

# Biomedical Technologies and Innovation Doctoral Programme (BIOTIN)



<b>Title of the PhD Project</b>	<b>Efficient community detection in biological networks</b>
<b>Acronym</b>	<b>BIODETECT</b>
<b>Research Fields of the Project</b>	Parallel computing, graph algorithms, bioengineering, tissue regeneration
<b>Keywords</b>	Community detection, GPU architecture, parallel software development, sequence-function relationship, molecular recognition
<b>Host Institution, Department and Campus Location</b>	Izmir Institute of Technology, Computer Engineering Department, Urla, Izmir
<b>PhD Awarding Institution and Graduate Programme</b>	Izmir Institute of Technology, Graduate School, PhD in Computer Engineering
<b>Name and Affiliation of Main Supervisor</b>	Asst. Prof. Işıl Öz (IZTECH)
<b>Name and Affiliation of Co-supervisors</b>	Asst. Prof. Deniz Tanıl Yücesoy, (IZTECH) Assoc. Prof. Ezgi Karaca, (IBG)
<b>Research Environment and Infrastructure (max. 300 words)</b>	<a href="#">PARS Research Group</a> in Computer Engineering Department at IZTECH, works on parallel program development on multicore/GPU architectures. With graduate and undergraduate students, we focus on the optimization and performance analysis of parallel systems. While our local infrastructures provide compute resources, we have access to European supercomputers within the scope of the European High-Performance Computing Joint Undertaking (EuroHPC JU).
<b>Scientific Context of the Project (max. 300 words)</b>	Reproducing the lost hard tissues (bone, tooth) using tissue-specific biomolecules has been a long-standing challenge. Rapidly expanding computational power and data analysis models offer tools for designing novel protein/peptide-based therapeutics by extracting the essential sequence-function relationship information, unprecedented just a few years ago. One of the key issues, however, is the difficulty of accessing powerful models that allow an analysis of the complex biological big data acquired from high-throughput experimentation. Community detection methods enable us to understand the structure of large and complex graphs representing different networks, including social networks, human cells, and protein-protein interactions. While current community detection algorithms improve the performance of the executions, very large networks consisting of a large amount of biological data, including biological units such as genes, proteins, individuals, or

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	<p>species, require further reduction in execution times to process complete graphs in reasonable times. Our project aims to design and develop efficient parallel community detection algorithms and implementations by accelerating target computations on multicore and GPU architectures. We will build both algorithmic and computational techniques utilizing parallel resources in target architectures. Hence, considering the biological data obtained from our collaborators, e.g., evolutionary selection of therapeutic peptides, virtual screening, and MD simulations, our design and implementation will process large graphs representing real biological networks. Our project will enable scientists working with large biological systems to discover the characteristics of networks efficiently. As part of this project, the development effort will open new directions to make our implementation available for various real-life problems.</p>
<p><b>Brief Workplan</b></p>	<p>0-12: Training/courses on parallel computing</p> <p>0-12: Literature search on community detection algorithms and optimizations</p> <p>12-24: Develop baseline implementation based on state-of-the-art algorithms</p> <p>24-30: Explore parallel optimization methods specific for graph processing</p> <p>30-40: Design computationally efficient algorithms</p> <p>40-60: Develop parallel implementations for the target algorithms</p> <p>50-60: Performance analysis on HPC centers</p>
<p><b>Innovative Aspects of the Project</b></p>	<p>BIODETECT will develop computationally efficient algorithms for solving community detection for large graphs representing biological networks. We will utilize efficient executions with large data for designing novel protein/peptide-based therapeutics and tissue generation.</p>
<p><b>Training Opportunities of the Project</b></p>	<p>The PhD student will attend <a href="#">PRACE</a> courses that are held both online and on-site. She/he will learn basic and advanced HPC concepts and apply the techniques to the project. Moreover, she/he will attend training schools in <a href="#">Hipeac</a> network and <a href="#">CERCIRAS</a> COST action, which the supervisor is part of. Additionally, the training activities during the sectoral visit will enable the development of soft skills.</p>
<p><b>Interdisciplinary Aspects</b></p>	<p>While the main target is to develop computationally efficient algorithms and performance-oriented techniques for the community detection problem, it is essential to solving the problem for biological networks presented by cosupervisors with bioengineering and bioinformatics backgrounds.</p>
<p><b>Intersectoral Mobility</b></p> <p><input checked="" type="checkbox"/> <b>Short Visit</b></p> <p><input type="checkbox"/> <b>Secondment</b></p>	<p><i>Host: Siemens Healthineers (TR)</i></p> <p><i>Context of Mobility: Innovation management, Entrepreneurship, Prototyping, IP rights, 3D modelling</i></p>

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<p><b>Intersectoral Mobility</b></p> <p><input checked="" type="checkbox"/> Short Visit</p> <p><input type="checkbox"/> Secondment</p>	<p><i>Host: Istanbul Health Industry Cluster (ISEK)</i></p> <p><i>Context of Mobility: Entrepreneurship Training, Thematic Pre-incubation Program</i></p>												
<p><b>International Academic Secondment - 1</b></p>	<p><i>Host Supervisor: Osman Ünsal</i></p> <p><i>Host Institution: Barcelona Supercomputing Center</i></p> <p><i>Host Department: Computer Sciences - Computer Architecture for Parallel Paradigms</i></p> <p><i>Duration: 6 months</i></p> <p><i>Estimated Time of Mobility: 2nd year of the PhD</i></p>												
<p><b>International Academic Secondment - 2</b></p>	<p><i>Host Supervisor: Marisa Gil</i></p> <p><i>Host Institution: Polytechnic University of Catalonia</i></p> <p><i>Host Department: Computer Architecture Department</i></p> <p><i>Duration: 6 months</i></p> <p><i>Estimated Time of Mobility: 3rd year of the PhD</i></p>												
<p><b>Main Supervisor</b></p>													
<p><b>Brief CV</b></p>	<p><b>Asst. Prof. Işıl Öz</b></p> <p>E-mail: <a href="mailto:isiloz@iyte.edu.tr">isiloz@iyte.edu.tr</a></p> <p><b>ACADEMIC DEGREES</b></p> <table border="0"> <tr> <td>Ph.D.</td> <td>Computer Engineering</td> <td>Boğaziçi University, Turkey</td> <td>2013</td> </tr> <tr> <td>M.Sc.</td> <td>Computer Engineering</td> <td>Marmara University, Turkey</td> <td>2008</td> </tr> <tr> <td>B.Sc.</td> <td>Computer Engineering</td> <td>Marmara University, Turkey</td> <td>2004</td> </tr> </table> <p>Google Scholar: <a href="https://scholar.google.com/citations?user=Jber3GMAAAAJ&amp;hl">https://scholar.google.com/citations?user=Jber3GMAAAAJ&amp;hl</a>  <a href="https://orcid.org/0000-0002-8310-1143">https://orcid.org/0000-0002-8310-1143</a></p>	Ph.D.	Computer Engineering	Boğaziçi University, Turkey	2013	M.Sc.	Computer Engineering	Marmara University, Turkey	2008	B.Sc.	Computer Engineering	Marmara University, Turkey	2004
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<p><b>Co-supervisors</b></p>													
<p><b>Brief CV</b></p>	<p><b>Asst. Prof. Deniz Yücesoy</b></p> <p>E-mail: <a href="mailto:denizyucesoy@iyte.edu.tr">denizyucesoy@iyte.edu.tr</a></p> <p><b>ACADEMIC DEGREES</b></p> <table border="0"> <tr> <td>Ph.D.</td> <td>Materials Science and Engineering</td> <td>University of Washington, US</td> <td>2018</td> </tr> <tr> <td>M.Sc.</td> <td>Materials Science and Engineering</td> <td>University of Washington, US</td> <td>2014</td> </tr> <tr> <td>B.Sc.</td> <td>Molecular Biology &amp; Genetics</td> <td>Izmir Institute of Technology</td> <td>2009</td> </tr> </table> <p>ResearchGate: <a href="https://www.researchgate.net/profile/Deniz-Yucesoy">https://www.researchgate.net/profile/Deniz-Yucesoy</a>  <a href="https://orcid.org/0000-0002-9590-3178">https://orcid.org/0000-0002-9590-3178</a></p>	Ph.D.	Materials Science and Engineering	University of Washington, US	2018	M.Sc.	Materials Science and Engineering	University of Washington, US	2014	B.Sc.	Molecular Biology & Genetics	Izmir Institute of Technology	2009
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