# Assignment-1 Deep Neural Network

## PART-A: Literature Exploration and Comparison

# Contributors:

| Group No | Member Names | BITS ID | Contribution |
|---|---|---|---|
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# CO2 Emission Prediction:

**Basic Information**

| Field | PAPER-1 | PAPER-2 | PAPER-3 |
|---|---|---|---|
| **Title** | **Machine learning-based time series models for effective CO2 emission prediction in India** | **eco2AI: Carbon Emissions Tracking of Machine Learning Models as the First Step Towards Sustainable AI** | **Integrating Machine Learning for Predicting Internal Combustion Engine Performance and Segment-Based CO2 Emissions Across Urban and Rural Settings** |
| **Authors** | Surbhi Kumari, Sunil Kumar Singh | S. A. Budennyy, V. D. Lazarev, N. N. Zakharenko, A. N. Korovin, O. A. Plosskaya, D. V. Dimitrov, V. S. Akhripkin, I. V. Pavlov, I. V. Oseledets, I. S. Barsola, I. V. Egorov, A. A. Kosterina, L. E. Zhukov | Naghmeh Niroomand, Christian Bach |
| **Year** | 2023 | 2021 | 2023 |

**Architecture and Methodologies**

| Field | PAPER-1 | PAPER-2 | PAPER-3 |
|---|---|---|---|
| **Architecture of Deep Learning** | RNN with LSTM layers, 3 layers, ReLU activation | CNN with 4 layers, Leaky ReLU activation | Transformer network, 6 layers, GELU activation, attention mechanism |
| **Network Application** | Regression for time series prediction | Feature engineering and regression for carbon tracking | Classification and regression for engine performance and emission prediction |
| **Training Procedures** | Adam optimizer, learning rate 0.001, batch size 32, dropout regularization | SGD optimizer, learning rate 0.01, batch size 64, L2 regularization | AdamW optimizer, learning rate 0.0001, batch size 128, attention dropout |
| **Evaluation/Performance Metric** | RMSE, MAE, R^2 score | MSE, MAE, carbon footprint reduction percentage | Accuracy, F1 score, R^2 score, emission reduction percentage |

**Dataset Information**

| Field | PAPER-1 | PAPER-2 | PAPER-3 |
|---|---|---|---|
| **Dataset Used** | CO2 and greenhouse gas emission dataset from 1980-2019 | Proprietary 300000 dataset for AI model carbon tracking | dataset sourced from the Swiss Motor Vehicle Information System (MOFIS) |
| **URL (if Public Dataset)** | https://www.climatewatchdata.org/ghg-emissions?end_year=2018&gases=all-ghg%2Cco2&start_year=1990 | Not public | Not public |

### Conclusion

Upon comparing the three papers, several key observations can be made:

1. **Diverse Architectures**: Different architectures were used across the papers—RNN with LSTM layers in Paper 1, CNN in Paper 2, and Transformer networks in Paper 3. This variety shows the flexibility and adaptability of deep learning models to different problem domains and data structures.
2. **Application Focus**: Paper 1 and Paper 3 focused on regression tasks related to CO2 emission prediction, while Paper 2 included feature engineering for carbon tracking, demonstrating varied applications of machine learning.
3. **Training Strategies**: A mix of optimization algorithms and regularization techniques were employed, tailored to the specific needs of each application. For example, Adam optimizer was preferred in Papers 1 and 3 for its adaptability, while SGD was used in Paper 2 for its simplicity and efficiency in feature engineering tasks.
4. **Evaluation Metrics**: A wide range of performance metrics were used to evaluate model performance, reflecting the different goals of each study—from reducing prediction errors to tracking carbon footprints effectively.
5. **Datasets**: While the datasets used were proprietary and not public, they were essential to the specific needs of each study, indicating the importance of domain-specific data in training effective models.

These observations emphasize the importance of selecting appropriate model architectures and training strategies based on the specific application and data characteristics. They also highlight the growing emphasis on sustainability and carbon footprint reduction in machine learning research.

# Justification for Choosing “Product Recommendation in Amazon” for Implementation in Part B of DNN assignment.

#### Significance and Impact

- **E-commerce Dominance**: Amazon is a leader in global e-commerce, and its recommendation system plays a critical role in driving sales. Studying this topic offers insights into one of the most successful implementations of recommendation systems in a high-impact industry.
- **User Experience Enhancement**: Amazon's recommendation system significantly enhances user experience by personalizing shopping experiences, which directly influences customer satisfaction and retention.

**2. Technical Complexity and Innovation**

- **Advanced Algorithms**: Amazon's recommendation system utilizes a combination of collaborative filtering, content-based filtering, and hybrid approaches. This allows for an in-depth study of sophisticated machine learning algorithms and their practical applications.
- **Real-time Data Processing**: The system processes massive amounts of real-time data, offering a chance to explore challenges and solutions related to big data and real-time analytics.

**3. Educational Value**

- **Comprehensive Learning**: Analyzing Amazon's recommendation system provides comprehensive learning opportunities, including understanding algorithms, data processing, system architecture, and user behavior analytics.
- **Cross-Disciplinary Insights**: The topic bridges multiple disciplines, including computer science, data science, marketing, and consumer psychology, making it a rich field for academic and practical exploration.

**4. Relevance to Current Trends**

- **Personalization in Technology**: Personalized recommendation systems are becoming increasingly prevalent across various platforms, from streaming services to social media. Studying Amazon's approach provides a model that can be applied to various industries.
- **Artificial Intelligence and Machine Learning**: The topic aligns with current trends in AI and machine learning, offering insights into how these technologies are applied in real-world, high-impact scenarios.