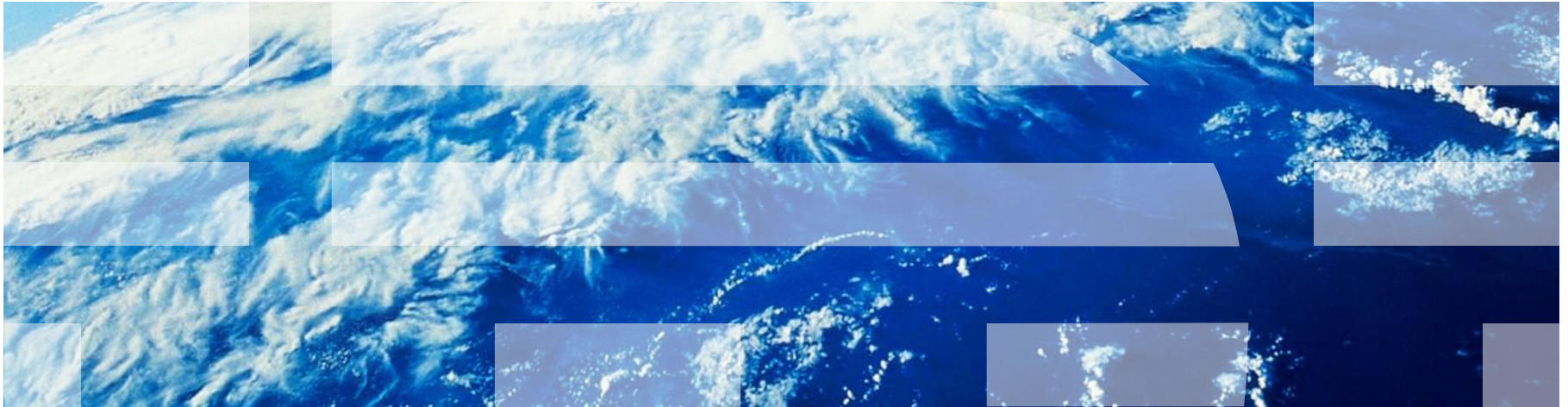


ILOG Optimization and Analytical Decision Support Solutions for Finance and Banking



Agenda

- Context of today's seminar
 - What's ILOG Optimization?
 - How does it work?
 - Recent Optimization developments
- What can it achieve in Finance ? – use cases
 - Portfolio Optimization
 - Trade Matching and Timing
 - Cash Management
 - Loan Configuration and Lending
 - Trade Settlement - Netting
- Q&A

What Can Optimization Do?

Optimization helps businesses make complex decisions and trade-offs about limited resources

- **Discover previously unknown options or approaches**

Automatically evaluate millions of choices

- **Automate and streamline decisions**

Compliance with business policies and regulations

Free up planners and operations managers so that they can leverage their expertise across a wider set of challenges

- **Explore more scenarios and alternatives**

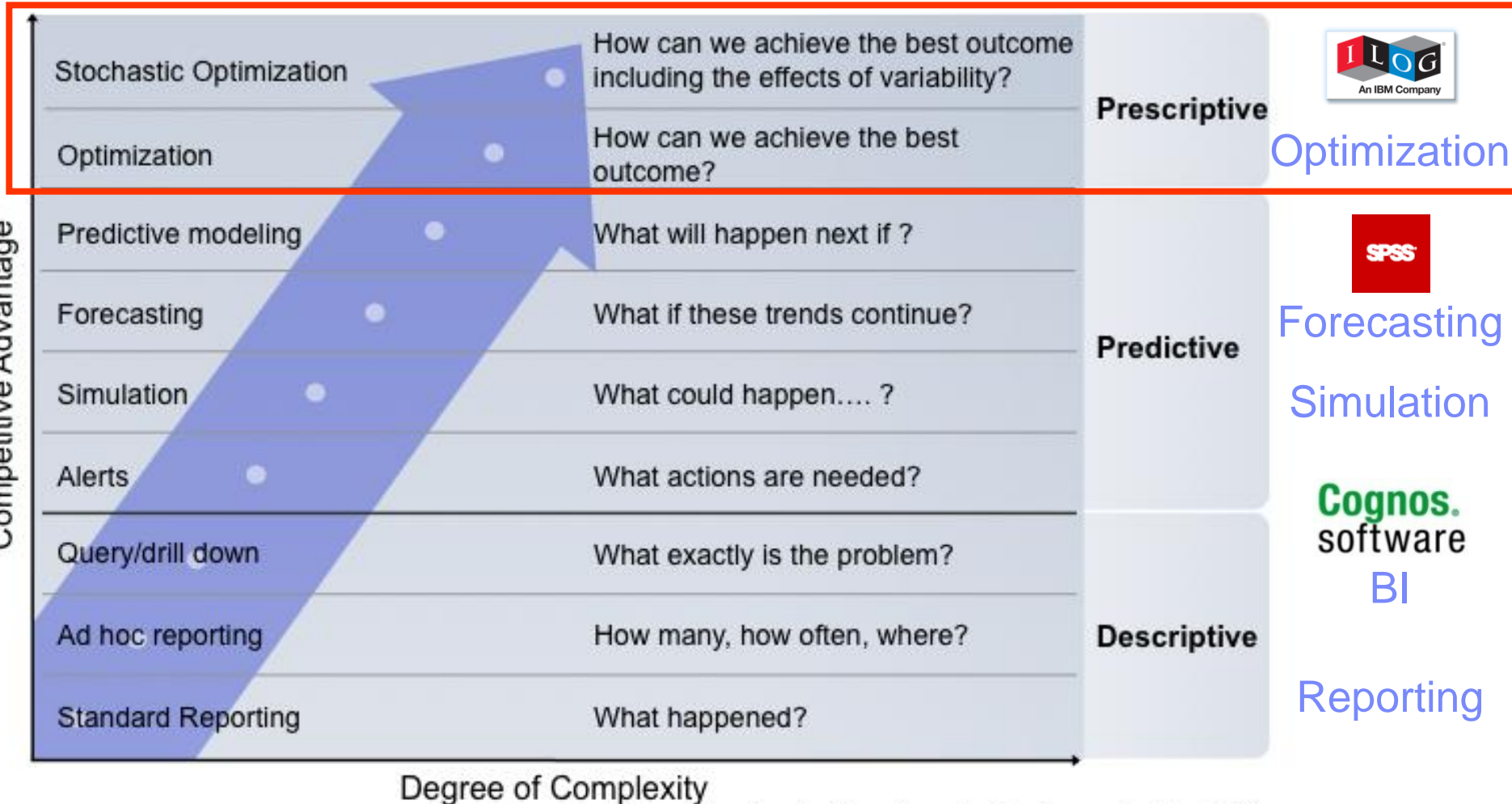
Understand trade-offs and sensitivities to various changes

Gain insights into input data

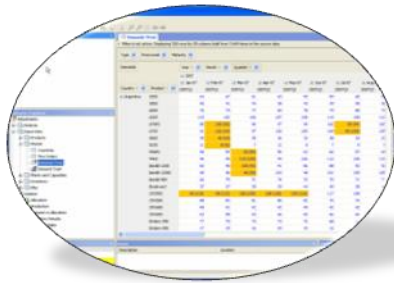
View results in new ways

Where does Optimization sit in the Business Analytics Spectrum?

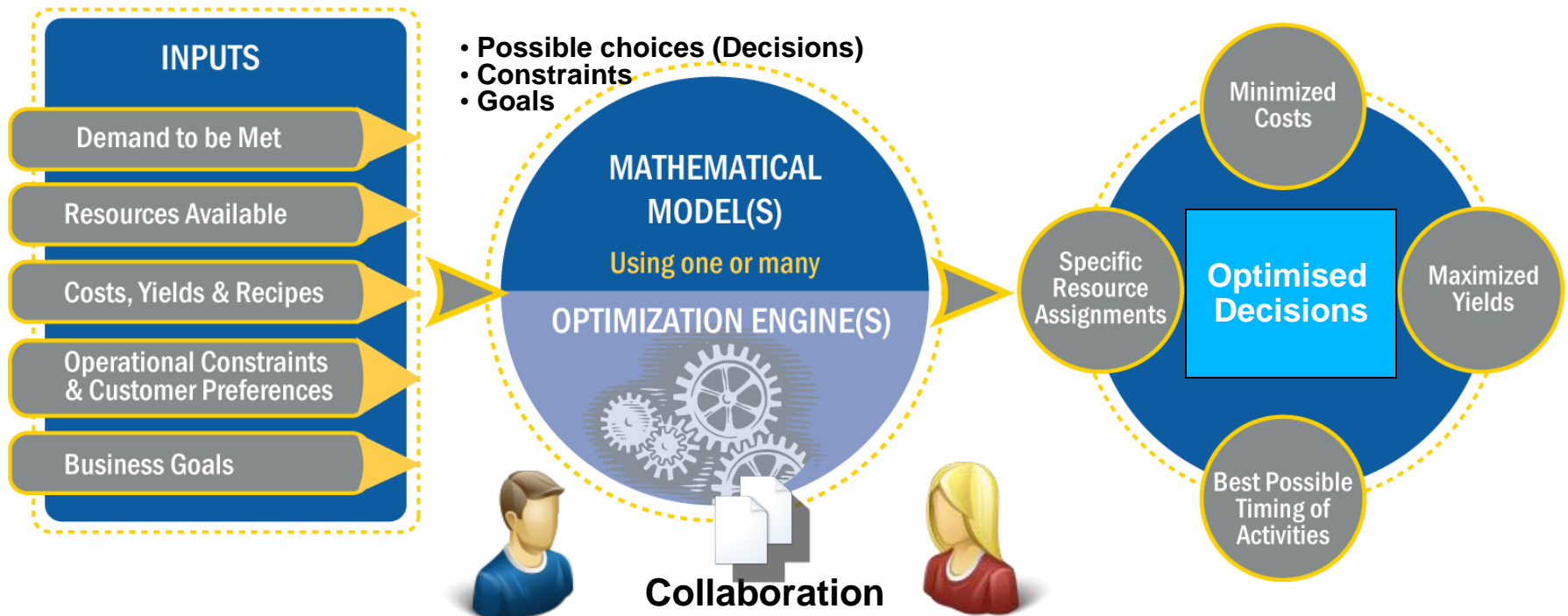
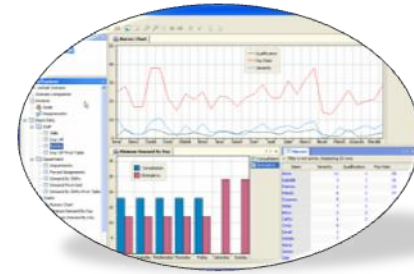
Business Analytics Landscape



How Does Optimization Work?

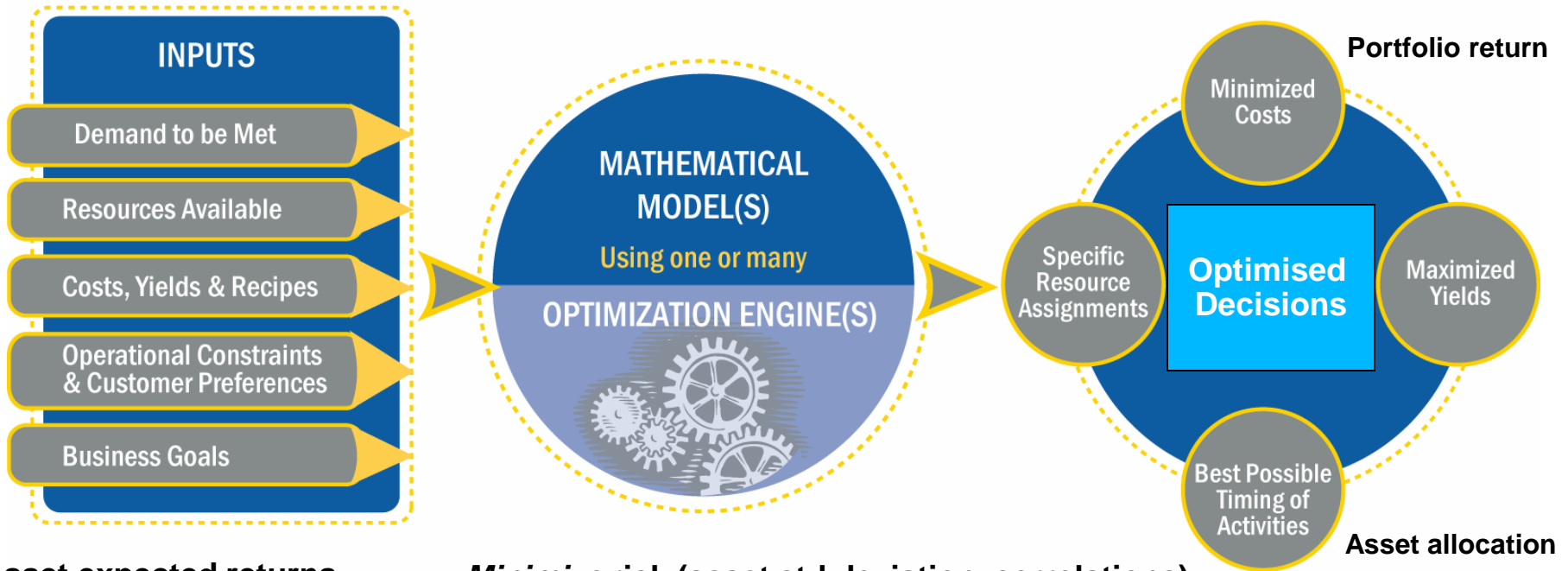


What-If Analysis



Portfolio management example

Portfolio Management Example



- Asset expected returns
- Asset std deviation of returns
- Asset return correlations

Minimize risk (asset std deviation, correlations) or CVaR

Subject to

Sum (asset expected returns) ≥ target

...

Build a custom model

Simple Portfolio Optimization model

```
range float FloatRange = 0.0..Wealth;
```

```
float alpha = ...;
```

```
float Covariance = ...;
```

```
float Return = ...;
```

```
dvar float Allocation[Investments] in FloatRange; // Investment Level
```

Data

Variables

```
dexpr float TotalReturn = sum(i in Investments) Return[i]*Allocation[i];
```

```
dexpr float TotalVariance = sum(i,j in Investments) Covariance[i][j]*Allocation[i]*Allocation[j];
```

```
dexpr float Objective = alpha * TotalReturn - (1 - alpha) (Rho/2)* TotalVariance;
```

Objectives

```
Maximize Objective;
```

```
subject to {
```

```
// sum of allocations equals amount to be invested
```

```
allocate: sum (i in Investments) (Allocation[i]) == Wealth;
```

Constraints

```
}
```

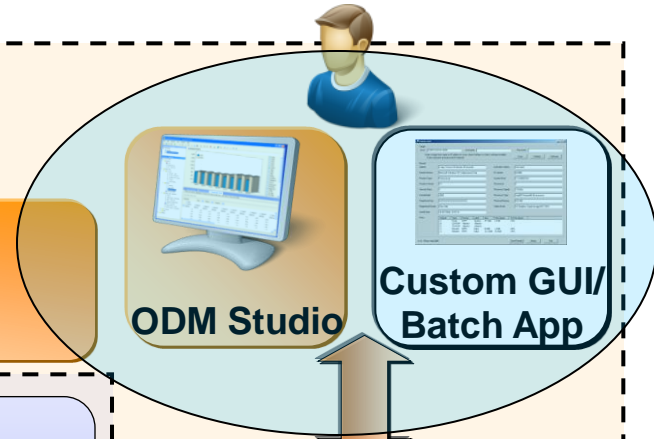
Decide how to use your models



ODM Enterprise

Application Development Tools

Data Modeling - Graphics - WAS



Service APIs

Model Development Tools

CPLEX Studio (IDE) - OPL Modeling Language

ILOG Concert Technology

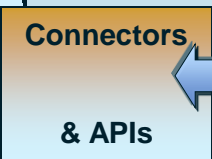
Optimization Solvers

Math Programming

CPLEX Optimizers

Constraint Programming

CPLEX CP Optimizer



Optimization Server



Data Server



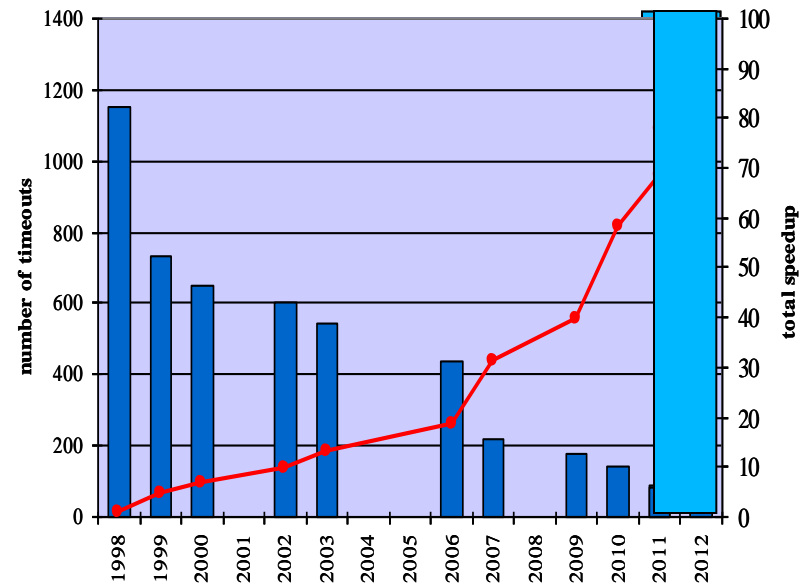
CPLEX Optimization Studio

Progress in Linear and Integer Programming (CPLEX engine)

- Since the early 90s
 - Linear Programming
 - Algorithmic: More than 2000 times faster
 - Hardware: Factor 1000
 - **Net: Algorithm * Machine ~ 2 000 000x**
 - Integer Programming
 - Tremendous improvements
 - Still, experimentation can be necessary
 - Algorithmic controls
 - User knowledge
 - (Re-)Formulation

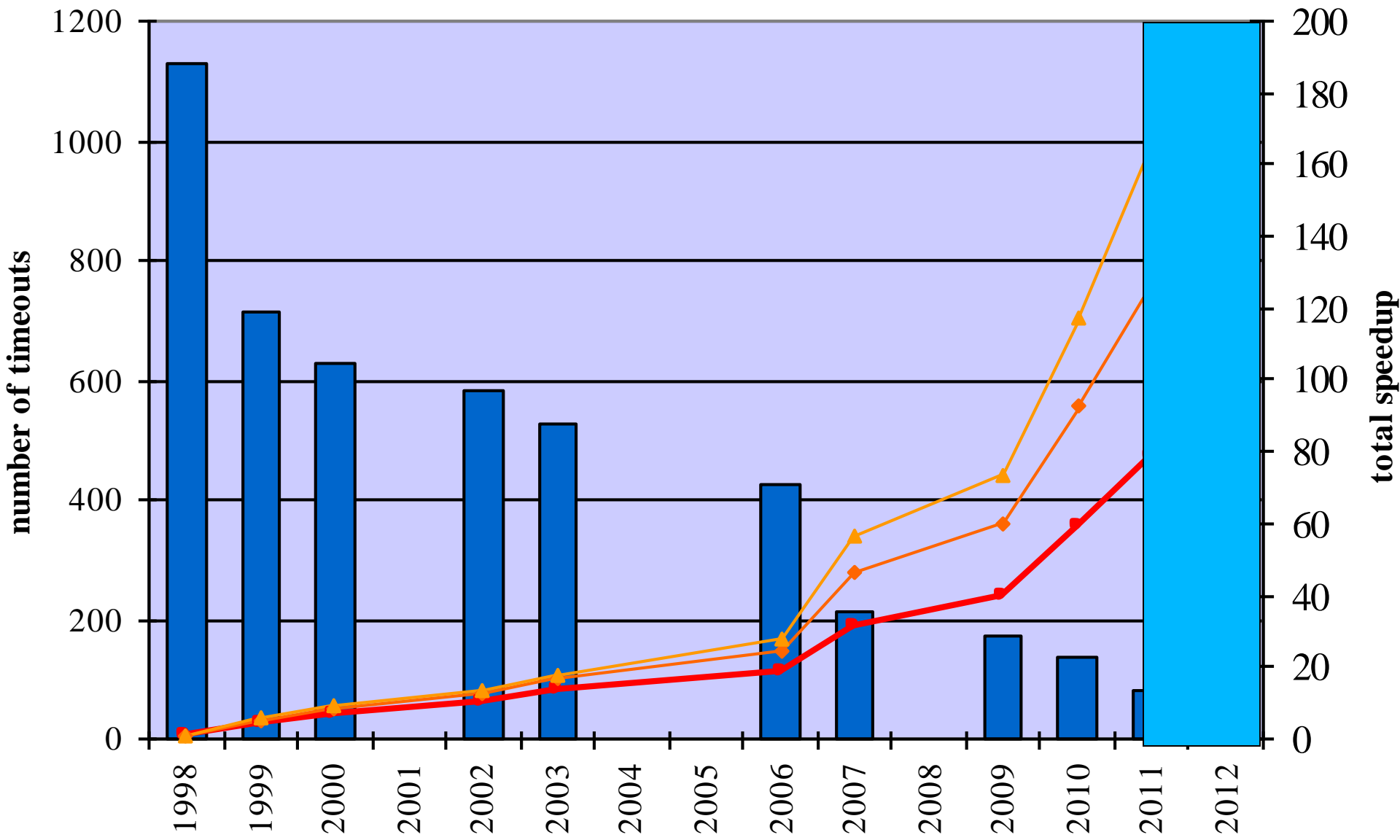
- Benefits
 - Larger, more accurate models
 - Example: Portfolio optimization under uncertainty
 - Optimizing over multiple processes
 - Taking into account more constraints and objectives
 - Real-time, execution level models

- The only engine *software that supports z/OS®*



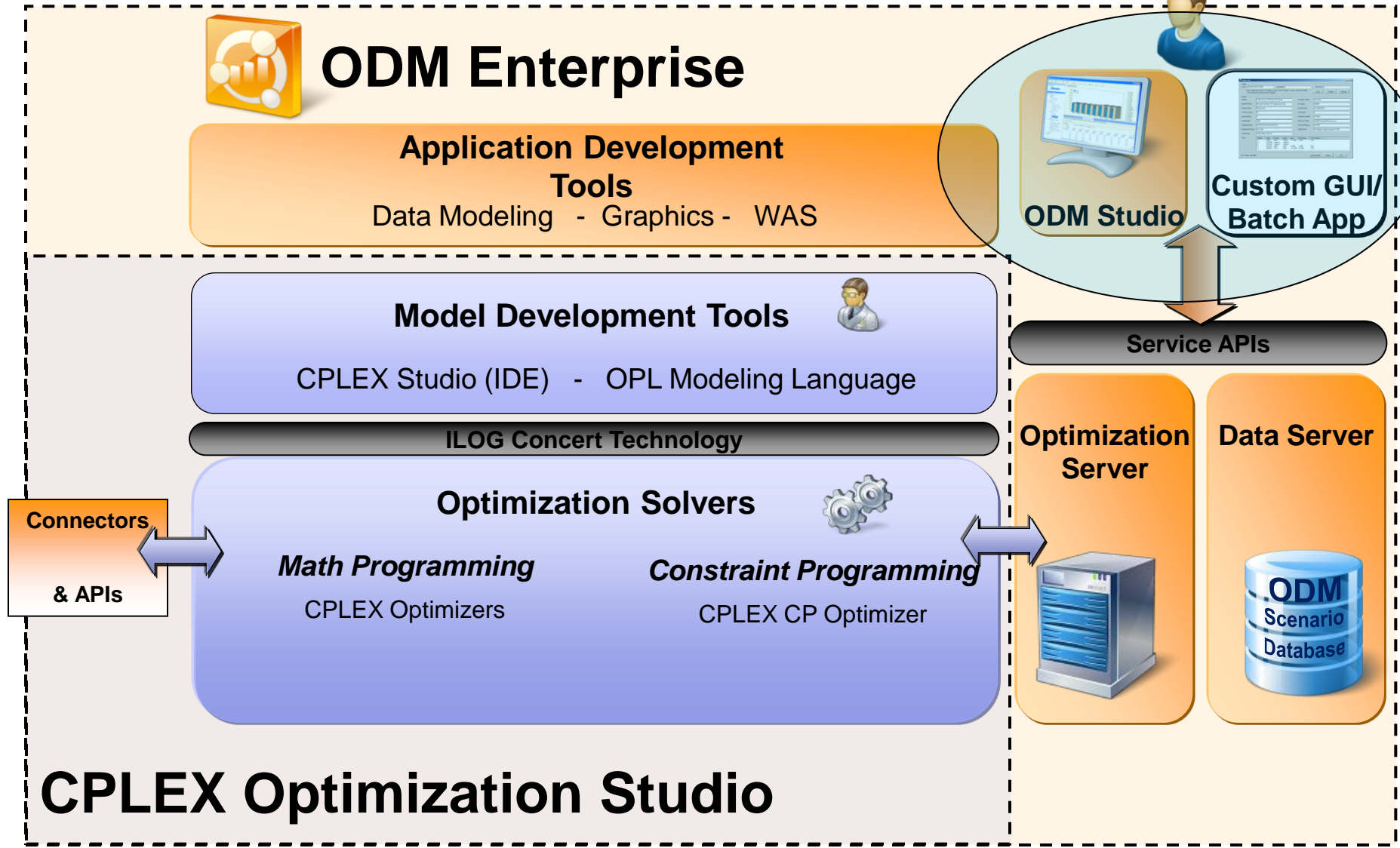
Integer Programming

Date: 31 Oct 2012
 Testset: 3177 models (1753 in ≥ 10 sec, 1515 in ≥ 100 sec, 1354 in ≥ 1000 sec)
 Machine: Intel X5650 @ 2.67GHz, 24 GB RAM, 12 threads (deterministic since CPLEX 11.0)
 Timelimit: 10,000 sec



Date: 31 Oct 2012
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 Timelimit: 10,000 sec

Decide how to use your models



ILOG ODM Enterprise Solve – portfolio rebalancing

Solve Progress
✕

3 positions moves maximum

Solve launched 2/7/12 11:39 AM Time elapsed: 0:00:02 Percent from Optimal Solution: **0 %**

✓ **Solution found**

Relax more requirements
Accept relaxation level

Close this dialog box when solve completes
 Continue in background...
Close

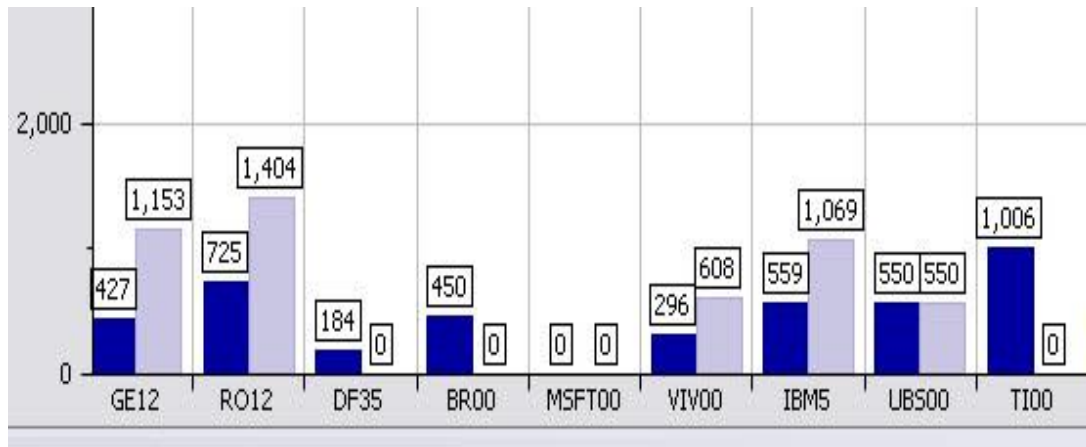
● **Combined Objective = 1119491.02** - Best Possible Optimal Solution
 📊 ▼ Hide chart

● **Score = 1,119,557.26** 📊 ▶ Show chart

● **Transaction Fixed Cost = \$ 30.00** 📊 ▶ Show chart

● **Transaction Variable Cost = \$ 36.24** 📊 ▶ Show chart

ILOG ODM Enterprise Results

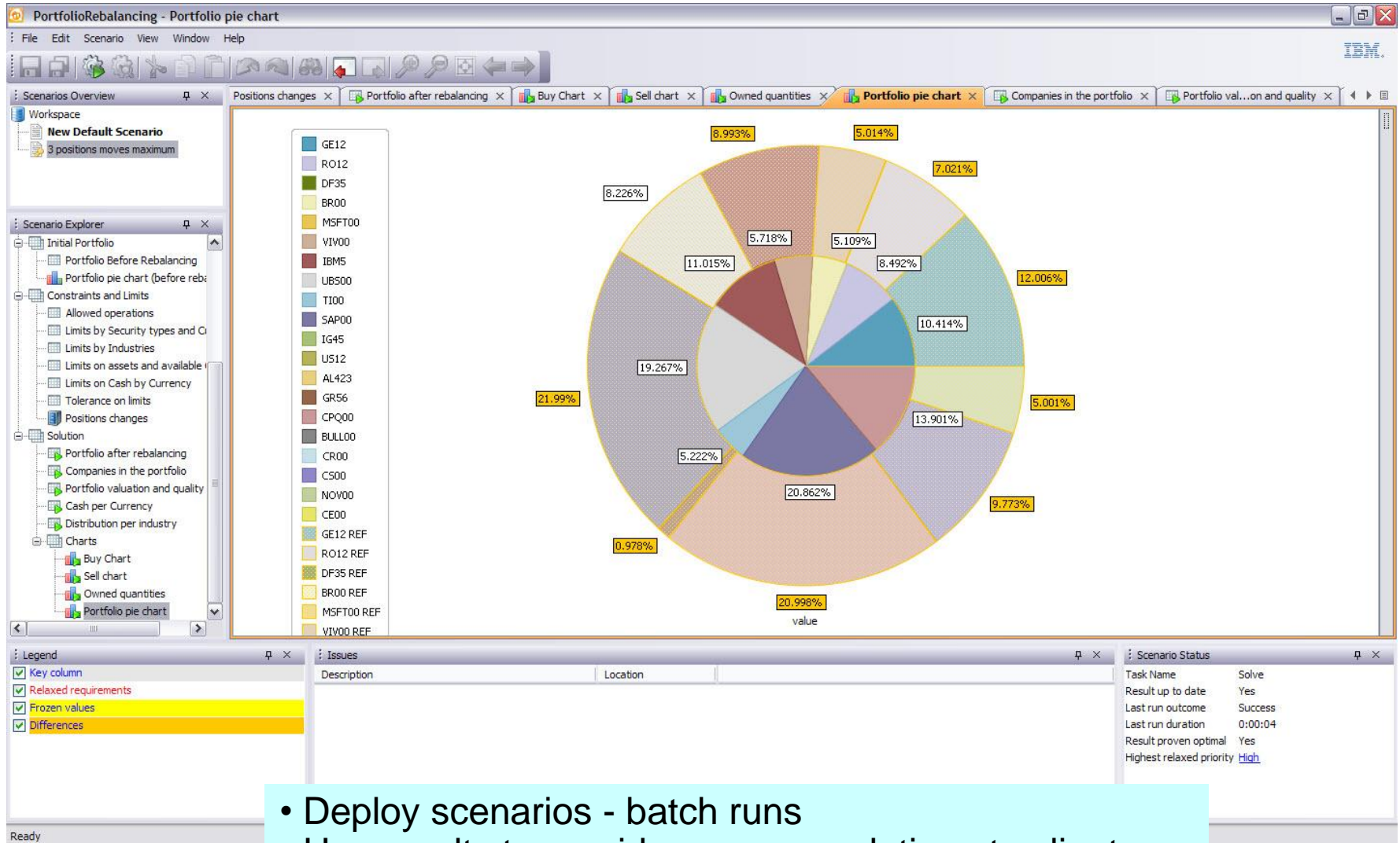


Positions changes x Portfolio after r

Filter is not active. Displaying 19 rows

Company Name	Presence
GeneralElectric	✓
Roche	✓
DeutscheFinance	
Bristol	✓
Microsoft	
Vivendi	✓
IBM	✓
UBS	✓
TexasInstruments	✓
SAP	✓
Infogram	
USTreasury	
Alcatel	
Compaq	✓
Bull	
Cross	
CreditSuisse	
Novartis	
CentralElectric	


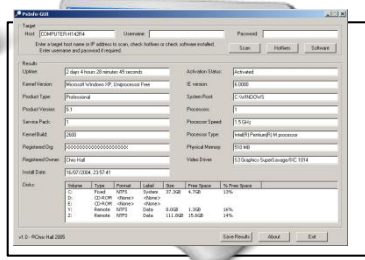
ILOG ODM Enterprise Results



- Deploy scenarios - batch runs
- Use results to provide recommendations to clients

ILOG ODM Enterprise - scenarios of usage

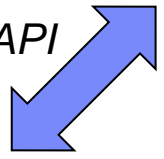
Portfolio Analyst : ODM Studio Existing GUI

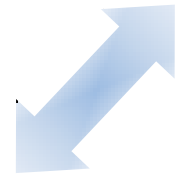
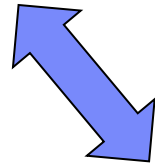
Portfolio Analyst Tactical Tuning



Processing Service API



Data Service API



ODM Optimization Server



ODM Scenario Repository



Optimization Applications in Finance



Optimization Problems in the Financial Industries



Classic Applications

- Portfolio Optimization
- Trade Matching and Timing
- Asset-Liability Management
- Cash Management

Novel Applications

- Loan Configuration and Lending
- Derivatives Pricing
- Workforce scheduling/dispatch
- Ad scheduling
- Targeted Marketing
- Collateral management
- Trade Settlement - Netting

Optimization Problems in the Financial Industries



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Portfolio Optimization

- **Issue:** Portfolio holders and managers seek maximum return from assets while limiting risks of adverse outcomes. Classical formulation by Markowitz has become enriched by several factors. Competitive advantage and client preferences lead fund managers to tailor portfolios to specific regional, sectoral, and other diverse preferences. Novel assets have risk characteristics very different from standard stocks and bonds.
- **Scope:** Thousands of assets, hundreds of sectors, hundreds of regions. Rebalancing frequency (daily, weekly,...)
- **Decisions:** Amount of fund allocated to each asset
- **Objectives:** Minimize risk as measured by variance of portfolio return, VAR, CVAR, ...
- **Requirements:**
 - Expected return at least achieves target
 - Total funds invested does not exceed amount available
 - Total funds invested per sector and/or region does not exceed limit
 - Limits on leverage

Retail Financial Services
Investment Banking

Portfolio Management

- Customer
 - The Asset Management Group of a major European retail bank
 - Manages financial assets for institutions, enterprises, and private clients
- Problem
 - Enhance quality of investment advice, improving customer service and creating a competitive differentiator
 - Redundant, incomplete, or inaccurate data impacts investment advice and trading
- Solution
 - IBM ILOG Business Rules Management System validates and consolidates incoming data from multiple feeds (mergers, acquisitions, stock data, etc.)
 - **IBM ILOG CPLEX** determines optimum portfolio based on investment guidelines, creating tax-efficient portfolios while meeting customers' investment goals and risk profile
 - **CPLEX** reduces “tracking error” between benchmarks and a tailored portfolio
 - Allows account managers to comply automatically with specific client requests and regulations
- Benefits
 - Consolidation of data reduced to seconds from days
 - Able to negotiate better rates with financial feeds through audit trail of rules (e.g. based on validation rules)
 - Ensures highest quality investment recommendations
 - Personalizes client offerings



Portfolio Optimization

- Customer
 - A financial services company
 - Provides portfolio management solutions to institutions and wealthy individuals
 - Widely recognized for pioneering research in tax-efficient investing
- Problem
 - Automate determination of best mix of tax-efficient investments in consistent and timely manner
- Solution
 - **IBM ILOG CPLEX** offers proven algorithms that lend the stability and reliability to enable the company to evaluate portfolios daily
 - Evaluation incorporates cash level; capital gains and losses; risk; investor needs; risk tolerance and time since last optimization
 - **IBM ILOG CPLEX Optimization Studio** simplifies the modeling process by quickly modeling a problem and converting it into code used by CPLEX
- Benefits
 - 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, from \$500,000 to \$500 million
 - Achieve twofold growth and enlarge its customer base
 - Respond faster to requests, delivering better service to customers



Passing Stress tests – Financial Risk Management – Sept 2011

- A global financial services company, with assets of more than \$1.4T, large bank holding company in the United States. serving clients in more than 150 countries with services including finance, insurance, banking, mortgages, equity and credit cards.
- Needed to meet Federal Reserve “stress test” standards to demonstrate its ability to remain stable throughout various economic fluctuations, and to gain approval to increase dividends.
- The IBM Team used IBM ILOG CPLEX to create a simulation for the stress tests, achieved through portfolio optimization. This involved:
 - balancing risk versus reward
 - finding the most appropriate asset allocation according to investment goals,
 - market history and forecast using a unique approach to quantify 'black swan events' such as the financial crisis of 2008, ensuring that risk was properly accounted for.
 - The model was then implemented as the primary solution for investment trading.
- The bank was able to meet the Federal Reserve's standards and pass the stress tests. The bank also expects
 - increased profit on investment portfolios,
 - increased market share
 - And, improved customer satisfaction.

Optimization Problems in the Financial Industries



Classic Applications

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Trade Matching

- **Issue:** Portfolio managers engage in trading activity to invest new money and to rebalance asset allocations to achieve investment goals. Many firms manage multiple portfolios. Trade matching enables executing trades among multiple portfolios within a firm to avoid transactions costs of going to the markets
- **Scope:** Hundreds of funds, thousands of assets, hundreds of transactions per week
- **Decisions:** Amount of each security to buy or sell from/to each fund
- **Objectives:** Minimize net cost to move the assets
- **Requirements:**
 - Achieve target asset allocation in each fund
 - Minimize net transfers of assets among funds
 - Market transactions fill net supply or demand in each fund

Investment Banking

Trade Matching



- Customer
 - One of the world's largest investment managers
 - 13 global offices and clients in 40 countries
- Problem
 - Optimize portfolio management applications to help the firm create competitive advantage and provide substantial savings to clients
- Solution
 - **IBM ILOG Optimization** used in three core portfolio management applications
 - Trade Crossing: match thousands of assets in buy and sell orders, avoiding market trades and related transaction costs
 - Optimized In-kind: transfer a large majority of portfolio assets directly ("in-kind") into targeted funds, saving clients hundreds of millions in transaction costs
 - Fund Rebalancing: create optimal holdings of fund assets through appropriate trades, allowing fund managers to perform accurate index tracking, while minimizing transaction costs
- Benefits
 - Saved \$500 million in transaction costs
 - Crossing and In-Kind Trading are a major source of competitive advantage for the company
 - High complexity of reconciling risk/return objectives, fund policies, and regulatory guidelines makes fund rebalancing process a differentiating factor in the investment industry

Trade Scheduling

- Customer
 - The company provides
 - Execution management and algorithmic trading systems for equities, currencies and derivatives
- Problem
 - Minimize average implementation shortfall across portfolio trade list
 - Implementation shortfall: difference between prevailing security price when list sent to trading and execution price
- Solution
 - IBM ILOG CPLEX generates schedule for completing trade list within specified time window
- Benefits
 - Clients – significantly reduced implementation shortfall and dramatically improved performance fluctuation
 - The company – differentiation from competitors, new business for flagship product, increased revenues from the trade scheduling product



Optimization Problems in the Financial Industries



Classic Applications

- Portfolio Optimization
- Trade Matching and Timing
- Asset-Liability Management
- **Cash Management**

Novel Applications

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Managing Cash

- **Issue:** Cash is necessary for economic liquidity but handling cash entails numerous costs and earns no returns. Banks need to manage cash efficiently to reduce costs while providing essential services
- **Scope:** Billions of daily cash transactions, tens of thousands of disbursement points, hundreds to thousands of vaults, horizon one day to several weeks on a scale of hours to days
- **Decisions:** Amount of cash to hold at each disbursement point and vault, shipment amounts to/from each disbursement point, how much cash to invest or liquidate into or from other assets
- **Objectives:** Minimize carrying costs, minimize transportation costs
- **Requirements:**
 - Cash available at each dispersal point meets demand at that point in each time period
 - Cash withdrawn or deposited at each vault does not exceed limits in each time period
 - Amount of cash transported to/from each disbursement point does not exceed transport capacity
- **Benefits**
 - Reduce cash inventories by +30% (optimization + better forecasting + better management)
 - Reduce replenishment costs by +50%
 - Decrease cross-shipping fees about +50%

Retail Financial Services

Optimization Problems in the Financial Industries



Classic Applications

- Portfolio Optimization
- Trade Matching and Timing
- Asset-Liability Management
- Cash Management

Novel Applications

- [Loan Configuration and Lending](#)
- Derivatives Pricing
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- Collateral management
- Trade Settlement - Netting

Loan configuration

- **First Union Home Equity Bank Brings Personalized Loans to the Web** Using ILOG Optimization Software New Loan Arranger Technology Instantly Matches Loans with Real Customers
- MBS Loan pooling for Ameriquest (Now Citybank)
 - Sell loan pools to Freddie Mac, Fannie Mae and private investors
 - Increase profitability
 - Minimize time to market of loan pools (2 weeks → less than 5 minutes)
 - The engine that increased profit by providing ability to build pools that closely match the investor desired characteristics, provided what if analysis ability, minimized the penalty on characteristics violations after due diligence

Optimization Problems in the Financial Industries



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Targeted Marketing

- **Issue:** Competing for customers' business requires structuring attractive packages for customers that satisfy your profitability and risk tolerance criteria
- **Scope:** Hundreds to thousands of offers per day, tens to hundreds of products and product features to offer
- **Decisions:** Which products and product features to offer which customer
- **Objectives:** Maximize customer acceptance
- **Requirements:**
 - Offer satisfies profitability criteria
 - Offer satisfies risk criteria

Retail Financial Services

Target Marketing



- Customer
 - A Spanish Bank, one of the largest in Europe, has more than 90 million retail customers world-wide
- Business Problem
 - Enhance customer care and help drive sales and operational efficiency
 - Generate, filter, and optimize sales opportunities to maximize both customer satisfaction and bank return on investment (ROI)
- Solution
 - Everyday, IBM WebSphere ILOG JRules receives several million sales opportunities from an upstream marketing automation process, all qualified with a success probability. JRules filters all opportunities, to remove those that do not make sense and selecting those that provide added customer value without risking the customer relationship.
 - Using the filtered sales opportunities, IBM ILOG ODM Enterprise maximizes the use of the sales network while minimizing costs and enforcing constraints such as avoiding contacting the same customer via different channels.
- Benefits
 - Generate, filter and optimize sales opportunities
 - Handle multiple contact channels
 - Improve customer satisfaction
 - Maximize bank ROI for customer contacts
 - Allocate and execute the opportunities in the right channel

Optimization Problems in the Financial Industries



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- Collateral management
- **Trade Settlement - Netting**

Settlement and Clearing

- **Issue:** Quickly and reliably settle securities transactions
- **Scope:** Hundreds of trading institutions, thousands of assets, millions of transactions per day
- **Decisions:** Amount of each security and of cash exchange among from/to each trading institution
- **Objectives:** Minimize securities and cash transactions
- **Requirements:**
 - Net transfer of each security and of cash into each institution equals net demand
 - Net transfer of each security and of cash out of each institution equals net supply

*Exchanges
Investment Banking*

A Large Central Bank in Europe

IBM ILOG Optimization on z/OS as a core technology for a night settlement module

What Makes It Smarter

The volume of trades is expected to be high (over a million transactions), and finding the best set of trades to execute each night in a short time window is an extremely challenging technical problem. The bank turned to IBM to help find a solution combining core optimization technology and business expertise to come up with a superior solution.

Business Results (post state)

- 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.

Solution Components

- IBM ILOG CPLEX on z/OS
- IBM Labs, Lab services and Research involved

Key elements

- Optimization plays a key role in delivering
 - Smarter Decisions
 - Faster Decisions
 - Deeper Insights
 - Information into Action
- Optimization addresses hot button issues in Banking and Financial Markets
 - Better Risk Management
 - More Efficient Operations
 - Innovative Client Services

3 Ways to Use IBM Products and Services to Help Your Business Run More Efficiently

- Build an optimization application yourself
 - If you have the Optimization experts, IBM technology will make their development faster and more reliable

- Use a packaged solution for your business
 - IBM and its ISV partners have configurable applications for many kinds of business issues
 - Portfolio Optimization, Cash Management, Trade Scheduling, ...

- Let IBM help you build it
 - Our Professional Services and Partners can provide the expertise to build custom applications that meet your business requirements

Q&A