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Application of Topology in the field of Anthropology

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ABSTRACT

In this paper, topology and its application in cultural anthropology was considered and how the various tools in topology have one way or the other been applied. This paper had been compared some differences and similarities that exist among some ethnic groups in Ghana by using connectedness, hamming distance and levenshtein distance.

Keywords: Topology, Anthropology, Connectedness, Disconnectedness, Open set, Closed set, Hamming distance, Levenstein distance (DL), Differences, Similarities.

1. Introduction

Topology is the study of position and location of object. Topology is basically considered as one of the three main branches of Pure Mathematics in addition to algebra and analysis. Topology grew from geometry as the study of shapes as well as their characteristics, deformations and mappings applied between them. Topology is mostly recognized as a rubber sheet geometry. In traditional or basic geometry, plane objects such as circle, quadrilaterals, triangles, polyhedral etc are seen to be rigid with well-defined angles between their edges and faces. As in topology, distance and angles can be completely ignored without having any significant effect on the transformation of the object. The objects in the topology are treated as if they are made of rubber capable of being deformed from one form to another form without having object torn apart (C. Adams et al., 2008). Topology is simply believed to have been born out of a real life challenge some years ago somewhere in the eighteenth century. The first work on topology is highly attributed to Leonhard Euler in 1736 when he published the solution to the Koenigsberg bridge problems. In that paper, Euler was aware he was dealing with different types of geometry where distance was not relevant. Once in Russia, a city called Koenigsberg, the river bridge had overflowed its banks and run through the city. There exist some seven bridges that connected the regions in the city. People wanted to find out the possibility of going through the city but crossing each bridge only once. Even Euler believed, it was impossible to walk across the bridges given their position. However, it is widely regarded that the birth of modern topology was due to H. Poincare in 1895 when he published Analysis situs. One of the motivations for general topology also came through ideas of convergence which go back to 1817 when B. Balzano generalized the notion of convergence. Topology is an important and interesting area of Mathematics. It is also fundamental that, its influence is evident in almost every other branch of Mathematics. The applications of topology help in solving mathematical problems in our societies and in other Mathematics related courses such as Physics and Engineering. This makes the study of topology relevant to all who aspire to be Mathematicians, whether their first love is in algebra, analysis, Category theory, Chaos, Continuum mechanics, Geometry, Industrial Mathematics etc. In this particular work, much of our focus is laid on how to apply some topological tools such as Hamming distance, Levenshtein distance, Connectedness and others in the field of anthropology, most particularly, social anthropology and

cultural anthropology which made up socio-cultural anthropology. Anthropology was derived from the Latin word anthropology (the study of human) and in Greek word anthropos (human being). Anthropology therefore is the study of human being and their ancestors through time and space in relation to the physical characters, environment, social relationships and culture. An anthropologist takes a broad approach to understand many different aspects of human experience which we call holism. Aristotle, first defined anthropologists as speaking or treating of man in the Ancient Greek Lexicon. This was later discovered by James Hunt in his first attempt to address the Anthropological Society of London as the president and founder of the association in 1863. Marvin Harris, a historian of anthropology started the Rise of Anthropology theory with the ideology that Anthropology is not only the study of mankind but also the science of history. Harris saw history as different as the founder of sociocultural anthropology. Herbert Spencer, once in the Universal history of mankind, the 18th century Age of enlightenment Objective, made it clear that as natural history takes care of the characteristics of organisms' past and their present so as sociocultural history hugely minds the characteristics of the societies' past and their present. Throughout this study, we were able to discover that anthropologists consider the past through archaeology to see how human groups lived hundreds or thousands of years ago and what was important to them. We also saw what made up the biological bodies and genetic as well as our bones, diet, culture and health. Even though, nearly all human being needs the same things to survive, like food, water and companionship, the way people greet, speak etc are very different. For example, everyone needs to eat but people prepare, share and eat foods differently. Basically, there are four main subdivisions of anthropology, namely; biological or physical anthropology, cultural anthropology, linguistic anthropology and social anthropology. Social anthropology is the study of people, what they make, what they do, what they think and how they organize their social relationships and the society. On the other hand, Cultural anthropology is the branch of anthropology that focuses on the study of cultural variation among humans. Cultural anthropology also studies into details the cultural aspect of human communities. A variety of methods involved in cultural anthropology include participant observation (often called field work because it requires the anthropologist spending an extended period of time at the research location). Some notable personalities like Franc Boas and Sir Edward Taylor have worked on the field of cultural anthropology. Sir Edward Taylor in 1871 wrote a book titled "Culture and Civilization" to explain different cultures all among the world.

2. Definitions and Examples

2.1 Connectedness

Let x be a topological space (Adams et al., 2008)

- (i) We call x connected if there does not exist a pair of disjoint non-empty open sets whose union is x .
- (ii) We call x disconnected if x is not connected.
- (iii) If x is disconnected, then a pair of disjoint non-empty open sets whose union is x is called a separated of X .

2.2 Example 1

Consider the following subsets of the plane that is, R^2 , $A = \{(0, y) : \frac{1}{2} \leq y \leq 1\}$

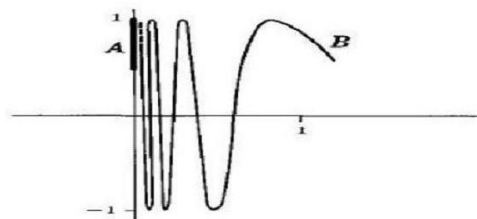


Figure 1: shows the connection between B and A.

Each point in A is an accumulation point of B, hence A and B are connected set.

2.3 Hamming distance

The hamming distance of any two set of words or strings x and y with the same length n is denoted by $DH(X, Y)$, $DH(X, Y)$ is the minimum number of places in which the two words are usually the source word (x) and targeted word (y) different when they are arranged orderly

2.4 Example 2

Let x and y be the codes of two (2) different words given as shown in Table 1 below. Since x and y have a length, let the position where x and y differ by 1 and set the place where x and y are same be 0. Assuming the position of x and y give $1 + 1 + 0 + 0 + 1 + 0 + 1 = 4$. This is true because x and y differ in the 1st, 2nd, 7th, and 9th positions. Hence $DH(X, Y) = 4$

X	1	1	1	0	1	0	0	1	0
Y	0	0	1	0	1	0	1	1	1

2.5 Levenshtein Distance (DL)

Levenshtein distance is also another topological tool under metric space which is used to measure the similarities and differences between two or more sets of sequences whose lengths may be equal or not. Levenshtein distance between any two sets of strings or words say x and y is denoted by $DL(X, Y)$ where x is assumed to be the source word and y be the target word, is then the minimum number of deletions (d), insertions (i) and or substitution and replacement (r) required to transform source string x into the target string y, thus

$DL(X, Y) = \text{Min}(is + ds + rs)$ where is = total number of insertions made:

ds = total number of deletions made

rs = total number of replacement substitution made

2.6 Application and Analysis

Connectedness is a topological feature that is used to express how two or more sets are joined together, disjoint partially or completely separated.

Considering three regions, Asante, Northern and Brong Ahafo region. Let X represents Asante, Y represents Northern and Z represents Brong Ahafo region. Now with these three regions, connectedness as a mathematical tool was used to find out whether some of these regions are either connected or disconnected.

Considering some cultural practices such as food, language, clothing, dance and game.

Let put the above cultural practices into mathematical language and statements: Food \rightarrow a

Clothing \rightarrow b

Language \rightarrow c Dance \rightarrow d Culture \rightarrow e

Let $K = (a, b, c, d, e)$, where K represents the universal set.

Let $X = (a, b, c, d)$, $Y = (c, d, e)$, and $Z = (a, b, c)$, where the fact had already been established that, X, Y and Z represents the above regions respectively.

Now to show if some of these regions are either connected or disconnected, let the union and the intersection among them by representing X, Y and Z in a Venn diagram.

Diagram (a)

$$X \cap Y = (c, d)$$

$$X \cup Y = K$$

Since region X and Y have in common (c, d) and the union of these two nonempty sets give back the topological space $K = (a, b, c, d, e)$, then this is clear that, these two regions are culturally connected. Refer to figure two below.

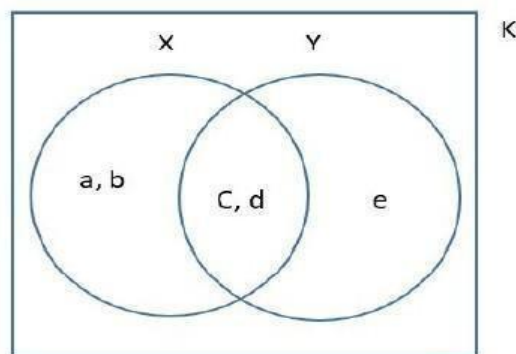


Figure 2: Connected diagram

Diagram (b)

According to the deduction from diagram (b), it could be seen that, the intersection of Z and Y is empty but the union of these two nonempty sets produce the topological

space K , therefore region Z and Y are indeed disconnected. Refer to figure 3 below.

$$Z \cap Y = \emptyset$$

$$Z \cup Y = K$$

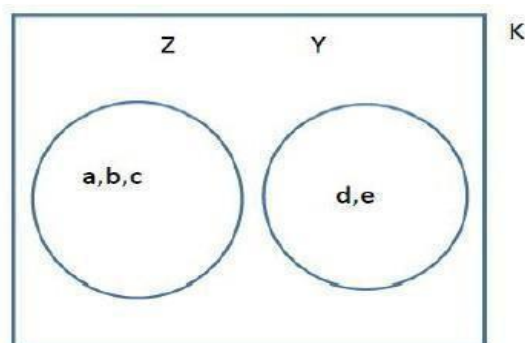


Figure 3: disconnected diagram

2.7 Theorem

If a code C of length n is chosen so that its minimum distance is d , then every message of length n with $\lfloor \frac{d-1}{2} \rfloor$ or fewer errors can be corrected.

Let consider these three (3) major ethnic groups in Ghana, the Asantes, Ewes and the Fantes denoted by A, E, and F respectively. Again, considering these five main cultural practices in Ghana; food, language, clothing, dance and game. Taking where there does not exist any cultural difference between any two ethnic group as zero (0) and where there exists difference as one (1). Then the above information can be summarized in the tabular forms as shown in Table 2 below.

Cultural practices	Asantes (A)	Ewes (E)	Differences
Food	Fufu	Akple	1
Language	Twi	Ewe	1
Clothing	Kente	Fesease	1
Dance	Adowa	Agbadza	1
Main game	Football	Football	0

Table 2: Showing the five main cultural practices in Ghana.

Table 3: Showing Asantes (A) and Fantes (F)

Cultural practices	Asantes(A)	Fantes(F)	Differences
Food	Fufu	Fufu	0
Language	Twi	Fante	1
Clothing	Kente	Kente	0
Dance	Adowa	Adowa	0
Main game	Football	Football	0

Finally, consider the Ewes and the Fantes, Table 4: Showing Ewes and the Fantes

Cultural	Ewe	Fantes(F)	Differences
Food	Akpele	Fufu	1
Language	Ewe	Fante	1
Clothing	Fesease	Kente	1
Dance	Agbadza	Adowa	1
Main game	Football	Football	0

However, the Hamming distance between each of the pairs could be obtained by counting the number of positions where there exist differences.

The Hamming distance between the Asantes and the Ewes is given as

$$DH(A, E) = 1 + 1 + 1 + 1 = 4$$

The Hamming distance between the Asantes and Fantes is $DH(A, F) = 1$

The Hamming distance between the Ewes and the Fantes is

$$DH(E, F) = 1+1+1+1=4$$

By Table 2 and 3 and using transitivity law, then Table 3 can easily be deduced.

3. Concluding Remarks

Topology is applied in almost every part of our lives especially, with cultural aspect and traditional lives. It appears from the work that, in our homes, hospitals and many more places we make use of topology daily. Topology is one of the powerful and useful tools as far as Mathematics is concerned. Mathematics is useful to humanity which falls under anthropology and by transitivity, topology is also useful to humanity and anthropology at large. Since the topic is too broad, only few topological tools were considered in the application of anthropology.

3.1 Recommendation

It is recommended that, students must continue to work on this topic to cover the unintroduced areas such as Compactness, Neighborhood, Interior, Exterior and many more. Since the Levenshtein distance is used for spelled checking, speech recognition and plagiarism detection. Students should hence be encouraged to work on such topics as their project topics. It is also recommended that; extra effort and attention must be given to study culture, its differences and similarities across tribes and ethnic groups to promote national peace and unity. Finally, much attention should be laid on the study of topology and anthropology in order to unveil their life applications to the world. It is imperative that, people continue to project and bring out findings around the area of topology and that of anthropology to discover the hiding topics.

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