

# Emotion Recognition through Sinhala Song Comments on Youtube

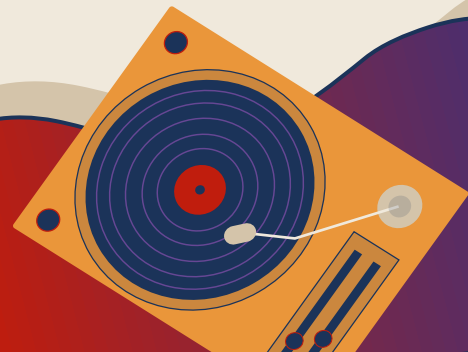
W. M. Y. De Mel - 239153X

Research Supervisor - Dr. Nisansa de Silva



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The background is a light beige color with abstract, wavy shapes in shades of orange, red, and purple. On the left, there is a stylized illustration of a purple electric guitar with a light-colored body and a wooden neck. On the right, there is a stylized illustration of a red keyboard instrument, possibly a synthesizer or digital piano, with white and black keys. Several small, stylized musical notes are scattered across the background.

01

# Introduction

# Introduction

- **Music Information Retrieval(MIR)** is the field concerned with extracting, analyzing, and understanding information from music data [1]
- **Music Emotion Recognition(MER)** is a subfield of **MIR** that focuses on the development of computational methods for the automatic identification and analysis of the emotional content present in music applying machine learning and signal processing techniques [2].
- The objective of MER is to enable the recognition and response to the emotional distinctions of music [3].
- MER represents a growing area of research at the intersection of musicology, psychology, and computational science [4].
- The pursuit of MER is deeply rooted in the historical and theoretical exploration of the relationship between music and emotions. From the ancient Greeks' belief in the emotive power of music to the modern-day endeavours of psychologists and musicologists [5].

[1] C. Plachouras, P. Alonson-Jiménez, and D. Bogdanov, "mir\_ref: A representation evaluation framework for music information retrieval tasks," arXiv preprint arXiv:2312.05994, 2023.

[2] S. Hizlisoy, S. Yildirim, and Z. Tufekci, "Music emotion recognition using convolutional long short term memory deep neural networks," Engineering Science and Technology, an International Journal, vol. 24, no. 3, pp. 760-767, 2021.

[3] Y. E. Kim, E. M. Schmidt, R. Migneco, B. G. Morton, P. Richardson, J. Scott, J. A. Speck, and D. Turnbull, "Music emotion recognition: A state of the art review," in Proc. ismir, vol. 86, 2010, pp. 937-952.

[4] Y. Deldjoo, M. Schedl, and P. Knees, "Content-driven music recommendation: Evolution, state of the art, and challenges," arXiv preprint arXiv:2107.11803, 2021.

[5] Y.-H. Yang and H. H. Chen, "Machine recognition of music emotion: A review," ACM Transactions on Intelligent Systems and Technology (TIST) vol 3 no 3 pp 1-30 2012

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02

# Research Problem

# Research Problem

- Analyzing emotions in social media comments on songs, particularly in languages such as Sinhala, faces challenges due to limited NLP resources, with existing research mainly focusing on English, leaving a significant gap in understanding emotional responses to Sinhala music.
- The research question explored in this thesis is:

***"How to utilize emotion recognition on the comments for Sinhala songs on social media."***



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03

# Research Objectives

# Research Objectives

- Identify the best emotional model categories for Sinhala comments on Sri Lankan songs.
- Develop a deep learning model to identify emotions in Sinhala social media comments on songs.
- Investigate the relationship between song popularity and the emotions it generates for Sinhala songs on social media.





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# Related Work

# Related Work

## Importance of MER Studies

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- Importance lies in its potential to deepen our understanding of the emotional aspects of music, enhance user experiences, and contribute to the development of emotionally intelligent technologies [2].
- MER can inform personalized music recommendations, contribute to affective computing [3].
- Extensive research spanning fields such as medicine, neuroscience, psychology, and music consistently attests to the efficacy of music therapy across a spectrum of populations, including medical, psychiatric, and sub-clinical settings [6, 7].
- In conjunction with these clinical applications, music has various applications for emotion regulation in everyday life [8].

[2] S. Hizlisoy, S. Yildirim, and Z. Tufekci, "Music emotion recognition using convolutional long short term memory deep neural networks," *Engineering Science and Technology, an International Journal*, vol. 24, no. 3, pp. 760-767, 2021.

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[7] D. Han, Y. Kong, J. Han, and G. Wang, "A survey of music emotion recognition," *Frontiers of Computer Science*, vol. 16, no. 6, p. 166335, 2022.

• [8] M. V. Thoma, S. Ryf, C. Mohiyeddini, U. Ehlert, and U. M. Nater, "Emotion regulation through listening to music in everyday situations," *Cognition & emotion*, vol. 26, no. 3, pp. 550-560, 2012.

# Related Work

## Challenges in MER Studies

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- Cross-cultural differences in music perception and emotional expression can have significant implications for MER [9].
- Cultural differences in musical training and exposure can affect the ability to recognize and express emotions in music [3].
- Subjective perception of emotions, making consensus on recognition results difficult [5, 10, 11].
- Significant challenges lie in acquiring reliable emotion annotations essential for training and evaluation [11].
- The absence of a standardized annotation protocol further complicates the comparison and evaluation of different MER systems [5, 10].

[3] Y. E. Kim, E. M. Schmidt, R. Migneco, B. G. Morton, P. Richardson, J. Scott, J. A. Speck, and D. Turnbull, "Music emotion recognition: A state of the art review," in Proc. ismir, vol. 86, 2010, pp. 937-952.

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[9] X. Wang, Y. Wei, and D. Yang, "Cross-cultural analysis of the correlation between musical elements and emotion," Cognitive Computation and Systems, vol. 4, no. 2, pp. 116-129, 2022.

[10] F. H. Rachman, R. Sarno, and C. Fatichah, "Music emotion classification based on lyrics-audio using corpus based emotion." International Journal of Electrical & Computer Engineering (2088-8708), vol. 8, no. 3, 2018.

[11] Y. S. Can, B. Mahesh, and E. André, "Approaches, applications, and challenges in physiological emotion recognition—a tutorial overview," Proceedings of the IEEE, 2023.

# Related Work

## Emotion Categorization in Music Psychology [7, 12]

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- The classification of emotions has long been debated within psychological research, primarily revolving around two prominent models.
  - Categorical Model
  - Dimensional Model
- Categorical models advocate for discrete classification, delineating emotions into distinct categories such as happiness, sadness, anger, fear, and disgust.
- Dimensional models propose a continuum-based classification, emphasizing valence (positive/negative) and arousal (high/low) as core dimensions for describing emotions.

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[12] X. Hu, J. S. Downie, and A. F. Ehmann, "Lyric text mining in music mood classification," *American music*, vol. 183, no. 5,049, pp. 2-209, 2009.

# Related Work

## Categorical Model

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- Emotion categorization model introduced by Hevner is a systematic approach to understanding the affective value and expressiveness of music through the categorization of adjectives based on their feeling-tone [13].
- Arrange adjectives into groups that share similar emotional characteristics [13].
- This arrangement allows for a comprehensive and nuanced understanding of the emotional nuances conveyed by music [7, 12].
- This approach not only simplifies the analysis of emotional content in music but also facilitates the comparison of results across various compositions, contributing to a deeper understanding of the affective value of music [7, 12].



[7] D. Han, Y. Kong, J. Han, and G. Wang, "A survey of music emotion recognition," *Frontiers of Computer Science*, vol. 16, no. 6, p. 166335, 2022.

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# Related Work

## Categorical Model (Cnt.)

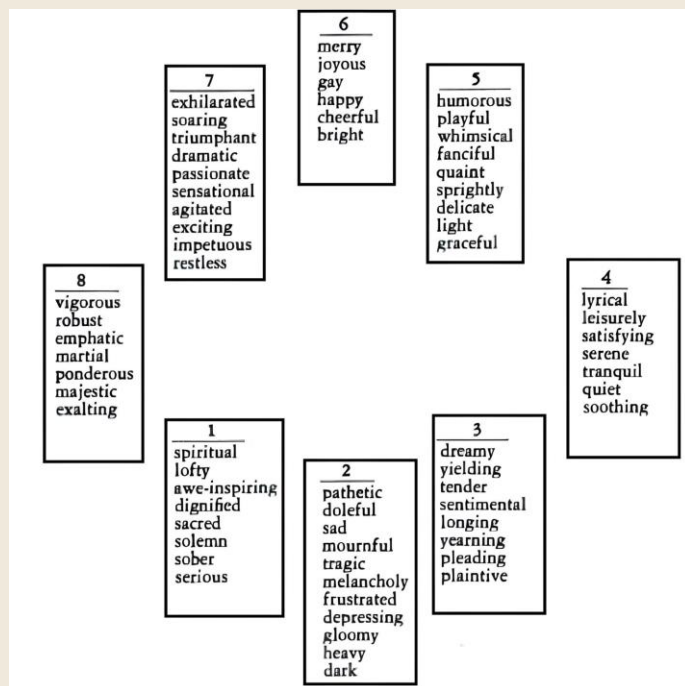


Fig. 1: Hevner's eight clusters of affective terms [13]

- Since categorical models may oversimplify the complex nature of emotional experiences, this has inherent limitations [6, 11].
- The subjective variation in how people experience and perceive emotions introduces complexity and makes categorical models less flexible when applied to a variety of populations [6, 11].
- Limited ability to capture nuanced emotional reactions hinders their effectiveness in tailored interventions [6, 11].

[6] D. Han, Y. Kong, J. Han, and G. Wang, "A survey of music emotion recognition," *Frontiers of Computer Science*, vol. 16, no. 6, p. 166335, 2022.

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• [13] K. Hevner, "Experimental studies of the elements of expression in music," *The American journal of psychology*, vol. 48, no. 1, pp. 246-268, 1936.

# Related Work

## Dimensional Model

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- Valence-arousal model by Russell [14] is a widely accepted dimensional model used to represent and understand emotions [7].
- According to this model, emotions are characterized along two primary dimensions: valence and arousal [15, 16].
- Valence refers to the degree of pleasantness or unpleasantness of an emotion, Arousal, on the other hand, represents the level of physiological activation or energy associated with an emotion [15].
- By combining these two dimensions, a two-dimensional space is formed, creating a framework for understanding and categorizing a wide range of emotional states [15].

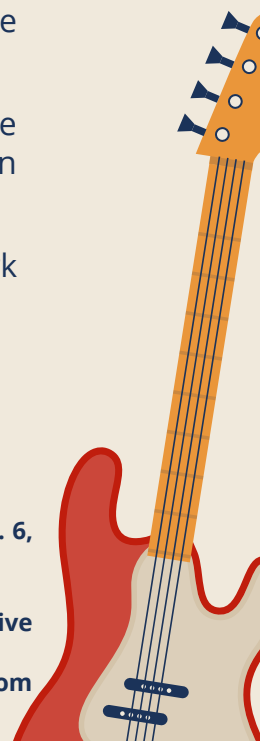


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[14] J. A. Russell, "A circumplex model of affect," *Journal of personality and social psychology*, vol. 39, no. 6, p. 1161, 1980.

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• [16] R. L. Rosa, D. Z. Rodriguez, and G. Bressan, "Music recommendation system based on user's sentiments extracted from social networks," *IEEE Transactions on Consumer Electronics*, vol. 61, no. 3, pp. 359–367, 2015.



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## Dimensional Model (Cnt.)

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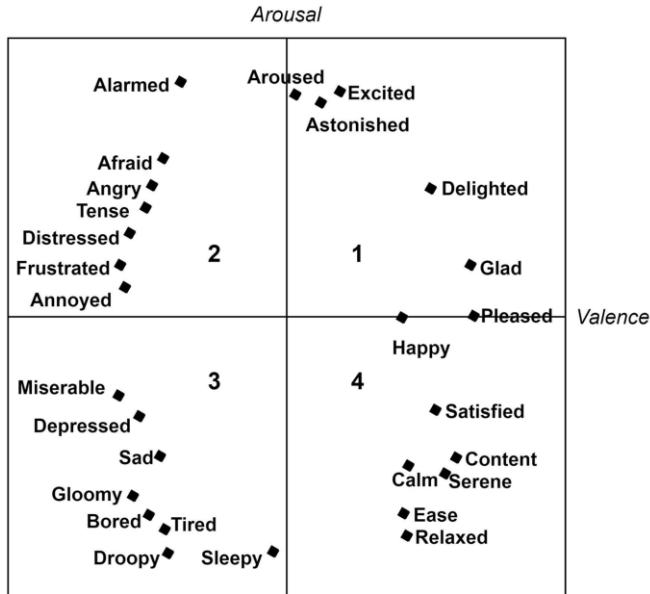


Fig. 2: The 2D valence-arousal emotion space [14]

[14] J. A. Russell, "A circumplex model of affect." *Journal of personality and social psychology*, vol. 39, no. 6, p. 1161, 1980.

• [15] R. Panda, R. Malheiro, and R. P. Paiva, "Novel audio features for music emotion recognition," *IEEE Transactions on Affective Computing*, vol. 11, no. 4, pp. 614–626, 2018.

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# Related Work

## Sinhala Sentiment Analysis

- Sinhala language is spoken by 20 million people in Sri Lanka, Sinhala is the mother tongue for 16 million, with 79.7% literacy. It belongs to the Indo-Aryan branch in the Indo-European language tree and has a unique writing system [17, 18].
- In linguistic contrast to English's Germanic branch, Sinhala is classified as a class 01 language according to Joshi et al. [19], subsequently Ranathunga and de Silva [20] categorise this as class 02 language.
- The lack of resources, including annotated datasets and sentiment lexicons, poses a major obstacle in creating reliable Sinhala-specific sentiment analysis models. The complexities of Sinhala sentiment expression, influenced by contextual and cultural factors, add layers of difficulty [21].
- Despite challenges, there are rich opportunities for academic research and real-world applications in Sinhala sentiment analysis [17, 21].

[17] N. De Silva, "Survey on publicly available sinhala natural language processing tools and research," arXiv preprint arXiv:1906.02358, 2019.

[18] V. Dhananjaya, P. Demotte, S. Ranathunga, and S. Jayasena, "Bertifying sinhala—a comprehensive analysis of pre-trained language models for sinhala text classification," arXiv preprint arXiv:2208.07864, 2022.

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- [20] S. Ranathunga and N. de Silva, "Some languages are more equal than others: Probing deeper into the linguistic disparity in the nlp world," arXiv preprint arXiv:2210.08523, 2022.28

[21] V. Jayawickrama, G. Weeraprameshwara, N. de Silva, and Y. Wijeratne, "Seeking sinhala sentiment: Predicting facebook reactions of sinhala posts," arXiv preprint arXiv:2112.00468, 2021.

# Related Work

## Traditional ML Approaches for Music Emotion Recognition

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- Using appropriate text pre-processing methods (tokenization, stop word removal, stemming, lemmatization, etc) including data transformation and filtering can significantly enhance the performance of the sentiment classifier [22].
- Researchers combined the bag of words technique with term frequency-inverse document frequency and Chi-square methods in sentiment analysis, aiming to extract the most relevant features and enable a comprehensive analysis [23].
- Studies have utilized a diverse set of machine learning algorithms, including Naïve Bayesian, Support Vector Machine Classifier (SVM), Stochastic Gradient Descent (SGD), Linear Regression (LR), Random Forest, and Decision Tree, to classify reviews based on sentiment orientation, and the evaluation of classifiers involved multiple performance metrics such as accuracy, precision, recall, and F1 score [23].

[22] E. Haddi, X. Liu, and Y. Shi, "The role of text pre-processing in sentiment analysis," *Procedia computer science*, vol. 17, pp. 26–32, 2013.28

[23] T. U. Haque, N. N. Saber, and F. M. Shah, "Sentiment analysis on large scale amazon product reviews," in *2018 IEEE international conference on innovative research and development (ICIRD)*. IEEE, 2018, pp. 1–6.

# Related Work

## Traditional ML Approaches For Music Emotion Recognition (Cnt.)

- SVM is effective in handling high-dimensional data and deciphering complex decision boundaries [24].
- Random Forest is esteemed for its resilience against over-fitting and adeptness in managing extensive datasets [24].
- Conventional algorithms, such as SVM and Random Forest, face challenges in capturing intricate semantic relationships and contextual subtleties in natural language, emphasizing the superior performance of deep learning models in sentiment analysis [23, 24].

[23] T. U. Haque, N. N. Saber, and F. M. Shah, "Sentiment analysis on large scale amazon product reviews," in 2018 IEEE international conference on innovative research and development (ICIRD). IEEE, 2018, pp. 1-6.

[24] A. Yadav and D. K. Vishwakarma, "Sentiment analysis using deep learning architectures:a review," Artificial Intelligence Review, vol. 53, no. 6, pp. 4335-4385, 2020.

# Related Work

## DL Approaches For Music Emotion Recognition

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- There is a Increase in use of Deep Learning-based models, driven by the surge in neural network utilization for text classification tasks, particularly sentiment analysis [25].
- Ray and Chakrabarti [26] utilized a seven-layer deep Convolutional Neural Network (CNN) for aspect term extraction and sentiment classification, complemented by rule-based techniques to improve accuracy.
- Introduction of models BERT [27], RoBERTa [28], mBERT [27] (a multilingual extension of BERT), and XLM [29] ; addressed the challenge of text classification across diverse languages, especially those with limited linguistic resources.
- Multiple studies [27, 30, 31] have shown that the implementation of a hybrid deep learning model - The bidirectional LSTM followed by a CNN produces promising results compared to BERT followed by Bi-LSTM and CNN.

[25] M. M. Agüero-Torales, J. I. A. Salas, and A. G. López-Herrera, "Deep learning and multilingual sentiment analysis on social media data: An overview," *Applied Soft Computing*, vol. 107, p. 107373, 2021.

[26] P. Ray and A. Chakrabarti, "A mixed approach of deep learning method and rule based method to improve aspect level sentiment analysis," *Applied Computing and Informatics*, vol. 18, no. 1/2, pp. 163–178, 2022.

[27] J. Devlin, M.-W. Chang, K. Lee, and K. Toutanova, "Bert: Pre-training of deep bidirectional transformers for language understanding," *arXiv preprint arXiv:1810.04805*, 2018.

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# Related Work

## DL Approaches For Music Emotion Recognition (Cnt.)

- XLM-R [32], developed by Facebook:
  - Surpasses its predecessors (mBERT and XLM) across various tasks such as classification [32].
  - Achieves unprecedented excellence in cross-lingual understanding, enabling training in one language and seamless application to others without the need for additional training data [33].
  - Stands out as a pioneering multilingual model, exhibiting remarkable efficacy in low-resource language scenarios [32, 33].
- DL models are adept at capturing long-term dependencies and contextual information, making them highly suitable for tasks involving natural language data [24].

[24] A. Yadav and D. K. Vishwakarma, "Sentiment analysis using deep learning architectures:a review," Artificial Intelligence Review, vol. 53, no. 6, pp. 4335–4385, 2020.

[32] A. Conneau, K. Khandelwal, N. Goyal, V. Chaudhary, G. Wenzek, F. Guzmán, E. Grave, M. Ott, L. Zettlemoyer, and V. Stoyanov, "Unsupervised cross-lingual representation learning at scale," arXiv preprint arXiv:1911.02116, 2019.

[33] Y. K. Wiciaputra, J. C. Young, and A. Rusli, "Bilingual text classification in english and indonesian via transfer learning using xlm-roberta." International Journal of Advances in Soft Computing & Its Applications, vol. 13, no. 3, 2021.

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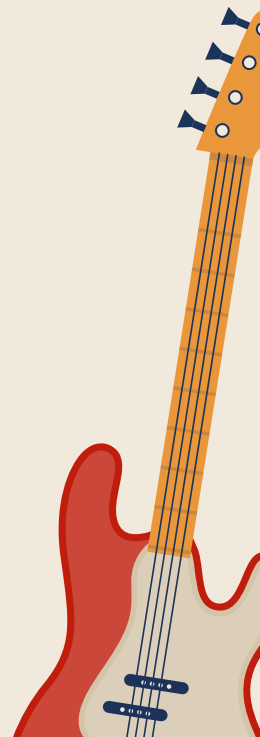
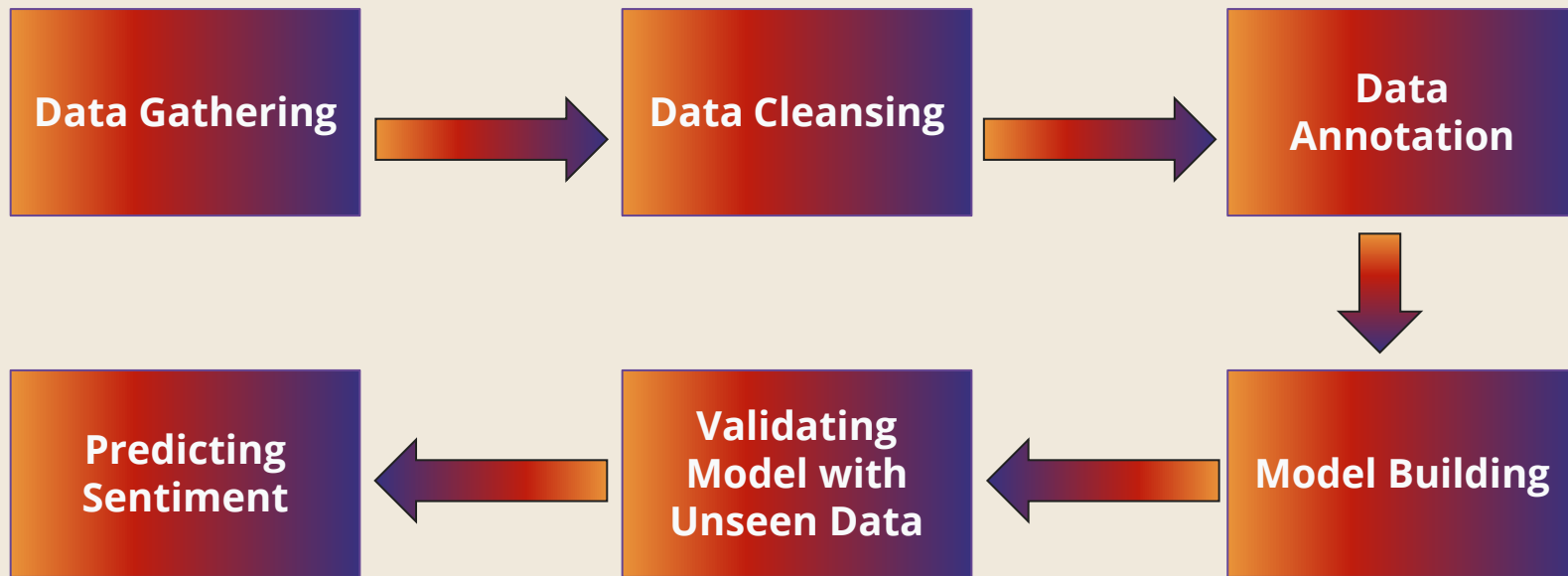
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# Proposed Approach

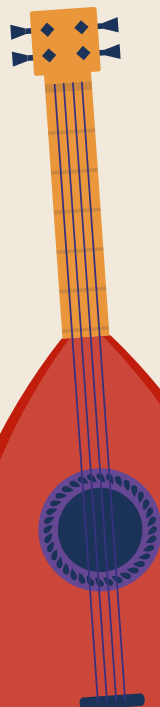
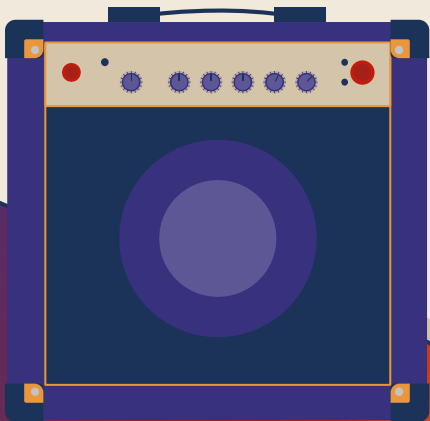
# Proposed Approach

## High Level Solution

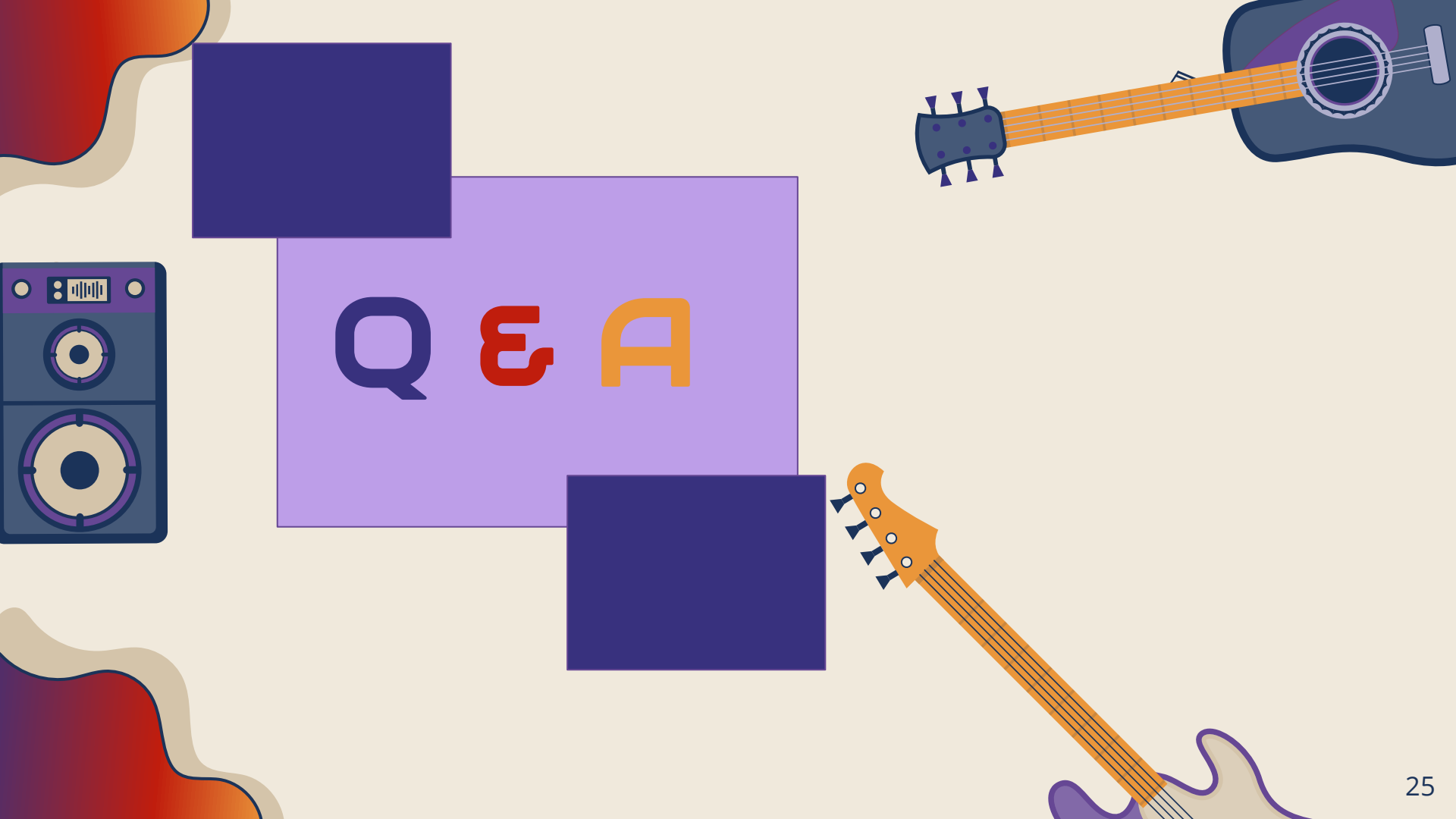
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# Thank You!








Q & A

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