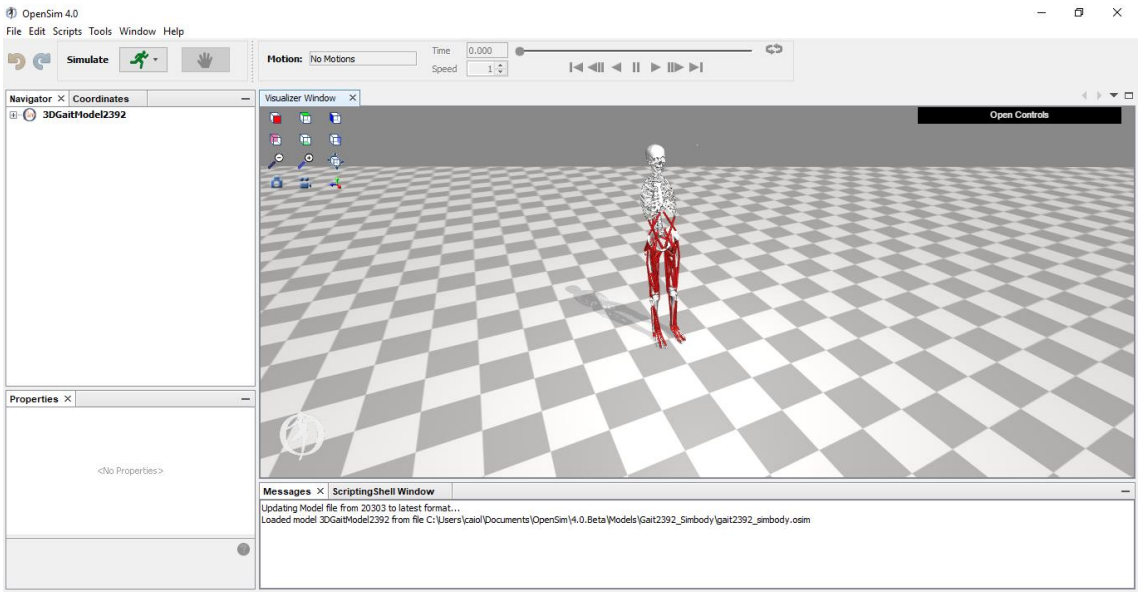
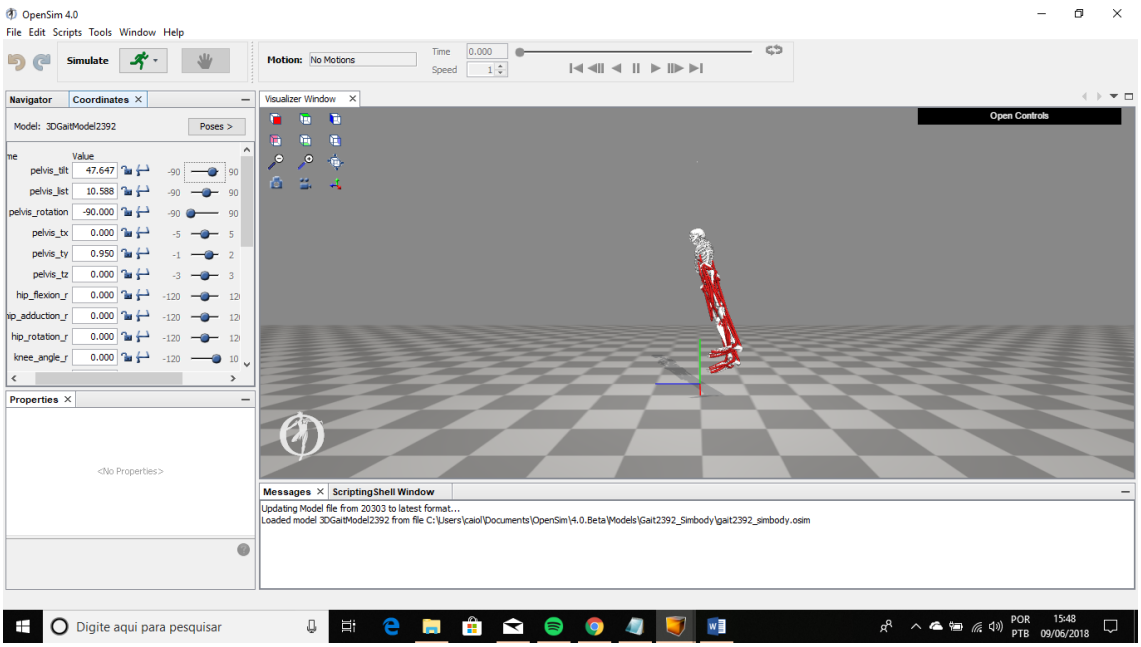
Nome: Caio Lima RA:11074012

Tutorial OpenSim 1

Loading Model



Rotating



1. Degrees of Freedom

a. Use the Coordinate slider to view the degrees of freedom of the model. *How many degrees of freedom does the model have? List them.*

R: It has 23 degrees of freedom 1 per joint

- **Pelvis 6 degrees of freedom**
- **6 hip (3 for riht and 3 for left size)**
- **2 Knees (left and right size)**
- **2 ankles (left and right size)**
- **2 subtalar (left and right size)**
- **2 mtp (left and right size)**
- **3 lumbar**

b. All models are approximations. Compare the degrees of freedom in the model to the degrees of freedom in your lower limbs. *Which motions have been simplified? Which motions have not been modeled at all?*

The hip moviments was simplificated and the toe and fingers weren't took in to account

2. Muscle Paths

a. Muscle-tendon paths are represented in OpenSim by a series of points connected by line segments. To see a list of all the muscles:

- In the Navigator, expand the **Forces**, **Muscles,** and **all** headings.
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- To display a single muscle, **right-click** on a specific muscle name under the **all** group, e.g., *glut_med1_r*, and select **Display > Show Only** from the popup menu.
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- To toggle the display of all muscles, **right-click** on the **Muscles** or **all** heading, and select **Display > Show** or **Display > Hide**

How many muscles are in the model?

R: There are 92 muscles

Is this greater than the number of degrees of freedom?

R: Yes its great than the numbers of degrees wich is 23 but each degree needs 2 muscles so 46

What is the minimum number of muscles required to fully actuate the model?

R: 46 because there are 23 degrees of freedom

Hint: Full actuation of the knee, for example, means both knee flexion and knee extension.

In this model, the gluteus medius is represented by multiple lines of action (e.g., glut_med1_r, glut_med2_r, glut_med3_r). *Name two other muscles in the model that are represented with multiple lines of action. Why do you think these muscles are represented in this way?*
Hint: Other muscles with multiple lines of action use the same naming convention as the gluteus medius.

R: Some muscles have more than 1 function

b. For some muscles, two points, the muscle origin and insertion, are sufficient to describe the muscle path. For other muscles that wrap over bones or are constrained by retinacula, intermediate *wrapping* or *via* points must be defined. To view these *wrapping* points:

-
- Restore the default joint coordinates by clicking the **Poses** button and selecting **Default**. Then zoom in on the right knee joint.

-
- Hide all other muscles except the ***r knee extensors*** muscle group.

-
- Fully flex the right knee using the **knee_angle_r** Coordinates slider.

Notice that wrapping points are introduced in some of the knee extensors at certain knee angles, such that the muscles appear to wrap around the bones.
Which knee extensor muscles have wrapping points? At what knee angle does the wrapping point appear for each of those knee extensors? A muscle may have more than one wrapping point.

3. Modeling Limitations

Some muscles in the lower limb model pass through the bones or deeper muscles at extreme ranges of motion. Zoom in on the right hip, and display only the *glut_med3_r* muscle (*r hip extensors* group). Examine this muscle for the full range of hip flexion angles. *Do you see any problems with glut_med3_r ?*

In what ways are point-to-point representations of muscle paths a simplification of musculoskeletal geometry?

R: They are simplificating muscles that conect joints

Questions

4. Muscle Fiber Length vs. Joint Angle

a. Study the plot of muscle fiber length vs. knee angle. *Do you think these curves would look different if, for example, the right hip was flexed?*

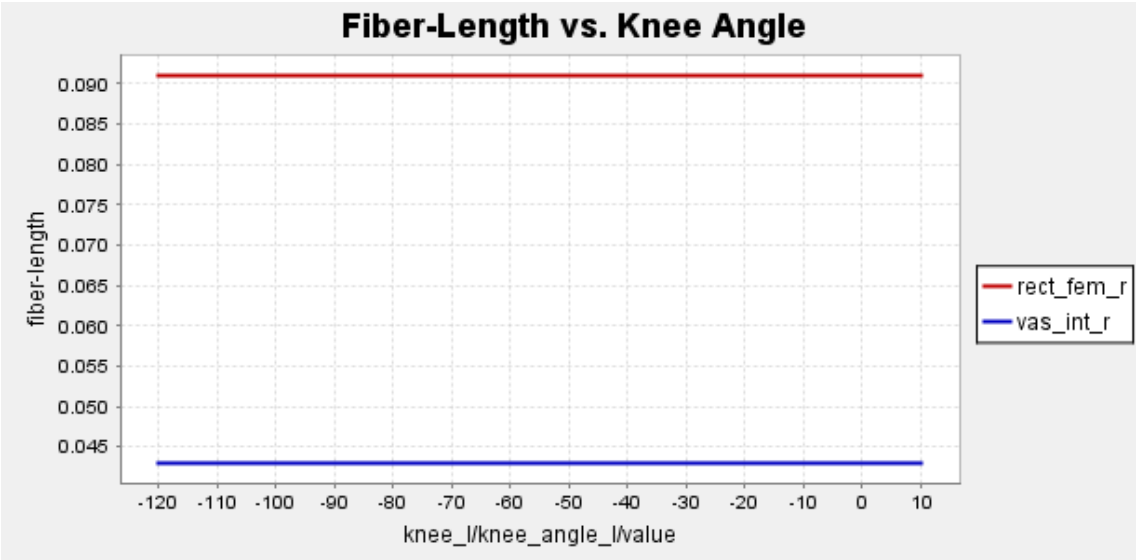
R: Yes because it will flex all the structure

b.You will now flex the right hip by recalling the pose you previously saved:In the Coordinates window, click **Poses** and select your saved pose (**r hip flex 45**).

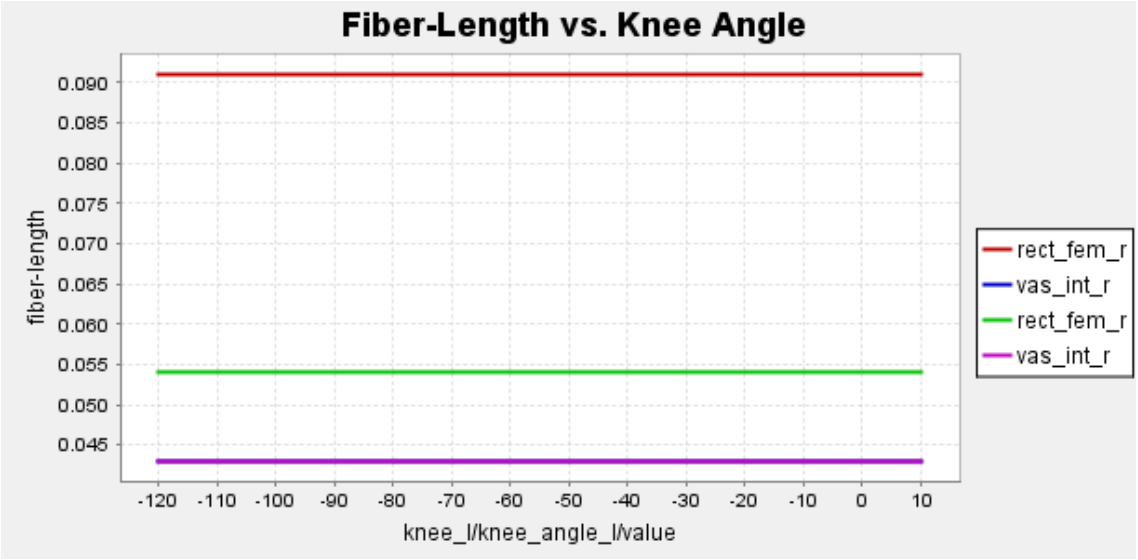
- To add curves for 45º hip flexion using the same Quantities and Muscles, click **Add**.
*Note: To print or save a plot, **right-click** on the plot and select **Print** or **Export Image**.*

Compare the two sets of curves you have just plotted. *How have the curves changed?*

Can you explain your findings? How can bi-articular muscles complicate analysis?



Original position



New position

5. Muscle Moment Arm vs. Joint Angle

Now plot knee extension moment arm vs. knee angle for the same two muscles:

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- Return the model to its original position by clicking **Poses > Default**.

-
- To delete the previous curves, select all the names from the **Curves List** and click **Delete**.
  *Note: To select multiple curve names, hold down **ctrl** while selecting.*

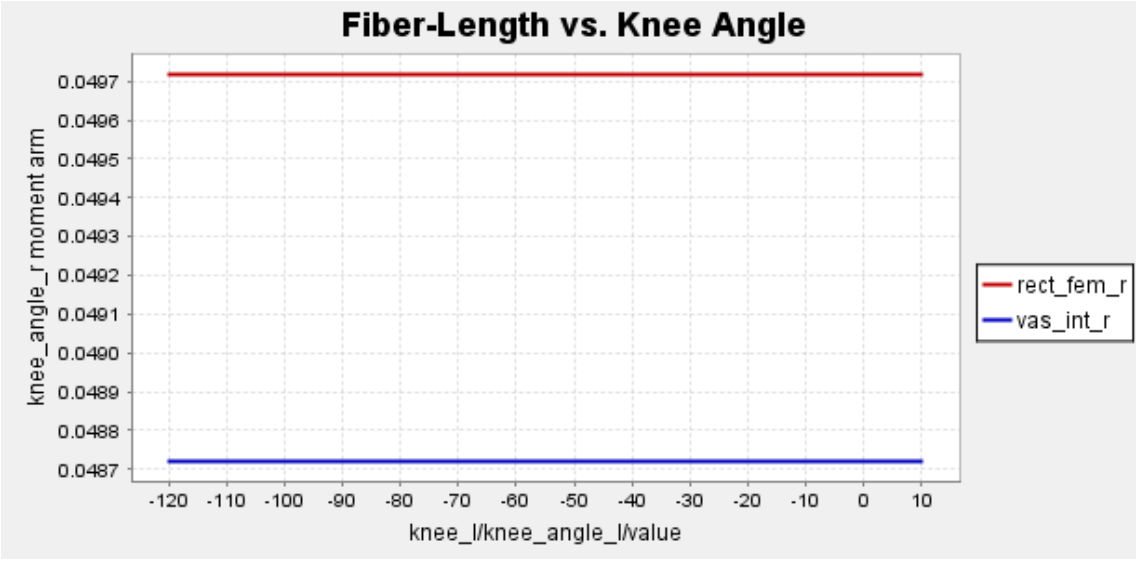
-
- Click **Y-Quantity**, select **moment arm**, and **knee_angle_r**.

-
- To add curves using the same Muscles and X-Quantity as previously selected, click **Add**. *Note: If you **hover** the cursor over a curve, a tool tip will give the coordinates at that particular point.*

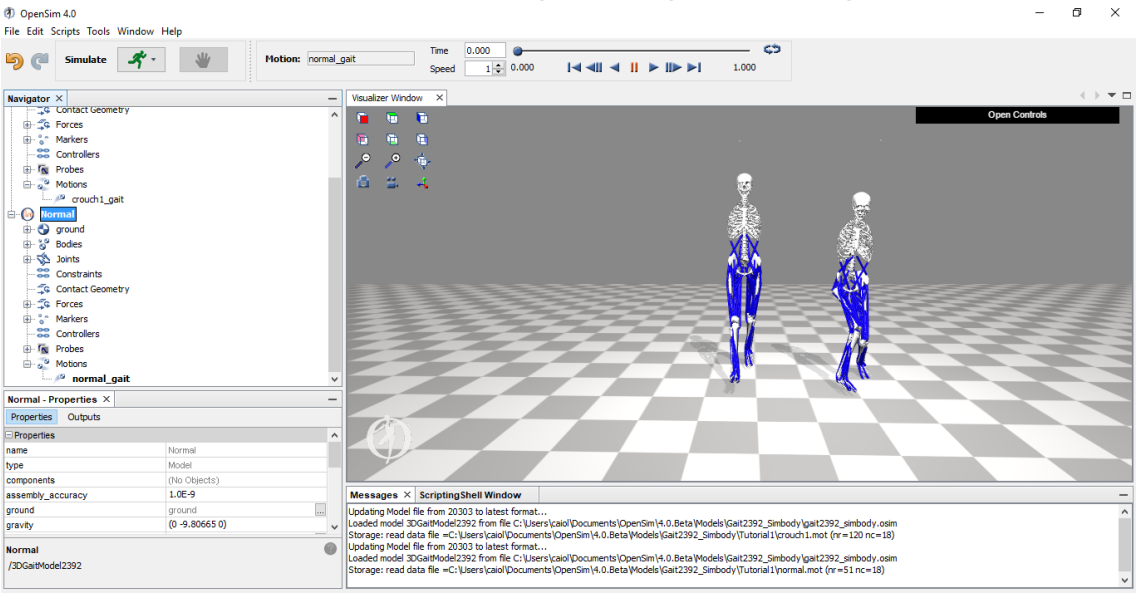
  Study the plot of knee extension moment arm vs. knee angle for rectus femoris and vastus intermedius. *At what knee angles do the moment arms peak? What are the peak moment arms?*

  You may notice that the moment arm curves have a discontinuity. *At what knee angle do the discontinuities occur? What do you think causes this? Hint: Look at Question 2.b*

  Once you have answered these questions, you can close the current plotter.



IV. Assessment of Hamstrings Length During Crouch Gait



Questions

6. Range of Motion

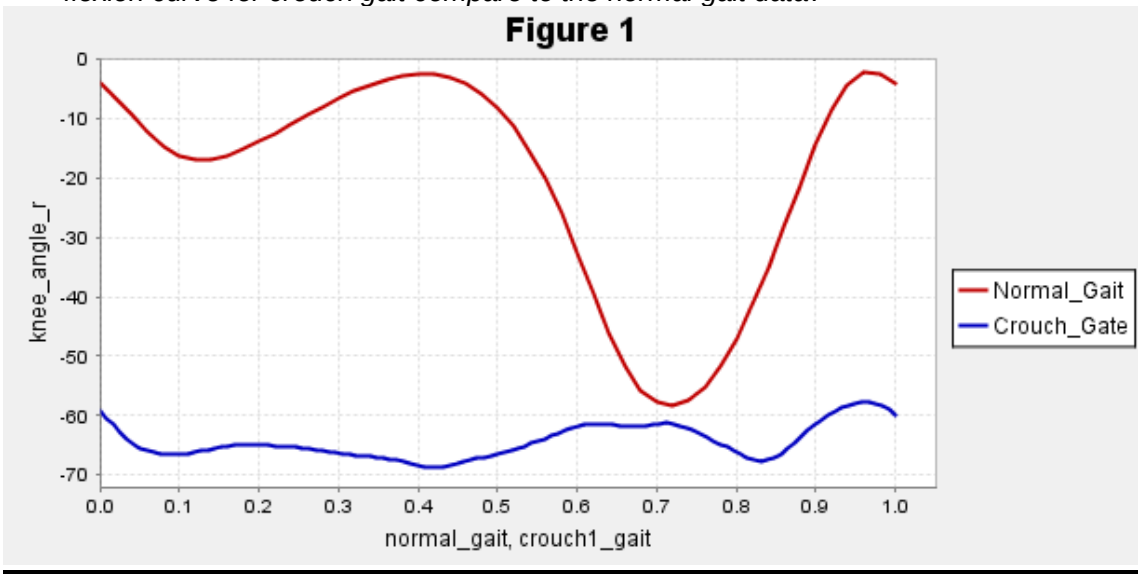
To animate the models and visually compare the crouch gait data to the normal gait data, click **play**. Notice that both motions are synchronized, as shown. Be sure to loop the animation, adjust the play speed, and rotate the models. *What differences do you observe between crouch gait and normal gait?*

Now quantitatively compare knee flexion angles over the crouch and normal gait cycles.

- In a new plot, click **Y-Quantity**, select **normal_gait**, and select **knee_angle_r**. Click **OK**.
- Click **X-Quantity** and select **normal_gait**. Click **OK**.
- Edit the text in the **Curve Name** textbox to read **Normal Gait**.
- To add the curve of *right knee angle vs. gait cycle*, click **Add**.
- Make the *Crouch* model current by selecting it (double-click) in the Navigator. It should become bold-faced.
- In the same plotter window, click **Y-Quantity**, select **crouch1_gait**, and select **knee_angle_r**. Click **OK**.
- Click **X-Quantity** and select **crouch1_gait**. Click **OK**.
- In the **Curve Name** textbox edit the text to read **Crouch Gait**, then click **Add**.

Can you identify the intervals at which heel strike, stance, toe off, and swing phase occur for a "normal" gait cycle? Sketch a plot of the curve, and label the intervals.

What is the "normal" range of knee flexion during stance phase? How does this knee flexion curve for crouch gait compare to the normal gait data?



7. Hamstrings Length

To address the surgeon's question, compare the hamstrings (semitendinosus) length over the crouch gait cycle to the hamstrings length over the "normal" gait cycle.

- To delete the previous curves, select all the names from the **Curves List** and click **Delete**.
  *Note: To select multiple curve names, hold down **ctrl** while selecting.*
- Make the *normal* model current by selecting it from the **Model** drop down menu.
- Click **Y-Quantity** and select **muscle-tendon length**.
- Click on **Muscles** and select **semiten_r** from the list**.** Click **Close**.
  *Note: To quickly find the semiten_r, type **semi** into the **pattern** textbox.*
- Click **X-Quantity** and select **normal_gait**.
- In the **Curve Name** textbox edit the text to read **Normal Gait**.
- To add the curve of *hamstrings length vs. gait cycle*, click **Add**.
- To make a similar curve for the crouch gait data, make the *crouch* model current. Then, click on **Y-Quantity** and re-select **muscle-tendon length**.
- Click on **Muscles** and select **semiten_r** .
- Click **X-Quantity** and select **crouch1_gait**.
- In the **Curve Name** textbox, edit the name to read **Crouch Gait**, and then click **Add**.

Study the curves. *Based on the plot, what recommendation would you give the surgeon? Can you think of any limitations of your analysis?*