12-months Post-doctoral research on

Computer graphics, Artificial Intelligence and Human-Computer Interaction,

Interactive Machine Learning for 3D Point Cloud Analysis

Collaborators:

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This postdoc is part of:

– **The SSLAM project (ANR-22-CE23-0004),**
– **the ANITI Associated Chair on Interactive Machine Learning.**

Context

3D acquisition devices are becoming easily accessible and widespread thanks to the decrease in the costs of the technology and its improvement. Their main advantage is the capture of our environment as a full 3D representation composed of millions or even billions of unorganized points denoted *point clouds*. However, there is a need for efficient and reliable processing systems to help expert users to analyze and reconstruct geometrical structures from large scale 3d point clouds.

In the last decade, machine learning (ML) techniques have been used successfully to improve optimization-based and heuristic-based approaches for several processing of types of data, such as text, voice and images. But, when applying these techniques for processing point clouds, several specificities have to be handled: the sampling is heterogeneous and unstructured, which hinders the use of convolutions and the direct application of perceptrons. The data may have different scales in shape and structures, and even though the promise of processing point clouds with ML approaches is to be as effective as on 2D images, the reality is that the unstructured nature of point clouds, their dependence to scale, rotations and translations, their third dimension and the massive nature of real acquired data makes current ML approaches mostly unpractical on most of actual problems.
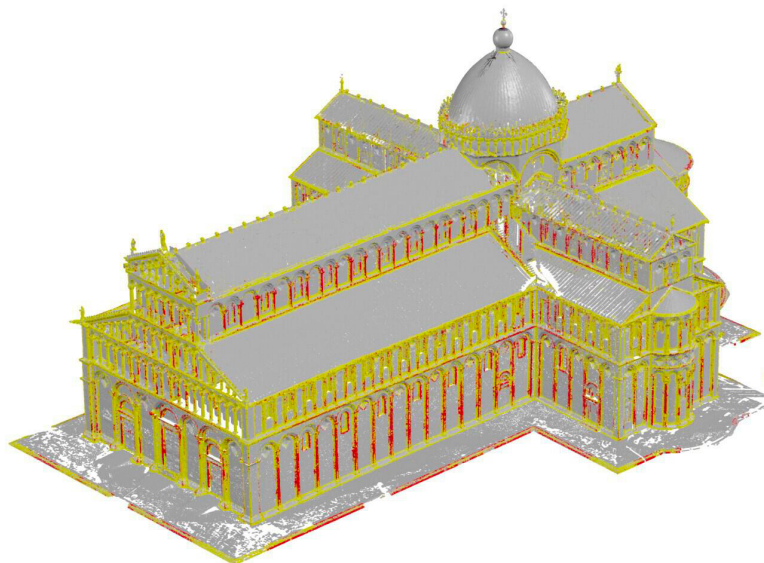

Figure 1. Classification of edges produced by the PCEDNet on the Pisa Cathedral point cloud model [HL*22].

Project goals

The general objective of our project is to support the classification of 3D point clouds using human-centered machine learning applications.

The goal relates to how to improve the point cloud classification given its interlink with the points descriptors and the user's interactive 3D annotation. From the user point of view, interacting with a 3D point cloud to select or unselect specific points is a complex spatial task, which can be affected by sampling noise. Besides, interactive point cloud selection is usually performed using the point's spatial position [CB*23], which makes it difficult and tedious to select points with specific parameters (e.g., a given curvature). In addition, we showed in previous work that preprocessing and parameterizing 3D point clouds before learning drastically improves classification results [HL*22]. However, the definition of the parametrization in the general setting, and its adaptation to user inputs remains an open challenge.

In this project, we aim at addressing two the scientific challenges:
- How to use a variety of point's parameters to improve point clouds interactive annotation by humans and classification by ML models,
- How to design and visualize information produced during the learning process in order to interactively guide the user to improve the annotation.

Expected results

- State of the art on Interactive Machine Learning (IML) with 3D point clouds;
- Design and implement of a proof-of-concept system demonstrating IML with 3D point clouds.
- Writing a scientific article describing the research conducted.

Skills and competences

The candidate should have the following skills:
- Background in Computer Graphics and Artificial Intelligence
- Interest for research-related activities, critical thinking and initiative.

Dates and grant

The postdoc is expected to start early 2025 for a duration of 12 monts.
Salary will vary depending on the candidate experience.

Working group

The post-doc will take place at the *Institut de Recherche en Informatique de Toulouse* (IRIT), at Toulouse (France). Toulouse is the capital city of the Occitanie region, the fourth-largest city in France and the centre of the European aerospace industry.

This postdoc will be supported by an internship (summer 2025), a PhD (start in September 2025), and a Research Engineer from the SSLAM project. The recruited researcher will also collaborate with PhD students of the STORM group working on point cloud processing, and with Research Engineers from the StableProxy ANR project and from the startup RollingDot.

Application

Please send your CV and a short motivation letter to: Nicolas.Mellado@irit.fr

References

[CB*23] Maxime Cordeil, Thomas Billy, Nicolas Mellado, Loic Barthe, Nadine Couture, Patrick Reuter. 2023. ImmersiveIML–Immersive interactive machine learning for 3D point cloud classification: the neural network atyour fingertips. IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMARAdjunct2023), Oct 2023, Sydney, Australia.
[HL*22] Chems Eddine Himeur, Thibault Lejemble, Thomas Pellegrini, Mathias Paulin, Loïc Barthe and Nicolas Mellado. 2022. PCEDNet : A Lightweight Neural Network for Fast and Interactive Edge Detection in 3D Point Clouds. ACM Transactions on Graphics, 41(1).