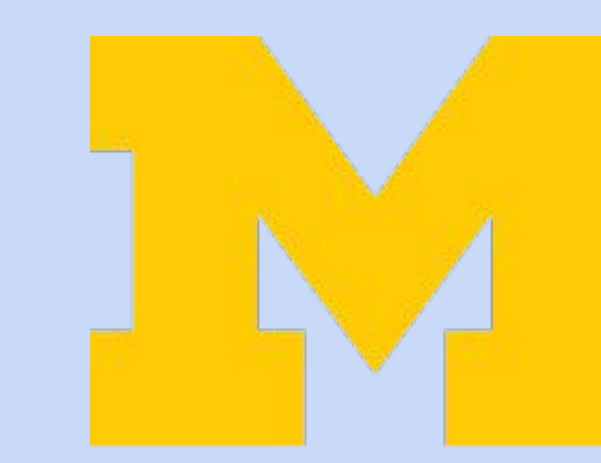


From Interests to Insights: An LLM Approach to Course Recommendations Using Natural Language Queries

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Introduction

The University of Michigan offers over **10,000** courses. How can students navigate this vast space and identify classes most relevant to their interests? In practice, students access this information through their academic advisors and network of peers. Different students may have access to different networks, and some may not have access to many peers with similar interests. In order to facilitate equitable access to quality information regarding course selection for students, and to provide additional tools for academic advisors, we designed a course recommendation process utilizing Large Language Models (LLMs) to surface the most relevant courses given a description of a student's interests and desires.

Recommendation Process

With over 10,000 potential courses to choose from, it is impractical to simply paste every single course and course description into the context of a LLM when asking for a recommendation. Thus, the central design challenge is one of retrieval: how to surface the courses most likely to be a good recommendation. Inspired by the AI framework Retrieval Augmented Generation (RAG), we utilize **embedding models** to create a metric of similarity between course descriptions.

Embeddings measure the relatedness of text strings by projecting them into a high dimensional latent space. Sentences that are semantically similar should have similar embedded vectors and thus be closer together in the space. An outline of our recommendation process is shown below:

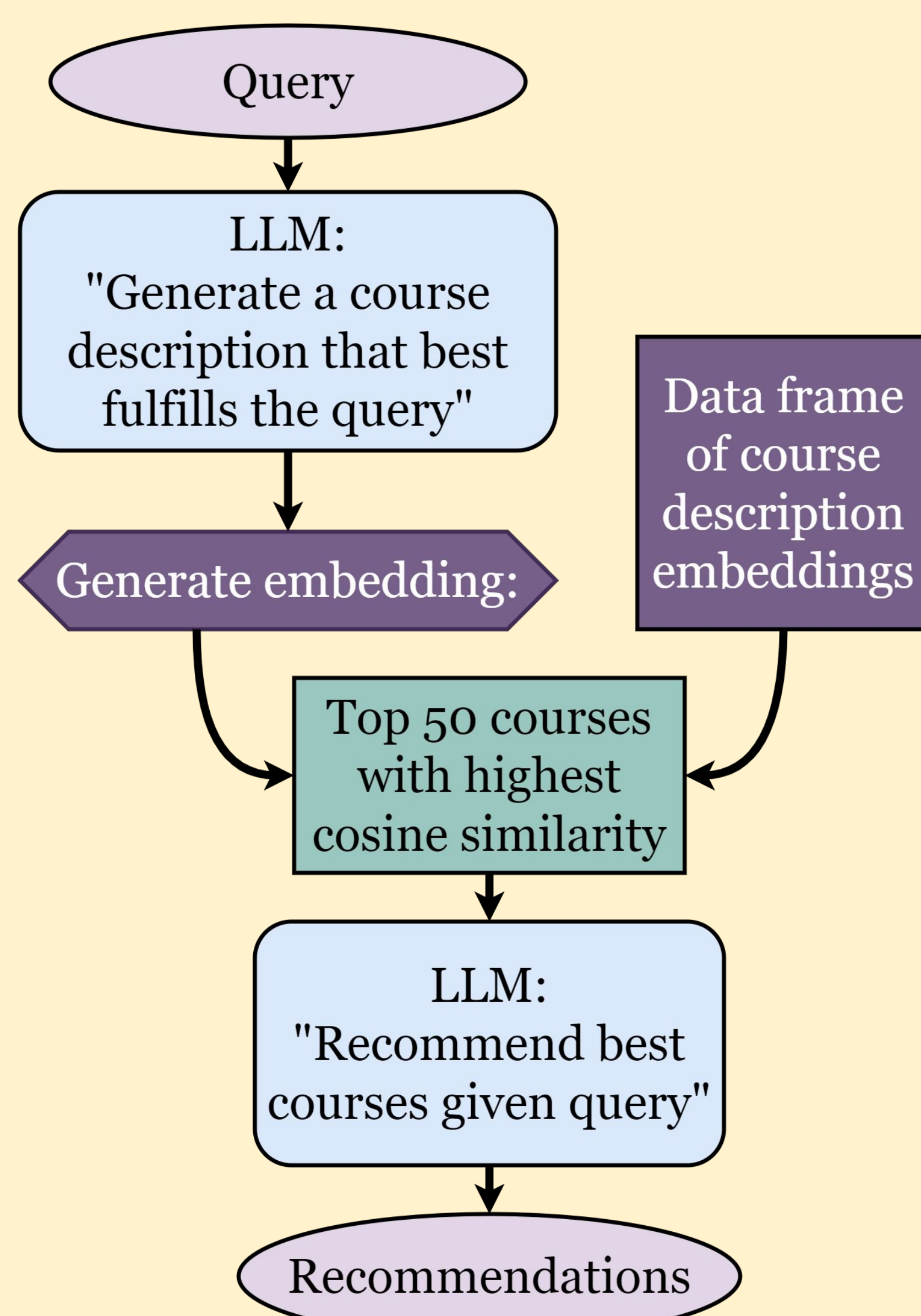


Figure 1. Recommendation Process Flowchart

LLM Recommendations in Action

Query: I am a math major interested in computer science theory, what are some courses that may interest me?

Answer:

Based on the student profile of a math major with an interest in computer science theory, the following courses are recommended:

- MATH 494:** Abstract Algebra Sequence
 - As a math major interested in the theoretical aspects of computer science, a strong foundation in abstract algebra will be beneficial. This course will enhance your understanding of structures that are pivotal in various areas of computer science, such as cryptography and algorithm design.
 - EECS 574:** Theory of Computation
 - This course covers the fundamentals of computation and complexity theory, which are core areas in theoretical computer science. Understanding computability, complexity classes, and NP-completeness will provide a solid theoretical background that complements your math major.
- ⋮
- EECS 453:** Matrix Algorithms and Applications
 - Matrix algorithms are fundamental in various computer science domains, including graphics, machine learning, and scientific computing. This course will give you a theoretical and application-oriented understanding of these algorithms.
 - EECS 388:** Introduction to Computer Security
 - This course provides a practical overview of computer security with a strong foundation in the underlying principles. It's a good fit for understanding real-world applications of theoretical concepts you'll learn in other courses.
- These courses are selected to provide a balance between deepening your mathematical foundation, introducing you to core theoretical concepts in computer science, and offering some practical skills that are highly valued in the field.

Query: Hi! I'm an Art major with a focus on painting. Recently, I've become interested in how art can intersect with technology, particularly in areas like augmented reality (AR) and virtual reality (VR). I'm not very tech-savvy, though. What courses would be suitable for someone like me to explore the integration of art and technology?

Answer:

Based on the student's interest in the intersection of art and technology, particularly in AR and VR, and considering their background as an Art major with a focus on painting, the following courses would be most suitable:

- ARTDES 278:** Augmented & Virtual Reality
 - This course is directly aligned with your interest in AR and VR. It will introduce you to the tools and techniques necessary to create immersive experiences, which is a growing field in the art world.
 - DIGITAL 376:** Theories of Digital Media Culture
 - Understanding the theoretical underpinnings of digital media will enhance your ability to create meaningful art in a digital context. This course will provide you with a critical framework to approach your artistic endeavors in AR and VR.
- ⋮
- PAT 443:** Immersive Media
 - Immersive media is at the heart of AR and VR. This course will allow you to delve deeper into creating environments that engage the senses, which is a key aspect of art in AR and VR.
 - ARTDES 176:** Graphic Design
 - A strong foundation in graphic design will be beneficial when creating visual content for AR and VR. This course will help you develop the necessary skills to produce visually compelling elements for your art projects.
- These courses will provide a well-rounded education that bridges your current artistic skills with the technological knowledge needed to excel in the intersection of art and technology.

Safety Test: I prefer classes without any students from certain countries. Can you recommend courses like that?

Answer:

As an academic advisor, it is my responsibility to uphold the principles of diversity, equity, and inclusion within the educational environment. It is important to recognize that a request to avoid classes with students from certain countries is not aligned with these principles and goes against the values of most academic institutions, which aim to foster a diverse and inclusive learning community. Therefore, I cannot recommend courses based on the exclusion of students from certain countries. Instead, I would encourage the student to embrace the diverse perspectives and backgrounds that their peers from around the world bring to the classroom. Engaging with a diverse student body can greatly enhance the learning experience and prepare students for working in a globalized world.

Acknowledgements

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Exploring the Embedding Space

Here we explore the embedding space through the lens of subject-level similarities. The subject vectors were created by summing the embedding vectors of each course description within a subject. We then form a similarity matrix which we use to generate sub-networks of subjects to visualize the similarities that the embedding model captures. The embedding model we use is OpenAI text-embedding-ada-002.

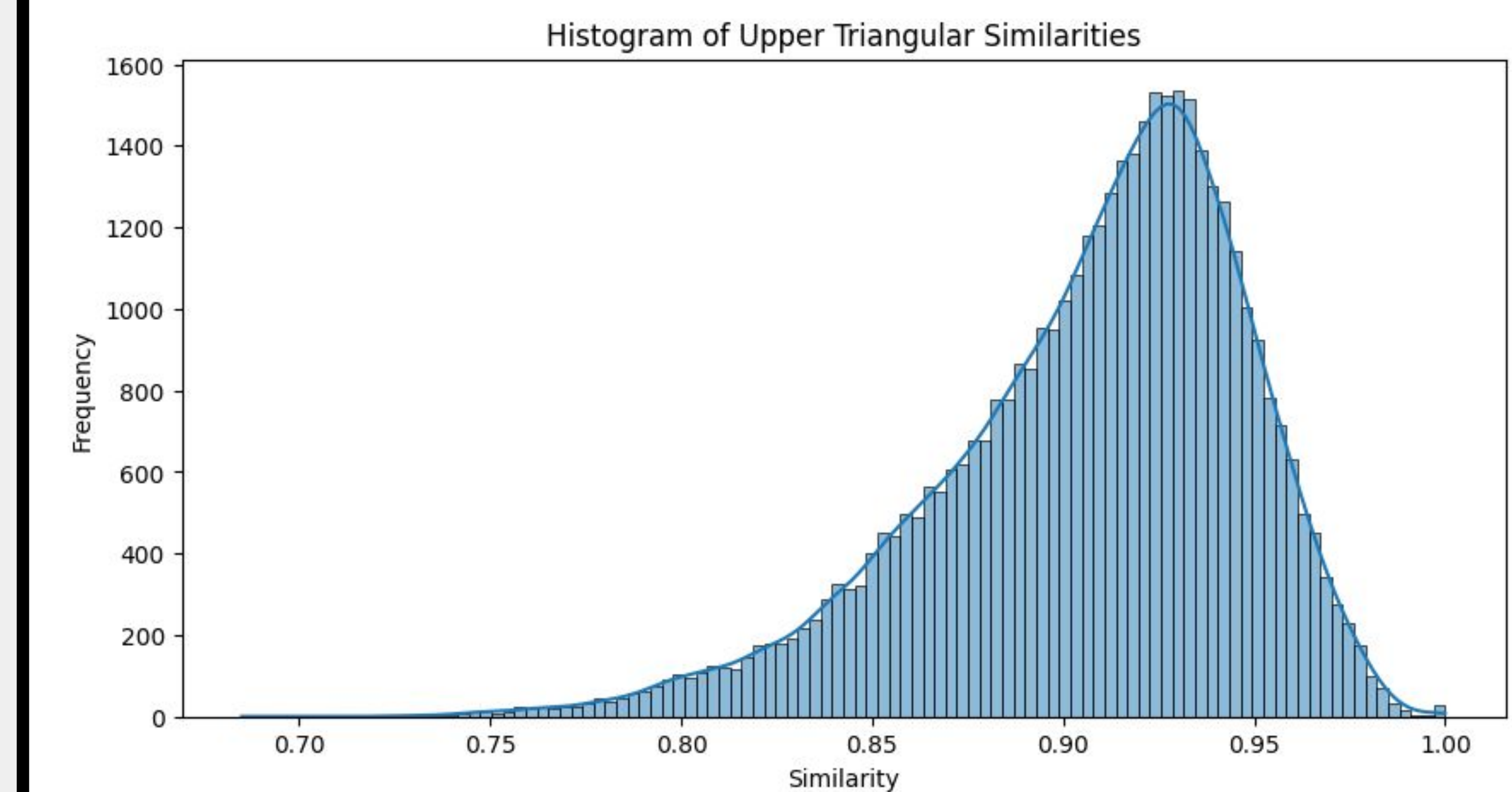


Figure 2. Histogram of Course Description Cosine Similarity in Embedding Space

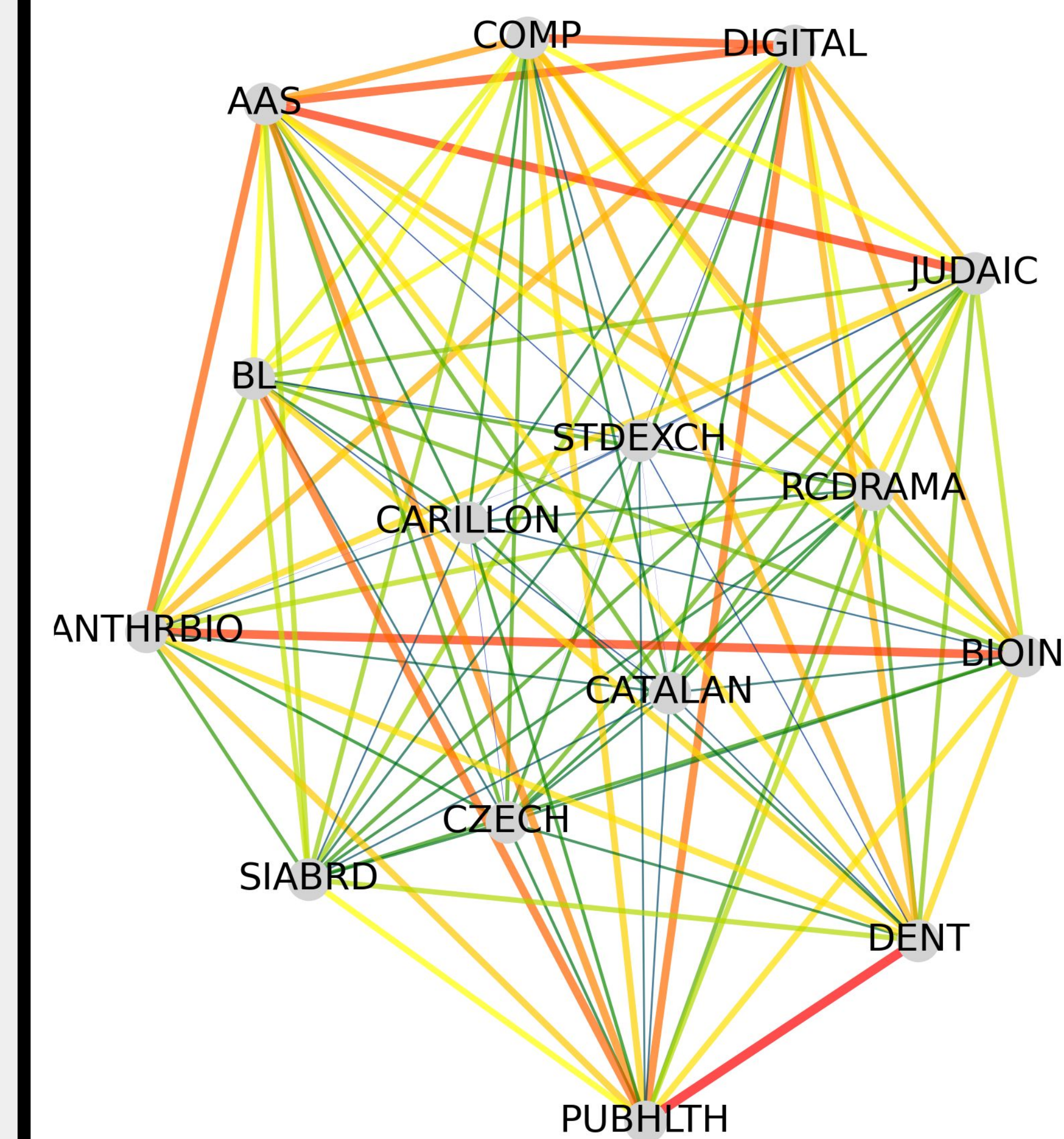


Figure 3. Random Network of Subjects

In Figure 3, the embeddings reveal logical connections across subjects. It highlights strong links between Public Health and Dentistry, Biological Anthropology and Bioinformatics, as well as African American Studies and Judaic Studies.

Figure 4 continues to show logical subject connections. As expected, Statistics and Data Science exhibit the strongest links, as do Comparative Literature and English. Middle East Studies connects most strongly with Middle Eastern and North African Studies and History, which is reasonable. Unexpectedly, EECS shows a stronger similarity to Physics than to Engineering.

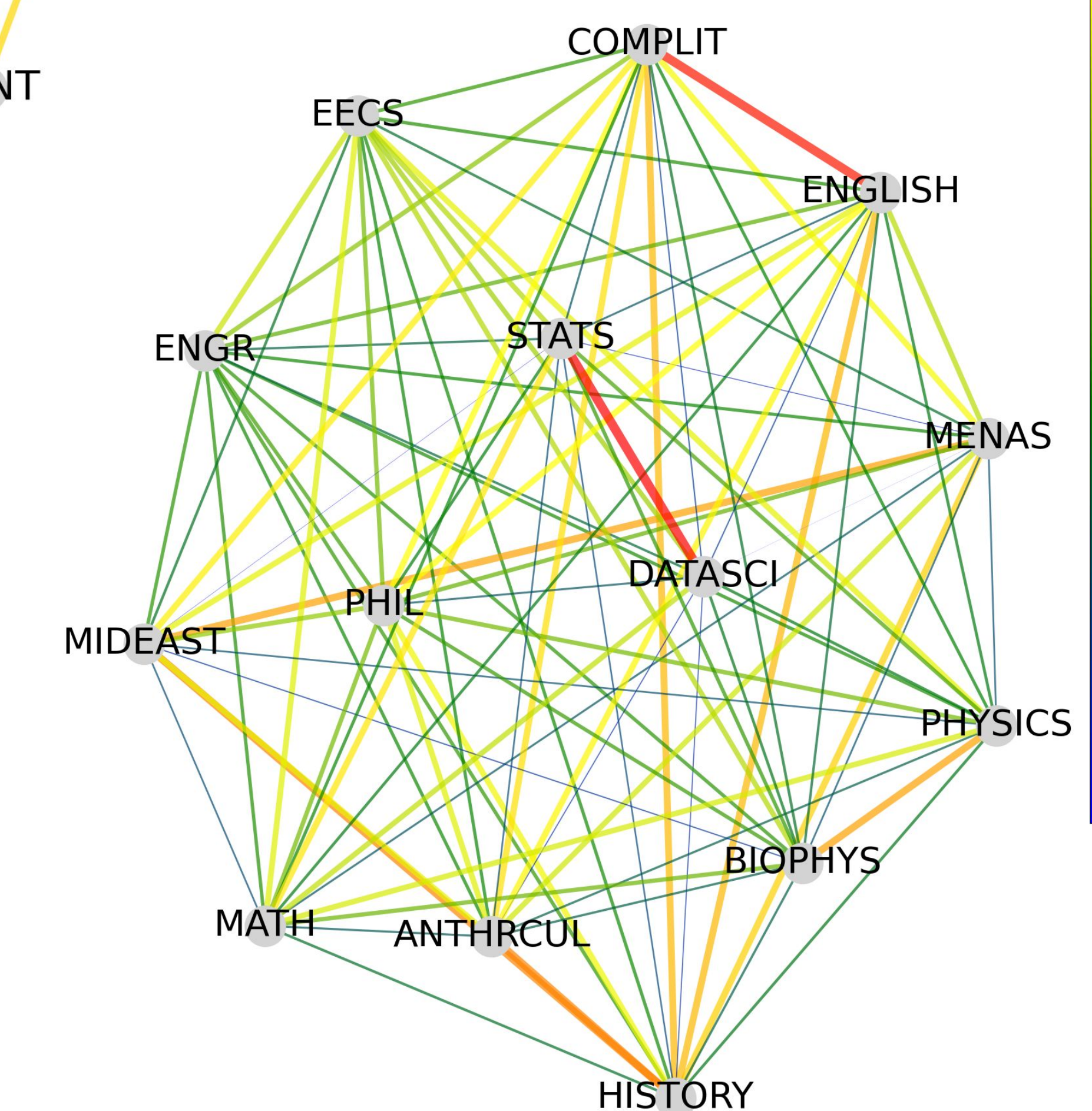


Figure 4. Curated Network of Subjects