Characteristics of Big Data and Dimensions of Scalability

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Course Website: Access from your "Moodle" portal

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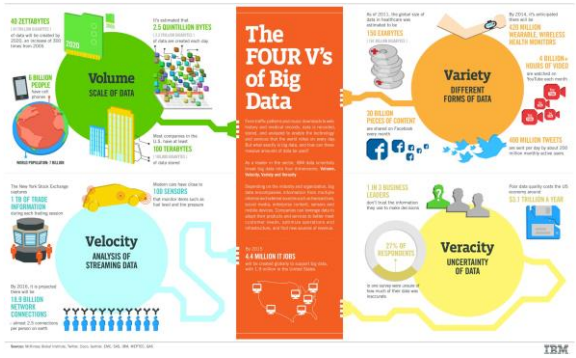
Characteristics of Big Data



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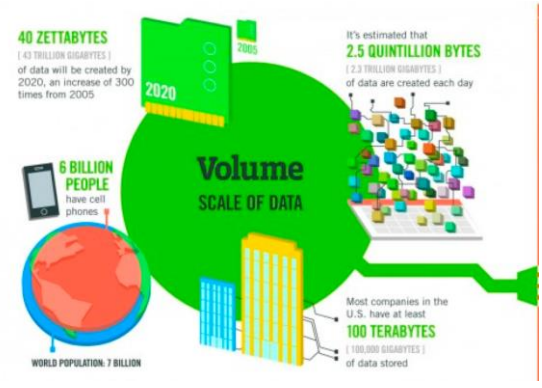

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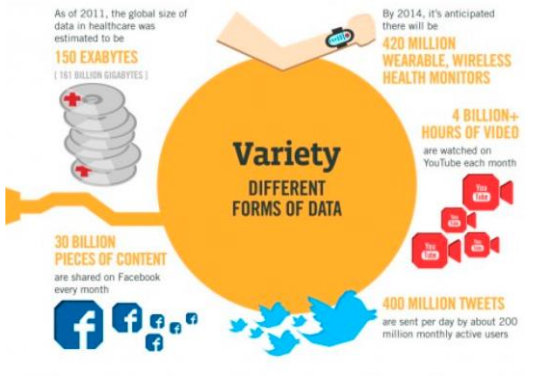

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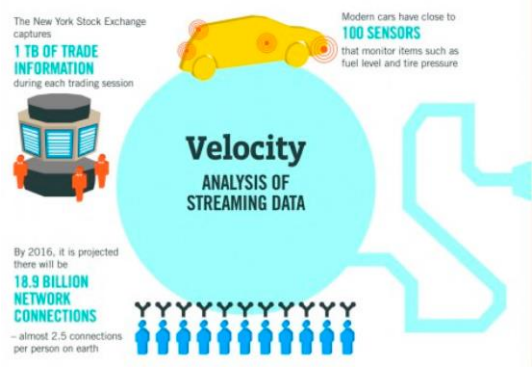

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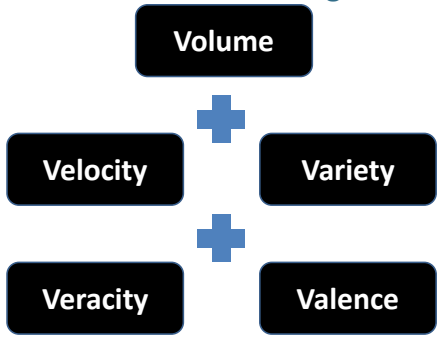
Characteristics of Big Data



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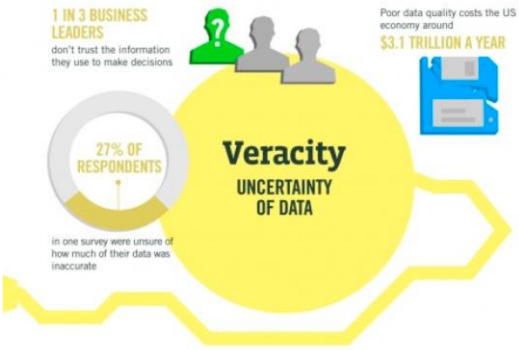

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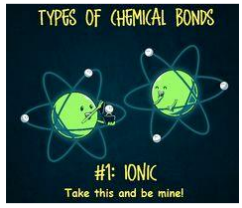
Valence



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Characteristics of Big Data

Volume + **Value**

Velocity **Variety**

Veracity **Valence**

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Volume

Volume = Size

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Every minute…

204 Million emails

200,000 photos

1.8 Million likes

1.3 Million video views

72 hours of video uploads

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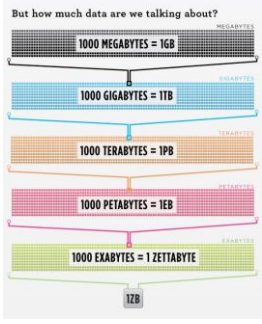

100 MBs ~= couple of volumes of Encyclopedias

A DVD ~= 5 GBs

1 TB ~= 300 hours of good quality video

LHC ~= 15 PBs a year

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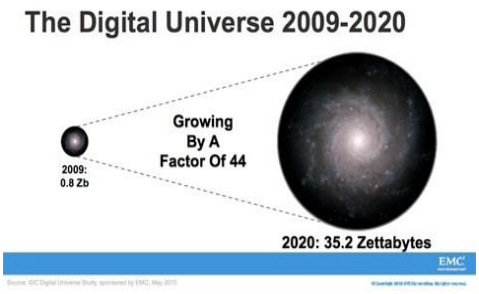

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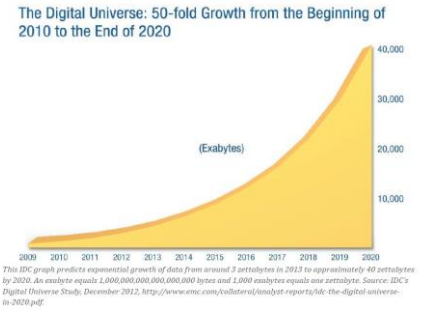
Exponential data growth!



This IDC graph predicts exponential growth of data from around 3 zettabytes in 2013 to approximately 40 zettabytes by 2020. An exabyte equals 1,000,000,000,000,000,000 bytes and 1,000 exabytes equals one zettabyte. Source: IDC's Digital Universe Study, December 2012, http://www.emc.com/collateral/analyst-reports/idc-the-digital-universe-in-2020.pdf

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Relevance of Volume for Us?

More data = Better safety

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Challenges: Storage and more…

Storage → **Distribution** → **Processing**

Data acquisition

Retrieval

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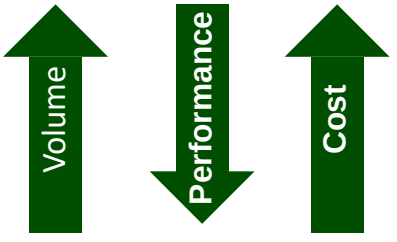
Processing Big Data



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Scalability - Variety

Variety == Complexity

Data were confined onlyto tables

Cars marketplace

vendor	Model	Price	Mileage	VIN Code
Chevrolet	Corvette	17226	25965.0	ILLAKAWAZDZ
Chevrolet	Corvette	34229	46429.0	RCPHSRYGXKR
Chevrolet	Corvette	27982	50209.0	NWLGCEVEHGI
Chevrolet	Corvette	51825	72998.0	NGVZSCUZGSN
Chevrolet	Corvette	52845	34364.0	PSDRUYYOUJG
Chevrolet	Malibu	37874	37273.0	VLFPQPWMEFC
Chevrolet	Malibu	15600	71441.0	EXLJGDWOZSU
Chevrolet	Malibu	52447	46700.0	NLMGJZAKBPC
Chevrolet	Malibu	27129	36254.0	OIPFUIENLEHDH
Chevrolet	Malibu	28846	77182.0	WRCOOPREZLJ
Chevrolet	Malibu	46165	60590.0	HJFTTHQHSFJF
Chevrolet	Malibu	18763	37790.0	JLMHIAFSHUT

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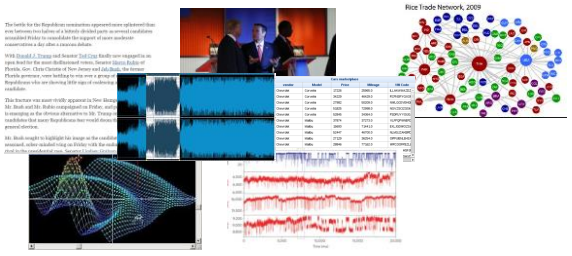
Today, Data are more heterogeneous



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Axes of Data Variety

Structural Variety – formats and models	**Semantic Variety – how to interpret and operate on data**
Media Variety – medium in which data get delivered	**Availability Variations – real-time? Intermittent?**

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Variety within a Type

- Think of an email collection
  - Table-like part

from:	**Banikumar Maiti (GMAIL)** <banikumar.maiti@gmail.com>
to:	Reghu Rajan <reghurajan@gmail.com>
cc:	Amarnath Gupta <aguptasd@gmail.com>
date:	Tue, Feb 2, 2016 at 2:29 PM
subject:	Re: Connecting
mailed-by:	gmail.com
signed-by:	gmail.com

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Variety within a Type

- Think of an email collection
  - Sender, receiver, date… Well-structured
  - Unstructured Text

Dear All,
I would like to congratulate you for putting together a wonderful show.
It was only possible by your hard work.
Dreaming of an UNIQUE show. This credit goes to Zubair. You
dreamed about it and made it happen.

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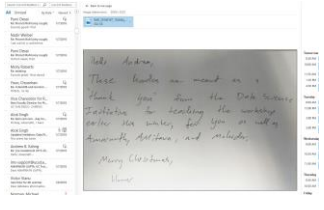
Variety within a Type

- Think of an email collection
  - Sender, receiver, date… Well-structured
  - Body of the email Text
  - Media



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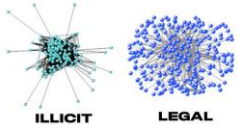
Variety within a Type

- Think of an email collection
  - Sender, receiver, date… Well-structured
  - Body of the email Text
  - Attachments Multi-media
  - Who-sends-to-whom



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Variety within a Type

- Think of an email collection
  - Sender, receiver, date… Well-structured
  - Body of the email Text
  - Attachments Multi-media
  - Who-sends-to-whom Network
  - A current email cannot reference a past email Semantics

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Variety within a Type

- Think of an email collection
  - Sender, receiver, date… Well-structured
  - Body of the email Text
  - Attachments Multi-media
  - Who-sends-to-whom Network
  - A current email cannot reference a past email Semantics
  - Real-Time? Availability

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Scalability Issues

- Impact of data variety
  - Harder to ingest
  - Difficult to create common storage
  - Difficult compare and match data across variety
  - Difficult to integrate
  - Management and policy challenges

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Velocity

Velocity == Speed

$$\bar{v} = \frac{\Delta x}{\Delta t}$$

Speed of creating data
Speed of storing data
Speed of analyzing data

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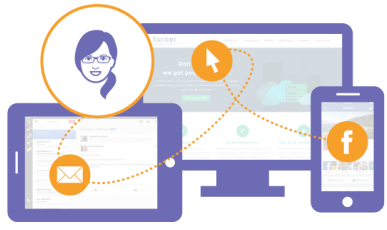
Big Data → **Real-time action**



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Late decisions

Missing opportunities

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How to decide what to pack ?

Use weather information of last year at this time?

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How to decide what to pack ?

Use weather information of last month ?

OR

Use weather status of this week or today ?

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Action

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Real-time Processing

Batch Processing

Collect Data → Clean Data → Feed in Chunks → Wait → Act

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Real-time Processing

Real-Time Processing

Instantly capture streaming data → Feed real time to machines → Process Real Time → Act

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Batch Processing → **Incomplete**

Real-Time Processing → **Fast**

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Rate needed for data-driven actions

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Rate of generation and processing of data

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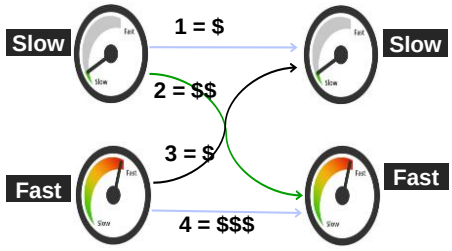
Speed of Data Generation | **Speed of Data Processing**



Which path to choose?

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Veracity == Quality

Validity

Volatility

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Veracity == Quality

Accuracy of data

Reliability of the data source

Context within analysis

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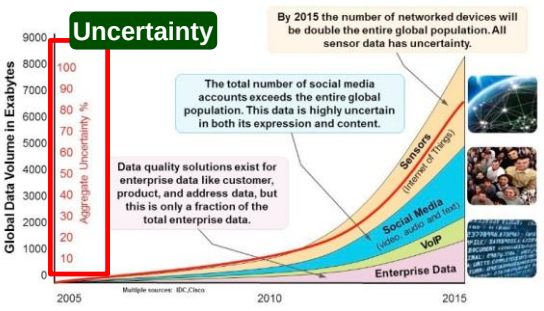

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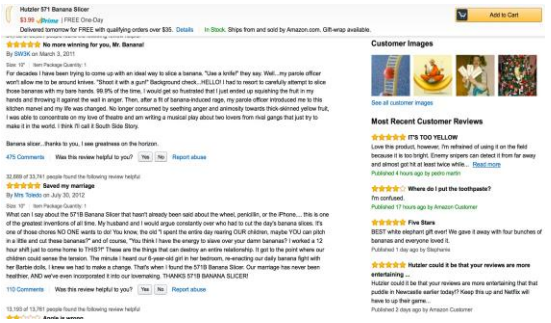
When sentiment analysis doesn't work?



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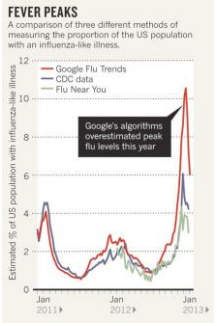

Uncertainty

Provenance

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Veracity == Quality

Accuracy of data

Reliability of the data source

Context within analysis

?

Uncertainty

Provenance

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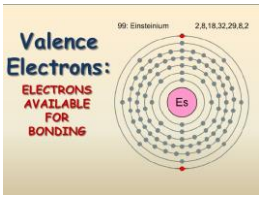
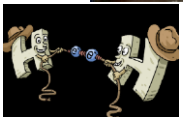
Valence == Connectedness

Valence – a Concept from Chemistry





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Valence – Measure of Connectivity

Data Connectivity

- Two data items are connected when they are related to each other

- Valence
  - Fraction of data items that are connected out of total numbe possible connections

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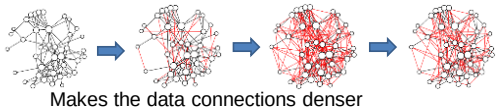
Why worry about Valence?

Valence increases over time



Makes the data connections denser

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Valence: Challenges

- More complex data exploration algorithms
- Modeling and prediction of valence changes
- Group event detection
- Emergent behavior analysis

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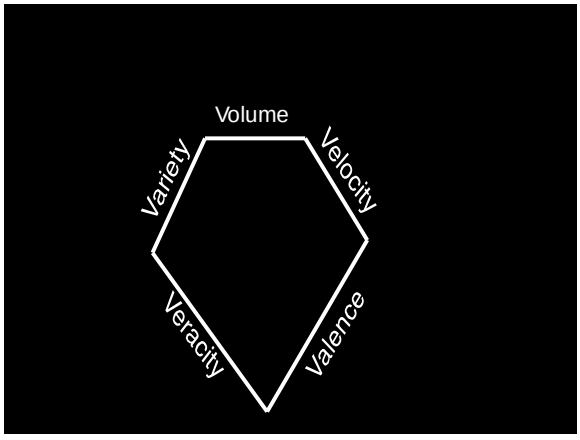

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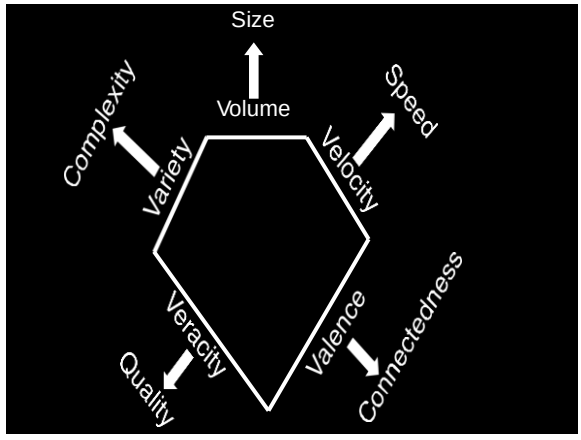

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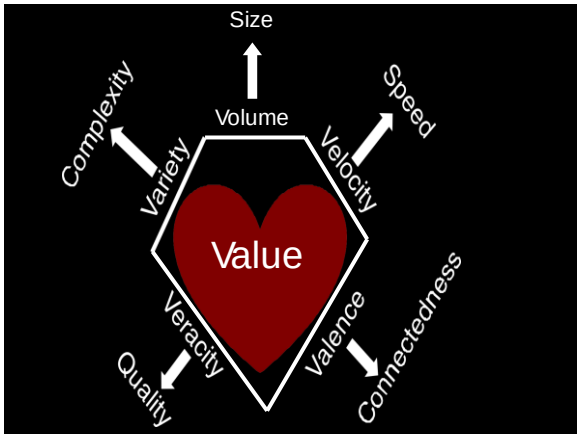

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Eglence Inc. Big Data Case:

Catch The Pink Flamingo

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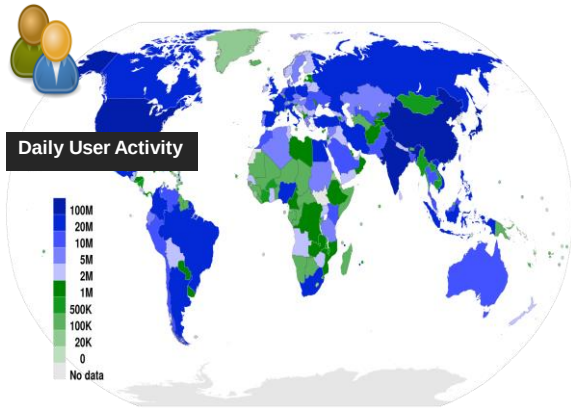

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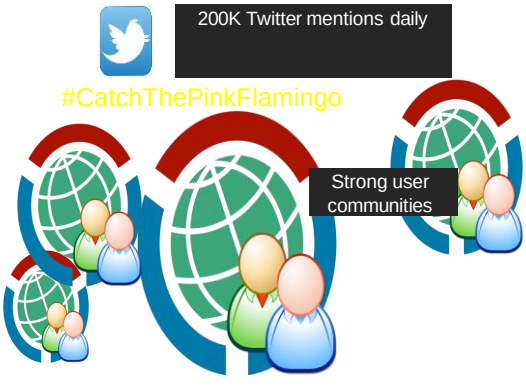

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Data Source	
Machine	• User activity logs
People	• Twitter conversations
Organization	• User demographic info • Game stats

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Dimension	
Volume	• Big daily workload and associated data on players and game stats
Variety	• Multiple types of data
Velocity	• Real-time analysis of usage activity
Veracity	• Demographic info not accurate
Valence	• Connections between players

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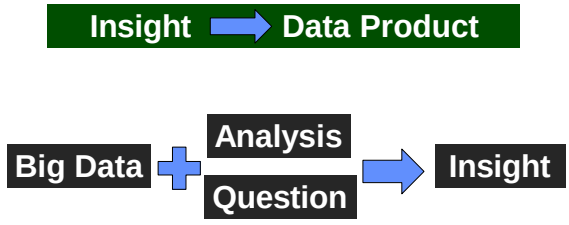

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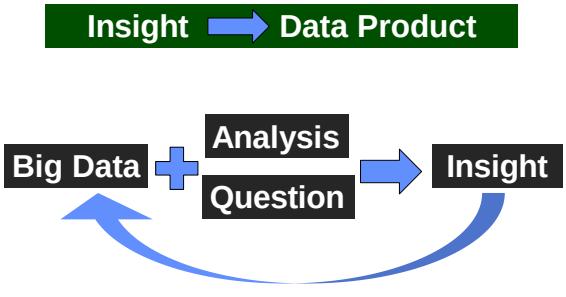

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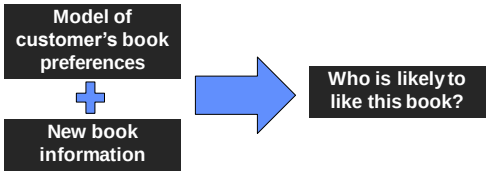
Find Potential Audience for a Book



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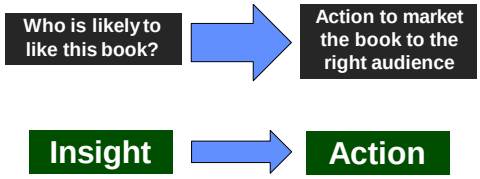
Market a New Book



Insight → **Action**

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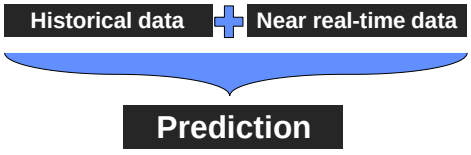
Actionable Information



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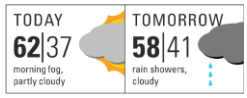
Prediction



Action

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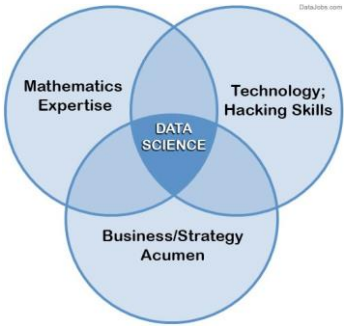
Data Science is Team Work!



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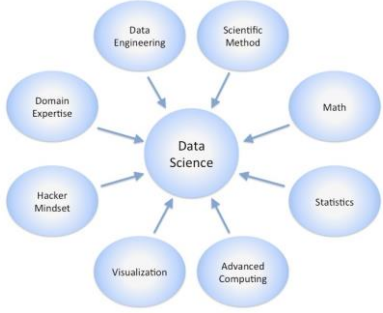

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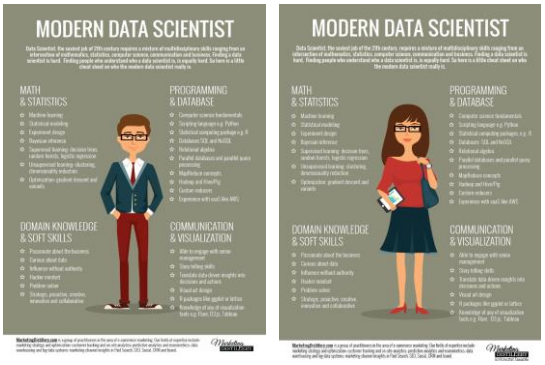

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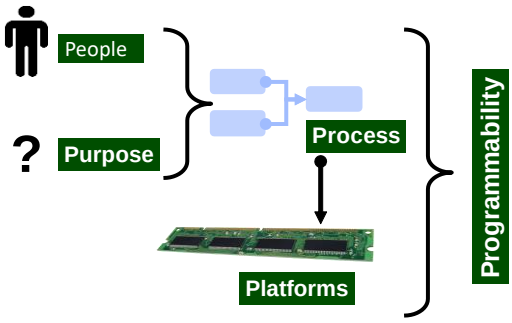
Five P's of Data Science



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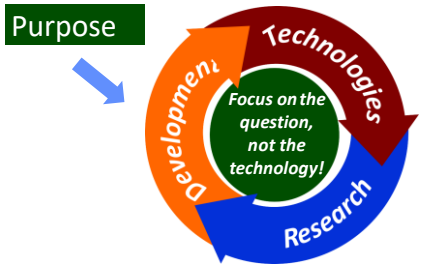

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Let's not dive into the techniques yet! What is the problem at large? How do you see yourself solving it?

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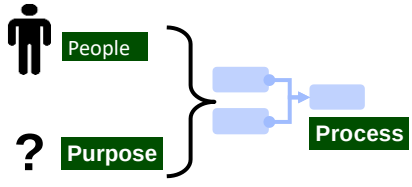

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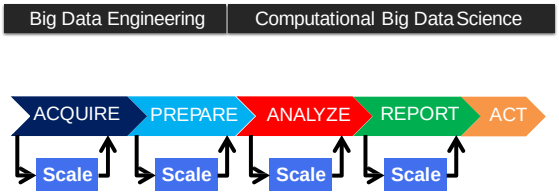

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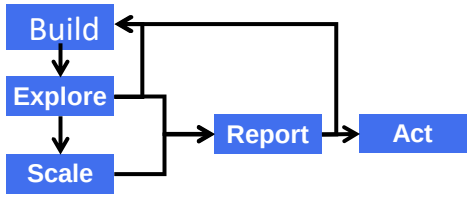

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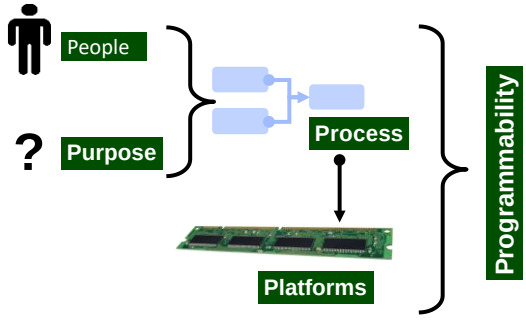

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Process: Build metrics for accountability

- Cost
- Timeline
- Planning of deliverables
- Expectations
- Purpose

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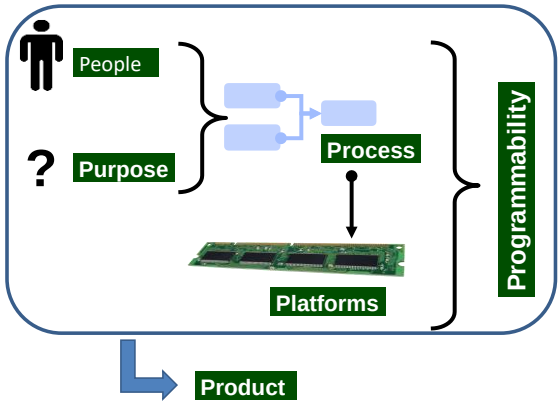


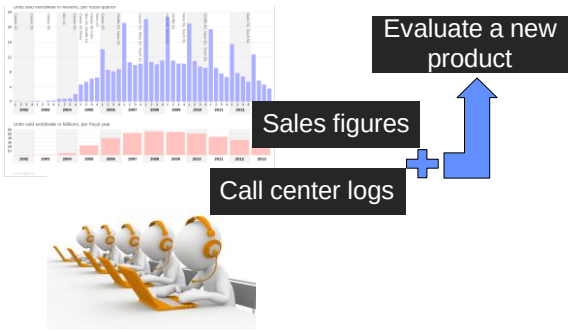
84

Define the Problem

"A problem well defined is a problem half solved."

Charles F. Kettering

85



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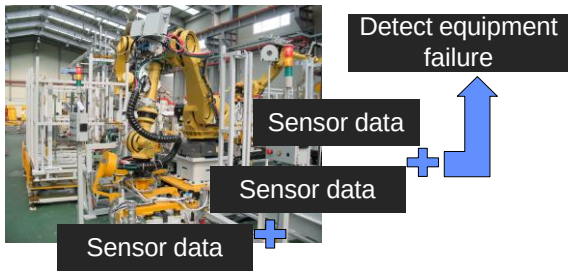

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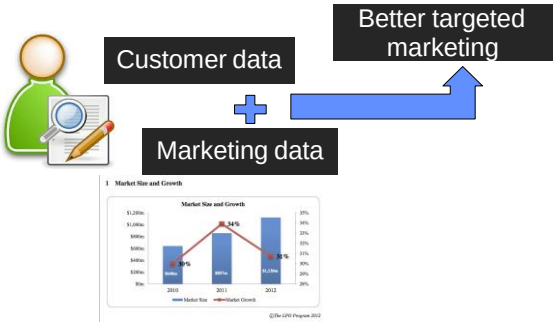

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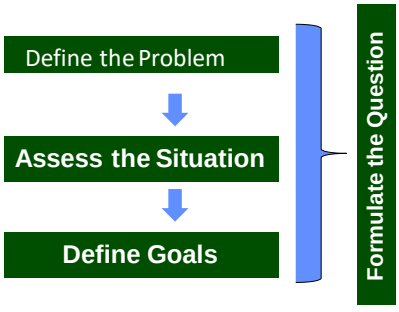

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Steps in the Data Science Process

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ACQUIRE PREPARE ANALYZE REPORT ACT

Step 1: Acquire Data

- Identify data sets
- Retrieve data
- Query data

92

ACQUIRE PREPARE ANALYZE REPORT ACT

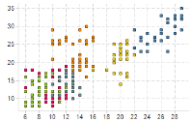
Step 2: Prepare Data

- Step 2-A: Explore
- Step 2-B: Pre-process

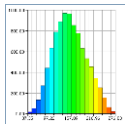
93

ACQUIRE PREPARE ANALYZE REPORT ACT

Step 2-A: Explore Data



Understand nature of data

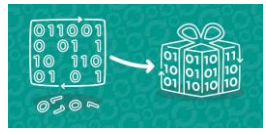


Preliminary analysis

94

ACQUIRE PREPARE ANALYZE REPORT ACT

Step 2-B: Pre-process Data



Clean Integrate Package

95

ACQUIRE PREPARE ANALYZE REPORT ACT

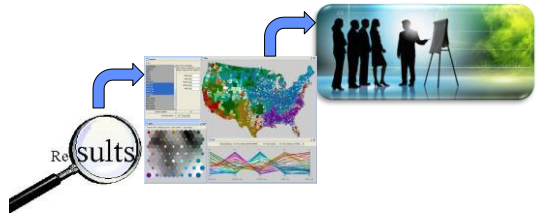
Step 3: Analyze Data

- Select analytical techniques
- Build models

96

ACQUIRE PREPARE ANALYZE REPORT ACT

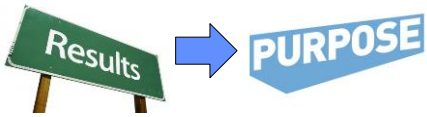
Step 4: Communicate Results



97

ACQUIRE PREPARE ANALYZE REPORT ACT

Step 5: Apply Results



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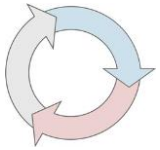
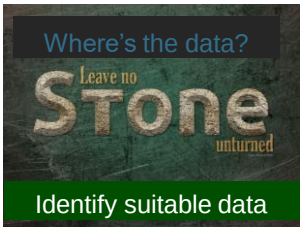
ACQUIRE PREPARE ANALYZE REPORT ACT



Iterative process

99



Identify suitable data

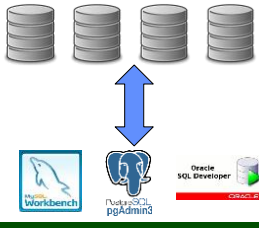
Acquire all available data

100

Data comes from many places…

…with many ways to access it

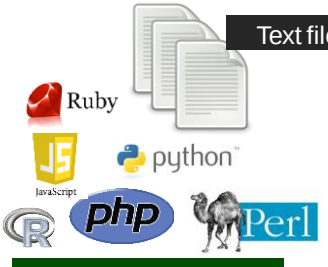
101



Traditional databases

SQL and query browsers

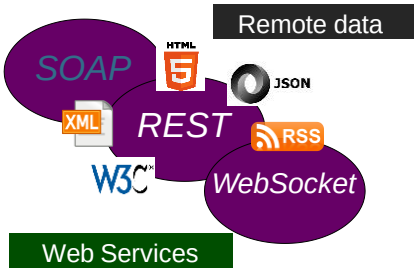
102



Text files

Scripting languages

103



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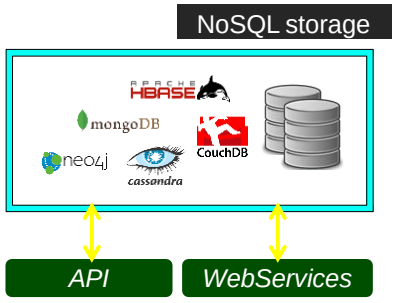

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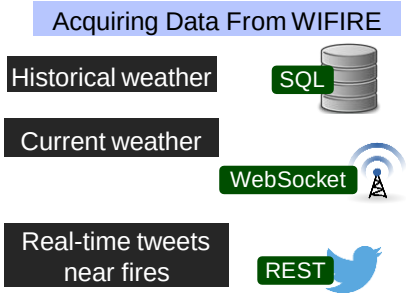

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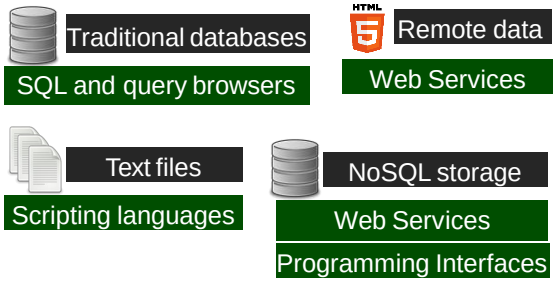

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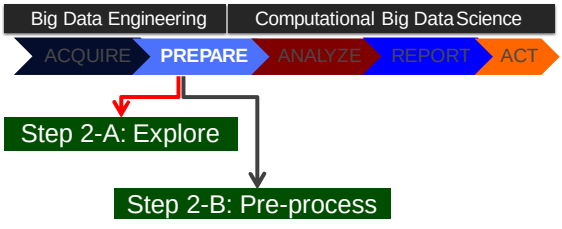
Exploring Data

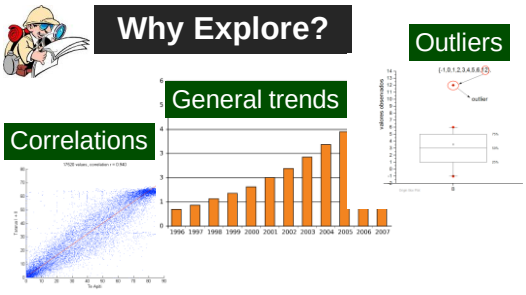


108

Why Explore?

Goal: Understand your data

109



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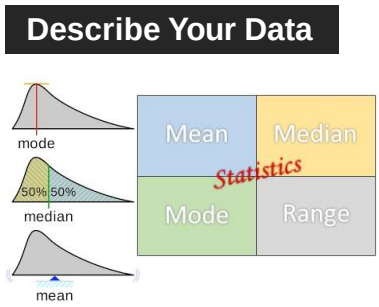

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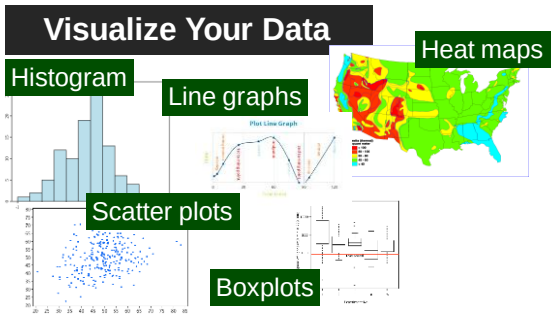

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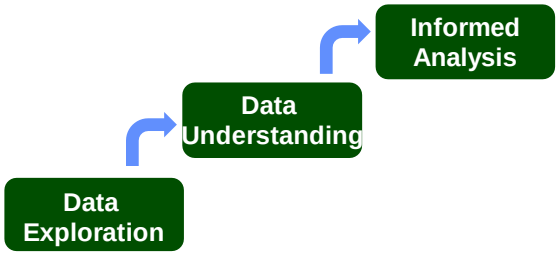

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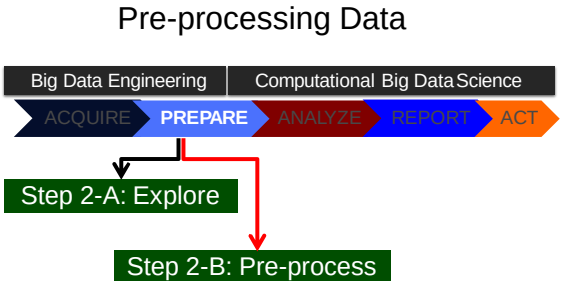

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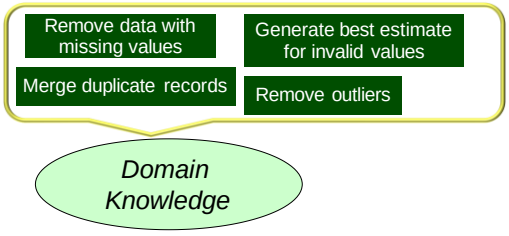
Addressing Data Quality Issues



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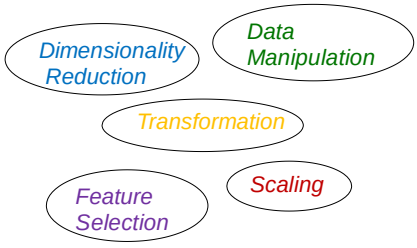
Getting Data in Shape

117

Data Munging



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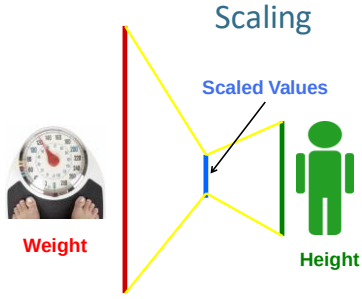
Scaling



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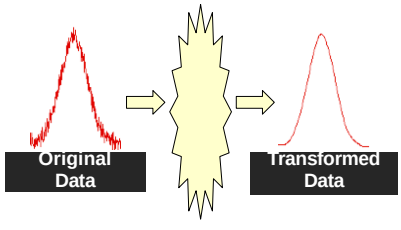
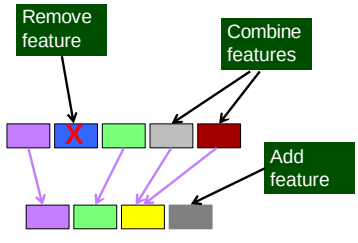
Transformation



120

Feature Selection



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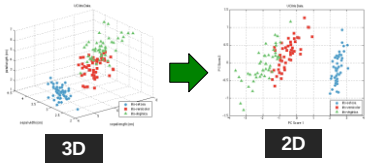
Dimensionality Reduction



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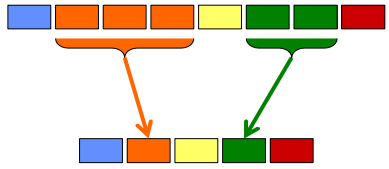
Data Manipulation



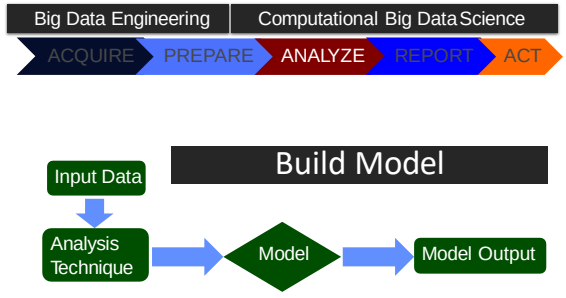
123

Always Remember!

Garbage in = Garbage out

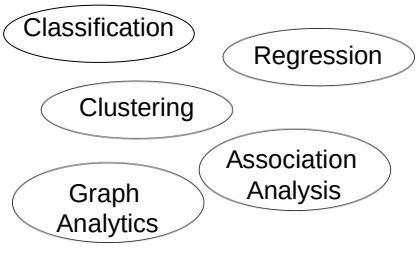
Data preparation is very important for meaningful analysis!

124



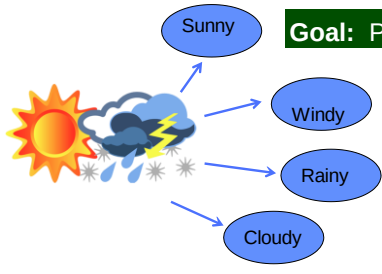
125

Categories of Analysis Techniques



126

Classification



127

Regression

Goal: Predict numeric value

128

Clustering

Goal: Organize similar items into groups

129

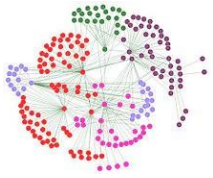
Association Analysis

Goal: Find rules to capture associations between items

130

Graph Analytics

Goal: Use graph structures to find connections between entities



131

Modeling

Select technique

Build model

Validate model

132

Evaluation of Results

133

Classification & Regression

Predicted Value VS Correct Value

134

Clustering

135

Association Analysis & Graph Analytics

Investigate

Validate

136

Determine Next Steps

Repeat analysis?

Take deeper dive?

Act on results?

137

Select technique

Build model

Evaluate

Classification
Regression
Clustering
Association Analysis
Graph Analytics

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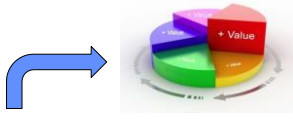
Big Data Engineering | Computational Big Data Science

ACQUIRE PREPARE ANALYZE REPORT ACT

What to Present

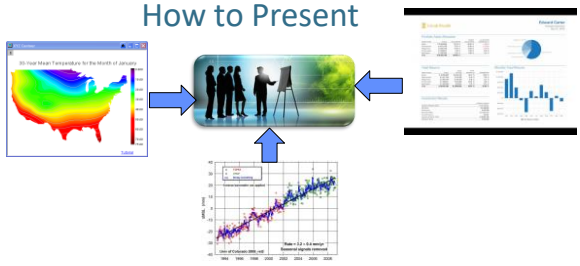


139

What to Present

140

How to Present



141

Visualization Tools

R python D3

Google Developers CHARTS tableau

Timeline JS
Beautifully crafted timelines that are easy and intuitive to use.

142

Present

with

using

tableau

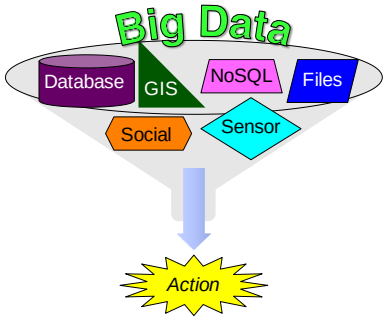
Google Developers CHARTS

Power BI

143

Big Data Engineering | Computational Big Data Science

ACQUIRE PREPARE ANALYZE REPORT ACT



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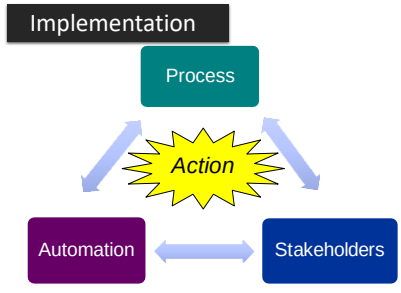

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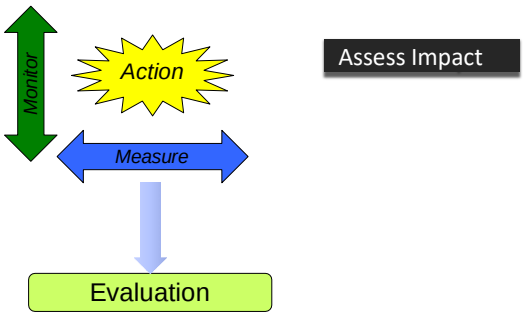

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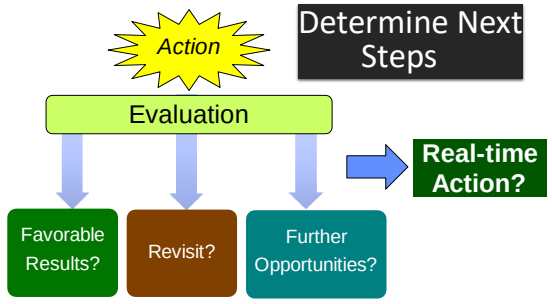

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