

# **E-education Environment for Scientific Collaboration and Graduate Studies:**

## ***Virtual Financial Market***

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# Introduction

In 1975 the well-known mathematician and educator Paul Halmos said:

"The best way to learn is to do;  
the worst way to teach is to talk.

The best way to teach is to make students ask, and do.  
Don't preach facts- stimulate to act"

P. HALMOS, *The problem of learning to teach*, *Amer. Math. Monthly* 82 1975, 750-758

**We shall discuss how to follow this idea.**

The objective is to start collaboration with educators, researchers and students of different universities along similar lines.

# Web-Sites

The identical web-sites  
contain the complete two-semester course:

*[http : //optimum2.mii.lt](http://optimum2.mii.lt)*

*[http : //optimum2.mii.lt](http://optimum2.mii.lt) : 8080*

*[http : //pilis.if.ktu.lt/~jmockus](http://pilis.if.ktu.lt/~jmockus)*

*[http : //pilis.if.ktu.lt](http://pilis.if.ktu.lt) : 8090*

*[http : //kopustas.elen.ktu.lt/~jmockus](http://kopustas.elen.ktu.lt/~jmockus)*

*[http : //kopustas.elen.ktu.lt](http://kopustas.elen.ktu.lt) : 8080*

*[http : //eta.ktl.mii.lt/~mockus](http://eta.ktl.mii.lt/~mockus)*

*[http : //mockus.org/optimum](http://mockus.org/optimum)*

Ports 8080 and 8090 open servlets.

The course is updated at the end of each semester  
responding to students preferences and contributions.

# Graduate studies

## Learning

All the needed materials are on the web as 120 slides (basic formula), books (complete description), and Java applets and servlets for running and updating

## Evaluation

Is in the form of scientific seminar:  
the teacher just responds to students questions and comments.

Important part of evaluation is the quality of home work.  
Attendance is regarded, too.

## Learning Tools

Standard tools of distance studies provides knowledge and skills.

Virtual environment develops creative abilities.

# Applications

## Examples of Virtual Environments:

1. Virtual financial market.
2. Virtual housing market.
3. Virtual computer market.
4. Virtual car market.
5. Virtual container.
6. Virtual Walras market.
6. Prediction models.
7. Optimal investment model.
8. Optimal school scheduling model.

All the examples illustrate a new approach to important real life problems

These and the other examples are open and available for any interested person with internet connection.

# Stock Rates, 100 Virtual Stocks

Figure 1 shows average daily stock rates for a virtual 'year' equal to 360 virtual 'working days'.

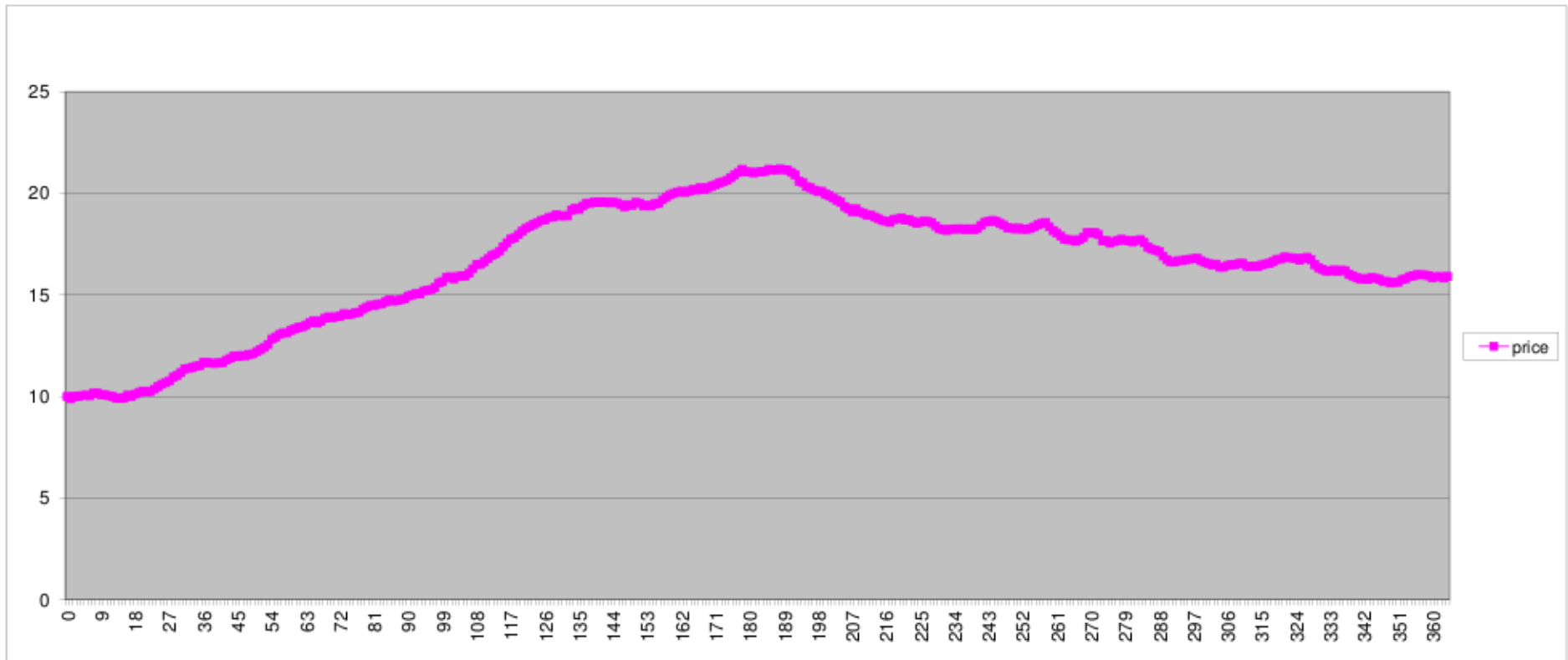


Figure 1: Average simulated prices, market inertia  $\alpha = 0.0$

# Daily Profits. 100 Virtual Stocks

Figure 2 shows average daily profits of eight prediction models.

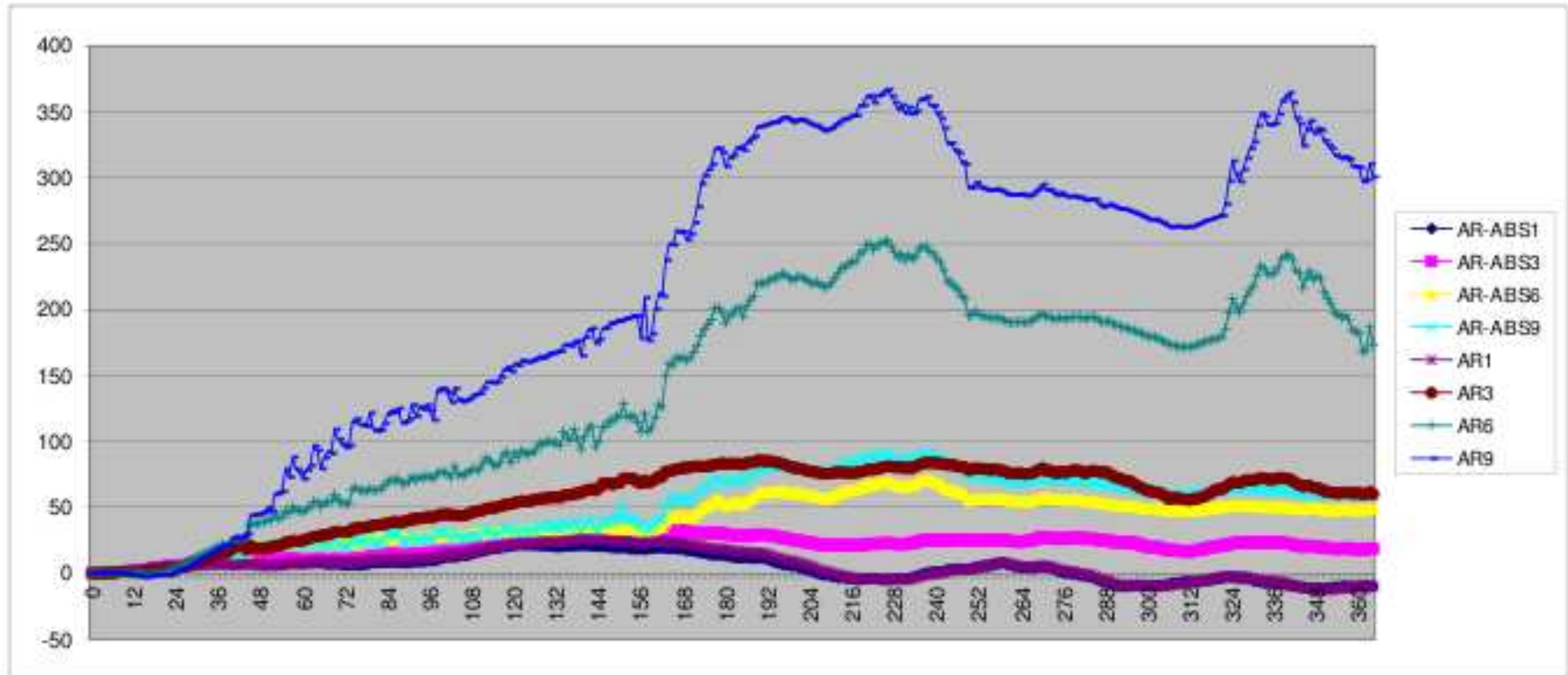


Figure 2: Final profits of eight prediction models,  $\alpha = 0.0$

# Final Profits, 100 Virtual Stocks

Figure 3 illustrates final profits of eight prediction models.

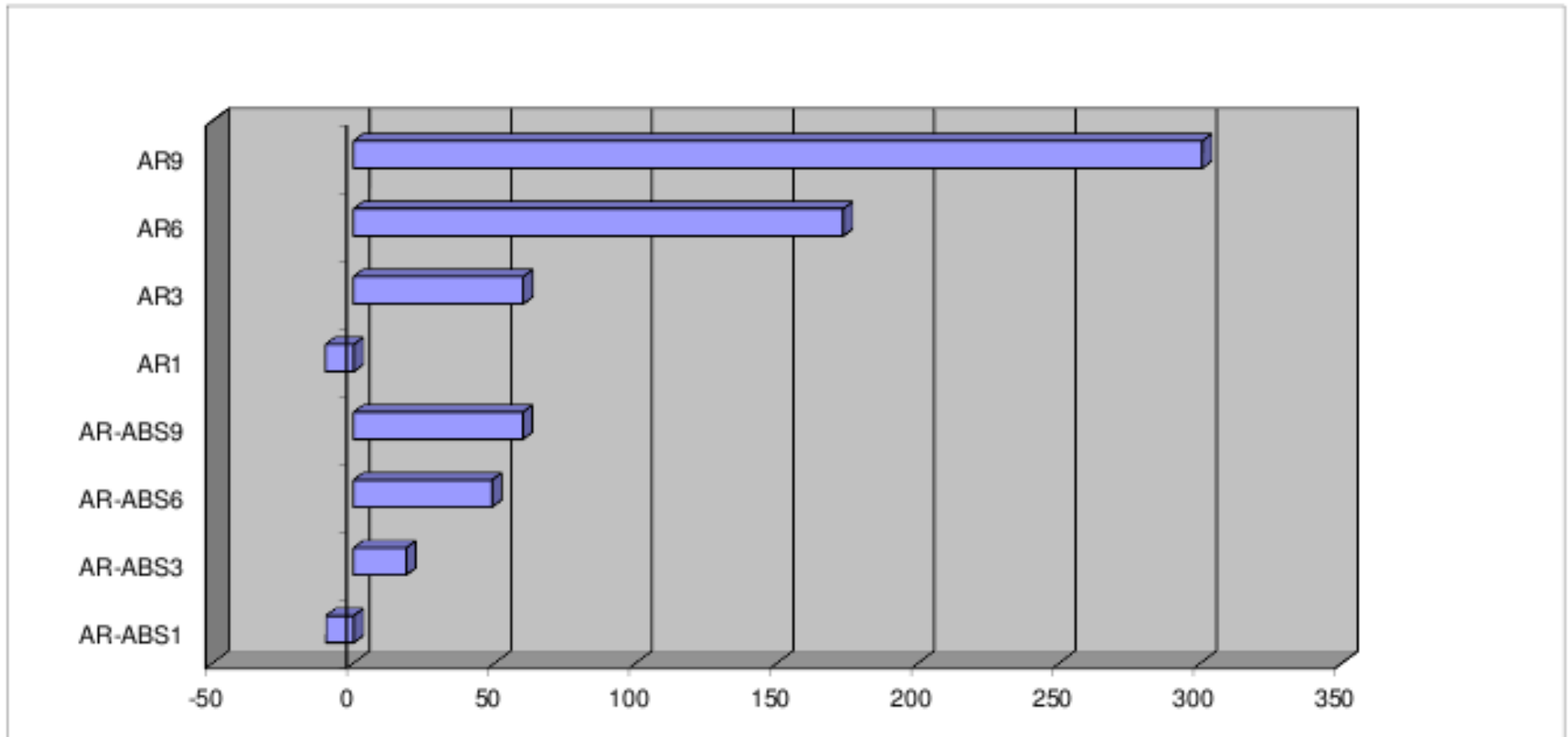


Figure 3: Final profits of eight prediction models,  $\alpha = 0.0$



# MSE, 100 Virtual Stocks

Figure 4 illustrates MSE of eight prediction models.

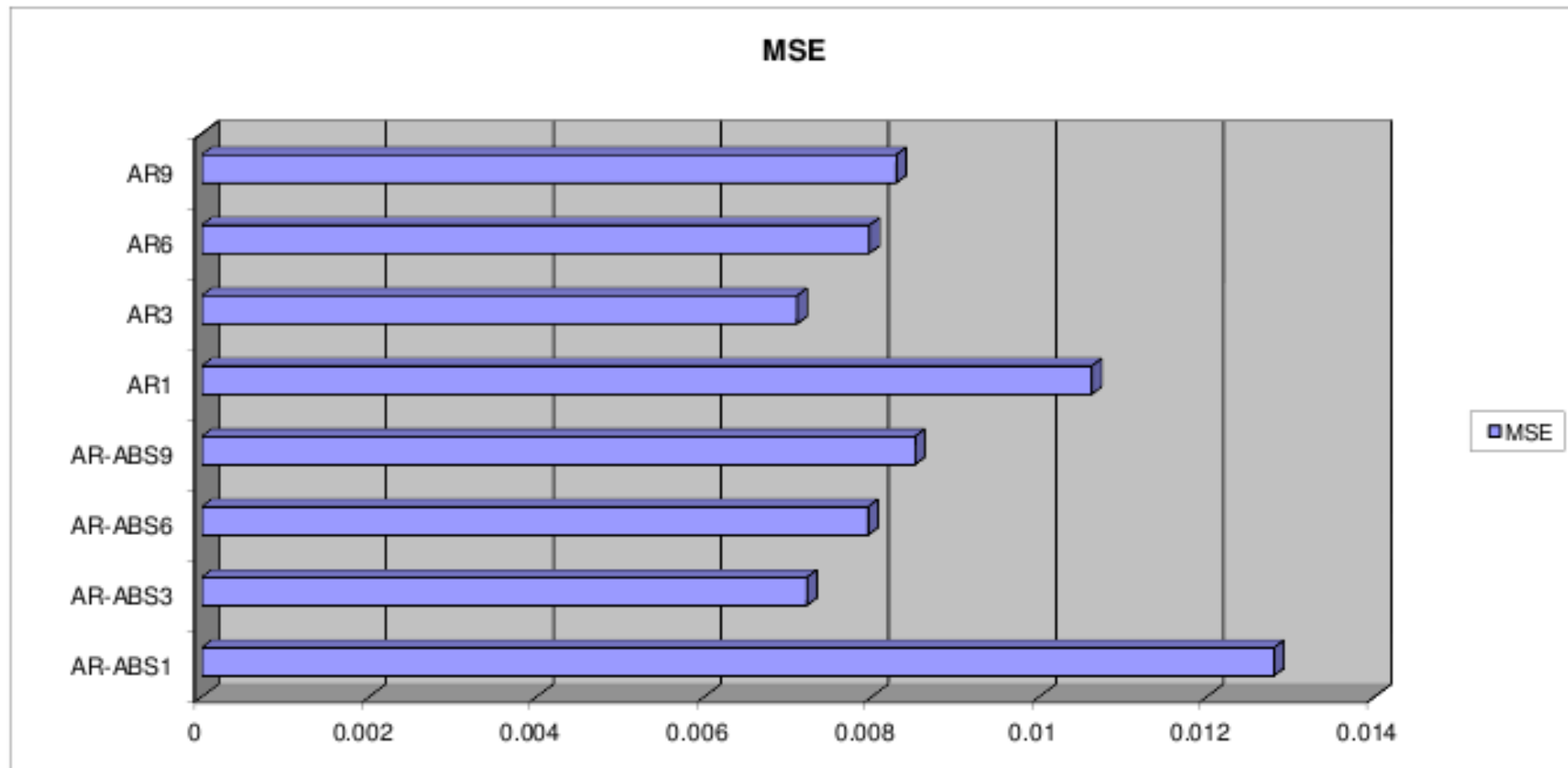


Figure 4: MSE of eight prediction models,  $\alpha = 0.0$

# MSE of 200 International Stocks

Figure 5 shows the average MSE of 200 stocks using AR(p) and AR-ABS(p),  $p=1,3,6,9$ .

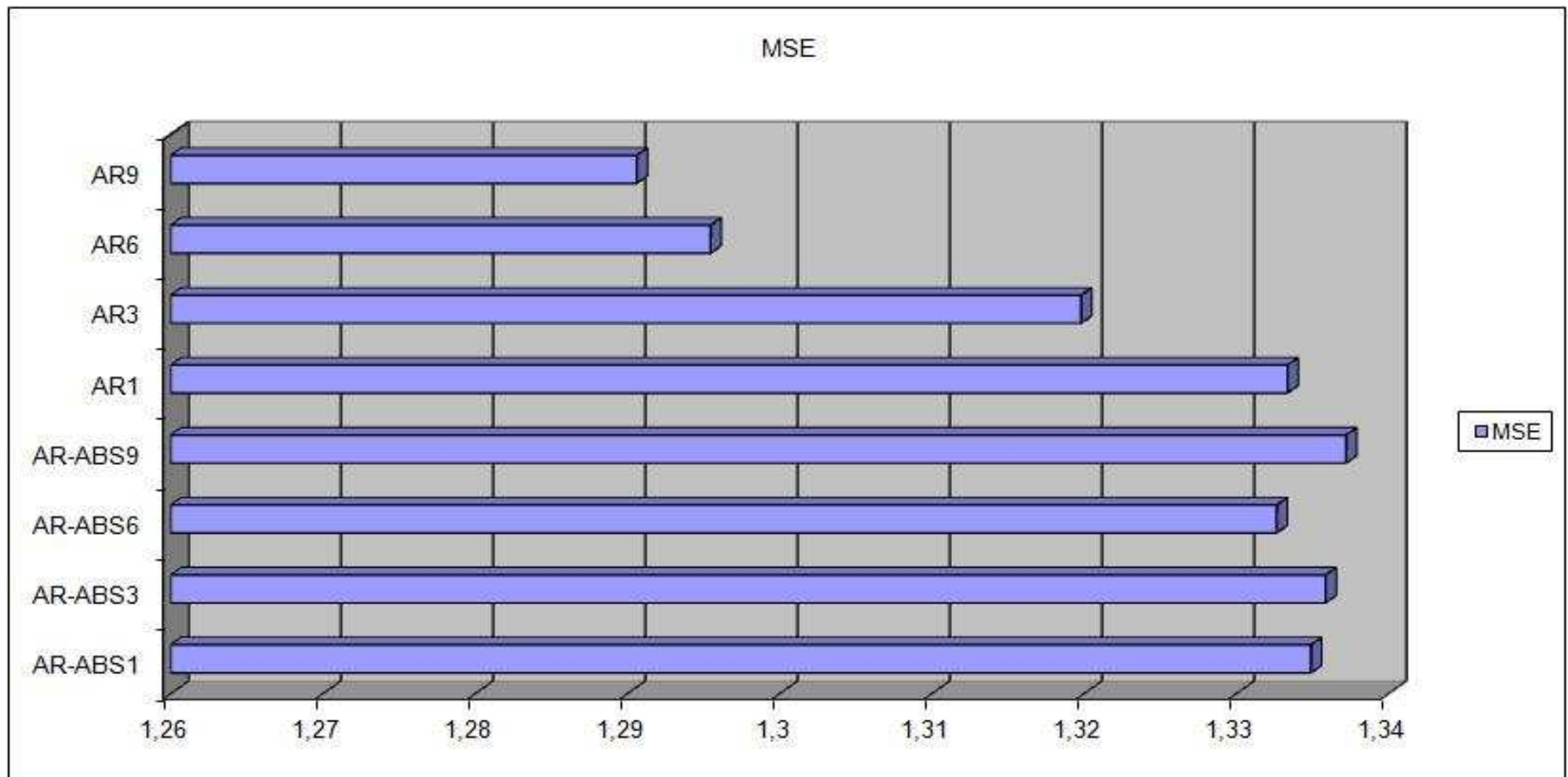


Figure 5: MSE of real stock market, average of 200 stocks

# Google Stock Profits

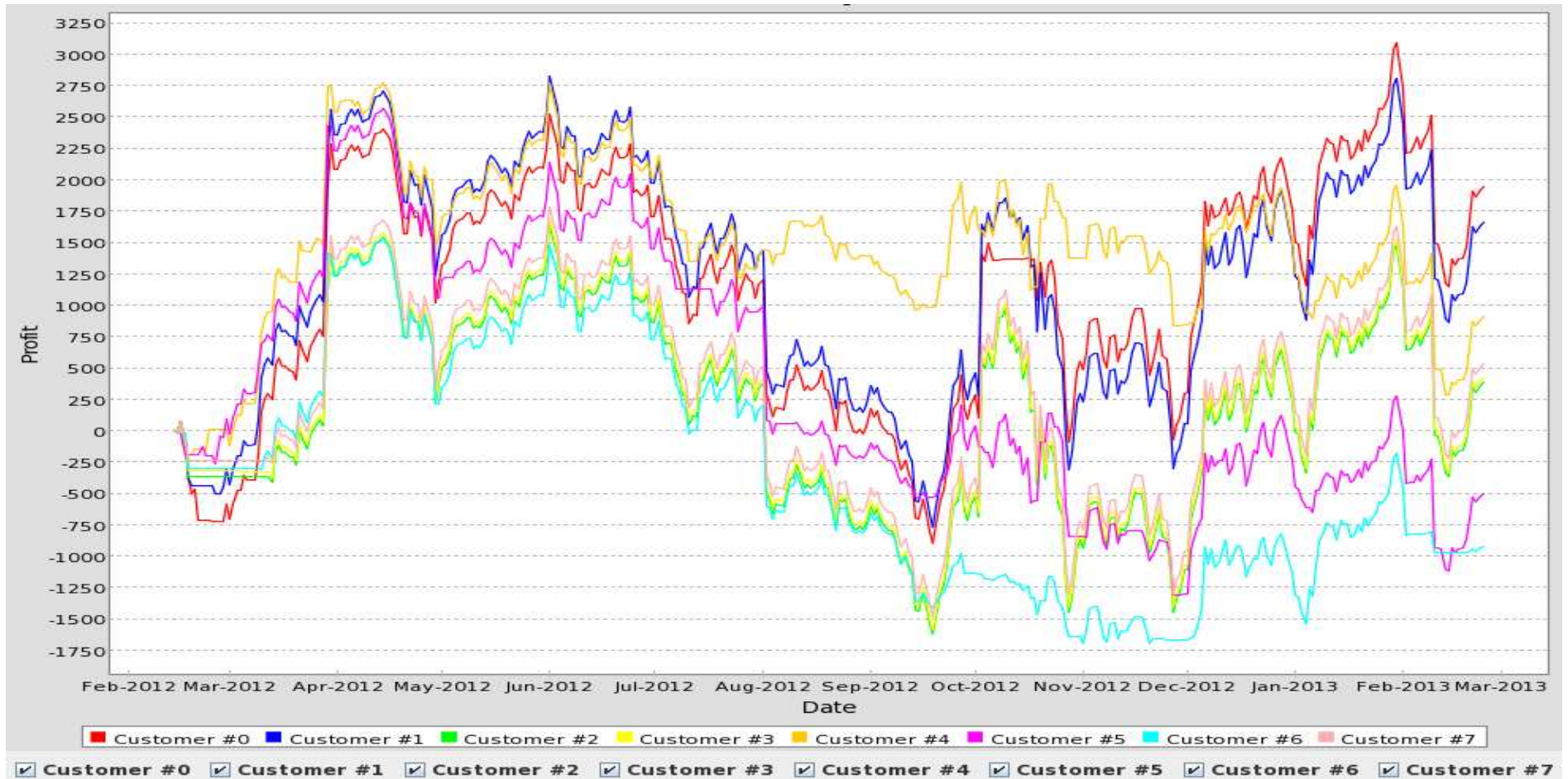


Figure 6: A sample of daily profits of eight customers buying-selling Google stocks

# Apple Stock Profits

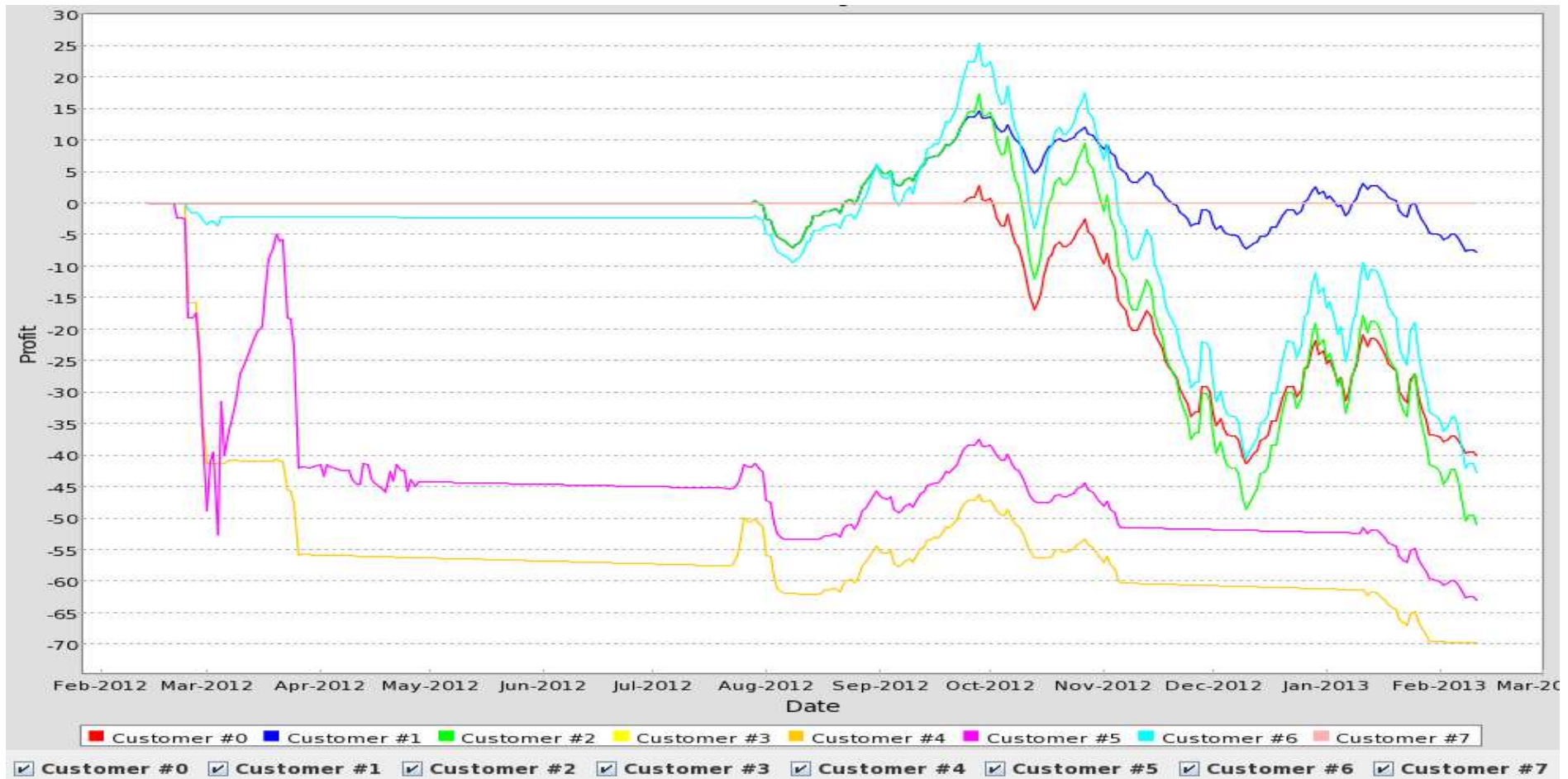


Figure 7: A sample of daily profits of eight customers buying-selling Apple stocks

# Bank Profit, 2000 Virtual Days

Figure 8 illustrates the bank profit

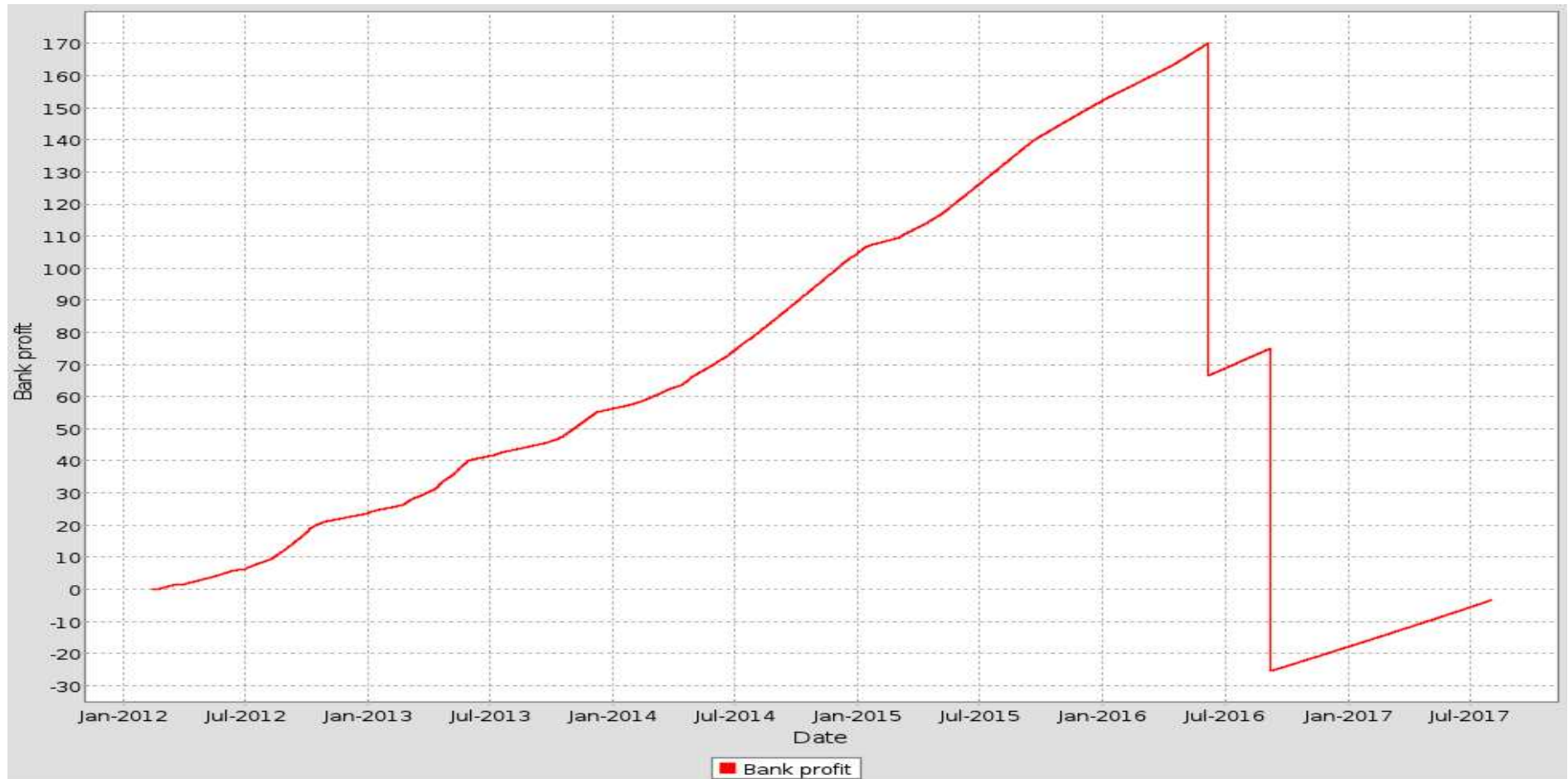


Figure 8: Bank profit



# Setup, Google Stocks

Figure illustrates the setup for Google stocks

|                     |                                   |                          |                                  |                       |                                  |
|---------------------|-----------------------------------|--------------------------|----------------------------------|-----------------------|----------------------------------|
| <b>Yield of CD:</b> | <input type="text" value="0.02"/> | <b>Transaction cost:</b> | <input type="text" value="0.5"/> | <b>Bank interest:</b> | <input type="text" value="0.1"/> |
|---------------------|-----------------------------------|--------------------------|----------------------------------|-----------------------|----------------------------------|

|                        |  |
|------------------------|--|
| <b>Stock options:</b>  |  |
| <b>Volatility:</b>     | <input type="text" value="0.9"/>         |
| <b>Dividend:</b>       | <input type="text" value="0.0"/>         |
| <b>Inertia:</b>        | <input type="text" value="0.9"/>         |
| <b>Limit X:</b>        | <input type="text" value="100.0"/>       |
| <b>Start from day:</b> | <input type="text" value="1"/>           |
| <b>Termin:</b>         | <input type="text" value="2000"/>        |
| <b>Choose data:</b>    | <input type="text" value="Real Data"/> ▼ |
| <b>Stock name:</b>     | <input type="text" value="GOOG"/>        |

Figure 9: Setup for Google stocks.

# Setup, 8 Major Stockholders

Figure shows the setup for 8 stockholders.

|  |  |  |  |
|--|--|--|--|
| <b>Customer #0</b><br>Method: AR-ABS9<br>Has stock : 19<br>Profit: 1943<br>max Credit: 10000.0<br>Borrowed sum: 9674<br>Insolvment: false<br>Force buy: 1.0<br>Force sell: 1.0 | <b>Customer #1</b><br>Method: AR-ABS6<br>Has stock : 19<br>Profit: 1660<br>max Credit: 10000.0<br>Borrowed sum: 9957<br>Insolvment: false<br>Force buy: 1.0<br>Force sell: 1.0 | <b>Customer #2</b><br>Method: AR-ABS3<br>Has stock : 18<br>Profit: 383<br>max Credit: 10000.0<br>Borrowed sum: 10623<br>Insolvment: false<br>Force buy: 1.0<br>Force sell: 1.0 | <b>Customer #3</b><br>Method: AR-ABS1<br>Has stock : 18<br>Profit: 425<br>max Credit: 10000.0<br>Borrowed sum: 10580<br>Insolvment: false<br>Force buy: 1.0<br>Force sell: 1.0 |
| <b>Customer #4</b><br>Method: AR9<br>Has stock : 17<br>Profit: 906<br>max Credit: 10000.0<br>Borrowed sum: 9487<br>Insolvment: false<br>Force buy: 1.0<br>Force sell: 1.0      | <b>Customer #5</b><br>Method: AR6<br>Has stock : 15<br>Profit: -501<br>max Credit: 10000.0<br>Borrowed sum: 9673<br>Insolvment: false<br>Force buy: 1.0<br>Force sell: 1.0     | <b>Customer #6</b><br>Method: AR3<br>Has stock : 10<br>Profit: -922<br>max Credit: 10000.0<br>Borrowed sum: 7036<br>Insolvment: false<br>Force buy: 1.0<br>Force sell: 1.0     | <b>Customer #7</b><br>Method: AR1<br>Has stock : 18<br>Profit: 531<br>max Credit: 10000.0<br>Borrowed sum: 10474<br>Insolvment: false<br>Force buy: 1.0<br>Force sell: 1.0     |

Figure 10: Software window showing the setup of 8 stockholders

# Virtual Container

Figure 11 shows the results of optimization.

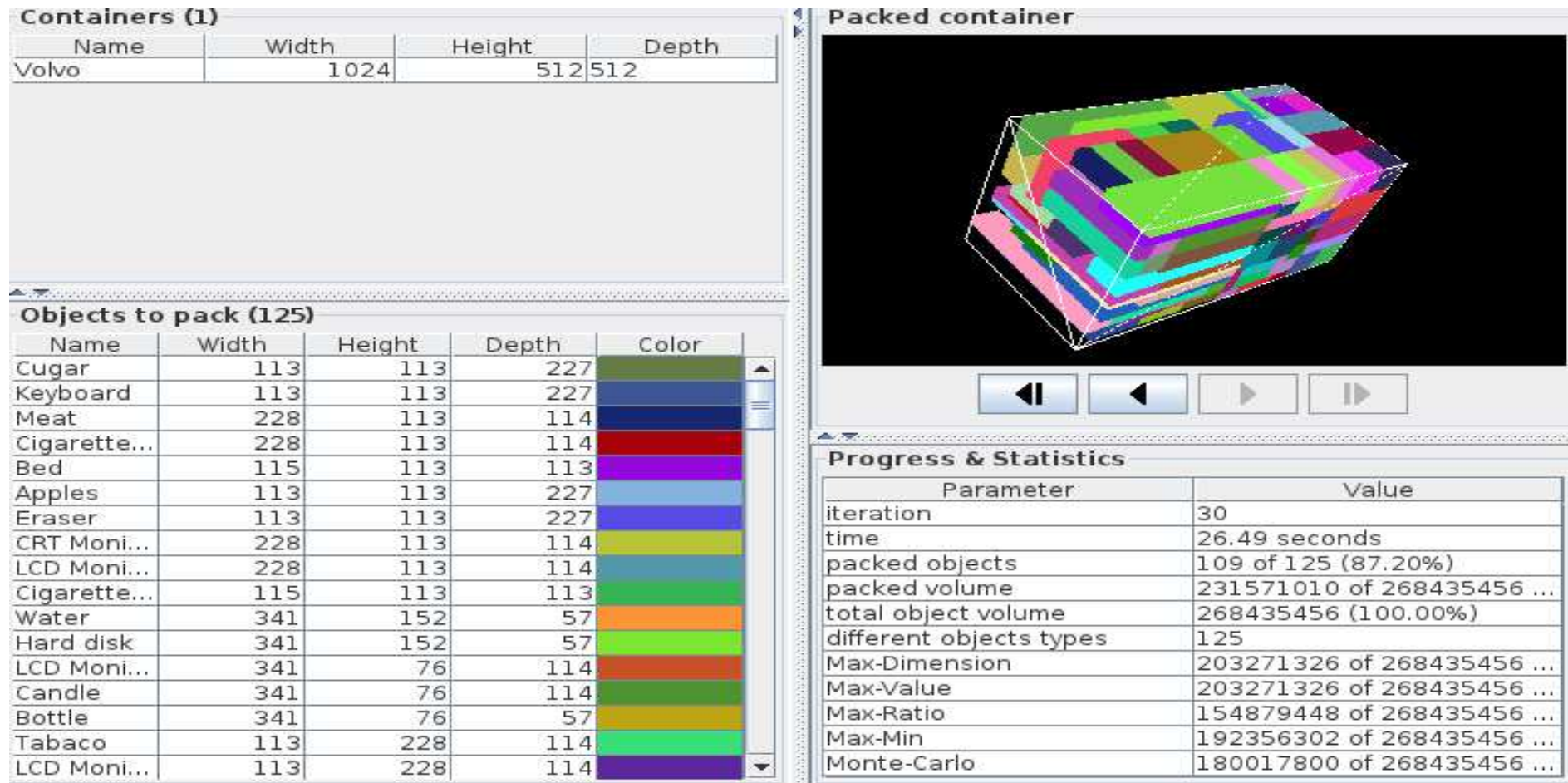


Figure 11: Virtual Volvo container



# Statistics

**Beginning:** 1998

**End:** open

**Number of contributing students;** about 500

**Number of selected models:** about 80

**Number of files:** about 80.000

**Volume;** about 2 GB

**References:** the content is published in books and papers by well-known international publishers.

# Publications on Virtual Markets

1. Mockus J (2003) Stock exchange game model as an example for graduate level distance studies. Computer Applications in Engineering Education 10:229-237, iSSN 1061-3773
2. Mockus J (2006) Investigation of examples of e-education environment for scientific collaboration and distance graduate studies, part 1. Informatica 17:259-228.
3. Mockus J (2010) On simulation of optimal strategies and Nash equilibrium in the financial market context. Journal of global optimization 48:129-143.
4. Mockus J, Raudys A (2010) n the efficient-market hypothesis and stock exchange game model. Expert systems with applications 37:5673-5681.

# Conclusions on Virtual Markets

1. The virtual financial market model helps students better understand the theories of games and markets.
2. Using and improving the model students develops their creative abilities.
3. The financial prediction models minimizing the standard prediction errors do not necessarily provide maximal profits.
4. Comparing different prediction models one should simulate the expected profit by a model reflecting personal priorities and market parameters.
5. The proposed model is the first step in this direction, further improvement involves massive parallelization.
6. The aim of well-known results on financial markets is prediction for greater profits, the aim of this work is simulation for better understanding.