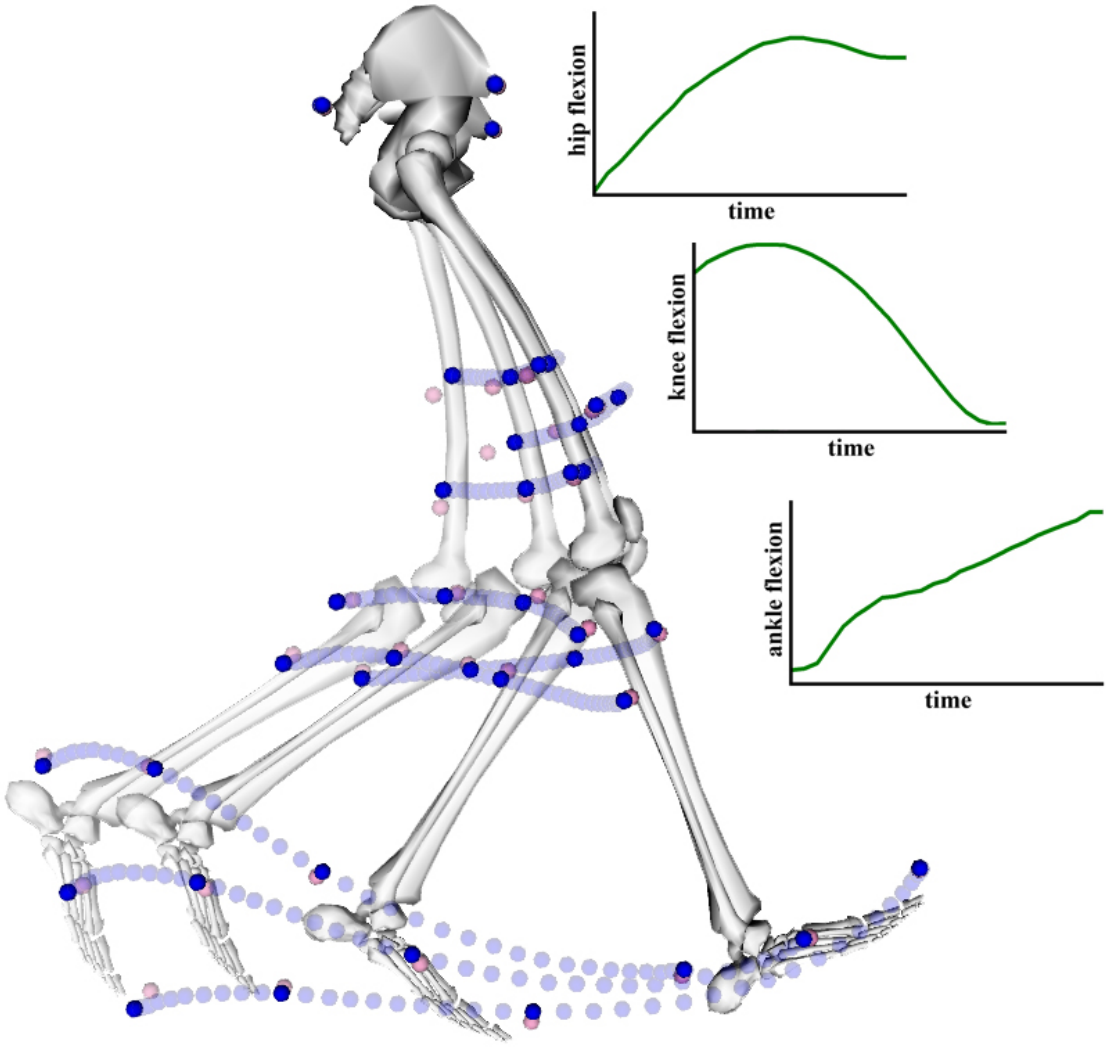


Inverse Kinematics

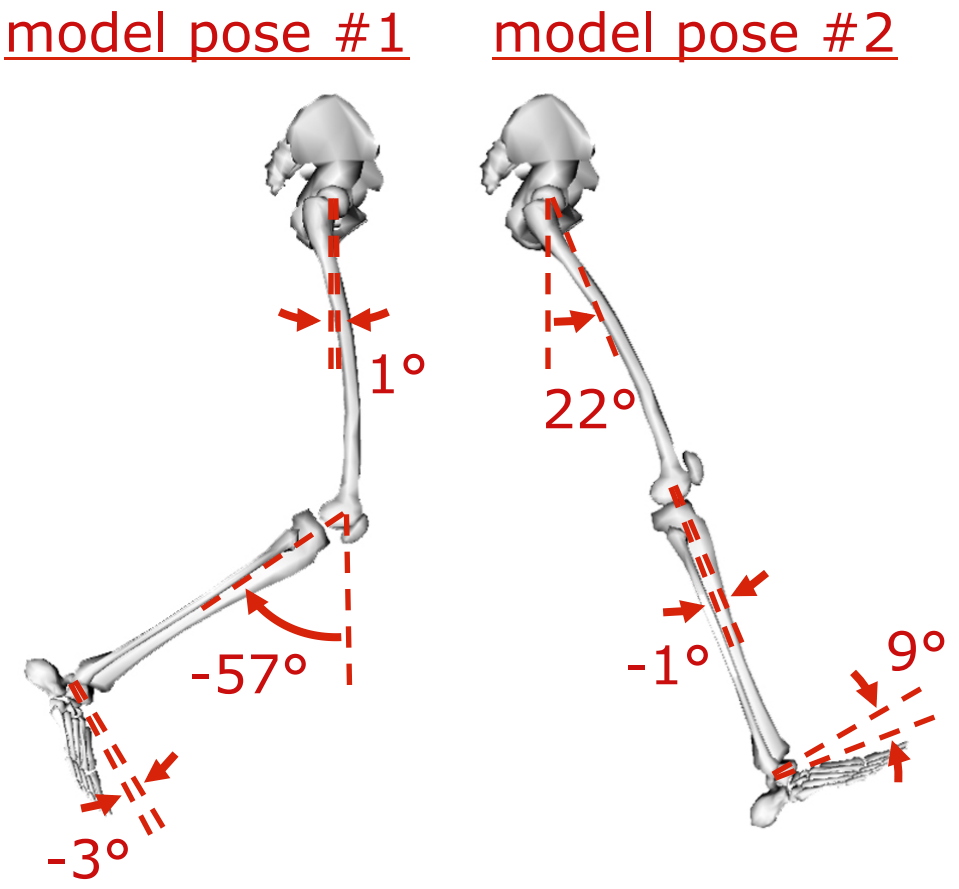
OpenSim Workshop

Key Concepts

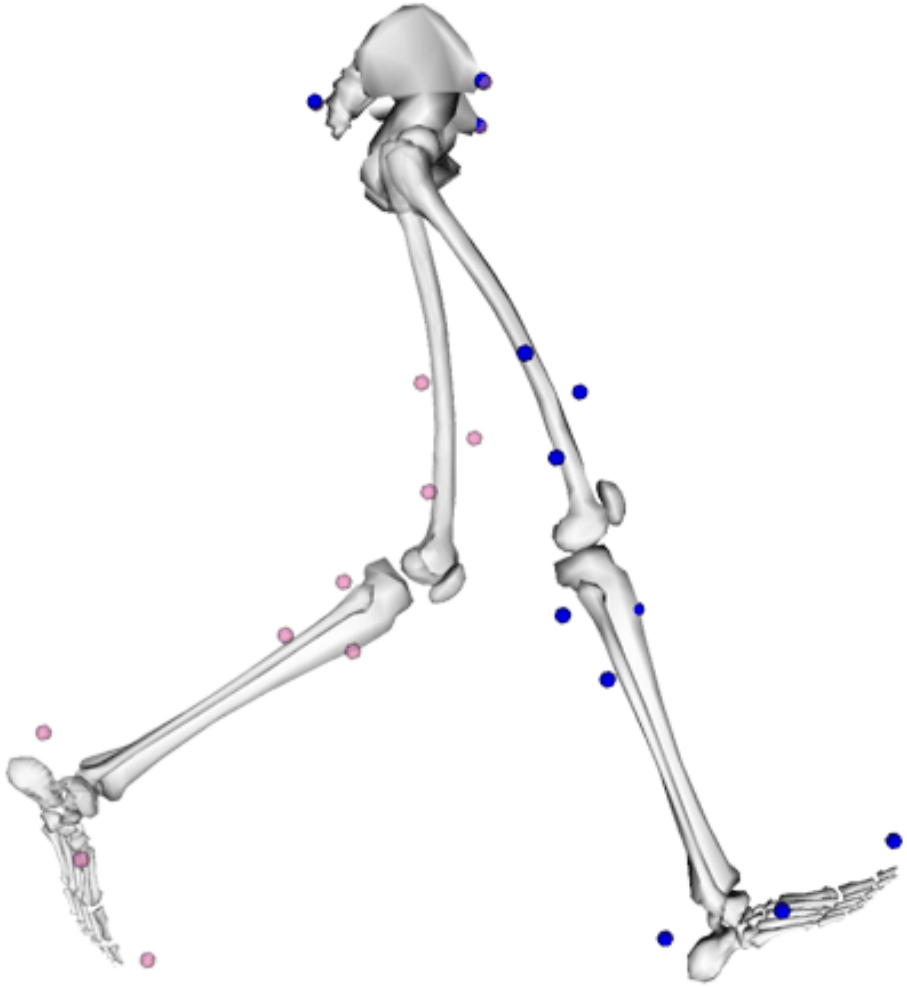
- Model pose and coordinates
- Marker error
- Coordinate error
- Weighted least squares minimization

Model Pose and Coordinates

- Model Pose
  - Orientations and locations of body segments in the model
  - Defined by set of model coordinates
- Coordinate
  - Joint angle or distance specifying relative orientation or location of two body segments

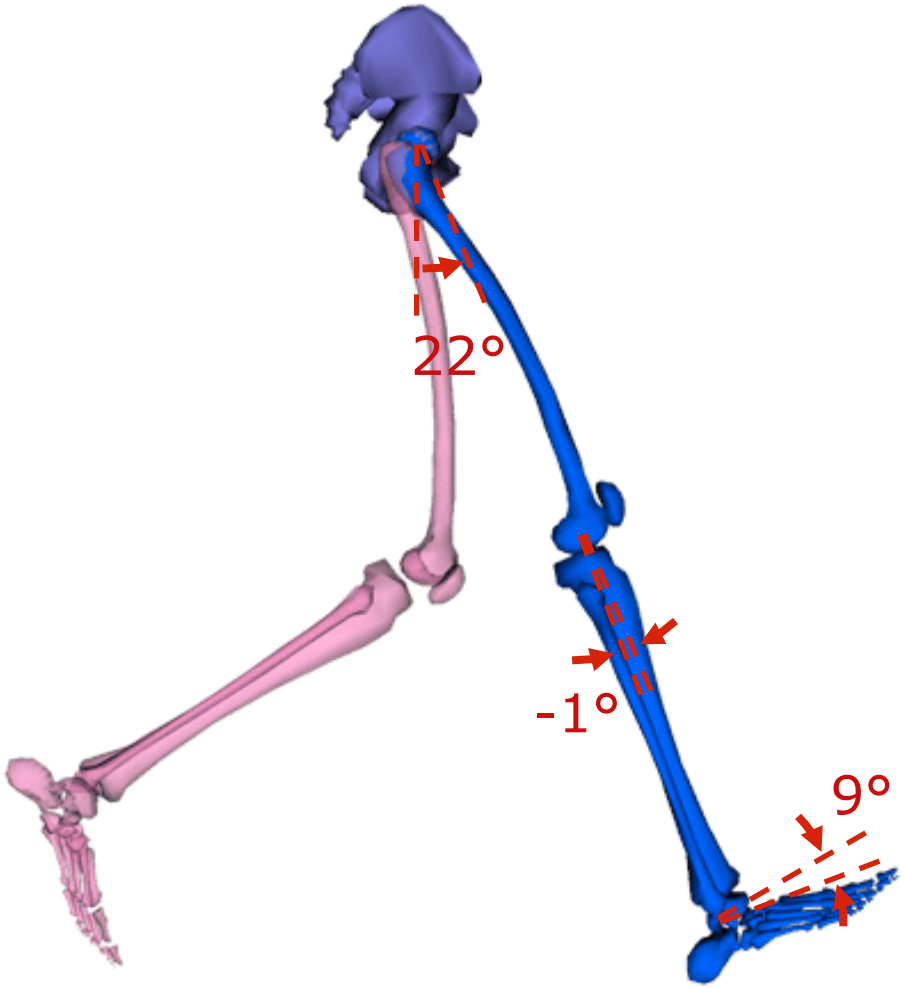


Marker Error



Marker Error

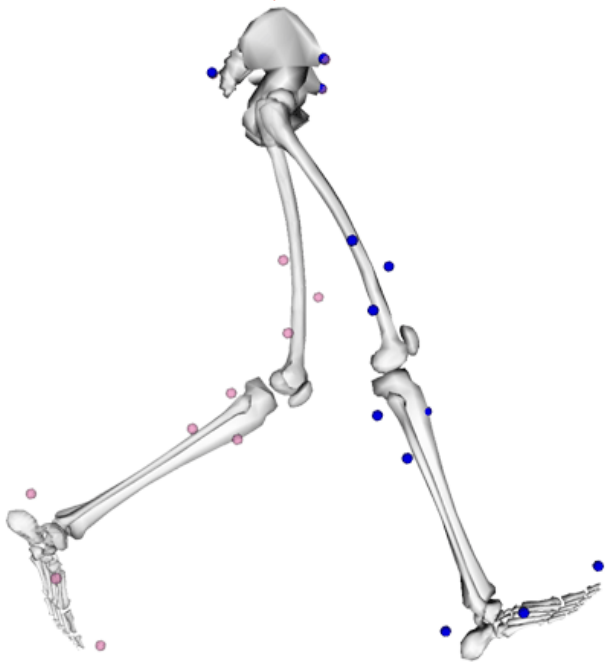
Coordinate Error



Coordinate Error

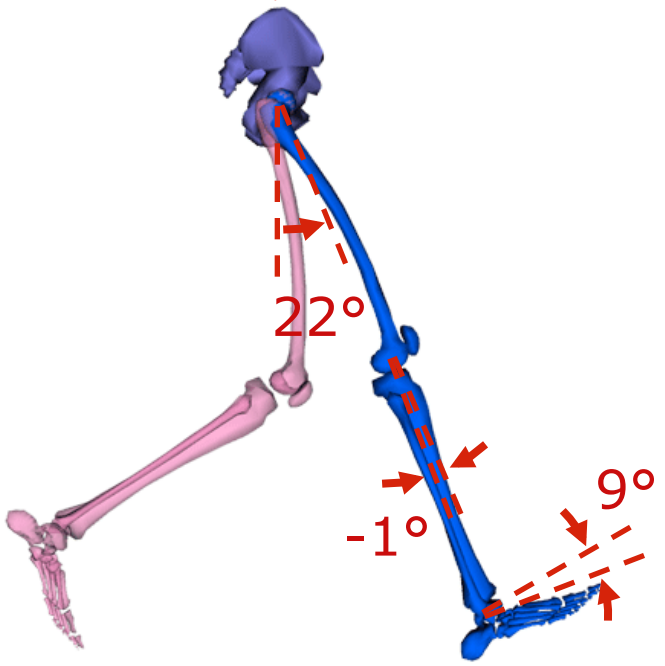
Weighted Least Squares Minimization

$$\min_{q}\left[\sum_{m=1}^{\#\text{ markers}} w_m \left\| \boldsymbol{x}_m^{\exp} - \boldsymbol{x}_m(\boldsymbol{q}) \right\|^2 + \sum_{c=1}^{\#\text{ coordinates}} \omega_c \left(q_c^{\exp} - q_c \right)^2 \right]$$



Marker Error

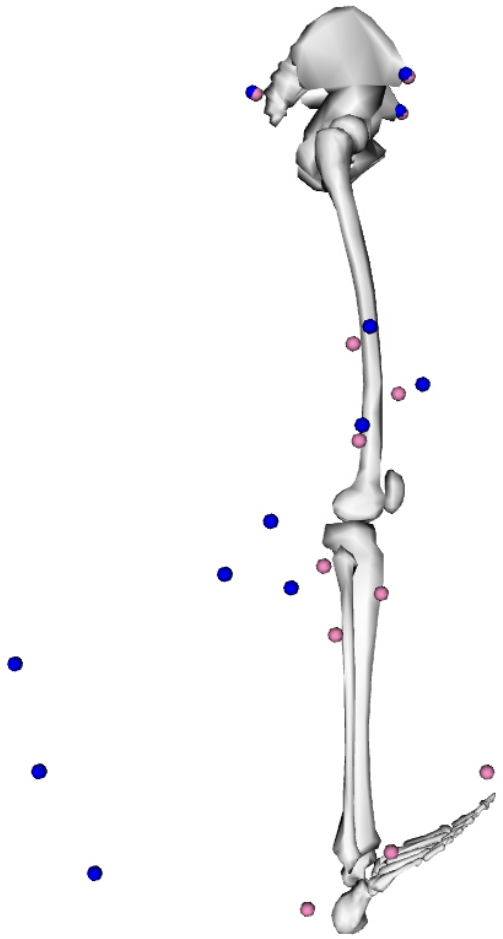
+



Coordinate Error

Exercise

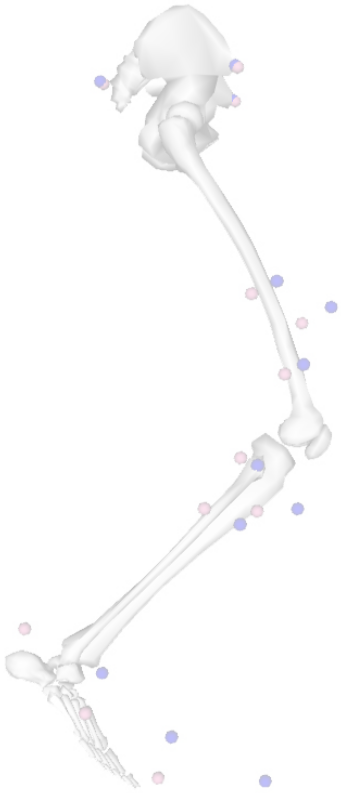
1. For the model shown on the right which **coordinate(s)** need to be ***adjusted to*** create a model pose ***"best matches"*** the **experimen markers** shown at the beginning swing phase?



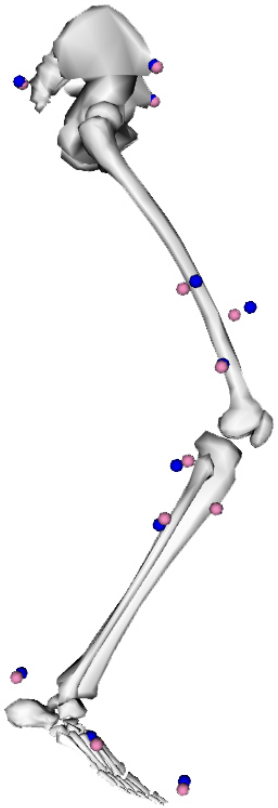
A. Hip
B. Knee
C. Ankle
D. Hip and ankle
E. Knee and ankle

Exercise

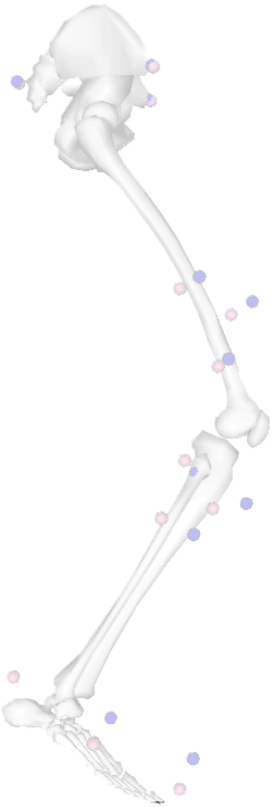
2. For the **model poses** and experimental markers shown below, which combination of pose and markers has the ***minimum*** **marker errors**?



A.



B.



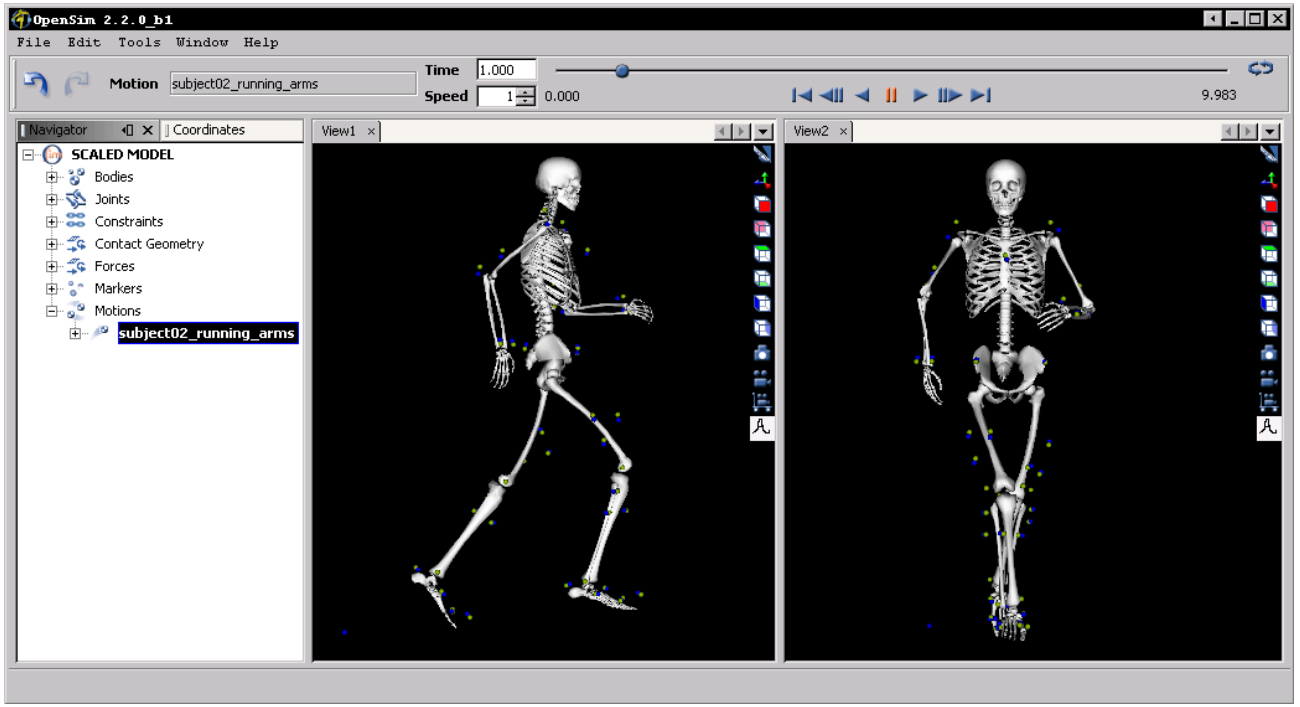
C.

Exercise

3. In theory, experimental **markers on the thigh and shank** could have ***more skin movement artifacts*** compared with the **foot markers**; which of the following scenarios would be ***most appropriate*** for the **weighted least squares minimization** solved by the Inverse Kinematics Tool?

   A. Decrease tracking weights on thigh markers
   B. Decrease tracking weights on shank markers
   C. Increase tracking weights on foot markers
   D. All of the above

Inverse Kinematics (IK)



TIPS & TRICKS
Marker weights are relative
Check max and RMS marker errors in messages window
Weight "motion" marker triads on body segments higher than anatomical markers
Max marker error should be < 2 cm with RMS error <1 cm