brainglobe: cellfinder support for two-dimensional brain images (David Ruiz)

Personal details

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- **Zulip username:**
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- **Location & time-zone:**
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- **Personal website / project portfolio:**
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- **Code contribution**
  https://github.com/brainglobe/cellfinder/pull/508

Project proposal

Synopsis
This project will extend Cellfinder to support 2D brain slice images alongside its current 3D volumes. By adapting the blob detection algorithm and implementing a neural network classifier optimized for 2D data, the tool will cater to neuroscientists using standard microscope slices while preserving existing 3D functionality. This enhancement will broaden Cellfinder's usability and impact in neuroimaging research.

Implementation timeline

Minimal Deliverables:

- Adapt the blob detection algorithm to accurately detect cell candidates in both 2D and 3D images.
- Develop and integrate a new neural network classifier for 2D cell candidate images.
- Provide comprehensive tests, updated documentation, and a blog post demonstrating 2D image support.

Stretch Goals:

- Add support for batch processing of multiple 2D slice images in one run to facilitate high-throughput analysis of series of brain sections.
- Experiment with more advanced or specialized models (e.g. applying transfer learning from pre-trained histology image networks) to further improve 2D classification accuracy if time permits.

12-Week Timeline (25–30 hrs/week):

- **Weeks 1–2:** Analyze the existing 3D pipeline, set up the environment, and gather sample 2D brain slice images.
- **Weeks 3–4:** Implement and test the modified blob detection algorithm for 2D images.
- **Weeks 5–6:** Develop and fine-tune the 2D classifier model using Keras/PyTorch.
- **Weeks 7–8:** Integrate the new classifier into Cellfinder and conduct end-to-end testing (ensuring 3D functionality remains intact).
- **Weeks 9–10:** Optimize performance, expand automated tests, and update documentation.
- **Weeks 11–12:** Draft and publish a blog post, finalize evaluations, and submit the final report.

Communication plan:

I will maintain clear, regular communication by holding weekly mentor video calls, posting daily updates on Zulip, sharing weekly progress summaries, and regularly pushing code to GitHub. Urgent issues will be resolved with additional ad-hoc calls, ensuring transparent, timely collaboration throughout the project.

Personal statement

- **Past experience**

I have six years of Python programming experience and am in my final year of Computer Engineering at the University of Seville. My background includes extensive work with image processing and machine learning frameworks (especially Keras and PyTorch), along with proficiency in libraries such as NumPy and Pandas. I have already contributed to Cellfinder on GitHub and have worked on projects involving both 2D and 3D image data.

- **Motivation: why this project?**

I am driven by a passion for making advanced computational tools more accessible to researchers. The challenge of extending Cellfinder's capabilities to include 2D brain slice images is particularly exciting because it directly addresses a significant gap in the current tool, thereby expanding its user base to many neuroscientists who rely on 2D microscopy data. I am enthusiastic about the opportunity to merge my skills in image processing and deep learning with a project that has tangible implications for brain research. By enabling a wider range of imaging modalities, this project not only enhances technical performance but also contributes to accelerating discoveries in neuroscience.

- **Match: why me?**

My technical foundation and hands-on experience uniquely position me to address the challenges of adapting Cellfinder for 2D data. I have a proven track record in implementing and optimizing deep learning models, and my previous contributions to the Cellfinder repository demonstrate my ability to work effectively within an open source environment. I excel at bridging the gap between theoretical research and practical application, and I am committed to delivering robust, well-documented solutions. My proactive problem-solving approach and strong communication skills ensure that I can collaborate effectively with mentors and the broader community to meet and exceed project goals.

- **Availability**

I have arranged a vacation from June 27 to June 29, and no other engagements are scheduled during that period.

GSoC

- **GSoC experience**

I expect to obtain hands-on experience on a real project and on the open-source community

- **Are you also applying to projects with other organisations in GSoC 2025?**

No, all three projects that I'm applying to belong to NIU. My preferences in case I get selected in more than one would be:

1st → Improve cellfinder's classification algorithm
2nd → cellfinder support for two-dimensional brain images
3rd → Add to BrainGlobe's data visualisation tool