Pl@ntNet

Participation of INRIA & Pl@ntNet to ImageCLEF 2011 plant images classification

Equipe-projet IMEDIA

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The PlantLeaves dataset

Classification task on the crowsourced dataset PlantLeaves (70 common European Tree species)

Challenges are:

- Be able to manage 3 categories of pictures

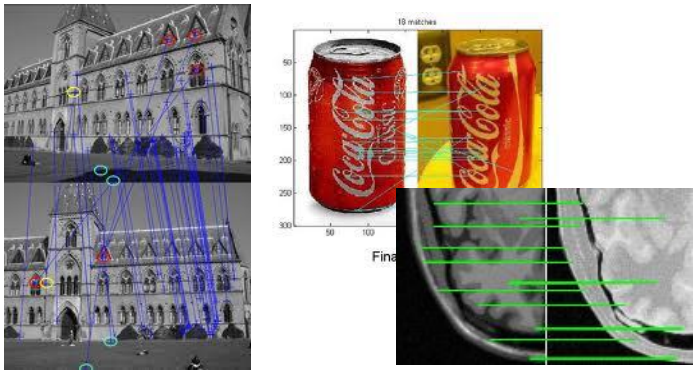
- Be able to face to a wide morphological visual diversity:
    - Simple and compound leaves
    - Margin shapes
    - Color variation
    - Light reflection
    - Leaflet number
    - Leaflet orientations
    - etc.

Questions: is possible to conceive:
- one same approach for scan, scan-like and photograph pictures ?
- one single effective approach to face the morphological diversity ?
- a full automated process ?
- scalability ?

Two distinct approaches

RUN1

Large-scale matching-based retrieval



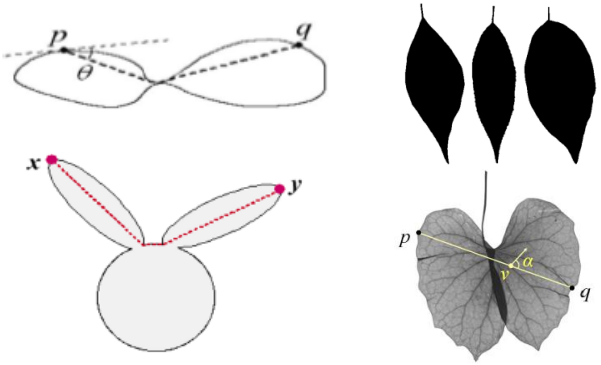
Original approach for leaf classification

Advantages

- *No complex training*
- *Robustness to **Clutter/Background***
- *Use of **rigid geometry:** less sensitive to **statistical bias** between referenced and queried images (ex: scans vs. pictures)*

RUN2

Shape Descriptions



Closer to State Of The Art methods

Advantages

- *No complex training*
- *Fast and light*

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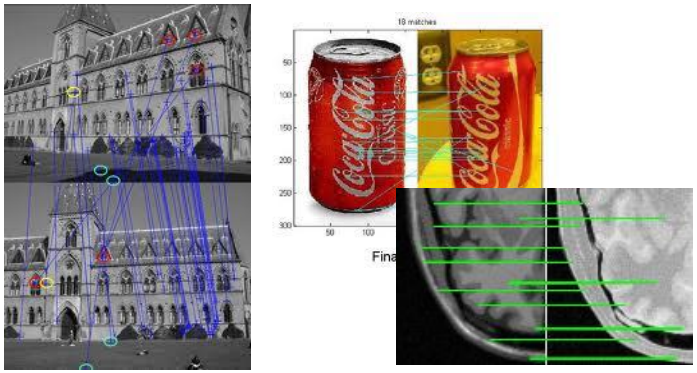

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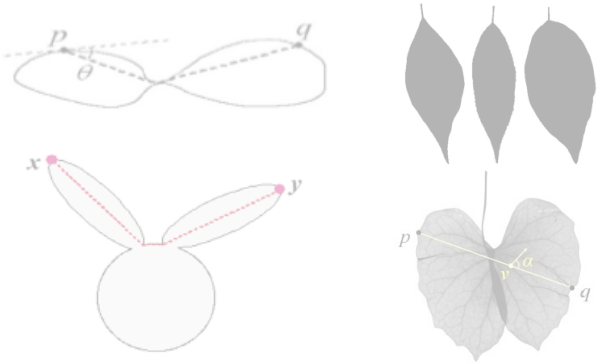

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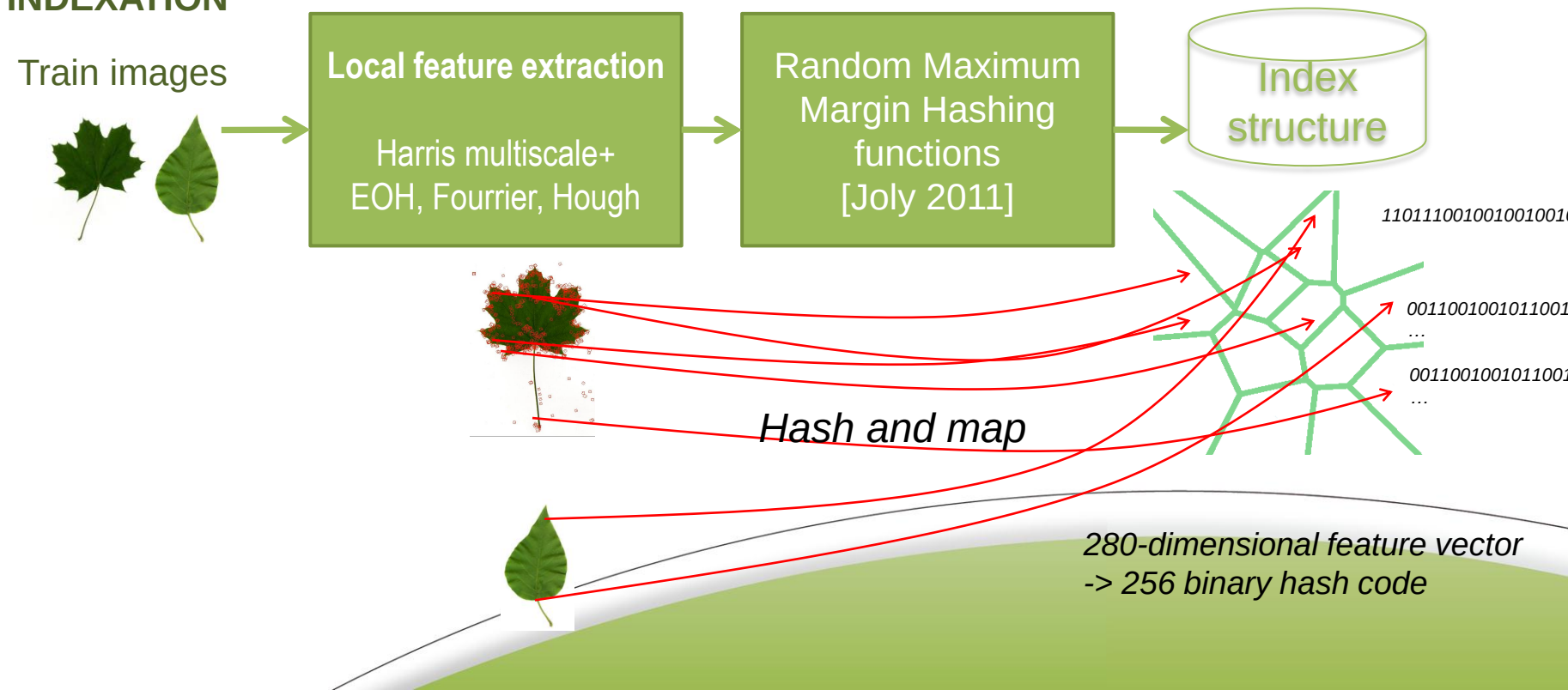
RUN1: Large-scale matching-based retrieval

Large-scale matching methods designed for rigid objects (buildings, logos, etc.) do **work surprisingly well for leaves**

- *Some parts of leaves remain affine invariant*
- *Spatial verification boost discrimination between similar species*

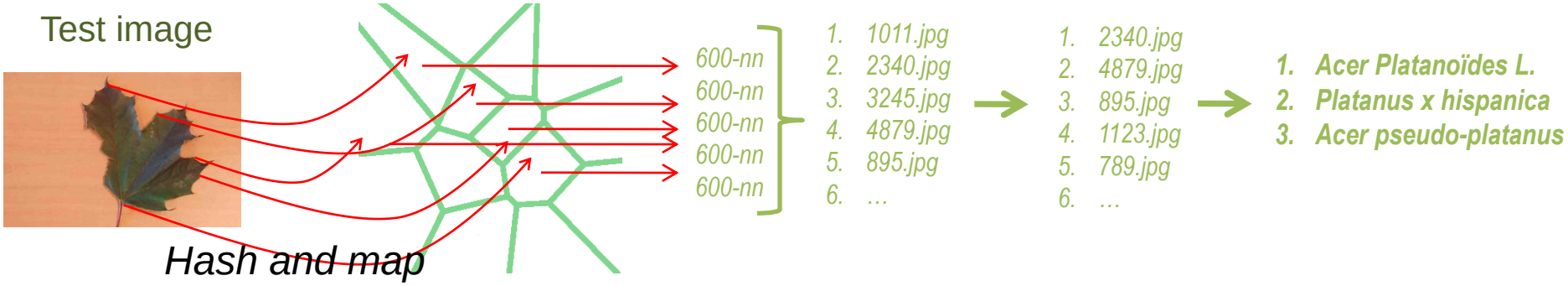
INDEXATION

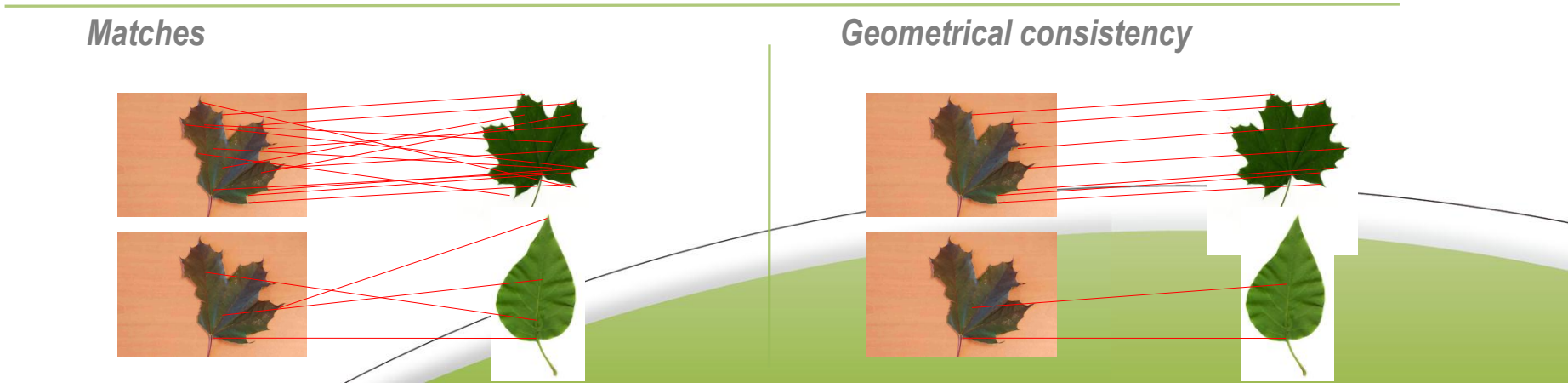


RUN1: Large-scale matching-based retrieval

QUERY

Local feature extraction → Hashing with RMMH → Ranking by number of matches → Geometrical consistency re-ranking (RANSAC-like) → Top-10 knn decision rule

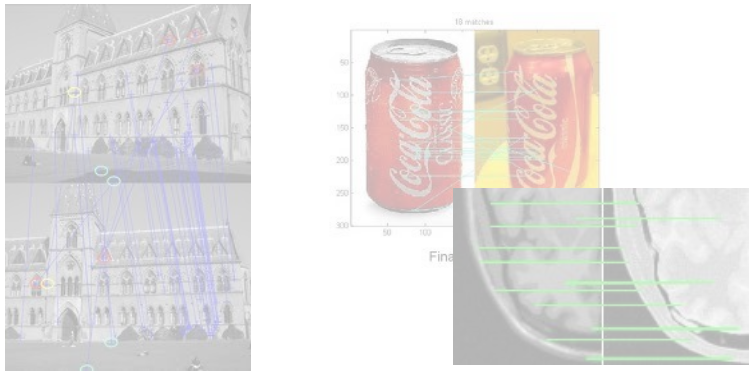




RUN2: Shape Boundary Description

RUN1

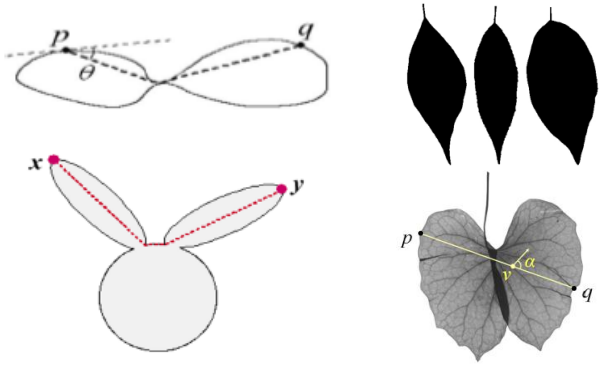
Large-scale matching-based retrieval



Original approach for foliar classification

RUN2

Shape Descriptions



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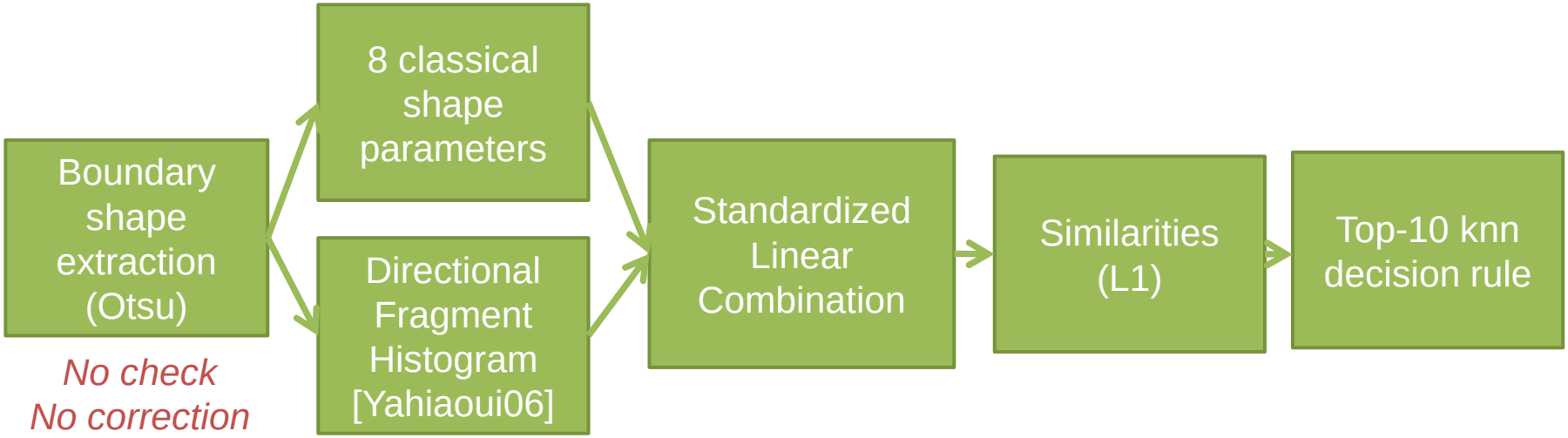
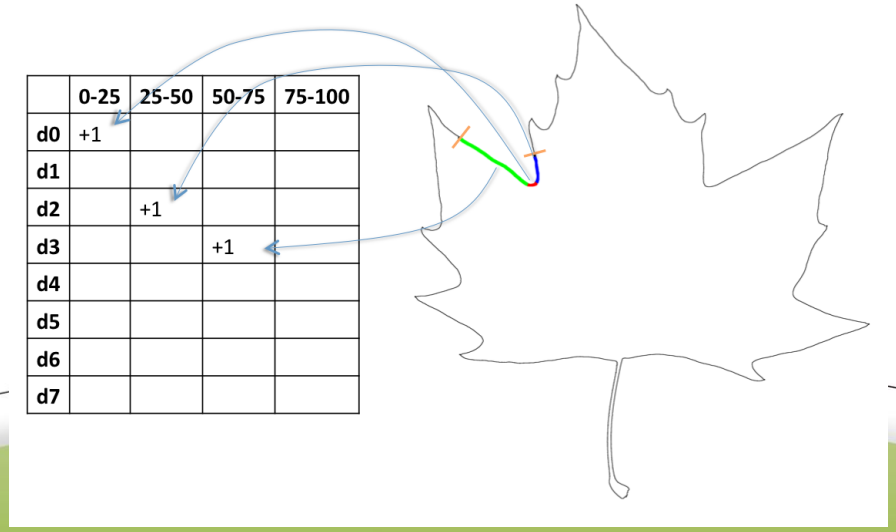


Directional Fragment Histogram

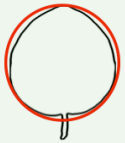
Local distribution of directions from a sliding element (0.5% of boundary perimeter)
->Gradient number distribution by orientation
->900-dimensionnal histogram (180 directions x 5 intervals)



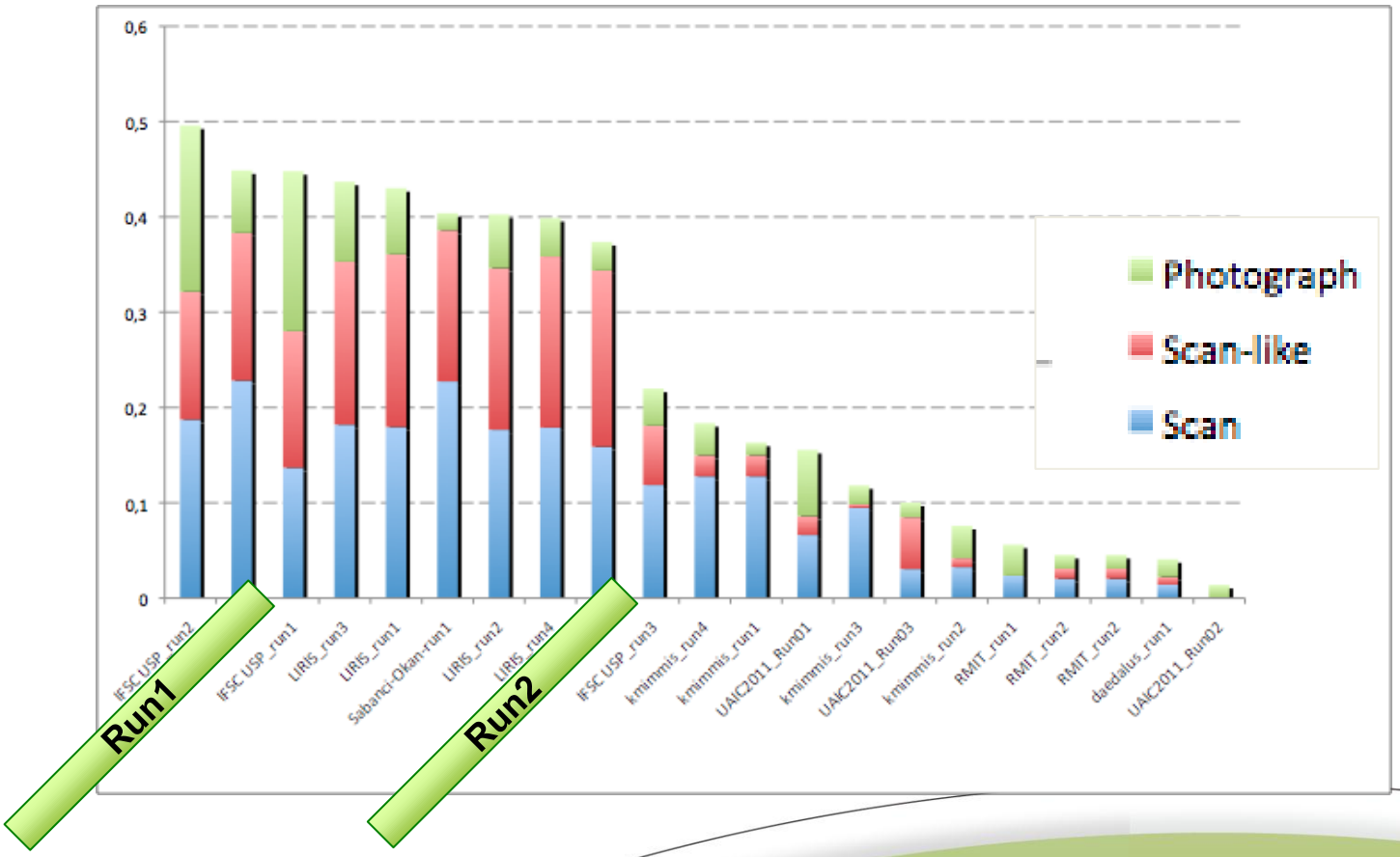
RUN2: Shape Boundary Description

Geometric parameters

Global shape descriptions complementary to local descriptions given by DFH

Diameter			Convex Perimeter Ratio		$\frac{P_s}{P_h}$
Aspect ratio		$\frac{D_{max}}{D_{min}}$	Form Factor		$\frac{4\pi A_s}{P_s^2}$
Rectangularity		$\frac{A_s}{A_b}$	Sphericity		$\frac{r_i}{r_e}$
Convex Area Ratio		$\frac{A_s}{A_h}$	Eccentricity		$\frac{\lambda_1}{\lambda_2}$

Results: overview



Results: Scan-Like

First place for the RUN2 (DFH+geom.) on the Scan-like category

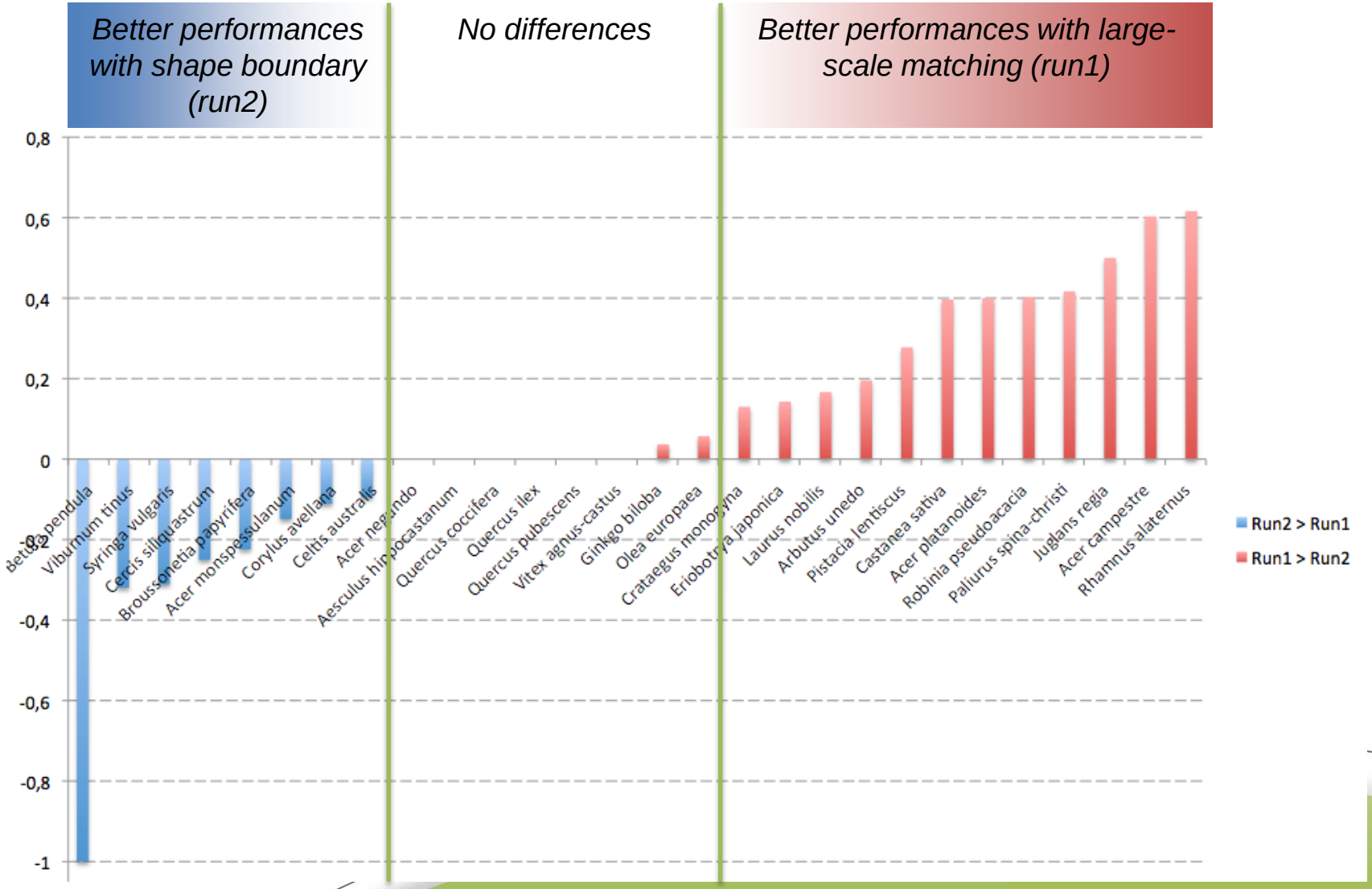
- DFH more robust with imprecise contours
- Complementary informations on global and local shape descriptions

Results: Scan

First place for the RUN1 (large scale matching) on the Scan category

- Scans ≈ **Pure morphological** context (artifacts are minimized)
- Supposed to be the easiest image category for state of the art methods (shape)

Result: Run1 vs Run2 by species



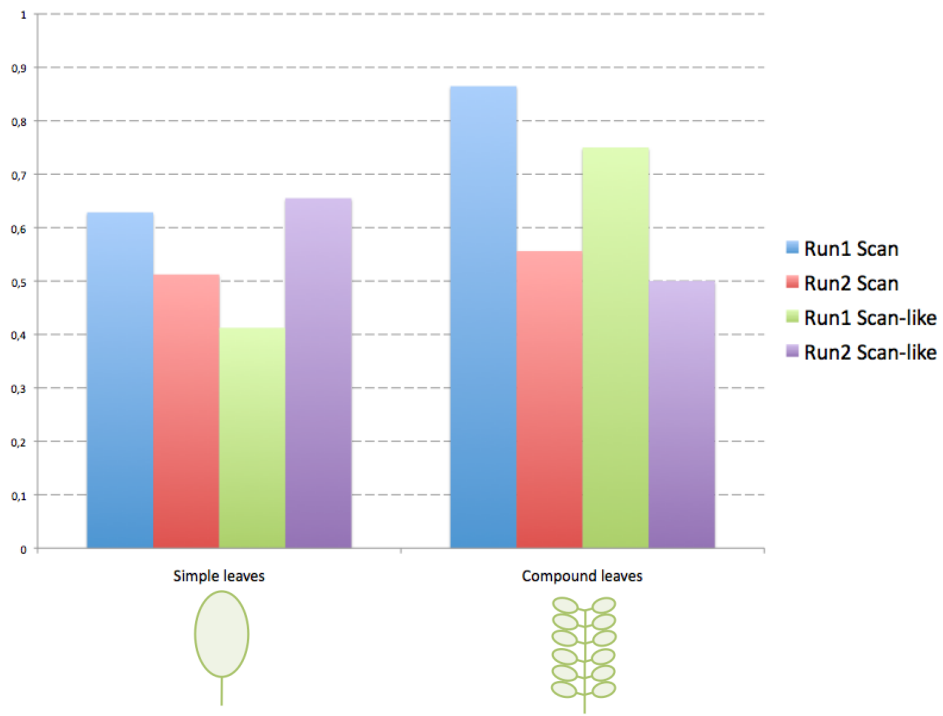
Result: Run1 vs Run2 by morphological features

The two approaches do not works on the same morphological features

Run1 (matching) seems to work better than Run2 (shape) on **compound leaves**

->compound leaf boundary is generally difficult to extract (leaflet overlaps, holes,…)

But Run1 (matching) seems to be more sensitive to picture acquisition artifacts (simple)

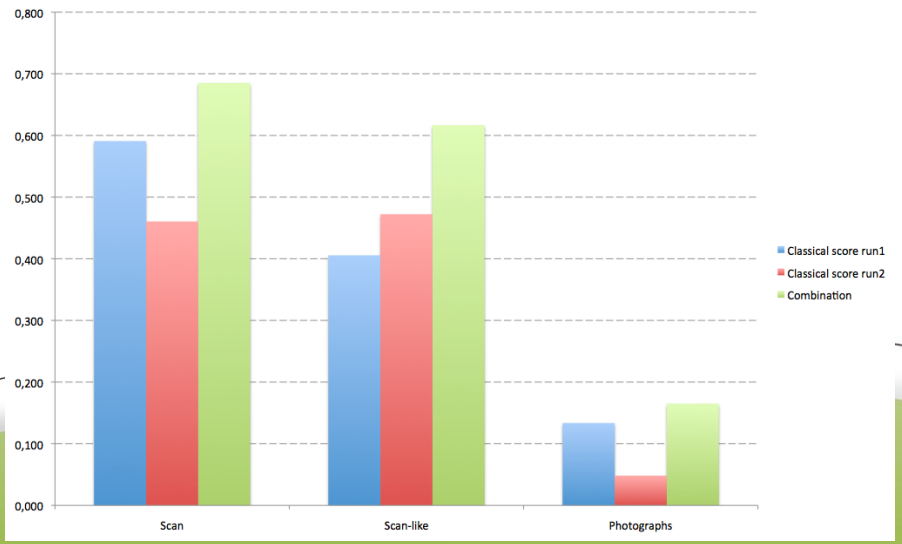


Result: Run1 vs Run2 by images

Rather small part of well-identified pictures is shared by the two approaches

Pictures	Total	Only Run1	Only Run2	Common	% Common
Scan	722	163	68	264	**36,62**
Scan-like	180	26	38	47	**26,11**
Photographs	539	62	17	10	**1,86**
total	1440	250	123	321	**22,29**

Promising improvement of performances by combining the approaches



Conclusion and future work

Two very distinct approaches, but both efficient (two 1st places for scan and scan-like categories)

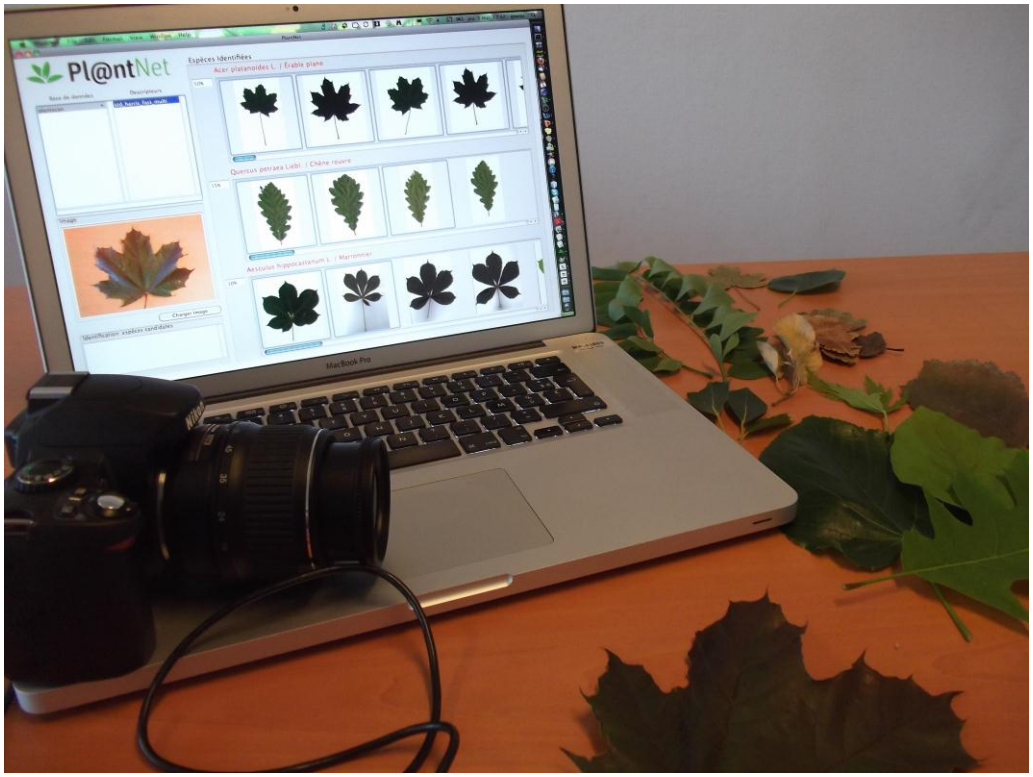
One important result
The matching approach allows to reach the 1st place in a **pure morphological** context (scans)

Improvements

Run1 (Matching): part based model instead of global affine model
Run2 (Shape): more geometrical parameters, new specialized descriptions of leaf content (on venations for instance)

Combination
Definitely will give great improvements
But must conceive an elaborated scheme fusion, not a basic combination

Thank you !



Demo:

Want to play with some leaves picked in the neighborhood of the hotel ?

Some successful difficult queries

Ripped leaf	Dead leaf	Rotated leaf Natural background Shadows	Dry leaf Non uniform background with a hand	Leafage
Acer platanoïdes L. *(Norway Maple "Schwedleri")*	Ginkgo biloba L. *(Maidenhair Tree)*	Acer platanoïdes L. *(Norway Maple)*	Quercus pubescens Willd. *(Downy Oak)*	Aesculus hippocastanum L.*(Horse Chesnut)*
1st suggestion	1st suggestion	1st suggestion	2nd suggestion	3rd suggestion

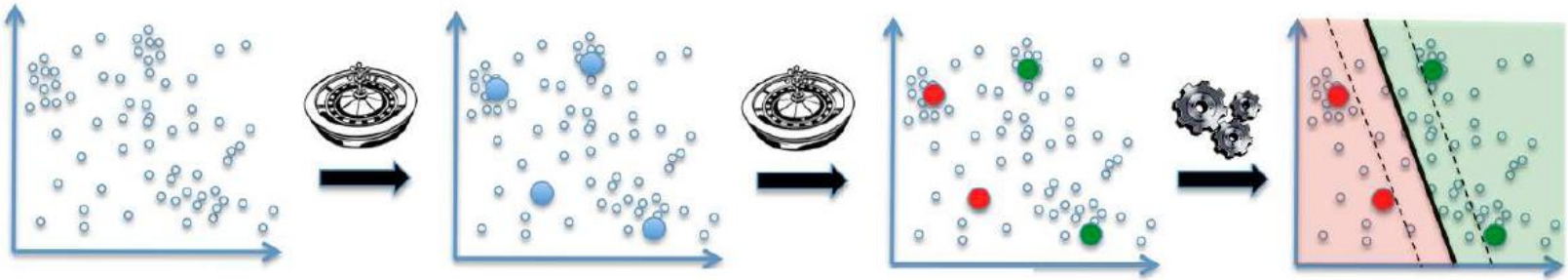
Result

RUN1: Large-scale matching-based retrieval

RUN2: Shape Descriptions

RUN1: Large-scale matching-based retrieval

- Pour résoudre les problèmes d'**indexation** et de **passage à l'échelle**
- Une méthode de **hachage** basée sur la classification supervisée de données **labellisées aléatoirement**



$$h(\mathbf{x}) = sgn\left(\sum_{i=1}^{m} \alpha_i^* \kappa(\mathbf{x}_i^*, \mathbf{x}) + b_m\right)$$

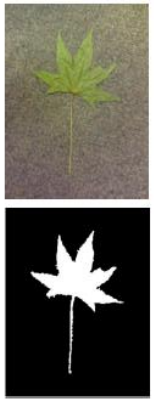
[CVPR2011]

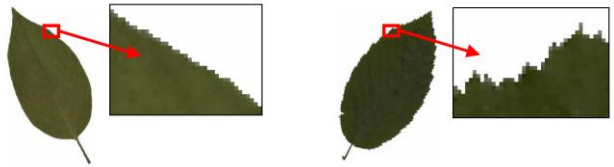
- Un **fort potentiel théorique** pour beaucoup d'autres problèmes: réduction de dimension, compression, **apprentissage** (un nouveau de type de classifieur)

Leaf-based Identification: State-of-the-art

Most SOA methods are Segmentation-based

- Global visual features describing leaves boundaries
- Most used one = IDSC feature ("Shape classification using the inner distance", PAMI 2007)
- Many alternative shape descriptors (e.g. wavelets for local analysis)





(a) (b)

Issues of segmentation-based methods

- Background/Clutter
- Holes, Shadows, …

Hole and lobe detection

Shadows and virtual leaflet detections

Light reflection and virtual holes

Existing systems

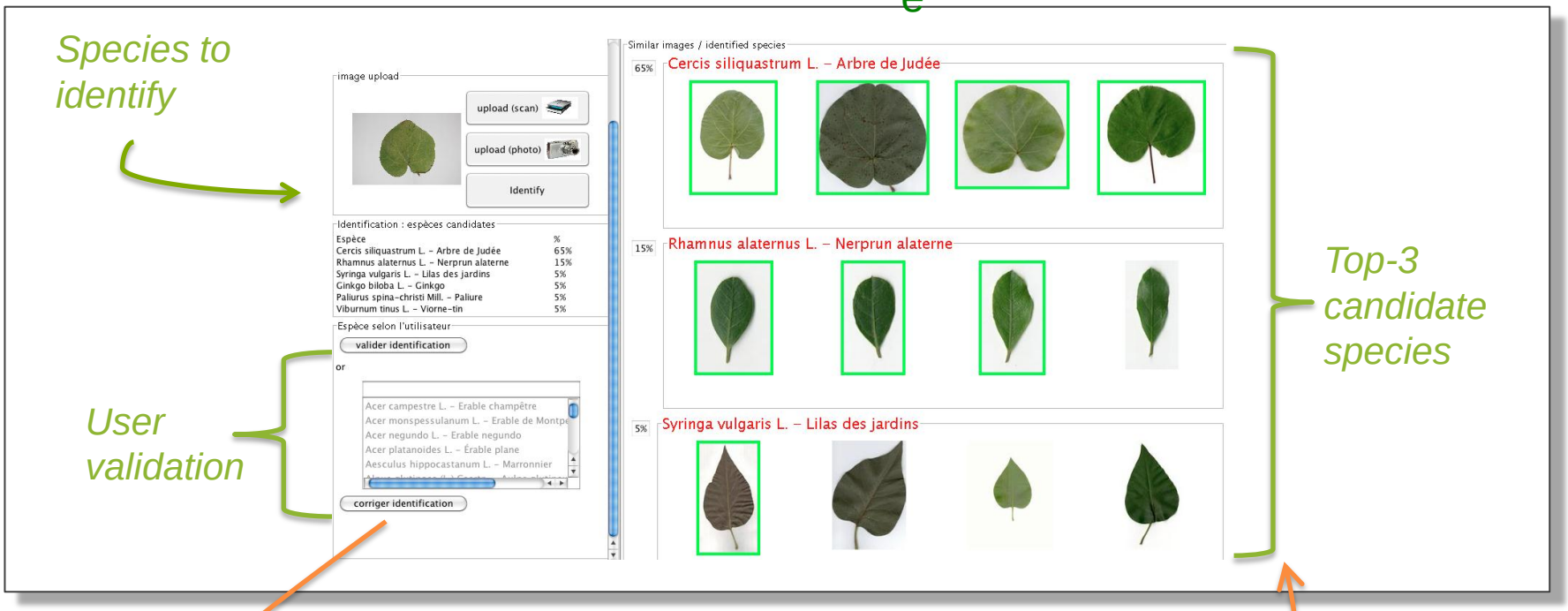
- Well, mainly the one from Columbia & Maryland (P. Belhumeur)
- Iphone version = **Leafsnap** (http://leafsnap.com/)
- **Segmentation-based** (white background required)
- Based on Smithsonian data (**not crowdsourced**)

Through a Web Application: Identification + Crowdsourcing

- Online Content-based Visual Identification
- Online Species Validation/Annotation

Enjoy

Contribute



Known or new species

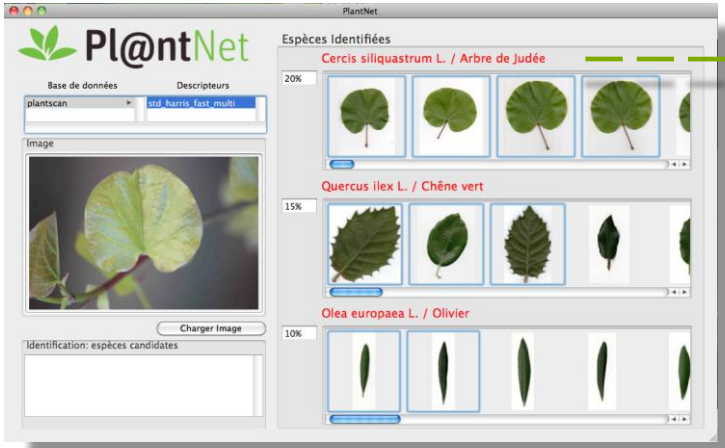
Validation

Visual knowledge

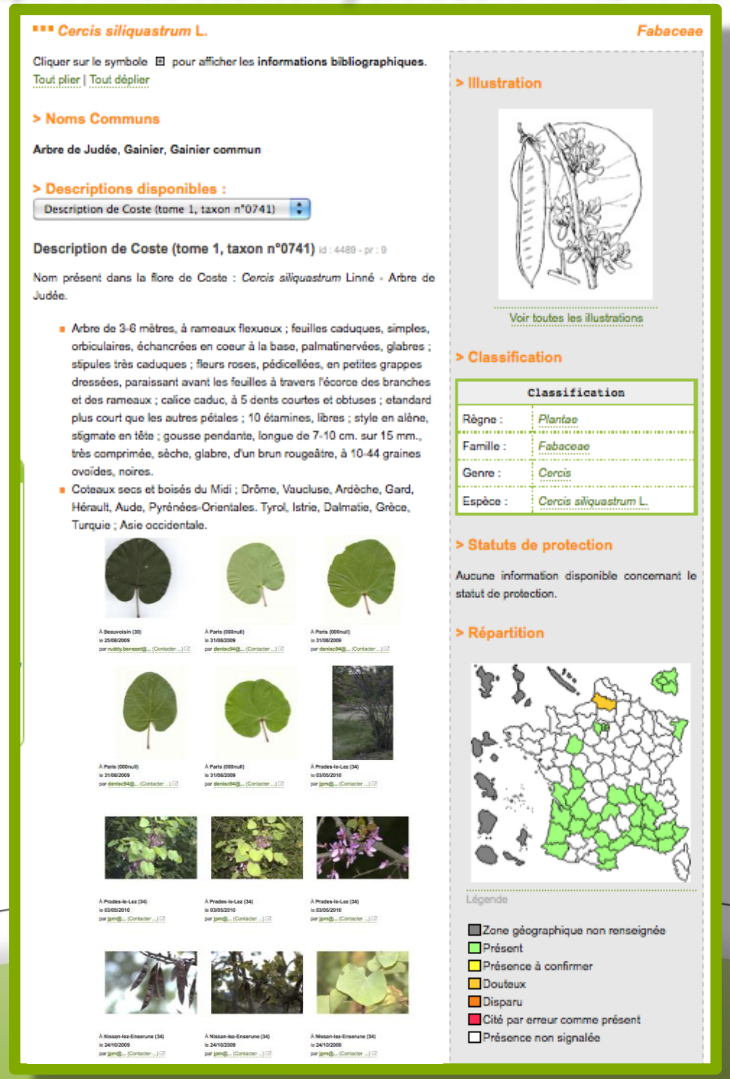
Exploited for next queries

http://combraille.cirad.fr:8080/demo_plantscan/

Towards a botanical information search engine



http://www.tela-botanica.org/eflore/BDNFF/4.02/nn/75048/



- The visual content based identification for **bridging the taxonomic gap** and finding **more botanical informations** on species

-> Hyperlinks to Tela Botanica website

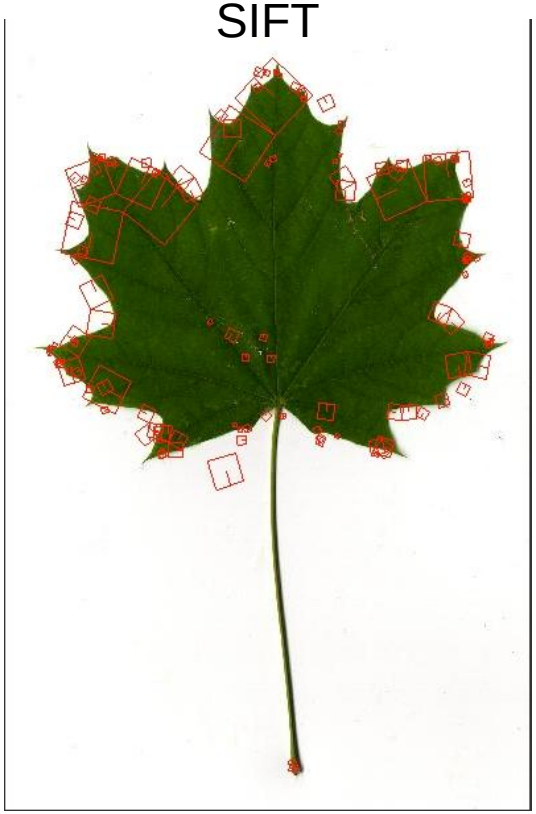
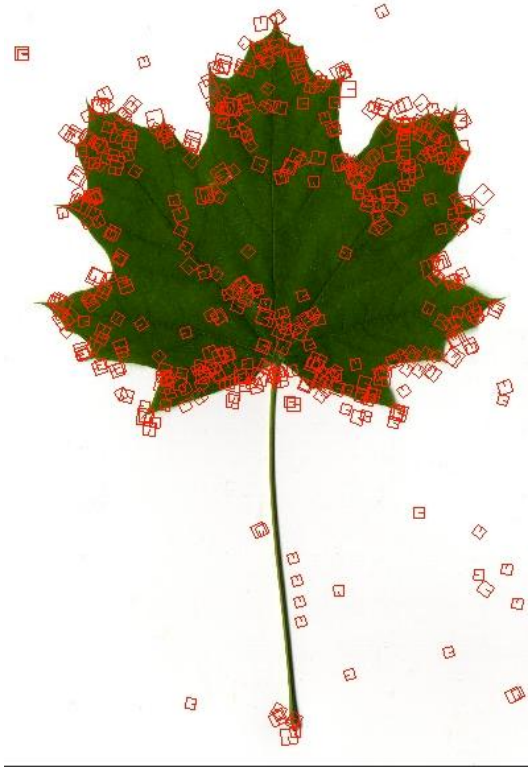
- *More illustrative pictures of leaves, flowers, fruits, bark…*
- *Species distribution across geographical areas*
- *Textual description of plant morphology*
- *Taxonomical context*

RUN1: Large-scale matching-based retrieval

1. **Feature extraction:**

Harris Multi-scale
-> more informative than SIFT for leaves (teeth, apices, venations, petiole, …)
+
Local texture and shape *description*
->Edge Orientation Histogram
->Fourrier 2D Histogram
->Hough Histogram

SIFT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