

# Maya Gif

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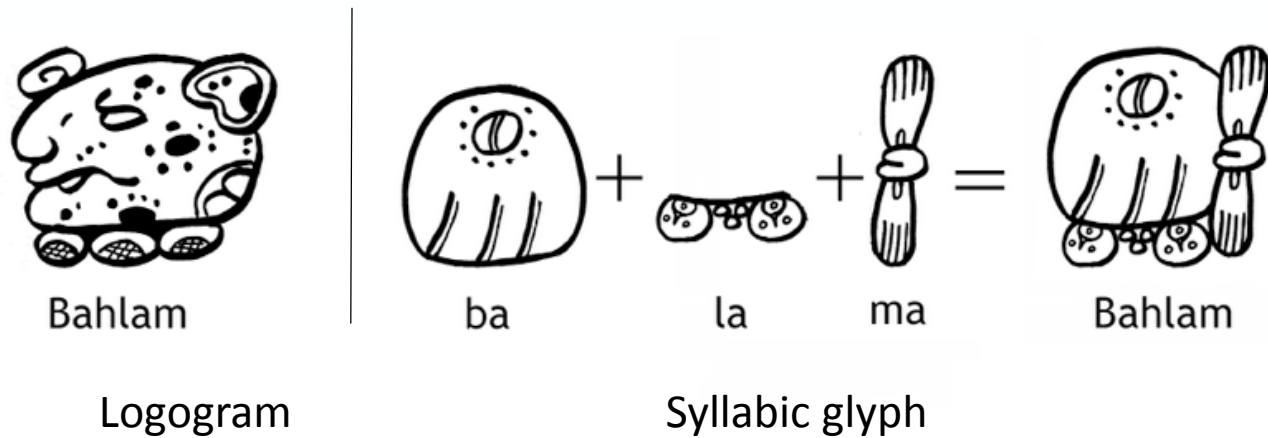
# Maya Gif Project Overview

The proposed project is to use different image recognition and deep learning methods on Maya glyphs datasets. The project provides an opportunity to test and experiment different methods:

- Convolutional Neural Network to identify Mayan numbers located on Mayan glyphs
- Shape Context method
- Feature Matching

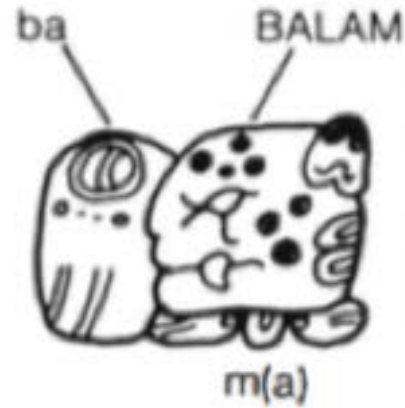
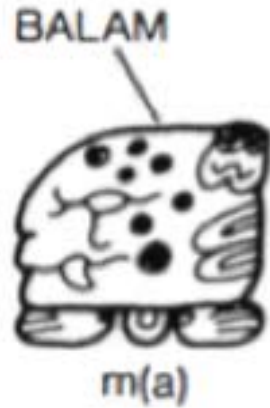
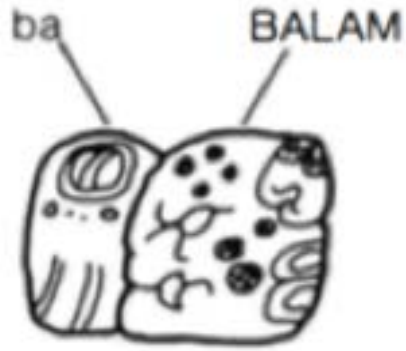
# What is a Maya glyph?

- Writing system of Maya civilization
  - Both Logograms & Syllabic glyphs
- Example: jaguar

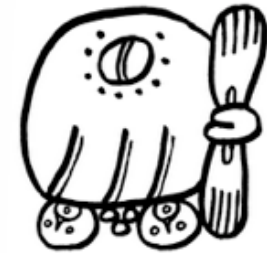


	j	k	k'	l	m
a					
e					
i					
o					

# What is a Maya glyph?

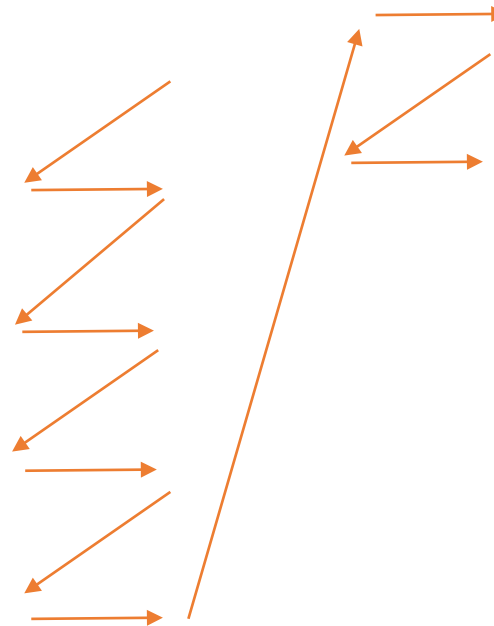
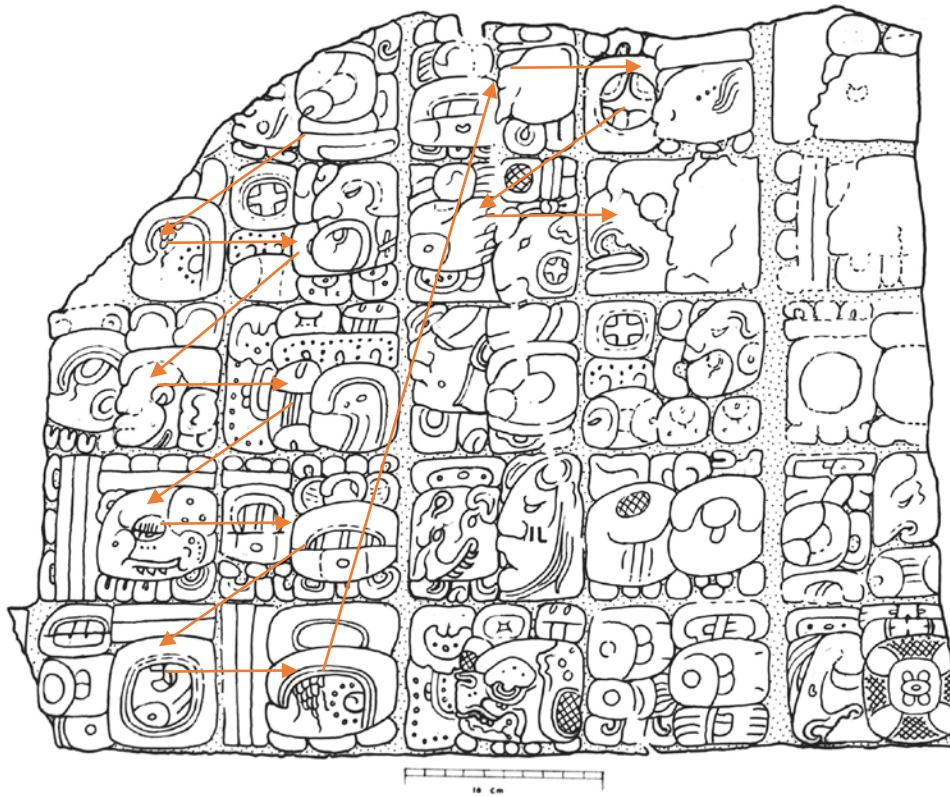


- 1 word in English: jaguar
- Several representations & variants



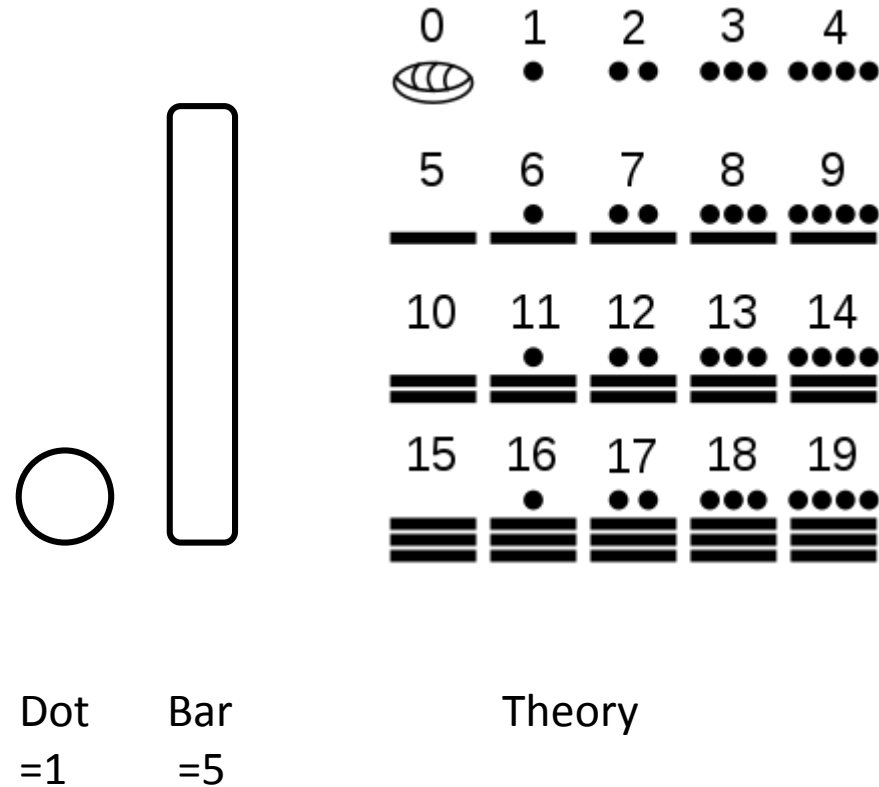
[\(Pope, 1999\)](#) Pope, Maurice. The Story of Decipherment: from Egyptian Hieroglyphs to Maya Script. Thames and Hudson. 1999.

# How to read Maya glyphs?



- Maya sentence
- Beginning with Maya dates (number+period)

# Numbers and calendar glyphs in Maya glyph



Theory

-- baktuns

-- tuns

-- kins

-- Cumku



-- katuns

-- uinals

-- Ahau

Real example

# Maya glyphs and computational methods?

## Background of Digital Humanities

- Digital Humanities:

"a nexus of fields within scholars use computing technologies to investigate the kinds of questions that are traditional to the Humanities or ask traditional kinds of humanities-oriented questions about computing technologies"

- Division between *making* and *interpreting*
- "Creative tension"

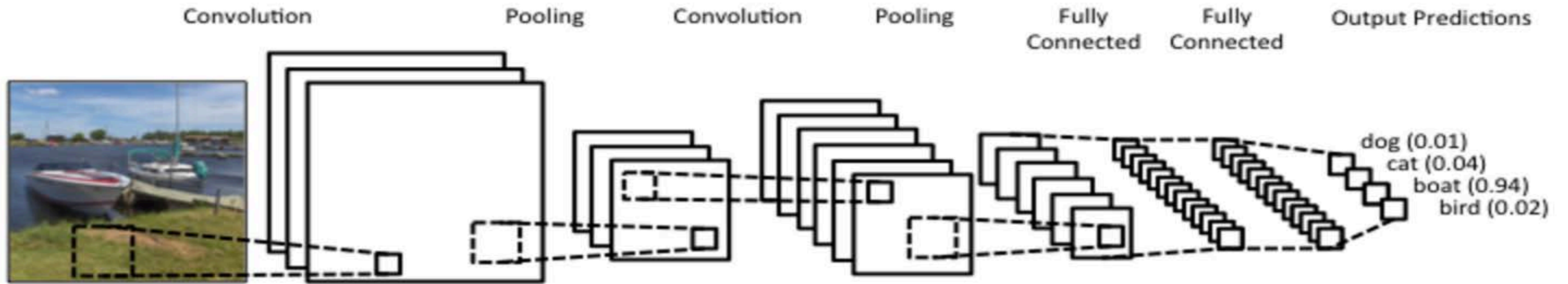
Fitzpatrick, Kathleen. "The humanities, done digitally." *Debates in the digital humanities* (2012): 12-15.

# Brainstorming and initial ideas

- Can the computer be trained to identify glyphs ?
  - > Experimentation with Convolutional Neural Network
- Can the computer be trained to identify part of glyphs (components) ?
  - > Experimentation with Feature Matching
- Can the computer help us to cluster glyphs to identify variants?
  - > Experimentation with Shape Context



# Convolutional Neural Network: How it Works



Britz, D. (2016, January 10). Understanding Convolutional Neural Networks for NLP. Retrieved from <http://www.wildml.com/2015/11/understanding-convolutional-neural-networks-for-nlp/>

- Filtering
- Encoding by transformation
- Classification

# Convolutional Neural Network: Our Approach

- Used MNIST and a Cat/Dog classifier
- Fit the model with glyph images
- Test on concepts

WHY REINVENT THE  
WHEEL WHEN YOU  
DON'T HAVE TO?



# Convolutional Neural Network: Results

```
100/125 [=====>.....] - ETA: 1s - loss: 0.6933 - acc: 0.4975
101/125 [=====>.....] - ETA: 1s - loss: 0.6933 - acc: 0.4994
102/125 [=====>.....] - ETA: 1s - loss: 0.6933 - acc: 0.4988
104/125 [=====>.....] - ETA: 1s - loss: 0.6933 - acc: 0.5036
105/125 [=====>.....] - ETA: 1s - loss: 0.6933 - acc: 0.5024
106/125 [=====>.....] - ETA: 1s - loss: 0.6932 - acc: 0.5047
107/125 [=====>.....] - ETA: 1s - loss: 0.6932 - acc: 0.5047
108/125 [=====>.....] - ETA: 1s - loss: 0.6932 - acc: 0.5046
109/125 [=====>.....] - ETA: 1s - loss: 0.6933 - acc: 0.5034
110/125 [=====>.....] - ETA: 1s - loss: 0.6933 - acc: 0.5028
112/125 [=====>.....] - ETA: 0s - loss: 0.6933 - acc: 0.5006
113/125 [=====>...] - ETA: 0s - loss: 0.6933 - acc: 0.4994
114/125 [=====>...] - ETA: 0s - loss: 0.6933 - acc: 0.5005
115/125 [=====>...] - ETA: 0s - loss: 0.6933 - acc: 0.5022
116/125 [=====>...] - ETA: 0s - loss: 0.6933 - acc: 0.5022
117/125 [=====>..] - ETA: 0s - loss: 0.6933 - acc: 0.5021
118/125 [=====>..] - ETA: 0s - loss: 0.6933 - acc: 0.5005
119/125 [=====>..] - ETA: 0s - loss: 0.6933 - acc: 0.5011
120/125 [=====>..] - ETA: 0s - loss: 0.6933 - acc: 0.5000
121/125 [=====>.] - ETA: 0s - loss: 0.6933 - acc: 0.4995
123/125 [=====>.] - ETA: 0s - loss: 0.6933 - acc: 0.5020
124/125 [=====>.] - ETA: 0s - loss: 0.6933 - acc: 0.5025
125/125 [=====] - 11s 87ms/step - loss: 0.6933 - acc: 0.5019 - val_loss: 0.6932 - val_acc: 0.4963

Process finished with exit code 0
```

# Feature Matching

- How do you solve a puzzle?



Mordvintsev, A. & Abid, K. (2013). Feature Detection and Description: Harris Corner Detection. Retrieved from [http://opencv-python-tutroals.readthedocs.io/en/latest/py\\_tutorials/py\\_feature2d/py\\_features\\_meaning/py\\_features\\_meaning.html](http://opencv-python-tutroals.readthedocs.io/en/latest/py_tutorials/py_feature2d/py_features_meaning/py_features_meaning.html)

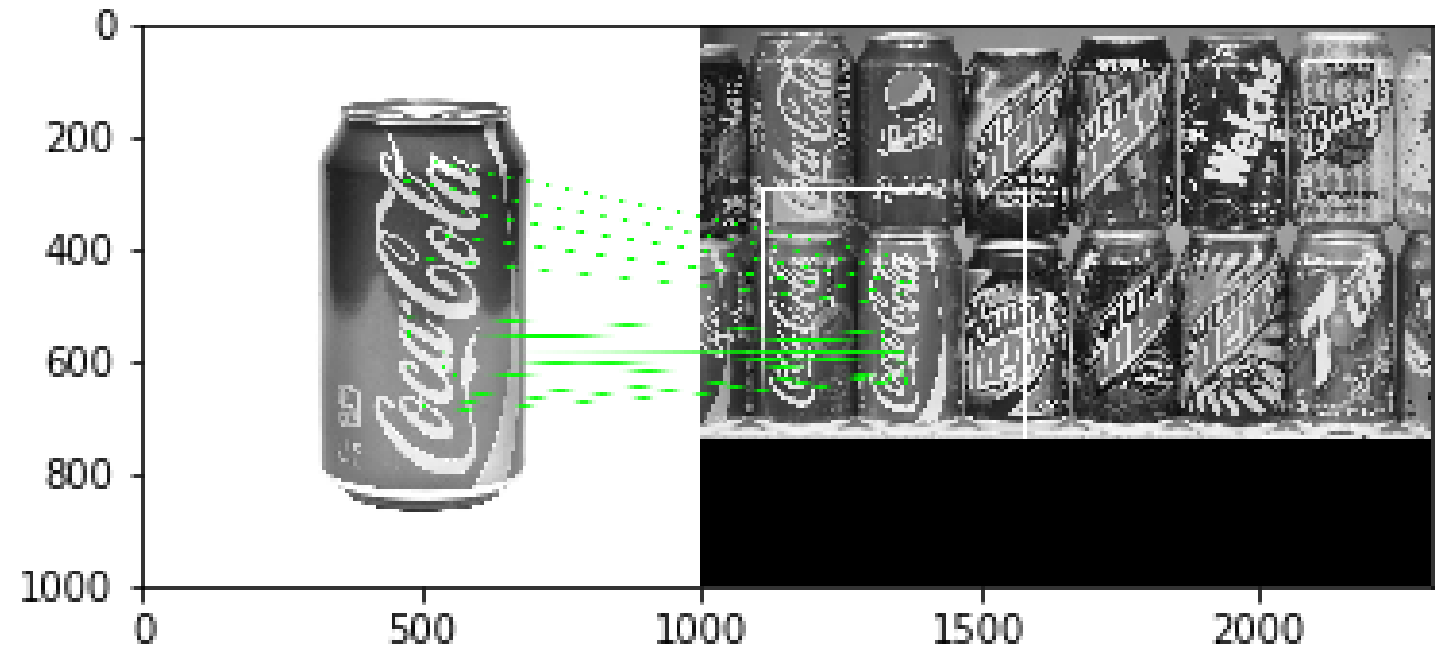
# Feature Matching

- Harris Corner Detection
- SIFT Algorithm

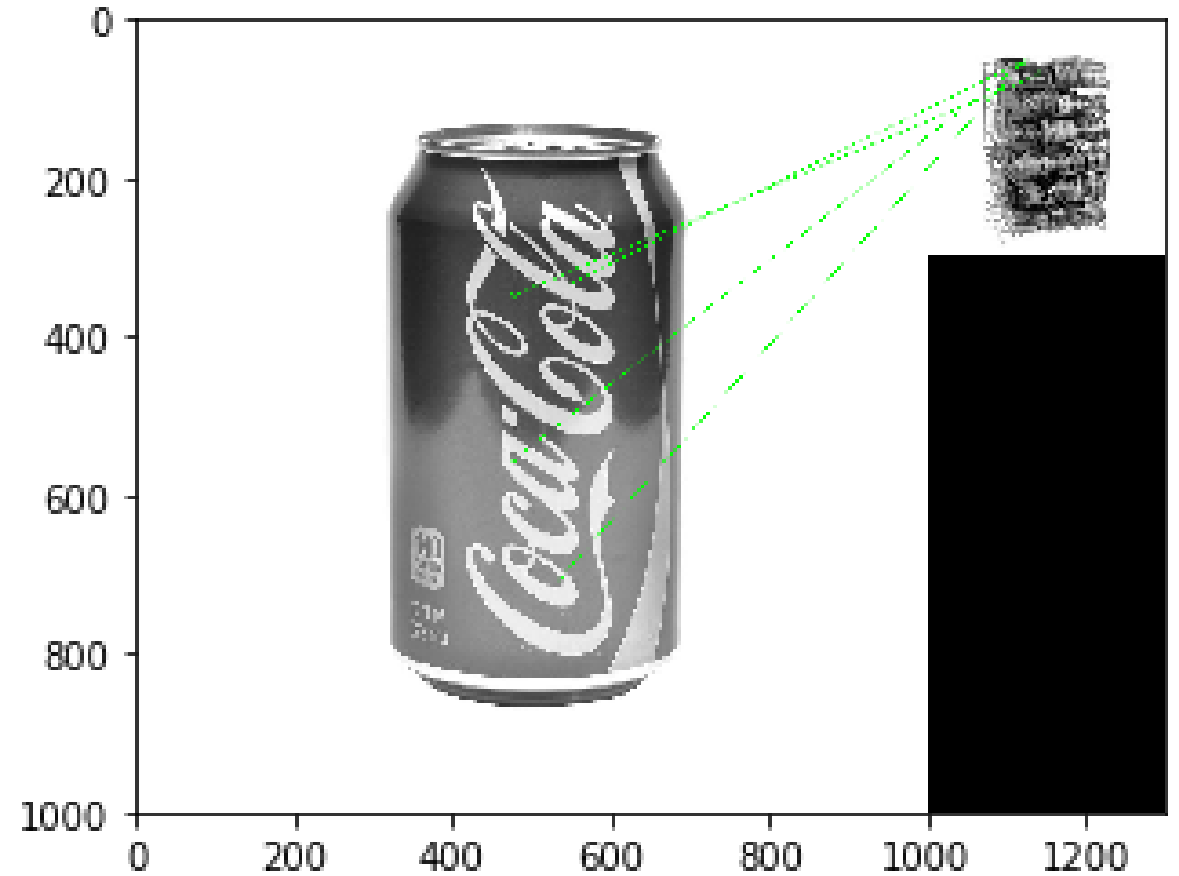


Mordvintsev, A. & Abid, K. (2013). Feature Detection and Description: Harris Corner Detection. Retrieved from [http://opencv-python-tutroals.readthedocs.io/en/latest/py\\_tutorials/py\\_feature2d/py\\_features\\_meaning/py\\_features\\_meaning.html](http://opencv-python-tutroals.readthedocs.io/en/latest/py_tutorials/py_feature2d/py_features_meaning/py_features_meaning.html)

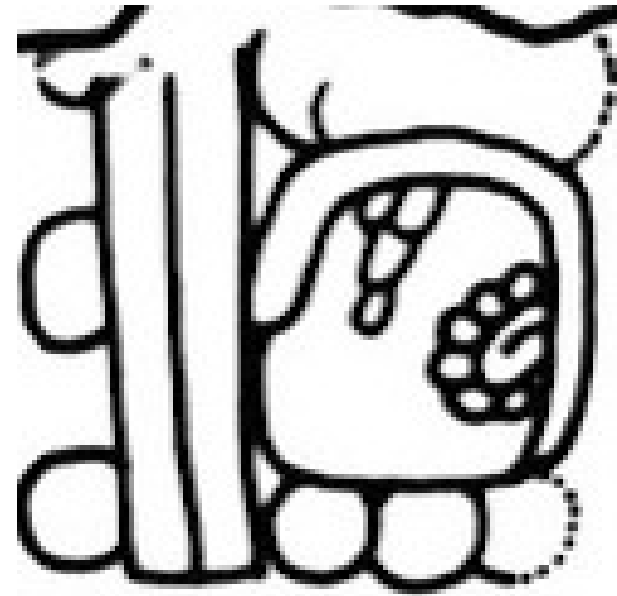
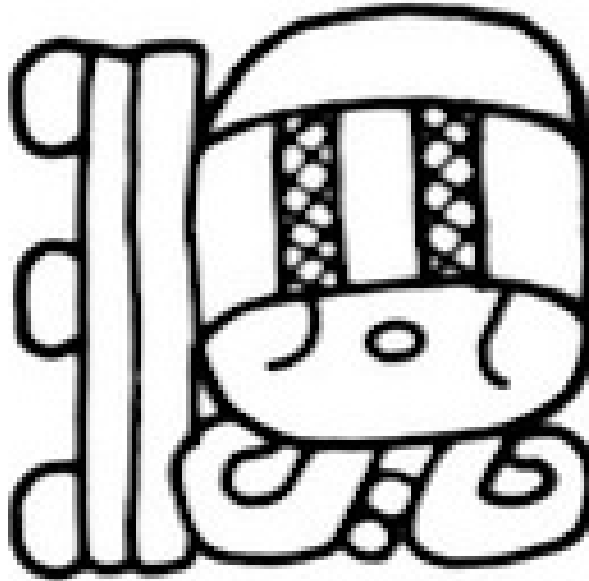
# Feature Matching



# Feature Matching

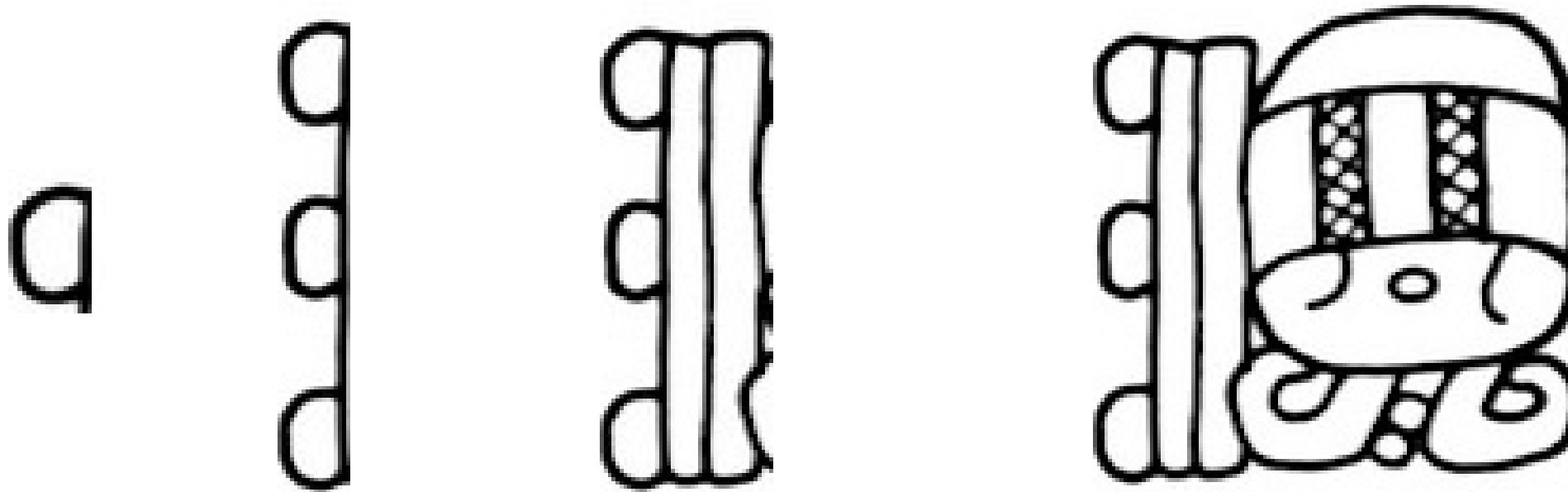


# Feature Matching

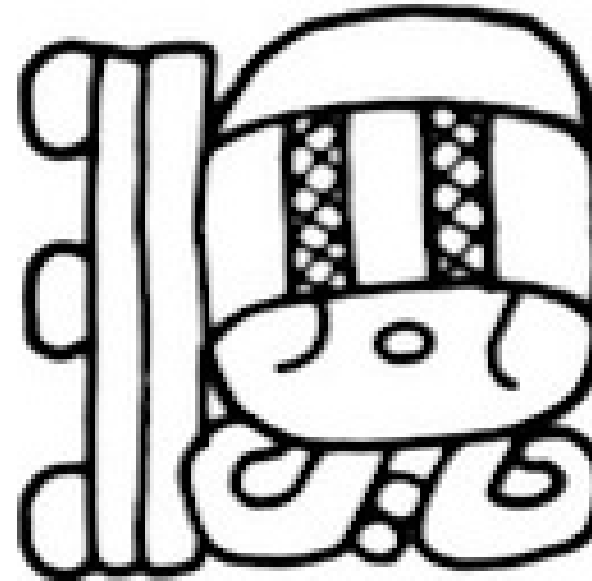
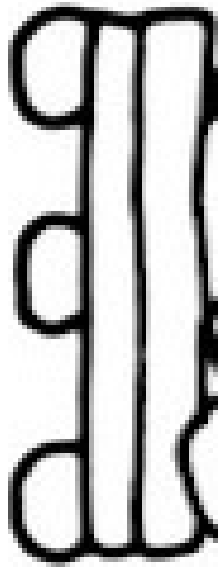
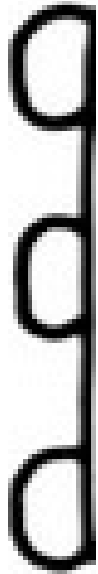




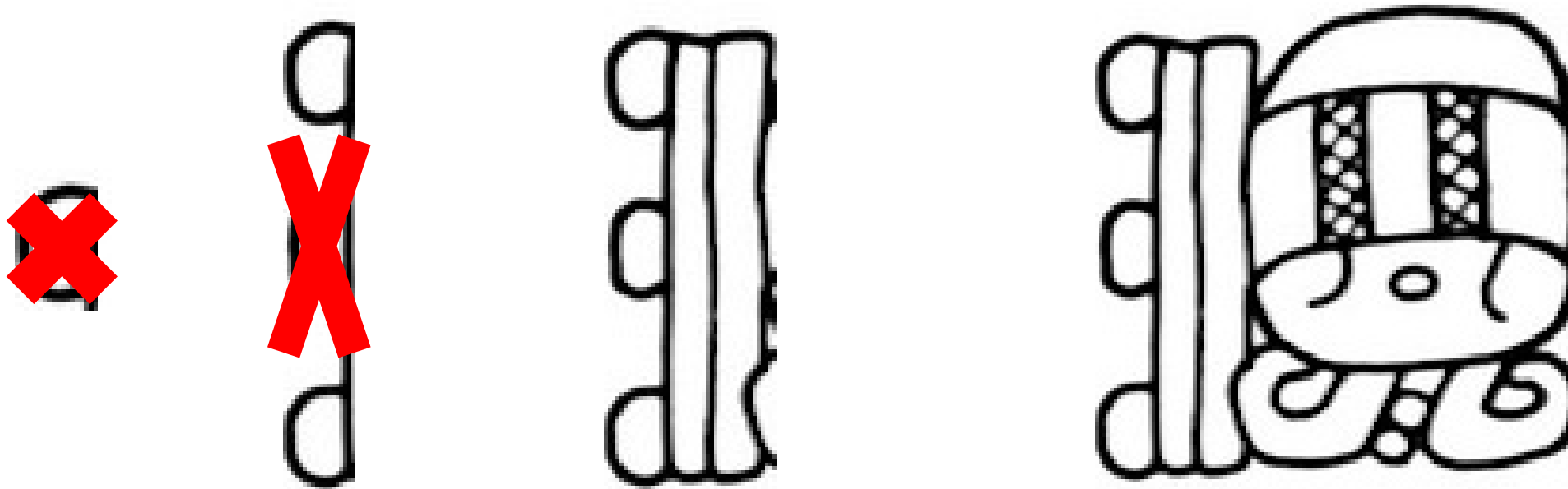
# Feature Matching



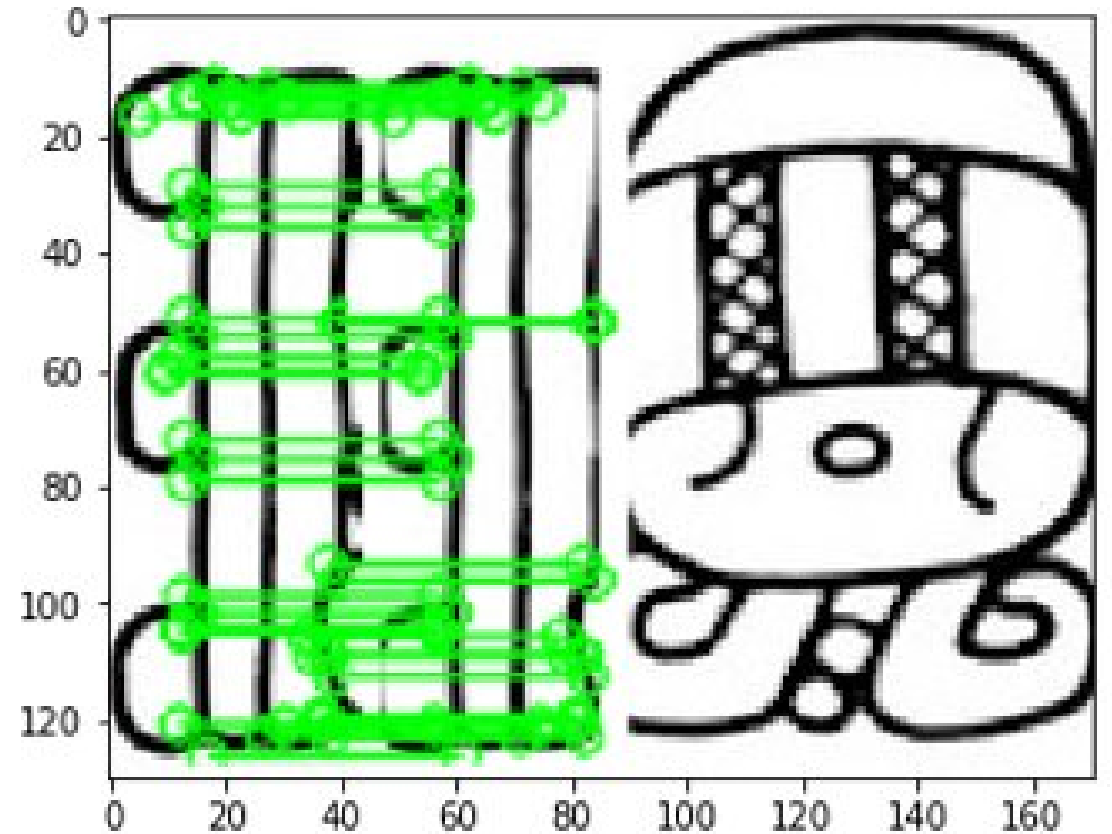
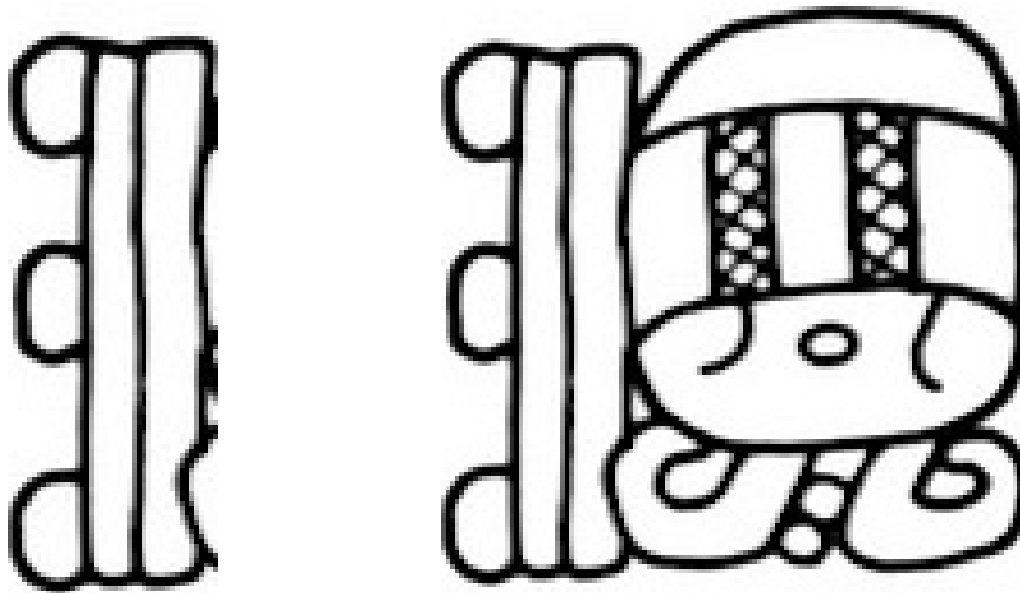
# Feature Matching



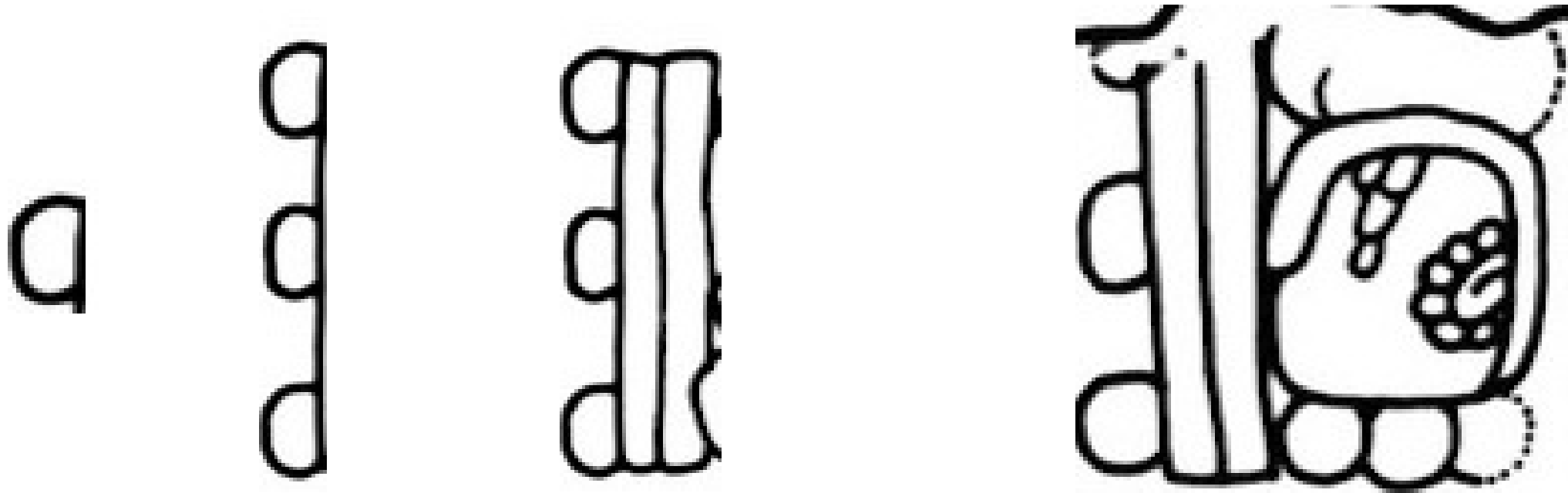
# Feature Matching



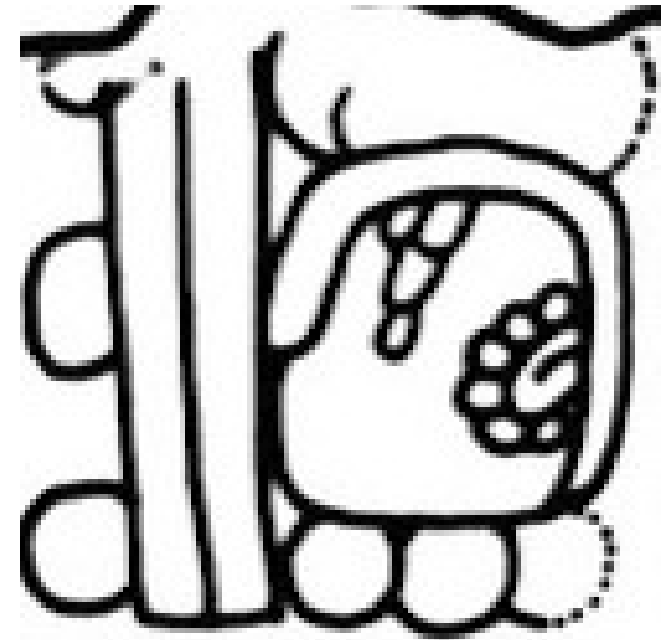
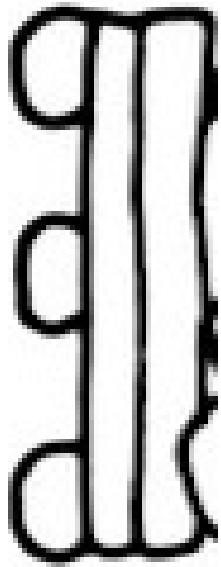
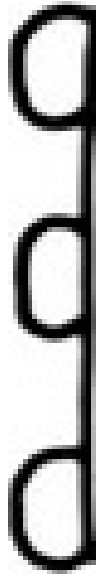
# Feature Matching



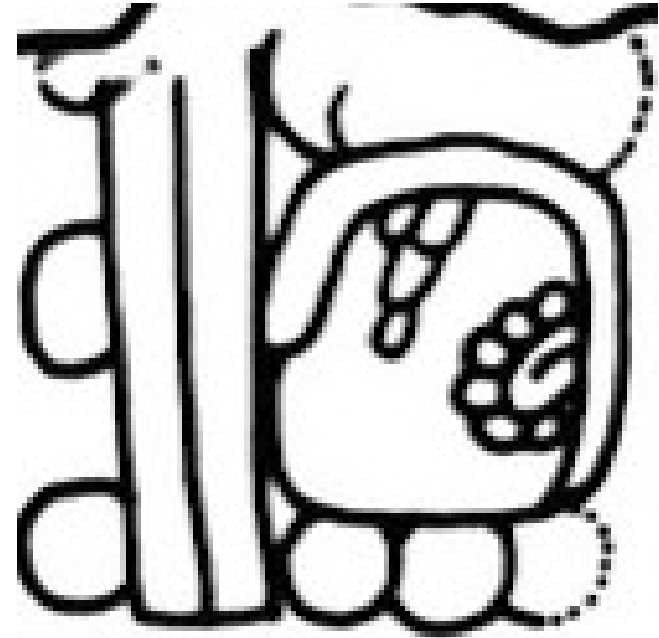
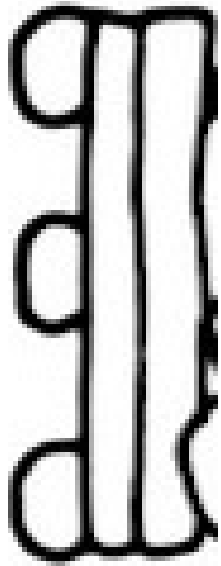
# Feature Matching



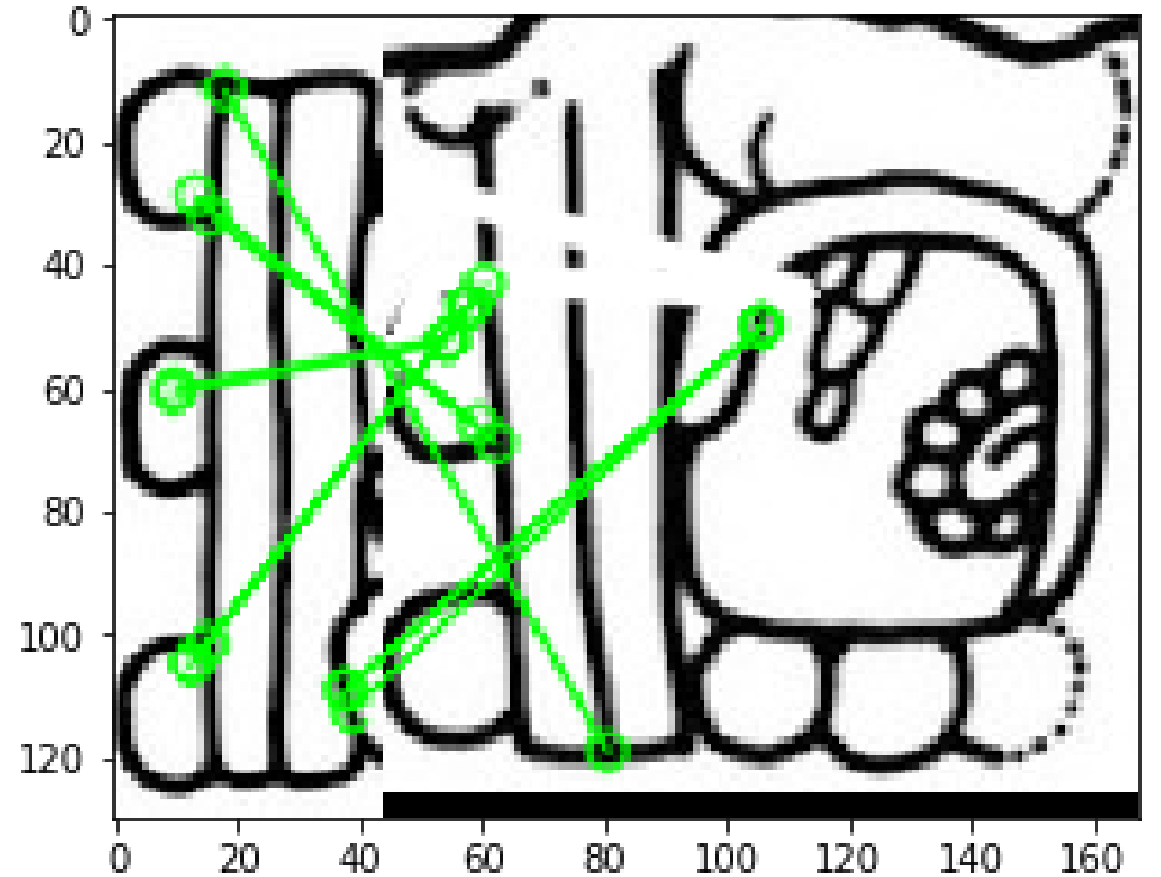
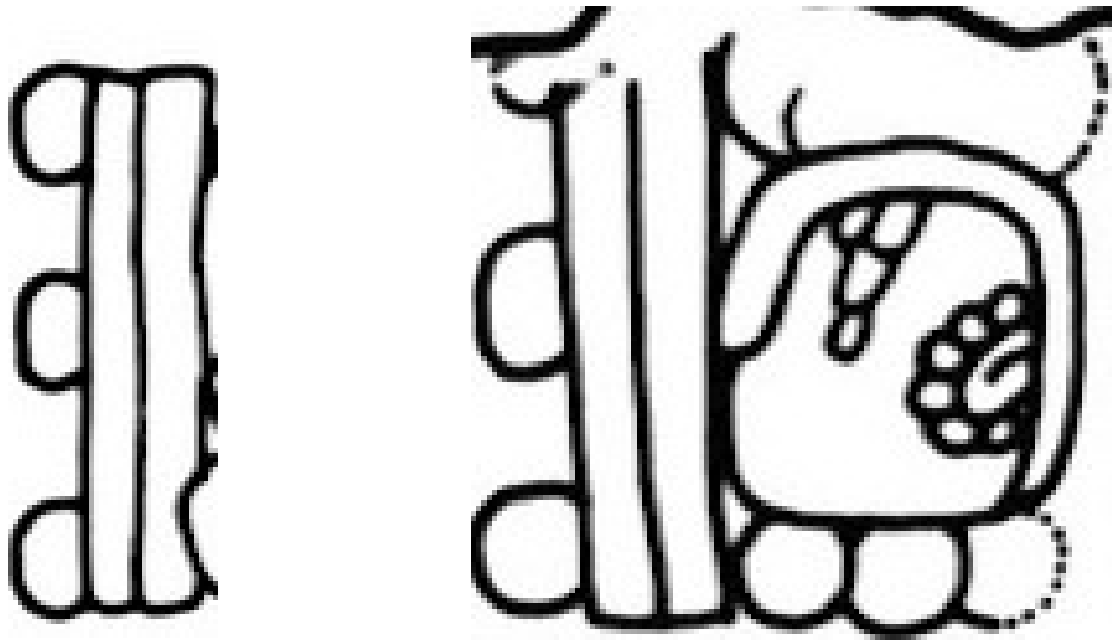
# Feature Matching



# Feature Matching

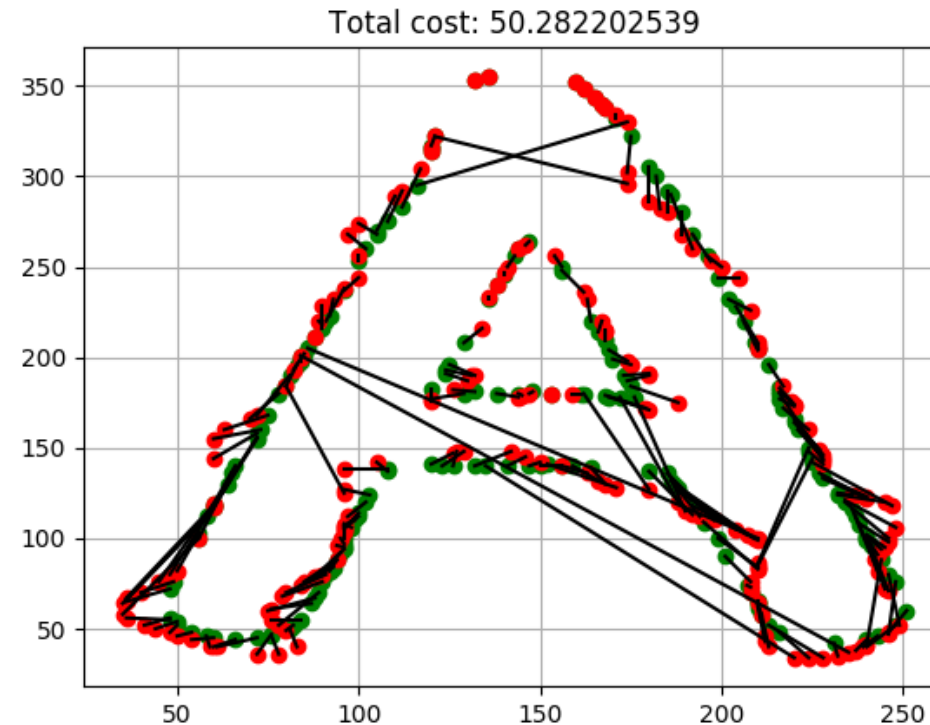


# Feature Matching





# Shape Context



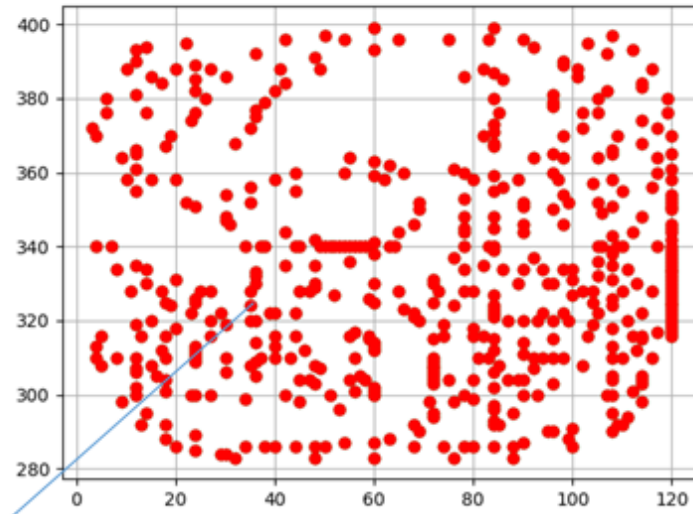
<https://github.com/creativ/Python-Shape-Context>

Gülcan Can, Jean-Marc Odobez, and Daniel Gatica-Perez. 2016. Evaluating shape representations for Maya glyph classification. *J. Comput. Cult. Herit.* 9, 3, Article 14 (September 2016), 26 pages.

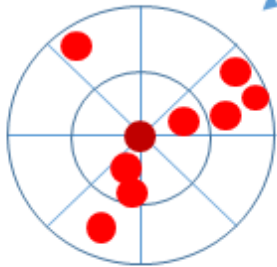
ICGE2017-2018: Group Maya Gif – Davenport Dominique/Guillem Anais/Simoës Ana/Sweet Tyrome



Fish

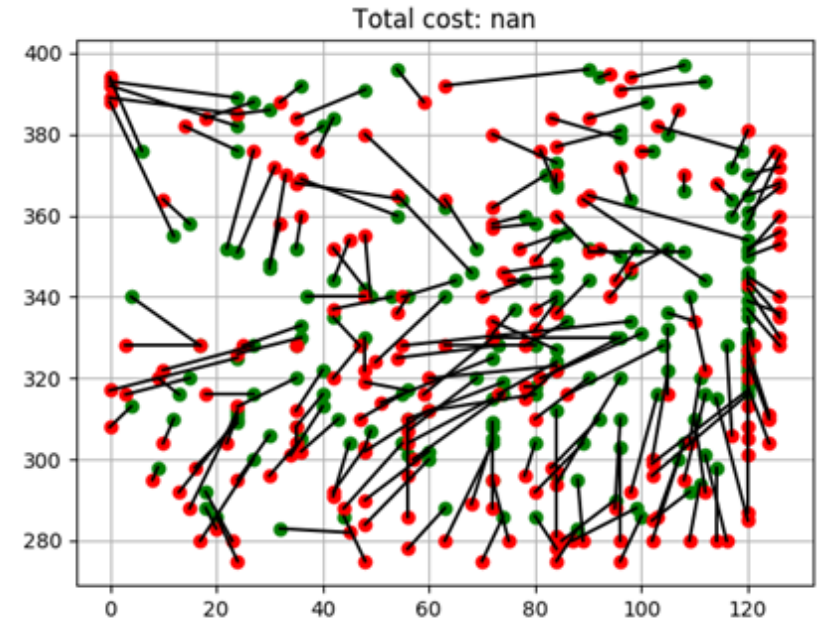


500 points from image



$P=[1,0,0,0,0,2,0,0,3,0,1,0,0,1,0,0]$

Example for  $r=2$ ,  $\phi=8$

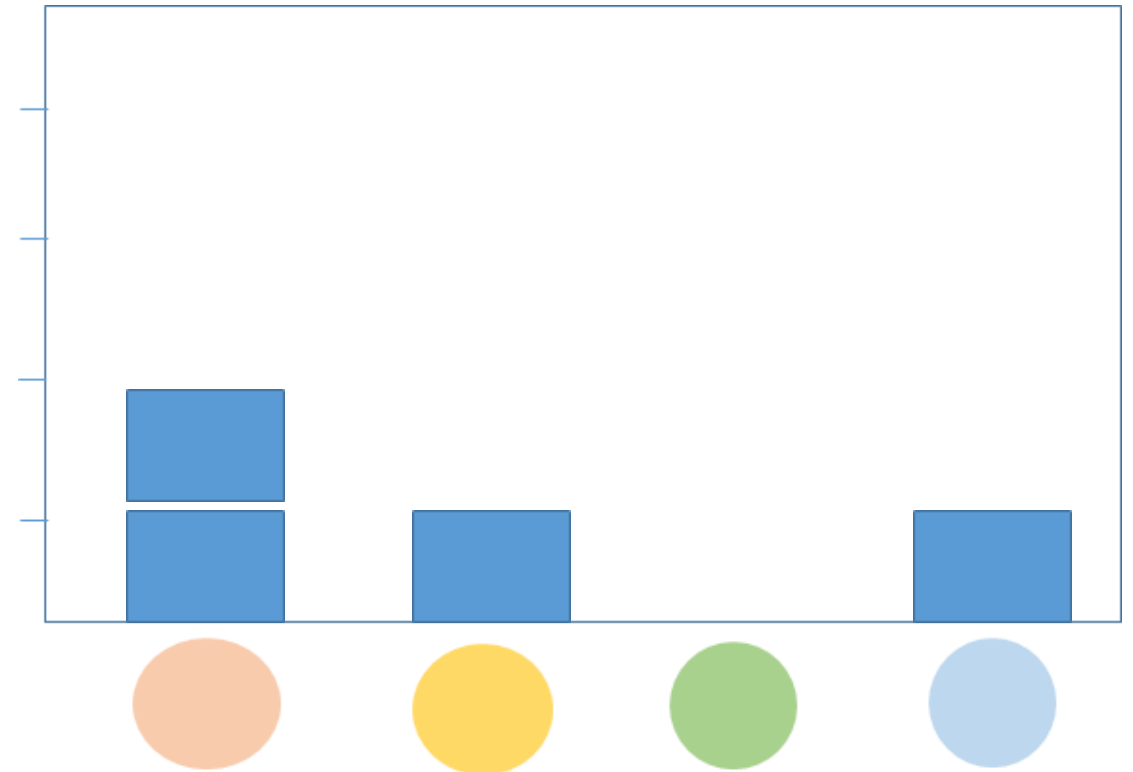
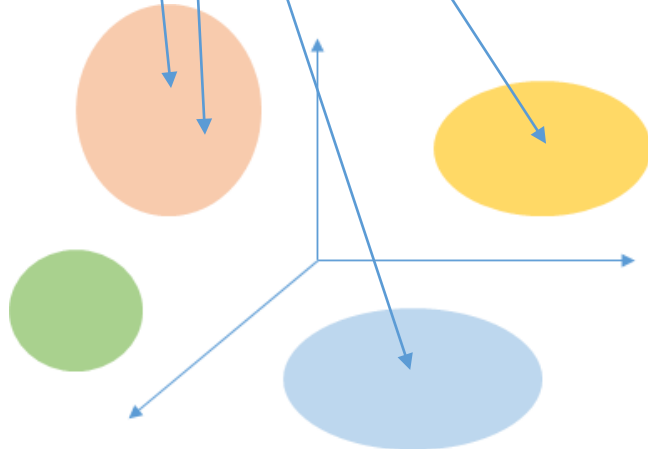
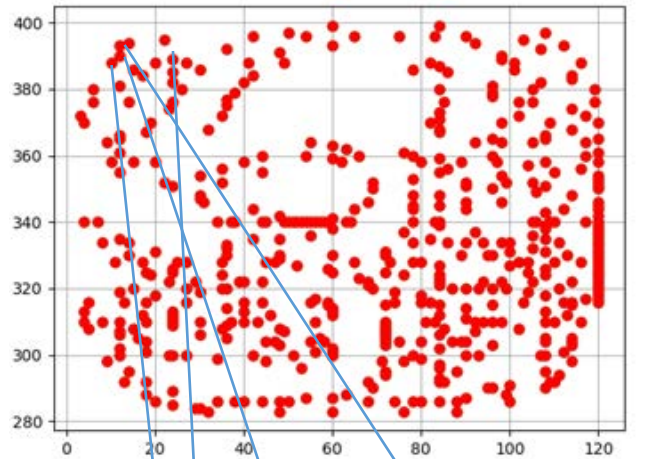


Generally good for many points but cost time.

Hungarian Algorithm- Developed to solve the 'assignment' problem

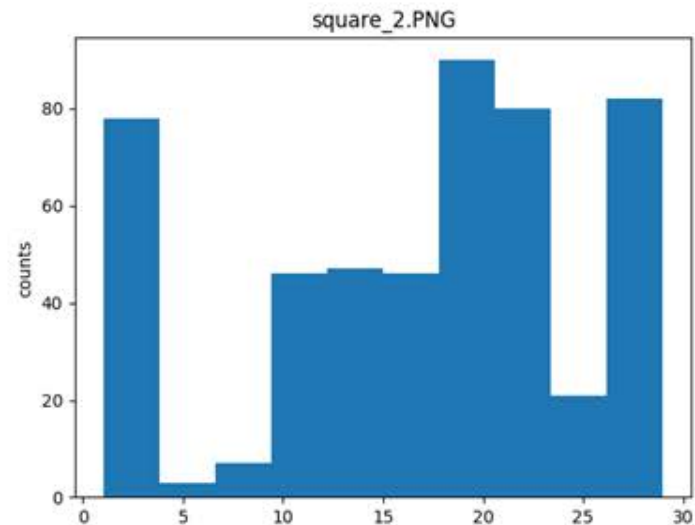
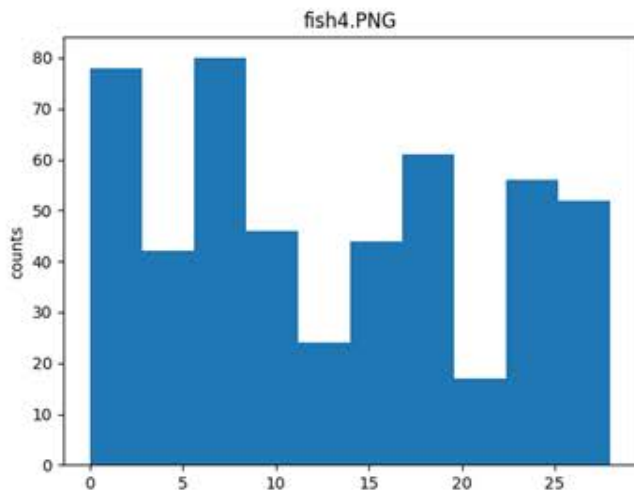
Here used to determine which points should be assigned to each other to give the lowest cost

# K-Means Clustering as a Solution – (Give each drawing a finger print)



We have a 60 dimensional vector for each point.  
Each vector can be plotted in a 60 dimensional space and grouped.

# Comparing 'finger prints'



N=600

Number of clusters=20



0



39.2



80.4



58.5



89.6



91.3



92.2



68.4

N=600  
# of clusters=25

Averaged over 10 runs



Test



$41.4 \pm 1.7$



$54.7 \pm 1.9$



$60.9 \pm 2.6$



$66.6 \pm 3.0$



$68.4 \pm 3.4$



$70.9 \pm 2.1$



$72.4 \pm 3.9$



$77.8 \pm 1.6$



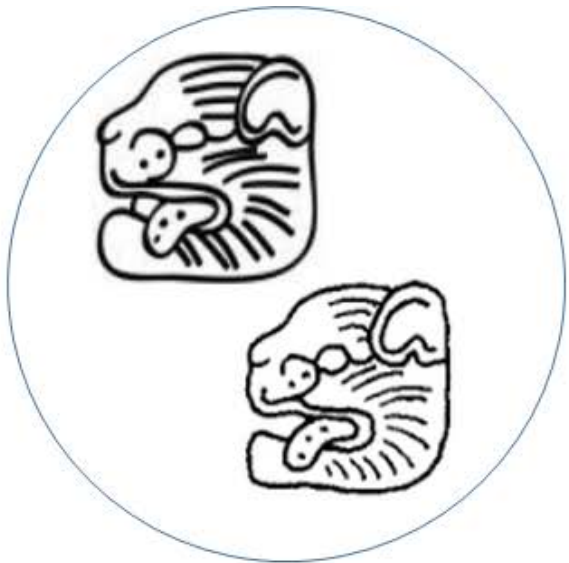
$86.2 \pm 1.6$



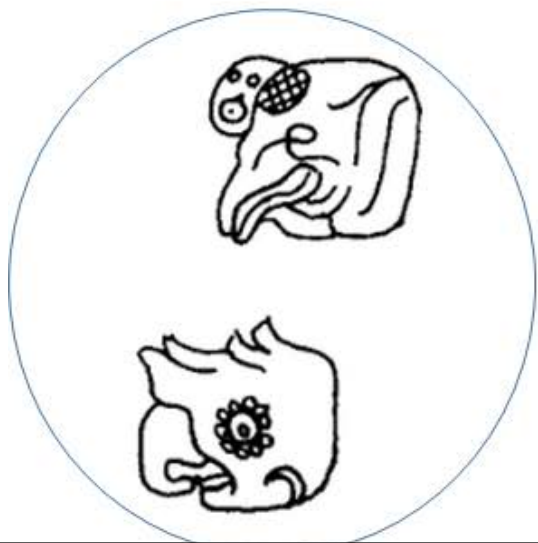
$91.9 \pm 3.91$



$95.2 \pm 2.6$



## Clustering of Histograms

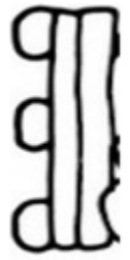


# Bigger Data??

609 images



- Questionable results
- More systematic approach needed
- Fundamentally difficult problem



Test

Numbers play an important role in many glyphs



64.5



171.7



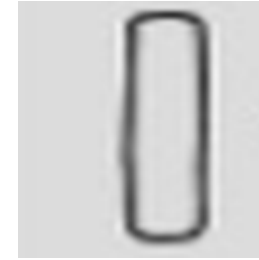
74.9



63.6



60.8



73.6



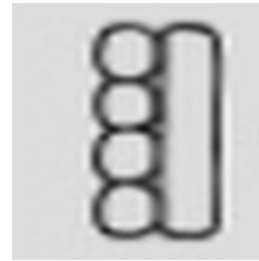
147.4



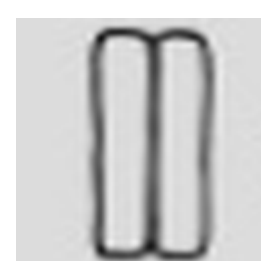
107.7



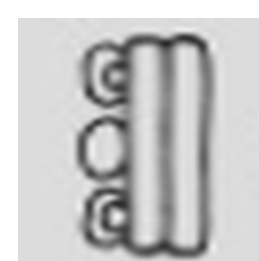
141.8



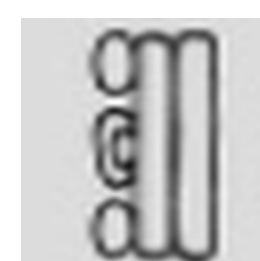
150.2



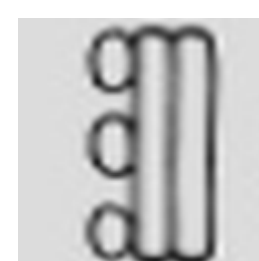
137.9



52.8



57.3



50.5



# Conclusion & intermediary results

- Promising use of computational methods for Maya glyphs analysis after only some experimentations
- Datasets: online access of Maya Glyphs drawings, but need of transformation, structuration and enrichment of semantic for going further with the data
- One method does not solve it all, plurality of approach/methods is necessary

# ICGE project experience

- Hand on training with different deep learning and image recognition methods
- Interdisciplinary approach of the question
- Real case-study of Maya Glyphs and archaeological data

Variables

		Well Defined	Not Well Defined
Data Sample/ Data Population	Well Defined	HEAVEN	LIMBO
	Not Well Defined	PURGATORY	HELL

Courtesy of Prof. Mark Aldenderfer:  
Multivariate Analysis in Archaeology

Thank you!

# Maya Gif

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