1. Prefrontal Cortex → AI: Decision-Making Logic / Reinforcement Learning

- **Brain Role**: Planning, problem-solving, and decision-making
- **AI Equivalent**: Reinforcement learning agents (like AlphaGo), where AI learns optimal decisions through reward-punishment mechanisms

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🔹 2. Hippocampus → AI: Memory Storage / Neural Network Weights

- **Brain Role**: Long-term memory formation
- **AI Equivalent**: Model weights and memory units in networks like RNNs, LSTMs, and Transformers that "remember" patterns over time

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🔹 3. Occipital Lobe → AI: Computer Vision (CNNs)

- **Brain Role**: Visual processing (shapes, colors, motion)
- **AI Equivalent**: Convolutional Neural Networks (CNNs), used in facial recognition, object detection, and medical imaging

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🔹 4. Amygdala → AI: Emotion Recognition / Sentiment Analysis

- **Brain Role**: Processing emotions, especially fear and pleasure
- **AI Equivalent**: Emotion AI (Affective computing) in chatbots, healthcare, and driver monitoring systems

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🔹 5. Cerebellum → AI: Robotics / Motor Control Systems

- **Brain Role**: Coordination, balance, motor skills
- **AI Equivalent**: AI in robotics – motion planning, real-time feedback loops, and sensor fusion for robot stability

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🔹 6. Neural Synapses → AI: Artificial Neurons & Weight Connections

- **Brain Role**: Signal transmission via synaptic strength (learning through reinforcement)
- **AI Equivalent**: Connection weights in neural nets – learning is simulated by adjusting these weights using backpropagation

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◆ **7. Corpus Callosum → AI: Multi-Agent Systems / Parallel Processing**

- **Brain Role**: Bridge between left and right brain for communication
- **AI Equivalent**: Distributed systems or multi-agent models where different models/nodes communicate and collaborate in real-time

Brainwave Emotion Detection using Synthetic EEG Data on AWS

This document outlines a complete pipeline for detecting human emotions using synthetic EEG data. The system mimics the DEAP dataset process and performs machine learning analysis using Amazon Web Services (AWS). Below are the detailed steps and associated AWS services involved.

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1. Synthetic EEG Data Generation

- **Objective**: Generate realistic EEG data for training due to the unavailability of real datasets.
- **Tools Used**: Python (NumPy, Pandas)
- **Output**: `synthetic_eeg_emotion_data.csv`

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2. AWS S3 (Simple Storage Service)

- **Purpose**: Store the synthetic dataset for easy access and scalability.
- **Activities**:
  - Created a bucket: `brainwave-analysis-bucket-new`
  - Uploaded the synthetic dataset CSV file
  - Configured access permissions for S3 object

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3. AWS IAM (Identity and Access Management)

- **Purpose**: Authorize SageMaker to access S3
- **Activities**:
  - Updated IAM role: `AmazonSageMaker-ExecutionRole-*`

- Added permission for `s3:GetObject` for the specified S3 bucket

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4. Amazon SageMaker

- **Purpose**: Run and scale Jupyter Notebooks for ML training and evaluation
- **Activities**:
  - Launched Jupyter Notebook instance
  - Uploaded the notebook `Brainwave_analysis.ipynb`
  - Selected correct Python kernel: `conda_tensorflow2_p310`
  - Installed necessary packages: TensorFlow, Matplotlib, Scikit-learn
  - Loaded data directly from S3 bucket using `boto3`

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5. Machine Learning Pipeline

- **Preprocessing**:
  - Cleaned and normalized EEG signals
  - Scaled features using `StandardScaler`
- **Model Training**:
  - Built separate regression models for Valence and Arousal
  - Used a basic Dense Neural Network in TensorFlow/Keras
- **Evaluation**:
  - RMSE and R^2 metrics calculated
  - Observed that the initial models had high RMSE and negative R^2 (indicating room for improvement)

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6. Visualization and Analysis

- **Visualized**:
  - Prediction vs. Actual plots
  - Mood swings using line charts to represent emotion fluctuation over time
- **Libraries Used**:
  - Matplotlib
  - Seaborn

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7. GPU Debugging in SageMaker

- **Problem Faced**:
  - CUDA GPU not recognized
  - `nvidia-smi` failed due to improper driver/kernel environment
- **Resolution**:

- Used CPU for execution since GPU support was not functional
- Ensured TensorFlow ran without GPU to avoid errors

Summary of AWS Services Used

AWS Service	Purpose
Amazon S3	Dataset storage and accessibility
Amazon IAM	Role-based access control for SageMaker to read S3 objects
Amazon SageMaker	ML environment for running the training, evaluation, and plots

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Next Steps

- Improve model accuracy using advanced architectures like LSTM or CNN
- Incorporate real-time EEG data streams
- Deploy the model as an API via Amazon SageMaker Endpoint
- Integrate edge devices for real-world emotion detection