The Power of tracking the invisible: Geoinformatics and Human Social Behaviour

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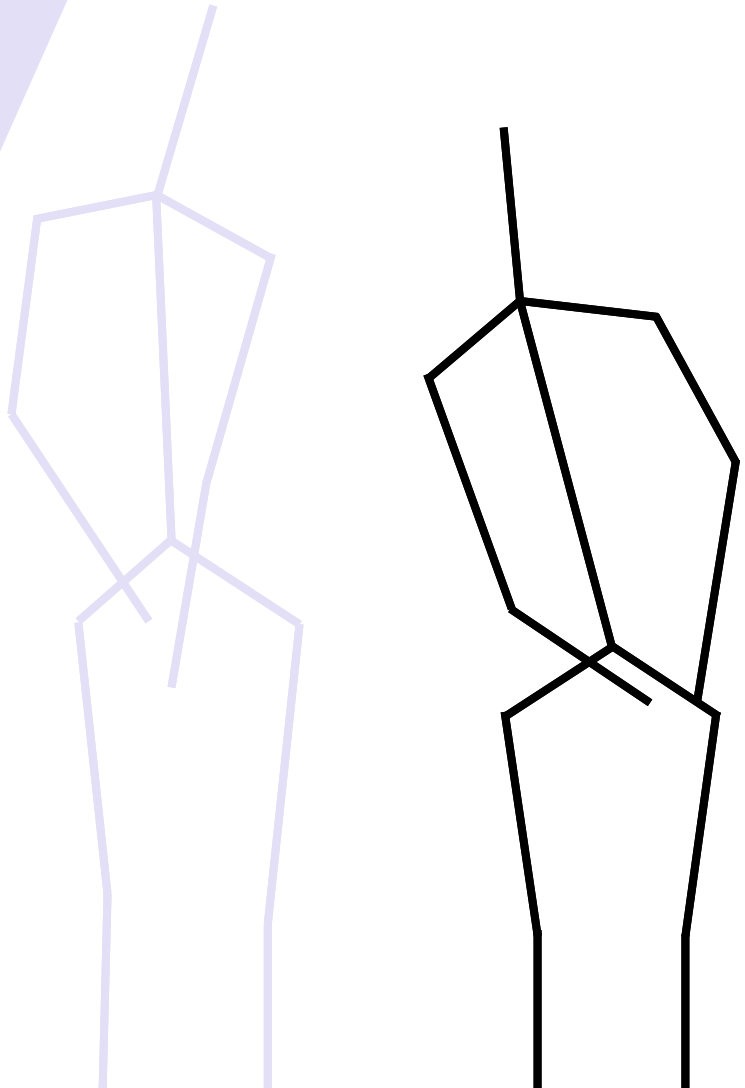
University of Münster

PYCON 22 COLOMBIA



Personal Intro

Software Developer and Project Manager

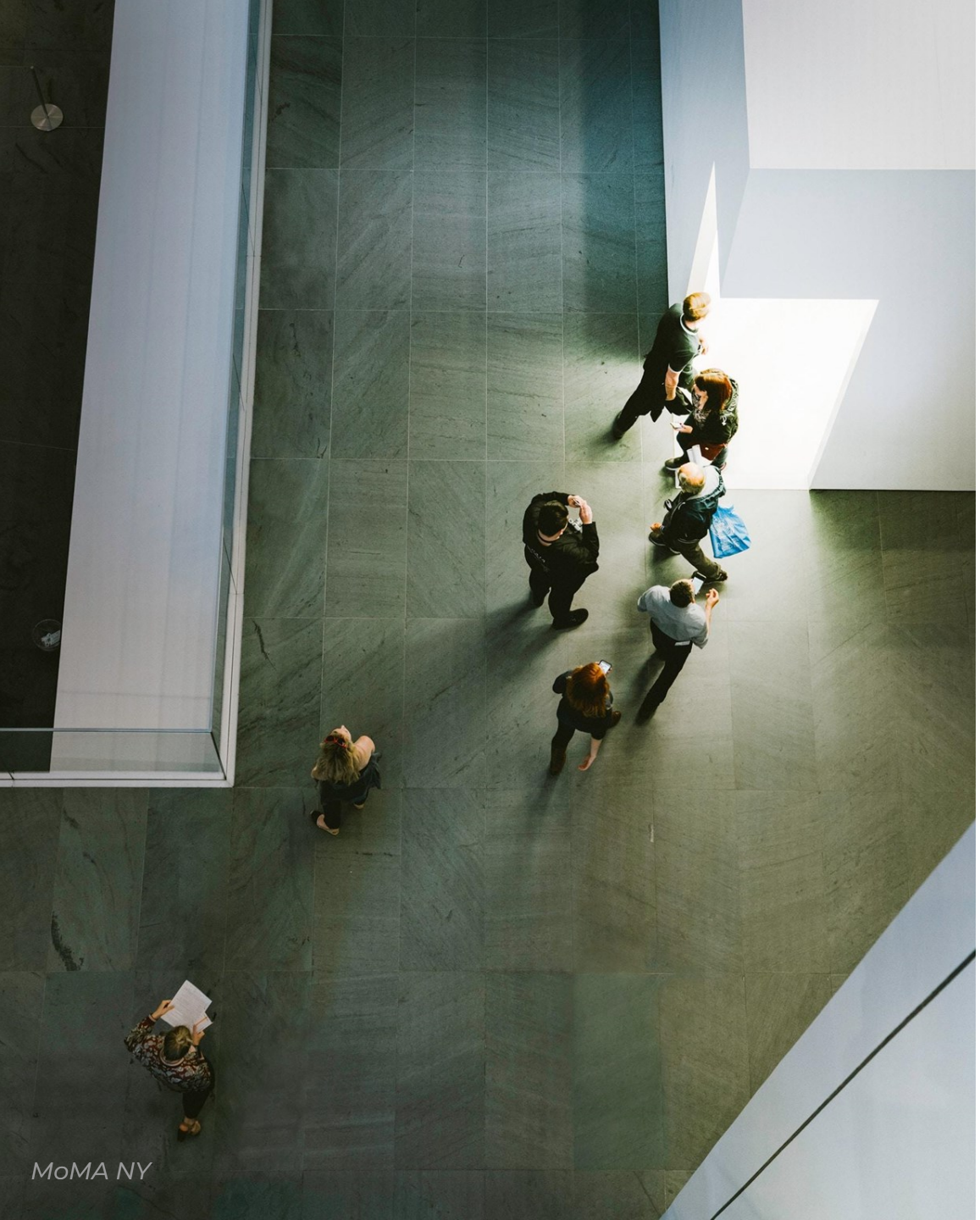
Pursuing a Doctorate in Geoinformatics in Germany

Interested in integrating Spatial Cognition and Computer Science

Spatial Science

goes beyond geographic

Maps


MoMA NY


Physically
occupied space
MoMA NY


Physically
occupied space
MoMA NY


Socially
occupied space
MoMA NY

Why to track?

Improve architectural and exhibitions design

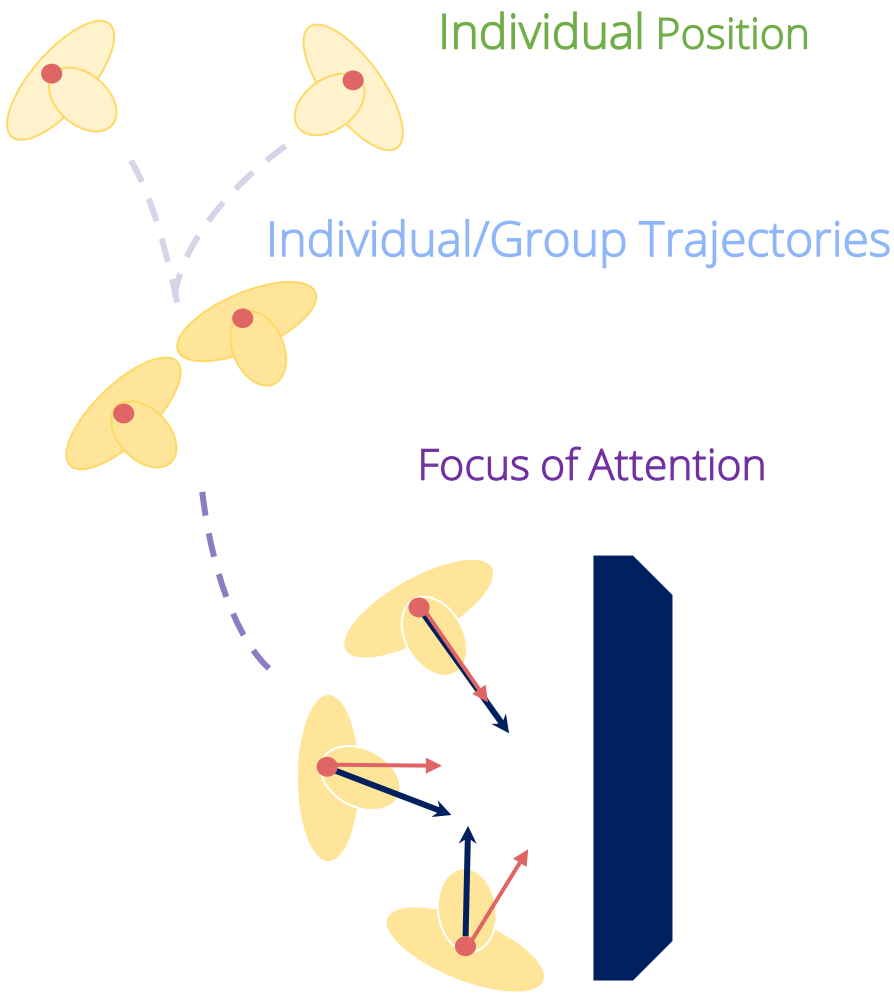
Offer better services in stores

Analyse behaviour during interactions

Appropriate social behaviour for robots

How can we detect
human behavior
automatically?

What to track?



Social Signals
(Vinciarelli, 2009)

Groups

Interaction

People

Space and environment	Face and eyes behaviour	Gesture and Posture
Distance (Proxemics) Arrangement (seated or standing)	Gaze Focus of attention	Body orientation

Social Signals
(Vinciarelli, 2009)

How to extract this data?

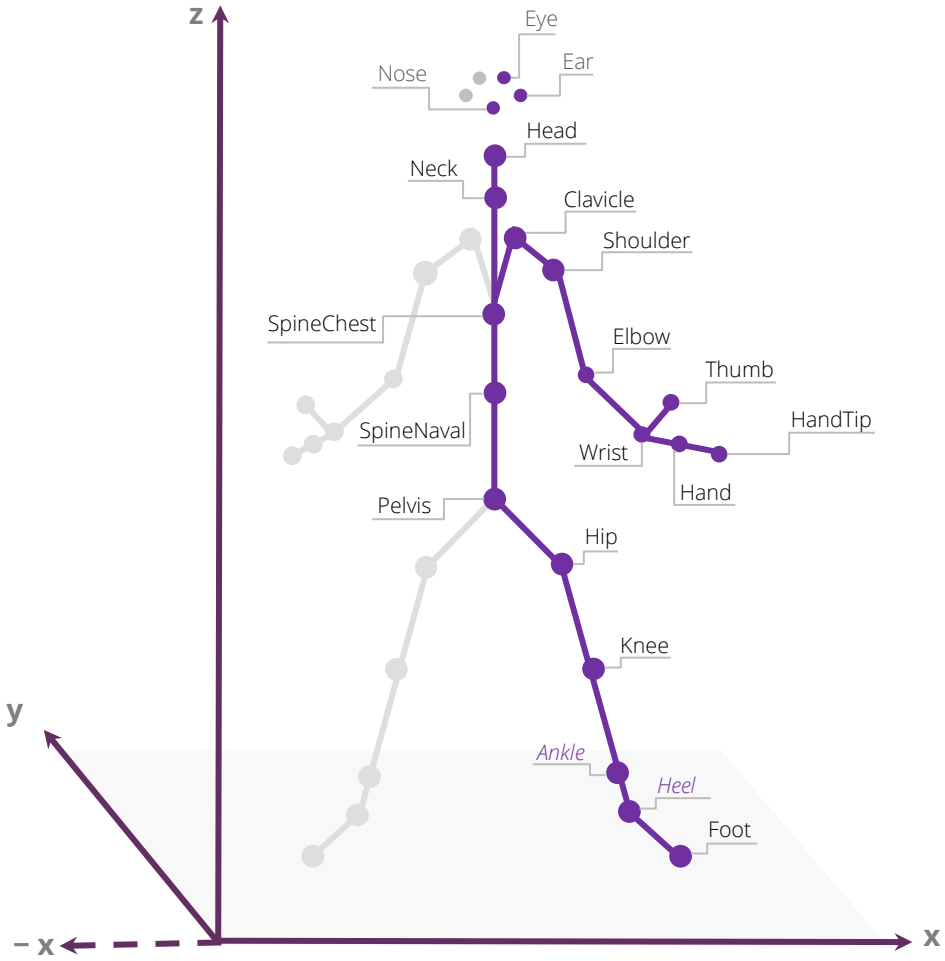
No manual observation

Simple design and setup

Unobtrusive

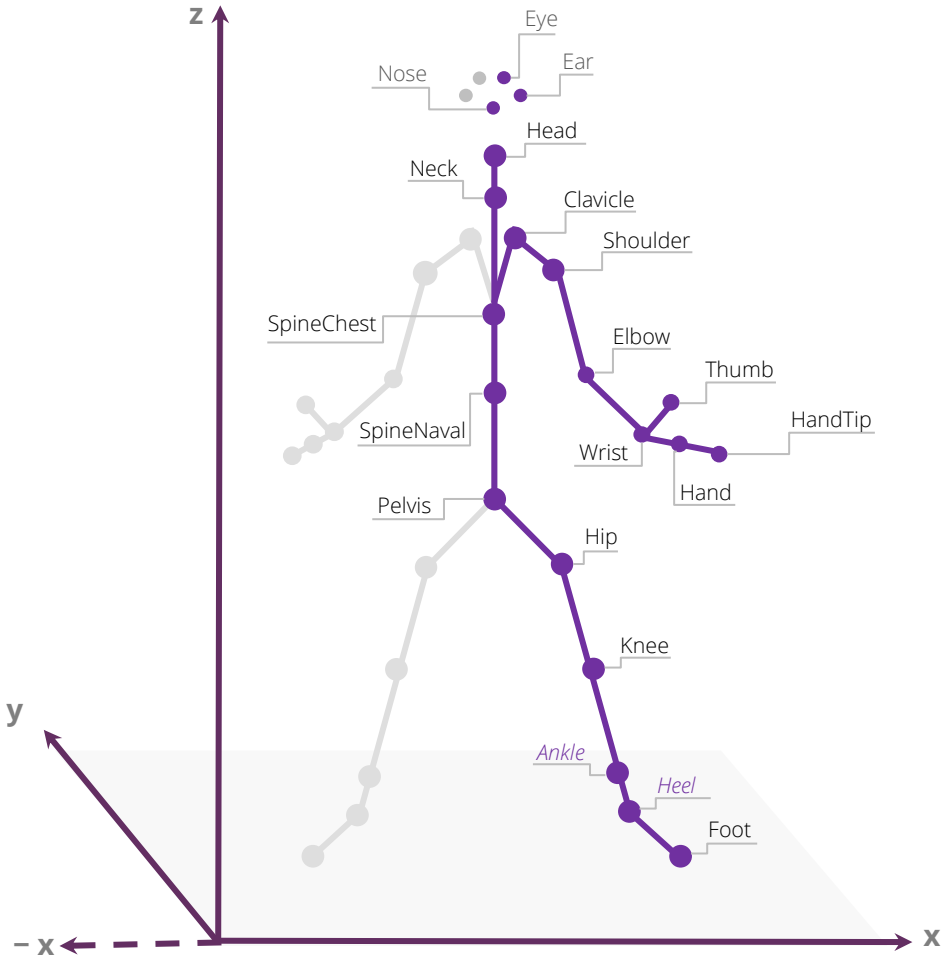
Identity safe

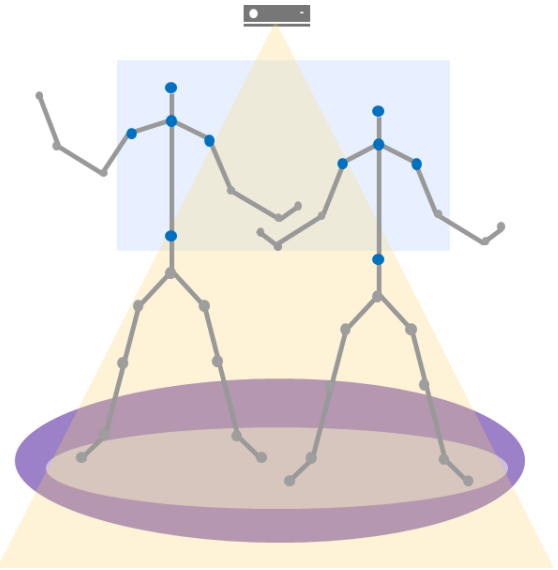
Using Skeleton Data



(Sosa-Leon, Schwering. 2022)

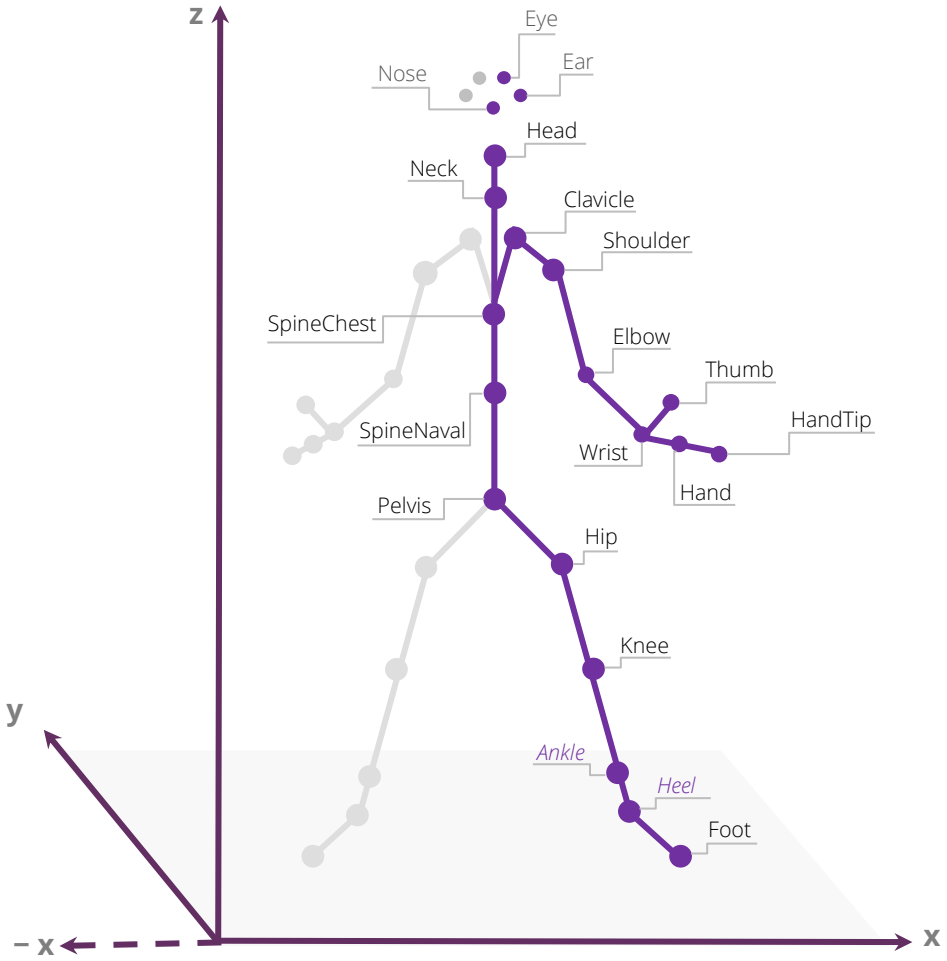
Using Skeleton Data





(Sosa-Leon, Schwering. 2022)

Using Skeleton Data



Which technology?

(Sosa-Leon, Schwering. 2022)

Optical and vision

WebCam
Python, C++

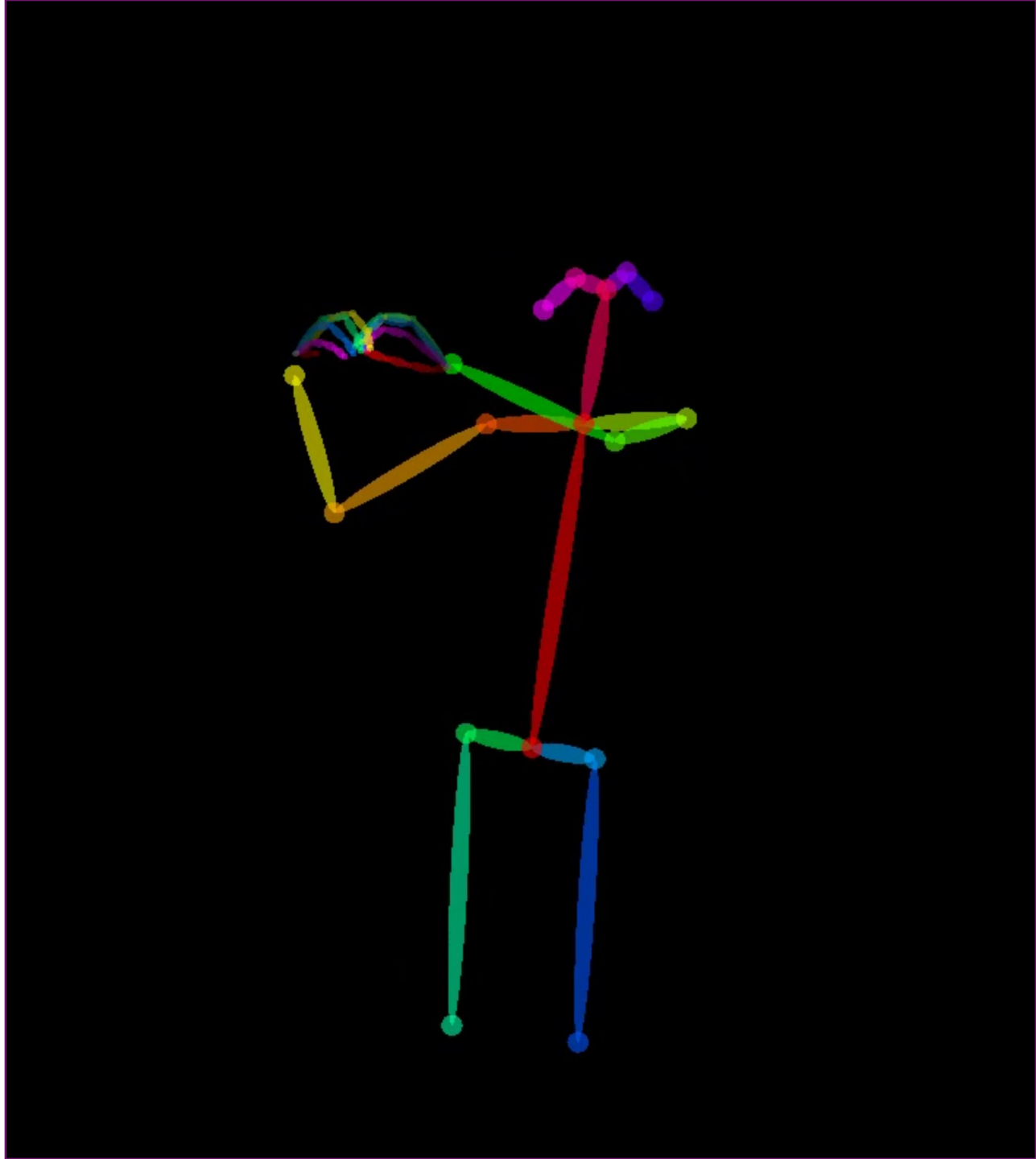
STEREOLABS

Stereo Depth-Camera

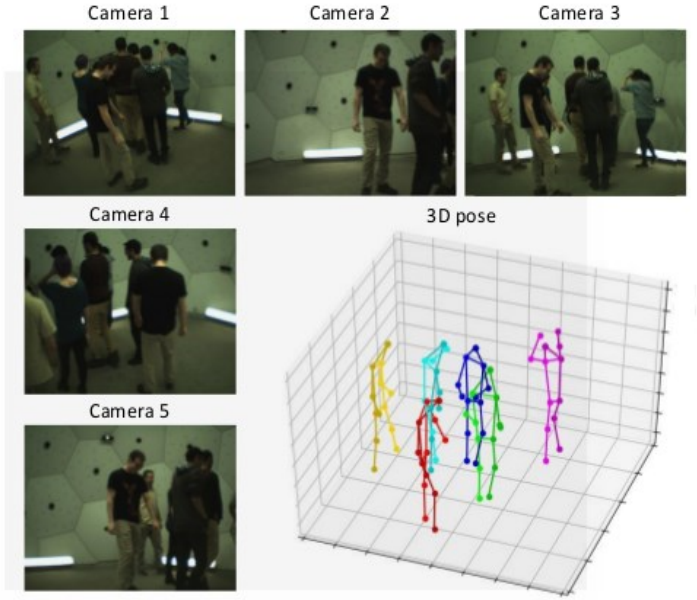
Dedicated camera
Python, C++

OpenPose

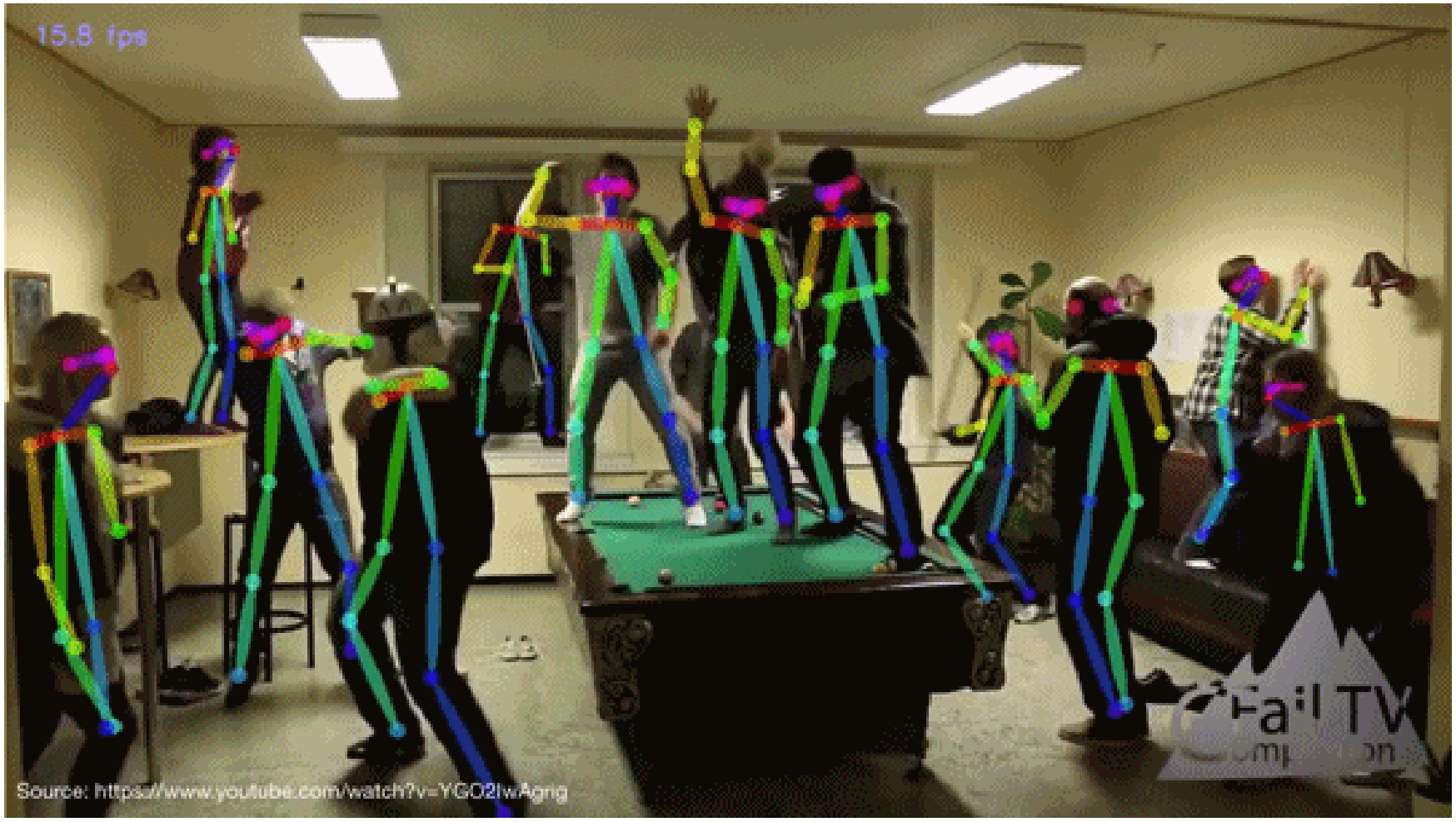
Optical and vision



VISION	
Accuracy	1cm - 1m
Cost	Medium - High
Complexity	High
Scalability	Low



Multi-person and multi-view 3D pose reconstruction example from the Panoptic dataset by Dong et al. 2019

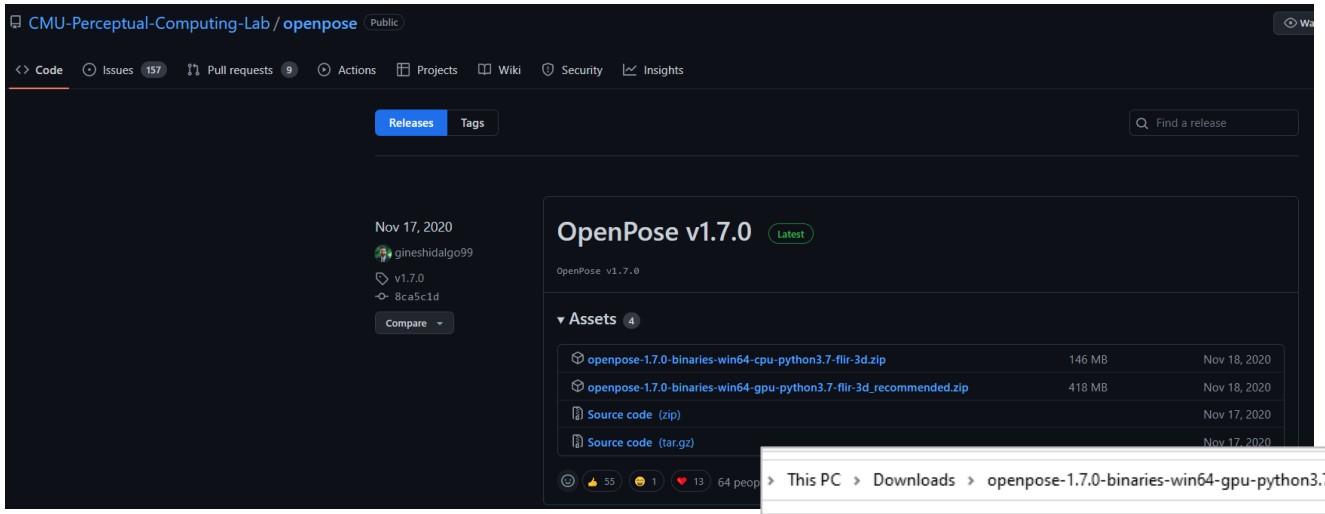

15.8 fps
Source: https://www.youtube.com/watch?v=YGO2IwAgnq

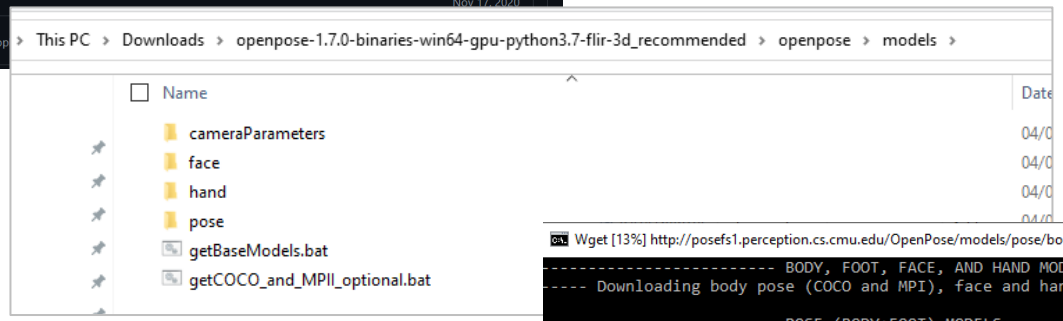
OpenPose:
Install and Configure

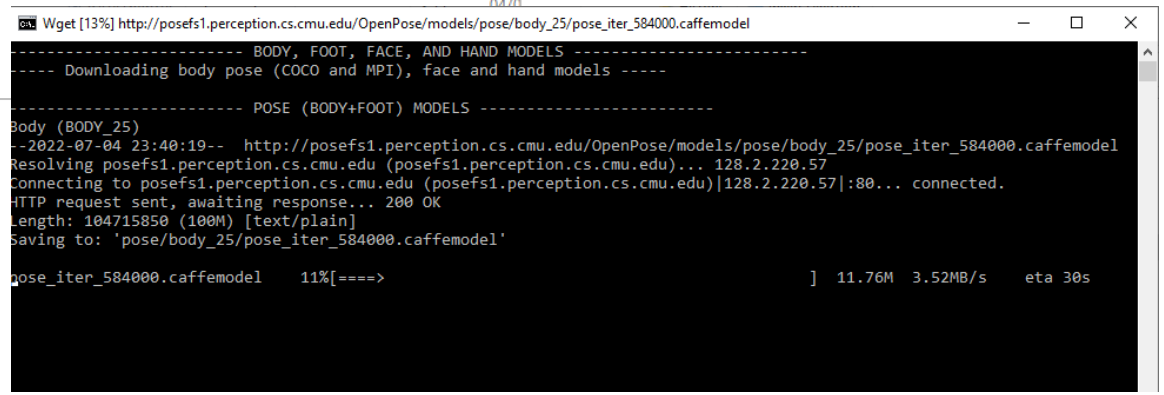
Detailed steps in:

- openpose/doc at master · CMU-Perceptual-Computing-Lab/openpose (github.com)

Library setup

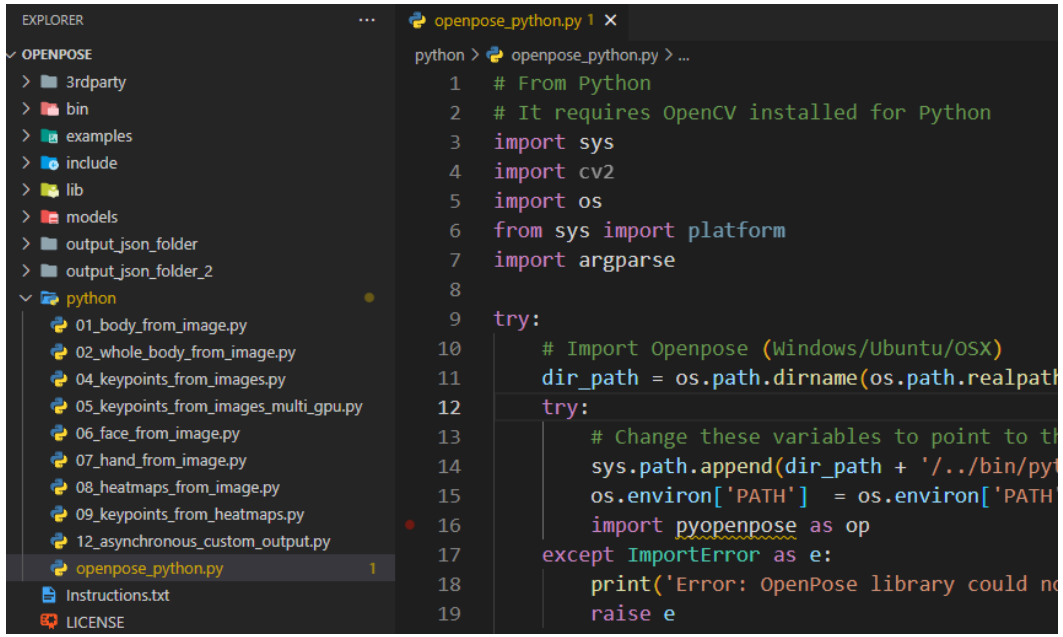




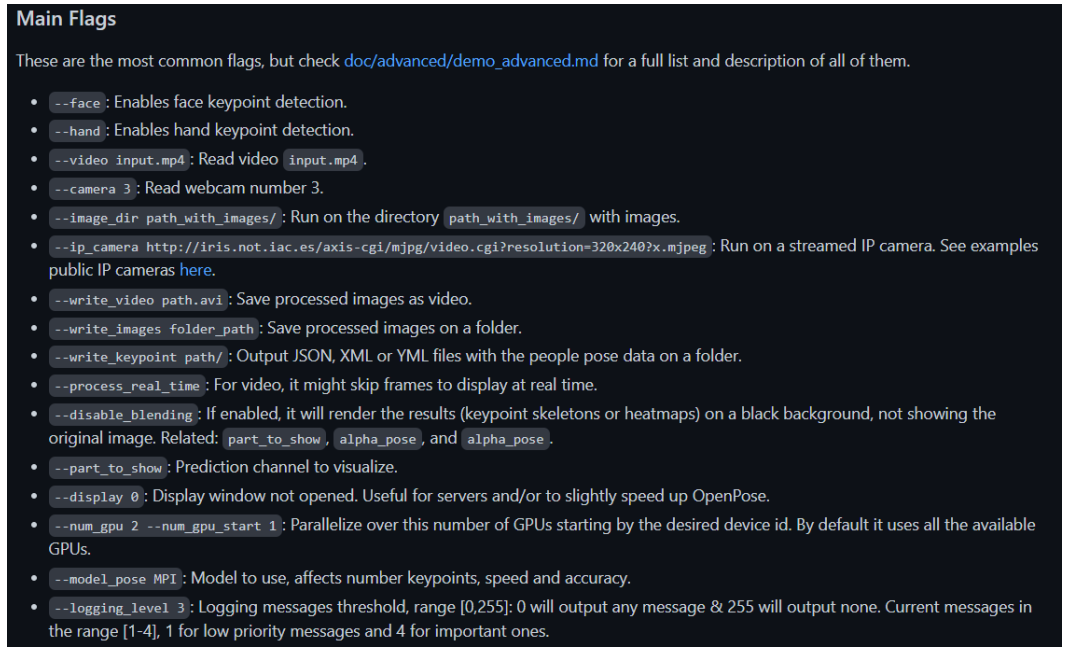


Development environment setup

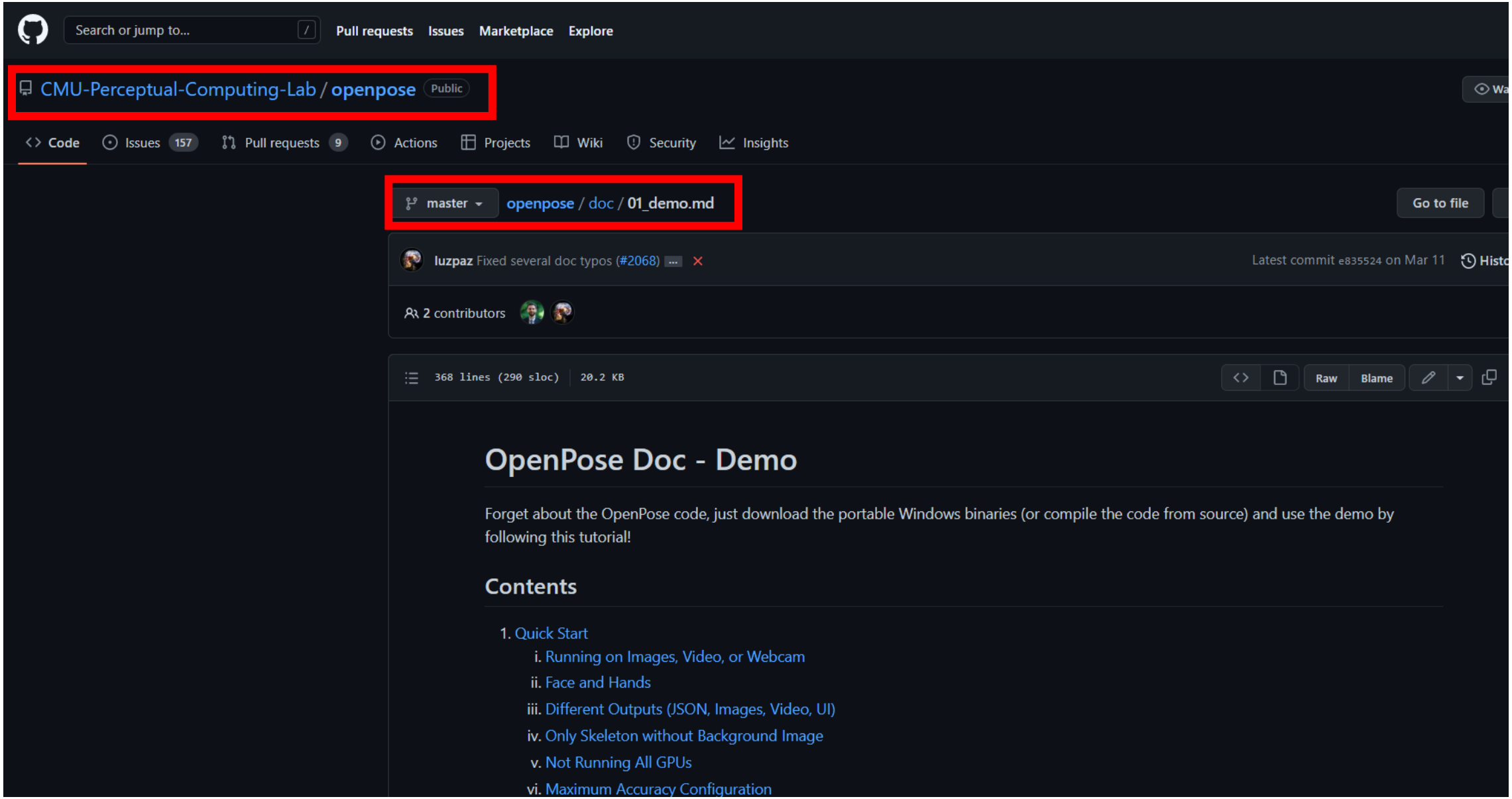
Manual Install



Terminal



OpenPose: Implementation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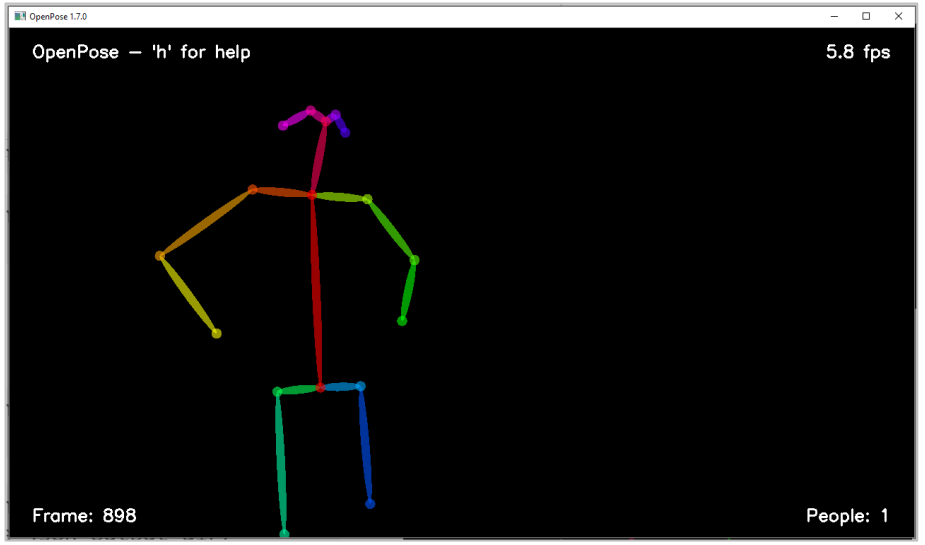
openpose / doc / 01_demo.md
Go to file
luzpaz Fixed several doc typos (#2068) ...
Latest commit e835524 on Mar 11
2 contributors
368 lines (290 sloc)
20.2 KB
Raw
Blame
OpenPose Doc - Demo
Forget about the OpenPose code, just download the portable Windows binaries (or compile the code from source) and use the demo by following this tutorial!
Contents
1. Quick Start
i. Running on Images, Video, or Webcam
ii. Face and Hands
iii. Different Outputs (JSON, Images, Video, UI)
iv. Only Skeleton without Background Image
v. Not Running All GPUs
vi. Maximum Accuracy Configuration

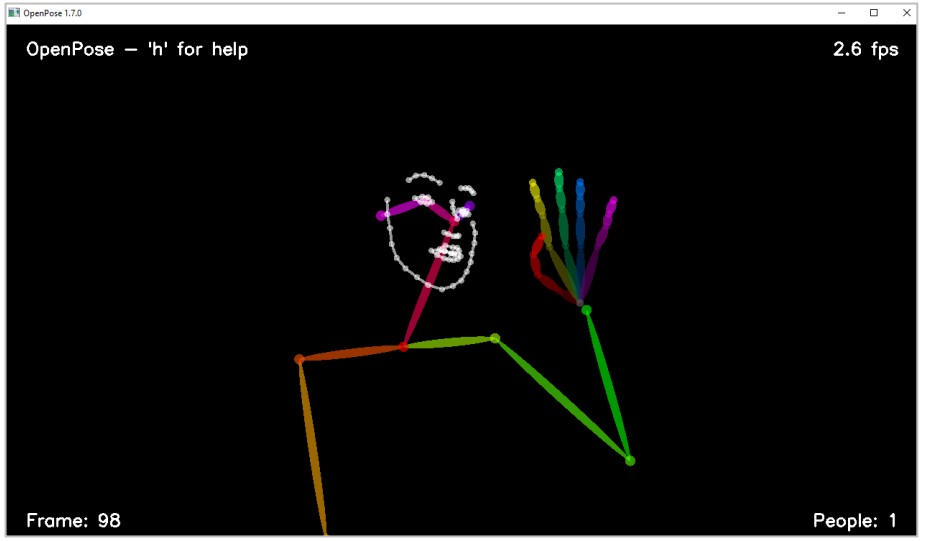
```
$ OpenPosePath .\bin\OpenPoseDemo.exe --camera 0
```

```
$ OpenPosePath .\bin\OpenPoseDemo.exe --camera 0
--disable_blending
```




```
$ OpenPosePath .\bin\OpenPoseDemo.exe --camera 0
--disable_blending --hand --face
```

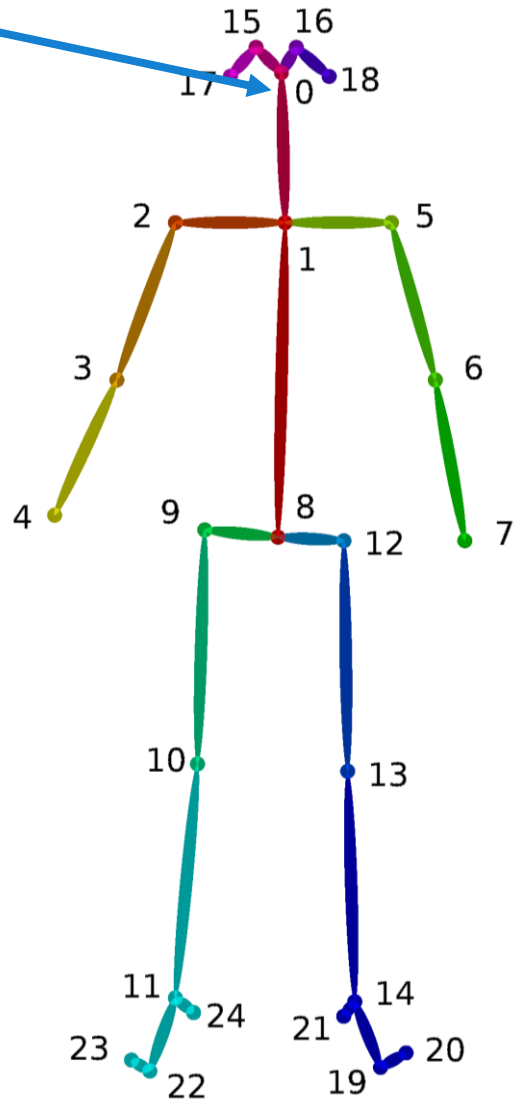
```
$ OpenPosePath .\bin\OpenPoseDemo.exe --camera 0
--disable_blending --write_json output_dir/
```



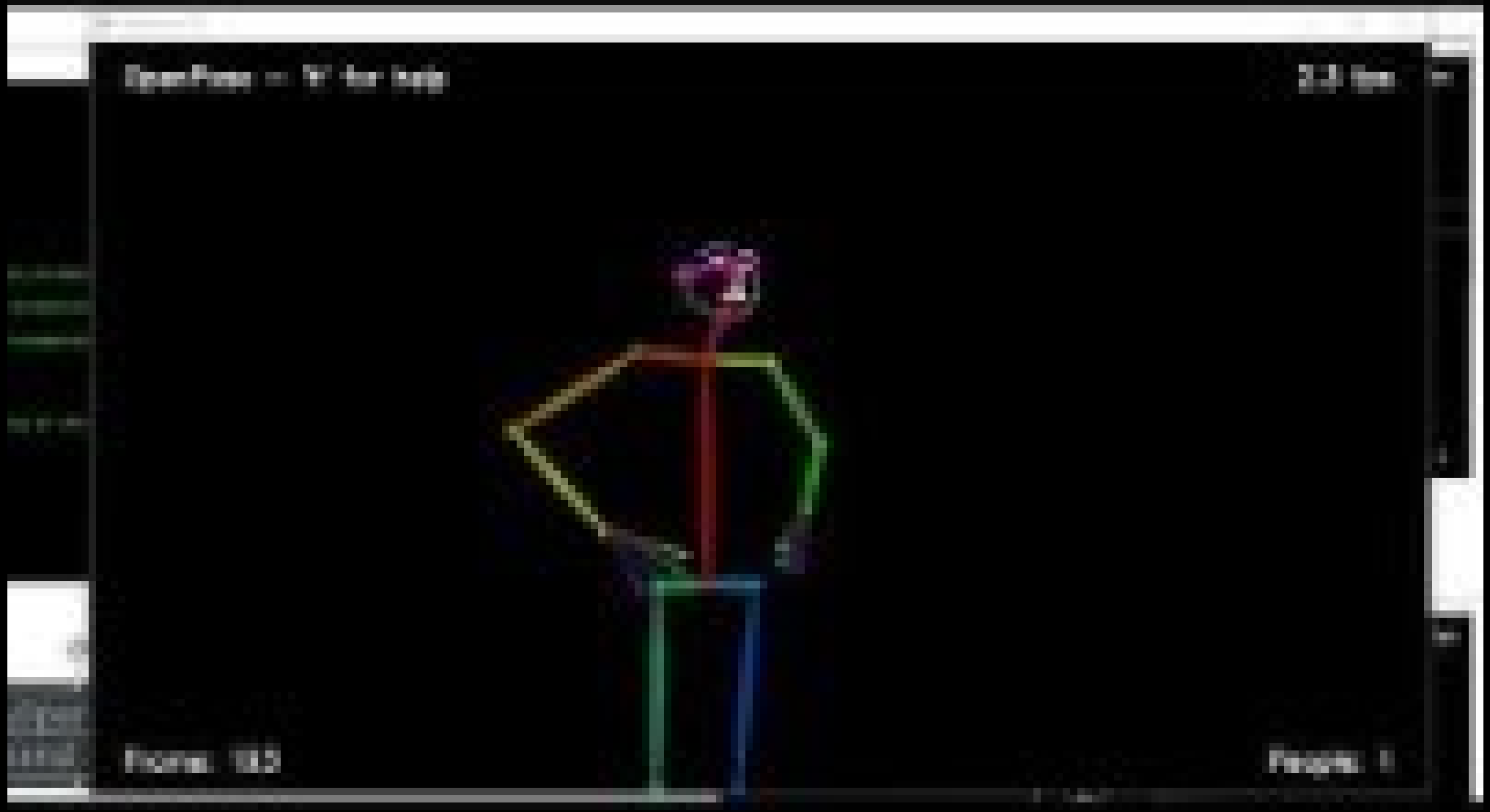
Coordinates [x, y]

Joint key


```
{
  "version": 1.3,
  "people": [
    {
      "person_id": [-1],
      "pose_keypoints_2d": [
        460.801, 335.437, 0.850702,
        400.14, 505.938, 0.582054,
        286.541, 490.276, 0.35841,
        0, 0, 0,
        0, 0, 0
        525.609, 513.785, 0.599199,
        588.262, 715.622,0.582557,
        0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
        421.75, 319.851, 0.86914,
        478.469, 333.515, 0.868618,
        355.145, 353.095, 0.75606,
        494.225, 378.595, 0.0532065,
        0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
      ],
      "face_keypoints_2d": [],
      "hand_left_keypoints_2d": [],
      "hand_right_keypoints_2d": [],
      "pose_keypoints_3d": [],
      "face_keypoints_3d": [],
      "hand_left_keypoints_3d": [],
      "hand_right_keypoints_3d": []
    }
  ],
  "part_candidates": [
    {
      "0": [
        98.448, 229.773, 0.150741,
        886.051, 259.087, 0.0928216,
        982.02, 296.339,0.159637,
        460.801, 335.437, 0.850702
```

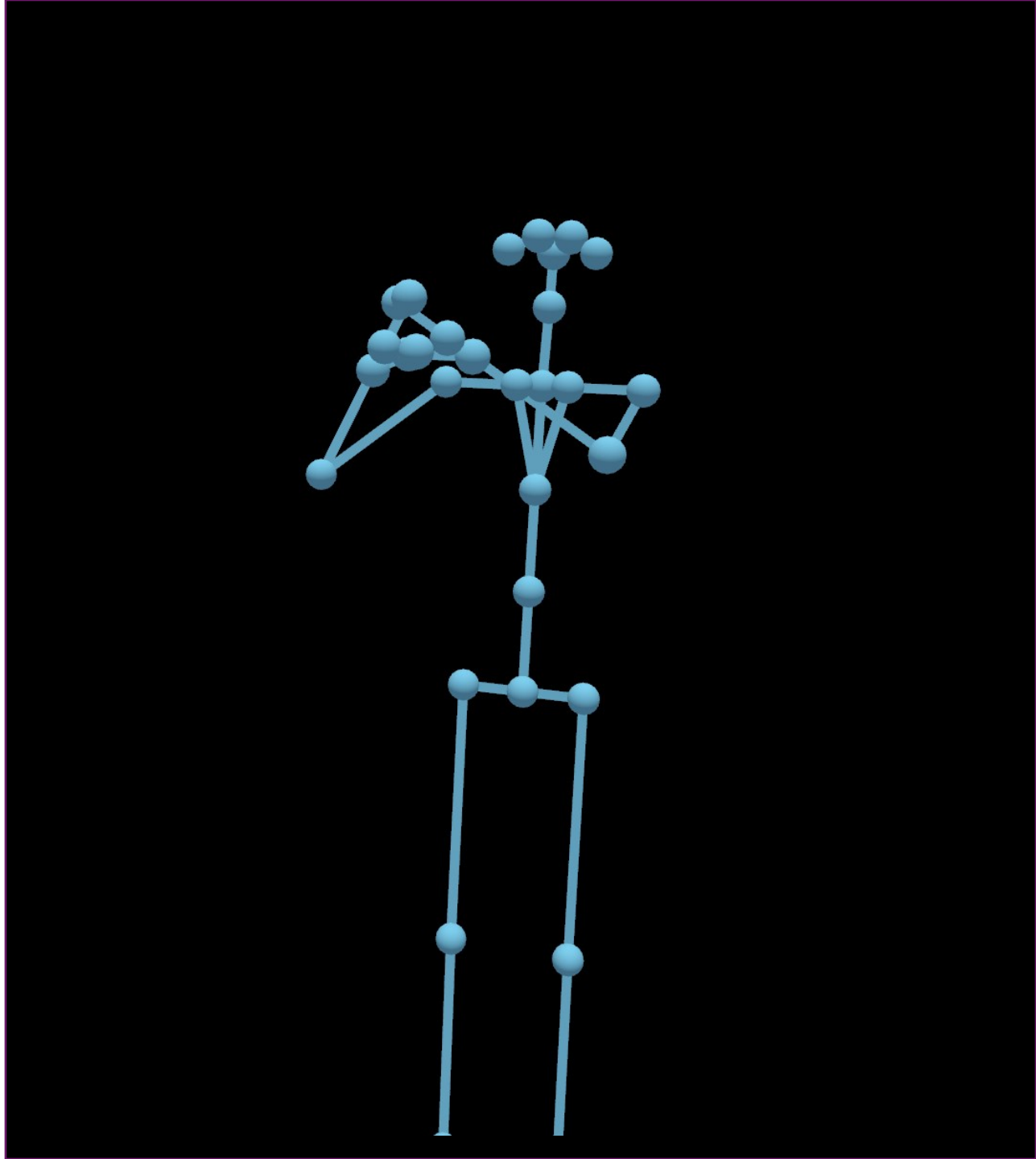
OpenPose: Test

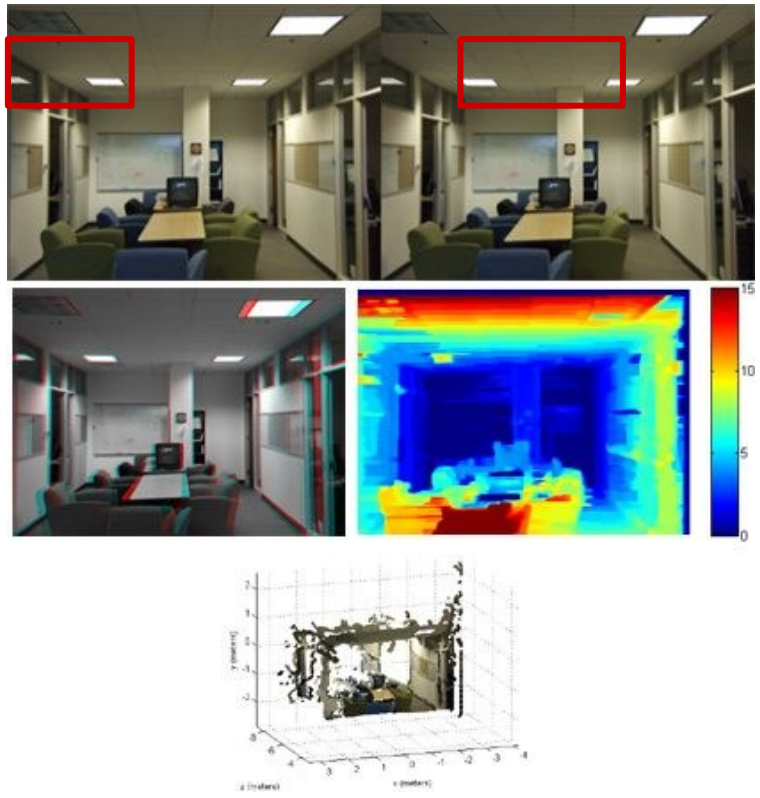


OpenPose: Skeleton tracking test - YouTube

Zed 2i

Stereo Depth Camera





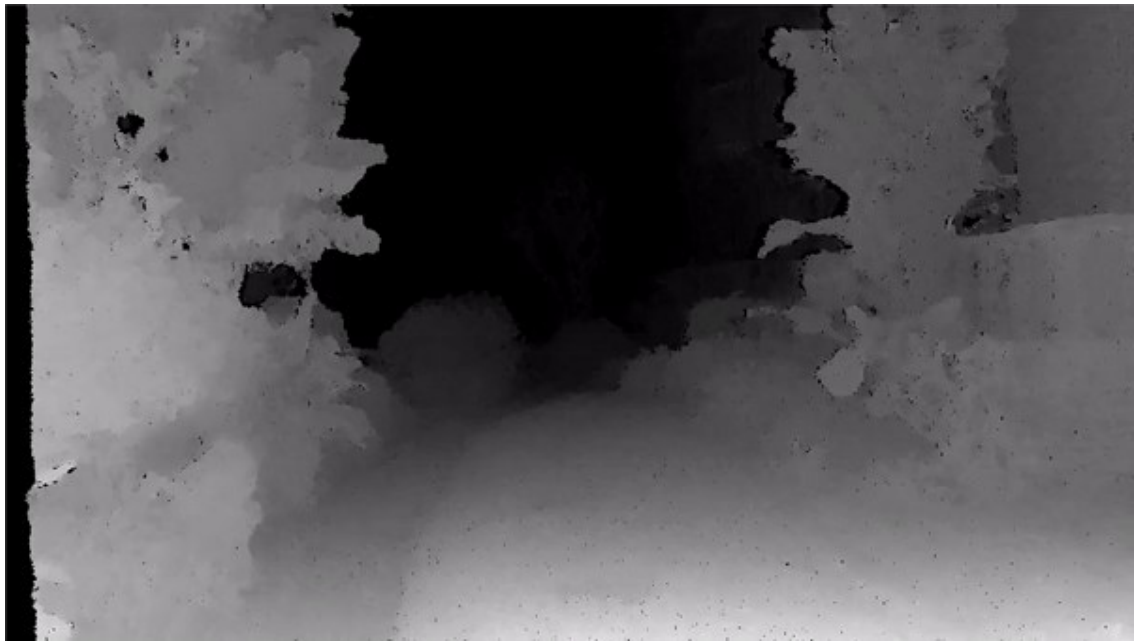
Mathworks Stereo Vision

STEREOVISION

(stereoscopic or camera array)

Accuracy	mm to cm Base-line (spacing between cameras) dependent Mid range
Range	1-20m
Cost	Medium - High
Complexity	High
Scalability	Medium
Light performance	Low: Weak - Bright: Good

Measurement and Inspection



Augmented Reality

Identification

Location

Zed2i: Install and Configure

Detailed steps in

- Zed 2i · violetasdev/bodytrackingdepth_course Wiki (github.com)
- Stereolabs Docs: API Reference, Tutorials, and Integration

Camera setup

Requirement	Detail
Operative system	Windows 10, Ubuntu 16.04, 18.04
Processor	Quad-core 2,7GHz or faster
RAM	8 GB
Graphics driver	NVIDIA GPU with Compute Capabilities >3.0 - Support CUDA
Graphics card	NVIDIA GEFORCE GTX 1060 or higher
USB connector	**USB 3.0 port this is very important**

Camera setup

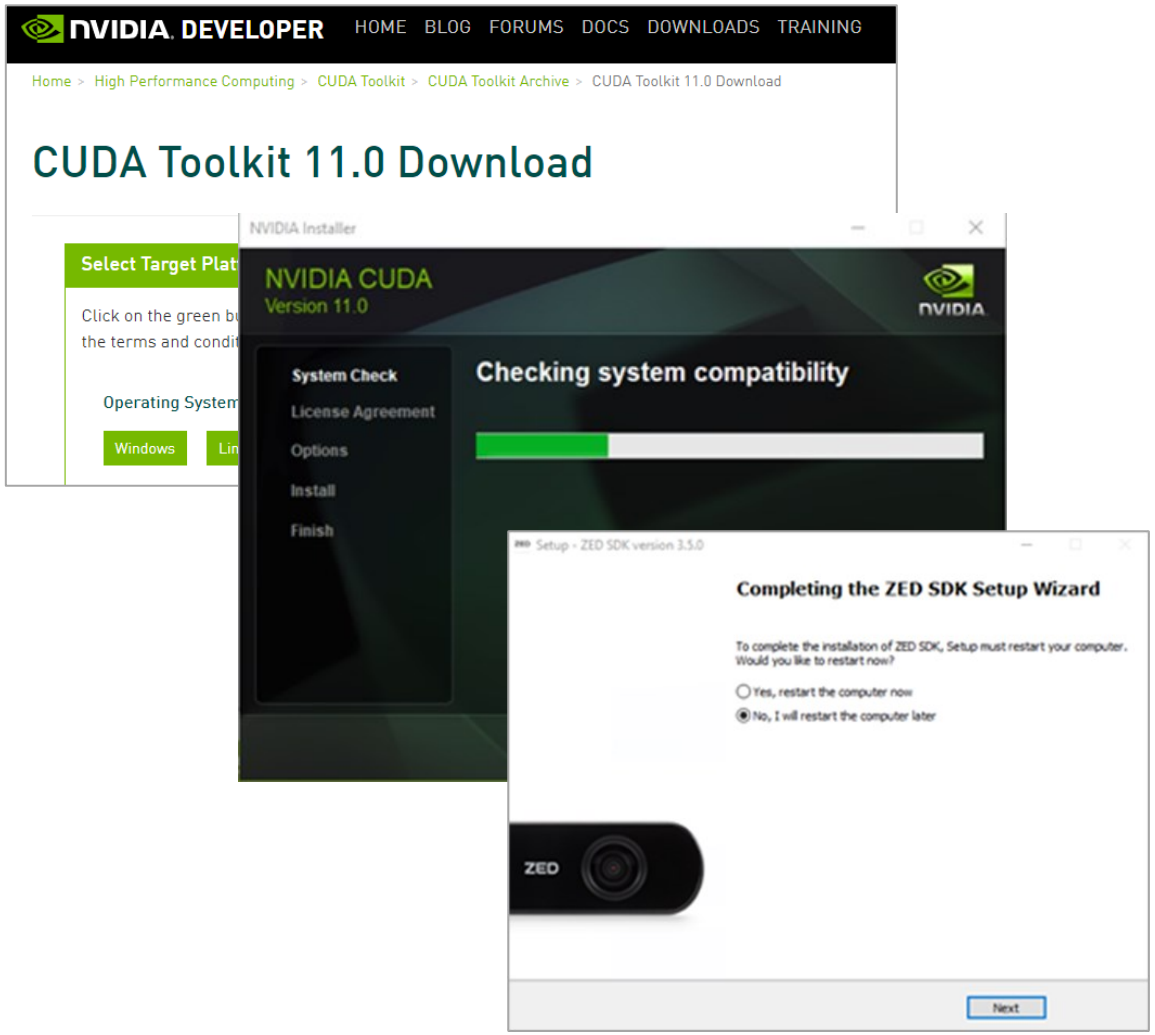
SDK Downloads

The ZED SDK allows you to add depth, motion sensing and spatial AI to your application. Available as a standalone installer, it includes applications, tools and sample projects with source code. Please check out our GitHub page and SDK documentation for additional resources.

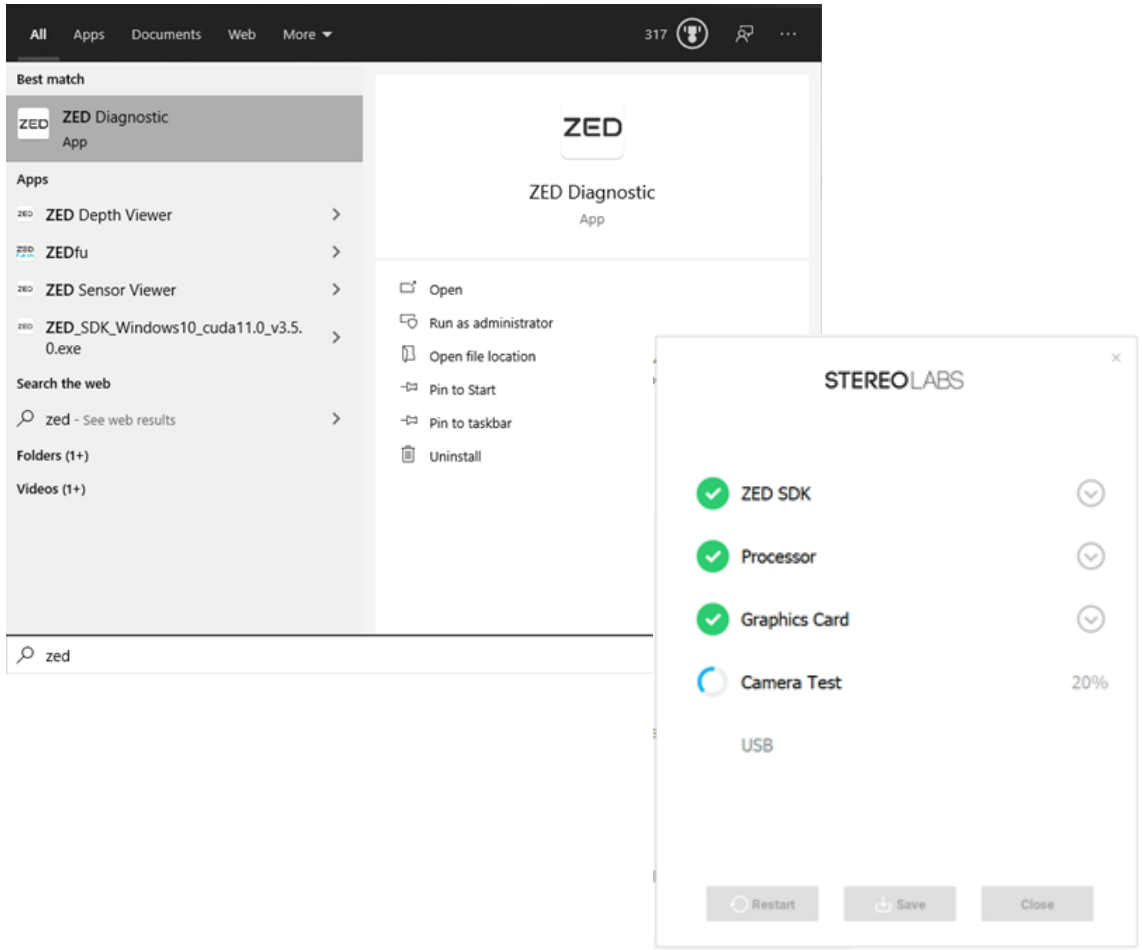
CUDA 11.X (11.0*->11.5)

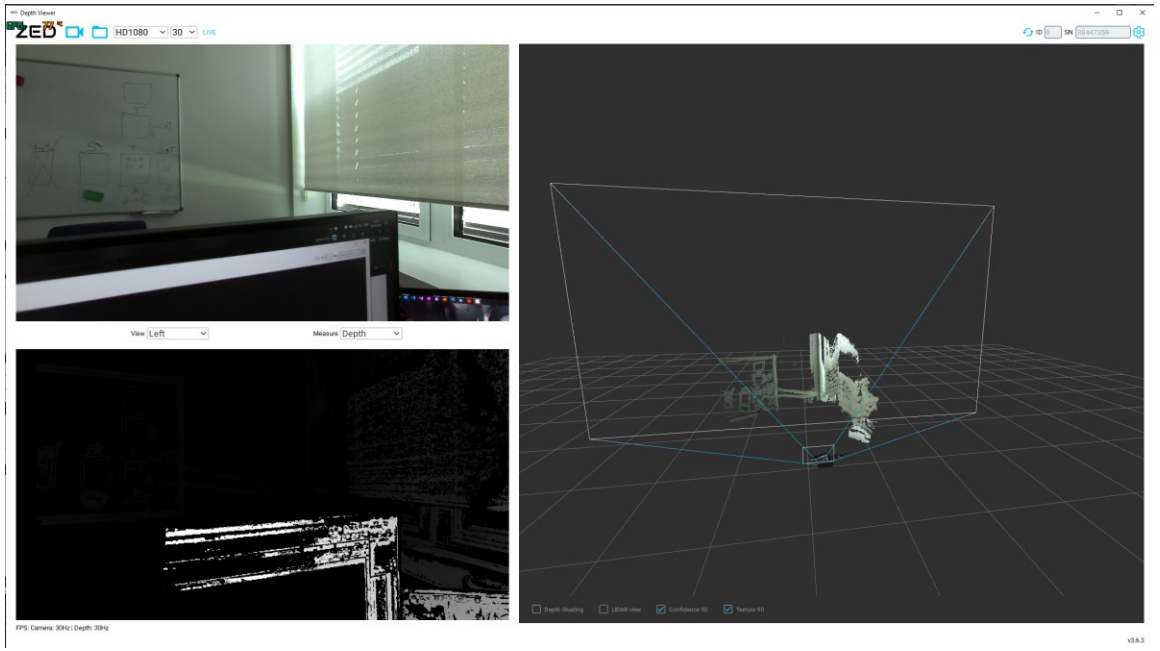
ZED SDK for Windows 10/11 3.7.4 (*CUDA 11.0 is not supported)
ZED SDK for Ubuntu 20 3.7.4
ZED SDK for Ubuntu 18 3.7.4

Stereolabs



Camera setup





Development environment setup

Manual Install

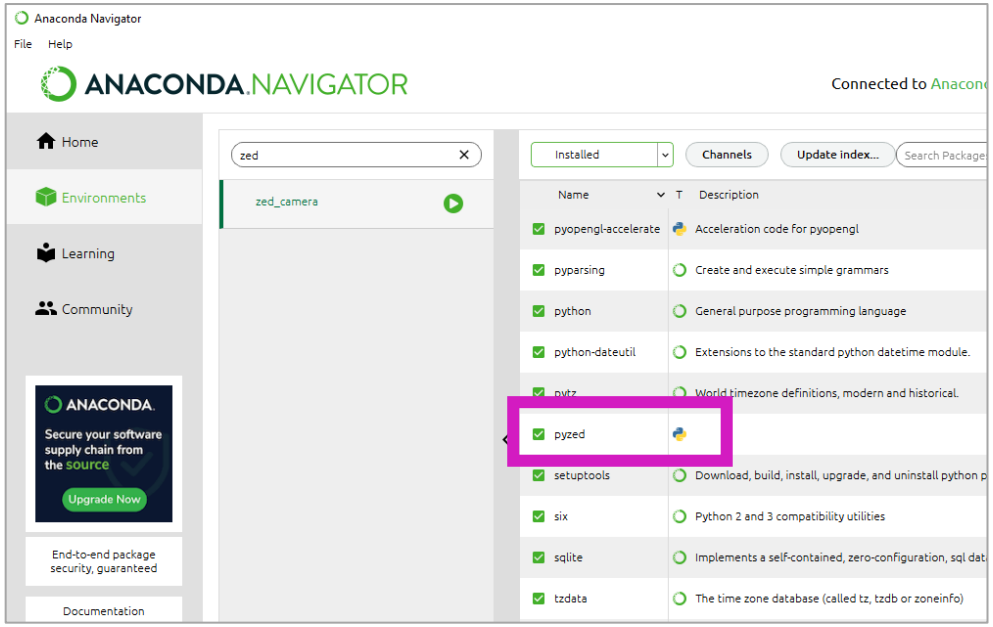
Windows

```
(zed_camera) PS C:\Program Files (x86)\ZED SDK> python3.exe .\get_python_api.py
-> Downloading to 'C:\Program Files (x86)\ZED SDK'
Detected platform:
        win
        Python 3.9
        ZED SDK 3.6
-> Checking if https://download.stereolabs.com/zedsdk/3.6/win/py39 exists and is available
```

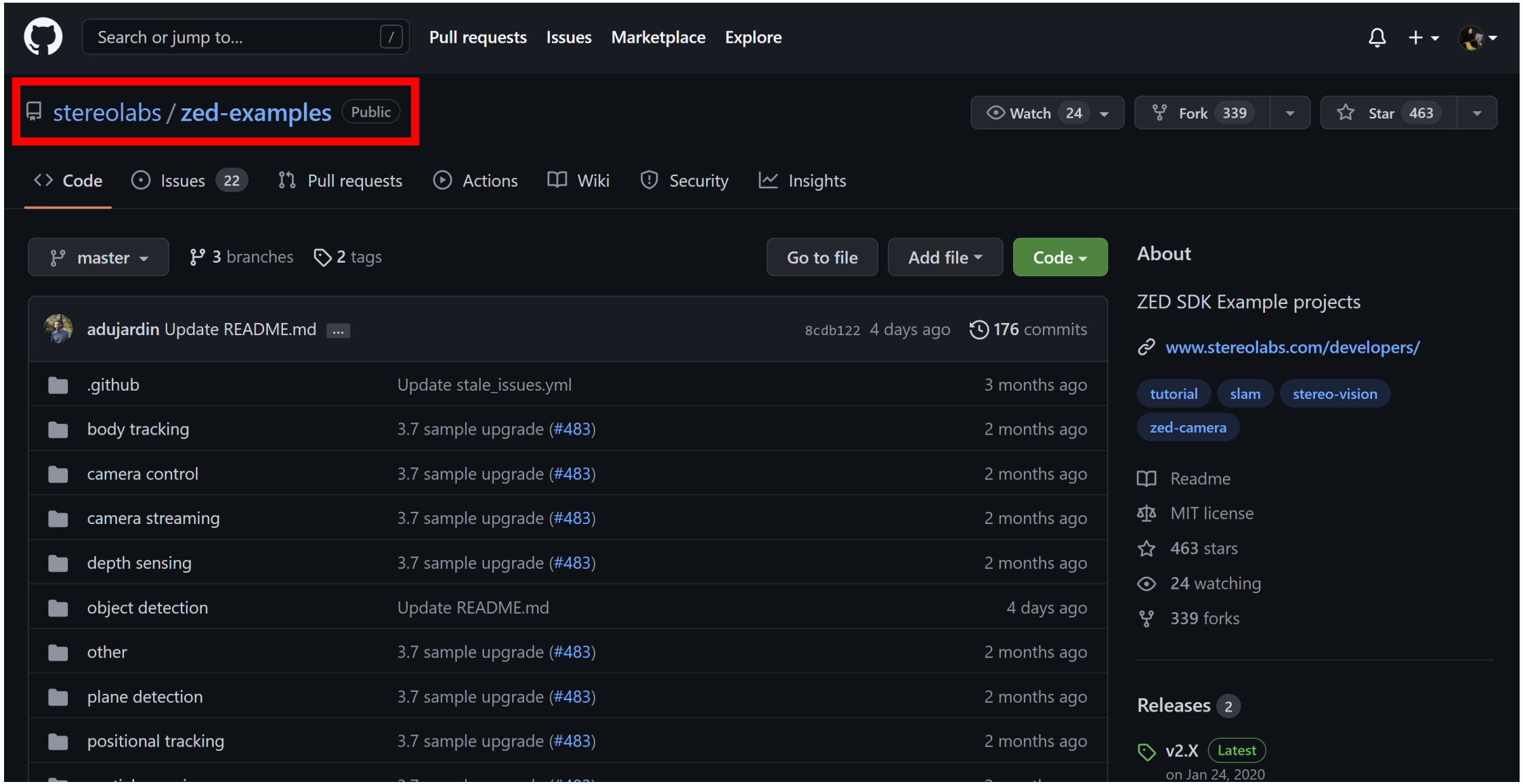
Linux

```
$ cd "/usr/local/zed/"
$ python3 get_python_api.py

    # The script displays the detected platform versions
    Detected platform:
        ubuntu18
        Python 3.6
        CUDA 11.0
        ZED SDK 3.5

    # Downloads the corresponding whl package
    Checking if https://download.stereolabs.com/zedsdk/3.5/ubuntu18/cu110/py36 exists and is available
```

Anaconda Environment



Zed2i: Implementation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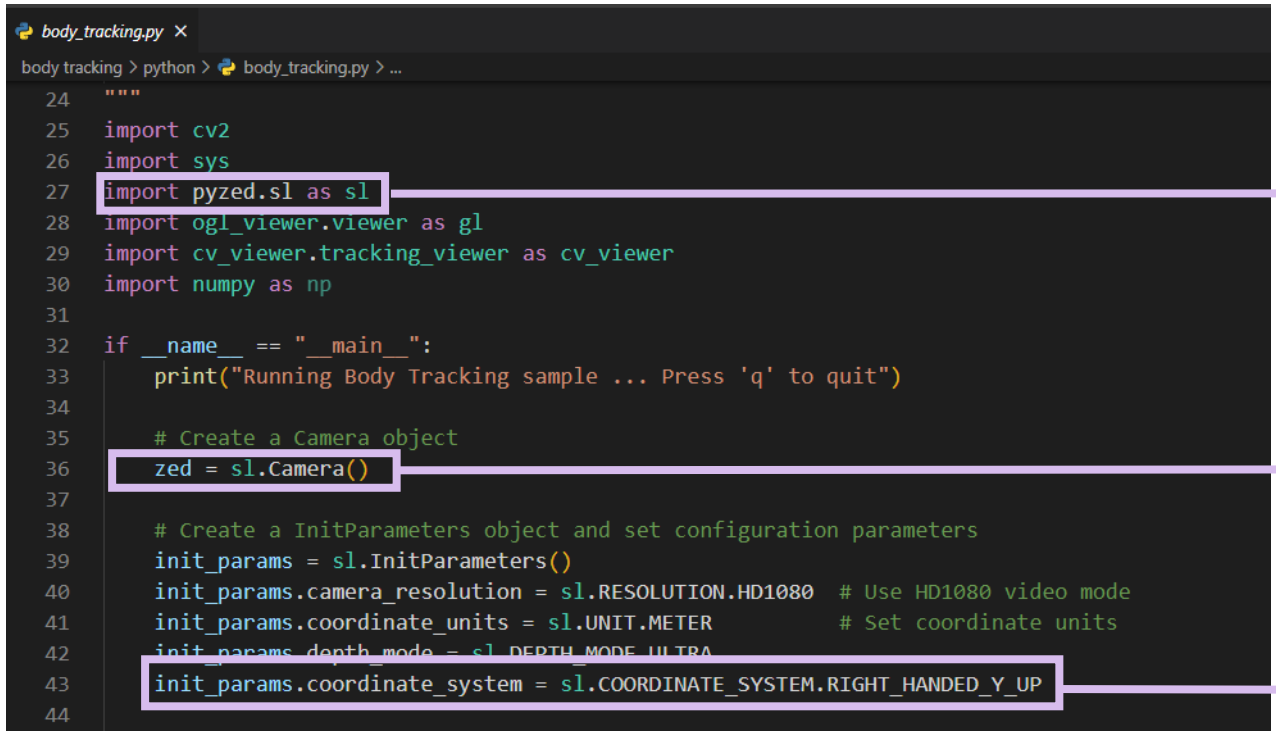
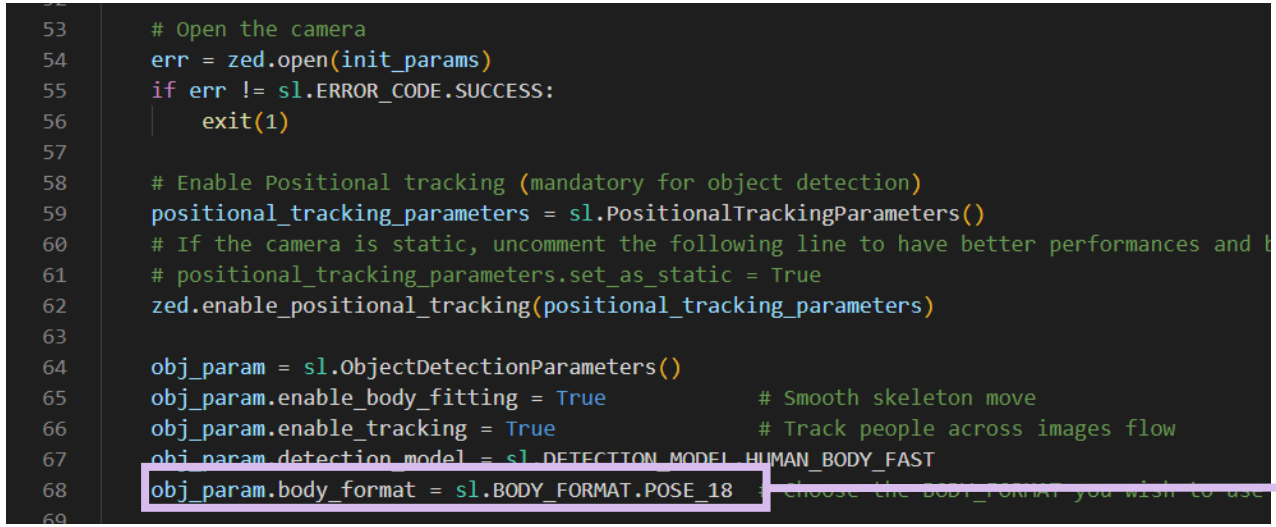
8cdb122 4 days ago
176 commits
.github Update stale_issues.yml 3 months ago
body tracking 3.7 sample upgrade (#483) 2 months ago
camera control 3.7 sample upgrade (#483) 2 months ago
camera streaming 3.7 sample upgrade (#483) 2 months ago
depth sensing 3.7 sample upgrade (#483) 2 months ago
object detection Update README.md 4 days ago
other 3.7 sample upgrade (#483) 2 months ago
plane detection 3.7 sample upgrade (#483) 2 months ago
positional tracking 3.7 sample upgrade (#483) 2 months ago
About
ZED SDK Example projects
www.stereolabs.com/developers/
tutorial
slam
stereo-vision
zed-camera
Readme
MIT license
463 stars
24 watching
339 forks
Releases 2
v2.X Latest
on Jan 24, 2020



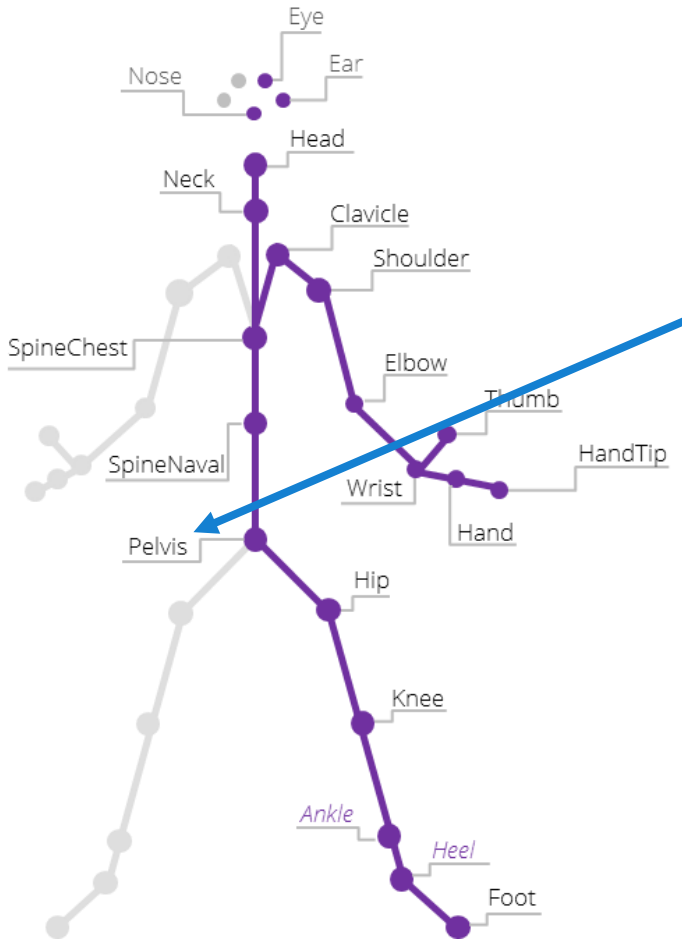
SDK library

Camera invoke

Coordinate System



Skeleton data format



Joint key

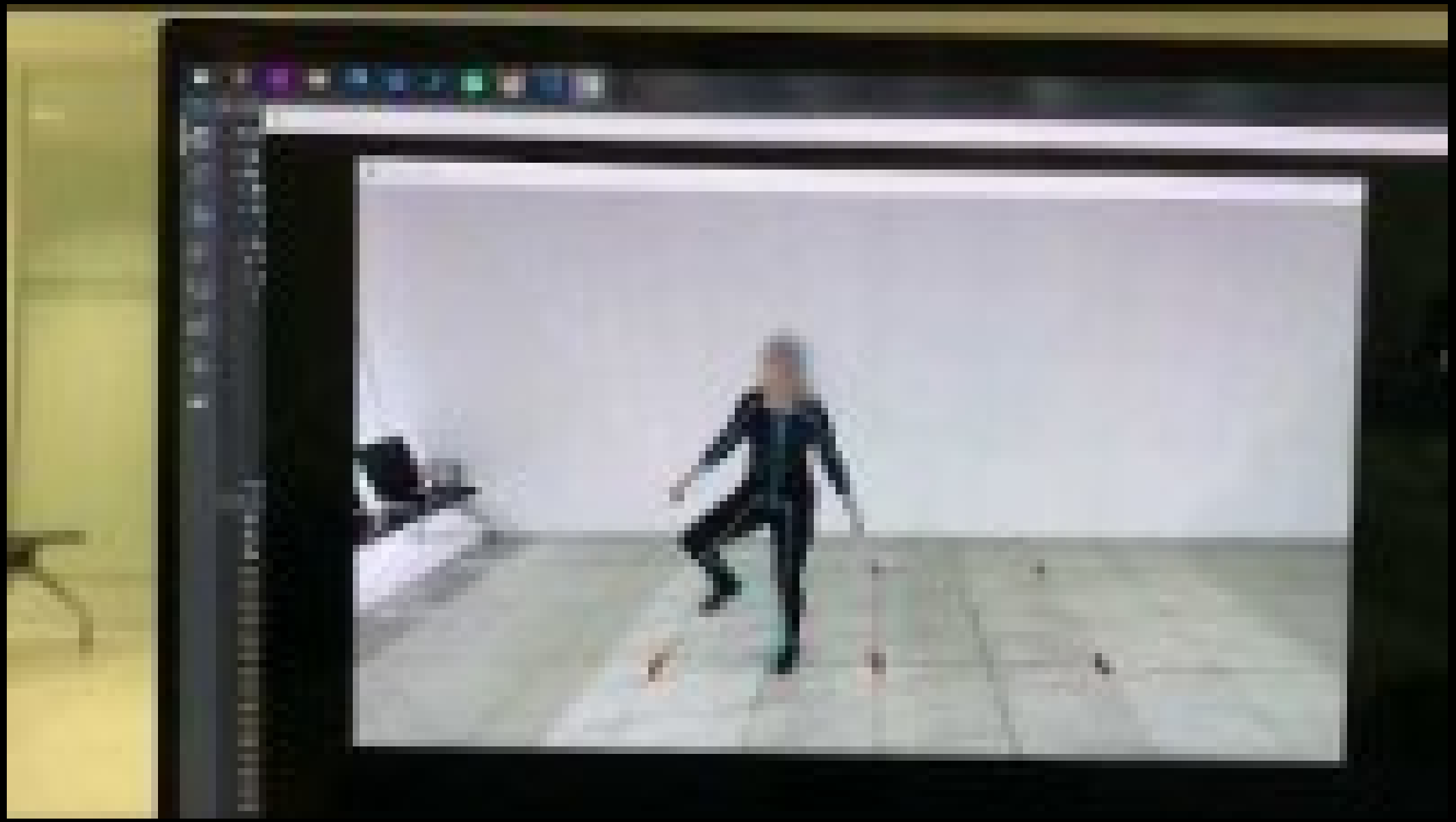
Coordinates [x, y, z]

```
# elif body_format == sl.BODY_FORMAT.POSE_34:
    #Get skeleton data joints
joints={
        'Pelvis':obj.keypoint[0][0]*-1,obj.keypoint[0][1],obj.keypoint[0][2]],
        'NavalSpine':[obj.keypoint[1][0]*-1,obj.keypoint[1][1],obj.keypoint[1][2]],
        'ChestSpine':[obj.keypoint[2][0]*-1,obj.keypoint[2][1],obj.keypoint[2][2]],
        'Neck':[obj.keypoint[3][0]*-1,obj.keypoint[3][1],obj.keypoint[3][2]],

        'ClavicleLeft':[obj.keypoint[4][0]*-1,obj.keypoint[4][1],obj.keypoint[4][2]],
        'ShoulderLeft':[obj.keypoint[5][0]*-1,obj.keypoint[5][1],obj.keypoint[5][2]],
        'ElbowLeft':[obj.keypoint[6][0]*-1,obj.keypoint[6][1],obj.keypoint[6][2]],
        'WristLeft':[obj.keypoint[7][0]*-1,obj.keypoint[7][1],obj.keypoint[7][2]],
```

(Sosa-Leon, Schwering. 2022)

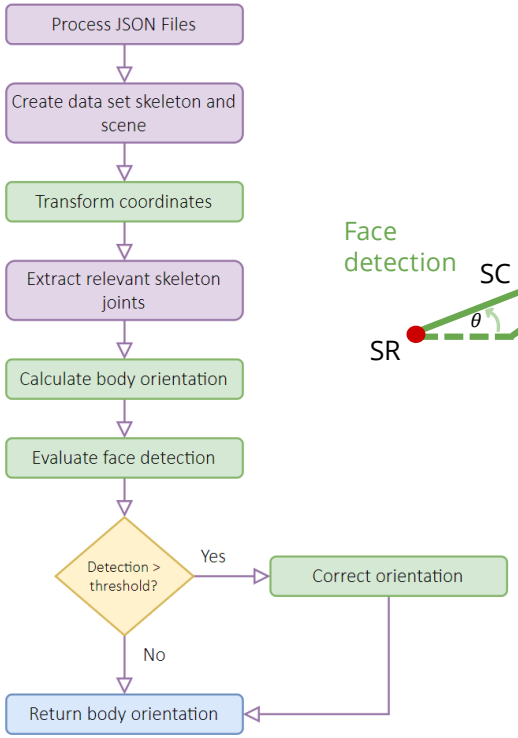
Zed2i: Test

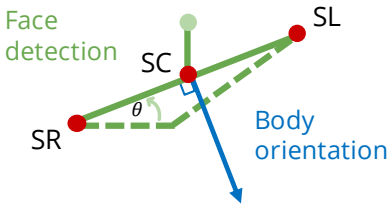


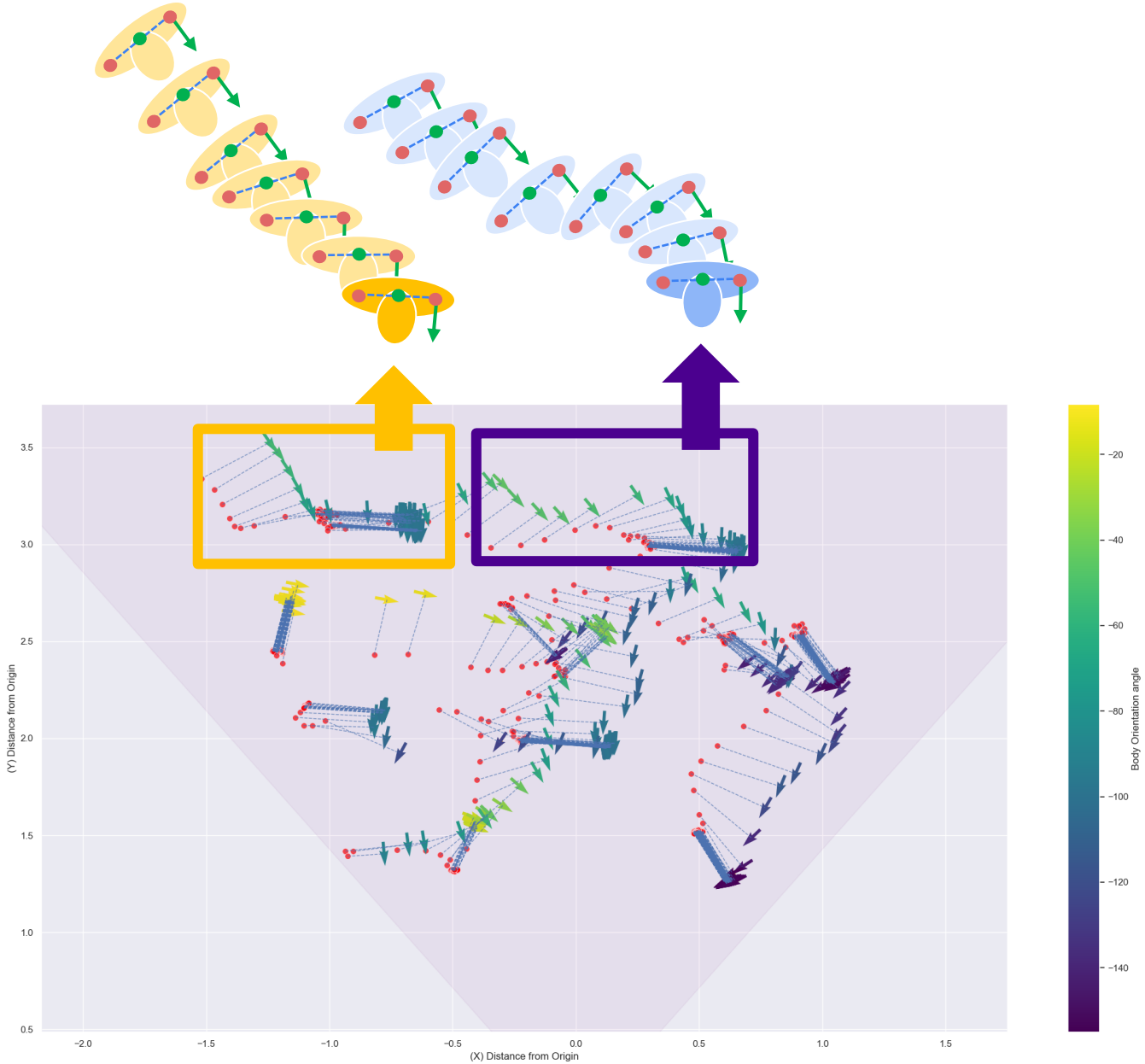
Zed2i: Skeleton tracking test - YouTube

Application:
Detecting social groups

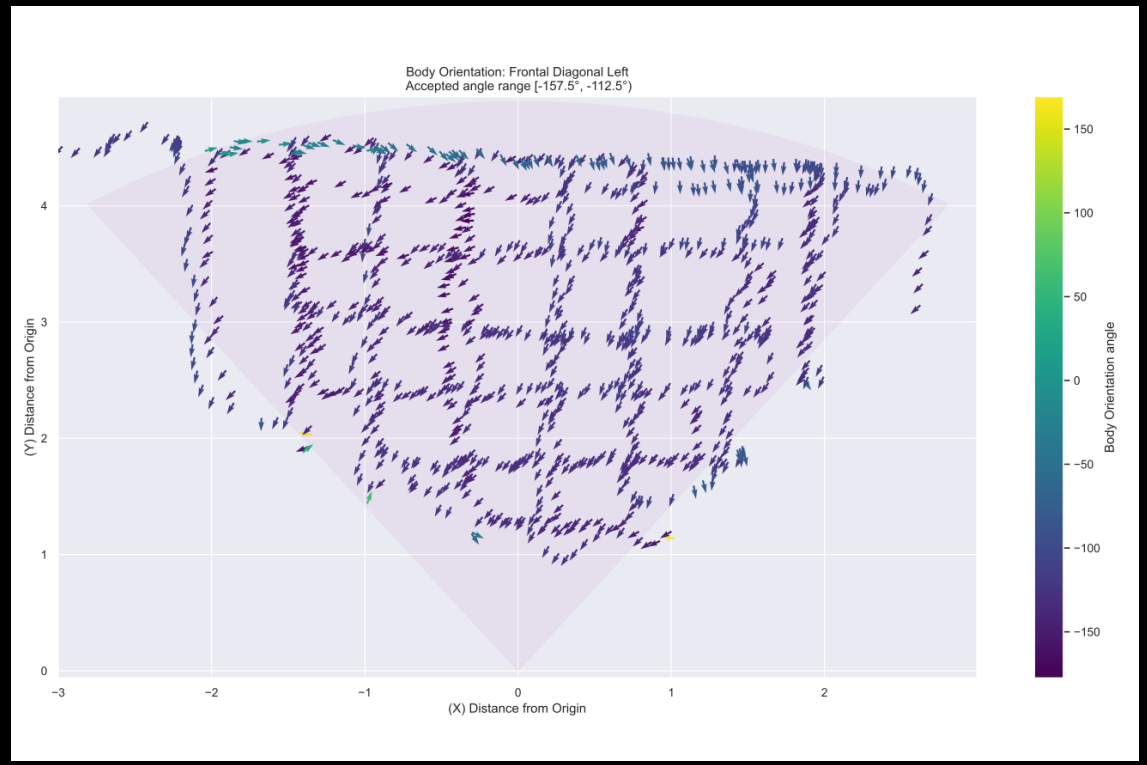
Skeleton data processing algorithm

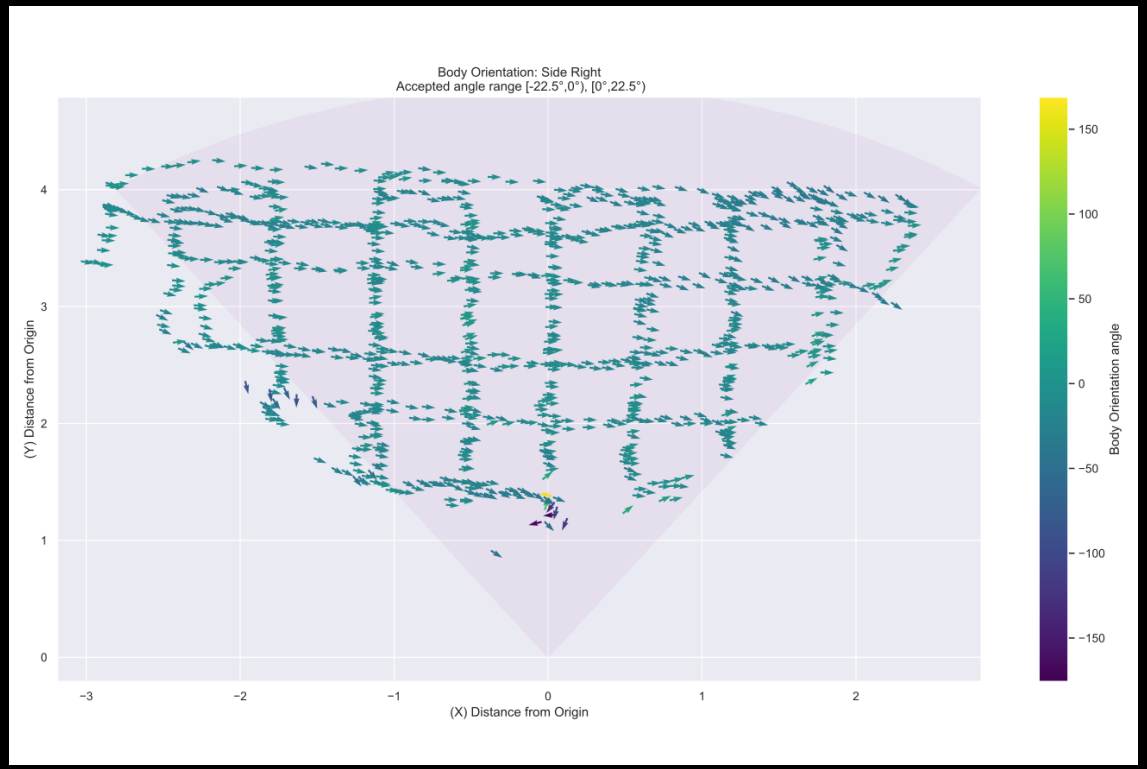






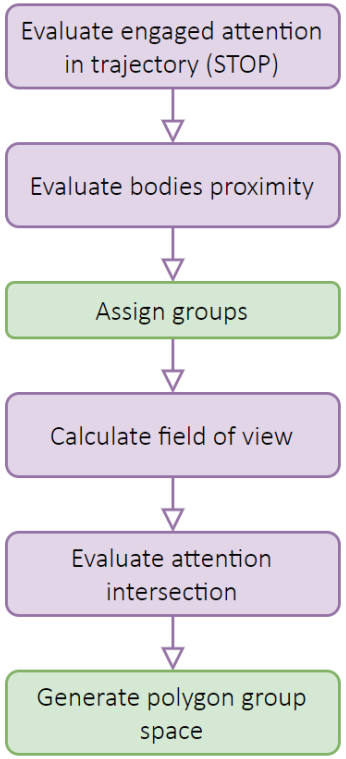
(Sosa-Leon, Schwering. 2022)

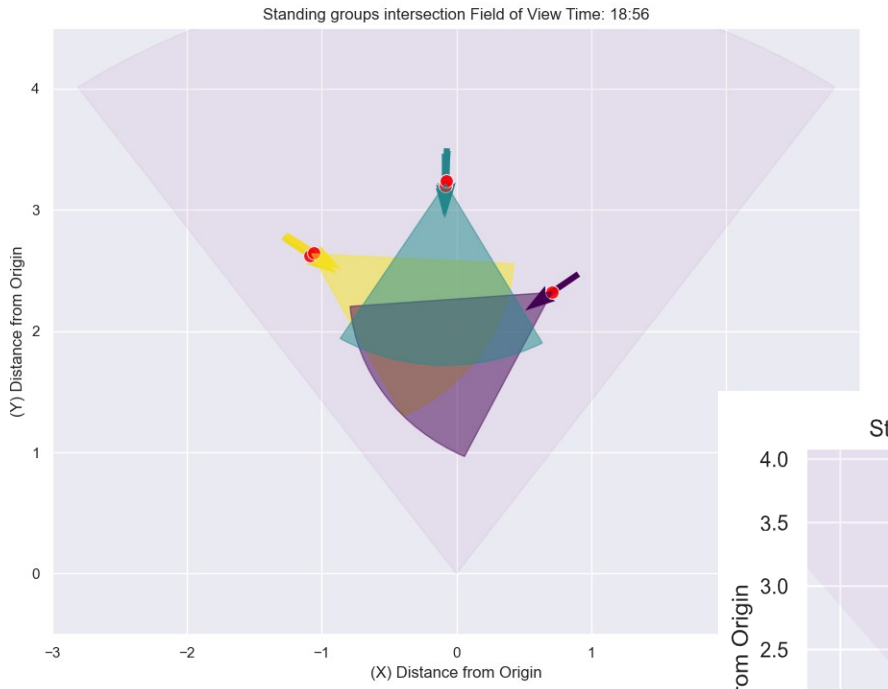




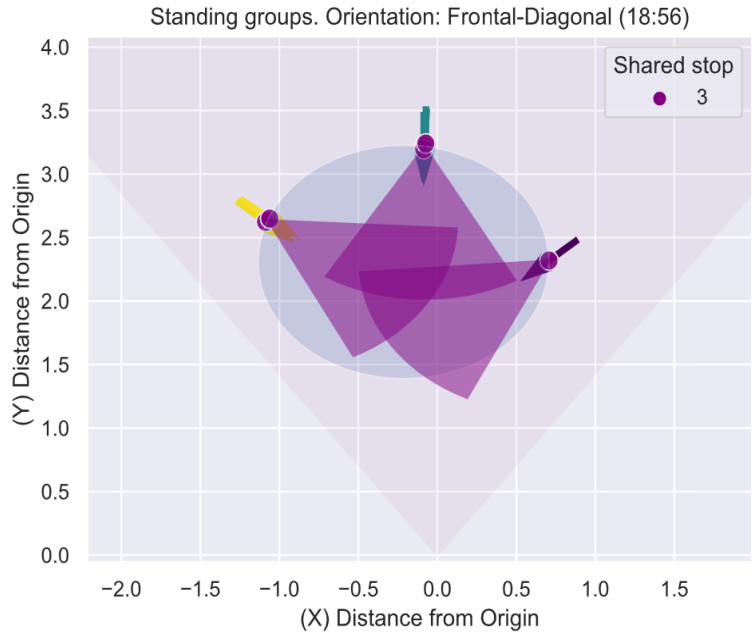
(Sosa-Leon, Schwering. 2022)

Group detection algorithm





> 90%



(Sosa-Leon, Schwering. 2021)

Challenges

Social

Cultural context

Privacy concerns

Bias in algorithms (height, weight, skin color behavior)

Social

Cultural context

Privacy concerns

Bias in algorithms (height, weight, skin color behavior)

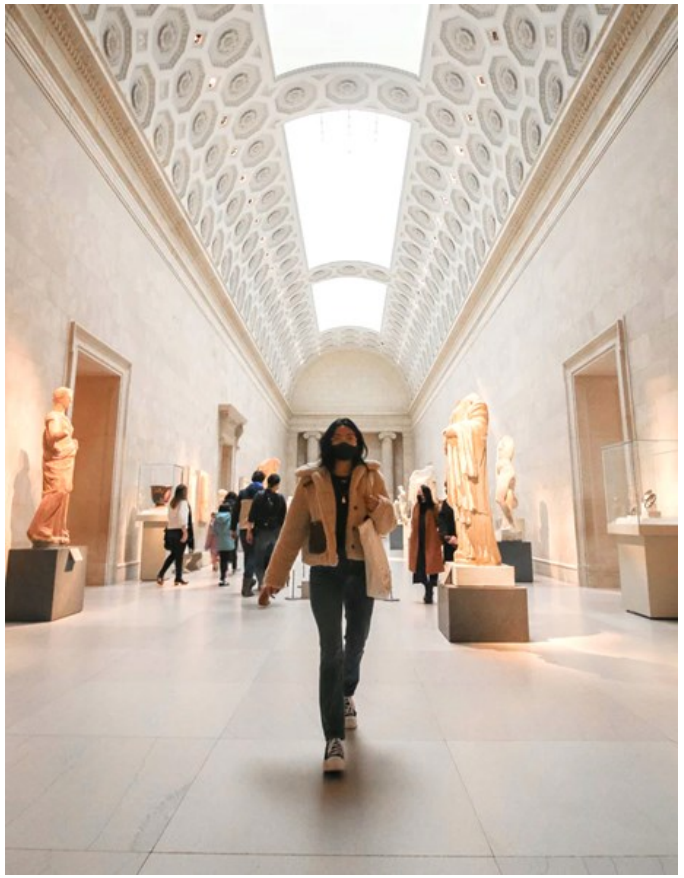
Technical

Computational power

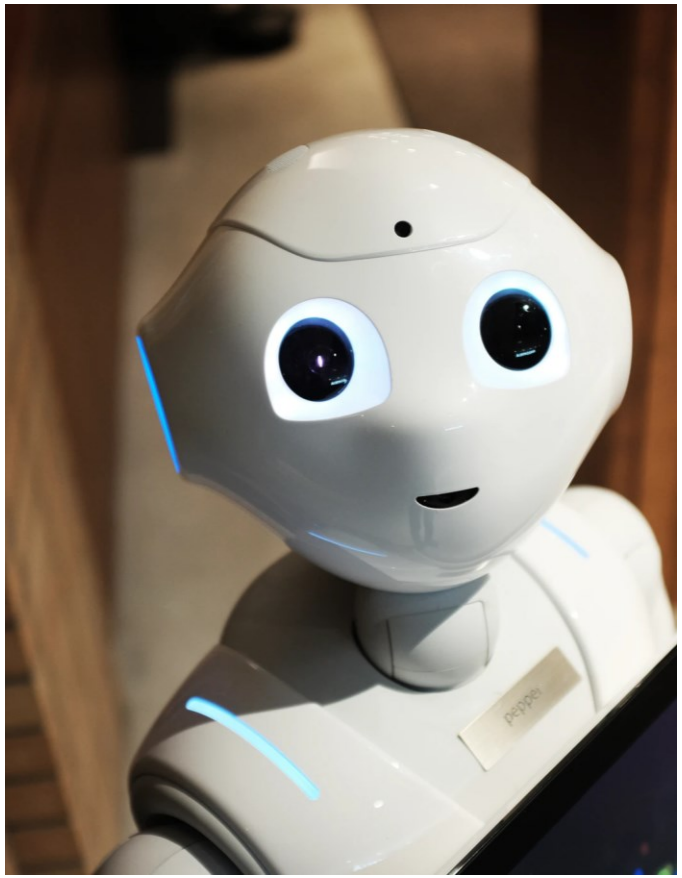
Environmental factors

Set-up configuration and placement

Services we use



Places we explore



Artificial agents we create

The Power of tracking the invisible: Geoinformatics and Social Human Behavior

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