COMP9313: Big Data Management

Introduction to Big Data Management

What is big data?

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January 6, 2013 at 6:17pm ·

Big data is like teenage sex: everyone talks about it, nobody really knows how to do it, everyone thinks everyone else is doing it, so everyone claims they are doing it...

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Tweeted by Prof. Dan Ariely, Duke University

What is big data?

- No standard definition!
- Wikipedia:
  - Big data is a field that treats ways to analyze, systematically extract information from, or otherwise deal with data sets that are too large or complex to be dealt with by traditional data-processing application software.
- Amazon:
  - Big data can be described in terms of data management challenges that – due to increasing volume, velocity and variety of data – cannot be solved with traditional databases.

What is big data?

Word could which is generated from the top-20 results when search “what is big data” in Google.

What is big data?

- A set of data
- Special characteristics
  - Volume 体积
  - Variety 品种
  - Velocity 速度
  - …
- Traditional methods cannot manage
  - Store
  - Analyse
  - Retrieve 检索?
  - Visualization 可视化
  - …

That’s why we need this course

Big Data Definitions Have Evolved Rapidly

- 3 V's
  - In a research report by Doug Laney in 2001
  - Volume, Velocity and Variety 体积，速度和变化
- 4 V's
  - In Hadoop – big data tutorial, 2006
  - Veracity 准确性
- 5 V's
  - Around 2014
  - Value
- 7 V's, 8 V's, 10 V's, 17 V's, 42 V's, …

Major Characteristics of Big Data

体积

Volume

多样性

Variety

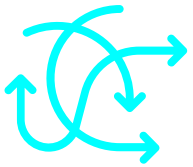
准确性

Veracity

Big Data

速率

Velocity



可变性；易变性

Variability

价值

Value

Visibility

可视性

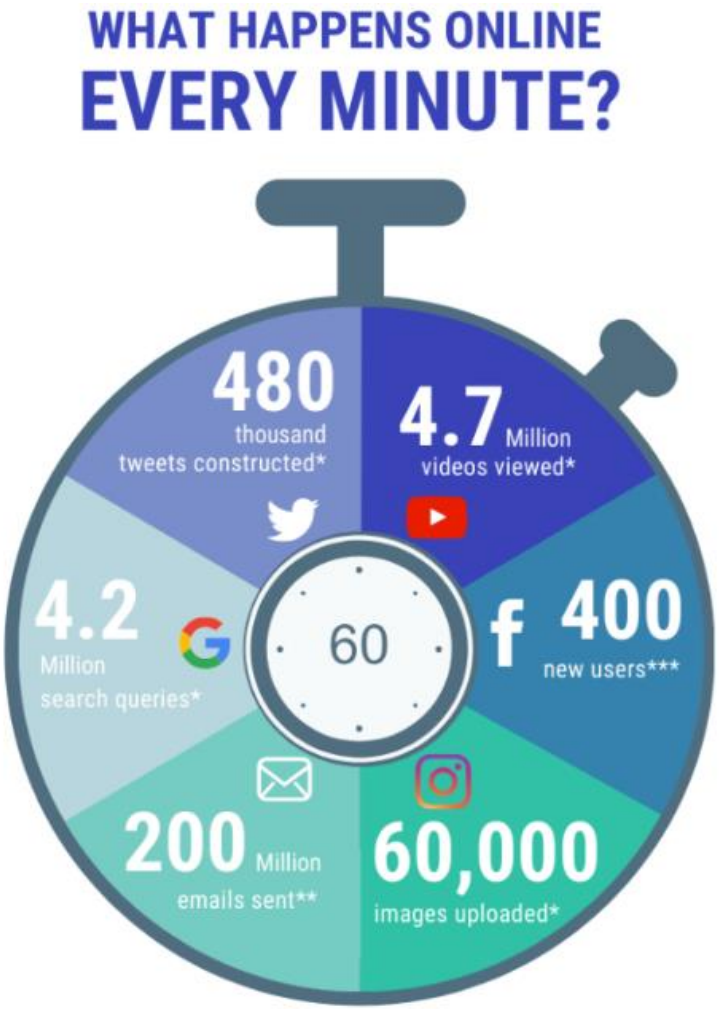
Volume (Scale)

- Quantity of data being created from all sources
- The fundamental of big data

大数据的基础

- 18 Zetabytes (ZB) of data in 2018, will grow to 175 ZB in 2025
  - 1 zettabyte ≈ 10^3 exabytes ≈ 10^9 terabytes
  - Source: https://www.seagate.com/files/www-content/our-story/trends/files/idc-seagate-dataage-whitepaper.pdf

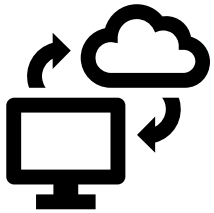
Volume



Source: https://www.nodegraph.se/how-much-data-is-on-the-internet/

Volume – Why Challenging?

Model	RAM	Disk	Data
Macintosh Classic (1990)	1MB – 4MB	0 – 40MB	
Power Mac G4 (2000)	256MB – 1.5GB	20GB – 60GB	5 EB in 2003
iMac (mid 2010)	4GB – 16GB	500GB – 2TB	1 ZB in 2012
iMac (early 2019)	8GB – 64GB	1TB – 3TB	~40 ZB



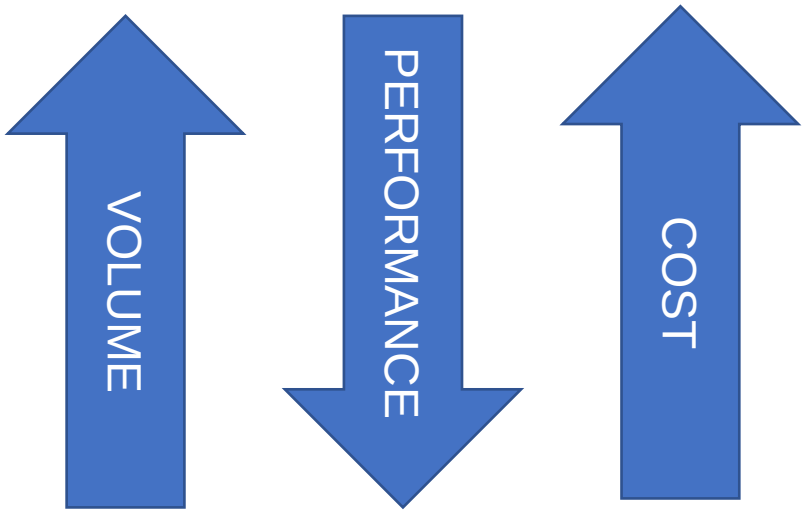
?

1990s 2000s 2010s future

DBMS Storage

Volume – Why challenging?

- Time complexity
  - Sort algorithms: O(N logN)
  - Merge join: O(N logN + M logM)
  - Shortest path: O(V logV + E logV)
  - Nearest neighbor search: O(dN)
  - NP hard problems



Variety (Diversity)

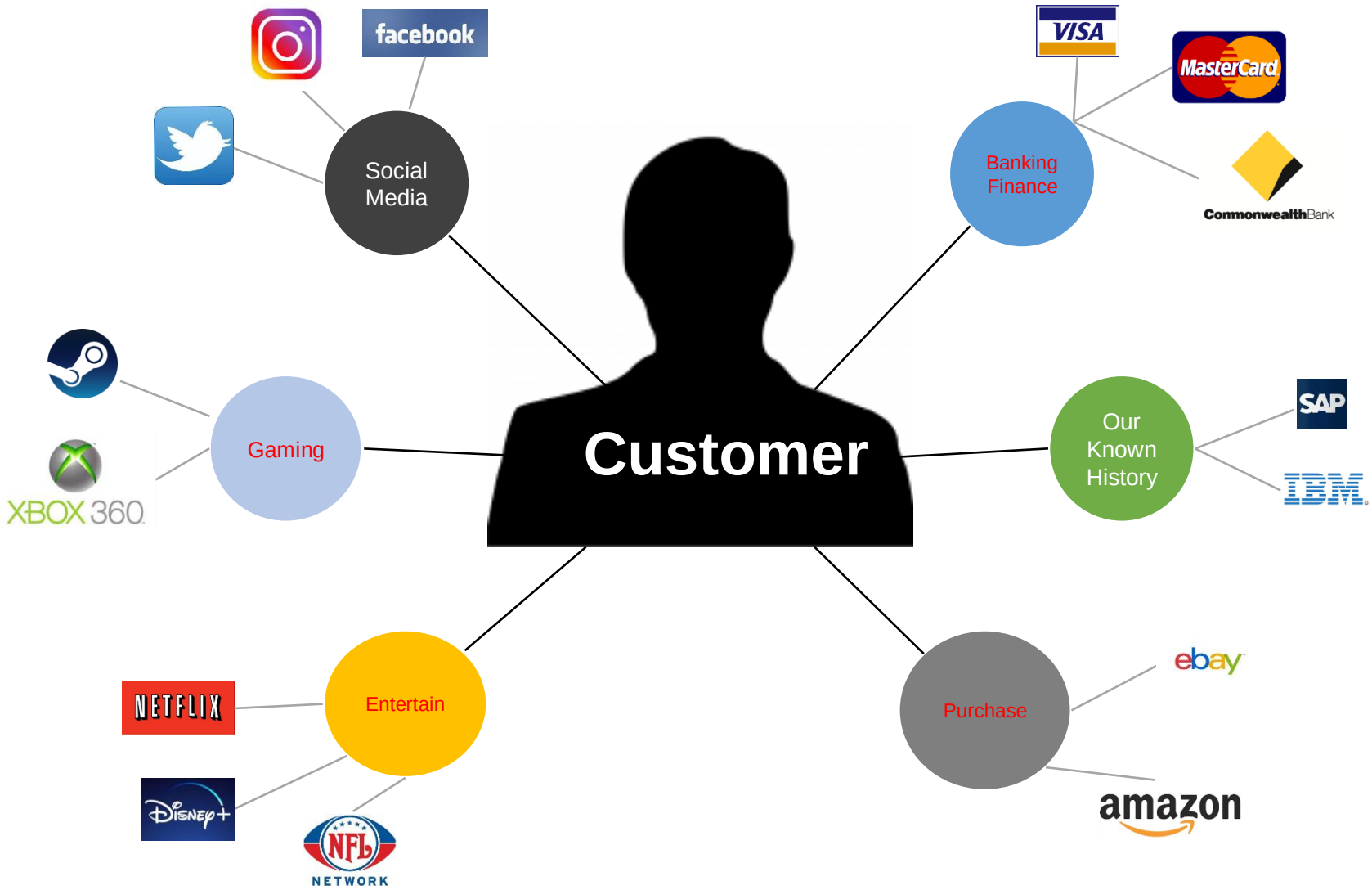
- Different Types
  - Relational data (tables/transactions)
  - Text data (books, reports)
  - Semi-structured data (JSON, XML)
  - Graph data (social network, RDF)
  - Image/video data (Instagram, Youtube)
- Different sources
  - Movie reviews from IMBD and Rotten Tomatoes
  - Product reviews from different provider websites
  - Personal information from different social apps

Variety

- A single application can be generating or collecting multiple types of data
  - Email
  - Webpage

- If we want to extract knowledge, then all the data with different types and sources need to be linked together

Variety - A Single View to the Customer



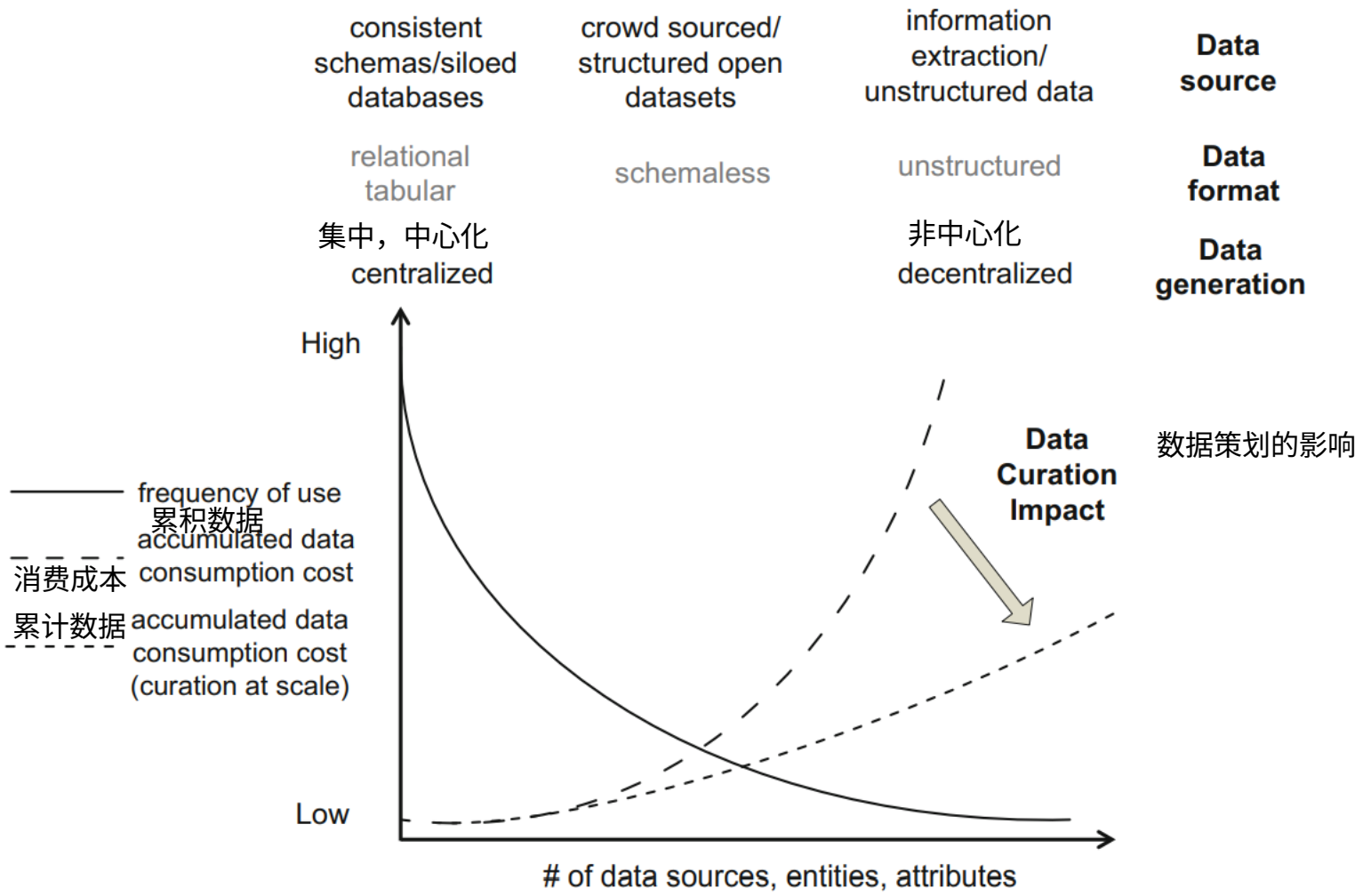
Variety – Why Challenging?

数据整合

- Data integration
  - Heterogeneous 由很多种类组成的；各种各样的
    - Traditional data integration relies on **schema mapping**, the difficulty and time complexity is directed related to the level of heterogenity and data sources 异质性和数据源
  - Record linkage in variety data 在品种数据中记录联动
    - needs to identify if two records refer to the same entity. How to make use of different types of data/information from different sources？ 需要确定两个记录是否引用同一实体。 如何利用不同来源的不同类型的数据/信息？
- Data curation 数据保管
  - Organization and integration of data collected from various sources
  - Long tail of data variety

数据多样性和数据整理的漫长尾巴

The Long Tail of Data Variety and Data Curation



Source: Curry, E., & Freitas, A. (2014). Coping with the long tail of data variety.

速度

Velocity (Speed)

- Data is being generated fast, thus need to be
  - stored fast
  - processed fast
  - analysed fast

- Every second
  - **8,991** Tweets sent
  - **994** Instagram photos uploaded
  - **4,683** Skype calls
  - **93,508** GB of Internet traffic
  - **83,165** Google searches
  - **2,915,385** Emails sent

Source: http://www.internetlivestats.com/one-second/

Velocity

- Reason of growth
  - Users:
    - 16 million in 1995 to 3.4 billion in 2016
  - IoT:
    - sensor devices, surveillance cameras
  - Cloud computing:
    - $26.4 billion in 2012 to $260.5 billion in 2020
  - Website:
    - 156 million in 2008 to 1.5 billion in 2019
  - Scientific data:
    - weather data, seismic data

高速

Velocity

现在，数据以连续的方式实时流传输到服务器，并且只有在延迟非常短的情况下，结果才有用

- Data is now streaming into the server in real time, in a continuous fashion and the result is only useful if the delay is very short.

- Many application need immediate response
  - Fraud detection
  - Healthcare monitoring
  - Walmart's real-time alerting

速度 速度

Velocity – Why Challenging?

- Batch processing

- Real time processing

- Transmission
  - Transferring data becomes a prominent issue in big data
  - Balancing latency/bandwidth and cost
  - Reliability of data transmission