

Predictive Models of Skin Through the Integration of Machine Learning and Computational Mechanics

Abstract:

The mechanical function and adaptation of the skin to the environment is integral to our survival. Skin can develop lesions or get injured, through burns, cancer, trauma, or congenital defects that need repair. However, skin reconstruction and regeneration are still prone to complications and suboptimal outcomes such as hypertrophic scarring. This talk will present recent advances in the theory, numerics, and experimentation of skin in the context of reconstructive surgery. First, the talk will focus on reconstructive surgery simulation and optimization through the development of machine learning metamodels. Both patient specific cases and general surgery designs will be explored. The key advancement in this area is the replacement of deterministic models of the mechanical behavior of tissue by probabilistic surrogates that account for the inherent variability in biological systems. The second application that will be covered is skin growth in response to stretch, which is the basis of a widely applied reconstructive procedure known as tissue expansion. In collaboration with Dr. Arun K. Gosain, from Lurie Children's Hospital in Chicago, the team has established an animal model of skin expansion. The talk will cover the Bayesian calibration of a computational model of the procedure using the data from the animal experiments. Once again, rather than a deterministic finite element model, a multi-fidelity Gaussian process surrogate is used to account for the variability in clinical, mechanical and biological parameters. Moving forward, the combination of *in silico* - *in vivo* approaches and machine learning will continue to increase our understanding of how form and function is controlled in living tissues and how it can be leveraged to improve medical treatment.

Bio:

Dr. Buganza-Tepole is an Assistant Professor of Mechanical Engineering at Purdue University since Fall 2016. Before that he obtained his Ph.D. in Mechanical Engineering from Stanford University in 2015 and was a postdoctoral scholar at Harvard for one year before starting his research group at Purdue. He is a recipient of the Claudio X. González Fellowship and a Fellowship from the Mexican National Science Council. He has also received the Stanford Graduate Fellowship in Science and Engineering (SGF) and the Diversifying Academia Recruiting Excellence Fellowship (DARE). Dr. Buganza Tepole's group studies the interplay between mechanics and mechanobiology. Utilizing computational methods, simulations, and experimentation, his group seeks to understand the fundamental mechanisms of tissue mechanics and adaptation, and improve clinical diagnostics and interventional tools.