
CAPSTONE PROJECT

ResearchMate: RESEARCH AGENT

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OUTLINE

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- **Proposed System/Solution**
- **System Development Approach** (Technology Used)
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PROBLEM STATEMENT

Problem Statement No.1 - Research Agent

The Challenge- A Research Agent is an AI system designed to assist with academic and scientific research tasks. It can autonomously search for literature, summarize papers, and organize references. Using natural language processing, it understands research questions and retrieves relevant information. The agent can generate reports, suggest hypotheses, and even draft sections of research papers. It saves time by automating repetitive tasks like citation management and data extraction. Research Agents enhance efficiency, accuracy, and innovation in both academic and industrial R&D.

Students and researchers often face challenges in summarizing academic topics, formulating hypotheses, and managing citations efficiently. These tasks are time-consuming and often require domain expertise. There is a need for an intelligent assistant that can automate and simplify the research process using AI.

PROPOSED SOLUTION

- **Agent Architecture:**
 - Design an autonomous AI research agent using **IBM Watsonx AgentLab**
 - Leverage **Granite LLM** and **prompt chaining** to simulate agentic behavior
 - Structure the agent to execute a sequence of research-related tasks automatically
- **Prompt Instruction Logic:**
 - Accept a general or predefined research topic
 - Perform the following key steps:
 - ❑ Simulate context (mimicking academic knowledge retrieval)
 - ❑ Summarize the topic using formal academic tone
 - ❑ Propose a testable hypothesis
 - ❑ Suggest research subtopics/questions
 - ❑ Draft an introductory paragraph
 - ❑ Provide an APA-style dummy citation

PROPOSED SOLUTION

- **Implementation (Agent Lab):**

- Developed and configured in **Watsonx Agent Lab** using **ReAct + LangGraph** architecture
- Variable-based input removed due to beta limitations — replaced with context-aware generic flow
- Prompt tested successfully with multiple academic topics
- Structured output with clear section headings

- **Deployment Approach:**

- Direct deployment via AgentLab not completed due to backend service errors
- System tested within AgentLab interface and validated through output consistency
- Screenshots and outputs included in results to demonstrate agent functionality

- **Evaluation:**

- Validated output quality based on:
 - ❑ Relevance of generated summary and hypothesis
 - ❑ Accuracy of simulated academic tone
 - ❑ Clarity and structure of generated text
- Compared outputs across multiple topics to ensure consistency

PROPOSED SOLUTION

- **Result:**
 - The **ResearchMate agent** was successfully tested within the IBM Watsonx AgentLab environment.
 - The system produced structured academic outputs for multiple research topics, including:
 - ❑ A 100–150 word summary
 - ❑ A relevant, testable hypothesis
 - ❑ 2–3 research subtopics/questions
 - ❑ A sample introductory paragraph
 - ❑ A realistic dummy citation in APA format
 - Outputs were clear, coherent, and contextually accurate for the given topics.
 - Screenshots of agent responses are included in the report and presentation slides as evidence of successful task execution.
 - Despite deployment challenges, the project demonstrates the **agentic capabilities** of IBM Granite LLM through structured prompt-based reasoning and response generation.

SYSTEM APPROACH

- **Platform:** IBM Watsonx Agent Lab
- **Model Used:** Granite LLM
- **Architecture:** Prompt chaining (Agentic workflow)
- **Inputs:** User research topic
- **Outputs:** Summary, Hypothesis, Subtopics, Intro Paragraph, APA Citation

ALGORITHM & DEPLOYMENT

- **Algorithm Type**

- **Type:** Prompt-based, zero-shot reasoning using LLM
- **Behaviour:** Agentic – handles complex tasks in sequence
- **Chaining:** Internal logic chaining (not external tools)
- **Tone Control:** Formal academic tone using instruction templates

- **Deployment Details**

- **Environment:** IBM Watsonx Agent Lab interface
- **Input Handling:** Static or embedded topic due to variable binding limitation in beta
- **Output Format:** Section-wise structured response
- **Deployment Status:**
 - ❑ Successfully tested within Agent Lab
 - ❑ Deployment failed due to backend variable binding issue
 - ❑ Output validated via screenshots and report documentation

RESULT

The screenshot displays the IBM Watsonx web interface for configuring an AI agent. The browser address bar shows the URL: `dataplatfom.cloud.ibm.com/wx/agents/2917f25a-f05e-48d4-adc7-79129335c798?project_id=30ec6622-fe17-498a-bb8e-ea13f4ccf856&context=wx#`. The interface is divided into two main sections: 'Build' on the left and 'Agent preview' on the right.

Build Section:

- Model:** Set to 'mistral-large'.
- Framework:** Set to 'LangGraph'.
- Architecture:** Set to 'ReAct'.
- Instructions:** A text box contains the instruction: "You are an autonomous AI research agent built to assist with academic writing and scientific exploration. When a student enters a research topic:". A link for 'Advanced configuration' is visible.
- Knowledge:** A section for adding knowledge sources.
- Tools:** Includes buttons for 'Add a tool' and 'Create custom tool'.
- Added tools (5):** A list of tools is shown, including 'Google search' with the description 'Retrieve information from the Internet with the Google search engine.'.

Agent preview Section:

- Welcome to ResearchMate:** A message stating 'ResearchMate is an AI-powered academic assistant. It autonomously summarizes research topics.'.
- Sample questions:** Two example prompts are provided: 'What research topic would you like help with today?' and 'Are you looking for a general overview or something more specific?'.
- Input field:** A text box at the bottom prompts the user to 'Type something...'. The interface also features a 'Deploy' button and an 'Autosave on' toggle.

RESULT

The screenshot displays the IBM Watsonx ResearchMate interface in a web browser. The browser's address bar shows the URL: `datapatform.cloud.ibm.com/wx/agents/2917f25a-f05e-48d4-adc7-79129335c798?project_id=30ec6622-fe17-498a-bb8e-ea13f4cd856&context=wx`. The page header includes the IBM Watsonx logo, an 'Upgrade' button, and user information for 'Shreya Padmakumar's Acc...' with a location of 'Dallas'.

The main interface is divided into two primary sections: 'Build' on the left and 'Agent preview' on the right.

Build Section:

- Model:** Set to 'mistral-large'.
- Icon:** A circular icon with a chess knight piece.
- Placeholder image:** A 3D illustration of a computer monitor displaying data, a laptop, and a smartphone, all connected by lines.
- Quick start questions:** A section with a text input field and two pre-defined questions: 'What research topic would you like help with today?' and 'Are you looking for a general overview or something more specific?'.
- Configuration:** Includes dropdown menus for 'Framework' (set to 'LangGraph') and 'Architecture' (set to 'ReAct').
- Instructions:** A link to 'Advanced configuration'.

Agent preview Section:

- Welcome to ResearchMate:** A message stating 'ResearchMate is an AI-powered academic assistant. It autonomously summarizes research topics.'
- Sample questions:** Two interactive buttons with the same questions as in the Build section.
- Input field:** A text input field at the bottom containing the text 'Quantum machine learning for protein folding prediction'.

RESULT

The screenshot displays the IBM Watsonx ResearchMate web application. The browser's address bar shows the URL: `dataplatform.cloud.ibm.com/wx/agents/2917125a-805e-48d4-adc7-79129335c798?project_id=30ec6622-fe17-498a-bb8e-ea13f4cd856&context=wx`. The page header includes the IBM Watsonx logo, an 'Upgrade' button, and user information for 'Shreya Padmakumar's Acc...' in 'Dallas'. The main navigation bar shows 'Projects / ResearchMate / ResearchMate' and buttons for 'Share feedback', 'Autosave on', 'New agent', and 'Deploy'.

The interface is divided into two main sections: 'Build' and 'Agent preview'.

Build Section:

- Icon:** A circular icon with a white chess knight on a black background.
- Placeholder image:** A 3D illustration of a laptop, a tablet, and a smartphone displaying data.
- Quick start questions:** A section titled 'Add up to 4 quick start questions that your users can select.' containing two questions:
 - 'What research topic would you like help with today?'
 - 'Are you looking for a general overview or something more specific?'
- Configuration:** A section with two dropdown menus:
 - Framework:** Set to 'LangGraph'.
 - Architecture:** Set to 'ReAct'.
- Instructions:** A link to 'Advanced configuration'.

Agent preview Section:

- User input:** 'You: 11:07 PM' followed by the text 'Quantum machine learning for protein folding prediction'.
- Agent response:** 'ResearchMate 11:07 PM' followed by a thinking state '1. Thinking...' and a box labeled 'Steps created by Agent'.
- Input field:** A text input field at the bottom with the placeholder 'Type something...'.

RESULT

The screenshot displays the IBM watsonx ResearchMate web application. The browser's address bar shows the URL: `datapatform.cloud.ibm.com/wx/agents/2917d5a-805e-48d4-adc7-79129335c798?project_id=30ec6622-fe17-498a-bb8e-ea134cd856&context=wx`. The page header includes the IBM watsonx logo, an 'Upgrade' button, and user information for 'Shreya Padmakumar's Acc...' in 'Dallas'.

The main interface is divided into two primary sections: 'Build' on the left and 'Agent preview' on the right.

Build Section:

- Model:** Set to 'mistral-large'.
- Icon:** A circular icon with a white chess knight on a black background.
- Placeholder Image:** A 3D visualization of a protein structure with a blue and purple color scheme.
- Quick start questions:** A section with a prompt 'Add up to 4 quick start questions that your users can select.' and two example questions: 'What research topic would you like help with today?' and 'Are you looking for a general overview or something more specific?'. Each question has a trash icon for removal.
- Configuration:** A section with two dropdown menus: 'Framework' set to 'LangGraph' and 'Architecture' set to 'ReAct'.
- Instructions:** A link to 'Advanced configuration'.

Agent preview Section:

- Header:** 'Agent preview'.
- Messages:**
 - User:** 'You: 11:07 PM' with the message 'Quantum machine learning for protein folding prediction'.
 - ResearchMate:** 'ResearchMate 11:07 PM' with a 'Summary' section.
- Summary:** A paragraph stating: 'Quantum machine learning for protein folding prediction is an emerging field that combines the power of quantum computing with machine learning algorithms to predict the three-dimensional structure of proteins. Proteins are large biomolecules that perform a vast array of functions within organisms, and their structure is determined by the sequence of amino acids, which is dictated by the nucleotide sequence of their genes. The prediction of protein folding is a challenging problem that has been tackled using various computational approaches, including machine learning and quantum computing.'
- Testable Hypothesis:** A paragraph stating: 'Recent advancements in deep learning methods, such as AlphaFold2, have shown promising results in protein structure prediction. However, the problem remains challenging, and researchers are exploring the use of quantum computing methods to improve the accuracy and efficiency of protein folding predictions. Quantum machine learning algorithms, such as quantum walks and quantum-inspired optimization, have been proposed as potential solutions for this problem.'
- Research Subtopics or Questions:** A section with a numbered list: '1. What are the advantages and limitations of using quantum machine learning algorithms for protein folding prediction?'. Below the list is a text input field with the placeholder 'Type something...' and a 'Send' button.

RESULT

The screenshot displays the IBM watsonx web application interface. The browser address bar shows the URL: `datapatform.cloud.ibm.com/wx/agents/2917f25a-805e-48d4-adc7-79129335c798?project_id=30ec6622-fe17-490a-bb8e-ea13f4ccf856&context=wx`. The page title is "IBM watsonx". The navigation bar includes "Projects / ResearchMate / ResearchMate", "Share feedback", "Autosaved 11:07 PM", "New agent +", and a "Deploy" button.

The main interface is divided into two panels:

- Build Panel:**
 - Icon:** A circular icon with a stylized 'W' and a checkmark.
 - Placeholder image:** A diagram showing a server rack, a laptop, and a cloud icon.
 - Quick start questions:**
 - "Add up to 4 quick start questions that your users can select."
 - "What research topic would you like help with today?"
 - "Are you looking for a general overview or something more specific?"
 - Configuration:**
 - Framework:** LangGraph
 - Architecture:** ReAct
 - Instructions:** A link to "Advanced configuration".
- Agent preview Panel:**
 - Research Subtopics or Questions:**
 1. What are the advantages and limitations of using quantum machine learning algorithms for protein folding prediction?
 2. How can quantum computing methods be integrated with existing machine learning algorithms to improve protein structure prediction?
 3. What are the potential applications of quantum machine learning for protein folding prediction in drug discovery and biomedical research?
 - Introductory Paragraph:**

Protein folding prediction is a critical problem in computational biology and bioinformatics, with important applications in drug discovery, biomedical research, and protein engineering. The three-dimensional structure of a protein is determined by its amino acid sequence, and predicting this structure is essential for understanding the protein's function and interactions with other molecules. Recent advancements in machine learning and quantum computing have shown promise in improving the accuracy and efficiency of protein folding predictions. In this paper, we explore the use of quantum machine learning algorithms for protein folding prediction and discuss their potential applications and limitations.
 - Dummy Citation:**

Smith, J., & Doe, J. (2024). Quantum machine learning for protein folding prediction: A review. *Journal of Computational Biology*, 31(4), 456-478. doi: 10.1089/cmb.2024.0045
 - How did I get this answer?:** A link to view the reasoning.
 - Input field:** A text box with the placeholder "Type something..." and a "Send" button.

RESULT

The screenshot displays the IBM watsonx web interface. The browser address bar shows the URL: `dataplatfrom.cloud.ibm.com/wx/agents/2917f25a-f05e-48d4-adc7-79129335c798?project_id=30ec6622-fe17-498a-bb8e-ea13f4ccf856&context=wx`. The interface is divided into two main sections: 'Build' on the left and 'Agent preview' on the right.

Build Section:

- Configuration:**
 - Framework: LangGraph
 - Architecture: ReAct
- Instructions:**

You are an autonomous AI research agent built to assist with academic writing and scientific exploration.

When a student enters a research topic:

Your task is to:

 1. Search for relevant academic knowledge about this topic (simulate with realistic examples).
 2. Summarize the topic in 100–150 words using clear, academic language.
 3. Propose a testable hypothesis related to this topic.
 4. Suggest 2–3 research subtopics or questions worth exploring.
 5. Draft an introductory paragraph that could appear in a research paper.
 6. Provide a realistic dummy citation in APA format.

Structure your output clearly using headings for each section.
Be concise, informative, and formal in tone.
- Knowledge:**
- Tools:**

Agent preview Section:

The preview shows the agent's output for the topic: "through quantum machine learning impact the drug discovery process".

Introductory Paragraph

Protein folding prediction is a critical challenge in computational biology, with significant implications for understanding protein function and designing therapeutic interventions. Traditional methods have relied on classical machine learning algorithms, which, while powerful, are limited by the computational complexity of the problem. The advent of quantum machine learning offers a promising avenue to overcome these limitations. By leveraging the unique properties of quantum systems, such as superposition and entanglement, quantum machine learning algorithms have the potential to revolutionize protein folding prediction, leading to more accurate and efficient models. This paper explores the current state of quantum machine learning for protein folding prediction, proposes a testable hypothesis, and outlines key research questions to advance the field.

Dummy Citation

Smith, J., & Doe, A. (2024). Quantum Machine Learning for Protein Folding Prediction: A New Frontier in Computational Biology. *Journal of Quantum Biology*, 10(1), 123-135. doi:10.101/qbio.2024.001

How did I get this answer?

- 1: {"query": "Quantum machine learning for protein folding prediction"} ✓
- 2: Generating final answer ✓

Steps created by Agent

Type something...

CONCLUSION

- ResearchMate demonstrates how agentic AI systems can autonomously support academic research tasks. Using IBM Watsonx, the assistant generates structured outputs that help users kickstart their research process. Despite deployment issues in AgentLab, the project showcases functional and educational value.
- Summary of findings:
 - The **ResearchMate agent** successfully simulates an academic research assistant using IBM Watsonx Agent Lab.
 - It generates structured outputs including summary, hypothesis, subtopics, introduction, and citation.
 - The agent demonstrates effective multi-step reasoning and academic tone, meeting the expectations of agentic AI behavior.
- **Effectiveness of the Solution:**
 - Accurately performs research support tasks with minimal input.
 - Enables students and early researchers to rapidly structure their research process.
 - Reduces time spent on literature understanding and hypothesis framing

FUTURE SCOPE

POTENTIAL ENHANCEMENTS AND EXPANSIONS:

- **Dynamic Input Support:**
Enable user-driven topic selection with natural language input using form fields or chat interface.
- **External Data Integration:**
Incorporate academic databases (e.g., Semantic Scholar, arXiv) or citation engines to retrieve real references.
- **Advanced AI Techniques:**
Use retrieval-augmented generation (RAG) to ground outputs in verified literature. Fine-tune LLMs for domain-specific summaries (e.g., medicine, law).
- **User Feedback Loop:**
Add feedback capture to refine agent outputs over time, improving hypothesis quality and summary relevance.
- **Scalable Web Deployment:**
Build a lightweight frontend + backend app and deploy on IBM Cloud Lite or use containerization for cross-platform support.
- **Multi-language & Accessibility Support:**
Expand the agent's usability for global researchers using multilingual models and assistive UI features.
- **Edge AI Integration:**
Explore edge deployment for offline or on-campus access in research labs and classrooms.

REFERENCES

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- Zhang, Y., & Kumar, S. (2023). The Role of Quantum Computing in Transforming Modern Medicine. *Journal of Computational Health Science*, 10(2), 112–129.
(Used as a sample dummy citation)

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Completion Certificate



This certificate is presented to

Shreya Padmakumar

for the completion of

**Lab: Retrieval Augmented Generation with
LangChain**

(ALM-COURSE_3824998)

According to the Adobe Learning Manager system of record

Completion date: 24 Jul 2025 (GMT)

Learning hours: 20 mins



THANK YOU