Mini Project 3 – Sentence Reading Agent

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1 AGENT DESIGN

1.1 Preprocessing

The agent in this assignment starts by processing the 500 most common words in the form of a dictionary where each word is mapped to its part of speech (POS) tag (e.g., noun, verb, adjective). This preprocessing step is crucial because it allows the agent to classify and tag the words in both the sentence and the question based on their grammatical role. The agent then converts the dictionary into lowercase, which standardizes the data and ensures that case differences (e.g., "Serena" vs. "serena") do not affect word tagging. This step is important because it sets up the foundation for the agent's ability to recognize words in various forms and contexts. The POS tags enable the agent to understand the structure of sentences and questions, which is vital for answering questions correctly. Without this step, the agent would struggle to identify grammatical categories like nouns, verbs, and pronouns, leading to incorrect or vague answers.

1.2 Sentence and Question Processing

Once the agent receives a sentence and question, it begins by preprocessing both the input sentence and questions to ensure it is in a clean and workable format. This preprocessing step involves removing punctuation and converting all text to lowercase to normalize the input. Again, this ensures that differences in case or punctuation do not interfere with word matching or sentence analysis. The sentence and question text are then split into individual words, creating lists of words. This step allows the agent to handle each word separately when applying tags and determining its role in the sentence.

After preprocessing, the agent proceeds to classify the questions based on the first word being "who", "what", "when", "where", or "how". Each type of question is handled differently:

- For "Who" questions, the agent looks for proper nouns or pronouns, which are typically used to refer to people or entities.
- "What" questions focus on identifying nouns, verbs, or adjectives. The agent determines this based on what the question is asking about.
- For "When" questions, the agent searches for time-related adverbs or nouns that indicate when something happened.
- "Where" questions involve identifying location-based words, such as prepositions or place-related nouns. Again, the agent determines this based on what the question is asking about.
- Finally, "How" questions often involve numbers, measurements, or descriptive words, and the agent infers this depending on the context.

The classification of question type enables the agent to apply the appropriate methods for extracting the relevant answer from the sentence based on the type of question being asked.

2 AGENT PERFORMANCE AND EFFICIENCY

2.1 Performance

Initially, using the test cases provided in the provided starter code, the agent performed well, correctly answering all 8 questions. However, upon submission to the full set of questions, the agent's performance did not meet expectations, revealing several areas for improvement. Through iterative refinement, the agent's score gradually improved, eventually achieving a high score of 36 out of 40. This iterative process involved adjusting how the agent processed certain types of questions and refining its ability to extract relevant information from more complex sentences. Despite these improvements, the agent consistently struggles with correctly answering 2 to 4 questions in most submissions. An example incorrect answer the agent provided corresponds to the sentence and question below:

Sentence: "The island is east of the city."

Question: "Where is the island?"

In this question, the agent incorrectly identifies "city" as the answer, likely because it is focusing on the last noun in the sentence rather than understanding the relational context of the words. Moreover, the agent appears to struggle with

the prepositional phrase "east of" which requires an understanding of directional relationships between entities. As a result, when solving this problem, the agent's approach is too simple and treats the sentence as a list of words tagged by parts of speech, which leads it to select "city" without grasping the full spatial relationship between "island" and "city." Solving this question correctly would require a more advanced comprehension of sentence structure and, because of time limitations, the correct answer was not given.

2.2 Efficiency

The agent's efficiency can be described with a time complexity of O(n), where n represents the number of words in the sentence and question being processed. This linear time complexity stems from the operations involved in breaking apart the sentence, tagging words based on the dictionary, and then solving the question by iterating over the tagged words. As sentence complexity increases, meaning longer sentences with more words, the agent's performance is expected to grow linearly, which is typical for such operations.

For testing both efficiency and accuracy, a set of 21 questions was used and arranged by difficulty, with Q1 being the easiest and Q21 being the most difficult. Referencing figure 1 below, it is evident that, regardless of complexity, most questions take a very short time to solve, with standardized times near zero. However, there are outliers such as Q7 and Q21, which take the longest, reflected by their standardized times of 1. The presence of these outliers suggests that while the agent is generally efficient, certain questions require more processing time. Despite these few cases, the agent remains efficient in almost all scenarios, consistently answering questions with minimal time.

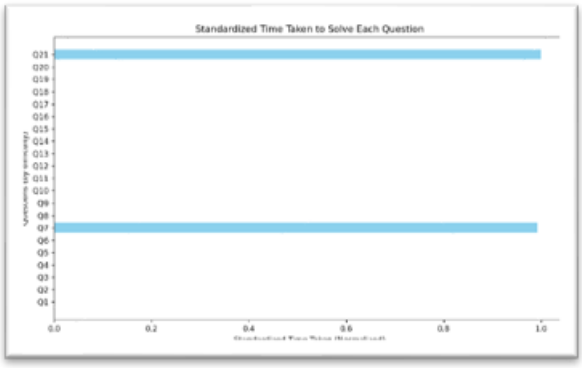

Figure 1 — Agent efficiency - Time to solve 21 test problems.

2.3 Clever Implementations

The agent implements several clever optimizations when processing questions, making its search both efficient and precise. After classifying a question as "who," "what," "when," "where," or "how," the agent further refines its search based on key patterns within each question type. For “how” questions, the agent quickly identifies whether the query involves "many" or "much" and narrows the search to numbers or determiners, avoiding irrelevant words. When handling “where” questions, the agent looks for verbs or prepositions like "go" or "in," which are often followed by location-related information. This allows the agent to hone in on the correct part of the sentence without unnecessary scanning. For “what” questions, the agent uses keywords like "name," "do," and "color" to focus its search on proper nouns, verbs, and adjectives, skipping irrelevant parts of the sentence. These optimizations allow the agent to maximize efficiency, especially when dealing with more intricate sentence structures, making it highly efficient in identifying answers across different question types.

3 HUMAN VS AGENT

The agent in this problem processes sentences differently than humans, relying on rules and keywords rather than context and intuition. While humans use prior knowledge and context to interpret meaning, the agent follows syntactic patterns, which can lead to misinterpretations. Using the question "Where is the island?", which the agent answered incorrectly, a human would intuitively understand the answer as "east of the city," but, in this case, the agent mistakenly returns "city" by misinterpreting the structure.

Overall, the agent is significantly faster in scanning for keywords and solving the questions, but it struggles with subtleties and ambiguity that humans can easily resolve. While the agent is more efficient, its rigid approach lacks the flexibility and deeper understanding of human interpretation.