The ImageCLEF 2013 Plant Identification Task

Goëau H., Joly A., Bonnet P.,
Boujemaa N., Barthelemy D. and Molino J.-f.

The ImageCLEF 2013 Plant Identification Task

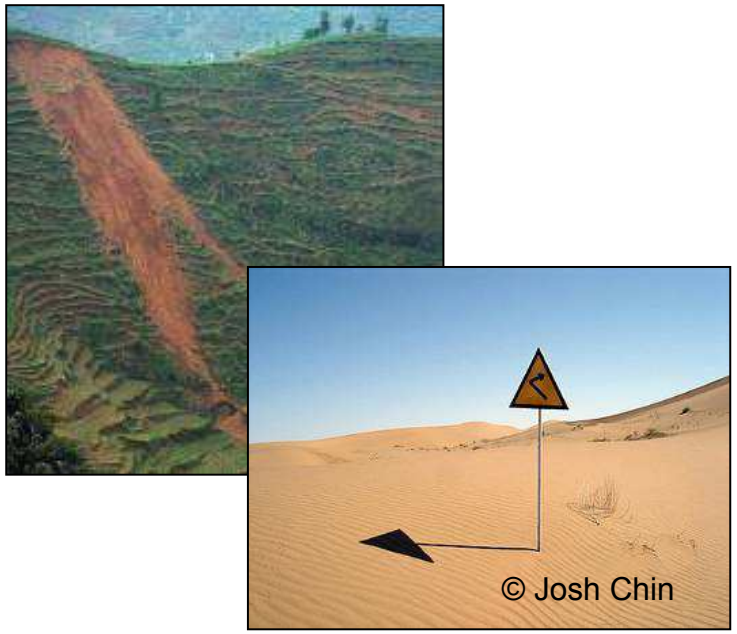
- **Introduction**
- Task resources & description
- Participants and results
  - SheetAsBackground
  - NaturalBackground
  - Details by views
- Conclusion

Context & challenges

Biodiversity erosion & Global warming affects the **environment** as well as **agriculture** and **food security**

Accurate knowledge of **plants** (distribution and ecology) is essential for **sustainable agriculture** and **biodiversity conservation**

But accessing basic information about plants is still challenging



Botanical data is:

- *decentralized* and *heterogeneous*
- *complex* (un-structured tags, empirical measurements,…)
- *sparse* and *incomplete*
  - *huge & unknown number of species (300K ?)*
  - *"long tail distribution" (1 record per species !)*

Towards bridging the taxonomic gap

As a consequence, **identifying plants is very difficult**

-> How to control plant's distribution and plant ecology ?

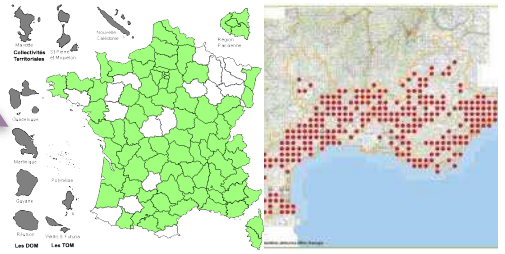
Ailanthus altissima *(Mill.) Swingle*

Tree of heaven
Faux verni du Japon

Árbol de los dioses
臭椿 chòuchūn
"Malodorous tree"

Ornamental species

Invasive species in Europe



Possible solutions

- **Collaborative Information Systems**
  Sharing and speeding up integration of raw data
- **Multimedia Image Retrieval & Identification Tools**

But …

CBIR SoA not well studied on plants
Few, small, biased datasets

Motivations of this task

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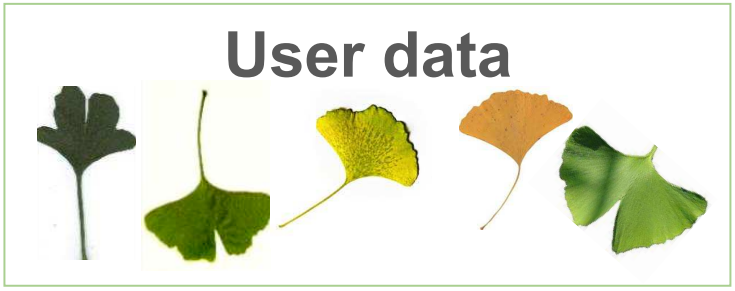
Task characteristics & Data creation

An **attractive** task as **simple** as possible but as **realistic** as possible

- *Simple* : 1 media type (image),
  2 mains categories *SheetAsBackground ; NaturalBackground*
- *Realistic* : collaborative data, numerous contributors

how to reduce bias between training data and real user's data ?

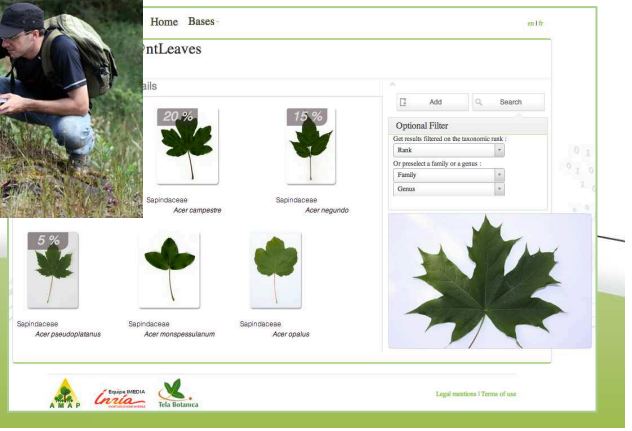


Let real users collect training data and botanists validate

+

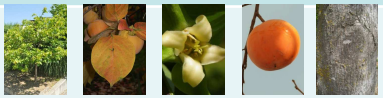
Grow training data with an online Identification and Validation Tool

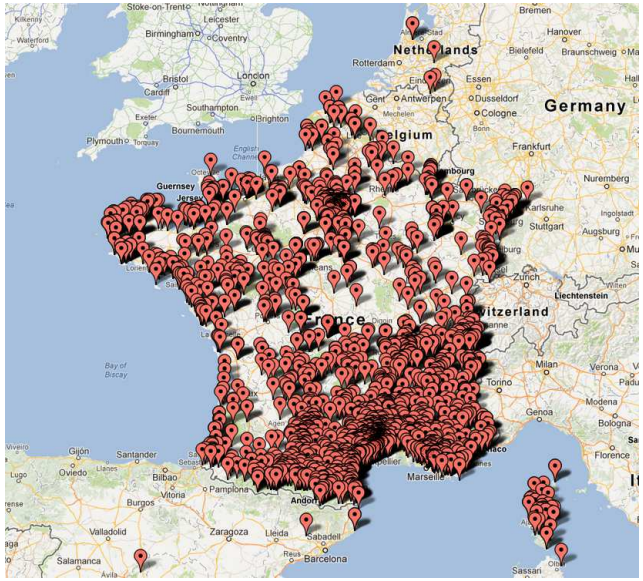
=The PlantViews dataset



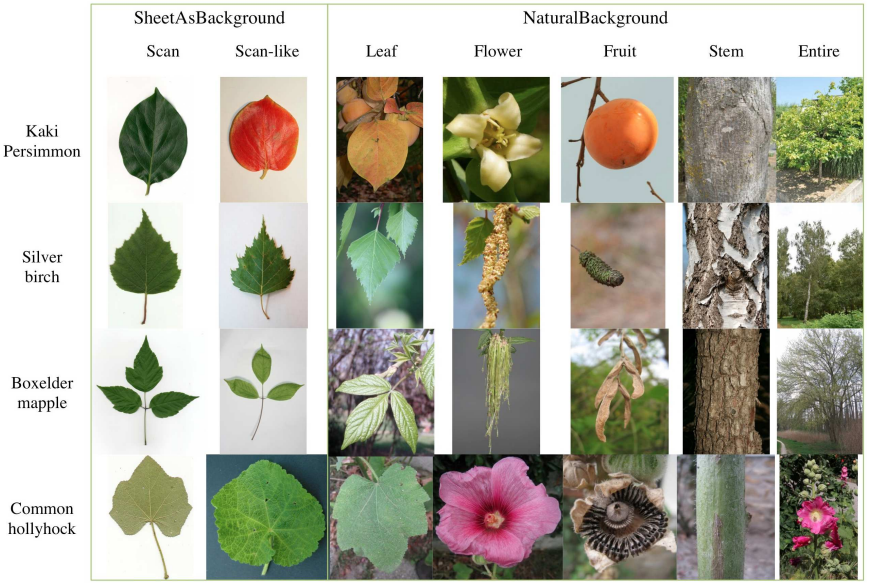
Pl@ntViews dataset

	2011	2012	2013
Species NB	71	126	250
Images NB	5 400	11 500	26 077 (327 contributors)
View types	Leaves	Leaves	





- **2 mains categories of images**
  - 11 031 img *sheetAsBackground*
    - Leaf scan & scan-like (42%)
  - 15 046 img *NaturalBackground*
    - Leaf (16%)
    - Flower (18%)
    - Fruit (8%)
    - Stem (8%)
    - Entire plant (8%)



Pl@ntViews dataset

- **Metadata (XML)**
  - IndividualPlantID
  - Data and time
  - Image type "NaturalBackground" or not
  - Content (Leaf, Flower, Fruit, etc.)
  - Full taxon *(APGIII)*
  - ClassID Species identifier
  - Common name
  - Author name
  - Locality name
  - GPS
  - …

```
<?xml version="1.0" encoding="UTF-8"?>
<Image>
  <FileName>5438.jpg</FileName>
  <Date>03/11/10</Date>
  <Type>pseudoscan</Type>
  <Author>Pierre Bonnet</Author>
  <Organization>Inra</Organization>
  <Content>Leaf</Content>
  <IndividualPlantId>215</IndividualPlantId>
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    <Subclass>Ginkgoidae Engl.</Subclass>
    <Superorder>Ginkgoidae Engl.</Superorder>
    <Order>Ginkgoales Gorozh.</Order>
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  </Taxon>
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  <GPSLocality>
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    <Latitude>43.60817337036133</Latitude>
  </GPSLocality>
</Image>
```

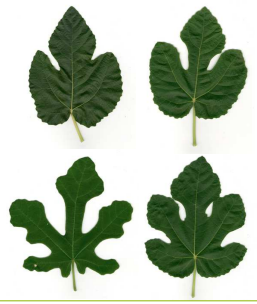
- **A unique dataset !**
  - Pictures of views of species, coming from **different individual plants**
  - **Hundreds of contributors**, with numerous devices
  - Pictures at **different periods** of the year (over 3 years)
  - **Taxonomic validation** by a network of botanists

Pl@ntViews dataset

Leaf diversity

Leaf at different growing stage of *Platanus x hispanica* Mill ex. Münchh. (London plane)

Shooting conditions and used devices, *Acer platanoides L.* (Norway mapple)

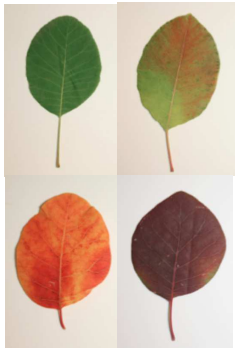


Lobe number and deep of leaf lobes on *Ficus carica L.* (Common fig)

 # Users =

 # *localities*
 # *seasons*
 # *environments*
 # *climate*
 # *ecosystems*
 # *devices*

Leaflets number variability on *Fraxinus angustifolia* Vahl (Narrow-leafed Ash)

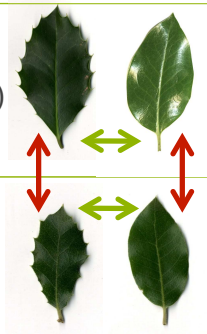


Autumnal variability of the lamina color on *Cotinus coggygria* Scop. (Eurasian smoketree)

Growing stage: two compound leaves **from the same tree !** *Gleditsia triacanthos* L. (Honey Locust)

Ilex aquifolium L. (European holly)

Quercus ilex L. (Holm oak)



Intra-species diversity versus visual similarities between species

Pl@ntViews dataset

Flower diversity

COLOR

Brown White Green Rose Blue Yellow

Sym ¦ metry

Radial **Bilateral**

Structure

4 5 6 >>6

Number of petals

Orientation

Face **Profil**

Size

small middle big

Pl@ntViews dataset

Fruit, Stem and Entire plant

Fruit types

With an important diversity of colors, shape, texture, orientation, etc.

Stem types

The visual diversity of the bark of the *Robinia pseudoacacia*.

Entire plant

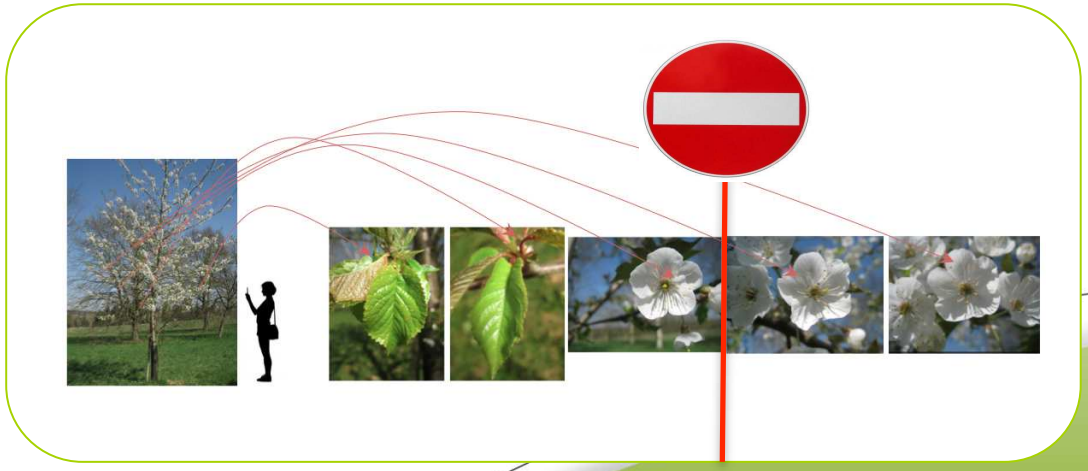
From large trees to small herbs

Task description

- **Retrieval task**
  - For each test picture, a list of ranked species
  - Separate scores for the 2 mains categories
  - Free training strategy

		Images	Plants	Authors	Species
SheetAsBackground	**Train**	9781	732	36	126
	Test	1250	150	14	70
NaturalBackground	**Train**	11204	2553	176	244
	Test	3842	2454	229	238
Entire	Train	1455	955	104	234
	Test	694	567	107	177
Flower	Train	3521	1328	127	233
	Test	1233	970	142	203
Fruit	Train	1387	512	64	156
	Test	520	302	77	103
Leaf	Train	13285	1046	73	210
	Test	2040	420	68	143
Stem	Train	1337	629	38	131
	Test	605	408	35	77
All	**Train**	20985	11204	176	250
	Test	5092	3842	229	241

- **Plant-based splits:**



A plant centred approach
& a multiple organ queries

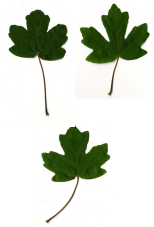
Can't be split
all images in training or test dataset

Task description

Score

$S_{u,p,n}$ = 1 / RankOfCorrectSpecies

- **Unbalanced** real-world data



Plant p_1 *Plant p_2* *Plant p_3*

User u_1 (Anne) *User u_2 (Daniel)*


$Score_{scan}$ ***s***

To not give too much importance to individual plants with numerous images

To not give too much importance to users who contribute a lot

« As a new user of the plant identification system, what is the score I can expect? »

- **Normalized** Average Score

$$S = \frac{1}{U}\sum_{u=1}^{U}\frac{1}{P_u}\sum_{p=1}^{P_u}\frac{1}{N_{u,p}}\sum_{n=1}^{N_{u,p}} s_{u,p,n}$$

$$\neq \sum_{\text{all test pictures}} S_{u,p,n}$$



0 to 1

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Participation and Methods

2011 : 8 teams / 20 methods
2012 : 10 teams / 30 methods
2013 : 12 teams / 33 methods

	Groups	Runs	Features	Prediction based on
	AGSPPR	3	SPACT, SIFT, global shape	SVM
	BTU DBIS	4	Global color histograms EOH, Tamura, CEDD, FCTH.	SVM
	I3S	2	SIFT + BOW	SVM
	INRIA	4	Shape: Triangular, Directional Fragment, Context Corners, LBP/SURF/Fourier/EOH/HSV/wRGB, date	Matching + nn SVM
	LAPI	1	Curve partitioning	Linear Discriminate Analysis
	LIRIS ReVes	2	Lab/Gabor/SURF Hu/Zernike/centered moments, geoloc.	Naïve distance based
	MICA	3	GIST/SURF + BOW	SVM
	Nlab	3	SIFT variation + FisherVector	Linear Logistic Regression
	SABANCI- OKAN	1	Numerous shape and texture desc. wHSV, date.	SVM
	SCG USP	3	LBP, Fractal, Gabor, geometrical	Linear Discriminate Analysis
	UIAC	4	Joint composite descriptor, geoloc.	Nn rules, naïve Bayesian
	VicomTech	2	Trace transform, Shape relationship	SVM

Results - *Key to succeed*

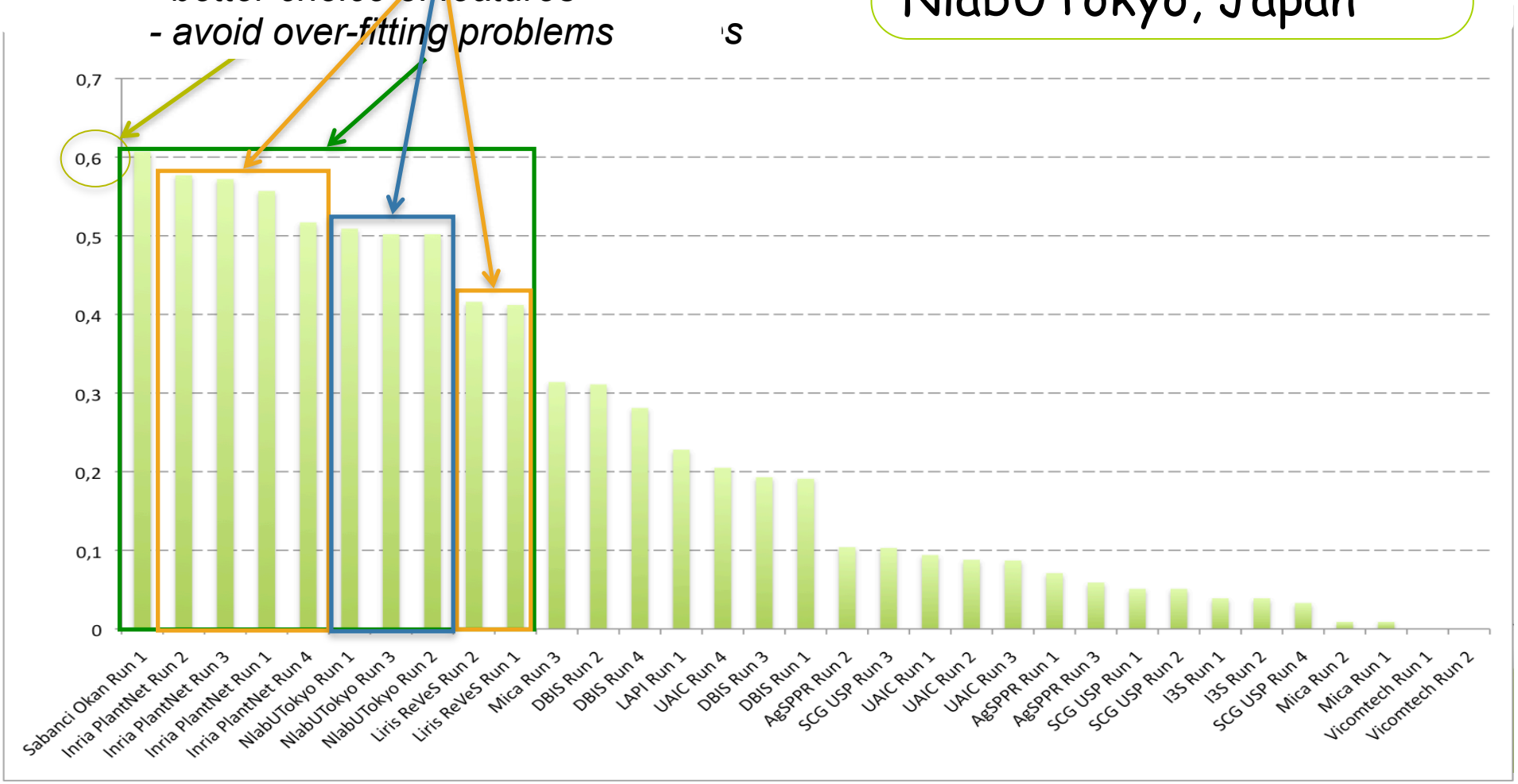
SheetAsBackgroung

Individual-plants not split during preliminary evaluation.

Multi-shape based approach

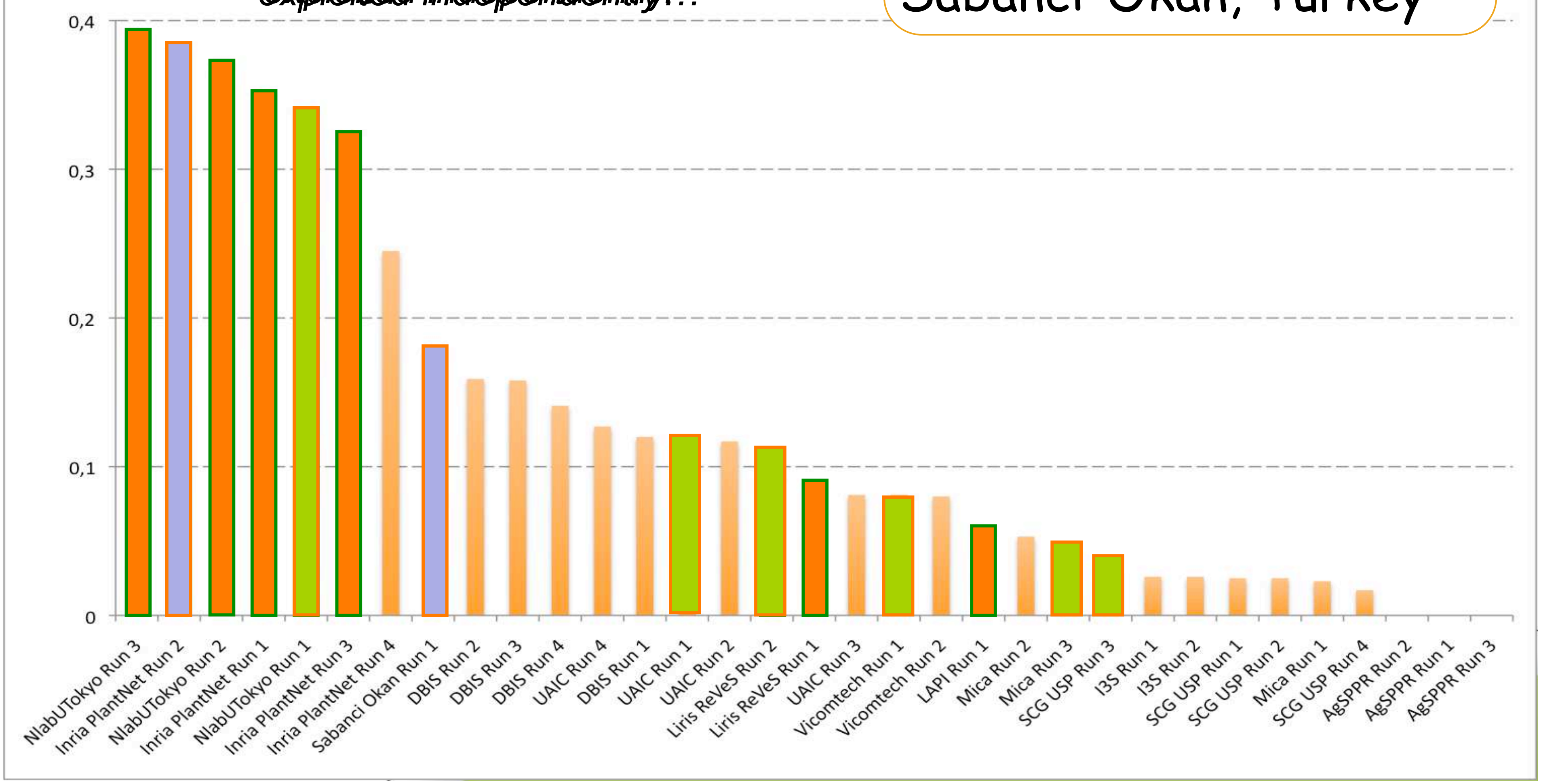
- *better choice of features*
- *avoid over-fitting problems*

Sabanci-Okan, Turkey
Inria PlantNet, France
NlabUTokyo, Japan



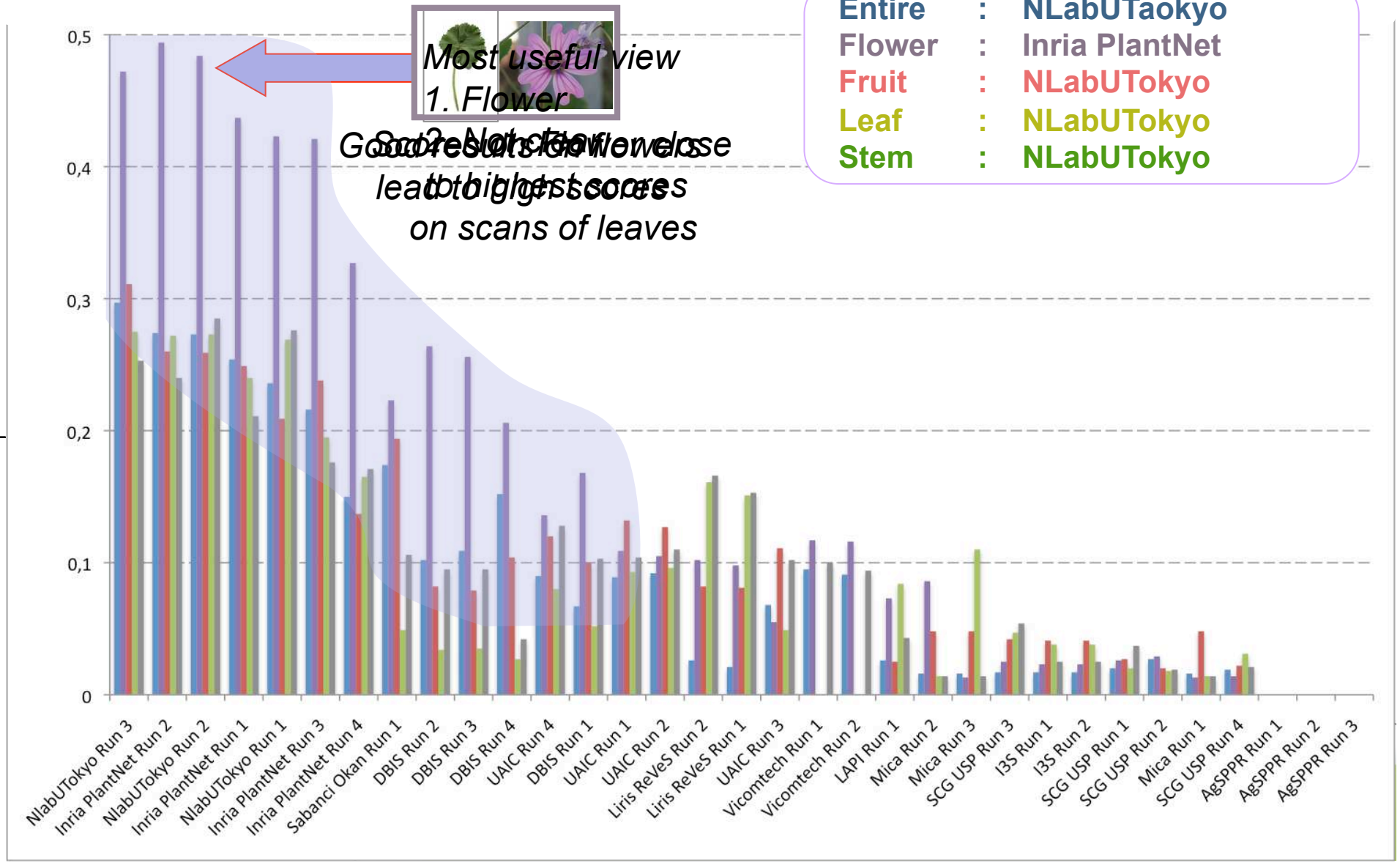
Results - *Key to succeed*
NaturalBackground

NlabUTokyo, Japan
Inria PlantNet, France
Sabanci-Okan, Turkey



Results – *Complementary remarks*

NaturalBackground (details)



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Conclusion

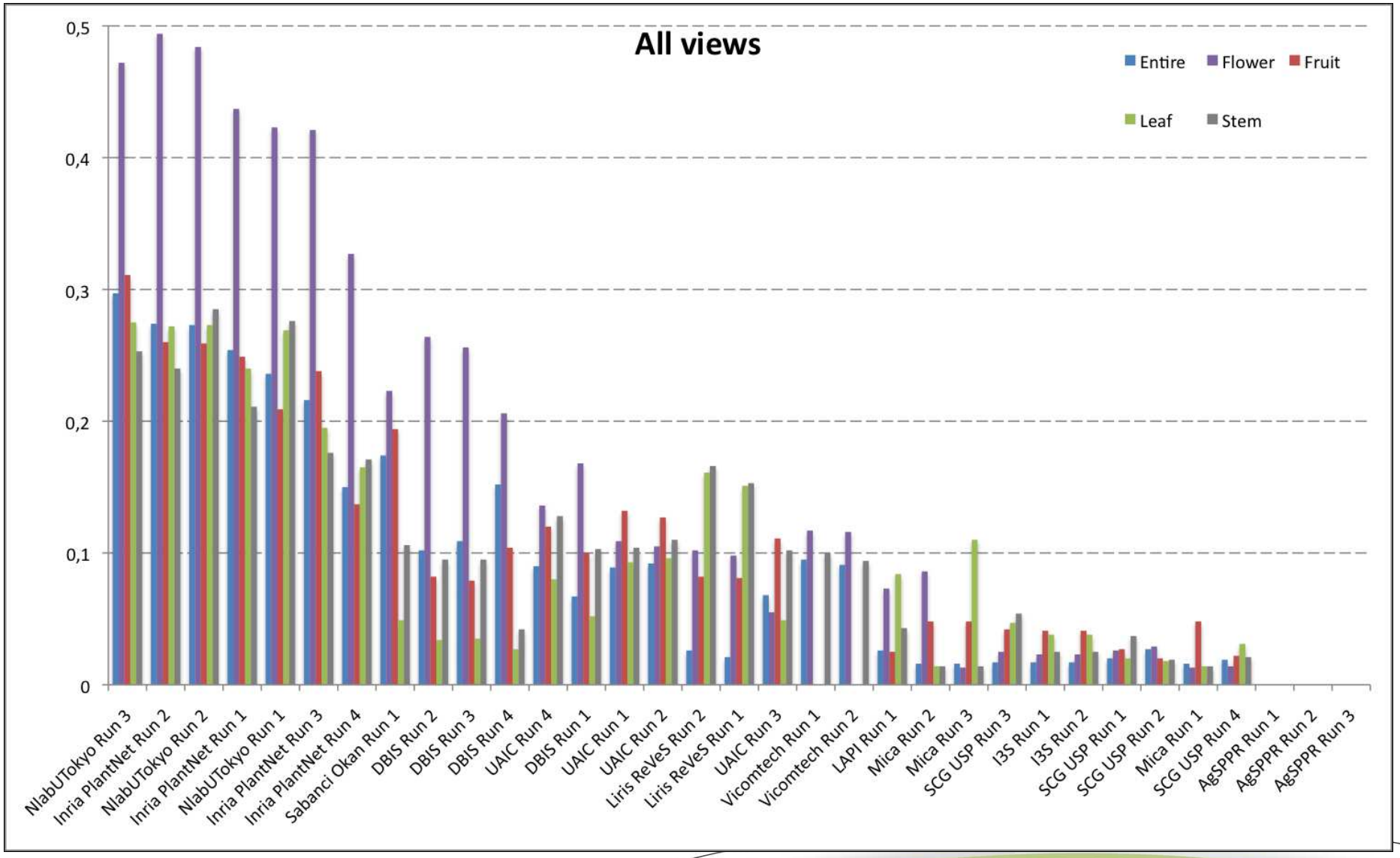
- **Good participation** ⟶ Increasing interest of the community
- Still **good results on** *Leaf-SheetAsBackground*
  Performances with a realistic number of species (3000 to 5000 sp.) ?
- Real **difference** between Leaf-*SheetAsBackground* and Leaf-*NaturalBackground*
- Challenging unconstrained pictures
  Very **promising results** on *NaturalBackground* (mainly for flowers)
- No method above the others for the 2 categories
- Training strategy is essential
- Metadata:
  - + Impact of dates
  - Not clear GPS impact
  - Still unused data (taxonomic context, common names, Exif, …)

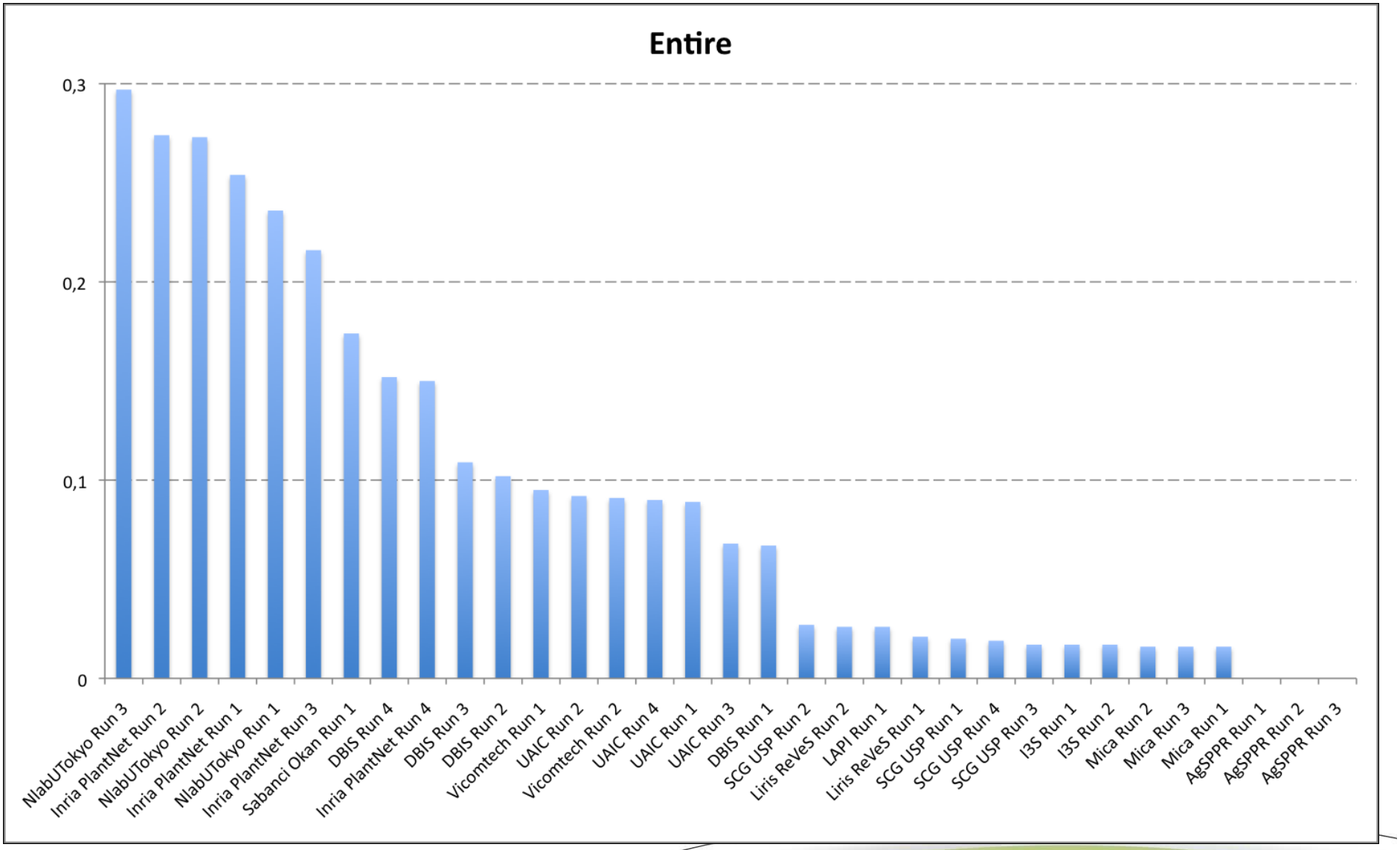
Perspectives and issues

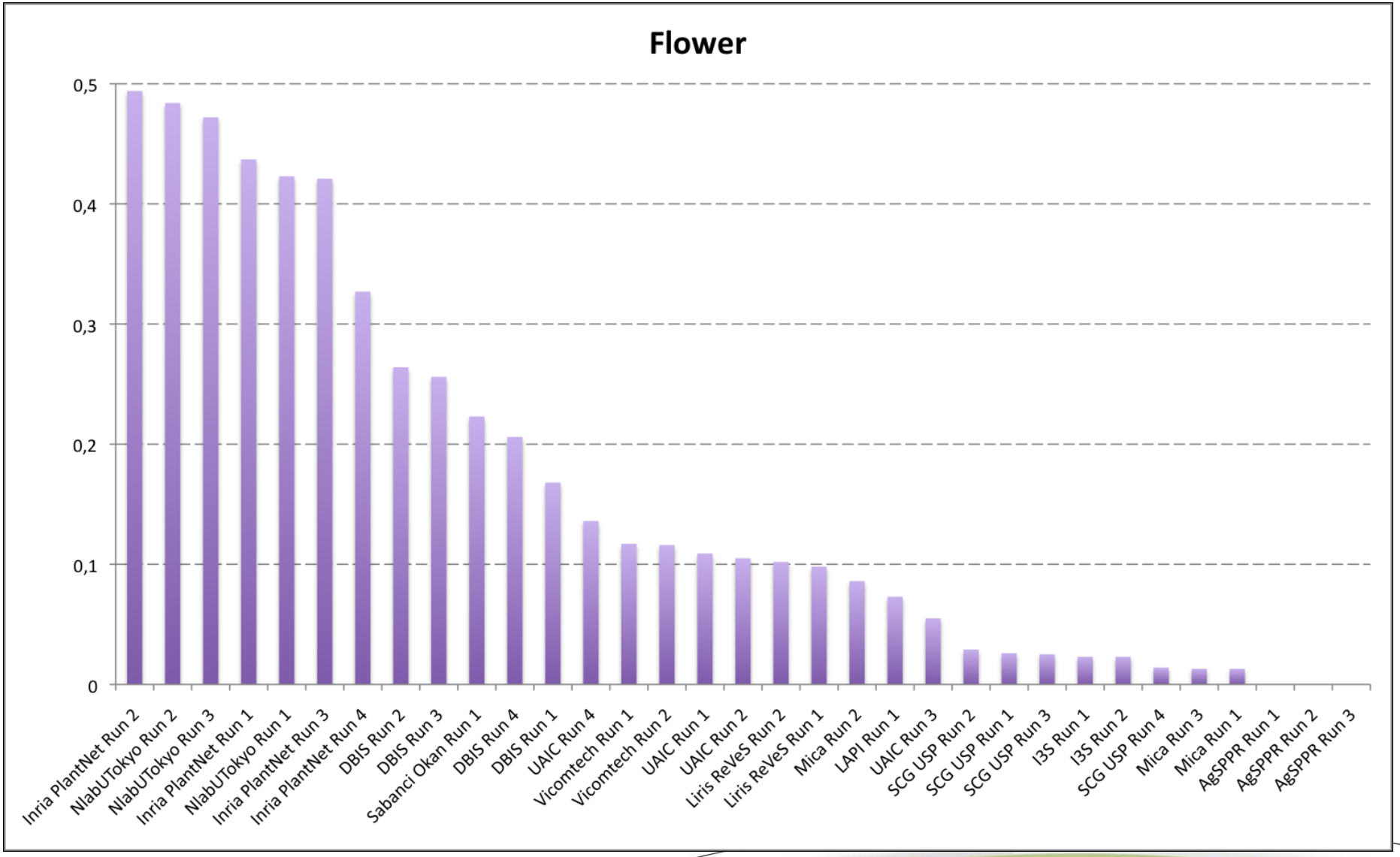
- Task evolution through a new Lab, close to ImageCLEF, dedicated to environmental data management

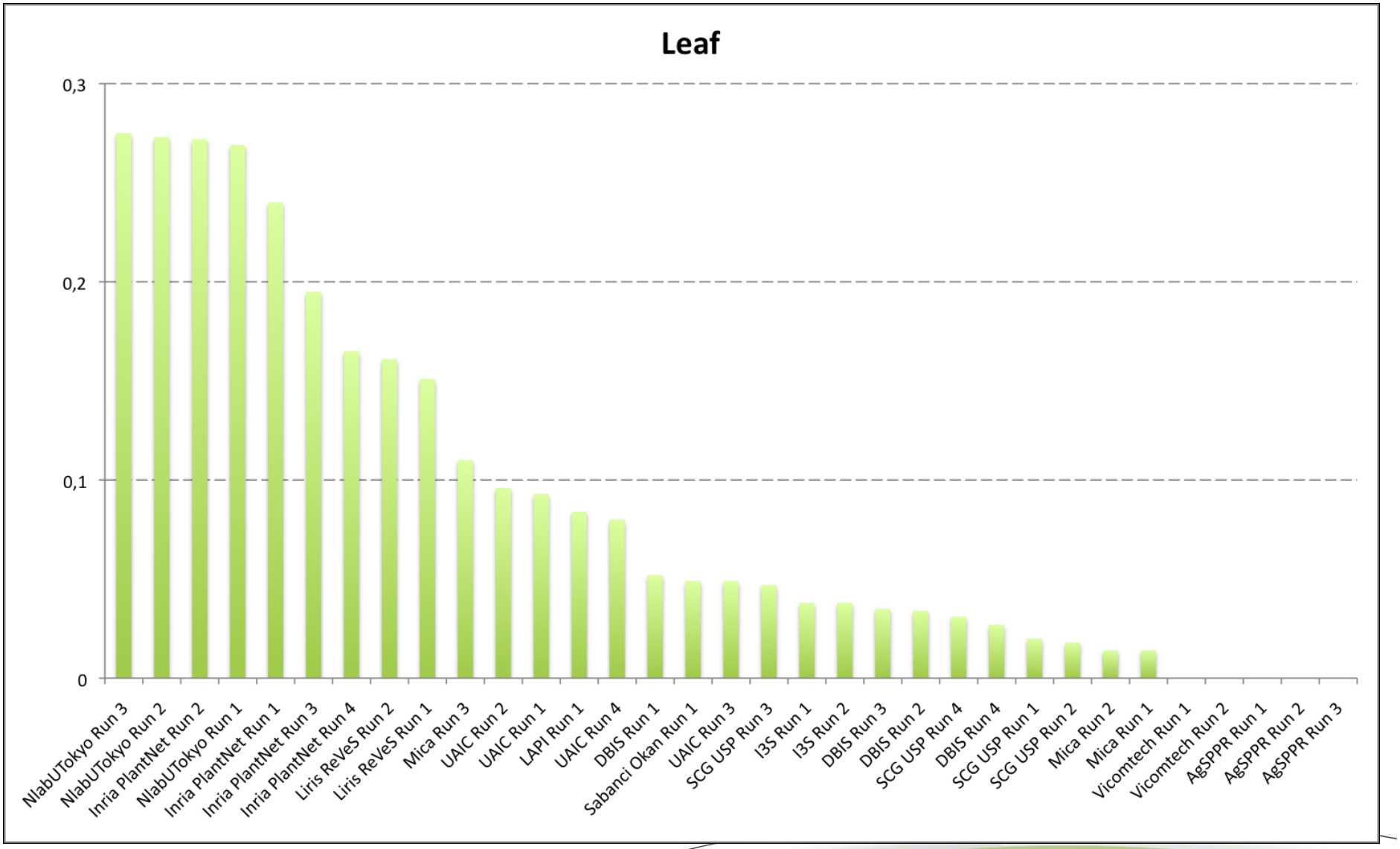
- Growing task, with
  - More data, depending on collaborative contributions
  - More species (up to 500 or 1 000 sp.)
  - More content types (branch images)
  - More metadata (data quality evaluation, …)
  - More multi-modal information
    (multi-lingual species names, species distribution, species description, …)

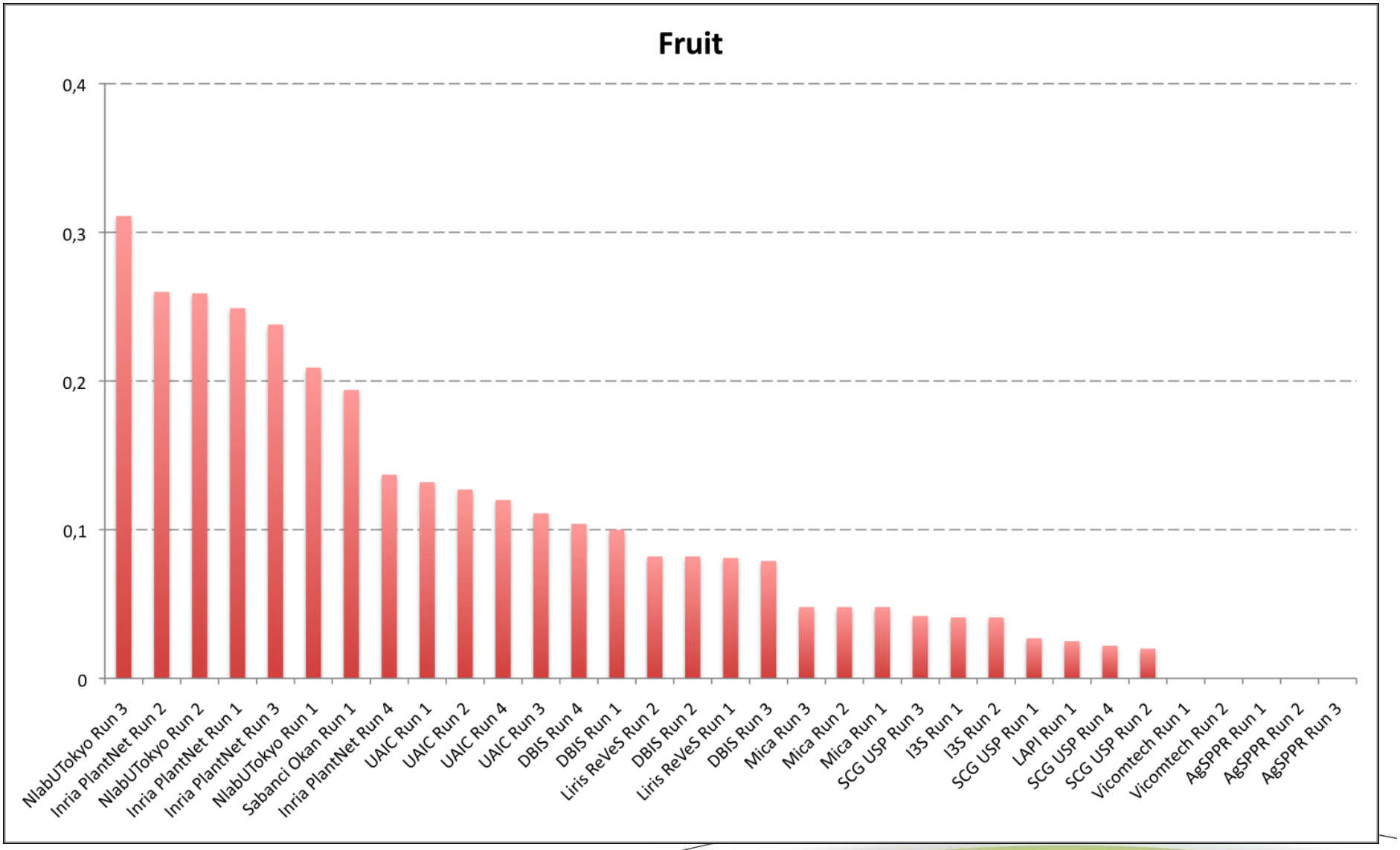

Thank you!!

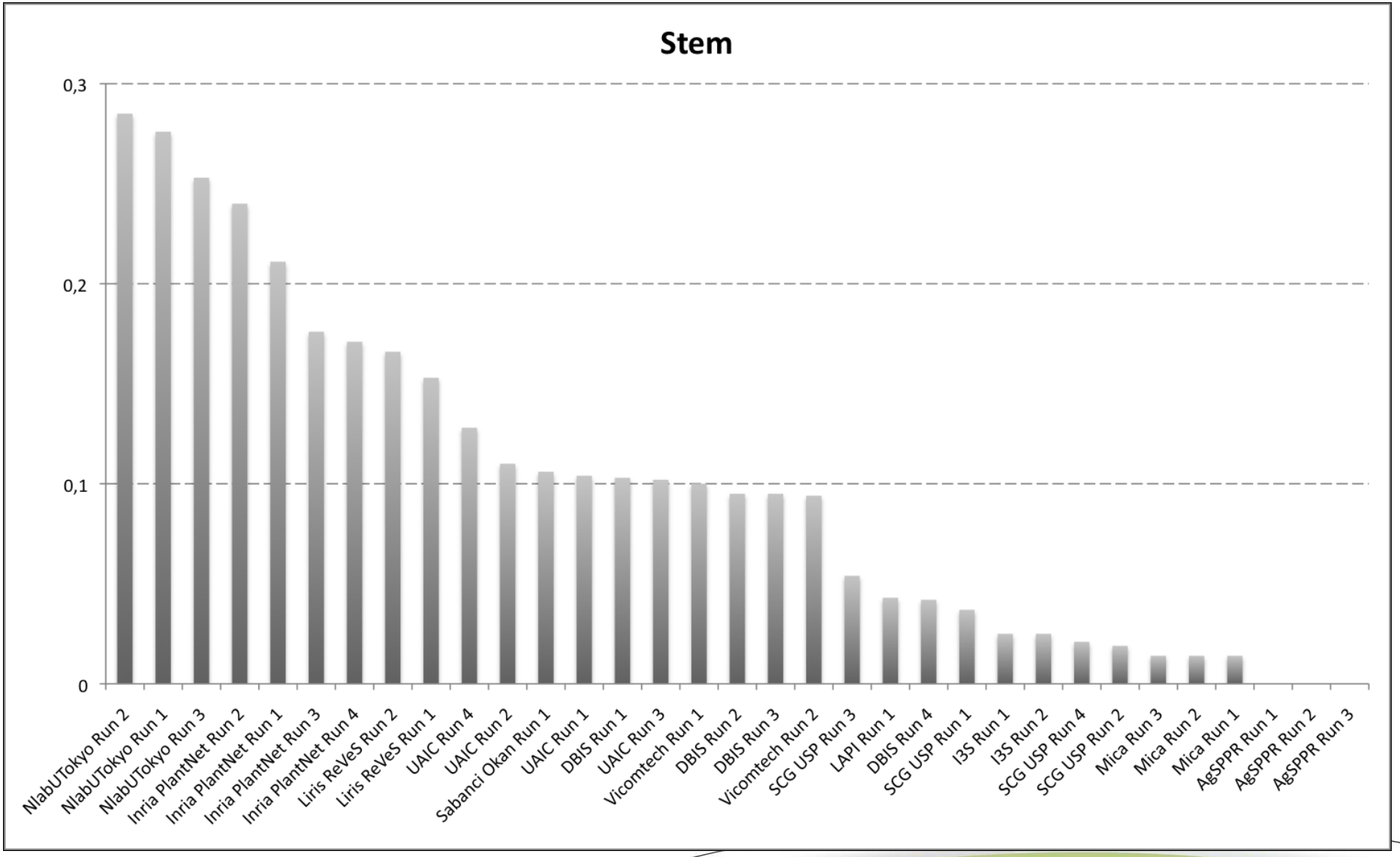

All views
Entire
Flower
Fruit
Leaf
Stem
0,5
0,4
0,3
0,2
0,1
0
NlabUTokyo Run 3
Inria PlantNet Run 2
NlabUTokyo Run 2
Inria PlantNet Run 1
NlabUTokyo Run 1
Inria PlantNet Run 3
Inria PlantNet Run 4
Sabanci Okan Run 1
DBIS Run 2
DBIS Run 3
DBIS Run 4
UAIC Run 4
DBIS Run 1
UAIC Run 1
UAIC Run 2
Liris ReVeS Run 2
Liris ReVeS Run 1
UAIC Run 3
Vicomtech Run 1
Vicomtech Run 2
LAPI Run 1
Mica Run 2
Mica Run 3
SCG USP Run 3
I3S Run 1
I3S Run 2
SCG USP Run 1
SCG USP Run 2
Mica Run 1
SCG USP Run 4
AgSPPR Run 1
AgSPPR Run 2
AgSPPR Run 3

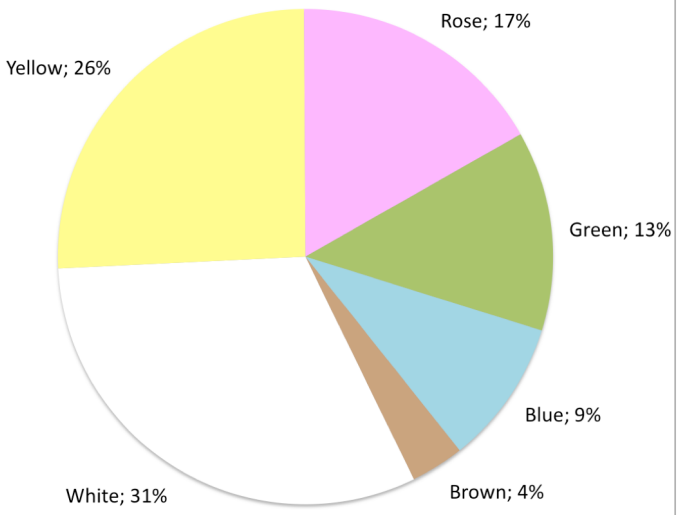

Entire
0,3
0,2
0,1
0
NlabUTokyo Run 3
Inria PlantNet Run 2
NlabUTokyo Run 2
Inria PlantNet Run 1
NlabUTokyo Run 1
Inria PlantNet Run 3
Sabanci Okan Run 1
DBIS Run 4
Inria PlantNet Run 4
DBIS Run 3
DBIS Run 2
Vicomtech Run 1
UAIC Run 2
Vicomtech Run 2
UAIC Run 4
UAIC Run 1
UAIC Run 3
DBIS Run 1
SCG USP Run 2
Liris ReVeS Run 2
LAPI Run 1
Liris ReVeS Run 1
SCG USP Run 1
SCG USP Run 4
SCG USP Run 3
I3S Run 1
I3S Run 2
Mica Run 2
Mica Run 3
Mica Run 1
AgSPPR Run 1
AgSPPR Run 2
AgSPPR Run 3

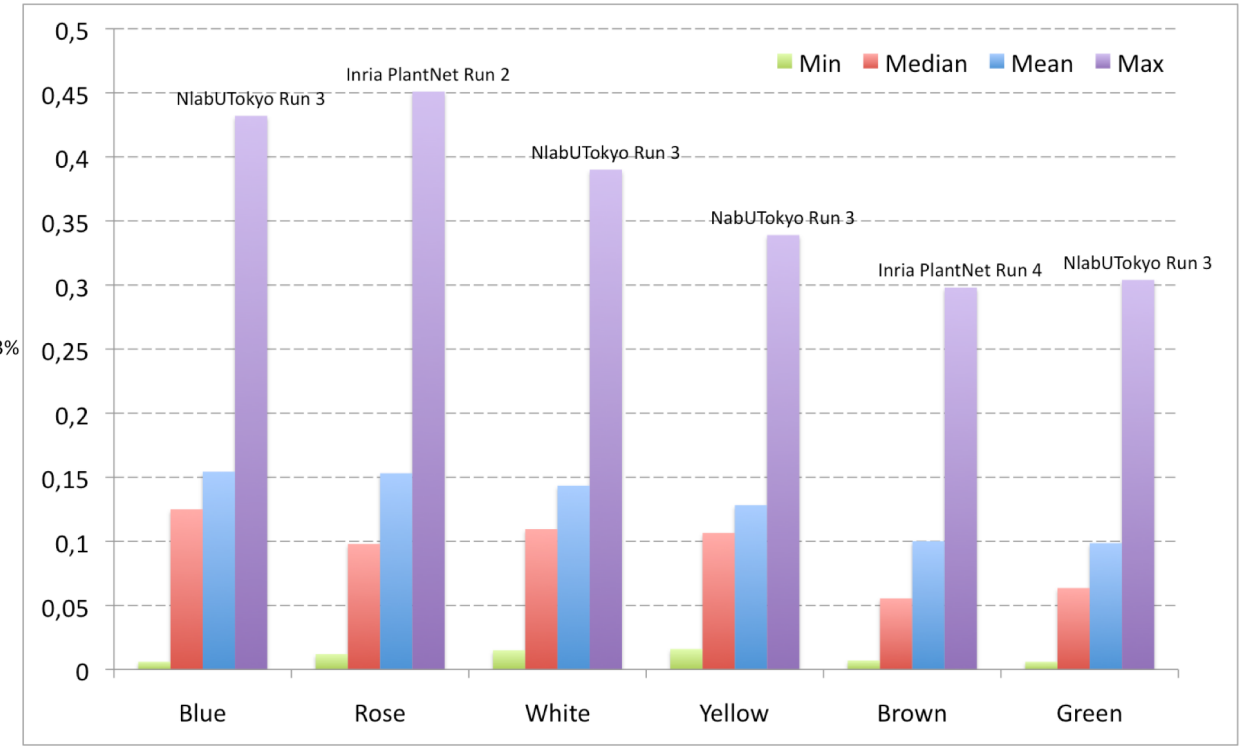

Flower
0,5
0,4
0,3
0,2
0,1
0
Inria PlantNet Run 2
NlabUTokyo Run 2
NlabUTokyo Run 3
Inria PlantNet Run 1
NlabUTokyo Run 1
Inria PlantNet Run 3
Inria PlantNet Run 4
DBIS Run 2
DBIS Run 3
Sabanci Okan Run 1
DBIS Run 4
DBIS Run 1
UAIC Run 4
Vicomtech Run 1
Vicomtech Run 2
UAIC Run 1
UAIC Run 2
Liris ReVeS Run 2
Liris ReVeS Run 1
Mica Run 2
LAPI Run 1
UAIC Run 3
SCG USP Run 2
SCG USP Run 1
SCG USP Run 3
I3S Run 1
I3S Run 2
SCG USP Run 4
Mica Run 3
Mica Run 1
AgSPPR Run 1
AgSPPR Run 2
AgSPPR Run 3


Leaf
0,3
0,2
0,1
0
NlabUTokyo Run 3
NlabUTokyo Run 2
Inria PlantNet Run 2
NlabUTokyo Run 1
Inria PlantNet Run 1
Inria PlantNet Run 3
Inria PlantNet Run 4
Liris ReVeS Run 2
Liris ReVeS Run 1
Mica Run 3
UAIC Run 2
UAIC Run 1
LAPI Run 1
UAIC Run 4
DBIS Run 1
Sabanci Okan Run 1
UAIC Run 3
SCG USP Run 3
I3S Run 1
I3S Run 2
DBIS Run 3
DBIS Run 2
SCG USP Run 4
DBIS Run 4
SCG USP Run 1
SCG USP Run 2
Mica Run 2
Mica Run 1
Vicomtech Run 1
Vicomtech Run 2
AgSPPR Run 1
AgSPPR Run 2
AgSPPR Run 3


Fruit
0,4
0,3
0,2
0,1
0
NlabUTokyo Run 3
Inria PlantNet Run 2
NlabUTokyo Run 2
Inria PlantNet Run 1
Inria PlantNet Run 3
NlabUTokyo Run 1
Sabanci Okan Run 1
Inria PlantNet Run 4
UAIC Run 1
UAIC Run 2
UAIC Run 4
UAIC Run 3
DBIS Run 4
DBIS Run 1
Liris ReVeS Run 2
DBIS Run 2
Liris ReVeS Run 1
DBIS Run 3
Mica Run 3
Mica Run 2
Mica Run 1
SCG USP Run 3
I3S Run 1
I3S Run 2
SCG USP Run 1
LAPI Run 1
SCG USP Run 4
SCG USP Run 2
Vicomtech Run 1
Vicomtech Run 2
AgSPPR Run 1
AgSPPR Run 2
AgSPPR Run 3


Stem
0,3
0,2
0,1
0
NlabUTokyo Run 2
NlabUTokyo Run 1
NlabUTokyo Run 3
Inria PlantNet Run 2
Inria PlantNet Run 1
Inria PlantNet Run 3
Inria PlantNet Run 4
Liris ReVeS Run 2
Liris ReVeS Run 1
UAIC Run 4
UAIC Run 2
Sabanci Okan Run 1
UAIC Run 1
DBIS Run 1
UAIC Run 3
Vicomtech Run 1
DBIS Run 2
DBIS Run 3
Vicomtech Run 2
SCG USP Run 3
LAPI Run 1
DBIS Run 4
SCG USP Run 1
I3S Run 1
I3S Run 2
SCG USP Run 4
SCG USP Run 2
Mica Run 3
Mica Run 2
Mica Run 1
AgSPPR Run 1
AgSPPR Run 2
AgSPPR Run 3


Rose; 17%
Yellow; 26%
Green; 13%
Blue; 9%
White; 31%
Brown; 4%


0,5
0,45
0,4
0,35
0,3
0,25
0,2
0,15
0,1
0,05
0
Min
Median
Mean
Max
NlabUTokyo Run 3
Inria PlantNet Run 2
NlabUTokyo Run 3
NabUTokyo Run 3
Inria PlantNet Run 4
NlabUTokyo Run 3
Blue
Rose
White
Yellow
Brown
Green