

Deliverables, Previous and Future Work

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- 1 cross-fertilisation between the SWC/GCNU and the AIND in NaLoDuCo experimentation.
- 2 dissemination to the research community of hardware and software technology for NaLoDuCo experimentation.

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- 1 hardware specifications for recordings of behaviour and neural activity used at the SWC/GCNU¹ and at the AIND for head-fixed foraging² and freely moving odour exploration.
- 2 software for managing long-duration recordings (e.g., data storage, data indexing).
- 3 software for online/offline quality control.
- 4 software for creating alerts.
- 5 software for online (behavioral and neural) data visualisation.
- 6 software for online (behavioral and neural) data analysis.

¹https://sainsburywellcomecentre.github.io/aeon_docs/reference/hardware.html

²<https://www.allenneuraldynamics.org/platforms/behavior>

Previous work

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- the SWC has performed foraging experiments
 - lasting xx weeks and recording behaviour only
 - lasting yy weeks and recording behaviour and electrophysiology
 - data is stored in files and in a MySQL database
- the AIND has performed foraging experiments in head-fixed mice. These experiments are a few hours long.
- the AIND is setting up the odour exploration experiments that will last several days.
- items 1–2: above have been completed for the SWC foraging experiments
- item 3: the SWC has developed several quality control for behavior.
- item 4: alerts have been developed for behaviour and ephys.

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- item 5: the SWC has developed some online behavioural data visualisation tools in Bonsai.
- item 6: funded by BBSRC, we have integrated into Bonsai tools for online data analysis:
 - estimate kinematics of mice
 - estimate kinematic states of mice using Hidden Markov Models
 - clusterless point-process decoder of mice position and replay from ephys recordings.
- disseminated documentation of hardware used at the AIND to perform head-fixed foraging experiments³ in virtual reality setups.
- disseminated documentation on software used at the SWC to control NaLoDuCo foraging experiments (see [repo](#))

³<https://www.allenneuraldynamics.org/platforms/behavior>

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- disseminated documentation on machine learning methods integrated into Bonsai for analyzing behavioral and neural time series in real time (see **repo**)

Future work

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- item 3: the SWC and the AIND have developed several tools for offline quality control. Next, we need to build online versions of them.
- item 4: develop more software for data visualisation.
- items 5 and 6: develop more software for online data analysis.
 - online estimate of latent variables from Neuropixels recordings.
 - online estimate of RL models.
- assist Dr. Carl Schoonover (AIND) on the use hardware and software developed at the SWC/GCNU to create olfactory learning NaLoDuCo experiments.

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- 1 methods to analyse behavioural and electrophysiological recordings from NaLoDuCo experiments that are **online** and **adaptive to non-stationarity** in measurements.

For behavioural data, we will investigate methods to

- track multiple body parts of animals (deep neural networks)
- infer kinematics of foraging mice (linear dynamical systems)
- segment behaviour into discrete states
- characterize short- and long-term periodicities in behavior
- infer the rules that govern mice behaviour from behavioural observations only] (i.e., policy inference).

For neural data, we will investigate methods to:

- estimate low-dimensional continual representations of neural activity (i.e., latents inference)
- segment neural activity into discrete states
- characterize short- and long-term periodicities in neural activity
- decode environment variables from neural activity

- 2 integration of these methods into DANDI, as in Dendro, so that users can run them on NaLoDuCo datasets stored in DANDI.

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- 1 At the Gatsby we have invented several methods for the characterisation of neural time series (e.g., Yu et al., 2009; Duncker and Sahani, 2018; Rutten et al., 2020; Yu et al., 2024; Buesing et al., 2012b,a; Macke et al., 2015; Soulat et al., 2021; Walker et al., 2023; Turner and Sahani, 2014; O'Shea et al., 2022)
- 2 **Dendro** allows to perform advanced data analysis on DANDI. It allows to reuse previous analysis.

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