Improving People Search Using Query Expansions How Friends Help To Find People

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Searching George Bush using Yahoo! news photo search



20 10:24 AM

Tibet crisis won't dissuade Bush from attending Olympics ... AFP/File via Yahoo! News - Mar 20 2:00 PM

Bush ' cautiously optimistic ' about missile deal with Moscow ... AFPIPOOIFILe via Vahool News - Mar



U.S. President George W. Bush shakes hands with Gov. Charlie Crist after arrhung on Air Force One in Jacksonville ... Reuters via Yahoo! News - Mar 18 9:00 AM



President George W. Bush receives a hug from his brother former Gov. Jeb Bush as ... AP via Yahoo! News - Mar 18 5:42 PM



President George W. Bush speaks at the Blount Island Marine Terminal in Florida ... Reuters via Yahoo! News - Mar 18 6:54 PM



A protestor dressed as U.S. President George W. Bush takes part in a demonstration marking the fifth anniversary of the U.S. invasion of Iraq in Washi ...

Reuters via Yahoo! News - Mar 19 7:48 AM



A protestor walks past a caricature depicting U.S. President George w. Bush at a demonstration marking the fifth anniversary of the U.S. invasion of

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U.S. President George W. Bush addresses the Economic Club of New York March 14, ... Reuters via Yahoo! News - Mar 19 7:28 AM



Bush prays for US troops on Easter holiday... AFP/File via Yahoo! News - Mar 21 8:14 AM



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Presentation outline

- Problem and challenges
- Related work and motivation of our work
- Query expansion implemented in two approaches
 - ► generative mixture model
 - linear discriminant model
- Conclusion

Finding people in captioned news images



German Chancellor **Angela Merkel** shakes hands with Chinese President **Hu Jintao** (...)



Kate Hudson and Naomi Watts, Le Divorce, Venice Film Festival -8/31/2003.

- Task: Find all faces of X
 - Manual construction of labeled training sets costly
 - Continued labeling effort needed for new people
- Only text does not work: only 44% of faces are person of interest
 - ► Averaged over our set of 23 people with ground truth annotation
- Better approach: use correlation of names in caption and faces in image

Challenges in the data



• Appearance variations: illumination, expression, pose, scale, occlusion,

Challenges in the data



- Appearance variations: illumination, expression, pose, scale, occlusion,
- Naming variations: Bush, George W. Bush, US president, ...
- Imperfect detectors: both for names & faces

Related work

• Work on related problems: multiple people, scripts in video, social networks (Berg et al. CVPR '04), (Everingham et al. BMVC '06), (Stone et al. CVPR '08)

Related work

• Approach in previous work on same problem:

(Ozkan & Duygulu CVPR'06), (Guillaumin, Mensink, Verbeek & Schmid CVPR'08)

- ► Given query name X
- Select all images with X in caption
- Analyze faces in those images to rank or classify them

• Underlying principles:

- Text filtering makes queried person the most frequent
- Task is reduced to finding the big mode among clutter

• Failure case:

- If text-filtering yields a precision < 40%
- Mode finding might return wrong person

Improving people search using query expansions

- Motivation: avoid confusion with co-occurring people
- Query Expansion: use more images than just those with X in caption
 - ► Find names co-occuring with the queried person: "friends"
 - Query database for images with friends in caption, but not X
 - ► Adds "negative" examples, different from typical query expansion in retrieval

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- Example: search for "Bush", expand with "Powell", "Rumsfeld", and "Rice"



Initial situation (left), models based on queries for friends (middle), simplified person identification (right).

Query expansion example: Berlusconi





Faces 1 - 25

<-- 1 2 3 4 5 6 7 --> Show All Show Friends | Hide Friends | Show Console output | Hide Console

Friend 1 bush

Friend 2 schroeder

Friend 3 saddam hussein

Friend 4 tony blair



Data and pre-processing pipeline

- Data set: 15.000 captioned images from Yahoo! News (Collected by Tamara Berg)
 - ► Hand labeling of all faces in images with one of the 23 query names in caption
- Name detection: off-the-shelf detector (Deschacht & Moens, WOLP'06)
- Face detection: off-the-shelf detector (Mikolajczyk, Schmid & Zisserman, ECCV'04)
- Face representation: based on local features
 - Detector of facial features: mouth, nose, eyes, ... supervised training (Everingham et al. BMVC '06)
 - Concatenate SIFT descriptors of all facial feature



Examples of facial feature detection



SIFT descriptor

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Approach 1: Gaussian mixture model

- Goal: which, if any, of the F faces in this image is X?
 - Coded in assignment variable $\gamma \in \{0, 1, \dots, F\}$
- Mixture model over set of feature vectors ${\cal F}$
 - A-priori over γ : equal for $\gamma \neq 0$
 - Gaussian density for faces of X
 - ► generic "background model" for other faces

$$p(\mathcal{F}) = \sum_{\gamma=0}^{F} p(\gamma)p(\mathcal{F}|\gamma), \qquad p(\mathcal{F}|\gamma) = \prod_{i=1}^{F} p(f_i|\gamma),$$
$$p(f_i|\gamma) = \begin{cases} p_{\mathrm{BG}}(f_i) = \mathcal{N}(f_i; \mu_{\mathrm{BG}}, \Sigma_{\mathrm{BG}}) & \text{if } \gamma \neq i \\ p_{\mathrm{FG}}(f_i) = \mathcal{N}(f_i; \mu_{\mathrm{FG}}, \Sigma_{\mathrm{FG}}) & \text{if } \gamma = i \end{cases}$$

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- EM algorithm to find face model and assignments
 - ► Background model fixed, only foreground Gaussian and prior updated
 - After convergence evaluate $p(\gamma | \mathcal{F})$

Query expansion in the Gaussian mixture model

- Learn a Gaussian for each friend using standard 2-component model
 - Using images with friend in the caption but without X
 - ► At most 15 friends, at least 5 images per friend
- Define new background model: mixture of N friends + generic model

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- Run EM on standard 2-component model using mixture background
- Errors in friend model possible, but trained on images without X in caption

Results using Gaussian mixture model



Comparing mixture model without (green), and with (yellow) query expansion

- Failure case of previous work: low text-based precision (<40%)
- Progress mainly in those cases: 20%-50% increase in precision

Results using Gaussian mixture model (2)

- Green: 1 background Gaussian: fitted to all faces with X in caption
- Red: 1 background Gaussian: fitted to all faces in expansion
- Blue: Mixture background: composed of Gaussian for friends + expansion



Precision averaged over the 23 queries at different levels of recall

Approach 2: logistic discriminant model

- Motivation: diagonal Gaussian model rather limited
 - ► Too little data to allow learning of richer model
- Logistic discriminant: same nr. of parameters put to use for separation
 - Laplace prior for sparsity in the weight vector

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- Positive examples: all faces in images with X in caption
- Negative examples:
 - random set of faces without X in caption
 - faces in query expansion

Iterative re-labeling of noisy positive data

- Positive data is very noisy
 - ▶ on average only 44% correct
- People appear once per image
 - most of the time
- Iterative re-labeling of noisy positive examples
 - ► Learn initial classifier from all faces after text search
 - Re-label most suspicious faces as negative
 - Re-train classifier using new labels
 - Repeat until one face per positive image is left



Results logistic discriminant model

- Green: Discriminate noisy positives from a set of random faces
- Red: Iteratively re-labeling of noisy positive set
- Blue: Idem, but use query expansion as negative example set



Precision averaged over the 23 queries at different levels of recall

Comparison of results with state-of-the-art

- Red: Discriminative model, re-labeling, query expansion (this paper)
- Blue: Gaussian mixture, query expansion (this paper)
- Green: Similarity-based method (our CVPR '08)
- Black: Similarity-based method (Ozkan & Duygulu, CVPR '06)



Precision averaged over the 23 queries at different levels of recall

More than 10% increase in precision for recall levels up to 90%

Performance in absence of captions

- Classifiers learned from caption based supervision
- Test on "Labeled Faces in the Wild" data set
 - ▶ public data set, 13.000 hand labeled faces, no captions



In each row: top 10 ranked faces for one person

Conclusions

• Query expansion improves people search

- Generative model benefits most from expansion
- Discriminative model yields best performance
- Significant progress when text-based precision is low
 - These remain the most difficult cases

• Our methods using query expansion improves earlier work

- \blacktriangleright +10% precision compared to our CVPR'08 work
- ▶ +20% precision compared to Ozkan & Duygulu CVPR'06

Questions?



Mensink & Verbeek (INRIA)