

Foreword

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The focus of this special issue of *Mathematics in Computer Science* is near set theory and applications.¹ The study of various forms of nearness relations in proximity space theory and the penultimate notions of *near* and *far* in topology² span over 100 years, starting with an address by F. Riesz at the 1908 ICM congress in Rome.³

Basically, two types of near sets are represented in this issue, namely, spatially near sets and, more recently, descriptively near sets. Classical, spatially near sets (nonempty sets are near provided their closures have a non-empty intersection in some compactification) were introduced by F. Riesz and elaborated on by a host of researchers such as E. Čech⁴ (1936–1939 Brno seminar), V. Efremovič (1951), J.M. Smirnov (1951), S. Leader (1959), S.A. Naimpally (1970) and his students, W.J. Thron (1973), H. Herrlich (1974), and others, continuing to the present.⁵

Descriptively near sets (pairs of either disjoint or non-disjoint nonempty sets that resemble each other) were inspired by correspondence between J.F. Peters and Z. Pawlak⁶ in 2002, collaboration between J.F. Peters,

¹ An overview of the theory and applications of proximity space-based near sets is given in J.F. Peters and S.A. Naimpally, Applications of near sets, Notices of the Am. Math. Soc., 59(4), 2012, 536–542.

² See, e.g., S.A. Naimpally and J.F. Peters, Topology with Applications. Topological Spaces Via Near and Far, World Scientific, 2013.

³ See, e.g., S.A. Naimpally, Near and far. A centennial tribute to Frigyes Riesz, Siberian Electronic Math. Reports 2, 2005, 144–153.

⁴ For details, see E. Čech, Topological Spaces, ed. by Z. Frolik and M. Katětov, Wiley, London, 1966.

⁵ See, e.g., S.A. Naimpally, Proximity Approach to Problems in Topology and Analysis, Oldenbourg, Munich, 2009, and A. Di Concilio, Proximity, a powerful tool in extension theory, function spaces, hyperspaces, Boolean algebras and point-free geometry, in Contemporary Mathematics, ed. by F. Mynard and E. Pearl, Am. Math. Soc., RI, 2009, 89–114.

⁶ Reflected in a philosophical poem: Jak Blisko (How Near), Systemy Wspomagania I, 2007, 57.

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A. Skowron, and J. Stepaniuk,⁷ in 2006, and formally introduced by J.F. Peters⁸ in 2007. The early work on descriptively near sets has been augmented, thanks to the collaboration between J.F. Peters, S.A. Naimpally, S. Tiwari, C.J. Henry, F. Fashandi and A.H. Meghdadi.⁹ The early preoccupation with an applied view of descriptively near sets has led to topological and proximity space foundations of such sets in recent years. From the beginning, descriptively near sets have proved to be useful in digital image analysis and pattern recognition, spanning a broad spectrum of applications that include camouflage detection, micropalaeontology, handwriting forgery detection, biomedical image analysis, content-based image retrieval, population dynamics, quotient topology, textile design, visual merchandising, and topological psychology. Remarkably, near set theory has led to the recent discovery of near groups by E. Inan and M.A. Ozturk¹⁰ in 2012.

In the course of development of near set theory, recent extensions of classical proximity nearness relations reflect a growing perception of the connections between descriptively near sets and traditional proximity space theory and this has contributed greatly to the growth of the theory, leading to a number of novel approaches in a variety of applications in computer science as well as in science and engineering. The discovery of descriptively near sets has made it possible for researchers to bring to life very abstract topological structures such as merotopic or approach spaces, providing the place where formerly purely mathematical concepts have been given a real-life content. This specific view of near set theory as a general framework has proved to be very fruitful in both theoretical and practical aspects, which, we hope, is demonstrated by this special issue.

The articles included in the issue reflect the above roots and history of near set theory. Doungrat Chitcharoen and Sheela Ramanna introduce a new form of Pawlak flow graphs within the framework of near set theory. Anna Di Concilio addresses the role of nearness (proximity) in point-free geometry, providing an extension of this framework to a very important area of research. Homa Fashandi brings some preliminary results about the nearness of covering uniformities and its application to image analysis. Christopher Henry introduces a metric defined by means of neighbourhoods to measure nearness between digital images. Sheela Ramanna and Christopher Henry offer a signature based approach along with its applications to the problem of perceptual nearness of images. James Peters broadly covers the theoretical and practical role of local near sets in pattern discovery (in proximity spaces). Surabhi Tiwari introduces a concept of completeness and proves the Niemytzki-Tychonoff theorem for ϵ -approach nearness spaces. Lidong Wang, Xiaodong Liu, and Yashuang Mu combine global k-means clustering algorithms and AFS topological neighbourhoods to bring some improvement in the clustering problems. Marcin Wolski discusses methodological differences between near set theory and rough set theory within the category theory framework.

In order to make the issue self-contained, the articles are preceded by a tutorial about near set theory, entitled *Near Sets. An Introduction*, which should allow the reader to better understand and appreciate the content of this volume.

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⁷ See J.F. Peters, A. Skowron, and J. Stepaniuk, Nearness in approximation spaces, CS&P 2006, Humboldt Univ., 2006, 435–445.

⁸ J.F. Peters, Near sets. General theory about nearness of objects, Fund. Inform. 75(1–4), 2007, 407–433, and J.F. Peters, Near sets. General theory about nearness of objects. Applied Math. Sci., 1(53), 2007, 2609–2629.

⁹ For a recent overview of the descriptive approach to near sets, see C.J. Henry, Near Sets: Theory and Application, Ph.D. diss., supervisor: J.F. Peters, ECE Dept., Univ. of Manitoba, 2010. For recent work directly related to topics in this MCS special issue, see H. Fashandi, Topology Framework for Digital Image Analysis with Extended Interior and Closure Operators, Ph.D. diss., supervisor: J.F. Peters, ECE Dept., Univ. of Manitoba, 2012 and A.H. Meghdadi, Fuzzy Tolerance Neighbourhood Approach to Similarity in Content-Based Image Retrieval, Ph.D. diss., supervisor: J.F. Peters, ECE Dept., Univ. of Manitoba, 2012.

¹⁰ E. Inan and M.A. Öztürk, Near groups in nearness approximation spaces. Hacettepe J. of Math. and Stat. 41(4), 2012. *to appear*.