The Authorizer's Assistant: A Knowledge-Based Credit Authorization System for American Express

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Abstract

In 1988 American Express fully deployed for U.S. Personal and Gold Card Products, the Authorizer's Assistant (AA), a knowledge-based system to complement on-line credit authorizations. Historically, the AA has gone through two major phases, the AA "Pilot" and the AA "Rollout". The goal of the AA Pilot was two fold: to prove that Artificial Intelligence has a place in American Express (not necessarily to prove any particular hardware or software product) and to develop the expertise associated with credit authorizations. Once the business case was proven based on the results of the AA Pilot, management invested the funds required to initiate the AA Rollout phase, the goal being to fully deploy the AA in an IBM production setting. A significant component of the AA Rollout was the system integration into the IBM mainframe environment.

Introduction

As an AI application the AA is significant for the level of acceptance it has achieved in a major corporation:

- The AA is applied to a critical front-end business function. The approval of credit is at the heart of the American Express card business.
- System development and deployment was based on a favorable business Return on Investment analysis rather than as a demonstration of high technology.
- Business control of the system has been successfully transferred from development to the operations staff.
- The AA is not only an assistant to authorizers, it authorizes millions of dollars of credit daily without human intervention.
- The system is powerful. In a real-time mode, 890 rules are applied to thousands of transactions each hour. The system is operational 24 hours a day, 365 days per year.

The Authorization Process

A computer program called CAS (Credit Authorization System) handles phone calls and automated requests from Service Establishments that need authorization to accept charges from American Express Cardmembers. CAS runs on an IBM mainframe under TPF, a high speed/high volume transaction-based IBM operating system also used for airline reservations. CAS automatically approves most charge requests. Others are referred to authorizers for closer examination.

The reasons that charge requests are referred, given to human authorizers to resolve rather than approved automatically, vary with respect to the kind of data that is involved:

- *Negative Data*: The Cardmember has reported his card lost or stolen.
- *Velocity Data:* If there are abnormally frequent charge requests on the account, an authorizer will examine the account for,

among other things, the possible fraudulent use of the card.

At this point, the authorizer has to carefully balance the business aspects of credit. If credit is denied too often, American Express will lose business and Cardmembers. If credit is extended too freely, a larger percentage of customers may end up unable to pay off their accounts. In addition to credit losses, the authorizer must watch for fraud losses due to use of the card by an unauthorized individual or improper use of the card by a Service Establishment.

The authorizers have varying levels of experience and skill. Prior to the AA, the authorizers performed their job by accessing numerous screens of data from databases holding raw information about the Cardmember. This data includes previous uses of the card, payments made, the status of bad checks, address and phone number, etc. The authorizers had to quickly scan this data, mentally transform the data into meaningful information, and apply American Express policy to arrive at a resolution.

Overview of the AA

The AA serves two primary functions, namely as an authorizer itself, resolving certain types of transactions autonomously, and as an assistant to authorizers in their decision-making process. In an advisory role, the AA provides information and recommendations with respect to all aspects of the authorization process.

The AA augments the current authorization process by providing four new screens for an authorizer (example cases and associated screens are not included due to confidentiality reasons):

- **The Main Screen** provides all the account information required to resolve a referral, including a summary of activity on the account, an analysis of the Cardmember's credit worthiness, possible fraud concerns, a recommendation from the AA and a brief explanation. All relevant information from the multiple database screens are included.
- **The Explanation Screen** summarizes on one page both the AA's reasoning about the credit worthiness of the account and any fraud concerns. Included in this summary is the American Express authorization policy that supports each step of the reasoning.
- **The Interactive Screen**, which is really a series of related interactive screens, guides authorizers through telephone conversations with Cardmembers, Service Establishments or financial institutions. This facility is particularly useful in training new authorizers.
- **The Post-Resolution Screen** prompts authorizers to remove or add notations to the account. These notations are messages to authorizers analyzing future transactions involving this account.

System Configuration

The architecture of the AA at the processor level can be broken down into four layers:

- AA Expertise: This layer was written by Inference Corporation and includes the rules and supporting LISP code for expertise. The expertise determines salient features and patterns of the account, credit and fraud analysis, advice synthesis and ultimately final recommendations and explanation.
- AA Application Layer: This layer was written by Inference to manage multiple transactions on a single machine, handle error conditions, provide debugging tools and traces, and monitor internal operations through finite state automata.
- Communications Layer: Code written to pass data between the AA Applications Layer and SNA, establish the terminal emulation, and perform the logging in and out procedures with CAS and IMS.
- SNA: The IBM communications layer written by Symbolics (commercial product).

Within a single transaction 55% of the processing is for AA expertise and application layers and 45% is for communications overhead and IMS transaction processing. Within the AA expertise and application layers, the processing time spent parsing the IMS data

is 17%, expertise is 67%, screen building is 8% and the management of multiple transactions is 8%. Garbage-free LISP coding techniques were employed to efficiently utilize memory and maximize processor CPU time.

The AA resides on rack-mounted Symbolics workstations. Each workstation is connected via SNA to the CAS system residing on an IBM mainframe and to the American Express IMS databases residing on other IBM mainframes. CAS controls the transaction traffic to the workstations, and shuttles the results of the AA from the workstations to the authorizers' terminals. The workstations are totally independent of each other and contain a separate copy of the AA software each handling up to 9 authorizers simultaneously. They are, however, connected to a central display terminal which services as a system-wide monitor and controller for normal production operator functions such as bringing a workstation on or off line, and loading enhanced application programs.

In this configuration, the AA serves essentially as a coprocessor to CAS with independent access to IMS databases. As a coprocessor, the operation of the AA has minimal impact on the existing system. Also, the majority of the AA functionality and hence its potential for failure lie outside the business critical CAS system.

The AA was written by Inference Corporation under contract to American Express. The knowledge-based system employs over 890 rules in the ART (Automated Reasoning Tool) language also developed by Inference Corporation. Symbolics Inc. provided communication software to connect the workstations to the IBM mainframes. Application software for accessing IMS databases as well as changes to the CAS system to incorporate the AA were written internally by American Express.

Development Timeline

A development timeline of the AA's evolution includes the following approximate dates:

- July 1985: American Express issues competitive RFP.
- October 1985: Contract between American Express and Inference is signed.
- November 1985 - February 1987: AA Pilot development and installation.
- March-April 1987: Acceptance testing by American Express; AA Pilot in experimental on-line use at one operating center.
- May-August 1987: Deployment ROI analysis; AA Rollout design phase.
- September 1987: American Express decision to deploy AA.
- October 1987 - April 1988: AA Rollout code development.
- May-July 1988: Integration testing.
- July-October 1988: Beta test.
- November 1988: AA in full operational use in all U.S. centers.

The expertise portion of the AA (as opposed to the system and communication code) was developed by approximately 4.5 full time equivalent Inference Knowledge Engineers over a 13 month period, from November 1985 to November 1986, as part of the AA Pilot. Inference also provided 1.5 System Engineers during the AA Pilot.

Some modifications to the expertise code were made during the AA Rollout phase. This included a set of rules that told the AA when it could, and could not, make decisions autonomously, extensions to a broader range of American Express card products, and updates to American Express credit policy. During the AA Rollout, the overall manpower requirements were reduced to approximately 3.0 full-time equivalent Knowledge and System Engineers from Inference and 1.5 Systems Specialists from Symbolics.

AA Validation

Prior to its decision to deploy the AA nationwide, American Express conducted a series of extensive tests on the AA's expertise and performance. The Authorizer's Assistant was validated during development by running thousands of actual cases that were captured from on-line transactions for this sole purpose. This

heuristic approach, while cumbersome, is appropriate in situations where a non-algorithmic solution is unavailable. In addition to the domain expert, several expert authorizers assisted in the process of reviewing cases either on the AA development machines or on paper copies of AA results. In experiments using the AA as advisors to authorizers, American Express found a 20% increase in authorization productivity. Based on productivity savings alone, the AA would pay for itself in less than two years.

There was also clear indication on the AA's positive effect on revenues and losses. The AA recommended 33% less denials of charges, boosting potential revenues. Also the AA was more effective at predicting accounts that would result in collections, about half as many cases would result in credit and fraud losses, a potential savings of more than 5 times that of the productivity savings. In summary, the AA performed significantly better than average authorizers, resulting in more accurate and consistent decisions and in improved customer service.

Integration Issues

Integration of the Authorizer's Assistant to the IMS databases proved formidable, and from a project origination perspective, needs to be addressed in the early stages. In retrospect, two key design decisions come to mind. First, was the decision in the AA Rollout to develop one IMS transaction specifically for the AA to collate the data residing on the many individual databases that house Cardmember data, rather than individual calls by the AA to each required database. Historically, the goal of the AA Pilot was to develop an operational AA (with minimal impact to current operations) which served as the basis for an ROI analysis (Klahr et al. 1987). The AA Pilot interface to the database was not optimal but did prove sufficient. Once the ROI was completed, custom interfaces such as the IMS transaction were developed. This approach simplifies the database control within the AA application itself, and reduces communication overhead at the Symbolics machine level and within the American Express network. The overall speed of an AA transaction is significantly faster in the AA Rollout due to the reduced time associated with the database calls.

The second decision was to design the AA to emulate a terminal which logs onto the required systems. In retrospect, the AA should have been designed utilizing a form of application to application protocol (APPC).

Lessons Learned

Upon completion of any software project of size and importance, it is important to reflect and learn from the experience. We have included some thoughts below:

- On-site benchmarking of hardware, software and system integration products should occur; not all product offerings were robust at selection time.
- Standard project management skills are integral to the success of AI projects as well as more traditional software efforts.
- Project team communication is paramount to successful implementation. The weekly (sometimes daily) conference calls kept the project team focused on both problems and successes.
- A committed user team is required. They were a driving part of the team from day one. User team was comprised of three layers of management including overall project tracking.
- Managing vendor relations is a consummate balancing act. They must all be positive team players and deliver both independently (problem resolution) and as part of the total team. To everyone's credit, the vendors on the AA were well integrated into the overall project team.
- Expertise enhancements continuously evolve. Developing a timeline that allows for expertise refinements throughout the project lifecycle is recommended.

Maintenance

Credit policies typically evolve over time either in response to a changing economy, changing business strategy, or improved knowledge. Since the AA is an

implemention vehicle for policy, changes must be made quickly and reliably.

We have found from experience that changes to expertise originating from management directives, systems support or end-users can be implemented very quickly in this rule-based environment, often within 24 hours. The time frame includes coding the changes, expertise testing against off-line case data, on-line testing within a test environment, and final release into production utilizing change control procedures. This work is now being performed by our standard maintenance and operation support group and not our AI development group. For American Express, AI has been successfully transferred from the lab to production.

Criteria for Success

American Express has determined that the AA was successful based on three key criteria. First, the quality of the credit and fraud expertise in the AA met and exceeded management expectations. This expertise is now solidly embodied in a computer program that applies the rules consistently, giving management greater insight and control over this key business function.

Secondly, the AA met stringent system uptime and response time standards that American Express has established to meet our customer service requirements.

Finally, since the AA can autonomously resolve transactions, American Express can meet the projected growth for authorizations without significantly larger staffing requirements.

Conclusion

The AA has significant impact on a strategic portion of the business American Express conducts, and on the millions of people who use the American Express Card. It is an engineering achievement that demonstrates that existing AI technology can be successfully applied to real-world problems.

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