Bachelor Thesis: BA Mathematics / BA Physics

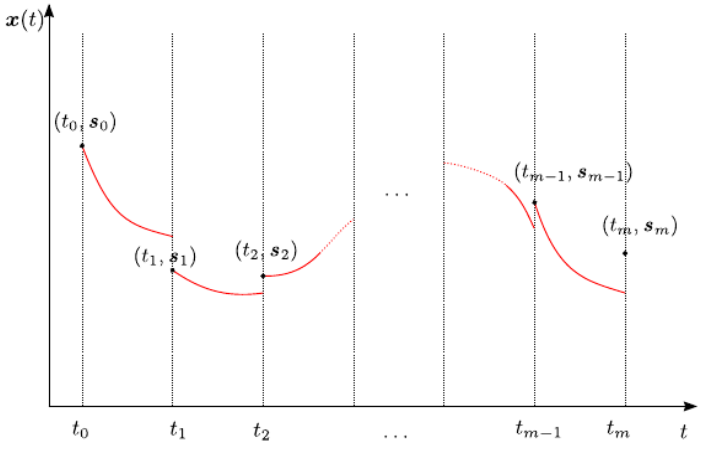
“ Optimal performance of Olympic-style weight lifting “

Background:

Olympic weightlifting is comprised of 2 events: the snatch, and the clean-and-jerk. In the snatch the weight is lifted from the ground to an overhead position in one movment. In the clean-and-jerk the weight is lifted from the ground to the shoulders (the clean) and then from the shoulders over head (the jerk). These motions are very technical, and performance is very sensitive to technique.

We have established a connection with the Bundesstützpunkt Leimen. Mathias Steiner (Olympic gold medalist 2008) trained at Bundesstützpunkt Leimen, and there are many competitive lifters who are currently training there. They are very interested in understanding how variations in limb segment length, and joint strength affect the optimal movement during the beginning of the lift.

Project:



Both the human body and the Olympic-weight lifting movements are very complex. To make the problem tractable we will use a planar model that is actuated by torque muscles. Both the model and the torque muscles have been implemented. Next, only the first phase of the lift will be analyzed. This phase begins with the weight on the ground, and ends when the lifter has pulled the bar up to their waist at high velocity.

Using the direct-multiple-shooting optimal control code Muscod, we will then solve for the muscle excitations that maximize the upward velocity of the bar as it passes the hips. If time permits we can use Muscod to answer some questions of interest to the trainers and athletes at Leimen: What is the optimal lifting motion for a tall lifter vs. short lifter? How does the lifting technique change if strength ratio between the hips/knees/back change?

Conditions:

Knowledge of physics (e.g. "Theoretical Mechanics") and numerical methods/optimization ("Numerics of Ordinary Differential Equations" or the lectures "Algorithmic optimization 1/2 ") is required. In addition programming experience in C++ and Matlab is also required.

Contact:

Prof. Dr. Katja Mombaur, katja.mombaur@iwr.uni-heidelberg.de
Dr. Matt Millard, matthew.millard@iwr.uni-heidelberg.de
www.orb.uni-hd.de