Title of research:

Research Capacity in Topology based 3D Object Classification Methods (TOC)

Objectives:

- To identify key insights gained by Topological Data Analysis (TDA) in the 3D objects scan classifications, and its application to real world use case.
- Developing a knowledge base in TDA in BMW.
- Developing a Python based library for TDA tasks.

Please give a brief justification of your proposed research project:

The development of 3D data collections and 3D retrieval methods is rapidly increasing, due to the advances in 3D data generation and processing. There is no doubt that after text, sound, images and videos, 3D data explosion is happening.

This explosion of poses a serious question in index, querying and retrieval methods for 3D shapes. The application domains for BMW range from 3D parts classification in production, till 3D shapes classification in autonomous driving LIDAR space. TDA has proven to be particularly important in this the domain of 3D objects classification.

The proposal here is to investigate this methods and apply methods to production and/or autonomous driving use cases.

Domains of application that can benefit:

- Classification of objects in a sequence of Lidar space (in Autonomous Driving)
- Objects classification of 3D models of car parts for 3D printing (in Production)
- 3D data databases (Product)
- Search indexes (Service)

The hope of this research project would be:

- To develop a Library (in Python preferably) which BMW data scientist can use out of the box to apply 3D point-clouds segmentation.
- To apply TDA based 3D Shapes Characterization to autonomous driving related Lidar space and/or car parts 3D models.

1) Svensson S., Arcelli C., di Baja G.S. (2003) Characterising 3D Objects by Shape and Topology. In: Nyström I., Sanniti di Baja G., Svensson S. (eds) Discrete Geometry for Computer Imagery. DGCI 2003. Lecture Notes in Computer Science, vol 2886. Springer, Berlin, Heidelberg

   Available from: https://link.springer.com/chapter/10.1007/978-3-540-39966-7_11 [Accessed 3 June 2018]

2) Masaki Hilaga, Yoshihisa Shinagawa, Taku Kohmura, and Tosiyasu L. Kunii. 2001. Topology matching for fully automatic similarity estimation of 3D shapes. In Proceedings of the 28th annual conference on Computer graphics and interactive techniques (SIGGRAPH '01). ACM, New York, NY, USA, 203-212.

DOI: https://doi.org/10.1145/383259.383282 Available from: https://www.cs.jhu.edu/~misha/Papers/Hilaga01.pdf [Accessed 3 June 2018]

3) Julien Tierny, Jean-Philippe Vandeborre and Mohamed Daoudi, « Partial 3D shape retrieval by Reeb pattern unfolding », Computer Graphics Forum, Vol 28, 2009.

4) https://pdfs.semanticscholar.org/7e9e/b6f7b38d187389e968230dbf0a6ca0bad1e2.pdf