Contribution to the discussion: Handreichung zur Rezension von Forschungssoftware in der Archäologie und den Altertumswissenschaften (Homburg, Klammt, Mara et al., 2020)

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Closed museum and cultural heritage institutions during the current public health crisis have led to increased public and academic engagement with digitized cultural heritage, including discussions surrounding access and inclusion in the development of digitized content. In view of the wider adoption of digital approaches to cultural heritage, Timo Homburg, Anne Klammt, Hubert Mara, Clemens Schmid, Sophie Charlotte Schmidt, Florian Thiery, and Martina Trognitz address a critical gap in the use of technology to support research efforts: namely, scholarly evaluation of the software that is used to create, process, and analyze research data. Although the paper mainly addresses software used in archaeological research contexts, the recommendations are equally applicable in most digital engagements with cultural heritage, such as in gallery, library, archive, and museum (GLAM) contexts. The recommendations provide brief introductions to the main concepts, reasons, and aspects that must be considered when writing a software review. As such the paper provides a low-threshold and accessible introduction to important aspects that deeply influence archaeological research and affect the quality of the (digital) archaeological record (see also Pereault, 2019).

As someone who has written about experiences in dealing with research software and databases, I would like to point out that reviewing research software must be well-considered. Unlike a book or paper, research software is often used in multiple projects and by individuals who rely on the software and often do not have the financial capacity to replace software. Reviewing research software poorly can have serious consequences on projects incorporating the software, especially if the review is read by individuals not well-versed in technological assessments, and could lead to diminished support of the software in the long-term. However, writing about software can have a considerable benefit, namely drawing awareness to the digitization process and issues that might arise through translating physical properties of objects or archaeological contexts into the 0 and 1 of a digital environment (Geismar, 2018; Huggett, 2015). Reflecting on the role, use, and creation of research software and the relationship between analog and digital approaches would ensure that software is recognized as scholarly output (Jay, Haines & Katz, 2021).

The paper is an excellent compilation of the many aspects that must be considered in the development of research software for archaeological studies. Although it is entitled "Handreichung zur Rezension von Forschungssoftware in der Archäologie und den Altertumswissenschaften" (German version) or "Recommendation for the Review of Research Software…" (English version), the paper is actually doing a lot more and is reminiscent of a "best practice" description or "Standards for…" as Ben Marwick and Suzanne Pilaar Birch entitled a related paper in 2018. The paper first provides definitions of the most important elements, such as "research software". The authors then go on to provide reasons for the need to review research software (more to this later), and then the FAIR-principles, Open Science, and the CARE-principles are briefly introduced. The description of the processes that must be considered in a software review is detailed and here the paper greatly profits from the wide range of backgrounds and interests of the authors which include archaeology, art history, computer science, software engineering, computer linguistics, among others. As such the authors are able to draw on their expertise and formulate an extensive and highly useful catalog of questions ("Fragenkatalog") for the review of research software from multiple vantage points. The catalog is a highly versatile element of the paper as the questions are equally applicable in other scenarios, such as the planning and development of research software or also the evaluation of project proposals.

While the primary aim of the paper is to argue for specific review methods of research software, the secondary aim is to educate readers in a user-centered manner. In this respect the authors provide a practical example for user orientation ("Zielgruppenorientierung"), one of the main elements listed in the catalog of questions. The authors are very thoughtful in their use of accessible language, the addition of explanations of words and concepts, and the avoidance of technical jargon. Additionally, the basics of data management and ethics in the creation of data are introduced in a very compact format. As a result, the paper can be used by many different groups of readers as well as in a classroom setting to discuss the implementation of digital tools in research and to teach the basics of digital literacy. Furthermore, the original German publication was supplemented by an excellent English translation, increasing the

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number of readers that the paper is able to reach. Although the question catalog mainly focuses on technical aspects of user-centered design, user orientation is a useful strategy for archaeologists and GLAM professionals and can successfully be used to consider future users/readers of archaeological information, communicate research results to different groups of readers, and to be mindful of the possible effect of archaeological research on other groups, such as indigenous communities. User-centered design has been applied in some museums, for example, to increase engagement between visitors and museums. Within an archaeological context, Sara Perry has argued for a user-centered approach to propose methods for facilitating dialogue about cultural heritage across audiences (Perry, 2019).

The review process described in the paper sets a very high standard for the review of research software which is to be expected based on the topic. In particular, the catalog of questions raises the issue of who might be qualified to review software to the extent suggested by the authors, especially when software used across several projects might be at stake. The authors point out that reviewers of software must explain their own background and skills relating to research software and encourage reviewing software in teams. The review criteria described in the recommendations, however, are considerable and will be time consuming if done properly (a point also made by Jay, Haines & Katz, 2021). Additionally, it is likely that individuals qualified to undertake such reviews are ECRs, however, they might not be able to dedicate time to writing papers that might not be considered to be scholarly output that contributes towards established markers on their CV. I expect that identifying individuals with the needed set of skills (in addition to time and employment) to review software might be difficult, incentivizing the review process by remunerating authors might not only increase the number of willing reviewers but also boost the perceived importance of such reviews.

Although I largely agree with the points set forth by the authors, their argument for the need to review research software does not sufficiently explore the role digital methods take on within a humanistic research project. On page 359 the authors argue that "Durch die Umsetzung in Code wird Praxis und Wissen explizit manifestiert und weiterentwickelt. Wir argumentieren, dass diese Leistung gewürdigt und sichtbar gemacht werden müssen,…". I agree that the production of code and software as part of the research process must be valued more highly and that reviews of software would support this, however, the process of writing about software also forces the author to reflect on decisions made in the development process of software and provide arguments to support these decisions. The Vienna Manifesto for Digital Humanism addresses this aspect and its authors call for the following: "Practitioners everywhere ought to acknowledge their shared responsibility for the impact of information technologies. They need to understand that no technology is neutral and be sensitized to see both potential benefits and possible downsides." (Werthner et al., 2019). By writing about technology researchers reflect on the processes as well as the role of technology in their projects leading to a deeper understanding of possible ethical issues, biases, and digital culture more broadly. As also stated by the authors, the guiding question in such reflections will need to be the description of the use of the research software in archaeology alongside an assessment of the scholarly aim or research question.

An element that has received greater attention since the publication of the recommendations are the CARE-principles and ethical considerations. Debates surrounding the repatriation of contested or looted objects as well as CAREful engagement with data relating to indigenous communities have increased in the past year, in part through the increased (media) attention for the Benin Bronzes (see Hicks, 2020; on CAREful publication: Marwick & Pillar Birch, 2018). Post-colonial arguments deeply influence archaeology and make it necessary to reflect on the role of technology and software in the way knowledge is organized, but also biases that might be perpetuated through the use of specific vocabularies and ontologies (Müller, 2021; Roopika Risam, 2019; Stobiecka, 2020). As technology advances, ethics will become more important to the study of all aspects of cultural heritage and will need to be explored in greater detail. By drawing greater attention to ethical considerations in the development of software rather than solely focusing on technological prowess, it is possible to ensure that archaeology and the interpretation of the archaeological record is done in an equitable manner and will stand up to rigorous critique in the future.

In their recommendations the authors do something much bigger though too, they do not frame the discussion of reviewing research software as something that only "digital archaeologists" need to think about but – as signaled through the accessible language – the issue affects everyone who uses a computer or any form of digital tool to collect

information/data for their research. As such it is a fundamental aspect of research that needs to be more broadly considered. As we move towards a post-digital perspective, we need to ensure that engagement with technology as well as the creation and review of software is also viewed as scholarly output. The recommendations are particularly suited to supporting this long-term trend by illustrating the many different aspects that need to be considered when creating software.

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