**Assignment: Differences Between Traditional Machine Learning and Neural Networks**

**1. Comparison Table**

| **Aspect** | **Traditional Machine Learning (ML)** | **Neural Networks (NN)** |
| --- | --- | --- |
| **Definition** | Uses algorithms based on statistics to learn patterns from structured data. | Computational models inspired by the human brain that learn via layers of neurons. |
| **Examples** | Linear Regression, Logistic Regression, Decision Trees, SVM, KNN, Naive Bayes | Perceptron, CNNs (for images), RNNs (for sequences), Deep Neural Networks (DNNs) |
| **Feature Engineering** | Manual – requires expert knowledge to select/create features | Automatic – extracts features during training (especially in deep learning) |
| **Data Requirements** | Performs well on small to medium datasets | Requires large datasets to perform optimally |
| **Computational Power** | Can run efficiently on standard CPUs | Often needs GPUs or TPUs due to high computation demand |
| **Model Complexity** | Simple to moderately complex; easier to understand and debug | High complexity; difficult to interpret ("black box") |
| **Training Time** | Generally faster to train | Slower due to multiple layers and more parameters |
| **Accuracy in Complex Tasks** | Lower accuracy for unstructured or high-dimensional data | High accuracy in complex tasks like image, voice, and text processing |
| **Interpretability** | High interpretability (e.g., Decision Trees) | Low interpretability; hard to understand internal logic |
| **Scalability** | Scales well on structured problems with limited features | Scales extremely well with high-dimensional or unstructured data |
| **Use Cases** | Fraud detection, churn prediction, customer segmentation, tabular data modeling | Face recognition, voice assistants, autonomous vehicles, medical imaging |

**2. When Deep Learning (Neural Networks) Offers Advantages**

| **Scenario** | **Reason Neural Networks Are Better** |
| --- | --- |
| **Image Classification (e.g., CIFAR, MNIST)** | CNNs automatically detect features like edges, shapes, and patterns from raw images |
| **Speech Recognition (e.g., Alexa, Siri)** | RNNs/LSTMs handle time sequences and remember past inputs |
| **Natural Language Processing (NLP)** | Transformers (e.g., BERT, GPT) capture word context and sentence meaning for tasks like translation |
| **Autonomous Driving** | Combines inputs from sensors (cameras, LiDAR) and recognizes surroundings in real-time |
| **Medical Diagnosis (e.g., tumor detection)** | Detects subtle patterns in X-rays, MRIs, or CT scans that humans or traditional ML may miss |
| **Recommendation Systems** | Learns complex user preferences over time from massive behavioral datasets |

**3. Summary**

* **Traditional ML** is best suited for structured data (e.g., Excel-type datasets), when interpretability, speed, and limited data are factors.
* **Neural Networks/Deep Learning** excel in **unstructured data** (images, audio, text), **automatic feature learning**, and **high accuracy** when trained with **large datasets** and **high computational resources**.

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