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Diagnosis of Skin Disease Level (Acne Vulgaris) Using the Dempster Shafer Method

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ABSTRACT

Acne vulgaris is a facial skin disease that often appears in adolescents and adults. This disease can reduce the patient's self-confidence, and can cause permanent scars on the face if left unchecked. This problem can be handled with early detection, namely by building a Decision Support System (DSS) application that can diagnose the severity of acne vulgaris using the Dempster Shafer Theory (DST) method. The results of the study are in the form of an DSS application that can be used to diagnose the severity of acne vulgaris, namely by calculating and taking the diagnostic results that have the highest density value.

Keywords: Acne Vulgaris, Dempster Shaver, Decission Support System
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INTRODUCTION

Face is the part of the body that is most often in contact with foreign objects, such as wind, dust, dirt, microbes, cell phones and other foreign objects that can cause irritated facial skin. Facial skin disease that appears is acne vulgaris, or the layman's term is acne. Acne vulgaris usually occurs in teenagers or young adults when hormonal changes occur so that the facial skin produces more oil. In this condition, the pores of the skin become clogged, causing an inflamed pocket of pus. Kligmann, a world-renowned researcher on the problem of Acne Vulgaris, believes that no one in the world goes through his life without an Acne Vulgaris (acne) on his facial skin. In addition to hormonal changes, what triggers the emergence of Acne vulgaris are menstruation, pregnancy, the use of Family Planning pills and stress. For some severe cases, sufferers can feel very depressed and lose confidence in themselves. Unfortunately, many sufferers don't care and take it for granted, even though the scars they cause can leave an imprint on facial skin like permanent smallpox scars.

A Decision Support System (DSS) application will be built that can help diagnose the severity of this disease. With the initial diagnosis, it is hoped that the severity of the facial skin disease Acne vulgaris can be known and treated more quickly. The scientific method that can be used to help diagnose the severity of acne vulgaris is the Dempster Shafer Theory (DST) method. Dempster Shafer Theory or evidence theory or also referred to as belief function theory is a general framework for uncertainty reasoning with understood relationships with other frameworks, such as probability theory. This method is a mathematical theory developed by Arthur P. Dempster and Glenn Shafer, which is used to prove based on belief functions and plausible reasoning. This method is used to combine separate pieces of information or evidence to calculate the probability of an event. The research will be conducted by collecting data and symptoms through various sources, such as print media and electronic journals.

Based on the description above, the author intends to design an application that can diagnose the severity of Acne Vulgaris skin disease using the DST method, by conducting a thesis research entitled "**Diagnosis of Skin Disease Level (Acne Vulgaris) Using the Dempster Shafer Method**".

RESEARCH METHODS

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2.1 Analysis

The interaction between the user and the system can be described in outline through an activity diagram, as shown in Figure 2.1.

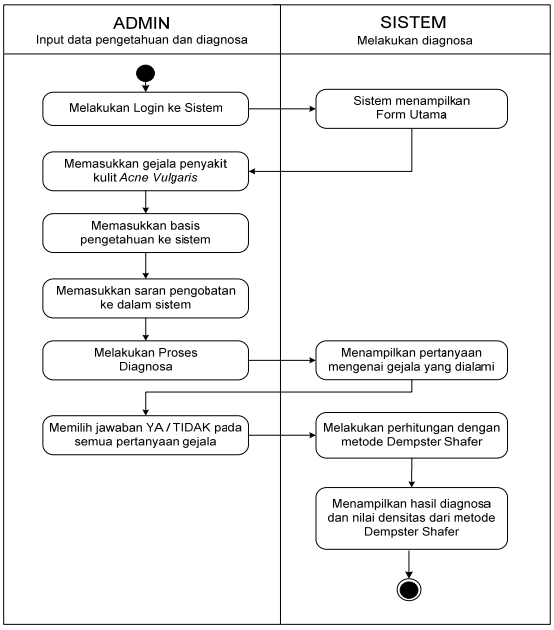

Figure 2.1 Activity Diagram System

Processes carried out by the user and the system. User behavior from logging in until the system finally displays the results of the diagnosis with Dempster Shafer is described in the activity diagram.

2.2 Diagnostic Process Analysis

The hypothesis is the level of the disease that will be diagnosed by the system. There are five hypotheses in the application as shown in table 2.1.

Table 2.1 System Hypothesis

Hypothesis code	Hypothesis
A1	*mild Acne* (scale 0)
A2	*mild moderate acne* (scale 2)
A3	*Acne* Medium(scala 4)
A4	*Pretty Heavy Acne* (scale 6)
A5	*very severe acne* (scala 8)

The five hypotheses are preceded by the emergence of symptoms or evidence. Table 2.2 contains ten symptoms that appear in the skin disease acne vulgaris.

Table 3.2 symptom

Symptom Code	Symptom
G01	Have black open comedones
G02	Have white closed comedones

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Symptom Code	Symptom
G03	Has papules or comedones that have irritated and form small red or pink bumps on the skin surface < 0.5 cm in diameter and filled with white, rice-like objects
G04	Has a pustule or a collection of irritated pimples that are red at the edges and white in the center filled with white/yellow pus with a diameter > 0.5 cm
G05	Has cysts and nodules, large irritating pimples that cause pain and feel hard to the touch
G06	Have 3 or less comedones and slightly scattered papules
G07	Has few pustules or 3 or more irritated papules with pimples that can be seen from 2.5 meters away
G08	Has 20 white and black blackheads, accompanied by less than 15 inflamed pimples.
G09	Has 20 to 100 more white heads and black heads, as well as 15 to 50 inflamed pimples with multiple pustules measuring 1-2 cm long and recognizable from 2.5 meters away
G10	Having acne that is interconnected with acute inflammation and spreads all over the face and can reach the neck, chest and arms

Based on the predetermined rules, the knowledge base used in the application of the Dempster Shafer can be seen in table 2.3.

Table 2.3 Knowledge Based

Symptom Code	A1	A2	A3	A4	A5	Density
G01	✔	✔	✔	✔		0.55
G02	✔	✔	✔	✔		0.55
G03		✔	✔	✔	✔	0.6
G04			✔	✔		0.6
G05				✔	✔	0.6
G06	✔					0.7
G07		✔				0.8
G08			✔			0.9
G09				✔		0.95
G10					✔	0.95

The '✔' symbol in each cell indicates that the symptom in that row is experienced by the disease in that column. For example, if a patient experiences symptoms of G01, G02, G03, G06 and G07, the calculation using the Dempster Shafer method is as follows:

1. Symptoms experienced = Having black open comedones (G01)
   m1[A1, A2, A3, A4] = 0.55
   m1[θ] = 1 - 0.55 = 0.45
2. ymptoms experienced = Have white closed comedones (G02)
   m2[A1, A2, A3, A4] = 0.55
   m2[θ] = 1 - 0.55 = 0.45

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Combination rule for m2 :
a. [A1, A2, A3, A4][0.55] x [A1, A2, A3, A4][0.55] = [A1, A2, A3, A4][0.3025]
b. [A1, A2, A3, A4][0.55] x [θ][0.45] = [A1, A2, A3, A4][0.2475]
c. [θ][0.45] x [A1, A2, A3, A4][0.55] = [A1, A2, A3, A4][0.2475]
d. [θ][0.45] x [θ][0.45] = [θ][0.2025]
calculation result m2 :
a. m2[A1, A2, A3, A4] = (0.3025 + 0.3025 + 0.3025) / (1-0)
m2[A1, A2, A3, A4] = 0.7975
b. m2[θ] = 0.2025 / (1-0)
m2[θ] = 0.2025

3. Symptoms experienced = Has papules or comedones that have irritated and form small red or pink bumps on the skin surface with a diameter of < 0.5 cm and contain white objects such as rice (G03).
m3[A2, A3, A4, A5] = 0.6
m3[θ] = 1 - 0.6 = 0.4
combination rule for m3 :
a. [A1, A2, A3, A4][0.7975] x [A2, A3, A4, A5][0.6] = [A2, A3, A4][0.4785]
b. [A1, A2, A3, A4][0.7975] x [θ][0.4] = [A1, A2, A3, A4][0.319]
c. [θ][0.2025] x [A2, A3, A4, A5][0.6] = [A2, A3, A4, A5][0.1215]
d. [θ][0.2025] x [θ][0.4] = [θ][0.081]
Calculation result m3 :
a. m3[A2, A3, A4] = 0.4785 / (1-0)
m3[A2, A3, A4] = 0.4785
b. m3[A1, A2, A3, A4] = 0.319 / (1-0)
m3[A1, A2, A3, A4] = 0.319
c. m3[A2, A3, A4, A5] = 0.1215 / (1-0)
m3[A2, A3, A4, A5] = 0.1215
d. m3[θ] = 0.081 / (1-0)
m3[θ] = 0.081

4. Experiencing symptoms = Having 3 or less comedones and slightly scattered papules (G06)
m4[A1] = 0.7
m4[θ] = 1 - 0.7 = 0.3
combination rule for m4 :
a. [A2, A3, A4][0.4785] x [A1][0.7] = [Ø][0.33495]
b. [A2, A3, A4][0.4785] x [θ][0.3] = [A2, A3, A4][0.14355]
c. [A1, A2, A3, A4][0.319] x [A1][0.7] = [A1][0.2233]
d. [A1, A2, A3, A4][0.319] x [θ][0.3] = [A1, A2, A3, A4][0.0957]
e. [A2, A3, A4, A5][0.1215] x [A1][0.7] = [Ø][0.08505]
f. [A2, A3, A4, A5][0.1215] x [θ][0.3] = [A2, A3, A4, A5][0.03645]
g. [θ][0.081] x [A1][0.7] = [A1][0.0567]
h. [θ][0.081] x [θ][0.3] = [θ][0.0243]
Calculation result m4 :
a. m4[A2, A3, A4] = 0.14355 / (1-(0.33495 + 0.08505))
m4[A2, A3, A4] = 0.2475
b. m4[A1] = (0.2233 + 0.2233) / (1-(0.33495 + 0.08505))
m4[A1] = 0.4828
c. m4[A1, A2, A3, A4] = 0.0957 / (1-(0.33495 + 0.08505))
m4[A1, A2, A3, A4] = 0.165
d. m4[A2, A3, A4, A5] = 0.03645 / (1-(0.33495 + 0.08505))
m4[A2, A3, A4, A5] = 0.0628
e. m4[θ] = 0.0243 / (1-(0.33495 + 0.08505))
m4[θ] = 0.0419

5. Symptoms experienced = Having few pustules or 3 or more irritated papules with pimples that can be seen from a distance of 2.5 meters (G07)
m5[A2] = 0.8

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m5[θ] = 1 - 0.8 = 0.2
combination rule for m5 :
a. [A2, A3, A4][0.2475] x [A2][0.8] = [A2][0.198]
b. [A2, A3, A4][0.2475] x [θ][0.2] = [A2, A3, A4][0.0495]
c. [A1][0.4828] x [A2][0.8] = [Ø][0.38624]
d. [A1][0.4828] x [θ][0.2] = [A1][0.09656]
e. [A1, A2, A3, A4][0.165] x [A2][0.8] = [A2][0.132]
f. [A1, A2, A3, A4][0.165] x [θ][0.2] = [A1, A2, A3, A4][0.033]
g. [A2, A3, A4, A5][0.0628] x [A2][0.8] = [A2][0.05024]
h. [A2, A3, A4, A5][0.0628] x [θ][0.2] = [A2, A3, A4, A5][0.01256]
i. [θ][0.0419] x [A2][0.8] = [A2][0.03352]
j. [θ][0.0419] x [θ][0.2] = [θ][0.00838]
Calculation result m5 :
a. m5[A2] = (0.198 + 0.198 + 0.198 + 0.198) / (1-(0.38624))
m5[A2] = 0.6741
b. m5[A2, A3, A4] = 0.0495 / (1-(0.38624))
m5[A2, A3, A4] = 0.0807
c. m5[A1] = 0.09656 / (1-(0.38624))
m5[A1] = 0.1573
d. m5[A1, A2, A3, A4] = 0.033 / (1-(0.38624))
m5[A1, A2, A3, A4] = 0.0538
e. m5[A2, A3, A4, A5] = 0.01256 / (1-(0.38624))
m5[A2, A3, A4, A5] = 0.0205
f. m5[θ] = 0.00838 / (1-(0.38624))
m5[θ] = 0.0137

6. The acne vulgaris skin disease experienced was the one with the highest density value. Thus, the disease suffered by experiencing symptoms G01, G02, G03, G06 and G07 is hypothesis A2 or Mild Acne Medium (scale 2) with a density value of 0.6741 or 67%..

2.3 *Database Design*

The database is used to store data that will be used by the system, such as login data, hypothesis data, symptoms to diagnostic data. The following is a database design of the system.

Table 2.4 User

No	*Field Name*	*Type*	*Size*	*Index*	Description
1	UserName	*Text*	30	*Primary key*	User Name
2	UserPwd	*Text*	50	-	Password
3	TipeUser	*Text*	30	-	Tipe User

Table 2.5 Hipotesis

No	*Field Name*	*Type*	*Size*	*Index*	Description
1	KodeHipotesis	*Text*	10	*Primary key*	Disease Code
2	NamaHipotesis	*Text*	50	-	Desease name
3	Keterangan	*Text*	255	-	Description of desease
4	Saran	*Text*	255	-	suggestion

Table 2.6 Symptom

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No	*Field Name*	*Type*	*Size*	*Index*	Description
1	KodeGejala	*Text*	10	*Primary key*	Symptom code
2	NamaGejala	*Text*	100	-	Symptom name
3	NilaiDensitas	*Number*	*Double*		Density value

Table 2.7 Learning Base

No	*Field Name*	*Type*	*Size*	*Index*	Description
1	KodeGejala	*Text*	10	*Foreign key*	Symptom code
2	KodeHipotesis	*Text*	10	*Foreign key*	Hypothesis code

Tabel 2.8 Tabel Diagnosa

No	*Field Name*	*Type*	*Size*	*Index*	Description
1	NoDiagnosa	*Text*	10	*Primary key*	Diagnostic number
2	Tanggal	Date	Smalldatetime	-	Diagnostic date
3	Nama	*Text*	50	-	Patient's name
4	Usia	*Number*	Byte	-	Age
5	Alamat	*Text*	100	-	Address
6	JK	*Text*	20	-	Sex
7	Hipotesis	*Text*	10	-	Illness
8	NilaiAkhir	*Number*	*Double*	-	-

Tabel 2.9 Tabel DiagnosaD

No	*Field Name*	*Type*	*Size*	*Index*	Description
1	NoDiagnosa	*Text*	10	*Foreign key*	Diagnostic number
2	KodeGejala	*Text*	10	-	Kode gejala

The database table relationship can be seen in Figure 2.2.

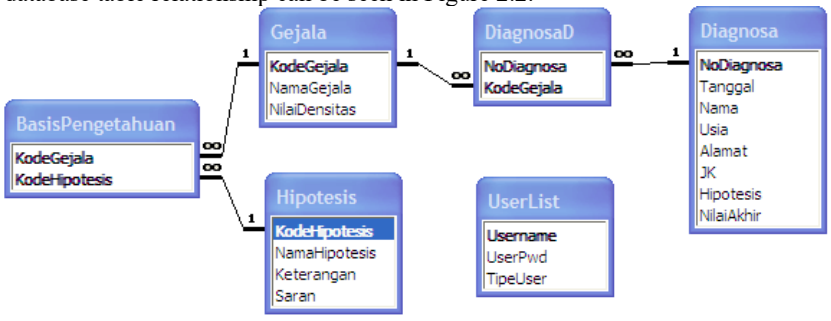

Figure 2.2 Table Relationship

3. Result and Discussion

3.1 Result

The following describes the implementation results and how to run the decision support system application for diagnosing the severity of acne vulgaris skin disease using the Dempster Shafer method. The login form will appear when the application is run. The login form has two types of users, namely regular users and admins. When selecting the user type "User / Guest"

After the user enters the correct username and password, the Main Form will appear as shown in Figure 3.2. At this stage, the admin can access all forms in the application. The Main Form contains a toolbar to access the forms contained in the application, including the Symptom form, Knowledge Base form, Suggestion form, Diagnosis Process form, View Results form, User form, log out, view the About form and close the application.

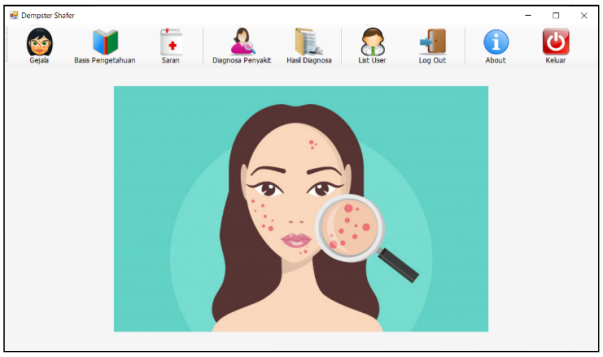

Figure 3.1 Main *Form*

Users can display the symptom form by pressing the “Symptoms” button on the Main form. Symptoms form display can be seen in Figure 3.2.

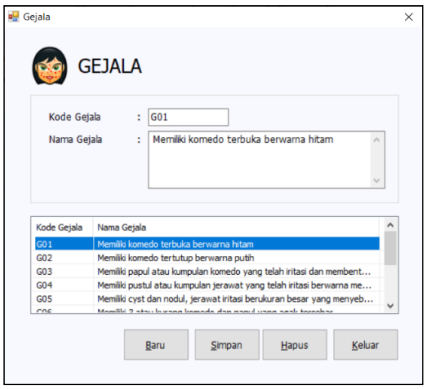

Figure 3.2 Symptoms Form

Users can display the knowledge base form by pressing the “Knowledge Base” button on the Main form. The display of the Knowledge Base form can be seen in Figure 3.3.

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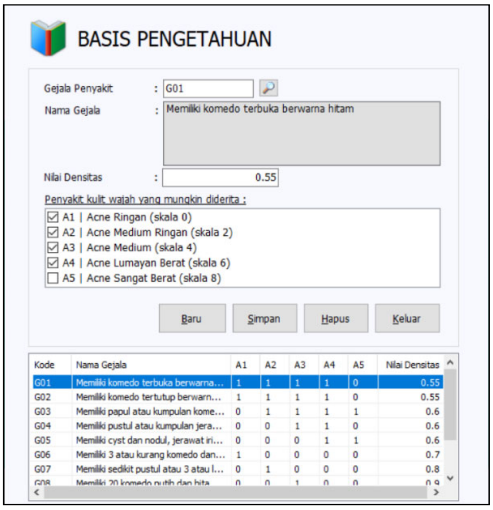

Figure 3.3 Knowledge Base Form

Users can display the suggestion form by pressing the "Suggestion" button on the Main form. The suggestion form display in the application can be seen in Figure 3.4.

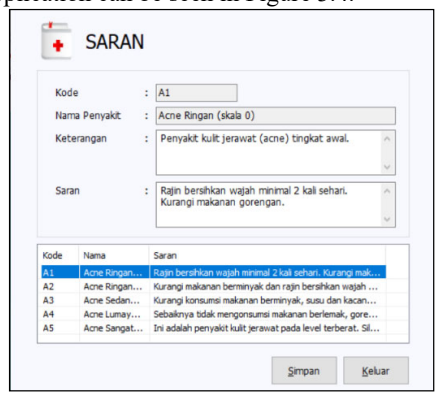

Figure 3.4 Suggestion Form

To diagnose the disease, the user can press the “Diagnose Disease” button on the Main form, and the Identity Input form will appear as shown in Figure 3.5.

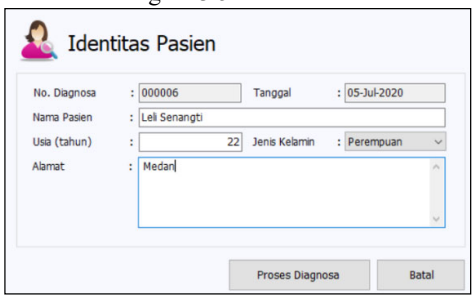

Figure 3.5 Identity Form

After filling in the identity, the user can press the “Diagnose Process” button, and the Diagnosis Process form will appear as shown in Figure 3.6.

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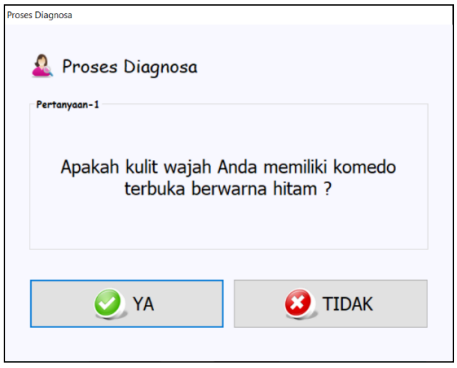
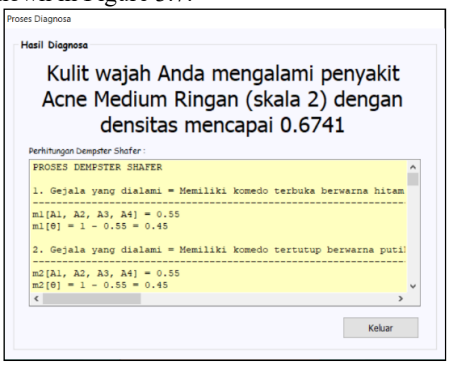


Figure 3.6 Diagnose Process

After the user has answered all the questions from the DSS application, the diagnostic results will appear on the Diagnosis Results form, as shown in Figure 3.7.



Gambar 3.7 Diagnose Result

The calculation steps displayed on the Diagnosis Results form are as follows:

Dempster Shafer Process

1. Symptoms experienced = Have black open comedones (G01)
m1[A1, A2, A3, A4] = 0.55
m1[θ] = 1 - 0.55 = 0.45

2. Symptoms experienced = Have white closed blackheads (G02)
m2[A1, A2, A3, A4] = 0.55
m2[θ] = 1 - 0.55 = 0.45
Combination rule for m2:
1. [A1, A2, A3, A4][0.55] x [A1, A2, A3, A4][0.55] = [A1, A2, A3, A4][0.3025]
2. [A1, A2, A3, A4][0.55] x [θ][0.45] = [A1, A2, A3, A4][0.2475]
3. [θ][0.45] x [A1, A2, A3, A4][0.55] = [A1, A2, A3, A4][0.2475]
4. [θ][0.45] x [θ][0.45] = [θ][0.2025]
m2 calculation result:
m2[A1, A2, A3, A4] = (0.3025 + 0.3025 + 0.3025) / (1-0)
m2[A1, A2, A3, A4] = 0.7975
m2[θ] = 0.2025 / (1-0)
m2[θ] = 0.2025

3. Symptoms experienced = Having papules or comedones that have irritated and form small red or pink bumps on the surface of the skin with a diameter of < 0.5 cm and filled with white objects such as rice (G03)
m3[A2, A3, A4, A5] = 0.6

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m3[θ] = 1 - 0.6 = 0.4
Combination rules for m3:
1. [A1, A2, A3, A4][0.7975] x [A2, A3, A4, A5][0.6] = [A2, A3, A4][0.4785]
2. [A1, A2, A3, A4][0.7975] x [θ][0.4] = [A1, A2, A3, A4][0.319]
3. [θ][0.2025] x [A2, A3, A4, A5][0.6] = [A2, A3, A4, A5][0.1215]
4. [θ][0.2025] x [θ][0.4] = [θ][0.081]
m3 calculation result:
m3[A2, A3, A4] = 0.4785 / (1-0)
m3[A2, A3, A4] = 0.4785
m3[A1, A2, A3, A4] = 0.319 / (1-0)
m3[A1, A2, A3, A4] = 0.319
m3[A2, A3, A4, A5] = 0.1215 / (1-0)
m3[A2, A3, A4, A5] = 0.1215
m3[θ] = 0.081 / (1-0)
m3[θ] = 0.081

4. Symptoms experienced = Have 3 or less comedones and papules that are somewhat scattered (G06)

m4[A1] = 0.7
m4[θ] = 1 - 0.7 = 0.3
Combination rules for m4 :
1. [A2, A3, A4][0.4785] x [A1][0.7] = [Ø][0.33495]
2. [A2, A3, A4][0.4785] x [θ][0.3] = [A2, A3, A4][0.14355]
3. [A1, A2, A3, A4][0.319] x [A1][0.7] = [A1][0.2233]
4. [A1, A2, A3, A4][0.319] x [θ][0.3] = [A1, A2, A3, A4][0.0957]
5. [A2, A3, A4, A5][0.1215] x [A1][0.7] = [Ø][0.08505]
6. [A2, A3, A4, A5][0.1215] x [θ][0.3] = [A2, A3, A4, A5][0.03645]
7. [θ][0.081] x [A1][0.7] = [A1][0.0567]
8. [θ][0.081] x [θ][0.3] = [θ][0.0243]
M4 calculation result:
m4[A2, A3, A4] = 0.14355 / (1-(0.33495 + 0.08505))
m4[A2, A3, A4] = 0.2475
m4[A1] = (0.2233 + 0.2233) / (1-(0.33495 + 0.08505))
m4[A1] = 0.4828
m4[A1, A2, A3, A4] = 0.0957 / (1-(0.33495 + 0.08505))
m4[A1, A2, A3, A4] = 0.165
m4[A2, A3, A4, A5] = 0.03645 / (1-(0.33495 + 0.08505))
m4[A2, A3, A4, A5] = 0.0628
m4[θ] = 0.0243 / (1-(0.33495 + 0.08505))
m4[θ] = 0.0419

5. Symptoms = Having a few pustules or 3 or more irritated papules with pimples that can be seen from a distance of 2.5 meters (G07)
m5[A2] = 0.8
m5[θ] = 1 - 0.8 = 0.2
Combination rules for m5 :
1. [A2, A3, A4][0.2475] x [A2][0.8] = [A2][0.198]
2. [A2, A3, A4][0.2475] x [θ][0.2] = [A2, A3, A4][0.0495]
3. [A1][0.4828] x [A2][0.8] = [Ø][0.38624]
4. [A1][0.4828] x [θ][0.2] = [A1][0.09656]
5. [A1, A2, A3, A4][0.165] x [A2][0.8] = [A2][0.132]
6. [A1, A2, A3, A4][0.165] x [θ][0.2] = [A1, A2, A3, A4][0.033]
7. [A2, A3, A4, A5][0.0628] x [A2][0.8] = [A2][0.05024]
8. [A2, A3, A4, A5][0.0628] x [θ][0.2] = [A2, A3, A4, A5][0.01256]

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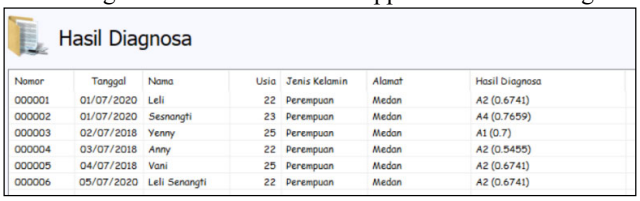
9. [θ][0.0419] x [A2][0.8] = [A2][0.03352]
10. [θ][0.0419] x [θ][0.2] = [θ][0.00838]
Combination rules for m5:
m5[A2] = (0.198 + 0.198 + 0.198 + 0.198) / (1-(0.38624))
m5[A2] = 0.6741
m5[A2, A3, A4] = 0.0495 / (1-(0.38624))
m5[A2, A3, A4] = 0.0807
m5[A1] = 0.09656 / (1-(0.38624))
m5[A1] = 0.1573
m5[A1, A2, A3, A4] = 0.033 / (1-(0.38624))
m5[A1, A2, A3, A4] = 0.0538
m5[A2, A3, A4, A5] = 0.01256 / (1-(0.38624))
m5[A2, A3, A4, A5] = 0.0205
m5[θ] = 0.00838 / (1-(0.38624))
m5[θ] = 0.0137

Your facial skin has A2 disease with a density of up to 67.41 %

Suggestion:
Reduce oily food and diligently clean your face at least 2 times a day.

To see all the diagnostic results that have been carried out, the user can press the "Results" button on the Main form, and the View Diagnostic Results form will appear as shown in Figure 3.8.



Nomor	Tanggal	Nama	Usia	Jenis Kelamin	Alamat	Hasil Diagnosa
000001	01/07/2020	Leli	22	Perempuan	Medan	A2 (0.6741)
000002	01/07/2020	Sesnangti	23	Perempuan	Medan	A4 (0.7659)
000003	02/07/2018	Yenny	25	Perempuan	Medan	A1 (0.7)
000004	03/07/2018	Anny	22	Perempuan	Medan	A2 (0.5455)
000005	04/07/2018	Vani	25	Perempuan	Medan	A2 (0.6741)
000006	05/07/2020	Leli Senangti	22	Perempuan	Medan	A2 (0.6741)

Figure 3.8 Display View Results

3.2 Discussion

The designed system can diagnose the severity of acne vulgaris skin disease using the Dempster Shafer method. The results of the diagnosis are decided based on the symptoms experienced by the patient and entered by the user by the question and answer method carried out by the system with the patient.

The advantages of the application of a decision support system for diagnosing the severity of acne vulgaris skin disease using the Dempster Shafer method are as follows:

1. The system can be used to diagnose the severity of acne vulgaris skin disease using the Dempster Shafer method.
2. The system can display calculation steps, so that it can help learning how the Dempster Shafer method works.
3. The system can display all the diagnostic results that have been done by the user.
4. The system has 2 types of users, namely administrators who can add symptoms and change the existing knowledge base in the system, and types of users or ordinary users who can only carry out the diagnostic process.

In addition to the advantages, the decision support system for diagnosing the severity of acne vulgaris skin disease also has the following disadvantages:

1. System knowledge is completely dependent on the expert or admin inputting knowledge into the application. The system cannot add to its own knowledge.
2. The system cannot be accessed online via a web browser or mobile via a smartphone.

4. Conclusions

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After completing the design of the Decision Support System (DSS) application to diagnose the severity of acne vulgaris skin disease using the Dempster Shafer method, several things can be concluded as follows:

1. The DSS application can be used to diagnose the severity level of acne vulgaris by using the Dempster Shafer method, namely by calculating and taking the diagnostic results that have the highest density value.
2. The application can display calculation steps, so that it can help learning how the Dempster Shafer method works.
3. The application can display all the diagnostic results that have been carried out by the user.

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