NeuroGraph: Cognitive Trait to Neural Pattern Knowledge Graph System

1. Introduction

NeuroGraph is an end-to-end system designed to extract neuroscience-based relationships from text and map how cognitive traits

influence neural activity patterns. It converts unstructured research literature into a structured knowledge graph for analysis

and visualization.

2. Preprocessing Pipeline

• Lowercasing for uniformity

• Unicode normalization to clean hidden formatting artifacts

• Biomedical-aware tokenization using SciSpaCy

• Lemmatization to reduce inflectional variation

• Stopword removal while preserving scientific vocabulary

• Regex-based punctuation and noise removal

This ensures a clean text representation suitable for neural relationship extraction.

3. Triple Extraction Model

Relationships are extracted in (subject, relation, object) format with metadata including cognitive condition and intensity.

Entity classes include traits, neural regions, neural activation patterns, and environmental factors.

Relation classification uses syntactic parsing and semantic role heuristics.

4. Knowledge Graph Construction

The graph is stored in Neo4j. Nodes represent traits, brain regions, activation patterns, and environmental influences.

Edges represent functional influence relationships (e.g., AFFECTS, MODULATES). Graph visualization uses PyVis with

force-directed layout for interpretable neural structure representation.

5. Model Evaluation

The system includes an evaluation interface comparing extracted triples to ground truth annotations.

Metrics: Precision, Recall, and Accuracy. The UI uses color-coded scoring to indicate model performance reliability.

6. System Workflow

Document → Preprocess → Extract Triples → Build Knowledge Graph → Visualization → Evaluation

7. Conclusion

NeuroGraph enables structured interpretation of how cognitive traits influence neural processes. The system supports research,

education, and hypothesis generation in cognitive and computational neuroscience.