Dragan Simić
Svetlana Simić
Vasa Svirčević

Invoicing and Financial Forecasting of Time and Amount of Corresponding Cash Inflow

Article Info:

Management Information Systems,
Vol. 6 (2011), No. 3,
pp. 014-021

Received 13 Janyary 2011
Accepted 20 April 2011

UDC 336.76:519.8 ; 005.523:336

Summary

Cash is the centre of all financial decisions. It is used as basis for the future investment projections and enterprises' financial plans. A concept of intelligent system for financial forecasting, the dynamic of issuing invoices and receiving corresponding cash inflow for fair exhibitions is presented in this article. This intelligent system is based on artificial intelligent method case-based reasoning (CBR) where the previous experience for new forecasting is taken into account. This research is a discussion about the problem of invoice curve and the corresponding cash inflow curve at the moment of the fair exhibition. The invoice curve reaches its saturation point, while the cash inflow curve is still far away from the saturation point. The solution to this problem is the saturation point for the cash inflow curve. Therefore managers want to know how high the cash inflow of some services would at a certain point of time in the future, with respect to invoicing. If they could predict reliably enough what would happen in the future, they could plan important business activities to ensure faster invoiced income and future activities. Methodological aspects have been tested, in practice, as a part of the management information system development project for Novi Sad Fair company.

Keywords

financial forecasting, invoice, cash inflow, case-based reasoning, decision support

1. Introduction

Intelligent information systems use current information to predict the consequence of future action. One of the primary roles of these systems is to provide managers with knowledge-based expertise to make more effective decisions. In such a way, the systems can provide the support needed to cope with today's turbulent environment. Human reasoning is based on the decision makers' ability to process what they know, whether they learn by example or create new approaches. Reasoning is used by managers to discover data patterns, helps to infer multiple meanings from a single input, and generalize from diverse inputs.

The use of *case-based reasoning* (CBR) in forecasting the dynamic of issuing invoices and receiving corresponding cash inflow based on experience stored in the *case-base* knowledge container is presented in this paper. CBR (Kolodner, 1993) systems make use of past information in order to generate new solutions to new problems. The quality of the information stored within the case base will determine the quality of the solutions offered by these systems.

Presented research is the previous project continuation in Simić, Kurbalija & Budimac, (2003) and it brings about significant enhancements in comparison to the previous solution. Performed simulations have shown that predictions made by proposed CBR financial forecasting system differ only in 10 % in respect to what actually happened. Predictions obtained in this manner are important for future planning in a company such as Novi Sad Fair, whose core business is to organize exhibitions, because achievement of sales plans, revenue and company liquidation are measures of success in corporate business.

The rest of the paper is organized as follows: The following section elaborates, in detail, motivations and reasons for the inclusion of CBR in intelligent cash flow forecasting. Section 3 overviews invoicing and cash inflow pertaining to an exhibition, our previous research and starts discussion about our present research. Section 4 describes the predicting model and application of the method to the given problem by the proposed algorithm. Section 5 shows measurements carried out and results, while Section 6 presents possibilities for improving the existing forecasting system and future work. Section 7 concludes the paper.

2. Background

2.1. Intelligent Decision Support Requirement

Novi Sad Fair company is a complex organization, and its basic activity is organizing trade fairs, although it has many other activities throughout the year. Ten times a year, about 30 fair exhibitions are organized, with nearly 4.000 exhibitors taking part, both from the country and from abroad. Designing intelligent decision support based on artificial intelligent methods was driven by the results of a survey. The survey was made on the sample of 42 users of the current management information system divided into three groups: strategic-tactical management (9 people), operating managers (15 people), and transactional users (18 people). After very detailed statistical evaluation of the survey (Simić, 2004), the following conclusions, among others, were drawn:

- Development of the decision support system should be focused on problems closely related to financial estimations and financial market trends spanning several years.
- The political and economic environment of the country and region influences business and management, which means that it is necessary to implement those influences precisely in the observed model. It is also necessary to take into account future event estimations.

Implementation of this non-exactly mathematical model is a very complex problem. As an example, let us take a look into the problem accentuated by company managers. During any fair exhibition, the total cash inflow is only 30-50% of the total invoice amount. Therefore managers want to know how high the cash inflow of some services would be in some future time, with respect to invoicing. If they could predict reliably enough what would happen in the future, they could plan important business activities to ensure faster invoiced income and future activities which would lead to a better exhibition.

One possible approach to dealing with external influences is observing the case histories of similar problems – cases over a long period of time and making estimation according to conclusions based on these observations. This approach, generally speaking, intelligent search which is applied to solving new problems by adapting solutions that worked for similar problems in the past, is called case-based reasoning. This paper also discusses high value cash inflow and forecasting maximum time and amount of cash inflow for other business and financial categories.

2.2. The Principles of Cash Flow Forecasting

In general, cash is the centre of all financial decisions. It is used as basis for the future investment projections and enterprises' financial plans. The cash flow forecast identifies the sources and amount of a business cash inflow and the destinations and amount of cash outflow over a given period. Cash flow forecasting enables one to predict peaks and troughs in the cash balance. The forecast is usually done annually or quarterly in advance and divided into weeks or months. In extremely difficult cash flow situations, a daily cash flow forecast might be helpful.

Cash flows are cash inflows and outflows. A cash flow forecast might be an invaluable business tool if it is used effectively. One must bear in mind that it is dynamic – one needs to change and adjust it frequently depending on the business activity, payment patterns and supplier demands. Thus a Cash-Flow Statement may be defined as a summary of receipts and disbursements of cash for particular period of time. Cash flow Statement traces the various sources which bring in cash, for example: cash from operating activities, sale of current and fixed assets, issue of share capital and debentures, etc., and applications which cause outflow of cash such as operation loss, purchase of current and fixed assets, redemption of debentures, preference shares and other cash long-term debt.

A statement of cash flow, when used in conjunction with the rest of the financial statements, provides information that enables users to evaluate the changes in net assets of an entity, its financial structure (including its liquidity and solvency) and its ability to affect the amounts and timing of cash flow in order to adapt to changing circumstances and opportunities. Cash flow information is useful in assessing the ability of the entity to generate cash and cash equivalents and enables users to develop models to assess and compare the present amount of the future cash flow of different entities.

Historical cash flow information is often used as an indicator of the amount, timing and certainty of future cash flow. It is also useful in checking the accuracy of past assessments of future cash flow and in examining the relationship between profitability and net cash flow.

2.3. Case-Based Reasoning

Case-Based Reasoning (CBR) is a technique that has its origin in knowledge-based systems. CBR systems learn from previous situations. The main element of a CBR system is the *case base*. It is a structure that stores problems, elements – *cases*, and their solutions. So, a case base can be visualized as a database that stores a collection of problems with some sort of relationship to solutions to every new problem, which gives the system the ability to generalize in order to solve any new problem.

The learning capabilities of CBR system rely on their own structures, which consist of four main phases (Aamodt & Plaza, 1994): *retrieval*, *reuse*, *revision* and *retain*. Figure 1 shows a graphical representation of those four phases. The *retrieval* phase consists of finding the cases in the case base that most closely resemble the proposed problem. Once a series of cases have been extracted from the case base, they must be *reused* by the system. In the second phase, the selected cases are adapted to fit the current problem. After offering a solution to the problem, it is then *revised*, to check whether the proposed alternative is in fact a reliable solution to the problem. If the proposal is confirmed, it is *retained* by the system, modifying some knowledge containers and could eventually serve as a solution to future problems.

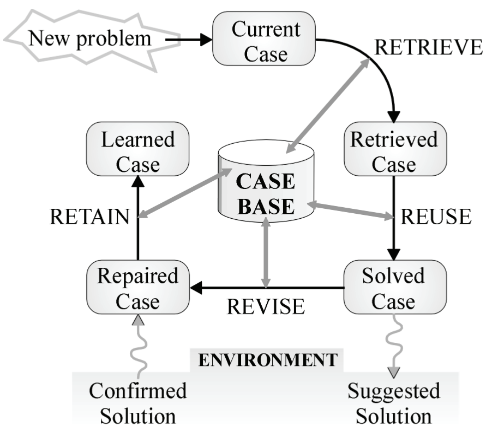

Figure 1 Basic representation of the Case-Based Reasoning Cycle (Adapted from Aamodt & Plaza, 1994)

The main advantage of this technique is that it can be applied to almost any domain, even to domains where rules and connections between parameters are not known. Case-Based Reasoning has been used to solve a great variety of problems. It is a cognitive structure that can be easily applied to solve problems such as those related to soft computing (Liu & Wirtz, 2005), since the procedures it uses are quite easy to assimilate in the soft-computing approaches. CBR has also helped to create applications for a variety of environments, such as health sciences (Corchado, Bajo, & Abraham, 2008), where images can play an important role (Bichindaritz & Marling, 2006), 2006; Herrero, Corchado, Pellicer, & Abraham, 2009) or e-Learning (Decker, Rech, Altho, Klotz, & Voss, 2005). As it has evolved, CBR has been used to solve new problems, applied as a methodology to create plans, and broken down into distributed version (Perianez & Pascual-Granged, 2008). Oceanographic problems (Fdez-Riverola & Corchado, 2004) have also been addressed using these techniques in order to predict the value of highly inconsistent parameters.

The use of past knowledge to generate new solutions makes CBR systems very useful as a decision support system. Distributed and multi-agent (Carrascosa, Bajo, Julian, Corchado, & Botti, 2008) systems have used the CBR methodology to exploit its decision-support capabilities as an addition to their characteristics. On the other hand, as it is a methodology, CBR has been successfully applied to quite different knowledge fields and combined with a great variety of techniques. Most of the techniques used within CBR systems serve to classify, adapt, revise solutions, etc. Artificial neural networks and fuzzy logic have also been used to complement the capabilities of the CBR methodology (Hsu & Ho, 2004). Another way of using neural networks to adapt the retrieved information is to change the weight of the connection between the neurons depending of the retrieved cases (Zhang, Ha, Wang, & Li, 2004). Changing the weights allows the system to adapt the solution to the problem. If the case-base structure is integrated into neural network, then the revision phase consists of changing the organization of the case base, depending on the corrections of the proposed result and other neural variables such as neuron age, activation value and last use (Watson, 1999).

The main problem with CBR is to find a suitable measure of similarity – the measure that can tell to what extent two problems are similar. The higher the values of the similarity function are, the more similar are the objects. Similarity measures, such as the *k-NN* (k nearest neighbors) and also modern variations such as Significant Nearest Neighbor where the value of *k*, which is the number of neighbors to consider, is calculated by taking into account the dissimilarity between the new case and the past cases stored in the case base, have been used to retrieve cases from the case base. Genetic algorithms (GA) are also used to revise the corrections and the solutions. After running those algorithms, the solutions can be accepted, and added to the case base.

3. Invoicing and Cash Inflow Pertaining to an Exhibition

For the last 78 years, the fair exhibitions have been drawing attention of both the wide audience and the experts. They started at Novi Sad Fair as exhibitions of agricultural products, mechanization, food and live-stock displays. Today, the International Fair of Agriculture successfully presents 1800 domestic and 200 foreign companies, which are the most distinguished representatives from all fields of agricultural production and food-processing industry in South Eastern Europe.

The company, Novi Sad Fair, possesses data on invoicing and payment processes for every exhibition during the period of 5 years - containing between 27 and 32 exhibitions per year. The processes are presented as sets of points where every point is determined by the time of measuring (day from the beginning of the invoicing process) and by the amount being invoiced or received on that day. It can be concluded that these processes can be represented as curves (Figure 2).

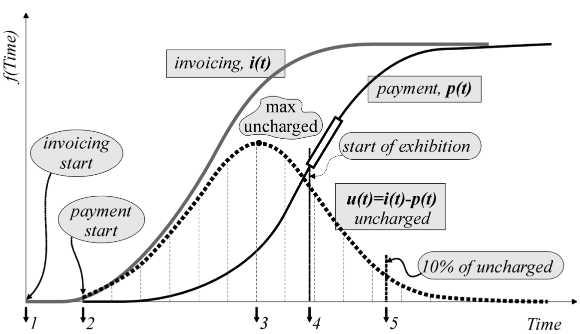

Figure 2 Invoicing, cash inflow (payment), uncharged curves and the important points for a fair exhibition (Adapted from Aamodt & Plaza, 1994)

By analysing these processes, the process of invoicing usually starts several months before the exhibition (*the first important point*) and the amount being invoiced grows rapidly until circa the exhibition beginning. After that time, the amount being invoiced remains approximately the same till the end of the process. The process of payment starts several days after the corresponding process of invoicing (*the second important point*). After that, the amount of payments grows, but not as quickly as the amount being invoiced. Then comes the point when the amount of unsettled invoices becomes the largest (*the third important point*), and it is presented on the unsettled invoices curve. At the moment of an exhibition (*the forth important point*) the amount of payment is most frequently between 25% and 65% of the amount invoiced. Afterwards, the amount of payment continues to grow until it reaches a constant value and stays approximately constant till the end of the process. The saturation time of payments is usually a couple of months later than the saturation time of invoicing, and the payment saturation amount is always less than or equal to the saturation amount of invoicing. A good business result is considered to be when 90% of the invoiced amount has been settled or, conversely, 10% has remained unsettled (*the fifth important point*). The analysis shows that the saturation amount of payments is between 80% and 100% of the saturation amount of invoicing. The maximum amount of payments represents the amount of payment achieved by regular means. The balance is expected to be settled later by court order, other special business agreements or, perhaps, will remain unsettled due to debtor bankruptcy.

3.1. Previous Research

In previous research, every invoice and all cash inflow curves, respectively, consisted of 100 points of invoice (cash inflow) value measured every 4 days out of 400 days from the beginning of invoicing. The points were connected with *cubic* "*spline*", as smooth curves. Invoice and cash inflow curves had been put in the same starting point, which simplified similarity measures among the curves, but it did not succeed completely (Simić et al., 2005). The previous research contains discussions about the problem of invoice curve and the cash inflow curve at the moment of the exhibition. Then, the invoice curve reaches its saturation point, while the cash inflow curve is still far away from the saturation point. The solution to this problem is the saturation point for the cash inflow curve.

3.2. Present Research

The presented research is the continuation of the previous project (2003-2007) (Simić, Kurbalija, & Budimac, 2003; Simić, Kurbalija, & Budimac, 2004; Simić, Kurbalija, Budimac, & Ivanović, 2005; Simić & Simić, 2007). As it was mentioned in Simić et al. (2005), several significant changes have been made for the future, i.e. present research. Invoice and cash inflow curves start at different times representing a realistic business-making manner. Thus, there is a time difference between the first invoice moment and the first cash inflow moment. Secondly, invoice and cash inflow are measured every day during period of 400 days. Thirdly, instead of cubic "*spline*" interpolation, *linear* *interpolation* was applied among every single point. This has brought about the usage of a new algorithm for the linear interpolation case. It can be considered that previously started CBR system adjustments fit the realistic business-making manner to a great extent. As an example of this exhibition business activities are presented for the International Fair of Agriculture in Table 1 for the period from 2000 to 2004. It is very important to mention that this exhibition is the biggest money maker in Novi Sad Fair Company.

Table 1 "International Fair of Agriculture" - Basic data about exhibition per year

Year	The beginning of invoicing	The beginning of payment	Payment delay (days)	The duration of exhibition	% of payment at the beginning of exhibition	% of payment in 400 days time
2000	11.01.2000	12.01.2000	1	13.05 – 21.05	39	88
2001	25.12.2000	08.01.2001	14	12.05 – 20.05	47	99
2002	14.01.2002	15.01.2002	1	11.05 – 19.05	55	99
2003	18.12.2002	20.01.2003	33	17.05 – 23.05	65	99
2004	24.12.2003	06.01.2004	13	15.05 – 22.05	63	99

The invoicing of the most important exhibition, taking place in May, which usually starts in December of the previous year, and cash inflow of services, which is mostly performed by the end of a calendar year, represents the process that lasts for about 400 days. As it can be seen, an average cash inflow delay is 12 days from the day of invoicing. It is very important to decide which day will be the first day of invoicing because of the following events: Christmas Invoicing and Financial Forecasting of Time and Amount of Corresponding Cash Inflows (25/12); the end of the tax and business year (31/12), New Year (01/01), Orthodox Christmas (07/01), and Orthodox New Year (14/01). In these days the business activity is reduced and companies are very careful about making payments. It is also very important to mention that the Fair Company pays salaries in that period.

The percentage of unsettled invoices at the beginning of the exhibition is form 39 to 65%, which is 95-99% of the total invoiced amount for 400 days from the beginning of the invoicing process representing very good financial result.

4. Model and Application of the System

4.1. Predicting Model

As mentioned before, this research is a discussion about the problem of invoice curve and the cash inflow curve at the moment of the exhibition. The invoice curve reaches its saturation point, while the cash inflow curve is still far away from the saturation point. The solution to this problem is the saturation point for the cash inflow curve. The system therefore analysis curves, in the following way:

- past invoice and cash inflow curves are stored in *case-base*;
- *case-base*, also, includes relevant data about exhibitions;
- pre-processing data from case-base;
- compare *new case* to similar curves from the past, stored in case-base – *retrieve* process;
- extract the best fitting invoice and cash inflow curves – *retrieve* process;
- adapt extracted curves according to previously defined rules – *reuse* process;
- automated numerical and logical control adapted curves – *revise* process;
- predict the future behavior of the cash inflow curve – *revise* process; and
- predict amount and time of saturation point on the cash inflow curve – *revise* process.

Retain activity is not implemented in this model because human must confirm *new case*, and add *new case,* modifying some knowledge in *case-base*.

4.2. The Calculation Cash Inflow Saturation Point

The cash inflow saturation point for one prediction is calculated using ten most similar invoice curves and ten most similar cash inflow curves from the retrieved cases from *case-base*. Since the values of saturation point are different for exhibition, every curve from the *case-base* must be scaled with a particular *factor*. In such a way, the invoice values of saturation of the old curve and actual, *new-case*, are the same. On the other side, the cash inflow values of saturation of the old curve and actual, *new-case*, also are the same. That factor is calculated as:

$$Factor_i = \frac{actual\_value\_of\_saturation}{old\_value\_of\_saturation_i} \quad (1)$$

The factors are calculated for invoice saturation point and corresponding cash flow point receptivity, for every curve. The system calculates distance. The *distance* between two curves can be represented as a surface between these curves. When distance is known, then the similarity (*sim*) can be efficiently and easily calculated as:

$$sim_i = \frac{1}{1 + dist_i} \qquad (2)$$

The values of *goodness* are directly proportional to the similarity between old and actual curves, but the sum of all goodness must be 1. The goodness for every old payment curve is calculated as:

$$goodness_i = \frac{sim_i}{\sum_{all\_i} sim_i} \qquad (3)$$

At this moment the adaptation solution of cash inflow saturation point is calculated as:

$$sat\_poin = \sum_i goodness_i \cdot sat\_poin_i \qquad (4)$$

Now, *retrieve*, *reuse* and *revise* CBR processes are finished and forecasting for saturation point for *new case* of cash inflow curve is done.

5. Measurement and Experimental Results

The *case-base* includes 142 *cases* for the exhibitions between from 2000 to 2004. The measurements of already known invoice and cash inflow value sets are done. Forecasting for past fair exhibitions has been made in order to provide accuracy of the proposed financial forecasting support system for assessing the values and times of regular cash inflow. The results of several conducted measurements for a number of past fair exhibitions will be shown in the following text. Measurements of the largest and the worthiest fair exhibition will be presented for: the International Fair of Agriculture in 2001 (Table 2) as well as the International Fair of Electronics in 2004 (Table 3).

Table 2 ”International Fair of Agriculture 2001” – Measurement results for 10 most similar

Exhibition		Similarity	Goodness	Factor	Saturation		Calculated	
					Amount	*Days*	*Amount*	*Days*
Electronic	2001	4.90E-16	0.2703698	14.73	6919096	211	27555628.5	57
Agricultural	2000	2.90E-16	0.1601229	1.98	59082883	316	18731829.1	51
Agricultural	2004	2.32E-16	0.1281594	0.57	205331947	335	14999673.9	43
Ambient	2000	1.34E-16	0.0737180	23.39	4279579	224	7379122.01	17
Hunting	2002	1.28E-16	0.0708781	17.89	5440482	190	6898583.63	13
Autumn	2001	1.13E-16	0.0625989	7.29	15863685	243	7239323.6	15
Jewellery	2000	1.10E-16	0.0608960	56.21	1734568	184	5937366.63	11
Autumn	2002	1.05E-16	0.0580166	11.38	10181279	312	6721976.92	18
Agricultural	2002	1.05E-16	0.0577425	0.62	172280407	270	6167701.84	16
Entrepreneurship	2002	1.04E-16	0.0574978	42.6	2529281	272	6195237.02	16
Similarity total		**1.81E-15**			**Saturation assessment**		**107826443**	**256**
					Real Saturation		**117882752**	**285**
					Error		**8 %**	**10%**

Table 3 ”International Fair of Electronics 2004” – Measurement results for 10 most similar

Exhibition		Similarity	Goodness	Factor	Saturation		Calculated	
					Amount	*Days*	*Amount*	*Days*
Entrepreneurship	2002	4.97E-13	0.179584	3.28	705722	355	415696,05	64
Medical	2001	3.11E-13	0.112569	0.82	2532998	172	233811,94	19
Financial	2004	2.98E-13	0.107862	0.24	9214296	213	238528,76	23
Entrepreneurship	2001	2.76E-13	0.099728	3.05	1102806	330	335439,48	33
Tourism	2003	2.66E-13	0.095999	1.05	2010585	142	202664,64	14
Machines	2003	2.37E-13	0.085787	2.46	839272	154	177117,36	13
Book Show	2000	2.25E-13	0.081174	2.96	846106	320	203298,26	26
Car Show	2002	2.21E-13	0.079980	0.44	5196571	230	182874,02	18
Construction	2003	2.19E-13	0.079053	0.22	9878942	288	171811,88	23
Ambient	2003	2.16E-13	0.078264	0.18	11900137	194	167642,99	15
Similarity total		**2,77E-12**			**Saturation assessment**		**2328885**	**248**
					Real Saturation		**2283863**	**230**
					Error		**2 %**	**7 %**

As it has already been stated the results of these measurements and case-based reasoning forecasting system show good results with the prediction error for:

- the amount of regular debt payment from 5 % to 10 %
- the time span of regular cash inflow from 2 % to 10 %.

Other measurements have also been completed showing that when the proposed forecasting system is used with a set of already known values, financial forecasting support system based on CBR method get results which in average differ up to 10 % in value of what actually happened in the past. These results are quite better than in our previous research (Simić & Simić, 2007).

6. Improving the Existing Forecasting System and Future Work

Although achieved results of this financial forecasting and decision support system give significantly good outcome, the research of the project can be continued. There are several important issues that research could focus on in the future.

1. Small improvement of the proposed forecasting algorithm

As measurement results show, there is quite different time span between forecasting and the real time saturation point. It could be improved if the forecasting system is programmed to take into account behavior of the cash flow curves from *case-base* and after the invoice saturation point.

2. Solution, revision and retaining

The system, too, has to support revision of the solution and the retaining of the solution fulfilling the basic case-based reasoning model. By memorizing: *the new case* (*the problem*); *suggested solution*; *the number of similar curves for obtaining suggestion*; *the real solution*; the forecasting system uses the information in the phase of reuse for the solution of the future problems.

3. Financial forecasting algorithm improvement

The existing algorithm operates with predictions at the moment of completing the exhibition service invoicing process. A new algorithm could provide predictions during the whole period of invoicing and cash inflow time (period). This means that cash inflow forecasting can be done immediately after the first invoice service cash inflow. Also, when the invoicing reaches saturation point and cash inflow continues to grow towards saturation, forecasting should give better results since the cash flow system converges the final value of the amount and time of cash inflow.

7. Conclusion

This paper describes, in great detail, the case-based reasoning part of the system, giving a thorough explanation of one case study. One section of the paper presents the intelligent decision support requirements, the principles of cash flow forecasting and the basis of artificial intelligent method case-based reasoning. In the other section of the paper, invoicing and cash inflow pertaining to a fair exhibition is presented. In the third section, proposed model, algorithm based on CBR method, application of the cash inflow forecasting system and the measurement and experimental results are presented.

The measurement and experimental results have been completed showing that, when the proposed forecasting system is used with a set of already known values, financial forecasting system based on CBR method gets results which in average differ up to 10 % in value of what actually happened in the past. Although achieved results of this financial forecasting gives significantly good outcome, the future research of the project can include the following: (1) small improvement of the proposed forecasting algorithm; (2) upgrade of the system for all CBR phases – retrieve, reuse, revise and retain; and (3) new financial forecasting algorithm which provides prediction during whole period of invoicing and cash inflow. The presented system is not limited to this case study but it can be applied to other companies' values as well as expenses, investment and profit.

References

Aamodt, A., & Plaza, E. (1994). Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches. *AI Communications, 7* (1), 39-59.

Bichindaritz, I., & Marling, C. (2006). Case-based reasoning in the health sciences: What's next? *Artificial Intelligence in Medicine, 36* (2), 127-135.

Carrascosa, C., Bajo, J., Julian, V., Corchado, J. M., & Botti, V. (2008). Hybrid multi-agent architecture as a real-time problemsolving model. *Expert Systems With Applications, 34* (1), 2-17.

Corchado, J. M., Bajo, J., & Abraham, A. (2008). GERAmI: Improving the delivery of health care. *IEEE Intelligent Systems. Special Issue on Ambient Intelligence, 3* (2), 19-25.

Decker, B., Rech, J., Altho, K. D., Klotz, A., & Voss, A. (2005). eParticipative Process Learning: process-oriented experience management and conflict solving. *Data Knowledge Engineering, 52* (1), 5-31.

Fdez-Riverola, F., & Corchado, J. M. (2004). FSfRT: Forecasting System for Red Tides. *Applied Intelligence, 21* (3), 251-264.

Herrero, A., Corchado, E., Pellicer, M. A., & Abraham, A. (2009). MOVIH-IDS: A Mobile-Visualization Hybrid Intrusion Detection System. *Neurocomputing, 72* (13-15), 2775-2784.

Hsu, C. C., & Ho, C. S. (2004). A New Hybrid Case-Based Architecture for Medical Diagnosis. *Information Sciences, 166* (1-4), 231-247.

Kolodner, J. L. (1993). *Case-based Reasoning.* San Mateo: Morgan Kaufmann Publishers.

Liu, X., & Wirtz, K. W. (2005). Sequential Negotiation in Multiagent Systems for Oil Spill Response Decision-Making. *Marine Pollution Bulletin, 50* (4), 469-474.

Perianez, R., & Pascual-Granged, A. (2008). Modelling surface radioactive, chemical and oil spills in the Strait of Gibraltar. *Computers and Geosciences, 34* (2), 163-180.

Simić, D. (2004). *Financial prediction and decision support system based on artificial intelligence.* Unpublished doctoral dissertation, University of Novi Sad, Novi Sad.

Simić, D., & Simić, S. (2007). An approach to efficient business intelligent system for financial prediction. *Soft Computing, 11* (12), 1185-1192.

Simić, D., Kurbalija, V., & Budimac, Z. (2003). An application of case-based reasoning in multidimensional database architecture. *Proceedings of 5th International Conference on Data Warehouse and Knowledge Discovery (DaWaK), Lecture Notes in Computer Science* (pp. 66-75). Heidelberg: Springe.

Simić, D., Kurbalija, V., & Budimac, Z. (2004). Improving the CBR system for financial prediction. *Proceedings of the International Conference on Information and Knowledge Engineering (IKE)* (pp. 561-567). Las Vegas: CSREA Press.

Simić, D., Kurbalija, V., Budimac, Z., & Ivanović, M. (2005). Case-based reasoning for financial prediction. *Proceedings of 18th International Conference on Industrial and Engineering Application of Artificial Intelligence and Expert Systems (IEA/AIE). Lecture Notes in Computer Sciences* (pp. 831-841). Heidelberg: Springer.

Watson, I. (1999). Case-based reasoning is a methodology not a technology. *Knowledge-Based Systems , 12* (5-6), 303-308.

Zhang, F., Ha, M. H., Wang, X. Z., & Li, X. H. (2004). Case adaptation using estimators of neural network. *Proceedings of 2004 International Conference on Machine Learning and Cybernetics* (pp. 2162-2166). IEEE: Piscataway.

Dragan Simić
University of Novi Sad
Faculty of Technical Sciences
Trg Dositeja Obradovića 6
21000 Novi Sad
Serbia
Email: dsimic@eunet.rs

Svetlana Simić
University of Novi Sad
Faculty of Medicine
Hajduk Veljkova 1-9
21000 Novi Sad
Serbia
Email: drdragansimic@gmail.com

Vasa Svirčević
Sunoko
Trg Marije Trandafil 7
21000 Novi Sad
Serbia
Email: vasasv@hotmail.com