Hands on: Divergence of movement (or rather, stability of movement)

During the intro lecture, we have seen how the local divergence exponent is calculated, and what the choices that need to be made are (mostly; number of dimensions, embedding delay, and where to calculate the slope). Now, it is time to play around with this ourselves. We will do so in three steps

1. First we will calculate the local divergence exponent of 1 data set, using standard parameters
2. Next, we will vary the embedding dimension and delay, and study the effects of doing so on the local divergence exponent for data from <u>one</u> subject
3. Next, we will vary the embedding dimension and delay for all subjects. The goal here is to show that, as long as you pick the same embedding dimension and delay for all subjects, there will be an effect of embedding dimension and delay, but this effect is very unlikely to affect your studies outcomes

In the zip file Divergence.zip, you will find 2 folders;

- Code; this is where all code is, it contains
    - A main.m file, which is already set up to start working on
    - The folder LocalDynamicStability (cloned from https://github.com/SjoerdBruijn/LocalDynamicStability), which contains
        - Example.m ;an example of how to use the code
        - Lds_calc_mehdizadeh.m ; a function to calculate local divergence exponent using multiple nearest neighbours, as in Mehdizadeh et al 2019.
        - Lds_calc.m ; a function to calculate the local divergence exponent according to Rosenstein et al 1993
        - Licence ; a license file
        - Makestatelocal.m ; a function to create a state space, given a certain dimension and delay
        - Readme.md ; the readme
        - Testdata.mat ; some test data, which is also used in the example.m
- Data ; a folder containing the data, which contains
    - Workshopdata.mat, a mat file containing the following variables:
        - Data (16x4) (subject x condition); a structure with the following fields;
            - Signal; the mediolateral trunk position of the trunk over time
            - Lhs; the indexes when left heel strikes happened

Now that we know the data structure, we can start to work on it. For now, we focus on condition one, subject one.

1. **Calculating the local divergence exponent using standard settings for one data set**

- First, run the example.m from within the folder where it is in, and try to understand the variables that you have.
- Next, use the script main.m as a start for your own analysis
    - First try to understand your data, which is already loaded for you in this script

- Next, copy and paste the necessary steps from the example.m to calculate the local divergence exponent from subject one, trial one.
- As you see, this may take quite some time (depending on your computer). To shorten the time it takes (especially in the next steps), you can consider to calculate the local divergence exponent for only a part of the trial. The easiest way to do this is to simply not give all heelstrikes to makestatelocal.m, but to limit it to (for instance) 100; this way, only a state space of the first 100 strides will be created.

2. Studying the effects of embedding dimension and delay, for one subject, one trial

- Using the script you just calculated, see what happens if you change the parameters of embedding dimension and delay. Does the local divergence exponent change in a predictable way for each of these parameters?
- If your programming skills allow, do this in a more systematical way; write a for loop over each of the parameters, and try for some range of the parameters.

3. Does what we found under 2. Affect results of your study?

The fact that the local divergence exponent changes with embedding dimension and delay in and of itself doesn't have to be that bad. It would only be bad if when choosing one embedding dimension and delay, you would get different *qualitative* outcomes. For instance if when choosing dim=5 and delay=10, you would find that condition 1> condition 2, but when choosing dim=7 and delay=15, you would find that condition 1<condition 2. To check if this could be the case, we can of course;

- Calculate the local divergence exponent for a given embedding dimension and delay
- Calculate if for another embedding dimension and delay
- See if the subject with the highest local divergence exponent for set of parameters 1, also has the highest for set of parameters 2.
- So, you task now is to study whether this could happen. First, focus on the ordering of subjects as a function of embedding dimension and delay. If you have time left, you can also study the conditions (which condition is the most unstable?)