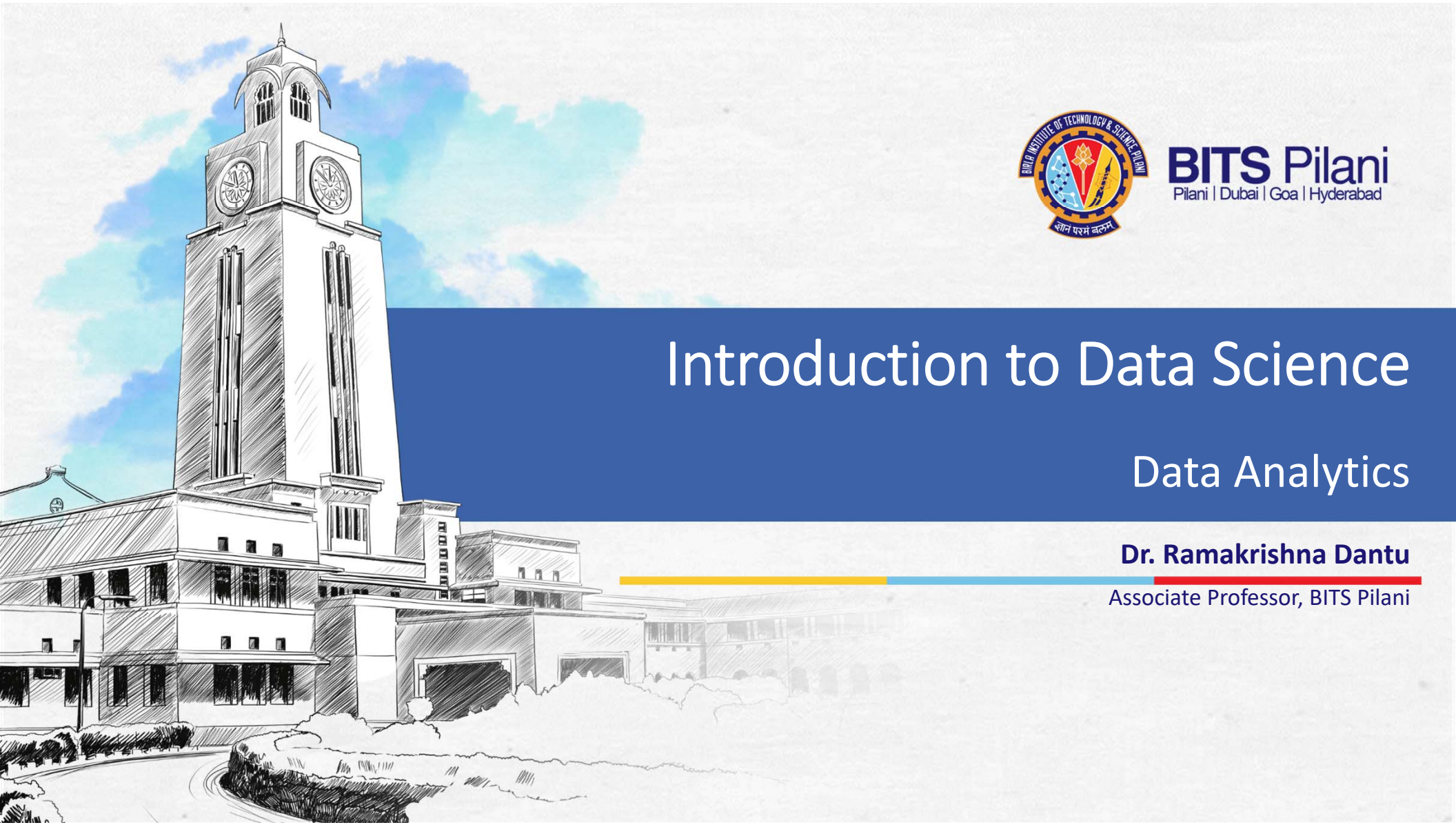

BITS Pilani
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Introduction to Data Science

Data Analytics

Dr. Ramakrishna Dantu
Associate Professor, BITS Pilani

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Disclaimer and Acknowledgement

- The content for these slides has been obtained from books and various other source on the Internet
- I here by acknowledge all the contributors for their material and inputs.
- I have provided source information wherever necessary
- I have added and modified the content to suit the requirements of the course

Introduction to Data Science

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Data Analytics Module Topics

- Defining Analytics
- Types of data analytics
  - Descriptive, Diagnostic
  - Predictive, Prescriptive
- Data Analytics – methodologies
  - CRISP-DM Methodology
  - SEMMA
  - BIG DATA LIFE CYCLE
  - SMAM
- Analytics Capacity Building
- Challenges in Data-driven decision making

What is Analytics?

Defining Analytics

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What is Analytics?

What home should I buy?

What route should I follow?

How to retain customers?

What treatment should I recommend?

What stock should I purchase?

Defining Analytics

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What is Analytics? – Dictionary meaning

- It can be used as a noun or verb.
  - Is Analytics the name of your department, or do you actually "do" Analytics?
  - Analytics can be a **noun**. "He is the HOD of Business Analytics department!"
  - Analytics can also be a **verb**. "I applied Analytics to the data to find patterns"
- Let's look at the dictionary meaning first
  - Analytics is the systematic computational analysis of data or statistics
    - -- Oxford
  - Analytics is a process in which a computer examines information using mathematical methods in order to find useful patterns
    - -- Cambridge
  - Analytics is the analysis of data, typically large sets of business data, by the use of mathematics, statistics, and computer software
    - -- dictionary.com

Source: http://the-data-guy.blogspot.com/2016/10/is-analytics-noun-or-verb.html

Defining Analytics

What is Analytics? – From websites

- It is the process of discovering, interpreting, and communicating significant patterns in data and using tools to empower your entire organization to ask any question of any data in any environment on any device
  - --Oracle
- Data Analytics refers to the techniques used to analyze data to enhance productivity and business gain
  - -- Edureka
- Data analytics is the pursuit of extracting meaning from raw data using specialized computer systems
  - -- Informatica
- I couldn't find a definition from popular websites such as Google, IBM, Microsoft, Amazon, etc.,

Source: Internet

Defining Analytics

What is Analytics?

- Analytics is the process of extracting and creating information from raw data by using techniques such as:
  - filtering, processing, categorizing, condensing and contextualizing the data
- Analytics is a broad term that encompasses the processes, technologies, frameworks and algorithms to extract meaningful insights from data
- This information thus obtained is then used to infer knowledge about the system and/or its users, and its operations to make the systems smarter and more efficient

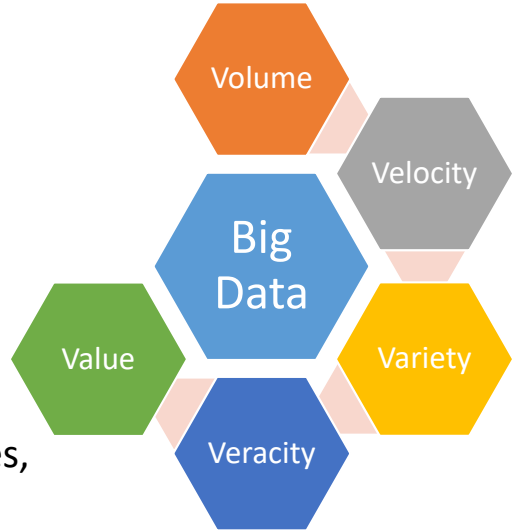
Source: Big Data Analytics – A Hands-on Approach by Arshdeep Bahga & Vijay Madisetti

Characteristics of Big Data

Characteristics of Big Data (5Vs)

Volume

- Big data is so large that it would not fit on a single machine
- Specialized tools and frameworks are required to store, process and analyze such data
- For example:
  - Social media applications process billions of messages everyday, IoT can generate terabytes of sensor data everyday, etc.
- The data generated by modern IT, industrial, healthcare, Internet of Things, and other systems is growing exponentially
- Cost of storage and processing architectures is going down
- The need to extract valuable insights from the data to improve business processes, efficiency and service to consumers
- Though there is no fixed threshold for the volume of data to be considered as big data
- Typically, the term big data is used for massive scale data that is difficult to store, manage and process using traditional databases and data processing architectures

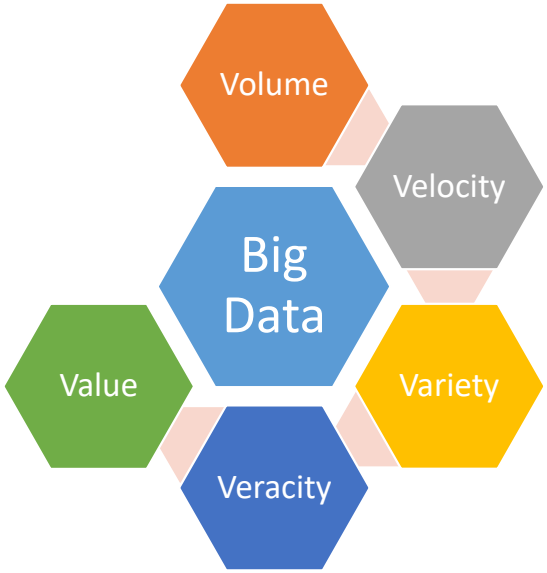


Source: Big Data Analytics – A Hands-on Approach by Arshdeep Bahga & Vijay Madisetti

Characteristics of Big Data (5Vs)

Velocity

- Velocity of data refers to how fast the data is generated
- Data generated by certain sources can arrive at very high velocities, for example, social media data or sensor data
- Velocity is the primary reason for the exponential growth of data in short span of time
- Some applications can have strict deadlines for data analysis (such as trading or online fraud detection) and the data needs to be analyzed in real-time
- Specialized tools are required to ingest such high velocity data into the big data infrastructure and analyze the data in real-time

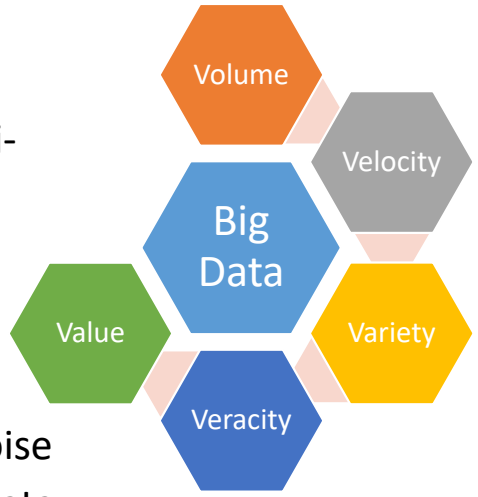


Source: Big Data Analytics – A Hands-on Approach by Arshdeep Bahga & Vijay Madisetti

Characteristics of Big Data (5Vs)

Variety & Veracity

- Variety
  - Variety refers to different forms of the data
  - Big data comes in different forms such as structured, unstructured or semi-structured, including text data, image, audio, video and sensor data
  - Big data systems need to be flexible enough to handle such variety of data
- Veracity
  - Veracity refers to how accurate is the data
  - To extract value from the data, the data needs to be cleaned to remove noise
  - Data-driven applications can reap the benefits of big data only when the data is meaningful and accurate
  - Therefore, cleansing of data is important so that incorrect and faulty data can be filtered out

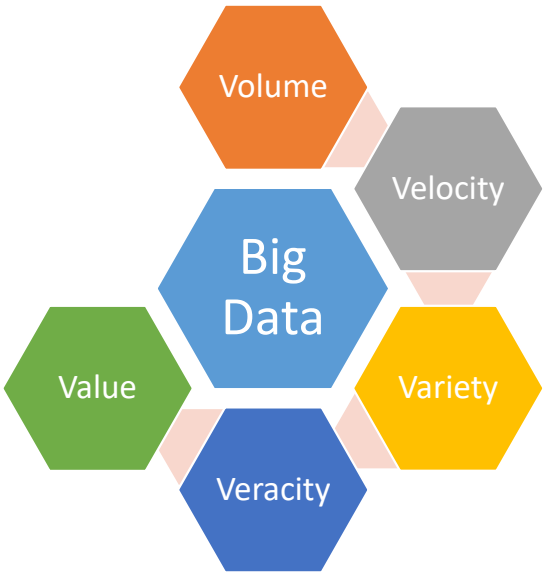


Source: Big Data Analytics – A Hands-on Approach by Arshdeep Bahga & Vijay Madisetti

Characteristics of Big Data (5Vs)

Value

- Value of data refers to the usefulness of data for the intended purpose
- The end goal of any big data analytics system is to extract value from the data
- The value of the data is also related to the veracity or accuracy of the data
- For some applications value also depends on how fast we are able to process the data



Source: Big Data Analytics – A Hands-on Approach by Arshdeep Bahga & Vijay Madisetti

Analytics Goals

The Driver

- What drives the choice of technologies, algorithms, and frameworks used for analytics?
  - Analytics goals of the analytic task at hand
    - To predict something
      - For example: whether a transaction is a fraud or not, whether it will rain on a particular day, or whether a tumor is benign or malignant
    - To find patterns in the data
      - For example: finding the top 10 coldest days in the year, finding which pages are visited the most on a particular website, or finding the most searched celebrity in a particular year
    - To find relationships in the data
      - For example: finding similar news articles, finding similar patients in an electronic health record system, finding related products on an eCommerce website, finding similar images, or finding correlation between news items and stock prices)

Source: Big Data Analytics – A Hands-on Approach by Arshdeep Bahga & Vijay Madisetti

Analytics Terminology

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Some references

- https://marketing.adobe.com/resources/help/en_US/reference/glossary.html
- https://analyticstraining.com/analytics-terminology/
- https://blog.hubspot.com/marketing/hubspot-google-analytics-glossary

Source: Big Data Analytics – A Hands-on Approach by Arshdeep Bahga & Vijay Madisetti

Types of Analytics

Types of Analytics

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Categorization of Analytics

- Analytics based on the objective
- Analytics based on the domain
- Analytics based on the type of data
- Are there any other possibilities??

Types of Analytics

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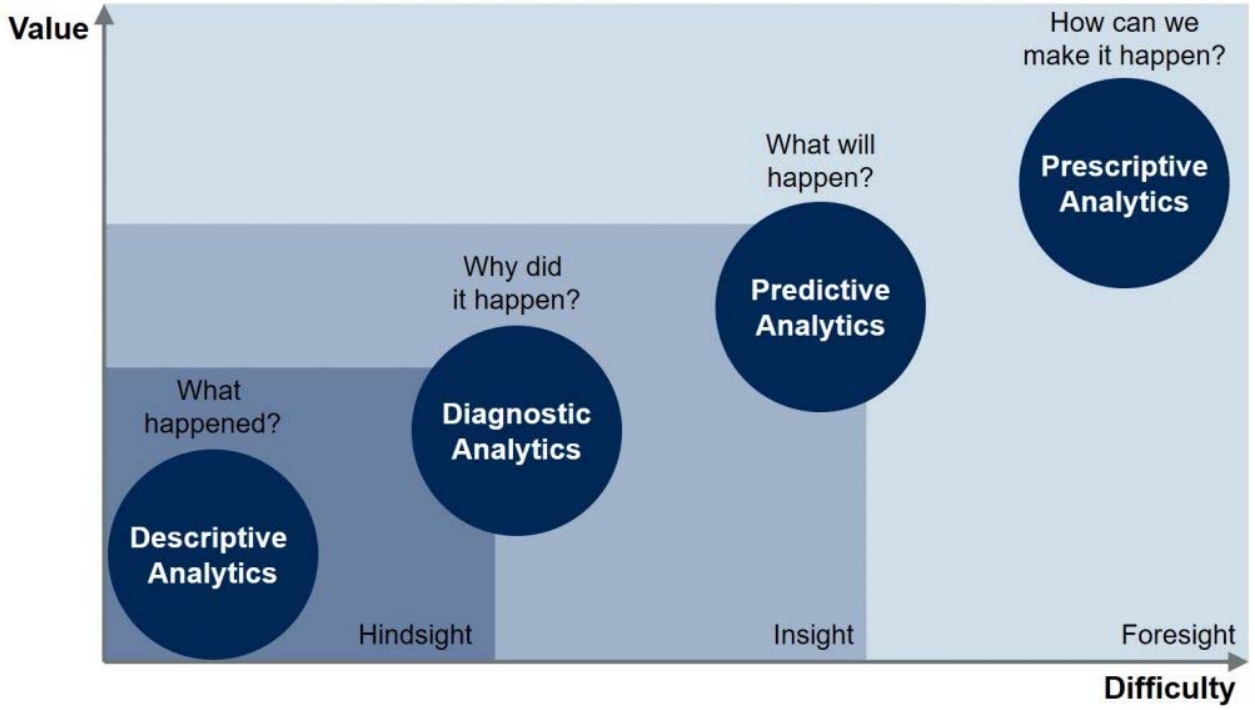
Types of analytics according to the objective



Source: https://blogs.gartner.com/jason-mcnellis/2019/11/05/youre-likely-investing-lot-marketing-analytics-getting-right-insights/

Types of Analytics

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Types of analytics according to the objective

• Descriptive Analytics – What is happening?	• Involves *retrospective analysis* of what happened using historical data • Data mining methods help uncover patterns that offer insight • Lays foundation for diagnosis and further analysis of what might happen in the future
• Diagnostic Analytics – Why did it happen?	• Looks for the root cause of a problem • Used to determine why something happened • Attempts to find and understand the causes of events and behaviors
• Predictive Analytics – What is likely to happen?	• Uses past data and external sources to predict the future • Involves forecasting • Uses data mining and AI techniques to analyze current data and develop future scenarios
• Prescriptive Analytics – What should be done?	• Dedicated to finding the right action to be taken. • Descriptive analytics provides a historical perspective, and predictive analytics helps forecast what might happen. • Prescriptive analytics uses these parameters to find the best solution

Types of Analytics

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Next level of Analytics

- Cognitive Computing
  - Human cognition is based on the context and reasoning
  - Cognitive systems mimic how humans reason and process
  - Cognitive systems analyze information and draw inferences using probability

  - They continuously learn from data and reprogram themselves
  - According to one source
    - "The essential distinction between cognitive platforms and artificial intelligence systems is that:
      - you want an AI to do something for you
      - a cognitive platform is something you turn to for collaboration or for advice"

Source: https://interestingengineering.com/cognitive-computing-more-human-than-artificial-intelligence
Image Source: https://towardsdatascience.com/cognitive-computing-what-can-it-be-used-for-8af4721928f5

Types of Analytics

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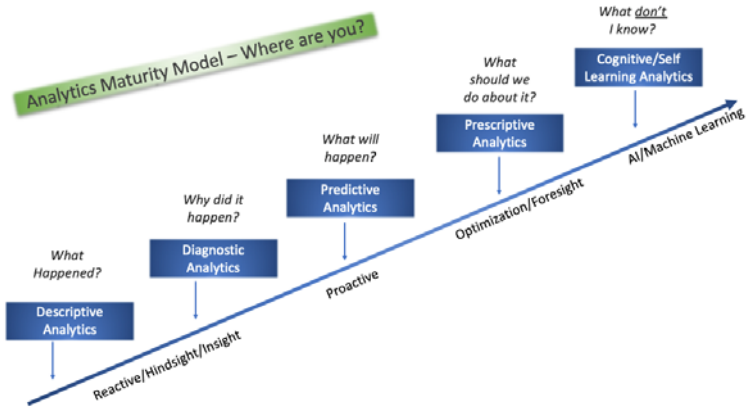
Next level of Analytics

- Cognitive Analytics – *What Don't I Know?*
  - Involves Semantics, AI, Machine learning, Deep Learning, Natural Language Processing, and Neural Networks
  - Simulates human thought process to learn from the data and extract the hidden patterns from data
  - Uses all types of data: audio, video, text, images in the analytics process
  - Although this is the top tier of analytics maturity, Cognitive Analytics can be used in the prior levels
  - It extends the analytics journey to areas that were unreachable with more classical analytics techniques like business intelligence, statistics, and operations research."
    - -- Jean Francois Puget



Applications: https://www.gflesch.com/elevity-it-blog/healthcare-retail-finance-are-leveraging-cognitive-computing

Source: https://www.ecapitaladvisors.com/blog/analytics-maturity/
https://www.xenonstack.com/insights/what-is-cognitive-analytics/

Types of Analytics

Application areas of Cognitive Analytics

- Healthcare, Financial Services, Supply Chains, Customer Relationship Management, Cybersecurity, etc.,.
- Chatbots:
  - Programs that can simulate a human conversation by understanding the communication in a contextual sense
  - Chatbots use the machine learning technique called natural language processing
  - Natural language processing allows programs to take inputs from humans (voice or text), analyze it and then provide logical answers
  - Cognitive computing enables chatbots to have a certain level of intelligence in communication
  - E.g., understanding user's needs based on past communication, giving suggestions, etc.

Source: https://www.newgenapps.com/blog/what-is-cognitive-computing-applications-companies-artificial-intelligence/

Types of Analytics

Application areas of Cognitive Analytics

- Sentiment analysis:
  - It is the science of understanding emotions conveyed in a communication
  - While it easy for humans to understand tone, intent etc. in a conversation, it is far more complicated for machines
  - To enable machines to understand human communication a training data of human conversations is used and then analyze the accuracy of the analysis
  - Sentiment analysis is popularly used to analyze social media communications like tweets, comments, reviews, complaints etc.

Source: https://www.newgenapps.com/blog/what-is-cognitive-computing-applications-companies-artificial-intelligence/

Types of Analytics

Major Players in Cognitive Computing

- SparkCognition
- Expert System
- Microsoft Cognitive Services
- IBM Watson
- Numenta
- Google DeepMind
- Cicso Cognitive Threat Analytics
- CognitiveScale
- CustomerMatrix
- HPE Haven OnDemand

Source: https://www.newgenapps.com/blog/what-is-cognitive-computing-applications-companies-artificial-intelligence/

Types of Analytics

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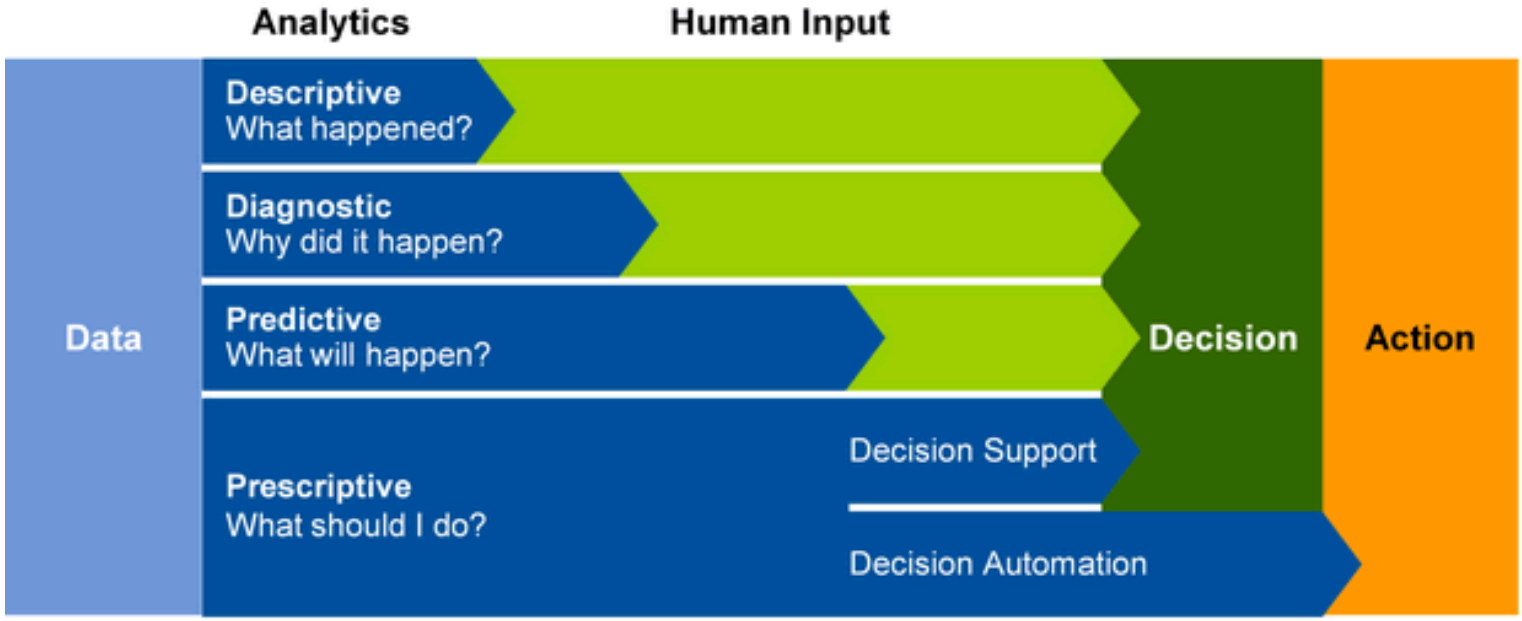
Level of automation in different types of analytics



Source: Gartner

Analytics Vs. Data Science

Types of Analytics

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How Analytics is Connected to Data Science

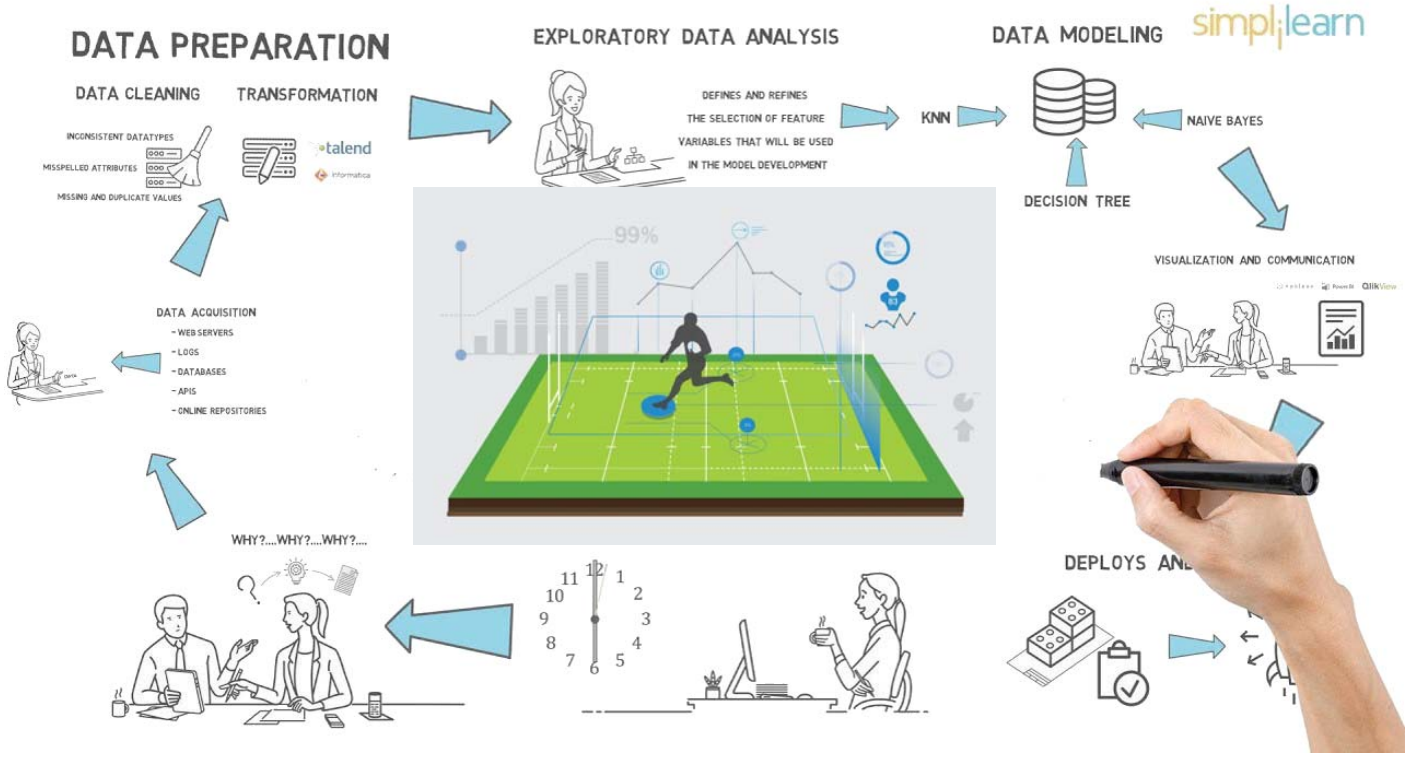

Image Source: Simplilearn - https://www.youtube.com/watch?v=X3paOmcrTjQ
Image Source: https://thedatascientist.com/why-now-is-the-right-time-for-sports-analytics/

Types of Analytics

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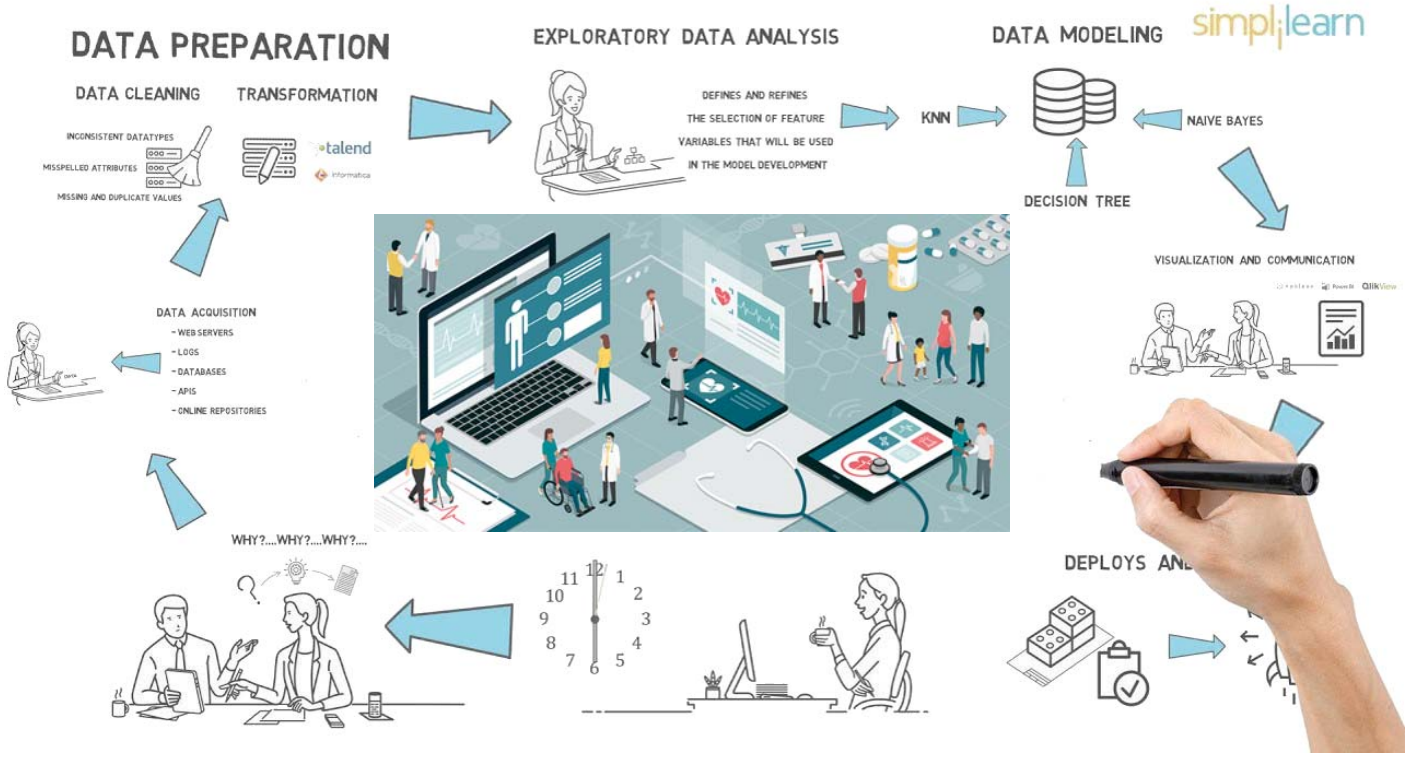
How Analytics is Connected to Data Science



Source: Simplilearn - https://www.youtube.com/watch?v=X3paOmcrTjQ

Types of Analytics

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Types of analytics according to the domain

- Marketing Analytics
- Financial Analytics
- Healthcare Analytics
- Sports Analytics
- HR Analytics
- Customer Analytics
- Web Analytics
- Social Analytics
- Cultural Analytics
- Political Analytics

Image Source: https://www.dreamstime.com/stock-photo-diverse-people-social-networking-concepts-image44309613

Types of Analytics

Types of analytics according to the type of data

- Text analytics
- Real-time data analytics
- Multimedia analytics
- Geo analytics
- Mobile analytics

Types of Analytics

Computational Tasks or "giants"

- The National Research Council characterized computational tasks for massive data analysis into seven groups (aka "giants")
- These groups include:
  - (1) Basis Statistics
  - (2) Generalized N-Body Problems
  - (3) Linear Algebraic Computations
  - (4) Graph-Theoretic Computations
  - (5) Optimization
  - (6) Integration and
  - (7) Alignment
- This grouping of computational tasks provides a taxonomy of tasks that is useful in analyzing data according to mathematical structure and computational strategy

Source: Big Data Analytics – A Hands-on Approach by Arshdeep Bahga & Vijay Madisetti

Types of Analytics

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Mapping between types of analytics and computational tasks or 'giants'

Descriptive Analytics
(What happened)
- Reports
- Alerts

Diagnostic Analytics
(Why did it happen)
- Queries
- Data Mining

Predictive Analytics
(What is likely to happen)
- Forecasts
- Simulations

Prescriptive Analytics
(What can we do make it happen)
- Reports
- Alerts

Basic Statistics	Generalized N-body problem	Linear Algebraic Computations	Graph Theoretic Computations	Optimization	Integration	Alignment Problems
▪ Mean ▪ Median ▪ Variance ▪ Counts ▪ Top-N ▪ Distinct	▪ Distances ▪ Kernels ▪ Similarity between pairs of points ▪ Nearest Neighbor ▪ Clustering ▪ Kernel SVM	▪ Linear Algebra ▪ Linear Regression ▪ PCA	▪ Graph Search Betweenness ▪ Centrality ▪ Commute distance ▪ Shortest Path ▪ Minimum Spanning Tree	▪ Minimization ▪ Maximization ▪ Linear Programming ▪ Quadratic Programming ▪ Gradient Descent	▪ Bayesian Inference ▪ Expectations ▪ Markov Chain Monte Carlo	▪ Matching between data sets (text, images, sequences) ▪ Hidden Markov Model

Source: Big Data Analytics – A Hands-on Approach by Arshdeep Bahga & Vijay Madisetti

Analytics Use Cases

Types of Analytics

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Analytics use cases

Industry process-specific use cases

Insurance
- Claim data extraction
- Claims management
- Regulatory compliance
- Risk evaluation
- Adjudication
- Match to issued policy

Healthcare & Life Sciences
- Automated diagnosis
- E2B transmission
- Prescription management
- Drug discovery
- Clinical documentation

Government & Non-Profit
- Disaster alerts
- Relief Management
- Traffic Management
- Weather forecasting
- Tax compliance

Financial Services
- Data extraction
- Data validation
- Breach identification
- Customer risk profiling
- Investment services

Banking
- Fraud detection
- Anti-money laundering
- Regulatory reporting
- Document extraction
- Payment reminders
- Real-time user authentication

Manufacturing
- Asset management
- Supply chain management
- Inventory management
- Energy management

Retain & CPG
- Distributed market place
- Food auditing
- Inventory control
- Loyalty programs
- Procurement optimization
- Supply chain traceability

Telecom & Media
- Network operations
- Fraud detection
- Predictive maintenance
- Customer service

Travel & Transportation
- Cargo management
- Travel recommendations
- Price forecasting
- Traffic congestion management
- Route rationalization

Utilities & Resources
- Load forecasting
- Demand management
- Predictive maintenance
- Energy trading
- Consumption insights & analysis

Source: https://avasant.com/report/intelligent-automation-use-cases/

Types of Analytics

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Analytics use cases

Enterprise process-specific use cases

Customer Service

- Customer enquiry routing
- Customer self-service support
- Customer feedback & Surveys

Finance & Accounting

- Order to cash
- Procure to pay
- Record to report
- Audit support
- Document review and analysis

Human Resources

- Resume screening
- Candidate profiling
- Performance management
- Employee virtual assistance

Marketing & Sales

- Price optimization
- Shelf audits
- Social media marketing
- Lead management
- Customer data management

Procurement

- Demand forecasting
- Payment processing
- Goods receipt and confirmation
- E-auctions
- Contract management

IT Process Specific use cases

IT Applications

- Application code generation
- Application configuration
- Application performance management
- Application self-healing
- Rapid prototyping
- Error detection and remedy management
- Release and deployment support
- Automatic code refactoring
- Test case generation
- Application development

IT Infrastructure & Operations

- Auto resolution of tickets
- Endpoint preemptive monitoring
- Autonomous cybersecurity
- Predictive analytics-led server management
- Predictive maintenance
- Threat detection
- log analysis
- Capacity planning
- Predictive infrastructure scaling
- Infrastructure cost management

Source: https://avasant.com/report/intelligent-automation-use-cases/

Types of Analytics

Applications – Descriptive Analytics

- Telecom company finding current trend of customers
- Online retail company finding number of site visits for tickets
- Healthcare provider learns how many patients were hospitalized last month
- Retailer – the average weekly sales volume
- Manufacturer – a rate of the products returned for a past month, etc.
- A placement agency – number of candidates being placed to top companies, candidates actually joining, candidates who accept but do not join etc.
- Consultancy firm – Doing salary analysis of different work streams, stages, industries

Source: Big Data Analytics – A Hands-on Approach by Arshdeep Bahga & Vijay Madisetti

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Predictive Analytics Case Study

Predictive Analytics – Case Study

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Predictive Policing – Seeing the crime before it happens

- Refers to the usage of mathematical, probabilistic, geospatial, and other analytical techniques in law enforcement to identify potential criminal activity
- This involves two aspects:
  - Applying advanced analytics to various data sets to predict a crime
  - Offer intervention (deploying resources in the areas where there is a potential for crime)
- Predictive policing falls into four categories
  - Predicting crimes
  - Predicting offenders
  - Predicting perpetrators' identities
  - Predicting victims of crime

Source: https://www.govtech.com/data/Role-of-Data-Analytics-in-Predictive-Policing.html

Predictive Analytics – Case Study

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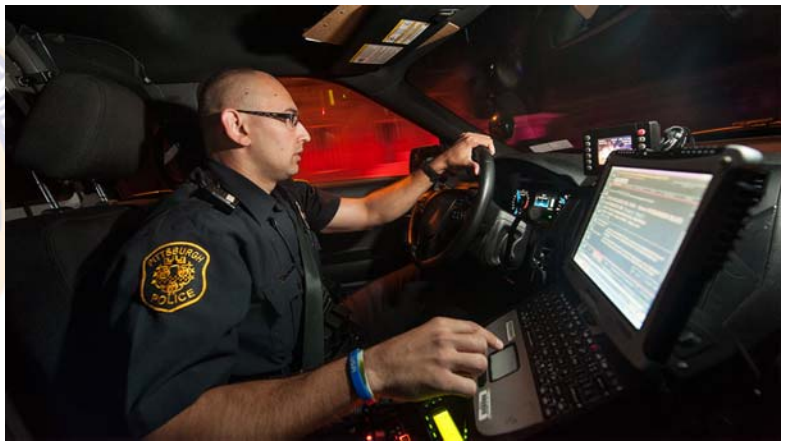
Predictive Policing – Seeing the crime before it happens

- At the start of each shift, crime data fed into the PredPol system provides officers with 15 different zones for four types of crime:
  - Auto theft, vehicle burglary, burglary and gang-related activity
- Each zone covers an area of 500 square feet



Source: https://www.govtech.com/data/Role-of-Data-Analytics-in-Predictive-Policing.html

Predictive Analytics – Case Study

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Predictive Policing – PredPol algorithm

- PredPol uses a machine-learning algorithm to make its predictions
- Historical event datasets are used to train the algorithm for each new city (ideally 2 to 5 years of data)
- It then updates the algorithm each day with new events as they are received from the department
- This new information comes from the agency's records management system (RMS).
- PredPol uses ONLY 3 data points – crime type, crime location, and crime date/time – to create its predictions
- No personally identifiable information is ever used
- No demographic, ethnic or socio-economic information is ever used
- This eliminates the possibility for privacy or civil rights violations seen with other intelligence-led policing models
- Predictions are displayed as red boxes (covering 150 x 150 sq mts) on a web interface via Google Maps
- The boxes represent the highest-risk areas for each day and for the corresponding shift: day, swing or night shift
- Officers are instructed to spend roughly 10% their shift time patrolling PredPol boxes

Source: https://www.govtech.com/data/Role-of-Data-Analytics-in-Predictive-Policing.html

Predictive Analytics – Case Study

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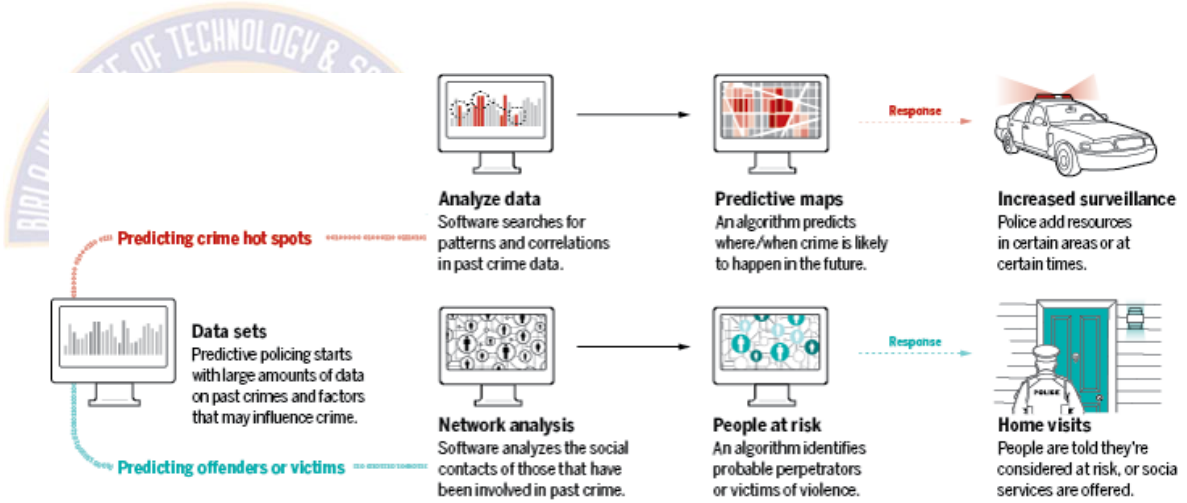
Predictive Policing – Predicting crime hot spots

- Descriptive and Diagnostic Analytics
  - Software searches for patterns and correlations in past crime data
- Predictive Analytics
  - Algorithm predicts when/where crime is likely to happen in the future
- Response
  - Police deploy resources in certain areas at certain times



Source: https://www.sciencemag.org/news/2016/09/can-predictive-policing-prevent-crime-it-happens

Predictive Analytics – Case Study

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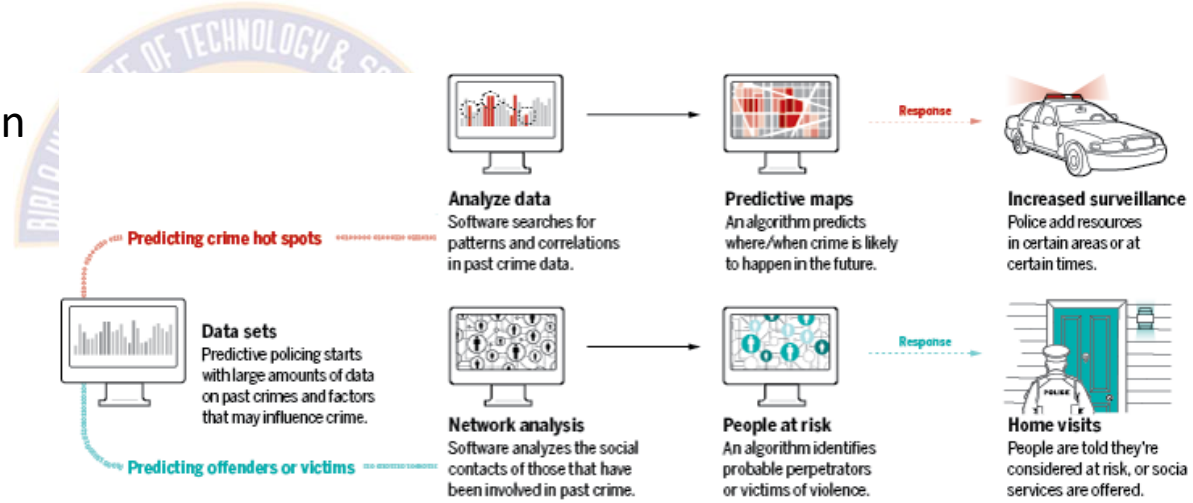
Predictive Policing – Predicting crime hot spots

- Descriptive and Diagnostic Analytics
  - Software analyzes the social contacts of those that have been involved in the past
- Predictive Analytics
  - Algorithm identifies probable perpetrators or victims of violence
- Response
  - People are told they're considered at risk, or social services are offered



Source: https://www.sciencemag.org/news/2016/09/can-predictive-policing-prevent-crime-it-happens

Predictive Analytics – Case Study

Predictive Policing

- Science Behind the News: Predictive Policing
  - https://www.youtube.com/watch?v=74_jreara3w

Healthcare Case Study

Healthcare Analytics – Case Study

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Healthcare Practices

- Private Practice
- Group Practice
- Large HMOs
- Hospital Based
- Locum Tenens

Source: https://www.micromd.com/blogmd/5-types-medical-practices/
Image Source: https://technologyadvice.com/blog/healthcare/best-medical-practice-management-software/

Healthcare Analytics – Case Study

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Healthcare Practice

- Private Practice
  - A physician practices alone without any partners and typically with minimal support staff
  - Ideally works for physicians who wish to own and manage their own practice
  - Benefits
    - Individual freedom, closer relationships with patients, and the ability to set their own practice's growth pattern
  - Drawback
    - Longer work hours, financial extremes, and a greater amount of business risk.

Source: https://www.micromd.com/blogmd/5-types-medical-practices/
Image Source: https://www.mediqfinancial.com.au/blog/the-essential-guide-to-starting-your-own-medical-practice/

Healthcare Analytics – Case Study

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Healthcare Practice

- Group Practice
  - A group practice involves two or more physicians who all provide medical care within the same facility
  - They utilize the same personnel and divide the income in a manner previously agreed upon by the group
  - Group practices may consist of providers from a single specialty or multiple specialties
  - Benefits
    - Shorter work hours, built-in on-call coverage, and access to more working capital
    - All of these factors can lead to less stress
  - Drawback
    - Less individual freedom, limits on the ability to rapidly grow income, and the need for a consensus on business decisions.

Source: https://www.micromd.com/blogmd/5-types-medical-practices/
Image source: https://www.physicianleaders.org/news/selling-medical-practice-you-need-exit-strategy

Healthcare Analytics – Case Study

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Healthcare Practice

- Large HMOs (Health Maintenance Organizations)
  - HMO, employs providers to care for their members and beneficiaries
  - The goal of HMOS is to decrease medical costs for those consumers
  - There are two main types of HMOs
    - The prepaid group practice model and the medical care foundation (MCF), also called individual practice association.
  - Benefits
    - More stable work life and regular hours for providers (physicians)
    - Less paperwork and regulatory responsibilities and a regular salary along with bonus opportunities
    - These bonuses are based on productivity or patient satisfaction
  - Drawback
    - The main drawback for physicians working for an HMO is the lack of autonomy
    - HMO's required physicians to follow their guidelines in providing care.
  - Examples:
    - The Kaiser Foundation Health Plan in California
    - The Health Insurance Plan of Greater New York
    - Group Health Cooperative of Puget Sound

Source: https://www.micromd.com/blogmd/5-types-medical-practices/

Healthcare Analytics – Case Study

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Healthcare Practice

- Hospital Based
  - In hospital based work, physicians earn a predictable income, have a regular patient base, and a solid referral network
  - Physicians who are employed by a hospital will either work in a hospital-owned practice or in a department of the hospital itself
  - Benefits
    - A regular work schedule, low to no business and legal risk, and a steady flow of income
  - Drawback
    - Lack of physician autonomy
    - Employee constraints and the expectation that physicians become involved in hospital committee work

Source: https://www.micromd.com/blogmd/5-types-medical-practices/

Healthcare Analytics – Case Study

Healthcare Practice

- Locum Tenens
  - Locum tenens is derived from the Latin phrase for "to hold the place of."
  - In locum tenens, physicians re-home to areas hurting for healthcare professionals
  - These types of positions offer temporary employment and may offer higher pay than more permanent employment situations
  - Benefits
    - Physicians working in locum tenens scenarios enjoy the benefits of variety and the ability to experience numerous types of practices and geographic locations
    - They also enjoy schedule flexibility and lower living costs
  - Drawback
    - The possibility that benefits are not included, and a potential lack of steady work
    - Physicians need to regularly uproot their families

Source: https://www.micromd.com/blogmd/5-types-medical-practices/

Healthcare Analytics – Case Study

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Healthcare Scenario – Sources of Data

- Common sources of practice data existing within the practice:
  - Revenue Cycle Management System (billing for a procedure, processing denials, collecting payments)
  - Electronic Health Records (EHRs) (provides services to a patient)
  - Scheduling & Information System (schedules an appointment)
  - Survey Results
  - Peer Review System
  - Other sources
- Analytics provides a platform to convert that data into actionable information for the practice
- As reimbursement shifts to a value-based care model, it is critical to have insight into both clinical and business metrics to prepare for the future

Source: https://integratedmp.com/healthcare-practice-analytics-101-numbers-charts-dashboards-oh-my/

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Healthcare Scenario – Integrated Medical Partners (IMP)

- https://www.youtube.com/watch?v=olpuyn6kemg
- IMP
  - Primarily offers
    - Revenue Cycle Management (RCM) and Advanced Analytics among others
  - Helps maximize collections for independent physician practices
  - Provides practice performance analytics
  - Offers tailored solutions to partner with physicians and hospitals so that they can
    - Improve patient care, enhanced compliance, operational efficiency, and increase profitability

Source: https://integratedmp.com/healthcare-practice-analytics-101-numbers-charts-dashboards-oh-my/

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Healthcare Scenario – Denial of Claims

- Consider that the healthcare practice has seen an increase in denied claims over the past several months
- Increased denials impact negatively on the financial performance of the organization
- Therefore, the company needs tools to help identify and resolve the root cause of the denials
  - This trend needs to be reversed as soon as possible, but how?
- The different types of analytics provide necessary insights into the data and the cause of the denial increase

Source: https://integratedmp.com/4-key-healthcare-analytics-sources-is-your-practice-using-them/

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Healthcare Scenario – Descriptive Analytics

- Descriptive – *what happened?*
  - Descriptive analytics will tell you what is happening in the practice
  - In this example, there has been an increase in the number of denied claims over the past several months
  - Further research identifying a trend revealed that the increase in denials is specific to a *particular denial code*
  - What is this denial code?
    - This denial code is for a referring provider (doctor) who is not enrolled in the Medicare Provider Enrollment, Chain, and Ownership System (PECOS).
- Now, the question is why this provider is not enrolled in PECOS?

Source: https://integratedmp.com/4-key-healthcare-analytics-sources-is-your-practice-using-them/

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Healthcare Scenario – Diagnostic Analytics

- Diagnostic – *why did it happen?*
  - The descriptive analytics has identified an increase in denials specific to a referring provider
  - The next step is to diagnose to understand why this change occurred
    - Identify why the referring provider is not enrolled in PECOS
  - So, we utilize diagnostic analytics to understand why this change occurred
  - Looking for changes in referring provider patterns at the time the increase in PECOS denials began would help to identify *new referring providers*
  - It will also identify whether these new referring providers are enrolled in PECOS
  - For the purpose of this example, assume we identify one referring provider who is new to referring to your practice that is not enrolled in PECOS.

Source: https://integratedmp.com/4-key-healthcare-analytics-sources-is-your-practice-using-them/

Healthcare Analytics – Case Study

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Healthcare Scenario – Predictive Analytics

- Predictive – what will happen?
  - Predictive Analytics allows us to learn from historical trends to predict what will happen in the future
  - Utilizing descriptive and diagnostic analytics, we can determine the historical referral pattern of the new referring provider not enrolled in PECOS
  - Assuming this provider remains not enrolled in PECOS and refers a steady stream of patients to the organization
    - predictive analytics will tell us the expected denials associated with these claims
  - The resulting impact of this situation is identified

Source: https://integratedmp.com/4-key-healthcare-analytics-sources-is-your-practice-using-them/

Healthcare Analytics – Case Study

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Healthcare Scenario – Prescriptive Analytics

- Prescriptive – what should I do?
  - Prescriptive Analytics assists in determining the best course of action from the information gathered from descriptive, diagnostic and predictive analytics
  - In this scenario, the best course of action would be to contact the new referring provider, express appreciation for the new referrals, but also evidence that the provider's referrals are resulting in denied claims due to PECOS enrollment
  - By working with this provider to become enrolled in PECOS, denied claims can now be rebilled
  - In addition, future claims are less likely to be denied due to the provider not being certified/eligible to be paid for the procedure/service on the claim date of service
  - The key to prescriptive analytics is implementing a solution that will prevent the same breakdown from occurring again in the future
  - By reducing the likelihood of claim denials, the overall financial health of the physician practice benefits

Source: https://integratedmp.com/4-key-healthcare-analytics-sources-is-your-practice-using-them/

Analytics Maturity Models

Types of Analytics

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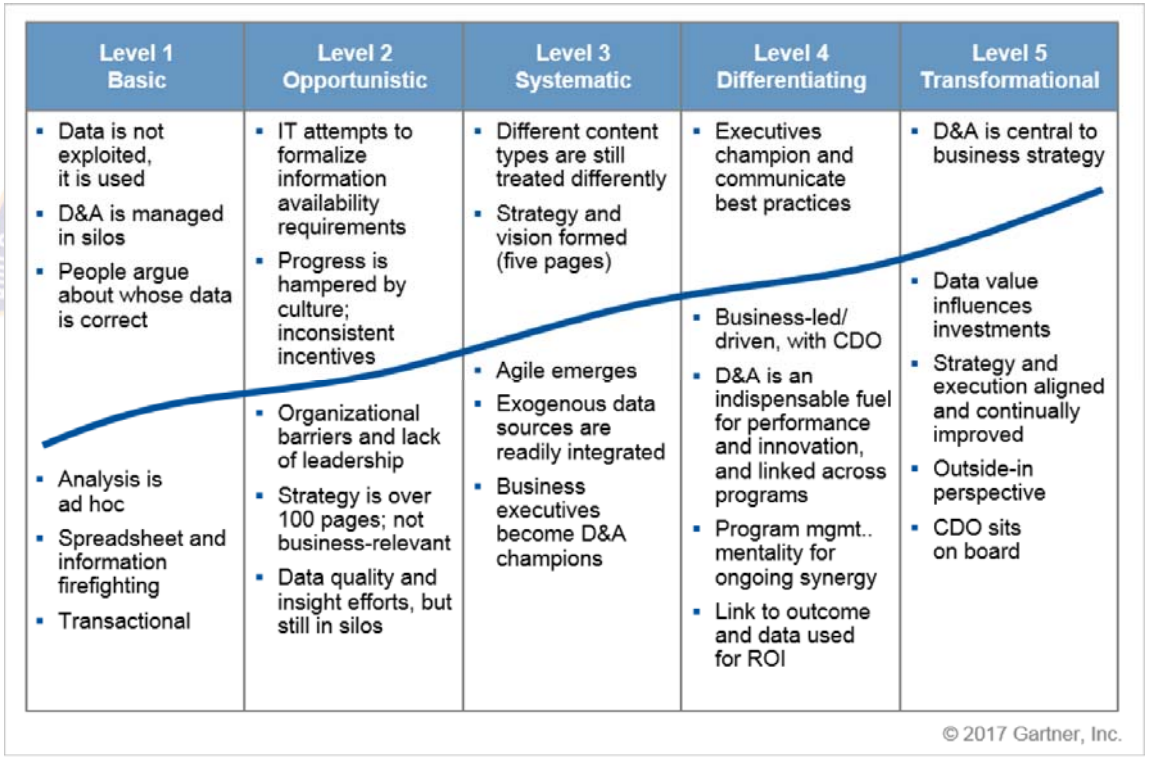
Gartner Maturity Model for Data and Analytics

- D&A – Data and Analytics
- CDO – Chief Data Officer
- ROI – Return on Investment
- *Outside-in approach* is guided by the belief that customer value creation is the key to success
- *Inside-out approach* is guided by the belief that the inner strengths and capabilities of the organization will produce a sustainable future
- Synergy: the combined power of a group of things when they are working together that is greater than the total power achieved by each working separately



Source: Streaming Change Data Capture by Dan Potter; Itamar Ankorion; Kevin Petrie - O'Reilly Media, Inc., 2018

Types of Analytics

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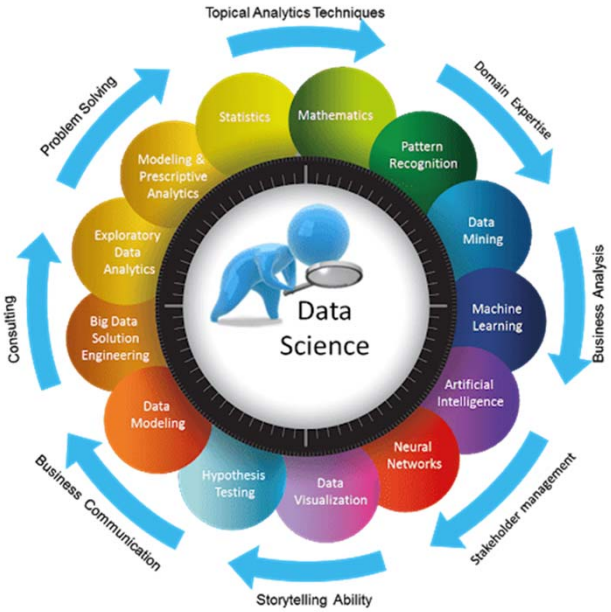
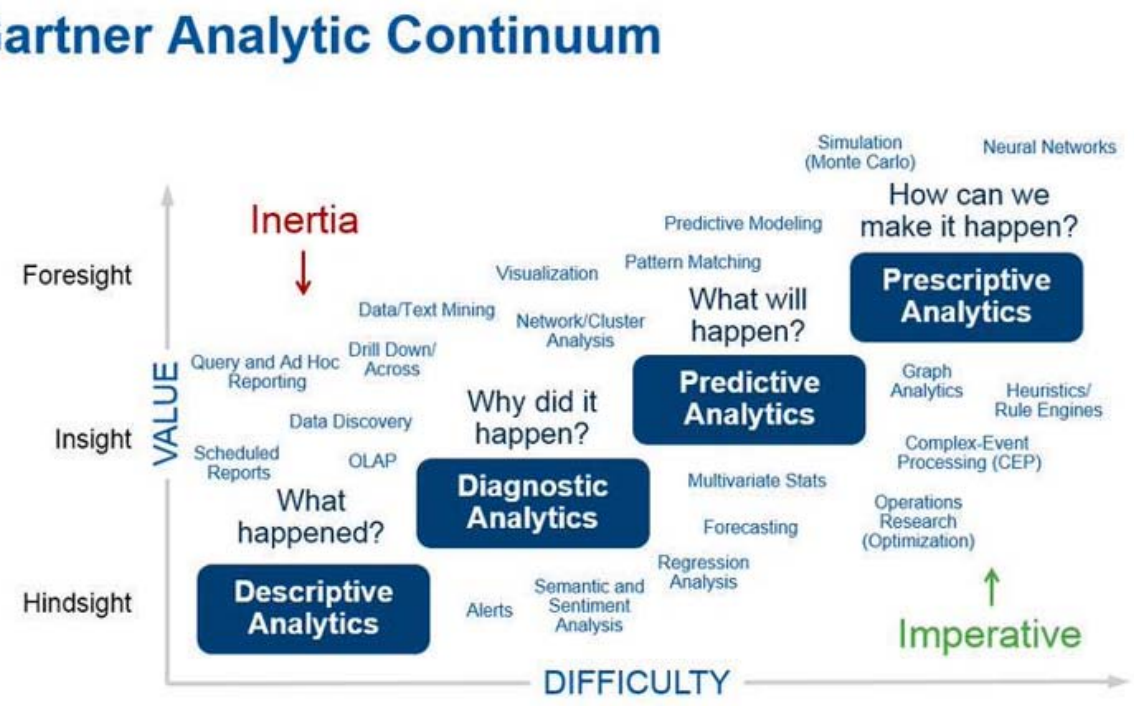
Analytics Maturity Vs. Value





Source: Gartner
Source: http://www.verival.com/DataScience

Types of Analytics

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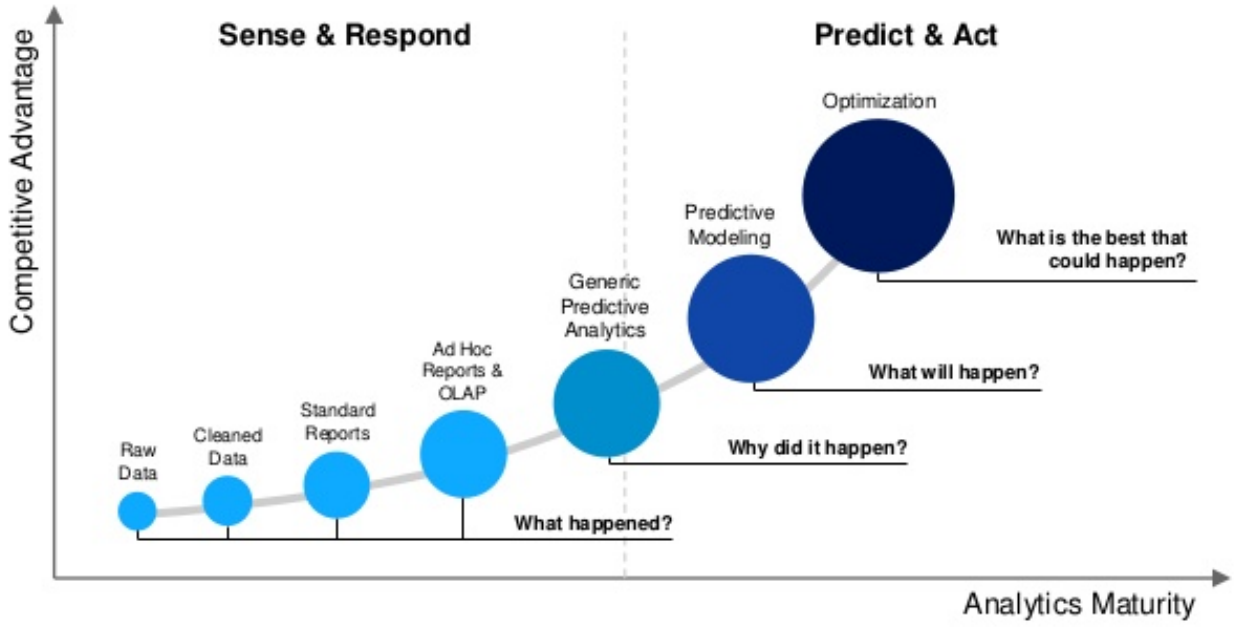
Analytics Maturity Vs. Competitive Advantage

- The model shows varying stages of a company, its level of analytics needs, and how organizations can grow and move up to the next level of analytical maturity.
- By learning how to apply these concepts to your organization, you'll empower your teams and yourself with the framework to drive action at the right level for the stage you're at
- The concept of transforming raw data into prescriptive analytics is easily digestible in each of these graphics.



Source: https://www.jirav.com/blog/data-analytics-maturity-models

Types of Analytics

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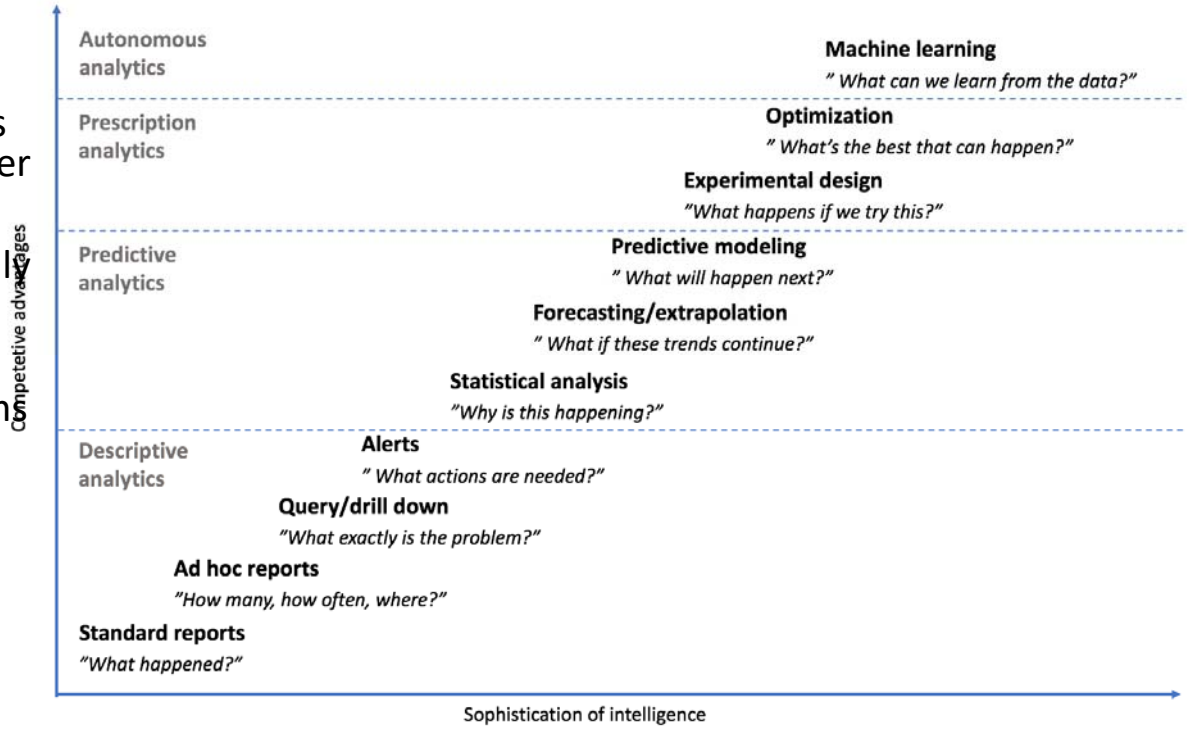
Competing on Analytics

- Potential competitive advantage increase with more sophisticated analytics
- Companies in the bottom third of this figure should be trying to move further up it
- Business Intelligence (BI) tools typically cover descriptive analytics
- Moving towards predictive analytics can enable companies to see problems before they arise
- Prescriptive analysis then helps to specify the actions an organization should carry out
- Autonomous analytics can power decisions without human interaction



Source: Competing on Analytics: The new science of winning by Thomas H. Davenport and Jeanne G. Harris

Types of Analytics

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Competing on Analytics

- Without human interaction may sound scary as jobs may be affected but the fact is that it increases productivity and more time can be spent innovating rather than investing in a manual process
  - Google search is a good example.
- Not all organizations need to be at the autonomous analysis stage – but all need to be moving away from the bottom of the chart.

Analytics Maturity Model

stylumia

	Level 1 Analytically Impaired	Level 2 Localized Analytics	Level 3 Analytics Aspirations	Level 4 Analytical Company	Level 5 Analytical Competitor
Data	Inconsistent, poor quality	Usable in functional silos	Beginning to create centralized repositories	Integrated data warehouse	Relentless search for new data & metrics
Enterprise	NA	Siloes of data, tech. and talent	Early stages of enterprise-wide approach	Key data, tech. and analysts are centralized	All key analytical resources centrally managed
Leadership	No awareness or interest	Only at functional or process level	Begins to recognize importance of analytics	Support for analytical component	Strong passion for analytics
Targets	NA	disconnected	Efforts aligned to small set of targets	Centered on few key domains	Supports overall strategic objectives
Analysts	Few skills in specific functions	Few isolated analysts	Influx of analysts in key target areas	Specialized analysts in central organization	Mix of analytics experts and amateurs

source: Competing on Analytics, Thomas Davenport

Source: Competing on Analytics: The new science of winning by Thomas H. Davenport and Jeanne G. Harris

Types of Analytics

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Competing on Analytics

FUNCTION	DESCRIPTION	EXEMPLARS
Supply chain	Simulate and optimize supply chain flows; reduce inventory and stock-outs.	Dell, Wal-Mart, Amazon
Customer selection, loyalty, and service	Identify customers with the greatest profit potential; increase likelihood that they will want the product or service offering; retain their loyalty.	Harrah's, Capital One, Barclays
Pricing	Identify the price that will maximize yield, or profit.	Progressive, Marriott
Human capital	Select the best employees for particular tasks or jobs, at particular compensation levels.	New England Patriots, Oakland A's, Boston Red Sox
Product and service quality	Detect quality problems early and minimize them.	Honda, Intel
Financial performance	Better understand the drivers of financial performance and the effects of nonfinancial factors.	MCI, Verizon
Research and development	Improve quality, efficacy, and, where applicable, safety of products and services.	Novartis, Amazon, Yahoo

Source: HBR: Competing on Analytics: by Thomas H. Davenport and Jeanne G. Harris

Skills & Tools for Analytics

Skills Required for Analytics

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Technical & Business Skills

- Technical skills for data analytics:
  - Packages and Statistical methods
  - BI Platform and Data Warehousing
  - Base design of data
  - Data Visualization and munging
  - Reporting methods
  - Knowledge of Hadoop and MapReduce
  - Data Mining
- Business Skills Data analytics:
  - Effective communication skills
  - Creative thinking
  - Industry knowledge
  - Analytic problem solving

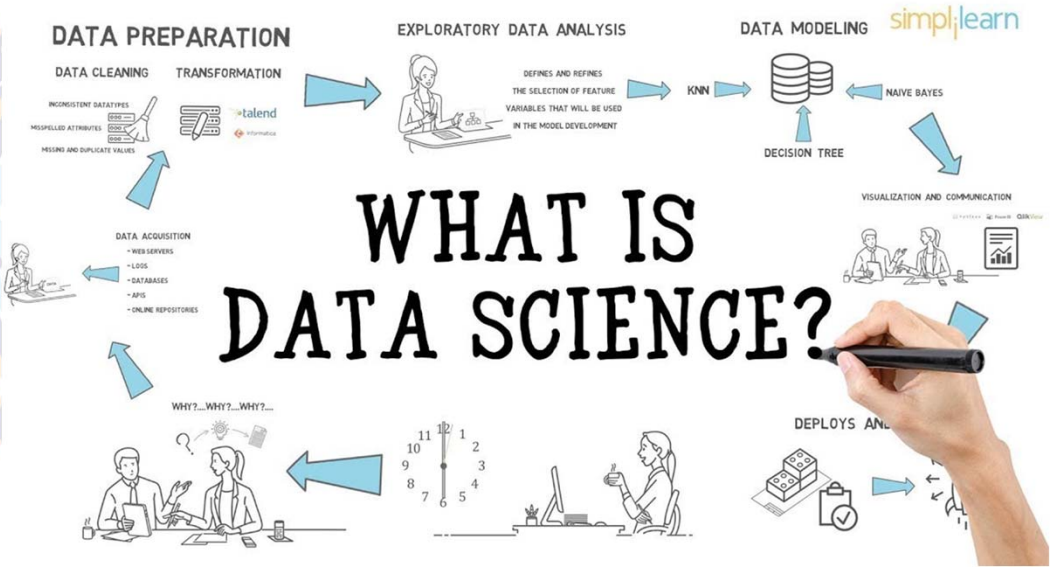

Image Source: Simplilearn - https://www.youtube.com/watch?v=X3paOmcrTjQ

Tools in Analytics

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Commercial & Open Sources Tools

- Commercial
  - SAS
  - WPS
  - MS Excel
  - Tableau
  - Pentaho
  - Statistica
  - Qlikview
  - KISSmetrics
  - WeKa
  - BigML
  - RapidMiner
- Free Tools
  - R Programming
  - Google Analytics
  - Python
  - Spotfire
  - Anaconda Jupyter
  - Apache Spark


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Thank You!