**International Journal of Artificial Intelligence, Data Science, and Machine Learning**
Grace Horizon Publication | Volume 5, Issue 2, 37-46, 2024
ISSN: 3050-9262 | https://doi.org/10.63282/3050-9262.IJAIDSML-V5I2P105

*Original Article*

# Compliance-Aware AI Adjudication Using LLMs in Claims Engines (Delta Lake + LangChain)

Parth Jani[1], Sangeeta Anand[2]
[1] IT Project Manager at Molina HealthCare, USA.
[2] Senior Business System Analyst at Continental General, USA.

***Abstract*** *- Together with the continually shifting regulatory environment, the growing complexity of healthcare claims processing creates an immediate demand for more sophisticated, more flexible claims adjudication solutions. Conventional rule-based engines can fail to guarantee current compliance with changing standards, notably those published by the Centers for Medicare & Medicaid Services (CMS). Using Large Language Models (LLMs), which can understand & apply CMS rules in almost actual time, our approach offers a compliance-aware adjudication framework. Our method minimizes human rule updates and more compliance issues by dynamically interpreting their regulatory changes and incorporating them into claims decision-making processes using the natural language comprehension capabilities of LLMs. Delta Lake is our basic layer for more scalable, consistent data storage and versioned data access, therefore ensuring traceability & openness at every stage of adjudication. Together with LangChain, which combines structured data operations with LLMs, this system offers a strong, verifiable, flexible adjudication engine. This case study shows how the system handled thousands of claims in a mid-sized healthcare payer environment while following the newest CMS rules with over 90% accuracy in automated more compliance evaluations. This reduced administrative load and error rates as well as gave regulatory teams an understanding of how decisions were derived. This paper shows how generative AI combined with modern data infrastructure may change claims adjudication, improve its responsiveness, more compliance, and also more efficiency in the fast changing regulatory environment.*

***Keywords*** *- AI Adjudication, Claims Engine, CMS Compliance, Large Language Models, Delta Lake, LangChain, Healthcare Automation, NLP Compliance, Intelligent Processing, Dynamic Rule Interpretation, Generative AI, Medical Claims Workflow, Claims Processing Automation, Real-Time Compliance, Data Integrity, Healthcare AI, and Regulatory Compliance Systems.*

## 1. Introduction

A vital function of the healthcare system is the processing of healthcare claims, which guarantees that patients get the benefits to which they are entitled & that providers are paid for the delivered services. The process includes verifying the accuracy of claims, determining if treatments under a certain health plan are covered & handling payments. Fast, open, compliant claims adjudication solutions are ever more needed in the changing healthcare scene. Particularly those set by the Centers for Medicare & Medicaid Services (CMS), the more complexity of regulatory rules still presents major challenges for payers and providers. Constant changes to CMS policies aggravate the complexity even further & call for more flexible, more automated solutions to control their changing needs.

### *1.1 Conventional Rule-Based Adjudication Against AI-Driven Approach*

Healthcare claims adjudication has historically relied on their rule-based systems, assessing claims against set criteria using predefined algorithms or logic. When laws were quite stable and the procedures for claims processing were well established, these approaches were usually more effective. Still, traditional approaches have begun to show flaws as the healthcare industry becomes increasingly more complex. A major challenge of rule-based adjudication is the difficulty of guaranteeing consistent respect to the often changing CMS regulations. Rule changes or fresh interpretations of regulations must enter human hands to cause more delays, higher administrative expenses, and sometimes errors. One powerful substitute are AI-driven approaches, particularly those based on Large Language Models (LLMs). Large language models (LLMs), notably those grounded on GPT architecture, can understand and generate text that mimics human language. These models provide a degree of flexibility and also adaptability not possible by more traditional approaches; they might be trained to understand & evaluate their regulatory standards. Large language models eliminate the need for human updates by independently adjusting to the latest laws and regulations, therefore making them appropriate for more circumstances needing constant compliance monitoring and enforcement. By means of

more precise and rapid decision-making capabilities, the combination of AI with claims adjudication systems may maximize operations, eliminate human error, and increase compliance.

### *1.2 Rising CMS Guideline Complexity*

For programs like Medicare and Medicaid, which serve millions of Americans annually, the Centers for Medicare & Medicaid Services (CMS) sets the guidelines controlling healthcare claims. Covering subjects ranging from coding standards to billing policies & also payment systems, the CMS regulations are long and also regularly changed. Originally extremely difficult and sometimes changed, these guidelines are very necessary for ensuring fair & equitable distribution of healthcare resources. For healthcare businesses, particularly with respect to more compliance management across a significant volume of claims, the growing complexity of CMS rules offers significant challenges. Every claim might include several codes, patient eligibility checks & service authorizations needing validation against a changing legal environment. Furthermore, differences in the way many entities payers, providers & more government agencies interpret the laws might lead to disputes, denied claims, or even fraud. The changing character of CMS regulations makes a manual, rule-based approach to claims adjudication insufficient as it cannot change with the times in the regulatory scene.

### *1.3 Relative Importance of Dynamic Rule Enforcement and Real-Time Interpretation*

In the modern healthcare scene, one must be able to understand & apply regulations immediately. Dependent on set rules, conventional systems can find it difficult to quickly follow freshly set guidelines or reinterpreted present standards. Payers and suppliers may therefore start becoming noncompliant, causing more operational inefficiencies, costly administrative processes & even legal consequences. Particularly those driven by LLMs, AI-based systems employing actual time interpretation and dynamic rule enforcement may be able to solve these challenges. These models ensure that claims are evaluated using the most current criteria right away by regularly absorbing and evaluating the most recent CMS regulations. Furthermore, LLMs may automatically adjust the adjudication procedure on their own independent adaptation to regulatory changes, therefore eliminating user input. This provides improved accuracy & more compliance in addition to optimizing the claims processing. Dynamic rule enforcement suggests that instead of resting on fixed thinking, the system may change its decision-making in response to the evolving terrain of healthcare regulations. For example, the system may start using the updated rules right away following the publication of the latest judgment or interpretation of a CMS guideline on approaching claims. Avoiding errors and cutting the time spent on hand corrections depend on this actual time adaptability.

### *1.4 Goals of the Paper*

This work seeks to provide a fresh approach for compliance-aware claims adjudication based on Large Language Models (LLMs) combined with a scalable and trustworthy data infrastructure powered by Delta Lake. We propose an architecture combining Delta Lake for scalable and auditable data storage with the natural language processing capacity of LLMs to dynamically understand and apply CMS rules. Real-time claims processing including automatic rule updates and a detailed audit trail for all adjudication decisions is made possible by this architecture.

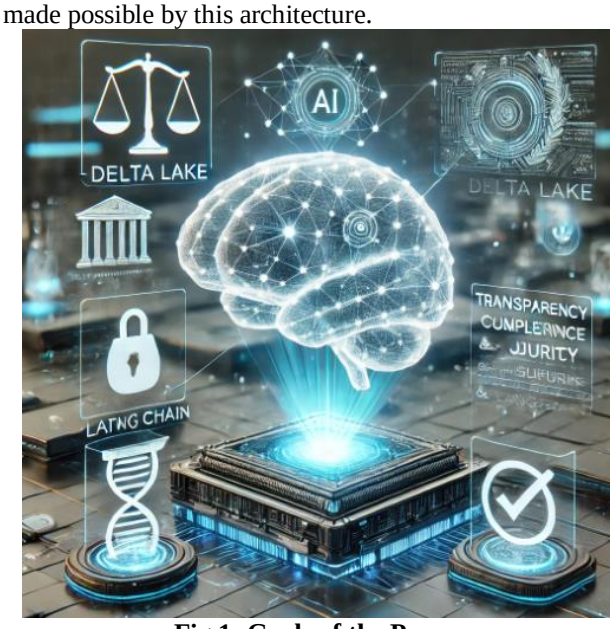


**Fig 1: Goals of the Paper**

This paper will investigate how the LLM-powered, Delta Lake-supported system may overcome the constraints of traditional rule-based systems, improve adherence to CMS criteria, and provide healthcare firms a more efficient and flexible claims adjudication procedure. By improving its responsiveness, compliance, and scalability within growing regulatory complexity, we will show, via case studies and notable outcomes, the potential of this architecture to transform healthcare claims processing.

## 2. Literature Review / Background Concepts

### *2.1 CMS Guidelines and Their Role in Claims Validation*

Establishing guidelines for the Medicaid and Medicare programs, the Centers for Medicare & Medicaid Services (CMS) is more essential in the United States healthcare system. These guidelines provide the structure for claims validation, therefore ensuring that healthcare providers get compensation for services compliant with their federal standards. Among the CMS guidelines are thorough rules on coding, service authorization, coverage restrictions & also payment policies. Healthcare payers and providers have great difficulty guaranteeing more compliance given the broad scope and complexity of these regulations. CMS guidelines are more flexible and often changed, which makes it difficult to match claims adjudication systems with the most current criteria.

Different application of these values might result in claims rejections, delayed payments, or costly penalties for regulations. A little change in a coding standard or billing requirement might have domino effects on claim validity, hence payers should regularly check their CMS updates and modify their adjudication systems suitably. The complexity & the frequency of CMS standards demand that claims validation systems be both flexible & also responsive to rapidly changing regulations, a need not sufficiently addressed by traditional, rule-based systems.

### *2.2 Synopsis of Delta Lake for Audit Trails and Data Integrity*

An open-source storage layer, Delta Lake enables consistent, scalable, high-performance data management. For big data loads, it offers the benefits of ACID (Atatomicity, Consistency, Isolation, Durability) transactions; thus, it is particularly relevant in situations when data dependability, consistency & also traceability are absolutely more vital. Delta Lake is the best infrastructure available for maintaining audit trails for every claim adjudication and ensuring data integrity in claims processing. Delta Lake's ability to manage huge volumes of information while guaranteeing data consistency a major challenge in healthcare claims processing which calls for the actual time processing of vast claims data under regulatory compliance.

Delta Lake is very essential for guaranteeing openness in adjudication decisions as it can track data changes (via time travel) and provide a thorough history of modifications (through versioned data). Maintaining conformity to CMS criteria benefits notably from this degree of traceability as it helps healthcare facilities to have a complete record of how claims were evaluated against the most recent regulatory criteria, therefore promoting both responsibility & openness. Moreover, Delta Lake is perfect for applications needing high speed & also scalability as it fits Apache Spark and many other big data technologies, therefore enabling effective data processing. In claims adjudication, where numerous claims have to be managed quickly and in line with the most recent legislation, this is very crucial.

### *2.3 Langchain Design for LLM Operation Sequencing*

LangChain is a framework enabling the integration of several processes, or "chains," utilizing Large Language Models (LLMs) like GPT-based models, hence simplifying the development of applications motivated by language models. The LangChain architecture lets developers create more complex pipelines combining many language model capabilities to do consecutive difficult operations. LangChain may be used in claims adjudication to effectively & methodically examine and understand CMS criteria. LangChain helps LLMs to read control language & apply these interpretations to specific claims data by combining different techniques, therefore enabling actual time compliance with current CMS regulations. LangChain may let a model, for instance, first examine the most current CMS guidelines, then search a claim's data, and then assess if the claim is legitimate or calls for extra investigation.

When regulatory conditions change, this modular architecture helps to update or replace specific components and offers flexibility in the interplay of components within a claims adjudication system. Furthermore, LangChain improves its features by helping many other tools and databases to be integrated. This might involve using outside compliance checklists or searching the CMS's archives, therefore providing a complete & adaptable adjudication option. LangChain is a perfect tool for building a compliance-oriented claims adjudication system as it guarantees that every stage of the process is auditable & accessible by means of data and decision organizing capacity.

### *2.4 Previous Studies on AI-Driven Claims Processing*

In recent years, AI-driven claims processing has drawn attention as a solution for the flaws in traditional rule-based adjudication systems. Several applications of ML and natural language processing (NLP) technologies including Large Language Models (LLMs) have automated and enhanced claims validation. First efforts in AI-driven claims processing focused on automating data extraction from claims forms and confirming the accuracy of claims codes, therefore automating repeating tasks. The first uses exposed how well AI might reduce administrative tasks and speed the claims processing. Recent advances have looked at using deep learning models to decode more complex regulation material, including CMS guidelines. These systems greatly reduce the time needed for compliance evaluation by evaluating their regulatory text and using it immediately on claims data.

Helping payers find & more fix anomalies or outliers in claim data, researchers have looked at the application of AI in risk assessment, fraud detection, and decision support. In this field, artificial intelligence's promise resides in its ability for constant learning from new data, hence improving its flexibility and response to changes in regulations. Nevertheless, despite these advances, AI-based systems still face challenges particularly in maintaining transparency, explainability, and conformity to strict regulatory criteria. Any claims adjudication system must guarantee the auditability of AI models and the traceability of their results, particularly in areas like healthcare where data security and regulatory compliance are of great importance.

### *2.5 Rule Rigidity, Protracted Updates, Inadequate Interpretability: Constraints of Current Systems*

While traditional rule-based adjudication systems have served their purposes throughout time, they have some clear shortcomings. One such drawback is "rule brittleness," in which case systems struggle to adapt to changes in regulations or upgrades. Maintaining these systems need for human involvement and reconfiguration due to the regular changes in CMS policies, which causes delays, errors, and increased running costs. Furthermore, rule-based systems are rigid and unable of handling complex or conflicting needs requiring interpretation. For instance, a rule-based system may misread a new CMS guideline with complex language or need major human retraining to accommodate the new rule.

Particularly in comparison to AI-driven approaches, the slow speed at which rule-based systems may absorb changes raises serious concerns. Especially big language models, AI models can instantly assess and adapt to regulatory changes, hence enabling faster & more agile decision-making. Nevertheless, a major problem related to AI systems is the "black box" feature of many ML models, in which case human users find it difficult to understand the rationale behind decisions. Especially with regard to regulatory compliance, this lack of transparency might make claims processing difficult. One workable approach to these limitations is the integration of AI models including LLMs with systems that provide data reliability and openness, like Delta Lake. Along with addressing the fragility and slow updating of traditional systems, the resulting architecture would provide a more interpretable, auditable, and adaptable adjudication mechanism.

## 3. Technical Architecture & Workflow

Combining reliable, verifiable data storage with advanced AI-driven decision-making, the proposed system for more compliance-aware claims adjudication utilizing Large Language Models (LLMs) and Delta Lake addresses This system guarantees their regulatory compliance by tackling the complex and changing their features of CMS rules and offers a complete solution for the efficient processing of healthcare claims. LangChain is used in design to coordinate LLMs for the dynamic interpretation and execution of CMS rules; Delta Lake provides a data layer guaranteeing more scalability, versioning & thorough auditability. A thorough study of the full system architecture and procedure is presented here.

### *3.1 All-around System Design*

The system architecture consists of many necessary parts:

- Pipelines for Ingestion of Claims
- Delta Lake Data Persistence
- Using LangChain to Interpret and Apply LLM
- Output Production (Decision, Reason, Compliance Documentation)
- Transparency, Documentation, and Responsibilities
- Compatibility with Electronic Medical Record Systems and Claims Processing Engines

#### *3.1.1 Ingression Pipeline for Claims*

Assimilation of claims data into the system forms the initial part of the operation. Electronic Medical Records (EMR) systems, claims management systems & many other healthcare data repositories might all be among the sources of the claims data origin from. Usually, each claim includes thorough information including patient demographics, service codes, provider

information, treatment dates & also related expenses. Tasked with retrieving data in actual time or batch mode, the ingestion pipeline translates it into a standardized format for processing and feeds it into the Delta Lake underlying data storage layer. The pipeline guarantees only genuine claims by managing error detection, data validation & also schema enforcement.

*3.1.2 Delta Lake's Data Retention:*

Claims data is kept in Delta Lake, a very scalable Apache Spark data storage system, upon input. Delta Lake offers complete ACID (Atomicity, Consistency, Isolation, Durability) transaction support in addition to consistent, reliable storage. Versioning the data helps to enable rollback in case of errors or changes & also temporal navigation that is, retrieval of previous data versions. Delta Lake's strong points schema enforcement & data quality checks ensure data integrity all through the claims adjudication process. Compliance depends on versioning as it provides an unambiguous audit record of every data alteration & decision taken throughout the adjudication process.

*3.1.3 LangChain LLM Interpretation and Applications*

Following claim data intake and storage comes the step of CMS regulation interpretation & application for the claim. This is the evidence of LLM effectiveness. LangChain controls many steps in the process to ensure dynamic & more exact rule interpretation and execution. It is a framework helping to coordinate LLMs.

- LangChain is meant to combine several actions and cues, therefore enabling the usage of LLMs in more complex systems. LangChain lets claims adjudication run like this:
- Regulatory Interpretation: Often kept in a regulatory database or repository, LangChain picks up the most current CMS guidelines. By using LangChain, the LLM examines these ideas & finds more necessary compliance requirements relevant to the current claim.

LangChain applies the dynamic rule implementation based on the CMS standards on the specific facts of the claim after analysis. The model checks if the claim follows the specified guidelines & points out any non-compliance. Based on the interpretation (allowed, denied, or requiring further research), the LLM forms a decision about the claim. LangChain ensures that company rules and legal requirements are followed in logical progression.

*3.1.4 Compliance Documentation, Decision, Rationale, Output Production*

The system generates the result based on the LLM's judgment consisting of:

- The adjudication's result will show whether the claim is approved, denied, or tagged for more review.
- Justification: Based on the CMS rules and claim data, a clear English explanation of the reasoning for the approval or rejection of a claim. Based on the thought process of the LLM, this justification may be shared with interested parties for transparency & clarity.

Comprising all relevant rule interpretations, data elements & the decision-making process, Compliance Trace is a thorough, verifiable document that defines the assessment of the claim in more compliance with CMS standards. Delta Lake maintains this record, which is accessible for dispute resolution, compliance check, or further auditing.

***3.2 LangChain's Prompt Orchestration Techniques***

Quick coordination is more crucial in an AI-driven system such as this to guide the LLM to exactly understand & apply CMS requirements. LangChain provides a structure for designing more complex triggers that may be tailored to fit certain legal criteria. Several strategies are used in competent rapid engineering:

- Using modular prompt construction: LangChain helps to create modular prompts that each target a different aspect of the claim adjudication process, therefore avoiding reliance on a one, unified query. One prompt could focus on confirming service codes, another on patient eligibility & even another on validating payment rules.
- LangChain makes more sequential connecting of prompts easier, thereby establishing a logical adjudication process. This approach helps to make little decisions wherein the result of each prompt provides input for the next process. This iterative & modular technique helps to apply more complex legal rules to claim information.
- LangChain's ability to keep context across many phases helps the LLM to understand more complex requirements needing context-specific analysis. LangChain assures that the LLM detects when to apply certain conditional rules; certain CMS rules may be applied simply under specific conditions.

***3.3 Making Use of Memory, Tools, and Agents***

- Strong features for memory management, outside resources, and agent-based decision-making abound throughout LangChain's design.

- Recollect: LangChain preserves a record of previous prompts and decisions, therefore enabling the LLM to maintain context during extended interactions including multi-step adjudication processes. In claims processing, this is more crucial as decisions usually depend on multiple data points and legal criteria.
- LangChain helps various tools including current claims engines, external validation systems, and query of regulatory databases to be integrated. This lets the LLM include more facts or context as required to guide its decisions.
- LangChain agents allocate certain tasks to specific sub-models based on expertise. For a given service code, for example, one agent would be tasked to confirm CMS compliance while another agent would focus on eligibility rules. This modular approach ensures a flexible and extendable adjudication procedure.

### *3.4 Rule Base Management*

Dynamic and maybe instantly updated from the CMS rule repository is the foundation of this system. The system absorbs the CMS rules, does LLM analysis on them, and uses them to improve the adjudication engine's logical & also decision-making structure. Important elements of rule base management consist in:

- Automobile changes: Using an API or a scheduled intake pipeline, the system may independently get the most current CMS rule updates. This ensures that the LLM regularly consults the most recent policies, therefore eliminating the need for hand rule changes.
- Versioning: The rule base is also susceptible to versioning, much like claims data in Delta Lake. This assures that claims handled under previous policies can be consistently found and inspected and helps the system to maintain a historical record of the development of CMS rules.

### *3.5 Rapid Engineering for Regulatory Mapping*

A key component in ensuring more accurate claims adjudication is matching the CMS criteria with the claim data. This means creating exact signals that let the LLM apply relevant guidelines within the claim's conditions. A number of strategies cover:

- Suggestions Particular to Regulation: Every question is designed to cover certain CMS standards components or categories. This focused approach ensures that the adjudication process is exact & meticulously follows legal criteria.
- The questions are meant to match specific claim data items such as patient demographics or service codes with the relevant regulatory criteria. This helps the LLM to quickly find more compliance flaws and provide exact findings.

### *3.6 Verifiability, Interpretability, and Documentation*

- A basic need of healthcare claims processing is the ability to monitor & more audit every decision taken. Together, LangChain and Delta Lake provide thorough auditability & also transparency.
- Every phase of the adjudication process including the claim information, relevant legal guidelines, and final decision is documented. This paperwork ensures that the complete adjudication process is open and under constant inspection.
- Natural language reasons help to clarify the decision-making process of the LLM by providing open justification for every assessment of any claim.
- Delta Lake ensures that every log is kept in a versioned and unchangeable state, therefore offering an audit trail for dispute settlement and compliance verification.

### *3.7 Integration Using Electronic Medical Records and Current Claims Engines*

This design links with EMR systems and existing claims engines to provide seamless operation within medical corporations. By means of APIs and data connections, the system may move data to and from other platforms, thereby ensuring that claims are handled within a coherent flow. This interface helps businesses to embrace the AI-driven adjudication system without requiring a significant overhaul of present systems, therefore enabling deployment and scalability. From small payers to large health insurance companies, the system's ability to connect with different healthcare technology enables its implementation across many use cases, hence keeping compatibility with present infrastructure.

## 4. Case Study: Implementing in a Mid-Sized Payer System

### *4.1 Background: Payer System with 2 Million Claims/Month*

Processing over 2 million claims each month, the healthcare payer in this case study serves a wide clientele in the Medicare and Medicaid areas. Using an outmoded claims adjudication system grounded on traditional rule-based thinking, the company evaluated more claims against a set of CMS guidelines. The system handled routine claims well but struggled to adjust to the fast changes in CMS criteria, which resulted in delayed updates, too many human reviews & also repeated compliance problems. The payer decided to redesign its claims adjudication system by using an AI-driven platform employing Large Language Models (LLMs), LangChain for workflow orchestration, and Delta Lake for data storage in response to the growing complexity of

CMS guidelines & the need for a more flexible, scalable solution. While ensuring total auditability & more transparency, the goals were to improve more compliance, reduce human participation & speed claims processing.

### *4.2 Problems of Current Infrastructure*

The legacy structure of the payer presented numerous important difficulties:

- Control is Regulation The system relied on a set of predefined, strict standards for claim validation, which often became outdated due to few improvements. Thus, even little changes in CMS criteria would cause more compliance issues and higher rejection rates.
- CMS rules are regularly changed, so integrating these improvements into the current system proved to be a slow task. Several weeks of integration for the latest rule update caused delays in claims processing and payment.
- The rigid nature of the rule-based method means that a good number of claims need hand evaluations. This caused operational inefficiencies & increased the load on claims handlers, therefore extending the payment period.
- Important for both internal audits & also external CMS evaluations, the historical system lacked the comprehensive auditing tools required to monitor changes to claims or offer thorough rationales for adjudication decisions.

### *4.3 Integration Practices*

To reduce interruption to daily operations, the transfer from the old system to an AI-driven, LLM-based architecture was carried out incrementally. The integration process consisted of the main necessary phases:

#### *4.3.1 Is Starting with Delta Lake from Traditional Data Lakes*

Moving data from the existing conventional data lakes to a more stable & more scalable platform, Delta Lake, was the first step of the transformation. The team focused on making sure that every claim historical as well as modern was migrated under total integrity & with version control capabilities. Conversion and Cleaning of Data: The data was cleaned and adjusted to fit Delta Lake's schema, which required a lot of work because of variances & also mistakes in the data storage of the former system. To ensure actual time data intake from the old system into Delta Lake, an effective ETL (Extract, Transform, Load) pipeline was built to automate this process. Delta Lake's ACID transaction features help the payer organization to track data changes throughout time. This meant that, in order to guarantee their compliance and auditability, the system could save a record of claims and adjudications. For claims decisions, the ability for "time travel" between various data versions provided necessary traceability. Delta Lake's versioning helped to simplify the more basic identification of issues in claims handling. Should any deviations be found, the system is able to return to a prior legal condition of the data, therefore ensuring that no false claims judgments are handled.

#### *4.3.2 Step 2: Creating LangChain Workflows Made Possible by CMS Rule Prompts*

Following data migration to Delta Lake, LangChain was next used to coordinate LLM activities. Dynamic evaluation of CMS rules & also application of them to every claim in actual time was the target. Guidelines of the Centers for Medicare & Medicaid Services LangChain helped to create tools for independently evaluating & comprehending CMS guidelines. Originally taught under previous CMS rules, the LLM was enhanced with the most current regulatory materials to ensure understanding of the complexity of the rules. LangChain first read the rules, then applied them to claims information, and last generated adjudication results, therefore enabling the sequential integration of various phases in the decision-making process. Using LangChain, the LLM efficiently processed claims and matched them with the most recent CMS regulations. The system checked every claim against CMS policies including eligibility, service codes & authorization limits. Should a claim fall short of the necessary requirements, LangChain set off a signal for further investigation or rejection. Building Modular Prompts: The LangChain systems were designed to handle more certain aspects of claims adjudication. While one method evaluated patient eligibility, another focused simply on verifying their service codes. As CMS rules developed, this modular architecture made simple modification of specific rule sets possible.

#### *4.3.3 Third step: Immediate Compliance Notifications*

The slow integration of revised CMS regulations was a main challenge of the previous system. Delta Lake and LangChain let updates be sent actual time. After CMS rules were changed, the system could quickly absorb the latest criteria, run LangChain for processing, and apply them in all next claims adjudications within hours. CMS updates were obtained automatically via an API and then included into the system. The updated CMS rules guided the reconfiguration of the LLM model & adjusted LangChain processes to fit these changes. Previously requiring weeks, this automation greatly reduced the time required for improvements. LangChain's ability to dynamically link rules with specific claim items helped the player to be more proactive about CMS guideline changes. LangChain might quickly reallocate the relevant prompts to handle claims based on the latest eligibility rule CMS adopted for certain healthcare services.

#### *4.3.4 Fourth step: Interaction with Current Claims Systems*

The payer's present claims handling system now includes the AI-powered adjudication tool. The connection lets claims be handled utilizing the front-end interface of the present day and the latest AI-driven backend system for decision-making. Integration of Application Programming Interventions: APIs were designed to interface the present claims engine with the latest adjudication system. From the claims management platform, claims data was delivered to Delta Lake, where the LLM-based adjudication process occurred, and results were sent back to the claims engine for ultimate processing. The transfer for claims adjusters was made as seamless as possible. They kept using the current interface while having access to thorough adjudication results, justifications, and compliance traces generated by the LLM. This assured lowest interference with regular operations and promoted user acceptability.

### *4.4 Results*

Using LangChain and Delta Lake, LLM-based adjudication produced some interesting outcomes:

- Reduced Manual Evaluations: The ability of the technology to dynamically apply CMS rules in actual time greatly reduced the amount of claims requiring human inspection. About 30% of claims at first needed human involvement; this number dropped to only 10% after the AI-driven system was put into place.
- By means of the automatic assimilation of CMS rule modifications & their prompt deployment, the payer effectively reduced the implementation time for latest CMS guidelines from weeks to just hours. This greatly improved the payer's ability to retain more compliance and speed claim processing.
- Delta Lake's auditability features combined with LangChain's natural language explanations helped the payer to clearly state & support claims judgments to both internal auditors & also outside CMS authorities. This improved system's confidence lowered the likelihood of tests or penalties.

### *4.5 Realizations and Challenges Overcome*

Though some lessons were learned along the way, the switch was mostly successful:

- Uniformity and integrity of data: Data transfer from the old system to Delta Lake called for thorough cleansing & conversion. Inconsistent or incomplete data prolonged the process and underlined the importance of data integrity before system transfer.
- Training the LLM to suitably interpret CMS requirements was a complex & ongoing task with fine-tuning. As the latest needs are developed, it must be continuously upgraded and adjusted. Maintaining the correctness of the model across actual time processing called for dedicated work.
- Although the system produced significant improvements, numerous internal users showed early resistance to adopt the latest platform because of the change in workflow. Surmounting this challenge required ongoing education and support.
- Notwithstanding these challenges, the AI-driven claims adjudication system successfully addressed payer essential concerns like rule rigidity, slow updates, and inefficiencies in human assessments, thereby producing a more scalable, flexible, and compliant claims processing system.

## 5. Conclusion & Future Work

Using Large Language Models (LLMs) for actual time CMS compliance interpretation marks a significant progress in their healthcare claims processing. The technology guarantees that claims are handled in line with the most current legislation by dynamically interpreting & also implementing constantly changing their CMS criteria using LLMs. This approach greatly speeds processing, lowers manual assessments & enhances more adjudication decision accuracy & homogeneity. LangChain for modular orchestration and Delta Lake for data storage & versioning is a great mix that guarantees the system is both scalable & also auditable. Combining Delta Lake's robust data architecture with LangChain's ability to coordinate more and more complicated processes helps to properly manage their massive claims & assures 100% compliance & also transparency. Important for tracking changes and guaranteeing their regulatory compliance, Delta Lake preserves the integrity of claims data storage with versioning, time-travel tools & also rollback capabilities.

LangChain helps to effectively coordinate LLM activities, dynamic rule interpretation, actual time updates, and simple interface with present systems, thereby considerably reducing operational overhead and improving the flexibility of the claims adjudication process. The objective is to create a completely autonomous claims processing system that examines judgments & learns from previous adjudications, therefore enhancing its decision-making capability over time. Combining advanced capabilities like GPT fine-tuning on certain CMS datasets helps the LLM to more precisely understand growing regulatory complexity. Furthermore, increasing the system's ability to negotiate a dynamic healthcare environment is looking at multi-agent reasoning for complex claims requiring cross-functional decision-making and regulatory drift detection. With continuous improvements expected to solve the growing issues in healthcare regulation, this architecture allows more intelligent, efficient, and compliant claims processing.

## References


[1] Draper, Chris, and Nicky Gillibrand. "The Potential for Jurisdictional Challenges to AI or LLM Training Datasets." *AI4AJ@ ICAIL*. 2023.

[2] Gromova, Elizaveta A., Daniel Brantes Ferreira, and Ildar R. Begishev. "ChatGPT and other intelligent Chatbots: legal, ethical and dispute resolution concerns." *Revista Brasileira de Alternative Dispute Resolution-Brazilian Journal of Alternative Dispute Resolution-RBADR* 5.10 (2023): 153-175.

[3] Ladkin, Peter Bernard. "Involving LLMs in legal processes is risky: An invited paper." *Digital Evidence & Elec. Signature L. Rev*. 20 (2023): 40.

[4] Atluri, Anusha. "Insights from Large-Scale Oracle HCM Implementations: Key Learnings and Success Strategies ". *Los Angeles Journal of Intelligent Systems and Pattern Recognition*, vol. 1, Dec. 2021, pp. 171-89

[5] Chaganti, Krishna C. "Advancing AI-Driven Threat Detection in IoT Ecosystems: Addressing Scalability, Resource Constraints, and Real-Time Adaptability."

[6] Haugen, Sindre. *Language model ai and international commercial arbitration*. MS thesis. uis, 2023.

[7] Anand, Sangeeta. "AI-Based Predictive Analytics for Identifying Fraudulent Health Insurance Claims". *International Journal of AI, BigData, Computational and Management Studies*, vol. 4, no. 2, June 2023, pp. 39-47

[8] Vats, Shaurya, et al. "Llms–the good, the bad or the indispensable?: A use case on legal statute prediction and legal judgment prediction on indian court cases." *Findings of the Association for Computational Linguistics: EMNLP 2023*. 2023.

[9] Atluri, Anusha, and Vijay Reddy. "Total Rewards Transformation: Exploring Oracle HCM's Next-Level Compensation Modules". *International Journal of Emerging Research in Engineering and Technology*, vol. 4, no. 1, Mar. 2023, pp. 45-53

[10] Vasanta Kumar Tarra, and Arun Kumar Mittapelly. "Data Privacy and Compliance in AI-Powered CRM Systems: Ensuring GDPR, CCPA, and Other Regulations Are Met While Leveraging AI in Salesforce". *Essex Journal of AI Ethics and Responsible Innovation*, vol. 4, Mar. 2024, pp. 102-28

[11] Nay, John J. "Large language models as fiduciaries: a case study toward robustly communicating with artificial intelligence through legal standards." *arXiv preprint arXiv:2301.10095* (2023).

[12] Vasanta Kumar Tarra. "Claims Processing & Fraud Detection With AI in Salesforce". *JOURNAL OF RECENT TRENDS IN COMPUTER SCIENCE AND ENGINEERING ( JRTCSE)*, vol. 11, no. 2, Oct. 2023, pp. 37–53

[13] Pont, Thiago Dal, et al. "Legal summarisation through llms: The prodigit project." *arXiv preprint arXiv:2308.04416* (2023).

[14] Yasodhara Varma. "Scalability and Performance Optimization in ML Training Pipelines". *American Journal of Autonomous Systems and Robotics Engineering*, vol. 3, July 2023, pp. 116-43

[15] Anand, Sangeeta. "Quantum Computing for Large-Scale Healthcare Data Processing: Potential and Challenges". *International Journal of Emerging Trends in Computer Science and Information Technology*, vol. 4, no. 4, Dec. 2023, pp. 49-59

[16] Syed, Ali Asghar Mehdi, and Shujat Ali. "Multi-Tenancy and Security in Salesforce: Addressing Challenges and Solutions for Enterprise-Level Salesforce Integrations". *Newark Journal of Human-Centric AI and Robotics Interaction*, vol. 3, Feb. 2023, pp. 356-7

[17] KAPOOR, SAYASH, PETER HENDERSON, and ARVIND NARAYANAN. "Promises and pitfalls of AI for legal applications." (2023).

[18] Kupunarapu, Sujith Kumar. "AI-Driven Crew Scheduling and Workforce Management for Improved Railroad Efficiency." *International Journal of Science And Engineering* 8.3 (2022): 30-37.

[19] Mendes, Bruno Miguel Lopes. *Integration of AI and Law Viewed Through Explainability: A Framework to Facilitate AI Integration in the Judiciary*. MS thesis. Universidade NOVA de Lisboa (Portugal), 2023.

[20] Atluri, Anusha. "Post-Deployment Excellence: Advanced Strategies for Agile Oracle HCM Configurations". *International Journal of Emerging Research in Engineering and Technology*, vol. 4, no. 1, Mar. 2023, pp. 37-44

[21] Guha, Neel, et al. "Legalbench: A collaboratively built benchmark for measuring legal reasoning in large language models." *Advances in Neural Information Processing Systems* 36 (2023): 44123-44279.

[22] Mehdi Syed, Ali Asghar, and Erik Anazagasty. "AI-Driven Infrastructure Automation: Leveraging AI and ML for Self-Healing and Auto-Scaling Cloud Environments". *International Journal of Artificial Intelligence, Data Science, and Machine Learning*, vol. 5, no. 1, Mar. 2024, pp. 32-43

[23] Rao, Zhiguo, et al. "Assessment of the difference between mid-and long chain compound specific δDn-alkanes values in lacustrine sediments as a paleoclimatic indicator." *Organic Geochemistry* 76 (2014): 104-117.

[24] Chaganti, Krishna C. "Leveraging Generative AI for Proactive Threat Intelligence: Opportunities and Risks." *Authorea Preprints*.

[25] Pondell, Christina R., and Elizabeth A. Canuel. "Sterol, fatty acid, and lignin biomarkers identify the response of organic matter accumulation in Englebright Lake, California (USA) to climate and human impacts." *Organic Geochemistry* 142 (2020): 103992.

[26] Anand, Sangeeta. "Designing Event-Driven Data Pipelines for Monitoring CHIP Eligibility in Real-Time". *International Journal of Emerging Research in Engineering and Technology*, vol. 4, no. 3, Oct. 2023, pp. 17-26

[27] Gao, Li, et al. "Mathematical modeling of the aquatic macrophyte inputs of mid-chain n-alkyl lipids to lake sediments: Implications for interpreting compound specific hydrogen isotopic records." *Geochimica et Cosmochimica Acta* 75.13 (2011): 3781-3791.

[28] Varma, Yasodhara. "Scaling AI: Best Practices in Designing On-Premise & Cloud Infrastructure for Machine Learning". *International Journal of AI, BigData, Computational and Management Studies*, vol. 4, no. 2, June 2023, pp. 40-51

[29] De Mesmay, Romain, et al. "Novel mono-, di-and tri-unsaturated very long chain (C37–C43) n-alkenes in alkenone-free lacustrine sediments (Lake Masoko, Tanzania)." *Organic Geochemistry* 38.2 (2007): 323-333.

[30] 30. Tarra, Vasanta Kumar, and Arun Kumar Mittapelly. "Sentiment Analysis in Customer Interactions: Using AI-Powered Sentiment Analysis in Salesforce Service Cloud to Improve Customer Satisfaction". *International Journal of Artificial Intelligence, Data Science, and Machine Learning*, vol. 4, no. 3, Oct. 2023, pp. 31-40

[31] Mehdi Syed, Ali Asghar. "Zero Trust Security in Hybrid Cloud Environments: Implementing and Evaluating Zero Trust Architectures in AWS and On-Premise Data Centers". *International Journal of Emerging Trends in Computer Science and Information Technology*, vol. 5, no. 2, Mar. 2024, pp. 42-52

[32] Lattaud, Julie, et al. "Influence of hydraulic connectivity on carbon burial efficiency in Mackenzie Delta Lake sediments." *Journal of Geophysical Research: Biogeosciences* 126.3 (2021): e2020JG006054.