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PROCESS OF MARKET STRATEGY OPTIMIZATION USING DISTRIBUTED COMPUTING SYSTEMS

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Abstract
If market repeatability is assumed, it is possible with some real probability to deduct short term market changes by making some calculations. The algorithm, based on logical and statistically reasonable scheme to make decisions about opening or closing position on a market, is called an automated strategy. Due to market volatility, all parameters are changing from time to time, so there is need to constantly optimize them. This article describes a team organization process when researching market strategies. Individual team members are merged into small groups, according to their responsibilities. The team members perform data processing tasks through a cascade organization, providing solutions to speed up work related to the use of remote computing resources. They also work out how to store results in a suitable way, according to the type of task, and facilitate the publication of a large amount of results.

Keywords
economic systems, financial systems, moving average models, optimization problems, performance analysis, prediction methods, prediction problems, project management, work organization.

Introduction

Automated market strategies overview

The automated market strategy is a program based on a specific algorithm that calculates the value of its internal indicator, and then makes a decision to open or close a position based on results. Of course the decision-making logic diagram is determined in advance by the author of the strategy. The issue of creating appropriate investment strategies is the subject of many studies of both trade practitioners [1–6] as well as representatives of the world of science [7–9].

It can also be classified as data mining [10, 11] and pattern recognition task [12]. Of course strategies work with varying real world investment success. Some strategies perform better than others and are able to predict the behavior of the market and can, as a result, open better positions. A better position, in this case, is defined by a strategies ability to achieve a higher profit [13].

For simple investment strategies based on crossing of price and moving average[1] quite quickly, a need to add a set of filters [5, 14] represented by numerical parameters arises. The values of these parameters form a multidimensional space of possible filters for the investment strategy. The simplest approach to find sets of parameters which give the best results is a naive iterative search all over the data parameters. However, when using this approach it becomes necessary to limit the possible values of the parameters and also requires expert knowledge to exclude some of the positive features of machine learning. In the literature, there is no description of the results of the

[1]Moving average is a calculation on data points from time series used to smooth out short-term fluctuations and highlight longer-term trends.

investigation process investment strategies. Most of the literature shows final results. This paper focuses on testing the market strategy and optimization of its parameters. Also it is shown here how to prepare data for strategy, divide them into appropriate test periods, and then test it in a distributed environment.

A number of modifications and improvements can be used consisting of:

- acceleration kits to work out the best search parameters using the methods of computer parallelization, artificial intelligence [15], genetic algorithms [16],
- choosing the best division between the learner and the tester parts of the system.

Frequently, testing of transactional systems is done directly using the trading platform, in recent years the Metatrader platform has become a common choice [17, 18]. Additional features for allowing the acceleration of work on the investment strategy are created using a specialized programming language – mql4 or mql5. This platform, as with other similar solutions, does not allow for selection of different periods parameters of learning and testing. There are modifications that need to be made using a universal programming language to overcome this, though limitations in the design and verification of transactional strategies may remain an issue, and it may only be possible to search for new parameter values using the external code. In this paper, both approaches are presented: acceleration of calculations and the appropriate division into learning and testing parts.

The aim of the authors was to improve the process of automated market strategy. As a subject of a study a real project was chosen, where a group of scientists conducted research on investment strategies. The focus was on work-flow optimization as well as on selection and using appropriate tools. One of results obtained was new team structure supported by distributed computing to increase computation performance. Other significant improvement allows distribute computation over network.

Current solutions in strategy optimization

Most strategies are based on some parameters (i.e. number of steps forward after which the position is closed) which are variable in time. Choosing the right parameters determine the quality of strategy. Since, as already mentioned, parameters vary with time there is a requirement for continuous selection and the continuous optimization of these parameters [19].

Simple examples will be discussed, based on which a strategy for the optimization process needed will be shown. In the case of a strategy having six optimization parameters, the task of carrying out research in 20 markets may be too time-consuming task for one person. The strategy used in this example is based on channel breakouts but we tested the proposed model on many other strategies. Another aspect is that the requirements this task poses to the strategy maker. It is not enough to be a market expert, one should also be a good programmer (to write code optimizations), have knowledge of the methods of parameter optimization, as well as being able to carry out preparation of the report. Thus there is a need to create a team and organize the work. It is not enough just to copy an already developed strategy. The probability of continual profit is not large, and in order to increase it, a large amount of work must be done. More and more new players are blindly approaching automatic strategies, tempted by the vision of easy and fast profit [3, 4].

The main issues when trying to solve problems with search algorithms of algorithmic trading are:

- efficiency of calculations,
- need to verify strategies on many markets,
- a long way from the algorithm idea to the verification in the form of a fully functional transactional system.

Testing strategies

The main aim of this paper is to find solutions that would solve problems described above. Authors try to find the approach that would allow the reduction of time needed to develop a transaction-ready system from the basic concept of the algorithm. Answer how to organize tests, how to optimize scripts and how to structure the team. It is assumed that whole process involves at least five people. In this paper authors present that set goals can be accomplished in two ways, firstly by reducing the computation time by computational distribution, secondly by the appropriate organization of work during the verification process using the transaction system. This paper provides ready solution for some of the market strategies research organization. Using knowledge from here it's easy to get right direction at the beginning of the research. Authors gathered available knowledge from other sources and also performed own researches in this area.

Organization of computing process

Main focus of this article is optimization of strategy building process. Also strategy optimization it-

self is described, because it was a goal of original projects. Complex and time consuming process put author into consideration of making research on the process organization. Overall goal is strategy optimization, it could be achieved by structuring research team and organizing work-flow in addition to technology.

In this article all of the issues of the organization process will be discussed. The article is based on research project carried out by the authors, as well as the experience gained by the authors in a variety of similar projects. The authors also take into consideration recommendations arising from the literature of design organization methodologies for project works [20].

Structure of scripts

Due to the characteristics of the issue and established workflow, prepared scripts that optimize the parameters must be specially designed. As mentioned before, the MATLAB environment was used.

Data structure

Starting from scratch, the data taken for testing is standardized for all markets. For all datasets we extracted the parts for a selected time period, chose the number of sample measurements (candles), and decided the output format. Each market has its own unique characteristics [21]. Primary characteristics are the basic unit price, known as pips, and spread – the value charged by the broker on each transaction. These values are defined as variables in all the scripts and before running the script on the market their value has to be set. Using this solution, strategies are fully portable between markets.

Strategy core

The logic of the strategy is enclosed within a function. Strategy function is not a key element of this paper that is why is not exposed further. This function is used in all studies and tests, ensuring uniformity of action. Optimization code for each task is in a separate file, and is also enclosed within the optimization function. This function contains of all the mechanisms for calculating the best values of the parameters and testing these parameters in the past. Prediction problem in this case is defined as finding best set of parameters and learning period length to predict best market transactions. During optimization sets of parameters are compared against each other based on i.e. achieved profit. To determine those sets a wide range of algorithms can be used i.e. Particle Swarm Optimization as it was done in [22]. Work on this paper helped to select Particle Swarm Optimization as very good and fast method for finding best or near-best prediction parameters. A lot depends on the code optimization task [23, 24].

Test executor

The last script type is a boot script in which engineers define the parameter space to explore, give the variables specific to the market, or perform other required configurations. This is the only file in which the technician will make any changes. The division of files is made to allow groups with no programming knowledge, working outside their field of competence to change parameters easily. The technician receives the prepared code, and knows that he/she does not have to modify the job file or strategy, and knows that all he/she has to do is to modify the boot file. In practice if technician is able to estimate how long it will take to complete specific research, he/she can run multiple tasks sequentially using one boot script.

Strategy optimization verification

Each set of strategy data available for this process must be split into two parts, one for learning and one for testing. Some experts are using three parts, the last one at the level of strategy verification. As it was mentioned before ratio between these parts could be also another subject of optimization.

Strategy optimization process

Next the optimization script must be executed on learning part of data. For each set of parameters algorithm must calculate prediction (strategy function) and eventual profit on every row of whole learning part. If a learning period is a year and hour intervals are used, this gives about 6200 rows of data to iterate through.

It's why only one set of parameters was calculated. Depending on the type of an optimization function and some other conditions process may iterate through almost all of possible parameter sets.

Strategy common parameters

Most of parameters depend on a specific strategy. But there are some of them which could be found or additionally added to almost every strategy. For example a number of strategy steps analyzed form past or a threshold used for a final advice (decision). Usually a number of parameters that could be applied to a strategy is not less than ten.

Strategy optimization complexity

All arguments mentioned above shows that strategy optimization and verification process is complex and time consuming process. For example during this research strategy optimization for a ten years learning period for a 15 parameters took on average about 28 hours.

Team structure

Team is built from several members with specific dedicated roles [25, 26]. There are some limitations in number of team member. Also it is assumed that there are some experts with strategy knowledge available to involve. Below are listed roles and dependencies of team members.

- **Strategy Expert** – Project Manager. The inventor of the strategy and researches. The person with the best knowledge of market characteristics and trading on the given markets. Ultimately responsible for the final results of project.
- **Publication Engineer** – Deputy Project Manager. A team member with expert knowledge in market strategies. The Publication Engineer should have a significant impact on the shape of the research. His main task is the collecting and preparation of the results for their subsequent publication.
- **Optimization Engineer** – developer (MATLAB), responsible of final strategy implementation (initial implementation is undertaken by experts) and code optimization. Also preparation of the whole issue of testing, so mainly designing of the researches scripts. Should also have good knowledge about market strategies, which is required to be able to develop correct strategy codes. It is involved in the arrangements of substance, but most of all concerning on conduction test.
- **Strategy Engineer** – brokerage platform programmer. The person responsible for transferring the strategy from the language used for testing strategies to running with optimized parameters in the real market on the brokerage platform.
- **Optimization Technician** – the person responsible for carrying out optimization and testing. Using the received scripts and market data, this team member performs optimization and testing. Furthermore the Optimization Technician will collect the results and in accordance with the template will prepare reports for publication engineer. As he performs optimization in the differing markets the team should increasingly better understand the market characteristics, so they can better select ranges of test parameters which will help to improve calculations.

Figure 1 shows a hierarchy of team members, the tasks they carry out and the results of their work.

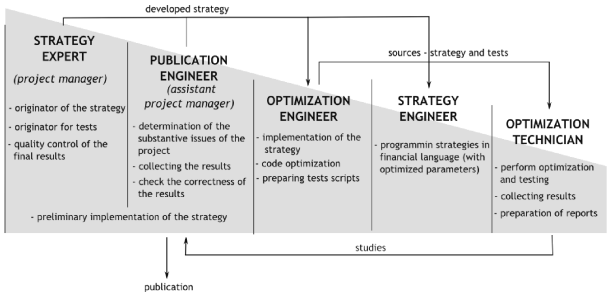

Fig. 1. Hierarchy of team members.

Workflow organization

Workflow limitations

Because of the team structure tasks can be performed cascaded, requiring only standard weekly meetings to bring together the whole team. Research is restricted to a limited number of weeks, so this cycle size helps achieving goal on time. In the meeting the team should discuss the progress of work, results and further tasks required. It is a time for exchanging views between members of the team, the Optimization Technicians could provide suggestions for Optimization Engineers about quality of test scripts or the Publication Engineer can submit comments to Optimization Technicians about reports that they have sent. In addition to these meetings, members work in their groups according to task requirements.

Cascade process

The Cascade Process works by making non-overlapping work phases, each of which follows from the previous [20]. The experts determine the contents of each task before the meeting. Then engineers continue working on code optimization tasks and other members of the team can terminate the previous tasks [27]. When the code reaches the final stage, Optimization Technicians can perform research. Strategy Engineer has time until the end of research to prepare the brokerage platform code for the strategy. At the same time, it is already possible to organize another meeting to discuss the next task.

The whole process is shown in Fig. 2.

Of course, the organization of such a solution entails some disadvantages, if work is stuck on any particular stage, other team members will not be able to carry out the next stages. However, the dependent relationship between the team members cannot be removed (Fig. 3).

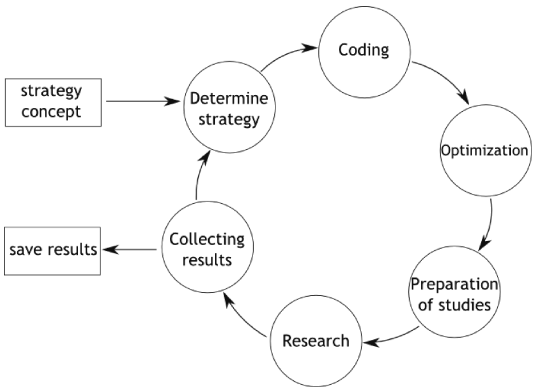

Fig. 2. Strategy workflow.

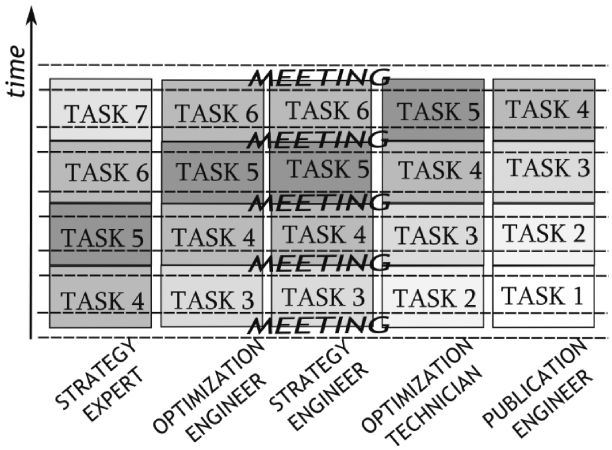

Fig. 3. Task flow among team members.

Distributed computing

In this study, distributed architecture can be used for acceleration and calculations for different markets can be distributed. Because markets are considered independently, the problem can be parallelized almost indefinitely. According to [28] for such specific issue the effective acceleration is obtained with the increasing number of processing units. You can also take this method a step further and share calculations for each market for independent time periods. However, in the current state of the application it is not necessary, also it will unnecessarily complicate the implementation process and would lead to the sequential computation (for common time periods), which would have made distributed calculations less efficient (Fig. 4).

In this paper we adopted the solution that the computer "agents" are running client programs, which periodically polls the server (the application is a Web Service) for another portion of the tasks to be performed. In addition, the checksum of data at the client side is calculated, to minimize the transmission over the network. In the case of non-compliance checksum only most recent data are collected (those which checksum are incompatible). The adoption of this approach is advantageous for several reasons:

- it provides ease of implementation as a Web Service,
- it allows the configuration of any number of computers – agents,
- it is possibly quickly add another market,
- it allows to add any new calculations for the time periods without the involvement of new people,
- it is easy to update both the client and Web Service sides independently,
- it requires minimal changes to the existing network security and should not require the addition of new rules for port sharing,
- it is also possible (and easy) to add new investment strategies,
- furthermore this approach allows to use the output format not only to record the results, but also to transfer data between terminals and server.

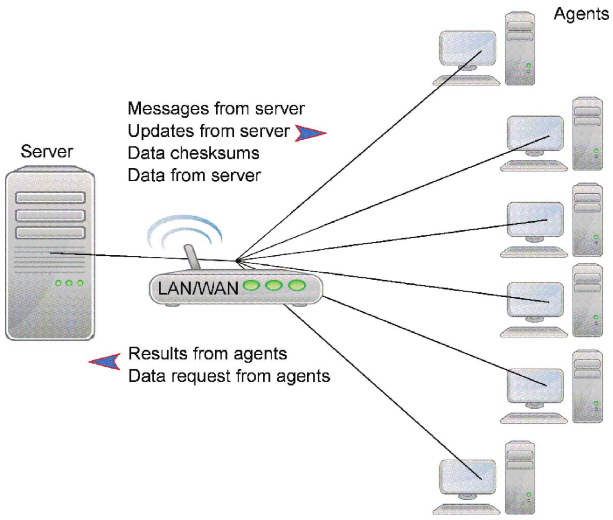

Fig. 4. Schema of distributed computing.

This approach allows, at the moment of new data arrival, to prepare the results for all markets in a relatively short period of time. It is also possible to simultaneously search for optimal parameters for multiple markets. This gives the opportunity to find optimal solutions for many strategies simultaneously.

Results

All results returned by the scripts are saved to text files – it is a requirement dictated by the fact that all of the research is done remotely. In the MATLAB workspace there is only information about the work progress and its correctness. By storing all rele-

vant information in the files, they can be easily downloaded to a local computer for further processing.

Types of saved files:

- main result file – text file (.txt) which has all information that needs to be included in reports for current research and also contains additional information about the progress of the optimization from which we can draw additional conclusions,
- .csv – in CSV files we collect all of matrices and vectors which store the tests results; this gives simple access to data for any time period of the tests,
- .png – all charts are saved as PNG files; this format will facilitate further work.

All listed files are named corresponding to their content and the time series they are referring to. A sample main file could look as follows:

```
==============
| Research 7a
| Author  Thomas Cook
| Market  EURJPY
| Pip                    0.01
| Spread  3 * pip
==============
+ Test procedure:
- Data loading:         OK
- Optimization:         OK
- Tests:                OK
- Saving charts:        OK
- Saving results:       OK
- Saving *.csv:         OK
+ Results:
- Ma:                   10.
- VolLength:            20.
- SL:                   0.95
************************************
+ Final result:         420.64
```

Summary

For medium-sized research projects of this type, one very important thing is proper organization of the process in its entirety. These are projects where there is already a concept of management, but not so large that it was cost-effective to start full professional conduct [29]. General principles proposed by the authors for these types of projects can be treated as suggestions. The article shows that the project is important not only itself - skills in organizing the processing of these substantive issues are essential. Presented solutions allow to achieve a significant improvement in project development.

The aim of further research will be to develop a system to perform complex tests on a larger number of markets achieving the highest possible efficiency ratio unit. To demonstrate the versatility of a strategy that is, both the algorithm and applied filters, because the parameters will be selected for each market separately, it is necessary to test this strategy as much as possible on many markets. With the increasing number of markets surveyed in order to perform the test at the same time it will be necessary to increase the size of the research team. Along with the increased number of team members, the number of resources allocated to the management and exchange of information will increase. The goal of authors was to develop such a team structure and distribution of tasks as well as the implementation of new solutions for control of distributed computation in such a way that each team member effectiveness will be as large as possible. The authors believe that the work presented in the test method will help to achieve better results than traditional approaches. The method obviously requires further improvements, such as increasing the automation of the whole process for the preparation and processing of data.

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