Nonlinear system model and method for computing and optimizing athletic performance and rehabilitation

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Value Proposition

Training is widely accepted as a method to improve one's performance in sports. However, athletes typically have to rely on experience, heuristics, and rough approximations to design their training routines. Despite tremendous advances in sensor technology, computational methods and the science of physiology, athletic training software remain grounded in outdated science or conventional wisdom. While several dynamic approaches have been proposed to model the response of the human body to physical training, they rely on linear assumptions and fail to account for physiological phenomena such as performance saturation (diminishing returns) and over-training. Moreover, many of them rely on population-based statistical assumptions rather than personal physiology and fitness of humans. There is an opportunity, therefore, for an accurate physiological model and heuristic algorithm to help optimize training routines for athletes, recovering patients, and fitness enthusiast. The current models available for predicting performance as a function of training have significant predictive limitations. A more sophisticated model is needed to improve performance predictions and design optimal training strategies.

Technology

Duke inventors have reported a new mathematical model and heuristic algorithm for athletic performance intended to be implemented with existing physiological data collection technologies to help optimize training for athletes and individuals rehabilitating from injuries. The mathematical model incorporates nonlinear aspects of human physiology, which allows representation of the dynamics of fitness adaptations and the onset of fatigue with a significantly more sophisticated approach. This invention can predict athletic performance based on training inputs. The model accounts for well-known physiological phenomena such as the concepts of saturation (diminishing returns) and over-training which are currently not accounted for in other athletic performance models. This invention may also utilize a dynamical systems model of oxygen uptake to distinguish between aerobic and anaerobic training loads. The inventors have successfully predicted athletic performance in several pilot studies using this technology.

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Advantages

- Can be used to predict athletic performance and also to optimize training strategies that are personalized for a given athlete based on their individual physiology, fitness, athletic/rehabilitation goals, and constraints
- Accounts for the personal physiological and fitness of an individual using their physiology, fitness, athletic/rehabilitation goals, and constraints rather than relying on population-based statistical assumptions
- Can more accurately predict the separate adaptations of the aerobic and anaerobic body systems in response to exercise
- Has immediate applications for the health and fitness communities and is easily implementable with existing physiological data collection technologies

Publications

- A nonlinear model for the characterization and optimization of athletic training and performance (Biomedical Human Kinetics, 2017)