Big Data –
a threat or a chance?

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Big Data

What is “Big Data”?

- well, lots of data, right? *… we come back to this in a moment.*
- certainly, a buzz-word… *… but a relevant one!*

Examples

- big data from numerous **sensors** (Internet of Things, …)
- bid data in large **social networks** (Facebook, Twitter, …)

Broadly used definition

- 3V-def.: “Big data” is **high-volume**, **-velocity** & **-variety** information assets that demand cost-effective, innovative forms of **information processing** for **enhanced insight** and **decision making.** [Doug Laney, 2001 / Gartner]

Big Data, V#1: Volume

Certainly, *Big Data* (usually) **refers to lots of data!**

> "Big data" refers to datasets
> whose size is **beyond the ability of typical database** software tools to **capture**, **store**, **manage**, and **analyze**.

[McKinsey Global Institute 2011]

Available data grows exponentially

- Exabytes of data available world-wide
  - 1 EB = 1000 PB = 1 million TB = 1 billion GB
  - hundreds of EB transferred via the Internet, annually
  - EB of new information stored, annually

Big Data, V#2: Variety

Big Data beyond numbers

- text, images & sound, relational data, …
  unstructured data
- 30 billion pieces of information on Facebook per month!
  400 million tweets per day
  4 billion hours of videos are watched on YouTube / month
  >400 million wearable, wireless health monitors
- Daniel Keim, 2007: 100 million FedEx transactions per day, 150 million VISA credit card transactionen per day, 300 million long distance calls in ATT's network per day, 50 billion e-mails worldwide per day, 600 billion IP packets per day DE-CIX backbone

Dark Data: available, but unused data

Big Data, V#3: Velocity

Real-time Big Data / Streaming Data Analysis, but also

- rapidly changing data
- data at different speeds and uneven rates (bursts)

Big Data – a moving target!

- lots of generated information cannot be stored!
  - 90% of health care data is discarded (videos, *etc.*)

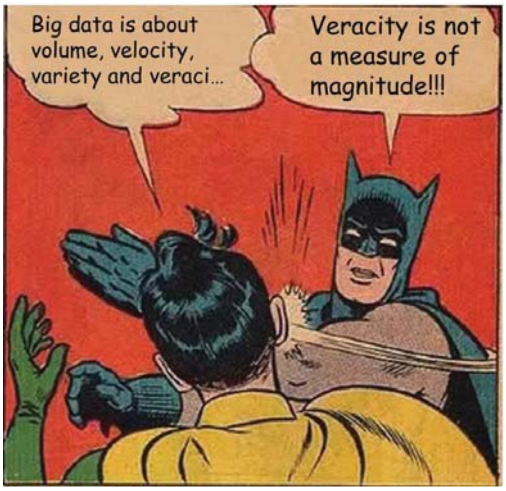
Big Data, V#4(?): Veracity [IBM, …]

Uncertain / low-quality data

- >$3 trillion loss to US economy due to bad data quality
- high degree of uncertainty

D. Laney blogs:

- Batman on Big Data:


Big data is about volume, velocity, variety and veraci...
Veracity is not a measure of magnitude!!!

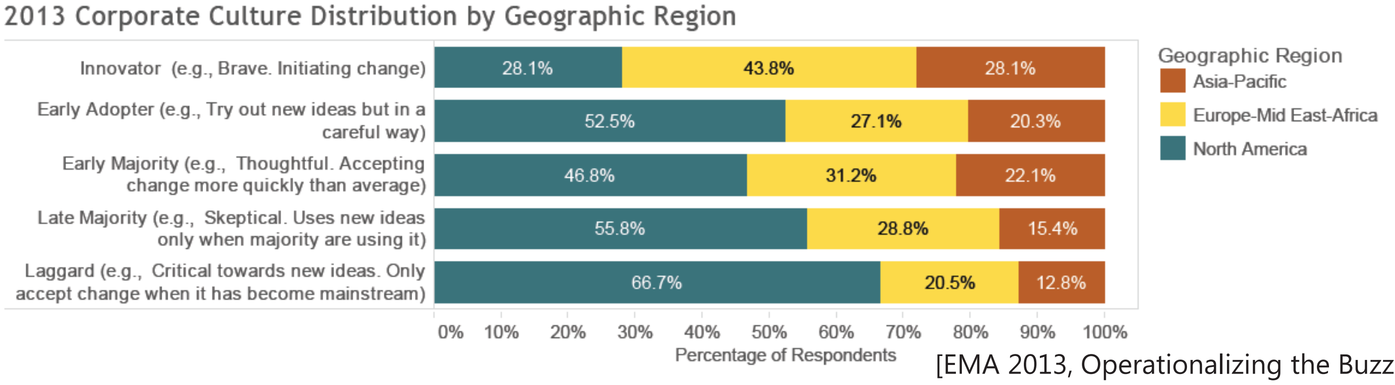
Even more Vs: [K. Normandeau]

- validity: the right data for the right decisions?
- volatility: when valid, storing for how long, etc.?

Big Data in Practice

Big data is

- generated, aggregated, analyzed, and consumed
- **sensed, collected** (networks), **stored** (cloud), **and anlyzed** (machine learning)
- **process-mediated** ("nicer" data),
  machine-generated (Internet of Things),
  human-sourced (from messages to videos)



[EMA 2013, Operationalizing the Buzz]

Big Data Technology – selection

Conceptual

- MapReduce [Google, 2004]
  - **map**: distribution of queries to many nodes
  - **reduce**: gathering of results and delivery
- NoSQL ("not only SQL"), for ex. Cassandra (key-value)

Software

- Hadoop [Apache], MongoDB

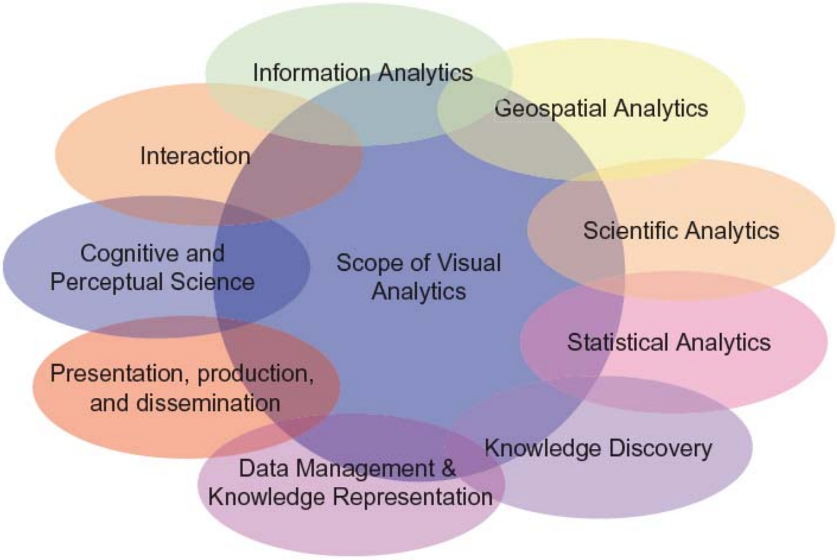
Analytics Technologies

- A/B testing, crowdsourcing, data fusion and integration, genetic algorithms, machine learning, natural language processing, signal processing, simulation, time series analysis and visualisation [McKinsey, 2011]

Big Data and Visual Analytics

Visual Analytics

- Illuminating the Path book: 2005
- VisMaster book: 2010


Information Analytics
Geospatial Analytics
Interaction
Scientific Analytics
Cognitive and Perceptual Science
Scope of Visual Analytics
Statistical Analytics
Presentation, production, and dissemination
Knowledge Discovery
Data Management & Knowledge Representation

Big Data – Challenges & Opportunities

[McKinsey GI, 2011]

Selected Challenges

- shortage of *Big Data* talent (up to 200.000 needed in the US plus 1.5 million «data-savvy» managers)
- contextualization of Big Data – Big Data needs to be complimented by Big Judgment [Harvard Business Review]
- prediction difficult without theory

Selected Opportunities

- annually $300 billion to the US health care system, incl. cost savings up to 8%
- annually $250 billion to the European public sector adm.
- job opportunity (analysts, managers, *et al.*)!

Big Data in Business

Five opportunities according to McKinsey GI, 2011:

- **reduced searching & processing time**, e.g., in the public administration sector, as well as **concurrent engineering** in manufacturing due to **accessible Big Data**
- enabling **experimentation** to **discover needs, expose variability,** and **improve performance**
- **segmenting populations** to **customize actions**
- **replacing/supporting human decision making** with **automated algorithms** based on **Big Data Analytics**
- innovating **new business models**, **products**, and **services**

Active enterprises include:

- **eBay, Amazon, Walmart, Facebook,** in *finance*, *real estate*, …

Big Data and Privacy Concerns

Snowden informed about NSA…

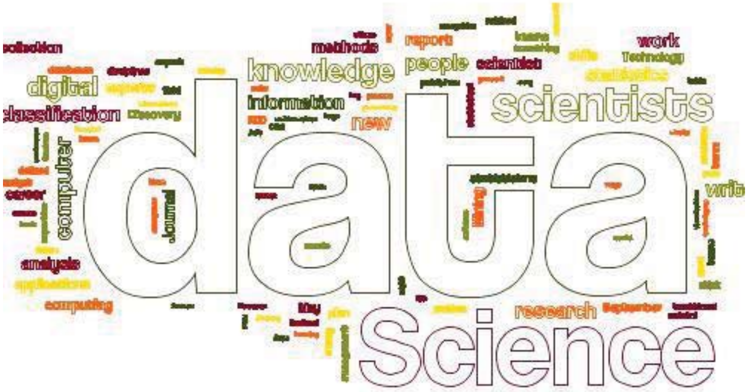
As data get large, networked, reside in the cloud, we fear

- unauthorized access
- data misuse
- identity theft

Examples:

- leaked health data
- credit card fraud
- monitored privacy

But let’s talk about science a little..



Big Data and the Fourth Paradigm

2009, Microsoft: the 4th paradigm: data-intensive scientific discovery

- refers to the last talk by Jim Gray, 2007, “A Transformed Scientific Method”
- from **empirical** (initially), via **theoretical** (modern times), and **computational science** (last decades) to **data-intense science** (now)
- eScience: **capture**, **curation**, **analysis**, **vis**.
- needle-in-a-haystack problems comparably “easy” (Higgs)
- more difficult: trends, clusters, patterns (N^2, or more)

Big Data in Science

Sources of Big Data

- **meteorology**, **genomics**, **connectomics**, **complex physics simulations**, and **biological** and **environmental research**
- **mobile phones**, **remote sensing**, **logs**, **cameras & microphones**, **RFID sensors** & **sensor networks**

Big Science Examples

- The Large Hadron Collider experiments:
  - about 150 million sensors
  - delivering about 40 millions times per second (!!)
- Sloan Digital Sky Survey (since 2000)
  - more data in a few weeks than all of astronomy so far
  - about 200 GB per night, now >140TB of data

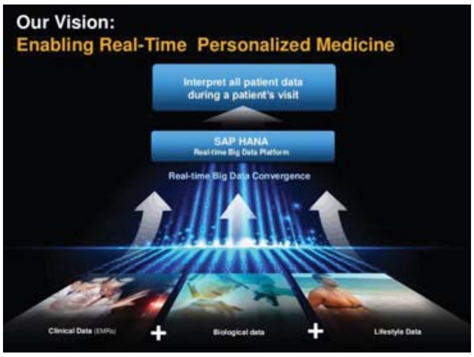
Big Data in Medicine

P4 medicine [Leroy Hood]

- predictive, preventive, personalized, and participatory

Computational Medicine [Arvid Lundervold, 2014]

- embracing IT, bioinformatics, etc., for "systems medicine"



Our Vision:
Enabling Real-Time Personalized Medicine

Interpret all patient data during a patient's visit
SAP HANA
Real-time Big Data Platform
Real-time Big Data Convergence
Clinical Data (EMRs)
+
Biological data
+
Lifestyle Data

[SAP]

Examples:

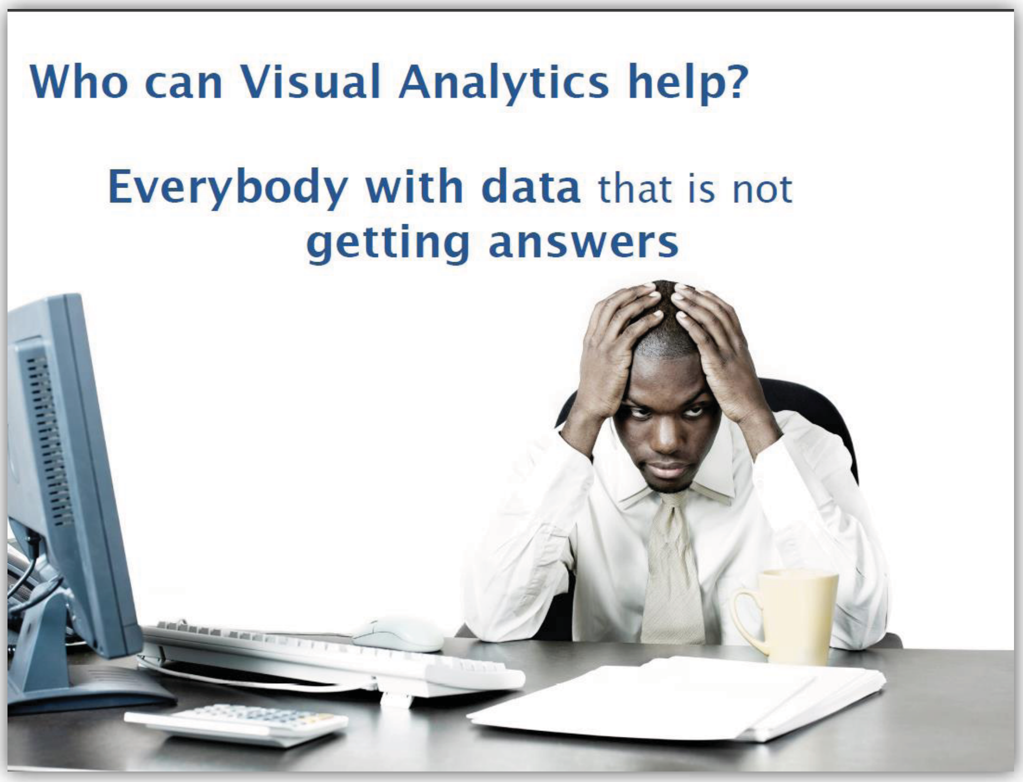
- predictive medicine
- large-scale cohort studies

Case: [EMA 2013 Operationalizing the Buzz]

- Brigham and Women's Hospital: improved drug risk awareness due to Big Data (much fast results)

Big Problems with Small Data

Christian Chabot (CEO of Tableau), 2008:



Who can Visual Analytics help?

Everybody with data that is not getting answers

VAST Keynote

Conclusions

Big Data is maturing, it's unavoidable

EMA 2013: the next Big Data challenge: Ethics!

Big Data is transforming Science (4th paradigm, etc.)

- Chris Anderson, Wired, 2008: The End of Theory

New opportunities, new challenges

- big business, P4 medicine
- "the other" Vs, dark data
- how to turn data into knowledge?
- technological challenges, new ways of thinking
- it's – not at the least – also an educational challenge!

Acknowledgements

You! ☺

Questions?

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Lots of references…