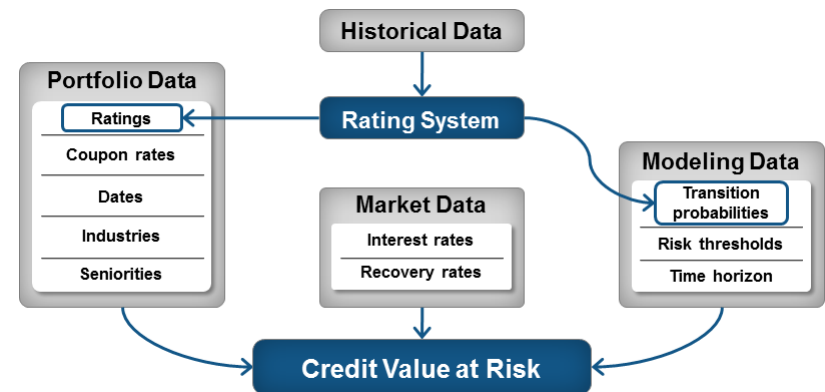
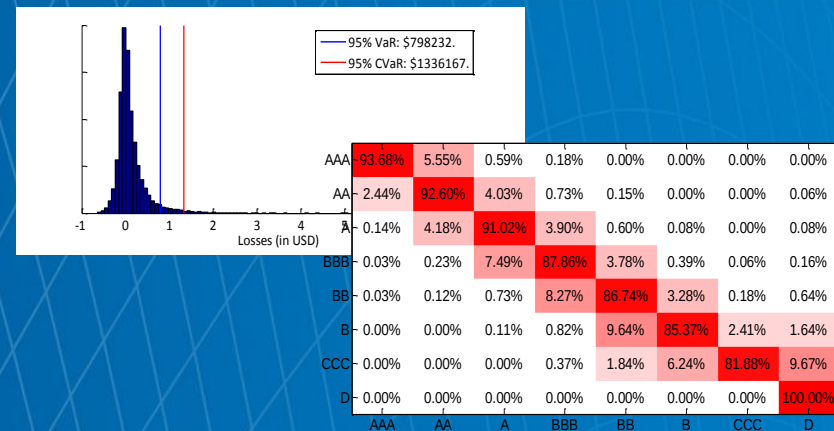


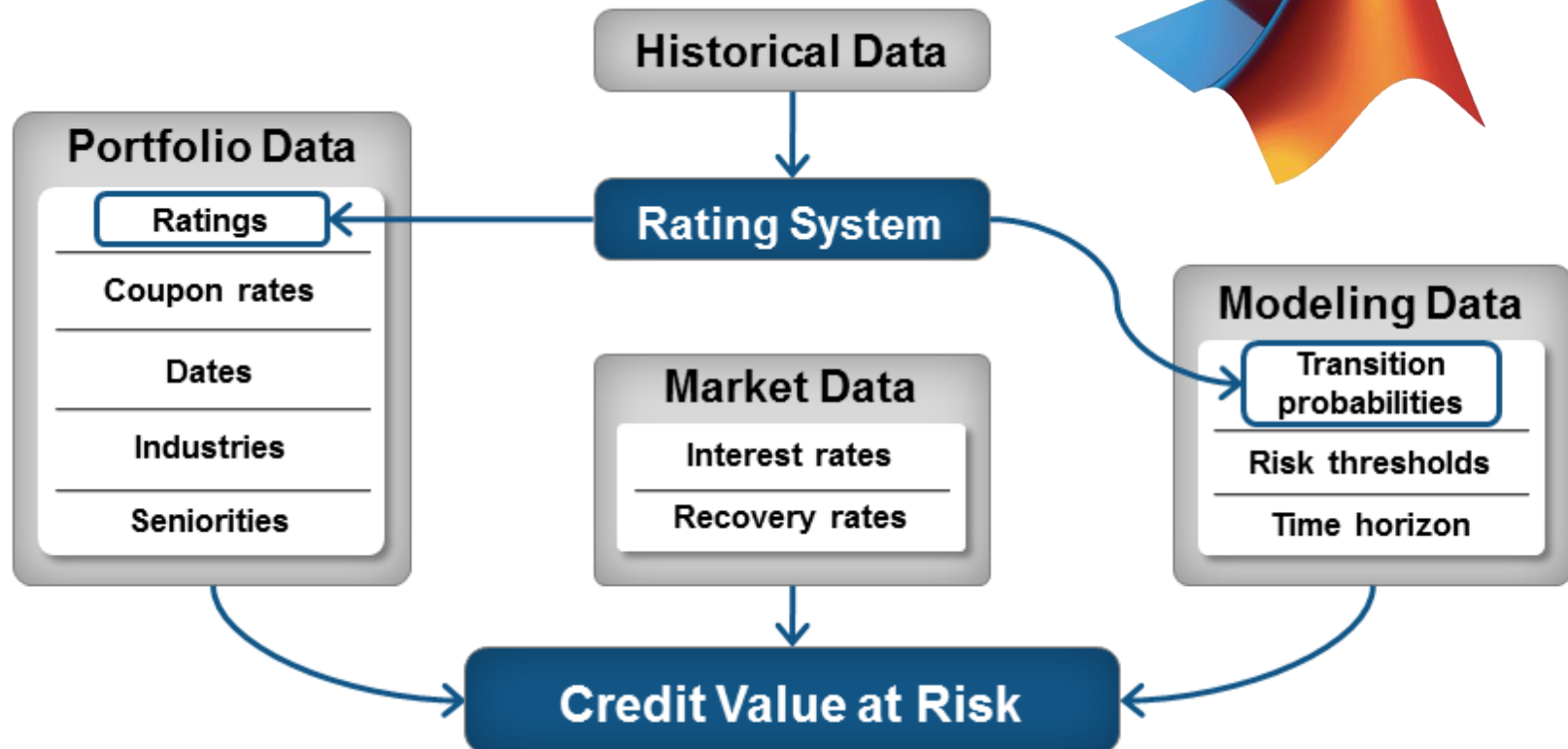
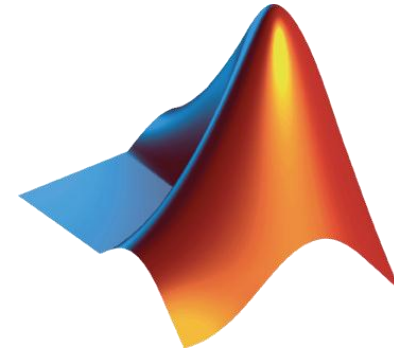
Credit Risk Modeling with MATLAB



Martin Demel, Application Engineer



Case Study

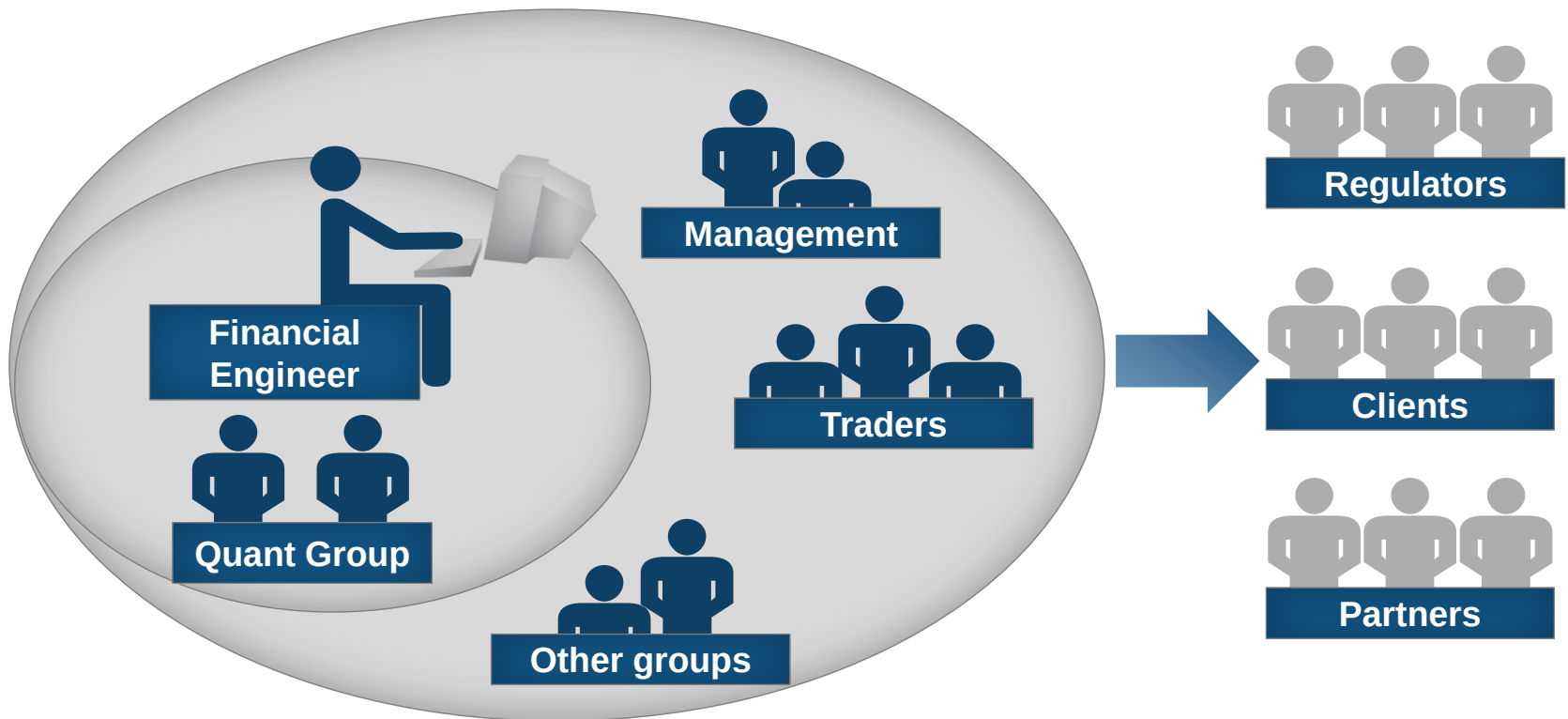


Challenges you are facing today

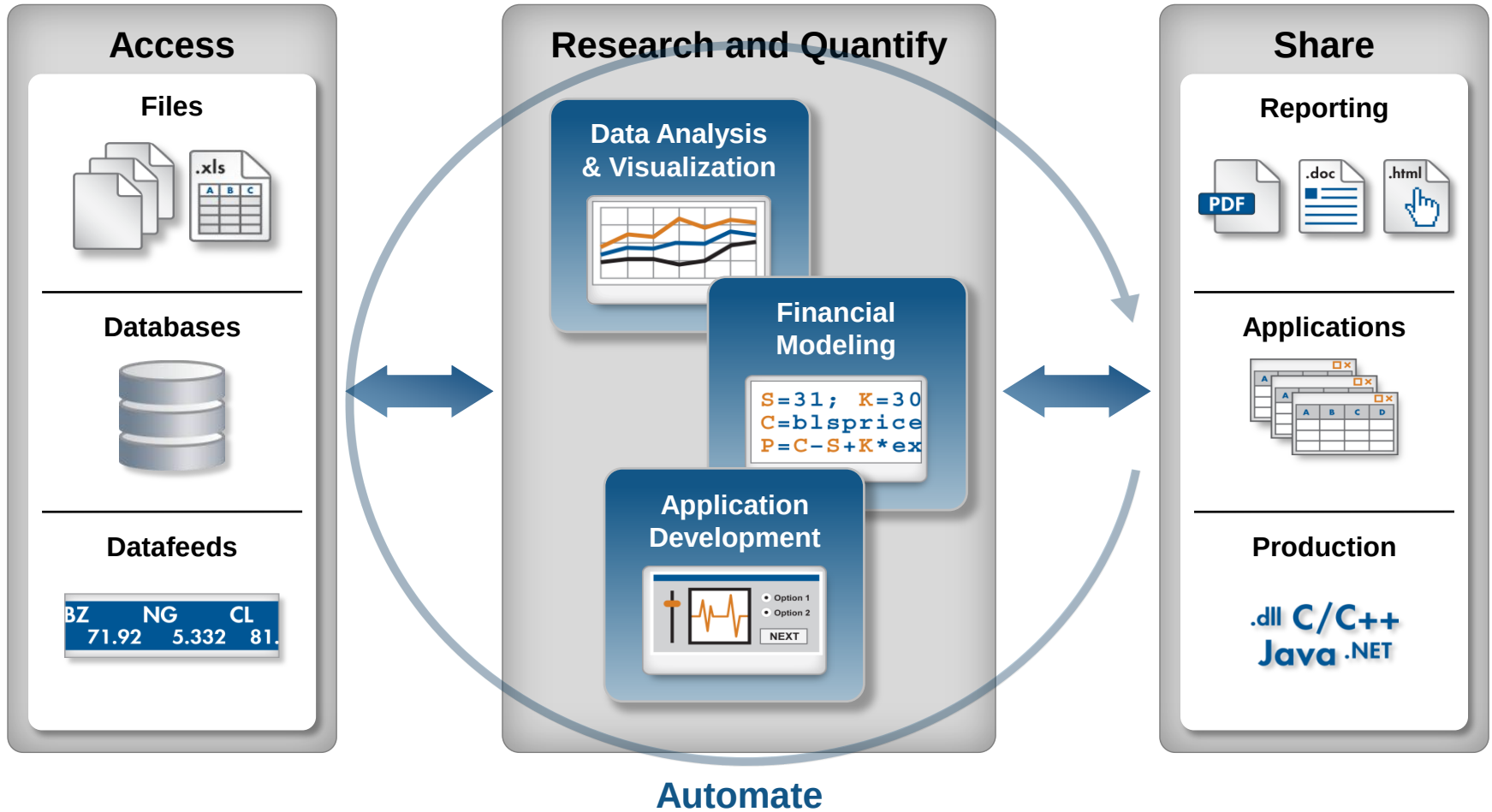
- Analysis is evolving
 - More data
 - Larger models
- Markets are changing
 - Shifting behavior
 - Rapid evolution
- Need for transparency is increasing
 - More collaboration
 - Extra oversight



Challenges through the organization



Computational Finance Workflow

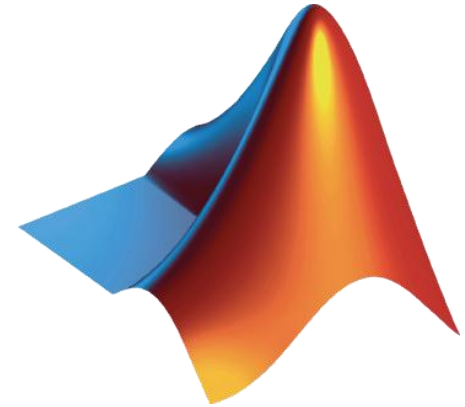


MATLAB – Introduction

MATLAB – Programming Language

MATLAB – Interpreter

MATLAB – Development Environment



MATLAB – Summary

MATLAB – A Complete Development Environment

MATLAB Editor/Debugger

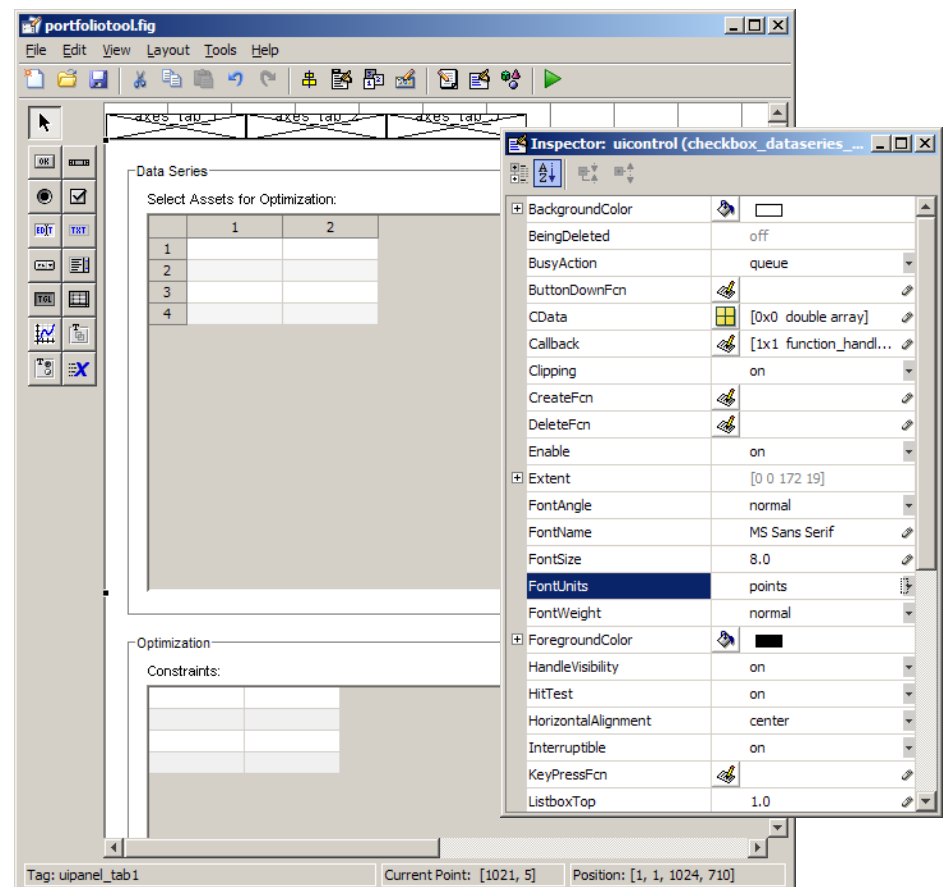
- Capture work from history
- Color coded
- Break points

Performance Tools

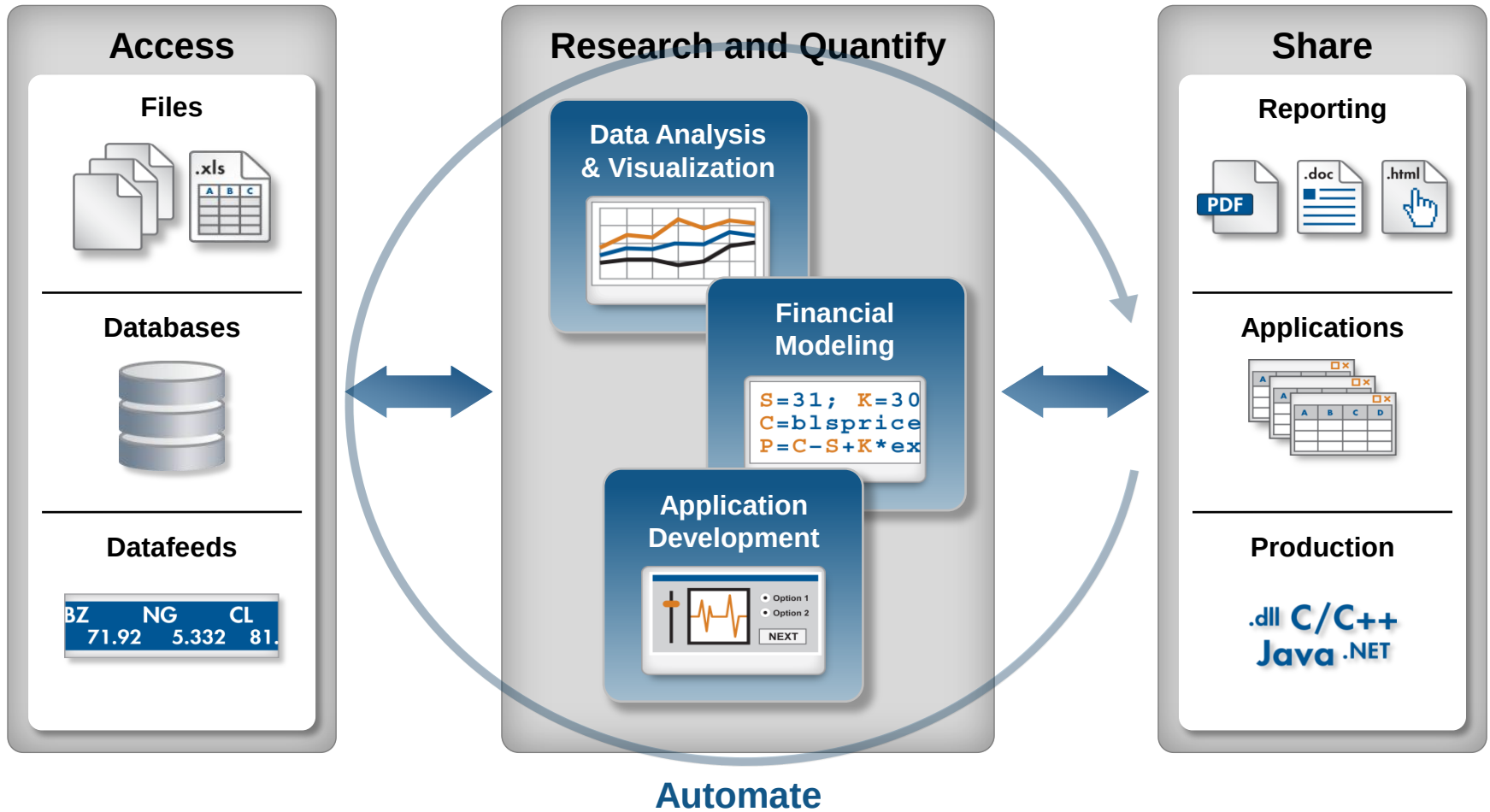
- Profiler
- Code Analyzer

GUI Builder

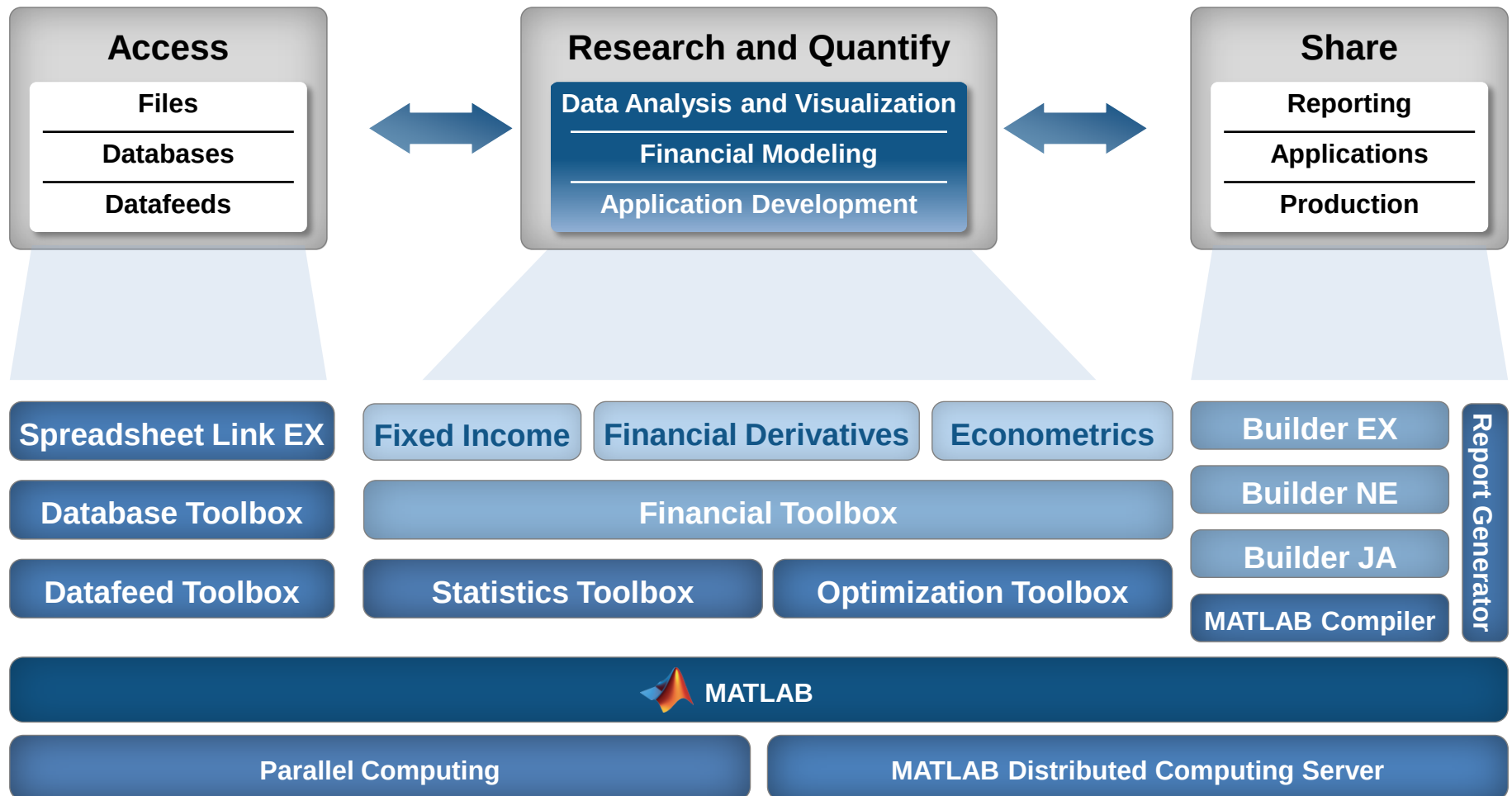
- Drag and drop graphical user interface



Computational Finance Workflow



Computational Finance Workflow



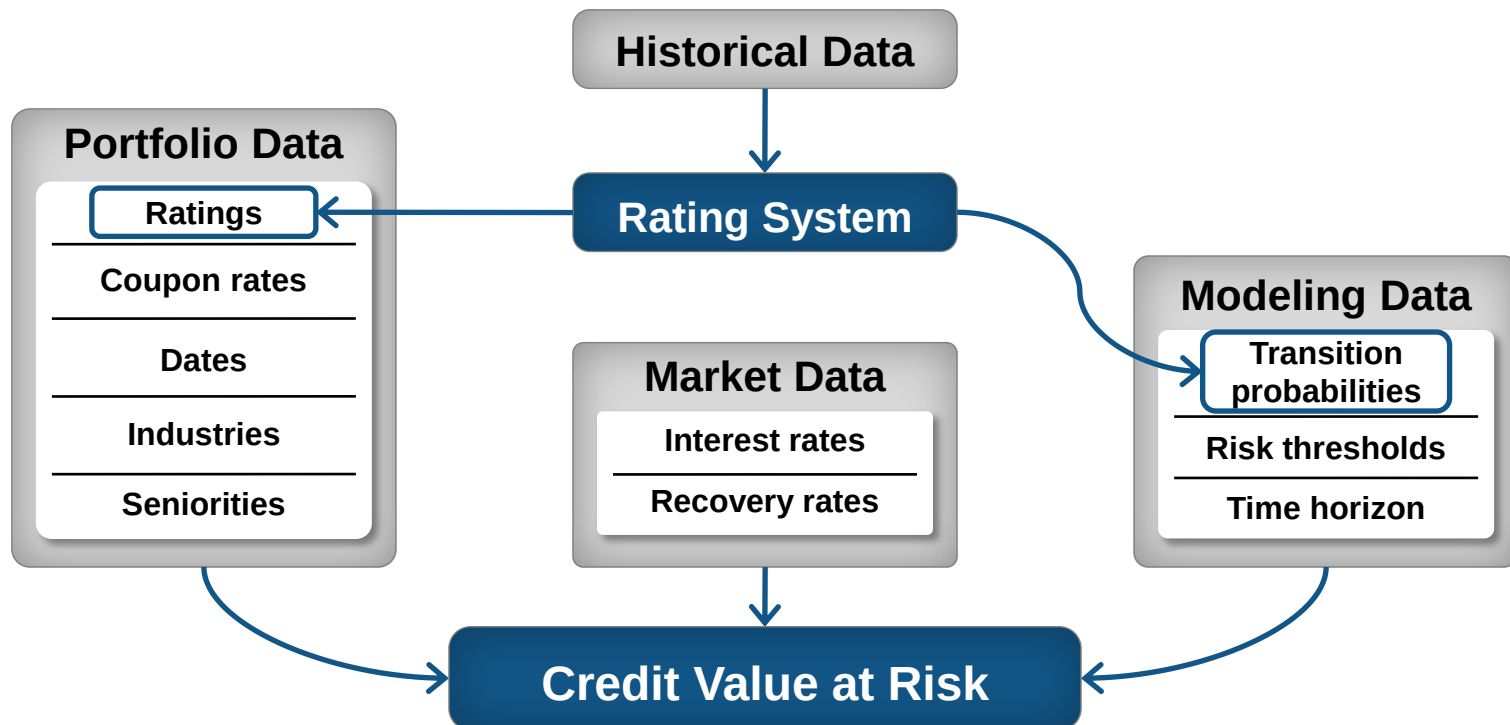
The problem at hand: Credit Risk

- Quantitative credit analyst
- Overseeing a bond portfolio
 - 1311 different obligors
 - 12 different industries
 - Maturities in 1 to 4 years
- Management asks: “What is the risk associated with this portfolio?”



Credit Risk Application

- Goal: Develop a tool that can be used for *easy* and *fast* computation of Credit VaR



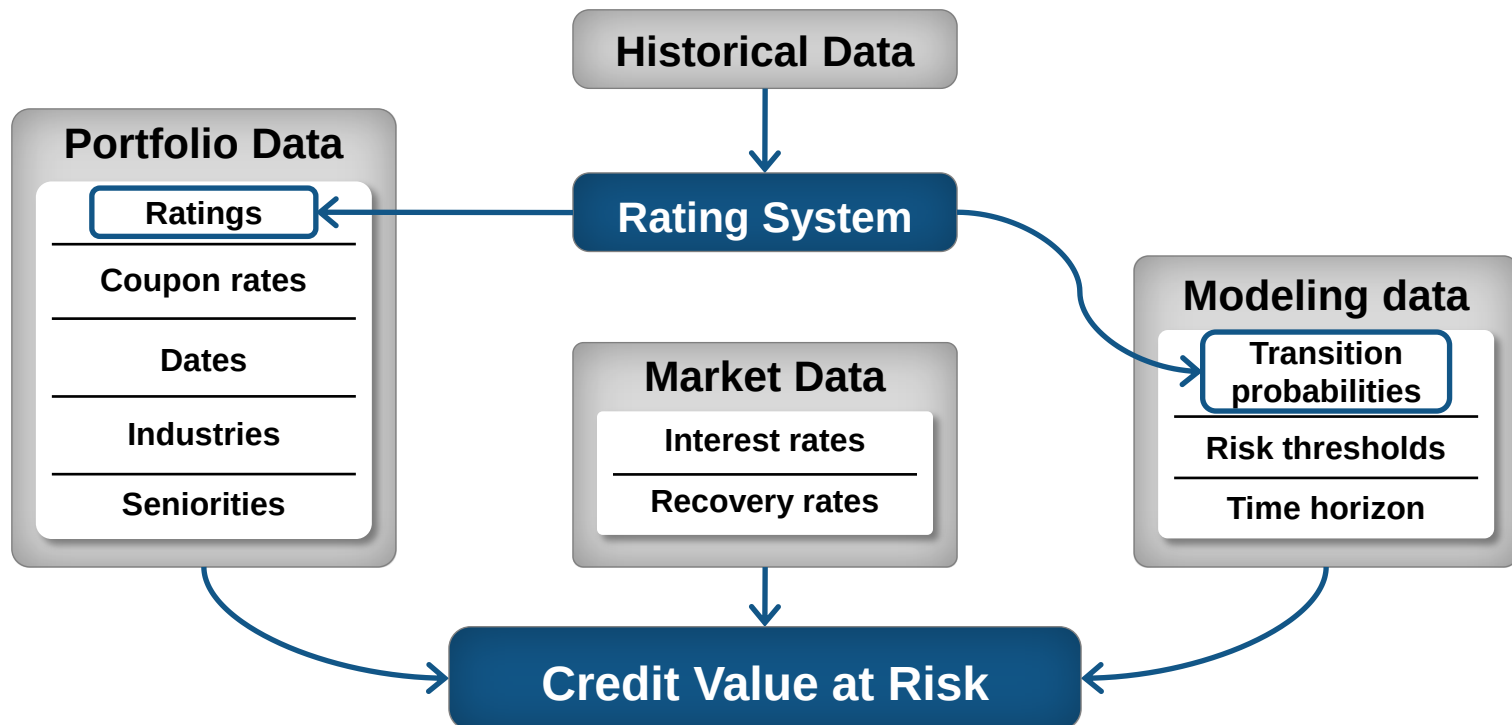
What are our challenges?

- Computing power
 - Over 1,000 bonds
 - 10,000 simulations
- Ever-changing needs
 - Quick to develop
 - Easy to adapt
- Increased transparency
 - Quick to deploy
 - Easy to explain to others

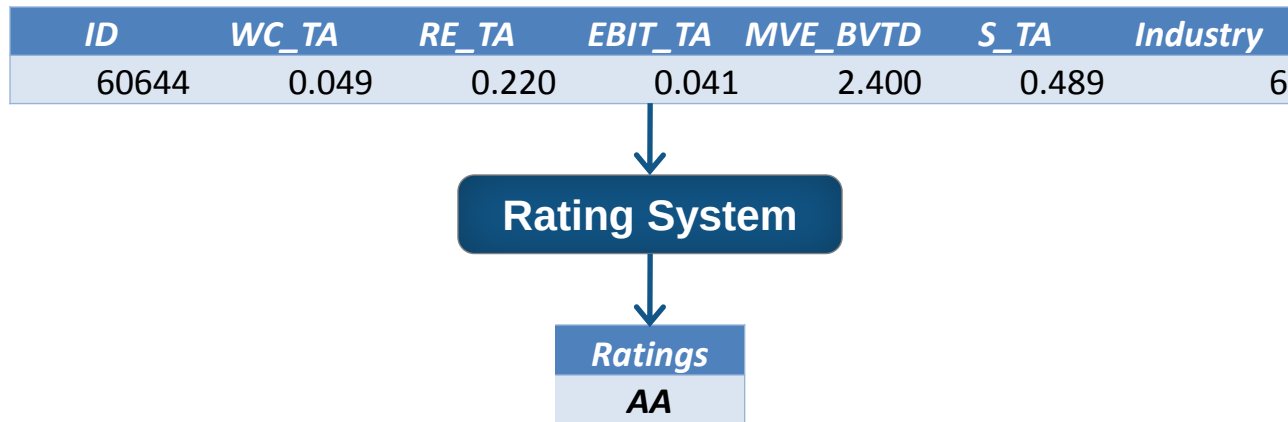


Task 1: Calibrating the rating system

- **Goal:** Develop a classifier that can rate obligors based on financial information



Task 1: Calibrating the rating system

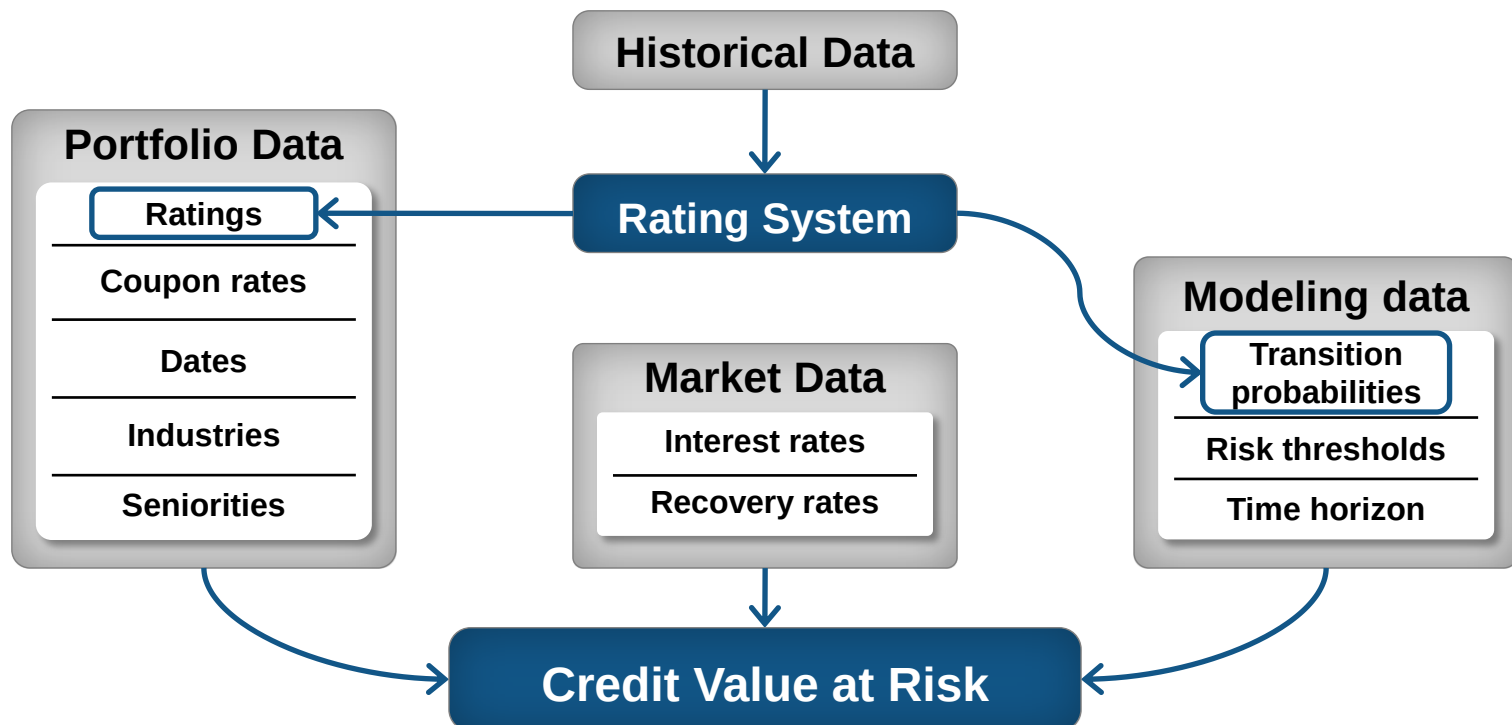


Sub-tasks

1. Import raw data: database and Excel
2. Perform *ad hoc* data analysis
3. Create a robust classifier

Task 2: Estimating transition probabilities

- **Goal:** Evaluate probabilities of credit up-/downgrades based on historical information



Task 2: Estimating transition probabilities

Migration History

ID	Date	Rating
1	07-Jul-05	A
1	31-Nov-07	BBB
2	07-Jul-05	AAA
2	02-Dec-08	AA
2	02-Dec-09	AAA
3	07-Aug-06	A
3	27-Sep-08	AA

Migration Matrix

31-Dec-06	31-Dec-07	31-Dec-08	31-Dec-09
A	BBB	BBB	BBB
AAA	AAA	AA	AAA
A	A	AA	AA

Transition Probability Matrix

	to AAA	to AA	to A	to BBB
from AAA	0.5	0.5	0	0
from AA	0.5	0.5	0	0
from A	0	0.33	0.33	0.33
from BBB	0	0	0	1

Task 2: Estimating transition probabilities

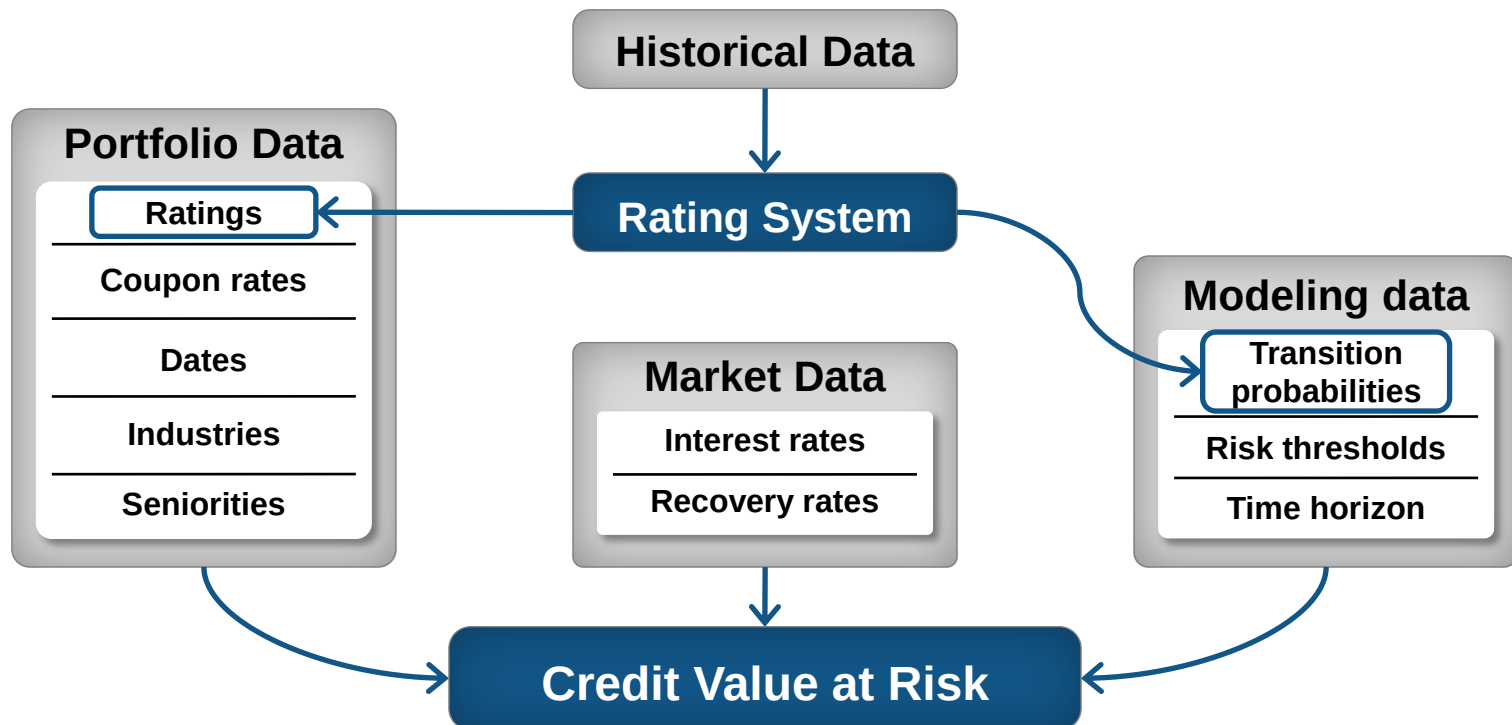
Sub-tasks

1. Convert raw data
2. Minimize computation time
3. Visualize transition probability matrix

AAA	93.68%	5.55%	0.59%	0.18%	0.00%	0.00%	0.00%	0.00%
AA	2.44%	92.60%	4.03%	0.73%	0.15%	0.00%	0.00%	0.06%
A	0.14%	4.18%	91.02%	3.90%	0.60%	0.08%	0.00%	0.08%
BBB	0.03%	0.23%	7.49%	87.86%	3.78%	0.39%	0.06%	0.16%
BB	0.03%	0.12%	0.73%	8.27%	86.74%	3.28%	0.18%	0.64%
B	0.00%	0.00%	0.11%	0.82%	9.64%	85.37%	2.41%	1.64%
CCC	0.00%	0.00%	0.00%	0.37%	1.84%	6.24%	81.88%	9.67%
D	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
	AAA	AA	A	BBB	BB	B	CCC	D

Task 3: Credit risk analysis

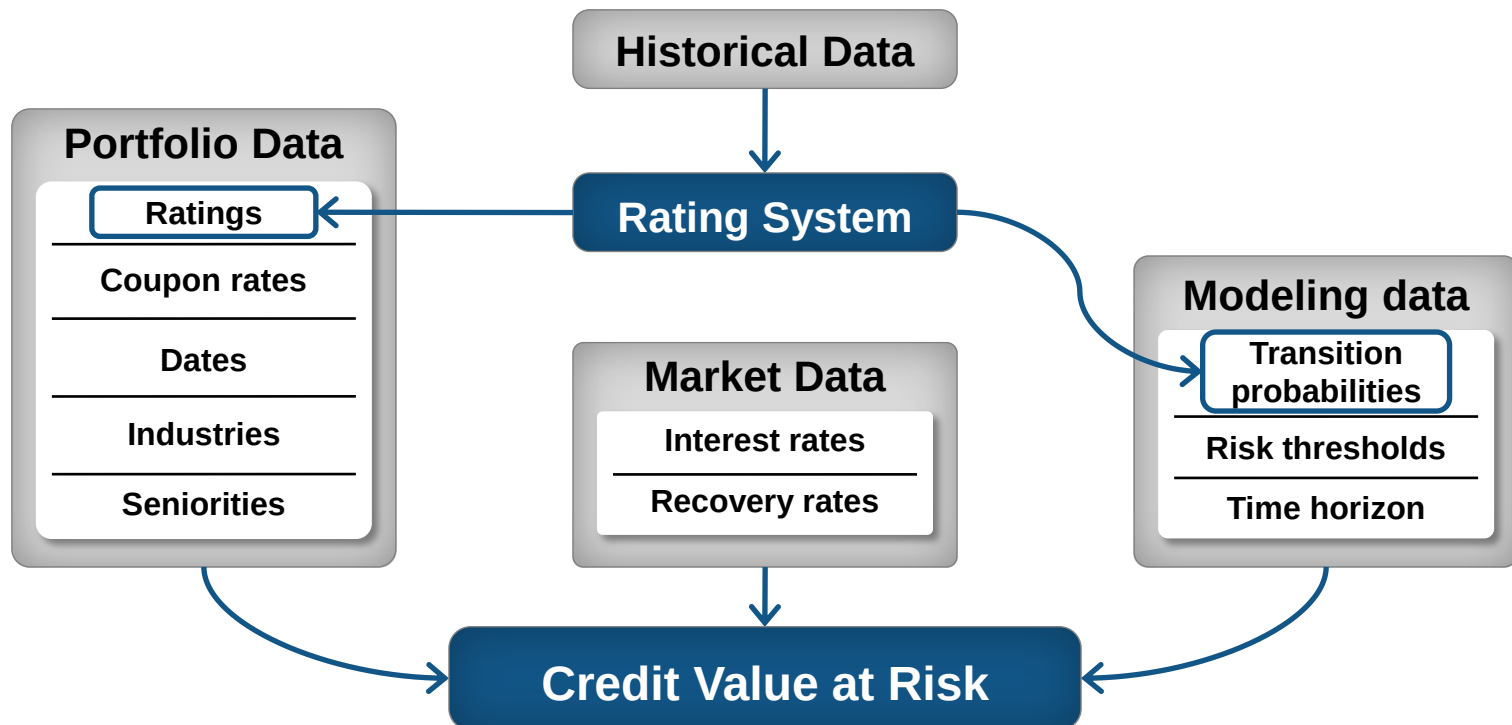
- Goal: Calculate credit value at risk for bond portfolio



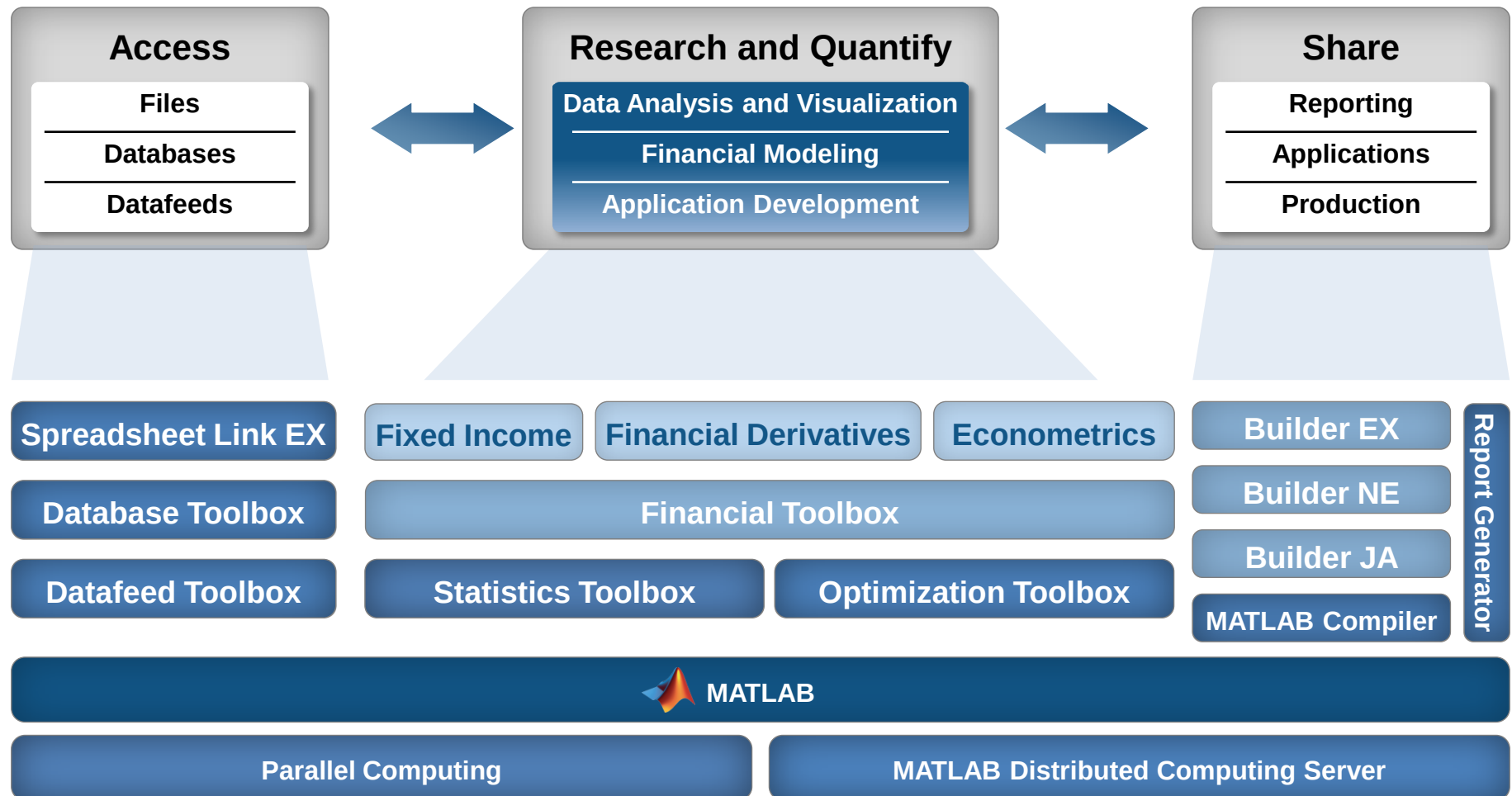
Task 3: Credit risk analysis

Sub-tasks

1. Value bonds
2. Perform Monte Carlo simulation
3. Re-value portfolio for each simulated result



Computational Finance Workflow



Support and Community



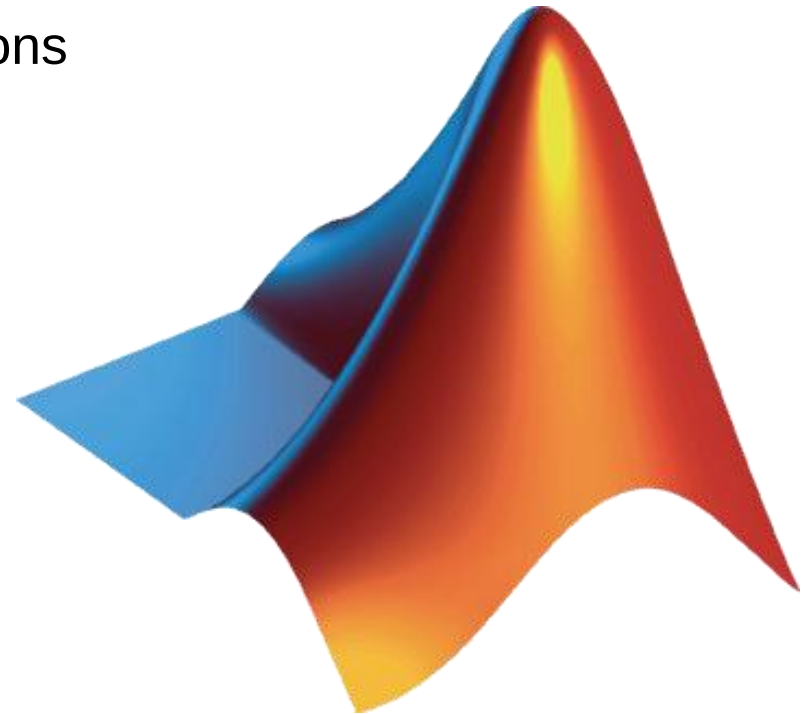
Review: What are the challenges?

- Computing power
 - Over 1,000 bonds
 - 10,000 simulations
- Ever-changing needs
 - Quick to develop
 - Easy to adapt
- Increased transparency
 - Quick to deploy
 - Easy to explain to others



MATLAB's solutions

- Computing power
 - Fast engine, thousands of functions
 - Parallel computing
- Flexible tools
 - GUIs for *ad hoc* analysis
 - MATLAB Central
- Increased transparency
 - Report generation
 - Quick to deploy.. *after the break*



Accessing Data from MATLAB

Access

Explore & Discover

Share

Files

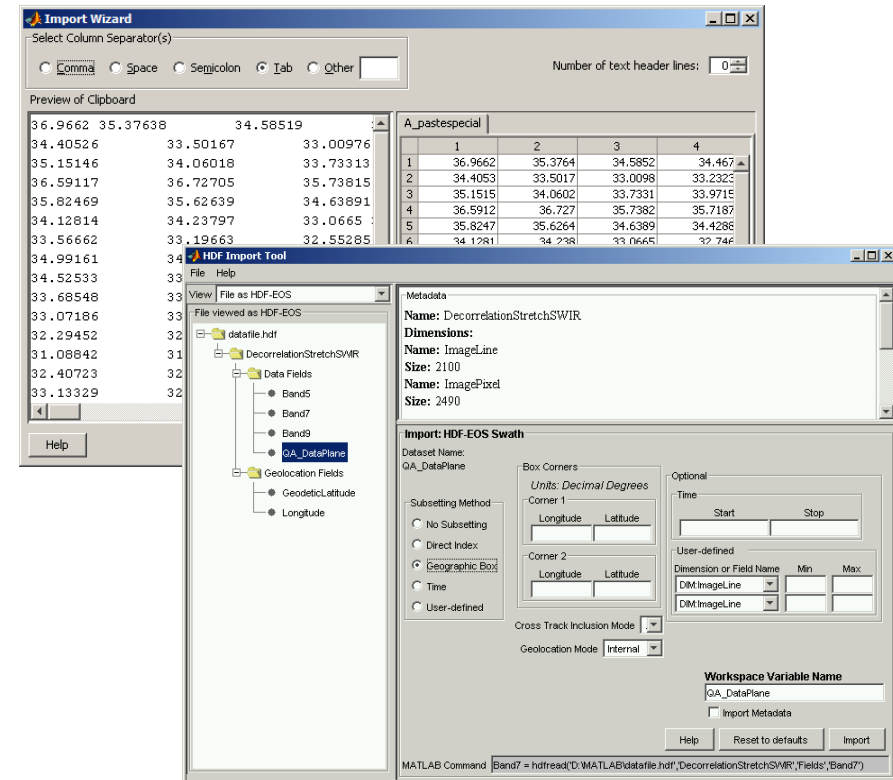
- Excel, text, or binary
- Multimedia, scientific
- Web, XML

Applications and languages

- C/C++, Java, FORTRAN
- COM, .NET, shared libraries
- Databases

Measurement hardware

- Data acquisition hardware for signals or images
- Stand-alone instruments and devices



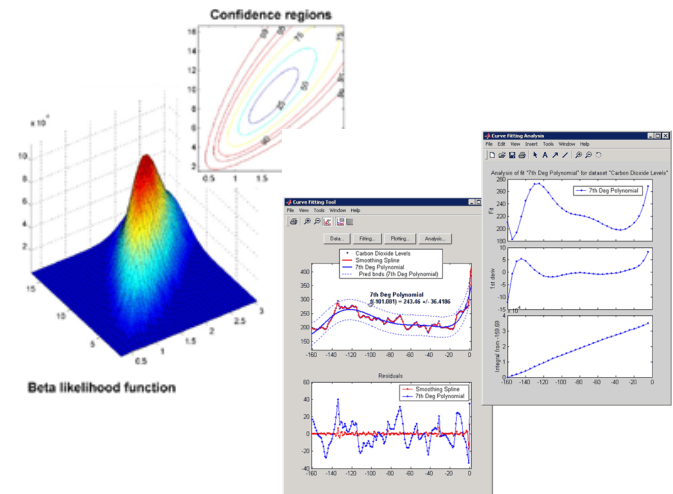
Data Analysis and Visualization in MATLAB

Access

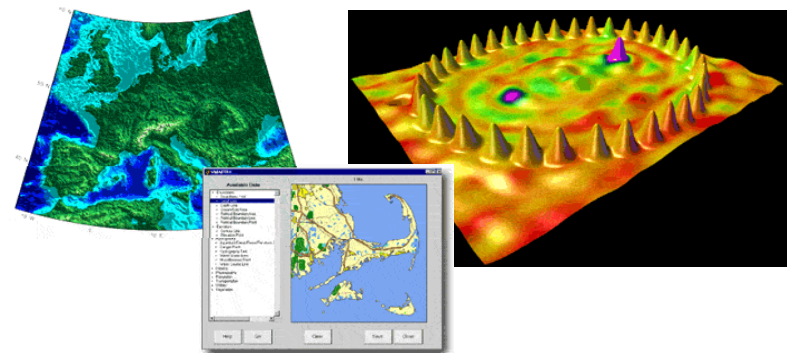
Explore & Discover

Share

- Data analysis
 - Manipulate, preprocess, and manage data
 - Fast, accurate analysis with pre-built math and engineering functions



- Visualization
 - Built in graphics functions for engineering and science (2D, 3D, VolViz)
 - Interactive tools to annotate and customize graphics



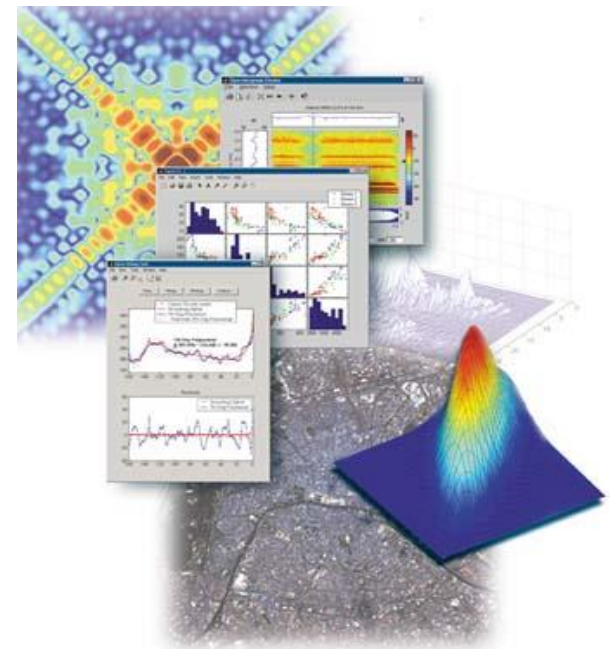
Expanding the Capabilities of MATLAB

Access

Explore & Discover

Share

- MathWorks add-on tools for:
 - **Statistics and curve fitting**
 - Signal and image processing
 - System identification and control system analysis
 - **Neural networks** and fuzzy logic
 - **Optimization**
 - Model-based calibration and more ...
- Partner products for:
 - Additional interfaces
 - Domain-specific analysis
 - Niche applications



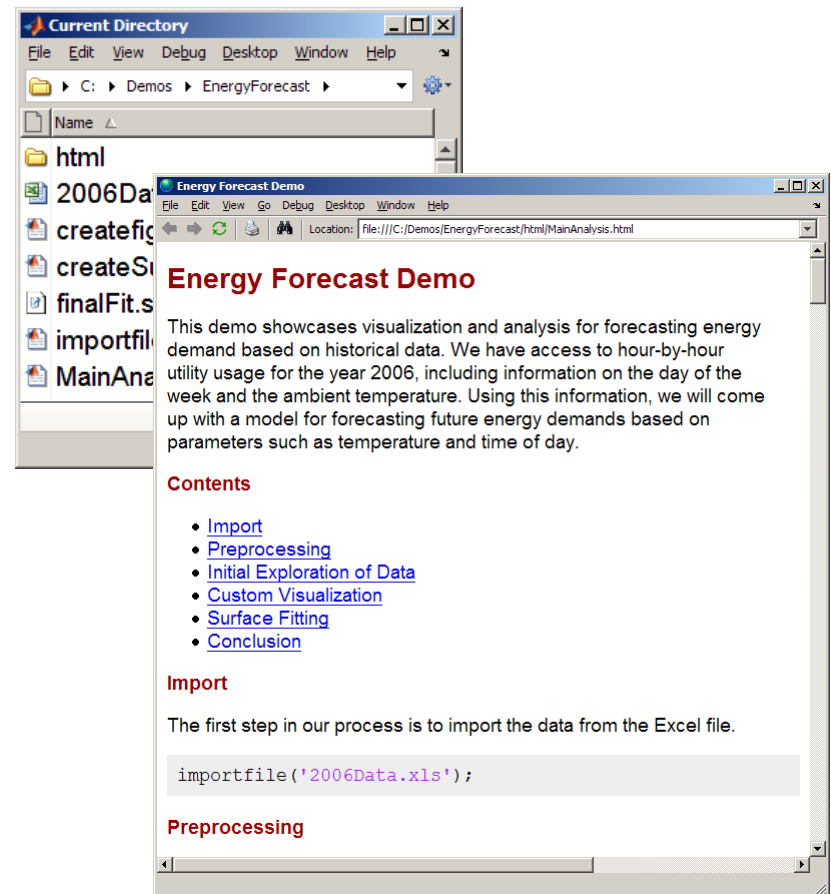
Sharing Results from MATLAB

Access

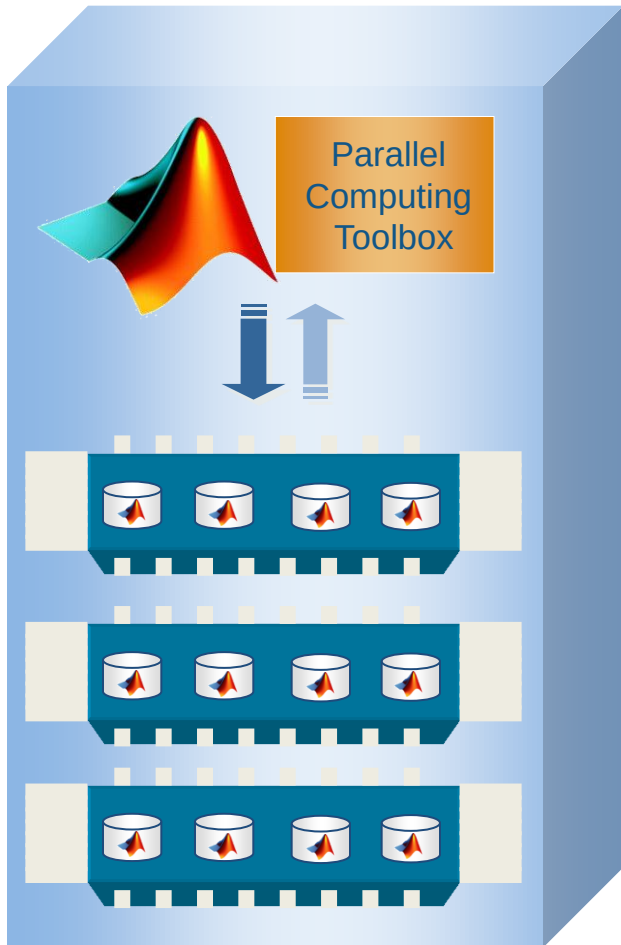
Explore & Discover

Share

- Automatically generate structured reports
 - **Published MATLAB files**
 - MATLAB Report Generator
- Feed your results into downstream design tools
- Deploy applications to other environments

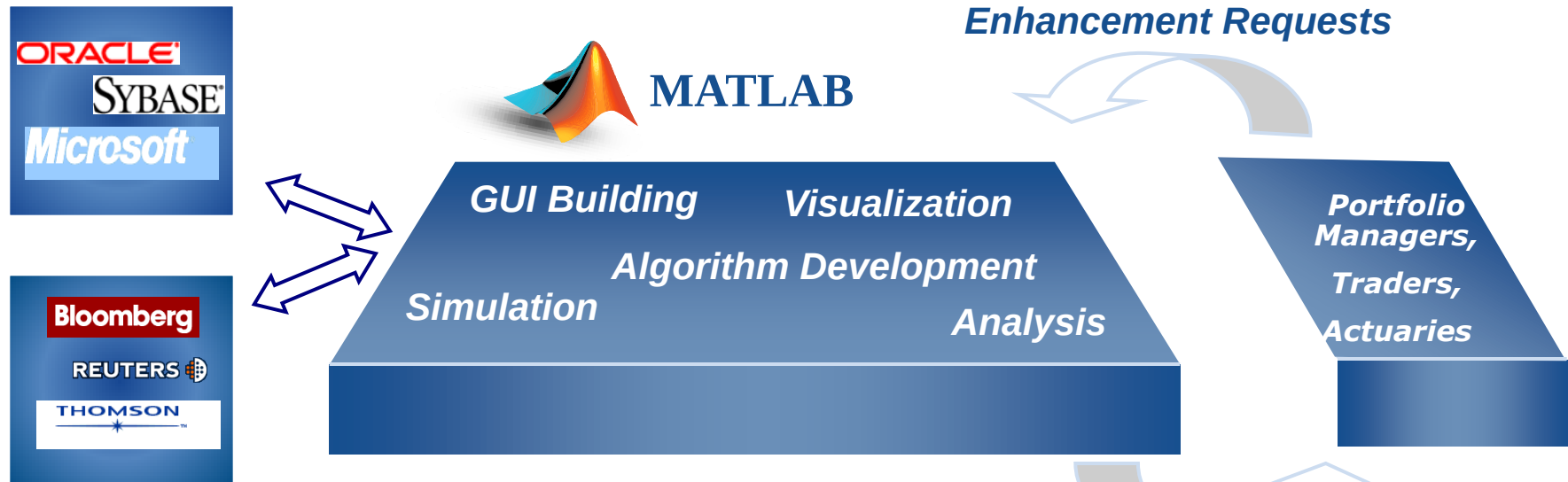


12 Local Workers: Parallel Computing Toolbox



- Easily experiment with explicit parallelism on multi-core machines
- Rapidly develop parallel applications on local computer
- Take full advantage of desktop power
- Separate computer cluster not required

Deploying with MATLAB

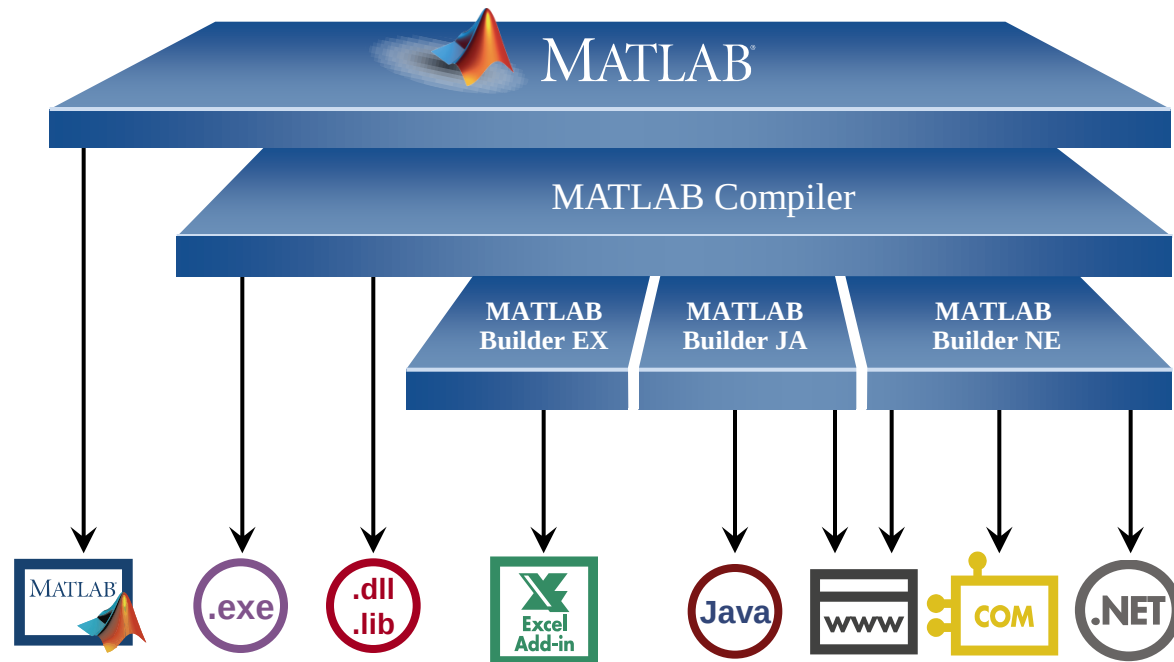


Traditional prototype to production system port
... development timeline **2 weeks ~ 6+ months**

MATLAB prototype to production system
... Push button in the new project manager

Deploying Applications with MATLAB

- Give MATLAB code to other users
- Share applications with end users who do not have MATLAB
 - Use MATLAB Compiler to create standalone executables and shared libraries
 - Use MATLAB Compiler add-ons to create software components



Deploying to C/C++ with MATLAB Compiler

