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Continuous Fraud Monitoring and Detection via Advanced Analytics

State-of-the-Art Trends and Directions

2014 ACFE European FRAUD CONFERENCE

Hilton Amsterdam

Apollolaan 138, 1077 BG

Amsterdam, The Netherlands

Monday, March 24th 2014

ACFE 25 YEARS
Association of Certified Fraud Examiners
Together, Reducing Fraud Worldwide

MONDAY, 24 MARCH — Main Conference

13:40-15:00 **Concurrent Sessions**

4A: Continuous Fraud Monitoring and Detection via Advanced Analytics

Scott Mongeau, Ph.D.
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The Netherlands
Deloitte.

Level: Intermediate
Prerequisite: An understanding of data analytics as it relates to fraud detection and examination
Field of Study: Auditing

- Understand continuous fraud monitoring and detection as an integrated people, processes and systems solution
- Grasp analytics-driven fraud detection and mitigation as a process of cyclical improvement
- List the key advanced analytics fraud detection approaches
- Situate self-improving advanced analytics as a game-changing value driver
- See a targeted example of self-improving analytics applied to fraud detection

Learning Objectives

ANALYTICS

- Describe analytics
- Understand the limits of analytics

FRAUD ANALYTICS

- Fraud analytics as an integrated process
- Fraud analytics at industrial scale

TRENDS

- Diagnostics and network analytics
- Issues and problems of analytics

Speaker Background

Scott Mongeau

Analytics Manager
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Experience

- **Deloitte Nederland**
  Manager Analytics
- **Nyenrode**
  Lecturer, Business Decision Making
- **SARK7**
  Owner / Principal Consultant
- **Genentech Inc.**
  Web Manager / Financial Analyst / Enterprise Architect
- **Atradius**
  Web Analytics Manager
- **CFSI**
  CIO
- **Consulting Programmer**

Education

- **PhD (ABD)**
  Nyenrode Business University
- **MBA**
  Erasmus Rotterdam School of Management (RSM)
- **MA Financial Management**
  Erasmus RSM
- **Certificate Finance**
  University of California Berkeley
- **Grad Degree Info Sys Mgmt**
  Royal Melbourne Institute of Tech (RMIT)
- **MA Communications**
  University of Texas
- **B Phil**
  Miami University of Ohio

Continuous Fraud Monitoring and Detection via Advanced Analytics

State-of-the-Art Trends and Directions

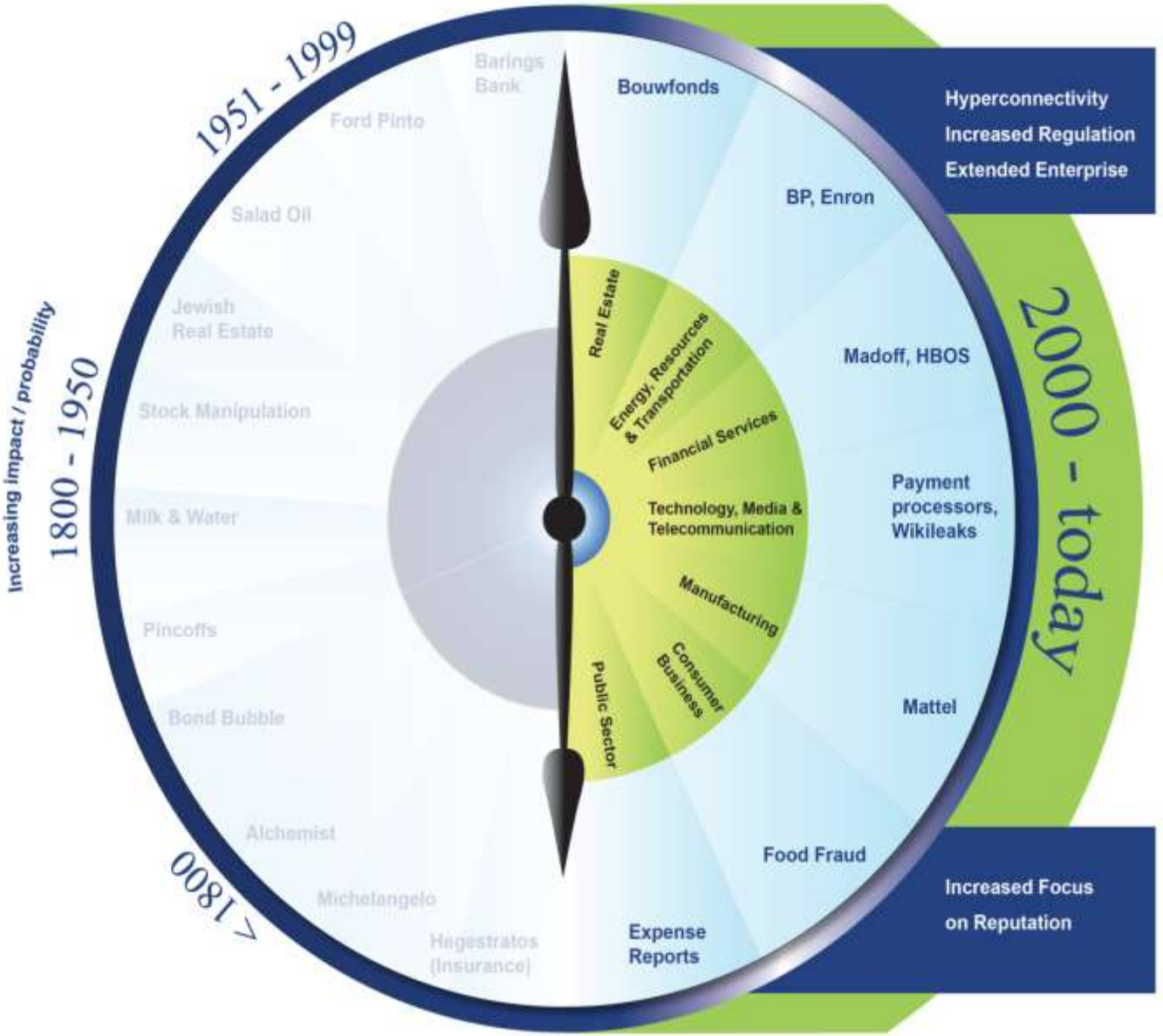
1	Fraud in context
2	Advanced analytics
3	Fraud analytics
4	Trends and directions
5	Practice approach

I. Fraud in context

Spotlight on fraud

As a though leader in the fraud analytics domain, Deloitte delivers data-driven solutions to detect and mitigate fraud, corruption, and business risk issues

Continuously evolving and increasingly sophisticated



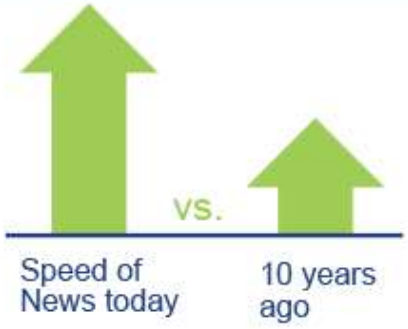
Financial Crime Factsheet

5% x Annual = Loss from Fraud

$2.9 Trillion Worldwide

66% Survey takers

Believe that the industry will never be able to get cybercrime under control



Increased Scrutiny by regulators & the public

Reputation offline vs. online

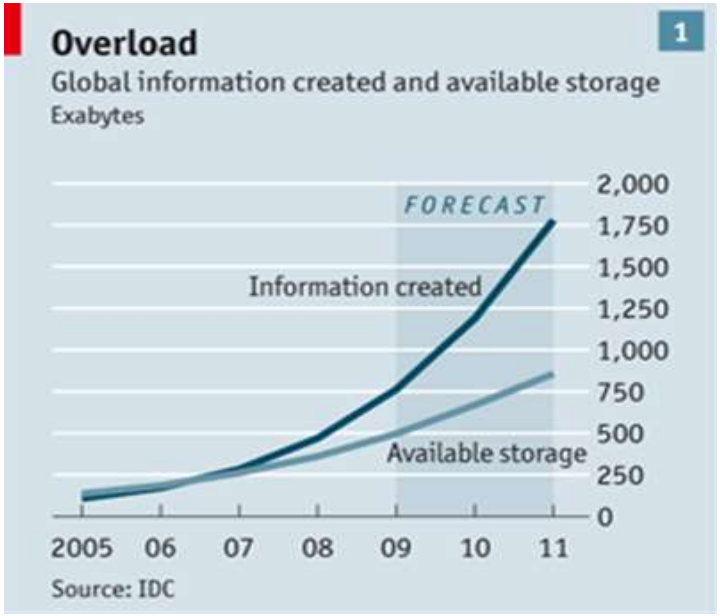
Financial crime impacts reputation

Business challenges which make Analytics a hot topic

External and internal pressures have increased severely

Data Trends

A recent report by the Economist highlights that data-assets continue to grow exponentially



The Economist. Data, data everywhere. Feb 25th 2010

External and Internal Drivers

A recent Kennedy Report indicates that a variety of internal and external industry drivers are pushing our clients to embrace Analytics

Top internal and external industry factors contributing to adoption:

External

1. External competitive pressure
2. Increased regulatory pressure
3. Technology advancement

Internal

1. Data proliferation and growth
2. Increasing sophistication of users
3. Maturation of ERP systems

- 'Business Intelligence' and 'Analytics' features as number one 'spending priority for CIOs in 2012', as per a worldwide survey of 2300 CIOs by **Gartner** executive program
- According to **Gartner**, next generation Analytics and Big Data (BD) features among the 'Top ten technology trend in 2012'
- According to Analyst firm, **Ovum**, Big Data will be among the most significant drivers of technological change in 2012
- According to **Deloitte**, by the end of 2012, more than 90% of fortune 500 companies will have some Big Data initiative

Fraud: External

External Fraud

- **Credit Application Fraud** related to credit (card, mortgage, personal loan) fraud
- **Online Fraud** related to electronic channels
- **Transactional Fraud** related to card (credit/ debit) or payments fraud
- **Claims Fraud** related to insurance claims settlement
- **Other industry-specific frauds** (commission fraud, …)

Fraud: Internal

- **Assets misappropriation**

  Perpetrator steals or misuses an organization's (e.g. false invoicing, payroll fraud,…) resources.

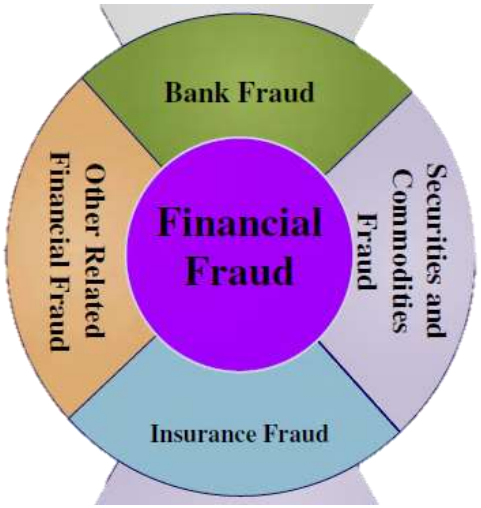
- **Corruption**

  Fraudsters use their influence in business transactions in a way that violates their duty to their employers in order to obtain a benefit for themselves or someone else (conflict of interest, cash extortion, collusion…)

- **Fraudulent statements**

  Intentional misstatement or omission of material information from organization's financial reports - "cooking the books".

Financial crime categories



Bank Fraud

- Account takeover
- Identity theft
- Loan and mortgage application fraud
- Credit card / debit card

Securities & Commodities Fraud

- Collaborative crime
- Incentive architectural weaknesses

Insurance Fraud

- Systemic fraud
- Endemic fraud
- Medial / healthcare fraud

Corporate / Mass-Market Fraud

- Falsification of financial information
- Self-dealing by insiders
- Obstruction of justice and concealment
- Criminality

Public Sector

- Tax fraud
- Money laundering
- Forgery and counterfeiting

* E.W.T. Ngai, Yong Hu, Y.H. Wong, Yijun Chen, Xin Sun, The application of data mining techniques in financial fraud detection, Decision Support Systems, Volume 50, Issue 3, February 2011, Pages 559-569.

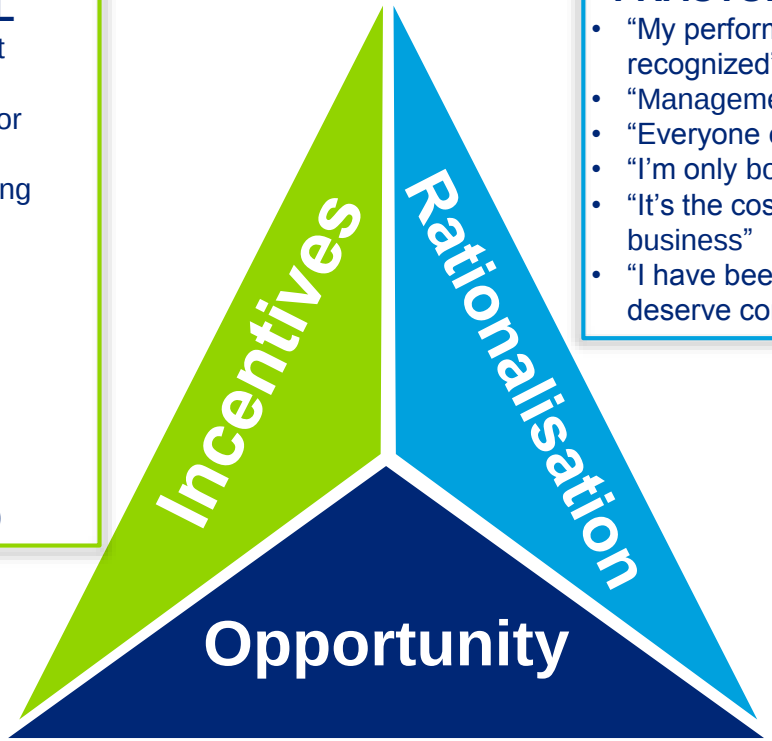
Fraud risk assessment

Why does financial crime occur?

At scale, financial crime WILL occur with statistical regularity if the right combination of elements are present.

TRANSACTIONAL
- Expectations to meet (financial) targets
- Hide failing projects or contracts
- Need for new financing

PERSONAL
- Financial problems
- Extravagant life style
- Addictions (drug or gambling habits)
- Greed or revenge
- Character flaws (i.e. sociopathic disorder)



FRACTURED LOGIC...
- "My performance isn't recognized"
- "Management doesn't care"
- "Everyone else is does it"
- "I'm only borrowing"
- "It's the cost of doing business"
- "I have been mistreated and deserve compensation"

SYSTEMIC WEAKNESSES
- Lack of oversight
- Conflict
- Implementation of new accounting software
- High volume transactions (easy hiding)
- New & complex products
- Grey areas in the rules
- Ineffective internal controls

Value Proposition

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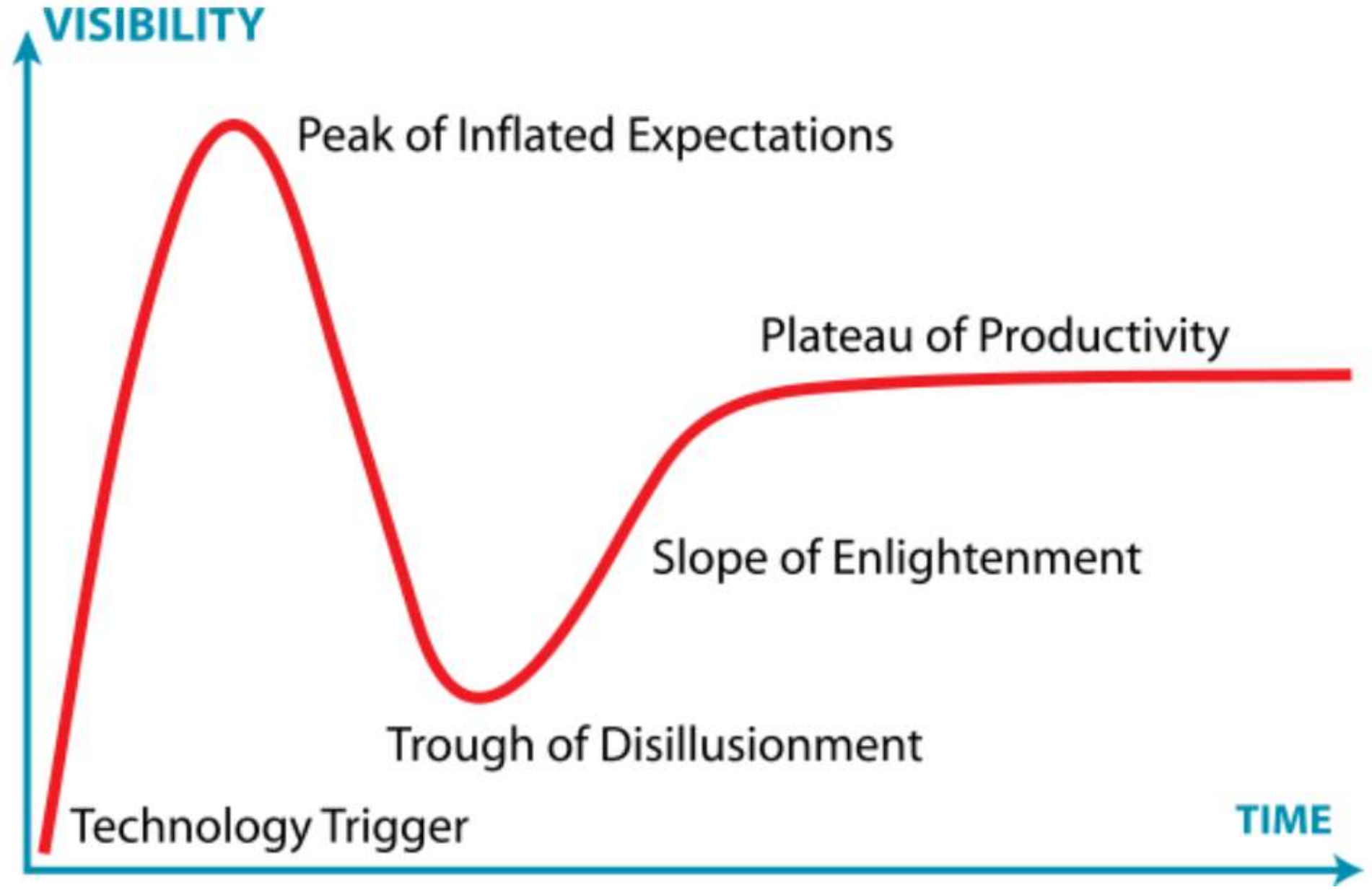
II. Advanced analytics

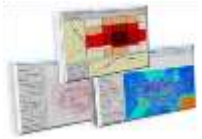
Advanced Analytics

Deloitte offers powerful advanced analytics solutions by integrating people, processes, and technology perspectives.



Business challenges which make Analytics a hot topic

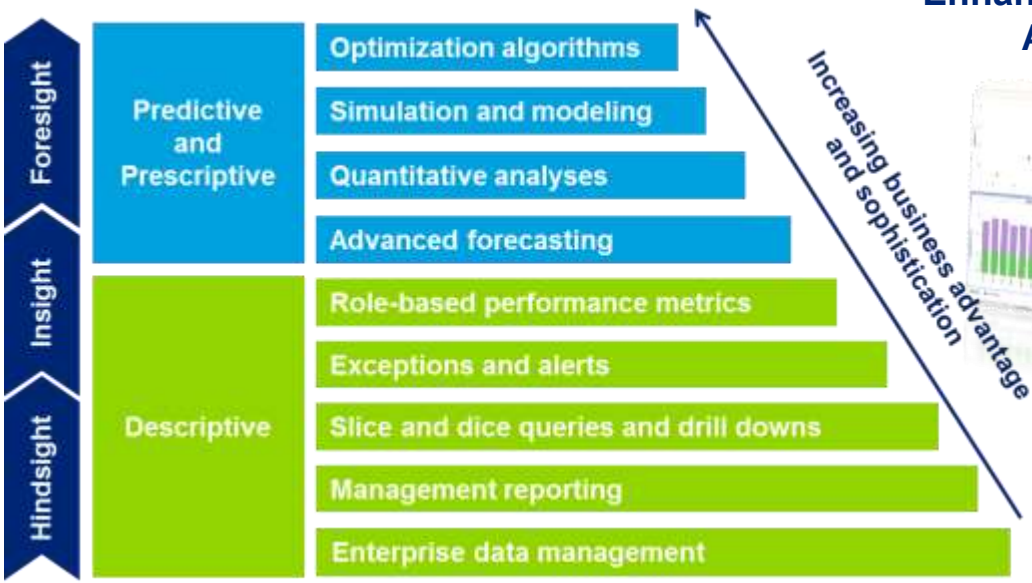
Mega-trends changing the landscape around decision making

	**Profitable Growth** - The need to remain competitive compels investment in Analytics and the tools to improve insight into financial, economic, environmental and market information. The goal? - **more informed and responsive decisions.**
	**Regulations** – Regulators are demanding deeper insight into risk, exposure, and public responsiveness from financial, health care, and many other sectors requiring integrated data across the enterprise.
	**Hidden Insight** - The growing complexity of global business has raised the stakes at all levels of decision-making. Facing more information than humans can possibly process, decision makers need more powerful tools for uncovering hidden patterns that may go undetected.
	**New Signals** - Holistic signal detection from traditional internal and external structured and unstructured data plus voice, e-mails, social networks, sensor enabled facilities, products, instruments must be integrated and monitored for real time operational insight and decision-making.
	**Data Volumes, Velocity and Variety** – Global data volumes continue to grow exponentially. New data sources, including social media and other “big data” types, provide an opportunity to gain additional insight and drive a need for new IT strategies, processes and tools.
	**Technology** - Both a significant driver and important enabler. Rise of social computing, mobility, cloud and in-memory computing require new approaches. The good news, today’s computing capacity and analytical tools can meet the challenges.

Business challenges which make Analytics a hot topic

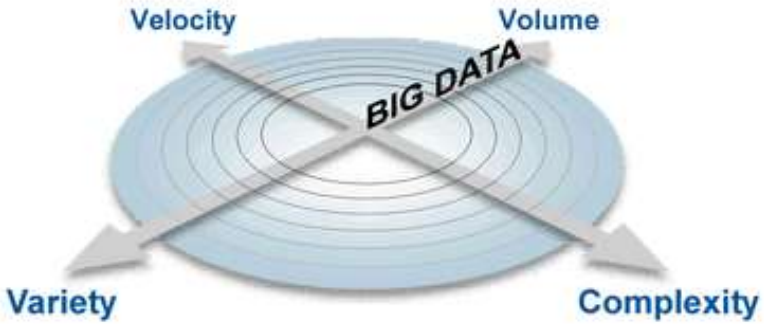
Enterprise, Social, Mobile Data Mash-up

Dimensions of Analytics



Enhanced "What if" Analysis

Interactive Graphics and Dashboards



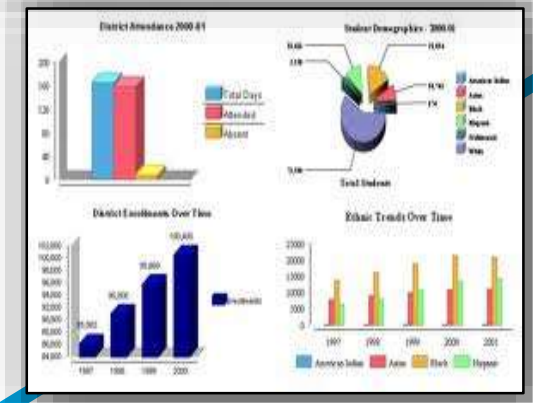
"Real-time" Reporting

SOPHISTICATION

VALUE

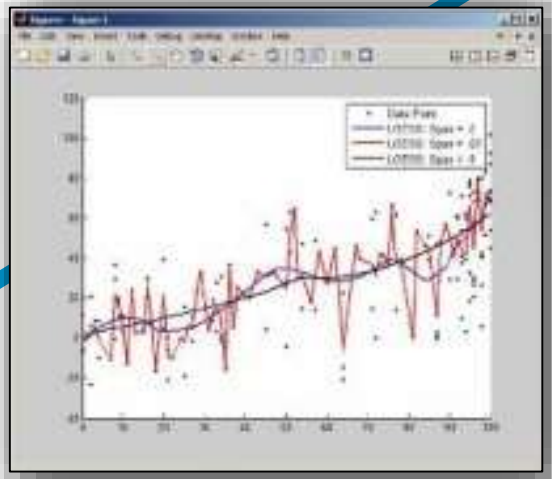
What happened?

DESCRIPTIVE



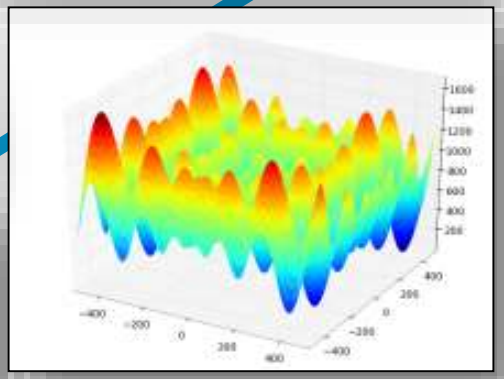
What are trends?

PREDICTIVE



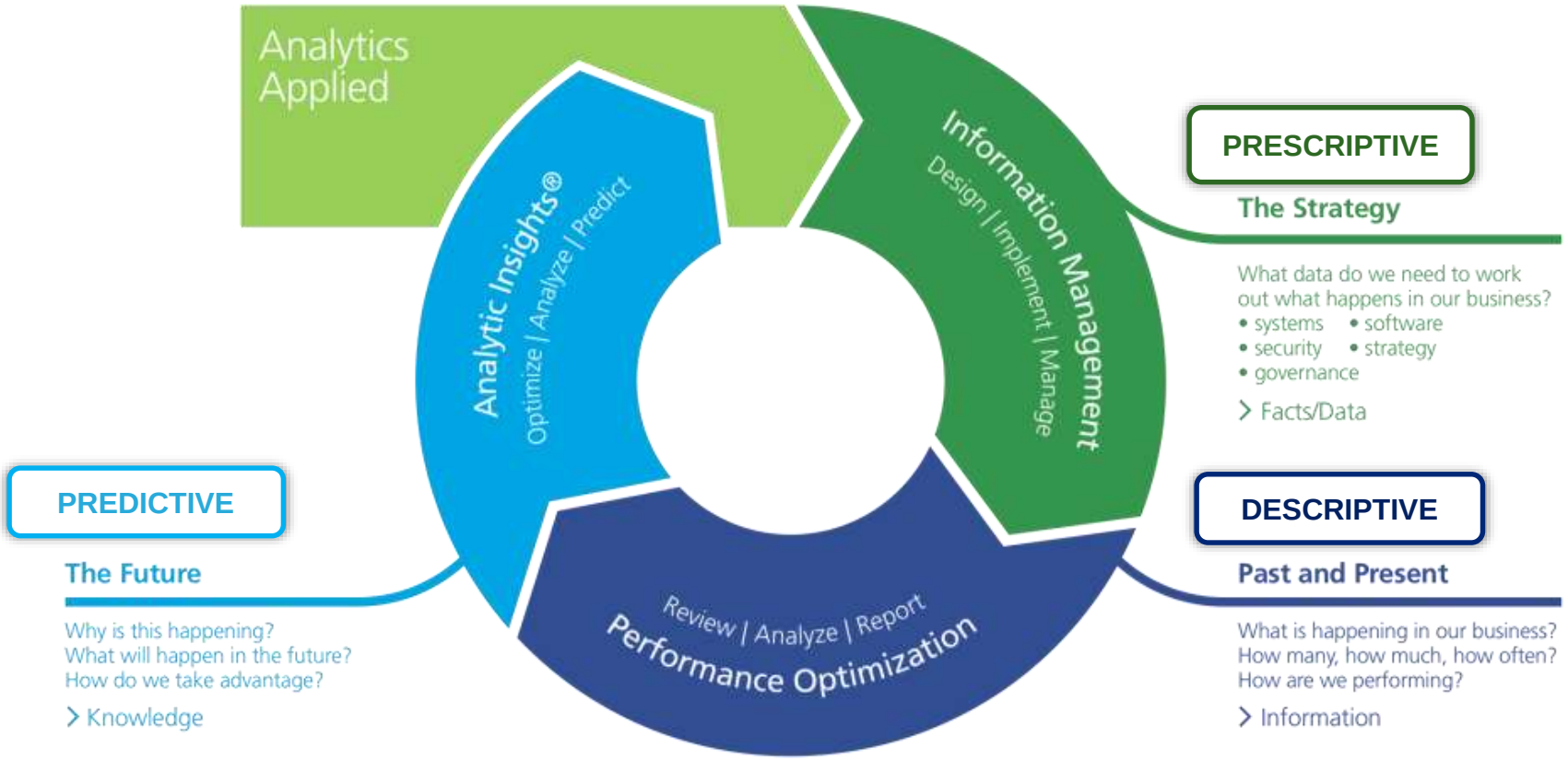
What to do?

PRESCRIPTIVE



Analytics as a process

Making smarter decisions



SOPHISTICATION

VALUE

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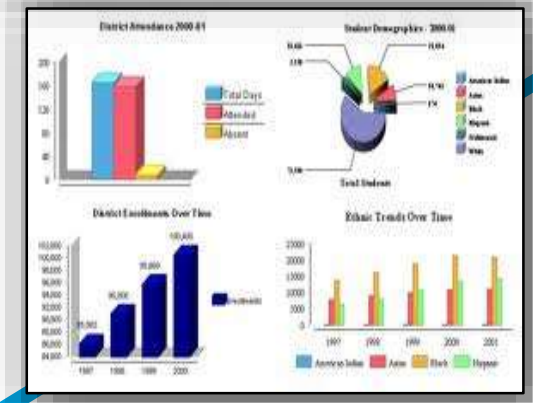

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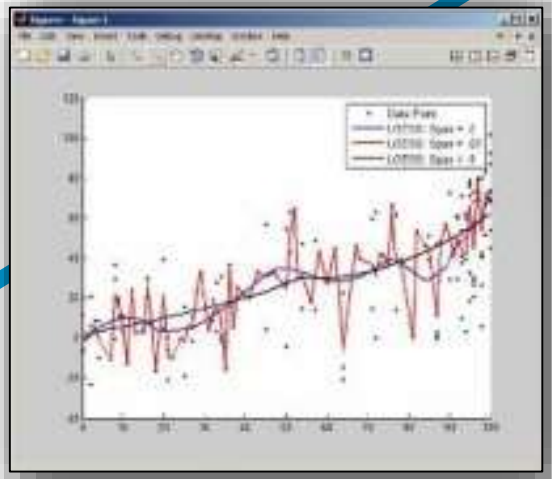

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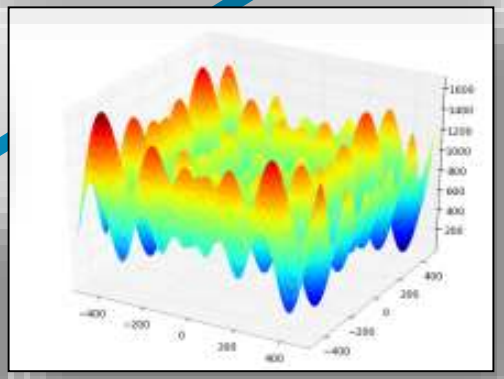
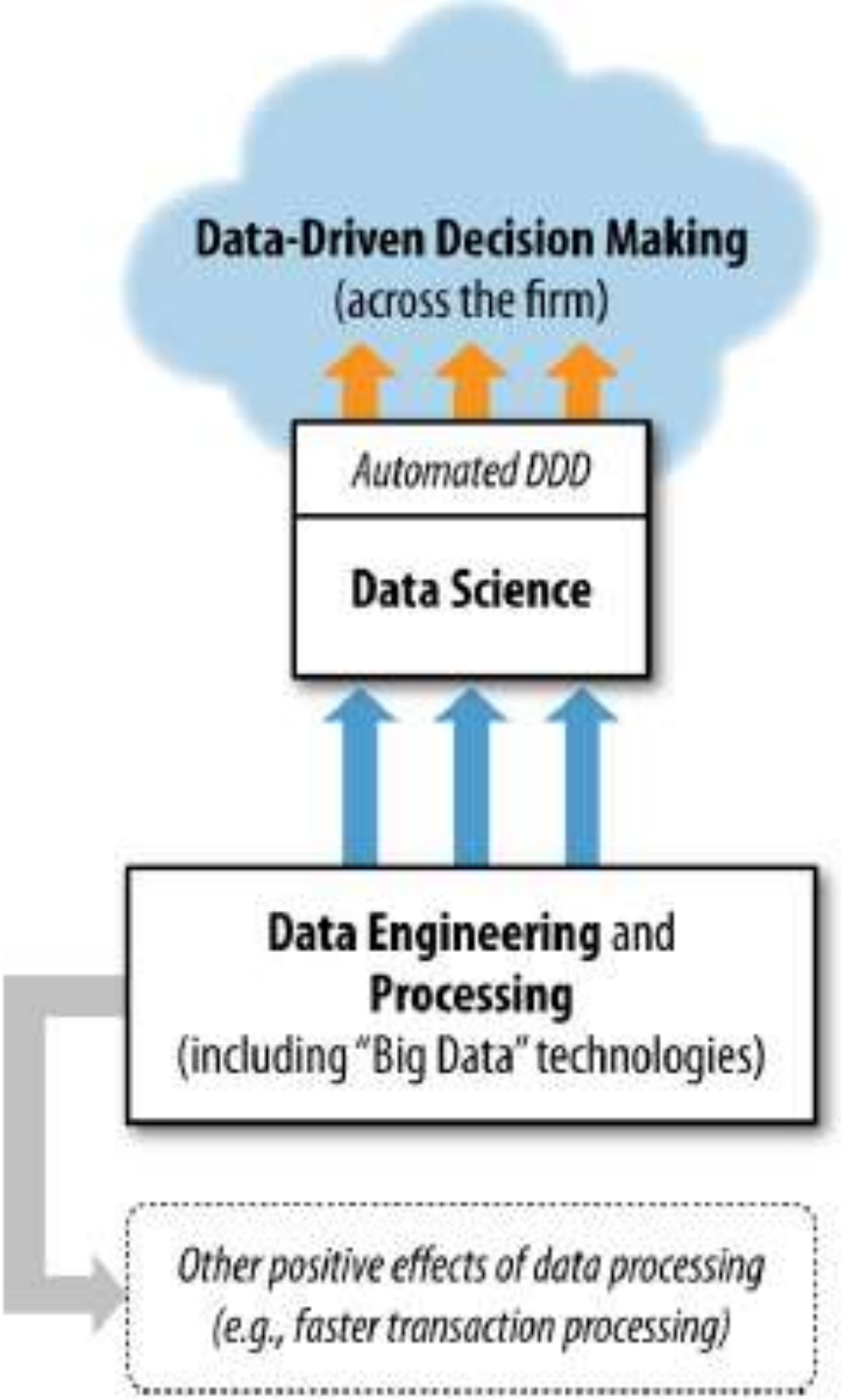
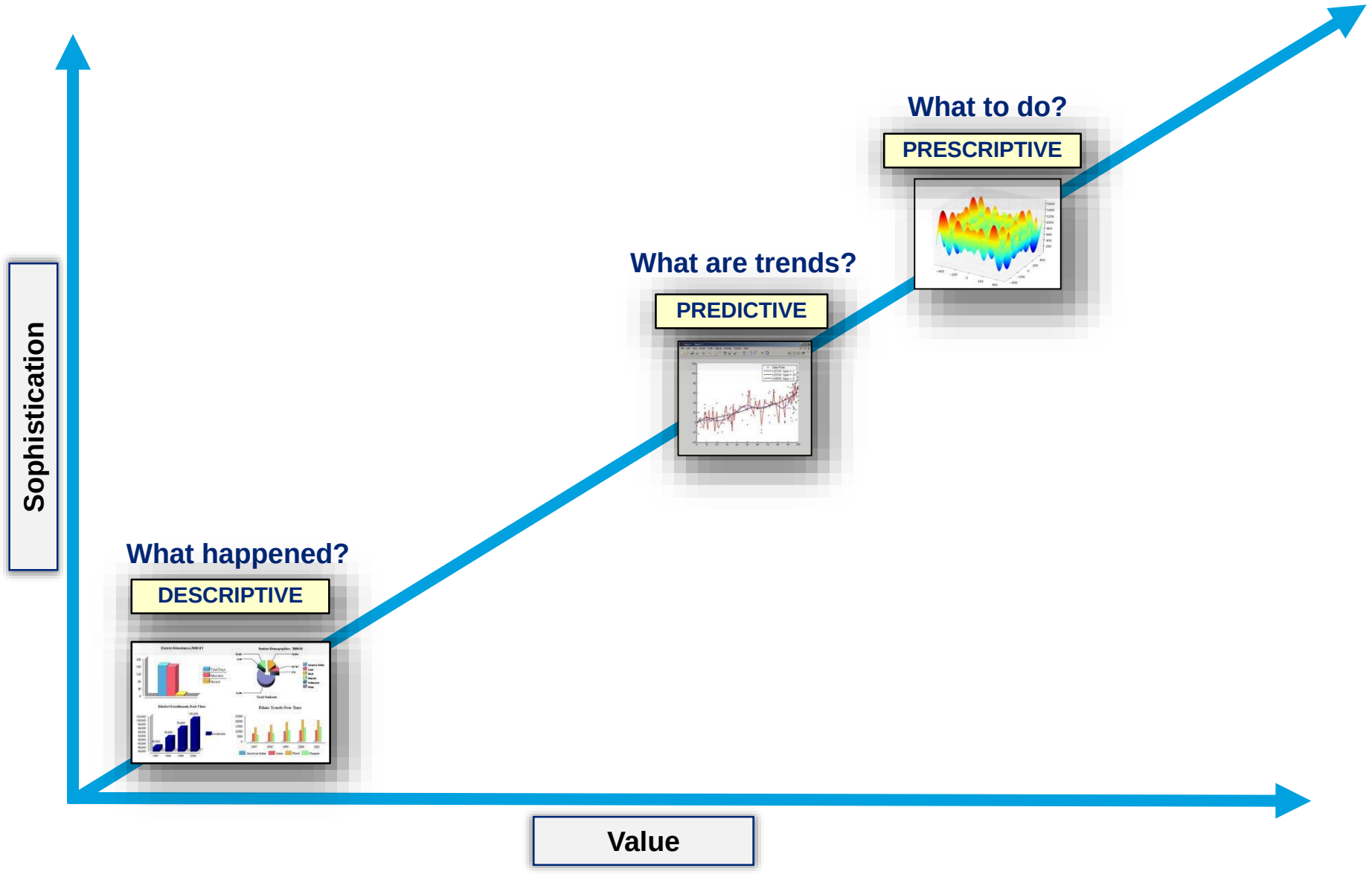
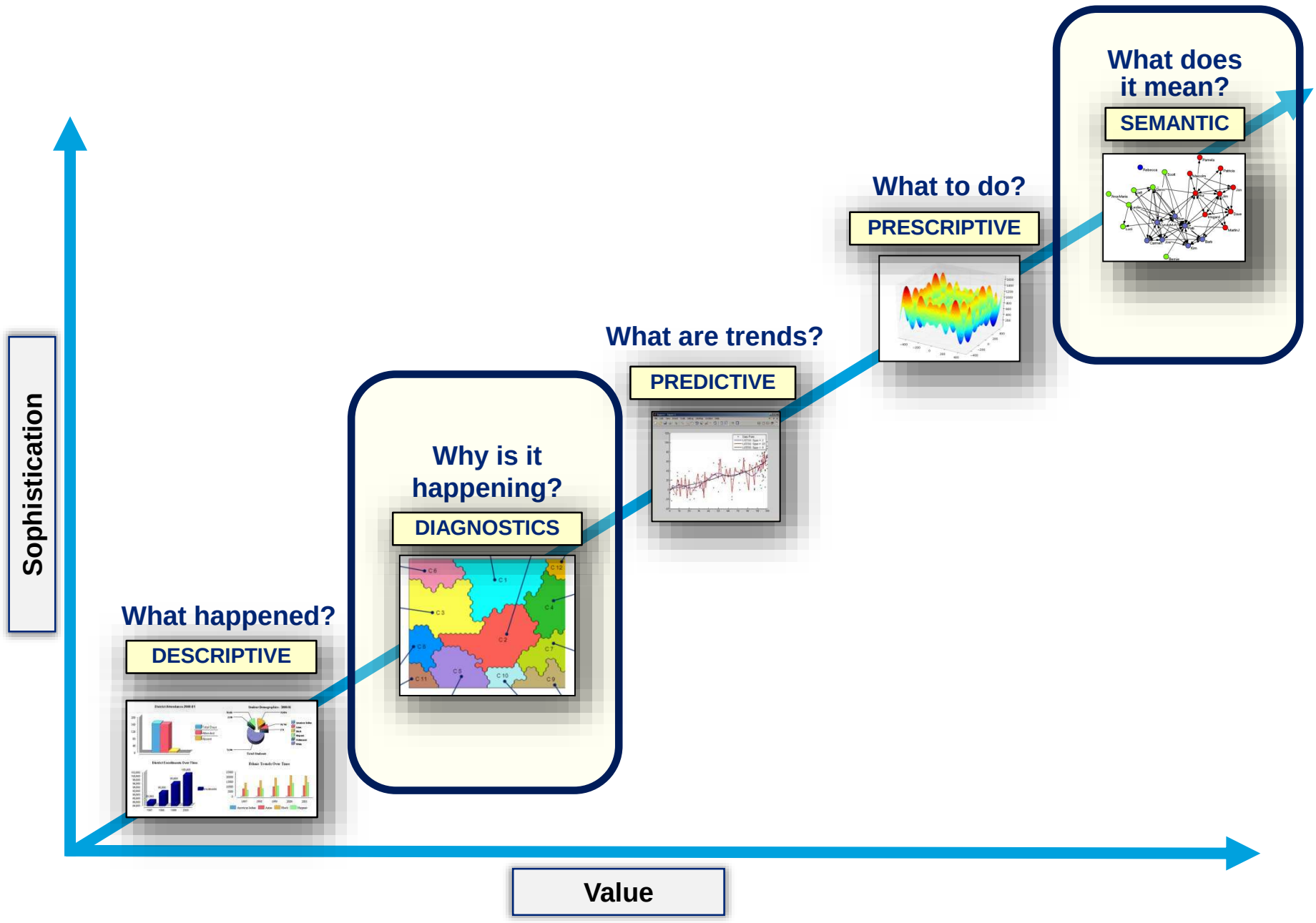


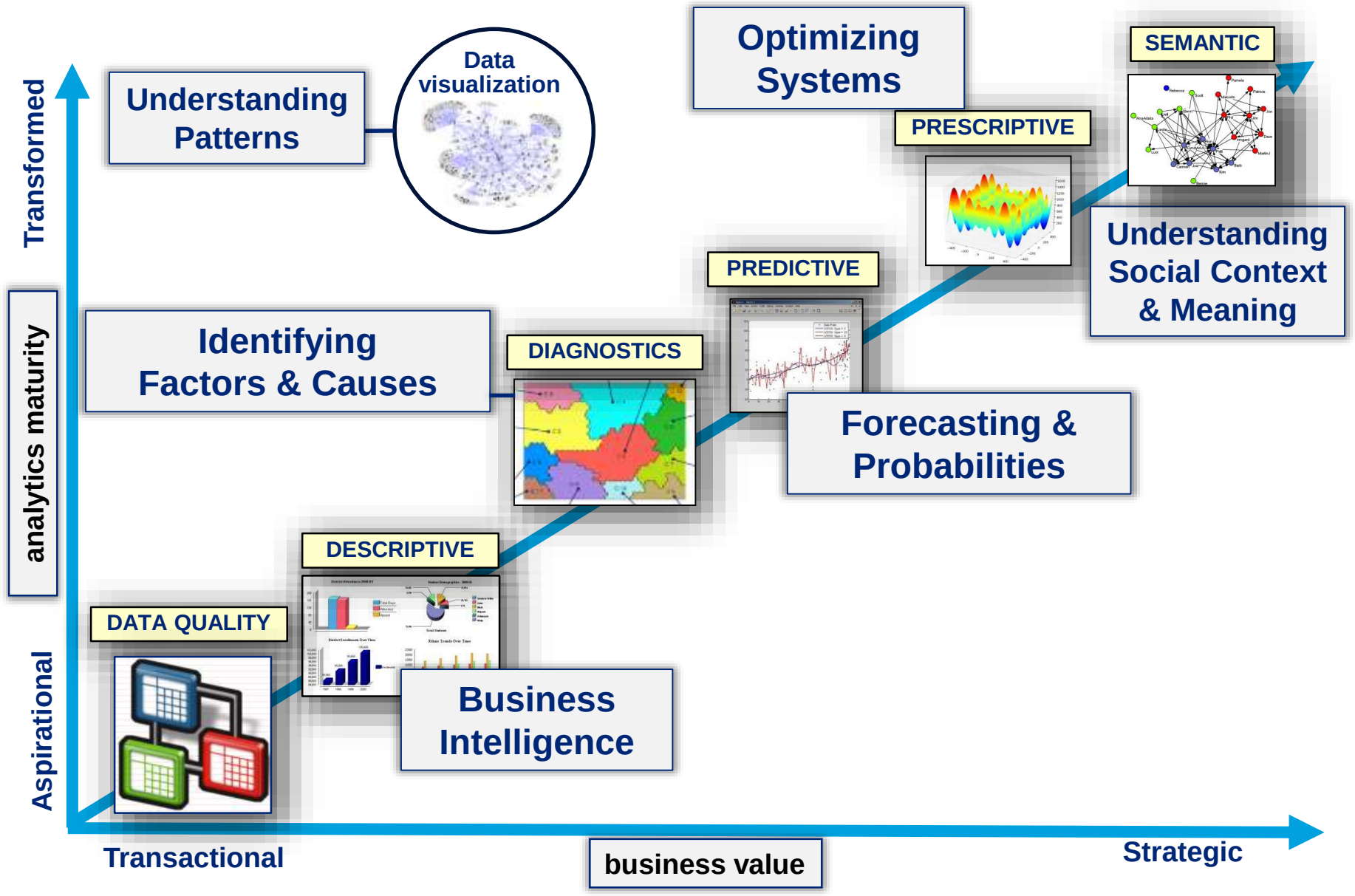
Provost, F., Fawcett, T. (2013). Data Science for Business: What you need to know about data mining and data-analytic thinking.







Advanced Analytics



Advanced Analytics

Transformed

analytics maturity

Aspirational

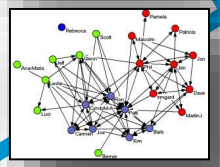
Transactional

business value

Strategic

6. What does it mean?

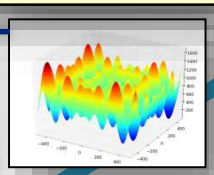
SEMANTIC



Specifying Social Context & Implications
- Text analytics, sentiment analysis, social network analysis
- TECH: SAS, specialty, Gephi, Neo4j
- OPPORTUNITIES: fraud investigation, discovery

5. What to do?

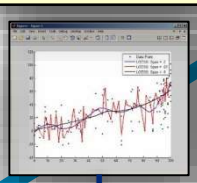
PRESCRIPTIVE



Optimizing Systems
- Operations research, simulation, optimization
- TECH: R, SAS, specialty
- PROJECTS: capital optimization, VAR

4. What are trends?

PREDICTIVE



Forecasting & Probabilities
- Time series analysis, econometrics, probabilities
- TECH: Excel, R, SAS, MatLab
- PROJECTS: Belastingdienst, Achmea

3. Why is it happening?

DIAGNOSTICS

Identifying Factors & Causes
- Model validation, determining causes
- TECH: R, SAS, MatLab, SPSS

Data visualization

Understanding & Patterns
- Analytics model validation
- TECH: SAS, Gephi
- OPPORTUNITIES: discovery, research, sentiment analysis

2. What happened?

DESCRIPTIVE

Business Intelligence
- Reports, dashboards, drill-down
- TECH: SAP BO, SAS, Qlikview
- PROJECTS: Shell, Audit Analytics

1. What do we know?

DATA QUALITY

Data Quality
- Data process / governance
- Master Data Management (MDM)
- Integration (ETL) & metadata

Key components of an analytics solution

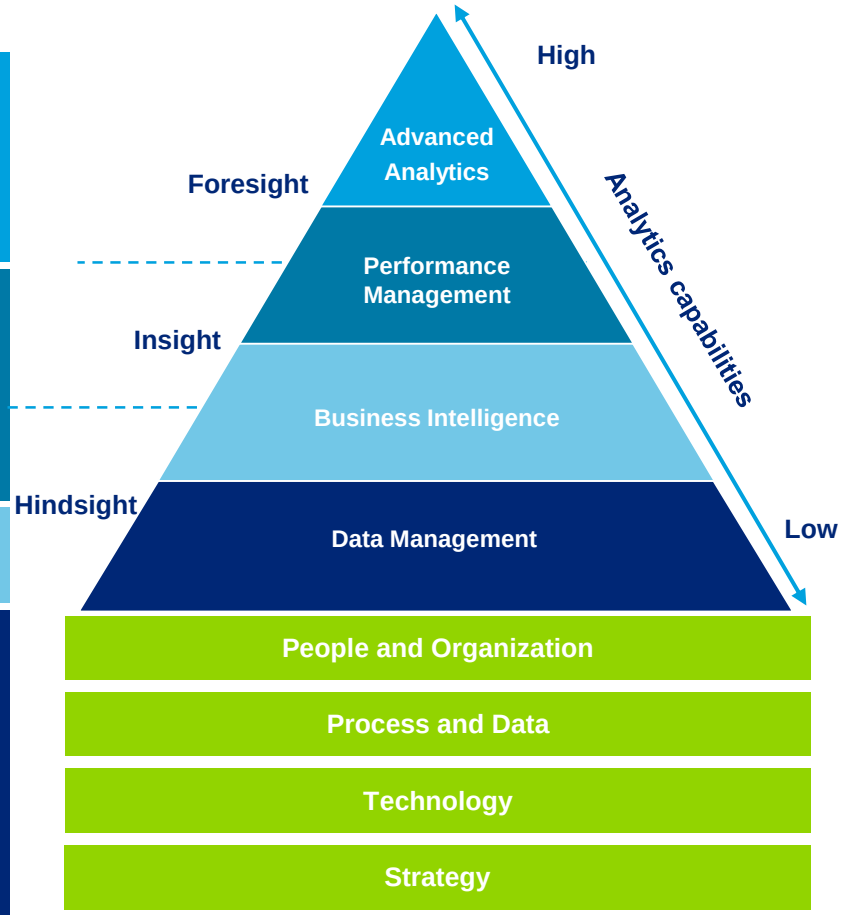
Analytics sits on top of a support structure

Advanced Analytics answer the questions: why is this happening? what if trends continue? what will happen next? what is the best outcome?

- **Budgeting, planning and forecasting**
- **Profitability modelling and optimisation**
- **Scorecard applications**
- **Financial reporting and consolidation**

Querying, reporting, online analytical processing, and "alerts" that can answer the questions: what happened; how many, how often, and where; where exactly is the problem; and what actions are needed.

- Data Governance
- Data Architecture, Analysis and Design
- Data Security Management
- Data Quality Management
- Reference and Master Data Management
- Data Warehousing and Business Intelligence Management



Advanced analytics methods

CENTRAL QUESTIONS

- What is "normal"?
- What is abnormal or suspicious?
- What are key distinctions between two?
- How can data analytics drive the process to identify & reduce deviations?
- Identify process and cost efficiencies in the detection and correction cycle

UNSUPERVISED DISCOVERY

- What are common fraud patterns / processes?
- What is statistically "normal"?
- What are central structural process characteristics / patterns for normal versus fraud cases (steps, duration, cost, coupled services)?
- Big Data: machine-driven model identification and development

SUPERVISED MODEL DEVELOPMENT

- Structural modeling
- What patterns distinguish fraud / non-fraud?
- Demographic / geographic features
- Frequency
- Typical patterns of care / service
- Cost Patterns (outliers)
- Time series/sequence analysis (steps/phases)

OUTLIER DETECTION

- Regression analysis
- Statistical measures
- Visual analytics

RULES BASED

- Known patterns
- Permutation analysis

TEXT BASED

- Regression analysis
- Statistical measures
- Visual analytics

HYBRID EXPLORATORY

- Machine deductive
- Computer-assisted structured pattern discovery

SOCIAL NETWORK ANALYSIS (SNA)

- Identification of fraud networks
- Analysis of unusual patterns (billing, territorial, communication)
- Simulation of incentive-based structural weaknesses in the system (risk and weakness analysis / evaluation)

How can Analytics help?

Successful uses of analytics is rooted in framing the business problem

Applying Analytics…	For example:
Customer & Growth **…to enhance the customer lifecycle, sales and pricing processes, and overall customer experience**	▪ Detailed segmentation to better target cross-sell and up-sell activity ▪ Understanding lifestyle factors to improve pricing & risk calculations for insurance products ▪ Predicting the impact of different compliance actions (e.g. court cases) on [music] licensing revenues ▪ Identifying and managing the most profitable customers (customer lifetime value) across a portfolio of products and services
Operations & Supply-chain **…to provide insights across the organisation's value chain**	▪ Analysing spend to identify efficiencies across the value chain ▪ Monitoring vehicle fleet use and forecast demand to optimise fleet size and deployment ▪ Identifying candidate locations for new sites (e.g. depots, or retail outlets) based on a range of geospatial factors ▪ Monitoring traffic flows using mobile-phone location data
Finance **…to measure, control, and optimise financial management processes**	▪ Consolidating financial reporting with other data to provide multi-dimensional views and more accurate financial forecasts ▪ Simulating the impact of changes in the financial markets (e.g. stress testing of the banking system) ▪ Analysing aggregated financial returns to suggest tax efficient structures
Workforce **…to enhance and optimise workforce processes and intelligence**	▪ Reducing overtime by optimising scheduling ▪ Forecasting demand to improve workforce planning ▪ Identifying early indicators of attrition to improve retention ▪ Analysing employee data to identify those most at risk of workplace accidents
Risk & Regulatory **…to measure, monitor and mitigate enterprise risk**	▪ Identifying and investigating instances of fraud and error in payment systems ▪ Monitoring compliance with financial regulations (e.g. sanctions, anti-bribery & corruption laws, etc) ▪ Identifying cyber-security breaches from patterns of user behaviour

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III. Fraud analytics

Financial Crime

Detecting and mitigating Financial Crime in an increasingly regulated & globalized environment

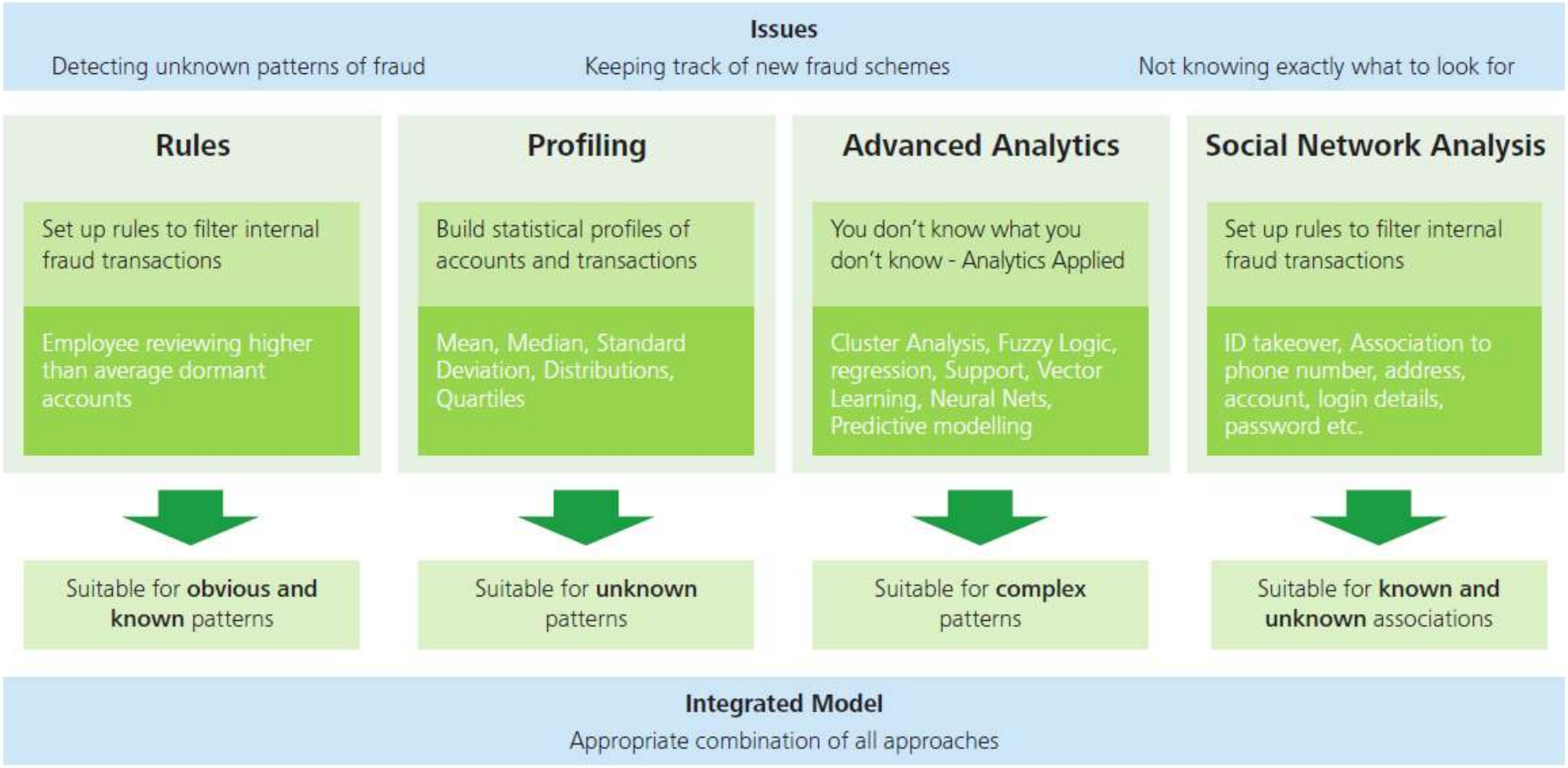
How to prevent, detect and investigate fraud

Building blocks

- Process and Procedures
- People and Organization
- IT Systems

Dimensions	Process & Procedures	Systems	People & Organisation
Prevention	Embedded in Daily Operations (Application/origination and transactional process)	Highlight Risky Patterns Rules reflecting legislative compliance	Identify relevant Fraud typologies to be translated into Systems & Procedures
Detection	Channelling of alerts ensuring balance between false/positives	Raise alerts, ability to block high risk transactions & build case management	Balance between rule based regulatory compliance and neural capability to proactively prevent fraud
Analysis	Alerts prioritized to analysts, customer contact part of customer service care	Alerts presented in a way that can be managed with a single view of the customer	Alerts automated, queued according to risk. Case management input for organization and customer profile
Investigation	Provide Framework for investigation work: - Internal reporting - Legal and regulatory - Addition to credit risk information	Risk based or regulatory approach Repository for investigation	Recover evidence reusable in court Provide reports to regulators Build customer profile for credit risk

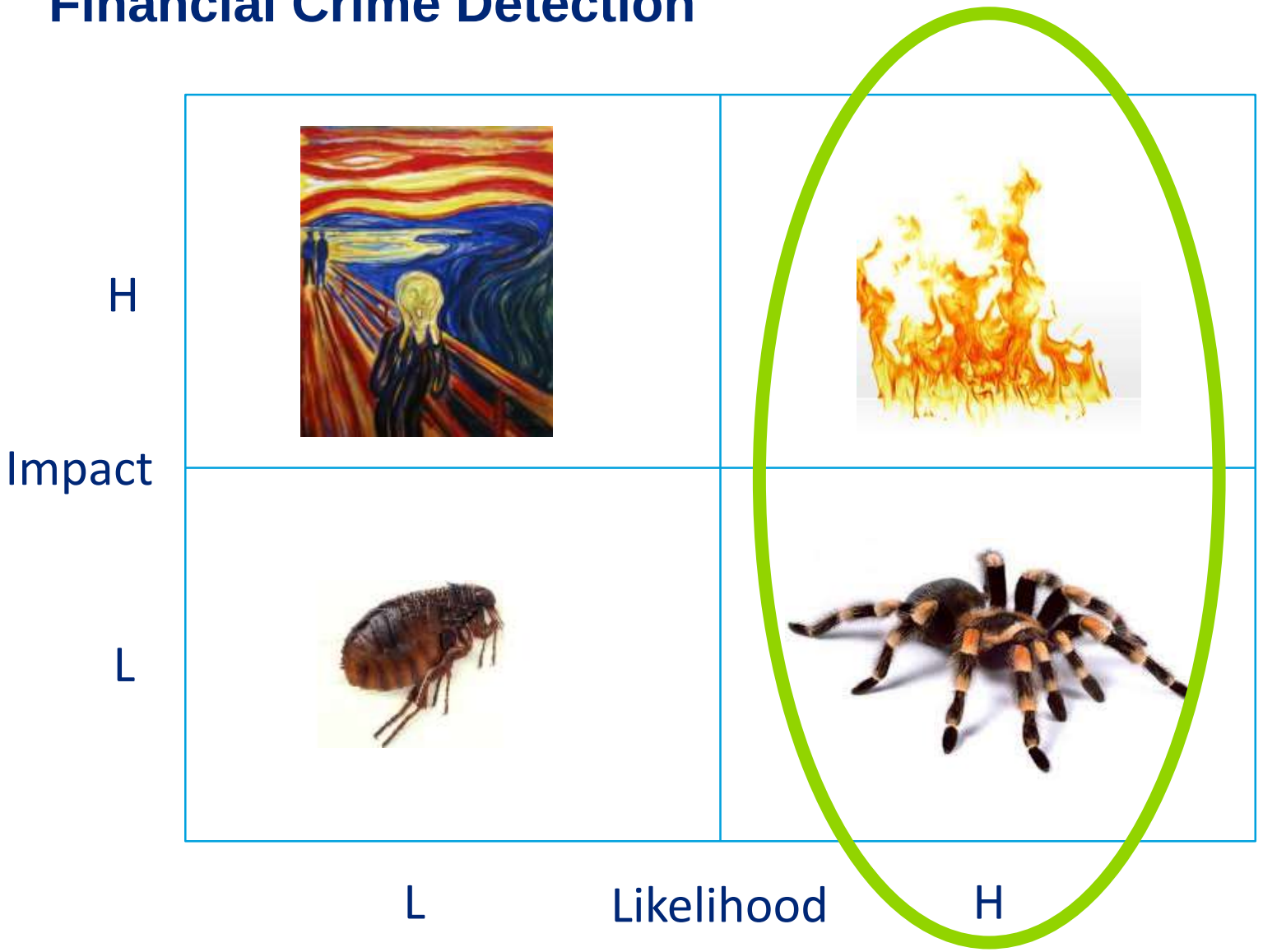
Financial crime analytics (FCA) approaches



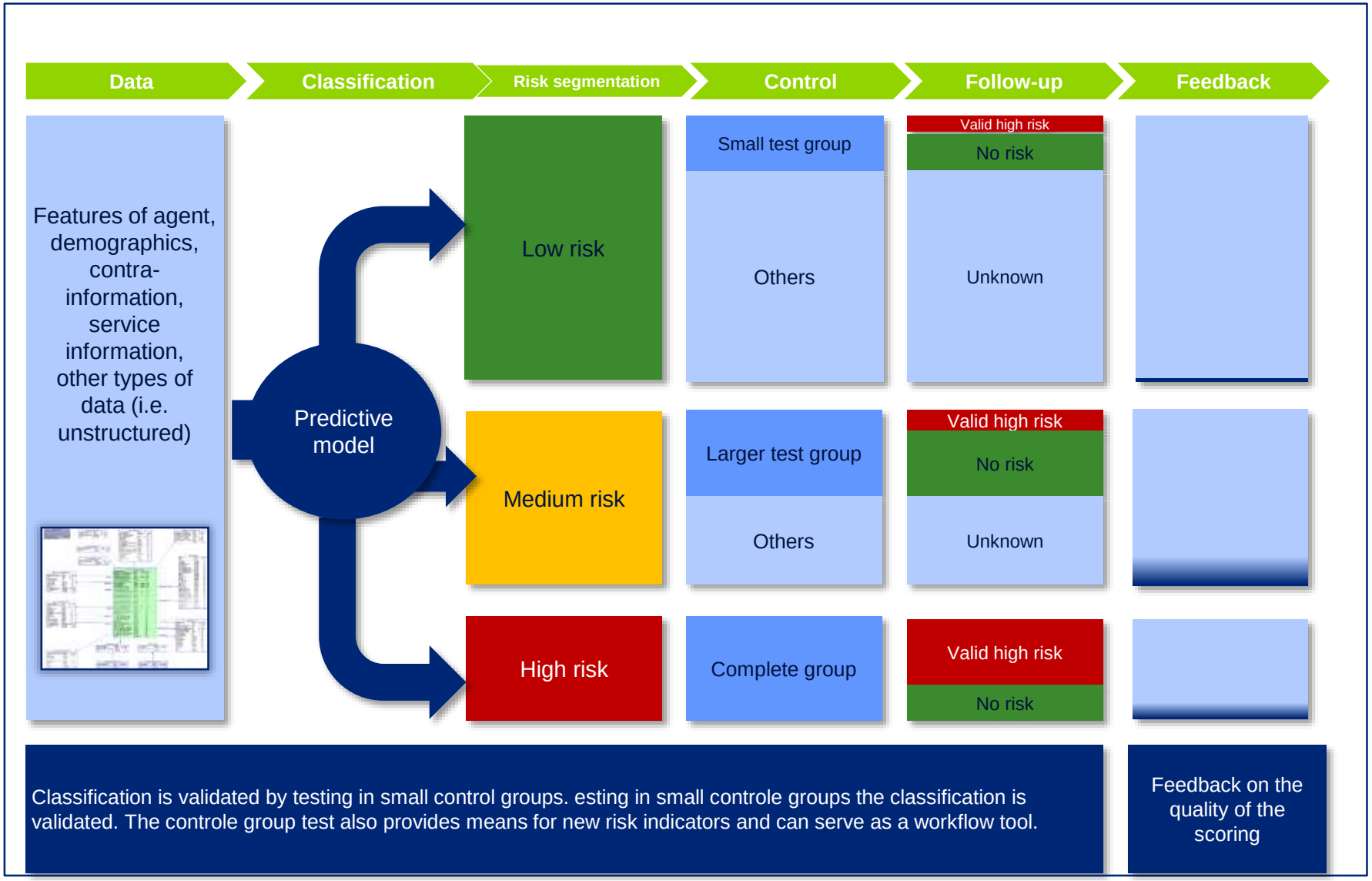
Rule-Based vs. Predictive approach

Traditional Analytics (Rule-Based)	Predictive Modeling
• Looks at combining static learnings from fraud events in the past to detect occurrences that will take place in the future. Generally expressed as rule-based analysis. • **Static and limited** in detection capability (rule based) but generates **immediate results**. • Simple approach that is **quite easy to develop**. However, typically is not as effective as predictive modeling at picking up sophisticated patterns of fraud. • As patterns and trends change**, unless the rules are modified manually or through a reactive process, the events will not be picked up.** • Rule-based analytics commonly **displays low maintenance costs from a human capital perspective.** However, from a model development point of view, exhibits steady elevated sunk costs over time.	• Primary focus is to forecast the likelihood that an event in T**NOW** contains correlations and patterns in behaviors with selected events in T**PAST**. • An **automated algorithm** that, once developed, is extremely efficient, which helps identify emerging trends and patterns previously unknown. • **Require specialized data mining** attitudes and therefore impose possible changes to the underlying operating model. However, due to the inherent **ability to pick up unknown trends, is highly effective in identifying complex fraud.** • Generally exhibits high maintenance costs from a human capital perspective. However, **from a model development point of view, exhibits lower sunk costs over time**.

Financial Crime Detection



Self-learning risk classification model (example)



Advanced Analytics Methods *

Methods for Detecting and Minimizing Fraud

CATEGORY	Fraudulent activities	Data mining class	Data mining techniques
Bank fraud	Credit card fraud	Classification	Ada boost algorithm, decision trees, CART, RIPPER, Bayesian Belief Network,
			Neural networks, discriminant analysis
			K-nearest neighbor, logistic model, discriminant analysis, Naïve Bayes, neural networks, decision trees
			Support vector machine, evolutionary algorithms
		Clustering	Hidden Markov Model
			Self-organizing map
	Money laundering	Classification	Network analysis

Advanced Analytics Methods 2 *

Methods for Detecting and Minimizing Fraud

CATEGORY	Fraudulent activities	Data mining class	Data mining techniques
Insurance fraud	Crop insurance fraud	Regression	Yield-switching model
			Logistic model, probit model
	Healthcare insurance fraud	Classification	Association rule
			Polymorphous (M-of-N) logic
			Self-organizing map
		Visualization	Visualization
		Outlier detection	Discounting learning algorithm
	Automobile insurance fraud	Classification	Logistic model
			Neural networks
			Principal component analysis of RIDIT(PRIDIT)
			Logistic model
			Fuzzy logic
			Logistic model
			Logistic model, Bayesian belief network
			Self-organizing map
			Naïve Bayes
		Prediction	Evolutionary algorithms
			Logistic model
		Regression	Probit model
			Logistic model
			Probit model

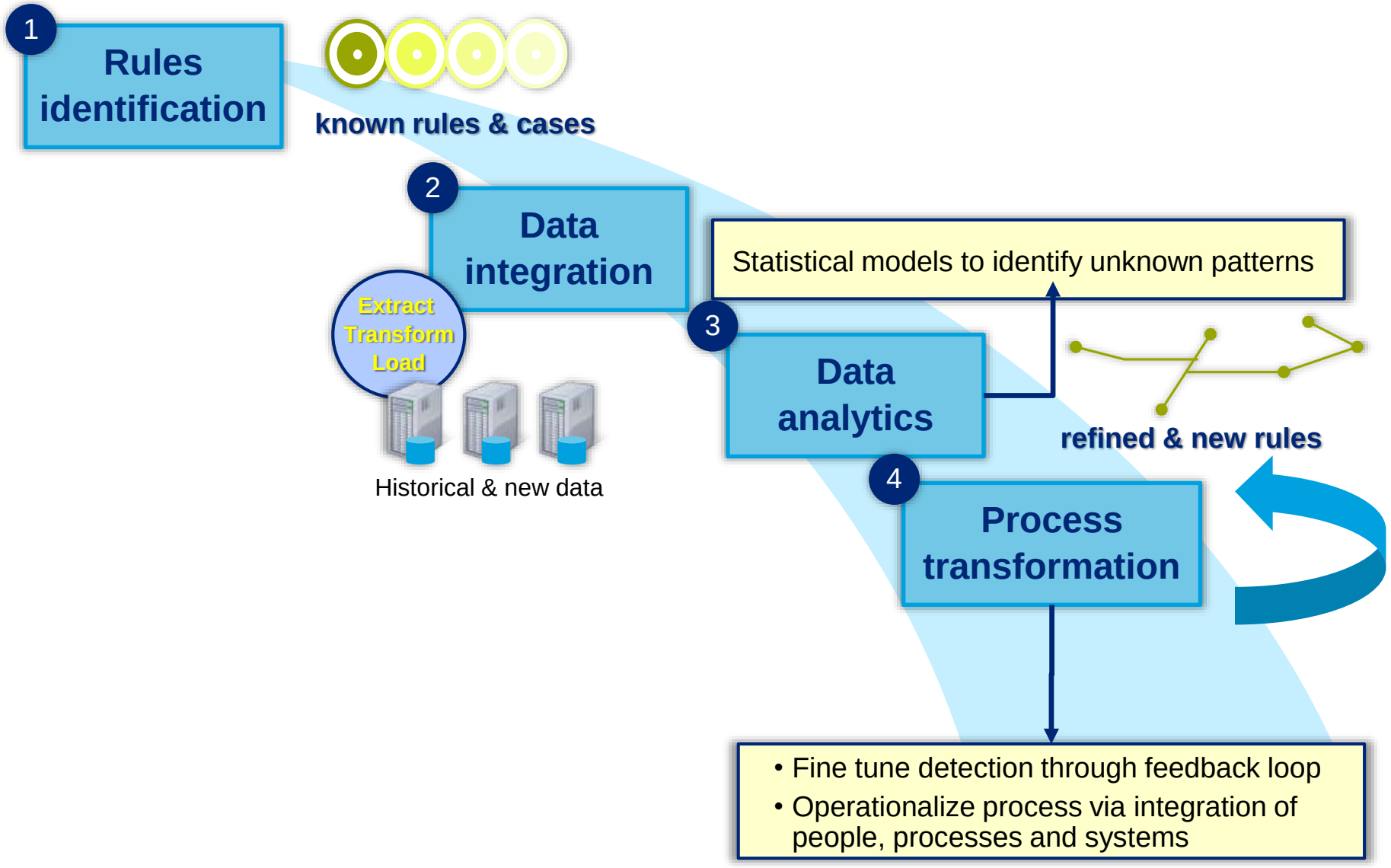
Advanced Analytics Methods 3 *

Methods for Detecting and Minimizing Fraud

CATEGORY	Fraudulent activities	Data mining class	Data mining techniques
Other related financial fraud	**Corporate fraud**	**Classification**	**Neural networks, decision trees, Bayesian belief network**
			Multicriteria decision aid (MCDA), UTilite's Additives DIScriminantes (UTADIS)
			Evolutionary algorithms
			Fuzzy logic
			Neural networks
			Neural networks, logistic model
			Logistic model
			CART
		Clustering	Naïve Bayes
		Prediction	Neural networks
		Regression	Logistic model
			Logistic model
			Logistic model

Financial crime detection & mitigation

Integrating and refining existing rules via data analytics



Financial crime detection & mitigation as a process

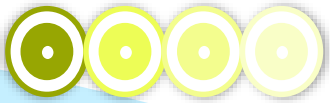
Integrating and refining existing rules via data analytics

1 Rules identification

- Establish baseline via historical cases / data
- Partner with domain experts on existing rules
- Identify key targets (i.e. parties, transactions)
- Set outlier baselines (‘normal’transactions)
- Known rule patterns*
- Identify potential supplemental data

*** Known Patterns (i.e.)**

- False claims
- Engineered claims
- Billing for services not rendered
- Overcharging for services
- Overcharging for items
- Duplicate claims
- Unbundling
- Kickbacks
- Collusion



known rules & cases

2 Data integration

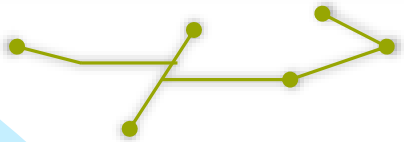
Extract Transform Load

Historical transactional data, known cases & metadata (existing & new)

- Map existing data models and sources
- Establish metadata layer for rules (new and external)
- Attach to and integrate required data sources
- Establish staging area for advanced analytics

3 Data analytics

- Exploratory data and rule model analytics
- Analyze existing known positives against historical data using multiple methods to focus and refine rules
- Apply supervised and unsupervised methods and linear and non-linear techniques to refine understanding
- Develop statistically based models to identify previously unknown patterns
- Fine tune anomaly detection rules through feedback loop



refined & new rules

4 Process transformation

- Fine tune anomaly detection through feedback loop
- Identify infrastructure requirements (As-Is => To-Be)
- Operationalize process via integration of people, processes and systems
- Establish protocols for rules maintenance, reporting, alert generation, and dashboard monitoring

Fraud Detection and Mitigation

Core solution components

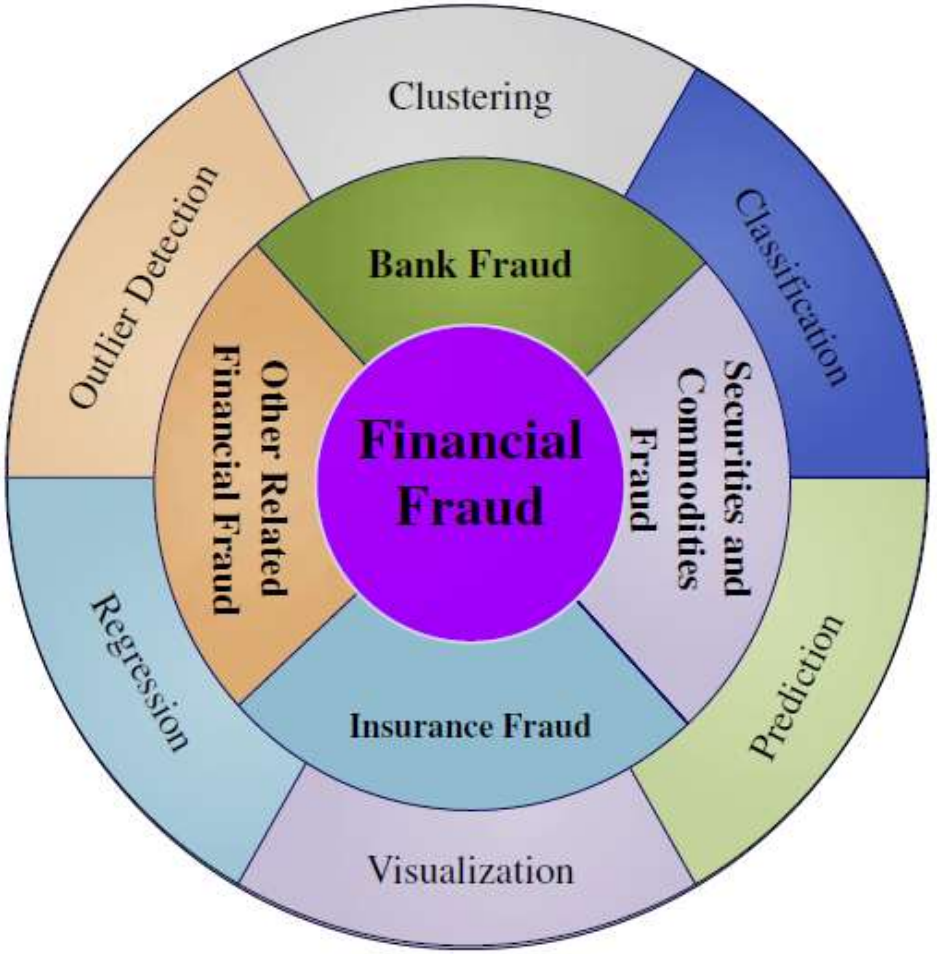
1. Data Management

- Data gathering
- Data governance / quality

2. ADVANCED ANALYTICS

3. Decision process management

- Value / portfolio management (determining when to pursue or drop cases)
- Scoring / triage / prioritization
- Alerts management
- Rule management
- Model management
- Case management
- Presentation / visualization



Financial crime assessment cycle

Managing fraud reduction as a business process

Result
Culture

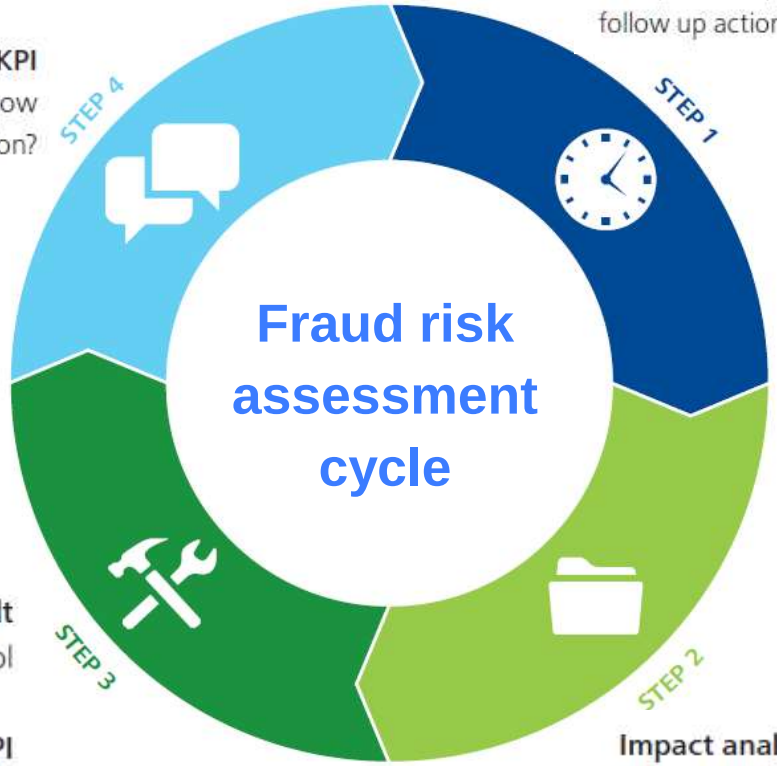
KPI
How do employees know your vision?

Prevention through communication
About follow up, how to inform employees, how to motivate employees

Periodic assessment
Business risks, assessment of impact and probability, follow up actions

Result
Fraud risk assessment

KPI
How, how often, and with what level of detail



Result
Internal control

KPI
How does management mitigate identified fraud risks?

Tailored approach
Follow up actions, changes to the organisation

Result
Insight in risk areas

KPI
How have risks been assessed and how has this been documented?

Impact analysis
Documentation of risk description, fraud triangle and internal controls

INTEGRATE: people, processes &systems

Embedding analytics in the organization

TEAMING

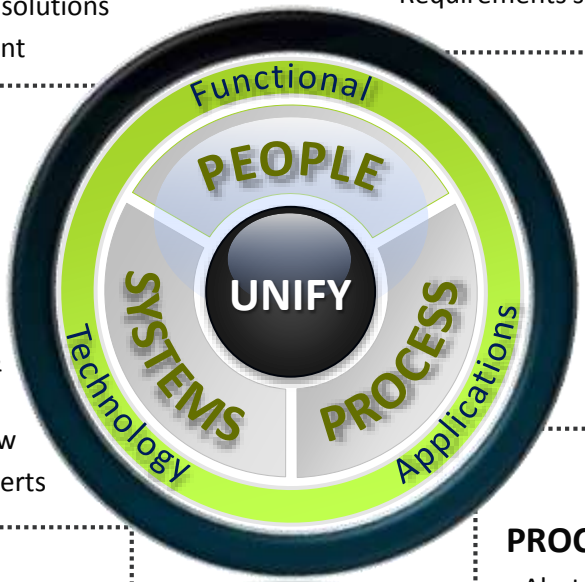
- Relationship management
- Technical project management
- Solutions architecture design
- Advanced analytics solutions design & deployment

LOGICAL DESIGN

- Mapping As-Is &To-Be data sources
- Document rules and ETL layer
- Establish analytics tests & methods
- Requirements specification

SKILLS

- Logical and technical architecture analysis / solutions design
- Database/cube design & querying
- Analytics rapid tool deployment
- Predictive analytics (supervised & unsup., linear & non-linear)
- R, SAP, SAS, SPSS, MatLab, QlikView
- ERP/BI/BW/RDBMS/ETL/OLAP experts



TECHNICAL DESIGN

- Rapid analytics deployment planning
- Operational solution design
- Analytics solution requirements / configuration / development

TOOLS

Rapid analytics environment

- SAP, R, SAS Base and specialty (MatLab, SAS EM, as needed)
- Database storage / querying

Production

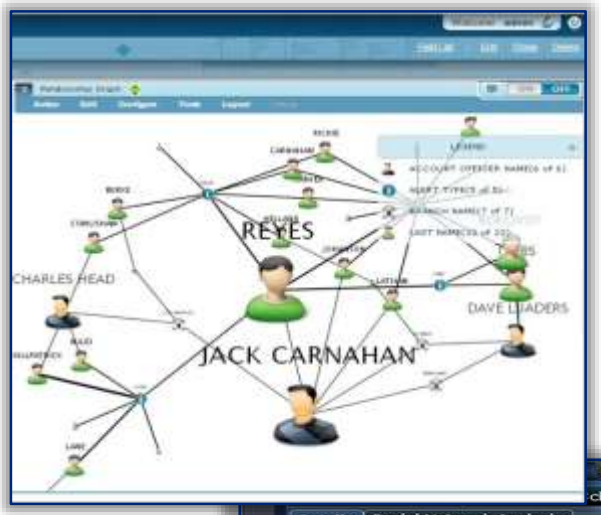
- ERP/BI/BW/

PROCESS DESIGN

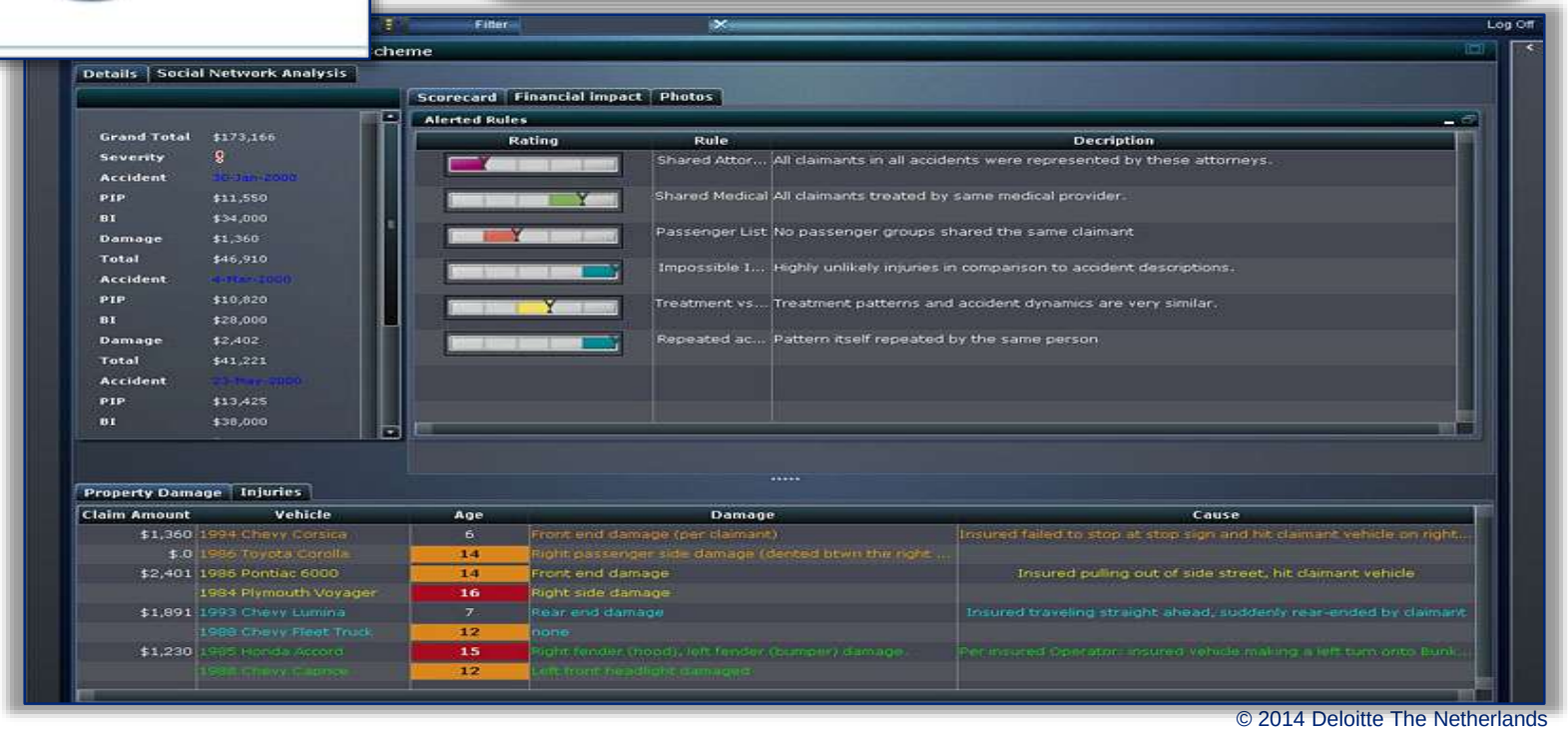
- Alerts & process management
- Rules / analytics management
- Closed-loop anlaytics (continual improvement)
- Reporting & visualizations
- Organizational integration

Process-driven fraud detection & mitigation

Fraud Detection and Mitigration Framework

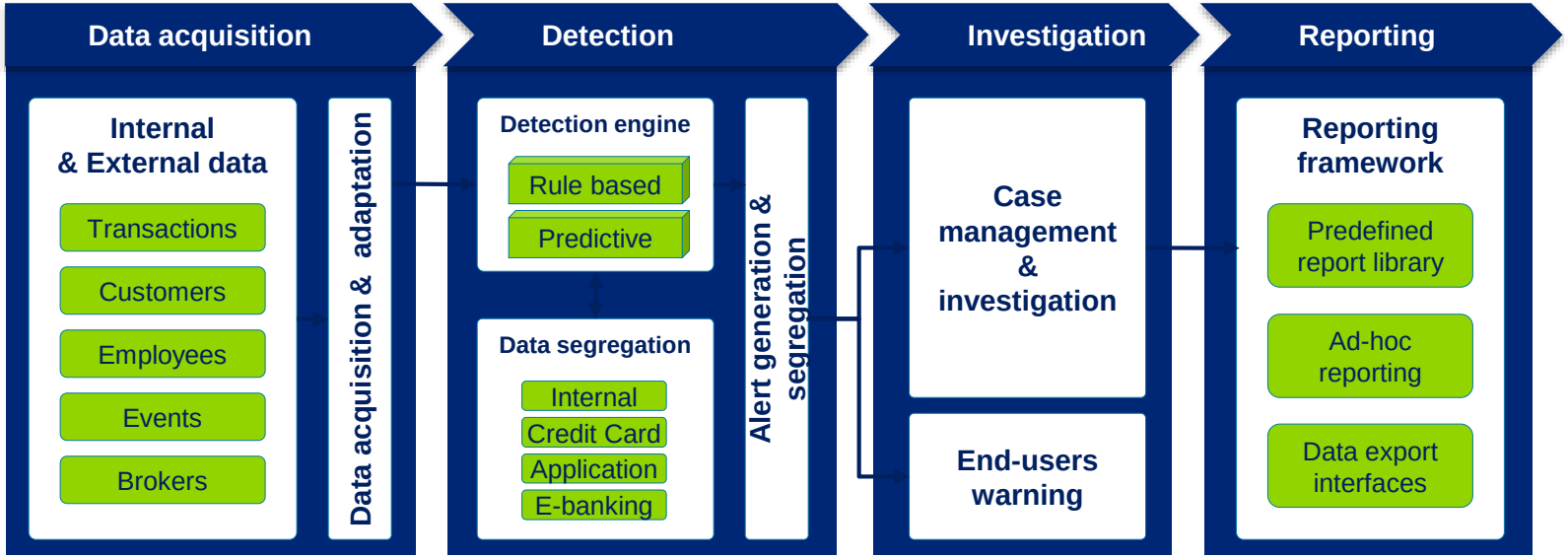


- Exploratory visual analysis
- Standard and exception reports
- Warnings / alerts
- Case tracking
- Machine-identified exceptions
- Fraud model maintenance and development

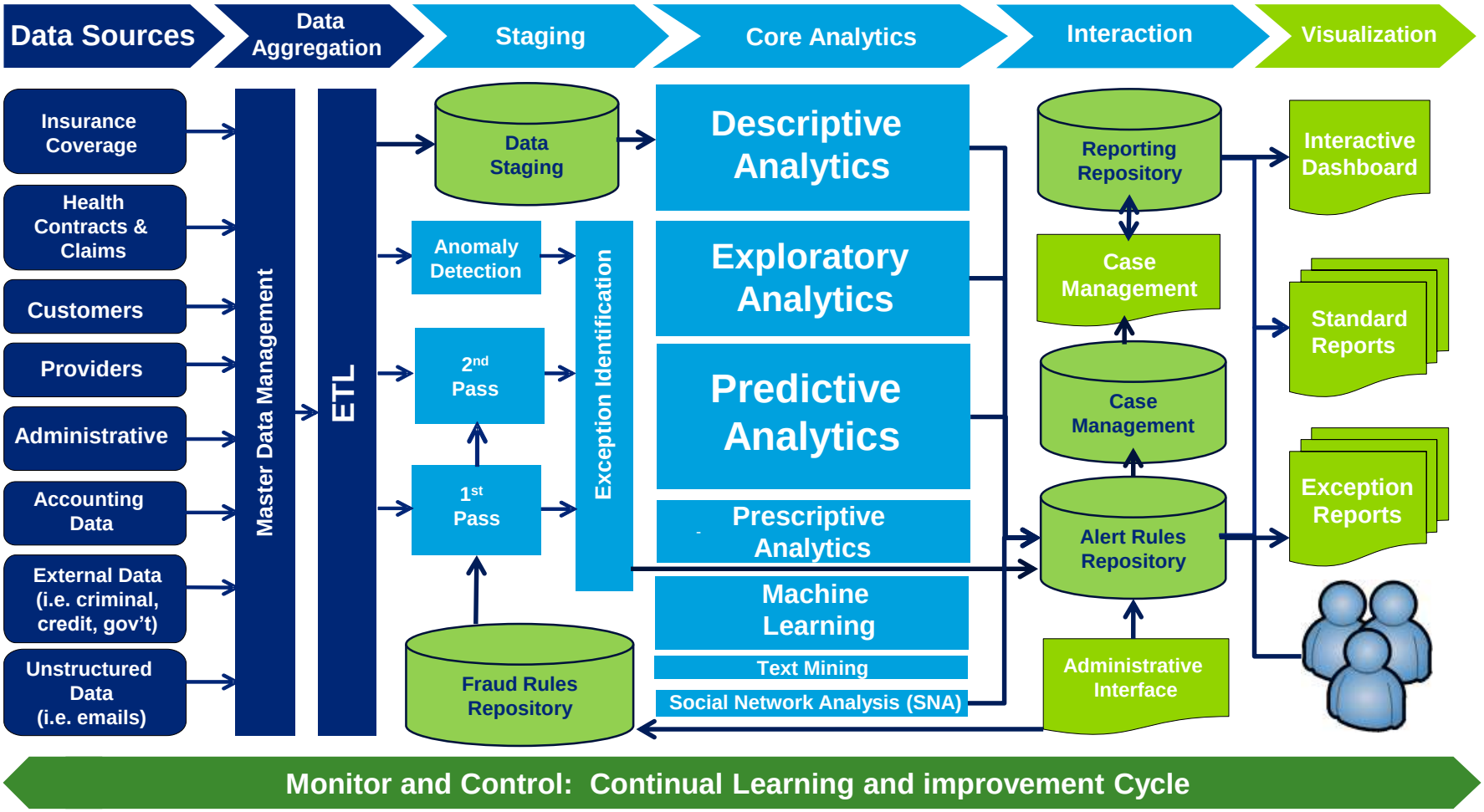


What is a fraud detection system?

- A Fraud system **strengthens** and **automates** the monitoring activities.
- Monitoring is done based on **internal** and **external** data such as employees, customer, counterparties, transactions, events and external databases.
- Detection and prevention processes are supported by **rules, predictive models or mixed approaches.**
- Tool usually contains an **investigation module** which helps users **to manage alerts** generated during the detection and prevention processes.



Integrated fraud monitoring and mitigation architecture

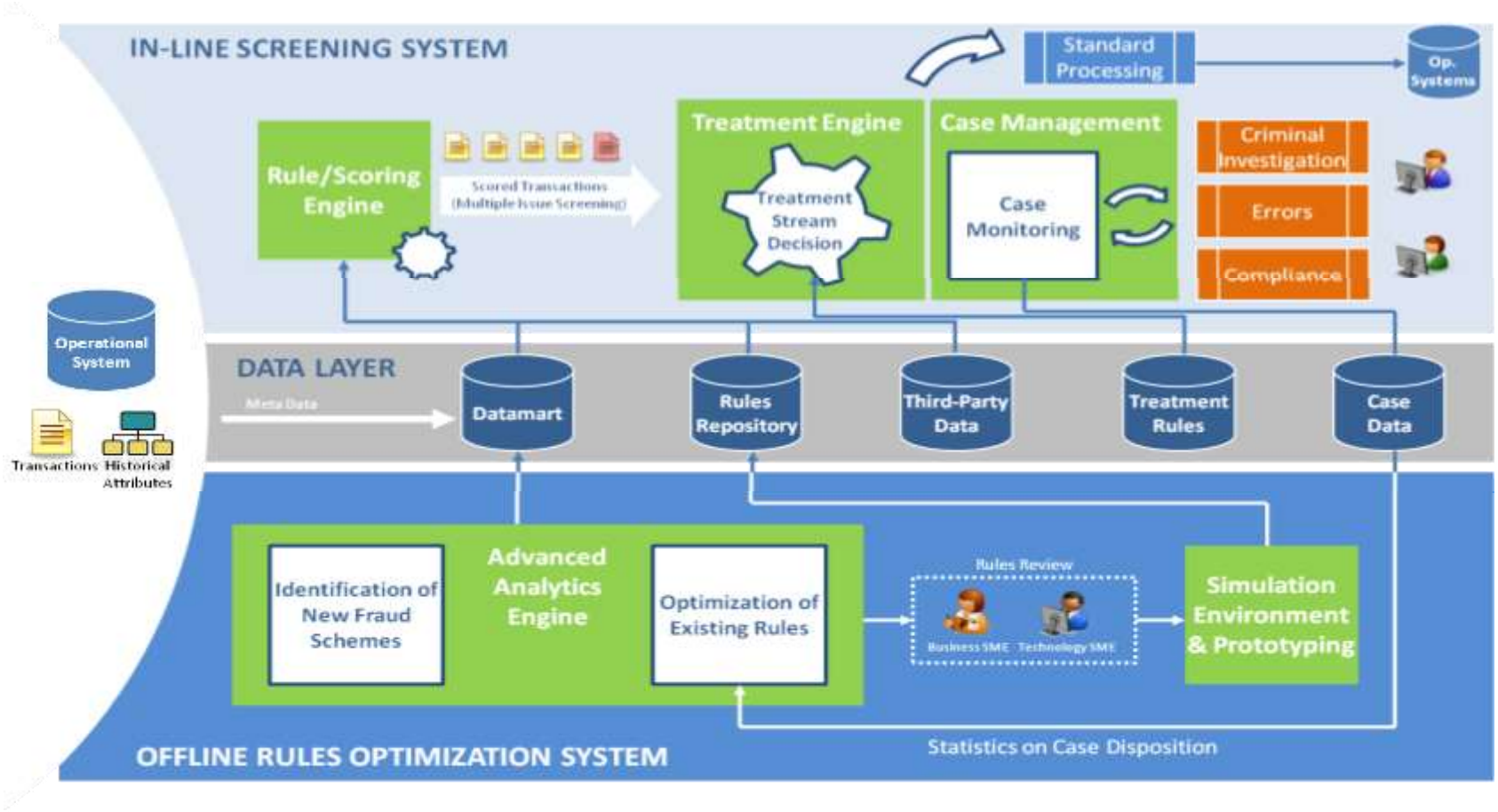


Financial crime mitigation as continuous improvement

Self-improving LEAN-like program combining people, systems &process

Closed-loop fraud monitoring process focused on continuous model refinement through hybrid operational and analytics-driven insights.

- Refined predictive models are applied to transactions to gain operational insights (data experiments)
- Models are continuously improved by tracking results in a rules optimization process



Continuous financial crime mitigation

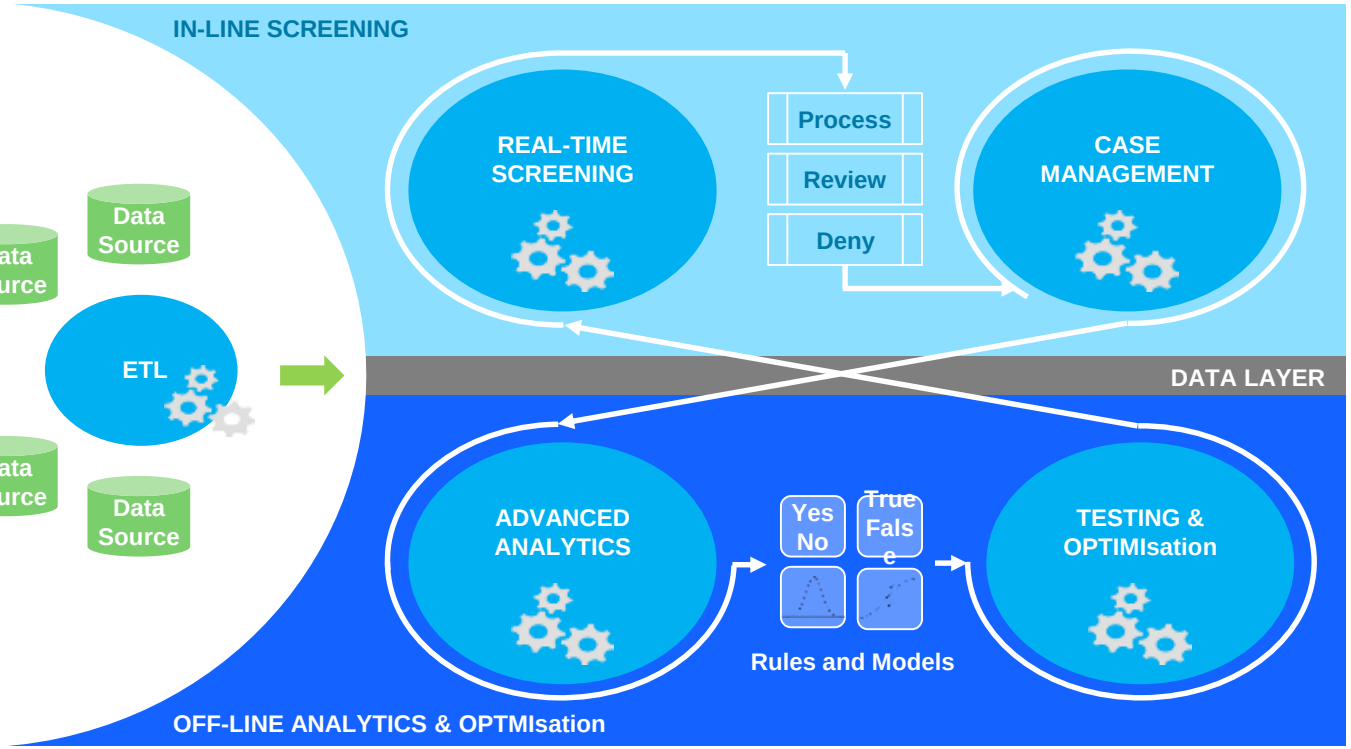
Building a self-learning feedback loop

As regulatory and economic environments change over time, schemes and errors related to fraud, waste, and abuse also change and evolve.

Transactional screening in “real-time”, while conducting analysis to identify new trends and patterns “off-line”, can help an organization protect resources for productive mission use.

The Deloitte continuous monitoring framework is similar to the performance of a sports car where many components need to work cooperatively for an effective, adaptable, and scalable solution.

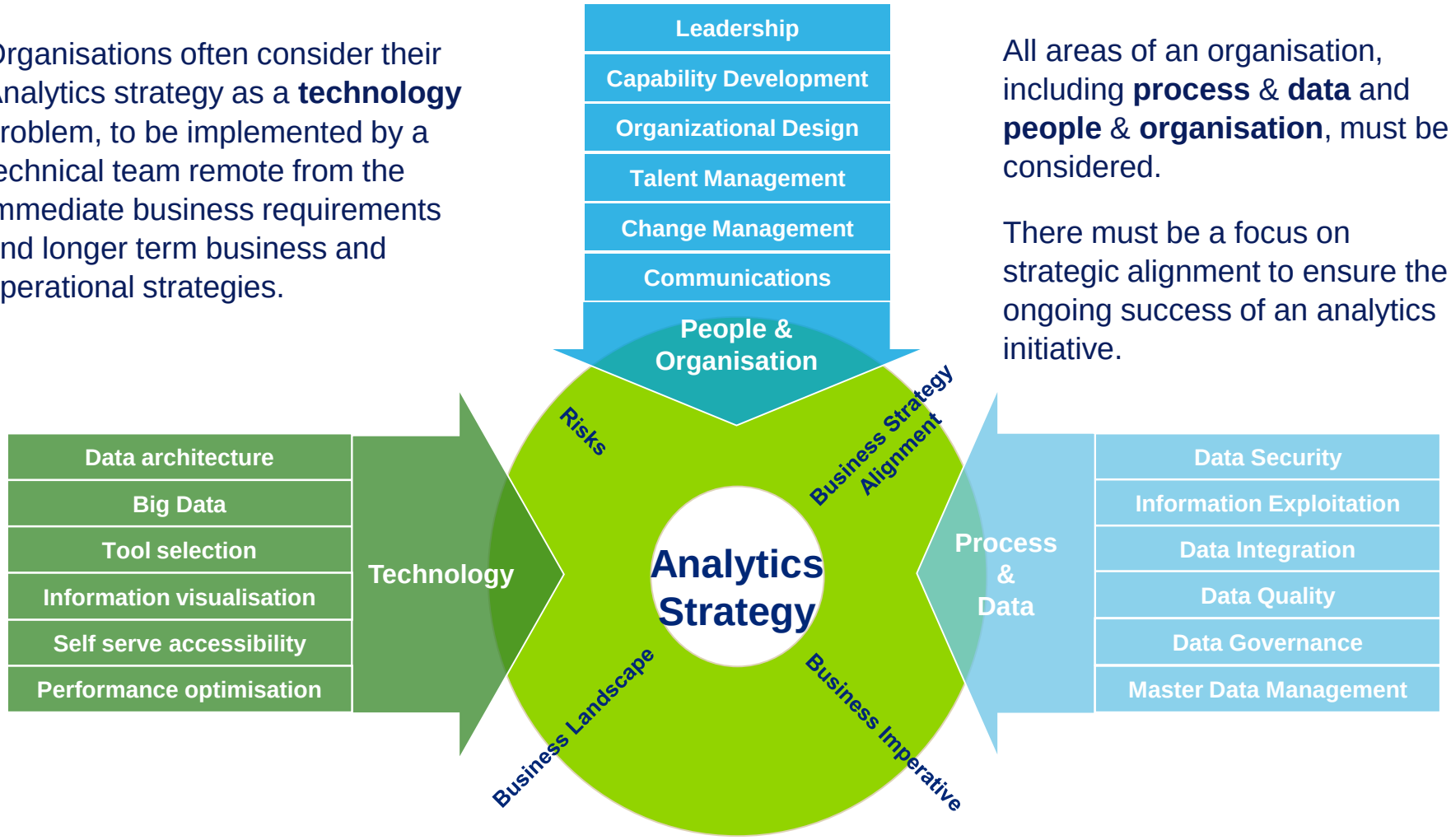
It is a hybrid of advanced technology driven by subject matter experts.



Structuring an analytics strategy

A cohesive strategy requires consideration of technology, process & data and people / organisation

Organisations often consider their Analytics strategy as a **technology** problem, to be implemented by a technical team remote from the immediate business requirements and longer term business and operational strategies.

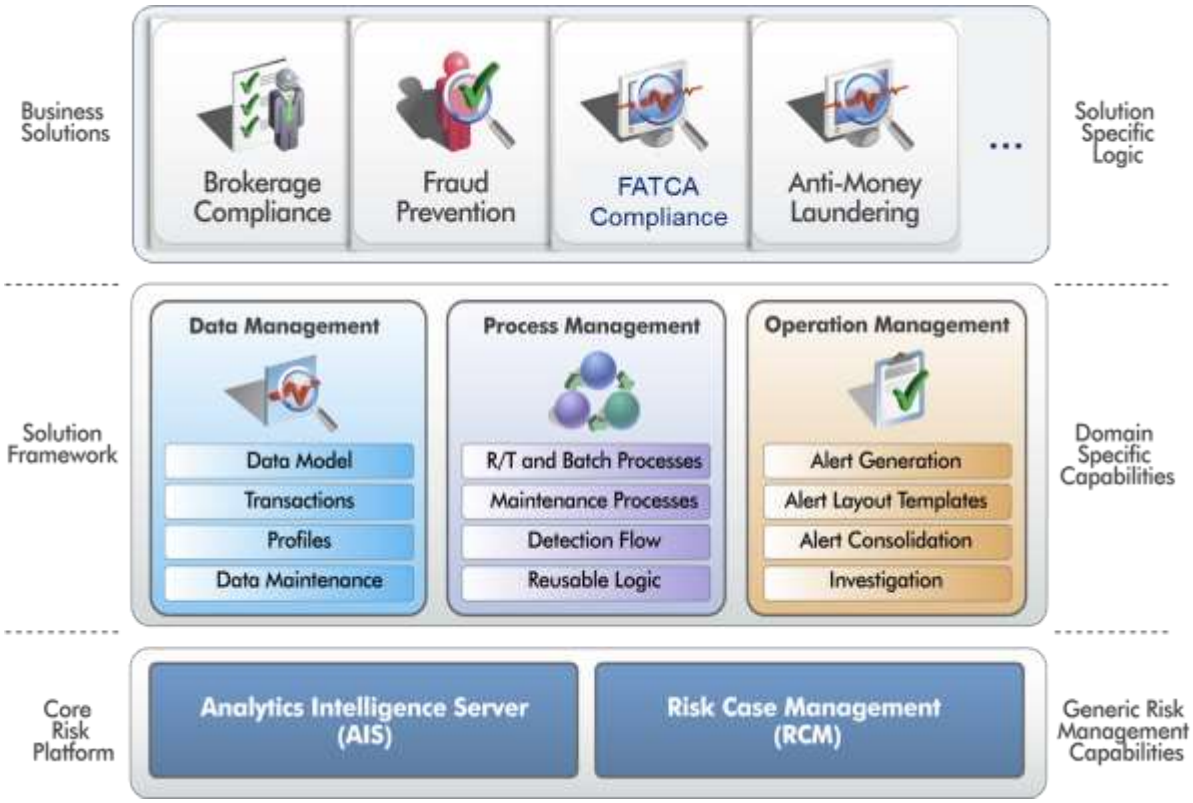


All areas of an organisation, including **process** & **data** and **people** & **organisation**, must be considered.

There must be a focus on strategic alignment to ensure the ongoing success of an analytics initiative.

The IT Solution: Automate Financial Crime Solution

- Automatic and efficient **enterprise-wide case manager**
- Wide offering as an “Out of The Box” solution combined with complete flexibility and capacity to implement custom needs and adapt to customers
- It enables incident response by supporting investigation, auditing and reporting workflows



Why invest in a fraud detection system?

- Helps you to **industrialize** and **systemize** your fraud management prevention and detections workflows.
- Well suited for **large volume** or a **wide range** of transactions types.
- Allows you to **concentrate resources** on **analyzing Fraud instead of on manual detections**.
- There is a **Business case** to do so: most vendors claim to have a break-even point **before 18 months** and a decrease on required resources
- Helps you to **"know what you don't know"** based on a predictive approach

A Fraud Prevention/Detection System is not a "nice to have" cost reduction method.

It is an essential component of your Operational Risk Management Framework and allows a better input into Basel 2 capital calculations.

Continuous Fraud Monitoring and Detection via Advanced Analytics

State-of-the-Art Trends and Directions

1	Fraud in context
2	Advanced analytics
3	Fraud analytics
4	Trends and directions
5	Practice approach

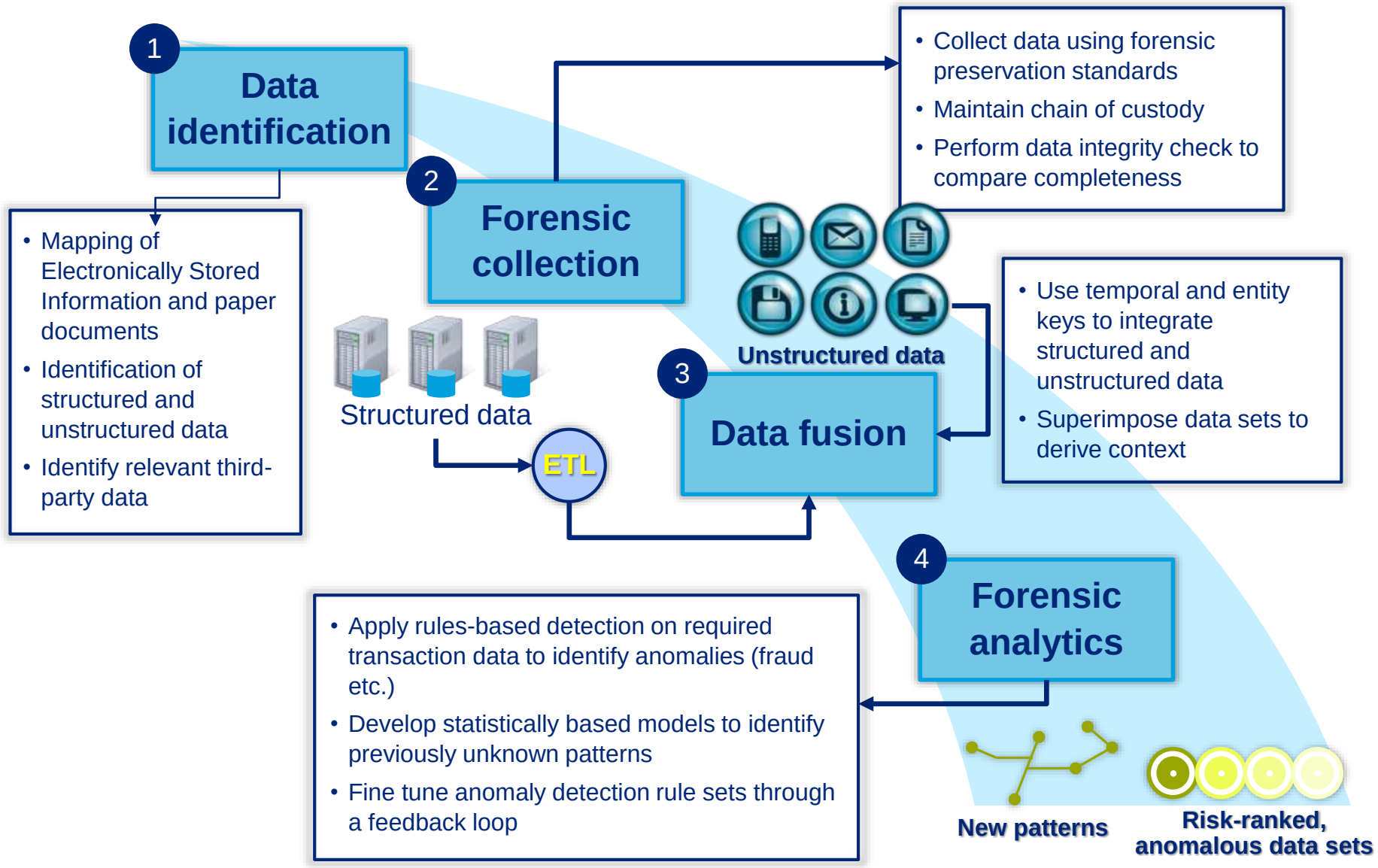
IV. Trends and directions

Trends in perspective

Fraud detection and mitigation via analytics is a rapidly evolving space. Deloitte maintains a focus on potting new developments in context.

Fraud likelihood detection methodology

Fraud Likelihood – a four-step methodology which can detect and predict fraud



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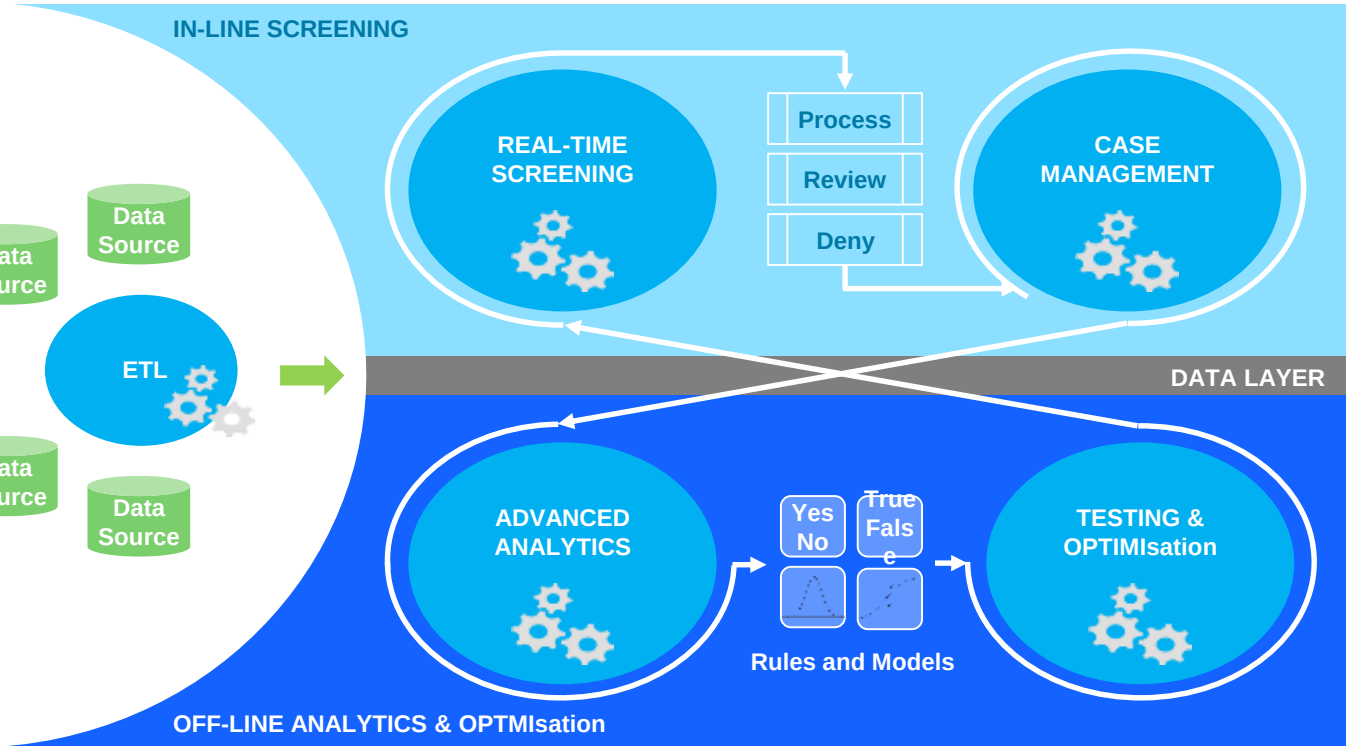
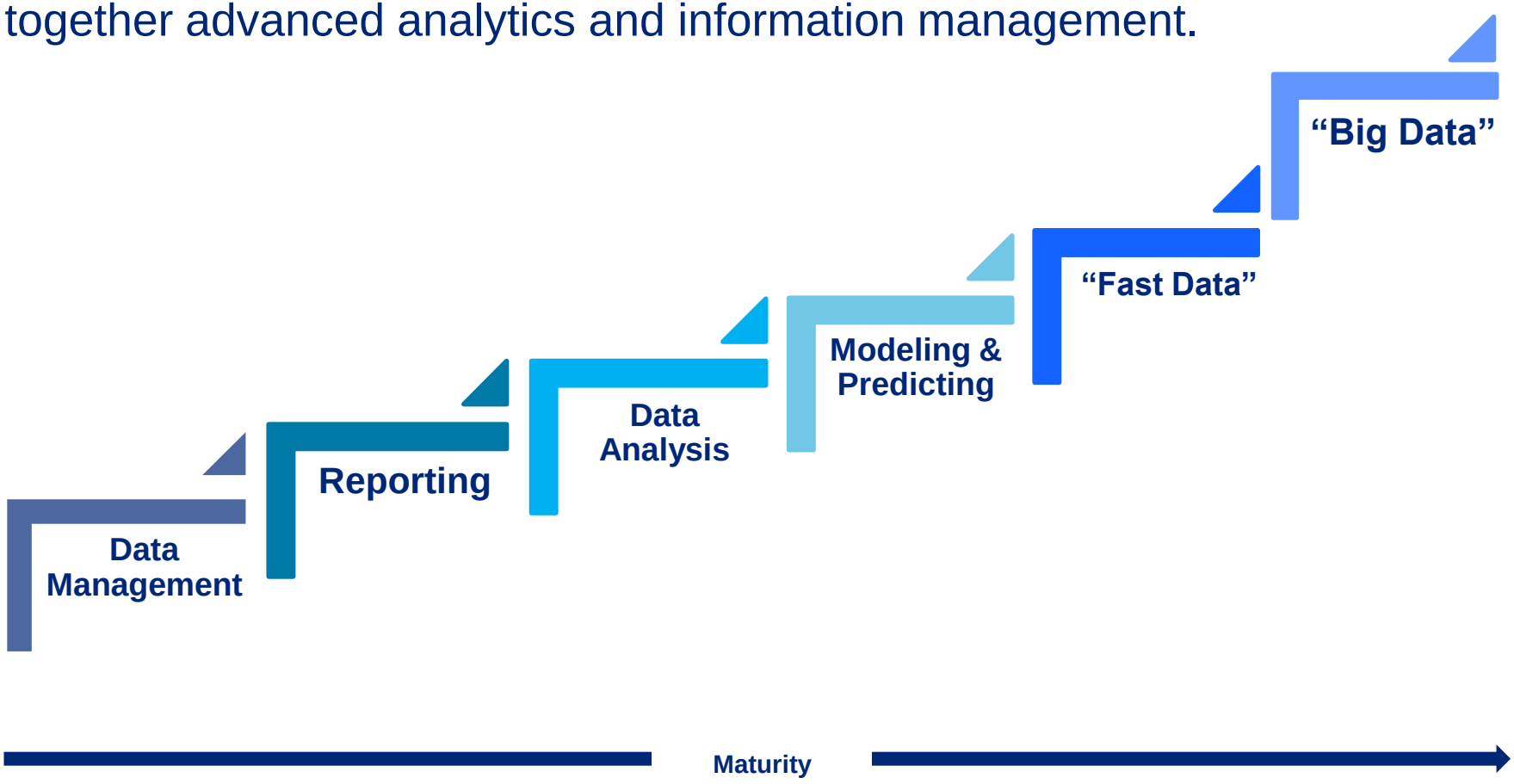


‘Big Data’ analytics technical maturity

Analytics technical capabilities along a maturity scale

Big Data is the next step in the analytics evolutionary path, bringing together advanced analytics and information management.

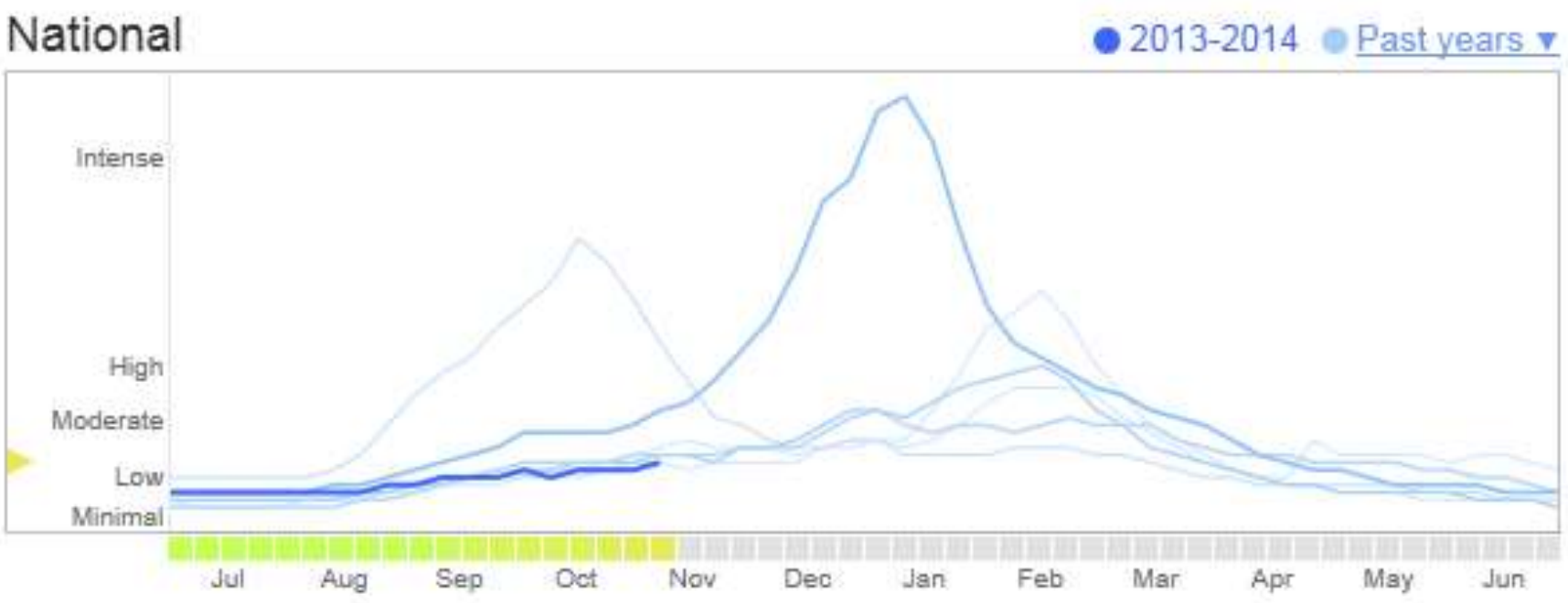


Source: TDWI, HighPoint Solutions, DSSResources.com, Credit Suisse, Deloitte

Big Data Approach

Explore flu trends - United States

We've found that certain search terms are good indicators of flu activity. Google Flu Trends uses aggregated Google search data to estimate flu activity. Learn more »



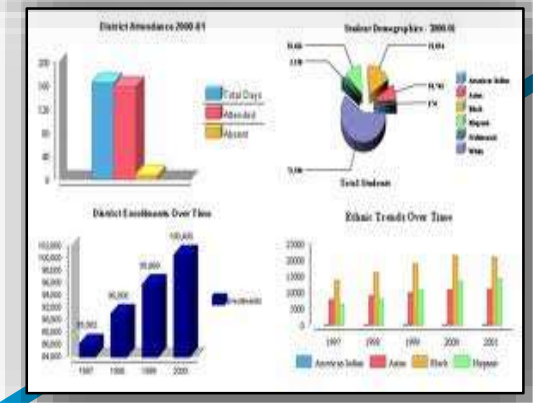
Cukier, Kenneth Neil, and Mayer-Schoenberger, Viktor. (May/june 2013) . The Rise of Big Data: How It's Changing the Way We Think About the World. Foreign Affairs. http://www.foreignaffairs.com/articles/139104/kenneth-neil-cukier-and-viktor-mayer-schoenberger/the-rise-of-big-data

SOPHISTICATION

VALUE

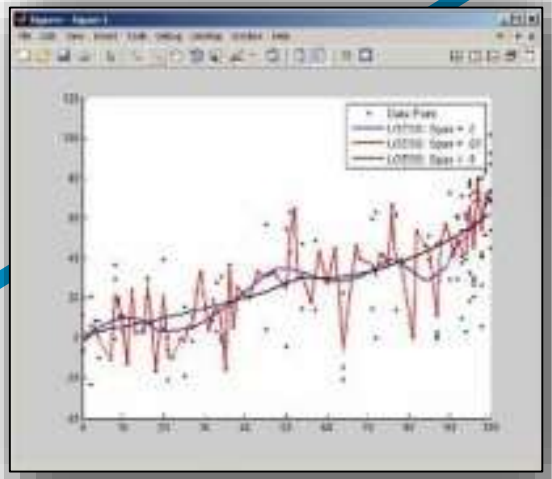
What happened?

DESCRIPTIVE



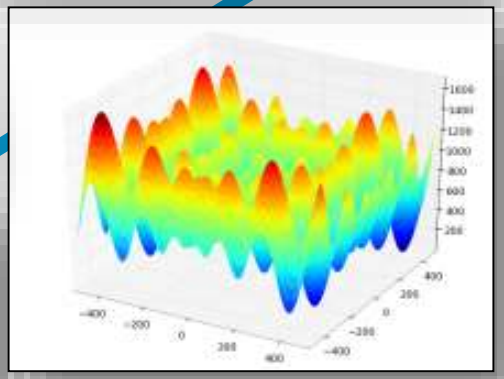
What are trends?

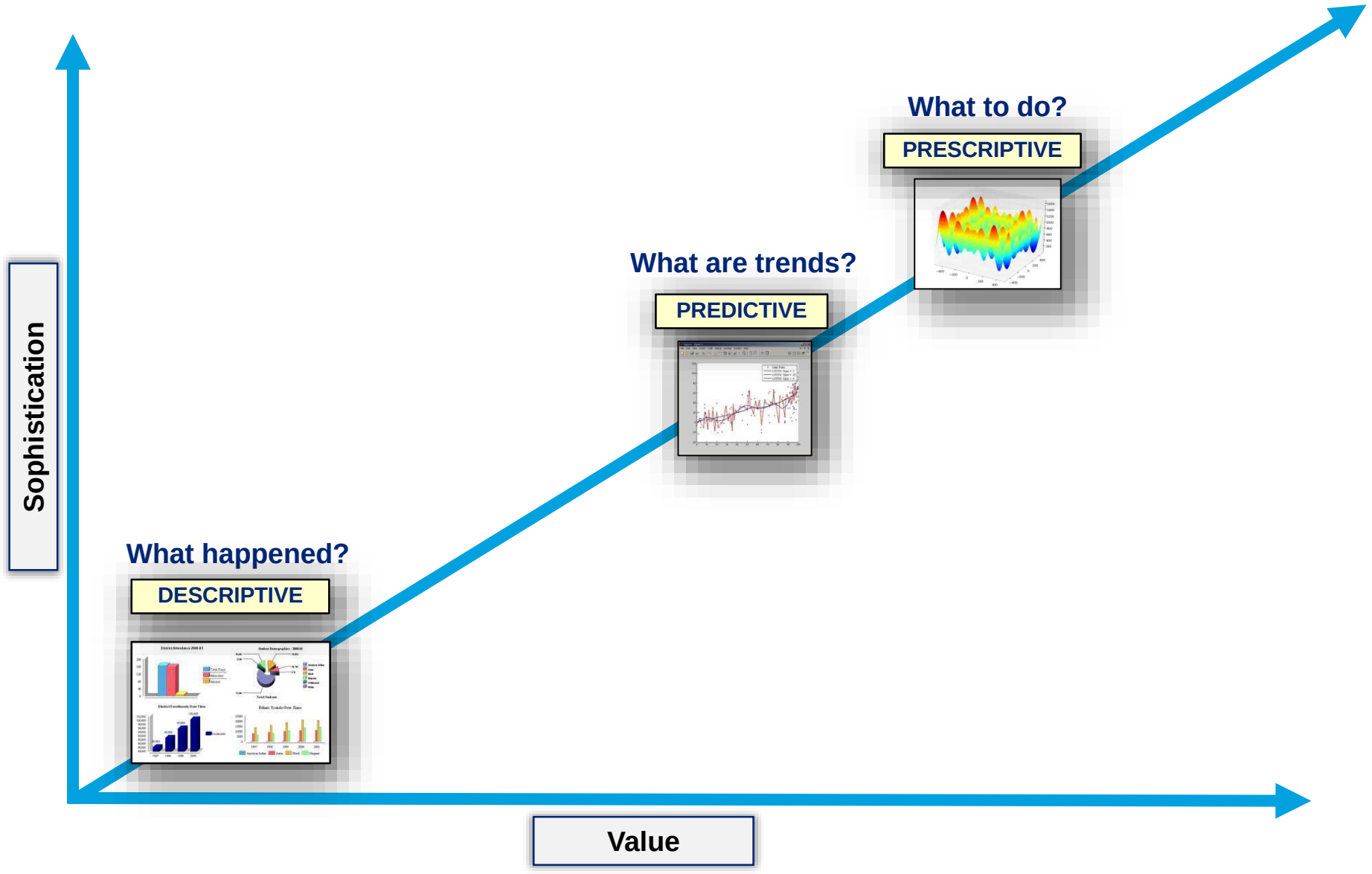
PREDICTIVE

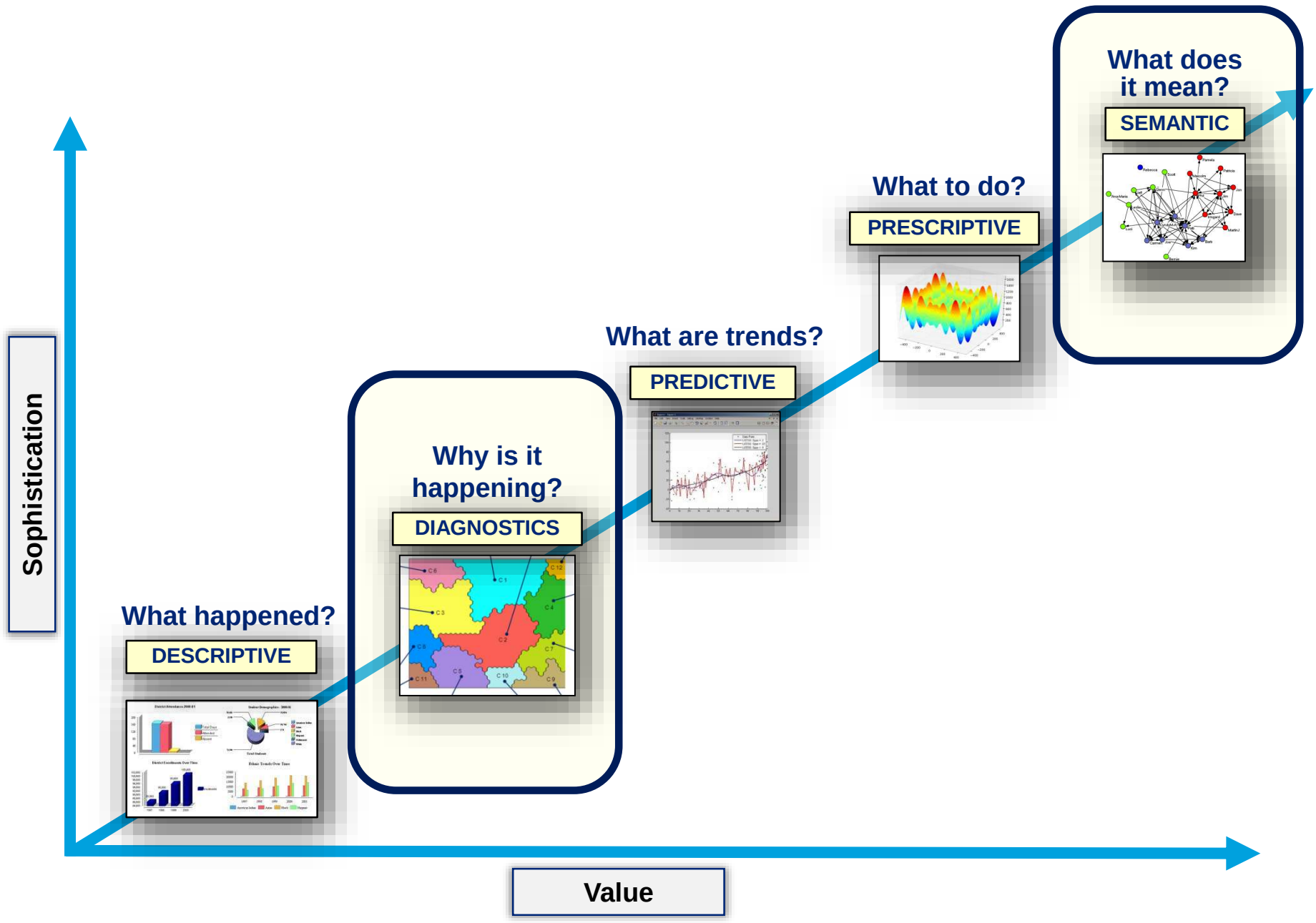


What to do?

PRESCRIPTIVE





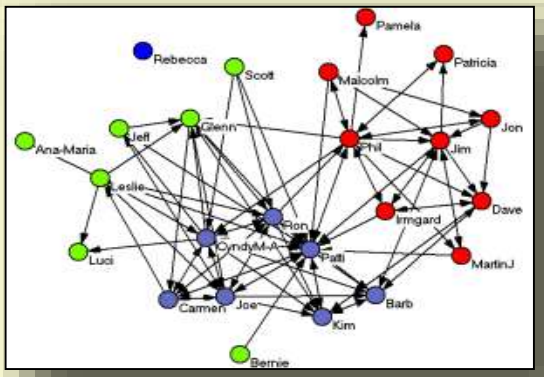


Why is it happening?

DIAGNOSTICS

What does it mean?

SEMANTIC



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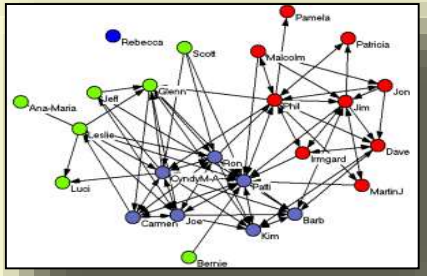
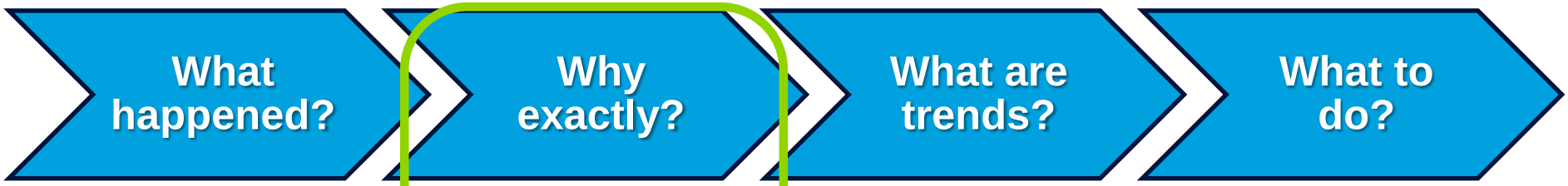


Advanced analytics methods

Establishing a progressive data analytics path



DESCRIPTIVE

OVERVIEW

Historical analysis to establish statistical benchmarks, to refine existing rules, and to identify new rules.

METHODS

Statistical measures, probabality distributions, correlation, regression, reporting, & visualization.

DIAGNOSTIC

OVERVIEW

Where rules are lacking, identifying root causes, key factors, and unseen patterns.

METHODS

Cluster & factor analysis, multiregression, Bayesian clustering, KNN, self-organizing maps, principal component analysis, graph & affinity analysis.

PREDICTIVE

OVERVIEW

Analysis of patterns to establish trends, quantify probabilities, and reduce uncertainties.

METHODS

Time-series analysis, econometric analysis, decision trees, ensembles, boosting, support vector machines, neural networks, naïve Bayes classifier.

PRESCRIPTIVE

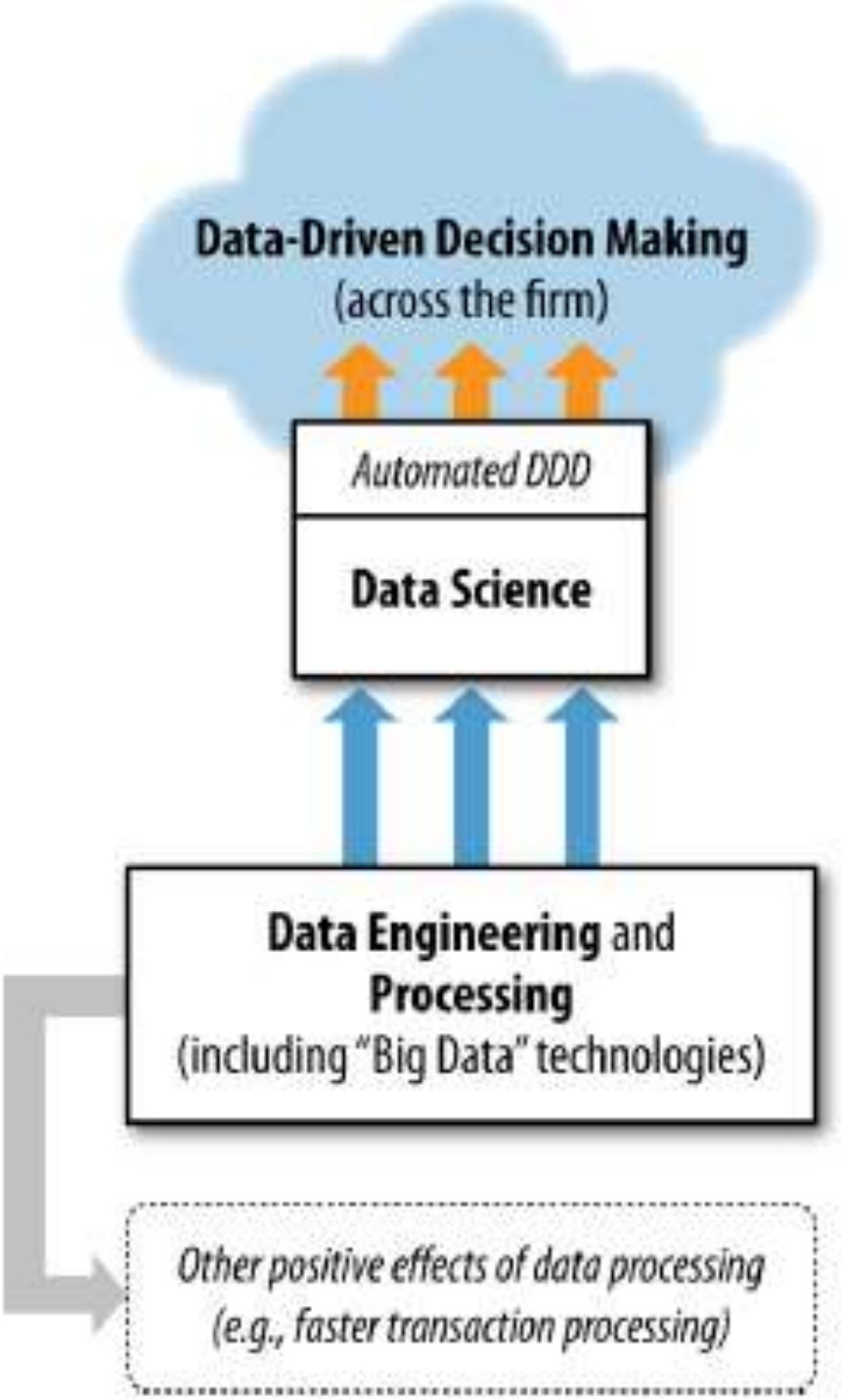
OVERVIEW

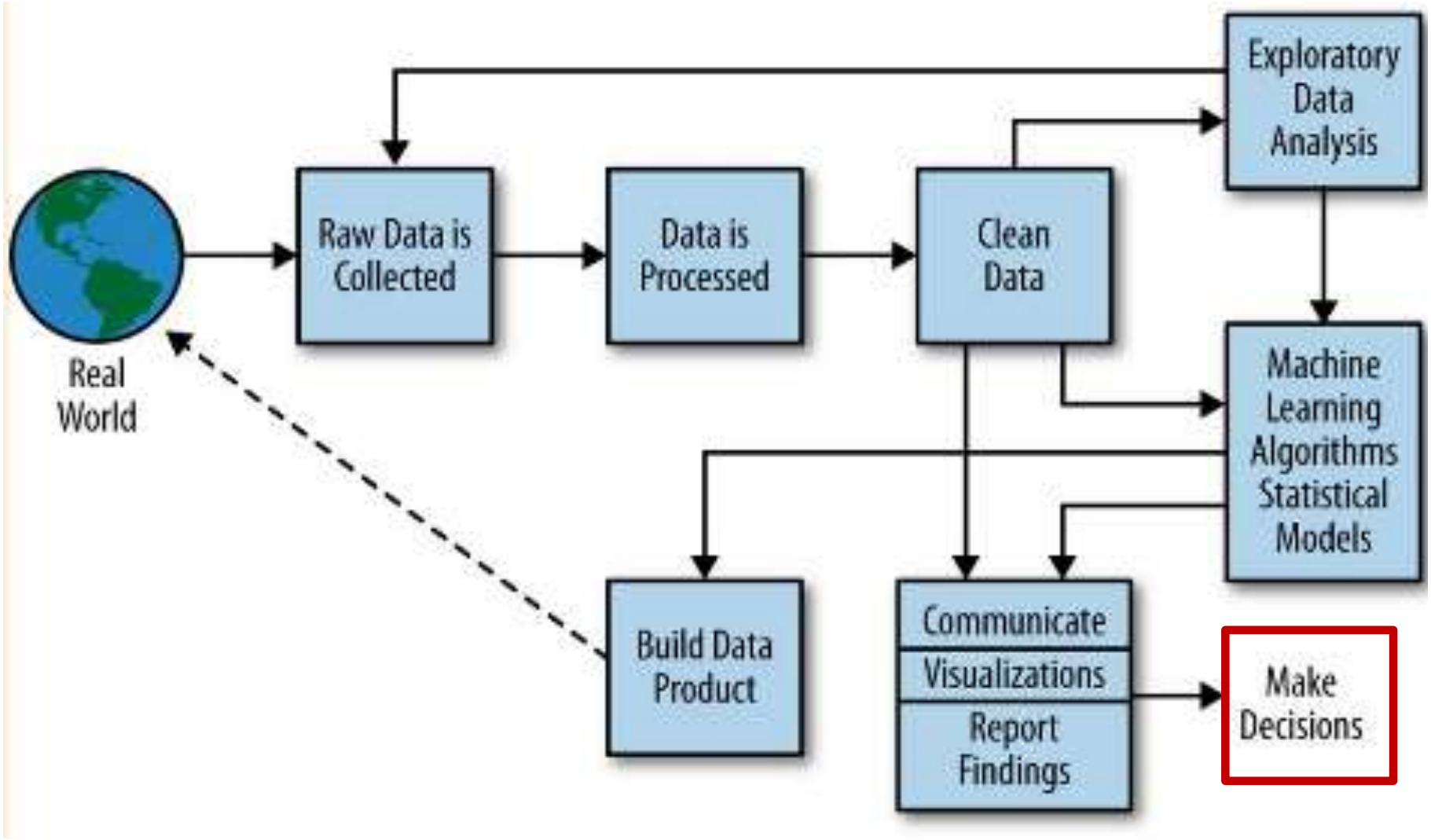
Methods which specify an optimal process to ensure business resources are being focused on key KPIs and measurable results.

METHODS

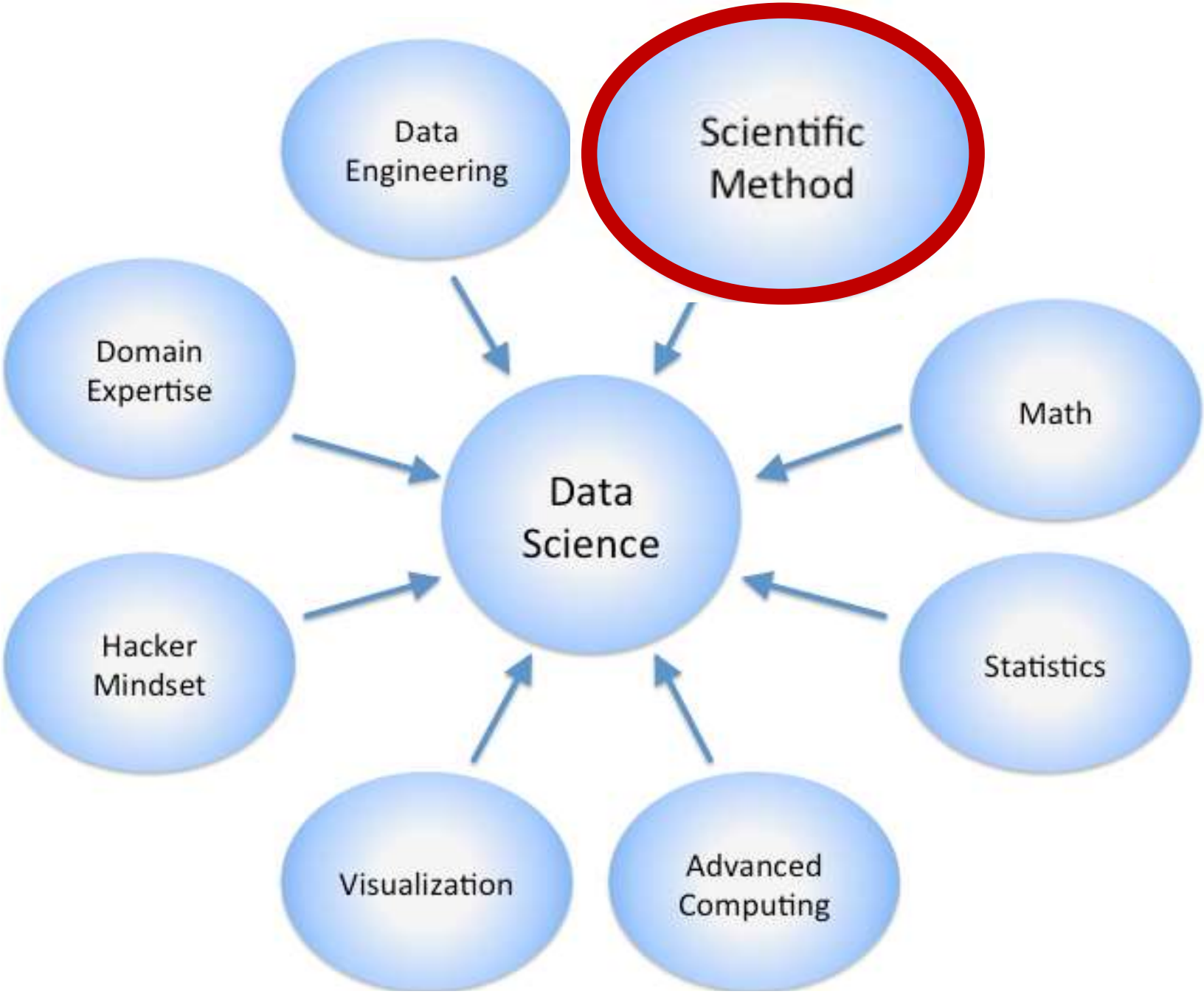
Sensitivity & scenario analysis, linear and nonlinear programing, Monte Carlo simulation.

Provost, F., Fawcett, T. (2013). Data Science for Business: What you need to know about data mining and data-analytic thinking.

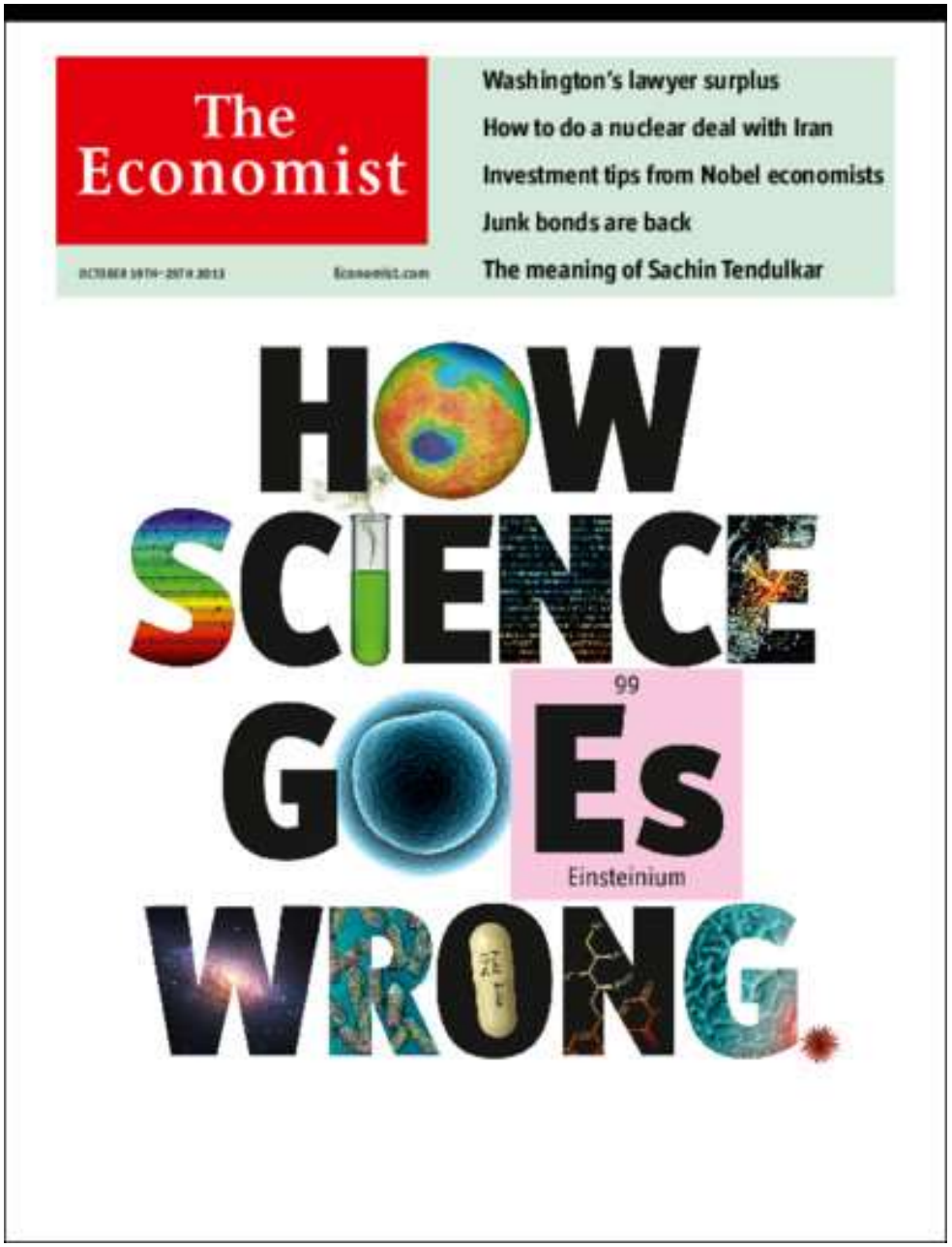


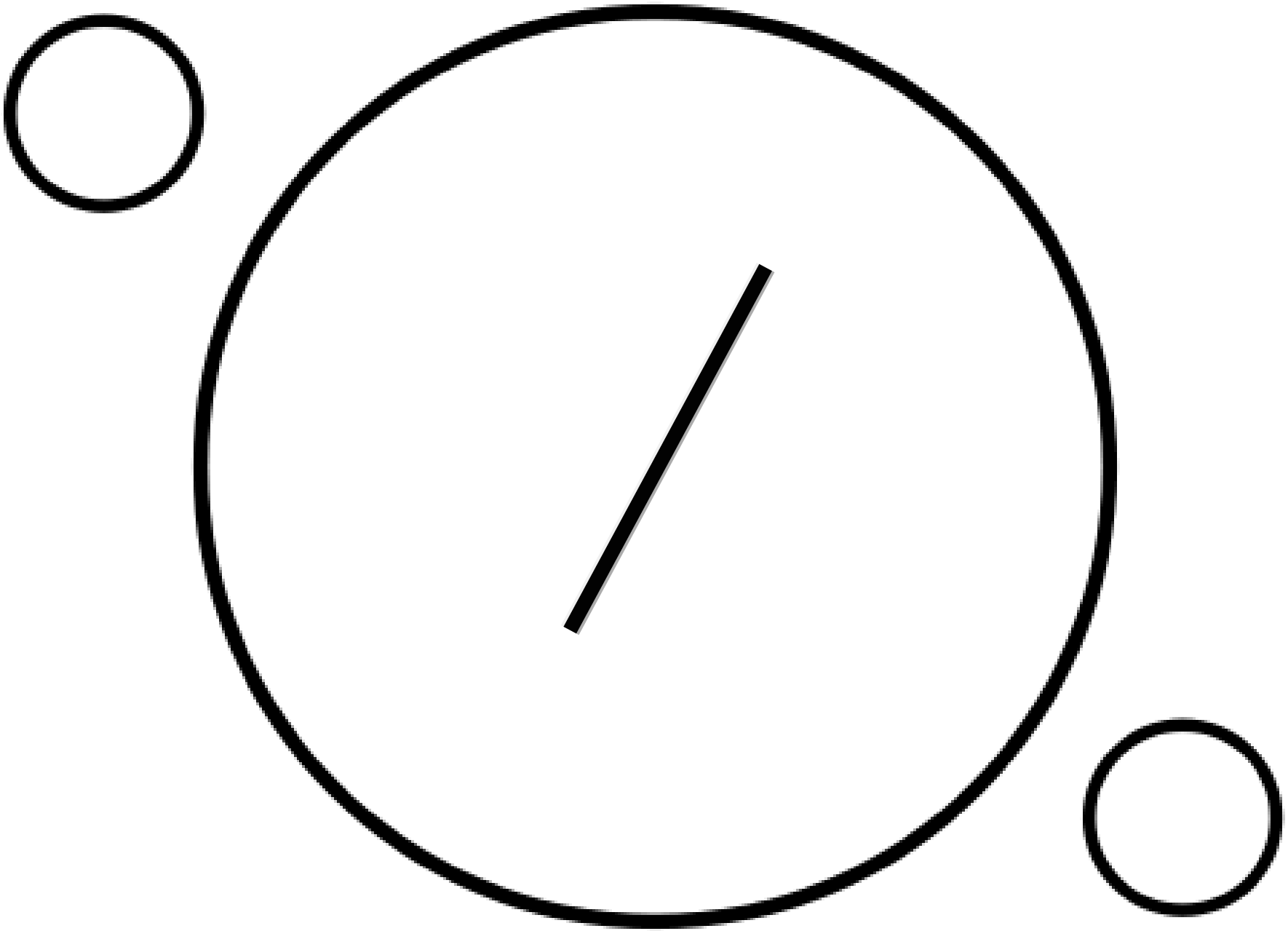


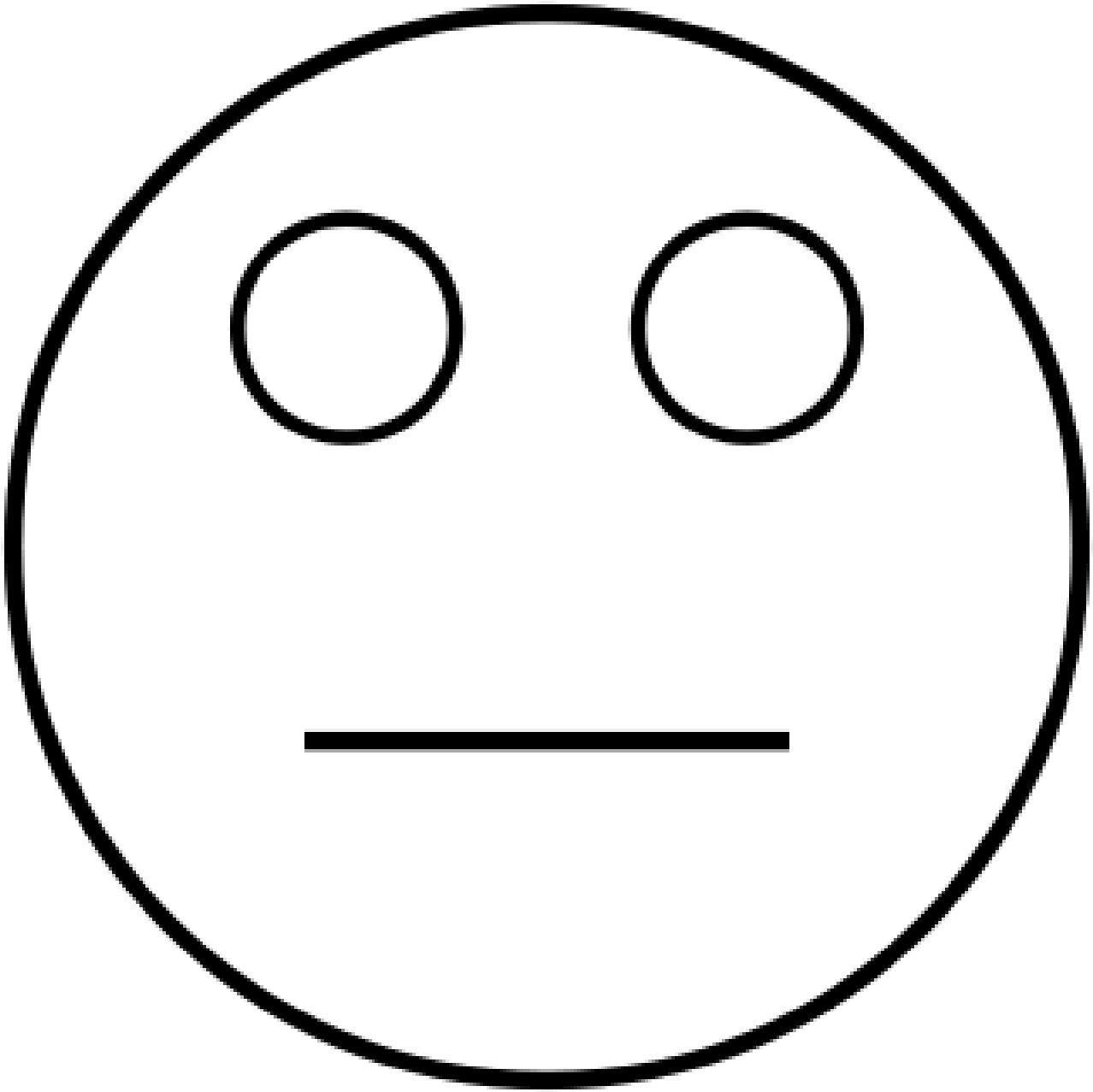
Schutt, Rachel; O'Neil, Cathy (2013-10-10). Doing Data Science: Straight Talk from the Frontline. O'Reilly Media.

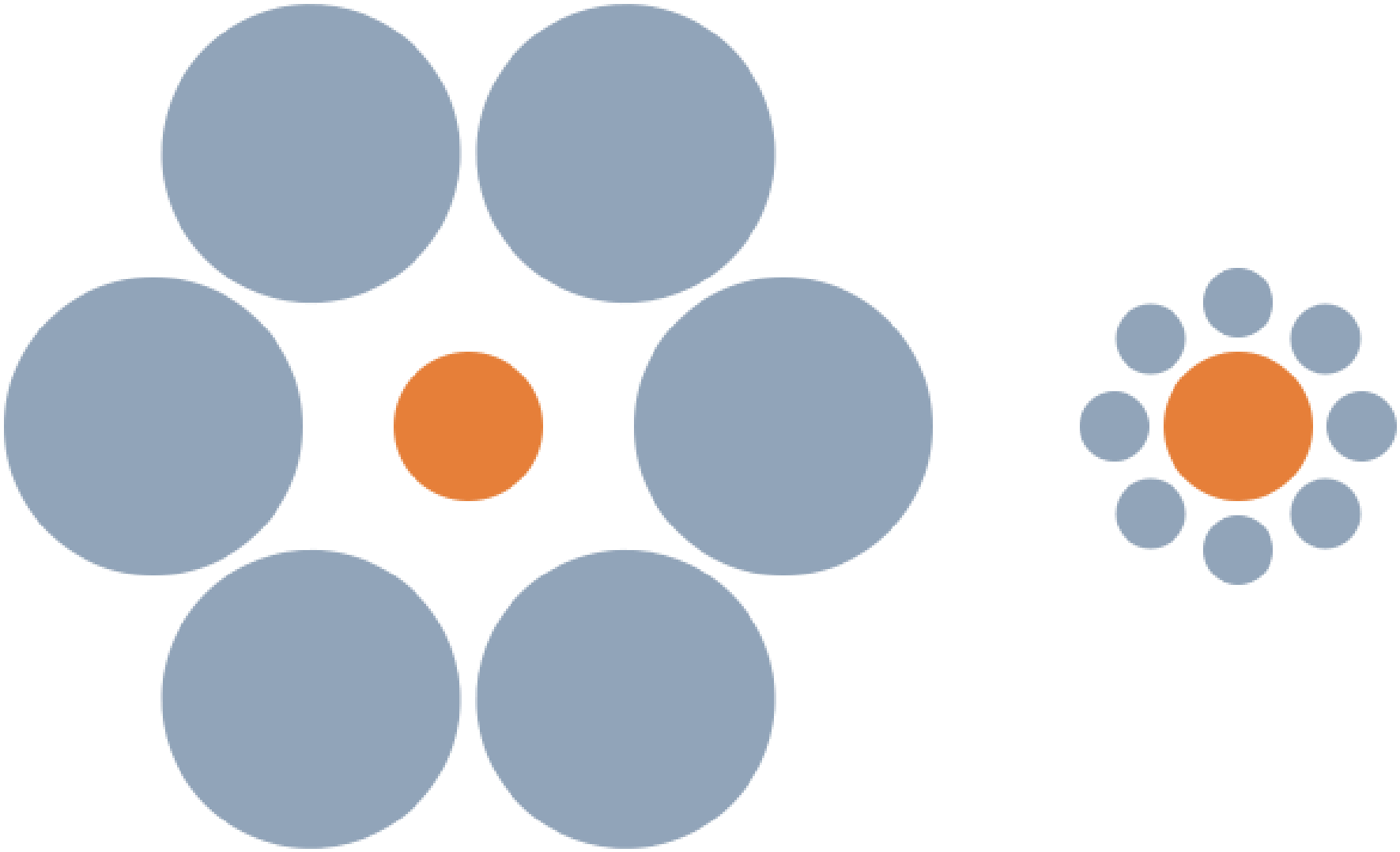


Calvin.Andrus (2012) Depicts a mash-up of disciplines from which Data Science is derived
http://en.wikipedia.org/wiki/File:DataScienceDisciplines.png



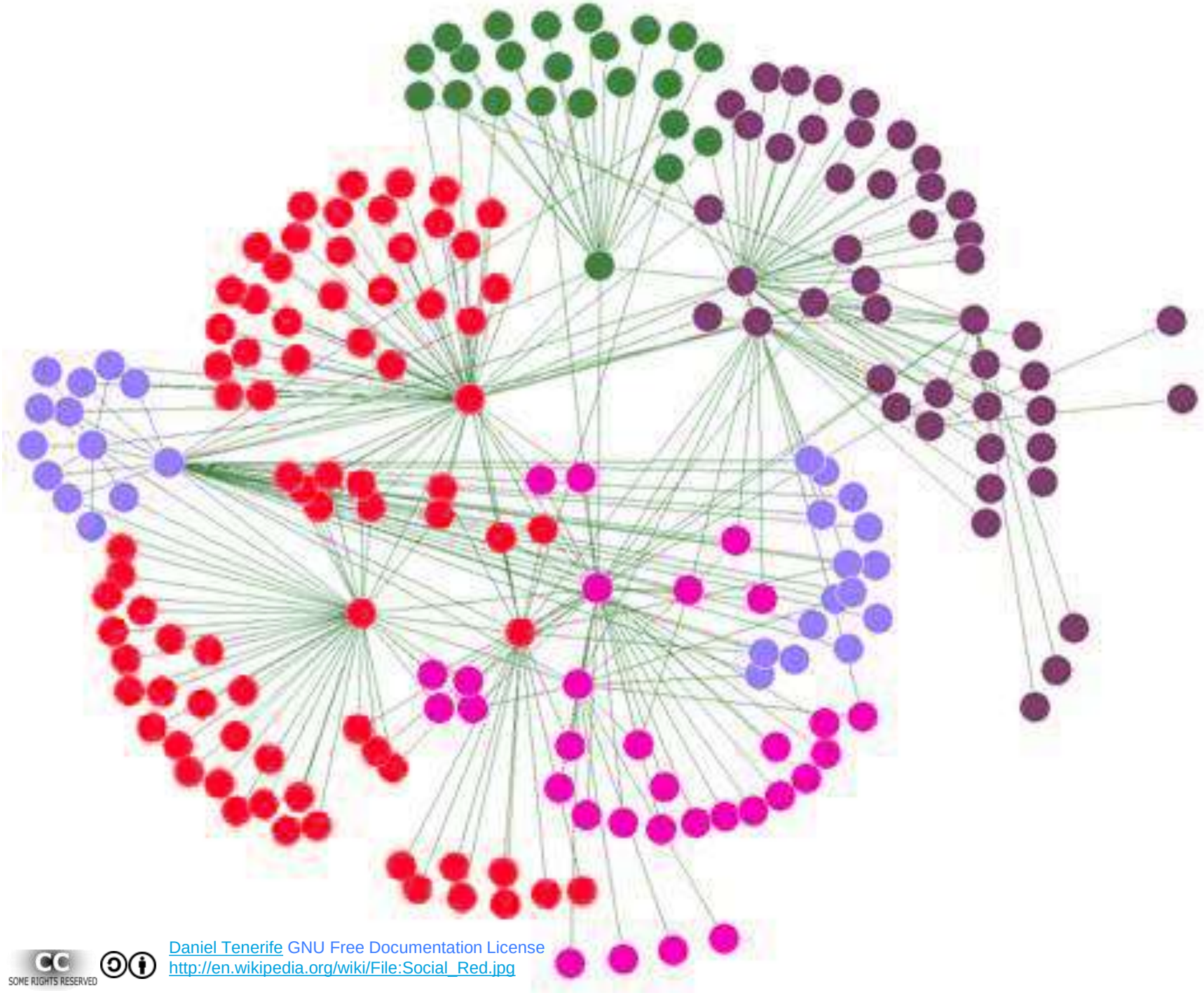




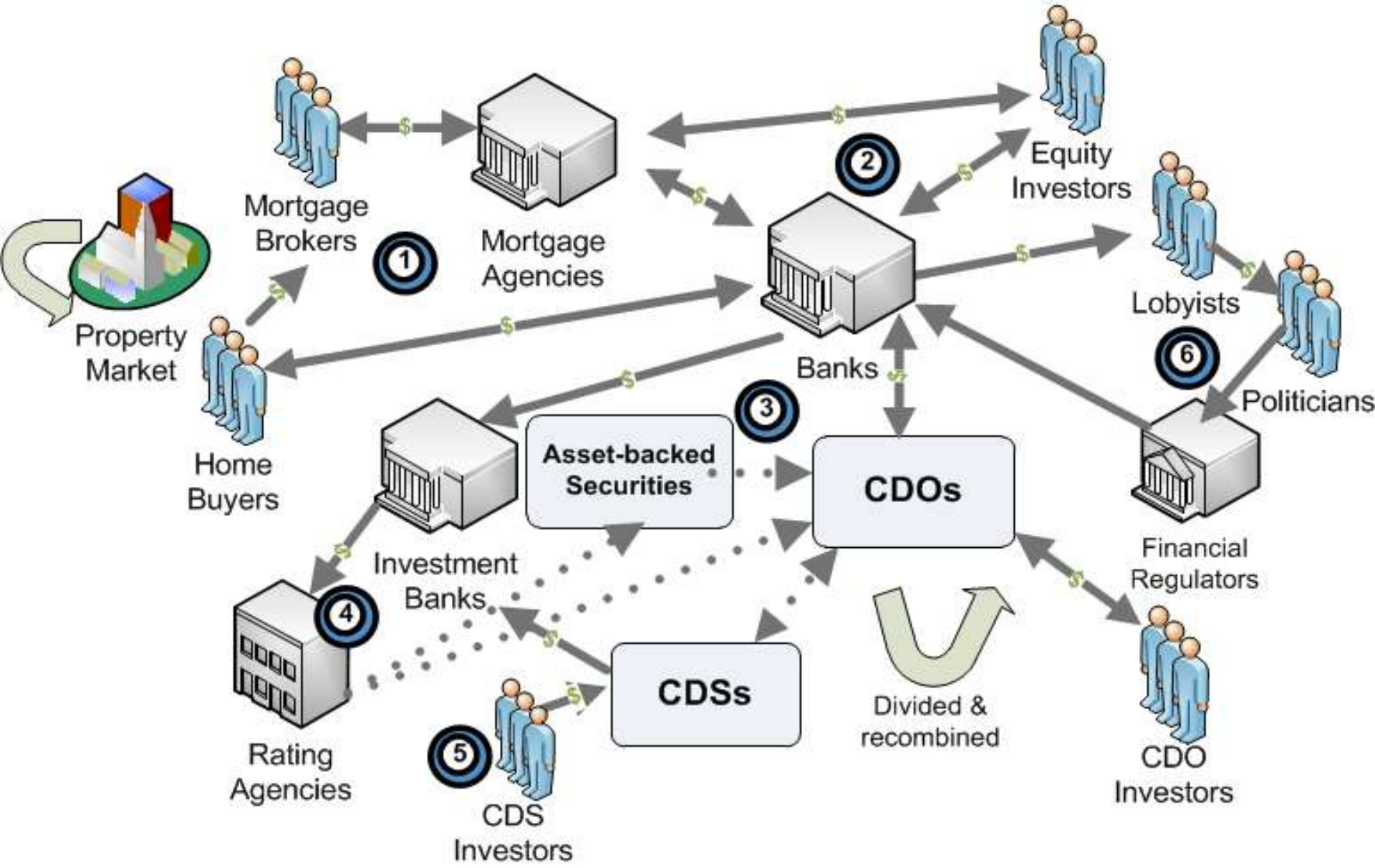


We were built to WIN, not to be RIGHT…

Beat (2007) http://commons.wikimedia.org/wiki/File:100m_women_Golden_League_2007_in_Zurich.jpg

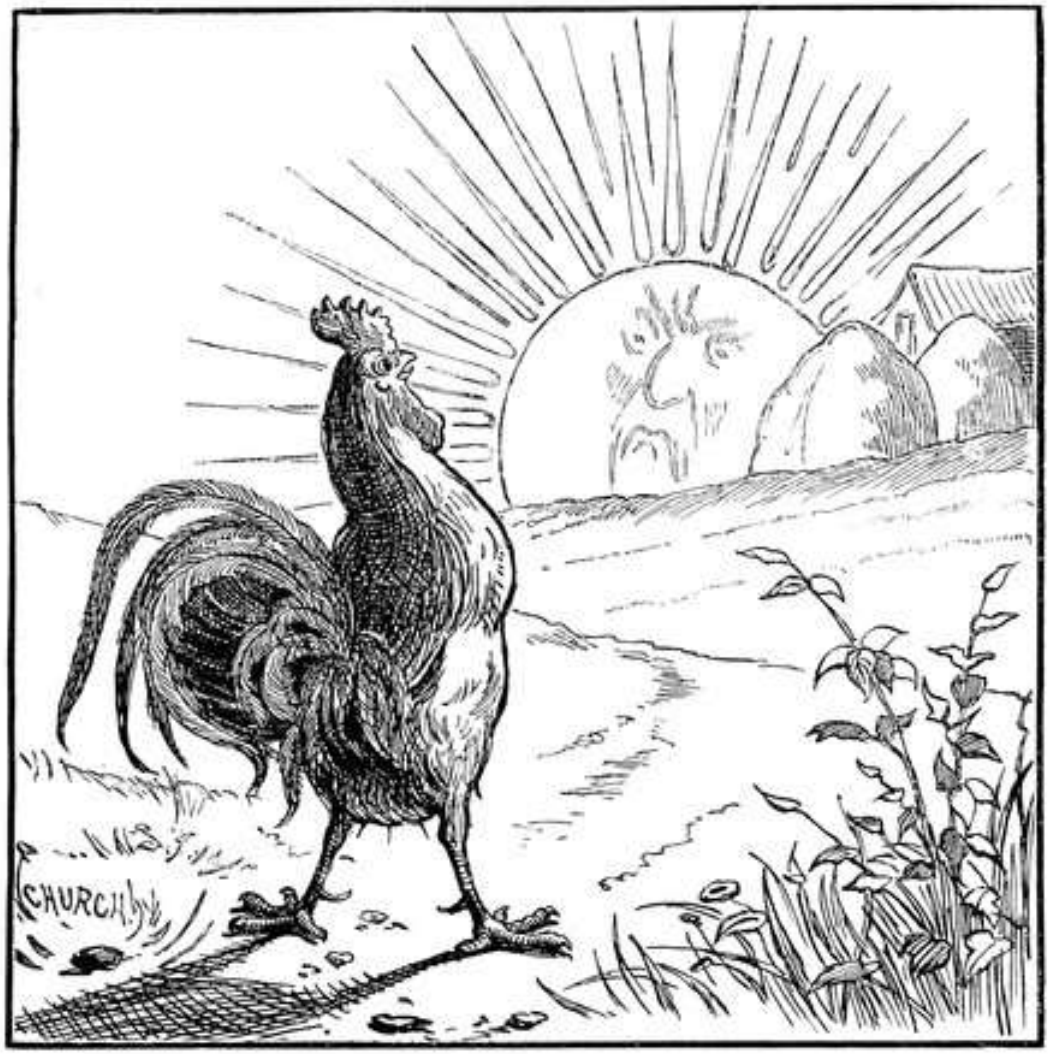


Power of incentives...



->overfitting<-

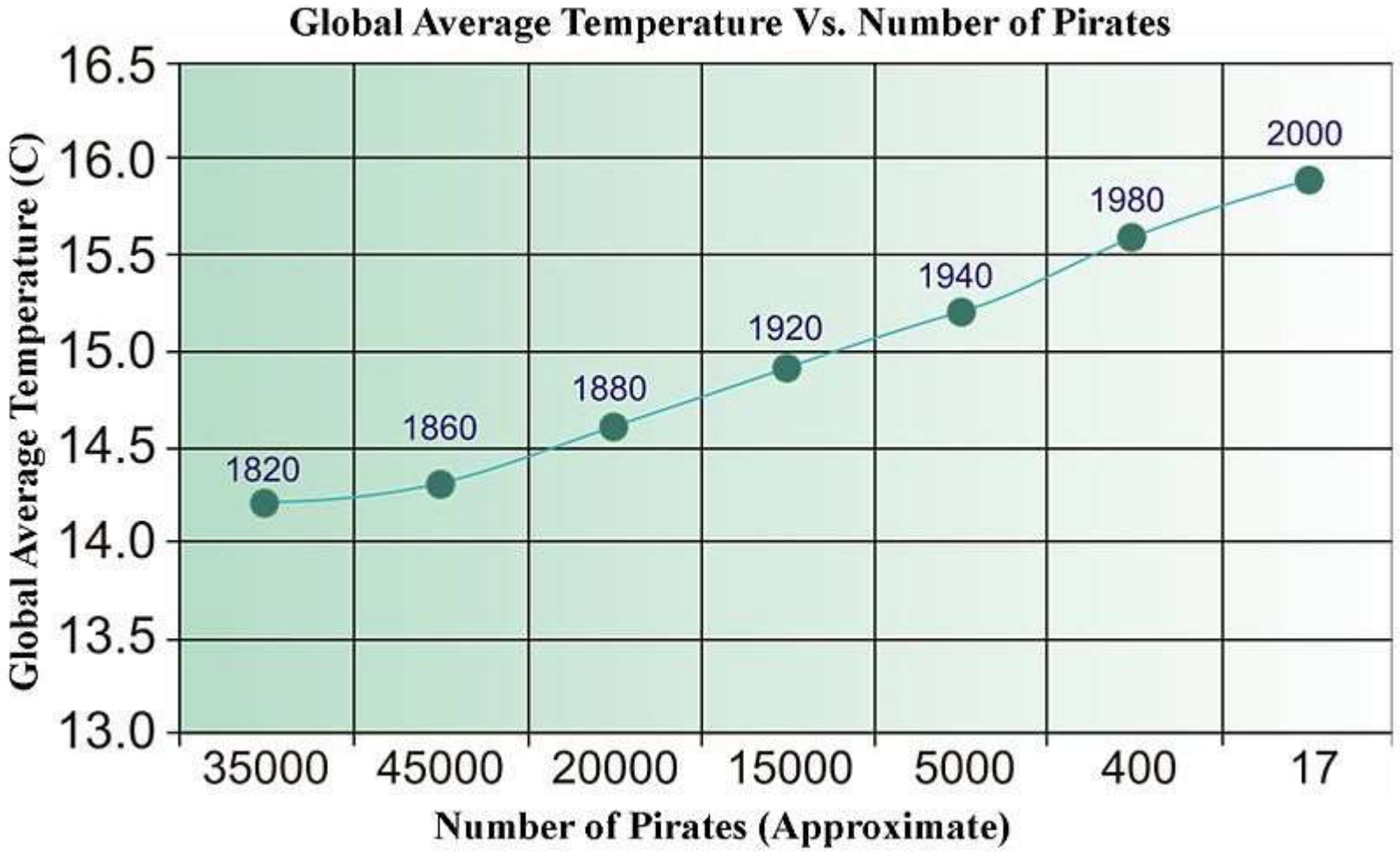
correlation vs. causation



cum hoc ergo propter hoc

http://commons.wikimedia.org/wiki/File:Rooster_Crowing_at_the_Sun.jpg Publisher was Century Company of New York

correlation vs. causation



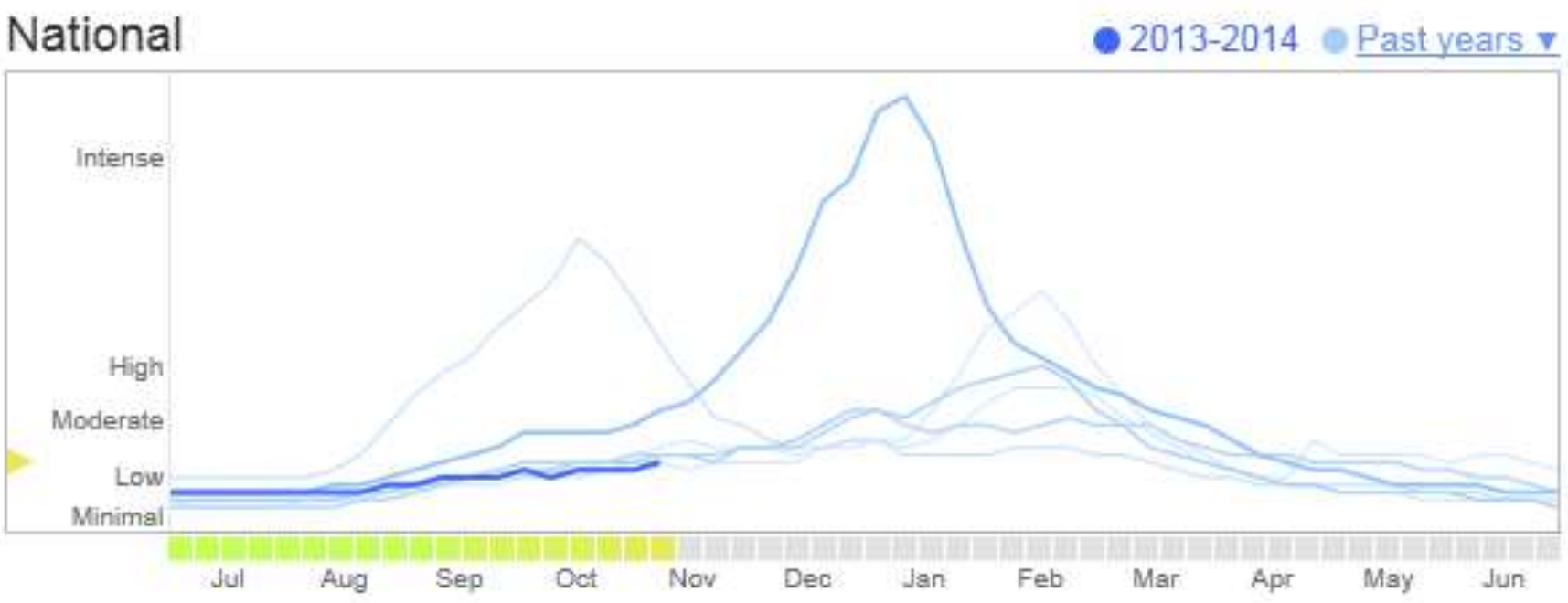
Two events occurring in close proximity does not imply that one caused the other

When the stakes are high, people are much more likely to jump to causal conclusions.

Big Data Approach

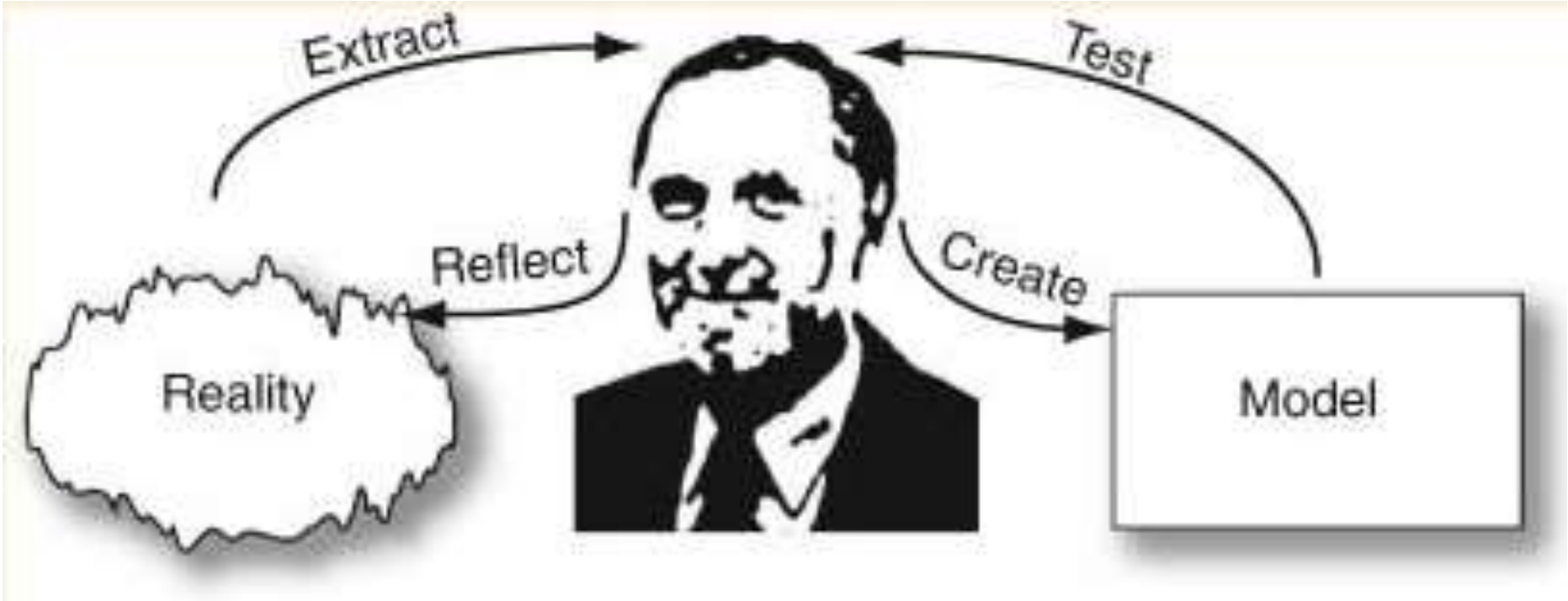
Explore flu trends - United States

We've found that certain search terms are good indicators of flu activity. Google Flu Trends uses aggregated Google search data to estimate flu activity. Learn more »



Cukier, Kenneth Neil, and Mayer-Schoenberger, Viktor. (May/june 2013) . The Rise of Big Data: How It's Changing the Way We Think About the World. Foreign Affairs. http://www.foreignaffairs.com/articles/139104/kenneth-neil-cukier-and-viktor-mayer-schoenberger/the-rise-of-big-data

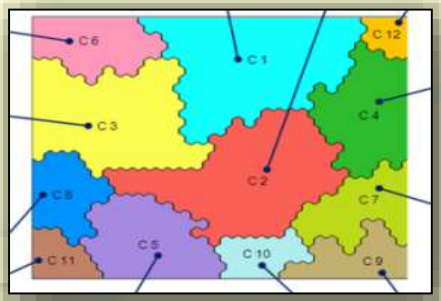
“The model should drive the data, not vice versa.”



Pidd, Michael. 2011. Tools for Thinking: Modelling in Management Science. Wiley.

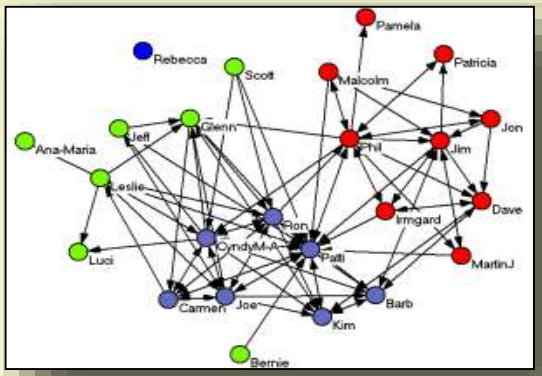
Why is it happening?

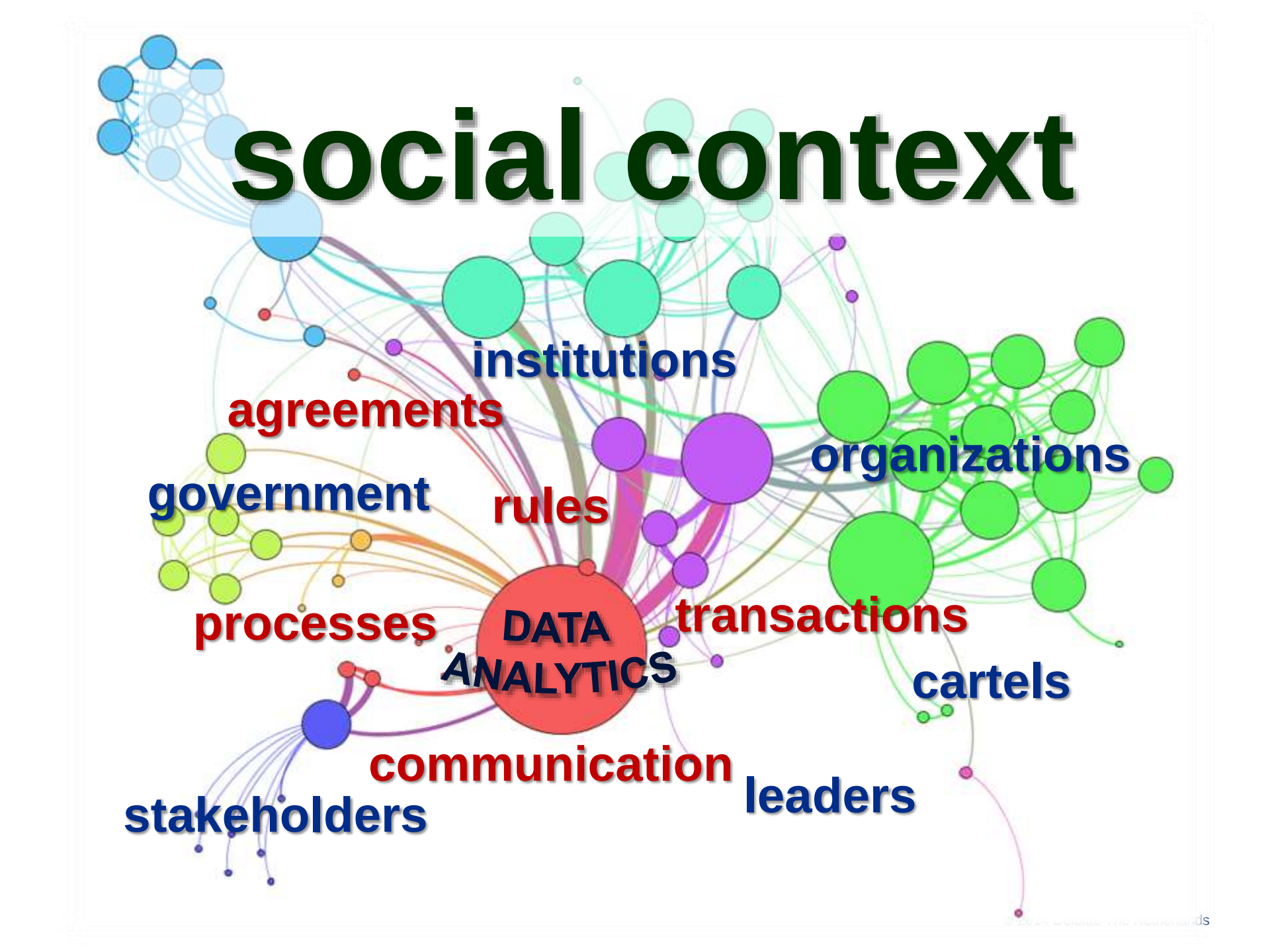
DIAGNOSTICS



What does it mean?

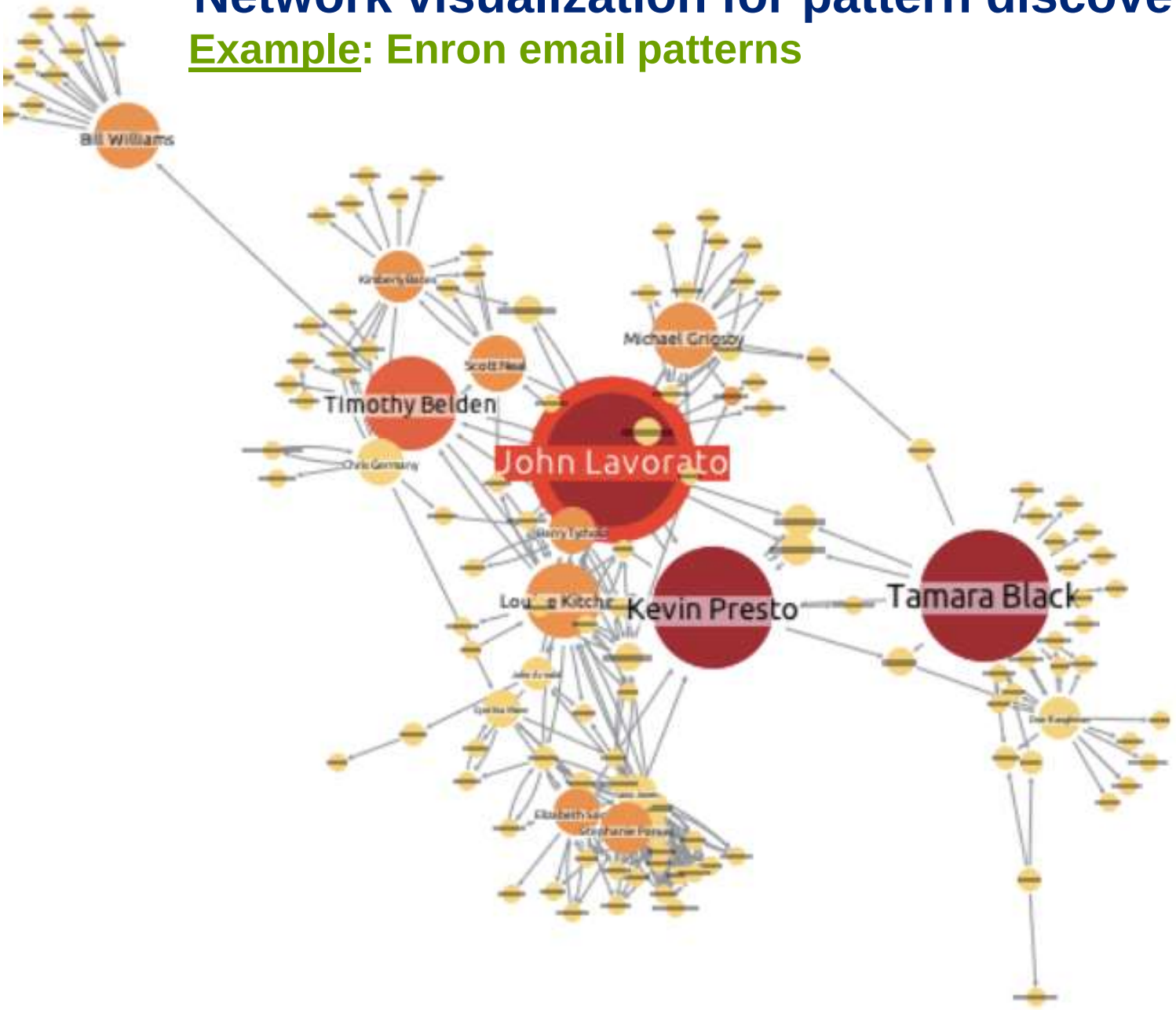
SEMANTIC




social context
institutions
agreements
organizations
government
rules
processes
DATA
ANALYTICS
transactions
cartels
communication
leaders
stakeholders

Network visualization for pattern discovery

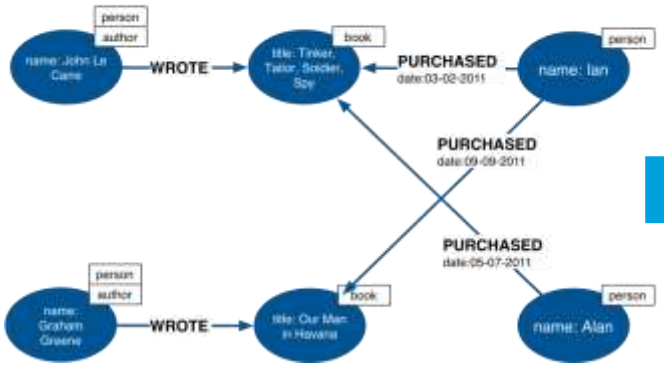
Example: Enron email patterns



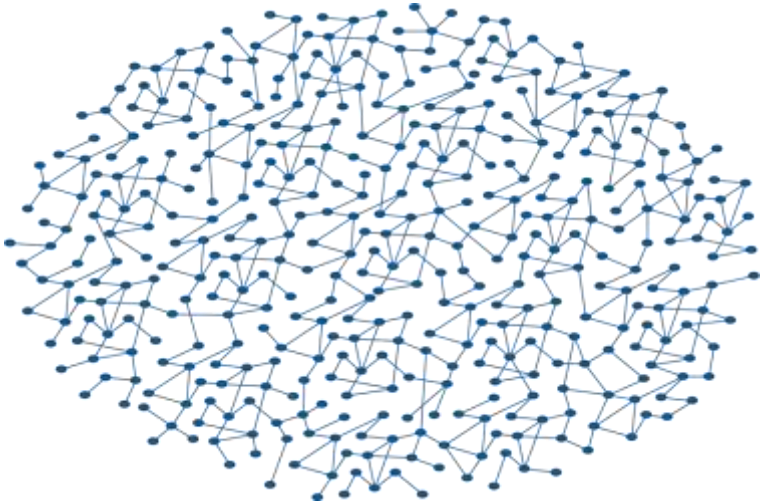
What does network analysis do?

Detecting fraud patterns in large networked datasets

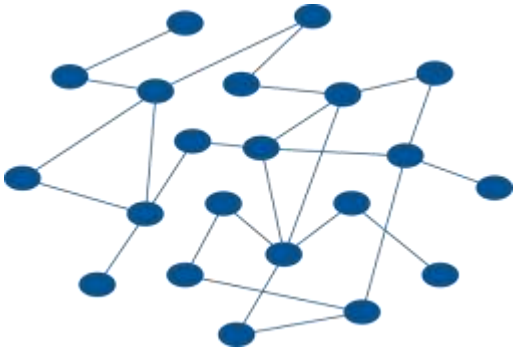
1. **Data encoded as networked relationships**



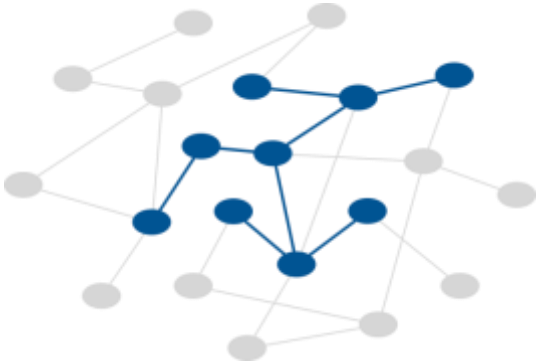
2. **Generate networks of relationships (i.e. people, transactions, property)**



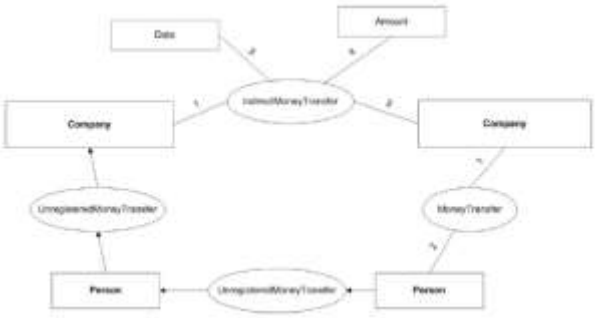
3. **Identify 'normal' and unusual clusters**



4. **Identify potential fraud patterns**



5. **Search for known fraud patterns / rules**



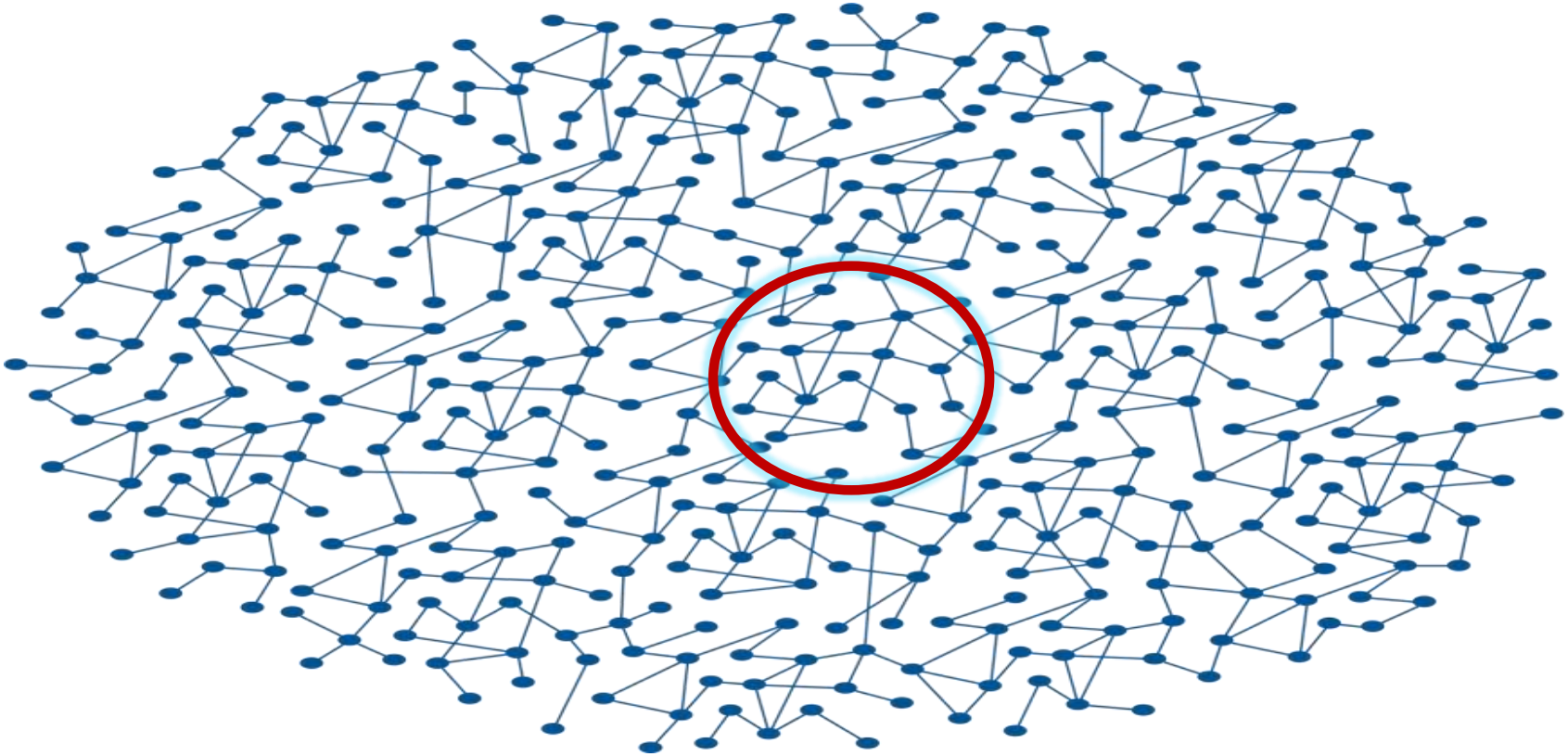
Assemble ‘libraries’ of known, searchable fraud patterns

Example: Simple VAT cross-border gas trading transaction fraud pattern

- Generic, transferable format
- Storing / querying transactional relations
- Basis for fraud pattern ‘libraries’
- Specific domains can be targetted
- Easily modified as patterns evolve
- Allows monitoring of cross-domain fraud (i.e. AML, BTW, and carrousel)
- Provides standard basis for queries / real-time monitoring

3. Detect known fraud patterns in ‘Big Data’

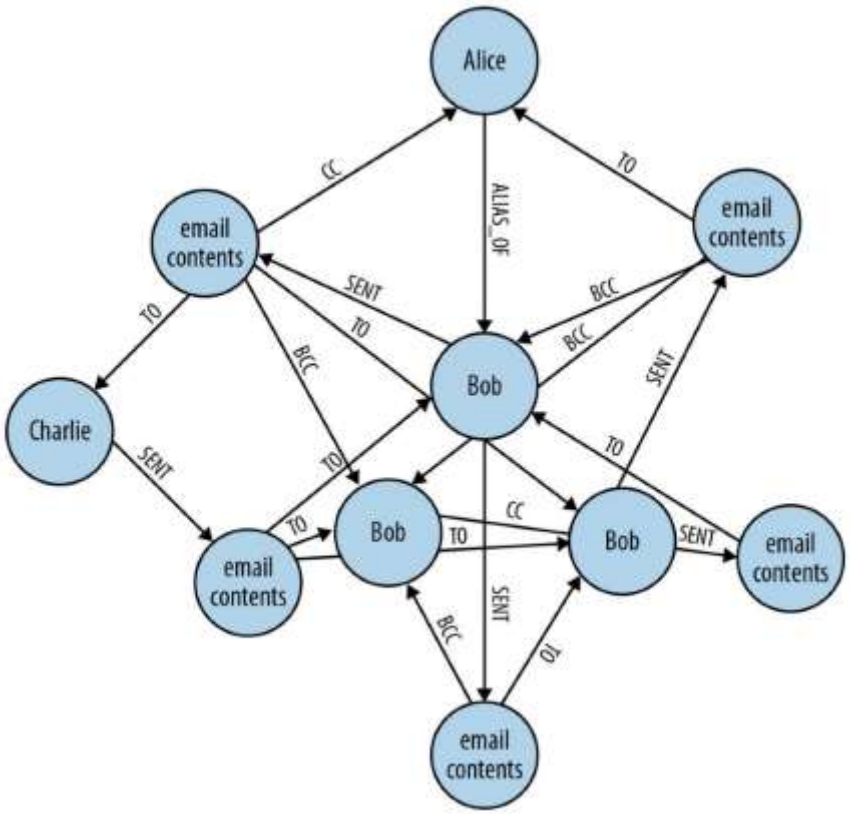
Example: Extracting known VAT fraud patterns from large datasets

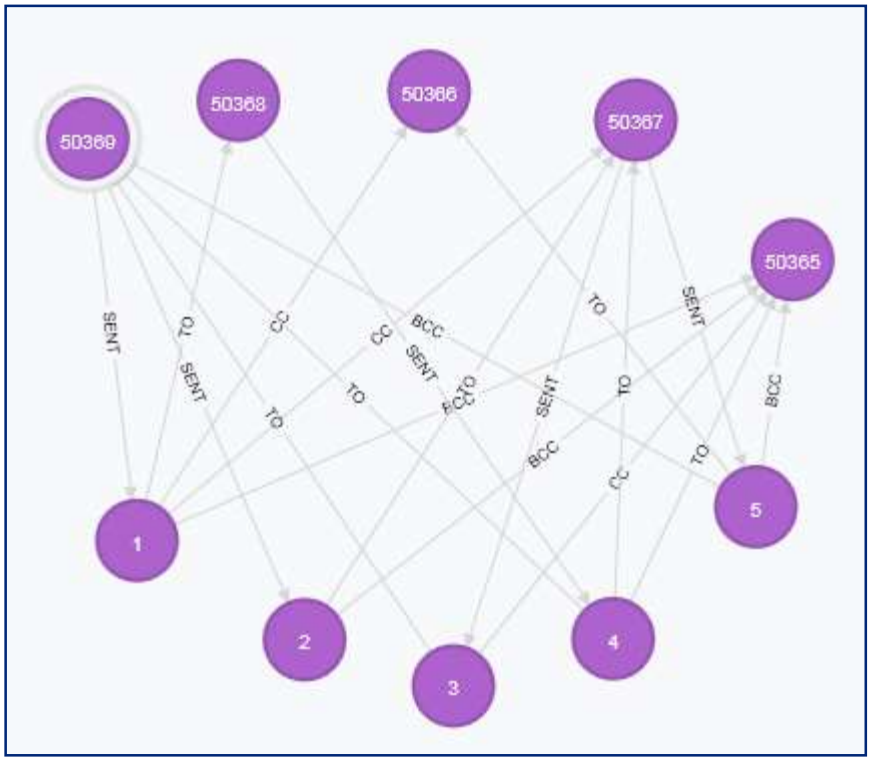


- Scan large datasets for transaction patterns
- Large storage capacity
- High-performance searching / querying
- Identify new patterns via statistical analysis (i.e. clustering, measures of centrality, odd transaction patterns based on sequence and/or date)

Examining patterns in suspect communications

Example: Statistical and automatic pattern discovery in email exchanges





- Suspicious communication patterns (i.e. use of emails, external forwarding)
- Combine communication network analysis with sentiment scoring (i.e. use of negative terms) and/or semantic analysis (content analysis)
- Method used by many intelligence agencies to detect criminal and terrorist networks
- Can combine other entities to enhance analysis (i.e. transactions, company ownership)

Continuous Fraud Monitoring and Detection via Advanced Analytics

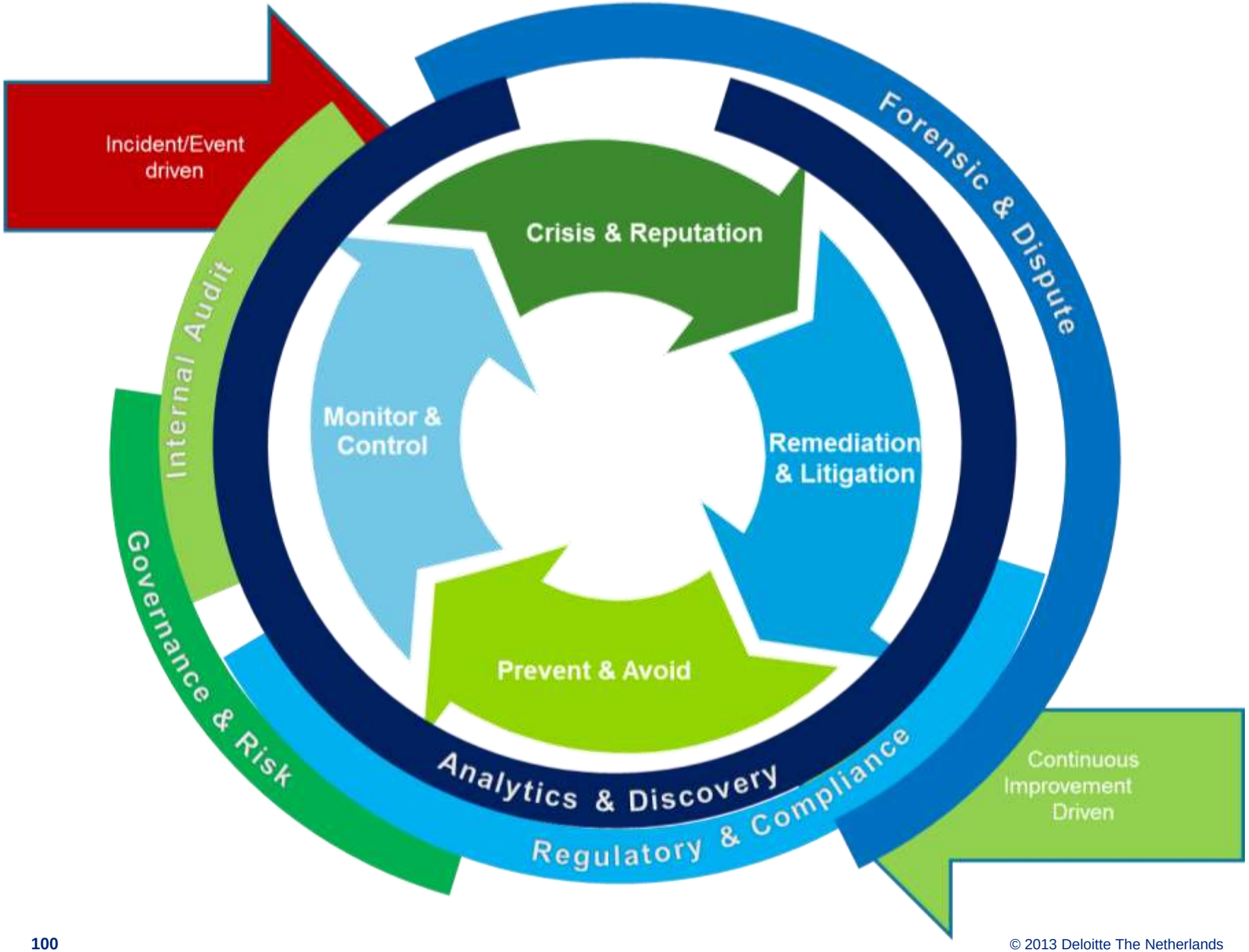
State-of-the-Art Trends and Directions

1	Fraud in context
2	Advanced analytics
3	Fraud analytics
4	Trends and directions
5	Practice approach

V. Practice approach

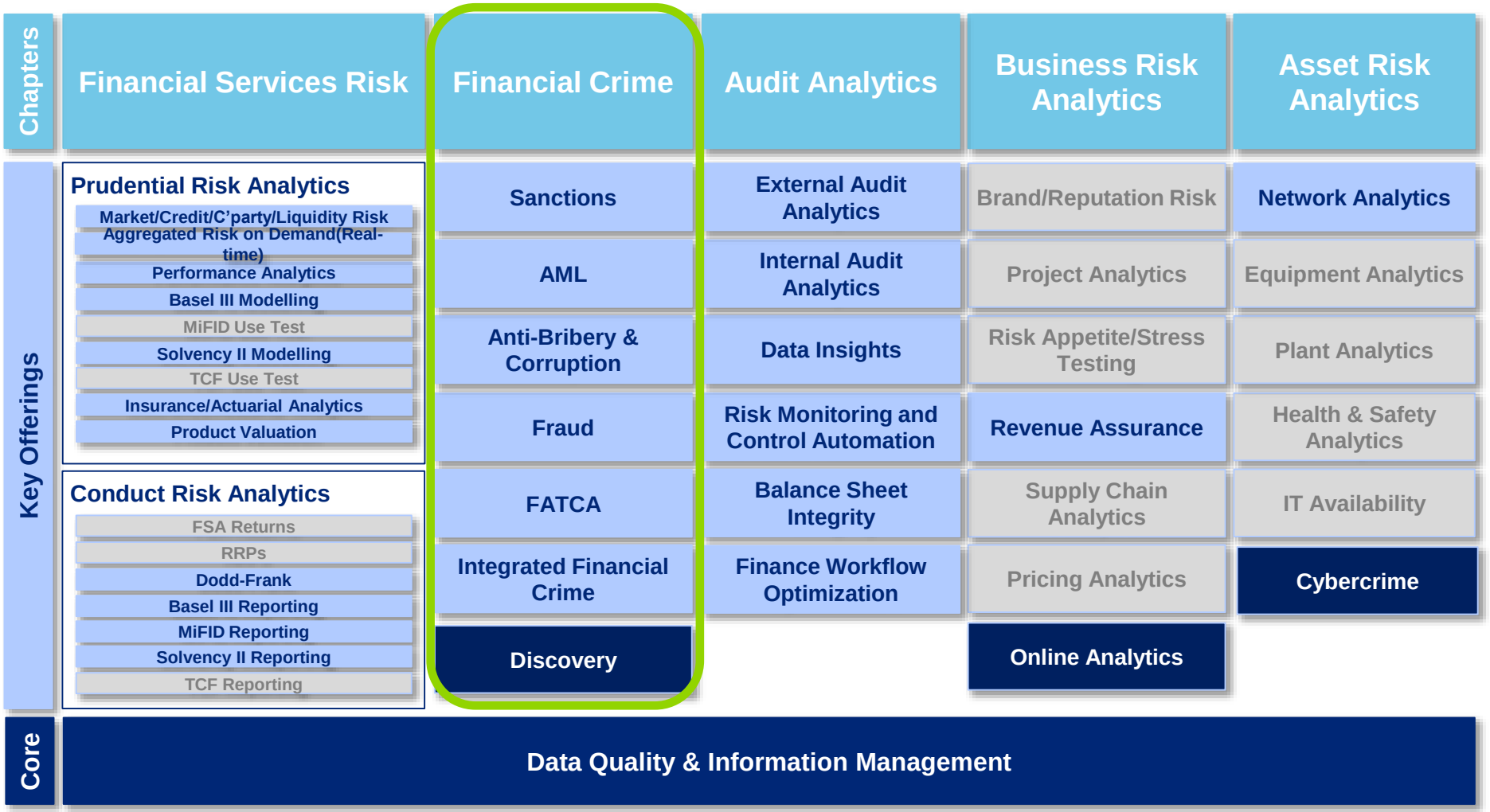
How we can support

As a though leader in the analytics domain, Deloitte delivers data-driven solutions to detect and mitigate fraud, corruption, and business risk issues



Deloitte Risk Services

Practice areas

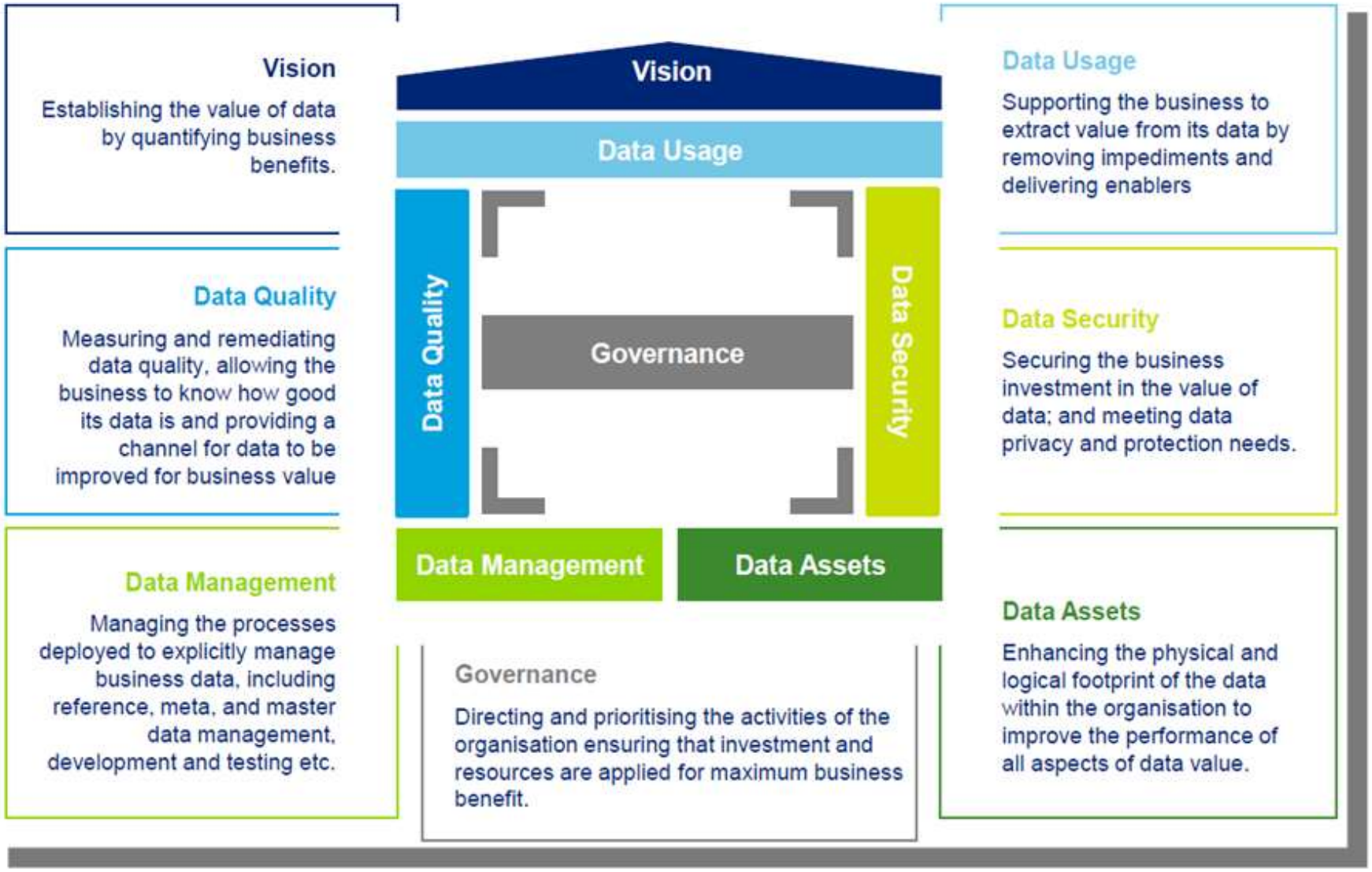


FSI VERTICAL SERVICE OFFERINGS

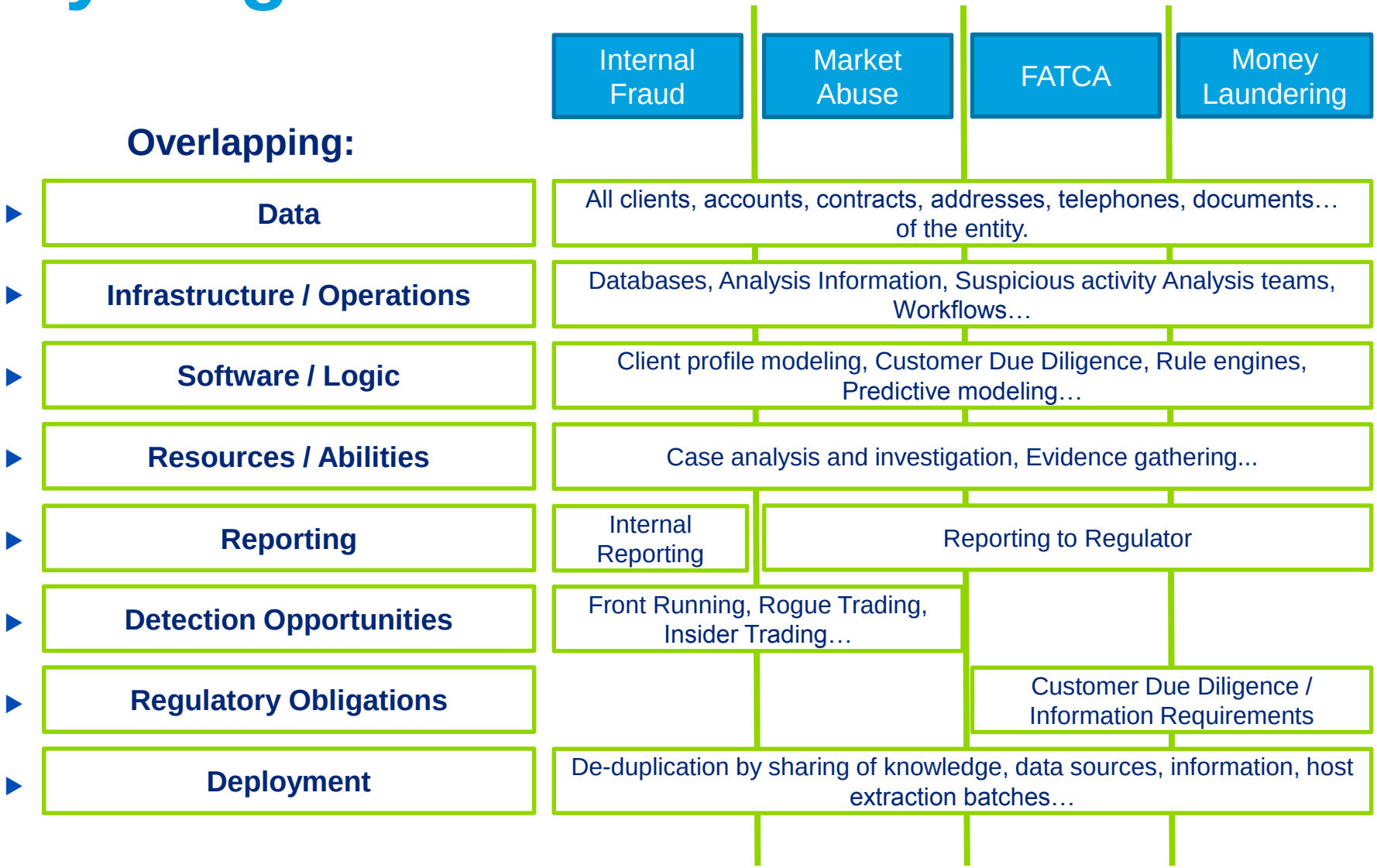
SCALE OF OFFERING

	Financial Crime / Fraud	Advanced Analytics	Data Governance	Compliance / Assurance
Continuous Monitoring / Transformation	Continuous monitoring / improvement	Full process solutions: Big Data infrastructure + organizational process transformation	Master Data Management (MDM) Organizational transformation	Compliance / assurance as strategic improvement: data governance, data quality, MDM, process improvements...
Mid-Level Enterprise	Integrated dashboard, alerts, analytics, data management	Dashboards / KPIs	Data standardization, ETL scoping, implementation	Dashboard + internal reporting, ETL & data quality
Advanced Deployment	Leased fraud monitoring service	Cloud-based (leased / subscription) or cloud POC	Data quality audit Data governance	Subscription-based compliance solutions
Project-Based One-Off Solutions	One-off “fix-it”	Targeted advanced analytics	Data migration / transformation project	One-off compliance reporting fix
Maturity Assessments	Risk assessment	POC / assessment	Data maturity assessment / best practices	Compliance / audit assessment

Information management foundation



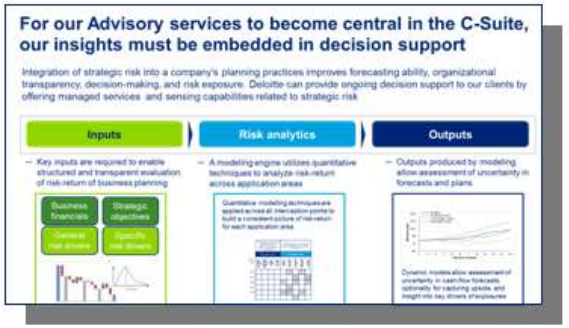
Synergies



Allied product / service practices

Strategic Risk Initiative

Deloitte's comprehensive approach to strategic risk helps companies better understand risks to and of strategy.

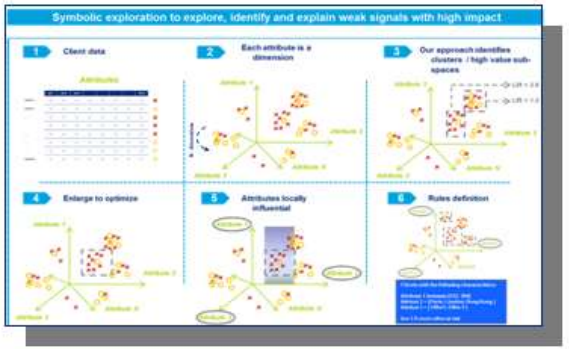


Integrated Financial Crime

Helping organisations to 'join the dots' across monitored data sets to provide more accurate, reliable and timely financial crime intelligence that will help identify criminal activities that would otherwise have remained undetected.

Advanced Knowledge Discovery

An acquisition, specializing in advanced, non-parametric, knowledge discovery analytics. State-of-the-art technology based on Artificial Intelligence, fully operational and in use at a variety of clients.



ERS context 2

Allied product / service practices

Conduct Risk Analytics: PROACT Library

The PROACT library is an interactive tool to help organisations understand the complex inter-linkages between regulations and the data management controls required to meet these standards.

Credit Risk Analytics: IFRS9 Impairment Analytics

An application that calculates the IFRS 9 impairment results and impact based on methodology and assumptions choices, enabling variations to be played out across “bucket” definitions, methodology options and macroeconomic scenarios.

Allied product / service practices

Transaction Reporting Analytics

Providing cross-product, cross-business unit insight on trading behaviours, enabling identification and prioritisation of transactions requiring further investigation.

External Audit Analytics: Spotlight

The Spotlight platform provides audit teams with a self service Audit Analytics platform, containing our leading standardised analytics set, available with up to date client data, 365 days a year.

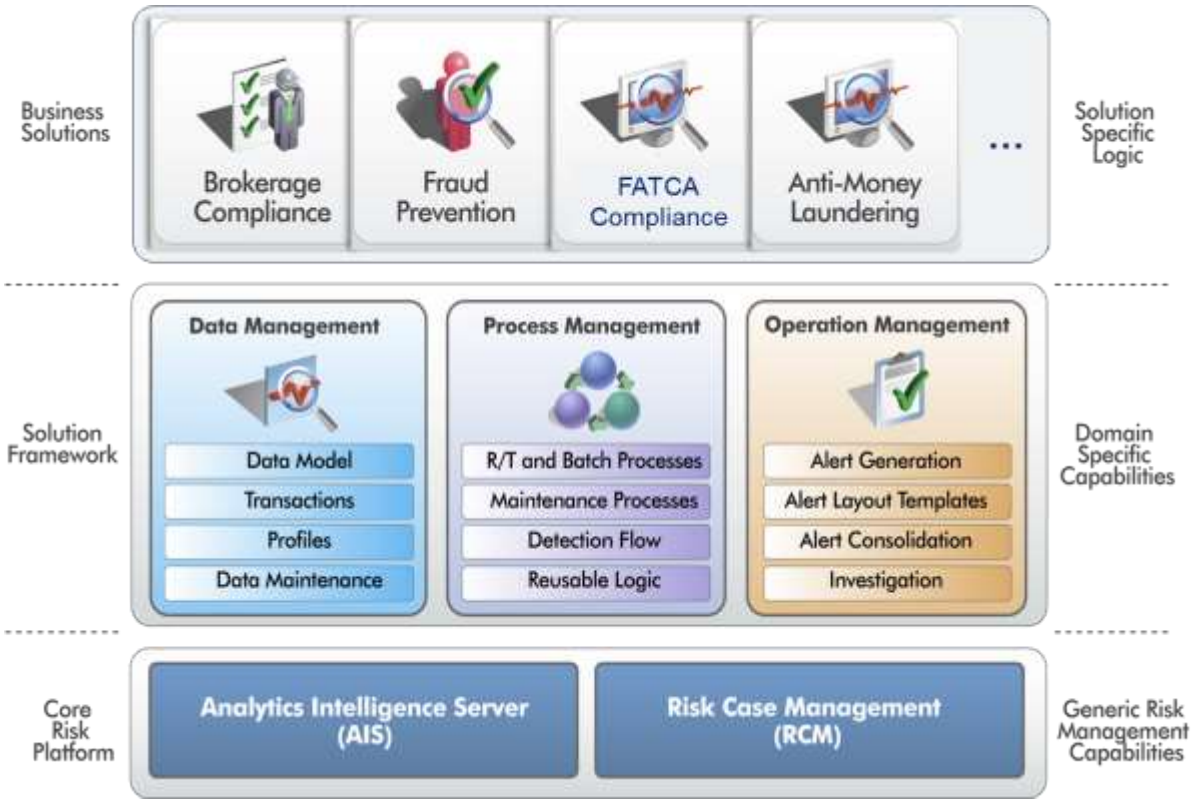
How does ERS take Analytics to clients?

Successful uses of analytics are always rooted in real business problems

	Applying analytics…	For example:
Assurance	…to scale the insights drawn from audit, and slashing the time-to-realise insight	• Spotlight • Reconciliations • Balance sheet integrity • Risk monitoring and control automation
Finance	……to measure, control, and optimise financial management processes	• Transaction reporting analytics • FINREP/COREP • Stress testing
Financial Crime	…to integrate disparate data sets thus spotting collusion and cross-topic fraud	• Integrated financial crime • AML transaction monitoring optimisation • FATCA
Governance, Regulatory & Risk	…to measure, monitor and mitigate enterprise risk and help ensure compliance	• DRAGONFLY • IFRS9 Impairment Analytics • Strategic Risk Initiative • Risk Transformation

The IT Solution: Automate Financial Crime Solution

- Automatic and efficient **enterprise-wide case manager**
- Wide offering as an “Out of The Box” solution combined with complete flexibility and capacity to implement custom needs and adapt to customers
- It enables incident response by supporting investigation, auditing and reporting workflows



Risk Assessment

Policies & Procedures

Prevention

Detection

Reporting

APPENDIX

Academic references of interest

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Decision Support Systems, Volume 50, Issue 3, February 2011, Pages 602-613

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The application of data mining techniques in financial fraud detection: A classification framework and an academic review of literature Original Research Article

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Fraud dynamics and controls in organizations Original Research Article

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Jon S. Davis, Heather L. Pesch

A process-mining framework for the detection of healthcare fraud and abuse Original Research Article

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Wan-Shiou Yang, San-Yih Hwang

Our global financial crime footprint

Global Highlights

Our global practice consists of over 450 Financial Crime practitioners.

We have one of the largest and most mature Financial Crime practices that delivers seamless and consistent services for our global clients.

Core Competencies

Assessing Financial Crime risk at the enterprise and business unit level.

Assessing internal controls.

Identifying Financial Crime risks associated with customers, products, services, channels and geographies.

Selecting technology solutions that address the risks identified.

Implementing technology solutions and optimizing their performance.

Performing Financial Crime Compliance programme assessments.

Assessing the organisational and governance structures designed to support Financial Crime programmes.

Drafting and enhancing enterprise wide and business line specific policies and procedures.

Creating and delivering training programmes.

Conducting forensic transactional analysis.

Global Presence

Unique Qualifications

We have been assisting financial institutions develop, implement and maintain effective Financial Crime programmes for over 20 years.

Our Financial Crime professionals are comprised of former bankers, bank regulators, IT specialists, federal prosecutors, compliance officers, statisticians, and industry specialists.

Our Financial Crime professionals are thought leaders in the field. We are invited regularly to speak at Financial Crime conferences and seminars around the world.

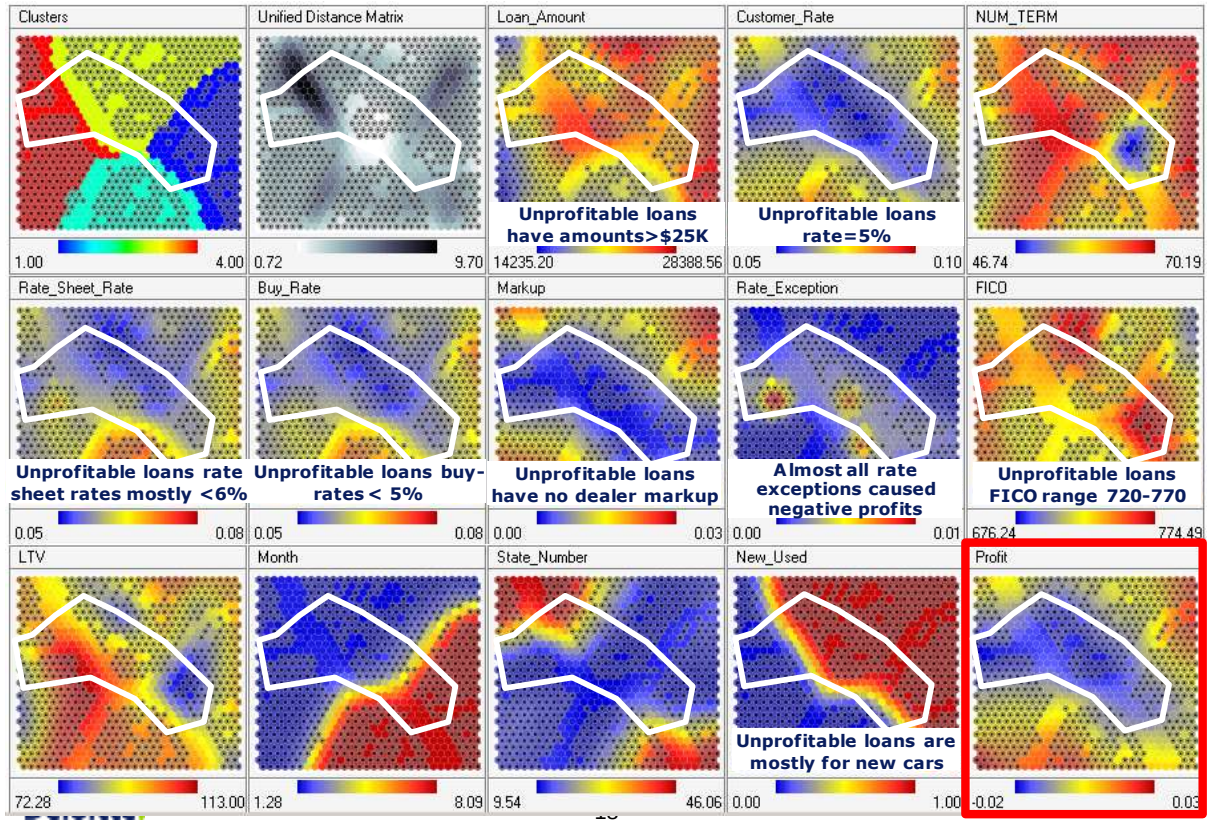
Analytics hubs around the world provide Financial Crime analytics services.

NETHERLANDS CASE: Financial Crime Analytics - Revenue Leakage Analytics

A large financial services organization contracted Deloitte to identify and profile unprofitable loans as well as quickly determine drivers of unprofitable loans to predict future ones.

Approach

Deloitte analyzed over 160,000 historical loan transactions across 12 variables and through self-organizing maps and neural network analysis, were able to profile the loans, identifying the profitability by regions and dealers.



Value provided and benefits that the client achieved:

- Predictive models improved the understanding of the relationship among the variables
- Discovered three key drivers, which have the same impact on loan profitability
- Helped increase overall profitability of loans

NETHERLANDS CASE: Uncovering fraud using advanced data visualisation

HINDSIGHTVR

Client Need

- Presentation of complex evidence or investigative findings to Clients, or in a Courtroom, Tribunal or Investigative Hearing.
- To preset complex and/or highly technical evidence in an easily understood way – telling the story
- Report created for client tells the full picture to a level of detail - what is needed to be presented is the “Executive Summary” supported by the detail where appropriate. We can provide the “Electronic Executive Summary”
- People increasingly take in information visually – think of how presentation of the news uses graphical techniques compared with the “newsreader telling the story “ of a few years ago
- Software designed for analysis and investigation does not always offer the most appropriate format for presenting conclusions, especially where these need to be related to other data or evidence

Deloitte Approach & Tools

- Deloitte work with HindsightVR who are specialists in evidence presentation
- Dpict brings together all the materials into one easily navigated desktop whatever the media format
- Visualisation of concepts and pulling together of related strands of information into a single picture - chronology, relationships, computer contents, organisational structures etc – and presents the results in a single screen
- Interactive graphics for dynamic and flexible presentation of information
- Database controlled, menu driven, easy to operate

Outcome / Benefits

- Effective presentation of findings in an easily understandable way
- Brings clarity to complexity
- Aid to Counsel in presenting evidence, equally suitable for presenting findings to Clients or for company internal briefings
- Cost effective :
  Savings in Court time = Savings on external fees for Counsel etc.
- Provides support to enable expert witness evidence to be more easily understood
- Differentiator from service of other firms

Deloitte Analytics Input

The Deloitte team collected data from structured and unstructured sources to perform analysis to identify high level and detailed findings for the investigation.

The high level findings were collated and fed into Dpict in order to provide the client with a single view of the summary of the key findings.

It provided an accessible way to display the findings of specialist financial, computer and technical expert investigators, making it ideal as a support to their witness evidence in Fraud and Commercial Dispute matters.

The Presentation System also provided the facility to drill down to the supporting detail in order to support the complex associations with all of the key findings.

ITALY - Deloitte Financial Advisory S.r.l.

Financial Crime Investigation Case Study – Data Analytics Applied to Intangible Expenditures

The **General Counsel** of a primary international Group operating in the defense industry has asked Deloitte, as external and independent advisor, to conduct a preliminary investigation regarding past transactions carried out by its local and foreign subsidiaries, related to the **purchasing of intangible services** for a three year period.

The objective of the analysis was to provide the market and stakeholders with an independent external opinion to address media coverage about incidents of **kickbacks and bribery** involving the Group.

The analysis was predominantly a data analytics effort. It involved the collection of structured and unstructured accounting and procurement data from different systems, having different formats, languages, currencies, etc., acorss diffierent legal entities and countries.

The quantity of data collected from the companies in scope has generated more than **40 million transactions** involving more than **100 thousand** vendors.

ITALY - Deloitte Financial Advisory S.r.l.

Financial Crime Investigation Case Study – Data Analytics Applied to Intangible Expenditures

Through **Data Analytics** techniques the collected data was normalized and placed in a central repository specifically set up at the client premises for confidentiality reasons.

The Data Analytics team was assisted by a team of Forensic practitioners in order to define a **matrix of controls and exceptions** that included - as an example - keywords searches taken from a review of press articles, BIS researches, sanction lists and specific fraud indicators, which when combined in a statistical model and applied to the entire population of transactions, generated a **"ranking" of potentially suspicious transactions** for more indepth manual review to be performed at each legal entity.

The synergy between the experiences of the forensic team and the data analytics team enabled a **risk based yet thorough analysis that is repeatable and defensible** of the company data, without the need for hundreds of onsite reviewers for an extended period of time.

The project has generated more than **5M€** (including both the analytics and the forensic reviews) and involved 4 data analytic *FTE* for 4 months.

TAX FRAUD REFERENCE CASE ONE

Member of the VAT Expert Group (VEG) of the European Commission

Profile

- Deloitte Member of the VAT Expert Group (VEG) of the European Commission
- Link: http://ec.europa.eu/taxation_customs/taxation/vat/key_documents/expert_group/index_en.htm

Deloitte Background

- On 20 September 2012 Deloitte has been appointed to the EU VAT Expert Group of the European Commission.
- In total 22 industry associations and professional services firms, and 38 individuals were chosen to assist the European Commission in the development and implementation of VAT policies for the next 2 years.
- They will be supported by the Government Revenue Solutions team, and a network of country experts.
- Deloitte is represented by Piet Vandendriessche and Justin Whitehouse as his alternate.
- In addition 6 other Deloitte people – i.e. 3 effective members and 3 alternates - have been appointed: Christian Buergler (Austria); Drazen Nimcevic (Croatia); Helena Schmidt (Croatia); Odile Courjon (France); Jean-Claude Bouchard (France); Justin Whitehouse (United Kingdom) and Joachim Agrell (Sweden).

TAX FRAUD REFERENCE CASE TWO

Office of the Revenue Commissioners Ireland

Client Profile

- **Client:** Office of the Revenue Commissioners Ireland
- **Industry/sector:** Revenue and Customs
- **Size:** 6,000+ employees
- **Scale:** Over the course of the existing contract Deloitte has had up to 55 people engaged on a full time basis with Revenue.
- **Start Date:** August 2010
- **End Date:** August 2013

Deloitte Approach

- David George leads the Justice, Immigration & Borders, and Public Safety sector within Deloitte Australia's public sector practice.
- David met with the Revenue CIO, the Head of CACD and other Revenue personnel from Customs and IBI in June 2013 to discuss the issues around developing an intelligence capability within Revenue.
- In an Irish context, Deloitte partner, David Hearn participated in the Local Government Reform Review Group and provided strategic input in relation to the implementation of Local Property Tax.

Outcome / Benefits

- The need to implement the full intelligence cycle in order to be able to solve difficult intelligence problems such as illegal tobacco.
- A recommendation to have a centralised intelligence capability within Revenue rather than having elements spread across different departments within Revenue (e.g. IPD).
- The need to professionalize the workforce and workforce planning to support an intelligence capability.
- The importance of having a unified risk model across streams (e.g. cargo and passenger) that allows you to play with targeting thresholds based on the intelligence found.
- The need to build activity models (e.g. organized crime group supply chains) that can be applied across streams, so that if an organized crime group is disrupted in one, it can be discovered in another.
- The triage of intelligence reports is an important issue in intelligence management.
- The potential of using Palantir as a tool to support intelligence management and analysis and the experience of other agencies using this tool in the US, Australia and New Zealand, with a focus on the value to be gained in cross-agency collaboration.

TAX FRAUD REFERENCE CASE THREE

Internal Revenue Service (IRS), United States

Client Profile

- **Client:** Internal Revenue Service (IRS), United States
- **Industry/sector:** Revenue and Customs
- **Size:** There are in excess of 97,000+ employees in the IRS with $2.5 trillion in gross collections and $12.1 billion expenditure. Operations support accounted for $4 billion of the expenditure.

Deloitte Approach

- The program involved integrating the following software solutions:
  - Integrated Data Warehouse (Greenplum Data Computing Appliance and Massively Parallel Processing Database)
  - Extract, Transform, Load (Informatica Power Center)
  - Analytics Platform (SAS Grid platform)
  - Business Rules Management System (Fico Blaze Advisor)
  - Business Intelligence (Business Objects Enterprise)
  - Application Code (Java Custom Code)
  - Job Scheduling (Control-M)
  - Case Management (SAS Fraud Framework for Tax)
- Deloitte played a key role in integrating and successfully testing disparate software components in an integrated model prototype environment consisting of one 4-node SAS Grid for model training in off-line loop and another 4-node SAS Grid for case management in the in-line loop built on Linux operating system.

Outcome / Benefits

- **Return Review Program (RRP)**
- RRP is a mission-critical, automated system that will be used to enhance IRS capabilities to detect, resolve, and prevent criminal and civil non-compliance thereby reducing issuance of fraudulent tax refunds.
- The current Electronic Fraud Detection System (EFDS) at IRS is aging and has been unable to keep up to the changes in the tax code or current business priorities. RRP is designated as a replacement for EFDS, which will take the existing EFDS functionality, and improve it by adding new features, a more robust scoring ability, and making the system in line with the IRS Enterprise Architecture.
- Overall functionality of the RRP system includes data mining and modelling, predictive analytics, fraud scheme detection, real-time fraud scoring, workload management and work stream identification based on fraud score card analysis, as well as the ability to incorporate real-time business rule changes.
- Of the four stages, stage one is due to go live in Jan 2014 and stage two Jan 2015. Deloitte provided the following services:
  - demonstrated an understanding of the inherent complexity of the IRS Enterprise Architecture, including the existing legacy system as well as the new system
  - played a key role in gathering requirements for the new system which required an understanding of the integrated system as a whole
  - helped provide data interfaces to aid system integration
  - helped consolidate five disparate applications into one
  - Integration with single authentication server
  - Running new systems in parallel until full capabilities are replicated

TAX FRAUD REFERENCE CASE FOUR

The Government of Armenia (GOAM)

Client Profile

- **Client:** The Government of Armenia (GOAM)
- **Industry/sector:** Revenue and Customs

Profile

- After years of institutional challenges, GOAM has launched a comprehensive reform program to streamline tax policy and regulation, lighten the tax compliance burden on businesses, curtail corruption, and instill greater trust between taxpayers and tax authorities.
- Effective revenue policy and efficient tax administration will improve the business enabling environment and contribute to Armenia‘s economic growth.

Big Data Marketing Analytics & Visualization

Large Banking Client

Revenue

Deloitte's Role

- Deloitte was engaged by the client to deploy an IBM Big Insights based Big Data solution
- Deloitte teams architected and deployed the POC solution for the client
- Deloitte was also tasked to create the business use cases and business applications leveraging Hadoop

Business Problem / Objective

- Due to the decreasing refinance volume, banks and mortgage brokers faced increasing pressure to become more effective marketers and target the right customers. Opportunities existed for financial services clients to leverage data from multiple sources to efficiently enable their marketing campaigns. Client sought to leverage emerging capabilities provided by Hadoop to create "analytical sandboxes" for mortgage analytics and customer marketing offers
- Combining disparate data sources, both structured and unstructured, our client was seeking to leverage Hadoop Big Data technologies for Customer Marketing

Outcomes / Learning's

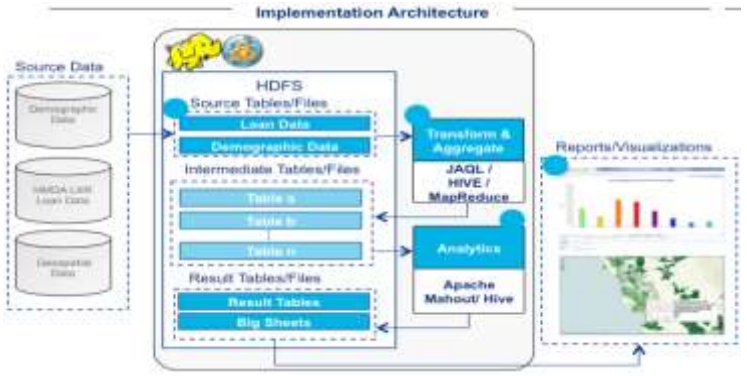
- Demonstrated Hadoop as a viable alternative to execute business cases for Customer Marketing offers and Next Best Customer Action
- Enabled analytics of publically available mortgage origination data augmented with geospatial, and demographic data from private sources to help effectively individualize loan product offerings
- Visualizing Mortgage origination opportunities was also a net result of the project

Scope / Approach

- Created a proof of concept to demonstrate the capabilities of Apache Hadoop (enabled by IBM Big Insights) to run analytics on publically available mortgage origination data augmented with geospatial, and demographic data from private sources to help effectively individualize loan product offerings
- Loan, geospatial and demographic data was loaded into HDFS
- Data was transformed, cleansed and joined using JAQL, Hive and MapReduce

Analytics Component

- Analytics were run using Apache Mahout and Hive; results were stored in HDFS. Apache Mahout was used to run the recommendation algorithm
- Tableau and IBM Big Sheets were used for the final visualization



Contact Details

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Financial Crime Analytics

The standard of excellence as a one-stop-shop for full services on financial crime and fraud related advanced analytics solutions.

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