Introduction

OpenPose [arXiv:1812.08008, arXiv:1704.07809] is a program that represents a real-time multi-person system to jointly detect human body, hand, facial and foot keypoints (which are in total 135-keypoints) on images. This can be interesting for doing research on movements. The program can detect up to 25-keypoints of the body and 21-keypoints for each hand, further it can estimate 70-keypoints of the face which makes it valuable to use in a scientific setting. You will only need to have a video recording from the situation where you want to know the movement from and let the program do its thing. The program works on one person but also several people.

Here are some requirements for the video:

- Make sure you have a fixed camera position
- The higher the framerate of your camera, the better. With a lower framerate chances are that fast moving body parts (e.g. during hand gestures) are not recognized by the program
- If people switch positions in the video, (e.g. person A was first on the left and person B on the right, but then person A changes places with person B), make sure to check the eventual timeseries data to find out whether the initial person A is still recognized as person A, etc.

As useful as OpenPose is, a lot of behavioral researchers do not use it yet, in part because of the relatively inaccessible way to operate this program. Instead of a program like SPSS or Adobe Premier, OpenPose operates with commands in command prompt, which is not always part of the job description of a behavioral researcher. This is why this manual is made for everyone who wants to use OpenPose for research purposes and doesn't know (yet) how to operate command prompt, and R.

During the manual we will guide you through the downloading process, how to start OpenPose and how to actually get output from the program into something you can analyze, using a R-script. Throughout the manual we will try to foresee which problems could occur and answer questions that we encountered ourselves.

We are showing you how to use the version 1.4.0 of OpenPose. Whilst writing this manual, a newer version was developed. The versions work exactly the same (according to the website), with the exception that the new version requires a higher power computer and graphic card. So if your computer can handle the requirements of the program, feel free to use the newest version. Otherwise, the version 1.4.0 works fine for research goals.

In the remainder of the manual, you will find the following contents:

Step 0: Check the requirements

- CUDA (Nvidia GPU) version:

  - NVIDIA graphics card with at least 1.6 GB available

  - At least 2.5 GB of free RAM memory for BODY_25 model or 2 GB for COCO model

  - Highly recommended: cuDNN

- OpenCL (AMD GPU) version:

  - vega series graphics card

  - at least 2 GB of free RAM memory

- CPU-only (no GPU) version:

  - Around 8 GB of free RAM memory
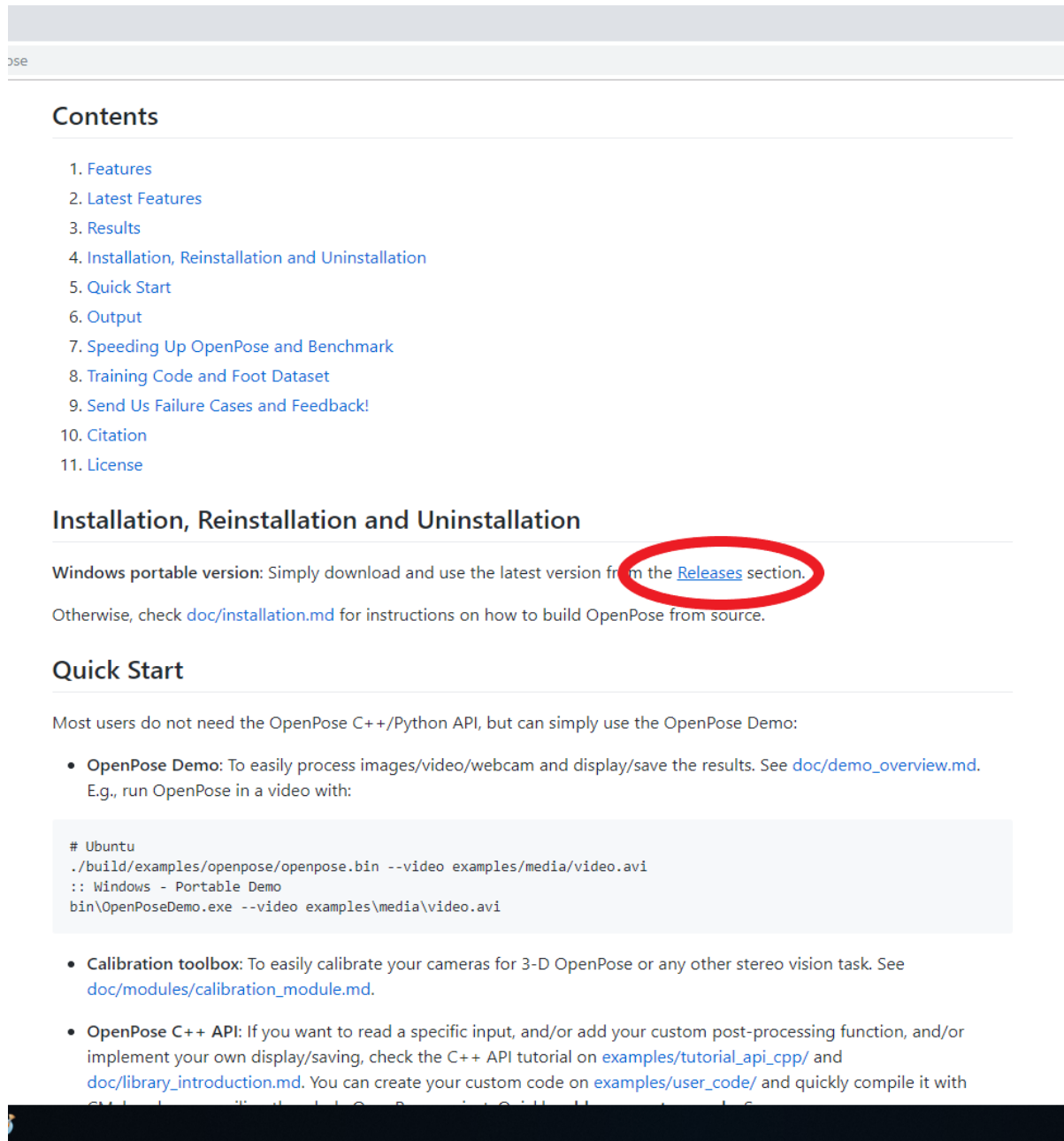
- Highly recommended: a CPU with at least 8 cores

To check whether you have a graphics card with GPU, you can the task manager (Ctrl+Alt+Del). If you have a graphics card with a GPU, you can find the type at the right op of the window.
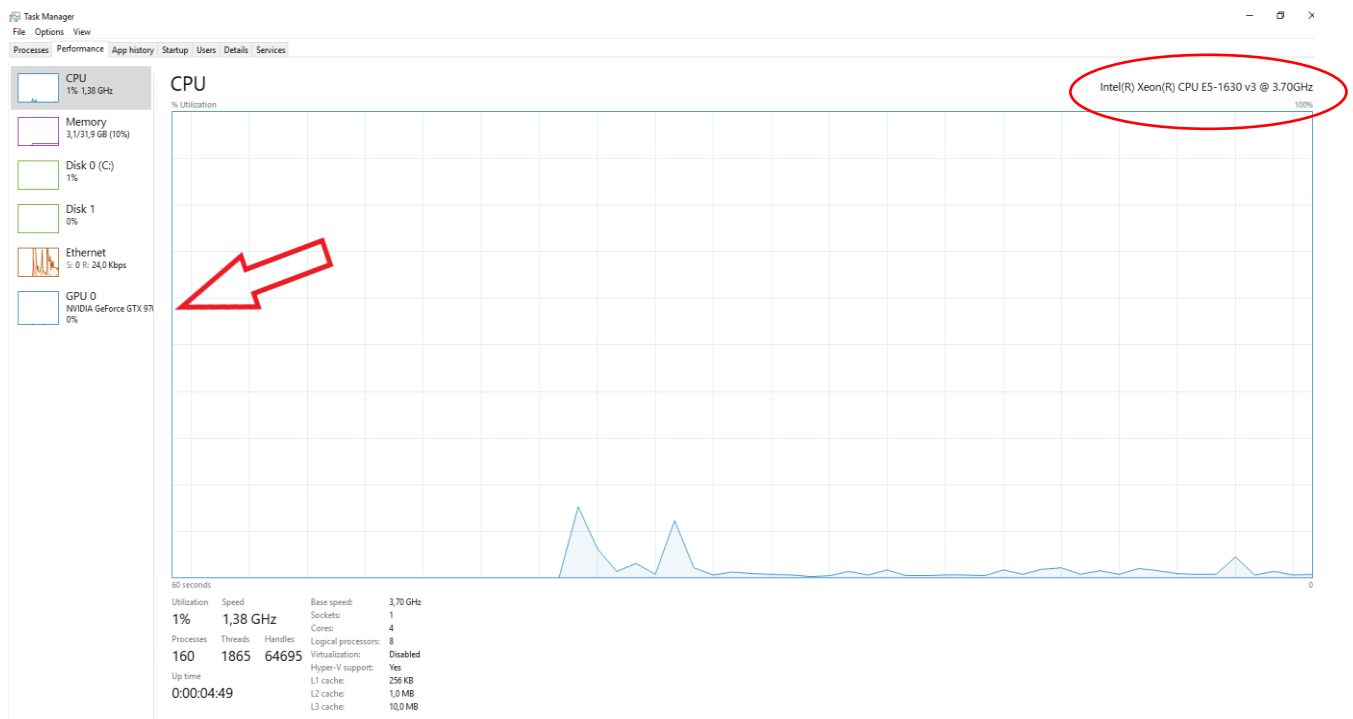
Step 1: Download OpenPose

You can find OpenPose's main website over here: https://github.com/CMU-Perceptual-Computing-Lab/OpenPose

Scroll down the main page, until you find the heading *Installation, Reinstallation, and Uninstallation.* Underneath that heading you can find a link to the Releases-page. Click on that link.

On the Releases-page, scroll to the version of OpenPose that you want to install (i.e. 1.4.0 or 1.5.0) depending on the features of your computer. Select the zip-file that ends with [...recommended.zip]. The zip-file will now start downloading to your Downloads-folder.
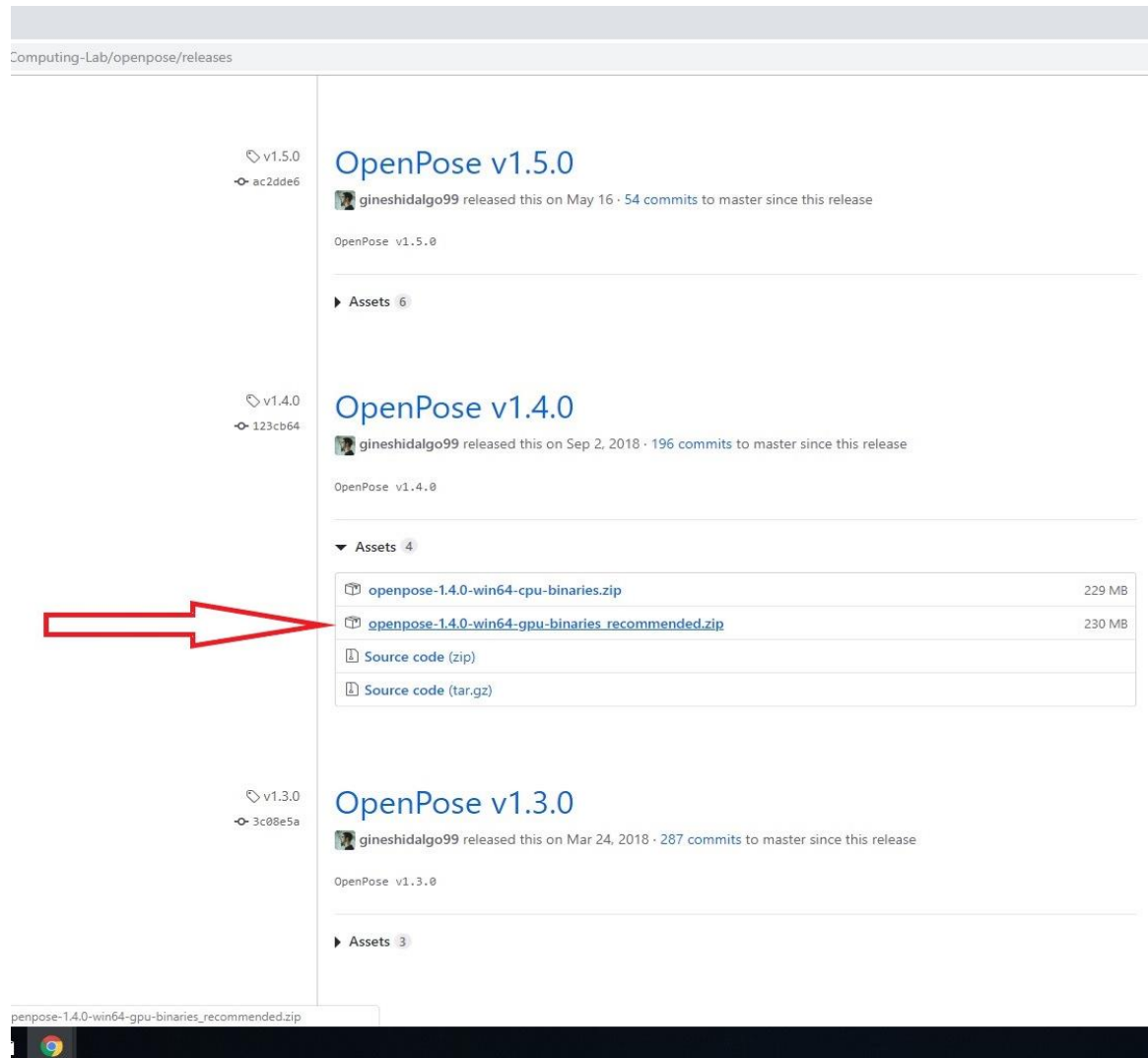
Go to your Downloads-folder and extract the zipfile when it has finished downloading.
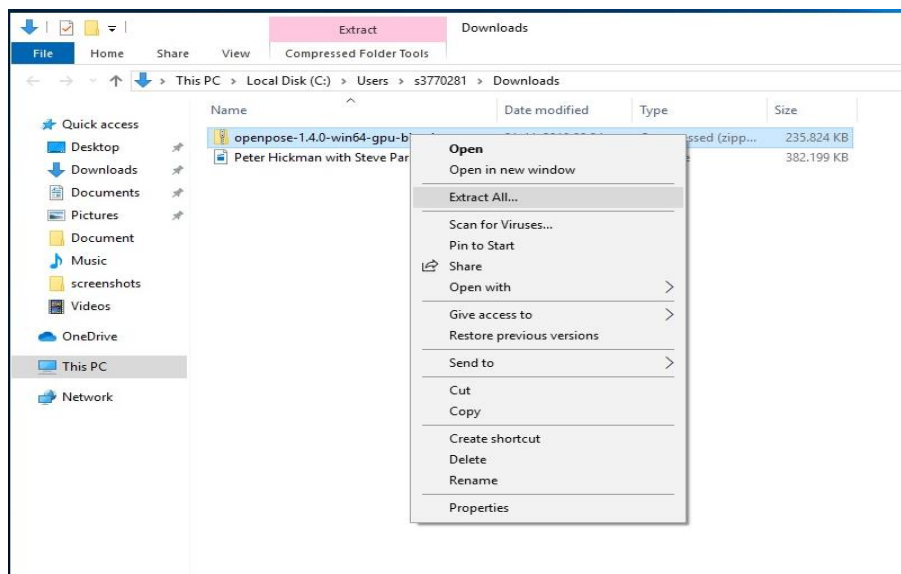
Then copy the contents of the folder.
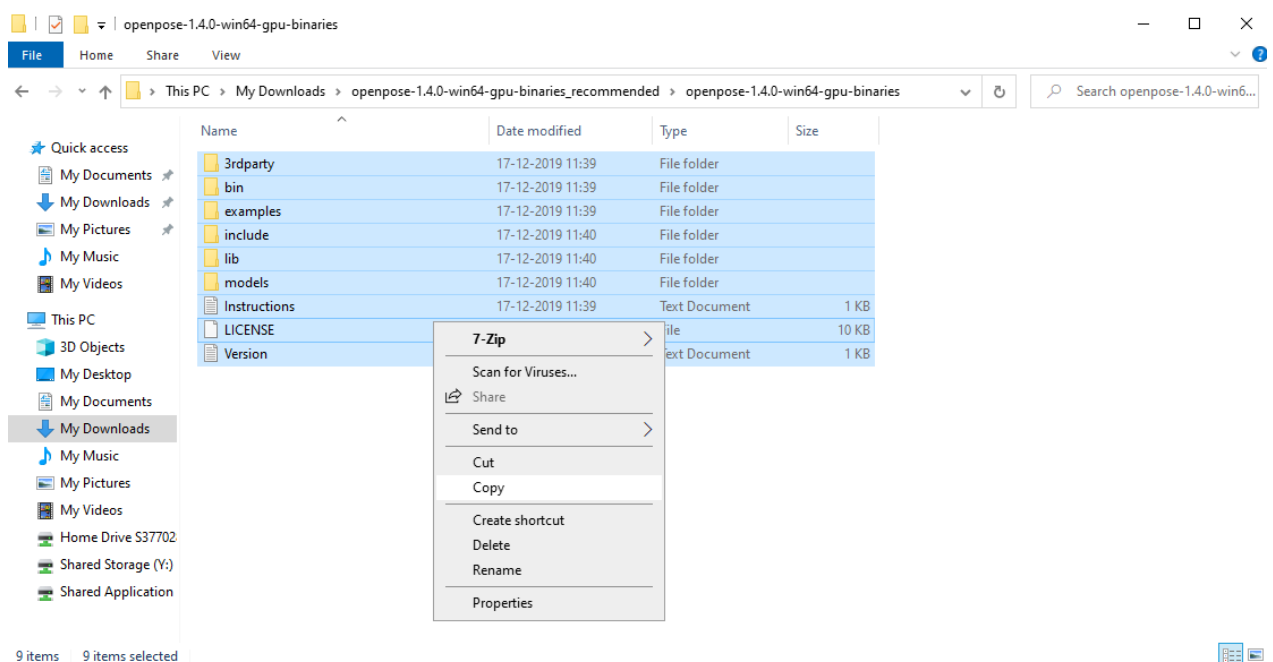
Create a folder on your desktop named 'openpose'. Paste the previously copied files and folders in this new folder. It is important to save the files and folder exactly the same as in this manual, because otherwise the process and command lines of running the program in this manual will not work.
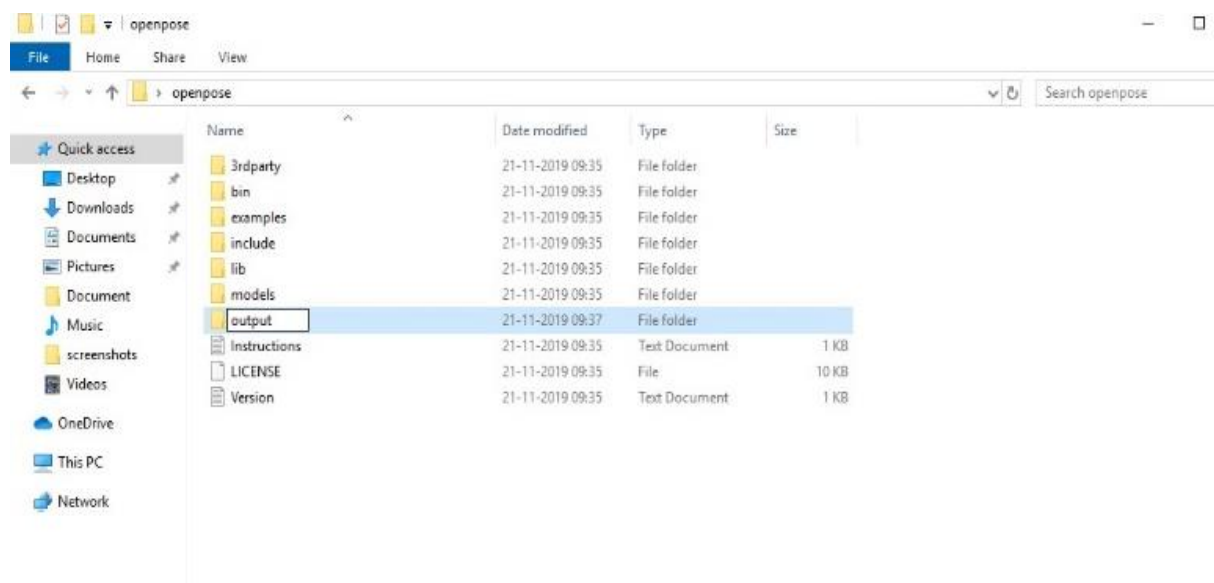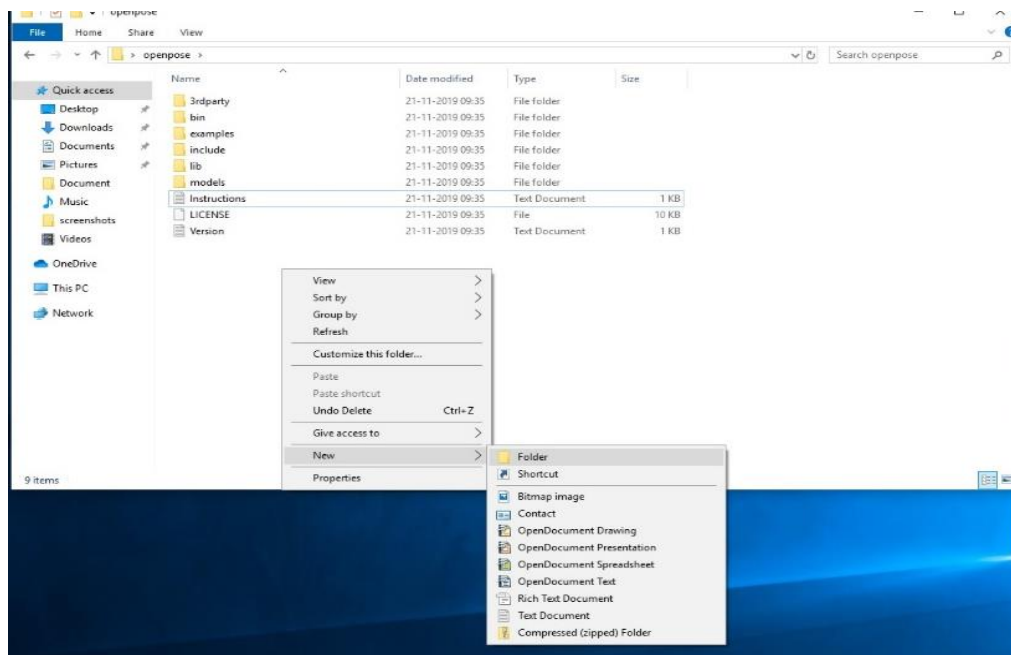
Double-check whether the OpenPose-folder is located at:
`C:\Users\[username]\Desktop\openpose`

(whereby `[username]`= your username)

In the openpose folder on your desktop, create a new folder, called 'output'.

This folder will contain the output of OpenPose.

Step 2: Copy the to-be-analyzed video to the correct folder

In the OpenPose-folder, you will find different folders. Copy the video-example, which you downloaded together with this manual, to the examples-folder. When you want to use OpenPose to analyze your own video's, you can copy your own video to the examples-folder instead.
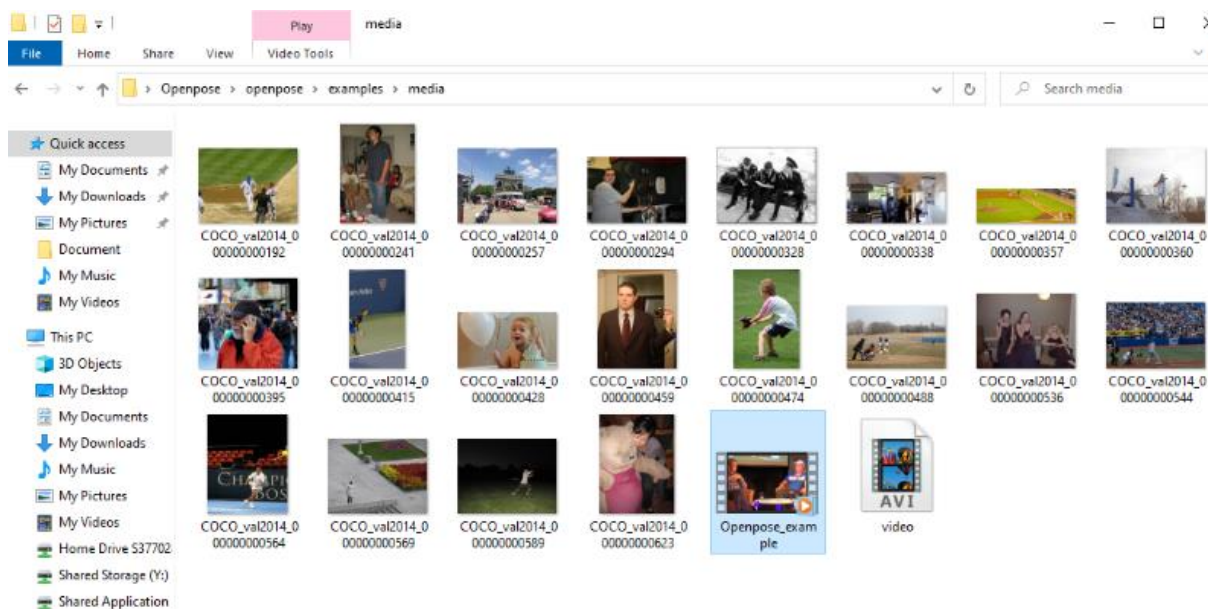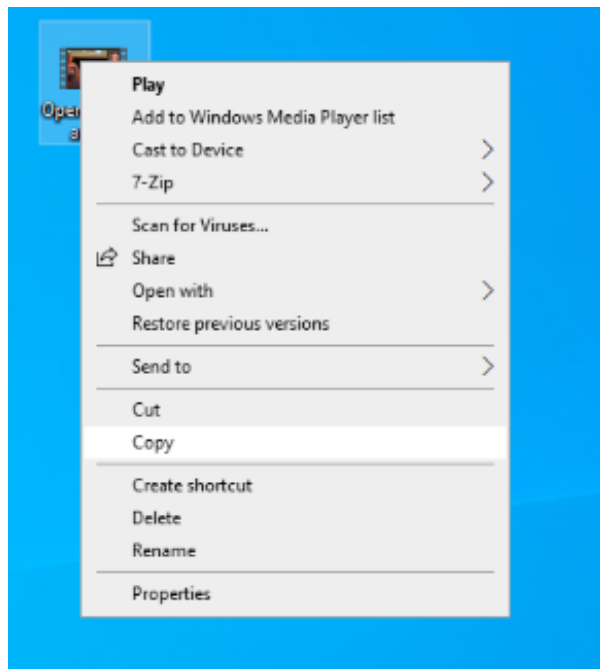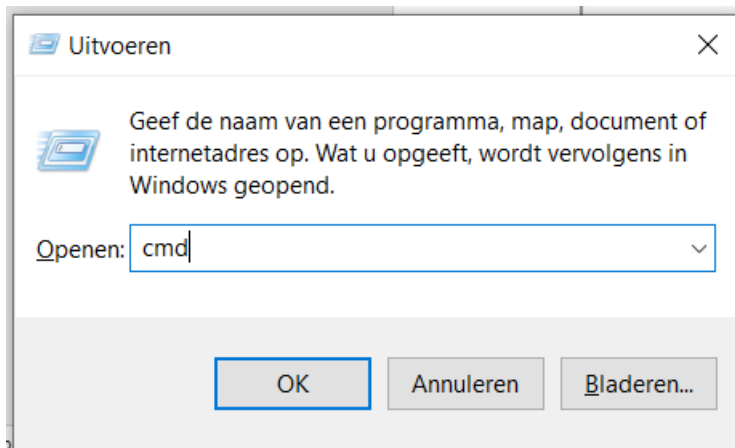
Step 3: Start OpenPose

1) Open command prompt.
   You can open command prompt by simultaneously pressing a) the ⊞-button at the bottom left of your screen, and b) the R-button.
   In the window that pops-up, you can type "cmd", and then press "OK". Command prompt will now open, irrespective of your operating system's default language (e.g. Dutch, as in the picture below).

2) Type the following commands, and press `enter` after each command
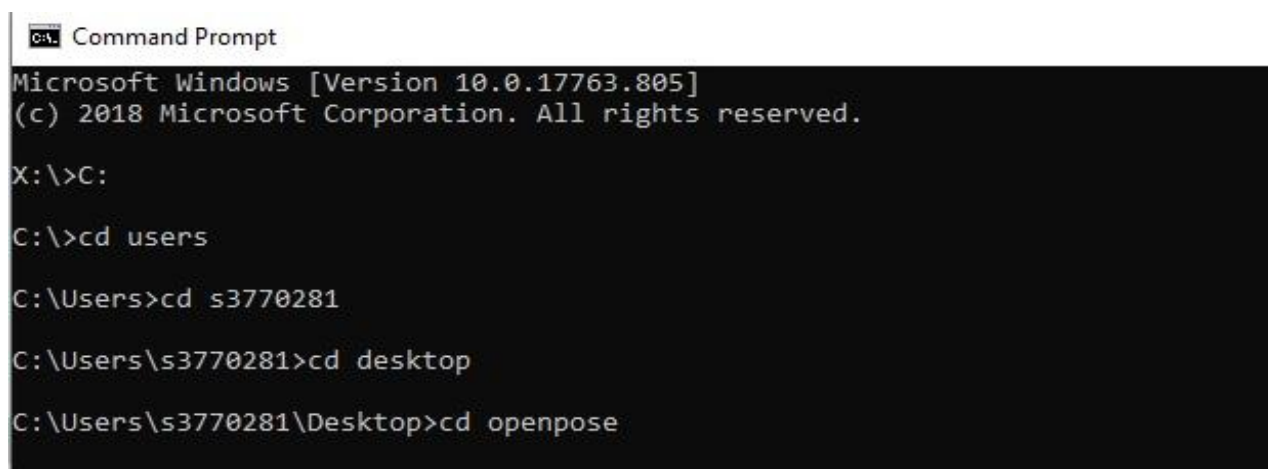
   `C:`

   `cd users`

   `cd [username]` (whereby `[username]` = your username; in this example: `s3770281`)

   `cd desktop`

   `cd openpose`

   After typing the commands, your command prompt window should look similar to the picture below.

3) Now to start OpenPose, type the following command: `bin\OpenPoseDemo.exe` `--video examples\media\Openpose_example.mp4` `--hand` `--write_json output/` then press `[enter]`
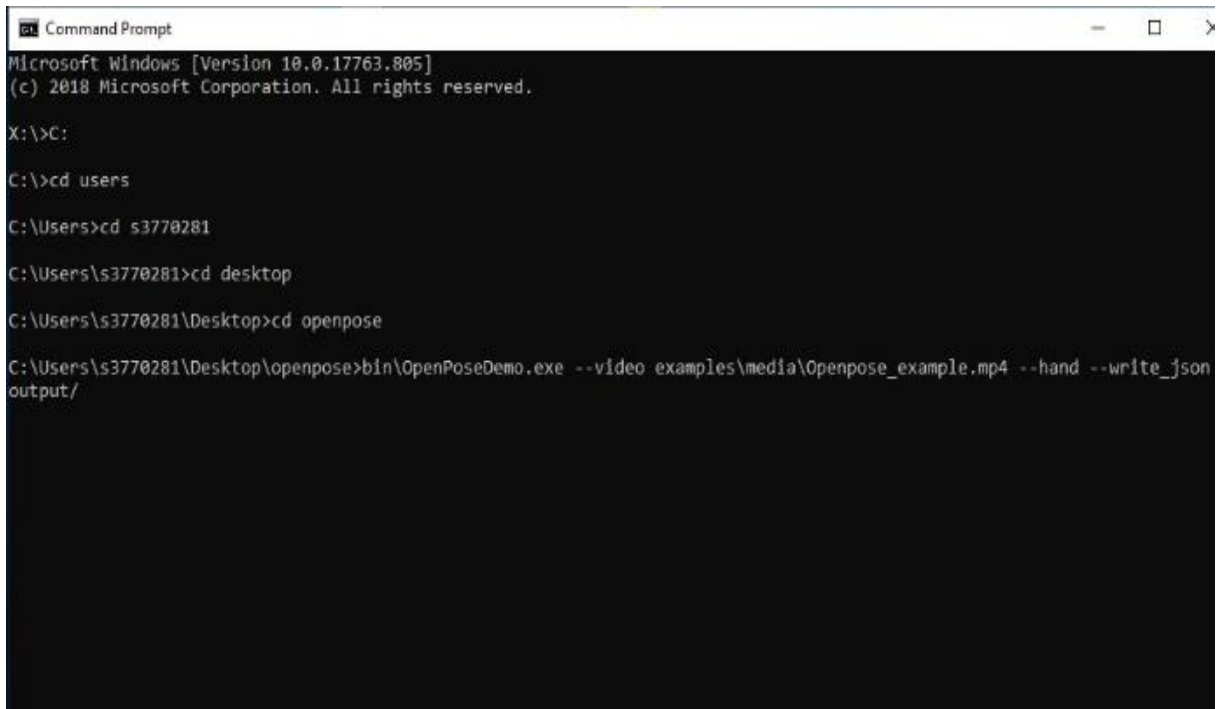
Here is an explanation of the command and it's "flags" (--[...]):

- `--video [...]`: location of the video > this means OpenPose will work on a video and what the name of the video is. To analyze your video, you need to change "Openpose_example.mp4" to the name of your video. These are video-types that OpenPose works with (Link naar FAQ voor video types). Make sure that there are no spaces in the name of your video file.
- `--hand`: This command will make OpenPose not only look at the 25 body key points but also the 21 key points for each hand.
- `--write_json output/`: This command makes OpenPose put the output in the folder where you can find it later.

Tip: You can copy the command to a notepad and adjust it to your liking. Afterwards you can just copy-paste it to command prompt.

You can also find the command line online, following the link: https://github.com/CMU-Perceptual-Computing-Lab/openpose/blob/master/doc/demo_overview.md On this website, you can also find more information about the possibilities of the program and additional possible flags.

It is possible that at this step the error 'caffe' will present itself. You can find more information about this error in the FAQ*.*
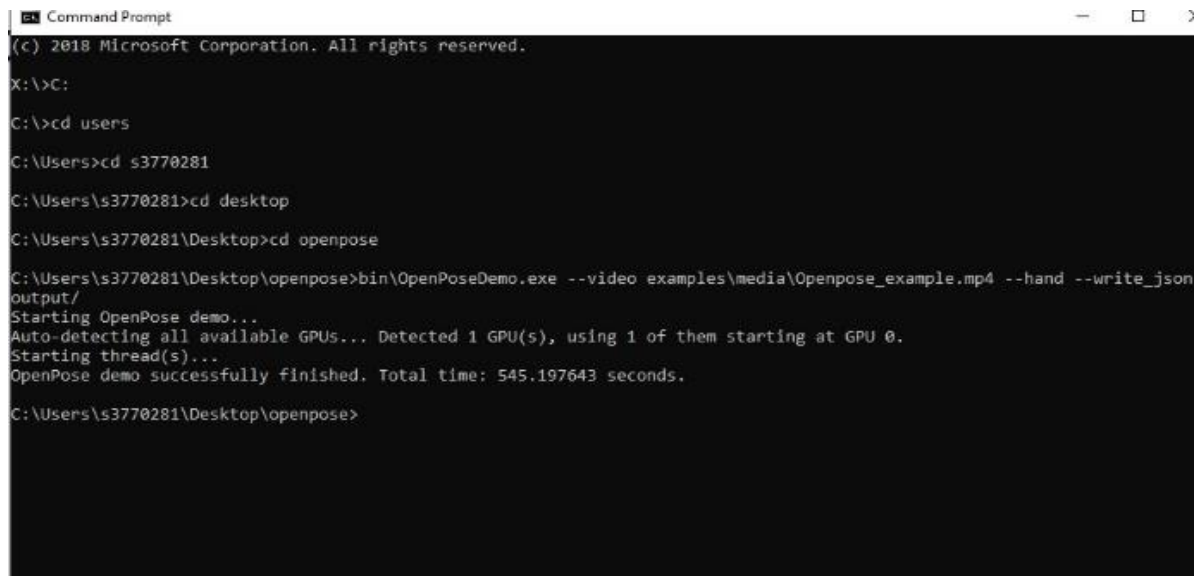
This picture shows all the command lines. After pressing [enter] a picture similar to the one below will appear.

This picture shows what it looks like when OpenPose is running on the demo-video.

After running OpenPose, command prompt should look like this.

Step 4: The output

The output can be found in the folder we made in the beginning. In the folder 'output' you can find the JSON files. Move all these files to the folder where you need them.

Step 5: Finish

After you moved the json-files to the correct new folder, we advise you to delete the video-file from the examples-folder, and to empty the output-folder. This makes sure that you have enough space on your drive for subsequent runs of OpenPose, and that you do not mix up json-files of different video's, respectively.

FAQ for OpenPose

What should I do when I get an 'caffe error'?

If you get an caffe error, it is possible that you first need to download the models for OpenPose yourself. To do so, simply go to: Openpose > models > getModels, double click and start the downloading process
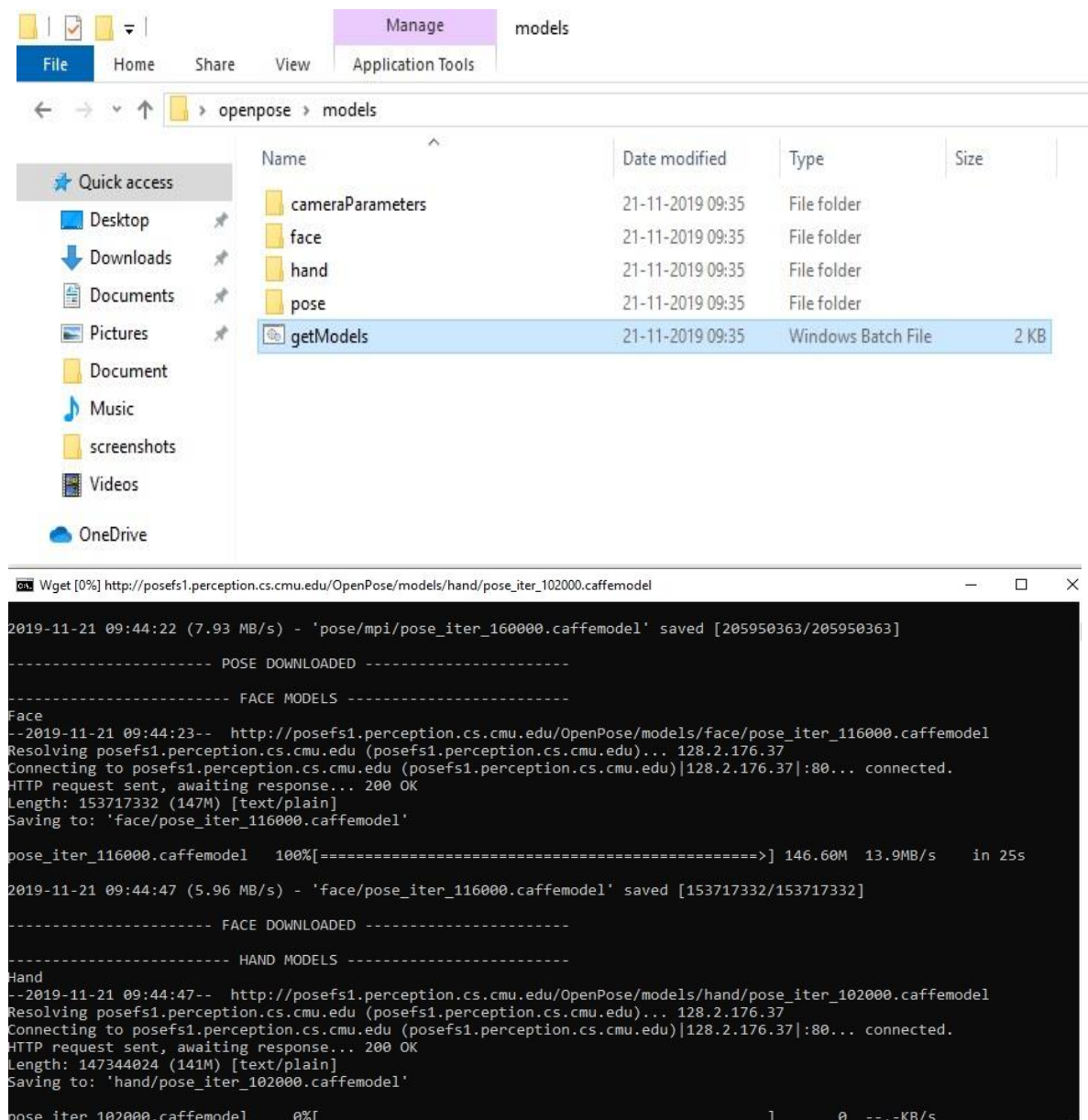
What should I do when I get a warning about a CUDA problem?

The CUDA problem can occur when the computer you are working on does not have the right processor. For more information, please check:

https://arvrjourney.com/human-pose-estimation-using-openpose-with-tensorflow-part-1-7dd4ca5c8027

Relevant links for OpenPose

With this link you will find more information about the commands and how to quick start OpenPose:
https://github.com/CMU-Perceptual-Computing-Lab/openpose/blob/v1.4.0/doc/quick_start.md

With this link you can find an overview from the possibilities of the Demo OpenPose:
https://github.com/CMU-Perceptual-Computing-Lab/openpose/blob/master/doc/demo_overview.md

With this link you can find more information about the output from OpenPose:
https://github.com/CMU-Perceptual-Computing-Lab/openpose/blob/master/doc/output.md

With this link you can find a YouTube tutorial for OpenPose:
https://www.youtube.com/playlist?list=PL_Nji0JOuXg24bHB60SB2TwF0PpwhJkCF

Running the R-script to create timeseries of people's movements

After running OpenPose, you get many JSON files as output. To be able to actually analyze people's movements, you need to convert the output into one (csv)file. Furthermore, since OpenPose actually recognizes people in still images, it often happens that the order of people in the output-list changes from image to image. For example, while person A was person 1 in image no. 10, person A becomes person 2 in image no. 11, then person A becomes person 4 in image no.12, and then person A becomes person 1 again in no. image 13.

To deal with this change in persons from image to image, we wrote an R-script[1] that first combines all the JSON files into one (so-called) data frame, and then creates a new data frame that consecutively orders all the values of person A and that consecutively orders all the values of person B. This last data frame is then saved as a csv-file that you can use for further analysis.

Running the R-script involves the following steps:

1. Copy the R-script called `openpose2R_2persons_2D_nohand_noface_JSONtoTimeSeries.R` to the folder that contains the JSON files, i.e. the output of OpenPose.
2. Open the R-script and run it. After running the R-script, a csv-file should appear in the folder with JSON files. This csv-files contains the timeseries data (x- and y-pixel coordinates, and confidence parameter [c]) body key points of max. 2 persons.

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[1] To run the R-script, you can download RStudio over here: https://rstudio.com/products/rstudio/#rstudio-desktop. Make sure to follow the instructions.