# **Credit Risk Modeling with MATLAB**









## **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

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# **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







# **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	А
1	31-Nov-07	BBB
2	07-Jul-05	AAA
2	02-Dec-08	AA
2	02-Dec-09	AAA
3	07-Aug-06	А
3	27-Sep-08	AA

#### Migration Matrix

31-Dec-06	31-Dec-07	31-Dec-08	31-Dec-09
А	BBB	BBB	BBB
AAA	AAA	AA	AAA
А	А	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% -
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# 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**





# MATLAB<sup>®</sup> CENTRAL



MathWorks<sup>•</sup> | *Training Services* 



# **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



- 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

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# **Data Analysis and Visualization in MATLAB**

Access

**Explore & Discover** 

- 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





Share

# **Sharing Results from MATLAB**

Access

**Explore & Discover** 

- 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**





# **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**

