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AI Optimizes Intel's Business Processes: An Audit Case Study

Yoav Shoham
Advanced Analytics
Data Scientist, Intel IT

Eiran Bolless
Advanced Analytics
Data Scientist Manager, Intel IT

Executive Overview

Business focus is changing from data management to intelligent action. Artificial intelligence (AI) can add significant power and effectiveness to human processes by recognizing patterns across massive amounts of historical data. The Intel Inside® Program (IIP), a co-branding members-based marketing program designed to help consumers identify which products use Intel® technology, receives thousands of reimbursement claims per month. Intel's Global Audit Team (GAT) selected claims to audit for non-compliance, but the sheer volume of data made it difficult for humans to see the patterns that help better predict non-compliance.

Intel IT's Advanced Analytics team developed the Compliance Analysis and Prediction Service (CAPS) using AI to support and optimize the decision process for which IIP claims to select for audit. In 2011, we conducted a proof of concept (PoC) of the CAPS model with the following goals:

- Automate the process of selecting claims for audit
- Increase the effectiveness of predicting non-compliant claims
- Continuously improve the model through machine learning
- Gain user trust in AI

CAPS reduced manual selection for GAT auditors and increased effectiveness, meeting the team's business objectives without requiring additional resources. In 2013, CAPS-selected audits were 29 percent of all audits conducted. We increased reliance on the service as its accuracy increased. In the first half of 2017, CAPS-selected audits represented 84 percent of all audits conducted. During this same time period, CAPS-selected claims accounted for 97 percent of total dollars recovered from non-compliant claims. CAPS-selected claims recover an average of USD 20 million of marketing value per year that may have been lost due to non-compliance.

The claims selected by CAPS accounted for 97 percent of total dollars recovered from non-compliant claims—an average of USD 20 million in marketing value per year that may have been lost due to non-compliance.

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Contributors

Intel IT
– **Einat Ronen**, Sales AI Manager
– **Amitai Armon**, Advanced Analytics Chief Data Scientist
– **Moty Fania,** Advanced Analytics Principal Engineer
– **Nicholas Bigoni**, Systems Analyst
– **Elaine Rainbolt**, Industry Engagement Manager

Intel Finance
– **Ambrose Usih**, Senior Finance Manager

Acronyms

AI	artificial intelligence
CAPS	Compliance Analysis and Prediction Service
GAT	Global Audit Team
IIP	Intel Inside® Program
PoC	proof of concept
ROI	return on investment

Background

The Intel Inside® brand represents world-class technology and manufacturing from Intel. The Intel Inside® program is one of the world's largest co-operative marketing efforts with hundreds of members licensed to use the Intel® brand on their devices. The Intel brand is a reminder to end users that the devices they purchase contain Intel® technology and offer the performance, quality, reliability, and compatibility they expect from Intel.

The Intel Inside® Program (IIP) is a core element of Intel's worldwide marketing and brand campaigns. Co-branding is the foundation of the program. Today, the IIP supports over a thousand manufacturers who are licensed to use the Intel Inside® logos.

Auditing Intel Inside® Program Claims

To participate in the program, IIP members integrate Intel® processors or other Intel technology into their branded products and market them with the Intel Inside logo.

IIP members can qualify for reimbursement of specific marketing activities if they submit a claim that complies with program requirements. As part of the business process, Intel's Global Audit Team (GAT) selects samples from the incoming claims and audits them for compliance. Ideally, every claim would be audited for compliance, but due to resource constraints and the thousands of claims submitted each month, the audit team is only able to randomly or manually select claims for auditing based on human ability to recognize non-compliance (see Figure 1 on the next page). This process increased the possibility of non-compliant claims slipping through, which could result in a loss of marketing value.

The GAT determined that it needed to upgrade its audit process to more accurately identify non-compliant claims.

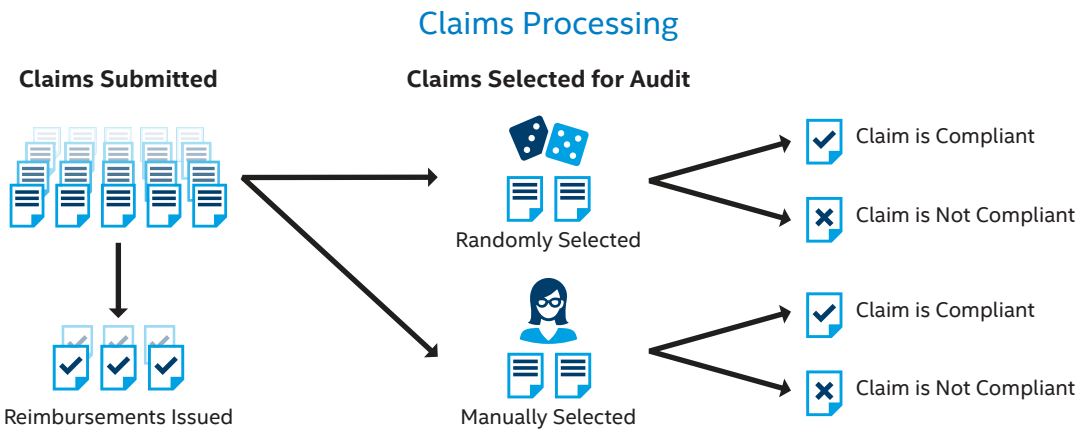

Figure 1. The volume of claims submitted each month made it difficult for the Global Audit Team (GAT) to easily identify potentially non-compliant claims.

The Potential of Artificial Intelligence

The focus of technology is rapidly changing from data management to intelligent action. While the capabilities of machines and humans are different, some processes and tasks are better suited to machines rather than humans. When integrated with the creativity and emotional intelligence of humans, artificial intelligence (AI) can add significant power and effectiveness—together, humans and machines are better than either one alone.

For example, the selection of claims for audit is based on volumes of historical data with more parameters than humans can quickly and consistently process. Each claim should be evaluated using more than 100 different patterns of detection—a difficult task for humans. The GAT could only absorb portions of the data and could not effectively detect broader patterns. This complexity of historical data and patterns made the GAT's process a perfect task for a machine-learning algorithm.

The Value of AI at Intel

From identifying potential customers to assessing the risk of financial transactions, intelligent data analysis is a core element of Intel's business success. We can improve the performance of human actions with machine insights. Automated support systems like Compliance Analysis and Prediction Service (CAPS) enable technology to act on our behalf—if we choose. These systems can complete arduous tasks and free people to do more, with fewer resources. Our artificial intelligence (AI) systems learn from vast amounts of complex, unstructured data, and turn it into actionable insights. With these insights, employees can make better, faster decisions and develop more efficient and effective business processes, which typically lead to cost savings or revenue growth. Implementing and using AI systems is critical for our continued growth in a competitive environment.

Solution

Intel IT's Advanced Analytics team developed the Compliance Analysis and Prediction Service (CAPS), designed to support the decision process for which IIP claims are selected for audit (Figure 2). Building an AI solution is a journey, and it can take time to create models and fine tune them as new information is available. Our goals included increasing the recovered dollars from non-compliant claims, continuously improving the algorithm through machine learning, and gaining user trust in AI. CAPS identifies patterns through data manipulation and predicts non-compliant IIP claims. Effectiveness is tracked based on a percentage of the total non-compliant claims, the percent of dollars reviewed, and the percent of claims accurately predicted for audit. CAPS provides the GAT with actionable information in real time.

One of the most powerful features of CAPS is the ability to automatically tune its models through self-learning, improving its success rate over time. It learns from past claims submissions, creating a new predictive model based on updated data each month. This preserves the prediction capabilities and adapts the model to new trends in the data, new business processes, or changes in the program guidelines. CAPS uses system performance indicators that are designed to monitor both changes in the members' behavior and the accuracy of its model based on the percentage of non-compliant claims previously predicted. It also monitors the return on investment (ROI) of the system itself. These performance measures allow the GAT, as well as IT, to control and react to business changes, which can impact the number of non-compliant claims and help increase trust in the system.

The self-learning component acts as a closed-loop process that can sustain itself for years with minimal human intervention. Also, because data flows in and out with very little retention, data redundancy is eliminated.

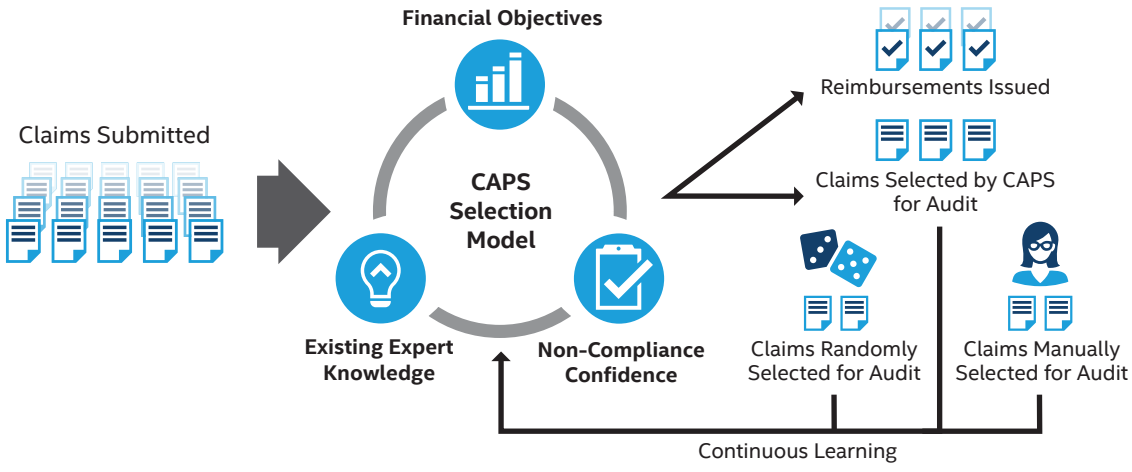

Figure 2. The Compliance Analysis and Prediction Service (CAPS) self-learning component uses analytics to retrain itself on new trends in the data, generating new models with updated information each month to preserve and improve effectiveness.

The CAPS Solution Architecture

The CAPS process is comprised of the following parts:

- **Data source and data preparation.** Reimbursement claim information is received in XML format, and the system automatically generates features so that each claim is represented by a vector. These vectors represent hundreds of different dimensions and patterns that the machine evaluates based on the past behavior of similar claims. In addition to features created from raw data, it also performs arithmetic transformation to emphasize small changes in the data that would be otherwise hard to detect.
- **Prediction algorithm.** The prediction system maximizes the recovery amount from the reimbursement claims while considering various business factors. It selects claims for audit based on predefined expert knowledge, non-compliance confidence, and financial objectives. The algorithm produces non-compliance probability/confidence for each new claim submitted to CAPS using Random Forest*. The Random Forest model generates an ensemble of decision trees, with each tree being a weak classifier that tries to capture different types of non-compliant claims.
- **Maintenance.** To preserve and improve the effectiveness of the system and learn new trends in the data, a new Random Forest model is generated each month (see Figure 3). The new model is based on past prediction performance, new expert knowledge, and changing business requirements, such as financial objectives.

During the modeling phase, we also evaluated different algorithms such as Support Vector Machine (SVM), logistic regression, and others. Ultimately, we selected Random Forest for production because it demonstrated the best results based on the data, and most importantly, stability in its results. Some of the challenges of this data set that we tested included imbalanced data (most of the claims are complaint), minimally labeled data, and avoiding local minima or overfitting the training data.

The model is built on servers using Intel® Xeon® processors, which not only meet, but exceed, our current compute needs as Intel Xeon processors are exceptionally well suited for inference-based AI models.

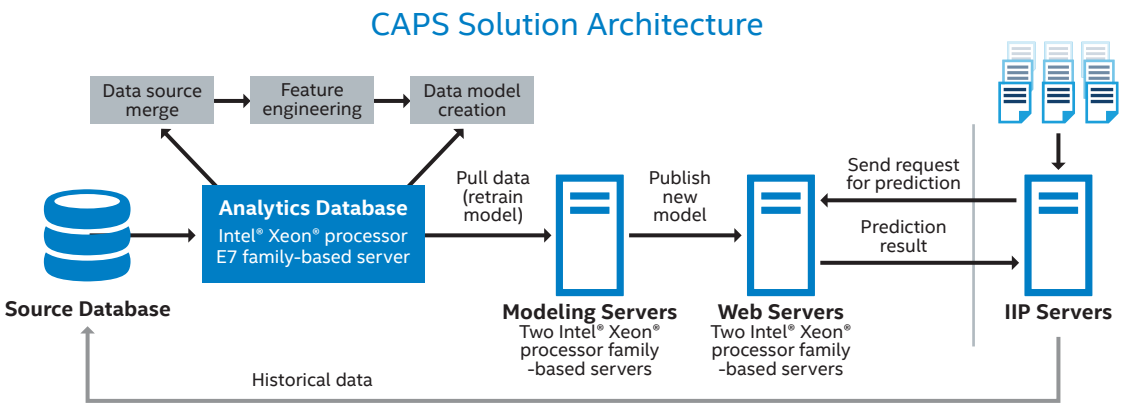

Figure 3. A Random Forest* model is generated each month to preserve and improve the system's effectiveness as it learns new trends in the data.

Proof of Concept

We began testing the CAPS model in 2011 to determine its ability to learn patterns in the data and assist in effective claim selection. Near the end of 2011, we launched a proof of concept (PoC) to demonstrate the CAPS learning model and its ability to identify patterns and predict non-compliant claims. During 2012, 14 percent of the claims audited by the GAT were based on CAPS selections. More accurate predictions and increased effectiveness helped grow trust in CAPS and improved adoption during the following years.

Results

The built-in ROI formula measures the recovered dollars from non-compliant claims selected by CAPS compared to randomly selected claims. The dollars recovered through randomly selected claims has remained the same over a five-year period. But CAPS-selected claims recovered between 9 to 19 times more dollars than randomly selected claims in the same time period (see Figure 4). The automatic selection reduces work for experts and helps the audit team meet their business objectives with fewer audits, eliminating the need for more resources. Ongoing changes in business requirements, as well as varied non-compliance rates based on location and other factors, mean that the model is always changing and learning. This can cause flux in accuracy while still increasing the total dollars recovered.

The CAPS-selected audits accounted for 29 percent of all audits conducted in 2013, 59 percent in 2015, and 84 percent in the first half of 2017. The remainder of audit selections were composed of randomly selected audits, which is a minimum requirement to detect new types of non-compliance, as well as to evaluate CAPS performance.

To maintain the efficiency and timeliness of CAPS, we tested and implemented additional features into the model during 2015. We also incorporated additional improvements to adapt the prediction system to new financial objectives. Other changes may be implemented in the future to support business process changes to the program as they arise.

CAPS now provides a fully automated, end-to-end online solution that uses a machine-learning algorithm to predict the probability of non-compliance of new claims. Because of its success, the business process has been changed and all submitted claims are first routed to CAPS. Claims which are predicted as non-compliant are automatically sent to GAT auditors.

Ratio of Average Dollars Recovered by CAPS over Randomly Selected Claims[1]

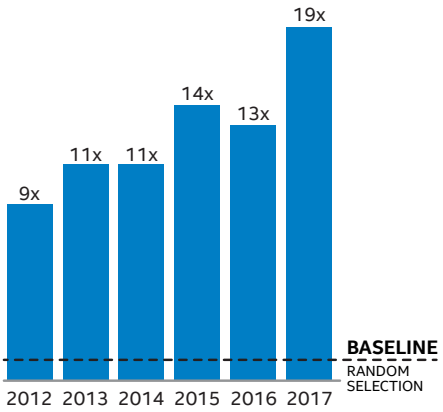

Figure 4. The ratio of dollars recovered by Compliance Analysis and Prediction Service (CAPS)-selected audits over randomly selected audits has increased 9 to 19 times over a five-year period.

[1] The average dollars recovered by manually selected claims reduced each year as the team increased CAPS usage and is immaterial to the discussion.

Lessons Learned

For AI to reach its full potential, we need to put our trust in it. A lack of trust in the effectiveness of AI can create a substantial barrier to realizing the full value it can provide. CAPS gained the trust of the GAT by demonstrating improved accuracy, consistency, and efficiency, while generating savings. This led to increased usage of CAPS. While the capabilities of machines and humans are different, they work better together. The power and accuracy of AI complements the creativity and emotional intelligence of humans. Together they are more powerful than either one alone.

Conclusion

Selecting IIP claims for audit required evaluating volumes of information and identifying patterns and trends over time. The effectiveness of the audit selection process was limited by the human ability to quickly and consistently analyze historical information related to these claims. The IIP audit selection process was a good opportunity for Intel to take advantage of machine-learning algorithms.

Intel IT's Advanced Analytics team developed CAPS to provide a more effective decision process for which claims are selected for audit. CAPS significantly increased the dollars recovered from non-compliant claims, averaging 9 to19 times higher than random selections. In the first half of 2017, 84 percent of claims audited were selected by CAPS. During this same time period, the CAPS-selected claims accounted for 97 percent of total dollars recovered from non-compliant claims. CAPS-selected claims recover an average of USD 20 million of marketing value per year that may have been lost due to non-compliance. We will continue to use and maintain CAPS for the foreseeable future.

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