A Survey on Bioimage Analysis Needs, 2015

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Abstract

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Abstract

To quantitatively assess the need for image analysis in biological research, we conducted a bioimaging community-wide survey in 2015. This report summarizes the responses of 1905 researchers to five questions asking how image analysis is important in their research activity, and which type of support is in demand for successfully accomplishing their analysis tasks.

Introduction

Motivation: Image analysis is said to be important in biological research projects especially for those who use modern digital microscope systems. This, however, is based only on subjective accounts. To know the actual needs, a bioimaging community- wide survey was conducted in March 2015 by the startup members of the bioimage analyst network, consisting of 36 researchers from more than 10 countries across Europe.

The Survey: The survey had five questions each with multiple choice for answering, which were compulsory for submitting the response. Two additional question were required to be answered, for knowing the identity of respondent, and two optional text fields were provided for filling in the respondent's name and email address for later purpose, to receive survey results and reports on the progresses of the networking. Supplementary material 1 "The survey details" lists questions and multiple choices used for the survey. We focused at knowing the level of image analysis needs in bioimaging community. We also wanted to know more details such as which software is mostly used, or which types of image analysis technique need support, but we purposely omitted these details to limit the number of questions to cause an increase the number of responses.

Process: The survey was carried out through calls by sending emails through bioimaging related societies at international (e.g. ELMI) and at national (e.g. French Bioimaging, German Bioimaging) levels and were provided with link to the survey web page. Within the first four days, more than 1800 researchers responded already, and a total of 1905 researchers answered to the survey by the end.

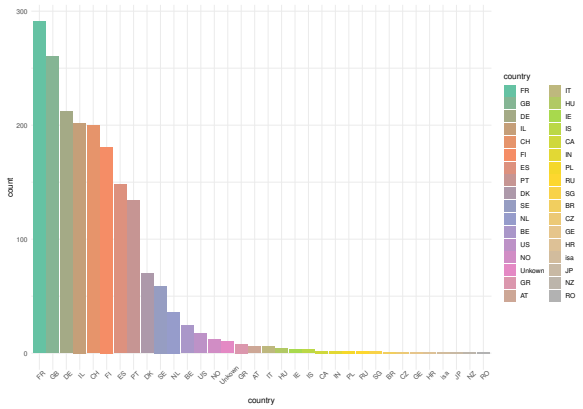

Fig. 1. Which country is your institute located?

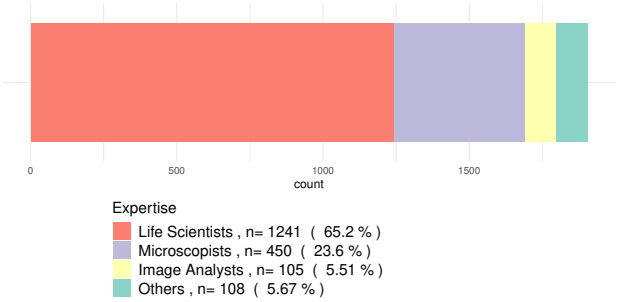

Fig. 2. Your Expertise?

Results

The breakdown of the countries of respondent's affiliation, Fig.1, showed that four countries, France (15.3%), Great Britain (13.7%), Germany (11.1%), and Israel (10.6%) comprised more than half (50.7%) of the total. 35% of responses were from other four countries, Switzerland (10.5%), Finland (9.5%), Spain (7.8%) and Portugal (7.1%), indicating that the summary statistics mostly reflect the research environments in these eight countries. For more detailed figure of the breakdown of countries, please refer to Table 1 in Supplementary material 2, "Breakdown - Locations of Respondents' Affiliation". We also asked respondents to choose their profession from four choices (Fig.2). Majority (65.2%) identified themselves as 'Life Scientist'. On the other hand, a significant proportion of respondents identified themselves as imaging professionals, either in microscopy or in image analysis (29.1%). This proportion is higher than the actual proportion within all researchers in the life sciences community.

These two results indicate the profile of respondents. They

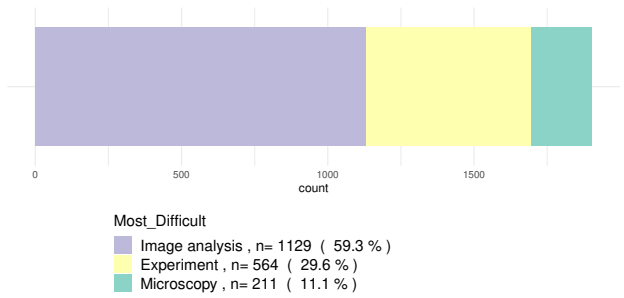

Fig. 3. Question 3: Which step in the imaging based research project is the most difficult for you?

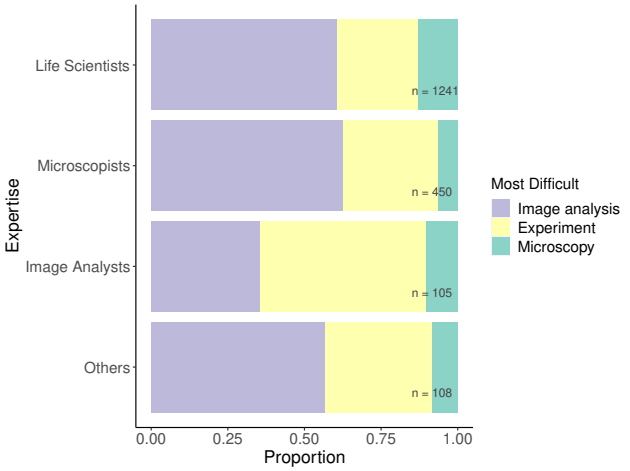

Fig. 4. Question3: Which step in the imaging based research project is the most difficult for you? Split by Expertise

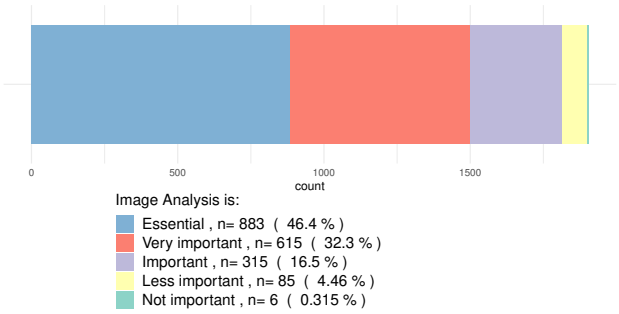

Fig. 5. How important is quantitative image analysis for your imaging project?

were from research institutes equipped with high-end imaging resources and professional imaging staffs supporting their imaging. This corresponds well that eight major countries of the affiliation of respondent are known to have relatively well-organized imaging facilities and also well-trained staffs. It is likely that this is due to the channels we used for calling the survey. As it was informed through mailing lists in bioimaging community, there was an apparent bias by this pre-filtering effect. This bias has pros and cons. Pros: the results reflects the needs of image analysis focused in the population heavily using imaging technique. Cons: the researcher population who has high interest in using imaging techniques in their research but do not have enough access to them are relatively masked from this survey results. Therefore, it is possible that the average environment for image analysis in Europe research institutions could be worse than the results we present in following sections.

A. Image analysis, the most difficult step in bioimaging. Biological research projects involving imaging proceed roughly with three steps. The first step is the experiment e.g. genetic modifications or physiological interventions to biological specimen, the second is to observe and capture images using microscope systems, and the third is the analysis of those images to measure the effect of experiments. By asking a question "Which step in imaging based research project is the most difficult for you?", we aimed at knowing which of those three steps casts difficulty to researchers (Fig. 3).
Results showed that almost 60% of respondents think image analysis is the most difficult step. Note that when the answers are split by expertise, this proportion becomes less with image analysts, but not with the other experts (Fig. 10).

B. Image Analysis is Essential and Very Important.. We also wanted to know how researchers are thinking about the importance of image analysis in imaging projects. In the scale we have given in the survey, almost 80% respondents answered that image analysis is essential or very important in imaging projects (Fig. 5). Not so long ago, microscope images were only to be presented in papers as proofs of signal distributions, overlaps, or presence. On the other hand, recent imaging technique demands quantitative analysis which has lead image analysis to became more central and important. For example, FRAP analysis inevitably needs image analysis. Super-resolution microscopy is build with image analysis algorithms to identify point signals. For these reasons, it is understandable that the majority of respondents think image analysis as an important method in imaging-based researches.

C. 45% supported, 39% lacking support with Image Analysis, while 16% are independent. . We wanted to know how respondents are supported with image analysis in their institution. As we expected that the situation of respondents are various and a simple scaling between poorly to well supported will not fully cover those situations, we designed the multiple- choice for this question to accommodate with those possible variability. The results gave us a valuable figure of the supporting environment for image analysis in the bioimaging community (Fig. 6). Results showed that 45% of respondents had supports for analyzing image, either by professionals in belonging institute, by lab-resident specialist or by company. On the other hand, 38.8% were lacking support, due to lack in sufficient number of professionals or because of the absence of professionals in the surrounding.
Lastly, a quite high proportion of respondents, 15.5%, answered that they do not need support because they could an-

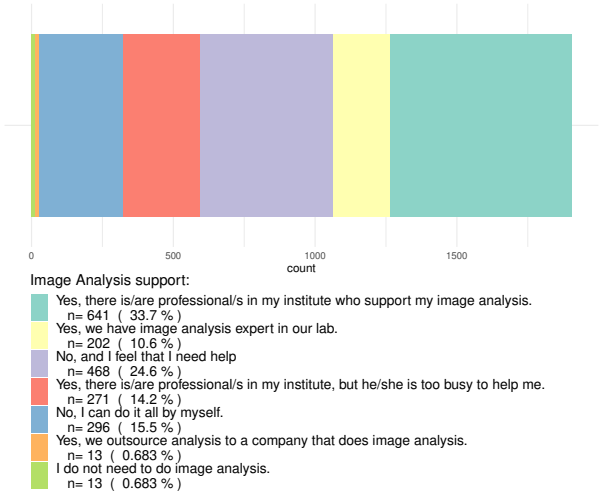

Fig. 6. Are there image analysis experts who support you to do image analysis?

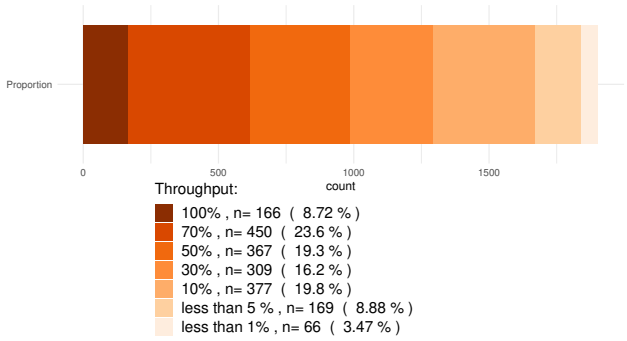

Fig. 7. What is the app. proportion of images that is analyzed vs captured?

alyze by themselves. This is probably not surprising because

1. 5.5% of respondents were image analysis professionals and

2. respondents were mainly from bioimaging community, where most people have some knowledge on image analysis and some of them have sufficient techniques to analyze images independently. Even with such a target population expected to have good imaging literacy, ca. 40% of people were still looking for help.

D. Overall Through-puts of Image Data is ca. 42%. We wanted to know the proportion of analyzed images among images captured by microscopes, because this could be a good measure of the efficiency of image analysis in the bioimaging community. We call this proportion "Through-put" in the following. The answers were broadly distributed between 10% and 70%. By averaging the through-put values weighted by the proportion of answers for each, we estimate that the overall through-put is approximately 42% (Fig. 7).
We should be careful with this estimated through-put for several reasons.
Firstly, the through-put answered by each respondent depends not only on the capability of their image analysis, but

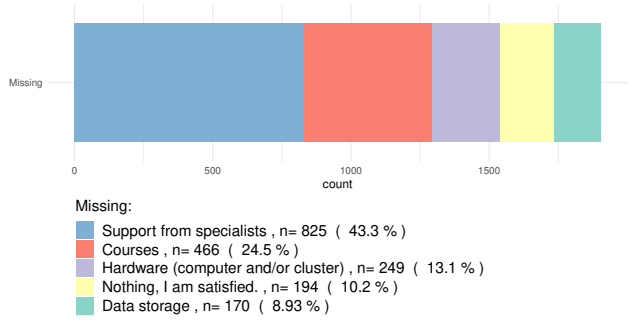

Fig. 8. Which resource do you miss mostly for optimally analyzing images?

also on the design of experiment they are conducting. For example, some projects might be trying to capture rare events in biological systems and take a prolonged time-lapse image sequences. In this case, most of captured images will be discarded without being analyzed because only a small fraction of images with the scene of the rare event is required. On the other hand, with high-through-put imaging methods, both image capturing and analysis are automatized. In this case, quite high percentages of images will be analyzed.
Secondly, there could be some variance in the way people interpret what "image analysis" is. For some people, counting cells visually might already be their "analysis", while for a more stringent analytical researcher, it could mean to identify position of target objects as precise as possible and also to statistically treat the measurement results including plotting. We did not set a strict definition of "analysis", because we were more interested in the estimation of through-put based on definition by each. This had advantage of our estimation to be flexibly coping with various "analysis", but has disadvantage that the real through-put, which may include the full potential of image analysis, is not taken into account. Nevertheless we should note that estimating this latter "real potential" is quite difficult since it requires detailed interview of researchers individually.
Some of image analysis experts saw this result and commented that this estimated through-put (42%) could be too high compared to their daily experiences working with life science projects. In addition, the estimated through-put has two uncontrolled factors mentioned above, variances in experimental design and the definition of "image analysis". We conclude that 42% is a figure based on subjective accounts, and that the number is valid only as a bulk estimation of the through-put of image data analysis in the community.

E. Supports and Courses are the Two Most Missing Resources in Image Analysis. To know what is the most missing resource for accomplishing image analysis, we asked this question and the result is shown in Fig. 8. The answer showed that the support by experts and courses for learning image analysis were the two most missing resources (67.8% together), largely exceeding hardware / storage resources (22%). This result indicates that knowledge on image analysis is largely felt missing in the bioimaging community.

There are 10.2% respondents answering “nothing is needed” and this proportion is roughly equivalent to those answered “no support needed” in the third question (15.5%).

Discussion

The answers to Q1 ("The most difficult step") and Q2 ("Importance of image analysis") strongly indicate that image analysis is thought to be very important, but at the same time the most difficult step in imaging-based projects. At the same time, answers to Q3 ("Support availability") and Q5 ("Missing resource") indicate that supports to overcome this difficulty is missing from about a half of those requiring help (Q3, 38.8%). It could be that this fraction have answered that the most missing resource is support by experts (Q5, Support, 43.3%), and there seems to be more people who do not need direct supports but demanding more for knowledge to tackle the difficulty by themselves (Q5, Courses, 24.5%). Finally, the through-put of analysis was estimated to be ca. 42%, and this through-put could potentially be boosted higher with more supply of knowledge and techniques to the bioimaging community. As the profile of respondents suggest that respondents were mainly from research institutes with relatively better infrastructure for imaging than the average in Europe, we think that there are even more demands for support and courses in the life science community.
As we were interested if there was any difference in the results when we focus only on the answers from life scientists. In short, the answers were with similar proportions even after the filtering (see Supplementary material 3: Results from Life Scientists).

Conclusion

Taken together, the survey showed that there is a strong need for image analysis in the bioimaging community, but image analysis is thought to be difficult due to lack in knowledge and technique, which could potentially be rescued by more supports and courses. More support may increase the overall through-put of image analysis in the bioimaging community.

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  402+8+12 (1/1/0/0) Subsection: Overall Through-puts of Image Data is ca. 42\%
  92+12+10 (1/1/0/0) Subsection: Supports and Courses are the Two Most Missing Resources in Im
  227+1+0 (1/0/0/0) Section: Discussion
  164+1+0 (1/0/0/0) Section: Conclusion


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Supplementary Note 1: The survey details

The questions and provided multiple choices were as follows.
Survey Closes: March 17 (Tue), 2015, 12pm. There are only 7 questions to answer.
Motivation: We thank you for accessing this page. Answering this short survey will help us to better understand the needs of the bioimaging community.
Using your answers we aim to get support for establishing an image analysis community and thereby enhance the through-put and quality of quantitative image analysis in Europe. You will be anonymous by default: we will only use statistics.
If you want to get information afterwards, please tell us your name and email address (optional).

Question 1.. Which step in imaging based research project is the most difficult for you?

- Experiment (genetic engineering, labeling, drug treatments)
- Microscopy
- Image analysis

Question 2.. How important is quantitative image analysis for your imaging projects?

- Essential
- Very Important
- Important
- Less Important
- Not Important

Question 3.. Are there image analysis experts who support you to do the image analysis?

- Yes, there is/are professional/s in my institute who support my image analysis.
- Yes, there is/are professional/s in my institute, but he/she is too busy to help me.
- Yes, we have image analysis expert in our lab.
- Yes, we outsource analysis to a company that does image analysis.
- No, I can do it all by myself.
- No, and I feel that I need help.
- I do not need to do image analysis.

Question 4.. What is the app. proportion of images that is analyzed vs captured? (Help text: We want to know a rough figure of analyzed images over captured images. "Analysis" means quantitative, at least some number is extracted.)

- less than 1%
- less than 5%
- 10%
- 30%
- 50%
- 70%
- 100%

Question 5.. Which resource do you miss mostly for optimally analyzing images?

- Hardware (computer and/or cluster)
- Data storage
- Support from specialists
- Courses
- Nothing, I am satisfied.

Question 6.. You are a:

- Microscopy Specialist (including facility staffs)
- Image Analysis Specialist (including facility staff)
- Life Scientist, not imaging specialist.

Question 7.. Which country is your institute located? (Help text: Please answer by ISO2 code eg. UK, FR, ES, DE, CH... (see http://www.nationsonline.org/oneworld/country_code_list.htm)
[Text Field]

Question 8.. [optional] Your name (Help text: If you want to know the survey results, please put your name and email address. We also will update you with our activity later on.)
[Text Field]

Question 9.. [optional] Your email address
[Text Field]

Supplementary Note 2: Breakdown - Locations of Respondents' Affiliation

Location of Respondents

Country	n	Proportion
FR	291	15.28%
GB	260	13.66%
DE	212	11.13%
IL	202	10.61%
CH	200	10.50%
FI	181	9.51%
ES	148	7.77%
PT	134	7.04%
DK	70	3.68%
SE	59	3.10%
NL	36	1.89%
BE	24	1.26%
US	17	0.89%
NO	12	0.63%
Unkown	10	0.53%
GR	8	0.42%
AT	6	0.32%
IT	6	0.32%
HU	4	0.21%
IE	3	0.16%
IS	3	0.16%
CA	2	0.11%
IN	2	0.11%
PL	2	0.11%
RU	2	0.11%
SG	2	0.11%
BR	1	0.05%
CZ	1	0.05%
GE	1	0.05%
HR	1	0.05%
isa	1	0.05%
JP	1	0.05%
NZ	1	0.05%
RO	1	0.05%

Supplementary Note 3: Results from Life Scientists

We were interested if there is any difference in the answers when we pick up only those from life scientists. In short, there was not much difference. The following stacked-bar charts are made by filtering the answers and focusing only on life scientists.

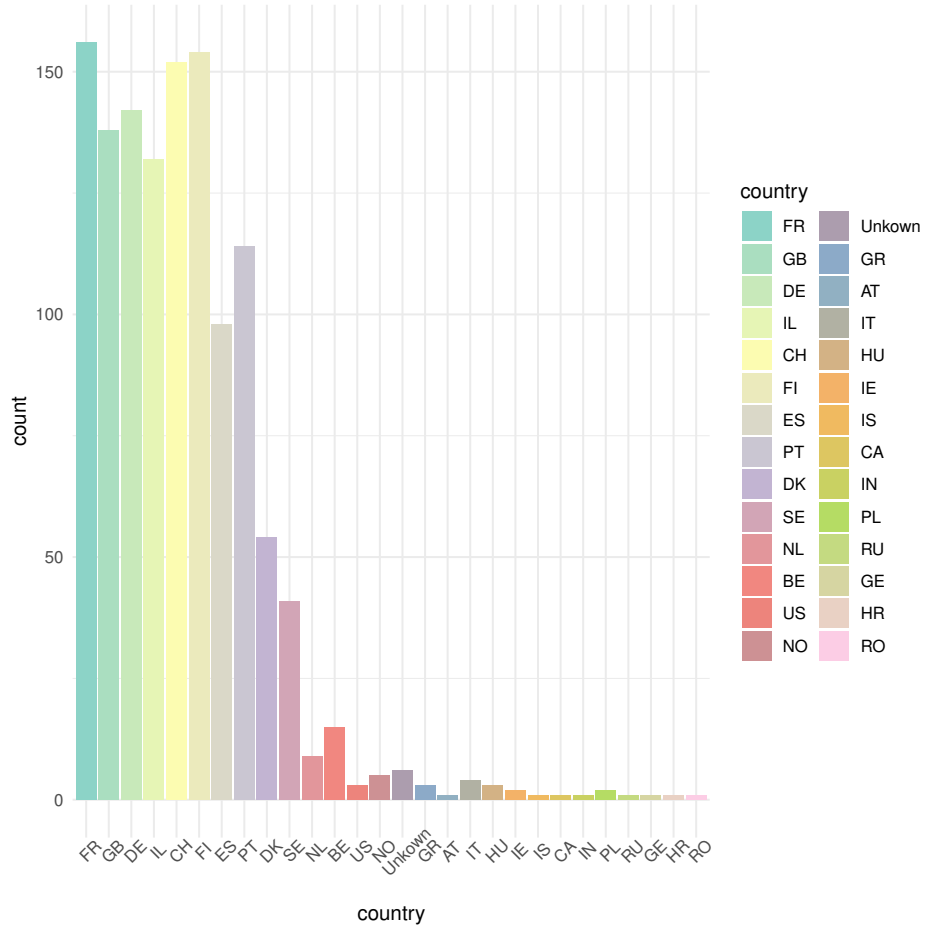

Fig. 9. Which country is your institute located? Only Life Scientists.

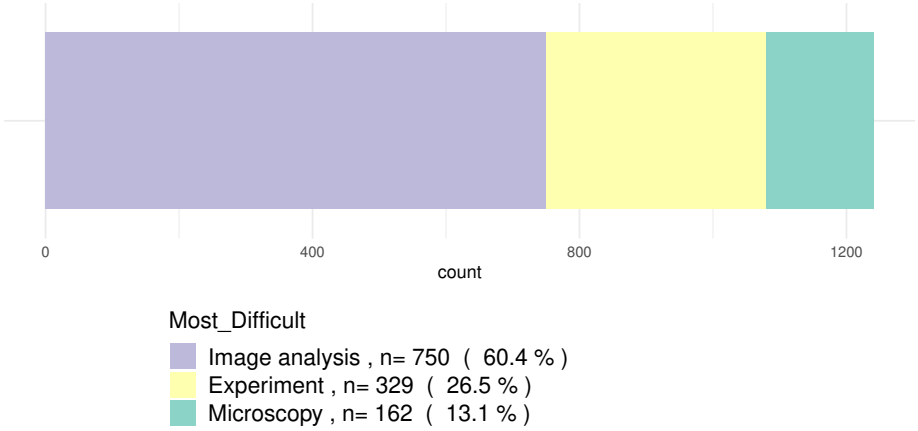

Fig. 10. Question3: Which step in the imaging based research project is the most difficult for you? Only Life scientists

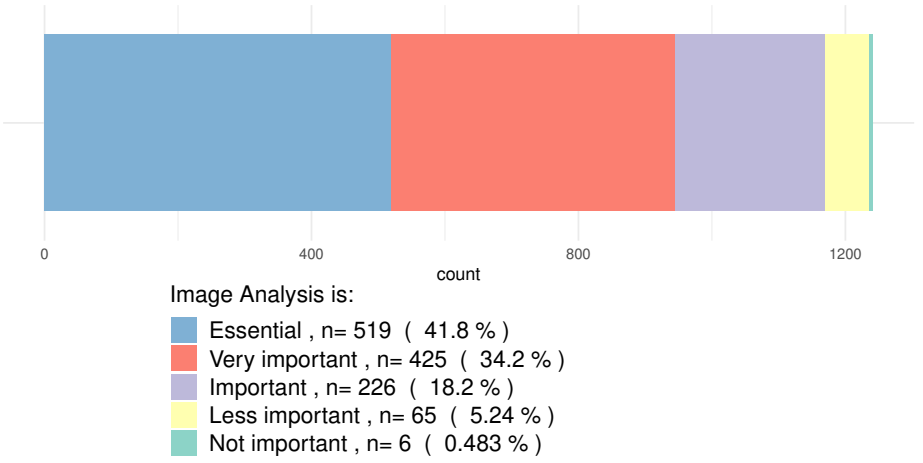

Fig. 11. How important is quantitative image analysis for your imaging project? Only Life scientists

Fig. 12. Are there image analysis experts who support you to do image analysis? Only Life scientists.

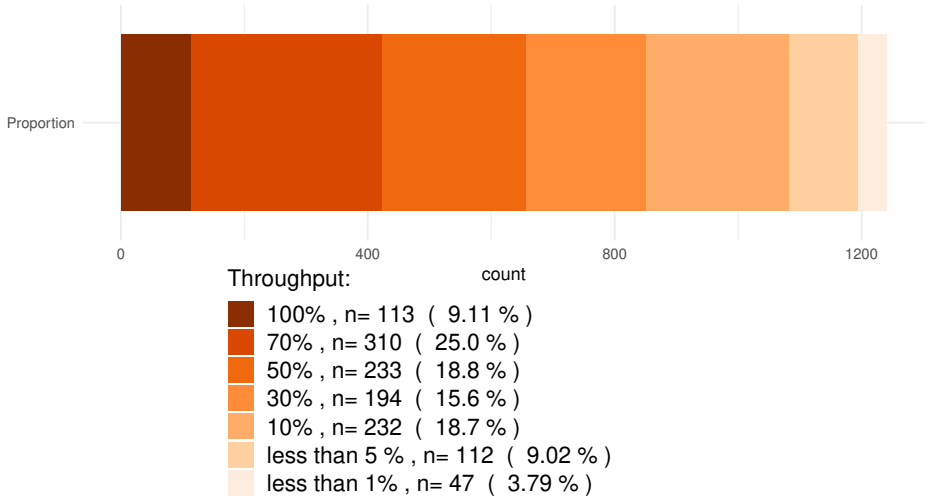

Fig. 13. What is the app. proportion of images that is analyzed vs captured? Only Life Scientists.

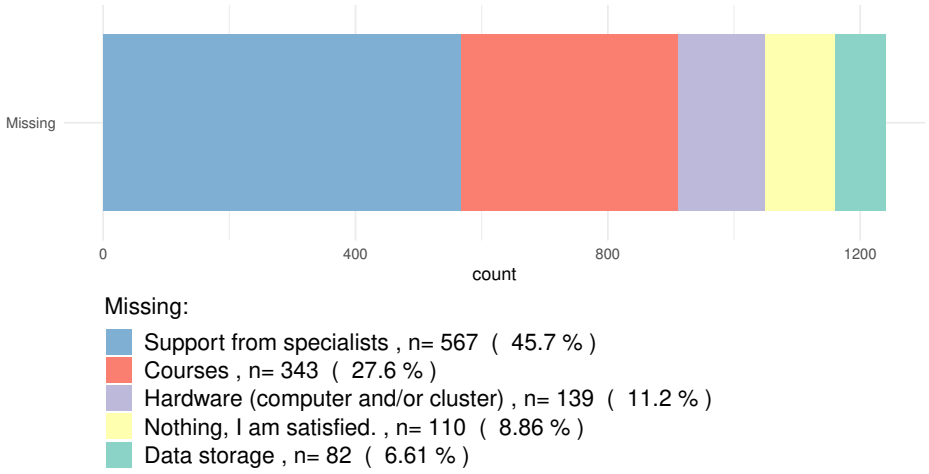

Fig. 14. Which resource do you miss mostly for optimally analyzing images? Only Life scientists.