

Developing Actionable Trading Strategies for Trading Agents

Chengqi Zhang

Director

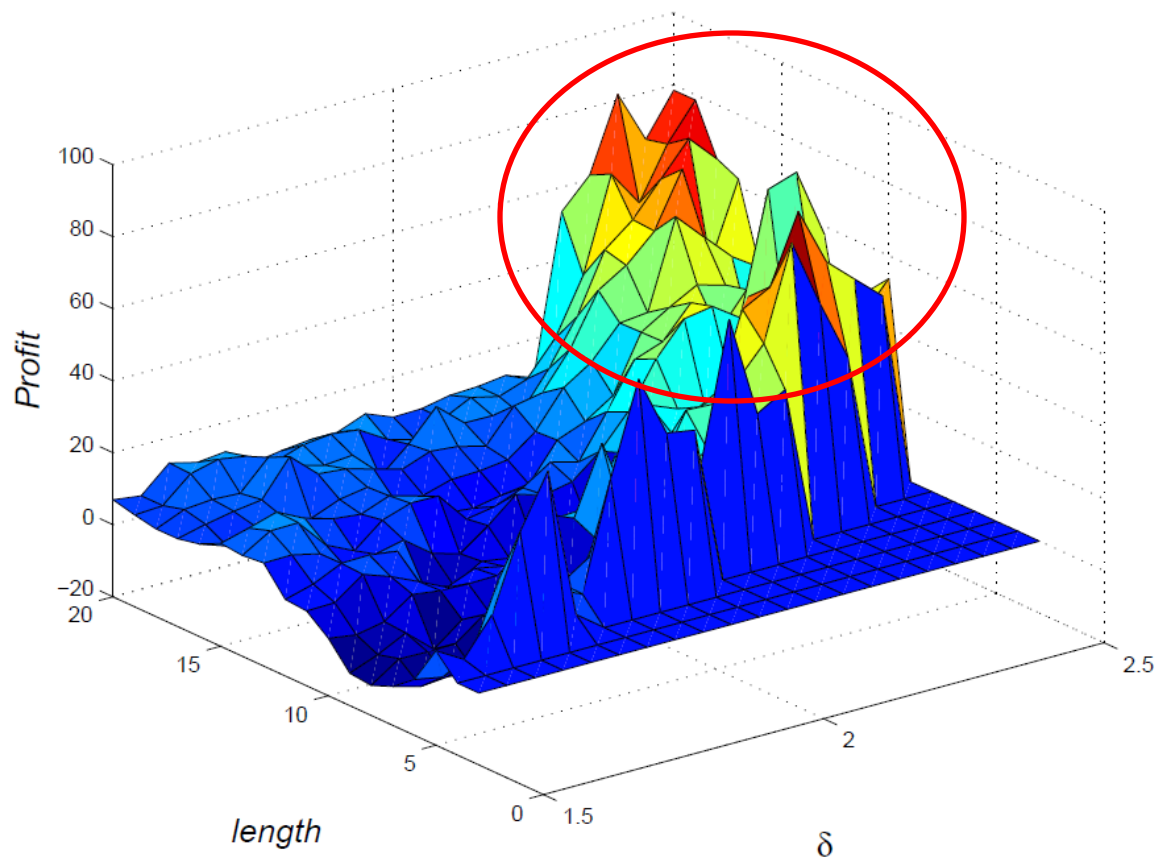
Centre for Quantum Computation and
Intelligent Systems (QCIS),
University of Technology, Sydney, Australia

UTS:QCIS
QUANTUM COMPUTATION & INTELLIGENT SYSTEMS

Key Ideas in this talk

- One scenario
 - ◆ If an agent is given one million dollars to trade, which stock, when, buy or sell, how many shares should be traded?
- Key points
 - ◆ Domain Knowledge is a key to developing actionable Trading Agent
 - ◆ Individual Smart trading strategy is important
 - ◆ Trading strategy integration
 - ◆ This talk will focus on how to develop actionable *trading strategies*

Relationships between the profits and strategies with parameters



Contents

- About QCIS Centre
- What is trading agent
- What is trading strategy
- Actionable trading agent/strategy
- Trading strategy optimization
- Enhancing trading strategy
- Multi-trading strategy integration
- F-Trade: support smart trading
- Conclusions

About QCIS Centre

- Name
 - ◆ Centre for Quantum Computation and Intelligent Systems (QCIS)
- People
 - ◆ **25** researchers include 6 Profs, 5 A/Profs, 4 Senior Lecturers, 4 Lecturers, 6 Postdocs, and
 - ◆ 40 Research Students
- Achievements
 - ◆ **11** ARC Grants in 2009 in life include 8 ARC DP and 3 ARC LP (AU\$1,000,000+)
 - ◆ Industry grants in 2009 (AU\$500,000+)
 - ◆ One of the leading research centres in Australia

Research Laboratories

- **Quantum Computation Laboratory**
- **Data Sciences and Knowledge Discovery Laboratory**
- **Decision Systems and e-Service Intelligence Laboratory**
- **Knowledge Infrastructure Laboratory**
- **Innovation and Enterprise Research Laboratory**

National Grants in Knowledge Discovery Lab (2009)

1. Domain Driven Data Mining ([ARC DP 2007-2009](#))
2. Data Mining of Activity Transactions to Strengthen Debt Prevention ([ARC LP 2007-2009](#))
3. Discovering Activity Patterns Driven by High Impacts in Heterogeneous and Imbalanced Data ([ARC DP 2009-2011](#))
4. Multiple Data Source Discovery: Group Interaction Approach ([ARC DP 2009-2013](#))
5. Pattern Analysis and Risk Control of E-Commerce Transactions to Secure Online Payments ([ARC LP 2009-2011](#))

Industry Grants in Knowledge Discovery Lab (2009)

- Applications
 - ◆ Stock Market Surveillance & Trading
 - ◆ Centrelink Debt Prevention
 - ◆ Fraud management for on-line e-payments
 - ◆ HCF (Medical Insurance Fraud detection)

Contents

- About QCIS Centre
- **What is trading agent**
- What is trading strategy
- Actionable trading agent/strategy
- Trading strategy optimization
- Enhancing trading strategy
- Multi-trading strategy integration
- F-Trade: support smart trading
- Conclusions

What is Trading Agent?

- Automated decision
- Smart decision
- Workable decision

>>> Actionable trading strategies

What is Trading Strategy

- In finance, a trading strategy (see also trading system) is a predefined set of rules for making trading decisions. (Wikipedia)
- A trading strategy indicates *when* a trading agent can take *what* trading actions under certain market *situation*.

What is Trading Strategy

- Trading strategy design problem
 - ◆ trading strategy set $\Omega = \langle T, B, P, V, I \rangle$
 - ★ time $T = \{t_1, t_2, \dots, t_m\}$
 - ★ behavior $B = \{buy, sell, hold\}$
 - ★ price $P = \{p_1, p_2, \dots, p_m\}$
 - ★ volume $V = \{v_1, v_2, \dots, v_m\}$
 - ★ instrument $I = \{i_1, i_2, \dots, i_m\}$
 - ◆ Our goal: actionable trading strategy set Ω' ($\Omega' \subset \Omega$)
 - $\delta_i^k \in \Sigma, a \in A\}$
 - $\Omega' = \{(\omega, \delta) \mid \omega \in \Omega, \delta \in \{(\delta_i^k, a)\}$
 - ★ trading agent a ($a \in A$)
 - ★ ω : optimal strategy instance
 - ★ δ : all constraint instances

What is Trading Strategy

- An trading strategy example

TRADING STRAGE 1: A generic strategy $FR(\delta)$

At time point t , get $high(t)$ and $low(t)$

IF $price(t-1) > high(t-1)$

$high(t) = price(t-1)$

ELSE

$high(t) = high(t-1)$

IF $price(t-1) < low(t-1)$

$low(t) = price(t-1)$

ELSE

$low(t) = low(t-1)$

Generate trading signals

IF $price(t) < high(t) * (1 - \delta)$

Generate *SELL* signal

IF $price(t) > low(t) * (1 + \delta)$

Generate *BUY* signal

Actionable trading agent/strategy

- Actionable trading strategy
- Trading strategy optimization
- Trading strategy enhancement
- Trading strategy integration
- Trading support system

Actionable trading strategy

$$\begin{cases} tech_int(t, b, p, v, i) \rightarrow \max[tech_int()] \\ biz_int(t, b, p, v, i) \rightarrow \max[biz_int()] \end{cases}$$

s.t.

$$\begin{cases} \Omega' = \{e_1, \dots, e_n\} \\ \Omega' \subset \Omega \\ m \succ n \end{cases}$$

$$\alpha_s = \sum b_i \times p_i \times v_i$$

$$\beta_s = \sum |b_i| \times \beta_i \times p_i \times v_i$$

$$SR = (R_p - R_f) / \sigma_p$$

$$TR = \frac{\sum_{i=1}^u \text{AskPrice}_i * \text{AskVolume}_i - \sum_{j=1}^v \text{BidPrice}_j * \text{BidVolume}_j}{\text{TotalInvestment}}$$

$$IR = \left(\sum_{i=1}^n (\text{Index}_{i+1} - \text{Index}_i) / \text{Index}_i \right) / n$$

Trading Strategy Optimization

- Evolutionary trading agent

- ◆ Modeling roles

- ★ Crossover
- ★ Mutation
- ★ ...

Role *R_mutateCandidateStrategies*

Statement *Mutation* is a process that parts of a chromosome are to be changed. This role determines to what extent the parts of a chromosome in a trading agent are to be mutated. The extent is the mutation rate.

Agent *A_EvolutionaryAgent*

Agent *A_UserAgent*

Agent *A_StrategyAgent*

Agent *A_CoordinatorAgent*

Attribute *aea:A_EvolutionaryAgent*

Attribute constant *mutrate:MutationRate*

Attribute *paraid[]:A_InParameters*

Attribute *aua:A_UserAgent*

Attribute *asa:A_StrategyAgent*

Attribute constant *strid:asa*

Attribute *aca:A_CoordinatorAgent*

Protocol *receiveStrategyMutationRequest*

Protocol *checkStrategyAgentValidity*

Protocol *openMutateSettingInterface*

Protocol *submitStrategyMutationRequest*

Protocol *returnStrategyMutationResponse*

Responsibilities

Liveness

\forall *strid:aca.checkStrategyAgentValidity()* \rightarrow

aua.openMutateSettingInterface(aea, asa.paraid[])

\rightarrow *aea.receiveStrategyMutationRequest(aua)*

\rightarrow *aca.submitStrategyMutationRequest(aua)*

\rightarrow *aea.executeStrategyMutation(aua, mutrate, aca)*

\rightarrow τ *aea.returnStrategyMutationResponse(aua, aca)*

Safety (Invariant) $0 < mutrate < 1.0$

Trading strategy optimization

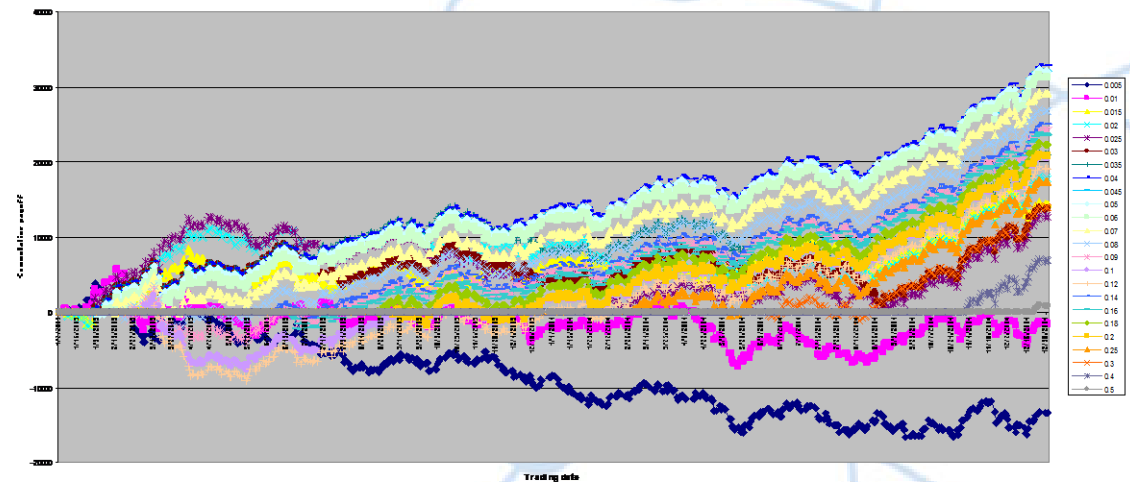
Develop optimized trading strategies for trading agents:

- Optimized trading strategies

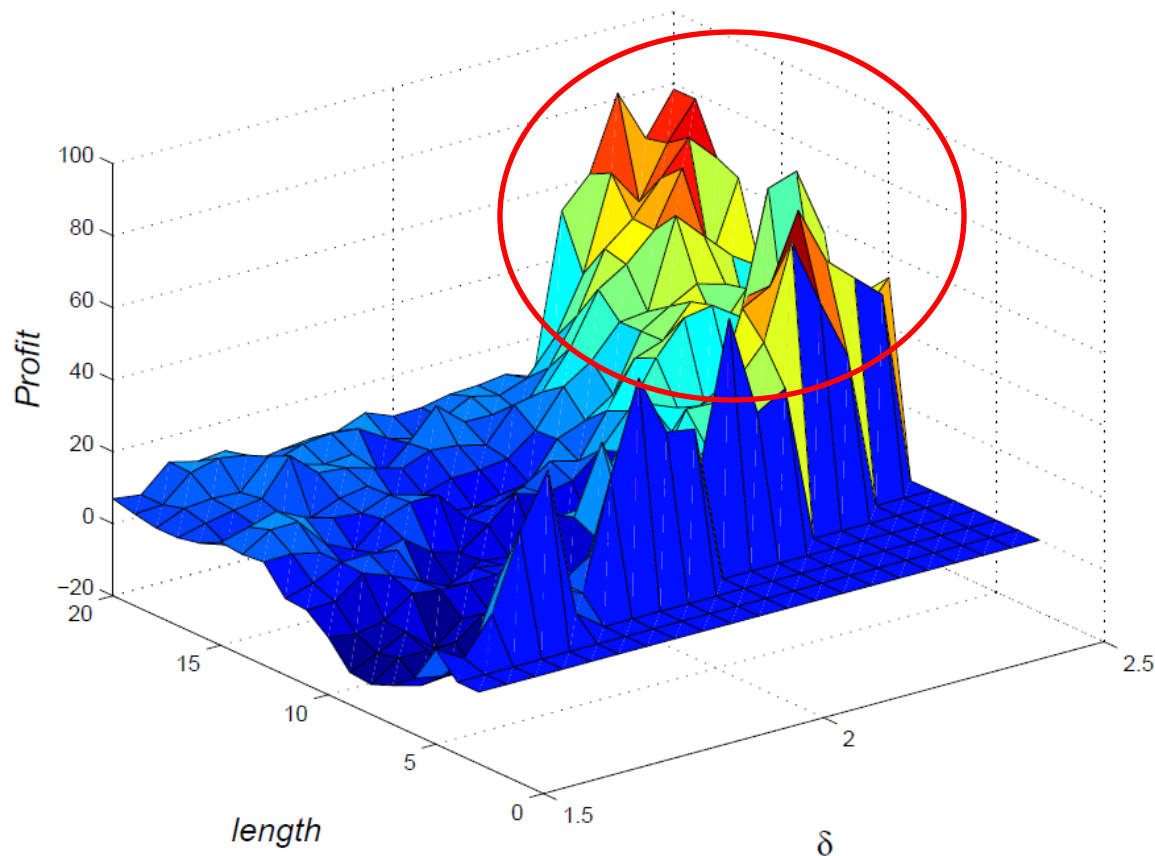
Checking business performance:

- Actionability of trading strategies

Trading rule parameter optimization



Relationships between the profits and strategies with parameters



Enhancing Trading Strategy

- Domain factors

$$M = \{I, A, O, T, R, E\}$$

$$\Sigma = \{\delta_i^k \mid c_i \in C, k \in N\}$$

$$\Omega = \{(\omega, \delta) \mid \omega \in \Omega, \delta \in \{(\delta_i^k, a) \mid \delta_i^k \in \Sigma, a \in A\}\}$$

Table 1. Domain factors and its impact to actionability

Organizational factors	Impact to actionability
Traded <i>instruments</i> I , such as stock or derivatives, $I = \{stock, option, feature, \dots\}$	Varying instruments determine different data, analytical methods and objectives
Market <i>participants</i> A , $A = \{broker, market maker, mutual funds, \dots\}$	Traders have the final right to evaluate and deploy discovered trading evidence to their advantage
<i>Orderbook</i> forms O , $O = \{limit, market, quote, block, stop\}$	Order type determines what data set (e.g., orderbook) to be mined, as well as particular business interestingness
Trading <i>session</i> , indicated by timeframe T showing whether a market includes call market or continuous session	Setting up the focusing session can prune order transactions
Market <i>rules</i> R , e.g., restrictions on order execution defined by exchange	They determine pattern validity of discovered trading patterns when deployed
<i>Execution</i> system E , e.g., a trading engine is order or quote-driven	It limits pattern type and deployment manner after migrated to a real trading system

Enhancing trading strategies

- Enhancing trading strategies
 - ◆ Based on a basic strategy, say $FR(\delta)$
 - ◆ Add domain specific factors
 - ◆ For instance,

$FR(\delta)$

$FR(t, \delta_H, \delta_L, h, d)$

TRADING STRATEGY 2: An enhanced $FR(t, \delta_H, \delta_L, h, d)$
At time point t , get $high(t)$ and $low(t)$
IF $price(t-1) > high(t-1)$
 $high(t) = price(t-1)$
ELSE
 $high(t) = high(t-1)$
IF $price(t-1) < low(t-1)$
 $low(t) = price(t-1)$
ELSE
 $low(t) = low(t-1)$
Generate trading signals
IF $price(t) < high(t) * (1 - \delta_H)$
 Generate *SELL* signal
 IF $position(t-1) \neq 0$ & $hold(t-1) = h$
 $position(t) = 1$
IF $price(t) > low(t) * (1 + \delta_L)$
 Generate *BUY* signal
 IF $position(t-1) \neq 0$ & $hold(t-1) = h$
 $position(t) = -1$

Results

- Enhancing trading strategies
 - ◆ Filter Rule Enhanced: FR(δ, h)
 - ◆ FR(δ, h) can greatly beat FR(δ)

	A	B	C	D	E	F	G	H	I	J	K	L
	Trade Date	Trade Price	Maximum Price	Minimum Price	Sell Cond Met	Buy Cond Met	Trade Signal Indicator	Trades	Position Hold Days	Positions	Payoff (\$)	Payoff (\$) Cumulative
4	1/22/2003	3027	0	0	0	0	0	0	0	0	0	0
5	1/23/2003	3066	0	0	0	0	0	0	0	0	0	0
7	1/6/2003	3075	0	0	0	0	0	0	0	0	0	0
8	1/7/2003	3099	0	0	0	0	0	0	0	0	0	0
9	1/8/2003	3072	0	0	0	0	0	0	0	0	0	0
10	1/9/2003	3062	3088	3027	0	0	0	0	0	0	0	0
11	1/10/2003	3065	3088	3065	0	0	0	0	0	0	0	0
12	1/13/2003	3063	3063	3065	-1	0	-1	0	0	0	0	0
13	1/14/2003	3077	3065	3063	0	0	-1	0	0	0	0	0
14	1/15/2003	3075	3077	3063	0	0	-1	0	0	0	0	0
15	1/16/2003	3062	3077	3063	-1	0	-1	0	0	0	0	0
16	1/17/2003	3055	3077	3062	-1	0	-1	0	0	0	0	0
17	1/20/2003	3060	3077	3055	0	0	-1	0	0	0	0	0
18	1/21/2003	3054	3077	3055	-1	0	-1	0	0	0	0	0
19	1/22/2003	3016	3075	3054	-1	0	-1	0	0	0	0	0
20	1/23/2003	3015	3052	3015	0	0	-1	0	0	0	0	0
21	1/24/2003	3021	3058	3016	0	0	-1	0	0	0	0	0
22	1/27/2003	3001	3055	3016	-1	0	-1	0	0	0	0	0
23	1/28/2003	2962	3054	3001	-1	0	-1	0	0	0	0	0
24	1/29/2003	2924	3021	2962	-1	0	-1	0	0	0	0	0
25	1/30/2003	2947	3021	2924	0	0	-1	0	0	0	0	0
26	1/31/2003	2943	3021	2924	0	0	-1	0	0	0	0	0
27	2/3/2003	2933	3001	2924	0	0	-1	0	0	0	0	0
28	2/4/2003	2934	2952	2924	0	0	-1	0	0	0	0	0
29	2/5/2003	2832	2947	2924	-1	0	-1	0	0	0	0	0
30	2/6/2003	2881	2947	2892	-1	0	-1	0	0	0	0	0
31	2/7/2003	2887	2943	2881	0	0	-1	0	0	0	0	0
32	2/10/2003	2870	2934	2881	-1	0	-1	0	0	0	0	0
33	2/11/2003	2871	2934	2870	0	0	-1	0	0	0	0	0
34	2/12/2003	2874	2892	2870	0	0	-1	0	0	0	0	0
35	2/13/2003	2812	2867	2812	-1	0	-1	0	0	0	0	0
36	2/14/2003	2812	2887	2818	-1	0	-1	0	0	0	0	0
37	2/17/2003	2839	2874	2812	0	0	-1	0	0	0	0	0
38	2/18/2003	2845	2874	2812	0	0	-1	0	0	0	0	0
39	2/19/2003	2864	2874	2812	0	0	-1	0	0	0	0	0
40	2/20/2003	2803	2854	2812	-1	0	-1	0	0	0	0	0
41	2/21/2003	2810	2854	2810	0	0	-1	0	0	0	0	0
42	2/24/2003	2845	2854	2803	0	0	-1	0	0	0	0	0
43	2/26/2003	2790	2854	2803	-1	0	-1	0	0	0	0	0
44	2/28/2003	2795	2854	2790	0	0	-1	0	0	0	0	0
45	2/27/2003	2783	2845	2790	-1	0	-1	0	0	0	0	0
46	2/28/2003	2794	2845	2783	0	0	-1	0	0	0	0	0
47	3/3/2003	2815	2845	2783	0	0	-1	0	0	0	0	0
48	3/4/2003	2803	2825	2783	0	0	-1	0	0	0	0	0
49	3/5/2003	2771	2825	2771	-1	0	-1	0	0	0	0	0
50	3/6/2003	2760	2816	2771	0	0	-1	0	0	0	0	0
51	3/7/2003	2732	2815	2769	-1	0	-1	0	0	0	0	0
52	3/10/2003	2733	2815	2732	0	0	-1	0	0	0	0	0
53	3/11/2003	2713	2803	2732	0	0	-1	0	0	0	0	0
54	3/12/2003	2710	2771	2713	-1	0	-1	0	0	0	0	0
55	3/13/2003	2709	2771	2710	0	0	-1	0	0	0	0	0

Figure 2. Some results of enhanced trading strategy FR

Results

- Enhancing trading strategies
 - ◆ Filter Rule Enhanced: $FR(\delta, h)$
 - ◆ $FR(\delta, h)$ can greatly beat $FR(\delta)$

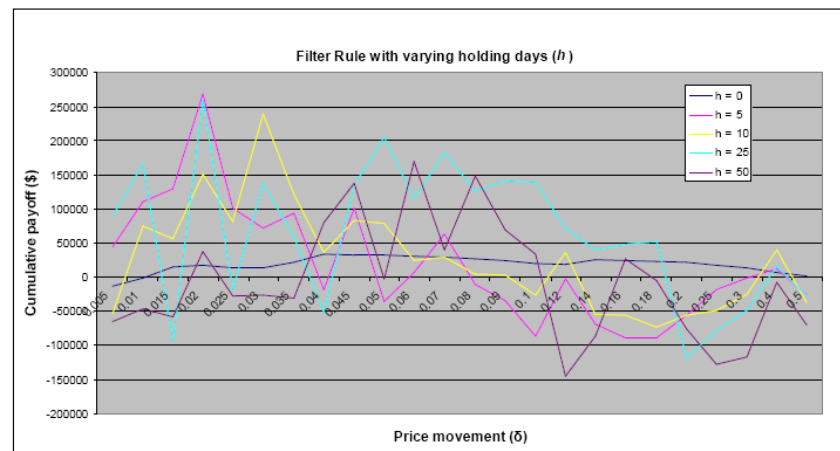
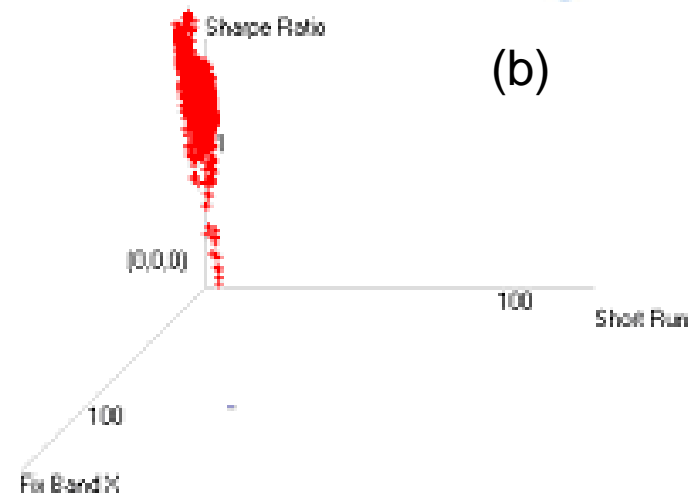
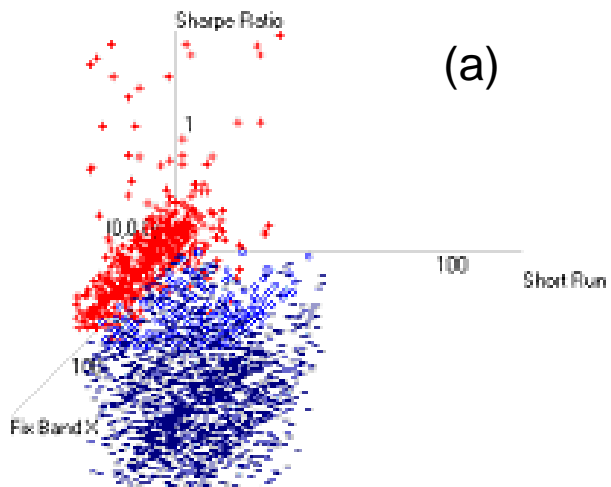
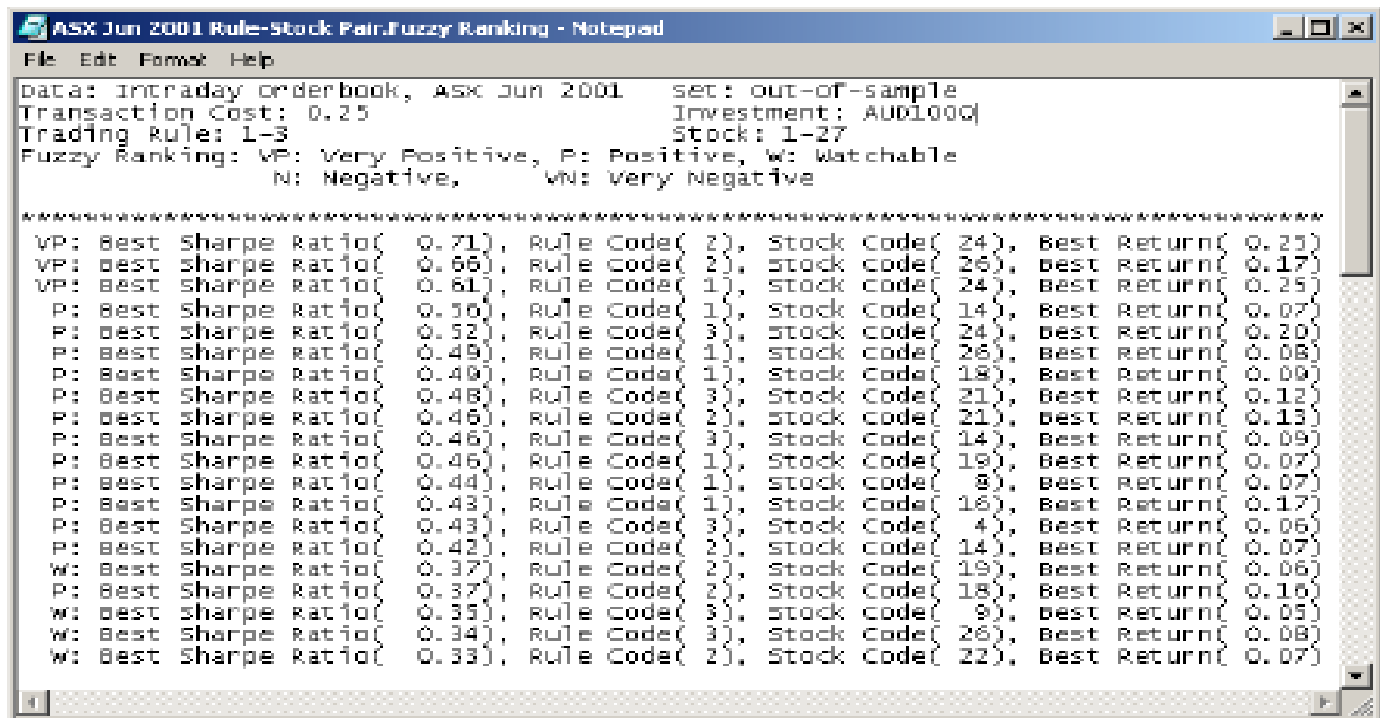


Figure 3. Performance comparison between base and enhanced trading strategies



Mining Trading Strategy-stock Pair

- An example



```
ASX Jun 2001 Rule-Stock Pair.Fuzzy Ranking - Notepad
File Edit Format Help
Data: Intraday Orderbook, ASX Jun 2001      set: out-of-sample
Transaction Cost: 0.25                      Investment: AUD1000
Trading Rule: 1-3                          Stock: 1-27
Fuzzy Ranking: VP: Very Positive, P: Positive, W: Watchable
              N: Negative,          VN: Very Negative

VP: Best Sharpe Ratio( 0.71), Rule Code( 2), Stock Code( 24), Best Return( 0.25)
VP: Best Sharpe Ratio( 0.66), Rule Code( 2), Stock Code( 26), Best Return( 0.17)
VP: Best Sharpe Ratio( 0.61), Rule Code( 1), Stock Code( 24), Best Return( 0.25)
P: Best Sharpe Ratio( 0.56), Rule Code( 1), Stock Code( 14), Best Return( 0.07)
P: Best Sharpe Ratio( 0.52), Rule Code( 3), Stock Code( 24), Best Return( 0.20)
P: Best Sharpe Ratio( 0.49), Rule Code( 1), Stock Code( 26), Best Return( 0.08)
P: Best Sharpe Ratio( 0.49), Rule Code( 1), Stock Code( 18), Best Return( 0.08)
P: Best Sharpe Ratio( 0.48), Rule Code( 3), Stock Code( 21), Best Return( 0.12)
P: Best Sharpe Ratio( 0.46), Rule Code( 2), Stock Code( 21), Best Return( 0.13)
P: Best Sharpe Ratio( 0.46), Rule Code( 3), Stock Code( 14), Best Return( 0.09)
P: Best Sharpe Ratio( 0.46), Rule Code( 1), Stock Code( 19), Best Return( 0.07)
P: Best Sharpe Ratio( 0.44), Rule Code( 1), Stock Code( 8), Best Return( 0.07)
P: Best Sharpe Ratio( 0.43), Rule Code( 1), Stock Code( 16), Best Return( 0.17)
P: Best Sharpe Ratio( 0.43), Rule Code( 3), Stock Code( 4), Best Return( 0.06)
P: Best Sharpe Ratio( 0.42), Rule Code( 2), Stock Code( 14), Best Return( 0.07)
W: Best Sharpe Ratio( 0.37), Rule Code( 2), Stock Code( 19), Best Return( 0.06)
P: Best Sharpe Ratio( 0.37), Rule Code( 2), Stock Code( 18), Best Return( 0.16)
W: Best Sharpe Ratio( 0.35), Rule Code( 3), Stock Code( 9), Best Return( 0.05)
W: Best Sharpe Ratio( 0.34), Rule Code( 3), Stock Code( 26), Best Return( 0.08)
W: Best Sharpe Ratio( 0.33), Rule Code( 2), Stock Code( 22), Best Return( 0.07)
```

Fig. 4. Fuzzily ranked trading rule-stock pairs

Mining Trading Strategy-stock Pair

- An example

TRADE RULE-STOCK PAIRS: TRSP($T, R, S, \rho_0, sr_0, r_0$)

Input: a set of historical intraday orderbook transactions T , a set of trading rules R , a set of stocks S , a coefficient threshold ρ_0 , a sharpe ratio threshold sr_0 , and a return threshold r_0

Output: Fuzzily ranked trading rule-stock pairs

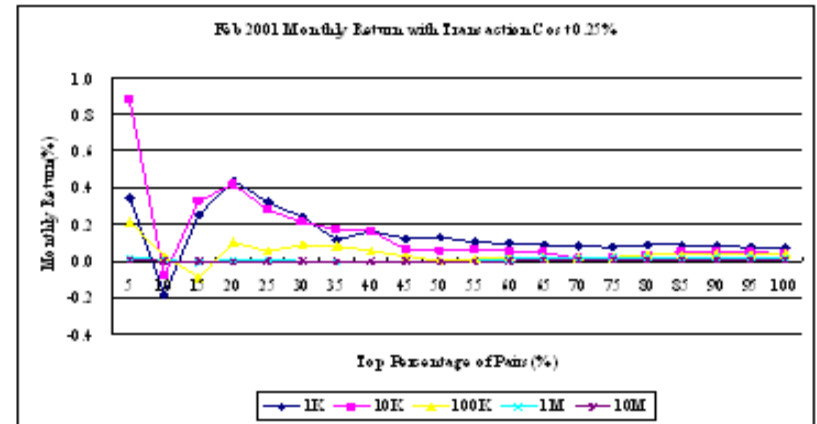
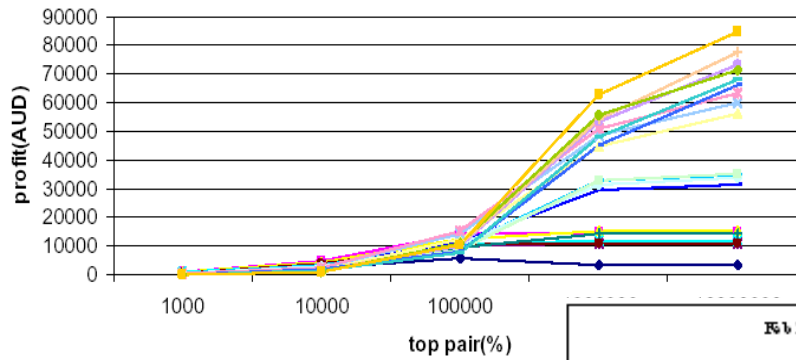
Interestingness: fuzzy ranking coefficient ρ , and sharpe ratio SR

Constraints: intraday data, market niche $M=\{\text{ASX stocks, any traders, market orderbook, continuous session, ASX order, none}\}$

Method:

1. Given a stock S_i and a type of trading rule R_j , identify the in-depth rules r_{ijm} ($m = 0, 1, \dots$) for the stock in T ;
 2. Identify all in-depth rules r_{ijm} ($i = 0, 1, \dots, j = 0, 1, \dots; m = 0, 1, \dots$) for all stocks S_i ($i = 0, 1, \dots$) and all types of trading rules R_j ($j = 0, 1, \dots$);
 3. Fuzzily aggregate the rule set r_{ijm} , and rank them to generate a fuzzily "optimal" rule for a given stock;
 4. Generate fuzzy "optimal" rule-stock pairs (s_i, r_j) ($i = 0, 1, \dots, j = 0, 1, \dots$) in terms of stocks and trading rules;
 5. Evaluate rule-stock pairs (s_i, r_j) in terms of technical and business interestingness measures respectively;
 6. Aggregate and fuzzily rank rule-stock pairs (s_i, r_j) in terms of ranking coefficient and business performance;
 7. Evaluate and recommend highly-ranking rule-stock pairs for trading support.
-

Profit to investment



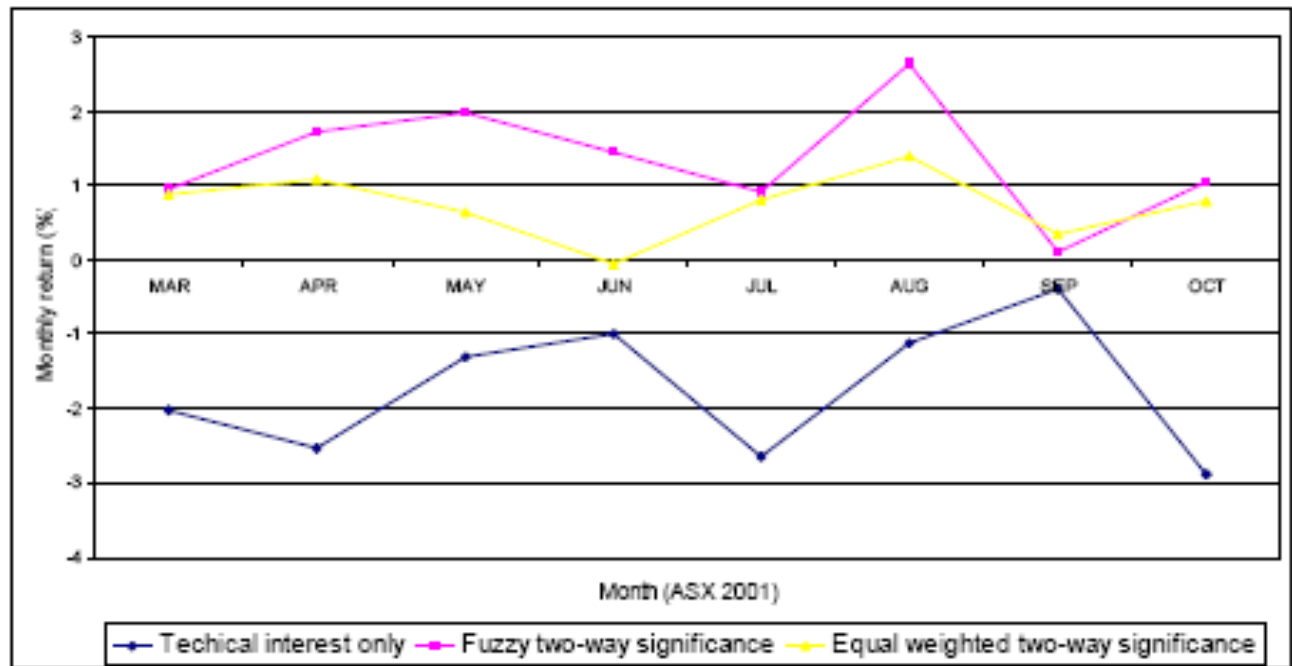
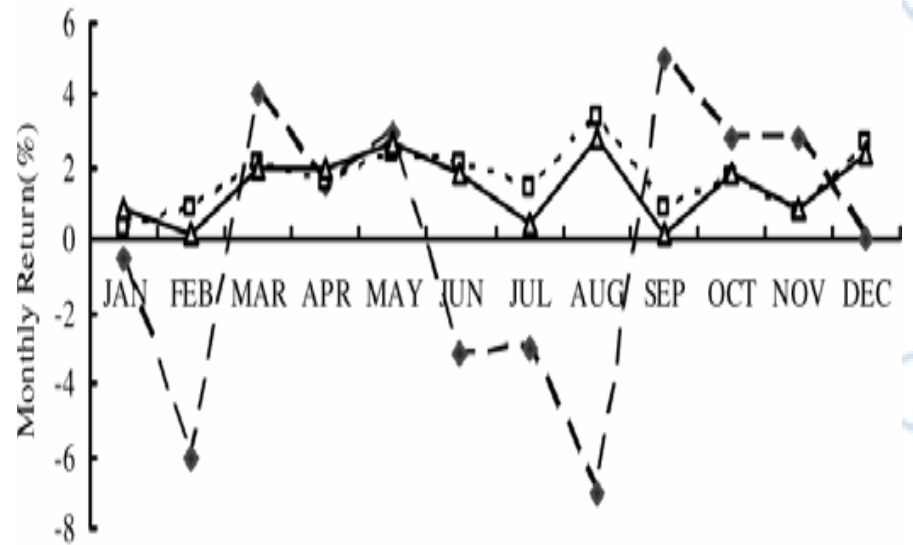
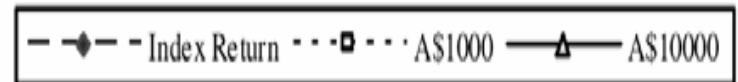


Fig. 6. Monthly return TR of top 10% rule-stock pairs (Technical interest only vs. fuzzy two-way significance vs. equally weighted two-way significance)

Comparison of Index Return and Pair Return



Out-of-Sample data Month



Multi-trading strategy integration

Table 1. Trading strategy base

Class	Types in a class
FR	FR-X, FR-XC, FR-XY, FR-XE
MA	MA-MN, MA-BMN, MA-CMN, MA-DMN
CB	CB-NXC, CB-NXBC
SR	SR-N, SR-NB, SR-NC, SR-NBC, SR-NDC
OBV	OBV-MN, OBV-B, OBV-C, OBV-D

- ◆ Evolutionary trading agent searches golden strategy for each class
- ◆ Golden trading agents negotiate for the local best
- ◆ Coordinator agent monitors for global best
- ◆ Coordinator agent selects and aggregates positions for all golden strategies
- ◆ Collaborative agent trades all selected golden strategies

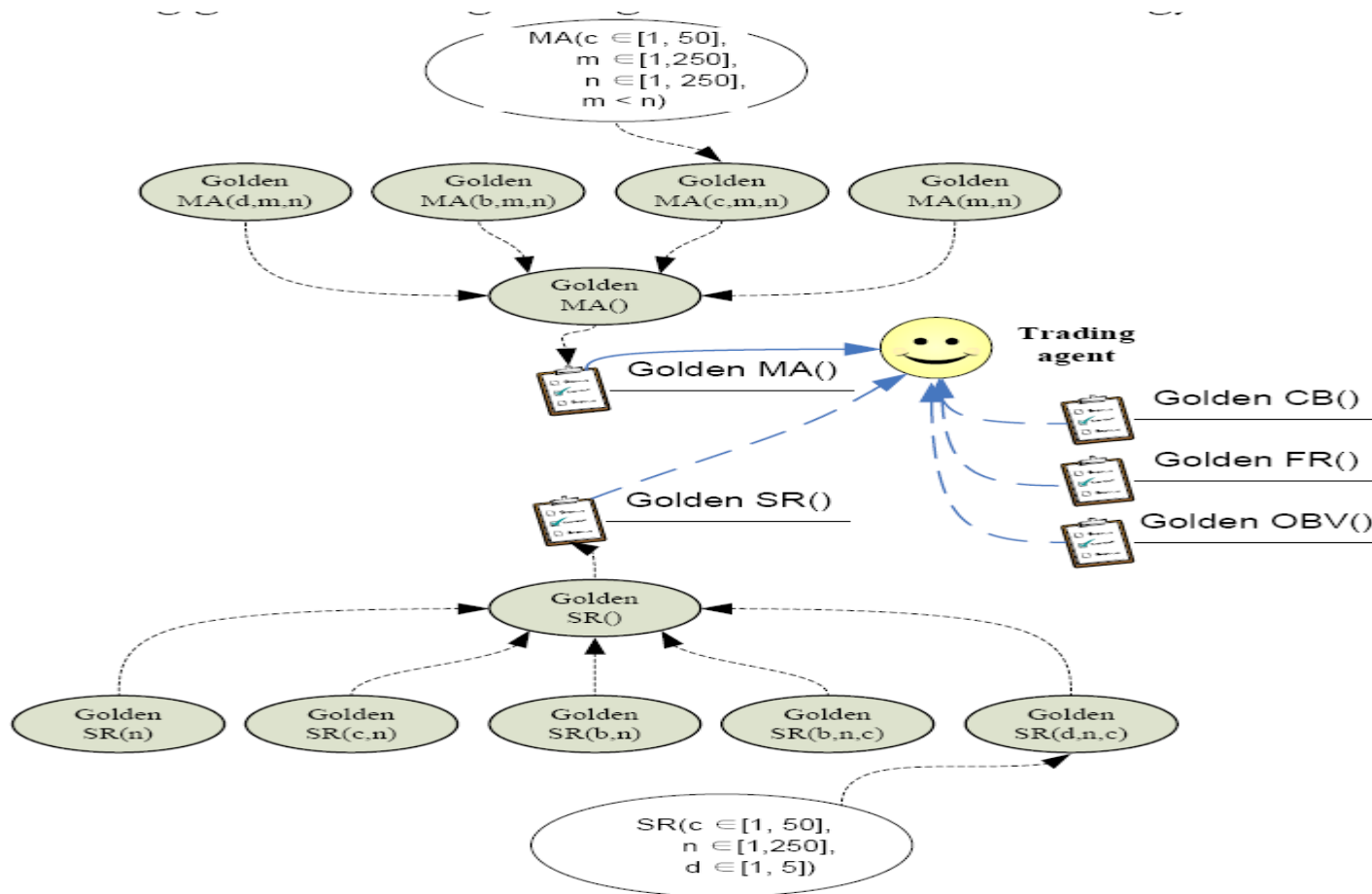


Figure 1. Multi-strategy integration for trading agents

Table 3. Data partition excerpt

	starting	Train end	Deploy end
Window 1	1/1/1997	30/12/1998	30/12/2000
Window 2	1/1/1998	30/12/1999	30/12/2001
Window 3	1/1/1999	30/12/2000	30/12/2002

■ Outputs

Table 5. Maximal benefits to parameter combinations (excerpt)
(Data: 2003; Market: ASX; Strategy: MA-BMN)

Parameter combinations	Benefit (\$)	Cost (\$)
$n = 2; x = 0.010; c = 25; b = 0.001$	32350	394.25
$n = 5; x = 0.010; c = 75; b = 0.015$	18200	268
$n = 5; x = 0.010; c = 50; b = 0.001$	16900	241.75
$n = 2; x = 0.015; c = 25; b = 0.005$	16550	256.5
$n = 2; x = 0.020; c = 25; b = 0.001$	12725	214.5

Table 4. Output excerpt of a trading strategy
(Strategy: MA-BMN; Data: 2004)

Date	Price	Sell	Buy	Position	(\$) Benefit	(\$) Cost
2004-8-16	3466	-1	0	-1	9200	103
2004-8-17	3480	-1	0	-1	8850	106.5
2004-8-18	3472	-1	0	-1	9150	108.5
2004-8-19	3481	-1	0	-1	8825	110.75
2004-8-20	3494	0	0	-1	8500	114

Table 6. Trading agent positions recommended by five trading
strategy classes (excerpt)
(Strategy class: MA, FR, CB, SR, OBV; Data: Hongkong; Year:
2006)

Date	Position MA	Position FR	Position CB	Position SR	Position OBV
2006-11-16	1	1	0	1	1
2006-11-17	1	1	0	1	1
2006-11-20	1	1	0	1	1
2006-11-21	-1	-1	0	1	1
2006-11-22	-1	-1	0	1	1

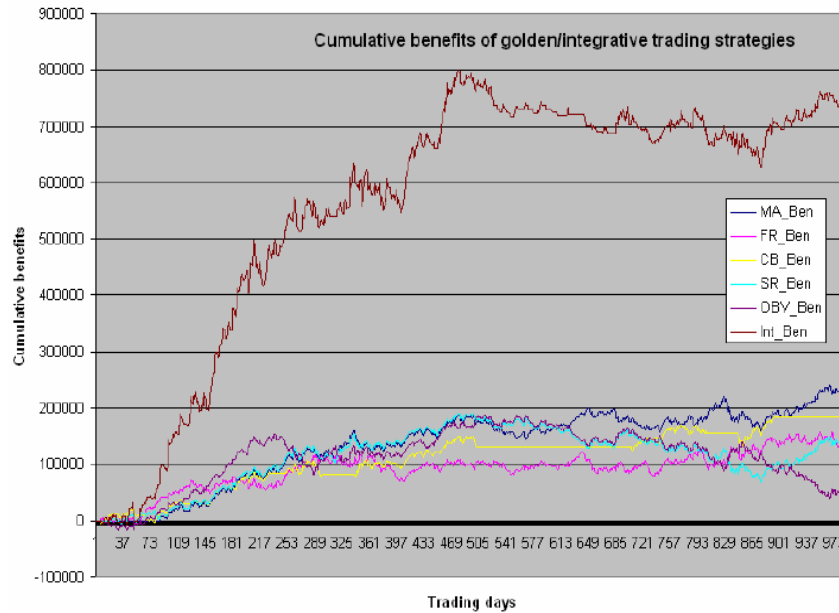


Figure 2. Cumulative benefits of each trading strategies (Year: 2003-2006, Market: Hongkong, Strategies: MA, FR, CB, SR, OBV, and Integrative)

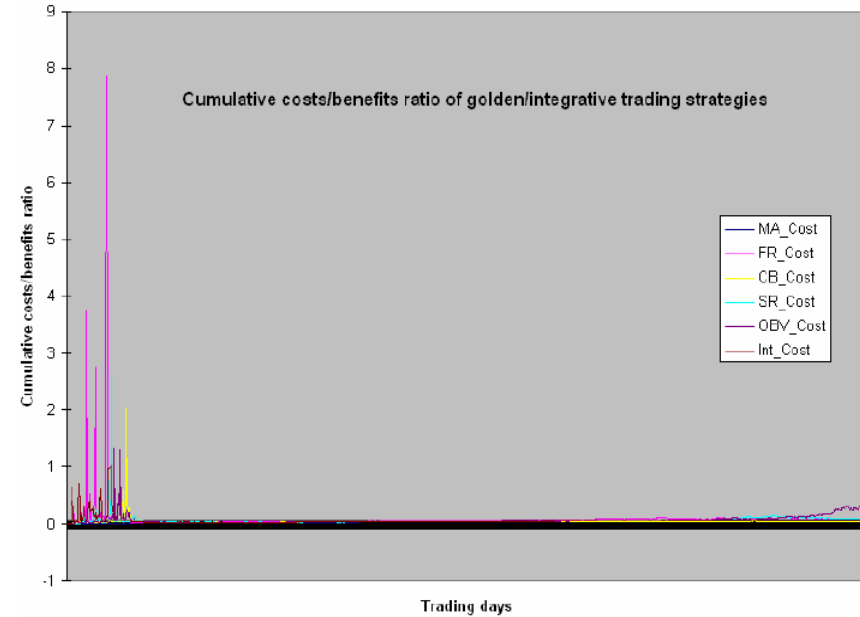
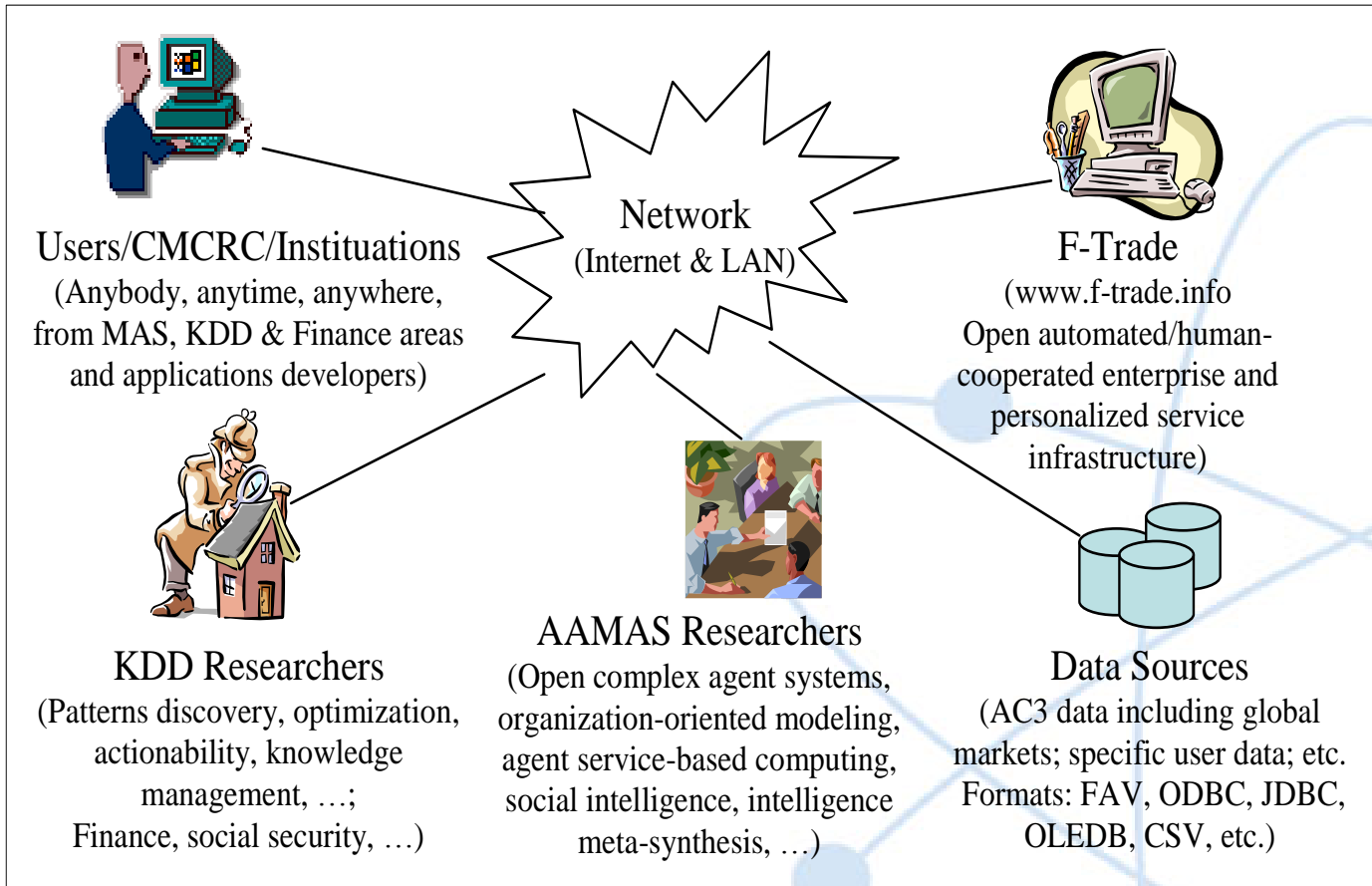


Figure 3. Cumulative cost/benefit ratio of each golden trading strategies (Year: 2003-2006, Market: Hongkong, Strategies: MA, FR, CB, SR, OBV, and Integrative)

F-Trade: Support Smart Trading

- Support Trading,
 - ◆ e.g., identifying better trading rules
- Support Surveillance,
 - ◆ e.g., identifying exceptional trading behavior
- Support Data Mining,
 - ◆ e.g., developing actionable trading strategies
- Support Agents,
 - ◆ e.g., developing multi-trading agent learning

Organizational scheme



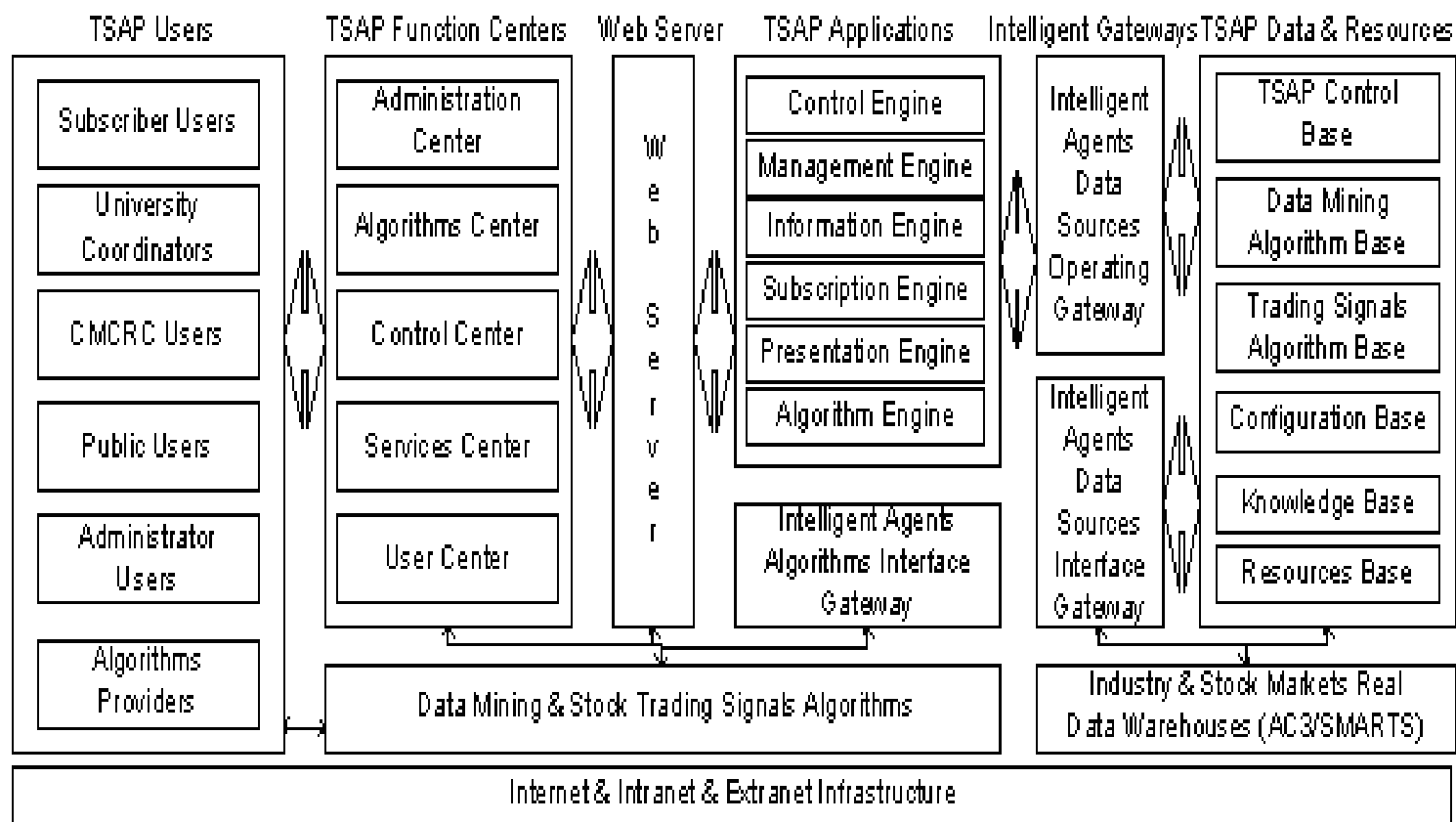
System environment

- **Data**
 - ◆ Global market orderbook data (tick-by-tick & daily)
 - ◆ AC3, CMCRC, SIRCA Ltd.
- **Implementation**
 - ◆ Web-based
 - ◆ Java, C, XML, SQL
 - ◆ Unix, Linux, Windows
 - ◆ App server (UTS) + database server (UTS) + data warehouse (AC3) + browsers
- **Trading rules/strategies**
 - ◆ Brokers/firms/financial researchers/data mining
- **System history**
 - ◆ TSAP 1 (2003) → F-Trade 2 (2004) → F-Trade 3 (coming)

Agent-based data mining infrastructure

- Software engineering of open complex agent systems
- OSOAD: Organization and Service Oriented Analysis and Design
 - ◆ Organizational abstraction
 - ◆ Organization-oriented analysis
 - ◆ Agent service-oriented design
- Agent service-based plug-n-play
 - ◆ Agent service-based system modules and services
 - ◆ Agent-based trading rules, DM algorithms
 - ◆ Remote data access, message passing, transactional processing, data sources
- Agent ontology-based management
 - ◆ Ontology for managing modules, algorithms, data sources, users
 - ◆ System reconstruction, personalization, customization
 - ◆ Human-agent interaction, interface management

Agent-based data mining infrastructure



Agent-driven data mining

- Agent service-based infrastructure
- Agentized trading rules and algorithms
- Agent ontology for rule/algorithm registration, in/out interface generation, etc
- Agentized rule/algorithm recommendation, subscription, reporting
- Message passing, request/response, dispatching among rules, interfaces, resources, reports, users

Control center

The screenshot displays the 'Financial Trading Rules Automated Development & Evaluation (F-TRADE 2.0)' web application. The browser window shows the URL 'http://deanning.it.uts.edu.au:8000/fsp/lophAction.do'. The application title is 'Stock Trading Signals Assessment Platform'. The main content area is titled 'F-TRADE Function Tree Configuration' and contains two identical configuration forms. Each form has a left-hand navigation menu with categories like 'Administration Center', 'Algorithms Center', 'Control Center', 'Services Center', and 'User Center'. The configuration forms include fields for 'Current Item ID', 'Current Item Name', 'Current Action', 'Action Type', 'SubItem Name', 'Action URL Object', and 'Action Type'. The top form shows 'Current Item ID: 10', 'Current Item Name: test', and 'Current Action: testAction.do'. The bottom form shows 'Current Item ID: 6' and 'Current Item Name: User Center'. Both forms have 'Modify Item' and 'Delete Item' buttons. The browser's address bar shows '207 blocked' and 'Autofill' options.

Financial Trading Rules Automated Development & Evaluation (F-TRADE 2.0)

Log Out 

- F-TRADE
 - Administration Center
 - Algorithms Library
 - Management
 - Algorithms Subscription
 - Management
 - CMCRC-Related
 - Institutions
 - Data Mining Resource
 - Management
 - Trading Signals Resources
 - Management
 - User Information
 - Management
 - User Notices Management
 - User Types Management
 - Algorithms Center
 - Algorithms Execution
 - Available
 - Algorithms Logon
 - Configuration
 - Algorithms Parameters
 - Snapshot
 - Algorithms Running Log
 - DataSources Configuration
 - Control Center
 - F-TRADE Function Tree
 - User Permission Control
 - Services Center
 - Algorithms Broadcast
 - Data Mining Resources
 - F-TRADE Introduction
 - F-TRADE Manual
 - Subscriptions Processing
 - Trading Signals Resources
 - User Notices
 - User Center
 - User Info Maintenance

- F-TRADE
 - Administration Center
 - Algorithms Library Management
 - Algorithms Subscription
 - Management
 - CMCRC-Related Institutions
 - Data Mining Resource Management
 - Trading Signals Resources
 - Management
 - User Information Management
 - User Notices Management
 - User Types Management
 - Algorithms Center
 - Algorithms Execution Available
 - Algorithms Logon Configuration
 - Algorithms Parameters Snapshot
 - Algorithms Running Log

F-TRADE Function Tree Configuration

Current Item ID:	<input type="text" value="3"/>
Current Item Name:	<input type="text" value="F-TRADE Funct"/>
Current Action:	<input type="text" value="/managerAction.do"/>
Action Type:	<input type="text" value="showframe"/>
	Modify Item Delete Item
SubItem Name:	<input type="text" value="Strategy Upda"/>
Action URL Object:	<input type="text" value="/strategyUpdateAction.do"/>
Action Type:	<input type="text" value="update"/>
	Add SubItem

Introduction

This is a web-based platform (F-TRADE) used to evaluate Stock Trading Signals and data mining algorithms. This platform is built on the huge historical and real stock information. It can be logged on from anywhere at anytime after register.

Individual investors can choose any built-in trading algorithm (or strategy) for any stock they choose to evaluate the performance of your strategy in history. The users can try to set different values for the parameters to find out the best combinations for the best performance of the strategy.

Besides the above function, brokers can build your own trading algorithms to plug-in the platform online for your private use to evaluate the performance. You can benefit from the huge historical real stock information under the platform. You can also benefit from the testing to find the best combinations of the parameters.

The F-TRADE platform includes five centers which are User center, Algorithm center, Administration center, Control center, and Service center. For the new users, please click "[User Manual](#)" to read on-line user manual. For the experienced users, please click the relevant functional icons in the left column. For the inquiry, please send email to the [Web Master](#).

Trading strategies of trading agents

Stock Trading Signals Assessment Platform - Windows Internet Explorer

http://datamining.it.uts.edu.au:8090/hsap/hsapAction.do

Google

Stock Trading Signals Assessment Platform

Financial Trading Rules Automated Development & Evaluation (F-TRADE 2.0)

Log Out

Algorithms Library Management

Algorithms Validity: Invalid Valid All

Algo Name	Algo Component Name	Algo Date	Algo Descr	Algo Functionality	Algo Input Parameters
Channel Breakout Enhanced	algo.ChannelBreakoutEnhanced	2003-09-23	Channel formed by high and low during previous days, buy when exceeds channel, sell at the moment below the channel	low channel=TradeBandHigh	SecurityName;StartDate;CloseDate;TimePoint;PreviousDays;TradeBand;FixedBand;HoldDays;TransactionCost;
VWAP Money Flow Basic	algo.VWAPMoneyFlowBasic	2003-10-02	Observer historical VWAP & Money Flow	trend analysis	SecurityName;StartDate;EndDate;
VWAP Execution Strategy I	algo.VWAPExecutionStrategyI	2003-11-15	VWAP trade strategy	vwap observing	SecurityName;TradeType;StartDate;EndDate;PreviousDays;StartTime;EndTime;BinWindow;ExecutionWindow;Position;Short;Shares;Distribution;Ratio;TotalShares;
Filter Rule Advanced	algo.FilterRuleAdvanced	2003-11-05	spread test + abnormal return + FR Enhanced	SP48BFR	SecurityName;StartDate;EndDate;PreviousDays;FixedBandF;FixedBandD;DelayFilter;HoldTrades;BrokerFee;SpreadCost;AbnormalReturn;
MACD Basic Analysis II	algo.MACDBasic	2004-04-04	DIF & DEA analysis Moving Average Convergence and Divergence	MACD Basic Analysis	StockCode;Date;Start_Date;Close;Period;Long;Period;Short;Period;MACD;Price_Band;
VWAP Execution Strategy II	algo.VWAPExecutionStrategyII	2004-04-04	Execution Strategy II, scan @ once	scan @ once	StockCode;TradeType;Order;Size;Start_Date;End_Date;Start_Time;End_Time;Time_Window;Limit;MarketOrder;Ratio;Days;Volume;Forecast;
VWAP Execution Strategy IV Optimized I	algo.VWAPExecutionStrategyIVOptimizedI	2004-04-04	Execution Strategy IV Optimized I, storing all records	VWAP Execution Strategy IV Optimized	StockCode;TradeType;Order;Size;Start_Date;End_Date;Start_Time;End_Time;Min_Time;Window;Precision;Limit;MarketOrder;Ratio;Max_Days;Volume;Forecast;
VWAP Execution Strategy IV Optimized II	algo.VWAPExecutionStrategyIVOptimizedII	2004-04-04	Execution Strategy IV Optimized II, storing the optimum only, three optimization options	related to "VWAP Execution Strategy IV"	StockCode;TradeType;Order;Size;Start_Date;End_Date;Start_Time;End_Time;Optimization_Objective;Min_Time;Window;Precision;Limit;MarketOrder;Ratio;Max_Days;Volume;Forecast;
VWAP Money Flow Online	algo.VWAPMoneyFlowOnline	2004-05-13	online to ac3	online	MarketCode;StockCode;Start_Date;End_Date;
Moving Average Enhance Online	algo.MovingAverageEnhanceOnline	2004-05-13	online to ac3	online	MarketCode;SecurityName;StartDate;CloseDate;ShortTermDays;LongTermDays;TimePoint;FixedBand;DelayFilter;HoldDays;TransactionCost;

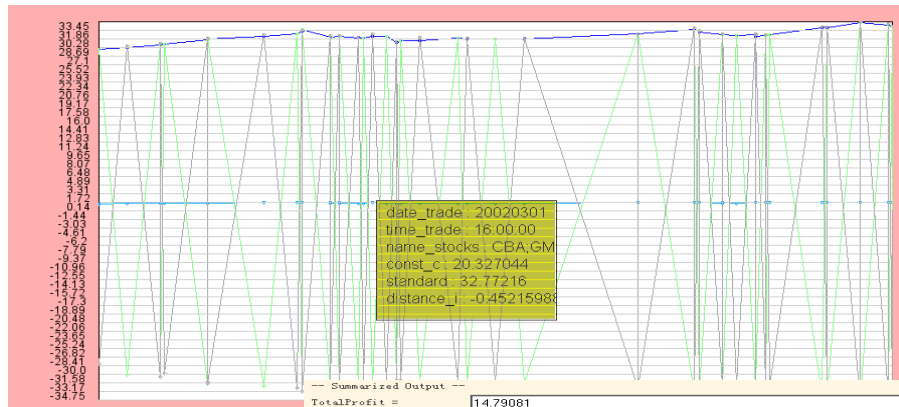
Done

Windows taskbar: Start, AA04307, AA04307, Index for Bca..., Welcome to A..., SquareBel1..., Stock Trading..., vwapmoney..., NATLAB 7.3..., Help, cas.doc - Not..., IED2: final.doc..., F-Trade.com, Microsoft Front..., Internet, 100%, 12:53 PM

Data mining-driven trading agents

- Data mining based trading rule agents
- KDD-driven trading agent optimizers with better rules and higher performance
- Mining actionable trading rules for trading agents in generic trading pattern set
- Parameter tuning of trading rule agents
- Trading rule recommenders
- Trading user assistants with better trading strategies

- Pairs mining based trading agent
 - Mining correlated stock pairs
 - Correlated stock miner agent
 - Stock pairs recommender
 - Pairs trading strategy solution



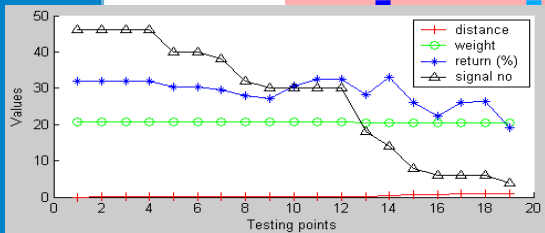
Security1 =

Security2 =

StartDate =

CloseDate =

PriceDistance =



--- Summarized Output ---

TotalProfit = 14.79081

BaseValue = 35.039413

RateReturn = 42.21192%

PairsTrades = 56

SystemStatus = TransactionNumber: 1506

--All Trading Records Found by Your Trading Rules : Pairs Trading Algorithm 1--

DATE_TRADE	TIME_TRADE	NAME_STOCKS	CONST_C	STANDARD	DISTANCE_I
20020102	10:30:00	CBA, GMF	21.768452	28.237844	1.5623555
20020108	12:00:00	CBA, GMF	20.391891	30.504902	-0.32490158
20020115	10:30:00	CBA, GMF	20.722973	30.504902	0.16509819
20020115	11:00:00	CBA, GMF	20.419333	30.91713	-0.2881298
20020116	10:30:00	CBA, GMF	21.234482	29.88656	0.9034405
20020125	10:30:00	CBA, GMF	20.532469	31.741585	-0.12158394
20020125	11:00:00	CBA, GMF	20.69261	31.535471	0.124528855
20020125	11:30:00	CBA, GMF	20.515494	31.947699	-0.1406988
20020125	12:30:00	CBA, GMF	20.681818	31.741585	-0.1084156
20020208	11:30:00	CBA, GMF	20.442404	32.566044	-0.26704407
20020213	15:30:00	CBA, GMF	20.748592	30.566044	0.21926427

Conclusions

- Trading agent can support real-life smart trading
- Actionable trading strategies are essential
- Actionability enhancement, optimization, and integration are important
- Actionable trading support system are very useful

Acknowledgements

- Many people have contributed to this research:
- From UTS:
 - ◆ A/Prof. Longbing Cao
 - ◆ Dr Jiarui Ni
 - ◆ Dr Li Lin
 - ◆ Dr Jiaqi Wang
- From CMCRC
 - ◆ Prof. Michael Aitken
 - ◆ Prof. Alex Frino

The End

Thanks!



<http://datamining.it.uts.edu.au>

<http://www.qcis.uts.edu.au>