# *Rate My Feedback*:

An NLP-Based Machine Learning Framework to Analyze and Construct Professor-Specific Suggestions from Student Written Evaluations.

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**Research Final Report**

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## Major Accomplishments

The end goal of any esteemed educational institution is to offer the best possible learning experience to its students. One effective way to achieve this is by regularly evaluating and enhancing the teaching methods. To bridge the gap between students' experiences and professors' teaching methods, our research embarked on an ambitious mission: analyzing students' feedback to offer actionable insights to educators. The following are two major accomplishments of the study:

1. Transforming Feedback into Visual Insights: Rather than sifting through innumerable feedback forms, using our natural language processing tools, educational institutions may view an insightful visualization that right away identifies the teaching's highlights and places for development. The systems automatically generate clear, simple-to-understand visuals from unstructured, unfiltered student input using sophisticated algorithms. This not only helps professors see where they excel but also where they might need to pivot.

2. Automated, Targeted Recommendations: Building on these insights, we created a system that curates personalized advice for educators. For instance, if the visual data indicates a teacher's assignments aren't clear, our system might pose a question: "How can I create clearer student assignments?" Immediately, it offers curated literature or resources that help the educator tackle that specific issue. It's like having a personalized teaching consultant at the click of a button!

To put it in simpler terms, our project is like a bridge between what students experience and what professors deliver. Through advanced technology, we've made it easier than ever for educators to see, understand, and act upon feedback, ensuring the classroom remains a dynamic, ever-evolving space of excellence.

And while we're proud of the technological strides we've made, we're even more excited about what this means for the future of education. By creating an environment where teaching is continuously refined based on genuine student feedback, we pave the way for a more engaging and effective educational journey for all.

**FINAL REPORT** - Summer Undergraduate Research Fellowship 2023

## I. Introduction:

Higher education's fundamental aim is to cultivate an enriching and conducive learning environment for students. Within this context, the role of professors and educators is pivotal. That being said, the ongoing enhancement of teaching methods, guided by student feedback, is vital to ensure a dynamic and optimized learning atmosphere. This research seeks to empower university professors with actionable insights through the application of advanced Natural Language Processing (NLP) techniques and Generative Artificial Intelligence (AI).

In recent years, the advent of intelligent search engines and language models, driven by generative machine learning frameworks, has ushered in a transformative era in user search experiences. Across diverse sectors, there is a growing exploration of NLP tools to analyze user reviews and extract invaluable insights for performance and service improvement. Our framework, known as *RateMyFeedback*, represents an NLP-driven system integrated with a Generative Pre-trained Transformer (GPT), uniquely crafted to dissect and generate personalized recommendations from student evaluations, tailored to individual professors. The framework's prowess extends to providing pertinent and personalized search results, catering to varying levels of granularity. It accomplishes this through a structured approach encompassing four critical phases: NLP model evaluation, tokenization, query construction, and recommendation. This research endeavor assesses the framework's real-world applicability within educational contexts, with the overarching goal of simplifying the analysis and interpretation of student feedback.

This paper introduces a novel methodology that harnesses NLP and Generative AI to streamline the feedback analysis process for higher education professors, ultimately fostering an improved learning environment for students.

## II. Research Objectives:

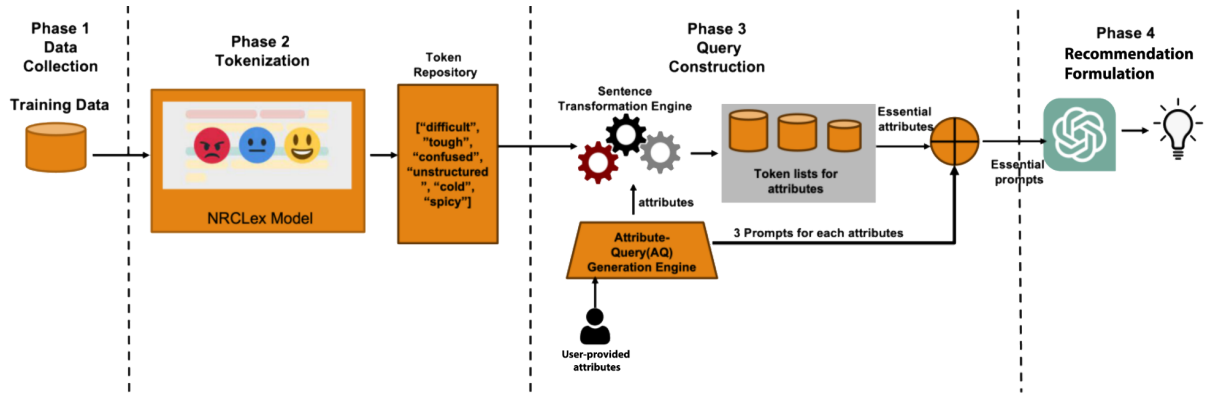
This research project aims to harness the power of NLP and Generative AI to convert unstructured student feedback (typically large collections of textual data) into structured insights (standardized visualizations efficiently accessible by software and humans alike), enabling professors to receive targeted recommendations for improving their teaching methods. By

achieving these objectives, the study endeavors to enhance the overall quality of higher education and the learning experience for students. Following are our detailed objectives:

1. Enhancing University Teaching Through Insightful Analysis of Student Feedback: The main goal of this research is to improve university teaching by transforming unstructured student feedback into structured insights using cutting-edge Natural Language Processing (NLP) and generative artificial intelligence (AI) techniques.
2. Using NLP to Transform Unstructured Student input into Structured Insights: This work tries to create a systematic method for handling unstructured student input. The goal is to extract organized, practical insights from the voluminous qualitative feedback submitted by students.
3. Offer Targeted and Relevant Recommendations to Professors to Enhance Teaching Methods: Providing university teachers with clear and practical suggestions for enhancing their teaching techniques is another important goal of this study. The project aims to provide useful insights that can result in educational improvements by carefully analyzing student feedback.
4. Streamline the Feedback Analysis Process for Professors: This study aims to streamline academics' feedback analysis procedures in addition to producing recommendations. The goal is to provide educators with effective methods and frameworks that enable a deeper understanding of student assessments and, in turn, support their professional growth.

## III. Methodology:

### 3.1. Framework Overview:



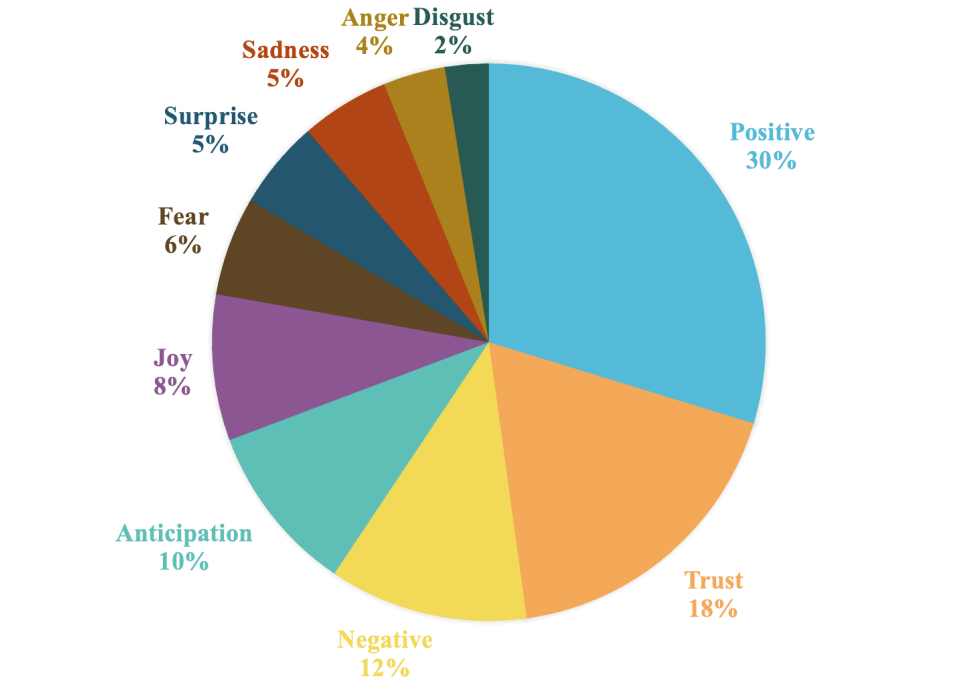

[Figure 1]: Framework Diagram showcasing the flow from NLP Evaluation to Recommendation.

The research framework consists of four interconnected phases:

- Natural Language Processing (NLP) Evaluation
- Tokenization
- Query Construction
- Recommendation and Response Generation

### 3.2. NLP Evaluation:

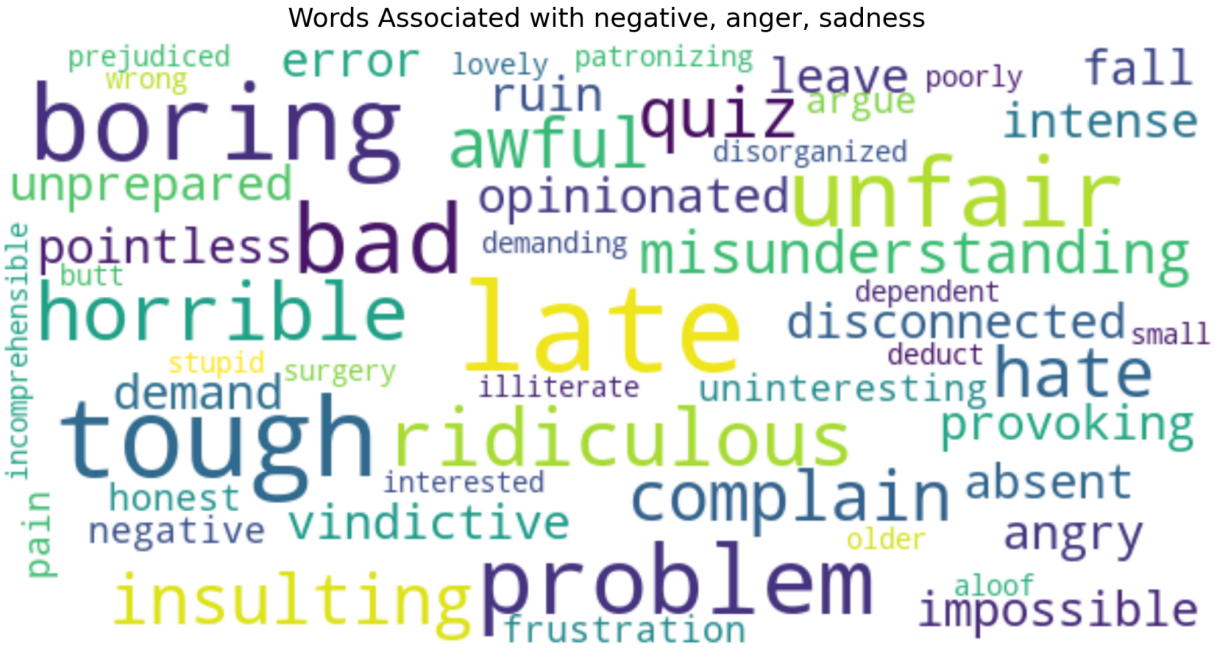
Most student feedback is presented in large collections of unstructured text. To analyze this feedback, we investigated and assessed different techniques such as emotion analysis, Word2Vec, Topic Modeling, and Clustering. This analysis process produced emotion keyword libraries and visual depictions that emphasized different aspects of the feedback, including the dominant emotions present in the dataset. After thorough evaluations, we chose the NRCLex Emotion Analysis model for the Tokenization phase because of its outstanding performance in categorizing texts and keywords.




[Figure 2]: Screenshot of the visualization dashboard generated using NRCLex, displaying feedback highlights of the dominant emotions encoded in student survey data.

### 3.3. Tokenization:

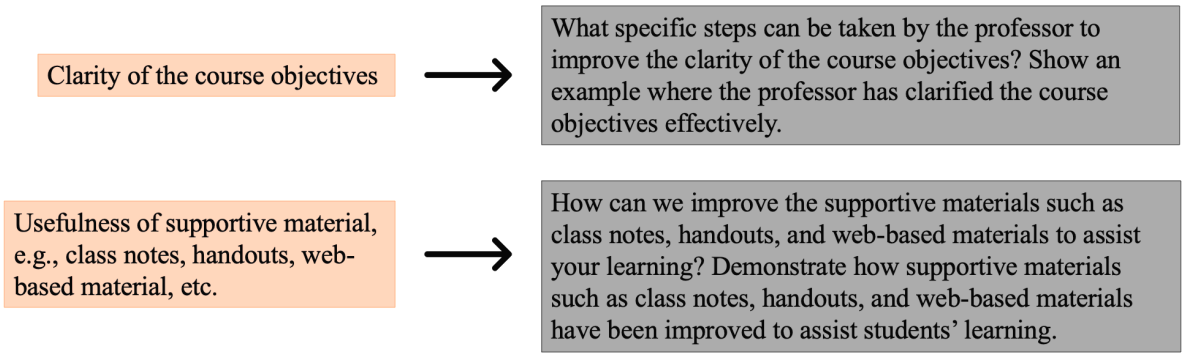
Once feedback was evaluated using the NRCLex Emotion Analysis model from Phase 1, crucial tokens, such as action verbs and adjectives, were extracted. These tokens acted as building blocks for subsequent stages and were stored in a token repository. Figure 3 displays the selected keywords generated that best characterize the chosen emotions for the education-domain study.




[Figure 3]: The keyword library for the education domain using a sample student survey data. This repository captures the anger, negative, and sadness emotions of the students.

### 3.4. Query Construction:

Utilizing the token repository from Phase 2 and university domain knowledge comprising 26 attributes, we developed a query generator engine that fabricates questions central to the areas of improvement identified earlier. Figure 4 displays sample questions derived from the university's domain knowledge.




[Figure 4]: Sample questions generated from the university domain knowledge.

### 3.5. Recommendation and Response Generation:

Leveraging the capabilities of the famous Generative Pre-trained Transformer (GPT) 3.5 Turbo from OpenAI, the constructed questions were input, prompting textual responses as recommendations for teaching refinements.

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Question: What can be done to increase the level of enthusiasm for the subject matter? Demonstrate a situation wher
e the level of enthusiasm for the subject matter was successfully increased.

To increase the level of enthusiasm for a subject matter, several strategies can be employed:

1. Make it relevant: Connect the subject matter to real-life situations or personal interests of the learners. Show
them how the subject matter can be applied in their daily lives or future careers.

2. Use interactive teaching methods: Incorporate hands-on activities, group discussions, debates, or role-playing
exercises to actively engage learners. This fosters a sense of participation and excitement.

3. Provide choice and autonomy: Allow learners to have some control over their learning by offering options for
projects, assignments, or topics within the subject matter. This promotes a sense of ownership and motivation.

4. Incorporate technology: Utilize educational technology tools, such as interactive simulations, virtual reality,
or online platforms, to make the subject matter more engaging and interactive.

5. Bring in guest speakers or experts: Invite professionals or experts in the field to share their experiences and
insights. This can inspire learners and show them the real-world applications of the subject matter.

6. Use multimedia resources: Incorporate videos, podcasts, infographics, or other multimedia resources to present
the subject matter in a visually appealing and dynamic way.

7. Provide positive reinforcement: Recognize and celebrate learners' achievements and progress. This can be done
through praise, certificates, or small rewards, which can boost enthusiasm and motivation.

A situation where the level of enthusiasm for the subject matter was successfully increased:

In a high school biology class, the teacher noticed that students were lacking enthusiasm for learning about
cellular processes. To address this, the teacher decided to incorporate a hands-on activity. The students were
divided into groups and given the task of creating a 3D model of a cell using various materials.

The students were excited about the opportunity to be creative and work collaboratively. They researched different
cell types, discussed the functions of organelles, and brainstormed ideas for their models. The teacher provided
guidance and resources, but allowed the students to take ownership of their projects.

As the students worked on their models, they became more engaged and enthusiastic about the subject matter. They
actively discussed the functions of each organelle, debated design choices, and shared interesting facts they
discovered during their research. The classroom atmosphere was filled with energy and excitement.
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[Figure 5]: Sample output of the recommendation engine, showcasing curated advice from Generative AI running GPT 3.5 Turbo.

## IV. Results and Accomplishments:

### 4.1. Visual Insights from Feedback:

One of our major accomplishments was the transformation of unstructured (textual) feedback into visual representations. These visuals offered professors a quick overview of their teaching effectiveness, spotlighting areas that warrant attention.

### 4.2. Automated Recommendations

Our recommendation system effectively linked identified areas of improvement with actionable resources. Professors were not only made aware of potential pitfalls in their teaching methods but were also provided with tools and potential actions to amend them.

## V. Significance and Implications:

The project's success means universities can continuously refine teaching methods, ensuring that student feedback directly influences positive change. Professors are better equipped to understand their strengths and weaknesses and have resources readily available to address them. Consequently, higher education institutions are in a better position to foster and maintain an optimal learning environment for their students.

## VI. Future Work and Conclusion:

### 5.1 Future Work:

We plan to incorporate advanced AI capabilities to enhance the feedback analysis process even more. Our goal is to broaden its applicability across various sectors such as e-commerce, education, and hospitality. We've already submitted a research paper detailing the diverse applications of these tools across multiple fields for peer review. Additionally, we're keen on exploring avenues to revolutionize prompt engineering in our future endeavors. Specifically, in this research, we address one way of formulating user prompts. We envision a lucrative collaboration with language studies to devise and

evaluate other effective prompting methods. We assert that this study is critical in shaping the future of generative AI.

**5.2 Conclusion:**

We introduce RateMyFeedback, an NLP framework designed to analyze student survey data, providing educational institutions with insights to elevate teaching quality. This framework unfolds through several distinct phases, each offering a unique lens into the survey data.

- Phase 1 - NLP Evaluation: This step delves into the analysis of various language processing models, delivering emotion keyword libraries and visual representations that spotlight diverse feedback facets.
- Phase 2 - Tokenization: Here, the engine extracts specific words/tokens, from the student survey provided, focusing on prevalent sentiments. The resultant token repository furnishes users with an initial understanding of sentiments encapsulated in the expansive survey data.
- Phase 3 - Query Construction: Leveraging the token collections from Phase 2 and university domain expertise, which encompasses 26 attributes, we design a query generator engine capable of formulating pertinent questions that can then be fed to ChatGPT. This tool formulates questions honing in on previously pinpointed improvement areas.
- Phase 4 - Recommendation and Response Generation: In this phase, the questions crafted from phase 3 are fed to a Generative Pre-trained Transformer (GPT), eliciting textual responses that serve as recommendations for academic enhancements.

Our empirical evidence underscores RateMyFeedback's proficiency in both analyzing surveys and proffering insights across all four phases. Further, our investigations indicate that RateMyFeedback adeptly mirrors human analysis. While it doesn't supplant human intervention, we maintain that it offers immense value as an auxiliary tool for humans sifting through vast survey datasets.

**Reflection on Summer Fellowship Experience at Pacific**

From my initial days at the University of the Pacific, I was immersed in a myriad of experiences and academic interaction  professional lens. Yet, the summer fellowship remains a pivotal moment in my educational path. Through this reflection, I hope to illuminate how the program reshaped my perspectives and aspirations.

**Bridging Theory with Practical Research**

The University of the Pacific's curriculum laid a strong foundation in theoretical concepts for me. But it was during the summer fellowship that these theories came alive, especially when diving deep into the realms of Artificial Intelligence and Language Processing. It was an eye-opening transition from understanding the concepts in the classroom to applying them in tangible, real-world scenarios. Within the context of the fellowship, I actively applied my Python coding and data analysis capabilities in real-world projects, further honing a myriad of essential skills. As I shepherded a research project from beginning to end, I recognized that real-world dilemmas often bring unforeseen challenges, a stark contrast to the neatly structured problems presented in textbooks. This hands-on research experience reinforced my passion and determination to further immerse myself in research-centric studies.

**The Power of Interdisciplinary Insights**

Collaborating with a diverse set of peers and audiences underscored the importance of presentation language for me. I recall employing intricate technical jargon during my initial luncheon presentation. However, based on constructive feedback from both the audience and my mentor, I recognized the need to adapt my speech and slides to suit the knowledge level and interests of my listeners. Questions posed by attendees not only sharpened my communication skills but also illuminated areas of improvement in my project. Interacting with individuals from assorted academic backgrounds enriched discussions, emphasizing the value of interdisciplinary dialogue and learning.

**Personal and Skill Development**

Apart from the academic insights, the fellowship was a journey of self-discovery for me. Confronting the hurdles along the way, accepting my own missteps, and persistently chasing solutions taught me more about myself than I could have imagined. It's where I discovered a

resilient spirit within me and learned to adapt, no matter the challenge. Through this experience, I didn't just enhance my analytical, communication, and time management skills; I truly got to know my strengths, my vulnerabilities, and my capacity to grow.

**A Note of Appreciation**

I would like to express my sincere gratitude for this fellowship opportunity. It wasn't just a research venture for me but a gateway to self-awareness, a testing ground for my capabilities, and a precursor to future accomplishments. The wholehearted support from the University of the Pacific, its benefactors, the Office of Undergraduate Research, and, especially, my supervising mentor, Dr. Vivek Pallipuram, was crucial in this transformative phase. I hope my journey illustrates the immense potential these fellowships offer, advocating for more students at the University to partake in such invaluable experiences.

In summation, as I transition to the next chapter of my academic journey, the insights and experiences from the summer fellowship will serve as guiding lights. It's not merely a chapter in my Pacific journey but a foundational block for my ongoing educational and professional pursuits.

**An accounting of the supplies/expenses funds:**

N/A

**Associated Publication**

1. "ChatReview: A ChatGPT-enabled natural language processing framework to study domain-specific user reviews."

   Published: Submitted in *Machine Learning with Applications*, under review at the Elsevier Journal.

2. "Camelot: A council of machine learning strategies to enhance teaching."

   Published: Appeared in the book titled *Machine Learning in Educational Services*.