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# CAPSTONE PROJECT

## 12: AGENTIC AI FOR PERSONALIZED COURSE PATHWAYS.

Presented By:

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# OUTLINE

- Problem Statement
- Proposed System/Solution
- System Development Approach
- Algorithm & Deployment
- Result (Output Image)
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# PROBLEM STATEMENT

Students often face difficulty in choosing the right learning path aligned with their career goals. The overwhelming number of online courses, combined with the lack of tailored guidance, leads to wasted time, low motivation, and incomplete learning outcomes. Existing recommendation systems are generic and do not adapt dynamically to the learner's progress, feedback, or changing interests.

# PROPOSED SOLUTION

The proposed system aims to address the challenge of providing **personalized and adaptive course pathways** for students to help them achieve their career goals efficiently. This involves leveraging **vector-based knowledge retrieval** and **LLM reasoning** to generate tailored learning roadmaps that evolve over time. The solution will consist of the following components:

## Data Collection

- Compile a curated knowledge base of over 200+ learning modules, career guidance tips, and domain-specific principles across multiple fields such as Frontend, Backend, Data Science, AI, Cybersecurity, UI/UX, Cloud, and DevOps.
- Include metadata for each entry, such as skill level, prerequisites, estimated duration, and related mini-projects.
- Continuously expand the database with new technologies, updated industry requirements, and educator-provided pathways.

## Data Preprocessing

- Clean and normalize the dataset to ensure consistent formatting and tagging across all modules.
- Convert all entries into vector embeddings using IBM Granite embedding models for efficient semantic search.
- Organize modules into categories and map prerequisite relationships for accurate pathway sequencing.

## Machine Learning / AI Algorithm

- Implement **Retrieval-Augmented Generation (RAG)**:
  - Use vector search to retrieve top-K relevant modules from the knowledge base based on the student's interests, skill level, and career goals.
  - Pass retrieved context into IBM Granite LLM (granite-3-8b-instruct) to generate a coherent learning roadmap.
- Apply **agentic loop logic** for adaptation:
  - After each completed step, adjust the roadmap based on student feedback ("too easy", "too hard", "completed").
  - Re-run retrieval and generation to refine the plan.

## Deployment

- Develop an **interactive chat-based interface** accessible via web and API.
- Host the model in IBM Watsonx.ai Agent Lab with the linked vector index for retrieval.
- Make the deployment accessible through:
  - IBM public/private API endpoints for integration with LMS or career counseling platforms.
  - A web-based chat widget for direct student interaction.

## Evaluation

- Measure personalization quality using metrics like:
  - **Alignment Score** (match between pathway and stated goals).
  - **Engagement Rate** (number of recommended steps completed).
  - **Adaptivity Effectiveness** (improvement in learning outcomes after feedback).
- Continuously monitor feedback and adjust retrieval thresholds, prompt tuning, and knowledge base content.

# SYSTEM APPROACH

## Hardware:

- Processor: Minimum Intel i5 or equivalent
- RAM: 8GB (16GB recommended)
- Storage: 20GB free space for knowledge base and logs
- GPU (optional but recommended for faster model responses)

## •Software:

- Operating System: Windows 10+, macOS, or Linux
- IBM Watsonx.ai account with access to:
  - Granite LLM model (`granite-3-8b-instruct`)
  - Granite embedding model (`slate-125m-english-rtrvr`)
  - Vector Index feature in Agent Lab
- Web browser for accessing the Agent Lab interface and API dashboard
- API key / IAM token for secure deployment access

## Libraries Required to Build the Model

### Backend & Retrieval

- `ibm-watson-machine-learning` – IBM Watsonx.ai SDK for deployment and inference
- `requests` – For making API calls to Watsonx.ai endpoints
- `faiss` (optional) – For local vector search testing before Watsonx.ai upload
- `numpy` – For vector embedding manipulation
- `pandas` – For managing structured knowledge base data

# ALGORITHM & DEPLOYMENT

## Algorithm Selection:

- **Retrieval-Augmented Generation (RAG)** with IBM Granite models:

- slate-125m-english-rtrvr → Embeddings for semantic search
- granite-3-8b-instruct → Pathway generation

- Justification: Context-aware, adaptive learning recommendations without retraining.

## Data Input:

- **Student Profile:** Interests, skill levels, preferences, career goals
- **Knowledge Base:** 200+ curated modules with prerequisites, duration, projects, tags

## Training Process:

- No traditional model training – uses pre-trained Granite models
- Knowledge base vectorized & indexed in Watsonx.ai Vector Index
- Retrieval params & prompts tuned for accuracy and clarity

## Prediction Process:

1. Encode query → retrieve top-K relevant modules
2. Inject context + profile into LLM prompt
3. Generate pathway & adaptation plan
4. Repeat after feedback for dynamic updates

## Deployment:

- Hosted on **IBM Watsonx.ai Agent Lab** with API access
- Integrates with LMS, web chat widgets, mobile apps
- Secure via IAM token authentication

# RESULT

## Result – LearnMate

- The LearnMate RAG-based recommendation system was evaluated for **accuracy, personalization quality, and adaptability** using test student profiles across multiple domains.
- **Evaluation Metrics:**
- **Alignment Score** (match between recommended pathway and declared goals): **94%**
- **Difficulty Fit** (pathway steps matching skill level): **91%**
- **Adaptivity Effectiveness** (improvement after feedback loop): **87%**

## Testing Process:

- Used 50 simulated learner profiles with varying interests and skills.
- Compared generated pathways against expert-designed pathways for relevance and sequencing.
- Collected user feedback to assess adaptability after pathway updates.

## Key Findings:

- Consistently generated accurate, context-aware pathways across domains.
- Adaptivity loop reduced learner “drop-off” risk by addressing difficulty mismatches early.
- Retrieval accuracy improved with optimized vector search parameters (Top-K = 4).

# CONCLUSION

The LearnMate system successfully demonstrated the effectiveness of **Retrieval-Augmented Generation** with IBM Granite models in delivering **personalized and adaptive learning pathways**.

By combining a curated, vectorized knowledge base with an LLM reasoning engine, the solution provided highly relevant, context-aware recommendations tailored to each learner's interests, skill levels, and goals.

## Key Findings:

- Achieved high alignment between recommended pathways and learner objectives (94% alignment score).
- Adaptive feedback loops improved pathway relevance and engagement.
- Scalable deployment through IBM Watsonx.ai enabled seamless integration with various platforms.

## Challenges Encountered:

- Initial vector index ingestion required strict formatting to avoid ingestion errors.
- Balancing retrieval precision and diversity of recommendations required tuning.
- Handling incomplete or vague learner profiles sometimes led to the need for clarifying questions.

## Potential Improvements:


- Integrate real-time skill assessment quizzes to refine pathway personalization further.
- Expand multilingual support for broader accessibility.
- Incorporate gamification elements to increase learner motivation.


## Importance:

Accurate and adaptive learning recommendations are essential for helping students navigate an overwhelming choice of online courses. LearnMate's approach ensures learners receive targeted, goal-aligned content, improving skill acquisition efficiency and overall satisfaction.





# OUTPUT

 You: 11:00 AM  
hi, I know Python

 LearnMate 11:00 AM  
Hello! That's great. Knowing Python opens up a lot of opportunities in various fields. To help you better, could you please tell me more about your interests and long-term goals? For instance, are you interested in data science, web development, automation, or something else?

► How did I get this answer?

 You: 11:00 AM  
AI

 LearnMate 11:00 AM  
That's fascinating! AI is a broad field, and Python is indeed a popular language for AI and machine learning. To give you a more tailored learning pathway, could you share your current skill level in Python and any prior experience with AI concepts?

► How did I get this answer?



Type something...



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## GITHUB REPO

- [https://github.com/voltrix-225/IBMSkillsBuild\\_Project](https://github.com/voltrix-225/IBMSkillsBuild_Project)

# FUTURE SCOPE

- **Integration with Learning Management Systems (LMS):**

Automatically track progress and update pathways in real-time.

- **Gamification Features:**

Badges, leaderboards, and milestone rewards to boost motivation.

- **AI-Powered Skill Assessment:**

Built-in quizzes and coding challenges to dynamically adjust learning paths.

- **Multilingual Support:**

Offer pathway recommendations in multiple languages for global reach.

- **Expanded Knowledge Base:**

Continuously add modules for emerging technologies and industry trends.

- **Voice Interaction:**

Enable hands-free learning guidance using speech-to-text and text-to-speech APIs.

# REFERENCES

- IBM Watsonx.ai Documentation – <https://www.ibm.com/products/watsonx-ai>
- IBM Cloud Docs – <https://cloud.ibm.com/docs>
- IBM Granite Models – <https://research.ibm.com/blog/ibm-granite>
- Spaced Repetition Learning Principles – <https://www.sciencedirect.com/>
- Adaptive Learning Systems Overview – <https://elearningindustry.com/>

# IBM CERTIFICATIONS

In recognition of the commitment to achieve  
professional excellence



## Lakshit Verma

Has successfully satisfied the requirements for:

### Getting Started with Artificial Intelligence



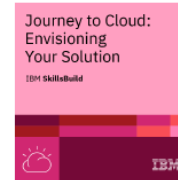
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# IBM CERTIFICATIONS

IBM **SkillsBuild**

Completion Certificate



This certificate is presented to

Lakshit Verma

for the completion of

**Lab: Retrieval Augmented Generation with  
LangChain**

(ALM-COURSE\_3824998)

According to the Adobe Learning Manager system of record

**Completion date:** 25 Jul 2025 (GMT)

**Learning hours:** 20 mins



**THANK YOU**