Dataset Description:

InclineExperiment.m contains leg joint kinematics, kinetics, and EMG activity from an experimental protocol approved by the Institutional Review Board at the University of Texas at Dallas. Ten able-bodied subjects walked at steady speeds and inclines on a Bertec instrumented treadmill for one minute per trial. Each subject walked at every combination of the speeds 0.8 m/s, 1.0 m/s, and 1.2 m/s and inclines from -10 degrees to +10 degrees at 2.5 degree increments, for a total of 27 trials. During each trial, a 10-camera Vicon motion capture system recorded leg kinematics, while force plates in the Bertec treadmill recorded ground reaction forces, and a Delsys Trigno EMG system recorded muscle activation of the rectus femoris, biceps femoris, tibialis anterior, and gastrocnemius. This data can be used to test different hypotheses and models of human locomotion at varying speeds and inclines.

Citation:

K. Embry, D. Villarreal, R. Macaluso, and R. Gregg, "Modeling the Kinematics of Human Locomotion over Continuously Varying Speeds and Inclines," *IEEE Transactions on Neural Systems and Rehabilitation Engineering*

Size:

4.2 GB

Environment:

The file is of *.mat format and can be opened using MATLAB. To do so in your MATLAB workspace, use the load command and the full file extension

load('C:\ example_folder\InclineExperiment');

This will load two variables to your workspace, Continuous and Gaitcycle.

Major Component Description:

This experiment's data is saved in two MATLAB structs, Continuous and Gaitcycle.

Continuous: This struct has one minute of data recorded at 100 Hz (6000 measurements). The EMG and force plate data, which record at 2000 and 1000 Hz respectively, were downsampled so that all data in this struct is shown at 100 Hz. The units for all quantities are included in the struct Data Hierarchies below.

y=Continuous.(subject).(trial).(datatype).(leg).(variable)

[y will generally be of dimensions 6000x1 or 6000x3, depending on if the variable is scalar-valued or has x,y,z components]

(subject) = ABXX: Individual results are shown for all 10 anonymous able-bodied subjects.

(trial) = subjectdetails: This field gives the subject's gender, age, height, weight, and left/right leg lengths.

sXXi/dYY: Results are given for each combination of walking speed and incline a subject performed. In the naming convention shown, XX = speed of the trial in m/s, and YY = incline of walking in degrees. Decimal points are replaced with an "x." An "i" before YY indicates an inclined trial, while a "d" indicates a decline. For example, s1x2i7x5 would mean the trial was recorded at 1.2 m/s at positive incline of 7.5 degrees. This information is also provided explicitly in (trial).description.

(datatype)= description: A cell array containing the speed and incline of this trial.

time: An array with the time since the beginning of the experiment for every frame.

kinematics.markers: An array with world-frame positions of all motion-capture markers, located on the Anterior Superior Iliac Spine (asi), Posterior Superior Iliac Spine (psi), the thigh, knee, tibia, ankle, heel, and toe of both legs.

kinematics.jointangles: An array with the joint angles for the pelvis, hip, knee, ankle, and foot as calculated by Vicon Plug-in Gait (Vicon, Oxford, UK).

Joint definitions, provided by Vicon:
(https://docs.vicon.com/display/Nexus25/Lower+body+modeling+with+Plug-in+Gait)
pelvis: (absolute) The angle between the pelvis and the laboratory coordinate system.
hip: (relative) The angles between the pelvis and the thigh (+x is flexion, -x is extension).
knee: (relative) The angles between the thigh and the shank (+x is

flexion, -x extension).
ankle: (relative) The angles between the shank and the foot (+x dorsiflexion, -x plantarflexion).
foot: Absolute. The angles between the foot and the global coordinate system.

emgdata.emg: Delsys EMG sensors (Model:Trigno wireless system, Delsys, Natick, MA) were attached to the rectus femoris (RF), biceps femoris (BF), tibialis anterior (TA), and gastrocnemius (GC). The EMG signals have been rectified and low-pass filtered (fc=40) with a zero-phase digital filter (MathWorks, Natick, MA).

emgdata.accel: Each Delsys EMG also contains a 3-axis accelerometer that reports an acceleration vector in the local frame.

kinetics.jointpower: An array of the power generated by each joint, determined by Plug-In Gait (Vicon).

kinetics.jointforce: An array of the force applied at each joint, determined by Plug-In Gait (Vicon).

kinetics.jointmoment: An array of the moment generated by each joint, determined by Plug-In Gait (Vicon).

kinetics.forceplate.force: A 3D force vector from force plates in the split belt instrumented treadmill (Bertec, Columbus, OH). These signals have been low-pass filtered (fc=40) with a zero-phase digital filter (MathWorks).

kinetics.forceplate.moment: A 3D moment vector from force plates in the split belt instrumented treadmill (Bertec).

kinetics.forceplate.cop: The center of pressure location (world-frame) from force plates in the split belt instrumented treadmill (Bertec).

(variable)= Field depends on the (datatype), see **Continuous struct Data Hierarchy** below.

(marker): In the markers (datatype), results are given per marker: asi, psi, thigh, knee, tibia, ankle, heel, or toe.

(joint): In several (datatype), results are given per joint: hip, knee, or ankle and for the jointangles (datatype), also pelvis and foot.

(muscle): For the emgdata (datatype), results are given per muscle: RF, BF, TA, or GC.

(forceplate): For the forceplate (datatype), results are given per the force, moment, or center of pressure (cop) measurement from Bertec forceplates (Bertec).

Gaitcycle: This struct contains the same underlying data as Continuous, but has been broken down into individual gait cycles which begin and end at heel strike. It contains most of the same fields as Continuous, plus the fields listed below:

y=Gaitcycle.(subject).(trial).(datatype).(leg).(variable)

[y will generally be of dimensions 150xM where M is the number of strides recorded for that subject and trial. The 150 points are a linear interpolation of the continuous signal over a given gait cycle.]

(datatype)= stepsout: Contains a vector of strides that we have identified to be outliers, as defined by having kinematics 3 standard deviations from the mean.

cycles.time: An array with the same dimensions as the other Gaitcycle data that indicates the time since the beginning of the corresponding stride.

cycles.frame: A vector that indicates what frame each heel strike occurred on.

(variable)= (joint): For the jointpower (datatype), results are given per joint: hip, knee, or ankle.

(muscle): For the emgdata (datatype), results are given per muscle: RF, BF, TA, or GC.

(direction): For most other (datatype), results are split into three component directions: x, y, or z.

(joint)_mean, (muscle)_mean, or (direction)_mean: The mean of all M strides' (datatype) for a given subject, trial, and leg. This will be a 150 x 1 vector. Note this mean includes strides that were indicated to be outliers.

(joint)_std, (muscle)_std, or (direction)_std: The standard deviation of all M strides' (datatype) for a given subject, trial, and leg. This will be a 150 x 1 vector. Note this standard deviation includes strides that were indicated to be outliers.

Known issues:

Kinematic data will be missing when less than three cameras have a concurrent view of a marker. These points are represented by a NaN in this dataset. We recommend the use of 'nanmean' and 'nanstd' on these data.

The right tibialis anterior EMG sensor was malfunctioning for AB04 – AB08. For those subjects, this sensor will sometimes return only zero values.

AB05 s1x2d7x5 is shorter than the other trials, at only 3730 frames.

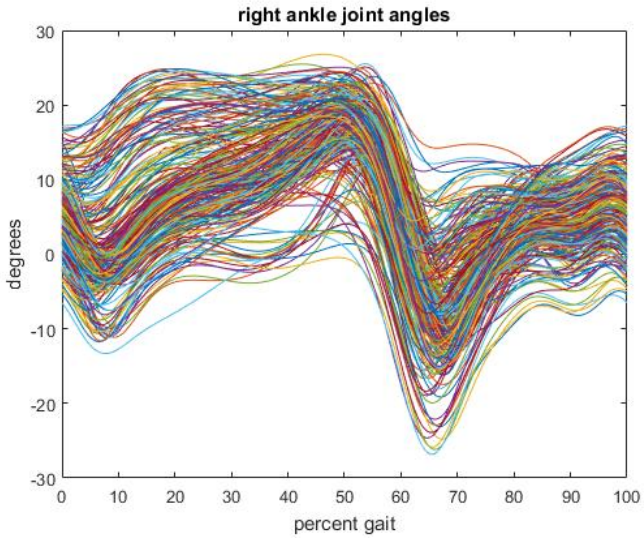
emgdata is unavailable for AB09 s0x8i2x5.

jointpower, jointforce, and jointmoment have not been filtered. We recommend a low-pass filter before use, but the cut-off frequency may depend on your application.

Example:

ExampleScript.m is a MATLAB script that demonstrates some common uses of this dataset, namely iterating over fields in the struct, removing strides that were indicated to be outliers, and taking the mean of data containing NaN values.

expected output:



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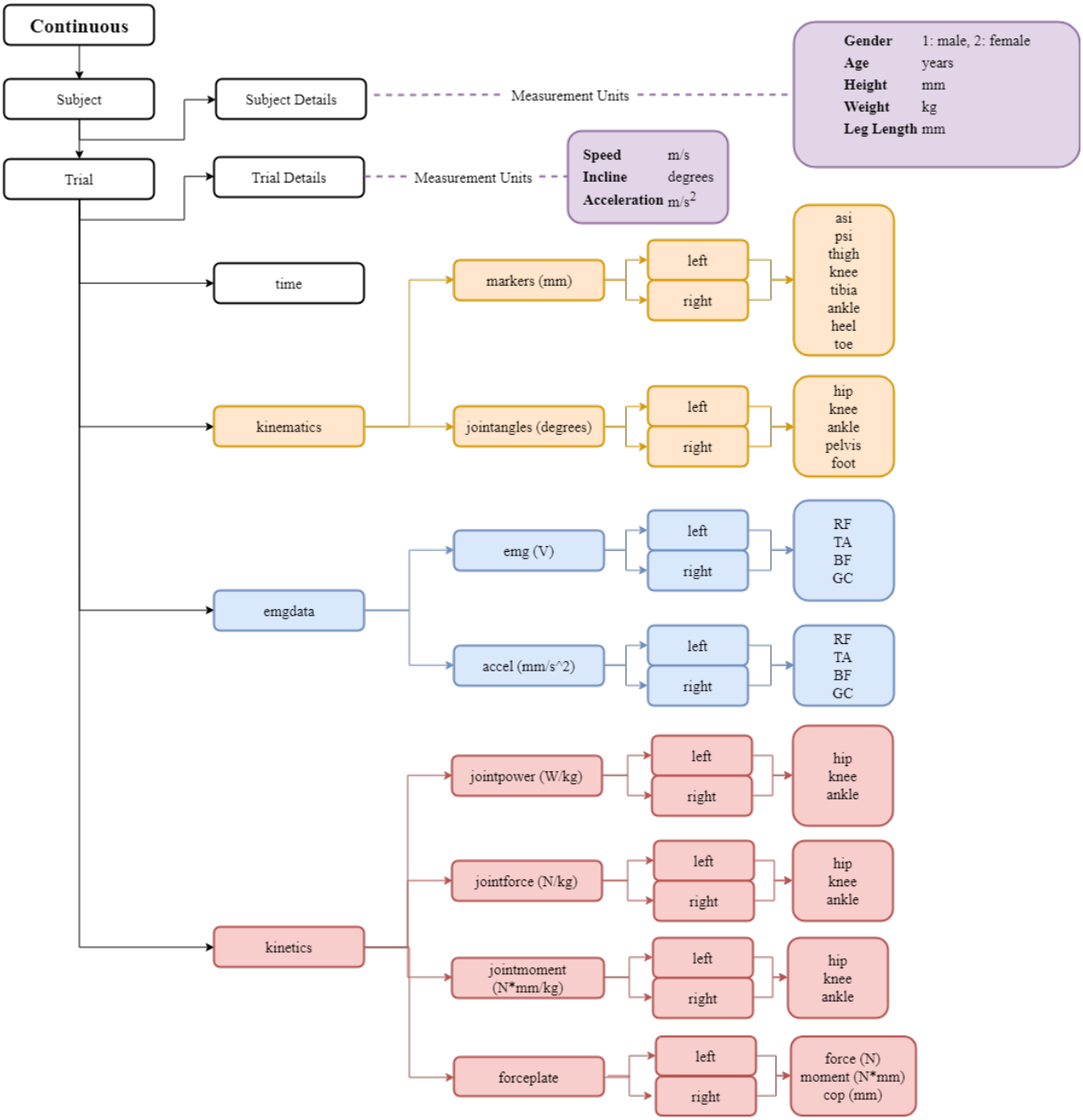
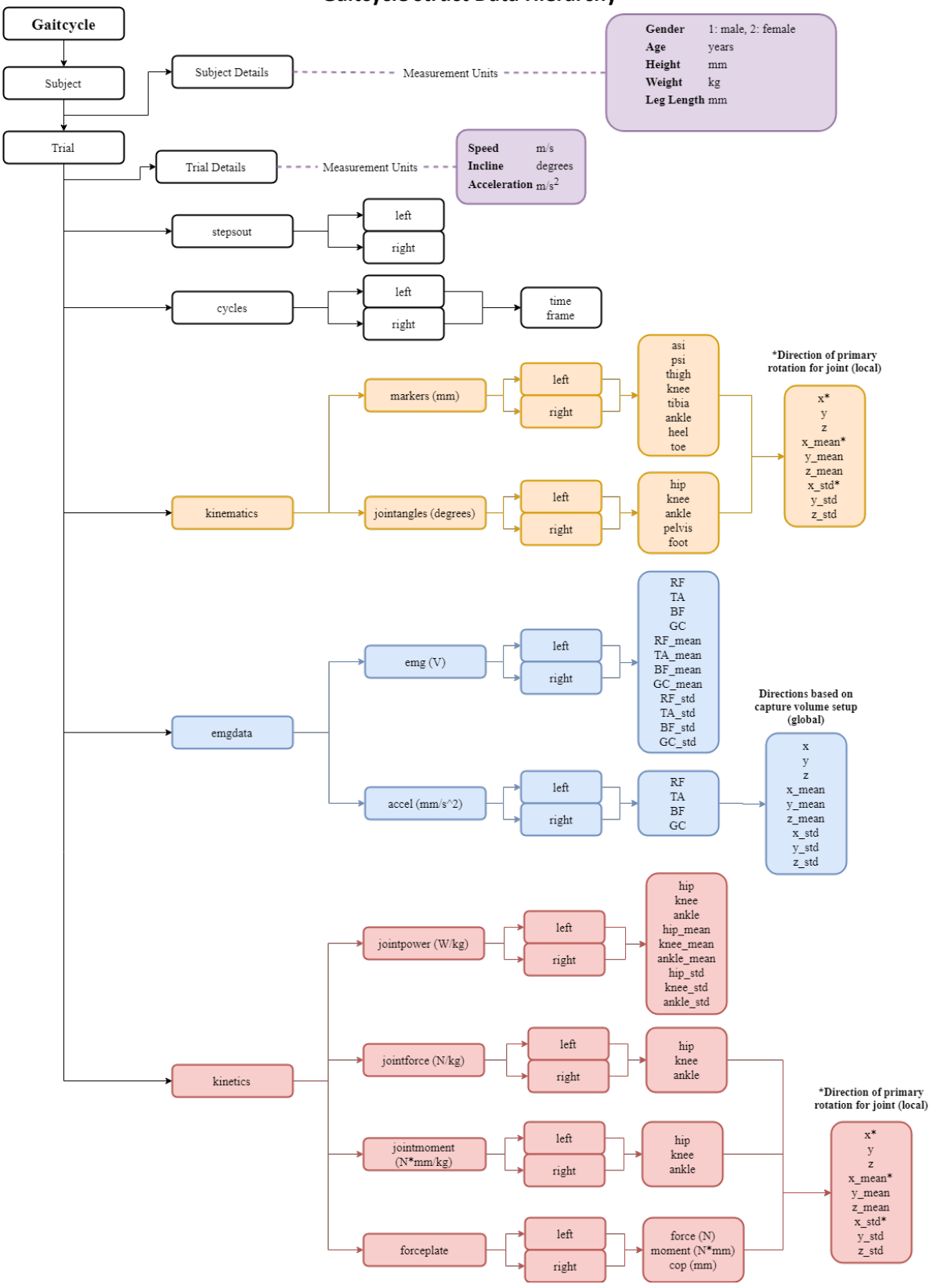
Continuous struct Data Hierarchy



Gaitcycle struct Data Hierarchy