Humankind 2.0: The Technologies of the Future
2. Big Data

Piero Scaruffi, 2016

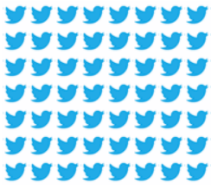
See http://www.scaruffi.com/singular/human20.html
for the full text of this discussion

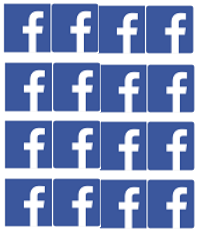
Big Data

- Very soon Homo Sapiens will be producing more data every year than in the previous 200,000 years

Big Data

- 2016:
  - The Internet has 32,585GB of Internet traffic every second
  - 2.4 million emails are sent every minute
  - Google processes 52,000 search queries per second
  - 5,000 tweets are posted on Twitter every second
  - YouTube delivers 115,846 videos per second
  - 50,000 Likes are generated daily on Facebook
  - 60,000 new photos are uploaded to Facebook every second

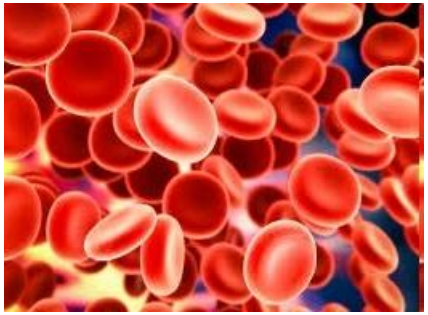




Sources: internetlivestats.com and onesecond.designly.com

From Silicon Valley to Data Valley

- More data will soon come from
  - Internet of Things
  - Wearables
  - Genetics
  - Nanorobots
  - Robots



data is the oil

of the 21st century

Gartner

DATA IS THE NEW OIL

Once "refined" data yield…

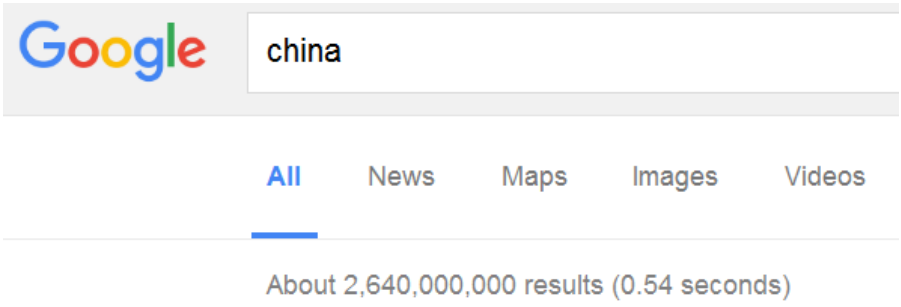
- Self-driving Car (and plane)
- Drones
- Ads on social media
- Upselling
- Wearables
- Decision making
- Smart objects

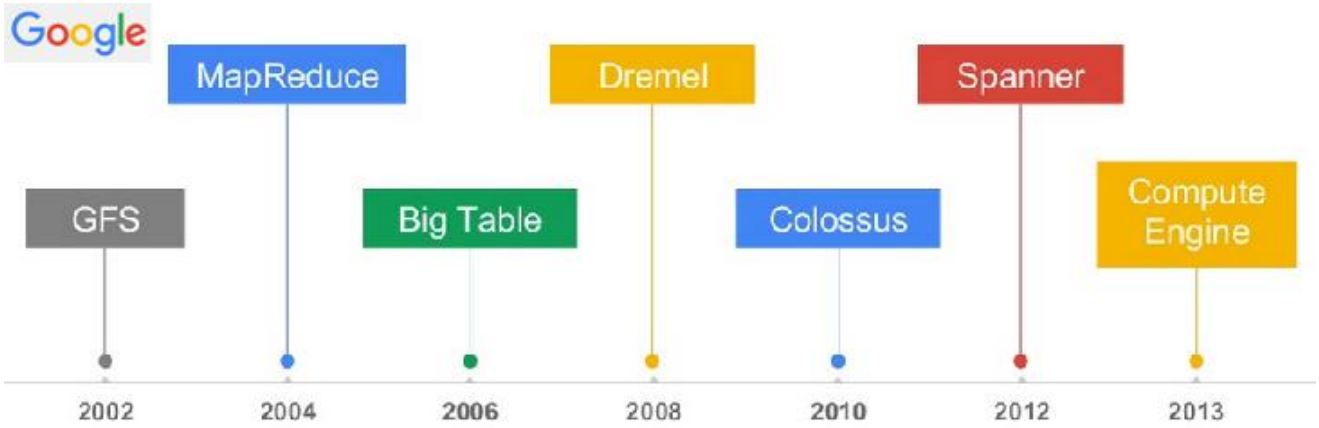
Big Data

- Infrastructure
  - Apache Spark: an engine for large-scale data processing (Matei Zaharia at UC Berkeley, 2009)
  - Nebula (NASA + Anso Labs + RackSpace) -> OpenStack (more than 500 companies in 2015)

Big Data

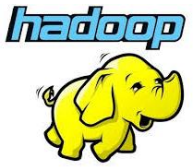
- Who has the biggest big data problem?



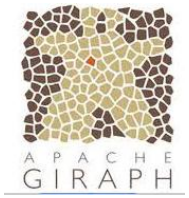


Big Data

- Google and Facebook
  - Facebook: Cassandra -> Apache Cassandra (2008) -> DataStax (2010)
  - Google: MapReduce (2004) -> Apache Hadoop (2006) -> Cloudera (2008)
  - Facebook: Hive (2007) -> Apache Hive (2008) -> Qubole (2011)
  - Google: Dremel (2006) -> BigQuery (2012) -> Metanautix (2012)
  - Google Borg (2004) -> Apache Mesos -> Mesosphere (2014)
  - Google: Pregel (2010) -> Apache Giraph

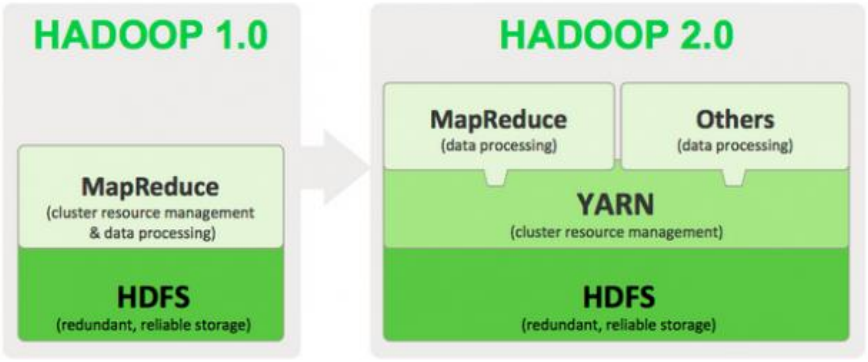


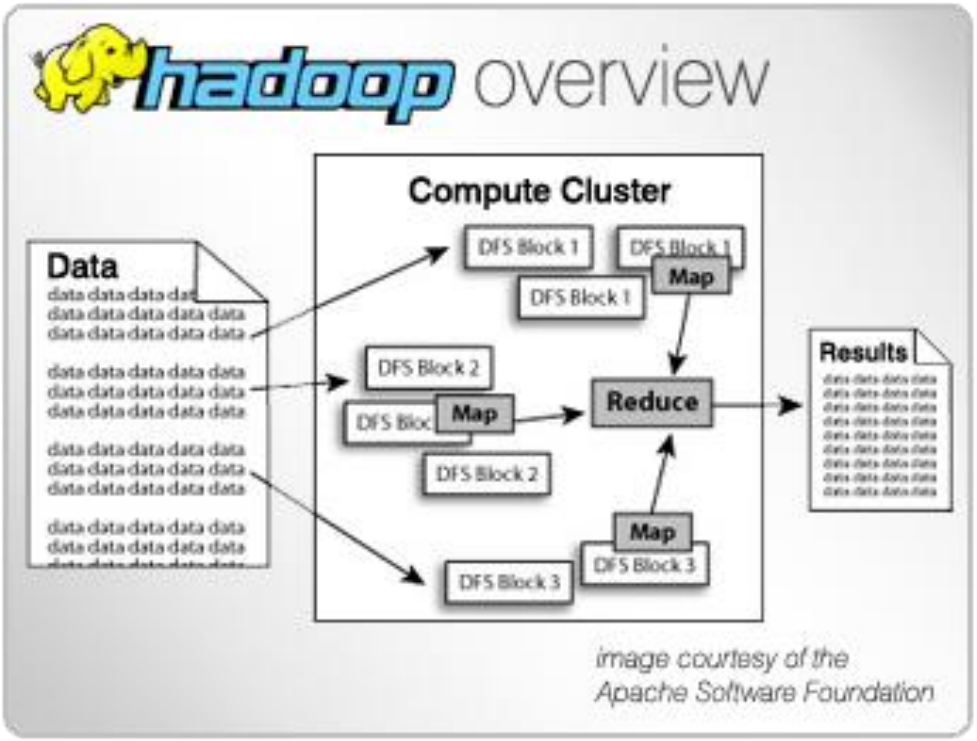


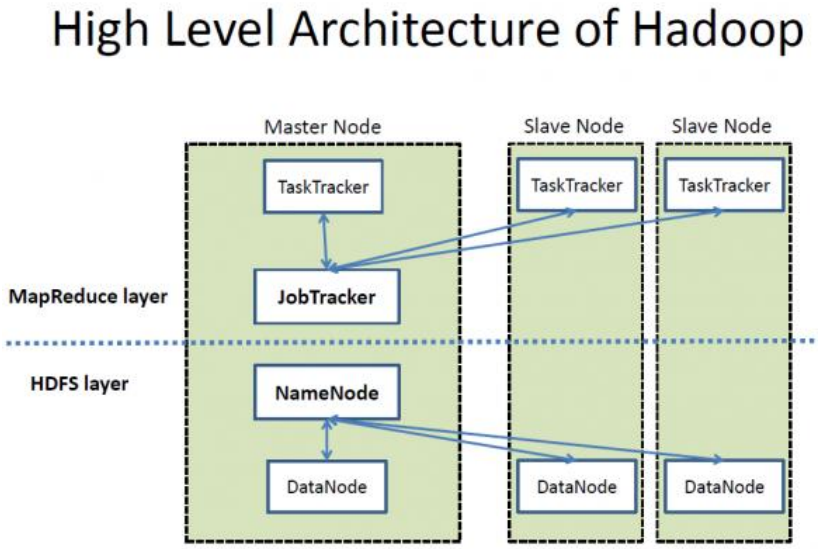


Big Data

- Hadoop

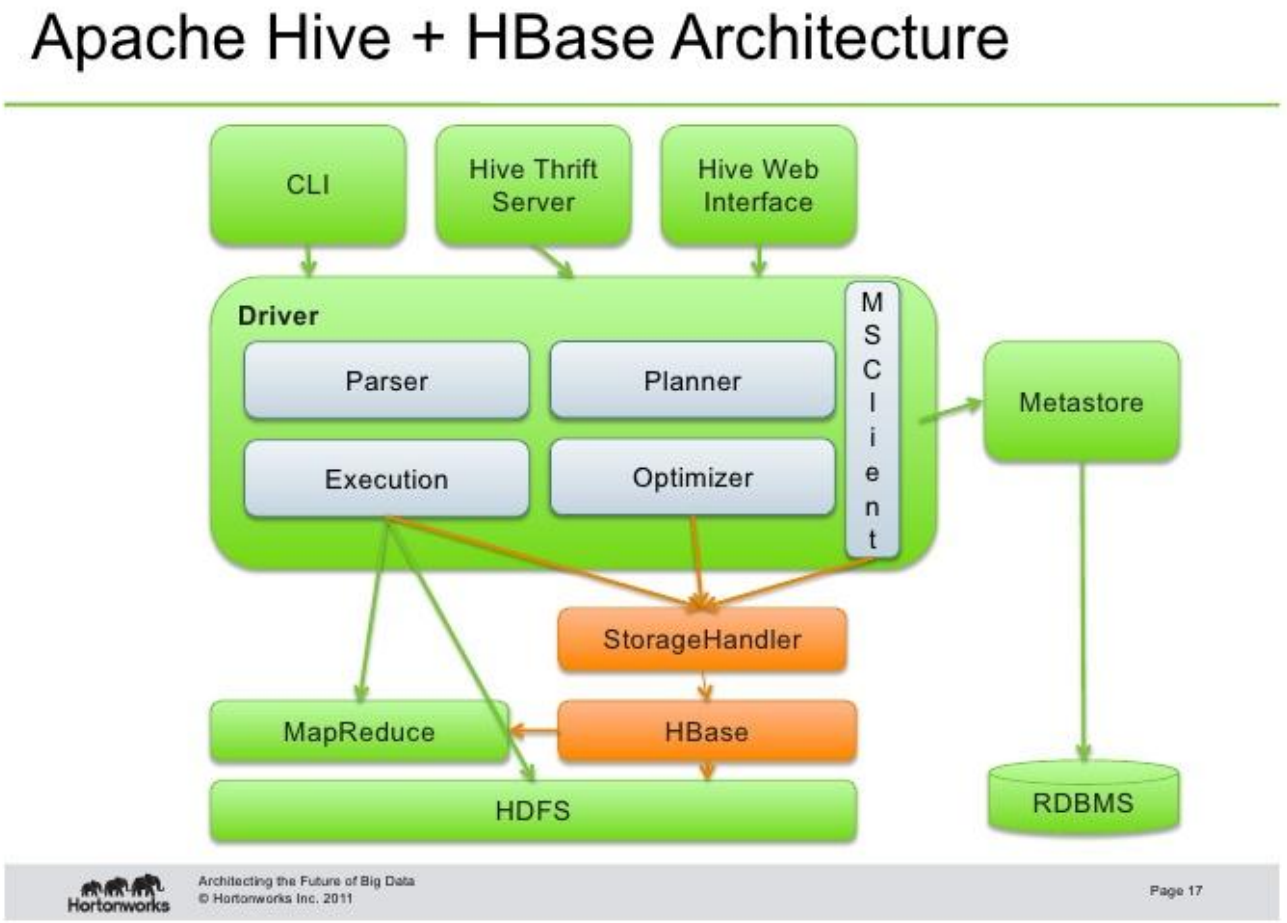






Big Data

- Hive



Big Data

- Big Query

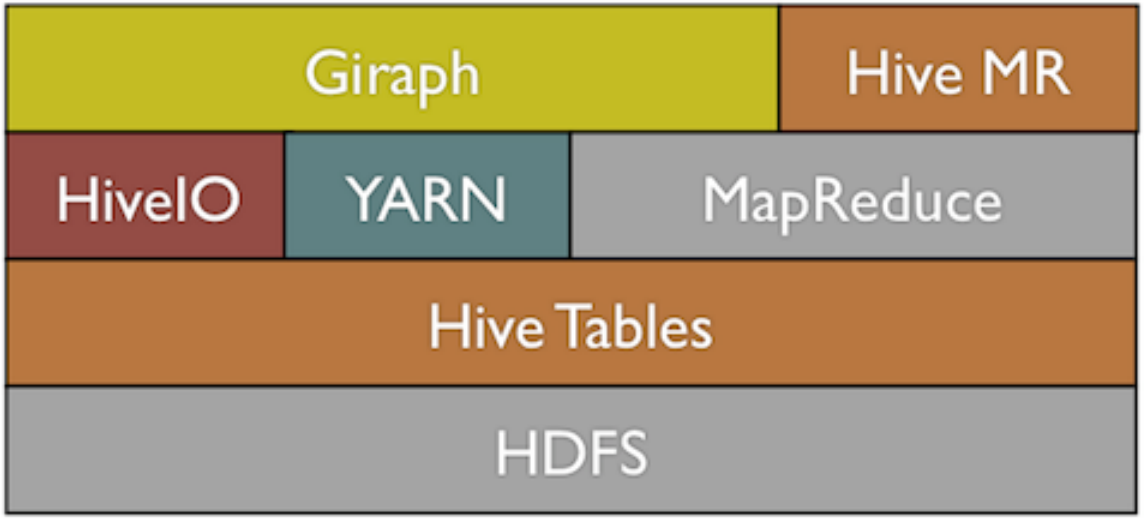
Big Data

- Giraph
  - It’s all about graphs
  - Main success factor of Google's search engine: better ranking of search results
  - Google's ranking is based on PageRank, a graph algorithm
  - Facebook’s social graph has more than one billion users and more than 100 billion friendships
  - Twitter’s social graph has billion of follower relationships

$$p_i = \sum_{j \in \{(j,i)\}} \frac{p_j}{d_j}$$

Big Data

- Giraph

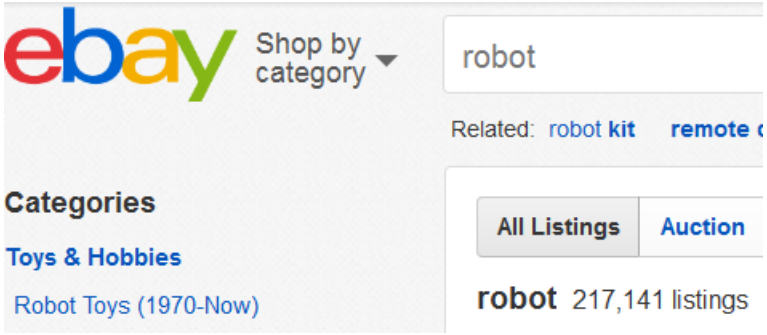


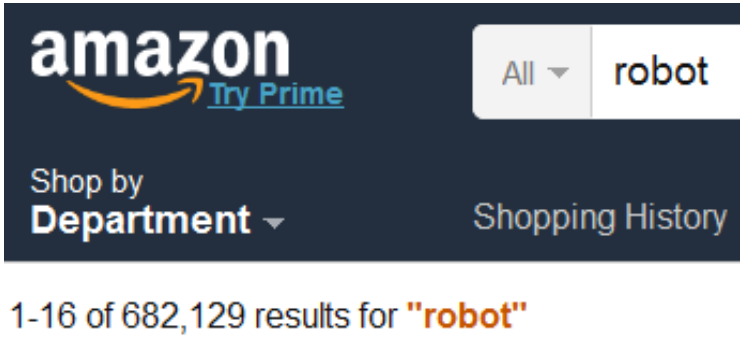
Facebook reveal trillion edge version of Apache Giraph in Graph Search

August 15, 2013 Chris Mayer

Big Data

- Big big-data users



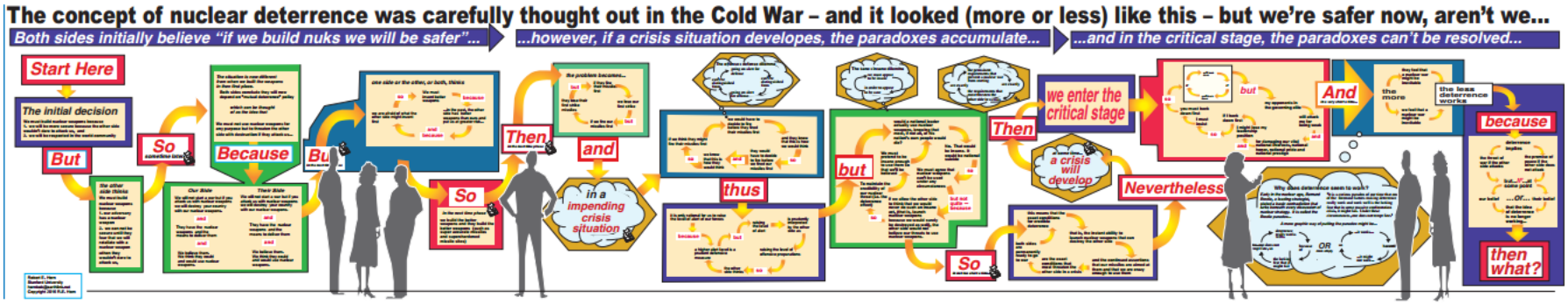


Understanding Big Data

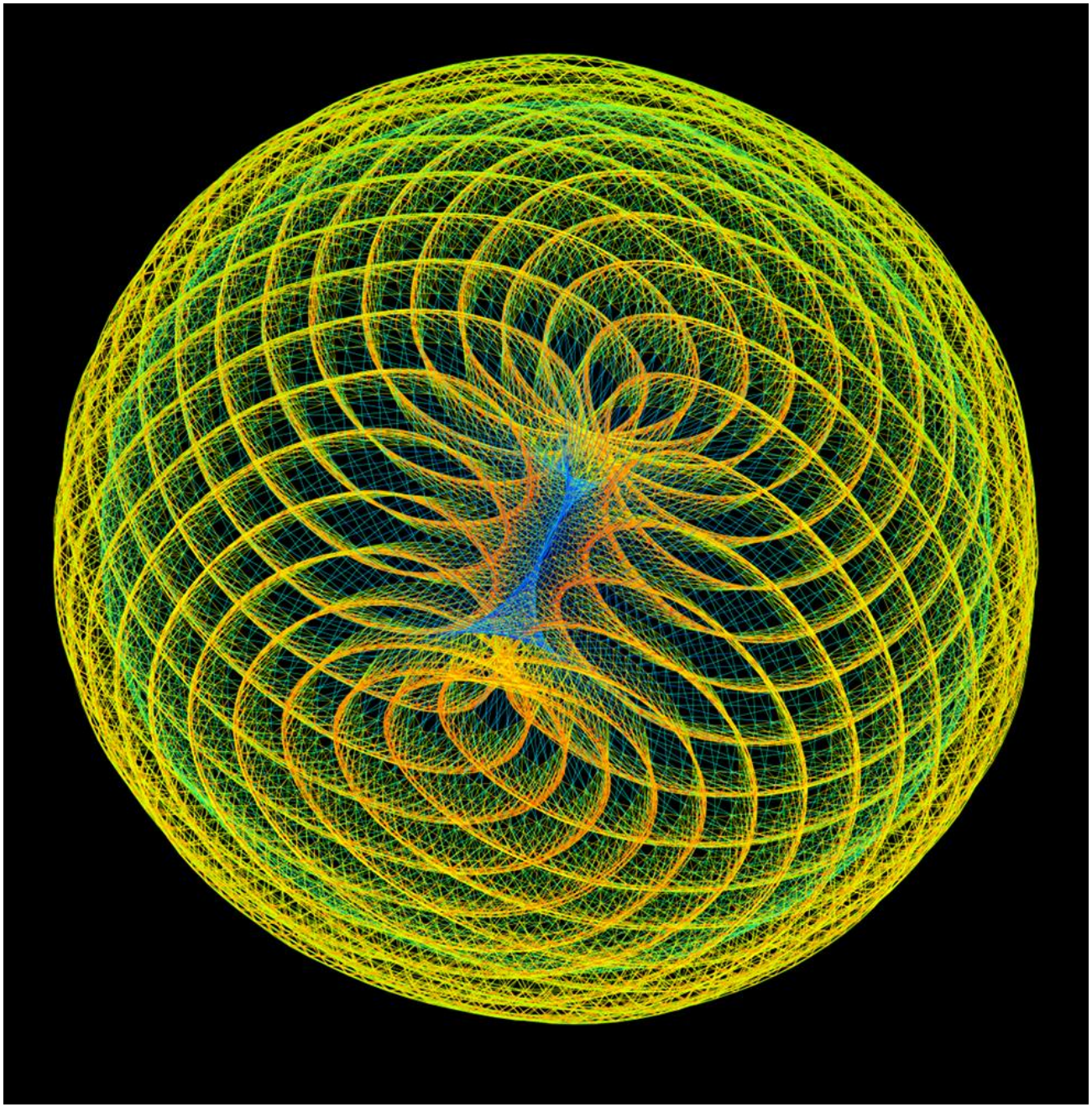
- The Data Loop
  - Most data are produced by machines
  - Increasingly data are read by machines
  - Most data are used to trigger events that produce more data

Big Data

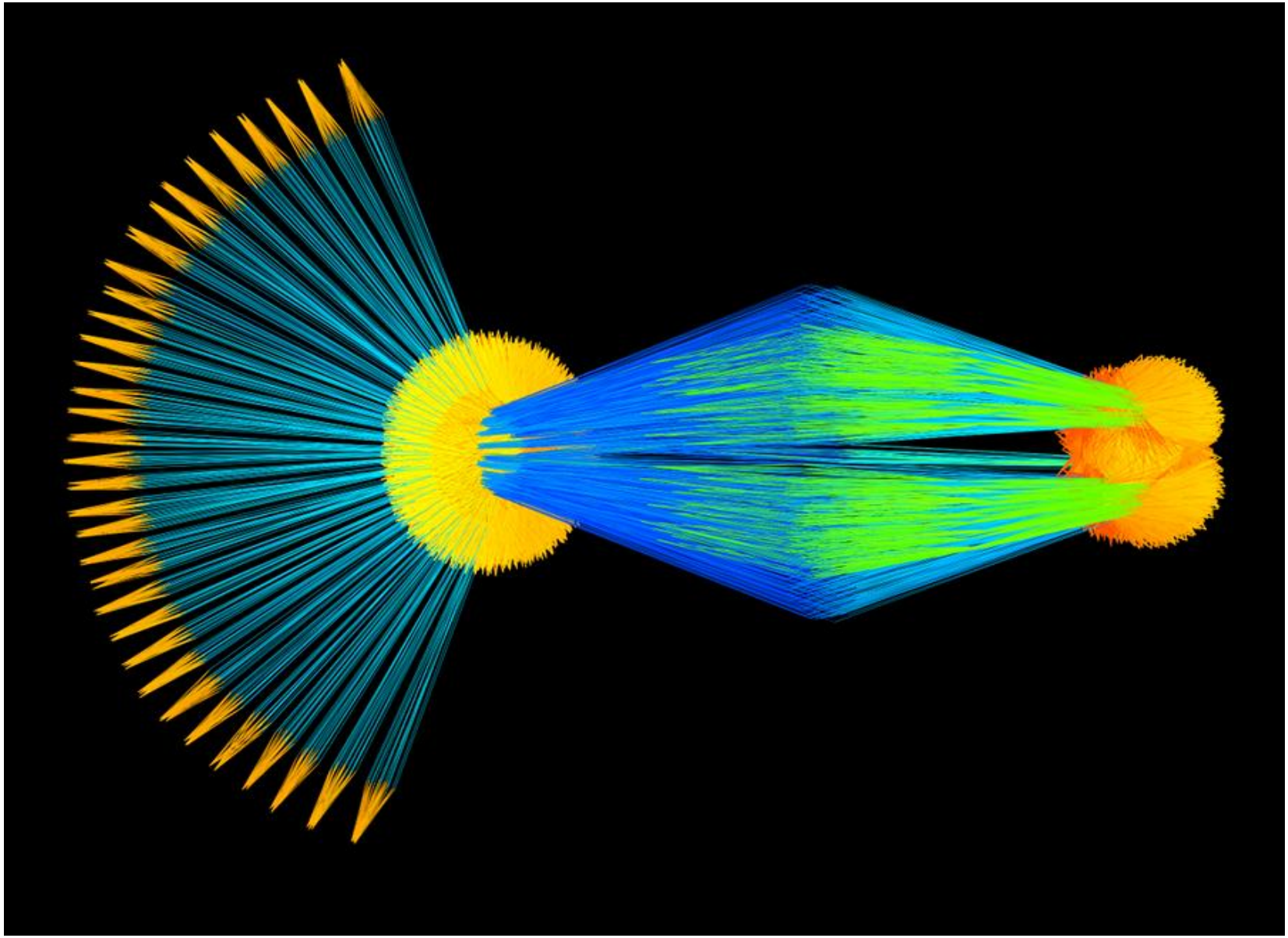
- Visualizing big data



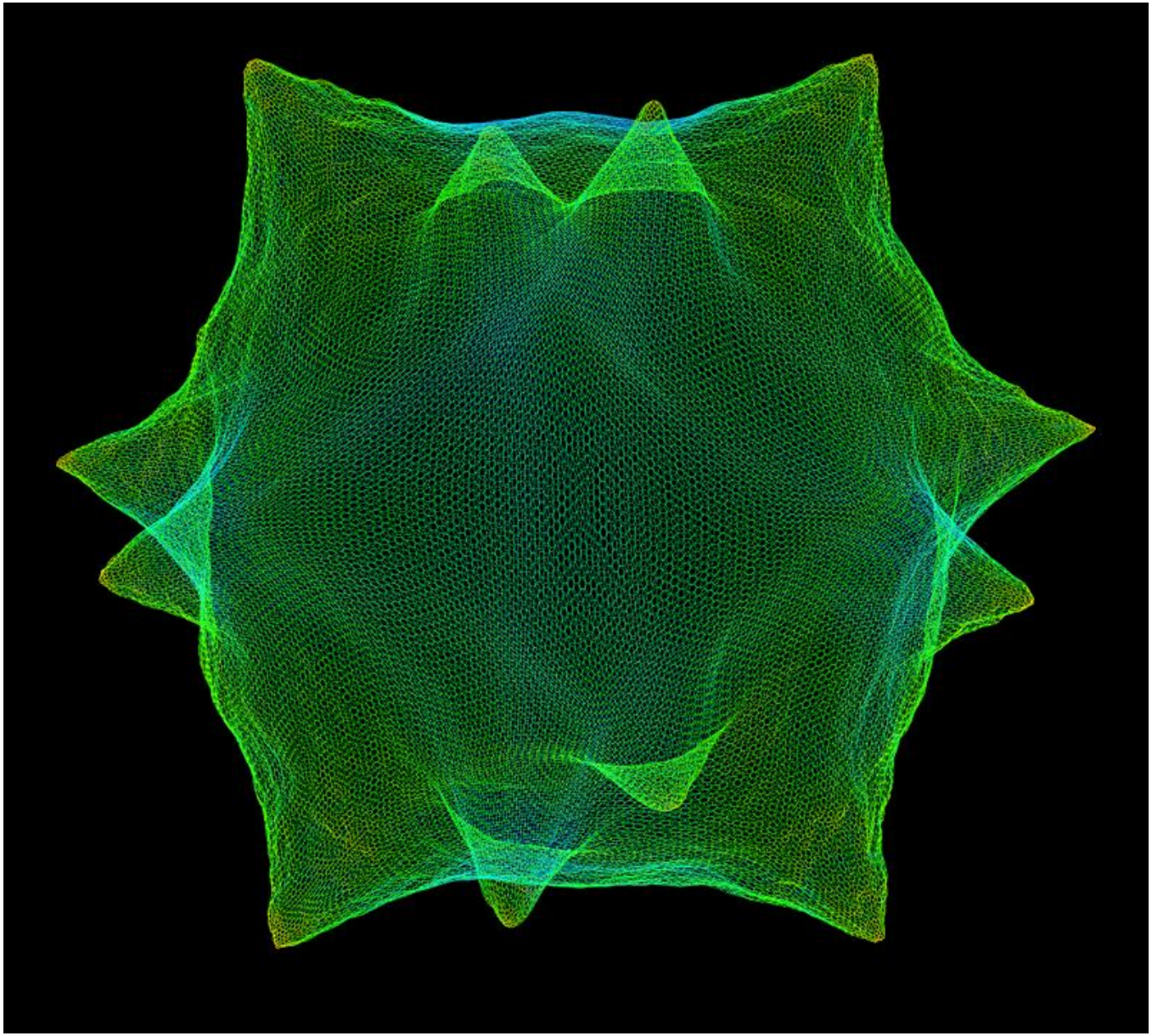
Bob Horn's digital murals



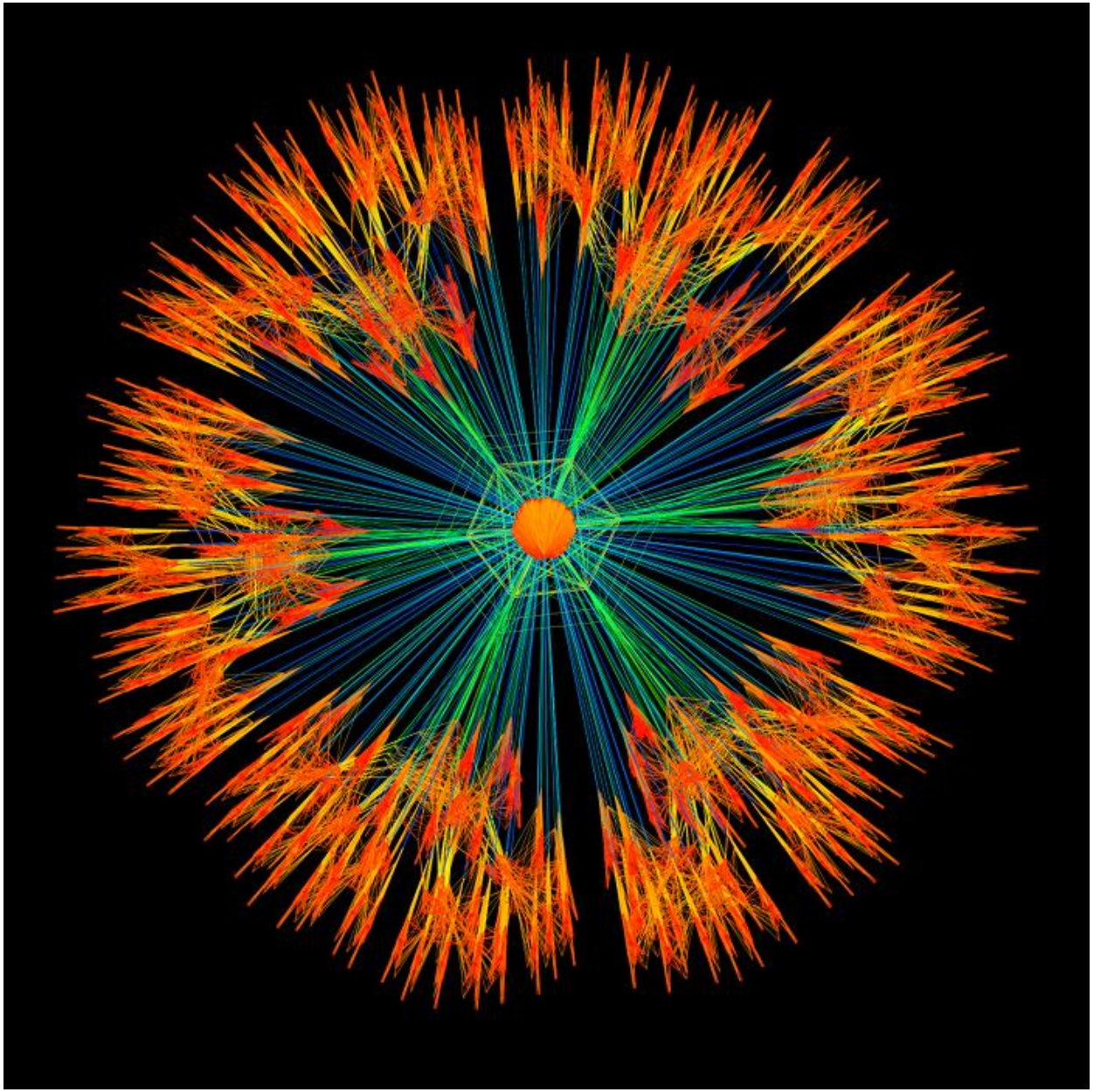
Hessian matrix from a quadratic programming problem



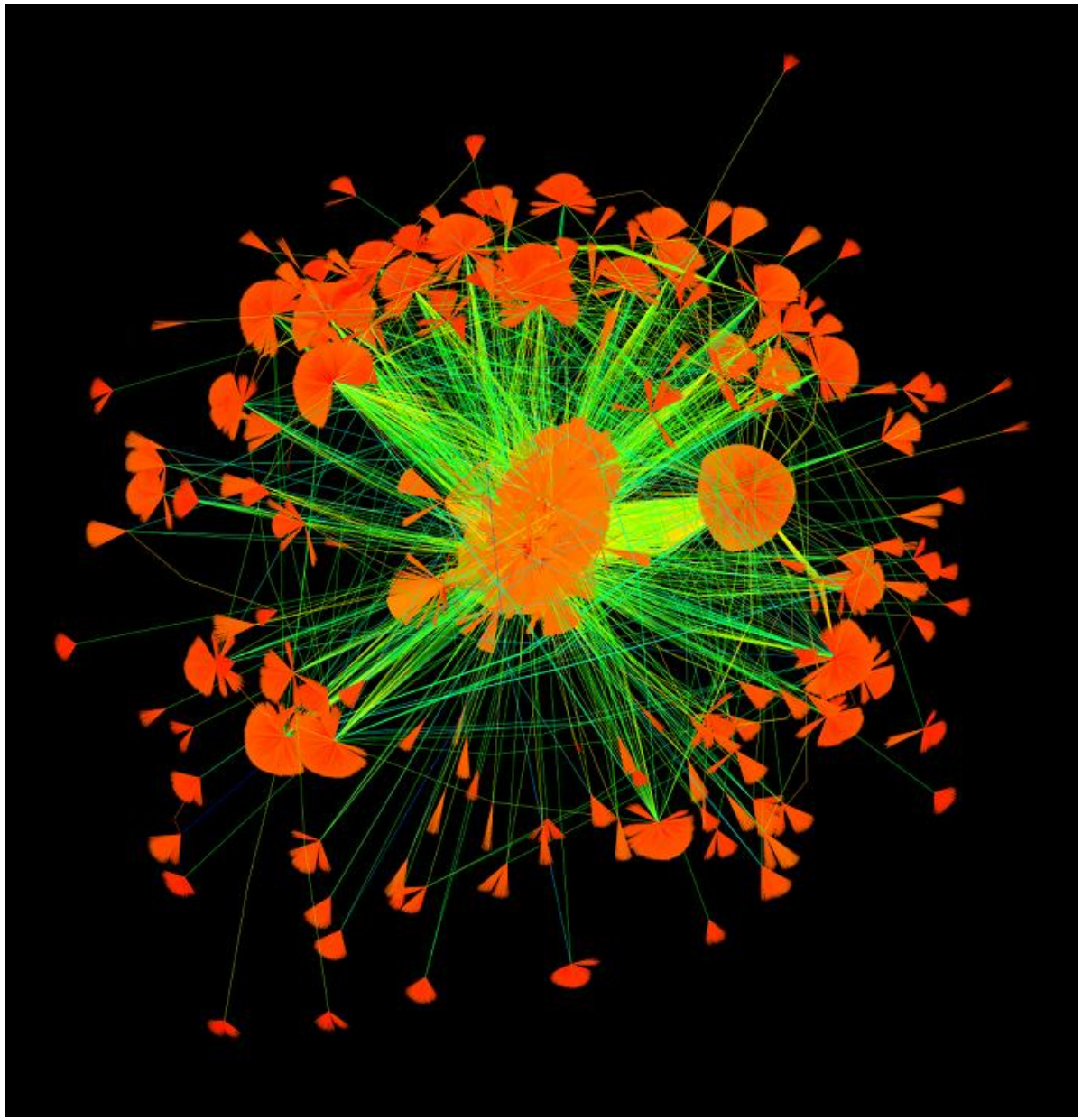
Linear programming problem



Computational fluid dynamics: shallow-water equations



Linear programming problem



Social network: people and the web pages they like

Big Data

- What those pictures are: solving a large system of linear equations with a large number (millions) of unknowns

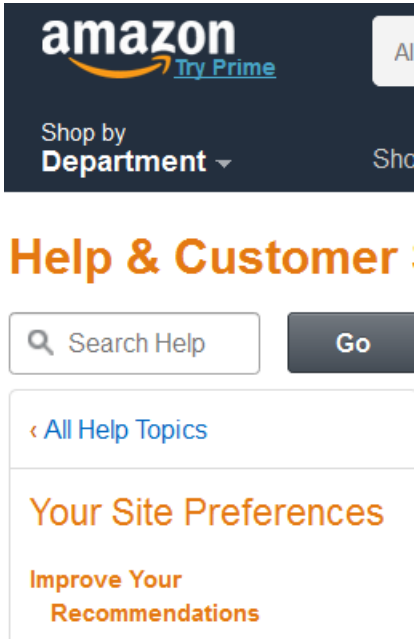
Images by Margot Gerritsen (Stanford Univ), Tim Davis & Yifan Hu
http://www.cise.ufl.edu/research/sparse/matrices/

Big Data

- Beyond "Data Analytics", "Business Intelligence", etc
  - The platforms are available for free (open source)
  - Cloud storage is cheaper and cheaper
  - The math is widely available (eg, "Mining of Massive Datasets"): anybody can use those methods to analyze big data.
  - There is no "top secret" in Big Data
  - There is a huge number of big customers

Big Data

- Beyond "Data Analytics", "Business Intelligence", etc
  - But we still do old-fashioned "data analytics" (eg, Amazon's "recommendation engine")
  - Target figured out a teen girl was pregnant before her father did



How Target Figured Out A Teen Girl Was Pregnant Before Her Father Did

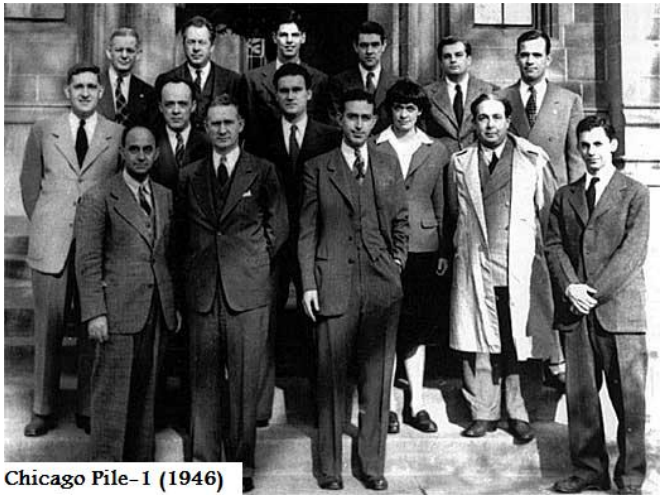
FEB 16, 2012 @ 11:02 AM 2,927,596 VIEWS

Big Data

- Beyond "Data Analytics", "Business Intelligence", etc
  - There is still no killer application
  - Maybe that's why Google, Facebook, etc give their platforms for free to third-party developers
  - Understanding big data is one field that will require a shift from competition to cooperation.

Big Data

- Big data requires an interdisciplinary approach
  - Nuclear power, the Moon mission and the Internet are examples of big-data innovations driven by interdisciplinary teams
  - Solving problems in human society is not just a math problem


Chicago Pile-1 (1946)


BBN (1969)

Big Data

- Big data requires an interdisciplinary approach
  - Harvard University's Institute for Quantitative Social Science
  - UC Berkeley's Institute for Data Science
  - US Government's "Big Data Research and Development Initiative"

Big Data's Killer App

- Interpret data as people, not numbers
  - Capture all the data about my body, my routines, most recent medical knowledge, and conditions around me (epidemics, pollution, etc) and
    - 1. prevent health problems;
    - 2. alert me about health problems;
    - 3. suggest improvements to my lifestyle
  - Sloan Foundation's Microbenet

Big Data's Killer App

- Applications that guess the future (predictive applications)
  - Look for patterns and then build hypotheses
  - Stanford's "Big Data in Biomedicine" with the motto "Data science will shape human health for the 21st century"

Small Data

- Big data: a combination of structured and unstructured data that can reach exabytes
- Problem: in many cases big data is overkill
- Small data are around us and are most of the data that we need for our apps
- *"Small data connects people with timely, meaningful insights, organized and packaged to be … actionable for everyday tasks." (*Digital Clarity Group)
- Small data is the right data
- Big Data is good for centralized models (control)
- Small data is good for distributed models (crowd*)*

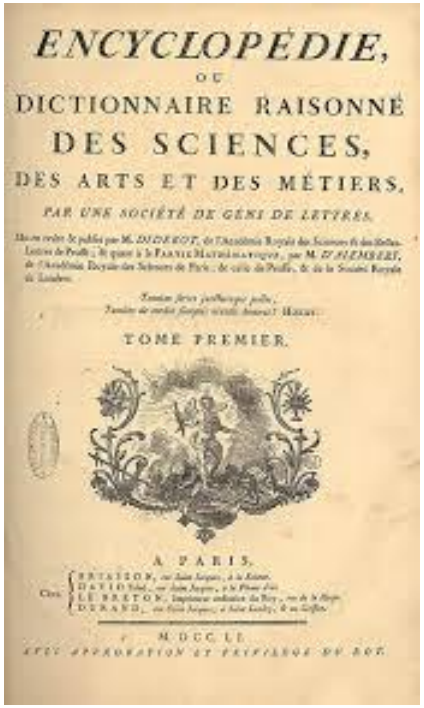
Quantified Self Movement

- Gary Wolf and Kevin Kelly (2007)
- You discover aspects of yourself that are obvious to all your friends but you never realized.
- Keeping a diary of your life, written by someone who follows you nonstop.
- The data will tell you who you really are.
- The data will help you improve yourself.

Quantified Self
self knowledge through numbers

Big Data for Everybody

- Democratizing knowledge
  - 18th century:
    - The "Encyclopedie" to share all the world's knowledge with ordinary people
    - Prussia introduced compulsory primary education
  - 19th century:
    - Education not a privilege but a duty (mandatory for all children)
    - The PhD


ENCYCLOPÉDIE,
OU
DICTIONNAIRE RAISONNÉ
DES SCIENCES,
DES ARTS ET DES MÉTIERS,
PAR UNE SOCIÉTÉ DE GENS DE LETTRES.
TOME PREMIER.
A PARIS.
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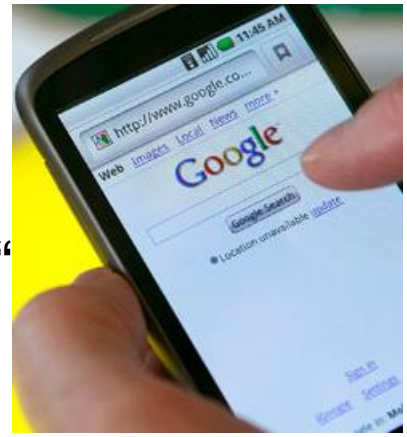
Big Data for Everybody

- Democratizing knowledge
  - 20th century:
    - The World-wide Web and the smartphone ("prosthetic knowledge“ Rich Oglesby)
  - 21st century:
    - Big data



Automation or Interaction: What's best for big data?

Organizer:
David Kenwright, MRJ Technology Solutions, NASA Ames Research Center

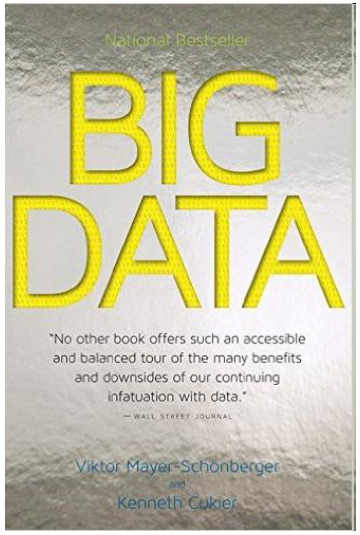
Panelists:
***David Banks**, Florida State University*
***Steve Bryson**, NASA Ames Research Center*
***Robert Haimes**, Massachusetts Institute of Technology*
***Robert van Liere**, CWI*
***Sam Uselton**, Lawrence Livermore National Laboratory*

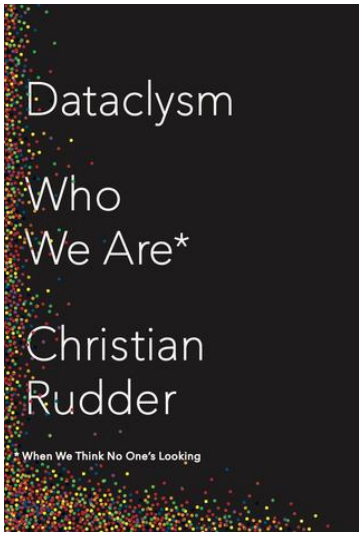
First panel in Big Data – Visualization Conference 1999

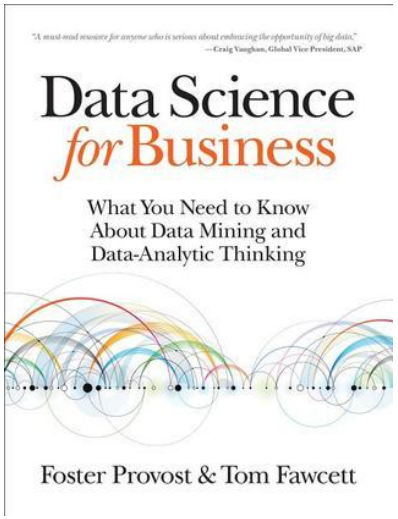
Big Data

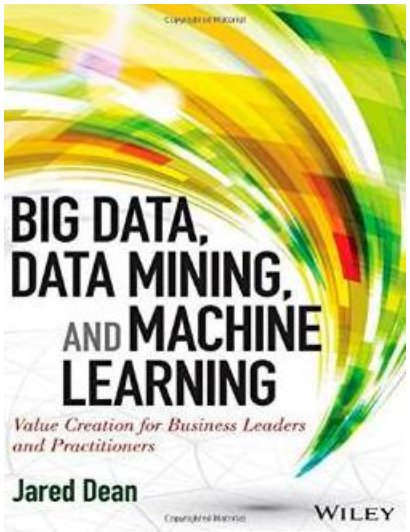
- Problems of democratizing knowledge
  - We don't even have access to the data that we generate
  - Ordinary people are the object, not the subject, of big data.

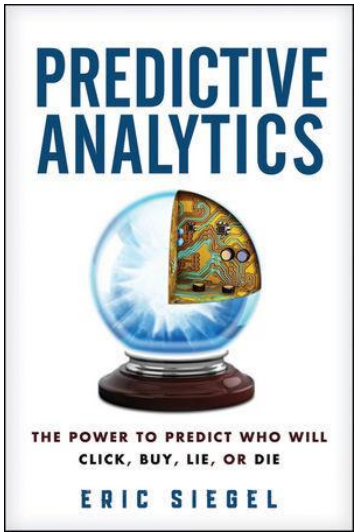
Bibliography





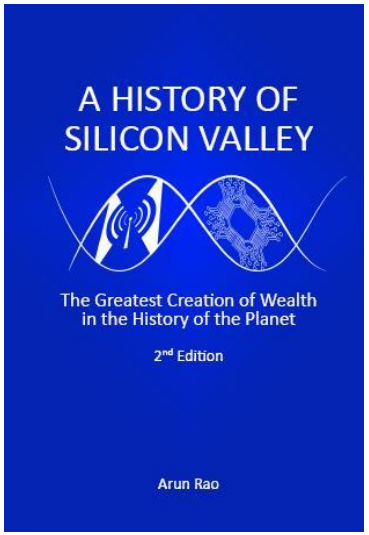


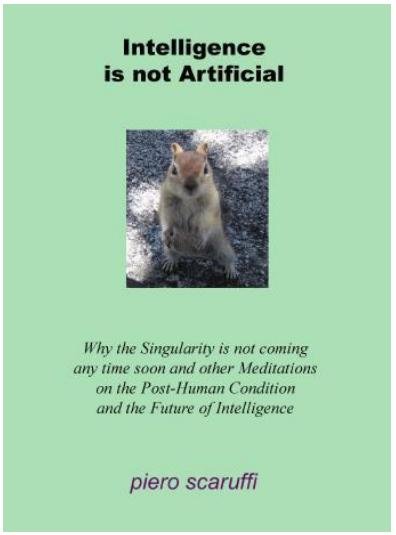


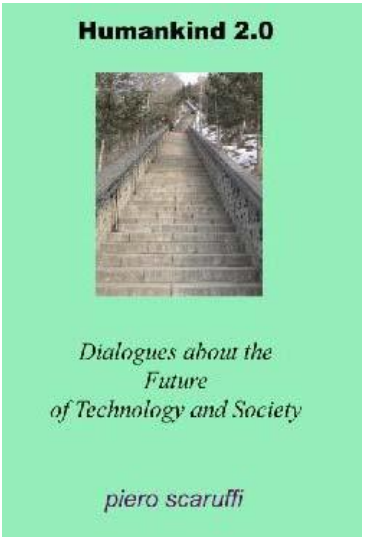


Contact

- www.scaruffi.com







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