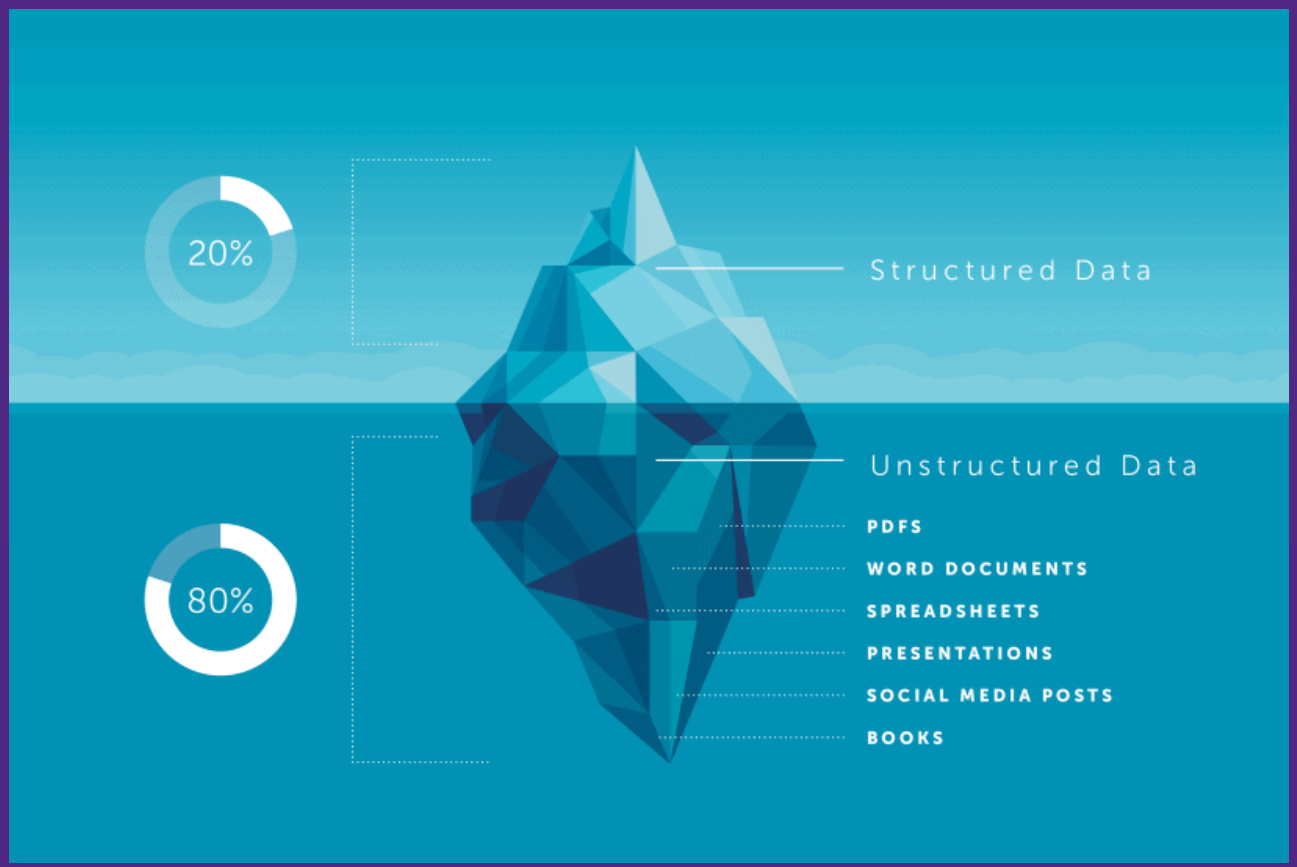
CS4417 / CS9647 / CS 9117
Unstructured Data



Course Content

- Analysis and Discovery (approx. ½)
  - Representing text and documents
  - Analyzing and discovering structure
- Systems and Applications (other ½)
  - Systems for large-scale unstructured data storage and processing
  - Contemporary software and applications

Tentative Topics

- Structure in Unstructured Data
- Text preprocessing and representation
- Document representation and retrieval
- Corpus structure
- Language structure
- Neural net language models, GPT
- Distributed programming models, MapReduce
- Systems and applications of distributed models
- Hadoop
- NoSQL, MongoDB

Logistics

- Lectures in NCB-113
  Tuesday 3:30pm to 4:20pm
- Lectures in SEB-1200
  Thursday 2:30pm to 4:20pm

- Instructor: Dr. Arshin Rezazadeh
- TAs: Chris Steward, Caro Strickland, Maxwell Yin
- Guest Lectures offered by Profs. from the CS Dept.

Communication

- *Using only OWL* for electronic communication
- OWL forums for questions and discussions
  - Can post anonymously if you want – instructor and TAs only can see poster's name
- OWL messaging to contact the instructional team directly
  - "Instructor" – Arshin
  - "Secondary Instructor" – Chris, Caro and Maxwell
- OWL will be monitored Monday – Friday, 9am to 5pm
- *Check the forums first*

Preparation

- I may post required readings and/or videos ahead of class.
- I will give at least one week's lead time; will send an OWL announcement.
- You are responsible for the assigned content, and it might be asked on the midterm/exam.

Evaluation

- 3 Assignments
  - 45% for undergrads, 35% for graduate students
- Midterm (Focus on first half; location TBA)
  - 20%
- Final (Focus on second half, but cumulative)
  - 25%
- Class participation (iClicker)
  - 10%
- Graduates only: Technical Topic Report
  - 10%

Technical Topic Report

- CS9647 and CS9117 Only
  - Individual, 2 Page report on a technology not covered in the course
  - *Check OWL assignment for full specification*

- Introduction
  - Overview of what the technology is and how it is applied
- Capabilities and Mechanisms
  - Describe what the technology can do and the techniques it uses
- Related Methods
  - Give a history of the development of the technology, and identify related technologies and competitors
- Opportunities
  - Speculate on how this technology could either evolve into new technologies or be applied in new ways in the future.

Questions?

- About topics?
- About logistics?
- About evaluation?

What is *Structured* Data?

- For this course, we are considering "structured" data to be things like
  - Relational databases
  - (Good) excel spreadsheets
  - (Closed-ended) survey data

What is Unstructured Data?

- Working definition: Unstructured data (or unstructured information) is information that does not have a pre-defined data model or is *not organized in a pre-defined manner*.

- Data may have *latent, implicit,* or *unknown* structure; natural language has *lots* of structure, but it does not have a complete formal description

Tasks Using Unstructured Data

- Information retrieval
  - Find documents relevant to a query
- Labeling
  - Spam/not spam
  - Sentiment analysis
  - Semantic association, annotating unstructured data with new information
- Structure-finding
  - Discover common topics
  - Discover networks of collaborators

Data Representations

- Often, a collection of data can be divided into ‘elements’
  - In statistics, sometimes called ‘units of analysis’
  - E.g., html page, photo, invoice, social media post
- Representations allow us to relate elements of unstructured data to each other.
- We will take a detailed look at how language is represented, and identify parallels to representing other kinds of data.

Example: Text Representations

- Bytes
  - Characters
    - Words
      - Sentences

Documents

- We can structure these by tokenization, tagging (part of speech, emotional valence), others.

- Vector representations (traditional and machine-learning derived)

Image Representations

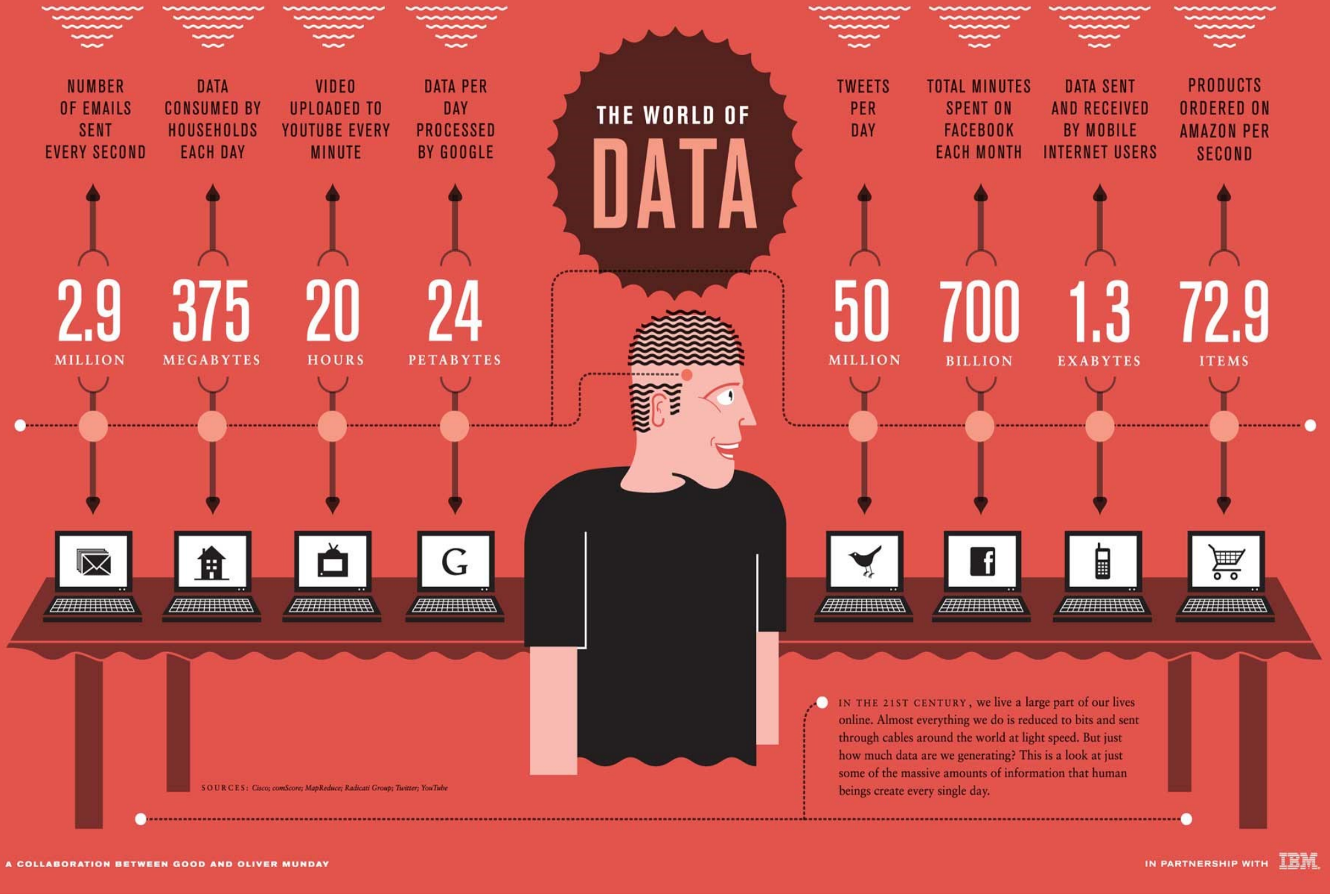
  - Bytes
- Pixels

Images

- “Word analogs” like SIFT, SURFs. Invariant(ish) with respect to viewpoint.
- Compression/transformation-based representations
  - Unsupervised: PCA, manifold learning, autoencoders
  - Supervised: Classification, regression

Unstructured Data are often BIG

- Volume *(size)*
- Variety *(representation)*
- Velocity *(stored vs. streaming)*
- Veracity
  - Accuracy and precision
  - Errors, completeness, and integrity
- Validity
  - Data governance and management


THE WORLD OF
DATA
NUMBER OF EMAILS SENT EVERY SECOND
2.9
MILLION
DATA CONSUMED BY HOUSEHOLDS EACH DAY
375
MEGABYTES
VIDEO UPLOADED TO YOUTUBE EVERY MINUTE
20
HOURS
DATA PER DAY PROCESSED BY GOOGLE
24
PETABYTES
TWEETS PER DAY
50
MILLION
TOTAL MINUTES SPENT ON FACEBOOK EACH MONTH
700
BILLION
DATA SENT AND RECEIVED BY MOBILE INTERNET USERS
1.3
EXABYTES
PRODUCTS ORDERED ON AMAZON PER SECOND
72.9
ITEMS
SOURCES: Cisco; comScore; MapReduce; Radicati Group; Twitter; YouTube
IN THE 21ST CENTURY, we live a large part of our lives online. Almost everything we do is reduced to bits and sent through cables around the world at light speed. But just how much data are we generating? This is a look at just some of the massive amounts of information that human beings create every single day.
A COLLABORATION BETWEEN GOOD AND OLIVER MUNDAY
IN PARTNERSHIP WITH IBM

As of 2011, the global size of data in healthcare was estimated to be

150 EXABYTES

[161 BILLION GIGABYTES]

By 2020, it's anticipated there will be

420 MILLION WEARABLE, WIRELESS HEALTH MONITORS

Variety

DIFFERENT FORMS OF DATA

4 BILLION+ HOURS OF VIDEO

are watched on YouTube each month

30 BILLION PIECES OF CONTENT

are shared on Facebook every month

400 MILLION TWEETS

are sent per day by about 200 million monthly active users


MARCH 21, 2011
A tale of two Libyas
Plus: Why the U.S. can't sit on the sidelines BY FAREED ZAKARIA
The GOP's misinformation campaign BY JOE KLEIN
Could your baby be depressed?
THE CULTURE
Word up: A dictionary of slang
TIME
YOUR DATA
FOR SALE
Everything about you is being tracked—get over it
BY JOEL STEIN
Owns a laptop
Household income: $100,000+
Age: 38-39
Likes: fashion
Major life-insurance holder
Likes: online news
Likes: Asian cuisi
Dislikes: cars
Likes: green living
Favorite celebrities:
Wi-fi warrior
Likes: business & financ
Sister is a la
Likes: parenting
Spent $180 on intimate app. & undergarments on Oct. 10, 2010
Male
Mother: Rosalind Burd
Likes: hiking
Dislikes: autos & vehicles
Married
Likes: movies
Magazine subscriber
Smart-phone user
Sister: Lisa Stein Browning
Purchased house in month of November
Likes: coffee & tea
Has used cocaine
Has had LASIK surgery
Likes: restaurants
Likes: online shopping
& actresses
Likes: cooking & recipes
Lives in New York City
Politically active
Religion: Jewish
: hockey
Likes: retail
Likes: newspapers
Likes: France
What data-mining companies think they know about Joel Stein

Big Data Challenges

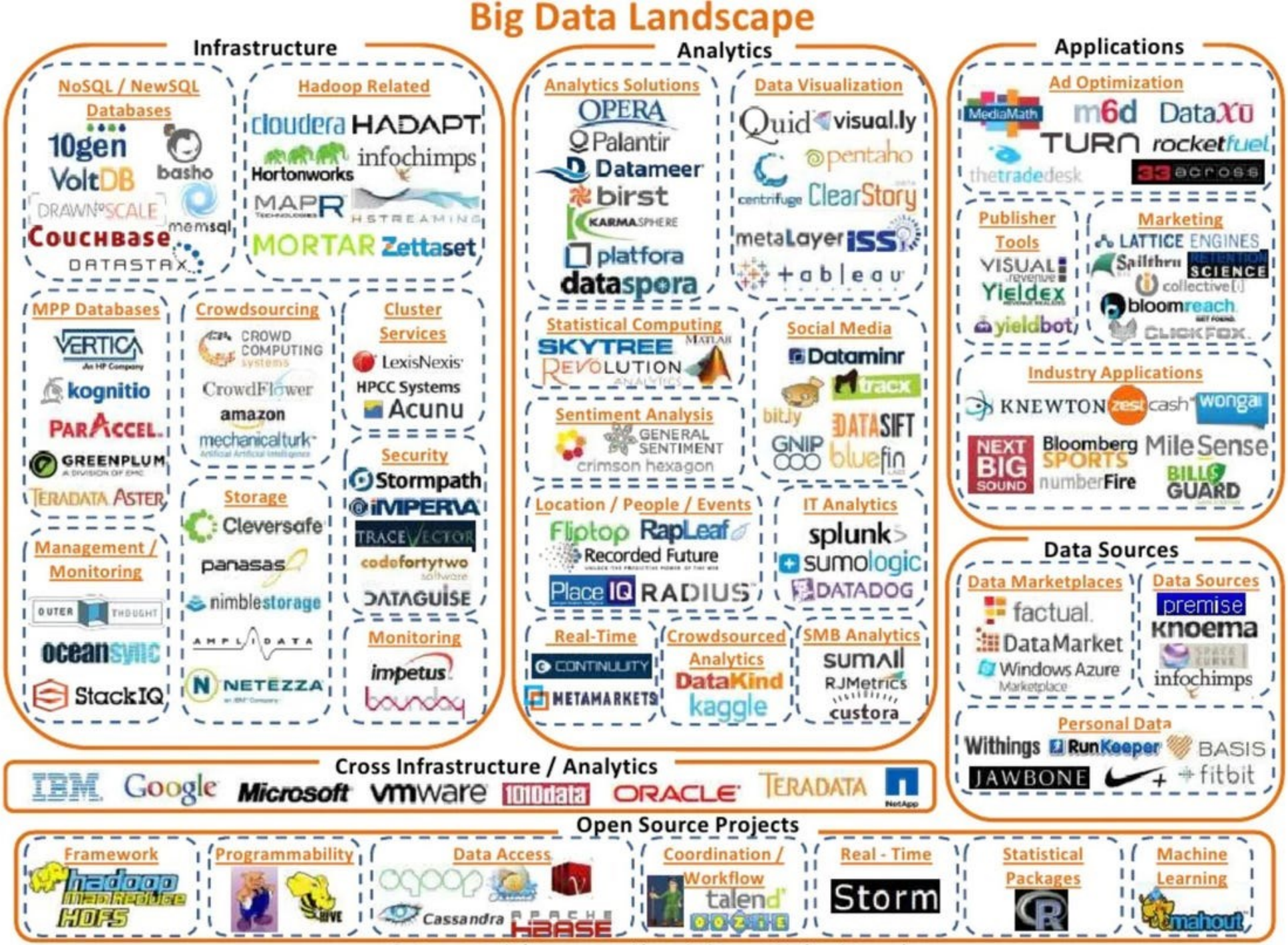
- Storage
- Computation
- Both of these ***must*** be distributed.

Big Data Solutions

- Storage
  - E.g., Hadoop Distributed File System, relies on replication, sharding
- Computation
  - E.g., MapReduce programming model, implemented by e.g., MongoDB, Hadoop, …

Big Data Analytics

- Big data analytics platforms package up solutions to storage and computation challenges
- Can be hosted locally, or deployed to a cloud platform
- Cloud is increasingly common – We can watch the world grind to a halt when AWS goes down.
  - (Ofc the “cloud” is just somebody else’s computer(s).)



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Big Data Platforms - Features

- Databases for unstructured data e.g., MongoDB
- Services that provide machine learning
- Systems that provide storage for massive amounts of data, lots of processing power, and programming support for running multiple tasks
- Data integration from multiple sources
- Tools for specific types of analytics, e.g., customer profiles

Adapting to Big and Unstructured Data

- Enterprises are looking to a new generation of databases referred to as NoSQL
- Document-centric
- Flexible schema
- Often, no traditional relations (one-to-one, one-to-many, many-to-many; more like none-to-none)

Summary

- Unstructured data lacks *a priori* structure spec
- Key challenges
  - Representation
    - How do we represent unstructured data to accomplish the tasks we need to?
  - Storage and computation
    - How do we support the development and use of representations on big datasets?