Title of research:

Research Capacity in Topology based Shape Recognition in 3D Point-Clouds (TSaR)

Objectives:

- To identify key insights gained by Topological Data Analysis (TDA) in the 3D Point-Clouds segmentation area, 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 extraction of semantic elements from 3D point clouds is an important topic for a wide field of applications in BMW, including production and autonomous driving applications.

The role of segmentation is crucial in most tasks requiring 3D space scan analysis. The success or failure of the task is often a direct consequence of the success or failure of segmentation. However, a reliable and accurate segmentation of a 3D space is, in general, very difficult to achieve by purely automatic means, even more so than 3D image analysis. The proposal here is to investigate the quality of 3D space segmentation via TDA.

Domains of application that can benefit:

• Object Recognition in a sequence of Lidar space (in Autonomous Driving)

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 on 3D point-clouds segmentation to autonomous driving related Lidar space.

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2. Herbert Edelsbrunner and John Harer, "*Computational Topology – an Introduction*", AMS 2010.

3. Julien Tierny, Guillaume Favelier, Joshua Aaron Levine, Charles Gueunet, Michael Michaux, "*The Topology ToolKit*", IEEE Transactions on Visualization and Computer Graphics (Proc. Of IEEE VIS 2017). http://topology-tool-kit.github.io

4. Andrei Sharf, Thomas Lewiner, Gil Shklarski, Sivan Toledo, Daniel Cohen-Or, "*Interactive topology-aware surface reconstruction*". ACM Trans. Graph. 26(3): 43 (2007)

5. Sylvain Paris, Frédo Durand, "*A Topological Approach to Hierarchical Segmentation using Mean Shift*", Proc. Of IEEE CVPR 2007