Detecting Activities of Daily Living in First-person Camera Views

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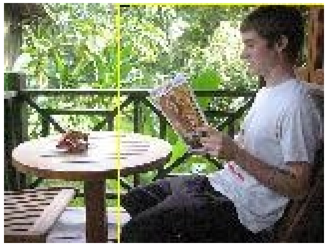
Activities of Daily Living (ADL)

- In healthcare
  - daily self-care activities within an individual's place of residence, in outdoor environments, or both
  - Feeding oneself
  - Maintaining hygiene
  - Dressing and undressing
  - ...

Visual Activity Recognition

- Automated analysis of ongoing events and their context in videos or still images.
  - Human activity recognition
    - Single human actions
    - Human human interaction
    - Human-Object interaction
    - Group activities
  - General events





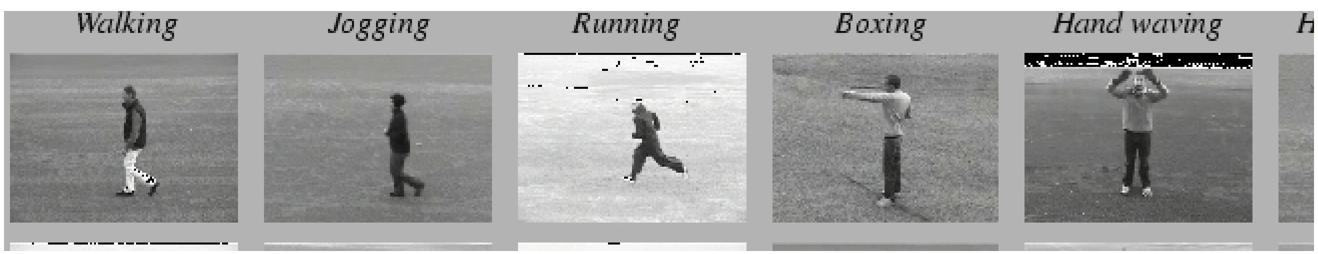


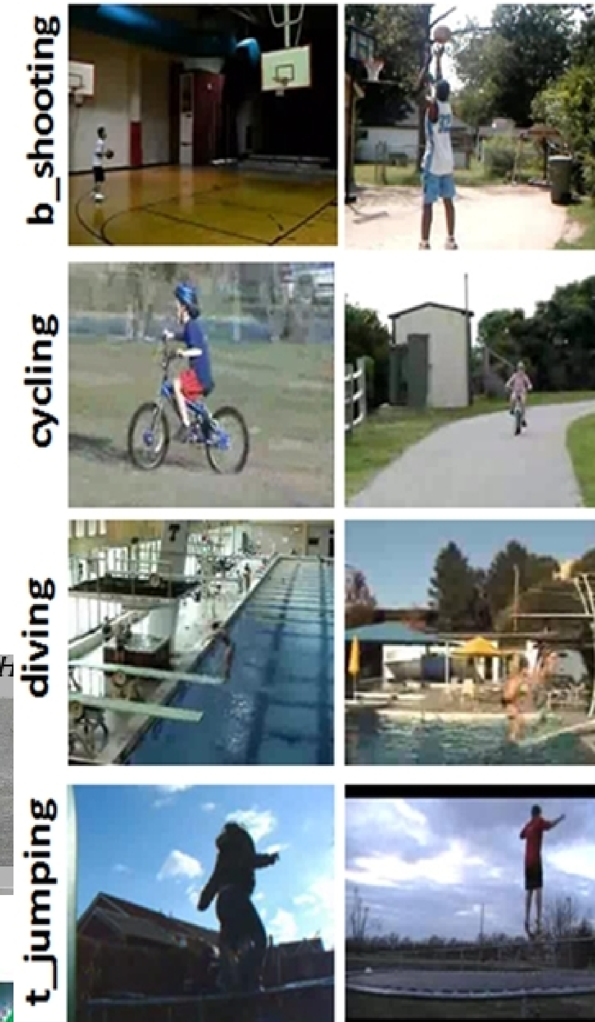
Detecting ADL

- Mostly human interacting with objects
  - tv, sofa, tooth brush, food, car, stove, …
- Applications
  - Tele-rehabilitation
    - Evaluate everyday functional activities
    - Long term, efficient monitoring
  - Life logging
    - Visual history or memory
    - Large scale
- “It is all about objects being interacted with”

Other Datasets

- Actor-scripted video footage
- Movies
- Sports
- Videos in the wild





Skateboarding Swing-Bench Swing-Side

This dataset

- Hard to define canonical activities
  - ADL from medical literature and rehabilitation
- Hard to capture intra class variation
  - Wearable camera on different persons
- Wearable camera (GoPro)
  - HD (1280x960)
  - 170 fov
  - 30 hz

This dataset

- 20 people in their own apartments
- 18 actions
- Unscripted
- 10 hours
- Annotation
  - Action label
  - Object bounding box
  - Object identity
    - tracking
  - Interaction
    - active/passive

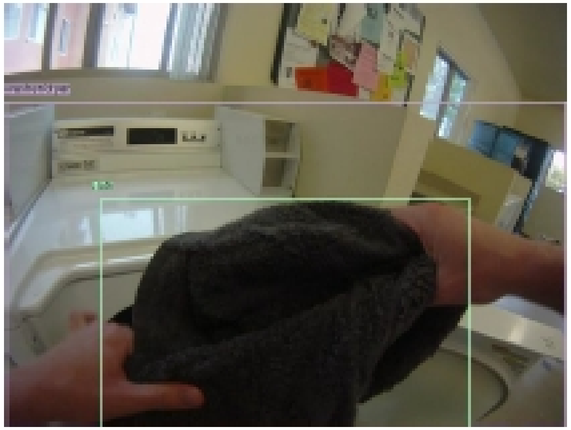
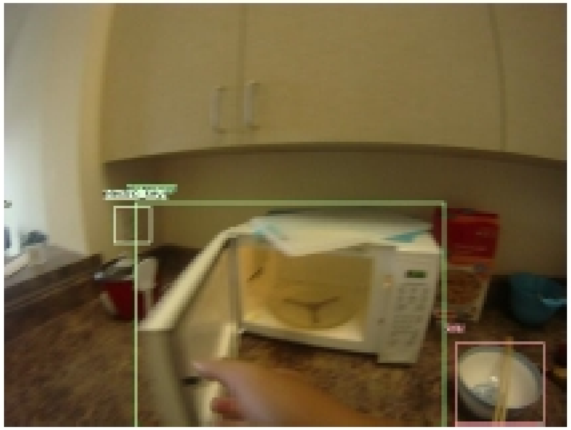
action name	mean of length (secs)	std. dev. of length
combing hair	26.50	9.00
make up	108.00	85.44
brushing teeth	128.86	45.50
dental floss	92.00	23.58
washing hands/face	76.00	36.33
drying hands/face	26.67	13.06
laundry	215.50	142.81
washing dishes	159.60	154.39
moving dishes	143.00	159.81
making tea	143.00	71.81
making coffee	85.33	54.45
drinking water/bottle	70.50	30.74
drinking water/tap	8.00	5.66
making cold food/snack	117.20	96.63
vacuuming	77.00	60.81
watching tv	189.60	98.74
using computer	105.60	32.94
using cell	18.67	9.45

This dataset - characteristics

- Large variation in scenes and objects

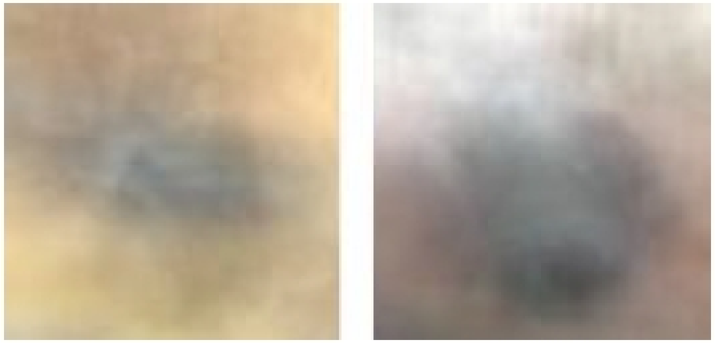
This dataset - charactristcs

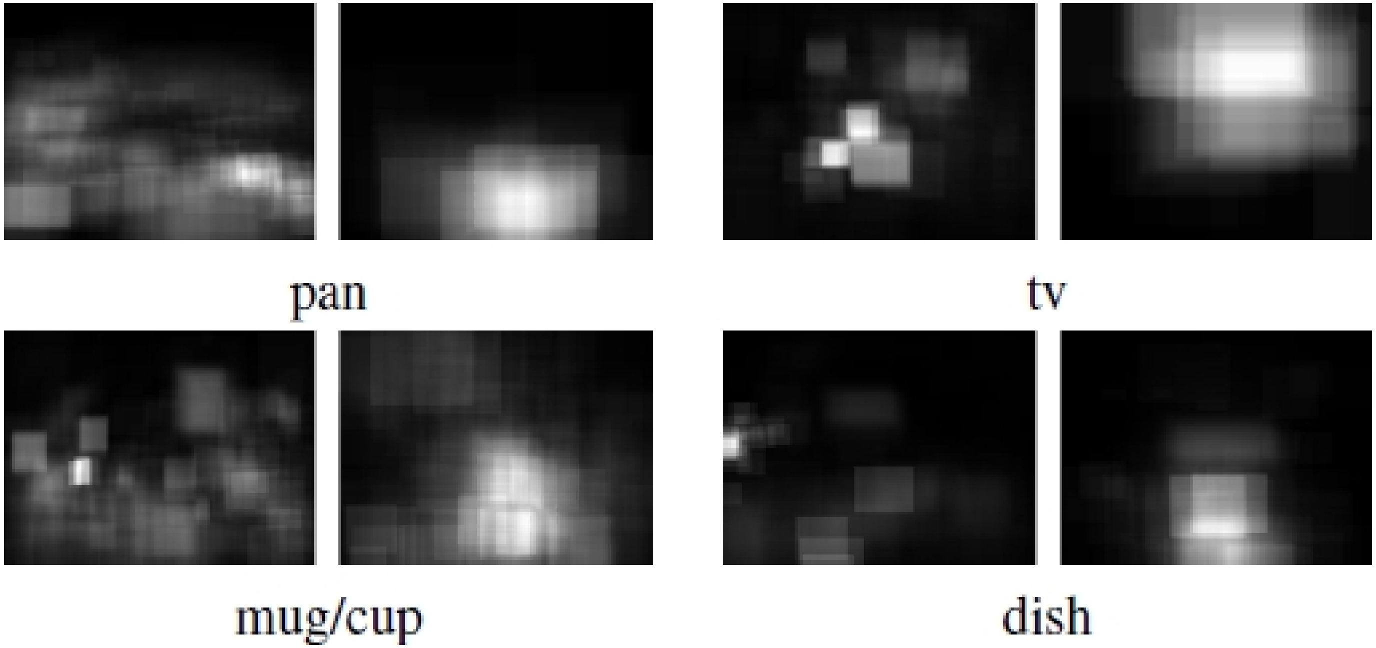
- Various object view point and occlusion level

This dataset - characteristics

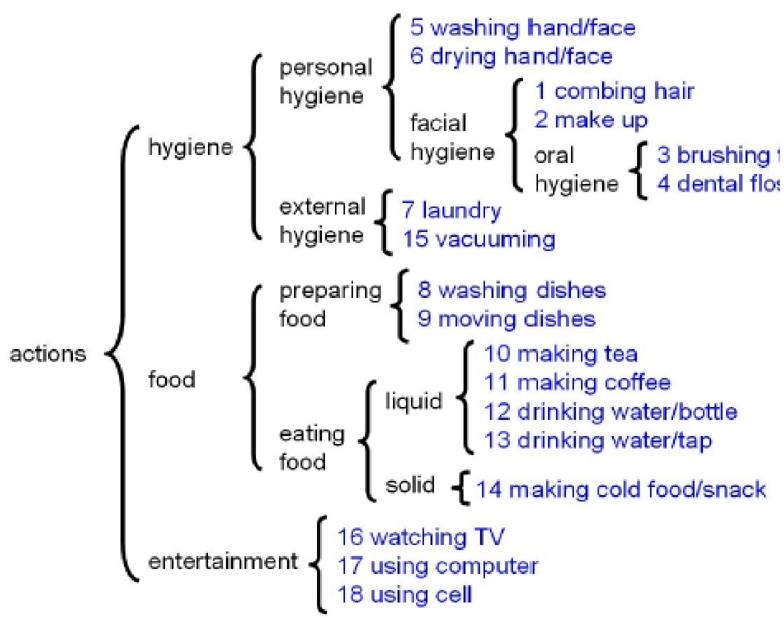
- Biases
  - active/passive objects
    - Location
    - pose

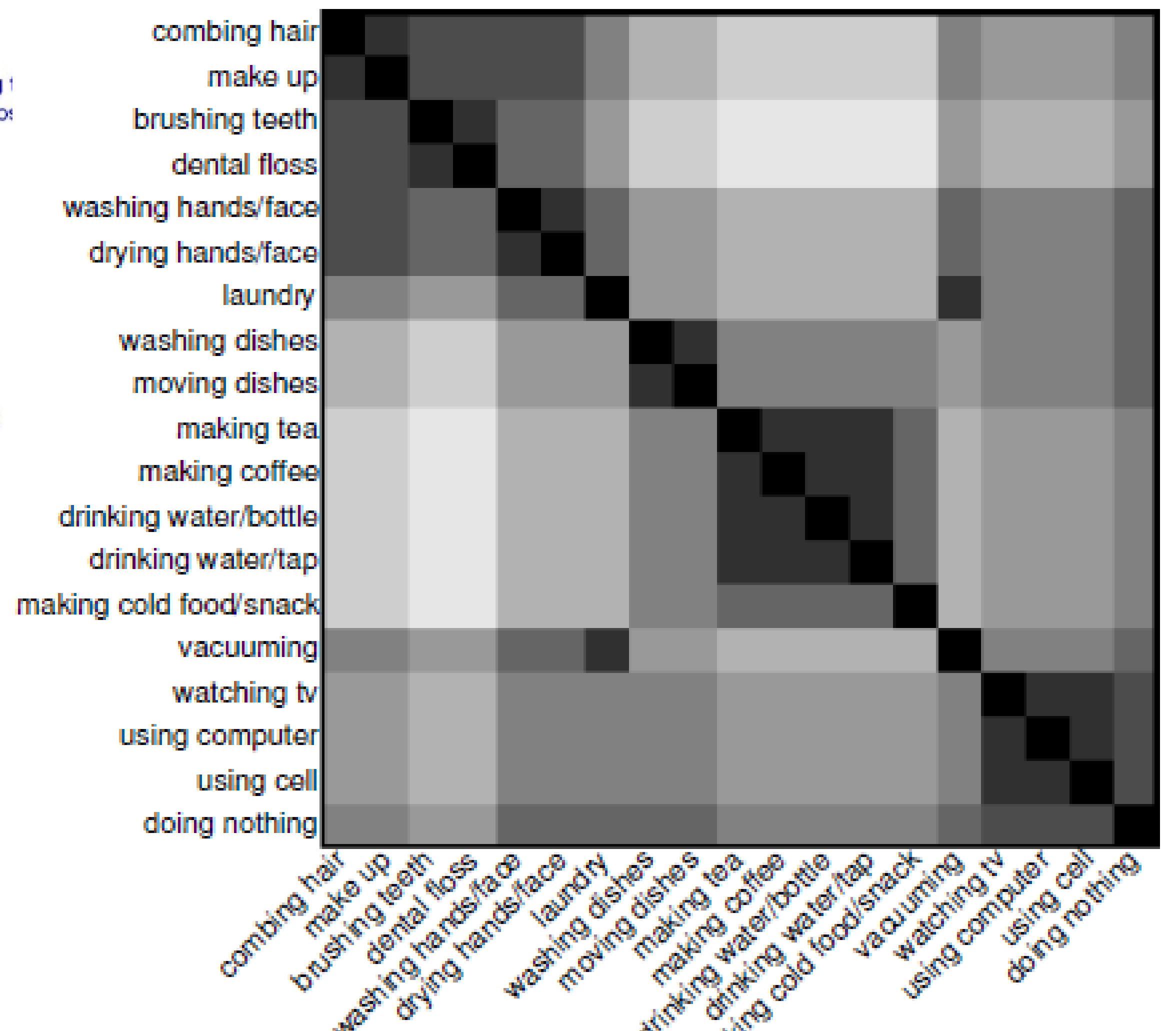




This dataset - characteristics

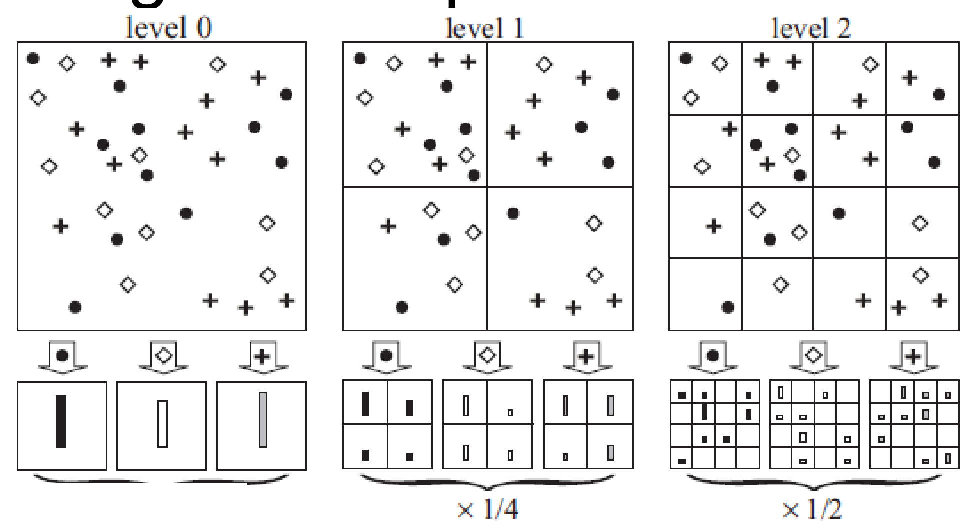
- Inherent functional taxonomy

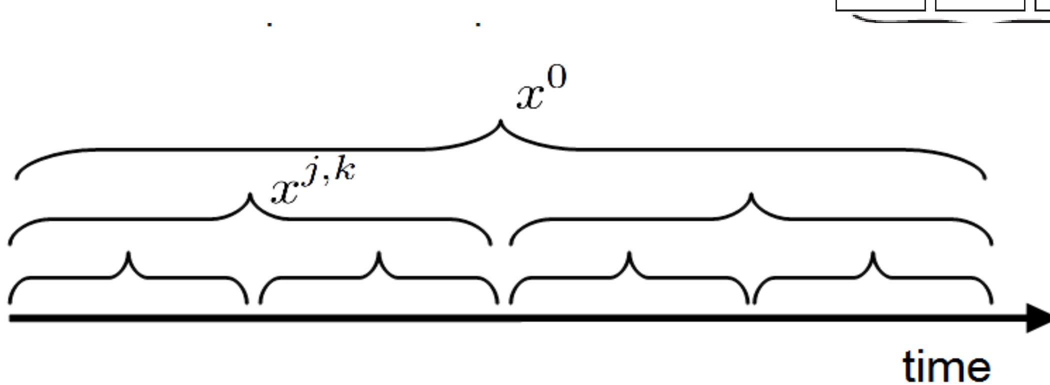




Learning - Features

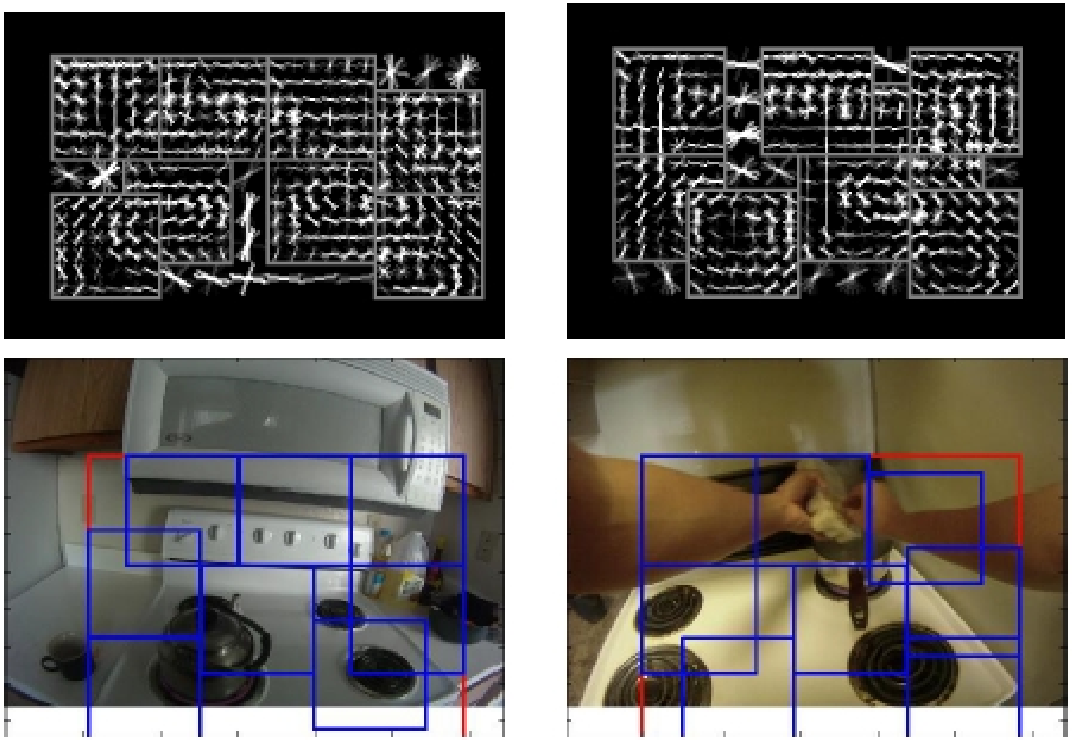
- Temporal pyramids
  - Spatial pyramids
  - Visual words → Object models
  - Modelling actions with long term dependencies
  - Felzenswalb's DPM
  - Location bias





Learning - Features

- Active Object Models
  - Objects look different when being interacted with
  - Detection of visual phrases, Farhad et. al. (cvpr 11)



(a) passive stove (b) active stove

Experiments

- Same individual does not appear in train and test
- Leave one out cross validation testing
- AP for object detection
- Action recognition
  - Classification error
  - Weighted taxonomy derived loss

Experiments object detection

- 24 objects
- 1200 bbox/object
- low number of instances
- High variation in viewpoint and occlusion state
- ImageNet

Object	ADL	ImageNet
tap	40.4 ± 24.3	0.1
soap liquid	32.5 ± 28.8	2.5
fridge	19.9 ± 12.6	0.4
microwave	43.1 ± 14.1	20.2
oven/stove	38.7 ± 22.3	0.1
bottle	21.0 ± 27.0	9.8
kettle	21.6 ± 24.2	0.1
mug/cup	23.5 ± 14.8	14.8
washer/dryer	47.6 ± 15.7	1.8
tv	69.0 ± 21.7	26.9

Experiments – action recognition

- Spatio-temporal interest points(stip)
- Object bag(O)
- Active object bag(AO)
- Ideal object detector(IO)
- Ideal active/passive object (IA + IO)
- Pre-segmented or sliding window
- Accuracy or taxonomy loss

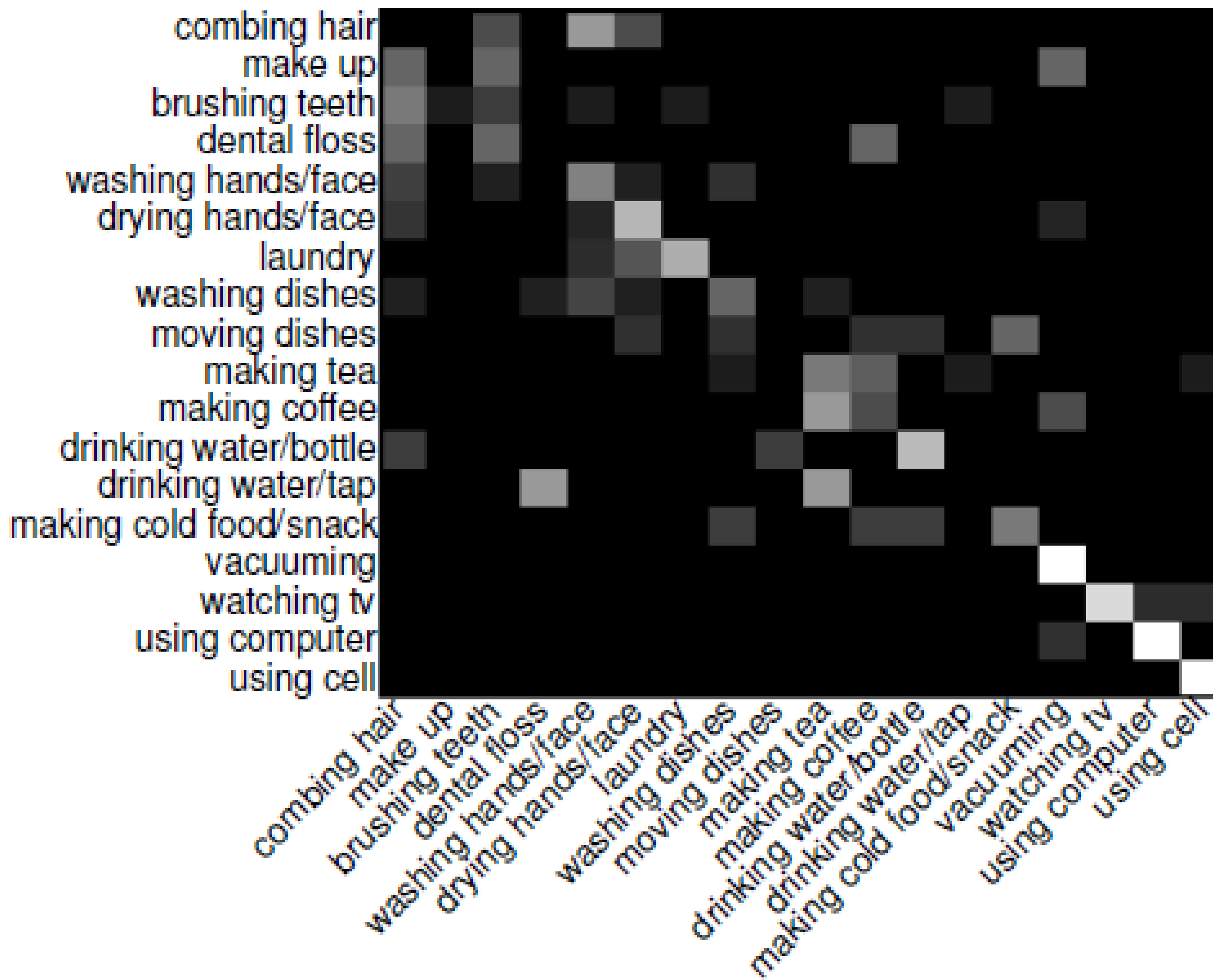
	pre-segmented			
	segment class. accuracy		taxonomy loss	
	pyramid	bag	pyramid	bag
STIP	22.8	16.5	1.8792	2.1092
O	32.7	24.7	1.4017	1.7129
AO	40.6	36.0	1.2501	1.4256
IO	55.8	49.3	0.9267	0.9947
IA+IO	77.0	76.8	0.4664	0.4851

	sliding window			
	frame class. accuracy		taxonomy loss	
	pyramid	bag	pyramid	bag
STIP	15.6	12.9	2.1957	2.1997
O	23.8	17.4	1.5975	1.8123
AO	28.8	23.9	1.5057	1.6515
IO	43.5	36.6	1.1047	1.2859
IA+IO	60.7	53.7	0.79532	0.9551

- “It is all about objects being interacted with”

Experiments – action recognition

- Small objects
- Scene based features



summary

- Most human activities involve objects
- Good detection of object and its state (active/passive) help activity recognition a lot
- Naturally captured datasets is more realistic...
- Objects appear visually different in various scenarios due to occlusion and interactions