A Neuro-Symbolic Approach to Monitoring Salt Content in Food

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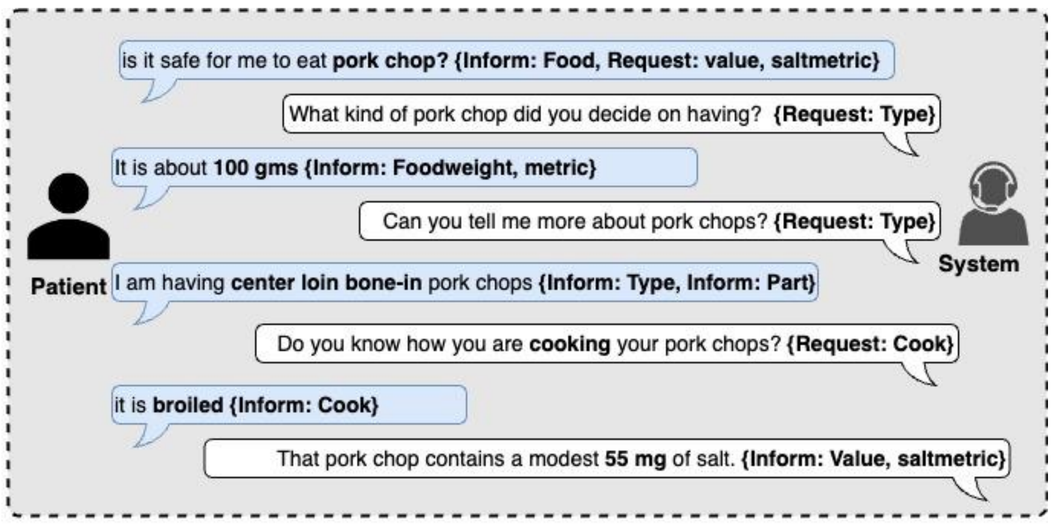
Introduction

- Heart failure (HF) is a prevalent chronic condition
- HF patients need to monitor their salt intake
- **Heart failure education sessions:** often focus on salt and food [1]
- Difficult to read food labels [3]
- **Goal**: Dialogue system to help HF patients

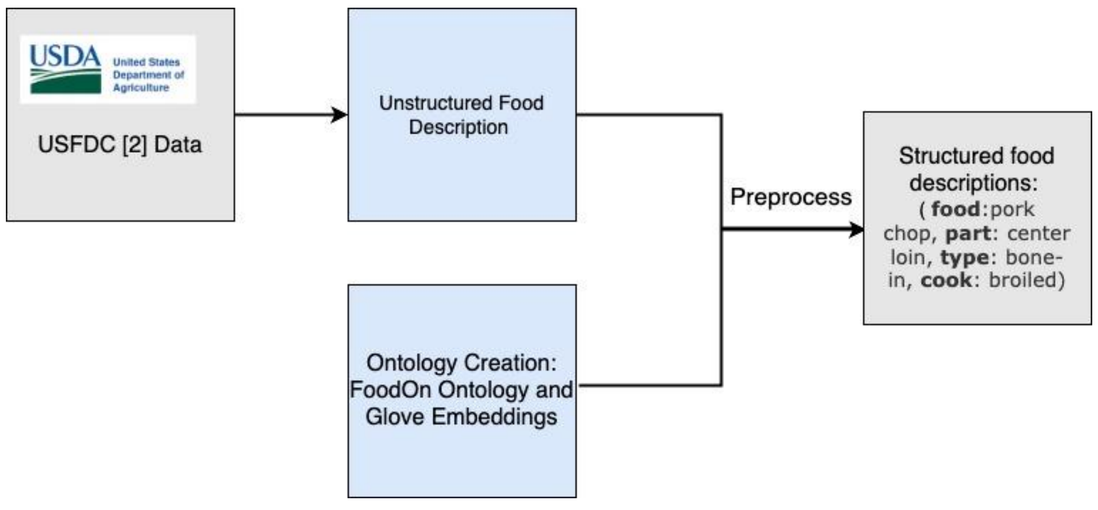


Sample Conversation

Challenges

- Lack of structured data on food
- Lack of conversational data on food
- Need to address vague user queries
  "What is the salt content in pork chops?"
- Need to ask clarification questions about food preparation and cooking method, varying portion size

Dataset Creation



Structured Dataset Creation

Conversational Dataset Creation

- Template based conversational dataset (MultiWOZ [5])
- Conversation alternates between user and system
- **Slots**: food, cook, type, animal, part, foodweight, metric
- System's questions and user's responses are randomly selected from template
- Types of turns
  - Matching answers
  - Random answers
  - Changing answers

# Dialogues	87,425
# Total turns	525,392
Avg turns per dialogue	6
# slots	7

Conversational Dataset Dialogue Statistics

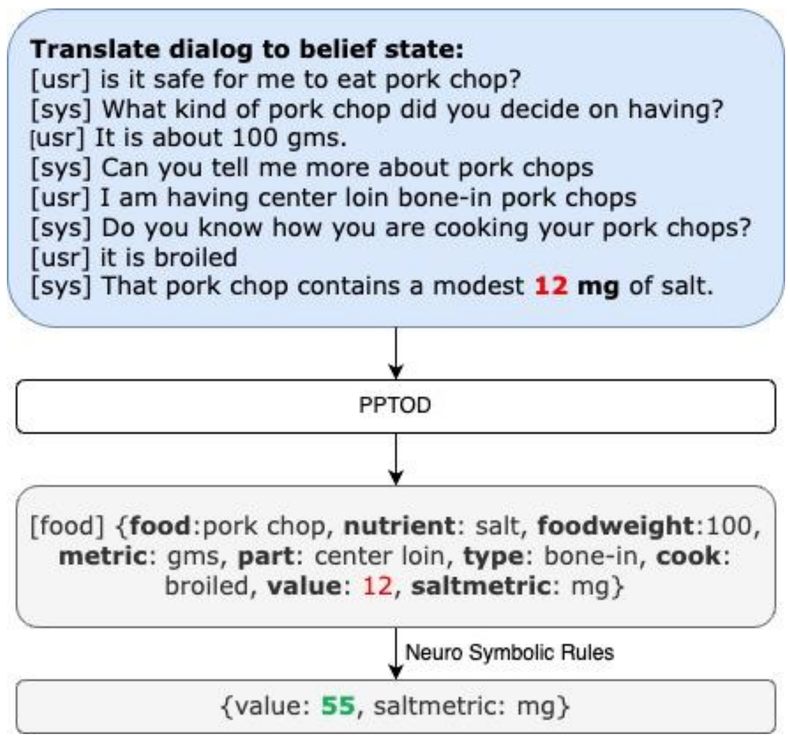
NS-PPTOD

PPTOD (Plug-and-Play Task Oriented Dialog System) [4]
- T5 based - model designed for task-oriented dialogue [6]
- Adept at in-context learning employing customized prompts

How do we use PPTOD?
- Trained with maximum likelihood objective
- Few-Shot Training
- **Performance**: correctly identified most slot values but not salt values

NS-PPTOD
- Added neuro-symbolic rules

NeuroSymbolic Rules:
- Retrieval of accurate salt value from database
- Mathematical calculation of correct salt value for queried food weights
- Able to respond to queries for non-standard food quantities (bowl, plate)



NS-PPTOD Model with Example: NS-PPTOD corrects PPTODs mistake

Evaluation

Train Size	Epochs	Joint Accuracy	
		PPTOD	NS-PPTOD
100	6	55.56	73.08
300	4	51.92	72.8
500	6	58.75	83.2
1000	6	58.53	85.2

Model Performance

Current Work

In-depth user study comparing NS-PPTOD with chatbot based on GPT4
- **Within subject study:** Patients interact with both systems
- Perform qualitative and quantitative analysis to evaluate understandability, usefulness, user preference, usability and system effectiveness

Extend dialog system to other domains: exercise, fluid intake, medication

Conclusions

- Training transformer model for determining salt content falls short in accuracy
- Neuro-symbolic rules required to enhance accuracy
- Proposed NS-PPTOD offers specialized solution to monitor salt

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