

The Rise of Analytics – Opportunities for O.R.

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My Background

- Studied engineering and worked as an engineer
 - Bachelor in Mechanical, major in Industrial Engineering
 - Held various engineering positions incl. process, machine vision, equipment development, factory IE, systems IE
- 27 years in American multinational companies (1988-2015)
 - 2 years at Texas Instruments KL
 - 25 years at Intel Penang & Kulim, including 2 years in Arizona
- Created in-house Operations Research group in 2002
 - Have done simulation, math optimization, and the relevant data integration to enable simulation and optimization
- Completed 2 post graduate degrees while working full time
 - M.Sc. in Decision Science, UUM in 2005
 - Doctor in Engineering (Eng Biz Mgt), UTM KL in 2014

Presentation Overview

- Current business and technological landscapes
- Overview of analytics and where O.R. fits
- Opportunities for O.R.
- Challenges of applying O.R. in Malaysia

The Forces Driving Our Future

- Digital future
- Entrepreneurship rising
- Global marketplace
- Urban world
- Resourceful planet
- Health reimagedined

The Forces Driving Our Future

- Digital future
 - Convergence of social, mobile, cloud, big data
 - Growing demand for anytime anywhere access to information
- Entrepreneurship rising
 - Technology enabling machines and software to substitute for humans
 - High-impact entrepreneurs are building innovative and scalable enterprises
 - Many new enterprises are digital from birth with young faces

The Forces Driving Our Future

- Global marketplace
 - Innovation will increasingly take place in rapid-growth markets
 - War for talent; greater workforce diversity providing competitive advantage
- Urban world
 - More cities across the globe

The Forces Driving Our Future

- Resourceful planet
 - Increasing global demand for natural resources
 - Growing concern over environmental degradation
- Health reimagined
 - Increasing cost pressure require more sustainable approach
 - Explosion in big data and mobile health technologies
 - From delivery of health care to management of health

Digital Future

- Technology is also changing the ways people work, and is increasingly enabling machines and software to substitute for humans. **Enterprises and individuals who can seize the opportunities offered by digital advances stand to gain significantly, while those who cannot may lose everything**



**Anytime anywhere access to information.
Machines and software substitute humans.**

How should we adapt?

Today's Technology Buzzwords

Big Data

Data Visualization

Data Scientist

Internet of Things

Wearable

Business Intelligence

Cloud

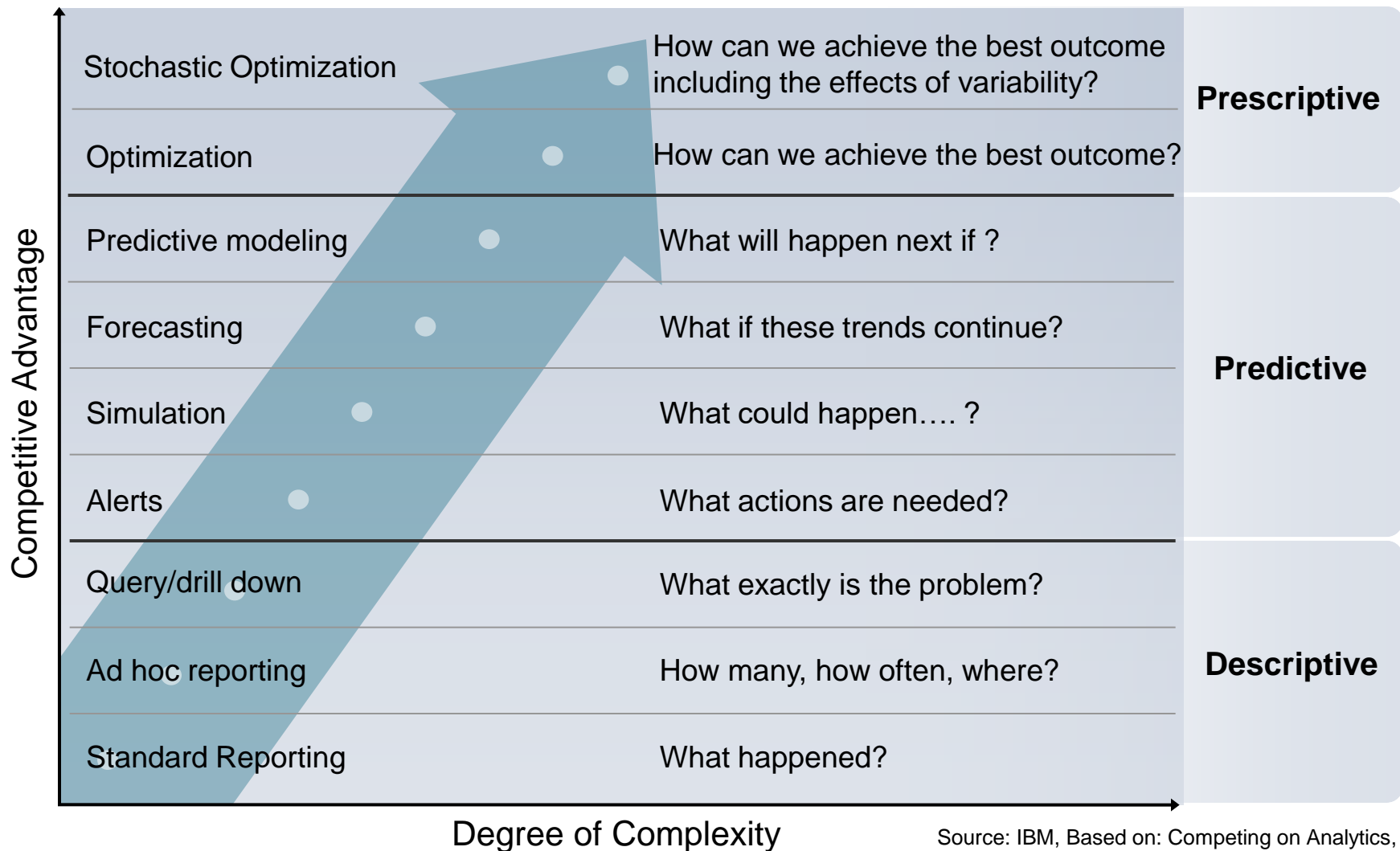
Analytics

Apps

Big Data and Traditional Analytics

	Big data	Traditional analytics
Type of data	Unstructured formats	Formatted in rows and columns
Volume of data	100 terabytes to petabytes	Tens of terabytes or less
Flow of data	Constant flow of data	Static pool of data
Analysis methods	Machine learning	Hypothesis-based
Primary purpose	Data-based products	Internal decision support and services

Analytics Evolution



Source: IBM, Based on: Competing on Analytics, Davenport and Harris, 2007

Analytics

- Descriptive analytics (what has occurred)
 - The simplest class of analytics, condense big data into smaller, more useful nuggets of information
 - e.g. counts, likes, posts, views, sales, finance
- Predictive analytics (what will occur)
 - Use available data to predict data we don't have using variety of statistical, modeling, data mining, and machine learning techniques
- Prescriptive analytics (what should occur)
 - Recommend one or more courses of action and showing the likely outcome of each decision so that the business decision-maker can take this information and act

Adapted from Information Week, definitions by Dr Michael Wu

<http://www.informationweek.com/big-data/big-data-analytics/big-data-analytics-descriptive-vs-predictive-vs-prescriptive/d/d-id/113279>

O.R. Leading Edge Techniques

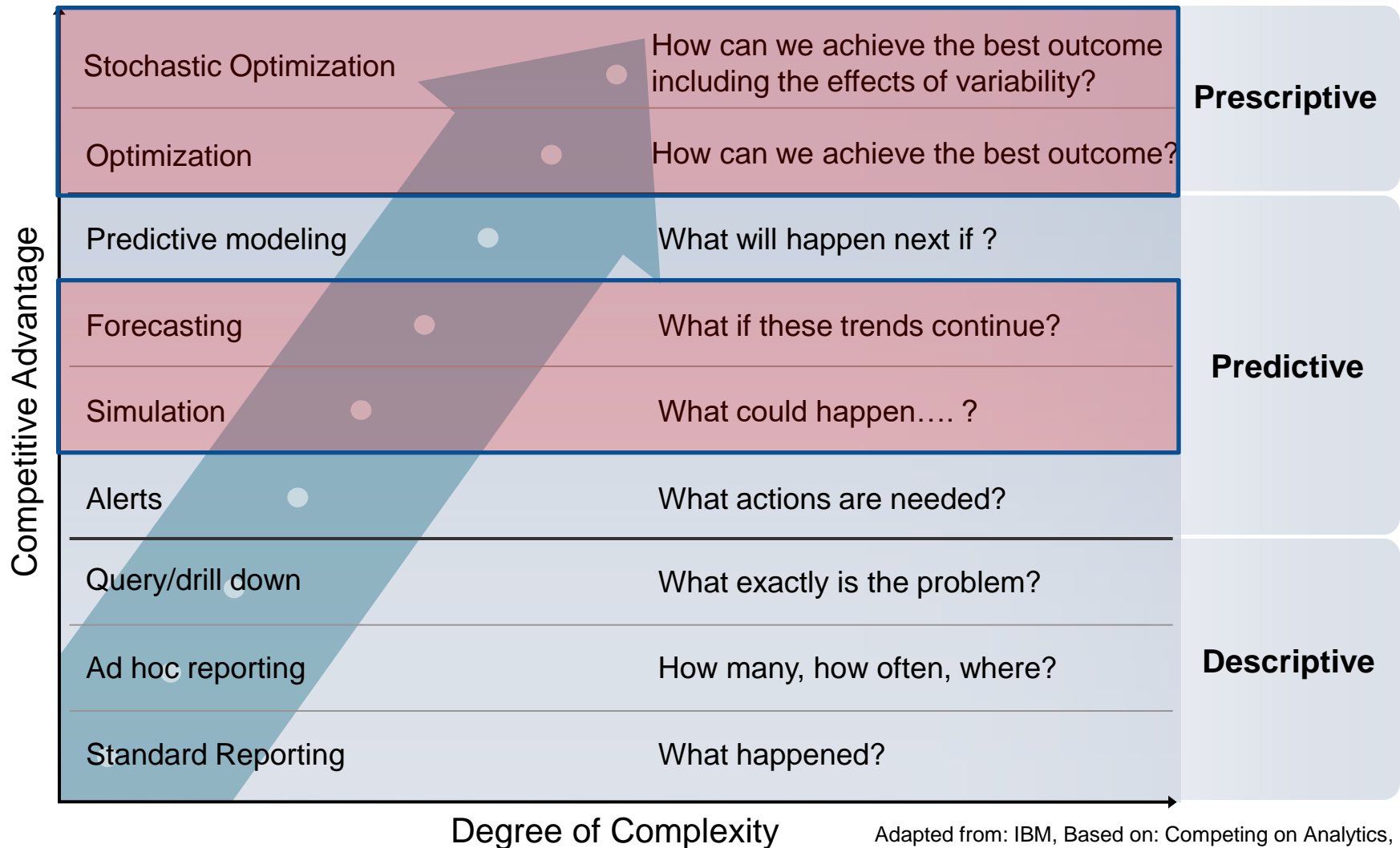
- Simulation
 - Giving you the ability to try out approaches and test ideas for improvement
- Optimization
 - Narrowing your choices to the very best where there are virtually innumerable feasible options and comparing them is difficult
- Probability and statistics
 - Helping you measure risk, mine data to find valuable connections and insights, test conclusions, and make reliable forecasts

O.R. Leading Edge Techniques

- Simulation (predictive)
 - Giving you the ability to try out approaches and test ideas for improvement
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Analytics Evolution

Operations Research

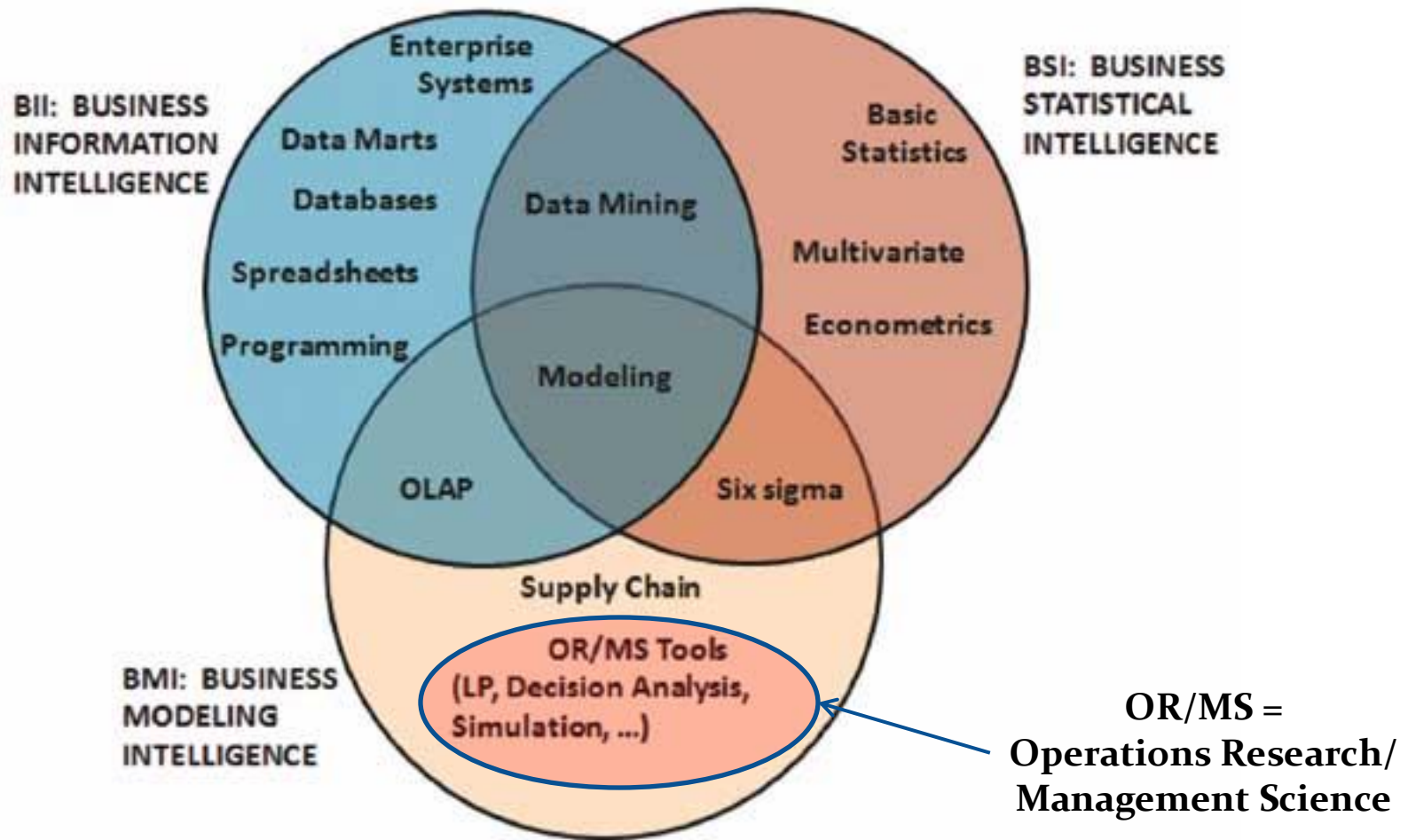


Adapted from: IBM, Based on: Competing on Analytics, Davenport and Harris, 2007

MS Excel Examples

- Descriptive aggregate functions:
 - SUM(), MIN/MAX(), COUNT(), STDEV(), AVERAGE()
 - Pivot tables
- Predictive:
 - Analysis ToolPak add-in
 - Data Mining add-in
 - XLMiner add-in
- Prescriptive:
 - Solver add-in

Business Intelligence Framework



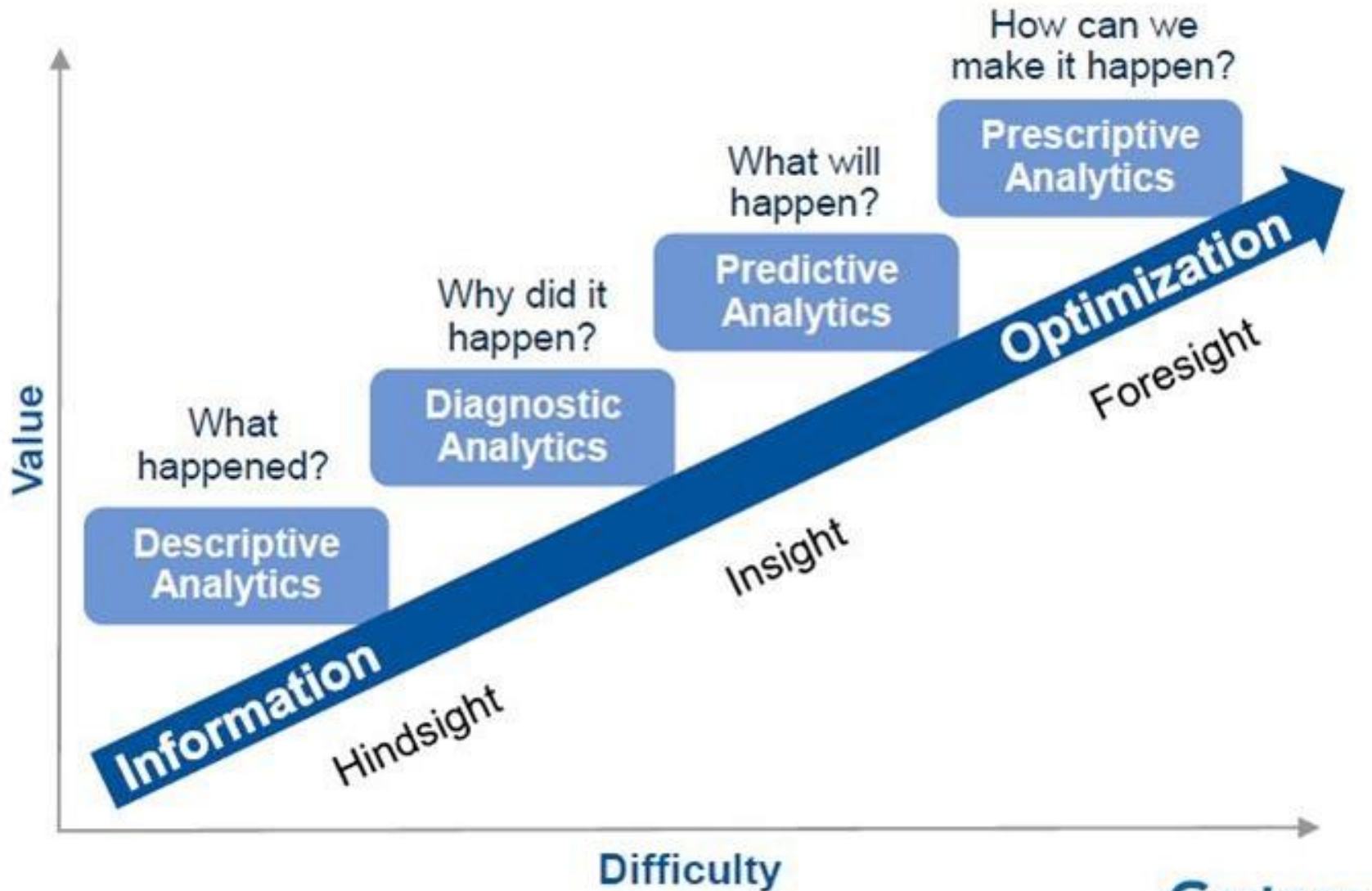
Back in Business, by Ronald K. Klimberg and Virginia Miori, OR/MS Today, Vol 37, No 5, October 2010, [<http://www.informs.org/ORMS-Today/Public-Articles/October-Volume-37-Number-5/Back-in-Business>]

Three Eras of Analytics

	Analytics 1.0	Analytics 2.0	Analytics 3.0
Types of companies	Large enterprises	Online and start-ups	All—“data economy”
Analytics objective	Internal decisions	New products	Decisions and products
Data type	Small, structured	Large, unstructured	All types combined
Creation approach	Long-cycle batch	Short-cycle agile	Short-cycle agile
Primary technology	Software packages	Open source	Broad portfolio
Primary analytics type	Descriptive	Descriptive, predictive	Prescriptive
Business relationship	Back office	“On the bridge”	Collaborative

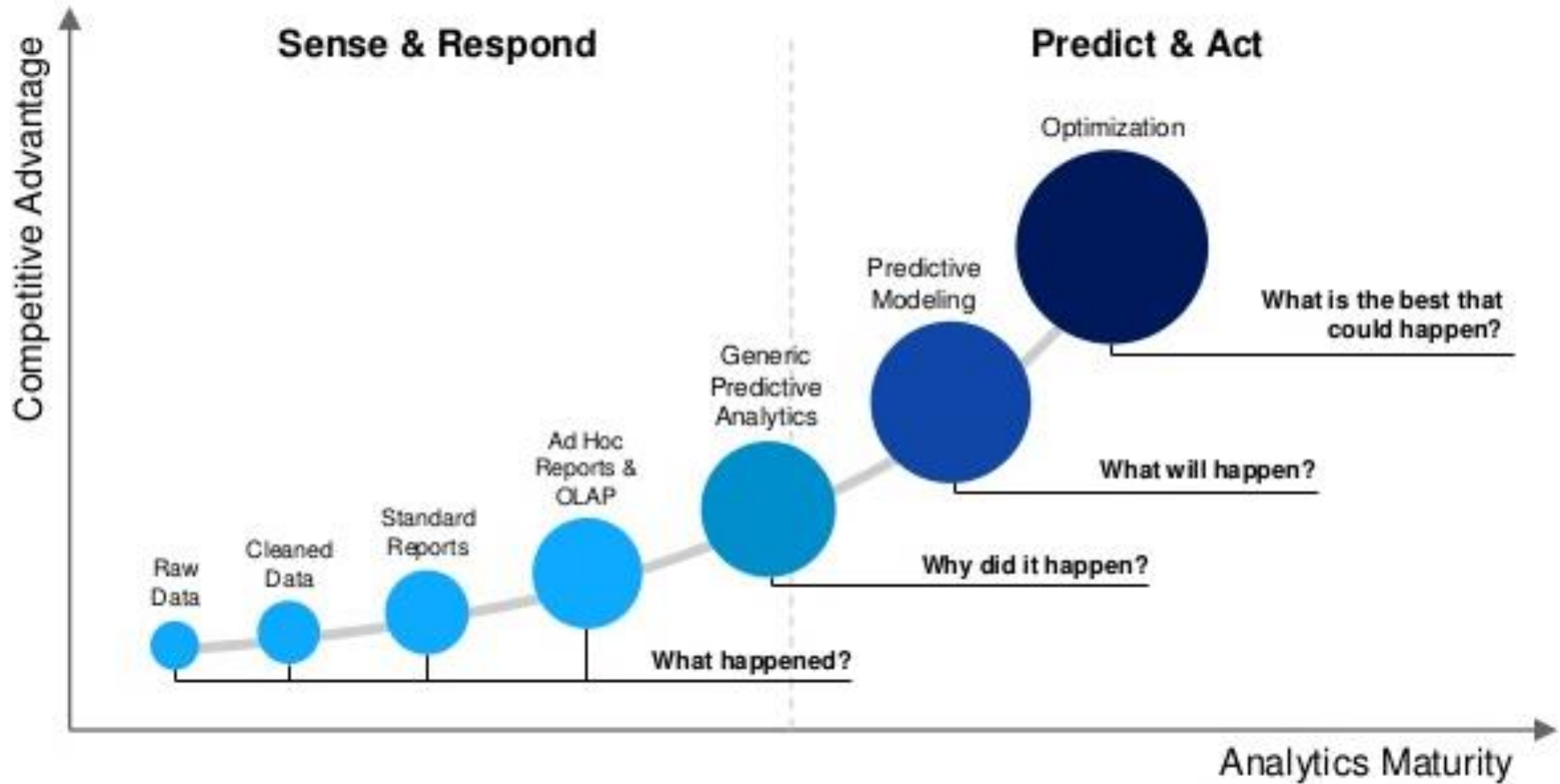
In 2013 Gartner called prescriptive analytics 'the final frontier for big data', where companies can finally turn the unprecedented levels of data in the enterprise into powerful action

Analytics Maturity (Gartner)



Gartner.

Analytics Maturity (SAP)



Key Messages

- Seize the opportunities offered by digital advances
 - Anytime anywhere access to information
 - Machines and software substitute humans
- Be part of analytics initiatives
 - Optimization is at the top of Analytics
 - Optimization is the final frontier for big data

How to start?

Skillsets Required

- Technical
 - Database (relational database, SQL)
 - Computer programming
 - Reporting tools and visualization
 - Analysis skills – statistics, prediction and optimization
- Business
 - Able to see from micro and macro perspectives
 - Have good communication skills
 - Understand the problem and its business values
- Good with data and numbers
- Can figure out things to do

Bad Excuses

- I can't do computer programming
- I can't do data query, transformation and analysis
- I have learnt but forgotten how to do linear programming
- Doing discrete event simulation is difficult

Which areas to work on?

3 Classes of Business Value

- Cost reductions
- Decision improvements
- Improvements in products and services

Examples

- Cost reductions
 - Capital dollars (e.g. fixed assets, equipment)
- Decision improvements
 - What-if analyses
 - Production planning decisions
 - Capacity planning
 - Supply-chain decisions
- Improvements in products and services
 - Analyze cycle time, utilization, inventory, yield, etc.

Data-driven Capital Decisions

- Capital equipment decisions
 - In justifying new capital equipment purchase, management should see actual utilization data and compare it to the goal used in capacity planning
- We deal with ‘noisy’ demand forecast data. If we reduce the time needed to procure capital equipment, we can make better decision later
 - There is no point planning too far out, except for strategic decisions such as new facility at greenfield site
- Analysis time must be ‘instantaneous’ and results not dependent on who is doing it

Production Planning

- For complex factories, real-time live full-factory simulation should be used as the engine for short-term product planning
 - Lot release decision
 - Equipment dedication and conversion strategy
 - Non-production activities
 - Preventive maintenance, training, etc.
 - Used successfully in semiconductor wafer fabs
- Deep expertise required in manufacturing execution, data integration and simulation customization

Supply Chain Optimization

- We have computing power and capable solvers which can do what is not possible previously
 - 16-bit has 2^{16} (65536) 64KB address space
 - 32-bit has 2^{32} (4,294,967,296) 4GB address space
 - Windows 32-bit memory limit for each process is 2GB
 - 64-bit has 2^{64} (1024^6) 16 exabyte address space
 - Windows 64-bit has user-mode address space of 8TB
 - Software which capitalizes on multi-core, multi-thread can solve large problems faster
- Can either buy the capability or develop in-house

O.R. in Malaysia – Challenges

- In any government-link organizations, decision making is top down, not data driven
- Malaysia is still seen as a low-cost geography by foreign investors (thanks to devaluating currency), not as a high-tech developed country like Singapore
- In Malaysia, the analytics focus is on descriptive and predictive, not prescriptive, due to lack of expertise
 - Many predictive analytics HRDF training offerings using R but only 1 training on mathematical optimization

Summary

- Seize the opportunities offered by digital advances to gain significantly
- Upskill knowledge given the current business and technological landscapes
- Exploit opportunities in optimization, be part of analytics initiatives, and add business values