Searching for Sub-images Using Sequence Alignment

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Presentation Outline

- Motivation
- Current approaches to the sub-image retrieval
- Sequence alignment methods
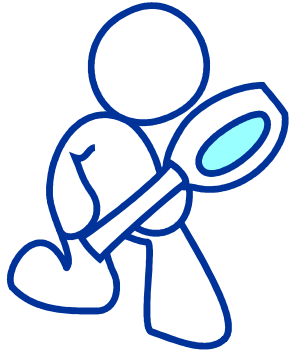- Conclusion

Motivation
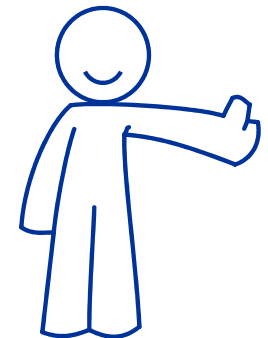

Image (query) & Search engine (technology) & Database of images =

Found images (response)
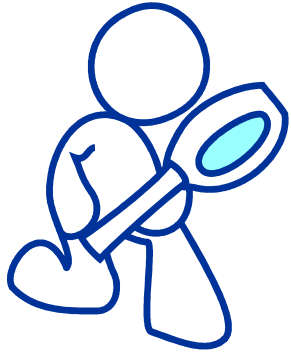
& Happy user

Motivation

Image
(query)

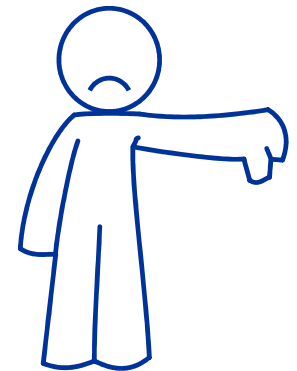& Search engine
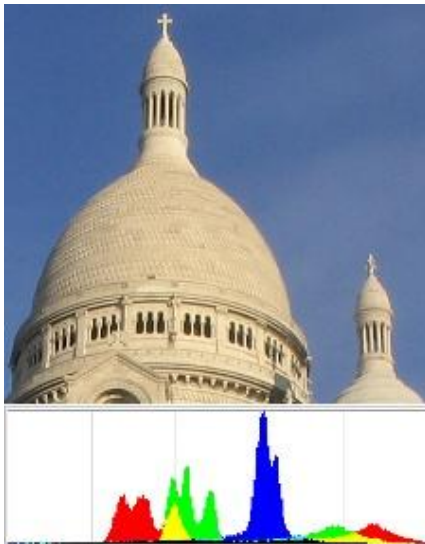(technology)

& Database of images =

Found images
(response)

& Disappointed
user

- Image characterization

Global descriptors

Local descriptors

Sub-Image Retrieval − L.F. Approaches

Query Image   Database Image(s)
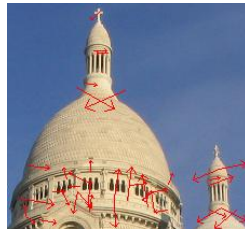
Sub-Image Retrieval — L.F. Approaches

Extract
local
features

Suppose our features are scale- and rotation-invariant
SIFT and its derivates, MSER, …

Query Image

Database Image(s)

Sub-Image Retrieval — L.F. Approaches

Extract local features → Transform local features
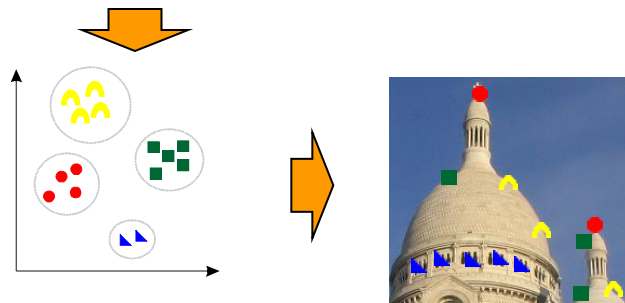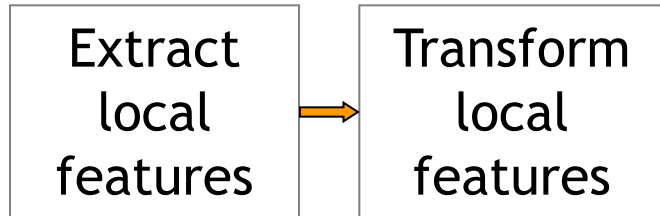
– local features => visual words
– image => bag-of-words

Query Image   Database Image(s)

Sub-Image Retrieval — L.F. Approaches

Extract local features	→	Transform local features	→	Find correspon-dences

Usually inspired by the text retrieval (tf-idf,...)

Query Image   Database Image(s)

Sub-Image Retrieval — L.F. Approaches

Extract local features	→	Transform local features	→	Find correspon-dences	→	Geometrical verification
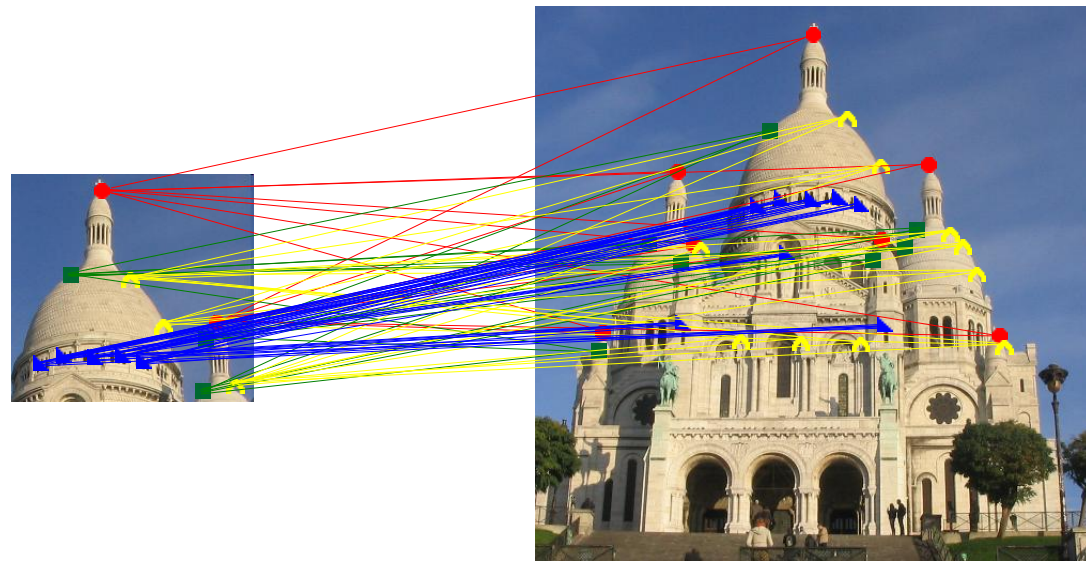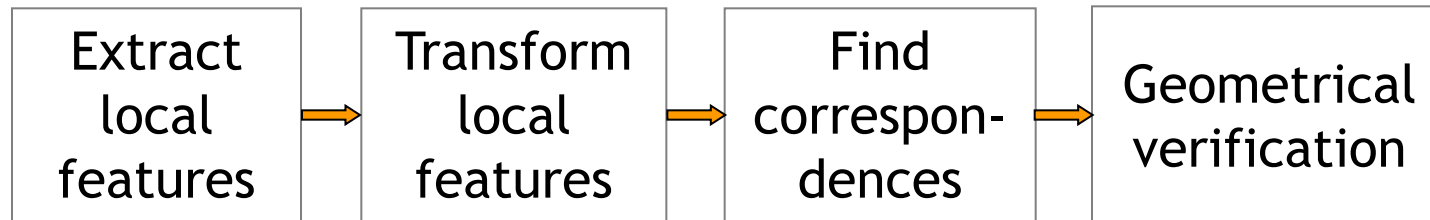
RANSAC,
Least Medians of
Squares,
Generalized Hough
Transformation,
…

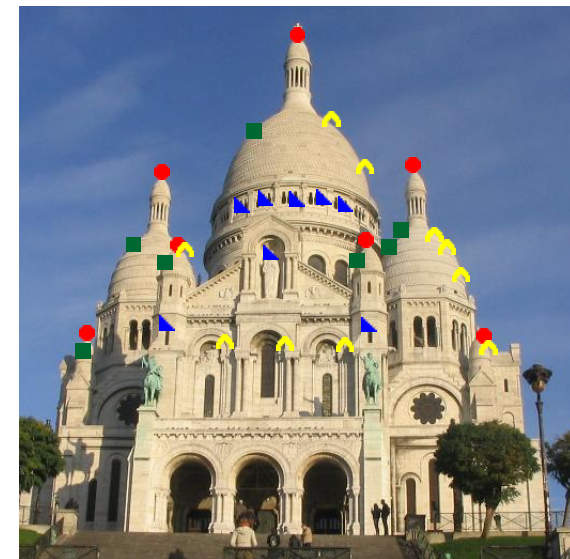Query Image   Database Image(s)

Sub-Image Retrieval — L.F. Approaches

Extract local features	→	Transform local features	→	Find correspon-dences	→	Geometrical verification	→	Rank the answer

Query image   Ranked answer

Sub-Image Retrieval — Our Approach

| Extract local features | Transform local features | Find correspon-dences | Geometrical verification | Rank the answer |
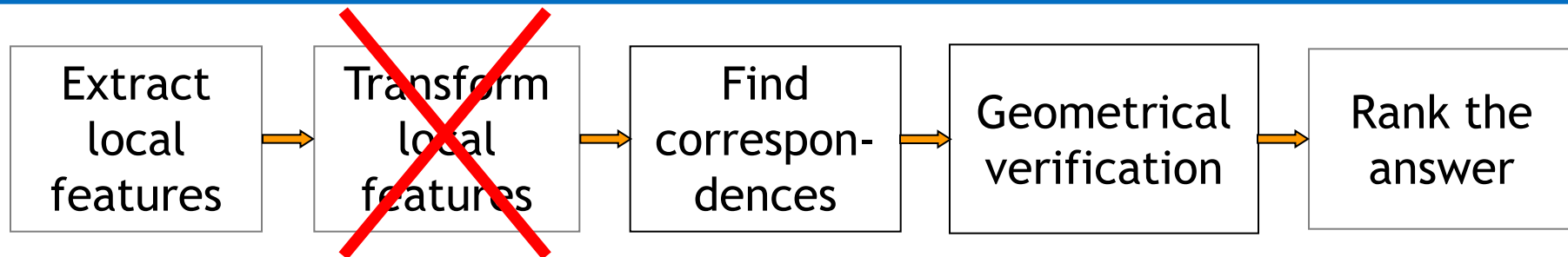
- ## Bag-of-words methods:
  - Rely on training data
  - Lost of information
- ## Local features (High-dimensional vectors) themselves create an alphabet in our approach

Sub-Image Retrieval — Our Approach

| Extract local features | → | ~~Transform local features~~ | → | Find correspon-dences | Geometrical verification | → | Rank the answer |
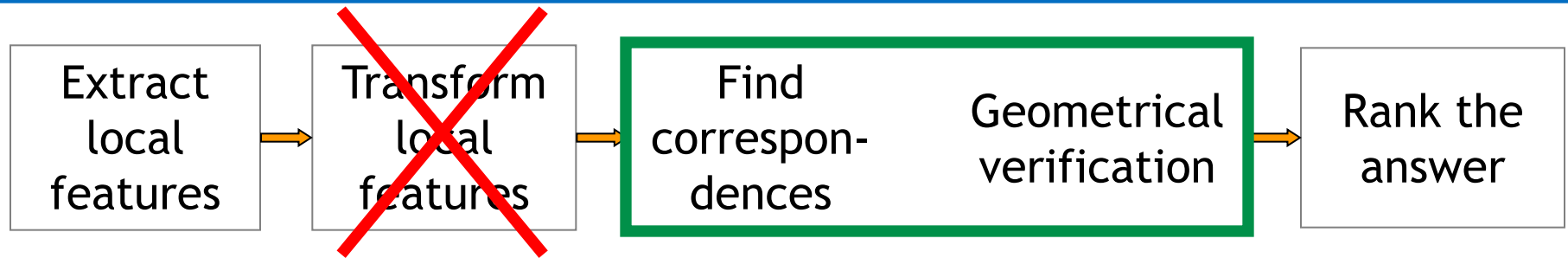
- Sequence alignment methods used for the geometrical verification

Sequence alignment
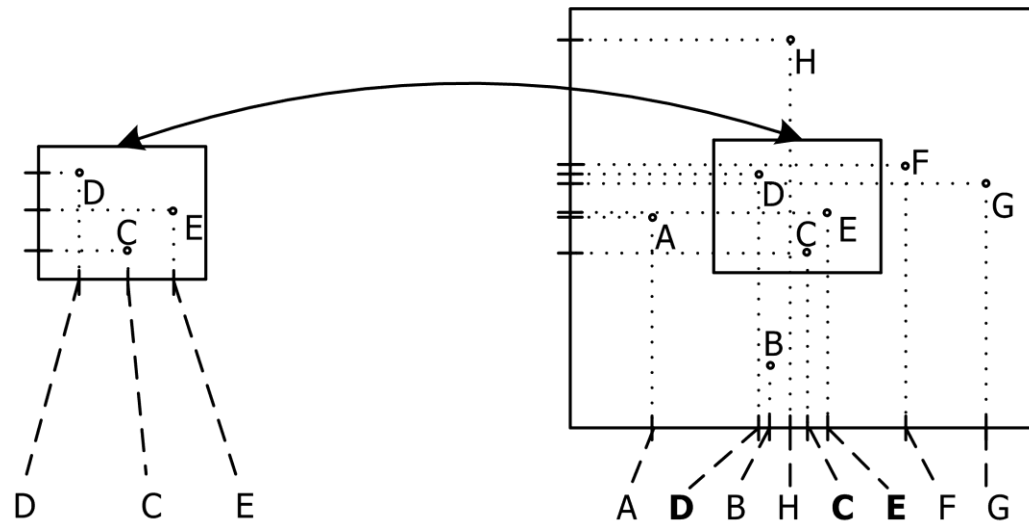
- Local features are projected into x/y axis => ordered sequence
- Sequences are compared using sequence-alignment methods

Sequence alignment methods

- Commonly used in bioinformatics (i.e. protein sequences alignment)
- User defined scoring scheme (match, mismatch and gap scores/penalties)
- Scoring matrix

Sequence-alignment methods – cont.

- ## Needleman-Wunsch (Global alignment)

```
-D--CE--           -        Gap
×|××||××           ×        Mismatch
ADBHCEFG           |        Match
```

- ## Smith-Watermann (Local alignment – deals better with starting/ending gaps -> sequences of the non-equal length)

```
-D--CE--           =        Gap opening
=|=-||=-           -        Gap cont.
ADBHCEFG           ×        Mismatch
                   |        Match
```

Sliding windows
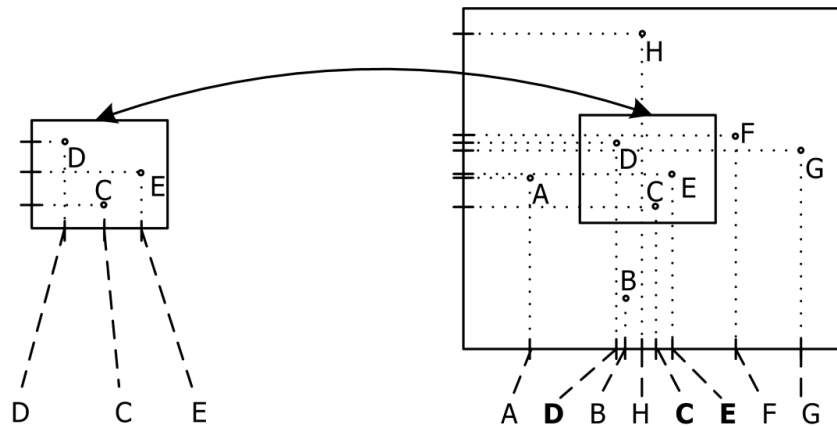
- Small query & large database image (and vice versa) leads to "noise" in projected sequences (letters B and H)
- => Split images (queries and database) into the fixed-size windows
- Run sequence alignment for each of the window separately

Evaluation

- BelgaLogos dataset
- Queries: 26 logos, database: 10 000 images
- Original method Joly&al – Visual words + RANSAC
  Mean Average Precision: 25.67
- Our method: 30.95

(Smith-Waterman,
Window size
128×128 px)

Method cons and pros

- ✚ Scale-change, shear invariant
- ✚ Flipping, rotation of 90° invariant (with projections re-ordering)
- ⊖ Not fully rotation and camera viewpoint change (tilt) invariant
- ✚ Method handles with multiple occurrences of the queried sub-image in one DB image
- ✚ Sequence of letters ≈ time series => **indexable** (contrary to RANSAC,...)

Future work

- Performance
  - Indexing
  - Features quantization
- Quality
  - Rotation invariance
  - Lower precision (too many false positives)
  - Large windows (more than one window)

Conclusion

- Sub-Image Retrieval
  - Features forms an alphabet
  - Geometric consistency validation using sequence alignment methods
  - (Sliding) windows to avoid the noise