Domain Subject Matter Expert -Driven AI/ML Implementation Framework

Enabling Seamless Interaction between Domain SME's and Specialized Domain Agents

[1]Nilesh S. Khedkar, [2]Raghuraj R Pandya, [3]Prashant Kumar, [4]Angel E Rojas Kingland

[1]Senior Maintenance Engineer, [2]Senior Data Scientist, [3]Senior Engineer, [4]Lead Maintenance Engineer,
[1]Corporate Maintenance Services Department,
[1]Saudi Aramco, Dhahran, Saudi Arabia
[1]Nilesh.khedkar@aramco.com, [2]raghuraj.pandya@aramco.com, [3]prashant.kumar.1@aramco.com,
[3]angel.rojaskingland@aramco.com

***Abstract*— In this Technical paper, we introduce a novel frontend assistant framework that enables seamless interaction between humans and specialized subject matter expert "Domain Agents." These Domain Agents utilize machine learning (ML) codes, scripts, or models to provide accurate answers to specific queries without hallucination. Our proposed framework supports a plug-and-play mechanism for integrating new ML scripts/models and upgrading existing ones without disrupting the end-user experience.**

The framework consists of six primary components: User Interface, Integration Hub, Domain Agent Ecosystem, Data Query Manager and Integrator, Feedback and Issue Tracking Engine, and Workbench for Domain Agent development and fine-tuning. By bridging the gap between humans and specialized Domain Agents, our framework fosters effective communication and empowers businesses to deliver exceptional user experiences.

This paper outlines the system architecture, technical requirements, and implementation roadmap for the AI/ML Implementation Framework. By adopting this framework, organizations can leverage the benefits of artificial intelligence and machine learning while ensuring accuracy and trustworthiness in their operations.

Index Terms - Artificial Intelligence (AI), Machine Learning (ML), Conversational Systems, Domain Agents, Frontend Assistant Framework, Natural Language Processing (NLP), Expert Systems, Human-Machine Interaction, Plug-and-Play Architecture, Modular Design, Hallucinations Prevention, Specialized Domain Expertise, Accuracy Enhancement, Trustworthiness Assurance, Scalability, Maintainability, Adaptable Interfaces, Business Needs Alignment, User Experience Enhancement, Seamless Upgrades

I. INTRODUCTION

The advancement of Artificial Intelligence (AI) has transformed the landscape of technological innovation, turning visionary concepts into tangible realities. At the forefront of this revolution are two pioneering fields: Conversational AI and Generative AI. While Conversational AI enables machines to engage in natural, human-like dialogue, Generative AI gives rise to novel content, encompassing images, text, and beyond. Collectively, these groundbreaking technologies are opening up unprecedented avenues for Maintenance and Reliability Engineers, granting them access to a new era of maintenance analytics. Moreover, they hold immense promise in accelerating the transition towards Prescriptive Maintenance, where proactive interventions optimize equipment performance, minimize downtime, and maximize overall efficiency.

By matching Domain experts thought processes, Conversational AI and Generative AI accelerate problem-solving and critical thinking. However, Generative AI faces notable limitations, including hallucinations, data scarcity, and fabricated responses. Addressing these challenges is essential to ensure the accuracy and trustworthiness of AI-generated output, particularly in maintenance and reliability domains requiring specialized knowledge like Maintenance and Reliability.

To fill this gap, we've created a game-changing framework that brings together the best of both worlds - expert know-how and innovative tech. Think of it as a collaboration between Maintenance Domain and machines, working hand-in-hand to deliver rock-solid insights that drive real results. With seasoned professionals guiding the process, our approach combines the nuance of human intuition with the power of machine learning. The result? Organizations can tap into the limitless potential of AI-powered solutions, all while keeping their feet firmly grounded in fact-based decision-making.

II. AI/ML FRAMEWORK

Our proposed framework encompasses six main components:

A. User Interface

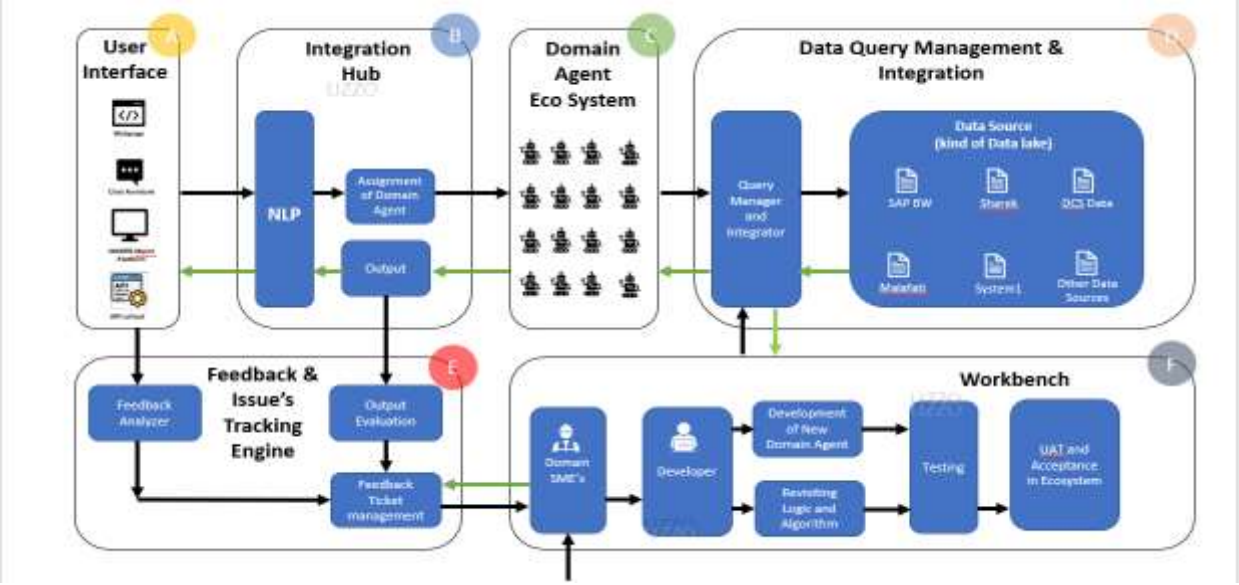
B. Integration Hub

C. Domain Agent Eco system

D. Data query management & Integration

E. Feedback & issue's Tracking Engine

F. Workbench



A. USER INTERFACE

III. User interface is the Front end where users can interact with the AI/ML framework and receive the desired output. The user interface will take care of access control and user experience and can vary depending on the application and intent of UI, we are envisioning the system to have following 4 type of user interfaces.

1) Tile or popup in website.
2) Popup window in windows desktop.
3) A Dedicated Webpage Interface.
4) A Possible API for providing access to other organizations based on request.

B. INTEGRATION HUB

A conversational AI module handling user inputs received from User interface via NLP, determining intent, and routing requests to relevant "Domain Agent".

Integration hub will seamlessly bridge the gap between the Frontend Assistant and Domain Agents. This Integration Hub orchestrates communication between components, handling API calls, data exchanges, and effortlessly integrating new Domain Agents via a robust plugin architecture.

C. DOMAIN AGENT ECOSYSTEM

Specialized ML/AL powered modules addressing specific micro usecases within designated areas of expertise. These Modules will be supervised by designated Domain SME's and can be plugged in or out of the ecosystem and follow an independent lifecycle based on the feedback. The technical design of the Domain agent will be scoped to facilitate the mounting, dismounting, as well capturing of the lesson learned from interactions. Each Domain Agent will have its own documentation which will be updated with revisions.

Domain Agent ecosystem is a library of multiple Domain Agents which are specialized Machine Learning (ML) and Artificial Intelligence (AI) modules, each tackling usecase or combination of multiple usecase within distinct areas of expertise. These modular components are carefully crafted to address unique pain points and opportunities identified in our usecase feasibility study, allowing us to provide targeted support exactly where it's needed most.

Each module is paired with a dedicated Subject Matter Expert (SME), who provides ongoing oversight and ensures the module stays true to its intended purpose. This collaborative approach allows us to refine and update individual modules independently, incorporating valuable lessons learned from real-world interactions.

This approach not only delivers precise, high-impact insights but also accelerates the development and deployment of use cases. By leveraging our modular framework, we can rapidly advance projects from Technology Readiness Level (TRL) 1 to TRL 8, significantly reducing the time and effort required to bring innovative solutions to end users.

Our framework is designed with flexibility in mind, making it easy to plug in new modules, swap out outdated ones, or adjust existing configurations as needs evolve. This adaptable framework also captures key takeaways from every interaction, enabling continuous improvement and refinement over time.

D. Data Query Manager & Integrator

To fuel the Domain Agents' generation of accurate and informative results, we're developing a centralized Data Query Manager and Integrator. This unified platform aggregates data from diverse sources, including DCS, System1, and SAP BW, providing a single point of access for authorized personnel. A shared repository for developers and SMEs, the Query Log and Library stores and manages all data queries executed against the integrated dataset. With this platform, we'll be able to leverage the combined strength of our datasets, driving better decision-making and empowering our Domain Agents to deliver even more accurate and insightful results.

E. Feedback and issue Tracking Engine

Our Feedback and Issue Tracking Engine plays a vital role in ensuring the quality and relevance of our Domain Agents' outputs. This engine facilitates transparent feedback loops between users, Domain Agents, developers and Subject Matter Experts (SMEs).

Key Features:

- User Feedback Mechanism: Allows users to rate and comment on the helpfulness and accuracy of Domain Agent responses.
- Issue Tracking System: Identifies and logs errors, inconsistencies, or inaccuracies in Domain Agent outputs.
- Automated Notification: Notifies SMEs of user-submitted issues, ensuring prompt attention and resolution.
- Collaborative Resolution Process: Facilitates discussion and collaboration between SMEs, developers, and stakeholders to resolve issues efficiently.
- Knowledge Base Updates: Integrates resolved issues and feedback into the knowledge base, enhancing future Domain Agent performances.
- Reinforcement learning: Integrates and supplement the Feedback and issue tracking engine.

By closing the loop between users, Domain Agents, and SMEs, our Feedback and Issue Tracking Engine drives perpetual growth, fine-tuning the entire ecosystem toward delivering exceptional experiences and informed decisions.

F. Workbench

Our Workbench will be a comprehensive environment designed to simplify and speed up the creation, testing, and fine-tuning of Domain Agents. This intuitive platform provides developers and SMEs with a range of tools and features to craft high-performing agents that meet specific business requirements.

Key Capabilities

- Visual interface for designing and configuring Domain Agent logic flows
- Integrated testing and simulation environments for rapid prototyping
- Collaboration tools for joint review and iteration with SMEs and stakeholders
- Version control and change management for tracking modifications
- Performance metrics and monitoring dashboards for optimizing agent behavior
- Streamline Development and Improve Results

With Workbench, we'll benefit from faster development cycles, reduced debugging times, and improved Domain Agent performance. Seamlessly collaborate with colleagues, iterate on designs, and deploy optimized agents that drive meaningful business outcomes.

IV. Technical Requirement

Development involves several programming languages and frameworks, including Python, JavaScript, and Node.js.

A. **Programming Languages:** Python, JavaScript, or equivalent languages suitable for NLP and ML development.
B. **Frameworks and Libraries:** TensorFlow, PyTorch, scikit-learn, NLTK, spaCy, etc.
C. **Data Storage:** Relational databases (e.g., MySQL), NoSQL databases (e.g., MongoDB), or cloud storage solutions (e.g., AWS S3).

We will keep on exploring the off the shelf scripts and programs which can be adopted and modified for the intended usage within the boundaries and policies set by company.

V. CONCLUSION

The Intelligent Frontend Assistant Framework offers a scalable and maintainable approach to building conversational systems that leverage specialized domain expertise while ensuring accuracy and preventing hallucinations. By providing a modular architecture and enabling seamless upgrades, this framework empowers organizations to create robust and adaptable AI-powered interfaces that meet evolving business needs. Our Intelligent Frontend Assistant Framework bridges the gap between humans and specialized Domain Agents, fostering effective communication and empowering businesses to deliver exceptional user experiences.