A Review on Soft Topological Spaces

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ABSTRACT

During recent years, soft set theory emerged as a best mathematical tool to deal with uncertainties, imprecision and vagueness. Many engineering, medical science, economics, environment problems have various uncertainties and the soft set theory came up with the reasonable solutions to these problems. A soft set is a collection of approximate descriptions of objects. We present here a systematic survey of the literature and give the developments of Topological Spaces in soft set theory. We also provided some applications of soft set theory in software engineering, innovation, medical diagnosis, data analysis, decision making etc

Keywords
Soft Set, Soft Proximity, Soft Mappings, Soft Topological Spaces, Soft Bitopological Spaces etc

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Introduction

A large portion of our genuine technical challenges in life, and so forth deals with di_erent uncertainties. In 1999, Molodtsov [1] put forwarded a new concept of a soft set hypothesis, and it is a very new approach to uncertainty management. The nature of soft set theory helps to simplify the decision-making process. Any additional information about the data does not deviate the soft set theory from its decision.

The soft set theory was introduced by Molodtsov in numerous areas such as Probability Theory, Perron integration, Operation Research, Game Theory, Smoothness of Functions.

In this review article, a uni_ed study on soft set theory is presented. This will provide a common platform to understand the intial concepts and thereby enhancing further study and research in soft set theory. This paper gives discusses, advances on soft set theory in various dimensions and its applications in diverse _elds. Additionally, the present investigation o_ers the response of, "how, when and where soft sets have applicability?".

Literature Review

Soft Sets and its Operations

Molodtsov [1] gave the principal meaning of soft set and viewed Zadeh's Fuzzy set as a distinctive soft set; they gave the idea of family of open neighborhood as soft set in topological spaces and its uses in “Stability and Regulations, Game Theory, Operation Research and Soft Analysis”. In addition, P.Maji et al. [2] described its operations with appropriate examples as equality of two soft sets, subset, superset , complement of a soft set, null and absolute soft set, AND and OR operations, union and intersection alongside with the Demorgan's laws. Afterward, Y.Xia and L.Zuhua [24] reintroduced some of Maji's operations on soft sets, and gave some new operations like “Two soft sets product and anty-product, inverse, soft set image and preimage”.

F.Feng and Y.Li [35] conducted a comprehensive study of several kinds of soft subsets and their induced soft equal relationship; they also found soft sets dependent on ontology and gave soft product (∧-products and ∨-products), and showed that “soft L-equal relationships are relationships of congruence over free soft algebras”. The ideas of product, vector sum and scalar multiplication of soft sets over linear spaces were proposed by S.Roy and T.K.Samanta in [91].

M.Irfan Ali, Fu Li, A. Sezgin with others [3, 13, 64] obtained that a few assertions in Maji et al. [2] were not valid and presented several new notions like “complement, restricted and extended intersection, restricted union, restricted difference, restricted symmetric difference, distributive laws and De Morgan's laws of soft sets”, and established relationship between each other. X.Ge and S.Yang [28] investigated some operational rules given in [2] and [3], and obtained correct forms for these rules. I.A. Onyeozili and T.M. Gwary [63] reintroduced operations, relation, function and matrices on soft sets with their properties. N. Çağman [53] used a single parameter set for each soft set and made modifications in operations of soft sets. I.Deli and N. Çağman [86] defined two persons soft games, which can applied uncertain problems and gave four methods of solution.

N.Çağman and S.Enginoğlu [4] redefined the soft sets operations and developed a *uni-int* decision-making method by utilizing the union-intersection decision function for the ∧-products. In addition, they provided some new decision functions and built different groups of similar type decision-making methods by the similar way. F.Feng et al. [16] gave further extension in uni-int decision-making method. By using soft sets of choice value and k-satisfaction relationships, they provided the theory of uni-int decision-making and its limits. In addition, they developed *uni–int*^{k}, *uni-int*^t_s and *int*^{m}-*int*^{n} decision-making methods.

Soft Equalities and Soft Relations

They discussed the algebraic structure of soft sets in [5] and suggested the principle of soft equality, derived those characteristics and showed that soft equality is a relationship

of congruence and established algebra of soft quotient. M.Abbas et al. [130, 131] gave new concepts of "generalized soft equality (g-soft equality), generalized finite soft operations like equality, union and intersection (gf-soft equality, gf-soft union, gf-soft intersection resp.) of two soft sets". They also proved that "lower and upper soft equality of two soft sets imply g-soft equality but converse does not hold". Further, T.M.Al-shami [132] obtained that some results in [130, 131] need not be true and presented the conditions in which these results are true; they also analyzed gf -soft union (intersection) for arbitrary family of soft sets.

Soft set relations were introduced by Babitha and Sunil [7], and addressed several similar concepts including "equivalent soft set relation, partition, composition, function etc". Hai-Long Yang and Zhi-Lian Guo [14] focused on soft set relations and developed the ideas of different kernels and closures of soft set relations. Soft set relation mappings and inverse soft set relation mappings were also proposed and got several properties on it. In [36] Feng with others proposed the idea of soft binary relation with their properties and explained its application in semigroup theory. They also proved that "soft relationships of congruence over semigroups with a fixed parameter set form a lattice". Further, Babitha and Sunil [11] suggested "antisymmetric relation, transitive closure and ordering of a soft set", and demonstrated certain theoretical findings based on this. M.I.Ali [17] developed the idea of soft equivalence relation and studied "how we can minimize the number of parameters for a soft set without manipulating its original classification ability". Further, in [30] they concluded, "We can define a fuzzy subset for any subset of the universe in approximation space and we can define a fuzzy set for each parameter in a soft set". X.Xin, K.Zhu with others in [124, 123] introduced some congruence relations, rings and ideals with generalized forms. They also obtained one-to-one correspondence between these relations and ideals (resp. rings, hemirings).

The concept of a mapping on soft classes was developed by Kharal and Ahmad in [12] and some images properties and inverse images of soft sets were studied with examples. Additionally, these ideas have been incorporated in medical expert systems. In [56], they gave the concept of new classes of soft sets with some properties and analyzed the concepts of "soft closure (resp. interior, boundary, continuity, open and closed maps) with the soft homeomorphism in soft topological spaces".

Soft Mappings

In [6], soft mappings were given and, with their use in medical diagnosis, "image and Inverse images of crisp and soft sets under soft mappings" were analyzed. In [37], Aras with others presented soft continuous mappings and suggested soft open and closed mappings, soft homeomorphism with several properties. In [72], characterizations of "soft continuity, openness and closedness of soft mappings" were introduced; they also established "soft separation axioms, open and closed mappings". In [83], Riaz proposed the several measures in soft mappings, and their positive and negative parts were analyzed; they also defined soft probability measure with its applications to soft σ-algebra. D.Wardowski [40] gave the concept of soft element of a soft set and developed its relationship in topological spaces with soft operations and soft objects, and then used the soft element to describe "a soft mapping that transforms a soft set into a soft set". S.Mondal with others in [126] presented soft mapping and continuous soft mapping in a different way with established Urysohn's lemma and Tietze's extension theorem in topological space.

Soft Topological Spaces and Groups

N. Çağman, S.Enginoğlu with others in [9, 78], described the soft topology on a soft set. Further in [8], Shabir presented soft topological spaces and explored the concepts of some different kinds of soft sets (resp. open, closed), soft points (resp. closure, interior, neighborhood) and soft separation axioms. Moreover, they added soft subspaces and characterization of open and closed sets in these subspaces. At last, "soft T_1-spaces (resp. normal and regular spaces)" also examined. A.H.Kocaman and N.Tozlu [122] presented "soft locally closed sets and soft LC-continuous functions with some decomposition of soft continuity and soft A-continuity". N.DemİrtaŞ and Z.G.Ergül [139] proposed the idea of soft locally b-closed sets and soft locally b-continuous functions. N.Tozlu and Ş.Yüksel [129] proposed the ideas of "soft A-sets and soft B-sets", and described their relationships with each other and other soft open sets; they also gave soft A-continuous and soft B-continuous function. Z.G.Ergul and N.Tozlu [127] proposed the ideas of "soft semi-regular sets, soft AB and αAB-sets, soft AB and αAB-continuous function". N.Demirtaş and O.DalkiIic [140] presented the terms of soft αA-set (αB-set, αC-set and αLC-set) and soft αA-continuity (αB-continuity, αC-continuity and αLC-continuity) in soft topological spaces. M.Chiney and S.K.Samanta [94] presented soft topology in a different way; they also gave certain basic properties of this new topology. A.Vadiveland and E.Elavarasan [92] introduced the concepts of regular semiopen (semiclosed) soft sets, soft regular semi continuous (open and closed) functions, soft regular semi homeomorphism and soft regular semi C-homeomorphism in soft topological spaces. W.K.Min [27] considered certain results in [8] to be wrong, and then examined the properties of soft separation axioms in [8] and demonstrating that "if a soft topological space is soft T1 and regular space, then it is soft closed". Depending on the semi open soft sets, A.Kandil et al. [54] proposed new soft separation axioms and showed that "under the bijection and irresolute open soft mapping, the properties of soft semi Ti-spaces (i= 1,2) are soft topological properties, and the properties of being soft semi Ti-spaces (i= 1,2,3,4) are hereditary properties". O.Tantawy et al. [85] presented "separation axioms soft Ti (i=0,1,2,3,4,5) by utilizing soft points". Further, K.Kannan [18] proposed soft closed sets in generalized way (say soft g-closed set) and discussed their union and intersection. They also introduced a new soft separation axiom such as soft T1/2-space, soft T0-space and soft T1-space with its basic properties. A.R.Prasannan and J.Biswas [134] introduced certain new soft separation axioms and showed that these axioms are stronger than the exisiting separation axioms. Q.H.Hamko with others in [141] proposed the notions of soft pc-Ti and soft pc-Ti*, i=0,1,2. J.Subhashinin and C.Sekar [52] gave a detailed

study of "soft pre generalized-closed and open set, soft pre generalized interior and closure, and soft P $T_{1/2}$-Space". S.Yüksel with others in [49] introduced soft regular generalized closed and open sets. A.Kalavathi and G.S.S.Krishnan [95] proposed "soft g* closed (resp. open) sets, soft g* closure (resp. interior) operator and soft g*Ti (i=0,1/2,1,2) and regular spaces". Kannan and Rajalakshmi [74] proposed the notions of "soft semi generalized, generalized semi, semi star generalized closed sets (say resp. soft sg, gs, s*g-closed sets), and soft s*g-compact space" with their relationship. A.Kandil with others in [48] gave "supra generalized closed soft sets (say supra g-closed soft set) in a supra topological space" with the details of their properties. With respect to a soft ideal, they also introduced "supra g-closed soft sets (say supra-Ĩg-closed soft sets)". Further, Z.G.Ergül and Ş.Yüksel [87] presented the notion of "supra regular generalized closed (open) soft sets with the same way". In [84], they proposed soft separation axioms and relationship between these axioms with their important properties. Afterward, in [89] they proposed these soft supra closed sets in strongly generalized form and say soft supra strongly g-closed sets, and provide their relations to other soft sets; they also gave union and intersection between them and their application in real life situation. In [100], they proposed soft supra strongly Ĩg-closed sets and examined their relationship to other soft sets; they also gave union and intersection between them, and justify their application in real life situations. In [47], they proposed the concepts of "supra soft topological spaces and presented several ideas like supra pre α, and semi-continuous soft functions", and provided a supra α-continuous mapping between soft topological spaces. They in [77], proposed the idea of "supra semi star generalized closed soft sets (say supra semi*g-closed soft sets)". C.G.Aras [117] gave the concepts of "intuitionistic fuzzy soft supra topological space, intuitionistic fuzzy soft supra closure (interior), fuzzy strongly soft supra connected space, fuzzy soft supra continuous mapping and intuitionistic fuzzy soft supra compact space".

A.Kandil with others in [88] provided the notion of "generalized pairwise closed soft sets (gp-closed soft sets)". They also gave several separation axioms like $PST^*_{1/2}$ and PSR*0 with characterization of these axioms. Latif and R.A.Hosny [75] provided properties of the soft β-separation axioms. Aditionally, under the bijection and irresolute open soft mapping, they showed that "soft β-Ti-spaces (i=1,2) have soft topological properties", under the bijection, irresolute soft and irresolute open soft functions "soft β-regular (resp. β-normal) spaces have soft topological properties", and "soft β-Ti-spaces (i=1,2,3,4) have hereditary properties". H.S.Al-Saadi and W.K.Min [111] proposed the concepts of "soft generalized ω-closed set (gω-closed set), soft ω-$T_{1/2}$-spaces with a soft weak structure". S.A.Ghour and W.Hamed [142] gave soft and strongly soft ω-open sets, and described their relationship with ω-open sets.

J.Mahanta and P.K.Das [26] presented semiopen and semiclosed soft sets. They also developed soft functions such as irresolute, semicontinuous and semiopen soft functions. B.Chen [43] reintroduced the concepts given in [8]. N.Xie [73, 42] proposed the notions of "soft points and semi-neighborhoods of these points, soft semi first-countable spaces, soft semi-pu-continuous at soft point and soft semiconnectedness". They also showed translation of soft sets into soft point sets. His study in soft semi-open (resp. closed) sets were continued by Sabir Hussain in [57], and introduced "soft semi-interior (resp. exterior, closure), soft semi-boundary and soft semi-open neighborhood systems". G.Şenel [112, 113] presented soft point in a different way and compared it with the definition of soft point made before; they also proposed soft matrix for soft points for each set of parameters.

Some significant results on soft interior, soft exterior etc. in soft topological spaces were identified by B.Ahmad and S.Hussain in [22]. E.Peyghan et al. [25] developed the ideas of "soft connectedness, soft locally connectedness and soft product spaces". Babitha and John [105] introduced the concepts of "soft continuous functions and soft product topology"; they also gave "soft homeomorphism, soft subbasis, soft connectedness, soft compactness and separation axioms". S.Hussain, I. Zorlutuna with others in [10, 19] continued this analysis of the properties of soft open (resp. closed, neighborhood, closure etc.), and provided connection between topologies of soft and fuzzy sets. D.N.Georgiou et al. [34] introduced new concepts and their results such as "separation axioms, convergence, Cartesian product, soft θ-topology and continuity".

A.Acikgoz N.A.Tas [76] proposed the notions of R-closed, A_R-, αAN_1-, αAN_2-, αNA_1-, αNA_2-, αNA_3-, αNA_4- and αNA5- soft sets and soft continuities. X.Chen [39] proposed soft set in L-set theory and gave several operators for it. G.Şenel [116] presented a soft topological space by using L-soft sets and new restricted and extended intersection on these sets.

G.Ilango and M.Ravindran [32] proposed "soft preopen (resp. preclosed, dense, preclosure, preinterior) sets, soft point and soft submaximal", and built a soft topology by utilizing soft preopen sets. Further, M.Akdag and A.Ozkan [59] presented the characteristics of these preopen (resp. preclosed) sets and invented "soft preclosure (resp. preinterior), soft preregular (resp. prenormal, P_3-, P_4-) spaces" in soft topological spaces.

M.Akdag and A.Ozkan [58] proposed the terms of soft β-interior (resp. closure) soft set; they also investigated soft β-continuous functions and their relations. Further, in [45] they introduced soft b-open sets and explored their relationships among "soft α-open (resp. semi-open, pre-open and β-open) sets". Moreover, they established "soft b-open (resp. b-continuous) functions". Further, A.Kandil with others in [46] presented the concepts of "γ-operation and several kinds of open soft sets". They also proposed the notions of "pre-soft (resp. β-soft) continuous functions", and built "an α-soft continuous mapping between two soft topological spaces". In [70], they gave the characteristics of "supra b-open (resp. closed, interior, closure) soft sets, class of supra b-open sets, supra b-continuous (resp. open and closed) soft functions", and studied several properties on them. In [67], they presented b-open soft sets and providing the relations of several soft continuities in a diagram. In [90], Latif studied connectedness on these sets and gave their application; they also introduced b-irresolute soft functions. Afterward, depending on these sets, S.A.El-Sheikh in [79] with others proposed new soft separation axioms, and analyzed that "soft b-Ti-spaces (i=1,2) have

soft topological properties and soft b-Ti-spaces (i=1,2,3,4) have hereditary properties". In [144], they proposed the concept of supra soft b-separation axioms and examined their relationship among these axioms. Y.Yumak and A.K.Kaymakci [71] proposed the concepts of "soft β-open (resp. closed, interior, closure) sets". In addition, they presented "soft β-continuity, soft β-irresolute and soft β-homeomorphism". In [29], they introduced "soft gβ (resp. gsβ) closed sets" over an initial universe.

The concepts of "soft filters, ultra soft filters with soft ideal and their bases" were developed by J.H.Park, R.Sahin with others in [115, 38], and produced there basic properties. They also presented adherence and convergence on these filters. H.Zhang and M.Luo [135] provided the "generator" of int-soft filters and introduced the concept of t-int-soft filters with their basic properties and characteristics.

A.Aygünoğlu and H.Aygün [21] described "soft topological spaces, soft product topology and soft continuity of soft mappings", and examined characteristics of these projection mappings. Moreover, they defined "soft compactness, theorems of generalized Alexander subbase and Tychonoff". Further, H.Hazra with others [20] provided "soft topology and soft subsets topology". They also gave continuity of soft mappings in these topologies. F.Lin [44] proposed several new concepts like "soft closed (resp. open) mappings, soft connected (resp. paracompact) spaces". A.Kandil with others in [50] invented the concept of connectedness with soft ideals to soft topological spaces, and established "$\star$-soft connected (resp. separated) sets and $\star_s$-soft connected sets". Afterward in [51], they gave the concepts of "soft ideals, compatible soft ideals and soft local function" to find a new soft topology i.e. $\star$-soft topology. Soft I-regularity and normality was given by Guler and Kale in [80]; they also obtained relationship between them. Further, A.Kandil et al. [55, 68, 69] proposed new concepts of compactness based on soft ideal". In addition, they gave "soft regular (resp. normal) spaces and several different soft functions of irresolute type. Moreover, by utilizing soft ideals they invented several kinds of open and semi-open soft sets with continuous and pre-continuous soft functions alongwith their topological properties.

N.Tozlu et al. [125] gave new concepts of soft α*-set, soft C-set and provide their relationship with other soft sets; they also provide soft C-continuous function and their relationship with other soft continuous functions. O.R.Sayed and N.Hassan [109] invented "soft t- (t*-, B-, α̃*- and C-) sets". T.Y.Ozturk and S.Bayramov [62] proposed soft compact set and with the help of this, they established soft compact-open topology in functional spaces.

Nazmul and Samanta [23] have focused on soft topological groups, developed soft topological soft groups and its subsystem and morphisms, and studied their properties. In [33] the concepts of "soft element, soft interior element, soft limiting element, soft neighborhood operator, soft closure operator etc." also discussed and their properties analyzed in the neighborhood system. M.K.Tahat with others in [121] presented the concepts of "soft groups, rings, homomorphism and isomorphism in these soft topological groups" with their subsystem.

W.Rong [66] introduced different kinds of spaces like "soft first-countable (resp. second-countable, separable and Lindelof) spaces". M.Milan [107] showed that "any soft topological space is homeomorphic to a topological space on E□U". M.Terepeta [110] proved that "topologies on soft sets are not equivalent to the topologies on universe set" and introduced relationship of similarity. C.G.Aras and S.Bayramov [128] gave "Uryshon's Lemma and Tietze Extension Theorem".

Soft Bitopological Spaces

B.M.Ittanagi [96] developed the idea of soft bitopological spaces; they also gave separation axioms like "soft T_0, pairwise soft T_1 and T_2 spaces" in it. G.Şenel and N.Çağman [97] added the notions of "soft closed (resp. α-closed, semi-closed, pre-closed, regular soft closed, g-closed and sg-closed) sets". In [81], Kandil with others proposed the concepts of "pairwise open (resp. closed, λ-closed, ∧-)) soft sets, pairwise soft interior and closure operator". A.Kandil et al. [93] gave some soft separation axioms like softness, pairwise soft T_0^*, T_1^*, T_2^* and R_1^*, with their properties. In [106], they proposed the ideas of "pairwise soft sub kernel and pairwise ∨-soft sets"; they also presented "generalized pairwise ∧-soft sets, generalized pairwise ∨-soft sets and soft closure operator" on family of it. S.M.Khalil and N.M.Ali Abbas [133] presented new classes of soft closed sets in topological and bitopological spaces.

P.Mukherjee and C.Park [99] invented the idea of fuzzy soft bitopological spaces; they also proposed "τ_I and $\tau_1\tau_2$-fuzzy soft open and closed sets, "τ_I and $\tau_1\tau_2$-fuzzy soft closure and interior, τ_i-fuzzy soft base for i=1,2". A.F.Sayed [101] proposed the concepts of kernel operator and Alexandroff fuzzy soft topology in these space. Additionally, they gave the concepts of "$\tau_1\tau_2$-Λ-fuzzy soft sets and $\tau_1\tau_2$-λ-fuzzy soft closed sets", and built an Alexandroff fuzzy soft topology by utilizing the family of $\tau_1\tau_2$-Λ-fuzzy soft sets. In [102], Sayed introduced several separation axioms like pairwise fuzzy soft T_i-spaces; (i=0,1,2) of fuzzy soft bitopological space.

G.Şenel [82] proposed the idea of soft bitopological Hausdorff space and gave several notions of "soft bitopological point, soft bitopological continuous function and soft bitopological homeomorphism". D.Sasikala et al. [103] provided soft W-Hausdorff space in three different ways. A.M.Khattak with others in [143] gave "soft limit point, soft interior point and soft neighborhood", and relationship between soft weak structures and soft weak closures; they also studied soft sequences uniqueness of limit in soft weak-Hausdorff spaces and product of soft Hausdorff spaces.

Soft Bigeneralized Topoloical Spaces

J.Thomas and S.J.John [119] provided the generalized form of a soft topological spaces; they also defined some related notions like soft basis, subspace soft generalized topology, soft μ-interior (closure, neighborhood, limit point, boundary and exterior) and soft continuity of soft functions. T.Y. Öztürk with others in [118] proposed the idea of soft bigeneralized topological spaces and gave some definitions of different kinds of soft sets, soft basis and soft neighborhood on the soft bigeneralized topological spaces.

C.G.Aras et al. [120] obtained "soft generalized continuity, soft generalized open and closed mapping and soft generalized homeomorphism".

Soft Hausdorff Spaces (SHS) and Soft Tychonoff Spaces (STS)

In [31], Varol and Aygün proposed convergence of sequences and homeomorphism, and explored the relationship in soft topological space between these concepts and Hausdorff axiom. A.Kandil with others in [65] presented the concepts of "quasi-Ĩ-open sets, quasi-Ĩ-closed soft sets, quasi-Ĩ-soft interior and closure", and studied relationship between them; they also proposed "soft semi Hausdorff spaces via soft ideals and semi-Ĩ-irresolute soft functions".
Soft strongly (resp. generality) open functions were given by S.Mahmood in [114]; they also examined "soft semi Hausdorff spaces, soft countable semi H-closed spaces and soft sequentially semi H-closed spaces".
S.Mahmood [115] gave the concept of STS and discussed some new spaces like soft PR-T_3, soft SCR-T_3, soft PN-T_4, soft SCN-T_5, soft S^2CR-T_3, soft SPR-T_3, soft SPN-T_4 and soft S^2CN-T_5, and provided their relationship and properties.

Soft Proximity and Soft Fuzzy Proximity

H.Hazra et al. [60, 61] gave the concept of soft proximity, Lodato soft proximities, soft proximal continuity and soft proximal neighborhood, and established topologies of soft sets by utilizing Kuratowski closure operators of soft sets. R.Singh and A.K.Umrao [138] presented the idea of d-proximity in soft universe and developed an approach by utilizing O0 (φ, D) and O (φ, D) operators; they also gave detailed study on k, t and d-proximity.
V.Çetkin et al. [98] proposed the notions of "soft fuzzy proximity, modified version of Katsaras soft fuzzy proximity and relationship between them"; they also built a complete lattice on a given set constitutes with the help of family of all soft fuzzy proximities.

Soft Sets on Nearness Approximation Spaces

In [104], they applied soft sets to near set theory and introduce some new notions of "soft nearness approximation spaces, soft lower and upper approximation" with their properties. H.Tasbozan et al. [108] combined near set theory and soft set theory to present near soft sets. R.Singh and A.K.Umrao [136] proposed the idea of nearness of finite order, S_n-merotopy in soft set theory. Again in [137], they presented heminearness spaces in soft set theory, and provide the relationship between categories of heminearness and soft binary heminearness spaces.
The relationship among "soft sets, Soft Rough Sets and topologies" were analyzed in [41], and combined soft sets with topologies to introduce the idea of topological soft sets and their properties; they also announced "every topological space built a soft approximation space on the initial universe".

Work by Kandil and others in soft topological spaces

Topology is an important and valuable discipline of mathematics. It would have several connections between other fields of science and mathematical models. Now a days, many scientists have researching and improving the soft set theory. One of these scientists is Kandil, and since 2014, Kandil has done a number of studies in soft topology with others. They provided new classes, pre-open classes (resp. α-open, semi-open and β-open) soft sets in [46], and consolodated these classes through the use of γ-operator in 2014. Some pre-continuous soft functions were also given by them. In [51], the definition of soft ideals in soft set theory, soft local functions and some new soft topologies from the original topology were given. They first provided supra soft topological spaces (X, μ, E) and then supra generalized closed soft sets in these supra topological spaces in [48]. In [55, 69], they presented this notion of soft topological spaces with soft ideals and their implications in different fields. Lin started the definition of connectedness in soft topological spaces, but in 2014 Kandil gave connectedness to soft topological spaces with ideals. Min provided some soft separation axioms and Kandil in [54] continued his study and gave some new and more specific separation axioms than open soft sets depending on the semi open soft sets. They introduced soft regular (normal) spaces with its several properties in 2015, on the basis of these semi open soft sets and soft ideals. Further, they continued fuzzy soft topological spaces and provide several characteristics of fuzzy soft semi connected (resp. separated and s-connected) sets with some examples. They also provided several sets in soft semi (quasi) Hausdorff spaces via soft ideals. In 2017, Kandil et al. [81, 93, 106] gave a few soft separation axioms in terms of pairwise softness in the soft bitopological spaces. They also studied the implications of these axioms in soft and crisp cases. Ittanagi provided the idea of a soft bitopological space but Kandil with others in [88] gave several structures of soft bitopological space (X, , η_1, η_2, E) and introduced few new classes in these spaces.

Applications of soft sets theory:

S. No.	Papers Title	Authors	Application	Publications
1.	"A novel approach to fuzzy soft sets in decision making based on grey relational analysis and MYCIN certainty factor"	"Ningxin Xie, Yu Han, Zhaowen Li"	Medical Diagnosis	International journal of computational Intelligence Systems
2.	"Soft Interval-Valued Intuitionistic Fuzzy Rough Sets"	"Mukherjee A."	Multi-criterian group decision making	Studies in Fuzziness and Soft Computing
3.	"A novel soft spatial weights matrix method based on soft sets"	"Xianning Wang, Zhi Xiao"	Model regional industrial agglomeration	Int. J. Applied Decision Sciences
4.	"Fuzzy soft expert system in prediction of coronary artery disease"	"Hassan N., Sayed O.R., Khalil A.M. and Ghany M.A."	Coronary artery disease	International journal of fuzzy systems
5.	"Integrating soft set theory and fuzzy linguistic model to evaluate the performance of training simulation systems"	"Chang K.H., Chang Y.C., Chain K., Chung H.Y."	Training simulation systems	PLOS| one
6.	"Soft decision making methods based on fuzzy sets and soft sets"	"Aktas H., Cagman N."	Decision making	Journal of Intelligent & Fuzzy Systems
7.	"Soft fuzzy rough set-based MR brain image segmentation"	"Namburu A., Samay S.K., Edara S.R."	MR brain image segmentation	Aplied Soft Computing
8.	"Soft set based association rule mining"	"Feng F., Cho J., Pedrycz W., Fujita H., Herawan T."	Data Mining	Knowledge-Based Systems
9.	"A Social Coice approach to graded soft sets"	"Fatimah F., Rosadi D., Hakim RB., Alcantud R."	Social choice	IEEE
10.	"Soft sets based symbiotic organisms search algorithm for resource discovery in cloud computing environment"	"Ezugwu A.E., Adewumi A.O."	Symbiotic organisms search	Future Generation Computer Systems
11.	"Soft failure mode and effects analysis using the OWG operator and hesitant fuzzy linguistic term sets"	"Chang K.H., Wen T.C., Chung H.Y."	Reliability Engineering	Journal of Intelligent & Fuzzy Systems
12.	"The relationship between soft sets and fuzzy sets and its application"	"Liu Z., Alcantud R., Qin K. and Pei Z."	Pattern Recognition	Journal of Intelligent & Fuzzy Systems
13.	"A new expert system in prediction of lung cancer disease based on fuzzy soft sets"	"Khalil A.M., Li S.G., Lin Y., Li H.X., Ma S.G."	Lung cancer disease	Soft Computing
14.	"An approach to evaluating sustainable supply chain risk management based on BWM and linguistic value soft set theory"	"Zhang X., Sun B., Chen X., Chu X., Yang J."	Supply chain management	Journal of Intelligent & Fuzzy Systems
15.	"Integrating the 2-tuple linguistic representation and soft set to solve supplier selection problems with incomplete information"	"Wen T.C., Chang K.H., Lai H.H."	Supply chain management	Engineering applications of artificial intelligence
16.	"Soft trees with neural components as image-processing technique for archeological excavations"	"Wozniak M., Polap D."	Image-processing	Personal and Ubiquitous Computing

Conclusion

The present paper provides a rigorous and vast survey of the research conducted in Soft Set Theory. Almost all aspect of soft set theory is considered from the year 1999 till date. Various theories proposed and different applications and techniques proposed till date is considered in detail. Soft sets have been studied in proximity spaces, multicriterion decision-making problems, medical problems, mobile cloud computing network, defence learning system, approximate reasoning etc. From this survey, we can infer that there is still lack of application of soft sets in approximate reasoning.

References

[1] Modotsov D., Soft set theory- first results, Comput. and Math. with App., 37 (1999) 19-31.

[2] Maji P.K., Biswas R. and Roy A.R., Soft set theory, Comput. and Math. with App., 45 (2003) 555-562.

[3] Ali M.I., Feng F., Liub X., Minc W.K. and Shabir M., On some new operations in soft set theory, Computers & Mathematics with Applications, 57 (9) (2009) 1547-1553.

[4] Çağman N. and EnginoğluS., Soft set theory and uni-int decision making, European Journal of Operational Research, 207 (2010) 848–855.

[5] Qin K. and Hon Z., On soft equality, Computers Math. Appl. 234 (2010) 1347-1355.

[6] Majumdar P. and Samanta S.K., On soft mappings, Computers & Mathematics with Applications, 60 (9) (2010) 2666-2672.

[7] Babitha K.V. and Sunil J.J., Soft set relations and functions, Computers and Mathematics with Applications, 60 (7) (2010) 1840-1849.

[8] Shabir M. and Naz M., On soft topological spaces, Computers and Mathematics with Applications, 61 (7) (2011) 1786-1799.

[9] Çağman N., Çitak F. & Enginoğlu S., Soft topology,Computers & Mathematics with Applications, 62 (1) (2011) 351-358.

[10] Hussain S. and Ahmad B., Some properties of soft topological spaces, Computers and Mathematics with Applications, 62 (11) (2011) 4058-4067.

[11] Babitha K.V. and Sunil J.J., Transitive closures and orderings on soft sets, Computers and Mathematics with Applications, 62 (5) (2011) 2235-2239.

[12] Kharal A. and Ahmad B., Mappings on soft classes, New Mathematics and Natural Computation, 07 (03) (2011) 471-481.

[13] Li F., Notes on the soft operations, ARPN Journal of Systems and Software, 1 (6) (2011) 205-208.

[14] Yang H.L. and Guo Z.L., Kernels and closures of soft set relations and soft set relation mappings, Computers and Mathematics Appllications, 61 (2011) 651-662.

[15] Park J.H., Park Y.B. and Kwun Y.C., Filterness of soft sets, Journal of Korean Institute of Intelligent Systems, 21 (6) (2011) 781–785.

[16] Feng F., Li Y. and Çağman N., Generalized uni–int decision making schemes based on choice value soft sets, European Journal of Operational Research, 220 (1) (2012), 162-170.

[17] Ali M.I., Another view on reduction of parameters in soft sets, Applied Soft Computing, 12 (6) (2012) 1814-1821.

[18] K. Kannan, Soft generalized closed sets in soft topological spaces, Journal of Theoretical and Applied Information Technology, 37 (1) (2012) 17-21.

[19] Zorlutuna I., Akdag M., Min W.K. and Atmaca S., Remarks on soft topological spaces, Annals of Fuzzy Mathematics and Informatics, 3 (2) (2012)171- 185.

[20] Hazra H., Majumdar P. and Samanta S.K., Soft topology, Fuzzy Information Engineering, 4 (2012) 105–115, https://doi.org/10.1007/s12543-012-0104-2.

[21] Aygünoğlu A. and Aygün H., Some notes on soft topological spaces, Neural Comput and Applic, (21) (2012) 113–119, https://doi.org/10.1007/s00521-011-0722-3.

[22] Ahmad B. and Hussain S., On some structures of soft topology, Mathematical Sciences, 6 (64) (2012), https://doi.org/10.1186/2251-7456-6-64.

[23] Nazmul S. and Samanta S.K., Soft topological soft groups, Math Sci, 6 (66) (2012), https://doi.org/10.1186/2251-7456-6-66.

[24] Xia Y. and Zuhua L., Some new operations of soft sets, 2nd International Conference on Uncertainty Reasoning and Knowledge Engineering, Jalarta, IEEE, (2012) DOI: 10.1109/URKE.2012.6319569.

[25] Peyghan E., Samadi B. and Tayebi A., On Soft connectedness, (2012), arXiv: 1202.1668 [math.GN].

[26] Mahanta J. and Das P.K., On Soft topological space via semiopen and semiclosed soft sets, arXiv:1203.4133v1, (2012), [Math.GN]

[27] Min W.K., A note on soft topological spaces, Computer and Mathematics with Applications, 62 (2011) 3524-3528.

[28] Ge X. and Yang S., Investigations on some operations of soft sets, World Academy of Science, Engineering and Teechnology, 75 (2011) 1112-1115.

[29] Arockiarani I. and Lancy A.A., Generalized soft gβ closed sets and soft gsβ closed sets in soft topological paces, International Journal of Mathematical Archive, 4 (2) (2013) 17-23.

[30] Ali M.I., A Note on soft sets, rough soft sets and fuzzy soft sets, Computers and Mathematics with Applications, 11 (2011) 3329-3332.

[31] Varol B.P. and Aygün H., On soft Hausdorff spaces, Annals of Fuzzy Mathematics and Informatics, 5 (1) (2013) 15–24.

[32] Ilango G. and Ravindran M., On Soft preopen sets in soft topological spaces, International Journal of Mathematics Research. 5 (4) (2013) 399-409.

[33] Nazmul S.K. and Samanta S. K., Neighbourhood properties of soft topological spaces, Annals of Fuzzy Mathematics and Informatics, 6 (1) (2013) 1–15.

[34] Georgiou1 D.N., Megaritis A.C. and Petropoulos V.I., On Soft Topological Spaces, Appl. Math. Inf. Sci., 7 (5) (2013) 1889-1901.

[35] Feng F. and Li Y., Soft subsets and soft product operations, Information Sciences, (2013), https://doi.org/10.1016/j.ins.2013.01.001.

[36] Feng, F., Ali M.I. and Shabir M., Soft Relations Applied to Semigroups, Filomat, 27 (7) (2013) 1183–1196.

[37] Aras C.G., Sonmez A. and Çakalli H., On Soft Mappings, (2013), arXiv:1305.4545v1 [math.GM].

[38] Şahin R., Kucuk A., Soft filters and their convergence properties, Annals of Fuzzy Mathematics and Informatics, 6 (3) (2013) 529–543.

[39] Chen X., Rough soft sets in fuzzy setting, ICSI, Lecture Notes in Computer Science, 7928 (2013) 530-539.

[40] Wardowski D., On a soft mapping and its fixed points, Fixed Point Theory and Applications, 182 (2013), https://doi.org/10.1186/1687-1812-2013-182.

[41] Li Z. and Xie T., The Relationship among soft sets, soft rough sets and topologies, Soft Computation, (2013) DOI 10.1007/s00500-013-1108-5.

[42] Chen B., Some local properties of soft semi-open sets, Discrete Dynamics in Nature and Society, (2013), http://dx.doi.org/10.1155/2013/298032.

[43] Chen B., Soft semi-open sets and related properties in soft topological spaces, Appl. Math. Inf. Sci., 7 (1) (2013) 287-294.

[44] Li F., Soft connected spaces and soft paracompact spaces, International Journal of Mathematical and Computational Sciences, 7 (2) (2013) 277-283.

[45] Akdag M.and Ozkan A., Soft b -Open Sets and Soft b-Continuous Functions, (2014),

https://doi.org/10.1007/s40096-014-0124-7.

[46] Kandil A., Tantawy O.A.E., El-Sheikh S.A. and Abd El-latif A.M., γ-operation and decompositions of some forms of soft continuity in soft topological spaces, Annals of Fuzzy Mathematics and Informatics, 7 (2) (2014) 181-196.

[47] El-Sheikh S.A. and Abd El-latif A.M., Decompositions of Some Types of Supra Soft Sets and Soft Continuity, International Journal of Mathematics Trends and Technology, 9(1) (2014) 37-56.

[48] [48] Kandil A., Tantawy O.A.E., El-Sheikh S.A. and Abd El-latif A.M., Supra generalized closed soft sets with respect to an soft ideal in supra soft topological spaces, Appl. Math. Inf. Sci., 8 (4) (2014) 1731-1740.

[49] Yüksel Ş., Tozlu N., Ergül Z.G., Soft regular generalized closed sets in soft topological spaces, Int. Journal of Math. Analysis, 8 (8) (2014) 355-367.

[50] Kandil A., Tantawy O.A.E., El-Sheikh S.A. and Abd El-latif A.M., Soft connectedness via soft ideals, Journal of New Results in Science, 4 (2014) 90-108.

[51] Kandil A., Tantawy O.A.E., El-Sheikh S.A. and Abd El-latif A.M., Soft ideal theory soft local function and generated soft topological spaces, Appl. Math. Inf. Sci., 8 (4) (2014)1595-1603.

[52] Subhashinin J. and Sekar C., Soft pre generalized - closed sets in a soft topological space, International Journal of Engineering Trends and Technology, 12 (2014) 356-364.

[53] Çağman N., Contributions to the theory of soft sets, Journal of New Results in Science, 3 (2014) 33-41.

[54] Kandil A., Tantawy O.A.E., El-Sheikh S.A. and Abd El-latif A.M., Soft semi separation axioms and some types of soft functions, Annals of Fuzzy Mathematics and Informatics, 8 (2) (2014) 305-318.

[55] Kandil A., Tantawy O.A., El-Sheikh S.A. and El-Latif A.A., Soft semi compactness via soft ideals, Appl. Math. Inf. Sci., 8 (5) (2014) 2297-2306.

[56] Georgiou D. N. and Megaritis A.C., Soft set theory and topology, Appl. Gen. Topol., 15(1) (2014) 93-109.

[57] Hussain S., Properties of soft semi-open and soft semi-closed sets, Pensee Journal, 76 (2) (2014) 133-143.

[58] Akdag M. and Ozkan A., On Soft β-Open Sets and Soft β-Continuous Functions, The Scientific World Journal, (2014), https://doi.org/10.1155/2014/843456.

[59] Akdag M. and Ozkan A., On Soft preopen sets and soft pre separation axioms, Gazi University Journal of Science, 27 (4) (2014) 1077-1083.

[60] Hazra H., Majumdar P. and Samanta S.K., Soft proximity, Annals of Fuzzy Mathematics and Informatics Volume, 7 (6) (2014) 867-877.

[61] Hazra H., Majumdar P. and Samanta S. K., Proximity of soft sets, Annals of Fuzzy Mathematics and Informatics Volume 8 (1) (2014) 113-123.

[62] Ozturk T.Y. and Bayramov S., Soft mappings Space, The Scientific World Journal, (2014), https://doi.org/10.1155/2014/ 307292.

[63] Onyeozili I.A. and Gwary T.M., A Study of the fundamentals of soft set theory, International Journal of Scientific & Technology Research, 3 (4) (2014) 132-143.

[64] Sezgin A. and AtagünA.O., On Operations of soft sets, Computers and Mathematics with Applications, 61 (2011) 1457-1467.

[65] Kandil A., Tantawy O.A.E., El-Sheikh S.A. and Abd El-latif A.M., Soft semi (quasi) Hausdorff spaces via soft ideals, South Asian Journal of Mathematics, 4 (6) (2014) 265-284.

[66] Rong W., The Countabilities of soft topological spaces, International Journal of Mathematical, Computational, Physical,

Electrical and Computer Engineering, 6 (8) (2012) 952-955.

[67] El-Sheikh S.A. and El-Latif A.M., Characterization of b-open soft sets in soft topological spaces, Journal of New Theory, 2 (2015) 8-18.

[68] Kandil A., Tantawy O.A.E., El-Sheikh S.A. and Abd El-latif A.M., Soft regularity and normality based on semi open soft sets and soft ideals, Appl. Math. Inf. Sci. Lett., 3 (2) (2015) 47-55.

[69] [69] Kandil A., Tantawy O.A.E., El-Sheikh S.A. and ABD El-Latif A.M., γ-operation and decompositions of some forms of soft continuity of soft topological spaces via soft ideals, Annals of Fuzzy Mathematics and Informatics, 9 (3) (2015) 385–402.

[70] Abd El-latif A. M. and Karatas S., Supra b-open soft sets and supra b-soft continuity on soft topological spaces, Journal of Mathematics and Computer Applications Research, 5 (1) (2015) 1-18.

[71] Yumak Y., Kaymakci A.K., Soft, β-open sets and their applications, Journal of New Theory, 4 (2015) 80-89.

[72] Zorlutuna I. and Cakır H., On continuity of soft mappings, Appl. Math. Inf. Sci., 9 (1) (2015) 403-409.

[73] Xie N., Soft points and the structure of soft topological spaces, Annals of Fuzzy Mathematics and Informatics, 10 (2) (2015) 309–322.

[74] Kannan K. and Rajalakshmi D., Soft semi star generalized closed sets, Malaysian Journal of Mathematical Sciences, 9 (1) (2015) 77-89.

[75] El-Latif A.M.Abd, Hosny R.A., On soft separation axioms via β-open soft sets, South Asian Journal of Mathematics, 5 (6) (2015) 252-264.

[76] Acikgoz A. and Tas N.A., Some new soft sets and decompositions of some soft continuities, Annals of Fuzzy Mathematics and Informatics, 9 (1) (2015) 23–35.

[77] El-latif A. M. Abd, Supra semi* generalized closed soft sets, Annals of Fuzzy Mathematics and Informatics, 10 (6) (2015) 995Enginoğlu S., Çağman N., Karataş S. and Aydm T., On Soft topology, El-Cezerî Journal of Science and Engineering, 2 (3) (2015) 23-38.

[78] El-Sheikh S.A., Hosny R.A. and Abd El-latif A.M., Characterizations of b-Soft Separation Axioms in Soft Topological Spaces, Inf. Sci. Lett., 4 (3) (2015) 125-133.

[79] Guler A.C. and Kale G., Regularity and normality on soft ideal topological spaces, Annals of Fuzzy Mathematics and Informatics, 9 (3) (2015) 373–383.

[80] Kandil A., Tantawy O.A.E., El-Sheikh S. A., and Hazza S.A., Pairwise open (closed) soft sets in soft bitopological spaces, Annals of Fuzzy Mathematics and Informatics, 11 4 (2016) 571-588.

[81] Şenel G., A New approach to hausdorff space theory via the soft sets, Mathematical Problems in Engineering, (2016), https://doi.org/10.1155/2016/2196743.

[82] Riaz M. and Naeem K., Measurable soft mappings, Punjab University Journal of Mathematics, 48 (2) (2016) 19-34.

[83] El-Latif A. M. Abd and Hosny R.A., Supra semi open soft sets and associated soft separation axioms, Appl. Math. Inf. Sci., 10 (6) (2016) 2207-2215.

[84] Tantawy O., El-Sheikh S.A., Hamde S., Separation axioms on soft topological spaces, Annals of Fuzzy Mathematics and Informatics, 11 (4) (2016) 511–525.

[85] Deli I. and Çağman N., Application of soft sets in decision making based on game theory, Annals of Fuzzy Mathematics andInformatics, 11 (3) (2016) 425–438.

[86] Ergül Z.G. and Yüksel Ş., Supra regular generalized closed soft sets in supra soft topological spaces, Annals of Fuzzy Mathematics and Informatics, 11 (3) (2016) 349–360.

[87] Kandil A., Tantawy O.A.E., El-Sheikh S.A. and Hazza S.A., Generalized pairwise closed soft sets and the associate pairwise

soft separation axioms, South Asian Journal of Mathematics, 6 (2) (2016) 43-57.

[88] Abd El-latif A.M., Soft supra strongly generalized closed sets, Journal of Intelligent & Fuzzy Systems, 31 (2016) 1311–1317.

[89] Abd El-latif A.M., A Soft connected properties and irresolute soft functions based on b-open soft sets, FACTA UNIVERSITATIS (NIS), Ser. Math. Inform., 31 (5) (2016) 947-967.

[90] Roy S. and Samanta T.K., Some properties of vector sum and scalar multiplication of soft sets over a linear space, Annals of Fuzzy Mathematics and Informatics, Volume 12, No. 3, (2016), pp. 351–359.

[91] Vadivel A. and Elavarasan A., Regular semiopen soft sets and maps in soft topological spaces, Annals of Fuzzy Mathematics and Informatics, 12 (6) (2016) 877-891.

[92] Kandil A., O.A.E. Tantawy, S. A. El-Sheikh, Shawqi A. Hazza, Pairwise soft separation axioms in soft bitopological spaces, Annals of Fuzzy Mathematics and Informatics, Volume 13, No. 5, (2017), pp. 563–x577.

[93] Moumita Chiney and S.K. Samanta, Soft topology redefined, 2016, arXiv: 1701.00466v1.

[94] A. Kalavathi &G. Sai Sundara Krishnan, Soft g* closed and soft g*open sets in soft topological spaces, Journal of Interdisciplinary Mathematics, Volume 19, 2016, Issue 1, Pages 65-82.

[95] Ittanagi B.M., Soft bitopological spaces, International Journal of Computer Applications, 107 (7) (2014) 1Şenel G. and Çağman N., Soft closed sets on soft bitopological space, Journal of New Results in Science, 5 (2014) 57-66.

[96] Çetkin V., Šostak A.P. and Aygün H., An Approach to the Concept of Soft Fuzzy Proximity, Abstract and Applied Analysis, Volume 2014, Article ID 782583, 9 pages.

[97] Mukherjee P. and Park C., On fuzzy soft Bitopological spaces, Mathematics and Computer Sciences Journal (MCSJ), Vol. 10 | No. 7 | Jul 2015.

[98] Abd El-latif A.M. and Karataş S., Soft Supra strongly generalized closed sets via soft ideals, Appl. Math. Inf. Sci. Lett., 5 (1) (2015), 21-26.

[99] Sayed A.F., On Characterizations of Some Types of Fuzzy Soft Sets in Fuzzy Soft Bitopological Spaces, Journal of Advances in Mathematics and Computer Science, 24(3) (2017) 1-12.

[100] Sayed A.F., Some separation axioms in fuzzy soft bitopological spaces, J. Math. Comput. Sci. 8 (2018), No. 1, 28-45.

[101] Sasikala D., Vijayalakshmi V.M. and Kalaichelvi A., W-Hausdorffness in soft bitopological spaces, International Journal of Mathematics Trends and Technology (IJMTT), 43 (3) (2017) 242-245.

[102] Öztürk M.A. and İnan E., Soft Nearness Approximation Spaces, Fundamenta Informaticae 124 (2013) 231–250.

[103] Babitha K.V. and John J., Studies on soft topological spaces, Journal of Intelligent & Fuzzy Systems 28 (2015) 1713–1722.

[104] Kandil A., Tantawy O.A.E., El-Sheikh S.A. and Hazza S.A., Some types of pairwise soft sets and the associated soft topologies, Journal of Intelligent & Fuzzy Systems, 2016, DOI:10.3233/JIFS-16180.

[105] Milan M., Soft topological space and topology on the Cartesian product, Hacettepe Journal of Mathematics and Statistics, Volume 45 (4) (2016), 1091 _ 1100.

[106] Tasbozan H., Icen I., Bagirmaz N. and Ozcan A.F., Sets and Soft Topology on Nearness Approximation Spaces, Faculty of Sciences and Mathematics, Filomat 31:13 (2017), 4117-4125.

[107] [109] Sayed O.R., Hassan N. and Khalil A.M., A decomposition of soft continuity in soft topological spaces, Afr. Mat., 2017, DOI 10.1007/s13370-017-0494-8.

[108] Terepeta M., On separating axioms and similarity of soft topological spaces, Soft Comput, 2017, DOI 10.1007/s00500-017-2824-z.

[109] Al-Saadi H.S. and Min W.K., On Soft Generalized Closed Sets in a Soft Topological Space with a Soft Weak Structure, International Journal of Fuzzy Logic and Intelligent Systems, Vol. 17, No. 4, December 2017, pp. 323-328.

[110] Şenel G., A Comparative Research on the Definition of soft point, International Journal of Computer Applications, 163 (2) (2017) 1-4.

[111] Şenel G., The Parameterization Reduction of Soft Point and its Applications with Soft Matrix, International Journal of Computer Applications, Volume 164 - No.1, 2017, 1-6.

[112] Mahmood S., Soft Sequentially Absolutely Closed Spaces, International Journal of Applications of Fuzzy Sets and Artificial Intelligence, Vol. 7 (2017), 73-92.

[113] Mahmood S., Tychonoff Spaces in Soft Setting and their Basic Properties, International Journal of Applications of Fuzzy Sets and Artificial Intelligence, Vol. 7 (2017), 93- 112.

[114] Şenel G., Soft Topology Generated by L-Soft Sets, Journal of New Theory, 24 (2018) 88-100.

[115] Aras C.G., A Study on intuitionistic fuzzy soft supra topological spaces, Proceedings of the Institute of Mathematics and Mechanics, National Academy of Sciences of Azerbaijan, Volume 44, Number 2, 2018, Pages 187-197.

[116] Öztürk T.Y., Aras C.G. and Yolcu A., Soft Bigeneralized Topological Spaces, Faculty of Sciences and Mathematics, Filomat 32:16 (2018), 5679–5690.

[117] Thomas J. and John S.J., On soft generalized topological spaces, Journal of New Results in Science, 4(2014) 1-15.

[118] Aras C.G., Yolcu A. and Öztürk T.Y., A Study on soft generalized continuity in soft bigeneralized topological spaces, Journal of Mathematical Analysis, Volume 9 Issue 5, 2018, Pages 106-118.

[119] Tahat M.K., Sidky F. and Abo-Elhamayel M., Soft topological soft groups and soft rings, Soft Computing, (2018) 22:7143–7156.

[120] Kocaman A.H. and Tozlu N., Soft locally closed sets and decompositions of soft continuity, Annals of Fuzzy Mathematics and Informatics, 11 (2) (2016) 173-181.

[121] Zhu K. and Zhan J., A study on soft Z-congruence relations over hemirings, Journal of Intelligent & Fuzzy Systems, 30 (2016) 467–474.

[122] Xin X. and Li W., Soft congruence relations over rings, Scientific World Journal, (2014) http://dx.doi.org/10.1155/2014/541630.

[123] Tozlu N., Yüksel Ş. and Ergül Z.G., Soft C-sets and a decomposition of soft continuity in soft topological spaces, International Journal of Mathematics Trends and Technology, 16 (1) (2014) 58-69.

[124] Mondal S., Chiney M. and Samanta S.K., Urysohn's lemma and Tietze's extension theoremin soft topology, Annals of Fuzzy Mathematics and Informatics,

[125] Ergul Z.G. and Tozlu N., Decompositions of soft continuity and soft AB-continuity, Annals of Fuzzy Mathematics and Informatics, 14 (5) (2017) 463-474.

[126] Aras G.C. and Bayramov S., On the Tietze extension theorem in soft topological spaces, Proceedings of the

Institute of Mathematics and Mechanics, 2017.

[127] Tozlu N. and Yüksel Ş., Soft A-sets and Soft B-sets in Soft Topological Spaces,Mathematical Sciences And Applications E-Notes, 5 (2) (2017) 17-25.

[128] Abbas M., Ali B. and Romaguera S., On Generalized soft equality and soft lattice structure, Filomat, 28 (6) (2014) 1191-1203, DOI 10.2298/FIL1406191A.

[129] Abbas M., Ali M. I. and Romaguera S., Generalized operations in soft set theory via relaxed conditions on parameters, Filomat, 31 (19) (2017) 5955–5964, https://doi.org/10.2298/FIL1719955A.

[130] Al-Shami T.M., Investigation and corrigendum to some results related to g-soft equality and gf-soft equality relations, Filomat, 33 (11) (2019) 3375–3383, https://doi.org/10.2298/FIL1911375A.

[131] Khalil S.M. and Abbas N.M.A., New classes of soft closed sets in bi-topological spaces, International Journal of Applications of Fuzzy Sets and Artificial Intelligence, 9 (2019) 109 – 117.

[132] Prasannan A.R. and Biswas J., New separation axioms in soft topological space, Annals of Fuzzy Mathematics and Informatics, 18 (1) (2019) 75-91.

[133] Zhang H. and Luo M., The "Generator" of Int-Soft Filters on Residuated Lattices, Mathematics, 7 (236) (2019), DOI: 10.3390/math7030236.

[134] Singh R. and Umrao A.K., On Finite order nearness in soft set theory, WSEAS TRANSACTIONS on MATHEMATICS, 18 (2019) 118-122.

[135] Singh R. and Chauhan R., On Soft heminearness spaces, Emerging Trends in Mathematical Sciences and its Applications, AIP Conf. Proc. 2061, 020016-1–020016-5; 2019, https://doi.org/10.1063/1.5086638.

[136] Singh R. and Umrao A.K., A Study on soft **d**-proximity, Jour of Adv Research in Dynamical & Control Systems, 10 (05) (2018) 1911-1914.

[137] Demirtaş N. and Ergül Z.G., Decomposition of soft continuity via soft locally b-closed set, Commun. Fac. Sci. Univ. Ank., Ser. A1 Math. Stat., 69 (1) (2020) 547-559.

[138] DemirtaşN. and DalkiIic O., Decompositions of soft α-continuity and soft A-continuity, Journal of New Theory, 31 (2020) 86-94.

[139] Hamko Q.H., Ahmed N.K. and Khalaf A.B., On Soft pc-separation axioms, De Gruyter, 53 (2020) 67-79.

[140] Ghour S.A. and Hamed W., On Two classes of soft sets in soft topological spaces, Symmetry, 12 (2020) 265, DOI: 10.3390/sym12020265.

[141] Khattak A.M., Zamir M., Alam M., Nadeem F., Jabeen S. and Zaighum A., Weak soft open sets in soft bi topological spaces, Journal of Mathematical Extension, 14 (1) (2020), 85-116.

[142] EL-Latif A.M. and Hosny R.A., Supra soft separation axioms and supra irresoluteness based on supra b-soft sets, Gazi University Journal of Science, 29 (4) (2016) 845-854.