



Międzynarodowa Środowiskowa Szkoła Doktorska  
przy Centrum Studiów Polarnych  
w Uniwersytecie Śląskim w Katowicach

ul. Bedzińska 60  
41-200 Sosnowiec  
tel. +48 32 368 93 80  
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**Title of PhD project:** Topological characteristics of dynamics

**Providing institute:** Institute of Mathematics, Polish Academy of Sciences, Warsaw.

**Requirements:**

1. Completed second-degree studies (Master's degree) in Mathematics, Computer Science, or a related field. Knowledge of research topics related to topological data analysis and the theory of dynamical systems.
2. Knowledge of issues in the theory of dynamical systems, typical tools, and methods used in numerical analysis.
3. Proficiency in English allowing for communication, reading scientific papers, and writing them.

**Description of the tasks:**

1. Analysis of data from theoretical models (systems of differential and difference equations), agent-based models, and real data in terms of their qualitative behavior.
2. Acquisition, processing, and analysis of large medical data sets.
3. Preparation, organization, and conduct of research in collaboration with other members of the Dioscuri Center in Topological Data Analysis and collaborators from medical and engineering institutions.
4. Preparation of scientific articles and conference presentations;
5. Regular reporting of work progress;
6. Assistance with daily scientific and educational tasks of the unit.

**Summary of the doctoral project:**

Computational topology methods have proven highly effective in analyzing static data, including point clouds and functional data. They have successfully been used to analyze the shape of materials, properties of (one-dimensional) solutions to various numerical problems, and similar tasks. These methods are also used for model validation, anomaly detection, generalized statistical conformity tests, and many others. However, to date, topological methods have not been applied to the qualitative analysis of dynamic data (vector fields and trajectories instead of point clouds). This is due to the fact that topological methods are



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well-developed for the analysis of single-variable functions, but generalizing the theory to multi- variable functions is a highly non-trivial issue. Nevertheless, the current computational techniques being developed at the Dioscuri Center hold promise for generalizing topological methods so that they provide a certain type of invariants for vector fields.

**Other information:**

The work will be carried out under the supervision of: Paweł Dłotko, [pdlotko@impan.pl](mailto:pdlotko@impan.pl),  
Institute of Mathematics, Polish Academy of Sciences.

The Secretary of the IEDS Recruitment Committee: +48 32 3689 380, e-mail:

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Information on the IEDS admissions: <https://www.mssd.us.edu.pl/en/admission-2024-2025/>