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On Shape Analysis and Applications

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Shape theory is a branch of mathematics and geometry that deals with the study of geometric shapes and their properties. It focuses on understanding and classifying shapes based on certain criteria, such as their topological, algebraic, or metric properties. Shape theory seeks to find rigorous mathematical definitions and methods for analyzing and comparing shapes.

The amount that space is curved can be considered by using theorems from Riemannian geometry. Physicists belive that the curvature of space is related to the gravitational field of a star according to a partial differential equation called Einstein's equation. The most interesting application of differential geometry is General Relativity. It is one of the most successful theories of our univers, and indeed one of the best theoretical models in all of sciences, based almost all on the differential geometry.

Cells and tissues not only interact and respond to the shape of their physical environment but they can also change it. Shape can be modified by processes such as growth, remodeling and/or the development of active forces by a living tissue. A key descriptor of shape is the curvature of the surface, and recent research has indeed shown that curvature not only is controlled by cells and tissues, but also plays an important role as a physical signal that can guide cell and tissue response. The difficulty of this topic is that it requires knowledge coming from a wide range of natural science disciplines, such as biology, mathematics, physics and materials science.

We consider curvature and curvature based functionals in considering shape and energy of curves, surfaces and knots. Infinitesimal bending of geometric objects will be discussed. Variations of geometric objects under infinitesimal deformations are used to describe change of shape and energy descriptors. Application of differential geometry at biology is motive for this talk. The talk is based on the book "*Shape and energy of geometric objects*" authored by Louis Kauffman, Marija Najdanovic , Svetozar Rancic and me. The talk is also a part of action CA22153.

Many other practical applications are in robotics to model the movement and manipulation of robots, computer vision to analyze and understand images and videos, in control theory to design and analyze control systems, in medical imaging to analyze and understand medical images such as CT scans and MRI. Differential geometry is used in machine learning to analyze and understand data.

Overall, differential geometry can be used in a variety of fields to model and analyze shapes and spaces. It can provide powerful tools for understanding the properties of complex systems and can be used to design new technologies.