3D-modeling of animal behaviour

A *DeepLabCut* and *Anipose* project to model the movement of rats in 3D

By: Edwin Ekberg, Fredrik Lastow, Szymon Stypa

Mentor: Andreas Heuer <3
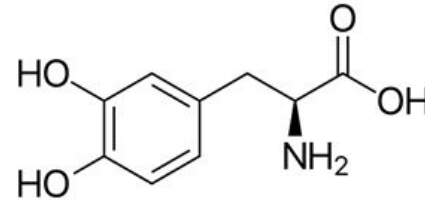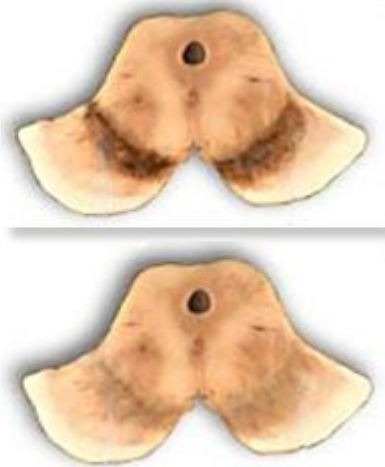
Why are we creating this model?

Background

- Research on Parkinson's Disease at the Wallenberg Neurocentrum (LU)

Parkinson's Disease

Symptom: Dopamine deficiency

Treatment: Replace Dopamine

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- Measure dopamine levels with various tasks, e.g. gait, cylinder and corridor
- Tedious and long tasks

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Automation!!

Our task

- Build a 3D model of rat's movements and behaviours in cell replacement therapy to lay the foundation for automated AI-based analyzation and classification
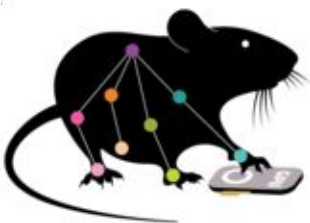
DeepLabCut

- DeepLabCut utilizes the feature detectors (ResNets + readout layers)
- Uses transfer learning to obtain specific animal models
- Due to transfer learning it requires very little labeled training data
- Successfully applied to rats, humans, various fish species, bacteria, leeches, various robots, cheetahs, mouse whiskers and race horses
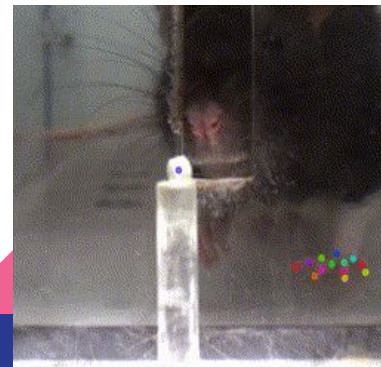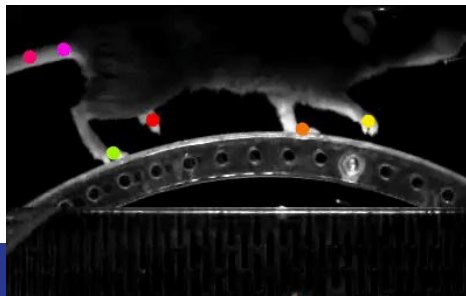
DeepLabCut

DeepLabCut: a software package for animal pose estimation

DLC GUI

jupyter

CO

use our Project Manager GUI, Jupyter Notebooks, Google Colab, or terminal!

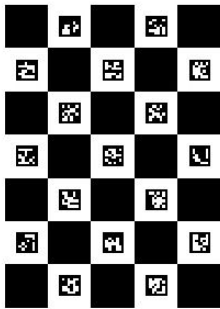Create a project, extract frames, + GUIs to label your data

Select + Train your deep neural network

Evaluate network performance

(active learning + GUIs if improvement needed)

Run inference on new videos, create labeled videos, + plot your results!

Anipose - 3D modeling

ChArUco

- Calibration of cameras using ChArUco board
- Requires DLC model
- Anipose includes:
    - 3D calibration module
    - filters to resolve 2D tracking errors (median, viterbi, autoencoder)
    - a triangulation module that integrates temporal and spatial constraints, as well as 3d-filtering
    - a pipeline to structure processing of large numbers of videos

Example - human hand

Setup

- Four cameras with 90 degrees separation
- Recorded and synced using OBS
- Resolution 640x480
- Calibration with 10x7 ChArUco-board
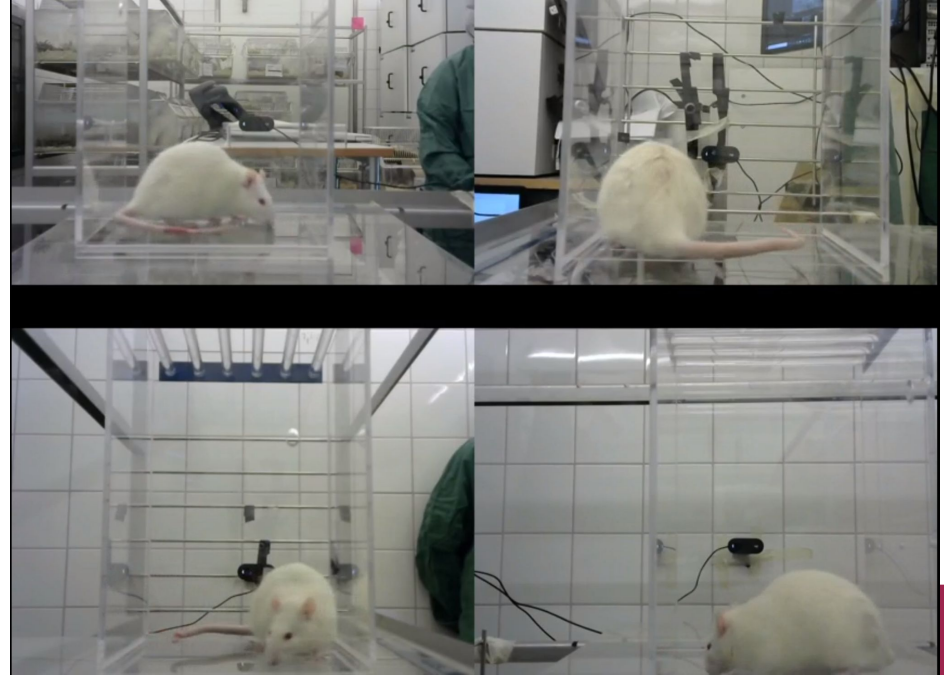
Procedure

- Label 160 frames [nose, ears, tail bone, paws]
- Train the DLC-model for ~300 000 iterations
- Generate pose estimation data for every camera
- Use calibration videos to estimate the camera parameters
- Triangulate corresponding points from every camera view
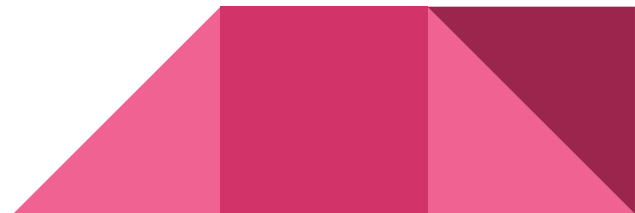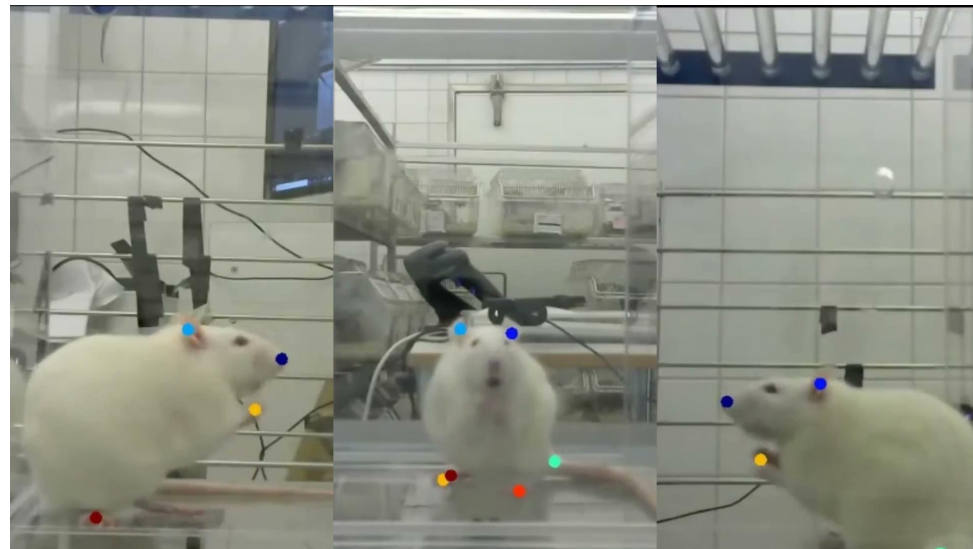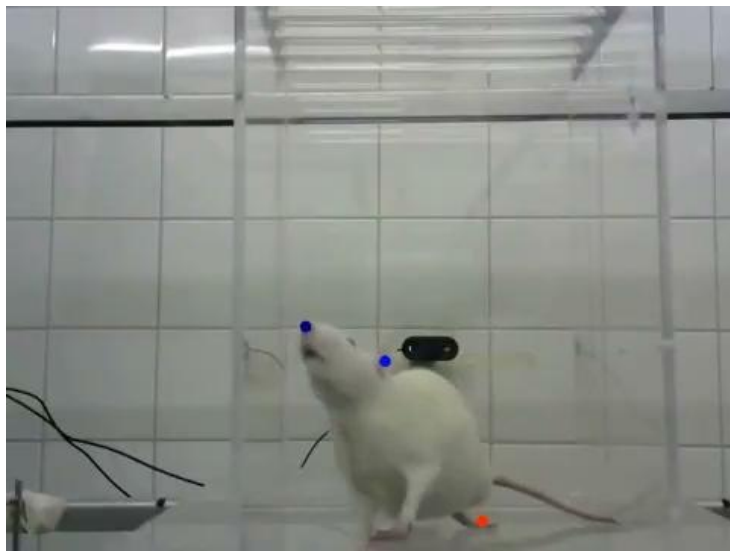- Build a 3D model from triangulated data

Training loss of DLC-model
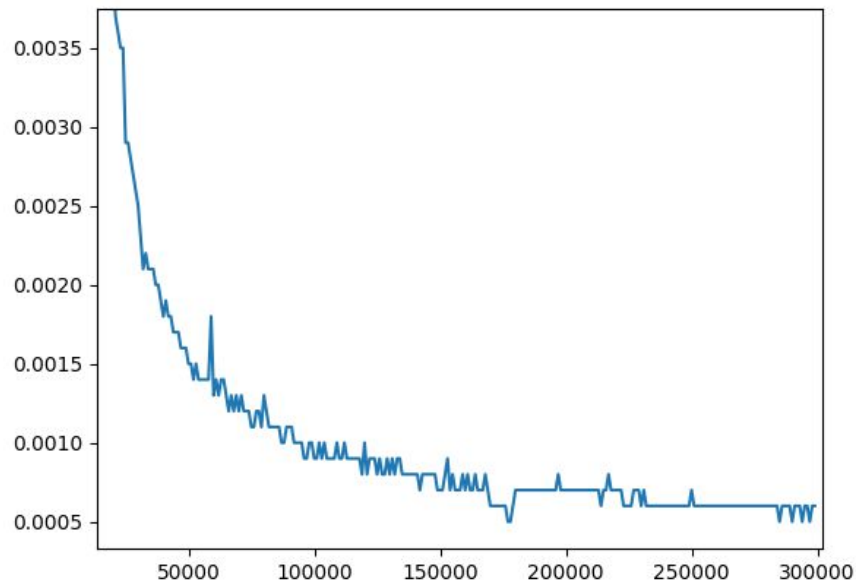
- No significant model improvement after 150k iterations (very fast convergence)
- Attributed to our large amount of training data

Results

Our biggest obstacles

- Processing power (at least 3 hour training on Google Colab)
- Resolution in video data
- **Dealing with incomplete/erroneous code bases**

Next steps …

- Improve DLC-model with higher resolution cameras and refine labels
- Use the 3D data to quantify and automate detection of dyskinesia severity

Thank you for listening!

And thanks to our wonderful mentor, Andreas!!

References

DeepLabCut: http://www.mackenziemathislab.org/deeplabcut

Anipose: https://anipose.readthedocs.io/en/latest/