Fine-tuned BERT with Dense Passage Retrieval (DPR) for Fake News Detection

**Introduction**

This document outlines the use of a **fine-tuned BERT model** combined with **Dense Passage Retrieval (DPR)** to detect fake news. This approach enhances classification by using semantically relevant context passages retrieved through dual BERT encoders.

**What is BERT?**

**BERT (Bidirectional Encoder Representations from Transformers)** is a transformer-based model developed by Google, pre-trained on large text corpora. It captures context bidirectionally, making it effective for a wide range of NLP tasks.

**Why BERT is Suitable for Fake News Detection**

| **Feature** | **Explanation** |
| --- | --- |
| Deep Language Modeling | Captures rich contextual representations bidirectionally. |
| Pretraining Benefits | Leverages large corpora like Wikipedia and BooksCorpus. |
| Transfer Learning | Easily fine-tuned on downstream tasks such as classification. |
| Versatility | Works well for classification, QA, NER, and more. |
| Interpretability | Attention weights can provide some insight into decision-making. |

**What is Dense Passage Retrieval (DPR)?**

**DPR** is a retrieval system that uses two BERT-based encoders:

* One for **questions/queries**
* One for **passages/documents**

This enables more accurate context retrieval than traditional sparse methods (like BM25), especially useful for factual verification in fake news detection.

**Why Combine BERT with DPR?**

Dense Passage Retrieval enables retrieval of **relevant supporting context** for a given news input. Fine-tuned BERT can then make more **informed classifications** based on that context.

**Typical workflow:**

1. Encode a corpus of trusted news articles using a **passage encoder**.
2. Encode the input query (new article) using a **query encoder**.
3. Retrieve top-k relevant documents using vector similarity (dot product).
4. Concatenate the query + context and feed it into a **fine-tuned BERT classifier**.
5. Output: real or fake.

**Device & Environment Requirements**

| **Component** | **Minimum** | **Recommended** |
| --- | --- | --- |
| GPU | GTX 1050 Ti / 1660 | RTX 3060 / T4 / A100 |
| VRAM | 4–6 GB | 12+ GB |
| RAM | 8 GB | 16–32 GB |
| Disk | 10 GB | SSD preferred for speed |

**BERT Model Sizes and Use Cases**

| **Model** | **Parameters** | **VRAM Needed** | **Use Case** |
| --- | --- | --- | --- |
| bert-base | 110M | ~4–6 GB | Balanced performance |
| bert-large | 340M | ≥12 GB | Higher accuracy, more memory |
| distilBERT | 66M | ~2–4 GB | Lightweight, good for testing |
| roberta-base | 125M | ~5–7 GB | Robust alternative to BERT |

**Summary: Why Fine-tuned BERT + DPR for Fake News Detection**

* **Context retrieval using DPR** makes classification more informed.
* **BERT’s bidirectional understanding** captures nuanced language.
* **Scalable and efficient** for real-time or batch fake news verification.
* **Easy to integrate** via Hugging Face’s transformers and dpr APIs.