Experimental Setup and Methodology

Dataset Characteristics

HARDWARE SPECIFICATIONS:

🖥 Computing Environment:
• OS: Windows 11 + WSL2 (Ubuntu 22.04)
• CPU: Intel/AMD x64 processor
• RAM: 16GB+ recommended
• GPU: NVIDIA RTX 3060 (12GB VRAM)
• CUDA: 12.9 (system) / 12.8 (PyTorch)

🧠 EEG Hardware:
• Device: Emotiv EPOC (14-channel)
• Sampling Rate: 128 Hz
• Electrode System: 10-20 International
• Channels: AF3, F7, F3, FC5, T7, P7, O1,
          O2, P8, T8, FC6, F4, F8, AF4

⚡ Performance:
• Training Time: 5-8 minutes per model
• Memory Usage: 2-3GB GPU memory
• Inference Speed: <1ms per sample

Metric	Value	Details
Total Trials	1000	Balanced dataset
Digit 6 Trials	500	Class 0
Digit 9 Trials	500	Class 1
Channels	14	EEG electrodes
Sampling Rate	128 Hz	Temporal resolution
Trial Length	~2 seconds	Variable length

Training Hyperparameters

VALIDATION METHODOLOGY:

🔁 Cross-Validation Strategy:
• Method: 5-fold stratified cross-validation
• Training: 80% of data (800 trials)
• Validation: 20% of data (200 trials)
• Test: Hold-out set (200 trials)

📊 Performance Metrics:
• Accuracy: Overall classification rate
• Sensitivity: True positive rate (Digit 6)
• Specificity: True negative rate (Digit 9)
• F1-Score: Harmonic mean of precision/recall
• Balanced Accuracy: Average of sensitivity/specificity

📈 Statistical Analysis:
• Significance testing: t-test (p < 0.05)
• Effect size: Cohen's d
• Confidence intervals: 95% CI
• Multiple comparison correction: Bonferroni

Parameter	LSTM	Transformer	EEGNet
Batch Size	32	32	32
Learning Rate	0.001	0.001	0.001
Optimizer	Adam	Adam	Adam
Loss Function	CrossEntropy	CrossEntropy	CrossEntropy
Early Stopping	Patience=10	Patience=10	Patience=5
Max Epochs	100	100	50