



Rock Art Session

Theory & Practice: Scandinavian Rock Art

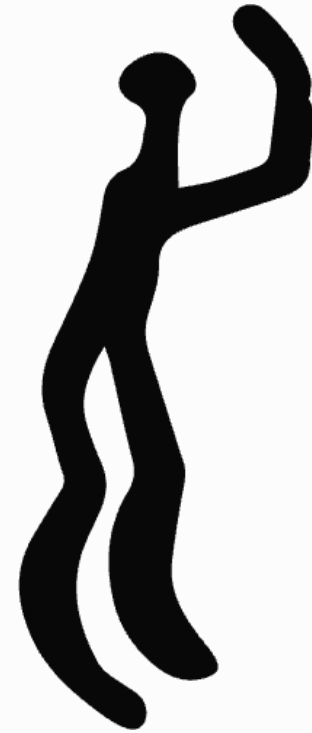
Ashely Green

Research Engineer
Department of Historical Studies + Svenskt Hällristningsforskningsarkiv
University of Gothenburg, Sweden



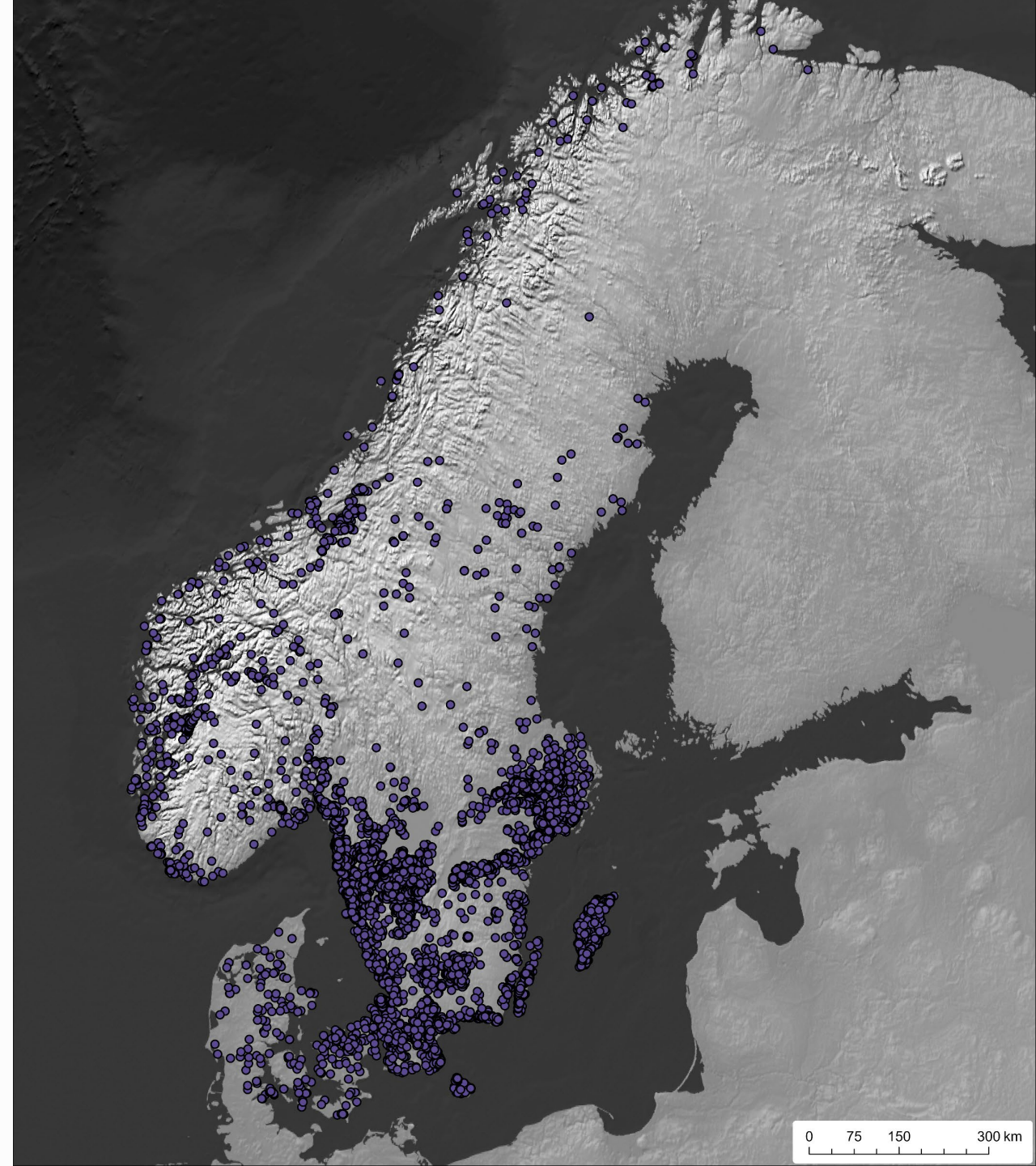
Outline

- Contextualise rock art
- Rock art and deep learning
- Data sets
- Exercises:
 - Training a model
 - Prediction



Scandinavian Rock Art

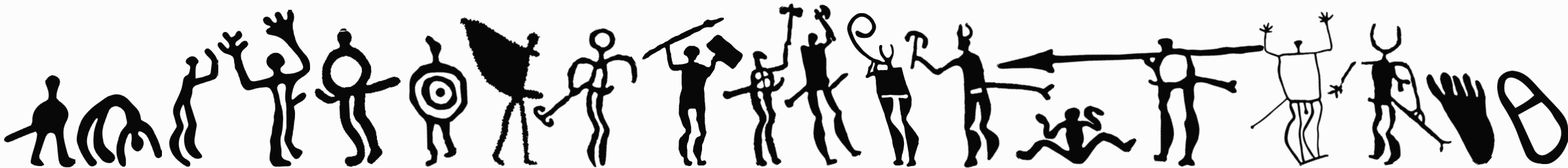
- ca. 26000 rock art sites
- Paintings + Carvings
 - Paintings date to Stone Age (5000 BCE+)
 - Carvings date to the Bronze Age – Iron Age (1700 BCE – 0AD)
- Figurative + Non-Figurative motifs



Boat



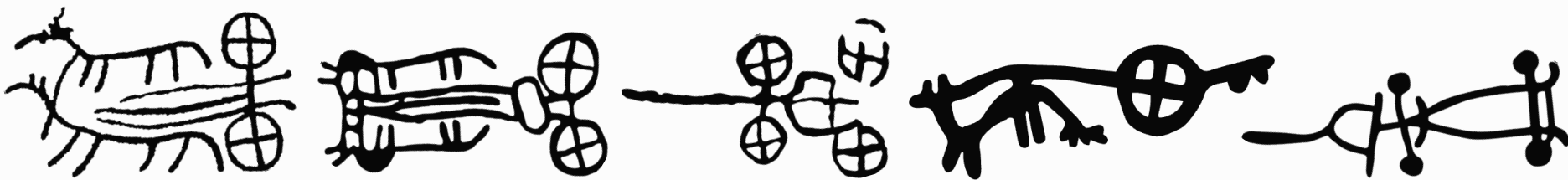
Anthropomorph



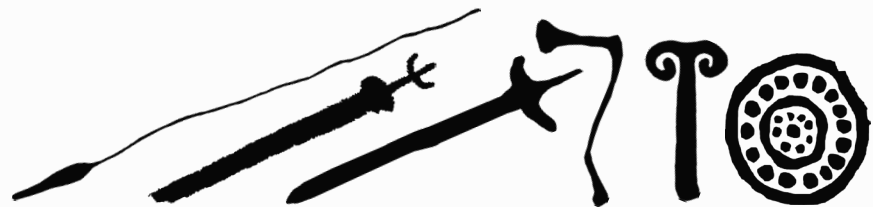
Animal



Wheeled Transport



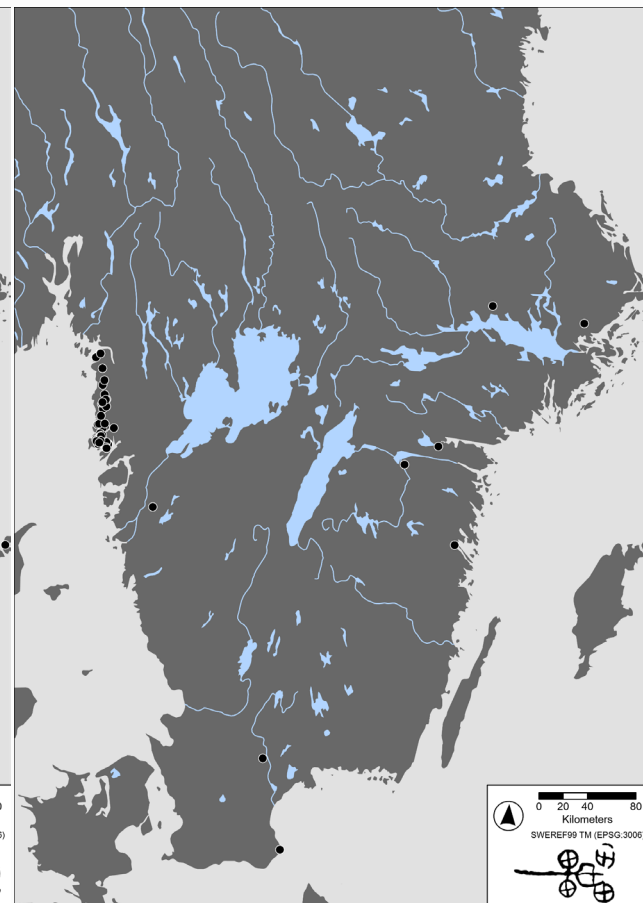
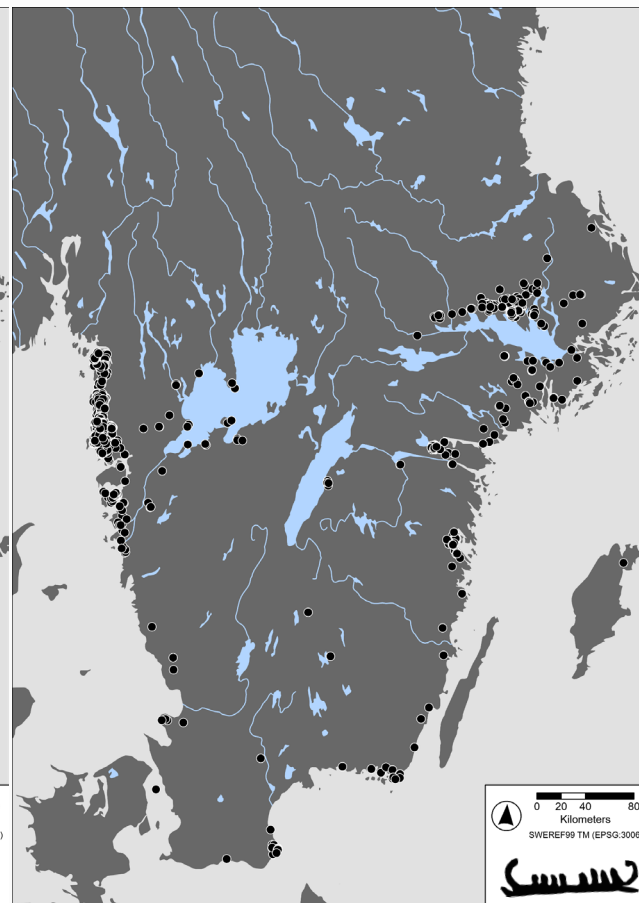
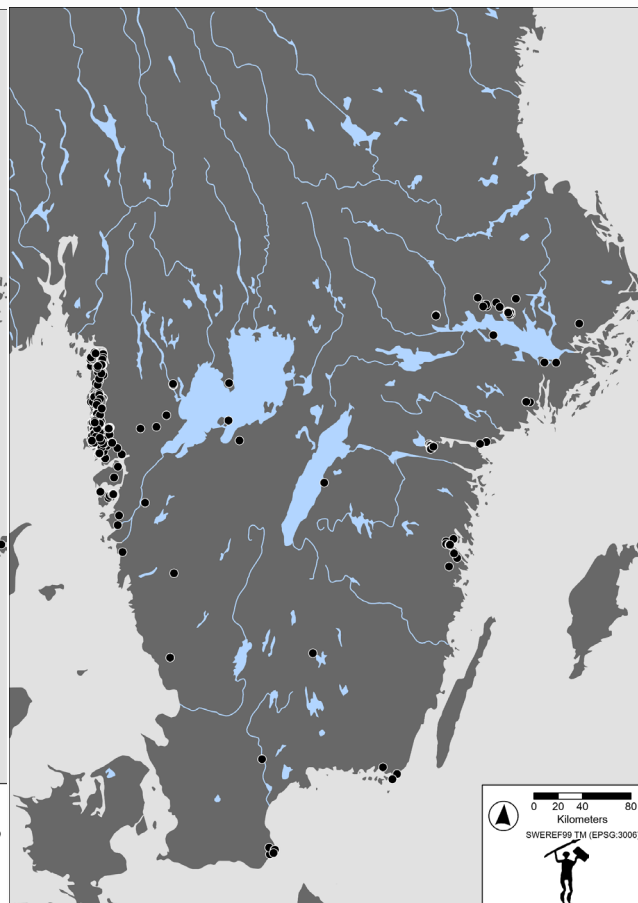
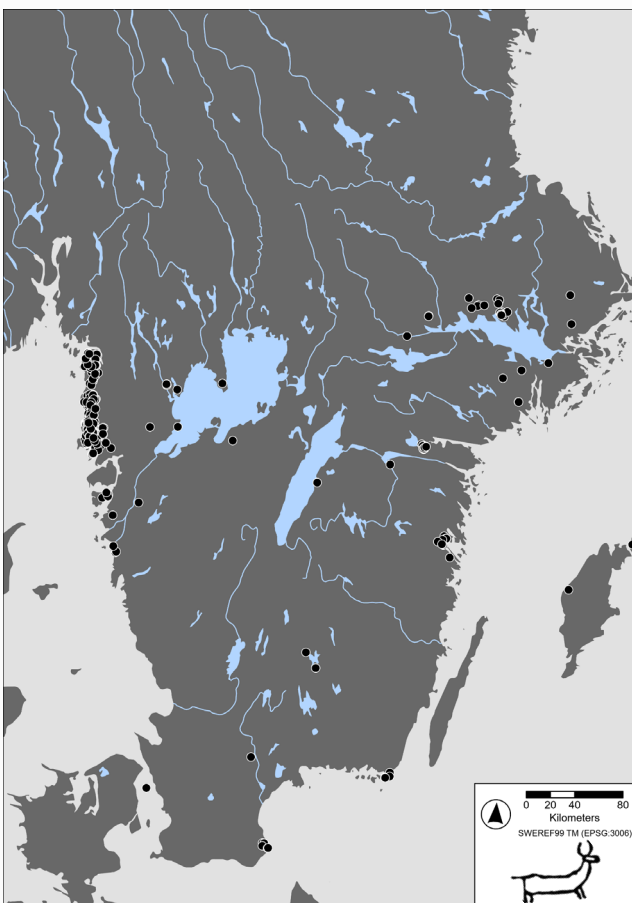
Weapon



Geometric



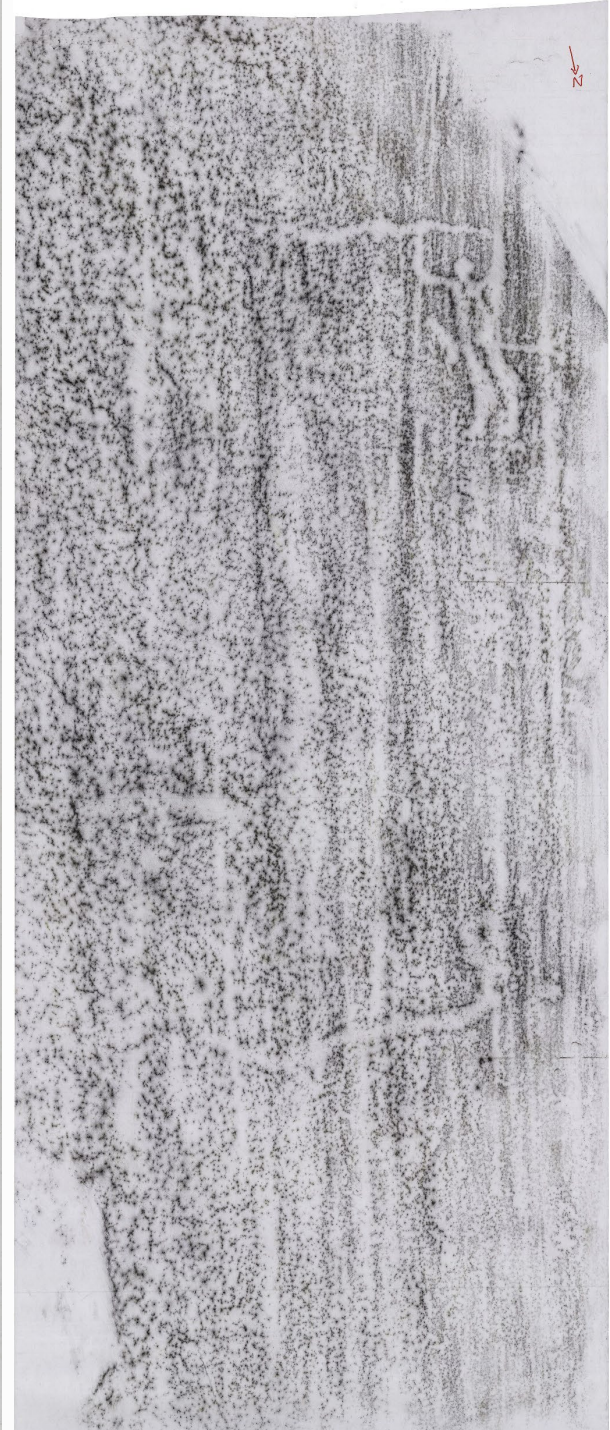
Scandinavian Rock Art

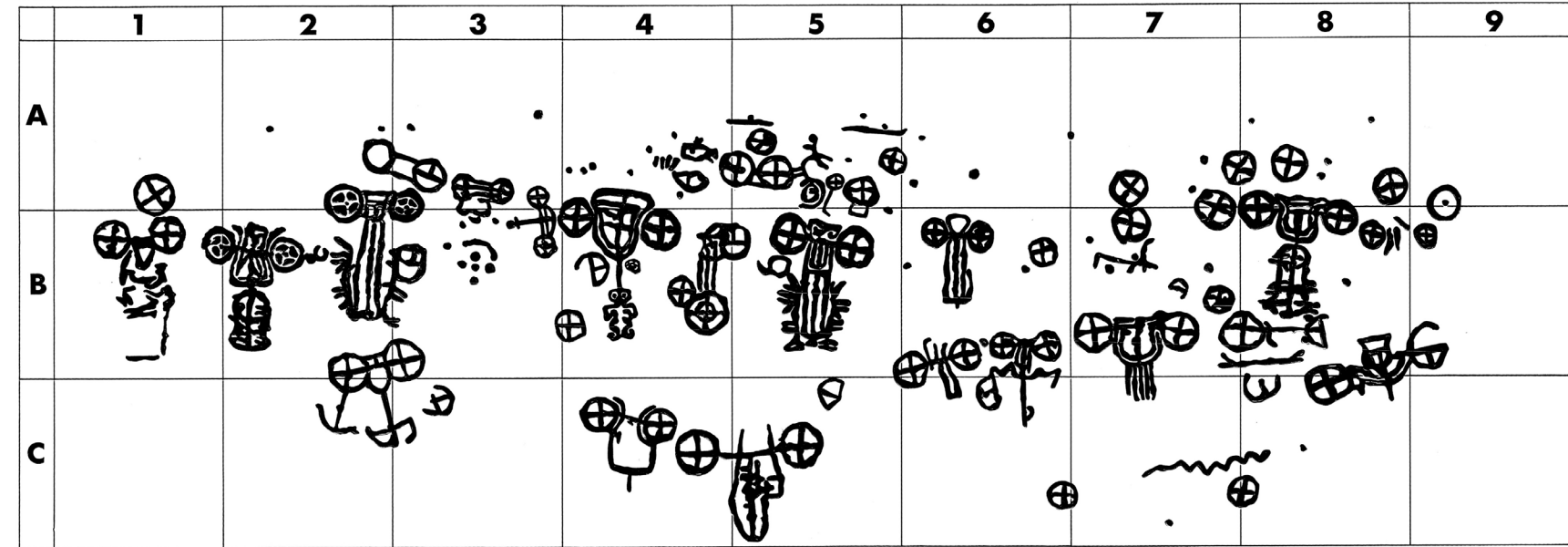


LEFT: RockCare 2004. *Rubbing of L1944:2485 - SHFA.*
shfa.dh.gu.se/image/133392

MIDDLE: Rabitz Johansen, M. 2012.
Rubbing of L1970:8075 - SHFA.
shfa.dh.gu.se/image/133890

RIGHT: Toreld, A. and Lundenmark, H.
2020. *Rubbing of L2020:8854 - SHFA.*
shfa.dh.gu.se/image/137048





Tanum 2365



TOP: Burenhult, G. 1971. *Graphic of L1991:1519 - SHFA*. shfa.dh.gu.se/image/133219

BOTTOM: Andersson, T. and Toreld, A. 2016. *Tracing (Plastic) of L1959:2876 - SHFA*. shfa.dh.gu.se/image/130494



LEFT: Högberg, T. 1973. *Slide of L1968:7551 - SHFA.*
shfa.dh.gu.se/image/133964

MIDDLE: Andersson, T. and Toreld, A. 2021. *Photo of L1969:3260 - SHFA.*
shfa.dh.gu.se/image/137125

RIGHT: Green, A. 2025. *Photo of L2003:1087 - SHFA.*
shfa.dh.gu.se/image/137020

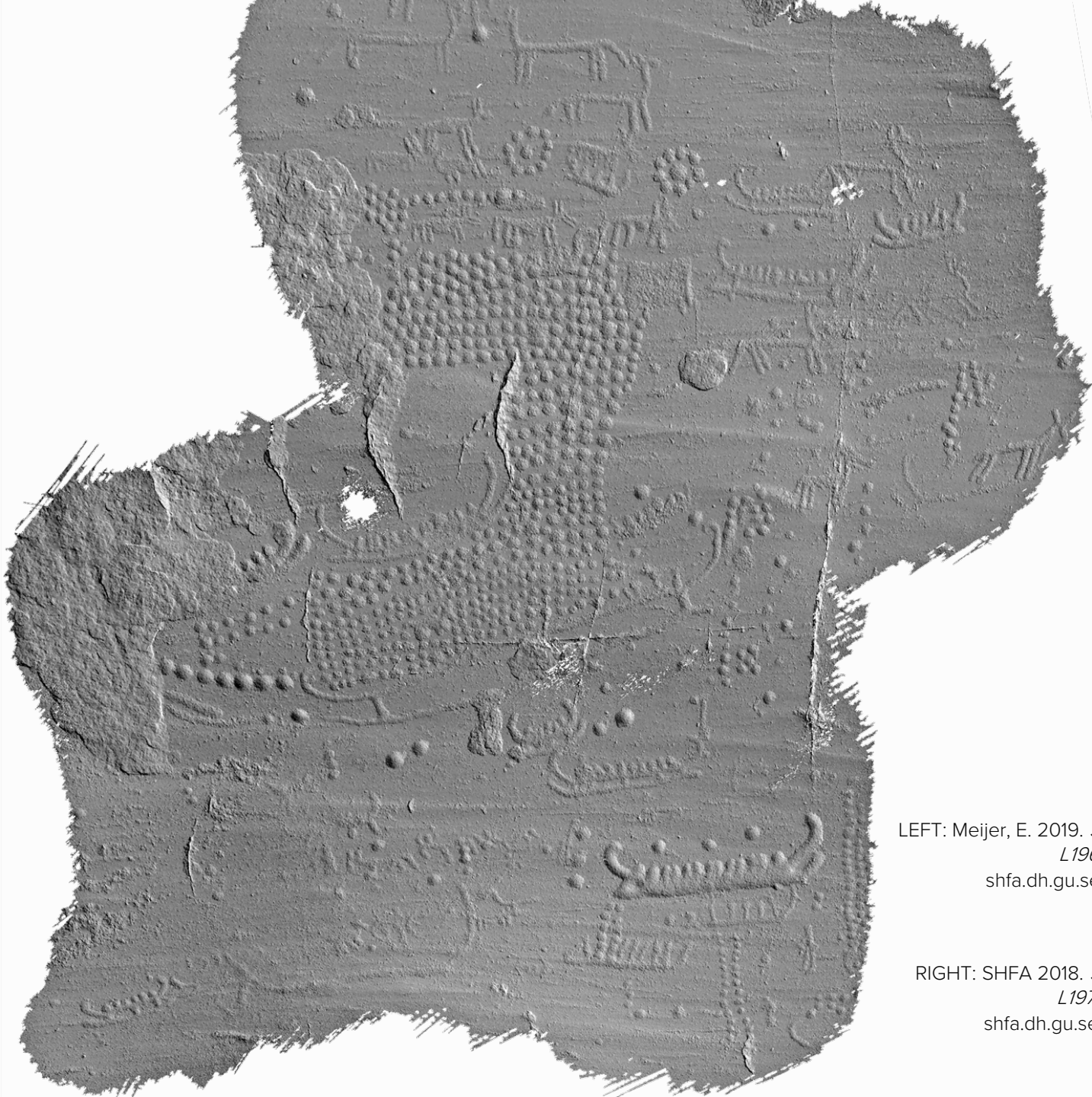




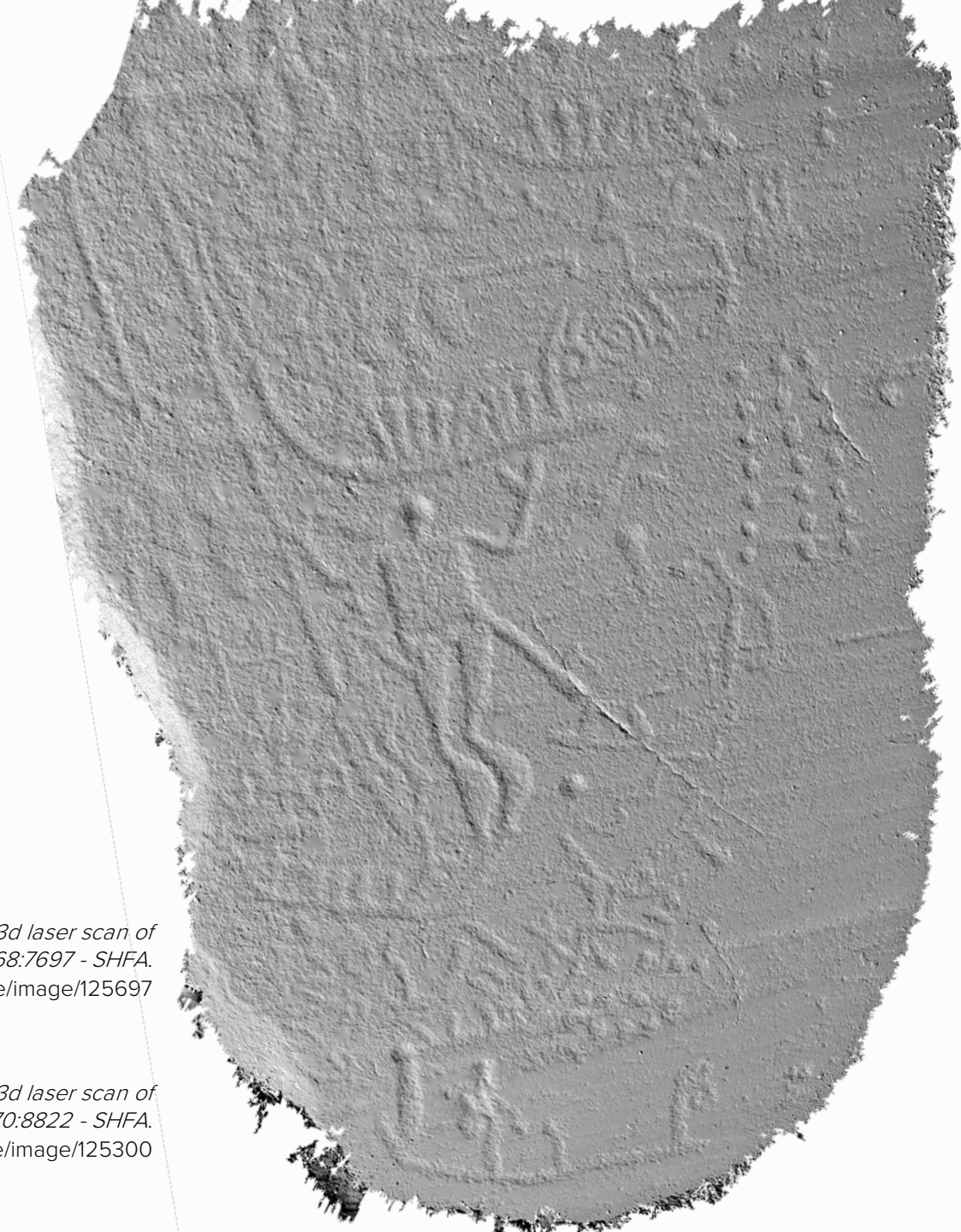
LEFT: Potter, R. 2022. *Overview photo of L1969:5867 - SHFA.*
shfa.dh.gu.se/image/135586



RIGHT: Potter, R. 2022. *Overview photo of L1969:6090 - SHFA.*
shfa.dh.gu.se/image/135574



LEFT: Meijer, E. 2019. *3d laser scan of*
L1968:7697 - SHFA.
shfa.dh.gu.se/image/125697



RIGHT: SHFA 2018. *3d laser scan of*
L1970:8822 - SHFA.
shfa.dh.gu.se/image/125300



Potter, R. 2026. *Orthophoto (SfM) of L1963:6913 - SHFA*. shfa.dh.gu.se/image/137135

So why don't we use some of these documentations for training?

Colour

Anderson, T. and Toreld, A. 2021. *Photo of L1969:3260 - SHFA*. shfa.dh.gu.se/image/137015



Toreld, A. and Lundenmark, H. 2020. *Photo of L1969:3521 - SHFA*. shfa.dh.gu.se/image/137164

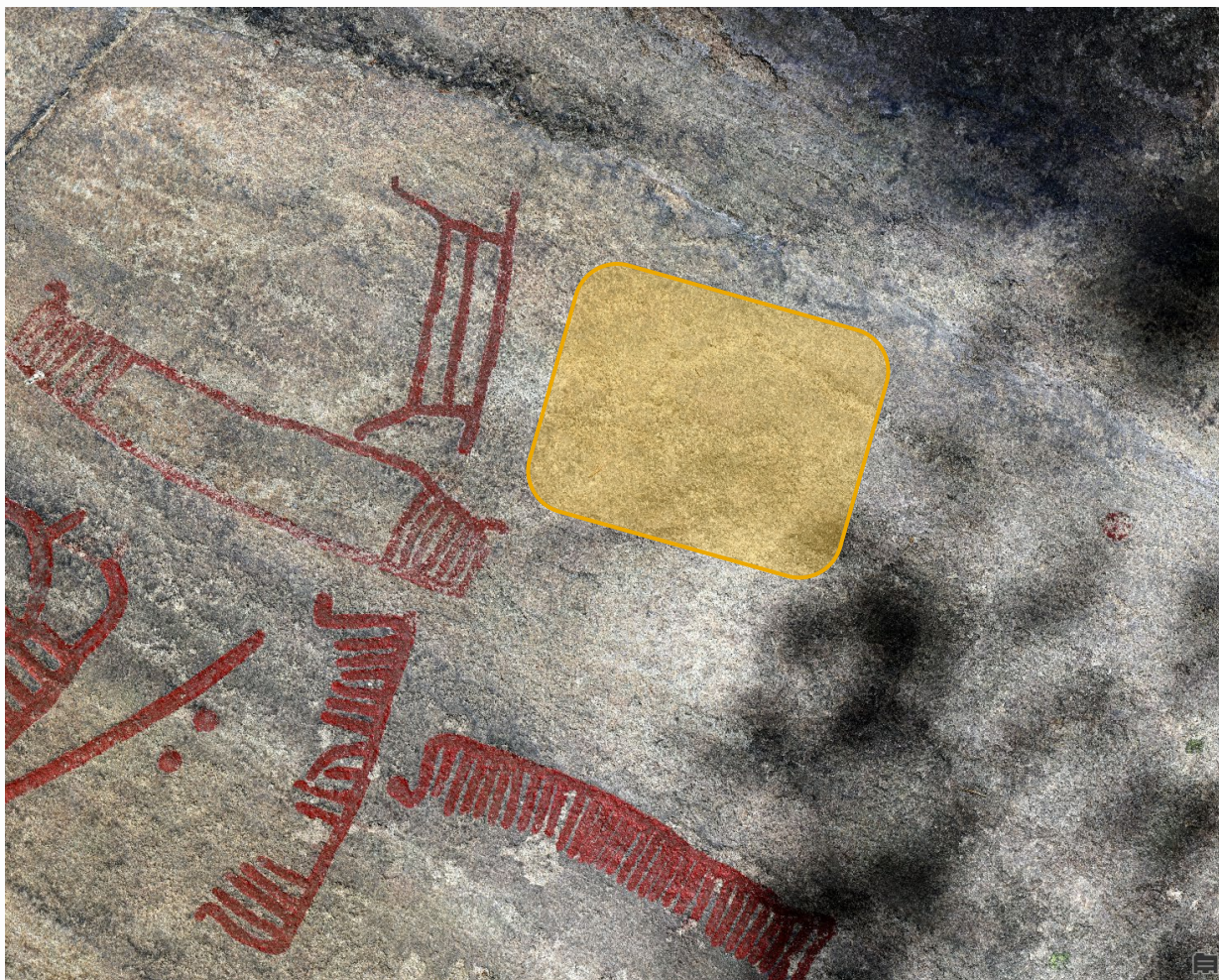


Green, A. 2025. *Photo of L1968:741 - SHFA*. shfa.dh.gu.se/image/137015

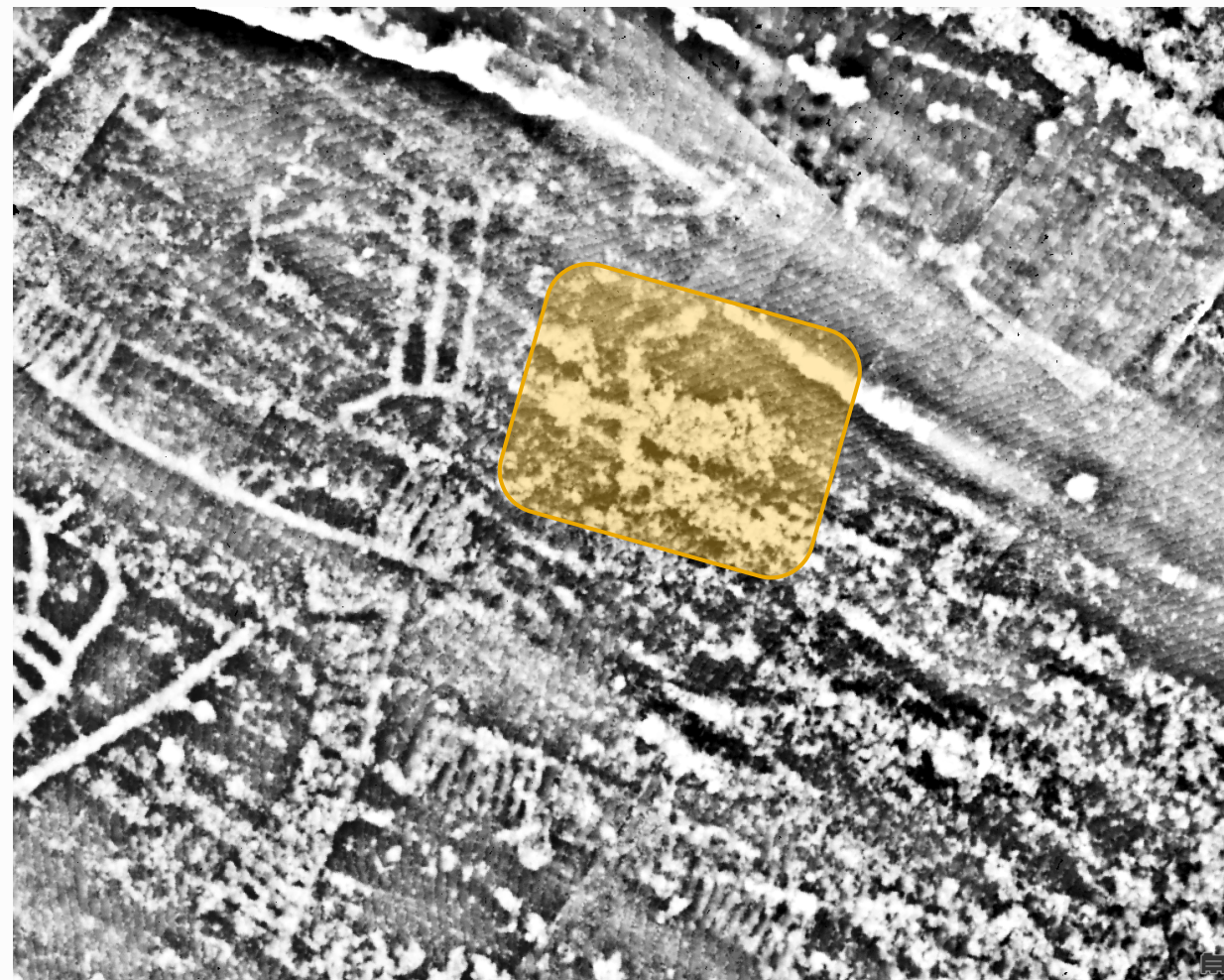


Högberg, T. 1972. *Photo of L1990:608 - SHFA*. shfa.dh.gu.se/image/119336

Colour



Potter, R. 2022. *Orthophoto of L1968:7559 - SHFA*. shfa.dh.gu.se/image/135270



Visualisation of L1968:7559. Visualisation: A. Green, Model: R. Potter

Annotation for supervised learning



Bertilsson, C. 2002. *Photo of L1968:6295 - SHFA.*
shfa.dh.gu.se/image/110376



Högberg, T. 1984. *Slide of L1990:608 - SHFA.* shfa.dh.gu.se/image/136698



Moyano Di Carlo, J. 2022. *Orthophoto of L1968:7305 - SHFA.*
shfa.dh.gu.se/image/137230

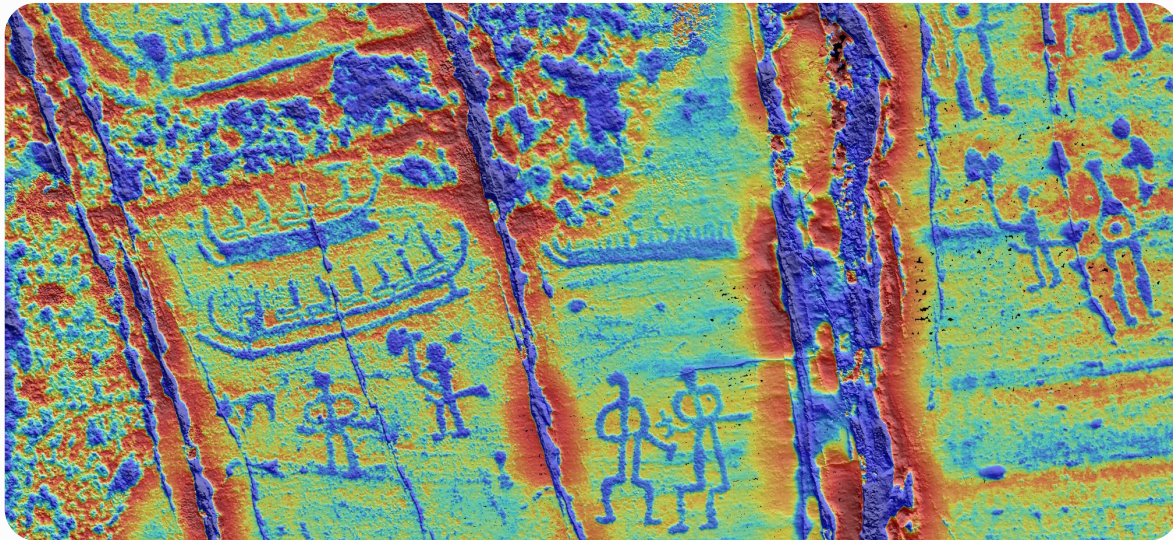
Annotation for supervised learning



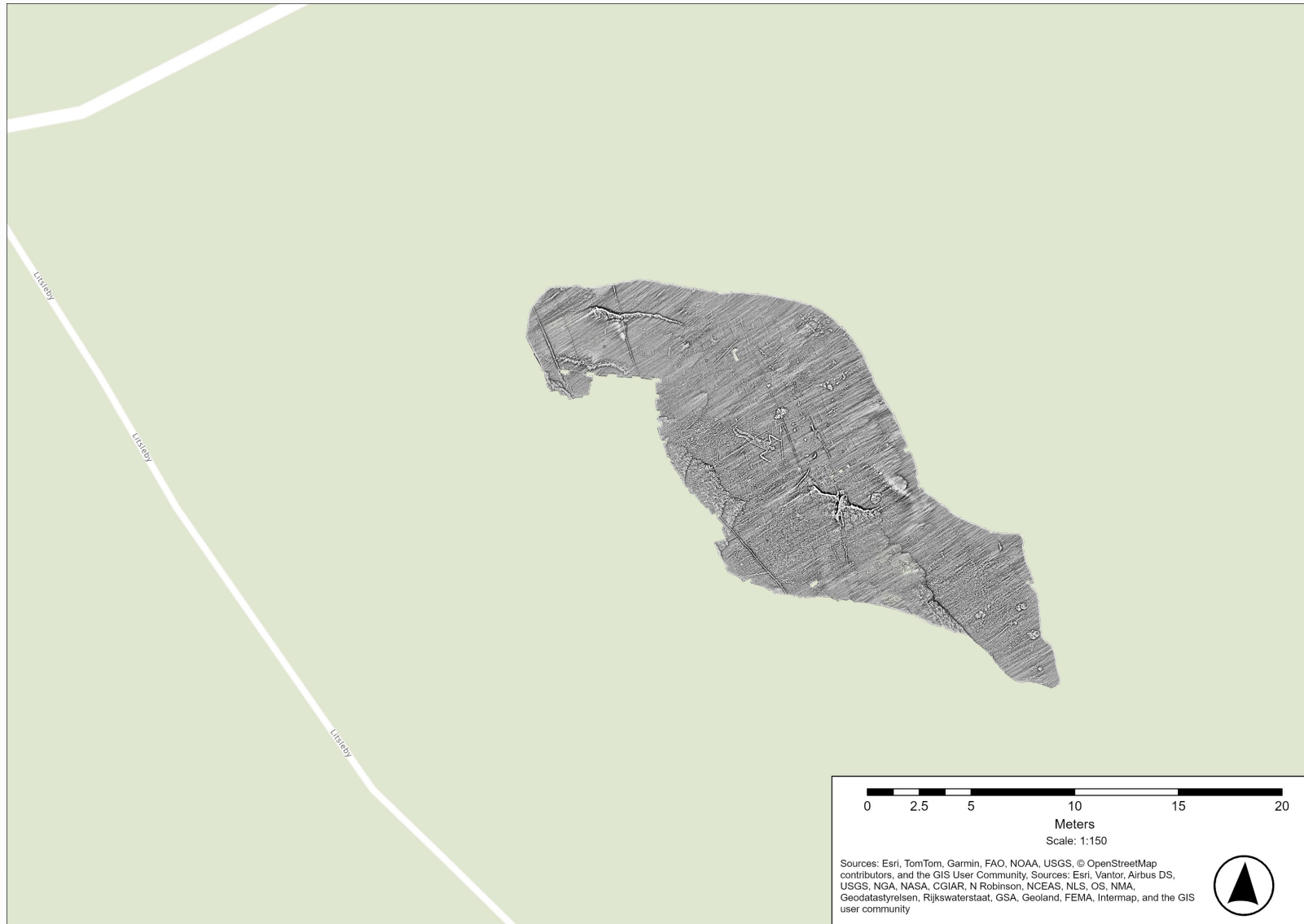
Annotation for supervised learning



Annotation for supervised learning

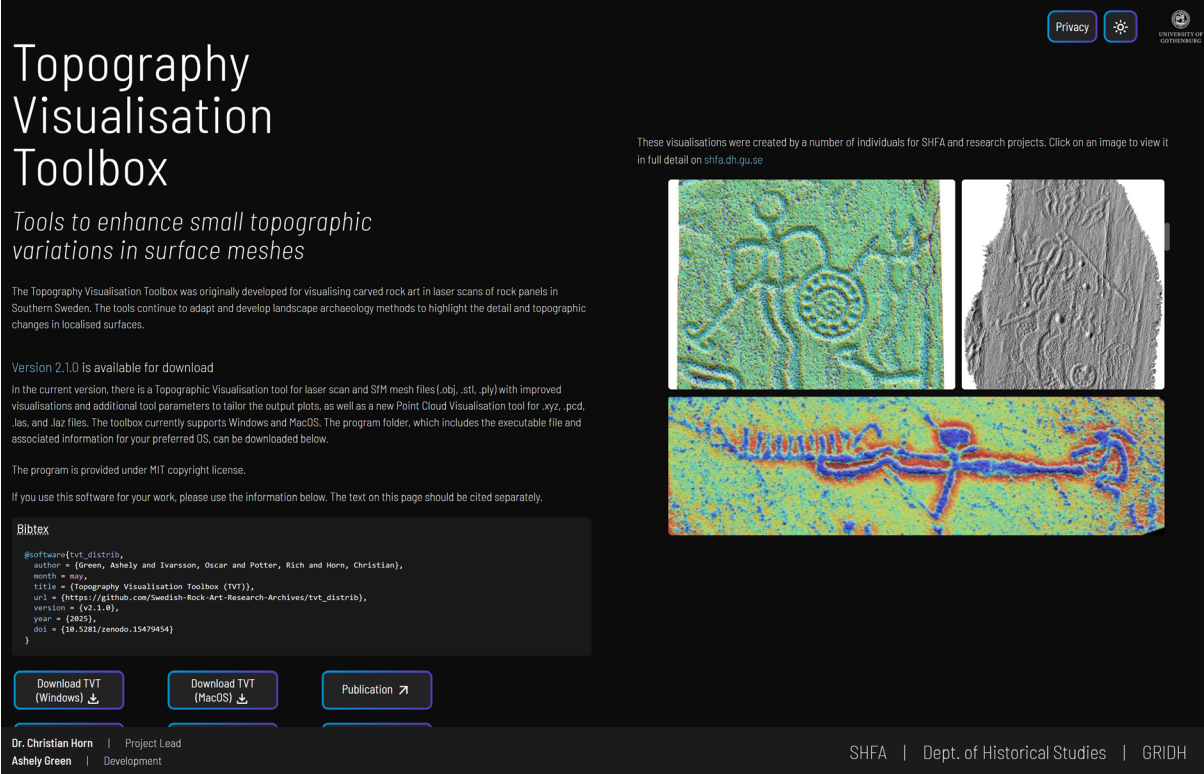


Georeferencing



Visualisation

- Enhance shallow features in 3D data
 - Developed for rock art in West Sweden
 - Planar surfaces
- 3D models + Point clouds
- Local relief model (LRM)
- Plot depth/elevation using colourscale



The screenshot shows the homepage of the 'Topography Visualisation Toolbox'. The header includes a 'Privacy' button, a settings icon, and the 'UNIVERSITY OF GÖTEBORGS' logo. The main title is 'Topography Visualisation Toolbox' in large white text. Below it, a subtitle reads 'Tools to enhance small topographic variations in surface meshes'. A paragraph explains the toolbox's origin: 'The Topography Visualisation Toolbox was originally developed for visualising carved rock art in laser scans of rock panels in Southern Sweden. The tools continue to adapt and develop landscape archaeology methods to highlight the detail and topographic changes in localised surfaces.' It then states 'Version 2.1.0 is available for download' and lists supported file formats and operating systems. A 'Bibtex' section contains a code block with citation information. At the bottom, there are three buttons: 'Download TVT (Windows)', 'Download TVT (MacOS)', and 'Publication'. The footer lists 'Dr. Christian Horn' as Project Lead and 'Ashely Green' as Development, along with affiliations 'SHFA | Dept. of Historical Studies | GRIDH'.

Topography
Visualisation
Toolbox

Tools to enhance small topographic variations in surface meshes

The Topography Visualisation Toolbox was originally developed for visualising carved rock art in laser scans of rock panels in Southern Sweden. The tools continue to adapt and develop landscape archaeology methods to highlight the detail and topographic changes in localised surfaces.

Version 2.1.0 is available for download

In the current version, there is a Topographic Visualisation tool for laser scan and STM mesh files (.obj, .stl, .ply) with improved visualisations and additional tool parameters to tailor the output plots, as well as a new Point Cloud Visualisation tool for .xyz, .pcd, .las, and .laz files. The toolbox currently supports Windows and MacOS. The program folder, which includes the executable file and associated information for your preferred OS, can be downloaded below.

The program is provided under MIT copyright license.

If you use this software for your work, please use the information below. The text on this page should be cited separately.

Bibtex

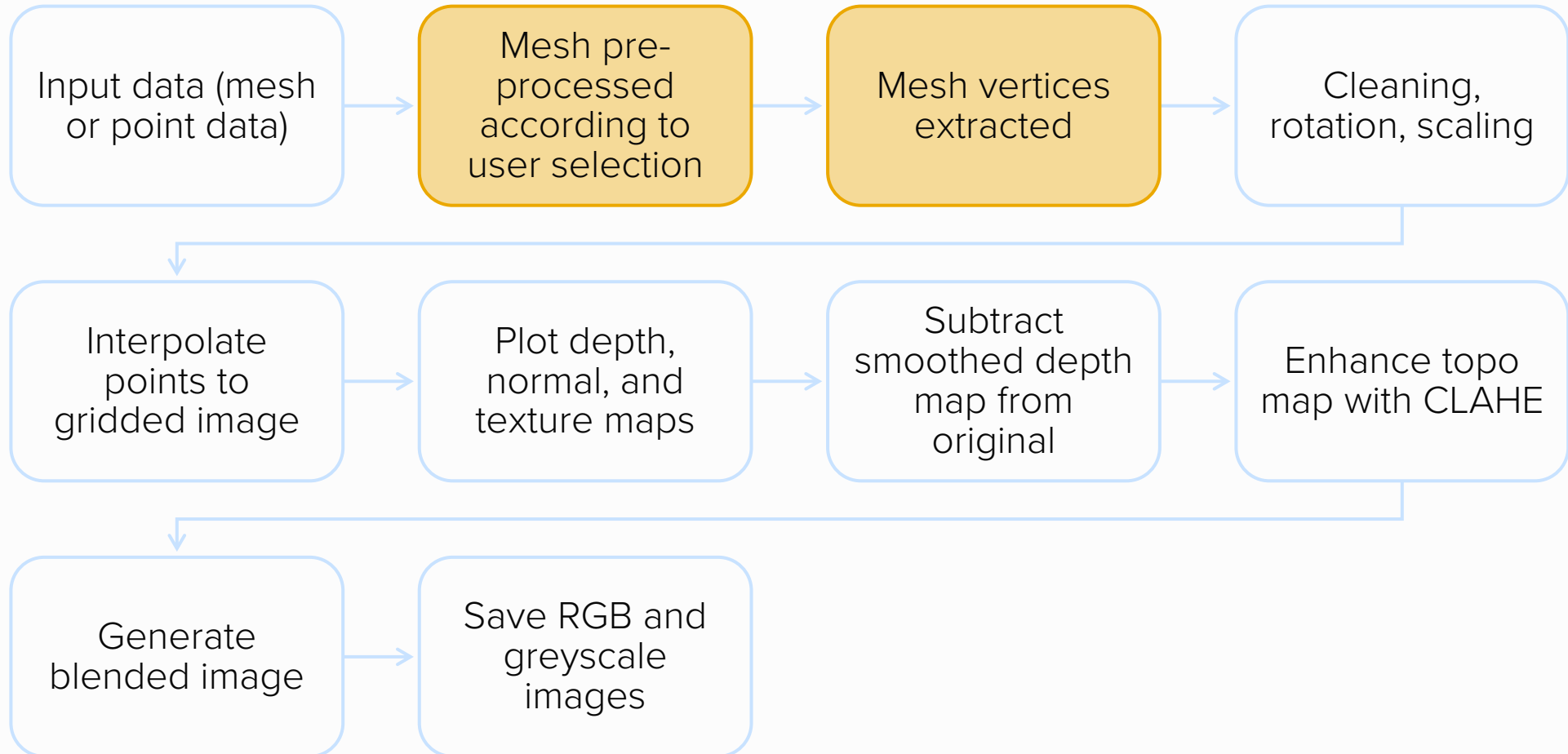
```
@software{tvt_distrib,  
  author = {Green, Ashely and Ivarsson, Oscar and Potter, Rich and Horn, Christian},  
  month = may,  
  title = {Topography Visualisation Toolbox (TVT)},  
  url = {https://github.com/Swedish-Rock-Art-Research-Archives/tvt_distrib},  
  version = {v2.1.0},  
  year = {2025},  
  doi = {10.5281/zenodo.15479454}  
}
```

Download TVT (Windows) Download TVT (MacOS) Publication

Dr. Christian Horn | Project Lead
Ashely Green | Development

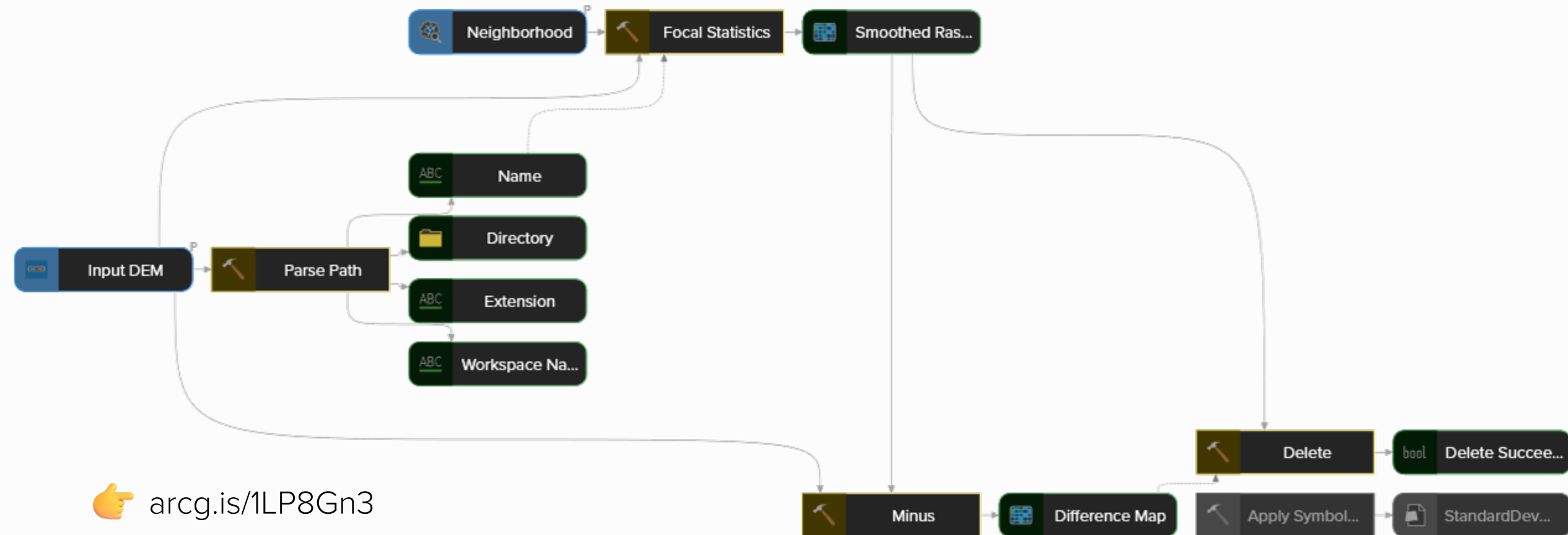
SHFA | Dept. of Historical Studies | GRIDH

Visualisation



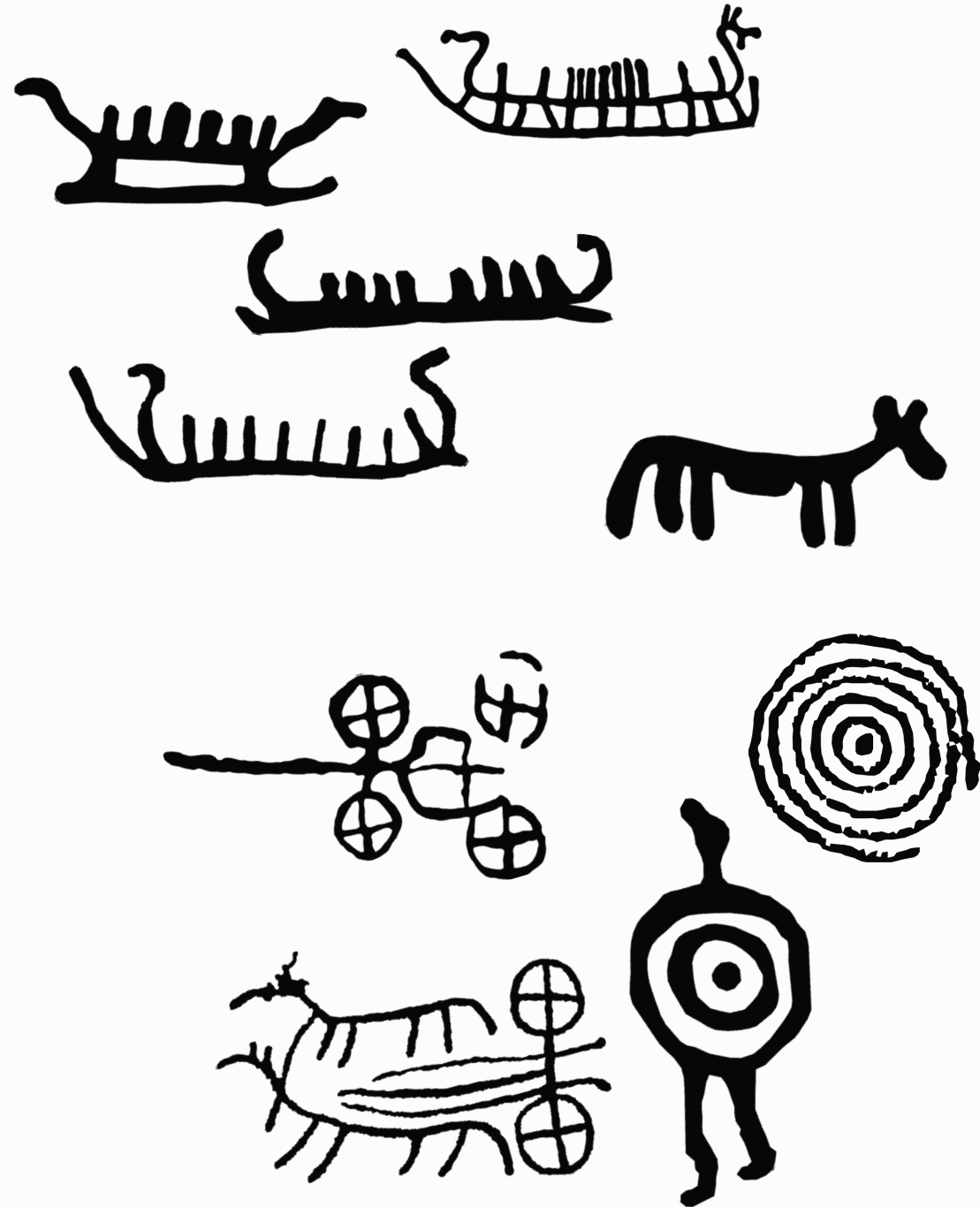
Visualisation

- Uses Digital Elevation Model (DEM)
- LRM method



Complexities of Rock Art

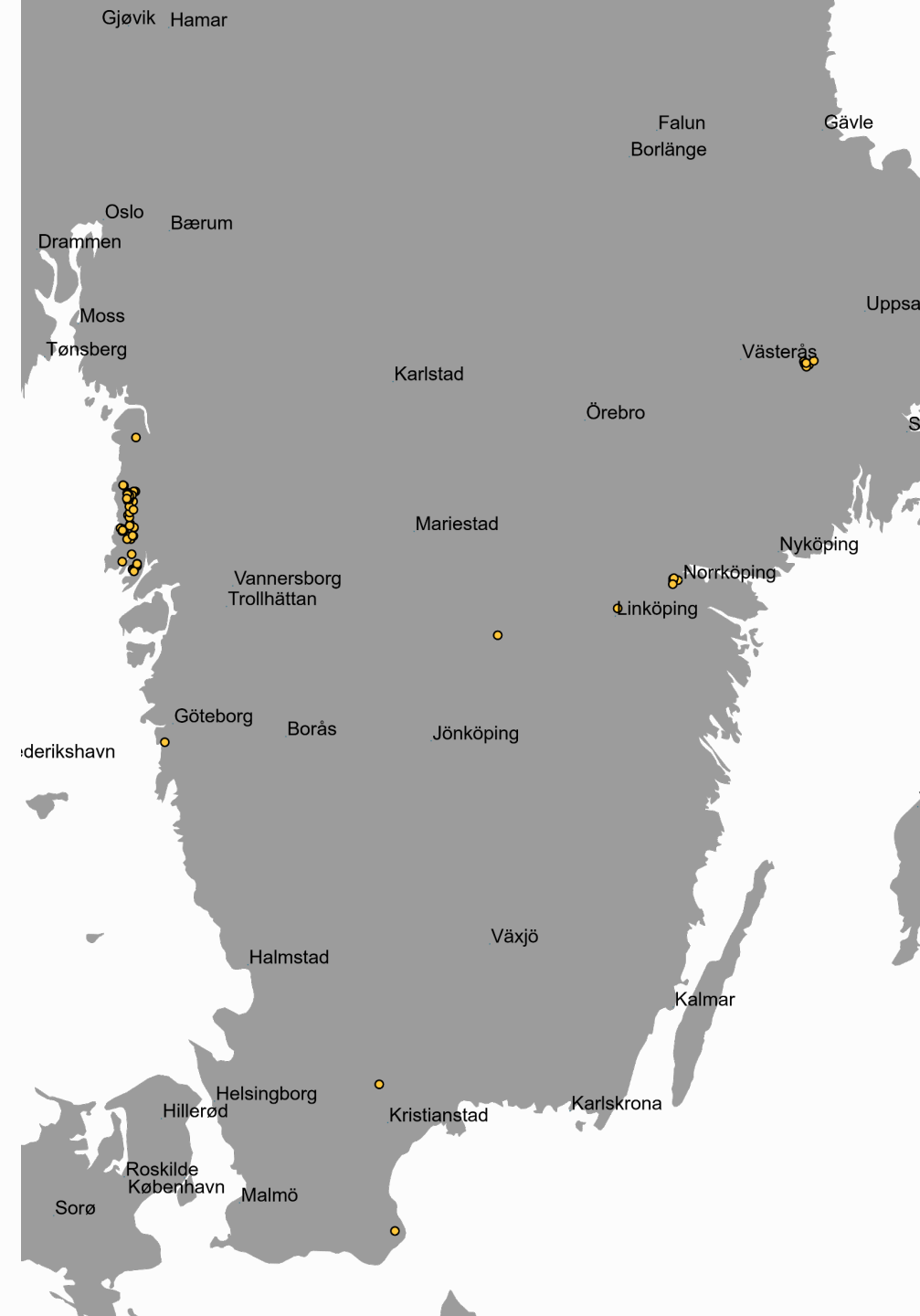
- Small objects
- Superimpositions (Overlapping motifs)
- Updated motifs
- Eroded motifs
- Inclusion of natural rock features
- Similar shapes
- Variability within classes
- Overrepresentation of some classes



Dataset – Current State

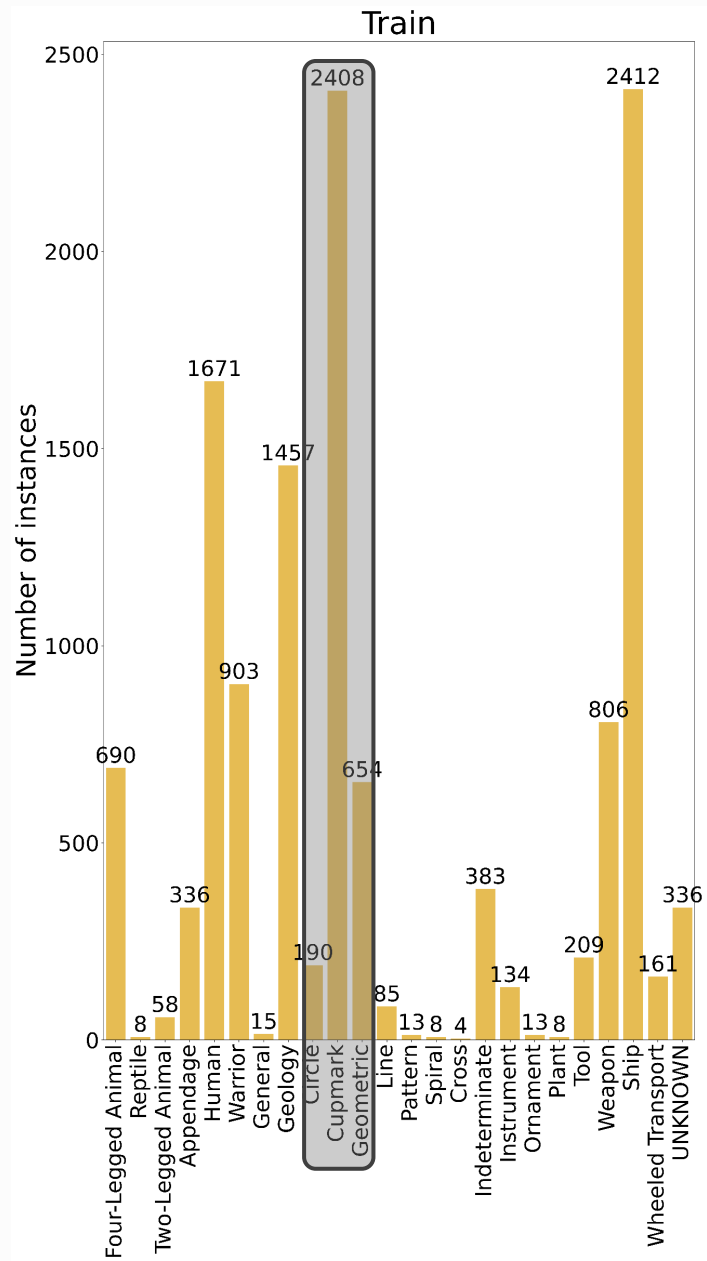
- Full dataset of **418** 3D models (laser scan and SfM)
- Use enhanced greyscale visualisations
- 2 interns annotated a sample of **375** visualisations in ArcGIS/QGIS
- Label hierarchy based on keywords in the SHFA database
 - Label (75) > Subcategory (26) > Category (9)

*Dataset contains 3D data from SHFA, Länsstyrelsen Västra Götaland, and Dept of Historical Studies (GU)

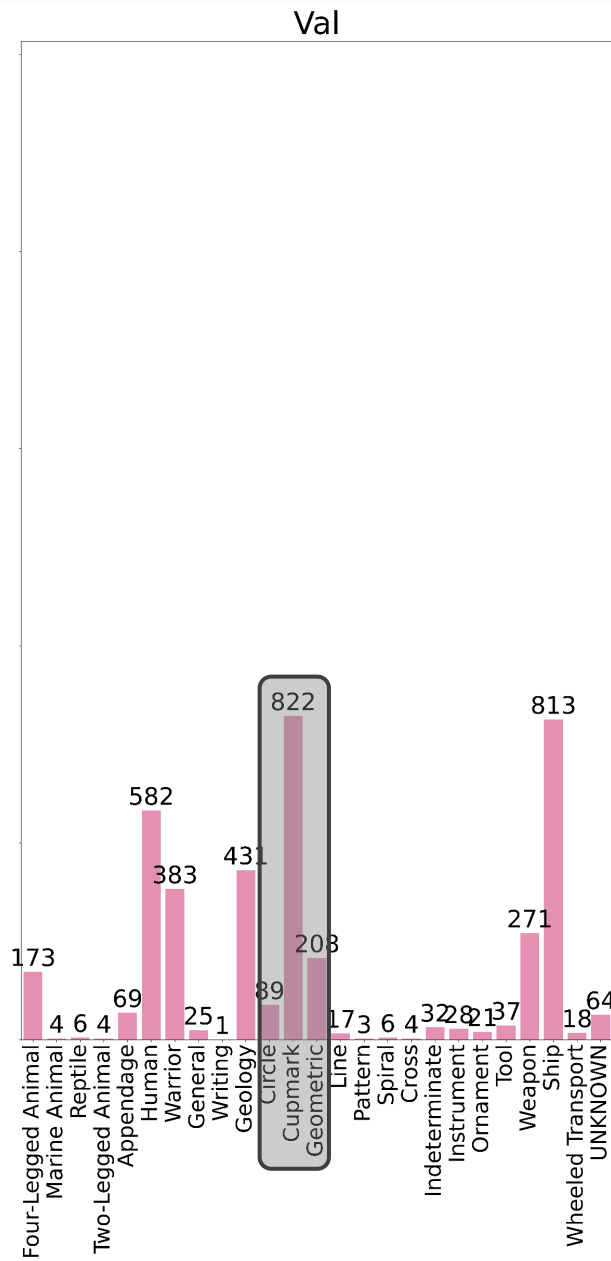


Dataset

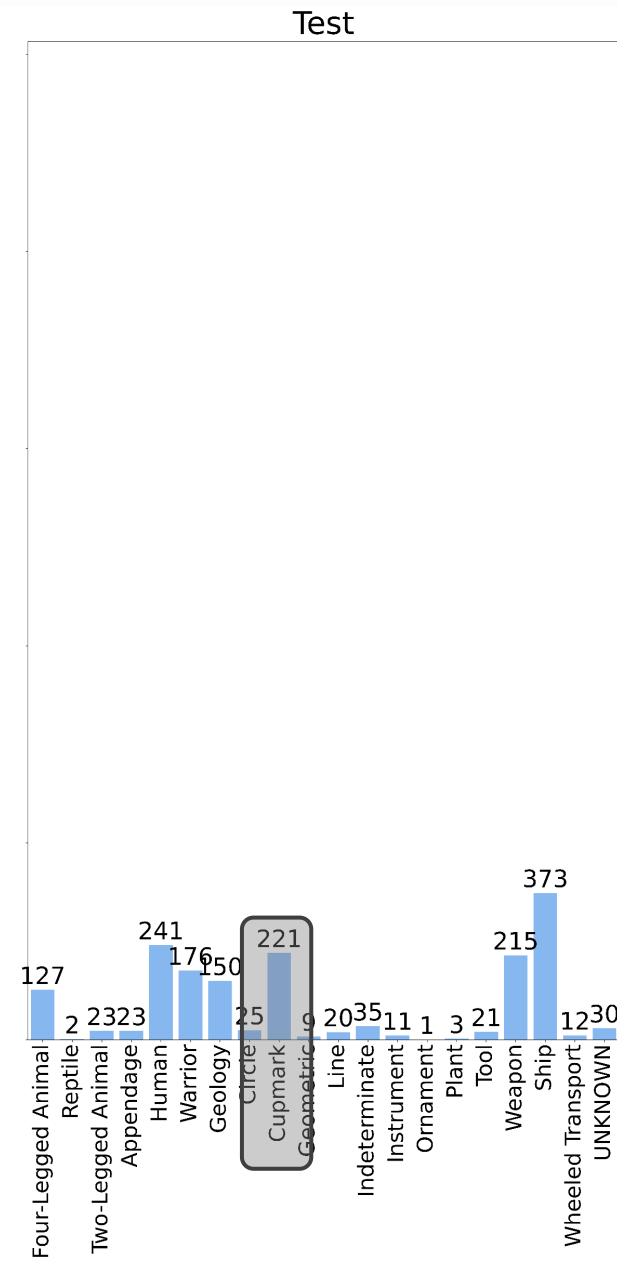
5074 images



1485 images



780 images



Dataset Export

1. Tile images with script in ArcGIS Pro
 - Similar plugins for QGIS (not tested!)
2. Polygons are clipped to the tile extent
3. Extract the vertices of each polygon and calculate their coordinates relative to the new image size
4. Create a text file with the class id and coordinates for each polygon in an image

Dataset Export

Polygon

Class ID

X Y coordinate

24 0.9995117184994227 0.10527343872710726 0.9986328128329337 0.10869140712716496 0.9967773435968559 0.10566406306346043 0.9938476565260681 0.10087890584818804 0.9913085937917222 0.09619140653599345 0.9884765628050449 0.09140625113971057 0.9851562504883205 0.08730468833204552 0.9823242185921485 0.08251953111677324 0.9793945315213607 0.07783203180457865 0.9768554687870148 0.07314453249238395 0.974121093884448 0.06835937527711167 0.9714843750659916 0.06367187596491708 0.9689453123316458 0.058886718749644684 0.9664062495972999 0.0541992194374501 0.9641601560247801 0.04941406222217781 0.9617187502840394 0.04462890682589493 0.9595703127956302 0.040332031850053296 0.9578124996436628 0.035839844706035295 0.9570312500612843 0.029394532242272953 0.9566406248153477 0.024511718942912375 0.9572265622295053 0.02050781221933562 0.9584960940514256 0.015429688570787858 0.9593749997179145 0.010351563103250805 0.9599609371320721 0.006347656379674049 0.9607421876239453 0.001464844899302875 0.9638671877724487 0.0004882822394307595 0.9667968748432365 0.0004882822394307595 0.969726562823519 0.0004882822394307595 0.9726562498943068 0.0004882822394307595 0.9750976565445422 0.0004882822394307595 0.978515624945377 0.0004882822394307595 0.982421874676259 0.0004882822394307595 0.9853515626565414 0.0004882822394307595 0.9877929683972821 0.0004882822394307595 0.9907226563775646 0.0004882822394307595 0.9931640621183053 0.0004882822394307595 0.9960937500985878 0.0004882822394307595 0.9993164063312017 0.001660157067479462 0.9995117184994227 0.0057617198751444 0.9995117184994227 0.009667968695643459 0.9995117184994227 0.01357421933513192 0.9995117184994227 0.016503907314748267 0.9995117184994227 0.01943359347537521 0.9995117184994227 0.022363281454991557 0.9995117184994227 0.025292969434607904 0.9995117184994227 0.02822265741422425 0.9995117184994227 0.031152343574851193 0.9995117184994227 0.035058594214339656 0.9995117184994227 0.03847656261439736 0.9995117184994227 0.040917968354582945 0.9995117184994227 0.04384765633419929 0.9995117184994227 0.04677734431381564 0.9995117184994227 0.049707032293431985 0.9995117184994227 0.05263671845405893 0.9995117184994227 0.055566406433675275 0.9995117184994227 0.05849609441329162 0.9995117184994227 0.06142578239290797 0.9995117184994227 0.06533203121340703 0.9995117184994227 0.06874999961346473 0.9995117184994227 0.07119140717263972 0.9995117184994227 0.0741210933326666 0.9995117184994227 0.07705078131288301 0.9995117184994227 0.07998046929249936 0.9995117184994227 0.0829101572721157 0.9995117184994227 0.08583984343274265 0.9995117184994227 0.08876953141235899 0.9995117184994227 0.09169921939197534 0.9995117184994227 0.09462890737159169 0.9995117184994227 0.09755859353221863 0.9995117184994227 0.10146484417170709 0.9995117184994227 0.10527343872710726

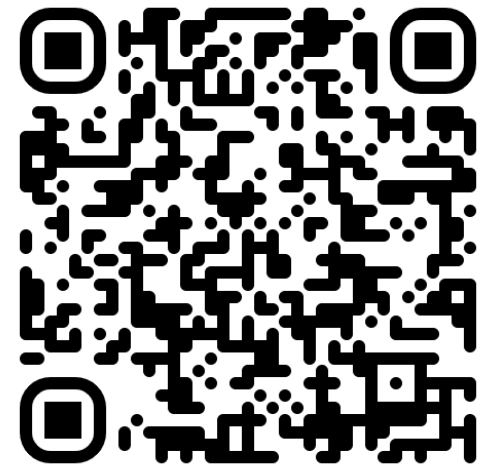
10 0.46367187458104625 0.64238281252629 0.468750000049738 0.6434570312702504 0.4736328124407141 0.6434570312702504 0.47871093790940583 0.6435546873543387 0.4846679690445866 0.6437499995225153 0.4906250001797673 0.6435546873543387 0.4951171873248068 0.6441406256778578 0.49843749964153117 0.647753906246092 0.5016601558741451 0.6504882820575318 0.5053710934368061 0.6531249999658939 0.5101562497436717 0.6522460933901101 0.515136719128253 0.6509765624779732 0.5198242184415134 0.6484375006536993 0.5219726559299227 0.6447265621823874 0.52373046908189 0.6396484385338397 0.5266601561526778 0.6359375000625278 0.5304687497994494 0.6345703130663025 0.5354492191840305 0.6346679691503908 0.5400390624131806 0.6352539074739099 0.5454101561342037 0.6347656252344791 0.5503906246092903 0.6353515635579982 0.555468750077982 0.6358398439784395 0.5613281251290523 0.6353515635579982 0.567285156264233 0.6348632813185674 0.5722656247393196 0.6353515635579982 0.5762695314638068 0.636035156146616 0.5814453121071143 0.6372070309746647 0.5864257814916956 0.6380859375504485 0.5914062499667821 0.6386718758739676 0.5974609371860733 0.6391601562944089 0.6023437495770494 0.6386718758739676 0.6073242189616307 0.6387695319580559 0.6124999996049383 0.6405273432906341 0.6174804689895195 0.6417968760217605 0.6220703122186695 0.6442382817619461 0.6266601563573142 0.6445312500142109 0.6316406248324007 0.6440429695937695 0.6365234372233768 0.643652343438427 0.6424804683585575 0.6431640630179857 0.6483398434096278 0.6426757807785549 0.6533203127942091 0.6426757807785549 0.657421874693312 0.6443359378460343 0.6616210935860201 0.6468749996703081 0.6648437498186339 0.6491210932423173 0.6688476565431211 0.6502929698893553 0.672949218442224

Annotation Demo

Optional: Try annotating a few visualisations of varying difficulty using Label Studio

<https://labelling.dh.gu.se/projects/9/data?tab=12&task=5198>

<https://tinyurl.com/labelling-ra>



Exercise

- Instance segmentation model for cupmarks (using a limited dataset)
- Focus on small object detection
- Export predictions with real-world coordinates



Why cupmarks?

- The minimum estimate of cupmarks in Fennoscandia is 500,000 – making them the most common motif
- Regularly occur in other rock art traditions
- Form patterns that are difficult to research further without vectorised data
- Little variation and high frequency can skew models that include cupmarks with other classes

Exercise

- <https://colab.research.google.com/drive/1jMxgBcO6QY1RwuNIcQuHPjuiqpEwMx78?usp=sharing>
- <https://tinyurl.com/ra-demo>

