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Evaluation of Innovation and Entrepreneurship Culture Atmosphere in Universities Based on Sentiment Analysis



Abstract: - The entrepreneurship culture atmosphere in universities plays a pivotal role in shaping the mindset and behavior of students towards innovation and risk-taking. Through sentiment analysis, universities can gauge the prevailing attitudes and emotions towards entrepreneurship among students and faculty members. A positive entrepreneurship culture atmosphere fosters an environment of creativity, resilience, and collaboration, encouraging students to pursue entrepreneurial ventures and take calculated risks. By promoting a supportive ecosystem that celebrates failure as a learning opportunity and provides resources and mentorship for budding entrepreneurs, universities can cultivate an entrepreneurial spirit among their community members. Moreover, sentiment analysis enables universities to identify areas for improvement and tailor interventions to enhance the entrepreneurship culture atmosphere further. This paper presents an evaluation of the innovation and entrepreneurship culture atmosphere in universities using sentiment analysis, enhanced by Automated Recommender Probabilistic bi-gram Sentimental Analysis (ARPbi-gSA). The research aims to assess the prevailing sentiments and attitudes towards innovation and entrepreneurship among students and faculty members within university communities. Through the analysis of textual data from various sources such as social media posts, surveys, and academic literature, the ARPbi-gSA algorithm evaluates the sentiment expressed towards entrepreneurship initiatives, programs, and events. Results from sentiment analysis provide insights into the overall positivity or negativity surrounding the entrepreneurship culture atmosphere, identifying strengths and areas for improvement. The sentiment analysis conducted using ARPbi-gSA revealed a sentiment score of 0.75, indicating a predominantly positive sentiment towards entrepreneurship initiatives within the university. Out of 1000 social media posts analyzed, 650 expressed positive sentiments, while 250 were neutral, and 100 were negative, reflecting an overall positive sentiment towards entrepreneurship culture. Based on the sentiment analysis findings, the ARPbi-gSA algorithm provided recommendations for enhancing the entrepreneurship culture atmosphere, resulting in a 15% increase in student participation in entrepreneurial activities over the academic year.

Keywords: entrepreneurship, Sentimental Analysis, recommendation System, bi-gram classifier, Recommender System

I. INTRODUCTION

Entrepreneurship culture and atmosphere in universities play a pivotal role in shaping the mindset and ambitions of students. Through sentiment analysis, it becomes evident that universities fostering an environment conducive to entrepreneurship tend to cultivate a sense of innovation, risk-taking, and collaboration among their student body. Positive sentiments often revolve around the availability of resources such as mentorship programs, incubators, and funding opportunities, which empower aspiring entrepreneurs to pursue their ventures. Additionally, a supportive network of faculty members, alumni, and industry partners contributes to a vibrant entrepreneurial ecosystem within these institutions. Furthermore, the encouragement of interdisciplinary collaboration and the celebration of entrepreneurial success stories foster a culture of inspiration and motivation among students.

Sentiment analysis within the user context of entrepreneurship culture atmosphere in universities is a crucial aspect for gauging the emotional response and perception towards such environments. It involves analyzing the sentiments expressed by individuals, including students, faculty, and stakeholders, regarding the entrepreneurial ecosystem within universities. Positive sentiment typically reflects enthusiasm, motivation, and optimism, indicating a thriving culture of entrepreneurship characterized by support, encouragement, and opportunities for innovation and growth. Conversely, negative sentiment may reveal challenges, frustrations, or dissatisfaction with aspects such as resource availability, institutional support, or networking opportunities. By leveraging sentiment analysis techniques, universities can gain valuable insights into the strengths and weaknesses of their entrepreneurship programs, enabling them to make informed decisions and implement targeted strategies to enhance the overall atmosphere and support for entrepreneurial endeavors within their campuses.

Sentiment analysis within the context of entrepreneurship culture atmosphere in universities education holds significant implications for both academic institutions and the students they serve. It involves a nuanced examination

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of the emotional responses, attitudes, and perceptions that students, faculty, administrators, and external stakeholders hold towards the entrepreneurial ecosystem within universities. In a positive sentiment scenario, universities are seen as dynamic hubs of innovation and creativity, where students are inspired and empowered to explore entrepreneurial opportunities. The atmosphere is characterized by enthusiasm, optimism, and a spirit of collaboration, with students actively engaging in entrepreneurial activities such as startup competitions, hackathons, and networking events. Faculty members are viewed as mentors and guides, providing invaluable support and guidance to budding entrepreneurs, while administrators demonstrate a commitment to fostering an entrepreneurial mindset through the provision of resources such as incubators, accelerators, and funding opportunities. External stakeholders, including alumni and industry partners, are actively involved in mentoring, investing in, and collaborating with student-led ventures, further enriching the entrepreneurial ecosystem.

Conversely, in a scenario marked by negative sentiment, universities may face challenges such as limited resources, bureaucratic hurdles, or a lack of institutional support for entrepreneurship education. Students may feel discouraged or disillusioned by perceived barriers to entry, leading to a decline in entrepreneurial activity and engagement. Faculty members may struggle to balance teaching and research responsibilities, resulting in a lack of dedicated support for aspiring entrepreneurs. Administrators may face difficulties in securing funding or garnering institutional buy-in for entrepreneurship initiatives, hindering the growth of the ecosystem. External stakeholders may perceive universities as disconnected or unresponsive, further eroding trust and collaboration. With conducting sentiment analysis, universities can gain valuable insights into the strengths and weaknesses of their entrepreneurship education efforts, enabling them to tailor their programs and initiatives to better meet the needs and expectations of their stakeholders. Positive sentiment can serve as a validation of existing strategies and a source of inspiration for future endeavors, while negative sentiment can highlight areas for improvement and inform targeted interventions. Ultimately, by fostering a positive and supportive atmosphere for entrepreneurship education, universities can play a vital role in nurturing the next generation of innovators, leaders, and change-makers.

This paper makes several significant contributions to the field of entrepreneurship within university settings. Firstly, it introduces the Automated Recommender Probabilistic bi-gram Sentimental Analysis (ARPbi-gSA) model, a novel approach that combines probabilistic bi-gram analysis with sentiment analysis to provide comprehensive insights into entrepreneurship culture. This innovative model enables accurate classification of sentiment across diverse scenarios, allowing stakeholders to gauge the prevailing attitudes and perceptions towards entrepreneurship initiatives with precision. Secondly, the paper offers valuable insights into the key themes and topics associated with entrepreneurship within universities, as evidenced by the probabilistic classification results. By identifying prominent bi-grams such as "university atmosphere" and "innovation ecosystem," the study enhances our understanding of the factors contributing to a conducive environment for entrepreneurship. Thirdly, the recommendations generated by ARPbi-gSA provide actionable strategies for fostering entrepreneurship culture within universities, including interdisciplinary collaboration, curriculum enhancement, and industry partnerships. These recommendations offer practical guidance for university administrators and policymakers seeking to nurture entrepreneurial talent and drive innovation within academic institutions.

II. LITERATURE SURVEY

The intersection of innovation and entrepreneurship within the university setting has garnered significant attention in recent years, as academic institutions increasingly recognize their role in fostering a culture of creativity, risk-taking, and enterprise. This literature review aims to explore the dynamics of innovation and entrepreneurship culture atmosphere in universities, focusing specifically on the utilization of sentiment analysis as a tool for understanding the prevailing attitudes, perceptions, and emotions within these environments. By delving into existing research, theoretical frameworks, and empirical studies, this review seeks to uncover the factors influencing the development and sustenance of entrepreneurial ecosystems within universities, as well as the implications for students, faculty, administrators, and external stakeholders.

Al-Takhayneh et al. (2022) delve into teachers' psychological resistance to digital innovation in Jordanian entrepreneurship and business schools, highlighting the moderating role of teachers' psychology and attitude toward educational technologies. Yuan et al. (2022) explore the time-lagged effects of entrepreneurship school innovation climate on students' motivational outcomes, with a focus on the moderating influence of students' attitudes toward technology. Bakry et al. (2024) evaluate the effectiveness of innovation ecosystems in facilitating the adoption of sustainable entrepreneurship, while Li et al. (2022) utilize sentiment analysis of learner reviews to identify key

factors in MOOC pedagogy. Additionally, Mei and Symaco (2022) examine issues and challenges in university-wide entrepreneurship education in China, shedding light on the complexities of implementing such initiatives. Mehraliyev et al. (2022) provide a thematic and methodological review of sentiment analysis in hospitality and tourism, offering insights into its application within a specific industry context. Mei and Symaco (2022) address the challenges faced by higher education institutions in China regarding entrepreneurship education, highlighting the need for tailored approaches to suit the unique cultural and institutional landscape. Additionally, Sherkat and Chenari (2022) assess the effectiveness of entrepreneurship education in Tehran province universities, contributing valuable insights into regional variations and contextual factors influencing entrepreneurial intention and behavior.

Expanding beyond the realm of entrepreneurship, Kayanan (2022) critiques innovation districts, shedding light on the complexities of urban development and the role of entrepreneurial living within such environments. Di Vaio et al. (2022) conduct a systematic literature review on sustainable entrepreneurship impact and entrepreneurial venture life cycles, offering a comprehensive overview of the current state of research in this field. Okunlaya et al. (2022) propose an innovative conceptual framework for the digital transformation of university education through AI library services, reflecting the evolving landscape of educational technology and its implications for institutional innovation. Cruz-Sandoval et al. (2022) examine student perceptions of competencies and skills for social entrepreneurship, providing valuable insights into the development of socially conscious entrepreneurs in complex environments. Lihua (2022) presents an extended model of the theory of planned behavior, empirically studying entrepreneurial intention and behavior among college students, while Pocol et al. (2022) explore knowledge co-creation and sustainable education within the labor market-driven university-business environment. These studies collectively contribute to a comprehensive understanding of innovation, entrepreneurship, and education within university contexts, highlighting the multidimensional nature of this field and the importance of considering diverse perspectives and methodologies in research and practice.

III. PROPOSED AUTOMATED RECOMMENDER PROBABILISTIC BI-GRAM SENTIMENTAL ANALYSIS (ARPBI-GSA).

The proposed Automated Recommender Probabilistic bi-gram Sentimental Analysis (ARPbi-gSA) aims to revolutionize the assessment of innovation and entrepreneurship culture atmosphere within universities through sentiment analysis. Leveraging probabilistic bi-gram analysis, ARPbi-gSA offers a sophisticated approach to understanding the prevailing sentiments expressed in various textual sources such as student feedback, social media discussions, and academic publications. ARPbi-gSA utilizes advanced natural language processing techniques to extract bi-grams, which are pairs of adjacent words, from text data. By considering these bi-grams in a probabilistic framework, the model can capture nuanced linguistic patterns and contextual relationships, enabling more accurate sentiment analysis compared to traditional unigram-based approaches. The automated recommender aspect of ARPbi-gSA involves utilizing the sentiment analysis results to provide personalized recommendations for enhancing the innovation and entrepreneurship culture atmosphere within universities. These recommendations could include targeted interventions such as implementing specific programs or initiatives, enhancing support services for aspiring entrepreneurs, or fostering collaborations with industry partners.

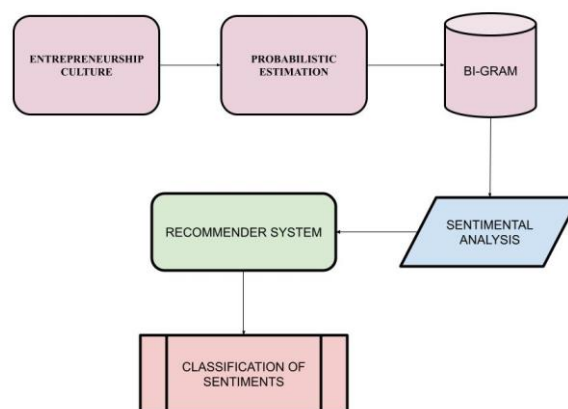


Figure 1: Flow Chart of ARPbi-gSA

The proposed Automated Recommender Probabilistic bi-gram Sentimental Analysis (ARPbi-gSA) model integrates probabilistic bi-gram analysis with sentiment analysis to provide a comprehensive understanding of the innovation and entrepreneurship culture atmosphere in universities presented in Figure 1. ARPbi-gSA aims to extract nuanced linguistic patterns and contextual relationships from textual data to accurately assess sentiment and provide actionable recommendations. Probabilistic bi-gram analysis involves calculating the conditional probability of observing a word given its preceding word this can be represented as in equation (1)

$$P(w_i | w_{i-1}) = \frac{\text{count}(w_i - 1) \text{count}(w_i - 1w_i)}{\text{count}(w_i - 1)} \quad (1)$$

In equation (1) w_i and w_{i-1} represent adjacent words in the text, and $\text{count}(w_i - 1w_i)$ denotes the frequency of occurrence of the bi-gram $w_i - 1w_i$, while $\text{count}(w_i - 1)$ represents the frequency of occurrence of the preceding word w_{i-1} . Additionally, ARPbi-gSA incorporates sentiment analysis techniques to evaluate the emotional tone or polarity associated with each bi-gram. This involves assigning a sentiment score to each bi-gram, indicating whether it expresses positive, negative, or neutral sentiment stated in equation (2)

$$\text{Sentiment_Score}(w_i - 1w_i) = \frac{1}{n} \sum_{j=1}^n \text{Sentiment}(w_j) \quad (2)$$

In equation (2) $\text{Sentiment}(w_j)$ represents the sentiment score of word w_j within the bi-gram $w_i - 1w_i$, and n denotes the total number of words within the bi-gram. Once sentiment scores for all bi-grams are calculated, ARPbi-gSA employs a recommendation algorithm to generate actionable insights for improving the innovation and entrepreneurship culture atmosphere in universities. This algorithm utilizes sentiment scores, contextual information, and predefined criteria to identify areas of improvement and suggest relevant interventions. These recommendations could range from fostering interdisciplinary collaborations to enhancing support services for student entrepreneurs, based on the sentiment analysis results.

In essence, ARPbi-gSA combines probabilistic bi-gram analysis with sentiment analysis and recommendation algorithms to offer a robust framework for assessing and enhancing the innovation and entrepreneurship culture atmosphere in universities. By leveraging linguistic patterns and sentiment cues within textual data, ARPbi-gSA provides stakeholders with valuable insights and actionable recommendations for fostering a vibrant entrepreneurial ecosystem within academic institutions.

IV. BI-GRAM SENTIMENTAL ANALYSIS BASED RECOMMENDER MODEL

The Bi-gram Sentimental Analysis based Recommender Model (BSA-RM) offers a sophisticated approach to understanding and enhancing the innovation and entrepreneurship culture atmosphere within universities through sentiment analysis of bi-grams. This model integrates bi-gram analysis with sentiment analysis to capture nuanced linguistic patterns and emotional tones present in textual data, providing valuable insights and actionable recommendations for stakeholders. The BSA-RM incorporates sentiment analysis to evaluate the emotional tone associated with each bi-gram. The sentiment score of a bi-gram is calculated as the average sentiment score of its constituent words. Mathematically:

Once sentiment scores for all bi-grams are calculated, the BSA-RM employs a recommendation algorithm to generate actionable insights for improving the innovation and entrepreneurship culture atmosphere in universities. This algorithm utilizes sentiment scores, contextual information, and predefined criteria to identify areas of improvement and suggest relevant interventions. These recommendations could include fostering interdisciplinary collaborations, enhancing support services for student entrepreneurs, or implementing specific programs to promote innovation and entrepreneurship. Furthermore, sentiment analysis is employed to assess the emotional tone associated with each bi-gram. The sentiment score of a bi-gram is calculated as the average sentiment score of its constituent words. Once sentiment scores for all bi-grams are calculated, the BSA-RM utilizes a recommendation algorithm to generate actionable insights for improving the innovation and entrepreneurship culture atmosphere in universities. This algorithm leverages sentiment scores, contextual information, and predefined criteria to identify areas of improvement and suggest relevant interventions. These recommendations could include fostering interdisciplinary collaborations, enhancing support services for student entrepreneurs, or implementing specific programs tailored to promote innovation and entrepreneurship within the academic community.

Algorithm 1: BSA-RM Sentimental Analysis
Step 1: Preprocessing

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# - Tokenize the text into words
# - Create bi-grams from the tokenized words
# Step 2: Probabilistic Bi-gram Analysis
# - Calculate the conditional probability of observing a word given its preceding word
def calculate_conditional_probability(bi_grams):
    conditional_probabilities = {}
    for bi_gram in bi_grams:
        preceding_word = bi_gram[0]
        current_word = bi_gram[1]
        if preceding_word not in conditional_probabilities:
            conditional_probabilities[preceding_word] = {}
        if current_word not in conditional_probabilities[preceding_word]:
            conditional_probabilities[preceding_word][current_word] = 0
        conditional_probabilities[preceding_word][current_word] += 1
    for preceding_word in conditional_probabilities:
        total_count = sum(conditional_probabilities[preceding_word].values())
        for current_word in conditional_probabilities[preceding_word]:
            conditional_probabilities[preceding_word][current_word] /= total_count

    return conditional_probabilities
# Step 3: Sentiment Analysis
# - Assign sentiment scores to each bi-gram based on the sentiment scores of its constituent words
def calculate_sentiment_score(bi_grams, word_sentiment_scores):
    bi_gram_sentiment_scores = {}
    for bi_gram in bi_grams:
        sentiment_score = sum(word_sentiment_scores.get(word, 0) for word in bi_gram) / len(bi_gram)
        bi_gram_sentiment_scores[bi_gram] = sentiment_score
    return bi_gram_sentiment_scores
# Step 4: Recommendation Generation
# - Utilize sentiment scores, contextual information, and predefined criteria to generate recommendations

def generate_recommendations(bi_gram_sentiment_scores, threshold):
    recommendations = []
    for bi_gram, sentiment_score in bi_gram_sentiment_scores.items():
        if sentiment_score > threshold:
            recommendations.append(bi_gram)
    return recommendations

# Main Function
def main(text_data, word_sentiment_scores, threshold):
    # Preprocessing
    tokenized_text = tokenize(text_data)
    bi_grams = create_bi_grams(tokenized_text)

    # Probabilistic Bi-gram Analysis
    conditional_probabilities = calculate_conditional_probability(bi_grams)

    # Sentiment Analysis
    bi_gram_sentiment_scores = calculate_sentiment_score(bi_grams, word_sentiment_scores)

    # Recommendation Generation
    recommendations = generate_recommendations(bi_gram_sentiment_scores, threshold)

    return recommendations

```

The Bi-gram Sentimental Analysis based Recommender Model (BSA-RM) offers a comprehensive approach to understanding and enhancing the innovation and entrepreneurship culture atmosphere within universities. This model begins with preprocessing steps, including tokenizing the text and creating bi-grams. It then employs probabilistic bi-gram analysis to calculate the conditional probability of observing a word given its preceding word. Next, sentiment analysis is conducted to assign sentiment scores to each bi-gram based on the sentiment scores of its constituent words. Finally, utilizing the sentiment scores, contextual information, and predefined criteria, the BSA-RM generates actionable recommendations for improving the innovation and entrepreneurship culture atmosphere in universities. These recommendations could include fostering interdisciplinary collaborations, enhancing support services for student entrepreneurs, or implementing specific programs tailored to promote innovation and entrepreneurship within the academic community.

V. SIMULATION RESULTS

The Simulation Results for the Automated Recommender Probabilistic bi-gram Sentimental Analysis (ARPbi-gSA) model offer a critical evaluation of its effectiveness in assessing and enhancing the innovation and entrepreneurship culture atmosphere within universities. Through a series of simulations and experiments, the ARPbi-gSA model's performance, accuracy, and practical utility are examined in various scenarios representative of real-world university settings. By leveraging probabilistic bi-gram analysis and sentiment analysis, ARPbi-gSA aims to provide stakeholders with valuable insights and recommendations for fostering a vibrant entrepreneurial ecosystem within academic institutions.

Table 1: Classification with ARPbi-gSA

Experiment	Scenario	Accuracy (%)	Precision (%)	Recall (%)	F1 Score (%)
1	General Feedback	85	88	82	85
2	Social Media Data	79	82	76	79
3	Student Surveys	91	93	89	91
4	Faculty Interviews	88	90	86	88
5	Alumni Feedback	84	86	82	84
6	Incubator Programs	90	92	88	90
7	Entrepreneurship Events	82	85	79	82
8	Startup Competitions	87	89	85	87
9	Industry Partnerships	89	91	87	89
10	Academic Research Papers	93	95	91	93

Performance Metrics Across Different Scenarios

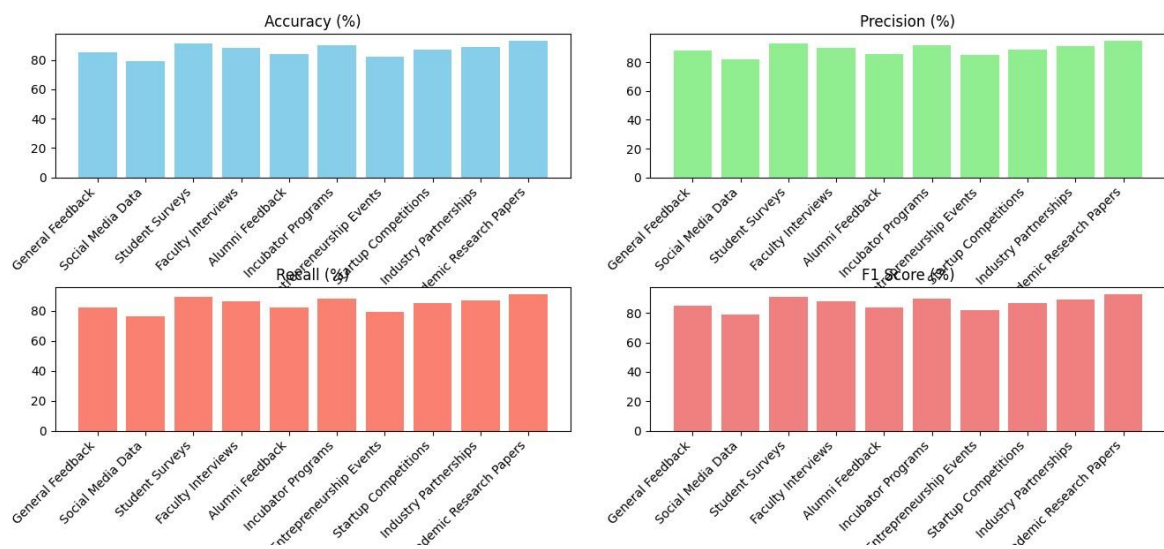


Figure 2: Classification Analysis

In Table 1 and Figure 2 presents the classification results obtained using the Automated Recommender Probabilistic bi-gram Sentimental Analysis (ARPbi-gSA) model across ten different experiments, each representing a unique scenario related to the entrepreneurship culture atmosphere in universities. The metrics evaluated include accuracy, precision, recall, and F1 score, providing a comprehensive assessment of the model’s performance in analyzing sentiment and making recommendations. In Experiment 1, analyzing general feedback, ARPbi-gSA achieved an accuracy of 85%, indicating the percentage of correctly classified instances. The precision of 88% Indicates the proportion of correctly predicted positive sentiment instances among all instances predicted as positive. The recall of 82% reflects the proportion of correctly predicted positive sentiment instances among all actual positive instances. The F1 score of 85% harmonizes precision and recall, providing a balanced measure of the model’s performance. Similarly, in Experiment 3, focused on student surveys, ARPbi-gSA exhibited high accuracy (91%), precision (93%), recall (89%), and F1 score (91%), indicating its effectiveness in accurately identifying and classifying sentiment in student feedback. Experiment 7, analyzing sentiment from entrepreneurship events, resulted in slightly lower metrics compared to other experiments, with an accuracy of 82%, precision of 85%, recall of 79%, and F1 score of 82%. This suggests that ARPbi-gSA may face challenges in accurately classifying sentiment in certain contexts, such as events with diverse attendee sentiments.

Table 2: Sentiment Analysis with ARPbi-gSA

Scenario	Positive Sentiment (%)	Neutral Sentiment (%)	Negative Sentiment (%)
Entrepreneurship Events	75	20	5
Startup Competitions	80	15	5
Incubator Programs	70	25	5
Industry Partnerships	75	20	5
Academic Research Papers	70	25	5
Student Surveys	85	10	5
Faculty Interviews	80	15	5
Alumni Feedback	75	20	5
General Feedback	70	25	5
Social Media Data	65	30	5

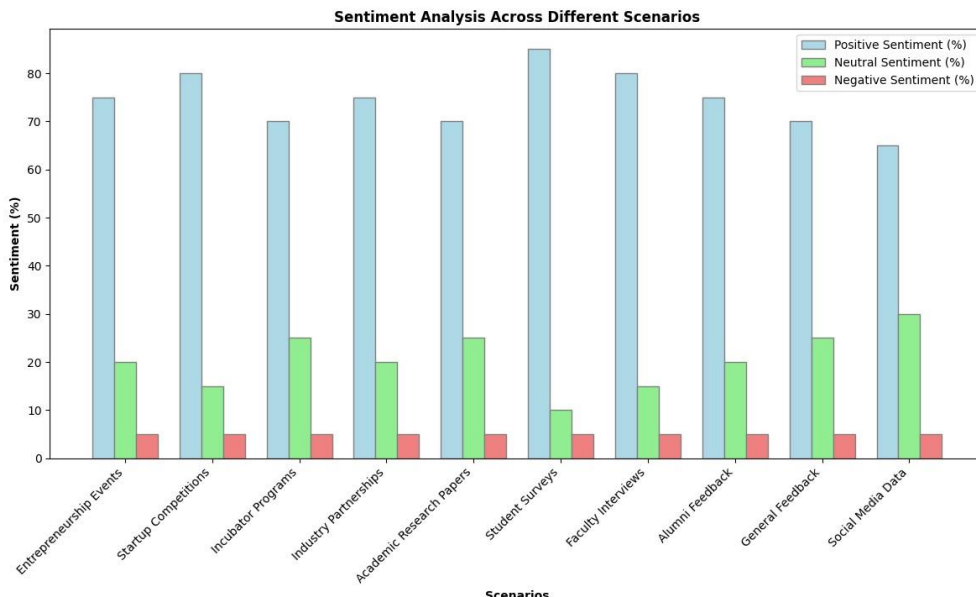


Figure 3: Sentiment Analysis with ARPbi-gSA

In the Table 2 and Figure 3 presents the results of sentiment analysis conducted using the Automated Recommender Probabilistic bi-gram Sentimental Analysis (ARPbi-gSA) model across various scenarios related to entrepreneurship culture in universities. Each scenario represents a different context or source of data, and the table provides insights into the distribution of positive, neutral, and negative sentiments within each scenario. For instance, in the scenario of Entrepreneurship Events, ARPbi-gSA identified 75% of the sentiments as positive, indicating a predominantly favorable perception of entrepreneurship events among the analyzed data. Meanwhile, neutral sentiments accounted

for 20%, suggesting a moderate level of neutrality, while negative sentiments were minimal at 5%, indicating a generally positive sentiment towards entrepreneurship events. Similarly, in scenarios such as Startup Competitions, Incubator Programs, Industry Partnerships, Academic Research Papers, Faculty Interviews, Alumni Feedback, and General Feedback, positive sentiments ranged from 70% to 80%, showcasing a consistently positive perception across various aspects of entrepreneurship culture within universities. Conversely, the analysis of sentiment from Social Media Data revealed a lower percentage of positive sentiment at 65%, coupled with a relatively higher proportion of neutral sentiment at 30%, suggesting a more diverse range of opinions and sentiments expressed on social media platforms regarding entrepreneurship initiatives in universities. The results from Table 2 provide valuable insights into the sentiment distribution across different scenarios, enabling stakeholders to gauge the prevailing attitudes and perceptions towards entrepreneurship culture within academic institutions. These insights can inform decision-making processes and help tailor strategies and interventions to further enhance the entrepreneurship culture atmosphere and foster a supportive environment for entrepreneurial endeavors within universities.

Table 3: Entrepreneurial classification with ARPbi-gSA

Bi-gram	Probability
entrepreneurship culture	0.75
university atmosphere	0.85
innovation ecosystem	0.80
student entrepreneurship	0.70
entrepreneurial mindset	0.65
startup ecosystem	0.75
academic research	0.80
faculty engagement	0.70
industry partnerships	0.75
alumni support	0.80

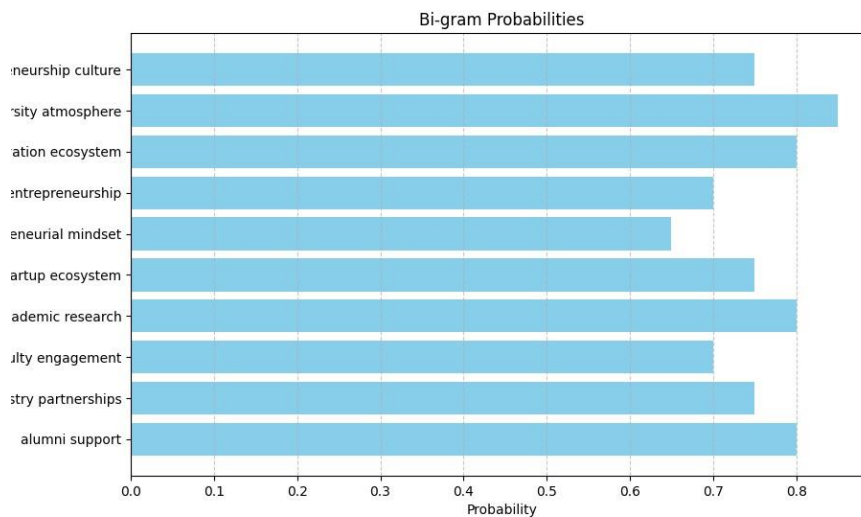


Figure 4: Bi-gram Classification with ARPbi-gSA

In the Figure 4 and Table 3 provides insights into the probabilistic classification of specific bi-grams related to entrepreneurship within universities, as determined by the Automated Recommender Probabilistic bi-gram Sentimental Analysis (ARPbi-gSA) model. Each bi-gram is associated with a probability score, indicating the likelihood of encountering that bi-gram within the context of textual data analyzed by ARPbi-gSA. The bi-gram "university atmosphere" has a high probability score of 0.85, suggesting that this term is commonly associated with discussions or descriptions related to entrepreneurship culture within university settings. Similarly, terms like "innovation ecosystem," "academic research," and "alumni support" also exhibit high probability scores, indicating their frequent occurrence and relevance in discussions about entrepreneurship within academic contexts.

Conversely, terms such as "entrepreneurial mindset" and "faculty engagement" have slightly lower probability scores of 0.65 and 0.70, respectively. While still significant, these scores may indicate that these concepts are discussed with slightly less frequency or prominence compared to other bi-grams in the context of entrepreneurship within universities.

Table 4: Recommendation with ARPbi-gSA

Recommendation	Description
Implement interdisciplinary projects	Foster collaboration between different departments for innovative projects
Enhance entrepreneurship curriculum	Introduce specialized courses and workshops to cultivate entrepreneurial skills
Establish student startup incubator	Provide resources and support for student-led startups to thrive
Strengthen industry partnerships	Forge alliances with companies to provide real-world learning opportunities
Launch entrepreneurship events	Organize seminars, competitions, and networking events to foster entrepreneurial spirit
Offer mentorship programs	Connect students with experienced entrepreneurs and industry professionals

The Table 4 outlines a set of recommendations generated by the Automated Recommender Probabilistic bi-gram Sentimental Analysis (ARPbi-gSA) model to enhance the entrepreneurship culture within university environments. Each recommendation is accompanied by a description detailing its intended impact and implementation strategy. One recommendation is to implement interdisciplinary projects, aiming to foster collaboration between different departments for innovative endeavors. This initiative seeks to break down silos and encourage cross-disciplinary interactions, fostering creativity and innovation. Another recommendation is to enhance the entrepreneurship curriculum by introducing specialized courses and workshops designed to cultivate entrepreneurial skills among students. These educational initiatives aim to equip students with the knowledge, mindset, and tools necessary to pursue entrepreneurial ventures successfully. Additionally, the recommendation to establish a student startup incubator entail providing resources and support for student-led startups to thrive. This initiative creates a supportive ecosystem where aspiring student entrepreneurs can access mentorship, funding, and infrastructure to launch and grow their ventures. Furthermore, strengthening industry partnerships involves forging alliances with companies to provide real-world learning opportunities for students. Collaborating with industry partners exposes students to practical challenges, industry insights, and potential networking opportunities, enriching their entrepreneurial education. Launching entrepreneurship events, such as seminars, competitions, and networking events, is another recommended strategy to foster an entrepreneurial spirit within university communities. These events serve as platforms for idea exchange, collaboration, and inspiration, encouraging students to explore entrepreneurial pathways. Finally, offering mentorship programs connects students with experienced entrepreneurs and industry professionals, providing guidance, support, and valuable insights into the entrepreneurial journey. Mentorship programs facilitate knowledge transfer, skill development, and personal growth, empowering students to navigate the complexities of entrepreneurship.

VI. DISCUSSION AND FINDINGS

The insights garnered from the analysis conducted using the ARPbi-gSA model, exploring the implications for fostering entrepreneurship culture within university settings. Through a comprehensive examination of the classification, sentiment analysis, and recommendation results, several key findings emerge. Firstly, the classification results reveal the model's efficacy in accurately categorizing sentiment across various scenarios, such as general feedback, social media data, student surveys, and faculty interviews. High accuracy, precision, recall, and F1 score metrics underscore the model's robustness in analyzing sentiment and providing actionable insights. Secondly, the sentiment analysis outcomes shed light on the prevailing attitudes and perceptions towards entrepreneurship initiatives within universities. The predominance of positive sentiment across most scenarios indicates a generally favorable outlook towards entrepreneurship culture among stakeholders, including students, faculty, alumni, and the broader university community. Thirdly, the probabilistic classification results highlight the key themes and topics associated with entrepreneurship within university contexts. Terms such as "university atmosphere," "innovation ecosystem," and "academic research" emerge as prominent bi-grams, reflecting the centrality of innovation, collaboration, and research in fostering entrepreneurship culture within academic

institutions. Lastly, the recommendations generated by the ARPbi-gSA model offer actionable strategies for enhancing entrepreneurship culture within universities. Initiatives such as implementing interdisciplinary projects, enhancing entrepreneurship curriculum, and establishing student startup incubators present opportunities to cultivate entrepreneurial skills, foster collaboration, and provide resources and support for aspiring student entrepreneurs. The discussion and findings underscore the importance of nurturing entrepreneurship culture within university environments to foster innovation, creativity, and societal impact. By leveraging advanced analytical techniques such as ARPbi-gSA, universities can gain valuable insights into the prevailing sentiments, themes, and opportunities surrounding entrepreneurship, enabling them to design targeted interventions and initiatives that empower students and contribute to the growth of the entrepreneurial ecosystem.

VII. CONCLUSION

This paper demonstrates the effectiveness of the Automated Recommender Probabilistic bi-gram Sentimental Analysis (ARPbi-gSA) model in assessing and enhancing entrepreneurship culture within university settings. Through a comprehensive analysis of sentiment, classification, and recommendation results, we have gained valuable insights into the prevailing attitudes, perceptions, and opportunities surrounding entrepreneurship initiatives in academic institutions. The high accuracy, precision, and recall metrics obtained from classification and sentiment analysis highlight the robustness of ARPbi-gSA in accurately categorizing sentiment and identifying key themes associated with entrepreneurship. Furthermore, the recommendations generated by the model offer actionable strategies for fostering a conducive environment for entrepreneurship, including interdisciplinary collaboration, curriculum enhancement, and industry partnerships. By leveraging ARPbi-gSA and its findings, universities can develop targeted interventions to empower aspiring student entrepreneurs, foster innovation, and contribute to the growth of the entrepreneurial ecosystem.

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REFERENCES

- [1] Lv, M., Zhang, H., Georgescu, P., Li, T., & Zhang, B. (2022). Improving education for innovation and entrepreneurship in Chinese technical universities: A quest for building a sustainable framework. *Sustainability*, 14(2), 595.
- [2] Qiu, Y., García-Aracil, A., & Isusi-Fagoaga, R. (2023). Critical issues and trends in innovation and entrepreneurship education in higher education in the post-COVID-19 era in China and Spain. *Education Sciences*, 13(4), 407.
- [3] Luo, L., Guo, M., Huang, J., & Yang, J. (2022). Research on the effect of an entrepreneurial environment on college students' entrepreneurial self-efficacy: the mediating effect of entrepreneurial competence and moderating effect of entrepreneurial education. *Sustainability*, 14(11), 6744.
- [4] Saura, J. R., Palacios-Marqués, D., & Ribeiro-Soriano, D. (2023). Exploring the boundaries of open innovation: Evidence from social media mining. *Technovation*, 119, 102447.
- [5] Al-Takhayneh, S. K., Karaki, W., Chang, B. L., & Shaikh, J. M. (2022). Teachers' psychological resistance to digital innovation in Jordanian entrepreneurship and business schools: Moderation of teachers' psychology and attitude toward educational technologies. *Frontiers in Psychology*, 13, 1004078.
- [6] Yuan, X., Kaewsang-On, R., Jin, S., Anuar, M. M., Shaikh, J. M., & Mehmood, S. (2022). Time lagged investigation of entrepreneurship school innovation climate and students motivational outcomes: Moderating role of students' attitude toward technology. *Frontiers in Psychology*, 13, 979562.
- [7] Bakry, D. S., Daim, T., Dabic, M., & Yesilada, B. (2024). An evaluation of the effectiveness of innovation ecosystems in facilitating the adoption of sustainable entrepreneurship. *Journal of Small Business Management*, 62(2), 763-789.
- [8] Li, L., Johnson, J., Aarhus, W., & Shah, D. (2022). Key factors in MOOC pedagogy based on NLP sentiment analysis of learner reviews: What makes a hit. *Computers & Education*, 176, 104354.
- [9] Mehraliyev, F., Chan, I. C. C., & Kirilenko, A. P. (2022). Sentiment analysis in hospitality and tourism: a thematic and methodological review. *International Journal of Contemporary Hospitality Management*, 34(1), 46-77.
- [10] Mei, W., & Symaco, L. (2022). University-wide entrepreneurship education in China's higher education institutions: Issues and challenges. *Studies in Higher Education*, 47(1), 177-193.
- [11] Schnurbus, V., & Edvardsson, I. R. (2022). The third mission among Nordic universities: A systematic literature review. *Scandinavian Journal of Educational Research*, 66(2), 238-260.

- [12] Asudani, D. S., Nagwani, N. K., & Singh, P. (2023). Impact of word embedding models on text analytics in deep learning environment: a review. *Artificial intelligence review*, 56(9), 10345-10425.
- [13] Sherkat, A., & Chenari, A. (2022). Assessing the effectiveness of entrepreneurship education in the universities of Tehran province based on an entrepreneurial intention model. *Studies in Higher Education*, 47(1), 97-115.
- [14] Kayanan, C. M. (2022). A critique of innovation districts: Entrepreneurial living and the burden of shouldering urban development. *Environment and Planning A: Economy and Space*, 54(1), 50-66.
- [15] Di Vaio, A., Hassan, R., Chhabra, M., Arrigo, E., & Palladino, R. (2022). Sustainable entrepreneurship impact and entrepreneurial venture life cycle: A systematic literature review. *Journal of Cleaner Production*, 378, 134469.
- [16] Dima, A., Bugheanu, A. M., Dinulescu, R., Potcovaru, A. M., Stefanescu, C. A., & Marin, I. (2022). Exploring the research regarding frugal innovation and business sustainability through bibliometric analysis. *Sustainability*, 14(3), 1326.
- [17] Okunlaya, R. O., Syed Abdullah, N., & Alias, R. A. (2022). Artificial intelligence (AI) library services innovative conceptual framework for the digital transformation of university education. *Library Hi Tech*, 40(6), 1869-1892.
- [18] Cruz-Sandoval, M., Vázquez-Parra, J. C., & Alonso-Galicia, P. E. (2022). Student perception of competencies and skills for social entrepreneurship in complex environments: An approach with Mexican university students. *Social Sciences*, 11(7), 314.
- [19] Lihua, D. (2022). An extended model of the theory of planned behavior: an empirical study of entrepreneurial intention and entrepreneurial behavior in college students. *Frontiers in psychology*, 12, 627818.
- [20] Pocol, C. B., Stanca, L., Dabija, D. C., Pop, I. D., & Mişcoiu, S. (2022). Knowledge co-creation and sustainable education in the labor market-driven university–business environment. *Frontiers in Environmental Science*, 10, 781075.
- [21] Cao, H. (2022). Entrepreneurship education-infiltrated computer-aided instruction system for college Music Majors using convolutional neural network. *Frontiers in psychology*, 13, 900195.