International Journal on Electrical Engineering and Informatics - Volume 8, Number 2, June 2016

Pattern Discovery using QG for Question-Answering Pairs

Wiwin Suwarningsih[1,2], Iping Supriana[3], and Ayu Purwarianti[4]

[1,3,4]School of Electronic Engineering and Informatics, Bandung Institute of Technology
[2]Research Center for Informatics, Indonesian Institute of Science
[1,2]wiwin.suwarningsih@students.itb.ac.id, [3]iping@informatika.org, [4]ayu@informatika.org

Abstract: The hardest things in developing the question-answer system are to raise a question that comes from natural language sentences and to find the answers to some questions relevant to the query. In this paper, the strategy to be developed is how to apply a natural language processing using a technique automatically to generate questions and answers. A number of new ideas have been explored including a semantic-based template using a combination of semantic role labeling (SRL) with the predicate argument (PA) to create a semantic pattern within the scope of medical Indonesian sentences. It was more focused on Question Generating (QG) with a discourse task involving the following three steps: (1) Parsing the labeling of semantic-based element PICO with progression to PPPICCOODTQ (Problem, Patient, Intervention, Compare, Control, Outcome, Organs, Drug, Time, Quantity); (2) Identification and Transformation sentence; and (3) Filtering for answering Question construction. This study has presented a new approach by utilizing the semantic role labeling and flexibility template. This approach achieved the accuracy values of 0.80 simple sentence. The results showed the improvement of the performance of question generation from the information on medical outcomes.

Keywords: question-answering pairs, medical question generating, sentences transformation, PPPICCOODTQ element.

1. Introduction

One of the key objectives of QG is to provide an architecture, which contains two phases of work and the components to be developed for the document management used in a specific language [1]. From the goals to be achieved by Lindberg et al. [2], the question generation process includes (1) the content selection: selecting the source text (usually a single sentence) that can generate inquiries; (2) the target identification: determining the words and/or phrases that serve as the question words; and (3) the question formulation: determining the right questions tailored to the content identification. Question generating system can be helpful in closed-domain Question Answering (QA) such as medical, clinical and biomedical QA [3] [4]. Using QG approach to the question and answer system to a closed domain can be mapped to other domains with little or without any efforts [5]. Some QA systems for a closed domain have already used a number of pairs of questions and answers, for example at QG system focused on student learning that provides QA services. As in a research conducted by [2] and [16], introducing a template-based approach is to generate a natural language question automatically in supporting online learning. It is similar with Michael and Noah [6] [7] in generating a set of questions on the process of creating a system of education generating automated queries of any materials. Mostow and Chen [9] built a system with some self-questioning strategies to assist children in generating the question of narrative fiction. It has been proven that using a set of questions comes to be an effective method to assist the learners to learn better [8]. Unfortunately, many studies have shown that students frequently ask the same questions and tend to ask banal questions [15].

Other studies that focus on developing a framework for generating questions draw up a number of rules to change a declarative sentence into a question. Silviera [10] proposed several generation system architecture questions with variation in shallow and deep questions using

Received: January 16th, 2015. Accepted: April 21st, 2016
DOI: 10.15676/ijeei.2016.8.2.1

some different model representations. On the other hand, Yao [11] proposed a new approach based on a semantic pattern to QG using Minimal Recursion Semantics (MRS) to produce a meta-level semantic representation on the specified scope.

A research related to the generation of queries used three categories of approaches: based syntax (e.g. [5] [12] [13]), based semantic (e.g. [4] [14] [15]) and a template-based (e.g. [2] [17]), each of which had contributed as listed in Table 1. To-based syntax [5] [12] [13], parse sentences use syntax parser, simplify complex sentences by identifying key phrases as well as by applying the transformation rules of syntax and replacement of the word-based NER asked. It then obtained the best average accuracy at 80.79%. As for based semantic [4] [14] [15], this study successfully combined the semantic role labeling (SRL) with a syntactic transformation, the selection phase of the content of the first sentence parsed role labeling semantics to identify potential targets and selection criteria simply using a predicate argument structure. It then obtained the best average accuracy at 81.15%. For template-based [2] [17], it used the Natural Language Generation Markup Language (NLGML) to generate the inquiries and expressions of natural language as well as the addition of template such as: What-would-happen-if, When-would-x-happen, What-would-happen-when and Rev-x. It then obtained the best average accuracy at 79.80%. Having reviewed these studies, we obtained some things that can be further explored and improved to produce a strategy using a semantic-based template for medical Indonesian generation question.

Table 1. Summary of previous work and contribution of this work

QG Method	Contribution
Syntax Based [5] [12] [13]	• Simplifying the complex sentences by identifying the key phrase; • Applying the transformation rules of syntax and replacement of question words based NER
Semantic Based [4][14][15]	• Combining semantic role labeling (SRL) with syntactic transformation; • In the selection of the first sentence parsed content with the role of semantic labeling to identify potential targets; • Selected targets using simple selection criteria using the structure PA
Template Based [2][17]	• Generating inquiries and expressions of natural language using Natural Language Generation Markup Language (NLGML); • Templates added include What-would-happen-if, When-would-x-happen, What-would-happen-when and Why-x
This work (Semantic based Template)	• Converting Indonesian natural language to PPPICCOODTQ element for content selection and question type identification Indonesian medical sentence; • Mapping semantic role labelling using PPPICCOODTQ element to develop a number of semantic rules and to provide a good set of question answering (QA) pair patterns.

The works of researchers previously created the basis of this work and we in this study aimed to create a system for question generation (QG) that is able to take as an input of a medical article of text. The proposed method in this paper was to present a new approach by utilizing the semantic role labeling and flexibility template (semantic based template). The purpose of doing so was to clarify the contribution of this paper and provided an overview of the approach taken. The focus on QG with a discourse task involved the following three steps: (1) Parsing the labeling of semantic-based element PICO with progression to PPPICCOODTQ (Problem, Patient, Intervention, Compare, Control, Outcome, Organs, Drug, Time, Quantity); (2) Identification and Transformation sentence; (3) filtering for question answering construction.

The rest of the paper is organized as follows: Section 2 describes several related work on question generation, followed by Section 3 presenting the details of the proposed method.

Furthermore, Section 4 shows the evaluation and results and Section 5 describes the experiment. Finally, the conclusion and future directions are presented in Section 6.

2. Related Work

Question Generation has been widely used in various uses such as educational or online learning (e.g.: [2] [4] [7] and [19]), role identification for medical or clinical sentences (e.g.: [20] [21]) and other concern such as combined approach (e.g. [5] [6] [18]). Their differences are highlighted as follows:

The following issues have been address for educational or online learning using question generation such as Lindberg *et al.* [2] that introduced a template-based approach that incorporated some semantic role labels into a system automatically generated a natural language question to support online learning. Yao *et al.* [4] presented a question generation system based on the semantic rewriting approach. They here obtained a principle way of generating questions that avoided the ad-hoc manipulation of syntactic structures. In addition, they were able to use an independently developed parser and generator for the analysis and generation stage. The generator typically proposes several different surface realizations of a given input in view of its extensive grammatical coverage. Michael and Smith [7], meanwhile, focused on question generation (QG) for the creation of educational materials for reading practice and assessment. Their objective was to generate some fact-based questions about the content of a given article. Iwane et al. [19] proposed framework based on a learner's actions and the context of an expository text with three basic types of questions that can be generated based upon these actions. The actions could be in the form of writings or markings. Some associated questions can also be generated based on the type of a question.

Another study utilizing the PICO frame in the medical domain has been used to identify and analyze the role of the medical domain limitations of the technology that has been developed for debriefing system. As research conducted by [20], proposed an alternative approach for organizing and identifying the role of semantics using the PICO. While, at [21], it was to exploring approaches for generating questions about the effects of drug use, which automatically provided an answer in the form of information to treat certain diseases.

Another related work concerned with the combined approach such as Michael [6] proposed a way to generate the WH-questions to assess the extent of knowledge of the readers in understanding the information in the text. Validation questions generated can be done automatically by involving a teacher to choose and revise the right questions. On the other hand, Bednarik and Kovacs [18] focused on the job on how effective the application of stochastic general computational methods was in the processing of semantic and grammatical Hungarian as the problem domain. The system was developed using some automated generation queries to a more flexible and open frame. In contrast, Husam et al. [5] have made a sentence-to-question generation. QG system that produces a set of sentences that imply question requires an answer

3. Proposed Method

In this paper, a number of new ideas have been explored such as a semantic-based template using Semantic Role Labeling (SRL) with PPPICCOODTQ components. The combination applied to the structure was Predicate Argument SRL. SRL PPPICCOODTQ-based components used to make the transformation rules of declarative sentences to interrogative sentences were to produce a template of questions. On the other hand, Predicate Argument structure was used to create the pattern of questions and answers. The results of each template parsing were filtered using PA template. It was because PA template contained the pattern of answers; while Question template did not have any answer pattern. The flowchart of this study is illustrated in Figure.1.

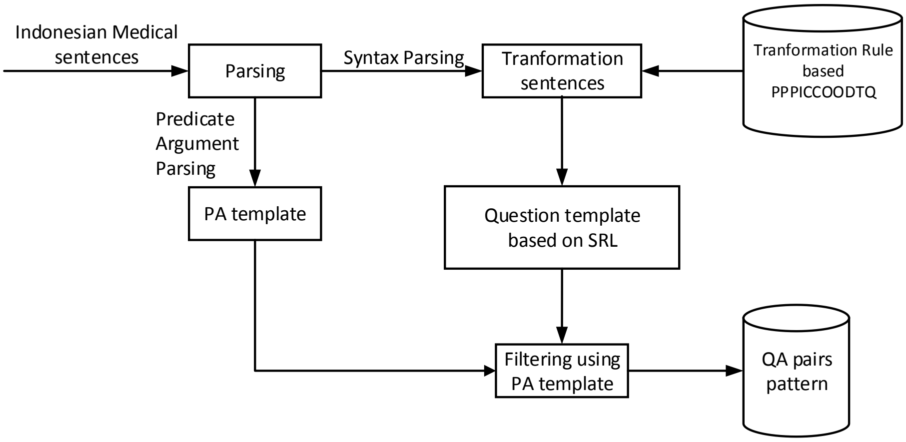

Figure 1. Flowchart of pattern discovery for QA pairs

4. Result and Evaluation

To build a query, a generation system supporting components is needed to produce optimal performance. One of the components that can be developed is self-directed learning, as this is a very vital interest for QG [10]. Many previous works have examined QG from single sentences, but this technique has almost exclusively more focused on generating factoid questions. Factoids are questions requiring the learner to recall some facts explicitly as stated in the source text [12]. For this, we have attempted to build a support for the system components Ime-QG (Indonesian Medical Question Generation). Supporting components included (1) Parsing with semantic labeling (2) Identification and Transformation sentence, and (3) filtering for construction of question answering. Each of these components would be explained one by one as follows.

A. Parsing with Semantic Labeling

Components required at the early stages of the process of generating questions comprised parsing the semantic labeling with an aim to select the contents of the sentence. The steps taken included: parsing the syntax to obtain the Parts of Speech (POS) tagging to determine which each word was as a noun, verb, or preposition. Here, the list of POS for medical domain used the results of research as conducted by Alfan [23]. Secondly, it was through syntactic parsing to identify the type of phrase contained in the sentence; and thirdly, through a semantic analysis to process a sentence tree that has been affixed to the semantic rules to generate the representations of meaning in the form of semantic rules. Semantic rules used in this paper were based on the PPPICCOODTQ element (see Table 2.).

Table 2. PPPICCOODTQ element based semantic rules

Semantics Rule	Specification
λxλy population (x, y)	y is a kind of disease of x
λxλy patient (x, y)	y is the patient of x
λxλy problem (x, y)	y is the problem of x
λxλy intervention (x, y)	y is the interference of x
λxλy compare (x, y)	y is a comparison of x
λxλy control (x, y)	y is the control of x
λxλy outcome (x, y)	y is the result of x
λxλy organs (x, y)	y is this part of the body x
λxλy drug (x, y)	y is a drug that is used on the x
λxλy time (x, y)	y is the time required from x
λxλy quantity (x, y)	y is a measure of x

The conversion of natural language to PICCOLO DTQ element aims to select the content of the sentence. In this research, the conversion of natural language medical domain Indonesia using a development of PICO frame into PPPICCOODTQ element was backgrounded as follows: (i) Frame PICO just organizing a structure conducive to the type of clinical question or medical that can be developed based upon the needs [24] [25] [26]; (Ii) The identification of role-based semantic frame PICO that can be used to identify the more flexible answer of the candidates [28] [29] [30], (iii) Frame PICO as the essential element to be used in the pattern of semantic-based models in medical questions [27]; and (iv) attempt to obtain the answers from the potential identification of named entities and correspondence between semantic roles Frame PICO that can be used [20] [21].

In details, we have attempted to provide a picture of the process of parsing and semantic analysis using the sentence (1).

Gejala cacar air adalah badan lelah, nyeri sendi, demam (1)
(English : Symptoms of chickenpox is a tired body, joint pain, fever)

The stages of decomposition for sentence (1) included:

- Part Of Speech formed is an
  gejala/N
  cacar/N
  air/N
  adalah/IN
  badan/N
  lelah/JJ
  ,/,
  Nyeri/JJ
  Sendi/N
  ,/,
  Demam/N

- The identification of the phrase: *cacar air* is a Noun Phrase (NP), *badan lelah* and *nyeri sendi* are the Adjective Phrase (JJP). Thus, labelling sentence examples-1 became:
  gejala/N
  [*cacar/N air/N*]/NP
  adalah/IN
  [*badan/N lelah/JJ*] /JJP
  ,/,
  [*Nyeri/JJ Sendi/N*]/JJP
  ,/,
  Demam/N

- The establishment of a parse tree with frame-based semantic analysis labelling PPPICCOODTQ for sentence (1) (see Figure 2). The use of lexical semantic embedding rules is listed in Table 3.

Table 3. Rules attached for Lexical Semantics with PPPICCOODTQ element

POS label	Role	Lexical Semantic
N, JJ		λx object(x, A)
VB	<INTERVENTION>	λxλy intervention(x,y)
NP	<COMPARE>	λx object(x, A) ^ λxλy compare(x,y) |
	<CONTROL>	λx object(x, A) ^ λxλy control(x,y) |
	<OUTCOME>	λx object(x, A) ^ λxλy outcome(x,y) |
	<COMPARE>	Λxλy compare(x,y) |
	<CONTROL>	λxλy control(x,y) |
	<OUTCOME>	λxλy outcome(x,y) |
	<ORGANS>	λxλy organs(x,y) |
	<DRUG><PROBLEM>	λxλy drug(x,y) | λxλy problem(x,y)
JJP	<COMPARISON>	λxλy comparison(x,y)
VBI	<INTERVENTION><PROBLEM>	λxλy intervention(x,y) ^ λxλy problem(x,y) |
	<INTERVENTION><POPULATION >	λxλy intervention(x,y) ^ λxλy population(x,y)
VBT	<INTERVENTION><PROBLEM> <PATIENT>	λxλy intervention(x,y) ^ λxλy problem(x,y)^ λxλy patient(x,y) |
	<INTERVENTION><POPULATION > <PATIENT>	λxλy intervention(x,y) ^ λxλy population(x,y)^ λxλy patient(x,y)

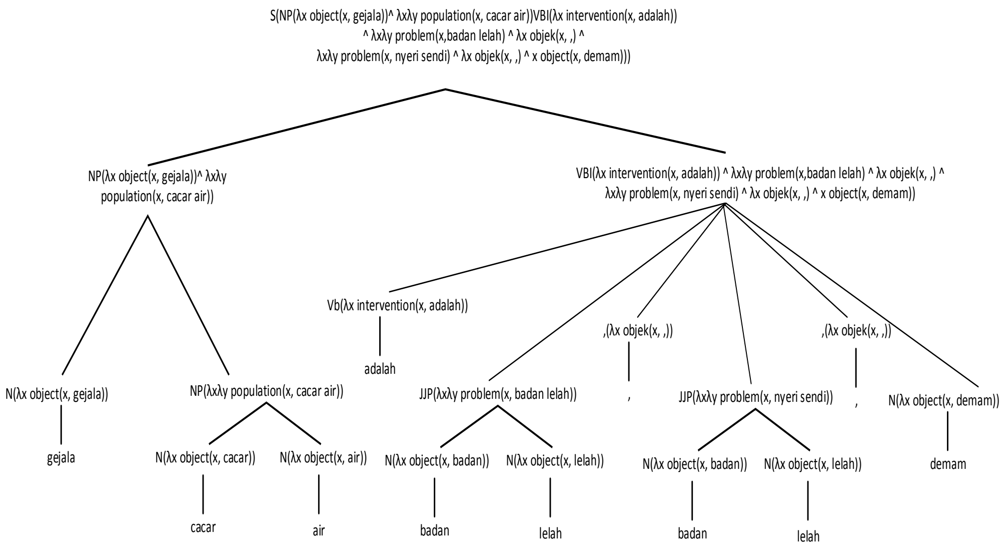

Figure 2. Parse tree with PPPICCOODTQ element based semantic labeling

The establishment of a parse tree with semantic labelling was required to define the phrase or keywords contained in the sentence (see Figure 2). Furthermore, keyword phrase was used for the extraction of information (inclusing the manufacture of extraction rules and relations between phrases or keywords) in the sentence.

The extraction of this information was used to identify the role of a word or phrase owned by the sentence (1). The results of this extraction showed 3 groups of words as a phrase in which *cacar air* was a Noun Phrase, while the *badan lelah* and *nyeri sendi* were the Adjective Phrase. Being apart from that extraction was necessary for the reasoning relation between entities in drawing conclusions based on the input data. It can be concluded that the semantic parsing was capable of identifying and classifying the semantic entities and relationships in the context of the word or phrase. Furthermore, this semantic role would be analyzed by the system and were classified for the generation of questions.

Id Rule	Template of Rule based on PPPICCOODTQ element
R1	[PATIENT] [POPULATION] *harus* [INTERVENTION] [PROBLEM] *dan* [PROBLEM]
R2	(*gejala, tanda-tanda*)[POPULATION] *adalah* [PROBLEM], [PROBLEM], [PROBLEM] .
R3	*penyakit yang* [INTERVENTION] *oleh* [PROBLEM]
R4	[INTERVENTION] [PROBLEM] *akibat* [POPULATION] *gunakan* [DRUG]
R5	[PATIENT] [POPULATION] *harus* [INTERVENTION] [PROBLEM] *dan* [PROBLEM]
R6	*Cara* [INTERVENTION] [POPULATION] *adalah* [CONTROL], [CONTROL] dan [CONTROL]
R7	*kendala* [INTERVENTION] *untuk* [PATEINT] *penderita* [POPULATION] *adalah* [PROBLEM]
R8	*manfaat* [CONTROL], [CONTROL], dan [CONTROL] untuk [PATEINT] adalah [INTERVENTION] [POPULATION]
R9	*upaya* [PATEINT] [INTERVENTION] [POPULATION] *adalah* [CONTROL]
R10	[COMPARE] [INTERVENTION] [COMPARE] *dari* [ORGANS] *ke* [ORGANS]
R11	[INTERVENTION] *ke* [ORGANS][PATIENT]

Figure 3. Rule base on PPPICCOODTQ element

The process of information extraction using the rules based on PPPICCOODTQ element is shown in Figure 3 and NE relations contained is shown in Figure 4. The result of the extraction of information for the sentence in example 1 can be seen in Figure 5.

Id Relation	Form of NE Relations
Rel1	[CONTROL] ***MENGATASI*** [POPULATION]
Rel2	[POPULATION] ***DISEBABKAN-OLEH*** [PROBLEM]
Rel3	[PROBLEM] ***INDIKASI*** [POPULATION]
Rel4	[DRUG] ***UNTUK-MENGOBATI*** [POPULATION]
Rel5	[OUTCOME] ***INDIKASI*** [POPULATION]
Rel6	[DRUG] ***MENGAKIBATKAN*** [POPULATION]
Rel7	[CONTROL] ***MENGATASI*** [POPULATION]
Rel8	[PROBLEM] ***MENGAKIBATKAN*** [POPULATION]
Rel9	[CONTROL] ***MENGAKIBATKAN*** [OUTCOME]

Figure 4. Name Entity Relations.

Gejala cacar air adalah badan lelah, nyeri sendi, demam (1)
(English : Symptoms of chickenpox is a tired body, joint pain, fever)

↓ Identification of the sentence for NE

Cacar air = <POPULATION>
Badan lelah = <PROBLEM>
Nyeri sendi = <PROBLEM>
Demam = <PROBLEM>

↓ Put in the rule base extraction. The extraction rule its forms

R2: *gejala* [POPULATION] *adalah* [PROBLEM], [PROBLEM], [PROBLEM]

↓ Information extraction by establishing relationships between NE

Rel2: [POPULATION] ***DISEBABKAN-OLEH*** [PROBLEM]
Rel3: [PROBLEM] ***INDIKASI*** [POPULATION]
Rel8: [PROBLEM] ***MENGAKIBATKAN*** [POPULATION]

Figure 5. Information Extraction for sentence "*Gejala cacar air adalah badan lelah, nyeri sendi, demam*"

B. Sentence Identification and Transformation

At this stage, the author developed a concept for the transformation of declarative sentences into some interrogative sentences. As for how that would be done was to identify the phrases using a semantic role labeling. In this case, the role of semantics acted as a key in a transformation process. The performance of this transformation was based upon transformation rules and the methods used for manufacturing transformation rules were the result of utilizing the relation between NE. Then, it was assumed that sentence with a dependency relationship would share the role of semantics growing up or associated in the same sentence. It was based upon a number of studies in which the hypothesis of lexical semantics was in the behavior of the word, especially regarding the expression and interpretation of rules to a large extent determined by the meaning. We built a number of rules varied with the diversity of patterns based on PPPICCOODTQ element. Forming a pattern was used as a template for transformation semantic declarative sentences into interrogative sentences.

For each slot in the pattern formation template semantics, we have taken the advantage of the relationships among the NE where the role of semantics could be checked and adjusted to the chapmans identification. The role of the text was in line with the rules of transformation and altered by a slot in the template pattern semantics by means of extracted and put into question. By utilizing relation to the sentence NE-1, it could be identified Rel2: [POPULATION] *DISEBABKAN-OLEH* [PROBLEM], Rel3:[PROBLEM] *INDIKASI* [POPULATION], Rel8: [PROBLEM] *MENGAKIBATKAN* [POPULATION] and transformation rules that form to the sentence-1 can be seen in Table 4.

Table 4. Rule for Transformation

Id RuleT	Rule for Transformation
RT1	If System finds role = <POPULATION> then question_sentence = *Apa* + *penyebab* + <POPULATION>? (What+causes+ <POPULATION>?)
RT2	If System finds role = <PROBLEM> then question_sentence = *Apa* + *indikasi*+ <PROBLEM>? (What+ indication+ <PROBLEM> ?)
RT3	If System finds role = <PROBLEM> then question_sentence = *Apa* + *indikasi* + <PROBLEM>+,+<PROBLEM>? (What+ indication+ <PROBLEM>>+,+<PROBLEM> ?)
RT4	If System finds role = <PROBLEM> then question_sentence = *Apa* + *indikasi* + <PROBLEM>+,+<PROBLEM>+,+ <PROBLEM>? (What+ indication+PROBLEM>>+,+<PROBLEM>+,+ <PROBLEM> ?)
RT5	If System finds role = <PROBLEM> then question_sentence = *Apa* + *yang* + *mengakibatkan*+ <PROBLEM> ? (What + are the causes + <PROBLEM> ?)
RT6	If System finds role = <PROBLEM> then question_sentence = *Apa* + *yang* + *mengakibatkan* + <PROBLEM>+,+ <PROBLEM> ? (What + are the causes + <PROBLEM>+,+<PROBLEM> ?)
RT7	If System finds role = <PROBLEM> then question_sentence = *Apa* + *yang* + *mengakibatkan* + <PROBLEM>+,+ <PROBLEM>+,+ <PROBLEM> ? (What + are the causes + <PROBLEM>+,+<PROBLEM> +,+ <PROBLEM>?)

As shown in Table 4, transformation rules with NE-Rule: RT1 was formed from Rel1, while RT2-RT4 id was formed from rel2 and RT5-RT7 id was formed from Rel3. Thus, the generation of questions based on the rule in Table 4 can be seen in the sentence (2) through (16).

Question form using RT1 produced one kind of interrogative sentence only, namely:

Apa penyebab cacar air ? (What causes chicken pox ?) (2)

Question form by using R2 produced three kinds of interrogative sentence because the identification of the role <PROBLEM> There were three combinations: *badan lelah*, *nyeri sendi* and *deman*.

Apa indikasi badan lelah? (What indication of tired?) (3)
Apa indikasi nyeri sendi? (What indication of joint pain?) (4)
Apa indikasi demam? (What indication of fever?) (5)

Question form using RT3 produced three kinds of interrogative sentence because the identification of the role <PROBLEM> there were three combinations: namely *badan lelah* + *nyeri sendi*, *badan lelah* + *demam* and *nyeri sendi* + *demam*.

Apa indikasi badan lelah, nyeri sendi? (What indication of tired, joint pain?) (6)
Apa indikasi badan lelah, demam? (What indication of tired, fever?) (7)
Apa indikasi nyeri sendi, demam? (What indication of joint pain, fever?) (8)

Question form by using RT4 only produced one kind of interrogative sentence, namely:

Apa indikasi badan lelah, nyeri sendi, demam? (What indication of tired, joint pain, fever ?) (9)

Question form using RT5 produced three kinds of interrogative sentence because of the identification of the role <PROBLEM> There were three combinations: *badan lelah*, *nyeri sendi* and *demam*.

Apa yang mengakibatkan badan lelah? (What are the cause of tired?) (10)
Apa yang mengakibatkan nyeri sendi? (What are the cause of joint pain?) (11)
Apa yang mengakibatkan demam? (What are the cause of fever?) (12)

Question form using RT6 produced three kinds of interrogative sentence because the identification of the role <PROBLEM> there were three combinations: *badan lelah* + *nyeri sendi*, *badan lelah* + *demam* and *nyeri sendi* + *demam*.

Apa yang mengakibatkan badan lelah, nyeri sendi? (What are the cause of tired, joint pain? (13)
Apa yang mengakibatkan badan lelah, demam? (What are the cause of tired, fever?) (14)
Apa yang mengakibatkan nyeri sendi, demam? (What are the cause of joint pain, fever?) (15)

Question form using RT7 only produced one kind of interrogative sentence:

Apa yang mengakibatkan badan lelah, nyeri sendi, demam? (What are the cause of tired, joint pain, fever ?) (16)

Sentence (2) through (16) have not produced the answer for being limited to the transformation of declarative sentences into interrogative ones. To obtain the necessary questions to the pattern matching, templates predicate argument already had a couple questions answers.

C. Filtering for Question Answering Construction.

The filtering process was performed using the phrase of the question Predicate Argument template. This was purposely to produce a pattern based upon the template that already had a pattern of responses. The concept of filtering by using predicate this argument was the result of a manual analysis of the sentence used as a training resource and the template argument predicate would be defined (see Table 5) with a predicate as the role = <INTERVENTION>, and the other as an argument. The use of role = <INTERVENTION> as the predicate was based on the following reasons: (i) the units of an event or action and capture more semantics of the keywords, so the more promising that the answer could be more appropriately extracted [31] [32]; (ii) that described the relationship between a noun and was used to handle the expression not mediated by the verb [33].

Table 5. PA template for question answering pair

ID QA-PAIRS	Question Template	Answering Template
QA-1	*Apa* + *manfaat* + <COMPARE> [?]	<INTERVENSION> + <PROBLEM>
QA-2	*Apa* + *manfaat* + <CONTROL> [?]	<INTERVENSION> + <PROBLEM> |
QA-3	*Apa* + *manfaat* + <CONTROL> [?]	<INTERVENSION> + <POPULATION>
QA-4	*Apa* + *manfaat* + <CONTROL> [?]	<INTERVENSION> + <OUTCOME>
QA-5	*Apa* + *indikasi* + <OUTCOME> [?]	<PROBLEM>+,+ <PROBLEM>
QA-6	*Apa* + *indikasi* + <PROBLEM>+, +<PROBLEM>+,+ <PROBLEM>?	<POPULATION>
QA-7	*Apa* + *penyebab* + <PROBLEM> [?]	<POPULATION>
QA-8	*Apa* + *penyebab* + <POPULATION> [?]	<PROBLEM>+,+ <PROBLEM> +,+ <PROBLEM>
QA-9	*Apa* + *yang* + *mengakibatkan* + <PROBLEM>+,+ <PROBLEM>+,+ <PROBLEM>?	<POPULATION>
QA-10	*Bagaimana* + <INTERVENSION> + <PROBLEM>[?]	<COMPARE>
QA-11	*Bagaimana* + <INTERVENSION> + <PROBLEM>[?]	<CONTROL>
QA-12	*Bagaimana* + <INTERVENSION> + <POPULATION[?]	<COMPARE>
QA-13	*Bagaimana* + <INTERVENSION> + <POPULATION[?]	<CONTROL>
QA-14	*Bagaimana* + <PROBLEM> + *dapat dihindari* [?]	*Lakukan* +<CONTROL>+,+ <CONTROL>+ *dan*+ <CONTROL>
QA-15	*Bagaimana* + <POPULATION>+*dapat dihindari* [?]	*Lakukan* +<CONTROL>+,+ <CONTROL>+ *dan*+ <CONTROL>
QA-16	*Bagaimana*+ <POPULATION>+*dapat dihindari* [?]	Minum + <DRUG>
QA-17	*Bagaimana*+ <OUTCOME> + *dicapai* [?]	*Teratur* + *Minum* + <DRUG>
QA-18	*Bagaimana*+ <OUTCOME> + *dicapai* [?]	*Lakukan* + <CONTROL> +, + <CONTROL> + *dan* + <CONTROL>
QA-19	*Bagaimana*+ <OUTCOME> + *dicapai* [?]	<INTERVENSION> + *pemicu* + <PROBLEM>
QA-20	*Bagaimana*+ <OUTCOME> + *dicapai* [?]	<INTERVENSION> + *pemicu* + <POPULATION>
QA-21	*Mengapa*+ <CONTROL> + *diperlukan*[?]	<INTERVENSION> + <PROBLEM>
QA-22	*Mengapa*+ <CONTROL> + *diperlukan*[?]	<INTERVENSION> + <POPULATION>
QA-23	*Mengapa*+ <CONTROL> + *diperlukan*[?]	<INTERVENSION> + <OUTCOME>
QA-24	*Mengapa*+ <CONTROL> + *diperlukan*[?]	<INTERVENSION> + <COMPARE>
QA-25	*Mengapa*+ <PROBLEM> + *harus diatasi* [?]	*Agar* + <INTERVENSION> + <OUTCOME>
QA-26	*Mengapa*+ <PROBLEM> + *harus dihindari* [?]	*Agar* + <POPULATION> + <INTERVENSION>
QA-27	*Mengapa*+ <POPULATION> + *harus dihindari* [?]	*Agar* + *tidak* + <INTERVENSION> + <PROBLEM>
QA-28	*Mengapa* + <DRUG> + *harus* + *dikonsumsi* [?]	*Agar* + <INTERVENSION> + <OUTCOME>
QA-29	*Mengapa*+ <DRUG> + *harus* + *dikonsumsi* [?]	*Agar* + *tidak* + <INTERVENSION> + <PROBLEM>
QA-30	*Mengapa* + <DRUG> + *harus* + *dikonsumsi* [?]	*Agar* + <POPULATION> + <INTERVENSION>
QA-31	*Berapa* + <DRUG> + *dikonsumsi* [?]	<QUANTITY> | <TIME>
QA-32	*Kapan* + <DRUG> + *diminum*[?]	<TIME>

The results from the question generation may appear more than one question. However, it was not supported by the pair answer. Hence, it needed a selection process for the questions raised by filtration using a structure of the PA. In this study, it was carried out by making a comparison process against PA template that has been formed as shown in Table 4. Sentences (2) to (16) were processed using pattern matching. If the pattern was found matching with the question, it would show the pattern of a couple of questions and answers. If the pattern was not found, the process would be terminated later. The phase filtering functioned to sort a number of interrogative sentences taken from the transformation stage sentence. The sorting process was performed using a template pattern matching in PA with the sentence pattern transformation results. The algorithms used for pattern matching were modified from Deterministic Finite Automata (DFA) method as created by Knuth *et al*. [34]. Figure 5 presents the concept of the algorithm for pattern matching.

The workings of this algorithm were to compare two databases containing a pattern of PPPICCOODTQ and PPPICCOODTQ query from an input sentence. The pattern was read one by one and compared. If the pattern was found equal, it was then recorded and continued to the next string up with an unreadable input pattern and reached that mark a question (?). Conversely, if the pattern did not match the pattern, it was ignored then. Based on the concept of the pattern matching algorithm, sentence selection results were Sentence (2), (9) and (16). While the answers obtained each sentence (17), (18) and (19) was with a description of the following explanation:

- Sentence (2) using the ID-PAIRS QA: QA-8, the answer is a sentence (17)
- Question : *Apa penyebaba cacar air* ? (What causes chicken pox?) (2)
- Pattern Answer: <PROBLEM>+,+<PROBLEM>+,+<PROBLEM>
- Answer : *badan lelah, nyeri sendi, demam* (tired, joint pain, fever) (17)

- Sentence (9) using the ID-PAIRS QA: QA-6, the answer was a sentence (18)
- Question : *Apa indikasi badan lelah, nyeri sendi, demam?* (What indication of tired, joint pain, and fever?) (9)

- Pattern Answer: <POPULATION>
- Answer : *cacar air* (chicken pox) (18)

- Sentence (16) using the ID-PAIRS QA: QA-9, the answer was a sentence (19)

- Question : *Apa yang mengakibatkan badan lelah, nyeri sendi, demam*?
- (What are the cause of tired, joint pain, fever ?) (16)

- Pattern Answer: <POPULATION>
- Answer : *cacar air* (chicken pox) (19)

5. Experimental

A. Experimental Data

To build a corpus Indonesian - particularly the medical domain, we have built our own medical Indonesian sentence named entity based on PPPICCOODTQ element. We collected a number of medical articles in Indonesia from two popular sites in Indonesia (http://health.detik.com/ and http://www.klikdokter.com/tanyadokter) for the data in 2015 (after eliminating the same medical entities, 1000 medical sentences for each classification and features are obtained). We randomly selected 70% of sentences for training and 30% for testing.

```
Algorithm for pattern matching & found of answering
{This algorithm is used to filter the questions and find the answer pairs}
Input: Sentence question PPPICCOODTQ pattern
Output: The pattern of the sentence answers found
Method: Each state of each pattern PPPICCOODTQ nd each node has multiple
          labels (such as POS tagging, NER)

// Create a pointer to the next state
Int j = 0
Int p = 0

// identification for PPPICCOODTQ in the database table = d.pico
// identification to query PPPICCOODTQ of sentence = q.pico

// Matching process
For (int i = 0; i <N; i ++) // N is the length of the pattern
        If (q.pos (i) = d.pos (j) then // compare position PPPICCOODTQ
                                                  with the pattern of
        PPPICCOODTQ Next [j] = next i];
               j ++; // pattern match then copy and increment
        Else
               Next [j] = x + 1;
        x = next [x]; // do the opposite pattern does not match
Endif

// If the pattern corresponding questions and found, show patterns of
response
If (j = p) then
        print "Answering pattern";
Endif
Endfor
```

Figure 5. Algorithm for pattern matching & found of answering

B. Experimental Procedure

The testing procedure was performed to evaluate the method we proposed. Here we used a combination of the two different sentences for a total sentence 300. The sentence consisted of 167 simple sentences (a sentence consisting of 95 active and 72 passive), and 133 complex sentences (using a number of conjunctions "*tetapi*", "*ketika*", "*sehingga*", "*jadi*" and "*maka*"). This needed to be done during the testing phase, so that the system was able to recognize the diversity of Indonesian regular grammar.

To measure the success of the generation of the best questions required diagnosis accuracy. In this test we used the evaluation metrics that measured the accuracy of each combination of sentences. Accuracy is the ratio of cases classified correctly shared throughout the case:

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \tag{1}$$

where TP is true positive for correct result, TN is true negative for correct absence of result, FP is false positive for unexpected result and FN is false negative for missing result.

C. Experimental Result

The results of tests performed in the form of the level of accuracy were from a group of test data simple sentences and compound sentences. In Table 5 it can be seen that the testing of simple sentences provided an accuracy of 0.80 and 0.71 compound sentences. Errors in testing due to a simple sentence could not distinguish active verbs and verb passive. On the other hand, errors in the resulting compound sentence ambiguous semantic role labeling for less specification labeling rules.

Table 6. Result of Experiment with Combination Sentence

Combination of Sentence	Accuracy
Simple sentence	0,80
Complex sentences	0,71

Evaluation on the semantic-based template was still required handler ambiguity semantic role labeling rules. Likewise, the handling of different types of sentences definitions or explanations, where the type of the sentence does not have a title. Since the foundation of rule making transformation by filtering using a predicate argument is used as the predicate is a verb with role = <INTERVENTION>. So for the confectionary type of sentence definition we use as the predicate is a word with POS = IN (example words*: ialah, adalah* and *yaitu*). Based on this it needed more specific rules for dealing with the labeling rules that had the same roles and criteria for the types of sentences that did not have the title.

6. Conclusion and Future Work

The new strategy has been developed in this paper by applying a natural language processing using a number of automated techniques to generate questions and answers. The new strategy explored in this paper was a semantic-based template that used a combination of semantic role labeling (SRL) and the predicate argument (PA) to create a semantic pattern within the scope of medical Indonesian sentences. This method of mixing and matching algorithms was in the form of transformation and filtering rules based on the predicate argument. The results in this initial phase has produced a selection scheme of very simple question but still needed to be taken into account opportunities to further improvements in the accuracy of high-level introduction to the Role in more complex sentences.

Research using the generation of these questions can produce some answers to question couples through the process of transformation and filtering without requiring an expert linguist. However, there are still some weaknesses that must be corrected regarding the compliance with the rules of transformation, and building a knowledge base for managing rules and patterns as well as to deal with conflicts when there are new rules entered into the system.

For the future research, it should overcome the above weaknesses that might involve adapting learning using machine learning. To identify an ambiguous role and establish a set of formulas for the transformation and filtering, the system is able to produce and find the right answer.

7. References

[1]. M. K. Kim and H. J. Kim, "Design of question answering system with automated question generation," Proc. - 4th *Int. Conf. Networked Comput. Adv. Inf. Manag. NCM* 2008, vol. 2, pp. 365–368, Sep. 2008

[2]. Lindberg D, Popowich F, John N and Phil W, "Generating Natural Language Questions to Support Learning On-Line", *Proceedings of the 14th European Workshop on Natural Language Generation, IEEE Conference Publications*, pp. 105–114, 2013.

[3]. Michael H, "Automatic Factual Question Generation from Text", *Thesis* on Language Technologies Institute, School of Computer Science, Carnegie Mellon University, (January 23, 2015) www.lti.cs.cmu.edu.

[4]. Lindberg D, "Automatic Question Generation from Text for Self-Directed Learning", Thesis of Master of Science in the School of Computing Science, *Faculty of Applied Sciences, Simon Fraser University*. (January 25, 2015) summit.sfu.ca/system/.../etd7872_DLindberg.pdf

[5]. Yao X, Gosse B and Yi Z, "Semantics-based Question Generation and Implementation", *In Dialogue and Discourse Journal* 3(2), pp. 11-42, 2012.

[6]. Ali H, Yllias CS, Hasan A, "Automatic Question Generation from Sentences", 17e conférence sur le Traitement Automatique des Langues Naturelles (*TALN'2010*), pp. 234-24-, 2010.

[7]. Michael H, Noah AS, “Good Question! Statistical Ranking for Question Generation”, Human Language Technologies: *The 2010 Annual Conference of the North American Chapter of the ACL*, pp. 609–617, 2010.
[8]. Michael M, Noah AS, “Question Generation via Over generating Transformations and Ranking”, *Language Technologies Institute, School of Computer Science, Carnegie Mellon University*, CMU-LTI-09-013, (January 23, 2015) www.lti.cs.cmu.edu.
[9]. Aimee AC and Mark AM, “The benefits of embedded question adjuncts for low and high structure builders”. *Journal of Educational Psychology*, 4(3), pp. 339-348, 2007.
[10]. Jack M and Wei C, “Generating Instruction Automatically for the Reading Strategy of Self-Questioning”. In *Proceeding of the 2009 conference on Artificial Intelligence in Education, IOS Press*, pp. 465–472, 2009.
[11]. Natalia S, “Towards a Framework for Question Generation”. In *Proceedings of the first Workshop on the Question Generation Shared Task and Evaluation Challenge*, pp. 250-256, 2008.
[12]. Yao X, “Question Generation with Minimal Recursion Semantics”, *Master Thesis* in Language and Communication Technologies University of Groningen & Saarland University. (January 21, 2015) http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.232.3140&type=pdf.
[13]. Saidalavi K, Ajeesh E, and Rajarshi D, “Natural language question generation using syntax and keywords”. In *Proceedings of QG2010: The Third Workshop on Question Generation*, pp. 1-10, 2010
[14]. Andrea V and Le AH, “Wlv: A question generation system for the qgstec 2010 task”, In *Proceedings of QG2010: The Third Workshop on Question Generation*, pp. 80–83, 2010.
[15]. Yao X, Gosse B, Zhang Y, “Semantic based Question Generation and Implementation”, *Journal of Dialogue and Discourse*, volume 3(2), pp. 11-42, 2012.
[16]. Niu Y, Hirst G, ”Analysis of semantic classes in medical text for question answering”, In *Proceedings of the ACL-2004 Workshop Question Answering in Restricted Domains, ACL*, pp. 212-220, 2004.
[17]. Per Urlaub, “Reading strategies and literature instruction: Teaching learners to generate questions to foster literary reading in the second language”, In *journal System*, volume 40(2), pp.296-304, 2012
[18]. Zhiqiang C, Vasile R, Hyun-Jeong Joyce Kim, Suresh C. Susarla, Pavan Karnam, and Arthur C. Graesser, “Nlgml: A markup language for question generation”. In Thomas Reeves and Shirley Yamashita, editors, *Proceedings of World Conference on E-Learning in Corporate*, Government, Healthcare, and Higher Education 2006, pp. 2747-2752, 2006.
[19]. Laszlo Bednarik, Laszlo Kovacs, “Automated EA-type Question Generation from Annotated Texts”, 7th *IEEE International Symposium on Applied Computational Intelligence and Informatics*, pp: 191-195, 2012
[20]. Noriyuki Iwane, Chunming Gao, Makoto Yoshida, “Question Generation for Learner Centered Learning”, IEEE 13th *International Conference on Advanced Learning Technologies*, pp. 330-332, 2013
[21]. Y. Niu, G. Hirst, G. McArthur, P. Rodriguez-Gianolli, “Answering clinical questions with role identification”, In *Proceedings of the ACL-2003 Workshop Natural Language Processing in Biomedicine, ACL*, pp: 73–80, 2003.
[22]. Y. Niu, X. Zhu, G. Hirst, “Using outcome polarity in sentence extraction for medical question-answering”, In *Proceedings of the AMIA 2006 Symposium, AMIA*, pp : 599-603, 2006.
[23]. D. Demner-Fushman, J. Lin, “Answer extraction semantic clustering, and extractive summarization for clinical question answering”, in: *Proceedings of the 21st Int’l Conf. Comp. Ling. and 44th Ann. Meeting Assoc. Comp. Ling*. (COLING-ACL 2006), Sydney, Australia, pp. 841–848, 2006[b].

[24]. Alfan Farizki Wicaksono, Ayu Purwarianti, "HMM Based Part-of-Speech Tagger for Bahasa Indonesia". In *Proceeding of the Fourth International MALINDO Workshop* (MALINDO2010). Pp. 98-104, 2010.
[25]. H. Yu, “Towards answering biological questions with experimental evidence: automatically identifying text that summarize image content in full-text articles”, In *Proceedings of the AMIA 2006 Symposium, AMIA*, pp.834–838, 2006.
[26]. H. Yu, C. Sable, “Being Erlang Shen: identifying answerable questions”, In *Proceedings of the IJCAI’05 Workshop Knowledge and Reasoning for Answering Questions* (KRAQ’05), Edinburgh, UK, pp. 6–14, 2005[a].
[27]. H. Yu, C. Sable, H.R. Zhu, “Classifying Medical Questions based on an Evidence Taxonomy”, In *Proceedings of the AAAI-05 Workshop Question Answering in Restricted Domains*, AAAI, pp. 345-352, 2005[b].
[28]. P. Jacquemart, P. Zweigenbaum, “Towards a medical question-answering system: a feasibility study”, Stud. Health. Technol. Inform. 95, p: 463–468, 2003.
[29]. D. Demner-Fushman, B. Few, S.E. Hauser, G. Thoma, “Automatically identifying health outcome information in MEDLINE records”, *J. Am. Med. Inform. Assoc*. 13, p : 52–60, 2006[a].
[30]. D. Demner-Fushman, J. Lin, “Knowledge extraction for clinical question answering: preliminary results”, in: *Proceedings of the AAAI-05 Workshop Question Answering in Restricted Domains*, AAAI Press, pp. 786-792, 2005,
[31]. D. Demner-Fushman, J. Lin, “Answering clinical questions with knowledge-based and statistical techniques”, Comput. Linguist, pp: 3363–103, 2007,
[32]. Daisuke Kawahara, Nobuhiro Kaji, Sadao Kurohashi, “Question and Answering System based on Predicate-Argument Matching”, *Proceedings of the Third NTCIR Workshop 2003, National Institute of Informatics*, pp : 150-153, 2003.
[33]. Tomohide Shibata, Sadao Kurohashi, Shotaro Kohama, Akihiro Yamamoto, 2013, “Predicate-argument Structure based Textual Entailment Recognition System of KYOTO Team for NTCIR-10 RITE-2”, *Proceedings of the 10th NTCIR Conference*, pp : 537-544, 2013.
[34]. Koichiro Yoshino, Shinsuke Mori, and Tatsuya Kawahara, “Language Modeling for Spoken Dialogue System based on Sentence Transformation and Filtering using Predicate-Argument Structures”, *In Proc. of SIGDIAL*, pages 59–66, 2012
[35]. Knuth D.E., Morris (Jr) J.H., Pratt V.R., “Fast pattern matching in strings”, *SIAM Journal on Computing* 6(1):323-350, 2001.

Wiwin Suwarningsih. She was obtain his Magister degree from Informatics department, Bandung Institute of Technology. Currently she still studying at School of Electrical Engineering and Informatics, Bandung Institute of Technology as doctoral student since 2013. Currently she is working as a researcher at Indonesia Institute of Science. Her research interest are on text minning and question answering system.

Iping Supriana Suwardi received the docteur-ingenieur degree in Informatics from the Institute National Polytechniques, Grenoble, French in 1985. He is currently a Professor of the School of Electrical and Informatic Engineering, Bandung Institute of Technology, Indonesia.

His research interest include: information automation, dynamic computer graphic, image analysis, recognition system, and image interpretation. He has authored or coauthored over 50 published articles.

He is the inventor and the implementer of the Gigital Mark Reader (DMR). DMR is software employed for evaluating examination results automatically using computer scanning. DMR is widely used in Indonesia education institutuion.

Ayu Purwarianti. She was graduated from her bachelor and master degree at Informatics Program, Bandung Institute of Technology. She got her doctoral degree from Toyohashi University of Technology, Japan. Since 2008, she has become a lecturer at School of Electrical Engineering and Informatics, Bandung Institute of Technology, Indonesia. Her research interent is on computational linguistics, mainly on Indonesian natural language processing and Indonesian text mining. She is now active as the education officer at IEEE Indonesia.