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Geometric reconstruction for digital twins

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In recent years there has been an explosion of interest in digital twins in many disciplines, but particularly within the field of manufacturing. A core topic of importance in modelling digital twins, is reconstruction of geometric models of physical parts. There exist many scanning techniques and data modalities that can form the input to reconstruction algorithms. Layered image data arising from for example CT scans or successive photographs, is one modality that is particularly suitable as the input to state-of the-art image processing neural networks (e.g., CNNs). Such networks can in turn be used for various modelling purposes such as segmenting the images and detecting defects.

It is important to use suitable representations to compactly model the data, ensuring that the digital twin remains accurate and responsive to real-time interrogation and visualization. In many use cases it is also necessary to model the interior of an object; not just it's boundary as is common in computer aided design (CAD) [1]. Implicit representations, which have recently sparked interest in the machine learning community, are particularly well suited to this task. In particular, implicit spline functions enable objects exhibiting dominantly smooth features and potentially complex topological behaviour to be captured in a single representation, despite the regularity of the underlying layered input data [2].

Though data-driven modelling approaches can provide detailed digital twin models, there are often aspects of a model that are difficult to capture in data with measurement devices. Thus, complementing these with physics-based approaches that can model fluid dynamics, thermal distortions, or elasticity can provide a more complete digital twin model.

In this talk we will discuss how the techniques described above can be applied for the purpose of generating digital twin models in a general setting.

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