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An Interpretation of Algorithm Results for Narrative Blood Chemistry Laboratory: A Systematic Review

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ABSTRACT

The laboratory is one of the places to analyse disease and further provide input on improving treatment for certain types of disease through assessment. Blood sugar test is a significant test to determine a patient's health problems. Blood test results are still being introduced as a manual report containing a table of contractions and their qualities and units, which will then be read and shown to patients by specialists and medical personnel. Unfortunately, most of the specialists and their assistants had mixed translations in reading the report. Therefore, to assist specialist doctors and health nurses in obtaining similar data, this study proposes a Natural Language Generation (NLG) approach by applying Bigram's calculations to produce an understanding of the side effects of fasting and non-fasting blood sugar tests. The means of exploration are information extraction, understanding information, compilation of archives, micro planning and recognition, as well as the reporting period. This framework converts the mathematical arrangement of the test results into printed information in Indonesian which becomes the account understanding in the research facility reports on the consequences of fasting and non-fasting blood science tests. The results in this framework are reports as word archives. The test results of this examination indicate that the level of ease of account understanding of the test results obtained by specialists reaches 90%.

Keywords: Interpretation, Narrative Blood, Laboratory, Algorithm, A Review.

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INTROSUCTION

The laboratory test is very important in helping to diagnose disease and determine prognosis [1]. It is a multiphase process: test needs identification, test request, central supply or laboratory request, preparation of physical examinations, patient and family education, collection, labelling and specimens storing, and health education [2][3].

This research only focuses on the results of fasting and non-fasting blood chemistry test, in which patients are required to fast before the test [4]. Usually, there are 3 types of diseases that require fasting before the test, namely: glucose, uric acid, and cholesterol. Blood chemistry test is a laboratory examination that uses the patient's blood sample to analyse organic chemicals in the blood [5][6].

The result of blood chemistry test obtained from the laboratory is usually still in the form of a report with a table containing medical abbreviations of chemical elements contained in the blood, it is in the form of numbers, ranges of normal values, and units [7]. But this result does not include general explanations so that it can be interpreted differently by doctors, medical staff and referrals. Therefore, an interpretation in the form of narrative explanation is needed as a means of obtaining the same information from the table of the test result between doctors and medical staff in the hospital [8].

In this research, the writers use Bigram in the process of producing narrative paragraphs.

METHODOLOGY

General Architecture

The method proposed by the writers to implement the Bigram Algorithm in the process of interpreting the narrative results of a blood chemistry test consists of four steps [9][10]. The steps are Data Extraction, Data Interpretation, Micro Planning & Realization, and Report Generation. The first step that is carried out by the system is Data Extraction which is responsible for extracting the data available in the word extension file. After the data extension, the next step is Data Interpretation which is tasked with interpreting the extracted data and then storing it in the list variable that will be searched the connection of them with Knowledge Base containing a range of normal and abnormal values in several elements of fasting and non-fasting blood chemistry test. The next step after Data Interpretation is Micro Planning & Realization which is divided into

several sub-steps, including, Sentences Segmentation, Tokenization, Sentence Segmentation with Bigram Algebra, and the last step, report generation, will produce narrative paragraphs. The steps above can be seen in the form of general architecture in Figure 2.1.

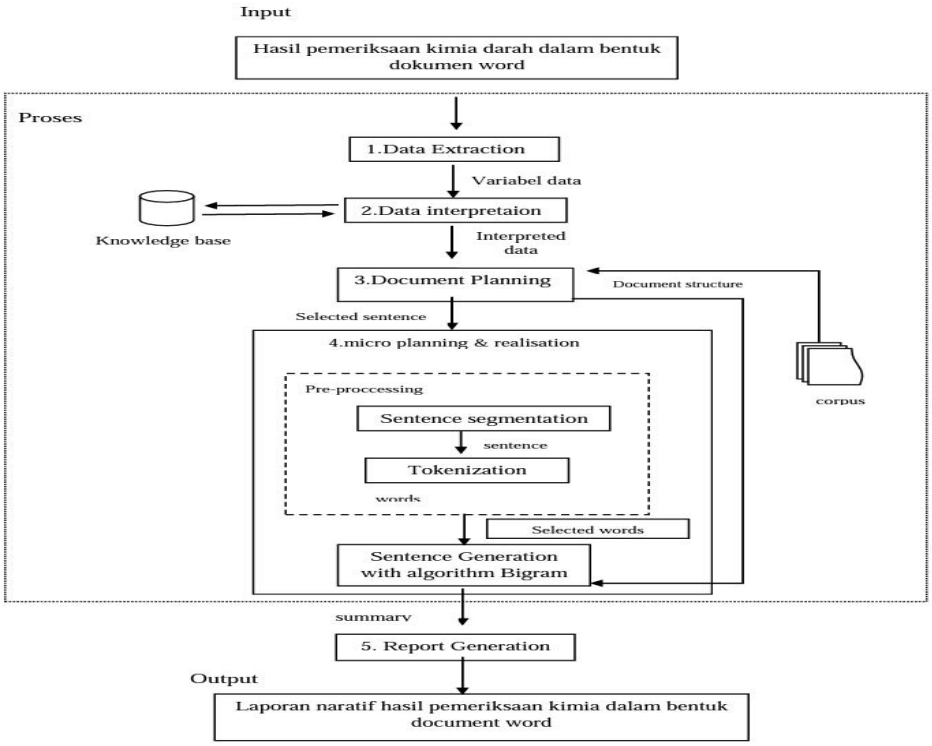

Figure 2.1. General Architecture

A. Data Input

Data on the results of fasting and non-fasting blood chemistry tests were taken from the University of North Sumatra hospital in Medan using the Clinical Chemical Analyzer. The Clinical Chemical Analyzer is a device used to measure the levels of blood chemistry [16]. It will display the test results that are typed manually by laboratory personnel in the form of word documents with the format agreed upon by medical personnel. Figure 2.2. and Figure 2.3 are reports of fasting and not fasting blood chemistry.

Data on the results of fasting and non-fasting blood chemistry tests in the form of word documents are then used as input to this system to be processed at a later step. The data on the results of fasting and non-fasting blood chemistry tests in the form of word documents consist of two parts, the patient's personal data on the upper right and the results of fasting or non-fasting blood chemistry test. The patient's personal data consists of two main columns in the table. The first column contains the patient's personal data entity which consists of the patient's name, laboratory number, date of birth, sex, and date of the check. The second column contains the values of the entity in the first column. Then there are data on the results of the fasting blood chemistry laboratory test under the patient's personal data consisting of 3 columns and 10 lines. The 3 columns are each titled test, results, and normal values. Then 10 lines consist of examination categories and types of checks. The examination categories include diabetes, kidney function, fat function. For the diabetes category, it consists of fasting glucose, 2-hour glucose pp. Furthermore, the category of kidney function is Uric acid. For the fat function category, it consists of cholesterol, LDL, HDL, and Triglyceride. As for the results of the of non-fasting blood tests are similar with the categories on the fasting blood test, only in the category of diabetes, there is only result of the non-fasting test or called add random. The order of data from the test results is different in each hospital so that the contents must adjust to the format of the research hospital. Examples of results of fasting and non-fasting blood chemistry tests are shown in Figure 2.2. and Figure 2.3.

B. Process

The process of processing data from the blood chemistry laboratory test consists of four main processes, namely:

1. Data Extraction

Based on the general architecture in Figure 3.1 the first process is data extraction which is the process of reading data that will be stored in the form of a data list variable to be used at the step of data interpretation. The data list variable consists of the patient's personal data, the category of the test, the type of the test and the results of the test as shown in Figure 2.2 and Figure 2.3. The output of this process is the data list variable.

2. Data Interpretation

Data interpretation is a process of connecting data variables with a knowledge base to obtain the conditions of each component of blood chemistry.

Table 2.1. The rules for the abnormality level of each blood chemistry component

No	Status	Rules
1	Normal	The value of fasting and non-fasting blood chemical components is between the lowest and highest limits according to the data in Table 2.1.
2	Abnormal increases	The value of fasting and non-fasting blood chemical components is above the highest limit range according to the data in Table 2.1
3	Abnormal decreases	The value of fasting and non-fasting blood chemical components is above the highest limit range according to the data in Table 2.1

3. Document Planning

Document planning is a process that is responsible for determining what information will be presented (data selection) and how to structure the document (document structuring). Input from this process is interpreted data which is output from data interpretation and corpus. The corpus used contains a collection of explanatory sentences about the abnormality of blood chemistry components originating from various literature and has been validated by experts in the field, namely clinical pathology specialists at University of North Sumatra Hospital Medan.

4. Micro-Planning and Realisation

Micro-planning is a process of selecting words and arranging them into sentences so that they have meaning. Realization is a process that will produce paragraphs of narrative interpretation of the results of laboratory tests of blood chemistry in the context of free grammar.

Table 2.2. The results of the sentence process are segmentation of the] details of the results of blood chemistry test

Before sentence segmentation	After sentence segmentation
The patient experiences a decrease from the normal limit of uric acid. The patients have uric acid levels below the normal limit. The uric acid level of the patient has increased above the normal limit.	1. The patient experience a decrease from the normal limit of uric acid. 2. The patients have uric acid levels below the normal limit. 3. The uric acid level of the patient has increased above the normal limit.

5. Sentence Segmentation with Algorithm Bigram

In this process, possible next word equivalents are sought using the bigram probability. The word with the highest probability value will be chosen as the next word equivalent and arranged until a sentence is formed. The Bigram is used to estimate the probability calculation of the next word P (n) if the previous word P (n-1) has been selected. Then the next word can be determined after the word " *patient* ". The word "*patient*" in the corpus is 3 and the frequency of the word " *the patient has* " in the corpus is 1, the probability is P (*have* | *patient*) = 1/3 = 0.33333333. Furthermore, the frequency of the word " *patient"* in the corpus is 3 and the word " *the patient has* " in the corpus is 2, the probability is P (*mengalami* | *patient*) = 2/3 = 0.66666667 so the next word with the highest probability value after "*patient*" is the word " *experience* ". In Table 2.5, there is a complete process to produce a sentence using Bigram.

Table 2.3. Results of sentence generation with bigram

n-1	N	P (n-1, n)	P(n-1)	P(n|n-1)
Patient	Experience	2	3	0,66666667
Patient	Have	1	3	0,33333333
experience	Enhancement	2	2	1
Enhancement	From	1	2	0,5
From	Limit	2	2	1
Limit	Normal	2	2	1
Normal	Blood glucose	1	2	0.5
Blood glucose		1	1	1

C. Report Generation

In this process, the data of the patient's blood and urine chemistry test are combined with a table containing the results of the examination with the narrative paragraphs of the interpretation results in Indonesian which are obtained from the output of microplanning and realization. The result of the merger is a Word extension file

RESULTS AND DISCUTTION

From 37 data test, 15 of them were fasting blood tests results and 21 of them were non-fasting blood test results of patients at the University of North Sumatra Hospital in Medan in the form of word documents. Of the 37 documents tested in the system, 37 narrative interpretations were obtained.

Based on Figure 3.1 it can be seen the scales of the narrative interpretation that has been assessed by the doctor. The following is an explanation that can be analysed as follows:

a) The readibilty aspect is an aspect that shows the level of understanding and ease of the reader in reading the sentences contained in the narrative

interpretation. The results of the doctors' assessment show that:

- 21% of doctors stated that the narrative interpretation produced by the system was very easy to understand
- 55.5% of doctors stated that the interpretation of the narrative produced was easy to understand
- 17.5% of doctors stated that the interpretation of the narrative produced was quite understandable
- 5% of doctors stated that the resulting narrative interpretation was difficult to understand
- 1% of doctors stated that the resulting narrative interpretation was very difficult to understand

b) The aspect of clarity is an aspect that shows the level of clarity in delivering information into sentences contained in narrative interpretation. The results of the study are as follows:

- 22% of young doctors stated that the narrative interpretation was very clear
- 42% of young doctors stated clear narrative interpretations
- 25.5% of young doctors state that the narrative interpretation is quite clear
- 9% of young doctors stated that the narrative interpretation was unclear
- 1.5% of young doctors stated that the narrative interpretation was very unclear

c) The general aspect of appropriateness is an aspect that aims to identify whether the sentences contained in the interpretation of the output narrative of the system can increase the reader's knowledge of the information on the results of chemical examinations. The results of the study are as follows:

- 19.5% of young doctors state that narrative interpretation is very appropriate
- 40% of young doctors state the right narrative interpretation
- 26.5% of young doctors stated that the narrative interpretation was quite appropriate
- 11.5% of young doctors stated that narrative interpretation was inappropriate
- 2.5% of young doctors stated that the narrative interpretation was inappropriate

Based on the level of narrative interpretation that was assessed by 10 doctors who had participated in filling out the questionnaire produced by the system based on the aspect of readability, it was able to convey information on the results of blood chemistry examination that is easily understood by 90% of doctors. Then in the aspect of clarity, the doctors stated that the interpretation of the narrative produced was clearly conveying information on the results of the blood chemistry examination. While in the general aspect of appropriateness, the doctors stated that 86% of the narrative interpretations produced by the system were correct in helping doctors obtain information on the results of blood chemistry examinations. To calculate the final percentage or overall, of each aspect of the naturalness assessment level using the equation [2] where the final percentage is the sum of the assessment aspects of scale 3 to 5.

$$Persentase\ Aspek = \sum_{i=3}^{5} \text{Persentase Skala} \quad (1)$$

CONCLUSION

a. The final results of fasting and non-fasting blood chemistry testing using Bigram's calculations are as follows:

2. Bigram calculations used in this study can make understanding of the story based on mathematical information based on the table about the consequences of fasting and non-fasting blood tests obtained from the Hospital of the University of North Sumatra, Medan as word notes.

3. The results from the three general perspectives are obtained from the tests by specialists, it may well be argued that the estimates from the three characteristic points of view result in about 90% of the overall fit.

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NAME: CG
LAB NO.: 00
DATE OF BIRTH: 04/04/1953
SEX: F
DATE OF CHECK: 04/13/2018

Test	FASTING RESULT	NORMAL VALUE
Diabetes		
Fasting glucose	224	70 – 80 mg/dl
2-hour pp Fasting glucose	113	70 – 80 mg/dl
Kidney function		
Uric acid	40	P: 3.5 - 7.2 W: 2.9 - 5.2 mg /dl
Fat		
Cholesterol Total	201.7	< 200 mg/dl
HDL Cholesterol	57	W: 35 - 70 mg/dl P: 35 - 55 mg dl
LDL Cholesterol	144	< 130 mg/dl
Triglyceride	91	< 150 mg/dl

Figure 2.2. Examples of data from laboratory tests on fasting blood chemistry in word format

NAME: MSL
LAB NO.: LK001
DATE OF BIRTH: 23/06/1953
SEX: M
DATE OF CHECK: 21/07/2018

TEST	NON-FASTING RESULT	NORMAL VALUE
Diabetes		
Non-Fasting glucose	127	<200 mg/dl
Kidney function		
Uric acid	20	P: 3.5 - 7.2 W: 2.9 - 5.2 mg /dl
Fat		
Cholesterol Total	121.7	< 200 mg/dl
HDL Cholesterol	80	W: 35 - 70 mg/dl P: 35 - 55 mg dl
LDL Cholesterol	120	< 130 mg/dl
Tryglyceride	90	< 150 mg/dl

Figure 2.3. Examples of data from laboratory tests on non-fasting blood chemistry in word format

In Figure 3.1 below, it will show the level of each assessment aspect of 37 examples of narrative interpretation as the output of the system in this research which was assessed by 10 doctors.

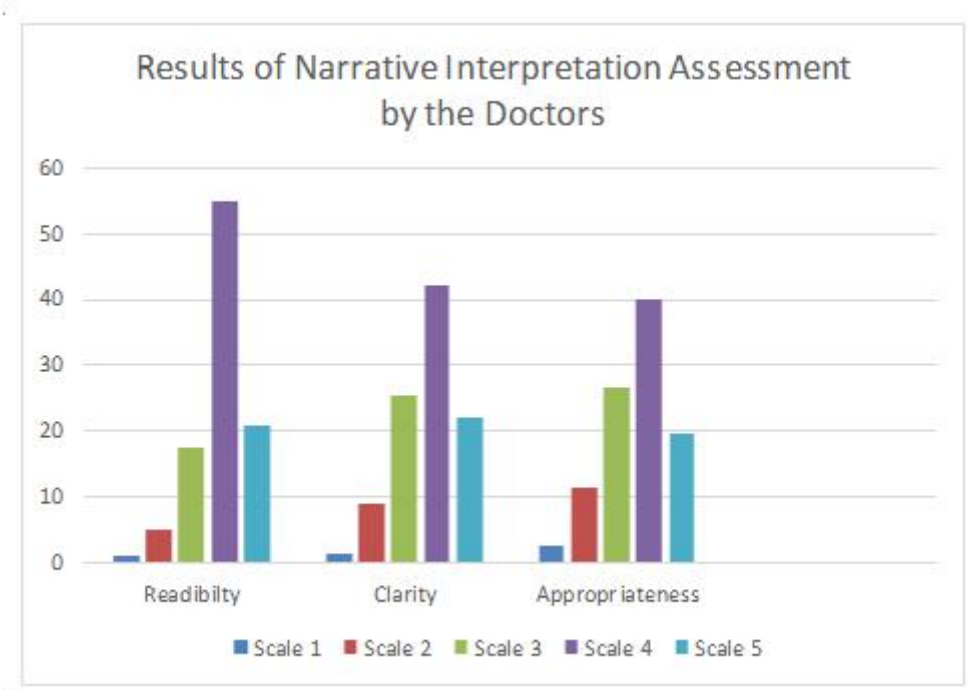

Figure 3.1. Narrative Interpretation Rate assessed by the doctors