Knowledge Graph-Based Decision Support Solution for Drug Information

Use Case Overview

This project proposes developing a knowledge graph to support patients, particularly those managing Parkinson's and other chronic conditions, in accessing structured drug information. Using the REBEL (Relation Extraction By End-to-End Language) model, we will extract entities and relationships from trusted documents to construct a comprehensive and queryable knowledge graph. This graph will allow users to explore connections among drugs, symptoms, side effects, interactions, and other key elements, presenting complex medical data in an intuitive format.

Knowledge Graph Design Using REBEL

1. Document Parsing and Relation Extraction

- REBEL Model: Process articles, research papers, and medical databases. REBEL uses deep learning techniques to extract relationships directly from text, parsing sentences to identify entities and their relationships in a structured, scalable manner.
- Extraction of Subject-Relation-Object Triplets: The REBEL model identifies meaningful connections such as drug–symptom, drug–interaction, and drug–side effect relationships, which will form the backbone of the knowledge graph. Each document parsed will produce triplets like:

Subject: Levodopa —> Relation: treats —> Object: Tremor

Subject: Levodopa —> Relation: has side effect —> Object: Nausea

Subject: Dopamine agonists —> Relation: contraindicated for —> Object: Pregnant women

Subject: Levodopa —> Relation: interacts with → Object: Antidepressants

2. Entity and Relationship Design

- **Key Entities (Nodes):**
  1. **Drugs:** Levodopa, Dopamine agonists, MAO-B inhibitors
  2. **Symptoms:** Tremor, Rigidity, Bradykinesia
  3. **Side Effects:** Nausea, Dizziness, Hallucinations, Dyskinesias
  4. **Interactions:** Antidepressants, Blood pressure medications
  5. **Drug Classes:** Anticholinergics, COMT inhibitors, Amantadine
  6. **Genetic Factors:** LRRK2, SNCA, Parkin
  7. **Biomarkers:** Alpha-synuclein, DJ-1, Urate
  8. **Non-motor Symptoms:** Depression, Anxiety, Sleep disorders
  9. **Therapy Types:** Deep Brain Stimulation, Physical therapy, Occupational therapy

- **Key Relationships (Edges):**
  1. **Treats:** links drugs to the symptoms they manage
  2. **Has Side Effect:** connects drugs to common side effects
  3. **Interacts With**: indicates known drug interactions
  4. **Contraindicated For:** flags populations for whom a drug may be unsuitable
  5. **Associated With:** Links genetic factors to increased risk of Parkinson's
  6. **Measured By:** Connects biomarkers to diagnostic or progression monitoring tools
  7. **Complements:** Shows how different therapies or medications work together
  8. **Indicated For:** Specifies which symptoms or stages of disease a treatment is most appropriate for
  9. **Metabolized By:** Indicates which enzymes process the drug, relevant for understanding drug interactions

This structure will provide a navigable network of relationships, allowing users to query and receive concise information tailored to their health needs.

Data Sources for Knowledge Graph Population

- https://www.ninds.nih.gov/health-information/disorders/parkinsons-disease
- https://www.apdaparkinson.org/living-with-parkinsons-disease/treatment-medication/medication/
- https://my.clevelandclinic.org/health/treatments/parkinsons-disease-medications
- https://www.mayoclinic.org/diseases-conditions/parkinsons-disease/diagnosis-treatment/drc-20376062
- National Institute on Aging (NIA) - Parkinson's Disease Information
- The Michael J. Fox Foundation for Parkinson's Research
- American Academy of Neurology (AAN) Guidelines
- European Parkinson's Disease Association (EPDA)
- PubMed Central (PMC) for peer-reviewed research articles

Potential Enhanced Knowledge Graph Features

1. **Temporal Aspects:** Incorporate time-based information to show how treatments may change over the course of the disease progression.
2. **Dosage Information:** Include typical dosage ranges and titration schedules for medications, which can be crucial for patient understanding.
3. **Clinical Trial Data:** Link to ongoing and completed clinical trials for emerging treatments, providing hope and potential participation opportunities for patients.
4. **Patient Reported Outcomes:** Integrate anonymized patient experiences and reported efficacy of treatments to provide real-world context.

5. **Cost and Insurance Information:** While this data can be complex and variable, providing general cost tiers or insurance coverage likelihood can be valuable for decision-making.
6. **Drug-Food Interactions:** Expand the interaction data to include common food interactions, such as protein intake affecting levodopa absorption.
7. **Off-Label Uses:** Include information on common off-label uses of medications, which can be prevalent in Parkinson's treatment.
8. **Pharmacogenomic Data:** Incorporate genetic factors that may influence drug efficacy or side effect profiles, supporting personalized medicine approaches.

Expected Outcomes

This project will deliver a knowledge graph populated with curated information on drugs relevant to Parkinson's and chronic conditions, enabling users to access drug-related insights with ease. The graph structure, through REBEL's parsing, will offer clear, accessible knowledge on drug purposes, side effects, interactions, and contraindications. This tool is designed to scale and incorporate additional medical topics, ultimately providing a valuable decision aid for patients seeking clarity on their treatments.