

Algorithmic Trading with MATLAB®

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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





Algorithmic trading workflow





Algorithmic trading 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





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

Development and testing





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

Development and testing





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

Development and testing





Key tasks

Key tasks

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



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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]
 - $\text{ parent2} = [1 \ 0 \ 0 \ 1 \ 0 \ 0 \ 1 \ 0 \]$
 - $\text{ child } = [1 \ 0 \ 0 \ 0 \ 1 \ 1 \ 0 \ 1 \ 0]$
- Mutation
 - parent = [1 0 1 0 0 1 1 0 0 0]
 - $\text{ child } = [0 \ 1 \ 0 \ 1 \ 0 \ 1 \ 0 \ 0 \ 1]$





Key tasks

Key tasks

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

Solutions

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





Review: 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





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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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



Pairs indicator: rebalance every 60 minutes with previous 420 minutes' prices.



Implementing the Decision Engine

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

Development and testing





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



Software components



MATLAB's solutions

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





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