Geometric modelling for Big Data and Artificial Intelligence

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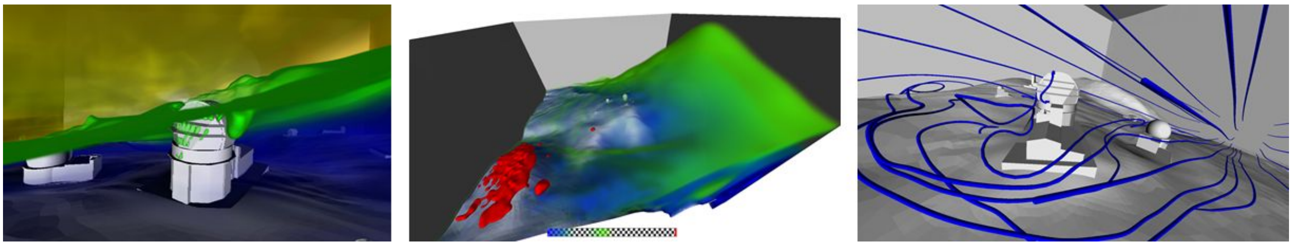


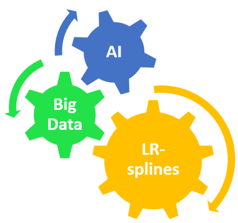
Figure 1: LR-spline model of a wind simulation at the proposed location of a telescope. Left and middle: transparent multi-scale visualization of the wind speed. Right: streamlines of the wind velocity. Data courtesy of the GiD and CRATOS groups at CIMNE.

Over the last ten years, a new field of research has emerged: Big Data Analytics (BDA). Originating in companies such as Google and Facebook, massively distributed systems offer new tools for exploring large datasets. In parallel, a steady increase in computing power and available training data has enabled the field of Artificial Intelligence (AI) to gain critical mass. It has made real-time object recognition possible, and enabled successes such as AlphaGo, the AI Go player developed by Google. It is the first computer program to beat a professional Go player, 20 years after Deep Blue first defeated Kasparov in chess.

The challenge of managing, investigating, and visualizing big datasets is not new in the fields of Science, Technology, Engineering and Mathematics (STEM). From seismic surveys of new oil fields, through Computational Fluid Dynamics (CFD) simulations of waterpower turbines, to large-scale meteorological forecasts, we have always faced limitations in computing power and storage capacity. Recent developments in BDA offer a new set of tools for overcoming these challenges. However, there are significant new challenges that arise from the structural differences between most STEM data and the unstructured textual data typical in classical Big Data applications. STEM data such as simulation results and sonar surveys has a spatial structure, displays complex behaviour, and comes in inconveniently large chunks.

The above challenges can be addressed by combining our experience in geometric data modelling with techniques from BDA and AI. Geometric data structures capture spatial relations and behaviour in the data, adding a layer of valuable information to the model. Furthermore, current knowledge of the physical system underlying STEM data is typically described on a geometric model such as a Finite Element mesh or an Isogeometric spline model. Using compatible data structures enables the development of hybrid models, combining these traditional models with novel data-driven approaches.

The ANALYST project, funded by The Norwegian Research Council, is a collaboration between SINTEF Digital, The Intervention Centre at Oslo University Hospital and the Norwegian Hydrographic Service. It will explore the use of Locally Refined (LR-) spline modelling and AI in Big Data Analytics, with applications such as medical and geospatial data. In this presentation we will show the first results of ANALYST, using LR-splines to model and analyse Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) scans.



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