

3D Shape Analysis: From Classical Optimisation Methods to Feature Learning for Shape Matching

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Abstract

The field of 3D shape analysis is concerned with the extraction of “useful” information from geometric data. Shape analysis has a high relevance for a wide range of applications, such as autonomous driving, biomedicine, or augmented/virtual reality. A core task of 3D shape analysis is shape matching, i.e. identifying correspondences between given shapes. While traditional shape matching methods rely on optimising a task-specific objective function, modern shape matching oftentimes involves data-driven components. We will first introduce traditional methods for shape matching, starting with the linear assignment problem and the quadratic assignment problem. We then present product graph formalisms in different settings, including 2D to 2D, 2D to 3D or shape to image, and 3D to 3D shape matching. We then discuss recent developments in learning-based shape correspondence methods, from learning shape correspondence with topological data structures to spectral approaches that provide efficient structure and circumvent annotations altogether. Furthermore, we discuss the practical relevance of these methods to application domains in image-to-image and shape-to-image correspondence, medical imaging and surgical navigation, and discuss how recent developments in foundation models play a role in shape analysis. Finally, the tutorial will conclude by addressing the challenges of shape matching, including handling partial shapes, and will explore potential future directions in the field.
