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Measure of Knowledge in Students at Uniandes, Ecuador, on the Manifestations of Oral Cancer

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Abstract. Oral cancer is a disease that deserves as much attention as possible from specialists. It is vitally important that specialists know the manifestations of this disease and they must be able to early detect it. That is why we carried out a survey on the students and teachers of the Uniandes Dental Care Unit to assess the knowledge they have about this illness. Likert scale was chosen to perform the measurement because of the subjective nature of the opinions. However, more accuracy is necessary to assess the responses. Therefore, we used the indeterminate Likert scale, based on Triple Refined Indeterminate Neutrosophic Sets, for each of the responses, which allowed us taking into account contradictory opinions. It consists of five elements: "Negative membership", "Indeterminacy leaning towards negative membership", "Indeterminate membership", "Indeterminacy leaning towards positive membership", and "Positive membership". To measure the result, an indeterminate minimum spanning tree (MST) clustering algorithm is used. The importance of this study lies in the fact that is the first one of this kind carried out in the country, which may be a starting point for other researches on this topic in the national territory.

Keywords: Triple Refined Indeterminate Neutrosophic Set, indeterminate Likert scale, indeterminate minimum spanning tree clustering algorithm, survey, oral cancer.

1 Introduction

Cancer is one of the chronic diseases that, due to globalization processes, increasingly affects a considerable number of people. A disease that has plagued humanity forever is nowadays the second cause of incidence and death in almost all the world.

Oral cancer is a chronic condition; it is not contagious and does not discriminate geographic area, age, sex, race or anatomical location. Its origin is multifactorial and perhaps the only way to cure it is to prevent it, diagnose it and treat it in an adequate way. For this reason, this study aims to assess the degree of knowledge in ninth and tenth semester students of the Uniandes Dental Care Unit about the manifestations of oral cancer; to guide them towards education, prevention and timely detection in professional practice[1]. During the field research, surveys and interviews were carried out in order to collect information on the knowledge of oral cancer; the results justify this investigative work [2].

Cancer begins when cells become abnormal and multiply uncontrollably. These cells form a growth of tissue called tumor. A tumor may have a benign (noncancerous) or malignant (cancerous) nature. Cancer cells may invade nearby tissue and might sometimes spread through the bloodstream and lymphatic system, to other parts of the body [2].

Oral health status is a fundamental aspect that affects perceptions about the quality of life of the general population. The Canadian Dental Association points out that oral health is a state of the tissues of the mouth and related structures that positively contributes to physical, mental and social well-being, to the enjoyment of life's possibilities, allowing the individual talk, eat, and socialize unhindered by pain, discomfort, or embarrassment, [2].

In this sense, oral cancer is a debilitating, disabling, multifactorial disease, which is considered catastrophic and increasingly affects a significant group of people around the world, since due to its destructive nature, it is capable of producing notable anatomical and physiological sequelae in those who suffer from it, [3].

According to the World Health Organization, oropharyngeal cancer is the sixth most frequent worldwide. The incidence, prevalence and severity of this disease vary from country to country. An annual incidence of around

275000 oral cancer and 130000 pharyngeal cancer is estimated. The calculations of the American Society Against Oropharyngeal Cancer, reports that 137000 people will suffer from this disease and 7300 will die due to this cause in the immediate future, [2].

In Quito, Ecuador the Cancer Institute (SOLCA) presents statistical records of tumors, reporting different locations in oropharyngeal structures, where the salivary glands, mouth, nose, sinuses, and tongue are the most frequent, [2].

According to the Pan-American Health Organization (PAHO), Ecuador is among the American countries with the highest prevalence of adolescents who use tobacco, which is one of the main predisposing factors for oral cancer that increases dramatically and affects the youngest population. Until a few years ago, the main causes of this type of cancer were the consumption of cigarettes and alcohol. Currently, it has drawn much attention about the close relationship existing between tumors of the oropharyngeal area and the human papilloma virus (HPV), [4].

At the Uniandes Dental Care Unit, no studies related to this research have been carried out. Either at the city or the province, so this study constitutes a fundamental pillar within the oncology area, whose purpose is to early detect the presence of oral cancer, so that the patient may receive timely treatment and increase his quality of life, through efficient and effective care.

In this research, we considered that the first aspect that must be taken into account to early fight this disease is that dentists or final years dental students be capable of detecting this disease and be duly informed about it. For this purpose, we conducted a survey on ninth and tenth semester students from the Uniandes Dental Care Unit, to assess knowledge about the manifestations of oral cancer. In addition, we interviewed specialists in the area, in order to obtain information that contributes to this investigation.

We considered to evaluate the interview and survey based on a Likert scale, [5, 6], which is a proven way of making subjective evaluations. However, this type of measurement scales has limitations. For example, it does not necessarily accurately capture the person's feeling about what is being valued. That is why we apply an indeterminate Likert scale, which consists of five evaluations that can express more accurately the presence of mixed feelings in each of the respondents. This scale uses the Triple Refined Indeterminate Neutrosophic Sets (TRINS) ([7, 8]) that are part of the neutrosophic theory of the Refined Neutrosophic Sets, [9-14]. TRINS consist of five elements: "Negative membership", "Indeterminacy leaning towards negative membership", "Indeterminate membership", "Indeterminacy leaning towards positive membership", and "Positive membership". In addition, each respondent can evaluate his feelings or knowledge in each of the elements of the scale, which provides greater accuracy to the study. The assessment can be made with the help of five-star or five-face rating graphs. Neutrosophy has been also successfully used to solve health and educational problems, [15-19].

To measure group trends, we used an indeterminate minimum spanning tree (MST) clustering algorithm as defined in [7], based on classical algorithms to find a minimum spanning tree in a connected and weighted graph [20].

This paper is split into the following sections: Section 2, explains the basic concepts of Neutrosophy, Triple Refined Indeterminate Neutrosophic Sets, distance between TRINS[21], indeterminate MST clustering algorithm, among others. Section 3 contains the methods and results of applying the survey and interview to students and teachers of the Uniandes Dental Care Unit[22], evaluated in form of TRINS, and the application of a clustering algorithm. The last section presents the conclusions of the paper.

2 Basic concepts

This section summarizes the main concepts on Neutrosophy[21, 23, 24] and others concepts useful to comprehend this paper.

Definition 1: ([7, 8]) The *Single-Valued Neutrosophic Set* (SVNS) N over U is $A = \{< x; T_A(x), I_A(x), F_A(x) > : x \in U\}$, where $T_A: U \to [0,1]$, $I_A: U \to [0,1]$, and $F_A: U \to [0,1]$, $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$.

Definition 2: ([7, 8]) The *refined neutrosophic logic* is defined such that: a truth T is divided into several types of truths: $T_1, T_2, \ldots, T_p$, I into various indeterminacies: $I_1, I_2, \ldots, I_r$ and F into various falsehoods: $F_1, F_2, \ldots, F_s$, where all $p, r, s \geq 1$ are integers, and $p + r + s = n$.

Definition 3: ([7, 8]) A *triple refined indeterminate neutrosophic set* (TRINS) *A* in X is characterized by positive $P_A(x)$, indeterminacy $I_A(x)$, negative $N_A(x)$, positive indeterminacy $I_{P_A}(x)$ and negative indeterminacy $I_{N_A}(x)$ membership functions. Each has a weight $w_m \in [0,1]$ associated with it. For each $x \in X$, there are $P_A(x), I_{P_A}(x), I_A(x), I_{N_A}(x), N_A(x) \in [0,1]$, $w_P^m(P_A(x)), w_{I_P}^m(I_{P_A}(x)), w_I^m(I_A(x)), w_{I_N}^m(I_{N_A}(x)), w_N^m(N_A(x)) \in [0,1]$ and $0 \leq P_A(x) + I_{P_A}(x) + I_A(x) + I_{N_A}(x)(x) + N_A(x) \leq 5$. Therefore, a TRINS *A* can be represented by $A = \{\langle x; P_A(x), I_{P_A}(x), I_A(x), I_{N_A}(x), N_A(x)\rangle | x \in X\}$.

Let *A* and *B* be two TRINS in a finite universe of discourse, $X = \{x_1, x_2, \ldots, x_n\}$, which are denoted by:

$A = \{\langle x;\ P_A(x), I_{P_A}(x), I_A(x),\ I_{N_A}(x), N_A(x)\rangle | x \in X\}$ and $B = \{\langle x;\ P_B(x), I_{P_B}(x), I_B(x), I_{N_B}(x), N_B(x)\rangle | x \in X\}$,

Where $P_A(x_i), I_{P_A}(x_i), I_A(x_i),\ I_{N_A}(x_i), N_A(x_i), P_B(x_i), I_{P_B}(x_i), I_B(x_i),\ I_{N_B}(x_i), N_B(x_i) \in [0,1]$, for every $x_i \in X$. Let w_i (i = 1,2,...,n) be the weight of an element x_i (i = 1,2,...,n), with $w_i \geq 0$ (i = 1,2,...,n) and $\sum_{i=1}^{n} w_i = 1$.

The *generalized TRINS weighted distance* is defined as follows, [7, 8]:

$$d_\lambda(A,B) = \left\{\frac{1}{5}\sum_{i=1}^{n} w_i \left[|P_A(x_i) - P_B(x_i)|^\lambda + \left|I_{P_A}(x_i) - I_{P_B}(x_i)\right|^\lambda + |I_A(x_i) - I_B(x_i)|^\lambda + \left|I_{N_A}(x_i) - I_{N_B}(x_i)\right|^\lambda + |N_A(x_i) - N_B(x_i)|^\lambda\right]\right\}^{1/\lambda} \quad (1)$$

Where $\lambda > 0$.

Definition 4: Let A_j (j = 1,2,...,m) be a collection of m TRINS, then we define the TRINS distance matrix $D = (d_{ij})_{m\times m}$, where $d_{ij} = d_\lambda(A_i, A_j)$ is the generalized TRINS distance between A_i and A_j and satisfies the following conditions:

1. $d_{ij} \in [0,1], \forall i,j = 1,2,\ldots,m$;
2. $d_{ij} = 0$ if and only if $A_i = A_j$;
3. $d_{ij} = d_{ji}$ for all $i,j = 1,2,\ldots,m$.

The *Indeterminate Likert Scale* consists of the following five elements:
– Negative membership,
– Indeterminacy leaning towards negative membership,
– Indeterminate membership,
– Indeterminacy leaning towards positive membership,
– Positive membership.

These values substitute the classical Likert scale with values:
– Strongly disagree,
– Disagree,
– Neither agree nor disagree,
– Agree,
– Strongly agree.

The advantage of the Indeterminate Likert Scale over the classical one is that the surveyed and interviewed person has the possibility to evaluate all the elements of the scale with degrees between 0% and 100%. However, the classical scale only allows him/her to select no more than one element with 100%. Thus, many contradictory feelings of the person are not captured in the classical way. Whereas, using the Indeterminate Likert Scale, the interviewer can assess using e.g., "Negative membership" with 95%, "Indeterminacy leaning towards positive membership" with 4% and "Indeterminate membership" with 1%, and we obtain more accuracy this way.

To obtain the results of the survey, in [7] is proposed an indeterminacy-based minimum spanning tree (MST) clustering algorithm. This algorithm adapts the Kruskal's algorithm for solving minimum spanning tree, [25]. The minimum spanning tree problem consists in looking for a subset of edges that, forming a tree, include all the vertices and where the total cost of all the edges of the tree is the minimum.

The idea is to define the graph (G, V), where every vertex represents an interviewed denoted by $F_i \in \{F_1, F_2, \cdots, F_m\}$, while every edge F_iF_j is associated with the value d_{ij} of the TRINS distance matrix D. The Kruskal's algorithm is defined in [25] to solve minimum spanning tree problems and used in [7] with this purpose. To form the cluster, a threshold value $\varepsilon > 0$ is fixed. Next, if $d_{ij} > \varepsilon$ then the edge F_iF_j is disconnected in G. Finally, the resulting graph is formed by clusters; and each of them contains the connected vertexes.

3 Results

This section shows the results of processing the survey of the knowledge on oral cancer applied at Uniandes, Ecuador.

The survey consists of one set of closed questions which are applied to 37 students; and another set of open questions for an interview applied to 10 professionals.

The closed questions and their possible responses of the survey are:

1. Do you spend the necessary time to carry out an interrogation, data collection, lymph node examination and both, extra and intraoral clinical examination?

Yes ☐
No ☐

2. What do you consider the highest risk factor for oral cancer?

Genetic predisposition ☐
Smoking habit ☐
Physical trauma from irritating elements ☐
Parallel tobacco and alcohol use ☐

3. Are people who chew tobacco at higher risk of oral cancer?

Yes ☐
No ☐

4. Do you consider that in our environment, men suffer more from oral cancer than women do?

Yes ☐
No ☐

5. The virus that is most associated with oral cancer is:

Epstein Barr virus ☐
Herpes Type I ☐
Papilloma virus ☐

6. How does the early lesion of oral cancer appear?

Asymptomatic ☐
Symptomatic ☐

7. What could be a warning sign of a cancer injury?

Fordyce granule ☐
Melanin pigmentation in mucosa ☐
Chronic ulcers ☐

8. Can you clinically differentiate a candidiasis from a leukoplakia?

Yes ☐
No ☐

9. What is the most frequent type of oral cancer in our environment?

Ameloblastoma ☐
Mucoepidermoid carcinoma ☐
Lymphoma ☐
Lichen planus ☐
None ☐

10. What is the type of clinical injury with which oral cancer commonly occurs?

Ulcer ☐
Dental plaque ☐
Nodule ☐
Macula ☐
None ☐

11. What is the age with the highest number of cases of oral cancer?

From 18 to 30 years old ☐
From 31 to 40 years old ☐
More than 40 years old ☐

12. If a patient has an ulcer, in how many days we suspect malignancy when despite he/she receiving treatment there is no tendency to heal?

5 days ☐
10 days ☐
15 days ☐
20 days ☐

13. Do you know the oral areas where the cancerous lesions associated with human papilloma virus (HPV) infections are most frequently located?

Yes ☐
No ☐

14. Do you teach your patients to self-test for signs and symptoms of oral cancer and pre-cancer?

Yes ☐
No ☐

15. Do you know about oral washing with toluidine blue in the early diagnosis of malignant lesions?

Yes ☐
No ☐

Through the interviews applied to 10 general dental teaching professionals and specialists in each area, who are tutoring the treatments carried out on patients who come to Uniandes Dental Care Unit during the academic period April-September 2018, the following questions were asked:

1. Do you consider that students make an adequate record in the clinic history, as well as the background and possible predisposing risk factors for oral cancer, before performing dental care on patients?
2. What are the premalignant lesions, related to manifestations of oral cancer that have been most frequently identified by students during dental practices at Uniandes Dental Care Unit?
3. Do students perform clinical and radiological examinations of edentulous and partially edentulous patients, including revision of mucous and tooth-supported prostheses?
4. Given the suspicion of a precancerous oral lesion, do you think that during dental practice at Uniandes Dental Care Unit, toluidine blue washing could be implemented as a test to aid in the early diagnosis of oral cancer; to be able for referring to the specialist?
5. Assessing the level of knowledge that the final year students have; regarding, precancerous and cancerous lesions in the oral cavity. Do you think they are ready to apply their knowledge to benefit patients during clinical practice?

Let us denote by $\mathrm{St} = \{\mathrm{St}_1, \mathrm{St}_2, \cdots, \mathrm{St}_{37}\}$ the set of surveyed students. A team of independent experts was hired for asking the question: Has student St_i the necessary knowledge on oral cancer?

The results are evaluated by consensus of the team members for every one of the students. Experts based their opinions on the answers of the students to the 15 questions. Expert's assessment is subjective, thus, we consider it is more adequate and accurate to use the indeterminate Likert scale supported in a graphical scale of five-symbols rating, as shown in Figure 1.

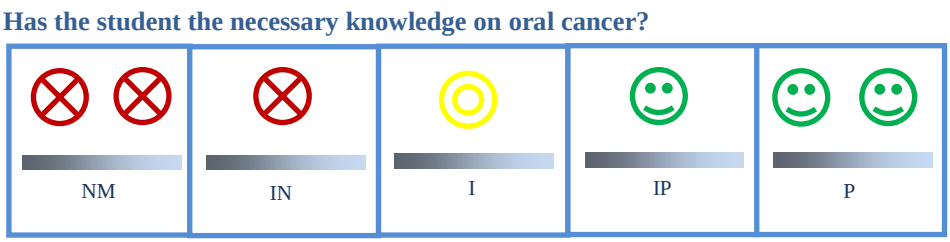

Figure 1: Graphical scale associated with the indeterminate Linkert scale: Negative membership (NM), Indeterminacy leaning towards negative membership (IN), Indeterminate membership (I), Indeterminacy leaning towards positive membership (IP), and Positive membership (PM).

Experts' team was requested about the degree they consider St_i satisfies the question in the following scale:
– Negative membership (NM),
– Indeterminacy leaning towards negative membership (IN),
– Indeterminate membership (I),

– Indeterminacy leaning towards positive membership (IP),

– Positive membership (PM).

Every one of them is associated with a number in the interval [0, 100]%, which are represented in the bar contained into every square. The use of a pictorial scale allows experts to select more easily the most accurate opinion. The opinions are represented by TRINS for the evaluation of each student.

The results of every of the 37 surveyed students was collected and evaluated by experts. Next, TRINS were associated with those evaluations. D, which is the TRINS distance matrix of order 37 was calculated for parameter $\lambda = 2$. Later, we defined the graph (G, V) associated with D, and we applied the Prim's algorithm ([26]) to obtain the indeterminate minimum spanning tree (MST). Finally, those vertices satisfying $d_{ij} > 0.14167$ were disconnected.

Four clusters were obtained, $\{F_1, F_2, F_3, F_4, F_5, F_{11}, F_{12}, F_{31}, F_{33}\}$ which were evaluated as PM, $\{F_7, F_8, F_{10}, F_{13}, F_{14}, F_{15}, F_{16}, F_{17}, F_{18}, F_{19}, F_{29}\}$ were evaluated as IP, $\{F_6, F_{20}, F_{21}, F_{22}, F_{23}, F_{24}, F_{25}, F_{26}, F_{27}, F_{28}, F_{30}, F_{32}, F_{34}, F_{35}, F_{36}, F_{37}\}$ have evaluation of IN, and $\{F_9\}$ have evaluation of NM.

Thus, 24.324% of students have the necessary knowledge on oral cancer, 29.730% have an 'Indeterminacy leaning towards positive membership' evaluation in their necessary knowledge on oral cancer, 43.243% have an "Indeterminacy leaning towards negative membership", and 2.7027% are classified as 'negative membership'.

With respected to the questions asked to the professionals, enumerated with j = 1,2,3,4,5,6,7,8,9,10; the evaluation of the results are summarized in Table 1 for each of the 5 questions.

Profesional\Question	**#1**	**#2**	**#3**	**#4**	**#5**
#1	⟨0.1, 0,0,0.2,0.8⟩	⟨0.7, 0.2,0.1,0,0⟩	⟨0.5, 0,0.1,0,0.4⟩	⟨0.7, 0,0.1,0,0.3⟩	⟨0.1, 0,0,0.1,0.9⟩
#2	⟨0, 0,0,0.2,0.8⟩	⟨0.75, 0.05,0,0,0⟩	⟨0.4, 0.1,0,0,0.5⟩	⟨0.6, 0,0.1,0,0.2⟩	⟨0.6, 0,0.1,0,0.2⟩
#3	⟨0.6, 0.1,0.1,0,0⟩	⟨0.9, 0.1,0,0,0⟩	⟨1, 0,0,0,0⟩	⟨0.9, 0.1,0,0,0⟩	⟨0.9, 0.1,0,0,0⟩
#4	⟨0.2, 0,0.1,0.1,0.6⟩	⟨0.8, 0.1,0,0,0⟩	⟨0.6, 0,0.1,0,0.3⟩	⟨0.7, 0,0.1,0,0.2⟩	⟨0.7, 0.2,0.1,0,0⟩
#5	⟨0, 0,0.1,0.1,0.9⟩	⟨0, 0,0,0,1⟩	⟨0.3, 0.2,0.1,0,0.2⟩	⟨0.65, 0,0.1,0.1,0⟩	⟨0, 0,0,0.1,0.9⟩
#6	⟨0, 0,0.1,0.2,0.8⟩	⟨0.8, 0.1,0.1,0,0⟩	⟨0.6, 0.2,0,0,0.1⟩	⟨0.7, 0,0.1,0.1,0⟩	⟨0.6, 0.1,0.3,0,0⟩
#7	⟨0.2, 0,0,0,0.7⟩	⟨0.85, 0.1,0,0,0⟩	⟨0.7, 0.2,0,0,0.1⟩	⟨0.7, 0,0.2,0.1,0⟩	⟨0.6, 0,0.3,0,0⟩
#8	⟨0.1, 0.1,0,0.1,0.6⟩	⟨0.75, 0.1,0,0,0⟩	⟨0.8, 0.2,0.1,0,0⟩	⟨0.6, 0.1,0.1,0.1,0⟩	⟨0.8, 0.2,0,0,0⟩
#9	⟨0.1, 0,0.2,0,0.9⟩	⟨0, 0,0,0,1⟩	⟨0.4, 0,0,0,0.5⟩	⟨0.5, 0,0.1,0.1,0⟩	⟨0, 0,0,0,1⟩
#10	⟨0, 0,0,0.1,0.9⟩	⟨0, 0,0,0,1⟩	⟨0.4, 0,0,0.1,0.5⟩	⟨0, 0,0,0,1⟩	⟨0, 0,0,0,1⟩

Table 1: Data collected from converting professionals' answers in TRINS on the five-question interview.

Let us remark that the professionals understood the meaning of assessing with five-value scale, thus, they used this scale adequately.

The result of forming D, the TRINS distance matrix that was calculated from Table 1, is summarized in Table 2. Let us note that $\lambda = 2$ and $w_i = \frac{1}{5} = 0.2$, were fixed.

Index	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	0	0.18601	0.34928	0.23324	0.26926	0.24166	0.24920	0.27148	0.27055	0.32435
2	0.18601	0	0.28320	0.11045	0.32481	0.12410	0.14318	0.16643	0.33136	0.38079
3	0.34928	0.28320	0	0.19698	0.46141	0.24739	0.21000	0.18682	0.46989	0.53963
4	0.23324	0.11045	0.19698	0	0.36510	0.10954	0.10630	0.10817	0.37363	0.42755
5	0.26926	0.32481	0.46141	0.36510	0	0.35057	0.36304	0.37390	0.094340	0.25554
6	0.24166	0.12410	0.24739	0.10954	0.35057	0	0.075498	0.11180	0.37256	0.44317
7	0.24920	0.14318	0.21000	0.10630	0.36304	0.075498	0	0.10583	0.38013	0.45222
8	0.27148	0.16643	0.18682	0.10817	0.37390	0.11180	0.10583	0	0.39408	0.45706
9	0.27055	0.33136	0.46989	0.37363	0.094340	0.37256	0.38013	0.39408	0	0.23152
10	0.32435	0.38079	0.53963	0.42755	0.25554	0.44317	0.45222	0.45706	0.23152	0

Table 2: TRINS distance matrix of the results from Table 1.

In Figure 2 we depict the edges of the minimum spanning tree and their associated cost. For simplicity, we omitted the rest of the edges.

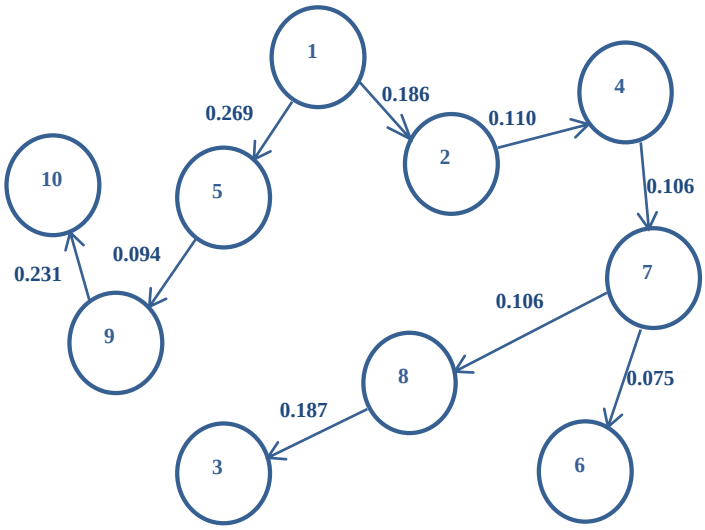

Figure 2: Edges of the minimum spanning tree and their associated cost obtained from the results of Prim's algorithm.

The clusters are obtained fixing $\varepsilon = 0.187$, which is graphically represented in Figure 3.

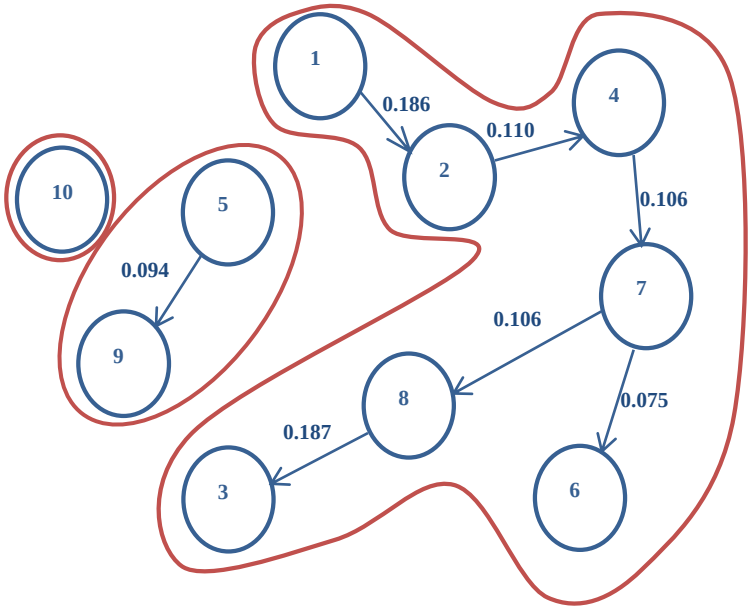

Figure 3: Clusters obtained for $\varepsilon = 0.187$.

Thus, three clusters are obtained, they are: $\{F_1, F_2, F_3, F_4, F_6, F_7, F_8\}$, $\{F_5, F_9\}$, and $\{F_{10}\}$. One cluster prevails, containing 70% of the opinions, where the prevalent judgment is that students have many deficiencies to detect oral cancer and many assertions as well.

Conclusion

In this investigation, we studied the current situation of knowledge on oral cancer by the ninth and tenth semesters' students of the Dental Care Unit at Uniandes, Ecuador. 37 students were surveyed through a 15 closed questions questionnaire, while 10 teachers were interviewed about their opinions regarding the students' knowledge on this topic. From the results, we may conclude that the students do not yet have the necessary knowledge about oral cancer and need training. The use of the indeterminate Likert scale ensured that mixed feelings were captured in the evaluations. The results were based on clusters obtained from applying an indeterminate minimum spanning tree clustering algorithm. Specifically, the Prim's algorithm was used. Only 24.324% of the surveyed students are trained to detect oral cancer, 29.730% of the students are not trained yet, but they show a positive trend, while the rest do not show good results. According to the professionals, there is a

predominant cluster, where experts consider that students have some skills to detect oral cancer, but they need more training. For the authors, this is the first time in Ecuador that such a study has been carried out.

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