Kenan Herbert

KBAI: Project 2

Purpose

The objective of this project is to design and implement an artificially intelligent chatbot that can answer simple questions about the class syllabus. This agent seeks to utilize Production Systems, Problem Reduction, and other means of creating human-esque cognition to provide these answers.

Relating to Human Cognition

The language we use every day is governed by rules and relationships that provide meaning to the strings of words. Our agent must learn to use these rules to find relationships within strings of words. Us humans are very smart, and we can keep track of vast amounts of rules and relationships and specific instances that break these rules. However, our intelligence truly comes from our ability to generalize. Our agent must do the same. Rules and heuristics will govern how our agent behaves, however, exceptions to the rules always exist and we must be aware of these as well. Utilizing the basic grammar techniques and vocabulary that humans use, our agent is very capable.

Domain Knowledge

In this project, our agent has a limited vocabulary it must be aware of. However, 158 words can be used in almost endless combinations. The strings given to our machine are sensible, legal sentences with at most nine words. These legal sentences will be asking about a specific domain of an object. Since our machine is being asked about the class syllabus, the objects that may be asked about are the three assignments and three projects, the midterm, the final, the class forum, and the goals of the course. For our assignments, projects, midterm, and final, the machine can be asked about the RELEASEDATE, DUEDATE, WEIGHT, PROCESS, or DURATION of these objects.

Generating Test Questions

For this project, 80 test questions were generated. Many were sourced from piazza, but the driving force behind generating these questions was providing a diverse set of examples to rigorously test the agent's ability to parse a sentence into its core parts. Sentences with multiple verbs, interwoven phrases, and large prepositional phrases were crucial in pushing the agent to find better generalizations and exceptions to each rule. Most important were sentences that actively tried to break the agent. Questions with valid designs and objects, but invalid domains were tricky at first, but ultimately solvable. At the end of the document is a set of 20 questions from this testing set.

Implementation

Representing Sentence Structure

In our agent, we represent sentence structure with various phrases. Our agent builds sentences our of Question Phrases (QP), a Main Verb Phrase (MVP), and a Subject Phrase (SP). Optionally, we may also see a Secondary Verb Phrase (SVP), an Object Phrase (OP), or an Auxiliary Verb Phrase (AVP). Each of these phrases plays a key role in identifying the most important aspects of the sentence. Here is one example sentence that highlights these phrases.

(1) When will assignment 10 be released?

Here, the red is our QP, dark green is our MVP, blue the SP, and light green is the AVP. The QP begins to point us in the right direction of what domain we are referring to. A question word such as "When" leads our agent to begin thinking DURATION, RELEASEDATE, or DUEDATE instead of WEIGHT or PROCESS. The subject, "assignment 10" tells our agent we are looking at an assignment. However, our agent knows there are only three assignments, so our agent begins to believe it cannot answer this question. Finally, in the AVP, our agent sees the key verb "released." This word weights our agent towards the RELEASEDATE domain, however since "assignment 10" is nonsensical, our agent will reply with intent 0. Below is another example.

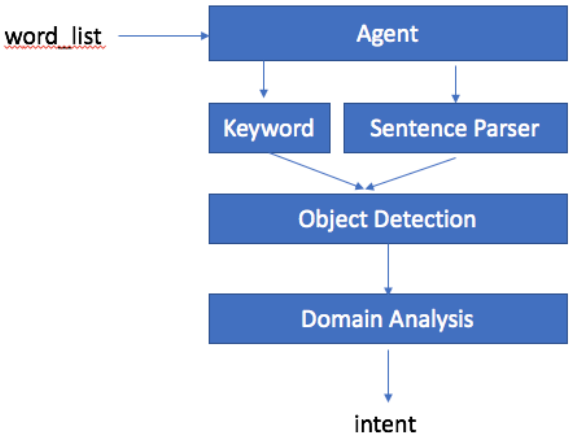
(2) Where do I need to turn in project 2?

Here, our question has a more complicated verb structure we need to be aware of. Again, we begin at the QP. Our agent sees "Where" and is immediately slightly weighted towards the PROCESS domain. We continue to our MVP, which consists of a compound verb. "Do" is an interesting verb in that it can stand on its own and participate as a reference to another verb, in this case "need." The MVP is split by the simple subject "I." Simple subjects like "I" or "We" encourage our agent to believe the object of the sentence lies after the verbs. The next phrase is an AVP that contains the verb "turn." Coupled with "in" this becomes a clear indicator that our question's domain is PROCESS. This AVP also alerts our agent that the object of the sentence is not in the subject, and instead in a following OP. Here, our agent discovers "project 2" and deduces the question is pertaining to project 2's PROCESS. In general our agent looks at the most generalized structure as:

Question Phrase → Main Verb Phrase → Subject Phrase →
Secondary Verb Phrase → Object Phrase → Auxiliary Verb Phrase

The bold phrases are almost guaranteed to have the above order and are guaranteed to exist. The non-bold phrases are only sometimes detected, however their existence is very important to helping our agent find the object of the question.

Process



1. word_list is inputted to our agent
2. Sentence parser generates phrases with POS analysis
3. Keyword search narrows down possible domains and objects
4. Keyword search is combined with sentence structure to determine the question object
5. The question object, with further structural and keyword analysis yields the question domain
6. Our agent outputs the calculated intent of the question

Above is a diagram representation of the process our agent goes through to deliver an intent calculation. After our agent has parsed the question into its constituent phrases, it can then make inferences about where important information is. After keyword detection and sentence parsing, our agent tallies up a score for each object and domain. The (object, domain) pair that receives the highest score is found in the intent map and the appropriate intent is returned to the user. The Sentence Parser heavily utilizes decision trees and semantic networks to determining the underlying structure in the question. First the Sentence Parser finds the parts of speech of each word, then using grammar rules programmed via decision trees, establishes the phrases that constitute the question. Then, our parser connects these phrases using semantic networks in a way that is simpler and more meaningful to finding the question's relevant information. The scoring method our keyword analysis uses is a form of Generate & Test. In our case, we generate a score for each possible intent, and take that which is highest. The agent performs very strongly in identifying the appropriate question object, and if that object is sensible.

Shortcomings

Unfortunately, as with all agents, there are shortcomings. This agent failed on several questions. The most notable of which are below:

1) When is the second midterm due?
2) What file must we submit for the second project?
3) What file do we download at piazza?

The biggest issue was deciding between a tie score in the unknown intent (0) and either of the general intents. Attempts to mitigate this included subtracting score from intents other than unknown when a nonsensical object such as "assignment 10" appeared and rebalancing the points gained and lost for various keywords and structural relationships. Similarly, when nonsensical questions are provided the agent has an increasingly difficult time providing sensible answers.

Question Set

1) "how do I know how much project 2 is worth",
   "intent": 0
2) "question": "how do I know where to submit project 1",
   "intent": 34
3) "question": "how do I know when to submit project 1",
   "intent": 10
4) "question": "what percentage of learning goals is ai skills",
   "intent": 42
5) "question": "what file must we submit for the second project",
   "intent": 37
6) "question": "what file do we download at canvas",
   "intent": 0
7) "question": "what file do we download at piazza",
   "intent": 0
8) "question": "how do we submit the code for project 2",
   "intent": 37
9) "question": "how do we submit the report for project 2",
   "intent": 37
10) "question": "how do we submit the report for assignment 2",
    "intent": 35
11) "question": "how do we submit the code for assignment 2",
    "intent": 0
12) "question": "how do we submit the code for the final",
    "intent": 0
13) "question": "when is the midterm",
    "intent": 4
14) "question": "when is the final",
    "intent": 8
15) "question": "what is the relationship between human cognition and ai",
    "intent": 0
16) "question": "when will project 1 be available",
    "intent": 2
17) "question": "how do I submit project 4",
    "intent": 0
18) "question": "where do I need to turn in project 2",
    "intent": 0
19) "question": "where can I download the midterm",
    "intent": 0
20) "question": "Where are the announcements",
    "intent": 41
21) "question": "What is the procedure for submitting assignment 1",
    "intent": 33
22) "question": "What project do I turn in by week 6",
    "intent": 0
23) "question": "When will project 2 be distributed",
    "intent": 5