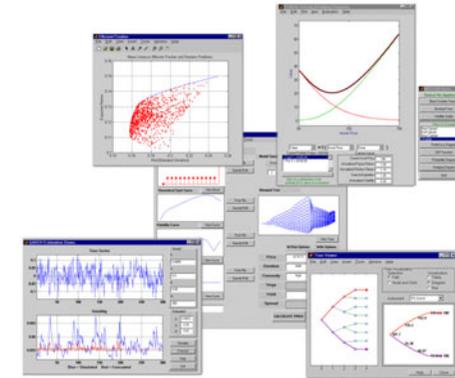


# Managing Risk with Extreme Value Theory and Copulas : A MATLAB Financial Case Study



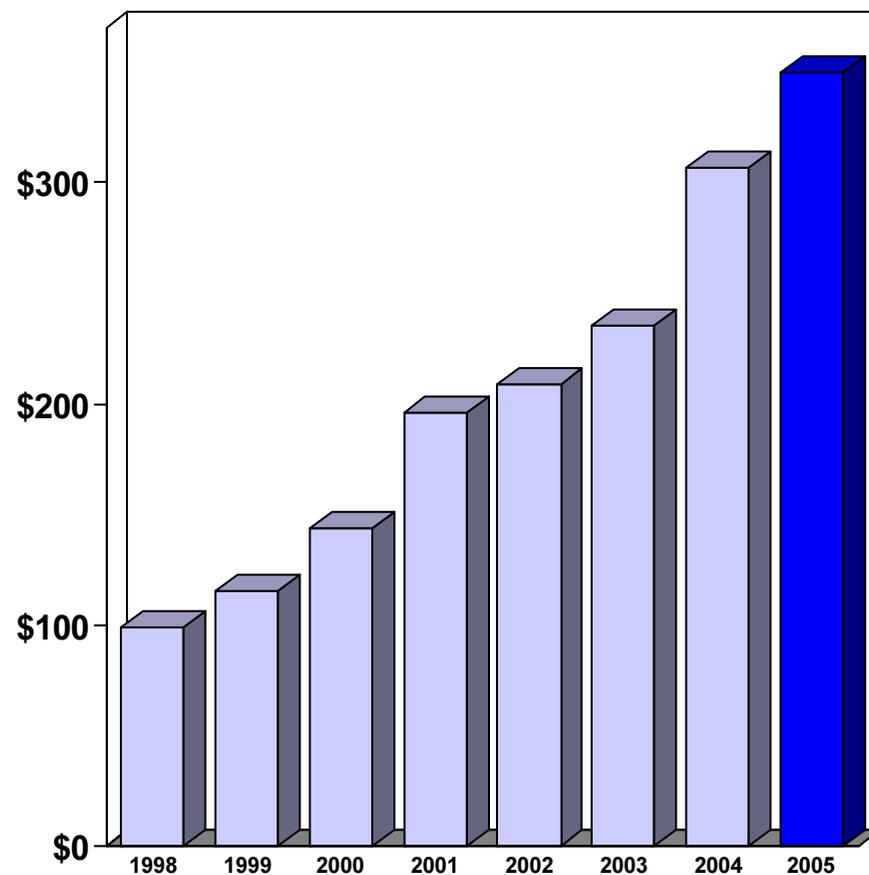
Financial Products Group



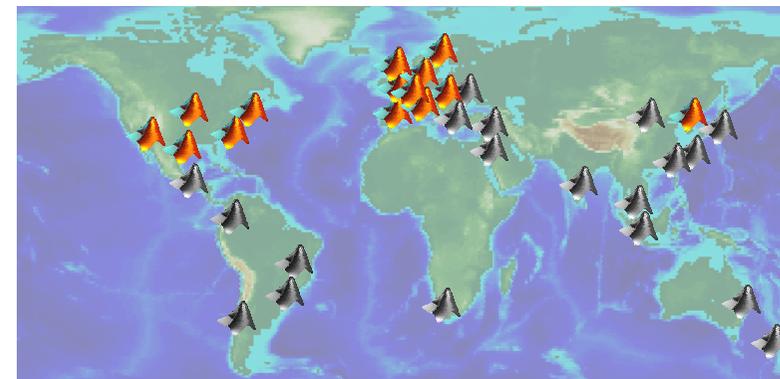
Eugene McGoldrick & Rick Baker  
Financial Products Development

# 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

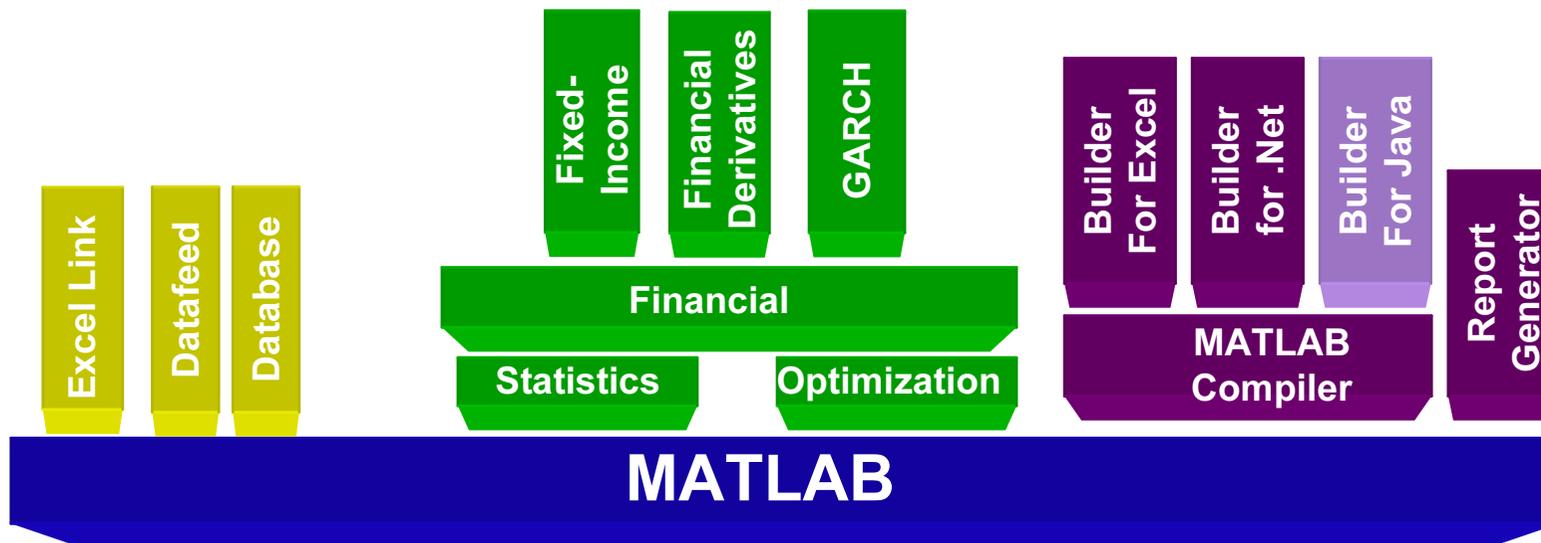
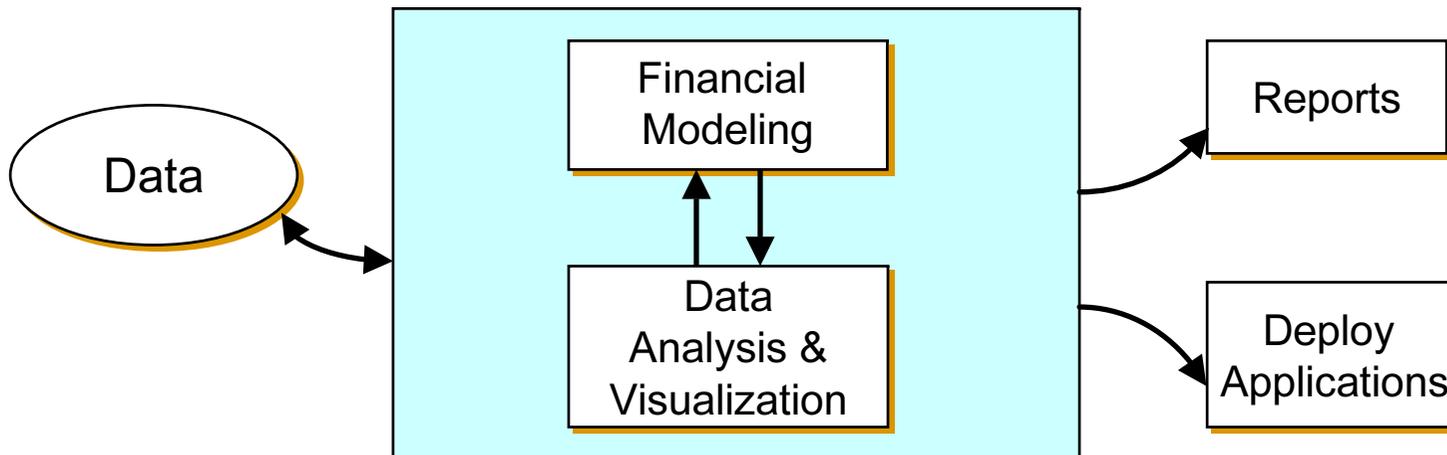
# Business Challenges

- **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 professionals develop complex financial models using MATLAB and its family of toolboxes**

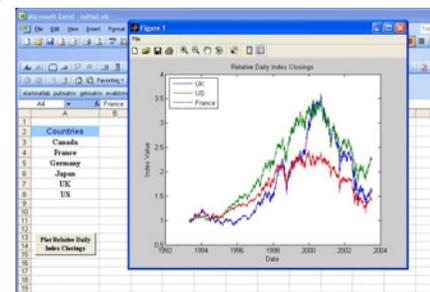
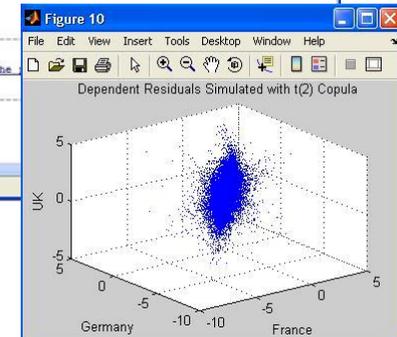
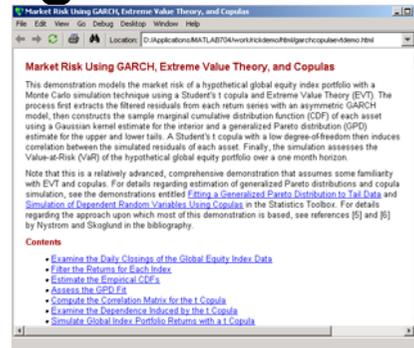
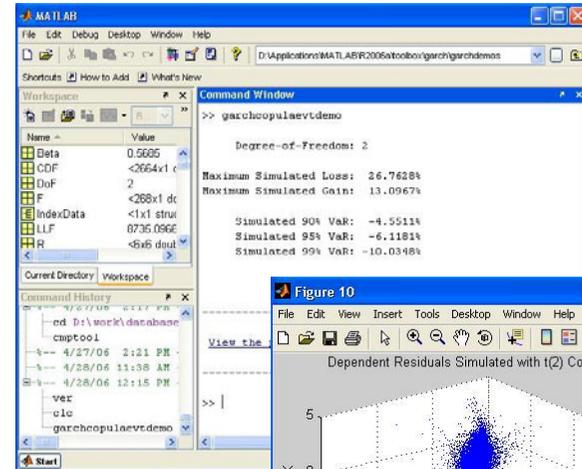
**and**

***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



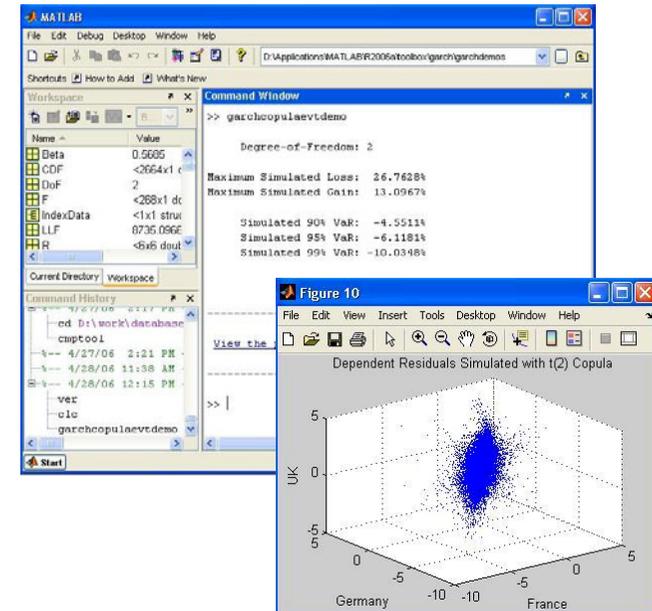
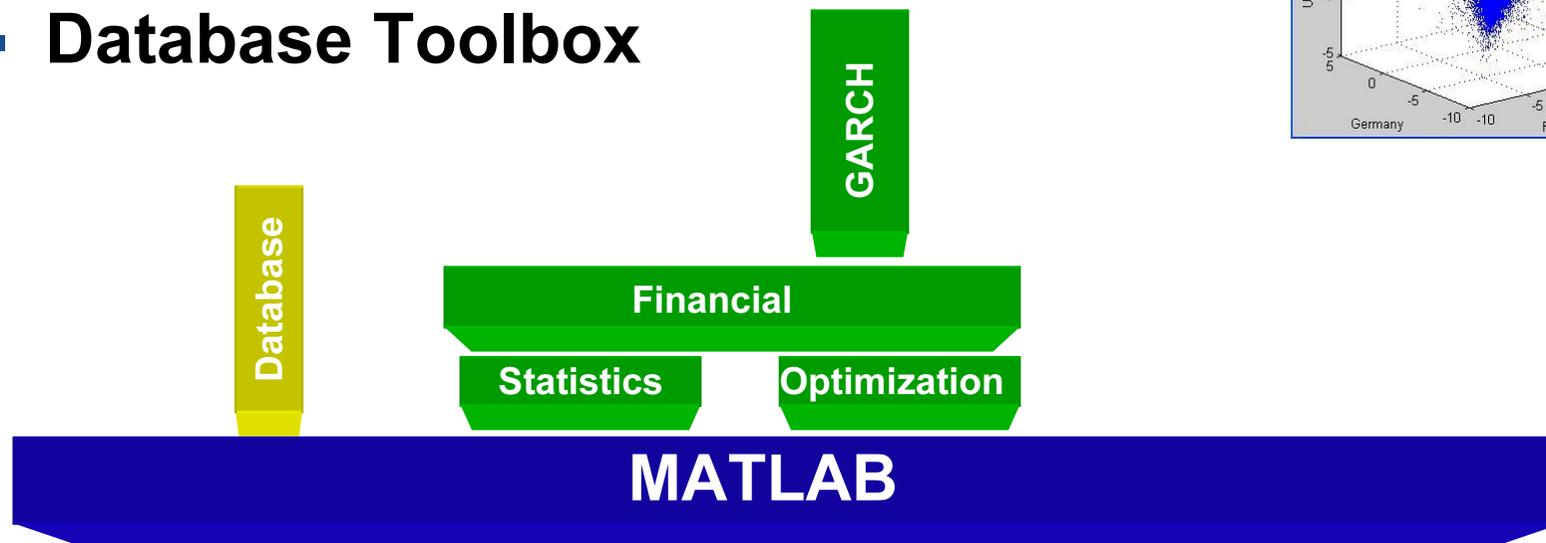
# MATLAB Presentation

**Managing Risk with Extreme Value Theory and Copulas**

**Rick Baker**

# Products used to develop the model

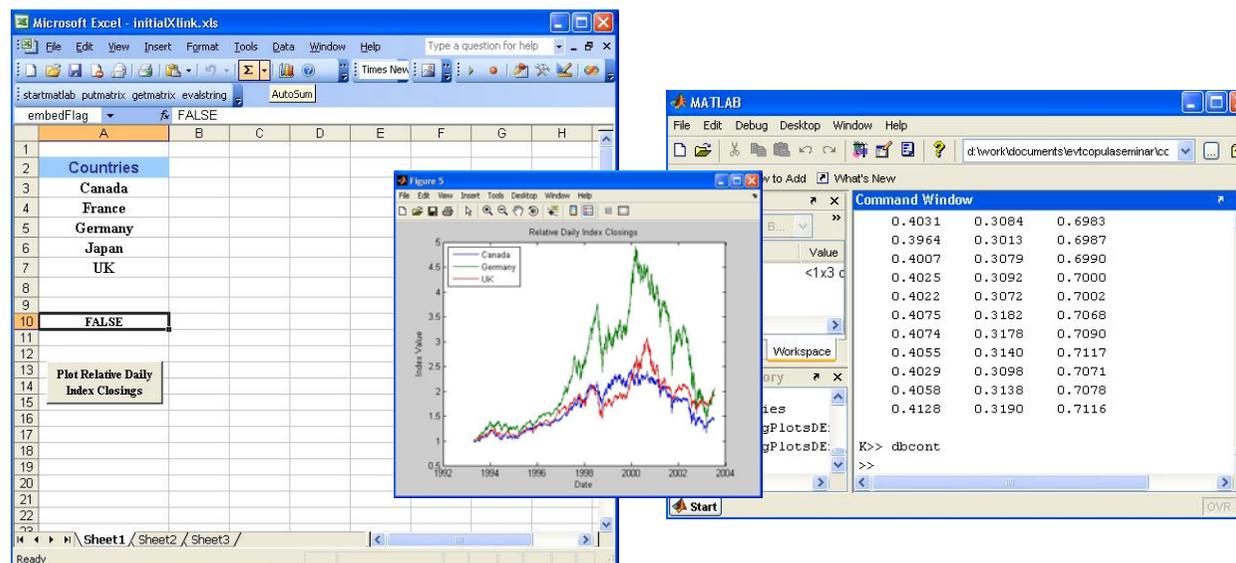
- MATLAB
- Statistics Toolbox
- Optimization Toolbox
- GARCH Toolbox
- Database Toolbox



# Interaction with Excel ... Excel Link

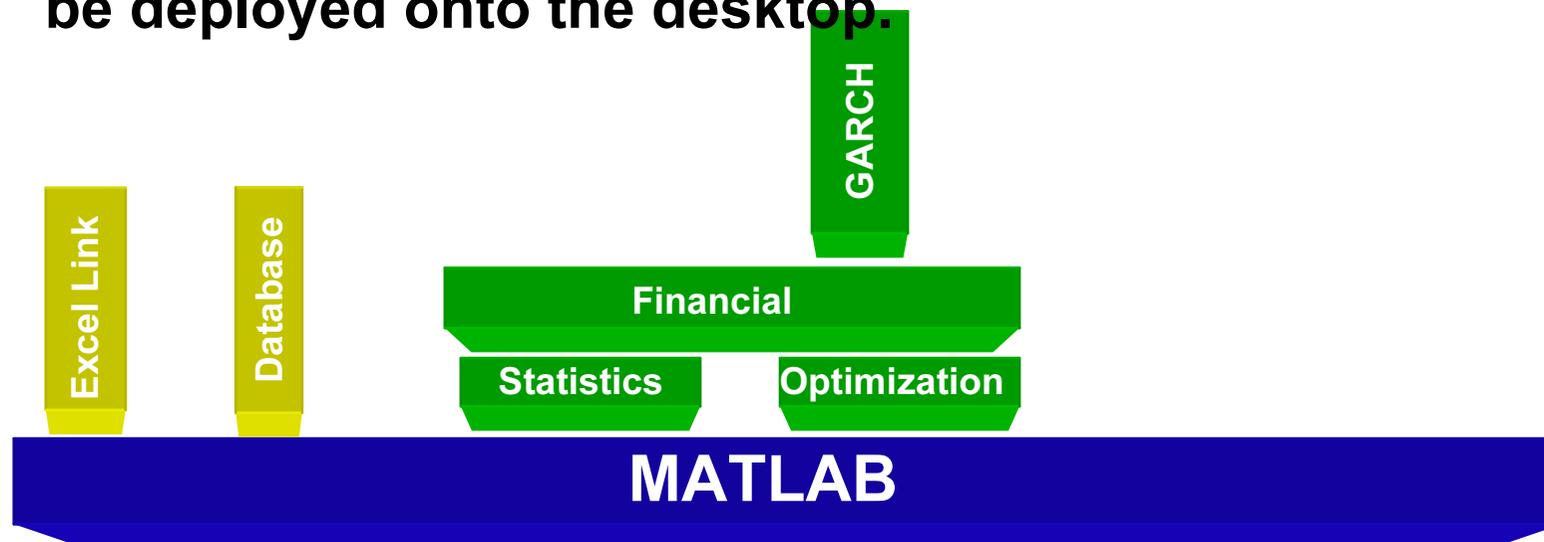
# Excel Link

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



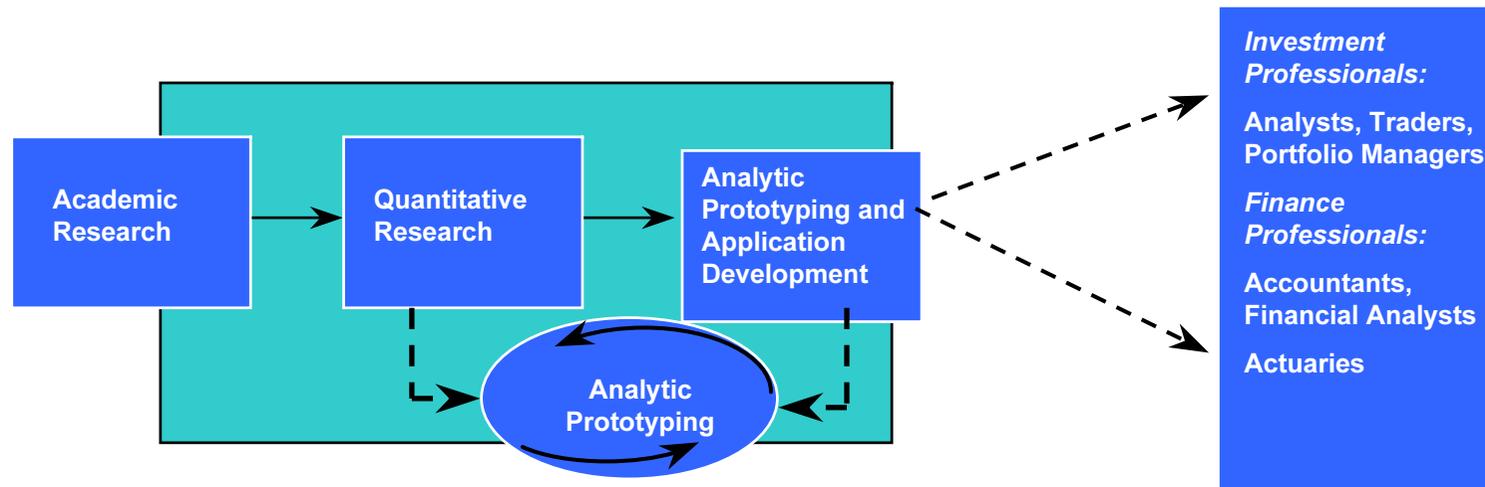
# MATLAB – Excel Link Application

- 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.



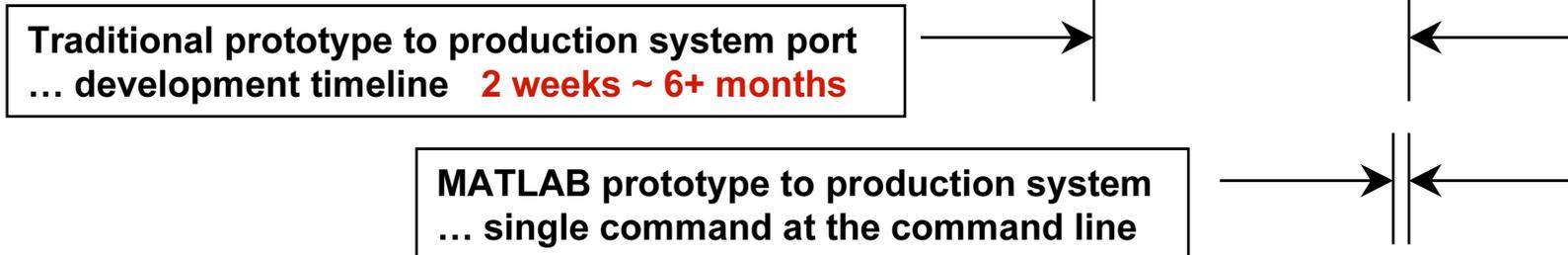
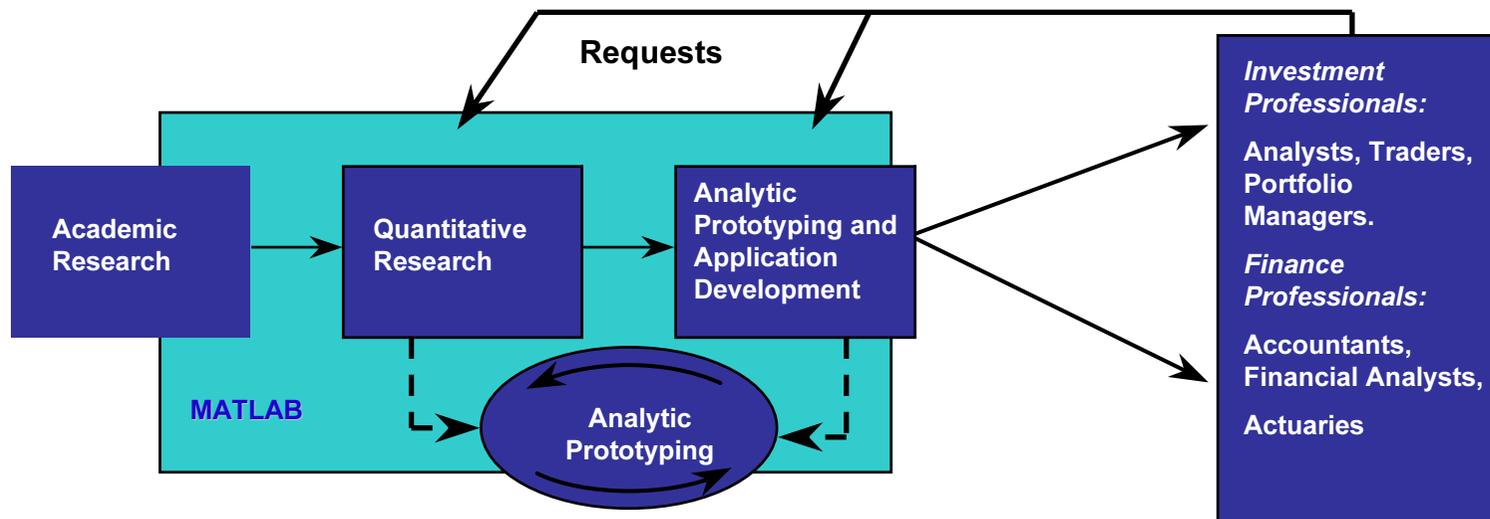
# Deploying the model/algorithm

# Model Development Process



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

# MATLAB Prototype to Production



# The MATLAB Compiler

Your  
MATLAB  
App



Your  
MATLAB  
Functions

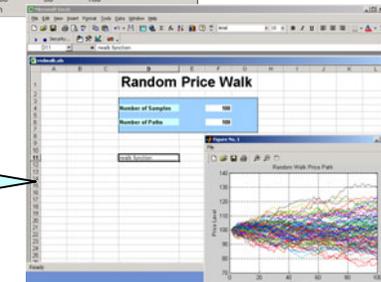
```

1 function ButterflyValue=Butterflyval(OptionProps)
2
3 %function ButterflyValue=Butterflyval(SpotPrice, StrikePrice,
4 %compute the value of the butterfly
5
6
7 % Make sure input is column vector
8 OptionProps = OptionProps(:);
9
10 % Check for correct input properties
11 [m,n] = size(OptionProps);
12
13 % Vector Check
14 if n > 1
15     error('Function Requires a Vector Input','Input Dimension Error')
16 end
17
18 % Check for right length of input
19 if m < 7
20     error('Function Requires 7 inputs','Input Length Error')
    
```

Deploy as a  
standalone



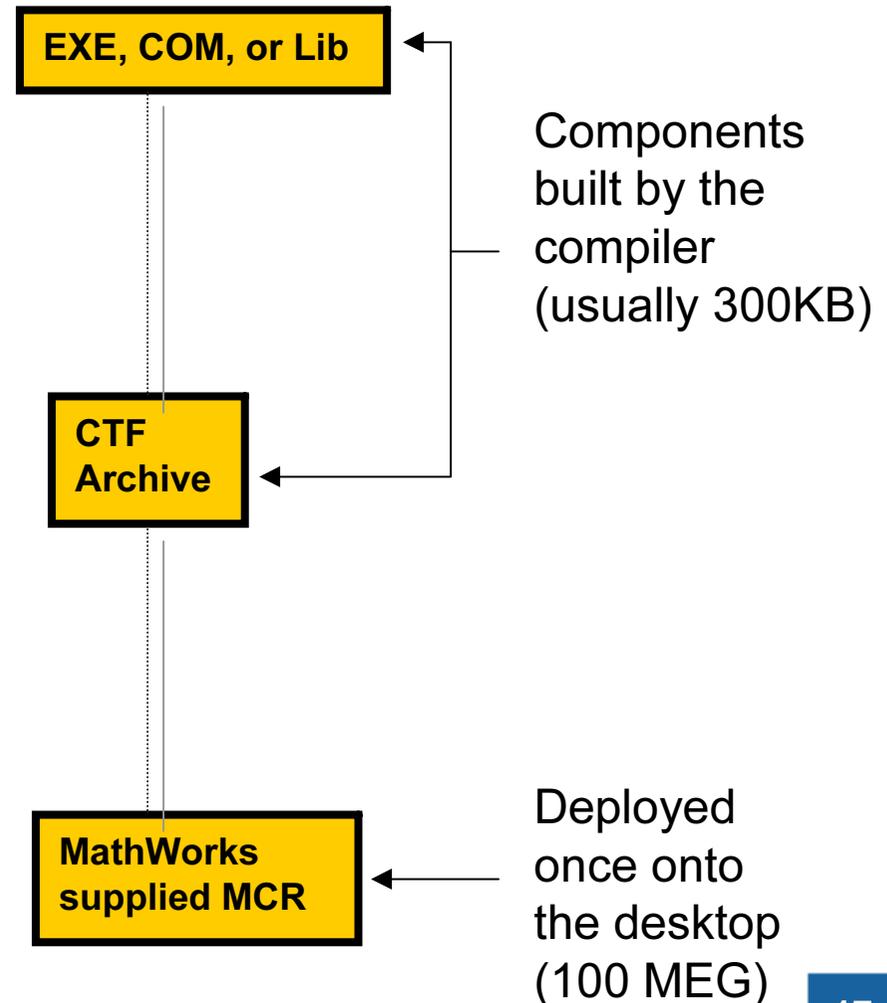
Integrate into other  
environments



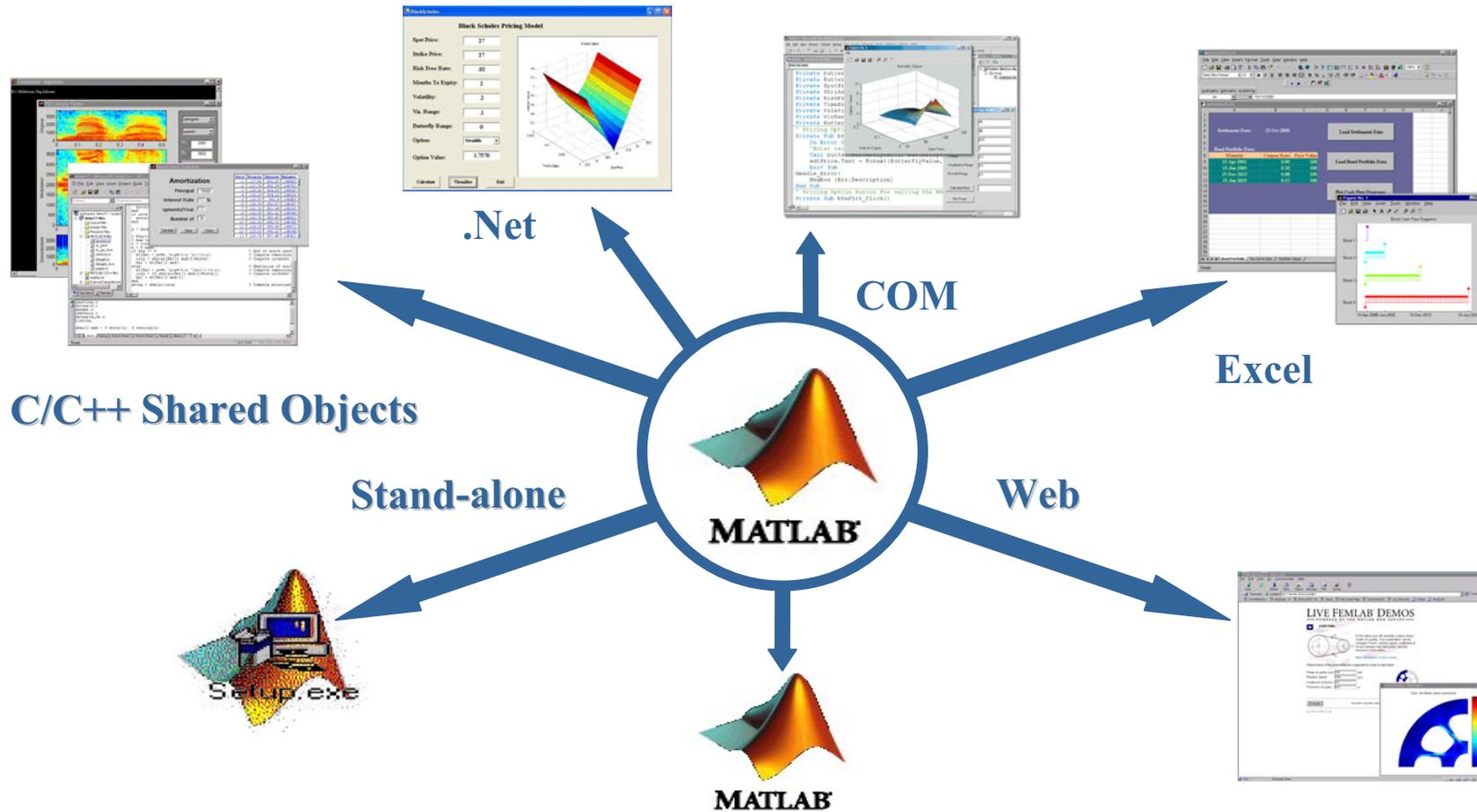
- Works with C/C++ compilers (Microsoft Visual Studio)
- Creates executables, components, or libraries
- Supports the entire MATLAB language (OOP's, JAVA, EVAL, ActiveX)
- Deploy applications at no cost

# Compiler architecture ... 3 Components

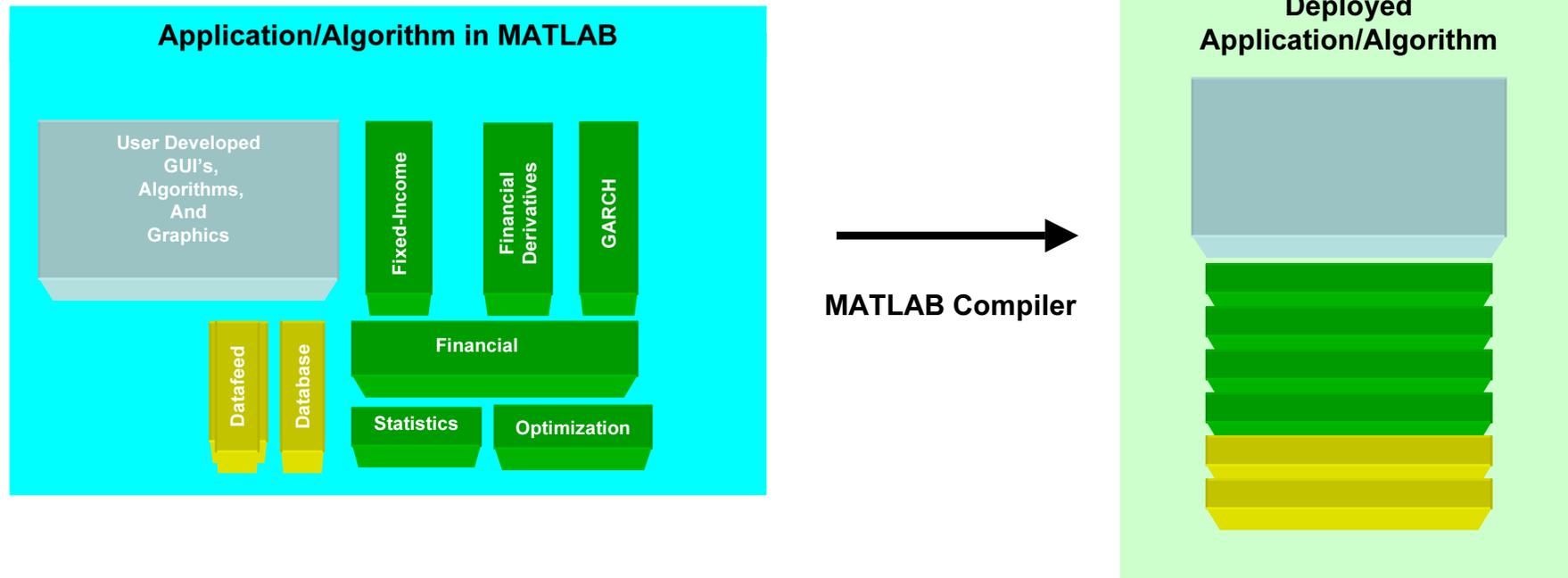
- **Executable, Component or Library**
- **Component Technology File (CTF)**
  - CTF file contains all supporting m files, mex files, java files, MAT files, etc. that are needed to allow application to run.
  - Enables customers to protect their IP due to new encryption model used in building the CTF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



# Deploying with MATLAB



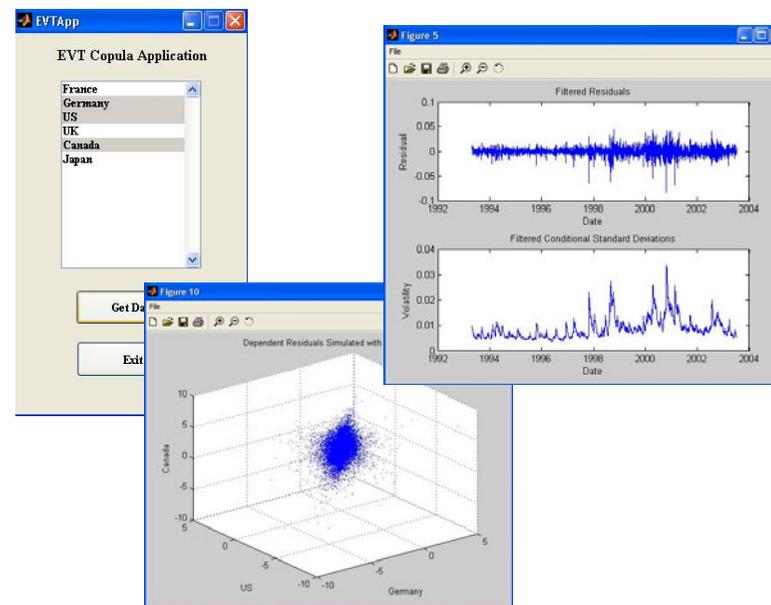
# Application/Component Deployment from MATLAB



- 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



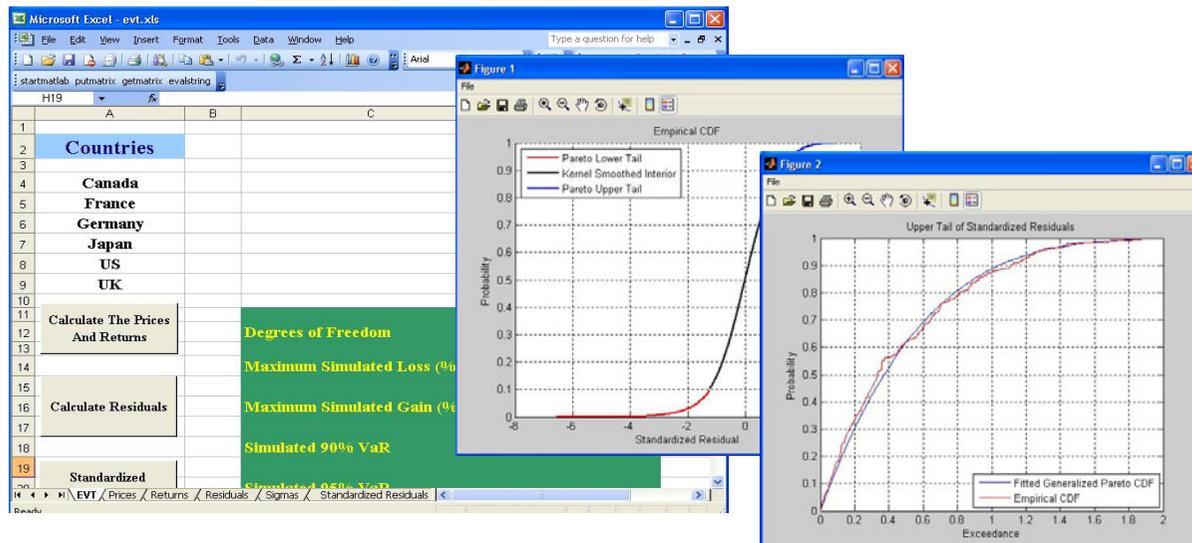
MATLAB Application

MATLAB  
Compiler

MATLAB

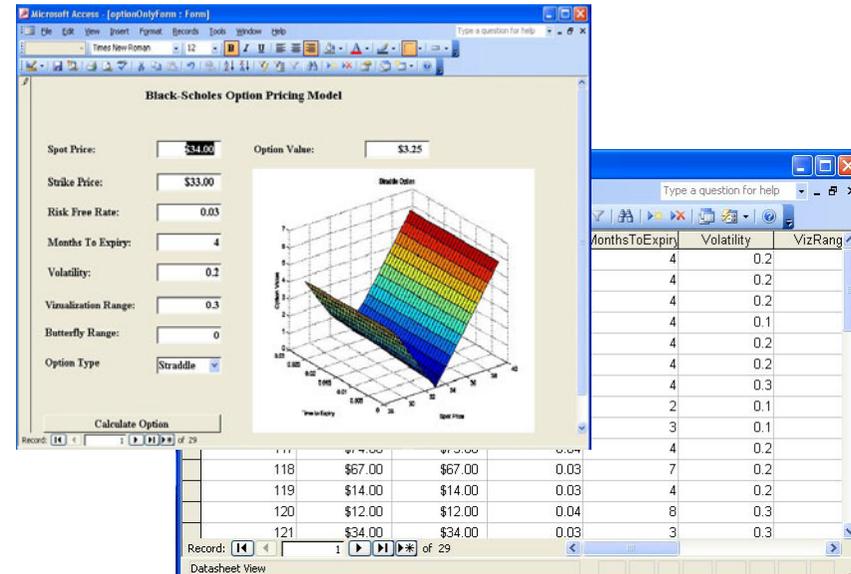
# Deploying to Excel ... Excel Add-ins

- 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



MATLAB Algorithm

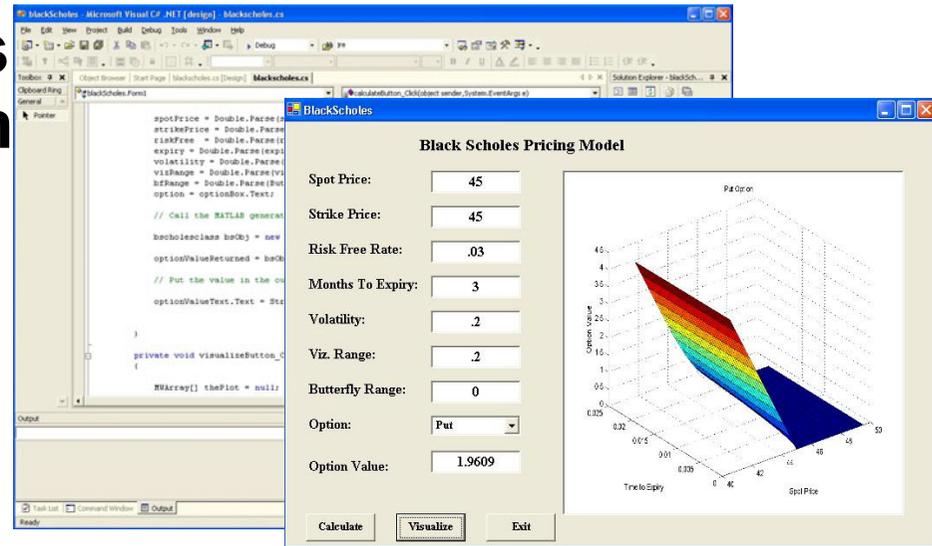
Builder for .Net

MATLAB Compiler

MATLAB

# Deploying to .Net

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



MATLAB Algorithm

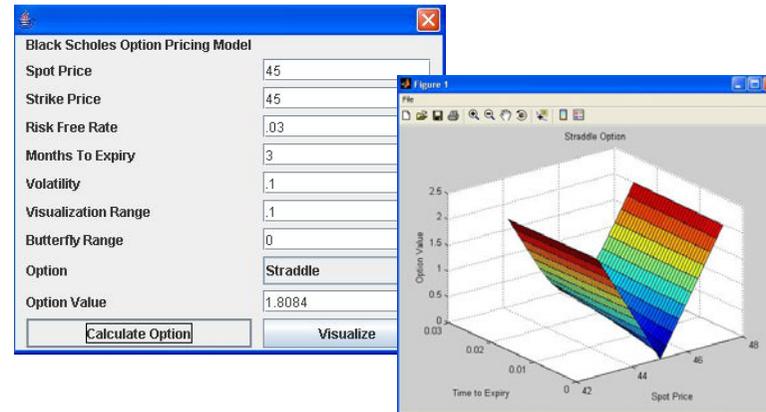
Builder  
for .Net

MATLAB  
Compiler

MATLAB

# Deploying to Java (Beta)

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



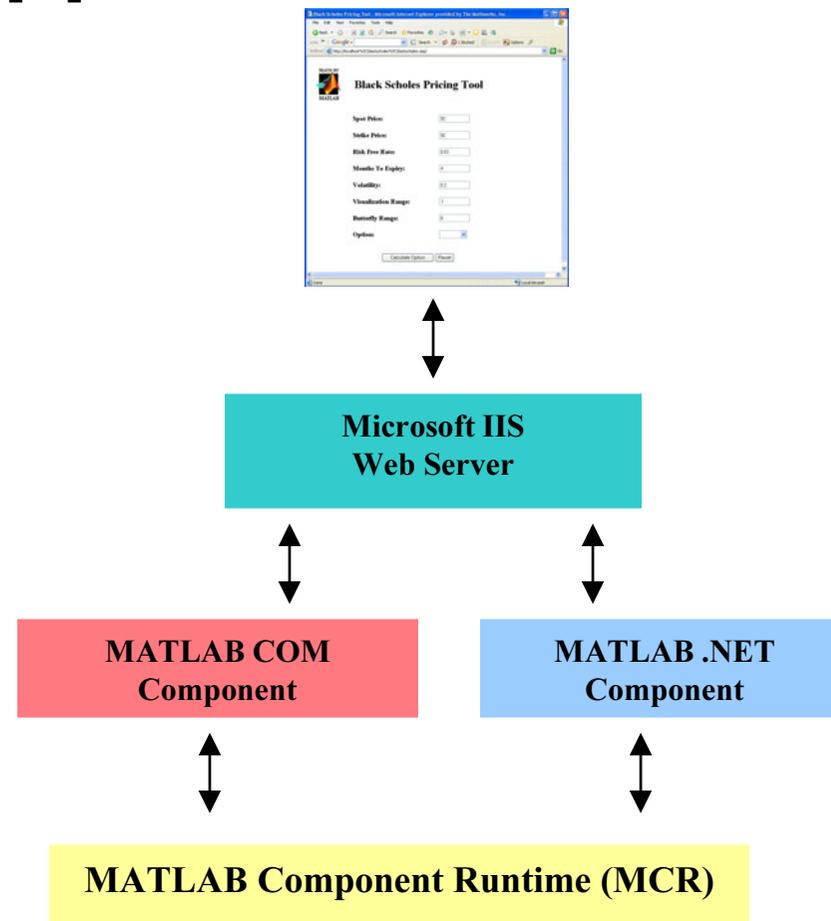
MATLAB Algorithm

Builder  
For Java

MATLAB  
Compiler

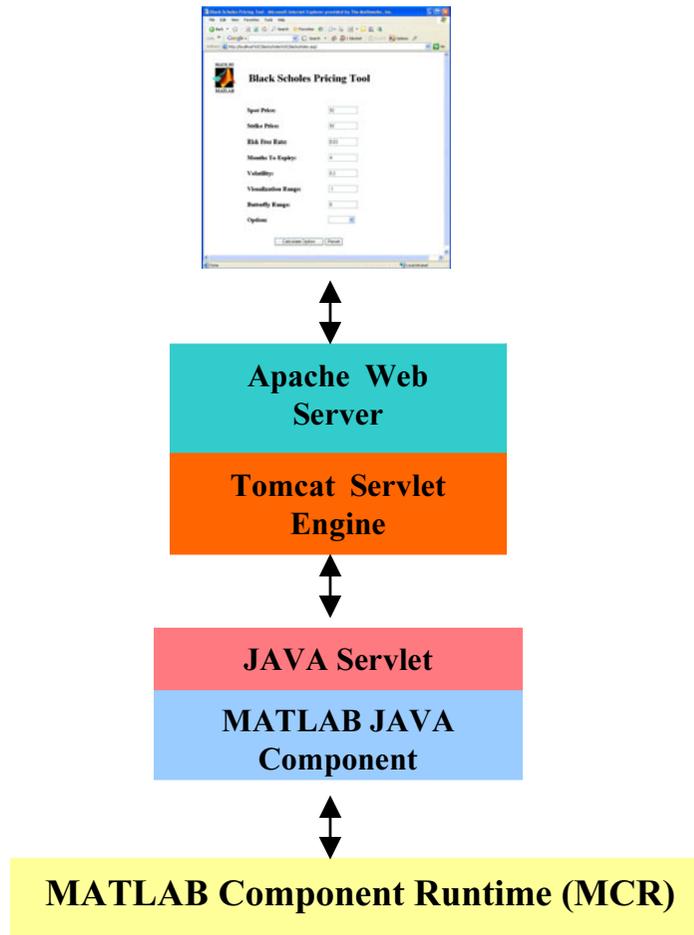
MATLAB

# 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)**

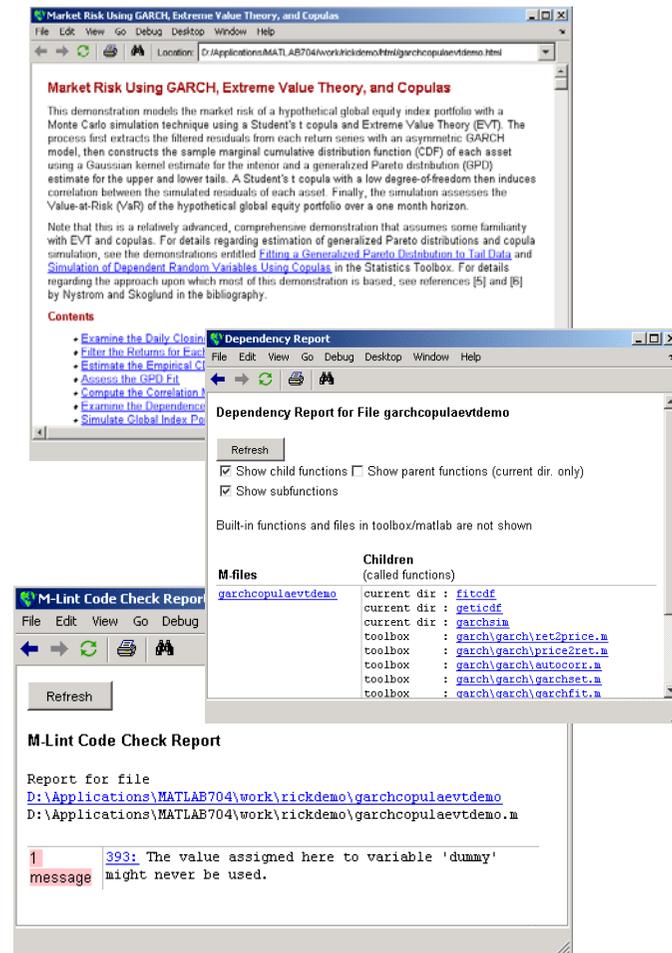
# Reporting

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

# Compliance and Model Verification

Presentation  
Quality  
Reports

- **Documentation of code**
  - 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

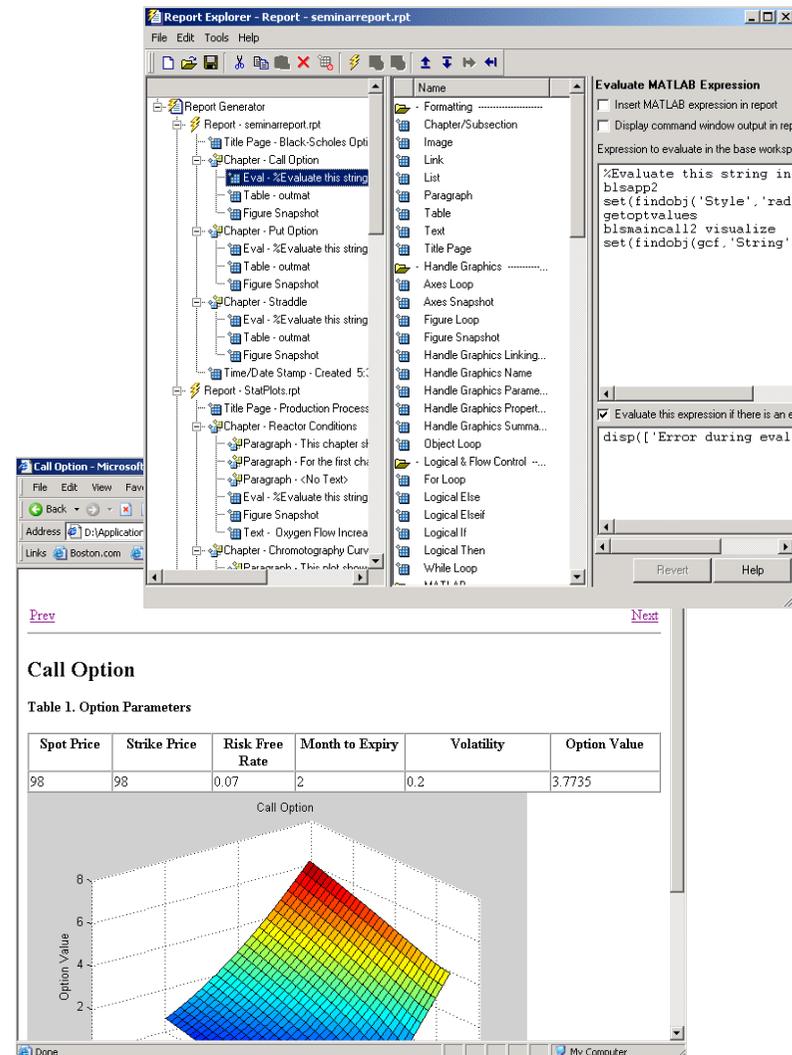


The image shows three overlapping MATLAB report windows. The top window is titled "Market Risk Using GARCH, Extreme Value Theory, and Copulas" and contains a detailed text report. The middle window is titled "M-Lint Code Check Report" and shows a list of errors, with one error highlighted: "393: The value assigned here to variable 'dummy' might never be used." The bottom window is titled "Dependency Report for File garchcopulaevtdemo" and displays a table of dependencies.

M-files	Children (called functions)
garchcopulaevtdemo	current dir : <a href="#">fitcdf</a>
	current dir : <a href="#">getcdf</a>
	current dir : <a href="#">garchim</a>
	toolbox : <a href="#">garch\garch\ret2price.m</a>
	toolbox : <a href="#">garch\garch\price2ret.m</a>
	toolbox : <a href="#">garch\garch\autocorr.m</a>
	toolbox : <a href="#">garch\garch\garchest.m</a>
	toolbox : <a href="#">garch\garch\garchfit.m</a>

# 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



The screenshot shows the Report Explorer window for a report named 'seminarreport.rpt'. The left pane shows a hierarchical tree of report sections, including 'Report Generator', 'Title Page', 'Chapter - Call Option', and 'Table - outmat'. The middle pane lists various report elements like 'Image', 'Table', 'Text', and 'Figure Snapshot'. The right pane shows the 'Evaluate MATLAB Expression' dialog with a code snippet for evaluating a string in the base workspace. Below the dialog, a preview of the report page is shown, featuring a table of option parameters and a 3D surface plot of option value.

**Table 1. Option Parameters**

Spot Price	Strike Price	Risk Free Rate	Month to Expiry	Volatility	Option Value
98	98	0.07	2	0.2	3.7735

The 3D plot below the table is titled 'Call Option' and shows a surface representing the option value as a function of spot price and strike price. The vertical axis is labeled 'Option Value' and ranges from 2 to 8. The surface is colored with a gradient from blue (low value) to red (high value).

# Wrap Up

# MATLAB for Business Applications

## Business Tools on the Desktop

- Excel
- Word
- Browsers
  
- Live Market Data
  
- Databases
  - Oracle
  - Microsoft Access
  - Microsoft SQL Server
  - Sybase SQL Server
  - ....

## MATLAB Tools

- Excel Link & Data Import Tool
- Publisher, copy figure
- Publisher and Report Generator
  
- Datafeed Toolbox
  
- 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**

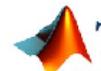
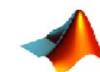
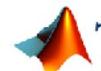
# Insurance and Energy Trading Companies

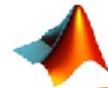
- **Allstate Insurance**
- **American RE**
- **AXA**
- **Element RE**
- **John Hancock**
- **Kemper RE**
- **Liberty Mutual**
- **New York Life**
- **Zurich RE**
- **Williams Energy**
- **Reliant Energy**
- **TXU**
- **Mirant**
- **ExxonMobil**
- **Entergy Koch**
- **Constellation Power Source**
- **Sempra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

# Support and Community

 The MathWorks  
**Connections Program** The MathWorks  
**Consulting Services** The MathWorks  
**Book Program** The MathWorks  
**Training Services** MATLAB® **CENTRAL**

 The MathWorks  
**Consulting Services**

- **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**



- **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



## **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**

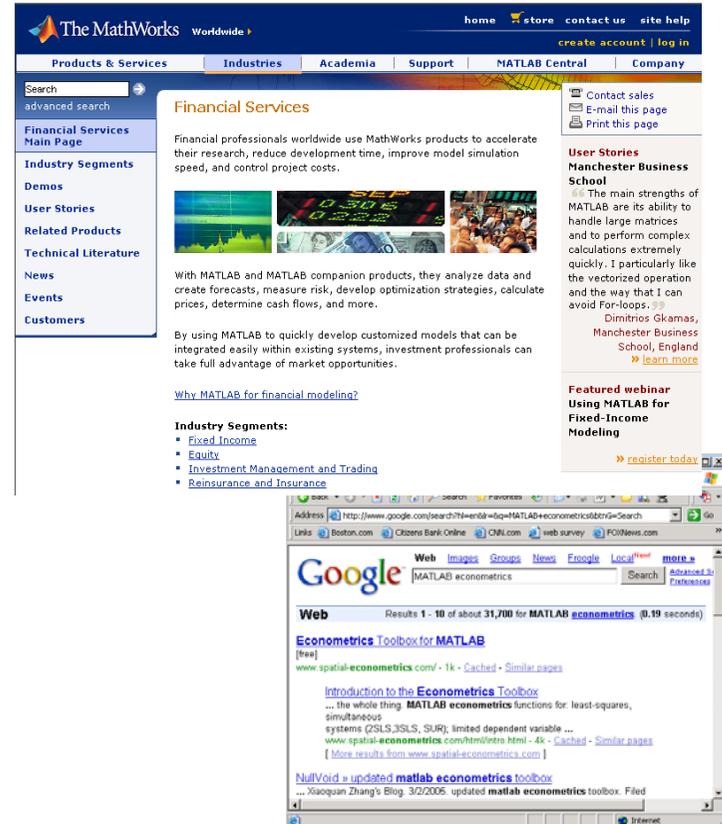
- **Specialized third-party toolboxes for MATLAB**
- **Interfaces to partners' software and hardware products**
- **Specialized training courses and consulting services**
- **System integrators and suppliers that incorporate MathWorks products**

## 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](http://www.mathworks.com)



The image shows two screenshots. The top screenshot is a screenshot of the MATLAB website's 'Financial Services' page. The page features a navigation menu with 'Products & Services', 'Industries', 'Academia', 'Support', 'MATLAB Central', and 'Company'. The main content area is titled 'Financial Services' and includes a search bar, a sidebar with navigation options like 'Financial Services Main Page', 'Industry Segments', 'Demos', 'User Stories', 'Related Products', 'Technical Literature', 'News', 'Events', and 'Customers', and a main text block describing how MATLAB helps financial professionals. It also lists 'Industry Segments' such as Fixed Income, Equity, Investment Management and Trading, and Reinsurance and Insurance. The bottom screenshot is a Google search result for 'MATLAB econometrics', showing the top result from 'spatial-econometrics.com' with a link to 'Introduction to the Econometrics Toolbox'.