

Application of Decision Tree in Detecting an Illness Based on the Symptoms

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Abstract—Tree is one of the subjects discussed in IF2120 – Discrete Mathematics course. Decision tree is a tool for decision making by using a tree model. The decision tree is used to find out the result of every possible decision made, which can then be used to detect the initial symptoms of a disease more specifically an illness. Minor illness is a health disorder caused by bacteria, viruses, or physiological system abnormalities or tissue in organs (in living organism) but is not life threatening. This paper will discuss about how decision tree can detect the initial symptoms of an illness, with the aim that it can be treated more quickly.

Keywords—Decision Tree, Health, Symptoms of an illness, Tree

I. INTRODUCTION

Health is a very important aspect so that humans can survive, but there are still many people who are still unable to recognize the initial symptoms of an illness and how to treat it. whereas if the initial symptoms of an illness can be dealt with quickly, we can avoid getting sick. Therefore if we want our body to be healthy, we must know the initial symptoms of an illness and how to treat it. In this paper, we will focus more on the initial symptoms of some disease and how using a decision tree can detect the disease.

The diseases that will be discussed in this paper are chicken pox, dengue fever, dyspepsia, fever, Gastroesophageal Reflux Disease (GERD), influenza, measles (rubeola), sinusitis, and typhus. Before discussing how the decision tree can determine what the illness is, we will first discuss the diseases mentioned earlier.

II. DISEASES

A. Chicken Pox

Chicken pox (varicella) is an infection caused by the *Varicella zoster* virus. The patients infected are characterized by the appearance of small reddish rash fluid-filled blisters throughout the body. Chickenpox is highly contagious to people who haven't had the disease or been vaccinated against it. The infection itself appears 10 to 21 days after getting infected by the virus and usually last for about 5 until 10 days. The initial symptoms of chicken pox are fever, loss of appetite, headache, tiredness and a general feeling of unwellness (malaise) and usually the symptoms start surfacing one or two days before the

rash.



Picture 1 Rash Caused by Chicken Pox

Source: https://www.mayoclinic.org/-/media/kcms/gbs/patient-consumer/images/2013/08/26/10/29/ds00053_im00287_ans7_chicken_poxthu.jpg.jpg accessed on December 05, 2018

B. Dengue Fever

Dengue fever is an infectious disease caused by the *Dengue* virus. This virus enters the human body through the bites of mosquito types *Aedes aegypti* and *Aedes albopictus*, which live in tropical and subtropical regions. Mild dengue fever may cause high fever, rash, and muscle and joint pain. However, a severe form of dengue fever (Dengue Hemorrhagic Fever) can cause a sudden drop in blood pressure and in the worst case, dengue fever may result in death.



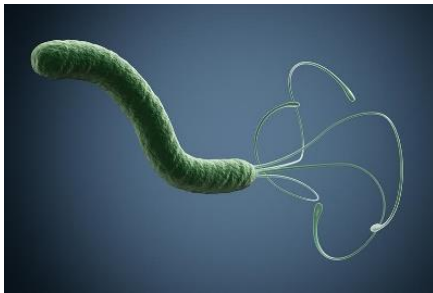
Picture 2 *Aedes aegypti*

Source: https://cdn.helloseh.com/wp-content/uploads/2016/05/shutterstock_369189926.jpg?x54339 accessed on December 05, 2018

C. Dyspepsia

Dyspepsia is a general term that describe the uncomfortable feeling in your upper abdomen that occurs due to some conditions including *Helicobacter pylori* bacterial infection, side effects of nonsteroidal anti-inflammatory drugs (NSAIDs), and stress. Dyspepsia itself is not a disease, but a sign of health

condition. People with dyspepsia may have the following symptoms which are early fullness during a meal, uncomfortable fullness after a meal, discomfort in the upper abdomen, burning in the upper abdomen, bloating in the upper abdomen, and nausea. Less frequent symptoms including vomiting and belching.



Picture 3 *Helicobacter pylori*

Source: <https://www.bu.edu/research/files/2017/03/h-research-iStock-508664292.jpg> accessed on December 05, 2018

D. Fever

Fever is a temporary increase in human body temperature, often caused by an illness. For adults, fever is not a concern unless it reaches 39.4 C or higher whereas for children, a slightly higher temperature may indicate a serious infection. Usually, fevers go away within a few days. There are many drugs that can lower a fever, but sometimes it's better left untreated because fever seems to play a key role in helping your body fight a number of infections.



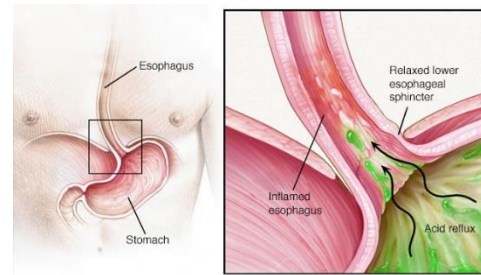
Picture 4 Fever

Source:

https://res.cloudinary.com/dk0z4ums3/image/upload/v1470387721/attached_image/demam-alodokter.jpg accessed on December 05, 2018

E. Gastroesophageal Reflux Disease (GERD)

Gastroesophageal Reflux Disease (GERD) occurs when stomach acid frequently flows back into the tube connecting the mouth and stomach (esophagus) which causes irritation in the lining of esophageal cells. In certain conditions, everyone can experience gastro-esophageal reflux. This reflux often occurs after eating and takes place in short period. Normal reflux will become gastro-esophageal reflux when symptoms often occur (around 2-3 times a week) or if the esophagus is damaged.



Picture 5 How Gastroesophageal Reflux Disease (GERD) occur
Source: https://www.mayoclinic.org/-/media/kcms/gbs/patient-consumer/images/2017/10/12/13/48/r7_heartburn-8col.jpg accessed on December 05, 2018

F. Influenza

Influenza is a viral infection that attacks respiratory system (nose, throat, and lungs). There are three types of influenza viruses, namely influenza A, influenza B, and influenza C. Type A virus are capable of infecting animals and commonly hosted by wild birds. Type A virus is constantly changing and responsible for many cases of large influenza epidemics. Type B virus is found only in humans. Unlike type A virus, type B virus may cause a less severe reaction than type A virus, but sometimes, type B virus can still be extremely harmful. Type C virus is found only in humans too however, the symptoms caused by type C virus are milder than type A virus or type B virus. For most people, influenza resolves on its own naturally. But sometimes, influenza and its complications can be deadly. Unlike other diseases, influenza does not have a 100% effective vaccine. This is due to all influenza viruses undergo frequent genetic changes thus reducing the effectiveness of vaccines.



Picture 6 Influenza virus

Source: <http://www.knowpublichealth.com/wp-content/uploads/2017/05/Influenza-virus.jpg> accessed on December 05, 2018

G. Measles (Rubeola)

Measles (rubeola) is an infection caused by a virus in the *Paramyxovirus* family. The patients infected are characterized by the appearance of reddish skin rashes that appear 7-14 days after exposure to the virus and can last for 4-10 days. Measles can cause serious deadly complications if not treated properly for children. The initial symptoms of measles are fever, dry cough, runny nose, sore throat, inflamed eyes, the appearance of flat blotches that often flow into one another on the skin, and the appearance of white tiny spots with bluish-white centers on a red background found inside the mouth on the inner lining of the cheek.



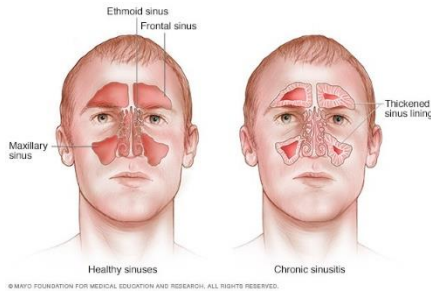
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Picture 7 Rash Caused by Measles

Source: https://www.mayoclinic.org/-/media/kcms/gbs/patient-consumer/images/2013/08/26/10/30/ds00331_im00266_ans7_measles_thu.jpg accessed on December 05, 2018

H. Sinusitis

Sinusitis is an infection due to the cavities around your nasal passages (sinuses) to become inflamed and swollen. This interferes with drainage and causes mucus to build up. Based on the incubation period, sinusitis is divided into 2 types, namely acute sinusitis and chronic sinusitis. Acute sinusitis can last until 4 weeks meanwhile chronic sinusitis may last until 3 months and often occur. With sinusitis, it might be difficult to breathe through your nose and the area around your eyes and face might feel swollen, also you might have throbbing facial pain or a headache.



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Picture 8 Healthy Sinuses and Chronic Sinusitis Sinuses

Source: https://www.mayoclinic.org/-/media/kcms/gbs/patient-consumer/images/2016/04/07/14/56/mcd7_acute_sinusitis-8col.jpg accessed on December 05, 2018

I. Typhus

Typhus or typhoid fever is an infectious disease caused by *Salmonella typhi* bacteria. While typhus is rare in industrialized countries, it remains a serious health threat in developing countries, especially for children. Typhus usually spread through contaminated food and water or through close contact with someone who's infected. The initial symptoms of typhus are high fever, headache, abdominal pain, and either constipation or diarrhea.



Picture 9 *Salmonella typhi*

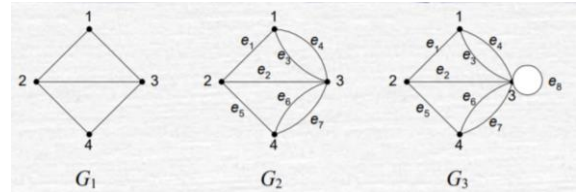
Source:

<https://foodsafetynewsfullservice.marlersites.com/files/2014/03/16877-1.png> accessed on December 05, 2018

III. THEORETICAL BASIS

A. Graph

Graph is a collection of points, called vertices, and lines between those points, called edges.



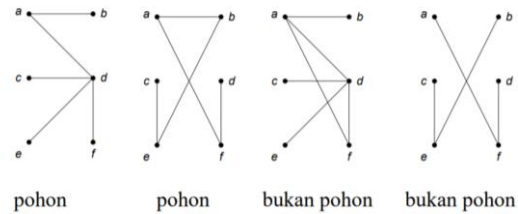
Picture 10 Graph

Source: [http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2015-2016/Graf%20\(2015\).pdf](http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2015-2016/Graf%20(2015).pdf) accessed on December 06, 2018

Theorem. Let $G = (V, E)$, which in this case G is a graph, V is a non-empty set of vertices, and E is the set of edges that connect a pair of vertices.

B. Trees

Trees are a special type of graph. Trees are connected non-directed graphs that do not contain circuits.



Picture 11 Tree and Graph

Source: [http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2013-2014/Pohon%20\(2013\).pdf](http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2013-2014/Pohon%20(2013).pdf) accessed on December 06, 2018

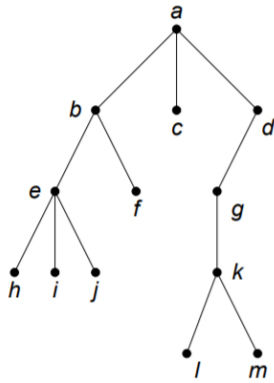
Theorem. Let $G = (V, E)$ be a simple non-directed graph and the number of vertices n . So, all of the statements below are equivalent:

1. G is a tree.
2. Each pair of vertices in G is connected with a single path.
3. G is connected and has $m = n - 1$ side.
4. G does not contain circuits and has $m = n - 1$ side.
5. G does not contain a circuit and the addition of one side to the graph will make only one circuit.
6. G is connected and all sides are bridges.

B. Rooted Tree

A rooted tree is a tree in which one vertex has been designated as the root and its sides are given direction thus becoming

directed graph.

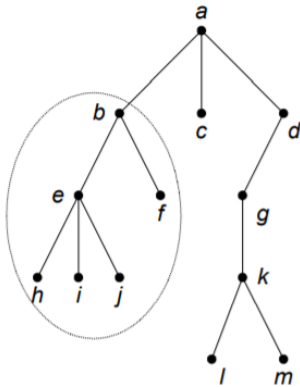


Picture 12 Rooted Tree

Source: <http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2016-2017/Makalah2016/Makalah-Matdis-2016-006.pdf> accessed on December 06, 2018

Rooted trees have the terminology such as follow:

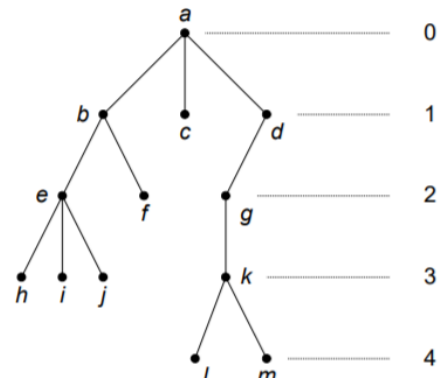
1. Child / Children and Parent
b, c, and d are children of vertices a
a is the parent of b, c, and d.
2. Path
The path from a to j is a, b, e, j.
The path length from a to j is 3.
3. Siblings
f and e are siblings, but g and e are not siblings because g and e have different parents.
4. Subtree



Picture 13 The Circled Part is the Subtree

Source: [http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2013-2014/Pohon%20\(2013\).pdf](http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2013-2014/Pohon%20(2013).pdf) accessed on December 06, 2018

5. Degree
The degree of a node is the sum of subtree or number of children on the node.
Degree a is 3, degree b is 2, degree d is one and degree c is 0.
6. Leaf
Leaves are nodes that have zero degrees or do not have children.
The nodes h, i, j, f, c, l, and m are leaves.
7. Internal Nodes
Internal nodes are nodes that has children.
Nodes b, d, e, g, and k are internal nodes.
8. Level



Picture 14 Level of a Tree

Source: <http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2016-2017/Makalah2016/Makalah-Matdis-2016-006.pdf> accessed on December 06, 2018

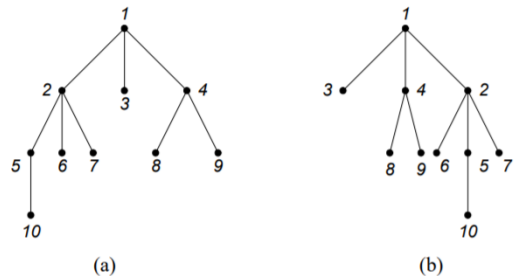
9. Height / Depth

The maximum level of a tree is called the height or depth of the tree.

The tree in picture 12 has a height / depth of 4.

D. Ordered Trees

Rooted trees where the order of their children is important are called ordered trees.



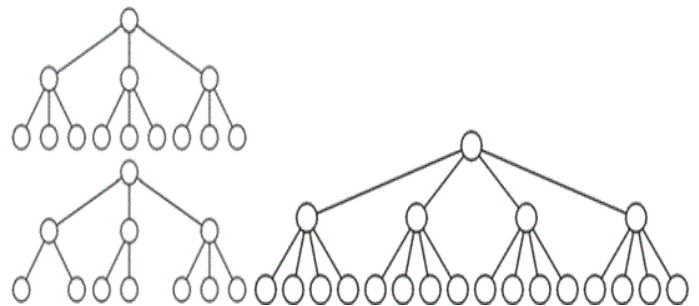
Picture 15 2 Different Rooted Trees

Source: <http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2016-2017/Makalah2016/Makalah-Matdis-2016-006.pdf> accessed on December 06, 2018

The trees in picture 15 has the same elements, but there are differences in the placement of elements so that trees a and trees b are 2 different trees

E. N-ary Trees

N-ary trees are rooted trees with each branch node having at most n children.

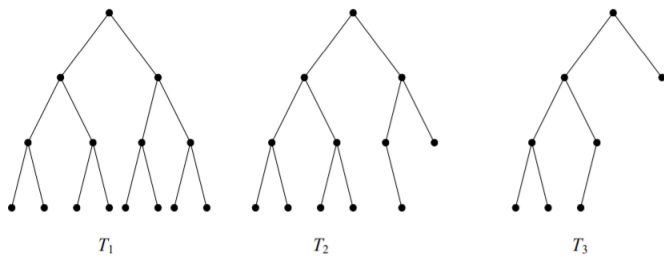


Picture 16 3-ary Trees and 4-ary Trees

Source: <https://www.urgenthomework.com/images/ternary-and-quaternary-tree.gif> accessed on December 06, 2018

F. Binary Trees

Binary trees are n-ary trees with $n = 2$ and each node in the binary tree has at most 2 children which is distinguished between the left child and the right child. Since there are differences in the order of children, binary trees fall into the ordered tree category.



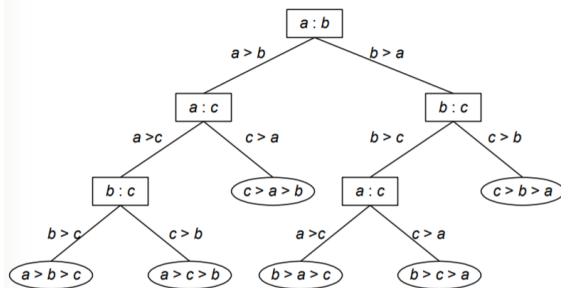
Picture 17 Balanced Binary Trees and Binary Trees

Source: [http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2013-2014/Pohon%20\(2013\).pdf](http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2013-2014/Pohon%20(2013).pdf) accessed on December 06, 2018

Balanced binary trees are trees whose left subtree and right subtree have the same height / depth or have a difference of height / depth of 1. In picture 16, T_1 and T_2 are balanced binary tree meanwhile T_3 isn't a balanced binary tree.

G. Decision Trees

Decision trees are one of the applied forms of binary trees. Decision trees are used to model a problem consisting of a series of decisions that will lead to a solution with the node stating the decision and the leaves stating the solution.



Picture 18 Decision Trees

Source: [http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2013-2014/Pohon%20\(2013\).pdf](http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2013-2014/Pohon%20(2013).pdf) accessed on December 06, 2018

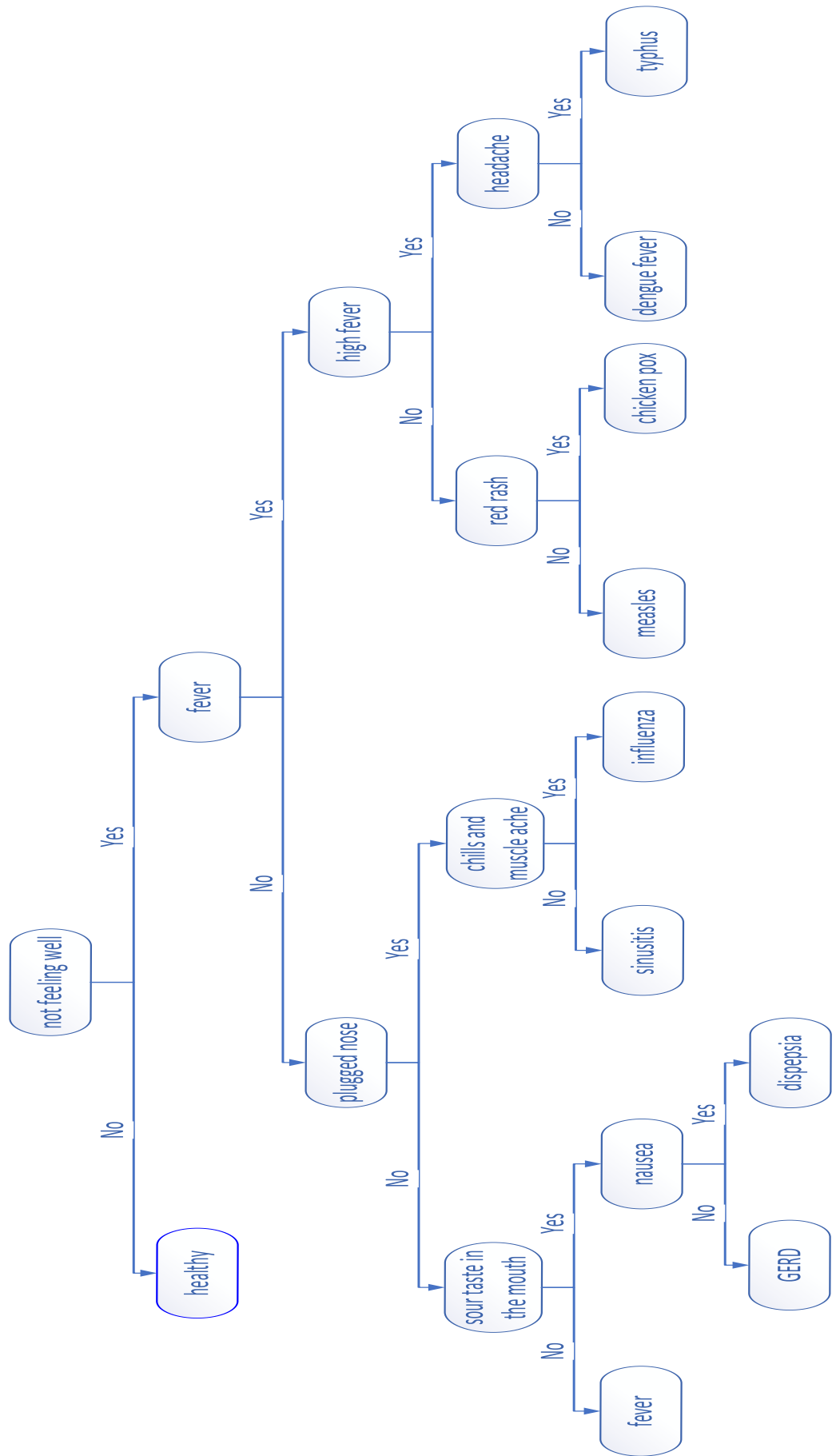
IV. APPLICATION OF SYMPTOMS DECISION TREE

The symptoms decision tree that I made applies the decision tree material from discrete mathematics courses to determine a person's illness based on the symptoms experienced by that person. I use decision trees because, each disease has several common symptoms that other diseases have and some symptoms that are specific to an illness so that to determine a person's disease, this decision tree can be applied to determine a person's disease based on the symptoms.

There are many ways to treat a disease, but each disease requires its own method. For example, fever and colds can be treated by buying drugs at a pharmacy or just by having enough rest, but diseases such as chicken pox, dengue fever and typhus require special medicine from a doctor's prescription or a special treatment from a doctor.

The purpose of using this symptoms decision tree is to help humans detect more accurately the disease suffered based on symptoms that arise so that they can determine what treatment or prevention measures are appropriate and whether to go see a doctor or not.

Symptoms Decision Tree



Picture 19 Symptoms Decision Tree

V. CONCLUSION

Decision tree is one of the topics in Discrete Mathematics, namely trees. There are many benefits from the decision tree, one of which is to determine the conclusions or the right results efficiently from various known situations or conditions. With the decision tree, it is expected that users can come to a conclusion or decision quickly and precisely.

This symptoms decision tree is useful for estimating a person's illness based on the symptoms experienced. The more detailed and complex the symptoms decision trees, the results / conclusions obtained from the decision making will be more accurate and precise.

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REFERENCES

- [1] [http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2015-2016/Graf%20\(2015\).pdf](http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2015-2016/Graf%20(2015).pdf) accessed on December 06, 2018 at 19.47 WIB.
- [2] [http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2013-2014/Pohon%20\(2013\).pdf](http://informatika.stei.itb.ac.id/~rinaldi.munir/Matdis/2013-2014/Pohon%20(2013).pdf) accessed on December 06, 2018 at 19.47 WIB.
- [3] <https://www.alodokter.com/cacar-air> accessed on December 05, 2018 at 21.23 WIB.
- [4] <https://www.alodokter.com/campak> accessed on December 05, 2018 at 21.23 WIB.
- [5] <https://www.alodokter.com/demam> accessed on December 05, 2018 at 21.23 WIB.
- [6] <https://www.alodokter.com/demam-berdarah> accessed on December 05, 2018 at 21.23 WIB.
- [7] <https://www.alodokter.com/penyakit-asam-lambung> accessed on December 05, 2018 at 21.23 WIB.
- [8] <https://www.alodokter.com/pilek> accessed on December 05, 2018 at 21.23 WIB.
- [9] <https://www.alodokter.com/sakit-maag> accessed on December 05, 2018 at 21.23 WIB.
- [10] <https://www.alodokter.com/sinusitis> accessed on December 05, 2018 at 21.23 WIB.
- [11] <https://www.alodokter.com/tifus> accessed on December 05, 2018 at 21.23 WIB.
- [12] <https://hellosehat.com/penyakit/asam-lambung-gerd-refluks-asam-lambung/> accessed on December 05, 2018 at 21.56 WIB.
- [13] <https://hellosehat.com/penyakit/cacar-air/> accessed on December 05, 2018 at 21.56 WIB.
- [14] <https://hellosehat.com/penyakit/demam/> accessed on December 05, 2018 at 21.56 WIB.
- [15] <https://hellosehat.com/penyakit/demam-berdarah-dengue-dbd/> accessed on December 05, 2018 at 21.56 WIB.
- [16] <https://hellosehat.com/penyakit/flu-adalah-influenza/> accessed on December 05, 2018 at 21.56 WIB.
- [17] <https://hellosehat.com/penyakit/maag-dispepsia/> accessed on December 05, 2018 at 21.56 WIB.
- [18] <https://hellosehat.com/penyakit/penyakit-campak/> accessed on December 05, 2018 at 21.56 WIB.
- [19] <https://hellosehat.com/penyakit/sinusitis/> accessed on December 05, 2018 at 21.56 WIB.
- [20] <https://hellosehat.com/penyakit/tifus-demam-tifoid/> accessed on December 05, 2018 at 21.56 WIB.

- [21] <https://www.mayoclinic.org/diseases-conditions/acute-sinusitis/symptoms-causes/syc-20351671> accessed on December 05, 2018 at 22.47 WIB.
- [22] <https://www.mayoclinic.org/diseases-conditions/chickenpox/symptoms-causes/syc-20351282> accessed on December 05, 2018 at 22.47 WIB.
- [23] <https://www.mayoclinic.org/diseases-conditions/chronic-sinusitis/symptoms-causes/syc-20351661> accessed on December 05, 2018 at 22.47 WIB.
- [24] <https://www.mayoclinic.org/diseases-conditions/dengue-fever/symptoms-causes/syc-20353078> accessed on December 05, 2018 at 22.47 WIB.
- [25] <https://www.mayoclinic.org/diseases-conditions/fever/symptoms-causes/syc-20352759> accessed on December 05, 2018 at 22.47 WIB.
- [26] <https://www.mayoclinic.org/diseases-conditions/flu/symptoms-causes/syc-20351719> accessed on December 05, 2018 at 22.47 WIB.
- [27] <https://www.mayoclinic.org/diseases-conditions/gerd/symptoms-causes/syc-20361940> accessed on December 05, 2018 at 22.47 WIB.
- [28] <https://www.mayoclinic.org/diseases-conditions/indigestion/symptoms-causes/syc-20352211> accessed on December 05, 2018 at 22.47 WIB.
- [29] <https://www.mayoclinic.org/diseases-conditions/measles/symptoms-causes/syc-20374857> accessed on December 05, 2018 at 22.47 WIB.
- [30] <https://www.mayoclinic.org/diseases-conditions/typhoid-fever/symptoms-causes/syc-20378661> accessed on December 05, 2018 at 22.47

PERNYATAAN

Dengan ini saya menyatakan bahwa makalah yang saya tulis ini adalah tulisan saya sendiri, bukan saduran, atau terjemahan dari makalah orang lain, dan bukan plagiasi.

Bandung, 10 Desember 2018



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