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EXPLORING ALGORITHMS FOR AUTOMATED FX TRADING – CONSTRUCTING A HYBRID MODEL

Interim Status Report

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1. Introduction

The content of this report is intended to begin the task of laying out what the project team will expect to deliver both in content and process. While the tone of this interim report is justifiably positive, there is still critical progress to be done and it is, therefore, still too soon to predict the full outcome of the project. As time passes and the interval before the course deadline diminishes, the importance of the remaining tasks is to be underlined. The team has tackled the most important remaining concerns and agreed on a plan that will help to prioritise remaining tasks of the project.

It has turned out – despite all the effort made, that the initial objective to comprehensively reconstruct many of the most promising models was too ambitious. Thus, due to the resource constraints we face, we were forced to concentrate on less.

2. Brief description of the project

The project examines different formalised strategies of foreign exchange (forex, FX) trading with an ultimate objective to make successful forecasting of future FX rates and to aid decision making. The client of the project is Nordea. The strategies are algorithms that manage an agent's currency position based on information about specific market indicators and time series data. A range of algorithms are assessed against an appropriate performance measure. The most promising algorithms for forecasting future FX rates have been chosen based on an extensive literature review.

The approach of the current project has become focused but the overall objectives remain largely unchanged. In sum, we intend to demonstrate that weighting of different algorithms' predictive power may be the best solution if one is to use algorithmic trading. We repeat our central research questions briefly for clarity.

1. What are the relevant algorithms for forecasting FX rate dynamics for the given currencies and thus for best maximizing a speculative agent's profitability or risk-adjusted return (eg Sharpe ratio) related to conduct of currency transfers (buy, sell, neutral) and why – pros and cons?

2. Which data inputs might be relevant in forecasting FX rates – dependencies and importance of each input?

3. How to implement selected algorithms and differentiate on their performance using an appropriate performance measure?

4. How to incorporate the best techniques into a hybrid model that takes advantage of the predictive power of the chosen sub-algorithms?

3. Progress and results

There are no major delays in the important internally defined milestones of the project. Table 1 (see column representing week 13) explicitly illustrates the current state of the most important deliverables. All in all, project related activities can be summarised as follows:

- Implementation – In progress
- Literature Review – In progress
- Testing – To be done on 4 April
- Analysis and Final Results – To be done / obtained weeks 15 – 16

- Final Documentation – In progress

Final work on the selected models or techniques that improve performance of FX trading systems will be completed soon and testing – in a cooperative effort – will be carried out on 4 April, 2008. The importance of proper testing for the results of the entire project is to be underlined. Therefore, prior to testing, experiments will be carefully designed. Written communication (per e-mail) will ensure cooperation and sharing of responsibilities in this and other remaining activities and will avoid excess burden on individual team members.

Most of the selected techniques rely fundamentally on Artificial neural networks (ANNs) that suit well in the FX environment characterised by complex, noisy or partial information. In addition to ANNs, other implemented techniques include Genetic algorithm (GA), GA building upon technical indicators (ie, Moving Average Convergence Divergence, MACD), Recurrent Reinforcement Learning (RRL), Support Vector Machine (SVM) and some linear models (GARCH etc). Out of these, GA, RRL and SVM are typically used to improve the performance of ANNs. The relevant literature that these algorithms are built upon is listed in the references. A more explicit reference to the relevant body of literature will be included in the final project report and not here due to nature of the interim status report.

The focus of the modelling effort thus far has been on making the models reliable. Thus only preliminary results on the constructed models' and or methods abilities can be reported at present. According to preliminary observations, **GA** based model (with **MACD indicators**) appears convincing but the same does probably not apply to pure GA method. The results with the **RRL** method, in turn, seem realistic with certain parameter combinations. Further testing of RRL will be carried out even if the literature states that the possible combinations of parameters can be vast and many parameters' interdependencies are complex. The RRL strand of literature even reveals that the parameters can only be tuned by trial and error. At the time of writing, however, it seems that the forecasting abilities of **ANNs** (in the way they have been implemented) cannot be given too much weight in the hybrid model. At the same time, as was intuitively quite clear, the **linear models'** predictive power has not proved to be good. Finally, results with **SVM** cannot yet be reported. Nevertheless, the project team remains optimistic as regards the abilities of the hybrid model, which is currently under active consideration.

Considering the use of input data variables in the project, important decisions have been made. After reviewing the literature and requesting information and data from Nordea, the project team decided to concentrate on the FX rates of the three target currency pairs – EUR/USD, EUR/SEK, EUR/RUB – as univariate inputs. In addition, selected multivariate inputs – such as FX rates of target currencies' neighbouring countries (EUR/DKK, EUR/NOK and EUR/ISK) and other major global currencies (EUR/GBP and EUR/JPY) – are used. Selected stock index data from relevant stock exchanges may also be used. The limited number of multivariate inputs is justified due to the objective of the project to predict changes in FX rates on a very short term basis and to model decision making in order to profit by exploiting these changes and the bid-ask spread. The true value of using several multivariate inputs would emerge when forecasting a longer term development.

4. Effort allocation and scheduling

We have fragmented the internal project related activities, effort allocation and deadlines in further detail (see table 1). It is important to note that the scope and objectives of the project have been further defined but that does not reflect any fundamental changes to the schedule presented in the project plan. The team has agreed on a plan according to which everybody will be involved in the approaching testing and analytical

phase. The ultimate responsibility for coordination of this cooperative final effort and the documentation is left to the head of project.

Table 1. Activities and deadlines of the team

Activities, detailed	Week 8	9	10	11	12	13	14	15	16	17	Responsible persons
Phase 1.										Extra week	
Constructing LLR						80 %	100 %				Tuomas
Constructing ANNs						60 %	100 %				Jussi
Data collection				100 %							Jenni
Literature survey I						60 %	100 %				Jenni
Documentation, literature						70 %	100 %				Jenni, Timo, Jani
Literature survey II						60 %	100 %				Timo
Outlining hybrid model							100 %				Jussi, Tuomas
Project plan		100 %									Jenni
Phase 2.											
Literature survey III, input							100 %				Jani
Constructing SVM						30 %	100 %				Timo
Constructing GA, MACD						60 %	100 %				Tuomas
Constructing GARCH, similar						80 %	100 %				Jussi
Time series analysis						80 %	100 %				Jussi
Documentation, input							100 %				Jani
Interim status report						100 %					Jenni
Phase 3.											
Determining weights for hybrid							100 %				Jussi, Tuomas, Timo
Preparing test data							100 %				Jussi
Experimental design							100 %				Tuomas
Testing							4 April				Everybody
Analysis, reporting									100 %		Everybody
Final check with Nordea									18 April?		
Final documentation									100 %		Jenni

Interpretation of categories above:
Activity started at some effort level
Activity semi-final
Activity final

5. Risks

Since certain categories of models have proved too demanding, the team focuses currently on selected relevant models as mentioned above. Therefore many of the risks mentioned in the project plan are tackled and focus is on the remaining risks.

Table 2. Remaining risks and measures taken

Risk description	Risk level	Probability	Measures taken
Insufficient time for revolutionary results	Medium	<30%	Focus on extensively documented categories of models that can be implemented with limited resources.
Models not performing as expected	Medium	<10%	Experiments carefully designed, resources reserved for fully-fledged testing.
Unexpected problems prior to deadline	Medium	<1%	Scope of the project carefully reviewed, extra week in store.
Loss of critical MATLAB code	High	<0,05%	Backup copying done.

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