SCIENCES & BIOENGINEERING SCIENCES

The Research Group

Artificial Intelligence Lab

has the honor to invite you to the public defense of the PhD thesis of

Felipe GOMEZ MARULANDA

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Automated 3D geometry segmentations for Computational Fluid Dynamics applications

Promotor:

Prof. dr. Ann Nowé

The defence will take place on

Thursday February 28 2019 at 16:00h

in Auditorium D.2.01 at the Campus Humanities, Sciences and Engineering of the Vrije Universiteit Brussel, Pleinlaan 2 - 1050 Elsene, and will be followed by a reception.

Members of the jury:

Prof. dr. Viviane Jonckers (chairman)
Prof. dr. Ann Nowé (secretary)
Prof. dr. Bernard Manderick
Dr. Nikos Deligiannis
Dr. Lukasz Kidzinski (Stanford University)
Prof. Tinne Tuytelaars (KULeuven)

Curriculum vitae

Felipe Gomez Marulanda (08/11/86) obtained a BSc and MSc in computer science from University of East London (UEL) in 2010 and Vrije Universiteit Brussel (VUB) in 2013. He started his PhD in the Artificial Intelligence Lab at the VUB under the supervision of Prof. Dr. Ann Nowé. His research focused on developing end-to-end Deep learning techniques that can directly used in 3D spaces such as point-clouds.
Furthermore, these techniques were used in the context of mesh generation for Computational Fluid Dynamics. Until now his research has led to publications of 4 articles published in peer-reviewed conferences and journals presented in different locations world wide.

Abstract of the PhD research

We investigate how Artificial Intelligence (AI) can be applied to components of Computational Fluids Dynamics (CFD) so as to overcome current limitations in this field. CFD consist out of two main components: mesh generation and simulation solver. The mesh generation fragments the object concerned into small parts on which the solver computes the simulation. We focused on the aspect of mesh generation, which we further divided into preprocessing of 3D geometries on the one hand, and setting the hyperparameters of the mesh generator on the other hand. Our research specifically focuses on using AI for automatic preprocessing of 3D geometries due to the limited amount of prior research in this field and the potential benefits it can bring to future CFD development.

A crucial element of preprocessing is segmenting the 3D geometry, which requires a great deal of domain knowledge and engineering time. Moreover, these efforts cannot be duplicated to other geometries that share similar characteristics. Over the last decade, the demand for better segmentation and classification algorithms in 3D spaces has significantly grown, due to the popularity of new 3D sensor technologies and advancements in the field of robotics and virtual reality amongst others. The use of AI techniques for the purpose of 3D geometry segmentations remains a challenge. An important impediment is that the ability to learn directly from 3D geometries has not been broadly researched. Current AI techniques have to transform 3D spaces into other spaces (i.e., feature or low dimensional spaces) as they are more manageable to handle. Nevertheless, these transformations often come with a negative impact on the accuracy of the segmentation task.

In this dissertation we propose a new pipeline of AI techniques that can directly work on 3D spaces, removing the necessity of geometrical transformations. Experiments show that our techniques consistently and significantly outperform the state-of-the-art results in the field of 3D object segmentation. Finally, in the future, our research can be coupled with the setting of mesh hyperparameters which will enable the creation of a fully automatic mesh generation system.