



North South University

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

PROJECT PROPOSAL

**CareerMAS: A Multi-Agent LLM Framework for
Career Guidance and Job Placement in Bangladesh**

Course Information

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1 Project Summary

This project, A Multi-Agent LLM Framework for Career Guidance and Job Placement in Bangladesh, aims to design and implement an intelligent, AI-driven ecosystem that addresses the critical challenges of career counseling and employment matching in the Bangladeshi context. Leveraging Large Language Models (LLMs) and a multi-agent framework, the system will provide personalized career guidance, skill gap analysis, and real-time job placement opportunities for students, job seekers, and professionals. The framework will consist of specialized AI agents working collaboratively to perform core functions such as career assessment, training recommendations, resume optimization, employer matching, and market trend analysis. By integrating with job portals, educational institutions, and industry partners, the system will create a comprehensive pipeline that bridges the gap between skill development and employment opportunities. The expected impact of the project is to enhance employability, reduce job market friction, and empower individuals with actionable insights tailored to the Bangladeshi job market. This initiative aims to not only streamline job placement but also foster long-term career growth, ultimately contributing to the country's economic development and human resource advancement.

2 Project Objectives

The project is designed to address the existing gaps in career counseling and employment opportunities by leveraging advanced AI technologies. Bangladesh faces a significant mismatch between education outcomes and job market demands, resulting in high unemployment rates among graduates and underutilized talent in the workforce. This project aims to build an AI-powered framework that provides personalized, data-driven career guidance and connects job seekers directly with relevant opportunities, thereby bridging this gap.

- Develop a multi-agent framework powered by Large Language Models (LLMs) that can deliver personalized career counseling based on individual skills, educational background, and aspirations.
- Create an AI-driven skill gap analysis system that identifies the competencies required for desired roles and recommends targeted training programs.
- Integrate a dynamic job-matching engine that connects job seekers with employers in real-time by analyzing job descriptions, candidate profiles, and market trends.
- Build tools for resume and portfolio optimization using AI, improving candidates' chances of securing job opportunities.
- Establish partnerships with job portals, educational institutions, and industry stakeholders to ensure seamless access to verified opportunities and career development resources.
- Continuously monitor and evaluate employment trends to provide up-to-date insights and forecasts, enabling users to make informed career decisions.

3 Project Background

3.1 Context and Rationale

Bangladesh faces a growing challenge in aligning education outcomes with labor market demands. Despite producing a large number of graduates each year, unemployment and underemployment remain high due to a lack of proper career guidance, limited awareness of industry needs, and mismatches between available jobs and the skill sets of job seekers. Traditional career counseling services are often inaccessible, outdated, or generalized, leaving students and professionals without the personalized direction they need. At the same time, employers struggle to find candidates who possess the right skills and competencies. This project addresses these challenges by leveraging cutting-edge artificial intelligence (AI) to create a multi-agent Large Language Model (LLM) framework. The framework will enable scalable, personalized career guidance, targeted skill gap analysis, and intelligent job matching tailored to the Bangladeshi job market. By bridging the gap between talent and opportunity, the system aims to reduce employment friction and support economic development.

3.2 Historical and Scientific Context

Career counseling and job placement services have historically been manual, resource-intensive processes. While digital job portals and online courses have emerged over the past decade, they often operate in isolation and fail to provide holistic, individualized support. Recent advancements in Natural Language Processing (NLP), particularly Large Language Models (LLMs), have opened new possibilities for understanding user profiles, job descriptions, and labor market trends at scale. The proposed framework builds upon the scientific principles of multi-agent systems, where multiple specialized AI agents collaborate to achieve complex objectives. These agents will use state-of-the-art techniques in information retrieval, semantic understanding, machine learning, and recommendation systems. This approach ensures a robust, dynamic solution capable of adapting to evolving market conditions.

3.3 Significance to the Broader Domain

This project aligns with global trends in using AI for workforce development and economic empowerment. By focusing on Bangladesh, it addresses a critical need in a developing economy where youth unemployment is a pressing issue. The multi-agent LLM framework can serve as a model for other countries facing similar challenges, offering a scalable solution that integrates career guidance, skill development, and employment placement into a single ecosystem. Furthermore, the project has the potential to advance research and applications in AI-driven human resource technologies, including adaptive learning systems, real-time labor market analytics, and intelligent job-matching platforms. Its success could inform future developments in AI for social good, ultimately helping to build stronger, more inclusive economies.

4 Literature Review

4.1 Existing Knowledge and Theoretical Basis

The project builds upon established knowledge in career guidance frameworks, job-matching algorithms, and AI-powered recommendation systems. Traditional models such as Holland’s Theory of Vocational Choice and the Social Cognitive Career Theory (SCCT) have long been used to understand career preferences and behavior. However, their manual implementation lacks scalability. With the rise of Natural Language Processing (NLP) and Large Language Models (LLMs) such as GPT, LLaMA, and PaLM, AI systems can now analyze unstructured data like resumes, job descriptions, and market reports with a high degree of semantic understanding. Additionally, multi-agent systems provide a modular way to assign specific roles (e.g., career counselor, skill gap analyzer, job matcher) to different AI agents, enabling coordinated decision-making. Recommendation system architectures, particularly collaborative filtering and content-based filtering, form the basis for personalized suggestions within the framework.

4.2 Gaps and Limitations in Previous Studies

Despite advances, several gaps remain in existing career guidance and job placement solutions:

- **Lack of personalization:** Many systems rely on generic recommendations, ignoring an individual’s unique background and aspirations.
- **Fragmented services:** Job portals, skill development platforms, and career counseling tools operate in silos, creating inefficiencies.
- **Limited local adaptation:** Most global platforms fail to address country-specific market needs, cultural contexts, and economic conditions, particularly in developing economies like Bangladesh.
- **Data integration challenges:** Existing systems often struggle to merge heterogeneous datasets (educational records, labor market analytics, and employer needs) into a unified framework.

These gaps highlight the need for a multi-agent, context-aware solution capable of providing holistic support.

4.3 Relevant Case Studies or Applications

Several initiatives demonstrate the potential of AI in career guidance and job placement:

- **LinkedIn’s AI-powered Job Matching Engine:** Uses user profiles and recruiter data to suggest jobs, but lacks deep skill-gap analysis and localized market adaptation.
- **Google’s Pathways2AI and Career Certificates:** Google’s AI-based tools and career certificate programs offer structured learning paths linked with job placement opportunities. These initiatives reflect the benefits of curriculum-to-career mapping and credential-based filtering in job placement systems.

- **BDJobs.com and Local Job Portals:** BDJobs is offering a rich dataset of job postings, employer requirements, and candidate profiles.
- **OpenAI’s GPT-based Career Guidance:** ChatGPT and GPT-powered bots have been used for tasks such as resume review, mock interviews, and career counseling.
- **AI4Bharat and Localized Language Models:** The AI4Bharat initiative in India showcases the power of localized AI models for addressing regional challenges in employment and education.
- **UNESCO’s Education-to-Employment Models:** Provide frameworks for linking education to labor markets but remain largely policy-driven with limited AI integration.
- **AI4Jobs (OECD Pilot Project):** Demonstrated the potential of AI for large-scale employment matching but highlighted challenges with bias and dataset diversity.

These examples validate the feasibility of using AI for employability but also reinforce the necessity for a localized, integrated, and multi-agent framework. The proposed system seeks to address these shortcomings by combining career counseling, skill development, and job placement into a single ecosystem tailored to the Bangladeshi context.

5 Design Approach

5.1 Overview of Approach

The proposed project will be architected as a **Hierarchical Multi-Agent System (HMAS)** utilizing the capabilities of **LangGraph** to facilitate structured, modular, and dynamic coordination among multiple intelligent agents. These agents will collaboratively contribute to the delivery of a comprehensive, end-to-end solution for career guidance, skills assessment, job recommendation, and placement. The system will incorporate state-of-the-art large language models (LLMs) from HuggingFace to enable deep natural language understanding (NLU) and generation (NLG), allowing agents to interact with users in a personalized, conversational, and context-aware manner. A core component of the system will involve the continuous acquisition and curation of domain-relevant data through automated web scraping and data mining techniques applied to major job portals such as bdjobs.com, chakri.com, and LinkedIn Jobs, as well as online educational and training repositories. These raw datasets will undergo thorough preprocessing, including cleaning, normalization, deduplication, and semantic structuring using RDF or ontological formats, ensuring they are suitable for training models and feeding downstream tasks like job matching and trend analysis. The hierarchical architecture will include top-level planner agents responsible for managing workflows, coordinating tasks, and dynamically invoking specialized agents based on user needs and system context, thereby improving scalability, fault tolerance, and interpretability. This modular approach not only allows for seamless agent collaboration and efficient task allocation but also supports future extensibility—enabling the integration of additional capabilities such as real-time labor market forecasting, user feedback loops, or integration with governmental or institutional employment services. Ultimately, the system aims to deliver intelligent, adaptive,

and data-driven career guidance that aligns user profiles with current market demands, enhances employability, and supports informed decision-making throughout the career development lifecycle.

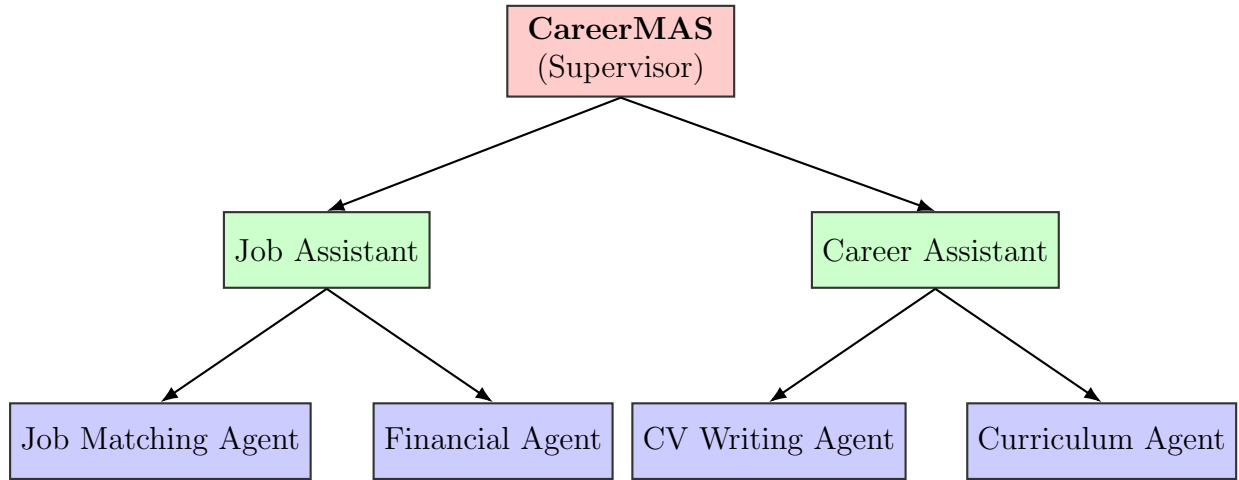


Figure-1: Hierarchical Multi-Agent Architecture

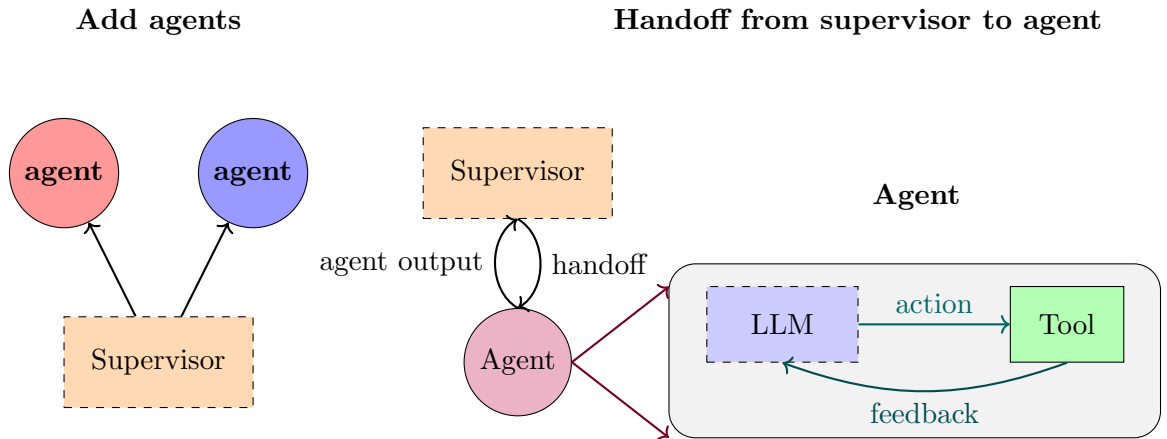


Figure 2: Supervisor-Agent Handoff Mechanism

5.2 Project Phases

5.2.1 Phase 1: Planning & Requirement Analysis

- Define system architecture and agent hierarchy using LangGraph.
- Identify data sources (job portals such as bdjobs.com, educational institutions, labor market analytics).
- Finalize HuggingFace LLM models and data processing pipelines.

5.2.2 Phase 2: Dataset Building (Data Mining & Web Scraping)

- Develop web scraping agents to collect job data from bdjobs.com, chakri.com, and similar platforms.
- Collect additional datasets from LinkedIn, public APIs, and educational repositories.
- Perform data cleaning, de-duplication, and normalization.
- Create structured datasets (job descriptions, required skills, salary ranges, industry classifications, candidate profiles).

5.2.3 Phase 3: System Development

1. Implement the hierarchical multi-agent framework using **LangGraph**
2. Develop specialized agents:
 - (a) **Job Matching Agent**: Matches job seekers with employers based on skills, experience, and preferences.
 - (b) **Financial Agent**: Manages and tracks financial-related tasks and operations.
 - (c) **CV Writing Agent**: Assists in CV/resume creation and adapts content based on current employment trends.
 - (d) **Curriculum-to-Career Agent**: Aligns NSU coursework with relevant job roles, internships, and career paths using academic and employment data.

5.2.4 Phase 4: Integration & Testing

- Integrate the framework with external job portals and educational platforms.
- Test agent workflows on real-world job market datasets.
- Evaluate dataset quality, recommendation accuracy, and system scalability using pilot user groups.

5.2.5 Phase 5: Final Deliverable & Deployment

- Deploy the system as a web-based platform.
- Deliver a comprehensive analytics dashboard for tracking performance.
- Establish pipelines for continuous learning, data updates, and LLM fine-tuning.

5.3 Tools and Resources

Frameworks & Libraries:

- LangGraph: For building the hierarchical multi-agent system.
- HuggingFace Transformers: For integrating state-of-the-art LLMs.
- LangChain: For chaining agent tasks and retrieval-augmented generation.
- BeautifulSoup, Scrapy, Selenium: For web scraping job portals (e.g., bdjobs.com).

5.3.1 Programming Languages:

- Python: Core development language.

5.3.2 Databases & Storage:

- MongoDB: For structured user and job data storage.
- Vector Databases (FAISS/Chroma DB) For semantic search and recommendation tasks.

This methodology ensures that the system is built on a robust dataset derived from real-time job market data, empowering the multi-agent framework to deliver highly accurate, localized, and adaptive career guidance and job placement solutions.

6 Testing Methodology

The success of the Hierarchical Multi-Agent LLM Framework for Career Guidance and Job Placement will be evaluated using both quantitative metrics and qualitative assessments.

6.1 System Accuracy and Performance:

- **Unit Testing of Individual Agents:** Each agent will be tested independently using both real and synthetic data for functionality and stability.
- **Integration Testing:** Agent interactions within the LangGraph framework will be validated for correct coordination and task flow.
- **Scenario-Based Testing:** Full user journeys will be tested to simulate real-world usage by NSU students and graduates.
- **Accuracy and Relevance Evaluation:** Outputs will be assessed using benchmark datasets and expert reviews for precision and relevance.
- **Performance and Scalability Testing:** System responsiveness and stability will be evaluated under different user loads and stress conditions.
- **Job Matching Accuracy:** Measured by precision, recall, and F1-score using a benchmark dataset of candidate profiles and job listings.
- **Career-to-Curriculum Alignment Testing:** The system will be tested using NSU curricula (CSE, BBA, EEE) to assess how well academic courses align with market-driven skill requirements.

6.1.1 Dataset Quality

- Completeness, freshness, and correctness of data collected via web scraping and data mining.
- Deduplication rate and accuracy of data classification (job sectors, skills, etc.).

6.1.2 Achievement

- Achievement of the key objectives defined earlier (career counseling, skill-gap analysis, job matching, market analytics, and dataset building).
- Meeting functional requirements like integration with external job portals and educational platforms.

6.1.3 User and Stakeholder Satisfaction:

- Surveys and interviews with job seekers, educational institutions, and employers.
- Net Promoter Score (NPS) and user retention rate.

6.1.4 Project Management Benchmarks:

- Completion within the planned timeline and budget.
- Successful delivery of all system features as defined in each project phase.

6.2 Monitoring and Reporting

- Agile Sprint Reviews: Progress will be reviewed bi-weekly to ensure alignment with objectives.
- Automated Monitoring Tools: Track agent workflow performance, data pipeline integrity, and platform uptime.
- Quality Assurance (QA) Testing: Conducted at every major milestone to identify and fix defects early.
- System Analytics Dashboard: A real-time dashboard will display job matching success rates, user engagement metrics, and system performance indicators.
- Final Evaluation Report: Upon project completion, a detailed report will summarize outcomes, lessons learned, and future recommendations.

This structured testing methodology ensures that the project delivers a reliable, accurate, and user-centric platform, meeting both technical and business objectives while maintaining stakeholder confidence.

7 Project Timeline

The project will be completed over a period of 1 month and structured into weekly phases with clear milestones.

- **Phase 1:** July 28, 2025 – August 3, 2025
- **Phase 2:** August 4, 2025 – August 10, 2025
- **Phase 3:** August 11, 2025 – August 17, 2025
- **Phase 4:** August 18, 2025 – August 25, 2025
- **Final Deliverable:** August 26–28, 2025

8 Budget

The estimated budget for the project, considering it is a university-level initiative, is outlined below:

8.1 Personnel

- No salaries—team members are contributing voluntarily as part of coursework or research.

Subtotal (Personnel): \$0

8.2 Equipment

- Personal laptops and university lab resources (in-kind contribution)

Subtotal (Equipment): \$0

8.3 Software

- OpenAI API: Using `gpt-4o` (\$2.50 per 1M input tokens, \$10.00 per 1M output tokens). Estimated usage: 1M input + 1M output tokens for 1 month = **\$12.50**
- HuggingFace – Free Tier or Student Access = **\$0**
- LangChain, LangGraph – Open-source version = **\$0**
- Vector DB – Use local FAISS or free-tier Pinecone = **\$0**

Subtotal (Software/Tools): \$12.50

8.4 Miscellaneous

- printing and others = **\$3**

8.5 Total Budget

\$15.5 (USD)

9 Team Members and Roles

- **Project Manager:** Saif Mohammed – Responsible for overseeing the project's execution and managing the timeline.
- **Team Member 1:** Saif Mohammed – Responsible for implementing the multi-agent framework, integrating LLMs, and building the system architecture.
- **Team Member 2:** Sabab Ashfak Fahim – Responsible for building data pipelines, performing skill-gap modeling, and optimizing recommendation algorithms.

- **Team Member 3:** Humayra Rahman Nipa – Responsible for collecting and processing datasets from bdjobs.com and other sources.
- **Team Member 4:** Ankita Kundu – Responsible for conducting system testing, ensuring quality assurance, and monitoring performance benchmarks.

10 Risks and Mitigation Strategies

- **Risk 1: Data Access Restrictions from Job Portals**
Mitigation Strategy: Establish partnerships with *bdjobs.com* and other portals to access data through APIs or licensing agreements.
- **Risk 2: High API Costs from OpenAI**
Mitigation Strategy: Optimize token usage, adopt caching strategies, and selectively fine-tune smaller open-source models for frequent queries.
- **Risk 3: Model Bias or Inaccurate Recommendations**
Mitigation Strategy: Regular audits, diverse training datasets, and human-in-the-loop validation for recommendations.
- **Risk 4: Project Delays due to Technical Challenges**
Mitigation Strategy: Agile development with buffer time in each phase and periodic sprint reviews.

11 Conclusion and Limitations

The proposed Hierarchical Multi-Agent LLM Framework for Career Guidance and Job Placement in Bangladesh aims to tackle the pressing issue of unemployment and skill mismatches. By integrating real-time job market data, advanced AI models, and structured multi-agent workflows, the project will deliver a scalable, localized, and user-centric platform. This project has significant potential to improve employability, bridge the gap between education and industry needs, and contribute to Bangladesh’s socio-economic growth. Initial deployment may depend on available job market data quality and access, and OpenAI/HuggingFace API costs could limit scalability if usage grows rapidly. However, strategies for cost optimization and eventual transition to fine-tuned open-source models have been planned.

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