



Internship on Computer graphics, Artificial Intelligence and Human-Computer Interaction,

Interactive Machine Learning for 3D Point Cloud Analysis

Supervisors:

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This internship is part of :

- the ANITI Affiliate Chair on Interactive Machine Learning,
- The [SSLAM](#) project (ANR-22-CE23-0004).

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 optimisation-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 challenging to use when tackling practical problems.

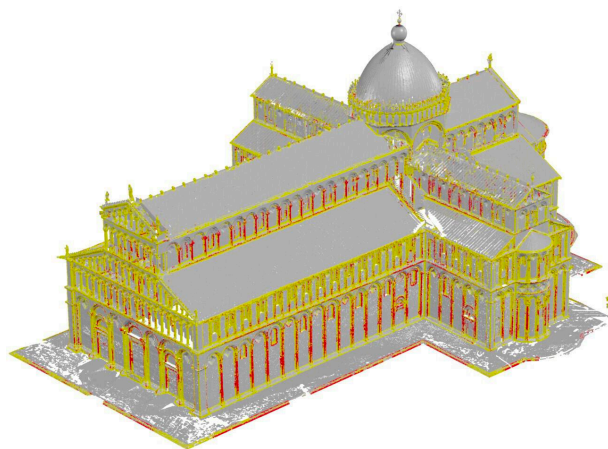


Figure 1. Classification of edges produced by the PCEDNet on the Pisa Cathedral point cloud model [HL*22].

Internship goals

The general objective of our project is to perform 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 internship, we aim at addressing the scientific challenge of how to use a variety of point's parameters and provide ML system feedback to improve point clouds interactive annotation by humans and classification by ML models.

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/or Artificial Intelligence
- Interest for research-related activities, critical thinking and initiative.

Dates and grant

The ideal internship dates are March-July 2025 (5 months), but other dates can be arranged. The internship grant is around 600€/month.

Comments

The internship 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 internship may lead to a PhD funding under the supervision of [M. Serrano](#), [L. Barthe](#) and [N. Mellado](#) (expected start of PhD in September 2025).

Application

Please send your CV and a short motivation email to: Marcos.Serrano@irit.fr, Loic.Barthe@irit.fr, Nicolas.Mellado@irit.fr

References

[CB*23] Maxime Cordeil, Thomas Billy, Nicolas Mellado, Loic Barthe, Nadine Couture, Patrick Reuter. ImmersiveIML– Immersive interactive machine learning for 3D point cloud classification: the neural network at your fingertips. IEEE International Symposium on Mixed and Augmented Reality Adjunct, 2023.

[HL*22] Chems Eddine Himeur, Thibault Lejembre, 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), 2022.