THE BOIS: DIAGNOSING DENGUE INFECTION BY USING AN INTELLIGENT SYSTEM

Muhammad Haikal Iman Bin Osman (A179376), Mohamad Saiful Nizam Bin Abd Aziz (A179830), Dineswaran A/L Navarasan (A180763), Dr. Kerk Yi Wen (Instructor)

Abstract. Dengue is a viral infection found in tropical and sub-tropical climates worldwide, mostly in urban areas. It is an infection transmitted to humans through the bite of infected mosquitoes which is classified as Aedes. A fuzzy system is a knowledge-based system that can reach a right conclusion utilizing specific data from individual patients. It is one of the most frequent forms of artificial intelligence in the medical system. A set of rules are used for representing the knowledge or data of dengue fever. Therefore, it is important to detect dengue disease at an early stage. The designed fuzzy system can be used for early diagnosis of dengue disease of a patient by using physical symptoms as input variables and converting these input variables into fuzzy membership functions. A promising forecast of dengue can spare an individual's life by making them aware of their health and be wary of the symptoms faced. In this task, we propose to build up an AI model to foresee dengue fever. We will use different classifiers in Weka to run and the calculation giving the most elevated forecast precision will be considered as the suitable model for our dataset.
Keywords. *Dengue, Aedes, Pattern recognition, Fuzzy modeling, Diagnosing Dengue Infection, Intelligent System.*

INTRODUCTION

Dengue fever is a contagious illness. High fevers, headaches, rashes, and pain all over the body are all possible symptoms. Dengue viruses are transmitted to humans through the bite of an infected Aedes mosquito, such as Aedes aegypti or Aedes albopictus. Dengue fever affects over half of the world's population, or about 4 billion people. Dengue fever is a common cause of sickness in high-risk settings. Dengue fever infects up to 400 million people each year. Approximately 100 million individuals are infected, with 40,000 people dying from severe dengue fever.

Dengue fever is caused by one of four closely related viruses: dengue virus 1, 2, 3, or 4. As a result, a person can contract the dengue virus up to four times over his or her lifetime. The goal of this Artificial Intelligence (AI) research is to assist individuals in diagnosing dengue symptoms. According to the statistics from the paper, symptoms normally start four to six days after infection and can continue up to 10 days. Sudden high fever, severe headaches, discomfort behind the eyes, severe joint and muscular pain, weariness, nausea, vomiting, skin rash that emerges two to five days after the commencement of the fever, and light bleeding such as nasal bleeds, bleeding gums, and easy bruising are the first signs.

Figure 1. Aedes aegypti.

Symptoms might be modest, and they can be mistaken for the flu or another viral infection. The virus affects younger children and persons who have never had it before in a milder way than it does older children and adults. However, major issues can arise.

Dengue hemorrhagic fever is an uncommon complication marked by a high temperature, damage to lymph and blood arteries, bleeding from the nose and mouth, liver enlargement, and circulatory system failure. Massive bleeding, shock, and death may occur as a result of the symptoms. The condition is known as dengue shock syndrome (DSS).

We may use AI to create a model, such as a Decision Tree, to achieve the desired result with a high level of accuracy. A dataset of 100 patient records will be included into the model, with the outcome being either positive or negative. General information about the patient, as well as bodily components such as severe headache, joint muscle discomfort, stomach pain, and body temperature, are among the qualities. A point-by-point representation of the dataset is used. We intend to build a model that achieves an accuracy rate of greater than 95% and works well with our dataset.

Figure 2. Aedes albopictus

METHOD

KNOWLEDGE EXTRACTION

The domain for our group project is medical and the name for this project is Diagnosing Dengue Infection. There are a few websites that we use for this project and the website that we referred to is:-Dengue fever by Mary Anne Dunkin. We acquired our dataset from:-Typhoid and dengue fever symptoms by Ashish Cawla. The dataset used to train our dengue prediction model was gathered from actual medical data of patients containing the symptoms and physical changes experienced during the time of infection such as body temperature, eye pain and joint muscle ache. These attributes as a whole are being used in our model so that the learning can be done by the system to predict the presence of dengue fever. The dataset provides possible information about the symptoms that could have led to dengue fever and showed the final result of whether the dengue fever is present or not, which makes it a dependent variable. Finally, the dataset is structured data because the dataset can be represented in rows and columns.

KNOWLEDGE REPRESENTATION

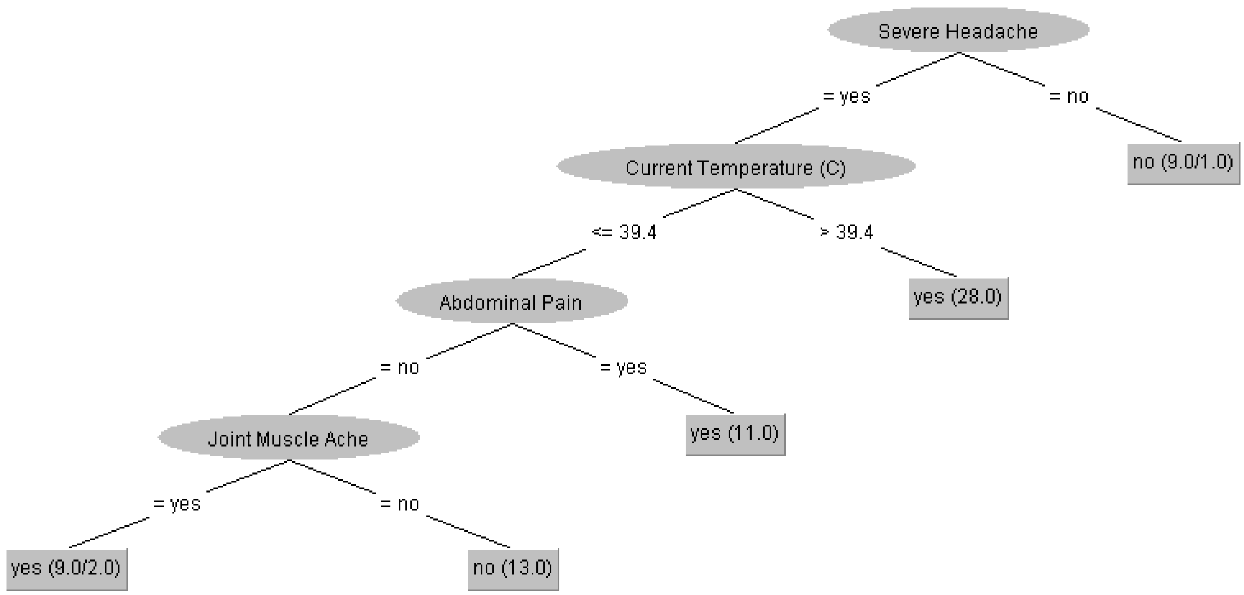


Figure 3. The Tree Generated From J48 Machine Learning Model.

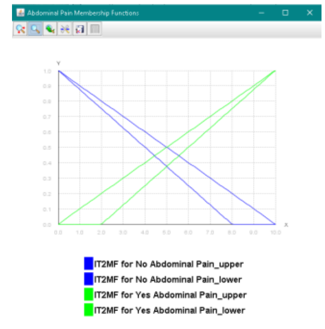
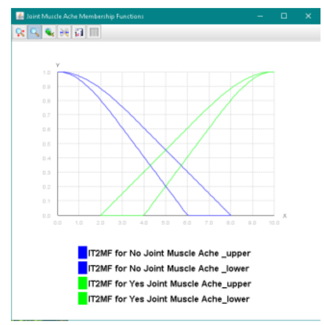
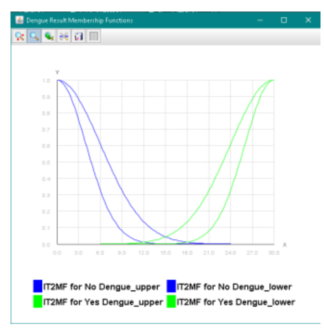
Rule 1: IF Severe Headache is no THEN dengue fever is false.
Rule 2: IF Severe Headache is yes AND Current Temperature is >39.4 THEN Dengue Fever is true.
Rule 3: IF Severe Headache is yes AND Current Temperature is <=39.4 AND Abdominal Pain is yes THEN Dengue Fever is true.
Rule 4: IF Severe Headache is yes AND Current Temperature is <=39.4 AND Abdominal Pain is no AND Joint Muscle Ache is no THEN Dengue Fever is false.
Rule 5: IF Severe Headache is yes AND Current Temperature is <=39.4 AND Abdominal Pain is no AND Joint Muscle Ache is yes THEN Dengue Fever is true.

Using the Weka Explorer in the classifier section, we have used Cross-validation as our test option and set the fold value into 10 so our dataset of 100 patients will be divided randomly into 10 parts. Cross-validation is primarily used in applied machine learning to estimate the skill of a machine learning model on unseen data.

INFERENCE ENGINE

For our project, we have used backward chaining as the inference engine. Backward chaining is a method used when a description is given backward from the goal, and in this case the dengue fever status of someone. In this kind of chaining, the right arrangements can be inferred successfully if pre-decided principles are met by the inference engine. Our system uses a bottom-up approach so the dengue fever status will be given based on the input from the users. Users would need to answer all the given questions which are based on their body symptoms and their health condition. The system will filter all the possibilities and finally conclude the users' possible dengue fever status.

HANDLING UNCERTAINTIES AND CONFLICTING KNOWLEDGE BASE

Linguistic Variable	Linguistic Value	Range	Fuzzy Representation
Abdominal Pain Membership Functions	No Abdominal Pain_Upper No Abdominal Pain_Lower Yes Abdominal Pain_Upper Yes Abdominal Pain_Lower	[0.0 , 0.0 , 10.0] [0.0 , 0.0 , 8.0] [0.0 , 10.0 , 10.0] [2.0 , 10.0 , 10.0]	
Joint Muscle Ache Membership Functions	No Joint Muscle Ache_Upper No Joint Muscle Ache_Lower Yes Joint Muscle Ache_Upper Yes Joint Muscle Ache_Lower	[0.0 , 0.0 , 6.0] [0.0 , 0.0 , 8.0] [2.0 , 10.0 , 10.0] [4.0 , 10.0 , 10.0]	
Dengue Result Membership Functions	No Dengue_Upper No Dengue_Lower Yes Dengue_Upper Yes Dengue_Lower	[0.0 , 6.0] [0.0 , 4.0] [30.0 , 6.0] [30.0 , 4.0]	

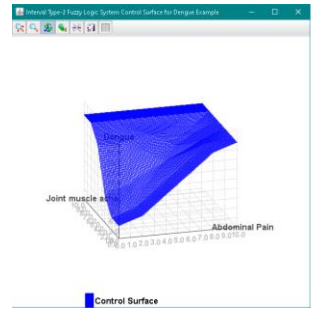
Interval Type-2 Fuzzy Logic System Control Surface for Dengue Example	

Table 2. The Fuzzification Process.

"The Abdominal Pain was: 7.0. The Joint Muscle Ache was: 8.0. Using center of sets type reduction, the IT2 FLS recommends a dengue of: 26.058535533520647. Using centroid type reduction, the IT2 FLS recommends a tip of: 25.62382102348451. Centroid of the output for DENGUE (based on centroid type reduction). left = 24.663531580328375 and right = 26.58411046664065 at y= 1.0. The Abdominal Pain was: 0.0. The Joint Muscle Ache was: 0.0. Using center of sets type reduction, the IT2 FLS recommends a dengue of: 3.9414644664793532. Using centroid type reduction, the IT2 FLS recommends a tip of: 3.9414644664793532. Centroid of the output for DENGUE (based on centroid type reduction). left = 3.091579932090684 and right = 4.7913490008868022 at y= 1.0

Interval Type-2 Fuzzy Logic System with 4 rules:

IF No Abdominal Pain AND No Joint Muscle Ache THEN No Dengue Result
IF No Abdominal Pain AND Yes Joint Muscle Ache THEN Yes Dengue Result
IF Yes Abdominal Pain AND No Joint Muscle Ache THEN Yes Dengue Result
IF Yes Abdominal Pain AND Yes Joint Muscle Ache THEN Yes Dengue Result"

Output 1. The Backtracking of The Fuzzification Process.

THE MACHINE LEARNING TECHNIQUES

We utilized three machine learning techniques in our task. HoeffdingTree, REPTree and Decision

Tree (J48) were picked to prepare our model with dengue information. Machine learning technique that we use in our project is the decision tree (J48) because this model is very commonly used by every data scientist and machine learning engineer and also produces the highest dengue dataset classification accuracy out of the 3 models used. If the instances belong to the same class, the J48 algorithm comprises numerous steps where the leaf is labelled with a comparable class. The potential data for each attribute will be calculated, and the gain in data will be calculated from the attribute test. Finally, based on the current selection parameter, the best characteristic will be picked. The J48 decision tree can handle data with specific properties as well as lost or incomplete attribute estimations. It also provides a more accurate portrayal and is easier to comprehend.

RESULTS - DIAGRAM AND TABLE

```
Number of Leaves  :     5

Size of the tree :      9


Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances          68               97.1429 %
Incorrectly Classified Instances         2                2.8571 %
Kappa statistic                          0.9352
Mean absolute error                      0.0389
Root mean squared error                  0.171
Relative absolute error                  8.7583 %
Root relative squared error             36.335  %
Total Number of Instances               70

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 0.979    0.043    0.979      0.979    0.979      0.935    0.963     0.967     yes
                 0.957    0.021    0.957      0.957    0.957      0.935    0.963     0.929     no
Weighted Avg.    0.971    0.036    0.971      0.971    0.971      0.935    0.963     0.954

=== Confusion Matrix ===

  a  b   <-- classified as
 46  1 |  a = yes
  1 22 |  b = no
```

Figure 4. The diagram above shows the result of the decision tree (J48) based on our dataset.

DIAGRAM AND TABLE

INTERFACE - INPUT & OUTPUT

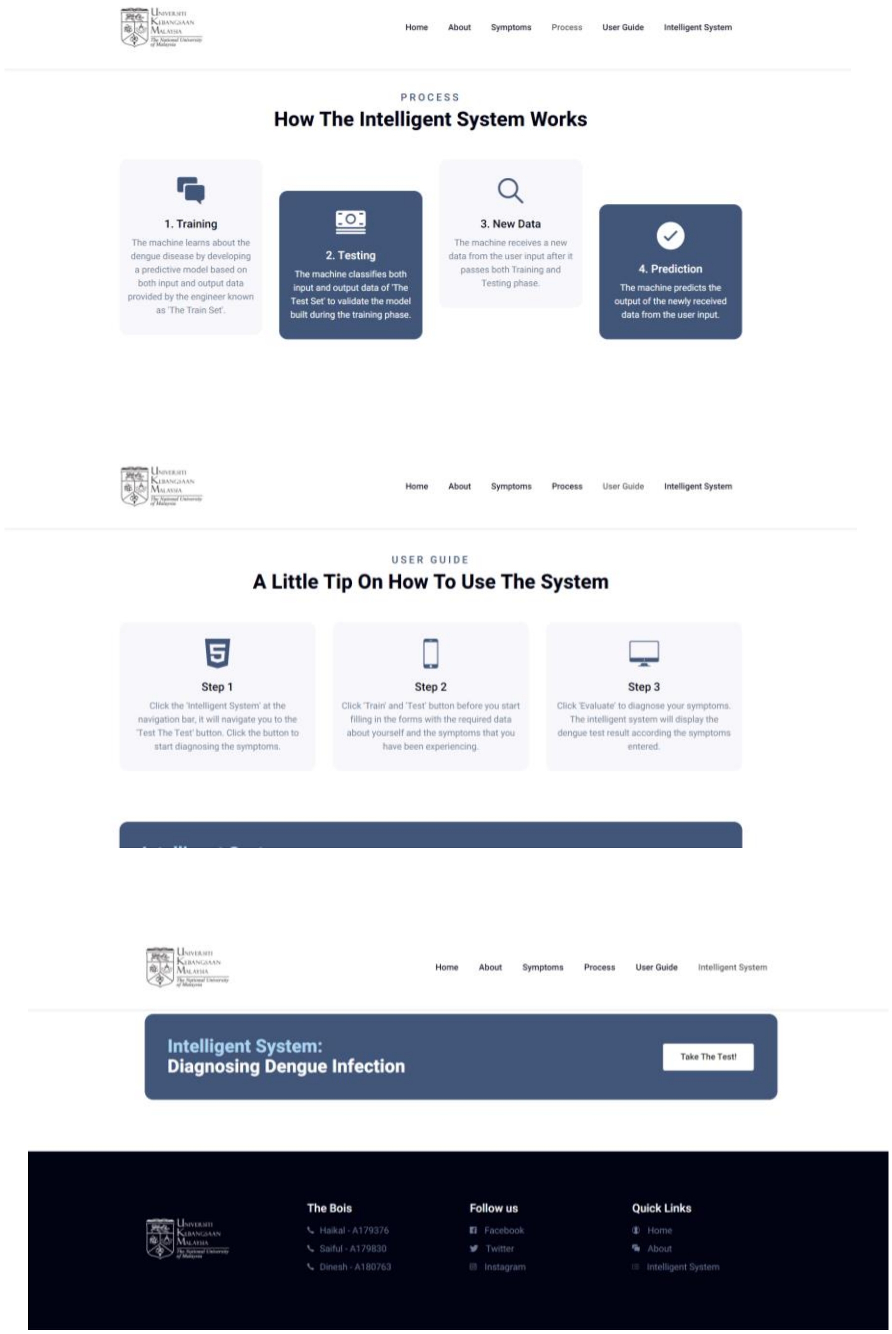
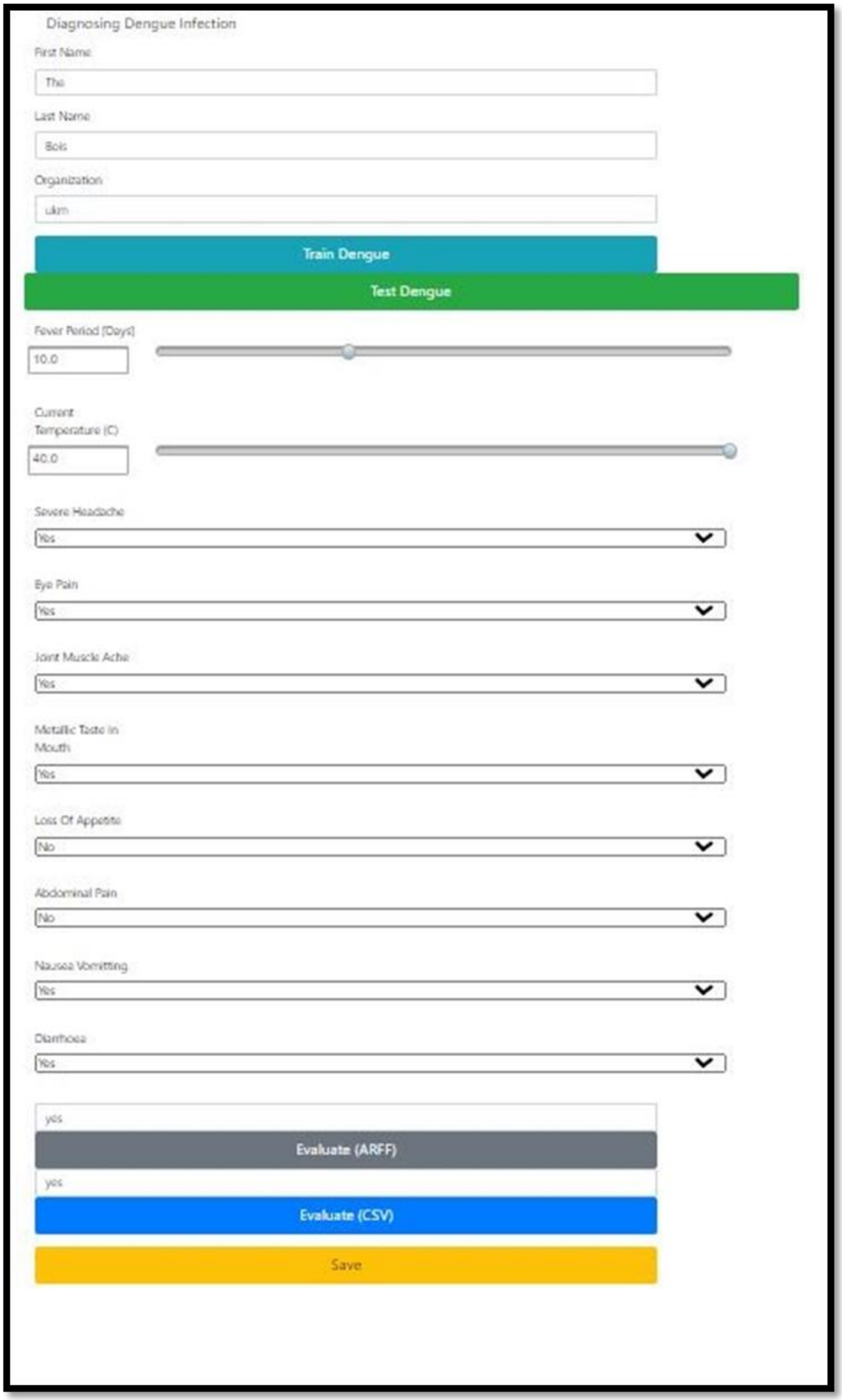


Figure 5. The diagram above shows the input and the output of diagnosing dengue infection.

Figure 6. The following is the code for the input and output generated.



After adding an instance

@relation TestInstances

@attribute 'Fever Period' numeric
@attribute 'Current Temperature (C)' numeric
@attribute 'Severe Headache' {yes,no}
@attribute 'Eye Pain' {no,yes}
@attribute 'Joint Muscle Ache' {yes,no}
@attribute 'Metallic Taste In Mouth' {no,yes}
@attribute 'Loss Of Appetite' {no,yes}
@attribute 'Abdominal Pain' {no,yes}
@attribute 'Nausea & Vomiting' {yes,no}
@attribute Diarrhoea {no,yes}
@attribute 'Dengue Test Result' {yes,no}

@data
10,40,yes,yes,yes,yes,no,no,yes,yes,yes

Index of predicted class label: 0.0, which corresponds to class: Dengue Test Result
prediction, yes

Backtracking - train
J48 pruned tree

Metallic Taste In Mouth = no
| Eye Pain = no
| | Joint Muscle Ache = yes: yes (16.0/1.0)
| | Joint Muscle Ache = no
| | | Current Temperature (C) <= 38.3: no (6.0)
| | | Current Temperature (C) > 38.3: yes (5.0)
| Eye Pain = yes: no (15.0)
Metallic Taste In Mouth = yes: yes (21.0)

Number of Leaves :   5

Size of the tree :   9

J48 pruned tree

Severe Headache = yes
| Current Temperature (C) <= 39.4
| | Abdominal Pain = no
| | | Joint Muscle Ache = yes: yes (8.0/2.0)
| | | Joint Muscle Ache = no: no (11.0)
| | Abdominal Pain = yes: yes (10.0)
| Current Temperature (C) > 39.4: yes (26.0)
Severe Headache = no: no (8.0/1.0)

Number of Leaves :   5

Size of the tree :   9

J48 pruned tree

Eye Pain = no
| Abdominal Pain = no
| | Current Temperature (C) <= 38.3
| | | Joint Muscle Ache = yes: yes (2.0)
| | | Joint Muscle Ache = no: no (5.0)
| | Current Temperature (C) > 38.3: yes (16.0/1.0)
| Abdominal Pain = yes: yes (21.0)
Eye Pain = yes
| Metallic Taste In Mouth = no: no (14.0)
| Metallic Taste In Mouth = yes: yes (5.0)

Number of Leaves : 6

Size of the tree : 11

J48 pruned tree

Metallic Taste In Mouth = no
| Eye Pain = no
| | Abdominal Pain = no
| | | Joint Muscle Ache = yes: yes (11.0/1.0)
| | | Joint Muscle Ache = no: no (6.0)
| | Abdominal Pain = yes: yes (11.0)
| Eye Pain = yes: no (14.0)
Metallic Taste In Mouth = yes: yes (21.0)

Number of Leaves : 5

Size of the tree : 9

J48 pruned tree

Eye Pain = no
| Abdominal Pain = no
| | Current Temperature (C) <= 38.3
| | | Joint Muscle Ache = yes: yes (2.0)
| | | Joint Muscle Ache = no: no (5.0)
| | Current Temperature (C) > 38.3: yes (16.0/1.0)
| Abdominal Pain = yes: yes (21.0)
Eye Pain = yes
| Metallic Taste In Mouth = no: no (14.0)
| Metallic Taste In Mouth = yes: yes (5.0)

Number of Leaves : 6

Size of the tree : 11

J48 pruned tree

Eye Pain = no
| Current Temperature (C) <= 38.3
| | Abdominal Pain = no: no (7.0/1.0)
| | Abdominal Pain = yes: yes (9.0)
| Current Temperature (C) > 38.3: yes (26.0)
Eye Pain = yes
| Metallic Taste In Mouth = no: no (16.0)
| Metallic Taste In Mouth = yes: yes (5.0)

Number of Leaves : 5

Size of the tree : 9

J48 pruned tree

Severe Headache = yes
| Current Temperature (C) <= 39.4
| | Eye Pain = no
| | | Fever Period <= 3: no (4.0)
| | | Fever Period > 3: yes (18.0/2.0)
| | Eye Pain = yes: no (7.0)
| Current Temperature (C) > 39.4: yes (26.0)
Severe Headache = no: no (8.0/1.0)

Number of Leaves : 5

Size of the tree : 9

J48 pruned tree

Eye Pain = no
| Abdominal Pain = no
| | Current Temperature (C) <= 38.3
| | | Joint Muscle Ache = yes: yes (2.0)
| | | Joint Muscle Ache = no: no (5.0)
| | Current Temperature (C) >

38.3: yes (15.0/1.0)
| Abdominal Pain = yes: yes (21.0)
Eye Pain = yes
| Metallic Taste In Mouth = no: no (15.0)
| Metallic Taste In Mouth = yes: yes (5.0)

Number of Leaves : 6

Size of the tree : 11

J48 pruned tree

Metallic Taste In Mouth = no
| Eye Pain = no
| | Abdominal Pain = no
| | | Joint Muscle Ache = yes: yes (11.0/1.0)
| | | Joint Muscle Ache = no: no (6.0)
| | Abdominal Pain = yes: yes (11.0)
| Eye Pain = yes: no (14.0)
Metallic Taste In Mouth = yes: yes (21.0)

Number of Leaves : 5

Size of the tree : 9

J48 pruned tree

Severe Headache = yes
| Abdominal Pain = no
| | Current Temperature (C) <= 38.3
| | | Joint Muscle Ache = yes: yes (2.0)
| | | Joint Muscle Ache = no: no (10.0)
| | Current Temperature (C) > 38.3
| | | Current Temperature (C) <= 39.4
| | | | Nausea & Vomiting = yes: yes (5.0)
| | | | Nausea & Vomiting = no: no (2.0)
| | | Current Temperature (C) > 39.4: yes (15.0)
| Abdominal Pain = yes: yes (21.0)
Severe Headache = no: no (8.0)

Number of Leaves : 7

Size of the tree : 13

Accuracy of J48: 94.29%

Reading Weather Details -
Fever Period 0.0
Current Temperature (C) 0.0
Severe Headache yes
Eye Pain yes
Joint Muscle Ache yes
Metallic Taste In Mouth yes
Loss of Appetite yes
Abdominal Pain yes
Nausea & Vomiting yes
Diarrhoea yes
Accuracy: 94.28571428571429

Backtracking - test
Confusion Matrix
========

```
  a  b   <-- classified as
 19  1 |  a = yes
  3  7 |  b = no
```

Accuracy of J48: 86.67%

Reading Weather Details -
Fever Period 0.0
Current Temperature (C) 0.0
Severe Headache yes
Eye Pain yes
Joint Muscle Ache yes
Metallic Taste In Mouth yes
Loss of Appetite yes
Abdominal Pain yes
Nausea & Vomiting yes
Diarrhoea yes
Accuracy: 86.66666666666667

Output 2.Backtracking.

For the backtracking, our dataset was divided randomly into 10 parts as the value of the cross-validation folds is 10. In Java, every part has its own percentage and the final accuracy percentage is shown by calculating the average percentage of each and every part. In Weka, the final accuracy percentage is shown by considering the most parts that are similar to each other and calculating the average percentage from them. As for the test backtracking, line 10 to line 20 can be deleted because it is only showing the default values for every attribute.

ACCURACY

Figure 7. Accuracy by using J48 classifier.

```
Number of Leaves  :     5

Size of the tree :      9


Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances          68               97.1429 %
Incorrectly Classified Instances         2                2.8571 %
Kappa statistic                          0.9352
Mean absolute error                      0.0389
Root mean squared error                  0.171
Relative absolute error                  8.7583 %
Root relative squared error             36.335  %
Total Number of Instances               70

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 0.979    0.043    0.979      0.979    0.979      0.935    0.963     0.967     yes
                 0.957    0.021    0.957      0.957    0.957      0.935    0.963     0.929     no
Weighted Avg.    0.971    0.036    0.971      0.971    0.971      0.935    0.963     0.954

=== Confusion Matrix ===

  a  b   <-- classified as
 46  1 |  a = yes
  1 22 |  b = no
```

Figure 8. Accuracy by using HoeffdingTREE.

```
Test mode:    10-fold cross-validation

=== Classifier model (full training set) ===

yes (48.000) NB1 NB adaptive1

Time taken to build model: 0.01 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances          61               87.1429 %
Incorrectly Classified Instances         9               12.8571 %
Kappa statistic                          0.6915
Mean absolute error                      0.1367
Root mean squared error                  0.2497
Relative absolute error                 30.7832 %
Root relative squared error             53.0333 %
Total Number of Instances               70

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 0.957    0.304    0.865      0.957    0.909      0.702    0.960     0.976     yes
                 0.696    0.043    0.889      0.696    0.780      0.702    0.960     0.946     no
Weighted Avg.    0.871    0.218    0.873      0.871    0.867      0.702    0.960     0.966

=== Confusion Matrix ===

  a  b   <-- classified as
 45  2 |  a = yes
  7 16 |  b = no
```

Figure 9. Accuracy by using REPTree.

```
|   |   Joint Muscle Ache = no : no (10/0) [3/0]
|   Metallic Taste In Mouth = yes : yes (7/0) [5/0]
Abdominal Pain = yes : yes (18/0) [5/0]

Size of the tree : 9

Time taken to build model: 0 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances          67               95.7143 %
Incorrectly Classified Instances         3                4.2857 %
Kappa statistic                          0.9039
Mean absolute error                      0.0756
Root mean squared error                  0.2053
Relative absolute error                 17.0396 %
Root relative squared error             43.6037 %
Total Number of Instances               70

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 0.957    0.043    0.978      0.957    0.968      0.904    0.975     0.986     yes
                 0.957    0.043    0.917      0.957    0.936      0.904    0.975     0.934     no
Weighted Avg.    0.957    0.043    0.958      0.957    0.957      0.904    0.975     0.969

=== Confusion Matrix ===

  a  b   <-- classified as
 45  2 |  a = yes
  1 22 |  b = no
```

Indicators	J48	HoeffdingTree	REPTree

Classification Accuracy	97.14%	87.14%	95.71%
Kappa statistic	0.9352	0.6915	0.9039
Mean absolute error	0.0389	0.1367	0.0756
Root mean squared error	0.1710	0.2497	0.2053

Table 3. The accuracy comparison of J48, HoeffdingTree, and REPTree.

Hence, we have chosen the J48 classifier model for our project as it provides the most accurate predictions based on our data which is 97.14% and has the Kappa statistic of 0.9352 which is considered almost perfect agreement in accuracy. It is also easier to visualize the patterns of the attributes as this technique constructs a tree to model the classification process. The other two classifier models, HoeffdingTree and REPTree only provide 87.14% and 95.71% accuracy and the representation of our data using these two models are a bit complicated and not related to the output that we expected.

ANALYSIS

KNOWLEDGE ACQUISITION CHALLENGES

The challenges that we have been through was to search for our data. We need to find the best dataset for our project by using the kangle website. We need to clean data to increase overall productivity and allow for the highest quality information in your decision-making. Benefits include: Removal of errors when multiple sources of data are at play. Fewer errors make for less-frustrated.

EXPLANATION ABOUT THE RULES AND CERTAINTY FACTORS OBTAINED

Based on the dataset that we got, the tree was generated from the weka. The rules were obtained from the tree during the pre-processing step. From the pre-processing step, we use the formula to calculate the certainty factor.

Certainty Factor (cf) Formula:

$$cf(cf_1, cf_2) = \begin{cases} cf_1 + cf_2 \times (1 - cf_1) & \text{if } cf_1 > 0 \text{ and } cf_2 > 0 \\ \dfrac{cf_1 + cf_2}{1 - min\,[|cf_1|, |cf_1|]} & \text{if } cf_1 < 0 \text{ or } cf_2 < 0 \\ cf_1 + cf_2 \times (1 + cf_1) & \text{if } cf_1 < 0 \text{ and } cf_2 < 0 \end{cases}$$

cf = The accuracy of J48 model = 97.14

SAMPLE PROVING OF CASE FROM THE FACTS AND RULES OBTAINED

```
After adding an instance
--------------------------
@relation TestInstances

@attribute 'Fever Period' numeric
@attribute 'Current Temperature (C)' numeric
@attribute 'Severe Headache' {yes,no}
@attribute 'Eye Pain' {no,yes}
@attribute 'Joint Muscle Ache' {yes,no}
@attribute 'Metallic Taste In Mouth' {no,yes}
@attribute 'Loss Of Appetite' {no,yes}
@attribute 'Abdominal Pain' {no,yes}
@attribute 'Nausea & Vomiting' {yes,no}
@attribute Diarrhoea {no,yes}
@attribute 'Dengue Test Result' {yes,no}

@data
10,40,yes,yes,yes,yes,no,no,yes,yes,yes
--------------------------
Index of predicted class label: 0.0, which corresponds to class: Dengue Test Result
prediction, yes
```

Figure 10. The sample proving of case from the facts and rules.

CONCLUSION

On the whole, there are many artificial intelligence techniques that can be used to resolve the problem. From the experience of preparing dengue fever models utilizing AI calculations, we increase adequate information about the working and usage of them. Artificial Intelligence is widely used in the field of medication and medicinal services. The intensity of the forecast of illness and the widespread of figuring and information will be the future in different clinical situations. Concerning dengue fever, we have now experienced the working and showing of three AI calculations which are REPTree, HoeffdingTree and J48. The REPTree created a decent accuracy of 95.71% while the HoeffdingTree has an accuracy of 87.14%. However, the J48 model performed better for our situation with 97.14% accuracy. All things considered, we can conclude that the J48 model would be the best appropriate calculation for dengue forecast. Plus, knowing the consequence of whether the disease is available or not utilizing an individual web interface increases the value of the model.

CONTRIBUTION OF MEMBER

Muhammad Haikal Iman bin Osman (A179376), a sophomore in Computer Science (Honours) at The National University of Malaysia (UKM). The Mobile Application Development Club (MAD Club) member - currently involved as the head programmer in the Diagnosing Dengue Infection research by using the Artificial Intelligence (A.I). Responsible for both the front and back-end of the intelligent system.

Mohamad Saiful Nizam bin Abd Aziz(A179830), currently studying bachelor of Computer Science (Honours) at The National University of Malaysia (UKM). One of the sports and recreation Exco in PERTAMA. Computer science student with aptitude for information systems analysis and computer programming currently involved in Diagnosing Dengue Infection research by using the Artificial Intelligence (A.I). Responsible for Fuzzy logic and journalism

Dineswaran A/L Navarasan(A180763), 2nd year student in Computer Science (Honours) at The National University of Malaysia (UKM). Member of the Autonomous Robot and Vision Systems (ARVIS) and currently involved in Diagnosing Dengue Infection research by using the Artificial Intelligence (A.I.). Responsible for data collection and report analysis.

All team members had participated committedly in the making of the intelligent system and the journal report on Diagnosing Dengue Infection.

Figure 11. From left to right - Haikal, Saiful, Dinesh.

REFERENCE

Dunkin, M. A. (n.d.). *Dengue fever: Symptoms, causes, and treatments*. WebMD. Retrieved January 21, 2022, from https://www.webmd.com/a-to-z-guides/dengue-fever-reference

Typhoid and dengue fever symptoms dataset: Data Science and Machine Learning. Kaggle. (n.d.). Retrieved January 21, 2022, from https://www.kaggle.com/general/91461

Forward chaining and backward chaining in AI - Javatpoint. www.javatpoint.com. (n.d.). Retrieved January 21, 2022, from https://www.javatpoint.com/forward-chaining-and-backward-chaining-in-ai

Dikran Marsupial, Wayne, & Md. Sabbir Ahmed. (1961, February 1). *Why do researchers use 10-fold cross validation instead of testing on a validation set?* Cross Validated. Retrieved January 21, 2022, from https://stats.stackexchange.com/questions/49692/why-do-researchers-use-10-fold-cross-validation-instead-of-testing-on-a-validati

What is fuzzy logic in AI and what are its applications? Edureka. (2019, December 10). Retrieved January 21, 2022, from https://www.edureka.co/blog/fuzzy-logic-ai/

Weka datasets, classifier and J48 algorithm for Decision Tree. Software Testing Help. (2022, January 5). Retrieved January 21, 2022, from https://www.softwaretestinghelp.com/weka-datasets/