TELKOMNIKA, Vol.13, No.1, March 2015, pp. 357~363
ISSN: 1693-6930, accredited A by DIKTI, Decree No: 58/DIKTI/Kep/2013
DOI: 10.12928/TELKOMNIKA.v13i1.648

Towards a Framework for an Indonesian Medical Question Generator

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Abstract

Question generating is the task of automatically generating questions from various inputs such as raw text, database, or semantic representation. In this paper, we attempt to describe a general framework that could help develop and characterise efforts to Indonesian medical questions generation. We propose a new style of question generation that actively uses sentences within a document as a source of answers. We use manually written rules to perform a sequence of general purpose syntactic transformations (e.g. identification of keywords or key phrases to NER based on PICO frame) to turn a declarative sentence into questions. The final result of this research is a pattern of question and answer pairs, where the test results show the pattern matching algorithm precision value of 0.101 and a recall of 0.712.

Keywords: *generating question, Indonesian medical text, PICO frame*

1. Introduction

Medical questions are often long and complex and take many forms [1]. One way to meet medical information needs is to refer to the published literature for related medical evidence [2]. This information is entered in a free flowing text. The goal of such recording is primarily limited to manual inspection or future referencing when the same patient asks again [3]. This paper presents a system designed to satisfy the information needs of patient. We explore these interesting research questions in the medical and clinical domains, focusing on the information needs of patients in preventive medical action. The method for the information needs of patients are manifold such as health information through advertising, Online Discussion [4], health education, question generation (QG) etc. QG is the task of generating reasonable questions from a paragraph, text or sentence and database. QG involves numerous complex subtasks which lie at the interface between Natural Language Understanding and Natural Language Generation [5].

Previously have done some research on this QG for a variety of method, techniques and domains such as semantics-based method, keyword-based techniques and logic reasoning question for student. Yao et al. [5], propose a semantics-based method of transforming the Minimal Recursion Semantics (MRS) representation of declarative sentences to that of interrogative sentences. Urlaub [6], studies the impact of the reading comprehension strategy of generating questions on literary reading development in a second language. Li and Huang [3] develop and evaluate a technique for an MQG (Medical Query Generator) that generates keyword-based queries from natural language descriptions of medical information needs. MQG aims at serving as a front-end component of a retrieval system: it generates queries to retrieve relevant texts, which are then ranked for further processing (e.g., relevant measurement and ranking). Khodeir et al. [8], estimate the student knowledge model in a probabilistic domain using automatic adaptively generated assessment questions. The student's answers are used to measure the actual student model. Updating and verification of the model are conducted founded on the matching between the student's and model answers. Wang et al. [9], present algorithms for automatic questions generation of logic reasoning with unique solutions.

Another piece of research, by Ajmera et al. [10], proposed techniques for exploit information to mine real customer concerns or problems and then map them to well written knowledge articles for that enterprise. This mapping results in the generation of question-answer (QA) pairs. Bednarik and Kovack [11], describe the principles and methods applied to

Received September 30, 2014; Revised December 13, 2014; Accepted January 10, 2015

determine automatically the word to be extracted form a chosen sentence for the question generation according to information gained by the methods mentioned above.

From these studies, we obtained some things that can be explored further and improved to produce questions generator for Indonesian medical language. In this paper, we propose a new style of question generation that actively uses sentences within a document as a source of answer. We use manually written rules to perform a sequence of general purpose a syntactic transformation (e.g. identification of keywords or key phrase to NER based on PICO frame) to turn a declarative sentence into questions.

The rest of the paper is organised as follows: Section 2 describes related work on question generation followed by Section 3 which details our QG framework. Section 4 describe about an Indonesian medical question generation. Section 5 shows the concept of pattern matching algorithm for ImQG. Finally, in Section 6 we give a conclusion and future directions.

2. Related Work

The QG framework can be considered as the integration of several frameworks from related areas of text mining [12],[14], natural language processing [6],[15],[19],[25], semantic knowledge management [4],[13],[14], pedagogy and software development [5],[9],[10]. Recently, several question generator frameworks in natural language tasks has been designed. In the following, we highlight their differences.

Iwane et al. [18], define a framework for learner-centred question generation on the tablet PC. The framework is based on a learner's actions and the context of an expository text. In assisting active learning, three different types of questions can be generated according to the learner's marking actions. Some associated questions can also be generated based on the type of question. The generated questions will promote active learning by motivating further self-questionings and markings.

The framework of Sumita et al. [19], consists of three main steps: sentence extraction, determining the blank part and generation option words. The selection of sentences, blank positions and optional words is determined with help of machine learning methods using statistical and discriminative models.

Heilman and Smith [20], define a framework for generating a ranked set of fact-based questions about the text of a given article. They describe an extensible approach to generating questions for the purpose of reading comprehension assessment and practice.

Lindbergh et al. [21], develop a template-based framework for QG. The primary motivation for this is the opportunity of a template-based approach to generate questions that are not merely declarative interrogative transformations.

Ali et al. [22], consider a kind of Text-to-Question generation task framework, where the input text is sentences. The QG system would then generate a set of questions for which the sentence contains, implies, or needs answers.

3. Proposed method

The paper gives first an overview of the main methods of Indonesian medical question generation (ImQD) then the architecture of the proposed system is presented. For that task, we propose an ImQD general framework (Figure 1), intended as an abstract and flexible model within which to characterise and compare actual systems of question generation. A brief description of each step described in section 4.

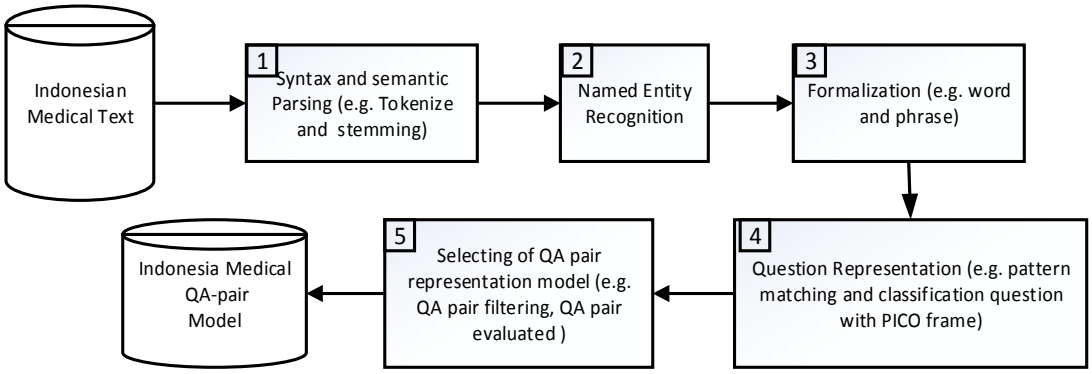

Figure 1. ImQG framework

4. Indonesian Medical Question Generation

The first modules of the framework are syntax and semantic parsing, which natural language sentences to a detailed, formal, meaning representation language (e.g. tokenise and stemming). It first uses an integrated shallow parser to produce a semantically augmented parse tree based on phrases, in which each non-terminal node has both a syntactic and a semantic label. A compositional-semantics procedure is then used to map the augmented parse tree into a definitive meaning representation. For example, Figure 3 illustrates the syntactic parse of the Indonesia sentences "*Peningkatan sistem imun menahan dari serangan virus*" (Improved immune system resists virus attack). Based on grammar in Figure 2, the parser assigns a VP for the verb phrase, an NP for the noun phrase, a JJP for the adjective phrase, an AdvP for the adverb phrase, a NumP for the numerals phrase and a PP for the prepositional phrase. Next, named entity recognition is a subtask of medical information extraction that seeks to locate and classify elements in a text into predefined categories. Such as the names of persons, organisation, location, time, problem, intervention, comparison, outcomes. The result of NER is in Table 1.

No	Rule	description:
1.	S → SUBJ PRED	S = sentence ; SUBJ = subjects ; PRED = predicate
2.	SUBJ → NP	NP = noun phrases ; AP = adverb phrases
3.	NP → (AP) N (PP) (JJP)	JJP = adjective phrase ; N = noun
	NP → PRP	PP = prepositional phrase (preposition)
4.	AP → JJ (PP)	PRP = personal pronoun
5.	PP → IN NP	RB = adverb (eg, sedang, agar)
6.	JJP → (N) JJ	VP = verb phrase
7.	PRED → (RB) VP	JJ = adjective (eg, cantik, malas)
8.	VP → (VBI) (VBT)	IN = preposition (eg di, ke, dari)
9.	VBT → VB (IN) OBJ	VBI = intransitive verb (eg, pergi)
	VBT → CC S	VBT = transitive verb (eg, membeli)
	VBT → SC S	CC = adverb/additional correlative conjunctions (eg, dan)
10.	OBJ → NP	SC = adverb/additional subordinate conjunctions (eg, jika)

Figure 2. Indonesian medical grammar based on POS [7]

Table 1. Name entity recognition based on key-phrase resulted

Word/phrase	NER	description
sistem imun (immune system)	<COMPARISON> = <C>	Key-phrase
serangan virus (virus attack)	<INTERVENSION> = <I>	Key-phrase

From these studies, we obtained some things that can be explored further and classification Indonesian medical question with frame PICO (Problem, Intervention, Comparison, Outcomes). The efficient identification of patient, intervention, comparison, and outcome (PICO) components in medical articles is helpful in evidence-based medicine. Evidence-based medicine or practice (EBM) involves answering medical questions by analysis of related articles from literature databases such as PubMed [2]. From Table 1. we can see that the formalisation process uses an annotation module to encode the text into a more or less rigid formalism. It is advisable that it be possible to perform deductive, and preferably also inductive and abductive inferences the formalisation. In this paper, the formalisation to correction of words or phrase the rules of the Indonesian language. The chosen formalism must also allow for a comparison to a previously built knowledge base in which medical knowledge is represented at the desired level of detail

The next step is question representation to medical knowledge and text representations will then be compared within a knowledge matching module, the specifics of which depend largely on the chosen formalism. These modules should extend the representation by performing all allowable inferences (such as Problem/Patient, Intervention, Comparison, Outcomes), then matching the results to the content of the medical knowledge base. PICO stands for : Patient/Problem used **Siapa (Who)** or **Apa (What)**; Intervention used **Bagaimana (How)**; Comparison used **Apa (What** is the main alternative); Outcome used **Apa (What)** are you trying to accomplish, measure, improve, effect. The match of patterns against a given free text is done at the lexical, syntactic and semantic levels. Also, we discard all matched phrases or words in which the answer based on the semantic category expected by the question. From the above NER result in Table 1, we can generate a question for each of the NER (see Table 2).

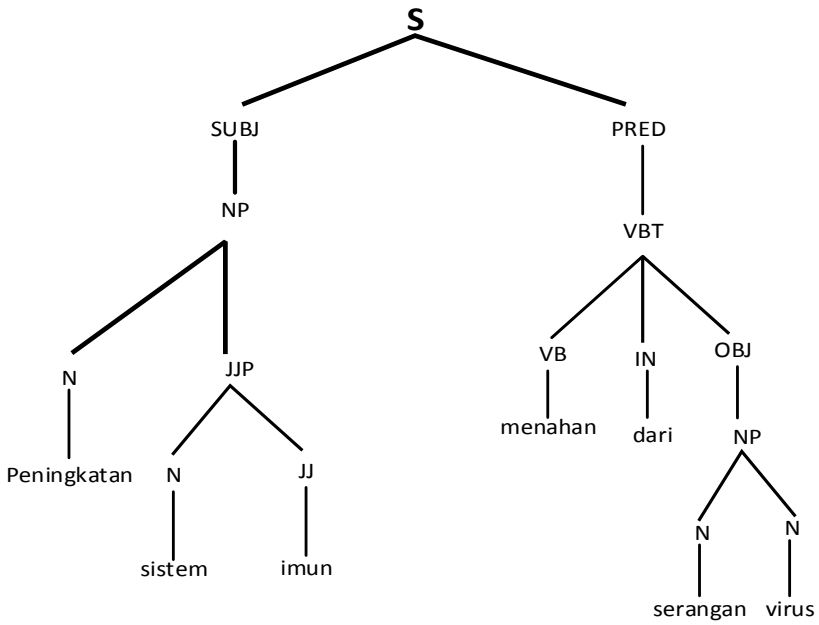

Figure 3. Sentence example and its shallow parser results

The results are passed on to a question representation module, where an array of Indonesian medical question models and question-answer pairs is searched in order to identify the types of questions to be generated for the selected input. The questions thus generated are then assessed and filtered. The results of question filtering with patterns based on POS and PICO Classification are in Table 3.

Table 2. Question Representation with question generation for "*Peningkatan sistem imun menahan dari serangan virus*"

	Question generation based of NER	Expected Answer Type based NER
1.	**Apakah** manfaat meningkatkan sistem imun ?	**<INTERVENSION>**
2.	**Apa** yang dimaksud dengan sistem imun ?	<DEFINISION>
3.	Sistem imun itu **apa** ya ?	<DEFINISION>
4.	**Apakah** dampaknya bila sistem imun meningkat?	<DIAGNOSIS>
5.	**Bagaimana** menahan serangan virus ?	**<COMPARISON>**
6.	**Bagaimana** virus menyerang tubuh ?	<DIAGNOSIS>

Table 3. The result of question filtering for "*Peningkatan sistem imun menahan dari serangan virus*"

Question	Question Pattern	Answer	Answer Pattern
Apakah manfaat meningkatkan sistem imun ?	**Apakah** + N + N + JJP	Menahan serangan virus	VB + NP
Bagaimana menahan serangan virus ?	**Bagaimana** + VB + NP	Peningkatan sistem imun	N + JJP

The final step is the selecting of a QA pair representation model (e.g. QA pair filtering, QA pair evaluated). In our framework, there are two rules for QA pair filtering. The first one is that if the phrase in a generated question has a pronoun as a part-of-speech, it is meaningless [23]. The second one is that a question that does not contains of NER based on PICO frame, it is meaningless.

5. The Concept of Pattern Matching Algorithm for ImQD

We approached the problem of finding the pattern matching with modified algorithm from Deterministic Finite Automata (DFA) methods [24]. The concept of pattern matching algorithm is in Figure 4. The algorithm proposed in the paper is extensive in terms of support various pattern based on POS/NER and each node can have multiple labels (such as POS tagging, NER).

5.1. Experimental Data for Pattern Matching Algorithm

In our database, there is no medical Indonesian question generation data available. For this reason, we built our own Indonesian medical question document pairs. We collected from two popular Indonesian health websites (detikhealth.com and kompashealth.com). In the question collection, we asked 10 Indonesian people to write Indonesian questions based on 50 articles that we selected manually from the Indonesian medical corpus.

5.2. Experimental Result for Pattern Matching Algorithm

The scope of the test consists of a sentence with POS pattern (such as N+N+JJ+VB+IN+N+N). This was necessary so that during the testing stage, the pattern matching algorithm would be able to recognise the Indonesian grammar. In this paper, we used 100 sentences with a POS pattern for the pattern matching algorithm experiment. For the pattern matching, we used two evaluation measures: precision and recall. Precision shows the average ratio of the relevant pattern. The relevant pattern is a pattern that contains an Indonesian grammar based on Indonesian POS. Recall shows a number of patterns that might have pattern-matching in our database. Our pattern matching achieves precision of 0.101 and recall of 0.712.

```
Algorithm for pattern matching
Input:  Sentence with POS pattern            // POS = Part of speech
Output: Pattern of sentence founded
Method: One state for each pattern based on POS/NER and each node can have multiple
        labels (such as word, POS tagging, NER).

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

// identification for POS on database table = d.pos
// identification for query POS from sentence = q.pos

// matching process
For (int i = 0; i < N; i++)          // N is length of pattern
If (q.pos(i) = d.pos(j) then  //compare POS at that position with next pattern POS
Next[j] = next i];
              j ++;                  //pattern match do copy and increment
else
next [j] = x + 1;
              x = next[x];           // pattern mismatch do opposite
endif

// If pattern match then POS founded
If (j = p) then                      // if POS at j position found at p position
Return i-p+j
Endif
Endfor
Return -1                            // if POS at j position not found at p position
```

Figure 4. Pattern matching algorithm for ImQG

6. Conclusion

In this paper, a new framework for Indonesian medical question generation and concept of pattern matching with Deterministic Finite Automata (DFA) methods was proposed. The framework is based on a parsing process for NER identification. NER identification includes word and phrase which are caused by self-questionings while identifying the POS pattern. After the system identifies a new concept or finds an answer to a question on the database sentence, the system will mark it on the sentence. In the proposed framework, four different types of question can be generated according to this NER identification. The final result of this research is a pattern of question and answer pairs, where the test results show the pattern matching algorithm precision value of 0.101 and a recall of 0.712. The future work is to fully implement the system and evaluate the effectiveness of its use in motivating user for active learning in the medical domain.

Acknowledgment

We thank anonymous reviewers for their helpful comments.

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