Deutsches Archäologisches Institut
Römisch-Germanische Kommission

Goethe Universität Frankfurt am Main
Uni Frankfurt Big Data Lab

Jersey Heritage

Image recognition applied to the hoard of Le Catillon II

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ClaReNet

Classifications and **Re**presentations for **Net**works.

From types and characteristics to linked open data for Celtic coinages

Team

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Goals

Using three Celtic coin series, ClaReNet tests the possibilities and limits of new classification and representation methods. For this purpose, traditional approaches to classification and feature extraction in numismatics and archaeology are compared with IT-based classification methods, including deep learning, and accompanied by a science & technology study.

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Agenda

The hoard of Le Câtillon II

AI-based methods

Conclusion & Findings

Ongoing

The hoard of Le Câtillon II (Jersey)

Philip de Jersey
Domain expert &
Project partner
ClaReNet

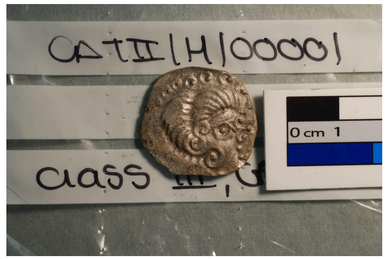
https://oxford.academia.edu/PhilipdeJersey

JERSEY HERITAGE

www.jerseyheritage.org/jersey-s-celtic-coin-hoard

All coin images used in this presentation have been made available by Jersey Heritage.

Digital photos of the coins of the Coriosolitae



The hoard of Le Câtillon II (Jersey)

Size comparison based on **expert** knowledge:

- staters: around 22mm
- quarter staters: around 13mm
- petit billons: similar to quarter staters

petit billon, quarter stater, stater - shown to the same scale

Generated via the images with object detection (**AI**) based on size:

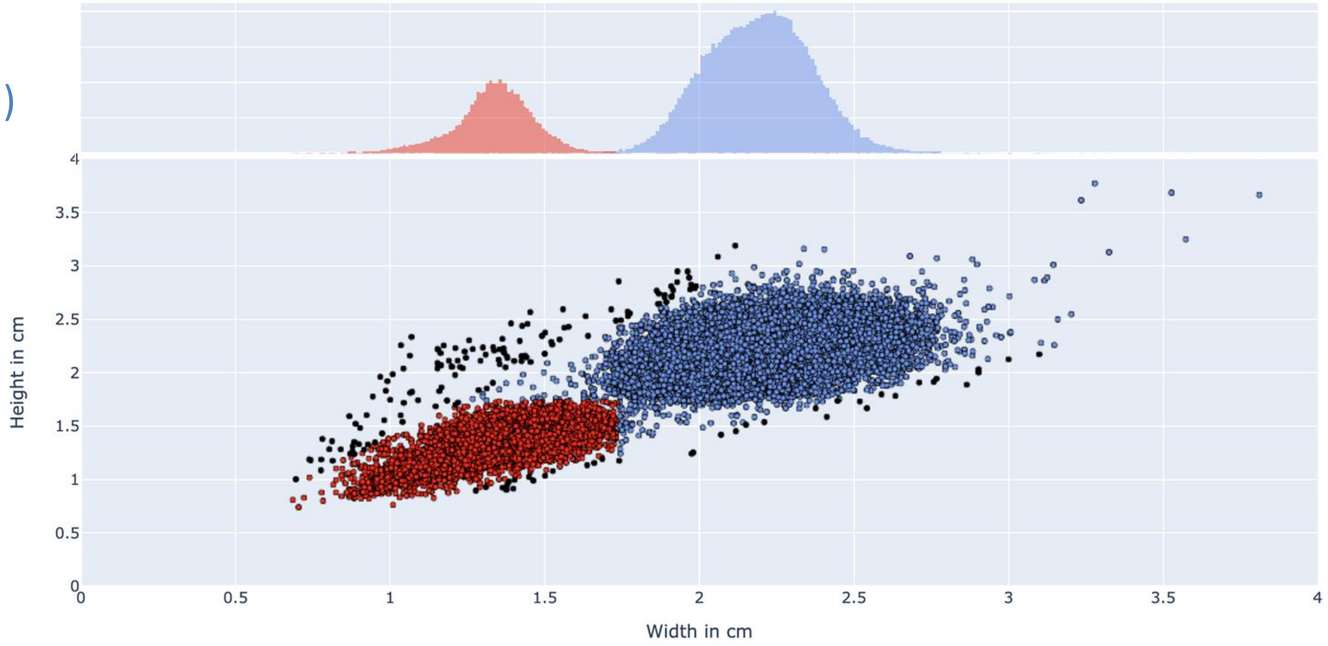
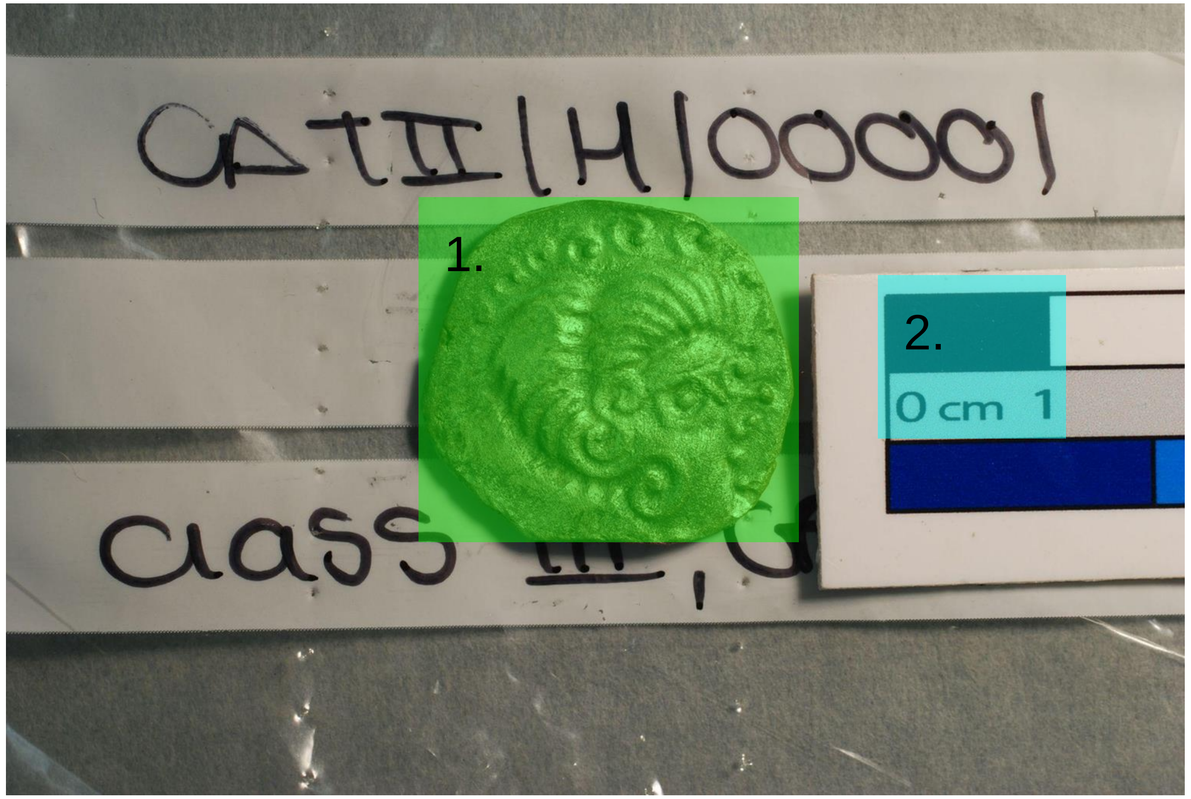


Image areas

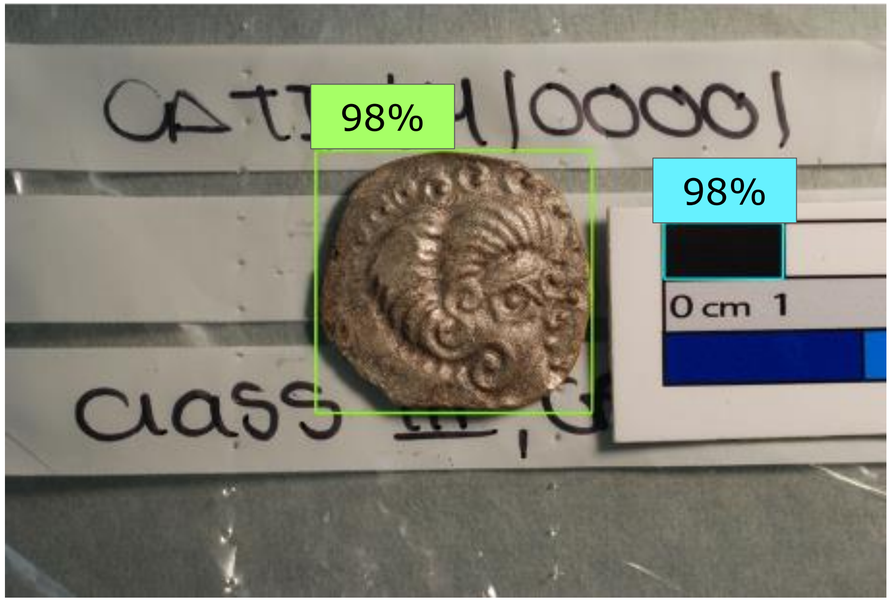


1. Coin
2. Scale (not always there)

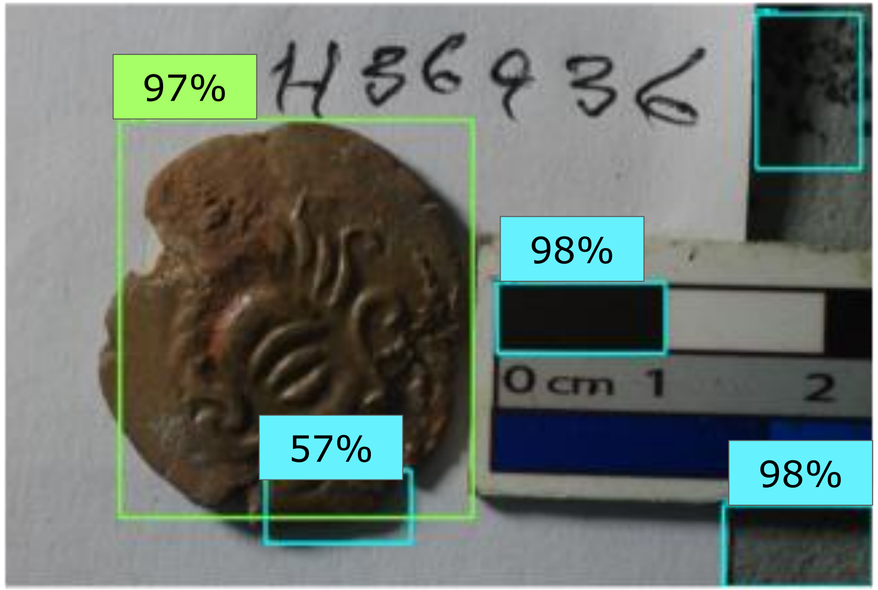
- Use object detection to detect coin and scale (if possible)
- Create a new dataset with cropped coins
- Get a size for each (possible) coin image

Object detection

Optimal detection: ~97%

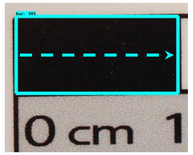


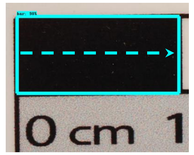
Problematic detection: ~3%



Dark areas get detected as scale, which will result in a bad calculation of the size.

Object detection - extract size





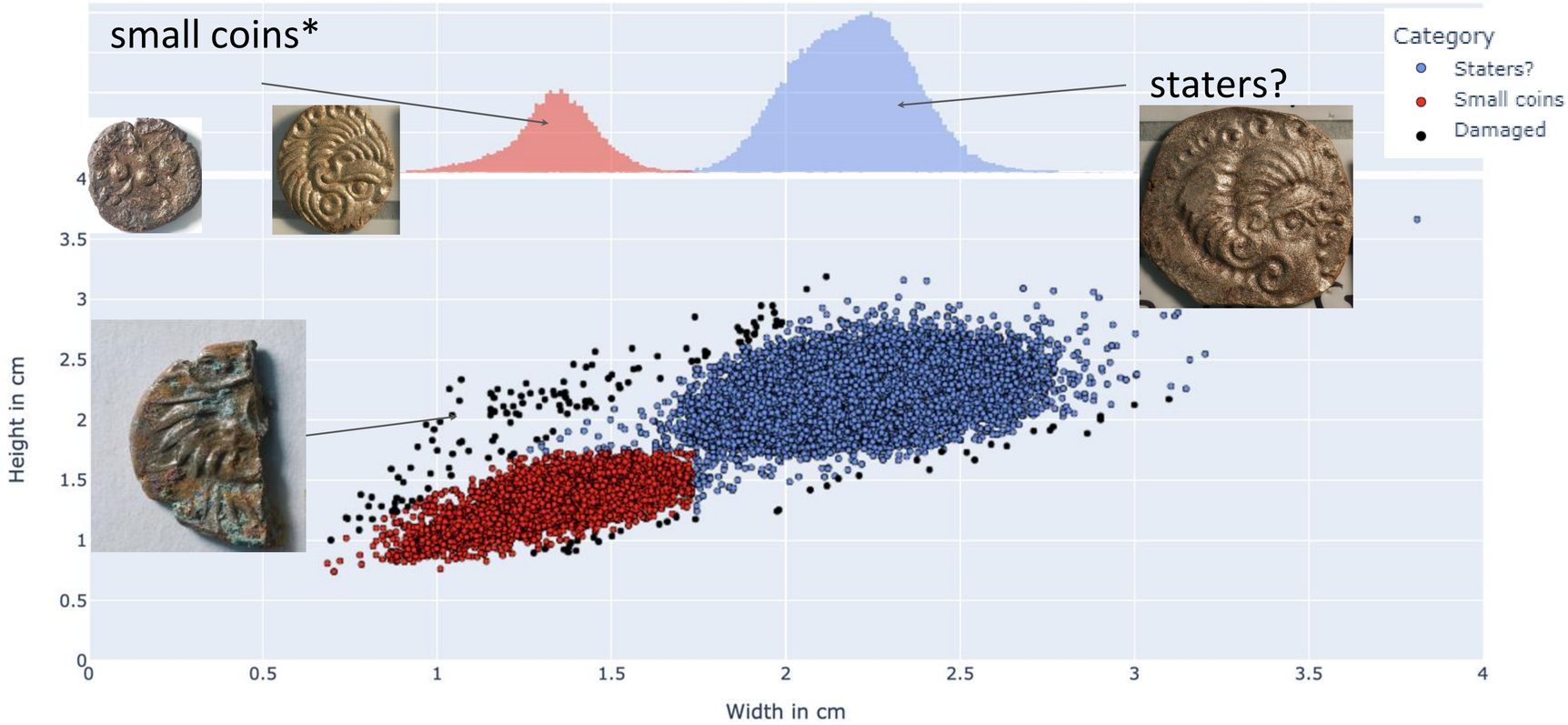
- Four size measurements per coin in cm based (2 per face)
- Height and width (in pixel) of the bounding box will be divided by the width of the bounding box for the scale

CoinID	Obv_length	Obv_width	Rev_length	Rev_width
00001	2.321	2.194	2.211	2.192

Object detection - divide dataset into size areas

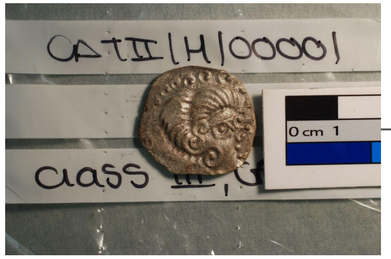
The plot shows the size of obverse and reverse separately.

Two hot areas: 22mm and 13mm, as our domain expert suggested.



*quarter staters or petit billons

Approach



input

Object detection

divide dataset based on size

average size 22 mm

crop image

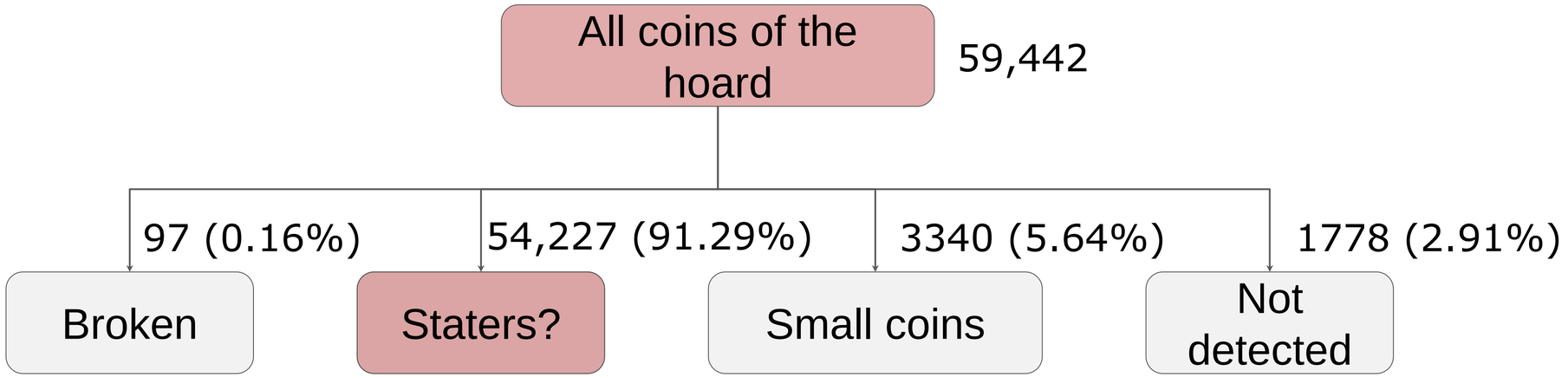
input

Unsupervised learning

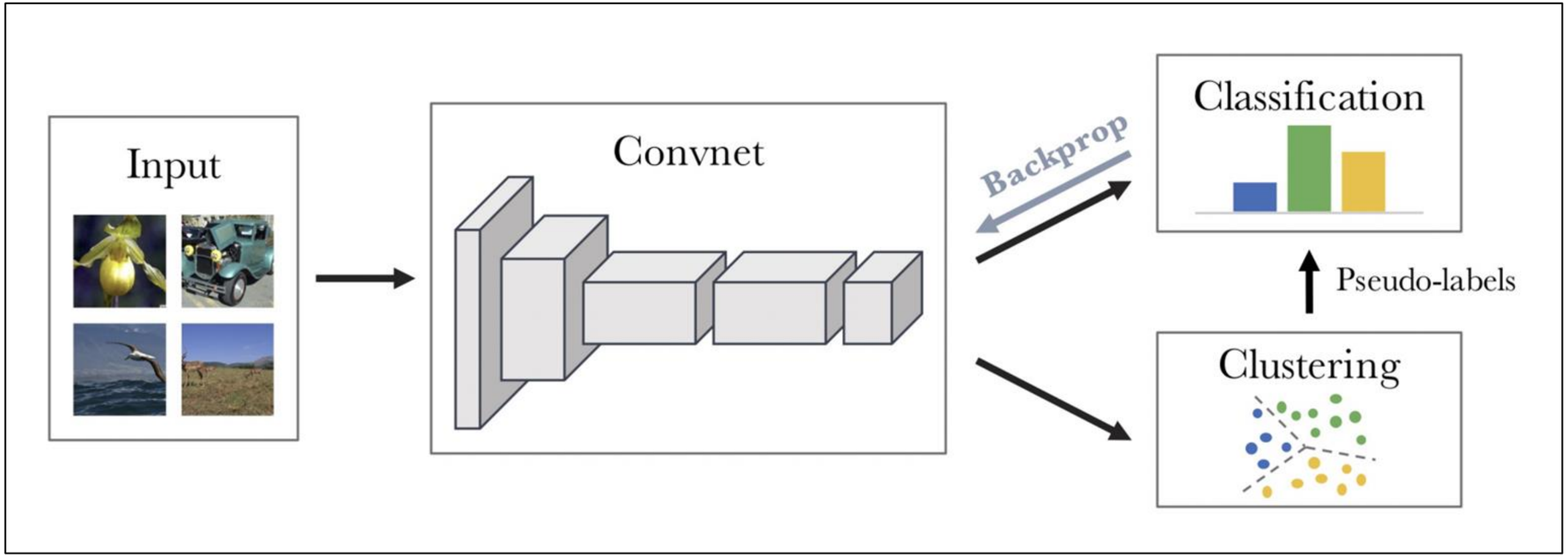
identify classes defined by the domain expert

(Photos: Jersey Heritage)

Divide and conquer methodology



Unsupervised Learning - DeepCluster by Caron et al. 2018



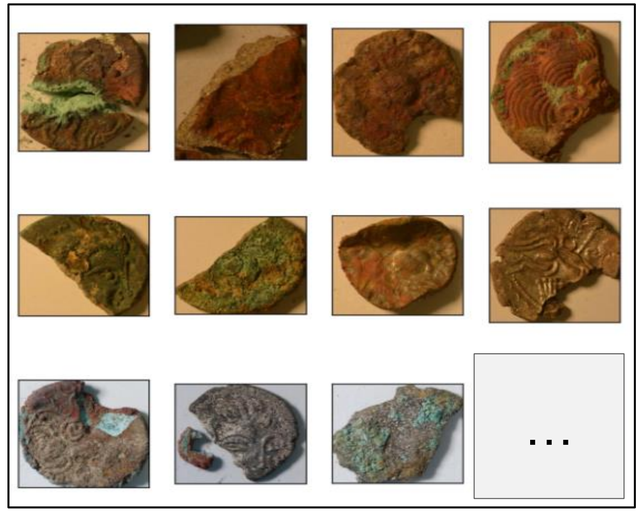
DeepCluster (Caron et al. 2018 Fig.1) *

*https://github.com/facebookresearch/deepcluster

Cluster evaluation (manually)

1. Obverse and reverse images were generally not mixed within clusters
   → shows that the method already works on a high level

2. Coins in poor condition were grouped together
   → can be used to clean the dataset for further process

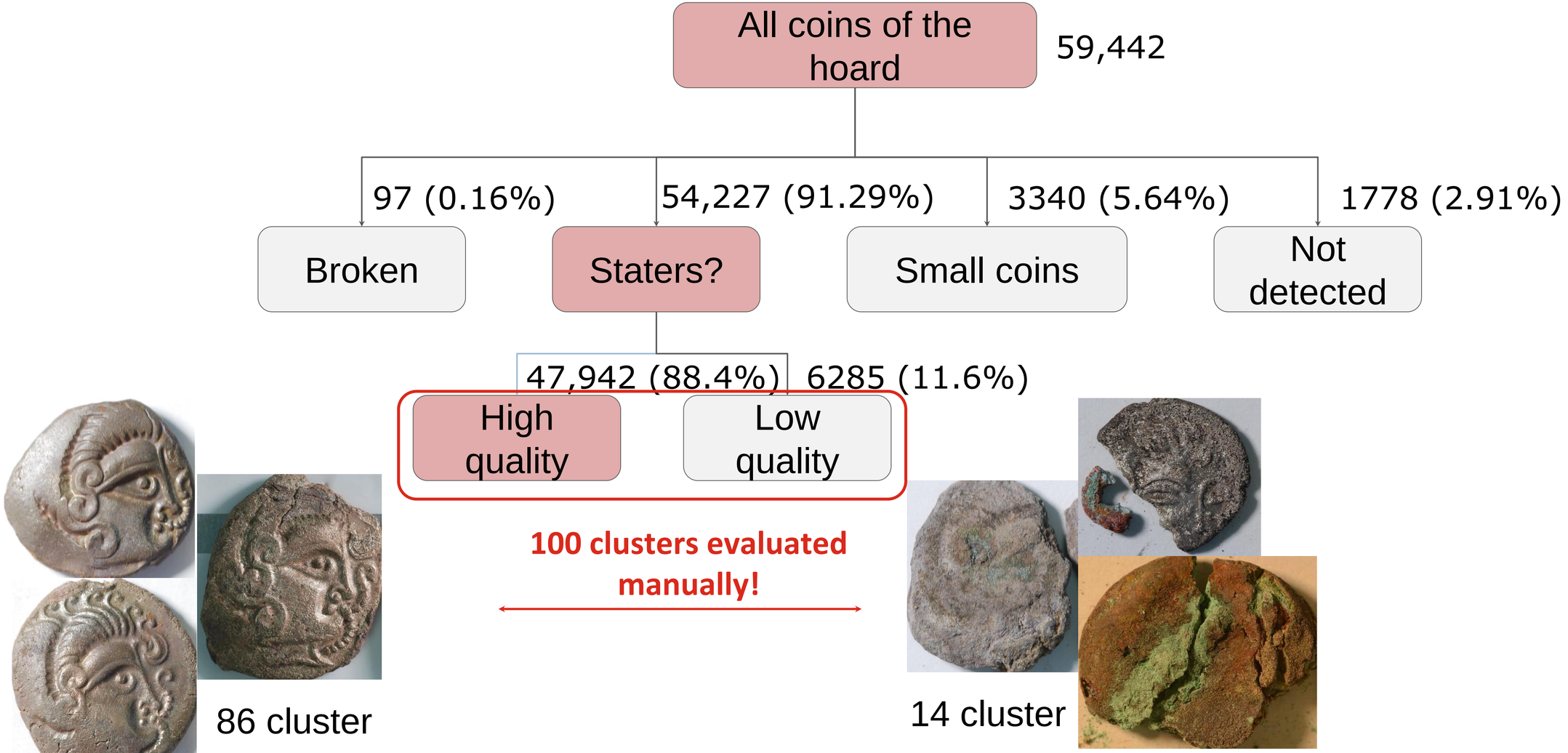


Cluster evaluation (manually)

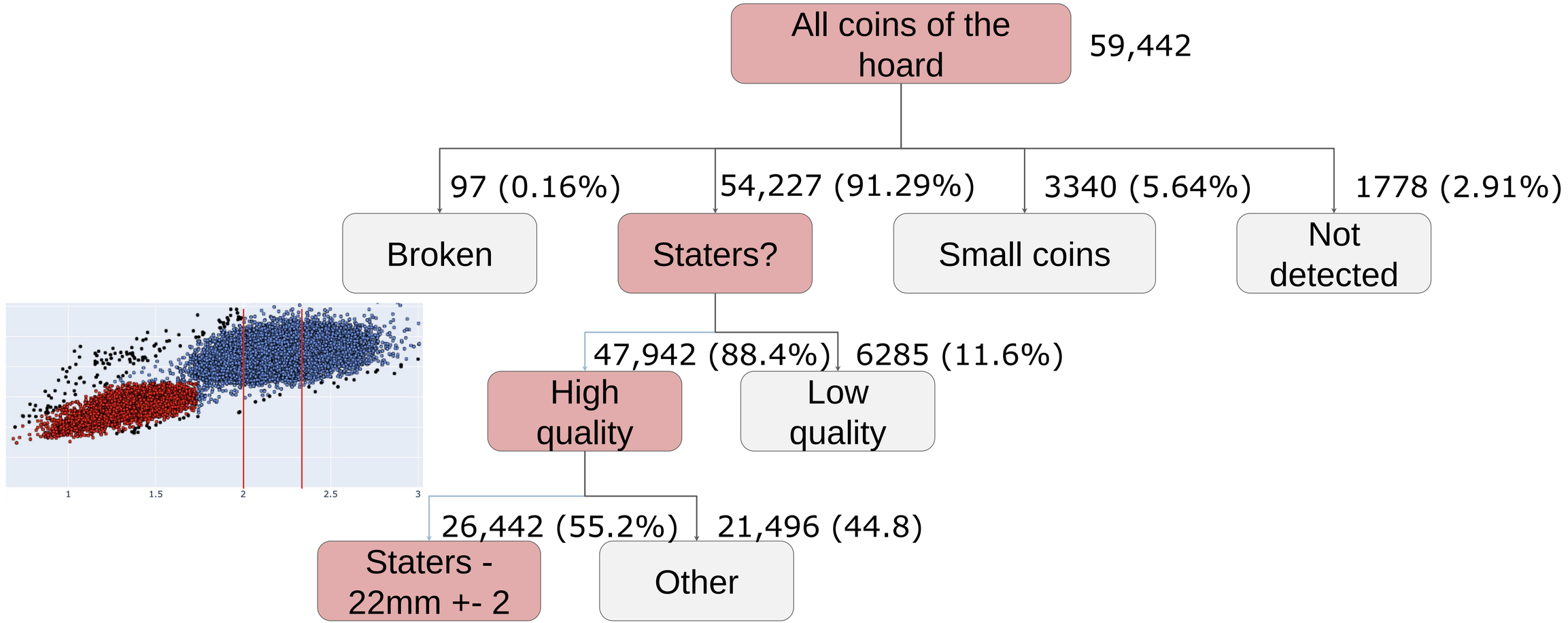
3. Different levels of wear

4. There are also some mixed clusters which do not have a lot in common

Divide and conquer methodology



Divide and conquer methodology



From unsupervised to supervised

22mm +- 2mm area, cleaned dataset - staters

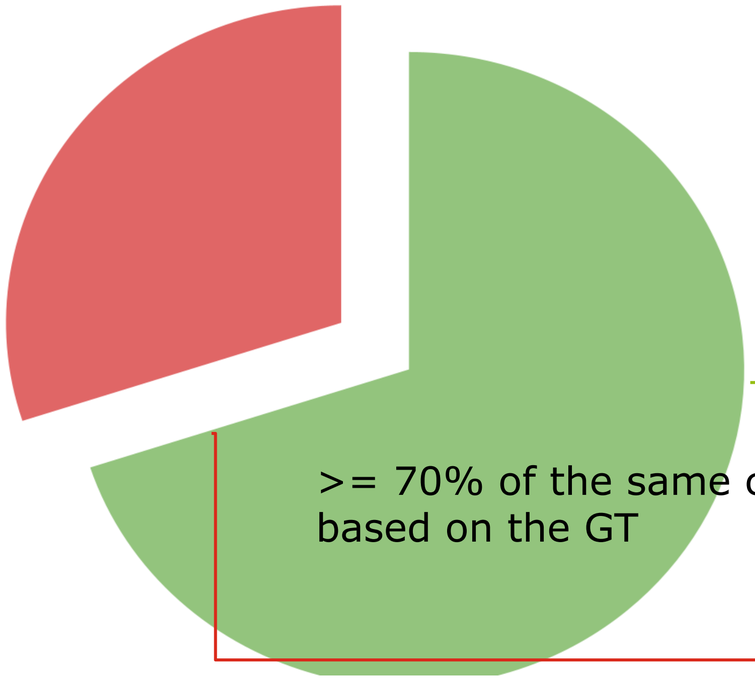
- 26,446 coins in total
- Only obverse images

Cluster$_1$ … Cluster$_{25}$

Ground Truth

compare

Goal: Divide into six classes



Training and Test

Unknown

From unsupervised to supervised

Training and Test

create

Supervised model

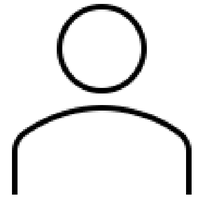
unknown

Predict

if prediction matches GT (X%) ~ 70%

reviewed data

else review with expert (Anzahl)



Review by expert

A list has been created of coins where the model assignment does not match the GT, with masked options (GT and model).

The list was then provided within the team and also to the expert and the coins are to be evaluated against the two options.

ID	Option_1	Option_2	Obverse	Choice	Comments
0	IV	V			
1	IV	V			

From unsupervised to supervised

Label:I
('Class_II', 99.98)
('Class_I', 0.01)
('Class_III', 0.0)

Label:IV
('Class_V', 74.18)
('Class_IV', 23.35)
('Class_I', 1.36)

wrongly labeled in ground truth

From unsupervised to supervised

Label:IV
('Class_III', 61.68)
('Class_IV', 38.2)
('Class_V', 0.12)

Label:V
('Class_V', 52.02)
('Class_IV', 40.58)
('Class_III', 6.17)

Label:V
('Class_IV', 99.36)
('Class_III', 0.49)
('Class_V', 0.1)

discussable / uncertain

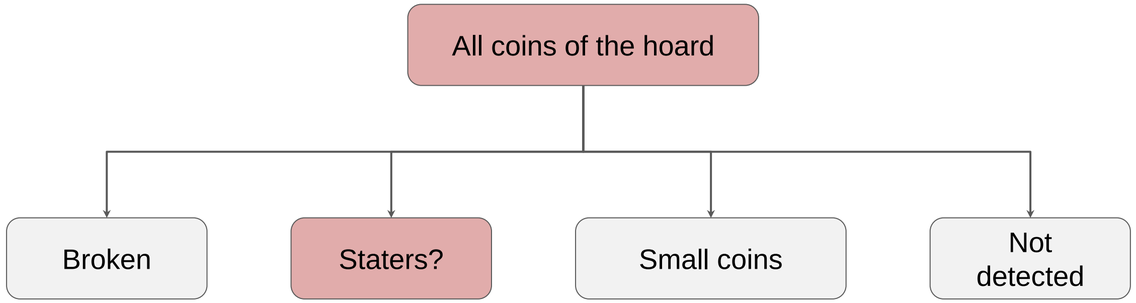
From unsupervised to supervised

Label:IV
('Class_V', 99.77)
('Class_IV', 0.23)
('Class_I', 0.0)

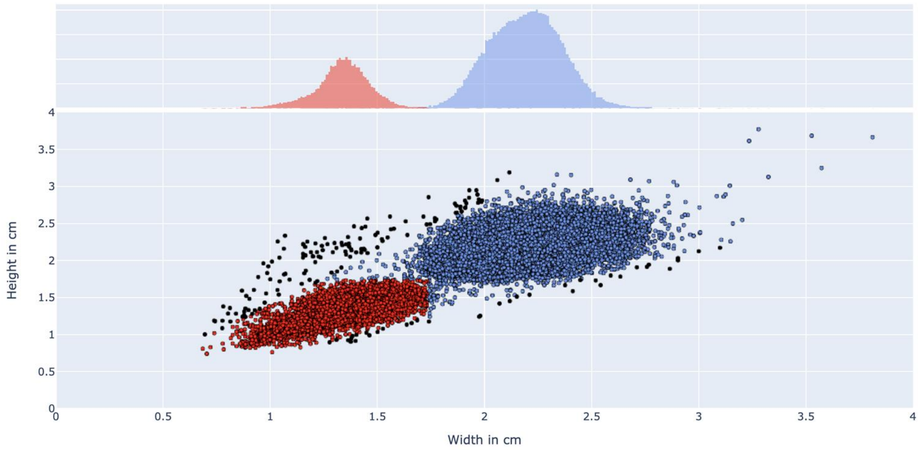
Label:I
('Class_II', 80.23)
('Class_I', 15.75)
('Class_V', 2.35)

wrong predictions
by AI

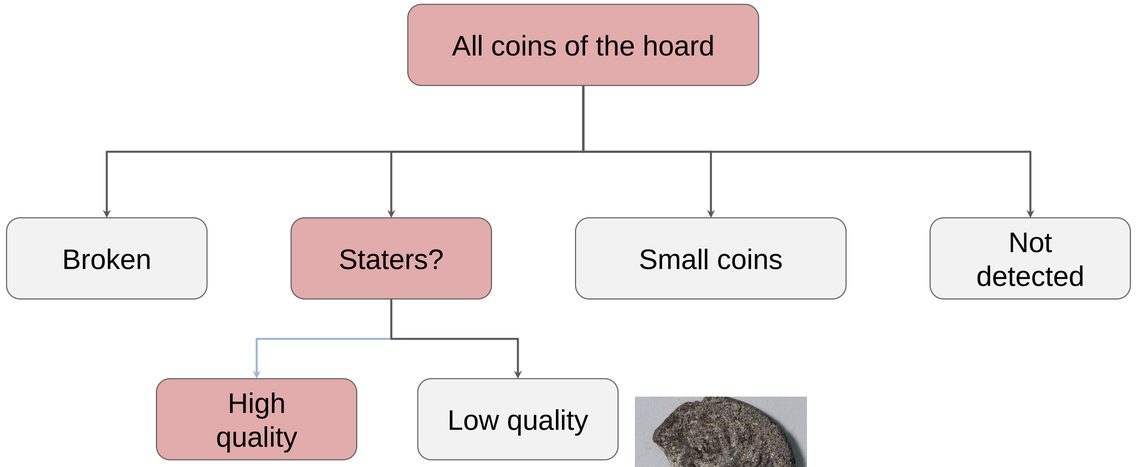
Summary



1. Even where the size information was missing, it was possible to divide the dataset by size, using object detection



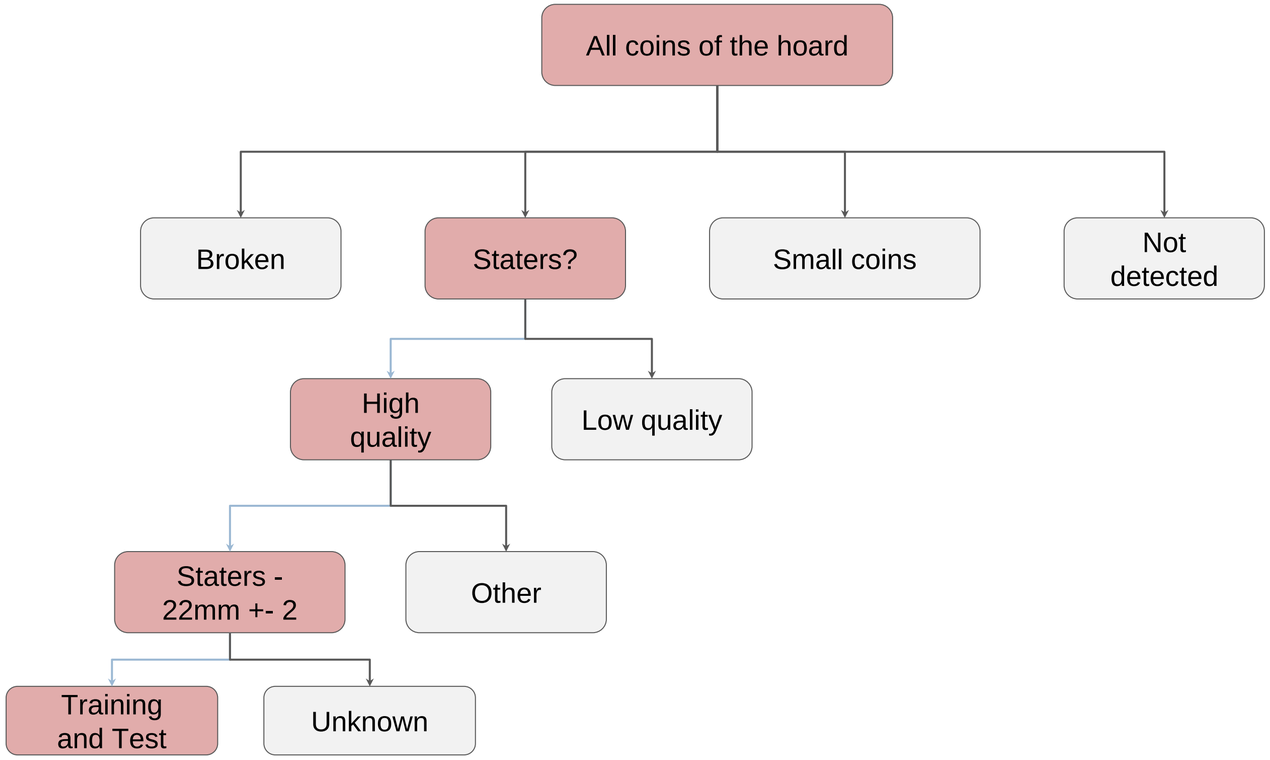
Summary



1. Even where the size information was missing, it was possible to divide the dataset by size, using object detection

1. Using DeepCluster, coins in poor condition were found and coins with a similarity were grouped together

Summary



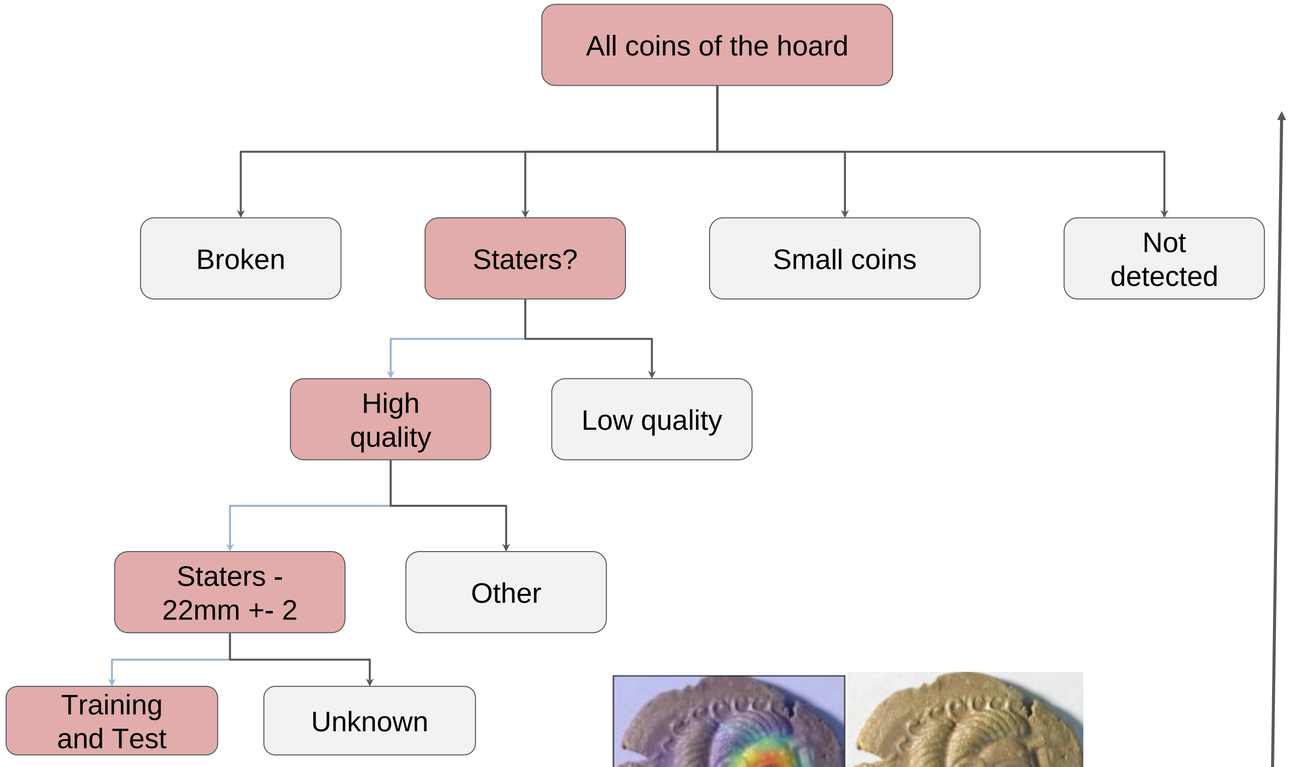
1. Even the size information was missing, it was possible dividing the dataset by size, using object detection

1. Using DeepCluster coins in poor condition were found and coins with a similarity were grouped together

1. By combining step 1+2, a dataset was created consisting mostly of high quality coins of the stater class

1. Applying DeepCluster and evaluating with the provided GT it was possible to create a supervised model

Summary



Label:I
ID:CATII-H-61671A.JPG
('Class_II', 99.98)
('Class_I', 0.01)
('Class_III', 0.0)

1. Review excluded coins with the supervised model
1. Review problematic cases with the domain expert
1. Improve the model & find mistakes in the GT
1. Apply the methodology on the other groups

Conclusions

Unsupervised methods can be used for presorting and in our case also support the existing class definitions (except class VI).

AI methods and humans (non experts) tend to have problems with classes IV, V and VI.
→ should/can this have an impact on defining the Stater classes?

As shown in our case the classes I - V could be supported by our deepcluster approach (for class VI the number of instances were too little).

→ would results based on AI methods be accepted by the community? … what would be the preconditions to accept it?

Thank you
for your attention

References

Caron, Mathilde - Bojanowski, Piotr - Joulin, Armand - Douze, Matthijs, Deep Clustering for Unsupervised Learning of Visual Features. European Conference on Computer Vision 2018

ClaReNet, https://clarenet.hypotheses.org/

Jersey Heritage, www.jerseyheritage.org/jersey-s-celtic-coin-hoard

Tensorflow 2 Object Detection API, https://github.com/tensorflow/models/blob/master/research/object_detection/g3doc/tf2.md

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