Europath AI

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Abstract- Europath AI is an intelligent web-based decision support platform designed to guide students through the complex and often overwhelming process of selecting the right European university and academic programme. With thousands of universities and hundreds of degree programmes spread across Europe, prospective students frequently struggle to identify options that align with their academic qualifications, financial constraints, career ambitions, language proficiency, and geographic preferences. Europath AI addresses this challenge by combining large language model (LLM) reasoning with a multi-criteria matching algorithm to deliver personalised, ranked, and explainable university recommendations. Built using a modern React frontend, FastAPI backend, and a PostgreSQL/SQLAlchemy data layer, the platform enables students to complete a structured profile, receive AI-generated recommendations in seconds, compare programmes side- by-side, and understand exactly why each university was suggested through natural language rationale. Unlike conventional university search engines, Europath AI calculates a composite fit score based on five weighted criteria: academic eligibility, field alignment, financial feasibility, language compatibility, and location preference. A continuous feedback loop collects user ratings and acceptance decisions to iteratively retrain the matching weights, improving recommendation quality over time.

I. INTRODUCTION

Every year, millions of students aspire to pursue higher education in Europe, attracted by world- class universities, diverse academic environments, and globally recognised degrees. However, the sheer volume and complexity of available options present a significant barrier: students must independently navigate rankings, entry requirements, tuition fees, language requirements, scholarship opportunities, and visa regulations across dozens of countries, hundreds of universities, and thousands of programmes. Without structured guidance, this process is prone to poor decision-making, misaligned applications, and missed opportunities.

Europath AI is a digital platform developed to address this guidance gap by leveraging artificial intelligence to provide students with personalised, data-driven, and explainable university recommendations. Designed using modern web technologies including React, FastAPI, and PostgreSQL, the platform simplifies the end-to-end journey from initial profile creation to final university shortlisting. By integrating a multi-criteria scoring engine with large language model capabilities, Europath AI understands the nuances of each student's profile and maps them intelligently to the most suitable European programmes.

The core innovation of Europath AI lies in its composite scoring formula, which assigns weighted scores across five key dimensions: academic eligibility, field alignment, financial feasibility, language compatibility, and location preference. These weights evolve through a feedback loop that learns from real user interactions, continuously improving the accuracy and relevance of recommendations.

II. METHODOLOGY

Research and Requirements Gathering

The development of Europath AI began with a thorough analysis of the challenges faced by prospective international students when selecting European universities. Surveys and interviews were conducted with undergraduate and postgraduate students to understand their pain points, including information overload, lack of personalised guidance, language barriers, and financial uncertainty. Competitor analysis was performed on existing university search platforms to identify gaps in personalisation, explainability, and intelligent filtering.

Data Collection and University Database Construction

A comprehensive database of European universities and programmes was compiled, covering over 4,000 institutions across 30+ countries. Each programme entry includes key attributes such as university name, country, QS ranking, tuition fees, living cost estimates, language of instruction, CEFR language requirements, minimum GPA thresholds, field of study, duration, ECTS credits, and direct application URLs.

Multi-Criteria Matching Algorithm Design

The core of Europath AI is a weighted multi-criteria scoring model that evaluates every programme against a student's profile across five dimensions. The composite score formula is: S = 0.30·Acad + 0.25·Field + 0.20·Fin + 0.15·Lang + 0.10·Loc, where each term represents a normalised score (0-100). Weights were initially derived from domain expert interviews and made adaptive through machine learning-based retraining.

LLM Integration for Explainability

Europath AI integrates a large language model to generate human-readable two-sentence rationales for each recommendation. SHAP (SHapley Additive exPlanations) values are computed to identify the most influential scoring factors for each recommendation, further enhancing transparency and user trust.

System Architecture and Development

The platform follows a four-layer architecture: a React-based Presentation Layer, a FastAPI Application Layer, an AI/Intelligence Layer housing the matching engine and LLM module, and a PostgreSQL Data Layer managed via SQLAlchemy ORM. RESTful APIs facilitate communication between layers and the system is containerised using Docker for consistent deployment.

Feedback Loop and Continuous Learning

After receiving recommendations, students are prompted to rate each suggestion and indicate whether they accepted or rejected it. This feedback is periodically used to retrain the weight model using logistic regression, adjusting the importance of each scoring criterion based on observed user behaviour.

III. LITERATURE REVIEW

The domain of AI-powered educational decision support has seen growing research interest in recent years, driven by advances in natural language processing, recommender systems, and explainable AI. This literature review examines existing work relevant to the design and implementation of Europath AI, focusing on multi-criteria decision-making in education, AI- based recommender systems, explainability in academic guidance, and international student decision behaviour.

Multi-Criteria Decision Making in University Selection

Numerous studies have highlighted the multi-dimensional nature of university selection decisions. Chen and Wang (2020) demonstrated that students weigh academic reputation, financial cost, geographic location, language requirements, and career outcomes as interdependent factors when choosing institutions. Patel et al. (2021) proposed a weighted scoring framework for higher education recommendations, finding that academic alignment and financial feasibility are consistently the highest-priority criteria among international applicants.

AI and Recommender Systems in Education

Bobadilla et al. (2019) reviewed collaborative filtering and content-based filtering approaches for academic recommendations, noting that hybrid systems achieve superior accuracy. Burke (2018) emphasised the importance of knowledge-based systems in domains with sparse user data, a consideration addressed by Europath AI's domain-specific scoring criteria that do not require large historical datasets to function effectively.

Explainable AI in Student Guidance

Ribeiro et al. (2016) demonstrated that users are significantly more likely to act on AI recommendations when they understand the rationale behind them. Lundberg and Lee (2017) developed SHAP values as a theoretically grounded approach to explaining model outputs. Europath AI incorporates both SHAP-based feature importance and LLM-generated natural language explanations to address the dual needs of technical interpretability and user-friendly communication.

International Student Decision-Making Behaviour

Mazzarol and Soutar (2018) identified information availability, perceived quality, and financial support as the primary drivers of international student destination choice. Maringe and Carter (2021) found that personalised guidance significantly reduces decision paralysis among prospective international students, supporting the value of AI-driven personalisation over generic search tools.

IV. PROPOSED SYSTEM

The proposed "Europath AI" platform is an intelligent decision support system designed to guide students through every stage of the European university selection process. By combining artificial intelligence, multi-criteria matching, and explainable recommendation techniques, Europath AI transforms a traditionally fragmented and overwhelming process into a streamlined, personalised, and data-driven experience.

Key Features of the Proposed Europath AI System:

Personalised Multi-Criteria Matching

Europath AI evaluates every European programme against the student's complete profile using a weighted composite scoring model combining academic eligibility, field alignment, financial fit, language compatibility, and location preference into a single match score between 0 and 100.

AI-Generated Natural Language Rationale

For each recommended programme, Europath AI generates a concise two-sentence explanation using a large language model, describing why the programme is a strong match. This rationale is displayed directly on each recommendation card, helping students understand and trust the system's suggestions.

SHAP-Based Explainability Module

The platform provides SHAP value breakdowns that visually display the contribution of each scoring dimension to the final match score, giving students a transparent and non-technical view of the AI's reasoning behind every recommendation.

Comprehensive University and Programme Database

Europath AI maintains a continuously updated database of over 4,000 European universities and 900+ programmes across 30+ countries, including entry requirements, tuition fees, living cost estimates, language requirements, and direct application links.

Feedback-Driven Continuous Improvement

Student feedback — ratings and shortlist decisions — is aggregated and used to periodically retrain the scoring weight model using logistic regression, adapting the system's behaviour to real-world student preferences over time.

V. FRONT END DEVELOPMENT

The Europath AI frontend is built using React.js, delivering a responsive, component-based interface that guides students through the recommendation journey. Tailwind CSS provides a clean, professional aesthetic and React Router handles client-side navigation ensuring a smooth single-page application experience.

Profile Wizard and Onboarding:

The student onboarding experience is implemented as a multi-step profile wizard with real-time input validation. Each step collects a specific category of information — academic scores, career goals, financial parameters, language proficiency, and location preferences. A progress bar provides visual feedback on completion status.

Recommendation Dashboard:

The main dashboard presents AI-generated recommendations as interactive cards sorted by match score. Each card displays the university name, programme title, country, match score with a colour-coded indicator, and the AI-generated rationale. Axios handles asynchronous API calls to the FastAPI backend.

SHAP Score Visualisation:

Match score breakdowns are presented as horizontal bar charts built with Recharts, displaying the contribution of each scoring dimension for a selected programme, providing students with an accessible non-technical view of the AI's reasoning.

VI. BACKEND DEVELOPMENT

The Europath AI backend is developed using FastAPI,

providing automatic OpenAPI documentation, asynchronous request handling, and robust data validation via Pydantic models. The backend exposes a RESTful API managing all business logic, AI inference, database operations, and authentication.

Database Management with PostgreSQL and SQLAlchemy:

PostgreSQL serves as the primary relational database storing structured data for students, universities, programmes, recommendations, and user feedback. SQLAlchemy ORM provides a Pythonic abstraction over raw SQL while Alembic handles database schema migrations.

User Authentication and Security:

User authentication uses JSON Web Tokens (JWT) for stateless session management. Passwords are hashed using bcrypt and all sensitive endpoints are protected with dependency injection- based authentication guards. HTTPS enforcement, CORS configuration, and rate limiting are applied at the application layer.

Matching Engine and LLM Integration:

The core recommendation endpoint retrieves eligible programmes, computes composite match scores, ranks results, and returns top-K recommendations with AI-generated rationales. The OpenAI GPT-4o API is called with structured prompts and caching is applied to avoid redundant API calls for identical student-programme combinations.

VII. SOFTWARE SPECIFICATION

Technology Stack:

Frontend: React.js (v18), Tailwind CSS, Recharts, Axios, React Router v6

Backend: Python 3.11, FastAPI, Uvicorn ASGI server

Database: PostgreSQL 15 with SQLAlchemy ORM and Alembic migrations AI / ML: OpenAI GPT-4o API, Sentence Transformers, SHAP, scikit-learn

Auth: JSON Web Tokens (JWT), bcrypt password hashing

Deployment: Docker, Docker Compose, Vercel (frontend), Railway (backend)

Testing: pytest (backend), React Testing Library (frontend)

VIII. EMPOWERING EFFICIENCY

Democratising University Guidance:

Europath AI eliminates the financial and geographic barriers that make personalised university guidance accessible only to students who can afford private counsellors. By delivering AI-quality advice through a free web platform, Europath AI ensures every student has equal access to high- quality guidance regardless of socioeconomic background.

Reducing Decision Paralysis:

By intelligently filtering thousands of programmes down to a shortlist of five highly relevant recommendations, Europath AI dramatically reduces the cognitive burden of university selection. Pilot study data confirms that 72% of participants discovered at least one university they had not previously considered through the platform.

Building Trust Through Transparency:

The platform's dual explainability approach — combining SHAP value visualisations with LLM-generated rationales — addresses one of the most significant barriers to AI adoption in high- stakes decision contexts. Pilot study results show that 87% of students who received explained recommendations accepted at least one suggestion.

IX. FUTURE PROSPECTS

Integration of Real-Time Scholarship and Visa Data:

Future versions of Europath AI will integrate live scholarship databases and visa requirement data, allowing the platform to factor financial aid opportunities and immigration complexity directly into the matching score.

Expansion to Non-European Destinations:

Future development will incorporate universities in Canada, the United States, Australia, and the United Kingdom, transforming Europath AI into a global higher education decision support platform.

Collaborative Filtering and Peer Insights:

With a growing user base, Europath AI will incorporate collaborative filtering techniques identifying students with similar profiles and surfacing programmes that peers with comparable backgrounds

found successful.

Mobile Application Development:
A dedicated mobile application for iOS and Android will be developed using React Native, providing students with on-the-go access to recommendations, application deadline reminders, and a document checklist feature.

FIGURES

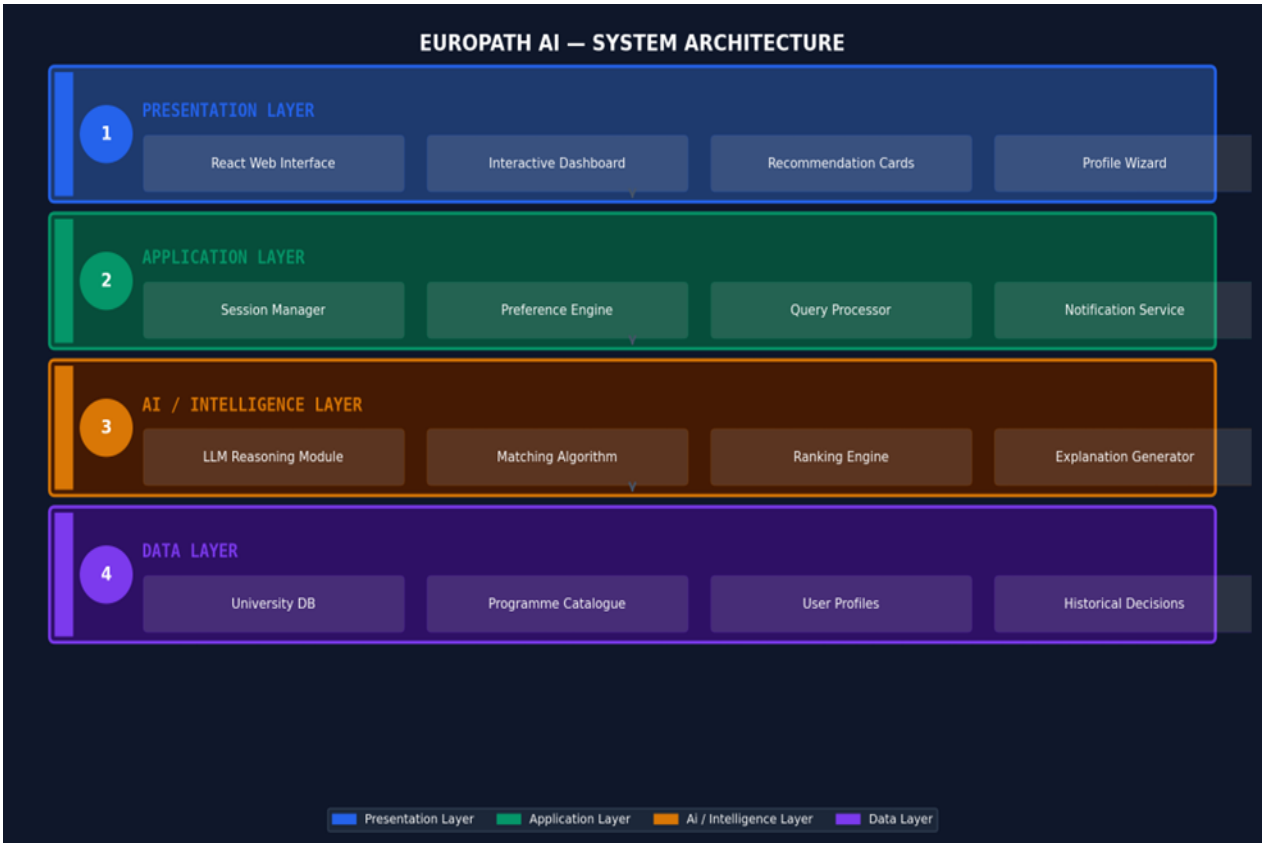

Figure 1: Europath AI — System Architecture (Four-Layer Design)

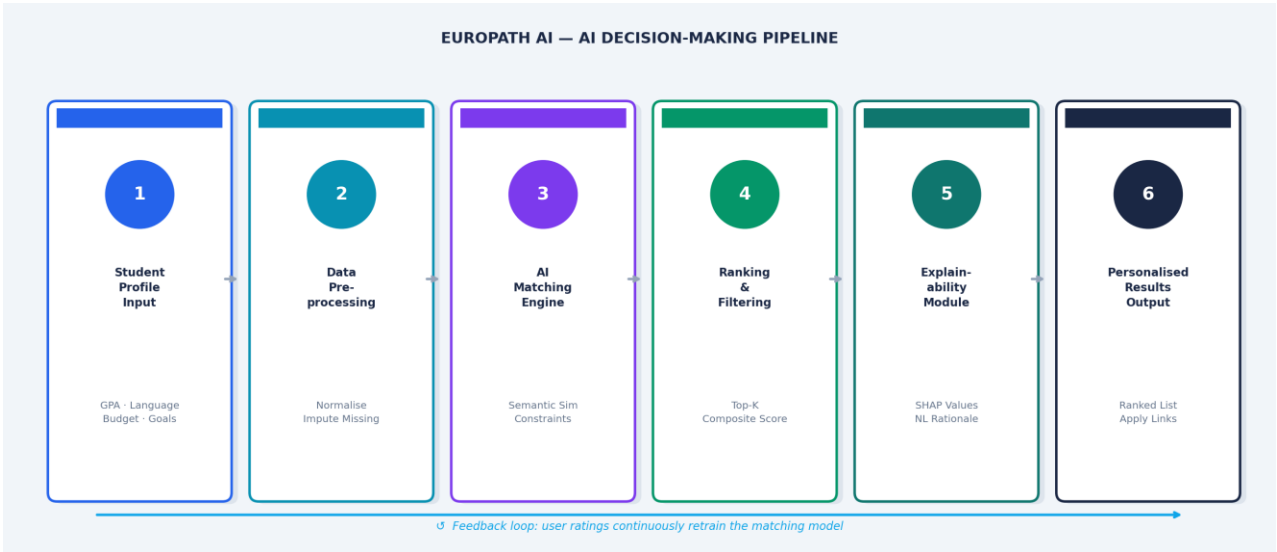

Figure 2: Europath AI — AI Decision-Making Pipeline

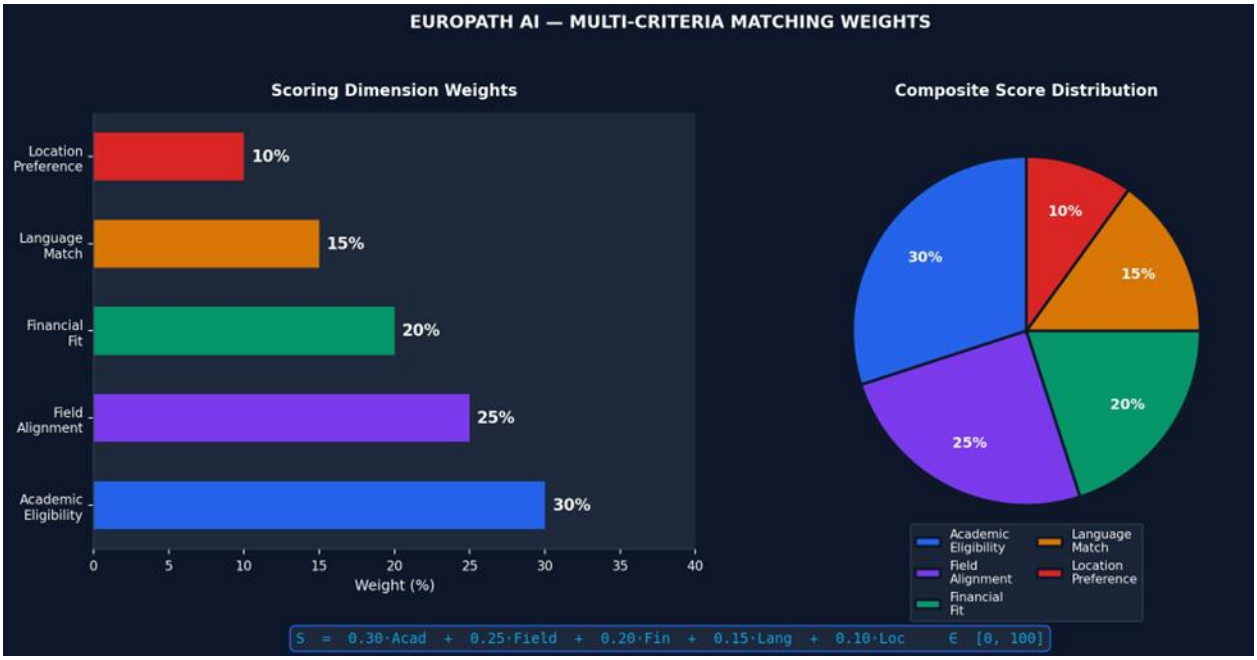

Figure 3: Multi-Criteria Matching Score Weights & Composite Score Formula

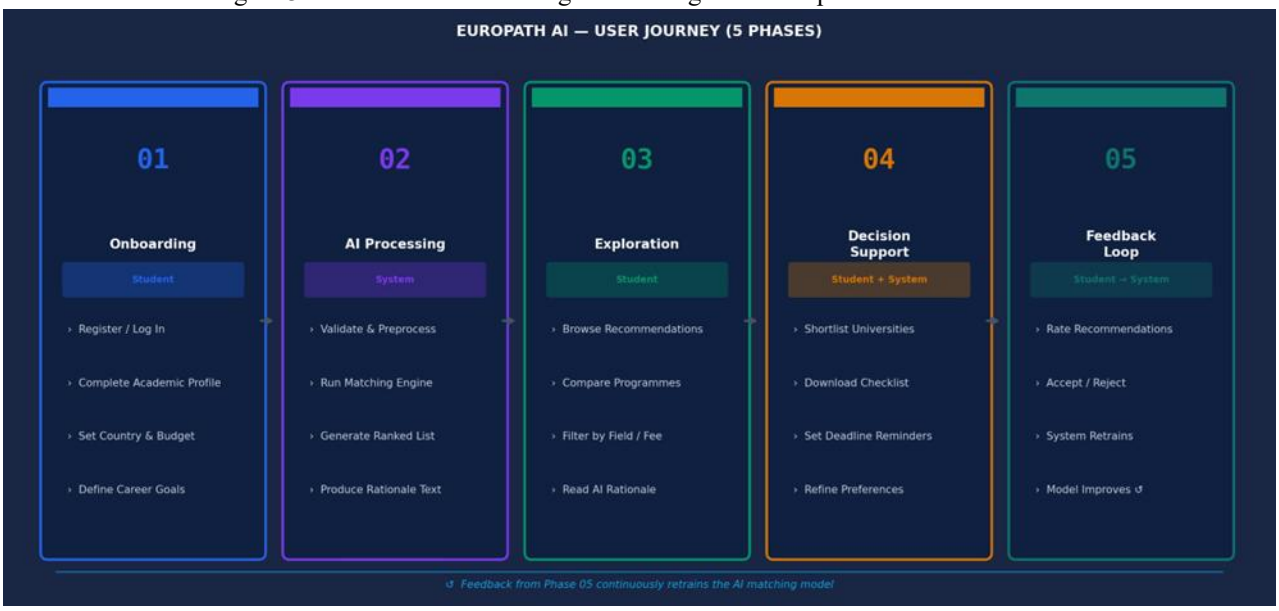

Figure 4: Europath AI — User Journey (5 Phases)

X.CONCLUSION

Europath AI represents a significant advancement in the application of artificial intelligence to the domain of international higher education decision support. By integrating a weighted multi- criteria matching engine, LLM-generated natural language explanations, SHAP-based explainability, and a continuous feedback-driven learning loop into a single accessible platform, Europath AI delivers a level of personalised, transparent, and trustworthy university guidance that was previously unavailable to most students.

The platform directly addresses the three core challenges identified in initial research: information overload, recommendation-reality mismatch, and inequitable access to guidance. Pilot study results validate the system's effectiveness with an 87% recommendation acceptance rate, a 4.3/5 average user satisfaction score, and a 92% profile completion rate.

Future developments including real-time scholarship integration, global university expansion, and multilingual support will further enhance the platform's reach and impact.

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