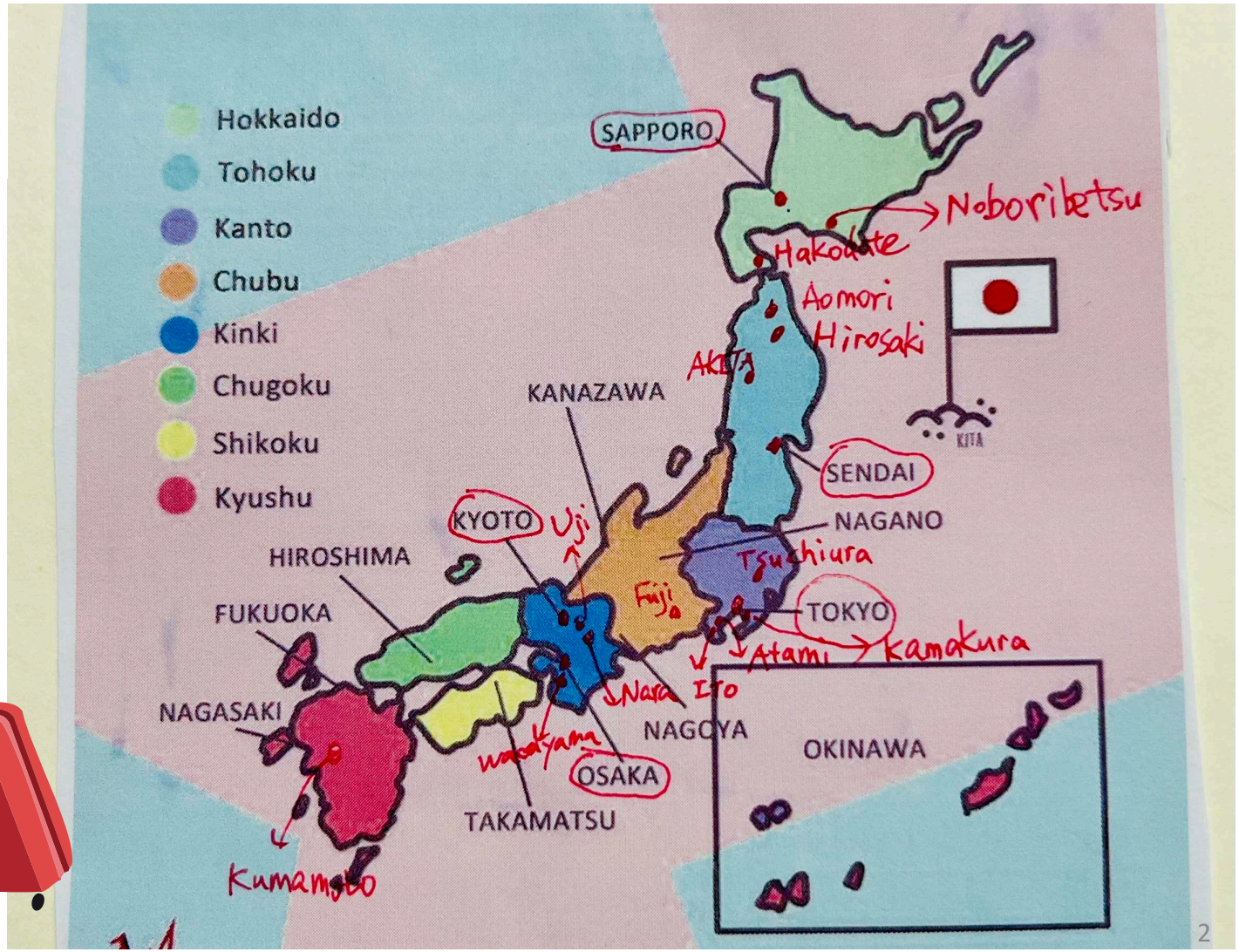
The 9th ACM/EG
Expressive Symposium

Sketch2Data: Recovering Data from Hand-Drawn Infographics

Anran Qi, Theophanis Tsandilas, Ariel Shamir, Adrien Bousseau

Create, observe, draw!

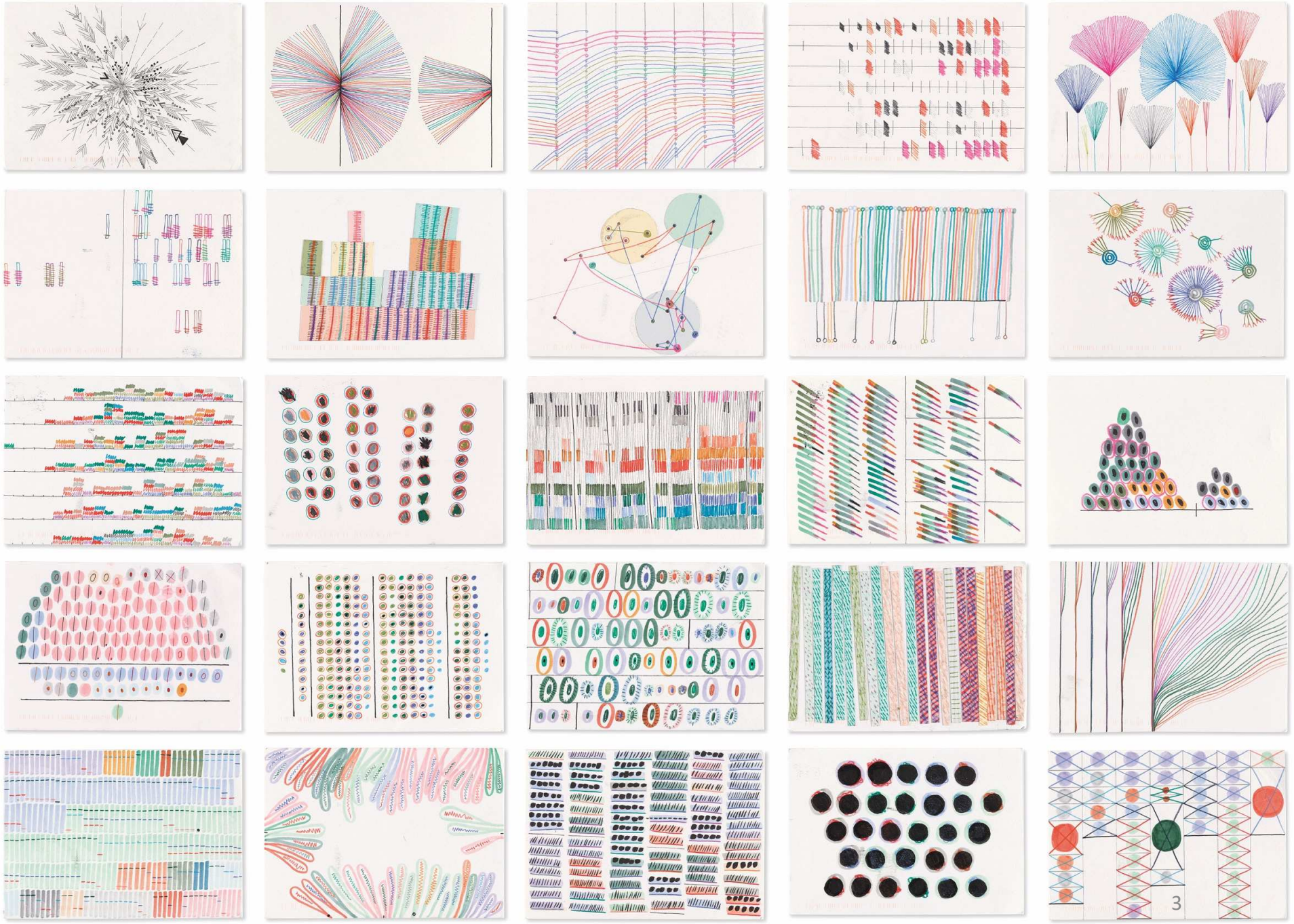
[*When*], with [*whom*]
I travelled to [*where*].



“Dear Data”

Stefanie Posavec

Giorgia Lupi



Motivation

Stefanie Posavec:

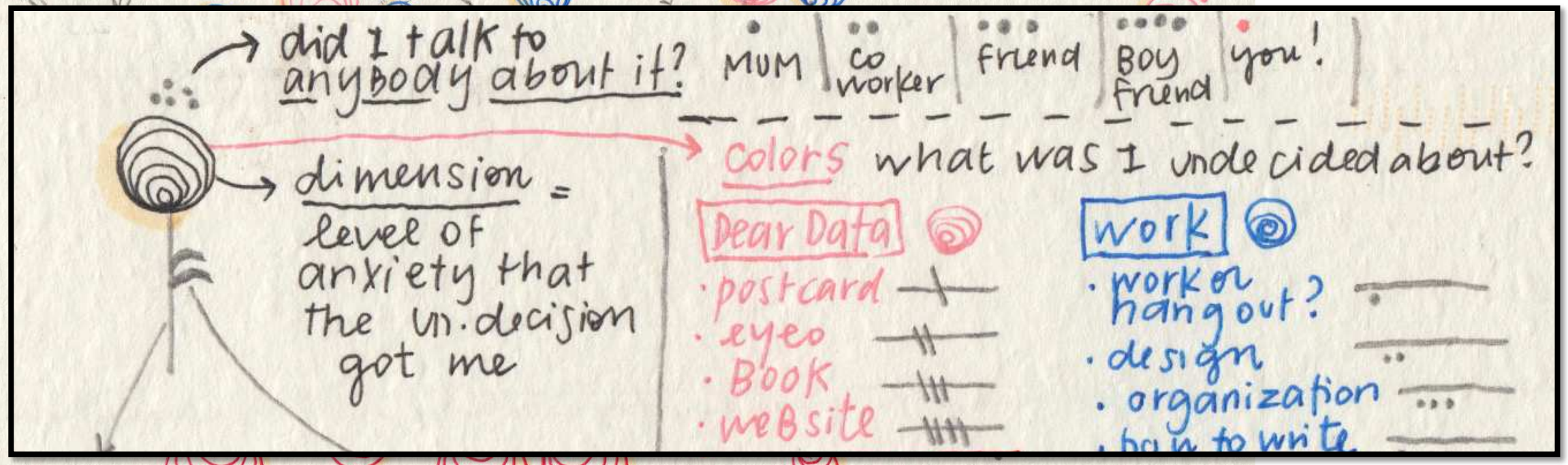
I believe that everyone in the world is a secret data-collector, even if they don't realize it!

Collecting the countries we travel to or the concerts we visit, or […]:

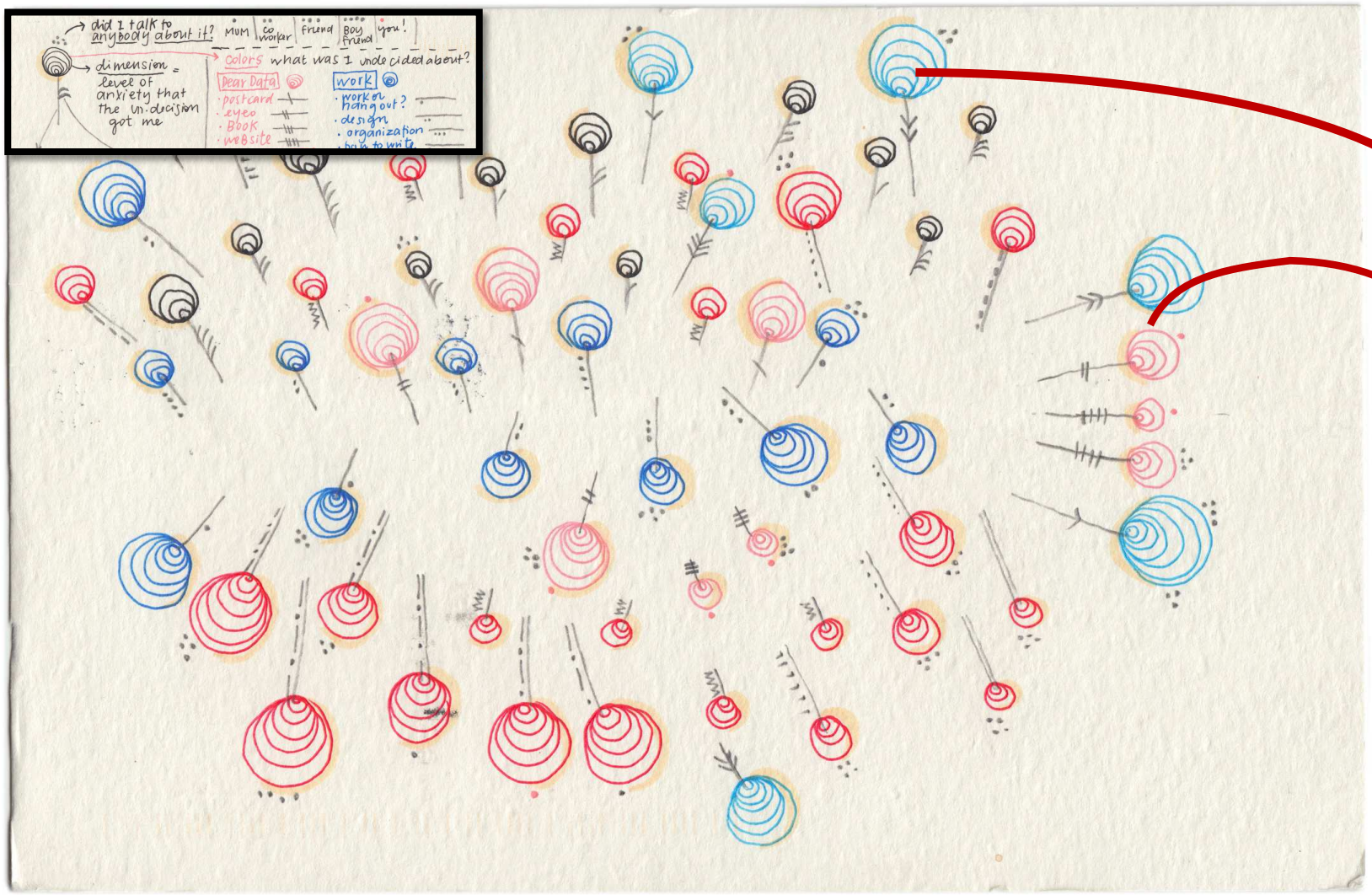
these measurements and numbers are all data,
*and anyone can **draw** this data to better understand themselves.*

WEEK 36
"SHALL I"

Each element (glyph, lollipop) represents a moment where I was undecided about whether to do/think something or not.



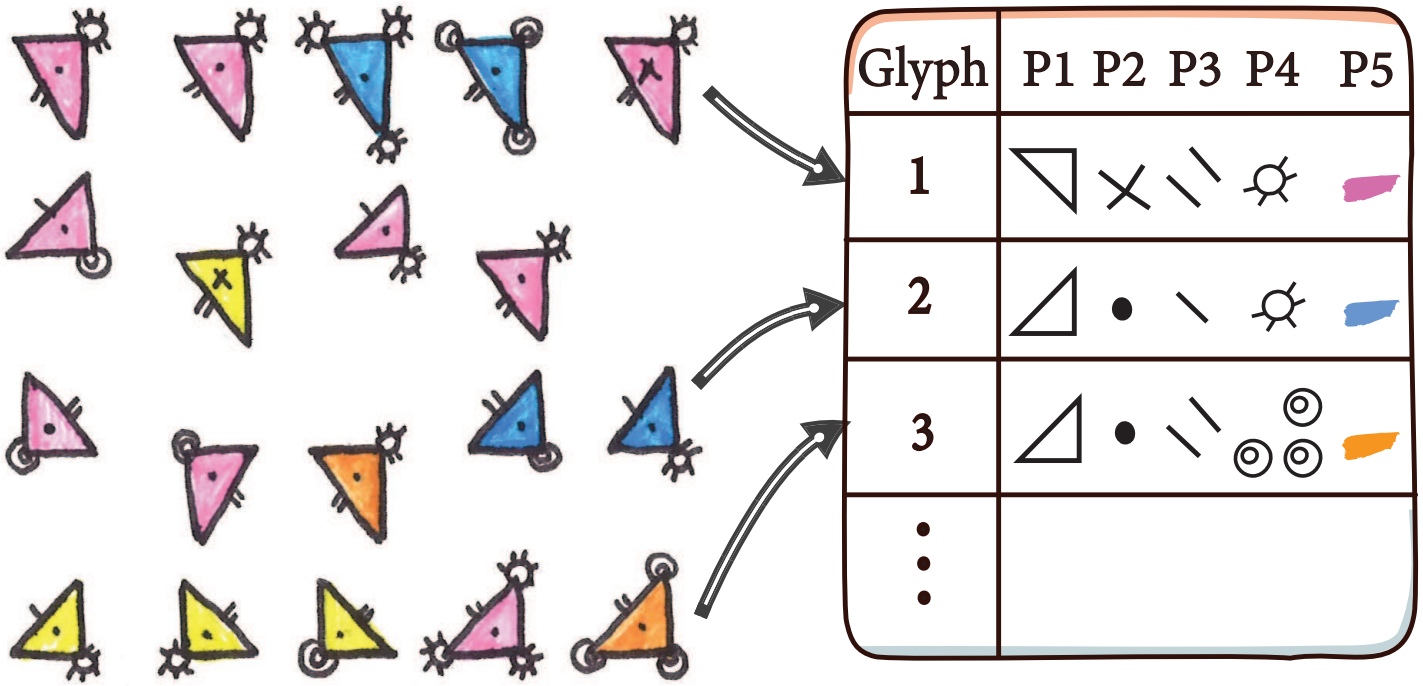
But… the data behind the drawing is locked!



Talk to whom	Anxiety level
Friend	6
Mum	4
⋮	

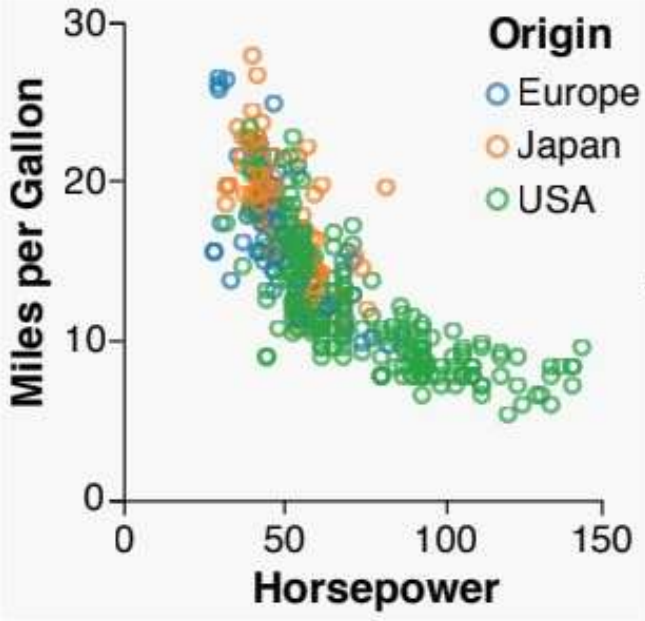
Goal

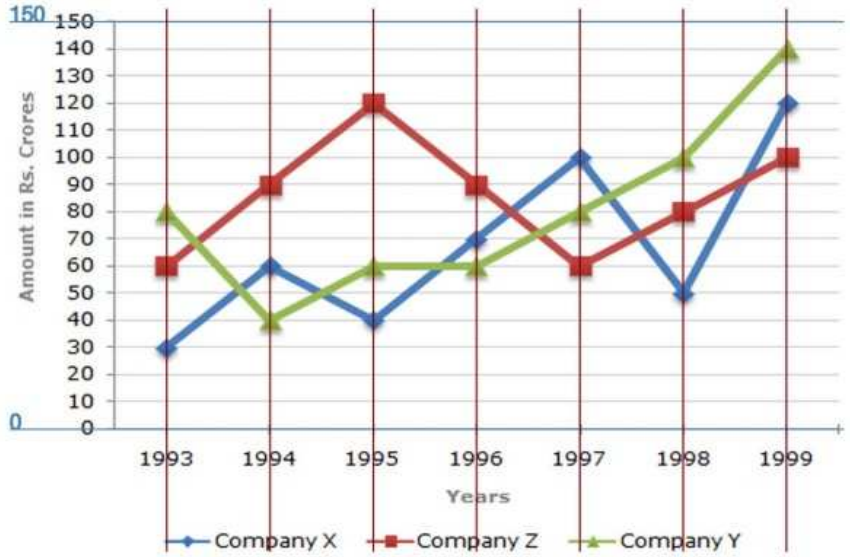
- Given a hand-drawn infographic, extract the underlying data.



The Challenges

- Existing tools reverse charts/graphs, not expressive glyphs.
- Our focus: freehand infographics, often noisy and diverse

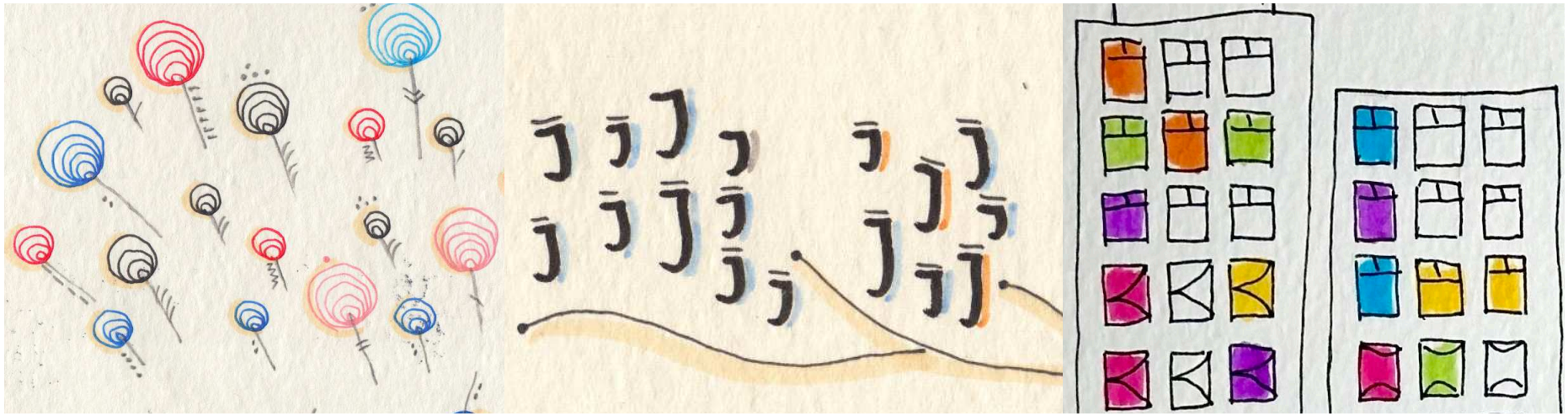


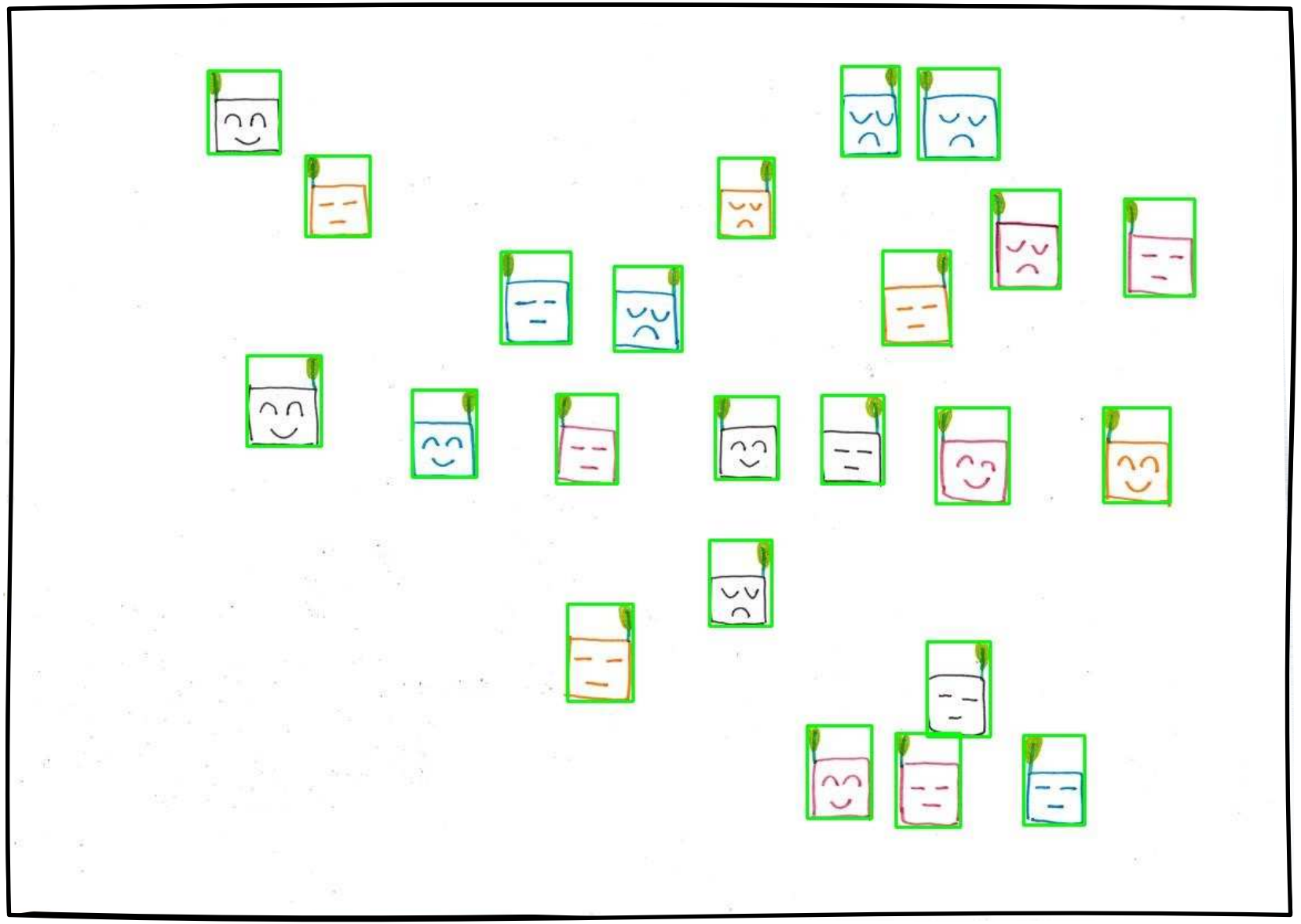


Poco, J, and Heer, J. Reverse-engineering visualizations: Recovering visual encodings from chart images. CGF2017
Jung et al. Chartsense: Interactive data extraction from chart images. CHI 2017.

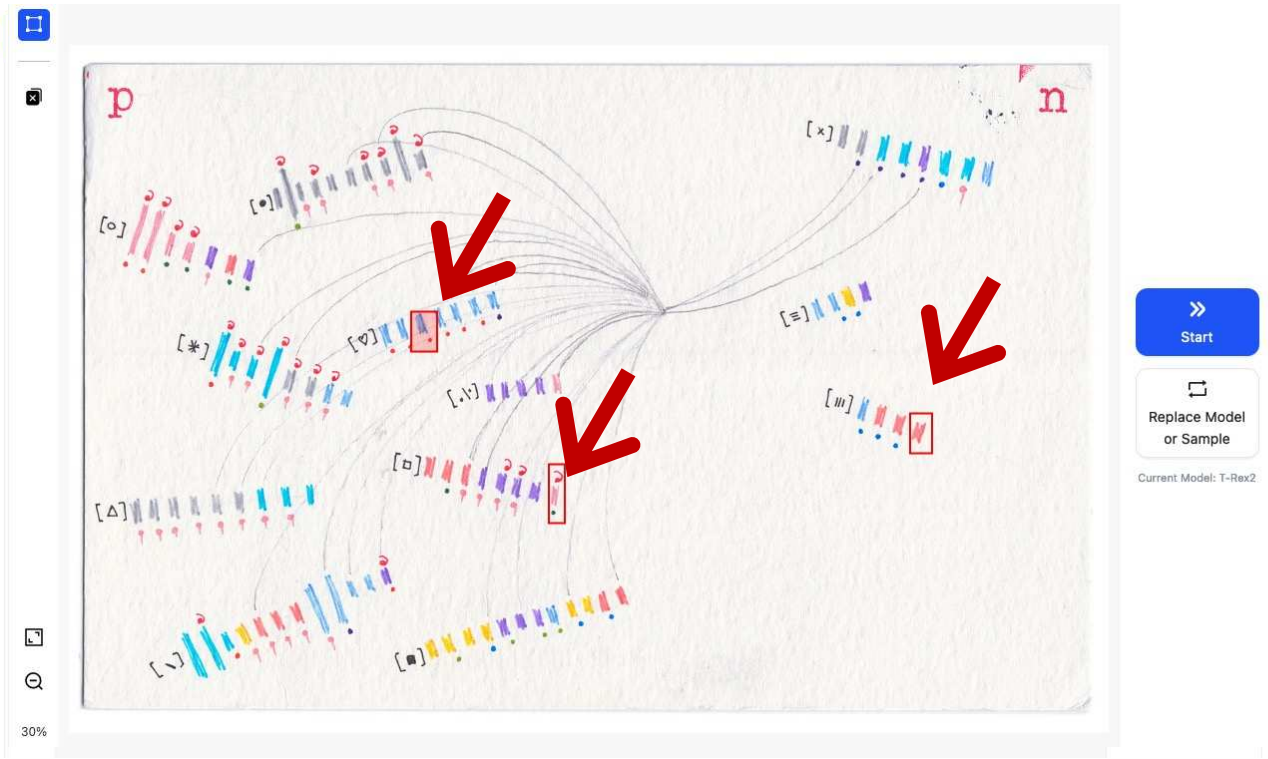
The Challenges

- Existing tools reverse charts/graphs, not expressive glyphs
- Our focus: freehand infographics, often noisy and diverse





What about a generic detector?



Jiang, Q, Li, F, Zeng, Z, Ren, T, Liu, S, Zhang, L. T-rex2: Towards generic object detection via text-visual prompt synergy. ECCV 2024,.

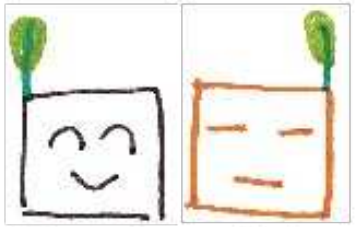
Our Approach: Sketch2Data

- Train a **specific** detector for a given visualization.

How to get the data?

Step 1: Parametric Glyph Templates

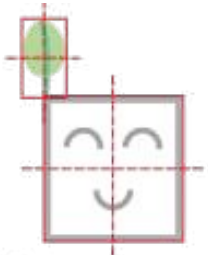
- Glyph = Group of marks + Composition rule + Visual parameters



Hand-drawn glyphs

Mark 1

Mark 2



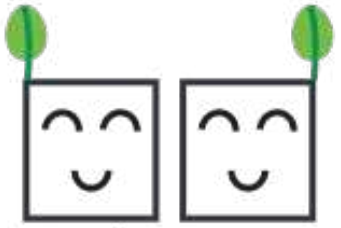
Color

meat seafood veggies drinks only

Shape

satisfied neutral unsatisfied

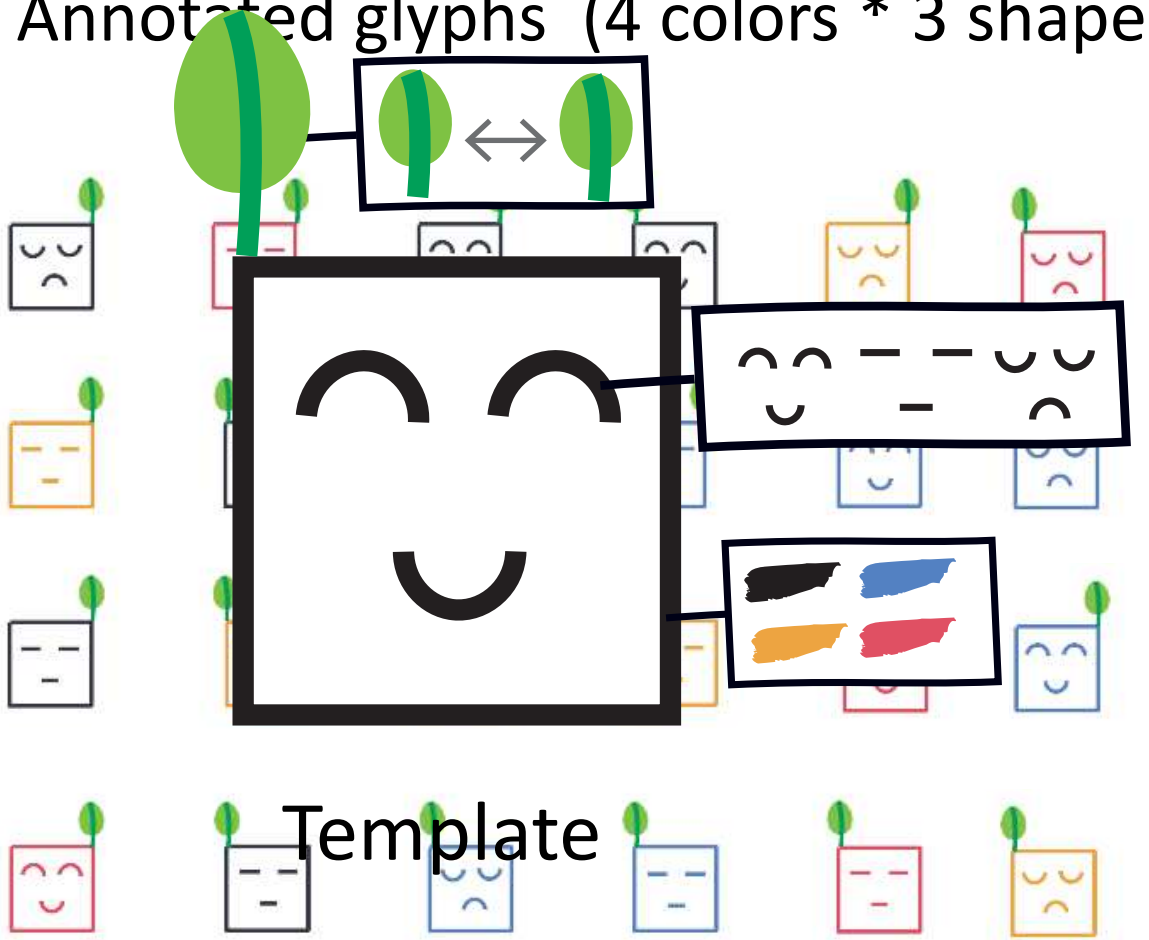
Position



lunch dinner

Step 1: Parametric Glyph Templates

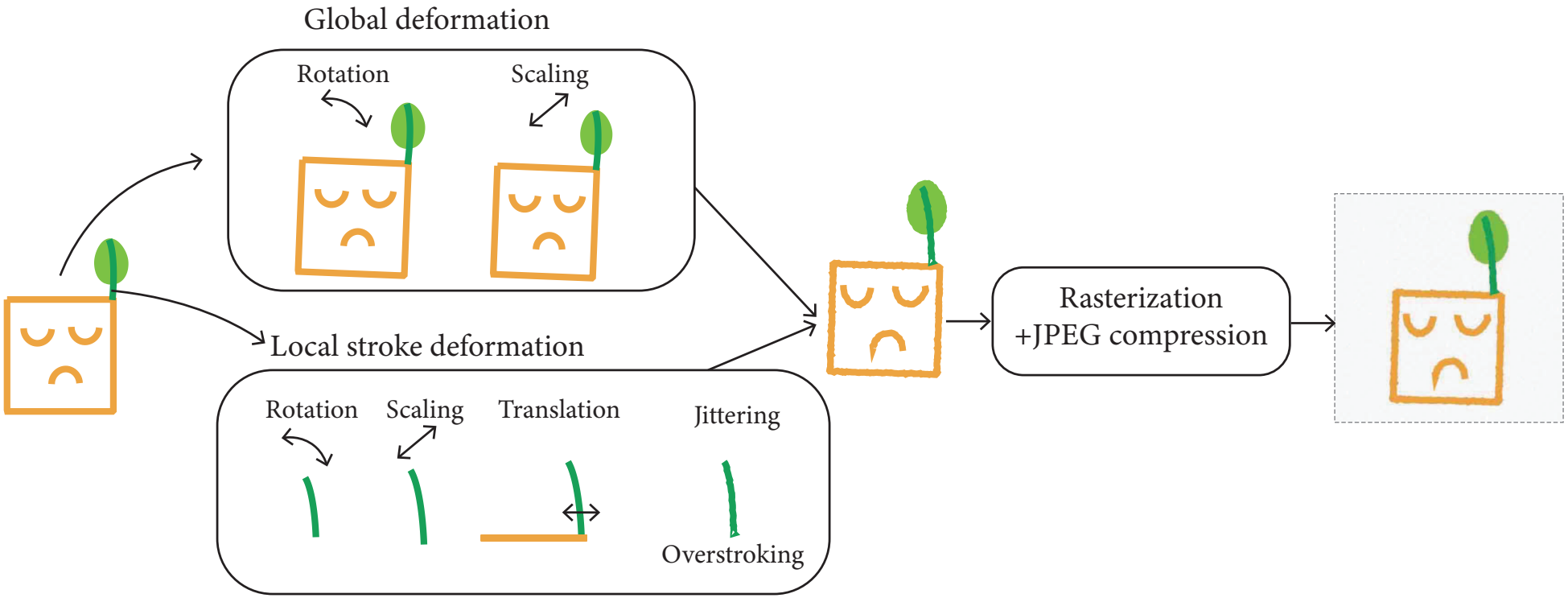
- Annotated glyphs (4 colors * 3 shapes * 2 positions)



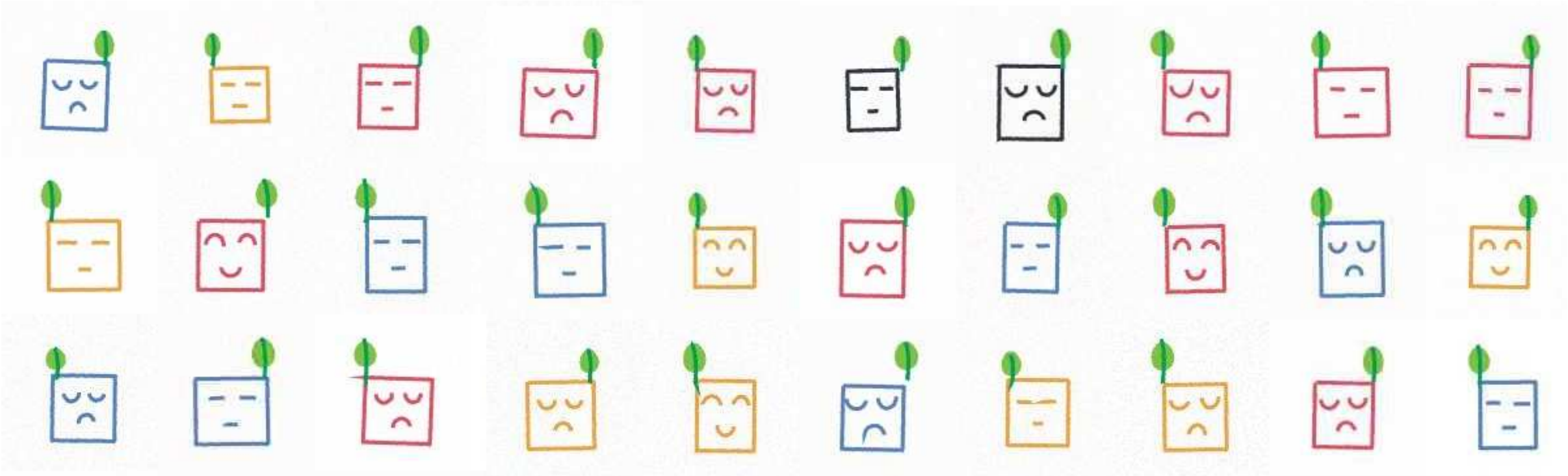
Template

Step 1: Parametric Glyph Templates

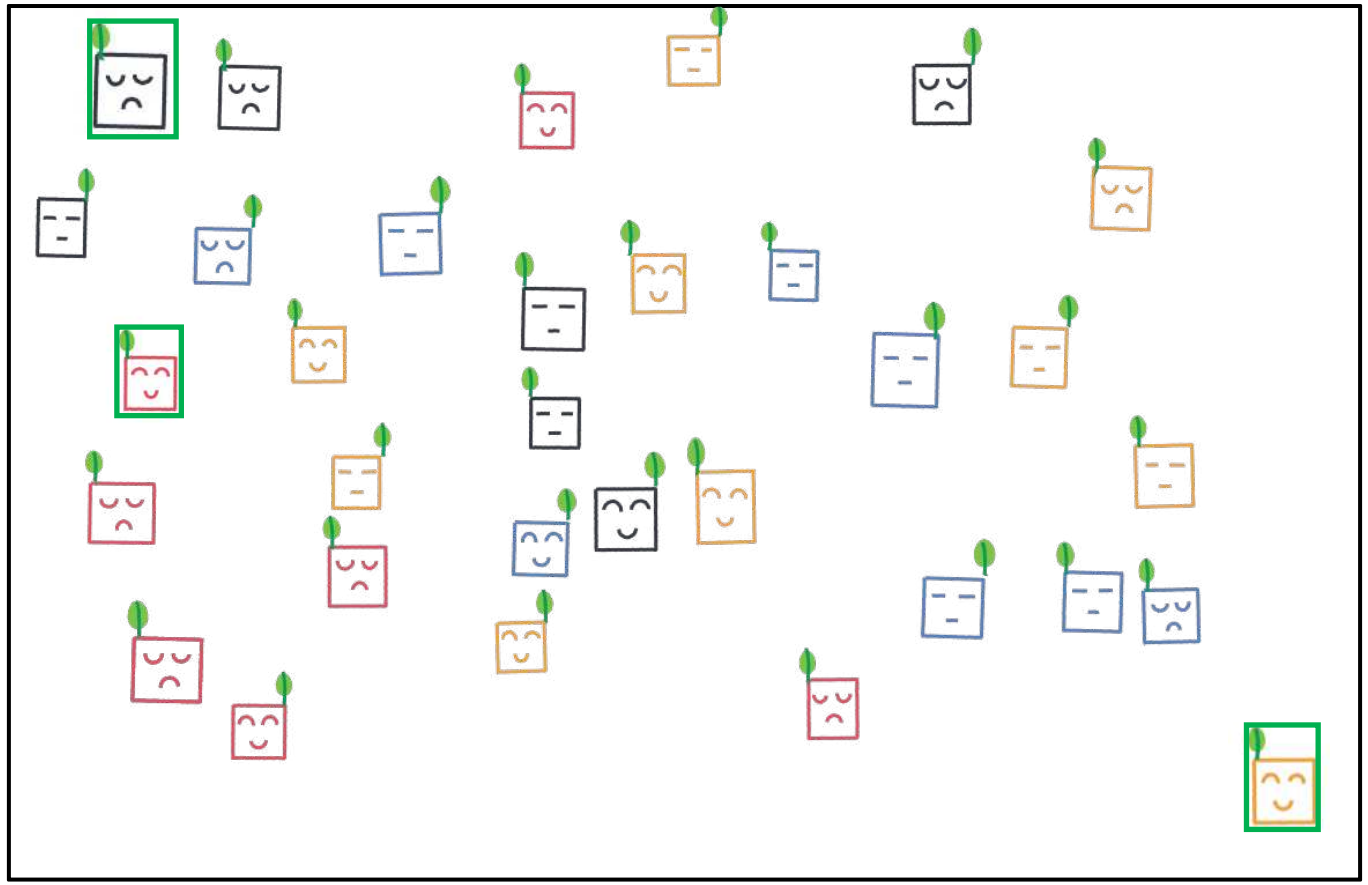
- Augmented glyphs



Glyphs

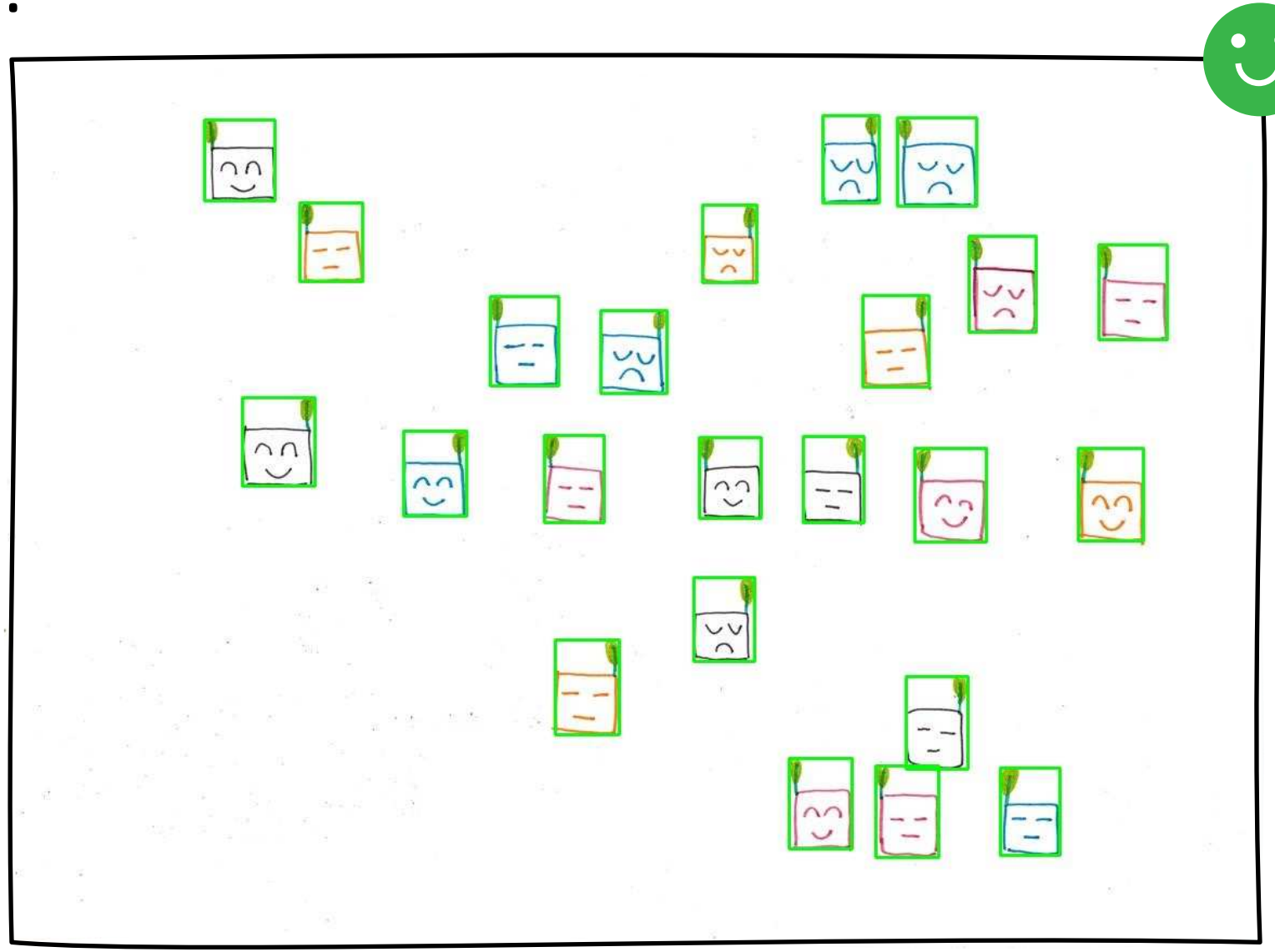


Glyph detection dataset



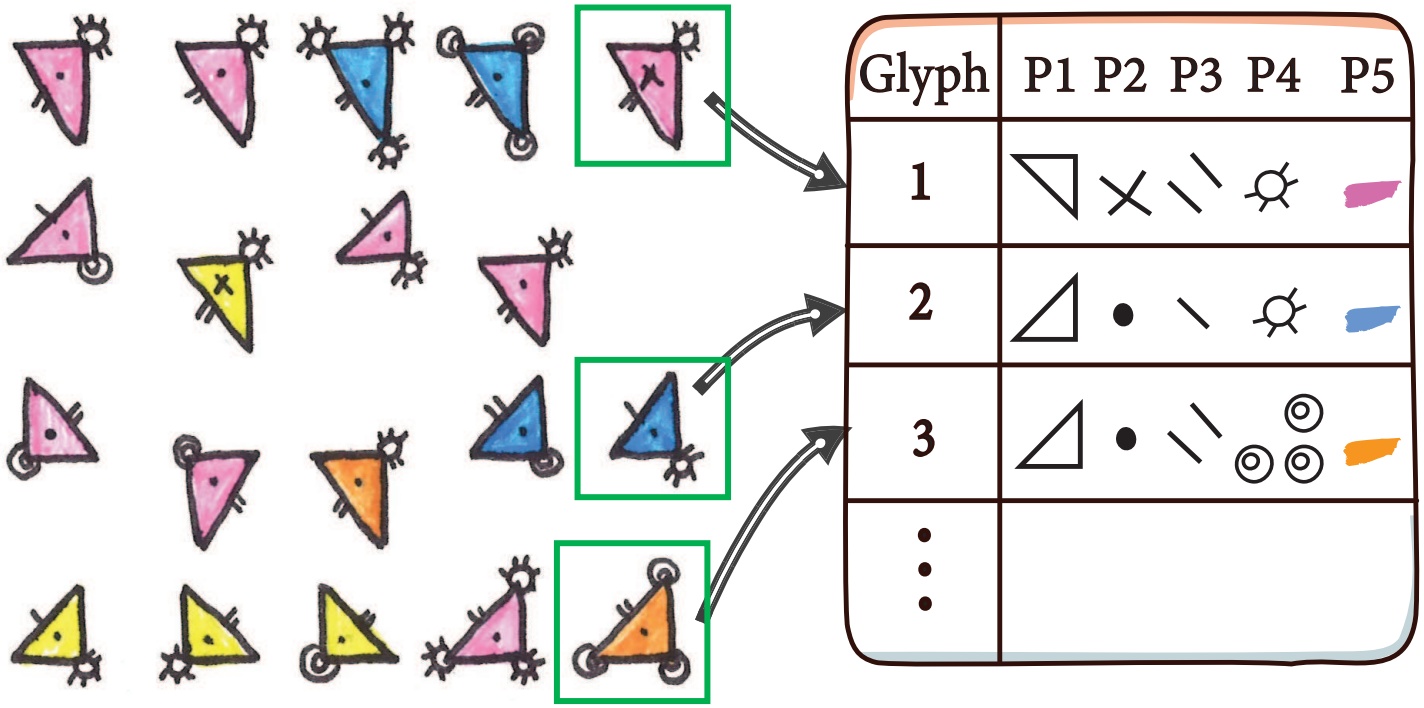
Step 2: Glyph Detector = Fine-tuned YOLOv8

Good!

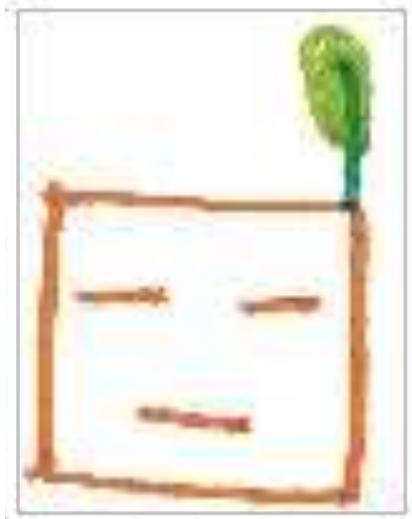


Recall the goal

- Not just locate the glyph, but also estimate its parameters.

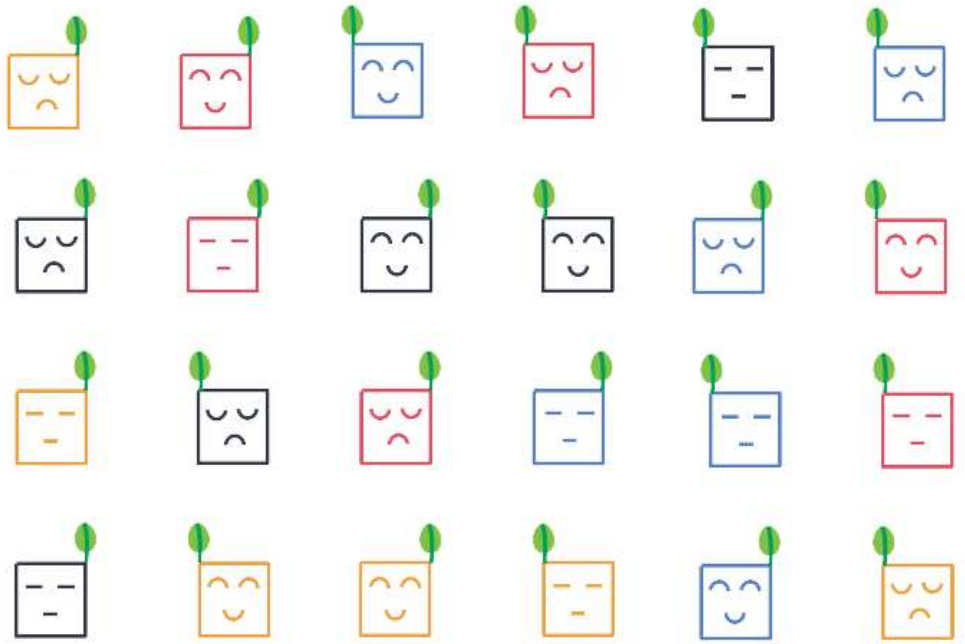


What about a direct lookup comparison?



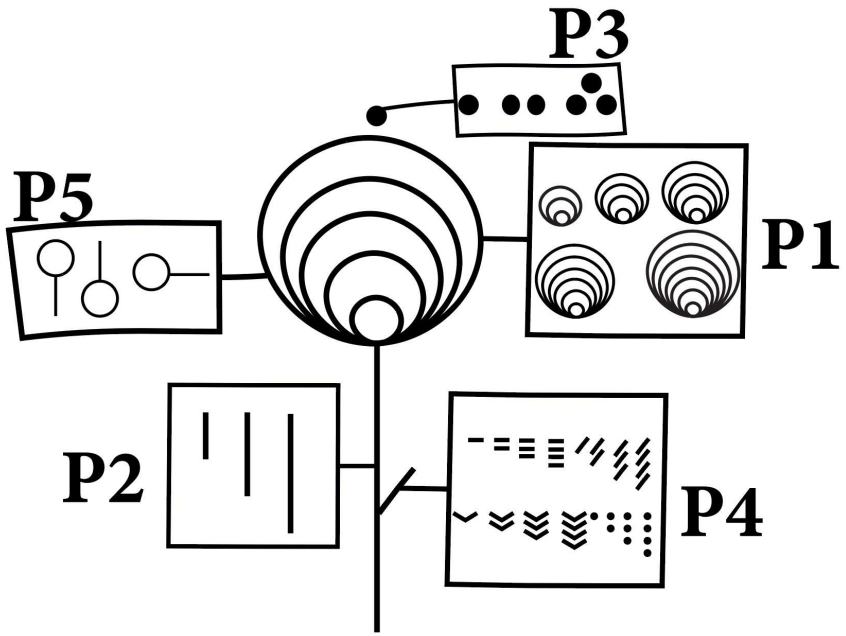
Compare

one by one

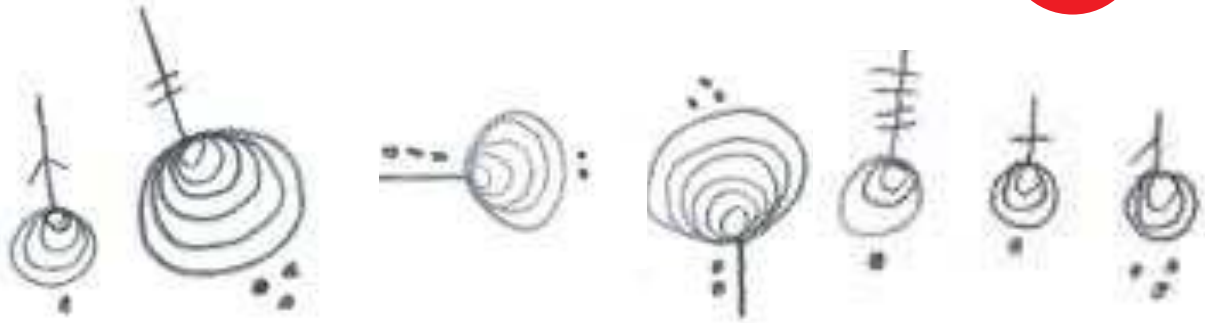


But …

2160 variations!



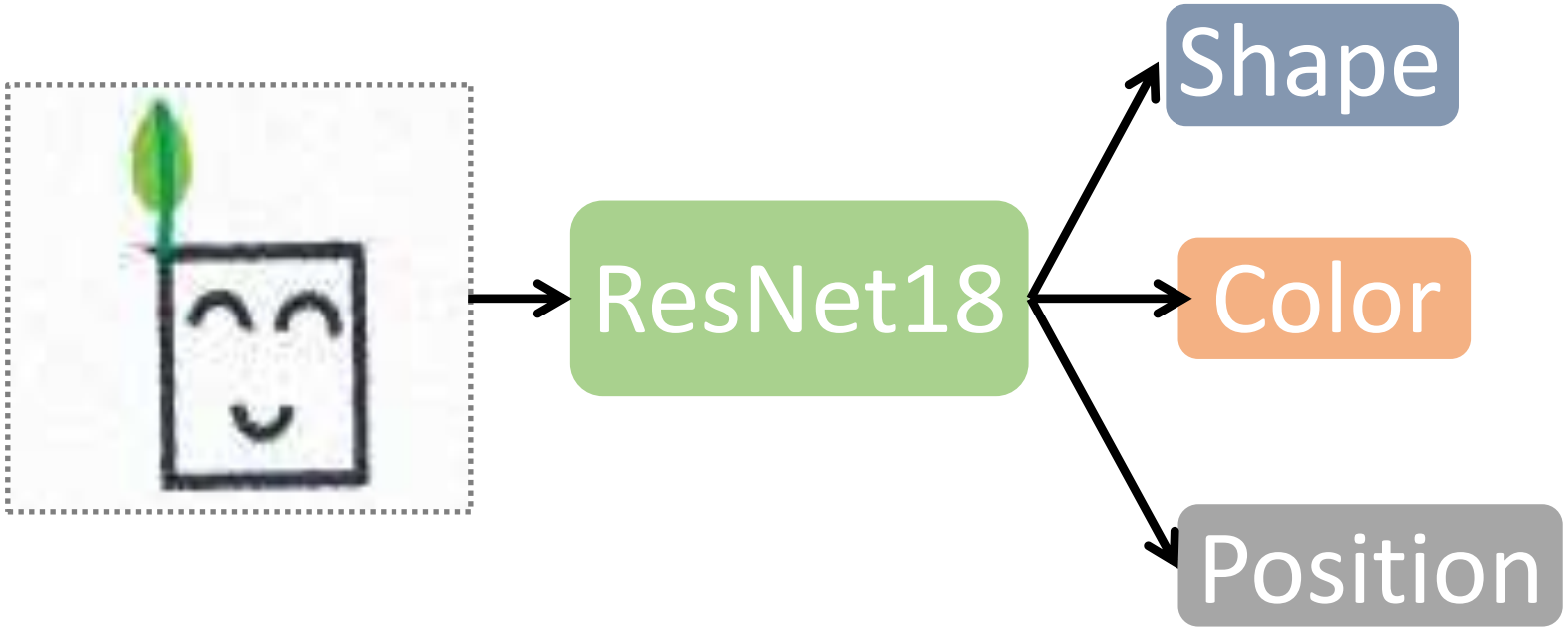
Misalignment and other defects.



Our Approach: Sketch2Data

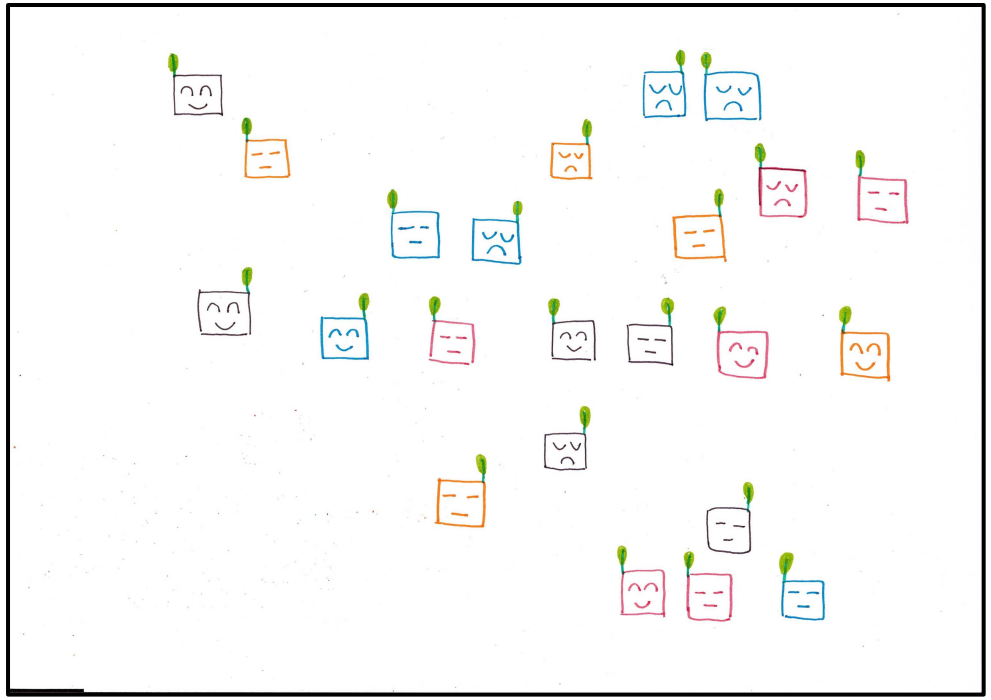
- Define a glyph template (components + variations)
- Synthesize data, train neural networks for detection + classification

Step 3: Parameter Estimator
= ResNet18 Multi-head Classifier

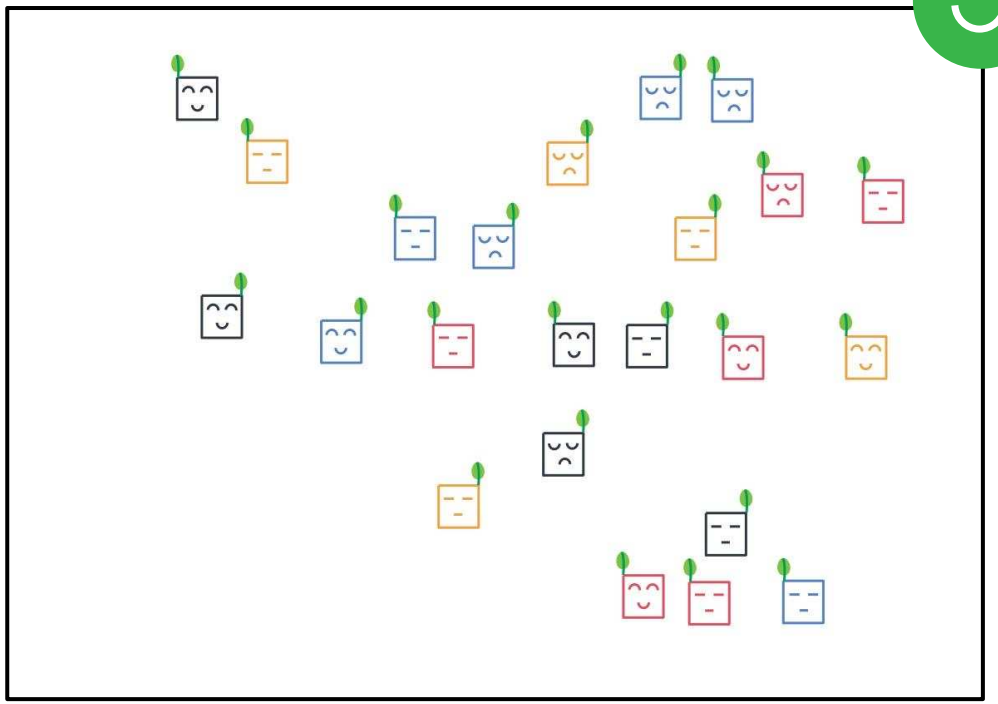


Good!

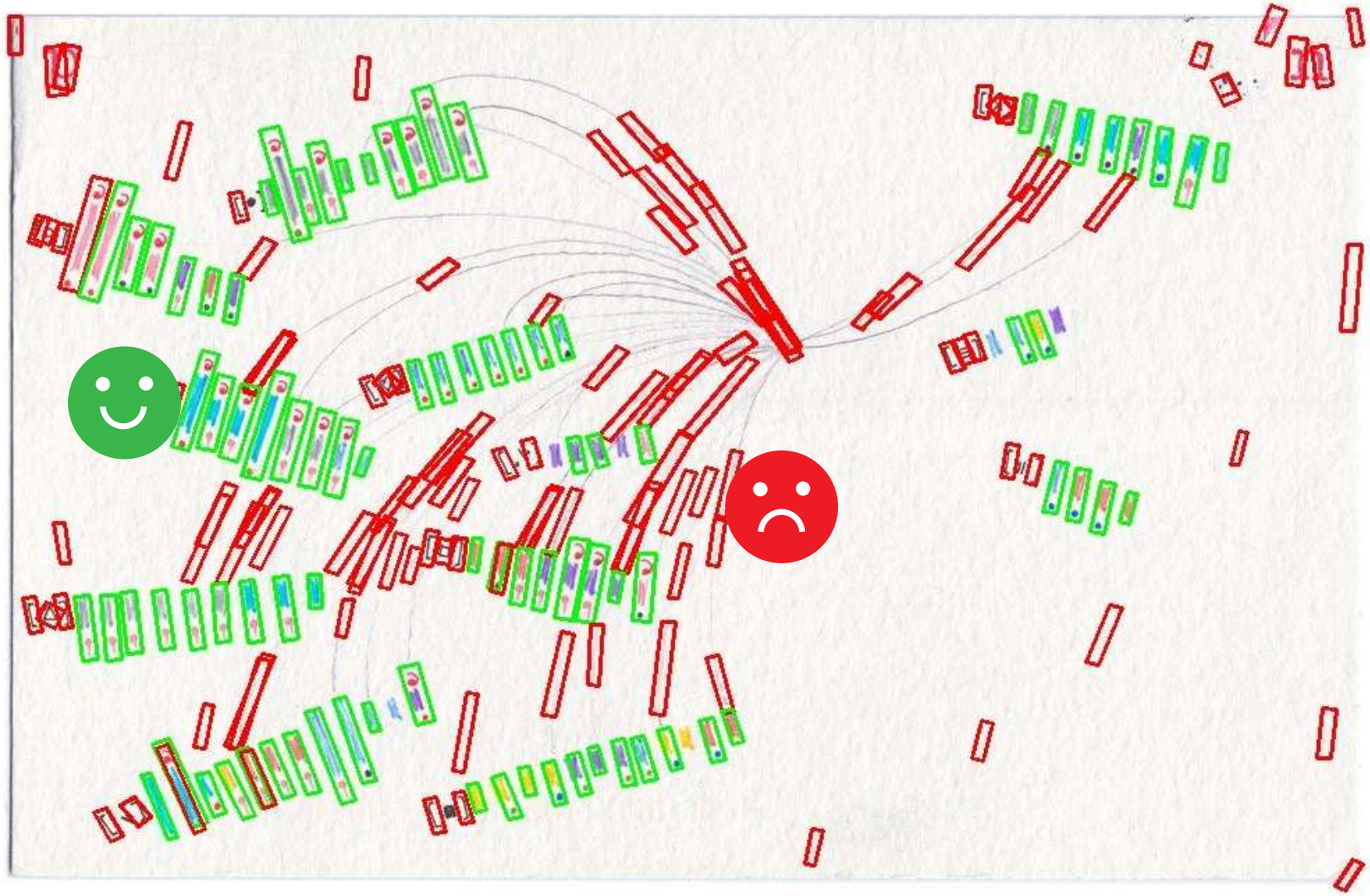
Original design



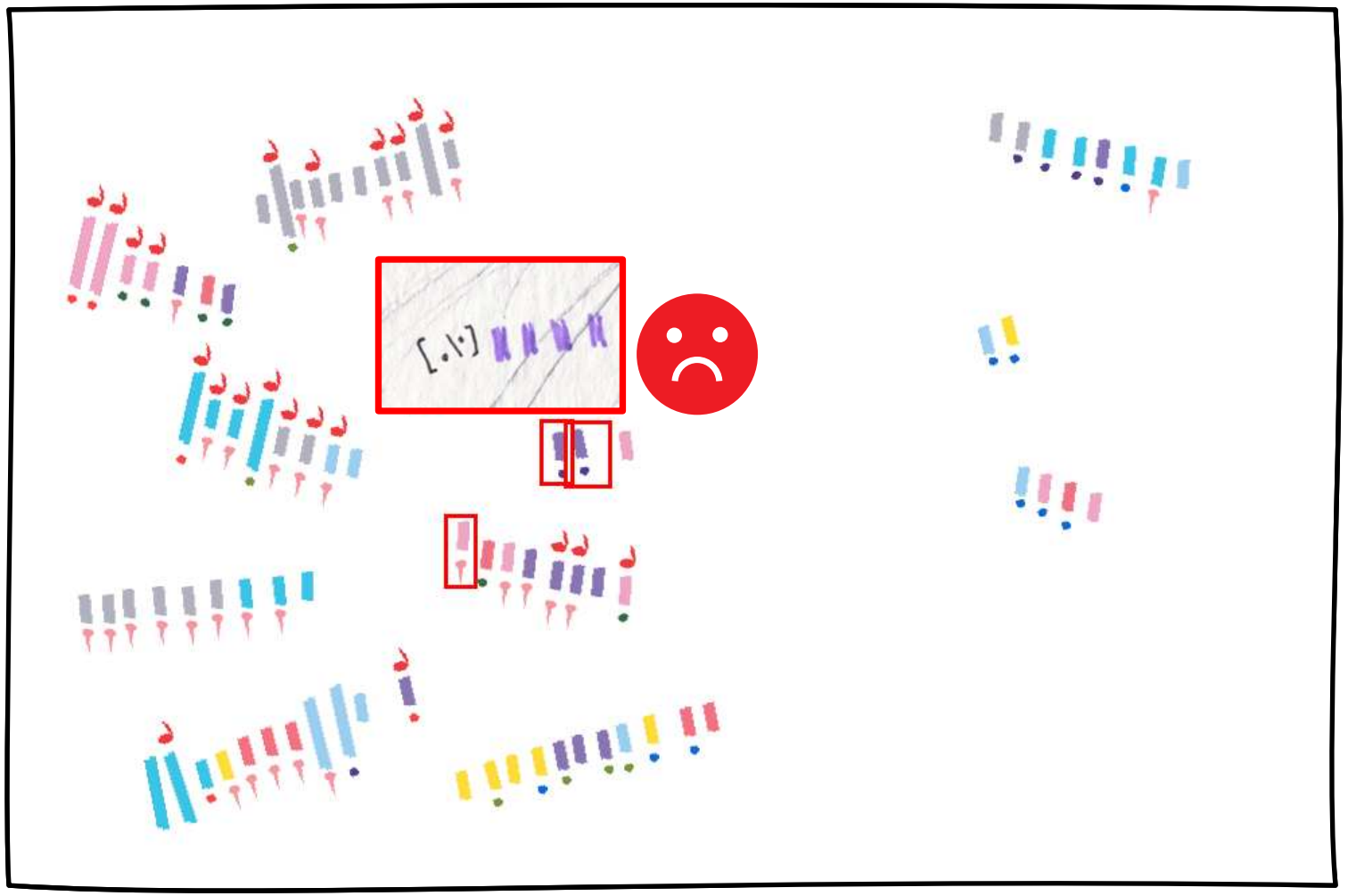
Reconstruction



Good, but …



Good, but …



Our Approach: Sketch2Data Pipeline

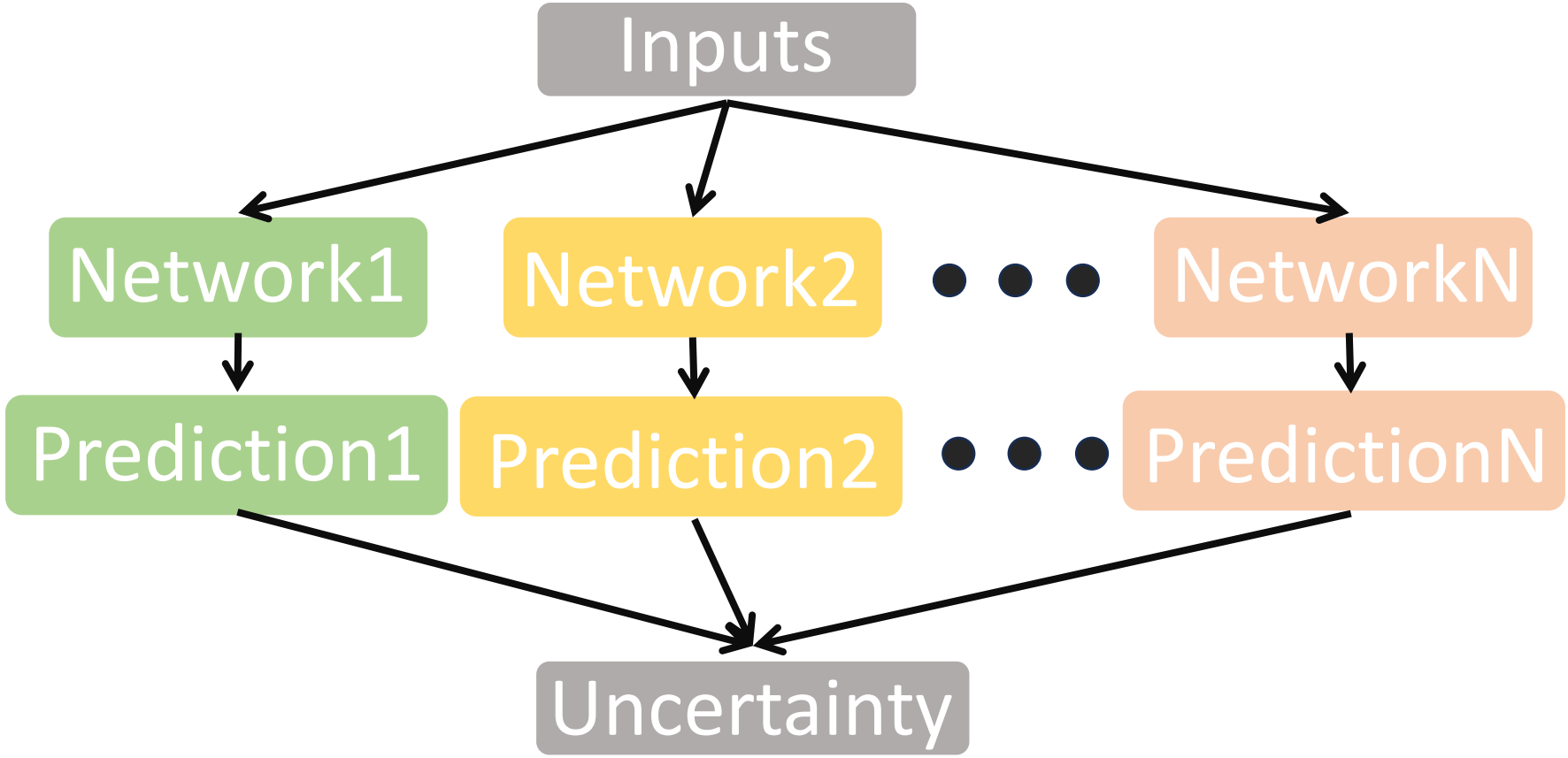
- Define a glyph template (components + variations)
- Synthesize data, train neural networks for detection + classification
- User interface for refinement and correction

Step 4: User-in-the-Loop Refinement

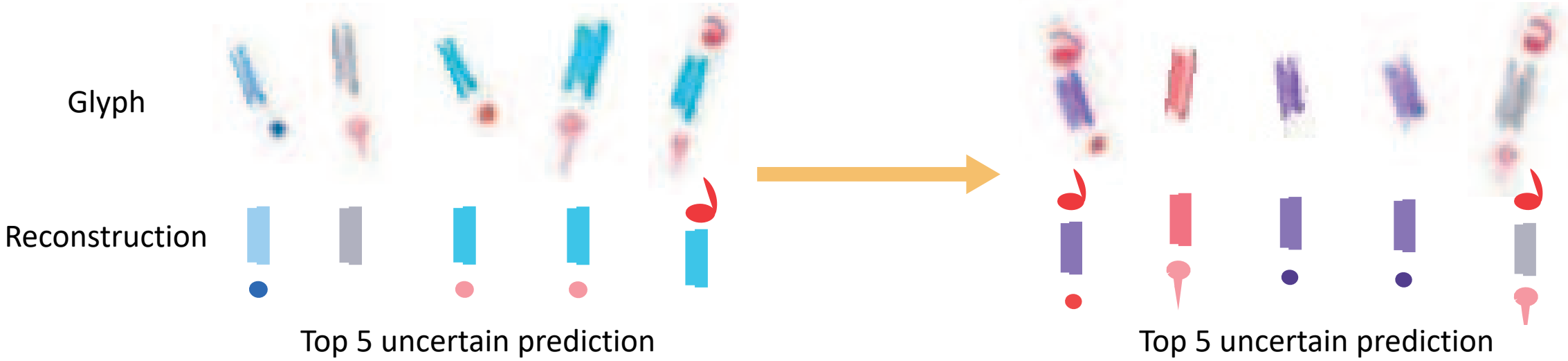
- Uncertainty helps catch ambiguous glyphs
- User interface for data review

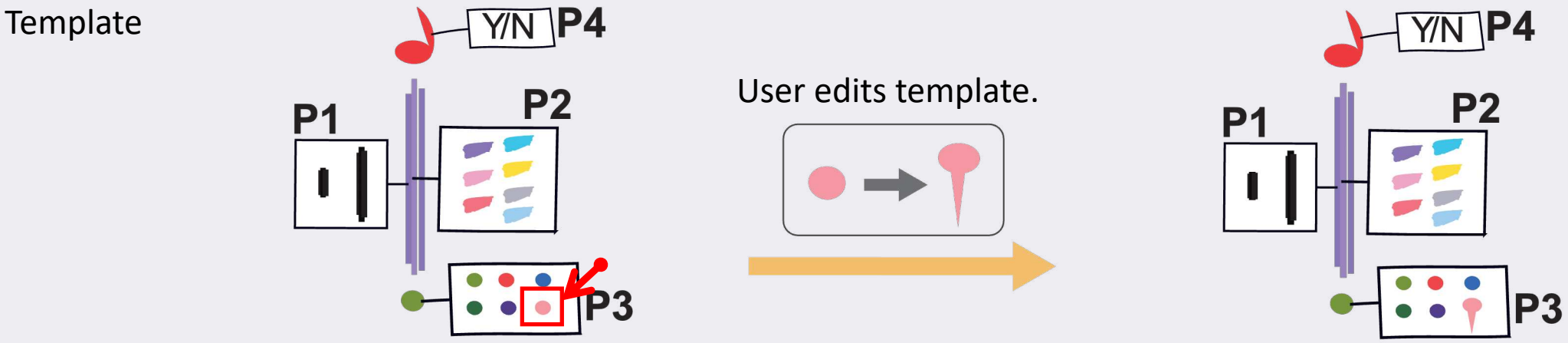
Uncertainty helps catch ambiguous glyphs.

- Ensemble of neural networks

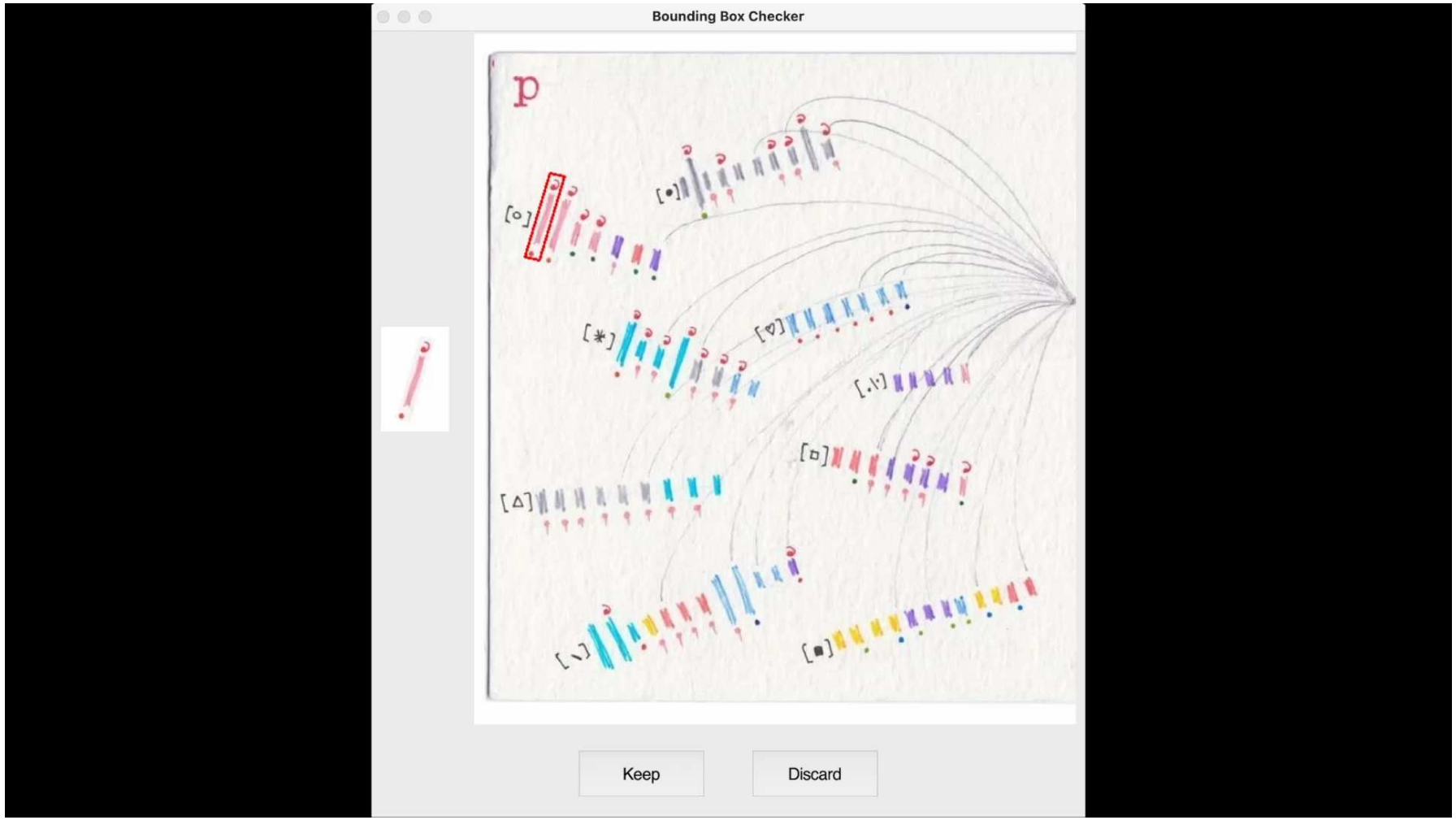


Uncertainty helps catch ambiguous glyphs.

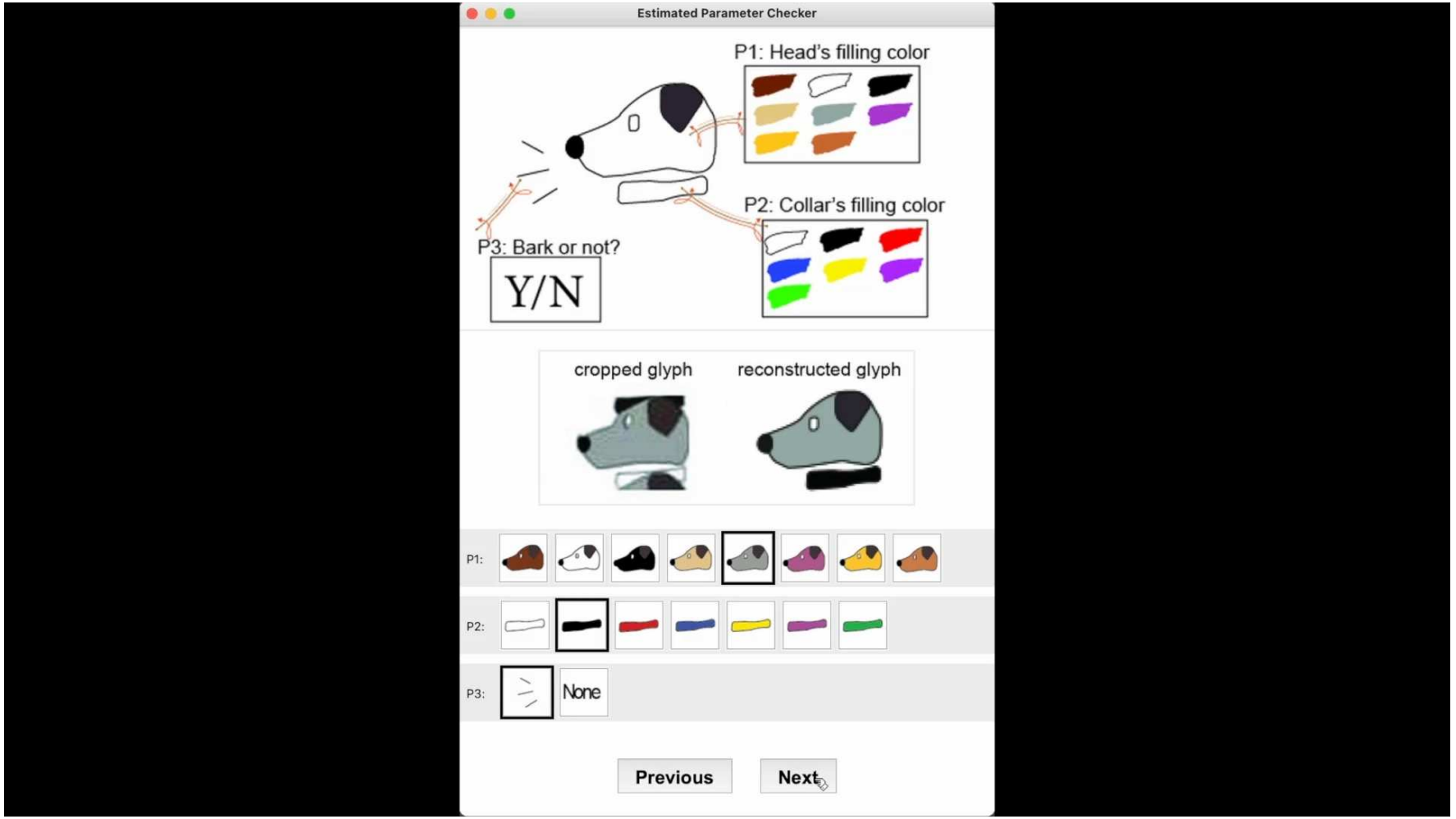




User Interface for Data Review



User Interface for Data Review

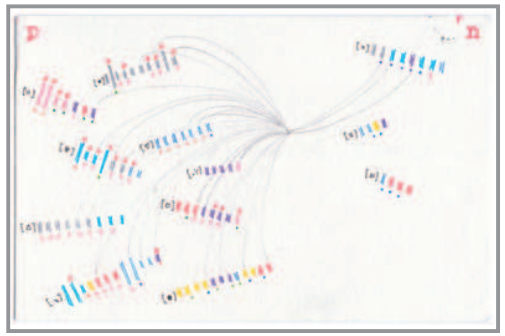


Dog: DataInk ©Haijun Xia.

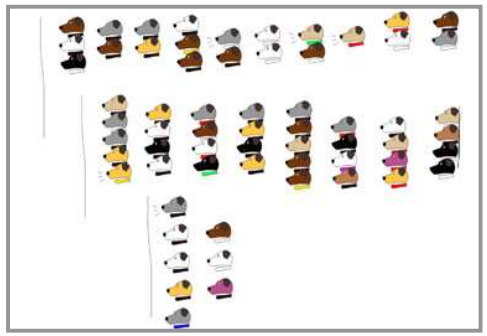
Evaluation

- The user wants to recover data from an existing visualization.
- The user wants to collect new data by drawing instances of a prescribed glyph template.

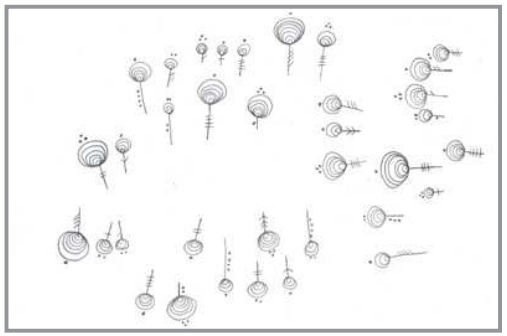
Benchmark: 10 infographics



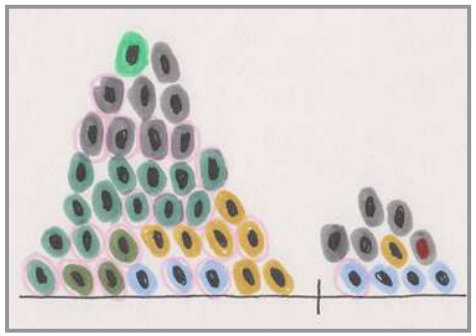
(1) Boyfriend



(2) Dog

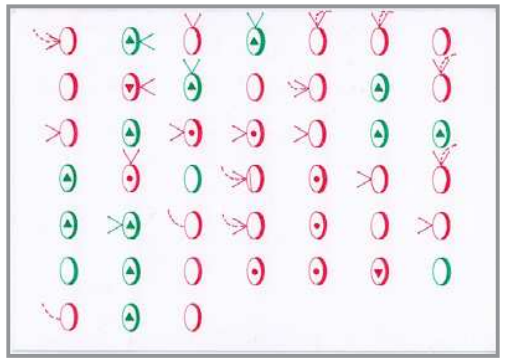


(3) Lollipop

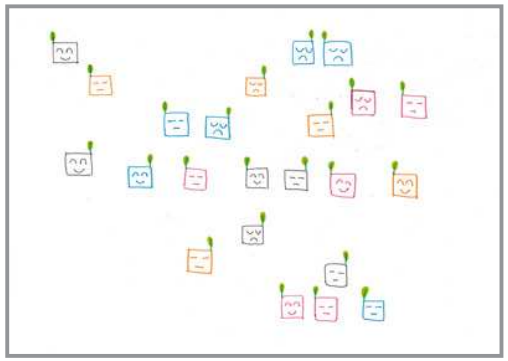


(4) Thoughts

(5) Tree

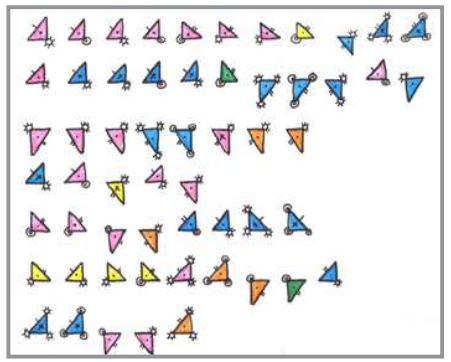


(6) Smell

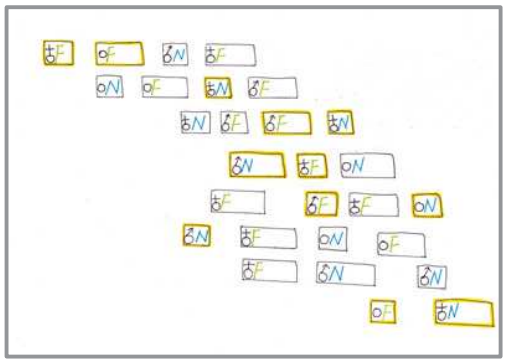


(7) Leaf

(8) Sound



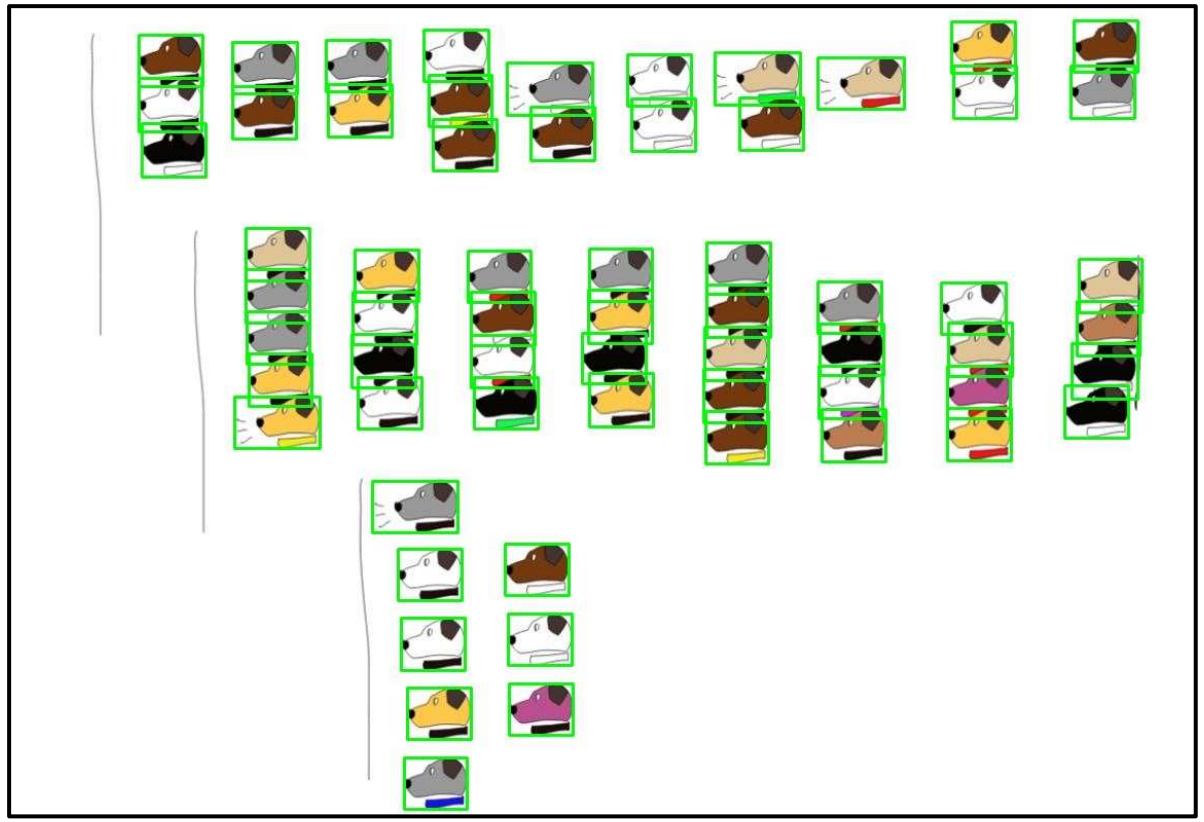
(9) Triangle



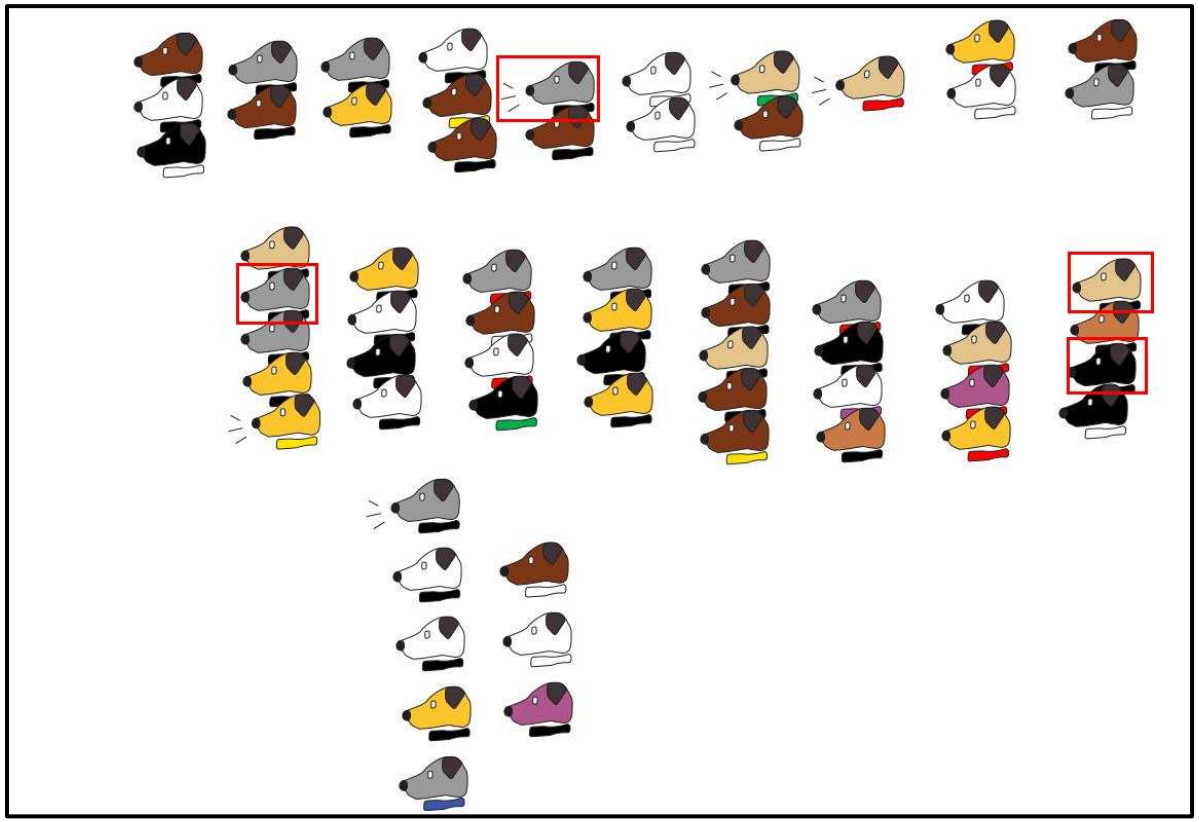
(10) Book

Benchmark: 10 infographics

Detection

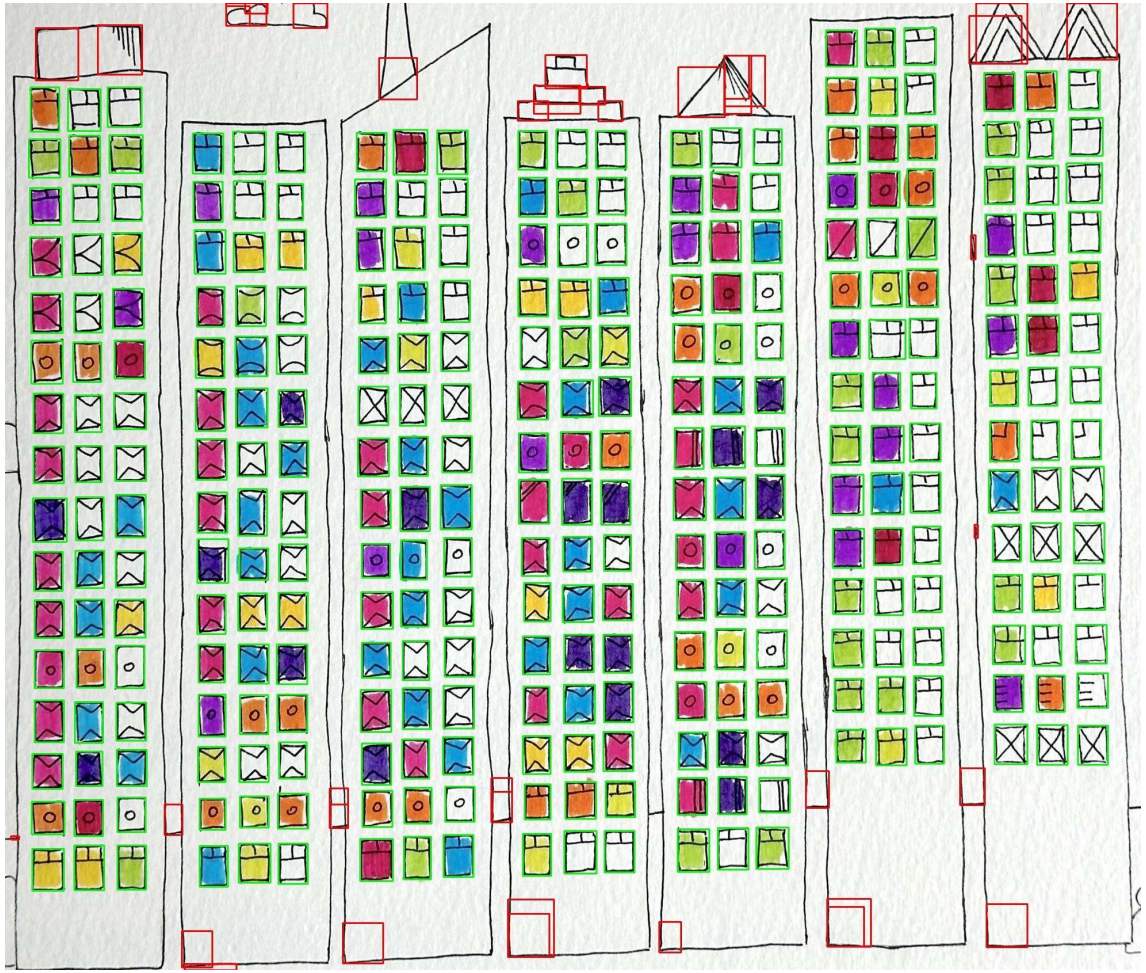


Reconstruction

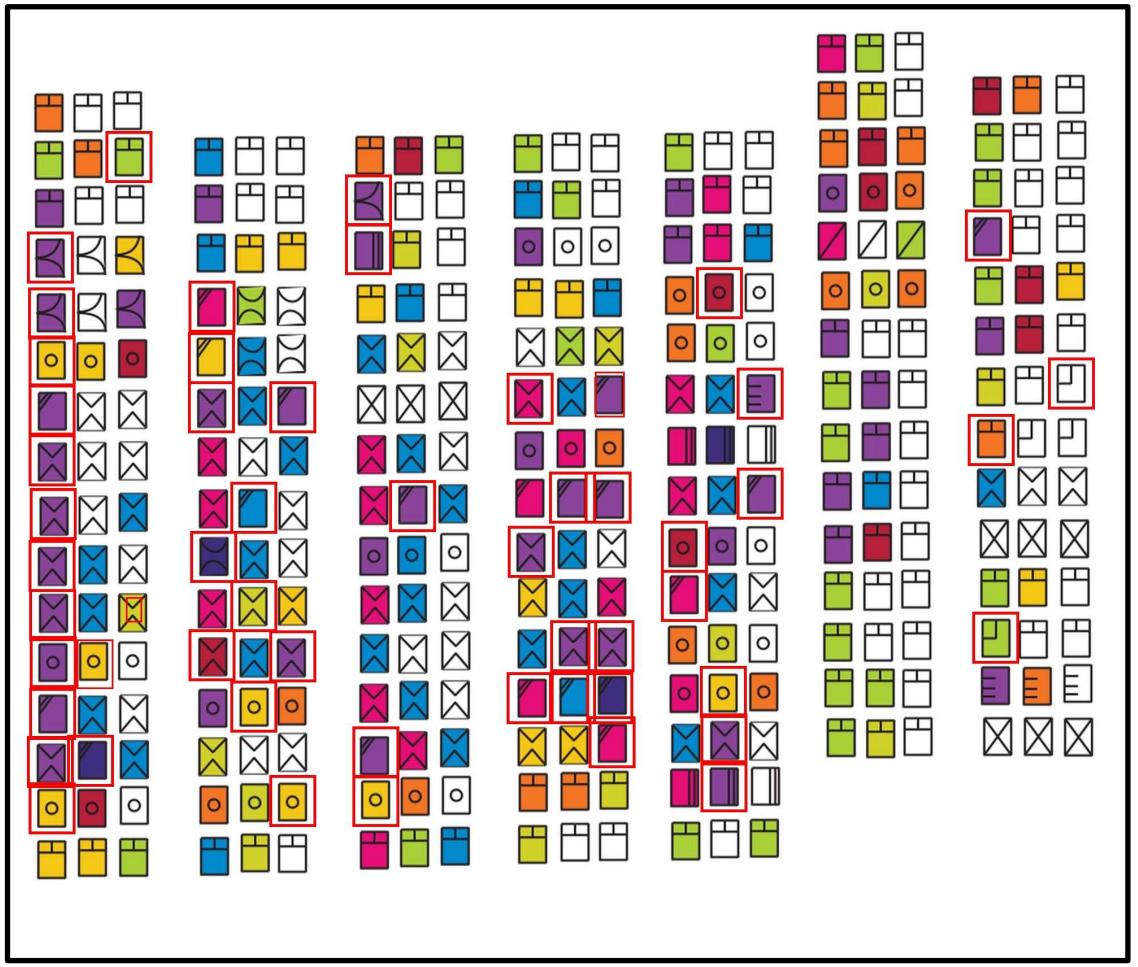


Benchmark: 10 infographics

Detection



Reconstruction



Sound: post on Facebook ©Anita Boeira

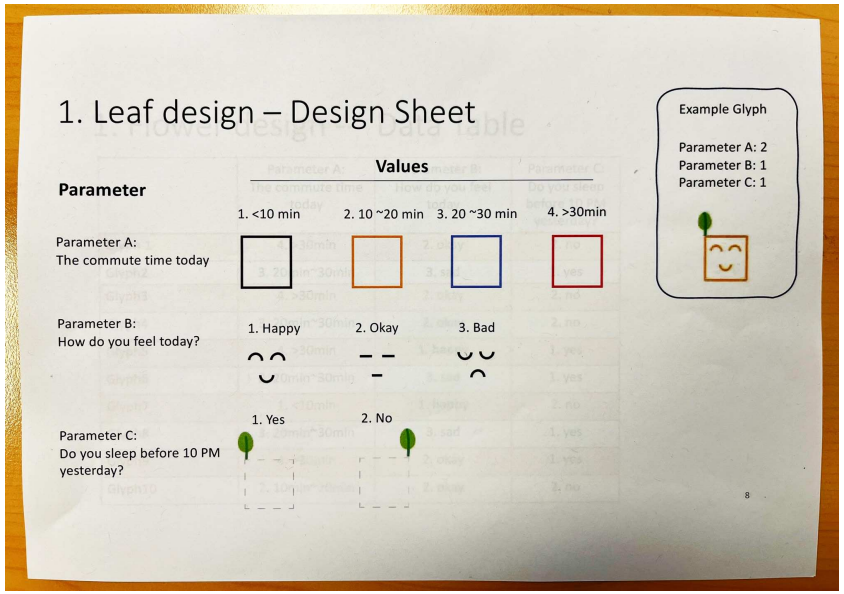
Evaluation

- The user wants to recover data from an existing visualization.
- The user wants to collect new data by drawing instances of a prescribed glyph template.

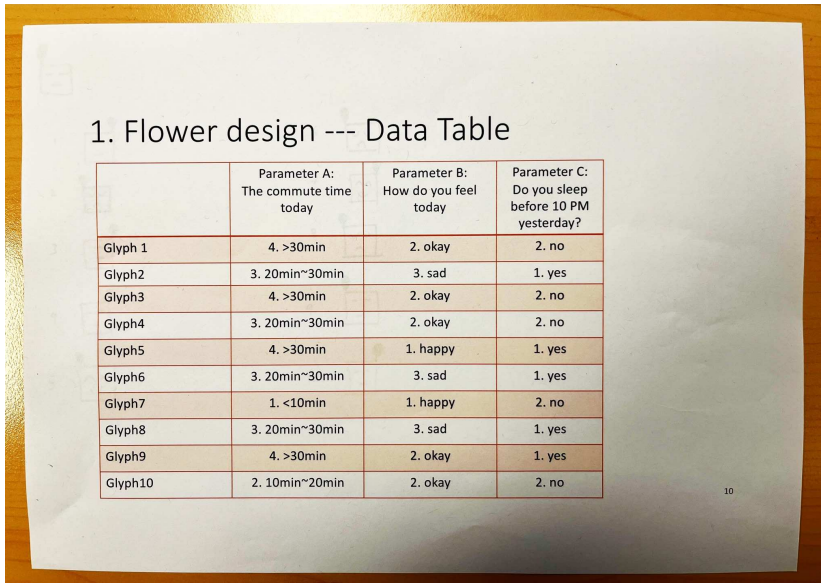
User Study

- 12 volunteers

(i) a template



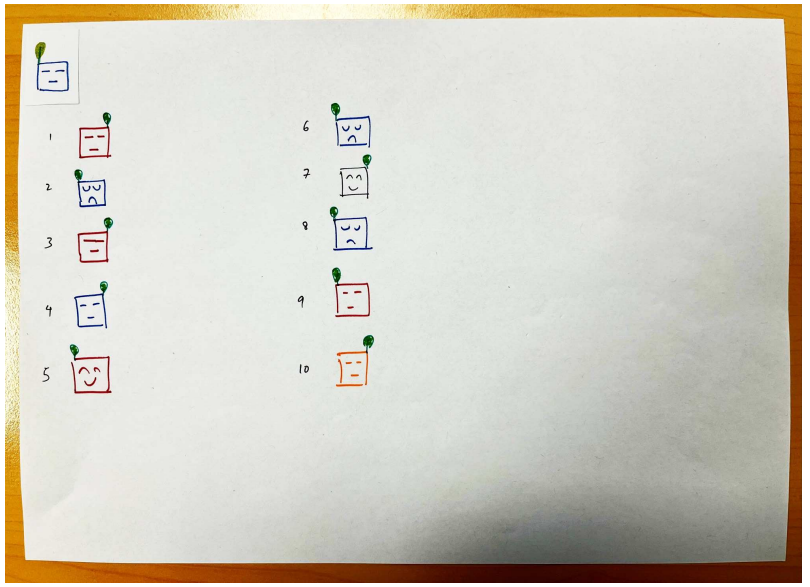
(ii) a data sheet



1. Flower design --- Data Table

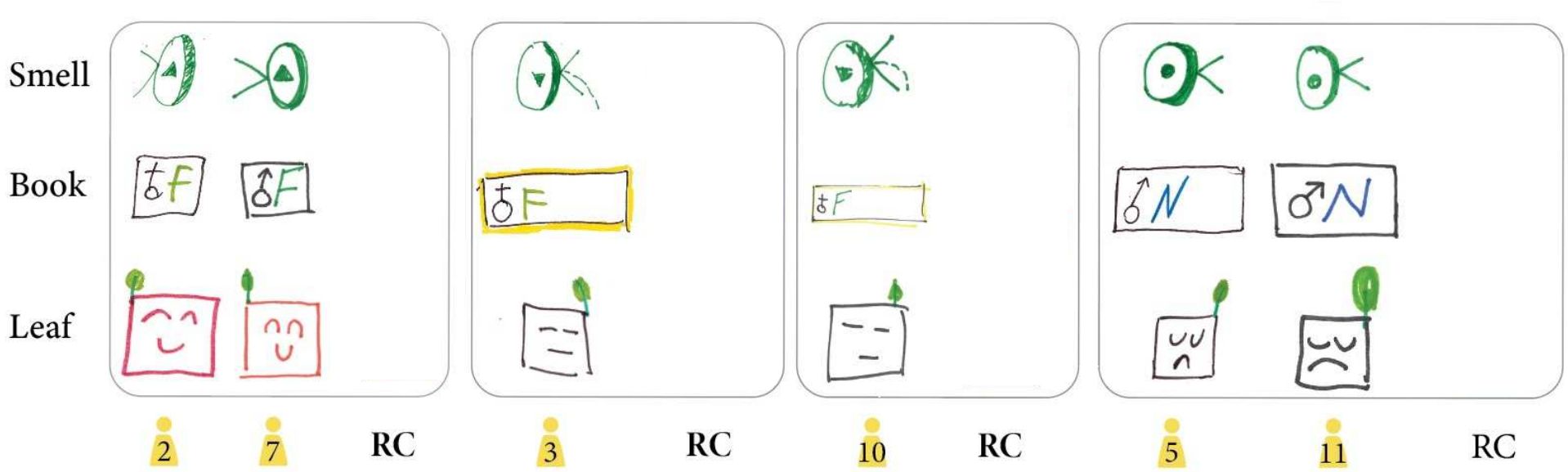
	Parameter A: The commute time today	Parameter B: How do you feel today	Parameter C: Do you sleep before 10 PM yesterday?
Glyph 1	4. >30min	2. okay	2. no
Glyph2	3. 20min~30min	3. sad	1. yes
Glyph3	4. >30min	2. okay	2. no
Glyph4	3. 20min~30min	2. okay	2. no
Glyph5	4. >30min	1. happy	1. yes
Glyph6	3. 20min~30min	3. sad	1. yes
Glyph7	1. <10min	1. happy	2. no
Glyph8	3. 20min~30min	3. sad	1. yes
Glyph9	4. >30min	2. okay	1. yes
Glyph10	2. 10min~20min	2. okay	2. no

(iii) a drawing sheet

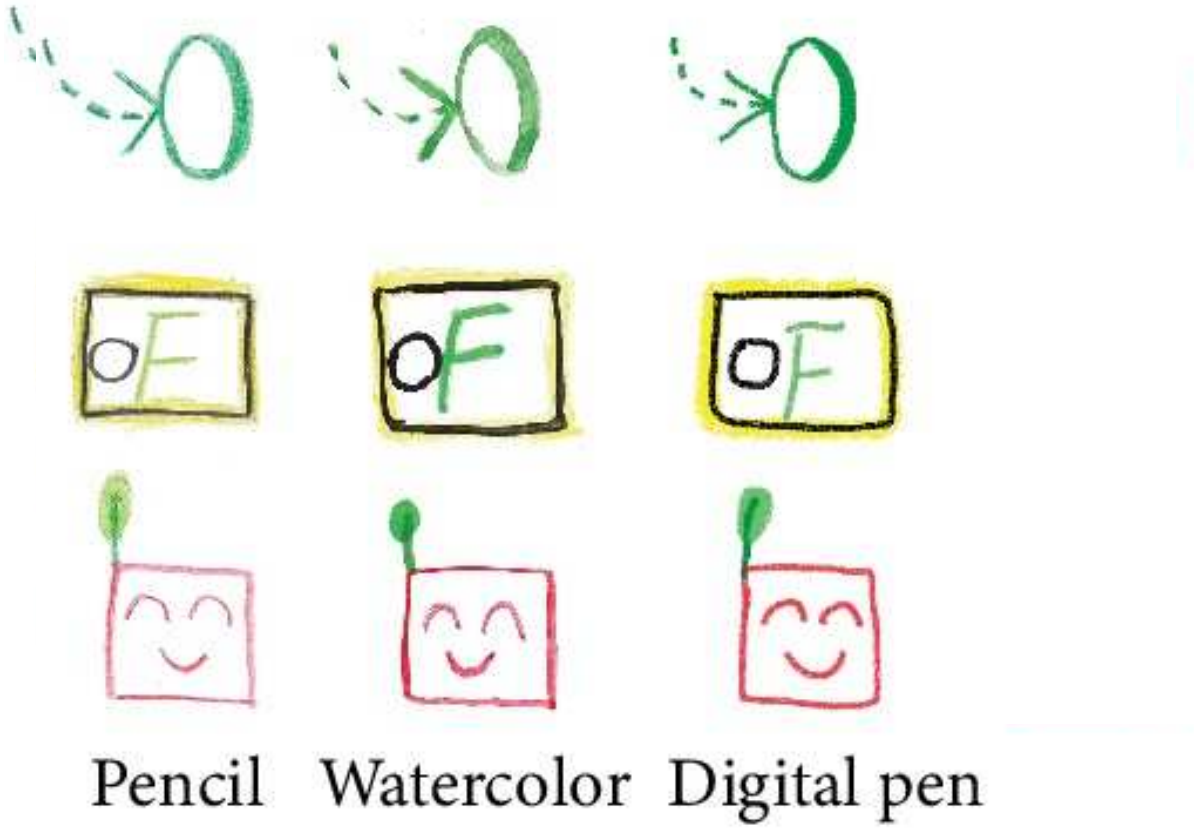


User Study

- 3 templates
- draw 10 different glyphs for each template (30 glyphs in total)

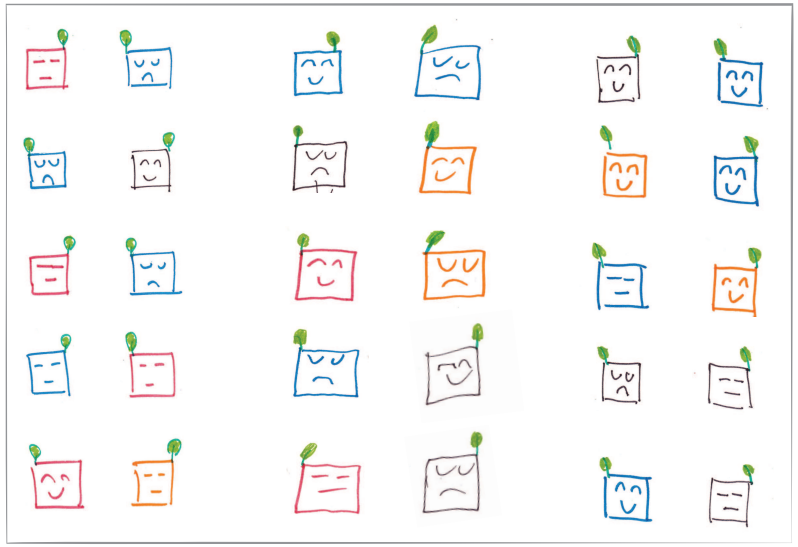


Glyphs drawn with different materials

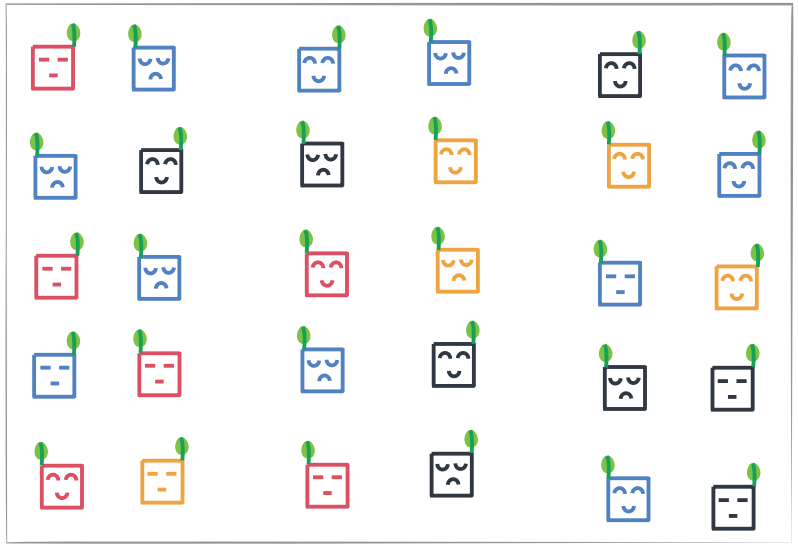


Applications

- Visualization editing



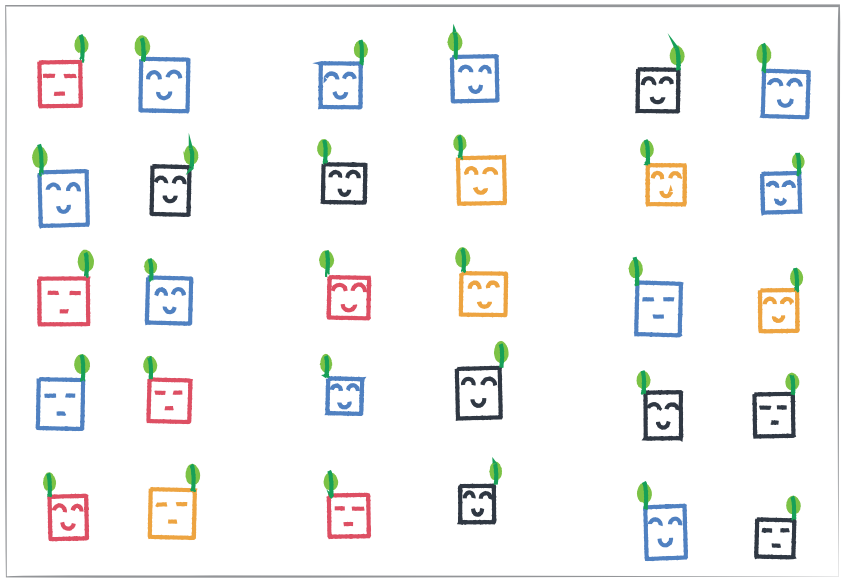
(a) Input drawing



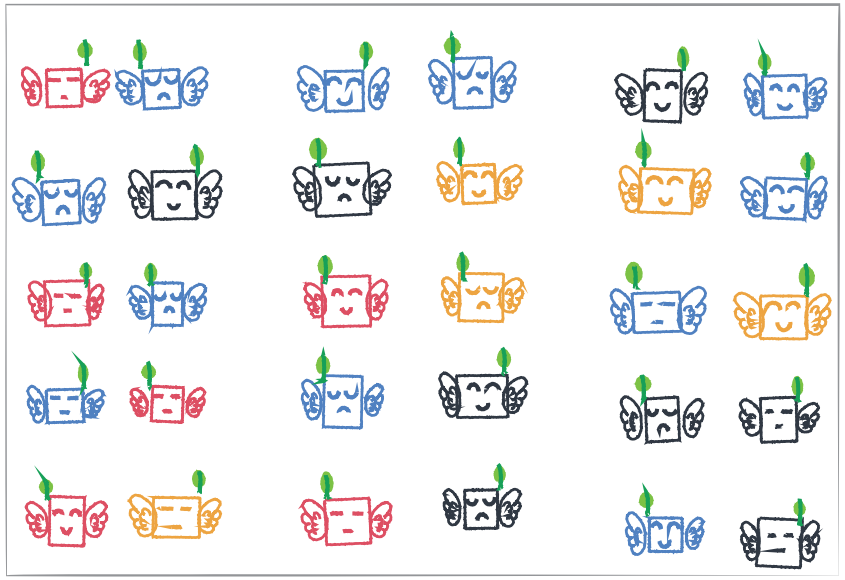
(b) Reconstruction

Applications

- Visualization editing



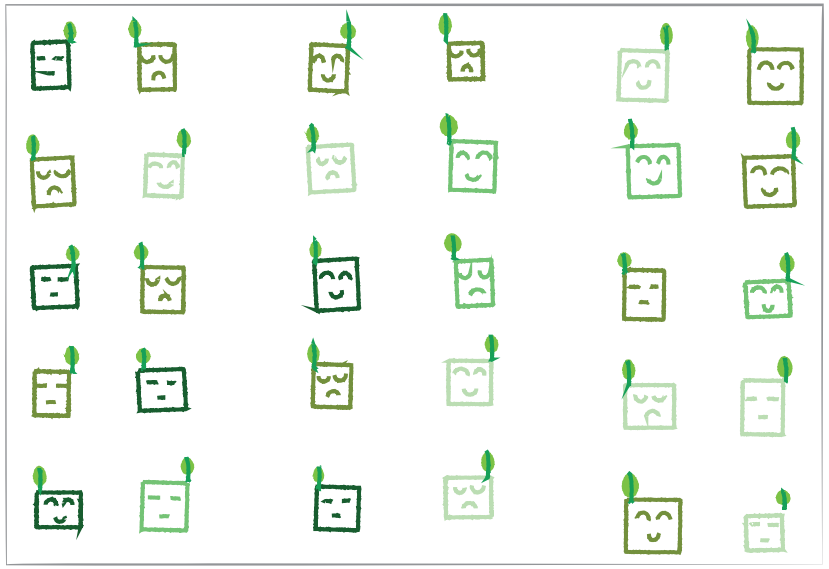
(c) Edit the data table values mapped to facial expression from ◡◡ to ◠◠



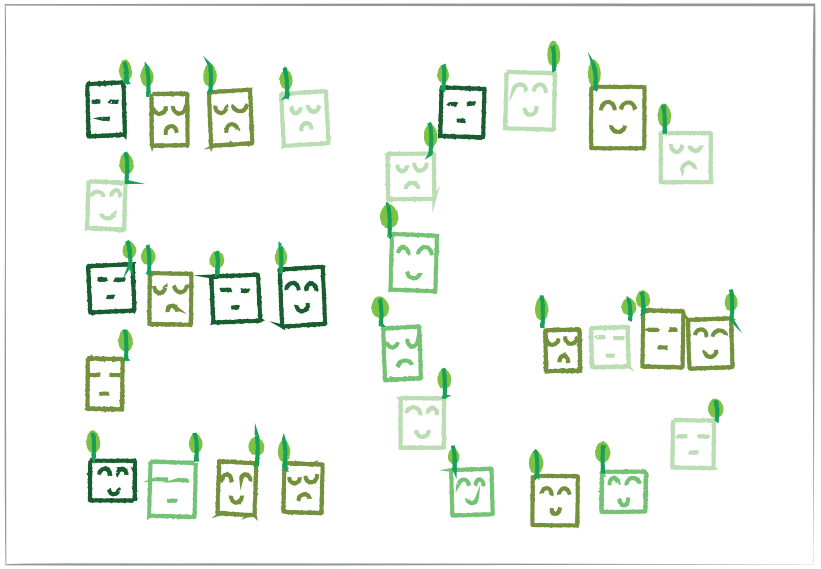
(d) Redesign the *Leaf* template by changing □ to 

Applications

- Visualization editing



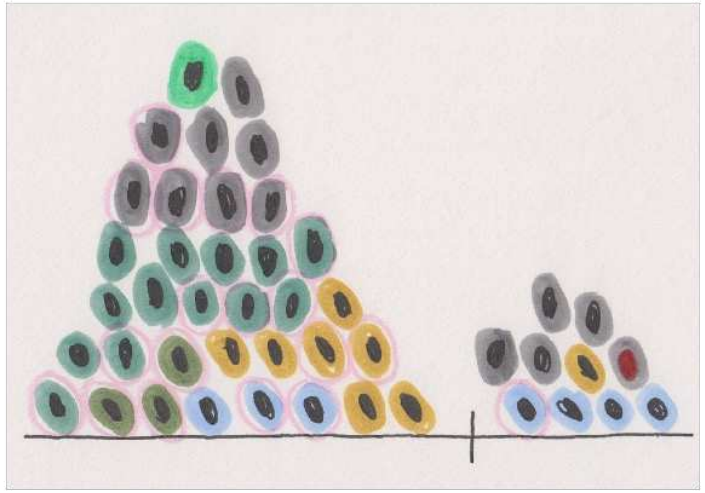
(e) Recoloring



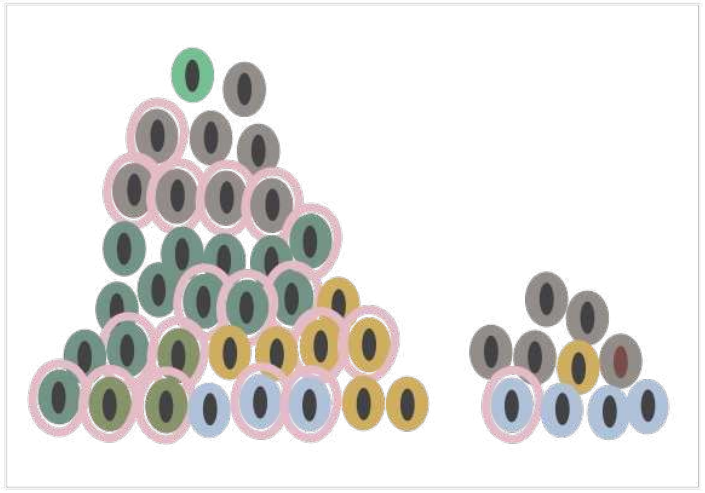
(f) Relayout

Applications

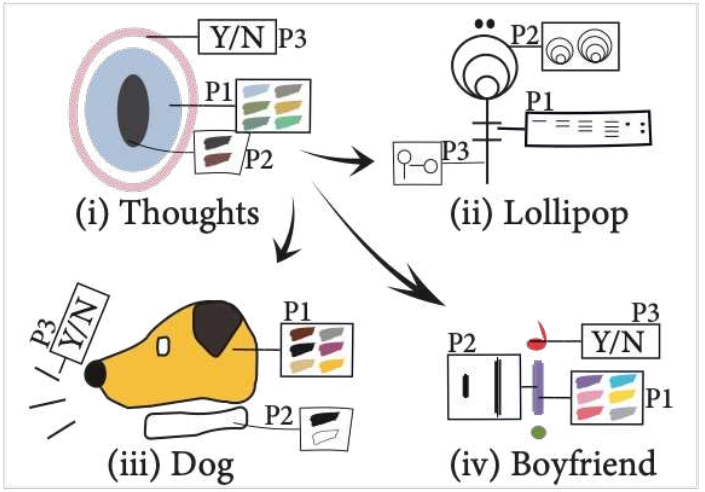
- Swapping templates



(a) Input drawing



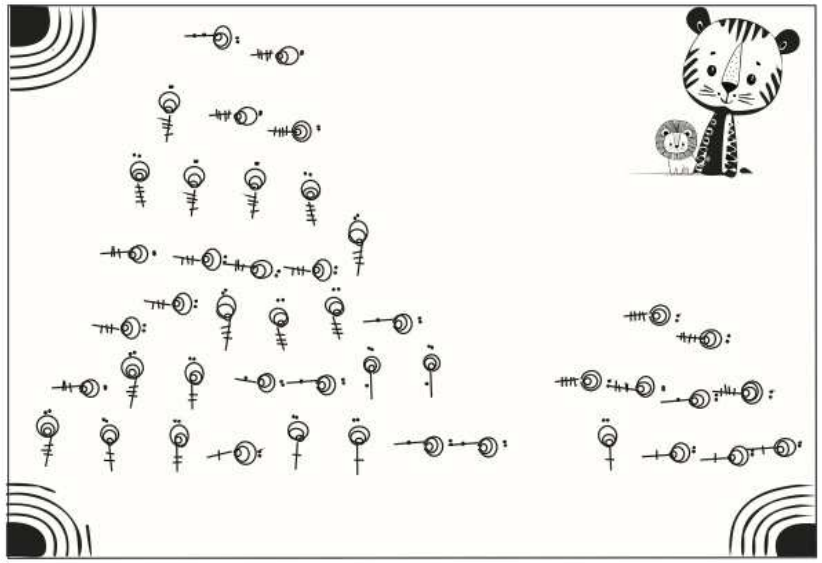
(b) Reconstruction



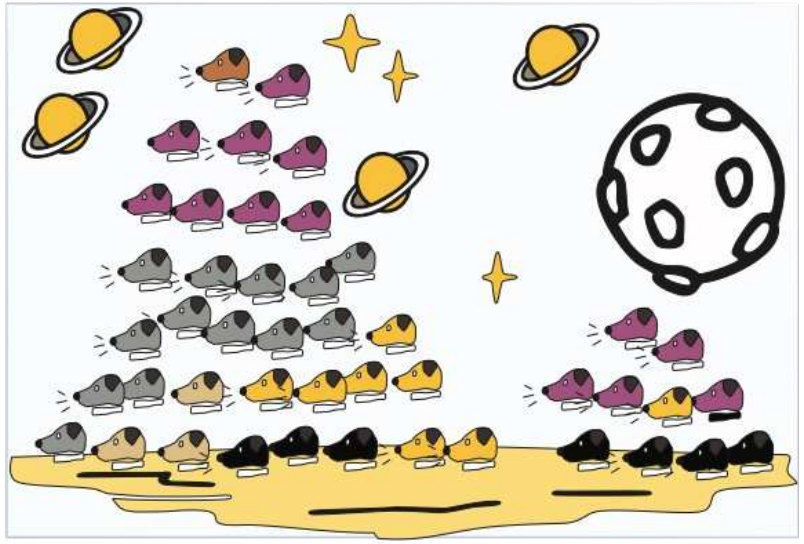
(c) Templates used to redesign

Applications

- Swapping templates



(d) Redesign with *Lolipop* template

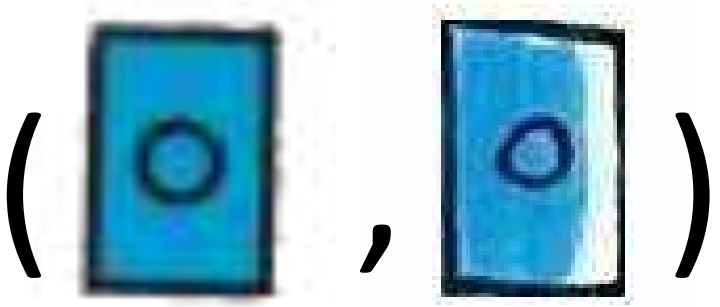


(e) Redesign with *Dog* template

(f) Redesign with *Boyfriend* template

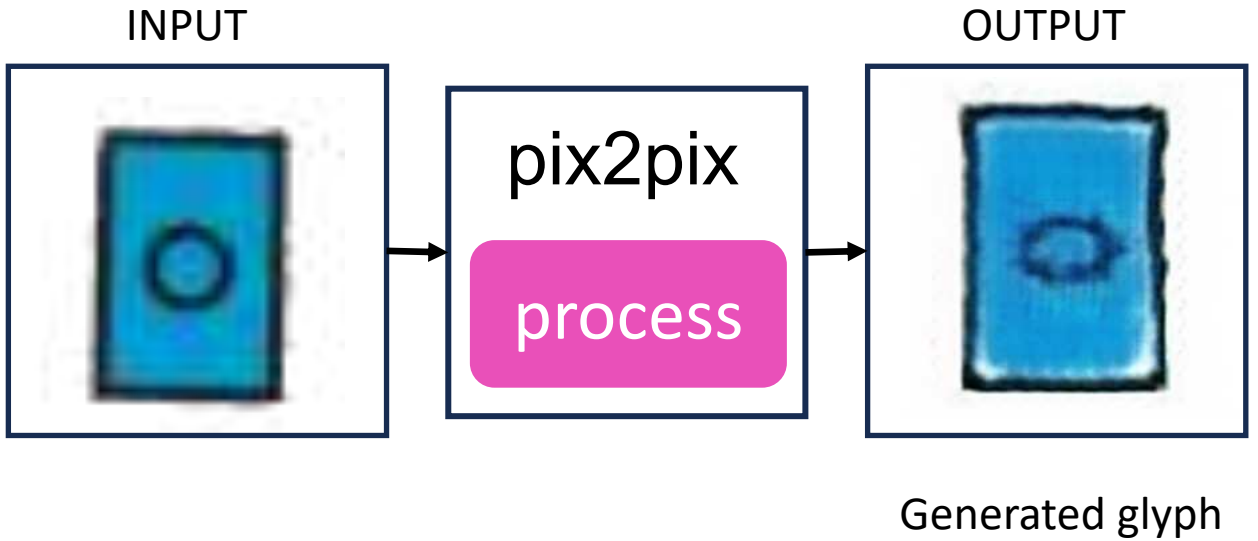
Applications

- Style transfer



Sythesised glyph from the template

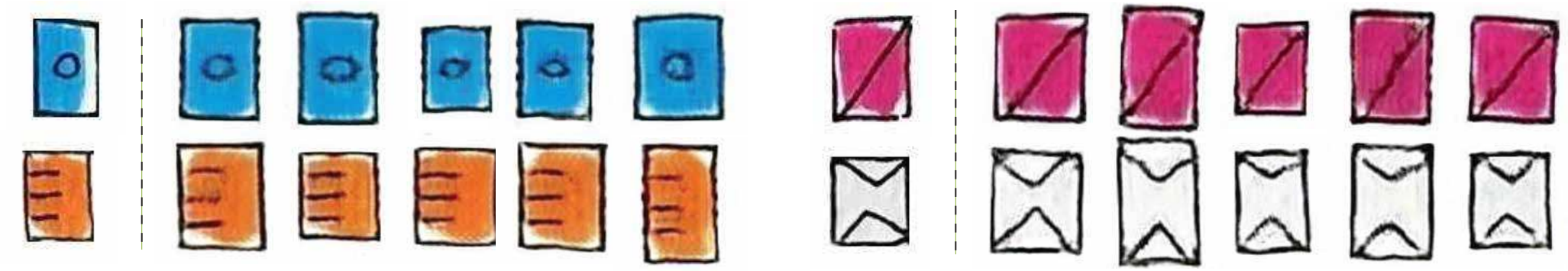
original hand-drawn



Generated glyph

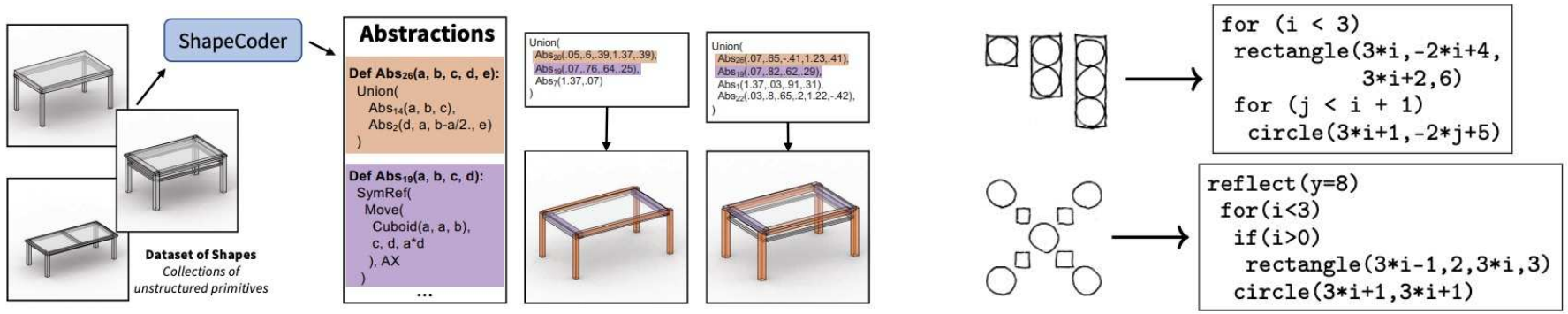
Applications

- Style transfer

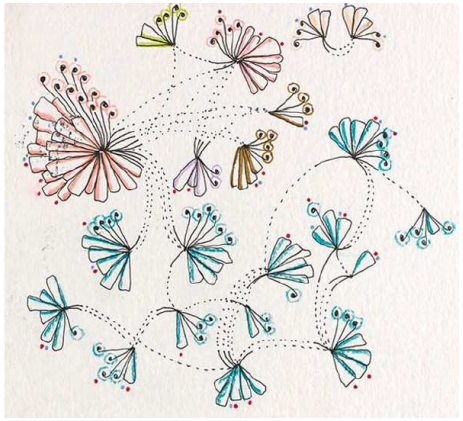


Future work

- Template inference ---> neuro-symbolic programming



- Layout modelling ---->



Jones, R. Kenny, et al. "Shapecoder: Discovering abstractions for visual programs from unstructured primitives." *TOG* 42.4 (2023): 1-17.
Ellis, Kevin, et al. "Learning to infer graphics programs from hand-drawn images." *NIPS2018*

Takeaways

- A method to recover data from hand-drawn infographics.
- Design a template for synthesizing datasets.
- Use deep neural networks to detect glyphs and estimate the values.

Thank you!

Questions