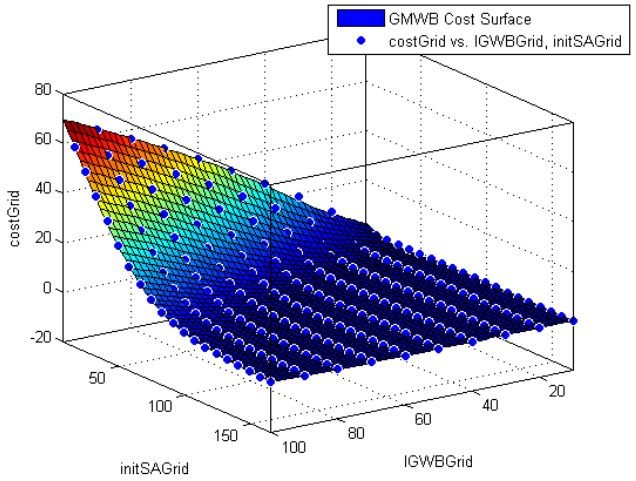
Modeling Variable Annuities with MATLAB

The MathWorks Computational Finance Team



Praha June 9, 2010

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Agenda

- Introduction
- Variable Annuities (GMWB) Case Study
  - Data Access
  - Financial Modeling
  - Deployment and Report Generation
- Wrap up and Q&A

Challenges in financial analysis

- Lack of computing power
  - Large data, large models
- Volatile markets
  - Ever-changing needs
- Increased transparency
  - More auditing and regulation
  - More sharing with colleagues

Customers Using MATLAB

Asset Management

Insurance

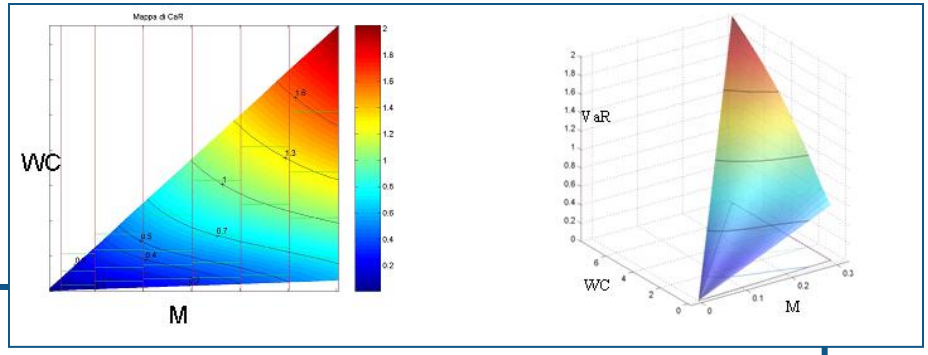
Energy Trading

Financial Services

Banks (Commercial,Retail,Investment)

Central Banks

Developing and Implementing Scenario Analysis Models to Measure Operational Risk at Intesa Sanpaolo



2D and 3D visualizations of value-at-risk calculations.

Challenge

Ensure compliance with Based II operational risk requirements

Solution

Use MATLAB to build scenario analysis models based on the loss distribution approach

Results

- Operational risk quantified and reduced
- Quantitative requirements met - capital measures calculated to 99.9% confidence level
- Scenario analysis calculation process automated

"We used MATLAB to build entirely new scenario analysis models. MATLAB saved us a significant amount of prototyping and development time. It also gave us flexibility-particularly useful in the early trial-and-error stages of the project."

Andrea Colombo and Stefano Desando
Intesa Sanpaolo

Link to technical article

UniCredit Bank Austria Develops and Rapidly Deploys a Consistent, Enterprise-Wide Market Data Engine

Zero-coupon yield curve plot in UniCredit Bank Austria's UMD environment.

Challenge

Improve risk management operations throughout a multinational financial institution

Solution

Use MATLAB, MATLAB Compiler, and MATLAB Builder JA to build and rapidly deploy a consistent enterprise-wide data warehouse with easily accessible derived market data

Results

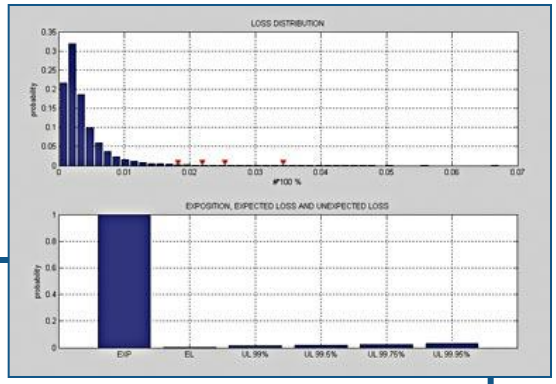
- Development time reduced by 50%
- Risk management improved across the bank
- Operational, audit, and maintenance costs reduced

"Many financial institutions are struggling to adapt their models to the volatility and limited availability of credit in today's markets. Using MathWorks products, we can develop and deploy models in response to new market conditions in days or weeks, instead of months."

Peter W. Schweighofer
UniCredit Bank Austria

Link to user story

Banche Popolari Unite Analyzes Credit Risk Using MATLAB



Loss distribution deployed by BPU in MATLAB.

Challenge

To analyze and identify potential portfolio credit risk

Solution

Use MATLAB and Statistics Toolbox software to develop a VaR model that enables fast computation and analysis of large data sets

Results

- Fast, precise analysis of more than 700,000 credit risk sensitive positions
- Reduction in algorithm development time
- Reliable analytical model

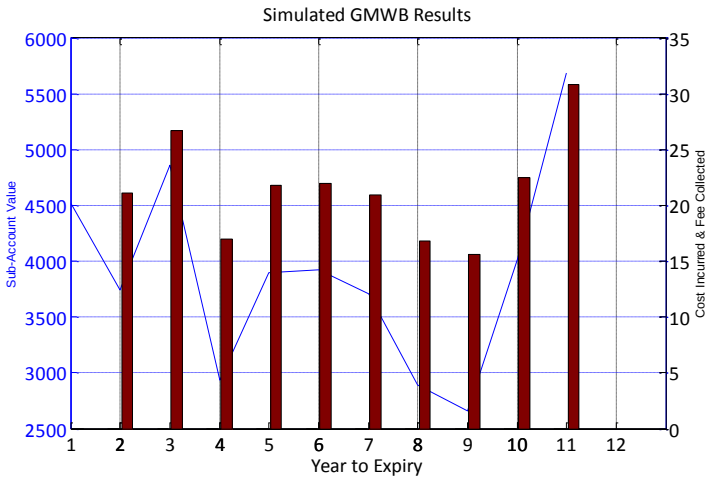
"The numerical computation and visualization capabilities of MATLAB are incredible! We can implement up to 100,000 simulations to hundreds of thousands of positions and relative aggregations quickly."

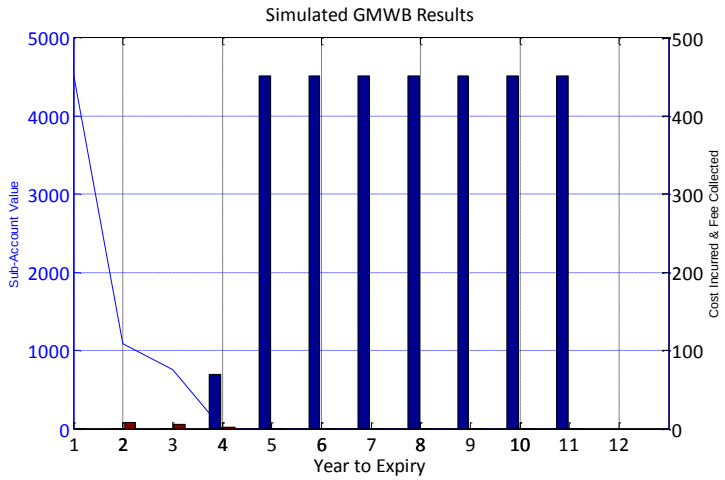
Roberto Modafferi
Banche Popolari Unite

Link to user story

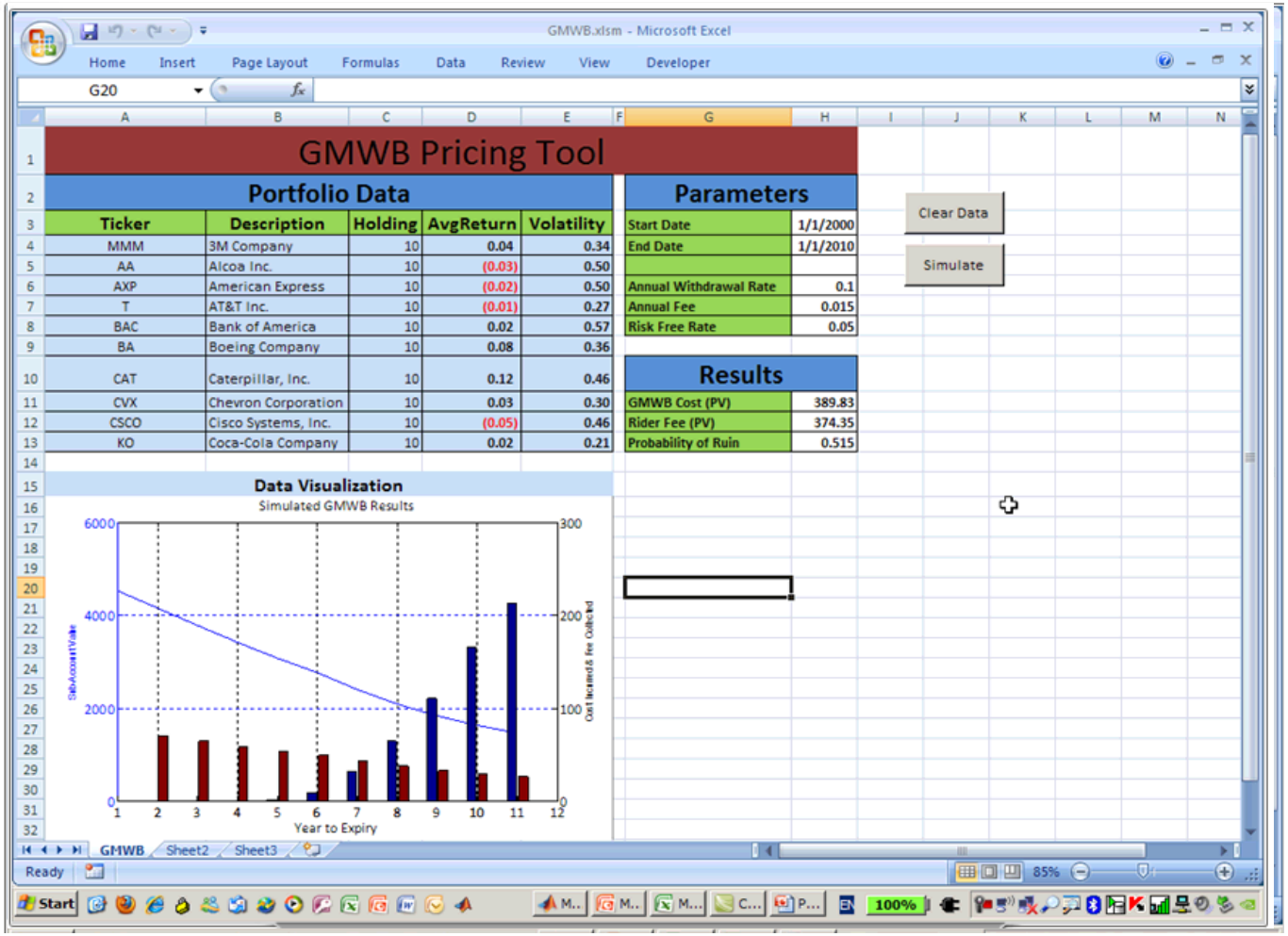
What is GMWB?

- Guaranteed Minimum Withdrawal Benefit
  - Investment Portfolio (Sub-Account), e.g. $100K
  - Withdrawal Rate, e.g. 10%
  - Rider Fee, e.g. 75 basis point

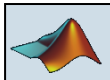




A GMWB Pricing Tool with MATLAB



Case Study: Pricing GMWB

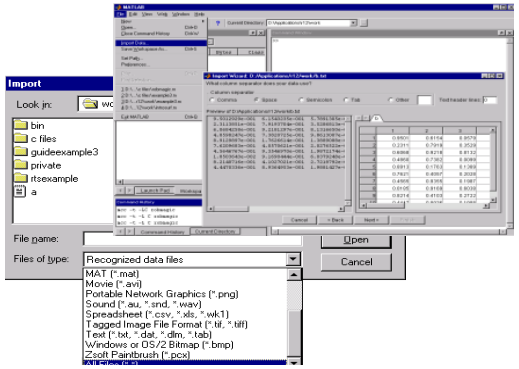


Data Import and Visualization

- Financial Modeling
- Deployment and Report Generation

Data I/O Overview

- Many interfaces to Excel spreadsheets and other file types



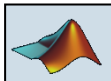
- Support for ODBC- and JDBC-compliant databases

ORACLE MySQL SYBASE Microsoft SQL Server

- Interface with data providers

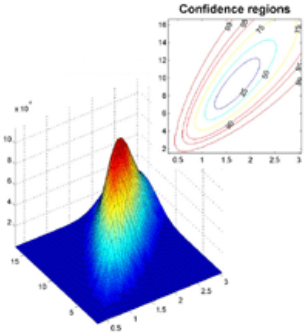
Bloomberg THOMSON REUTERS FACTSET Interactive Data HAVER kxsystems FEDERAL RESERVE BANK OF ST. LOUIS

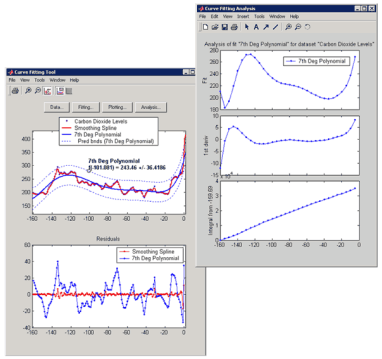
Case Study: Pricing GMWB

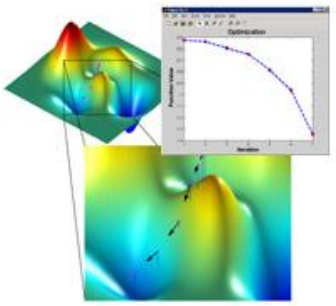
- Data Import and Visualization
-  Financial Modeling
- Deployment and Report Generation

Data Analysis in MATLAB

- Statistics
  - analyzing historical data, modeling data, simulating systems, and developing statistical algorithms.
- Curve Fitting
  - routines for preprocessing data, as well as creating, comparing, analyzing, and managing models.
- Optimization
  - proven algorithms for general and large-scale optimization
  - linear programming, quadratic programming, nonlinear least-squares, and nonlinear equations.
  - Genetic algorithm tools with numerous options for creation, fitness scaling, selection, crossover, and mutation
- Signal Processing, Neural Networks, Wavelets…

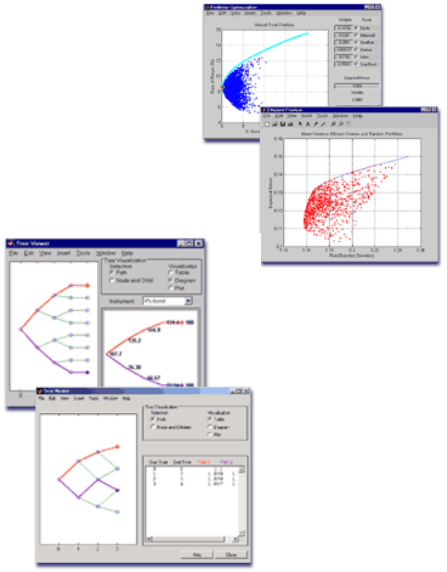


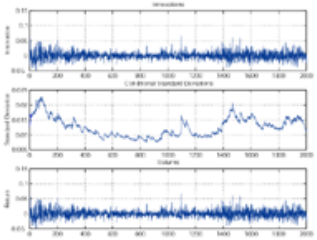




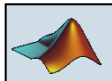
Financial Modeling with MATLAB

- Financial
  - perform portfolio optimizations, risk analyses, asset allocations, fixed income pricing, and much more
- Fixed Income
  - determine the price, yield, and cash flows for many types of fixed-income securities including mortgage-backed
- Financial Derivatives
  - analyze and model equity and fixed-income derivatives and securities contingent on interest rates
- Econometrics
  - perform Monte Carlo simulation of univariate returns, perform pre- and post-estimation diagnostic and hypothesis testing, estimate parameters of general ARMAX/GARCH models

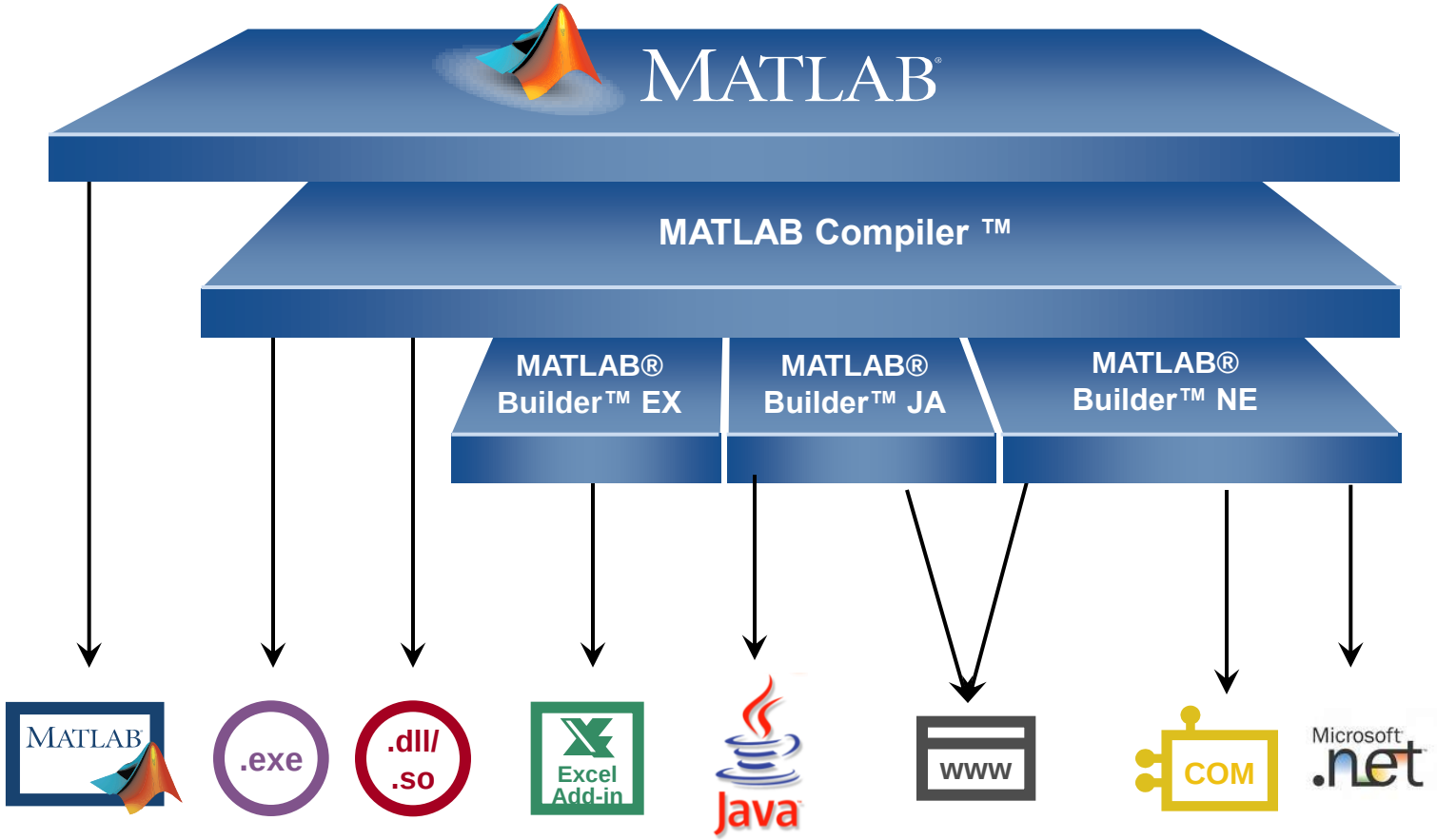




Case Study: Pricing GMWB

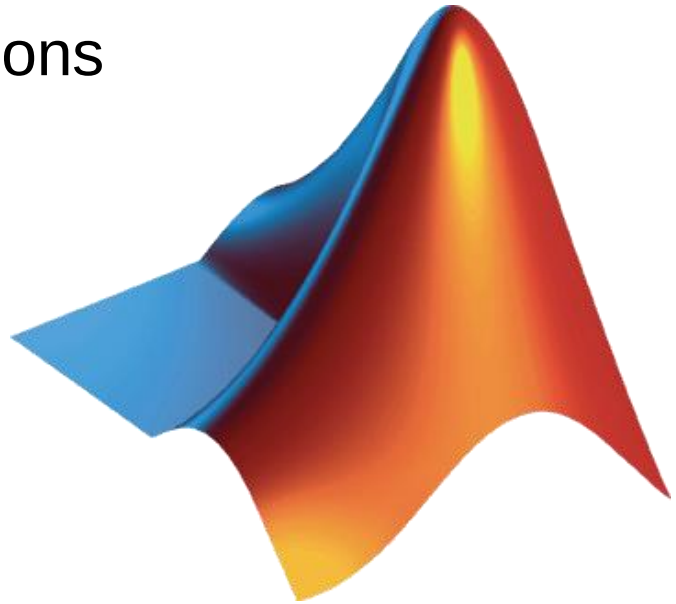
- Data Import and Visualization
- Financial Modeling
-  Deployment and Report Generation

Deploying with MATLAB

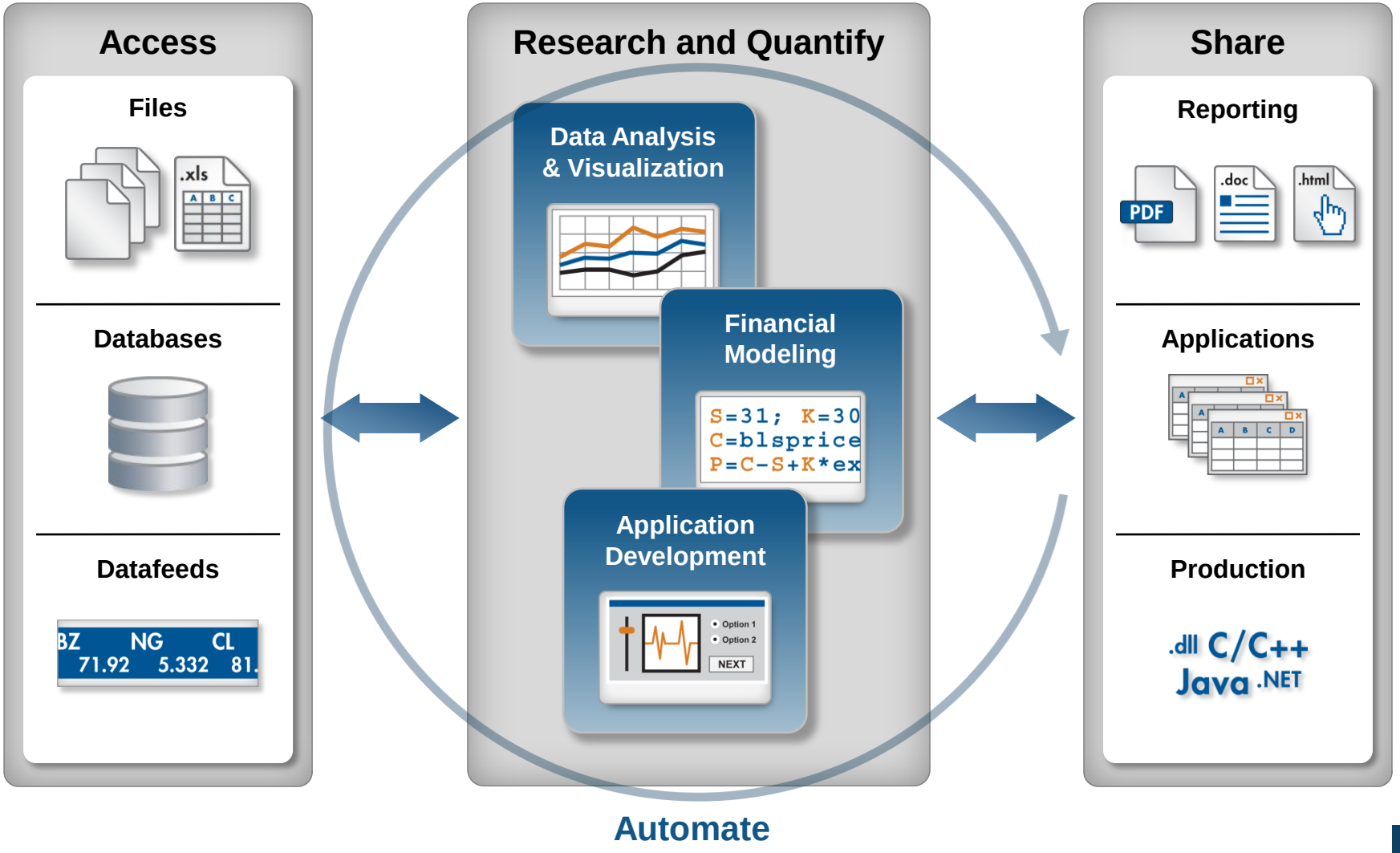


MATLAB's solutions

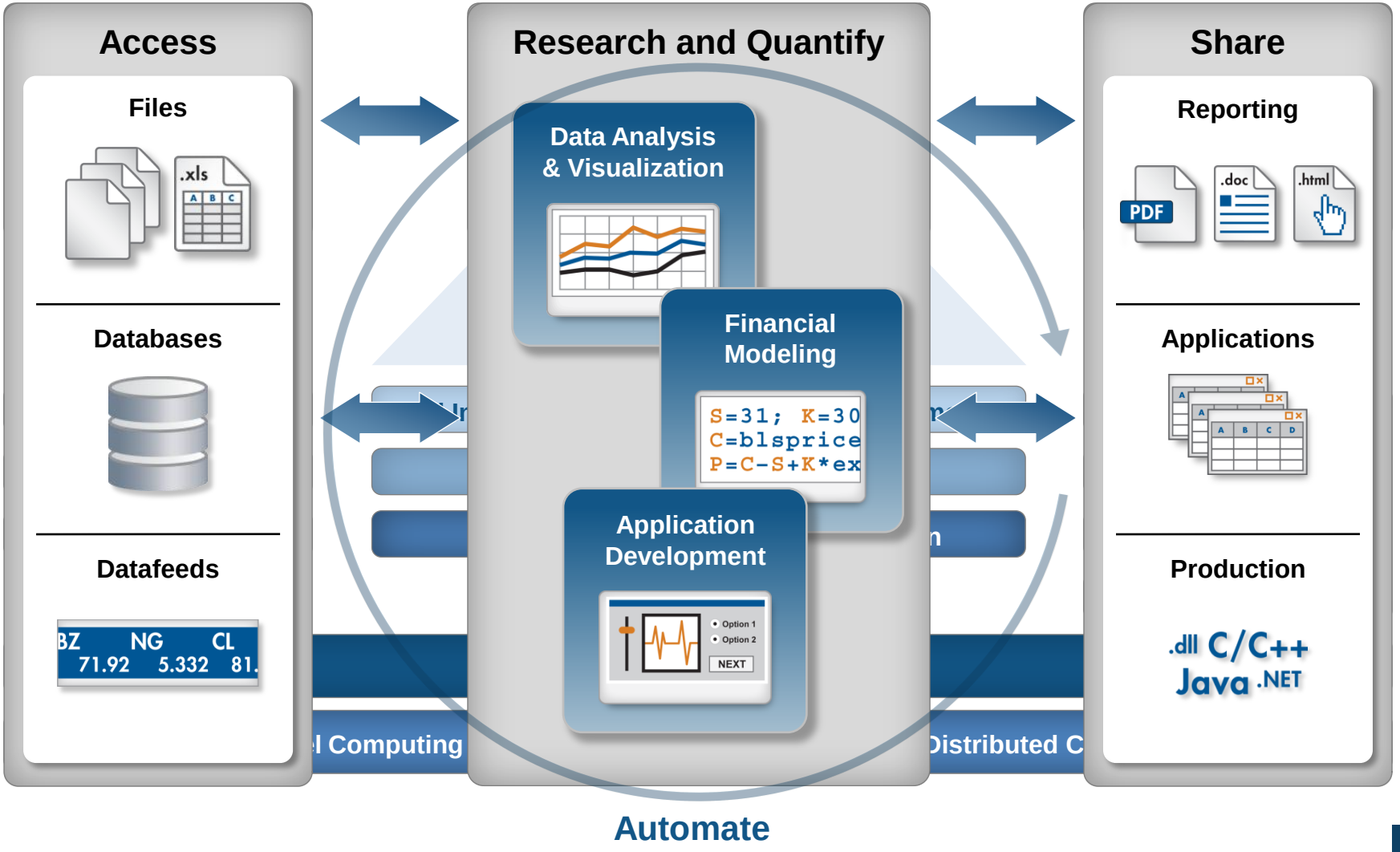
- Computing power
  - Fast engine, thousands of functions
  - Parallel computing
- Flexible tools
  - Fast prototyping environment
  - Visualization
- Increased transparency
  - Report generation
  - Quick to deploy



Computational Finance Workflow



Computational Finance Workflow



Questions?

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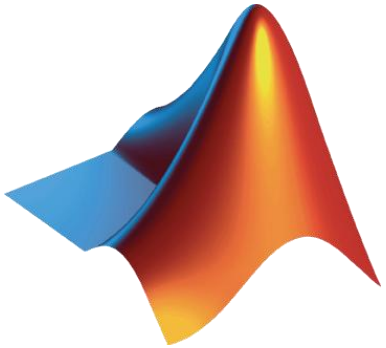
Thank You for Attending Today's Seminar

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