



Building AI Agents and Orchestration using UiPath Maestro

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Abstract - AI agents are integral to every business function, and strategies are being developed to integrate and adapt the workforce for AI agent use. In the future, the future of work is poised to progress towards using AI Agents alongside or assisting humans in day-to-day functions. LLM models power these agents and, as traditional automation deals with deterministic processes, AI agents can also automate non-deterministic processes. This is possible as AI agents make decisions based on real-time data. UiPath Maestro seamlessly coordinates tasks among AI agents, robots, and people, allowing developers to design end-to-end agentic processes using industry-standard BPMN constructs. Maestro is also very helpful in terms of visibility for businesses, as they can gain insight into historical instance executions, with powerful analytics integrated. This comprehensive solution supports the entire life cycle of long-running business processes, including modelling, implementation, monitoring, operations, and optimization. This research paper explores the context of AI agents, focusing on their development and the role of Maestro.

Keywords - RPA, AI, Agentic Automation, LLMs, Maestro, AI agents, BPMN, Context grounding, Vector Databases, Auto Pilot.

1. Introduction

UiPath's integration of AI dates back to early adoption of computer vision for UI automation. Over time, UiPath integrated AI into its products including Process mining, Task mining, and Document Understanding. In the subsequent years, UiPath partnered with major AI providers such as Open AI, Google, and Meta, embedding LLM based activities to UiPath activities and now extending to Auto Pilot with a focus on Agentic AI. UiPath's platform offers flexibility, letting firms choose LLM of their choice. The requests are managed through the AI trust layer. AI Agents follow instructions, execute automation, and make decisions based on the context, collecting information, and automating complex tasks that require language understanding and decision-making. Core features of AI agents include intelligent planning and synchronization: Agents plan different steps to achieve an outcome, collaboration : involves establishing coordination between robots, other agents, and humans, Autonomous decision-making: enables agents to independently perceive the environment and find ways to achieve their goals, adaptability: Agents self-learn, heal, and continuously improve their performance overtime.

Agents leverage various tools to perform their tasks. These include, but are not limited to, UiPath activities, pre-built automations, which can be combined to form a large agentic automation involving multiple processes, or connections to external services like email, Excel, or large language models (LLMs) from providers like OpenAI or GPT. There are several components that make an AI agent: a Natural language prompt, context, tools, activities, existing automations, connections to external services, and human-in-the-loop. A natural language prompt is vital to the instructions provided to the bot. Agents receive instructions in natural, human language, rather than passing exclusive commands. These components, along with principles like perception, planning, adaptability, reflection, and memory, enable agents to automate complex tasks that require language understanding and decision-making, distinguishing them from traditional, rule-based RPA. For example, an agent is expected to act when the prompt 'get me calendar invites for tomorrow' is given.

Also, providing agents with context to bot performance. For example, 'meet me at the bank' may have various connotations, as it could mean 'meet me at a bank', which is a financial institution, or 'meet me at a river bank'. UiPath

Maestro is the orchestration layer that enables seamless coordination between AI Agents, robots, and humans to achieve business outcomes. Using Maestro, business processes can be designed using BPMN (Business Process Model and Notation) to map workflows, tasks, events, and gateways. This can be done using the UiPath Process Designer or within UiPath Studio Web. It provides real-time data to track process instances, letting us consume information related to execution status, incident tracking, and the ability to resume long-running workflows from the point of error. This research paper, in subsequent sections, explores the key features of AI Agents and UiPath Maestro.

2. Implementing Agentic Process Automation:

2.1. Context Grounding:

Context is essential to gauge the prompt and interpret when ambiguous phrases surround the information. Context grounding refers to the process of providing an LLM (Large Language Model) information that is required to understand and respond accurately to a query. Without proper context phrases such as 'I'm ready', 'I saw a bank', or 'I'm set' cannot be interpreted by AI agent reliably. However, after providing sufficient context or pretext to the phrase, AI agents would understand the prompt. LLMs are designed to understand the context. They break the information into small chunks called tokens. Each LLM has a context window that acts as a memory for the current conversation. The input tokens are fed into this memory. Based on the tokens, LLMs would predict the next word or response. Hence, in Agentic AI, Context Grounding is essential for the LLM to provide the specific context. In UiPath, the Auto Pilot feature can be used to match the context. For this, relevant documents can be uploaded to the storage bucket in orchestrator, creating index for this context, and then enabling that index for autopilot. Once grounded, LLMs can answer the questions based on the provided documents

2.2. Vector Databases:

[1]Vector databases are used to store and manage information related to unstructured data such as audio, video, text, and images, allowing the LLM to understand the data. Unlike traditional databases that store information in rows and columns, vector databases capture the semantic meaning of data. Information is stored as vectors, which are a collection of numbers. These numbers are numerical representations of data that capture meaning and the relationship between data points. Before storing data in vector databases, there's an intermediate step called an embedding model. Its function is to transform raw, unstructured data- such as audio, video, images, or text-

into a numerical vector representation. These vectors are essentially collections of numbers that capture the meaning and relationships between different data points. These numbers doesn't store intuitive meaning for humans but capture the underlying semantic relationships and meaning of the data. Some of the embedding models are OpenAI embeddings API, Hugging Face models, and custom-trained networks. Once the raw data is converted into vector embeddings by an embedding model, these vectors are then stored in a vector database. This process is essential as vector databases rely on these numbers to enable semantic search, allowing AI to understand the meaning behind the query rather than just matching words. This also enables quick retrieval of information based on conceptual similarity. Once the data is converted into vector embeddings and stored, retrieval involves comparing a query's embedding with existing stored vectors. This comparison uses similar metrics to find the closest matches.

2.3. Agentic testing:

[2]UiPath implements agentic testing for the enterprise UiPath Autopilot for Testers. Using UiPath Autopilot for Testers is a collection of AI-Powered agents designed to boost the productivity of testers across testing life cycle. The three pillars of Auto Pilot for testers are Test Design, Test Automation, and Test Management. It is empowering testers with advanced AI capabilities. It is designed with the aim of addressing slow delivery, high costs, and low software quality of the current conventional testing practices. UiPath brings agentic testing to life for the enterprise primarily through UiPath Test Cloud, which is the next evolution of UiPath Test Suite. Autopilot's capabilities enhance testing phases, including test design, test automation, and test management. Cisco anticipates using Autopilot to eliminate manual testing by 50%, reduce tools, and decrease dependency on production data for testing. Users can use built in agents or can build customized AI agents using AI builder to match unique business needs. Instead of relying on binary pass/fail outcomes, agentic AI systems assess outputs for accuracy and relevance within specific contexts. This is particularly crucial for AI applications where nuanced understanding is key, helping to identify subtle vulnerabilities. Also, AI agents automatically detect changes in applications, such as changes in UI or API, and adjust the scripts accordingly, eliminating the need to see the and account for the scenario in the further phases of automation.

2.4. UiPath Agents:

[3]UiPath platform categorized AI As mentioned in Figure 1: Different types of AI **Agents**, Agents into four categories,

each designed to address different operational requirements. UiPath system agents are built-in agents within UiPath ecosystem. Autopilot and Healing Agent are examples of UiPath system agent. Both provide support that streamline automation lifecycle without requiring direct user intervention. UiPath built agents are the one created in studio web and are tailored for citizen developers. Even the users with minimal coding experience can build agents using agent designer in

studio web, providing opportunity for rapid creation of agents. UiPath coded agents caters to expert users who can build agents UiPath SDKs using Integrated Development Environments (IDEs). Keeping in view of diverse technological landscapes and systems, UiPath also provided the option to integrate external agents that have capabilities for incorporating and managing agents developed outside of UiPath.

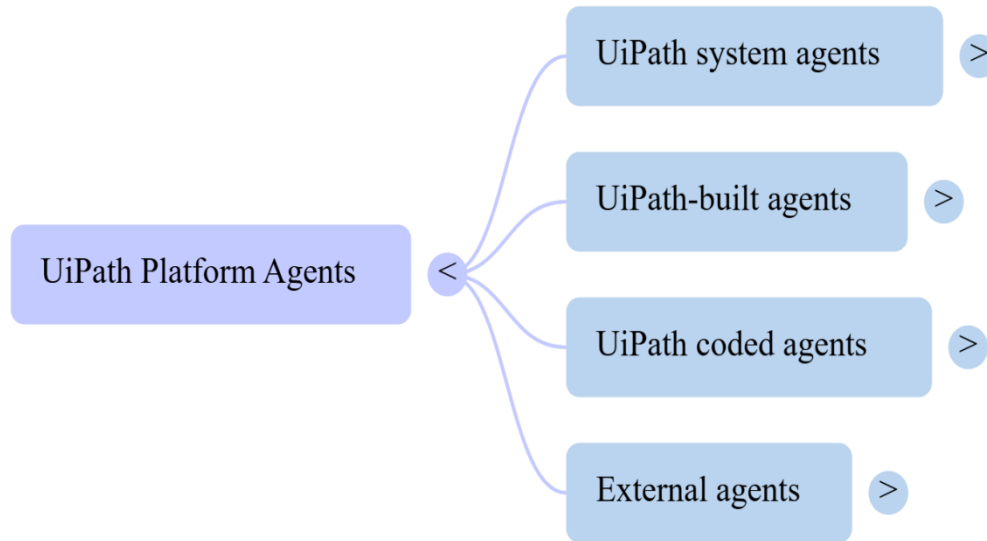


Figure 1: Different types of AI Agents

UiPath agents are accessible in two ways: UiPath Studio web and UiPath Automation Cloud.

- **UiPath Studio Web:** This serves as the Agents designer canvas, offering a guided, low-code experience for designing, testing, and deploying AI agents. This caters to large set of audience, including developers, AI engineers, and business users. It allows users to design and create their own automations regardless of their expertise level.
- **UiPath Automation Cloud:** This platform provides a comprehensive monitoring and management experience for AI agents. It offers an end-to-end solution for overseeing and controlling these agents.

3. Building AI Agents:

Currently, there are two way to build AI agents: UiPath Studio Web and AI Builder. As building AI Agents in AI builder will be deprecated soon, we will explore the features of building agents in UiPath Studio Web.

3.1. Building an Agent in UiPath Studio Web:

UiPath Studio Web allows users of all expertise levels to design and create automations, including the development of agents. To start with, studio.uipath.com and select the "Create New" button, then choose "Agent". This opens up a Agent designer canvas. An agent autopilot box will appear, prompting the user to describe the functions of the agent in detail in natural language. The Studio Web designer canvas is where you design your agent, supported by left and right panels for exploring the agent's structure and resources. On the left side panel agent structure is displayed and includes project explorer : Used to build agent, define prompts, tools, escalations and contexts , Data Manager : For defining input and output arguments, and Errors Panel: Displays issues at the design time, incorrect settings, and failed test runs. The panel on the right side includes Properties Panel: Branched into properties tab to configure agent level or component-level settings and dev tab for running test inputs , and debugging ; Agent Score: Shows agents readiness and test coverage for the tests conducted ; Run Output Panel : Reviews results from most recent test runs; and Autopilot: Provides AI prompt suggestions

improve prompts. All the elements are defined in Definition Panel that has sections general, tools, contexts, and escalations.

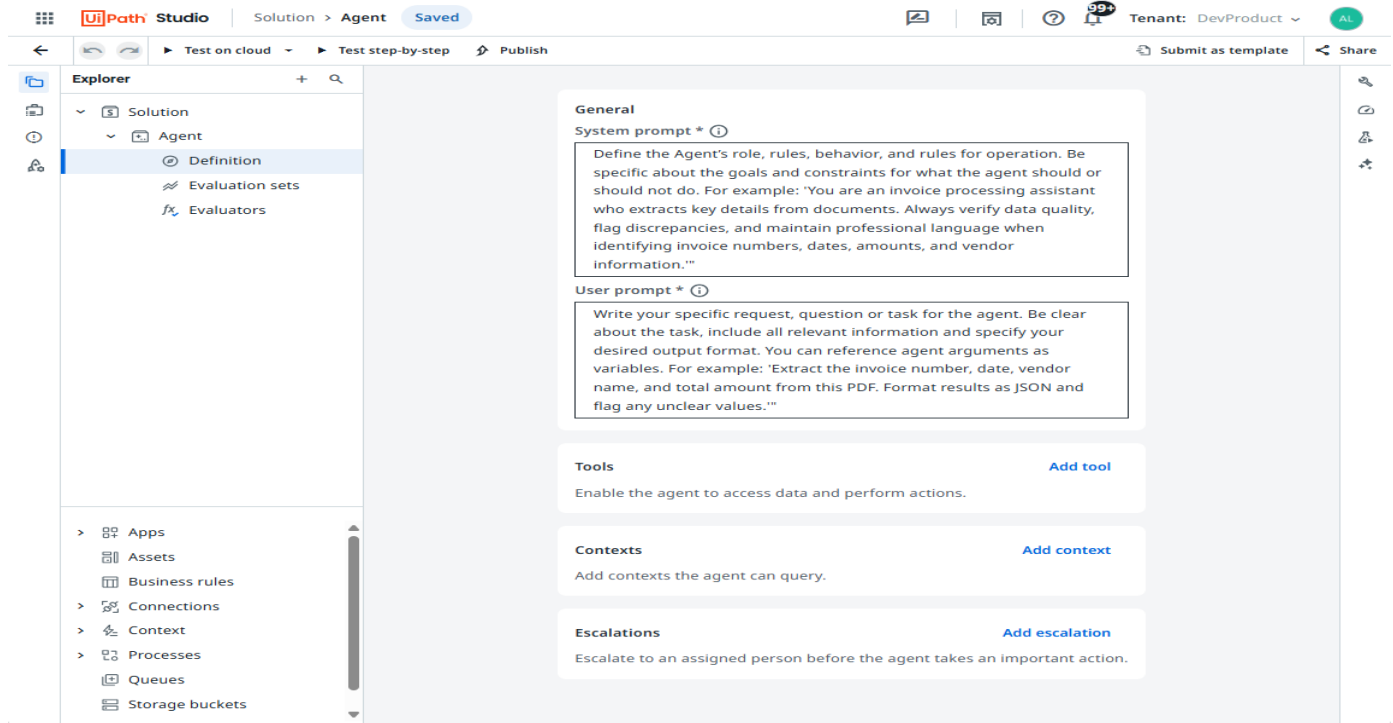


Figure 2: AI Agent on Studio Web

The general section is used to specify the system prompt, providing clear instructions to the agent, including the agent's role, behavior, and operational rules. Tools sections lets the agent connect with other agents or integration services while performing actions. Contexts space links sources of knowledge using indexes from context grounding to let the agent access specific data sources for context. The escalations section lets the user define human action before proceeding to next steps. Additionally, there's an option to choose default LLM model from AI trust layer or custom LLM model. The data manager panel is used to define input and output arguments that will be used in prompts. Once configured, testing is essential for AI agent. Select Tet on Cloud, confirm resources and sample input in Test Configuration window, and click run. In the evaluation set panel, there's an option to rename the default evaluation set and add test cases with outcomes that are expected. Also, evaluators can be added, in the evaluators panel, to validate the output of agent.

4. Agentic Orchestration with UiPath Maestro:

There are several limitations of single agent systems including struggles with tool selection, context pollution, auditing difficulties. There are several Advantages of Multi-Agent Systems including Divide and Conquer Approach:

Assigning agent to a specific set of tasks unburdens agents; Easy Maintenance: If one agent breaks, the other available agents can pick up; and Specialized Expertise: Each agent can be fine-tuned for its specific expertise. UiPath Maestro is presented as a Business Process Model and Notation (BPMN) tool and its purpose is to seamlessly integrate, manage, and monitor AI agents and complex processes. It uses BPMN 2.0 constructs such as tasks, events, and gateways to design and standardize workflows. For implementing long-running workflows and saving progress, the Studio Web BPMN Process Designer requires an active cloud license and access to UiPath Studio Web. There are five pillars of UiPath Maestro: Modelling, implementation, operation, monitoring, and optimization. Using BPMN elements such as tasks, events, or gateways, workflows can be designed as part of implementation, it provides usage of UtilUtilizing Decision Model and Notation (DMN) for managing business rules, with features for import, export, and version tracking.

4.1. Process Modeling:

[4]Maestro helps users start automation and covers various functionalities from modeling to optimization. The core functionality revolves around modeling processes in an industry-standard Business Process Model and Notation

(BPMN) format. It is designed for users of all expertise levels to create automations with UiPath Studio Web. Agentic processes are designed and configured within a dedicated designer that supports the BPMN format. The designer uses interconnected elements (steps) that represent different parts of a process. Key BPMN concepts include: events, tasks, gateways, data objects and data stores, participants, and sequency flows. Left Toolbar: Provides a wide range of BPMN elements, grouped under Gateways, Tasks, Events, Data, and Participants, which users can drag into the designer. Upon selecting element tool bar, it appears , offering actions such as changing type of element, adding end events, exclusive gateways, taks and intermediate events. Context menu offers options such as organizing connections and enabling or disabling the background grid. Validation Panel rules engine validates agentic process against BPMN rules, identifying warnings and errors. After modeling, processes can be configured, including properties, data manager, variables, and events.It supports configuring various task types, gateways, and subprocesses.

4.2. Process Operations:

[5]There are two critical aspects of its process operations capabilities: the Instance Management View and Variables and Element Filtering. These features are integral for monitoring, troubleshooting, and optimizing automated business processes. The Instance Management View serves as the primary operational summary for all process instances within UiPath Maestro™. It offers both real-time and historical insights into process execution, enabling users to monitor automation activity, diagnose failures, and identify performance trends. Key components and functionalities within this view include: Active Instances Dashboard, Incidents Table, and Processes Table.

4.3. Process Monitoring:

[6]UiPath Maestro offers comprehensive capabilities for monitoring and optimizing automated business processes, integrating with UiPath Insights to provide advanced analytical tools. This functionality is crucial for gaining insights into process performance and ensuring operational efficiency. Maestro seamlessly integrates with UiPath Insights, enabling real-time monitoring and troubleshooting of orchestrated processes. Users can create custom dashboards to align with specific Key Performance Indicators (KPIs), business rules, or operational objectives.

4.4. Process Optimization:

[7]For process optimization, Maestro provides two key components: the Optimization dashboard and the Optimization view. The Optimization dashboard analyzes how processes perform over time by offering visual insights into process duration, element delays, failure hotspots, and usage trends, enabling data-driven decisions to enhance efficiency and reliability, and allowing users to compare process versions and monitor automation strategy impacts. Complementing this, the Optimization view in the "Optimize" tab allows users to monitor historical executions across all agentic process versions to identify inefficiencies, bottlenecks, and delays, leveraging Process Mining capabilities.

5. Conclusion

In summary, AI agents are revolutionizing how business processes are being performed. Organizations that use traditional RPA are strategizing to build AI agents so that they can work alongside with traditional bots and humans. Customizing each requirement and assigning each agent to a specific function would be a better way to manage the workload among the AI agents. As the AI agents grow in number, contributing to agentic automation, there would be an imminent need to strategize and streamline the deployment processes. Hence, UiPath Maestro would be helpful in this aspect as it can tie up multiple agents, pass the information from one bot to another, and complete the required function. Maestro supports the entire process lifecycle, from initial design in UiPath Studio Web to continuous optimization through its Optimization dashboard and Optimization view.

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