Rethinking Industrial AI with Generative Agents: Smart Data Pipelines, KPI Dashboards, and MLOps Integration

Abstract

In the context of Industry 5.0, the demand for intelligent, scalable systems that streamline decision-making processes and optimize production efficiency is critical. This project focuses on developing an AI-driven platform capable of integrating various data streams, automating KPI analysis, and supporting real-time decision-making through the use of an advanced generative AI agent.

Central to the platform is the creation of a knowledge base that leverages an AI-powered Common Data Model, enriched with a dynamic taxonomy of Key Performance Indicators (KPIs). The platform integrates state-of-the-art MLOps practices, ensuring continuous monitoring, updating, and scaling of machine learning models that drive the system's core functionalities. By employing Retrieval-Augmented Generation (RAG) and generative AI, the AI agent will not only respond to user queries but also proactively assist users in generating new KPIs, dashboards, and reports tailored to their unique needs.

This project will also address the complexities of data handling, real-time processing, and the seamless interaction between the platform and external systems through API integration. Targeting SMEs with limited IT and AI expertise, the platform will provide a user-friendly interface while delivering the sophisticated tools required by system integrators.

Topic 1: Knowledge Base & Taxonomy

Max 10 students
Project Title: "Building the Knowledge Core: Developing a KPI Taxonomy for Industry 5.0"

Abstract:
This group will be responsible for the creation and management of the knowledge base and KPI taxonomy, which will form the informational core of the platform. This system will organize data efficiently, providing the context and structure necessary for interactions with the other platform modules.

Goals:

- Develop a comprehensive taxonomy of KPIs, defining relationships, descriptions, and relevant metadata (alerts, thresholds, etc.).
- Create and maintain a well-organized and accessible data structure for the entire system.

Tasks and Responsibilities:
- Define the structure of the KPI taxonomy and organize data hierarchically.
- Identify and describe the most relevant KPIs for monitoring production efficiency.
- Ensure that the taxonomy supports interaction with the AI agent and other system components.
- Evaluation of required computational resources

Milestones and Deliverables:
1. Milestone 1: Define the KPI taxonomy structure.
   Deliverable: Document detailing the taxonomy structure and key KPIs.

2. Milestone 2: Implement the initial knowledge base.
   Deliverable: Database containing the implemented taxonomy and the first set of KPI data.

3. Milestone 3: Integrate the knowledge base with the AI agent.
   Deliverable: Initial version of the knowledge base integrated with the AI agent.

Topic 2: Data Architecture & Storage

Max 8 students
Project Title: "Building the Foundation: Scalable Data Architecture for Industry 5.0"

Abstract:
This group will focus on designing and implementing the data architecture for the system, ensuring efficient data management, storage, and access, both for historical and real-time data streams.

Goals:
- Design a scalable and performant data architecture.
- Ensure efficiency in managing real-time data and long-term storage.

Tasks and Responsibilities:
- Design and implement the most suitable database (SQL, NoSQL, or hybrid).
- Ensure the architecture can handle real-time data and provide historical data insights.
- Support integration with other system modules and APIs.
- Evaluation of required computational resources

Milestones and Deliverables:
1. Milestone 1: Design the data architecture blueprint.
   Deliverable: Documentation outlining the data architecture and storage strategy.

2. Milestone 2: Implement the database for real-time data.
   Deliverable: Initial implementation of the database, supporting real-time data streaming.

3. Milestone 3: Integrate storage with the KPI engine and AI agent.
   Deliverable: Functional storage system integrated with KPI engine and AI components.

Topic 3: Data Processing

Suitable for remote students
Max 10 students
Suggested for Bionics Students

Project Title: "Turning Data into Insight for Real-Time Analysis"

Abstract:
This group will be tasked with building the data processing pipeline, filtering data streams and real-time analysis. The focus will be on implementing algorithms (including machine learning models) to derive insights from time series data.

Goals:
- Implement machine learning algorithms for time series analysis and anomaly detection in production data.

Tasks and Responsibilities:
- Develop the core logic for KPI calculation and analysis.
- Filter and preprocess data streams to ensure high-quality inputs for the KPI engine.
- Integrate machine learning models for time series analysis and predictive insights.
- Evaluation of required computational resources

Milestones and Deliverables:
1. Milestone 1: Develop initial ML pipeline for time series.
   Deliverable: Prototype of the ML pipeline with basic functionalities.

2. Milestone 2: Integrate ML models for time series analysis.
   Deliverable: Engine with integrated machine learning for time series processing (e.g., classification/regression/forecasting/clustering) and anomaly detection.

3. Milestone 3: Connect the KPI engine to real-time data streams.
   Deliverable: Integrated system that processes real-time data streams and connect with the KPI engine.

Topic 4: API & Integration

Max 10 students

Project Title: "Connecting the Dots: API and System Integration for Industry 5.0"

Abstract:

This group will focus on developing the API interface that allows the platform to communicate with external systems (BI tools, GUI, and other software). The group will also handle the integration of various system components to ensure seamless data flow and user interactions.

Goals:
- Develop a flexible API for communication with external tools and internal modules.
- Ensure seamless integration between the system's components (AI agent, KPI engine, data storage).
- Design, implement and maintain the code repository and related procedure

Tasks and Responsibilities:
- Design and implement RESTful APIs for external communication.
- Manage integration between platform components, ensuring smooth data exchange.
- Ensure API scalability and security for handling industrial data.
- Evaluation of required computational resources

Milestones and Deliverables:
1. Milestone 1: Design the API architecture.
   Deliverable: API architecture documentation and design plan.

2. Milestone 2: Implement the first version of the API.
   Deliverable: Initial API allowing basic data access and system interaction.

3. Milestone 3: Integrate the API with external systems and internal modules.
   Deliverable: API integrated with the knowledge base, KPI engine, and external BI tools.

Topic 5: RAG & Generative AI (Advanced AI Agent)

Suitable for remote students
Max 10 students

Project Title: "Beyond Chatbots: Building a Generative AI Agent for Proactive Decision Support"

Abstract:
This group will create an advanced AI agent based on Retrieval-Augmented Generation (RAG) and generative AI. The AI agent will assist users not only with queries but will also proactively help generate new KPIs, dashboards, and reports based on real-time data and system context.

Goals:
- Develop a generative AI agent using RAG for enhanced decision support.
- Enable the agent to assist in generating KPIs, dashboards, and reports based on user inputs and real-time data.

Tasks and Responsibilities:

- Design and develop the RAG architecture for the AI agent.
- Endow the agent with the ability to interact with the knowledge base and provide proactive recommendations.
- Ensure the agent can generate meaningful outputs, such as new KPIs or dashboard layouts, based on real-time data.
- Evaluation of required computational resources

Milestones and Deliverables:
1. Milestone 1: Develop the core RAG framework for the AI agent.
   Deliverable: Functional RAG architecture integrated with the knowledge base.

2. Milestone 2: Implement the context-related generative capabilities for KPI and dashboard generation.
   Deliverable: AI agent capable of generating new KPIs and dashboards based on inputs.

3. Milestone 3: Integrate the AI agent with real-time data and the KPI engine.
   Deliverable: Fully operational AI agent, supporting real-time interactions and proactive decision support.

Topic 6: GUI & User Experience

Max 10 students
Project Title: "Designing the Interface: Creating an Intuitive User Experience for Industrial AI"

Abstract:
This group will focus on developing the graphical user interface (GUI) that allows users to interact with the platform's features, including managing the KPI taxonomy, visualizing data, and using the AI agent's capabilities. The emphasis will be on creating a user-friendly, intuitive experience suitable for operators and system integrators alike.

Goals:
- Develop an intuitive and responsive GUI for managing KPIs, data visualization, and interaction with the AI agent.
- Ensure the GUI supports a smooth user experience for both technical operators and system integrators.

Tasks and Responsibilities:
- Design the user interface based on user needs and system functionalities.
- Implement front-end features that allow users to visualize KPIs and interact with the AI agent.
- Test the interface for usability and responsiveness, ensuring it meets the needs of different user types.
- Evaluation of required computational resources

Milestones and Deliverables:
1. Milestone 1: Create wireframes and mockups for the user interface.
   Deliverable: Wireframes and mockups showing the layout and user flow.

2. Milestone 2: Implement the core features of the GUI (KPI management, dashboarding).
   Deliverable: Initial GUI version with basic KPI management and data visualization features.

3. Milestone 3: Integrate the GUI with the AI agent and backend systems.
   Deliverable: Fully functional GUI, integrated with the AI agent, KPI engine, and real-time data.

Topic 7: Data Security, AI Explainability & Privacy

Suitable for remote students
Max 5 students
Project Title: "Securing the Future: Data Security, AI Explainability and Privacy for Industry 5.0"

Abstract:
This group will be responsible for implementing data security and privacy measures for the system. They will ensure compliance with industry standards and safeguard sensitive data during both transfer and storage. This includes developing encryption, authentication protocols, and vulnerability testing. The group will also be responsible for the explanations of model predictions in context-specific settings.

Goals:
- Implement a comprehensive security framework to protect data within the platform.
- Ensure compliance with relevant privacy regulations (e.g., GDPR) and industry standards.
- Explain (a subset of) decisions made by AI agents

Tasks and Responsibilities:
- Develop and implement security measures for data management (e.g., encryption, secure authentication).
- Design protocols for secure data transmission and storage.
- Identify and explain a subset of relevant AI models' decisions.
- Conduct security testing to identify and mitigate potential vulnerabilities.

Milestones and Deliverables:
1. Milestone 1: Define the system's security, privacy requirements and critical decisions that need to be backed-up by explainability techinques.
   Deliverable: Document outlining the security and privacy protocols necessary for the platform as well as the critical decisions requiring explainability.

2. Milestone 2: Implement key security protocols (encryption, access controls).
   Deliverable: Initial implementation of encryption and authentication for data management and first implementation of explainable solutions.

3. Milestone 3: Complete security testing and vulnerability assessments.
   Deliverable: Final report on security testing, with all identified vulnerabilities addressed and all critical predictions supported by a related explainable service.

Topic 8: KPI Calculation Engine

Max 5 students
Project title: “A computational engine for real-time KPI computation”

Abstract: This group will be tasked with building the KPI calculation engine that supports real-time analysis. The focus will be on implementing algorithms for processing KPI data and that supports dynamic KPIs that change over time.

Goals:
- Develop a real-time KPI calculation engine.
- Support dynamic KPIs

Tasks and Responsibilities:
- Develop the core logic for KPI calculation and analysis.
- Evaluation of required computational resources

Milestones and Deliverables:
1. Milestone 1: Develop initial KPI calculation logic.
   Deliverable: Prototype of the KPI engine with basic calculation functionality.

2. Milestone 2: Advanced KPI engine supporting dynamic KPIs.
   Deliverable: Engine with integrated support for dynamic KPIs, receiving new KPIs from the AI agent.

3. Milestone 3: Connect the KPI engine to real-time data streams.
   Deliverable: Fully operational KPI engine receiving and processing real-time data.

Milestones Structure

Milestone 1 (November 12th and 14th 2024)

1. **[Knowledge Base & Taxonomy/Ontology]**: Define the KPI taxonomy structure.
   Deliverable: Document detailing the taxonomy structure and key KPIs.
2. **[Data Architecture & Storage]**: Design the data architecture blueprint.
   Deliverable: Documentation of data architecture and storage strategy.
3. **[Data Processing]**: Develop the initial ML pipeline for time series.
   Deliverable: Prototype of the ML pipeline with basic functionalities.
4. **[API & Integration]**: Design the API architecture.
   Deliverable: API architecture documentation and design plan.
5. **[RAG & Generative AI]**: Develop the core RAG framework for the AI agent.
   Deliverable: Functional RAG architecture integrated with the mocked knowledgebase.

6. **[GUI & User Experience]**: Create wireframes and mockups for the user interface.
   Deliverable: Wireframes and mockups showing the layout and user flow.
7. **[Data Security & Privacy]**: Define security, privacy requirements, and explainability needs.
   Deliverable: Document outlining security, privacy protocols, and explainability requirements.
8. **[KPI Calculation Engine]**: Develop initial KPI calculation logic.
   Deliverable: Prototype of the KPI engine with basic calculation functionality.

Milestone 2 (November 26th and 27th 2024)

1. **[Knowledge Base & Taxonomy]**: Implement the initial knowledge base.
   Deliverable: Database with implemented taxonomy and initial KPI data.
2. **[Data Architecture & Storage]**: Implement the real-time database.
   Deliverable: Initial implementation of the database, supporting real-time data streaming.
3. **[Data Processing]**: Integrate ML models for time series analysis.
   Deliverable: Engine with integrated ML for classification, regression, forecasting, and anomaly detection.
4. **[API & Integration]**: Implement the initial API version.
   Deliverable: API allowing basic data access and system interaction.
5. **[RAG & Generative AI]**: Implement generative capabilities for KPI and dashboards.
   Deliverable: AI agent capable of generating KPIs and dashboards/reports based on user inputs.
6. **[GUI & User Experience]**: Implement core GUI features (KPI management, dashboarding).
   Deliverable: Initial GUI version with KPI management and data visualization features.
7. **[Data Security & Privacy]**: Implement key security protocols (encryption, access control) and explainability solutions.
   Deliverable: Encryption, authentication for data management, and initial explainability solutions.
8. **[KPI Calculation Engine]**: Develop advanced KPI engine supporting dynamic KPIs.
   Deliverable: Engine with support for dynamic KPIs, receiving updates from the AI agent (mocked).

Milestone 3 (December 9th 2024)

Fully documented project
Deliverable: Description of Work document, User Guide, API Doc, Code Repository

Milestone 4 (December 17th and 18th 2024)

Final Project Presentations. 30 minutes presentation, 15 minutes live demo, 10 demo Q&A