Deliverable D3.2

User-friendly versions of zero-code tools

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Change Log

Version	Date	Author	Description of changes
v0.1	09/04/2024	Caterina Fuster-Barceló	Initial draft
v0.2	16/07/2024	Arrate Muñoz Barrutia	Revision of the initial draft
v0.3	30/07/2024	Beatriz Serrano-Solano, Dorothea Dörr, Estibaliz Gómez de Mariscal	Edits and suggestions
v0.4	01/08/2024	Arrate Muñoz Barrutia	Final draft approved for submission

Acronyms and Abbreviations

AI	Artificial Intelligence
BMZ	BioImage Model Zoo
DL	Deep Learning
JDLL	Java Deep Learning Library
RDF	Resource Description File
UC3M	Universidad Carlos III de Madrid
WP	Work Package

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Executive Summary

The AI4Life project aims to democratise modern Artificial Intelligence (AI) methods for biological imaging, building bridges between life sciences and computer vision researchers that can expand the reach of cutting-edge techniques. Work Package 3 (WP3) is central to enhancing the BioImage Model Zoo, AI4Life's repository of FAIR pre-trained AI models, by ensuring that its Deep Learning (DL) tools are smoothly integrated into the life sciences community's workflows, thus improving the potential of biological research. This work package focuses on making these tools easily accessible for end-users and model contributors while providing robust support and effective deployment in real-world applications.

This Deliverable 3.2 (D3.2) describes the enhancements and developments made to zero-code tools within the AI4Life project, aimed at facilitating user-friendly interaction and integration with the BioImage Model Zoo. Significant developments include the introduction of new tools such as DL4MicEverywhere, the BioImage.IO Chatbot, the Java Deep Learning Library (JDLL), and the BioImage.IO Colab, which are linked explicitly to the BioImage Model Zoo. Additionally, this deliverable highlights the release of updated versions of established Community Partner tools like deepImageJ and the integration of new pre-existing tools with new Community Partners such as BiaPy and QuPath, broadening the ecosystem's reach and functionality. All software discussed is readily accessible through the BioImage.IO web page.

A pivotal aspect of this deliverable is the focus on user engagement and the incorporation of user feedback, which has been crucial in driving the recent advancements within the ecosystem. Enhanced feedback mechanisms have been implemented to further refine these interactions and contributions from the user community, ensuring continuous improvement and responsiveness to user needs.

1. Introduction

The AI4Life project is funded by the European Union's Horizon Europe research and innovation programme, led by the project coordinator Euro-BioImaging, and participated by ten partners, five of whom are European Research Infrastructures. The project started in September 2022 and will continue until September 2025.

AI4Life aims to bring state-of-the-art AI-based image analysis to life scientists by establishing and supporting innovative services that target both researchers in the life sciences and computational methods developers in the AI and computer vision fields.

Work Package 3 (WP3) focuses on "Direct Support" and contributes to Objectives 1, 3, 5, and 6 of AI4Life:

- **Objective 1**: Democratise the availability of AI-based image analysis methods as a FAIR service accessible through the AI4Life service landscape and computationally powered by the European Open Science Cloud (EOSC) infrastructure.
- **Objective 3:** Simple model deployment, sharing, and dissemination of AI-based methods as a new developer-facing service of the BioImage Model Zoo (BMZ)[1].
- **Objective 5:** Empower common image analysis platforms with AI tools.
- **Objective 6**: Organise outreach and training events for life scientists, such as targeted image analysis courses and workshops, as well as participation in the largest international conferences.

To contribute to the project objectives, WP3 is split into three different tasks:

- **Task 3.1** Direct support to the end-users.
- **Task 3.2** Usability of provided software tools.
- **Task 3.3** Dissemination documents and materials

This second deliverable focuses on Task 3.2. It specifically addresses the release of novel versions of zero-code community partner tools, including deepImageJ and ZeroCostDL4Mic, which have been enhanced to support a user-friendly connection with the BioImage Model Zoo. These improvements are designed to facilitate the integration into users' image-processing workflows, thereby strengthening the practical application of these tools in biological research.

The advancements covered in this deliverable ensure that the tools are not only more accessible but also more effectively integrated with the BioImage Model Zoo, making them readily available for end-use through the BioImage.IO web page. By enhancing these zero-code tools, WP3 aims to lower the barriers for life scientists to leverage advanced AI methods, thus broadening the scope of biological questions that can be addressed with these technologies. This deliverable will detail the updates to the zero-code tools, describe their integration with the BioImage Model Zoo, detail the user engagement and feedback mechanisms that made this possible and outline how these enhancements contribute to the overarching goals of WP3 and the AI4Life project.

[1] https://BioImage.IO/

2. Description of work

2.1 Implementation of Zero-Code Tools enhanced

The enhancements across our zero-code tools are significant in advancing the usability and accessibility of AI technologies for the life sciences community, further integrating with the BioImage Model Zoo and AI4Life frameworks.

BioImage Model Zoo Website

Test Run feature

A significant enhancement on the BioImage Model Zoo website[2] is the introduction of the "Test Run feature" integrated into the model cards shown in Figure 1. Thanks to ImJoy[3], this new functionality allows users to interactively run models directly within their web browsers using ImageJ.js[4], enhancing the practical accessibility of AI tools. The feature empowers users to not only preview the model's performance using pre-loaded example images but also provides the flexibility to upload and test the model on their own images. This immediate, hands-on interaction offers a first touchpoint, enabling users to check the model's efficacy and suitability for their specific datasets right from the outset.

This feature is especially beneficial for researchers exploring various models for potential application to their data. Facilitating an initial testing phase without needing local installation or setup significantly streamlines the process of selecting the most appropriate model for their needs. Currently, this capability is active on the majority of models, and efforts are ongoing to expand its availability across more models to ensure broader compatibility and user support. This enhancement boosts user engagement and profoundly impacts the decision-making process by providing a transparent, immediate demonstration of each model's capabilities and performance on real data.

[2] https://BioImage.IO/#/
[3] Ouyang, W., Mueller, F., Hjelmare, M., Lundberg, E., & Zimmer, C. (2019). ImJoy: an open-source computational platform for the deep learning era. Nature methods, 16(12), 1199-1200.
[4] https://imagej.net/software/imagej-js

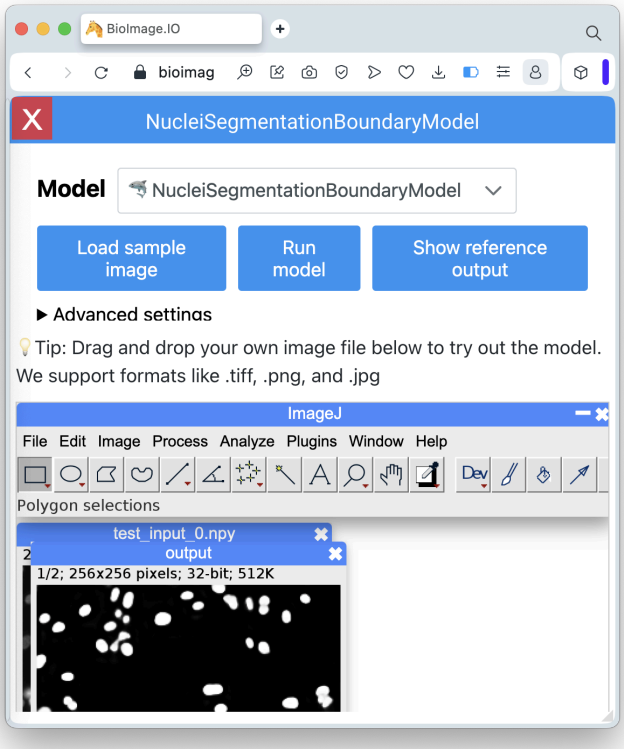

Figure 1: Screenshot of the BioImage Model Zoo with enabled test run feature. Running the model "NucleiSegmentationBoundaryModel" with the test run feature by loading the sample image and running it through ImageJ.js.

Model Upload

The model uploader for the BioImage Model Zoo has undergone significant enhancements to integrate and secure the model submission process (Figure 2). The uploader now uses an Amazon S3 (Simple Storage Service) bucket for storing models, datasets, and other resources. This transition to a cloud-based storage solution offers robust scalability, reliability, and speed, facilitating efficient management and retrieval of large volumes of data.

The submission process requires the Resource Description File (RDF) in YAML format, which provides a structured and standardised description of the models, datasets, or resources being uploaded. This format ensures all necessary metadata and descriptions are included systematically, improving the consistency and quality of submissions.

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In addition to the technical upgrades, we have implemented a user authentication system within the uploader through the Hypha service[5]. This login requirement enhances security and accountability by allowing us to track who submits each model, ensuring a transparent chain of custody and facilitating follow-ups if needed.

Another pivotal advancement is the introduction of the "Pending Uploads" system. This new workflow replaces the previous method of using GitHub pull requests for submissions. Now, once a user submits a model, it enters a pending state awaiting review. This allows our reviewers at the BioImage Model Zoo to conduct a preliminary submission assessment. They can verify the completeness and readiness of the model, dataset, or application and its documentation for inclusion in the Zoo. This step significantly refines the approval process, making it more streamlined and manageable, ensuring only fully vetted and compliant models are published.

These improvements collectively enhance the usability, security, and efficiency of the model submission process, aligning with our goals to make the BioImage Model Zoo a more accessible and reliable resource for the scientific community.

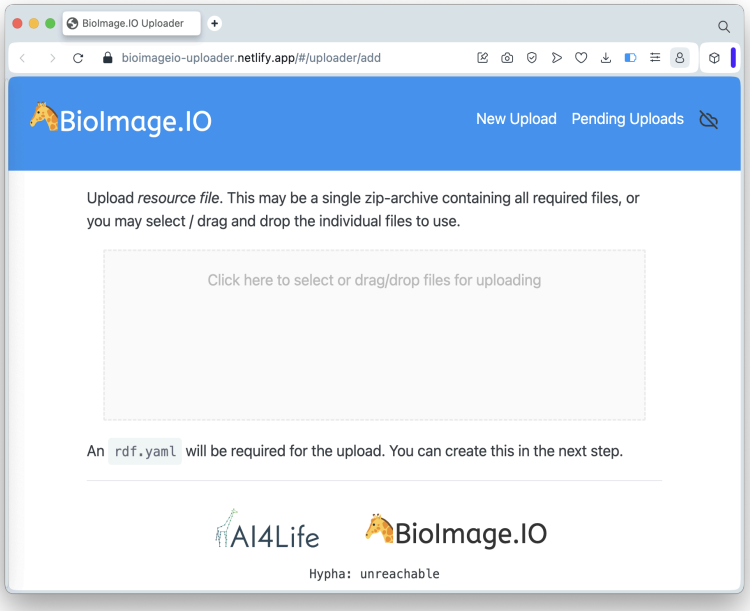

Figure 2: Screenshot of the Model Uploader of the BioImage Model Zoo. The image shows the enhanced portal for uploading resources (models, applications, datasets or notebooks) as a single zip archive or individual files.

[5] https://ha.amun.ai/#/

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ZeroCostDL4Mic

ZeroCostDL4Mic[6] has integrated more notebooks compatible with the BioImage Model Zoo, enhancing the diversity of DL approaches available for the life sciences community. This tool now supports a broader number of user-friendly notebooks to guide non-expert researchers through model training and evaluation and to export trained models in the BioImage Model Zoo format. Some notebooks are also equipped to fine-tune models from the BioImage Model Zoo and export them back to the BioImage.IO format. These functionalities facilitate broader dissemination and collaborative improvement of the model collection in the Zoo

Currently, ZeroCostDL4Mic can operate with the following models in the zoo:

BioImage Model Zoo runnable models (inference):

- Cell Segmentation from Membrane Staining for Plant Tissues `(humorous-owl)`
- B. Sutilist bacteria segmentation- Widefield microscopy - 2D UNet `(placid-llama)`
- Arabidopsis Leaf Segmentation `(non-judgemental-eagle)`
- Neuron Segmentation in 2D EM (Membrane) `(creative-panda)`
- 2D Enteric Ganglia segmentation U-Net `(committed-turkey)`

Models capable of being fine-tuned and exported to the BioImage Model Zoo format

- StarDist 2D
- UNet 3D
- UNet Multilabel

Models capable of being exported to the BioImage Model Zoo format

- Pix2Pix
- UNet 2D

DL4MicEverywhere

DL4MicEverywhere[7] significantly extends the capabilities of ZeroCostDL4Mic by encapsulating user-friendly DL-based workflows to facilitate their reproducibility across platforms—from personal devices to high-performance and cloud-based systems.

Aligned with Work Package 4 deliverables, DL4MicEverywhere provides standards and a framework for containerisation of DL workflows, including those in ZeroCostDL4Mic

[6] von Chamier, L., Laine, R. F., Jukkala, J., Spahn, C., Krentzel, D., Nehme, E., ... & Henriques, R. (2021). Democratising deep learning for microscopy with ZeroCostDL4Mic. Nature communications, 12(1), 2276.

[7] Hidalgo-Cenalmor, I., Pylvänäinen, J. W., G. Ferreira, M., Russell, C. T., Saguy, A., Arganda-Carreras, I., ... & Gómez-de-Mariscal, E. (2024). DL4MicEverywhere: deep learning for microscopy made flexible, shareable and reproducible. *Nature Methods*, 1-3.

notebooks or example bioimageio.core example notebooks. Doing so enhances the reproducibility of the Model Zoo without the barriers related to software installation and dependency incompatibilities.

JDLL

The Java Deep Learning Library (JDLL)[8] represents a significant advancement in the functionalities of deeplcy and deeplmageJ by enabling these tools to support a multitude of DL frameworks. This modularity is crucial as it simplifies the user experience, allowing for high-level interactions with various AI models without the necessity for deep technical knowledge of the diverse underlying frameworks. By abstracting the complexities of model integration, JDLL makes powerful DL tools more accessible to a wider range of users within the life sciences community.

JDLL's integration capabilities are particularly valuable in connection with the BioImage Model Zoo. It enables deeplcy and deeplmageJ to seamlessly interact with and use the models hosted on the BioImage Model Zoo, facilitating a straightforward implementation process for users who wish to apply these models to their imaging tasks. This feature dramatically enhances the usability of the Model Zoo's resources, bringing advanced AI tools into routine laboratory use without the barriers that typically accompany such advanced technologies.

deeplmageJ

A recent preprint[9] has highlighted substantial enhancements in deeplmageJ, which were made possible through the development of JDLL. These improvements include support for additional DL engines and more robust model handling capabilities. This expansion not only improves the performance and flexibility of deeplmageJ but also its integration with the BioImage Model Zoo.

With JDLL, deeplmageJ now offers improved interoperability with models from the BioImage Model Zoo, ensuring that the latest and most effective DL models are readily available to researchers. This integration supports a dynamic update and utilisation cycle, where deeplmageJ can automatically accommodate new models as they are added to the Model Zoo. Moreover, the enhancements allow users to effectively customise and tune these models to their specific research needs, thereby optimising the analytical outcomes.

[8] García López de Haro, C., Dallongeville, S., Musset, T., Gómez-de-Mariscal, E., Sage, D., Ouyang, W., ... & Olivo-Marin, J. C. (2024). JDLL: a library to run deep learning models on Java bioimage informatics platforms. Nature Methods, 21(1), 7-8.

[9] Fuster-Barcelo, C., Garcia Lopez de Haro, C., Gomez-de-Mariscal, E., Ouyang, W., Olivo-Marin, J. C., Sage, D., & Munoz-Barrutia, A. (2024). Bridging the Gap: Integrating Cutting-edge Techniques into Biological Imaging with deeplmageJ. bioRxiv, 2024-01.

By facilitating these interactions, JDLL and deepImageJ not only advance the computational capabilities at the disposal of researchers but also strengthen the collaborative ties within the BioImage Model Zoo community. This synergy fosters a richer development environment and promotes continuous improvement and innovation in the field of biological image analysis.

BioImage.IO Chatbot

The launch of the BioImage.IO Chatbot[10] represents a significant advancement in user engagement within the AI4Life project. Initially developed to simplify access to extensive documentation, the chatbot now enables interactive queries to the BioImage Model Zoo and facilitates real-time image analyses using its models. This interaction provides users with instant feedback on how various models perform with their specific data sets (Figure 3).

Documentation Navigation

The BioImage.IO Chatbot significantly facilitates documentation navigation for Community Partners associated with the BioImage Model Zoo. By providing a user-friendly interface, the chatbot allows easy access to detailed documentation, enhancing partners' understanding of model specifications and functionalities. This interactive tool efficiently guides users through the diverse resources of the BioImage Model Zoo, promoting a more intuitive and engaging experience in finding and using the information necessary for their research and development activities.

Model Query Functionality

Thanks to the code generation and execution capabilities, the BioImage.IO Chatbot is able to efficiently query and retrieve information about available models of the BioImage Model Zoo. Each model of the zoo is accompanied by its RDF, which the Chatbot can access to extract essential or requested information.

For instance, users can inquire about models that use a specific architecture like StarDist, or seek models tailored for particular tasks like image classification. The chatbot parses the tags and metadata contained in the RDF files to deliver precise answers, streamlining the process of navigating and exploring the model offerings. This integration simplifies the user experience, enabling efficient discovery and evaluation of models that meet specific research needs.

By facilitating direct and intelligent queries, the BioImage.IO Chatbot not only expedites the search for appropriate models but also enhances the accessibility and utility of the BioImage Model Zoo, making it a more user-friendly resource for the scientific community.

[10] Lei, W., Fuster-Barceló, C., Muñoz-Barrutia, A., & Ouyang, W. (2023). BioImage. IO Chatbot: A Personalized Assistant for BioImage Analysis Augmented by Community Knowledge Base. arXiv preprint arXiv:2310.18351.

Integration with the BioImage Archive

The chatbot's integration with the BioImage Archive extends its functionality, allowing users to access and retrieve relevant datasets seamlessly. This connection supports researchers in efficiently finding and applying the right models and data for their projects directly through an intuitive chat interface. It bridges the gap between data retrieval and model application, enhancing the usability of AI tools in biological research.

Model Integration

The BioImage.IO Chatbot provides robust model integration capabilities, facilitating the execution of advanced bioimage analysis tasks such as running Cellpose on user-provided data. This feature makes it easier to apply complex algorithms directly to personal datasets, enabling users to interactively test and evaluate the performance of models like Cellpose within their specific experimental setups. The Chatbot enhances the user experience by providing this capability, offering direct and practical insights into how specific models can be used for real-world biological imaging challenges.

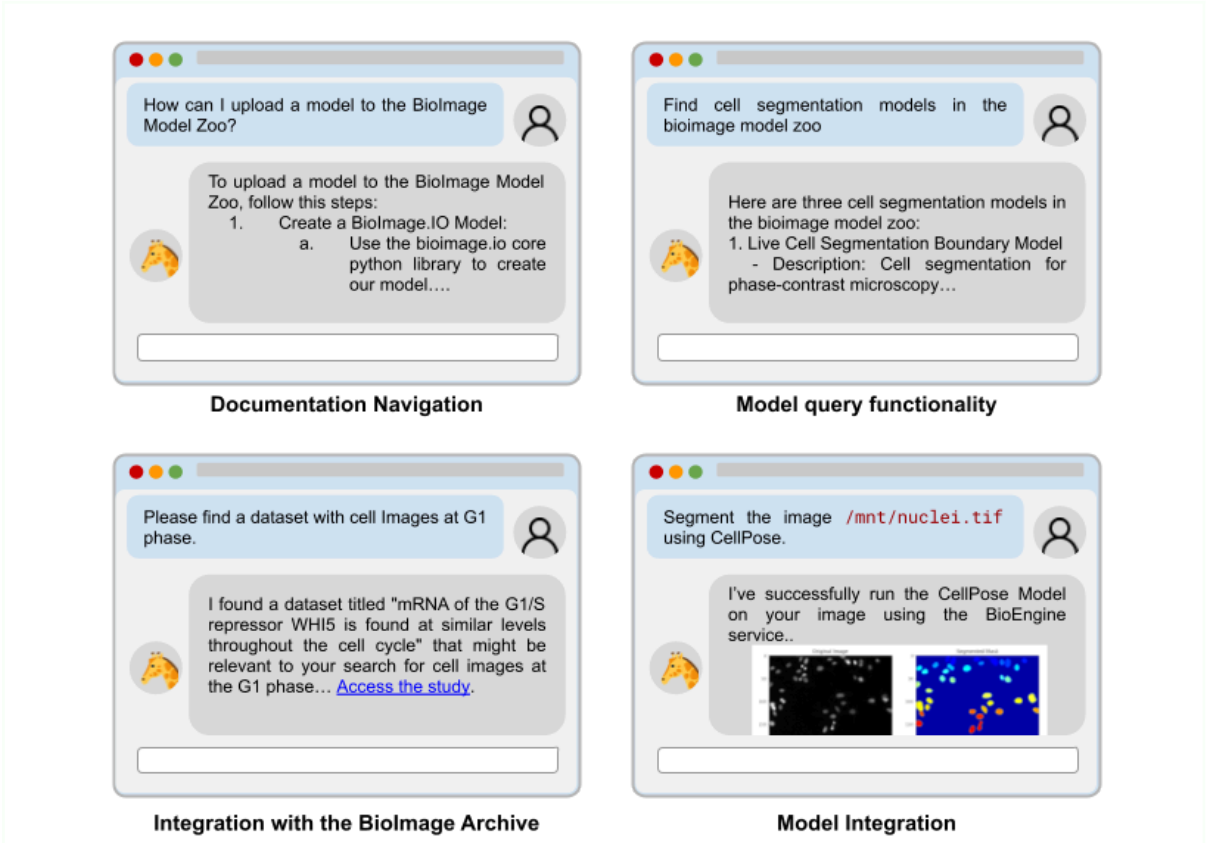

Figure 3: Example usage scenarios of the BioImage.IO Chatbot: documentation navigation, model query functionality, integration with the BioImage Archive, and Model Integration. (Top-left) Illustrates how the

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BioImage.IO Chatbot can navigate through the documentation of the BioImage Model Zoo (as well as for the Community Partners) and obtain the information that the user is looking for in a user-friendly format. (Top-right) The BioImage.IO Chatbot can generate and execute Python code to query information contained in the model's rdf to extract it and deliver it to the user. (Bottom-left) The BioImage.IO Chatbot is integrated with the BioImage Archive and able to navigate through its datasets. (Bottom-right) Users can analyse their own data by mounting a folder in the browser and running CellPose on it.

BiaPy

BiaPy[11] has recently become a Community Partner, enhancing its contributions to the field of bioimage analysis. As an open-source Python library, BiaPy is designed to ease the creation of bioimage analysis pipelines, also known as workflows. These pipelines are key in processing biology microscopy images in both 2D and 3D formats. BiaPy offers a range of pre-built solutions for various tasks, including semantic segmentation, instance segmentation, object detection, image denoising, single image super-resolution, self-supervised learning, and image classification. Using PyTorch as its backend, BiaPy is optimised for DL applications, and it is advisable to use it on a machine with a GPU to enhance training and execution speeds.

A crucial development for BiaPy is its integration with the BioImage Model Zoo. This collaboration enables BiaPy not only to use various models from the BioImage Model Zoo but also to fine-tune these models and export them in the BioImage Model Zoo format. This capability significantly enriches the interaction between BiaPy and the BioImage Model Zoo, showcasing a dynamic example of how advanced models are adapted and applied within the community.

BioImage Model Zoo models connected to BiaPy

- NucleiSegmentationBoundaryModel `(affable-shark)`
- LiveCellSegmentationBoundaryModel `(hiding-tiger)`
- Neuron Segmentation in EM (Membrane Prediction) `(impartial-shrimp)`
- EnhancerMitochondriaEM2D `(hiding-blowfish)`
- MitochondriaEMSegmentationBoundaryModel `(kind-seashell)`
- PlatynereisEMnucleiSegmentationBoundaryModel `(organized-badger)`
- PlatynereisEMcellsSegmentationBoundaryModel `(willing-hedgehog)`
- 3D UNet Arabidopsis Apical Stem Cells `(emotional-cricket)`
- CovidIFCellSegmentationBoundaryModel `(powerful-chipmunk)`
- MitchondriaEMSegmentation2D `(shivering-raccoon)`
- 3D UNet Mouse Embryo Live `(powerful-fish)`
- 3D UNet Mouse Embryo Fixed `(loyal-squid)`
- EpitheliaAffinityModel `(wild-whale)`
- 2D UNet Arabidopsis Ovules `(pioneering-rhino)`
- 2D UNet Arabidopsis Apical Stem Cells `(laid-back-lobster)`

[11] Franco-Barranco, D., Andrés-San Román, J. A., Gómez-Gálvez, P., Escudero, L. M., Muñoz-Barrutia, A., & Arganda-Carreras, I. (2023, April). BiaPy: a ready-to-use library for Bioimage Analysis Pipelines. In 2023 IEEE 20th International Symposium on Biomedical Imaging (ISBI) (pp. 1-5). IEEE.

- 3D UNet Lateral Root Primordia Cells `(thoughtful-turtle)`
- 3D UNet Arabidopsis Ovules `(passionate-t-rex)`
- EnhancerMitochondriaEM3D `(independent-shrimp)`
- EM3DBoundaryEnhancer `(determined-chipmunk)`
- HyLFM-Net-stat `(ambitious-sloth)`
- 3D UNet Arabidopsis Ovules Nuclei `(noisy-fish)`
- 2D UNet for label-free prediction of mCherry-H2B `(noisy-hedgehog)`
- PlantSeg Plant Nuclei 3D UNet `(efficient-chipmunk)`
- EnhancerBoundaryEM2D `(amiable-crocodile)`

Leica's AIVIA Software

A new collaboration between AI4Life and Leica Microsystems has been established to enhance the accessibility of deep-learning models developed by the bioimage community through integration into Leica's AIVIA software. Leica's AIVIA, a sophisticated AI-powered image analysis platform will now incorporate models from the BioImage Model Zoo, facilitating seamless integration and expanding the potential applications of these models in scientific research.

The integration exemplifies a successful industry-academia collaboration, highlighting the potential of open-access resources curated by academia to significantly impact the imaging industry. Models from the BioImage Model Zoo, now accessible in AIVIA, are not only a testament to the utility of these models but also an endorsement of the collaborative efforts to democratize access to AI tools. This initiative supports AI4Life's mission to lower the barriers to using pre-trained models, enabling researchers without extensive computational backgrounds or those relying on commercial platforms to leverage the full power of AI in their image data analysis endeavors.

BioImage.IO Colab

BioImage.IO Colab is an evolving project that enhances collaborative data annotation directly within a web browser facilitated by the integration with the BioEngine[12] – a cloud-based AI model serving platform launched as part of Deliverables D2.1 and D2.2 of WP2 – and Kaibu[13]–a web application for visualizing and annotating multi-dimensional images in the browser–. This initiative supports the safe, interactive annotation of images online, using the web browser, and simultaneously by different users. The BioEngine server management allows for the safe dissemination of images to annotate across users and the transfer back of annotations. Furthermore, users can benefit from pretrained models in the BioImage Model Zoo to practice AI-enhanced interactive annotation: use of a preliminary automatic DL segmentation as a starting point for manual annotation.

[12] https://ai4life.eurobioimaging.eu/announcing-bioengine/
[13] https://kaibu.org/#/app

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BioImage.IO Colab has been enhanced with example notebooks, compatible with Google Colab, (1) to guide users on the construction of their own collaborative annotations system and (2) exemplify the integration of human-in-the-loop for fine-tuning, which aligns with the D4.3 of WP4.

2.2 User-friendly connection with the BioImage Model Zoo

The BioImage Model Zoo plays a crucial role in facilitating user-friendly interactions with diverse models and enhancing the engagement between the community partner tools and end-users. This deliverable focuses on the dynamic interaction capabilities developed to improve how users engage with models hosted on the BioImage Model Zoo.

A central aspect of these enhancements is the flexibility offered by the platform, where each model's functionality—such as inference on new data or fine-tuning—is influenced by the computational engine used during its export and upload to the BioImage.IO website. Additionally, some community partner tools can export models back into the BioImage.IO format, thus perpetuating a cycle of continuous use and improvement. This cyclical interaction ensures that models are not only used but also enhanced and shared across the community.

As depicted in Figure 4, the relationship between the community partner tools and the BioImage Model Zoo is defined by their capacity to interact with the models. This functionality allows users to select the most suitable model and platform for their specific needs. They can even fine-tune existing models from the BioImage Model Zoo with their data and re-upload them, thereby initiating a new cycle of sharing and collaboration. This system fosters a community of practice that enhances the accessibility and applicability of bioimage models, promoting a collaborative ecosystem where innovations and improvements continuously evolve.

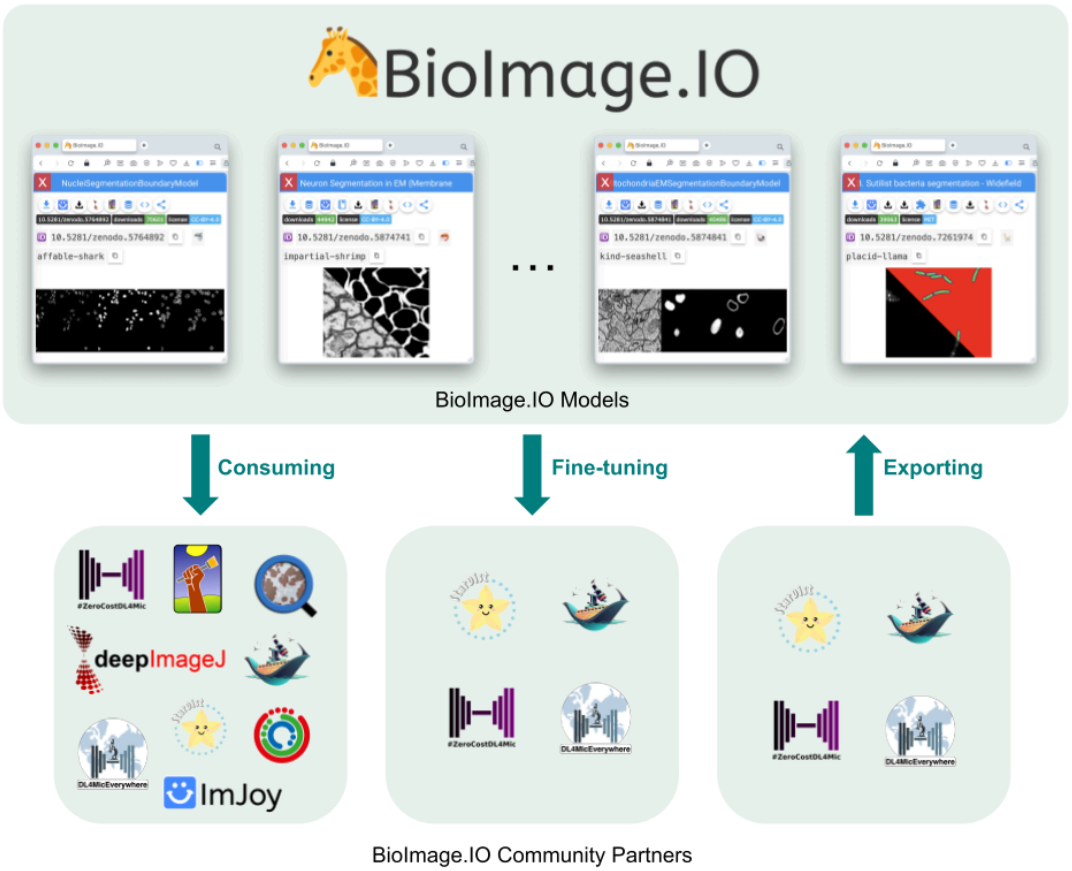

Figure 4: Interaction between the BioImage Model Zoo and Community Partners concerning how each Community Partner engages with BioImage.IO models. The nature of these interactions varies depending on the specific functionalities of each tool or software. For instance, DL4MicEverywhere and BiaPy are equipped with capabilities for fine-tuning models.

2.3 User Engagement and Feedback Incorporation

To enhance our platform, we have actively incorporated user feedback, focusing on making it more reliable, user-friendly, and accessible. We have employed various methods to engage users and gather their insights, which have been instrumental in refining and improving the platform. This section details the diverse forms of user engagement we have used and describes the enhancements made in response to the feedback received.

Image.sc Forum

The BioImage Model Zoo joined the image.sc forum as a community partner in March

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2023. As a Community Partner, we have the advantage of a dedicated tag[14] on the forum, allowing users to direct questions specifically to us (we have received 8 questions so far). This feature is particularly beneficial as it ensures immediate notifications of inquiries, which helps us to respond promptly. The forum serves as a communication channel, providing a public platform where the entire community can view and benefit from shared questions and answers. This openness is important for an open-source project like ours, as it allows anyone, not just those directly affiliated with the BioImage Model Zoo, to contribute answers. Utilizing the Image.sc forum, as a tool for feedback collection enables us to gather and integrate community insights, driving improvements across our platform.

Typeform

"Hi there, have questions or suggestions for BioImage.IO? Pop us a message" Through our dedicated Typeform[15], users have the option to contact us privately for assistance or to discuss potential collaborations. Since it was launched, we have been contacted 32 times. This method represents our most direct form of communication with users. While it is available for everyone, it is not our primary recommended channel for interaction; we generally encourage more transparent communication to facilitate open feedback. Nonetheless, Typeform remains a valuable tool for those who prefer a more confidential approach to reaching out.

Feedback form

We have recently introduced a new feedback form using Google Forms, which is designed to collect insights on user interactions with the BioImage Model Zoo (we have received 6 filled forms so far). This form is crafted to assess how users perceive and use the platform, with questions covering aspects such as the user's role, how they discovered the project and their evaluations of its accessibility and documentation. This form is conveniently located in the footer of the webpage to facilitate easy access and includes two distinct sections: one for users who primarily download and apply models within their own code or via a community partner software, and another for model producers who upload their models to the BioImage Model Zoo (Figure 5). The goal of this feedback form is to capture a range of perspectives, enabling us to continuously reassess and enhance the accessibility and functionality of the BioImage Model Zoo.

[14] https://forum.image.sc/tag/bioimageio
[15] https://oeway.typeform.com/to/K3j2tIt7?typeform-source=BioImage.IO

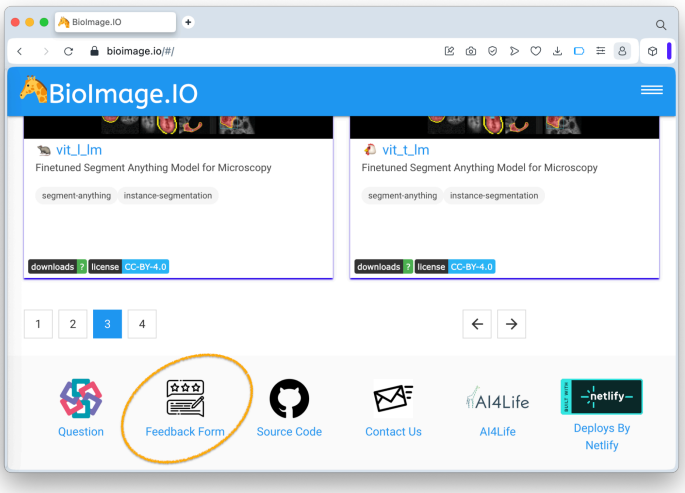

Figure 5: Incorporation of a Feedback Form to the BioImage Model Zoo website. At the footer of the BioImage.IO, a direct link to access the Feedback Form.

The responses received through the Google form, offered diverse perspectives and highlighted the need for improvement in our documentation and webpage. For instance, there is a clear need for a simplified guide on how to run BioImage Model Zoo models using Python code. We encourage the community to fill in the Google Form through social media and networking events to keep improving the website and documentation based on users' feedback.

GitHub Issues

GitHub issues serve as a crucial platform for collecting feedback and addressing inquiries or issues related to the BioImage Model Zoo, including concerns with models or the website itself. This tool is extensively used both as an internal task management system and as a means of engaging with the broader community, as reflected by their number (bioimage.io, 73; spec-bioimage-io, 36; JDLL, 8; core-bioimage-io-python, 51; bioimage-io-resources, 10; collection, 10). The open issues are handled by the Consortium and, when needed, in the BioImage Model Zoo weekly meetings. It is one of our primary methods for communication and feedback collection, proving to be highly effective for tracking and resolving issues raised by both team members and external users. This system allows us to maintain a clear and organised approach to improving the BioImage Model Zoo and responding promptly to community needs.

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Courses and Training

Courses and training sessions provide a vital opportunity for collecting user feedback. AI4Life has participated in more than 100 courses and training events, including dissemination events, so far. By engaging directly with users in educational settings, we gain valuable insights into their experiences with our tools and their effectiveness. This direct communication simplifies the process of gathering feedback, allowing us to quickly identify and address areas for improvement. For instance, during these sessions, we often gather actionable feedback through discussions and direct interactions, which can be as detailed as specific issues[16] raised by users. These insights are instrumental in refining our offerings and enhancing user satisfaction.

Events organised by AI4Life

We would like to highlight a couple of the events that AI4Life organised here. Namely, AI4Life participated in the 5th NEUBIAS Conference in Porto, Portugal, in May 2023[17]. It was a two-part event comprising the 'Defragmentation Training School and the Open Symposium'. The Training School was designed for the new generation of BioImage Analysts. It was focused on the development of workflow based image analysis and new integrated methods for cloud computing applied to life sciences. The Training School was supported by EOSC-Life, Euro-Bioimaging, AI4Life and i3S. The Open Symposium focused on recent scientific developments and open tools in bioimage analysis. There was a special session for AI4Life, covering Deep Learning-related topics.

A significant event that took place from June 10th to 14th, 2024, at Universidad Carlos III de Madrid[18], organised by AI4Life, greatly facilitated user engagement and feedback collection. The first segment of this event was a two-day workshop (June 10th-11th) attended by approximately 60 participants, primarily life scientists and biologists. This workshop showcased the BioImage Model Zoo along with tools from the community partners, such as BiaPy. The event then transitioned into a Uploathon from June 12th to 14th, conducted in a smaller, more focused setting with about 15 participants. This portion allowed for a deeper exploration of the BioImage Model Zoo and hands-on testing of tools like ZeroCostDL4Mic and BiaPy to retrain and upload models to the BioImage Model Zoo.

Direct and continuous communication with the participants throughout these sessions enabled the collection of substantial feedback. A prominent concern addressed was the ability to retrain BioImage Model Zoo models with data brought by the participants. As a result, recent efforts, particularly with BiaPy, have been directed towards enhancing the

[16] https://github.com/bioimage-io/BioImage.IO/issues/344
[17] https://ai4life.eurobioimaging.eu/neubias-conference-2023/
[18] https://ai4life.eurobioimaging.eu/event/workshop-hackathon-uploathon-madrid/

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capability to fine-tune 25 models[19] from the BioImage Model Zoo, reflecting our responsiveness to user needs.

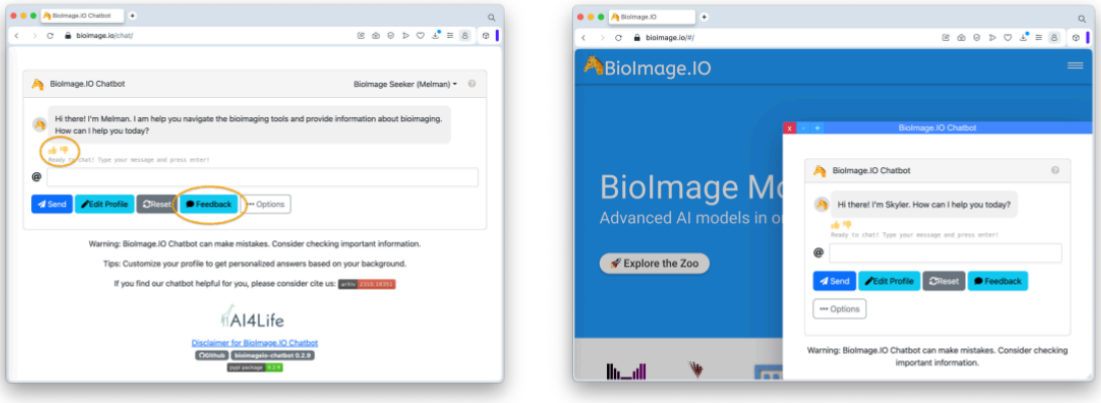
BioImage.IO Chatbot

The BioImage.IO Chatbot incorporates several features designed to enhance user engagement. Each time users interact with the chatbot, they have the option to provide immediate feedback by selecting a thumbs up or thumbs down, indicating their satisfaction with the responses they receive. Additionally, users can offer more detailed feedback via a dedicated feedback button. Our team meticulously analysed this input to understand user satisfaction and determine the necessity of incorporating suggested improvements directly into the chatbot.

It is important to recognize that the Chatbot's knowledge base is heavily reliant on existing documentation, particularly from the BioImage Model Zoo. Therefore, feedback not only helps in refining the chatbot's performance but also serves as an indicator of the effectiveness and clarity of our documentation. If feedback suggests confusion or dissatisfaction with the content itself, it provides valuable insights into potential areas where the BioImage Model Zoo or Community Partner's documentation may need enhancements to better meet user needs. This process underscores our commitment to continuous improvement and effective user support.

Furthermore, the BioImage.IO Chatbot has been integrated into the Help Desk section, accessible directly through the BioImage Model Zoo webpage (Figure 6). This integration positions the chatbot as a vital tool for assisting users in navigating through documentation and models, enhancing user engagement, and simplifying access to necessary resources.

[19] Models capable of being fine-tuned in BiaPy in Section 2.1 Implementation of Zero_Code tools - BiaPy



BioImage.IO Chatbot Feedback

BioImage.IO Chatbot Integration in the BioIamge Model Zoo

Figure 6: The BioImage.IO Chatbot showcasing its various feedback mechanisms and its role as a Help Desk integrated within the BioImage Model Zoo website.

Documentation Restructuring

The documentation[20] for the BioImage Model Zoo has undergone a comprehensive restructuring to enhance user accessibility and navigation. Feedback from various sources indicated that the previous documentation was overly detailed and structured, leading to complexity and user difficulty in locating specific information. In response, we have streamlined the number of sections, focusing on expanding each section comprehensively.

New sections such as the "Help Desk" have been introduced, featuring a Glossary and Frequently Asked Questions (FAQ) to assist users in quickly finding answers to common queries. The layout has been organised to segregate information based on user needs, such as distinct guides for users, developers, and tools from community partners. This separation ensures that users looking to engage with models through the community partner tools can easily access relevant information without sifting through unrelated content.

A significant aspect of the rework was to clearly delineate the different roles and participation methods within the BioImage Model Zoo. This clarity aims to prevent confusion among users, whether they intend to consume models, contribute as a community partner, or document a model. Overall, the goal of this documentation

[20] https://BioImage.IO/docs/#/

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overhaul is to make the information more user-friendly and tailored to specific user interactions, as illustrated in Figure 7.

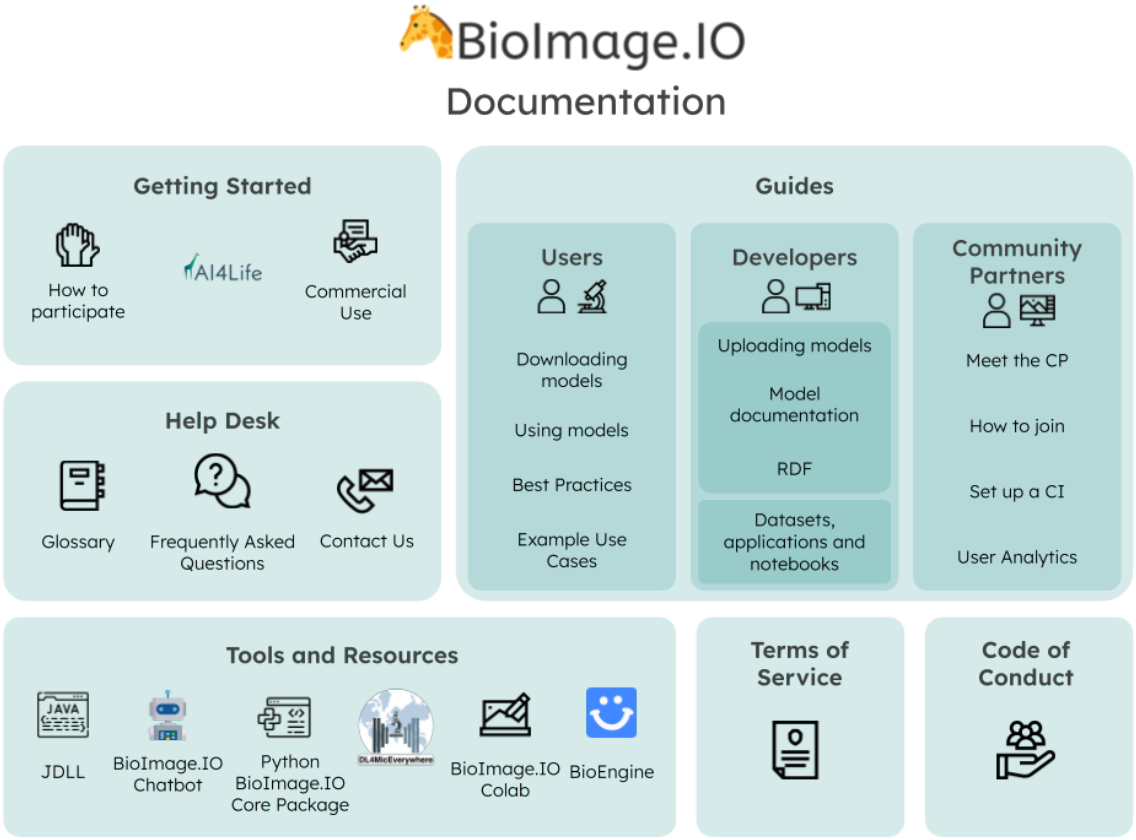

Figure 7: Diagram illustrating the reorganisation of the BioImage Model Zoo documentation. This figure demonstrates how information has been organised into distinct sections to streamline the process of finding relevant information while minimising confusion with unrelated content from other roles within the BioImage Model Zoo.

Model Upload

In response to user feedback and recent updates to Zenodo, we have developed a new, more user-friendly method for uploading models. This improved process, which is more accessible, has been detailed previously in Section 2.1. The enhancements are a direct result of the invaluable feedback collected from users, particularly during courses and training sessions. These sessions have provided critical insights that have allowed us to simplify and refine the upload process, making it significantly easier for users to engage with and contribute to the BioImage Model Zoo.

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3. Conclusion

The enhancements and developments of zero-code tools described in Deliverable D3.2 represent a significant advancement in making DL tools more accessible and functional within the BioImage Model Zoo. This deliverable highlights significant advancements achieved through the development of new tools like the BioImage.IO Chatbot, DL4MicEverywhere, and BioImage.IO Colab, as well as enhancements to existing tools such as deepImageJ. Additionally, integrating new community partners like BiaPy has further enriched the toolkit available. These developments ensure that all tools provide a user-friendly interface with the BioImage Model Zoo and can be readily accessed and used by end-users through the BioImage.IO web page.

We have significantly enhanced our user engagement and feedback incorporation mechanisms. By actively employing various interactive platforms and direct communication channels such as the BioImage.IO Chatbot, workshops, and the Image.sc forum, we have gathered invaluable user insights. These feedback loops have been crucial in refining the usability and functionality of our tools, ensuring they meet the evolving needs of the community. This continuous engagement not only fosters a collaborative atmosphere but also drives the ongoing enhancement of our offerings, reinforcing our commitment to user-centred development within the AI4Life project.

These improvements have streamlined the integration of AI tools into the life sciences community, allowing researchers to easily adopt and apply these advanced methods in their work. By reducing the complexity and technical barriers associated with these tools, WP3 has broadened the potential applications of AI in biological research, empowering scientists to tackle more complex questions and scenarios.

In conclusion, the progress detailed in Deliverable D3.2 not only supports the technical growth of AI applications in life sciences but also reinforces the collaborative framework within which these tools are developed and improved. This ensures that the BioImage Model Zoo remains a vital, evolving resource for the global scientific community, driving forward the innovation and application of AI in life science research.

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