Multi-Modal Image Retrieval for Complex Queries using Small Codes

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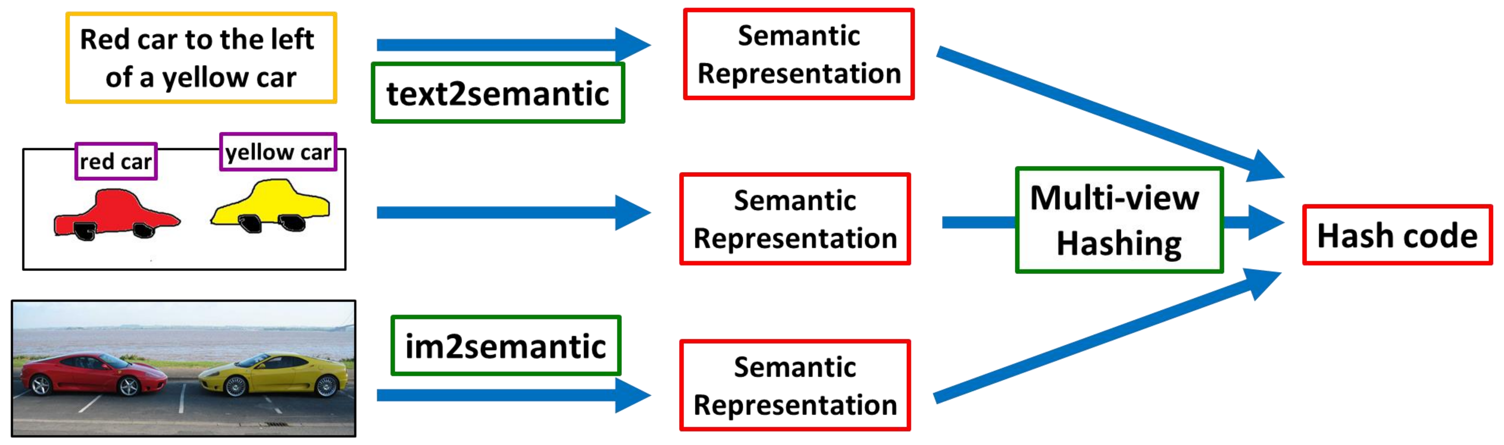
Problem and Motivation

Image Retrieval

- **Complex Queries:** Comprise of Objects, Attributes and Relationships.
- **Multi-Modal Queries:** Query can be an image, text or a sketch.
- **Scalability:** Approach should scale up to millions of images..



Approach

Semantic Representation

- Object/Attribute binary masks, with sketches as the primary form of representation.
- Encodes objects, attributes and relationships.
- Captures *Semantic Similarity* as opposed to *Visual Similarity*.

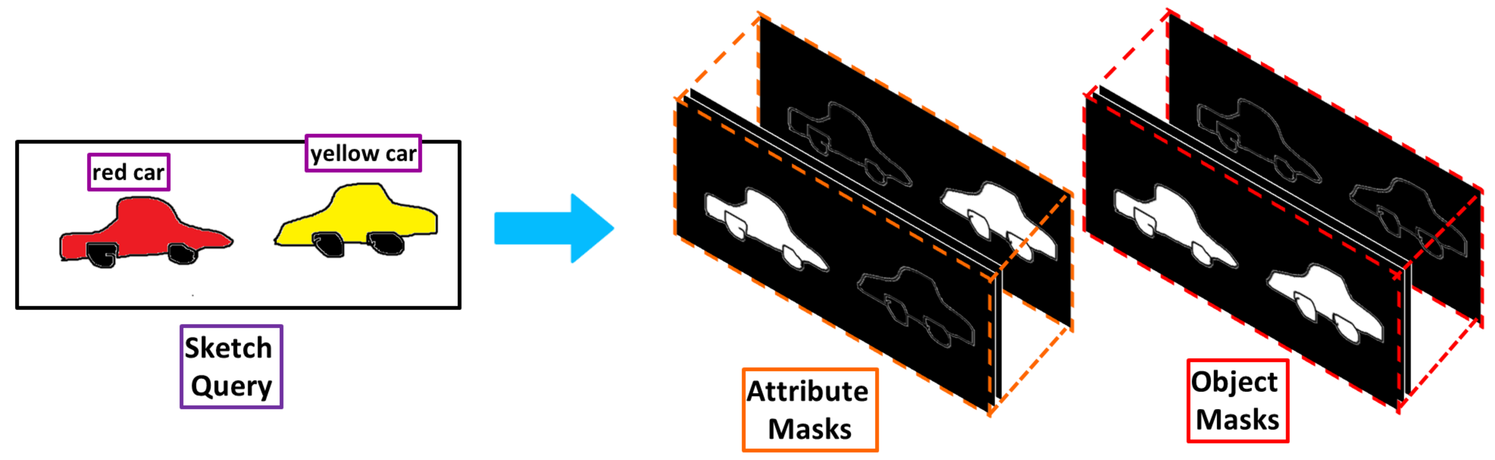
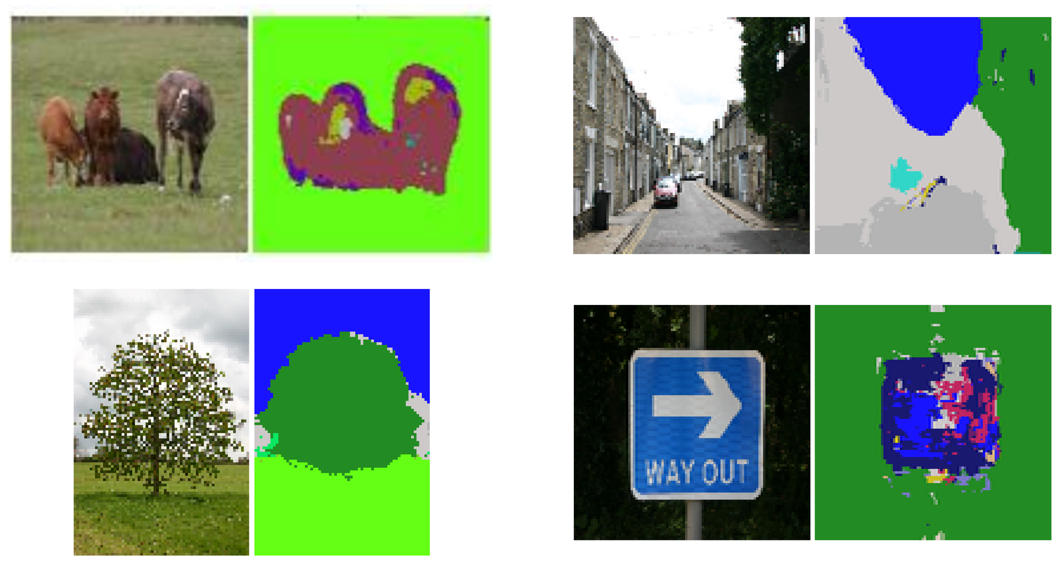


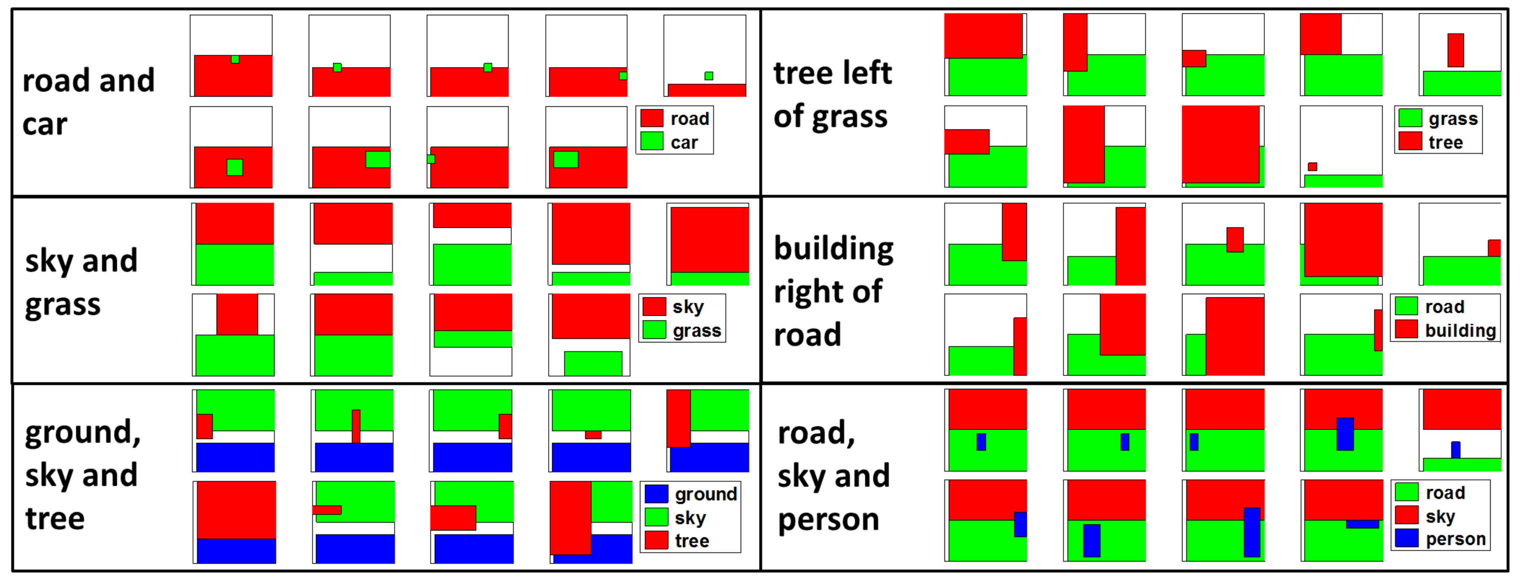
Image2semantic

- Semantic Texton Forests (Shotton et al.)
- Two stage random forest classifier: Utilizes local color/texture, spatial context and Image Level Priors.



Text2semantic

- Represent object configurations as an MRF.
- Sketches approximated by bounding boxes.
- Sample MRF to generate most likely sketches.



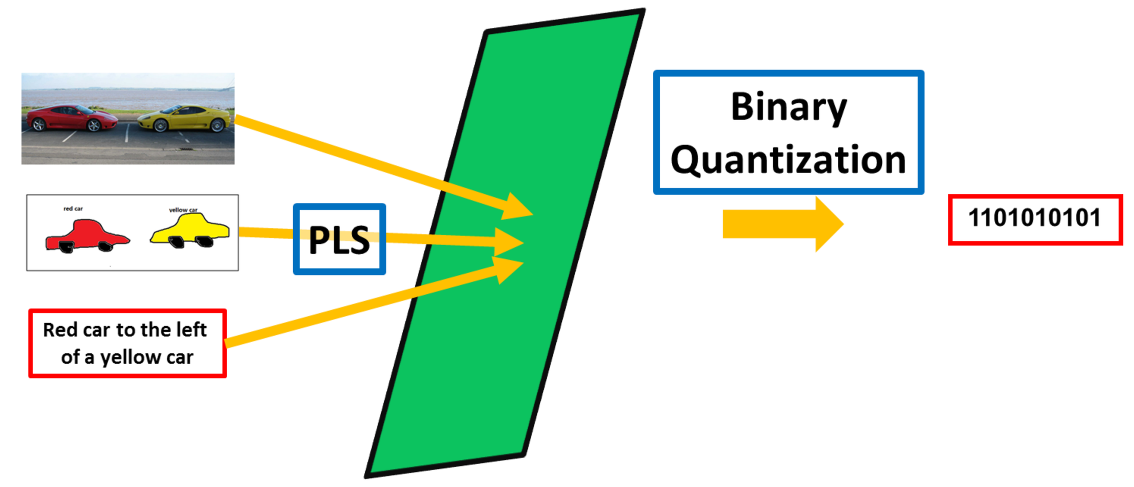
Multi-View Hashing

- Semantic Representations from each modality differ.
- Project different modalities (views) of the data to common low-dimensional subspace.
- Partial Least Squares (PLS) learns projection from each modality to the common subspace.
- Given two views X, Y; PLS decomposes them as:

$$X = TP^T + E; \quad Y = UQ^T + F; \quad U = TD + H$$

- Iteratively maximizes:

$$[\mathrm{cov}(t_i, u_i)]^2 = \max_{|w_{xi}|=1, |w_{yi}|=1} [\mathrm{cov}(Xw_{xi}, Yw_{yi})]^2$$

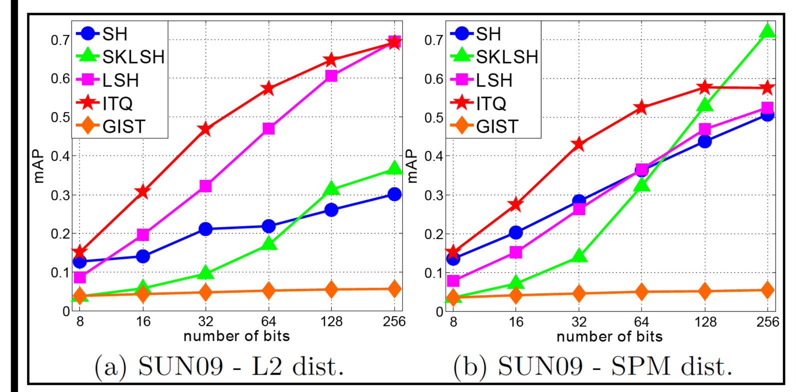


- Map vectors in the subspace to binary codes to reduce memory burden and enable fast matching (Hamming dist.).
- Randomly rotate projection matrix to uniformly distribute information across all dimensions. $\tilde{W}_x = W_x R$
- Iterative Quantization (ITQ) to compute optimal rotation matrix that minimizes the quantization error (Gong et al.):

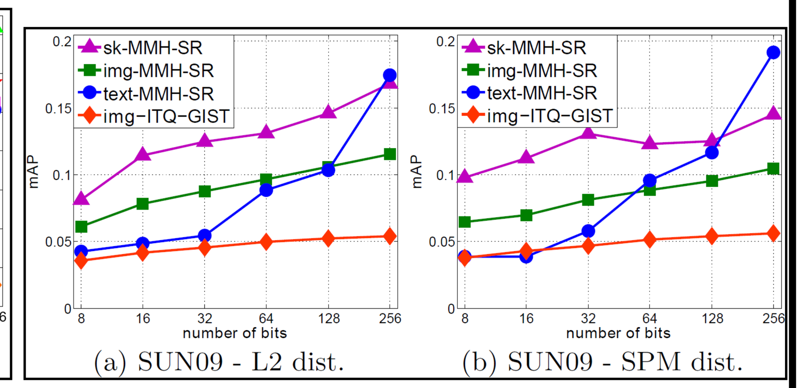
$$Q(H, R) = ||H - XW_xR||_F^2$$

Results

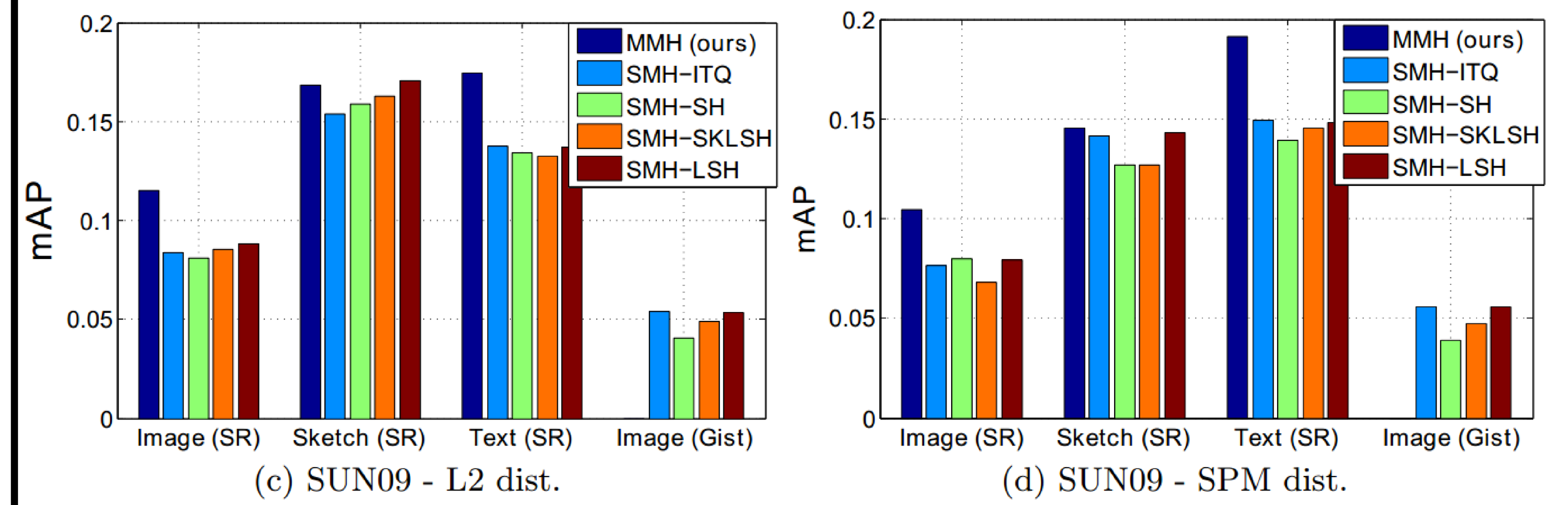
Quantitative Results



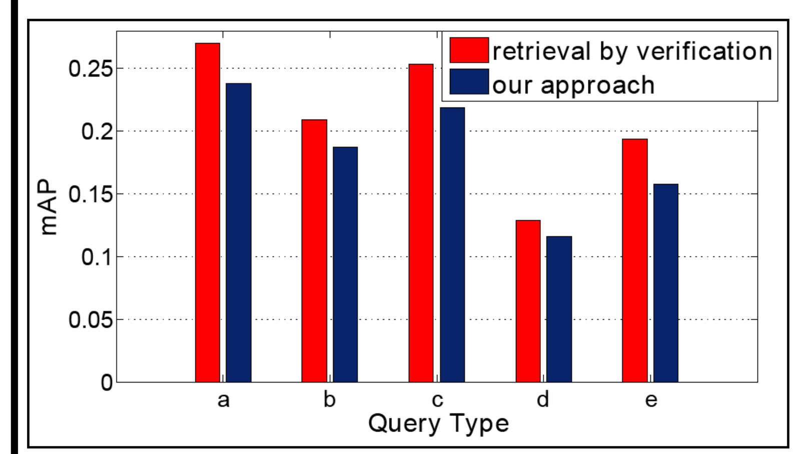
Single-Modality Hashing



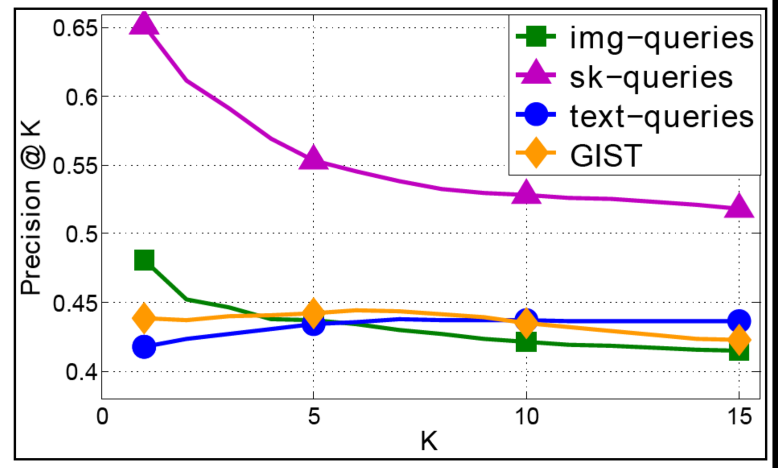
Multi-Modal Hashing



Multi-Modal Hashing vs Single-Modal Hashing



Text based Retrieval



Large Scale Retrieval: Flickr (1M images)

Qualitative Results

Text Queries

Sketch Queries

Image Queries