



Visual Search and Classification of Art Collections

Andrew Zisserman

Relja Arandjelovic and Florian Schroff

Department of Engineering Science

University of Oxford

Given ...

The Beazley Classical Art Collection at Oxford:

- 100K objects (mainly vases)
- 120K images of these



How can state of the art computer vision algorithms help: art experts? and/or the general public?

The Beazley Classical Art Collection

- maintained by experts for many years
- wealth of information on each vase
- mission statement to make collection available

Shape: amphora, neck;

Fabric: athenian;

Technique: black-figure;

Date: 550-500;

Artist: affecter;

Scholar: gardner;

Decoration: horsemen, draped men, one with spear, youth;
youth and men, some draped, one with spear, one with fillet;
zeus seated on chair (with lion) holding sceptre, hermes, draped
men, some with spears, bird;
youth and men, some draped, with spears;



Two classes of algorithms:

1. Object classification:

- Given a photo of any classical vase, classify it into its shape category, e.g. amphora, aryballos, krater ...
- Use 'GrabCut' of Rother et al for segmentation
- Visual descriptor + supervised classification

2. Exact object matching:

- Given a photo of a vase in the collection, retrieve information on that vase
- Visual google style of Sivic & Zisserman, 2003
- Large scale implementation of Philbin et al, 2007
- Uses visual words to index, affine homography to verify and rank

1. Object (shape) classification

The Objective ...

- Given a photo of a vase
 - classify its shape and retrieve similar vases from the archive



“It is an amphora
... and here are similar
objects in the archive”

What is this?

only shape of **silhouette** used

Next 0 1 2 3 4 5 6 7 8 9 ... 17 Showing vases 1 to 50 of 858.



Shape Representation

original image



foreground separation



silhouette representation



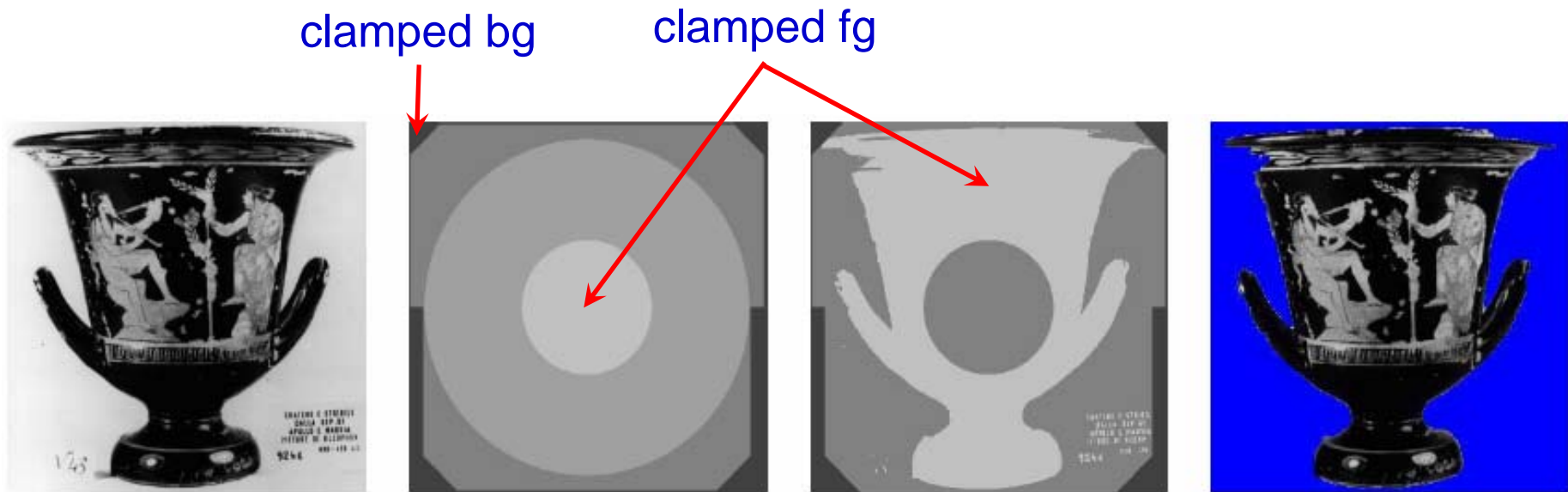
vector

$$\begin{bmatrix} X_1 \\ X_2 \\ \cdot \\ \cdot \\ \cdot \\ X_n \end{bmatrix}$$

x

- No representation of patterns or surface markings
- 100-dimensional “vase shape space”

Shape segmentation - details

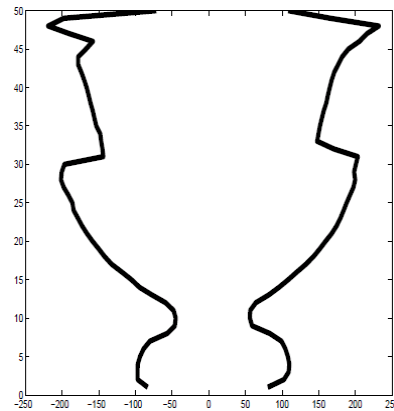


input

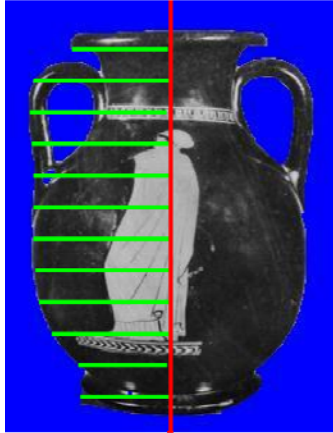
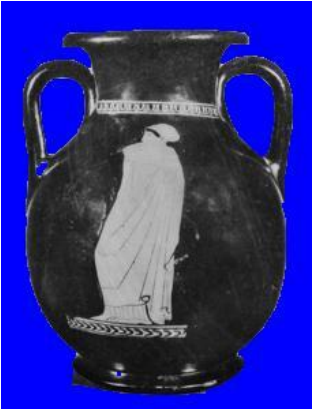
1st stage of
GrabCut

2nd stage
of GrabCut

segmentation



Shape Representation- details

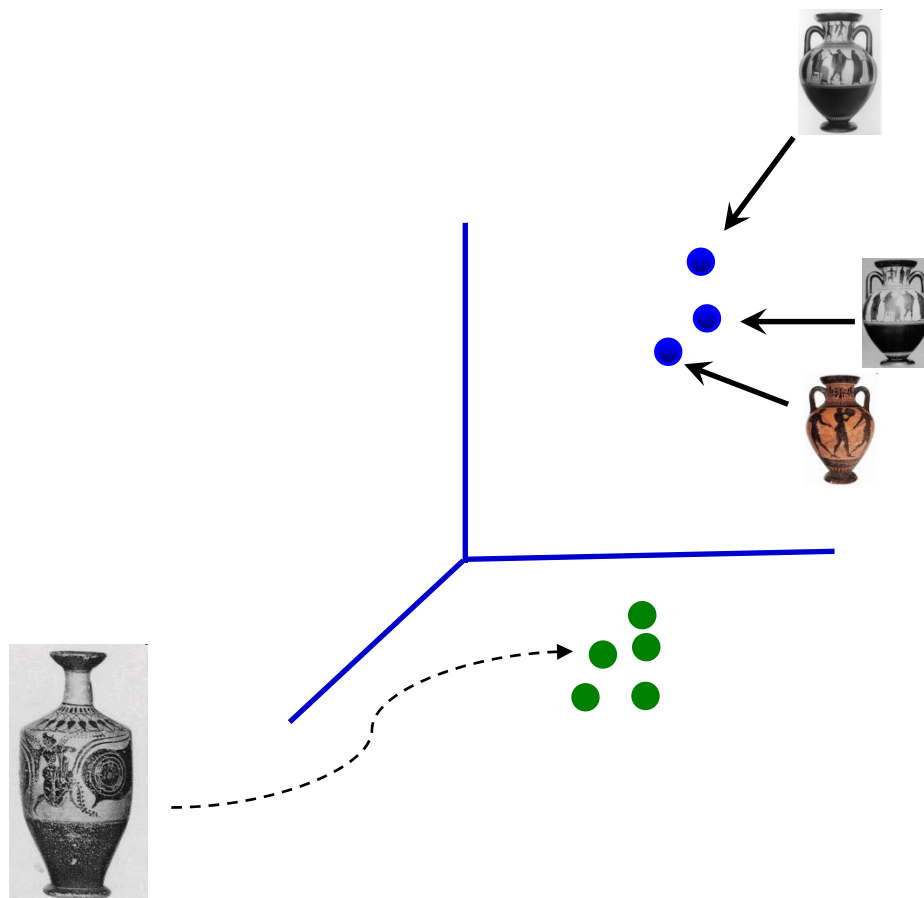


silhouette
(both sides)

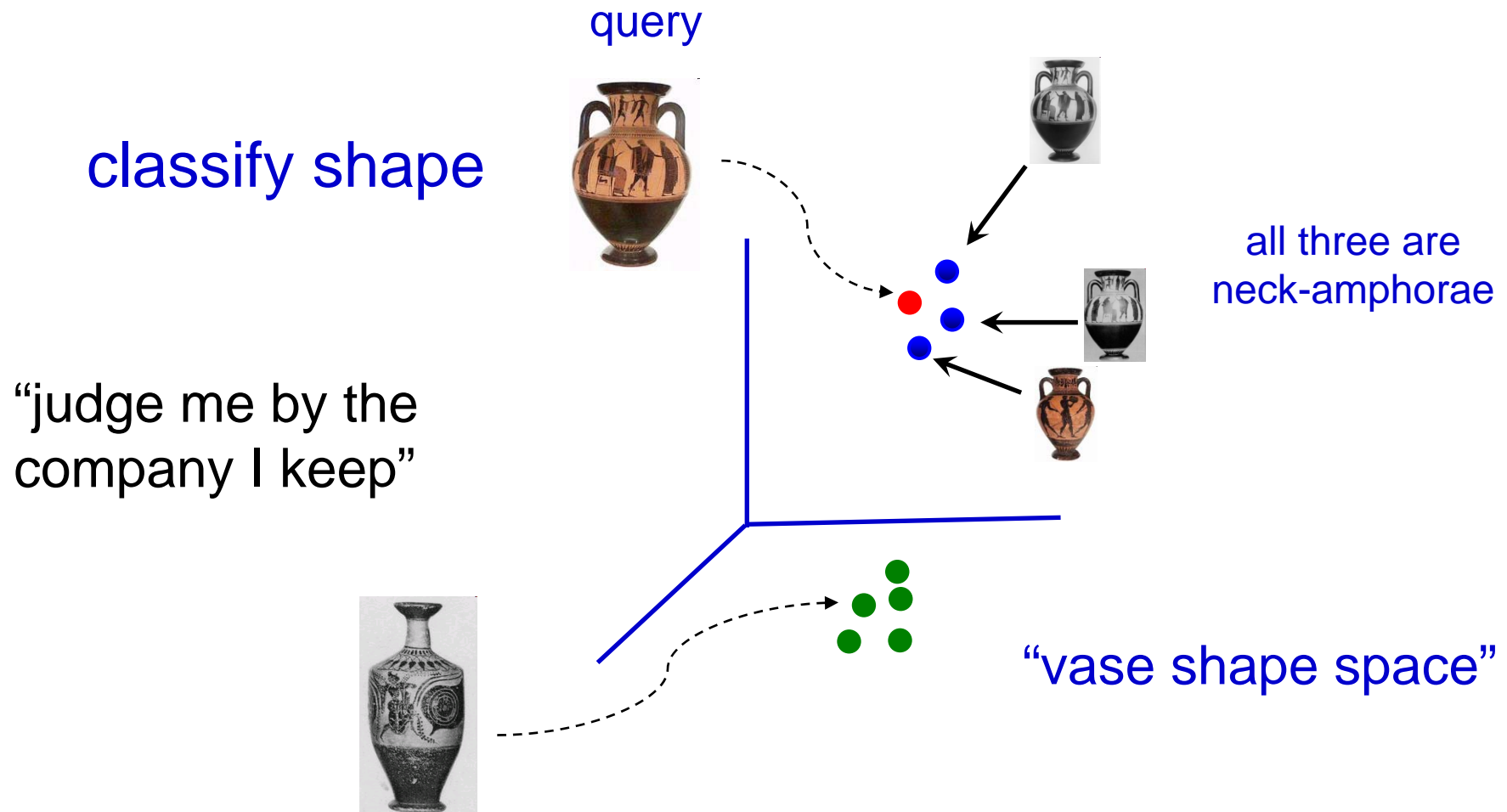


handles

Vase shape space



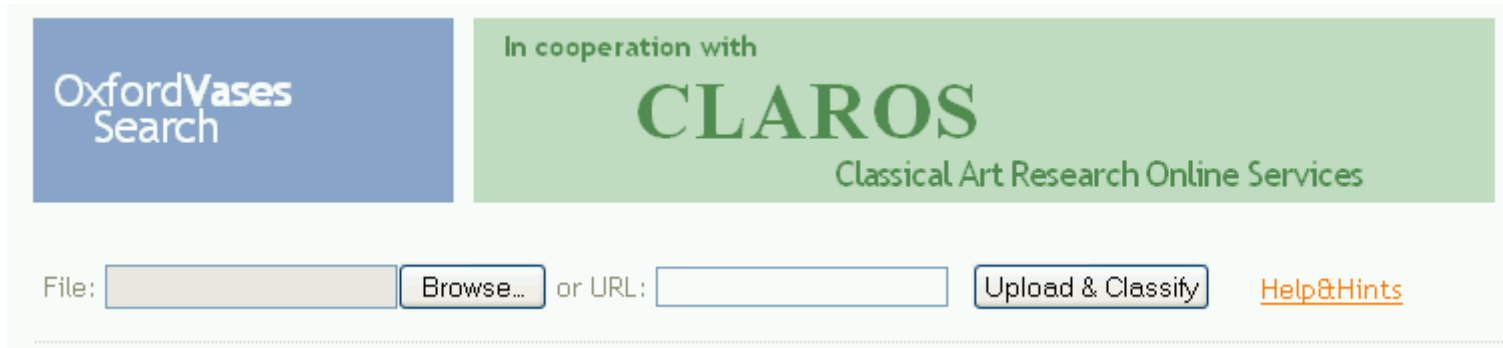
3 nearest neighbour classifier



- use random forest of KD trees for approximate NN search

Step by step demonstration:

Step 1: upload image



The screenshot shows the OxfordVases Search interface. On the left, there is a blue box with the text "OxfordVases Search". To the right, a green banner reads "In cooperation with CLAROS Classical Art Research Online Services". Below this, there is a form with a "File:" label, a text input field, a "Browse..." button, the text "or URL:", another text input field, an "Upload & Classify" button, and a "Help&Hints" link.

URL: <http://arthur.robots.ox.ac.uk:8088/>

Step by step demonstration:

Step 2: classify shape






OxfordVases Search

In cooperation with
CLAROS
Classical Art Research Online Services

File: Browse... or URL: Upload & Classify [Help&Hints](#)

Shape is **amphora neck** (click for shape timeline).

Uploaded vase-image Foreground separation Top 3 matches

('amphora', 'neck') ('amphora', 'neck') ('amphora', 'neck')

Step by step demonstration:

Step 3: matches in the Beazley archive



Application: check for inconsistent labelling in archive

Method:

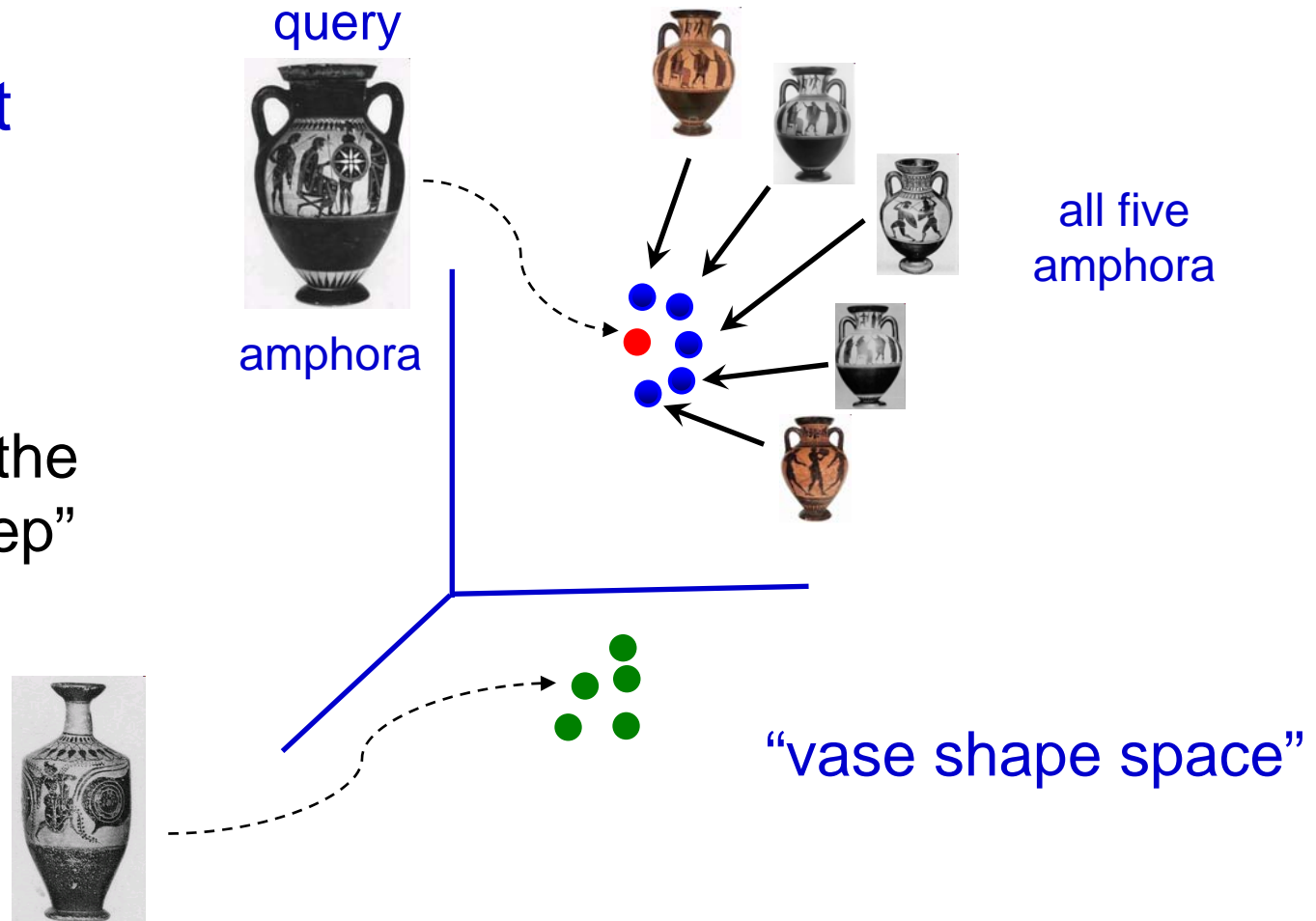
- use each image in turn as a query
- determine if predicted shape class matches labelled class

Result: there are many mistakes (hundreds)

Compute five nearest neighbours for each vase

consistent
labelling

“judge me by the
company I keep”



Require:

- five nearest neighbours to have the same label
- and to be within a distance of 7000

Mislabeledled (about 185)

Example



('amphora', ")



('lekythos',
'squat')



('lekythos',
'squat')



('lekythos',
'squat')



('lekythos',
'squat')



('lekythos',
'squat')

Incompletely labelled (about 82)

Example



('amphora', '')



('amphora',
'panathenaic')



('amphora',
'panathenaic')



('amphora',
'panathenaic')



('amphora',
'panathenaic')



('amphora',
'panathenaic')

Subclass does not agree

Correcting vase meta-info records

- Provided a tool to easily check potentially mislabelled vases
- Web-interface to amend shape annotation and correct mis- or incomplete labels
- Next: relax strict requirements for inconsistent labeling ...

2. Particular object retrieval

The Objective ...

- Retrieve images from the collection using only **visual** information
 - retrieval based on exact match of **surface markings** and shape



Visually defined query

?



Example

Search results

query



Search results 1 to 20 of 122196

1

Abspath: /data3/vases/allcc001001/Images100/00/7207.colour2/CC001001.JPE
Score: 444.0



2

Abspath: /data3/vases/allcc001001/Images100/00/7207.part/CC001001.JPE
Score: 11.0



3

Abspath: /data3/vases/allcc001001/Images100/00/7207.colour/CC001001.JPE
Score: 11.0



4

Abspath: /data3/vases/allcc001001/Images100/203/203805.B.DRAW/CC001001.JPE
Score: 0.016676
Warning: Score is low - result may be incorrect



Upload query image from file or URL

Example

Search results

query



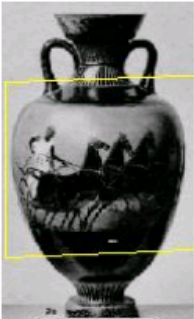
1

Abspath: allcc001001/Images200/011012/303121.B/CC001001.jpe
Score: 10.0



2

Abspath: allcc001001/Images200/GB01/CVA.GB01.31.2b/CC001001.jpe
Score: 5.0
Warning: Score is low - result may be incorrect





Application: check for duplicate vases in archive

Method:

- use each image in turn as a query
- determine if all the matching vases have the same id

Result: there are many duplicates (thousands)

Examples: exact duplicates – same image, different object in database

<p>alcc001001/Imag000/P107CVA.P10.462.1/CC001001.jpg [151.22245-8340-481A-4C034C-42877819]</p> 	<p>Filename read0</p> <p>View</p> <p>Score: 2873</p>	<p>alcc001001/Imag000/P107CVA.P10.462.2/CC001001.jpg [10375C-33 C910-4912-4A0F-16840A198533]</p> 
<p>alcc001001/Imag000/G2H10/CVA.G2H10.408.3/CC001001.jpg [710F8057-C1CA-4675-9A98-4E991A85019C]</p> 	<p>Filename read0</p> <p>View</p> <p>Score: 2727</p>	<p>alcc001001/Imag000/G2H10/CVA.G2H10.408.3/CC001001.jpg [710F8057-C1CA-4675-9A98-4E991A85019C]</p> 
<p>alcc001001/Imag000/G2H10/CVA.G2H10.408.3/CC001001.jpg [710F8057-C1CA-4675-9A98-4E991A85019C]</p> 	<p>Filename read0</p> <p>View</p> <p>Score: 2881</p>	<p>alcc001001/Imag000/G2H10/CVA.G2H10.408.3/CC001001.jpg [710F8057-C1CA-4675-9A98-4E991A85019C]</p> 
<p>alcc001001/Imag000/010913/20203A/CC001001.jpg [1CCC208F-A328-4751-9F18-448C126R991]</p> 	<p>Filename read0</p> <p>View</p> <p>Score: 2819</p>	<p>alcc001001/Imag000/010913/20203A/CC001001.jpg [1CCC208F-A328-4751-9F18-448C126R991]</p> 

283 of these

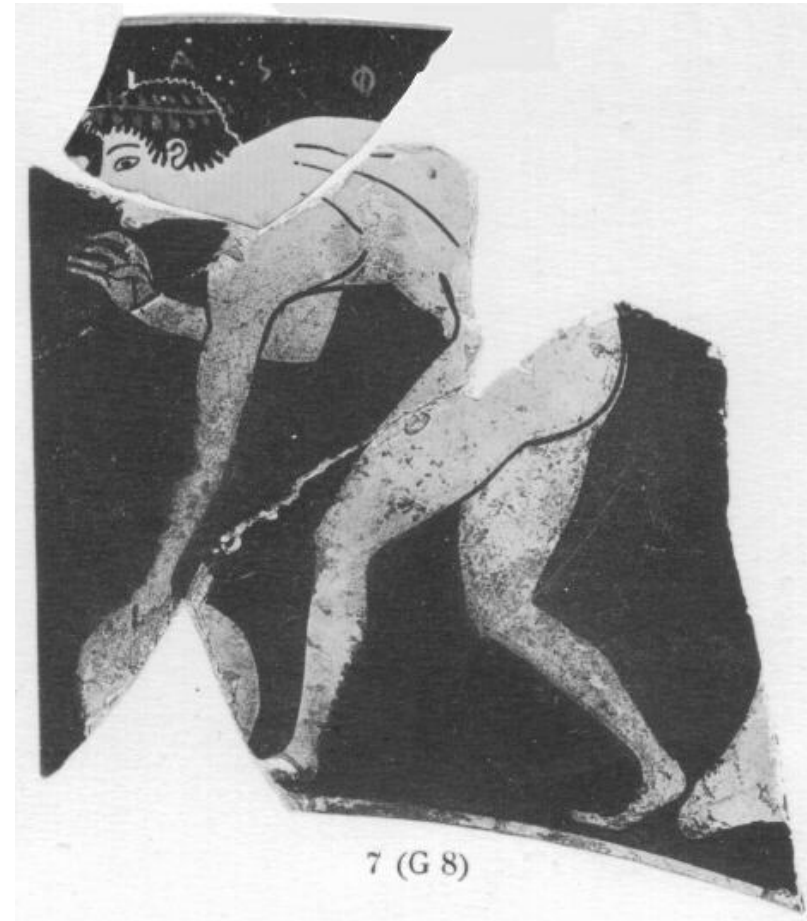
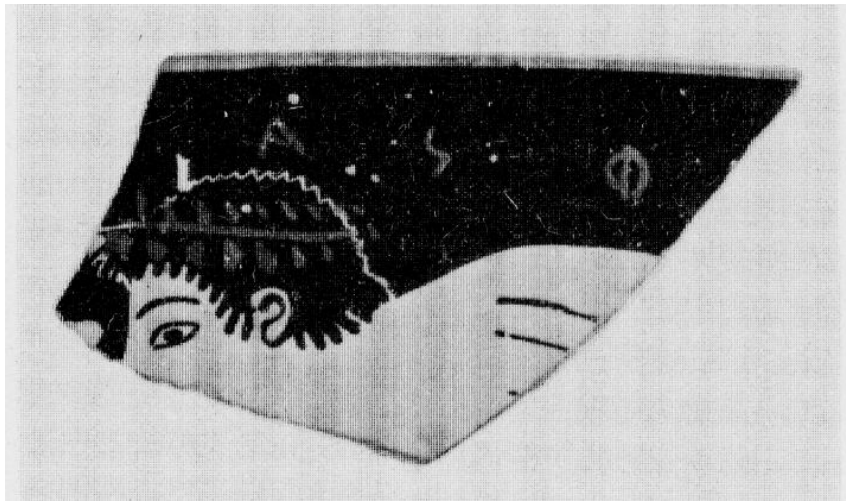
Close ups and sub images (1559 of these)

Example 1/3



Close ups and sub images (1559 of these)

Example 2/3



Close ups and sub images (1559 of these)

Example 3/3



Duplicate candidates (3543)

Example 1/6



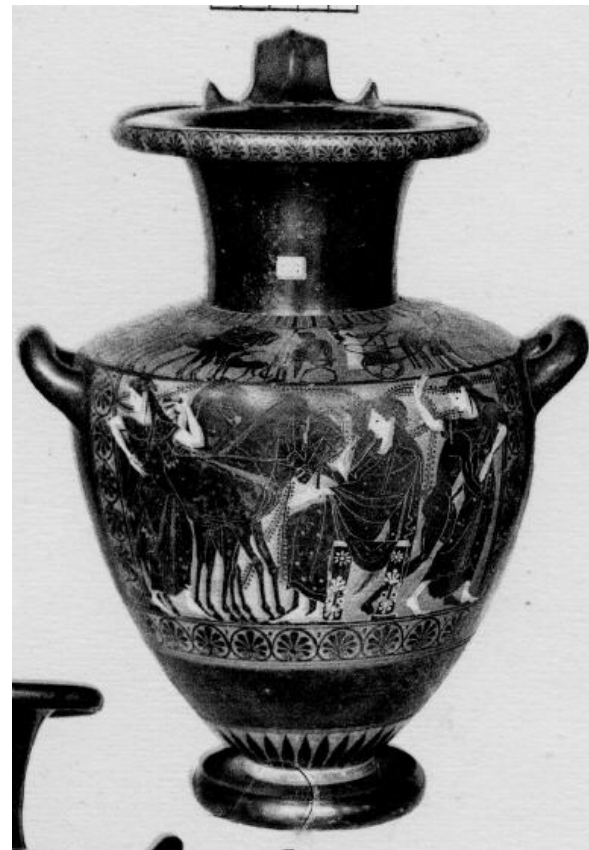
Duplicate candidates (3543)

Example 2/6



Duplicate candidates (3543)

Example 3/6



Duplicate candidates (3543)

Example 4/6: **Not a duplicate**



Heracles strangling the Nemean lion

Duplicate candidates (3543)

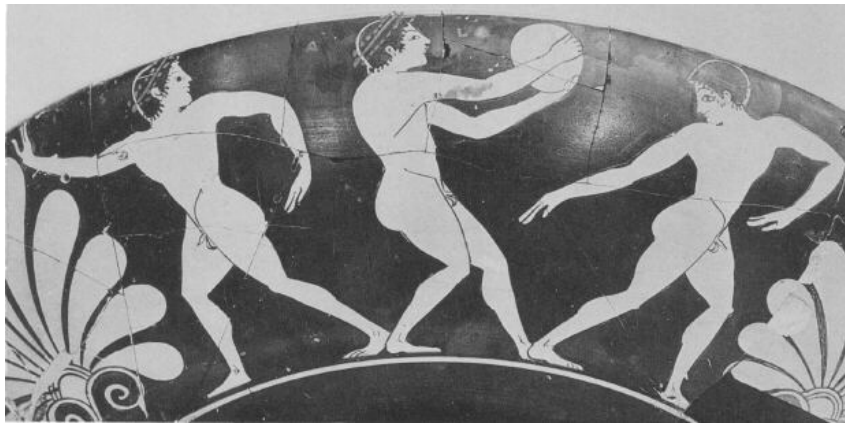
Example 5/6: Not a duplicate



Frontal chariots

Duplicate candidates (3543)

Example 6/6: **Not a duplicate**



Athletes

Summary

- Organization of art collections is entirely text based at present
- Questions that can be answered effortlessly with CV algorithms:
 - Is this object already in the archive?
 - Is this object duplicated in the database (same visual object, more than one entry)?
 - Is this object consistently classified/tagged?
- Futures:
 - visual merging of two databases
 - for vases, classification of decorations
 - also 3D reconstruction