DIPARTIMENTO DI INGEGNERIA
CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE -
PHD COURSE IN INDUSTRIAL AND INFORMATION ENGINEERING - 36TH CYCLE

Title of the research activity:	Algorithm Engineering and Parameterized Complexity
State of the Art:	Numerous computational problems of wide interest are known to be NP-hard in general, that is, unless P=NP, there exists no polynomial-time algorithm to solve such problems for any input instance. This motivated a long-standing systematic research of tractability results for various problems on specific classes of instances, and research in this direction constitutes one of the fundamental areas of Computer Science. Yet, the kind of instances that make a problem hard is generally far from being frequent in real datasets. Indeed, it is often possible to utilize the structure implicitly underlying many real-world instances to find exact solutions efficiently. The relatively young *parameterized complexity* field offers new tools to deliver efficient algorithms to practitioners working in applications. In the parameterized setting, we associate each instance with a numerical parameter, which captures how structured the instance is. This then allows the design and engineering of algorithms whose performance strongly depends on the parameter. In other words, parameterized algorithms naturally scale with the amount of structure contained in the instance and are in fact often used to efficiently process real datasets. The parameterized complexity landscape also consists of a variety of companion notions such as XP-tractability, kernelization and W-hardness.
Short description and objectives of the research activity:	Among others, the parameterized complexity tools are profitably applied in the fields of computational geometry and graph drawing, which in turn play a key role in various application scenarios, such as, for instance, social network analysis, financial fraud detection, and network visualization. In this context, the main objectives of the research will be the development of new combinatorial characterizations for problems of interest, the design and engineering of algorithms to solve such problems, the development of systems to be adopted and evaluated by practitioners. Examples of problems of interest are linear layouts of graphs; constrained, hybrid and beyond planarity; geometric graph representations. The students will join the Computer Engineering research group of the Department and will be provided

	with an adequate travel budget to attend conferences and visit international collaborators. Moreover, we expect that part of the research will require a close collaboration with external companies and institutions.
Bibliography:	Sujoy Bhore, Robert Ganian, Fabrizio Montecchiani, Martin Nöllenburg: Parameterized Algorithms for Book Embedding Problems. GD 2019: 365-378 Emilio Di Giacomo, Giuseppe Liotta, Fabrizio Montecchiani: Sketched Representations and Orthogonal Planarity of Bounded Treewidth Graphs. GD 2019: 379-392 Walter Didimo, Luca Grilli, Giuseppe Liotta, Lorenzo Menconi, Fabrizio Montecchiani, Daniele Pagliuca: Combining Network Visualization and Data Mining for Tax Risk Assessment. IEEE Access 8: 16073-16086 (2020) Rodney G. Downey, Michael R. Fellows: Fundamentals of Parameterized Complexity. Texts in Computer Science, Springer 2013, ISBN 978-1-4471-5558-4, pp. I-SSS, 3-707 Jörg Flum, Martin Grohe: Parameterized Complexity Theory. Texts in Theoretical Computer Science. An EATCS Series, Springer 2006, ISBN 978-3-540-29952-3, pp. 1-495
Scientific coordinator (s)	Giuseppe Liotta, Fabrizio Montecchiani
Contact (s)	giuseppe.liotta@unipg.it fabrizio.montecchiani@unipg.it