

Handwritten \rightarrow \LaTeX

Ole Kröger

IWR, Heidelberg University

Objectives

Recognize handwritten math symbols and combine them to a \LaTeX -formula

- Image of handwritten formula instead of stroke information

Data

- > 350,000 images of 82 different math symbols
- Combining 16 different symbols to easy formula
- Normalization of symbols
 - Removing the border
 - Scale to at most 40×40
 - Center the mass in a 48×48 image
 - Subtract mean and divide by standard deviation

Figure 1: Generated formula

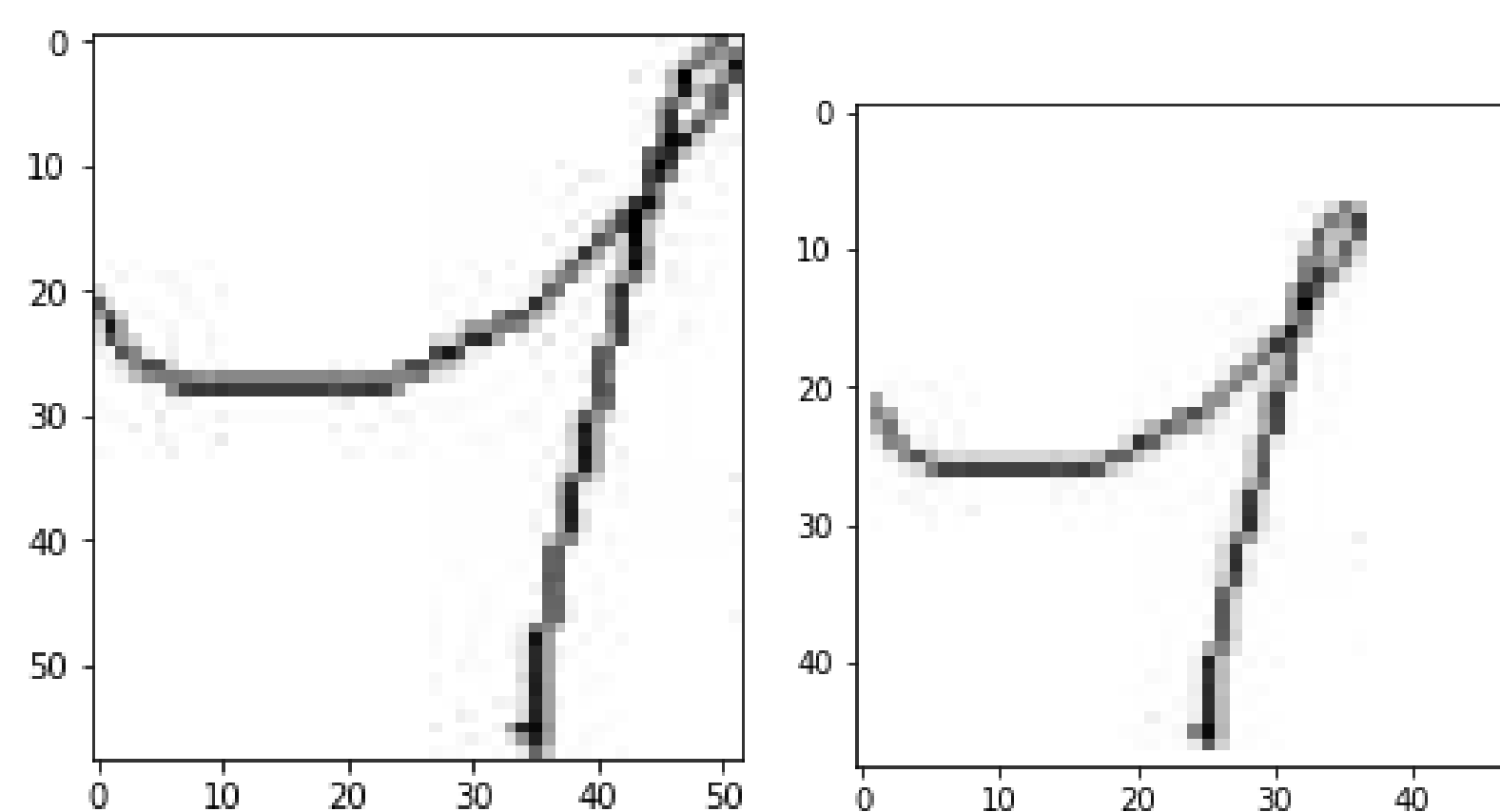


Figure 2: Crop and centered single math symbol

Approaches

Image classification and sliding window

- Image classification using CNN
- Sliding window for object detection
- Very slow
- Low accuracy due to prediction if overlapping (no false examples)

Object recognition in one step

- Detection and classification using Tensorflow API
- Training phase too long
- Too complicated for this problem

Final approach

Image classification using CNN
OpenCV for object detection

- 3 Layer CNN trained on > 100,000 images
- Classification with > 99% accuracy
- OpenCV contour finding and bounding boxes
- Combining overlapping bounding boxes
- fast and reasonable for this simple data

Conclusion

- Simple approach to detect and classify symbols
- Hard to combine bounding boxes and classification to actual formula

Pipeline

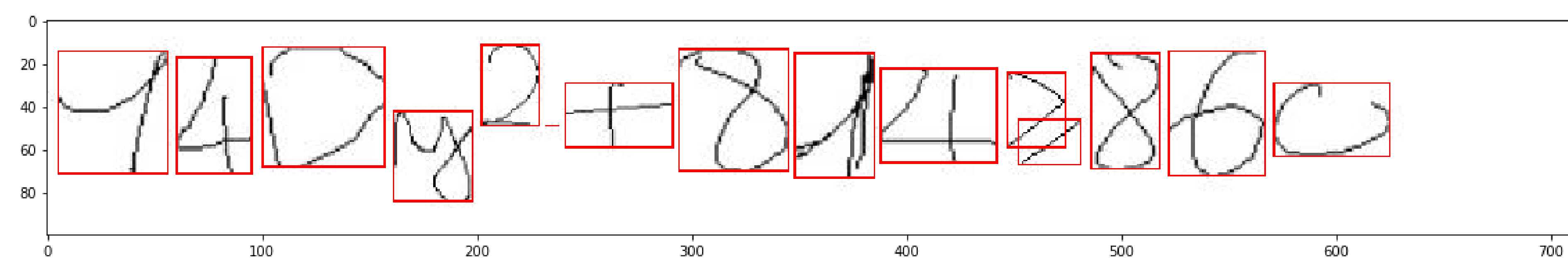


Figure 3: Find single bounding boxes using OpenCV

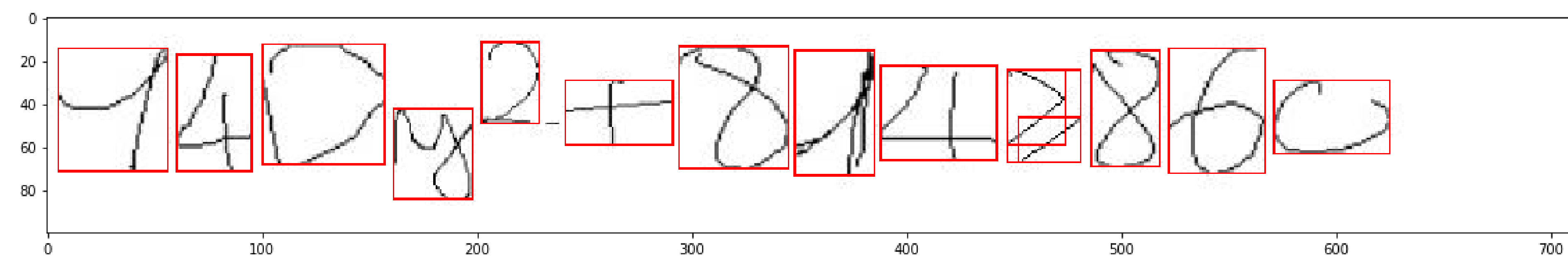


Figure 4: Combine horizontally overlapping boxes

Currently handcrafted translation into \LaTeX :

$$140y^2 + 814 \geq 860$$