



Getting started with motion analysis can be very challenging. In particular for students and non-researchers, it might be difficult to get access to biomechanical data. A sufficient database with basic sport- and clinical relevant movements could therefore help to understand the principles of motion analysis. Furthermore, such a database can be useful to learn the methods applied for musculoskeletal modeling. Getting an understanding of different types of movements with visual support can help to understand and analyze complex movement sequences.

Therefore, we would like to introduce the “MoLib” a library of different types of sport and clinically relevant movements. We hope that this platform can provide a comprehensive source for students to understand the basic principles of musculoskeletal modeling and help teachers to graphically support their lectures. The data provided here was recorded in the laboratory of the German Sports University Cologne, Institute of Biomechanics and Orthopaedics.

Each movement comes with multiple files with the c3d file extension (i.e. static reference measurement, several dynamic trials). Further information on how to work with .c3d files can be found in the [BTK and Mokka tutorial](#). Additionally, the library consists of data that have been processed with the OpenSim software (<https://opensim.stanford.edu/>). OpenSim is an open-source software to analyze and exchange musculoskeletal models and simulations. The free of charge software is therefore a great opportunity to get insight into the world of motion analysis and simulation.

As a continuously growing library, we are planning to update the library with additional movements. If you are interested in a particular type of movement please don't hesitate to contact us. To make the following tutorial consistent for future movements, we created a folder structure so that the loading of new movements works smoothly. For a detailed explanation of the folder structure, we refer to figure 1. Furthermore, unless it is marked differently, we will use the same full-body marker set for all movements. A detailed explanation of all markers can be seen in figure 2 or by loading a static reference measurement.

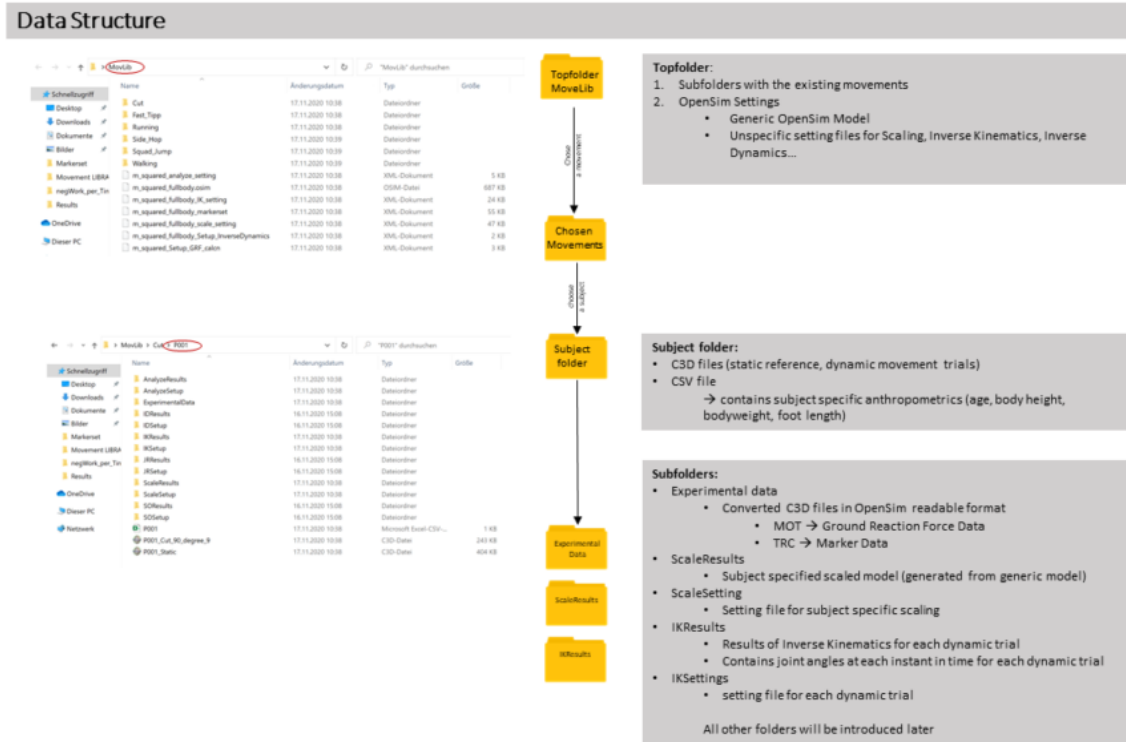


Figure 1: Data Structure



complete Markerset - Fullbody

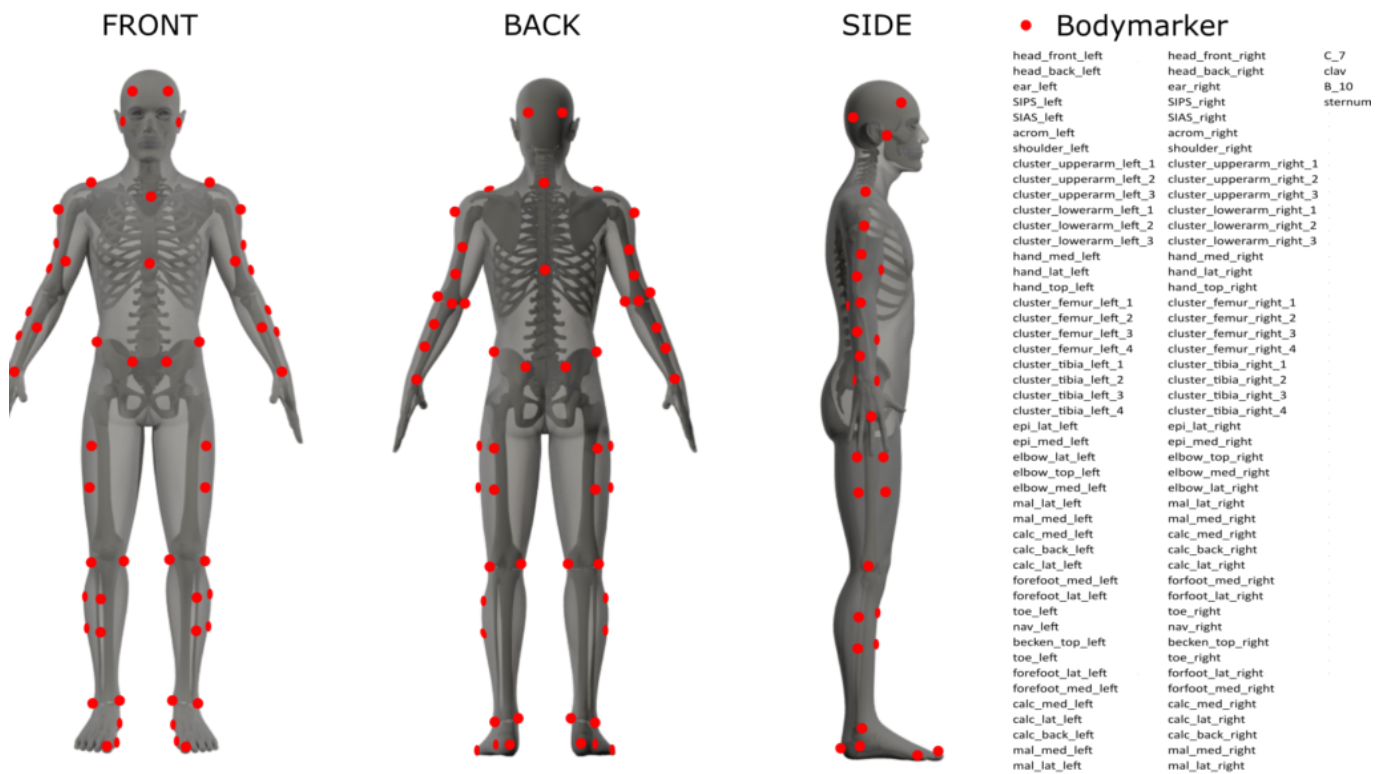


Figure 2: Markerset used in the Motion Library

Although we are analyzing the data in OpenSim and providing the results, this tutorial will not be a guide to perform movement analysis in OpenSim. Instead, the purpose of the movement library is to showcase biomechanical data. An OpenSim tutorial is already in the planning.

When finishing reading the article and watching the videos below you will be able to load inverse kinematics results, visualize movements, and display forces and marker data simultaneously.

Please note that we have so far only one participant in our database, more are planning to come. In the early phase, we have six various types of movements included: walking, running, change of direction, squad jump, side hop, and fast tips.



To getting started with the *MoLib* install OpenSim first. Please following the introduction below.

Quick Start Guide – How to download OpenSim 4.1

- Search for „OpenSim download“ or insert this link https://simtk.org/frs/?group_id=91
- Choose „Download Links“
- Choose your operating system
- Create an SimTK account or log in to your account
- Agree to the License Agreement and click the download button
- Find your OpenSim under Downloads on your Computer and install the Software
- Follow the installation steps on your Computer

The figure shows a screenshot of the OpenSim website. On the left, the 'Downloads' section lists two installers: 'OpenSim 4.1' for Windows (233 MB) and 'OpenSim 4.1 macOS' (244 MB). The 'Download Links' link is circled in red. Below this, the SimTK login form is shown, with the 'Einloggen' button and the 'Create new account' link circled in red. On the right, a license agreement form is shown, with the 'I Agree & Download Now' button circled in red.

Figure 3: How to install OpenSim

After you have installed OpenSim you can start to watch the following video tutorial, explaining how to load movements into OpenSim.

Or you can watch the following video to load markers and force data only.



Further information about OpenSim can be found at

<https://simtk-confluence.stanford.edu/display/OpenSim/Tutorial+1+-+Intro+to+Musculoskeletal+Modeling#Tutorial1-IntrotoMusculoskeletalModeling-IntroductiontotheOpenSimGUI>