

Data X

Introduction Data, Signals, and Systems

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IEOR Emerging Area Professor Award, UC Berkeley

Agenda on Day 1

- Course Introduction and Data-X Project (20 min)
- High Level Overview of Data (1:20 hours)
- Python Notebook to get started and install open tools (30 min, the rest on your own)
- Remaining Time – Advisor mixer and/or get help if needed from GSI/teaching team to install your coding environment.



Welcome to Applied Data Science with Venture Applications

Hosted by

Sutardja Center

Industrial Engineering End Operations Research Department

Data-in-Action (Data-X) Lab

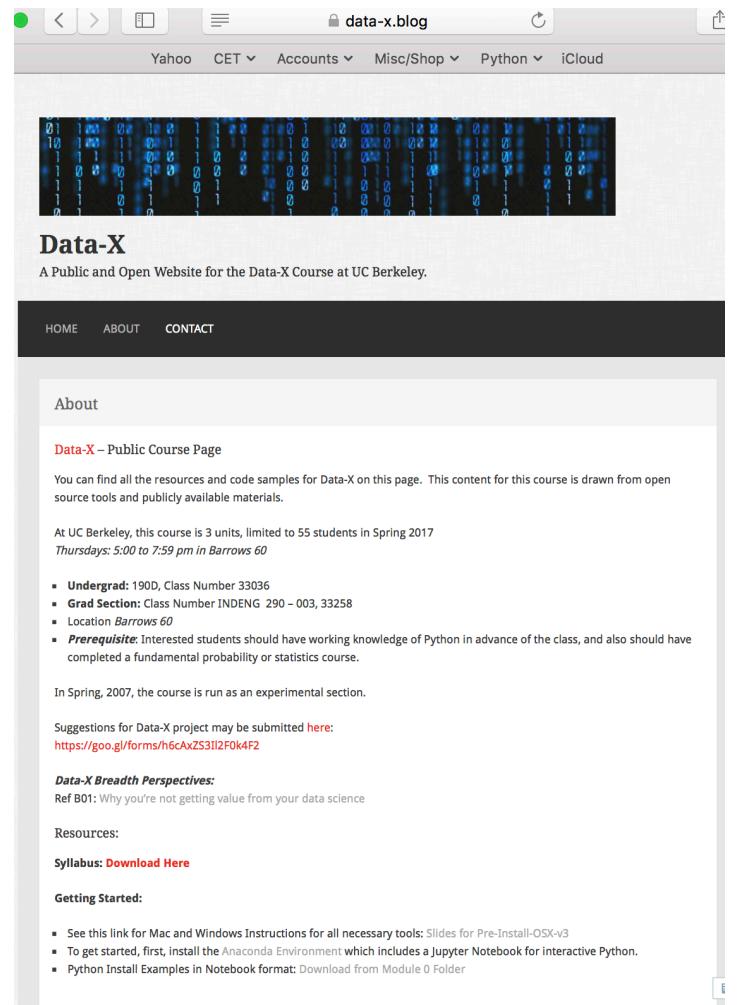
- Teaching Team Introductions (15 min)
 - Sana Iqbal , sana_iqbal@berkeley.edu
Alexander Fred-Ojala, afo@berkeley.edu (Visiting Scholar),
Kevin Bozhe Li, tbl4ew@berkeley.edu,
 - Many others have contributed. Many advisors.
- Pre-requisites:
 - 1) Working knowledge of Python, 2) Probability and/or Statistics, 3) Know basic matrix multiplication



Most Resources Are Available at data-x.blog

By Next Week:

1. Go to Data-X.blog
 - Syllabus
 - Instructions for SW Install
 - Link to GitHub with Cookbook Code Samples and Slides
2. Download Instructions to Install Python 3.x Anaconda Environment.
For now you only need Anaconda, don't worry about other packages that are not already included.
3. Self-Review Python references as needed. See Ref CS01 and as needed BIDS Python Bootcamp.
4. Follow Directions to create your own Jupyter notebook and solve problems. Turn in pdf copy electronically. This will be sent out separately
5. Come up with 3 ideas for a group project. Write 1-3 sentences for each. Bring it with you on paper to turn in at next class.

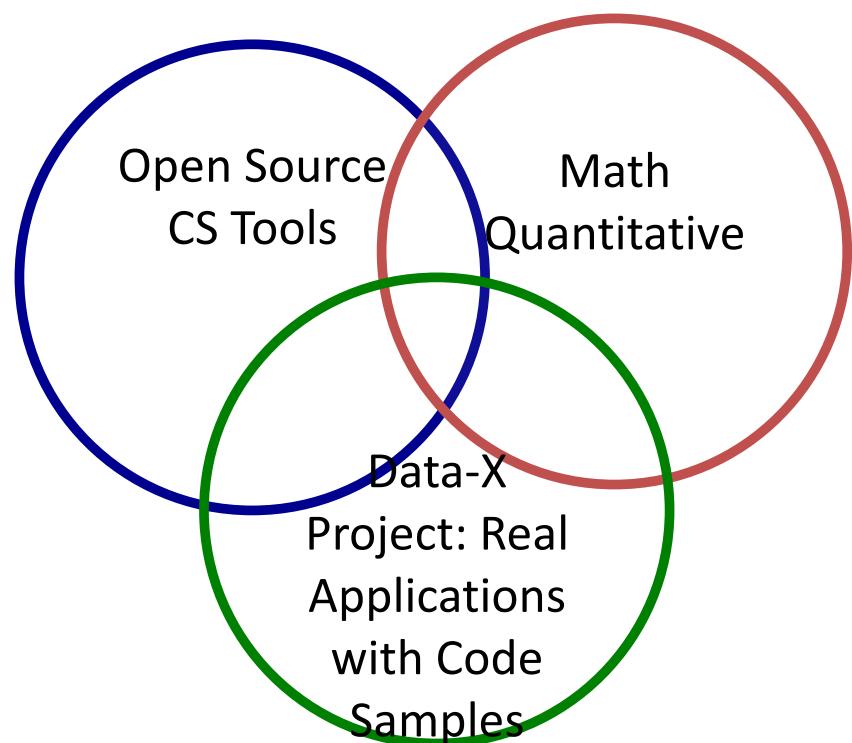


The screenshot shows a web browser window with the URL "data-x.blog" in the address bar. The browser's menu bar includes "Yahoo", "CET", "Accounts", "Misc/Shop", "Python", and "iCloud". The main content area displays the Data-X website. The header features a blue binary background image and the text "Data-X" followed by a subtitle: "A Public and Open Website for the Data-X Course at UC Berkeley". A navigation bar below the header contains links for "HOME", "ABOUT", and "CONTACT". The "ABOUT" section is currently active. It includes a sub-section titled "Data-X – Public Course Page" which provides information about the course being limited to 55 students in Spring 2017. It lists prerequisites such as Undergrad: 190D, Class Number 33036, Grad Section: Class Number INDENG 290 - 003, 33258, and Location Barrows 60. It also notes that interested students should have working knowledge of Python in advance of the class and completed a fundamental probability or statistics course. The section concludes with a note that the course is run as an experimental section in Spring, 2007. Below this, there are sections for "Data-X Breadth Perspectives", "Ref B01", "Resources", "Syllabus", and "Getting Started", each with its own descriptive text and links.



What is in this course

- Course Materials
- Applied Project
- Holistic Perspective:
Industry, Social
Applications,
Customer Driven



What is in this class?

New for fall 2017: More modeling

Common Open Source CS Tools:

- Numpy, SciPy
- Pandas
- TensorFlow, Sklearn
- SQL to Pandas
- NLP / NLTK
- Matplotlib

Often: Working Code First
Fill In Theory After

Quantitative

- Prediction: Regression
- ML Classification: Logistic, SVM.. Trees, Forests, Bagging, Boosting,..
- Entropy / Information Topics
- Deep Learning examples, including CCNs
- Correlations
- Markov Processes
- LTI Systems: Fourier, Filters where applicable
- Control Models where applicable

Building Block Code Samples

- Webscraping
- Stock market live download, simple trading
- Convolutional Neural Networks
- Next Word Predictor, Spell Checking
- Recommendation
- Web Crawler
- Chatbot, E-mail
- Social net interfaces including twitter

This class will help you combine math and data concepts

The course updates with new tools to stay current. You may learn and use tools not presented in the class project.



What is this class



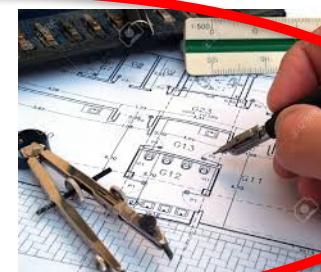
Make the Tools

Most CS



Use the Tools
(Optimally)

This IEOR Course



Architect the System



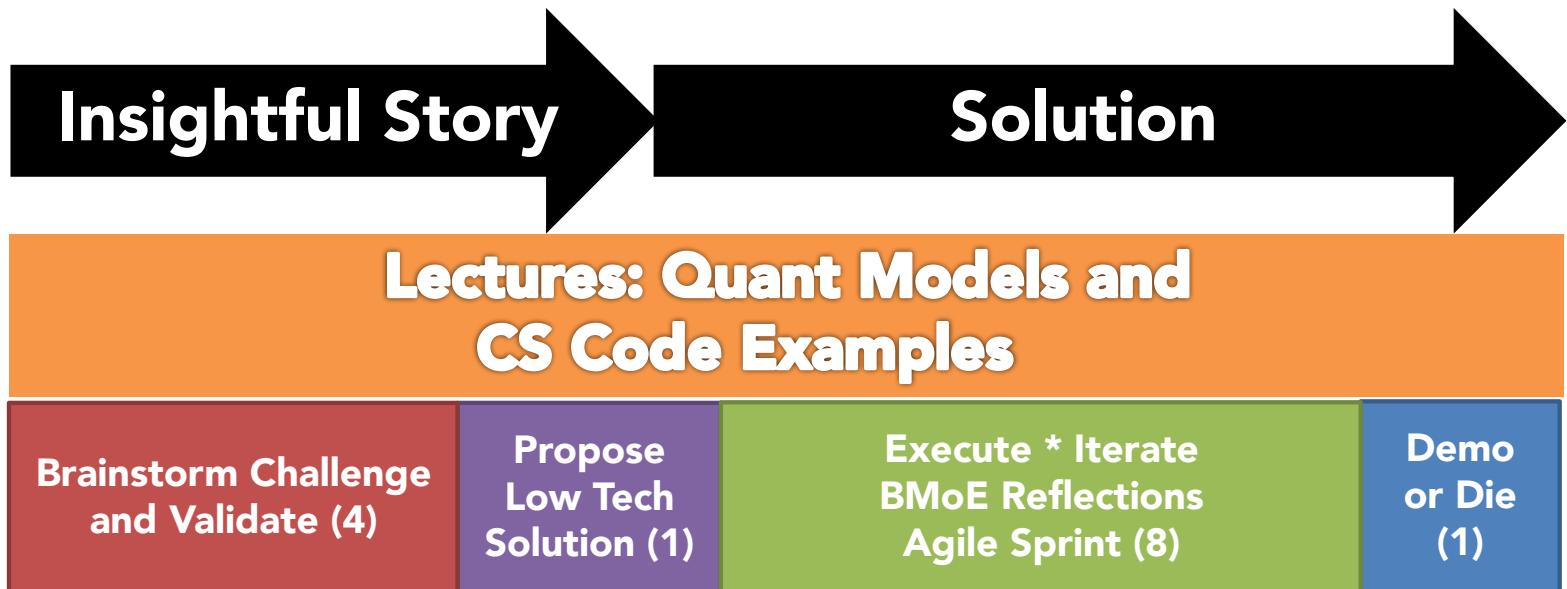
Why and how
you build

Sutardja Center



Data X

How the Data-X Course Works:



Team: typically 5 students, with available advisor network



Data X

Introduction Data, Signals, and Systems

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A High Level Overview of Data



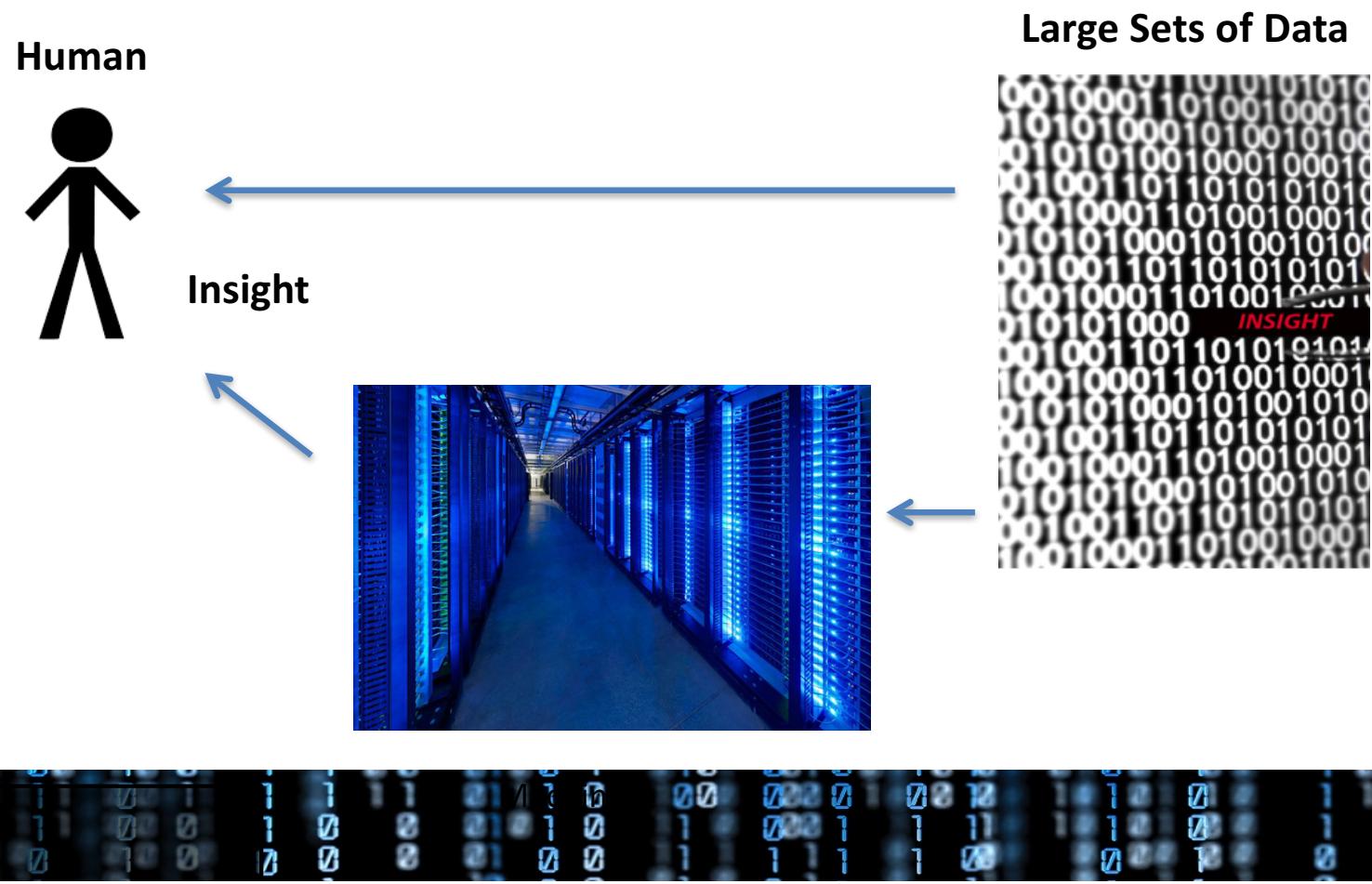
Basic Concept of Working with Data



- Data Wrangling
- In Production



Human Interpretation of Data



Data Concepts 1

Data, AI, and Business Models

Data X

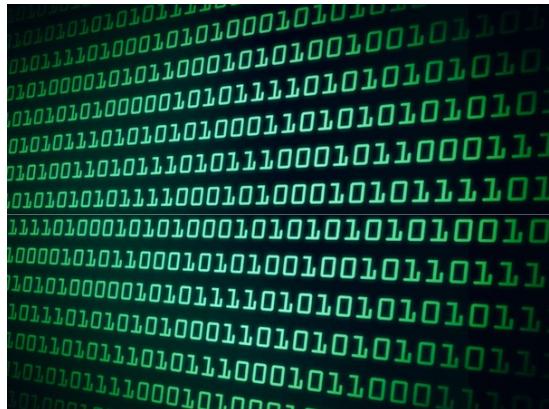
Anticipating the Next Industrial Revolution

Industrial Revolution 1.0



- Winner was whoever made something most cheaply
- Leveraged scale

Industrial Revolution 2.0



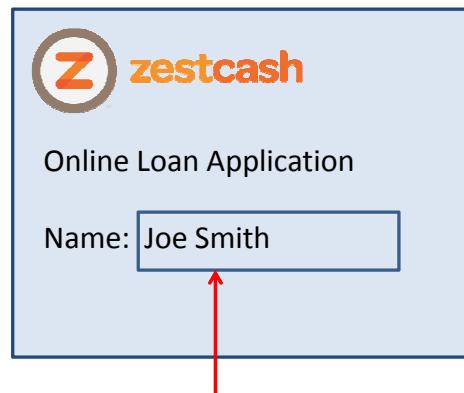
- Winner will be whoever makes best sense of the data
- Leveraging scale



Example: Data and Information is a competitive advantage

Real-life Example: ZestCash

- “All data is credit data”



The data says: greater credit risk!

The data says: lesser credit risk!



A close-up, low-angle shot of several wine bottles lined up horizontally. The bottles have dark labels and corked tops. The lighting is warm and focused on the necks and shoulders of the bottles, creating a soft glow and casting shadows. A dark rectangular overlay covers the top portion of the image.

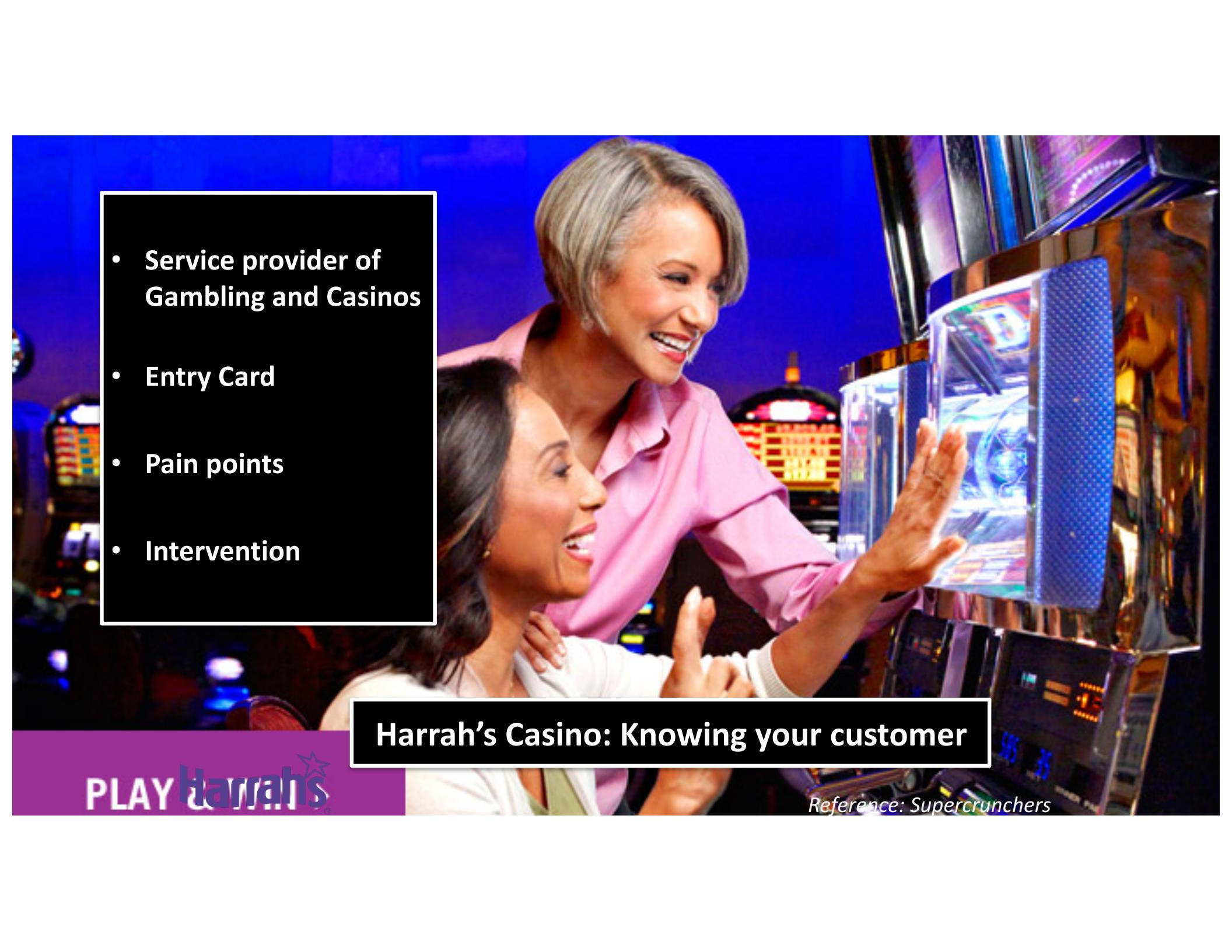
Scoring Wine

Wine quality =

$$12.145 + 0.00117 \times (\text{winter rainfall}) + 0.0614 \times (\text{average growing season temperature}) - 0.00386 \times (\text{harvest rainfall})$$

Oren Ashenfelter, Princeton. Now used by Christies Auction House

- Service provider of Gambling and Casinos
- Entry Card
- Pain points
- Intervention

A photograph of two women in a casino. One woman, wearing a pink shirt, is smiling and pointing at a slot machine screen. The other woman, wearing a white shirt, is also smiling and looking at the screen. They are surrounded by bright lights and other slot machines.

Harrah's Casino: Knowing your customer

PLAY Harrah's

Reference: Supercrunchers

Top 8 Business Models Using Data

1. Knowing your customer, better targeting and relationship.
E.g. Target, Disney, Netflix
2. Improving physical product or service with complimentary information:
E.g. UPS, FedEx
3. Data-driven reliability or security
E.g. GE, BMW, Siemens
4. Information Brokers, Arbitrage, and Trading Opportunities:
E.g. Investment funds.
5. Improving the customer journey/experience..
E.g. Harrah's

6. Functional Applications: HR/Hiring, Operations etc..
Eg Walmart, Baseball, Sports
7. Efficiency or better performance per dollar cost.
E.G. General IT, SAP, etc
8. Risk Management, regulation, and compliance
Eg. Compliance 360



An ML High Level Framework

In Real Life

- Objects
- Events / Experiments
- People / Customers
- Products
- Stocks
- ...

Features, but also loss of information

The diagram illustrates the process of extracting features from real-life entities and organizing them into a dataset. It shows a transition from 'In Real Life' objects to a 'Features, but also loss of information' stage, represented by a table. This table then branches into 'In Sample' and 'Out of Sample' datasets.

Sex	Age	Marital ...	Occupation	Job Time	Checking	Savings	Good/Bad Mark
female	27.17	Married	Semi-professional	0	No	Yes	Good
male	25.92	Married	Blue Collar	0.375	No	Yes	Good
male	23.08	Married	Blue Collar	1	No	Yes	Good
male	39.58	Married	Semi-professional	0	No	Yes	Good
male	30.59	Single	Blue Collar	0.125	No	No	Good
male	17.25	Married	Blue Collar	0.04	No	No	Good
female	17.67	Single	Semi-professional	0	No	No	Bad
male	16.5	Married	Blue Collar	0.165	No	No	Good
female	27.33	Married	Semi-professional	0	No	No	Good
male	31.25	Married	Semi-professional	0	No	Yes	Good
male	20	Married	Blue Collar	0.5	No	No	Bad
male	39.5	Married	Blue Collar	1.5	No	No	Good
male	36.5	Married	Blue Collar	3.5	No	No	Good
male	52.42	Married	Blue Collar	3.75	No	No	Good

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In Sample

Out of Sample

Some data has observed results

- Characteristics
- Patterns
- Models

- Predictions
- Similarities
- Differences
- Distance

Data X

An ML High Level Framework

In Real Life

- Objects
- Events / Experiments
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Some data has observed results

- Characteristics
- Patterns
- Models

- Predictions
- Similarities
- Differences
- Distance

$$X = \begin{bmatrix} -2 & 4 & 7 & 31 \\ 6 & 9 & 12 & 6 \\ 12 & 11 & 0 & 1 \\ 9 & 10 & 2 & 3 \end{bmatrix}$$

CS: Table

Math: Matrix X , with N rows – each person
m columns, each feature (age, salary, ...)

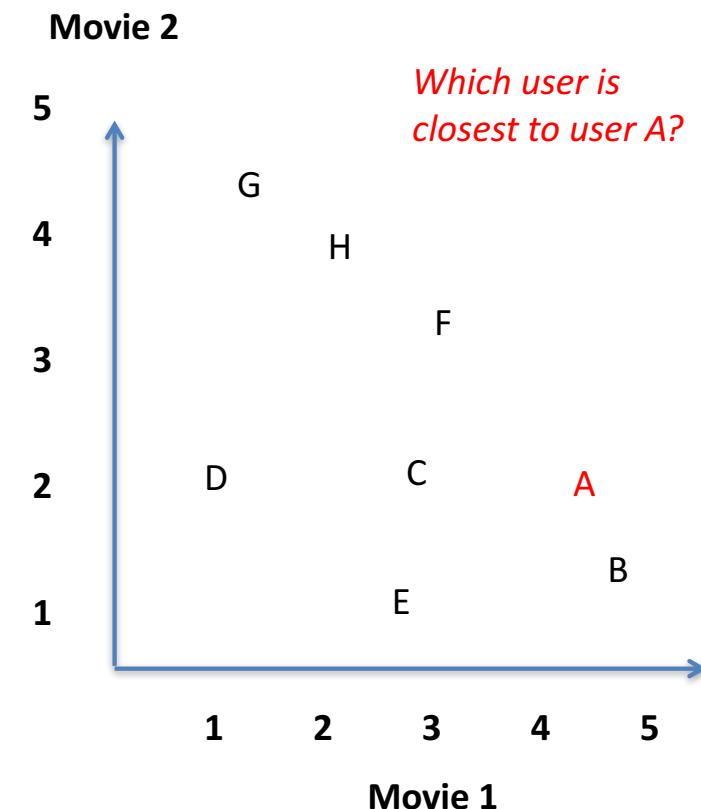


Data X

A Fundamental Idea: From Table to N- Dimensional Space

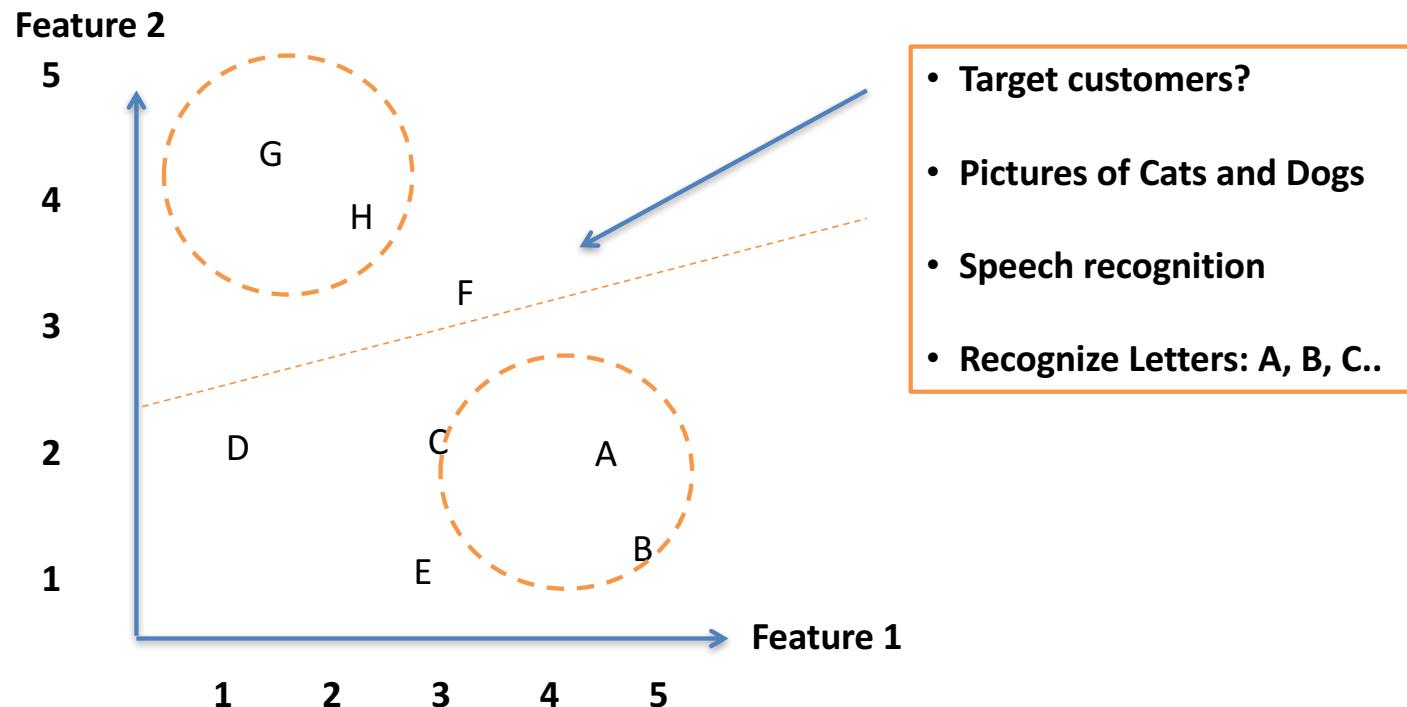
$X =$

Element	F1	F2	F3
A	4	2	2
B	4.5	1.5	3
C	3	3	5
D	1	2	2
E	3	1.5	5
F	3.5	3.5	1
..



Data X

Clustering to Classification



For Netflix: 70K \rightarrow 200K titles (dimensions), 10M plus users (points)

Factors: Accuracy vs Performance



A Fundamental Idea: From Table to Score

$X =$

Cust	F1	F2	F3
A	4	2	2
B	4.5	1.5	3
C	3	3	5
D	1	2	2
E	3	1.5	5
F	3.5	3.5	1
..

$F(X)$

Cust	Credit Score
A	552
B	381
C	760
D	330
E	452
F	678
..	..



Machine Learning: Learning from Data

Input Data = Matrix X

Customer 1: [Name, income, x, y, .. Features ..z]
Customer 2: [Name, income, x, y, .. Features ..z]
Customer N: [Name, income, x, y, .. Features ..z]

Output Data = Column Vector Y

Customer 1: [20]
Customer 2: [60]
Customer N: [05]

Purchases/year, repaid loan, ...

Target: What is $F(X) = Y$

a formula that we don't know

Sample data (training): (x_1, y_1) (x_2, y_2) ... (x_m, y_m)

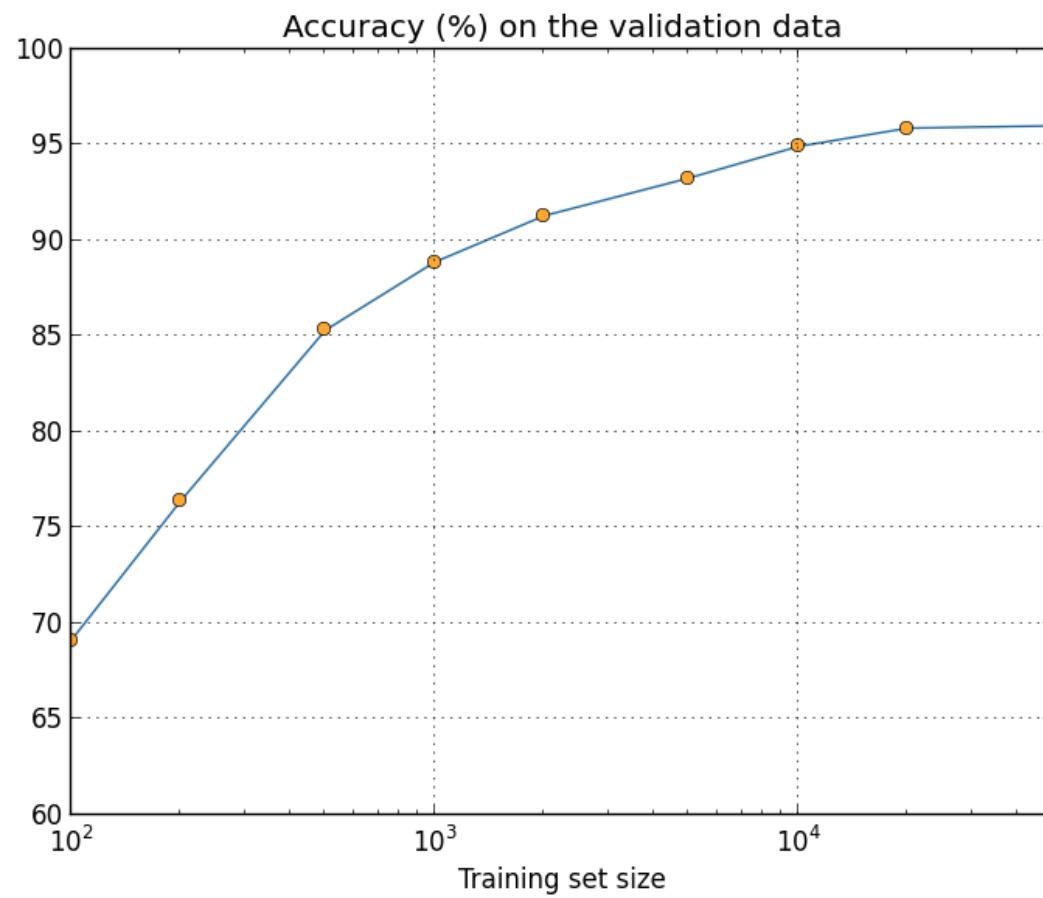
we have this

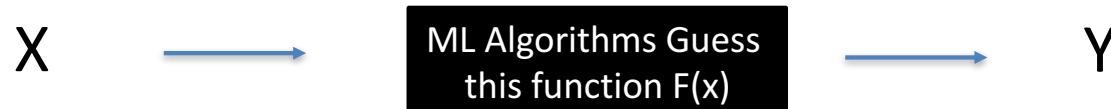
**Algorithm A
from H**

**Find $G(x)$ which is
approx. $F(x)$**

H: Hypothesis Set:
All possible
algorithms or formulas

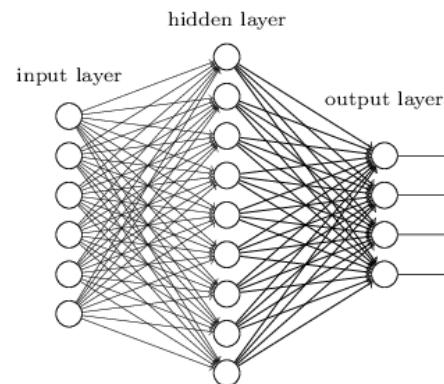
Data X





"Non-deep" feedforward neural network

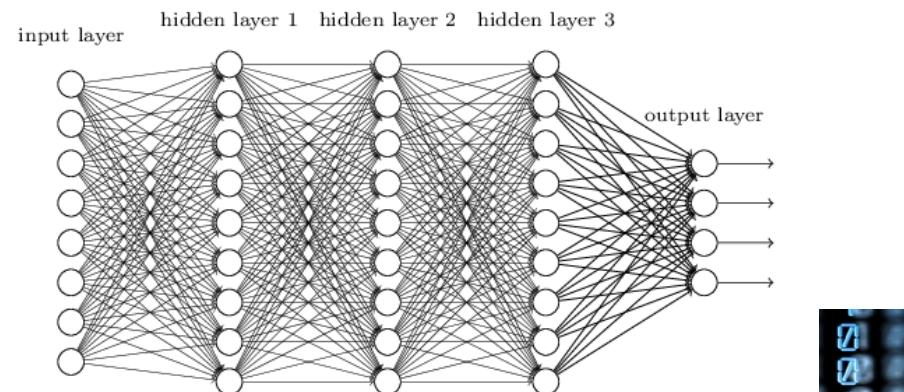
X



Y

Deep neural network

X



Y

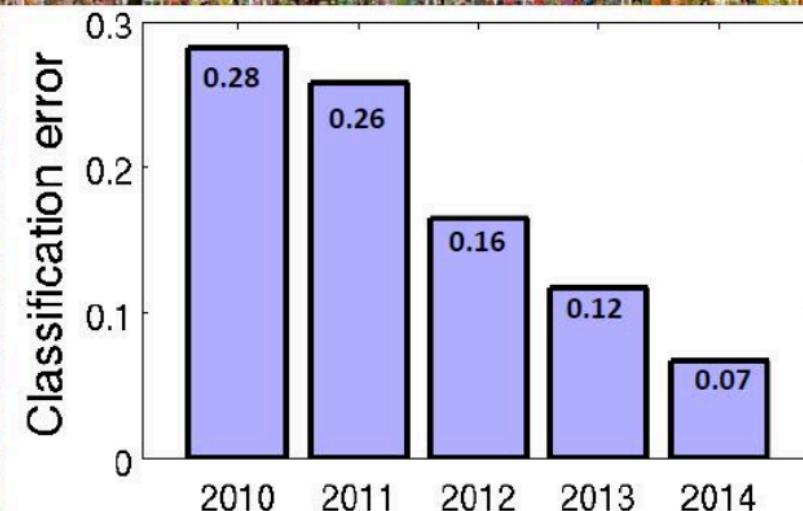


Data X

IMAGENET Large Scale Visual Recognition Challenge

Stanford

The Image Classification Challenge:
1,000 object classes
1,431,167 images

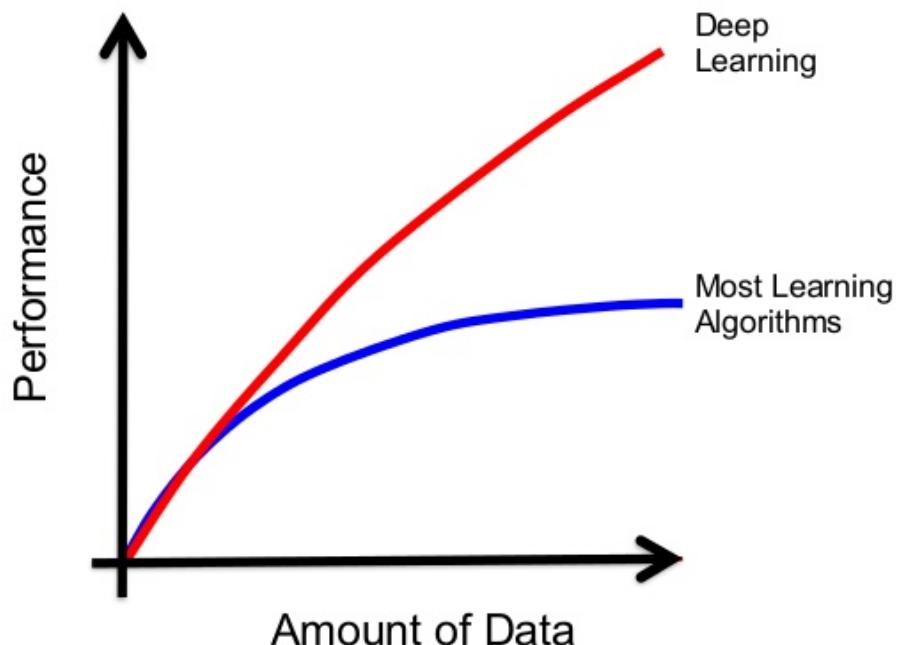


Neural net results are close to human results

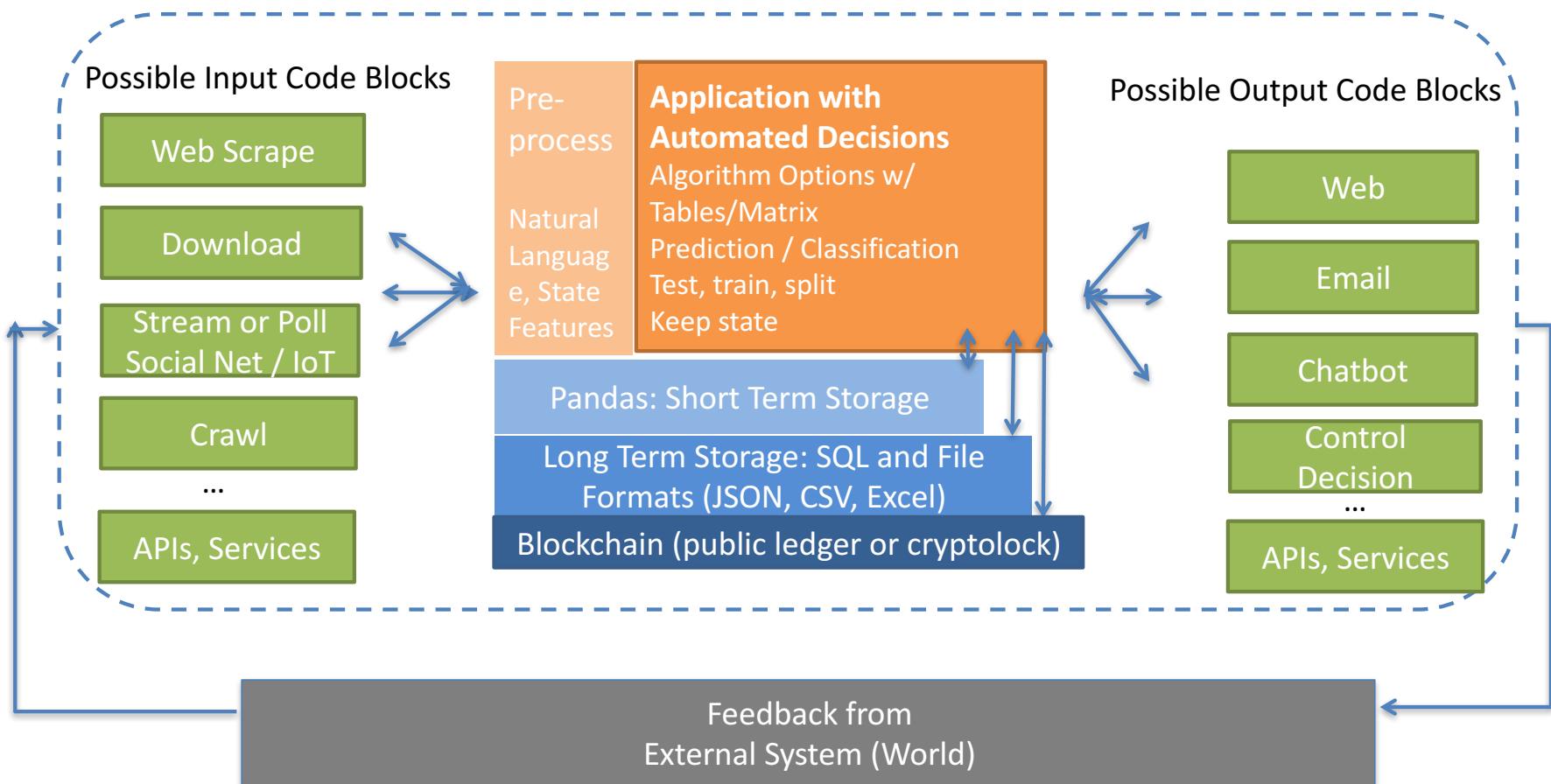
Data X

BIG DATA & DEEP LEARNING

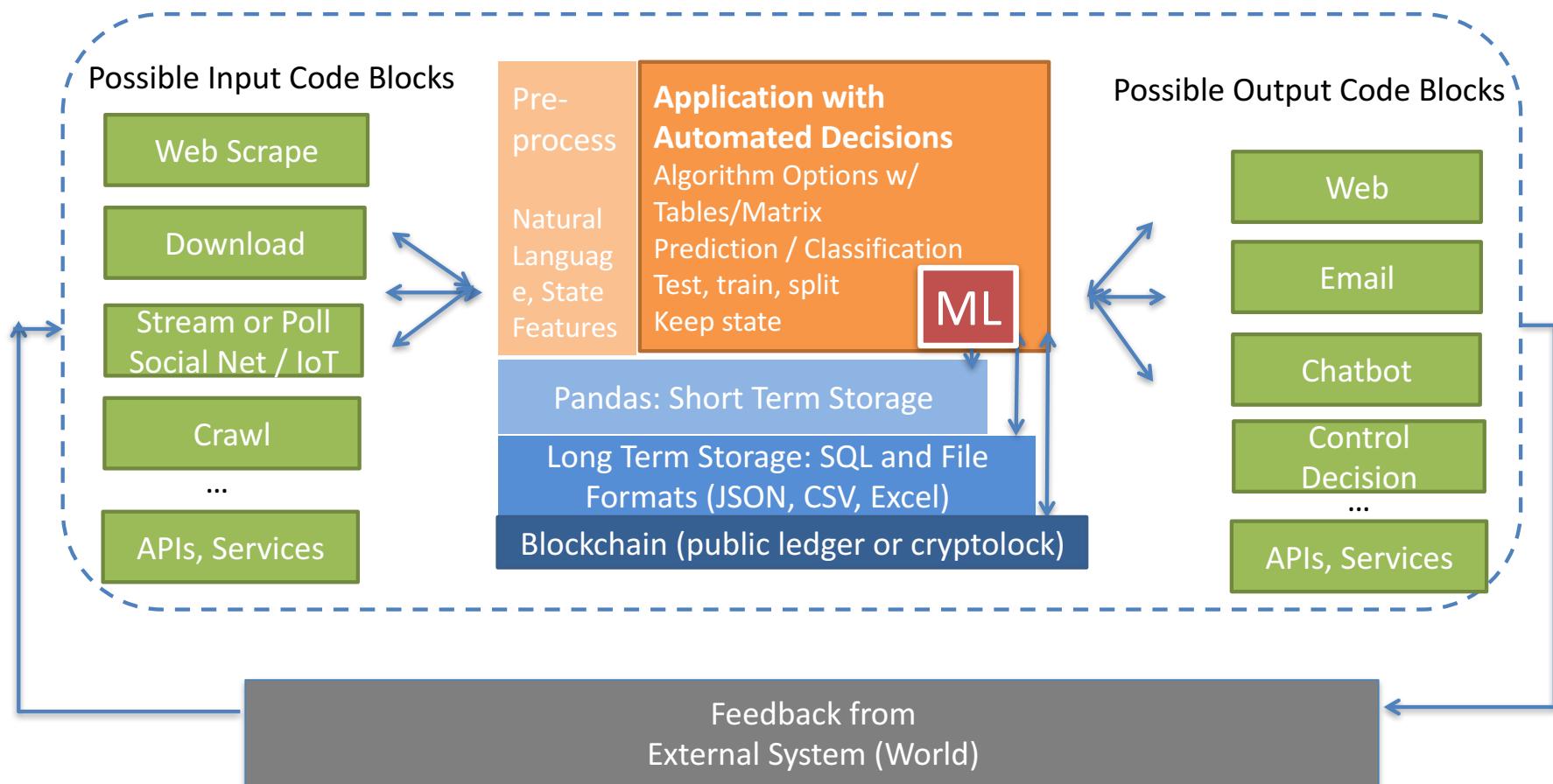
This means
Accuracy



The Data-X System View



The Data-X System View: It's more than ML, it's also systems and models



Project Types

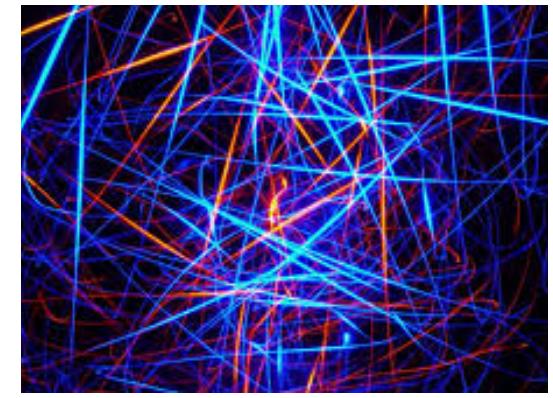


Business or Consumer
Use Case



Social Impact

(or improve part of a data pipeline)



Its Just Cool



Your Project Can also use a Data System for Social Impact

- Financial inclusion
- Health
- Aid to underprivileged
- Joining data for a research purpose
- Justice
- Environment
- ...



Homework For Week 1

- HW Part 1: For Your Project – By Next week
- Come up with 3 ideas for class projects in 1-3 sentences.
- A systems or application you will build
- **Communicate:** WHO the project is for, WHAT will it do, WHY this is needed/valuable.
- ---
- Homework Part II
- Complete and turn in: Python "Review" Breakout and Homework Notebook (BHW).



End of Section

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