Action class detection and recognition in realistic video

[ICCV07]

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E-team: Visual Saliency topics overview

• Object classes learning and recognition :	**7**	GRAZ, UFR, VISTA, KTH, Cambridge, IMEDIA, UvA
• Interest points, Local features, patches :	**6**	GRAZ, UFR, IMEDIA, VISTA, ENST, Cambridge, UvA
• Relations between local features :	**5**	UFR, IMEDIA, UvA, KTH, VISTA
• **Spatio-temporal salient regions :**	**4**	SZTAKI, UCL, VISTA, IMEDIA
• Texture :	**3**	SZTAKI, KTH, ENST
• Relations to Human visual attention :	**3**	KTH, UCL, SZTAKI
• Copy detection:	**3**	VISTA, IMEDIA, UCL
• Eyetracking, perceptual interface:	**1**	UCL

Human actions: Motivation

- Huge amount of video is available and growing
- Human actions are major events in movies, TV news, personal video …

Action recognition useful for:

- Content-based browsing
  e.g. fast-forward to the next goal scoring scene
- Video recycling
  e.g. find "Bush shaking hands with Putin"
- Human scientists
  influence of smoking in movies on adolescent smoking

What are human actions?

Definition 1:

- **Physical body motion**

[Niebles et al.'06, Shechtman&Irani'05,
Dollar et al.'05, Schuldt et al.'04, Efros et al.'03
Zelnik-Manor&Irani'01, Yacoob&Black'98,
Polana&Nelson'97, Bobick&Wilson'95, …]



KTH action dataset

Definition 2:

- **Interaction with environment on specific purpose**

same physical motion -- different actions depending on the context




Context defines actions

Challenges in action recognition

- **Similar problems to static object recognition:**
  variations in views, lightning, background, appearance, …
- **Additional problems:** *variations in individual motion; camera motion*

Example:

Drinking

Smoking

Difference in shape

Difference in motion

Both actions are similar in overall shape (human posture) and motion (hand motion)

⇨ Data variation for actions might be higher than for objects

But: *Motion provides an additional discriminative cue*

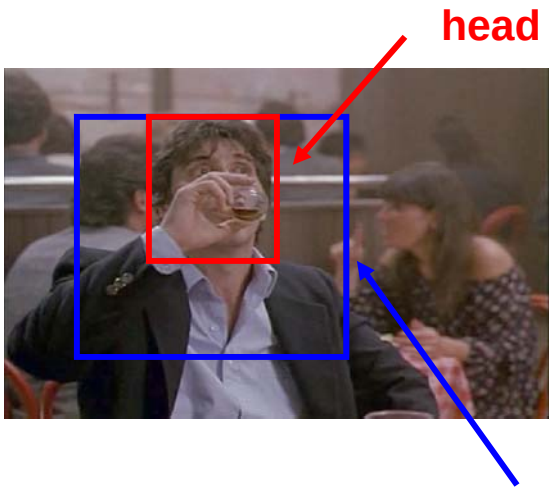
Action dataset and annotation

- No datasets with realistic action classes are available
- This work: *first attempt to approach action detection and recognition in real movies*: “Coffee and Cigarettes”; “Sea of Love”

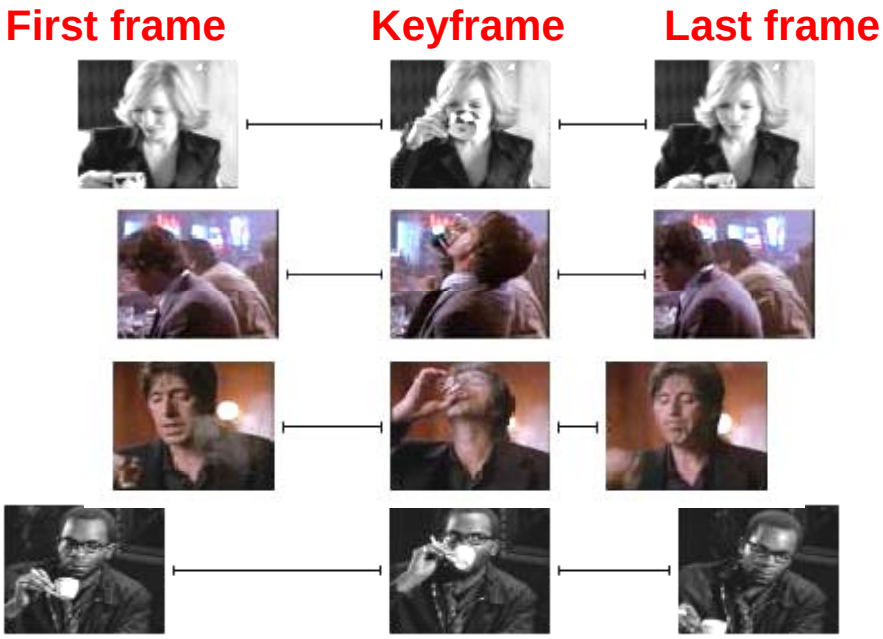
“*Drinking*”: 159 annotated samples

“*Smoking*”: 149 annotated samples

Spatial annotation



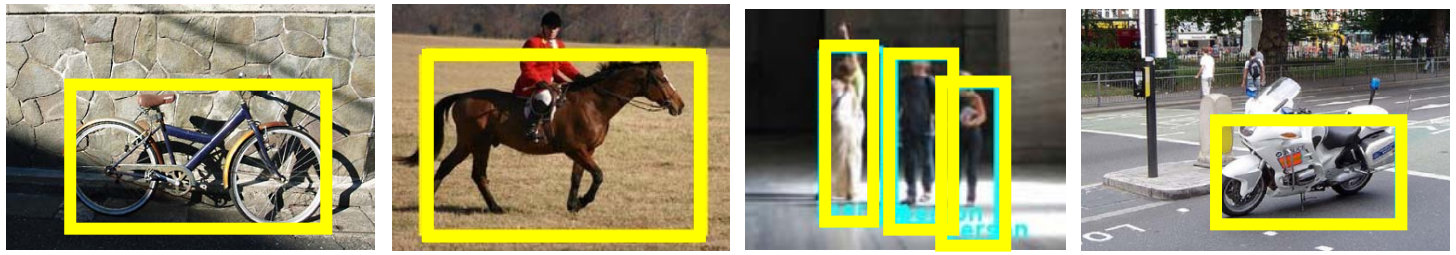
Temporal annotation



“Drinking” action samples

Actions == space-time objects?

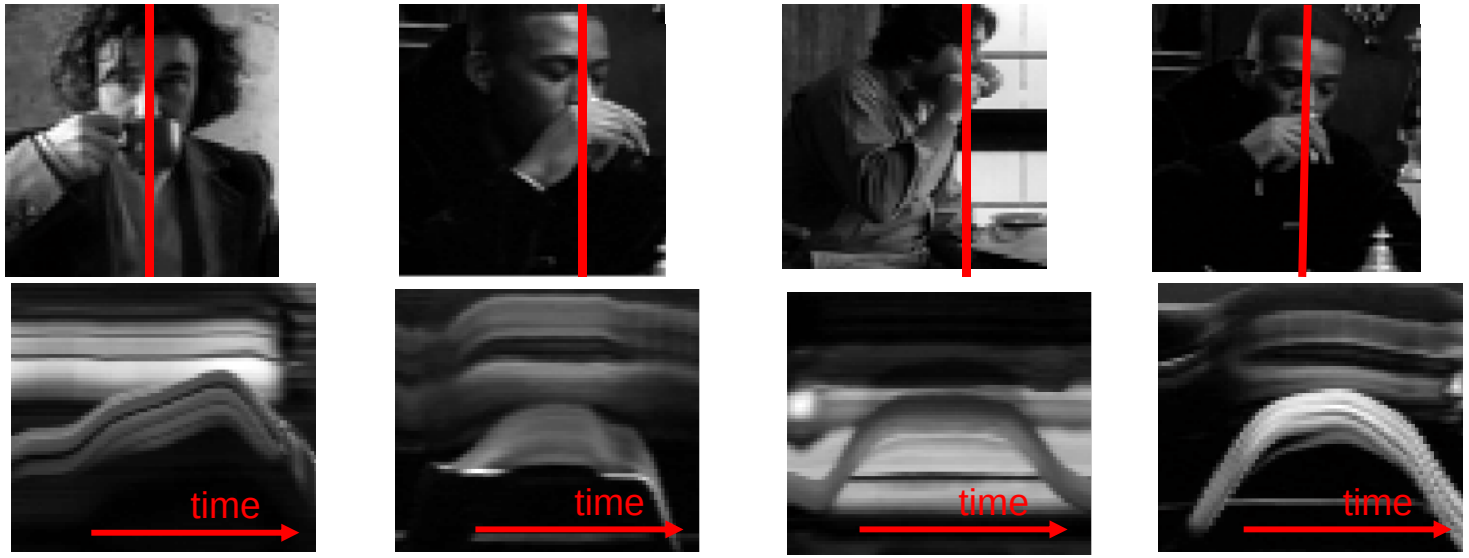
"stable-view" objects



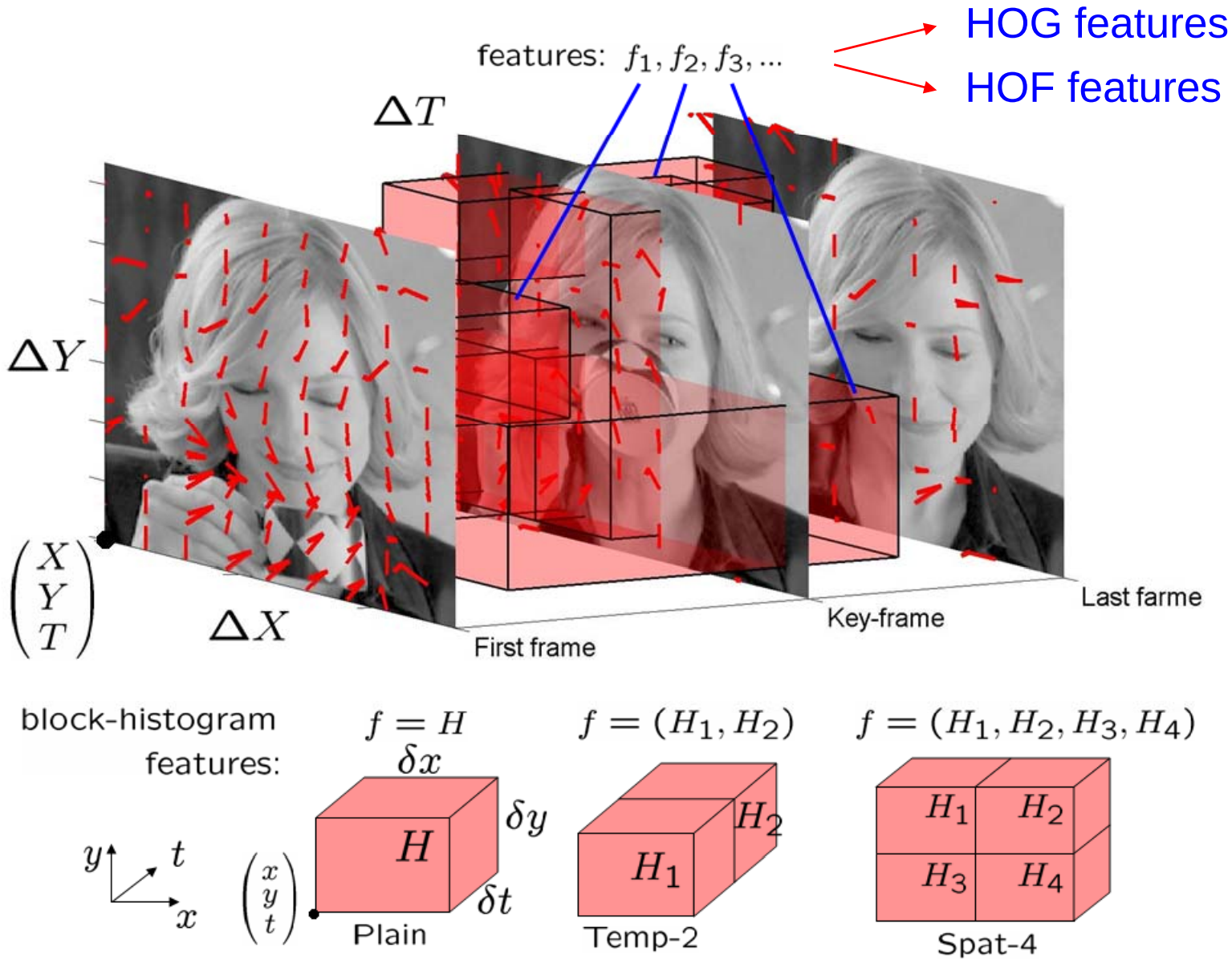
"atomic" actions

car exit | phoning | smoking | hand shaking | drinking

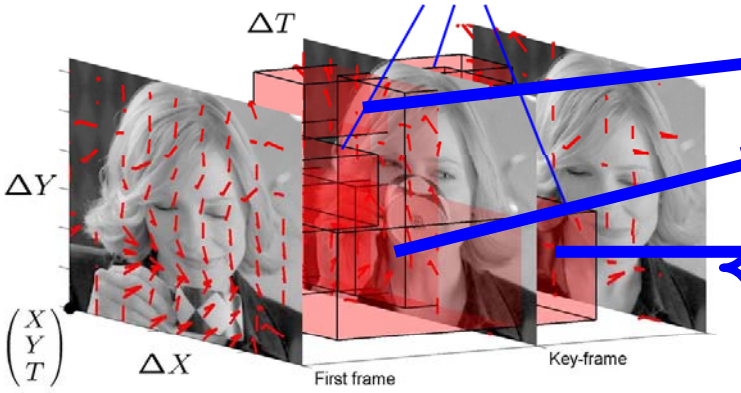
Objective: take advantage of space-time shape



Action features

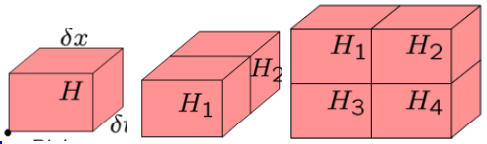


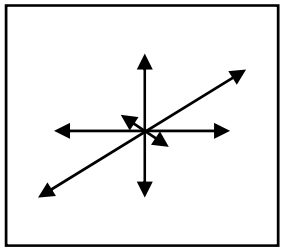
Histogram features



~10^7 cuboid features
Choosing 10^3 randomly

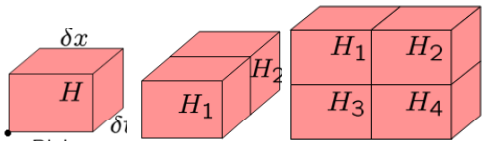
HOG: histograms of **oriented gradient**

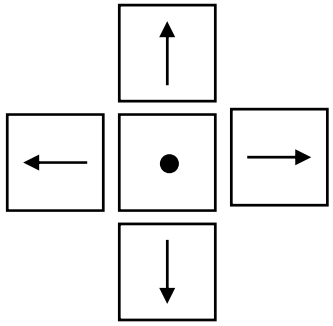




4 grad. orientation bins

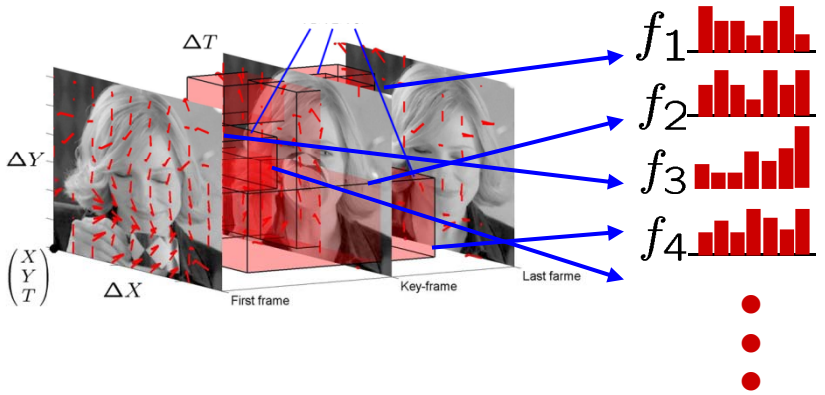
HOF: histograms of **optic flow**





4 OF direction bins
+ 1 bin for no motion

Action learning



f_1 f_2 f_3 f_4 ⋮

boosting

selected features

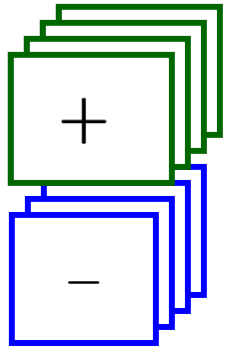
$$H(z) = \mathrm{sgn}\left(\sum_{t=1}^{T} \alpha_t h_t(f_t)\right)$$

weak classifier

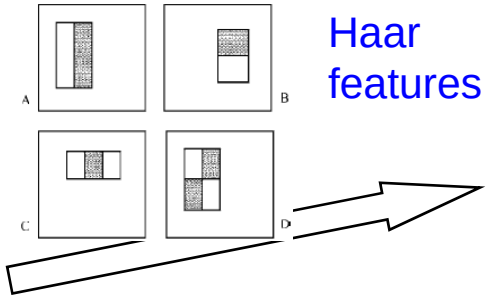
AdaBoost:

- Efficient discriminative classifier [Freund&Schapire'97]
- Good performance for face detection [Viola&Jones'01]

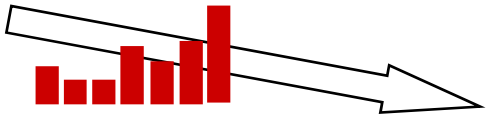
pre-aligned samples

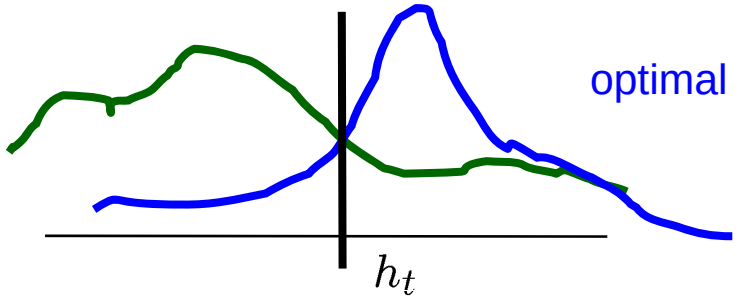


Haar features

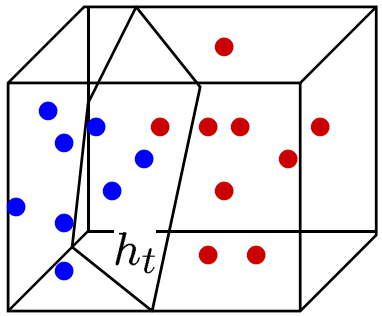


Histogram features





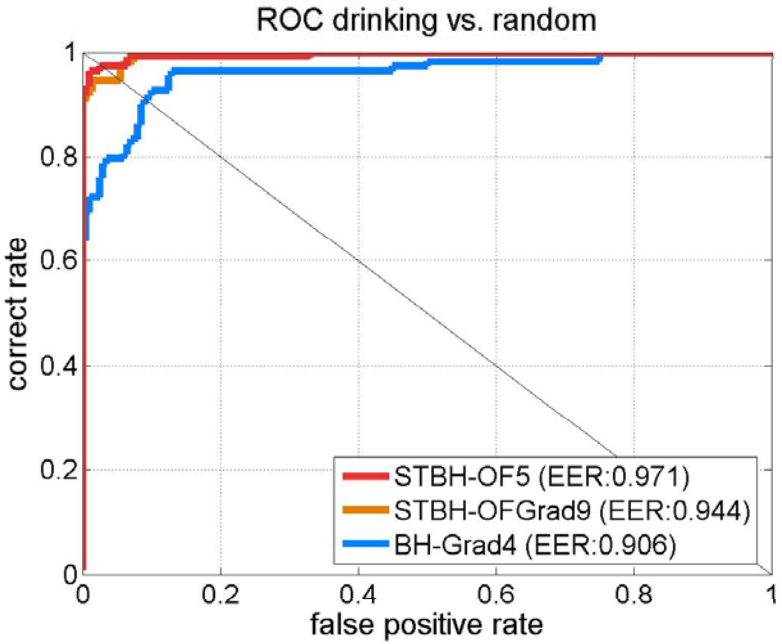
optimal threshold

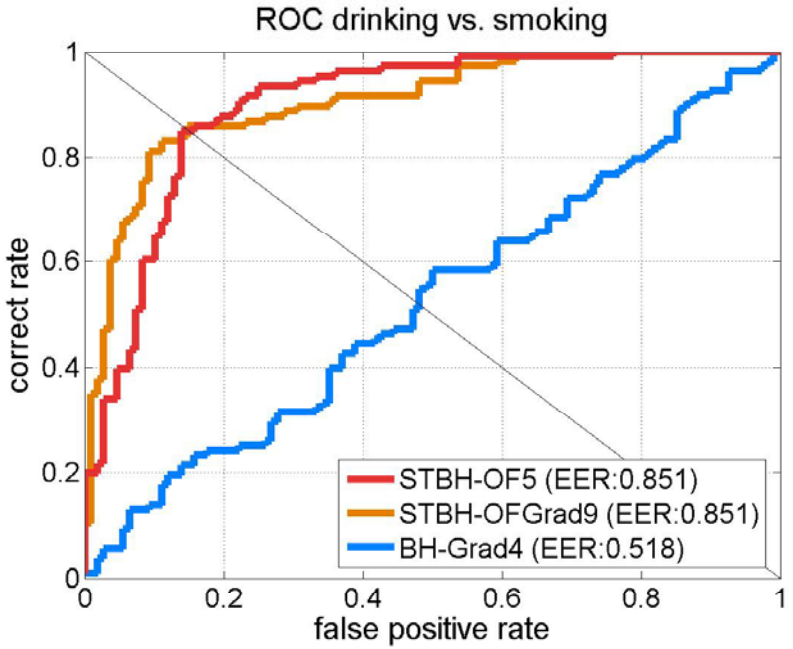


Fisher discriminant

Action classification test

Random motion patterns





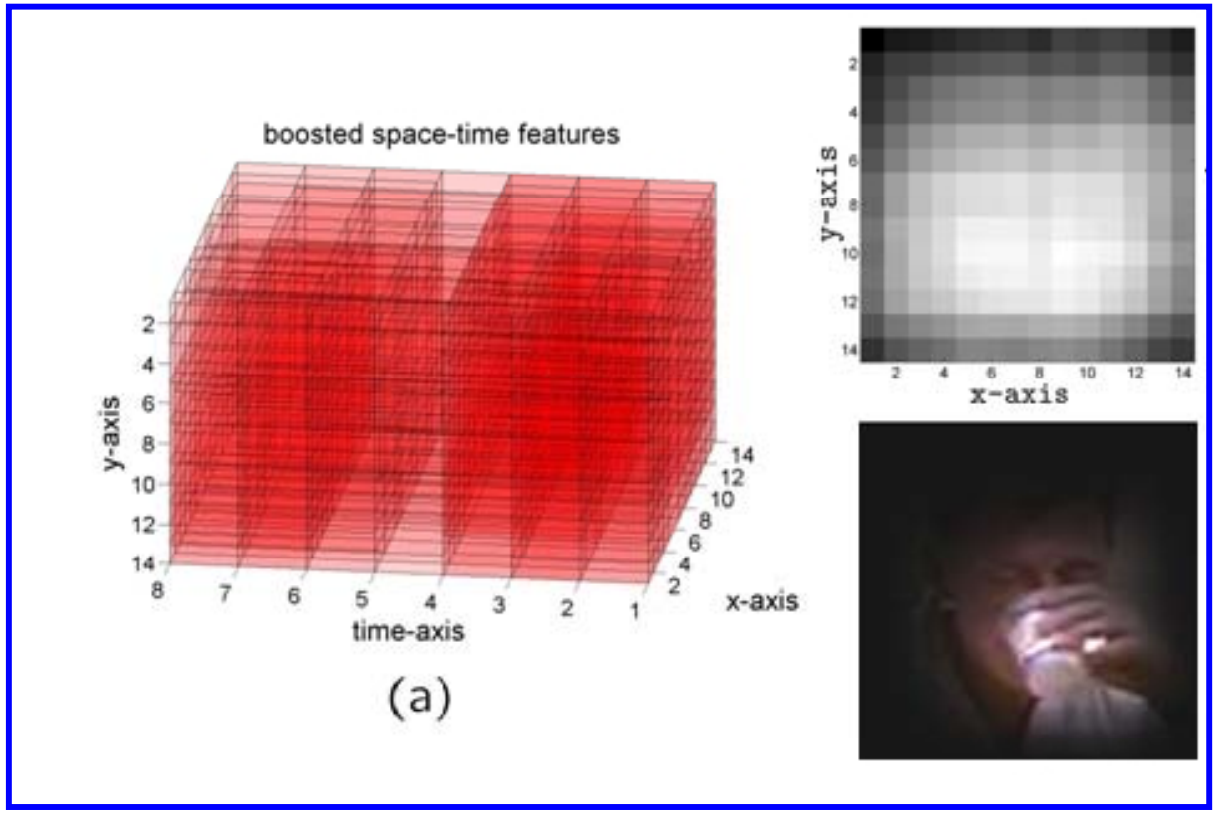
- Additional shape information does not seem to improve the space-time classifier
- Space-time classifier and static key-frame classifier might have complementary properties

Classifier properties

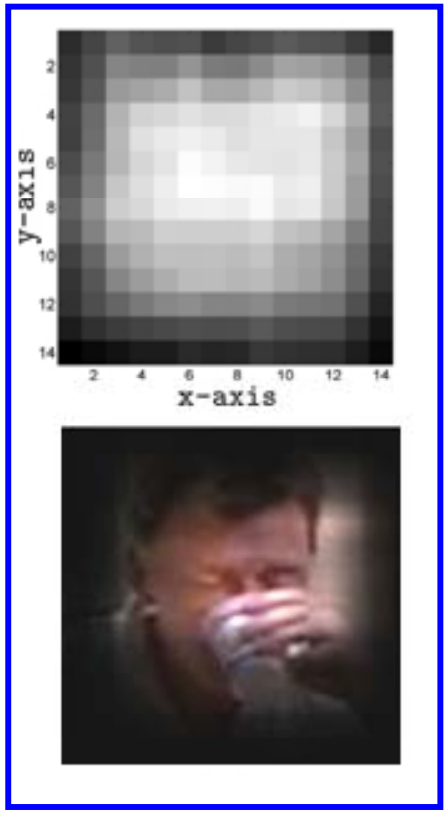
Compare selected features by

- Space-time action classifier (HOF features)
- Static key-frame classifier (HOG features)

Training output: Accumulated feature maps



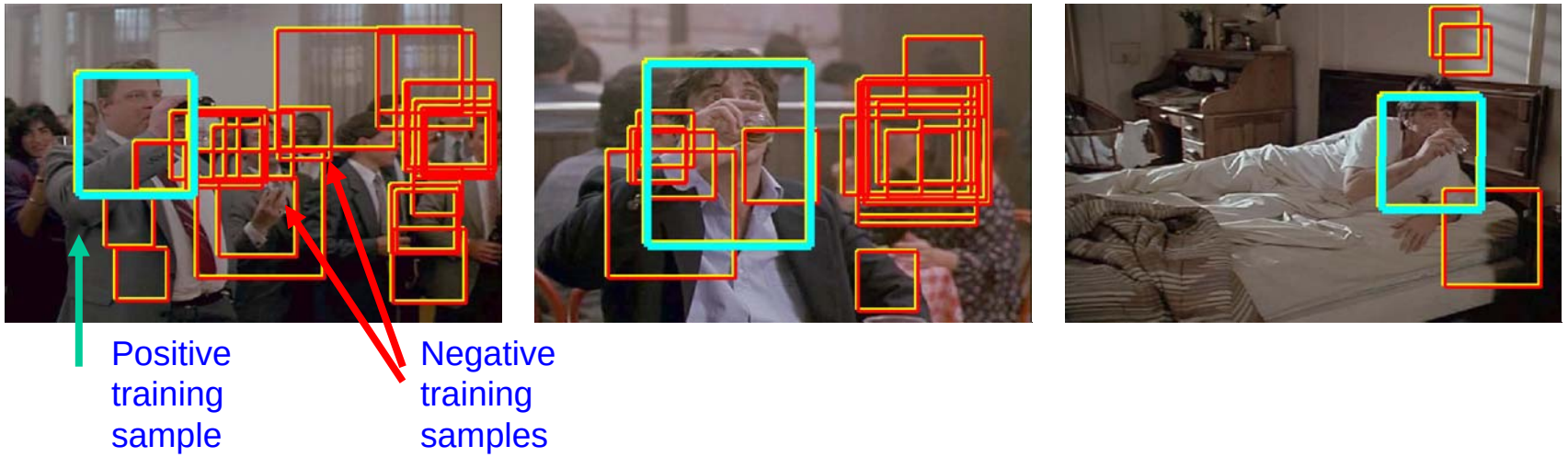
Space-time classifier



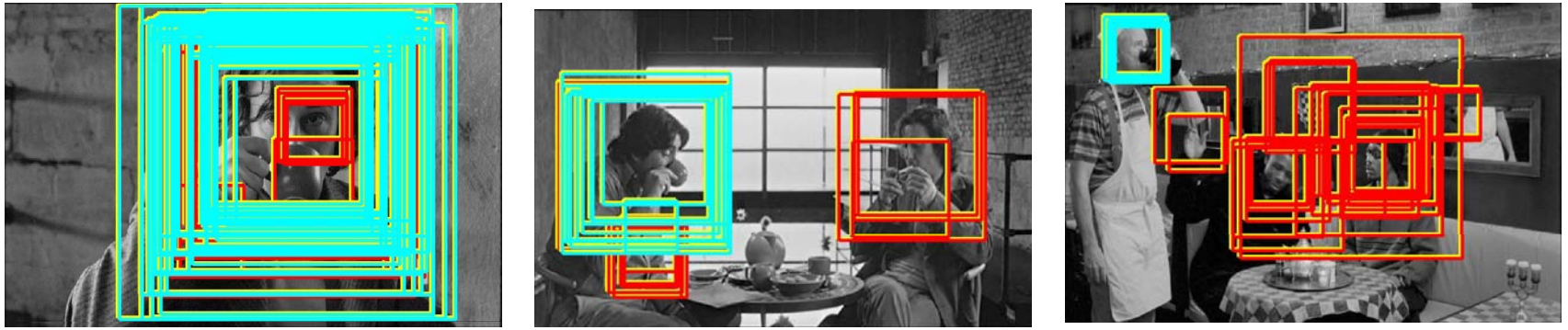
Static keyframe classifier

Keyframe priming

Training



Test



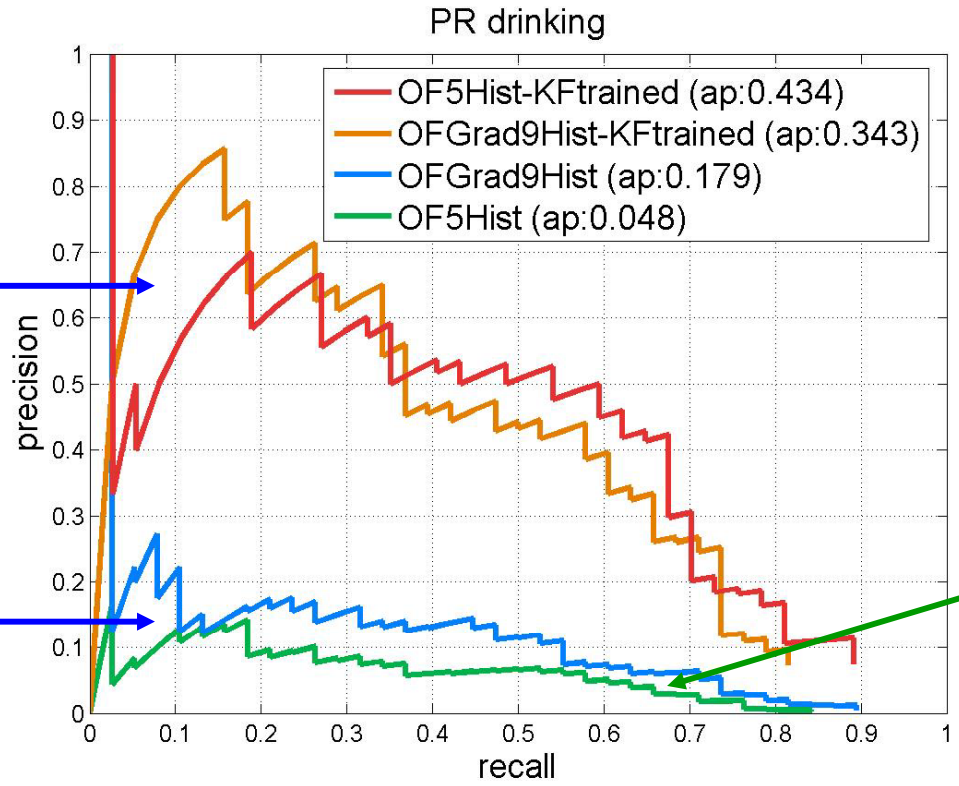
Action detection

Test set:

- 25min from “Coffee and Cigarettes” with GT 38 drinking actions
- No overlap with the training set in subjects or scenes

Detection:

- search over all space-time locations and spatio-temporal extents



Keyframe priming

No Keyframe priming

Similar approach to Ke, Sukthankar and Hebert, ICCV05

Test episode

20 most confident detections

Summary

- First attempt to address human action in real movies
- Action detection/recognition seems possible under hard realistic conditions (variations across views, subjects, scenes, etc...)
- Separate learning of shape/motion information results in a large improvement (overfitting?)

Future

- Need realistic data for 100's of action classes:
  -> (semi-) automatic action annotation from movie scripts
  [M.Everingham, J.Sivic and A.Zisserman BMVC06]
- Explicit handling of actions under multiple views
- Combining action classification with text