Tutorial 6 – Surrogate Muscle Models

Before starting the Treatment Optimization process, the user must create a surrogate model of the relevant OpenSim musculoskeletal geometry, which includes fitting muscle-tendon lengths and moment arms as a function of sampled joint positions. A Latin hypercube (LHS) sampling method around a nominal motion trajectory is used to sample muscle-tendon lengths and moment arms throughout a cloud of sample points surrounding the nominal motion trajectory. Surrogate model fitting is performed using polynomial regression, where the user specifies the degree of the polynomials. Once surrogate models of muscle-tendon lengths and moment arms have been fitted, the surrogate muscle-tendon length relationships are differentiated automatically to create surrogate muscle-tendon velocity relationships as a function of joint points and velocities.

Creating surrogate kinematics:

1. Inside the tutorial directory, open the file **surrogateKinematicsScript.m**
2. This file takes your **preprocessed** directory as an input and uses LHS to seed random values for joint angles throughout the experimental IK trajectory.
    a. LHS is a randomized algorithm, but we are using a pre-set seed (42) for this tutorial to ensure consistency.
3. Run **surrogateKinematicsScript.m**
4. This will create a new directory called **surrogateData**.
5. Open the OpenSim model **RightLegAndPelvis.osim** in the OpenSim GUI.
6. With **RightLegAndPelvis.osim** open, click *load motion* and load **surrogateData\IKData\drive_kick1.sto**
7. Animate the motion. It should look like the nominal kicking motion but with a lot of added "noise". This is caused by random sampling around the trajectory with the LHS algorithm.

Run Muscle Analysis:

With the surrogate kinematics created, the next step is to run the *Muscle Analysis Tool* to get muscle moment arms and muscle-tendon lengths for the model at the sampled kinematic points.

1. With **RightLegAndPelvis.osim** selected, open the *Analyze Tool*.
2. Load the settings file **MuscleAnalysisSettings.xml** and press **Run.**