ON APPLICATIONS OF WEB-BASED INTELLIGENT SYSTEMS: BANKING APPLICATIONS

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Vistas

With the advent of Web-based technology, the traditional decision support systems and intelligent systems need to be web-based so that the decision makers can access and use it using simple thin client browsers over the Internet/Intranet. This environment facilitates centralized decision making environment. Instead of solving a problem using a single intelligent technique (like expert system, neural network, case-based reasoning) alone, these techniques can be integrated to reduce their weaknesses, increase the strengths and solve complex tasks. Integration of analytical tools and intelligent systems further makes it powerful combination of knowledge and mathematical modeling. In this paper we describe the framework, which has advantages of using latest web-based plat-form, open XML technology and power of knowledge-based decision support systems. We describe how organizations like banks can make use of and benefit from such kind of framework and environment to transform themselves from traditional banks to knowledge-based and smart banks.

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Continuing business in today's competitive world is full of uncertainty and risk. Capturing new and retaining the customers is a challenge. To bring efficiency and cost advantage, organizations have to learn to manage not only the organizational resources intelligently but also expertise available within the organization.

Even though management information systems generate lot of information through reporting framework, common problem faced is availability of domain expertise in various functional areas to interpret the information contained in reports in effective and objective manner. Apart from knowledge and expertise in the domain area, the decision-maker needs the proper understanding of statistical, analytical terms and techniques to interpret the results and quantitative figures. The results can be better understood thoroughly and in objective manner if knowledge-based systems are used to interpret the reports. These systems would provide necessary qualitative explanations and can help management to avoid misunderstanding and misinterpretation of results.

In any organization, managerial decision-making is an integral part. Managers have to make lot of decisions every day to achieve certain goals or tasks. Effective utilization of various resources of an organization is necessary to increase productivity and achieve better profits. To bring efficiency and cost advantages, analytical tools help managers to model the problems, create various scenarios, use resources optimally, perform sensitivity and what-if analysis, forecasting, etc. as a component of decision making process. The manager's ability is always measured in terms of productivity. Managers try to produce better outputs for the given inputs. Managerial functions involve planning, organizing, directing and controlling. Analytical methods are scientific techniques and tools to analyse the problems and find the solutions to the managerial decision problems.

While analytical tools assist and support managers in making decisions, they don't assist in accumulating and managing precious expertise available in the organizations. Intelligent systems are best suited to do this. They facilitate to

acquire, extract, preserve, use and apply the knowledge in the organization and thereby making it intelligent. (**Refer Annexure One and Two**) These systems bring expertise and use the past experience of organization to deal with new problems. Facilitate to preserve the corporate knowledge (which a valuable asset of any organization) even after the decision maker leaves the organization. The preserved knowledge can be helpful to train new employees. The structure and type of knowledge differ from one type of organizations to other. Like a software organization has its knowledge in various software project assignments while a financial institution has it in past investment strategies, loan approvals, rating models, etc.

2. Why Intelligent Systems?

2.1 Centralized Decision-making

Managerial decision-making is one of the important and essential tasks in organizations. In a typical organization, it is a de-centralized process. Each decision maker tackles managerial problem by modeling it using techniques he has expertise/familiar with support tools he/she is having, etc. Again the interpretation of results of analytical models is subject to decision maker's expertise, which sometimes tends to be subjective or even biased. It may also happen that, the decision maker may not be aware of the latest corporate policies, rules while modeling the problem. Web-enabled managerial decision-making and knowledge-based systems can make the decision-making as objective, reliable, fool proof and centralized activity. Centralized systems make available the knowledge throughout the organization in a consistent manner. It also helps to make decisions under the broad policies, objectives and constraints of organizations as a whole. The management has stronger control on overall decision-making process and there can be substantial improvement in workflow. Web-based decision support systems running on corporate Intranet server are available to the entire organization and decision makers can connect to it using a simple browser. There is no need to have special software installed on manager's client machines. A problem can be modeled once and can be put on the corporate server to be accessed by many decision makers. For example, a credit-rating model can be built and made available on corporate Intranet. Individual branch manager can upload loan application details to the server. Server can send the rating after applying model. The manager can use this rating to accept/reject the proposal, to decide interest rate, etc. The advantage to branch manager is: the manager is not worried about the in-depth analysis of borrower under set of guidelines and less accountable for rating the loan application. However, the managers will have final say, because he/she can use his/her intuitive skills of judging the customers, which the machine based systems do not understand.

2.2 Building New Generation Smart Websites

There is lot of data and information made available on websites through web pages. But most of time, the visitor wants specific information and customized answers rather than ending up with reading, understanding and evaluating through lot of web pages. This really requires knowledge of searching the right information. This needs websites an expert interface like human experts that guides the customer intelligently on the path leading towards the right information.

Delivering the contents dynamically instead of static web pages about the products and services can help customers to find the right and the best product suitable for them or they are looking for, subject to their profiles, needs, objective and constraints. This needs the websites themselves to be intelligent capable of engaging the customers like intelligent sales person through series of questions and answers. The questions and answer options may be put in a simple layman's language to be understood by average customer instead using technical jargons. The system can control the flow of questions intelligently (avoid asking irrelevant questions), by judging what user wants, based on user answers. This not only helps customers to find right product in an easy way but also helps organizations to capture such conversations to keep track of what kind of customers visit, show interest in what kind of products. Such information organizations can use for cross-selling opportunities, keeping track of user profiles, their expectations, popular

products, target promotional materials etc. This is possible using the Web systems that manage these user interactions through server. Keeping track of user conversations is difficult through web applications (using Applets or ActiveX components) that run on client machines. User interaction in such systems is limited between client and user. Another advantage of having server side conversions, the customers can't see the models, rules websites use to engage them and help them in finding the right product etc. This type of product/information search is not like keyword search, where user gets no match found kind of answers. It is intelligent search (expert driven), which understands objectives and goals of customers instead of exact product they want. This kind of search returns closely matching (similar) products in case exact product not available.

Smart websites can save on call center costs and this kind of interface provides self-service to customers rather than assisted-service. The browser based kiosks or computer terminals connected to these smart servers can give expert advice to customers on their specific queries and information related to products and services (instead of giving static interface based on predefined queries). This can save lot of time of branch managers or concerned people.

2.3 Monitoring and Scanning the Databases Intelligently

Most of the corporate data resides in the databases. The data fed, used and generated by transaction processing systems are stored in databases. The information systems like management information systems, decision support systems use the data for processing, analyzing, generating reports and decision-making. Intelligent systems can help the organizations to extract or discover the knowledge from the databases, get information and interpret it, monitor and to intelligently search it. For example, an expert system can be built to get early warning signal about a borrower (before turning into default) by monitoring borrowers' data in the database. The database can be constantly monitored for irregularities, like when a sudden unusual reduction or increase in balance in account. The system can keep track of customer withdrawal patterns and can alert on deviation from this pattern. This brings intelligence in the databases. Rule-based systems can play a very important role in managing customer information in the databases. These systems can track various customers, prospective customers, their profiles, etc. in the database itself.

The case-based reasoning can be used to view the data stored in the databases as a cases and use the similarity reasoning to find out matching cases right away from the databases. Similarly, the products or product information that are stored in the databases can be searched intelligently using case-based reasoning. The advantage here, there is no need for special databases to be used by intelligent systems. These can work on existing databases without modifying them.

Intelligent rule-based Question and Answer interface on top of database can act as an expert guide to search the information in database instead of sending database queries (which user needs to understand and remember). This kind of interfaces can facilitate web-interfaces for customers to directly access information related to their accounts etc. like in automated call centers.

3 Integrated Systems

3.1 Hybrid Intelligent Systems

The widely used intelligent systems in management are expert systems, neural networks, case-based reasoning, fuzzy systems and genetic algorithms [Turban & Aronson, 2001]. These systems differ in ways they get, store and apply the knowledge, deal with uncertainty and incomplete information and knowledge, adapt to new knowledge, maintain the knowledge and so on [Medsker, 1995, Goonatilake & Khebbal 1995]. Expert systems are good when expertise is available and easy to extract from the human experts and various knowledge sources. Neural networks can learn and model complex relationships. Case-based reasoning helps to dig out the hidden expertise/knowledge in already solved problems (with partial domain knowledge) and use that to solve new problems of similar kind. Fuzzy systems deal with ambiguity

and uncertainty in human decision making while genetic algorithms are based on evolution principal and suitable for applications involving searching best solutions and optimizing.

Each of these systems has some inherent weaknesses and strengths. This makes them less suitable for solving problems using a single technique. For example problem with expert systems is extracting knowledge from experts, which is time consuming and costly, expert systems can't learn and adapt, but these systems are good in giving qualitative explanations and justifications for decisions they make. While, neural networks are best for learning and adapting but poor in explaining their results.

Combining these techniques enhance their overall strengths and lessen weaknesses thereby helping to solve overall problem in effective way [Medsker, 1995, Goonatilake & Khebbal 1995]. The same problem even can be solved by different techniques and results can be compared to make better decisions. Take an example, when a manager evaluates a borrower, the details of the borrowers can be fed to expert system, neural networks as well as case-based reasoning system. Manager can compare the results of all these systems and can make final evaluation of the borrower. This helps to make decisions that are not only based on expertise opinion (using expert system), but also on past experience of dealing with borrowers (using neural networks and case-based reasoning). The case-based reasoning system even go further and let the decision maker know how the new borrower will behave (repayment pattern) in future once loan is approved based on the experiences of past similar borrowers. This gives tremendous power to not only to match the customer profile with existing customers, but also to determine characteristics, what/how customer is likely to buy, spend or behave in future.

Various strategies, architectures, models and classification schemes have been suggested by many authors to integrate various intelligent systems for practical applications [Hilario, et al (1994), Medsker, 1995, Goonatilake & Khebbal 1995, Prentzas and Hatzilygeroudis, 2004, Sonar 2001]. Some of them based on functionality and characteristics of intelligent systems while others based on techniques and mechanisms used to integrate the systems. However, the final goal is to model the problem by taking advantages of strengths to achieve effectiveness and efficiency.

The weakness of developing full-fledged applications based on a single intelligent system leads to the recent trend to develop business applications enhanced with intelligent technique. Like expert systems often criticized having not full-filled the promises of replacing human expertise or achieving level of human expertise, these systems certainly have helped to make better and effective decisions. Instead of using rule-based system as stand-alone, these systems can be part of (or even embedded in) other business systems to bring intelligence in them or make them intelligent. Similarly frequently changing business rules can be put in rule-based systems as rules can be easily managed. The beauty of rule-based system is business rules and inference engine (a program that uses and applies rules to solve a problem) is separate, unlike in other business systems (where business logic and information is integrated inside the programming code). For example, the ever-changing Income Tax rules can be managed using rule-based system (instead of managing them in payroll system). Another usage of rule-based systems is to integrate various data sources and applications intelligently. The data extracted can be preprocessed (transformed, mapped, cleaned) using set of rules to a common format to be used for analysis using decision support systems and techniques like data mining.

3.2 Integrating Analytical Techniques and Intelligent Systems

Mathematical modeling is one of the crucial components in traditional decision support systems. It involves use of various analytical and statistical techniques like linear programming, forecasting techniques, times-series analysis etc. These systems support all phases of decision-making process: a) looking an opportunity and structuring the problem, b) formulating a suitable model, running the model, evaluating alternate solutions and, c) selecting proper solution among alternatives and implementing the decision. It is the decision maker who uses his/her expertise to select one of the alternative solutions. These

systems can find optimal solutions subject to various organizational constraints and policies. The traditional decision support systems assist human in decision-making by producing various alternative solutions but do not recommend the exact solution. Because these systems don't have the knowledge and do not learn or adapt etc. On contrary, intelligent systems are based on knowledge and use this knowledge to recommend the solutions. Like decision support systems create various scenarios assuming various possibilities/events in future that may occur. If past knowledge or expertise knowledge can help the decision maker in determining likelihood of occurring these events in the future, he/she can model the system well. Also, the decision maker needs proper understanding of various analytical and statistical terms to interpret and implement the results of decision support systems. Knowledge based systems can be used to interpret the results. Combining these two systems gives advantages of having and applying knowledge about the problem and solving problem using various mathematical modeling techniques [Zopounidis et al 1997].

The major advantages of combining these two types of systems are: a) understanding of operation and results of the decision support system in consistent and objective manner; b) the quantitative results are transformed to qualitative explanations, which are easier to understand, and are often of greater significance to the decision makers, c) using domain knowledge about the problem, knowledge about usability and suitability of analytical techniques, etc. before starting decision-making process, d) the objectiveness and completeness of the results are ensured: the combination of both increases the objectives of the final results, e) solving the problem not only considering quantitative facts but also analyzing the problem qualitatively, and, f) managing and controlling overall decision making process intelligently.

4. Banking Applications

Decision making in Banking and Finance domain is complex. Typical decision-making involves the decisions concerning performance or viability for a firm, the granting or denying of a credit application, construction and management of portfolio etc. These decisions that often deal with practical applications and problems. Such decisions are quite complex, risky, require proper examination of several qualitative as well as quantitative factors, and, often require processing of large volume of data need before coming to any conclusion. Data to be processed needs to be organized properly to make it comprehensible and relevant to the task in hand. Traditionally, financial statements have been a major source of information to decision-makers. The process of analysing financial data consists of several steps. In general, the analyst has to decide the objectives and perspective of the analysis (e.g. as creditor, investor etc.). Various techniques and databases need to be integrated to address decision making in banking and finance.

Many banks and financial institutions in US, Europe, Japan etc. have successfully developed and used expert systems in functional areas [Chorafas et al 1990, Duschessi et al 1988, Humpert & Holley 1988, **Nedovic & Devedzic, 2002,** Nikbakht & Tafti, 1989, Pau et al, 1989**, Ruparel & Srinivasan, 1992, Trippi and Turban, 1993].** Most of applications however are in commercial lending. This may be because commercial loans are the major source of revenue for most banks. As interest rates on commercial loans have decreased over the past few years, so have the profit margins on these loans. As a result, reengineering of commercial lending processes and management of advances has become necessary in order for banks to maintain a competitive edge in the loan industry, as well as to maximize profits on each loan. These systems have made substantial contributions to the profit of the banks, apart from other advantages.

Countrywide Finance developed an expert system CLUES (Countrywide Loan Underwriting Expert System) [Talebzadeh et al 1995] to increase the production capacity and productivity of countrywide branches, improve consistency of underwriting and reduce cost of originating a loan. This system was operational in hundreds of decentralized branches, processing thousands of loans each month and contributing millions a year to company's profit.

The CLUES decision process involves three steps:

- financial ability of the borrower to make the monthly mortgage payments,
- the credit history of borrower, and
- the appraisal report.

The system considers almost 550 facts about the borrower for analysis. There are around 1000 rules, 180 functions and 120 objects. 50% of the loans are automatically processed and do not require review by a human underwriter. Major benefits quoted :

- Consistency of underwriting,
- removal of human bias,
- improved customer service, and, d) use of system as a training tool to teach underwriting.

COMPASS [Sangster, 1995] was developed for Bank of Scotland in-house using expertise of bank's senior loan officer and took five years to develop. It was used for loans exceeding $15,000 in corporate branches representing 80% of total loan portfolio. Used in assessment, monitoring and administration of bank lending to middle-market corporate institutions throughout UK It succeeded in capturing and modeling the inherent risk of the Bank of Scotland's lending process. Use of this system has resulted in major improvements on bad and doubtful debts, increased efficiency in loan processing, less cost, improved loan structuring and pricing in relation to risk.

Systems like MARBLE (Managing and Recommending Business Loan Evaluation) include other technique along with expert system [Shaw & Gentry, 1988].

It had a model-base (program modules) for financial analysis, mathematical programming routines, forecasting and regression analysis. It also uses inductive learning to get the knowledge.

The overall of impact of AI based systems for bank lending can be summarized as follows:

- efficiency: reduced cost and fewer losses, increases productivity of individuals and tasks are performed quickly,
- effectiveness: improvement in customer service, fewer errors and improved consistency,
- expertise: distribution of expertise, enhanced individual expertise and preservation of expertise,
- education: expert systems used to train employees and changed education of individuals and
- environment: business risk is reduced, change in task processes etc.

There has been many applications where neural networks models have been successful especially in applications: prediction of bankruptcy and failures, classification of companies, credit scoring, credit evaluation, forecasting, credit card fraud detection, stock pattern recognition, market segmentation etc.

5. A Hybrid Expert System Framework

We have developed an Integrated Shell Environment to develop, deploy and run server-based Internet and Intranet Web applications based on intelligent systems, especially hybrid (integrated architectures) of rule-based systems, neural networks, genetic algorithms, case-based reasoning and analytical methods. It is completely Web-based (including Admin interfaces), supports thin web-clients, uses open standard technologies like XML (eXtensible Markup Language] , XSL (eXtensible Stylesheet Language), JavaScript extensively, automatically generates feature-rich DHTML pages and has in-built fully configurable data access layer for data extraction, integration, transformation and manipulation **(Annexure Three)**.

The framework has a web page generation wizard, which generates various default HTML templates. Appropriate templates are automatically invoked by the system depending upon the Q &A session. Some of these templates can be used to manage the data at the client machine in an off-line mode. The templates contain JavaScript code for addition, modification, on-line validation, navigation, searching, storing and retrieving data on/from client's machine. The system allows use of global variables that intelligent systems use inside web pages (using JavaScript), as well as web-based output reports. This gives the framework the power of using procedural business logic along with knowledge-based systems.

The framework uses a unique and novel way of integrating various intelligent systems and data sources in web environment [Sonar, 2004]. Representing the problem as well as result (output) as a case in a common XML format makes it flexible to store, interchange, and use the session data across various intelligent systems. There are other advantages of using this kind of framework apart from developing hybrid intelligent systems. For example, the rule-based engine can be used to integrate data sources to view data in a uniform way. The Q&A interface on top of database interface provides a self-help kind of environment while seeking information.

5.1 Prototype Systems

We have developed prototype systems to demonstrate the technical capabilities of the shell to develop practical applications using modular hybrid approach. We intend to develop two classes of rule-based systems: Internet-based and Intranet-based. Internet-based are meant for developing intelligent, dynamic and smart web sites to address applications like intelligent product and information search, on-line automated expert advice, technical help-desks, etc. Intranet-based would address applications like credit rating, market intelligence, etc to be used inside the organization. Following sections describe two of such prototype systems:

5.1.a. Intelligent Product Advisor

It is developed to advise customers on various banking deposit and loan products suitable for them depending upon their objectives, constraints and profiles. It asks set of intelligent questions in easy to understand language to the user (avoiding banking jargons like recurring, cumulative etc.). At the end of Q&A session, the system displays a report that contains information about product user is interested in, calculations of various figures like interest payment, deposit amount etc. Upon selection of option show matching product, it displays list of products available (retrieved from the database) in the bank matching user's criteria. The user can see more information about the product, by selecting a product (from the database) or by a linked web page describing the product browser (See **Annexure Four** for sample screenshots].

5.1.b Consumer Loan Evaluation System

We have developed this system taking inputs from people from various banks through personal interactions. We have collected lot of information by examining and collating input parameters from various application forms used by the banks to get customer information for retail loans. This has resulted in repository of variables (like name, income, documents provided, dependents etc.), options used (documents provided: Form 16, IT returns etc.), validation rules etc. A bank manager can select specific group of input parameters (variables) to be collected from the customer from the repository for a particular type of retail loan. Based on parameters selected, form templates are generated to enter and manage customer data. This form template even can be put on the web to be accessed by the customer so that they can fill it on the web and submit to the bank on-line. The customer can visit the respective branch manager to produce relevant documents supporting application. This saves time of entering customer information at the branches by the bank people [see **Annexure Five** for sample screenshots].

The customer information is stored in a database and is accessed using form template. Various predefined credit score model is used to evaluate overall score of the customer. Scores can be customized depending upon the bank's rating framework and need. The system uses combination of rules, scoring model as well as case-based reasoning to recommend the credit status. Case-based reasoning module also helps to show customers whose profile matches with current customer being evaluated. We propose such types of system to be hosted on central Intranet server to have decision-making consistency, better management control and centralized rules to evaluate loan proposals. The branch managers can access the system using simple web browser [see **Annexure Five** for sample screenshots].

6. Possible Applications in Indian Context

There are lots applications where such systems can play a very crucial and leading role in Indian banks to improve their decision making significantly, optimize resources and reduce

operational costs, improve customer service and satisfaction, increase productivity, gain competitive advantage. These applications are summarized as follow :

6.1 Retail Banking

Knowledge-based systems can be used to approve the retail advances and credit card applications. Thorough and in-depth qualitative assessment, ability to repay and appraisal of new borrower can be done with the automated expertise (rules) as well as on the basis of past experience of dealing with retail borrowers with profiles matching with the borrower's profile. The matching not only in terms of quantitative figures like gross income, dependents but also on qualitative aspects like job profile (nature, position held, industry, etc.), family background, residential area, life style and so on. Matching profiles will also help to determine common characteristic of group of people. This can help to minimize risk while assessing borrowers.

Monitoring and constant follow-up of: advances, especially repayments, customer enquiry, etc.

KYC (Know Your Customer) concept can be implemented and managed by monitoring the customer database or using intelligent customer information system. The 360 degree view of customer, studying repayment patterns, savings and withdrawal patterns, high-value customer targeting right customer, looking into cross-selling and up-selling opportunities.

Intelligent automated assistance (through dynamic smart websites, kiosks, computer terminals, thin client devices etc.) to the retail borrowers:

- to find and choose right product,
- to address their specific queries related to products like "what interest rate I will get", "what is EMI if I avail so much loan" etc.,
- to address their account queries like current balance, last few transactions etc.,
- to give advice on real-estates prices, good projects, builders etc.

6.2 Analysis of Corporate Borrowers and Management of Non-Performing Assets.

Corporate advances are in significant proportion compared to other assets. NPAs are inevitable burden on the banking industry. Hence the success of a bank depends upon the methods of managing NPAs and keeping them within tolerance level. Effective management of NPAs requires, good credit rating and risk management system, appropriate internal-checks, early warning systems, etc.

Intelligent decision support systems can be used in this area:

- by using in-house expertise available to develop credit scoring and rating models, appraisal systems,
- using past experience (organizational knowledge of assessing and dealing with borrowers) can be re-used to deal with new borrowers and evaluate them,
- to continuously monitor and interpret loan database, financial statements, market information to generate early warning signals.

6.3 Intelligent Interpretation of Reports

There are many reports generated by the management information systems like Asset-Liability Management System. Intelligent systems can be used interpret the reports in objective and consistent manner.

6.4 Monitoring Databases

The databases can be continuously monitored to find irregularities, to watch various transactions, to know customers better, to study withdrawal patterns and repayment patterns, to detect deviation from expected patterns and behaviour, to detect frauds and suspicious transactions etc.

6.5 Integrating Databases and Applications

In a bank, typically there are lots of heterogeneous database systems right from branch level to corporate level. Each system has its own way of storing and managing data. For example, one TBA-software may store sex of customer as Male and Female, while other may store it as M and F. Decision-making at head office often needs lots internal information: which is consistent, relevant and filtered especially at bank level. Information should be available in unified fashion irrespective of how it is stored and managed in the databases. This needs not only to integrate data from

heterogeneous databases but also to clean, map and transform it intelligently. This type of activity can well be managed using intelligent systems.

6.5 Performance Evaluation

Intelligent systems can be used to evaluate employee performance using rule-based systems. Various in-house intelligent systems can be developed to perform 360-degree assessment of employees.

Conclusion

Intelligent systems definitely have roles to play in domains like in banking and finance. There are many applications in banking and finance where intelligent systems have been successfully used for automating decision tasks. While individual techniques can address decision making problems they can be integrated to solve problem more effectively and efficiently. Combining analytical methods with intelligent systems gives power of mathematical models with intelligence. Advances in Web-technology have helped the decision makers and users to access the centralized systems and carry out decision-making using machines that support Internet browsers. Developing or integrating intelligent systems in Web-environment certainly helps in getting advantages of web and power of intelligent systems. Organizations are certainly going to benefit from this from better customer service, better management of in-house expertise and deliver products and services in smart way.

REFERENCES

Sangster Alan (1995), The Bank of Scotland's COMPASS-The future of Bank Lending?

Expert Systems with Applications, Vol 9 No 4, pp 457-468.

Chorafas, Dimitris N. Steinman, Heinrich (1990), Expert Systems In Banking, Macmillan Press Ltd.

Duschessi P, Shawky H & Seagle J.P., A Knowledge-Engineered System for Commercial Loan Decisions, Financial Management. Special Issue on Expert Systems, Vol. 17, No. 3, 1988

Duthie Andrew (2003), Microsoft® ASP.NET Programming with Microsoft Visual C#® .NET Version 2003 Step By Step.

Hilario, M, Pellegrini, C & Alexandre (1994), Modular integration of connectionist and symbolic processing in knowledge-based systems. International Symposium on Integrating Knowledge and Neural Hueristics, ensacola, Florida, 123-132.

Talebzadeh, H.,Mandutianu, S & Winner C (1995), Countrywise Loan Underwriting System, AI Magazine, Spring 1995, pp 51-64.

Humpert, B. & Holley, P. (1988). Expert systems in finance planning. Expert Systems. 5(2). Pp 78-117.

Goonatilake, S. & Khebbal, S. (1995). Intelligent Hybrid Systems, John Wiley and Sons.

Goonatilake, S. & Treleaven, P. (1995). Intelligent Systems for Finance and Business, John Wiley and Sons, pp 1-28.

Kolodner, J. (1993). Case-Based Reasoning. Morgan Kaufmann

Medsker, L. (1995). Hybrid Intelligent Systems, Kluwer Academic Publishers, Boston.

Nedovic L. & Devedzic V. (2002) Expert systems in Finance-A cross-section of the field. Expert Systems with applications.

Nikbakht Eshan & Tafti M.H.A. (1989), Applications of expert systems in evaluation of credit card borrowers, Managerial Finance, vol. 15, no. 5, pp. 19-27.

Pau, L.F. & Gianotti, C. (1990). Economic and Financial Knowledge-based Processing. Springer-Verlag.

Pau, L.F., Motiwalla J., Pao Y.H. & Teh H.H. (1989). Expert Systems in Economics, Banking and Management, North-Holland.

Prentzas Jim & Hatzilygeroudis Ioannis (2004), Integrating (rules, neural networks) and cases for knowledge presentations and reasoning in expert systems, Expert Systems with Applications, Vol 27(1), pp 63-75.

Ruparel Bharat and Srinivasan Venkat (1992), A dedicated shell for designing expert credit support systems, Decision Support Systems, 8, Pages 343-359.

Shaw M. & Gentry J (1988). Using an Expert System with Inductive Learning to Evaluate Business Loans, Financial Management, pp 45-56.

Sonar, R. M. & Saha A, An integration framework to develop modular hybrid intelligent systems. Frontiers in Artificial Intelligence and Applications: Vol 69, 1499-1506, IOS Press, Ohmsha, 2001.

Sonar R.M. (2004). A Web-based Hybrid Expert System Framework, Intelligent Systems and Control, Ed. M.H.Hamza, ACTA Press, 2004, pp 254-259.

Trippi Robert & Turban Efraim (1993), Neural Networks in Investing and Finance, IRWIN Professional Publications.

Turban Efraim & Aronson, J. (2001), Decision Support Systems and Intelligent Systems, Pearson Education Asia.

Zopounidis,C., Doumpos, M. & Matsatsinis, N.F.(1997). On the use of knowledge-based decision support in financial management: A Survey. Decision Support Systems. 20, pp 259-277.

Bibliography:

1] IBA (Indian Bankers' Association) bulletins and Journals

2] Research Papers/Technical Papers: Price Waterhouse Technology Centre.

Annexure One: Brief Introduction to intelligent systems

Some Definitions

Expert System: It is a system that stores ***knowledge*** *(*about a particular application area) and uses it. It acts as an expert consultant to solve the problems by using and applying the knowledge intelligently. Knowledge consists of the ***facts*** (data about the problem to be solved) and a ***set of rules*** to solve the problem. In Q & A mode, expert system works like a doctor asking series of relevant questions (to know symptoms) and gives expert opinion (diagnosis) based on answers (symptoms).

Case Based Reasoning: A CBR system contains repository (**case-base**) of solved problems (cases). It digs out the hidden expertise in the past cases and uses it to address a new problem (problem case). It finds out the most **closely matching** case/s with the problem case and recommends the decisions by re-using, and adapting the decisions in those cases.

Artificial Neural Networks: Simulate the working of biological nervous systems; upon training them to solve the problem by providing the past data, they **learn** complex relationships, patterns, etc. in the data. They hold this learnt relationship, patterns etc. (as an implicit knowledge) and use it to solve new problems.

Genetic Algorithms: Algorithms (problem solving) based on the Darwinian principle *Survival of the Fittest.* Use nature's principles of **selection** and **evolution** to produce best solutions to a problem. These algorithms are a very effective way of quickly finding a reasonable solution to complex problems. They are suited for applications like **optimization**.

Hybrid Intelligent Systems**:** Intelligent systems that integrate/use more than one type of intelligent systems to solve a problem. Integration helps to reduce weaknesses and increase the strengths of individual techniques.

Intelligent Decision Support Systems: Information systems that use analytical tools as well as intelligent systems to solve a problem.

Annexure Two : Brief Description of Various Expert Systems and Knowledge-based Decision Support Systems:

IPMS (Intelligent Portfolio Management System)

This decision support system uses quantitative optimization models, personal preferences, machine learning and expert systems. Information about individual stocks and historical instances of investment decisions. The knowledge base constructed based on historical database (through machine learning techniques) and advice of experts. The preference-evaluation system is used to capture the personal preferences of investor. Using interpreter, the qualitative factors in knowledge and preference base associated with quadratic programming model.

CLUES (Countrywide Loan Underwriting Expert System):

It is an automated mortgage underwriting rule-based expert system. Was developed to increase the production capacity and productivity of countrywide branches, improve consistency of underwriting and reduce cost of originating a loan. According to 1995 statistics, this system was operational in 300 decentralized branches, processing thousands of loans each month and contributing $0.91 million a year to company's profit. The CLUES decision process involves three steps: (1) financial ability of the borrower to make the monthly mortgage payments, (2) the credit history of borrower, and (3) the appraisal report. The system considers almost 550 facts about the borrower for analysis. There are around 1000 rules, 180 functions and 120 objects. 50% of the loans are automatically processed and do not require review by a human underwriter. Major benefits quoted: Consistency of underwriting, removal of human bias, improved customer service and use of system as a training tool to each underwriting.

Current status of CLUES: Desktop Underwriter®. It can provide consumers with point-of-sale underwriting recommendations in minutes for not only conforming loans, but also jumbo expanded criteria, home equity loans, and 125 percent loan-to-value (LTV) loans. Standard and Poor's LEVELS™ risk evaluation service also is available through Desktop Underwriter

Credit Clearing House ES:

Credit Limit Recommendation and assigning credit rating. Was developed by Dun and Bradstreet. There were some eight hundred rules. The system does payment, financial and business analysis. The matching rate with expert is 98.5% and 89% cases are handled without human intervention. The cost of development was $1million.

CGX (Credit Granting eXpert System)

CGX is a multi-criteria intelligent decision support system for credit-granting problems. The credit granting process is modeled through the multi-criteria method AHP (Analytical Hierarchy Process). The ultimate objective is to accept or deny credit. The evaluation criteria not only includes financial ratios but also qualitative criteria (customer's background, geographical location, business potential, etc.)

CREDEX

The system using quantitative and qualitative data concerning the examined company and its business sector as well as bank's lending policy, provides diagnosis of company's functions (commercial, financial, managerial and industrial) in terms of weaknesses and strengths

KABAL

Knowledge based system for financial analysis in the trade and industry portfolio in Norwegian savings banks. Includes analysis of financial statements, guarantees, markets and company management and

organization. It combines qualitative and quantitative criteria (market, management and organization) in the analysis of corporate performance.

FINEVA (FINancial EVAluation)

Assessment of corporate performance: combines expert system, principal component analysis and multi-criteria method to estimate the corporate performance and viability of firms. Principal component analysis is used to identify the most significant financial ratio and behaviour of the firms. The output that FINEVA produces is a specific ranking of the firms considered, according to a class of risk.

WATCHDOG

Investment monitoring system screen commercially available financial data of thousands of companies through financial ratios, and analyses trends and changes in risk measures

PARMENIDE

Developed for Italian Banco di Napoli, reviews loan applications on the basis of its prediction of the future position of the company applying for loan facility. It produced projected financial statements and cash flows, evaluates securities offered by the company, assesses the ability of the company to finance and repay the loan requested, and produces a final report recommending appropriate action. The system considers qualitative analysis of the management, background of company and its market share, etc.

COMPASS

Was developed for Bank of Scotland in-house using expertise of bank's senior loan officer and took five years to develop. According to 1995 statistics, the system was used for loans exceeding $15,000. It was used in corporate branches representing 80% of total loan portfolio. Used in assessment, monitoring and administration of bank lending to middle-market corporate institutions throughout UK The system includes customer information, analysis and modeling of accounts and expertise regarding viability, credential and safety relevant to proposed loan. It has succeeded in capturing and modeling the inherent risk of the Bank of Scotland's lending process. Use of this system has resulted in major improvements on bad and doubtful debts, increased efficiency in loan processing, less cost, improved loan structuring and pricing in relation to risk.

CLASS (Commercial Loan Analysis Support System)

The system is aimed for commercial loans to medium to large sized companies. It has been designed to seek out any potential weakness in the prospective borrower and conduct an extensive detailed field analysis of each weakness. It is rule-based system to analyse first four Cs of lending (credit, collateral, capital and capacity). Consists of 70 separate modules and uses 200 financial facts to evaluate loans. Credit Analysis: to measure

company's ability to repay its short and long-term obligations. Collateral analysis: to examine the relationship between the value of all assets and pledged assets. Capital analysis provides an indication of a company's leverage position. Capital analysis measures the degree to which loan can be supported by a company, using the same ratios as capital ratios. The system is designed to use up to five years of financial data, including balance sheets and income statements, along with financial ratios. It uses human expertise to do the trend analysis using graphical presentations, superimposing each major financial trend of the firm with corresponding industry trend.

MARBLE

(Managing and Recommending Business Loan Evaluation): Primary motivation was to develop a model for educating lending officers, loan review committees, audit analysts and students of business concerning the applications of expert systems to evaluation of business loans. It is a generalized expert system that mimics the lending expertise of several banking and finance professionals. The knowledge

base used in evaluation process is organized on the basis of ten different aspects (logically separated units): loan application, evaluation of a new customer relationship, a feasibility appraisal, detailed recommendations, credit worthiness of the borrower, how customer will use the bank, expected profitability to the bank, expected cash flow or profitability of the firm, ability to repay the loan and evaluation of collateral. It contains model-base contains programs for financial analysis, mathematical programming routines, forecasting and regression analysis. It also uses inductive learning to get the knowledge.

PLANPOWER: INVESTMENT PLANNING

Was one of the early and first expert systems in finance domain contained 250,000 lines of LISP code and required about 50 man-years of effort. It provides comprehensive financial plans. Its coverage includes cash management, tax planning, investment planning, risk management, borrowing, retirement, estate planning and special funding needs. Produces comprehensive reports, tables and charts for each client to determine what actions client should take to optimize his financial positions.

TARA (Technical Analysis and Reasoning Assistant).

Manufacturers Hanover Trust. Provides trader foreign exchange recommendations. Chase Personal Financial Planning System

–Chase Lincoln Bank. Helps the customers in planning investment strategies. The system churns out one of the 60 different investment options based on entered criteria. It took 5 years to develop

DEFEWS (Detection of Fraud and Early Warning System)

Monitors all commercial accounts for irregularities in electronic deposits and withdrawals, wire transfers and other transactions throughout the bank.

BUSINESS ANALYZER

The Business Analyzer is the architecture of a next generation knowledge-based facility for supporting and understanding of client businesses by Price Waterhouse practitioners. A key component is Business Analyzer, which finds anomalies in the financial results and gives justifications for them. The primary function of financial analysis is to identify unexplained discrepancies between expectations and stated performance. It finds possible explanations for the discrepancies, that has been observed- be they indicators of bad or good news. It identified trends, significant changes, and, other irregularities in the client businesses. CROSBY system is a prototype of business analyzer.

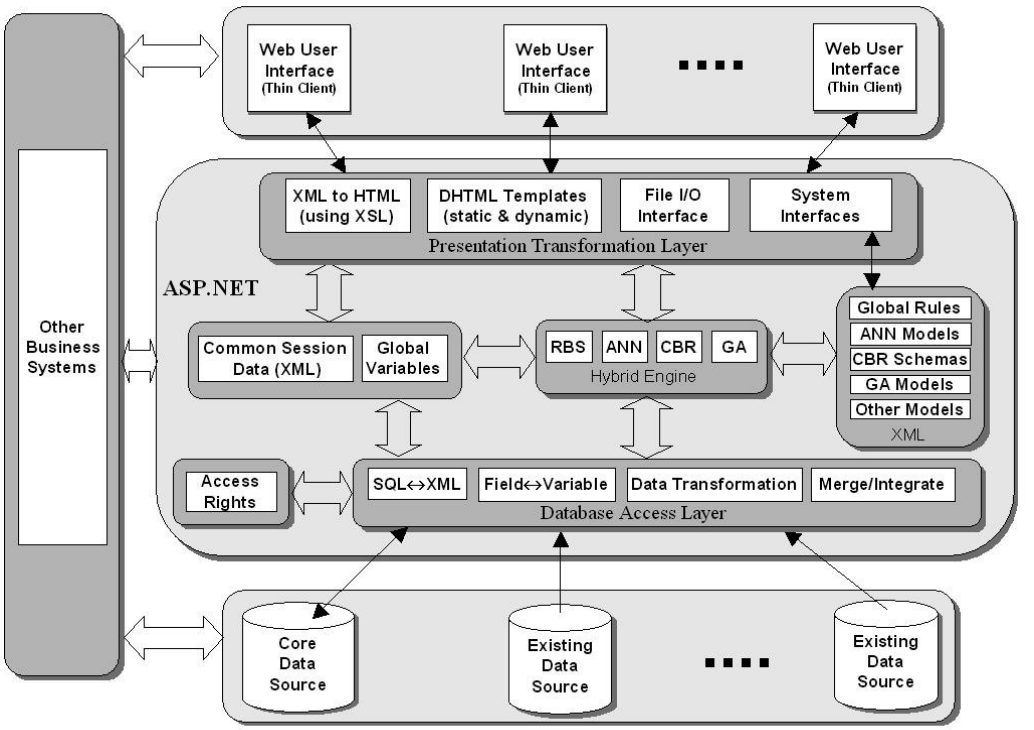
SONAR (Securities Observation, News Analysis and Regulation)

Monitoring NASDAQ for Potential Insider Trading and Fraud. To mine the data, NASD has developed an intelligent surveillance application — the Securities Observation, News Analysis and Regulation (SONAR) system — that automatically monitors the NASDAQ, OTC, and futures markets for suspicious patterns. SONAR has been in operational use since December 2001. Each day it processes between 8,500 and 18,000 news wires stories, approximately 1,000 quarterly and annual SEC filings from corporations, and evaluates price-volume models for 25,000 securities. The system generates 50-to-60 alerts ("breaks") per day for review by several groups of regulatory analysts and investigators. After review, a number of these are referred to the SEC or Justice Department for prosecution.

PORT-MAN

Port-Man expert system has been developed at the La Trobe University in Bundoora, Australia. Port-Man is a banking advisory system designed to assist bank officers to give advice on personal investment in a bank. It helps to speed up the consultation process and standardize the experience of the bank's financial consultants. The task of the system is to select a range of bank products that will satisfy the criteria for investment.

Annexure Three: Integration Framework



Annexure Four : Sample screen dumps (with only inside portion) of interactive session with expert system on Product Advisor

Search.Product Type

Welcome, tell us what you would like to do?

- (•) Would you like to keep your money with us?
- ( ) Are you in need of some money?

OK Back

Break Session

Search.Deposit Type

Ok, you are welcome to keep money with us. What are your plans?

- (•) You want your money back at end of some period?
- ( ) You need some money (interest) to take care of your periodic expenses?
- ( ) You want to put some money every month with us?

OK Back

Break Session

Search.Installment Amount

How much money you want deposit every month?

1000

OK Back

Break Session

Search.Variable Installment

Would the money (that you deposit) vary every month?

- ( ) Yes
- (•) No

OK Back

Break Session

Search.Deposit Period

Please specify exact number of: Months of your investment

12

OK Back

Break Session

Search.Maturity Value

You will get the following amount at the end of 12 Months

12329

OK Back

Break Session

Report

The product type selected	**Deposit**
The sub type of the product	**Recurring**
Total amount you have invested/will invest	**Rs.12000 (12*1000)**
Total period of your investment	**12 Months**
Total amount you will get at the end of period:	**Rs.12329**

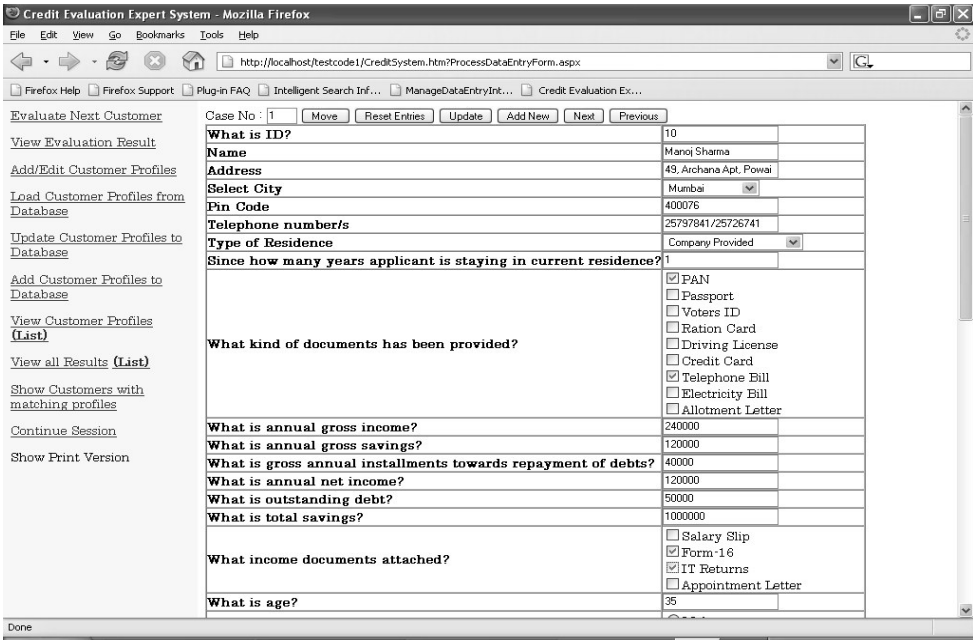
As a total interest you will recieve an amount of **Rs.329** at the end of **12 Months**

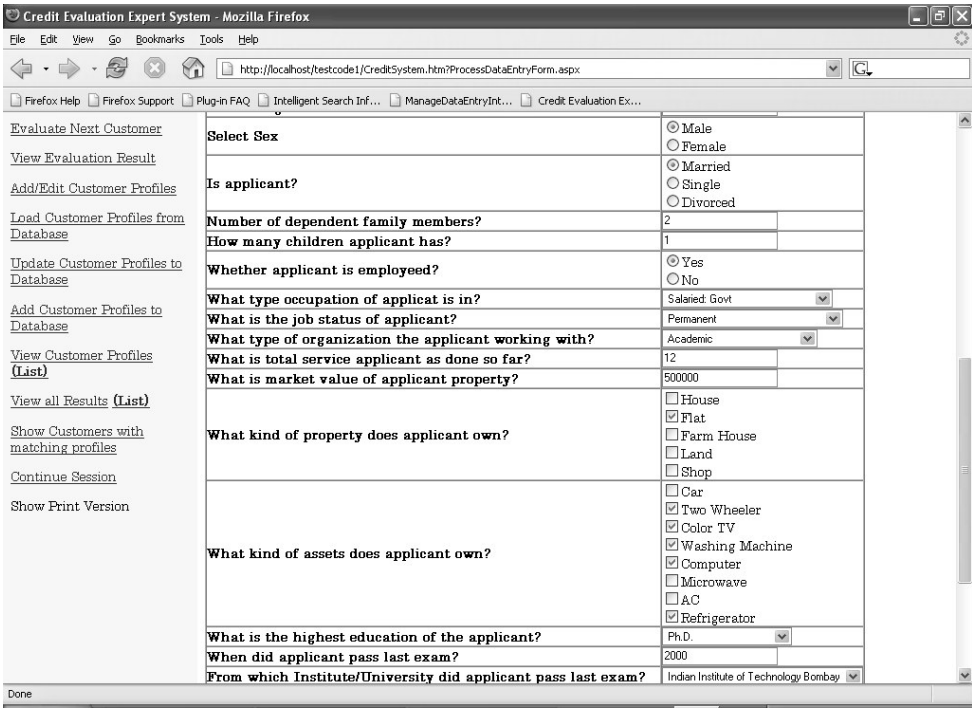
View Matching/Suggested Products

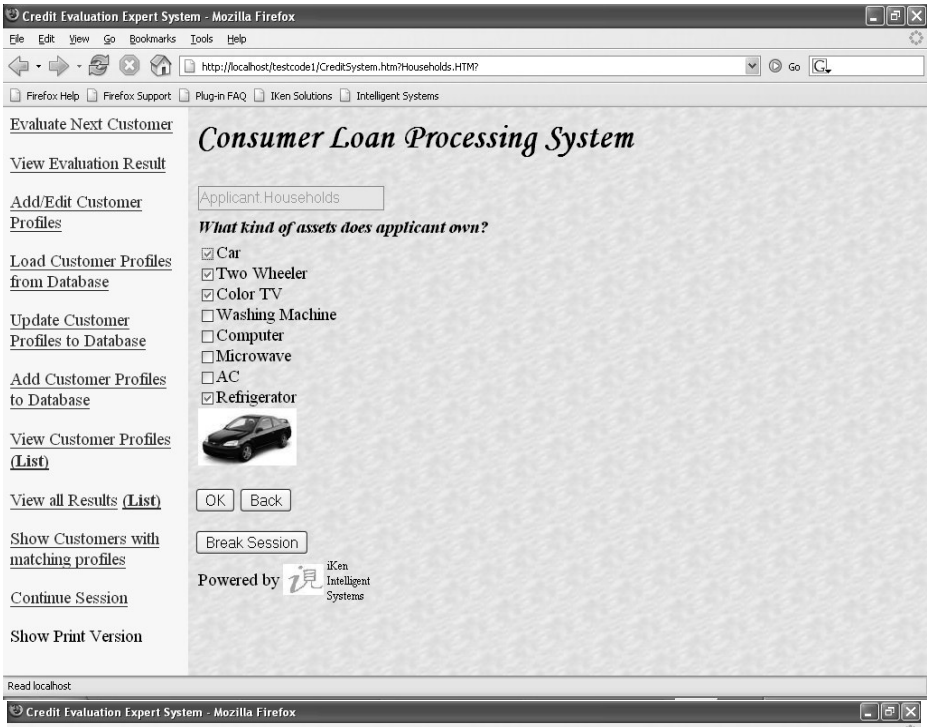
Product/s matching your criteria

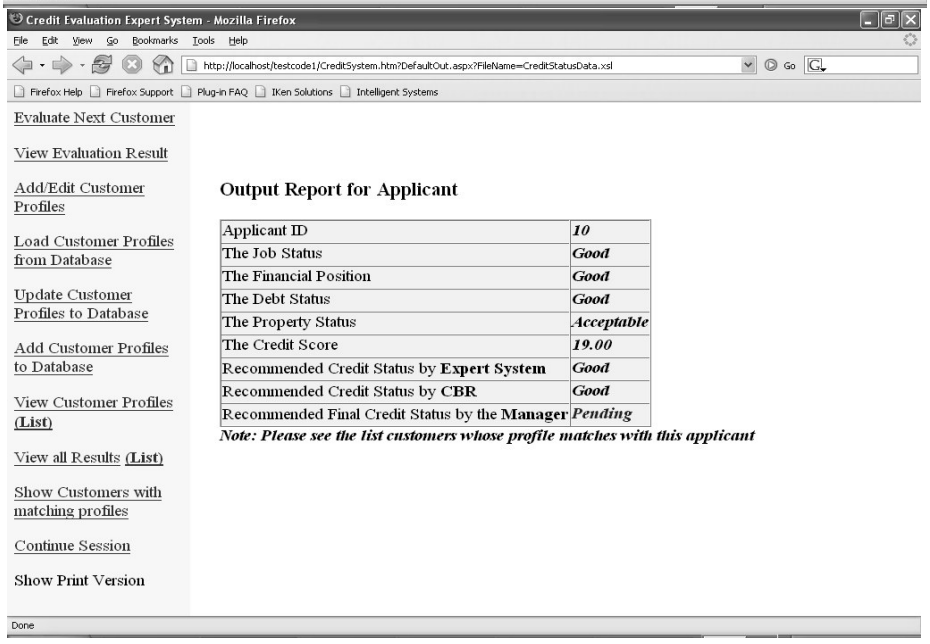
S.No.	BankProduct.Product_Code	BankProduct.Product_Name
1	030	PROGRESSIVE DEPOSITS

Annexure Five: Sample templates created for Consumer Loan processing expert system.






Credit Evaluation Expert System - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://localhost/testcode1/CreditSystem.htm?Households.HTM?
Firefox Help Firefox Support Plug-in FAQ IKen Solutions Intelligent Systems
Evaluate Next Customer
View Evaluation Result
Add/Edit Customer Profiles
Load Customer Profiles from Database
Update Customer Profiles to Database
Add Customer Profiles to Database
View Customer Profiles (List)
View all Results (List)
Show Customers with matching profiles
Continue Session
Show Print Version
Consumer Loan Processing System
Applicant Households
What kind of assets does applicant own?
Car
Two Wheeler
Color TV
Washing Machine
Computer
Microwave
AC
Refrigerator
OK
Back
Break Session
Powered by
iKen Intelligent Systems
Read localhost


Credit Evaluation Expert System - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
http://localhost/testcode1/CreditSystem.htm?DefaultOut.aspx?FileName=CreditStatusData.xsl
Firefox Help Firefox Support Plug-in FAQ IKen Solutions Intelligent Systems
Evaluate Next Customer
View Evaluation Result
Add/Edit Customer Profiles
Load Customer Profiles from Database
Update Customer Profiles to Database
Add Customer Profiles to Database
View Customer Profiles (List)
View all Results (List)
Show Customers with matching profiles
Continue Session
Show Print Version
Output Report for Applicant
Applicant ID 10
The Job Status Good
The Financial Position Good
The Debt Status Good
The Property Status Acceptable
The Credit Score 19.00
Recommended Credit Status by Expert System Good
Recommended Credit Status by CBR Good
Recommended Final Credit Status by the Manager Pending
Note: Please see the list customers whose profile matches with this applicant
Done