Final scientific report
Scientific Exchanges

The final scientific report must be submitted no later than one month after the end of the Scientific Exchange. The report can be short but must address the following.

1. General information

Grant number: IZEZ0_221844

Project title: Sharing and Curating Open Data in Musculoskeletal Imaging Research

Beginning of the Scientific Exchange: 15 January 2024

End of the Scientific Exchange: 18 January 2024

Funded participants (for events); visiting/host researcher (for visits): 20

(The name of supported persons have to be reported in "Collaboration" section of the Output Data)

2. Description of the Scientific Exchange

2.1 Activities

Briefly describe the activities that were conducted as part of the Scientific Exchange. Explain any deviation from the original plan.

The activities conducted in the four day workshop included:

- *Presentations by the participants*: In the first day of the workshop, after an introductory presentation by Serena Bonaretti, there were two scientific presentations: "Developing a repository for metadata: the SPECTRA experience" by Sarah Manske, and "Collaborative lifelong learning for MR image segmentation with Dafne: a reproducible research project" by Francesco Santini.
- *Working sessions*: We divided into 4 working groups, each of them working on a specific topic: MSK data file and format organizations; guidelines for data sharing in MSK imaging; file formats for biomechanical simulations; and file readers and writers for High Resolution computed tomography (CT). The working sessions started on the first day of the workshop, and continued until the last day.
- *Presentations by invited guests*: During each of the first three days of the workshop, we hosted an invited talk in the afternoon. The talks were: "Data Sharing for the CHAIMELEON project" by Ricard Martínez (University of Valencia), remote; "Open is not enough" by Tim Smith (CERN) at Schulthess Klinik; and "The SPHN data-enabling framework: From routinely collected healthcare to FAIR research data" by Katrin Crameri (Swiss Institute of Bioinformatics) and Patrick Hirschi (University Hospital Zurich) at Balgrist Hospital.
- *Conclusive session*: On the last day, we concluded the workshop with a thorough discussion, where we defined the next steps for the scientific activities that started during the workshop.
- *Guided tours of Balgrist Campus and Schulthess Klinik*: On the first and second day, we organized guided tours of the hosting infrastructures.

There were no major changes with respect to the original plan. The only change was the reduction of the presentation sessions by the participants from two (planned on the afternoons of the first and second day) to one (conducted on the afternoon of the first day). The motivation was to prioritize the creation of new material.

2.2 Results

Detail the results obtained and their significance.

The workshop was extremely productive. We started 4 new projects that are meant to support musculoskeletal (MSK) imaging researchers in sharing and curating open data:

- ORMIR-MIDS: Python package to organize MSK imaging folders and files according to a defined standard based on BIDS[1]. We reached consensus on the name of the Python package and on the imaging modalities to be included–various acquisition modalities of Computed Tomography and Magnetic Resonance (MR) imaging. In addition, we decided to follow the BIDS structure about subject and session levels, and to add the imaging modalities as subfolders. We also decided to store participants' information in tabular format, and to use Nifti as file format for images. Lastly, we started creating documentation for users and for developers
- Guidelines for data sharing: We created guidelines including: resources and examples of informed consent language used to prospectively acquire consent for data sharing; resources and examples of data use agreements for sharing of research data between institutions; a list of recommended image data repositories; resources and guidelines for data de-identification, and description of meta-data structure
- File formats for finite element simulations: We chose HDF5 (Hierarchical Data Format) to store and organize large amount of multi format data, and we integrated HDF5 with the existing pipeline in Ciclope, a package for micro finite element models from micro CT for assessment of mechanical properties of biological or artificial specimen.
- File readers and writers for High Resolution CT: We created tutorials to learn how to read, manipulate, and write .aim files–.aim is a proprietary file format provided by an imaging scanner producer. Because of this work, .aim files can now be handled with open source software. Images are converted into an open source file format (.mha) and metadata are extracted from the image header to store the image characteristics, including calibration factors.

2.3 Output data

Indicate on mySNF which outputs have resulted or are foreseen to result from the Scientific Exchange.
Under ***Output data → "Collaboration", make sure to list every person (including institution and country) supported within the Scientific Exchange grant*** *(the SNSF requires this information for its statistics).*

The output of the workshop consisted of new documentation and/or new code openly shared in GitHub repositories. For each project, find below a tabular representation of links to documentation, links to GitHub repositories, and their authors:

Project	**Link to Documentation**	**Link to GitHub repository**	**Authors**
ORMIR-MIDS (data and metadata structure standardization)	[presentation] https://github.com/ORMIRcommunity/2024_2nd_ORMIR_WS/blob/main/presentations/ormir_mids.pdf	https://github.com/ormir-mids	A. Cina, D. Cameron, F. Chiumento, F. Santini, G. Iori, J. Hirvasniemi, M. Monzon, S. Matuschik, S. Bonaretti, Y. Lee,
Guidelines for data sharing	https://github.com/ORMIRcommunity/ormir_index_guidelines/tree/main/_build/html	https://github.com/ORMIRcommunity/ormir_index_guidelines	S. Manske, K. Stok, F. Taddei, V. Stadelmann, A.K.O. Wong, A. Burghardt
File formats for finite	[presentation]	To be released soon	G. Iori, M. Pani, G.

[1] https://bids.neuroimaging.io/

element simulations	https://github.com/ORMIRcommunity/2024_2nd_ORMIR_WS/blob/main/presentations/biomechanics.pdf		Fraterrigo, G. Crimi, M. Wesseling, F. Galbusera, L. Grassi
File readers and writers for High Resolution CT	[Jupyter notebooks] https://github.com/OpenMSKImaging/vtkbone/tree/master/Tutorials	https://github.com/OpenMSKImaging/vtkbone/tree/master	M. Walle, D. Whittier, S. Poncioni, B. Matheson, J. Quintiens

All the participants to the workshop are listed under “Collaboration” in the “Output Data” section in mySNF.

3. Partnership aspects

3.1 Added value for the Swiss side

Describe the added value generated by the exchange for the Swiss participant/side.

The Swiss participants were seven from four institutions: F. Santini from University of Basel; V. Stadelmann, F. Galbusera, A. Cina, and M. Monzon from Schulthess Klinik (Zurich); S. Poncioni from University of Bern; and S. Bonaretti from Balgrist Campus (Zurich). The workshop allowed the Swiss-affiliated participants to create collaborations within Switzerland and internationally. For example, Francesco Santini and Vincent Stadelmann have already started collaborating on data processing for musculoskeletal imaging. In addition, the international participants had the opportunity to get to know some of the major Swiss MSK Research institutions, thus establishing new collaborations for the future.

3.2 Further collaboration

Indicate further planned collaborations resulting from the Scientific Exchange.

The four groups will continue collaborating to finalize the started projects throughout 2024. The concluded projects will be then presented during the 24th International Quantitative Musculoskeletal Imaging (QMSKI) workshop during the evening workshop entitled “Why and How sharing MSK imaging data”, which will be held on Tuesday, November 5. The remaining steps for the various projects are:

- ORMIR-MIDS: Completion of documentation for users and developers and extension to other MR sequences and CT acquisition modalities
- Guidelines for data sharing: Completion of the ebook with further examples and final editing, and hosting on a website
- File formats for finite element simulations: Integration of reading and visualization tools for HDF5 outputs from ParOSol, a new finite element solver that is currently being integrated in the computational pipeline of Ciclope
- File readers and writers for High Resolution CT: Creation of interfaces of this file reader with other existing packages for analysis of high resolution CT.