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Enabling the Next Generation of Naturalistic Long-Duration Neuroscience Experimentation with Advanced Machine Learning

April 21, 2024

1 Summary

Word limit: 550

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

Clearly describe your proposed work in terms of:

- context
- the research the infrastructure, facility or resource will enable
- aims and objectives
- potential user communities, applications and benefits

1.1 Context

The use of large amounts of data in image and speech recognition and more recently in large language models has generated breakthroughs in the capabilities of machine learning models. Yet, most animal experiments in Neuroscience still generate limited amounts of data, as animal behavior is heavily constrained and the duration of experiments is short. Long-duration experiments, where animals can move freely in naturalistic environments, combined with advanced machine learning methods, could reveal new aspects of behavior and brain function not evident in data generated in simpler experiments. At the Sainsbury Wellcome Centre (SWC) for Neural Circuits and Behavior and the Gatsby Computational Neuroscience Unit (GCNU) we are developing hardware and software infrastructure to perform long-duration and naturalistic foraging experiments, as well as creating advanced machine learning methods to control these experiments and extract insights from the generated data. Here we propose to create a resource to share openly (1) behavioral and electrophysiological recordings generated by our

foraging experiments, (2) hardware and software infrastructure to build long-duration and naturalistic experiments, (3) machine learning methods to process the data generated by these experiments, and (4) provide online support to people using the distributed data, hardware, software and methods.

1.2 The research the infrastructure, facility or resource will enable

The hardware, software and user support we propose to distribute will allow research groups around the world to develop their own long-duration and naturalistic experiments, enabling a new type of animal experimentation.

These experiments are costly, since they require specialized arenas to house freely behaving animals for extended periods of time, as well as hardware and software to monitor their behavior, to perform neural recording and to store large amounts of data. For researchers not able to develop their own experiments, we will share openly behavioral and physiological recordings from our mouse foraging experiments, enabling them to study long-duration mouse foraging at the behavioral and physiological levels.

The foraging experiments require behavioral and neural manipulations in real time, for which online machine learning algorithms are needed. In addition, the very large size of the datasets generated by these experiments demand novel machine learning methods. Thus, these foraging experiments generate new demands of machine learning algorithms that will be addressed with novel machine learning methods developed by us and/or by machine learning scientists using the openly shared foraging data.

1.3 Aims and objectives

The aims of the proposed resource are:

1. share behavioral and electrophysiological recordings from long-duration and naturalistic foraging experiments,
2. share hardware and software specifications to build long-duration naturalistic experiments,
3. share machine learning methods, and their implementations, for online and offline processing the data generated by these experiments,
4. provide online advice to scientists interested in use the distributed data, hardware, software and methods.

1.4 Potential user communities, applications and benefits

The following user communities could benefit from the proposed resource:

research groups interested in building long-duration and naturalistic experiments could generate new neuroscience discoveries in the big data regime (e.g., decision making in foraging behavior),

machine learning scientists interested in applying their methods to characterize online data or large quantities of offline data could generate novel algorithms with broad applications,

business entities like pharmaceutical companies developing novel automatic drug screening procedures on animal models, or personalized medicine companies remotely monitoring the activities of at risk patients in their homes could use the distributed hardware, software and machine learning methods for their purposes.

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)
- researcher co-lead (RcL)
- specialist
- professional enabling staff
- research and innovation associate
- technician
- visiting researcher

Only list one individual as project lead.

A research technical professional or research software engineer can be listed as a project lead or project co-lead, provided that:

- their appointment is resourced from the central funds of their research organisation at the time of application
- their level of responsibilities and duties is appropriate to a person with substantial research experience
- their contract extends beyond the duration of the project

The researcher co-lead role has replaced the research co-investigator role previously used in Je-S grant applications. They will be an individual who merits appropriate recognition for making a substantial contribution to the formulation and development of the application and will be closely involved with the project.

3 Application questions

3.1 Vision

Word limit: 1,700

What are you hoping to achieve with your proposed work?

What the assessors are looking for in your response

Explain how your proposed work:

- is of excellent quality and importance within or beyond the field(s) or area(s)
- has the potential to advance current understanding, or generate new knowledge, thinking or discovery within or beyond the field or area
- is timely given current trends, context, and needs
- impacts world-leading research, society, the economy, or the environment

Include the following in your statement:

- the uniqueness and expected added value of the proposed resource to the UK bioscience research community and infrastructure landscape
- how the resource relates to past and current resources in the subject area in both the UK and abroad
- full details of the resource and an overview of the associated objectives. Details on how these objectives are delivered should be included in the Approach section
- a description of the types of research that will be enabled by the resource
- consideration of the potential impact on the scientific community and other possibly dependent resources if the resource did not exist
- only if applicable, relevance of the proposed work to the plant health spotlight

In your vision, you should also clearly identify which of the following categories your proposed resource falls under, and expand on the relevant points raised below:

- establishment of a new and innovative resource that will be beneficial to a broader BBSRC user base. Explain why a new resource is needed and what unique and important features it will offer
- maturation and subsequent maintenance of a project-based resource into a community-based one. Briefly explain the background to the resource, current usage, proposed changes and the benefits this will lead to for the research community

- further development or essential maintenance of an existing community resource, with well-established access mechanisms. Explain current usage and how this project will increase its relevance, quality and utility, for example:
 - by enabling the resource to support FAIR (findable, accessible, interoperable, reusable) principles
 - by enabling new uses, for example metadata enrichment for machine learning and AI approaches
- association, or integration, of distinct resources. Explain current usage and how the proposed plans will create an upgraded resource with a greater value than the sum of the parts

References may be included within this section.

You may demonstrate elements of your responses in visual form if relevant. Further details are provided in the Funding Service.

3.2 Approach

Word limit: 4,400

How are you going to deliver your proposed work?

What the assessors are looking for in your response

Explain how you have designed your approach so that it:

- is effective and appropriate to achieve your objectives
- is feasible, and comprehensively identifies any risks to delivery and how they will be managed
- uses a clearly written and transparent methodology (if applicable)
- summarises the previous work and describes how this will be built upon and progressed (if applicable)
- will maximise translation of outputs into outcomes and impacts
- describes how your, and if applicable your team's, research environment (in terms of the place and relevance to the project) will contribute to the success of the work

Include the following when describing your approach:

- measurable targets against which the outcome of the work will be assessed
- significant technical details for the development, maintenance or enhancement of the resource, indicating how this is of internationally exceptional quality
- any proposed research efforts and how they directly facilitate development of the resource (if applicable)
- if the focus is on maintaining an existing resource instead of suggesting further development, provide evidence of why significant upgrades are not required at this time and detail why the resource needs continued support to maintain world-leading functionality (if applicable)

Describe the specific contribution of each applicant to the proposed resource:

- their scientific contributions, for example, research field and specialist knowledge, experience, resource management expertise, technical and data analysis expertise
- their role and responsibilities, for example, managerial, leadership, mentoring
- references to specific work packages are recommended
- highlight where applicants will work collaboratively to deliver specific project requirements

- include clear time commitments for each applicant

There is no need to duplicate information included in the ‘Applicant and team capability to deliver’ section.

References may be included within this section.

You may demonstrate elements of your responses in visual form if relevant. Further details are provided in the Funding Service.

A project Gantt chart is compulsory and should be inserted as an image at the very end of this section. The Gantt chart should identify appropriate deliverables, responsibilities and time points for each objective.

3.3 Community demand: letters (or emails) of support

Letters (or emails) of support demonstrating community demand are mandatory for BBR.

Upload a single PDF of maximum 8MB containing a maximum of 10 letters or emails of support. These should be uploaded in English or Welsh only. Enter the words ‘attachment supplied’ in the text box.

What the assessors are looking for in your response

The letters should give an indication of community demand for the resource in question, demonstrating the breadth of research and the high-quality science relevant to BBSRC remit that the resource would underpin.

Add the following details for each letter:

1. the organisation name (searchable via a drop-down list or enter the organisation’s details manually, as applicable)
2. contact name of the signatory

Letters of support aimed at demonstrating community demand should:

1. outline the uniqueness and expected added value of the proposed resource to the UK bioscience research community and infrastructure landscape
2. clearly explain the impact and benefit of the proposed resource on the writer’s research and the associated community
3. if possible, explain where this supported research has already demonstrated or could have potential for particular scientific, economic or societal impact
4. help to demonstrate the breadth of the relevant user community

Letters of support that fail to do so, in particular template letters indicating generic support without identifying a particular usage, are of negligible value for the assessment and should not be submitted. Carefully chosen letters containing relevant evidence of the requirement or benefit to be gained, are of greater value than large numbers of letters.

The Funding Service will provide document upload details when you apply.

3.4 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

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 count 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.

There is no need to duplicate information included in the ‘Approach’ section.

UKRI has introduced new role types for funding opportunities being run on the new Funding Service.

For full details, see [Eligibility as an individual](#).

References may be included within this section.

3.5 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.

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.

3.6 Project partners: letters (or emails) of support

Upload a single PDF containing the letters or emails of support from each partner you named in the Project Partner section. These should be uploaded in English or Welsh only.

Enter the words ‘attachment supplied’ in the text box, or if you do not have any project partners enter N/A.

What the assessors are looking for in your response Each letter or email you provide 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

The Funding Service will provide document upload details when you apply. If you do not have any project partners, you will be able to indicate this in the Funding Service.

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.

3.7 Management strategy

Word limit: 500

How do you plan to manage the resource?

What the assessors are looking for in your response

1. resources will be expected to have governance arrangements appropriate for the oversight and successful delivery of the project's complexity
2. provide details about the project's management and advisory structure
3. provide details of the approach to project and risk management, and the monitoring strategy for tracking progress of the proposed programme
4. provide details on how demand and access requests will be managed, and what support will be provided to the users of the resource
5. an advisory board is required for all projects, which is independent from both the academic institutions and project partners involved in the proposal. Provide information on the proposed membership of this advisory board and how it will be used
6. provide details on how the resource user perspective and their needs will be considered, including how feedback will be sought and subsequently used to inform the management of the resource

You may demonstrate elements of your responses in visual form if relevant. Further details are provided in the Funding Service.

3.8 Data management and sharing

Word limit: 1,500

How will you manage and share data collected or acquired as part of the proposed resource?

What the assessors are looking for in your response

Provide a data management plan using the [BBR DMP template](#) (PDF, 161KB) structure that clearly details how your proposed resource will comply with UKRI's published [data sharing policy](#), which includes detailed guidance notes.

3.9 Trusted Research and Innovation (TR&I)

Word limit: 500

Does the proposed work involve international collaboration in a sensitive research or technology area?

What the assessors are looking for in your response

Demonstrate how your proposed international collaboration relates to trusted research and innovation, including:

- list the countries your international project co-leads, project partners and visiting researchers, or other collaborators are based in
- if international collaboration is involved, explain whether this project is relevant to one or more of the 17 areas of the UK National Security and Investment (NSI) Act
- if one or more of the 17 areas of the UK National Security and Investment (NSI) Act are involved, please identify which areas

If your proposed work does not involve any international collaboration, answer 'n/a' here.

We may ask you to provide additional information about how your proposed project will comply with our approach and expectation towards TR&I, identifying potential risks and the relevant controls you will put in place to help proportionately reduce these risks.