We can’t understand anything about how the nervous system organizes and controls a movement until we can understand the movement itself and the biomechanics of the body controlled by the nervous system.

This Word Notebook is designed to be worked on in conjunction with the Colab Notebook titled “NotebookColab\_Kinematics\_WBDSdataset.ipynb.” These notebooks will guide you through the exploration of [“a public dataset of overground and treadmill walking kinematics and kinetics in healthy individuals”](https://doi.org/10.6084/m9.figshare.5722711) created by a [research group](https://peerj.com/articles/4640/) in Brazil.

Before starting your work on this assignment, it will be helpful to complete the Colab Notebook titled “NotebookColab\_Introduction.ipynb” if you have not already done so.

In working through the steps outlined below, you will learn more about movement and how it is measured and analyzed. Specifically, you will learn about how (some) human bodies walk in the context of current standard practices in the fields of biomechanics. You will also practice using data processing and visualization techniques common to neuroscience, physics, biology, and many data science professions.

Your work on these notebooks will scaffold discussions throughout the course about kinematics of a variety of movements, the challenges faced by the nervous system in controlling movement, and emerging technologies that are revolutionizing ways of quantifying movement.

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a. Dataset selection for raw data

* + select a dataset
  + load the selected dataset

b. Menu of analyses for the raw dataset (steps 4-6 below)

* 4. Explore raw kinematics data
* 5. Explore ground reaction force data
* 6. Identify individual gait cycle trials

1. Processed Data: Analyze time-normalized and processed data

Assignment Sections (step #s refer to the Colab Notebook)

**Section 1. Setup**

Read the Introduction (#1) and complete the Preparatory Steps (#2) to set up the Colab notebook environment for your work.

**Section 2. Dig right in and explore**

Follow the instructions in the Colab notebook Step #4. First, you will select: an “experimental subject” (person) by number; a walking environment (overland or treadmill); and a speed for the overland/treadmill. Then you will load the data for the person, environment, and speed you selected.

Reflection #1: Use the Colab notebook to make a plot that you can use to compare with your predictions about kinematics of walking you made during class. Make a figure (Figure 1) that compares each side by side in two panels (Figure 1A: your prediction, and Figure 1B: the data).

Explore more kinematic variables… follow your curiosities about what kinematics are related to each other and in what ways. There are many to choose from. Explore both ‘ipsilateral’ and contralateral comparisons.

Reflection #2: Choose a small subset (~2-4) of kinematic variables that interested you. Create a Figure (Figure 2) of the same variables in the same subject, but for two different environments (Figure 2A and 2B). Write a brief reflection on the comparison based on the figure you made. Remember to compare similar time windows (use the zoom features to control this). Annotate the plots to highlight aspects of the data and comparisons that you make note of in your reflection.

Reflection #3: Choose a small subset (~2-4) of kinematic variables that interest you. Create a Figure (Figure 3) with two panels (A and B) that compares two different speeds from the same subject in the same environment.

**Section 3. Practice some basic data processing.**

Follow instructions in the Colab Notebook for Steps #5 and #6.

In this section, you will transform the continuous measurements into trials and look at trial-to-trial variability. Each trial will be defined by the onset of a gait cycle. The onset of a gait cycle is determined based on kinetic data (ground reaction forces measured by the force plates).

Reflection #1: Choose one kinematic variable to focus on. Make a figure with two panels that helps you discuss trial-to-trial variability. For Figure 4A, plot of the kinematic variable you selected (with your specified gait trials overlaid). For Figure 4B, plot the kinetic variable you used to determine the trial onsets and the gait cycle.

**Section 4. Visualizing and analyzing the processed data.**

Follow instructions in the Colab Notebook for Step #7.

In this section, you will visualize and explore the processed data.

Make whatever figures and notes you want based on what you learn by exploring.

As you work, here are some things you might consider:

* What is “time-normalization” and why is it important for studying the kinematics of movement?
* What is different or unexpected about the dynamics of right versus left body parts based on your exploration of the raw data?
* Which directions in 3D space does the movement vary most along in this dataset?
* Why are the kinematics of the body analyzed in terms of angles rather than positions?

Write down questions you notice asking yourself as you explore and visualize: