BIOENGINEERING

SEMINAR

At 3:30 pm on June 26, 2013 (Wednesday)
MRDG Seminar Hall, 1st floor, Biological Sciences Building

Functional Inference of Complex Anatomical Tendinous Networks via Sparse Experimentation

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Important networks exist at anatomical scales such as the tendon network of human fingers: the complex array of collagen fibers that transmits and distributes muscle forces to finger joints. This network is critical to the versatility of the human hand, and its structure and function has been debated since at least the 16th century. This talk details experimental inference of the structure (both topology and parameter values) of this network through sparse interrogation with force inputs. A population of models representing this structure co-evolves in simulation with a population of informative future force inputs via the predator-prey estimation-exploration algorithm. Model fitness depends on their ability to explain experimental data, while the fitness of future force inputs depends on causing maximal functional discrepancy among current models. The approach is validated by inferring two known synthetic Latex networks, and one anatomical tendon network harvested from a cadaver's middle finger. We find that functionally similar but structurally diverse models can exist within a narrow range of the training set and cross-validation errors. For synthetic networks, models with low training set error and the smallest cross-validation error resemble the known target structurally. The low training set and cross validation errors for models for the cadaveric specimen demonstrate what, to our knowledge, is the first experimental inference of the functional structure of complex anatomical networks. This work expands current bioinformatics inference approaches by demonstrating that sparse, yet informative interrogation of biological specimens holds significant computational advantages inaccurate and efficient inference over random testing, or assuming model topology and only inferring parameters values. These findings also hold clues to both, our evolutionary history and the development of versatile grasping machines.