CENTER FOR MACHINE PERCEPTION

An Introduction to Local Features for

Wide-Baseline Matching, Object Recognition and Image Retrieval Methods, Stitching and more …

Jiří Matas, Ondra Chum and James Pritts

Center for Machine Perception, Czech Technical University Prague

Includes slides by:

- Darya Frolova, Denis Simakov,The Weizmann Institute of Science
- Martin Urban , Stepan Obdrzalek, Ondra Chum Center for Machine Perception Prague
- Matthew Brown,David Lowe, University of British Columbia

Lecture 1 outline

- Local features: introduction, terminology
- Motivation: generalisation of local stereo to wide-baseline stereo
- Examples: retrieval, panorama, recognition

Local Features

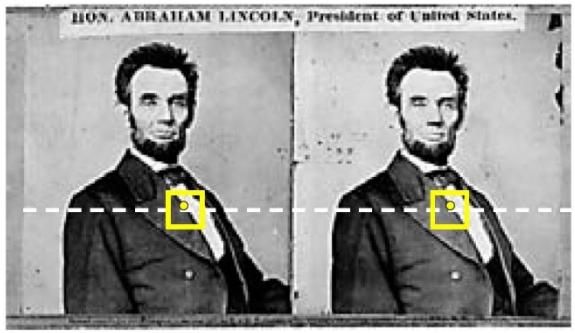
- Methods based on "Local Features" are the state-of-the-art for number of computer vision problems (often those, that require local correspondences).

- E.g.: Wide-baseline stereo, object recognition and image retrieval.

- Terminology is a mess:
  Local Feature = Interest "Point" = The "Patch" =
  = Feature "Point"
  = Distinguished Region
  = (Transformation) Covariant Region

Motivation: Generalization of Local Stereo to WBS

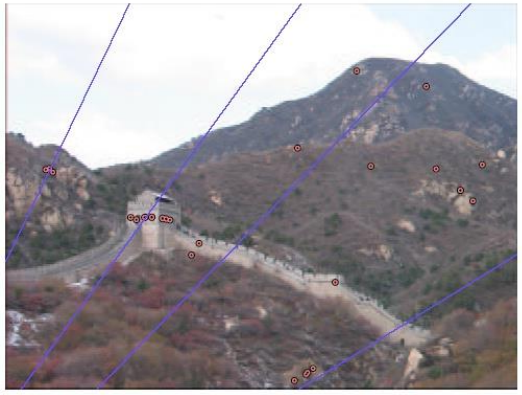
1. Local Feature (Region) = a rectangular “window”
   - robust to occlusion, translation invariant
   - windows matched by correlation, assuming small displacement
   - successful in stereo matching
2. Local Feature (Region) = a circle around an “interest point”
   - robust to occlusion, translation and rotation invariant
   - matching based on correlation or rotation invariants *(note that the set of circles of a fixed radius is closed under translation and rotation).*
   - successful in tracking and stereo matching



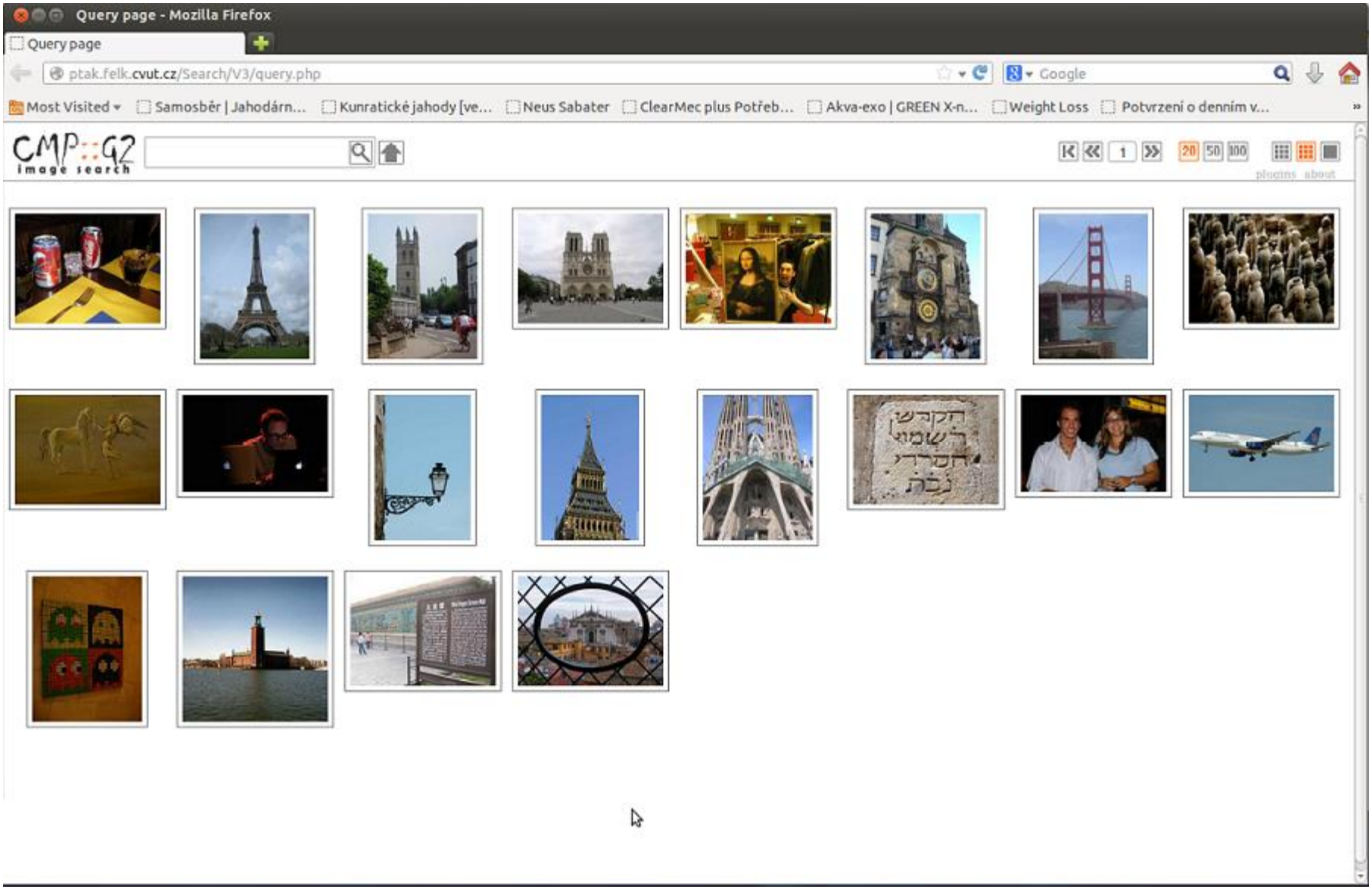
Hard Impossible for a Local feature based method?

Motivation: Generalization of Local Stereo to WBS

3. Widening of baseline or zooming in/out
   - local deformation is well modelled by affine or similarity transformations
   - how can the “local feature” concept be generalised? *The set of ellipses is closed under affine tr., but it’s too big to be tested*
   - window scanning approach becomes computationally difficult.




Local Features in Action (1): Image Retrieval



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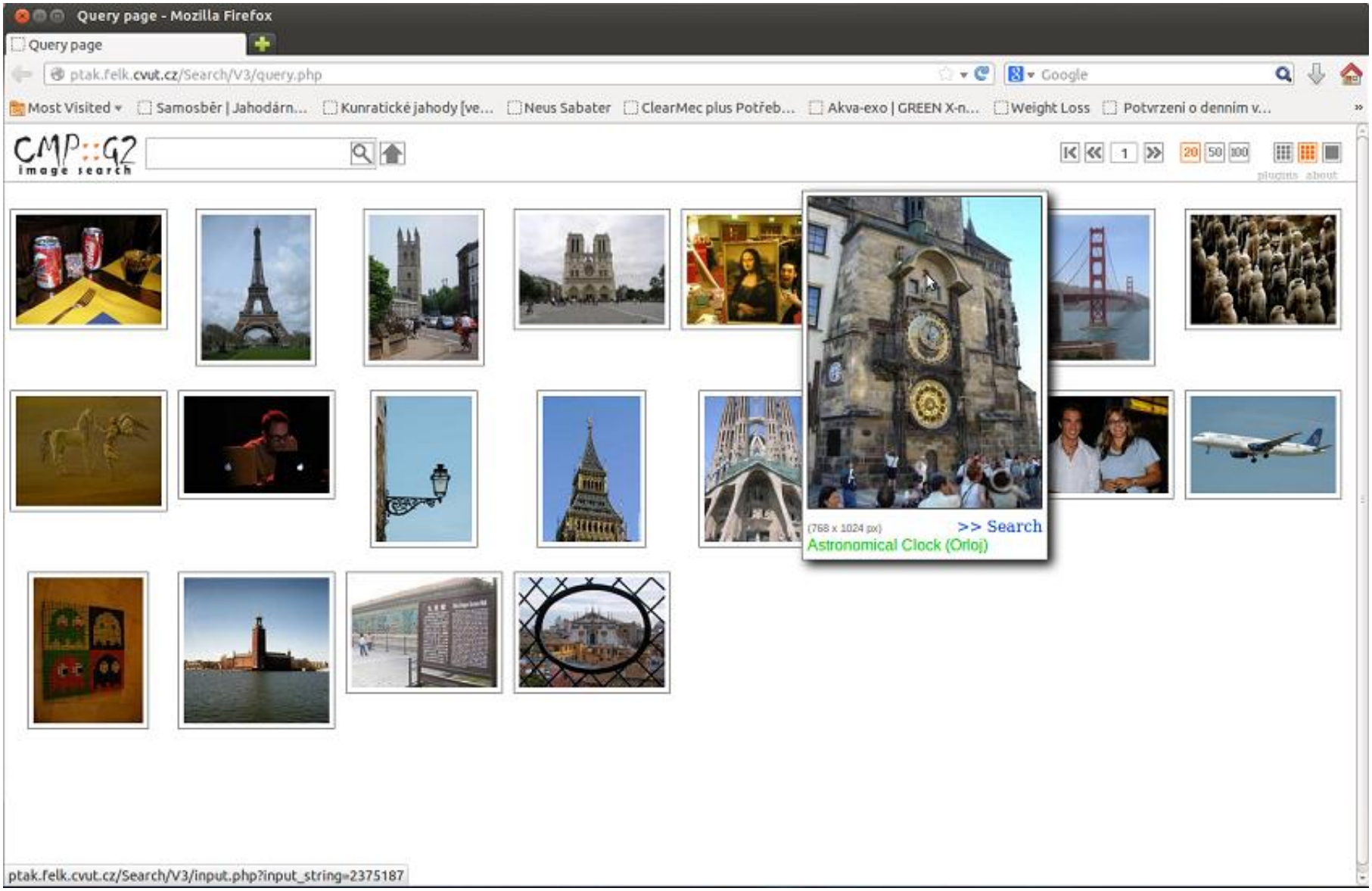

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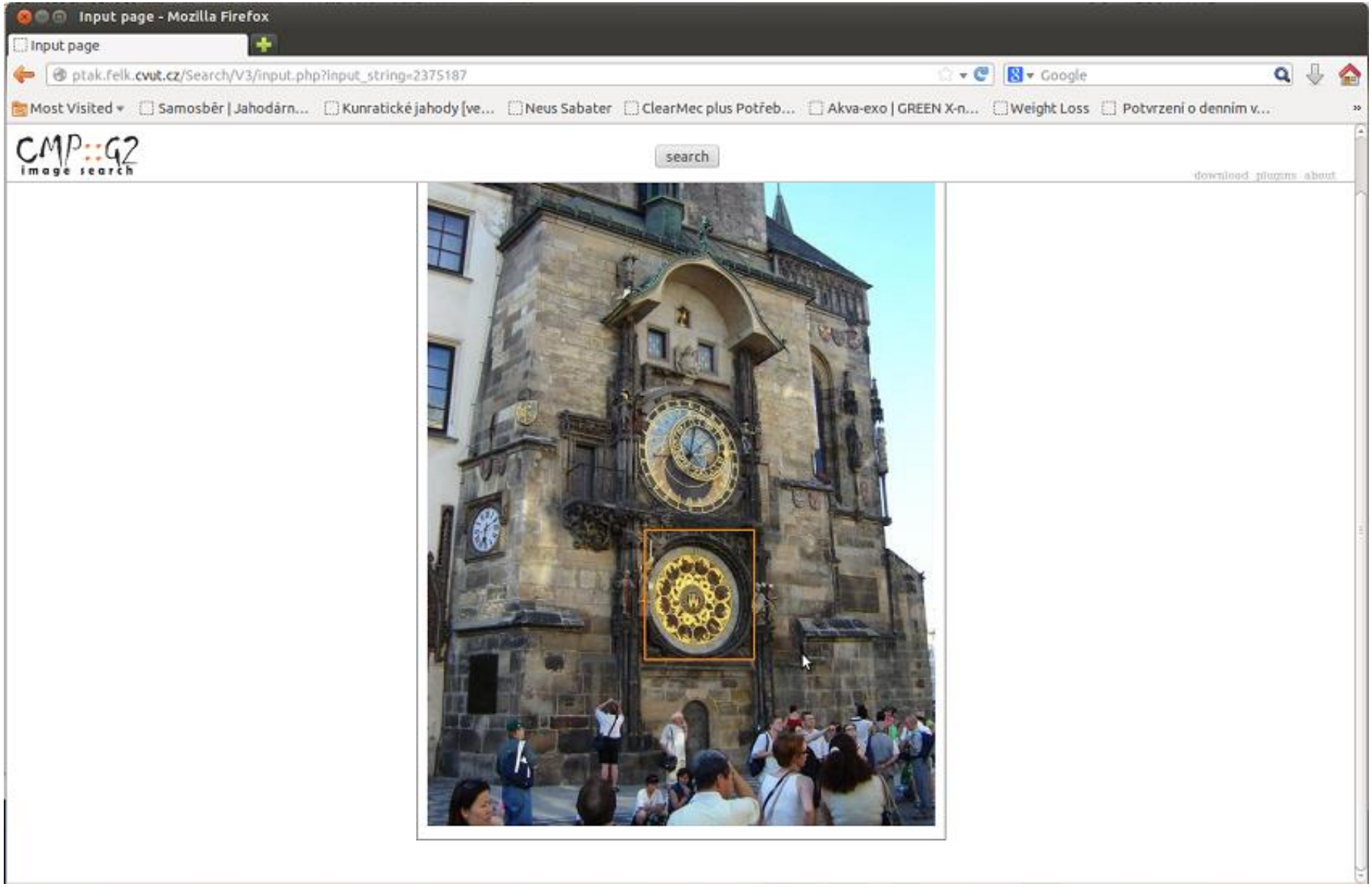

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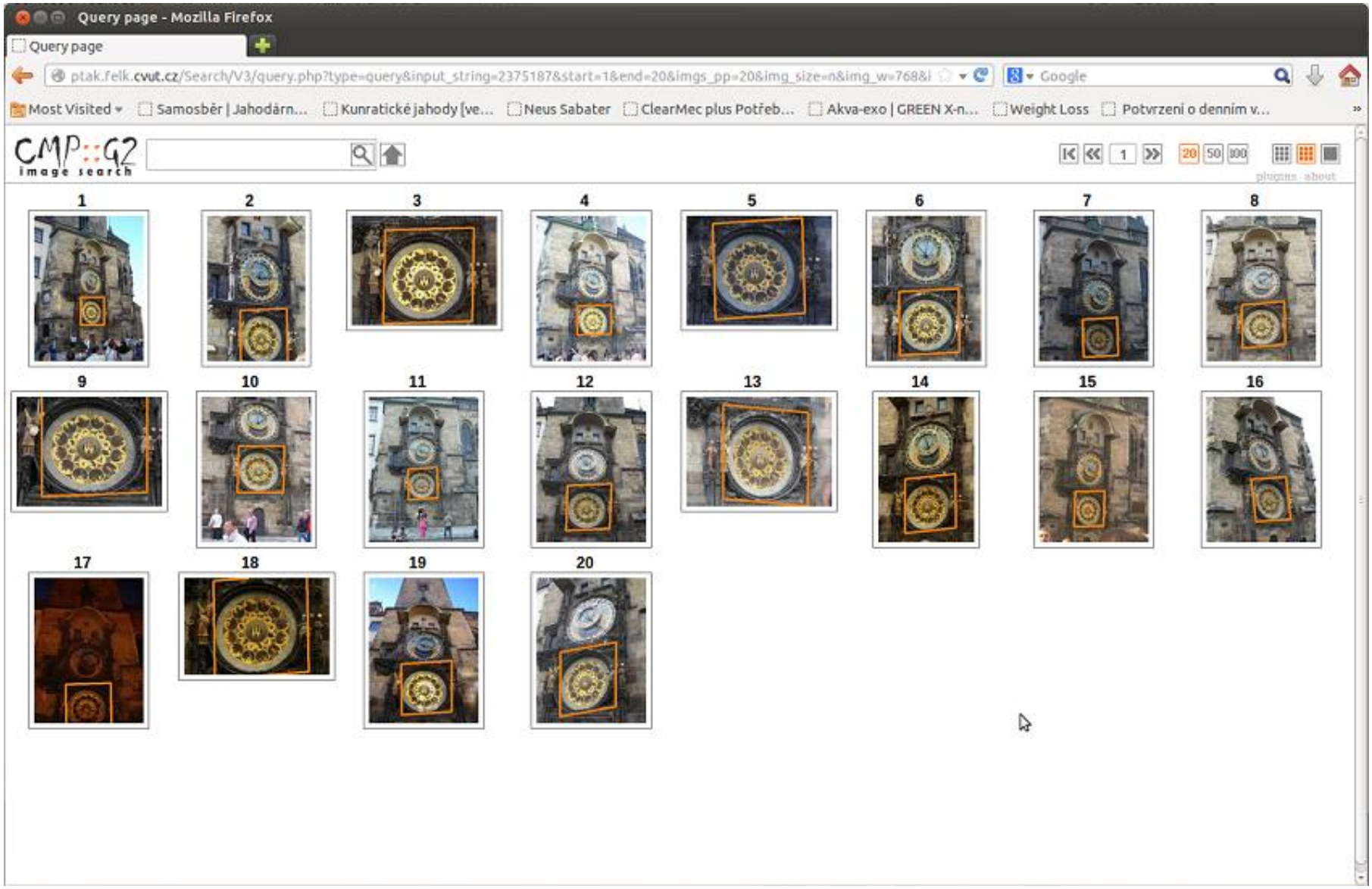

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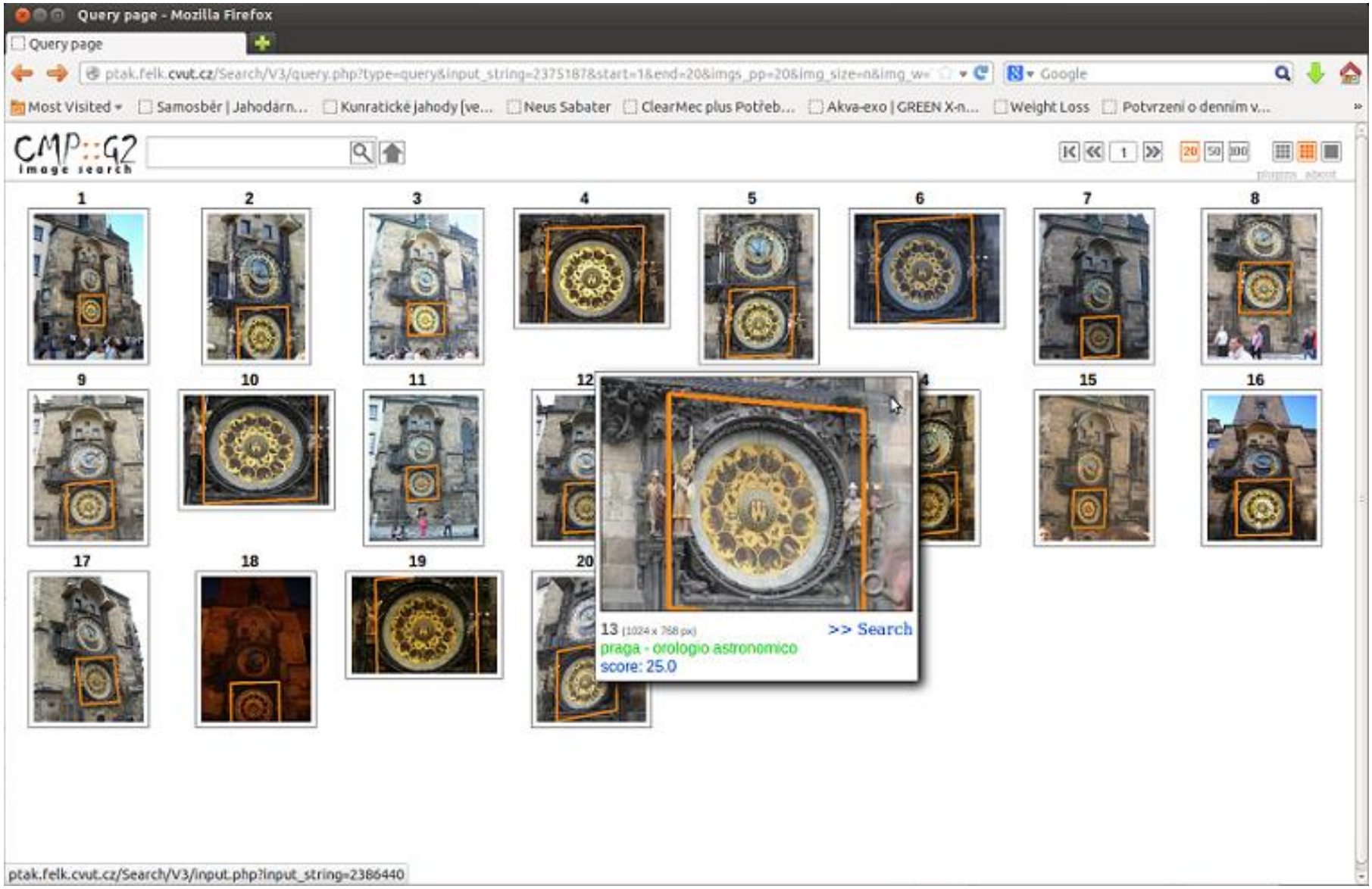

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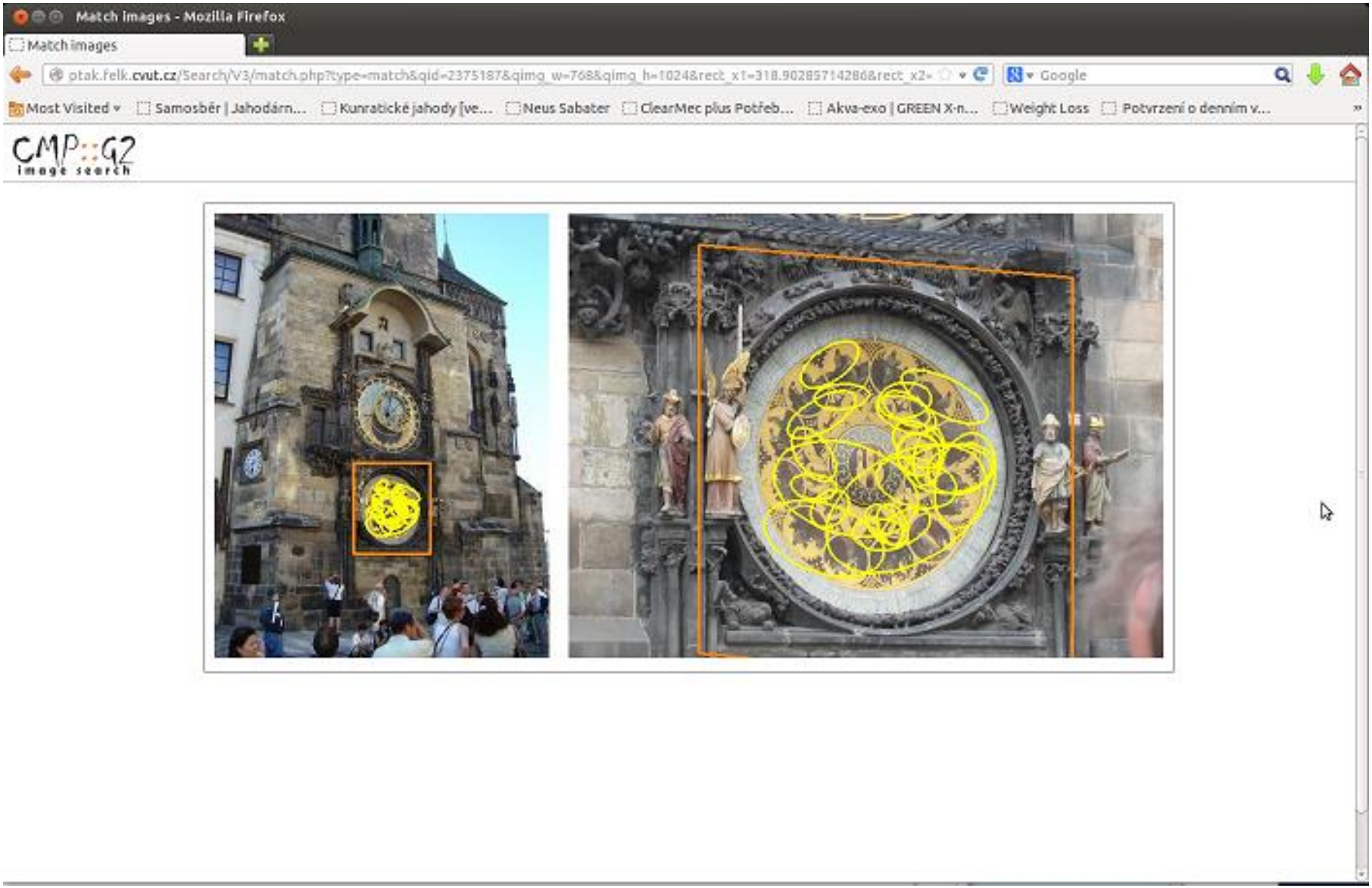


Local Features in Action (2): Building a Panorama

M. Brown and D. G. Lowe. Recognising Panoramas. ICCV 2003

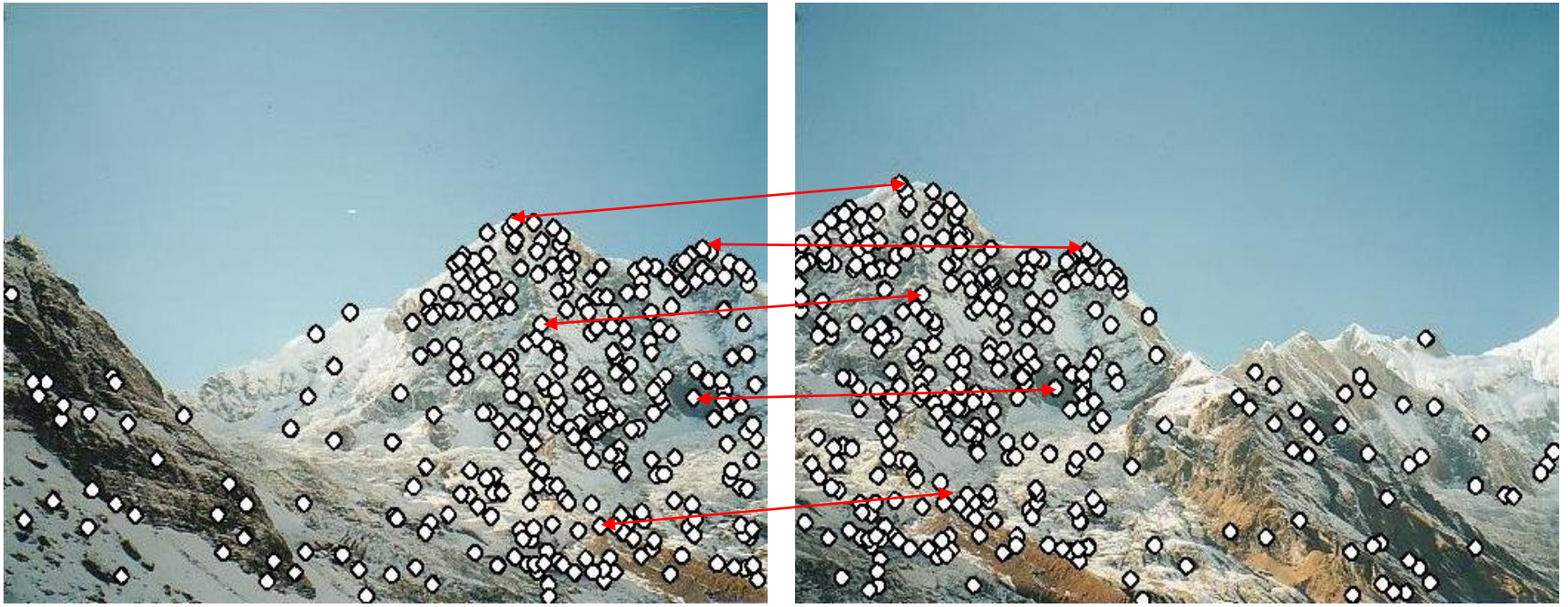
Local Features in Action (2): Building a Panorama

- We need to match (align) images = find (dense) correspondence
- (technically, this can be done only if both images taken from the same viewpoint)

Local Features in Action (2): Building a Panorama

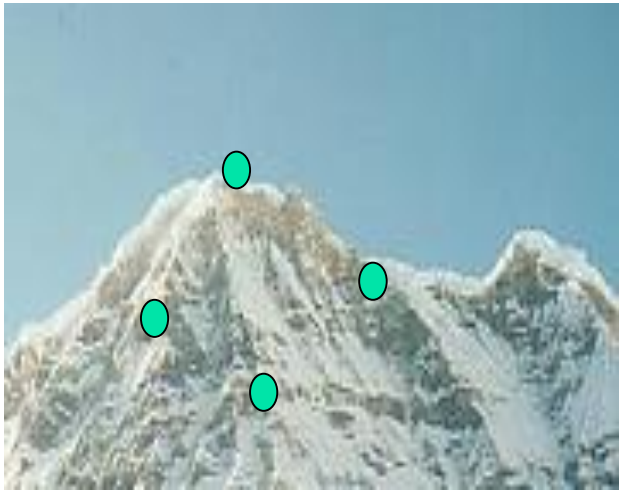
Possible approach:

1. Detect features in both images
2. Find corresponding pairs
3. Estimate transformations (Geometry and Photometry)
4. Put all images into one frame, blend.



Local Features in Action (2): Building a Panorama

- Problem 1:
  - Detect the *same* feature *independently* in both images*
  - Note that the set of “features” is rather sparse



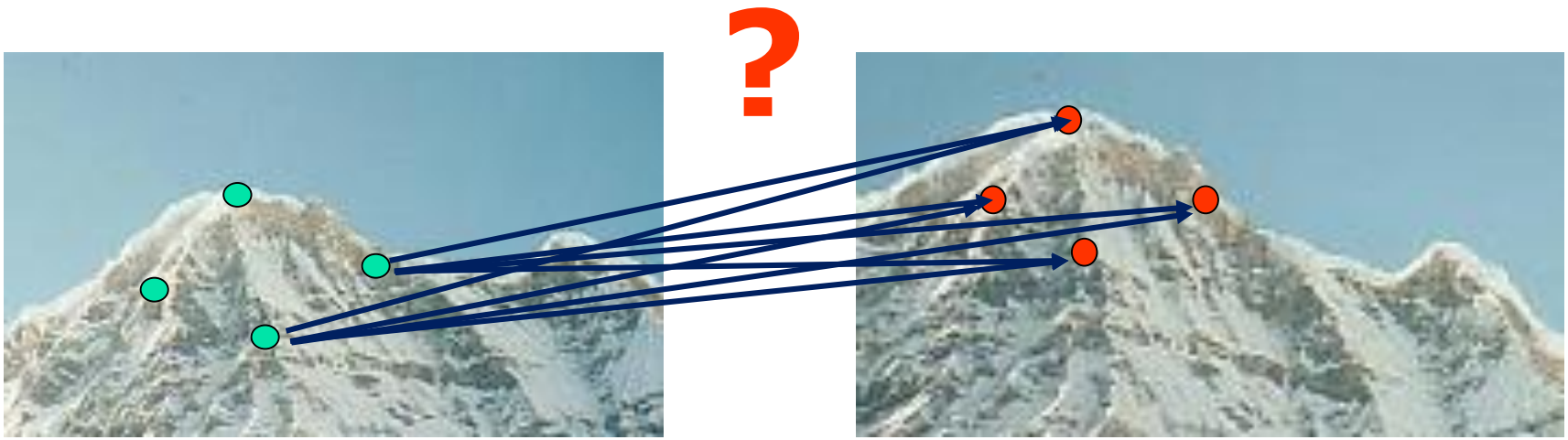
no chance to match!

A repeatable detector needed.

* Other methods exist that do not need independency

Local Features in Action (2): Building a Panorama

- Problem 2:
  - how to correctly recognize the corresponding features?



Solution:

1. Find a discriminative and stable descriptor
2. Solve the matching problem

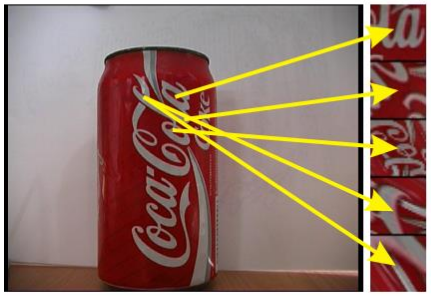
Local Features in Action (2): Building a Panorama

- Detect feature points in both images
- Find corresponding pairs
- Use these pairs to align images

Any alternatives?

Local Features in Action (4): "Recognition"

(as a Sequence of Wide-Baseline Matching Problems)

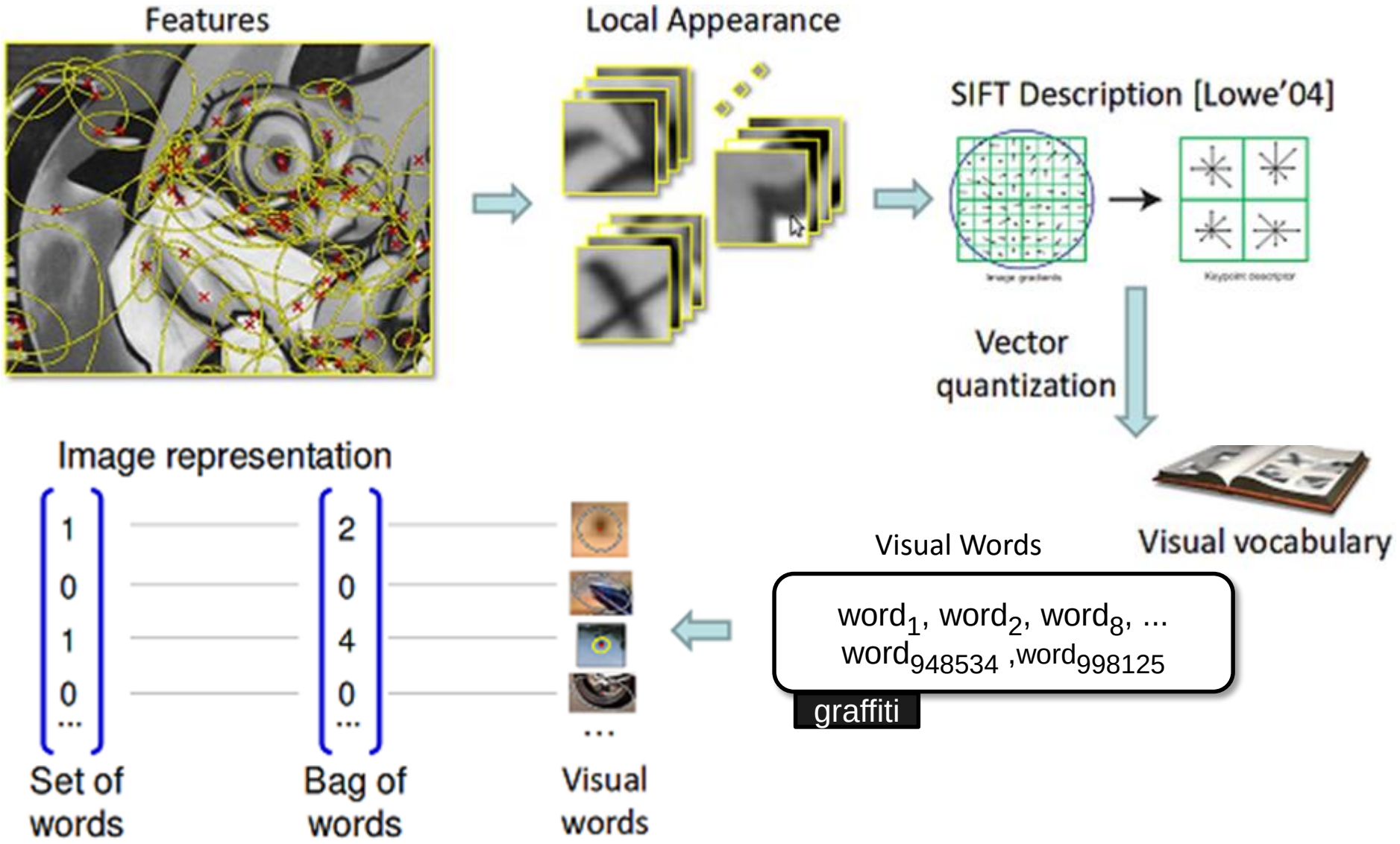


Properties: robust to occlusion, clutter, handles pose change, illumination but becomes unrealistic even for moderate number of objects.

(as a Sequence of Wide-Baseline Matching Problems)

Database processing | Matching | Query processing

Local Features in Action (3): Object Retrieval



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Thank you for your attention.