SIGGRAPH2010

The People Behind the Pixels

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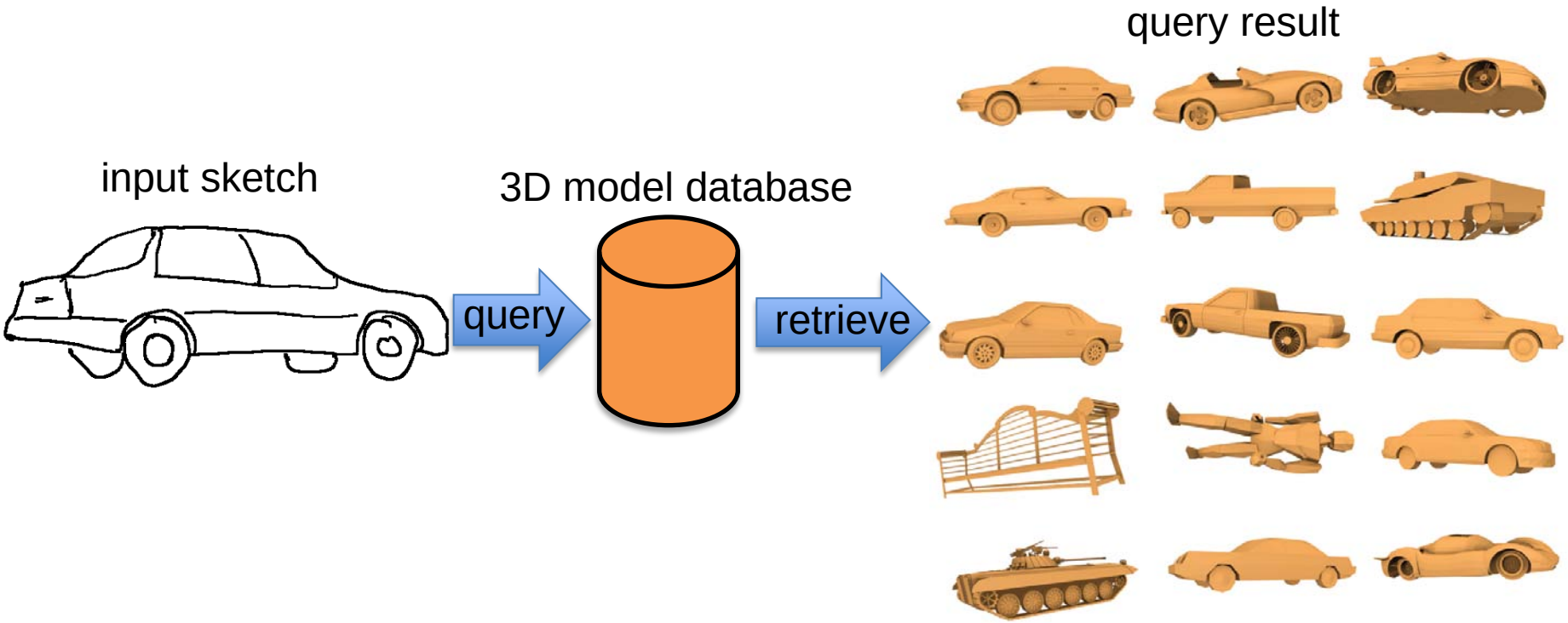
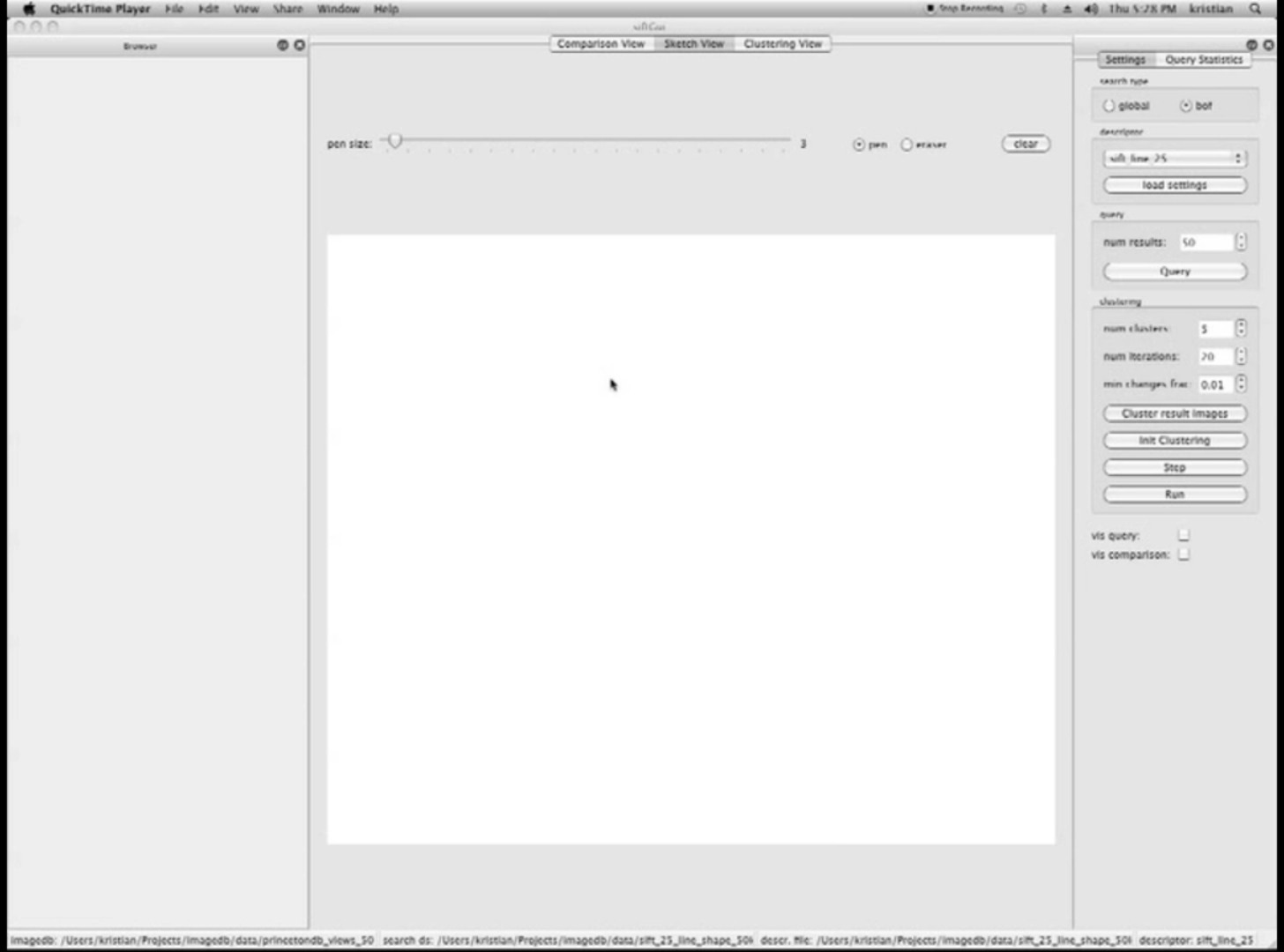
SKETCH-BASED 3D SHAPE RETRIEVAL

Goal: sketch-based shape retrieval

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descriptor: sift_line_25

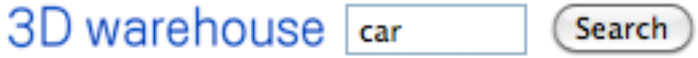
Outline

- **Background**
  - **Sketches as input**
- Overview
- Framework
- Results

Why sketches as input?

- 3 common strategies for input

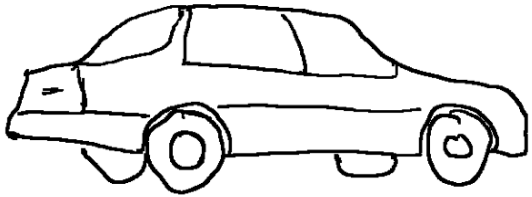
keywords



quick, simple, semantics

no/incorrect tags

sketch (2D)



rather simple, independent of external data

requires drawing skills

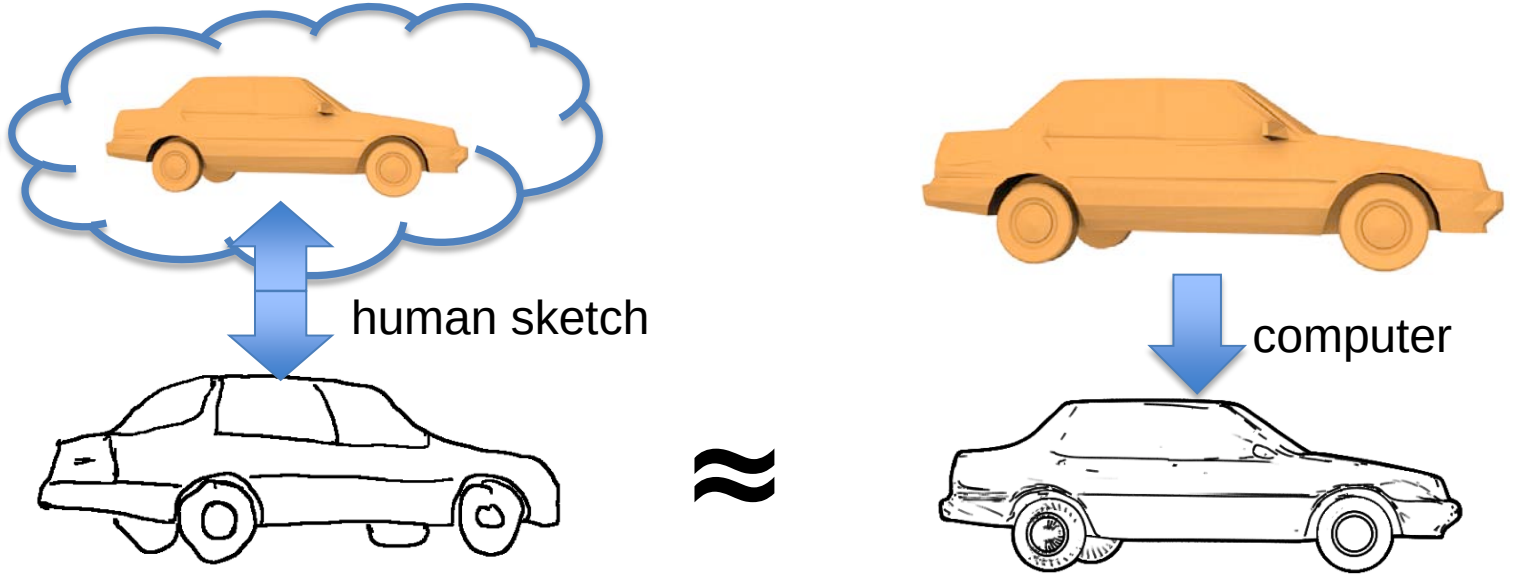
model (3D)

rich input leads to good results

example often not available

Why sketches as input?

- Shape parts index into human memory [Hoffman’97]
- 80-90% of lines explained by known definitions [Cole’08]

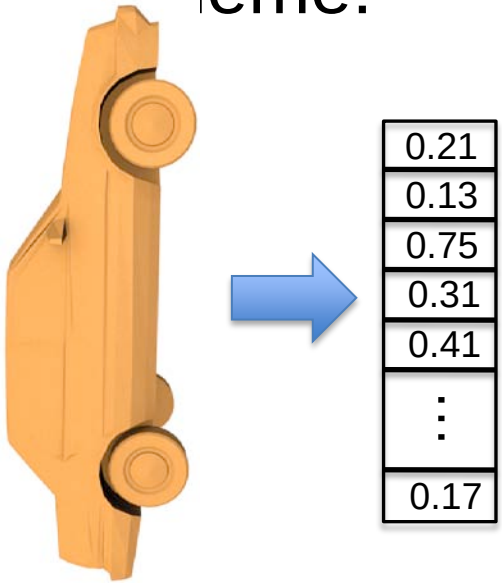


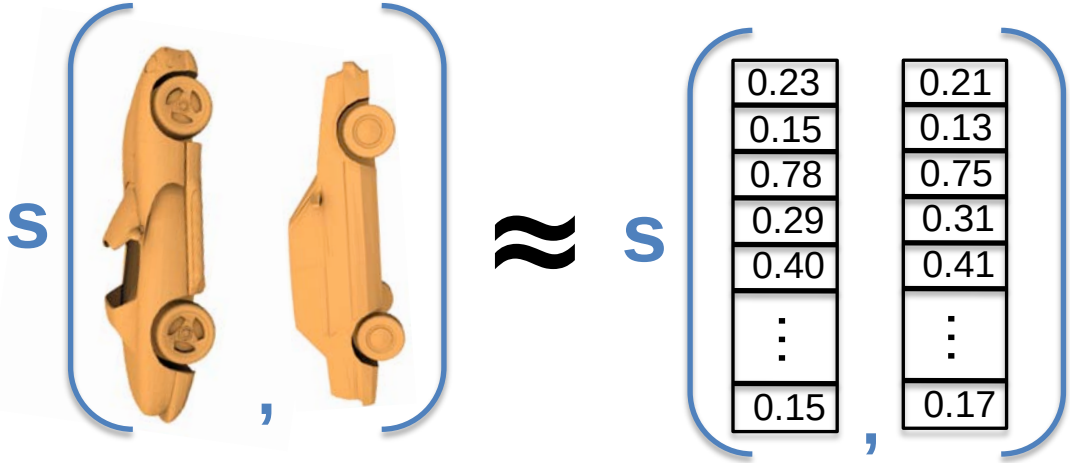
Outline

- Background
- **Overview**
  - **Previous work**
  - **Comparison with our approach**
- Framework
- Results

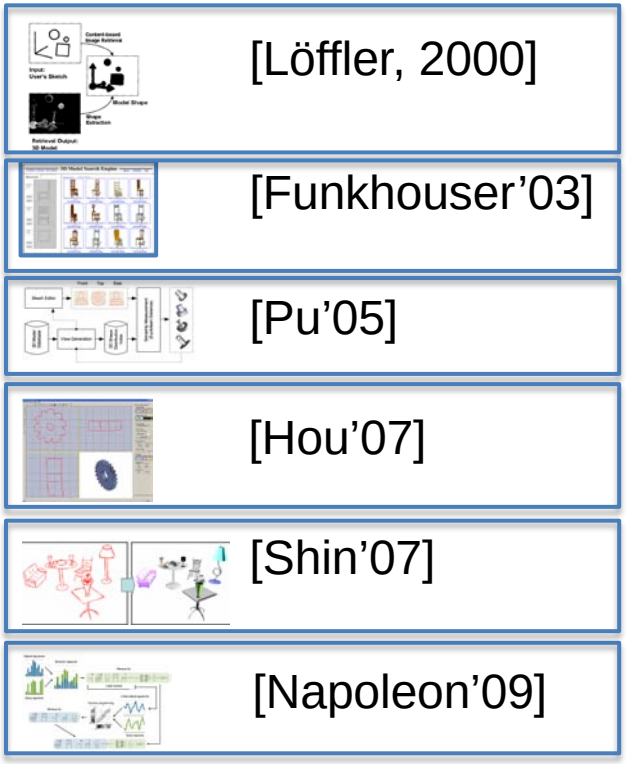
Overview

- Current retrieval systems rely on common scheme:



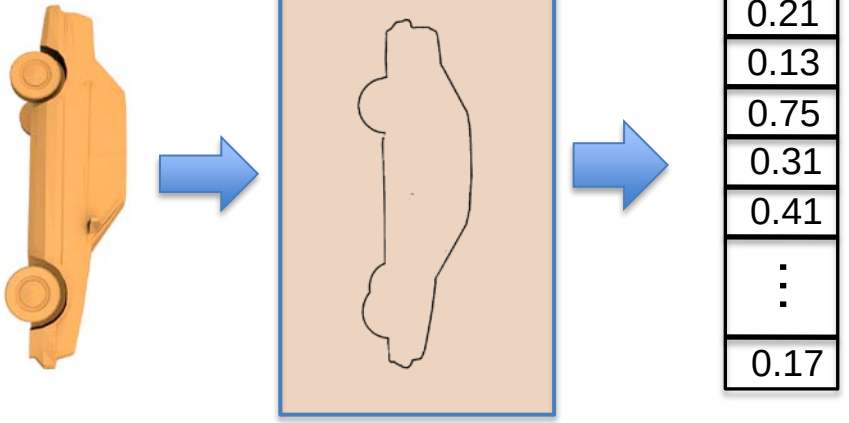


Previous work: global features



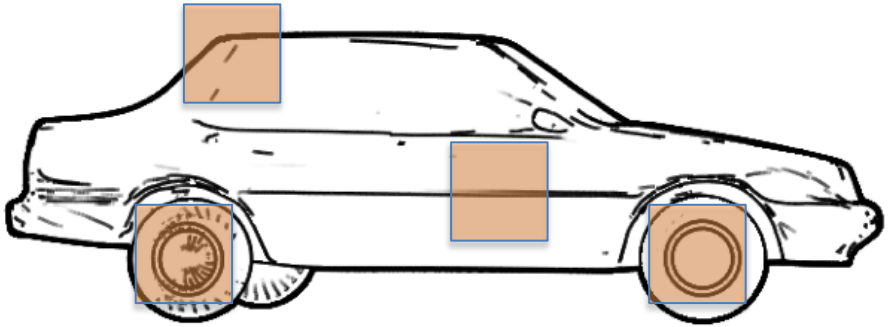
global analysis

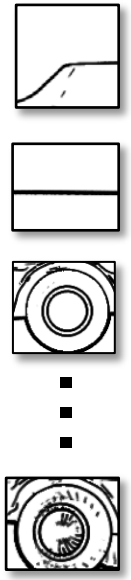
global descriptor

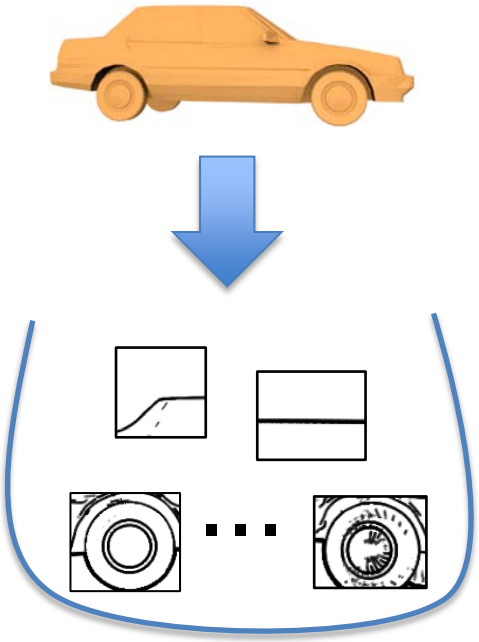


Our approach: local features

- Independent local features allow for:
  - translation invariance
  - partial matching
  - standard search data structures





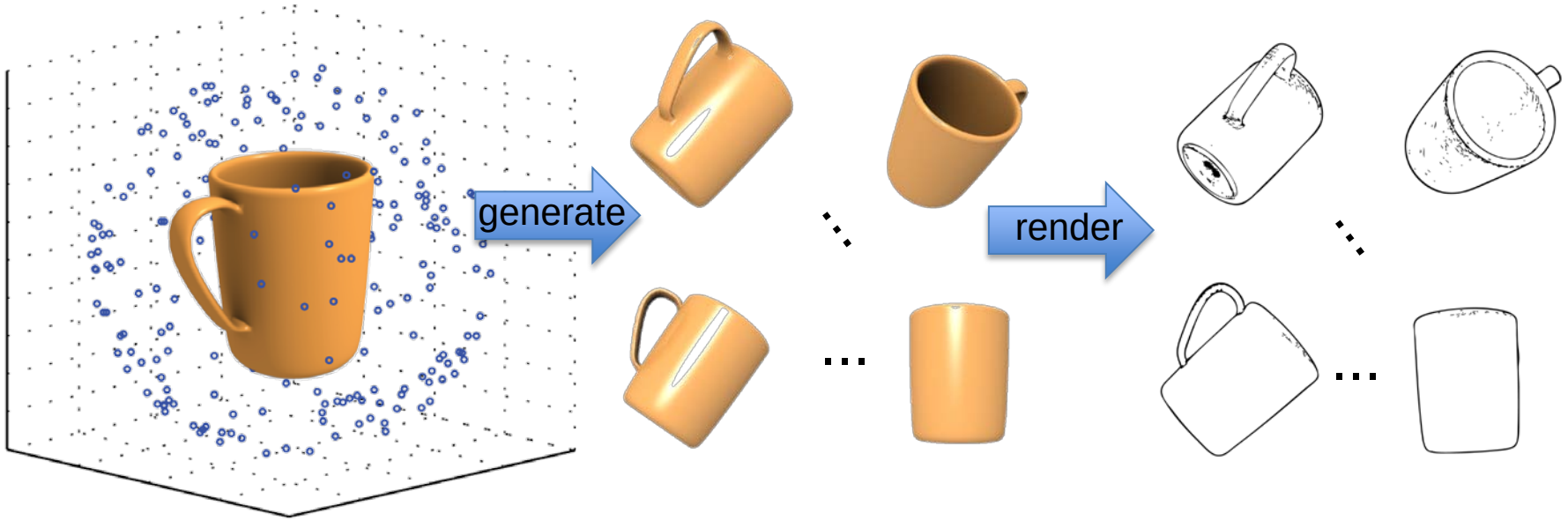


Bag-of-features [Sivic'03]

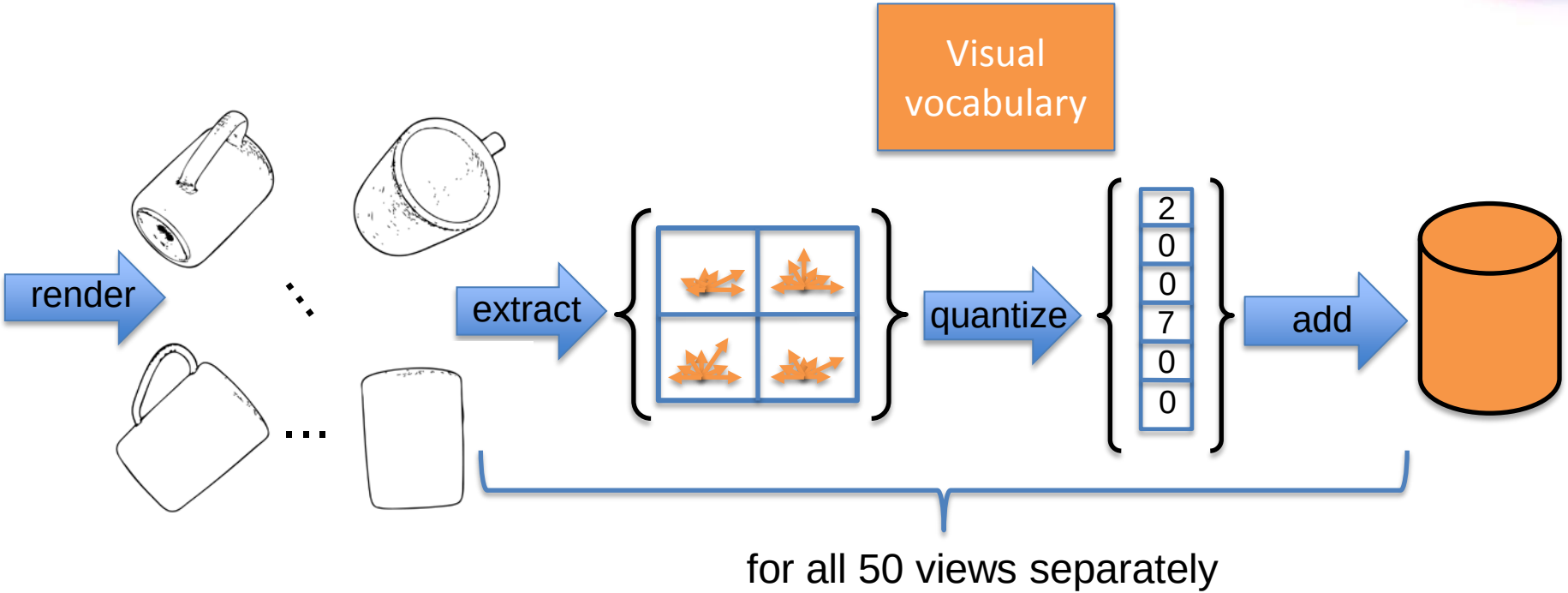
Outline

- Background
- Overview
- **Framework**
  - **Offline indexing**
  - **Learning visual vocabulary**
  - **Online search**
- Results

Offline indexing

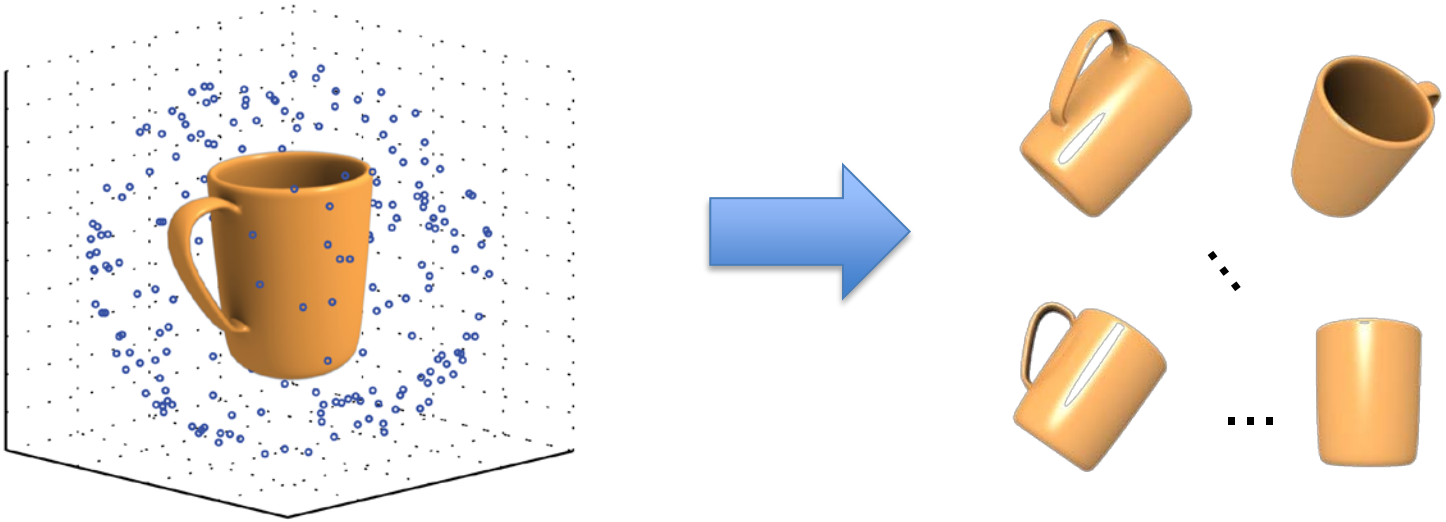


Offline indexing

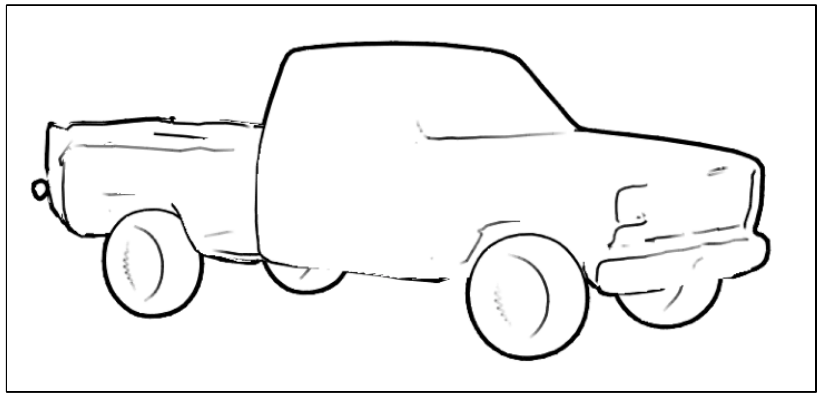


Offline indexing: view generation

- Uniformly sample bounding sphere: 50 samples



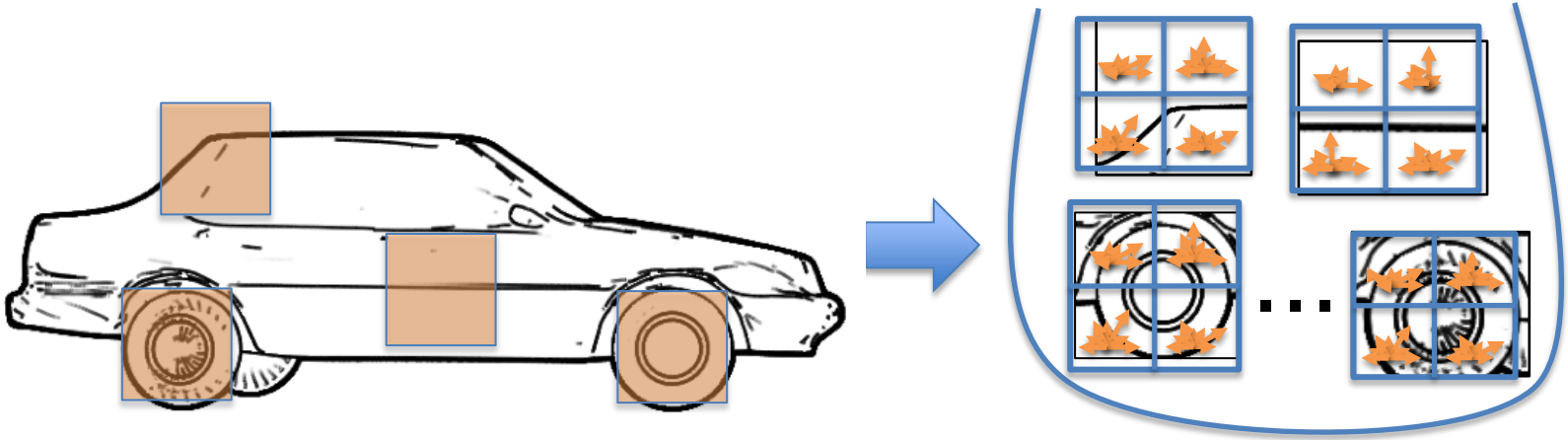
Offline indexing: NPR lines



- Occluding contours
- Suggestive contours [DeCarlo’03]

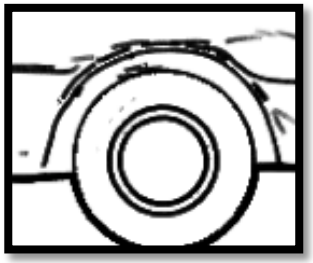
Offline indexing: sampling & features

- Sampling: 500 random samples on lines
- Representation: should be concise & robust
  - local image statistics

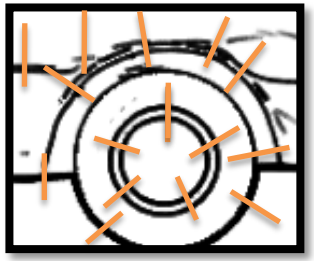


Offline indexing: features

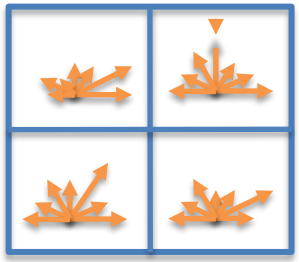
(1) Extract local region



(2) estimate orientations



(3) distribution of orientations

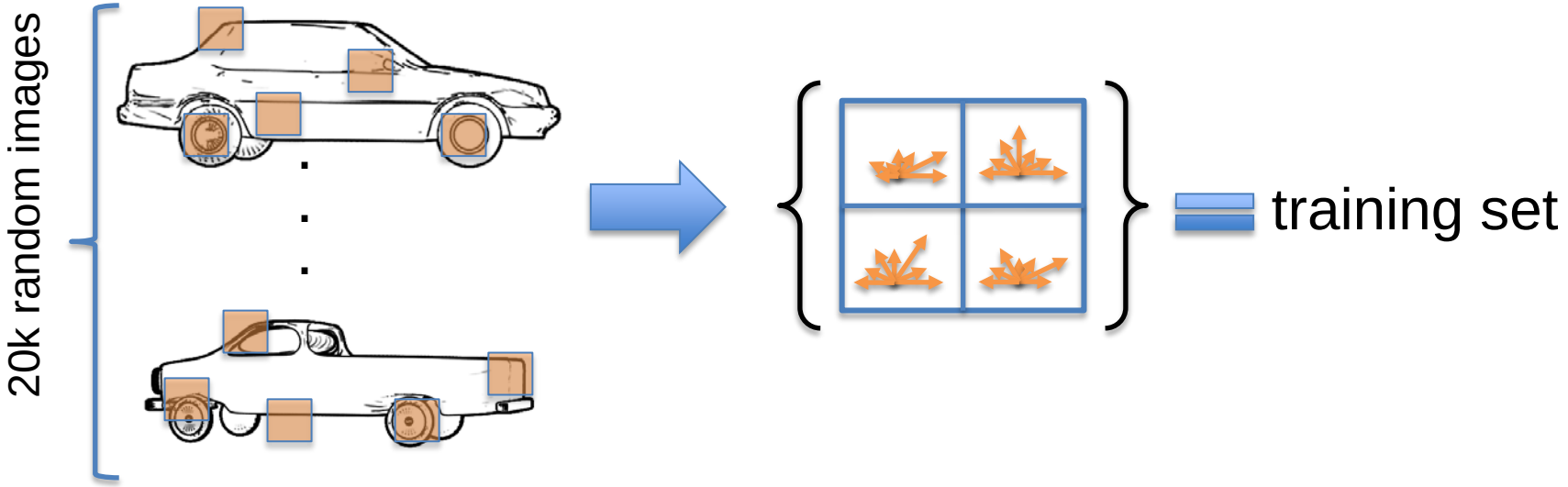


4x4 spatial, 8 radial bins

- No directionality information in gradients
- Binned distribution invariant to small deformations

Offline indexing: visual vocabulary

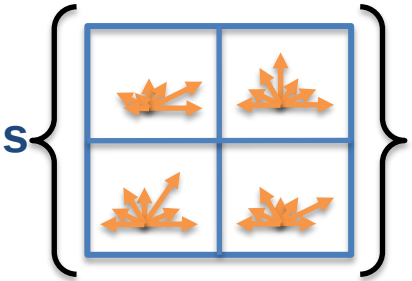
- 20k images (sampled from 50 views each of 2k models)
- 500 local features each
  - Training set size: 10 million local features



Offline indexing: visual vocabulary

training set

k-means



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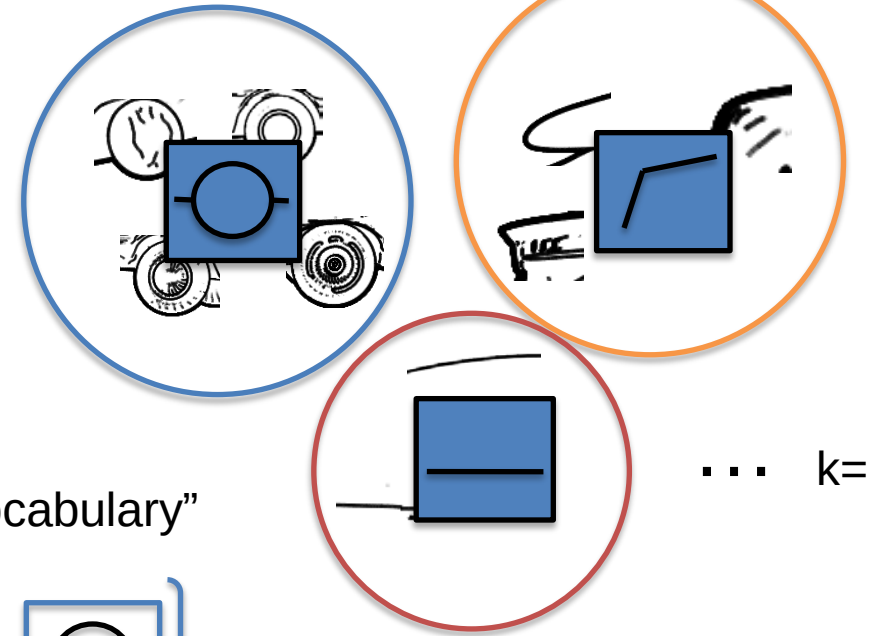
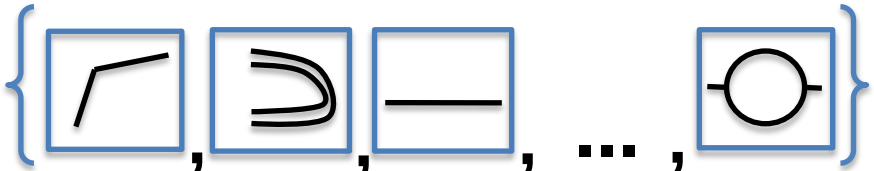


k=500

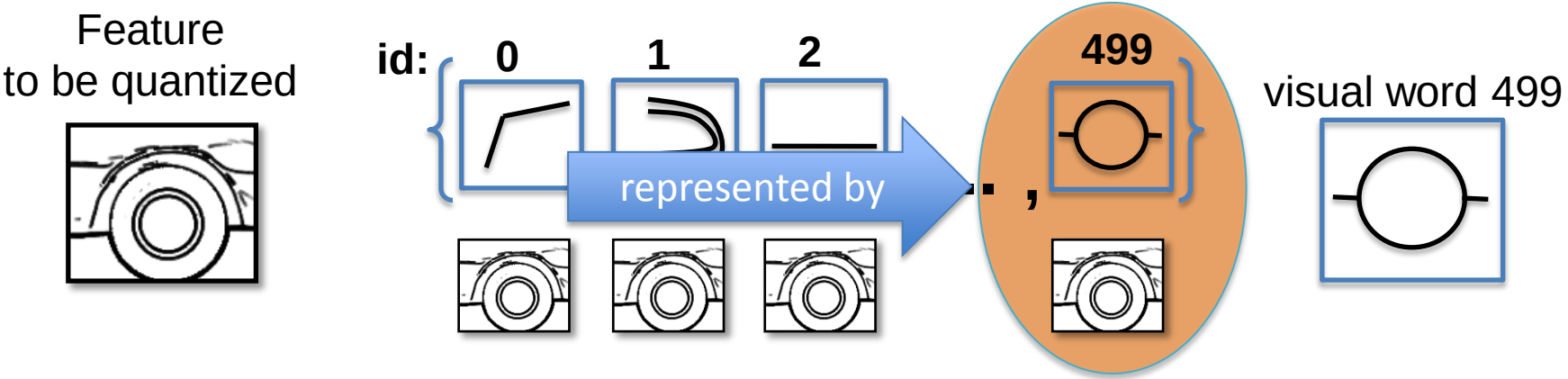
Cluster centers form “visual vocabulary”



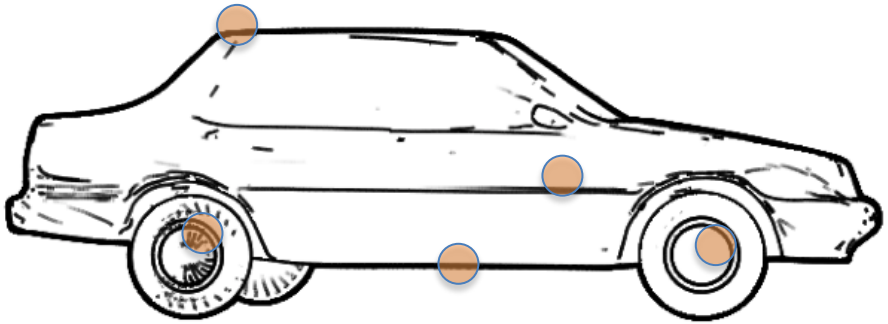
id: 0 1 2 499

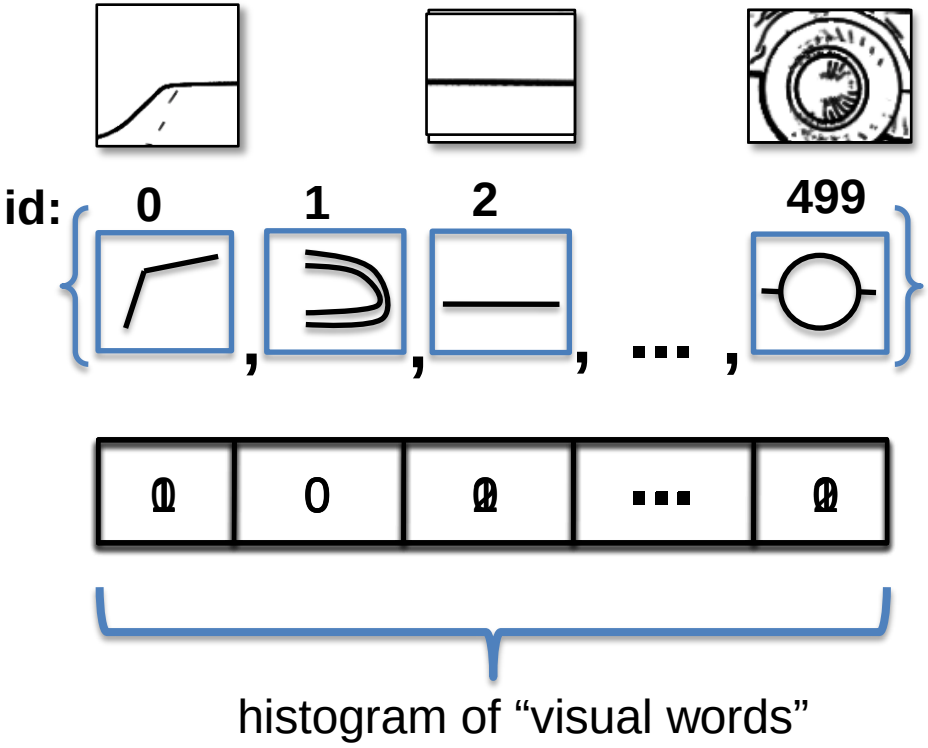
Offline indexing: quantization

- Quantization allows for
  - More compact representation
  - Grouping of perceptually similar features

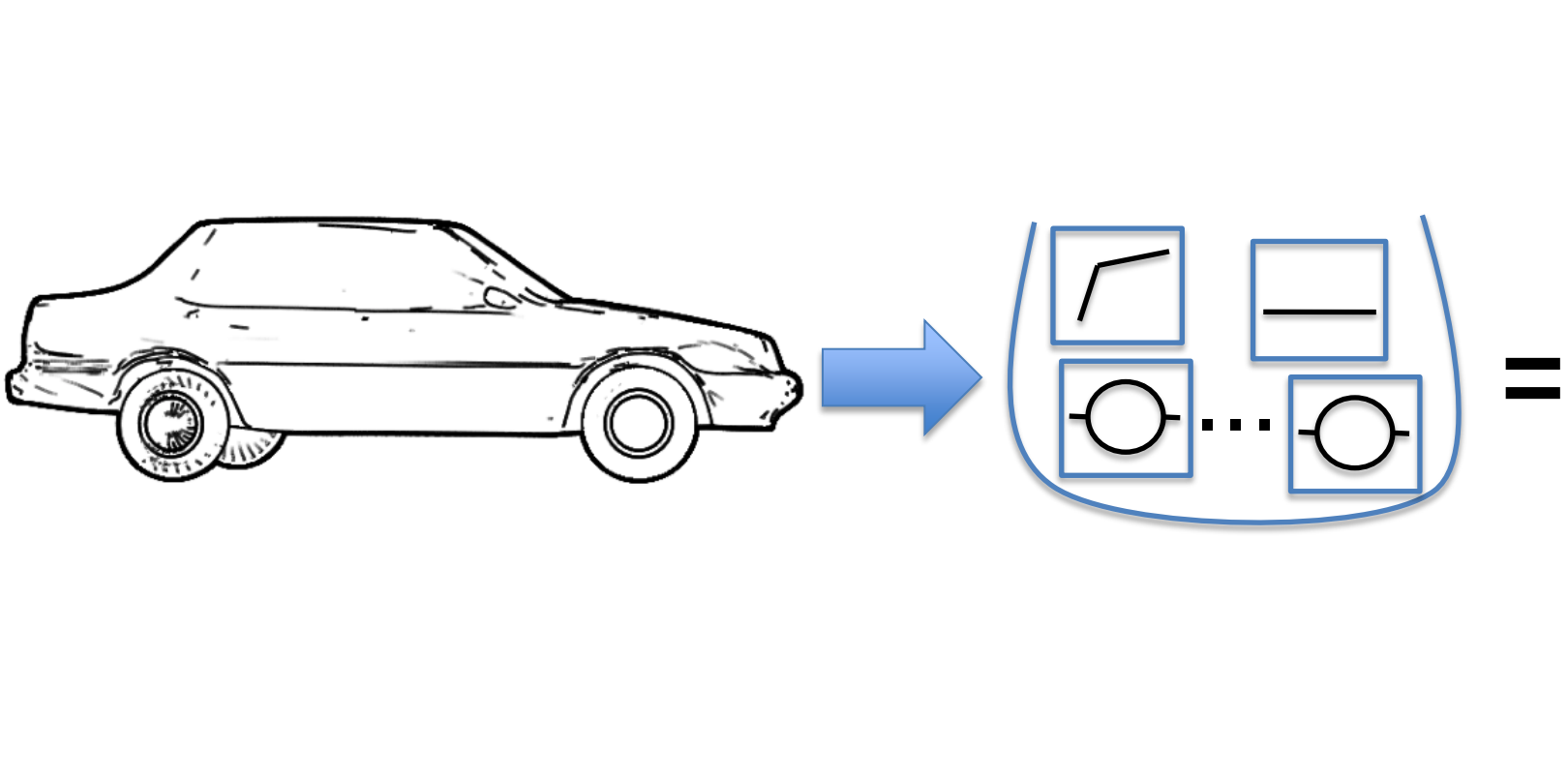


Offline indexing: representation

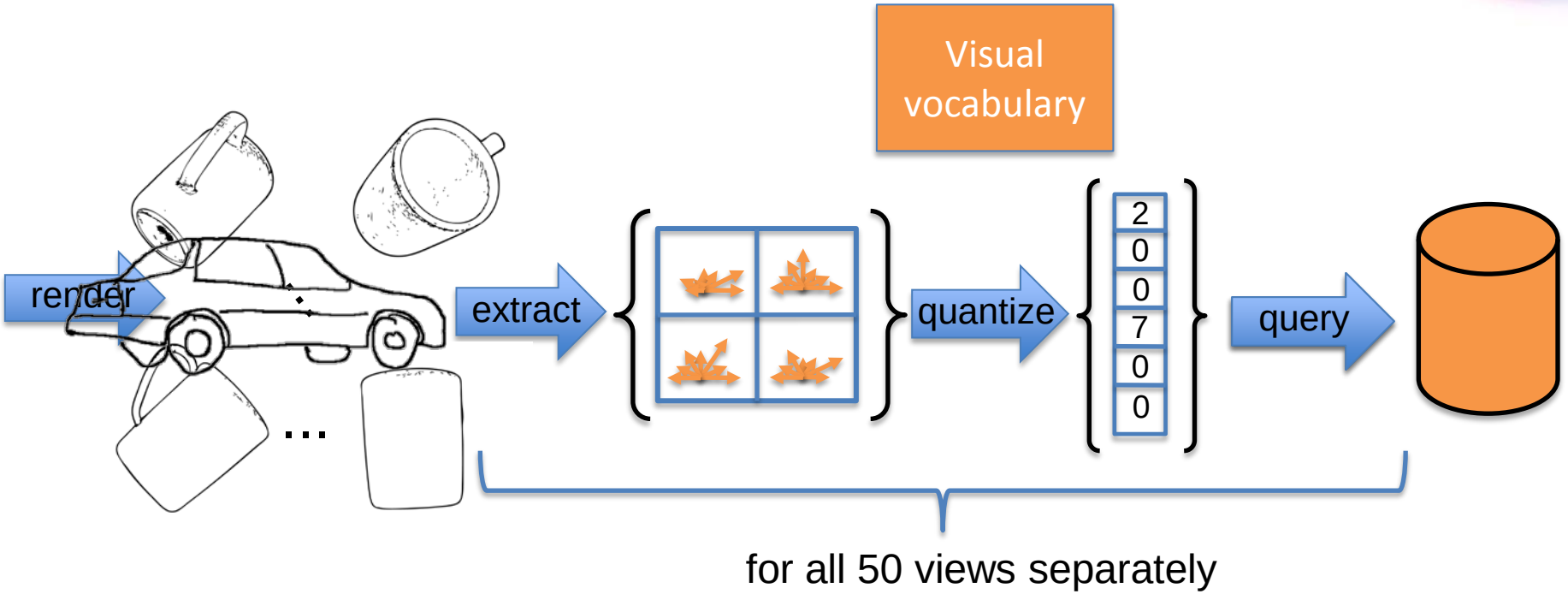




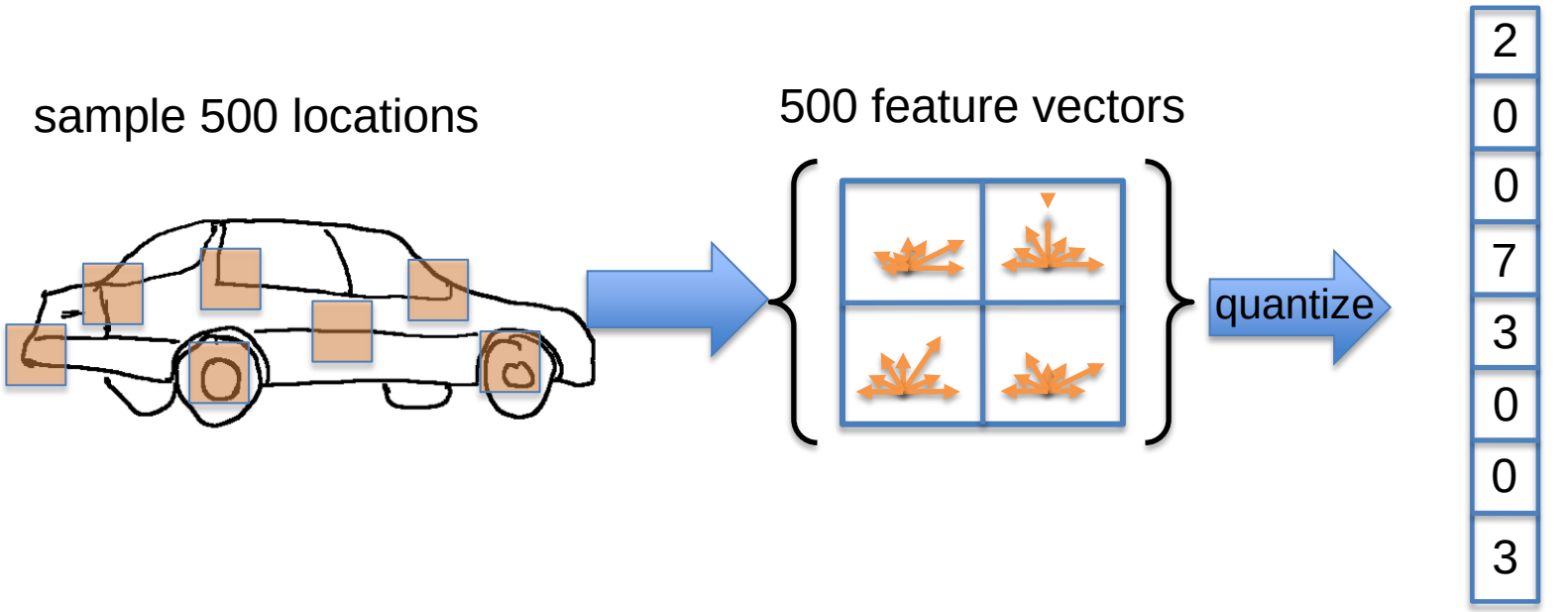
Offline indexing: representation



Online search

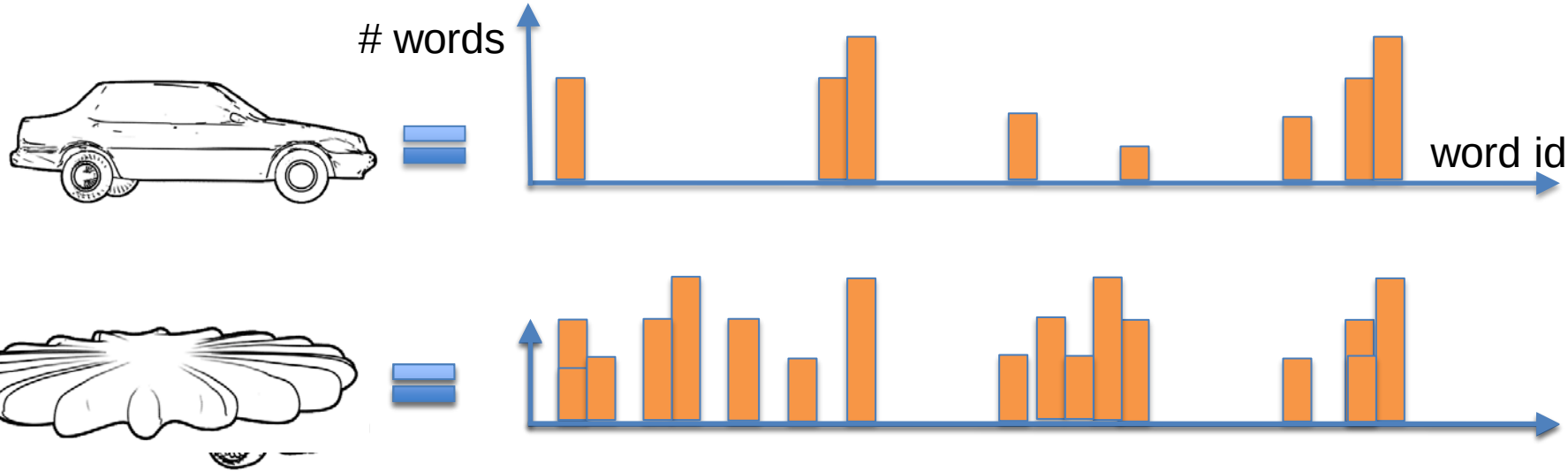


Online Search

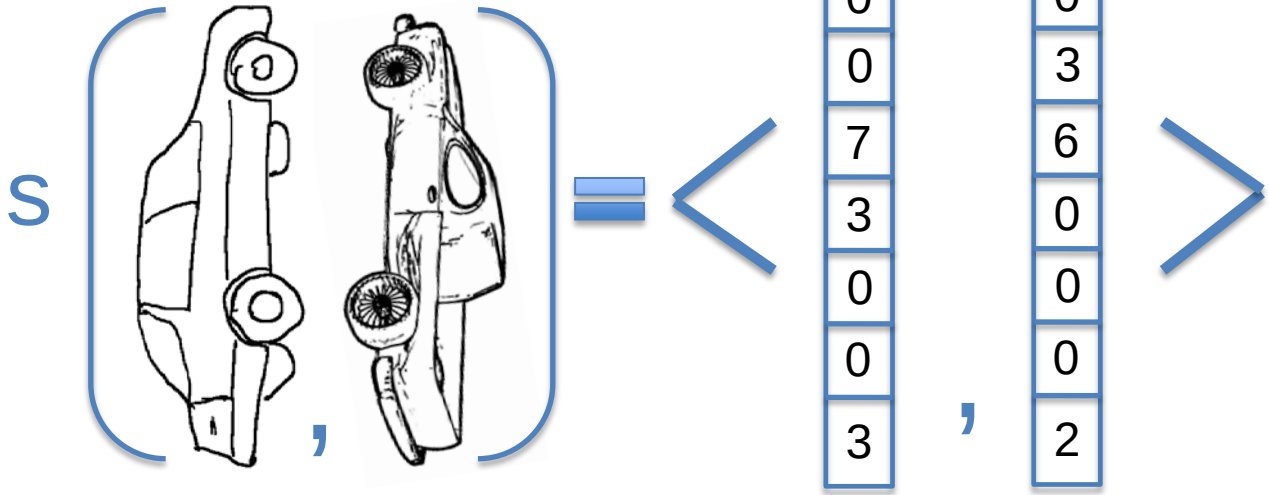


Online search

- Images as (sparse) histograms of visual words



Online search



- Similarity as angle in high-dimensional space
- Vectors sparse: use inverted index

Outline

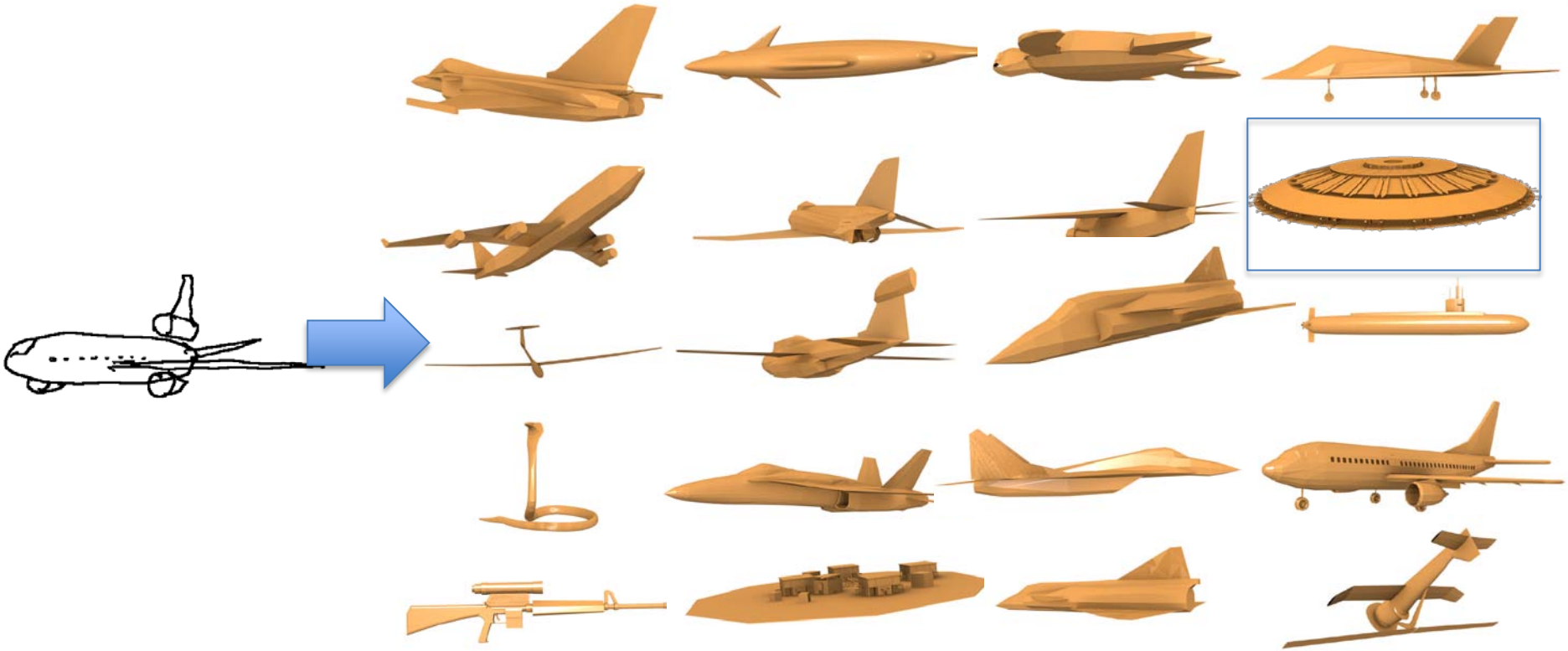
- Background
- Overview
- Framework
- **Results**
  - **Images**
  - **Discussion**

Results

- Based on Princeton shape db (~2k models)
  - ~10ms for a search

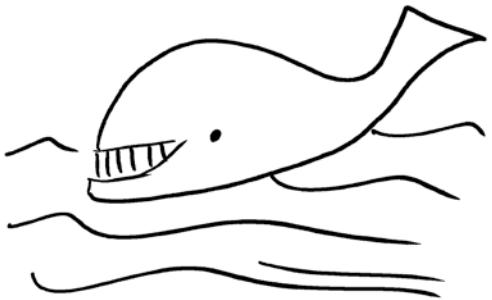
Results

Results



Failure cases

- NPR methods require high resolution meshes
- Sketches from “real users” can be quite abstract



Future work

- View generation
  - canonical, “salient” views – which provides best retrieval?
- Feature representation
  - multi-scale, rotation-invariance?
- Larger datasets than the PSB models
  - Method fast enough to handle millions of models
  - Will it remain effective?

Thanks

More information : http://www.telecom-paristech.fr/~boubek/papers/SBSR/

- Acknowledgements
  - Princeton shape benchmark [Shilane'04]
  - RTSC tool by Doug DeCarlo, Szymon Rusinkiewicz
  - Cited authors for images from their papers