Proceedings of the OHBM Brainhack 2023

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Abstract

The OHBM Brainhack 2023 combined educational innovation, creative expression, and scientific exploration to foster a vibrant and informal environment for learning and collaboration within our community. The event consisted of Train-Track and Hack-Track, which facilitated hacking skills development in a study group setting through hands-on project participation. In parallel, the Buddy System enhanced engagement and peer support, making it easier for newcomers to enjoy the Brainhack. For the first time, the Brainhack featured a "Rhyming Battle", during which the participants were encouraged to share their experiences creatively through artistic expression with a scientific humour. The Mini-Grant initiative was also proposed to recognise submitted projects prioritising open science, diversity, and interdisciplinary collaboration. Although the initiative received mixed responses from the attendees due to its competitive aspect, it offered valuable insights for future events. This manuscript aims to reflect on successes and lessons learned during the Brainhack 2024 and hopes to underscore how the different components collectively contributed to an enriching experience, highlight the importance of open science, community engagement, and academic diversity, and emphasise the vital role of creativity and collaboration in scientific pursuits.

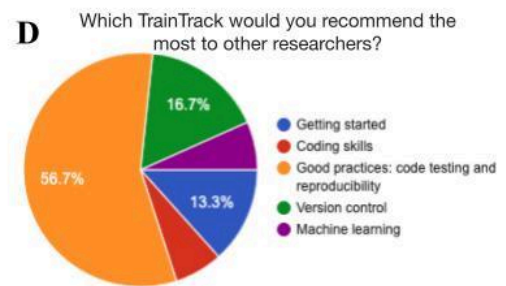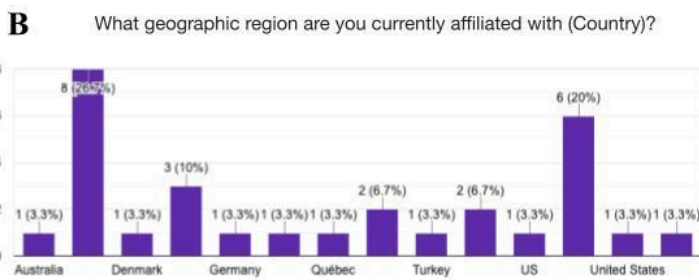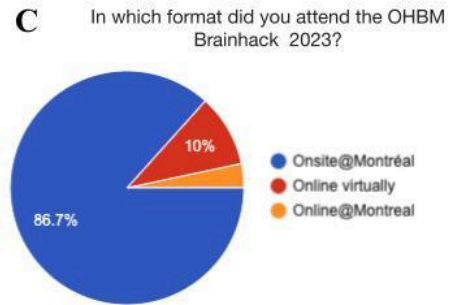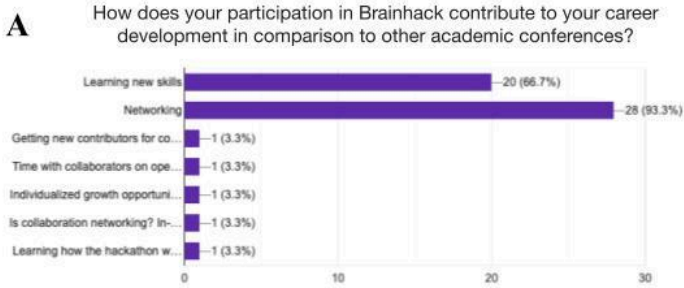*Keywords:* Open Science, Brainhack, Hackathon, Neuroimaging, Neuroscience

INTRODUCTION

The OHBM Brainhack is a satellite hackathon of the Organization for Human Brain Mapping (OHBM) annual meeting. It serves as a hub for neuroscientists of various disciplines and career stages to collaborate in a dynamic, open, and inclusive environment.Through its unique format, the Brainhack promotes open science by encouraging participants to engage in collaborative project development, skill-sharing, and community building. These efforts are deeply aligned with the mission of OHBM's Open Science Special Interest Group (OSSIG), fostering transparency, reproducibility, and accessibility in neuroscience research.

The 2023 OHBM Brainhack centered around three core pillars: 1) *Inclusivity* – Cultivating an environment where participants from all backgrounds, disciplines, and expertise levels feel welcome and empowered to contribute meaningfully; 2) *Empowerment* – Providing hands-on training and skill-building opportunities through structured and unstructured learning sessions to enhance participants' research abilities; 3)Innovation – Encouraging the development of novel and interdisciplinary projects that push the boundaries of neuroimaging and neuroscience research. This year's event continued to build upon the foundations laid by previous Brainhack editions. The hybrid format introduced in earlier years was retained to reduce the carbon footprint (Epp et al.. 2024) and address barriers such as lack of funding or visa challenges. This hybrid approach allowed broader participation from the global neuroscience community and reinforced the organizers' commitment to diversity, inclusion, and equitable access.

Notable new initiatives in 2023 included the Mini-Grant Initiative, designed to support projects prioritizing open science, diversity, and interdisciplinary collaboration. This initiative, while well-received, revealed mixed responses regarding its competitive nature, highlighting important insights for future event planning. This system fostered meaningful connections and enhanced participants' engagement with the Brainhack community.

In addition to these new elements, the *Train-Track* and *Hack-Track* components remained central to the event's structure. The Train-Track offered structured tutorials and self-directed learning sessions on topics such as coding, machine learning, and reproducible research practices. Meanwhile, the Hack-Track provided an opportunity for participants to collaborate on open projects submitted by community members, with many focusing on developing open-source software tools and pipelines for neuroimaging analysis.
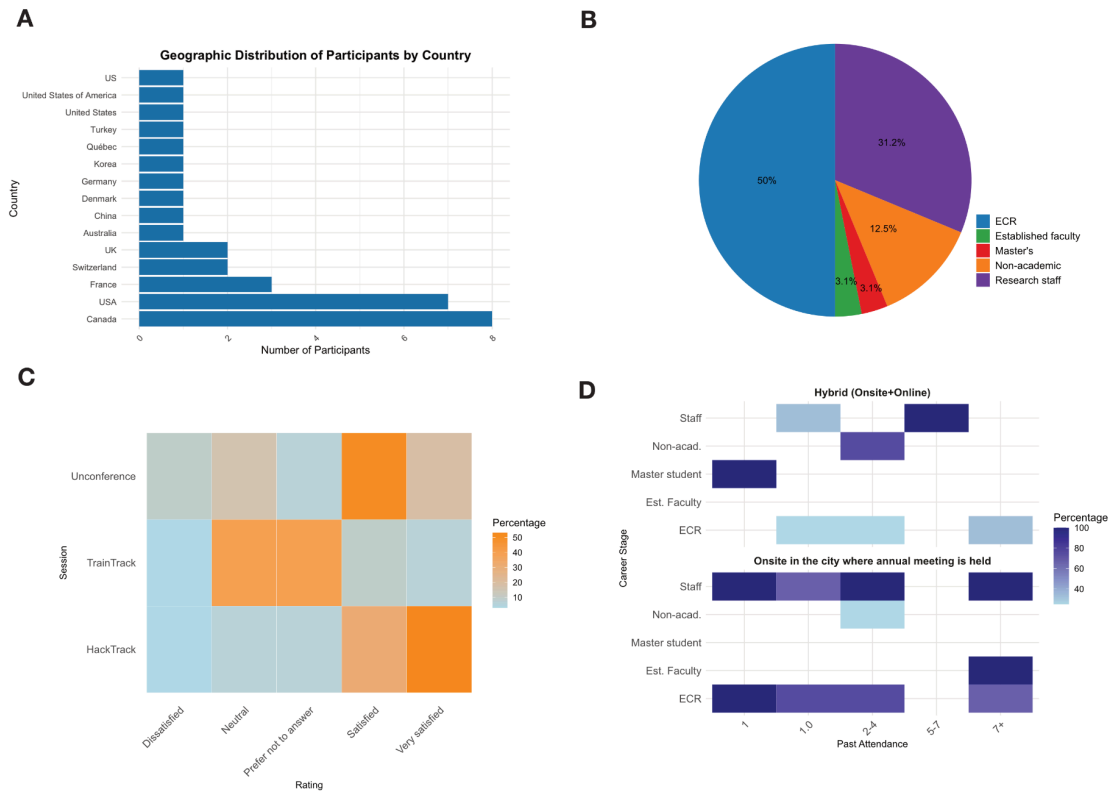
A How does your participation in Brainhack contribute to your career development in comparison to other academic conferences?

Learning new skills — 20 (66.7%)
Networking — 28 (93.3%)
Getting new contributors for co... — 1 (3.3%)
Time with collaborators on ope... — 1 (3.3%)
Individualized growth opportuni... — 1 (3.3%)
Is collaboration networking? in-... — 1 (3.3%)
Learning how the hackathon w... — 1 (3.3%)

B What geographic region are you currently affiliated with (Country)?

Australia 1 (3.3%)
8 (26.7%)
Denmark 1 (3.3%)
3 (10%)
Germany 1 (3.3%) 1 (3.3%) 1 (3.3%)
Québec 2 (6.7%)
Turkey 1 (3.3%) 2 (6.7%)
US 1 (3.3%)
6 (20%)
United States 1 (3.3%) 1 (3.3%)

C In which format did you attend the OHBM Brainhack 2023?

- Onsite@Montréal — 86.7%
- Online virtually — 10%
- Online@Montreal

D Which TrainTrack would you recommend the most to other researchers?

- Getting started — 13.3%
- Coding skills
- Good practices: code testing and reproducibility — 56.7%
- Version control — 16.7%
- Machine learning

Figure 1. The four panels illustrate key demographic and participation trends for the OHBM BrainHack 2023 participants. **Panel A** shows the geographic distribution, with Canada, the United States, and France as the most represented countries among 13 in total. **Panel B** presents the career status distribution, with Early Career Researchers (ECRs)—including PhD students and postdoctoral researchers—making up half of the attendees, followed by established faculty (31.2%) and Master's students (12.5%). **Panel C** depicts participant satisfaction ratings for sessions such as Unconference, TrainTrack, and HackTrack, showing higher satisfaction for HackTrack sessions overall. **Panel D** examines format preferences (hybrid vs. onsite), with a

stronger preference for hybrid participation among ECRs and attendees with more prior

experience at BrainHack events, while onsite preference was higher among established faculty.

1. **Train-Track**

Andrea Gondová

The Train-Track was an educational component aiming to create a supportive

environment for knowledge exchange, allowing participants toenhance their technical skills and

knowledge through both structured and flexible learning sessions. Suggested training materials

covered diverse range of topics, including coding skills, good coding and best research practices,

and machine learning. These materials consisted of tutorials and/or pre-recorded videos, largely

sourced from theBrainHack School (for more information, see Table 1 for training materials and

links). Additionally, participants were encouraged to customize their learning experience by

self-organizing study group with others sharing similar learning goals. Onsite sign-ups were also

avaliable for mentor-mentee pairings, offering antenddes opportunities to gain expertise in

advanced topics while expanding their professional networking. Various communication

platforms, including in-person sessions and Discord, were used to facilitate collaborative

learning.

Among the 31 respondents to the post-hackathon survey, 23% participated in Train-Track

sessions, with topics ranging from coding and machine learning to version control and coding

best practices. "Good practices" was the most recommended topic by participants. However,

feedback suggested a need for more structure and planning, such as scheduled sessions and topic

prompts, to improve accessibility and participation. Organizers acknowledged the value of increased structure while maintaining Train-Track's dynamic and community-driven nature. The goal remains to provide a flexible learning environment with suggested materials for inspiration, rather than prescriptive guidelines. To improve future iterations of Train-Track, organizers plan to introduce the program more clearly at the start of the event, encourage early interest in specific topics, and refine the program's structure and objectives to better support participants.

Topic	Session	Link to materials
Getting started	Setting-up a hack friendly environment	https://psy6983.brainhackmtl.org/modules/installation/
Coding skills	Intro to jupyter notebooks	https://docs.jupyter.org/en/latest/start/index.html
	Intro to bash	https://psy6983.brainhackmtl.org/modules/introduction_to_terminal/
	Python: Data analysis	https://psy6983.brainhackmtl.org/modules/python_data_analysis/
	Python: Visualisation	https://psy6983.brainhackmtl.org/modules/python_visualization/
	Python: Writing a script	https://psy6983.brainhackmtl.org/modules/python_scripts/
	Python: Packaging (pipy)	https://psy6983.brainhackmtl.org/modules/packaging/
Version control	Using Git and Github	https://youtu.be/zh_WFv0uk7w
		ttps://psy6983.brainhackmtl.org/modules/git_github/
	Data management with Datalad	https://youtu.be/QsAqnP7TwyY
		https://psy6983.brainhackmtl.org/modules/datalad/
	Containers for science	https://youtu.be/pc3YOZUG3lQ
Good practices	How to write good code	https://youtu.be/gfPP2pQ8Rms

	Reproducible workflows: The Turing Way	https://youtu.be/tk2eZSrM8oA
	Reproducible workflows: Transparent MRI	https://youtu.be/dSOQgyuL51U
Machine learning	Machine Learning basics	https://psy6983.brainhackmtl.org/modules/machine_learning_basics/
	Machine Learning for neuroimaging	https://psy6983.brainhackmtl.org/modules/machine_learning_neuroimaging/
	Machine Learning Reproducibility Checklist	https://www.cs.mcgill.ca/~jpineau/ReproducibilityChecklist.pdf

Table 1: Training materials provided for the Train-Track sessions at OHBM BrainHack 2023, including tutorials, pre-recorded videos, and resource links for coding, machine learning, and best practices.

2. Buddy System

Sina Mansour L

The Buddy System was established to support and engage newcomers at the Hackathon. This initiative pairs participants in a mentor-mentee fashion, with mentors guiding interests, projects to join, and networking opportunities throughout the Hackathon. Introduced in the previous 2022 edition, the system was refined for 2023 to create a more dynamic and natural community structure (see Figure 2). Pairs were given the freedom to choose their buddies to avoid any biases in matching, ensuring a fair and supportive environment for all participants. In doing so, first-time attendees and more experienced brainhackers were encouraged to network and get to know each other while also sharing information about what to expect from the

brainhack. This system has been instrumental in helping first-time attendees feel welcomed and integrated into the community.

Figure 2: (a) Front, and (b) back of a buddy card. Buddy cards were distributed amongst all attendees who expressed interest in participating in the refined dynamic buddy system. Individualized who participated were asked to share their cards with other brainhackers during lunch and coffee breaks. The cards acted as catalist to start a conversation and exchange thoughts, experiences, and contact information.

3. Hack-Track

Qing (Vincent) Wang

The Hack-Track is designed for hands-on project development, allowing participants to collaborate on diverse and innovative projects. Before the OHBM Hackathon 2023 began, project leaders submitted their proposals to our repository on GitHub, setting the stage for a dynamic and inclusive event. A pre-Hackathon online session advertised the schedule and

introduced participants to the online platform. At the start of the Brainhack, project leaders

pitched their projects, outlining goals, current status, and future aspirations.

The projects covered a wide range of topics, including coding, research tool

development, documentation, community guideline development, and visualization techniques.

This variety allowed participants to choose projects based on their interests and goals. Some

focused deeply on a single project, while others divided their time among multiple projects for a

broader experience. Participants selected projects to contribute to their expertise or to acquire

new skills and knowledge. Hackathon projects often introduced novel methods or programming

languages (e.g., Julia, WebAssembly, new visualizations), providing participants with practical

skills for future endeavors. Beyond the technical and educational aspects, the event also fostered

community building, with many participants drawn to projects for the opportunity to collaborate

and learn from new peers. Over three intensive days, 33 projects advanced significantly, thanks

to the collaborative efforts of 167 scientists from across the globe. Despite the challenges of a

hybrid event, especially in synchronizing video streams, we utilized various technologies within

Discord to facilitate seamless participant exchanges. This approach ensured that all participants,

regardless of geographical location, could fully engage in the hackathon's collaborative spirit.

4. Public Relations and Outreach

Bruno Hebling Vieira, Xinhui Li

Following the successful engagement from the OHBM Brainhack 2022, prior to the

Hackathon, we leveraged various social media platforms, including Twitter, Mattermost, and

WeChat, to announce registration information, and promote community engagement by sharing live project presentations during the event. Throughout the Hackathon, Discord served as the primary communication channel between organisers and participants as the general channel (Brainhack announcement) has been created for Brainhack 2022 and many of the existing projects can continue the channels for 2023 without the need to recreate the channel. A general channel was used to announce major events, while dedicated channels were automatically generated for each proposed project, facilitating focused group discussion among interested participants regarding project specifics. Overall, digital outreach remains a fundamental tool for dissemination, with approximately 30% of the pre-hackathon survey respondents reporting that they learned about the event from social media or the website.

Projects Reports

BrainViewer: Seamless Brain Mesh Visualization with WebGL
Authors: Florian Rupprecht, Reinder Vos de Wael

BrainViewer, a novel JavaScript package, is poised to transform how researchers and developers interact with brain meshes by enabling seamless visualization directly within web browsers. By harnessing the power of ThreeJS, BrainViewer offers a responsive and adaptable viewing experience. Its integration with the JavaScript event system facilitates the creation of intricate and customizable behaviors, enhancing its utility.

BrainViewer is currently in an active phase of development. With our commitment to meeting the demands of our short-term projects, we anticipate the first release of BrainViewer within the coming months. BrainViewer is available at https://github.com/cmi-dair/brainviewer. Upon release, it will be installable through the npm package management system. A live demo that moves based on microphone input is available at https://cmi-dair.github.io/brainviewer-demo/.

Current key features

- GPU Empowerment: BrainViewer harnesses the capabilities of WebGL and WebGPU (depending on device capabilities) to render brain meshes efficiently within web browsers, delivering a visually engaging experience. Notably, our test users have consistently praised the smoothness of interactivity.

- Deployment across ecosystems: BrainViewer supports a large number of devices, from large PC screens with mouse and keyboard to compact mobile screens with touch interfaces.

- Customizable Behaviours: BrainViewer's integration with the JavaScript event system empowers users to define complex and tailored behaviours, enhancing interactivity and exploration.

Clinica's image processing pipeline QC
Authors: Matthieu Joulot, Ju-Chi Yu

The goal of the project was to evaluate different quality check (QC) metrics and visuals for pipelines currently existing in Clinica (Routier et al, 2021), which deal with registration or

segmentation. That way, we would be able to find a few good metrics to separate the good images from the bad or moderately good ones, which the users would check using some visual we would generate for them.

We were able to output seven available QC metrics for registration, and with PCA, we evaluated their factor structure and kept only two metrics that captures the most QC information: 1) the correlation coefficients between the MNI template (target) and the subject's brain image, and 2) the dice score (i.e., a type of distance measure) obtained by a brain extraction tool (BET) algorithm called HD-BET.

We will look further into our pipeline based on this result, so that we can have a better idea of what we want to implement in the future version of Clinica, which will include QC.
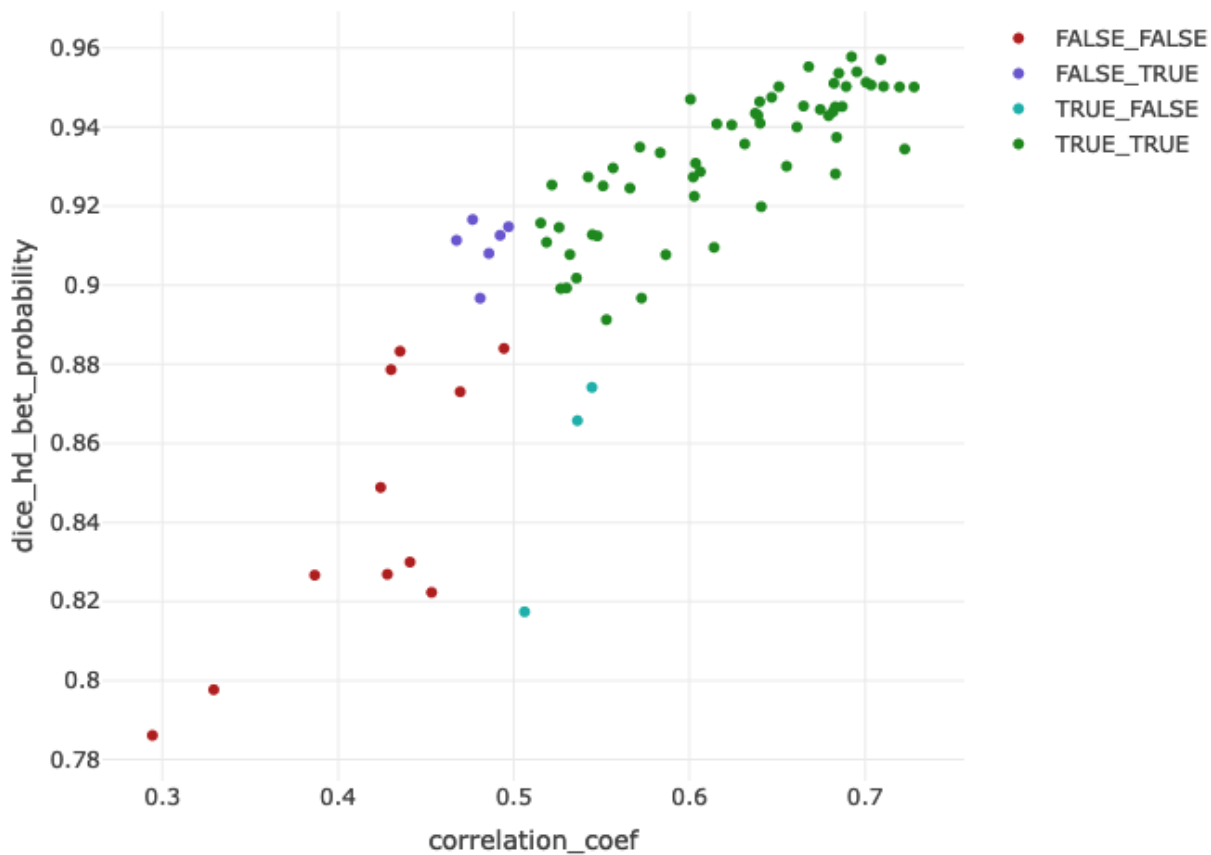
Figure 1: Scatterplot of HD BET Dice probability and correlation ratio between reference and moving images. Red color means both metrics are below the threshold, blue or purple means one of the metrics is below the threshold, green means both metrics are above the threshold.

Neuroimaging Meta-Analyses
Authors: James Kent, Yifan Yu, Max Korbmacher, Bernd Taschler, Lea Waller, Kendra Oudyk

Neuroimaging Meta-Analyses serve an important role in cognitive neuroscience (and beyond) to create consensus and generate new hypotheses. However, tools for neuroimaging meta-analyses only implement a small selection of analytical options, pigeon-holing researchers to particular analytical choices. Additionally, many niche tools are created and abandoned as the graduate student who was working on the project graduated and moved on. Neurosynth-Compose/NiMARE are part of a Python ecosystem that provides a wide range of analytical options (with reasonable defaults), so that researchers can make analytical choices based on their research questions, not the tool.

To enhance and broaden the ecosystem, our efforts were channelled into a variety of projects. Initially, we focused on making Coordinate-based Meta-Regression more efficient and user-friendly, with the goal of fostering the adoption of a more flexible and sensitive model approach to coordinate-based meta-analysis. Following that, we sought to improve the tutorial for Neurosynth-Compose, aiming to increase its usage by providing clear and accessible guidance on how to utilize the website effectively. Additionally, we aimed to refine the masking process for Image-Based Meta-Analysis, striving to incorporate more voxels/data, thereby enhancing the analysis's overall data richness. Finally, we embarked on running topic modeling of abstracts from papers associated with NeuroVault collections, a move intended to identify groupings of images that are suitable for meta-analysis, further contributing to the field's advancement and the utility of NeuroVault's resources.

Results

Progress was achieved across all the projects undertaken to enhance the ecosystem. For the Coordinate-based Meta-Regression, we identified several bugs and areas of inefficient code,

alongside creating notebooks that demonstrate usage and pinpoint issues, laying the groundwork

for future improvements. Feedback was meticulously provided to refine the tutorial, focusing on

improving its clarity and conciseness, thereby making it more accessible to users. In terms of the

Image Based Meta-Analysis, an outline of a solution to include more voxels was drafted,

complete with a plan for its implementation, promising to enrich the analysis by utilizing a larger

dataset. Furthermore, through topic modeling, we gained insights into the distribution of images

on NeuroVault, identifying how they are grouped, which aids in understanding the landscape of

available data for meta-analysis.

The improvements made to NiMARE and related tools provide more accessibility to

neuroimaging meta-analyses making it easier to perform crucial analyses in our field.

NARPS Open Pipelines
Authors: Boris Clénet, Élodie Germani, Arshitha Basavaraj, Remi Gau, Yaroslav Halchenko,

Paul Taylor, Camille Maumet

Different analytical choices can lead to variations in the results, a phenomenon that was

illustrated in neuroimaging by the NARPS project (Botvinik-Nezer et al. 2020). In NARPS, 70

teams were tasked to analyze the same dataset to answer nine yes/no research questions. Each

team shared their final results and a COBIDAS-compliant (Nichols et al., 2017) textual

description of their analysis. The goal of NARPS Open Pipelines is to create a codebase

reproducing the 70 pipelines of the NARPS project and share this as an open resource for the

community.

Results

During the OHBM Brainhack 2023, participants had the opportunity to improve the project in various ways. First, they focused on fostering a more inclusive environment for new contributors, refining the contribution process through proofreading and testing. Several pull requests (PR #66, PR #65, PR #63, PR #64, PR #52, PR #50) were dedicated to this effort, rectifying inconsistencies in the documentation and contributing procedures.

Additionally, they implemented GitHub Actions workflows to enable continuous integration, ensuring the testing of pipelines with each alteration (PR #47), and crafted a new workflow to detect code comments and documentation typos (PR #48).

Acquisition of new skills was another significant aspect, with individuals diving into NiPype and advancing pipeline reproductions. Thanks to Paul Taylor's contributions, a deeper understanding of AFNI pipelines emerged, particularly benefiting from afni_proc examples within the NARPS project (Taylor et al., 2023). This endeavor resulted in the initiation of new pipeline reproductions (PR #62, Issue #61, PR #59, Issue #57, Issue #60, PR #55, Issue #51, Issue #49).

Ultimately, the Hackathon yielded substantial progress: 6 pull requests merged, 4 issues opened, 4 closed, and 6 opened, showcasing a fruitful collaboration and dedication to project enhancement.

ET2BIDS - EyeTracker to BIDS
Authors: Elodie Savary, Remi Gau, Oscar Esteban

In the realm of neuroimaging, BIDS has become the de facto standard for structuring data. Its

adoption has simplified the data management process, enabling researchers to focus on their

scientific inquiries rather than the intricacies of data organization (Gorgolewski et al. 2016).

However, the inclusion of eye-tracking data within the BIDS framework has remained a

challenge, often requiring manual data rearrangement. The ET2BIDS project aimed to take a

significant step toward incorporating eye-tracking data into BIDS, leveraging the bidsphysio

library to facilitate this integration.

Bidsphysio is a versatile tool designed to convert various physiological data types, including

CMRR, AcqKnowledge, and Siemens PMU, into BIDS-compatible formats. In particular, it

offers a dedicated module called edf2bidsphysio to convert EDF files containing data from an

Eyelink eyetracker. An advantageous feature of the bidsphysio library is its Docker

compatibility, ensuring smooth cross-platform execution without the need for additional

installations.

Before starting our project, a bug had been identified in the Docker image, which hindered the

correct execution of the edf2bidsphysio module. Our primary focus was, therefore, to address

and resolve this bug in order to enable the utilization of the Docker image for eye-tracking data

conversion.

Results

The ET2BIDS project made significant progress in converting eye-tracking data into BIDS

format. We initially processed the test data from the GitHub repository, overcoming the bug that

had hindered the edf2bidsphysio module's execution. Moreover, with minor modifications to the

module, we successfully processed a dataset acquired by the authors using an Eyelink eye

tracker, showcasing potential bidsphysio versatility in handling various eye-tracking datasets.

Future prospects

The future of eye-tracking data integration into BIDS is evolving as we identify essential fields

and metadata necessary for reproducible research. BIDS specifications for eye-tracking data are

in development, with expanding guidelines for essential reporting in research studies (e.g. Dunn

et al. 2023).

As these guidelines grow, we will have to adapt bidsphysio to match the evolving BIDS

standards, ensuring it converts eye-tracking data in accordance with the latest recommendations.

Physiopy - Practices and Tools for Physiological Signals
Authors: Mary Miedema, Céline Provins, Sarah Goodale, Simon R.
Steinkamp, Stefano Moia

The acquisition and analysis of peripheral signals such as cardiac and respiratory

measures alongside neuroimaging data provides crucial insight into physiological sources of

variance in fMRI data. The physiopy community aims to develop and support a comprehensive

suite of resources for researchers to integrate physiological data collection and analysis with their

studies. This is achieved through regular discussion and documentation of community practices

alongside the active development of open-source toolboxes for reproducibly working with

physiological signals. At the OHBM 2023 Brainhack, we advanced physiopy's goals through

three parallel projects:

Documentation of Physiological Signal Acquisition Community Practices

We have been working to build "best community practices" documentation from experts in the physiological monitoring realm of neuroimaging. The aim of this project was to draft a new version of our documentation adding information from six meetings throughout the year discussing good practices in acquisition and use of cardiac, respiratory, and blood gas data. The documentation is finished and ready for editorial review from the community before we release this version publicly.

Semi-Automated Workflows for Physiological Signals

The aim of this project was to upgrade the existing code base for the peakdet and phys2denoise packages to achieve a unified workflow encompassing all steps in physiological data processing and model estimation. We mapped out and began implementing a restructured workflow for both toolboxes incorporating configuration files for more flexible and reproducible usage. To better interface with non-physiopy workflows, we added support for NeuroKit2 functionalities. As well, we added visualization support to the phys2denoise toolbox.

PhysioQC: A Physiological Data Quality Control Toolbox

This project was about creating a quality control pipeline for physiological data, similar to MRIQC, and leveraging NiReports. At the hackathon, we implemented a set of useful metrics and visualizations, as well as a proof-of-concept workflow for gathering the latter in an HTML report.

Going forward, development of these toolboxes and revision of our community practices continues. We welcome further contributions and contributors, at any skill level or with any background experience with physiological data.

**Cerebro - Advancing Openness and Reproducibility in
Neuroimaging Visualization**

Authors: Sina Mansour L., Annie G. Bryant, Natasha Clarke, Niousha
Dehestani, Jayson Jeganathan, Tristan Kuehn, Jason Kai, Darin Erat
Sleiter, Maria Di Biase, Caio Seguin, B.T. Thomas Yeo, Andrew Zalesky

Openness and transparency have emerged as indispensable virtues that pave the way for

high-quality, reproducible research, fostering a culture of trust and collaboration within the

scientific community (Munafò et al. 2017). In the domain of neuroimaging research, these

principles have led to the creation of guidelines and best practices, establishing a platform that

champions openness and reproducibility (Niso et al. 2022). The field has made substantial strides

in embracing open science, a feat achieved through the successful integration of open-source

software (Gorgolewski et al. 2011), public dataset sharing (Markiewicz et al. 2021), standardized

analysis pipelines (Nichols et al. 20217), unified brain imaging data structures (Gorgolewski et

al. 2016), open code sharing (Smout et al. 2023), and the endorsement of open publishing.

The joint efforts of these initiatives have established a robust foundation for cultivating a culture

of collaboration and accountability within the neuroimaging community. Nonetheless, amidst

these advancements, a crucial inquiry arises: What about the visual representations —the very

tools through which we observe and make sense of neuroimaging results? It is within this context

that we introduce *Cerebro* (Mansour L. et al. 2023), a new Python-based software designed to

create publication-quality brain visualizations (see Fig.x). Cerebro represents the next step in the

quest for openness and reproducibility, where authors can share not only their code and data but

also their publication figures alongside the precise scripts used to generate them. In doing so,

Cerebro empowers researchers to make their visualizations fully reproducible, bridging the

crucial gap between data, analysis, and representation.

Future guidelines

As Cerebro continues to evolve in its early development stages, this manuscript serves as a

manifesto, articulating our dedication to advancing the cause of open and reproducible

neuroimaging visualization. Cerebro is guided by a set of overarching goals, which include:

Fully Scriptable Publication-Quality Neuroimaging Visualization:

Cerebro's primary mission is to equip researchers with the means to craft impeccable brain

visualizations while preserving full scriptability. Cerebro enables researchers to document and

share every aspect of the visualization process, ensuring the seamless reproducibility of

neuroimaging figures.

*Cross-Compatibility with Different Data Formats:*

The diversity of brain imaging data formats can pose a significant challenge for visualization.

Many existing tools are constrained by compatibility limitations with specific formats. Drawing

upon the foundations laid by tools like NiBabel (Brett et al. 2020), Cerebro is determined to

provide robust cross-compatibility across a wide spectrum of data formats.

Integration with Open Science Neuroimaging Tools:

We wholeheartedly acknowledge that Cerebro cannot thrive in isolation. To realize its full

potential, it must seamlessly integrate into the existing tapestry of open science tools, software,

and standards. Through active collaboration with the neuroimaging community, particularly

through open, inclusive community initiatives such as brainhacks (Gau at al. 2021), Cerebro

aspires to forge cross-compatibility with established and emerging tools, standards, and pipelines. Our vision is one where the future of neuroimaging visualizations is marked by unwavering openness and reproducibility, fostered by this united effort.
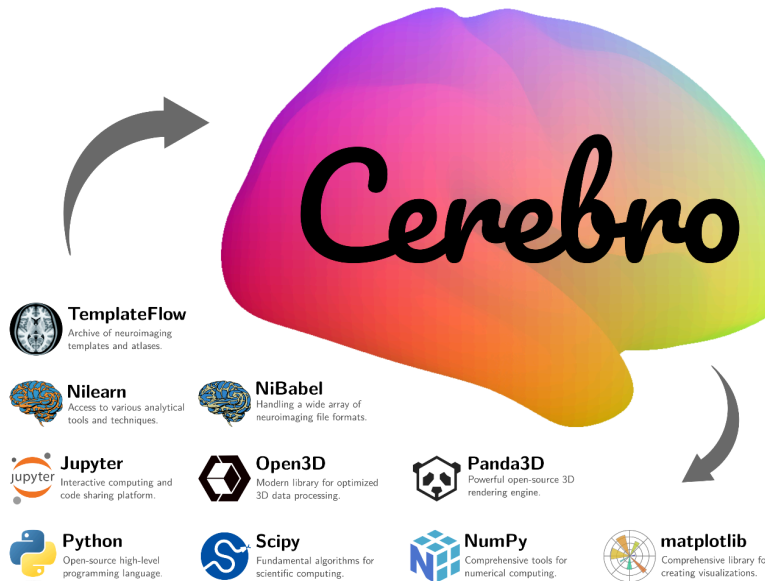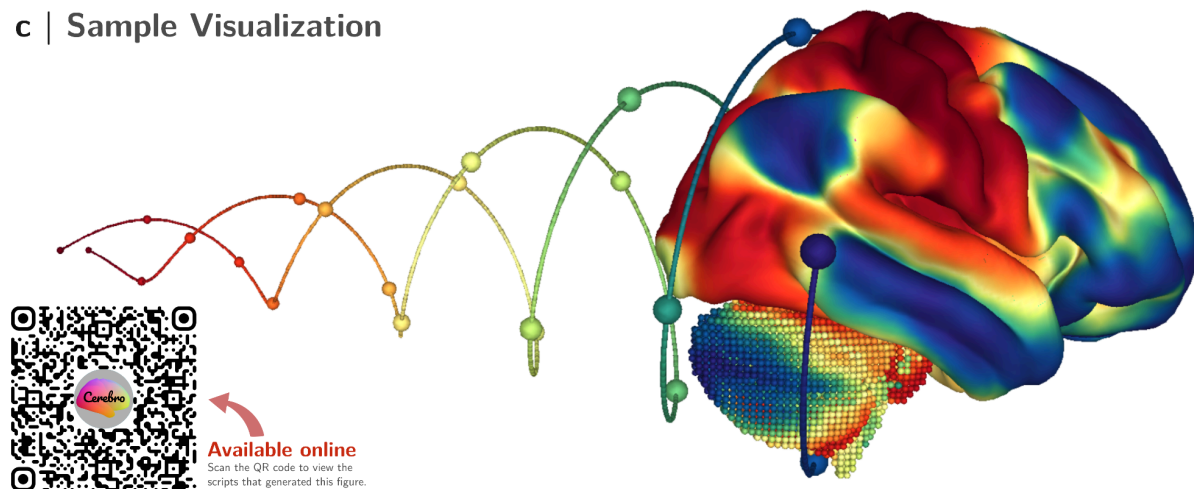

Figure x: Cerebro – A Python-Based 3D Brain Visualization Tool. (a) Cerebro leverages an extensive array of open-source Python tools, forming a robust foundation for its functionality. It

also integrates with these tools to enable seamless Pythonic neuroimaging visualizations. (b)

Cerebro prioritizes principles of scriptability, reproducibility, visualization quality,

cross-compatibility, and integration in its pursuit of providing a reliable solution for the

neuroimaging community. (c) An illustrative Cerebro-generated visualization, accompanied by a

scannable QR code linked to the publicly accessible reproduction scripts.

K-Particles: A visual journey into the heart of magnetic resonance imaging
Authors: Omer Faruk Gulban, Kenshu Koiso, Thomas Maullin-Sapey,
Jeff Mentch, Alessandra Pizzuti, Fernanda Ponce, Kevin R. Sitek, Paul
A. Taylor

The primary objective of this project is to leverage particle animations to provide insights into

the journey of traveling and sampling the k-space. By generating captivating visualizations, we

aim to demystify the concept of k-space and the role it plays in magnetic resonance imaging

(MRI), engaging both the scientific community and the general public in a delightful exploration

of this fundamental aspect of imaging. This project builds on our previous Brainhack experiences

that focused on generating 3D geodesic distance computation animations (Nikolaidis at al. 2021)

and particle simulation based brain explosions (Moia et al. 2024).

Methods

Our methodology is as follows. First, we start from a 2D brain image (e.g. selecting a slice from

a 3D anatomical MRI data (Brett et al. 2023, Harris at al. 2020, Virtanen et al. 2020). Then, we

take its Fourier Transform and subsequently perform masking (or magnitude scaling) operations

on k-space data (Bernstein at al. 2024), the transform. We then create simultaneous visualizations

of the k-space magnitude and corresponding image-space magnitude data. Note that the masking

of k-space data is where the participants of this project exercised their creativity, by setting up

various initial conditions and a set of rules to animate the mask data. In the final step, animated

frames are compiled into movies to inform (and entertain). The scripts we have used to program

these steps are available at: https://github.com/ofgulban/k_particles . Note that, we have also

included several animations where no brain images were used, but instead, we generated k-space

data directly in k-space to guide the unfamiliar participants with the concepts (see Figure x,

Panel A).

Results

As a result of this hackathon project, a compilation of our progress (Figure x, Panel B) can be

seen at https://youtu.be/_5ZDctWv5X4 as a video. Some of the highlights are:

- Audiovisualizer that maps audio features (e.g. amplitude) to k-space mask diameters

- Game of life (Gardner et al. 1970) simulation in k-space with Hermitian symmetry.

- Pacman moving in k-space is implemented as a series of radial sector masks.

- Semi-random initialization of particle positions and semi-randomly reassigned velocities
  that look like an emerging butterfly.

- Randomized game of life initialization with vanishing trails of the previous simulation
  steps that look like stars, clouds, and comets orbiting frequency bands in k-space.

- Semi-random initialization of particle positions and velocities that look like explosions.

- Predetermined initialization of particle positions (e.g. at the center) and semi-randomized
  velocities that look like fireworks.

- Dancing text animations where the positions of text pixels are manipulated by wave functions.

- Picture based (e.g. cropped faces of the authors) moving within the k space where each pixel's grayscale value is mapped onto a mask coefficient between 0-1.

Our future efforts will involve sophisticating the k-space simulations to generate more entertaining and educational content. For instance, instead of only visualizing the magnitude images, we can generate four panel animations showing real and imaginary (or magnitude and phase) components of the data.
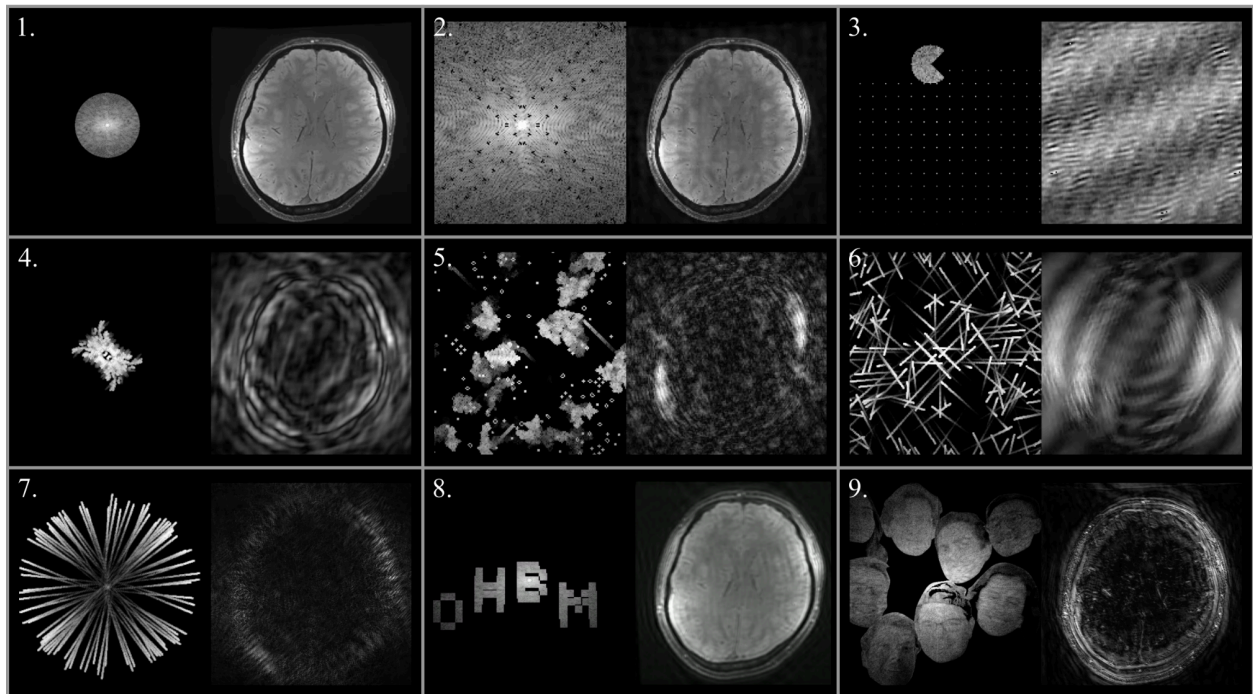
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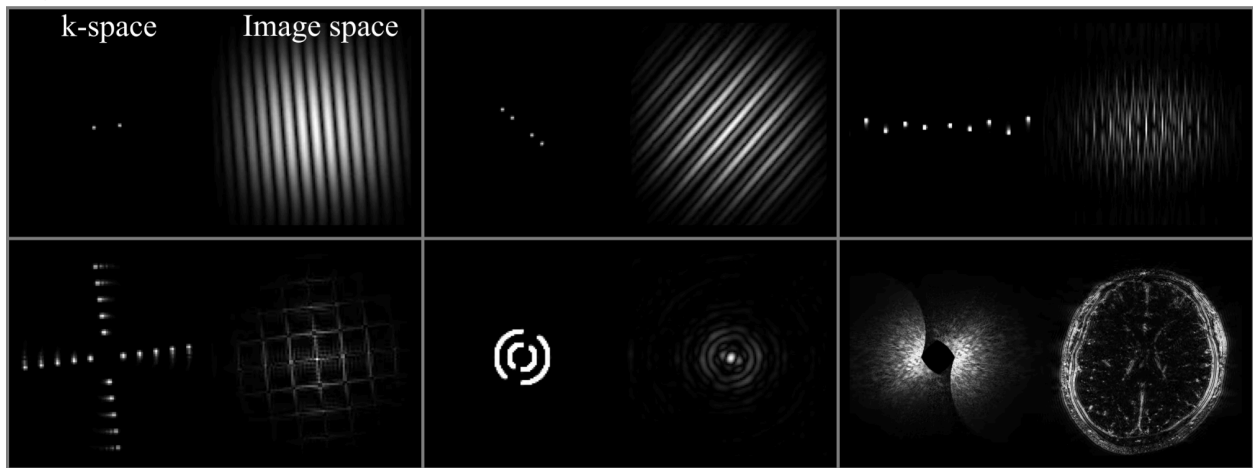
B)

Figure x: Our compilation of k-space animations generated during the brainhack can be seen at

https://youtu.be/XS0LEQExGU8?si=I5Zufp3AcCbdhYIR .

6. Mini-Grant Initiative at the OHBM Brainhack 2023

This year, we introduced Mini-Grant initiative, generously supported by sponsors, aimed at empowering and supporting *Brainhackers*. The grants were distributed across nine categories:

- Open Science Mini-Grant: Funding projects promoting open science principles like data sharing and open-source software.

- Diversity and Inclusion Mini-Grant: Supporting initiatives that enhance diversity and inclusion in science or academia.

- Public Science Communication Mini-Grant: Backing efforts to communicate scientific research to the public in an accessible manner.

- Innovative Teaching Method Mini-Grant: Encouraging creative approaches to science education.

- Interdisciplinary Collaboration Mini-Grant: Fostering cross-disciplinary research to address complex challenges.

- Student-Led Research Mini-Grant: Supporting science projects led by students.

- Global Science Collaboration Mini-Grant: Encouraging international research collaborations.

- Early Career Researcher Mini-Grant: Funding early-career scientists to conduct independent projects.

- Science and Art Integration Mini-Grant: Funding projects that blend scientific concepts with artistic expression.

These grants were based on project merit, with nominations made by teams or peers after the project pitches and rhyming battle. However, the response was less enthusiastic than anticipated, receiving only a limited number of nominations. This outcome prompted a reflection on the initiative's alignment with the community's core values. The competitive nature of the grant-awarding process might resonate poorly with the collaborative and inclusive ethos of the Brainhack community. In light of these reflections, a decision was made to retain the funds for future Brainhack events, with a new approach in mind. For the next OHBM Hackathon editions, the organizers could initiate the funding process earlier, allowing participants to submit proposals during registration. This process will enable us to review the needs of the projects in advance and provide support where it's most needed, such as for essential equipment like webcams or help with travel arrangement costs. The pivotal strategy aims to demonstrate our commitment to the community and ensure that support is available from the outset, fostering a more inclusive and resourceful environment

7. Rhyming Battle

One of the most memorable and engaging events at the OHBM Brainhack 2023 was the 'Rhyming Battle.' Held before the project presentations, this unique event featured three participants who artistically expressed their experiences and challenges encountered during the hackathon. They crafted short poems about their projects and the various aspects they faced during Brainhack, bringing a touch of lighthearted humour to their scientific endeavours (see Appendix). The Rhyming Battle provided an entertaining break from the Hackathon's more scientific aspects. It allowed attendees to resonate with each other's experiences, celebrating the struggles and triumphs inherent in scientific projects. The event showcased the creative and vibrant spirit of the Brainhack community. Voting for the winner was not straightforward, as the attendees were equally good. The prize was a single 3D homemade sculpture representing the Brainhack 2023 logo, made for the winner of the battle (Figure x). However, the enthusiasm of the battlers and the public was overwhelming, and we decided to 3D print the same sculpture for every battle participant. Ultimately, the spirit of Brainhack community prevailed (Gau et al., 2021; Levitis et al., 2021), and every participant was celebrated as a winner.

8. Conclusion

The OHBM Brainhack 2023 exemplified a vibrant fusion of education, innovation, and community spirit. Through initiatives like Train-Track, Hack-Track, the Buddy System, the Rhyming Battle, and the Mini-Grant program, the event fostered an environment rich in learning, creativity, and collaboration. These elements, coupled with a commitment to open science and

diversity, underscored the gathering's success in nurturing a dynamic scientific community.

Reflecting on the experiences and feedback from this year, Brainhack is poised to evolve,

embracing lessons learned to enhance future hackathons. This continuous improvement and

deepened community engagement are set to further empower and inspire participants in the years

to come.

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  volume    = 4,

  month     = mar,

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Supplemnentary

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Bedtime Story for Hackers

"The Chat in the Hack Comes Back"

Variation of a theme from Dr. Suess's "The Cat in the Hat Comes Back"

by Tonya White

There is no time for play, there is no time for fun,

There is no time for games, there is work to be done.

When my PI went back to her humble abode,

She said somebody has to finish this code.

Somebody, somebody has to you see.

So she looked at two somebodies, the postdoc and me.

So we looked at each other, and what could we do.

Hacking is fun, and much better with two.

But it's even more fun, with three, four or eight,

Make it a group, a hackathon would be great.

So I sent out the message to all on discord,

Come now, come quick, come all in accord,

There shall be coffee, there will be space,

</div>

There will be Internet, and a wonderful place.

With heads full of brains, the room started to fill,

The projects were shared, the coders were chill.

The coffee was hot, the projects were cool.

The computers were buzzing with their underlying boel…

…ian logic.

So there we all were, all hacking so fast,

But who should walk by, but the chat in the hack.

Your coding's in vain, the chat in the hack said,

With chatGPT, your coding is dead!

Not so, not so! We cried in accord,

We're creating new things, new things galore

Your ChatGPT takes only what's there,

It can't create things, just poof from thin air.

So we presented our projects, as we all sat around,

All remained still, still with no other sounds,

Except the sound of sips, the caffeinated type.

As we all looked in awe, seeing brain power and might.

After all the talks, and all the applause,

The room remained still, at least for a brief pause,

Then the chat in the hack laid down his hat,

I surrender he said, I take my words back.

Your hackathon is great, even though I was late,

Next year I'll be here, I'll make it a date.

Box X. Lyrics for the Rhyming Battle

Figure x. The 3D-printed trophy for the Rhyming Battle. The concept was created using MidJourney, requesting for "a golden statue in the shape of a brain, intricate Aztec designs etched into the metal, standing on a stone pedestal. Aztec designs include snakes, eagles, and other symbols of the ancient civilization." The generated image was 3D-modeled using Blender 3D and 3D-printed in a Creality Ender-3 V2 Neo printer, using white PLA. The sculpture was spray-painted in black and gold.

Untitled

James D Kent

Dip your toes into neurosynth compose,

Cause we're pros we got immaculate workflows.

It's the platform you'll be glad you chose

Shameless plug https://compose.neurosynth.org/

Now sit back and listen to my prose

Coordinate based regression is my current obsession,

Yifan's hunting bugs with relentless aggression.

she does it with a smile and a calming expression.

Optimizing functions with her matrices hessian.

We're not done, we got image based analyses.

Propelling science to interstellar galaxies.

Lea's been working on fixing technicalities,

Bringing science fiction into our very own realities.

Lest I forget, there is Kendra with Neurovault

The data processed just crumbles with her assault

breaking down abstracts like grinding the table salt

her flow is like lava, ideas solid like rock basalt

And there's more, we made a tutorial.

Here in Montreal, a region quite boreal

We be spreading knowledge like we bacterial.

If you think that's cool come check our material.

So, dip your toes into neurosynth compose

It's the platform you'll be glad you chose.

Untitled

François Paugam

Now this is a story
All about how
My life got flipped
Turned upside down
And I'd like to take a minute
So just listen
I'll tell you how I became contributor
of a package called nilearn

Look
If you had
One issue
Or one pull request
To refactor every test ever created
In one branch
Would you merge it?
Or just let it slip?

His code is ready
Nice tweaks, lines are pretty
There's a commit on his branch already
Code spaghetti

He's nervous, but on Github
He looks calm and ready
To fix bugs
But he keeps on forgettin'

What he wrote down
All the tests go so bad
He opens a PR
But the merge won't come out
He's chocking, how?
Everybody's joking now
The clock's run out
flake8 failed, blaow!

Don't git push
Cause I ain't run flake8
I'm trying
Not to fail the tests

It's like spaghetti sometimes
It makes me wonder how I keep from getting errors
Don't need no GPT hallucinating
I get my code hints from Hao-Ting

Rhyming or coding
It's all the same
Find fine lines online
Copy-paste them
Have an issue with that?
You know who to git-blame