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Application of Graph Theory in New Aarea of Real Life

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ABSTRACT :GraphtheoryisanimportantareaofAppliedMathematicswithabroadspectrumofapplications in many fields. In the Call for Papers for this issue, I asked for submissions presenting new and inoovative approaches for traditional graph-theoretic problems as well as for new applications of graph theory in emerging fields, such as network security, computer science and data analysis, bioinformatics,operationsresearch,engineeringandmanufacturing,physicsandchemistry,linguistics, or socialsciences.

I. INTRODUCTION:

InresponsetotheCallforPapers,wehadanenormousresonance,andaltogether151submissions have been received among which finally 20 papers have been accepted for this special issue, all of which are of high quality, reflecting the great interest in the area of Graph Theory. This corresponds to an acceptance rate of 13.2%. The authors of these accepted publications come from 13 different countries:USA,China,Pakistan,India,Iran,Marocco, Slovenia,UnitedArabEmirates,Oman,Spain, Mexico, Serbia, and Belarus, where most authors are from the first twocountries.

All submissions have been reviewed, as a rule, by at least three experts in the field of Graph Theory. Subsequently, all published papers in this special issue are briefly surveyed in increasing order of their publication dates. We hope that the readers will find interesting theoretical ideas in this special issue and that researchers will find new inspirations for future works. Since also for my previous special issue 'Discrete Optimization: Theory, Algorithms, and Applications' a lot of graph-theoretic works have been submitted, I would like to remind the readership on the follow-up issue'NovelApproachesforDiscreteOptimizationProblems'withasubmissiondeadlineofMay31, 2020, where also works related to graphs and networks are mentioned in the Call forPapers.

II. LITEURE SURVEY

The first accepted paper by Tilley [1] is related to the 4-color theorem which has been proven by showing that a minimal counterexample does not exist. Here the author proves that a minimum counterexamplemustalsosatisfyaparticularcoloringpropertywhichhedenotesasKempe–Locking.

However, the main intention of this paper is not an alternative proof of the 4-color theorem but an exploratory paper aimed at gaining a deeper understanding of why the 4-color theorem is true and a new approach to understand why planar graphs are 4-colorable by investigating whether the connectivity and coloring properties arecompatible. Janetal. [5]dealwithfuzzygraphs. Thegoalofthispaperistoshowthattherearesome serious flaws in the existing definitions of several root-level generalized fuzzy graph structures with the help of some counterexamples. To achieve this, first, we aim to improve the existing definition for interval-valued fuzzy graphs, interval-valued intuitionistic fuzzy graphs and their complements. Theauthorsalsopointoutthatasingle-valuedneutrosophicgraphisnotwelldefinedintheliterature by illustrative examples and present then a new definition and an application of such graphs in decisionmaking.

Xu et al. [8] deal with a particular topological index, namely with the distance degree index introduced by Dobrynin and Kochetova [9]. Topological indices can be used, e.g., for predicting physical, chemical, or pharmaceutical properties of organic molecules and chemical compounds. Theauthorsderiveexpressionsforthedistancedegreeindexforavarietyofgraphs,namelyforaline graph, a subdivision graph, a vertex-semitotal graph, an edge-semitotal graph, a total graph, and a paralinegraph.

Liu et al. [10] consider the normalized Laplacian which plays an important role when studying thestructuralpropertiesofnon-regularnetworks.TheydeterminethenormalizedLaplacianspectrum ofalinearheptagonalnetworkbyadecompositiontheoremforthenormalizedLaplacianmatrixand elementaryoperations.Inaddition,theauthorsderiveexplicitformulasforthedegree-Kirchhoffindex and the number of spanning trees with respect to a linear heptagonal network. Here the authors use the relationships between the roots andcoefficients.

Wang et al. [11] consider another distance-

based topological index, namely the Padmakar-Ivan (PI) index. They obtain results for this index from trees to recursively clustered trees, the so-called k-trees.Moreover,tightupperboundsofsuchindicesfork-treesareobtainedbyrecursiverelationships, and also the corresponding extremal graphs are given. In addition, the PI values of some classes of k-trees are derived andcompared.

Liu et al. [12] deal with several topological indices. In particular, they derive expressions for reformulated Zagreb indices of some derived graphs, such as the complement graph, the line graph, the subdivision graph, the edge-semitotal graph, the vertex-semitotal graph, the total graph and the paraline graph of a graph.

Liuetal.[13]usetheedgeisoperimetricproblemtodeterminetheexactwirelengthsofembedding an enhanced hypercube into windmill and necklace graphs by partitioning the edge set of the host graph. The results obtained in this paper may have a great impact on parallel computingsystems.

Yang et al. [14] consider the subtree problem of so-called fan graphs, wheel graphs and also graphsobtainedfrompartitioningwheelgraphsunderdynamicevolution.Theenumerationofthese subtree numbers is done through so-called subtree generation functions of graphs. In particular, they study extremal graphs, subtree fitting problems and subtreedensitiy behaviors of the graphs underconsideration.

Huangetal.[15]dealwiththeideaofregularity inneutrosophicgraphtheory.Theydescribethe utility of a regular neutrosophic graph and a bipartite neutrosophic graph to model an assignment problem, a road transport network, and a social network. Neutrosophic graphs are a useful concept to cope with uncertainty resulting from the inconsistent or indeterminate information in real-world problems. In particular, a regular neutrosophic graph, a star neutrosophic graph, a regular complete neutrosophicgraph,acompletebipartiteneutrosophic graphandaregularstrongneutrosophicgraph are introduced. The authors prove some properties of these graphs. Moreover, the concept of an m-highlyirregularneutrosophicgraphoncycleandpathgraphsisintroduced.Thedefinitionofbusy and free nodes in a regular neutrosophic graph is also presented. In addition, some properties of complement and isomorphic regular neutrosophic graphs are alsogiven.

Hui et al. [16] derive necessary and sufficient conditions for the graph join of a cycle with m vertices and a path with n vertices to be induced matching-extendable and bipartite-matching extendable,respectively. AgraphGiscalledinducedmatchingextendable,ifeveryinducedmatching inthisgraphisincludedinaperfectmatchingofG.Similarly,agraphisbipartitematchingextendable ifeverybipartitematchingisincludedinaperfectmatching.Thepaperfinisheswithsomesuggestions for future work, e.g., to investigate the relationships between k-extendable and forbidden subgraphs of agraph.

Falcon et al. [17] derive some results on graph theory in the context of molecular processes occurringduringtheS-phaseofamitoticcellcycle.Afterpresentingsomebasic conceptsongenetics, genetic algebras, evolution algebras, graph theory, and isotopisms of algebras, they introduce a total-coloredgraphthatcanbeassociatedwithanygivenevolutionalgebraoverafinitefield.Finally, theexistenceofafaithfulfunctorbetweenbothconsideredcategoriesofevolutionalgebrasandtheir total-colored graphs isshown.

Carbollosa et al. [18] introduce the f -index and the f -polynomial of a graph. Using this polynomial of several topological indices, they study relations, e.g., of the inverse degree index, the generalized first Zagreb index, and sum lordeg indices. They obtain inequalities involving the f-polynomialofmanygraphoperationsincludingthecoronaproductgraph,thejoingraph,andline .De la Senet al. [19] consider so-called (s − q)-graphic contraction mappings in b-metriclikeMarappan et al. [20] deal with the asymptotic analysis of severalevolutionaryoperators(mutationsandcrossovers)forfindingthechromaticnumberofagraphwhichistheminimumnumberofcolorsnecessarytocolorthevertic esofagraphsuchthatnoadjacentverticeshavethesamecolor. The selection of an appropriate operator has a great influence on finding good boundsforthechromaticnumberaswellasontheachievementofafasterconvergencewithasmallerpopulationsize.Inadditio n,necessaryandsufficientconditionsfortheglobalconvergenceofevolutionaryalgorithmshavebeenderived . Finally,thestochasticconvergenceofsomerecentlysuggestedevolutionary operators is investigated.

Worawannotai et al. [21] consider particular domination games. Such a game is played by two players,namelythedominatorandthestaller,whichalternativelychooseverticesuntilallverticesare dominated. They study a version of a domination game, where the set of chosen vertices is always independent. This game turns out to be a competition-independence game, which is played by a Diminisher and a Sweller, who want to construct a maximal independent set M: however, while the Diminishertriestominimize|M|,theSwellerwishestomaximize|M|.Inthispaper,theauthorscheck

whethersomewell-knownresultsfordominationgamesalsoholdforsuchcompetition-independence games and describe a family of graphs for which many parameters areequal.

Sotskov [22] gives a detailed review about mixed graph colorings in relation to scheduling problems with minimizing the makespan. Such a mixed graph contains both directed arcs and undirected edges.

III. CONCLUSION:

Here the author presents known results for two types of vertex colorings, referring to the chromatic number and the strict chromatic number of a graph, respectively, and he also reviews the complexity of these problems. Then he discusses in detail how the results for mixed graph colorings can be used for job shop scheduling problems with unit processing times as well as general shop schedulingproblems.Furtherseparatesectionsdealwithcoloringsofarcsandedgesofamixedgraph as well as with non-strict colorings of a mixedgraph.

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