1 Summary

Word limit: 550

In plain English, provide a summary we can use to identify the most suitable experts to assess your application.

We usually make this summary publicly available on external-facing websites, therefore do not include any confidential or sensitive information. Make it suitable for a variety of readers, for example:

- opinion-formers

- policymakers

- the public

- the wider research community

Guidance for writing a summary   Clearly describe your proposed work in terms of:

- context

- the challenge the project addresses

- aims and objectives

- potential applications and benefits

- its relevance to the BBSRC long-term research and innovation priorities and, if applicable Responsive Mode Spotlight areas

2 Core team

List the key members of your team and assign them roles from the following:

- project lead (PL)

- project co-lead (UK) (PcL)

- specialist

- professional enabling staff

- research and innovation associate

- technician

- researcher co-lead (RcL)

Only list one individual as project lead.

UKRI has introduced a new addition to the 'specialist' role type. Public contributors such as people with lived experience can now be added to an application.

Find out more about UKRI's core team roles in funding applications and our eligibility guidance.

3 Application questions

3.1 BBSRC schemes

Word limit: 1

Indicate the scheme through which you are applying.

In the text box, copy the number corresponding to the scheme you are applying through. These are:

1. standard (no scheme)

2. Industrial Partnership Award (IPA)

3. LINK

4. Brazil (FAPESP)

5. Luxembourg (FNR)

6. NSF-Bio

Additional guidance

This is for administrative purposes to help the initial application processing.

Please follow the scheme specific guidance below and upload the additional documents listed as a single PDF no larger than 8MB:

IPA or LINK:

- a letter from your institution's technology transfer office outlining the management of outputs from the proposed research

FAPESP:

- FAPESP proposal form

- FAPESP consolidated budget form

- FAPESP letter of eligibility

FNR:

- CVs of international collaborators

- FNR 'INTER' budget form

- FNR 'INTER' cost justification

NSF-Bio:

- US biosketches

- US budget forms

3.2 BBSRC remit classification

Word limit: 1

Your application will be considered by one of our four research committees made up of independent experts. Indicate which you feel would be best placed to assess your application.

In the text box, write only the letter (in uppercase) corresponding to the committee you feel would be best placed to assess your application. These are:

A animal disease, health and welfare

B plants, microbes, food and sustainability

C genes, development, and science, technology, engineering and maths (STEM) approaches to biology

D molecules, cells and industrial biotechnology

Additional guidance:

This is for administrative purposes to help the initial application processing. We will check your choice and make a final decision as to which committee will assess your application.

3.3 Vision

3.3.1 Context

Conventional systems neuroscience experiments are typically short in duration and often place significant constraints on subjects behaviours to simplify data analysis. However, these restrictions may limit our ability to observe critical aspects of brain function and behaviour that only manifest in more naturalistic and extended conditions.

At the Sainsbury Wellcome Centre (SWC) and Gatsby Computational Neuroscience Unit (GCNU) we are pioneering Naturalistic, Long-Duration, and Continual (NaLoDuCo) foraging experiments in mice that span weeks to months. During these experiments, we collect high-resolution behavioural and neural recordings in naturalistic settings.

This novel approach will enable researchers to explore neural mechanisms underlying ethological behaviours in naturalistic environments over months, for the first time. The experiments will shed new light on a wide range of poorly understood neural mechanisms, including how the brain structures complex behavioural sequences as a function of the animal needs, learning, adaptation, sleep-dependent memory consolidation and social dynamics.

The data generated from NaLoDuCo experiments represent an entirely new resource in neuroscience, with the potential to drive breakthroughs and discoveries that are beyond the reach of traditional experiments.

While naturalistic, long-duration, or continuous neuroscience experiments have been conducted in the past [4, 3, 5, 6, 2], to the best of our knowledge, we are the first to integrate all three of these features in a single experimental paradigm. Experiments of this type have been advocated by experts in the field years ago [1, p19], yet they have not been implemented so far.

This new type of experimentation will become mainstream in the coming years. However, experiments spanning weeks to months generate extremely large datasets—often reaching hundreds of terabytes—which present substantial challenges across data acquisition, management, distribution, visualisation, and analysis. Together, with our US partner, the Allen Institute for Neural Dynamics (AIND), we will address these challenges building software infrastructure to help scientists around the world perform NaLoDuCo experiments.

Since the project started in 2021, our UK business partner, NeuroGEARS Ltd. has been contracted by the SWC to lead the implementation of the NaLoDuCo experimental framework. It also provides services to the AIND.

3.3.2 Focus areas

Developing **platform technologies** to enable:

Scalable Data Sharing – Establishing infrastructure for **efficient storage and sharing** of massive, long-duration behavioral and neural datasets across research communities.

Interactive Data Exploration – Creating high-performance visualization tools to navigate and analyze multi-scale behavioral and neural recordings, enabling **immediate** insights into complex datasets.

Advanced Data Analysis – Developing **online and distributed** machine learning algorithms to characterize **non-stationary** behavioral and neural dynamics in continuous, high-dimensional data streams.

Scalable Spike Sorting – Designing **robust and adaptive spike sorting methods** to accurately assign spikes to neurons in **long-duration, non-stationary recordings**, supporting both **real-time and offline analysis**.

Adaptive Neural Perturbations – Implementing **real-time neuromodulatory interventions** to test causal relationships between neural activity and behavior over **extended time scales**.

3.3.3 Synergistic developments

Currently, both GCNU and AIND are independently developing methods to address the previous focus areas. We will join forces to co-develop these methods and our foraging research programs, leveraging our combined expertise for greater impact.

References

[1] Sandeep Robert Datta, David J Anderson, Kristin Branson, Pietro Perona, and Andrew Leifer. Computational neuroethology: a call to action. *Neuron*, 104(1):11–24, 2019.

[2] Ashesh K Dhawale, Rajesh Poddar, Steffen BE Wolff, Valentin A Normand, Evi Kopelowitz, and Bence P Ölveczky. Automated long-term recording and analysis of neural activity in behaving animals. *Elife*, 6:e27702, 2017.

[3] Hinze Ho, Nejc Kejzar, Hiroki Sasaguri, Takashi Saito, Takaomi C Saido, Bart De Strooper, Marius Bauza, and Julija Krupic. A fully automated home cage for long-term continuous phenotyping of mouse cognition and behavior. *Cell Reports Methods*, 3(7), 2023.

[4] Máté Nagy, Hemal Naik, Fumihiro Kano, Nora V Carlson, Jens C Koblitz, Martin Wikelski, and Iain D Couzin. Smart-barn: Scalable multimodal arena for real-time tracking behavior of animals in large numbers. *Science Advances*, 9(35):eadf8068, 2023.

[5] Saikat Ray, Itay Yona, Nadav Elami, Shaked Palgi, Kenneth W Latimer, Bente Jacobsen, Menno P Witter, Liora Las, and Nachum Ulanovsky. Hippocampal coding of identity, sex, hierarchy, and affiliation in a social group of wild fruit bats. *Science*, 387(6733):eadk9385, 2025.

[6] Aharon Weissbrod, Alexander Shapiro, Genadiy Vasserman, Liat Edry, Molly Dayan, Assif Yitzhaky, Libi Hertzberg, Ofer Feinerman, and Tali

Kimchi. Automated long-term tracking and social behavioural pheno-typing of animal colonies within a semi-natural environment. *Nature communications*, 4(1):2018, 2013.

3.4 Approach

3.4.1 Scalable data sharing

3.4.2 Interactive data exploration

3.4.3 Advanced data analysis

Having collected a new type of neuroscience dataset, created cloud infrastructure for open sharing, and developed open-source software for visualization, we will now provide functionality to automatically extract meaning from it.

Challenges and opportunities

The automatic analysis of NaLoDuCo experimental data opens unique challenges an opportunities. A few challenges are:

need of online learning The vast majority of machine learning algorithms process all data points at the same time; i.e., they are batch algorithms. This processing mode in inadequate for NaLoDuCo datasets, because they cannot be loaded into memory, due to their large data sizes. These datasets require **online learning** [2], a form of learning where models update their parameters one sample at a time, as soon as they are received.

addressing non-stationarity Non-stationarity occurs when the statistical properties of data change over time, leading to a mismatch between previously learned models and new data distributions. In the context of online machine learning, where models are continuously updated with incoming data, non-stationarity poses a significant challenge because it can degrade model performance if not properly addressed.

For example, in neuroscience experiments recording neural activity over weeks to months, the relationship between neural signals and behavioral outcomes may shift due to learning, fatigue, circadian rhythms, or environmental changes. A model trained on early data may become outdated as the neural response patterns and behaviour evolve.

The field of adaptive signal processing[1] studies algorithms for non-stationary data.

Initial algorithms to optimize

Implementation notes

Initial algorithms to optimize

Implementation notes

3.4.4   Scalable spike sorting

References

[1] Simon S Haykin. *Adaptive filter theory*. Pearson Education India, 2002.

[2] Shai Shalev-Shwartz et al. Online learning and online convex optimization. *Foundations and Trends® in Machine Learning*, 4(2):107–194, 2012.

3.5 Applicant and team capability to deliver

Word limit: 1,650

Why are you the right individual or team to successfully deliver the proposed work?

What the assessors are looking for in your response

Please ensure the current job titles of the core team members are included here to ensure eligibility can be established for the core team roles assigned. Find out more about UKRI's core team roles in funding applications and our eligibility guidance.

Evidence of how you, and if relevant your team, have:

- the relevant experience (appropriate to career stage) to deliver the proposed work

- the right balance of skills and expertise to cover the proposed work

- the appropriate leadership and management skills to deliver the work and your approach to develop others

- contributed to developing a positive research environment and wider community

You may demonstrate elements of your responses in visual form if relevant.

Further details are provided in the Funding Service.

The word limit for this section is 1,650 words: 1,150 words to be used for R4RI modules (including references) and, if necessary, a further 500 words for Additions.

Use the Résumé for Research and Innovation (R4RI) format to showcase the range of relevant skills you and, if relevant, your team (project and project co-leads, researchers, technicians, specialists, partners and so on) have and how this will help deliver the proposed work. You can include individuals' specific achievements but only choose past contributions that best evidence their ability to deliver this work.

Complete this section using the R4RI module headings listed. Use each heading once and include a response for the whole team, see the UKRI guidance on R4RI. You should consider how to balance your answer, and emphasise where appropriate the key skills each team member brings:

- contributions to the generation of new ideas, tools, methodologies, or knowledge

- the development of others and maintenance of effective working relationships

- contributions to the wider research and innovation community

- contributions to broader research or innovation users and audiences and towards wider societal benefit

Additions

Provide any further details relevant to your application. This section is optional and can be up to 500 words. You should not use it to describe additional skills, experiences, or outputs, but you can use it to describe any factors that provide context for the rest of your R4RI (for example, details of career breaks if you wish to disclose them).

Complete this as a narrative. Do not format it like a CV.

References may be included within this section.

The roles in funding applications policy has descriptions of the different project roles.

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3.6 Project partners

Add details about any project partners' contributions. If there are no project partners, you can indicate this on the Funding Service.

A project partner is a collaborating organisation who will have an integral role in the proposed research. This may include direct (cash) or indirect (in-kind) contributions such as expertise, staff time or use of facilities. Project partners may be in industry, academia, third sector or government organisations in the UK or overseas, including partners based in the EU.

If you are applying via the IPA or LINK scheme, please include details of industry partners here.

If applying under the BBSRC-NSF lead agency scheme, please include details of your US partner here.

Add the following project partner details:

- the organisation name and address (searchable via a drop-down list or enter the organisation's details manually, as applicable)

- the project partner contact name and email address

- the type of contribution (direct or in-direct) and its monetary value

If a detail is entered incorrectly and you have saved the entry, remove the specific project partner record and re-add it with the correct information.

For audit purposes, UKRI requires formal collaboration agreements to be put in place if an award is made.

3.7   Project partners: statement of support

Only complete a statement of support if you have named project partners in the project partner section above. A statement is required to be provided from each partner you named in the 'Project partners' section.

If you are applying via the IPA or LINK scheme, please include details of industry partner support here.

What the assessors are looking for in your response

A project partner is a collaborating organisation who will have an integral role in the proposed research. This may include direct (cash) or indirect (in-kind) contributions such as expertise, staff time or use of facilities.

Each statement should:

- confirm the partner's commitment to the project

- clearly explain the value, relevance, and possible benefits of the work to them

- describe any additional value that they bring to the project

Ensure you have prior agreement from project partners so that, if you are offered funding, they will support your project as indicated in the 'Project partners' section.

For audit purposes, UKRI requires formal collaboration agreements to be put in place if an award is made.

Do not provide a statement of support from host and project co-leads' research organisations.

Do not provide a statement of support from collaborators. Contributions from collaborators not listed as project partners can be outlined in 'Applicant and team capability to deliver'.

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