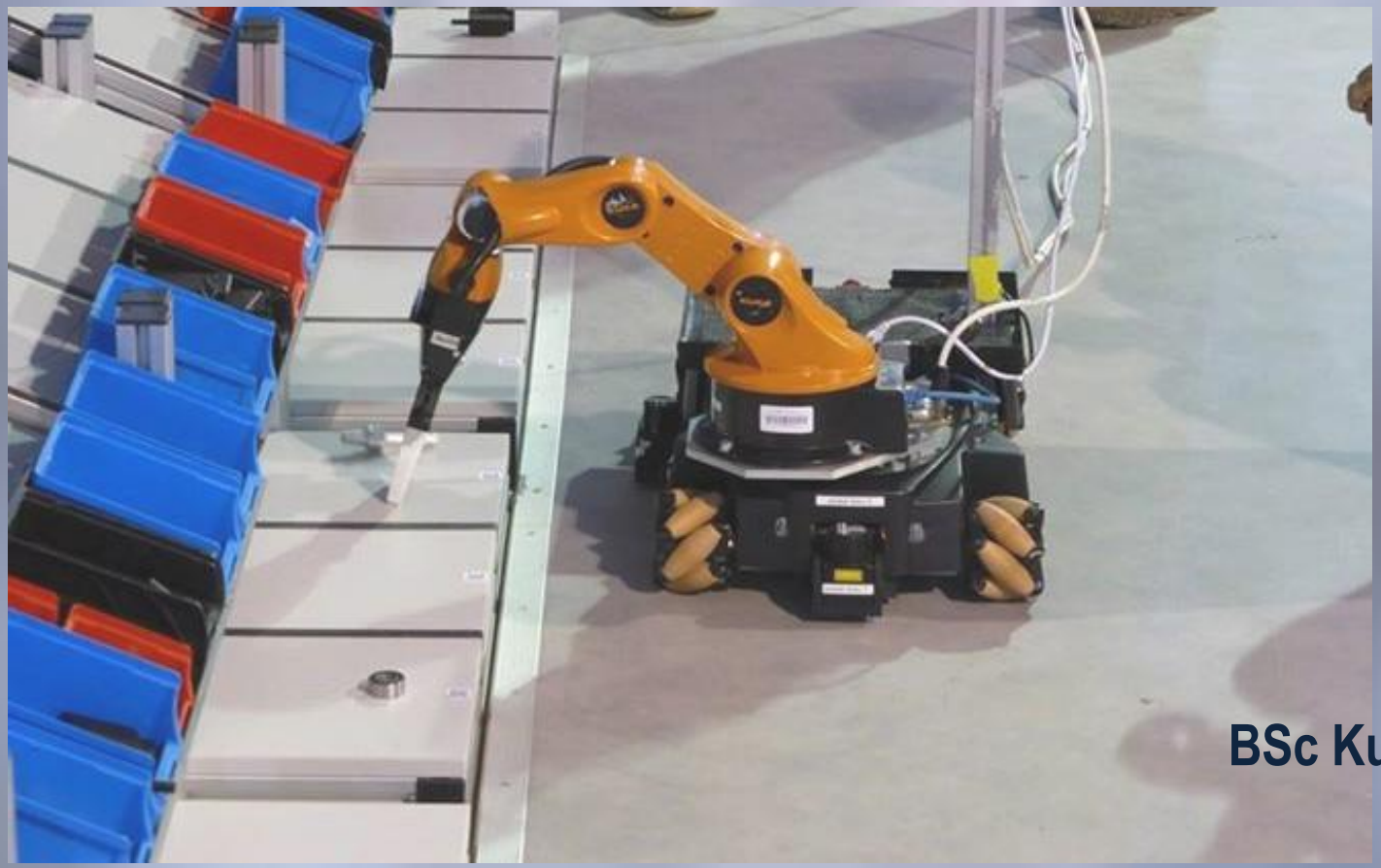
Taking up the **RoCKIn@Work** Object Recognition Challenge With The **Bag Of Keypoints** Approach



Areg Shahbazian

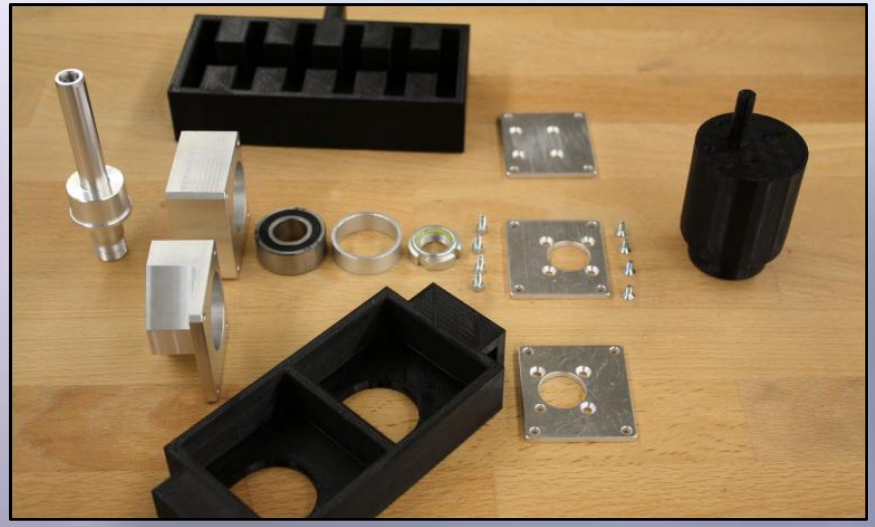
Supervisor:
Arnoud Visser

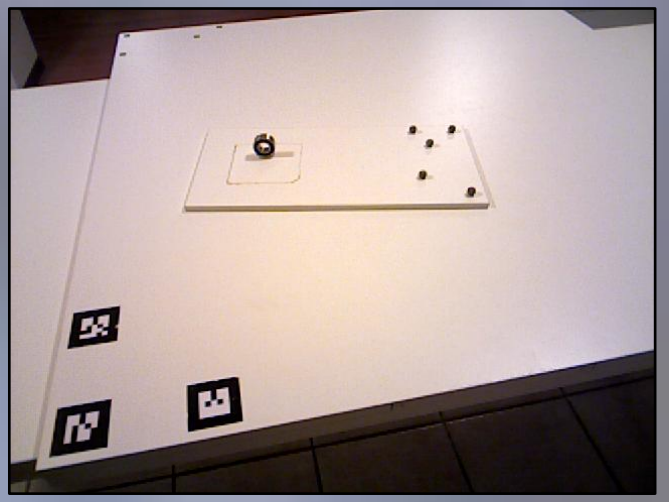
BSc Kunstmatige Intelligentie

Universiteit van Amsterdam

RoCKIn@Work 2014

- Recognize object-types
- App. 10 object types
- Benchmark





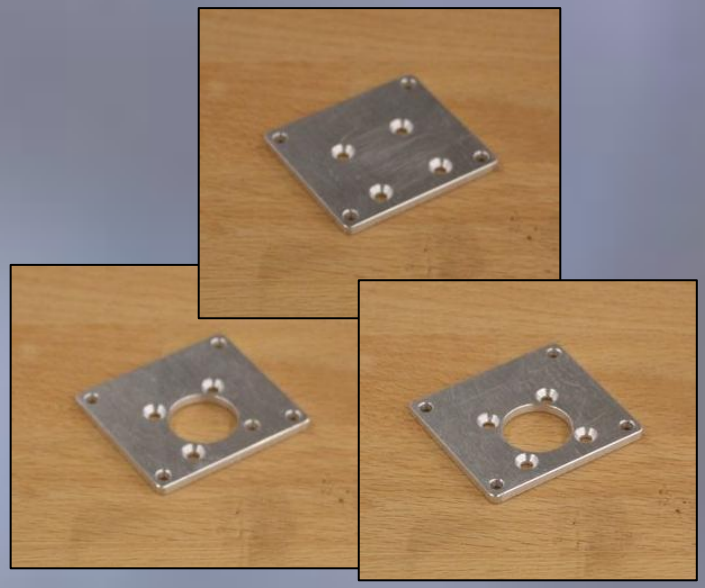
Research Question

- Investigate the performance of the **Bag Of Key-points** method combined with generic object features

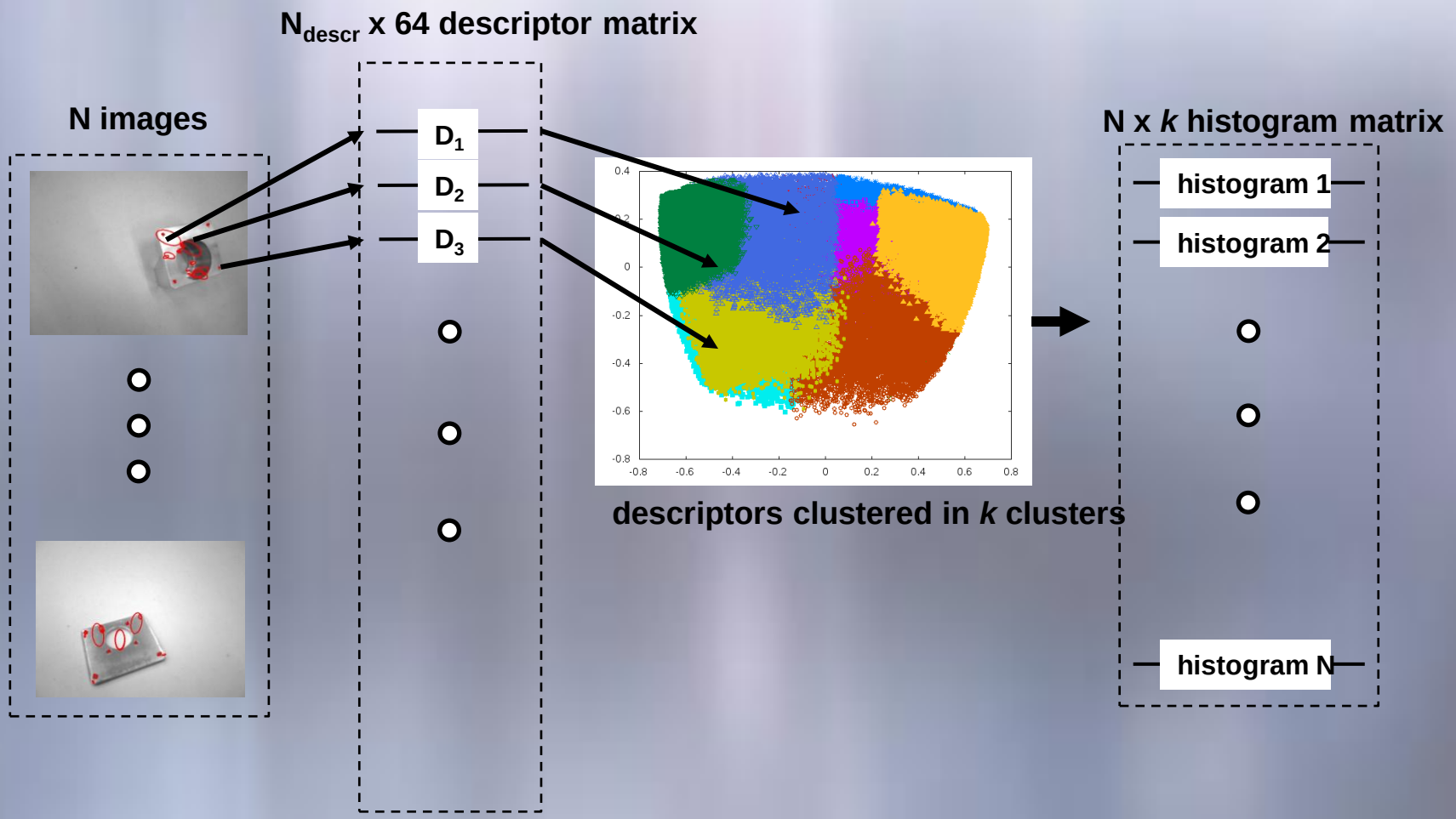
Csurka *et al.* 2004 [1]
- -Distinct classes (faces, trees, cars)
- -Much cluttering/noise/occlusion

smARTLab@Work 2014 [2]
- -Image intensity, object size
- -Changing camera position

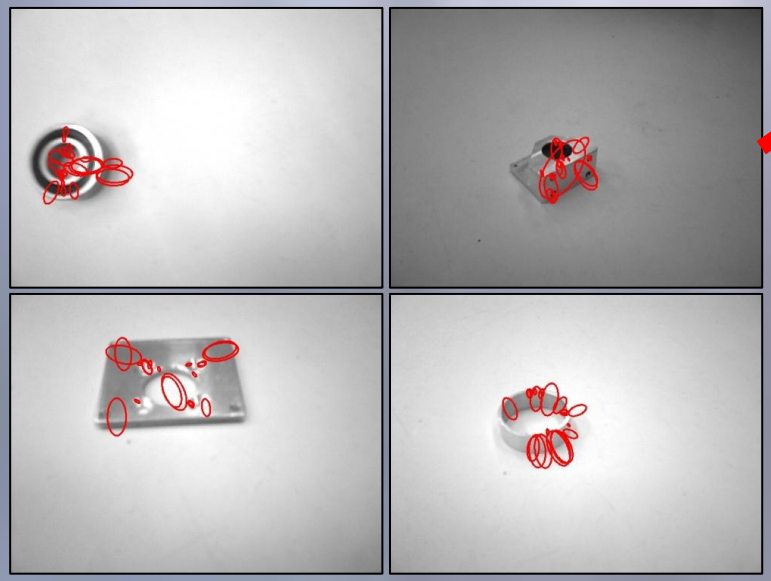
RoCKIn@Work 2014
- -Similar classes
- -Little noise



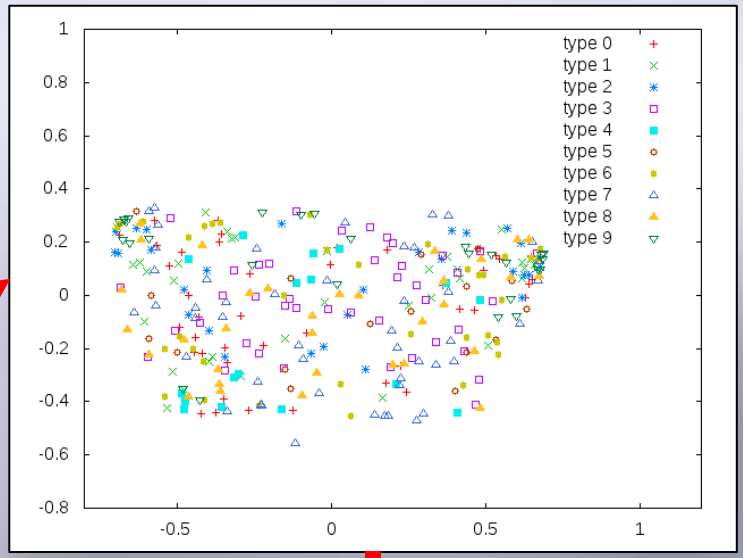
Bag Of Key-points

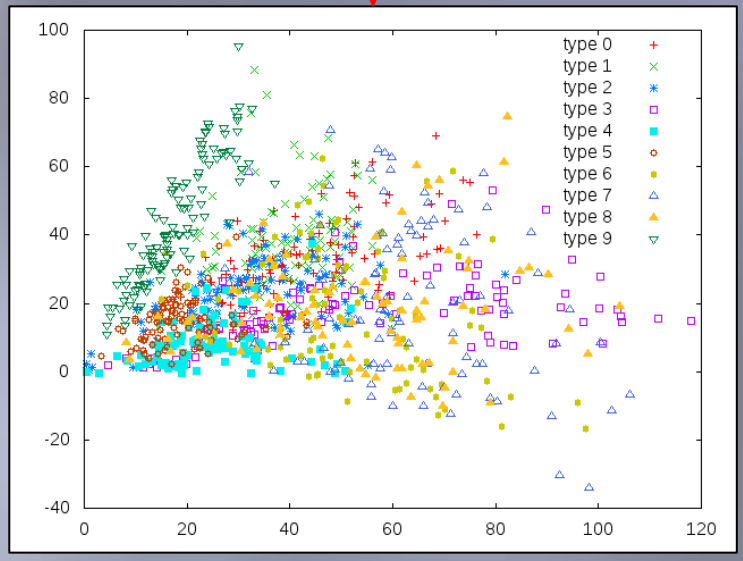


Bag Of Key-points



SURF descriptors





Histograms of descriptors

SURF [3] key-points:

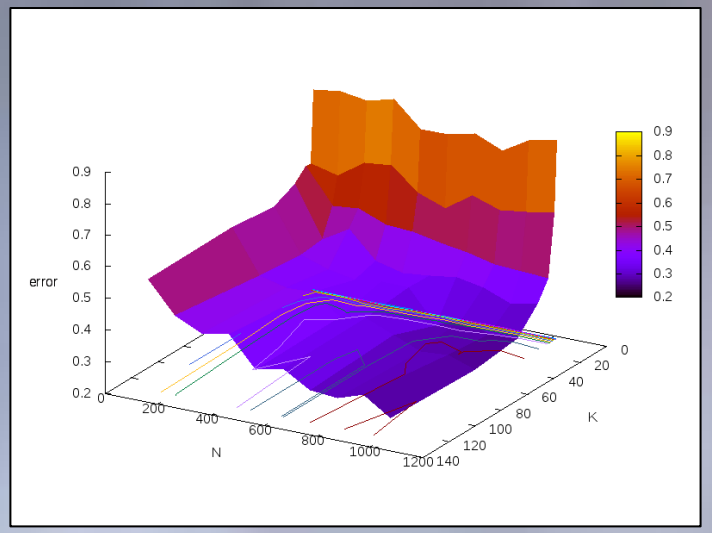
- **Scale- and rotation-invariant**
- **Fast implementation in OpenCV**

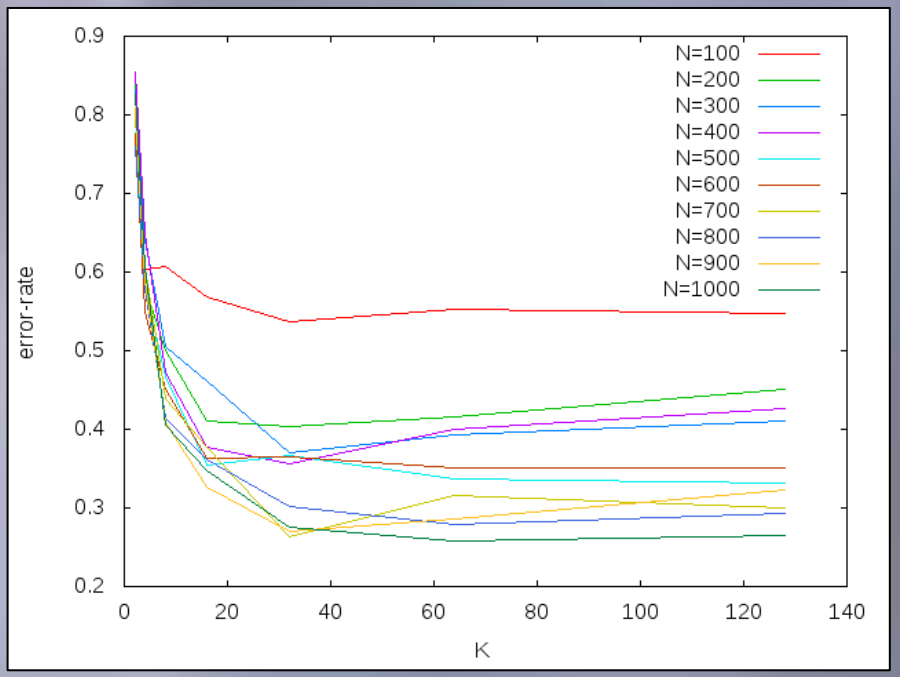
Research Methods

- Investigate:
  - -Influence of parameter *k* on the classification result
  - -Key-point histograms VS generic object features
  - -Classification algorithms

Parameter *k*

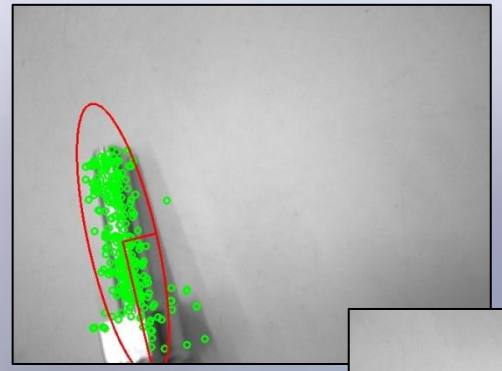
- Classification result determined by clustering result (compactness)?
- Optimal value of *k*

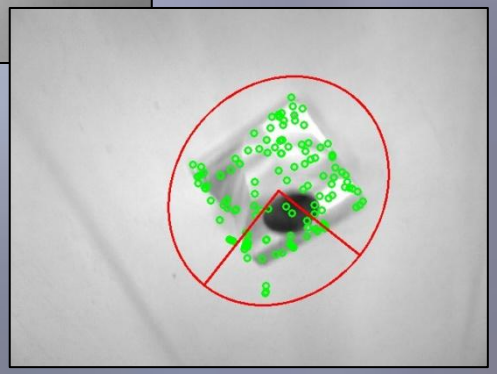


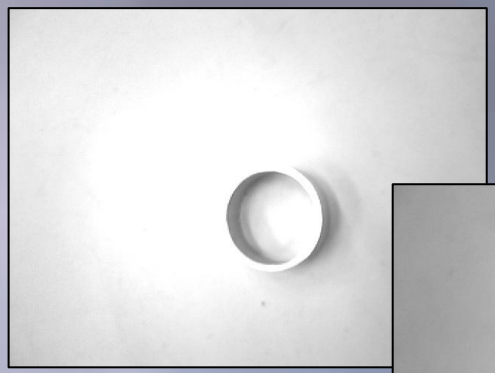


Key-points VS Generic Features

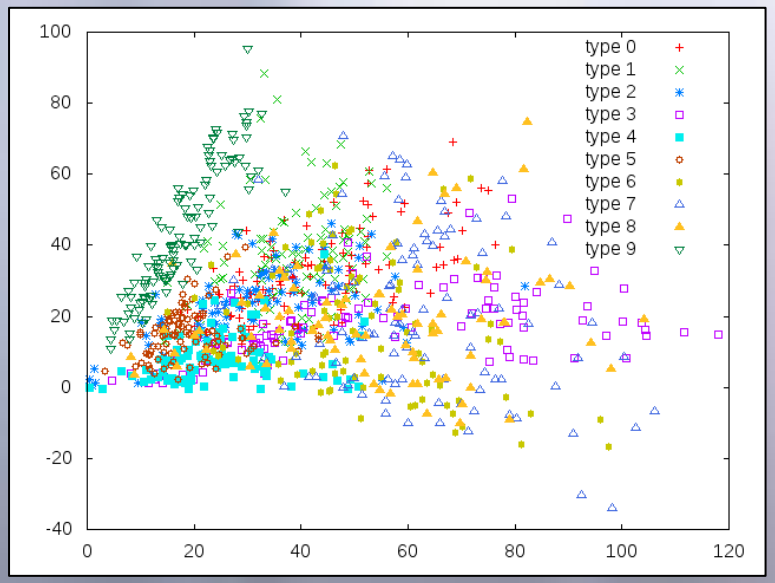
- SURF key-point histograms
- Extra Features
  - Distribution of key-points
  - Nr. of key-points
  - Occupied area
  - Nr. of Hough-lines [4]

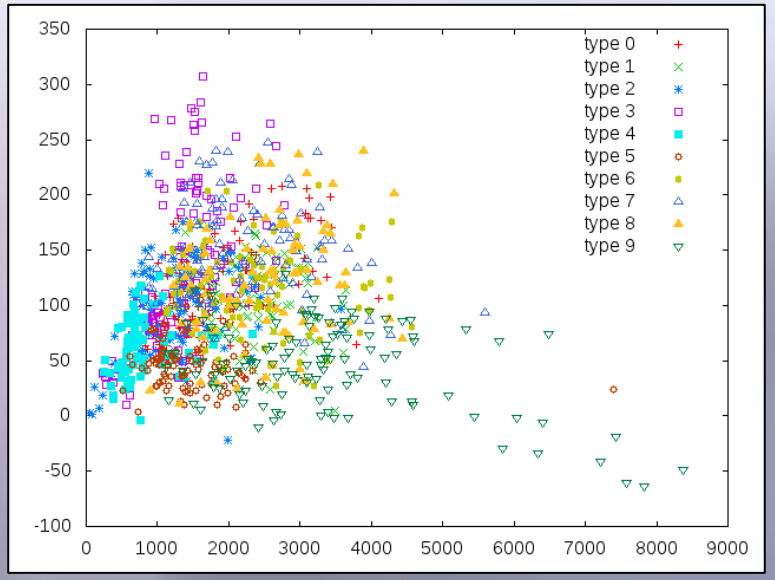






Key-points VS Generic Features Results



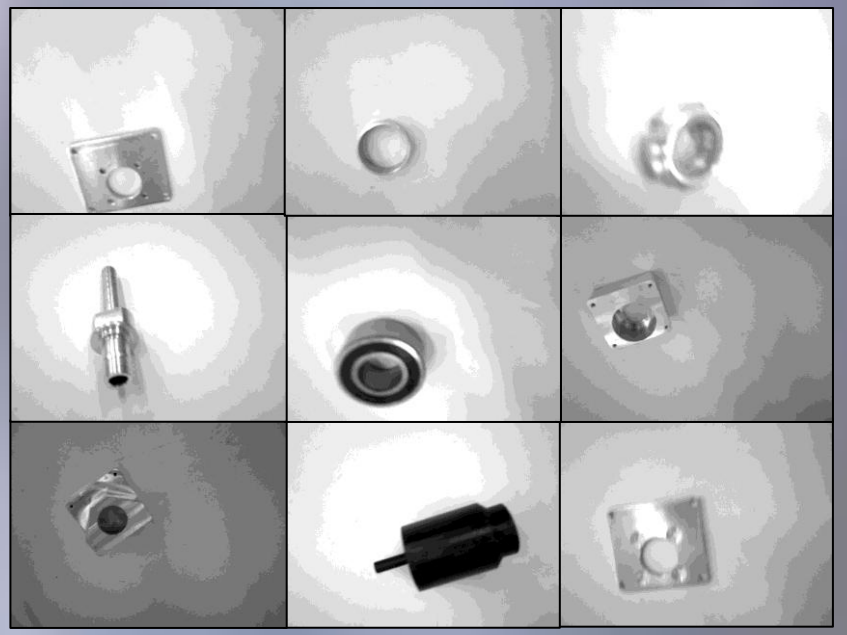


- **Results**
  - 10-folds cross validation
  - 1029 images

	histograms	only extra features	histograms and extra features
error-rate	0.247446	0.502294	0.216262

Classification

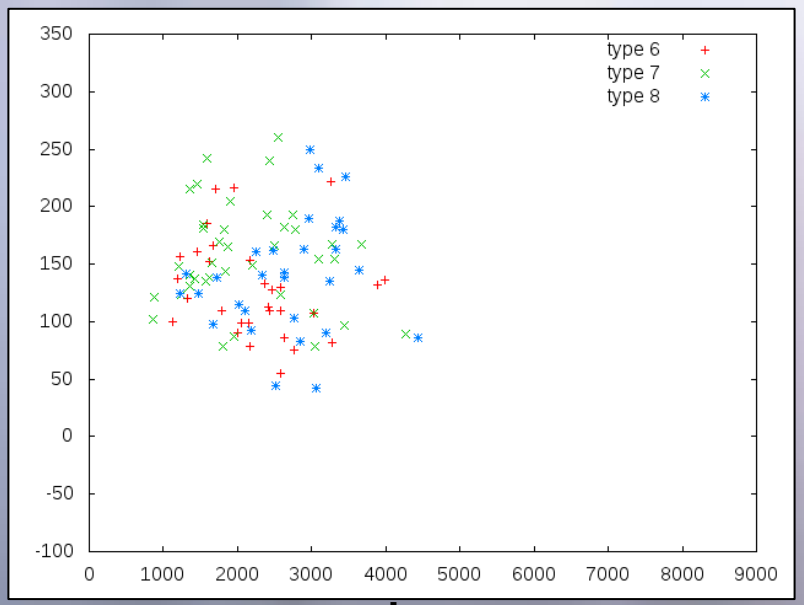
- Algorithms (WEKA [5] Java classes)
  - Support Vector Machines (Csurka *et al.* [1])
  - K-nearest neighbor
  - Naïve Bayes

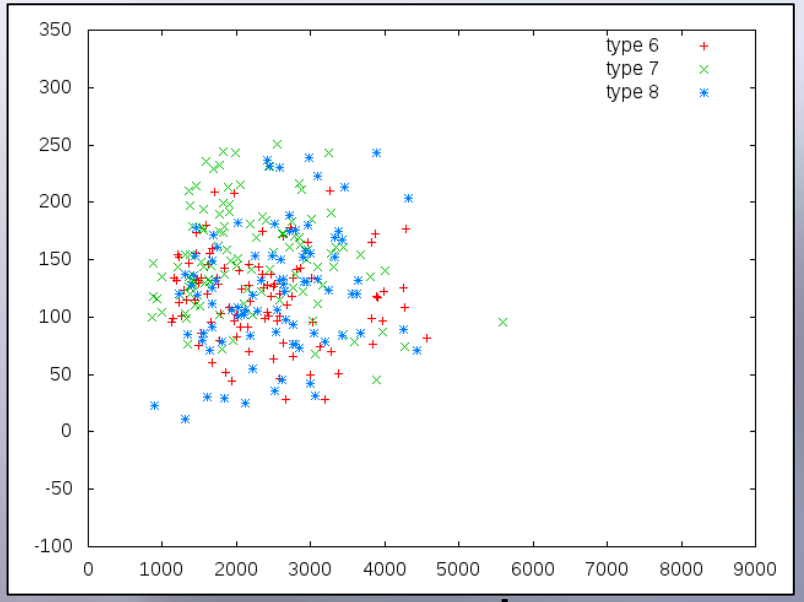


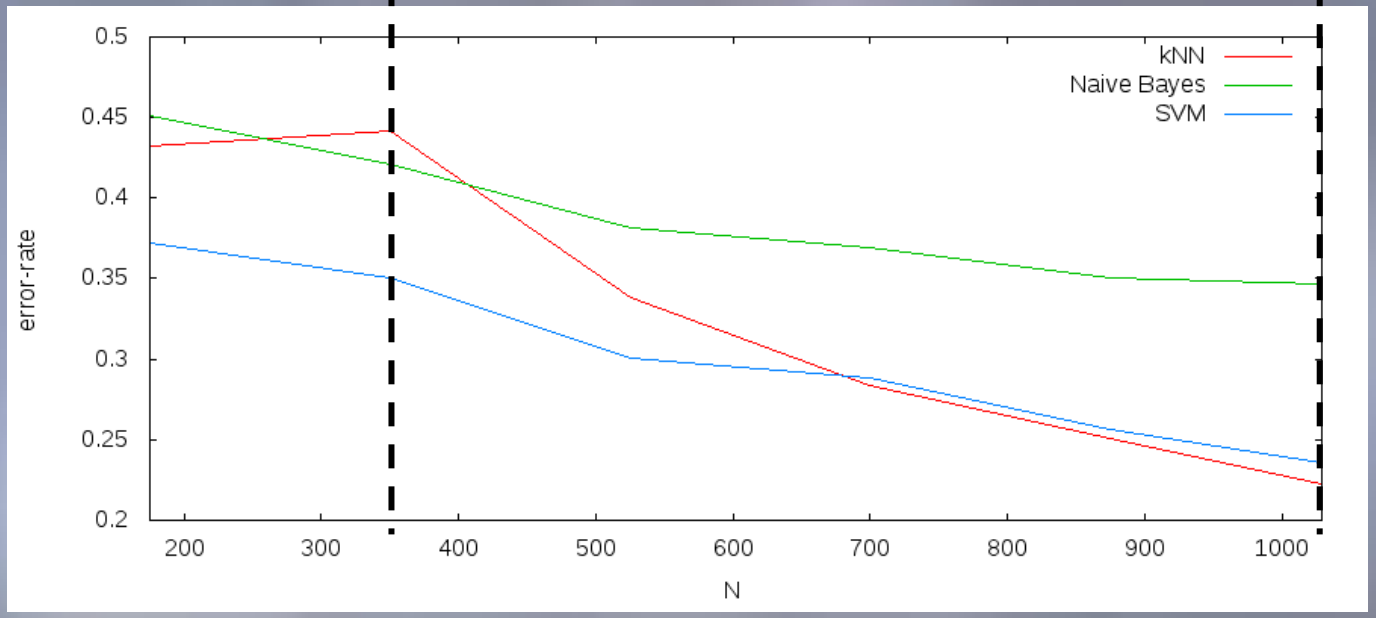
- Dataset
  - Controlled, no noise

- Method:
  - 10-folds cross validation

Classification Results





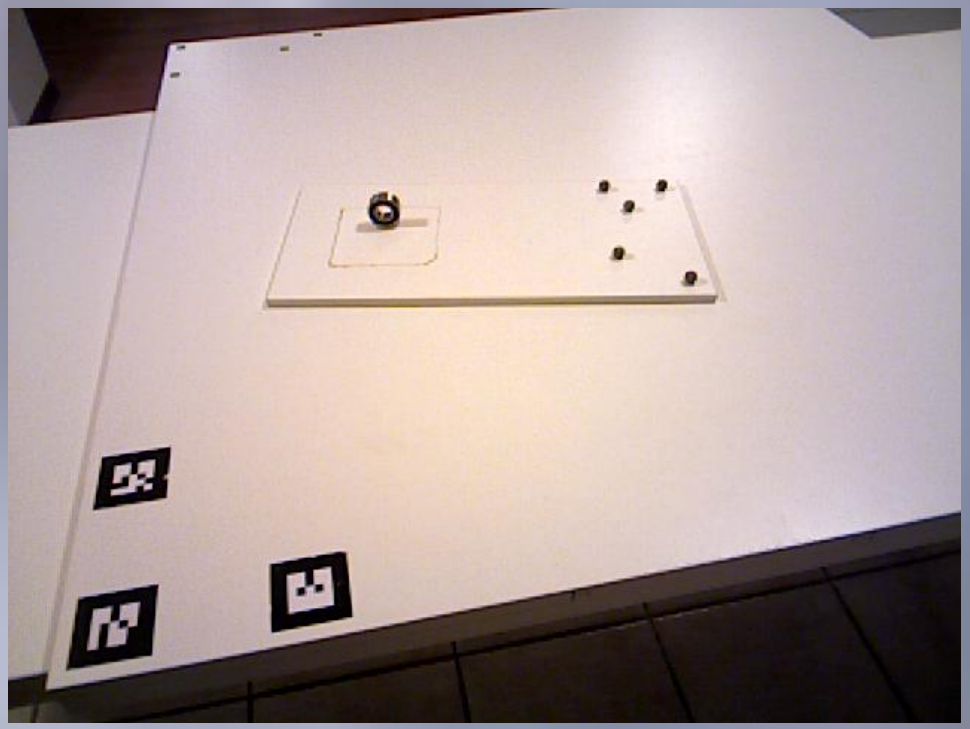


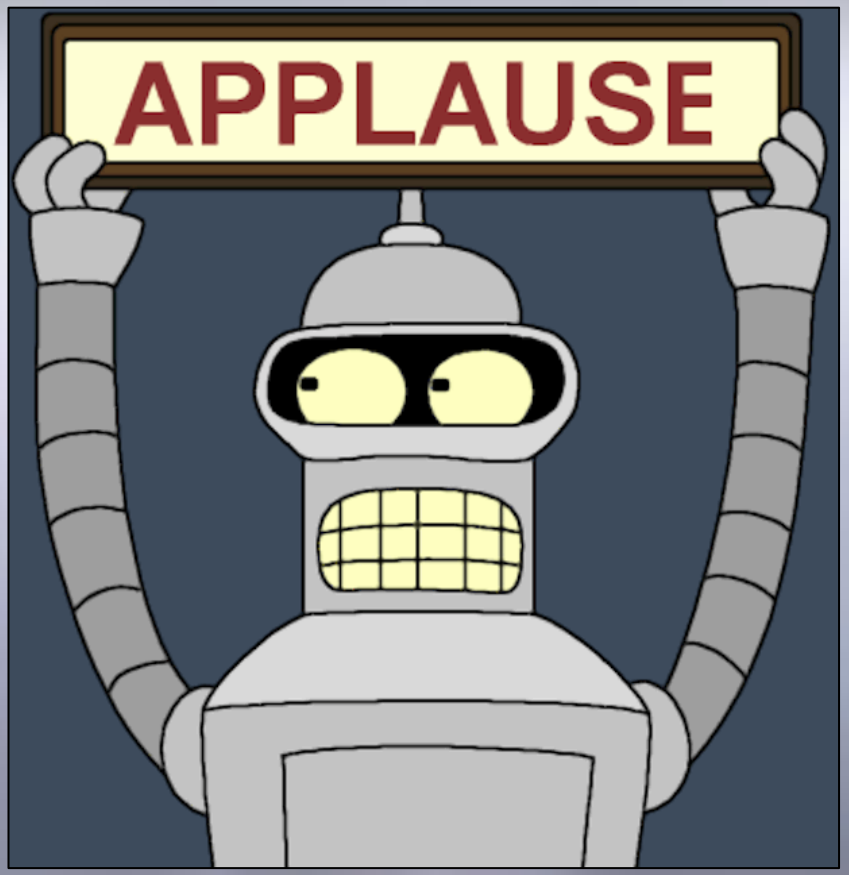
Conclusion

- Ideal number of clusters is not just dependant on clustering result
- Histograms of key-points are better than generic features, but both contribute to result
- K-nearest neighbor works best with big datasets

Future work

- Different clustering algorithm
- Different types of key-points
- Other datasets





[1] Gabriella Csurka, Christopher Dance, Lixin Fan, JuttaWillamowski, and Cédric Bray. Visual categorization with bags of keypoints. In Workshop on statistical learning in computer vision, ECCV, volume 1, pages 1–2. Prague, 2004.

[2] Bastian Broecker, Daniel Claes, Joscha Fossel, and Karl Tuyls. Winning the robocup@ work 2014 competition: The smartlab approach. In RoboCup 2014: RobotWorld Cup XVIII, pages 142–154. Springer, 2015.

[3] Herbert Bay, Andreas Ess, Tinne Tuytelaars, and Luc Van Gool. Speeded-up robust features (surf). Computer vision and image understanding, 110(3):346– 359, 2008.

[4] Richard O Duda and Peter E Hart. Use of the hough transformation to detect lines and curves in pictures. Communications of the ACM, 15(1):11–15, 1972.

[5] Mark Hall, Eibe Frank, Geoffrey Holmes, Bernhard Pfahringer, Peter Reutemann, and Ian H Witten. The weka data mining software: an update. ACM SIGKDD explorations newsletter, 11(1):10–18, 2009.