

Infrastructures for scalable multimedia search




The SAPIR Experience and Vision

ISTI-CNR, Pisa – Masaryk University, Brno

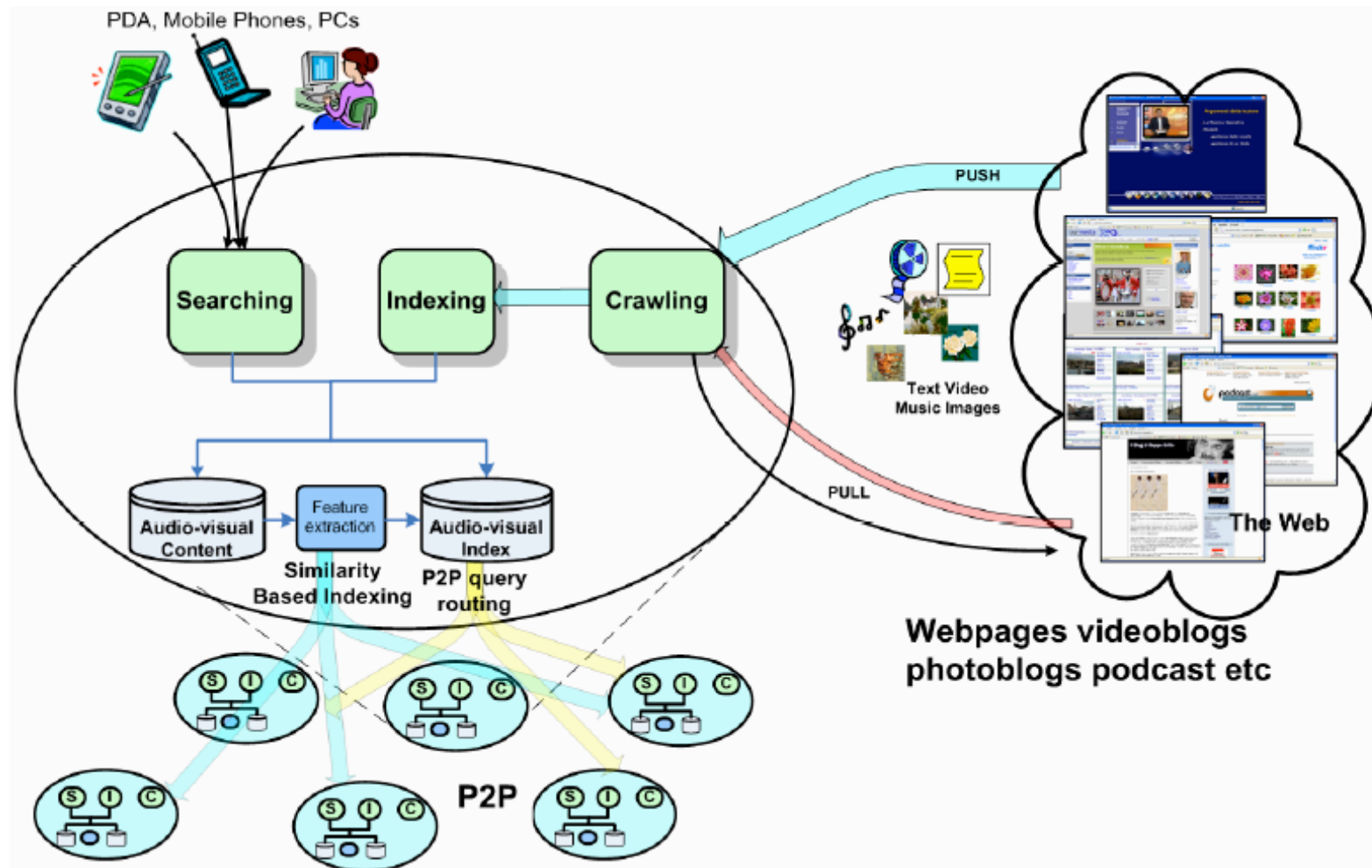
by

Fausto Rabitti and
Pavel Zezula

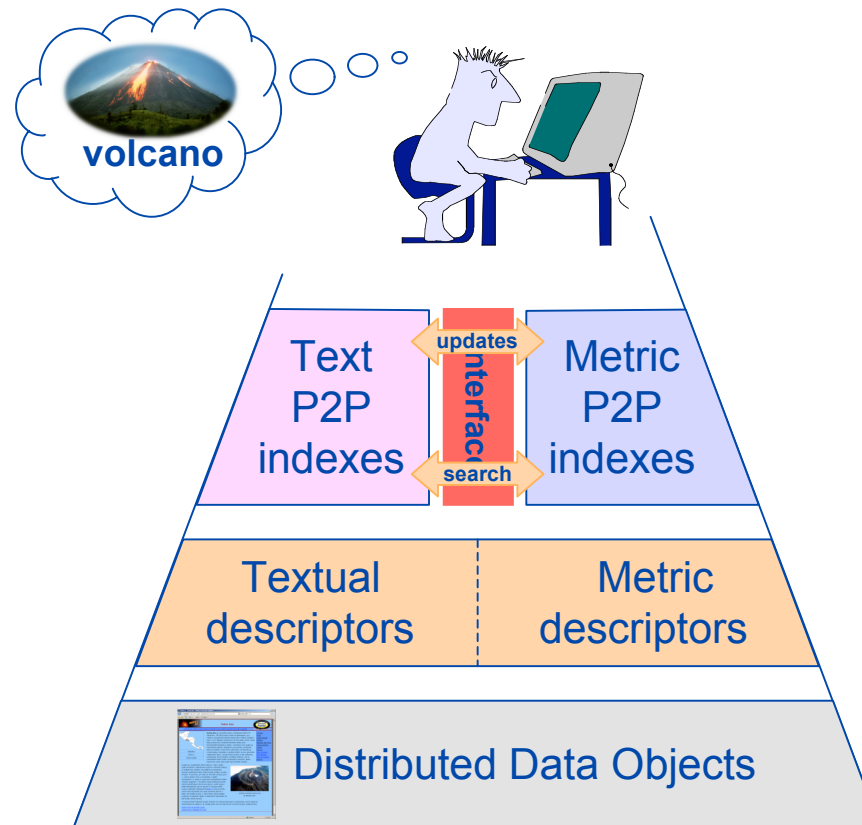
SAPIR Objectives

- Develop cutting-edge technology to index and search large scale audio-visual information by content.
- Make information available on many devices, enhanced by social networking while keeping privacy and preventing fraud
- Support new trends in MM content production: personal producer VS professional producers 
- Dimensions of the search problem: 
 - Effectiveness (based on **similarity search**) 
 - Efficiency (**scalability** is the key issue)

SAPIR Architecture



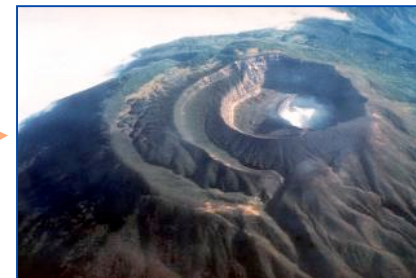
SAPIR Idea of MM Search



Objects

- Search for images
 - Locator of the image (URL)
 - Unique ID of the object

Web page



Image

http://www...

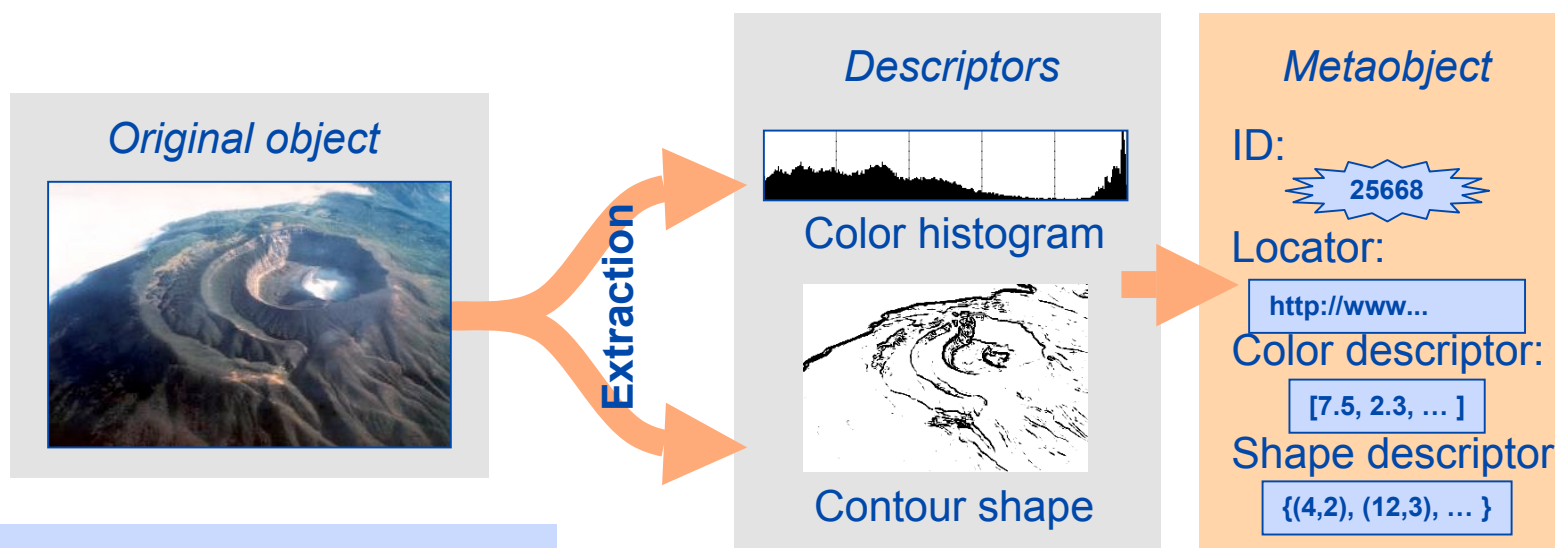
Locator

25668

ID

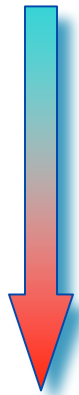
Object Descriptors

- Image feature extraction
 - MPEG7
 - results in several *metric descriptors*
 - represented by: *vectors* (color), *set of points* (shape)
 - compared by *quadratic form* (color), *Haustorff* (shape) dist.

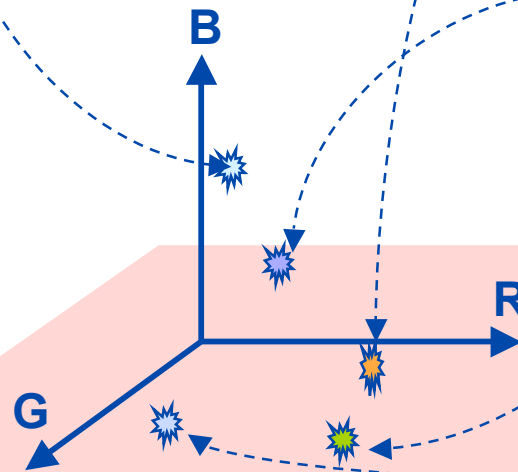
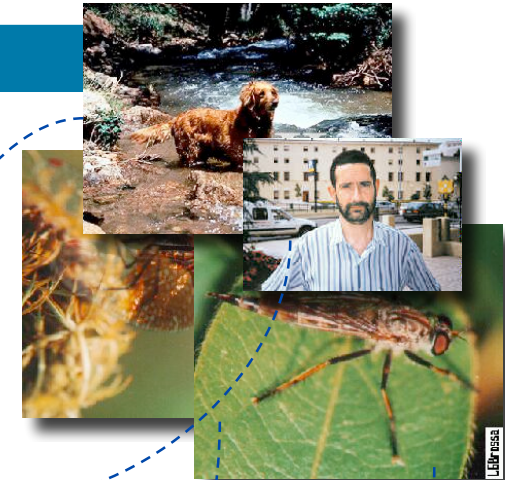


Similarity search: Feature-based Approach

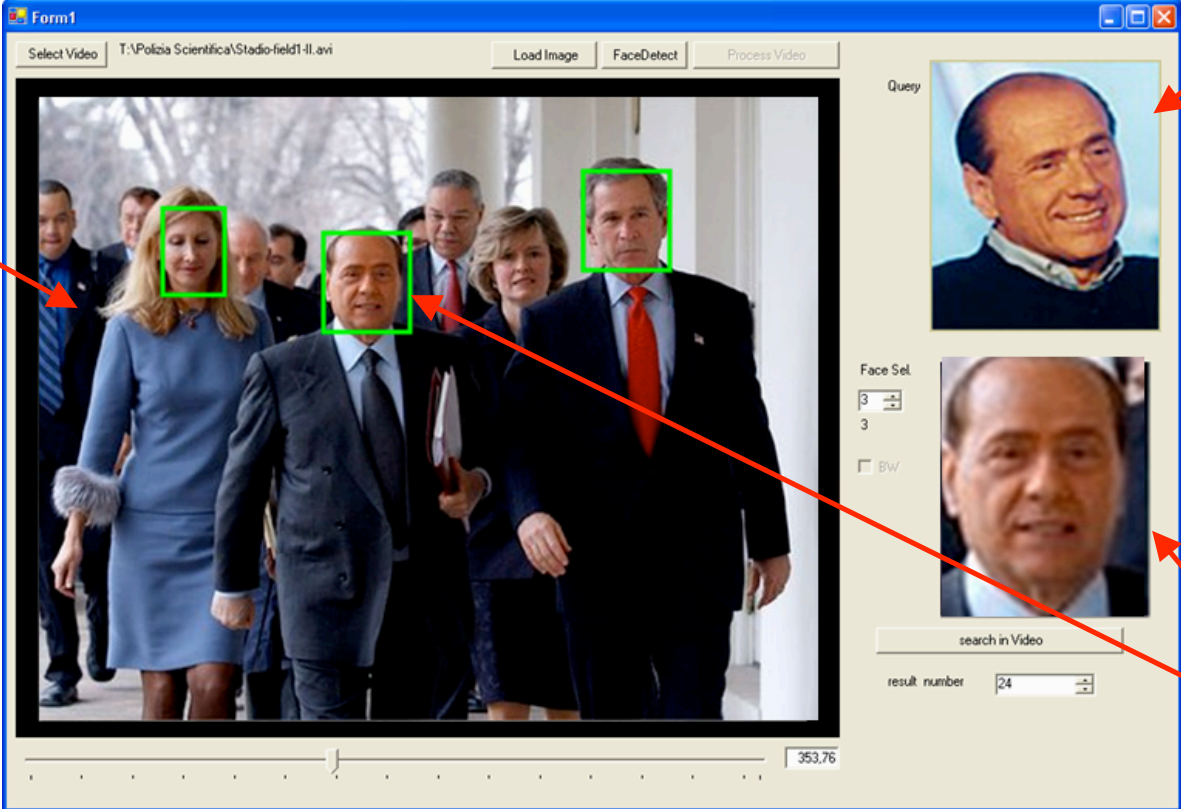
image layer



feature layer



Similarity Search: Face Recognition



The screenshot shows the SAPIR software interface. On the left, a video frame is displayed with three faces highlighted by green bounding boxes. A red arrow labeled "Video frame" points to this area. On the right, a "Query" image of a man's face is shown, with a red arrow labeled "Query" pointing to it. Below the query image, a "Face Sel" section shows a dropdown menu set to "3" and a "BW" checkbox. A "search in Video" button is located below this section. At the bottom right, a "result number" field displays "24", with a red arrow labeled "Result" pointing to it. The software window title is "Form1" and the file path is "T:\Polizia Scientifica\Stadio-field1-II.avi".

Data Acquisition and Indexing

- In order to make *significant tests* with the SAPIR infrastructure, the project needs a *huge amount of suitable MM data*: images and accompanying text
- Starting from June '07, we started extracting metadata from the *Flickr* archive (www.flickr.com) using the *GRID Diligent Infrastructure*
- The data collected so far represents the *world's largest multimedia metadata collection that will be available for research purposes*
 - Target collection: 100 million of images
 - Already processed: **42 million** of images
 - For each image we keep text data and 5 MPEG-7 features → **more than 200 millions of processed features.**

Pilot Job



CE

flickr


Home The Tour Sign Up Explore

You aren't signed in Sign In Help

Search everyone's photos Search

Image 123

ALL SIZES



Uploaded on September 3, 2006

Tags

- Japan [x]
- Kyoto [x]
- Torii [x]

[Add a tag](#)

Additional Information

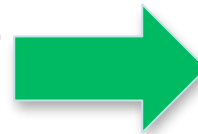
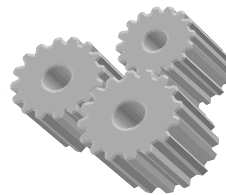
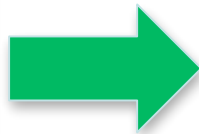
© All rights reserved [\(edit\)](#)

- Taken in Kyoto-shi, Kyoto Prefecture [\(map\)](#)
- Taken with a [Casio EX-Z1200](#)
- [More properties](#)
- Taken on [August 18, 2007](#) [\(edit\)](#)
- [See different sizes](#)
- Viewed 3 times (Not including you)
- [Edit title, description, and tags](#)

[This photo is public](#) [\(edit\)](#)

[Flag your photo](#)

[Comments](#)



```
<xml>  
  <MPEG-7>  
    ...  
  </MPEG-7>  
  <tags>  
    ...  
  </tags>  
</xml>
```

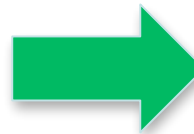
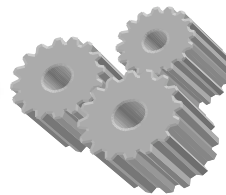
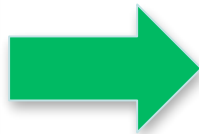



Image Search DEMOS

- SAPIR Demo based on MILOS:
 - 160K Flickr Objects (Image and accompanying text)
 - Combined similarity search (centralized): image and text
- SAPIR Demo based on MUFIN:
 - 10 million Flickr images
 - Large scale (distributed) image similarity search

SAPIR MILOS - Combined search


















Tag: flower & Example Image

Query



Field	Value
tag	flower

			results 1-15					
similar adv search	P6031833		similar adv search	P6031822		similar adv search	Tulip yellow and red	
	Location	Gifu Japan username: Jun184 Taken on: 2006-06-03 Extended metadata comments		Location	Gifu Japan username: Jun184 Taken on: 2006-06-03 Extended metadata		Location	Gifu Japan username: hshhshhsh Taken on: 2006-05-09 Extended metadata comments
	tags	flower flowers yellow orange		tags	flower flowers yellow orange fishery		tags	tulip yellow red nature flower spring excellence description A tulip from our garden
similar adv search	P6031824		similar adv search	P6031811		similar adv search	P6031827	
	Location	Gifu Japan username: Jun184 Taken on: 2006-06-03 Extended metadata		Location	Gifu Japan username: Jun184 Taken on: 2006-06-03 Extended metadata comments		Location	Gifu Japan username: Jun184 Taken on: 2006-06-03 Extended metadata comments
	tags	flower flowers yellow orange		tags	flower flowers yellow orange geo:lat=354225897 geo:lon=1393574997 photo:tagged description a href="http://alpb.lpb.jp/a/d/f/159674008" target="blank">http://alpb.lpb.jp/a/d/f/159674008		tags	flower flowers yellow orange
similar adv search	Beetles on Sunflower 052506		similar adv search	Parrottulip yellow and red		similar adv search	flower centre	
	Location	Washington DC username: wovovex Taken on: 2006-05-25 Extended metadata		Location	Gifu Japan username: hshhshhsh Taken on: 2006-05-10 Extended metadata comments		Location	MANCHESTER username: fashigh-energy Taken on: 2005-04-29 Extended metadata
	tags	washingtondc wovovex flower flowers insect insects bug bugs beetle beetles description The flowers were littered with these tiny little beetles		tags	tulip parrottulip red yellow nature flower spring		tags	flower yellow
similar adv search		Location	similar adv search	P6031834		similar adv search	cap	
	username	_moko_		Location	Gifu Japan username: Jun184 Taken on: 2006-06-03 Extended metadata comments		Location	Flores Taken on: 2006-01-30 Extended metadata
	tags	rose flower		tags	flower flowers yellow orange		tags	hat crochet vramtrade flower
similar adv search	P5271694		similar adv search	SaintMarksFall2005101513		similar adv search	cap	
	Location	Gifu Japan username: Jun184 Taken on: 2006-05-27 Extended metadata		Location	Denver username: Jean Charles, you fool!		Location	Flores Taken on: 2006-01-30 Extended metadata comments
	tags	flower flowers yellow		tags	flower flowers yellow		tags	hat crochet vramtrade flower description This was the pattern that Florence sent me with the yarn trade from quotCrazy for Knittingquot I made the cap nice one without the flowers. There was no mohair of the recommended gauge so I got so I thought wendwood wool and polycryl from Schoeller and used a flon hook for it



ISTI-CNR,

Powered by MUFIN
Masaryk University, Faculty of Informatics, Network
for
MUlti-metric Feature INdexing

k-nearest neighbors query ▾

Query object



Number of nearest objects

21

Change object

Search

KNNQueryOperation (21)

Loading: 11ms Search: 244ms



21

Query object

Number of nearest objects



[0,00000](#)



[0,50124](#)



[0,53994](#)



[0,57359](#)



[0,57929](#)



[0,58804](#)



[0,59997](#)



[0,65292](#)



[0,65477](#)



[0,66008](#)



[0,66180](#)



[0,66180](#)



[0,66398](#)



[0,67503](#)

k-nearest neighbors query ▾

Query object



Number of nearest objects

21

Change object

Search










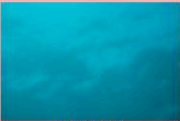










KNNQueryOperation (21)

Loading: 18ms Search: 193ms



21

Query object Number of nearest objects

 0,0000	 0,26585	 0,27800	 0,28730	 0,29562	 0,29829	 0,30453
 0,30806	 0,32359	 0,32561	 0,32784	 0,32850	 0,33003	 0,34063
						

Powered by **MUFIN**
 Masaryk University, Faculty of Informatics, Network
 for
 MUlti-metric Feature INdexing

k-nearest neighbors query ▾

Query object



Number of nearest objects

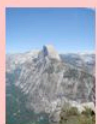
21

Change object

Search

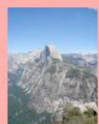
KNNQueryOperation (21)

Loading: 4ms Search: 323ms



21

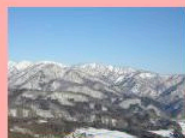
Query object Number of nearest objects



0.00000



0.90917



0.91115



0.92921



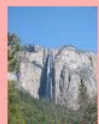
0.96542



0.96620



1.00319



1.00436



1.00554



1.02257



1.02581



1.04617



1.04958



1.05335



Powered by **MUFIN**
 Masaryk University, Faculty of Informatics, Network
 for
 Multi-metric Feature INdexing

k-nearest neighbors query ▾

Query object



Number of nearest objects

21

Change object

Search

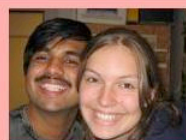
KNNQueryOperation (21)

Loading: 15ms Search: 468ms



21

Query object Number of nearest objects



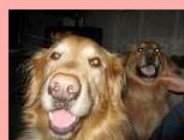
[0,73004](#)



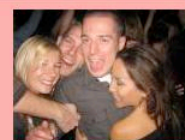
[0,78165](#)



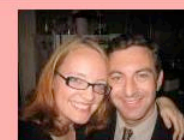
[0,80204](#)



[0,82136](#)



[0,82263](#)



[0,82677](#)



[0,82824](#)



[0,82882](#)



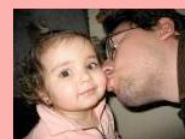
[0,83503](#)



[0,83702](#)



[0,84187](#)



[0,84593](#)



[0,84633](#)



[0,84930](#)



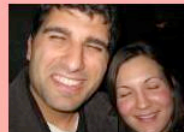
[0,85027](#)



[0,85177](#)



[0,85186](#)



[0,85199](#)



[0,85247](#)



[0,85420](#)



[0,85914](#)

k-nearest neighbors query ▾

Query object



Number of nearest objects

21

Change object

Search

KNNQueryOperation (21)

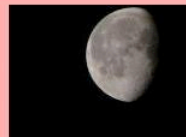
Loading: 26ms Search: 297ms



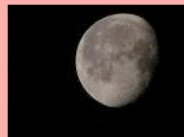
21

Query object

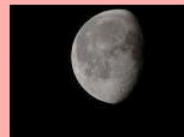
Number of nearest objects



[0,00000](#)



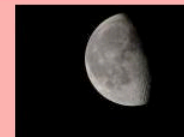
[0,30052](#)



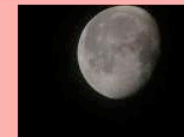
[0,32164](#)



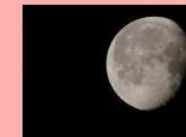
[0,34214](#)



[0,35199](#)



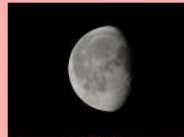
[0,35465](#)



[0,37057](#)



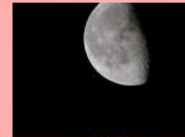
[0,40739](#)



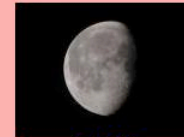
[0,45642](#)



[0,48655](#)



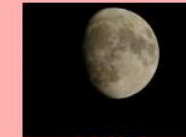
[0,49170](#)



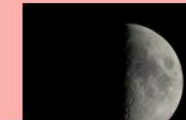
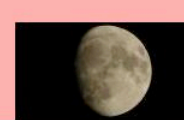
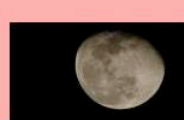
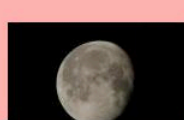
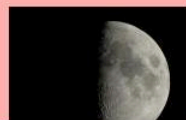
[0,49210](#)

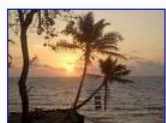


[0,49508](#)

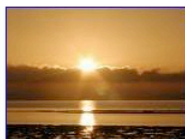


[0,50547](#)

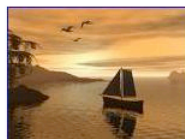




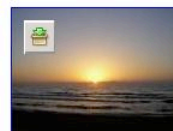
Sunrise in Belize
500 x 375 - 119k - jpg
bolsinger.blogs.com



Sunrise from Bay Trail, Foster City
1024 x 768 - 72k - jpg
www.fostercity.com



Sunrise
1024 x 768 - 94k - jpg



Sunrise Picture Image
737 x 553 - 120k - jpg



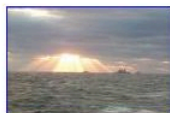
SUNRISE BEACH ...
400 x 300 - 103k - jpg



... Penzion Sunrise - studia
800 x 600 - 202k - jpg



Penzion Sunrise
800 x 600 - 94k - jpg



Sunrise at sea
640 x 426 - 166k - jpg
photos.somd.com



Obrázek ke článku
Sunrise ...
500 x 375 - 24k
pc.hrej.cz



... Hotel Sunrise Island View
800 x 535 - 128k
www.blue-style.cz
[Více z domény www.blue-style.cz]



+ Komentáře (2) City
800 x 521 - 198k
jankovarik.n

<http://lsd.f.muni.cz> - MUFIN Image Search - Mozilla Firefox

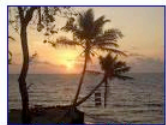
Powered by **MUFIN**
 Masaryk University, Faculty of Informatics, Network
 for
 Multi-metric Feature **INDEXING**

Loading: 245ms Extraction: 52ms Search: 246ms

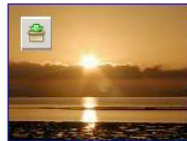
ApproxKNNQueryOperationPresentable (21)

Query object: 21
 Number of nearest objects

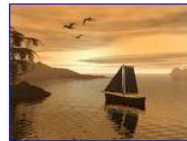
0,59443	0,60143	0,61355	0,66844	0,67236	0,69037	0,69151	
0,70049	0,71576	0,72080	0,72678	0,72690	0,72785	0,72881	



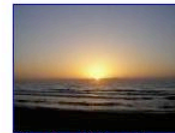
Sunrise in Belize
500 x 375 - 119k - jpg
[bolsinger.blogs](#)



Sunrise from Bay Trail, Foster City
1024 x 768 - 72k - jpg



Sunrise
1024 x 768 - 94k - jpg



Sunrise Picture Image
737 x 553 - 120k - jpg



SUNRISE BEACH ...
400 x 300 - 103k - jpg



... Penzion Sunrise - studia
800 x 600 - 202k - jpg



Penzion Sunrise
800 x 600 - 94k - jpg
[www.lefkada.cz](#)

[[Více z domény www.lefkada.cz](#)]



Sunrise at sea
640 x 426 - 166k - jpg
[photos.somd.com](#)



... Hotel Sunrise Island View
800 x 535 - 120k - jpg
[www.blue-style.cz](#)
[[Více z domény www.blue-style.cz](#)]

Powered by MUFIN
Masaryk University, Faculty of Informatics, Network
for
MULTI-metric Feature INDEXING

ApproxKNNQueryOperationPresentable (21) Loading: 58ms Extraction: 61ms Search: 181ms

21
Query object Number of nearest objects

 0,59341	 0,59585	 0,61388	 0,65273	 0,65776	 0,68846	 0,69060
 0,69845	 0,69907	 0,70178	 0,70660	 0,70848	 0,72591	 0,72658



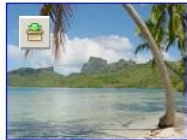
Sunrise ... Hotel Sunrise Island View
800 x 533 - 79k - jpg
[www.blue-style.cz](#)



sunrise Svěží vítr z Finska: Sunrise Avenue ...
400 x 265 - 100k - jpg
[www.danmusic.cz](#)



Wallpaper Beach 1152 x 864
1152 x 864 - 164k - jpg
www.smightly.com



BEACH TOWN PRESS books
available:
1024 x 768 - 158k - jpg
www.beachtownpress.com



AKCE - beach short
450 x 675 - 50k - jpg
www.zona-sport.cz



SUNRISE BEACH ...
400 x 300 - 103k - jpg
www.dantour.cz



oasis beach hotel
531 x 397 - 67k - jpg
www.dubai-info.net



Hotel The Jumeriach Beach posouvá
...
534 x 351 - 50k - jpg
www.dubai-info.net



Název: Tapeta Miami beach ...
400 x 300 - 86k - jpg
www.wallpaper.cz



Merco Beach Touch
350 x 349 - 49k - jpg
www.rajsportu.cz

http://isd.f.muni.cz - MUFIN Image Search - Mozilla Firefox

Powered by MUFIN
Masaryk University, Faculty of Informatics, Network
for
Multi-metric Feature INDEXing



PENZION PERIGIALI BEACH - pokoje
800 x 600 - 163k - jpg
www.lefkada.cz

ApproxKNNQueryOperationPresentable (21)

Loading: 83ms Extraction: 56ms Search: 164ms



21

Query object Number of nearest objects



[1,32927](#)



[1,33273](#)



[1,33490](#)



[1,34932](#)



[1,36989](#)



[1,37625](#)



[1,37848](#)



[1,37937](#)



[1,38345](#)



[1,38754](#)



[1,39045](#)



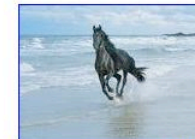
[1,39054](#)



[1,39255](#)



[1,40406](#)



... do.....oo..... d"")80"
1024 x 768 - 88k - jpg
rrrybicka.sblog.cz



... hotel SEA GULL BEACH
450 x 299 - 43k - jpg
www.egypt-last-minute.com

The whole wor

updated 5:17 p.m. EDT, Mon October 8, 2007

Pulled over by an F-16

EMMITSBURG, Maryland (AP) -- The skies were empty at a out of the area by F-16 fighter jets sent up because Preside



GETTY IMAGES
 F-16s like this one escorted the antique planes out of the no-fly zone Sunday.

North American Aerospace Defense Command to scramble escorted to nearby airports and forced to land. The others v

Meanwhile, at the annual event, attendees were staring at about to start. Suddenly, according to an account in The W plane buzzing along with a sleek fighter jet flying circles arc

It was hair-raising, said Tracey Potter, owner of Hagerstow menacing scary sound, and at the same time -- amazing."

Laura Brown, a spokeswoman for the FAA, said the pilots would not have had the problem if they had been using radios. She said all pilots have a responsibility to check the agency's notifications.

The pilots, who were being interviewed by the Secret Service, could face penalties, including suspension of their license, Brown said. [E-mail to a friend](#)

ApproxKNNQueryOperationPresentable (21)

Loading: 74ms Extraction: 920ms Search: 277ms



21

Query object Number of nearest objects



[0.77364](#)



[0.85269](#)



[0.95984](#)



[0.96521](#)



[0.97049](#)



[1.01155](#)



[1.02801](#)



[1.03910](#)



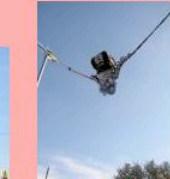
[1.04420](#)



[1.04749](#)



[1.05013](#)



[1.07668](#)



[1.08145](#)



[1.08398](#)



[1.08598](#)



[1.08986](#)



[1.09334](#)



[1.09921](#)

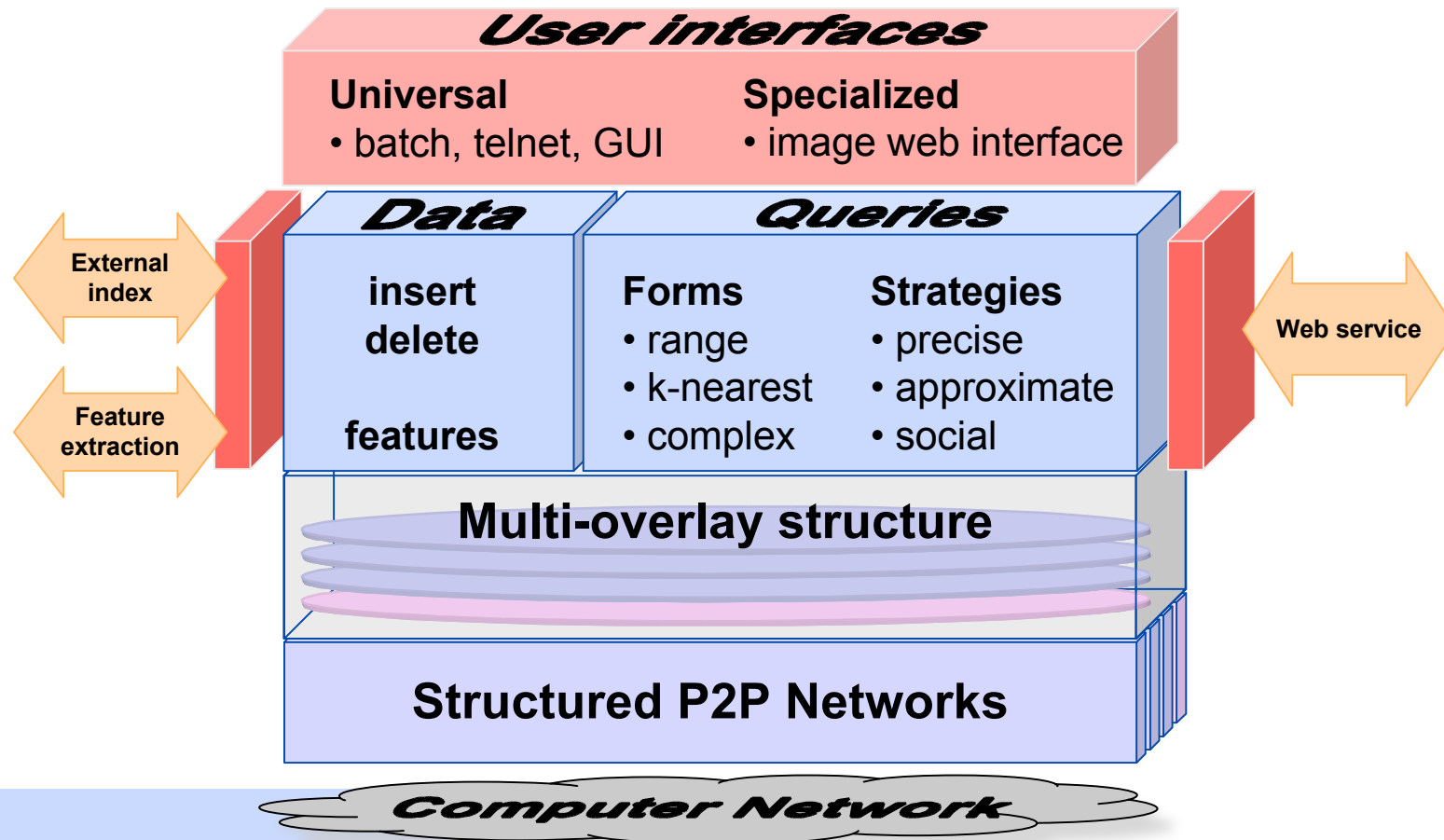
30 new
 luxury
 hotels

Scalable Similarity Search Architecture

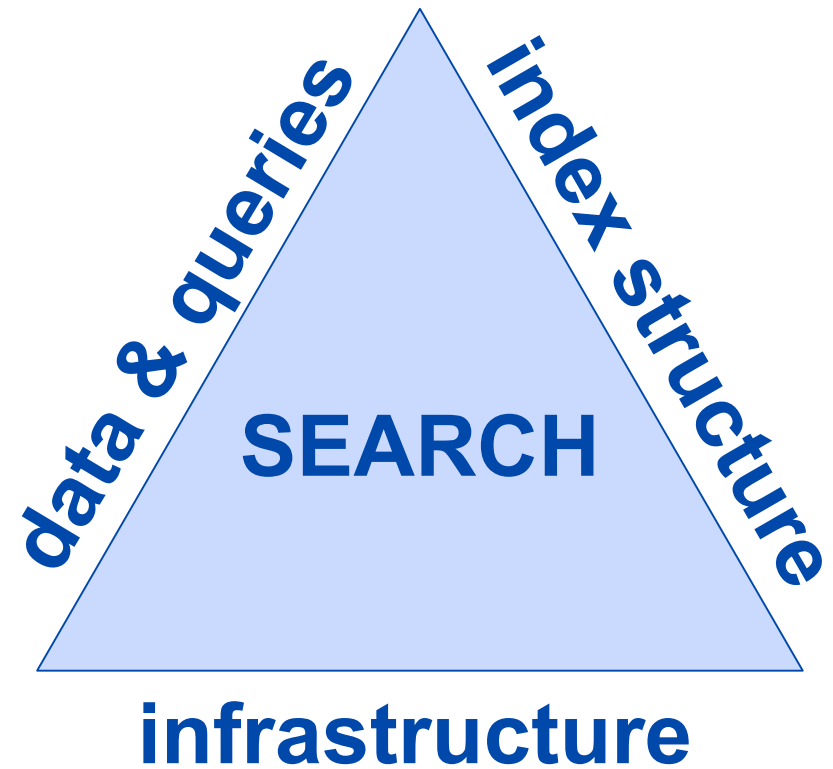


- Search powered by MUFIN
 - **MU**lti **F**eature **I**ndexing **N**etwork, or
 - **M**asaryk **U**niversity **F**aculty of **I**nformatics **Br**no
- Implementation paradigms:
 - Metric space model of similarity for *extensibility*
 - Structured P2P networks for *scalability*

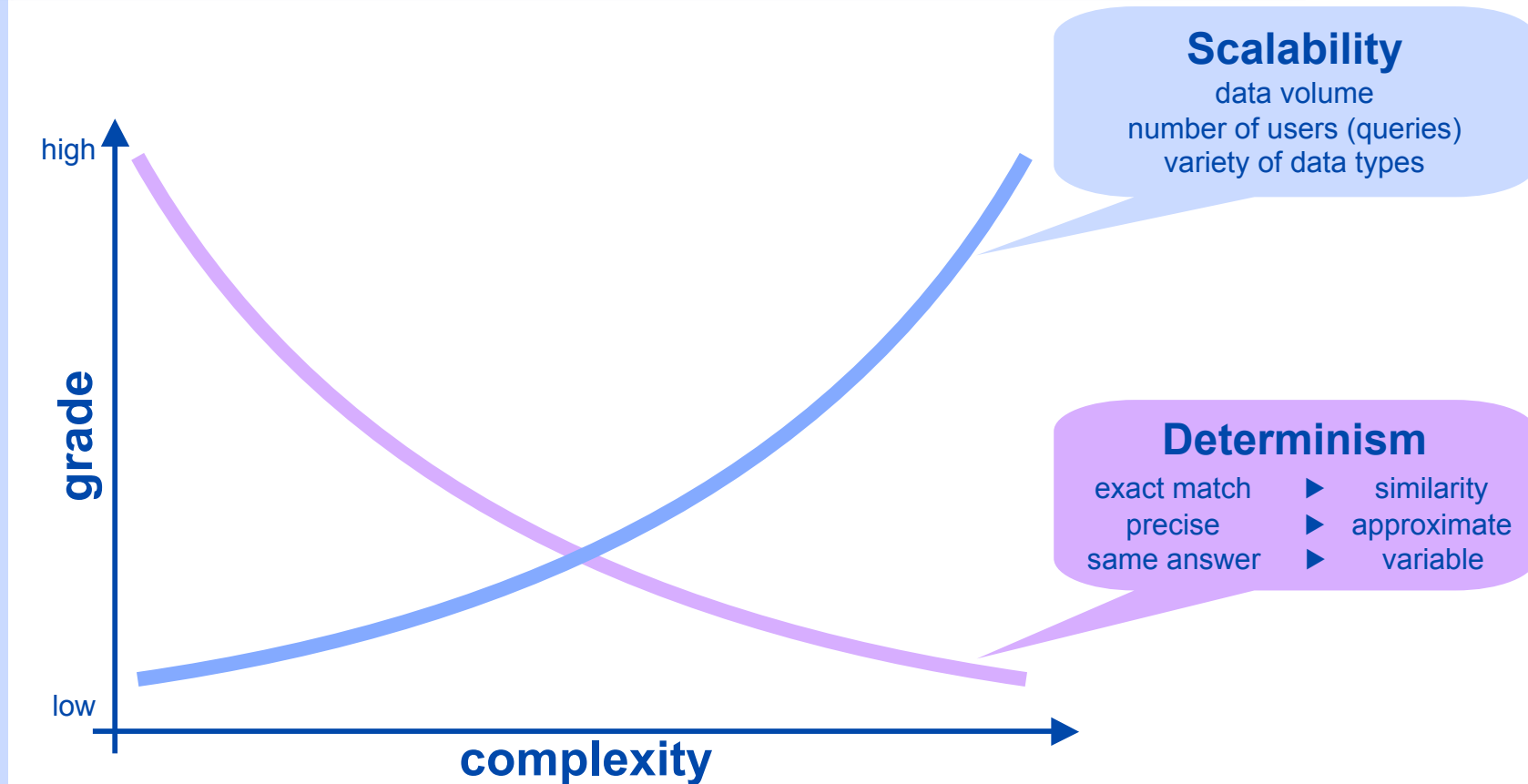
MUFIN Overview



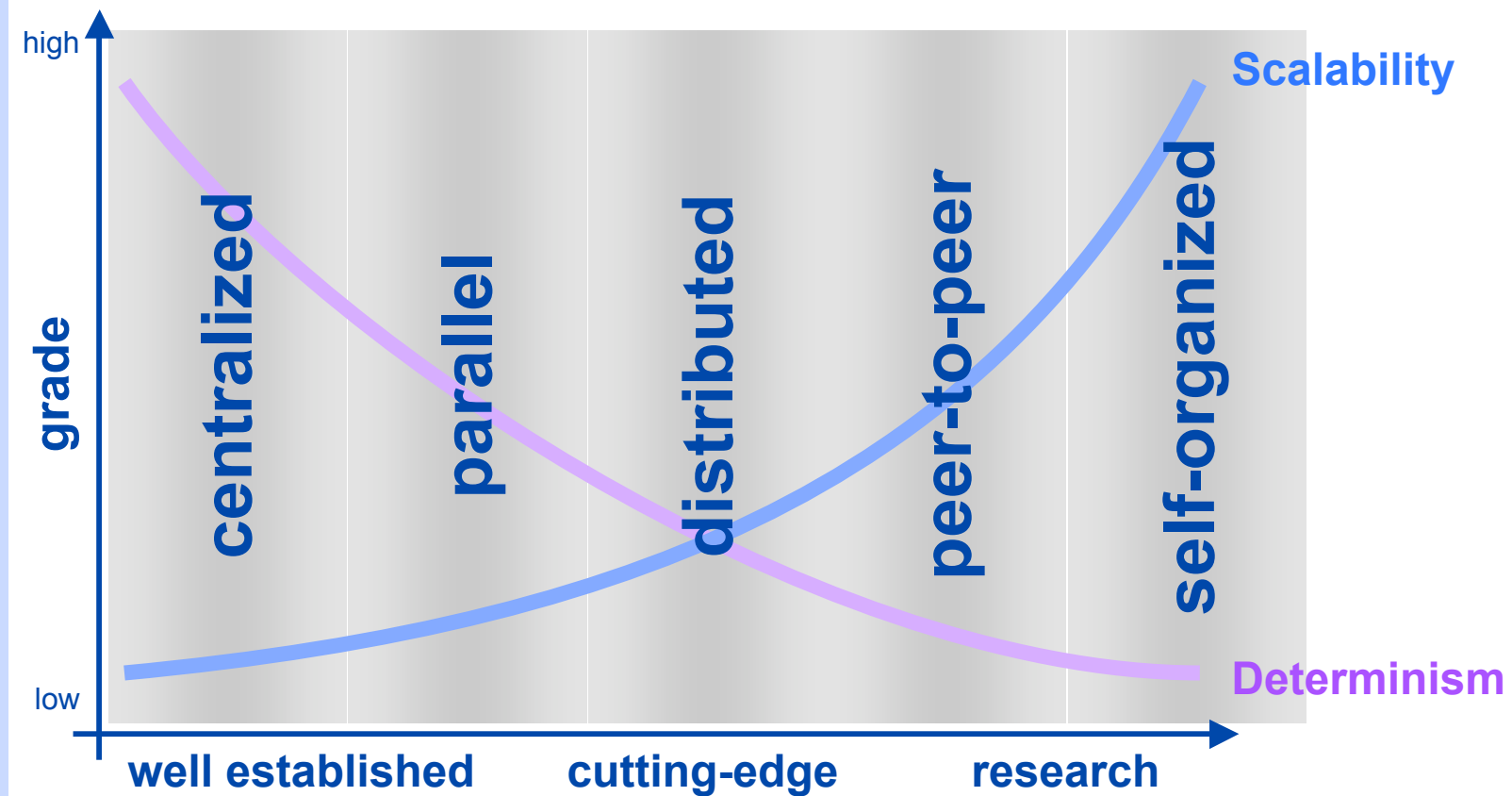
Search problem



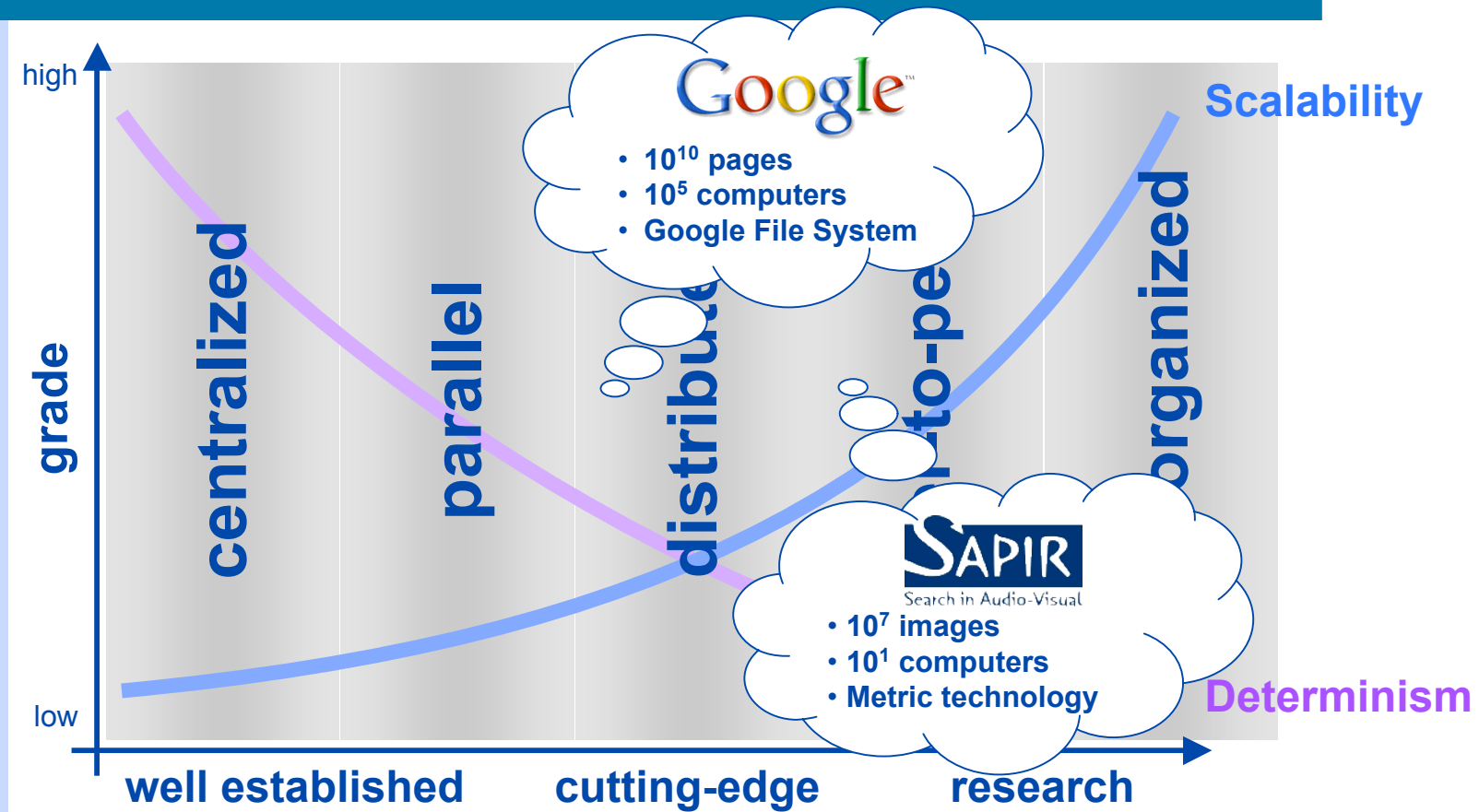
Search problem



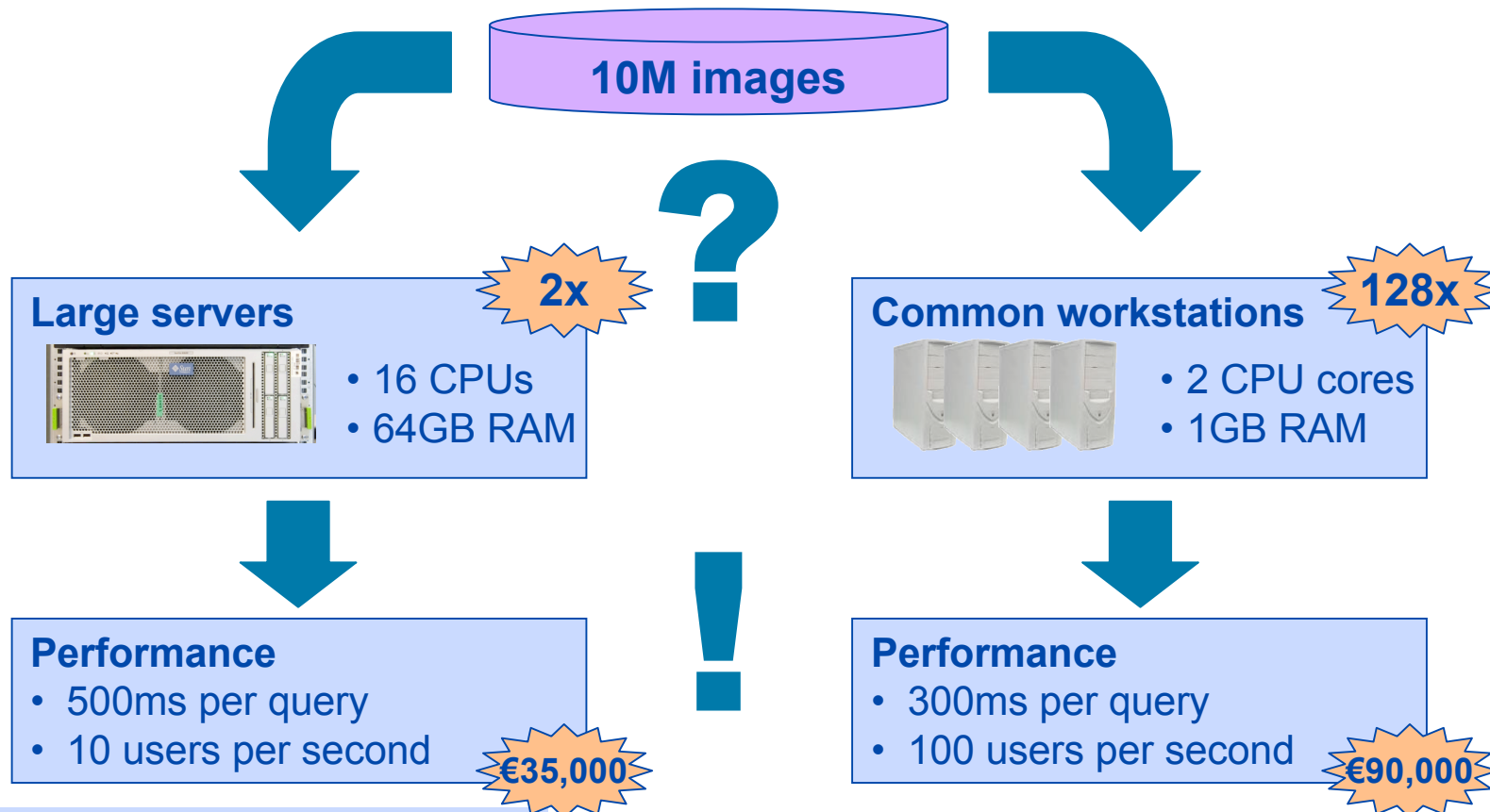
Search models



Search models



Infrastructures



Infrastructure challenges for multimedia data



- **Feature extraction** for different object types, e.g. indoor (outdoor) images, with people, etc. – typical grid-like application
- **Object classification**: machine learning techniques – computationally expensive
- **Online query execution** – hundreds (or more) queries per second
- **Robustness and reliability**

Why infrastructure models for scalability



- Huge **differences in costs** of different configurations
- Experimental **trials are expensive** or impossible
- There are **changes in technology** – CPU, storage, communication
- Feasibility **studies for future data** (query) extensions are needed

The End

- Questions?