**Tutorial 1 - Joint Model Personalization**

The Joint Model Personalization (JMP) tool optimizes joint parameters, body scaling, and marker placement to minimize IK marker distance errors. Reducing inverse kinematics marker distance errors reduces downstream errors in calculated inverse dynamic joint moments, muscle–tendon lengths and velocities, muscle moment arms, and ultimately muscle activations and forces. These quantities are used by subsequent Model Personalization tools.

The inputs to JMP are a scaled generic OpenSim model, kinematic marker data from one or more motion trials, and a JMP settings file. This tutorial will explore the creation of JMP settings file using both the NMSM Pipeline GUI in OpenSim, and by directly editing the settings file in a text editor.

1. **Setting up a JMP settings file:**
2. Activate the NMSM GUI in OpenSim by navigating to “Tools>User Plugins”, and click “rcnlPlugin.dll”
3. Open UF\_Subject\_3\_scaled.osim in the OpenSim GUI
4. With UF\_Subject\_3\_scaled.osim selected in the OpenSim GUI, navigate to Tools>Model Personalization>Joint Model Personalization
   1. The following window should be opened:

A screenshot of a computer

AI-generated content may be incorrect.

1. Rename the output model file to “[working\_directory]\UF\_Subject\_3\_scaled\_JMPV1.osim”
2. Click “Add” to open a window to create a JMP Task.
   1. Name this task “Scale Hips”
   2. Select the marker file to be “GaitTrial\_markers\_jmp.trc”
   3. Add a new body to this task:
      1. Body name: Pelvis
      2. Scale body: Yes
      3. Move markers: Y-axis
3. Create a new JMP Task:
   1. Name this task “Right Knee”
   2. Select the marker file to be “GaitTrial\_markers\_jmp.trc”
   3. Add a new joint to this task.
      1. Joint name: knee\_r.
      2. Parent frame translation: None
      3. Parent frame rotation: X-, Y- axes
      4. Child frame translation: None
      5. Child frame rotation: X-, Y- axes
4. Create a new JMP Task:
   1. Name this task “Left Knee”
   2. Select the marker file to be “GaitTrial\_markers\_jmp.trc”
   3. Add a new joint to this task.
      1. Joint name: knee\_l.
      2. Parent frame translation: None
      3. Parent frame rotation: X-, Y- axes
      4. Child frame translation: None
      5. Child frame rotation: X-, Y- axes
5. Save the settings file as “JMPSettingsV1.xml”
6. Open the JMP settings file in a text editor of your choice, and explore the document
7. **Running JMP:**
8. Open MATLAB and open runJMP.m in your tutorial directory.
9. Open the project file (Project.prj inside your installation of nmsm-core.)
10. Ensure MATLAB is set up to use multi-processing, not multi-threading:
    1. In the bottom left, of matlab click the parallel processing icon, and click “parallel preferences”.
    2. In the drop down menu for Default Profile, select Processes.
11. Run the MATLAB section labelled Run JMP V1
    1. With the section selected, press shift+enter to run a section.
    2. This JMP run will take a few minutes to run.
12. **Post JMP Analysis:**
13. In the OpenSim GUI, open the new model created by JMP.
14. Visually inspect this new model compared to the original model. What changed?
15. Analyze the plots created by runJMP.m
    1. How do the post-JMP marker errors compare to the max allowable error specified in the settings file?
16. **Experiment with different JMP formulations:**
17. With the post-JMP model selected in the OpenSim GUI, open a new JMP GUI window.
    1. This allows us to use the previous JMP run as a starting point for a new JMP run.
18. Rename the output model file to “[working\_directory]\UF\_Subject\_3\_scaled\_JMPV2.osim”
19. Create a new JMP Task:
    1. Name this task “Right Femur Markers”
    2. Select the marker file to be “GaitTrial\_markers\_jmp.trc”
    3. Add a new body to this task:
       1. Body name: femur\_r
       2. Scale body: No
       3. Move markers: Y-, Z-axes
    4. Add a new body to this task:
       1. Body name: femur\_l
       2. Scale body: No
       3. Move markers: Y-, Z-axes
20. Create a new JMP Task:
    1. Name this task “Left Femur Markers”
    2. Select the marker file to be “GaitTrial\_markers\_jmp.trc”
    3. Add a new body to this task:
    4. Add a new body to this task:
       1. Body name: femur\_l
       2. Scale body: No
       3. Move markers: Y-, Z-axes
21. Save this settings file as “JMPSettingsV2.xml”.
22. Run the MATLAB section labelled Run JMP V2
    1. With the section selected, press shift+enter to run a section.
23. Visually compare the new model created by this JMP run to the model created by JMPSettingsV1.
24. **Change max allowable error:**
25. Open JMPSettingsV1.xml in a text editor of your choice.
26. Rename the output model file to “[working\_directory]\UF\_Subject\_3\_scaled\_JMPV3.osim”
27. Change the max allowable error term to be 0.02 instead of 0.01.
28. Save this settings file as “JMPSettingsV3.xml”
29. Change the settings file name in runJMP.m to “JMPSettingsV3.xml”
30. Change the model file name in runJMP.m to “UF\_Subject\_3\_scaled\_JMPV3.osim”
31. Run the MATLAB section labelled Run JMP V3
32. With the section selected, press shift+enter to run a section.