

Data Analysis in Imaging: The journey from focussed interest group to full RMS section

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Summary

One of the fastest growing areas within the UK microscopy community is the analysis of imaging data. This article describes the formation of the **Data Analysis in Imaging (DAIM)** section of the Royal Microscopical Society (RMS), formed to represent the interests of RMS members in this rapidly expanding field. The need for a cohesive community of scientific image data analysts is highlighted to develop and disseminate rapid technological advancements, and to bring together disparate fledgling communities across a range of scientific domains. Previous initiatives to build such communities, such as **NEUBIAS** and the **RMS Image Analysis Focussed Interest Group**, are described, and the **DAIM** section is introduced, explaining its short and long-term goals to contribute to the international community of scientific image data analysts.

Identifying community needs

Recent years have seen astonishing advances in imaging and microscopy across many scientific domains. Innovations in both technologies and techniques have given rise to datasets with ever-increasing scale and complexity, promising to permit deeper insight into many important research questions across the physical and life sciences. However, these innovations have resulted in a vastly increased requirement for complex computational analysis in order to tease hard-earned scientific breakthroughs from these deluges of data.

Different sectors have historically progressed at different rates, driven largely by the domain-specific technological and experimental demands of their imaging workflows and the size of their communities. For example, within the life sciences, fluorescence microscopy in its various flavours has benefited from a very large community of practitioners, leading to many bioimage analysis advances being pioneered in this field. However, parallels can frequently be drawn to other imaging modalities, where tools and techniques can be

borrowed and, if necessary, adapted to different types of data. A common example across all imaging techniques is image segmentation, which is often a necessary step to extract quantitative information from images, by separating the objects of interest from the background. Segmentation tools across commonly used platforms (e.g. ImageJ/Fiji and scikit-image) have been deployed across multiple techniques in the life and physical sciences (Figure 1 demonstrates an identical Otsu threshold applied to images using different techniques from life and physical sciences).

In contrast, an all-too-common impediment to efficient image analysis is the widespread practice of inadvertently “reinventing the wheel”, whereby researchers feel driven to write whole analysis pipelines from scratch when tools for some or all of the task already exist. The reasons for this are manifold: limited experience in the field can lead to a lack of familiarity with the literature; the trend of highly innovative and useful image analysis methods frequently being relegated to supplementary information; an unfamiliarity with the way

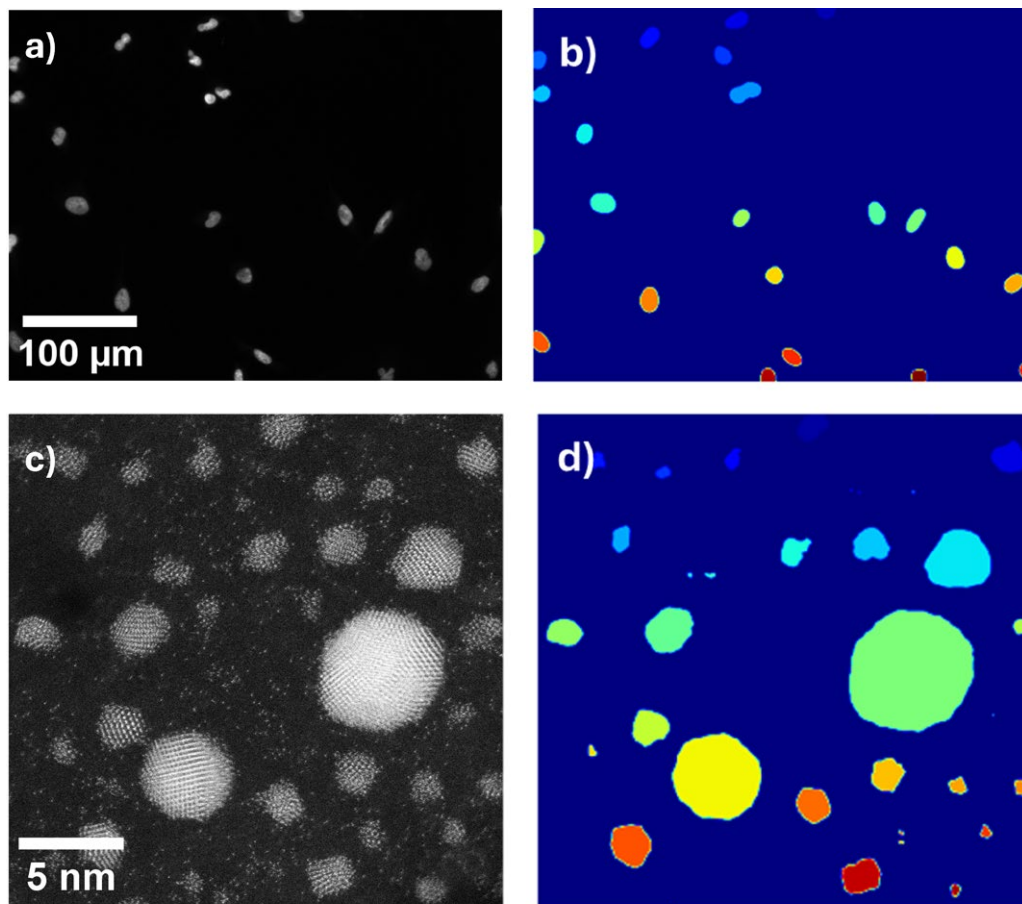


Figure 1. Image analysis is often equivalent between imaging techniques, scales and sample types. a) A fluorescent microscopy image of cell nuclei and b) the corresponding labels segmented using an Otsu threshold using scikit-image, highlighting the objects of interest. c) An annular dark field scanning transmission electron microscopy image of gold nanoparticles and d) the corresponding labels segmented using an Otsu threshold using scikit-image. The image in (a) is part of a public dataset from <https://doi.org/10.1038/sdata.2017.18>.

programmers typically distribute and maintain their software; multiple tools to choose from; and the language barrier that often exists between coders and experimentalists. Taking the example of image segmentation, the application of machine learning techniques has been rapidly expanding in this field, but the training and application of techniques are often repeated for different imaging modalities with no reference to previous applications elsewhere.

This brings up an important requirement for our community, namely the capacity to disseminate techniques and best-practice models as effectively as possible, rather than relying on the unpredictable and notoriously slow diffusion between each scientific discipline.

A success story that image data analysts can use as inspiration is the [Research Software Engineering \(RSE\)](#) community, which built bridges across disciplines and has created a huge network that plays a part in many different scientific fields.

Establishing networks - NEUBIAS

From the life sciences side, a crucial factor in coordinating the disparate group of image analysts into an increasingly cohesive community was the COST funded [Network of European Bioimage Analysts \(NEUBIAS\)](#). This five-year funded programme ran from 2016-2020 and formalised a range of key concepts that were targeted and developed by a set of workgroups. A central aim



Figure 2. Members of the image analysis focussed interest group (IAFIG) with staff at the European Bioinformatics Institute (EMBL-EBI) at a train-the-trainers course for image analysts. Photograph from Dominic Waithe.

was to establish the independent role of “bioimage analyst”, as distinct from the existing subdivisions in bioimaging. Broadly speaking, the role of bioimage analyst acts as a bridge between experimentalists and software developers, providing a means for both communities to benefit from each others’ expertise.

Focusing attention - the Image Analysis Focused Interest Group (IAFIG)

As a result of NEUBIAS, the IAFIG was formed by Dominic Waithe, one of the UK’s management committee representatives for NEUBIAS. Recognising the time-limited funding of the NEUBIAS COST action, the IAFIG was formed to be a long-term continuation of the work established in NEUBIAS, under the umbrella of the Royal Microscopical Society (RMS), the oldest organisation of its kind in the world. By embedding



Figure 3. Tutors and participants at an IAFIG Python for Bioimage Analysis training course in Cambridge in 2019. Photograph from Dominic Waithe.

the group within the established machinery of the RMS, the hope was to raise the profile of the role of image analysis within the Society and the community at large.

The flexibility afforded to RMS Focused Interest Groups allowed the group to rapidly grow and explore the needs of the community, but having come largely from NEUBIAS, this initial group was very strongly biased towards the life sciences. Much of the early activity of the IAFIG was centred around training, including a train-the-trainers course (Figure 2) and a [Python for Bioimage Analysis](#) training course (Figure 3), both in Cambridge.

Focussed Interest Groups and Science Sections in the RMS

Focussed Interest Groups are associated with and supported by the RMS, but do not follow the stricter rules and regulations of the Science Sections. They can be set up for a short period of time for specific activities, or as the first step to becoming a formal section of the Society. The Science Sections act to advise the Society on the latest advancements and developments in their respective fields to enable the RMS to provide the best in training and resources for the community.

Chief Executive of the RMS, Sali Davis, spoke of her vision for the FIGs and Sections overseen by RMS saying “Both FIGs and Sections are the perfect platforms for all communities within our sector to contribute to their professions, to give back in a meaningful way and to support the recruitment and retention of future members of the profession. Our aim as a staff team is to support the functions of the FIGs and the Sections and in doing so further promote and enhance the scientific eco-system in which we work on a national and international basis.”

Data Analysis in Imaging (DAIM)

To follow on from the success of the IAFIG and the foundations laid down by NEUBIAS, the DAIM section was created, demonstrating the RMS’s ongoing commitment to supporting science and scientists in microscopy and imaging.

What's in a name?

To begin with, we should explain why the new section chose the name “Data Analysis in Imaging” (DAIM, pronounced /'daim/), rather than, say, “Image Analysis in Microscopy”. The reason for this was that the committee wanted the section to be as inclusive as possible to the different types of analysis it intended to cover. Since not all data acquired during the process of imaging are images (for example spectra), and medical image analysis often extends to non-microscopy based data (e.g. CT scans), we chose to use DAIM.

Remit

An important distinction between the remit of NEUBIAS and that of the RMS is the broader scientific scope of the latter. Whilst the domain-specific details of the underlying data may be quite different, the computer vision methods employed are generally conceptually rather similar. Being under the umbrella of the RMS gives us the opportunity to link up communities that could really benefit from each other's experience, but that rarely get the opportunity to interact.

In building the first committee for DAIM, we endeavoured to include representation from as many relevant communities as possible. In particular a variety of different imaging modalities across physical, biological and medical domains are represented, as are other types of community including RSE, Early Career Researchers and industry. As a result of this, we ended up being slightly in excess of the usual quota for a Section committee. However, the RMS team, in particular the Chief Executives, Allison Winton and her successor Sali Davis, were very encouraging in allowing us to slightly bend the rules, with the understanding that it is more important to have the right group of enthusiastic people involved at the beginning than to strictly adhere to a quota. This has been particularly important given the very diverse makeup of the committee from across the RMS's remit, reflective of the wide range of disciplines image/data analysts come from, and the

natural turnover of committee members has since brought us back down to the size of a standard RMS Section committee.

The goals of the section

In the short term, the goal of the DAIM section is to gain a better understanding of the state and requirements of the community as it currently exists. To do this, we continue to work with other related communities and initiatives working in the same space. As we better understand these needs, the section is working towards filling any gaps or strengthening ongoing efforts. In practical terms, the DAIM committee addresses these challenges via a number of “Working Groups”, each consisting of a team, drawn from both the committee and the broader community, working together on a focussed task.

One of the most pressing current community needs highlighted by recent surveys is the need for accessible and up-to-date training across a wide range of imaging and analysis domains. A major goal of the DAIM section is to help in the provision of such training, whether developing whole new curricula, or simply signposting to some of the excellent training resources that already exist. In such a dynamic field, we expect that keeping pace with training requirements for new developments will also be a significant challenge, which we hope DAIM will be well placed to tackle. In the following section, we highlight our initial efforts to both determine the training needs of the community and to begin to deliver training in image analysis.

Our long-term goals for the future of DAIM are for the section to evolve to track the needs of the community, in parallel to the rapid advances being made. To do this we will need to build and maintain good relationships with practitioners across a number of different domains. We hope that in the future the DAIM section will be a respected source of advice and experience that the whole community, from experimental scientists through to software engineers, can feel engaged with.

Current activities

The first few DAIM committee meetings were spent identifying some key target areas where we felt that we could effectively contribute. As NEUBIAS and similar initiatives previously demonstrated, the need for accessible high quality training provision is clear, so our first act was to set up a Training Working Group, led by Stefania Marcotti and Dave Barry. This Working Group has been investigating the ever-evolving needs of the community as well as planning and coordinating training materials and activities, including the delivery of courses in the UK and Ireland. To assess these needs, the Working Group teamed up with counterparts in the [Center for Open Bioimage Analysis \(COBA\)](#) and [Bioimaging North America \(BINA\)](#) to conduct a survey of image analysts across the biological and physical sciences. Many important insights were gleaned from this survey and it is expected that this and future iterations will help to steer the direction of activities of DAIM and similar organisations to ensure maximum benefit for the community. The



Figure 4. Graphic from Sivagurunathan et al. showing the distribution of respondents in terms of role, location and domain experience.

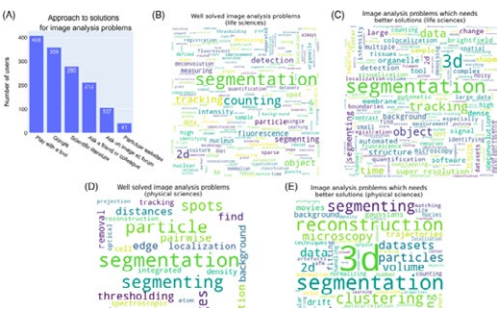


Figure 5. Graphic from Sivagurunathan et al. showing a range of different approaches taken to image analysis (A), and word clouds showing image analysis problems that are well solved in life sciences (B) and physical sciences (C), as well as problems that are in need of better solutions in life sciences (D) and physical sciences (E).

outcomes of this survey can be found in interactive figures at https://coba-nih.github.io/2023_ImageAnalysisSurvey/ (static examples of which are included in Figures 4 and 5).

The outcome of the survey was [published in the DAIM special issue of the Society's Journal of Microscopy](#), along with several other scientific articles focusing on analysis methods. The coordination of this special issue was driven by a working group led by Rocco D'Antuono, working closely with Michelle Peckham, at a time when the Journal has been undergoing a major shift towards Open Access publishing. The Open Science movement has historically been very well adopted amongst scientists working on computational analysis, with open source software and open data being key enabling principles in rapid and transparent advancement of the field. Many practitioners see Open Access publishing as a natural extension of this and the move towards this model will increase the accessibility of the research literature.

The DAIM committee has also been involved in the scientific organisation of the RMS's flagship conferences in recent years, including [MMC](#) and [Frontiers in Bioimaging](#), ensuring that researchers working on the latest analysis techniques are given plenty of opportunities to present their work and interact with their peers from across other domains to foster networking and collaborations.

One of the big success stories of the growth of a lively community over recent years has been the [image.sc](#) forum, which was formed as an amalgamation of several software specific forums and mailing lists. It has rapidly become the go-to place to ask questions and seek advice on many image analysis problems, particularly in the life sciences. Based upon this, and to add another dimension to the networking opportunities, the DAIM committee ran two "image.sc live!" events, led by Dale Moulding and funded by a Crick Networking Fund. The events were run on January 18-19th 2024, and 10-11th April 2024, with experts and participants joining in across

three different time zones (Europe/Africa, North/South America and Australia/Asia). The goal was to extend the traditional written format of image.sc to live virtual events, where people could discuss their problems with experts from around the world in a collaborative multi-user virtual platform (Gather Town, shown in Figure 6). As well as solving analysis problems, this was a good opportunity for experts and novices alike to network with their peers all around the world. Particular efforts were made to include researchers outside of Europe/North America that may have historically had fewer opportunities to interact with the global community.



Figure 6. A view of the “Image.sc Island” on the gather.town platform, as used in the “Image.sc Live!” events led by the DAIM team.

Future

The RMS has some incredible schemes for school outreach, in particular the [Microscope Activity Kits](#) and the [Hitachi Global STEM Outreach Project](#), which have reached over 200,000 students around the UK. The committee has been investigating ways to produce a similarly shareable activity for image analysis, with Stephen Cross taking up the challenge to extend his [MIA workflow builder plugin in Fiji](#) to make it suitable for schools. Although still a work in progress, we are very excited that this could be

an accessible and scalable tool to reach all those budding scientists in schools, see the sneak preview in Figure 7 below!

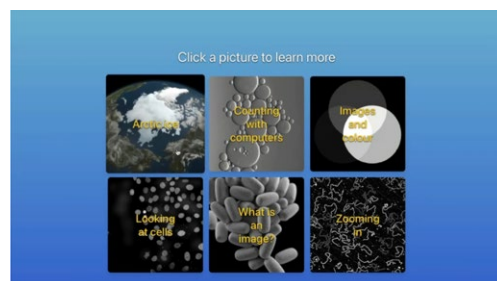


Figure 7. An interactive online tool developed to teach the basics of image analysis to schoolchildren, based upon the ModularImageAnalysis (MIA) Fiji/ImageJ plugin written by DAIM committee member Stephen Cross.

Computational analysis techniques are evolving rapidly, for example the use of AI methods are revolutionising many aspects of research and are likely to continue doing so for some time to come. This makes the DAIM committee a crucial component in keeping the RMS at the forefront of image and data analysis techniques, which are increasingly critical for scientific discovery.

In this article we have outlined the formation of the DAIM section, based on the growing needs of the UK's imaging community. We have highlighted a number of activities that the DAIM section have organised and which are currently under development. The future of microscopy increasingly requires complex image analysis, and the formation of the DAIM section will ensure that the UK remains at the forefront of the field.

