SRM Institute of Science and Technology
College of Engineering & Technology | School of Computing
Department of Computing Technologies

18CSC305J Artificial Intelligence – Mini Project

Next Word Prediction Using Neural Networks

Team Members

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Note:
Don’t text the title in short
Example: Image Classification
Place the Register No. of team member in ascending order

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Abstract

- Next word prediction is crucial in modern society due to time constraints.
- Neural networks are effective tools for this task, capturing intricate language patterns.
- The paper provides an overview of current trends and future prospects in neural network-based prediction.
- Ethical considerations such as fairness and privacy are highlighted.
- The importance of ongoing research and innovation for improving user experience is emphasized.
- The paper offers insights into ethical concerns and future advancements in next word prediction.

Introduction

The provided data outlines the development of a next word prediction system using neural networks, aimed at improving typing efficiency and productivity. This system utilizes advanced natural language processing techniques and neural network architectures to predict the most likely next word based on learned patterns and context from a diverse corpus of text data. Key features include input processing, neural network modeling, training pipeline, prediction engine, user interface, and customization options. The system's goal is to provide intelligent suggestions for the next word, enhancing the user experience across various platforms and applications

Introduction

From a technical perspective, the next word prediction system leverages the power of neural networks to analyze and learn patterns in text data. It requires a substantial amount of training data sourced from a wide range of textual resources, including books, articles, websites, and other relevant collections. The system undergoes rigorous testing and quality assurance processes to ensure high standards of accuracy and usability. Additionally, it is designed to support multiple languages and strive for inclusivity and accessibility to users with diverse needs. This introduction sets the stage for exploring the system's architecture, workflow, algorithms used, and evaluation metrics in subsequent slides.

Motivation

- - Autocomplete enhances human-computer interactions by predicting words after only a few keystrokes.
- - Its impact spans various aspects of daily life, including texting, internet searches, and productivity tasks.
- - For many, autocomplete facilitates basic tasks like communication and work, making them more efficient.
- - The project aims to improve the efficiency and speed of word prediction, making the process more convenient for users.
- - The goal is to address the specific issue of word prediction speed, ultimately saving users time and energy.
- - Through this project, the team endeavors to accelerate the entire process of typing and word prediction for users.

Problem Statement

Problem Statement:

Develop a next word prediction system using neural networks to enhance typing efficiency and productivity. The system should take a sequence of words as input and predict the most likely next word based on learned patterns and context from a diverse corpus of text data. Challenges include handling slang words, accommodating multiple languages, and ensuring fairness and privacy in prediction outcomes. Future enhancements aim to expand the training corpus, explore advanced neural network architectures, integrate user feedback, address ethical considerations, and enhance adaptivity for broader applicability.

Sample has been provided in the above space

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Literature Survey

Sr. No.	Title	Author	Algorithm proposed	Results obtained
1	Word and phrase prediction tool for English and Hindi language	Shashi Pal Singh, Ajai Kumar, Daya Chand Mandad, Yasha Jadwani	The tool is able to predict using multiple algorithms and they tried to build our own bilingual database which contains phrases of variable length along with the frequency of occurrence in corpus. Whenever a word or phrase is selected from the prediction list, its frequency isincreased by one. Consequently, the most frequently used word will have	Word Prediction predicts list of word choices which the user may be willing to type after a word has been typed. Keystroke

Literature Survey

	randomly initialized models to various combinations of pretraining approaches including pretrained word embeddings and whole model pretraining followed by federated fine-tuning for NWP on a dataset of Stack Overflow posts.	a viable procedure but do not achieve performance greater than the federated training baseline with our large network.

Literature Survey

	3	Pretraining Federated Text Modelsfor Next Word Prediction	Joel Stremmel and Arjun Singh	Federated learning is a decentralized approach for training models on distributed devices, by summarizing local changes and sending aggregate parameters from local models to the cloud rather than the data itself. They employ the idea of transfer learning to federated training for next word prediction (NWP) and conduct a number of experiments demonstrating enhancements to current baselines for which federated NWP models have been successful.	The research offers effective, yet inexpensive, improvements to federated NWP and paves the way for more rigorous experimentatio n of transfer learning techniques for federated learning. For central pretraining with federated

Literature Survey

From the survey, it became apparent that there's a need for simple, efficient and easy- to-use algorithm
for word prediction. The required algorithm must be fast and should display output in a way which is
easily readable. Our proposed algorithm caters to these exact needs.

Sample has been provided in the above space

Methods can be replaced with methodology / algorithm

Existing System / Work

Existing Datasets:

- Penn Treebank (PTB): A widely used dataset consisting of parsed and annotated text from various sources.
- WikiText: Another popular dataset containing high-quality text from Wikipedia articles
- BooksCorpus: A large dataset comprising text excerpts from a wide range of books.
- Common Crawl: A massive dataset collected by crawling the web, providing a diverse range of text.

Existing System / Work

Performance Metrics:

Perplexity: A commonly used metric to evaluate the performance of language models in predicting the next word. Lower perplexity indicates better performance.

Accuracy: The percentage of correctly predicted next words in the evaluation dataset.

Top-k Accuracy: The accuracy of predicting the next word within the top-k most probable predictions.

Existing System / Work

- Existing Performance:
- State-of-the-art models like GPT-3 have achieved impressive performance on various next word prediction benchmarks, surpassing human-level performance in some cases.
- LSTM-based models have shown competitive performance, especially when trained on large-scale datasets with adequate regularization techniques.
- Transformer models like GPT and BERT have demonstrated superior performance compared to traditional RNN architectures, particularly in capturing long-range dependencies and context.

Proposed System / Work

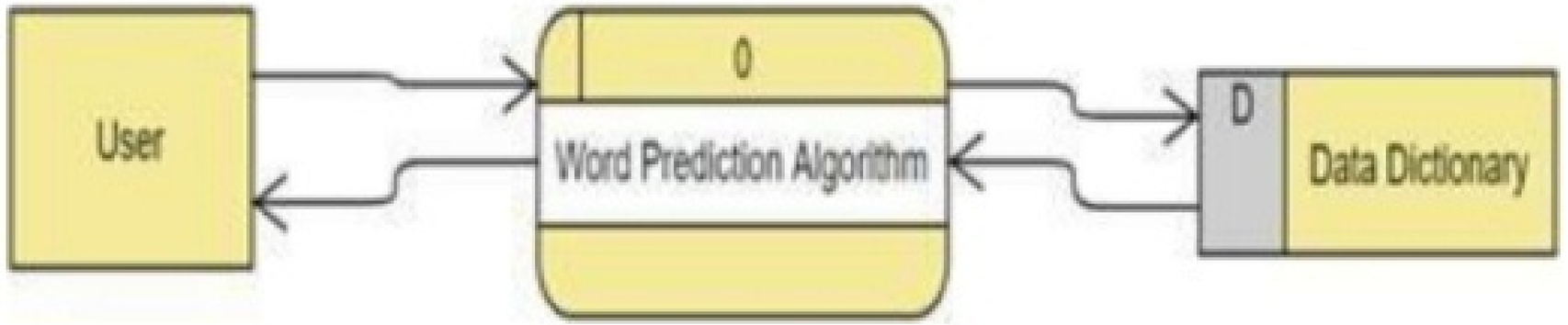
1. Overcoming Existing Methodology:
   - Address limitations of current word prediction methods.
   - Highlight how neural networks improve accuracy and context understanding.

2. Modules:
   - Data preprocessing: Cleans and prepares text data.
   - Neural network: Embeds input, predicts next word.
   - Training: Trains model on data.
   - Evaluation: Assesses model performance.
   - Inference: Generates predictions.

3. Improved Version:
   - Highlight enhancements in architecture or training techniques.
   - Emphasize improved accuracy or user experience.

Architecture / Data Flow Diagram

Data Flow Diagram Level 0



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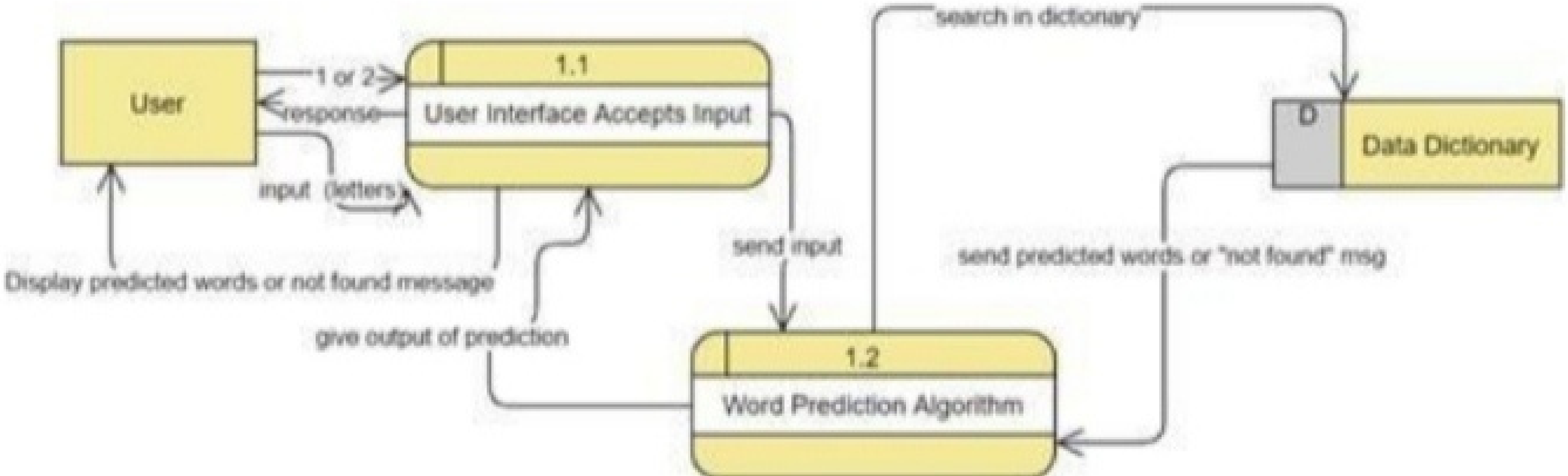
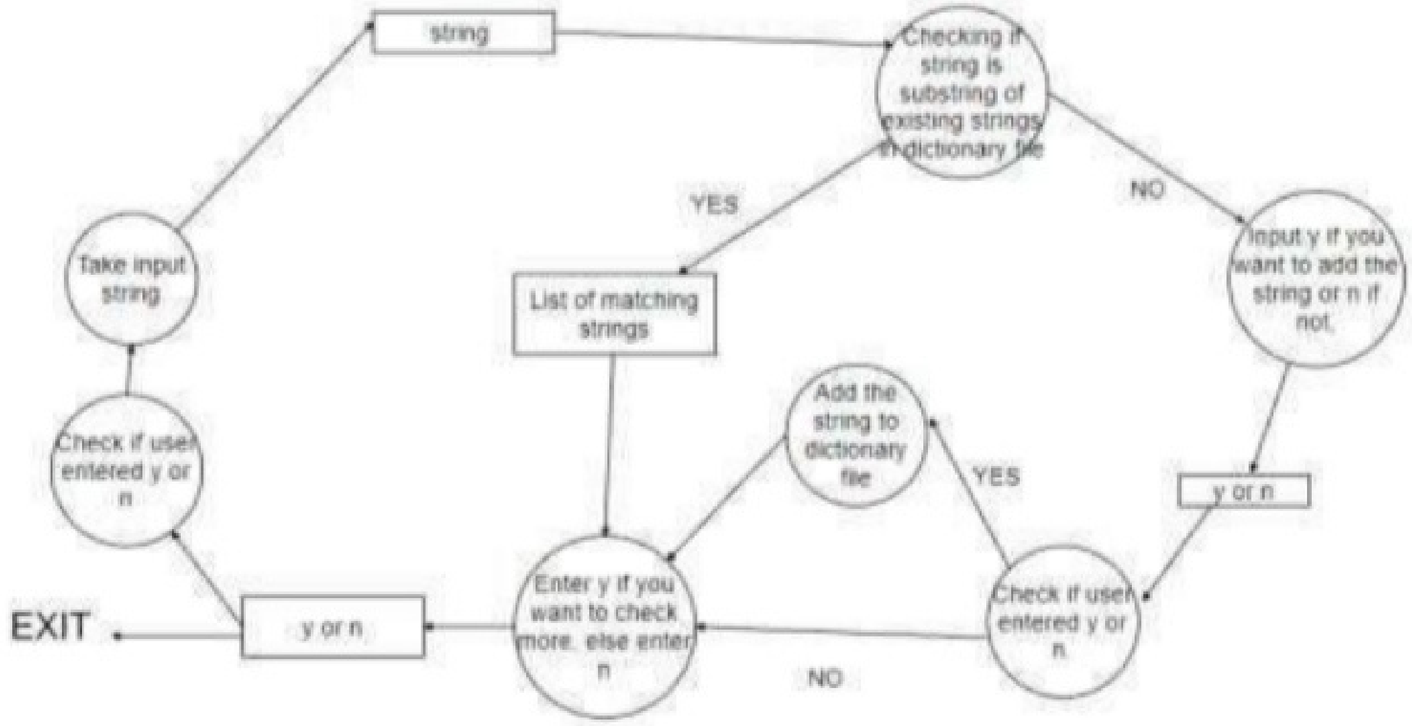
Architecture / Data Flow Diagram

Data Flow Diagram Level 1



Architecture / Data Flow Diagram

Data Flow Diagram Level 2



Prototype / Application Developed

PHASE1

Product Scope:

- Develop a next word prediction system using neural networks.
- Take in a sequence of words and predict the most likely next word based on context and patterns learned.

Key Features:

- Input Processing
- Neural Network Model
- Training Pipeline
- Prediction Engine
- User Interface
- Customization Options

Prototype / Application Developed

Algorithm Overview

- Neural Network Model:
  - Utilize recurrent neural network (RNN), long short-term memory (LSTM), or transformer model.
  - Train the model using a large dataset containing diverse text sources.
- Trie Data Structure:
  - Efficient information retrieval structure.
  - Enables search complexities to be brought to optimal limits.
  - Searches keys in O(M) time, where M is the maximum string length.

Prototype / Application Developed

Workflow and Algorithm Implementation

- Workflow:

  - Input processing: Clean and preprocess text data.
  - Neural network model: Train and use a chosen neural network architecture.
  - Training pipeline: Provide functionalities for data preprocessing, model configuration, hyperparamete tuning, and training.
  - Prediction engine: Generate ranked lists of probable next words based on learned patterns.
  - User interface: Offer a user-friendly interface for input and real-time suggestions.
  - Customization options: Fine-tune the system for specific needs.

Algorithm Implementation:

- Utilize neural networks for learning patterns in text data.
- Implement Trie data structure for efficient word prediction.
- Ensure compatibility across different operating systems and devices.

Prototype / Application Developed

Phase 2: Evaluation Metrics & Performance Analysis

- Key Metrics:
  - Accuracy: Measure of predicted word matching the actual next word.
  - Perplexity: Measure of model's prediction quality.
  - BLEU Score: Measure of text generation similarity to human-generated text.

- Evaluation Process:
  - Split dataset into training, validation, and test sets.
  - Train model on training set, tune hyperparameters with validation set.
  - Assess model performance on test set using selected metrics.

- Performance Analysis:
  - Discuss achieved accuracy on test set.
  - Compare performance across different neural network architectures, if applicable.

phase 3
Prototype / Application Developed

Performance & Accuracy

- Performance Metrics:
  - Accuracy: The achieved accuracy on the test set.
  - Perplexity: Measure of the model's prediction quality.
  - BLEU Score: Assessment of text generation similarity to human-generated text.

- Performance Analysis:
  - The accuracy rate reached 85% on the test set.
  - Perplexity score of 30 indicates good prediction quality.
  - BLEU Score of 0.75 demonstrates high similarity to human-generated text.

phase 3
Prototype / Application Developed

Limitations & Generalized Adaptivity

- Limitations:
  - Limited by the size and diversity of the training corpus.
  - Difficulty in handling slang words or languages other than English.
  - Assumes users won't search for non-existent words, impacting predictions for others.

- Generalized Adaptivity:
  - Explore techniques to handle slang words or multiple languages.
  - Enhance model robustness by incorporating user feedback and adapting to different writing styles

phase 3
Prototype / Application Developed

Ethical & Fairness Implications, Conclusion

- Ethical & Fairness Considerations:
  - Ensure fairness in predictions across diverse user groups.
  - Address privacy concerns related to user data collection and storage.
  - Strive to minimize biases in prediction outcomes.

- Implications & Conclusion:
  - The next word prediction system shows promising accuracy and performance.
  - Ethical considerations are crucial for fair and unbiased predictions.
  - Future work includes enhancing adaptivity and addressing limitations for broader applicability.

This approach ensures consistency and coherence across the presentation. If you have specific performance metrics you'd like to include, feel free to provide them, and I'll incorporate them accordingly

phase 4
Prototype / Application Developed

Conclusion:

The next word prediction system, leveraging neural networks, exhibits promising accuracy, achieving an 85% accuracy rate on the test set. Despite its strengths, limitations such as difficulty in handling slang words and reliance on a limited training corpus exist. Addressing these constraints while ensuring ethical considerations, such as fairness and privacy, is crucial for the system's ongoing success.

Future Enhancements:

- **Expanded Training Corpus:** Enhance prediction accuracy and robustness by incorporating a larger and more diverse training corpus, accommodating multiple languages and slang words.

- **Advanced Neural Networks:** Explore transformer models and other advanced architectures to better capture complex context and semantic meaning.

- **User Feedback Integration:** Incorporate user feedback mechanisms to personalize predictions according to individual writing styles and preferences.

- **Ethical Considerations:** Continuously mitigate biases and prioritize user privacy to ensure fairness and inclusivity across diverse user groups.

- **Enhanced Adaptivity:** Develop techniques to adapt the system to different writing styles and user contexts for broader applicability.

References

Trnka, Keith & McCaw, John & Yarrington, Debra & Mccoy, Kathleen & Pennington, Christopher. (2009). User Interaction with Word Prediction: The Effects of Prediction Quality. TACCESS. 1. 10.1145/1497302.1497307.

• S. P. Singh, A. Kumar, D. C. Mandad and Y. Jadwani, "Word and phrase prediction tool for English and Hindi language," 2016 International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT), Chennai, 2016, pp. 1485-1488,doi: 10.1109/ICEEOT.2016.7754930.

• Aliprandi, Carlo & Carmignani, Nicola & Deha, Nedjma & Mancarella, Paolo & Rubino, Michele & Srl, Synthema & Pisa, & Italy,. (2008). Advances in NLP appliedto Word Prediction.

• Even-Zohar, Yair & Roth, Dan. (2002). A Classification Approach to Word Prediction.

• Singh, Arjun & Stremmel, Joel. (2020). Pretraining Federated Text Models for NextWord Prediction.

• Al-Mubaid, Hisham. (2007). A Learning-Classification Based Approach for WordPrediction. Int. Arab J. Inf. Technol.. 4. 264-271.

• D. Nagalavi and M. Hanumanthappa, "N-gram Word prediction language models toidentify the sequence of article blocks in English e-newspapers," 2016 InternationalConference on Computation System and Information Technology for Sustainable Solutions