**Analysis of EEG Data for ADHD Diagnosis**

**1. Description of the Dataset**

1. **Experiment Focus**: The experiment aims to compare brain activity between children with ADHD and healthy controls using EEG recordings during visual attention tasks. The goal is to understand differences in neural patterns between the two groups.
2. **Participants**:
   * **ADHD Group**: 61 children diagnosed to DSM-IV criteria, aged 7-12, who have taken Ritalin for up to 6 months.
   * **Control Group**: 60 children aged 7-12, with no history of psychiatric disorders or high-risk behaviors.
3. **EEG Details**:
   * **Electrode Placement**: Based on the 10-20 system using 19 channels (Fz, Cz, Pz, etc.).
   * **Reference Electrodes**: A1 and A2 located on the earlobes.
   * **Sampling Frequency**: 128 Hz.
4. **Recording Protocol**: EEG was recorded during a visual attention task where children counted characters in cartoon images. The task continued uninterrupted after each response, ensuring continuous stimuli.

**2. Preprocessing**

1. **Data Filtering**:
   * Signals with fewer than 12,000 data points were padded, and those exceeding this threshold were truncated.
   * No frequency filtering was applied as per Section 2.2.
2. **Data Splitting**:
   * Training Set: 80% of the data.
   * Testing Set: 20% of the data.

**3. Feature Extraction**

1. **Selected Features**:
   * **Correlation Matrix**: Using Pearson correlation between electrode signals.
   * **Frequency Content**: Using Welch’s method for Power Spectral Density (PSD).
   * **Raw Signals**: Preprocessed EEG signals.

**4. Classification Method**

1. **Classifier**: A Convolutional Neural Network (CNN) was implemented due to its high performance in complex datasets.
2. **Training Configuration**:
   * **Epochs**: 100.
   * **Batch Size**: 16.
   * **Optimizer**: Adam optimizer for efficient learning.

**5. Training and Evaluation**

1. **Training**: The model was trained on the 80% training set using train\_test\_split from scikit-learn.
2. **Metrics**:
   * Confusion Matrix: To evaluate model performance:
     + **True Positives (TP)**: Correct ADHD predictions.
     + **True Negatives (TN)**: Correct control group predictions.
     + **False Positives (FP)**: Incorrect ADHD predictions.
     + **False Negatives (FN)**: Incorrect control group predictions.
   * **Performance Metrics**: Precision, Recall, F1-Score, and Accuracy.

**6. Results**

1. **Loss vs. Epoch**: A plot showing the reduction in training and validation loss across epochs.
2. **Accuracy vs. Epoch**: A plot showing improvements in accuracy across epochs.
3. **Confusion Matrix**:
   * Provides a summary of the classifier's ability to distinguish between ADHD and control groups.
   * Derived metrics like Precision and Recall further validate the model.

