



A promising step toward objective quantification of flake scar sequences in stone artifact analysis

Sam Lin  based on peer reviews by 3 anonymous reviewers

Florian Linsel, Jan Philipp Bullenkamp, Hubert Mara (2025) From Scar to Scar: Reconstructing Operational Sequences of Lithic Artifacts using Scar-Ridge-Pattern-based Graph Models. Zenodo, ver. 2, peer-reviewed and recommended by Peer Community in Archaeology. <https://doi.org/10.5281/zenodo.10969327>

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Determining the relative order of flake scar negatives on stone artefacts is critical for reconstructing past lithic reduction sequence and technological practices. This task, which forms a key component of the *chaîne opératoire* approach of lithic analysis, relies on analysts interpreting scar patterns based on various artefact morphological properties. However, its interpretive nature makes the results highly dependent on observer experience and susceptible to inter-observer error (see Kot et al. 2025). In this innovative study, Linsel and colleagues (2025) introduce a workflow that automates the determination of relative scar ordering from 3D artefact models. Using a set of parameters that approximate flake scar properties relevant to scar order differentiation, their approach summarises scar ordering in the form of a graph model. The authors test the workflow on two datasets—one created by the authors and another sourced from published artefact models—yielding promising results for high-resolution 3D models but variable accuracy overall. The authors explore possible factors influencing these variations and proposed future refinements, including a need for more ground-truthing datasets with minimal interpretive biases.

This method-focused paper has significant implications for Palaeolithic archaeology. It marks an important step toward the objective quantification of flake scar order, a key aspect in understanding past stone tool-making sequences. Moreover, it highlights the great potential of 3D technology and computational approaches in automating traditionally time-consuming analyses while reducing subjective bias in our analytical results.

References:

Florian Linsel, Jan Philipp Bullenkamp, Hubert Mara (2025) From Scar to Scar: Reconstructing Operational Sequences of Lithic Artifacts using Scar-Ridge-Pattern-based Graph Models. Zenodo, ver.2.1 peer-reviewed and recommended by PCI Archaeology <https://doi.org/10.5281/zenodo.14875156>

Kot, Małgorzata, Jerzy Tyszkiewicz, Michał Leloch, Natalia Gryczewska, and Sebastian Miller (2025) Reliability and validity in determining the relative chronology between neighbouring scars on flint artefacts. Journal of Archaeological Science 175 (2025): 106156.
<https://doi.org/10.1016/j.jas.2025.106156>

Reviews

Evaluation round #1

DOI or URL of the preprint: <https://doi.org/10.5281/zenodo.10969328>

Version of the preprint: 1

Authors' reply, 15 February 2025

Dear Sam, dear board members,

Thank you again for extending the deadline.

We fully agree that the article needed to be restructured, what we have done, and we have addressed all the issues raised by the reviewers.

We hope that all requirements are met and look forward to your decision!

Best wishes

Florian Linsel

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Decision by [Sam Lin](#) , posted 09 December 2024, validated 09 December 2024

Dear authors,

Sincere apologies for the delay. I have received feedback from three reviewers. All three reviewers (and I) found your work very exciting and of great value to lithic analysis. However, the reviewers also noted a need for more clarification regarding the structure of the paper and the technical content. In particular, Reviewer 3 raised several concerns regarding a need for clearer explanation and justification of the analytical and evaluation procedure.

Please address the concerns raised by the reviewers, and I look forward to see the revised version of your very interesting work.

Reviewed by anonymous reviewer 3, 29 October 2024

Title and abstract:

Does the title clearly reflect the content of the article? [x] Yes, [] No (please explain), [] I don't know

Does the abstract present the main findings of the study? [x] Yes, [] No (please explain), [] I don't know

Introduction

Are the research questions/hypotheses/predictions clearly presented? Yes, No (please explain), I don't know

Does the introduction build on relevant research in the field? Yes, No (please explain), I don't know

Materials and methods

Are the methods and analyses sufficiently detailed to allow replication by other researchers? Yes, No (please explain), I don't know

Are the methods and statistical analyses appropriate and well described? Yes, No (please explain), I don't know

Results

In the case of negative results, is there a statistical power analysis (or an adequate Bayesian analysis or equivalence testing)? Yes, No (please explain), I don't know

Are the results described and interpreted correctly? Yes, No (please explain), I don't know

Discussion:

Have the authors appropriately emphasized the strengths and limitations of their study/theory/methods/argument? Yes, No (please explain), I don't know

Are the conclusions adequately supported by the results (without overstating the implications of the findings)? Yes, No (please explain), I don't know

Comments:

The method presented here is of great value for the automatization of lithic scar pattern analysis. However, the aim of the study is not clear. Why is automatization necessary? What are the benefits? What the drawbacks? Are there other comparable methods? If so, what aspects of the new approach are better? I am in favor of publishing the method, however the manuscript needs major rewriting to incorporate the points/ questions raised above.

Furthermore, the manuscript needs restructuring:

The introduction should be re-written. It contains basically only methods. I suggest rewriting the introduction with a discussion of the state of the art, as well as a focus on why an automated scar recognition is useful.

Part of the Materials is also Methods (and should be moved there), like Preprocessing and the Manual Segmentation sections.

Detailed comments:

Lines 3-4: citation(s) is (are) required.

Lines 9-16: I suggest to insert a figure to illustrate the concept of flaking and to label the individual features (ridges, scars, dorsal/ ventral etc.).

Lines 19-36: This (as well as the paragraph before) is methods. I suggest rewriting the introduction with the focus of why an automated scar recognition is useful.

Table 1: Please indicate in the caption what the numbers referring to the publications mean.

Lines 69-72: „Intriguing for this ...“ This sentence is very long and hard to understand. Please re-write.

Line 87: please use the plural of the French term chaîne opératoire.

Figure 1: Please add a legend for the color coding of the scar and ridge labels.

Lines 107-108: „In recent years, the segmentation of artifact features on 3D models such as cutting edges

has been based on ridge rather than scar segmentation (Pop, 2019 ; Schunk et al., 2023).“ would be rather part of the new introduction when reviewing the former approaches..

Line 188: not „edge retouching“ - rather: „edge retouch“ or „retouching the edge“

Line 189 (see also line 208): „cutting edge“ is a very specific functional edge, but tools are used for various functions. I suggest to call it „working edge“ or „functional edge“.

Line 190: Why denticulate? When talking about edge retouch (especially a continuous one) the most appropriate tool is a scraper.

Line 213: in which way is the simplified graph simplified?

Reviewed by anonymous reviewer 1, 10 November 2024

The paper is very nicely written, with clear details of the technical aspects. I am excited to use the method proposed by the authors to annotate 3D flake models, as I think it could be immensely helpful for pre-processing data for use in machine learning.

I have a few comments, which are as follows:

In the Materials and Methods section, some aspects could benefit from further elaboration. I assume the paper’s target audience includes not only experts in computer science but also archaeologists who may wish to apply this method in their own research. Due to my limited knowledge of computer vision, I found it challenging to fully follow the steps and, more importantly, the underlying logic behind each dataset preparation step.

For example, the preprocessing using GigaMesh could be clarified with more details on how the meshes were oriented and an overview of the protocols followed according to the GMOCF routine. Additional clarification on this routine itself would be helpful—specifically, whether it is intended to distinguish two connected surfaces using a ridge made by connected vertices.

The Manual Segmentation section could also benefit from more detail. It was mentioned that both MeshLab and Blender were used, but it is unclear how the models were annotated in Blender. Were vertices on ridges marked manually to separate the scars, or did the authors follow some semi-automated processes? While Fig. 1 shows the segmentation steps in Blender, it is not clear how segmentation was actually conducted in the software.

It was also noted that flake scars were labeled, but the specific approach was not clear. For instance, were individual vertices and faces within each scar assigned a specific color to distinguish scars in later steps, or were scars labeled as shown in Fig. 6? If so, it may help to mention this earlier in the text. Providing additional details on these processes could benefit those interested in conducting similar 3D data processing.

I apologize in advance for any misunderstanding of the graph, and if I may have missed relevant points in the main text. In the Parameter-based Directions section, the authors created a graph G with nodes S and R . Is this intended as a bipartite graph, with scars and ridges as nodes possessing distinct properties? While Fig. 8 illustrates the graph, the caption could benefit from additional clarification to explain the meaning of the node colors, the rationale behind node numbering, and which nodes represent S and which represent R .

I enjoy the study’s succinct writing and clear organization, and I am eager to apply this method myself in the near future. I believe that by providing additional details for non-expert readers like myself, the authors could greatly enhance the paper’s readability and encourage broader application of this method.

Reviewed by anonymous reviewer 2, 18 November 2024

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