

Optimization in simple terms... for finance

Ferenc Katai, Ph.D
IBM ILOG CPLEX Studio PLM

The structure of the presentation

- Why optimization?
 - Extreme ROI figures in finance + in other industries
- Give an overview of the analytics market
 - Explain where math-based (operation research = OR) optimization is on the map of business analytics
- Explain how OR-based optimization is different from other analytics techniques like rule-based solution
 - Give guidelines where each technique should be used
- Optimization in finance/insurance
 - Problem description
 - Success stories
- Q&A

Extreme ROI with optimization

Extreme ROI - In Logistics/Transportation/Hotel

| Company | industry | Business problem | ROI | Public reference |
|------------------------------|----------------|---|--|------------------|
| UPS* | logistics | Air Network Design | 87M\$/2years + 10% fewer planes | ✓ |
| Logistics Co. – US | | Network design | 5M\$</year cost saving | ✓ |
| Logistics Co. – US | | Routing application | 0.6M\$/year reducing cost | |
| Dairy Co. - APAC | | Dairy Distribution | \$15M/year cost saving | |
| Brewing Company - US | transportation | Mfg Sourcing + Distribution | \$150M/year transportation cost saving | |
| Continental Airlines* | | Crew rescheduling | 40M\$ in a year | |
| Railway Co. - EU | | Scheduling/Pricing | \$16M/yr +rev + 2% (of 1.5Beuro = 30Meuro) lower OPEX | |
| NS Reiziger (Dutch Railway)* | | Time-tabling/rolling stock optimization/crew scheduling | 27M\$(20M€)/year reducing operational cost + 54M\$ (40M€)/year increase of fare revenue | ✓ |
| Hotel Group | hotel | Hotel planning | Some customers reduced cost by more than 10% (50M\$) | |

*Franz Edelman Competition Finalist/Winner, Science of Better, <http://www.scienceofbetter.org> , Published Case Studies

Extreme ROI - In Telco/Media/defense/Finance/Energy

| Company | industry | Business problem | ROI | Public reference |
|---------------------------|----------|---------------------------|--|------------------|
| AT&T* | telco | Network recovery | 35% reduction of spare capacity | ✓ |
| Media Co. – US | media | Sales process planning | In 1996-2000 increased revenue by 200M\$, reduced rework by 80% | |
| South African Defense* | defense | Force/Equipment planning | 1.1b\$/year | ✓ |
| Bank – US | finance | Cash Inventory Mgmt | Reduced replenishment cost by 55% + reduced cross-shipping fee by 63% (daily cash dispersion is 200M\$) | ✓ |
| Indeval (Mexico)* | | Security trade settlement | reducing the amount of cash that banks must have on hand to cover trades by 52 percent and saved Mexican banks more than \$240 million in interest in 18 months. | ✓ |
| Investment Co. | | Portfolio planning | For 600 clients with 185b\$ valued portfolio 100M\$< saving on transaction cost | ✓ |
| Grant, Mayo, van Oterloo* | | Portfolio optimization | 4M\$/year | ✓ |
| Energy Co. – US | energy | Hydro-power generation | Minimum 0.8M\$/year reducing cost | |
| REE (Red Electrica) | | Unit commitment | 130K\$(100K€)/day cost reduction | ✓ |

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Extreme ROI - In Manufacturing

| Company | Business problem | ROI | Public reference |
|--------------------------|--------------------------|---|------------------|
| Motorola* | Procurement Mgmt | 100-150M\$/year | ✓ |
| Samsung Electronics* | Semiconductor mfg | 50% reduction in cycle time | ✓ |
| Mining SW Co. – APAC | Mine production planning | 5% (35M\$<) cost saving | |
| Minining SW Co. – APAC | Mine operation planning | 20M\$< value increase (2-3% increase of b\$ minevalue) | |
| Car manufacturer Co. | Planning of sourcing | >50M\$/5years cost saving + 40M\$ upfront investment savings | |
| Car manufacturer Co. | Car mfg | Saved the cost of building a 3rd production line + investment payback in three days | |
| Soft Drin Co. | Production Sourcing | \$6M inv reduction + 2% fewer miles | |
| Steel manufacturer | Steel mfg | Reducing 30-40% stock (on 10b\$/year revenue) | |
| Brewing Company - US | Production planning | 1M\$</year reducing cost | |
| US Water Products Mfg | Inventory Optimization | \$6.2M working capital reduction | |
| 2 Chilean Forestry firms | Timber harvesting | 20M\$/year + 30% fewer # of trucks | |

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Analytics

Some insight videos from IBM on Analytics

- <http://www.youtube.com/watch?v=f-dfWLaDBPE&feature=related>
 - Jai Menon (IBM fellow) says: “all our lives is about making decisions. So in some sense the whole world is about analytics, isn’t it?”
- <http://www.youtube.com/watch?v=fFdITHMuy2w&feature=related>
 - Optimization is to utilize resources on the most effective way
- <http://www.youtube.com/watch?v=YSYDW54tGo8>
 - General analytics video

Business Intelligence, Business Analytics (INFORMS definitions)

▪ Descriptive

- the use of data to find out what happened in the past (what is happening now)
 - data modeling, trend reporting, regression analysis

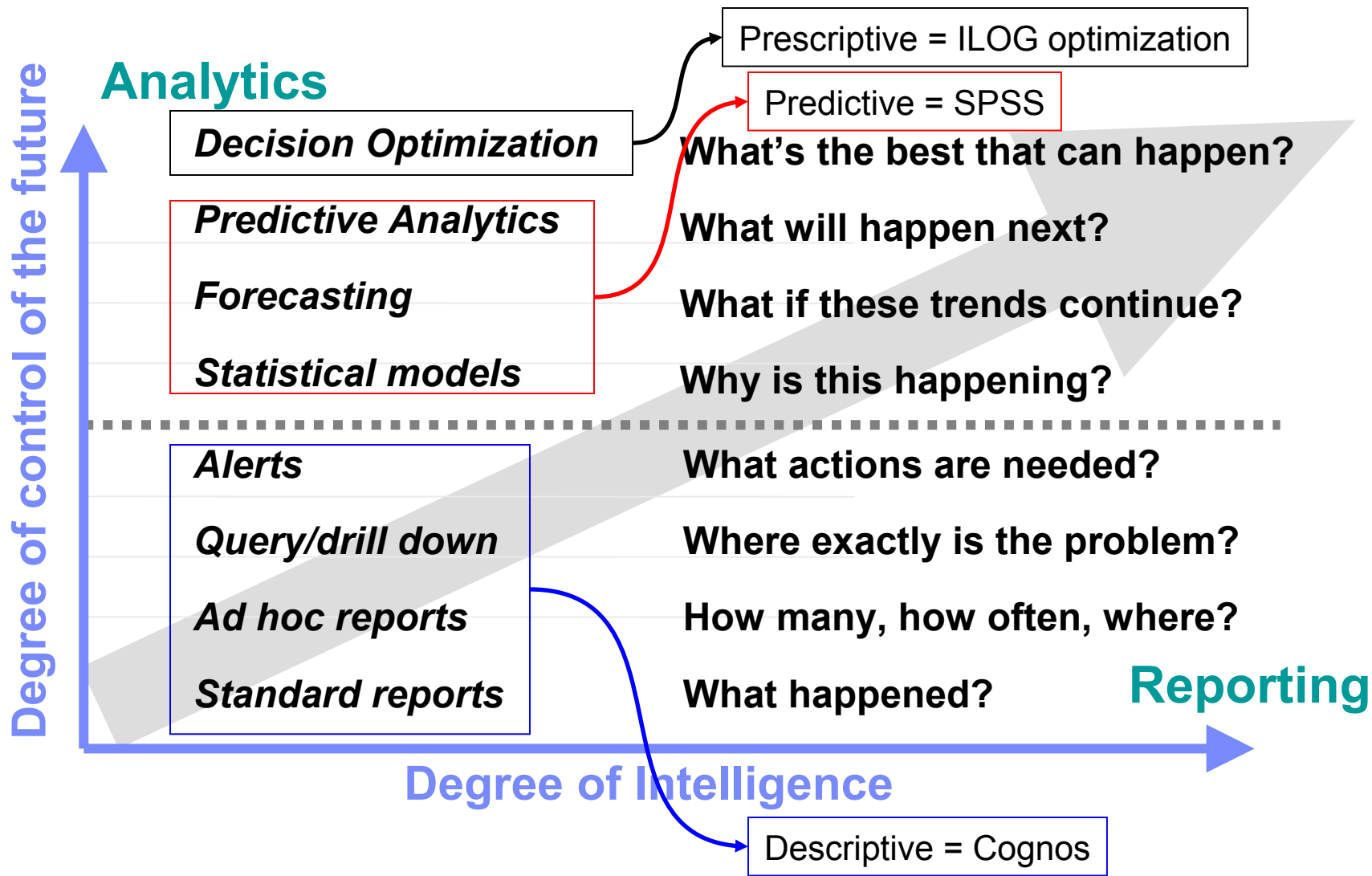
▪ Predictive

- the use of data to find out what could happen in the future
 - data mining, predictive modeling

▪ Prescriptive (= optimization)

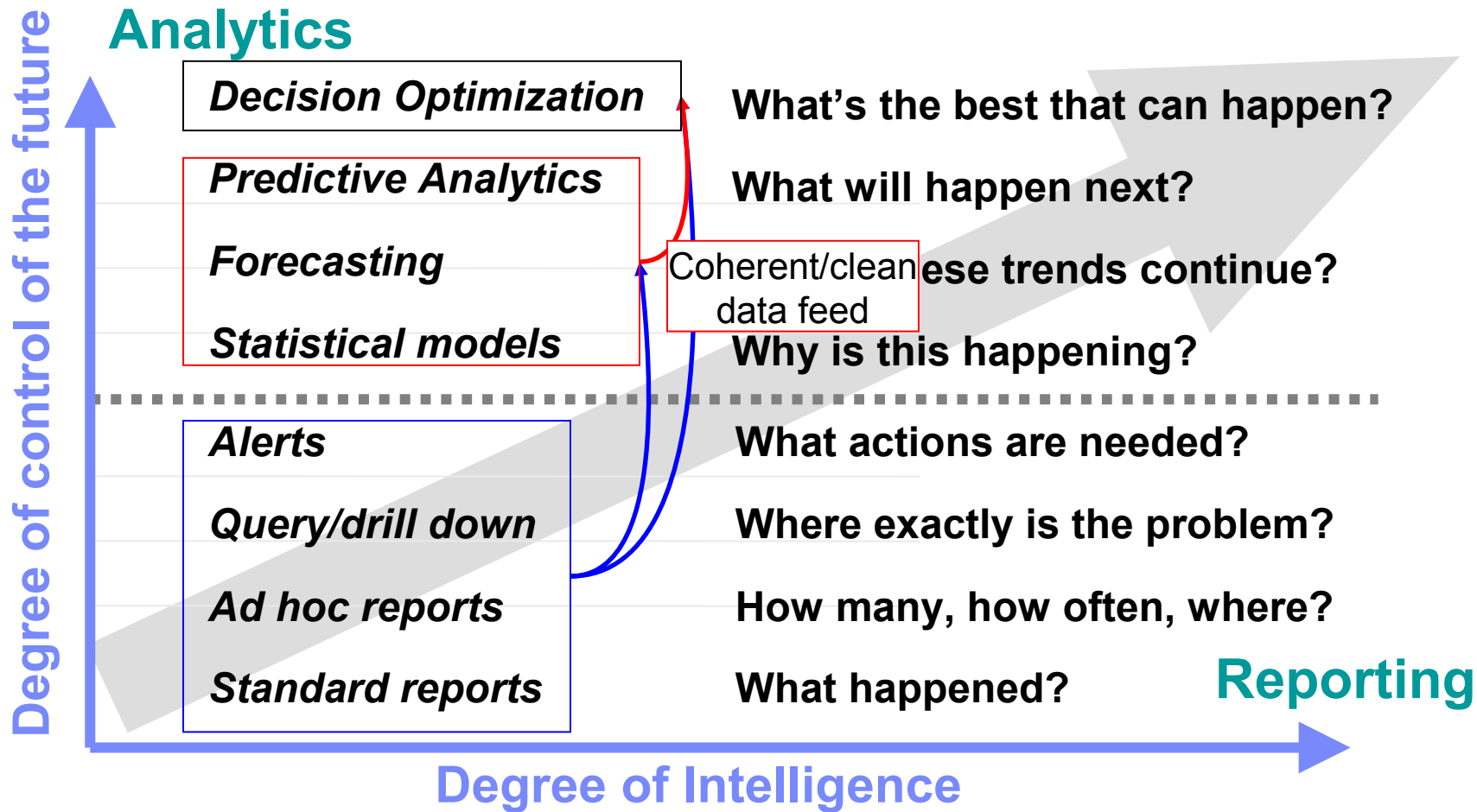
- the use of data to prescribe the best course of action for the future
 - optimization, simulation

Business Intelligence/Analytics (BI) - by IBM products



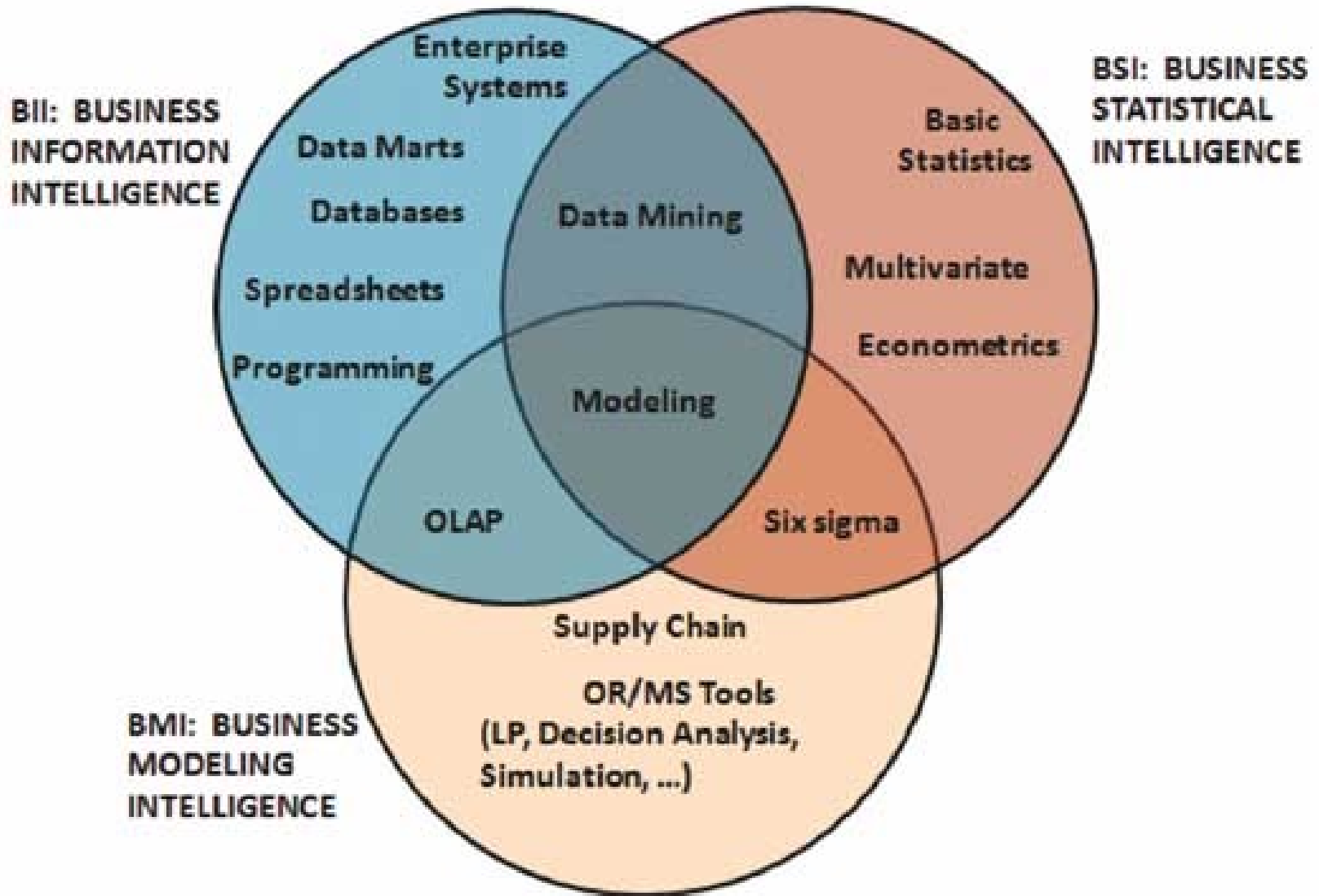
Thomas H. Davenport – Competing on Analytics

The techniques are in fact built on each other



Thomas H. Davenport – Competing on Analytics

Relation among BI's



Stages of decision making - the past

- First you want to collect data (of the present)
 - you definitely want to have reliable/clean data
- things of the past are shown/filtered/related in a way which may shed light on patterns and connections. Then you can drill into details to find patterns
- Then you can better understand why things happened on the way they did

Stages of decision making – the future – what likely happens

- Next, based on your past, you want to predict/forecast what the future brings if things go on unchanged
- you will use statistical/forecasting/etc methods to predict the future
- Then you have a chance to have a glimpse into a possible future
 - Things are probabilistic and always have some uncertainty

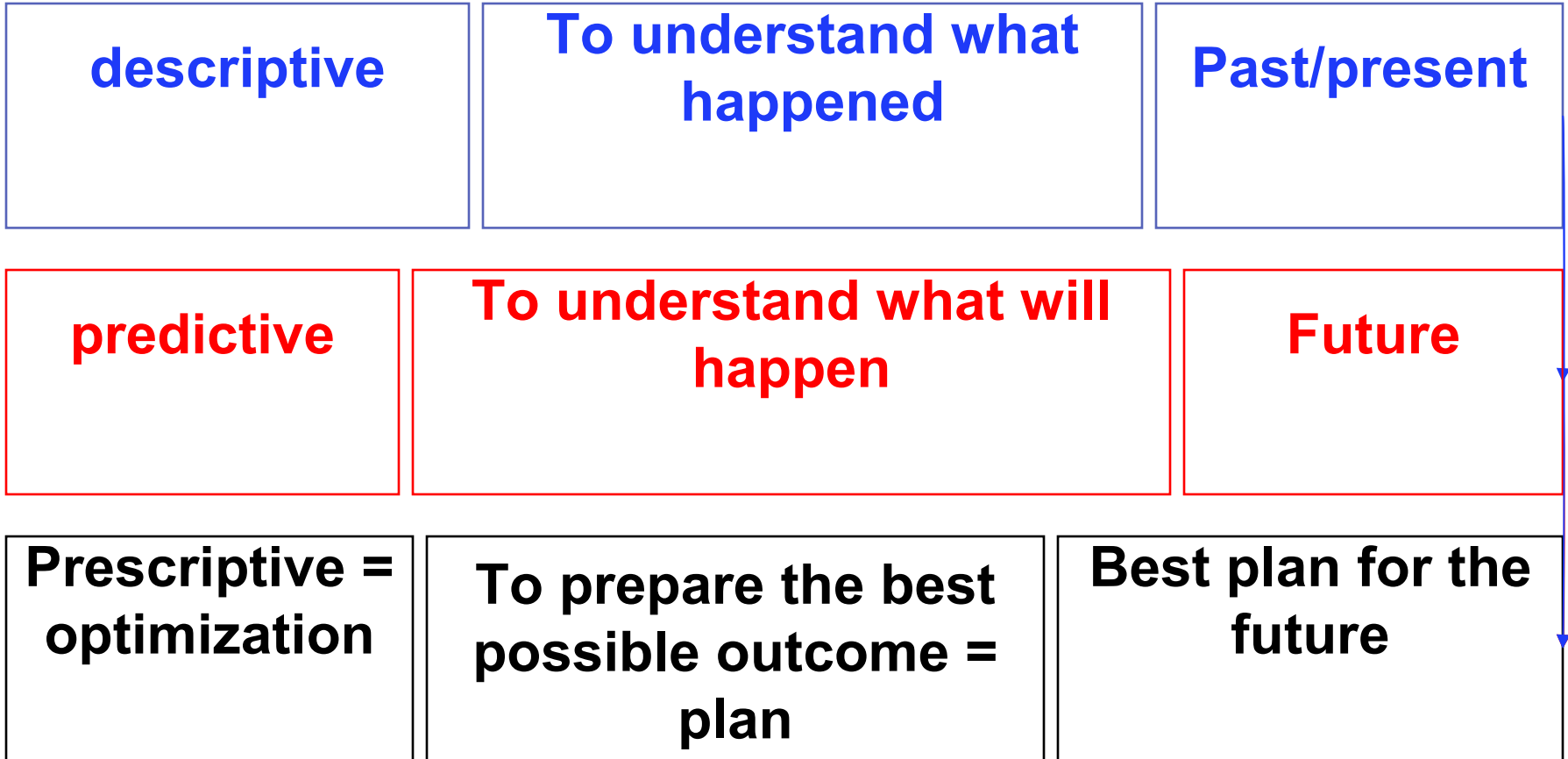
Stages of decision making - the future – what I can do then

- If you know the past = you have reliable/clean data
- you can predict what might happen
- Then you can plan your resources for it based on some goals (KPI)
 - Things are always measurable and exact...
... at the end

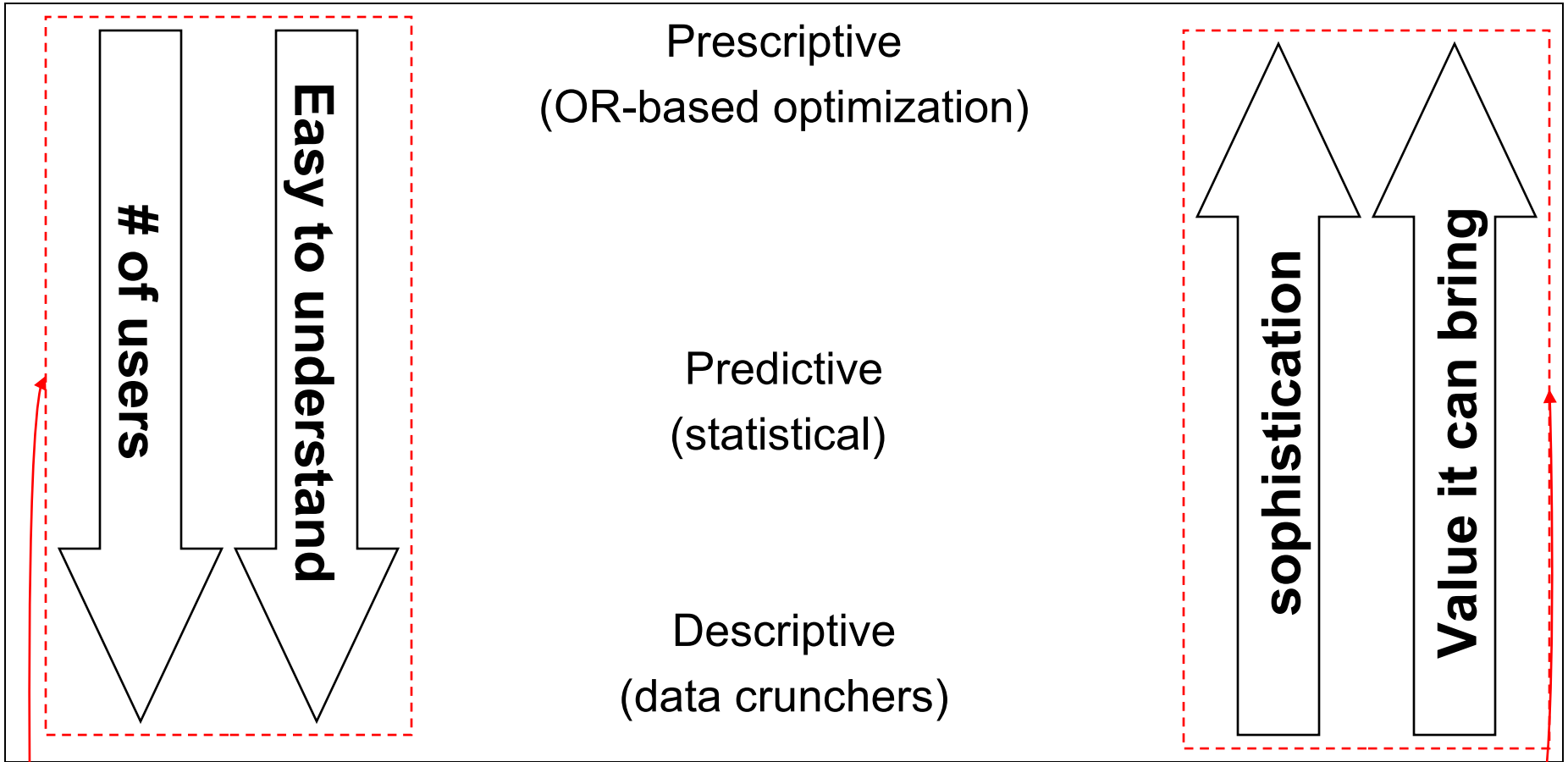
How all these come together

- Cognos type of data “sniffers” help the user to understand his/her data
 - It can live alone in its own world
- SPSS types of tools help the user to use statistical methods for predicting/forecasting
 - It can give you prediction what will happen if things go on un-changed
- ILOG Optimization type of tools help the user to create x plans/schedules (the plan measured by KPI's)
 - It's measurable and offers (document-able) ROI (due to the exact measurements/constraints) at once
 - E.g. predictions can be checked in the future
- Important remark
 - The first one's subject is data, the 2 others need good data since the best methods will produce as good result as the data quality was (garbage in, garbage out)

Summary



The extremes



The more we go to the direction of prescriptive the more sophistication is needed and the more value it can bring (because OR-based optimization is measurable)

The more we go to descriptive then it is easier to understand therefore more users are willing to use it + more user understand what she is doing

What does optimization mean?

- According to Cambridge Advanced Learner's Dictionary = "Optimization" = "the process of making something as good or effective as possible"
 - The 'something' is a problem/situation to solve, or rather to find a solution. That is, optimization is a kind of search among the alternatives
 - "good" means how good a solution is by a given measure
 - The closer the solution is to the extreme of a goal the better
 - E.g. "I'd like to find a restaurant close enough which is giving tasty food and cheap"
 - The goal is to find a restaurant measured by distance (cost of gasoline) + the cost of a meal + the rate of the food (# of stars)
- If the goal is not measurable directly something has to be invented: e.g. customer satisfaction (in a call center)= # of closed calls?
 - What is measured will prevail... over the intention
- The different measures should be "normalized" (= have the same measure, e.g. \$)
 - E.g. fix the stars and then everything is "money" = gasoline cost + food cost
- Do the optimization sequentially for the different measures. E.g.
 - Search for the best cost solution ⇨ minimization, then fix the best value
 - Search for the "best" star solution ⇨ maximization
 - Result ⇨ Maximum star value among the lowest cost solutions

Optimization with adjectives... - 1/2

- Some examples with...
 - Business optimization – to improve the business processes
 - rule optimization – optimize the way the rules are written + make fewer rules
 - Hard disk optimization – compact the hard disk
 - DB (query) optimization – use best practices to get the – probably – best performance of the DB access
- Most often than not the ‘optimization’ used with adjectives
 - Is NOT optimization in the exact/math sense, no any of the following applied
 - No search algorithm
 - No objective optimality criteria
 - No info how good a solution is (compared to the objective criteria)
 - The meaning is altered and it usually means ‘improvement’, ‘best practice’ which ‘works’ most (perhaps majority) of the time but NO guarantee that there is better ‘solution’ or there ‘is’ solution

Optimization without even the 'word'...

- Some examples without...
 - Manpower planning
 - Process/project scheduling
 - Container positioning
 - Component placement - putting electronic components on boards (e.g. phone/computer cards)
- Even if there is no mention of 'optimization' it is clear what are the goals
 - reduce the # of people to reduce cost
 - Keep all the due dates + increase throughput
 - Put more containers at the same place/move containers with as few movements as possible
 - Make as few movements of the soldering head as possible to reduce energy/increase throughput
- In these cases (in the examples) there is a choice to make and there is a clear/measurable goal (it fits OR-based optimization!)
 - However, there is always a possibility that human experience is enough
 - the best solution has been found already and it will not change significantly in the future
 - The human experience can be converted to rules and it is easily understandable by the planner

What are the alternatives to OR-based optimization?

Assumptions

- Still the plan/solution is made with a software
 - The provided data is 'clean'/meaningful to compute a solution
-
- Creating plan/solution visually on the screen manually
 - The knowledge of plan/solution creation is in the 'head' of the planner
 - Solution checker (usually with rules or some propagation engine): there is check on what constraints/conditions the plan/solution should satisfy with visual aid highlighting the 'not yet satisfied' parts.
 - Rule based system
 - It reflects human knowledge embeded in rules how to create a plan/solution
 - The rules are automatically executed and plan/solution is made by (almost) no human interaction – except correction: when the plan/solution doesn't satisfy all the constraints and human correction/acceptance is necessary

Rule based (expert) systems

- Rules offer knowledge in the form of
 - **IF** a given set of conditions are met **THEN** certain actions should be taken
 - **IF** (the weather is rainy AND I go to walk my dog) **THEN** (I have to take an umbrella AND I put a jacket on the dog)
 - **IF**(alarm 1, 11, 23 and 41 are off AND no alarm 17) **THEN** switch 19 is broken
 - **IF**(age<21 AND city = true) **THEN** the insurance premium = 3rd category
- User of rule-based systems can create the conditions and actions over a set of objects which are truly in their business domain (BOM)
- It is easy to understand/create/modify

Main differences between rule-based and OR-based decision making

- Rule-based
 - Reactive – when conditions are met rules are triggered
 - Local – when certain conditions are met the rules are triggered
 - Not really abstraction of the problem/business, the rules are ‘working’ on the business domain
 - Most cases it’s faster than OR-based approach – no search at all just actions if conditions are satisfied
 - Rules may contradict one another but for the real life problem the ‘solution’ is satisfactory
- OR-based
 - Proactive – all predefined constraints should be (usually)satisfied in a plan/solution
 - Global – it is a search guided by a goal (function)
 - abstract model is made (on which a search is conducted) to find the best values for the variables)
 - If constraints are contradicting (if real life is correctly represented by the model) then there is no solution for the real life problem and the user will know that in advance
 - it is possible to make suggestions which constraints should be eliminated to produce a plan/solution which satisfies the remaining constraints

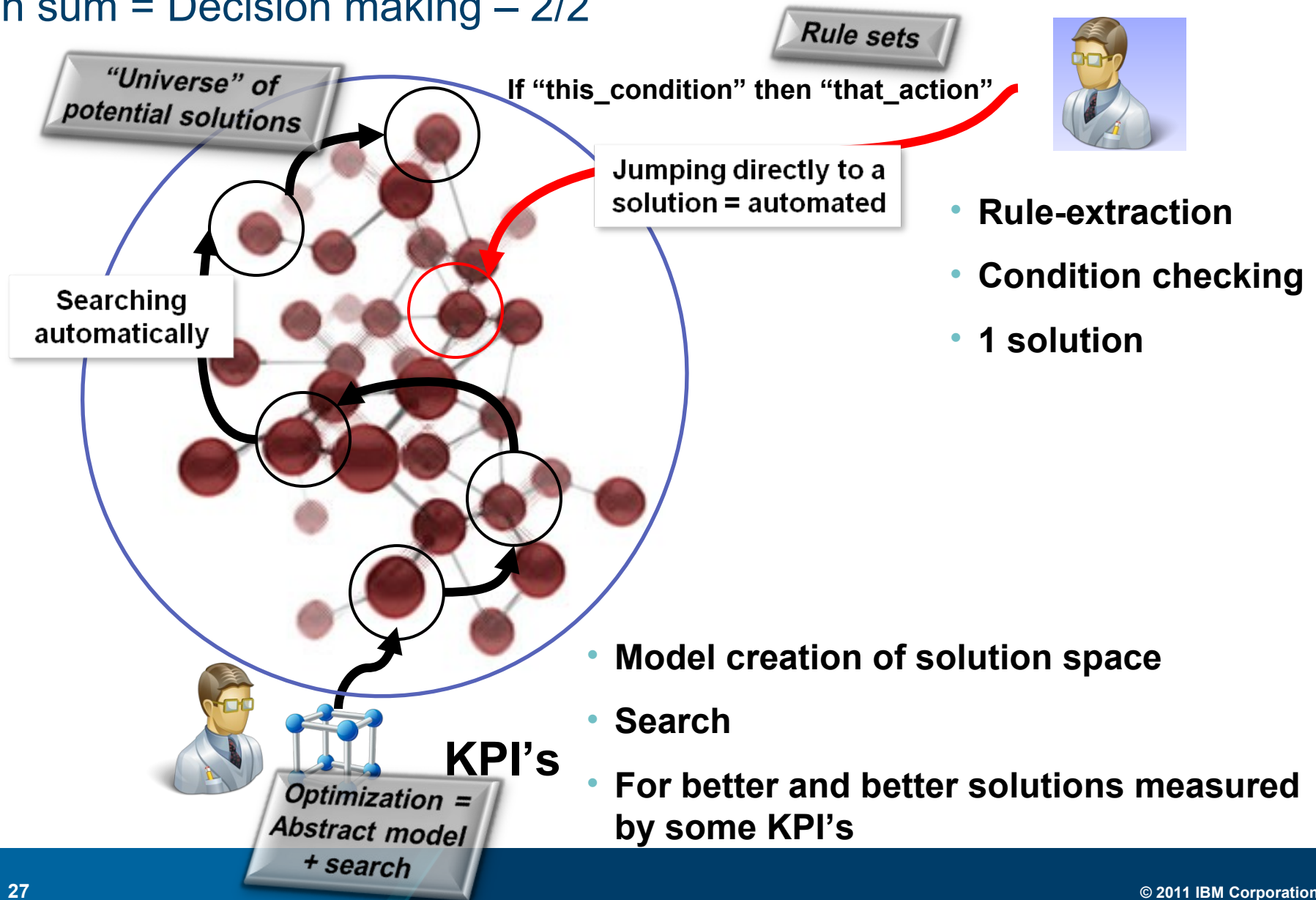
When should one be preferred over the other?

- Rule-based is preferred
 - the reality/data is changing too fast, no meaning to make an optimized plan because by the time it is made the plan is obsolete
 - Time to react is more important than the quality of the solution/plan
 - There is already accumulated human knowledge and it is valued over any machine made one
 - Changing the planning/business process is either risky or require too much change
 - It doesn't matter much if the solution is not perfect (maybe contradictory) or there might be better one
 - The problem could be described as a control problem
- OR-based is preferred
 - There is enough time to make/change the plan
 - The objectives/goals are clear and measurable
 - When the data is 'clean'/cover reality
 - The solution has to be bulletproof (no contradictions are acceptable)
 - When even small change in the plan can result in huge improvements
 - The problem is too complex to solve it by rules
 - Maintaining the rule system is too costly

In sum = Decision making – 1/2

- Expert is in total control = analytics is on the data
 - Cognos type of tools put the data at the fingertips to the expert, but usually not giving much more than that
 - Prediction/Statistical tools
 - Simulation-based, working with scenarios
- Expert's knowledge can be automated for some conditions = Rule-based systems
 - No search, the decision is pre-made for the “condition”
- Expert creates some model of the world and evaluate (search in) the world based on that model = OR(math)-based optimization
 - It is a search among the different possible alternatives based on the model
 - each model has several variables, each variable has several possible values, and the variables are connected thru different constraints
 - each alternative (solution) is measured by a goal (function = cost, time, # of people), that is, alternative 1 (a solution) is better than alternative 2 if the measurement on alternative 1 is better than the (same) measurement on alternative 2. It is said that a solution is optimal if it is the best alternative among all the possible solutions measured by a goal

In sum = Decision making – 2/2



What do we do with uncertainty in a plan?

- Uncertainty can be dealt with many ways
 - Make only those decisions which can be reversible
 - Not always possible
 - Plan-synchronization with reality + re-planning/scheduling
 - Depends how fast you can react/re-plan
 - Make smaller decisions and synchronize more frequently
 - Plan with many scenarios
 - Adapt to reality with switching to better scenarios (plans)
 - Create a plan which is robust enough to stand against different scenarios

But... Should one be preferred over the other?

- Every technology should be used for what it does best (e.g.)
 - data-/solution checking \Rightarrow rule-based
 - It's clearly condition checking
 - Things are measurable and abstract model is possible to create \Rightarrow optimization
 - the aim is optimality and the problem can be described best by constraints (the problem is difficult to express in rules, too many combinations to express)
- Usually the combination of both technology gives the best/optimal business value to the user!

Optimization in Smart financial institutions

Smart Institutions Need to Think and Act in New Ways

Rethink the Business Model

Drive a simplified and streamlined agile enterprise that balances growth, efficiency and business resiliency

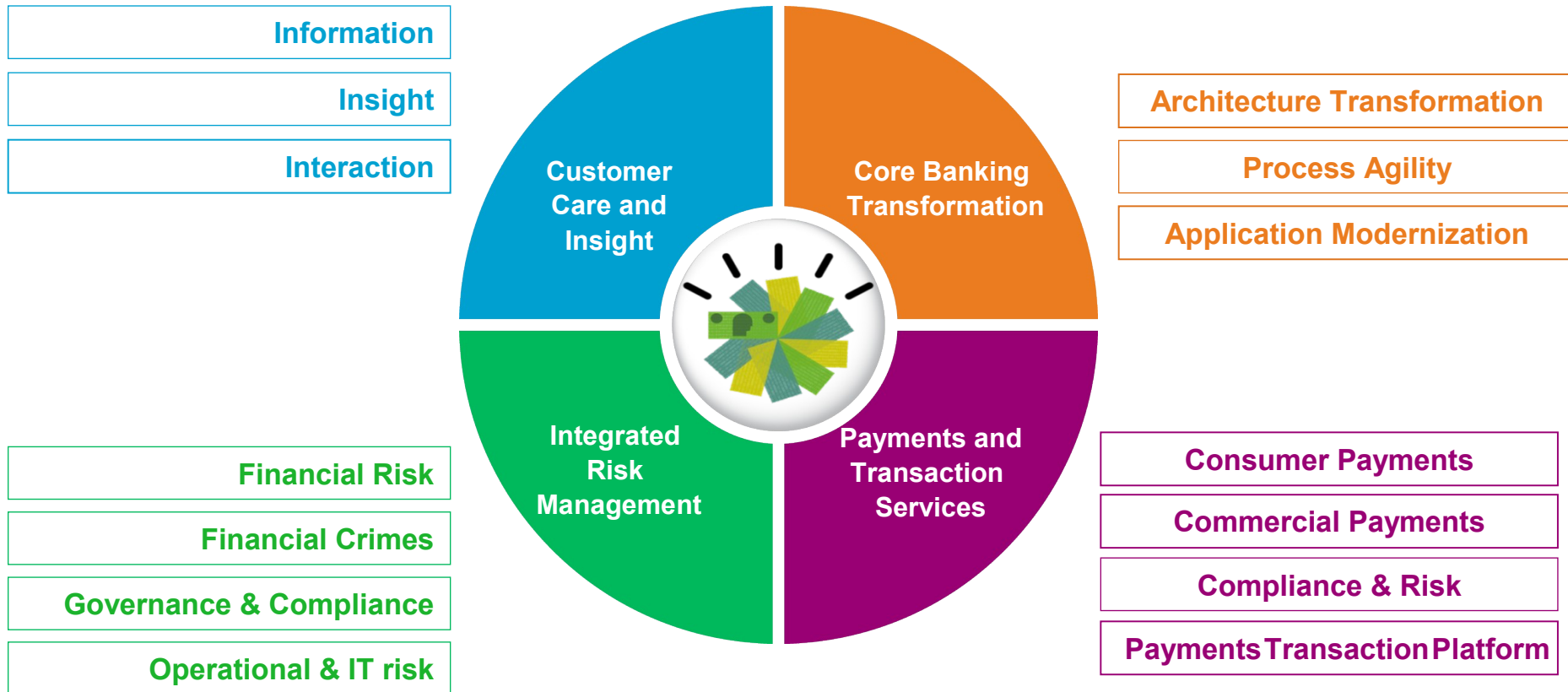
Focus on the Customer

Optimize data and leverage analytics to make informed decisions, deliver client-centricity and drive profitable growth

Integrate Risk Management

Achieve compliance objectives while mitigating operational risk, fighting crime and optimizing financial returns

Optimization enhances IBM Finance and Banking's opportunity to provide a better value proposition to create a Smarter Bank



To become a 'Smarter Bank'/financial institution customers need help solving these optimization challenges



- *Show me how I can:*
 - *Reduce risk through better hedging opportunities*
 - *Offer innovative, tailored portfolios to individual clients and market segments*
 - *Reduce carrying & transaction costs to improve operational efficiency*
 - *Respond quickly to loan requests to improve the customer experience*
 - *Identify growth opportunities by better matching terms to customer credit worthiness*

To be more concrete, Smarter finance/insurance companies want to Optimize these business functions

- Portfolio Optimization and Analytics
- Margin and Liquidity Management
- Financial Risk and Client Management
- Trade Matching and Timing
- Cash Management
 - Cash distribution
 - Cash delivery
- Derivatives Pricing
- Settlement and Clearing
- Loan Configuration and Lending
- Algorithmic Trading
- Smart Order Routing
- Campaign optimization (cross selling)
- Price optimization

Securities Settlement at INDEVAL reduces transaction costs by \$240M

Challenge

INDEVAL's securities settlement system was making it impossible for smaller financial institutions in Mexico to participate in financial markets due to high reserve requirements and excessive borrowing costs.

Solution

Indeval built a new securities settlement system, adopting best practices from international settlement banks. Using optimization, the value of pending trades was maximized and securities transactions were settled in near real time.

Benefits/ROI

- \$240 million USD in 18 months saved in borrowing costs for Mexican financial institutions
- 52% reduction in liquidity requirements for banks required for settlement
- 26% reduction in securities required for settlement



Indeval, Mexico's central securities depository, settles over \$250 billion USD in securities transactions per day.

IBM ILOG Optimization on z/OS: a core technology for Payments &

Challenge

Achieve a higher volume of trade settlements at a lower cost to increase liquidity and capital flow in the Eurozone.

With high trading volumes anticipated, the bank needed to find the optimal set of nightly settlement trades within their short time horizon.

Solution

The bank turned to IBM to help find a solution combining core optimization technology and institutional business expertise to come up with a superior solution.

Benefits/ROI

- Settling more trades at lower cost will increase liquidity and capital flow.
- Using IBM Optimization will allow the bank to respond more quickly to new constraints as legislation and customer behavior changes.
- The optimized settlement system should free up hundreds of millions of euro worth of collateral used to back up trades.



National Bank - EU

Portfolio Optimization helps companies achieve growth

Challenge

Customize active tax management for each managed account
Automate tradeoff between risk, return and taxes for each investor

Solution

Use CPLEX Optimization Studio to model risk, return, taxes and transaction costs

Evaluate and rebalance portfolios using

- Cash level in portfolio
- Capital gains and losses in the portfolio
- Portfolio risks
- Market and benchmark changes
- Investment needs and risk tolerance specific to each investor

Benefits/ROI

Compared with passive management, the company's portfolio optimizer increases after-tax returns by up to 1.5% per year

Accommodates a broader range of portfolios, \$100,000 USD to over \$1 billion USD

Achieved growth and enlarged its customer base

Responds faster to requests, delivering better service to customers

Stability and reliability of this software enable the company to evaluate each portfolio daily



Investment Advisory Firm with over \$25B in assets under management.

Widely recognized for its pioneering research and implementation of tax-efficient investing.

Optimized Portfolio Management leads to improved financial performance

Challenge

Comply with Federal stress test requirements and gain Federal approval to increase dividends

Find the most appropriate asset allocation according to investment goals, market history and forecasts

Analyze risks of investment portfolio from various perspectives

Arrive at rebalancing strategy to minimize transaction costs

Solution

A novel linear programming formulation using CPLEX Optimization Studio

Optimization model maximizes expected return while constraining the average of the worst scenario returns (CVAR)

Uses simulation to model investment risk

Enforces constraints such as: industry or regional concentration, and average credit rating, ...

Benefits/ROI

Better investment performance and better risk management for portfolios of non-traditional investments

Improved financial performance under Federal regulations

CPLEX, replacing a home-grown, domain-specific algorithm, increases flexibility to model real-world business constraints



Top-tier US bank with assets over \$2 trillion USD. Over 50 million customers world-wide

감사합니다 Natick
Grazie Danke Ευχαριστίες Dalu
Thank You Köszönöm
Спасибо Dank Gracias
谢谢 Merci Seé
ありがとう

Obrigado

Q&A