Future Applications of Topology by Computer Programming

A. S. Salama[a] O. G. El-Barbary[b]

[a] Mathematic Department, Faculty of Science, Tanta University, Tanta, Egypt
[b] Statistical & Computer Science Department, Faculty of Science, Tanta University, Tanta, Egypt
asalama@su.edu.sa, omniaelbarbary@yahoo.com

Abstract: Topological concepts are complex and difficult to compute by hand specifically for large universes. We know very well that the number of topologies can be made on a set of three elements are 29 different topologies. Imagine you want to calculate a particular topological operation on every one of these topologies and on universe has more than three objects. In this paper, we designed a JAVA computer software calculated many topological concepts and to any universe regardless of the number of its elements. This software is designed specifically for this emerged the importance of deep learning in many of the concepts and theories that have emerged recently in many applications of real life especially in computer science.

[A. S. Salama, O. G. El-Barbary. **Future Applications of Topology by Computer Programming.** *Life Sci J* 2014;11(4):168-172]. (ISSN:1097-8135). http://www.lifesciencesite.com. 25

Keywords: Topological Spaces; Rough Sets; Rough Approximations; Data Mining; Java Programming.

1. Introduction

We were all scholars and researchers in the field of topology public dream of inventing a way we facilitate the process of calculating the complex topological identifiers. Not only that, but our desire calculates more than that the identifiers developed in this science referred to frequently in various applications of life. Therefore, we consider our work in this paper is the real nucleus for more extensive and in-depth study in this field of science and not fear of the study sets over a wider breadth and depth applications. The software was developed in the Java programming designed this research to study some applications of science with the topology, rough set theory and fuzzy set theory together.

Topology is a significant and interesting area of mathematics, whose study introduces you to new concepts (semi-open, pre open, $\beta -$ open sets and others) and theorems, which are very useful in many applications. It is so essential that its power is obvious in almost every other branch of mathematics. This makes the study of topology applicable to all who hope to be mathematicians whether their first love is algebra, analysis, category theory, chaos, and continuum mechanics, dynamics, geometry, industrial mathematics, mathematical biology, mathematical economics, mathematical physics, mathematics of communication, number theory, numerical mathematics, operational research or statistics. Topological notions like semi-open, preopen, $\beta -$ open sets are as basic to mathematicians of today as sets and functions were to those of last century [7, 8,9]. Then, we think the topological structure will be so important base for knowledge extraction and processing.

M. E. Abd El-Monsef et.al [1] and N. Levine [5] introduced semi-open sets and β -sets respectively. $\beta -$ sets are also called as semi-preopen sets by Andrijevic [2]. Levine [6] generalized the concept of closed sets to generalized closed sets. Bhattacharya and Lahiri [8] generalized the concept of closed sets to semi-generalized closed sets via semi-open sets. The complement of a semi-open (resp. semi-generalized closed) set is called a semi-closed [4] (resp. semi-generalized open [3]) set. A lot of work was done in the field of generalized closed sets. In this paper we employ a new computational technique to obtain new classes of sets, called *TOPOLOGICA* –generated sets. These classes are obtained by generalizing semi-closed sets via semi-generalized open sets using our *TOPOLOGICA* designed software. It is shown that the class of *TOPOLOGICA* –generated sets properly contains the class of semi-closed sets and is properly contained in the class of semi-preclosed sets. Further it is observed that the class of *TOPOLOGICA* –generated sets is independent from the class of preclosed sets, the class of g-closed sets, the class of g α -closed sets and the class of α g-closed sets. Moreover this class sits properly in between the class of semi-closed sets and the class of semi-generalized closed sets.

2. Material and Methods

As will come knocking on the door to the suffering of some scientists in the topology to generate some new categories, which contributed to the newly in many applications. We are beginning the process of generating the topology and some categories of it such as open, closed, interior, closure and exterior subsets.

A topological space is a pair (U,τ) consisting of a set U and family τ of subsets of U satisfying the following conditions:

(1) $\phi, U \in \tau$,

(2) τ is closed under arbitrary union,

(3) τ is closed under finite intersection.

The pair (U,τ) is called a topological space, the elements of U are called points of the space, the subsets of U belonging to τ are called open sets in the space, and the complement of the subsets of U belonging to τ are called closed sets in the space; the family τ of open subsets of U is also called a topology for U.

For a subset A of a space (U,τ), $cl(A), \text{int}(A)$ denote the closure of A, the interior of A and the complement of A in τ respectively.

Below are the definition given a lot of topological concepts, which dealt with scientific research in the field of topology and its applications, but without the possibility of application to the real difficulty addressed on a large information systems to some extent.

Definition 2.1 [1-6] A subset A of a topological space (U,τ) is called:

(1) Semi-open set if $A \subseteq cl(\text{int}(A))$ and it is called a semi-closed set if $\text{int}(cl(A)) \subseteq A$.

(2) Pre-open set if $A \subseteq \text{int}(cl(A))$ and it is called a pre-closed set if $cl(\text{int}(A)) \subseteq A$.

(3) $\alpha-$open set if $A \subseteq \text{int}(cl(\text{int}(A)))$ and it is called a $\alpha-$closed set if $cl(\text{int}(cl(A))) \subseteq A$.

(4) semi-pre-open set ($\beta-$open) if $A \subseteq cl(\text{int}(cl(A)))$ and it is called a semi-pre-closed set ($\beta-$closed) if $\text{int}(cl(\text{int}(A))) \subseteq A$.

(5) Regular-open set if $A = \text{int}(cl(A))$ and it is called a regular-closed set if $cl(\text{int}(A)) = A$.

(6) Semi-regular set if it both semi-open and semi-closed in (U,τ).

(7) $\delta-$closed set if $A = cl_\delta(A)$, where

$cl_\delta(A) = \{x \in U : \text{int}(cl(G)) \cap A \neq \phi, x \in G, G \in \tau\}$.

The semi-closure (resp. α-closure, semi-pre-closure) of a subset A of (U,τ) is the intersection of all semi-closed (resp. α–closed, semi-pre-closed) sets that contains A and is denoted by $scl(A)$ (resp. $\alpha-cl(A)$, $spcl(A)$). The union of all semi-open subsets of U is called the semi-interior of A and is denoted by $\sin t(A)$.

Definition 2.2 [1-6]A subset A of a topological space (U,τ) is called:

(1) Generalized closed (briefly $g-$closed) set if $cl(A) \subseteq G$ whenever $A \subseteq G$ and $G \in \tau$.

(2) Semi-generalized closed set (briefly $sg-$closed) if $scl(A) \subseteq G$ whenever $A \subseteq G$ and G is semi-open set in (U,τ). The complement of an $sg-$closed set is called an $sg-$open set.

(3) Generalized semi-closed set (briefly $gs-$closed) if $scl(A) \subseteq U$ whenever $A \subseteq G$ and G.

(4) $\alpha-$generalized closed set (briefly $\alpha g-$ closed) if $\alpha cl(A) \subseteq G$ whenever $A \subseteq G$ and G.

(5) Generalized $\alpha-$ closed set (briefly $g\alpha-$closed) if $\alpha cl(A) \subseteq G$ whenever $A \subseteq G$ and G is $\alpha-$open in (U,τ).

(6) $g\alpha^{**}$-closed set if $cl(A) \subseteq \text{int}(cl(G))$ whenever $A \subseteq G$ and G is $\alpha-$open in (U,τ).

(7) Generalized semi-pre-closed (briefly $gsp-$closed) set if $spcl(A) \subseteq G$ whenever $A \subseteq G$ and G.

(8) $\delta-$generalized closed (briefly $\delta g-$closed) set if $cl\delta(A) \subseteq U$ whenever $A \subseteq G$ and G is $\alpha-$open in (U,τ).

(9) Q-set if $\text{int}(cl(A)) = cl(\text{int}(A))$.

3. How to use our software (*TOPOLOGICA*)

The image below (Figure 1) shows the opening screen of the software which describes the locations of input and output of the program. Using this window you can enter vocabulary of your universe community to be studied topological regardless of the amount of vocabulary. The program determines the type of study you are partial to all subsets of the universe or only some of them specifically to check the specific choice use $P(U)$ in calculations or use another set in calculations. You are required to also enter the topology to be accounted in the space provided for that. The maximum level of calculations is the number of iterations that the program stops when you reach it. For example, if this number is 3 then the program will calculate to operations namely $\text{int}(\text{cl}(\text{int}(X)))$ and $cl(\text{int}(cl(X)))$ for all subsets $X \subseteq U$ before it stops.

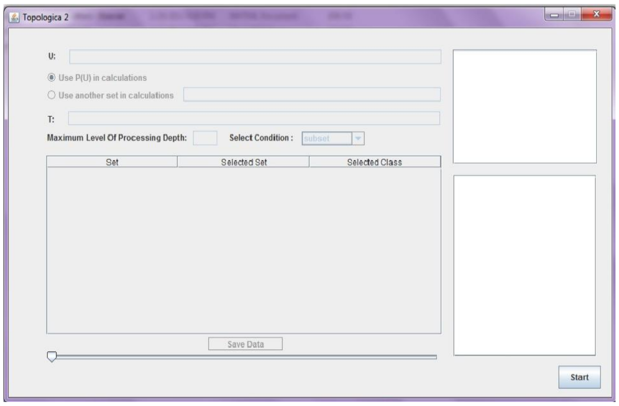

Figure 1: Opening screen of the TOPOLOGICA I program

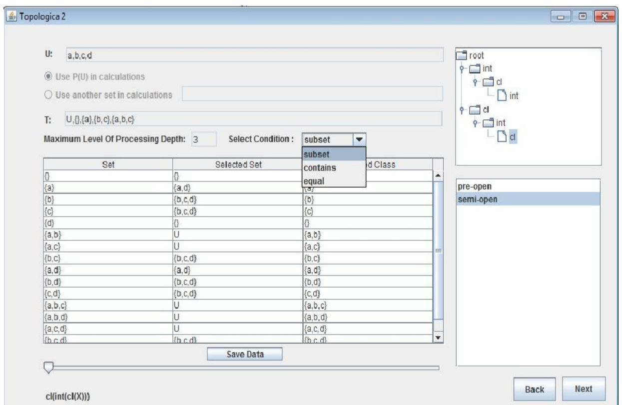

Figure 2: TOPOLOGICA I filled with data

When you press the start button in the right bottom corner of the above window the program starts and asks you to enter your universe U and your topology τ . Also, you asked to write the number of maximum level and to select a condition (subset, contains or equal). Top right corner is dedicated to the emergence of a series of topological operations (Figure 2). When you touch any tag in the upper right box shows the operation in the bottom of the window. Also, you can mark any class as important by right clicking on the operation in the upper right box and select mark as important. At any stage you can export your data to a separate Excel file by clicking on the save data button.

Now you can calculate all the identifiers in the previous section using this program. Do not stand the possibilities of this program to this extent only, but we can use the output of the program directly in the applications of rough set theory. For example you can use the class of pre-open sets (or any class) as a knowledge base to define all rough set theory approximations. Just clicking on the selected class right then choose "use this class in approximations" immediately be referred to the new phase of the program to calculate what you want from concepts of rough set theory [9] (See Figure 3).

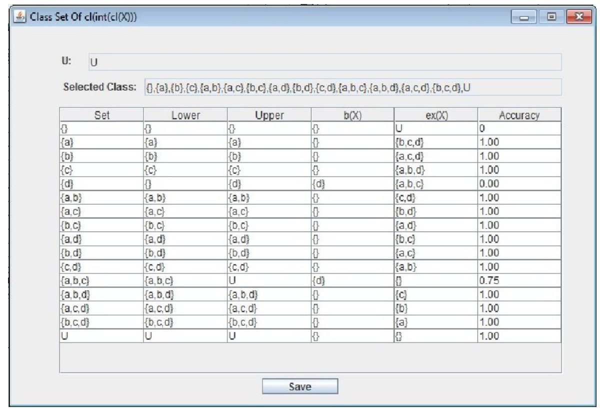

Figure 3: Selected class with rough set approximations

This program is about the very complex topological operations to just a push of a button. Can also discover many new topological subsets to raise the upper limit of the frequency of operations to any number you want. We can also learn from the program any better of the topologies in applications prior knowledge of the accuracy of this topology through a column of precision in the second phase of the program.

4. Results

We study in this section, what can be accomplished using this program as well as many examples of which can not be computed without it. Also we present many of applications that can be implemented using this program.

Now we offer a range of examples which can not be calculated without the program.

Example 4.1 If our universe is $U=\{a,b,c,d,e,f,g,h,i,j\}$ which contains 10 objects. Then we know that the power set $P(U)$ of the universe U contains 2^{10} subsets. Also, to calculate an operation to this large number of subsets (namely 1024 subsets) is very difficult and cumbersome. Imagine that you are looking for specific categories of recipes that have something to do or check and may require you to make some calculations dozens of times. In our example, search for all categories, which is investigating the following condition:

Table 1: The first output of our example

Selected Class	Selected Set	Working Set (X)
{}	{}	{}
{a}	{a,b,c,d,e,f,g,h,j}	{a}

{}	{}	{b}
{}	{}	{c}
{}	{}	{d}
{}	{}	{e}
{}	{}	{f}
{}	{}	{g}
{}	{}	{h}
{i}	{c,d,e,f,g,h,i,j}	{i}
{}	{}	{j}
{a,b}	{a,b,c,d,e,f,g,h,j}	{a,b}
{a,c}	{a,b,c,d,e,f,g,h,j}	{a,c}
{}	{}	{b,c}
{a,d}	{a,b,c,d,e,f,g,h,j}	{a,d}
{}	{}	{b,d}
{}	{}	{c,d}
{a,e}	{a,b,c,d,e,f,g,h,j}	{a,e}
{}	{}	{b,e}
{}	{}	{c,e}
{}	{}	{d,e}
{a,f}	{a,b,c,d,e,f,g,h,j}	{a,f}
{}	{}	{b,f}
{}	{}	{c,f}
{}	{}	{d,f}
{}	{c,d,e,f,g,h,i,j}	{b,c,d,e,f,h,i}
{a,b,c,e,g,h,i,j}	U	{a,b,c,e,g,h,i,j}
{a,b,d,e,g,h,i,j}	U	{a,b,d,e,g,h,i,j}
{a,c,d,e,g,h,i,j}	U	{a,c,d,e,g,h,i,j}
{}	{c,d,e,f,g,h,i,j}	{b,c,d,e,g,h,i,j}
{a,b,c,f,g,h,i,j}	U	{a,b,c,f,g,h,i,j}
{a,b,d,f,g,h,i,j}	U	{a,b,d,f,g,h,i,j}
{a,c,d,f,g,h,i,j}	U	{a,c,d,f,g,h,i,j}
{}	{c,d,e,f,g,h,i,j}	{b,c,d,f,g,h,i,j}
{a,b,e,f,g,h,i,j}	U	{a,b,e,f,g,h,i,j}
{a,c,e,f,g,h,i,j}	U	{a,c,e,f,g,h,i,j}
{}	{c,d,e,f,g,h,i,j}	{b,c,e,f,g,h,i,j}
{a,d,e,f,g,h,i,j}	U	{a,d,e,f,g,h,i,j}
{}	{c,d,e,f,g,h,i,j}	{b,d,e,f,g,h,i,j}
{c,d,e,f,g,h,i,j}	{c,d,e,f,g,h,i,j}	{c,d,e,f,g,h,i,j}
{a,b,c,d,e,f,g,h,i}	U	{a,b,c,d,e,f,g,h,i}
{a,b,c,d,e,f,g,h,j}	{a,b,c,d,e,f,g,h,j}	{a,b,c,d,e,f,g,h,j}
{a,b,c,d,e,f,g,i,j}	U	{a,b,c,d,e,f,g,i,j}
{a,b,c,d,e,f,h,i,j}	U	{a,b,c,d,e,f,h,i,j}
{a,b,c,d,e,g,h,i,j}	U	{a,b,c,d,e,g,h,i,j}
{a,b,c,d,f,g,h,i,j}	U	{a,b,c,d,f,g,h,i,j}
{a,b,c,e,f,g,h,i,j}	U	{a,b,c,e,f,g,h,i,j}
{a,b,d,e,f,g,h,i,j}	U	{a,b,d,e,f,g,h,i,j}
{a,c,d,e,f,g,h,i,j}	U	{a,c,d,e,f,g,h,i,j}
{}	{c,d,e,f,g,h,i,j}	{b,c,d,e,f,g,h,i,j}
U	U	U

$\forall X \in P(U), cl(\mathrm{int}(cl(\mathrm{int}(cl(\mathrm{int}(cl(\mathrm{int}(cl(\mathrm{int}(X)))))))))) \subset X$ with respect to the topology $\tau = \{U, \varphi, \{a\}, \{i\}, \{a,i\}, \{a,b,i\}, \{a,b\}\}$. It is not only a particular condition, but also there is flexibility to move the condition that you want at any stage during the implementation of the program. And output for the program be exported Excel file of the type required by the data. Below are the part of the output current in the case of our example.

Not only is this all that can be implemented in this stage but if it is found within the application of rough set theory. The program can calculate the upper approximation, lower approximation boundary region and exterior region for all classes using the pool from any other categories generated automatically using the program as well. Can be calculated at the same time the accuracy of approximation for each subset and see which groups have the highest accuracy, which can be sorted and re-use. See the output below:

Set	Lower(X)	Upper(X)
{}	{}	{}
{a}	{a}	{a,b}
{b}	{}	{b}
{c}	{}	{c}
{d}	{}	{d}
{e}	{}	{e}
{f}	{}	{f}
{g}	{}	{g}
{h}	{}	{h}
{i}	{i}	{i}
{j}	{}	{j}
{a,b}	{a,b}	{a,b}
{a,c}	{a,c}	{a,b,c}
{b,c}	{}	{b,c}
{e,f,h,i}	{i,e,f,h}	{e,f,h,i}
{a,g,h,i}	{a,i,g,h}	U
{b,g,h,i}	{i,g,h}	{b,g,h,i}
{b,d,f,g,i}	{i,d,f,g}	{b,d,f,g,i}
{c,d,f,g,i}	{i,c,d,f,g}	{c,d,f,g,i}
{a,e,f,g,i}	{a,i,e,f,g}	U
{b,d,e,f,g,h,i,j}	{i,d,e,f,g,h,j}	{b,d,e,f,g,h,i,j}
{c,d,e,f,g,h,i,j}	{i,c,d,e,f,g,h,j}	{c,d,e,f,g,h,i,j}
{a,b,c,d,e,f,g,h,i}	{a,i,b,c,d,e,f,g,h}	U
{a,b,c,d,e,f,g,h,j}	{a,b,c,d,e,f,g,h,j}	{a,b,c,d,e,f,g,h,j}
{a,b,c,d,e,f,g,i,j}	{a,i,b,c,d,e,f,g,j}	U
{a,b,c,d,e,f,h,i,j}	{a,i,b,c,d,e,f,h,j}	U
{a,b,c,d,e,g,h,i,j}	{a,i,b,c,d,e,g,h,j}	U
{a,b,c,d,f,g,h,i,j}	{a,i,b,c,d,f,g,h,j}	U
{a,b,c,e,f,g,h,i,j}	{a,i,b,c,e,f,g,h,j}	U
{a,b,d,e,f,g,h,i,j}	{a,i,b,d,e,f,g,h,j}	U
{a,c,d,e,f,g,h,i,j}	{a,i,c,d,e,f,g,h,j}	U
{b,c,d,e,f,g,h,i,j}	{i,c,d,e,f,g,h,j}	{b,c,d,e,f,g,h,i,j}
U	U	U

b(X)	ex(X)	Accuracy
{}	U	0
{b}	{c,d,e,f,g,h,i,j}	0.5
{b}	{a,c,d,e,f,g,h,i,j}	0
{c}	{a,b,d,e,f,g,h,i,j}	0
{d}	{a,b,c,e,f,g,h,i,j}	0
{e}	{a,b,c,d,f,g,h,i,j}	0
{f}	{a,b,c,d,e,g,h,i,j}	0
{g}	{a,b,c,d,e,f,h,i,j}	0

{h}	{a,b,c,d,e,f,g,i,j}	0
{}	{a,b,c,d,e,f,g,h,j}	1
{j}	{a,b,c,d,e,f,g,h,i}	0
{}	{c,d,e,f,g,h,i,j}	1
{b}	{d,e,f,g,h,i,j}	0.67
{b,c}	{a,d,e,f,g,h,i,j}	0
{}	{a,b,c,d,g,j}	1
{b,c,d,e,f,j}	{}	0.4
{b}	{a,c,d,e,f,j}	0.75
{b}	{a,c,e,h,j}	0.8
{}	{a,b,e,h,j}	1
{b,c,d,h,j}	{}	0.5
{b}	{a,c}	0.88
{}	{a,b}	1
{j}	{}	0.9
{}	{i}	1
{h}	{}	0.9
{g}	{}	0.9
{f}	{}	0.9
{e}	{}	0.9
{d}	{}	0.9
{c}	{}	0.9
{b}	{}	0.9
{b}	{a}	0.89
{}	{}	1

5. Conclusions

We draw in this research study all possible topological concepts using the computer programming. *TOPOLOGICA* is our first product for the application of such concepts in practical life such as data mining and others. I hope to be of such a program uses many useful when combined with the theory of rough sets or the theory of fuzzy sets.

Corresponding Author:
Dr. A. S. Salama
Department of Mathematics
Tanta University
Tanta, EGYPT
E-mail: geetakh@gmail.com

2/19/2014

References

1. M. E. Abd El-Monsef, S. N. El-Deeb and R. A. Mahmoud, β -open Mappings and β -continuous.mappings, Bull. Fac. Sci. Assiut Univ., 12(1983), 77-90.
2. D. Andrijevic, Semi-preopen sets, Mat. Vesnik, 38(1)(1986), 24-32.
3. P.Bhattacharya and B.K.Lahiri, Semi-generalized closed sets in topology, Indian J. Math., 29(3)(1987),375-382.
4. N.Biswas, On characterizations of semi-continuous functions, Atti. Accad. Naz. Lincei Rend. Cl. Sci. Fis. Mat. Natur., (8)48(1970), 399-402.
5. N.Levine, Semi-open sets and semi-continuity in topological spaces, Amer. Math. Monthly, 70(1963), 36-41.
6. N. Levine, Generalized closed sets in topology, Rend. Circ. Mat. Palermo, 19(2)(1970), 89-96.
7. Zhi Pei, Daowu Pei, Li Zheng, Topology vs generalized rough sets, International Journal of Approximate Reasoning 52 (2011) 231-239.
8. Zhi Pei, Daowu Pei, Li Zheng, Covering rough sets based on neighborhoods an approach without using neighborhoods, International Journal of Approximate Reasoning 52 (2011) 461-472.
9. Z. Pawlak, A. Skowron, Rough sets and Boolean reasoning, Information Sciences 177 (2007) 41–73.