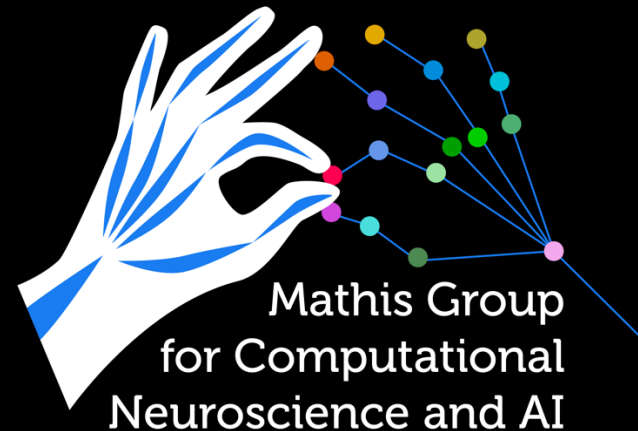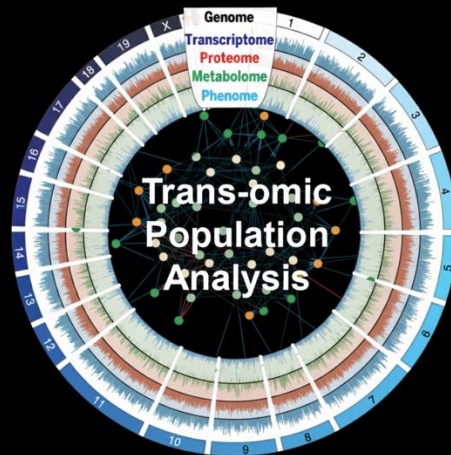# Deep phenotyping via hierarchical learning of mouse movement: Decoding aging through activity
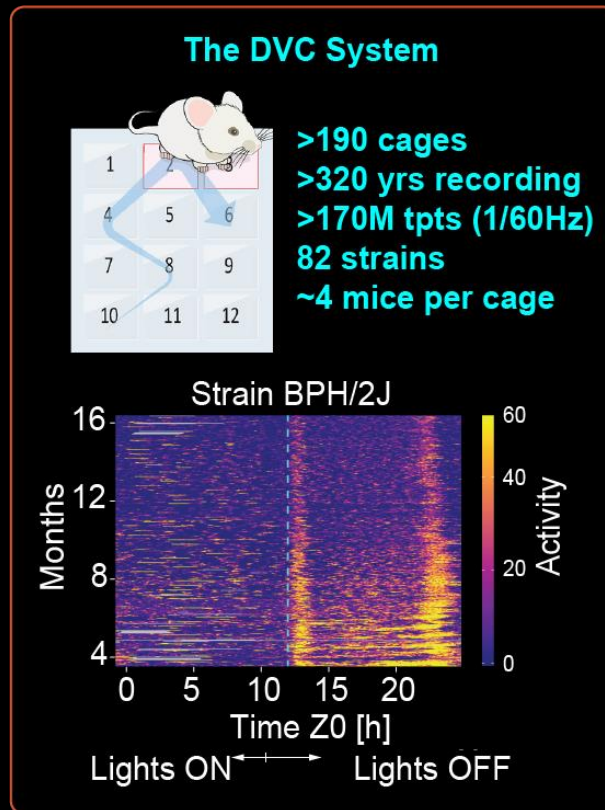
Gaurav Bhole[1], Jon Lecumberi[1], Giacomo von Alvensleben[1], Andy Bonnetto[2], Michal Grudzien[2], Johan Auwerx[1], Alexander Mathis[2]

[1]Laboratory of Integrative Systems Physiology

[2]Mathis Group for Computational Neuroscience and AI

The HDP: an integrated platform for Healthspan discovery

The DVC System

>190 cages
>320 yrs recording
>170M tpts (1/60Hz)
82 strains
~4 mice per cage

Strain BPH/2J

Months / Activity / Time Z0 [h]
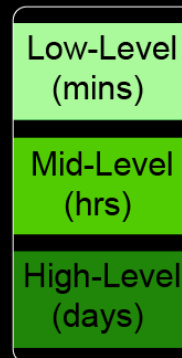
Lights ON → Lights OFF

82 inbred strains
>130k samples
>20 tissues
>4k female mice

DVC: 24/7 homecage activity and environmental monitoring

Classical Statistical Analysis

Deep Learning - Hierarchical Masked Autoencoder (hBehaveMAE)

Unsupervised Representation Learning

Low-Level (mins) → Human Presence, Bedding Change, ...

Mid-Level (hrs) → Day / Night, ...

High-Level (days) → Aging Patterns, Strain Identity, ...

Embeddings
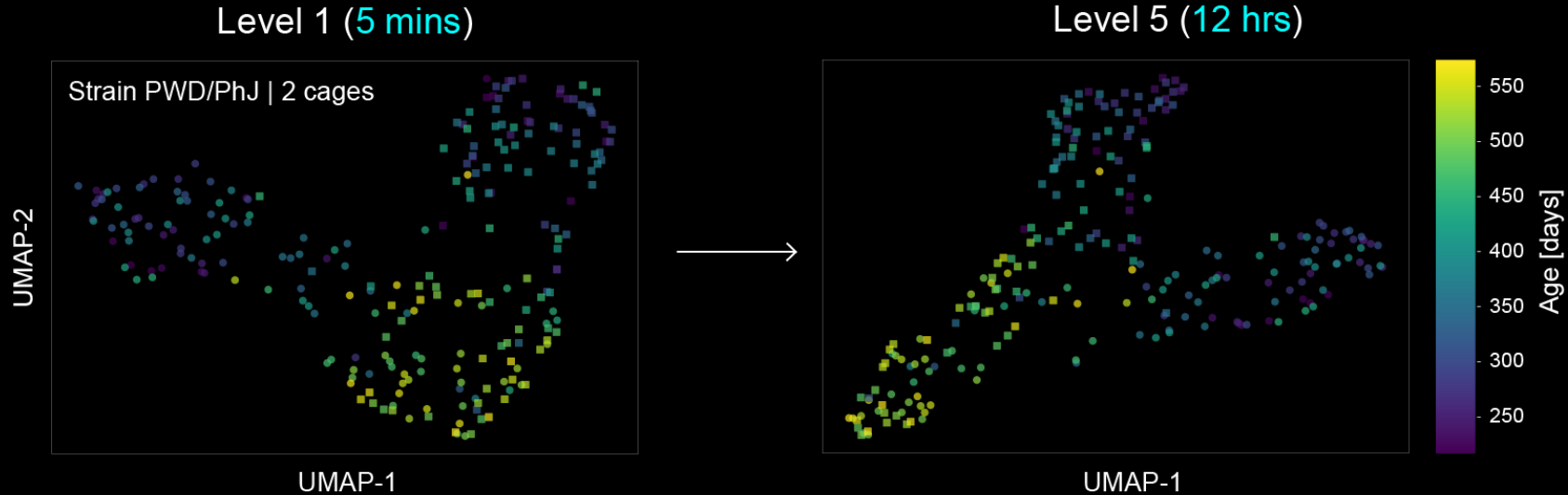
Downstream Analysis

Behavioural & Aging

.....

Genetic Mapping of Activity

DVC embeddings recapitulate phenotypic features

UMAPs of unsupervised learnt embeddings show patterns of age separation

Level 1 (5 mins)　　　　　　　　　　　　　Level 5 (12 hrs)

Categorical classification tasks

All levels combined

Features	Performance (Metric)
Strain Identity	56.6%* (Accuracy)
Age Prediction	~4 months (RMSE)
Day/Night	In Progress...
...	

*often mispredicted as another genetically similar strain

Future Prospects
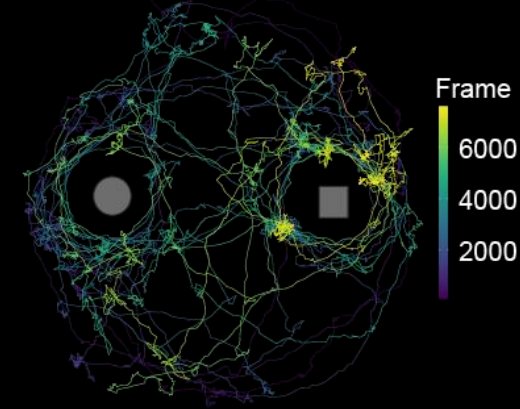

Pose estimation
Openfield videos, DeepLabCut
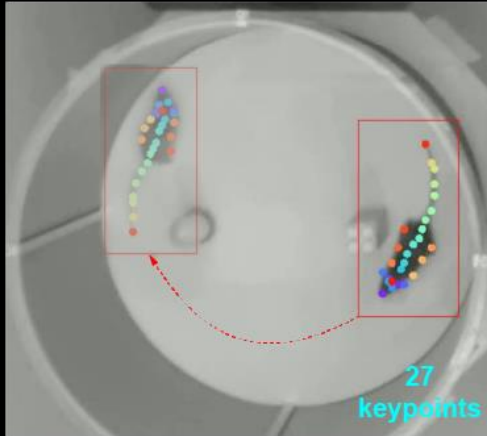
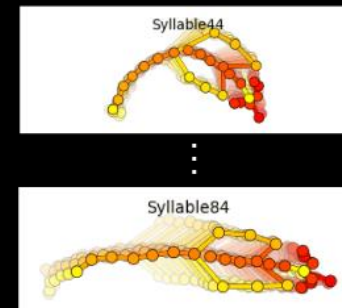>700 hrs single-animal recordings.
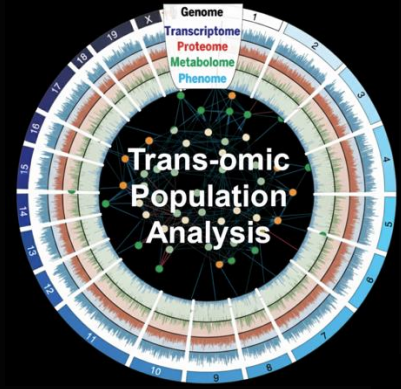Adult, Old. >3400 videos

DeepLabCut

Mouse center trajectory

Frame
6000
4000
2000

MoSeq

Behavioral syllables extraction
Keypoint-MoSeq

Syllable44

Syllable84

Changes
across strains

**Parsing the ageing
and genetics
of mouse behaviour**

Trans-omic Population Analysis
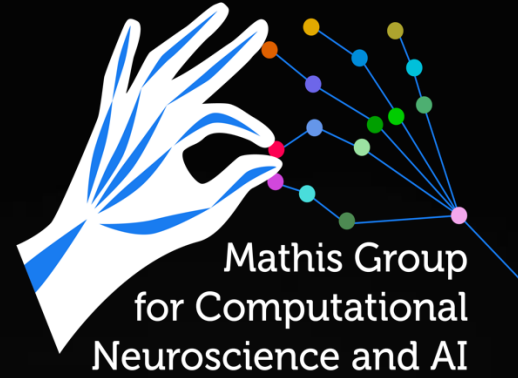
Laboratory of Integrative Systems Physiology

Animal Facility Team (UDP)

Credits

Mathis Group for Computational Neuroscience and AI

Mathis Group for Computational Neuroscience and AI

See you at Poster 5 !!!