AN ARCHITECTURE FOR ONTOLOGY-BASED SEMANTIC REASONING USING LLMS IN HEALTHCARE DOMAIN

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Presentation Plan

- Goals
- Use of LLM’s in Healthcare Domain
- Literature Review
- Proposed model
- Dataset
- Conclusion

Goals

1. LLMs are highly effective at extracting valuable insights from large-scale health data, including electronic health records and clinical notes.
2. Large Language Models (LLMs) and Knowledge Graphs (KGs) are significantly improving healthcare by enabling more accurate diagnoses and personalized treatments.
3. The combination of LLMs and KGs allows for more comprehensive analysis and interpretation of complex health data, leading to better healthcare outcomes.

Understanding Health Data for LLM's

Diagnosis

Using the system to assist in identifying potential diagnoses based on patient symptoms, medical history, and other relevant factors.

Treatment

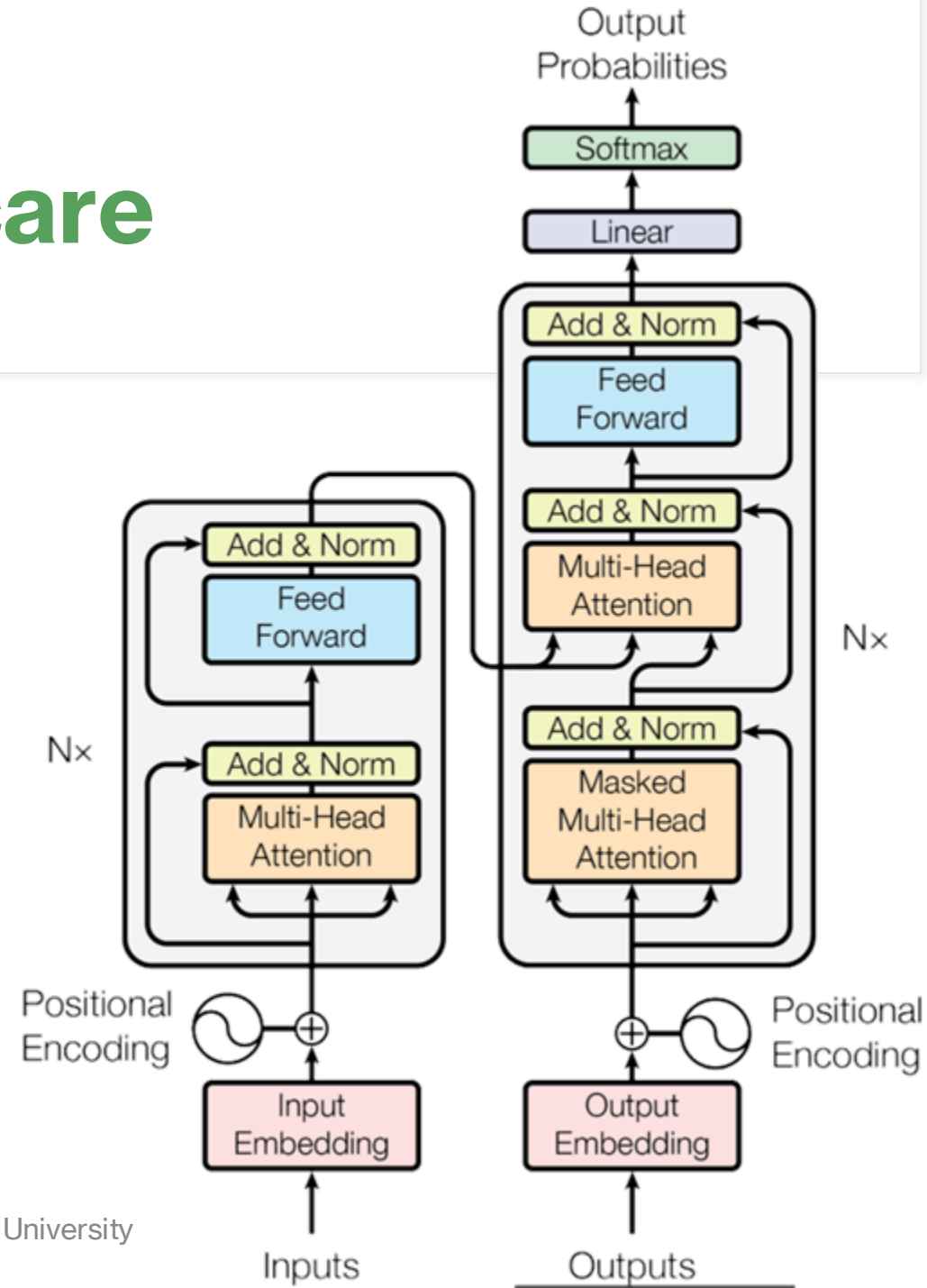
Providing evidence-based treatment recommendations based on the patient's condition, considering individual characteristics and preferences.

Personalized Care

Tailoring treatment plans and communication to individual patient needs and preferences, fostering a patient-centered approach.

Use of LLM's in Healthcare

- LLMs, as advanced versions of natural language processing technologies, understand large amounts of text data.
- They analyze the text, understand the context and produce meaningful results for the inputs.



Areas of Use for LLM's in Healthcare

1 **Drug Discovery**

LLMs are being used to develop query-answer systems for drug discovery in cancer research, validating gene-disease associations using machine learning techniques.

2 **Medical Decision-Making**

LLMs are being used in medical decision-making, leveraging decision trees to produce more reliable medical answers.

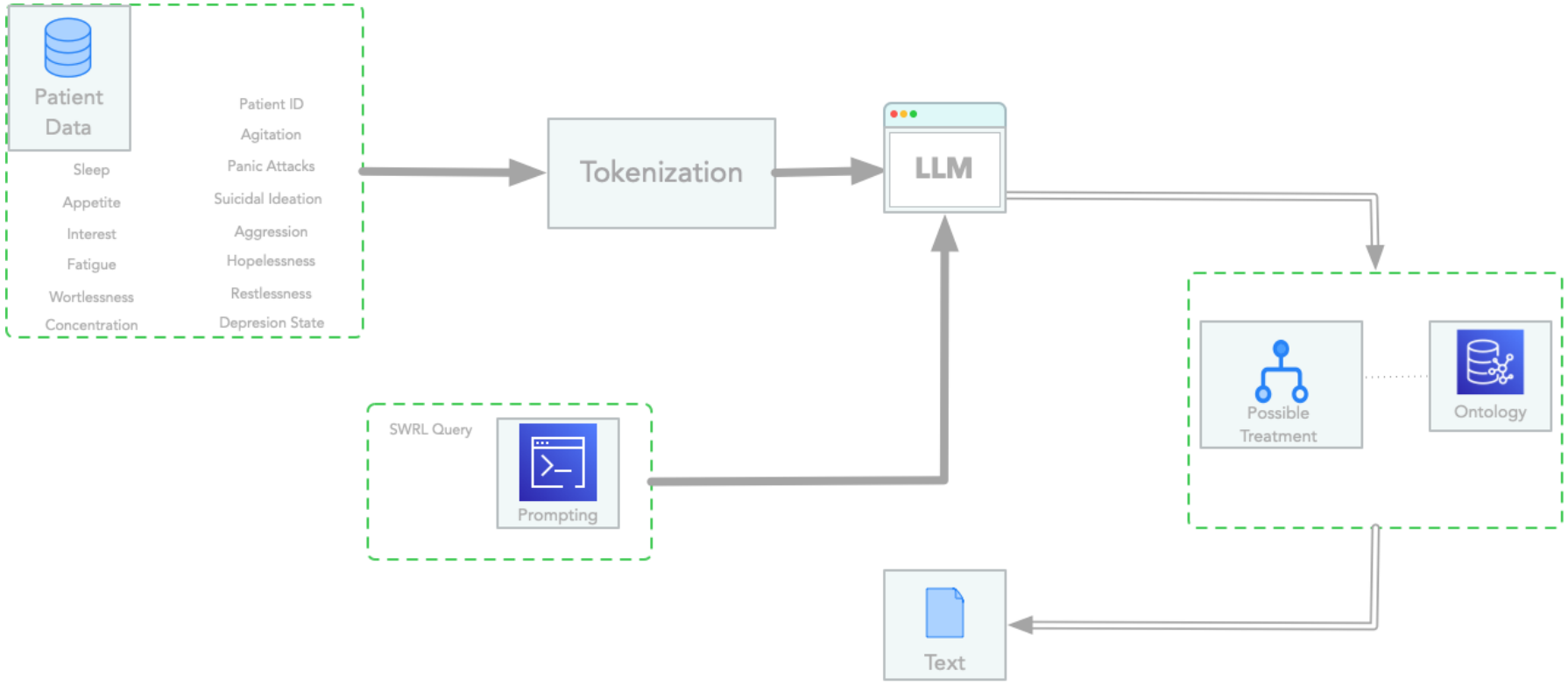
3 **Health Prediction**

LLMs are being used to make inferences about health based on semantic reasoning, using user demographics, health information, and wearable sensor data.

Literature Review

Title	Year	Domain	Method	Ontology Language	Dataset
A dynamic fuzzy rule-based inference system using fuzzy inference with semantic reasoning	2024	Alzheimer's disease diagnosis	Semantic features were created using ontological reasoning. Fuzzy was applied to the results.	Fuzzy OWL	Alzheimer's Disease Neuroimaging Initiative (ADNI)
Using type-2 fuzzy ontology to improve semantic interoperability for healthcare and diagnosis of depression	2023	Diagnosed with major depressive disorder	After the fuzzification process, knowledge base and rule base steps were used. Depression severity was clarified.	Fuzzy OWL	Anonymous patients' records
A framework for disease diagnosis based on fuzzy semantic ontology approach	2020	Treatment diagnosis for diabetes	Creating a linguistic fuzzy rule base for the information coming from the semantic model	Fuzzy OWL	Electronic Health Records (EHR)
An ostensive information architecture to enhance semantic interoperability for healthcare information systems	2024	Local health information system diabetes	The components of the semantic engine consist of the FHIR knowledge graph and transformation components	OWL	Medical Information Mart for Intensive Care (MIMIC)
Knowledge Graph-based Thought: a knowledge graph enhanced LLMs framework for pan-cancer question answering	2024	Drug discovery for cancer research	Creates the optimal subgraph using important information	-SynLethKG -SDKG -SOKG	--
From Large Language Models to Knowledge Graphs for Biomarker Discovery in Cancer	2023	Gene-disease relationship	Cancer information is integrated into the ontology. Final fine-tuning with LLMs	Ontological rules	-OncoNet Ontology (ONO) -Scientific Article

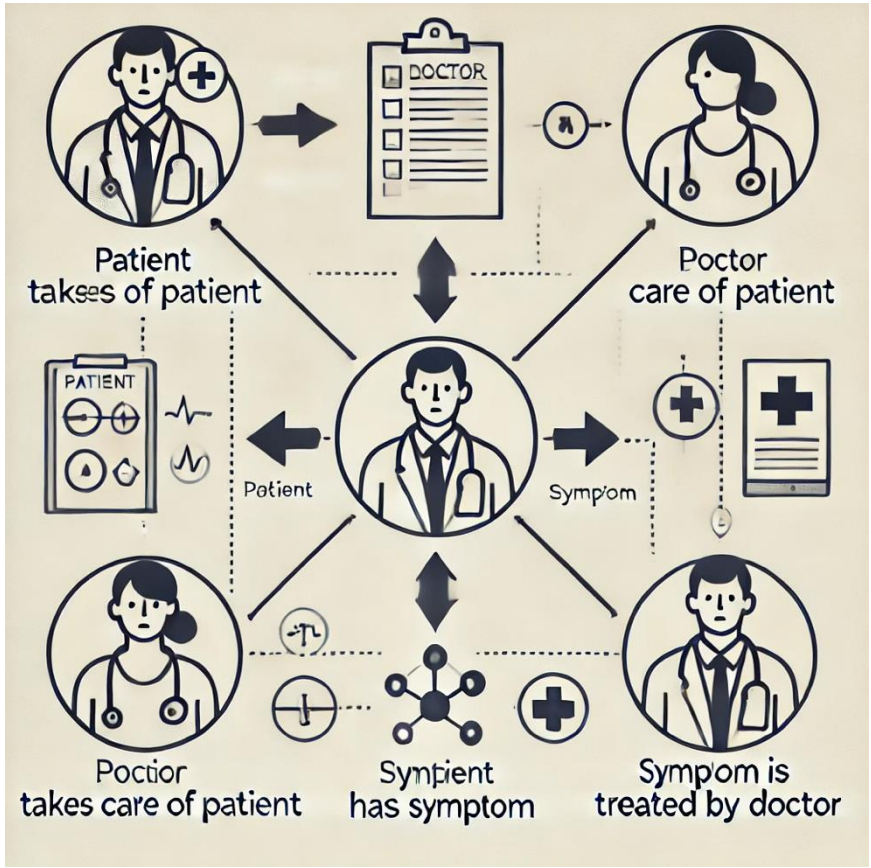
Proposed Model



Dataset

Personal Attributes of Information	
Frequency of Sleep Disturbance	Suicidal Ideation
Change in Appetite	Aggression
Loss of Interest in Activities	Experiencing Panic Attacks
Feeling of Worthlessness or Guilt	Despair
Fatigue or Low Energy	Restlessness
Difficulty Concentrating	General Depression State
Physical Agitation	

Example of SWRL Rule



Conclusion

- Ensuring the system is user-friendly for clinicians and provides understandable explanations for its reasoning and recommendations.
- Evaluating the system's ability to accurately identify relevant concepts and relationships from data and generate correct inferences.
- Less hallucinations on the treatment recommendations based on the rule execution results on the control of the LLM outputs.
- Future Work : RAG to Knowledge Graph → Entity Resolution based on the healthcare domain
- Future Work : Automatic Rule Extraction from Patient Reports

- Thank you for listening.. ☺

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