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Server Side Vote Clustering in Human-Computer Distributed Computing

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Key Words: *Volunteer computing, distributed computing, group decision making.*

Abstract. *There is a branch in distributed computing that relies on donated computational power called volunteer computing. In donated distributed computing projects people participate with their computers without receiving any payments. Most of the projects are pure computations, but in some cases, people are involved in some human activities, which are impossible to be done with modern computers. Such activities are rating the beauty of the computer-generated art or intuition about what will happen in some future events. This research presents part of the human-computer distributed system, which part is related to the clustering of human voting for future changes in currency prices.*

1. Introduction

In the field of distributed computing [14] there is a special branch in which human brain capabilities are involved in order to solve complex tasks (Human-Aided Computing) [13]. Generally distributed computing is used in complex task where desktop computers and even supercomputers are not able to calculate the results in acceptable amount of time or computational cost [1]. A problem is suitable for a distributed computing system if it fits in the class of parallel algorithms. It means that different steps in the calculations should have certain degree of independence as instructions are executed [8]. The main differences between parallel computing and distributed computing is that distributed systems are heterogeneous and with high network latency, no central clock and in most cases calculating nodes are not controlled by a single entity [11].

Distributed computing becomes invaluable when the problems to solve are outside of the capabilities of modern computers. A good example is when subjective human opinion is needed for evolution of beauty [7]. One of the most famous human-distributed computing projects is the Electric Sheep Screensaver [6]. In this project artificial animals are generated in the form of fractal animations [3]. These artificial individuals are evolved with genetic algorithms [9]. The key point in this project is that the fitness value for genetic algorithm individuals is calculated by users voting [5]. If the user likes the animation he/she votes with thumb-up. If the user dislike the animation he/she votes with thumb-down. The vote of the users is collected on the server side and it is used for the genetic algorithms evolution process. Subjective opinion for beauty of many different people is the key element in creation of such computer generated art.

The usage of artificial neural networks in financial forecasting as distributed computing was well presented in the MoneyBee project [4]. Training of artificial neural networks is a task with very high degree of possibilities in parallel calculations [12] and that is why it is so suitable for distributed solution. The project was organized as screen-saver for donated calculating power similar to [10]. Weights of the artificial neural networks were improved in the idle periods of participants computer usage. The success of MoneyBee project was taken for a base in VitoshaTrade project [2]. In VitoshaTrade artificial neural networks are trained as background process in MetaTrader 4 trading platform. The concept of screen-saver was changed with background process of a running application. With the expansion of mobile devices in VitoshaTrade project Android Active Wallpaper interface was promoted. By this step calculations were moved from background process of a running application to background service of Android OS wallpaper. The biggest advantages in mobile distributed computing are that devices are operating in 24/7 mode and mobile devices are much more numerous than desktop computers.

2. Vote Clustering with Self-Organizing Maps

As it was developed initially VitoshaTrade project does not use human opinion in financial forecasting process. Modern capabilities of Android OS mobile devices offer ways in which human vote can be collected. In this research an innovative human-computer distributed computing voting is proposed. On Android screen on daily basis notification is shown and the user is provoked to vote up or down for particular currency pair value change. The information provided by the users is collected on lightweight PHP/MySQL server application.

In order users' vote to be used for future forecasting collected information should be grouped according to each single user voting frequency and each user guess success rate. Such problem can be efficiently solved with self-organizing maps. In this research four groups (clusters) are of interest:

1) Users with high voting frequency and high guess rate;
2) Users with low voting frequency, but high guess rate;
3) Users with low voting frequency and low guess rate;
4) Users with high voting frequency, but low guess rate.

Finding the boundaries of the four groups is complicated and that is why self-organizing maps are the perfect tool for such clustering problem. The network is trained with the information collected from different users with different activity. Some of the users have longer period of system usage and they provide better spread in time information. Number of successful guesses, number of unsuccessful guesses and rate of voting days are supplied as network input.

Financial forecasting can be very complicated because of the high number of depending factors. Even the successful users make mistakes in their forecasts. For each user in the system personal success rate is calculated, but when future forecast should be calculated each user participate with its rating and correction coefficient given to one of the four groups in which he was classified. By such process of forecast establishment group of people proposes a subjective opinion for the future change of the currency pair value. Some people vote according to their knowledge, other people vote according to their personal calculations and a third group of people just vote inspired only by their intuition, even when they are not capable of explaining why they think so. In psychology it is well known that a group of people can achieve much better solutions than best efforts even from the top experts in particular field.

3. Experiments & Results

Experiments are done with 29 users who did voting for the change of EUR/USD currency pair. For each participant, the participation rate is measured by counting participation days divided to all days of the experiment. The other measured parameter is guessed the success rate.

Collected data are presented in *table 1*. The last column in the dataset is the classification group. Each participant was classified into one of the four groups.

As a classifier "kohonen" package in R was used. A square topology 2×2 was used for the self-organizing map:

(1) somgrid(xdim = 2, ydim = 2, topo = "rectangular").

As a learning rate, two parameters are chosen to be 0.0005 and 0.0001:

(2) alpha = c(0.0005, 0.0001).

Learning iterations were chosen to be 1000 as it is shown in the convergence graph (*figure 1*). The training set is relatively small and training finishes in milliseconds. In the first class, there are users with relatively low participation rates and relatively low guess success rates. In the second class, there are users with low participation rates, and with relatively low guess success rates. In the third class, there are users with high participation rates, but with relatively low guess success rates. In the fourth class, there are users with relatively high participation rates, and with relatively good guess success rates.

Classes are shown in *figure 2*. Classification done by R with self-organizing maps is visualized as groups' code in *figure 3*.

Table 1. Experimental data

#	Participation Rate	Guess Rate	Class	#	Participation Rate	Guess Rate	Class	#	Participation Rate	Guess Rate	Class
1	0.38	0.49	1	11	0.57	0.47	3	21	0.30	0.49	4
2	0.45	0.42	3	12	0.12	0.55	2	22	0.34	0.56	4
3	0.33	0.44	1	13	0.51	0.45	3	23	0.33	0.45	1
4	0.55	0.51	3	14	0.36	0.46	1	24	0.42	0.44	1
5	0.39	0.40	1	15	0.25	0.49	2	25	0.46	0.47	3
6	0.51	0.54	3	16	0.37	0.53	4	26	0.48	0.49	3
7	0.50	0.51	3	17	0.43	0.55	3	27	0.25	0.42	2
8	0.55	0.47	3	18	0.20	0.46	2	28	0.52	0.48	3
9	0.10	0.48	2	19	0.32	0.52	4	29	0.42	0.50	3
10	0.28	0.49	4	20	0.57	0.47	3				

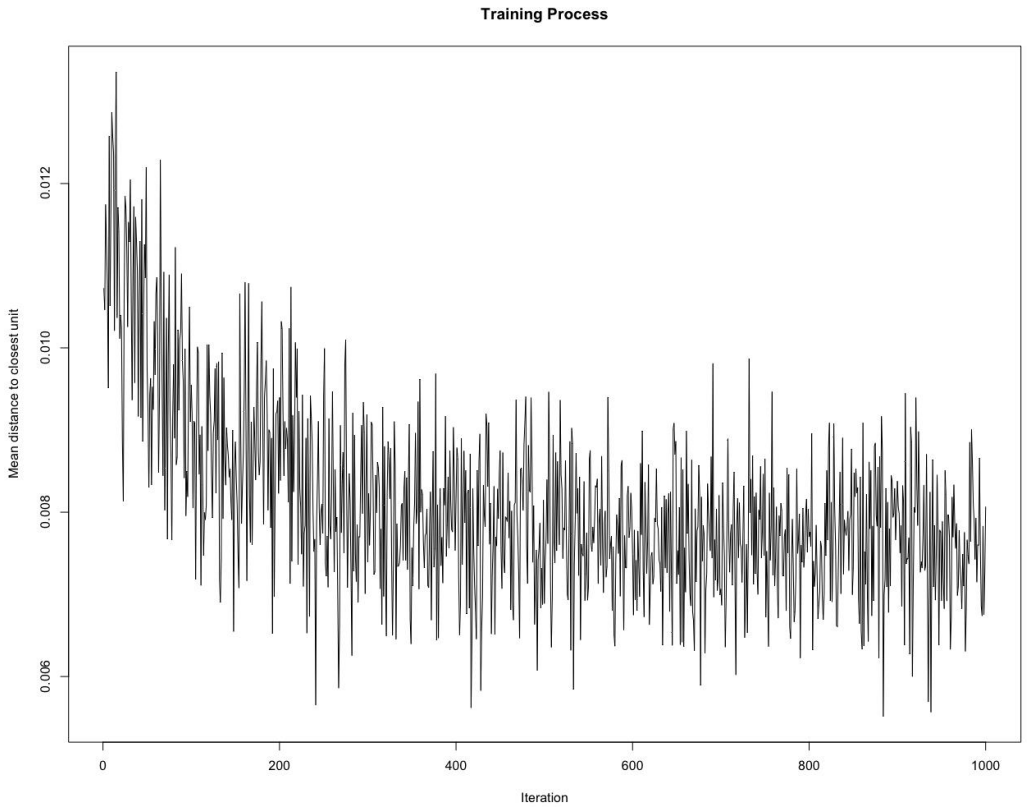

Figure 1. Training convergence

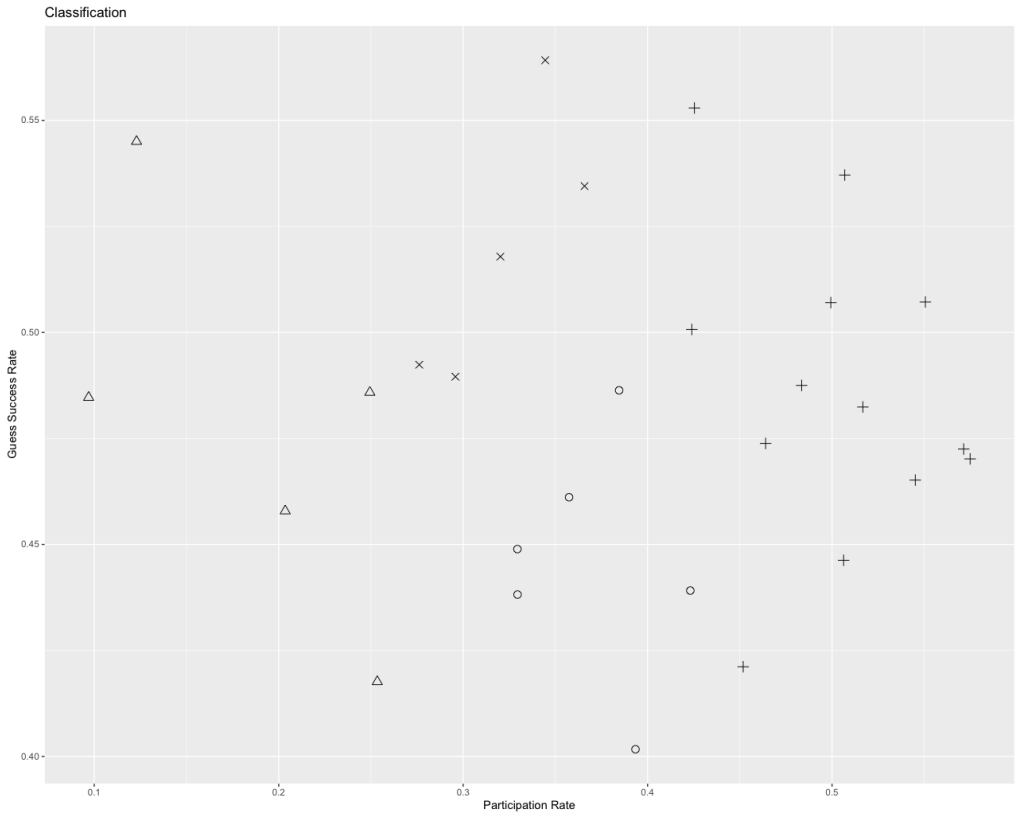

Figure 2. Classification

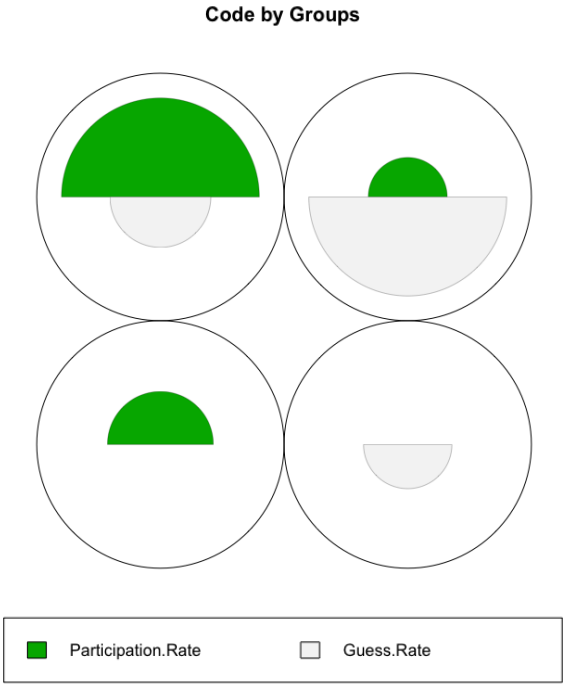

Figure 3. Croup's code

4. Conclusion

Human-computer distributed computing can be very promising tool for financial forecasting. Trading intuition is something that is not achievable with today's computers. Aggregated opinion of a group of people in combination with their knowledge and subconscious information processing can lead to much more reliable forecast results. With the support of modern mobile devices and wireless communication channels human-computer based distributed computing becomes widely accessible and cost effective.

The biggest disadvantage of group decision making is that it is always difficult to prove correctness of the decisions taken and it is always difficult to repeat the same solution.

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