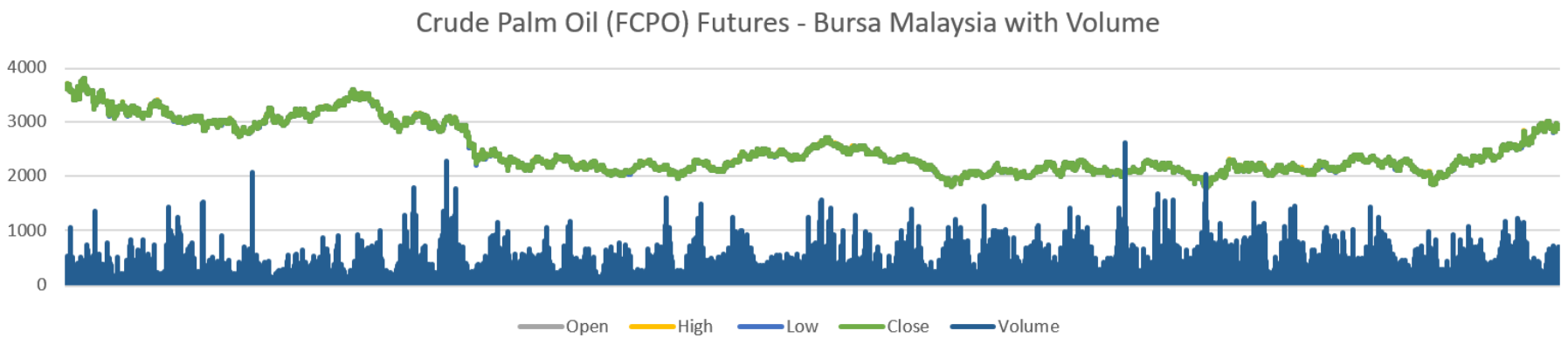
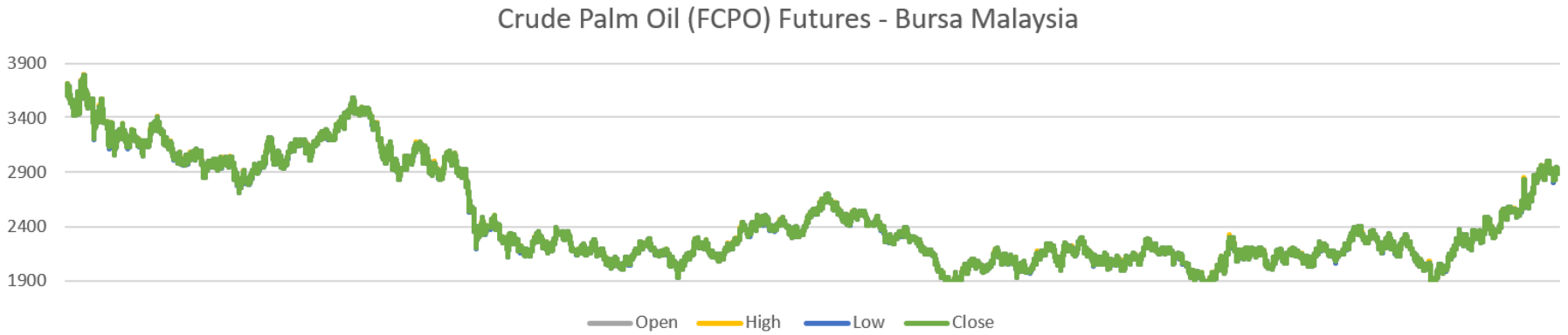
Crude Palm Oil (FCPO) Futures
Developing an Algorithmic Trading System





6 years per minute prices and trading volume for 37 Crude Palm Oil (FCPO) Futures

Background
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- Background information
  - You are requested to design and develop a real quantitative algorithmic trading system (Algorithmic Trading Strategies or rule sets) using (Genetic Algorithms **or** Evolution Computing) **and** (Fuzzy Logic/Set **or** Rough Set) to trade Crude Palm Oil (FCPO) Futures on Bursa Malaysia Derivatives Exchange.
  - With an initial investment fund allocated to you as a fund manager, you and your system want to obtain highest profit (or lowest loss, hopefully not) in a few years.
  - You test your system's trading strategy (rules) based on real historical market data, through simulation. Hence to calculate your ***position*** (holdings of a group of system selected FCPO) and the actual ***market value (MKV)*** of your position.
  - The trading strategy (rules) is modelled/optimized/learnt based on known historical market data, using computational intelligence techniques.

Data
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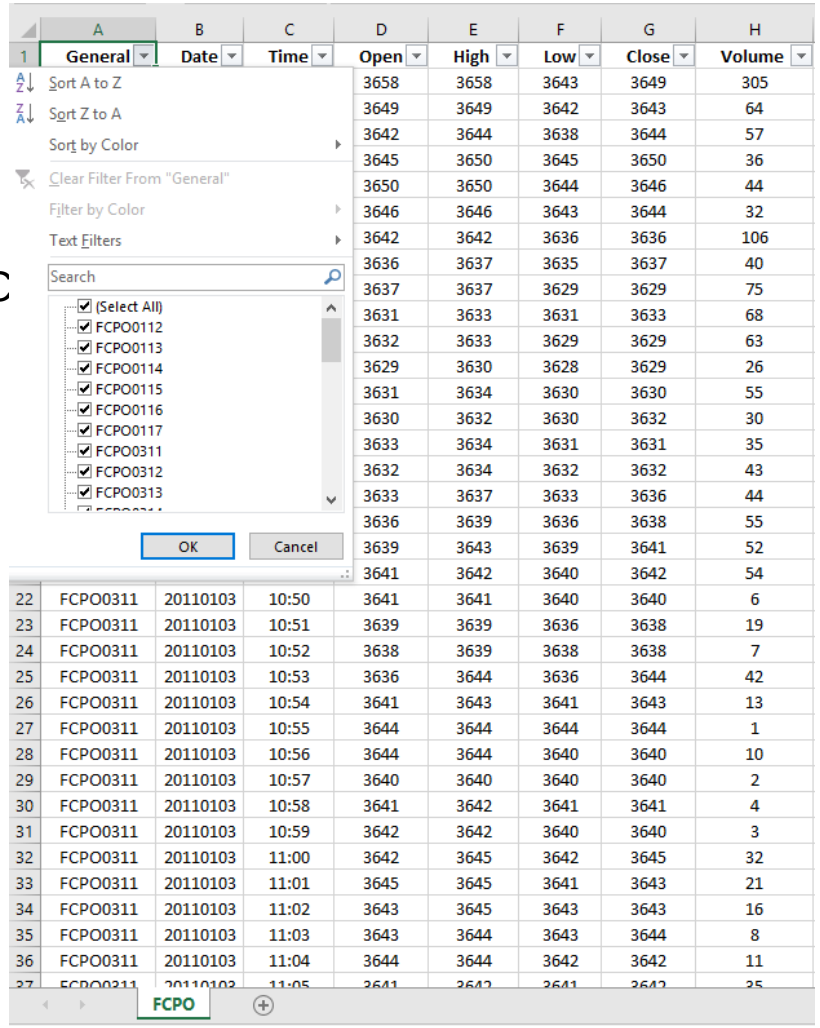
- Dataset
  - Prices and trading volume for 37 Crude Palm Oil (FCPO) Futures
  - 6 years per minute data
  - Date from 2011 JAN 03 10:30 to 2016 DEC 30 17:59
  - 355,959 valid records
  - There may be missing records at certain time of some dates. May require data pre-processing and cleaning
  - General: The ***financial instrument*** code for FCPO
  - Price unit: Malaysian Ringgit
  - Volume unit: thousands
  - Volume data is from one broker only, not aggregation of entire FCPO market players.



	General	Date	Time	Open	High	Low	Close	Volume
1				3658	3658	3643	3649	305
				3649	3649	3642	3643	64
				3642	3644	3638	3644	57
				3645	3650	3645	3650	36
				3650	3650	3644	3646	44
				3646	3646	3643	3644	32
				3642	3642	3636	3636	106
				3636	3637	3635	3637	40
				3637	3637	3629	3629	75
				3631	3633	3631	3633	68
				3632	3633	3629	3629	63
				3629	3630	3628	3629	26
				3631	3634	3630	3630	55
				3630	3632	3630	3632	30
				3633	3634	3631	3631	35
				3632	3634	3632	3632	43
				3633	3637	3633	3636	44
				3636	3639	3636	3638	55
				3639	3643	3639	3641	52
				3641	3642	3640	3642	54
22	FCPO0311	20110103	10:50	3641	3641	3640	3640	6
23	FCPO0311	20110103	10:51	3639	3639	3636	3638	19
24	FCPO0311	20110103	10:52	3638	3639	3638	3638	7
25	FCPO0311	20110103	10:53	3636	3644	3636	3644	42
26	FCPO0311	20110103	10:54	3641	3643	3641	3643	13
27	FCPO0311	20110103	10:55	3644	3644	3644	3644	1
28	FCPO0311	20110103	10:56	3644	3644	3640	3640	10
29	FCPO0311	20110103	10:57	3640	3640	3640	3640	2
30	FCPO0311	20110103	10:58	3641	3642	3641	3641	4
31	FCPO0311	20110103	10:59	3642	3642	3640	3640	3
32	FCPO0311	20110103	11:00	3642	3645	3642	3645	32
33	FCPO0311	20110103	11:01	3645	3645	3641	3643	21
34	FCPO0311	20110103	11:02	3643	3645	3643	3643	16
35	FCPO0311	20110103	11:03	3643	3644	3643	3644	8
36	FCPO0311	20110103	11:04	3644	3644	3642	3642	11

Trading Rules
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- Trading Rules
  - As a fund manager, you were initially allocated ***10 million*** Malaysian Ringgit (3.37 million Singapore Dollar) ***balance*** (cash) at the beginning of **2014 JAN 02** 10:30 to start trading. (3 years later from **2011 JAN 03**)
  - The ultimate purpose of trading (making buy/sell transaction) is to maximize profit at the end of **2016 DEC 30** 17:59.
  - You can discretionarily select a ***portfolio*** (group) of different FCPOs, at different ***positions*** (different volumes to hold).
  - Maximum trading frequency: one buy transaction **and** one sell transaction per instrument, per minute. (You can choose to trade less frequently, e.g. once per hour, per week, or other.)
  - For buy transaction (buy ***order***), use ***High*** price.
  - For sell transaction (sell ***order***), use ***Low*** price.
  - Each transaction (buy or sell) cost ***Maximum(30, 0.2% x volume x price)*** Ringgit per future instrument, per transaction. (Always one transaction for one future only)
  - You can only place buy ***order*** if you have sufficient ***balance***. (You cannot borrow cash.)
  - Any transaction is considered fulfilled immediately.
  - It's not necessary to trade at fixed interval, decision should be derived from system's **modelled/learnt trading strategy (rules)**.
  - The end of day total ***unrealized*** market value for your portfolio is calculated using ***Low*** price.
  - Total asset value = total unrealized market value + cash balance
  - **[Optional]** You can borrow future instruments and ***short sell***.
  - **[Optional]** ***Short*** (sell order) incurs additional borrowing cost: 0.01% daily interest accrual based on original market value of borrowed positions from the short day, to be deducted from balance, (**immediately** after short sell **on the short day**, and then at **the beginning of a next new day onwards**), until fully buying back/returning the borrowed positions.
  - **[Optional]** Accumulated short position's original market value is capped at ***5 million*** Ringgit.

System Design
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- System Design
  - Your ***mandatory*** technology (at least three) to use is:
    1. Business rule OR Business process based reasoning techniques, e.g. Heuristic for algorithmic trading strategy, e.g. MACD (Moving Average Convergence Divergence), RSI (Relative Strength Index), and ROC (Rate of Change), etc.
    2. Business resource optimization techniques: Search OR Constraint satisfaction OR Evolutional computing
    3. Knowledge Discovery OR Data Mining techniques
    4. Cognitive reasoning techniques
  - Your ***optional*** technology to use is time series forecasting, fuzzy logic or other machine learning techniques.
  - ***Open*** and ***Close*** prices are not used for calculating market value, but you can use them for modelling, rule induction or machine learning.
  - Your system can be trained / retained regularly, ad-hoc, or at any frequency. But no future information can be leaked during any training/learning/optimization.
  - For online retraining, please consider that this system is a real time trading system.
  - A simulator might need to be developed, to simulate the incoming new market information per minute/step (read in record by record from input Excel file or database)

System Simulation
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- System Simulation and Market Value Calculation
  - Simulate per minute feeding of market information based on provided FCPO dataset.
  - Based on modelled system output, conduct necessary trading: buy, sell or hold.
  - Calculate portfolio's unrealized market value, plus any cash balance to derive total asset value at end of each day, or potentially every minute.
  - Use window based modelling/training/testing approach:

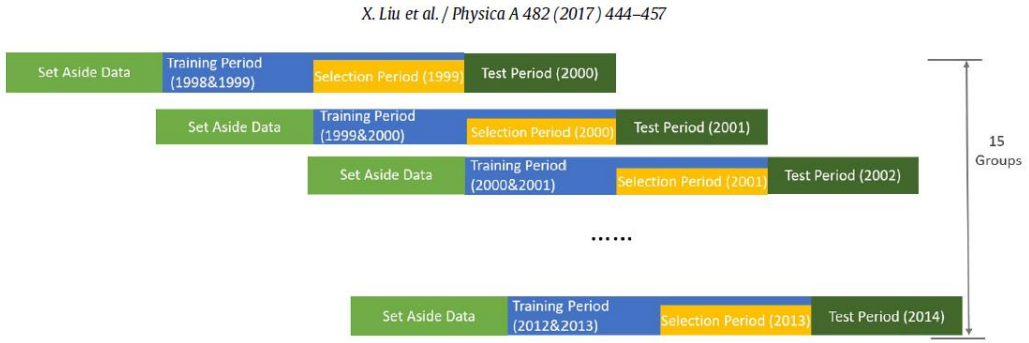

Fig. 1. Experimental groups.

No leakage of future information during simulated trading, e.g. current time is 2011 JUL 01 15:30, you and your current system/model should never have access to data from 2011 JUL 01 15:31 onwards, or have been "carelessly" trained using future data from current date time.

Technical Requirements
Developing an Algorithmic Trading System

- **Requirement 1**
  - **Adapted implementation** of a selected method from a relevant reference paper (clearly mention which reference paper is used in your final report), and apply to FCPO data to obtain results.
- **Requirement 2**
  - **[Option 1]** Model ***short sell*** into algorithmic trading strategy (rules), by **adapting** and **implementing** based on the **direct implementation** above.
  - **[Option 2]** Clearly **identify** a limitation (in terms of FCPO context) of existing method from relevant paper (elaborate this your final report), then **enhance** and **implement** it, and apply to FCPO data to obtain results, e.g. other machine learning, feature engineering, extra data sources, etc.
- **Requirement 3**
  - **20%** of CA mark: Quality and professionalism of submitted paper report
- **Requirement 4**
  - Proof of no future information leakage shown in result, code and report.

Elements for Paper/Report
Developing an Algorithmic Trading System

- Abstract
  - Summary of system design & modelling
  - Results from simulation (e.g. simulated total asset value)
- Introduction
  - Reference paper used/adapted for implementation
- Materials & Methods (System Design, Modelling & Simulation)
- Results & Discussion
  - One mandatory element: Detailed calculation/simulation to derive final total asset value (total unrealized market value + cash balance) at end of 2016 DEC 30 17:59.
- Conclusions
- System User Guide
- System Use Case Examples
- List of abbreviations
- Acknowledgments
- References

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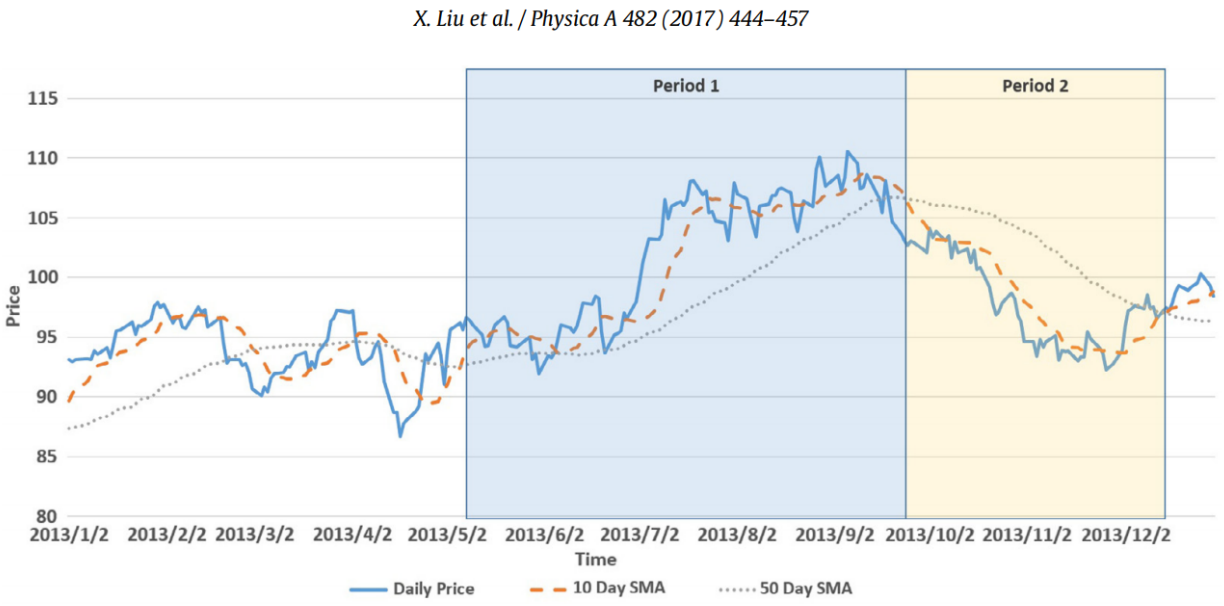

Schematic diagram of moving average strategy.

Quantified moving average strategy of crude oil futures market based on fuzzy logic rules and genetic algorithms

Author(s):

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NUS Online Library Reference Paper

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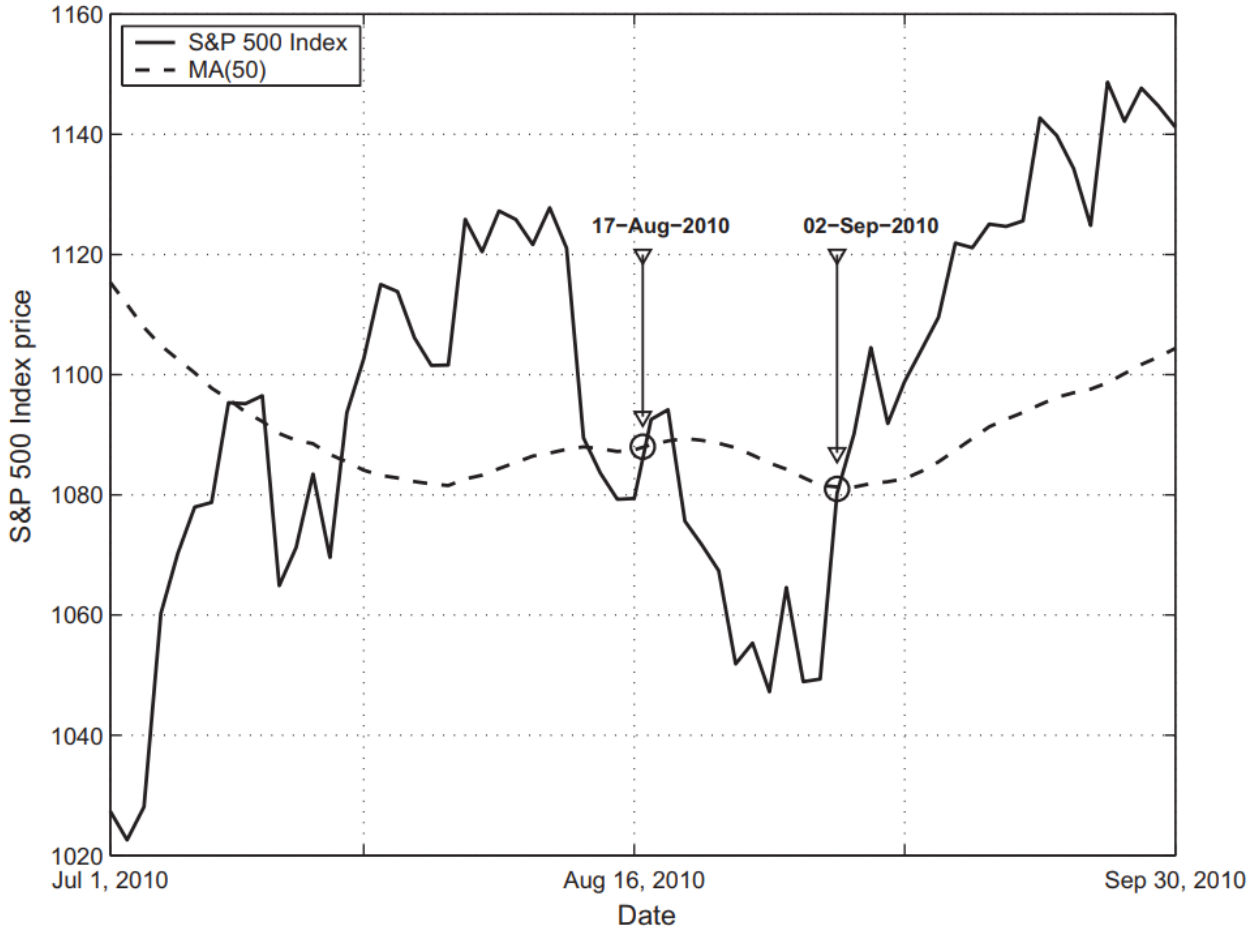
N. Gradojevic, R. Gençay / Journal of Banking & Finance 37 (2013) 578–586



Fuzzy logic, trading uncertainty and technical trading

Author(s):

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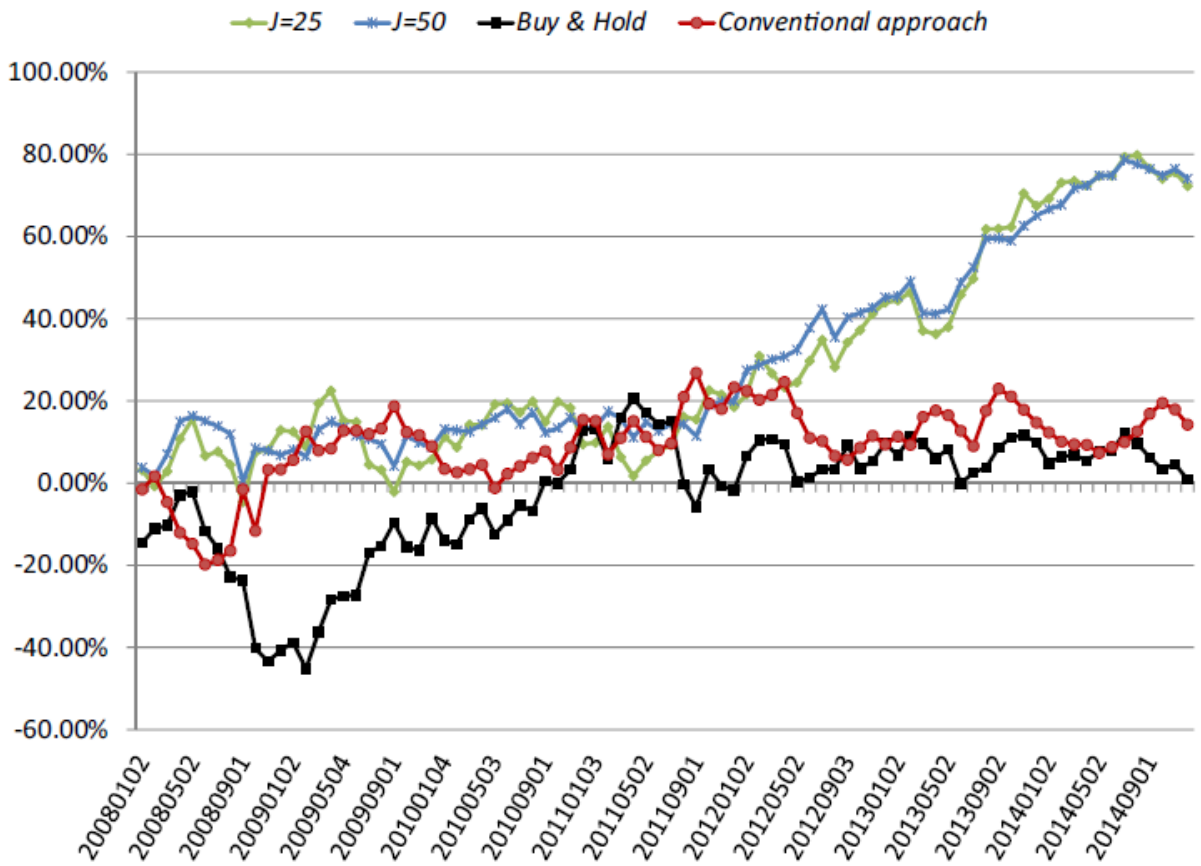

Fig. 6. Cumulative return for the rule discovery mechanism using a 6 month training period.

An intelligent hybrid trading system for discovering trading rules for the futures market using rough sets and genetic algorithms

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DavidEnke[c]

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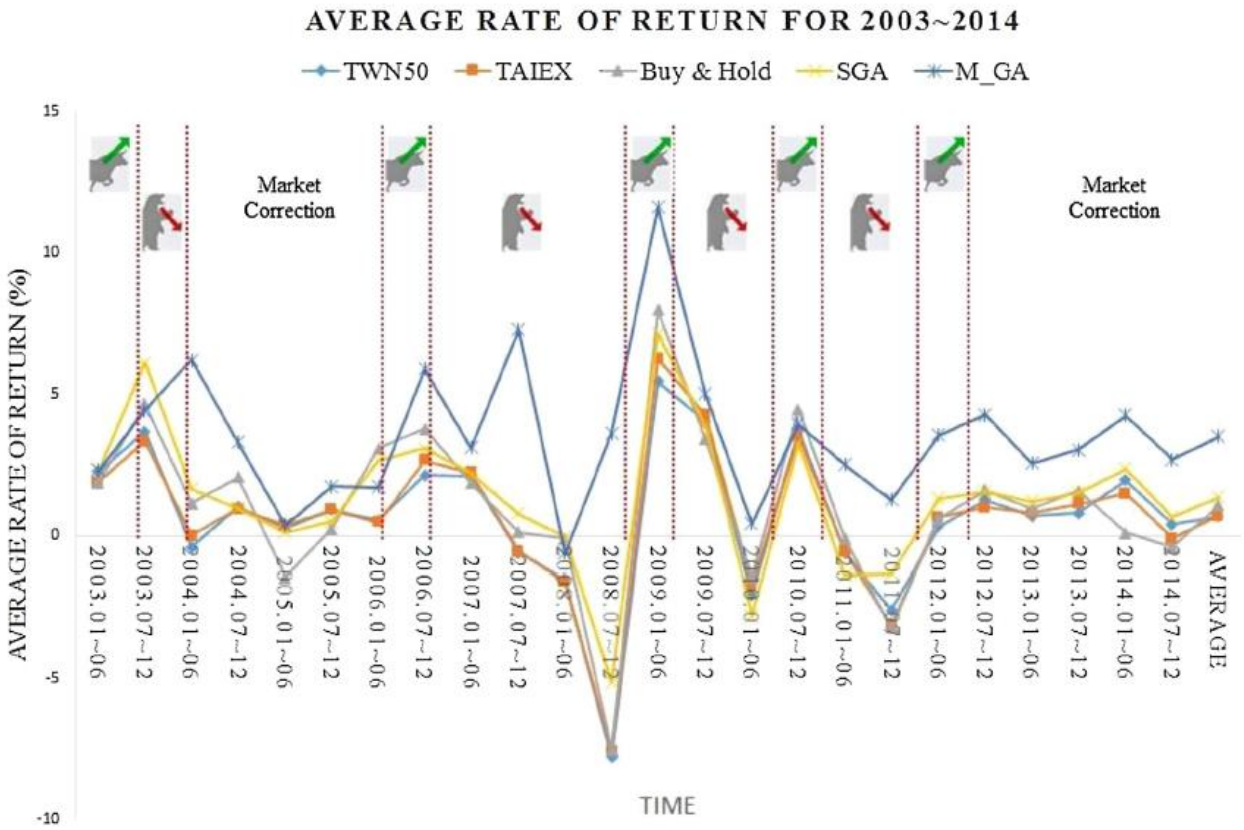

Fig. 15. Average rate of return diagram for 2003–2014.

Incorporating Markov decision process on genetic algorithms to formulate trading strategies for stock markets

Author(s):

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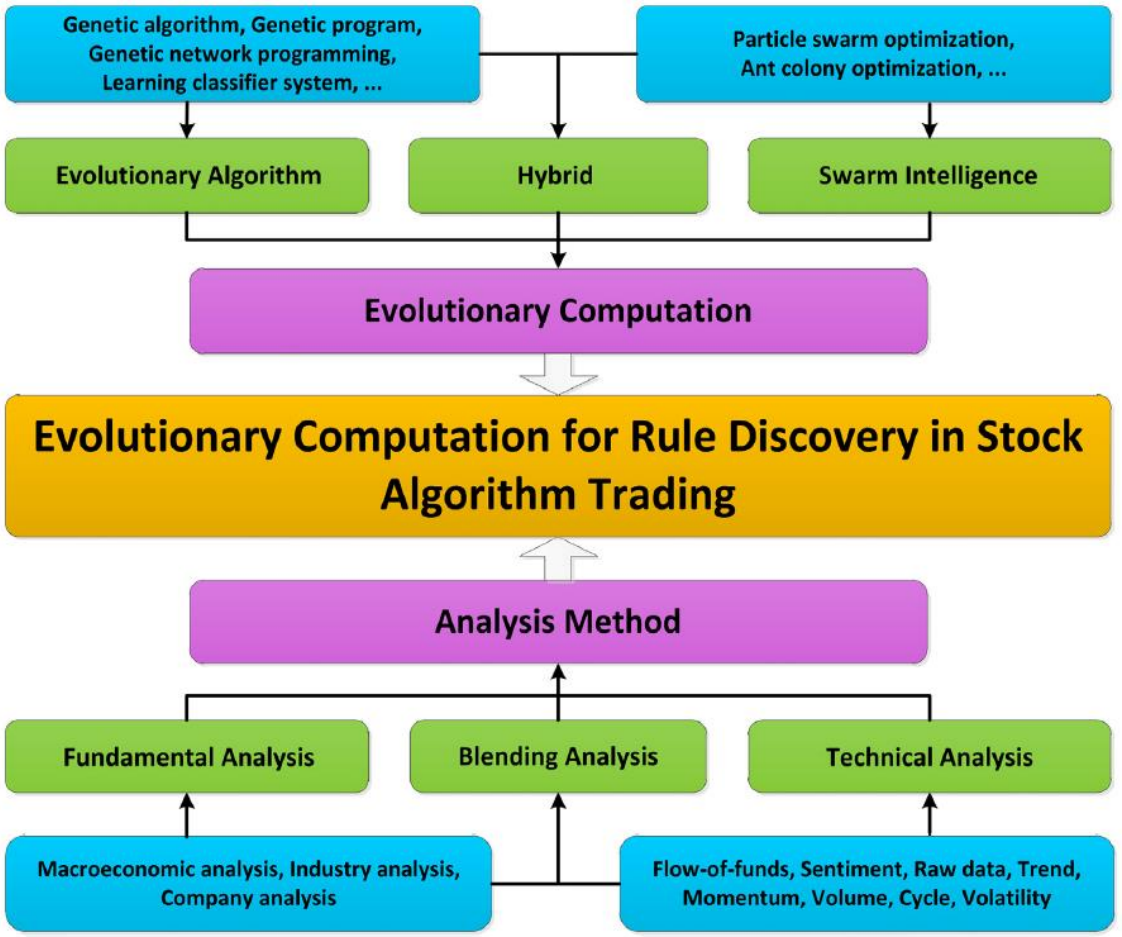

Fig. 3. Classification framework for EC techniques for rule discovery in stock algorithmic trading.

Application of evolutionary computation for rule discovery in stock algorithmic trading: A literature review

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