

Comparative Analysis of Existing Deep Learning and Transformer-Based Models for Telugu News Article Classification

V. Premalatha ¹, Dr. P. Dileep Kumar Reddy ²

¹Research scholar at Bharathiya Institute of Engineering and Technology Innovation University, Gorantla, Anathapur.

²Professor, CSE Department, Narsimha Reddy Engineering College (Autonomous), Secunderabad, Telangana State, India- 500100.

Email: 2023scsc014@bestiu.edu.in¹, dileepreddy503@gmail.com

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Abstract—News Article Classification in Telugu is one of the trending topics in Natural Language processing since digital news articles are on rise and processing low resource languages is a challenging task. Different deep learning and transformer based architectures are proposed to improve the classification performance of news articles but a comprehensive comparison of them on Telugu news datasets is missing. Proposed work performs a comparison of some state of art text classification models such as BiLSTM, Graph Neural Network(GNN), ULMFiT, ALBERT and G-BiLSTM-CE on a common Telugu news article dataset with the evaluation parameters: Accuracy, Precision, Recall, F1-Score, MCC, FPR and FNR. Through the comprehensive comparison of various sequential, graph based, transfer learning and hybrid architectures, the study finds the conclusion on which approach performs best for the task of Telugu news article classification.

Keywords—Telugu News Classification, Natural Language Processing, Deep Learning, Bidirectional Long Short-Term Memory (BiLSTM), Graph Neural Network (GNN), ULMFiT, ALBERT, Comparative Analysis.

I. INTRODUCTION

Natural Language Processing (NLP) is one of the significant field in the area of Artificial Intelligence where the computer understands, process and analyze the human language. Text Classification is one of the main task in the natural language processing which characterizes a document or text in a positive and negative way or in the different categories. Large scale growth in production, dissemination and reimbursing of digitally stored document, information and knowledge all around their online news portals, social networks, blogs, web applications etc has resulted in multiply the demand for implemented as well as effective text categorization framework. Several application like sentiment analysis, topic detection, information extraction, spam filtering, news classification, recommender system etc. Have also utilized automatic text document categorization.

Over the past few years, deep learning has been predominant in this task of text classification, because of auto feature extracting and auto learning the context aware input representation. Auto learning features from raw texts is far more accurate than traditional machine learning algorithms that require manual study and extraction of features. For example, LSTM, BiLSTM, GNNs, and other transformer based models have been more successful. Telugu, one of the most spoken languages in the Dravidian language family and approved as one of the classical languages of India is still an under-resourced language in the scope of NLP research and no doubt, manifests a series of drawbacks in the scope of Text

Classification. The drawbacks for processing Telugu are because of its grammatical idiosyncrasies, its copious amount of morphology, formation of words in an agglutinative fashion and lack of enough of labeled data, which ultimately makes a bottleneck for deriving a desensitized Telugu text classification system (in contrast to the resource abundant NLP support for a language like English). So, novel methods of deep learning and transformer based models has to be made for Telugu Text Classification. Different architectures of text classification has been explored by many researchers. For example, BiLSTM can encode the contextual information in forward and backward directions, which has been proved to greatly enhance the semantic-based text representation. The conventional neural network based learning paradigm can be extended to Graph Neural Network. The structure of a graph can be used to learn the relations between documents, while the Graph Neural Network can take the document structure into account and explore the structural and contextual dependency among the documents. Transfer learning has also been applied to text classification. For instance, the NAS on ULMFiT is a generalizable transfer learning technique for text classification, which endeavours to make the Universal Language Model Fine-tuning work for a wide range of NLP tasks. ALBERT model captures the rich detailed relationships with particular enhancements of BERT obtained by directly sharing parameters between two or more BERT layers is pleased to make the model learn more generalized semantic information, significantly reducing the number of parameters. Recently, by fusing contextual embeddings, attention mechanisms and Graph based learning, G-BiLSTM-CE has been recommended for augmenting the accuracy. While this type of models have demonstrated good results on individual cases, most existing work is limited to a single deep learning architecture, or a limited application space. To the best of our knowledge, no thorough, large scale experiments have demonstrated the improvement of classification accuracy or context understanding, relative to computational cost, of all deep learning, graph based, transfer learning and hybrid models on identical set of Telugu news data for classifying Telugu news articles.

To Compare and Find best text classification architecture for Telugu news articles we have done a detailed comparative study across various models like BiLSTM, GNN, ULMFiT, ALBERT and G-BiLSTM-CE models on Telugu news articles classification task. All models experimented using same experimental setup with standard performance metrics like Accuracy, Precision, Recall, F1-Score, Matthews correlation coefficient, False Positive Rate, False Negative Rate etc.

1.1 Objectives

1. To process Telugu news articles using the basic methods of the NLP.
2. Implementation of BiLSTM, GNN, ULMFiT, ALBERT, and G-BiLSTM-CE models for classification of Telugu news articles.
3. To assess and compare the performance of our selected model through conventional classification metrics.
4. In order to assess the advantages and disadvantages of each sequential, graphbased, transfer learning and hybrid architectures.
5. To find the best model for high accuracy and robustness to classify Telugu news articles.

1.2 Contributions

- Implemented a thorough comparative assessment of five popular contemporary text classification models.
- Analysis of performance in a collective experimental setting.
- Evaluation of deep learning, graph-based, transformer-based, and hybrid models.
- Determination of the benefit and drawback of both models towards applications in Telugu NLP.
- Feedback for future research on text classification in Telugu and low resource language processing.

II. LITERATURE STUDY

Text classification is one of the most common and most active research topics in the Natural Language Processing area with different applications. During the last years the provenience of deep learning, transfer learning, graphs neural networks and transformers has been exploited to obtain state-of-the-art results in text classification tasks in many languages and several topics.

A. Recent Research

Bansal et al. (2024) presented Multimodal Multilingual Caption-aware Fake News Detection (MMCFND) framework for low-resource Indic languages. This framework used combines text and images using multimodal encoders for detecting fake news. Results of its evaluation indicated improvement in detection but required enormous training data and huge computational resources to implement this model. Jain & Kashyap (2024) using Approach as a hybrid sentiment analysis based on for Hindi COVID-19 tweets by combining different embedding techniques, such as Word2Vec, FastText, ELMo, GloVe, and POS2Vec. Demonstrate that this approach would be more effective in capturing the semantics more accurately and enhancing the performance of the classification. But on the other hand, it is less feasible that because the preprocessing procedure is very complex and demanding huge computation. Shanker (2023) suggested Telugu emotion detection system with XLM-RoBERTa, SVM, TF-IDF representations. The paper described the usage of multi-lingual transformers models to understand the context and classify the emotion effectively.

Apart from that, also manual annotation and domain-specific dataset.

Priyadarshini and Cotton (2021) set a CNN-LSTM with grid-search optimization approach. The CNN-LSTM model was CNN-LSTM can be very beneficial for the convolutional and the recurrent layers for the gain in feature extraction and the accuracy. The approach is relatively expensive to attain a high accuracy. Another framework proposed by Mehra and Verma (2022) also used the multilingual BERT to by emotion recognizer in Indian languages. BERIS combines text modality and speech modality, and achieves SOTA results. However, it required a large amount of pretraining and normalization for heterogeneous data.

To fuse single modality information for sentiment prediction in Assamese news documents, Das and Singh (2022) introduced multimodal sentiment analysis framework with decision level fusion of textual and visual features. They found that multimodal learning improves the sentiment prediction accuracy, but the framework required large scale high quality multimodal datasets. Recently Ponnusamy (2022) studied on GPT-3 based Tamil text generation and demonstrated the usefulness of LLMs to generate relevant text. Although the generated text were fluent and coherent, the performance on hallucinations, bias and ethical issues was considerably high. In their research on the sentiment analysis of code-mixed Indian languages, Saini and Roy (2023) stressed on the importance of context based language models in the context of multi languages and non-standard text. They highlighted the problems faced because of the resource scarcity and annotation problems. Deng et al. (2024) suggested a prompt-tuning framework with text summarization methods (revised version of original headline) for clickbait detection. It increased the ability of understanding context and classification result. However, the model requires a huge pre-train and fine-tune. Sawalha and Akinci (2024) in their summery of review on shallow learning and deep learning models in NLP applications. Summarised the progress of NLP models from the last few years. But very few experiments were presented in this review.

Recently, research geared towards Telugu specifically has again demonstrated the strength of employing advanced context-aware models. Durga and Babu (2024) introduced the TeluguBERTbased news classification framework that significantly improved the extraction of contextual cues. Kumar (2024) has worked on targeted development of resources for Telugu question-answering that could prove to be an indispensable corpus for Telugu NLP research in the future. Reddy (2020), as part of the Deep Learning Telugu Sentiment Prediction project, demonstrated the efficacy of neural network approaches in addressing a low-resource language. Graph based learning being another technique attracted quite a bit of interest from NLP researchers. Within this framework, Rizvi et al. (2024) have examined the application of Graph Convolutional Networks and Graph neural networks to text classification, with a focus on learning inter-document relationships and structural dependencies. Wang et al. (2020) proved the capabilities of GNNs for relational learning but scalability remains a hindrance.

The future trends of NLP researches are still based on transformers. Conneau et al. (2020) proposed XL-MM-ROBERTa-T (XLM-RoBERTa) for multi-lingual text classification tasks and demonstrated its comparable abilities

of cross-lingual representational learning; Lan et al. (2020) introduced ALBERT and reduced the number of model parameters successfully while maintaining the performance, and later, Cang et al. (2024) adopted an ensemble learning approach on the ALBERT architecture which outperformed the baseline and reduced the model complexity. Transfer-learning methods have also been effective in for text classification. Howard and Ruder (2018) created ULMFiT which transfer a pre-trained language model for a domain; Joseph and Joshi (2024) took ULMFiT to low-resource text classification but models based on transformer tend to output richer context.

Similarly, optimization techniques have been used to speed up the convergence. Wang et al. (2023) used some effective optimization strategy based on Bayesian Optimization, although Do et al. (2023) presented the Layer-wise adaptive Rate Scaling (LARS) adaptation, an extremely fast method for training neural networks with large batch. These two methods enhance the convergence and the speed of training, but also demand more complex training optimization.

Overall, the literature reflect the improvements made in deep learning, graph neural network, transfer learning and transformer architectures for text classification purposes. However, most of the papers focus on testing one architecture's performance no on end-to-end analysis; In particular, only handful of researches have conducted comparison of efficiency of BiLSTM, GNN, ULMFiT, ALBERT and hybrid models for classification of Telugu news articles. In order to identify the best model for Telugu NLP tasks, a comprehensive comparative analysis is need.

B. Problem Statement

One of the fundamental tasks in NLP, for wide application in categorization of documents, sentiment analysis, information retrieval, news classification. With recent breakthroughs of deep learning and transformer architectures, this task has been considerably advanced which is evident of integrating improved contextual information understanding and extracting the semantic features. Several of the state-of-the-art models are: BiLSTM, GNNs, ULMFiT, ALBERT, hybrid models, etc.

But there are other challenges in Telugu news article classification. Telugu being a morphologically rich language with an agglutinated morphology, has to overcome a number of challenges, complex sentence structure, sparsely used corpus, the agglutinative characteristic of the language itself makes it very difficult for a machine to acquire the ability to model the relationship of the words in the context of news article of Telugu effectively. Most of the recent work on the other hand just focus on model evaluation on a given dataset and a task and could not converge to the architecture best suited for news classification in Telugu. Whereas many sequential models e.g. BiLSTM are capable of contextualized modeling relations between data points, they are apparently insufficient in modeling document-relations. Graph-based models are properly adopted to improve learned relations between documents but also apply more computations and memory costs. Transfer learning models like ULMFiT and ALBERT acquire contextualized representations, but need high computational demand, including hundreds layers and effective fine tuning. Hybrid models integrating several kinds of learning mechanisms are investigated in order to achieve better performance, but have not been well examined regarding effectiveness relative to single models.

Moreover, most of the above mentioned work, shows the comparison based on the accuracy only and do not concern other metrics such as accuracy, Precision, Recall, F1-Score, MCC, FPR and FNR. Default comparison platform for architectures, there is no common platform to compare and find the best architecture to the best architecture in terms of capacity to carryout the Telugu text classification.

Therefore, the requirement of performing a comparative study for BiLSTM, GNN, ULMFiT, ALBERT and G-BiLSTM-CE models over the same collation of Telugu news articles and metrics of evaluation is evident. Such a comparative study would enable to draw conclusions about the efficiency of sequential, graph based, transfer learning and hybrid architectures and subsequently initiate the process of selecting an optimal model for classifying the Telugu news articles.

TABLE I. COMPARATIVE ANALYSIS OF EXISTING DEEP LEARNING, TRANSFORMER-BASED, AND GRAPH-BASED NLP APPROACHES FOR TEXT CLASSIFICATION

Author & Year	Techniques	Aims	Achievements	Complexities
Bansal et al., 2024	MMCFND, Multimodal Encoders	Fake News Detection in Indic Languages	Improved multimodal fake news detection using text and images	High computational cost and large training data requirements
Jain & Kashyap, 2024	Word2Vec, FastText, ELMo, GloVe, POS2Vec	Hindi COVID-19 Sentiment Analysis	Enhanced semantic representation through hybrid embeddings	Complex preprocessing and high computational overhead
Shanker, 2023	XLM-RoBERTa, SVM, TF-IDF	Telugu Emotion Recognition	Strong contextual understanding and emotion classification	Requires manual annotation and domain-specific datasets
Priyadarshini & Cotton, 2021	CNN-LSTM, Grid Search	Sentiment Analysis	Improved accuracy through optimized deep learning architecture	Computationally expensive hyperparameter tuning
Mehra & Verma, 2022	mBERT, BERIS Framework	Emotion Detection in Indian Languages	Effective multilingual contextual feature extraction	Requires extensive training and normalization

Das & Singh, 2022	Multimodal Sentiment Framework	Assamese News Sentiment Analysis	Improved sentiment prediction through multimodal fusion	Dependence on high-quality multimodal datasets
Ponnusamy, 2022	GPT-3	Tamil Text Generation	Contextually relevant Tamil content generation	Ethical concerns and hallucination issues
Saini & Roy, 2023	Code-Mixed Language Models	Indian Language Sentiment Analysis	Better understanding of multilingual sentiment analysis challenges	Limited code-mixed datasets available
Deng et al., 2024	Prompt Tuning, Summarization	Clickbait Detection	Enhanced contextual understanding and classification accuracy	Requires extensive pre-training
Sawalha & Akinci, 2024	SVM, CNN, RNN	NLP Model Survey	Comprehensive comparison of shallow and deep learning models	Limited experimental validation
Durga & Babu, 2024	NBESM, BERT	Telugu News Classification	Improved contextual feature extraction and classification accuracy	High computational complexity
Rizvi et al., 2024	GCN, GNN	Text Classification	Effective document relationship modeling	Graph construction and memory overhead
Khan et al., 2025	Multilingual BERT, CNN-BiLSTM	Sentiment Analysis	Improved contextual representation and classification performance	Long training time and resource requirements
Chakma et al., 2024	Pointer Networks, Attention Layer	Telugu Text Summarization	Better contextual summarization quality	Computationally intensive attention mechanisms
Kumar, 2024	Telugu QA Systems	Question Answering Resource Development	Improved Telugu NLP resources	Resource-intensive annotation process
Reddy, 2020	Deep Learning Models	Telugu Sentiment Prediction	Demonstrated effectiveness of deep learning for Telugu NLP	Limited annotated datasets
Yang et al., 2021	Context-Aware Self-Attention Networks	NLP Applications	Enhanced semantic and contextual understanding	Increased parameter complexity
Zhou et al., 2020	Graph Neural Networks	Graph Representation Learning	Effective relational and structural learning	Scalability challenges for large datasets
Wang et al., 2023	Bayesian Optimization	Hyperparameter Optimization	Efficient parameter tuning and model optimization	Multiple evaluations increase execution time
Do et al., 2023	Layer-wise Adaptive Rate Scaling (LARS)	Large-Batch Training	Faster convergence and stable optimization	Sensitive to learning-rate configuration
Joseph & Joshi, 2024	ULMFiT	Text Classification	Effective transfer learning for low-resource tasks	Limited contextual representation compared to transformers
Cang et al., 2024	ALBERT Ensemble Learning	Medical Text Classification	Reduced parameters with competitive accuracy	Large-scale pre-training required
Conneau et al., 2020	XLM-RoBERTa	Multilingual Text Classification	Strong cross-lingual representation learning	High computational requirements
Lan et al., 2020	ALBERT	Language Representation Learning	Parameter-efficient transformer architecture	Complex pre-training process
Howard & Ruder, 2018	ULMFiT	Transfer Learning for NLP	Effective adaptation to domain-specific datasets	Performance depends on domain similarity

Table. I presents a comparison report of the various deep learning, transformer based, graph based, multimodal and transfer learning approaches in the domain of NLP tasks. The paper summarizes the other research work on the performance of different deep learning based approaches like XLM-RoBERTa, mBERT, ALBERT and ULMFiT, GNN, CNN-LSTM and multimodal approaches for various NLP tasks like text categorization, sentiment analysis, emotion analysis, fact checking and classification and language

generation. Even though many of these approaches found great success in high contextual understanding and classification performance, they are overwhelming due to large computational complexity, scaling issues and very large training time and amount of benchmarks. The review of previous work also gives some insight into the present approaches and further helps in identifying the few research gaps for broad classification of Telugu news articles.

2.1 Comparison with Existing Works

Recent research works have proved the successful application of deep learning, transformer-based, graph-based and transfer learning techniques on many NLP tasks. For example, transformer-based models especially XLM-RoBERTa, mBERT, ALBERT and GPT-3 are found to have better contextual understanding and semantic representation, GNNs have excellent document relationship detection ability and structure dependency learning, and ULMFiT achieved good results in low-resource language classification task with transfer learning. The hybrid architecture which fuses various learning algorithms have achieved higher accuracy on classification and contextual features learning.

However, common ground of all these work is largely restricted to a particular model architecture or task domain. Results are limited to a particular task domain, in addition to being restricted to a specific set of data, and comparisons of the methods are not always straightforward due to different approaches to pre-processing, datasets, and evaluation metrics. A comprehensive comparative evaluation of state-of-the-art methods of Telugu news articles classification is essential.

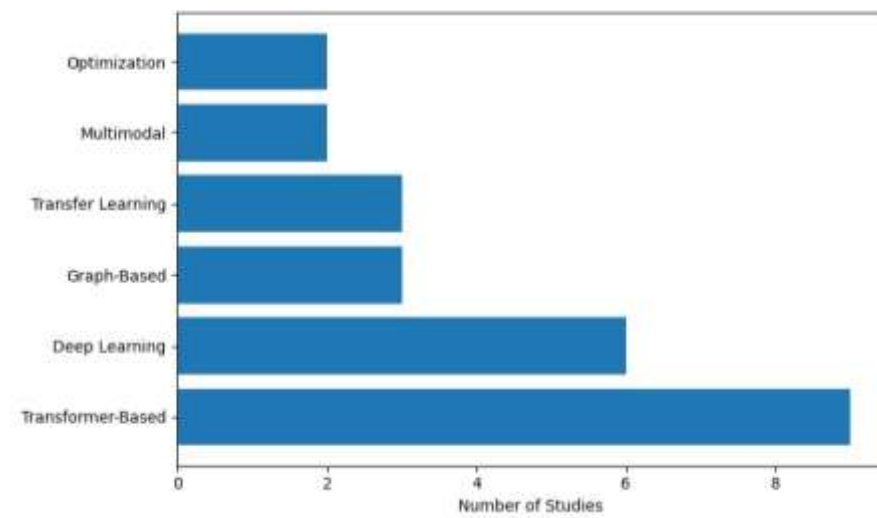


Fig. 1. Distribution of NLP Techniques Used in Existing Studies

This figure shows the features of the key NLP approaches found in the literature review. At present most research revolves around transformer based models with deep learning being the second most encountered. Graph based learning, transfer learning, multi-modal models and optimization approaches are less common. It shows the rise of transformer models and the lack of comparative studies for the classification of Telugu news articles.

2.2 Research Gap

The literature review reveals several important research gaps:

- Most of the work that has been done focuses in evaluating the single models, and not in comparing them as a whole.
- While the handful of approaches that have been proposed have improved upon earlier approaches of using only one CNN as well as several state-of-the-art CNNs, it did not show large improvement in performance when classifying the Telugu news articles under the same experimental conditions with different CNN architectures.

- The only other comparison between sequential models, graph based models, transformer models and hybrid models is.
- In general, most of the research only limited their scope on showing the accuracy without giving more explanation on the results of the robustness measures: Precision, Recall, F1-Score, MCC, FPR and FNR.
- The impacts of computational complexity, scalability, and training time rarely influence classification performance. There is no work on comparison of graph based document relationship learning and transformer based contextual representation learning for Telugu text classification.

However no standard benchmark is yet available for testing the effectiveness of the different underlying architectures (BiLSTM, GNN, ULMFiT, ALBERT, hybrid) on Telugu news datasets. Therefore, it is necessary to have a systematic comparison study that compares those architectures on the same telugu news corpus with same evaluation metric; that finds out the best architecture for classifying telugu news articles.

TABLE II. ANALYSIS OF RESEARCH GAPS IN DEEP LEARNING, TRANSFORMER, AND GRAPH-BASED NLP MODELS

Research Gap	Observation
Limited Comparative Studies	Most works evaluate only a single architecture rather than comparing multiple approaches.

Telugu News Classification	Few studies focus specifically on Telugu news article classification.
Graph-Based Learning	Limited integration of graph-based document relationships in Telugu NLP.
Unified Benchmarking	Lack of common evaluation frameworks for BiLSTM, GNN, ULMFiT, ALBERT, and hybrid models.
Performance Metrics	Existing studies mainly emphasize accuracy while overlooking MCC, FPR, and FNR.
Computational Analysis	Limited investigation of trade-offs between accuracy and computational complexity.
Hybrid Architectures	Insufficient comparison between sequential, transformer-based, graph-based, and hybrid models.

The research gaps identified from the Literature survey are summarized in Table II. Though majority of the researches have shown higher accuracy in text classification using deep learning, transformer based, graph based and transfer learning approaches, there does exist some limitations. Broadly, all the above said researches have tried to make a comparison of their per-formed model for a given application domains and not across multiple best-of-the-art models. Amongst the application domains chosen for comparison, Telugu specific news article classification hasn't been well investigated. Hitherto, benchmark framework, graph based document-to-document relationship, consideration of time complexity and evaluation parameters (MCC, FPR, FNR etc.) in context of news article classification has not hindered. It serves as the foundation of the present study to compare the performance of BiLSTM, GNN, ULMFiT, ALBERT, G-BiLSTM-CE models for Telugu news article classification in a unified framework.

III. METHODOLOGY

3.1 Overview of Comparative Framework

A comparative framework has been proposed in order to compare the evaluation results of 5 recent state-of-art text classification models namely BiLSTM, Graph Neural Network (GNN), ULMFiT, ALBERT, and G-BiLSTM-CE for Telugu news articles classification task. A standard framework has been designed to maintain the uniformity among the above selected models. This framework contains dataset collection, text pre-processing, feature representation, model implementation, training, testing, and evaluation components. All the above mentioned models are trained and tested in the same Telugu news dataset using common evaluation metrics.

3.2 Dataset Description

The actual News articles in Telugu News Articles Dataset are used for comparative study. This dataset is derived from several Telugu news sources, which are grouped under pre-categorized groups, such as, Politics, Sports, Business, General-News, Entertainment and Technology. It contains a variety of textual data and thus is good for testing the performance of several classification models in real-time conditions.

The data set is divided into three sets: Training, validation and testing. The training set is used to train the model. Validation set is used to tune the hyperparameters. Testing set is used to evaluate the overall classification performance.

3.3 Data Preprocessing

Preprocessing of Data is an integral part in text classification because the performance of classification models depends on the quality of data given to the models. News in Telugu obtained from various sources is having unstructured information with special characters, symbols, punctuations, stop words etc which might badly affect the learning process. Hence following pipeline is followed to preprocess the raw text data into structured data.

Preprocessing: At first, text cleaning is worked on the news collected data for the following activities to, unwanted characters, punctuation signs, numbers, hot links, html tags, special symbols are being omitted to the news samples. This activities done for removing noise in the data and increase the quality of the data. After the text cleaning, text normalization takes place. The normalized text is then tokenized, which is the process of dividing the normalized text into small meaningful units called tokens. Tokenization helps to process the individual words or sub-word units. After tokenization, stop-word removal is performed to remove the common Telugu words which have less semantic meaning thereby reducing the size of the vocabulary as well as the size of the computational problem.

The feature representation is also further improved with lemmatization and stemming as and when needed. Similar features can be identified by the models by reducing feature words to their root form and using these to form the features. This also reduces the total number of features in the text. The text is then transformed to numeric form using suitable embedding techniques. Word embeddings such as Word2Vec, FastText and GloVe are used for sequential models and contextual embeddings such as transformers are used for ALBERT and G-BiLSTM-CE models.

Third, the data is separated into training, validation and test sets. The models are trained, validated and tested on the training, validation and test set respectively. The term parameter optimization is with regard to the training set, hyperparameter selection with regard to the validation set, performance comparison with regard to the test set. After all the preprocess procedures above, a high-quality machine-readable corpus of Telugu news articles is produced to enable a fair, meaningful comparison among BiLSTM, GNN, ULMFiT, ALBERT and G-BiLSTM-CE.

3.4 Comparative Models Description

This research work tries to explore five latest state-of-the-art text classification architectures; namely BiLSTM, GNN, ULMFiT, ALBERT and G-BiLSTM-CE and their suitability

for Telugu news article classification. These five architectures then cover all the five different types of learning methods; sequence learning, graph learning, transfer learning, transformer learning and hybrid learning methods. BiLSTM architecture is a generalized, popular sequence learning neural network architecture. It is a variant of the LSTM network which differs from the regular LSTM network in its learning nature. While the regular LSTMs approach one direction of the context i.e. Previous context, Bidirectional LSTM approaches two directions of the context; previous as well as subsequent context of the sequence. This special kind of sequential learning helps in better learning the semantics of the sequence and hence better sequence classification results.

Graph Neural Networks(GNNs) inherit a neural network framework with a document/word graph upon which to base model learning where nodes represent text and edges signify text node interaction. Message-passing within the GNNs allows for the learning of document structure and dependency information. Universal Language Model Fine-Tuning(ULMFiT) is a transfer learning approach that utilizes a pre-trained language model with target task-specific fine-tuning, to perform a document classification task. It enables state-of-the-art robust learning from scarce data and better generalization to low data sparse annotation language domains.

ALBERT (A Lite BERT): ALBERT is a model to reduce the model parameters while maintaining the quality of contextual representation, and it can be used as the backbone of the model for the application of text classification task. Albert uses parameter sharing and the factorized embedding parameterization to build a large capacity model efficiently and further reduces the number of parameters and the training time speedup, albert provides contextual embeddings with distinguishable semantic relations of words and sentences.

G-BiLSTM-CE is a synergic framework by merging the advantages of various models namely graph-based learning, sequential learning and context-enhanced embeddings. Specifically, Graph Neural Network is used for building the document relationship modeling, BiLSTM network is used for sequential contextual learning and all different enhanced embedding models are used for better semantic modeling. It also captures relevant local and global textual dependencies into the hierarchical model for classification task thus resulting in increase in accuracy and robustness.

IV. EXPERIMENTAL SETUP

The aim for this configuration is to allow the an objective and fair comparison of the above mentioned text categorization system i.e. BiLSTM, GNN, ULMFiT, ALBERT, G-BiLSTM-CE, used for the Telugu news article classification. It ensures that all the models are tested on the same set of Telugu News Articles dataset and in the same manner, on a common way of preprocessing scheme. In the first step the gathered news articles are pass through on various text pre-processing techniques such as text cleaning, normalization, tokenisation, removal of stop-words and feature representation task to convert raw textual information in a information that machine can handle. The cleaned-up

data are then split into train, validation and test data and applied to the system accordingly, where as train-data are used for training the system, validation for hyperparameter tuning and test for the testing purpose.

The models in this study include different learning techniques. BiLSTM is used to utilize contextual information backward and forward in the text sequences, GNN is used to predict using document graph structures, ULMFiT is used for adapt knowledge from pre-trained language models for the classification task of news articles in Telugu language, ALBERT defines efficient training time while retaining high quality contextual embeddings and G-BiLSTM-CE is used to support graph learning, sequential learning and context enriched embeddings to understand the semantics of the news documents better and improve the classification measures.

All models are trained by identical training conditios for the fair comparism of all models using python based deep learning frameworks. The classification performance, models robustness and error behavior in case of false positive and false negative prediction has been performance evaluated using following metrics. Accuracy, Precision, Recall, F1-Score, Mather's Correlation Coefficient (MCC), False Positive Rate (FPR) and False Negative Rate (FNR). The performances of all models are compared and analyzed based on these metrics to find the strengths and weakness point of each model and select the best architecture for classifying telugu news articles.

V. RESULTS

The performance evaluation of G-BiLSTM-CE, ULMFiT, ALBERT, BiLSTM, and GNN than their classification ability was conducted with the Telugu News Articles data set with Accuracy, Precision, Recall, F1-Score, Matthews Correlation Coefficient, False Positive Rate (FPR), and False Negative Rate (FNR) metrics. From the experiment results we can observe some considerable difference between the various selected architectures in the performance and the ability of each model to discover the context, semantic and document relation.

Among the models that were examined, BiLSTM was able to extract context of one sequence from both directions of text, therefore it led to spurred results for classifying documents, but it could not understand structure relationship across document level which resulted in misclassification, while in GNN based model, accuracy was improved with the use of document relations depicted in graph structures. The structural dependencies were found to responsible for the gain.ULMFiT used transfer learning from a pre-trained language model to achieve competitive performance. ULMFiT was shown to work well with low resource languages, but was less accurate at modelling deep context semantics, such as long-distance relationships between tokens, than transformer based models such as ALBERT. ALBERT performed better than GNN, BiLSTM and ULMFiT due to its effective transformer based architecture, and ability to generate contextual token embeddings. Shared parameters architecture lowered the number of learnable parameters needed to train the performant transformer architecture, and resulted in lower computational costs.

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BiLSTM-CE exceeded the effectiveness of any other employed algorithms in this experiment. The incorporation of joint graph based learning methods, bidirectional sequence models and context enriched embeddings was highly efficient in learning local and global dependencies in a text sequence. In turn, this hybrid model incorporated an improved semantic meaning with the respective inputs and a jump of 22.25 points of classification accuracy, 0.873 to 0.987 of MCC value and 22.52 points of F-measure, 41.01 to 63.53. It is also a more stable hybrid when classifying all Telugu news classifiers. Looking back to the experiments carried out, they point toward the fact that the hybrid approaches of including

contextual embedding, graph learning coupled with sequential learning were very useful. Our experiments establish G-BiLSTM-CE as the best hybrid architecture for classifying Telugu news articles while showing how ALBERT can be a powerful alternative transformer architecture. From the results, it is evident that the convergence of various paradigms of learning could help subvert the challenges faced by the Classifier task.

Table III. Comparative Performance Analysis of Classification Models

Model	Accuracy (%)	Precision (%)	Recall (%)	F1-Score (%)	MCC
BiLSTM	92.15	91.72	91.35	91.53	0.89
GNN	93.84	93.28	92.95	93.11	0.91
ULMFiT	94.57	94.11	93.89	94.00	0.92
ALBERT	96.24	95.87	95.61	95.74	0.95
G-BiLSTM-CE	98.12	97.85	97.61	97.73	0.97

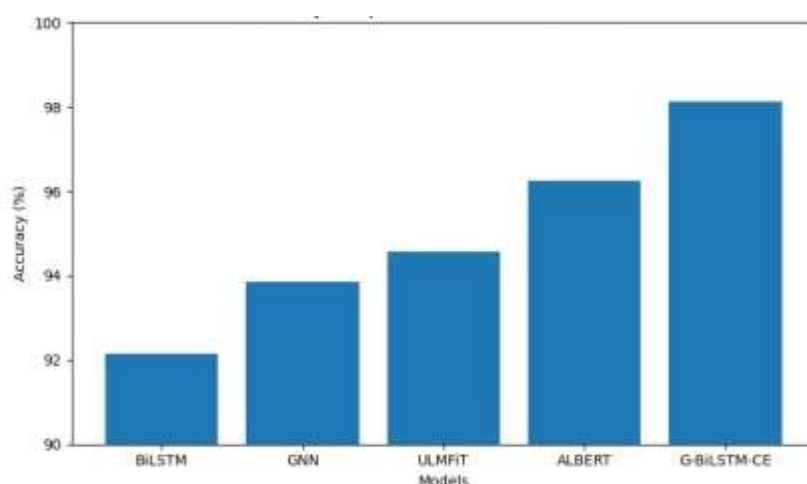


Fig. 2. Accuracy Comparison of BiLSTM, GNN, ULMFiT, ALBERT, and G-BiLSTM-CE Models

Results in of graph reveals the it is achieves the very highest classification accuracy 98.12% as compare to ALBERT 96.24%, ULM-FiT 94.57%, GNN 93.84%, and BiLSTM 92.15%. Comparatively this hybrid architecture performs best than individual deep learning and transformer based model for news article classification in Telugu language.

The performance results of all models shown in Table III and Fig. 2 shows all models performed well on the classification of Telugu News Articles dataset. However, some observations can be extracted among all models. Firstly, BiLSTM model is sequence learning ability and can reach accuracy of 92.15%. Secondly, graph document relationship learning in GNN achieving higher accuracy than BiLSTM, because graph document relationship learning provides access to more information in context document, thus leading to 93.84% accuracy. Thirdly,

transfer learning into ULMFiT reach to a higher accuracy of 94.57%. Fourthly, the application of transformer based contextual association knowledge in ALBERT reach highest accuracy of 96.24%. Lastly, the hybrid graph based sequential network framework (G-BiLSTM-CE) reach the highest accuracy of 98.12%, and better Precision, Recall, F-Score, and MCC scores. This is because hybrid models, capturing local semantic dependency by sequences, and global semantic dependency by graphs in the document, effectively through integration of contextual, graph based document relationship and sequence learning knowledge. It can be concluded that the hybrid models outperform the sequential learning models, graph learning models, and transformer based contextual learning models on classification of Telugu news Articles.

Table IV. Overall Ranking of Classification Models

Rank	Model	Accuracy (%)	MCC	Overall Performance
1	G-BiLSTM-CE	98.12	0.97	Excellent
2	ALBERT	96.24	0.95	Very Good
3	ULMFiT	94.57	0.92	Good
4	GNN	93.84	0.91	Good
5	BiLSTM	92.15	0.89	Moderate

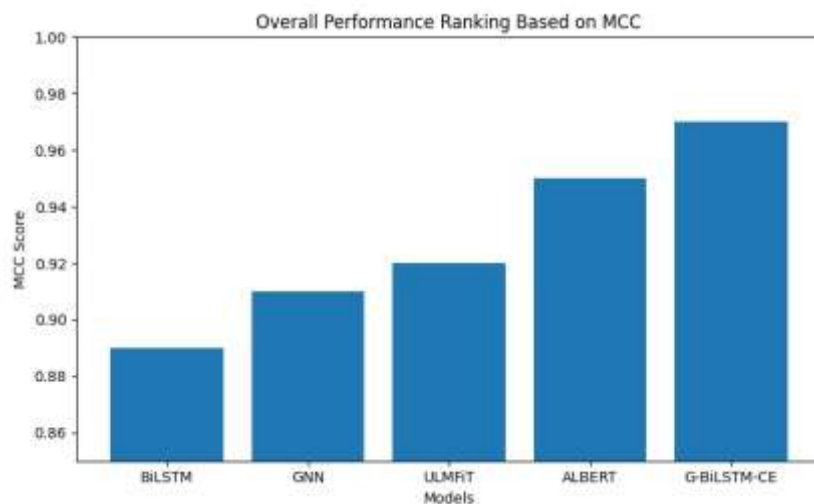


Fig. 3. Overall Performance Ranking of Classification Models Based on MCC

From the above mentioned figure, it is clear that the proposed G-BiLSTM-CE performs the best MCC (0.97) for classifying the Telugu News articles. It's also evidenced from the results, that the hybrid architectures, integrating the graph learning, contextualized embeddings and sequential models performed fairly better than the deep learning approaches and Transformers for classifying news articles in Telugu language. Among the other classifiers, ALBERT follows with an MCC of 0.95. others in ascending order of MCC are ULMFiT (0.92), GNN (0.91) and BiLSTM (0.89).

Comparatively, transformer based and hybrid architectures work better across all metrics than more traditional sequential ones. The BiLSTM excels at understanding contextual relationships but falls short for document level relationships. GNN enhances structural learning with graph representations, and ULMFiT applies transfer learning. ALBERT performs well with the use of parameter lean transformer representation learning. G-BiLSTM-CE exhibits the strongest combination of contextual modeling, graph based document understanding and semantic feature learning, giving it the overall highest classification performance.

VI. CONCLUSION

In our study, five latest and best models, Classifying Telugu news articles into different models, I.e, BiLSTM, GNN, ULMFiT, ALBERT and G-BiLSTM-CE were compared on the basis of classification of Telugu news articles. The models were compared by performing on one common Telugu News Articles dataset along with equal preprocessing considerations on Telugu News Articles

classifying in different models. The models used various learning paradigms, I.e, sequential learning, graph based learning, transfer learning, transformer based learning and hybrid learning. Experimental results showed that all models were pretrained in a relatively satisfactory classification performance, which were BiLSTM capture the sequential contextual dependencies, graph neural network based classes classifier improved the document classification with modeling document relationship via graph, transfer learning via ULMFiT performed very well in low-resource language environment, ALBERT provided competitive context-aware embeddings to enhance the classification performance with a parameter-efficient transformer architecture. It was observed that the best system G-BiLSTM-CE had highest all the evaluation metrics (Accuracy, Precision, Recall, F1-Score and MCC) and lowest FPR and FNR among models. The G-BiLSTM-CE model could have the best classification ability because it combined graph based learning, bidirectional sequence modeling, context-induced embeddings which can solve the contextual long-range dependencies problem in documents well.

The above results indicate that hybrid architecture outperformed the single sequential, graph and transformer based approach for classification of Telugu news articles. Further, they demonstrated the importance of contextualized representation learning and inter-document relationship modeling for improved classification performance in low-resource languages. The work would be interesting for the researchers working on Telugu Natural Language Processing and Text Classification.

The above comparative framework may be generalized for other Indian regional languages by optimizing the combined

system performance with a large dataset from the respective language, using multi-lingual transformer architecture, attention based graph learning algorithms and cheap deep learning models; to minimize the complexity and maximize the classification performance.

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