INEL

DGS-KORPUS

SIGN HUB

Summer School 2019

Language Documentation and Corpus Technology

OpenPose for Linguists

Maren Brumm, Marc Schulder, Thomas Hanke

UHH

Jointly organised by the long-term projects DGS-Korpus and INEL
of the Academy of Sciences and Humanities
in cooperation with the EU-funded project The Sign-Hub

AKADEMIE DER
WISSENSCHAFTEN
IN HAMBURG

Negation Devices in Sign Languages

- Negation particles ✔
- Negation content words ✔
- Manual negation morphemes (✔)
- Headshake ((✔))
- Facial expression ☹️

Headshake

- Not part of core annotation.
- But annotators were asked to add comments about further important observations.
- **Result:**
  >7000 comments mentioning headshakes.

Headshake + Lexeme

Negation Sign + HS

NO

no

Regular Sign + HS

BRING

not brought

Headshake + Phrase

HS negates phrase

TOGETHER FIT TOGETHER NOT

It has nothing to do with each other at all

Non-negating Headshake

HS indicates negative sentiment

ALL OFF-CLOSE TO-CLOSE

All of them have been closed down

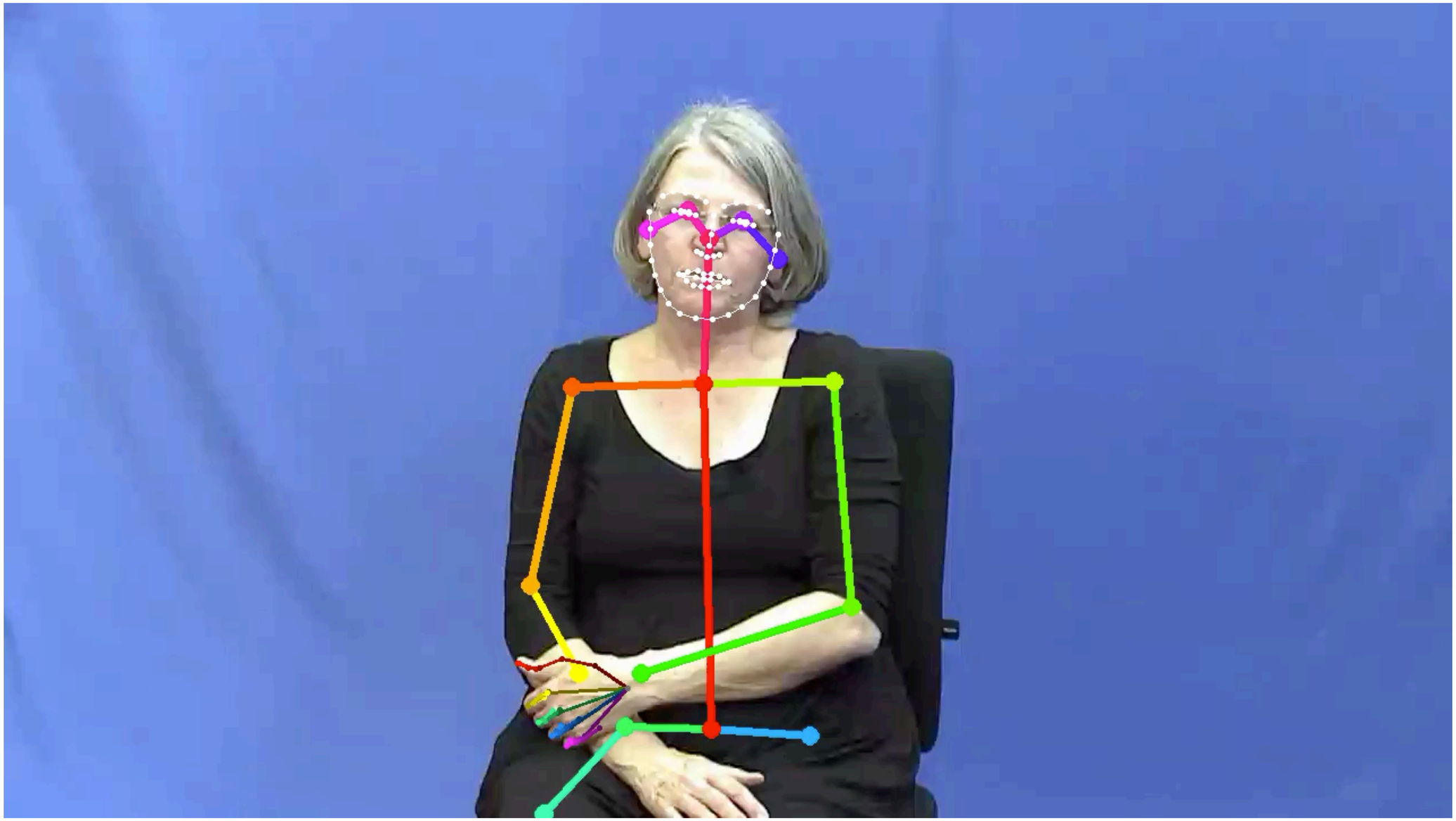
Manual Annotation is slow and expensive, so...

- **Approach 1:** Use German translations
  - Reduces annotation effort, doesn't replace it
  - Can only find negation headshakes
- **Approach 2:**
  Use the visual domain

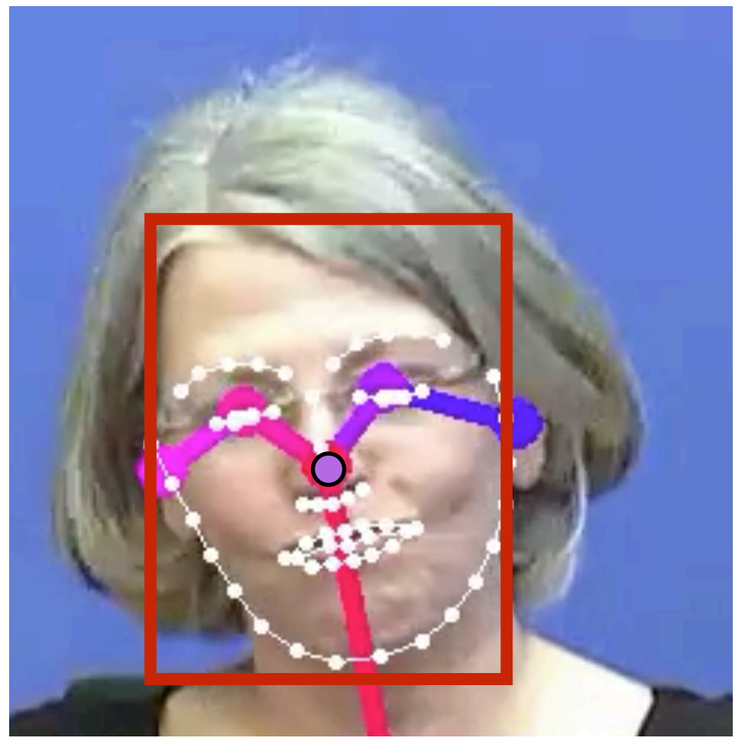
Into the Visual Domain: OpenPose (CMU)

OpenPose

OpenPose 2018



Detecting Headshakes in OpenPose Data



Track movement of the nose, relative to face contour.

Detecting Headshakes in OpenPose Data

1. Run Open Pose.
2. Train a neural network classifier to
   - detect headshakes in time series data;
   - determine duration of headshakes.

Neural Network Training Challenges

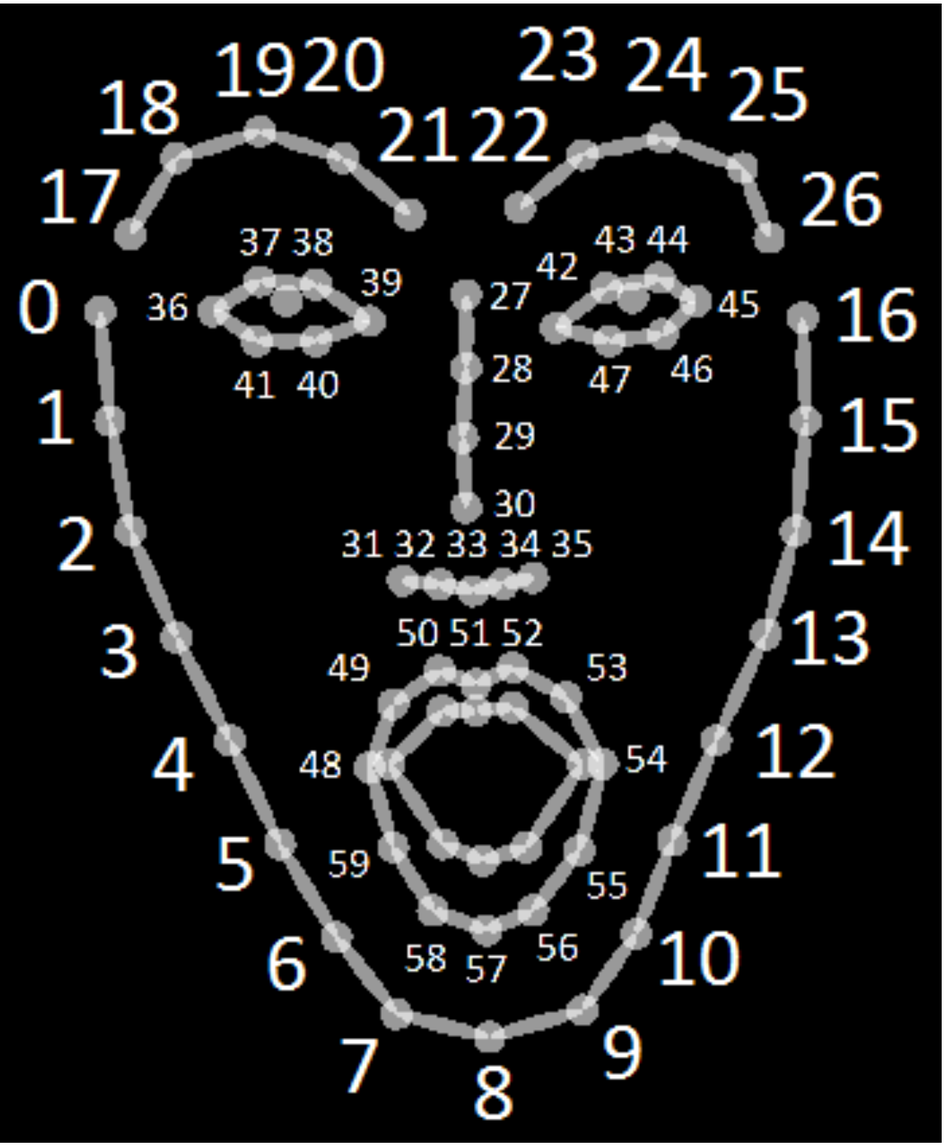
- Need annotator comments to train classifier, but time spans of comments are unreliable:
  - span is for sign, not headshake;
  - comment combines two observations, e.g. "constructed action + headshake".

➡ Comments indicate existence of headshake, but not time span.

➡ Translations may fulfil a similar function.

Uses for OpenPose

- Automatic annotation when human annotation not feasible.
- First pass annotation to assist annotator.
- Quality Assurance: Find annotator mistakes.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21 22
17 26
37 38 43 44
42
0 36 39 27 45 16
41 40 28 47 46
1 29 15
30
2 31 32 33 34 35 14
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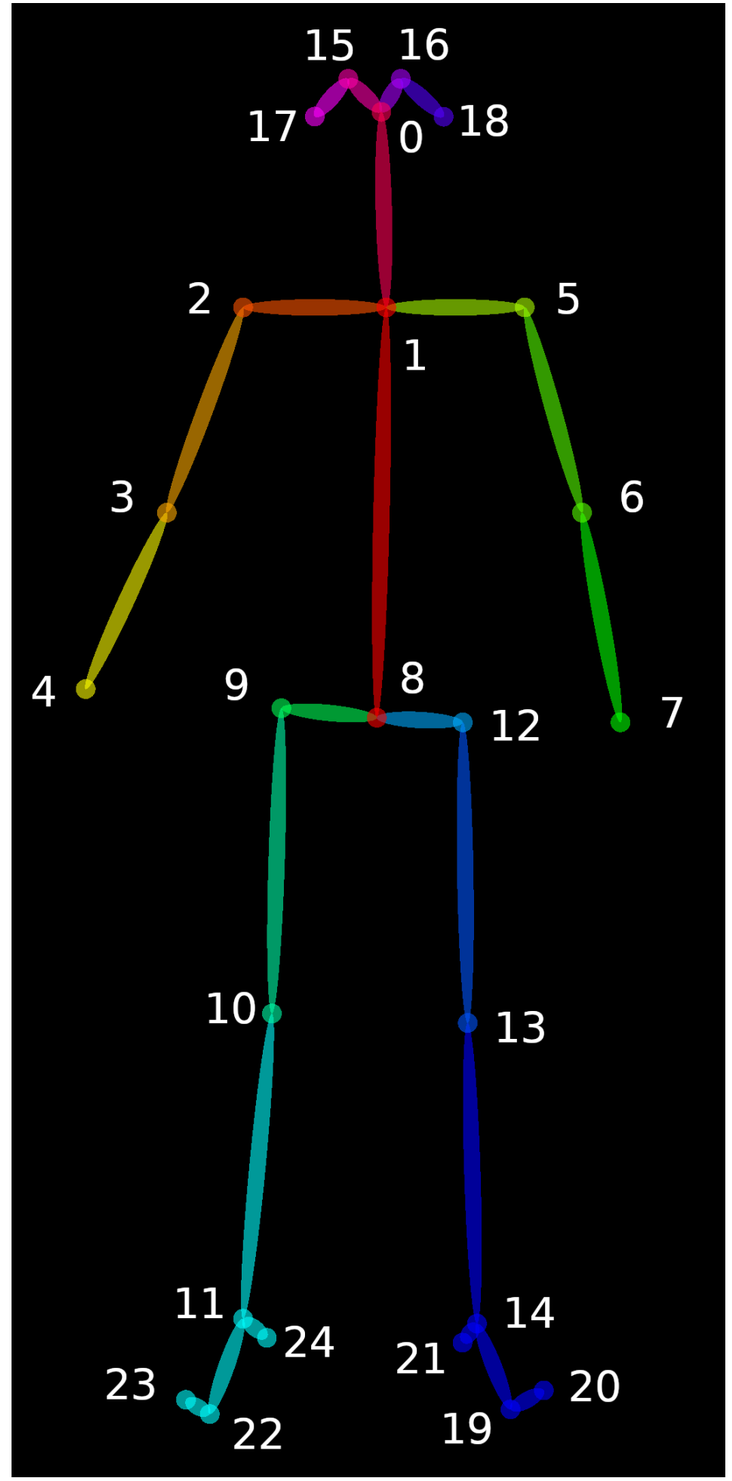
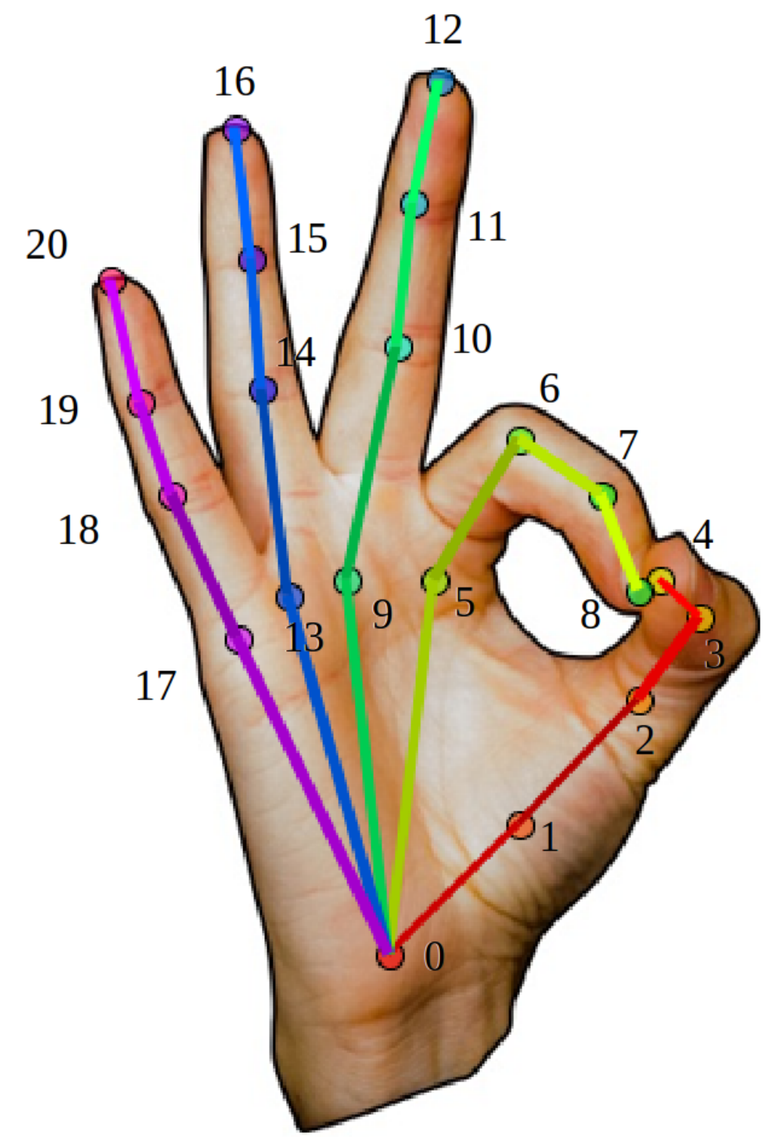
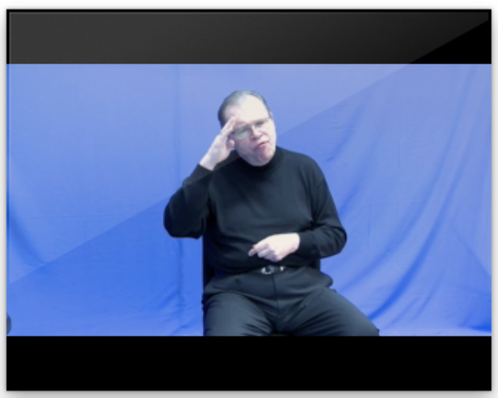
3 49 53 13
4 48 54 12
5 59 55 11
6 58 57 56 10
7 8 9

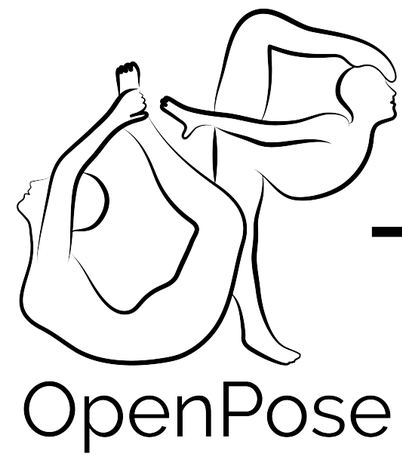

15 16
17 0 18
2 5
1
3 6
4 9 8 12 7
10 13
11 14
24 21
23 20
22 19


12
16
20 15 11
14 10
19 6
7
18 4
13 9 5 8
17 3
2
1
0

OpenPose Output



1837798.mp4



1 File per Frame

1837798_000000000000_keypoints.json
1837798_000000000001_keypoints.json
1837798_000000000002_keypoints.json
1837798_000000000003_keypoints.json
1837798_000000000004_keypoints.json
1837798_000000000005_keypoints.json
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1837798_000000000007_keypoints.json
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1837798_000000000016_keypoints.json
1837798_000000000017_keypoints.json
1837798_000000000018_keypoints.json
1837798_000000000019_keypoints.json
1837798_000000000020_keypoints.json

Hint: Open in an editor with syntax highlighting, e.g. Atom

OpenPose JSON Output


```
{"version":1.2,"people":[{"pose_keypoints_2d":[662.642,184.701,0.844587,666.649,290.495,0.756731,545.137,304.218,0.569373,
447.166,427.583,0.719658,535.315,259.093,0.744091,788.094,274.846,0.664159,868.337,451.1,0.729768,758.68,470.665,0.7455,70
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815609,703.32,243.905,0.835674,708.348,229.938,0.830498,711.141,215.412,0.759424,711.7,199.769,0.810839,711.141,185.802,0.
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155.074,0.9721,673.151,153.957,0.90221,680.414,153.957,0.897549,675.385,157.868,0.906627,668.681,158.985,0.94469,653.038,2
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0.698271,590.757,160.086,0.634325,600.058,144.584,0.660703,561.304,203.491,0.670806,576.03,187.214,0.756631,586.107,177.13
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_keypoints_3d":[]}]}
```


Photographer: Helen Graham
Subject: Snuggles

Ope tput


```
{"version":1.2,"people":[{"
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1.841,615.651,0.391784,617.
2,178.716,0.85956,672.477,1
,0,0,0],"face_keypoints_2d"
68137,626.221,251.168,0.562
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.663798,619.517,163.454,0.7
,0.730013,672.033,142.783,0
52,0.956426,656.949,180.774
34,0.921357,668.681,193.623
.628,0.782919,634.601,172.9
155.074,0.9721,673.151,153.
25.469,0.886009,658.066,216
203.68,0.960073,689.353,206
221.558,0.907744,662.536,22
,208.708,0.925622,685.442,2
78,176.863,0.731809,670.916
694.786,457.94,0.685826,668
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,716.81,514.775,0.835929,69
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.832909,566.729,200.39,0.54
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_keypoints_3d":[]}]}
```



```
,545.137,304.218,0.569373,
8,758.68,470.665,0.7455,70
.633,0.192912,0,0,0,623.49
,0,0,0,0,0,0,0,0,0,0,0,0,0
.569021,613.93,236.084,0.5
.618702,693.263,256.196,0.
.810839,711.141,185.802,0.
0.529645,612.813,167.924,0
8,0.712696,663.094,147.253
.689,0.93595,653.597,172.9
652,0.977437,663.653,197.5
6.863,0.746141,628.456,174
,160.102,0.927095,667.564,
,158.985,0.94469,653.038,2
1,204.238,0.84269,680.972,
85,220.44,0.901506,669.24,
5,212.619,0.971158,675.944
.005,215.971,0.928556,626.
,734.571,460.071,0.449957,
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4,669.921,501.987,0.650257
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02],"hand_right_keypoints_
0.850778,593.857,205.816,0
,0.521202,562.079,198.065,
15,0.70517,576.03,175.588,
14,0.756631,586.107,177.13
ypoints_3d":[],"hand_right
```


Photographer: Helen Graham
Subject: Snuggles

AKADEMIE DER WISSENSCHAFTEN IN HAMBURG

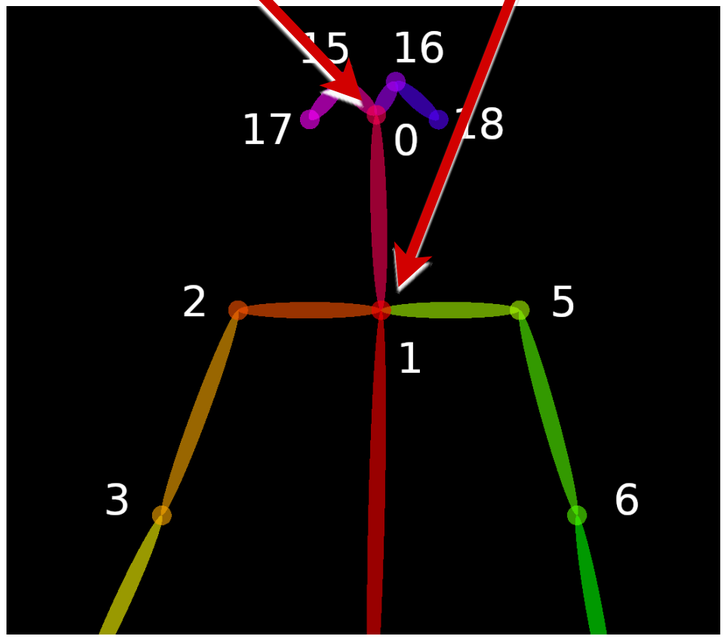
Indented JSON Output


```
{
  "version":1.2,
  "people":
    [
      {
        "pose_keypoints_2d":[662.642,184.701,0.844587,666.649,290.495,0.756731,545.137,304.218,0.569373,447.166,427.583,...],
        "face_keypoints_2d":[591.583,194.741,0.447692,599.404,207.591,0.556373,604.991,220.999,0.569021,613.93,236.084,...],
        "hand_left_keypoints_2d":[760.857,472.859,0.385735,734.571,460.071,0.449957,694.786,457.94,0.685826,668.5,...],
        "hand_right_keypoints_2d":[541.926,255.422,0.562895,562.854,247.671,0.585057,579.906,231.394,0.783543,591.532,...],
        "pose_keypoints_3d":[],
        "face_keypoints_3d":[],
        "hand_left_keypoints_3d":[],
        "hand_right_keypoints_3d":[]
      }
    ]
}
```

Keypoint Values

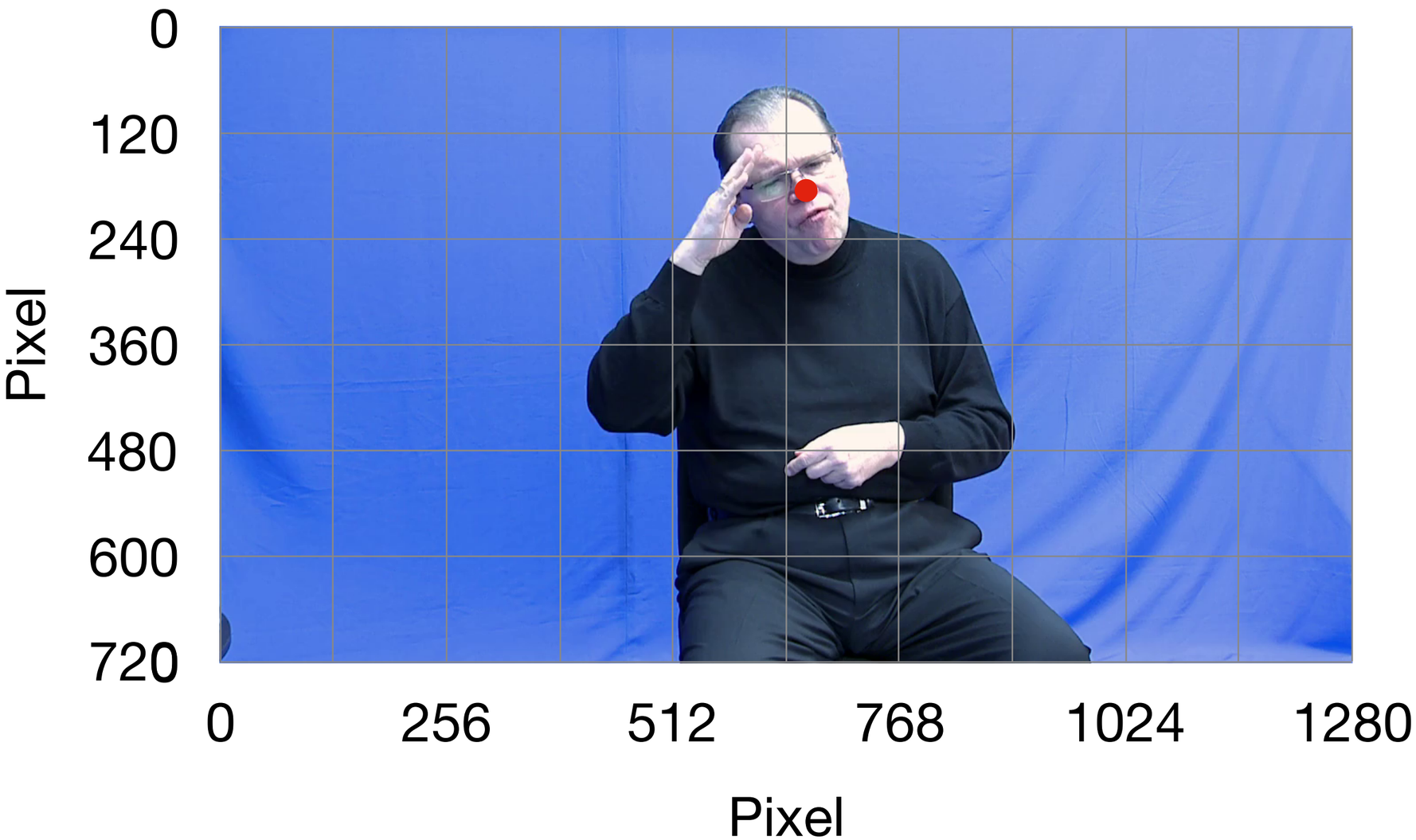
"pose_keypoints_2d": [662.642,184.701,0.844587,666.649,290.495,0.756731,545.137,304.218,0.569373,447.166,427.583,...],

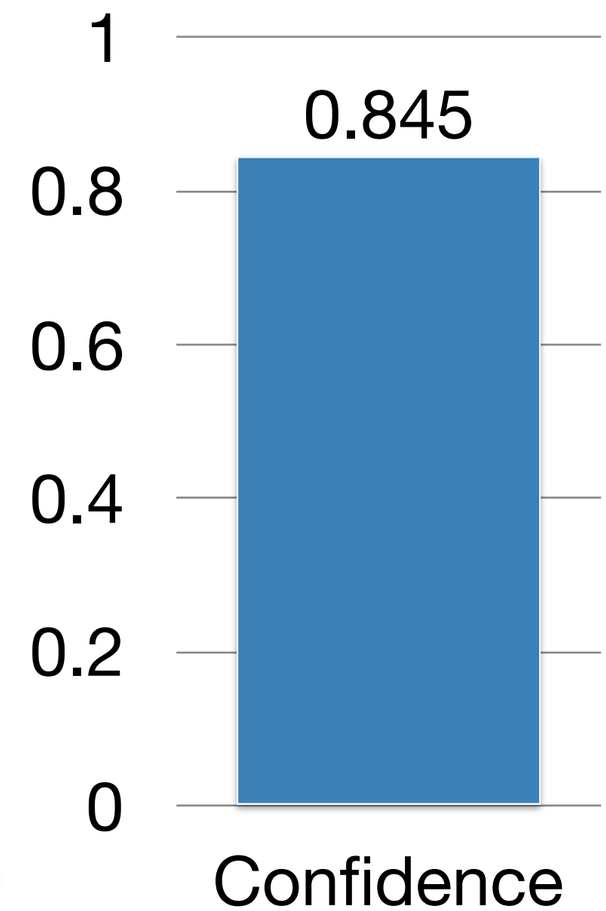
Keypoint 0 Keypoint 1 Keypoint 2



662.642,184.701,0.844587

X-Axis Y-Axis Confidence





Side Note: Multiple People


```
{
  "version":1.2,
  "people":
    [
      {
        "pose_keypoints_2d":[662.642,184.701,0.844587,666.649,290.495,0.756731,545.137,304.218,0.569373,447.166,427.583,...],
        "face_keypoints_2d":[591.583,194.741,0.447692,599.404,207.591,0.556373,604.991,220.999,0.569021,613.93,236.084,...],
        "hand_left_keypoints_2d":[760.857,472.859,0.385735,734.571,460.071,0.449957,694.786,457.94,0.685826,668.5,...],
        "hand_right_keypoints_2d":[541.926,255.422,0.562895,562.854,247.671,0.585057,579.906,231.394,0.783543,591.532,...],
        "pose_keypoints_3d":[],
        "face_keypoints_3d":[],
        "hand_left_keypoints_3d":[],
        "hand_right_keypoints_3d":[]
      },
      {
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        "face_keypoints_2d":[593.57,193.362,0.46221,600.317,206.293,0.557007,605.377,220.911,0.601475,614.372,234.966,...],
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        "face_keypoints_3d":[],
        "hand_left_keypoints_3d":[],
        "hand_right_keypoints_3d":[]
      }
    ]
}
```

Technical Requirements

Video:

- High resolution video (HD or 4K)
- 50 Frames per Second (lower framerate = more blur)
- High contrast background

Running OpenPose:

- **Minimum:** A fast modern computer
- **Intermediate:** Use graphics cards (GPU) for computations (more setup, but x2-30 faster)
- **Best:** High Performance Cluster

Running OpenPose on DGS Corpus

- 550 hours or recordings.
- 3 camera perspectives per recording.
- 1 hour recording = 87 hours processing
  (double-GPU machine)

Processing Time:

- Single computer: 5½ years
- High Performance Cluster: 4 months

OpenPose Installation

Windows:

- Download demo from https://github.com/CMU-Perceptual-Computing-Lab/openpose/releases
- Double click on `models/getModels.bat` to download the required body, face, and hand models
- You're done :-)

Mac/Linux:

- Complicated :-(
- Follow instructions at https://github.com/CMU-Perceptual-Computing-Lab/openpose/blob/master/doc/installation.md
- For Mac we provide scripts that should install everything.

OpenPose Installation

Mac:

- Start *Terminal*.
- Navigate to the class folder by writing "`cd` " and drag-and-dropping the class folder into *Terminal*.
- Install Python 3: `bash install_python3.sh`
- Install OpenPose: `bash install_openpose.sh`

Run OpenPose

Windows:

- Open programme: *Windows Command Prompt*
- Navigate to OpenPose main folder (e.g. `cd C:/openpose`)
- `bin\OpenPoseDemo.exe --video examples\media\video.avi`

Mac/Linux:

- Open programme: *Terminal*
- Navigate to OpenPose main folder (e.g. `cd ~/openpose`)
- `./build/examples/openpose/openpose.bin --video examples/media/video.avi`

Replace with path to your video

Additional options

Add any of the following bits to the end of the command from the previous slide:

- Enable face keypoint detection: `--face`
- Enable hand keypoint detection: `--hand`
- Save points to file:
  `--write_json outputfolder/ --display 0 --render_pose 0`
- Many more (e.g. higher accuracy settings) on https://github.com/CMU-Perceptual-Computing-Lab/openpose/blob/master/doc/demo_overview.md

Don’t want to run OpenPose yourself? Use DGS Corpus data :-)

Transcript	Age Group	Format	Topics	iLex File	ELAN File	Movie A	Movie B	Movie Total	SRT File	Movie AB	OpenPose
dgskorpus_ber_01	18-30	Experience of Deaf Individuals	Communication: Communication with Hearing People Deaf Culture Family and Relatives: Family Period of Life: Kindergarten Period of Life: Schooldays School and Education: Boarding School School and Education: Schooldays Society: Role Models Work and Profession: Kindergarten								
dgskorpus_ber_01	18-30	Joke	Food (Joke)								
dgskorpus_ber_01	18-30	Experience of Deaf Individuals	Communication: Communication with Hearing People Family and Relatives Family and Relatives: Family Personal Hygiene, Health, Illness: Cochlear Implant (CI) Personal Hygiene, Health, Illness: Illness Society: Hearing-Deaf Vacation, Free Time, Traveling: Free Time								

OpenPose **detects** keypoints on a body.

OpenPose does NOT tell you what a movement **means**.

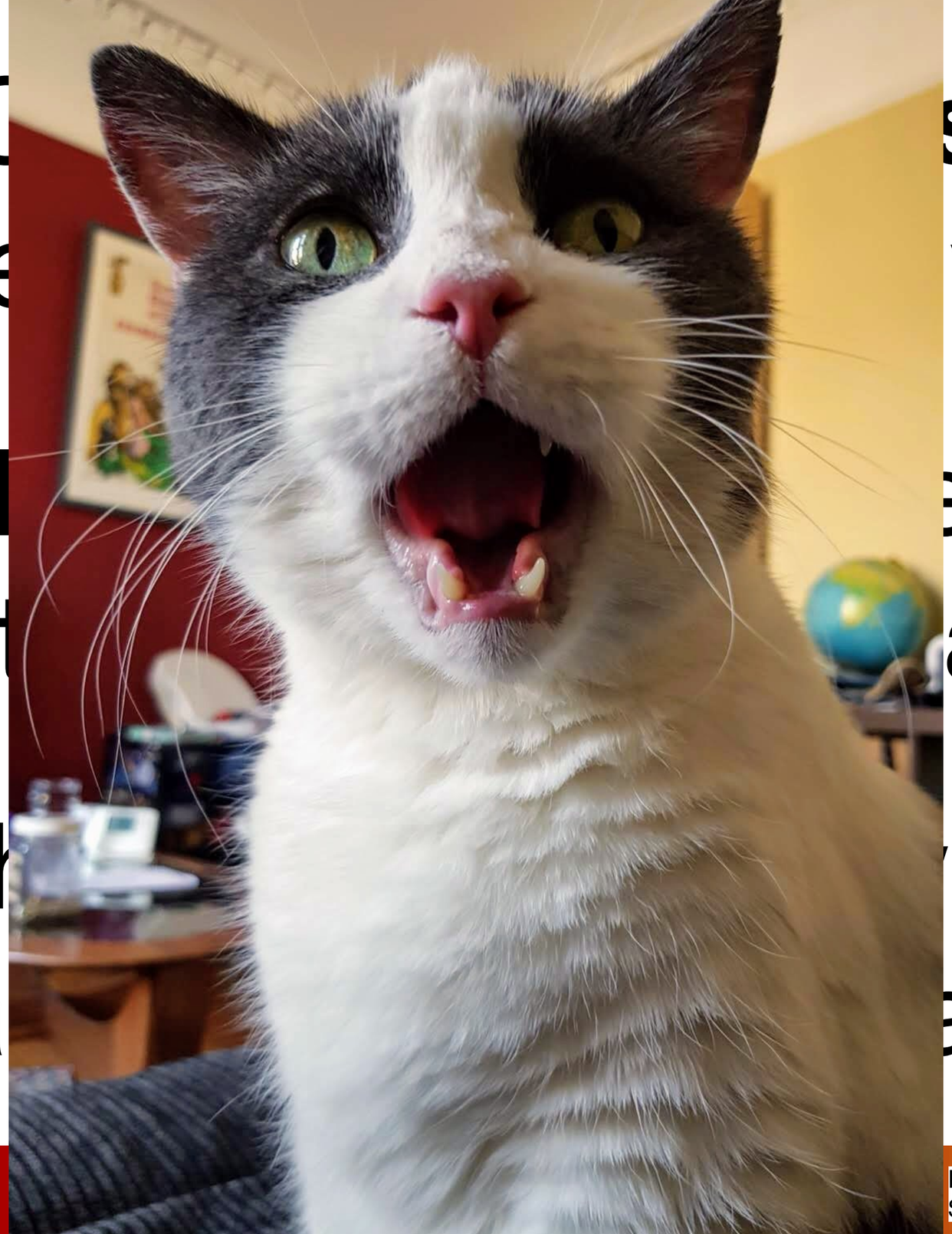
For that you need to write a **classification** program.

Photographer: Helen Graham
Subject: Snuggles

C s
ke y.

Openl ell you
what **ans**.

For th rite a
cla am.



Photographer: Helen Graham
Subject: Snuggles

AKADEMIE DER WISSENSCHAFTEN IN HAMBURG

Programming 101

- Our interactive tutorial uses Python.
- Python is extremely popular with researchers:
  - It is quick to learn.
  - It is easy to read.
  - It allows quick experimentation.
  - There are loads of external libraries (i.e more functionalities)
  - It was named after Monty Python

Source: Wikipedia

How to access the exercises

Mac:

- Make sure you have installed Python 3 and the *opencv* package (easiest way: use our installer script)
- Start *Terminal*.
- Type: `jupyter notebook`
- Press enter and wait for the Notebook to open in your browser.
- Navigate to the summer school class directory.
- Click on the .ipynb file of your choice.

How to access the exercises

Windows:

- Install the Python 3 version of Anaconda
- Use Anaconda Navigator to install the *opencv* package
- Go to *Windows Start Menu -> Anaconda3 -> Jupyter Notebook*
- Navigate to the summer school class directory.
- Click on the .ipynb file of your choice.

Wunsch

vʊnʃ

Any Questions?