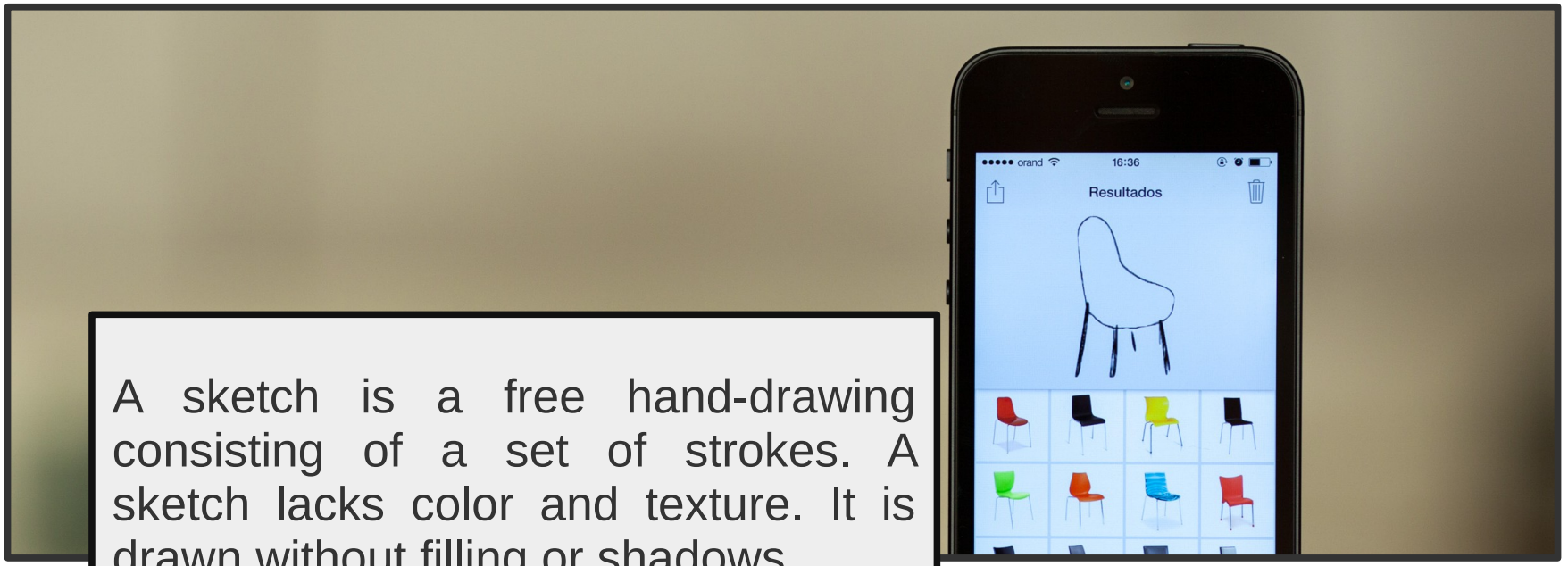
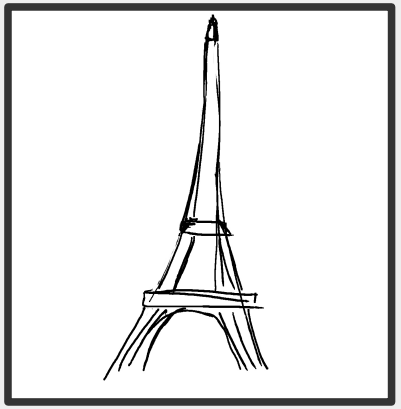
SKETCH BASED IMAGE RETRIEVAL

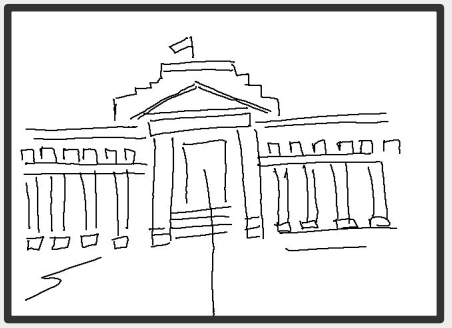
Jose M. Saavedra

INTRODUCTION



A sketch is a free hand-drawing consisting of a set of strokes. A sketch lacks color and texture. It is drawn without filling or shadows.



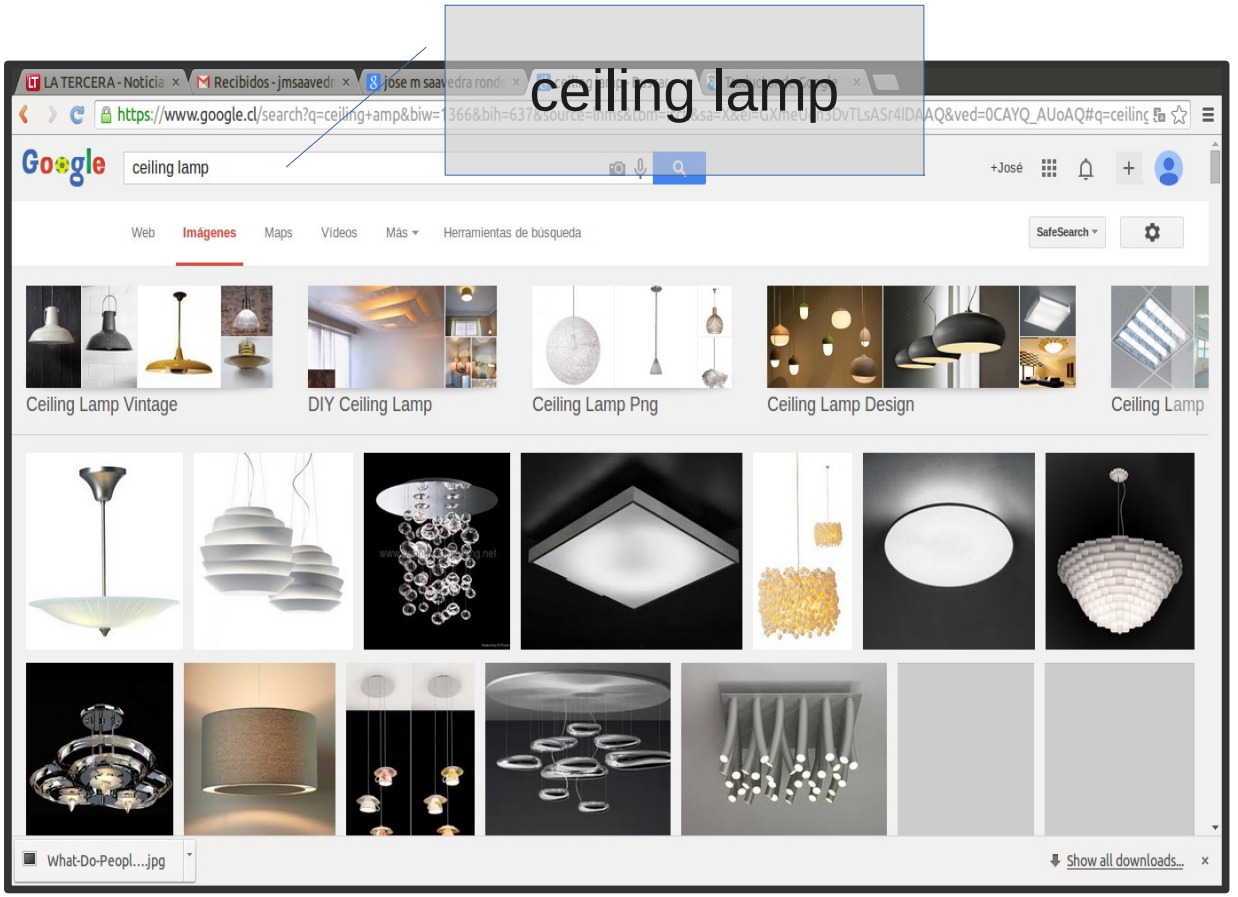


INTRODUCTION

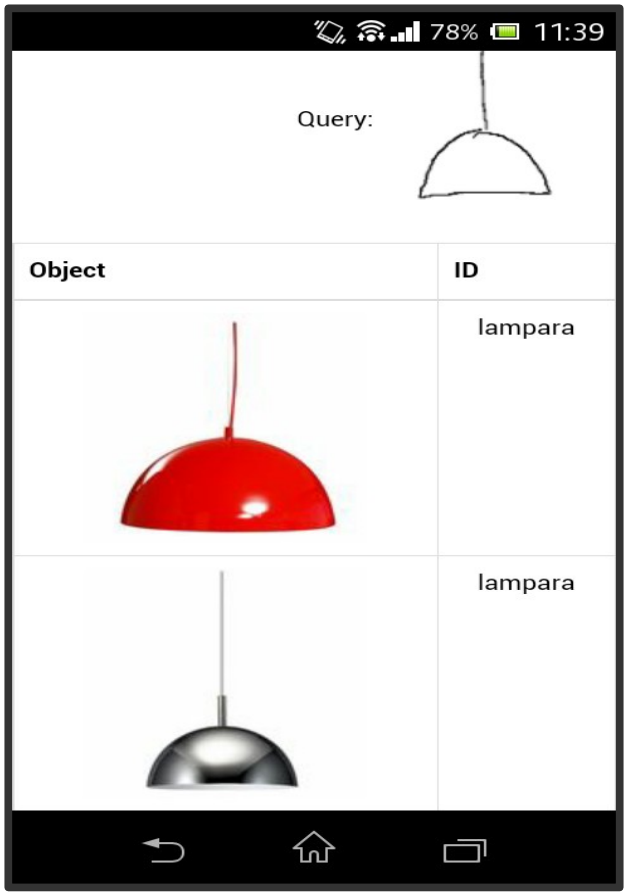
Making a sketch query is easy and accesible due to the emerging touch screen based technology

INTRODUCTION

- Applications
  - Searching retail catalogs



SBIR



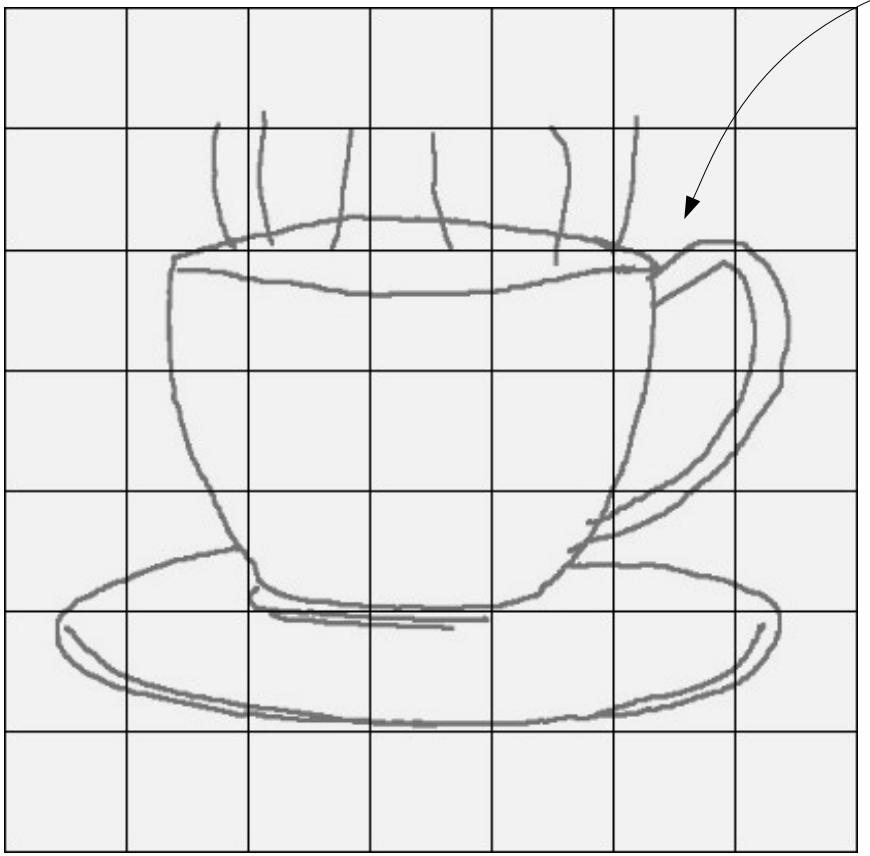
INTRODUCTION

- Applications
  - Promoting cognitive skills in children

SHELO
SOFT HISTOGRAM OF EDGE LOCAL ORIENTATIONS

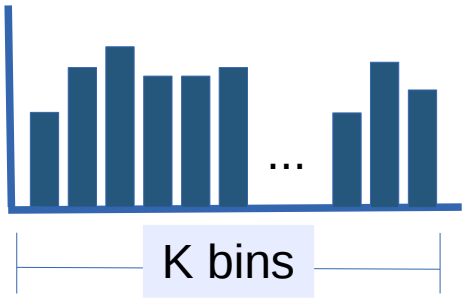
SHELO

- HELO [Saavedra et al. 2010]



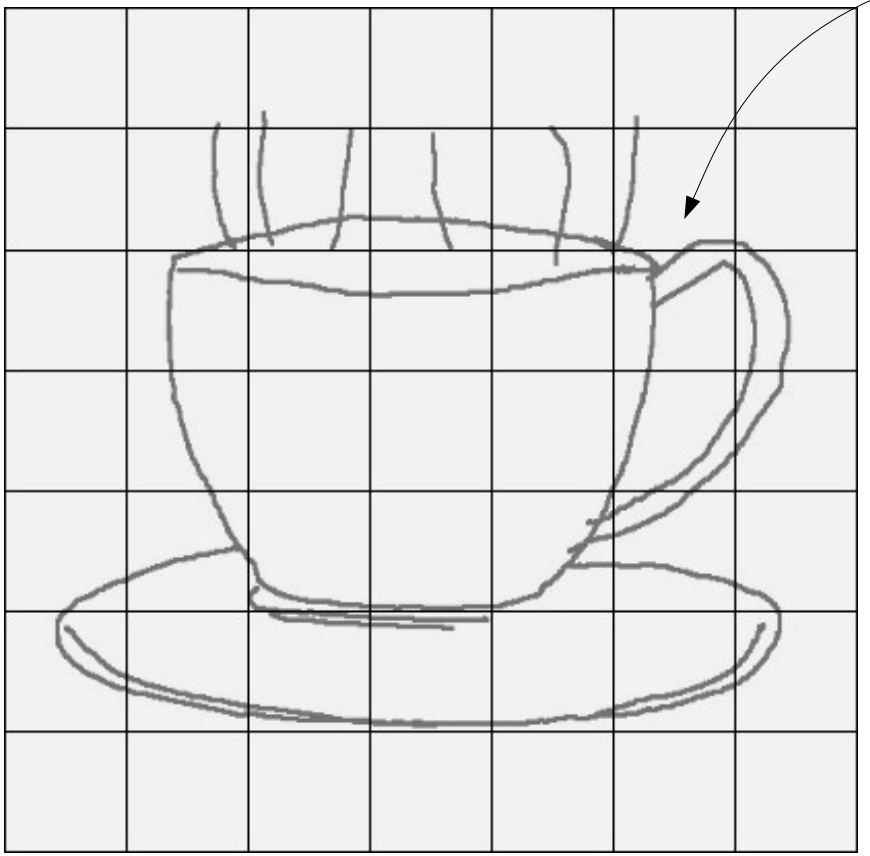
estimate a representative orientation

form an orientation histogram of K bins.



SHELO

- HELO [Saavedra et al. 2010]



estimate a representative orientation

How?

SQUARE GRADIENT METHOD

SHELO

- HELO [Saavedra et al. 2010]

  Square Gradient Method

  Let $[G_x, G_y]^T$ be the gradient vector for a pixel *(x,y)* .

$$\begin{bmatrix} G_\rho \\ G_\phi \end{bmatrix} = \begin{bmatrix} \sqrt{G_x^2 + G_y^2} \\ tan^{-1}\frac{G_y}{G_x} \end{bmatrix}$$

Cartesian to Polar

$$\begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} G_\rho cos(G_\phi) \\ G_\rho sin(G_\phi) \end{bmatrix}$$

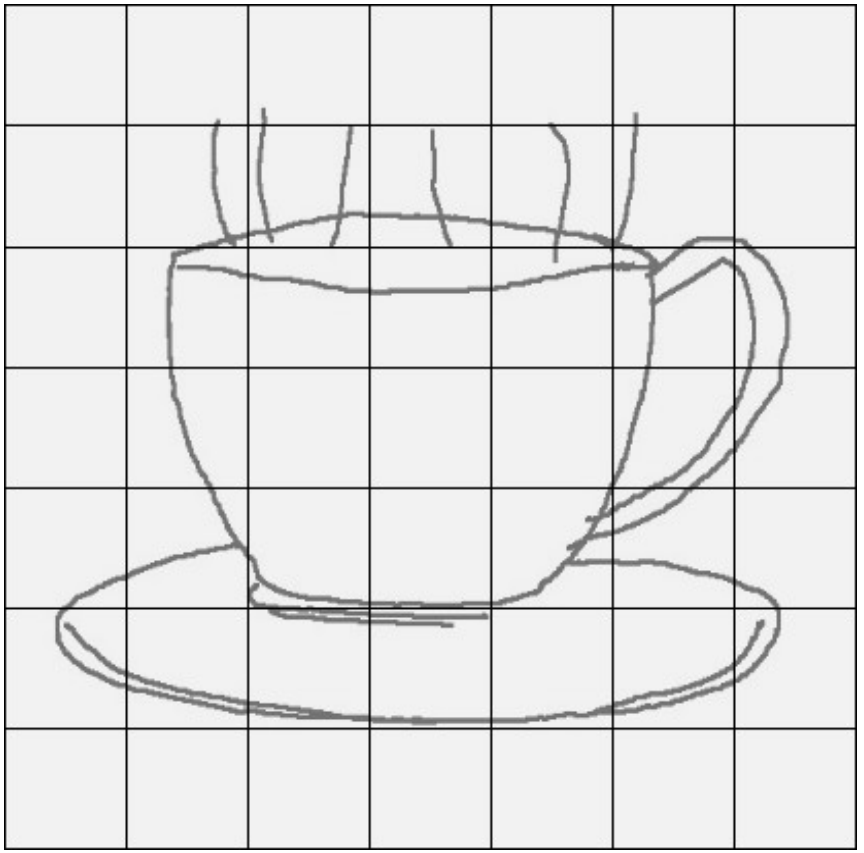
Polar to Cartesian

$$\begin{bmatrix} G_{sx} \\ G_{sy} \end{bmatrix} = \begin{bmatrix} G_\rho^2 cos(2G_\phi) \\ G_\rho^2 sin(2G_\phi) \end{bmatrix}$$

$$\begin{bmatrix} G_{sx} \\ G_{sy} \end{bmatrix} = \begin{bmatrix} G_\rho^2 (cos^2(G_\phi) - sin^2(G_\phi)) \\ G_\rho^2 (2sin(G_\phi)cos(G_\phi)) \end{bmatrix} = \begin{bmatrix} G_x^2 - G_y^2 \\ 2G_xG_y \end{bmatrix}$$

SHELO

- HELO [Saavedra et al. 2010]



- Divide the by a *WxW* grid.
- Compute a square gradient for each grid cell.
- The angle of a cell (i,j) is then computed as:

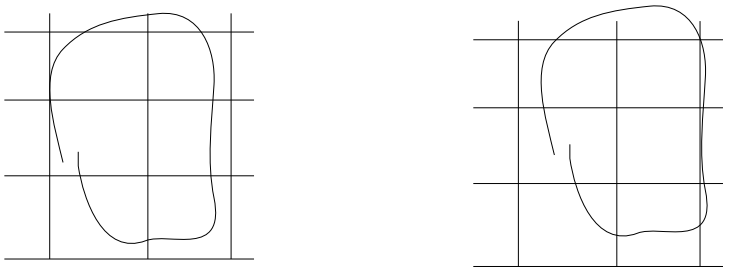
$$\alpha_{ij} = \frac{1}{2} tan^{-1}\left(\frac{L_y^{ij}}{L_x^{ij}}\right) + \frac{\pi}{2}.$$

$$L_y^{ij} = \sum_{(r,s)\in b_{ij}} 2G_x(r,s)G_y(r,s)$$

$$L_x^{ij} = \sum_{(r,s)\in b_{ij}} (G_x(r,s)^2 - G_y(r,s)^2)$$

SHELO

- HELO [Saavedra et al. 2010]
  - **Drawbacks**
    - It is based on a hard computation which may cause mis-computation related with an inconsistent “celling”



    - *Noisy orientations*. The gradient magnitudes are not considered in estimating an orientation cell.
    - Spatial distribution of strokes are not considered.

SOFT HISTOGRAM OF EDGE LOCAL ORIENTATIONS

[ICIP 2014]

SHELO

1.Cell orientation computed in a soft manner

$$L_y^{ij} = \sum_{(r,s)\in b_{ij}} 2G_x(r,s)G_y(r,s)$$

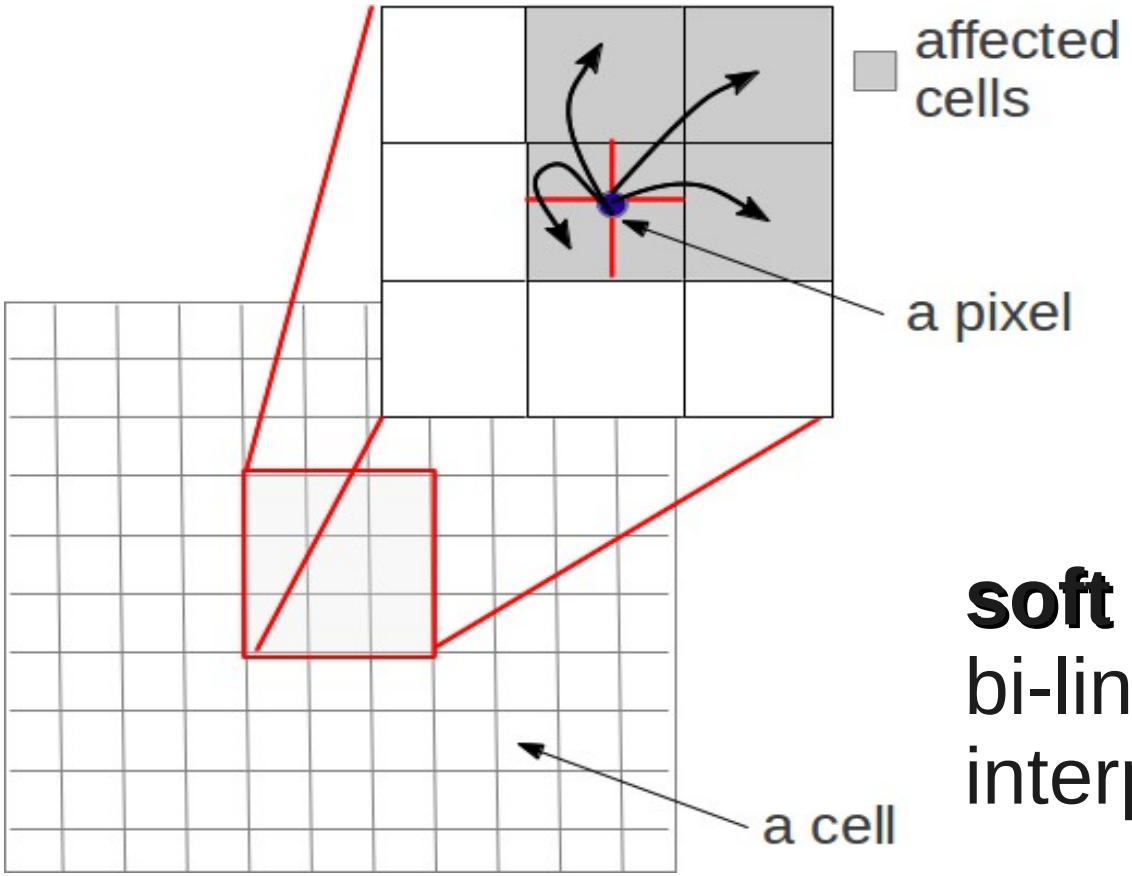
$$L_x^{ij} = \sum_{(r,s)\in b_{ij}} \left(2G_x^2(r,s) - G_y^2(r,s)\right)$$

$$L_y^{ij} = \sum_{(r,s)\in b_{ij}} |G_{xy}|2G_x(r,s)G_y(r,s)$$

$$L_x^{ij} = \sum_{(r,s)\in b_{ij}} |G_{xy}| \left(2G_x^2(r,s) - G_y^2(r,s)\right)$$

SHELO

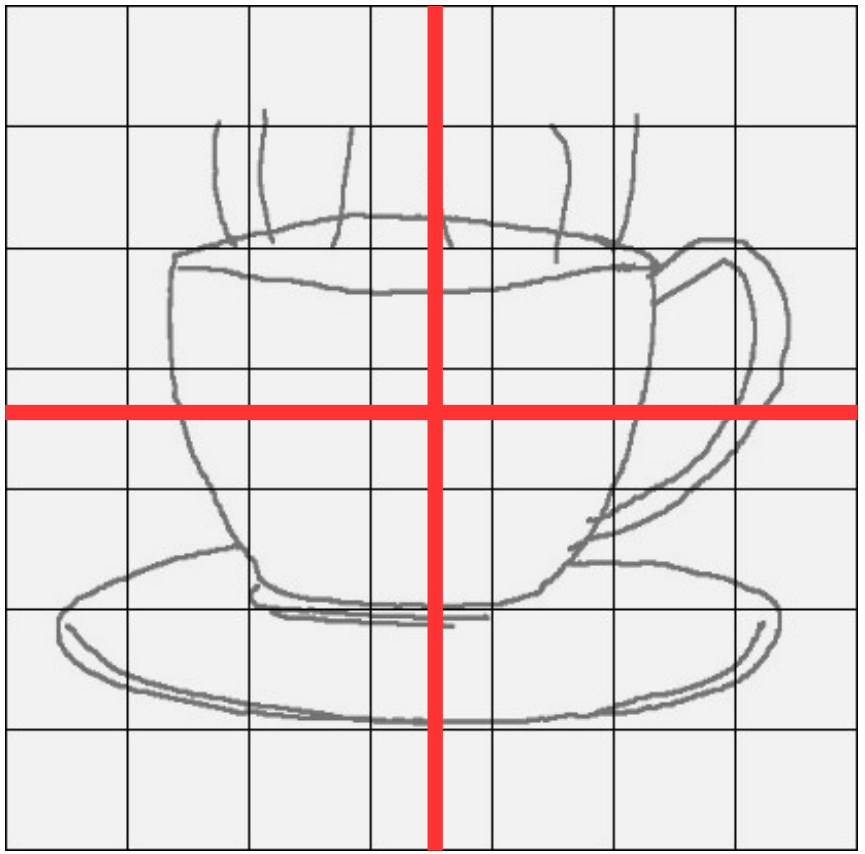
1.Cell orientation computed in a soft manner

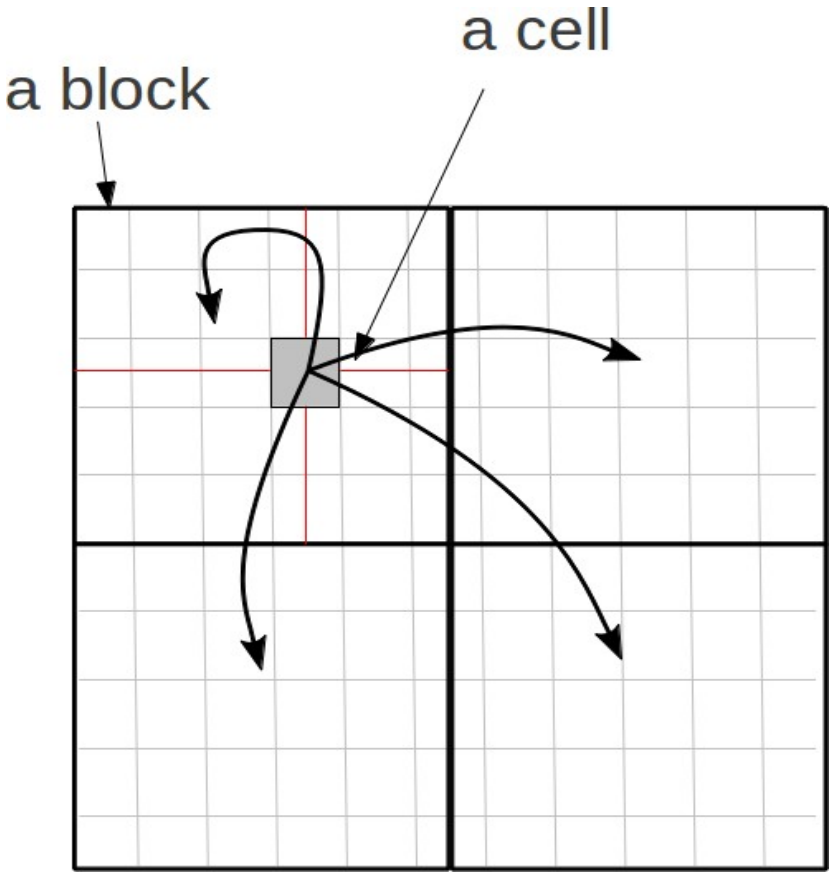


soft celling
bi-linear
interpolation

SHELO

2. Spatial division computing local histograms in a soft manner

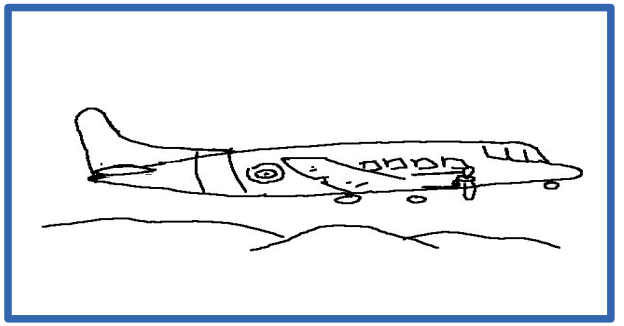




three-linear interpolation

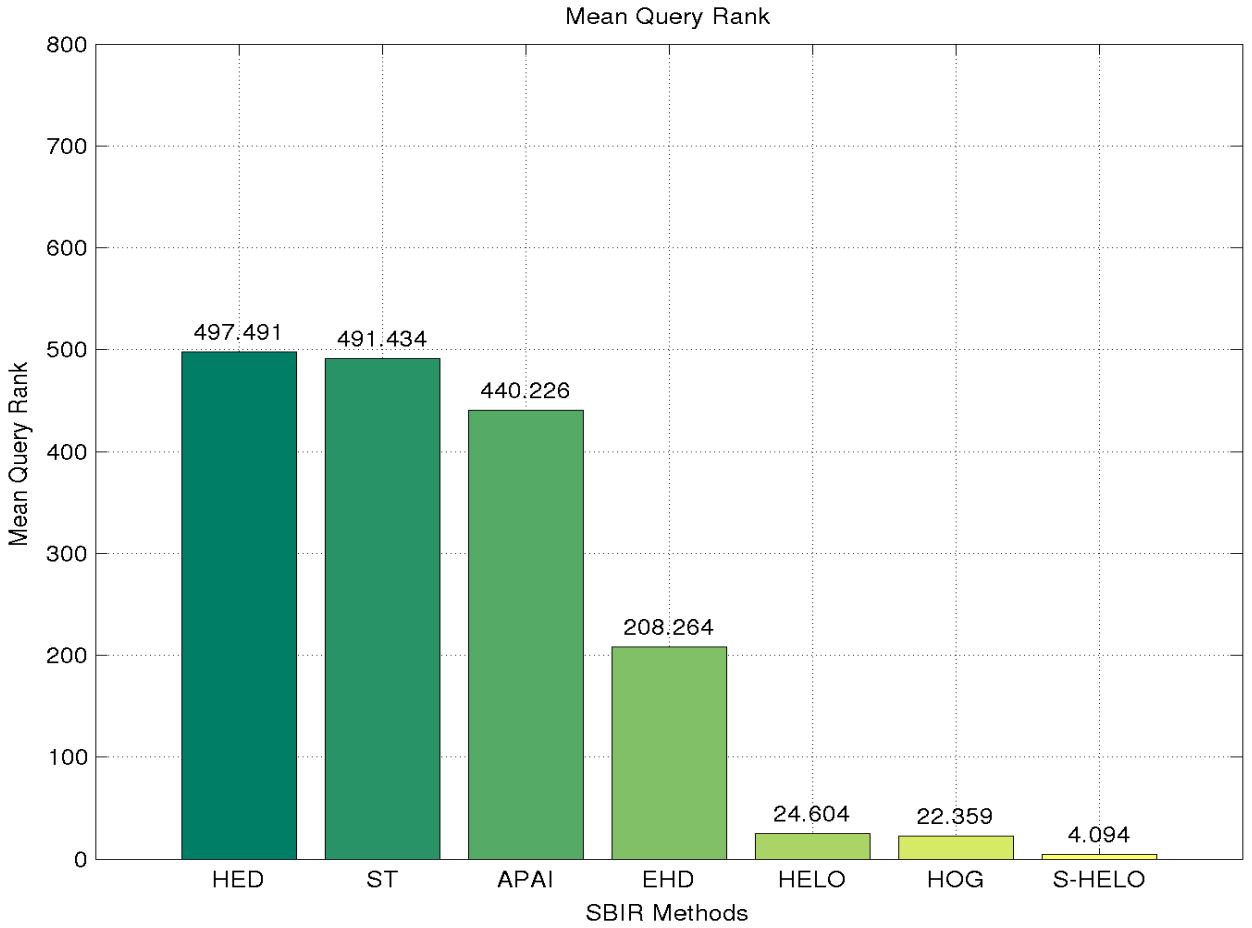
SHELO

- Results
  - Target Retrieval



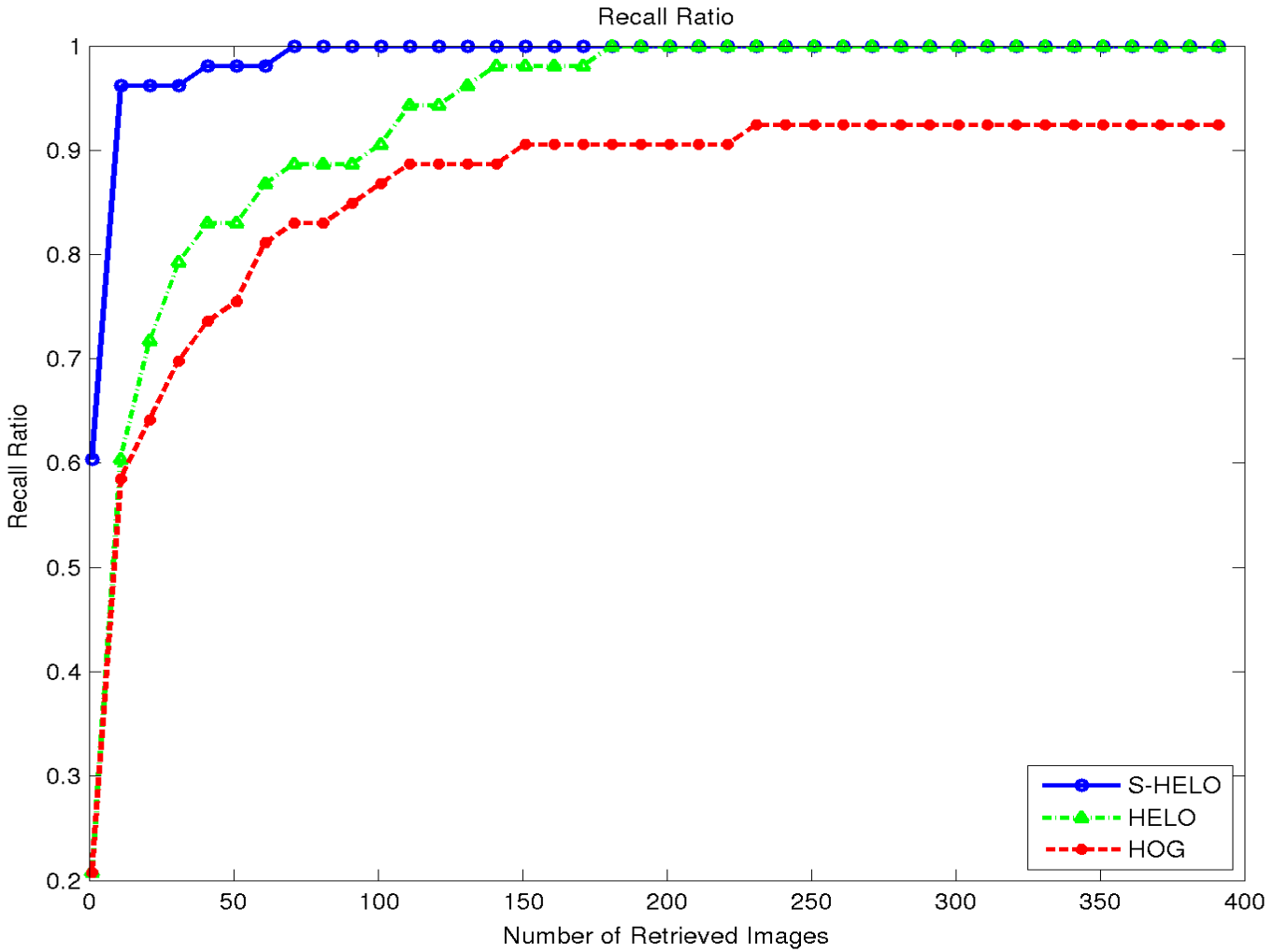
SHELO

Mean Query Rank: Average position in a ranking where a target image occurs.



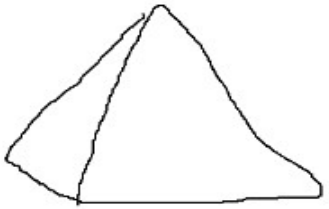
SHELO

Recall Ratio: Percentage of retrieved target images just looking the first N responses of a ranking.

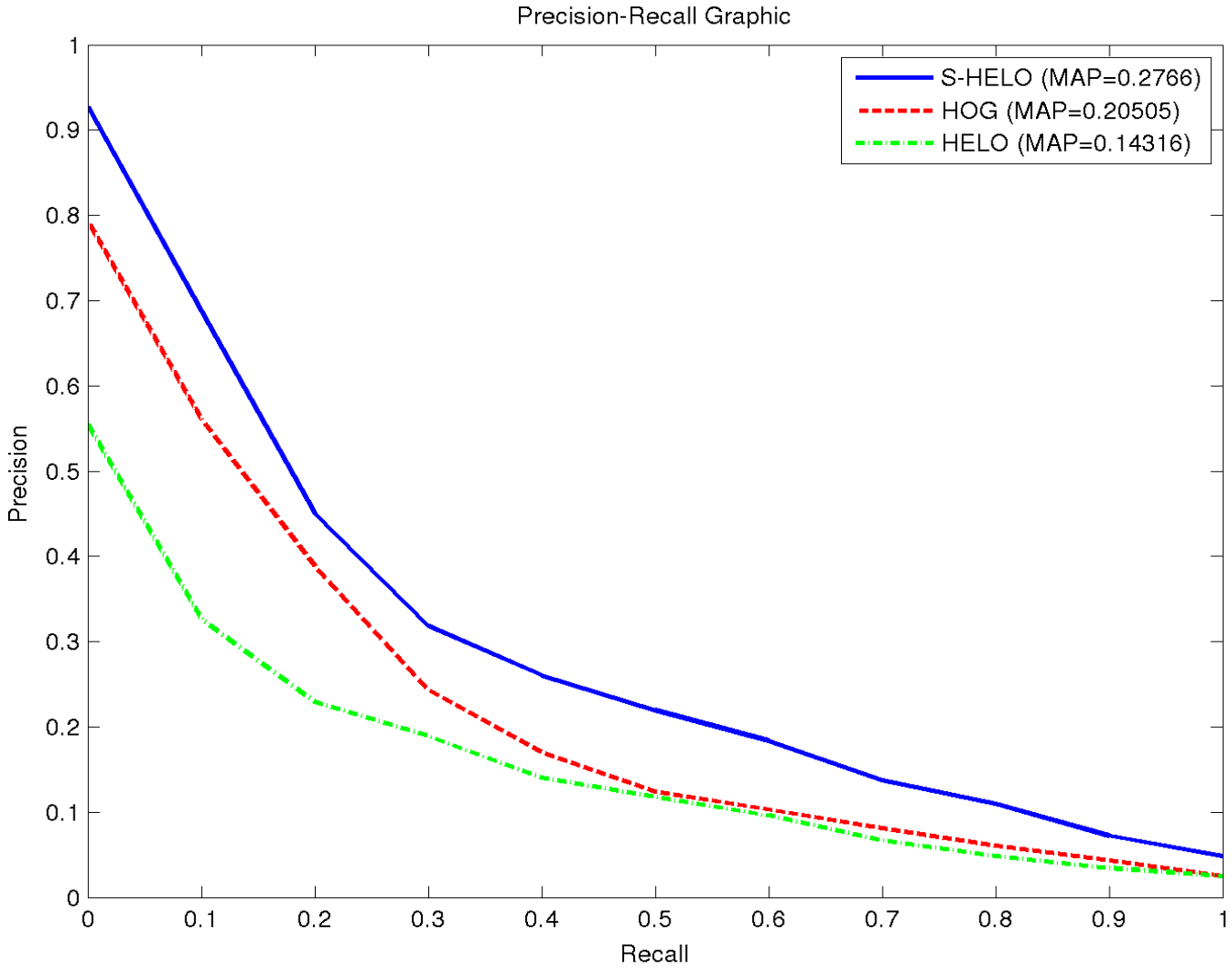


SHELO

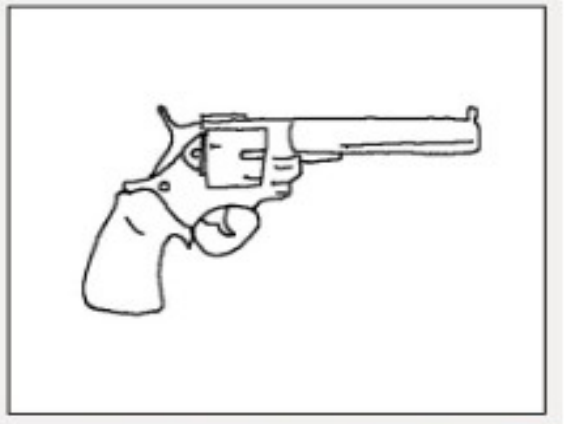
- Results
  - Similarity-based Retrieval



SHELO


Precision-Recall Graphic
S-HELO (MAP=0.2766)
HOG (MAP=0.20505)
HELO (MAP=0.14316)
Precision
Recall
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

SHELO



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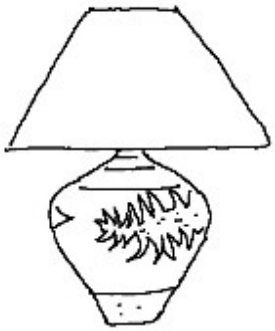

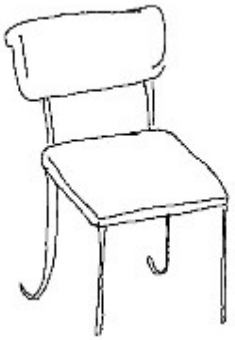

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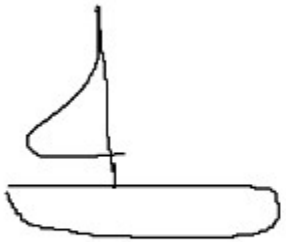
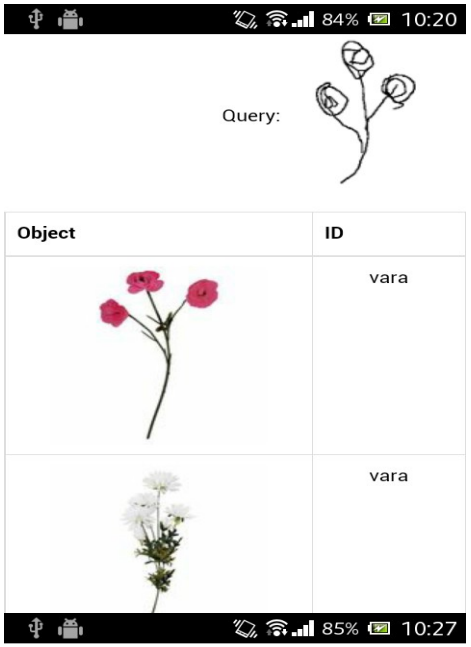
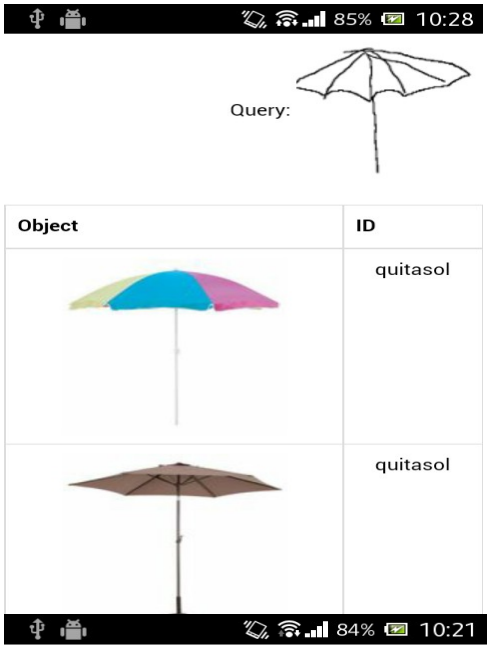
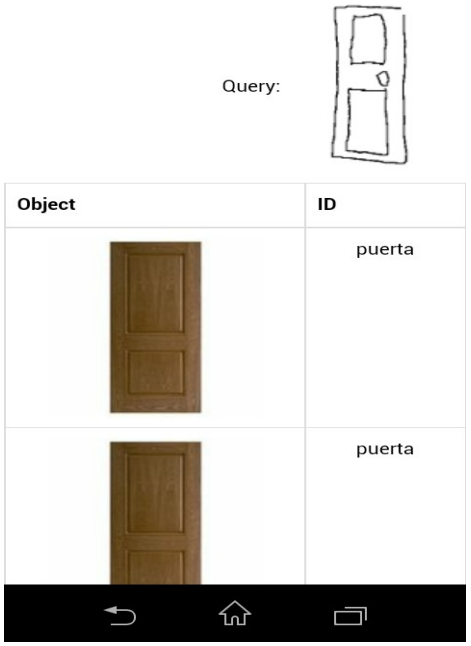
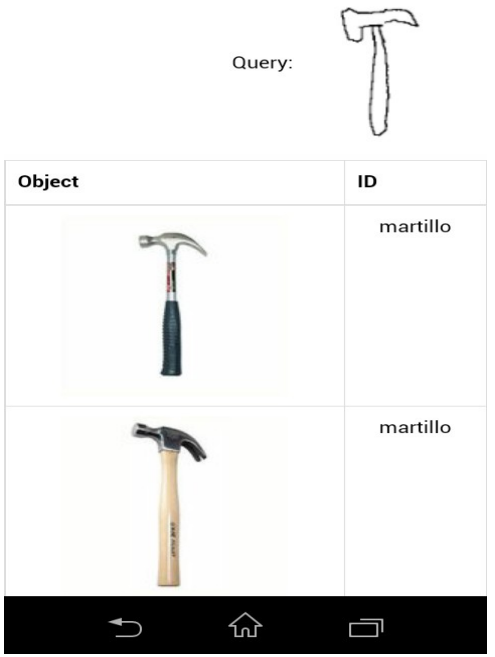


Industrial Applications









CURRENT WORK on SBIR

- Keyshapes Representation
  - Thesis Work (SBIR using Keyshapes)

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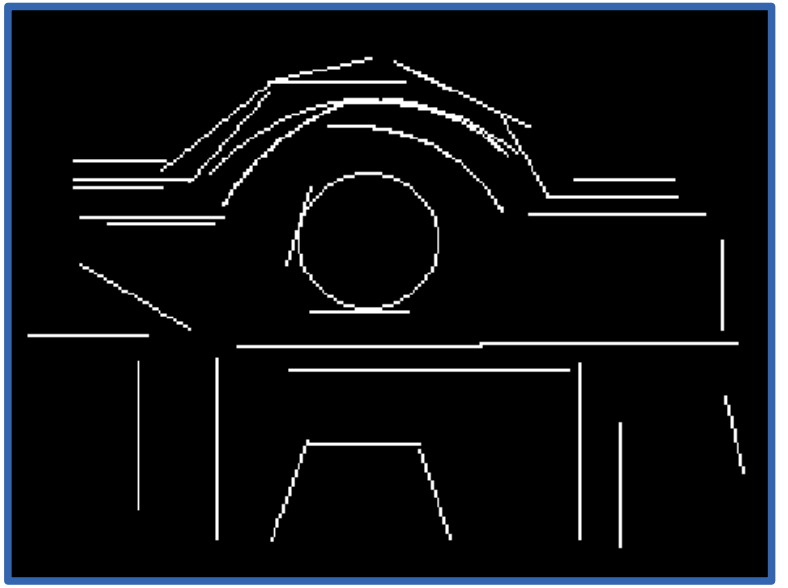

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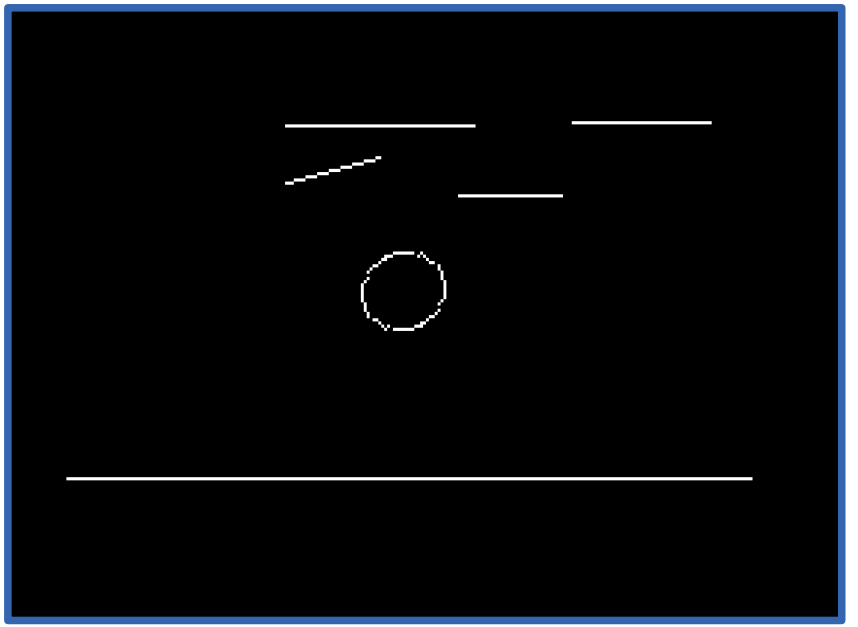
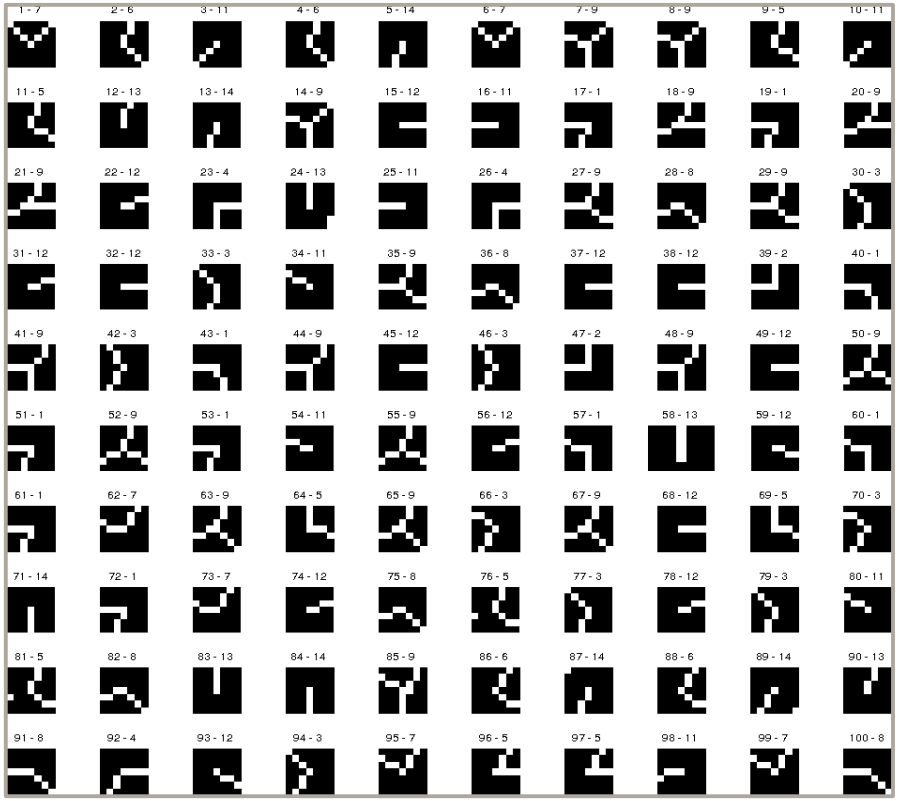


CURRENT WORK on SBIR

- Keyshapes Representation
  - Discovering sketch keyshapes



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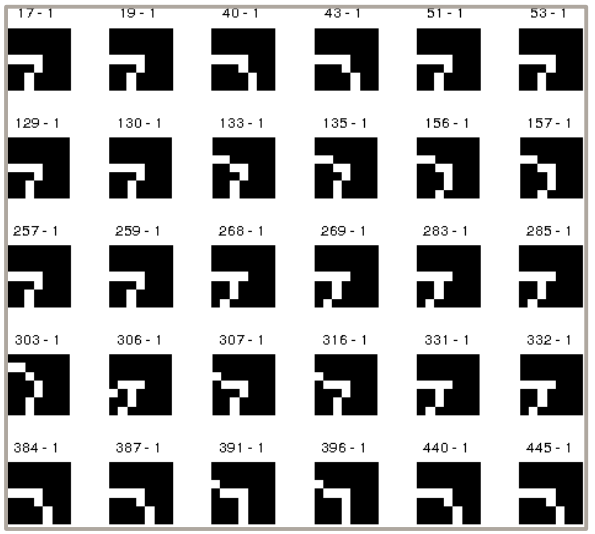
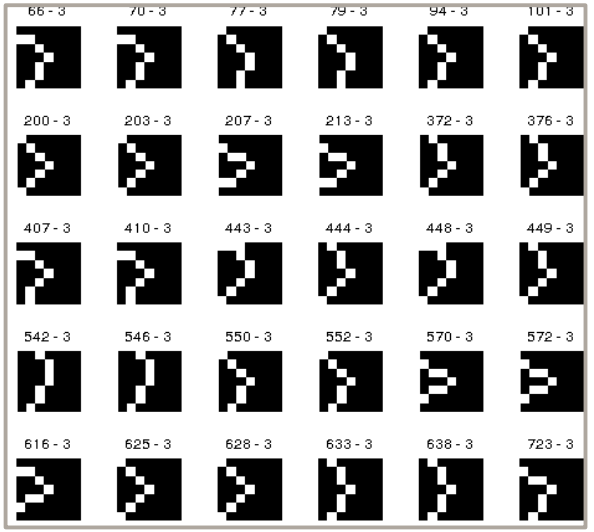
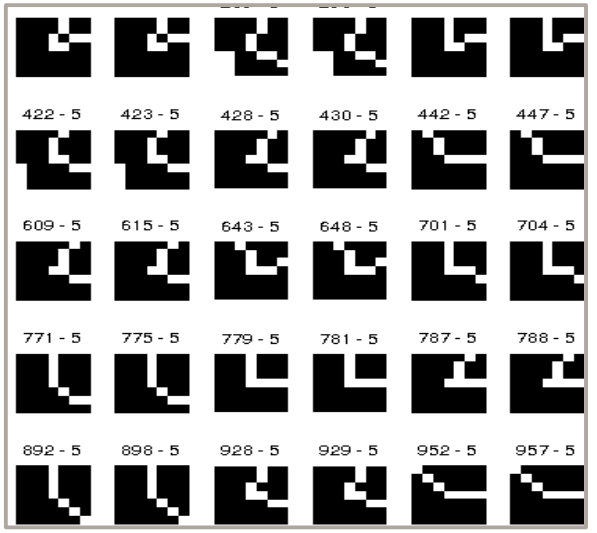
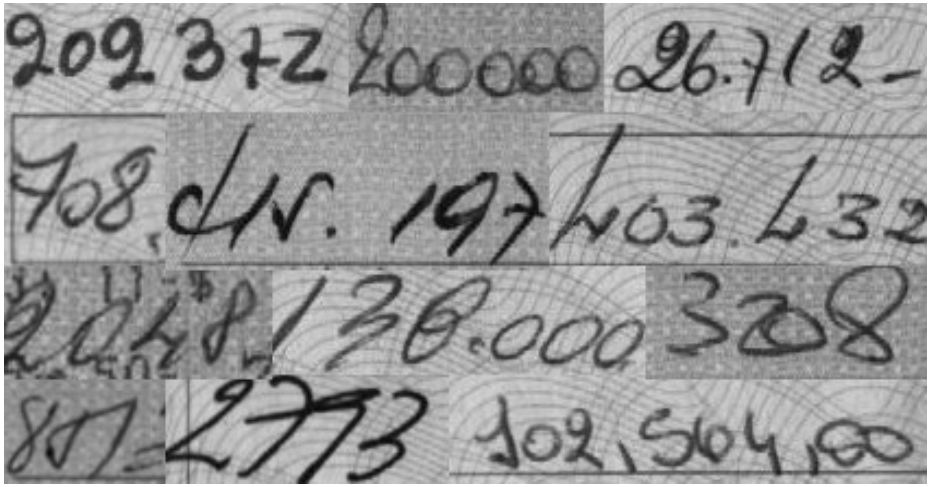
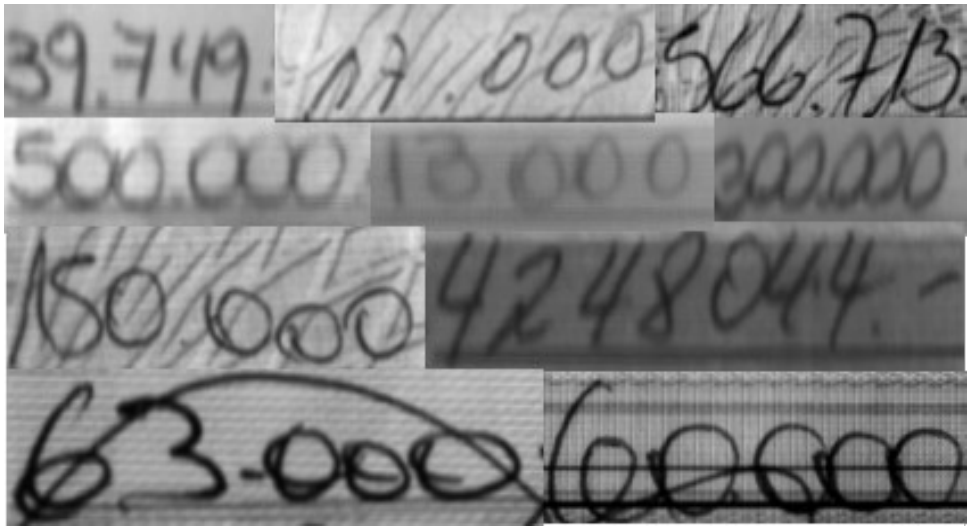






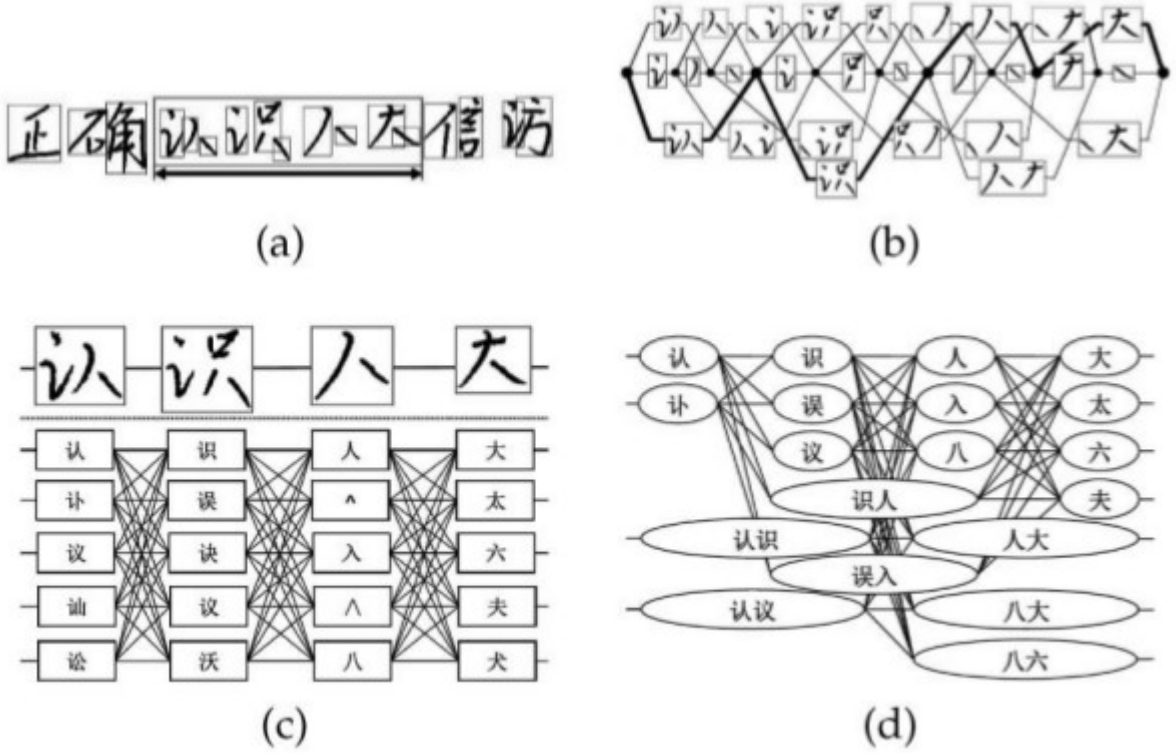
Handwriting Recognition





Handwriting Recognition

- Probabilistic Graphical Model



Qiu-Feng Wang; Fei Yin; Cheng-Lin Liu, "Handwritten Chinese Text Recognition by Integrating Multiple Contexts," Pattern Analysis and Machine Intelligence, IEEE Transactions on , vol.34, no.8, pp.1469,1481, Aug. 2012

Handwriting Recognition

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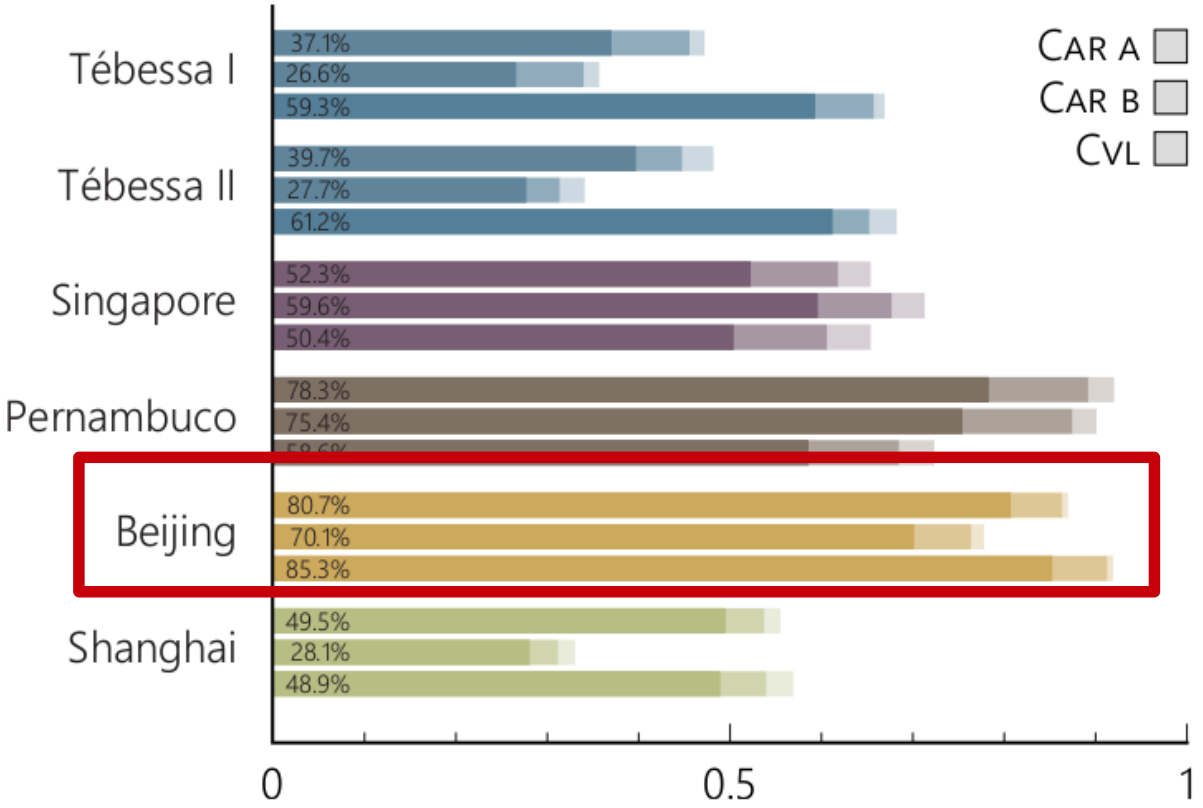

Content based Image Retrieval

Object Detection in Large DB

Object Detection in Large DB