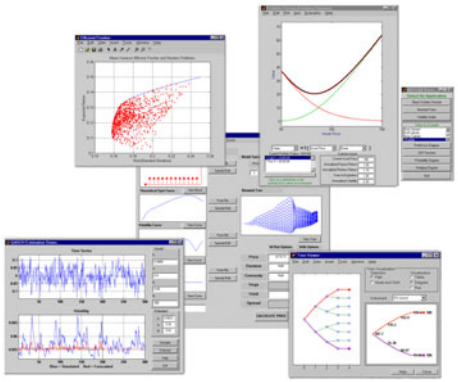
Managing Risk with Extreme Value Theory and Copulas : A MATLAB Financial Case Study



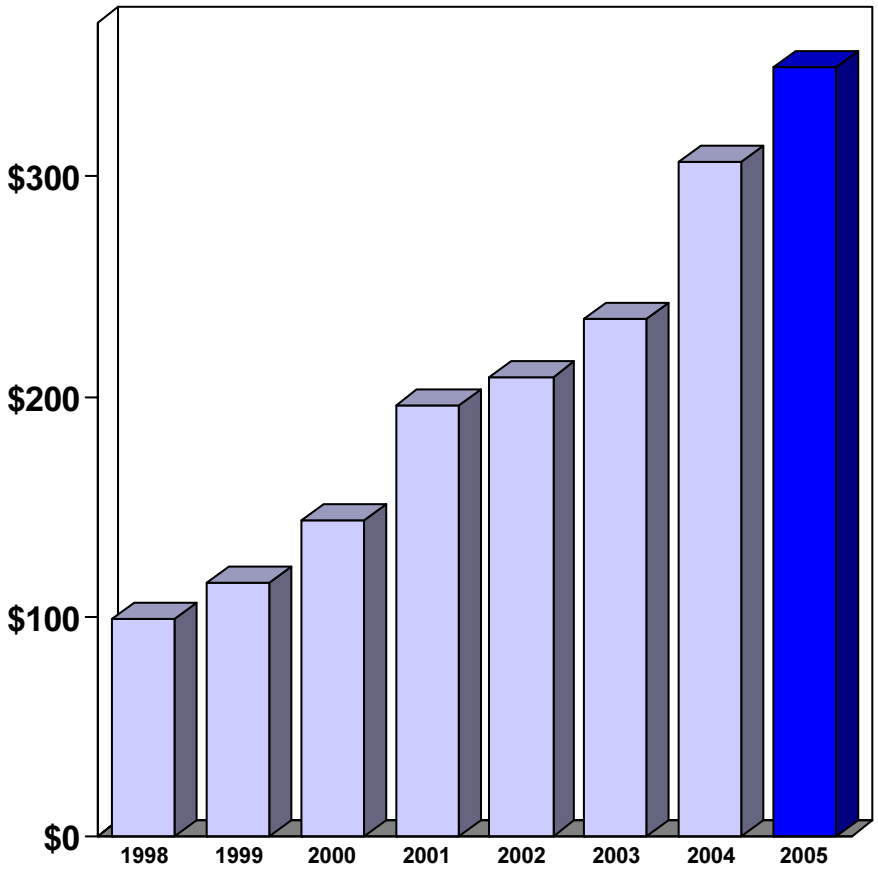
The MathWorks

Financial Products Group

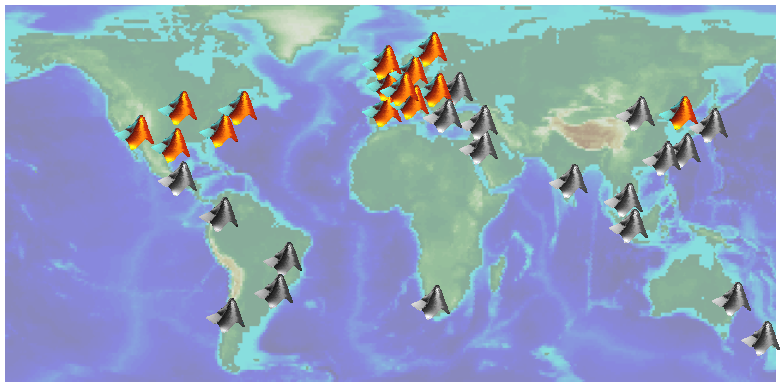
Eugene McGoldrick & Rick Baker
Financial Products Development

The MathWorks Today

2005 - continued MATLAB - Simulink growth



- 2005 Revenue - $350M
- 16% total revenue growth
- 1,300 employees - 38% in product development
- 1,000,000 current users - in 175 countries



Earth's topography on an equidistant cylindrical projection, created with the MATLAB® Mapping Toolbox

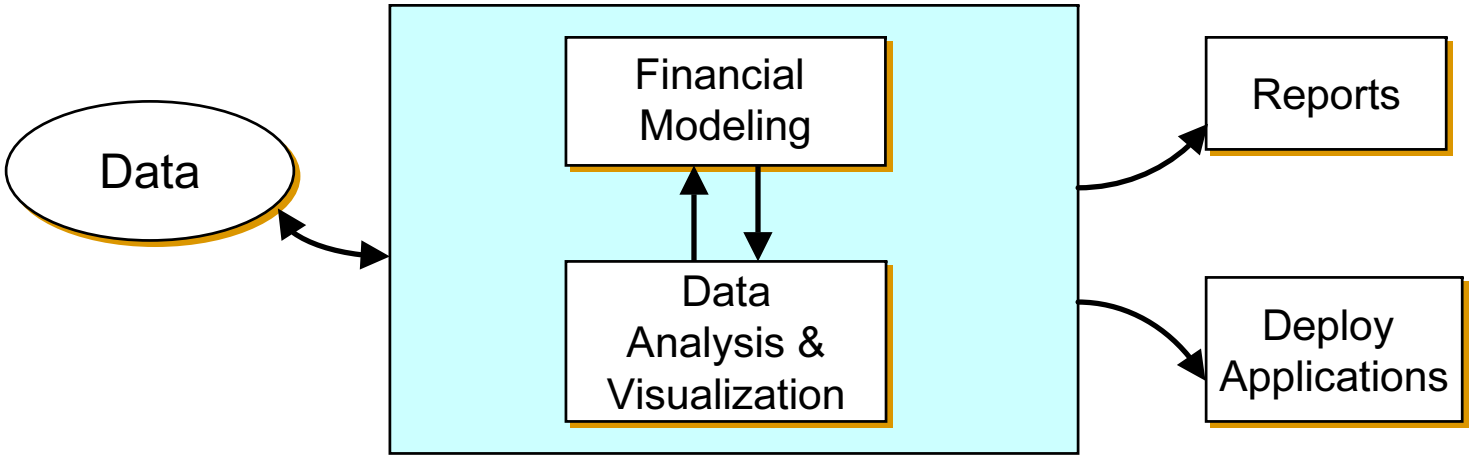
Business Challenges

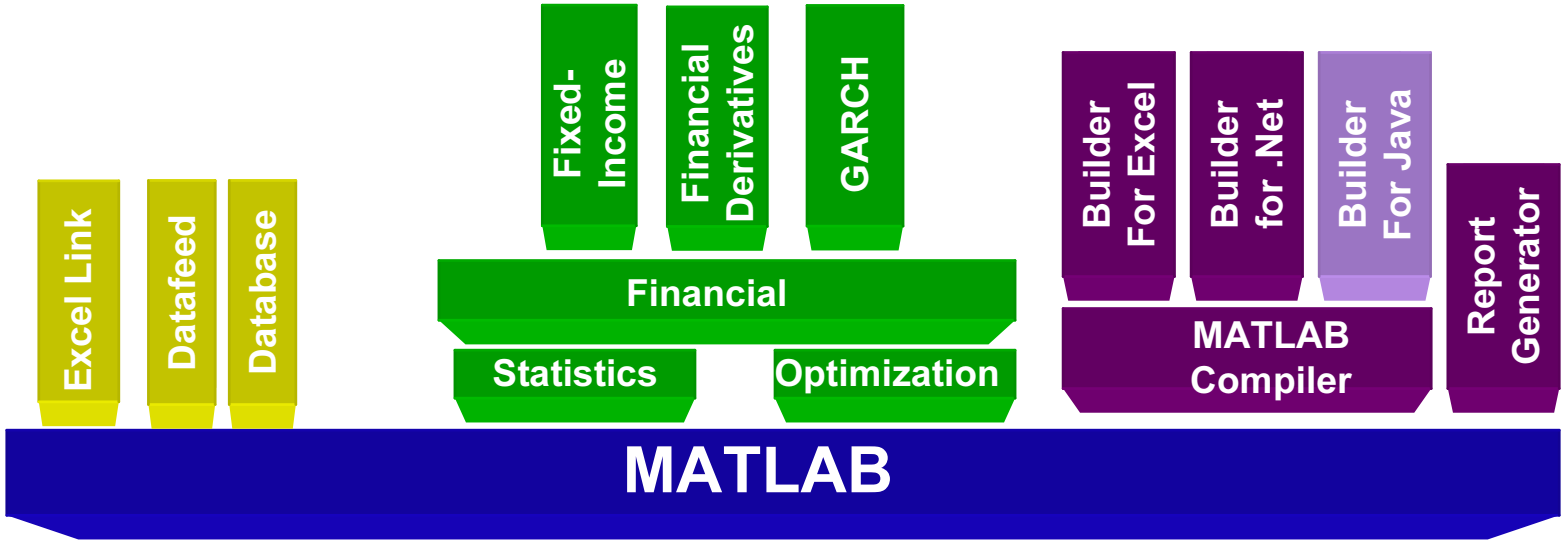
- **Development time**
- **Computational speed**
- **Deployment time**

Lost opportunity or added risk

Overview

Typical Process Flow





The Power of MATLAB

MATLAB is both

A Computational Environment:

Financial professional develop complex financial models using MATLAB and its family of toolboxes

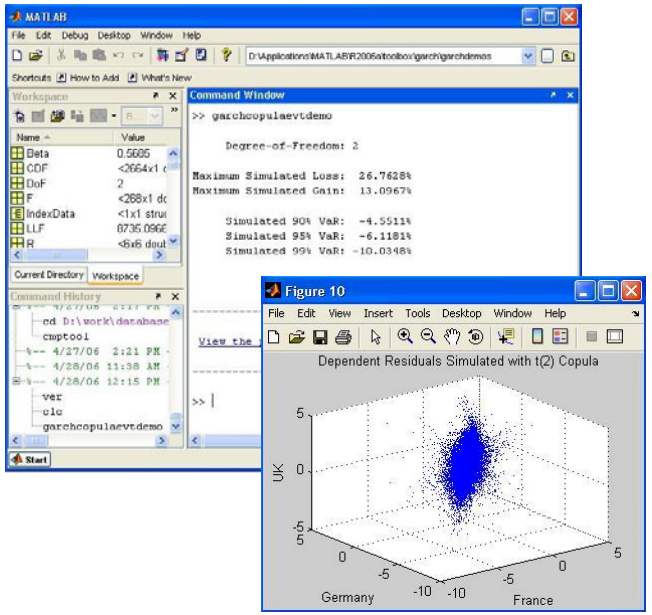
and

An Application Development Environment:

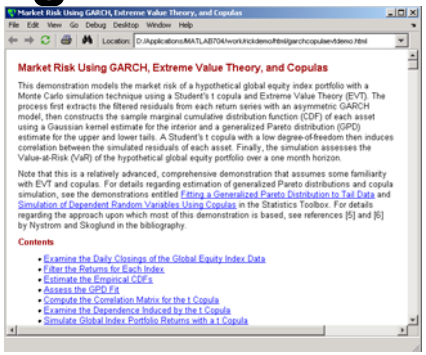
Models developed in MATLAB by financial professionals are translated into components using the MATLAB Compiler and distributed as stand-alone applications or quickly integrated into new or existing legacy applications by Information Technology Engineers

The Case Study

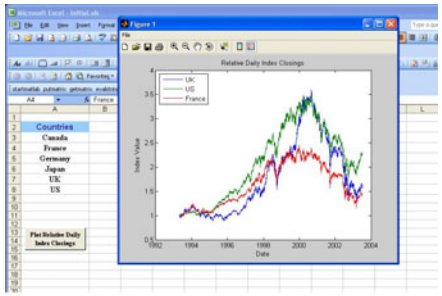
- Extreme Value Theory and Copula modeling with MATLAB



- Generating supporting documentation from MATLAB



- Deploying to desktop applications



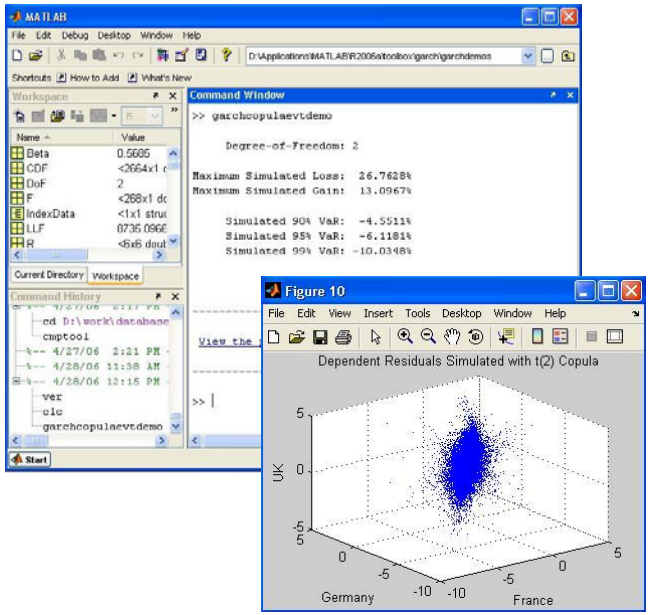
MATLAB Presentation

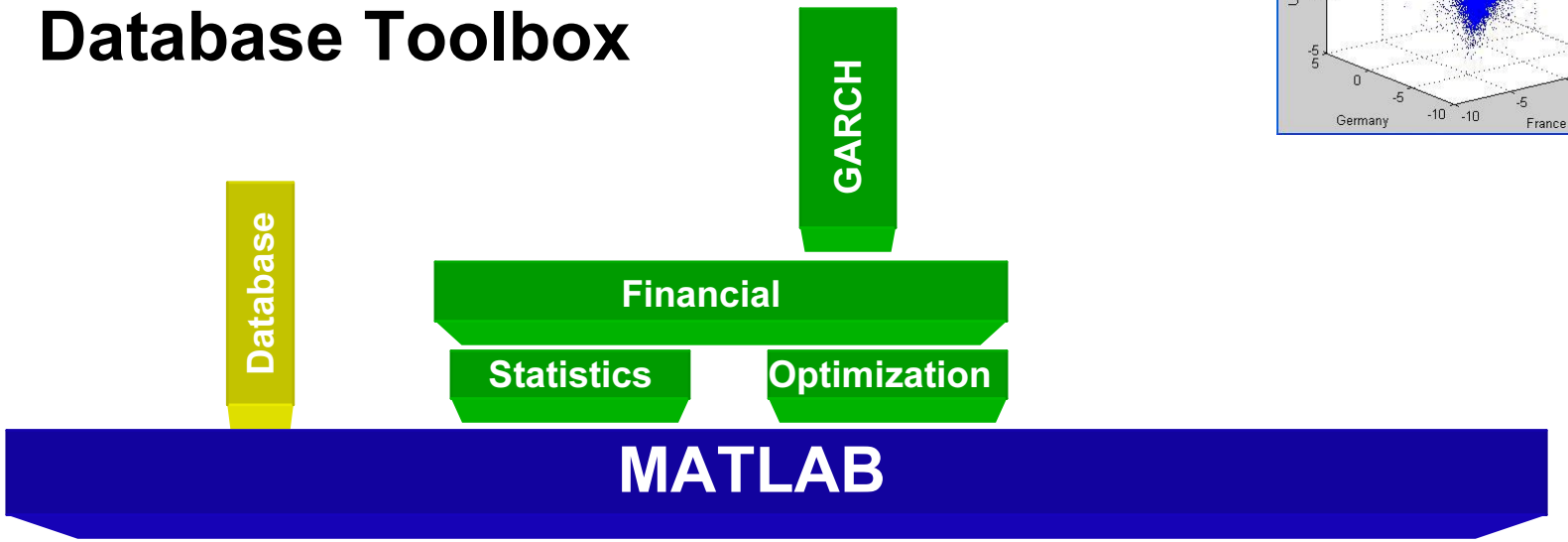
Managing Risk with Extreme Value Theory and Copulas

Rick Baker

Products used to develop the model

- MATLAB
- Statistics Toolbox
- Optimization Toolbox
- GARCH Toolbox
- Database Toolbox

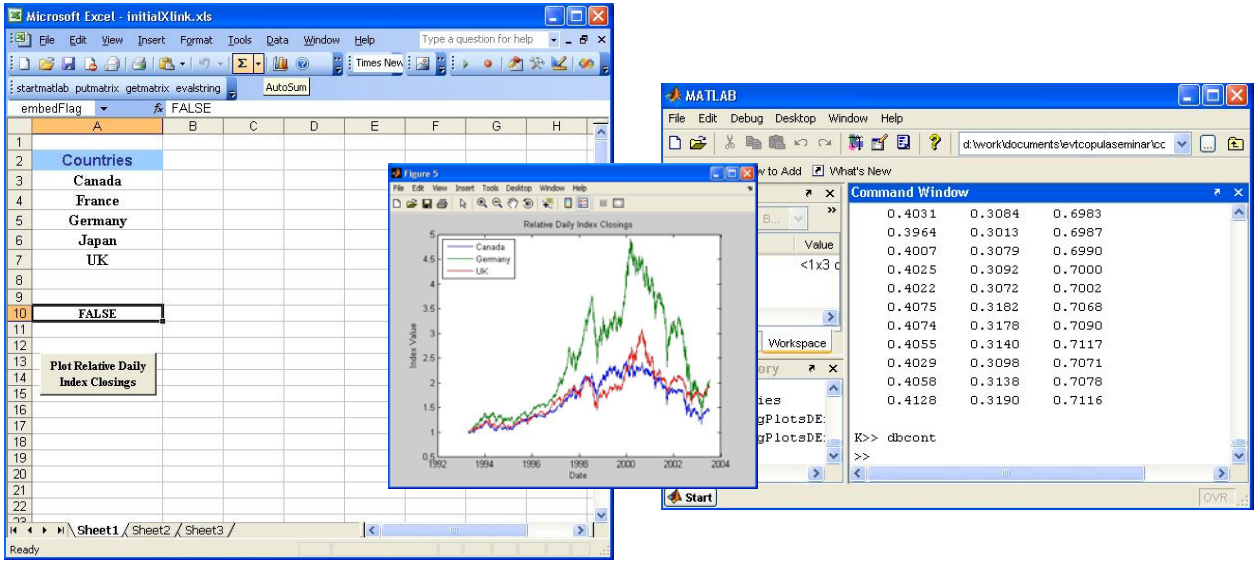




Interaction with Excel … Excel Link

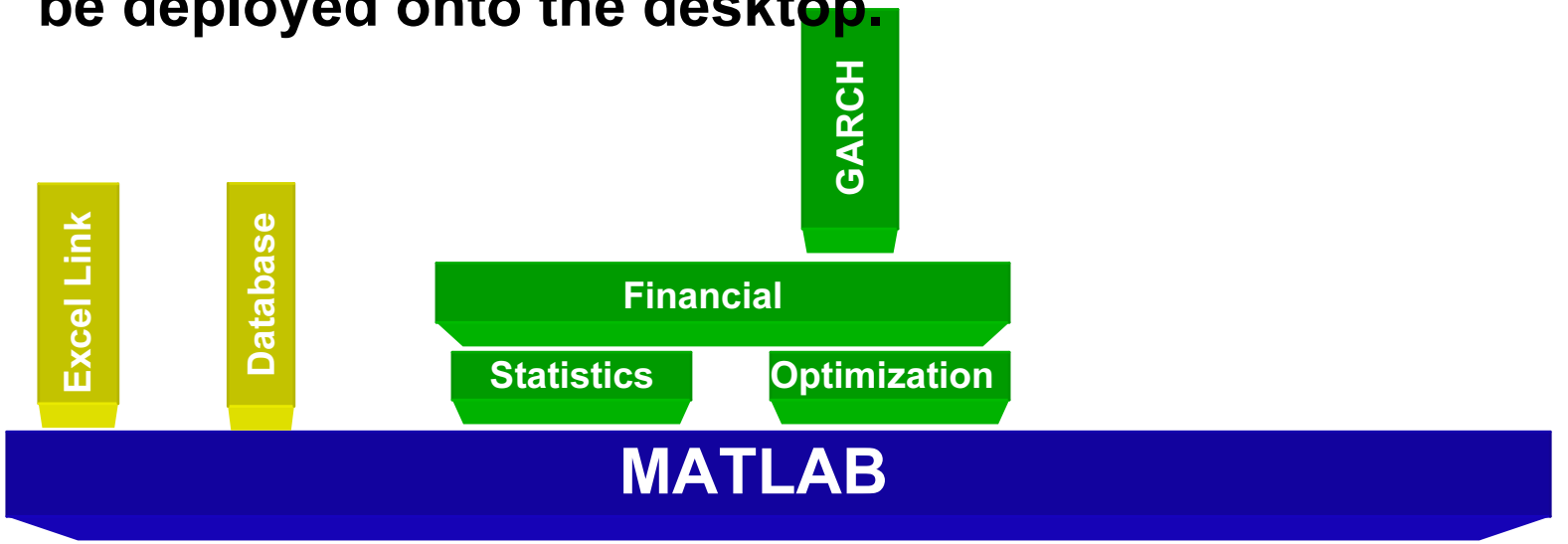
Excel Link

- Excel is the front end
- Excel Link is the communication layer between the MATLAB and Excel
- MATLAB is the computational/graphics engine



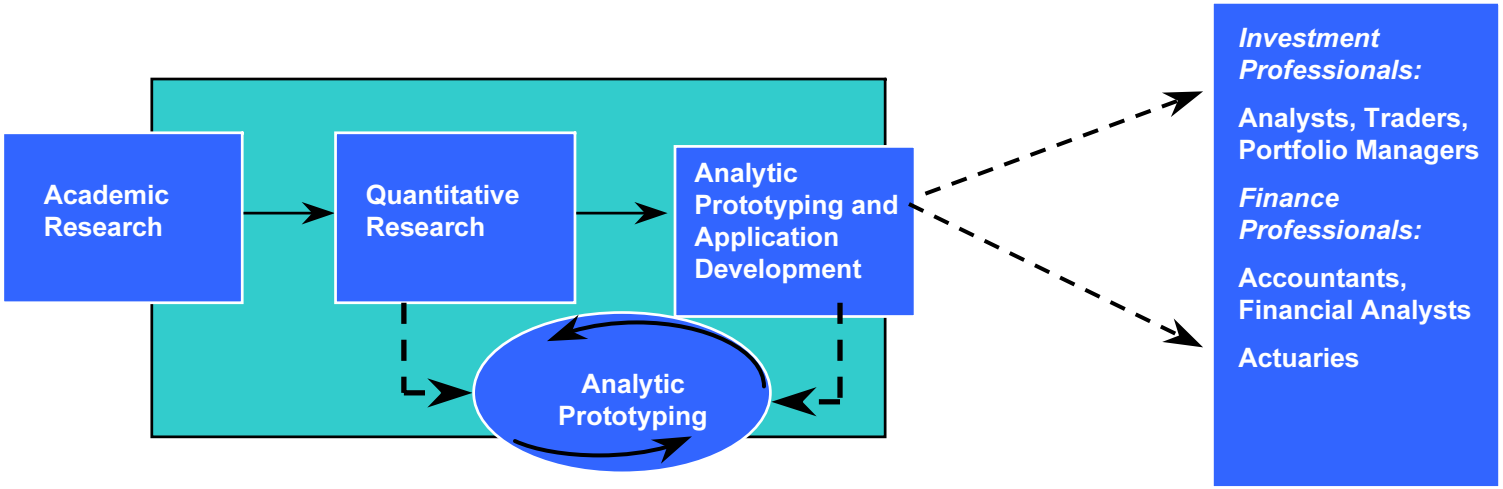
MATLAB – Excel Link Application

- MATLAB connects to the database
- Numerical algorithms are written and executed in MATLAB
- Excellent test environment for future models that will be deployed onto the desktop.



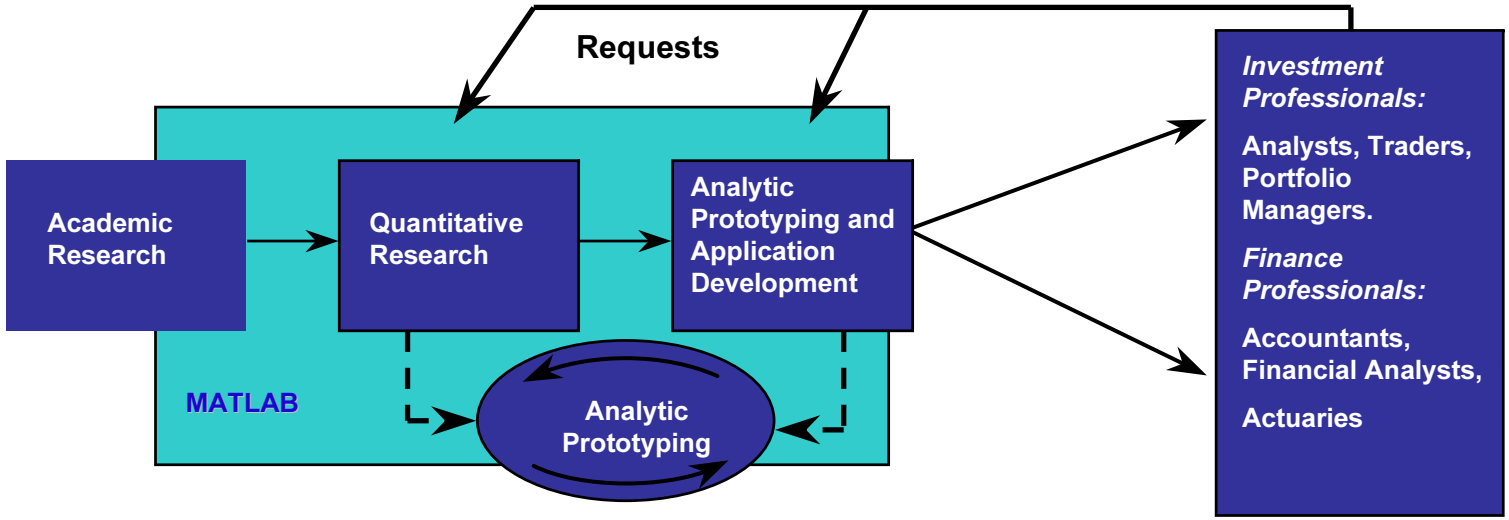
Deploying the model/algorithm

Model Development Process



	Strength	Weakness
Excel	▪ Ease of use	▪ Limited functionality
Excel, C/C++,VB	▪ Deployment	
Application Specific Software	▪ Functionality	▪ Learning curve ▪ Deployment

MATLAB Prototype to Production

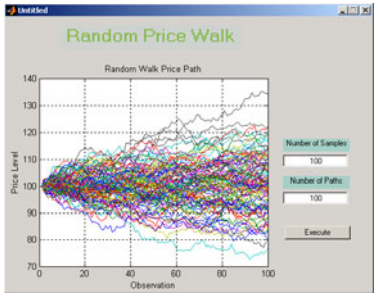


Traditional prototype to production system port
… development timeline 2 weeks ~ 6+ months

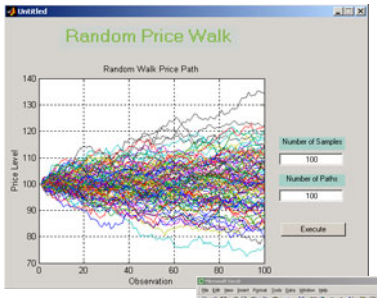
MATLAB prototype to production system
… single command at the command line

The MATLAB Compiler

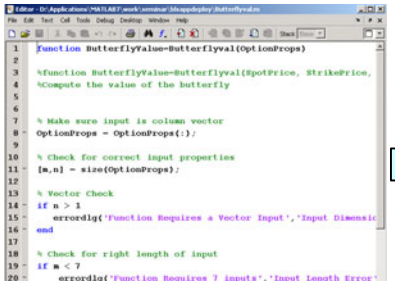
Your MATLAB App



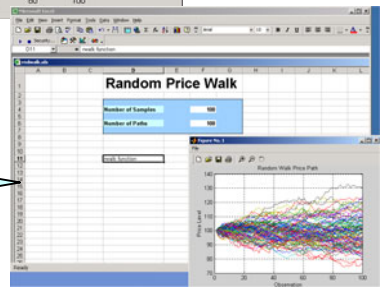
Deploy as a standalone



Your MATLAB Functions



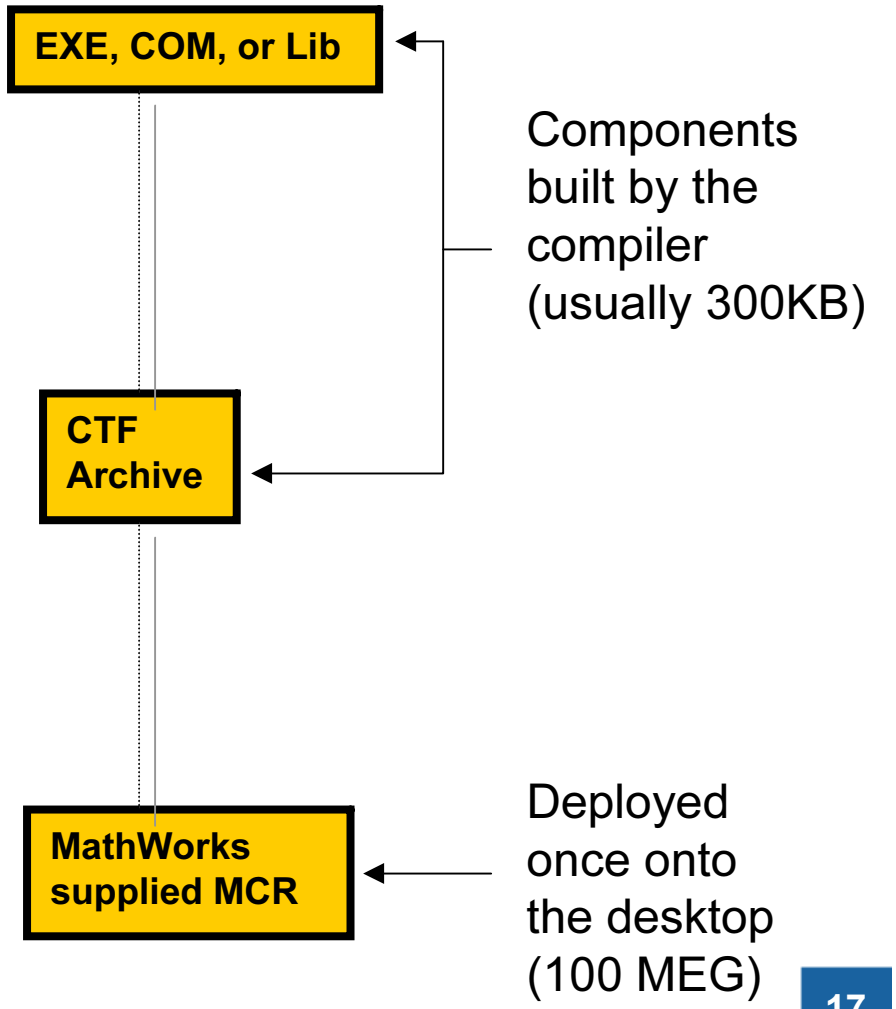
Integrate into other environments



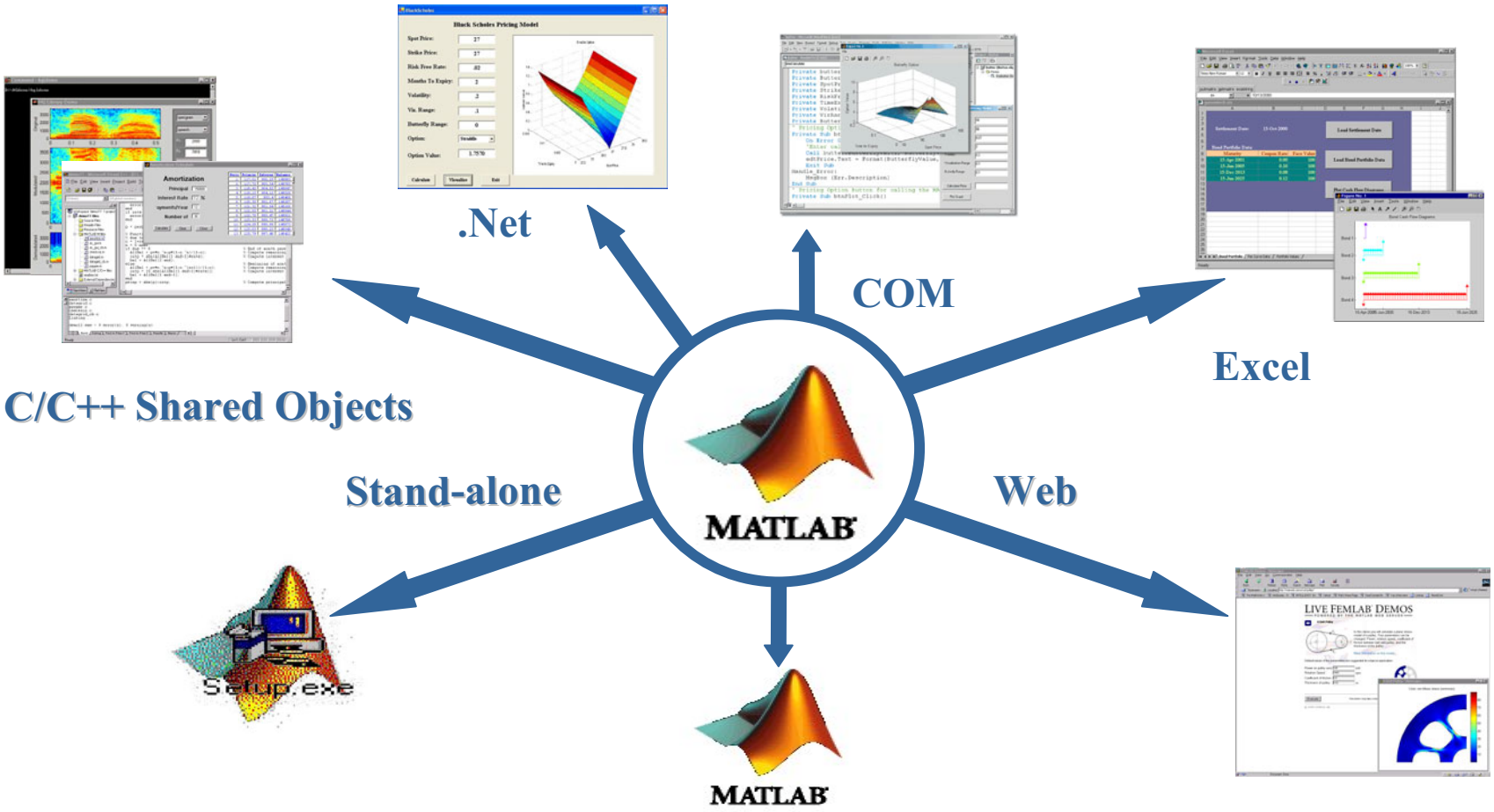
- Works with C/C++ compilers (Microsoft Visual Studio)
- Creates executables, components, or libraries
- Supports the entire MATLAB language (OOP's, JAVA, EVAL, ActiveX)
- Deploy applications at no cost

Compiler architecture … 3 Components

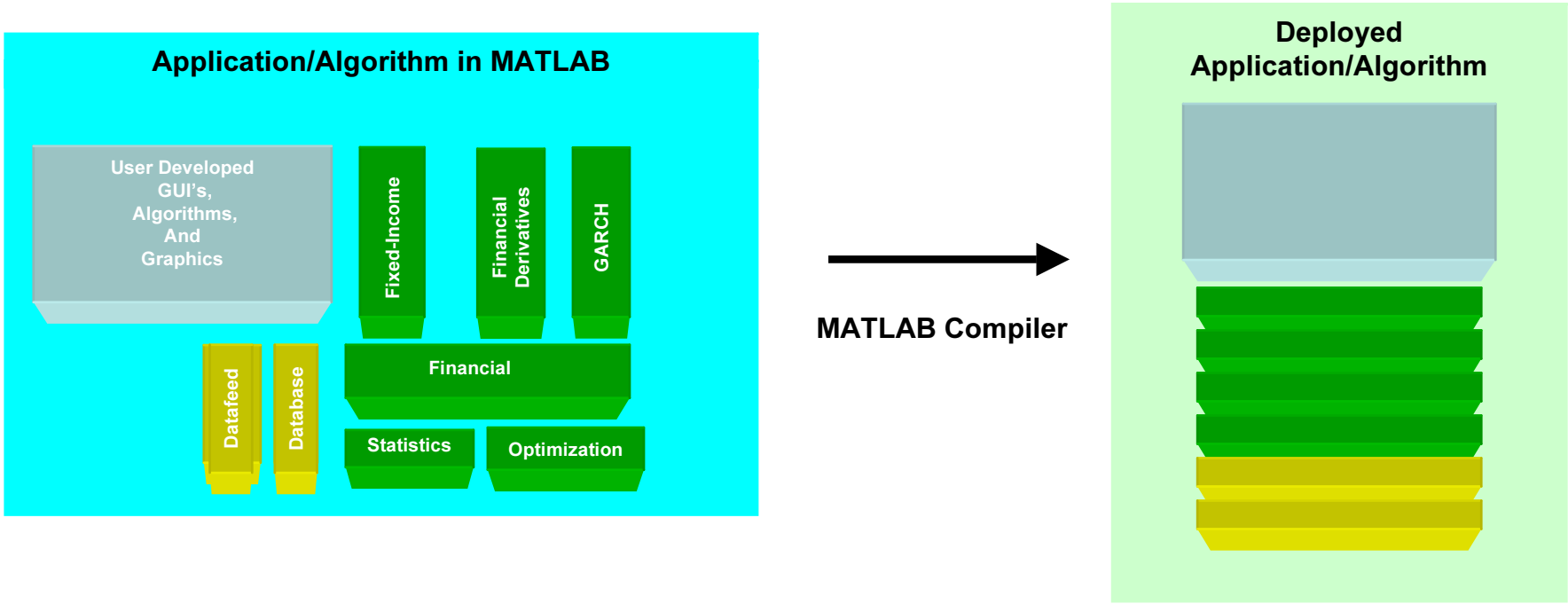
- **Executable, Component or Library**
- **Component Technology File (CTF)**
  - CTF file contains all supporting m files, mex files, java files, MAT files, etc. that are needed to allow application to run.
  - Enables customers to protect their IP due to new encryption model used in building the CTF archive.
- **MATLAB Component Runtime (MCR)**



Deploying with MATLAB



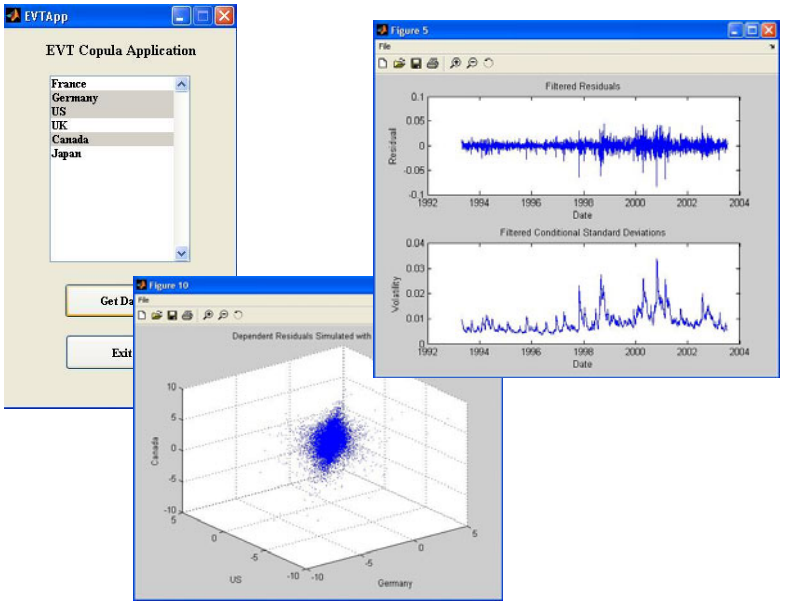
Application/Component Deployment from MATLAB



- **Taking a thin slice of Toolbox functionality that is relevant for the Application/Algorithm and packaging it up to support the Standalone Application/Component**

Standalone Applications

- Single command at command prompt (mcc)
- Build full applications in MATLAB
- Deploy to desktop … royalty free



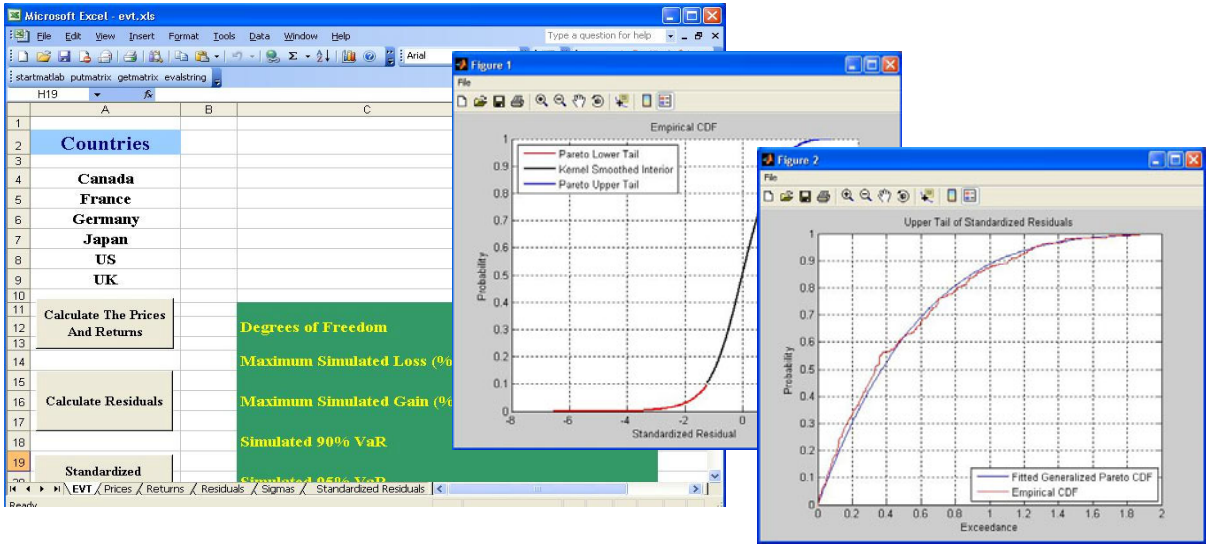
MATLAB Application

MATLAB Compiler

MATLAB

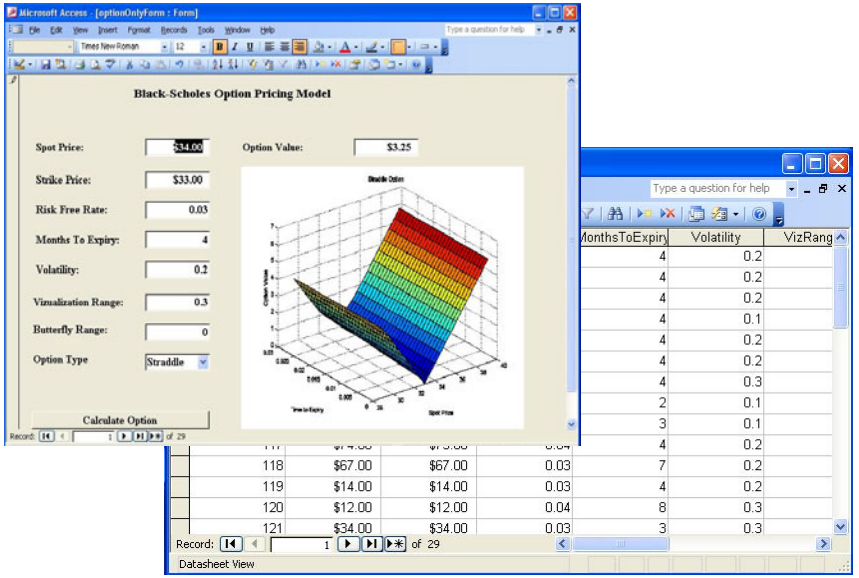
Deploying to Excel … Excel Add-ins

- Component and VBA code generated by Excel Builder
- "Black Box" model deployed to desktop, algorithms are protected.



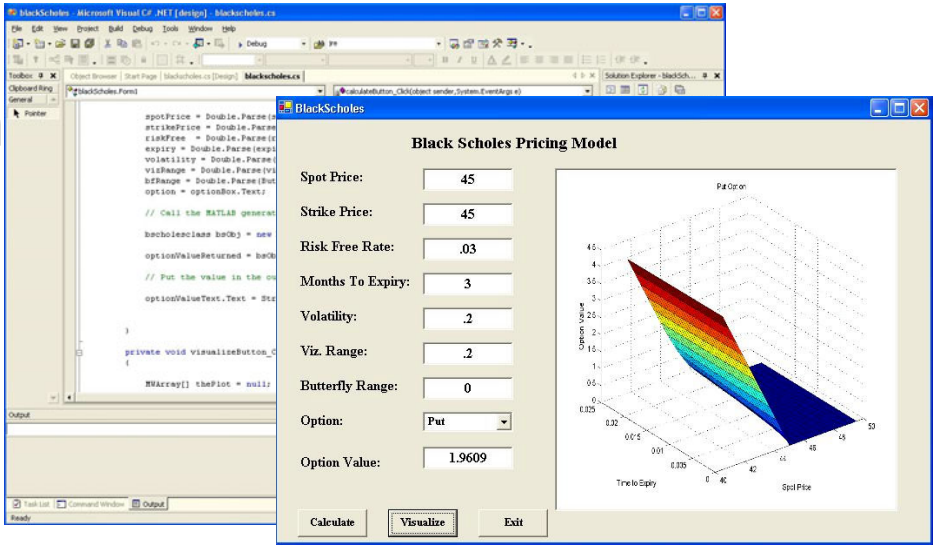
Deploying with COM

- Deploy components to any COM compliant language
  - C
  - C++
  - VB



Deploying to .Net

- Develop components that can be used with .Net languages
  - VB.Net
  - C#



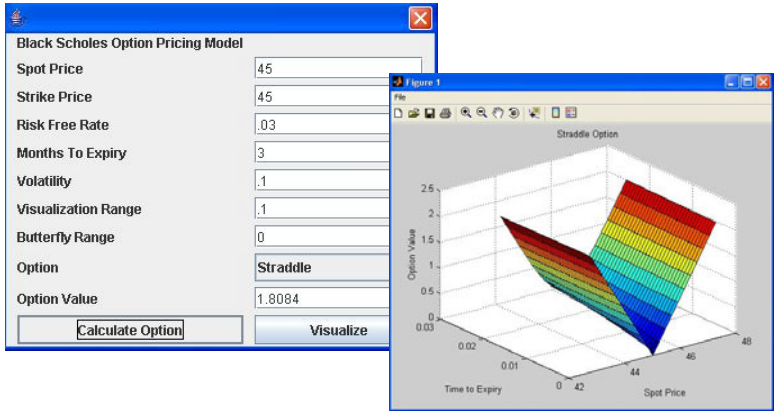
MATLAB Algorithm

MATLAB Compiler

MATLAB

Deploying to Java (Beta)

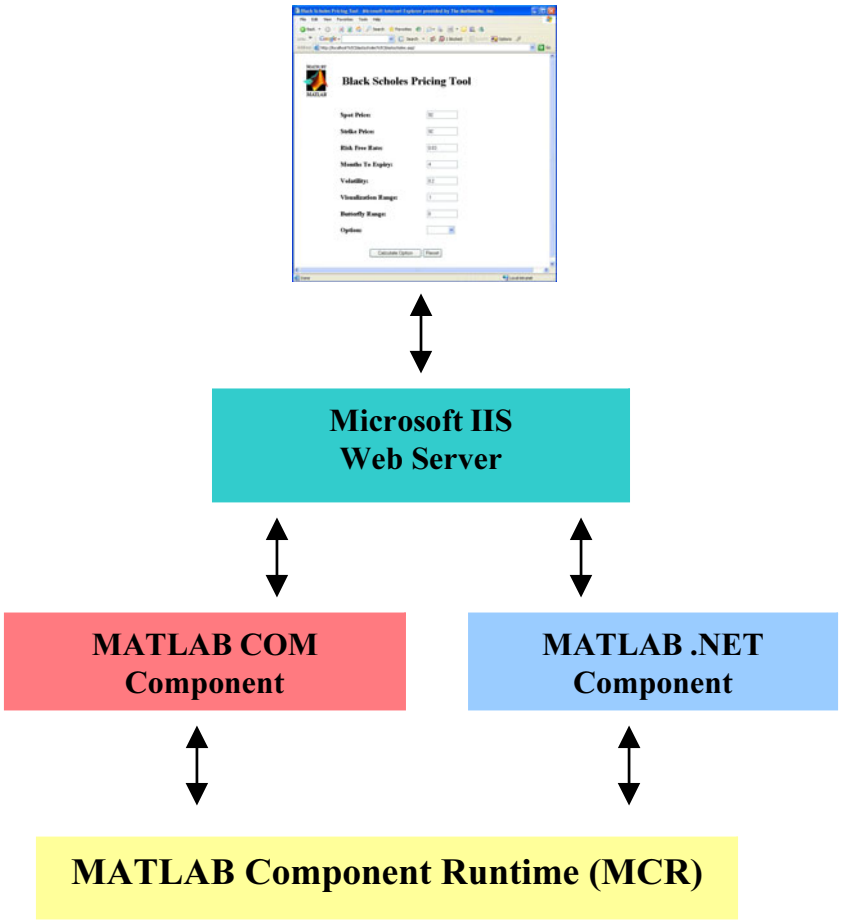
- Generate Java classes from MATLAB.
- Seamless Integration into JAVA applications



MATLAB Algorithm

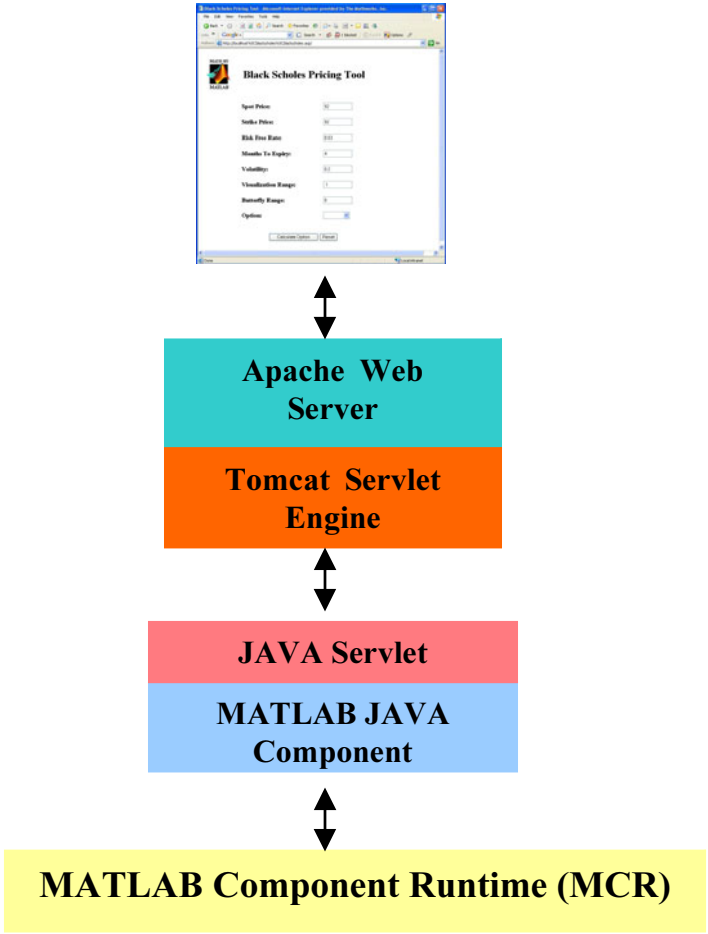
MATLAB

Web Applications … .Net/COM



- MATLAB generated .Net and COM components can be deployed to the web via Active Server Pages (ASP)

Web Applications … Java



- MATLAB generated Java components can be deployed to the web using JAVA Server Pages (JSP)

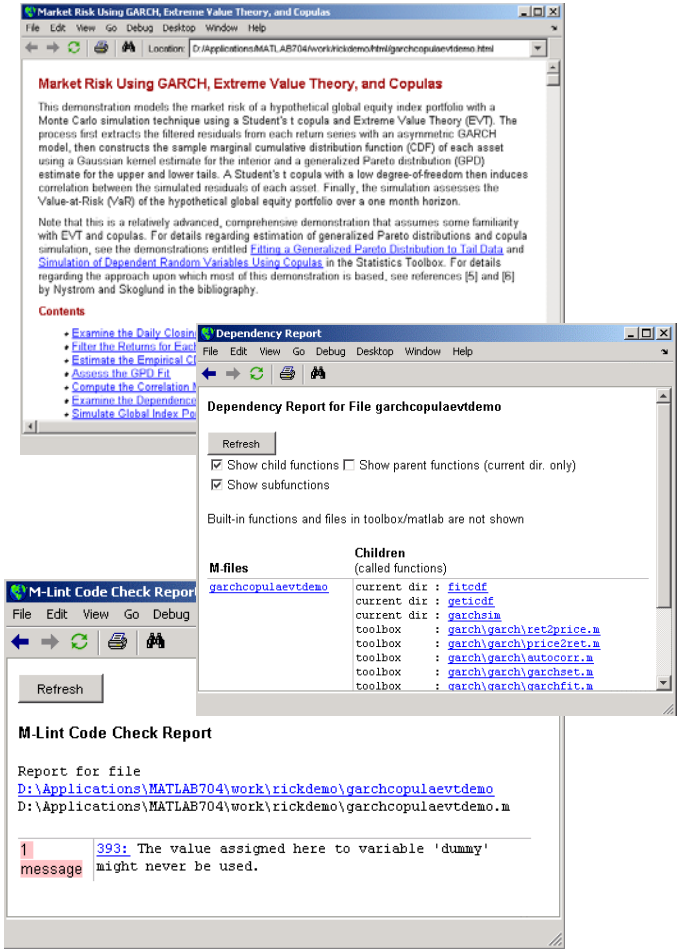
Reporting

- **Documents for compliance and model verification**
- **Generating custom daily/nightly reports**

Sarbanes-Oxley
Financial and Accounting Disclosure Information

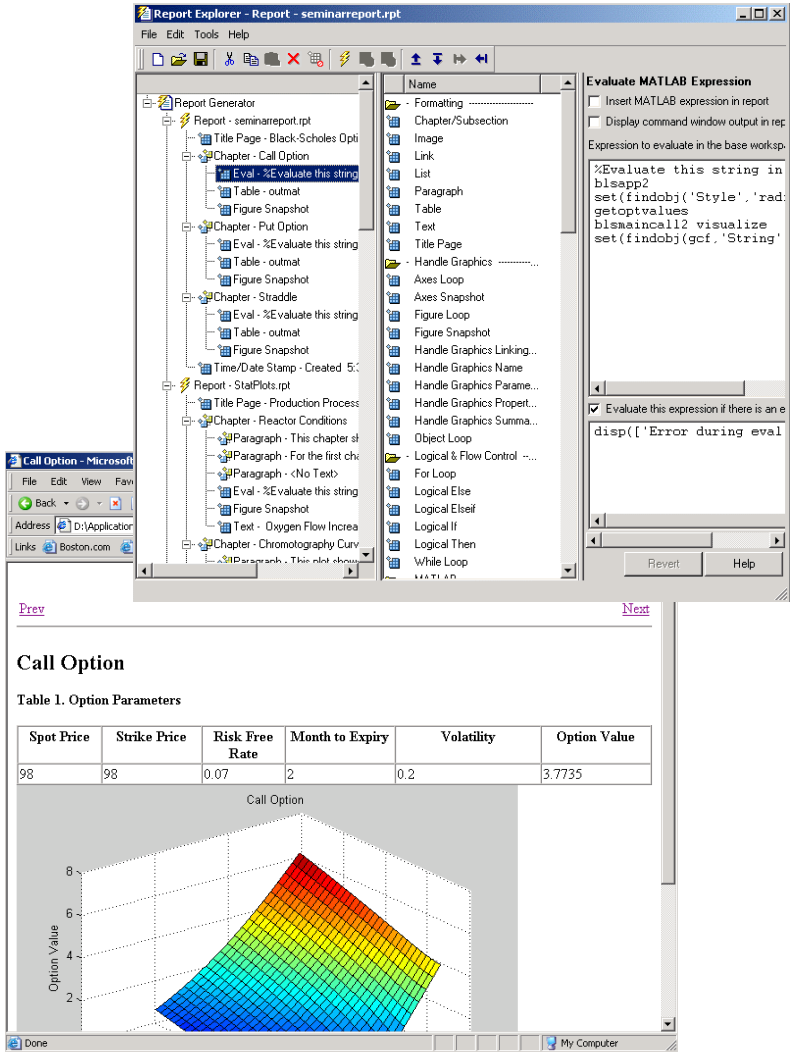
Compliance and Model Verification

- **Documentation of code** — Presentation Quality Reports
  - Display code and comments
  - Headings, links, and fonts
  - Graphics
  - Multi –output formats
    - HTML, XML, Word, LaTex, PowerPoint
- **Create dependency reports**
  - Understand parent/child relationships
- **Performance reports**
  - Recommendations for improvements
  - Check unused variables



Custom Report Generation

- **Template based report design**
  - Develop report outline
  - Reusable templates
- **Scripting features**
  - Chapters
  - Text, tables, links, graphs, code, etc
- **Multiple output formats**
  - HTML
  - XML
  - RTF



Wrap Up

MATLAB for Business Applications

Business Tools on the Desktop	MATLAB Tools
- Excel - Word - Browsers	- Excel Link & Data Import Tool - Publisher, copy figure - Publisher and Report Generator
- Live Market Data	- Datafeed Toolbox
- Databases • Oracle • Microsoft Access • Microsoft SQL Server • Sybase SQL Server • ….	- Database Toolbox • ODBC & JDBC • …

Benefits of MATLAB

- **Interactive environment**
- **An extensive library of viewable code that can be used "as is" or modified to incorporate business models**
- **Matrix based — handle and manipulate large data sets**
- **First rate graphics engine**
- **A considerably shorter application development process resulting in rapid delivery of model to the end user desktop**

The MATLAB Advantage

- Develop models faster
- Run large scale simulations
- Reduces the costs of model integration

Representative Customers

- Federal Reserve Bank
- Goldman Sachs
- J.P. Morgan Chase
- State Street
- Salomon Smith Barney
- Merrill Lynch
- Ernst & Young
- Deloitte & Touche
- Lehman Brothers
- Putnam Investments
- Prudential Securities
- Bank of America
- Freddie Mac
- Fannie Mae
- Moody's Investors
- Scudder Investment
- Price Waterhouse Coopers

Insurance and Energy Trading Companies

- Allstate Insurance
- American RE
- AXA
- Element RE
- John Hancock
- Kemper RE
- Liberty Mutual
- New York Life
- Zurich RE
- Williams Energy
- Reliant Energy
- TXU
- Mirant
- ExxonMobil
- Entergy Koch
- Constellation Power Source
- Sempra Energy
- Allegheny Energy
- Dominion Energy

Representative US Business Schools

- University of Chicago, GSB
- University of Pennsylvania, Wharton
- Stanford University
- Cornell University (Johnson)
- Sloan School (MIT)
- Carnegie Mellon University (Tepper)
- Duke University (Fuqua)
- Harvard Business School
- Northwestern University (Kellogg)
- University of Michigan (Ross)
- University of California at Berkeley (Haas)
- NYU (Stern)

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The MathWorks Connections Program

The MathWorks Consulting Services

The MathWorks Book Program

The MathWorks Training Services

MATLAB® CENTRAL

- **Engineering expertise and deep product knowledge, specializing in:**
  - **Application development using MATLAB**
  - **Model-based design using Simulink and Stateflow**
  - **Embedded-system development**
  - **Enterprise-wide integration of MathWorks products into engineering process and systems**
  - **Jumpstart services**

- **Project-based services for a growing number of industries, including Aerospace and Defense, Automotive, Communications, Power and Marine, and Financial Services**

The MathWorks Training Services

- Introductory and intermediate training in MATLAB and Application Deployment
- Specialized courses in Optimization, Statistics, and interacting with external applications like Excel.
- Pre-sale ("Try it before you buy it") or post-sale
- Flexible delivery:
  - Our place: Public training worldwide
  - Your place: Standard or customized training at your site
  - Cyberspace: Web-based training
    - Interactive, instructor-led e-learning
    - Train at work or at home, with flexible dates and times

www.mathworks.com/training

MATLAB® CENTRAL

File exchange and newsgroup access for MATLAB and Simulink users

- **130,000 visits per month**
- **Over 2,800 files in the exchange**
  - **General-purpose functions, industry- and application-specific tools and examples**
  - **100 new submissions per month**
  - **5,000 downloads per day**
- **5,000 posts to "CSSM" (comp.soft-sys.matlab) per month, 60% routed through MATLAB Central**

The MathWorks Connections Program

Over 300 add-on products and services from partners that complement and extend MathWorks products

- Specialized third-party toolboxes for MATLAB
- Interfaces to partners' software and hardware products
- Specialized training courses and consulting services
- System integrators and suppliers that incorporate MathWorks products

Further information

- **Visit MATLAB Central for some of the tools you've seen today**
- **Trials, onsite demonstrations, technical literature:**

  http://www.mathworks.com/products/industry/finance

- **Company and product information:**

  www.mathworks.com