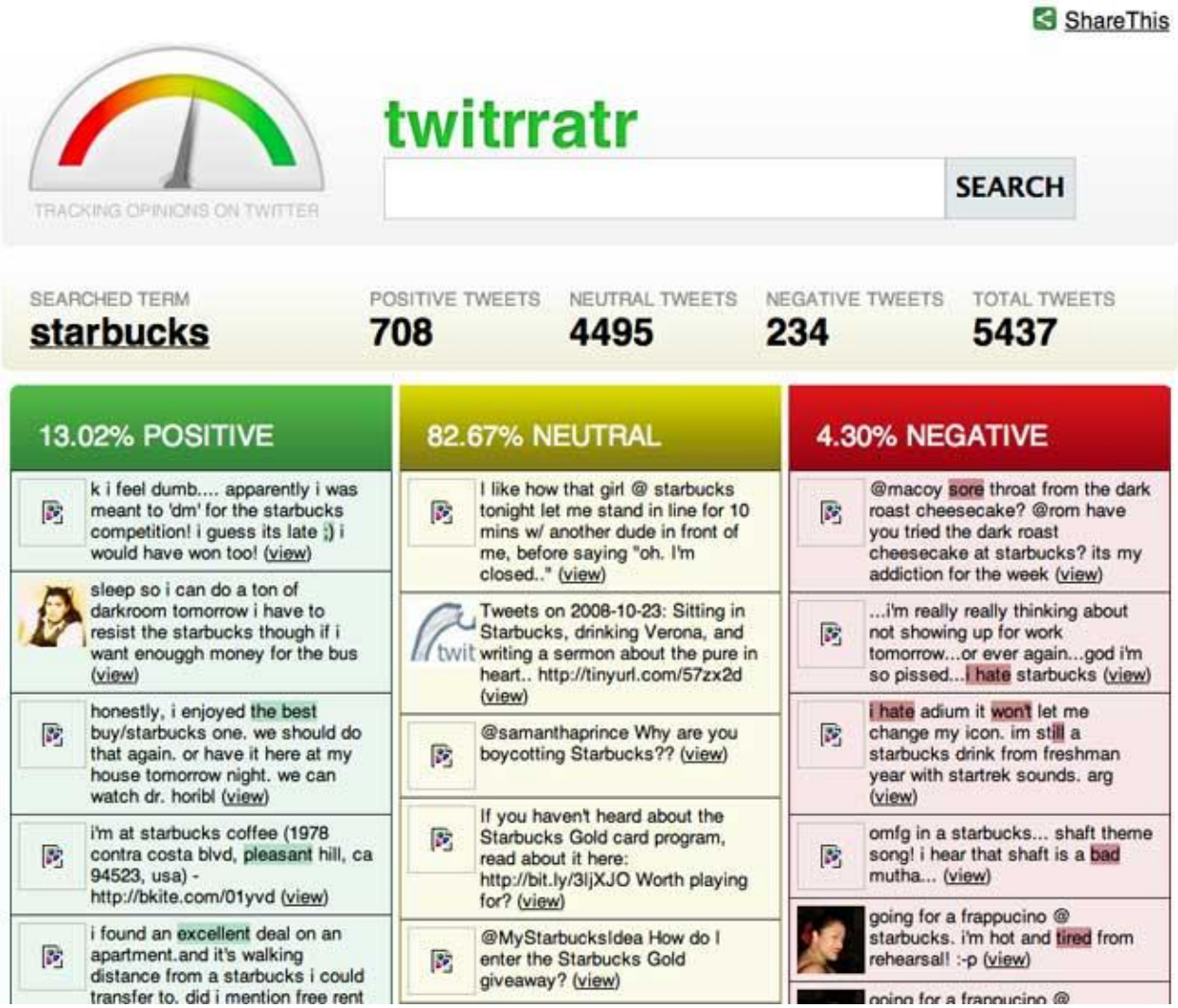
Models and reality



From Monahan, G., "Management Decision Making", Cambridge University Press, 2000

📖 Artificial Intelligence

Text analytics and sentiment analysis



Sentiment analysis of tweets

Natural Language Processing: ‘bag of words’ and sentiment analysis

features (words) | target

examples (news articles)

	bear	tea	love	bad	drink	sentim
All bears are lovely	1	0	1	0	0	56%
Our tea was bad	0	1	0	1	0	-35%
That bear drinks with bear	2	0	0	0	1	-5%
The bear drinks tea	1	1	0	0	1	4%
We love bears	1	0	1	0	0	63%

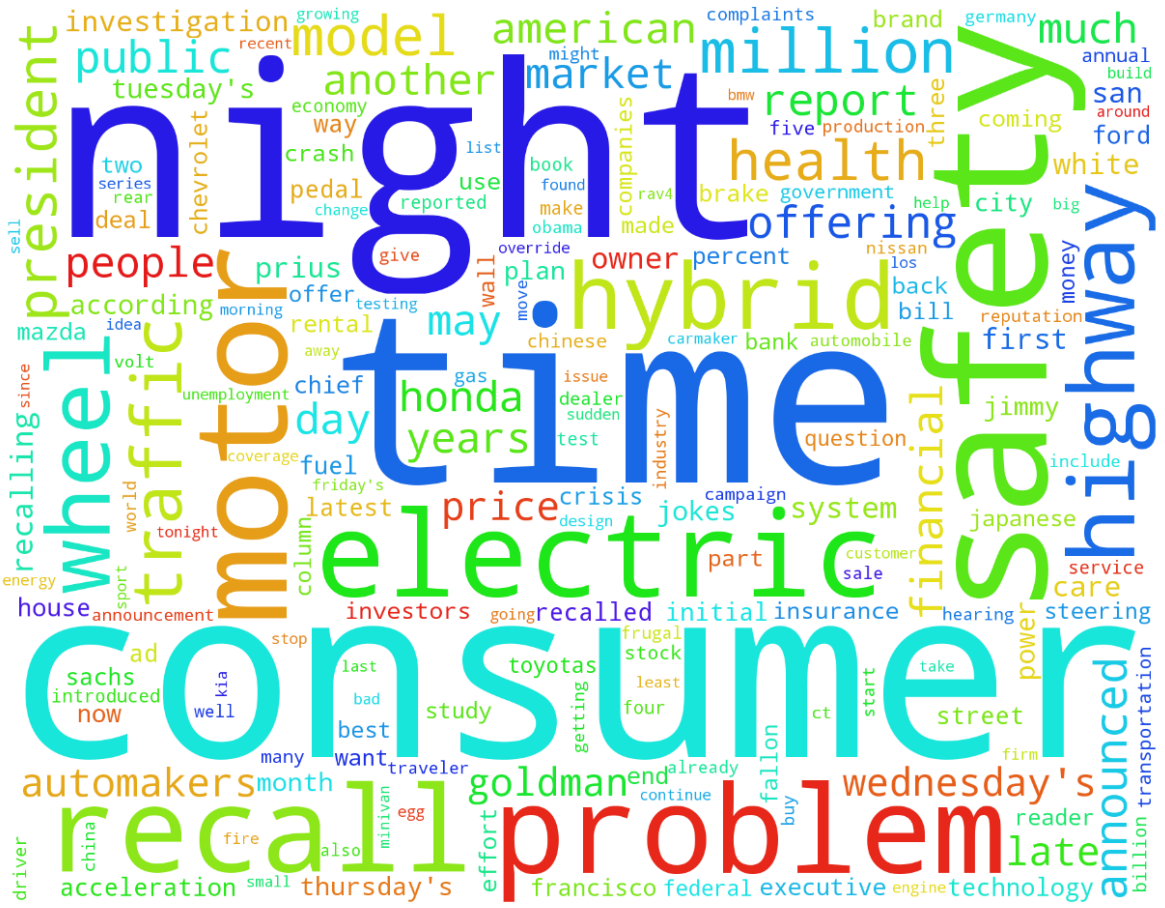
bag of words

x_1 x_2 x_3 x_4 x_5 y

Supervised machine learning algorithm:

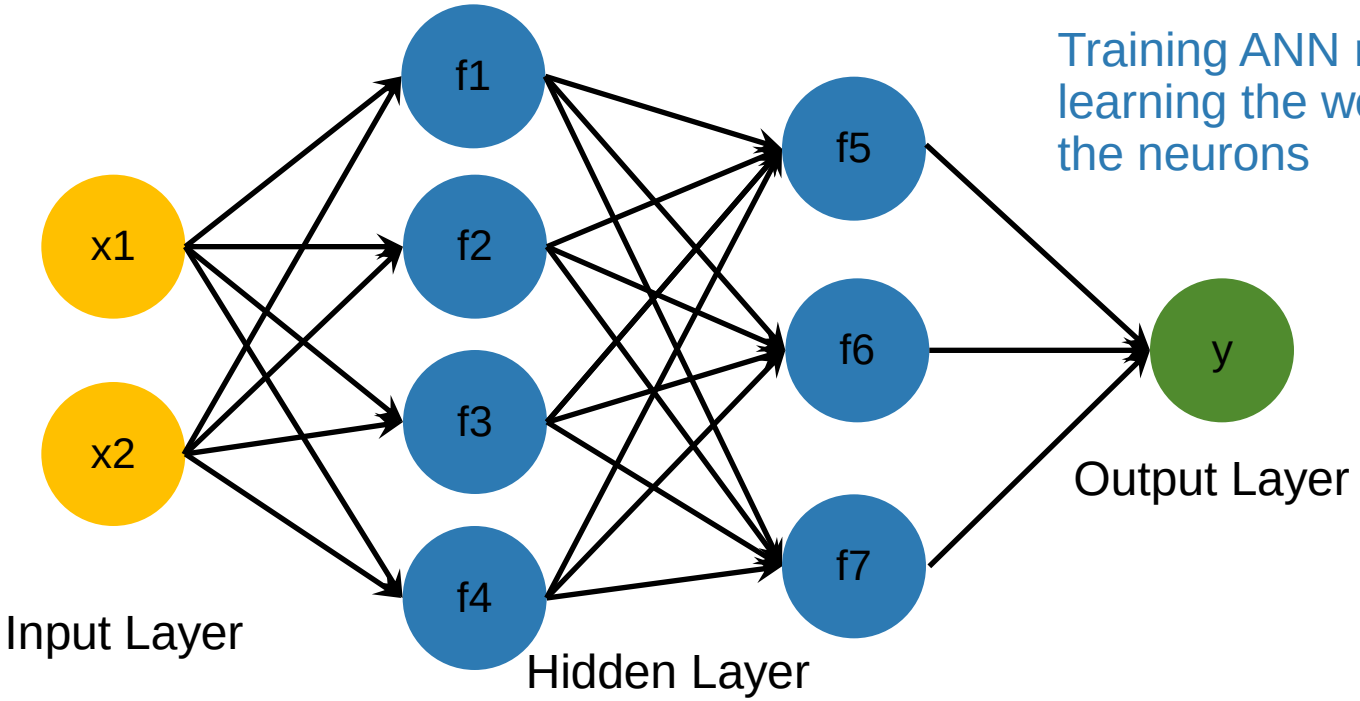
- ❑ Linear regression ⇦ $y = \beta_0 + \beta_1 \cdot x_1 + \beta_2 \cdot x_2 + \ldots + \beta_5 \cdot x_5 + \epsilon$
- ❑ Decision trees
- ❑ SVM regression
- ❑ k-NN regression
- ❑ Ensembles (random forests, XGBoost)
- ❑ Artificial neural nets (deep learning)

Natural Language Processing: word frequency (Word Cloud)

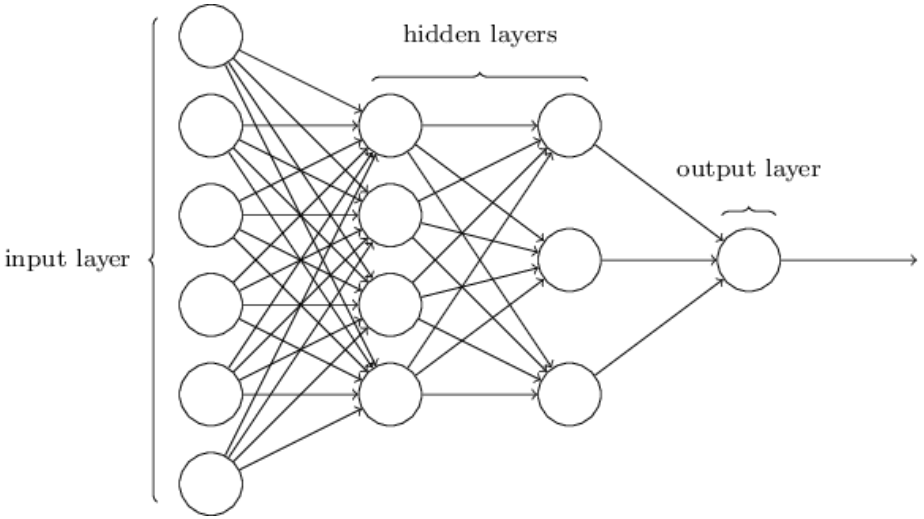


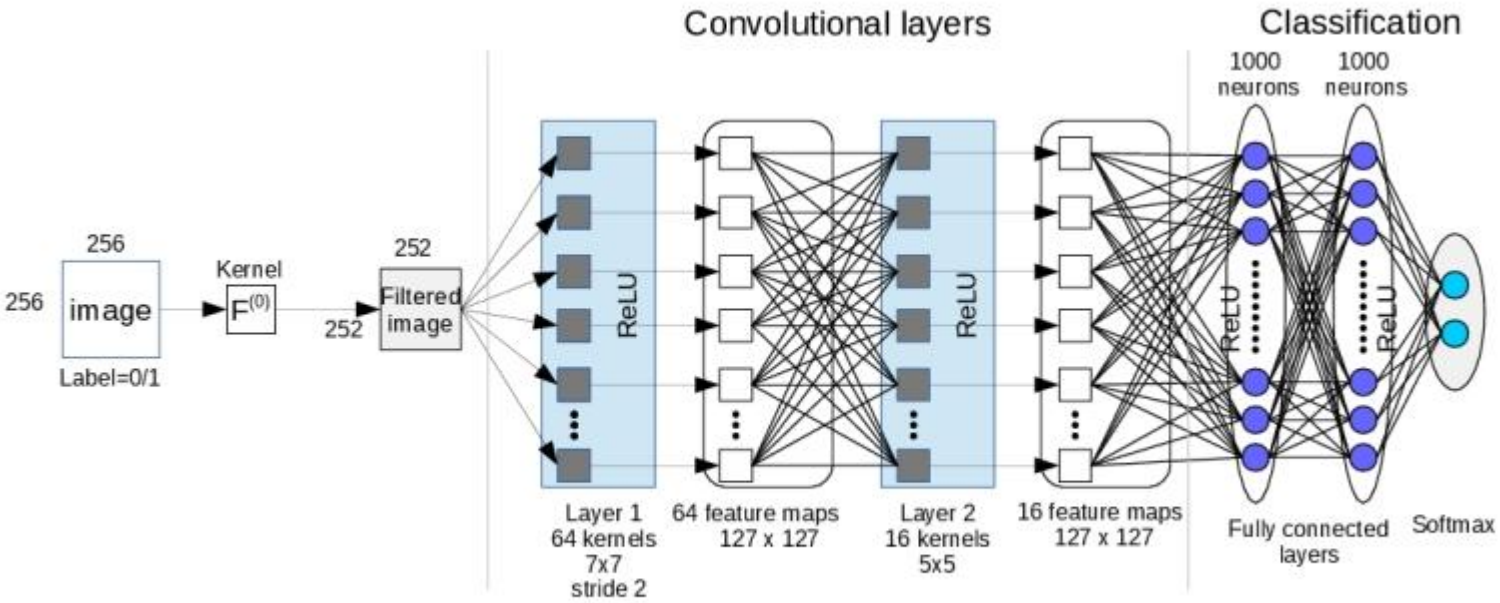
Neural networks and deep learning

- Based loosely on computer models of how brains work
- Model is an assembly of inter-connected neurons (nodes) and weighted links
- Each neuron applies a nonlinear function to its inputs to produce an output
- Output node sums up each of its input value according to the weights of its links
- Used for classification, pattern recognition, speech recognition
- “Black Box” model – no explanatory power, very hard to interpret the results



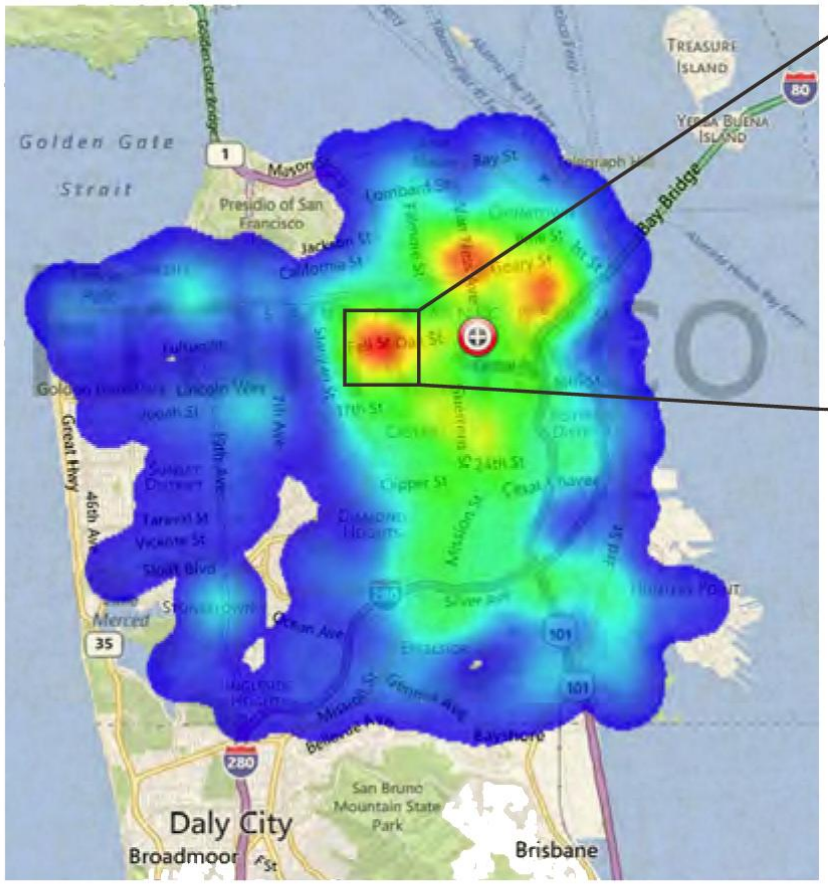
Neural networks and deep learning



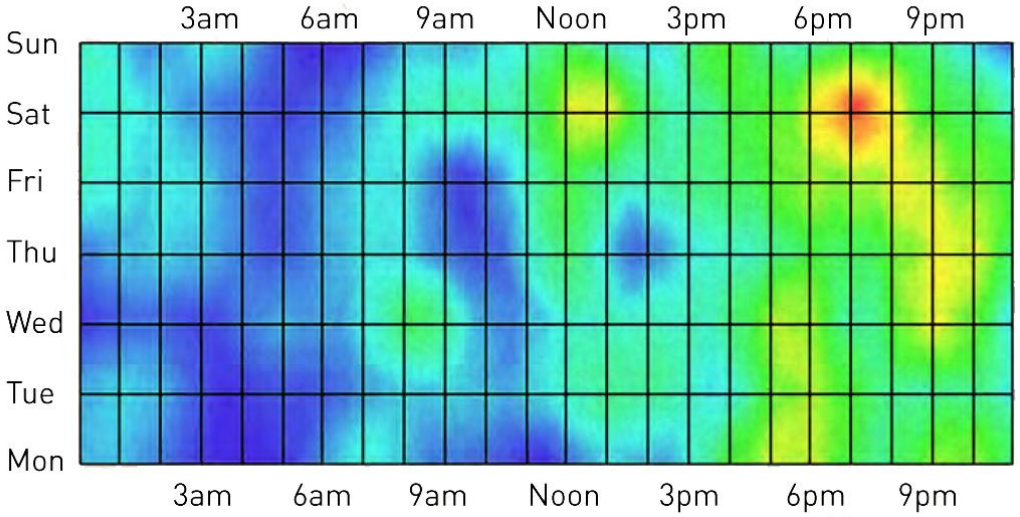


Spatio-temporal analytics – car theft hotspots

GEOSPATIAL HOTSPOTS



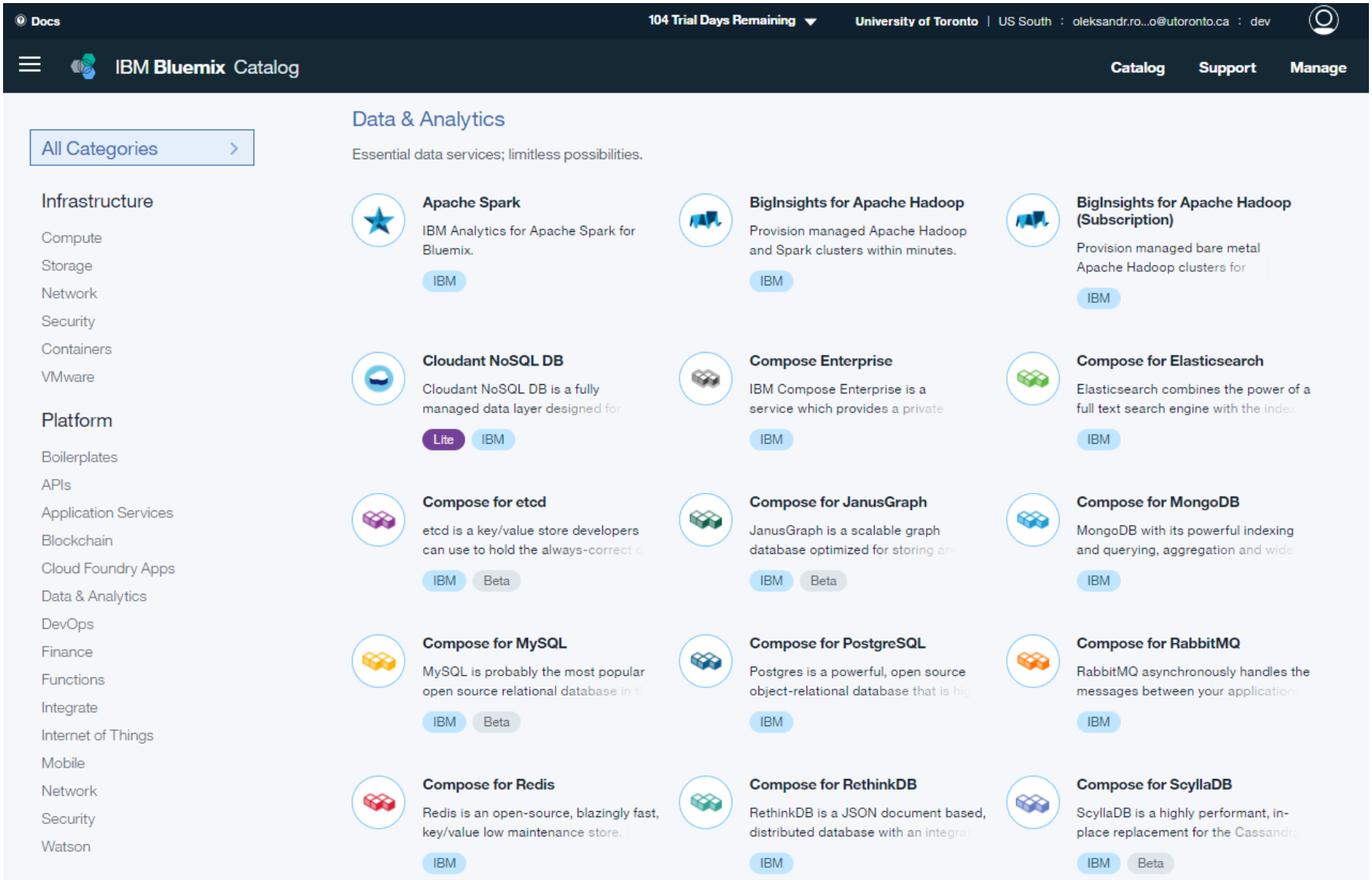
TEMPORAL HOTSPOT



Source: Booz Allen Hamilton, Field Guide to Data Science

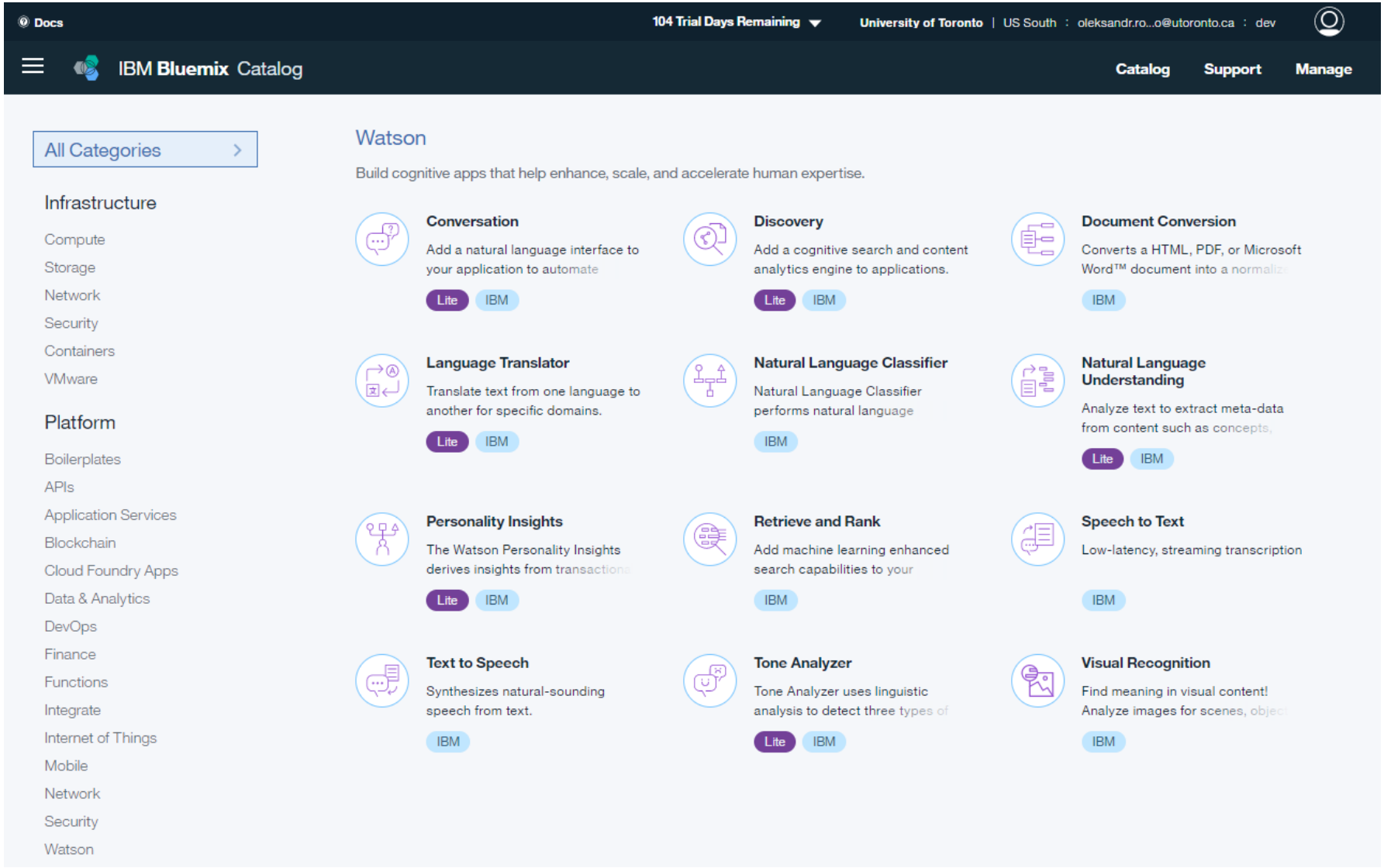
Cloud

IBM Cloud – Data & Analytics services



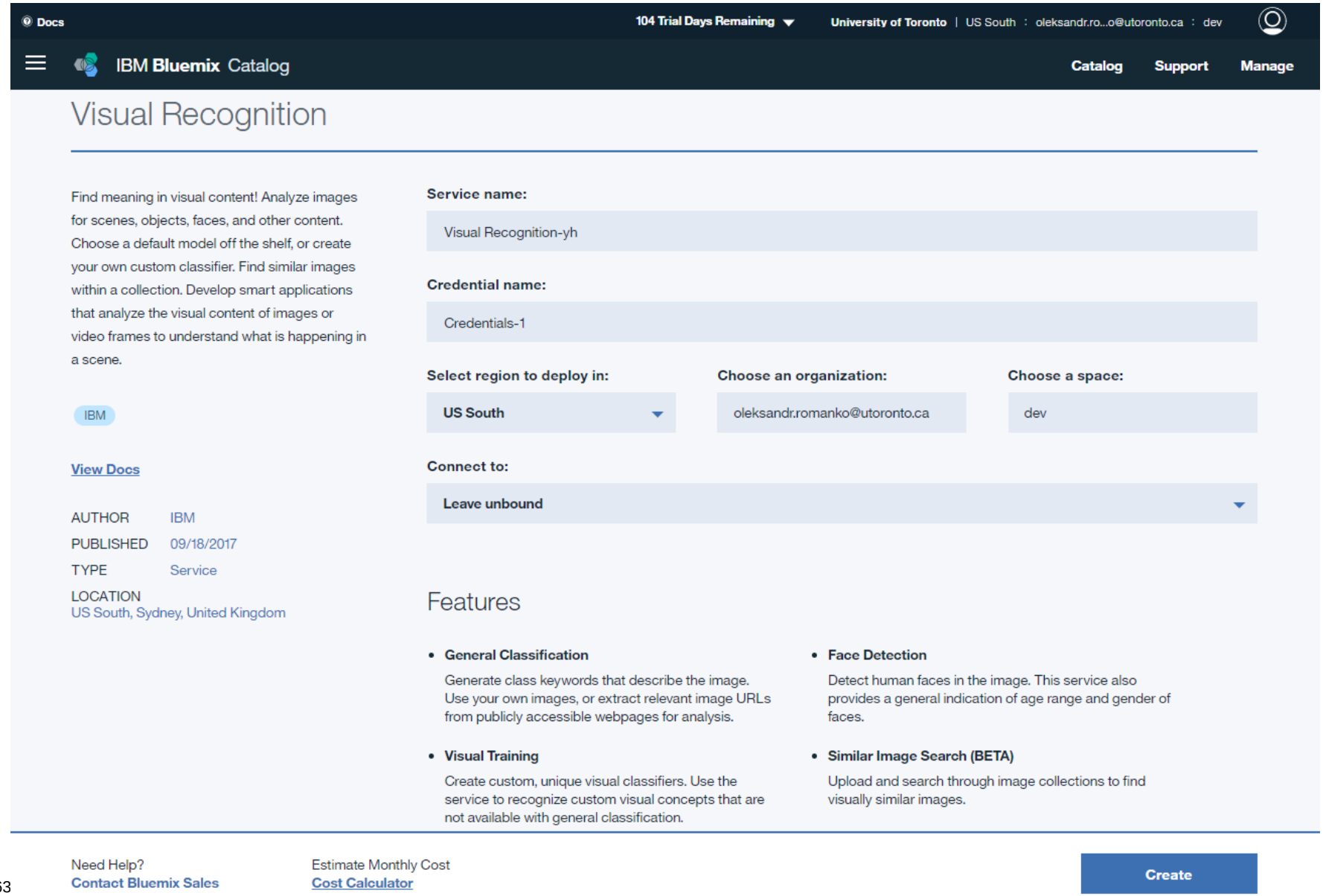
www.bluemix.net

IBM Cloud – Watson services



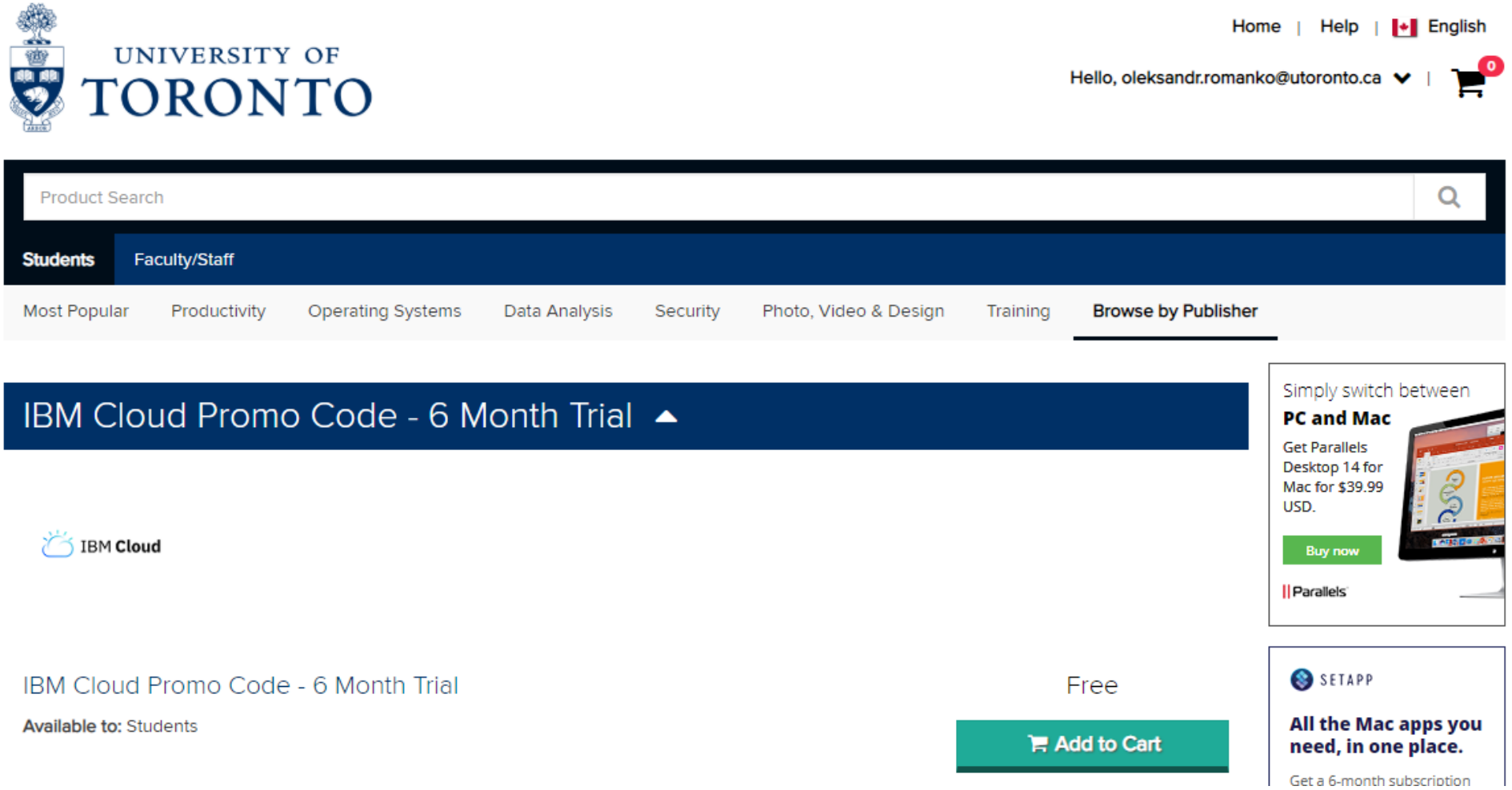
www.bluemix.net

IBM Cloud – Visual Recognition service



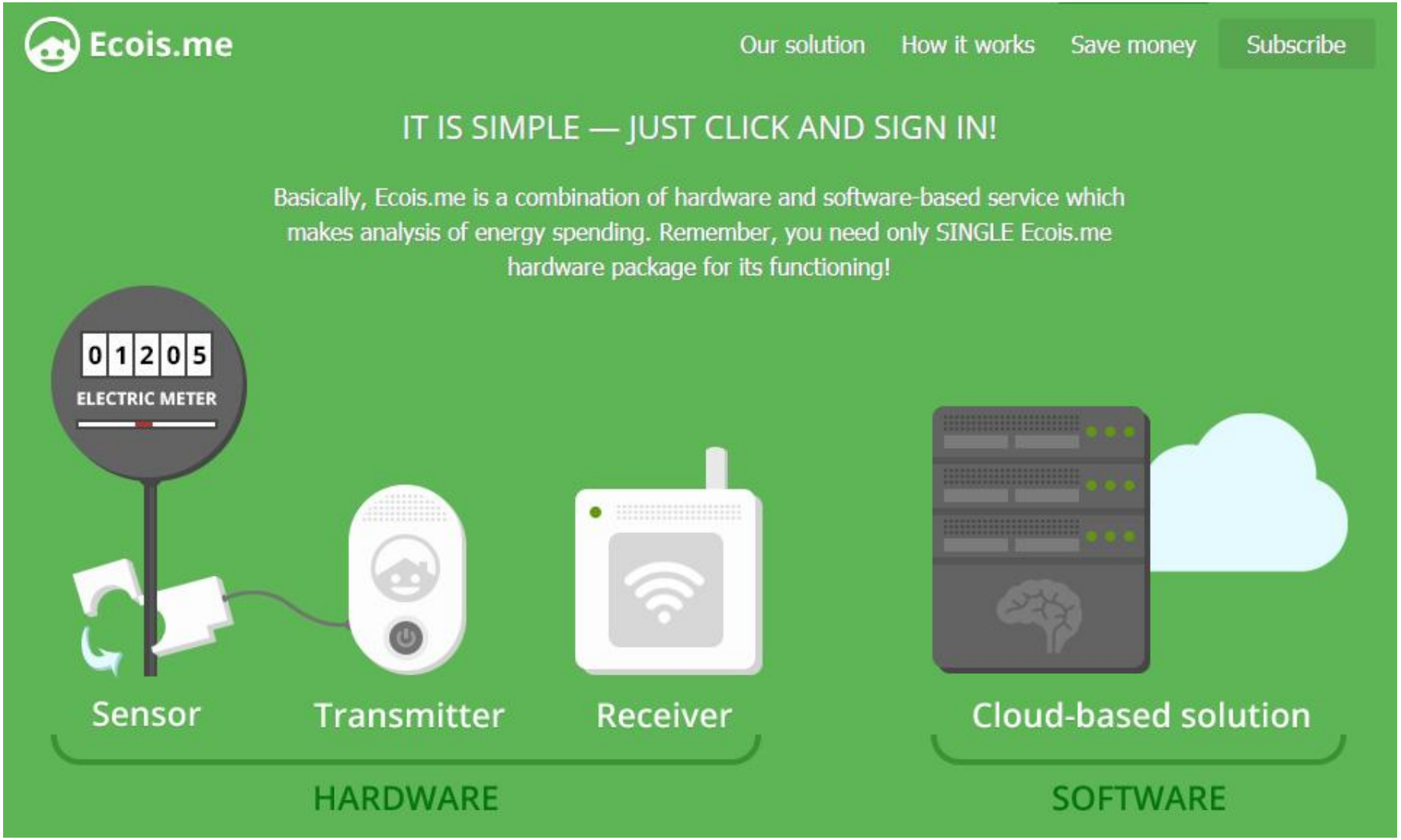
IBM Cloud – access for students

Get 6-month free access to IBM Cloud via UofT portal http://uoft.onthehub.com and login to IBM Cloud at https://console.bluemix.net

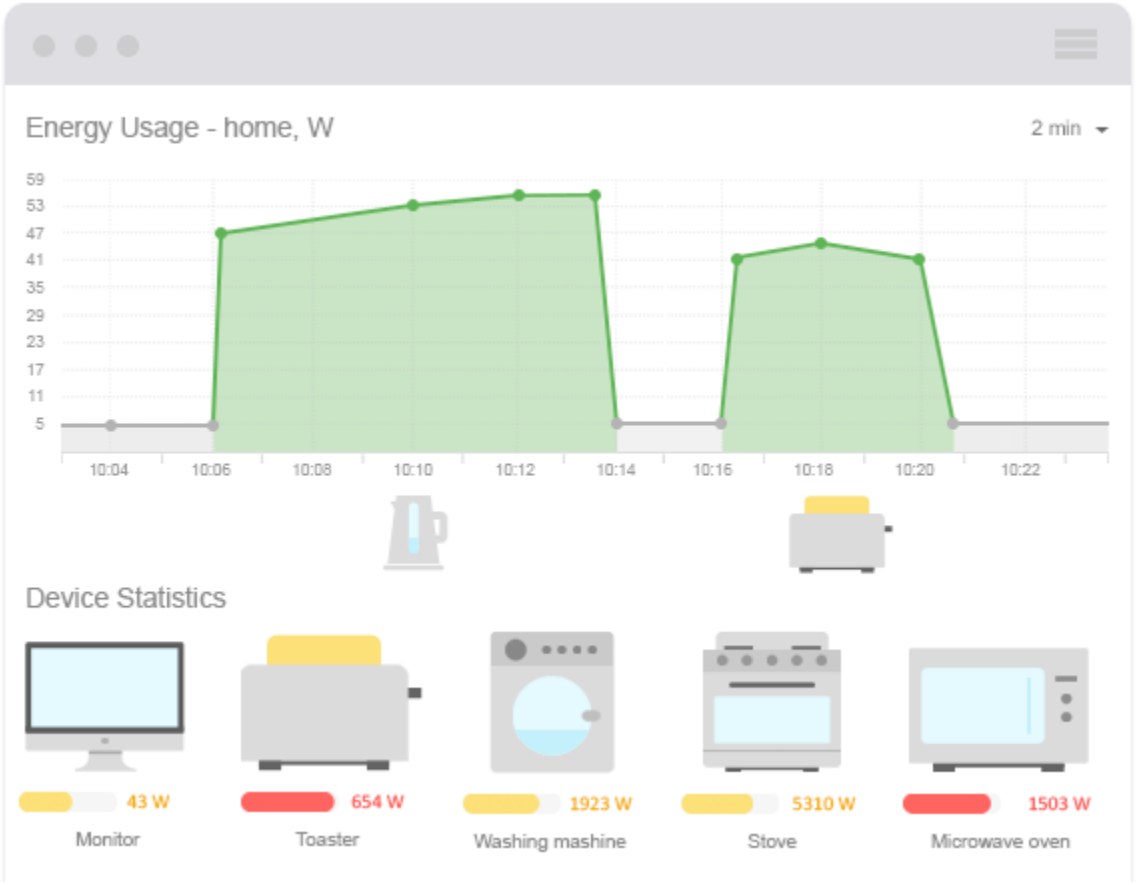


📖 Startups

Ecois.me


Ecois.me
Our solution
How it works
Save money
Subscribe
IT IS SIMPLE — JUST CLICK AND SIGN IN!
Basically, Ecois.me is a combination of hardware and software-based service which makes analysis of energy spending. Remember, you need only SINGLE Ecois.me hardware package for its functioning!
01205
ELECTRIC METER
Sensor
Transmitter
Receiver
Cloud-based solution
HARDWARE
SOFTWARE

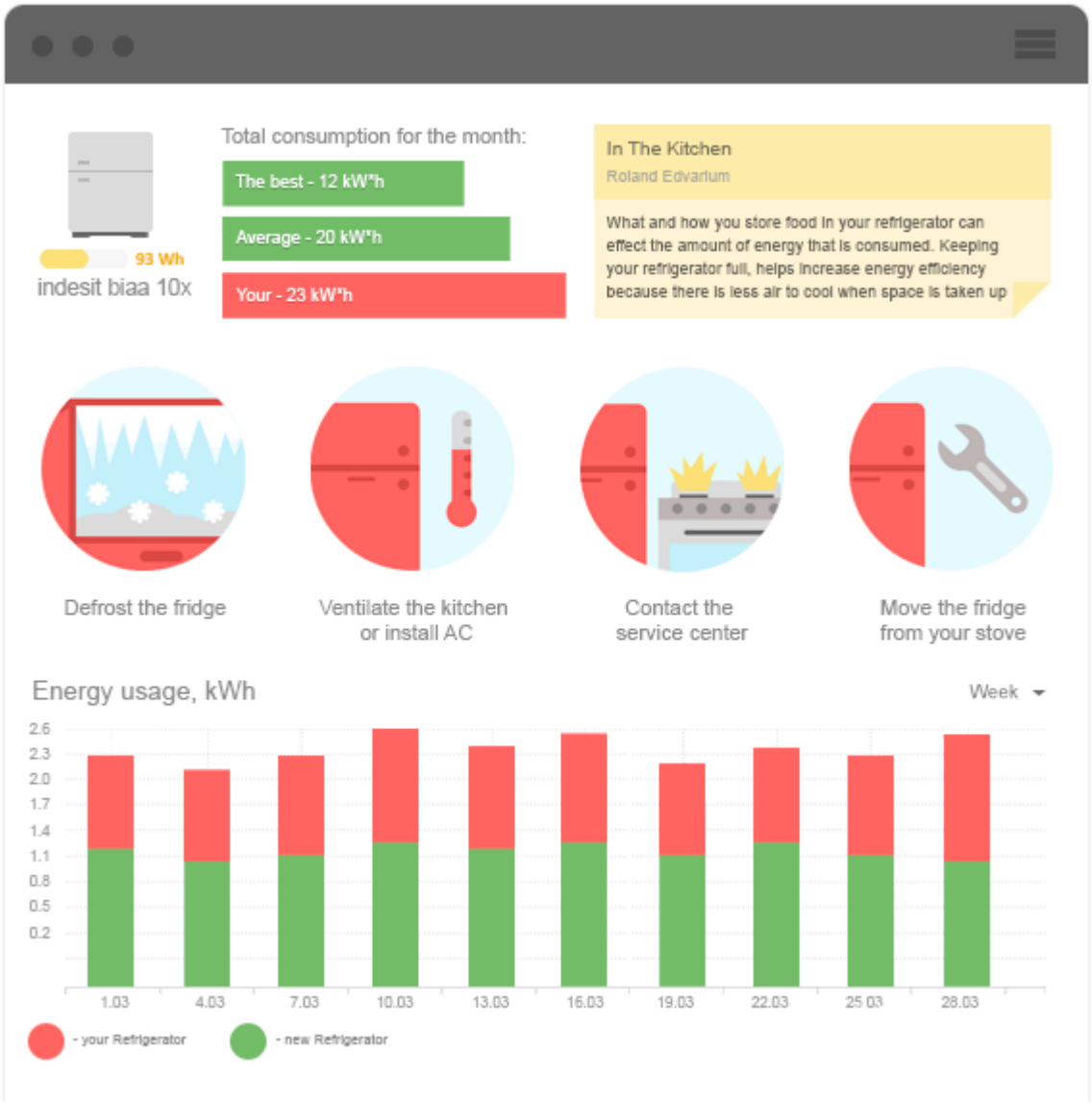
Ecois.me


Energy Usage - home, W
2 min
59
53
47
41
35
29
23
17
11
5
10:04
10:06
10:08
10:10
10:12
10:14
10:16
10:18
10:20
10:22
Device Statistics
43 W
Monitor
654 W
Toaster
1923 W
Washing mashine
5310 W
Stove
1503 W
Microwave oven

Ecois.me


2984 W
Philips HD4656
Kettle
Total consumption for the month:
The best - 100 kW*h
You - 140 kW*h
Average - 170 kW*h
In The Kitchen
Roland Edvarlum
Buy a teapot. If you are making tea for more than one person you can save on teabags and water. Use a tea cosy or use a woolly hat instead to keep the tea warm. Buy a teapot. If you are making tea for more than one
Energy usage, kW
Week
9,0
8,1
7,2
6,3
5,4
4,5
3,6
2,7
1,8
0,9
1.03
4.03
7.03
10.03
13.03
16.03
19.03
22.03
25.03
28.03
- your Kettle
- new Kettle
Kettle BRAUN WK 500 White save 50 EUR/year
Buy it now for 60 EUR

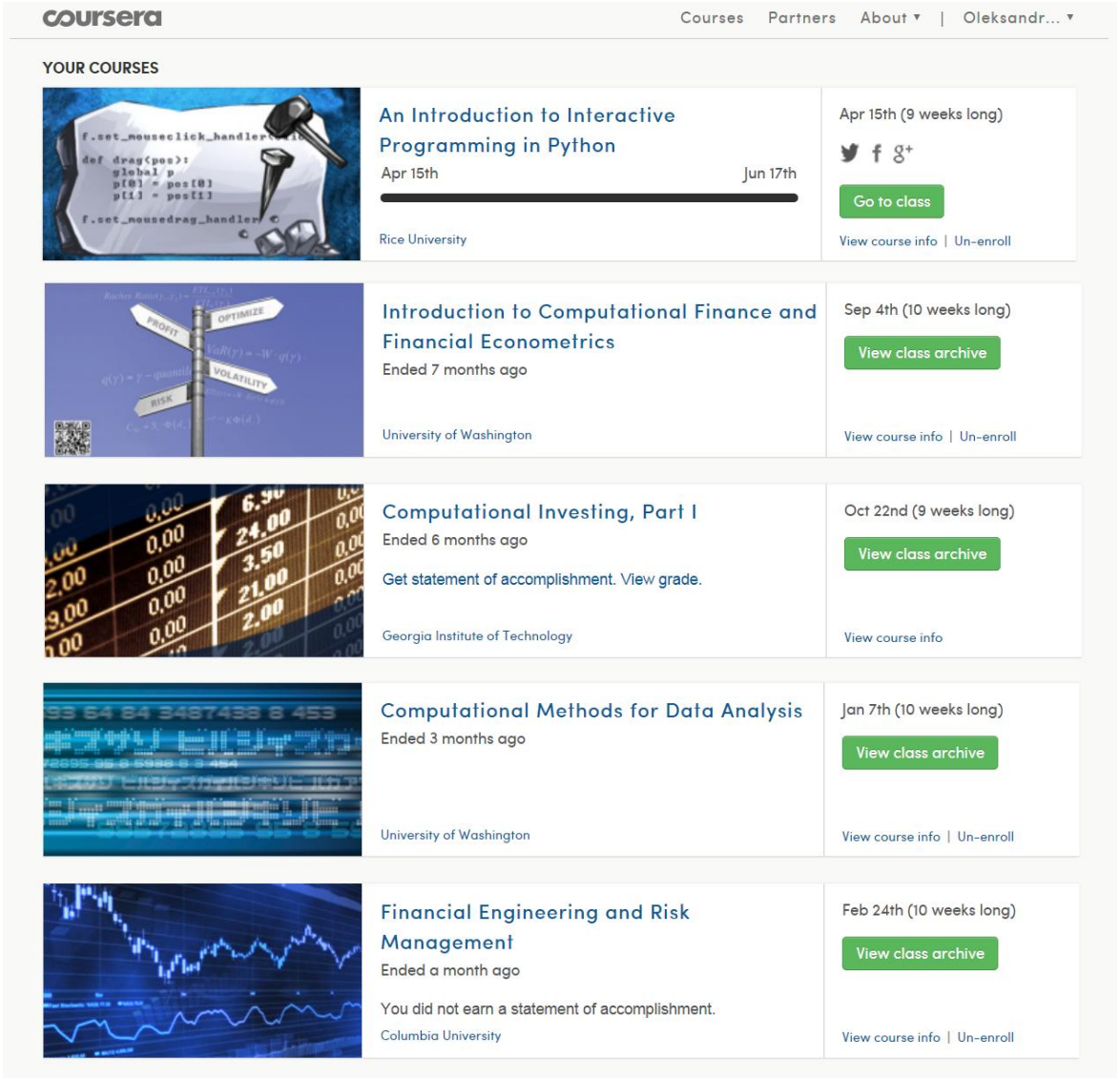
Ecois.me


93 Wh
indesit biaa 10x
Total consumption for the month:
The best - 12 kW*h
Average - 20 kW*h
Your - 23 kW*h
In The Kitchen
Roland Edvarium
What and how you store food in your refrigerator can effect the amount of energy that is consumed. Keeping your refrigerator full, helps increase energy efficiency because there is less air to cool when space is taken up
Defrost the fridge
Ventilate the kitchen or install AC
Contact the service center
Move the fridge from your stove
Energy usage, kWh
Week
2.6
2.3
2.0
1.7
1.4
1.1
0.8
0.5
0.2
1.03
4.03
7.03
10.03
13.03
16.03
19.03
22.03
25.03
28.03
- your Refrigerator
- new Refrigerator

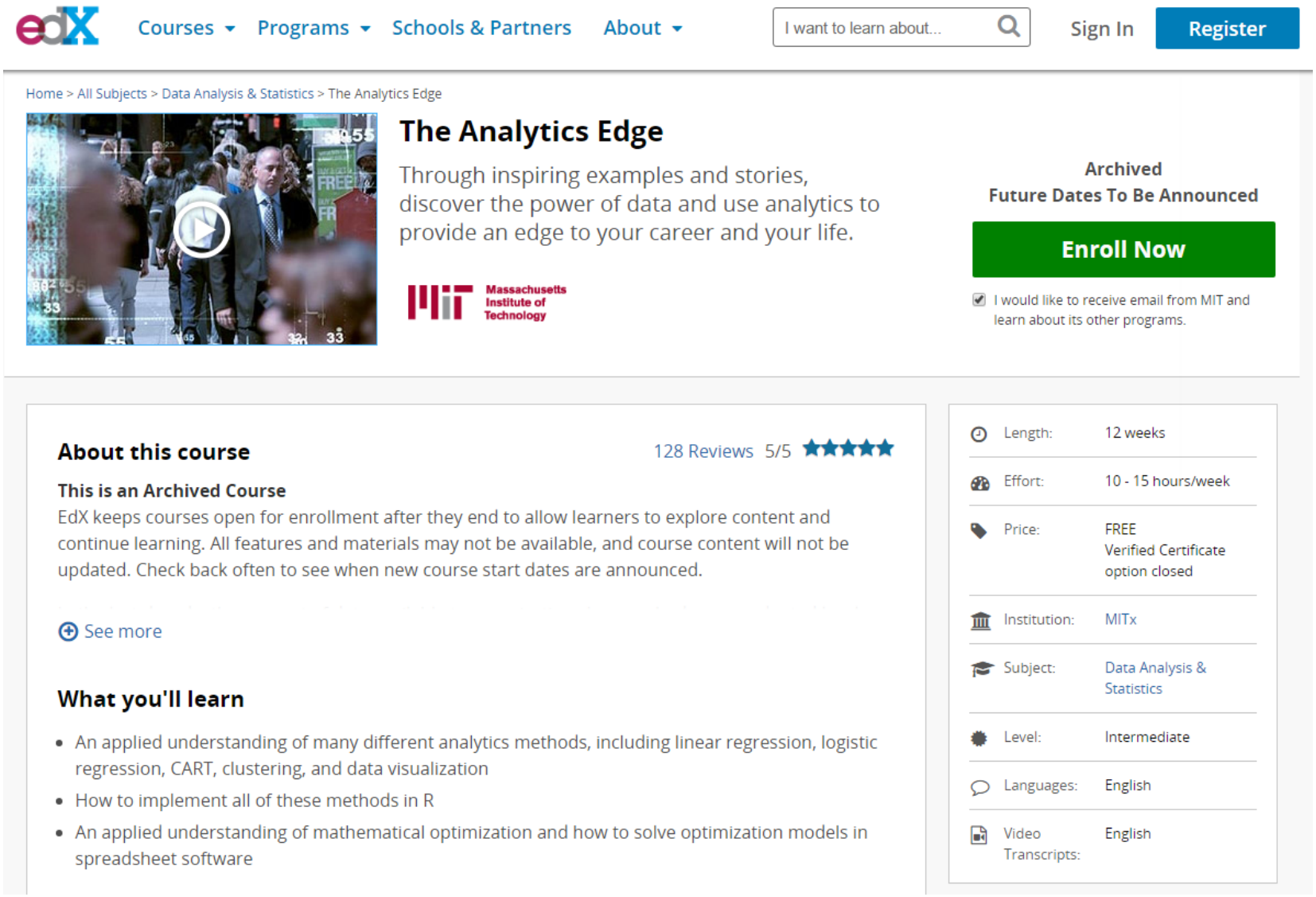
Nymi

📖 Online and In-Person Education

Coursera (coursera.org)



EdX (edx.org)


edX
Courses
Programs
Schools & Partners
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I want to learn about...
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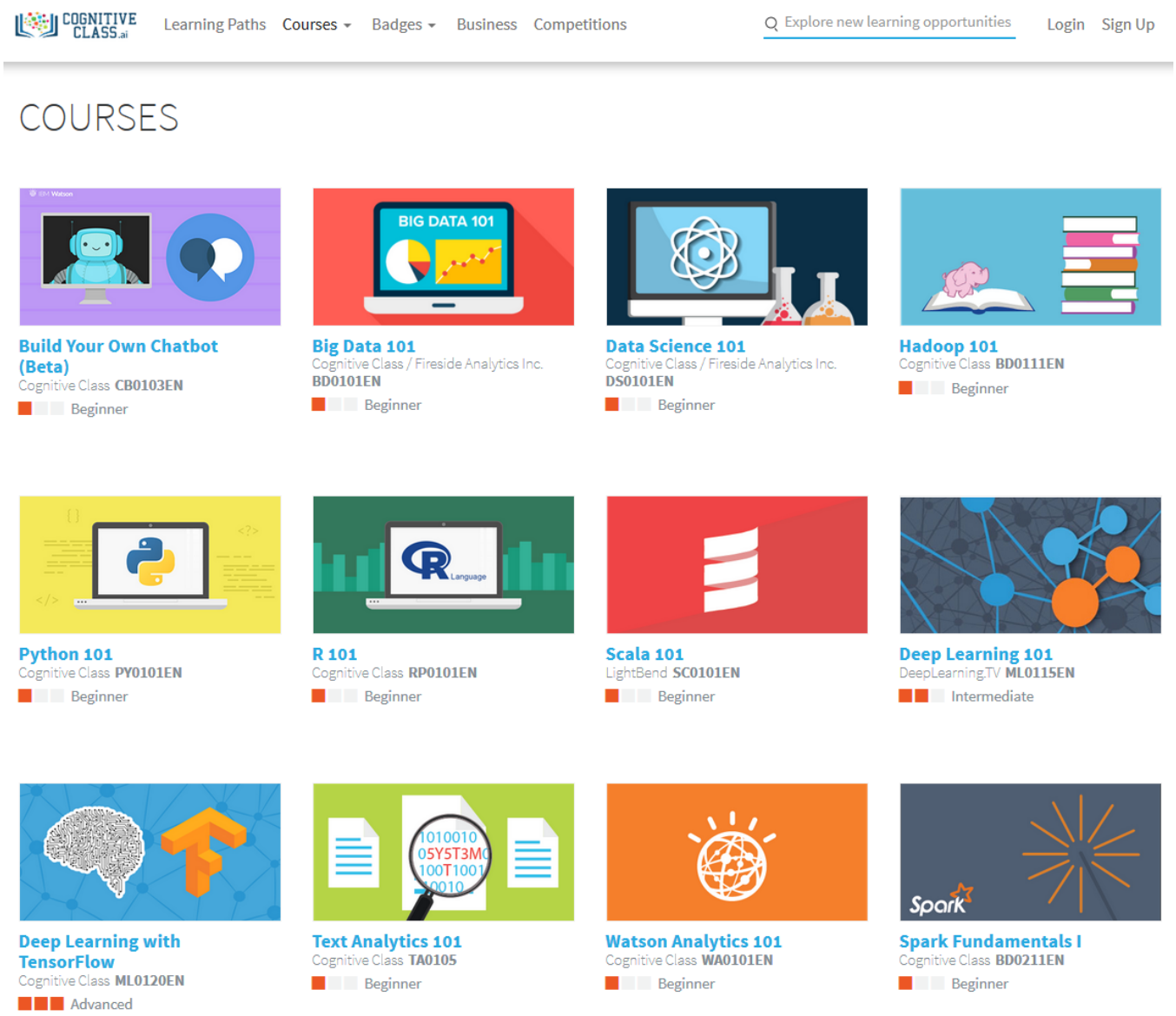
Register
Home > All Subjects > Data Analysis & Statistics > The Analytics Edge
The Analytics Edge
Through inspiring examples and stories, discover the power of data and use analytics to provide an edge to your career and your life.
Massachusetts Institute of Technology
Archived
Future Dates To Be Announced
Enroll Now
I would like to receive email from MIT and learn about its other programs.
About this course
128 Reviews 5/5
This is an Archived Course
EdX keeps courses open for enrollment after they end to allow learners to explore content and continue learning. All features and materials may not be available, and course content will not be updated. Check back often to see when new course start dates are announced.
See more
What you'll learn
An applied understanding of many different analytics methods, including linear regression, logistic regression, CART, clustering, and data visualization
How to implement all of these methods in R
An applied understanding of mathematical optimization and how to solve optimization models in spreadsheet software
Length: 12 weeks
Effort: 10 - 15 hours/week
Price: FREE Verified Certificate option closed
Institution: MITx
Subject: Data Analysis & Statistics
Level: Intermediate
Languages: English
Video Transcripts: English

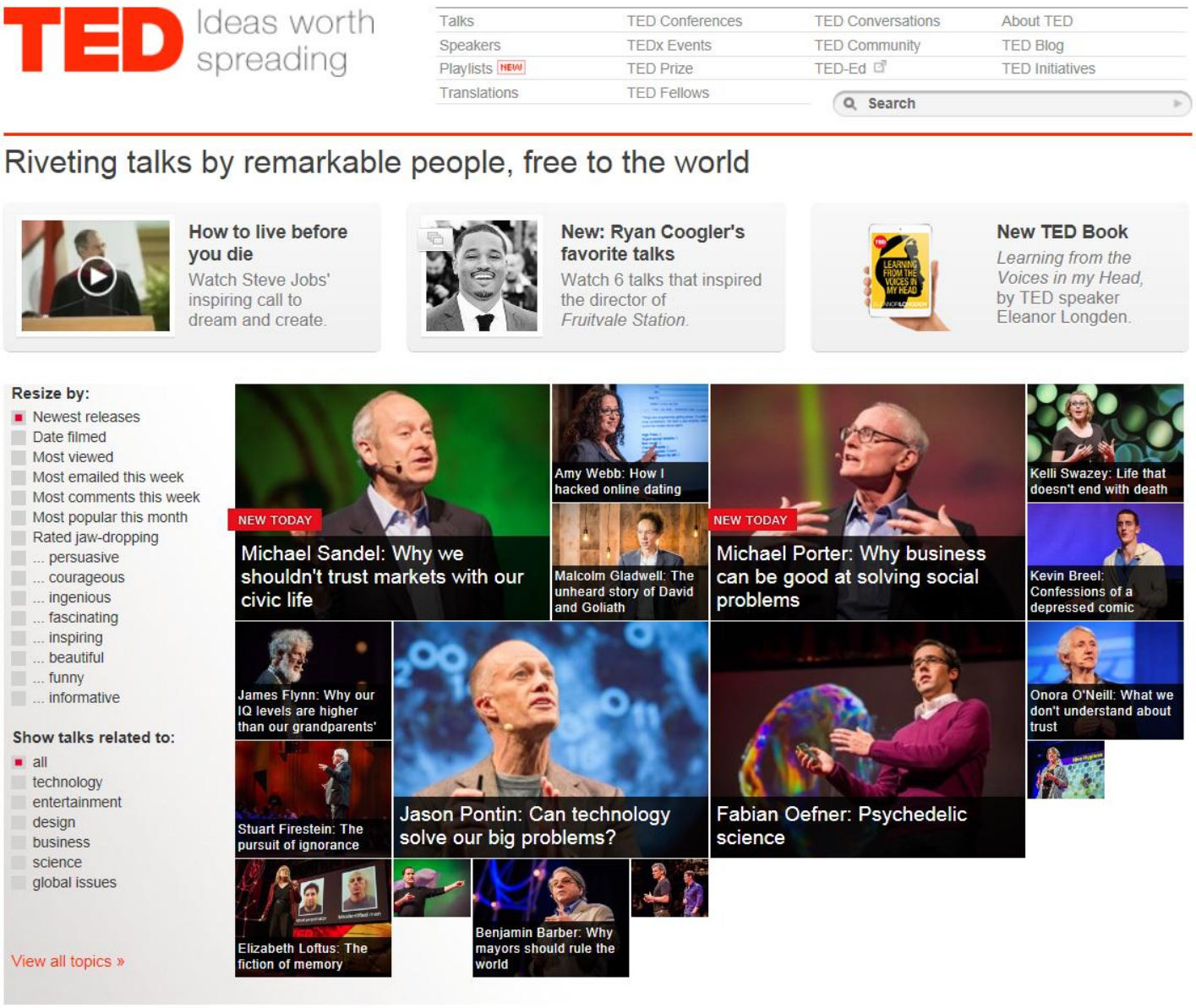
CognitiveClass MOOC
http://CognitiveClass.ai

CognitiveClass MOOC (http://CognitiveClass.ai)

- Free courses, free study materials
- Cloud-based sandbox for exercises
- 800000+ registered students
- 50+ courses



TED and TEDx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TED Conferences
TED Conversations
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Resize by:
Newest releases
Date filmed
Most viewed
Most emailed this week
Most comments this week
Most popular this month
Rated jaw-dropping
... persuasive
... courageous
... ingenious
... fascinating
... inspiring
... beautiful
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Malcolm Gladwell: The unheard story of David and Goliath
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James Flynn: Why our IQ levels are higher than our grandparents'
Onora O'Neill: What we don't understand about trust
Stuart Firestein: The pursuit of ignorance
Jason Pontin: Can technology solve our big problems?
Fabian Oefner: Psychedelic science
Elizabeth Loftus: The fiction of memory
Benjamin Barber: Why mayors should rule the world

📖 To Do before Lecture 2

Run IPython example provided in class

- **Use Python on cloud via Data Scientist Workbench**
  - Register for CognitiveClass.ai MOOC portal https://cognitiveclass.ai to access 60+ free data science courses and to use Python on the DSW cloud
  - You can use Python on DSW cloud via https://datascientistworkbench.com
- **Install Python**
  - Recommended to use Python version 3.X
  - You may use your own Python distribution, e.g., Anaconda that can be downloaded from https://www.anaconda.com/download/
- **Get access to IBM Cloud**
  - Register at UofT software portal http://uoft.onthehub.com and register for access to IBM Cloud from IBM – Cloud – Cloud Access – IBM Cloud section
- **Check class web-page on Quercus**