

Automated Trading System using Swarm Intelligence

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Overview

- Briefly on our project proposal by Ratchanon
- Our experiments by Papon
- Results and Discussions by Sirapop
- Application demo
- Possible future works

BRIEFLY ABOUT OUR PROPOSAL

- Importance of our work
 - Stock trading is risky.
 - Amateur investors lack of skills and experiences.
 - Human errors in decision making



The image is a collage of financial market data. On the right, there's a curved display showing various stock indices and sector performance. Visible text includes 'NASDAQ COMPOSITE' with a value of 10252.29, 'S&P 500 Index' with a value of 1165.69, and 'NASDAQ COMPOSITE' with a value of 1994.43. Other visible values include 179.73, 3552.58, 2957.81, 902.63, 681.22, 1165.69, 11.64, 1.0%, 17.11, 1.0%, 34.77, 1.1%, 17.11, 1.0%, 34.77, 1.1%, 17.11, 1.0%, 34.77, 1.1%. On the left, there's a person in a blue suit and tie, pointing their finger at a screen. The screen displays a line graph with a green line and several dollar signs (\$\$) floating around it.

- # BRIEFLY ABOUT OUR PROPOSAL
- Importance of our work
 - Stock trading is risky.
 - Amateur investors lack of skills and experiences.
 - Human errors in decision making
- 
- The image is a collage of financial market data. On the right, there is a large, curved display showing various stock market indices and sector performance. The NASDAQ Composite index is prominently displayed at the top right, showing a value of 10,252.29 with a +1.1% change. Below it, the S&P 500 Index is shown at 1,165.69 with a +1.0% change. Other indices like the NYSE Composite and Russell 2000 are also visible. The display is divided into sections for different sectors, including Finance, Technology, and Healthcare, each showing their respective performance. On the left, there is a smaller image of a person in a blue suit and tie, pointing their finger towards a screen. The screen displays several dollar signs (\$) and a line graph, suggesting a focus on financial analysis or investment. The overall theme is financial markets and investment.



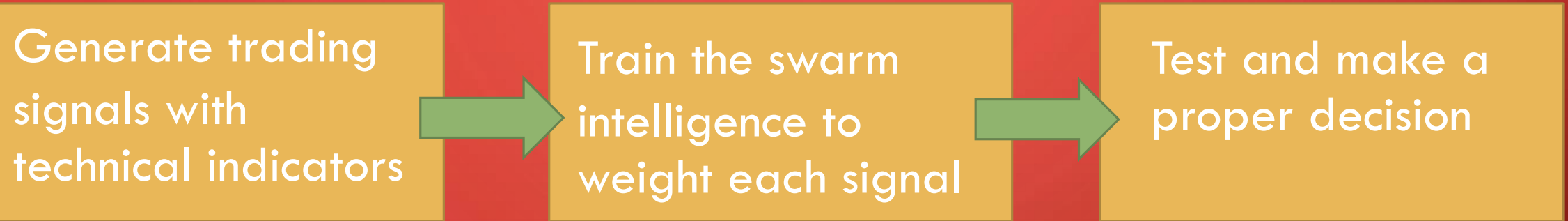
BRIEFLY ABOUT OUR PROPOSAL (CONT.)

- Technical analysis?
 - An attempt to forecast stock prices on basis of market-derived data.
 - Looking for trends and patterns in the data.
 - Open, close, high and low prices are inputs
- Technical indicators?
 - To generate buy and sell signals
 - To confirm price movement.
 - Many indicators, but can't really rely on just one indicator.



BRIEFLY ABOUT OUR PROPOSAL (CONT.)

- Our new approach to trading



$$Decision = \frac{\sum_{i=1}^n signal_i weight_i}{\sum_{i=1}^n weight_i}$$

If	Decision $> t_D$	→ Buy
	Decision $< -t_D$	→ Sell
Else		→ Hold/Do nothing

BRIEFLY ABOUT OUR PROPOSAL (CONT.)

- Technical Indicators used...
 - Simple Moving Average : SMA 100
 - Exponential Moving Average : EMA20/50, EMA20/100, EMA50/100
 - Moving Average Convergence Divergence (MACD)
 - Relative Strength Index (RSI)
 - Stochastic Oscillator (STO)
 - Commodities Channel Index (CCI)
 - William Percent Range (%R)



Briefly about our proposal (cont.)

- ▶ Swarm Intelligence?
 - ▶ consists typically of a population of simple agents interacting locally with one another and with their environment.
 - ▶ Two sample algorithms used in this project
 - ▶ PSO
 - ▶ CLONALG
 - ▶ To optimize each weight of each signal in decision equation.



► PSO

Step 1 : Initialization

Step 2 : Evaluate the objective function values of all particles in the swarm

Step 3 : Update personal best (P_i) and global best (P_g) in the swarm

Step 4 : Calculate velocity of each particle

Step 5 : Update position of each particle

Step 6 : Redo step 2 - 5 until the stopping criteria is met.

► CLONALG

Step 1 : Initialize antibodies AB

Step 2 : Evaluate affinities of all antibodies AB_i

Step 3 : Select n best antibodies according to their affinities $\rightarrow SAb$

Step 4 : Clone the selected antibodies for p numbers $\rightarrow C$

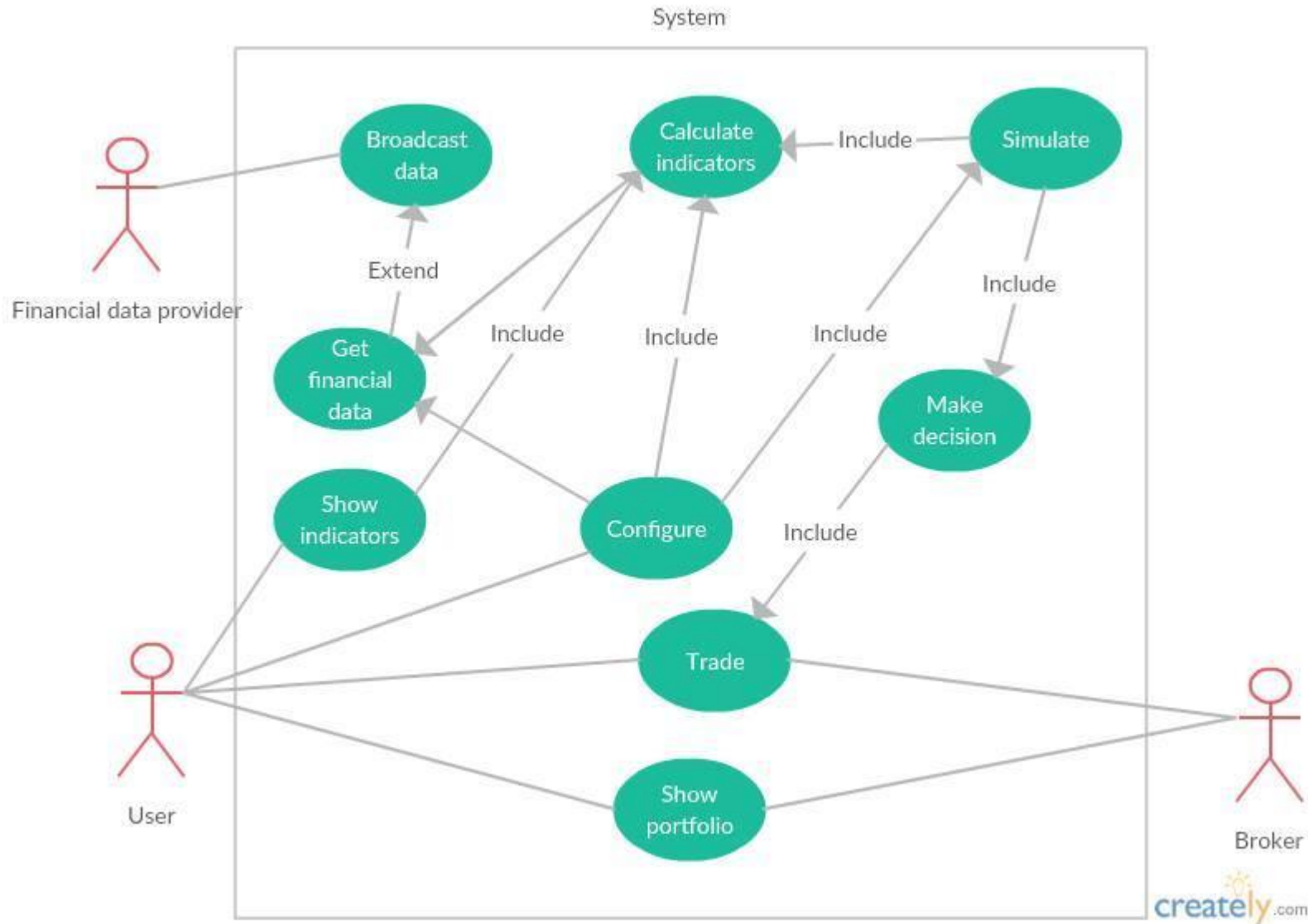
Step 5 : Mutate the clones

Step 6 : Evaluate affinities of the clones

Step 7 : Foreach C_i in C and AB_i in AB
If affinity of $C_i \geq AB_i$
Replace AB_i with C_i

Step 8 : Redo step 3-7 until the stopping criteria is met.

Briefly about our proposal (cont.)



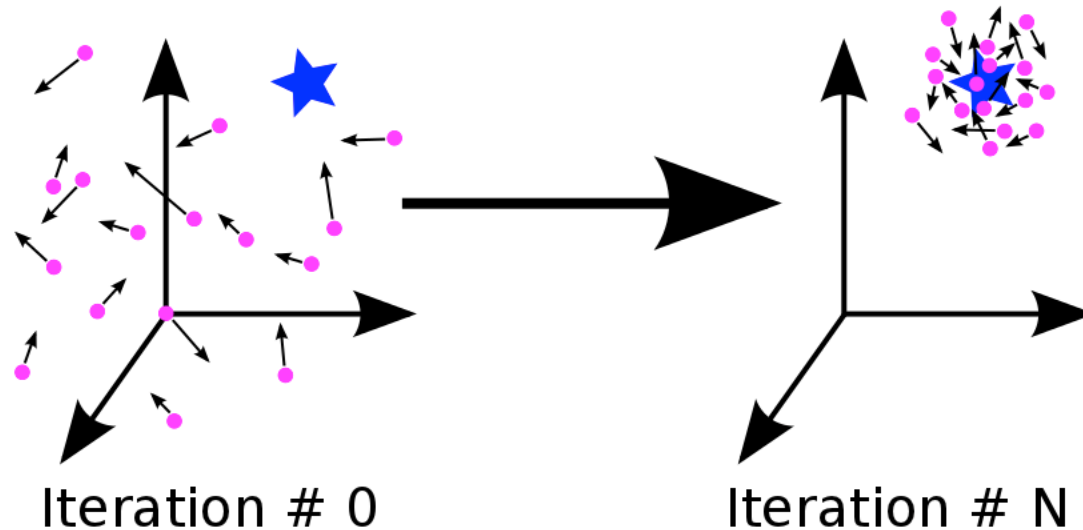
Our experiments

- ▶ Command line version of our application
- ▶ 10 highly active stocks from NYSE
- ▶ 10 stocks from SET
- ▶ Historical data from 2015 to 2016 downloaded from *finance.yahoo.com*.



Our experiments

- ▶ The first experimentation
- ▶ The use of PSO to optimize weights and make decision for every experimented data record.
- ▶ The objective function : % of return/initial money
- ▶ Goals :
 - ▶ Performance comparison with Buy & Hold and signal follow strategies.
 - ▶ Study the effects of changes in *decision threshold*. (0.1, 0.3, 0.5)
 - ▶ Study the effects of changes in population number between 20 and 25.



Our experiments (cont.)

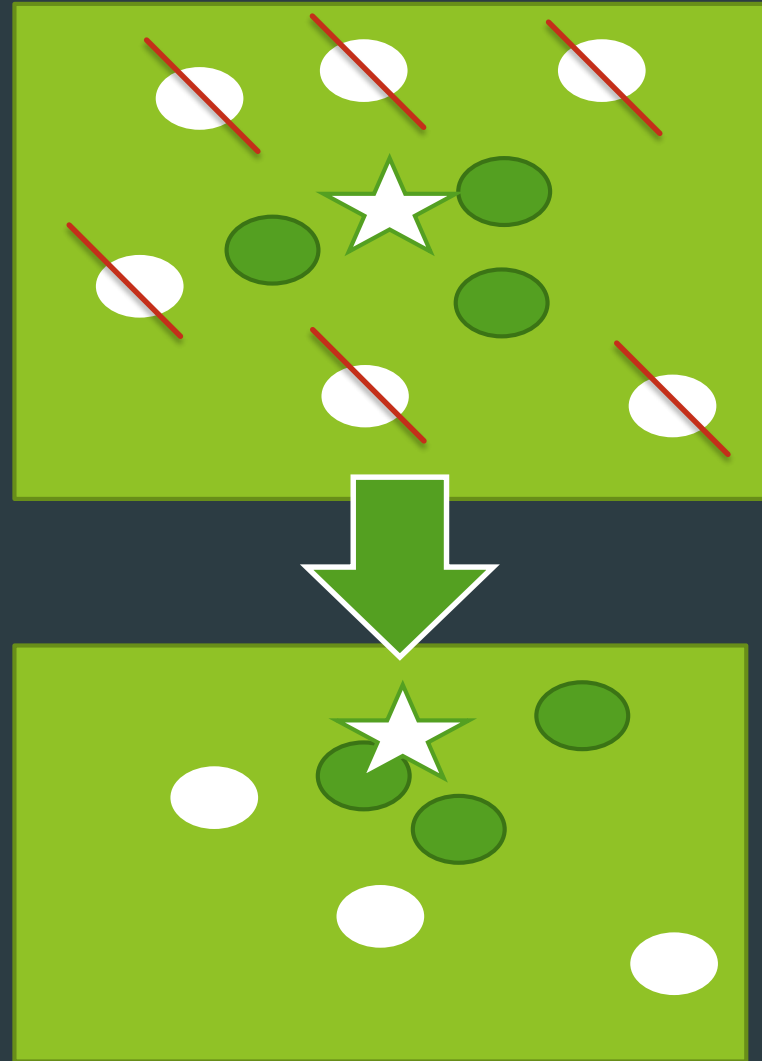
- ▶ Parameters of PSO
 - ▶ J. Kennedy and R. Eberhart version of PSO (1995)
 - ▶ c_1, c_2 from 2.5 to 0.5 and from 0.5 to 2.5, respectively
 - ▶ Inertia weight from 0.9 to 0.4
 - ▶ Refer to empirical studies by Shi and Eberhart (1999)

$$c = (c_f - c_i) * \left(\frac{calls}{MAXOBJCALLS} \right) + c_i$$

$$\text{Inertia weight } \omega = (\omega_i - \omega_f) * \left(\frac{MAXOBJCALLS - calls}{MAXOBJCALLS} \right) + \omega_f$$

Our experiments (cont.)

- ▶ The second experimentation
- ▶ The alternative algorithm
 - ▶ CLONALG
 - ▶ Performance comparison with PSO
 - ▶ Use the most effective threshold from previous experimentation.
 - ▶ The parameters follow the work of Castro, L.n. De, and F.j. Von Zuben's CLONALG.



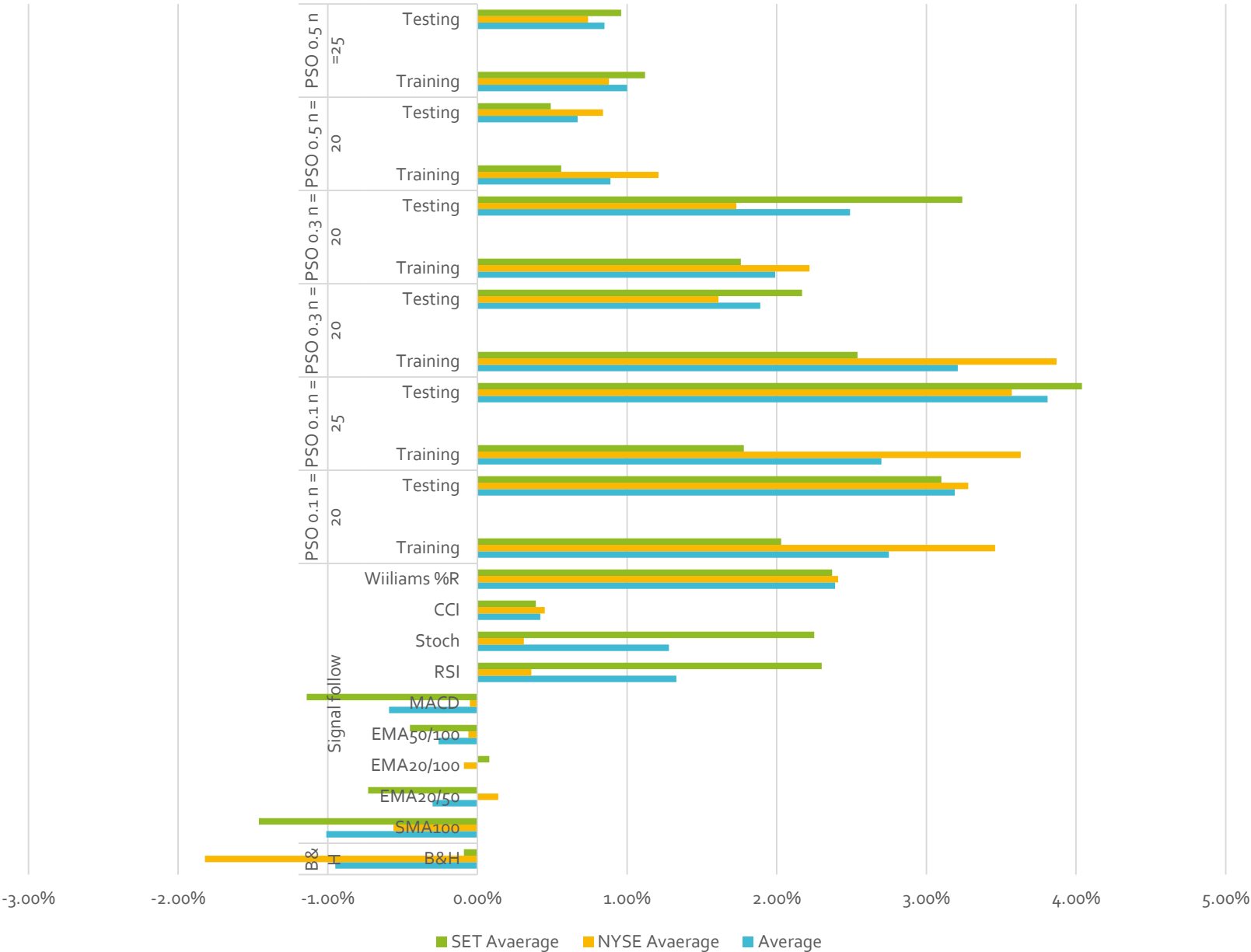
Our experiments (cont.)

- ▶ Parameters of CLONALG
 - ▶ 100% of selected antibodies with high affinity values (Objective function values)
 - ▶ 20% of antibodies with low affinity values will be replaced.
 - ▶ Multiplying factor (β) is set 1.
 - ▶ Low affinity value, high hypermutation rate. (Relation with highest affinity)

$$\text{Number of clones} = \sum_{i=1}^n \text{round}(\beta * \text{Population size})$$

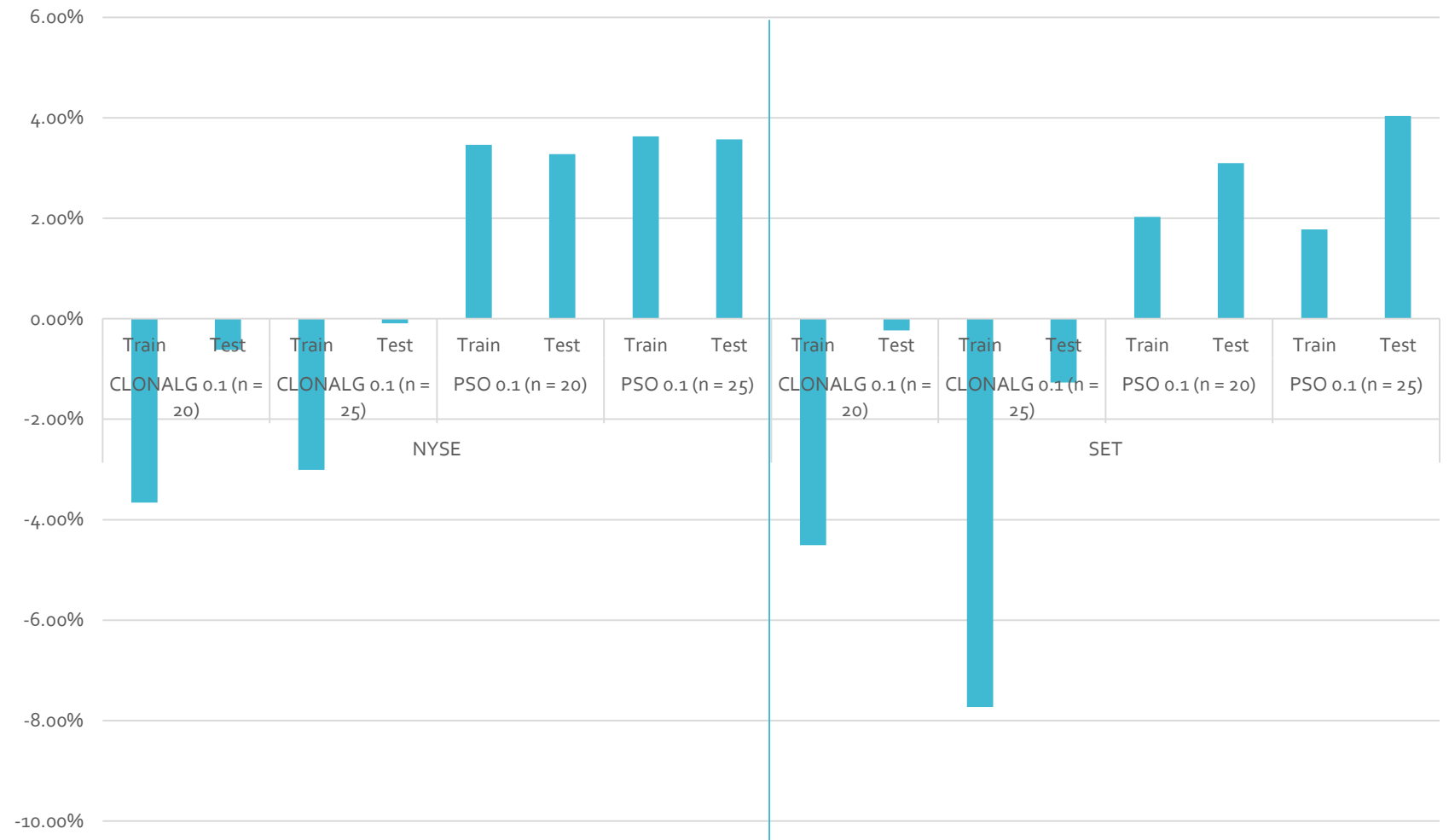
Results and Discussions

- Experiment 1



Results and Discussions (cont.)

- Experiment 2



Results and Discussions (cont.)

- Our GUI

The screenshot displays a Windows-style application window titled "MainWindow". It features a menu bar with "File", "View", "Tools", and "Help". Below the menu is a tabbed interface with four tabs: "Trading order", "History", "Result", and "Portfolio". The "Portfolio" tab is currently selected, revealing a yellow background with the text "Your portfolio" at the top. The main area contains several input fields: "Portfolio value", "Cash", "Profit/Loss", "Stock quote" (paired with a "Company name" field), and "No. of shares in your account" (paired with a "Price per share" field). At the bottom of this section are two buttons: "Deposit cash" (blue) and "Withdraw cash" (pink). To the right of the main content area is a vertical sidebar with a blue background and an orange border, containing two buttons: ". Run ." (cyan) and ". View Graph ." (pink).

Results and Discussions (cont.)

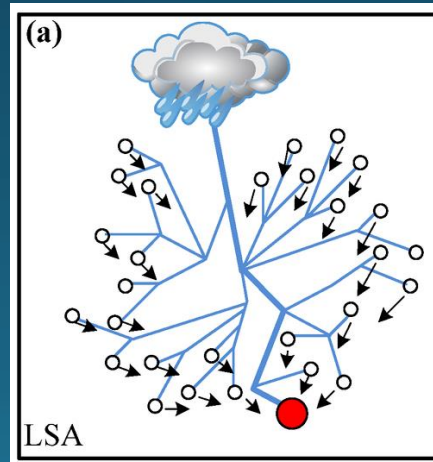
- Our program can utilize the ability of swarm intelligence to make a trading decision for users.
 - Overall, PSO works better than CLONALG
 - Both algorithms work better than Buy & Hold strategy
- Our program has user-friendly graphic user interface. General users can easily understand the steps of using this application.

Application Demo

- ▶ Minimum system requirements
 - ▶ Windows 7 32/64 bit
 - ▶ Minimum free space : 500 MB
 - ▶ Python 3.6.1
 - ▶ R Studio 1.0.143
 - ▶ Qt 5.8.0


Possible future works

- Add technical indicators to the system
- Add alternative swarm intelligence algorithms
- Better options and parameters configuration
- More add-ons for showing graphs aside from R and Python



References

- ▶ **Worasuchee C., Nuannimnoi S., Khamvichit R., and Attagonwantana P.** “An Automatic Stock Trading System using Particle Swarm Optimization.” **IEEE 14th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology. Phuket, 2017.**
- ▶ Castro, L.n. De, and F.j. Von Zuben. "Learning and Optimization Using the Clonal Selection Principle." *IEEE Transactions on Evolutionary Computation* 6.3 (2002): 239-51.
- ▶ Y. Shi and R. C. Eberhart, “Empirical study of particle swarm optimization,” in *Proc. IEEE Int. Congr. Evolutionary Computation*, vol. 3, 1999, pp. 101–106.
- ▶ Stevens, Leigh. *Essential Technical Analysis: Tools and Techniques to Spot Market Trends*. New York, NY: Wiley, 2002.



Q&A