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Natural Language Technologies Project

**Implementation a Star Wars-themed dialogue
system.**

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Introduction

User Experience

When StarWarsBot starts, he will randomly choose one from the three initial greeting phrases generated through the use of the SimpleNLG library:

During sentence generation, the addition of the onomatopoeia "Hhhh..." is intended to imitate the famous character Dart Vader® from the celebrated Star Wars® series.

Once the user has entered his or her name as prompted by the bot, he or she can then answer the questions generated through SimpleNLG and asked by the bot. The latter will be able to be able to analyze the user's answers and provide output based on the different instances that may be encountered:

- Correct question: The bot will congratulate user for answering the question correctly.
- Partially correct question: The bot will alert the user to the incompleteness of the answer, requesting additional missing information until the end of attempts.
- Wrong question: The bot will warn the user of the error made and re-submit the question just asked, until the maximum number of attempts has been reached. Whereupon the bot will move on to the next question informing the user that it has exhausted all available attempts.
- Response with nonexistent terms: the bot will try to show the user to be Annoyed by the answer entered as not sensible or incomprehensible.

The number of questions and the score obtained by the user will influence what will be the final evaluation and thus also the final comment by the bot.

Methodologies used in the implementation of the bot

The choice adopted on the analysis of the responses given by the user was to perform pattern matching on them. The advantage of this choice concerns the speed of processing the response to verify the correctness of the data received by the bot. However, this technique has a major syntactic and semantic limitation, since the main focus is on searching for the desired term. Therefore, the correct synonyms or the context in which the term is placed are not considered. Therefore, to the question "Tell me everything you know about topic X," the answer "Surely term A and term B have nothing to do with each other" is interpreted as correct because the bot is satisfied with the presence of the terms despite the user expressing that such terms are not part Of the topic asked.

Response generation with NLG

As will be covered later, the SimpleNLG library was decided to be used for feedback generation and thus for the construction a StarWarsBot dialog system.

SimpleNLG enables natural language generation in a simple way. It features the presence of a morphological/syntactic system, a realiser and finally allows microplanning.

Trindi Ticklist

- Q1: Is utterance interpretation sensitive to context? **NO**
- Q2: Can the system deal with answers to questions that give more information than was requested? **YES**
- Q3: Can the system deal with answers to questions that give different information than was actually requested? **YES, MANDATORY**
- Q4: Can the system deal with answers to questions that give less information than was actually requested? **YES**
- Q5: Can the system deal with ambiguous designators? **NO**
- Q6: Can the system deal with negatively specified information? **PARTIALLY**
- Q7: Can the system deal with no answer to a question at all? **YES**
- Q8: Can the system deal with noisy input? **YES**
- Q9: Can the system deal with 'help' sub-dialogues initiated by the user? **NO**
- Q10: Can the system deal with 'non-help' sub-dialogues initiated by the user? **NO**
- Q11: Does the system only ask appropriate follow-up questions? **YES**
- Q12: Can the system deal with inconsistent information? **PARTIALLY**
- Q13: Can the system deal with belief revision? **NO**
- Q14: Can the system deal with barge-in input? **NO**
- Q15: Is it possible to get a system tutorial concerning the kind of information the system can provide and what the constraints on input are? **NO**
- Q16: Does the system check its understanding of the user's utterances? **NO**

Representation and evaluation of the questions

The questions posed to the user are characterized by the following main attributes:

- **Category:** Each question requires information regarding specific topics in the Star Wars saga. Specifically, the categories indicated within the knowledge base include Jedi basics, Jedi code, Jedi hierarchy, the force, and Sith.
- **Weight:** Number belonging to $[1, 5]$, assigned according to the question type. They were introduced to distinguish the simplest from the most complex questions; they were useful when extracting questions and evaluating the outcome.
- **Score:** Score calculated in relation to the weight of the question (W) and the answer specified by the user. Regardless of question type, each score function returns a value belonging to $[0, W]$.
- **Maximum number of attempts (back-up strategy):** Indicator of the number of attempts (varying by question type) the user can use to correctly answer the question posed by the bot.

Each question is assigned a typology. The implemented typologies are:

- **Listed:** Require user to provide a complete description of the requested category, the weight chosen is 5.
- **Ad enumeration:** They ask the user how many main notions they remember about a category, the weight chosen is 3.
- **True or False:** They ask the user whether or not a given concept is related to the question category, the weight chosen is 2.

The score functions characterizing each question type are presented below:

- *ListScore(words_{answer}, words_{responses}, weight):*

$$\{weight \mid |words_{answer} \cap words_{responses}| > \frac{|words_{responses}|}{2}\}$$

altrimenti

- *EnumerationScore(n_{answer}, n_{responses}, weight):*

$$\{ [weight \cdot (-\frac{|n_{responses} - n_{answer}|}{n_{responses}})] \mid 0 \leq n_{answer} < 2 \cdot n_{responses} \}$$

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$$Conn_{responses} \geq 0: Score(n_{answer}, n_{responses}, weight)[0, weight]$$

- *TrueOrFalse(bool_{response}, element, ,): words_{responses} bool_{negation}*

$$weight \mid element \in words_{responses} \wedge (bool_{negation} \oplus bool_{response})$$

$$\{weight \mid element \notin words_{responses} \wedge (bool_{negation} \Leftrightarrow bool_{response})\}$$

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Finally, the user's totaled score is calculated by means of the following formula:

$$0 \leq TotalScore(Questions) : \frac{\sum_{g \in Questions} q_{score}}{\sum_{g \in Questions} q_{score}} \leq 1$$

The user is promoted to padawan if $(TotalScoreQuestions) \geq 0.6$.

The drawing of questions to be asked is done by observing the following criteria:

- The number of questions drawn is $|q|$.
- The average weight of drawn questions should be ≥ 2.5 if possible.
- Assuming the number of categories is $|c|$ then at least $\lfloor \frac{|q|}{|c|} \rfloor$ must be drawn applications associated with each category (assuming that the number of applications per category is sufficient).
- Takes into account all types of questions, even those with weights less than 2.5.
- Pseudo-random mechanisms extraction that do not violate the criteria outlined in precedence.

The implemented function is able to generalize the extraction even in cases where an average weight other than 2.5 is desired and there is a disproportionate number of questions depending on the category.

At the time of delivery, the knowledge base describes 5 response categories, and 3 question types makes it possible to generate 15 questions.

The number of questions to be drawn has been set at 5, so the extractor will draw one question per category.

Implementation

The Python language (tested on version 3.10.11) was chosen for the implementation of the project, and its OOP features were exploited to represent question types and the question handler.

In addition to the native Python features, the following libraries were used to facilitate the development of the chat-bot:

- NLTK, to derive a list of tokens from the input provided by the user, by means of the tokenize function.
- Word2Number, to recognize numbers written in English and associate them with their corresponding integers.
- SimpleNLG
 - For the generation of sentences related to the questions to be asked to the user (depending on the types of questions and their categories).
 - For generating the sentences associated with the answers to be presented to the user after
Having answered a question.

The knowledge base representation was implemented using JSON format. Within the "KB.json" file, all eligible categories for queries are listed, and for each of them it specifies a list of words considered descriptive of the category.

The code has been divided into several files, each of which implements certain functionality:

- Question.py: Defines the three question types, each of which is represented by a subclass that extends the Question class. This made it possible to define common state and procedures within the super class, avoiding duplication of code among the various question types.
- QuestionManger.py: Provides functions to support the main program, allows addition and extraction of Question instances by various criteria, including category and weight.
- NLGFunctions.py: Implements ad-hoc functions to generate sentences corresponding questions and answers for each Question class.
- StarWarsBot.py: Implements the main execution loop of the bot by interacting directly with the user, also defines the question extraction policy using method calls to the QuestionManager class.

The bot's memory is encapsulated in the state of Question objects encapsulated within Of the QuestionManager instance.

Processing of responses

Objective

The goal set during the preparation phase of the implementation strategy concerns the creation of a set of responses adaptable to the context and declined in formal and austere language. Also included among the types developed is the language structure of the questions mentioned in the "Questions" section in their various nuances aimed at making the dialogue system as closely akin to Darth Vader's personality.

Sources

The sources used to make the system as similar as possible to the Sith Lord were:

- Star Wars saga (first 3 films) in terms of character characterization
- The Jedi Path, for the basics on Jedi and Sith
- Quotes from Darth Vader (Wikipedia) in order to learn the structure of language and readjust it to the context under consideration

Each of them allowed for the analysis of facets of Darth Vader's language and inclinations, including the study of the syntactic form of sentences.

Methods and implementation

To generate Darth Vader's responses, natural language models offered by the SimpleNLG library were used, which allows various parameters to be set for text generation. language chosen for implementation is English since it is the same as the character's origin and more consistent with the desired linguistic results.

In this section, in particular, we want to analyze the semantic modulation provided to dialog system: the realized functions consist of a text-plan to specify the syntax and a sentence plan for sentence generation, which is done using the specified language tokens. NLGFunctions.py contains the functions composed as follows:

- `PrimaFrase()`: the system takes the dialogue initiative and the first sentence is generated randomly among three different options to provide variability at the beginning of the conversation.
- `ResponseToInput(name)`: the function has a parameter corresponding to the name entered by the user. In this case the particularity of the name corresponding to Luke (son of Darth Vader) was provided. For all other inputs, however, the generation of a phrase chosen randomly from three possible alternatives takes place.
- `SpecifyAllElements(category, attempt)`: function already described in the questions section. Conversation variability is created by adding a Back Strategy based on the number of user attempts to respond, also in the number of three.
- `ContainingYesOrNo(category, element, negated)`: this function is also part of the three main categories of questions and is extrinsic to the pitfall of double negation Intended to mislead the user.
- `ResponseToYesOrNo(category, question, score)`: the function is designed specifically for questions that have only "Yes" or "No" as an answer. It keeps track of the context of the conversation and the correctness of the answer by providing a contextual comment to the result obtained.
- `EnumerateAllElements(category)`: as specified in the "Questions" section, the function is intended to test how many notions are known about a specific category. The answer then predicts a number that must be compatible with the mentioned category.

- `BadResponse(badInput, question)`: the function is intended to implement the Back Strategy regarding inputs that are inconsistent with the conversation. Three error attempts are possible, and the generated responses take a form that incrementally becomes more severe and tending toward typical Darth Vader anger. Call the `SafeQuestion(category)` function on the last allowed response attempt in order to return to the context of the last question.
- `CorrectAns(question,score)`: provides feedback to the user regarding the Total or partial correctness and incorrectness of the answer.
- `Endquestioning()`: the function allows user to be notified that he has run out of response attempts. Unlike `BadResponse`, it is called when the user tries to respond by staying within the context, but fails to do so correctly.
- `Scorecomment()`: the function implements the final comment, the evaluation of Darth Vader based on the score obtained from the answers. When the score is less than 0.6 it means that the user is ineligible to become Darth Vader's Padawan, but if it is greater then the `FinalQuestion()` function is called, which aims to further characterize the conversation by emphasizing the nature of the main character. The latter question is aimed at understanding whether the user, despite his or her preparation, is inclined to embrace the "Dark Side" of the Force and the answer can be "yes" or "no."
- `ChooseTheDark(user_answer)`: The concluding function of the dialog has the user's input, i.e., the answer to the final question, as a parameter. It generates two different comments for the two possible answer options, which correspond to the rating Darth Vader gives the user. In both cases the user is qualified to become a Padawan by having answered the questions correctly, but if the answer given to the last question was "no," the system is able to provide a comment expressing disappointment. In the case of "yes" response from the user, the system returns a comment designed to emphasize the dark nature of the character consistent with the initial goals set.

Examples of conversation

Conversation with the bot by correctly answering all questions and choosing the dark side

```
I do not want to loose my time and patience.  
Hhhh...  
Maybe this is your lucky day so, tell me your name.  
Luke  
Hhhh...  
Nice Luke! Your name supposes that the force is strong with you.  
Like a perfect Skywalker...  
  
Can you tell me how many notions do you know about the force?  
I know four notions about it  
Your answer is correct let's go to another question.  
  
Is it false that self-discipline belongs to jedi basics?  
No  
Good! The Force seems to be on your side, you know something about jedi basics ...  
  
Can you tell me how many notions do you know about sith?  
I know 4 notions about it  
Your answer is correct let's go to another question.  
  
Is it true that anger belongs to jedi code?  
Absolutely no  
Good! The Force seems to be on your side, you know something about jedi code ...  
  
Hhhh...  
What can you specify about jedi hierarchy?  
The jedi hierarchy is composed by initiate, padawan, knight and master  
Your answer is correct let's go to another question.  
  
Hhhh...  
Are you ready to embrace the Dark Side of the force?  
Yes.  
This is the right choice.  
Your performance has impressed me.  
Your mastery of the Force is evident in your precise and efficient execution.  
Hhhh...  
The Dark Side is the path to true power, to bring order to chaos and to shape galaxy as we see fit.  
There is no power in light, only weakness and submission.  
You can be my Padawan and rule the darkness with me.
```

Conversation with bot by correctly answering all questions and NOT choosing the dark side

I am tired today my little Padawan.

Hhhhh...

That's a bad day so, tell me your name.

Luke

Hhhhh...

Nice Luke! Your name supposes that the force is strong with you.

Like a perfect Skywalker...

Can you tell me how many notions do you know about the force?

i know 4 notions

Your answer is correct let's go to another question.

Is it false that field belongs to jedi basics?

Yes

Good! The Force seems to be on your side, you know something about jedi basics ...

Hhhhh...

What can you specify about sith?

fear, anger, love, hate

Your answer is correct let's go to another question.

Is it true that peace belongs to jedi code?

yes

Good! The Force seems to be on your side, you know something about jedi code ...

Hhhhh...

What can you specify about jedi hierarchy?

initiate, padawan, knight, master

Your answer is correct let's go to another question.

Hhhhh...

Are you ready to embrace the Dark Side of the force?

No

Your performance has impressed me.

Your mastery of the Force is evident in your precise and efficient execution.

Hhhhh...

But the light is never a good way just a consolation.

I have to suppose that you are follower of Obi-Wan.

You can be a Padawan, but not mine.

Conversation with the bot by answering some questions incorrectly, failing to pass the test

You are brave my little Padawan.
Hhhh...
Now you have to prove your knowledge so, tell me your name.
Christian
Well christian ...
Are you ready for the challenge?
C'mon let's start! The Dark can't wait.

Hhhh...
What can you specify about jedi code?
Nothing
Your answer is not correct.
I need more precision.
Can you specify something else about jedi code?
I don't know
Your answer is not correct.
Hhhh...
This is not enough for me!.
Please, say somethings about jedi code.
No
Your answer is not correct.
You have exhausted my patience and I will not ask anymore about this question.

Is it true that armony belongs to jedi basics?
Yes
Damn! You are wrong! Need to study more about jedi basics.
You have exhausted my patience and I will not ask anymore about this question.

Can you tell me how many notions do you know about jedi hierarchy?
Not at all
I find your lack of faith disturbing...
Hhhh...
The light confused you.
Try to say something good and don't waste my time with your incompetence.
Can you tell me how many notions do you know about jedi hierarchy?
No
Very bad! Your lack of control is disturbing.
Hhhh...
Maybe you don't know the power of Dark Side.
Can you tell me how many notions do you know about jedi hierarchy?
Can't
You failed me yet again.
Hhhh...
I can not tolerate such arrogance from a simple initiated rookie.
Do you wish experience the full power of the Dark Side and feel the sting of my lightsaber?
Have to be focused we were talking about jedi hierarchy wake up!.
You have exhausted my patience and I will not ask anymore about this question.

Is it true that love belongs to sith?
Yes
Good! The Force seems to be on your side, you know something about sith ...

Can you tell me how many notions do you know about the force?
i know forty five i guess
Your answer is not correct.
You have exhausted my patience and I will not ask anymore about this question.

Your lack of preparation and focus is a clear indication of your weakness.
You squander your potential with careless mistakes.
You failed a simple test...
How can you expect to succeed in the greater challenges that lie ahead?
You must do better or face the consequences, come back when you really know the jedi art.

Conversation with the bot by partially answering questions and using nonsense terms

I do not want to loose my time and patience.
Hhhhh...
Maybe this is your lucky day so, tell me your name.
Leonardo
Well leonardo ...
Are you ready for the challenge?
C'mon let's start! The Dark can't wait.

Hhhhh...
What can you specify about jedi hierarchy?
initiate
Your answer is partially correct.
I need more precision.
Can you specify something else about jedi hierarchy?
initiate, padawan, knight and master
Your answer is correct let's go to another question.

Is it true that force belongs to jedi basics?
kflgdlk
I find your lack of faith disturbing...
Hhhhh...
The light confused you.
Try to say something good and don't waste my time with your incompetence.
Is it true that force belongs to jedi basics?
dklfgdkfl
Very bad! Your lack of control is disturbing.
Hhhhh...
Maybe you don't know the power of Dark Side.
Is it true that force belongs to jedi basics?
kldfnglkdf
You failed me yet again.
Hhhhh...
I can not tolerate such arrogance from a simple initiated rookie.
Do you wish experience the full power of the Dark Side and feel the sting of my lightsaber?
Have to be focused we were talking about jedi basics wake up!.
You have exhausted my patience and I will not ask anymore about this question.