

QUESTION ANSWERING FOR SUMEDANG LARANG KINGDOM USING THE MULTILAYER PERCEPTRON ALGORITHM

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ABSTRAK

Di Indonesia terdapat banyak kerajaan di masa lalu, salah satunya adalah Kerajaan Sumedang Larang. Sumedang Larang adalah kerajaan islam yang berada di bawah kekuasaan Kerajaan Pajajaran. Melalui sejarah, suatu bangsa akan dapat mengenali asal usul bangsanya sendiri, Oleh karena itu pengajaran tentang sejarah sangat penting ditanamkan sejak dini. Dengan pesatnya perkembangan teknologi, pengajaran saat ini tidak hanya berupa pengajaran formal, tetapi juga pengajaran informal. Saat ini pengajaran informal dapat melalui berbagai media, salah satu media yang sering digunakan adalah gadget. Pemanfaatan gadget sebagai media pembelajaran memungkinkan seseorang untuk belajar mandiri. Salah satu bentuk pembelajaran sejarah dengan memanfaatkan gadget dapat berupa Question Answering System (QAS). QAS mengizinkan pengguna untuk bertanya dengan menggunakan bahasa alami dan sistem akan menjawab pertanyaan tersebut. Oleh karena itu, penelitian kami bertujuan untuk membantu mengenalkan sejarah kerajaan sumedang larang kepada masyarakat. Kami membangun sebuah QAS dengan memanfaatkan model n-gram, algoritma Multilayer Perceptron (MLP) dan ontology. N-gram digunakan untuk memotong kata/kalimat dan mengubahnya menjadi matriks, sedangkan MLP digunakan untuk mengklasifikasikan teks dan ontology digunakan sebagai representasi pengetahuan. Pada penelitian ini, sistem mampu menjawab 35 pertanyaan dari 61 pertanyaan yang ada, sehingga memiliki akurasi sebesar 57,37%

Kata Kunci: Multilayer perceptron, ontology, question answering sistem

ABSTRACT

In Indonesia, there were many kingdoms in the past, one of which was the Sumedang Larang Kingdom. Sumedang Larang is an Islamic kingdom under the control of the Pajajaran Kingdom. Through history, a nation will be able to recognize the origin of its own nation. Therefore, teaching about history is very important to be instilled from an early age. Through the rapid development of technology, teaching today is not only in the form of formal teaching, but also informal teaching. Nowadays, informal teaching can be done through various media, one of the media that is often used is gadgets. The utilization of gadgets as learning media allows a person to learn independently. One form of history learning by utilizing gadgets can be in the form of a Question Answering System (QAS). QAS allows users to ask questions using natural language and the system will answer the questions. Therefore, our research aims to help introduce the history of the Sumedang Larang kingdom to the public. We build a QAS by utilizing the n-gram model, Multilayer Perceptron (MLP) algorithm, and ontology. N-gram is used to cut words/sentences and convert them into a matrix, while MLP is used to classify texts, and ontology is used as knowledge representation. In this study, the system was able to answer 35 questions out of 61 questions, so it had an accuracy of 57.37%.

Keywords: Multilayer perceptron, ontology, question answering system

I. INTRODUCTION

HISTORY is knowledge related to the past. History has an important role to recognize the identity of the nation, figures, and heroes. Indonesia has a lot of royal history in the past, one of them is the Sumedang Larang Kingdom. The Sumedang Larang Kingdom was founded by Batara Tuntang Buana, in 721 AD.

Through history, a nation will increasingly understand its identity, because history explains the origin of a nation. Therefore, the younger generation's awareness of history can be started through teaching history. History teaching can be done formally or informally.

The rapid development of technology has an impact on the creation of increasingly diverse teaching methods and media. Nowadays, informal learning is growing rapidly and is very popular with the public, especially informal learning using gadget media. The utilization of gadgets as learning media allows a person to learn independently. "Through independent study, students become doers, as well as thinkers" [1]. With the availability of technological facilities, especially gadgets, it is possible to have various forms of digital teaching innovation, one of which is QAS.

QAS is a system that allows users to ask questions in natural language, and the system will provide answers [2]. QAS answers questions based on the knowledge embedded in the system. The language used in QAS is a natural language [3]. Currently, the media for QAS development is very diverse, it can be a website or a message platform

such as Line, Telegram, and so on. In addition, the methods used in building QAS also vary. In QAS there is a text classification process, and MLP is used to classify text which has a better level of accuracy than Logistic Regression [4]. In addition, Carol Sebastian et al, made QAS using NLP and T5 Tokenizer. T5 Tokenizer is used to change NLP. into text format. The time spent predicting words less than 100 is 1,726 seconds [5]. Lakindu Gunasekara et al, developed QAS using Natural Language Understanding to understand input, the system accuracy was 83% [6]. In addition, the Convolutional Neural Network (CNN) algorithm specifically using the MLP method is used to estimate the similarity score of the input questions and related questions. The result of accuracy using MLP is 82.86% [7]. Hnin Ei Wynne, et al developed a system to detect fake news using the n -gram method, with an accuracy of 96% [8]. In addition, there are studies that develop QAS using ontology as a representation of knowledge. The research uses inferring schema mappings (ISM) to extract answers. Thus, the system is able to answer 992 of the 1125 questions available, or an accuracy rate of 87% [9]. In addition, ontology can be combined with classification algorithms [10]. The classification algorithm is used to identify questions, then the identification results will be matched with the ontology through a SPARQL query. The resulting accuracy is 93.4%.

Based on the problems mentioned earlier, it is necessary to have an informal learning facility, which makes it easier to learn, especially history learning. Therefore, we built a QAS based on the Telegram platform using n -gram, and the MLP algorithm. The MLP algorithm was chosen because it has a better accuracy rate than other models [4], resulting in a more accurate classification. We also use ontology as a knowledge representation [11,12]. With this QAS, we hope that the learning process about history will be easier and more comfortable.

II. METHODOLOGY

In this research, we use information about the Sumedang Larang Kingdom as a source of knowledge. The Sumedang Larang Kingdom is one of the Indonesian kingdoms located in West Java which was founded in 721 AD. As long as the Sumedang Larang Kingdom was established, there were 10 kings who ruled. The Sumedang Larang Kingdom was in its heyday when it was led by Prabu Geusan Ulun. Sumedang Larang kingdom also has many historical relics, these relics are stored in the Prabu Geusan Ulun Museum, in Sumedang Regency.

In this research, we also use n -gram to cut words/sentences and convert these sentences into a matrix form. N -gram is the process of cutting a string into n -characters. for example, the sentence “siapa raja pertama kerajaan sumedang larang” (who was the first king of the Sumedang Larang kingdom) using 2-gram and 3-gram, it will be “siapa raja” (“who king”), “pertama kerajaan” (“first kingdom”), “sumedang larang” (“sumedang larang”) and “siapa raja pertama” (“who first king”), “kerajaan sumedang larang” (“sumedang larang kingdom”). In addition, we use the feature matrix function to convert the words cut from the n -gram process into a matrix. This matrix will make it easier for the MLP algorithm to classify. The MLP algorithm is one type of artificial neural network that is able to work well in classifying 2 class labels. The perceptron model has the following equation,

$$y = w \cdot x + b \quad (1)$$

$$y = \varphi \left(\sum_{i=1}^n w_i x_i + b \right) \quad (2)$$

$$y = \varphi (w^T x + b) \quad (3)$$

where y is the bias equation, w is the weight, x is the input vector, b is the bias, and φ is the non-linear activation function. The MLP algorithm is used to classify the input text and categorize it into a predetermined class. In this research, we use 3 class categories: object, subject, and keywords. These three classes will be matched with the answers in the ontology. In its implementation using the MLP backpropogation model. The backpropogation algorithm compares the predicted value of the network with the data in the training data. In each process, the relationships in the network are adjusted for the world of Mean Squared Error (MSE) between the training data values and the actual values. In the adjustment is done backwards, or from the output layer to the input layer. The first step of backpropogation is to calculate the input for the conclusion based on the current input value and network weight, using the formula,

$$input_j = \sum_{i=1}^n o_i w_{ij} + \phi_j \quad (4)$$

Then generate the output using the sigmoid activation function

$$output = \frac{1}{1 + e^{-input}} \quad (6)$$

Calculate the error value between the training data and the actual value

$$error_j = output_j \cdot (1 - output_j) \cdot (Target_j - output_j) \quad (6)$$

Calculate the error value in the next layer using the formula,

$$error_j = output_j \cdot (1 - output_j) \sum_{k=1}^n Error_k w_{jk} \quad (7)$$

The stages of the method shown in Figure 1

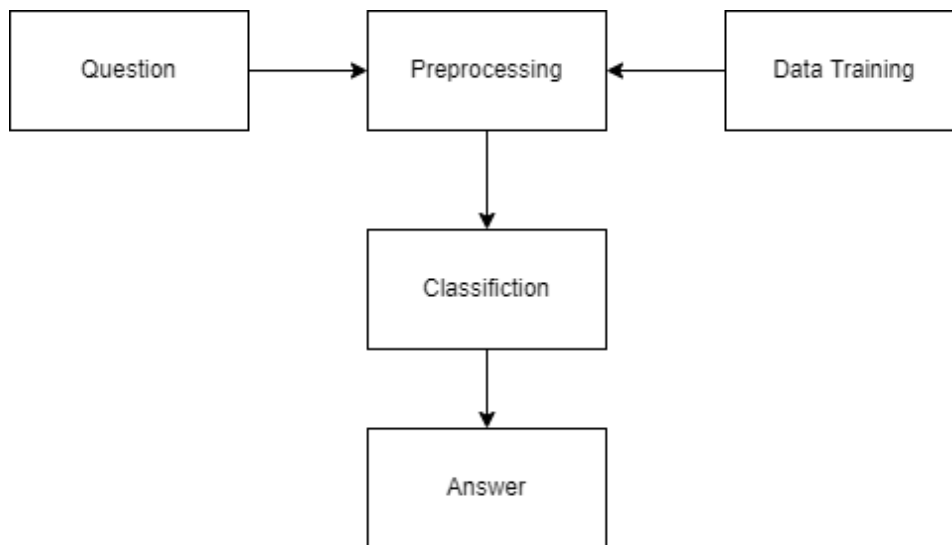


Figure 1. method stages

- a. Question
Data comes from user input.
For example: “Siapa raja pertama Kerajaan Sumedang Larang” (Who was the first king of Sumedang Larang?)
- b. Training Data
Data that contains a collection of questions in which there are class categories to facilitate matching with the ontology process.
- c. Preprocessing
The process of cleaning data, both user input data or training data.
For example: “siapa raja pertama kerajaan sumedang larang” (who was the first king of sumedang larang)
- d. Classification
Before classification, the data is cut using n -grams.
 n -gram: “siapa raja pertama sumedang” (who first king of sumedang)
then classified into which class.
- e. Answer
SPARQL query looks for data that matches the existing category classes in the ontology. Answers that fit the category will be the answers

III. RESULT AND DISCUSSION

The series of stages that we used in this research can be seen in Figure 2.

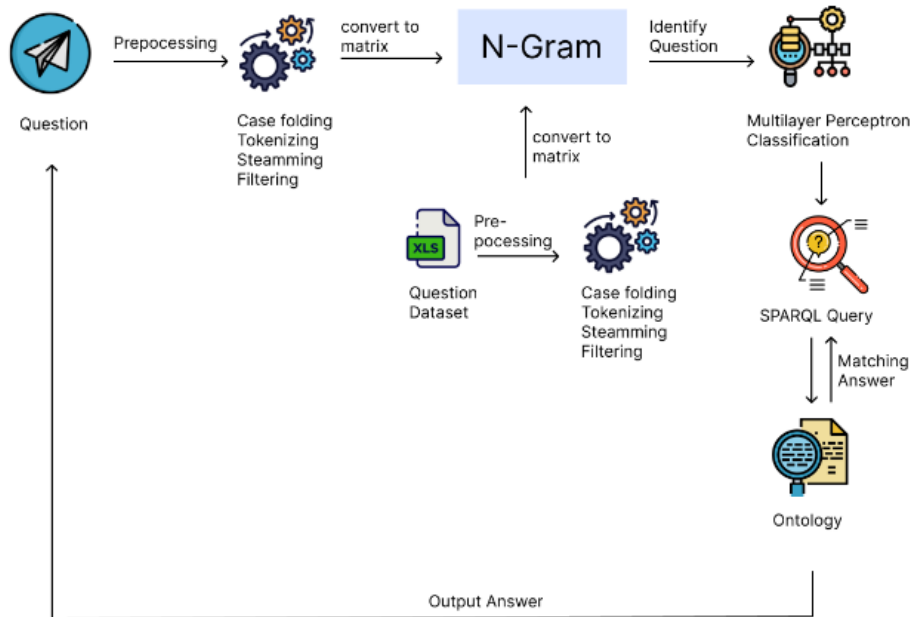


Figure 2. Development stages

This research is divided into 3 stages: question process, document process, and answer process.

A. Question Process

The Question Process is an early stage, and questions enter through the Telegram application. Sentences used must be in Indonesian and the question format must be in 5W+1H: what, where, when, whom, who, how. The questions are then cleared by the preprocessing stage.

B. Document Process

At this stage, the system processes the training documents used. The training document in this research uses question data about the Sumedang Larang kingdom. In the question document there are subject, object, and keyword fields that help to facilitate the next process. Before going to the next stage, the document is cleaned by the preprocessing stage. The preprocessing steps used are as follows:

1. Case folding

The stage of changing the text into the lowercase format and removing characters such as punctuation marks (',', ',', '?', '!') in sentences, aims to give the text a standard form. An example of this stage can be seen in Table 1

TABLE 1
PROCESS CASE FOLDING

before case folding	after case folding
Siapa raja pertama Sumedang Larang??!. (Who was the first king of Sumedang Larang??!.)	siapa raja pertama sumedang larang (who was the first king of sumedang larang)

2. Tokenizing

The stage of changing the text into smaller parts which are also called tokens. An example of this stage can be seen in Table 2

TABLE 2
PROCESS TOKENIZING

before tokenizing	after tokenizing
siapa raja pertama sumedang larang (who was the first king of sumedang larang)	[‘Siapa’, ‘raja’, ‘pertama’, ‘sumedang’, ‘larang’] ([‘who’, ‘was’, ‘the’, ‘first’, ‘king’, ‘of’, ‘sumedang’, ‘larang’])

3. POS tagging

The stage of categorizing into word classes, such as nouns, verbs, adjectives, and so on. An example of this stage can be seen in Table 3

TABLE 3.
PROCESS POSTAG

after postag	before postag
siapa raja pertama sumedang larang (who was the first king of sumedang larang)	[[('siapa', 'CD'), ('raja', 'NN'), ('pertama', 'OD'), ('kerajaan', 'NN'), ('sumedang', 'NN'), ('larang', 'NN')]] ([[('who', 'WP'), ('was', 'VBZ'), ('the', 'DT'), ('first', 'JJ'), ('king', 'NN'), ('of', 'DT'), ('sumedang', 'JJ'), ('larang', 'JJ')]])

The next step is to cut the sentence into n characters. Sentences in the dataset will be cut and grouped using n -grams. The use of n -gram in this study was up to four grams. The result of cutting sentences will be converted into a matrix form using a feature matrix. After that, MLP will classify questions based on their class. Figure 3 describes the MLP model with three layers, namely x as input layer, hidden layer and y as output layer.

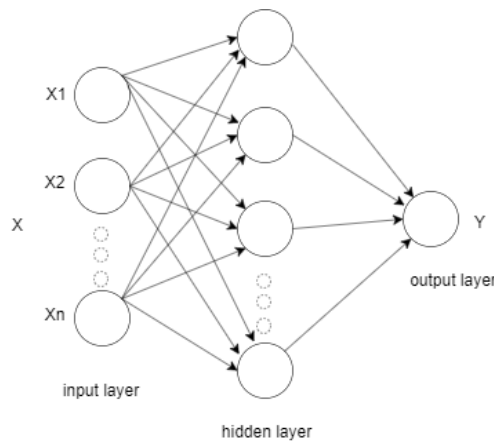


Figure 3. Multilayer perceptron architecture

C. Answer Process

Answer process is the process of the system getting answers. Information about the correct answer is stored in the ontology. We compiled the ontology using the protégé app. Figure 4 shows an example of the ontology domain we created.

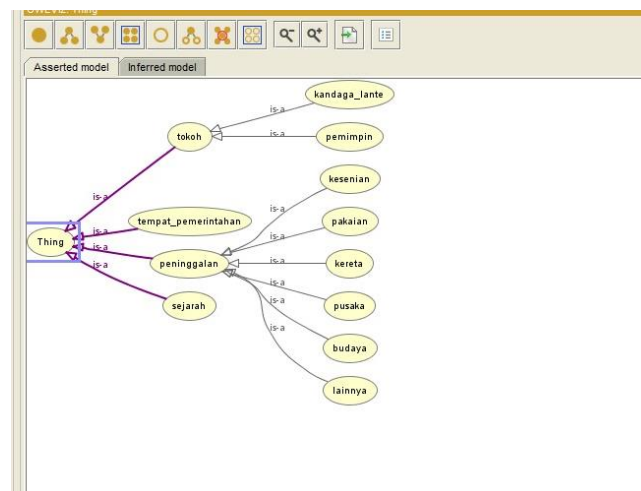


Figure 4. Diagram ontology

Knowledge information is divided into 5 main classes: figures, places of government, heritage, and history. Each main class has a subclass. The SPARQL query used can be seen in Figure 4

```
SELECT *
WHERE { ?subject rdf:type
sumedanglarang:""+subject+"";
sumedanglarang:kata_kunci ?katakunci;
sumedanglarang:""+object+"" ?object
FILTER(STR(?katakunci)=""+katakunci+"
")}
```

Figure 5. Query SPARQL

The SPARQL query searches for information based on subject, object and keyword categories. After the category class is found, the query will search for individual data based on object properties or data properties that match the keywords that have been determined in the ontology. If the searched data matches the category, then the query outputs the data as an answer to the question.

Our test is done by calculating the accuracy of the questions answered correctly by the system. To calculate accuracy, we use the following formula,

$$accuracy = \frac{\text{number of accurate responses}}{\text{number of questions}} \times 100\% \quad (8)$$

From the 61 questions available, the system is able to answer 35 questions correctly. Examples of questions that can be answered correctly / incorrectly by the system can be seen in Table 4.

TABLE 4
QUESTION RESULT

No	Question	Result	No	Question	Result
1	“siapa raja pertama di sumedang larang?” (who was the first king in sumedang larang?)	v	33	“siapa raja kedelapan di sumedang larang?” (who is the eighth king in sumedang larang?)	v
2	“siapa nama ayah dari batara tuntang buana?” (what is the name of the father of batara tuntang buana?)	not answered correctly	34	“siapa ratu ketiga di sumedang larang?” (who is the third queen in sumedang larang?)	v
3	“siapa nama lain batara tuntang buana?” (what is the other name of batara tuntang buana?)	x	35	“siapa yang menggantikan nyimas ratu patuakan?” (who replaces nyimas queen patuakan?)	v
4	“siapa nama istri batara tuntang buana?” (what is the name of batara tuntang buana's wife?)	x	32	“siapa yang menggantikan sunan patuakan?” (who will replace sunan patuakan?)	v
5	“siapa nama anak kembar raja batara tuntang buana?” (what is the name of king batara tuntang buana's twins?)	not answered correctly	33	“siapa raja kedelapan di sumedang larang?” (who is the eighth king in sumedang larang?)	v
6	“pada tahun berapa prabu tajimalela memimpin sumedang larang?” (in what year did king tajimalela lead sumedang larang?)	x	34	“siapa ratu ketiga di sumedang larang?” (who is the third queen in sumedang larang?)	v
7	“siapa raja setelah raja batara tuntang buana wafat?” (who is the king after the king of Batara tuntang buana died?)	x	35	“siapa yang menggantikan nyimas ratu patuakan?” (who will replace nyimas queen patuakan?)	v
8	“siapa raja kedua sumedang larang?” (who is the second king of sumedang larang?)	v	36	“pada masa raja siapa yang memindahkan ibukota sumedang larang ke kutamaya?” (during the time of the king, who moved the capital of sumedang larang to kutamaya?)	x
9	“dimana ibukota sumedang larang dipindahkan pada masa raja gajah agung?” (where was the capital of Sumedang forbidden to be moved during the era of gajah agung king?)	not answered correctly	37	“siapa nama lain dari nyimas ratu dewi inten dewata?” (what is the other name for nyima ratu dewi inten dewata?)	x
10	“pada masa raja siapa yang memindahkan ibukota sumedang larang ke ciguling?”	x	38	“siapa nama suami ratu pucuk umun?” (what is the name of queen pucuk umun's husband?)	x

	(during the king's time, who moved the capital of sumedang larang to ciguling?)				
11	“siapa raja ketiga sumedang larang?” (who is the third king of sumedang larang?)	v	39	“siapa nama anak ratu pucuk umun?” (what is the name of queen pucuk umun's daughter?)	v
12	“siapa raja setelah raja gajah agung wafat?” (who is the king after gajah agung king died?)	v	40	“dimana ibukota sumedang larang dipindahkan pada masa nyimas ratu dewi inten dewata?” (where was the capital city of sumedang larang to be moved during the nyimas ratu dewi inten dewata era?)	v
13	“siapa nama lain dari raja wirajaya?” (what is the other name of king wirajaya?)	x	41	“siapa nama anak nyimas ratu dewi inten dewata?” (what is the name of the daughter of nyimas ratu dewi inten dewata?)	v
14	“pada masa raja siapa yang memindahkan ibukota sumedang larang ke cipameungpeuk?” (during the king's time, who moved the capital of sumedang larang to Cipameungpeuk?)	x	42	“siapa raja kesembilan kerajaan sumedang larang?” (who is the ninth king of the sumedang larang Kingdom?)	v
15	“mengapa ibukota sumedang larang pindah pada masa pemerintahan raja wirajaya?” (Why was the capital of sumedang larang to move during the reign of king wirajaya?)	x	44	“siapa yang menggantikan ratu pucuk umun?” (who will replace the queen of pucuk umun?)	v
16	“dimana ibukota sumedang larang dipindahkan pada masa raja wirajaya?” (where was the capital of sumedang larang to be moved during the reign of king wirajaya?)	not answered correctly	45	“siapa nama lain dari raden angkawijaya?” (“what is the other name of raden angkawijaya?”)	v
17	“siapa nama anak raja Sunan Pagulingan?” (what is the name of the son of king sunan pagulingan?)	not answered correctly	46	“pada masa pemerintahan siapa sumedang larang menjadi kerajaan yang otonom dan merdeka?” (during whose reign was sumedang larang from becoming an autonomous and independent kingdom?)	not answered correctly
18	“siapa raja keempat sumedang larang?” (who is the fourth king of sumedang larang?)	v	47	“dimana wilayah sumedang larang pada masa prabu geusan ulun?” (where was the Sumedang larang area during the reign of King geusan ulun?)	x
19	“siapa ratu pertama sumedang larang?” (who was the first queen of sumedang larang?)	v	48	“siapa nama istri pertama prabu geusan ulun?” (what is the name of prabu geusan ulun's first wife?)	not answered correctly
20	“siapa raja yang menggantikan sunan pagulingan?” (who was the king who replaced sunan pagulingan?)	v	49	“siapa nama istri kedua prabu geusan ulun?” (what is the name of king geusan ulun's second wife?)	x
21	“pada masa raja siapa sumedang dibawah kerajaan pajajaran?” (at the time of the king who was sumedang under the kingdom of pajajaran?)	not answered correctly	50	“siapa nama anak prabu geusan ulun dari istri pertama?” (what is the name of prabu geusan ulun's son from his first wife?)	x
22	“siapa nama suami ratu istri rajamantri?” (what is the name of the husband of the queen and the wife of the king mantri?)	v	51	“siapa nama anak prabu geusan ulun dari istri kedua?” (what is the name of prabu geusan ulun's son from his second wife?)	x
23	“mengapa kerajaan sumedang dibawah kerajaan pajajaran pada masa ratu istri rajamantri?” (why was the sumedang kingdom under the pajajaran kingdom during the queen's wife rajamantri?)	v	52	“bagaimana peralihan kekuasaan dilakukan kepada prabu geusan ulun?” (how was the transfer of power carried out to prabu geusan ulun?)	v
24	“siapa raja kelima kerajaan sumedang?” (who is the fifth king of the sumedang kingdom?)	v	53	“pada tahun berapa Prabu Geusan Ulun memerintah?” (in what year did king geusan ulun rule?)	x
25	“siapa yang menggantikan ratu istri rajamantri?” (who replaces the queen of rajamantri's wife)	v	54	“pada tahun berapa prabu geusan ulun wafat?” (in what year did king geusan ulun die?)	v
26	“siapa nama saudara sunan guling?” (what is sunan guling's brother's name?)	not answered correctly	55	“pada tahun Prabu geusan ulun wafat?” (in the year king geusan ulun died?)	v
27	“siapa nama saudara Ratu Istri Rajamantri yang menggantikan raja sumedang selanjutnya?” (what is the name of ratu's wife	v	56	“siapa yang menggantikan raden geusan ulun?” (who will replace raden geusan ulun?)	v

	rajamantri's brother who will replace the next king of sumedang?)				
28	“siapa raja keenam kerajaan sumedang?” (who is the sixth king of the sumedang kingdom?)	v	57	“siapa yang menggantikan raden angkawijaya?” (who will replace raden angkawijaya?)	v
29	“siapa yang menggantikan sunan guling?” (who replaces sunan guling?)	v	58	“siapa raja kesepuluh kerajaan sumedang larang?” (who is the tenth king of the sumedang larang kingdom?)	x
30	“siapa raja ketujuh kerajaan sumedang?” (who is the seventh king of the sumedang kingdom?)	v	59	“pada tahun berapa sumedang larang berdiri?” (in what year was sumedang larang stand?)	v
31	“siapa ratu kedua kerajaan sumedang?” (who is the second queen of the sumedang kingdom?)	v	60	“siapakah raja yang mendirikan kerajaan sumedang larang?” (who is the king who founded the sumedang larang kingdom?)	not answered correctly
32	“Siapa yang menggantikan sunan patuakan” (who replaces sunan patuakan)	v	61	“dimana tempat Mahkota Raja Pajajaran disimpan?” (where is the King of pajajaran's crown kept?)	v

Where v represent answer question, x represent an unanswered question.

Based on these data, the accuracy of the system we built is as follows

$$accuracy = \frac{35}{61} \times 100\% = 57,37\% \quad (9)$$

An unanswered question due to the imperfect feature extraction process. This resulted in some questions not being answered correctly.

In addition to the unanswered questions, there are 10 incorrect answers. The answer that is not correct is the answer in the form of a semantic link (can be seen in Figure 6). This incorrect answer is because the SPARQL query template that we built is not able to execute answers with different relations.

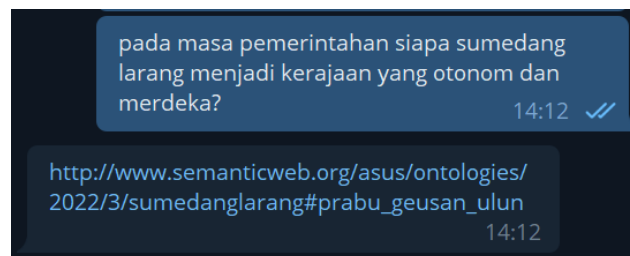


Figure 6. Not answered correctly

IV. CONCLUSION

In this research, the system was able to answer most of the questions from users in natural language (57.37%). The biggest challenge in developing natural language-based QAS is at the question understanding stage. We use n-gram and MLP to understand the natural language of the user, and SPARQL to explore answers from the ontology. These results can be improved in future research. In future research, we will improve the SPARQL query template, so that we can map the classification results from MLP with the right answer. In this study, it turns out that not all questions can be classified using the MLP method. Therefore, in future studies we will try methods other than MLP to compare the results.

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