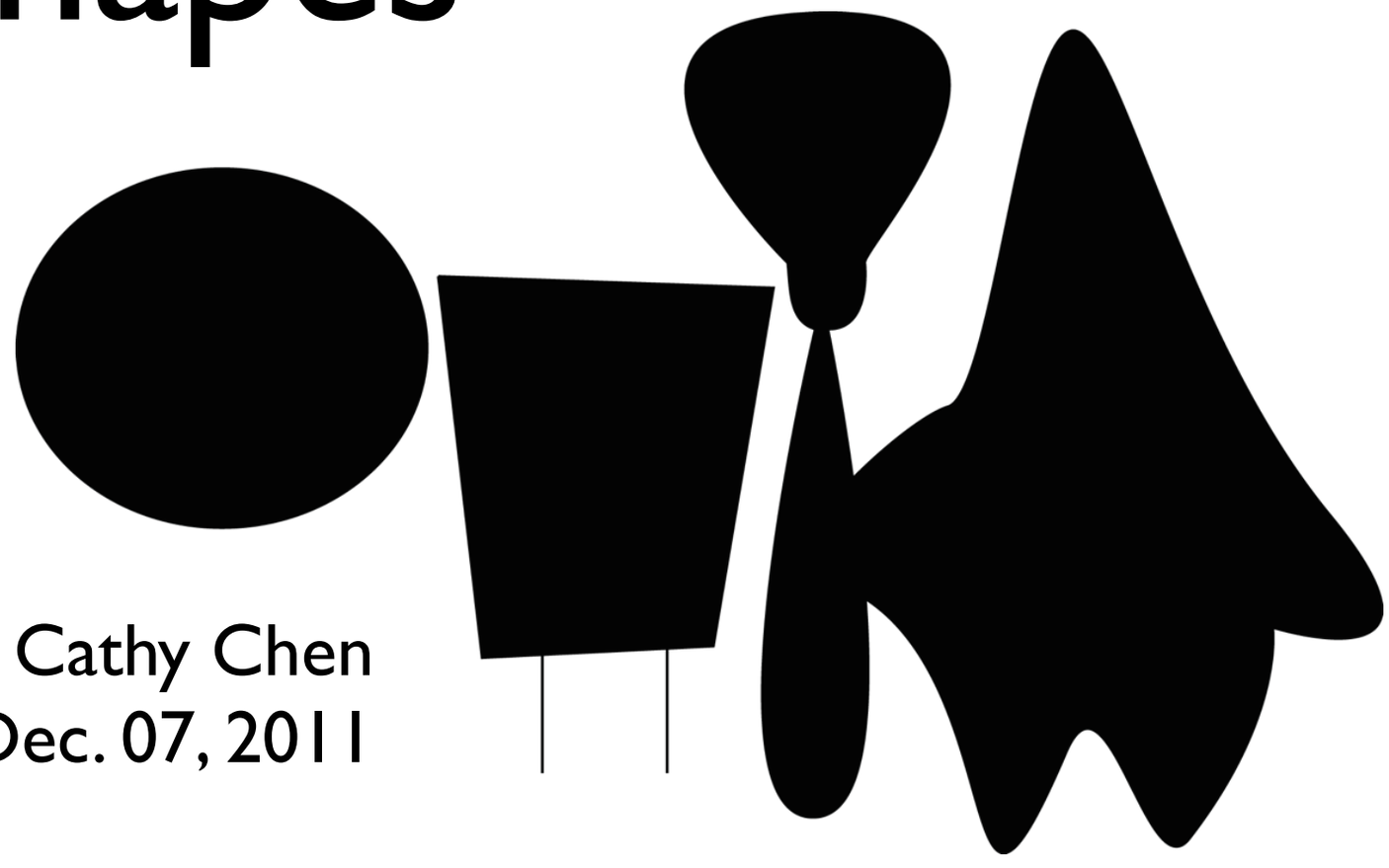
Minimal Distinguishable Shapes

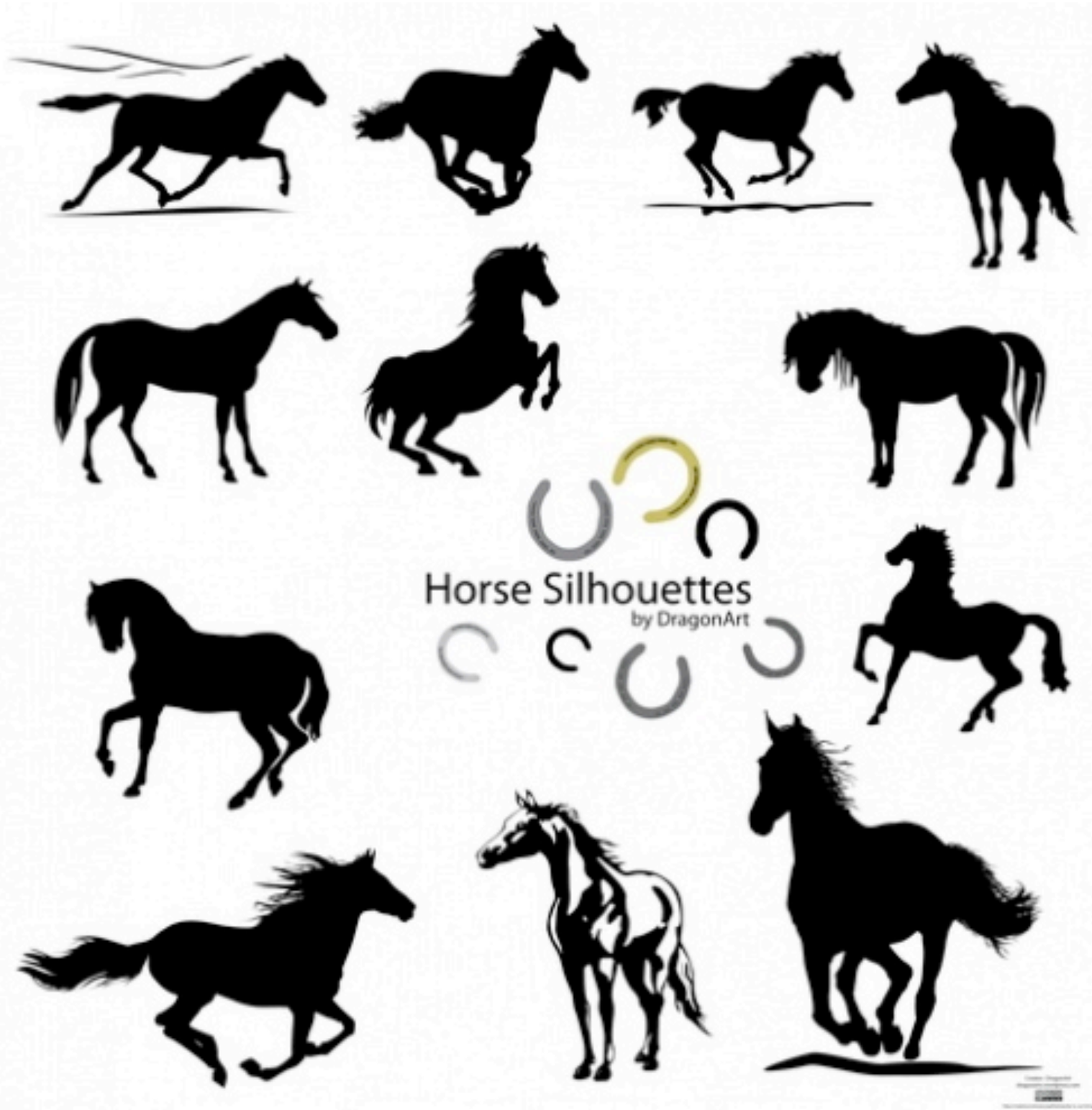


Chung-Lin Wen & Cathy Chen

Dec. 07, 2011

Introduction

- Human can distinguish an object even when it varies a lot
- Difficult for computers



- Photo courtesy: http://dragonartz.wordpress.com/2008/07/29/vector-horse-silhouettes/

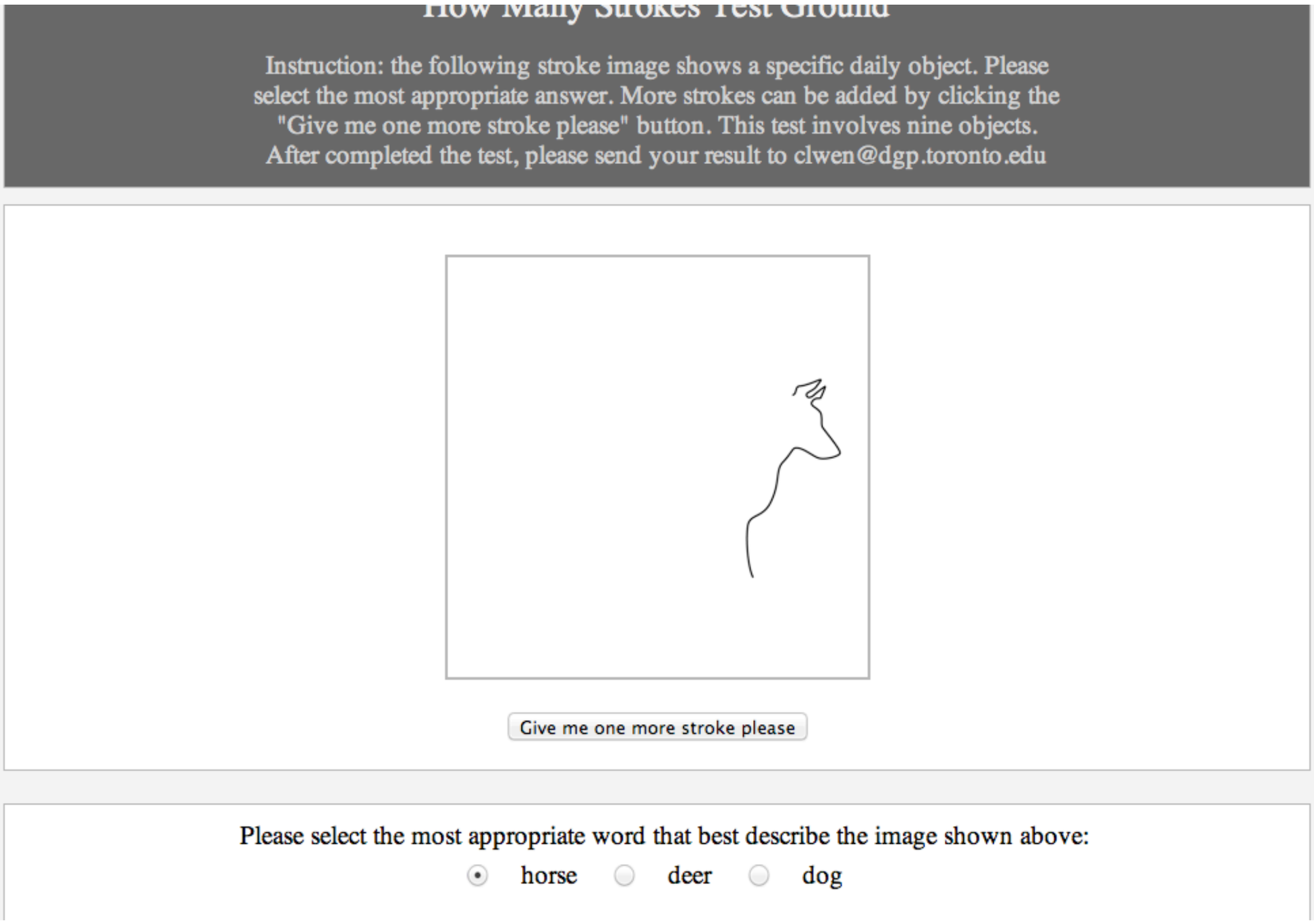
Introduction

- How do we “install” this knowledge to computers?

Introduction

- Is there general descriptors for each kind of an object?
- How do we have an quantitative understanding of this general descriptor?

Initial Approach



Feedback

- Order of strokes can be subjective
- The number of strokes depends on the other options

Another Approach

- How much can we simplify objects so that they are still distinguishable?

Set Design

- 13 sets
- min of five objects in each set
- familiar and abstract

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Set Design

- 13 sets
- min of five objects in each set
- familiar and abstract

Source Object Requirements

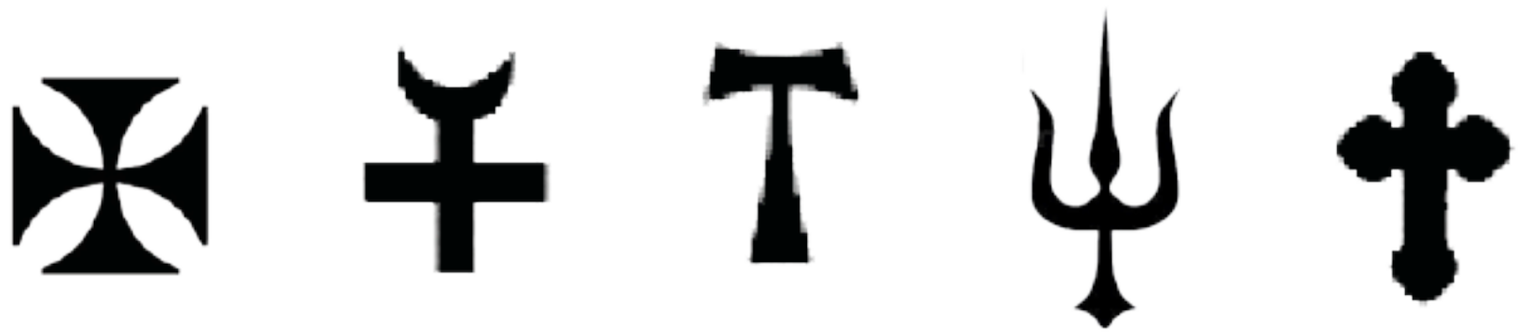
- closed shape
- black fill
- similar contours in each set

Instructions

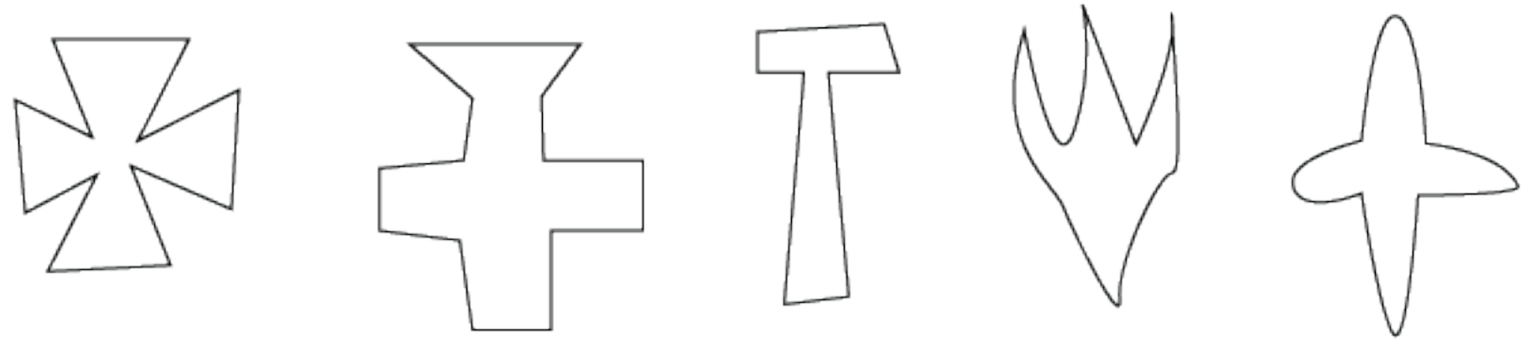
Direction:
Simplify each object on the page as much as possible yet still recognizable relative to the other objects on the same page.
use **CLOSED SHAPE**, which means one can draw an outline of the shape in one stroke without lifting the pen.

EXAMPLE

Source Objects



CORRECT



INCORRECT

Participants

- Artists/designers
- Other

Participants

- Artists/designers
- Other

Participants

- Artists/designers
- Other

Distinct Features

Distinct Features

Distinct Features

Distinct Features

Distinct Features

Distinct Features

Distinct Features

Distinct Features



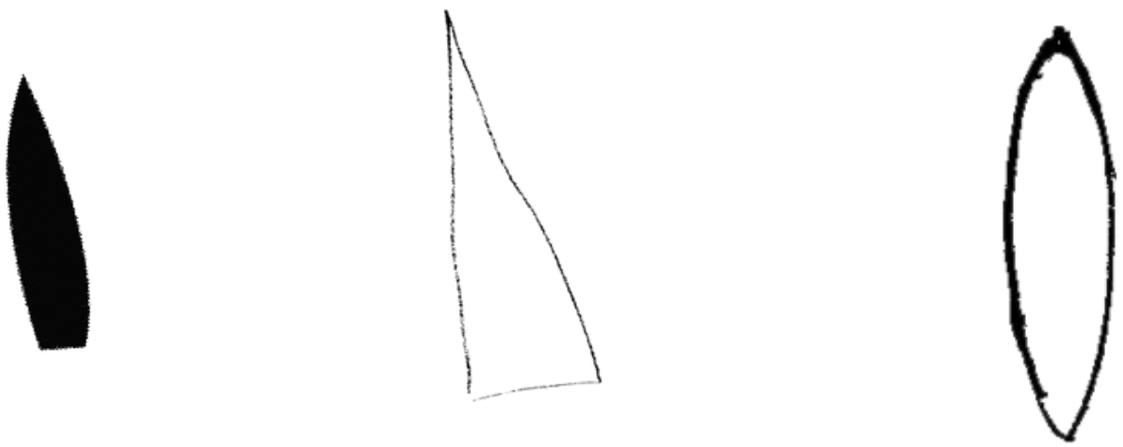




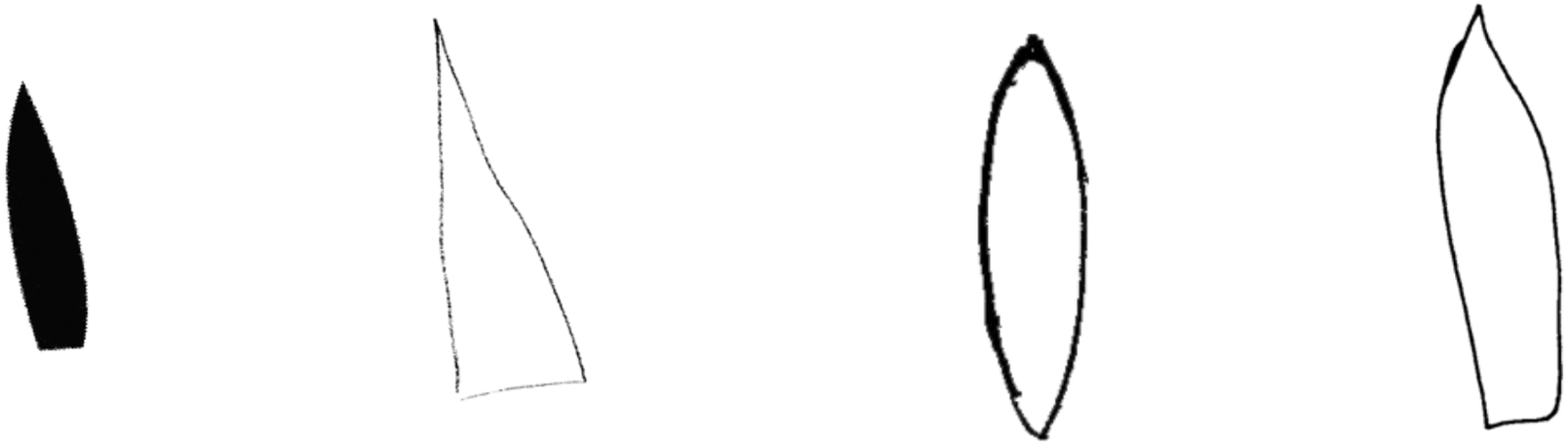

Few Simplifications

Few Simplifications

Few Simplifications

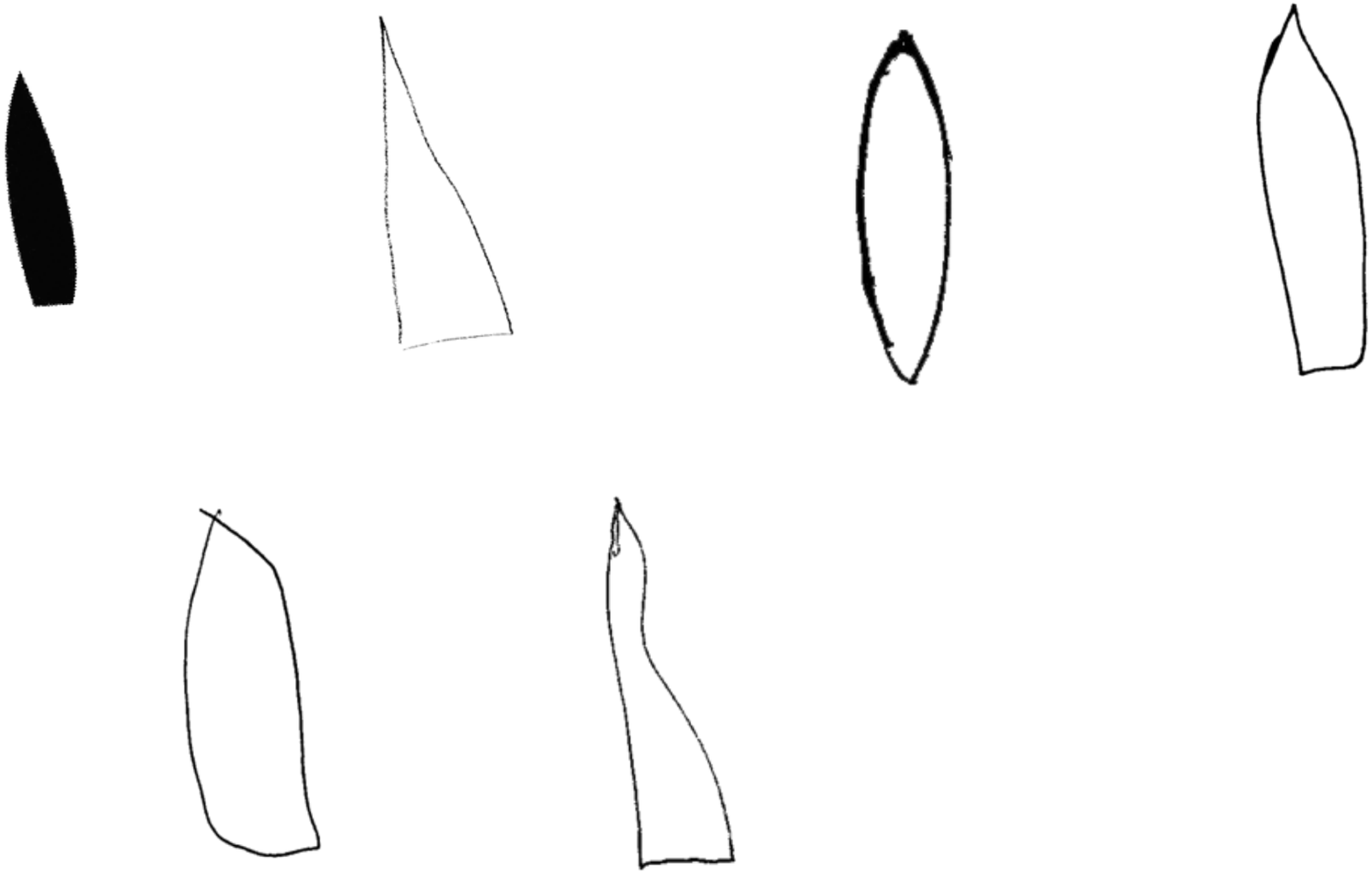


Few Simplifications

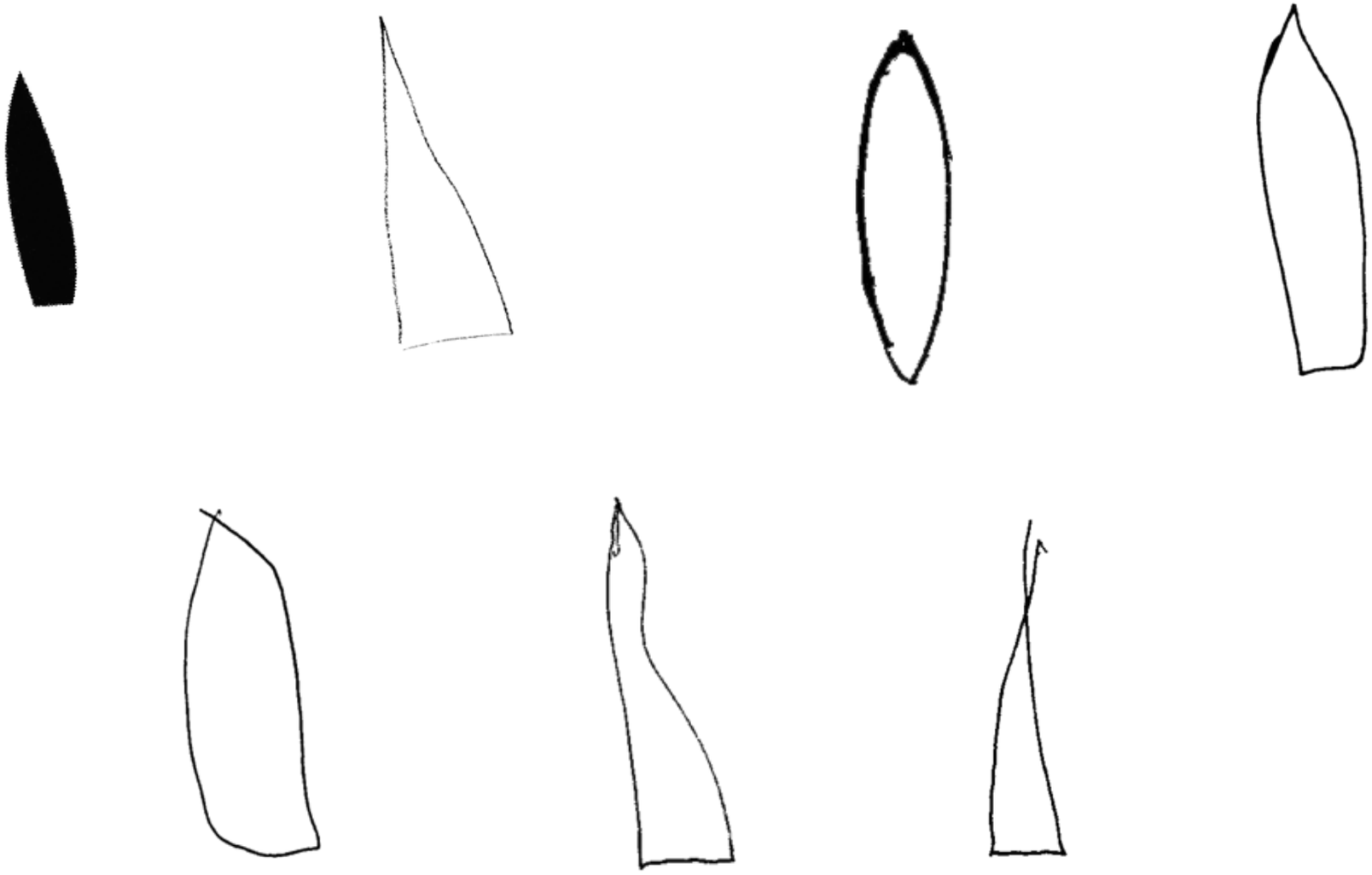


Few Simplifications

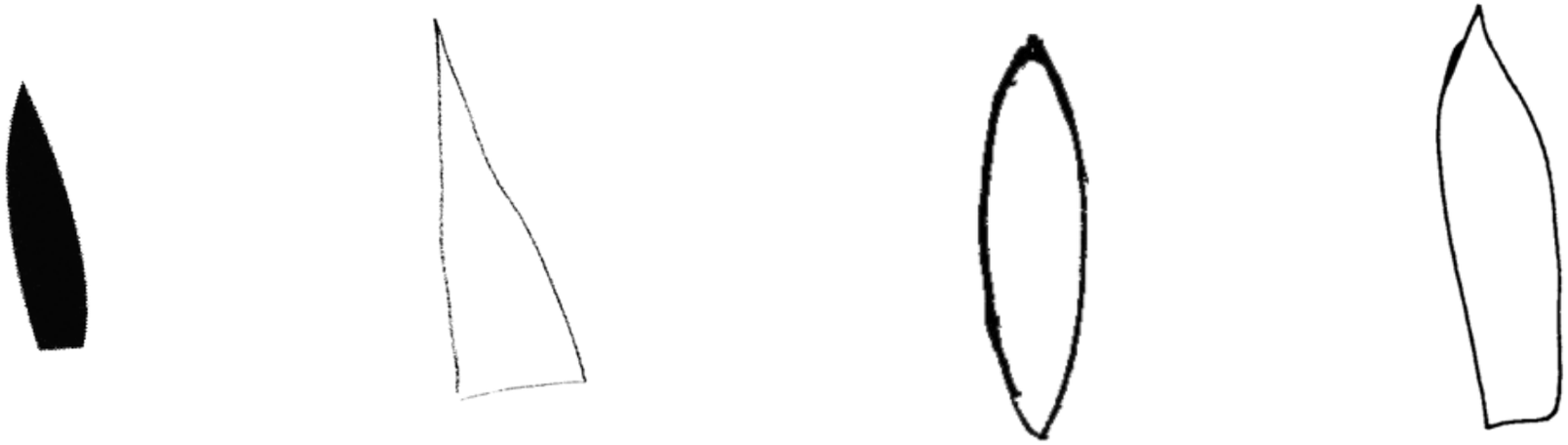
Few Simplifications

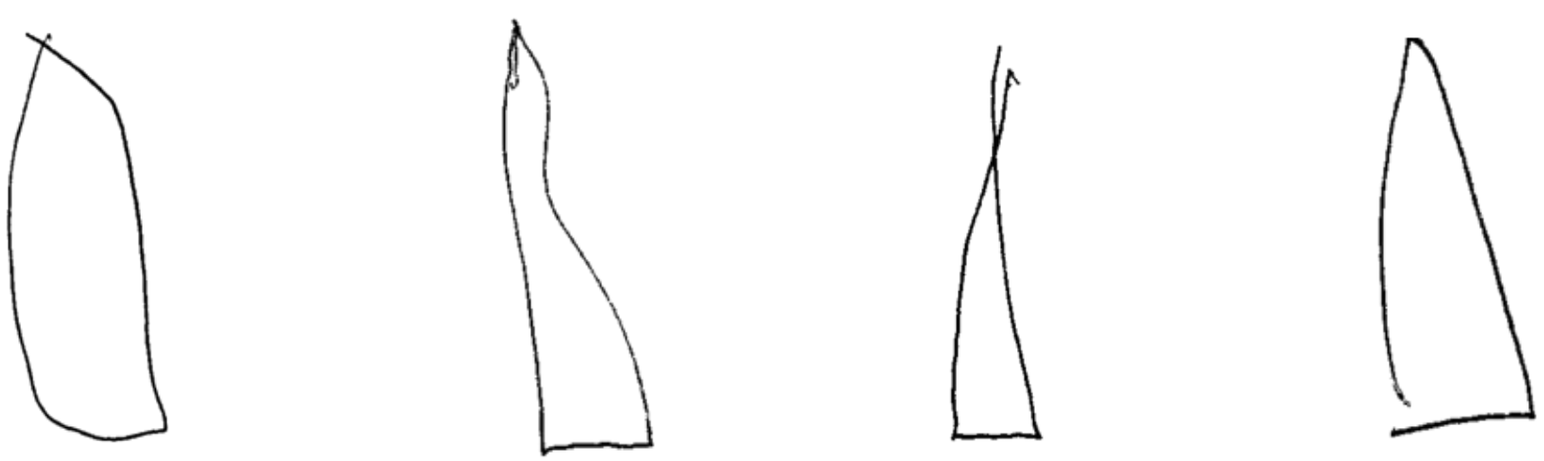


Few Simplifications

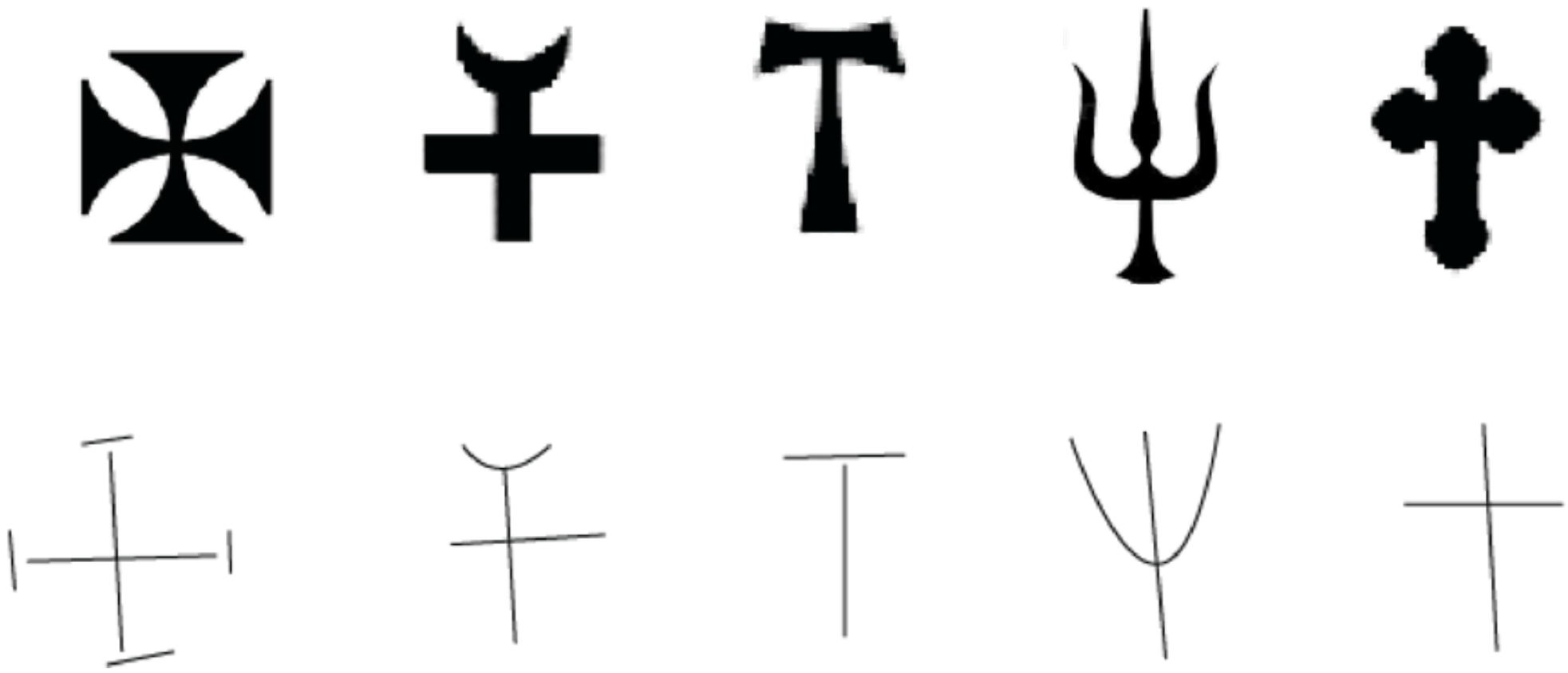


Few Simplifications





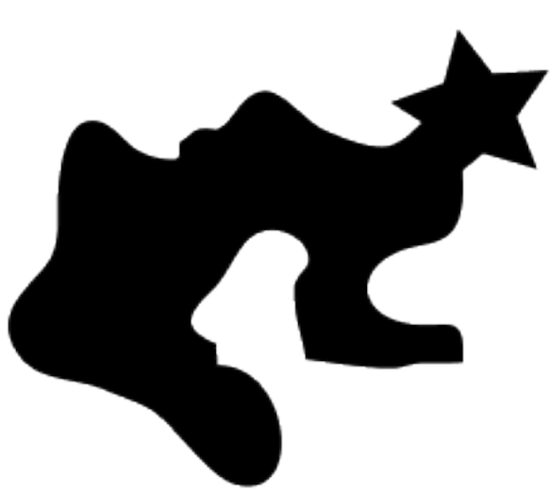
Line Simplifications



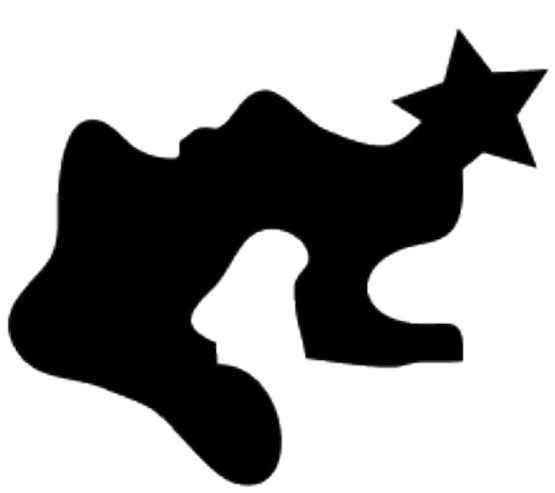
Curve to Angular

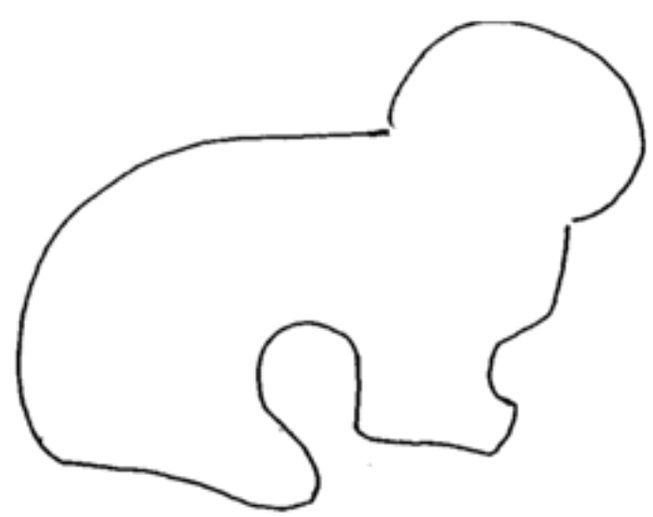
Curve to Angular

Sharp to curve



Sharp to curve





Repetition

Repetition

Verification

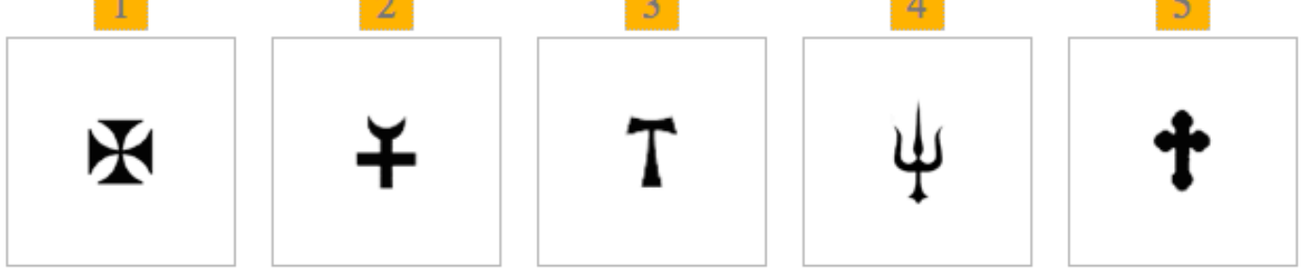
Minimal Distinguishable Shapes Experiment

Instruction: the top row shows the orignal images while the bottom row shows the simplified ones. Please match the original ones with the simplfied ones and send your result to clwen@dgp.toronto.edu

Currently start from simplified set made by artist #1, change to start from other artist (1 ~ 7): Change Starting Point

(Progress: 1/13)

1 2 3 4 5



(Optional) Feedback for this simplification: Good Average Bad

(Optional) Comment for this simplification:

Submit

Verification

- 14 participants, 182 units of verifications
- 159 (87.4%) units are correct
  23 (12.6%) units are incorrect

Verification

artist	1	2	3	4	5	6	7
precision (%)	88.5	88.9	76.9	84.6	96	96.2	80.8

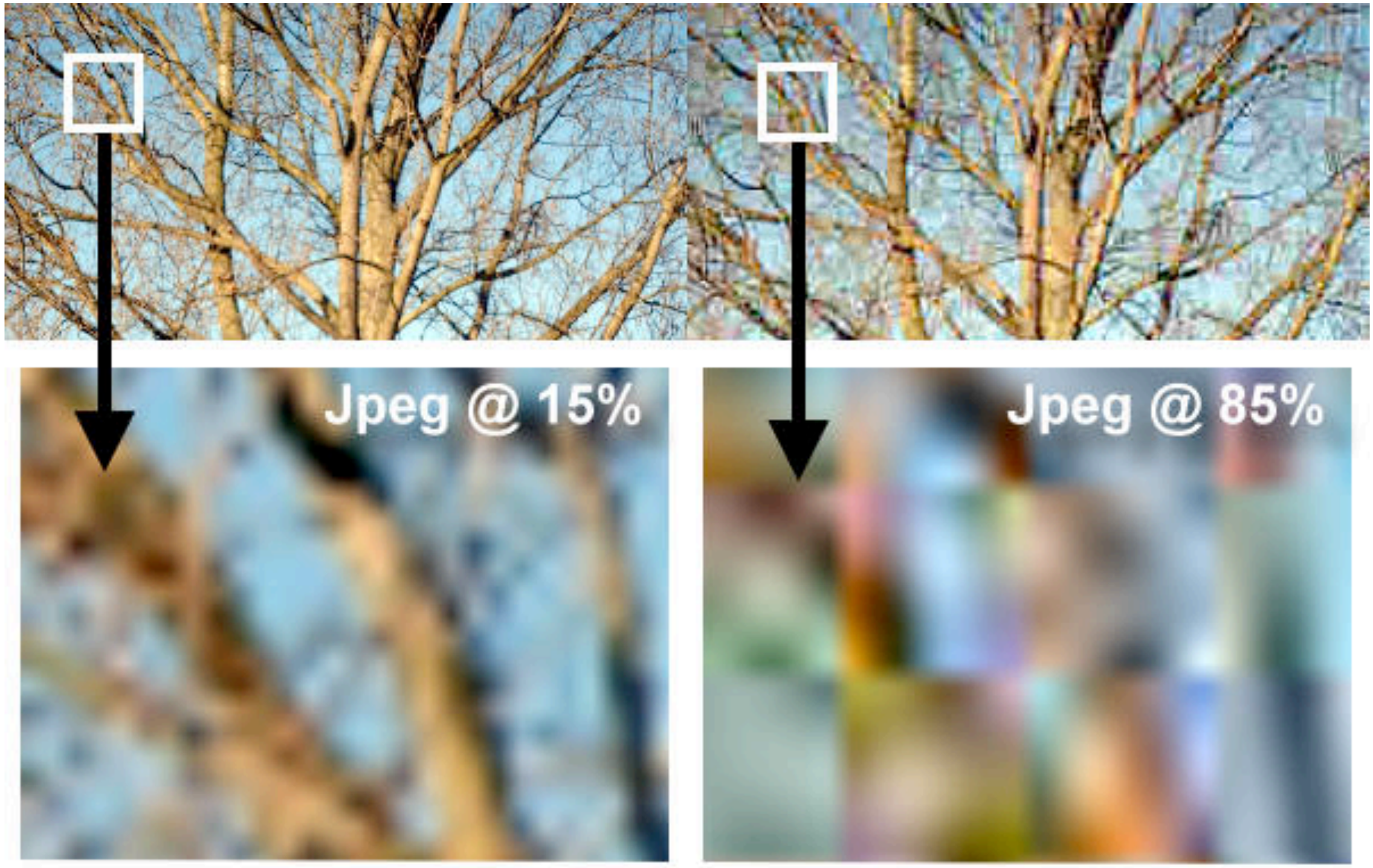
set	1	2	3	4	5	6	7	8	9	10	11	12	13
precision (%)	92.9	71.4	85.7	100	100	78.6	85.7	78.6	100	78.6	85.7	92.9	85.7

Verification

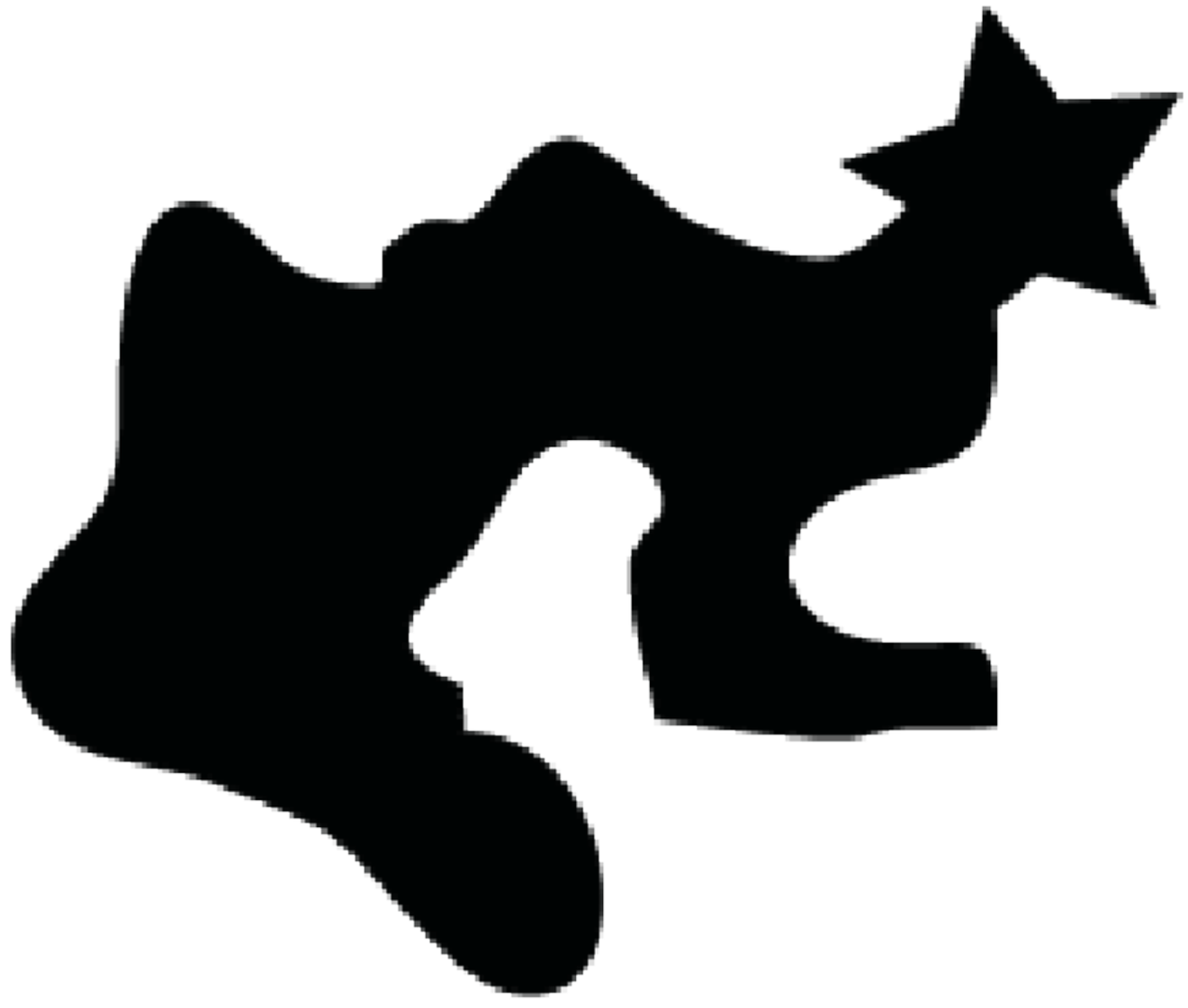
- It's hard to claim that artists that produce simplification with higher recall rates are better
- Depend on the extent of simplification

Future Works

- Recognizability v.s Extent of simplification

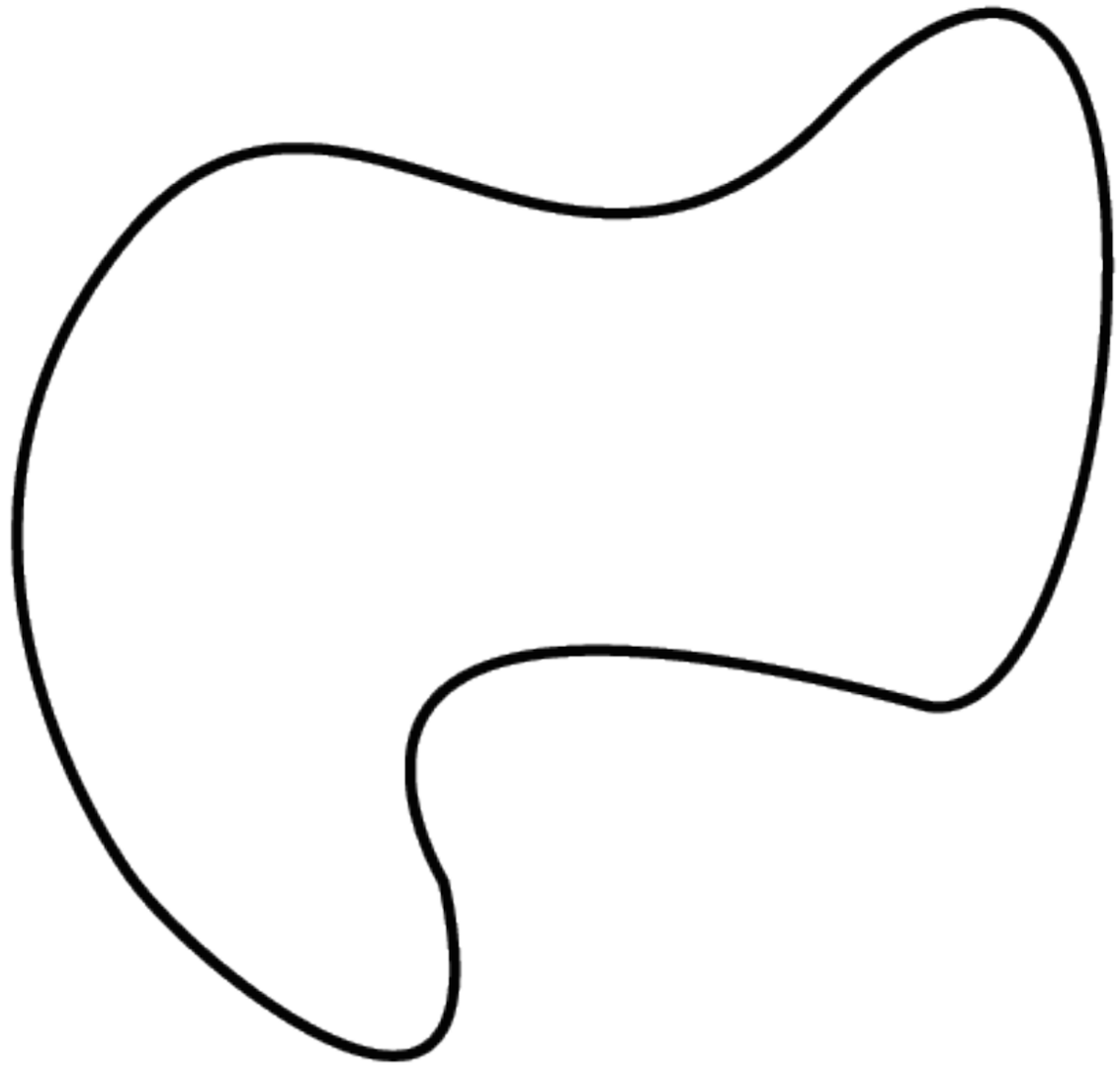


- Photo courtesy: http://meteo.milliflora.com/MET_Page_ConfigVideo.aspx

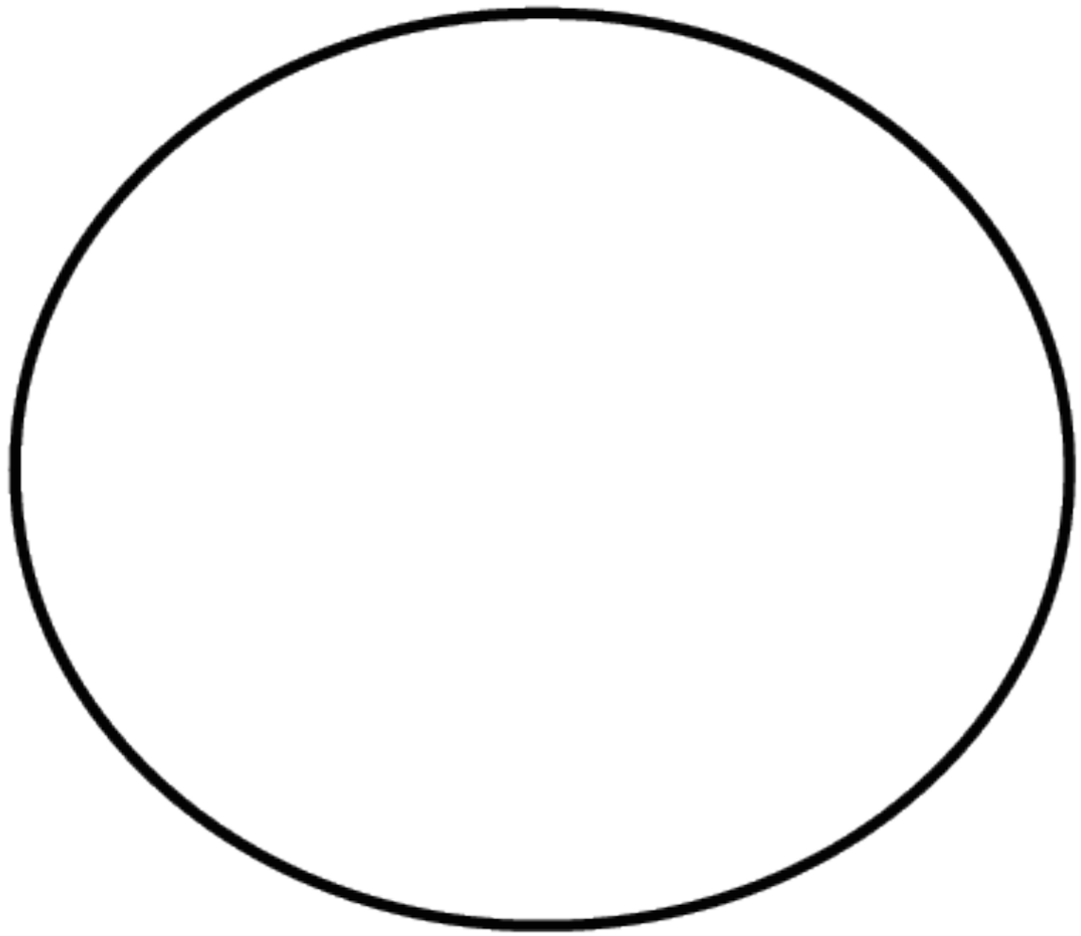


0% simplification

30% simplification

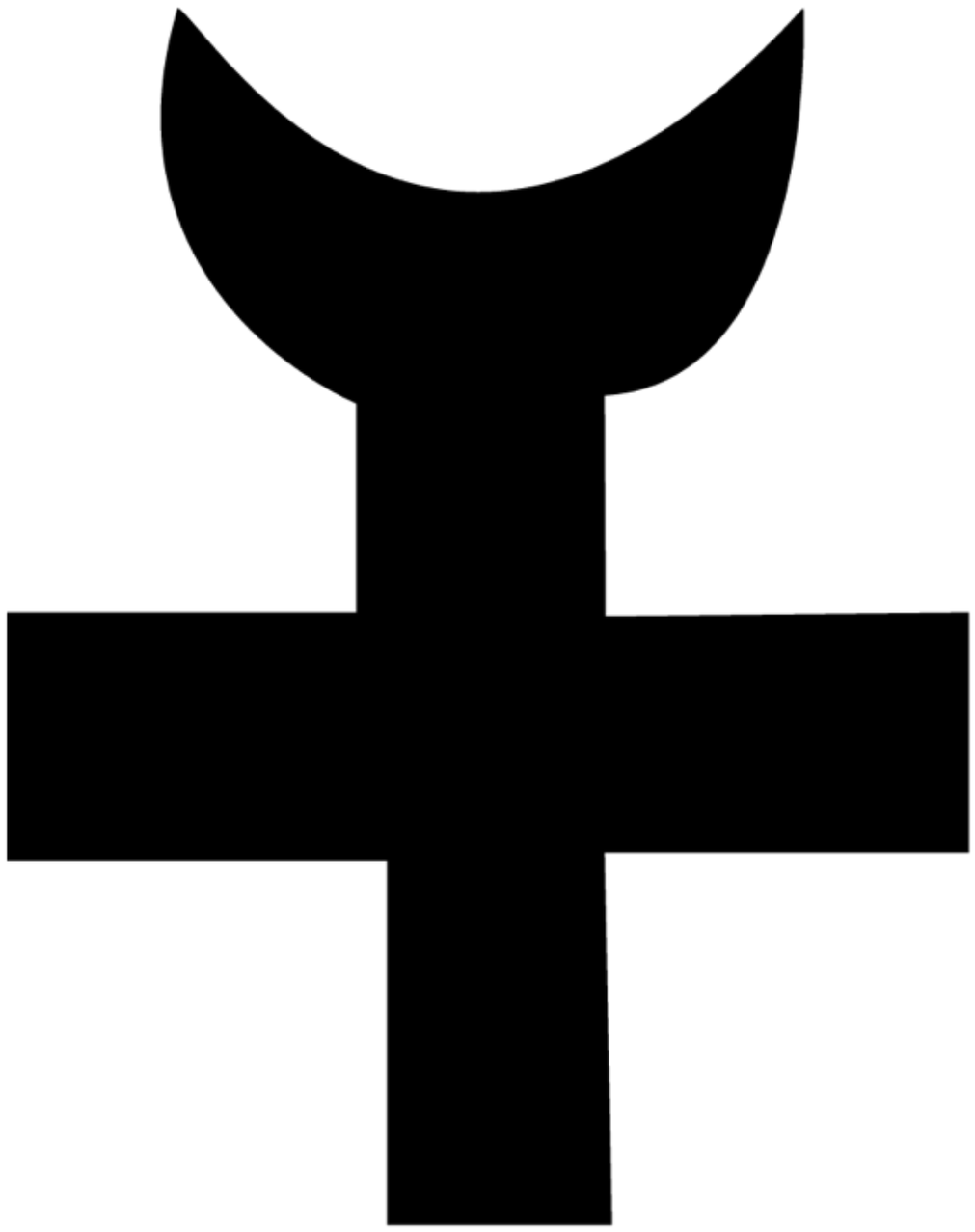


70% simplification

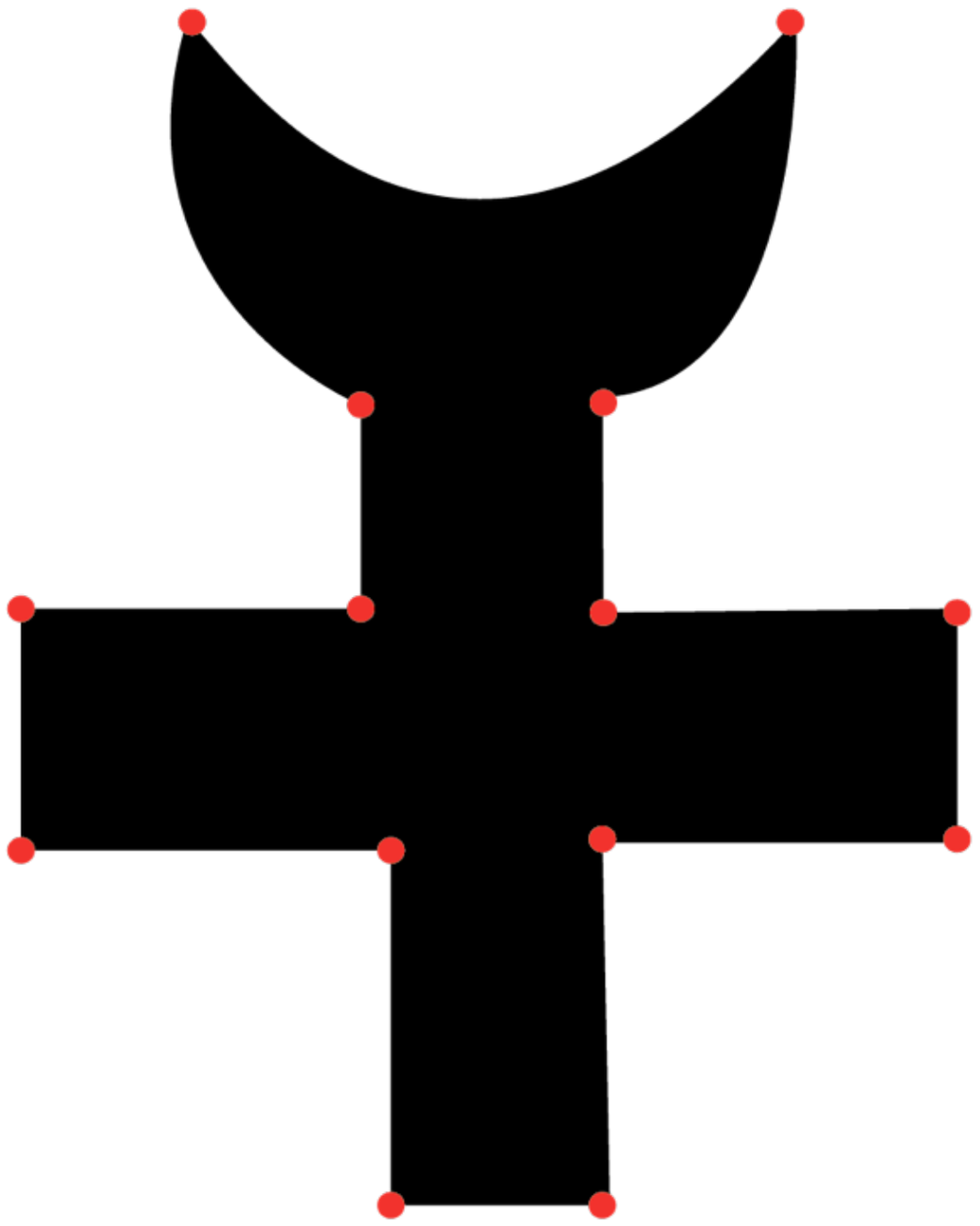


100% simplification

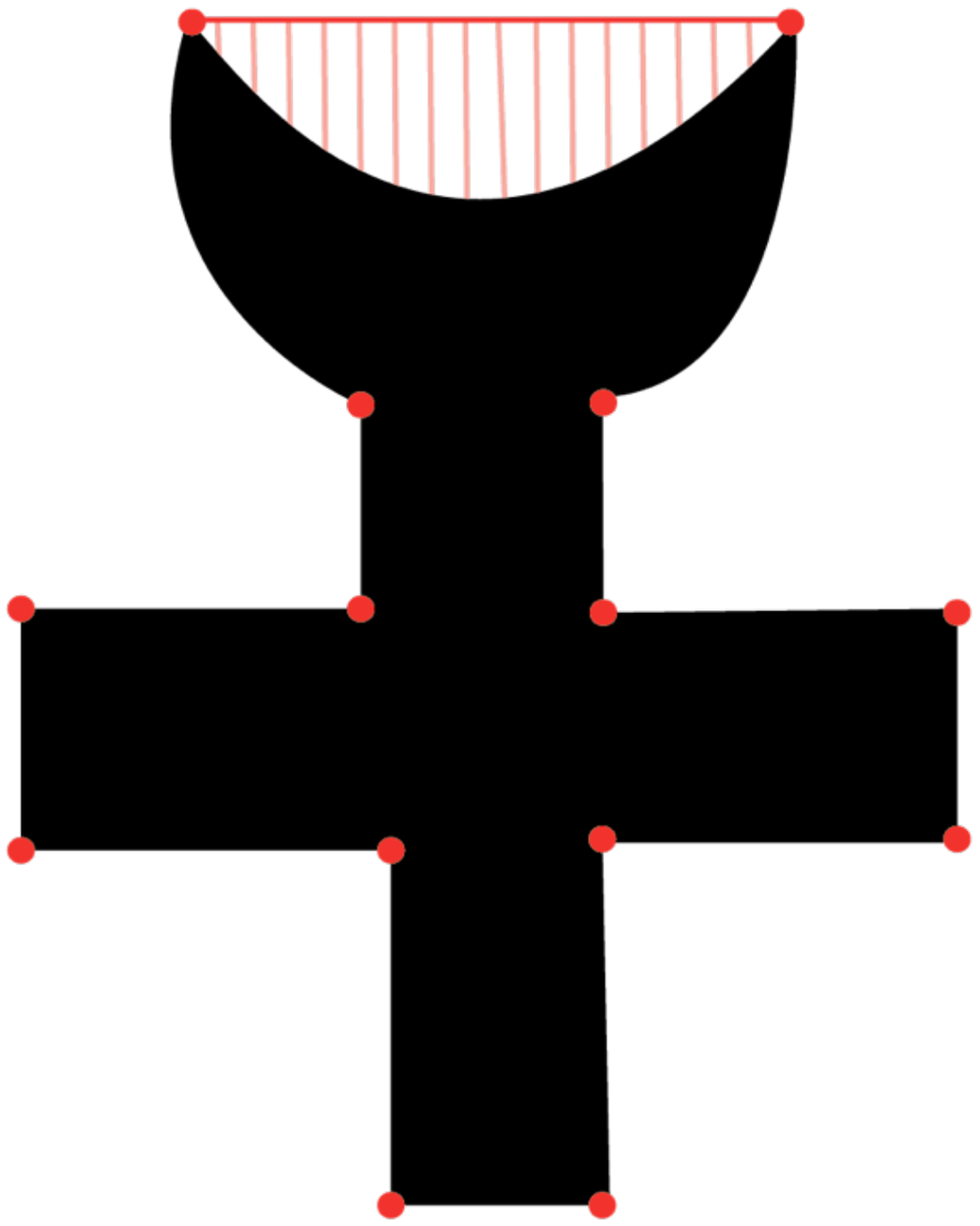
Algorithms



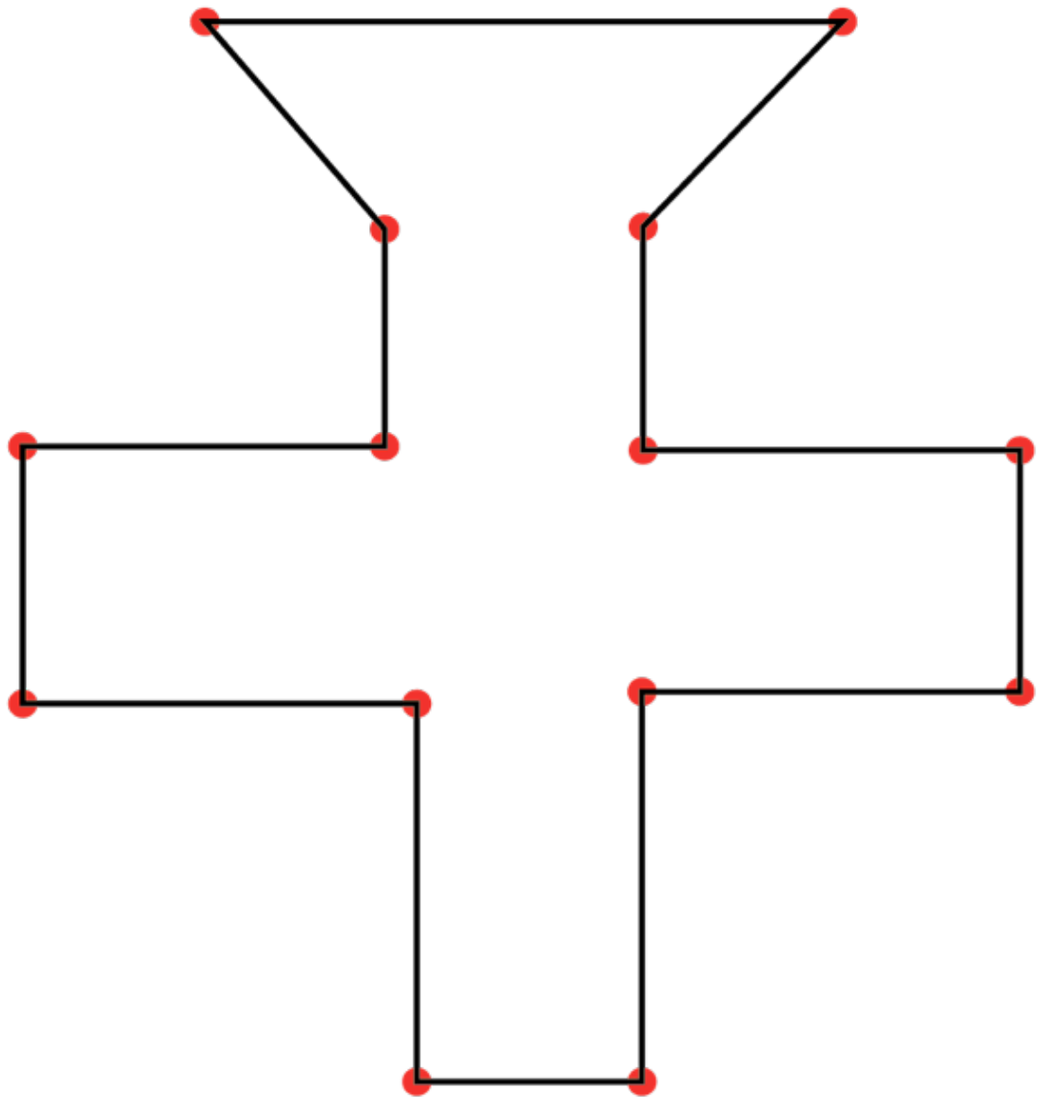
Algorithms



Algorithms



Algorithms



Summary

- We conducted a survey that observes the principles for shape simplification
- We would like to have a further study on the relation between recognizability and extent of simplification

Questions & Feedback?

Thank You!