



Face recognition in the wild: large-scale computer vision for web applications

Jan Erik Solem
Founder & CTO

CIVR2009, Thira



Polar Rose 

A person in a white shirt is pointing towards a screen. In the foreground, another person's hands are visible, holding a light blue device. The background is a warm, reddish-brown color, possibly a wall or a light fixture.

Polar Rose in brief

Evolution of large scale face recognition

Things we tried & lessons learned

Near-dupe detection

Challenges for the future



View map

[Edit Map Style](#)

[Feedback](#)

[Get Direction](#)

[Change Style](#)

[Export](#)

[Share](#)

A map interface showing North America and Europe. The map is centered on the Atlantic Ocean. Various countries are labeled: Canada, United States, Mexico, Norway, Sweden, Germany, Poland, France, Ukraine, Turkey, Algeria, Libya, Egypt, Mauritania, Mali, Niger, and Chad. The map includes navigation controls on the left (directional arrows and a zoom slider) and a scale bar at the bottom left (1000 km and 1000 mi). A 'Permalink' link is provided at the bottom left. At the bottom of the map area, there is a copyright notice: '© 2009 CloudMade - Map data CCBYSA 2009 OpenStreetMap.org contributors - Terms of Use'.

Annotations on the map include:

- A text box 'General management, computer vision' with a small image of two people sitting at a desk, located over Norway and Sweden.
- A text box 'Web development' with a small image of a group of people, located over Poland and Ukraine.
- A text box 'Computer vision' with a small image of two people in red shirts, located over France.
- A text box 'Business development' with a small image of a man's face, located over the United States.

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Polar Rose in brief

3 versions in 3 years summarized in 3? minutes

An aerial photograph of a large-scale construction site in Dubai, United Arab Emirates. In the foreground, several multi-story buildings are under construction, with their concrete skeletons and some glass facades visible. The ground is a mix of dirt, construction materials, and some completed infrastructure. In the background, the iconic Burj Khalifa is seen under construction, its distinctive tiered structure rising against a clear blue sky. Other skyscrapers of the Dubai skyline are visible in the distance. The overall scene depicts a major urban development project.

Spring 2007

Polar Rose as a global search engine for people tagged and recognized in photos across the web

IMG_0676.JPG

ADD NOTE SEND TO GROUP ADD TO SET BLOG THIS ALL SIZES PRINTS MORE ROTATE EDIT PHOTO DELETE



You say this is...

Tommy Ahlers

[Edit](#) or [View more photos of this person](#)

[This is a personal favorite](#)

[This is a picture of me](#)

[Set this as my user avatar](#)

[This is adult content and should be moderated](#)

[This is a bug](#)

[More information](#)

Add your comment

Uploaded on September 30, 2007 by Polar Rose Mikkel

Polar Rose Mikkel's photostream

657 photos

browse

Tags

Techcrunch40 [x]

[Add a tag](#)

Additional Information

- All rights reserved (edit)
- [Place this photo on a map](#)
- Taken with a Canon Digital IXUS 55. [More properties](#)
- Taken on September 17, 2007 (edit)
- [See different sizes](#)
- [Photo stats](#)
- Viewed 4 times (Not including you)
- [Edit title, description, and tags](#)
- [Replace this photo](#)
- This photo is public (edit)



Polar Rose

Enter a persons name here...

Search

polarbot found...

Showing 1 - 20 of 8058

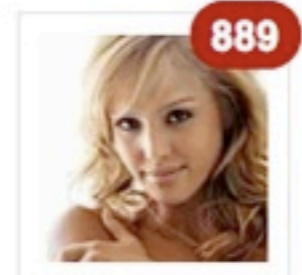
Sorted by: Name | [Date](#)



Barack Obama



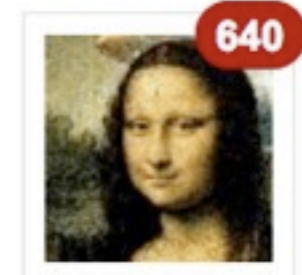
George W. Bush



Jessica Alba



John McCain



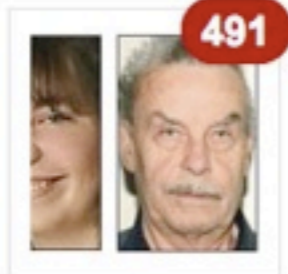
Mona Lisa



Britney Spears



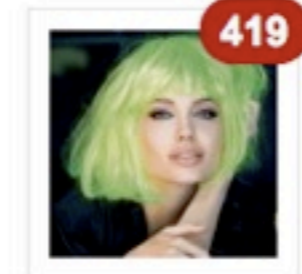
Sarah Palin



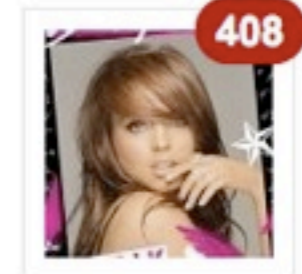
Josef Fritzl



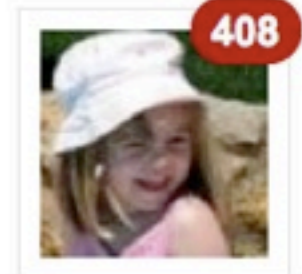
Heath Ledger



Angelina Jolie



Lindsay Lohan



Madeleine McCann

Polar Rose

Polar Rose

Enter a persons name here...

Search

polarbot found...

Showing 1 - 20 of 8058

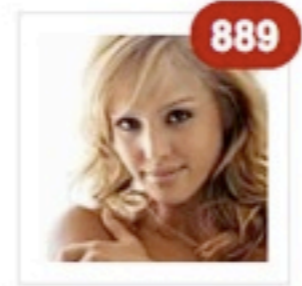
Sorted by: Name | [Date](#)



Barack Obama



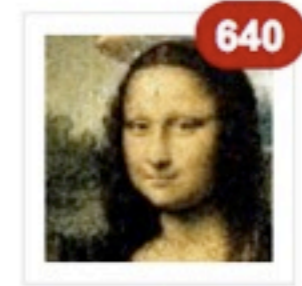
George W. Bush



Jessica Alba



John McCain



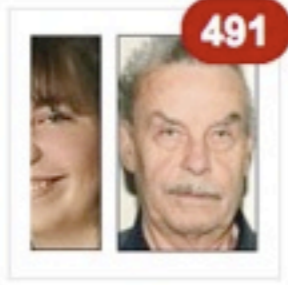
Mona Lisa



Britney Spears



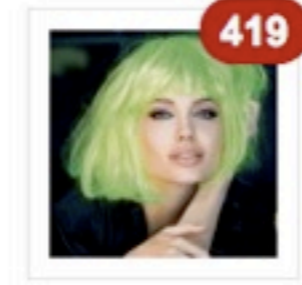
Sarah Palin



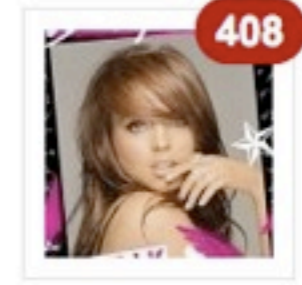
Josef Fritzl



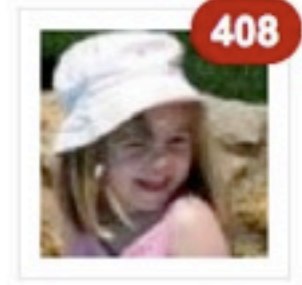
Heath Ledger



Angelina Jolie



Lindsay Lohan



Madeleine McCann

Polar Rose



george bush

Search Images

Search the Web

Advanced Image Search Preferences

SafeSearch is off

New! Google Image Labeler

Images Showing: All image sizes

Results 1 - 20 of about 8,940,000 for george bush. (0.11 seconds)

Related searches: george w bush



george-w-bush-picture.jpeg
370 x 398 - 28k - jpeg
weblogs.newsday.com



George Bush - Now I'm gonna save
...
720 x 540 - 119k - jpg
reefermagnets.com



George Bush - Now I can dress
myself ...
864 x 648 - 155k - jpg
reefermagnets.com



George W Bush, Denver, CO. Aug. ...
300 x 390 - 19k - jpg
www.endevil.com



we've seen George Bush jr's ...
300 x 450 - 28k - jpg
ihatehate.wordpress.com



"George Bush Jr" Photograph
362 x 450 - 35k - jpeg
www.art.com



George Bush Spanked
336 x 453 - 54k
simondonohue.files.wordpress.com



Lovable Mass Murderer George W
Bush.
467 x 818 - 60k - jpg
www.evilgeorge.net



George Bush Jr Photo
362 x 450 - 35k - jpg
www.allposters.com



George Bush leads the US toward
a ...
430 x 410 - 46k - jpg
www.greenpeace.org



Pope George Bush



The George W. Bush Appreciation



George-Bush frowning.jpg



George Bush on YouTube



George Bush. 1. Philadelphia



george bush

Search

Results 1 - 10 of 137 for : "george bush"



George W. Bush



George Bush



George W. Bush



George W Bush



George W. Bush



George W. Bush



George W. Bush



George W. Bush



George Bush



George Bush

Show 10 more stacks

232 photos in 137 stacks

Top

Some people named "george bush" are also known as:

George Herbert Walker Bush, George Walker Bush, George H W Bush, George W Bush | Джордж Буш, George W Bush, John McCain, George Bush Jr, George W Bush, President George W Bush, George H Bush, Bush George, and George W "chimpy Mcbushitler Vampire"

Conclusion

face recognition and user participation > better, more relevant results

- ✿ Hurdles in achieving scale (# plugin users),
- ✿ Plugin shut down 2009...
- ✿ ... data still lives at <http://search.polarrose.com/>



A person in a hooded jacket stands on a sled, pulling a team of dogs across a snowy, open landscape. The scene is captured in a sepia or muted color palette, giving it a historical or documentary feel. The person is positioned in the center background, and the dogs are in the foreground, pulling the sled. The ground is covered in snow, and the background is a vast, flat, open area.

Fall 2008

**Polar Rose enabled on partner sites with NameTagger
for sorting and searching user's albums**

Viewing, sorting and searching albums

familypictures

Album Comments (0) Visits: 05186 Name Tagger Minimize

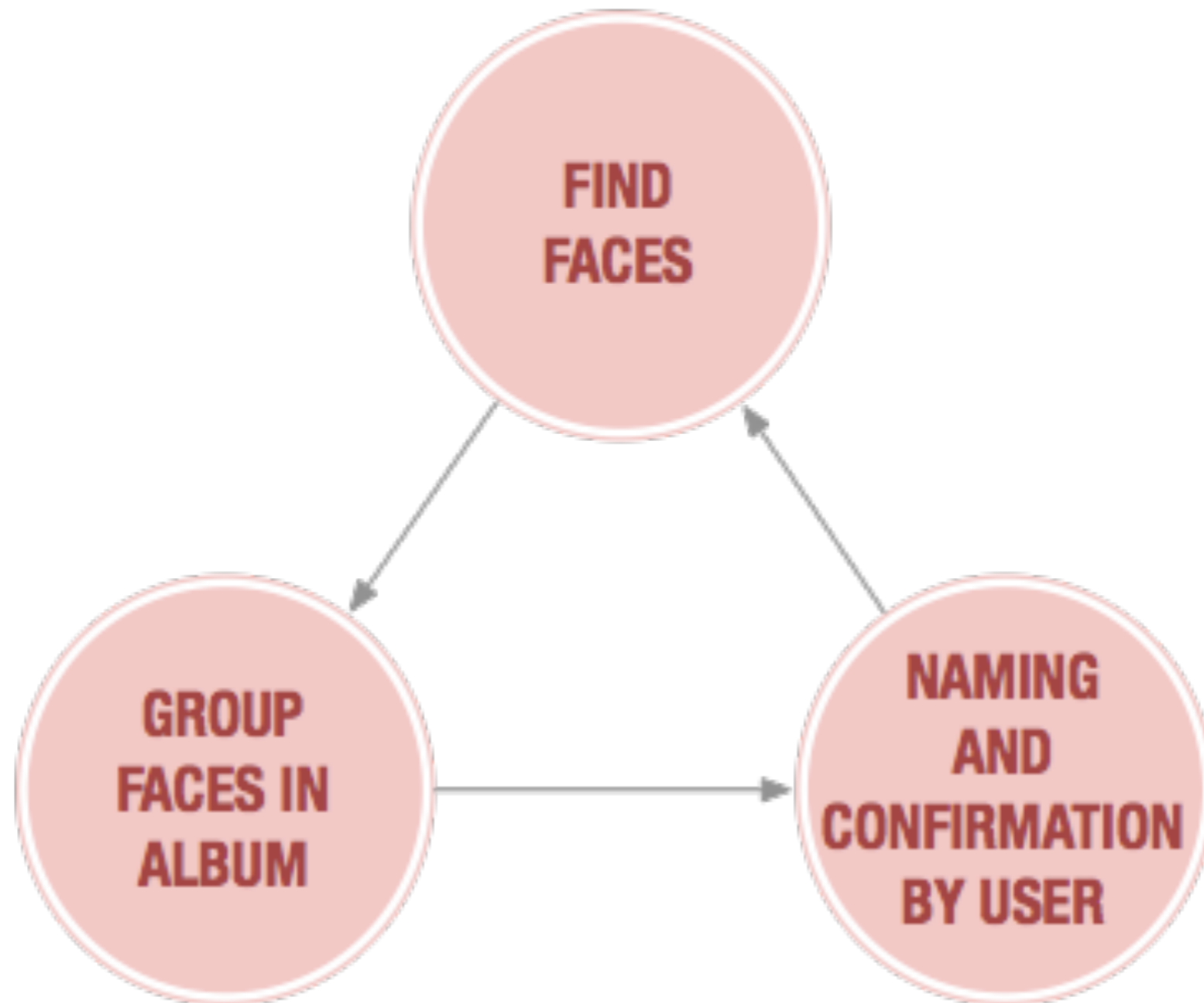
Search: Enter a name here... **Polar Rose** Search

Statistics: 24 PEOPLE, 24 NAMED, 0 UNNAMED

Top people: [Portrait 1] [Portrait 2] [Portrait 3] [Portrait 4] [Portrait 5]

Polar Rose 

the “bionic loop”



Polar Rose 



Spring 2009

Naming is sharing: Polar Rose integrates with user's social graph, help user and friends organize photos together

<http://www.flickr.com/photos/beija-flor/1571916042/>

✿ Name photos with
Facebook contacts using
face recognition

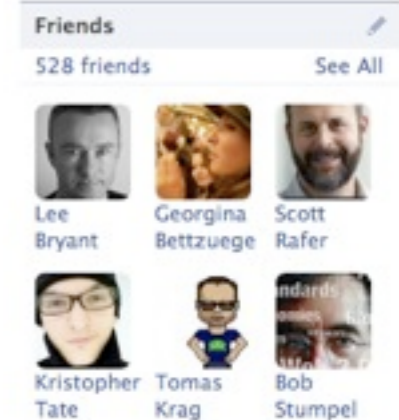
✿ **Naming is sharing:**
Every photo is shared
with the people in it

✿ **Identity is key!**

✿ Browse using faces:
Click on a face to see
more photos of that
person or the photos
they took

flickr™ +

facebook



Polar Rose ✿



Home

[All photos...](#)

[Your photos](#) ⁽⁵⁷⁾

[Photos of you](#) ⁽⁶⁸⁾

[People](#) ⁽³⁷⁾

[Following](#) ⁽⁴⁸⁾

[Search](#)

Your recent activity...

Welcome back Jan! – Here's all the latest activity and updates by the people you are following.

LOOK!

[David Hall](#)

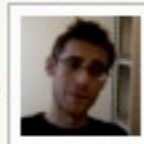


added [33 photos](#).

1 day ago

LOOK!

[Olle Jonsson](#)



added [58 photos](#).

1 day ago

LOOK!



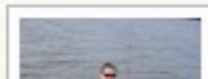
[Thijs Stalenhoef](#) added [a photo](#).

3 days ago



[Paweł Rutkowski](#) named [Tomasz Warkocki](#).

3 days ago





[Jan Erik Solem](#) and [Tomasz Korzeniowski](#)

Photo by [Łukasz Gębala](#)



[Jerome Piovano](#) , [Jan Erik Solem](#) and [Mikael Rousson](#)

Photo by [Łukasz Gębala](#)



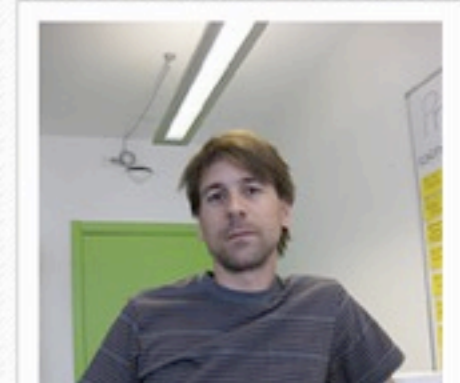
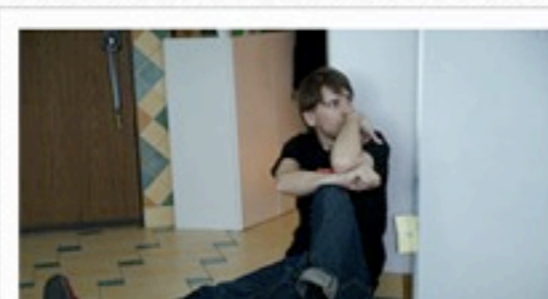
[Jan Erik Solem](#)

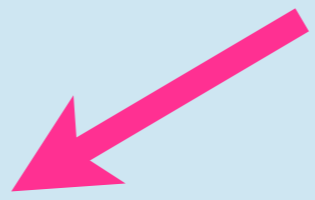
Photo by [Łukasz Gębala](#)



[Jan Erik Solem](#)

Photo by [Łukasz Gębala](#)





[People](#) [Following \(48\)](#) [Search](#)

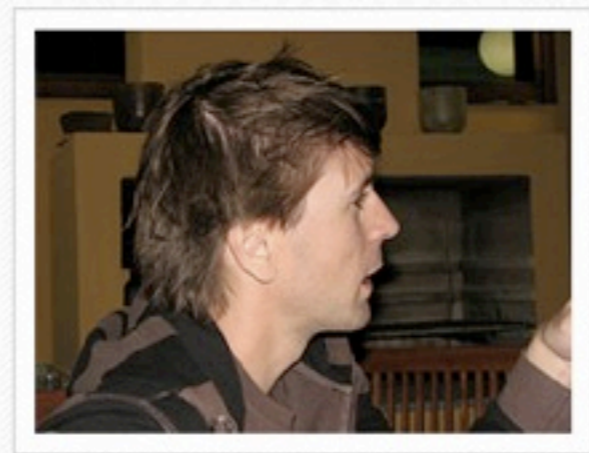
[Home](#) [All photos...](#) [Your photos \(57\)](#) [Photos of you \(68\)](#)



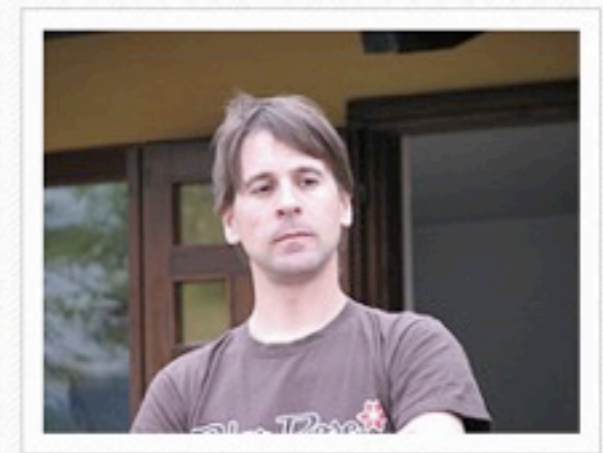
[Jan Erik Solem](#) and [Tomasz Korzeniowski](#)
Photo by [Łukasz Gębala](#)



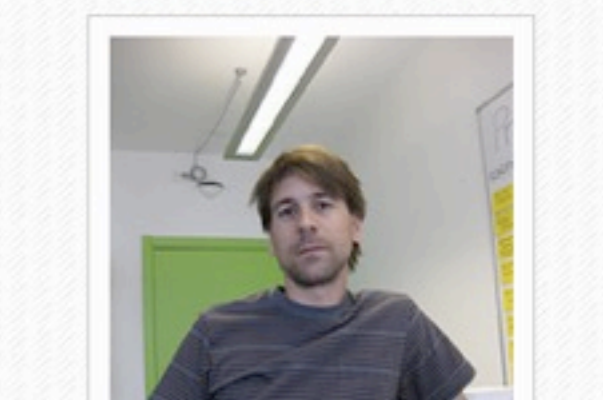
[Jerome Piovano](#), [Jan Erik Solem](#) and [Mikael Rousson](#)
Photo by [Łukasz Gębala](#)



[Jan Erik Solem](#)
Photo by [Łukasz Gębala](#)



[Jan Erik Solem](#)
Photo by [Łukasz Gębala](#)



YOUR PHOTOS ARE NOW PROCESSED!
CLICK THIS BUTTON TO NAME THE
PEOPLE IN YOUR PHOTOS.

Your photos (625)


Photos of you (0)

Other

Who's this?



Enter a name for this person...

- Mikk
-  Mikkel Thagaard
Polar Rose user
-  Mikkel Winther
Facebook contact

Cancel

Save

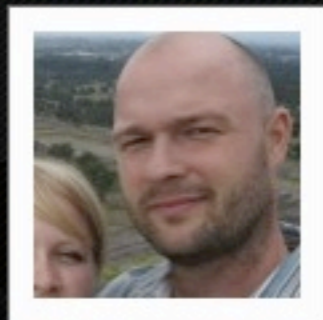
Are these also Mikkel Thagaard?



Your photos (6)

Photos of you (4)

Other people (14)



Mark any people shown above that are NOT Mikkel Thagaard by clicking on them – then click "Save".

[Select all](#) | [Select none](#)

Save

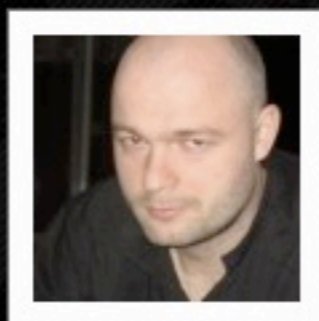
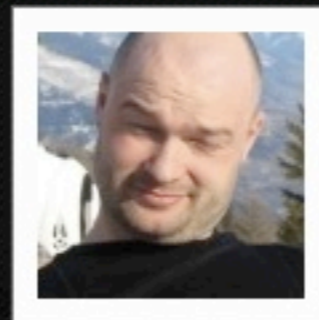
Are these also Mikkel Thagaard?



Your photos (6)

Photos of you (9)

Other people (39)



Mark any people shown above that are NOT Mikkel Thagaard by clicking on them – then click "Save".

[Select all](#) | [Select none](#)

[Save](#)

What's on your mind? Share

Henriette Weber oh joy! this rocks my world #rockbandism #Moo super eco friendly business card <http://is.gd/q28d>
3 minutes ago · Comment · Like

Oliver Thylmann Amazon AWS MapReduce : <http://aws.amazon.com/elasticmapreduce/> KICK ASS! #aws #amazon
9 minutes ago · Comment · Like

Nico Lumma ob das mit den kopfschmerzen heute noch mal besser wird?
10 minutes ago · Comment · Like

Andrej Nabergoj dedicated to you <http://blip.fm/~3ppby>
10 minutes ago · Comment · Like

Henriette Weber blogged at web avant-garde reflection on the slideshare prank yesterday. I feel like an idiot #bestofslideshare <http://is.gd/qfoc>
13 minutes ago · Comment · Like

Dave McClure Much Respect @TylerWillis for "Free Pizza FlashMob" outside the W 2.0 Hotel afterparty. Yum! #w2e
13 minutes ago · Comment · Like

Dave McClure RT @Megan Congrats to Michael and Xochi Birch for winning Web 2.0 (via @todsacerdoti)
15 minutes ago · Comment · Like

REQUESTS [See All](#)

57 friend requests 7 event invitations
 117 other requests 7 new updates

PEOPLE YOU MAY KNOW [See All](#)

Jens Christoffersen [Add as Friend](#)

SPONSORED

Ladies first? No chance.

This is your chance to prove that men run further, faster stronger than You in? Lace up the challenge!

Become a Fan of Brian Holms Nike+

HIGHLIGHTS

Kinnernet by Andrej Nabergoj 2 1

Puerto Rico March by Sidsel Nyholm

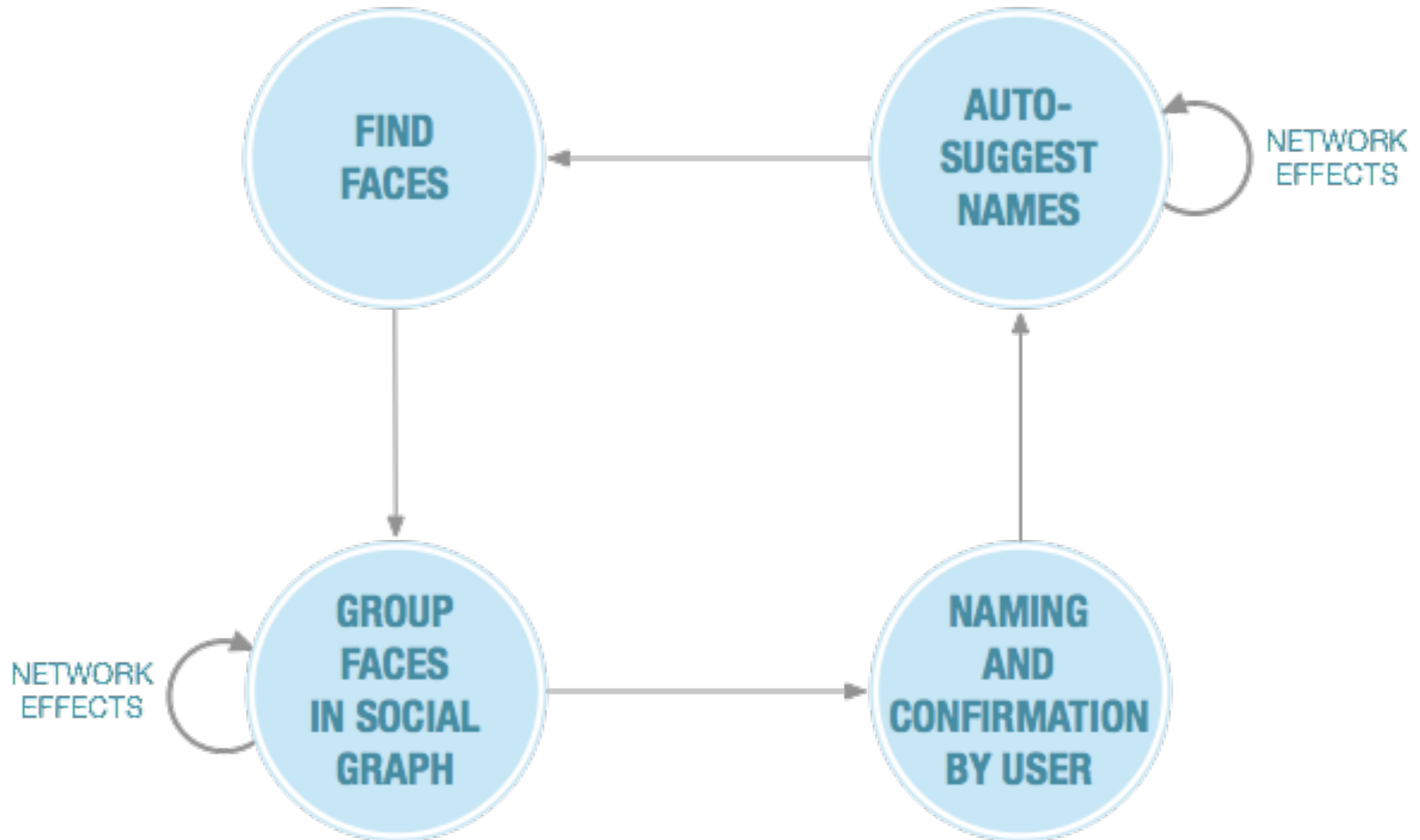
Tribeca Film Festival Sidsel Nyholm is a fan. [Become a Fan](#)

Notifications [See All](#)

- Niels Klintø** commented on your status. 7 minutes ago
- Rebecca Pruzan** commented on your status. 17 minutes ago
- Peder Bjerge** commented on your status. 22 minutes ago
- Mikkel Thagaard** named you in a photo using Polar Rose. 22 minutes ago
- Jesper Bindslev** accepted your friend request. 15 hours ago

Online Friends (38)

Network effects: cross-domain data sets



Polar Rose 



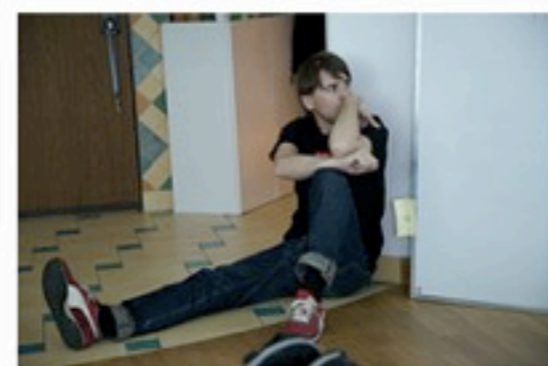
Unknown Person , Bartek Rymkowski and Jan Erik Solem

Photo by Łukasz Gębala



Unknown Person , Thijs Stalenhoef and Jan Erik Solem

Photo by Łukasz Gębala



Jan Erik Solem

Photo by Thijs Stalenhoef



Jan Erik Solem

Photo by Thijs Stalenhoef



Jan Erik Solem

Photo by Mikkel Thagaard



Jan Erik Solem

Photo by Mikkel Thagaard



Thijs Stalenhoef , Nikolaj Nyholm , Jan Erik Solem and Geoff Parker

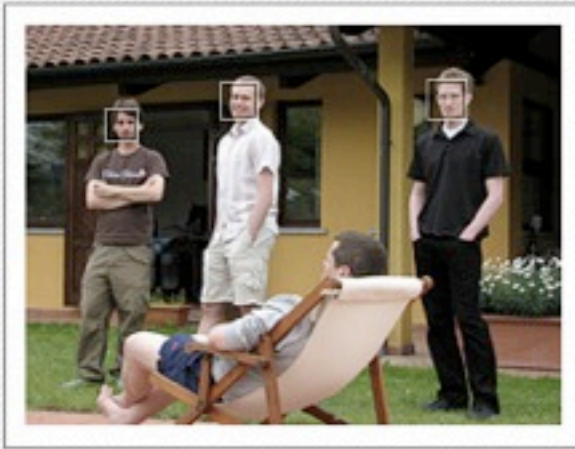
Photo by Mikkel Thagaard



Jan Erik Solem and Emil Elfrém

Photo by Mikkel Thagaard

Polar Rose 



Unknown Person , Bartek Rymkowski and Jan Erik Solem

Photo by Łukasz Gębala

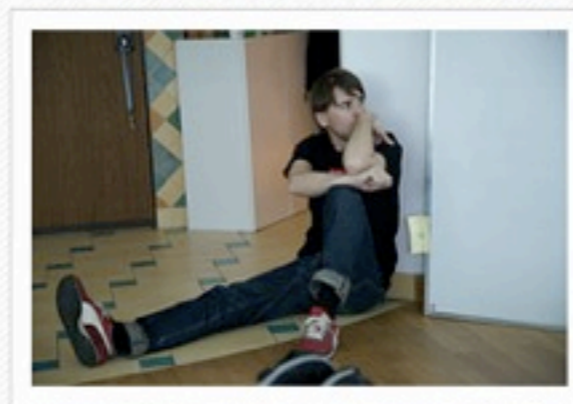
Photo by Łukasz Gębala



Unknown Person , Thijs Stalenhoef and Jan Erik Solem

Photo by Łukasz Gębala

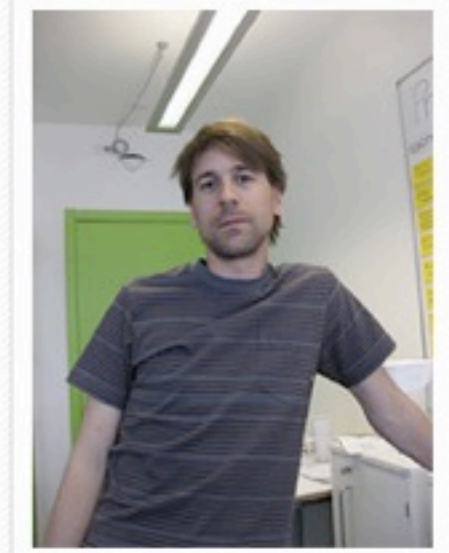
Photo by Łukasz Gębala



Jan Erik Solem

Photo by Thijs Stalenhoef

Photo by Thijs Stalenhoef



Jan Erik Solem

Photo by Thijs Stalenhoef

Photo by Thijs Stalenhoef



Jan Erik Solem

Photo by Mikkel Thagaard

Photo by Mikkel Thagaard



Jan Erik Solem

Photo by Mikkel Thagaard

Photo by Mikkel Thagaard



Thijs Stalenhoef , Nikolaj Nyholm , Jan Erik Solem and Geoff Parker

Photo by Mikkel Thagaard

Photo by Mikkel Thagaard



Jan Erik Solem and Emil Elfrém

Photo by Mikkel Thagaard

Photo by Mikkel Thagaard

Polar Rose 



Unknown Person , Bartek Rymkowski and Jan Erik Solem

Photo by Łukasz Gębala

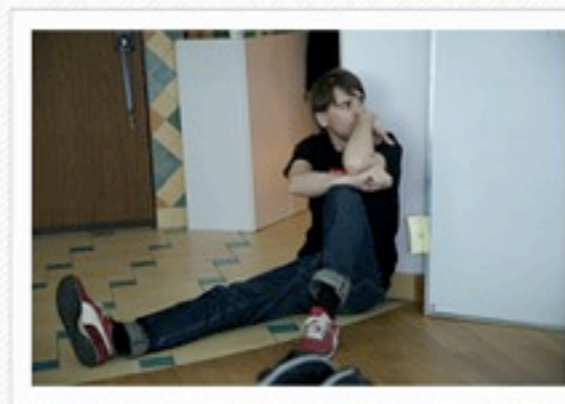
Photo by Łukasz Gębala



Unknown Person , Thijs Stalenhoef and Jan Erik Solem

Photo by Łukasz Gębala

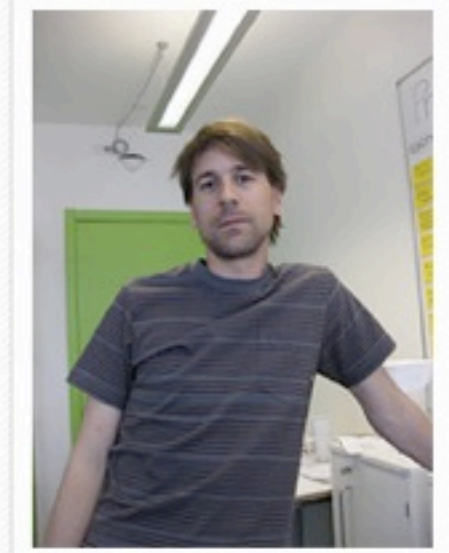
Photo by Łukasz Gębala



Jan Erik Solem

Photo by Thijs Stalenhoef

Photo by Thijs Stalenhoef



Jan Erik Solem

Photo by Thijs Stalenhoef

Photo by Thijs Stalenhoef

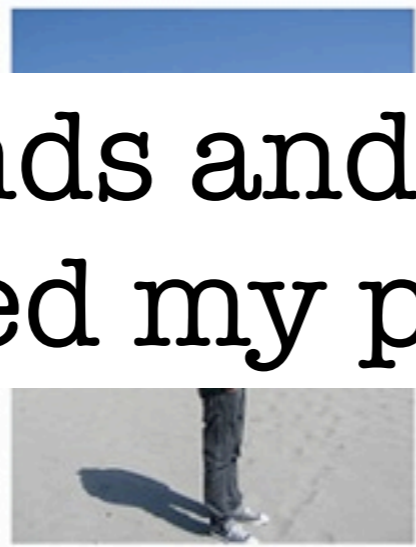
my friends and a piece of software organized my photos for me!



Jan Erik Solem

Photo by Mikkel Thagaard

Photo by Mikkel Thagaard



Jan Erik Solem

Photo by Mikkel Thagaard

Photo by Mikkel Thagaard



Thijs Stalenhoef , Nikolaj Nyholm , Jan Erik Solem and Geoff Parker

Photo by Mikkel Thagaard

Photo by Mikkel Thagaard



Jan Erik Solem and Emil Elfrém

Photo by Mikkel Thagaard

Photo by Mikkel Thagaard

Polar Rose 

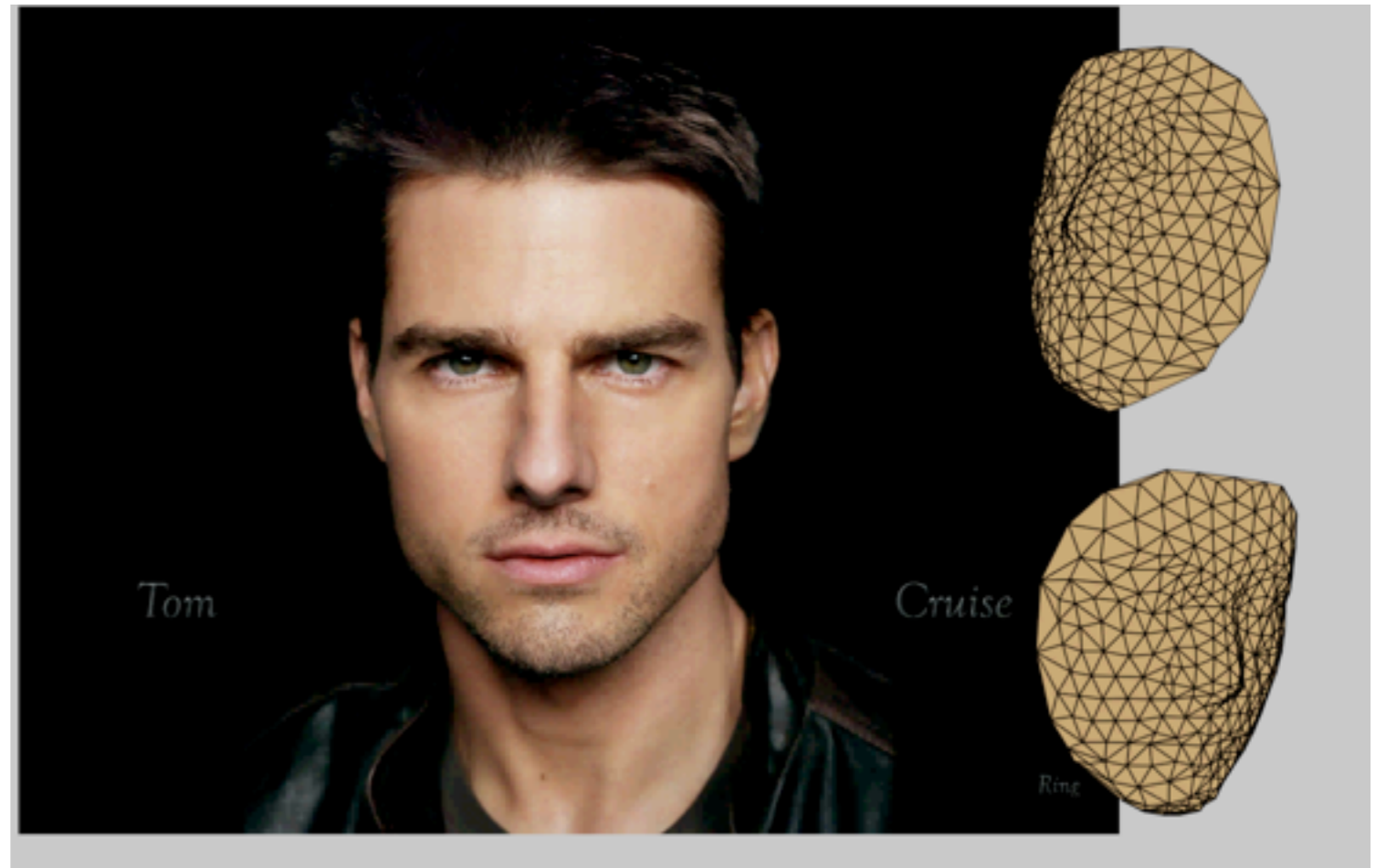
A man in a dark military uniform and cap stands in profile, looking at a large, complex control panel filled with numerous buttons, switches, and indicator lights. Some lights are illuminated in green and red. To his left, another man in a dark suit and hat sits on a chair, looking towards the camera. The setting appears to be a control room or a technical facility with large windows in the background. The word "Technology" is overlaid in the center of the image.

Technology

Our approach

✿ In short:

- accurate location of face landmarks (registration)
- fitting 3D estimate (pose & lighting)
- 2D shape & texture descriptors in registered images



✿ “old-school” in the sense of not using “brute force” ML on dense local descriptors (*doesn't work in our setting!*)

Polar Rose ✿



Things we tried & lessons learned

Checking for matches and dupes

Problem:

- ✿ Internal contract between services specifies <100ms for call to matching server!
- ✿ Need to do lookup in ~20M faces (60M images)

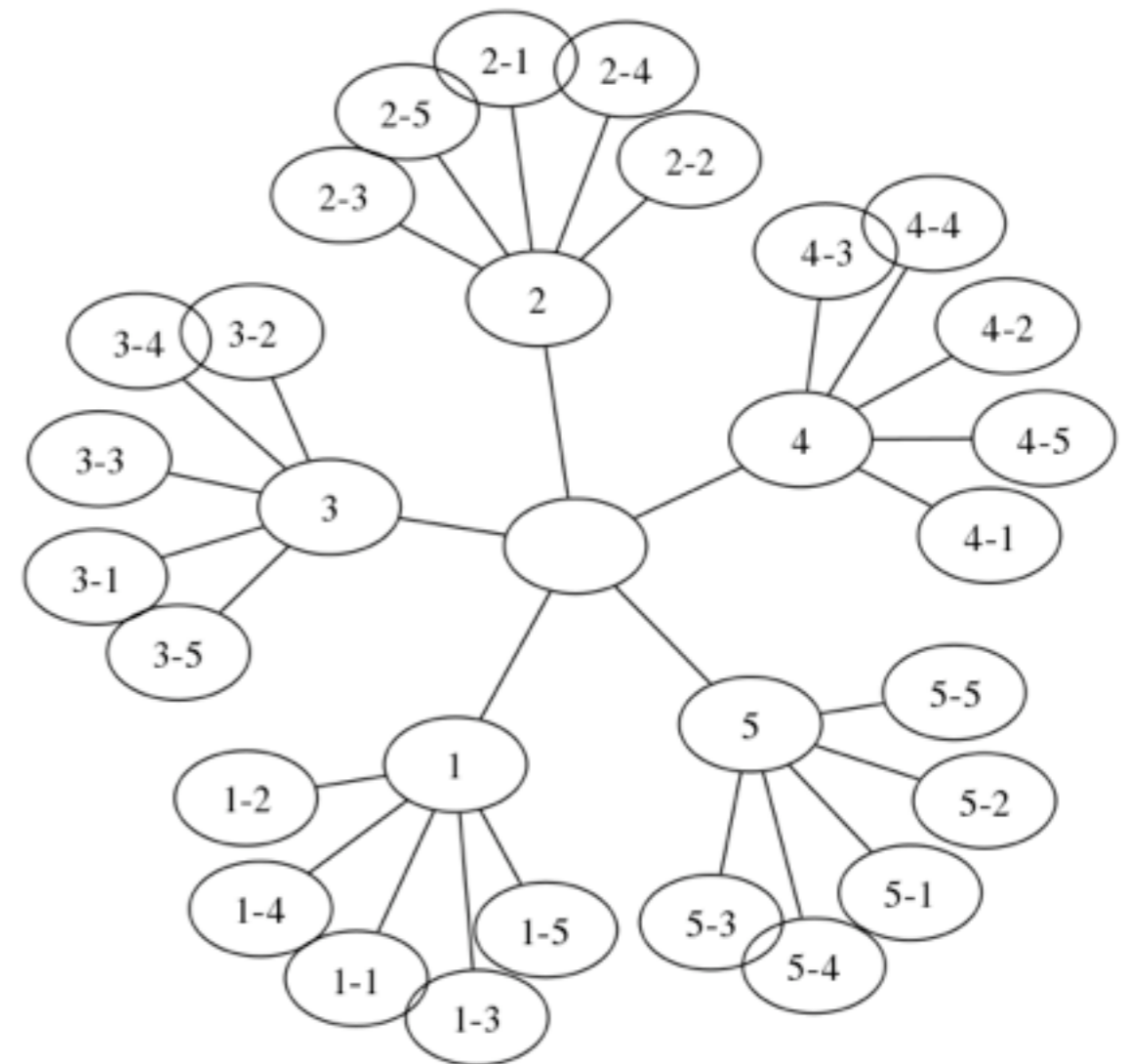
Checking for matches and dupes

Problem:

- ✿ Internal contract between services specifies <100ms for call to matching server!
- ✿ Need to do lookup in ~20M faces (60M images)

Solution:

- ✿ Everything in RAM (8GB)
- ✿ Binning using kd-trees
- ✿ Tune depth, branching and node size to get <100ms
- ✿ **No guarantees!**



Images need to be processed

Processing: Real time face detection and recognition

- In the browser: (Firefox) plugin using COM objects, tricky but doable.
Problem: effects on user's CPU, bad user experience.
- On GPU: (pre-CUDA/Stream) too much transmission overhead between CPU and GPU for our purposes.
- On Cell processor / Sony PS3: possible but transmission overhead between cores makes it too slow!
- On mobile devices: (detection) possible, not explored beyond that.

Processing: Batches and offline

- Amazon EC2: Works! Perfect for re-indexing, batch jobs and offload at peaks

Images need to be processed

✿ Processing: Real time face detection and recognition

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Problem: effects on user's CPU, bad user experience.
- On GPU: (pre-CUDA/Stream) too much transmission overhead between CPU and GPU for our
solved algorithmically instead!
- On Cell processor / Sony PS3: possible but transmission overhead between cores makes it too slow!
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✿ Processing: Batches and offline

- Amazon EC2: Works! Perfect for re-indexing, batch jobs and offload at peaks

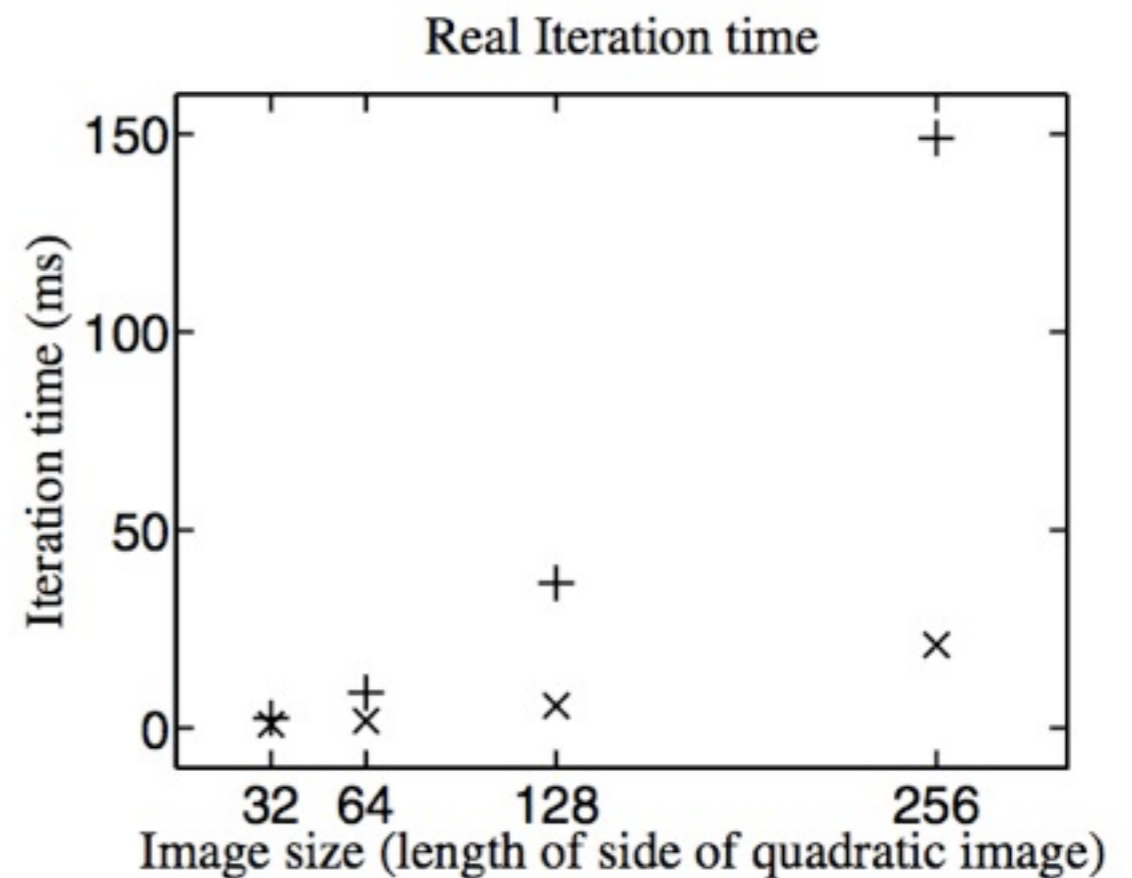
in production since EC2 launched!

Polar Rose ✿

[Netzell & Solem, ICPR2008]

Speed improvement of appearance based landmark localization (e.g. AAM)

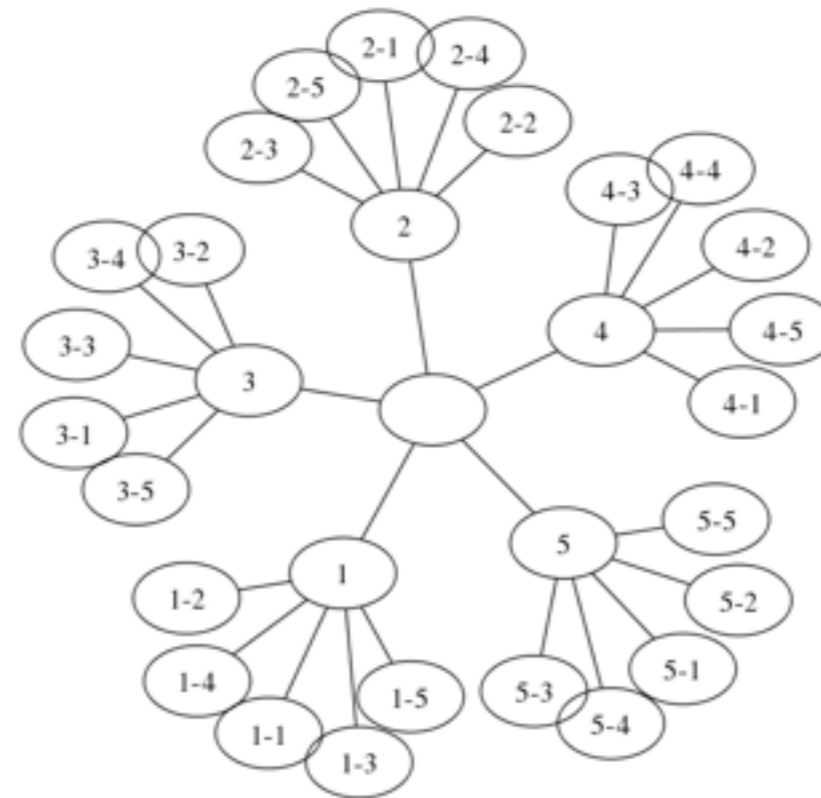
Pre-computation of image inner products. (for Hessian)



Other things

✿ Lookalikes

✿ Visual navigation of faces
("more loke this")



polarbot found...

Showing 1 - 20 of 8058

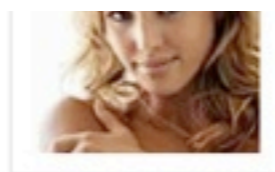
In total around 15% of our database machine tagged with conservative distance threshold.



Barack Obama



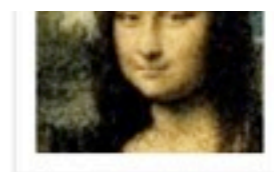
George W. Bush



Jessica Alba



John McCain



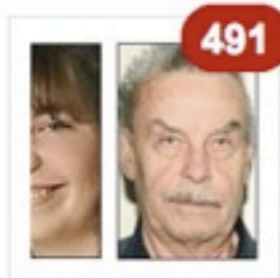
Mona Lisa



Britney Spears



Sarah Palin



Josef Fritzl



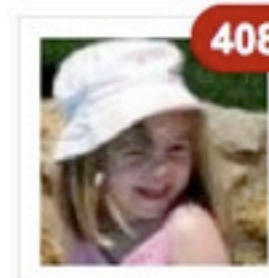
Heath Ledger



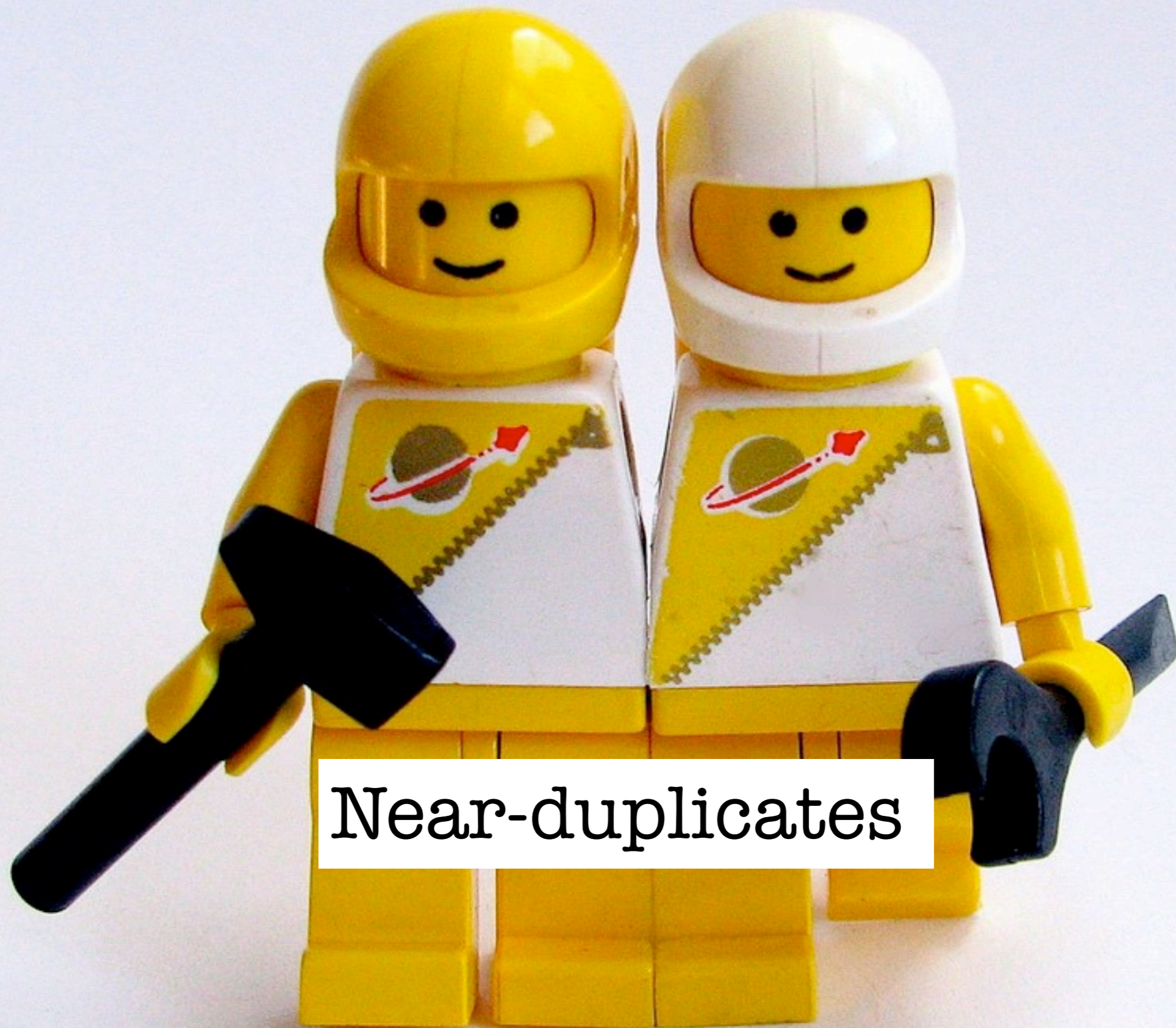
Angelina Jolie



Lindsay Lohan



Madeleine McCann



Near-duplicates

<http://www.flickr.com/photos/oskay/265900118/>

If your object descriptor is strong enough

at which it is
 interest to a
 er for driving with
 iving 70 mph in a
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 lation of the terms

the sentence, and
 May 5, 2007 by
 sands of

I in Lynwood,



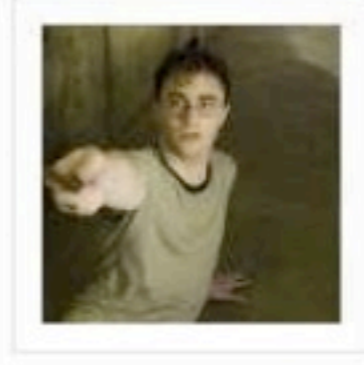
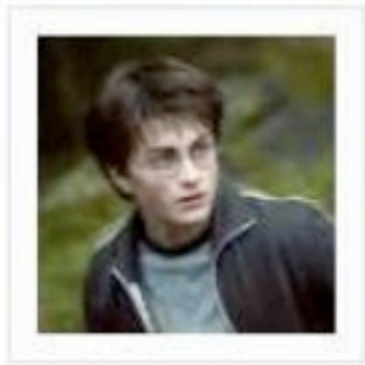
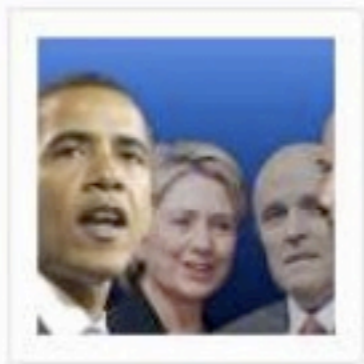
Paris Hilton's booking
 photograph

**Biggest Celebrity
 Meltdowns
 of 2007**

Lindsay, Paris & Brit provide
 fans with A-list soap operas

- Sound off: Which star had the biggest meltdown in '07?

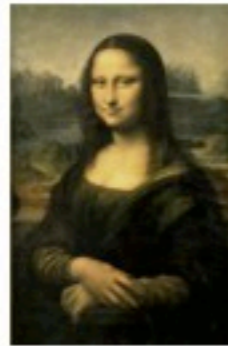
Polar Rose 



Polar Rose 



original 11036 - 192195.jpeg
180 x 270



original 11036 - 328420.jpeg
259 x 397



original 11036 - 328485.jpeg
267 x 400



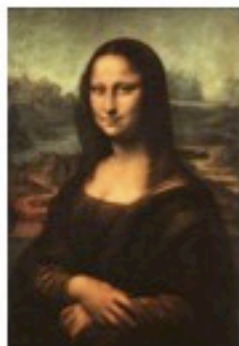
original 11036 - 328521.jpeg
190 x 281



original 11036 - 328523.jpeg
250 x 380



original 11036 - 328581.jpeg
170 x 252



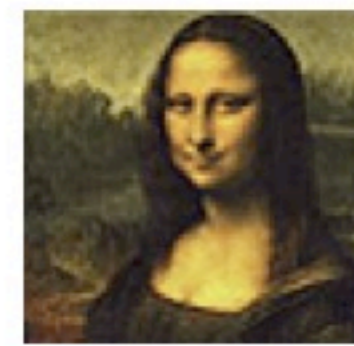
original 11036 - 328635.jpeg
276 x 400



original 11036 - 328662.jpeg
150 x 223

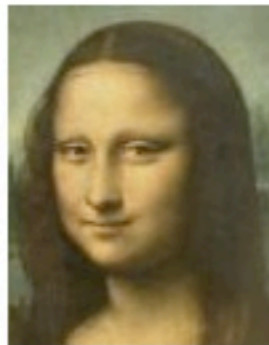


original 11036 - 328755.jpeg
103 x 145



original 11036 - 915766.gif
75 x 73

Hello world!



original 11036 - 1078271.jpeg
96 x 123



original 11038 - 11024.jpeg
114 x 146



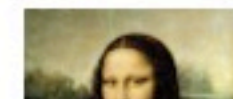
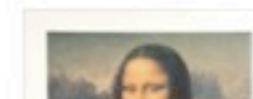
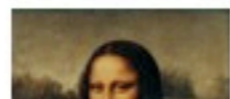
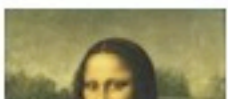
original 11038 - 11025.jpeg
107 x 122



original 11038 - 11038.jpeg
700 x 893



original 11038 - 275170.jpeg
203 x 152



Polar Rose 

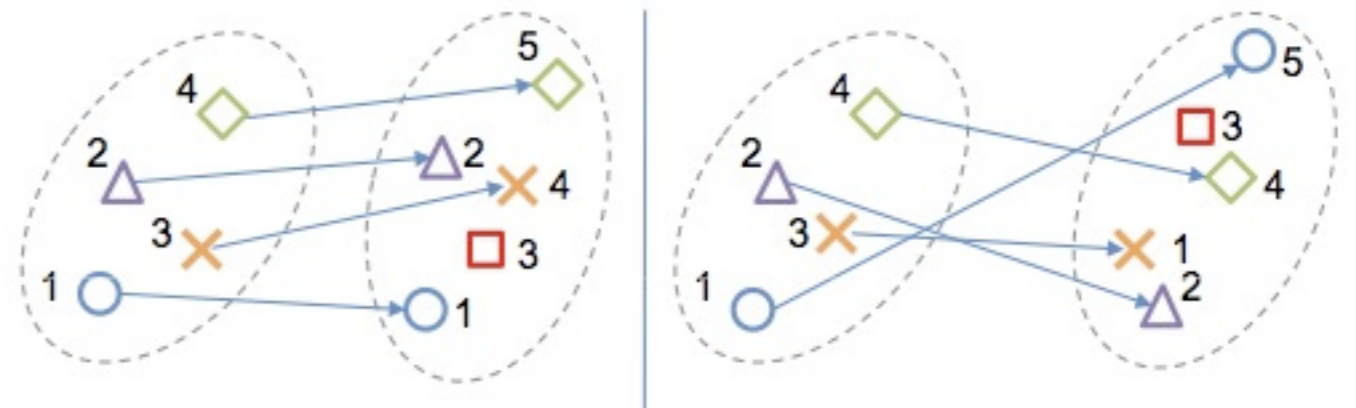
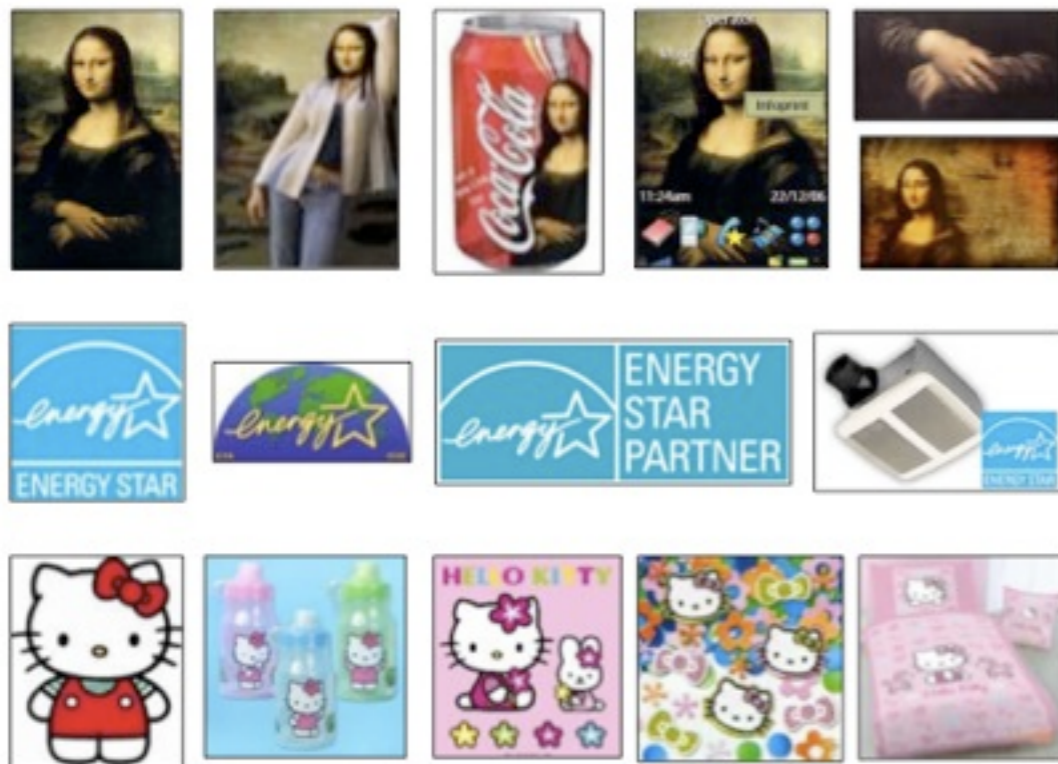
Browse duplicate results on
<http://search.polarrose.com/>



If descriptor not strong enough...

...(e.g. bag of features), try more with geometry!

Wu et al, “Bundling Features for Large Scale Partial-Duplicate Web Image Search”, CVPR 2009 [MSFT research]



Polar Rose

ALL PROBLEMS
ARE OPPORTUNITIES
IN DISGUISE

Challenges for the future

Challenges ahead

Goal: make sense of user's and friends photos


help organize

- replication of tags
- tagging tools with computer vision
- “follow” general concepts using object recognition
- time & location

help share

- across social networks
- subscribe to content

Questions/discussion



janerik@polarrose.com
skype: jesoalem
twitter: jesoalem