NLP with Deep Learning

1. Introduction to NLP & Deep Learning

- What is Natural Language Processing (NLP)
- Difference between classical and deep learning NLP
- Real-world applications and use cases (chatbots, translators)

2. Text Preprocessing & Linguistic Fundamentals

- Tokenization (words/subwords), stemming, lemmatization
- Part-of-speech tagging & basic syntax
- Cleaning and preparing text data for models

3. Text Representation & Word Embeddings

- Bag-of-Words (BoW), TF-IDF
- Word2Vec, GloVe, FastText embeddings
- Contextual embeddings (ELMo, BERT)

4. Neural Networks Foundations for NLP

- Feedforward networks basics
- Backpropagation and gradient descent fundamentals
- Activation functions and loss for NLP

5. Sequence Modeling: RNN, LSTM & GRU

- Recurrent neural networks (RNNs)
- Long Short-Term Memory (LSTM) and GRU units
- Sequence-based tasks (text generation, tagging)

6. Attention Mechanisms & Seq2Seq Models

- **Encoder–decoder architectures**
- **Global and local attention**
- **Beam search decoding for sequence generation**

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7. Transformer Architectures & Self-Attention

- **Self-attention concept and positional encoding**
- **Transformer encoder and decoder blocks**
- **Benefits over RNN-based models**

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8. Language Models: Statistical to Neural

- **N-gram language models and smoothing**
- **Neural language models and embeddings**
- **Pretrained model basics**

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9. Modern Large Language Models (LLMs)

- **BERT, GPT, RoBERTa, T5 and other transformer models**
- **Transfer learning and fine-tuning modern LLMs**
- **Use cases for text generation, summarization, QA**

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10. Chatbot Design & Conversational AI

- **Architecture for rule-based vs neural chatbots**
- **Dialog management and intent classification**
- **Evaluation of conversational responses**

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11. NLP Tasks: Classification, NER & QA

- **Sentiment analysis**
- **Named Entity Recognition (NER)**
- **Question answering and extraction tasks**

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12. Evaluation, Metrics & Model Optimization

- **Accuracy, precision, recall, F1-score, BLEU, ROUGE**
- **Hyperparameter tuning**
- **Overfitting and regularization strategies**

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13. Tools & Libraries (TensorFlow, PyTorch, Hugging Face)

- **NLP tooling: NLTK, spaCy**
- **Deep learning libs: TensorFlow, PyTorch**
- **Transformers: Hugging Face ecosystem**

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14. Projects, Deployment & Ethics in NLP

- **End-to-end NLP applications (chatbot, summarizer)**
- **Deploy models via APIs/web apps**
- **Ethical considerations: bias, privacy, responsible AI**
