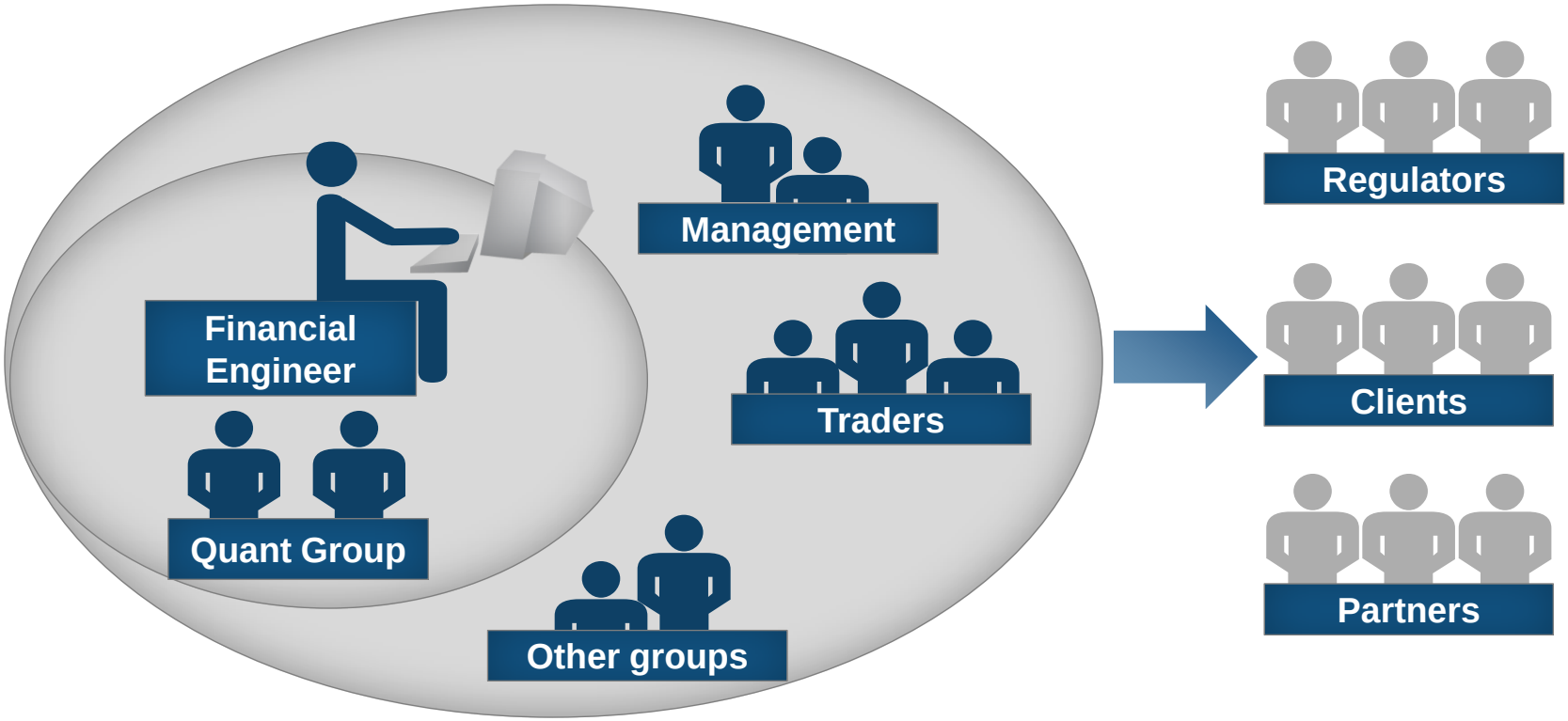
Algorithmic Trading with MATLAB®

MathWorks Computational Finance Team

Challenges when building trading strategies

- Increasing complexity
  - More data
  - More complicated models
- Increasing computational speed
  - Push to higher frequency
- Long deployment cycle
  - (Re)coding is costly and error-prone

Challenges through the organization



Customers using MATLAB

Asset Management

Insurance

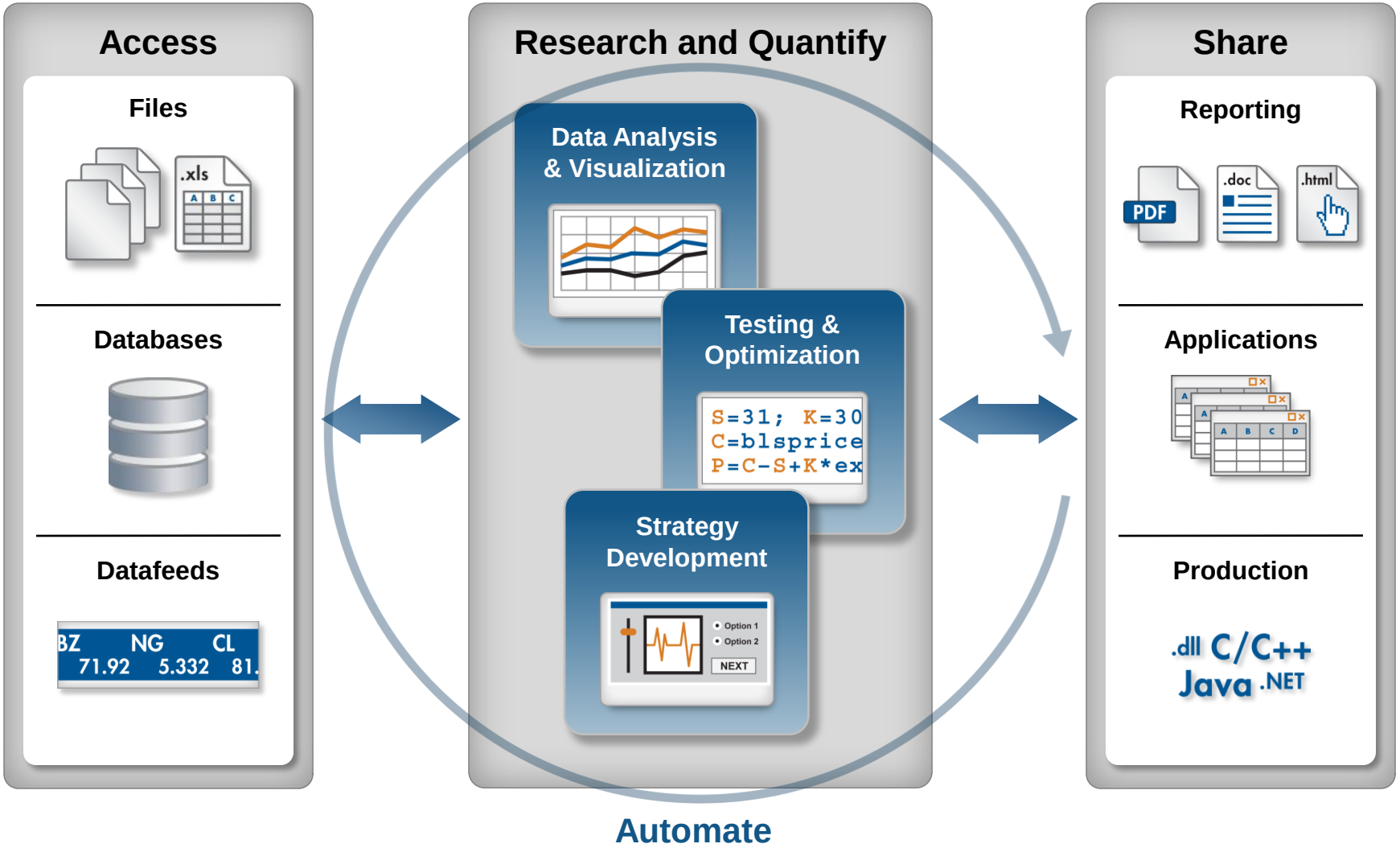
Energy Trading

Financial Services

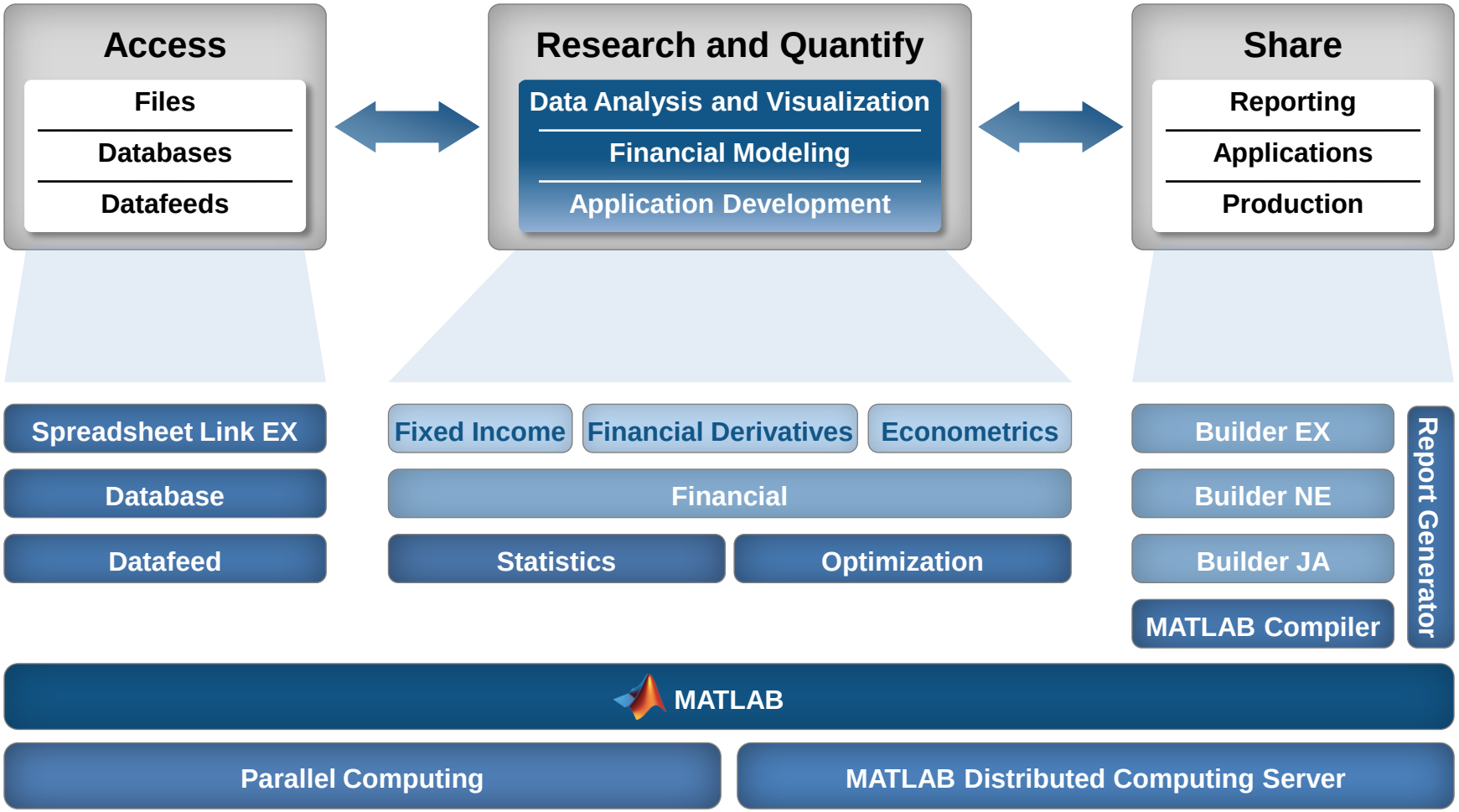
Banks (Commercial,Retail,Investment)

Central Banks

Algorithmic trading workflow

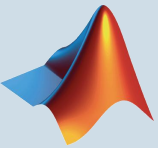


Computational Finance Workflow



Agenda

- Introduction: Algorithmic trading
- Developing an automated trading decision engine
  - Identify a successful trading rule
  - Extend trading rule set
  - Automate trading rule selection



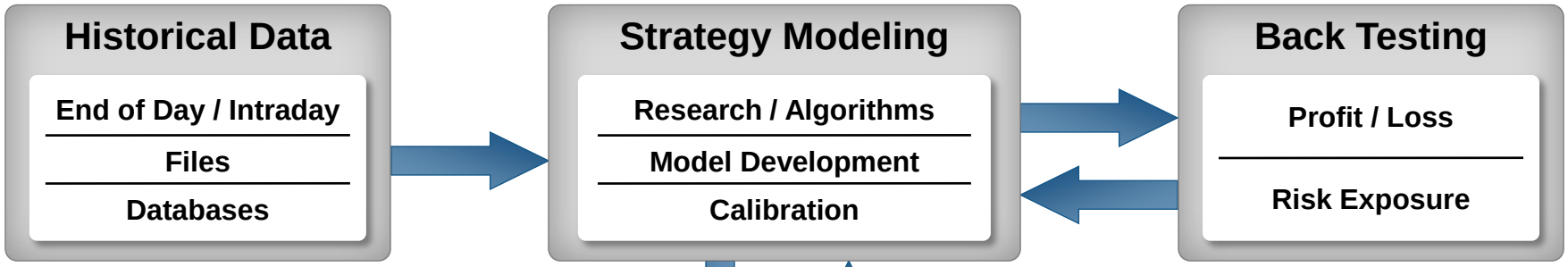
- Break
- Implementing MATLAB into your production trading environment
- Wrap up and Q&A

The problem at hand: Identifying profitable trading strategies

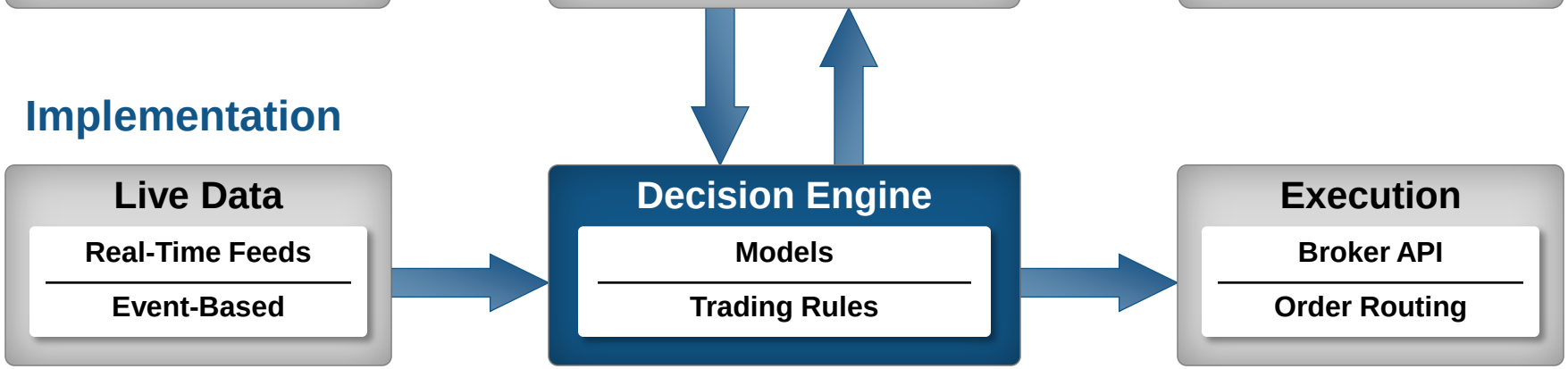
- Commodities analyst
- Developing a trading strategy
  - Multiple trading rules
  - High frequency
- Management requirements:
  - Tested on historical data
  - Uses sophisticated analytics to identify optimal trading rule combination
  - Integrates with existing data and execution APIs

Trading decision engine

Development and testing



Implementation

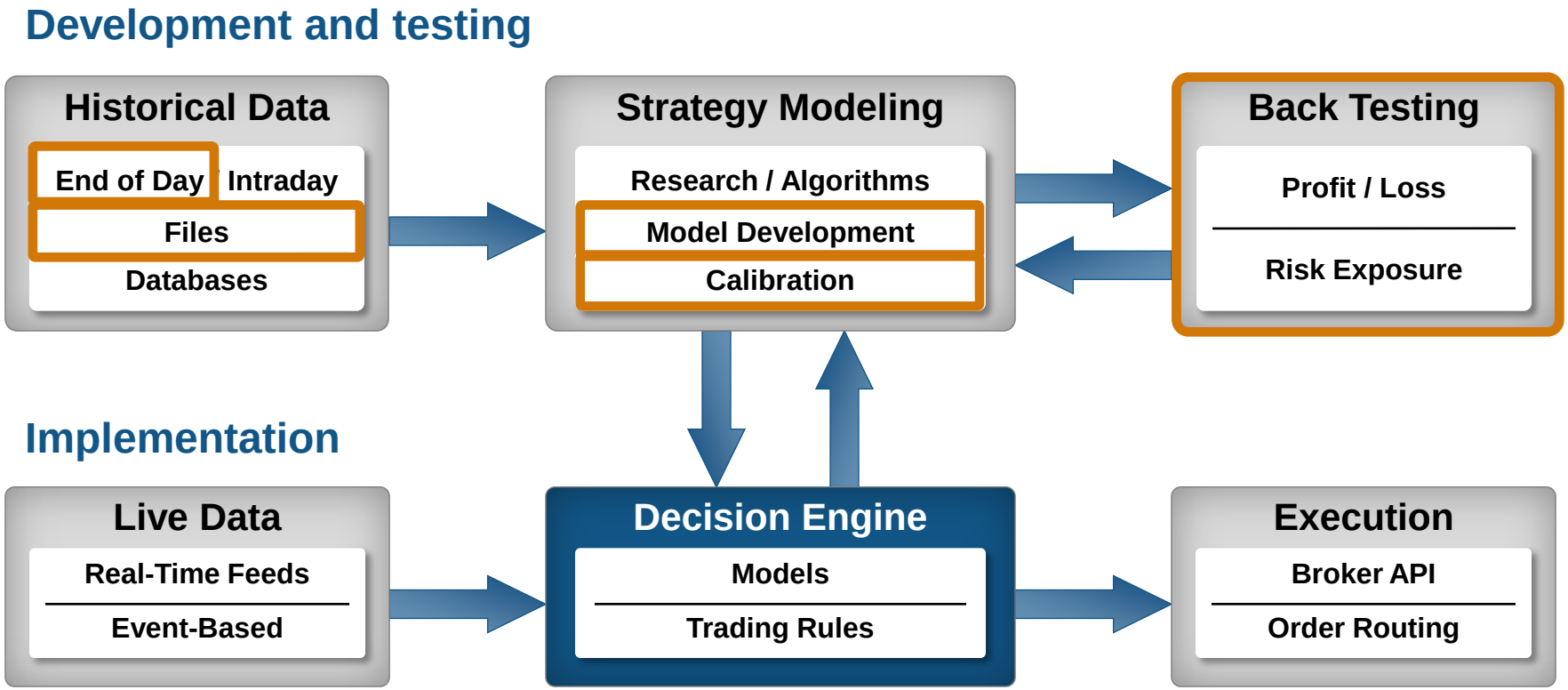


Requirements for the trading engine

- Sophisticated analytics
  - Custom rules & indicators
  - Non-traditional techniques
- Scalable speed
  - Higher frequency data
  - More trading rules
- Quick to develop and deploy
  - Try different strategies
  - Embed in trading engine

Task 1: Develop a back testing environment

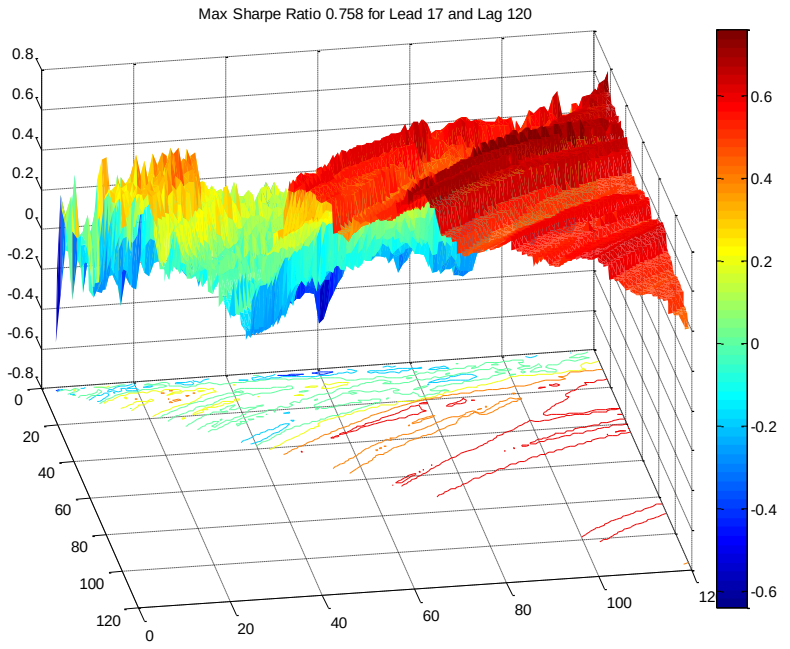
Goal: Build a back testing environment around historical data and a preliminary trading rule



Key tasks

Key tasks

- Import data from files
- Create a preliminary rule
- Test the rule's performance

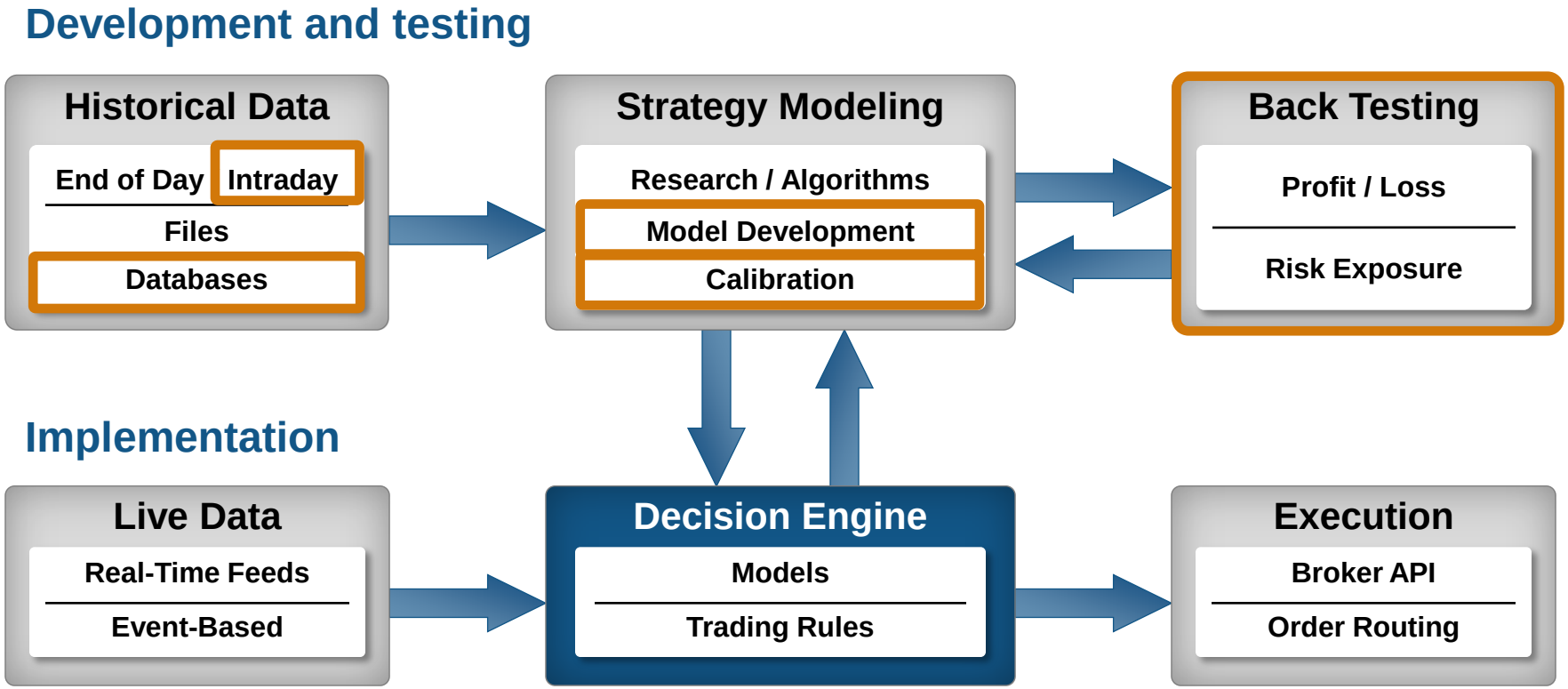


Solutions

- MATLAB data tools
- High-level programming and pre-built functions
- Powerful graphics environment

Task 2: Expand the scale of the engine

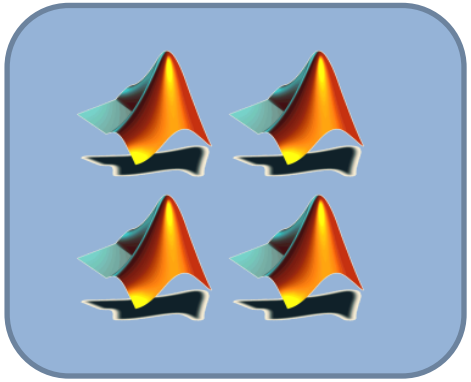
Goal: Move to a higher frequency (minute-by-minute) and re-calibrate the model



Key tasks

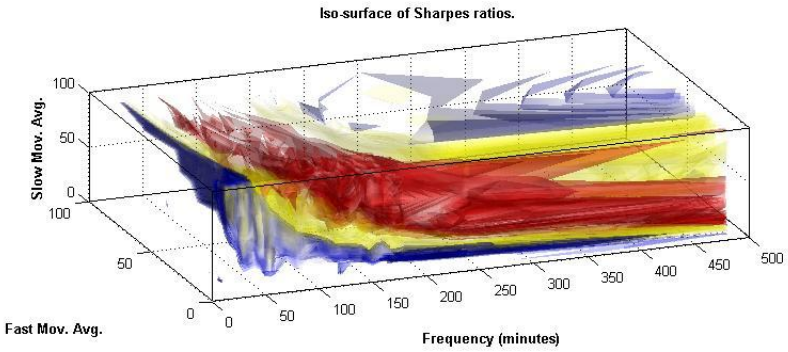
Key tasks

- Importing data from databases
- Increase computational speed



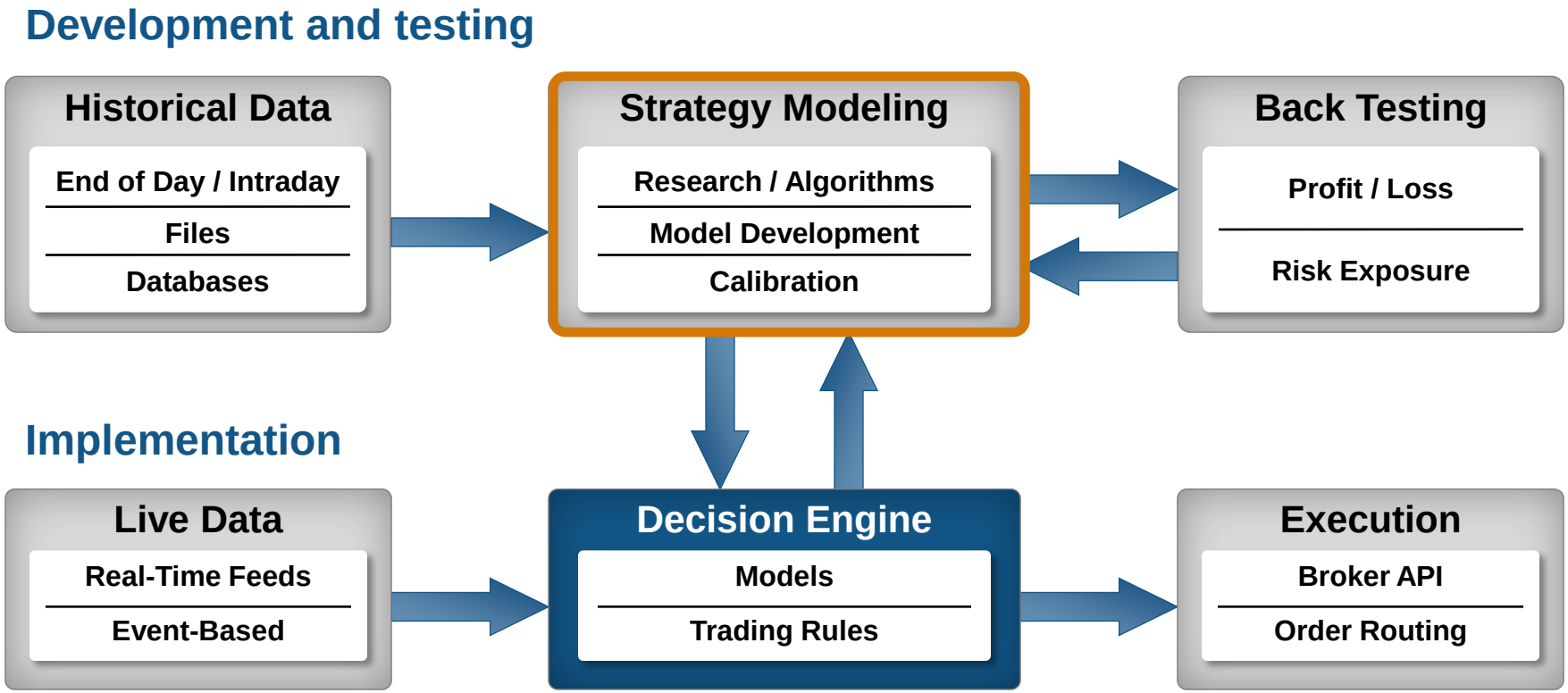
Solutions

- MATLAB data tools: Database Toolbox
- High-performance computing: Parallel Computing Toolbox, MATLAB Distributed Computing Server



Task 3: Rule selection engine

Goal: Develop a rule selection system for instruments using evolutionary learning

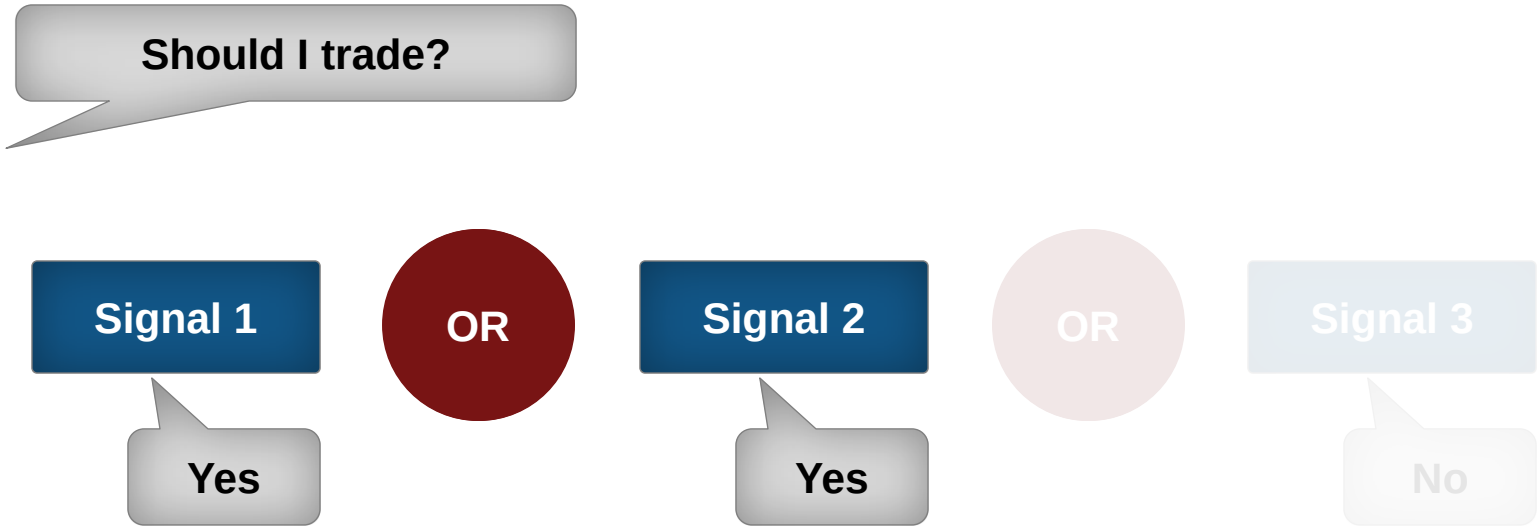


Key tasks

Key tasks

- Increase number of rules
- Incorporate advanced analytics to select best combination

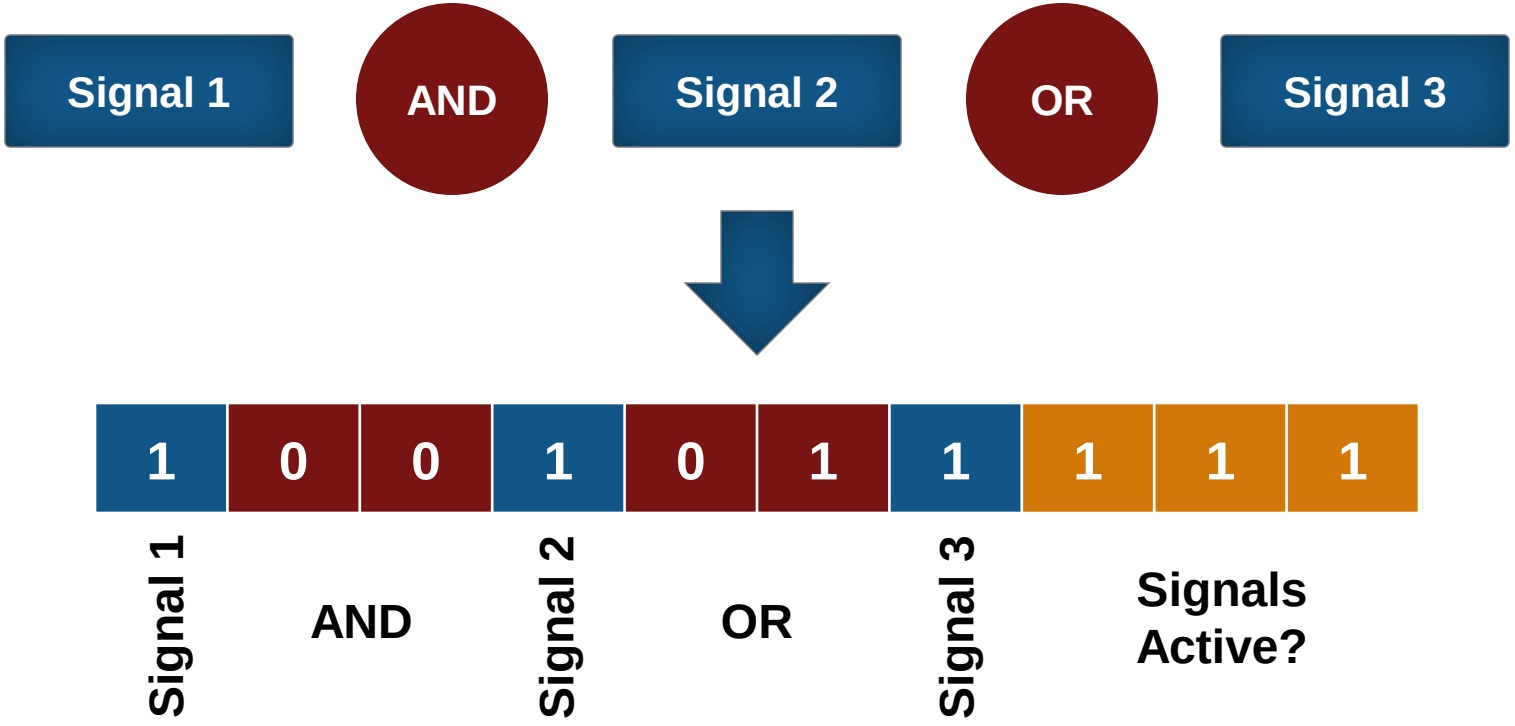
Working with multiple strategies



Dempster et. al., *Computational learning techniques for intraday fx trading using popular technical indicators*, IEEE Transactions on Neural Networks (2001).

Working with multiple strategies

- Represent different combinations as *bit strings*

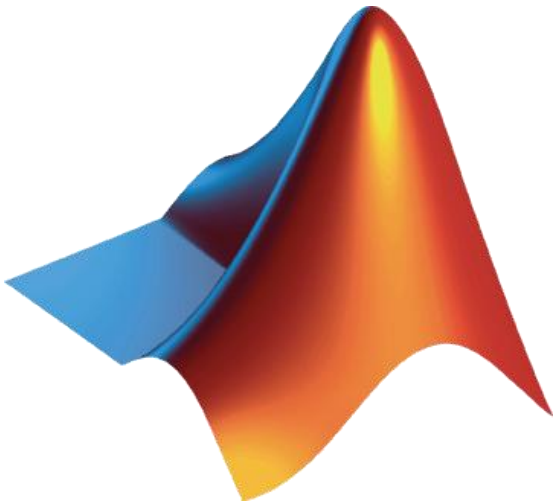


Building Custom Evolution Algorithms

- Selection
  - *Retain* the best performing bit strings from one generation to the next. *Favor these for reproduction*

- Crossover
  - parent1 = [1 0 1 0 0 1 1 0 0 0]
  - parent2 = [1 0 0 1 0 0 1 0 1 0]
  - child = [1 0 0 0 0 1 1 0 1 0]

- Mutation
  - parent = [1 0 1 0 0 1 1 0 0 0]
  - child = [0 1 0 1 0 1 0 0 0 1]



Key tasks

Key tasks

- Increase number of rules
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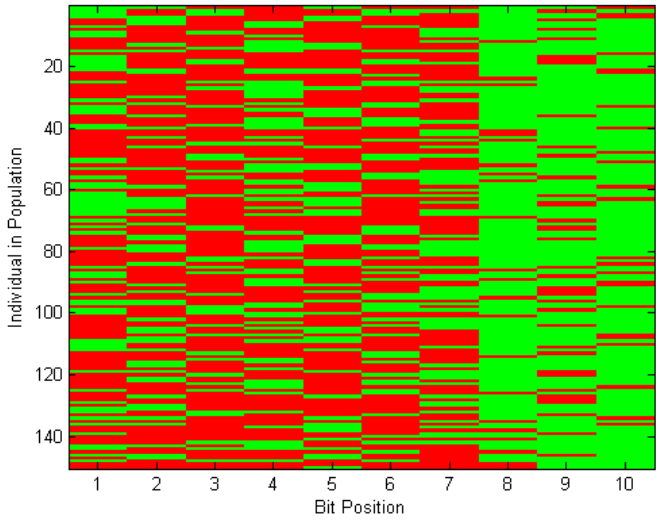
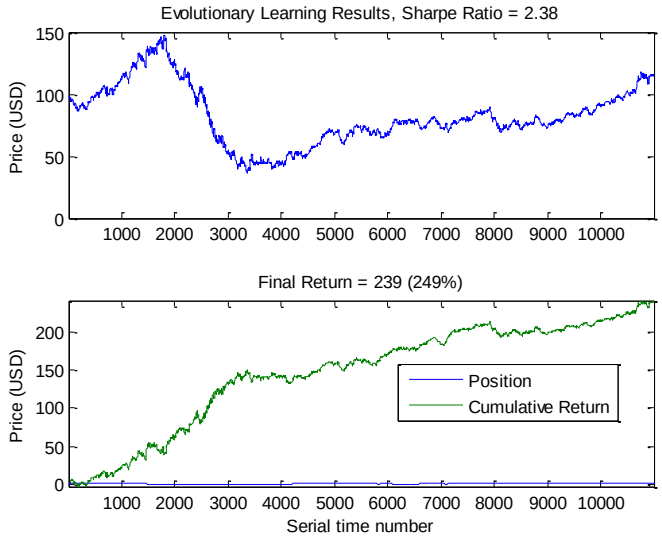
Solutions

- High-level programming
- MATLAB Toolboxes: Global Optimization, …





Review: Requirements for the trading engine

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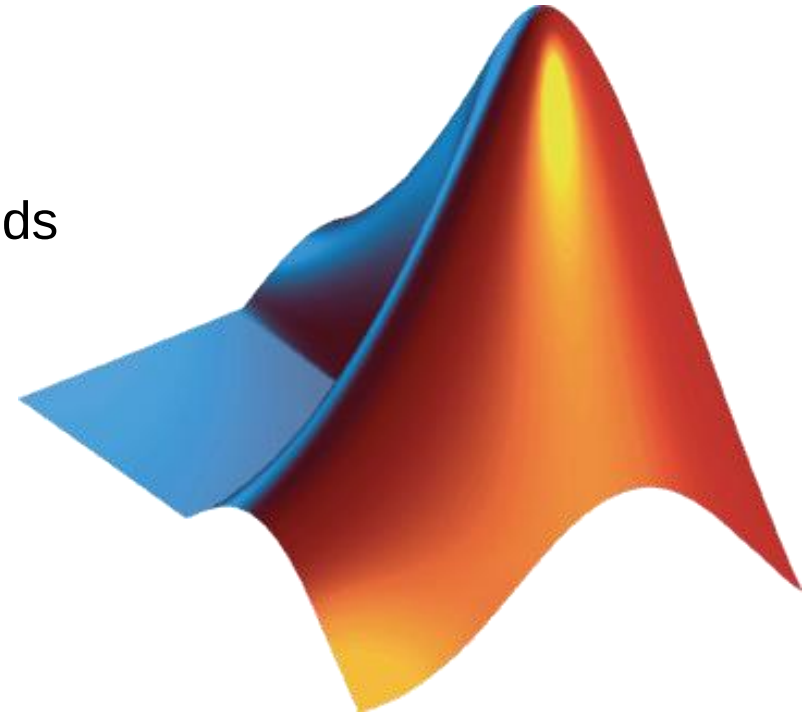
MATLAB's solutions

- Sophisticated analytics
  - Advanced graphics environment
  - Toolboxes give access to hundreds of new techniques
  - Flexible and customizable
- Scalable speed
  - Parallel computing solution
- Quick to develop and deploy
  - High-level programming
  - Automated deployment… *after the break*



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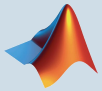
-  Break
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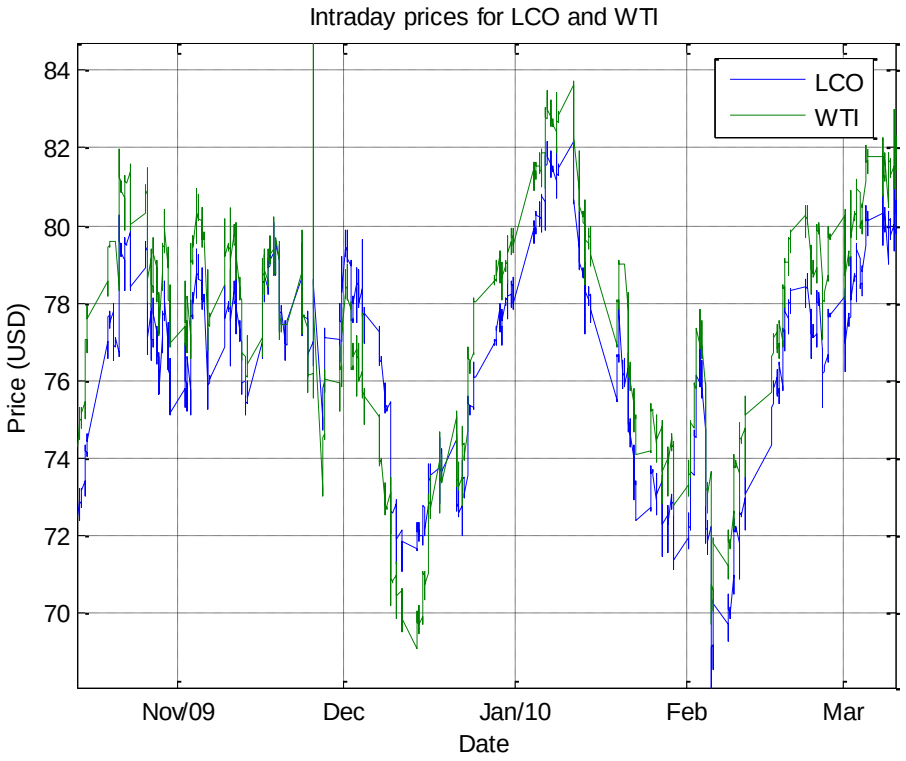
Pairs Trading in Brief

- *Cointegration:* Two or more time series share *long-term* behavior
- Identify a pair that has spread apart
- Take opposing positions
- Profit occurs when prices revert



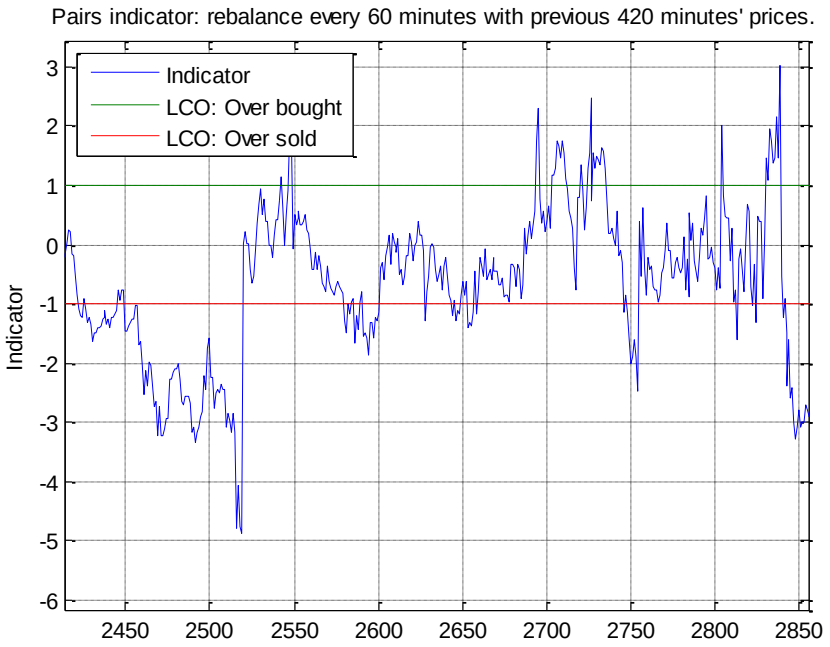
Key tasks / challenges

Key tasks

- Identify cointegrating relationships
- Test the strategy

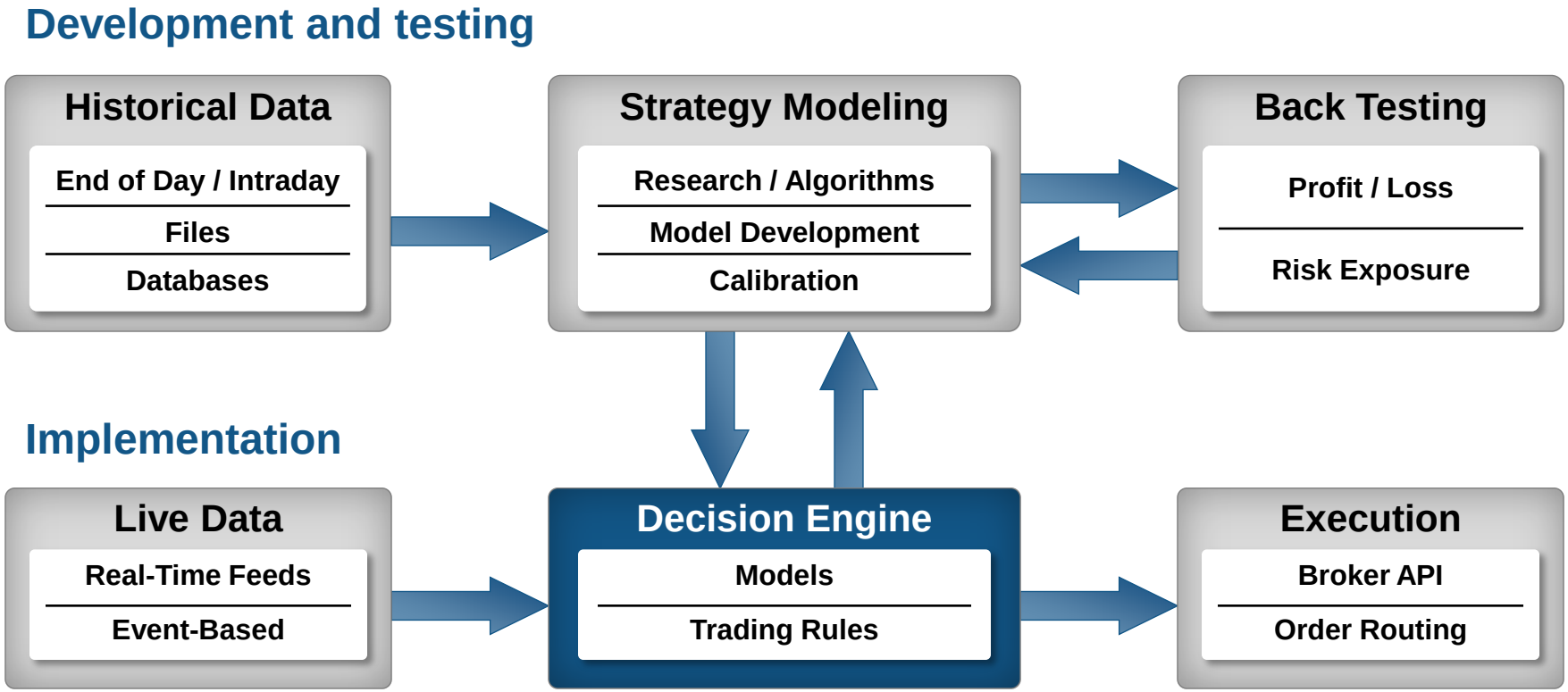
Solution

- Econometrics Toolbox
  - New in R2011a: Engle-Granger and Johansen frameworks
- Code reuse from previous tasks



Implementing the Decision Engine

Goal: Evaluate and test the decision engine with real-time feeds and execution through a messaging bus



Key Tasks

Key tasks

- Read live market data from data feed
- Connect to trading “engine”

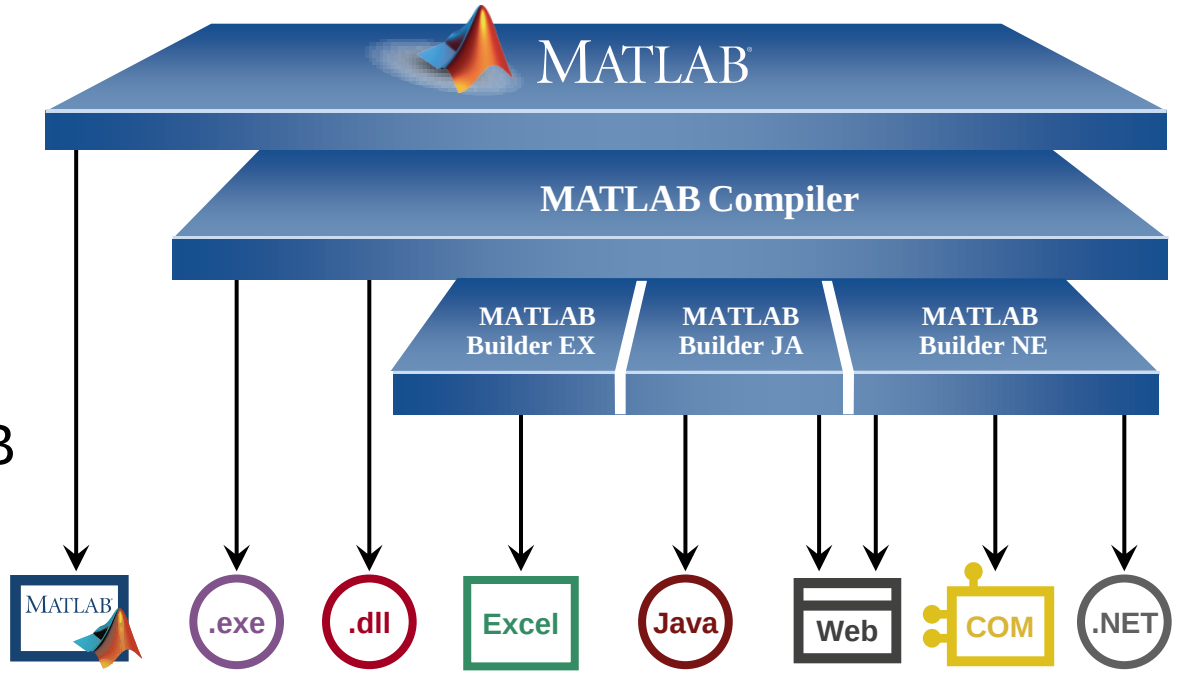
Solutions

- Datafeed Toolbox
- Many external APIs
  - .NET, Java, C/C++, etc.
  - 3rd party APIs

Date	Time	Action	Price
15-Mar-11	10:36	sell	$ 110.78
15-Mar-11	11:12	buy	$ 110.47
15-Mar-11	12:15	sell	$ 109.27
15-Mar-11	12:33	buy	$ 109.10
15-Mar-11	13:00	sell	$ 109.49
15-Mar-11	13:12	buy	$ 108.99
15-Mar-11	14:09	sell	$ 108.83
15-Mar-11	14:45	buy	$ 109.21
15-Mar-11	14:54	sell	$ 109.71
16-Mar-11	08:37	buy	$ 110.10
16-Mar-11	09:07	sell	$ 110.08
16-Mar-11	09:18	buy	$ 110.05
16-Mar-11	09:38	sell	$ 110.36
16-Mar-11	09:49	buy	$ 110.19
16-Mar-11	09:57	sell	$ 110.32
16-Mar-11	10:06	buy	$ 109.99
16-Mar-11	10:08	sell	$ 110.09
16-Mar-11	10:12	buy	$ 110.05
16-Mar-11	10:30	sell	$ 110.16
16-Mar-11	10:51	buy	$ 110.09
16-Mar-11	11:16	sell	$ 110.13
16-Mar-11	11:29	buy	$ 110.28
16-Mar-11	12:06	sell	$ 110.80
16-Mar-11	12:58	buy	$ 110.67
16-Mar-11	13:04	sell	$ 110.49
16-Mar-11	13:46	buy	$ 110.64
16-Mar-11	14:18	sell	$ 111.04
16-Mar-11	14:33	buy	$ 111.54
17-Mar-11	08:00	sell	$ 111.34
17-Mar-11	08:06	buy	$ 111.53
17-Mar-11	08:21	sell	$ 111.43
17-Mar-11	08:34	buy	$ 111.46

Deploying Applications with MATLAB

- Give MATLAB code to other users
- Share applications with end users who do not need MATLAB
  - Stand-alone executables
  - Shared libraries
  - Software components



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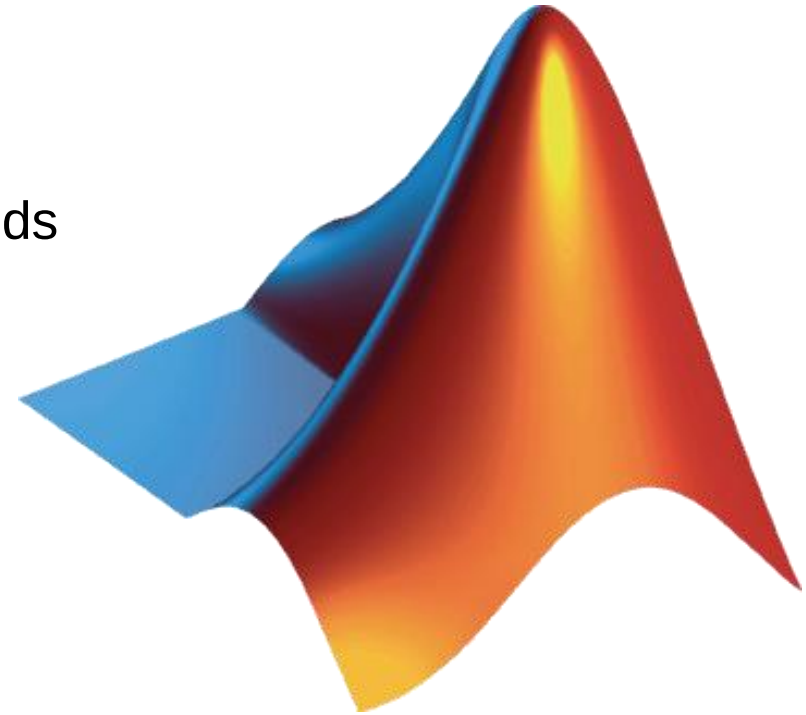
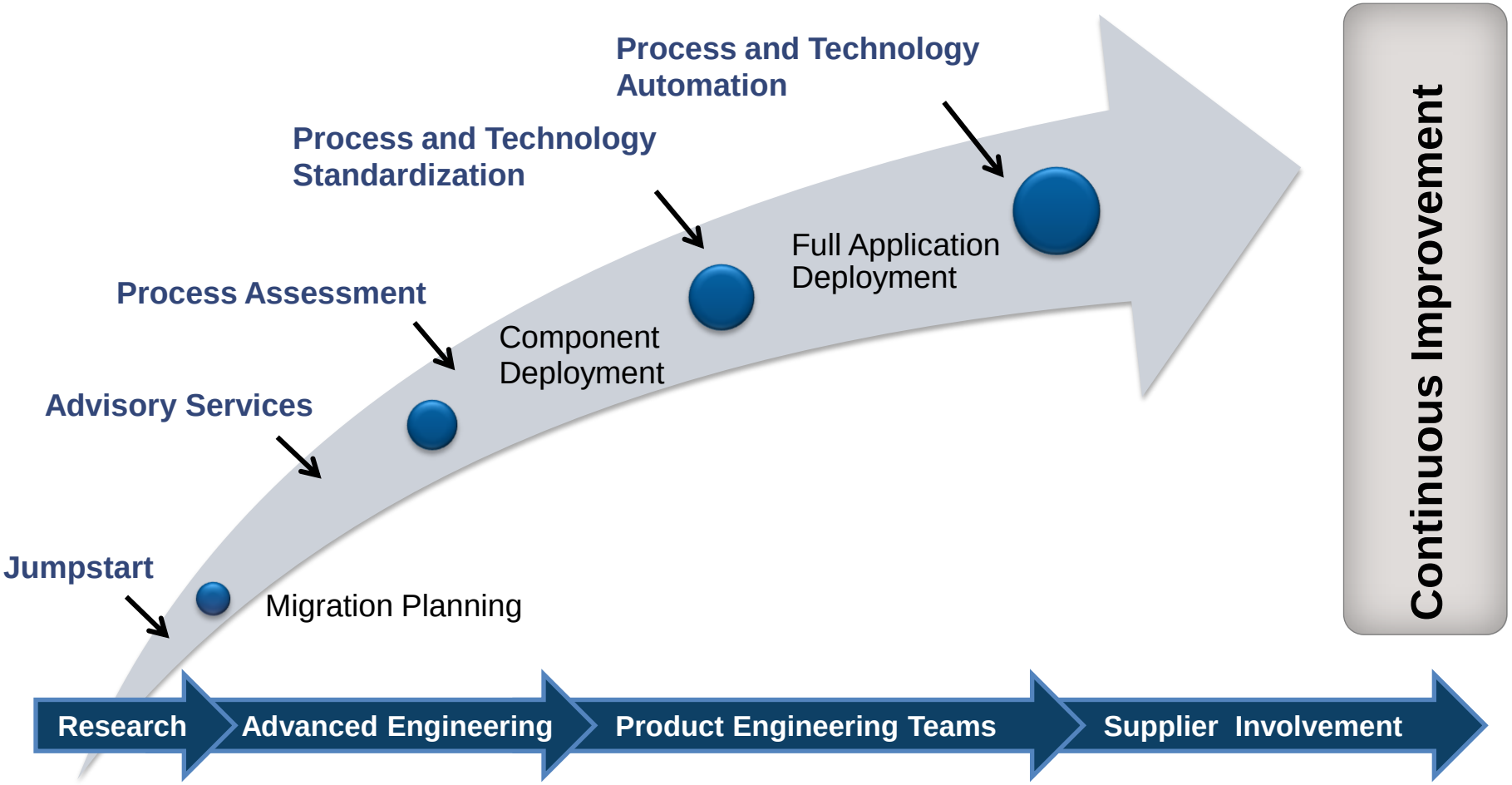


Support and Community

Consulting Services

Accelerating return on investment

A global team of experts supporting every stage of tool and process integration



Training Services

Exploit the full potential of MathWorks products

Flexible delivery options:

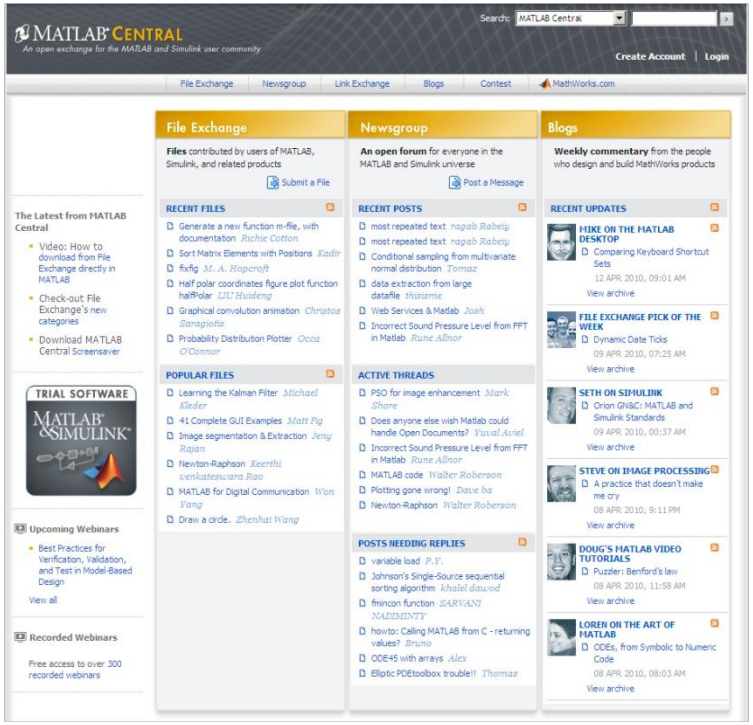
- Public training available worldwide
- Onsite training with standard or customized courses
- Web-based training with live, interactive instructor-led courses

More than 30 course offerings:

- Introductory and intermediate training on MATLAB, Simulink, Stateflow, Real-Time Workshop, and PolySpace products
- Specialized courses in control design, signal processing, parallel computing, code generation, communications, financial analysis, and other areas

MATLAB Central

- Open exchange for the MATLAB and Simulink user community
- 662,000 visits per month
- File Exchange
  - Upload/download access to free files including MATLAB code, Simulink models, and documents
  - Ability to rate files, comment, and ask questions
  - More than 9,000 contributed files, 400 submissions per month, 25,500 downloads per day
- Newsgroup
  - Web forum for technical discussions about MATLAB and Simulink
  - 200 posts per day
- Blogs
  - Frequent posts from key MathWorks developers who design and build the products
  - Open conversation at blogs.mathworks.com



Based on February 2009 data

Connections Program

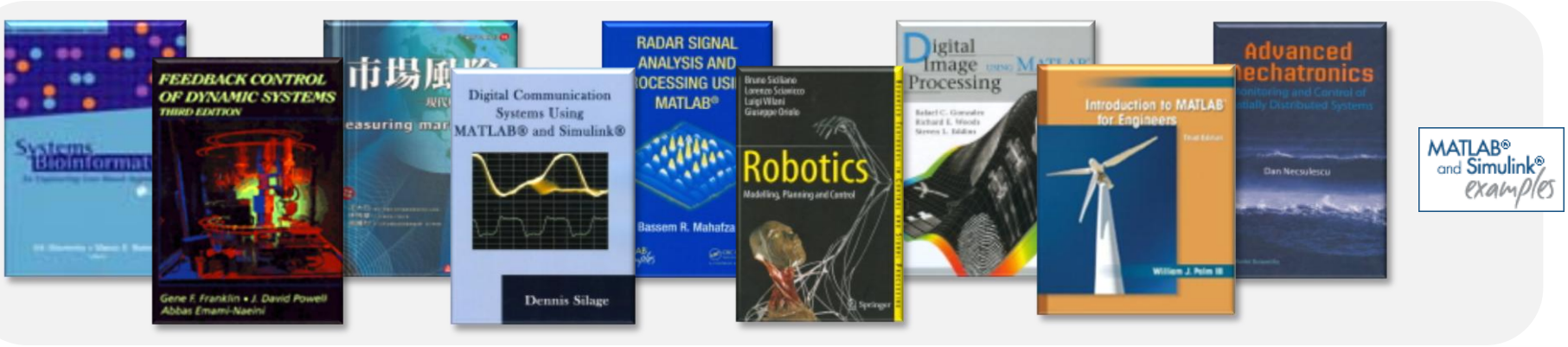
More than 300 add-on products and services that complement and extend MathWorks products:

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

Book Program

More than 1,000 books for educational and professional use, in 26 languages

- Controls
- Signal Processing
- Image Processing
- Biosciences
- Communications
- Mechanical Engineering
- Mathematics
- Aerospace Engineering
- Environmental Sciences
- Chemistry
- Finance
- Electronics



Technical Support

Resources

- Over 100 support engineers
  - All with MS degrees (EE, ME, CS)
  - Local support in North America, Europe, and Asia
- Comprehensive, product-specific Web support resources

High customer satisfaction

- 95% of calls answered within three minutes
- 70% of issues resolved within 24 hours
- 80% of customers surveyed rate satisfaction at 80-100%