

Muscle Analysis

1. Load a model

In this workshop we use gait2392 from the OpenSim model library, scaled to the patient from the “Fifth Grand Challenge Competition to Predict In Vivo Knee Loads”.

The scaled .osim model was prepared during the scaling step. It is located in the “5_Muscle_Analysis” folder and named **workshopModel2392-scaled.osim**.

2. Using the Plot tool

❖ Plotting the length of the right hamstrings during a walking trial:

After performing inverse kinematics, you can access information on muscle parameters during the motion using the plot tool. With the scaled model loaded, go to the “File” menu and select “Load Motion”. Load the inverse kinematics results (“**transformed_Gait_IK_results.mot**”) located in the “4_Inverse_Kinematics” folder.

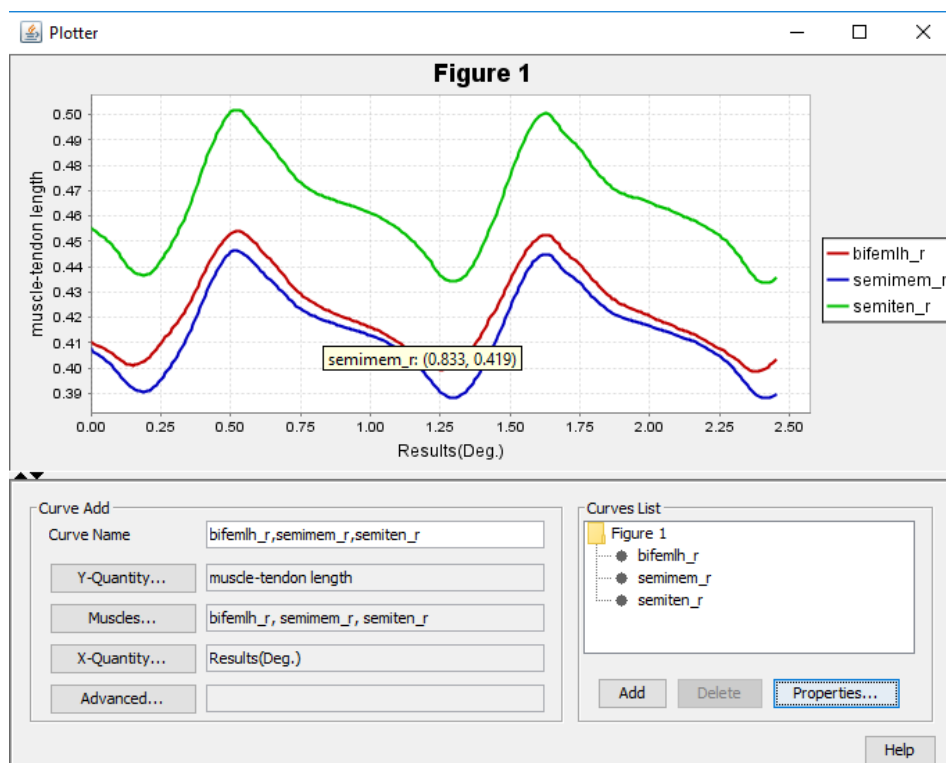
Go to the “Tools” menu and select “Plot...”.

Y-Quantity: muscle-tendon length

Muscles: “semimem_r”, “semiten_r”, “bifemlh_r”

X-Quantities: Select “Coordinates(Deg.)”

Click the “Add” button.



❖ Simulating left quadriceps weakness after total knee replacement:

Modify manually the muscle parameters in the .osim file to reduce by 35% (Marra et al. J Biomech Eng, 2015) the maximum isometric force of the left quadriceps muscles in order to simulate the effect of total knee replacement on that muscle group.

vastus lateralis: from 1871 N to 1216 N
vastus medialis: from 1294 N to 841 N
vastus intermedius: from 1365 N to 887 N
rectus femoris: from 1169 N to 760 N

Load both the weak model (“**workshopGait2392-scaled_weak_quadiceps_left.osim**”) and the simply scaled model (“**workshopModel2392-scaled.osim**”) that can be found in folder “5_Muscle_Analysis”.

NB: A script that uses the OpenSim API to modify the strength of the muscles crossing the knee joint can be found in folder “5_Muscle_Analysis\example_OpenSimAPI”.

- Plotting Passive Joint Moment

With the scaled model active, go to the “Tools” menu and select “Plot...”.

Y-Quantity: moment > knee_angle_l moment

Muscles: “vas_int_l”, “vas_lat_l”, “vas_med_l”, “rect_fem_l”, tick “sum only”

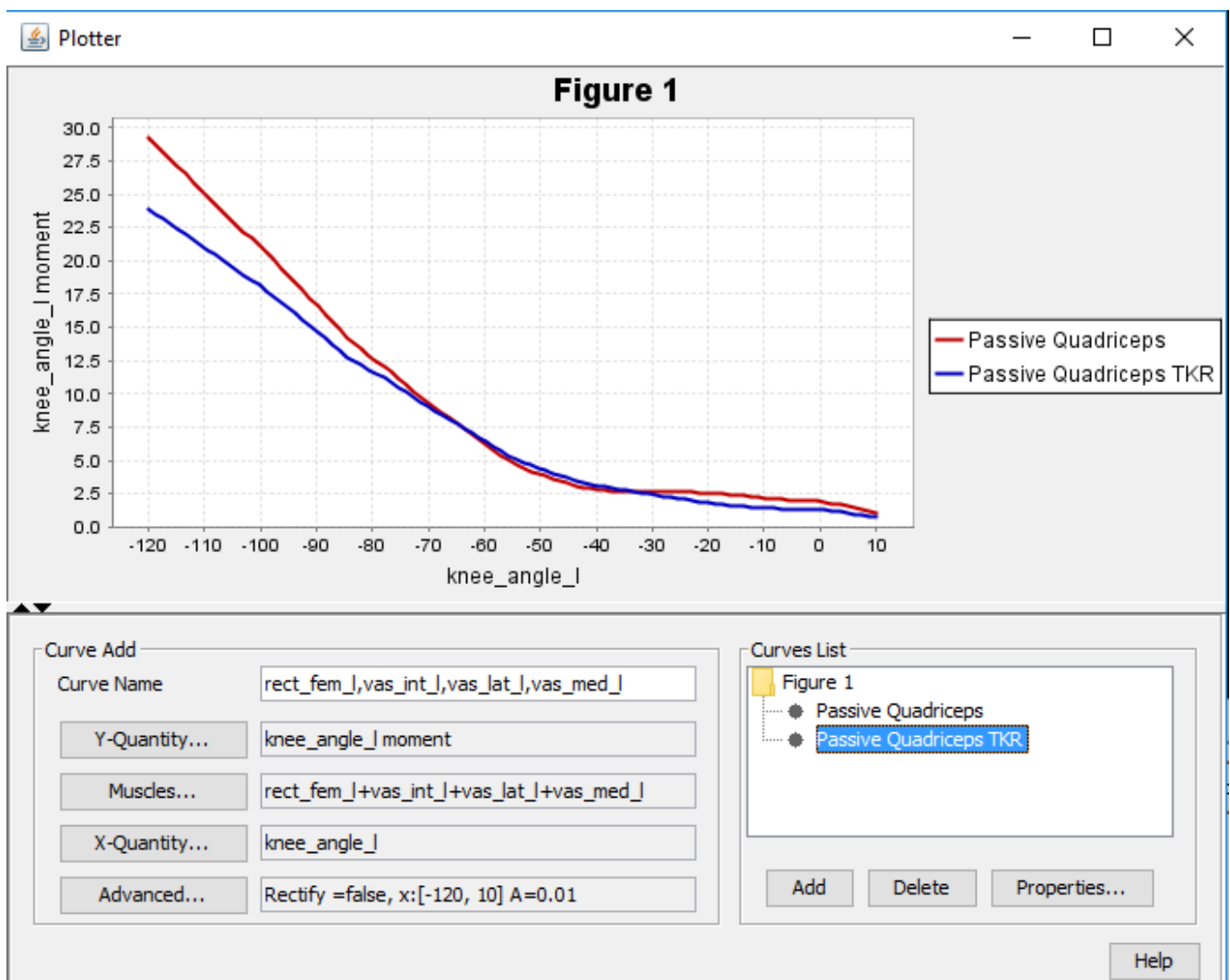
X-Quantities: knee_angle_l

Click “Advanced”, tick “Activation override”, enter “Activation 0.01”. Click “OK”.

Click the “Add” button.

In the “Navigation” tab select the weak model as active and repeat the previous steps in the same plotter window.

NOTE: You can rename curves and titles.



- Plotting Maximum Active Joint Moment

With the normal model active, go to the “Tools” menu and select “Plot...” to open a new plotter.

Y-Quantity: moment > knee_angle_l moment

Muscles: “vas_int_l”, “vas_lat_l”, “vas_med_l”, “rect_fem_l”, tick “sum only”

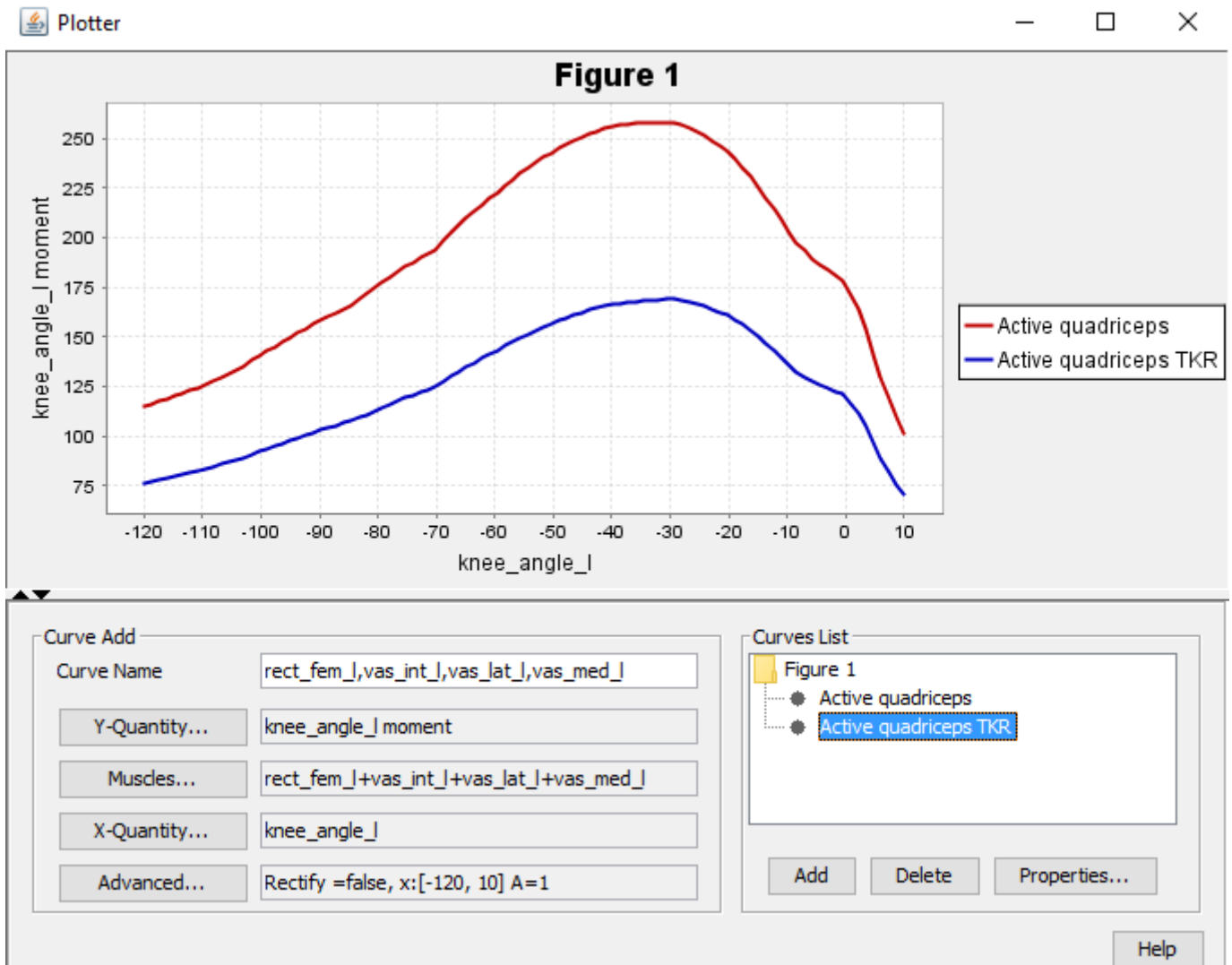
X-Quantities: knee_angle_l

Click “Advanced”, tick “Activation override”, enter “Activation 1”. Click “OK”.

Click the “Add” button.

In the “Navigation” tab select the weak model as active and repeat the previous steps in the same plotter window.

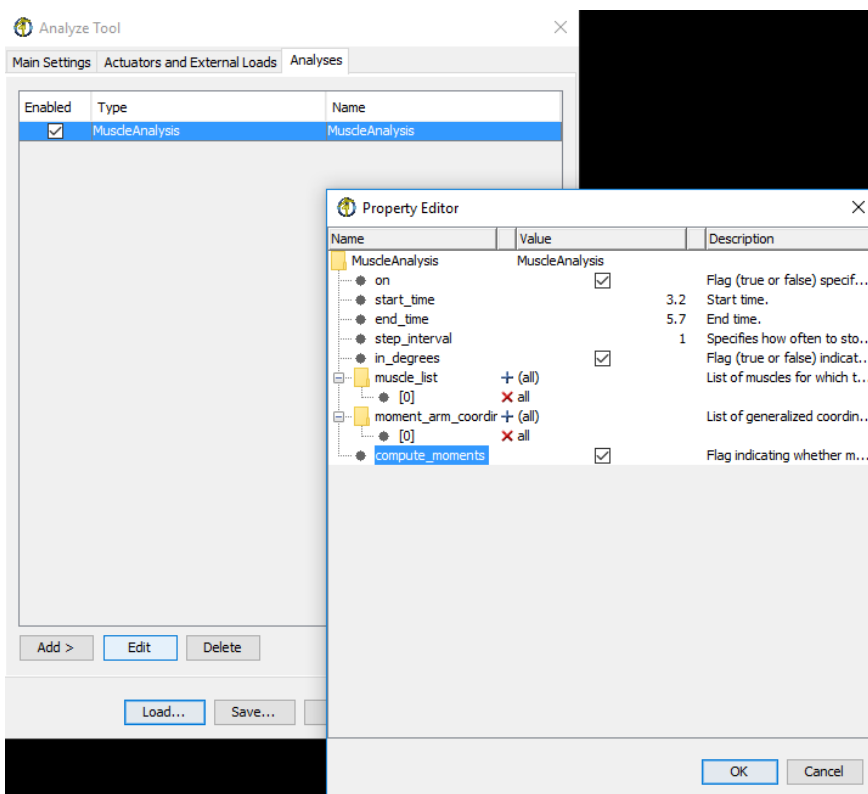
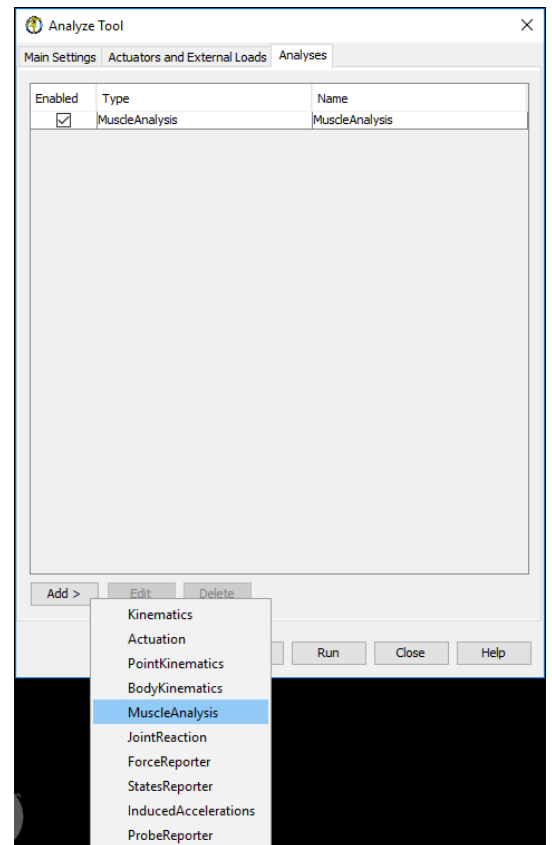
NOTE: You can rename curves and titles.



3. Using the Analyze Tool

OpenSim also has an “Analyze Tool” which can, amongst many other things, run muscle analysis. This tool will store all the information on muscle parameters during the motion in .sto files. Go to the “Tools” menu, and select “Analyze...”. You can load the setup file “**Setup_muscleanalysis.xml**” or use your own parameters. The .mot file with gait motion data used in this workshop was prepared during the inverse kinematics step (“4_Inverse_Kinematics” folder) and is called “**transformed_Gait_IK_results.mot**”.

To add a muscle analysis, go to the “Analyses” tab in the toolbox, click the “Add >” button, select “MuscleAnalysis”.



You can edit the parameters of the analysis when you click the “Edit” button. Don’t forget to tick the “compute_moments” box to compute the maximum moment muscles can produce.

NOTE: Results consist of a set of .sto files named with the “Prefix” specified in the “Output” section of the “Main Settings” tab of the toolbox. The set includes basic information about muscles during a simulation, in particular muscle moment arms and maximum moment produced by muscles for every joints.

4. Useful links

Please see more details about available analyses in OpenSim at the website:

<https://simtk-confluence.stanford.edu/display/OpenSim/Analyses>