The PASCAL Visual Object Classes Challenge 2011 (VOC2011)

Part 2 – Detection Task

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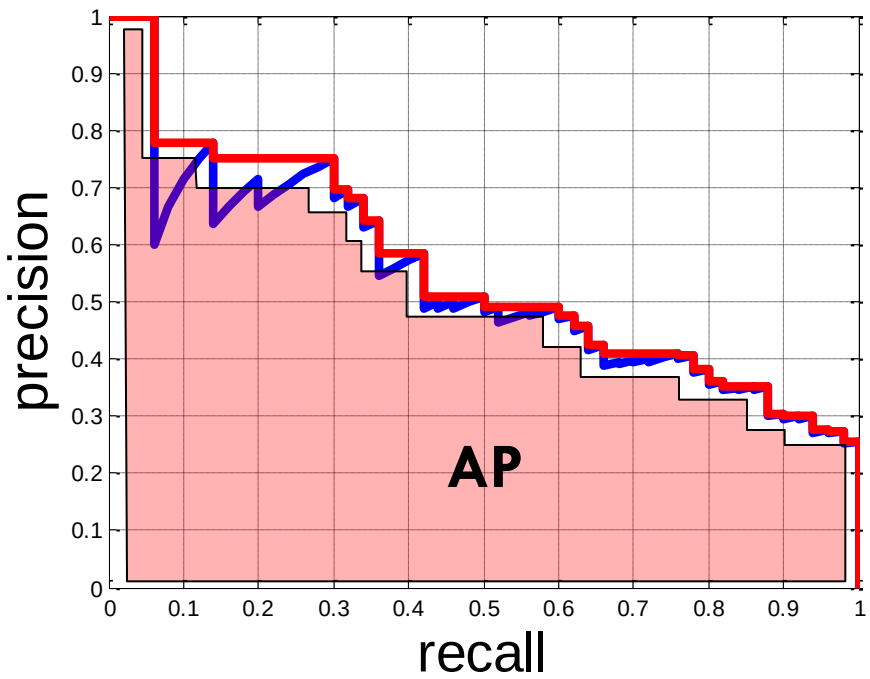
PASCAL2
Pattern Analysis, Statistical Modelling and Computational Learning

Detection Challenge

- Predict the bounding boxes of all objects of a given class in an image (if any)

- Competition 3: Train on the supplied data
  - Which methods perform best given specified training data?
- Competition 4: Train on any (non-test) data
  - How well do state-of-the-art methods perform on these problems?

Average Precision

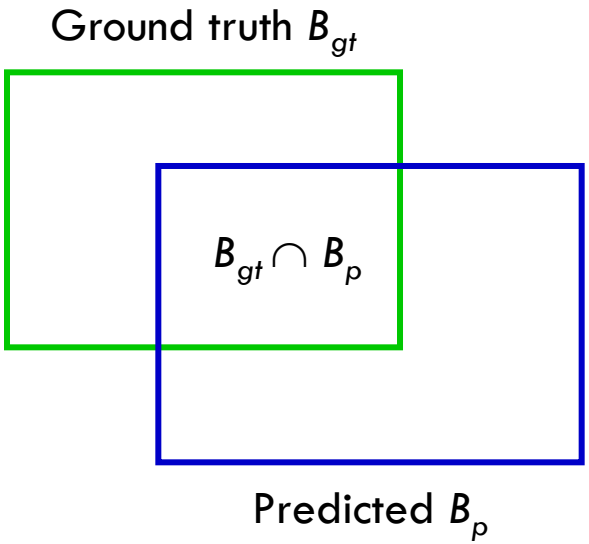


- Interpolate curve to create version for which the precision is monotonically non-increasing
- Measure area under interpolated curve

- Sawtooth shape is ignored
- Area is measured with maximum accuracy
- Good score requires both high precision **and** recall

Evaluating Bounding Boxes

- Area of Overlap (AO) Measure



$$AO(B_{gt}, B_p) = \frac{|B_{gt} \bigcap B_p|}{|B_{gt} \bigcup B_p|}$$

- Need to define a threshold *t* such that $AO(B_{gt}, B_p)$ implies a correct detection: 50%

Methods

- 13 Methods, 10 Groups
  - VOC2010: 22 Methods, 15 Groups
- Methods
  - Sliding window, SVM, multiple features e.g. HOG, LBP, bag of words
  - Classification-like representations: LLC, spatial pyramids, max pooling
  - Parts-based models, hierarchical models
  - Segmentation-based object hypotheses ("jumping window")
  - Combination with whole-image classification

Methods

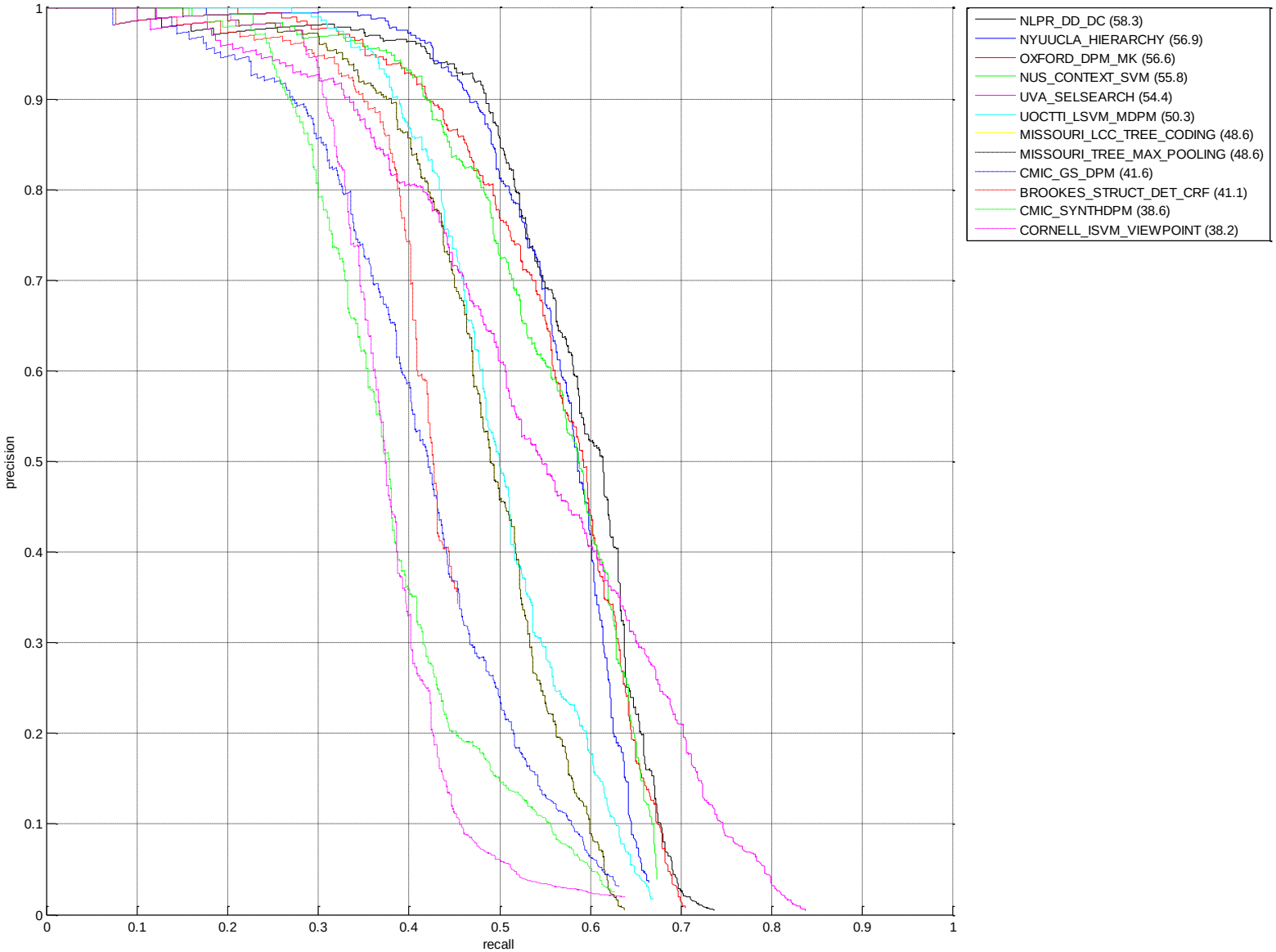
- Novelty
  - Use of explicit modelling of 3D structure
  - CRF for joint detection and segmentation inference
  - Representing part locations using GMM
  - Grammar model for person including occluder part

AP by Class/Method

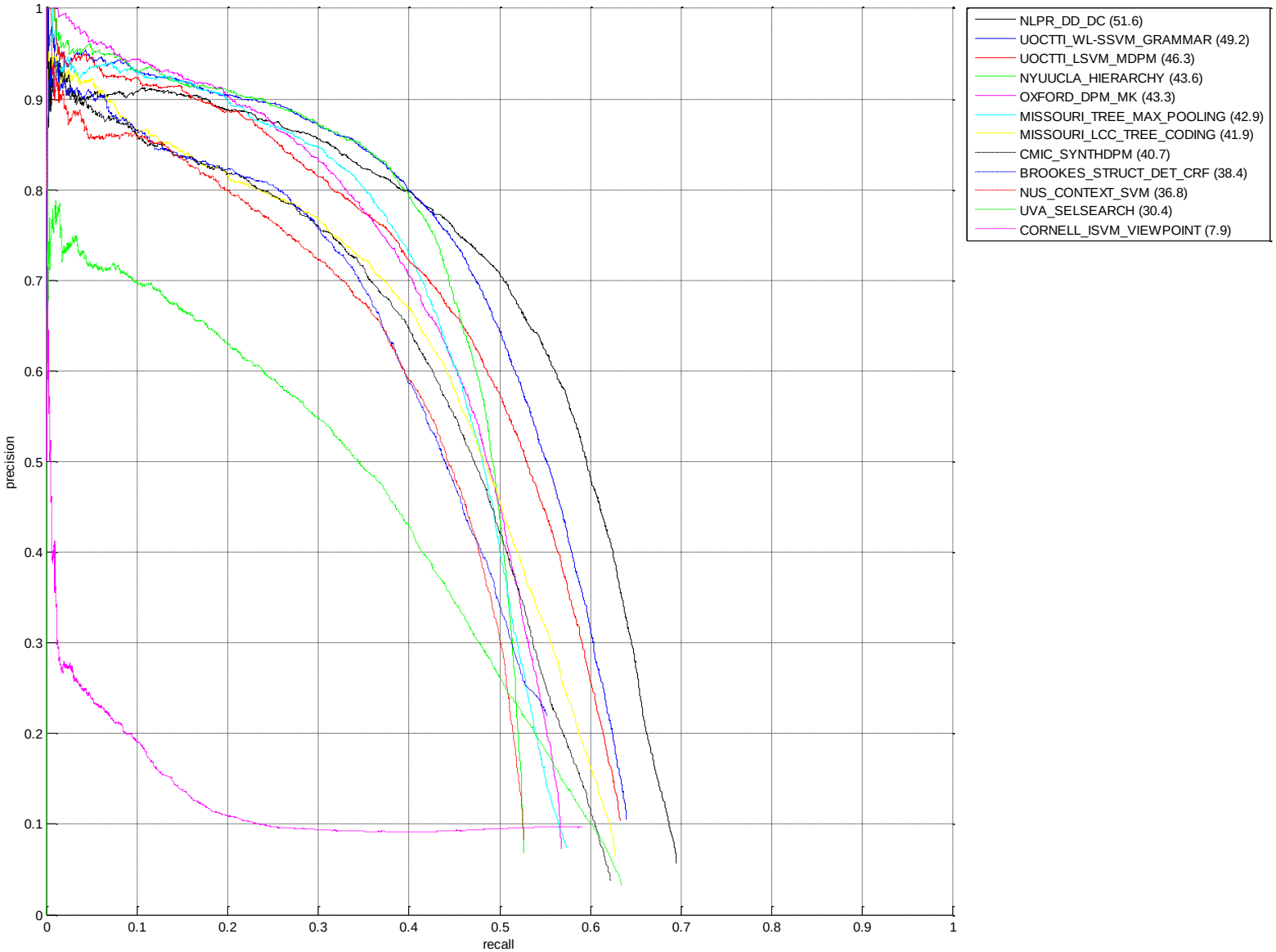
(1st, 2nd, 3rd place)

	aero plane	bicycle	bird	boat	bottle	bus	car	cat	chair	cow	dining table	dog	horse	motor bike	person	potted plant	sheep	sofa	train	tv/ monitor
BROOKES_STRUCT_DET_CRF	37.1	42.6	2.0	0.0	16.0	43.8	38.6	17.0	10.3	7.7	2.4	1.5	34.3	41.1	38.4	1.5	14.7	5.3	35.4	27.1
CMIC_GS_DPM				13.3	26.4		41.5				12.2			41.6		8.3	31.4			
CMIC_SYNTHDPM	40.4	47.8		11.4	23.7	48.9	40.9	23.5	11.9	25.5		10.9	42.0	38.6	40.7	7.5	30.4		38.4	34.8
CORNELL_ISVM_VIEWPOINT	42.5	43.7	5.4	4.8	18.1	28.6	36.6	24.2	12.6	20.5	4.4	17.5	15.2	38.2	7.9	1.7	23.2	7.1	41.0	25.7
MISSOURI_LCC_TREE_CODING	41.1	51.7	13.7	11.9	27.3	52.1	41.7	32.9	17.6	27.3	18.5	23.1	45.2	48.6	41.9	11.6	32.4	27.5	44.2	38.3
MISSOURI_TREE_MAX_POOLING	43.8	51.7	13.7	12.7	27.3	51.5	43.7	32.9	18.3	27.3	18.5	23.1	45.2	48.6	42.9	11.6	32.4	27.5	47.0	39.3
NLPR_DD_DC	55.0	58.1	22.5	18.8	33.9	57.6	54.5	42.6	20.2	40.3	29.3	37.1	54.6	58.3	51.6	14.7	44.8	32.1	51.7	41.0
NUS_CONTEXT_SVM	51.4	52.9	20.1	15.7	26.9	53.0	45.6	37.6	15.2	36.0	25.1	32.6	50.4	55.8	36.8	12.3	37.6	30.5	48.1	41.0
NYUUCLA_HIERARCHY	56.3	55.9	23.4	20.3	27.2	56.6	48.1	53.8	23.2	32.9	33.3	39.2	53.0	56.9	43.6	14.3	37.9	39.4	52.6	43.7
OXFORD_DPM_MK	56.0	53.3	19.2	17.2	25.8	53.1	45.4	44.5	20.1	32.1	28.1	37.2	52.3	56.6	43.3	12.1	34.3	37.6	51.8	45.2
UOCTTI_LSVM_MDPM	53.2	53.9	13.1	13.5	30.5	55.5	51.2	31.7	14.5	29.0	16.0	22.1	43.1	50.3	46.3	8.8	33.0	22.9	45.8	38.2
UOCTTI_WL-SSVM_GRAMMAR															49.2					
UVA_SELSEARCH	56.9	43.4	16.6	15.8	18.0	52.3	38.3	48.9	12.2	29.7	32.8	36.7	45.7	54.4	30.4	16.2	37.2	34.7	45.9	44.2

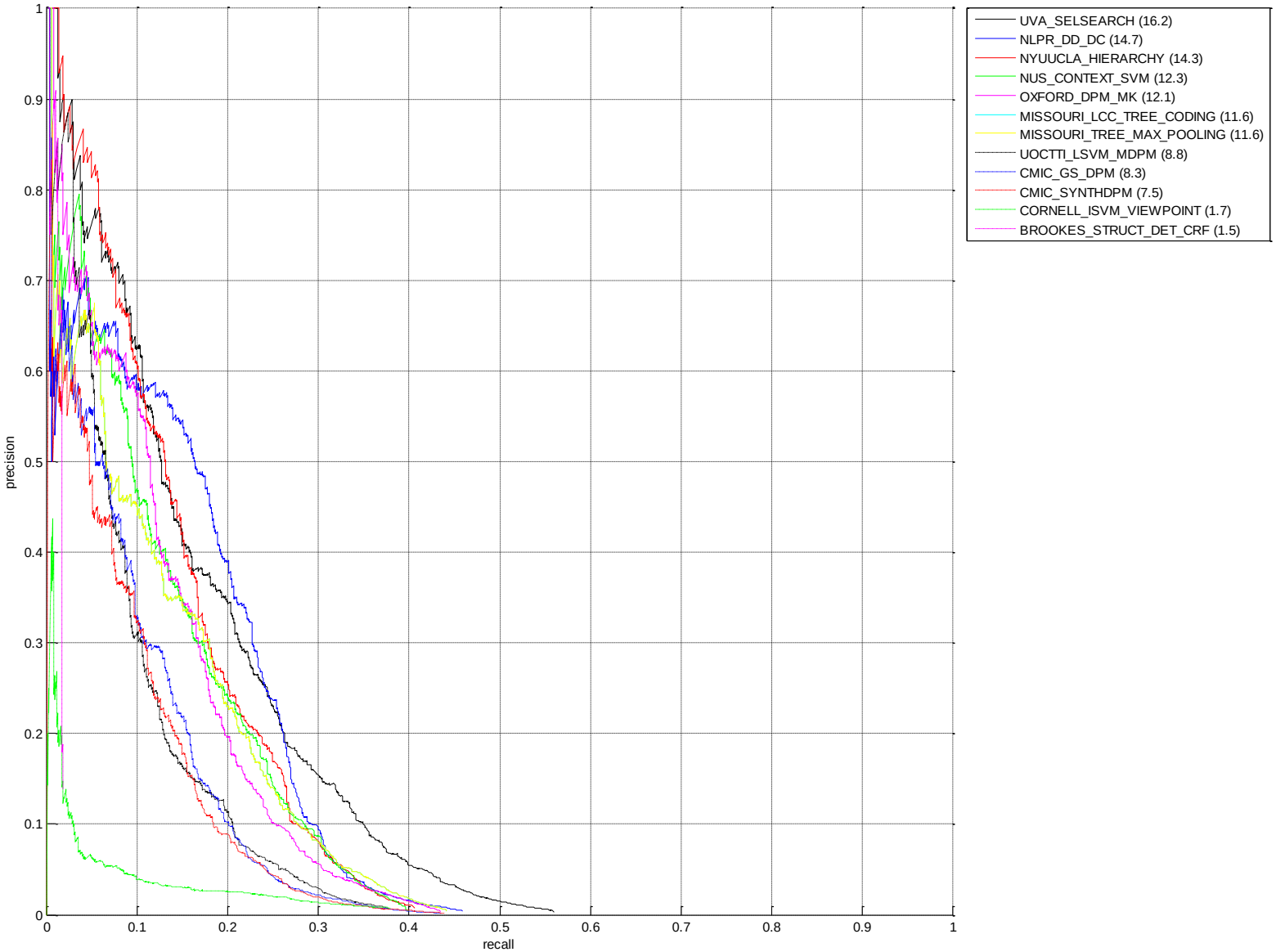
Precision/Recall - Motorbike



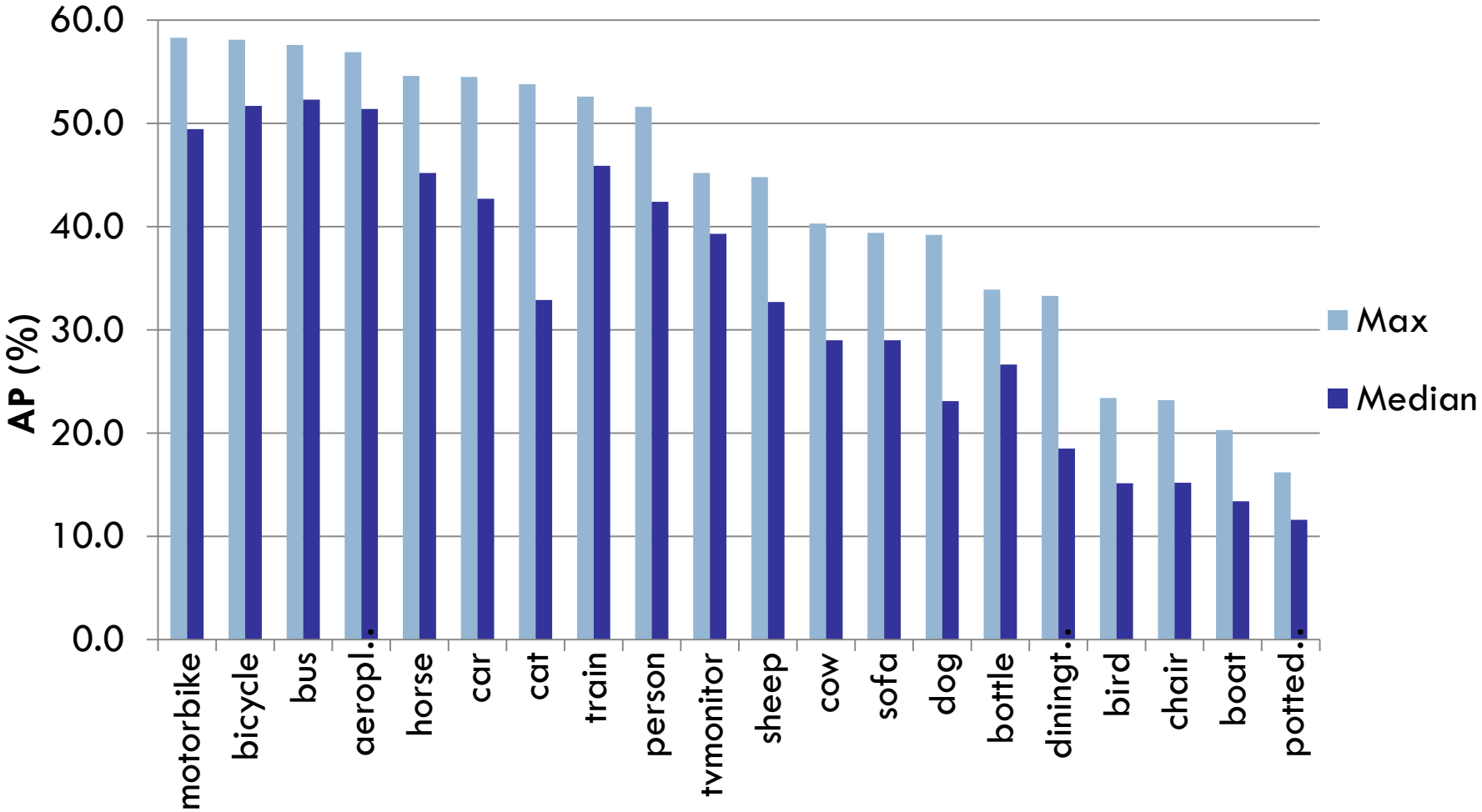
Precision/Recall - Person



Precision/Recall – Potted plant

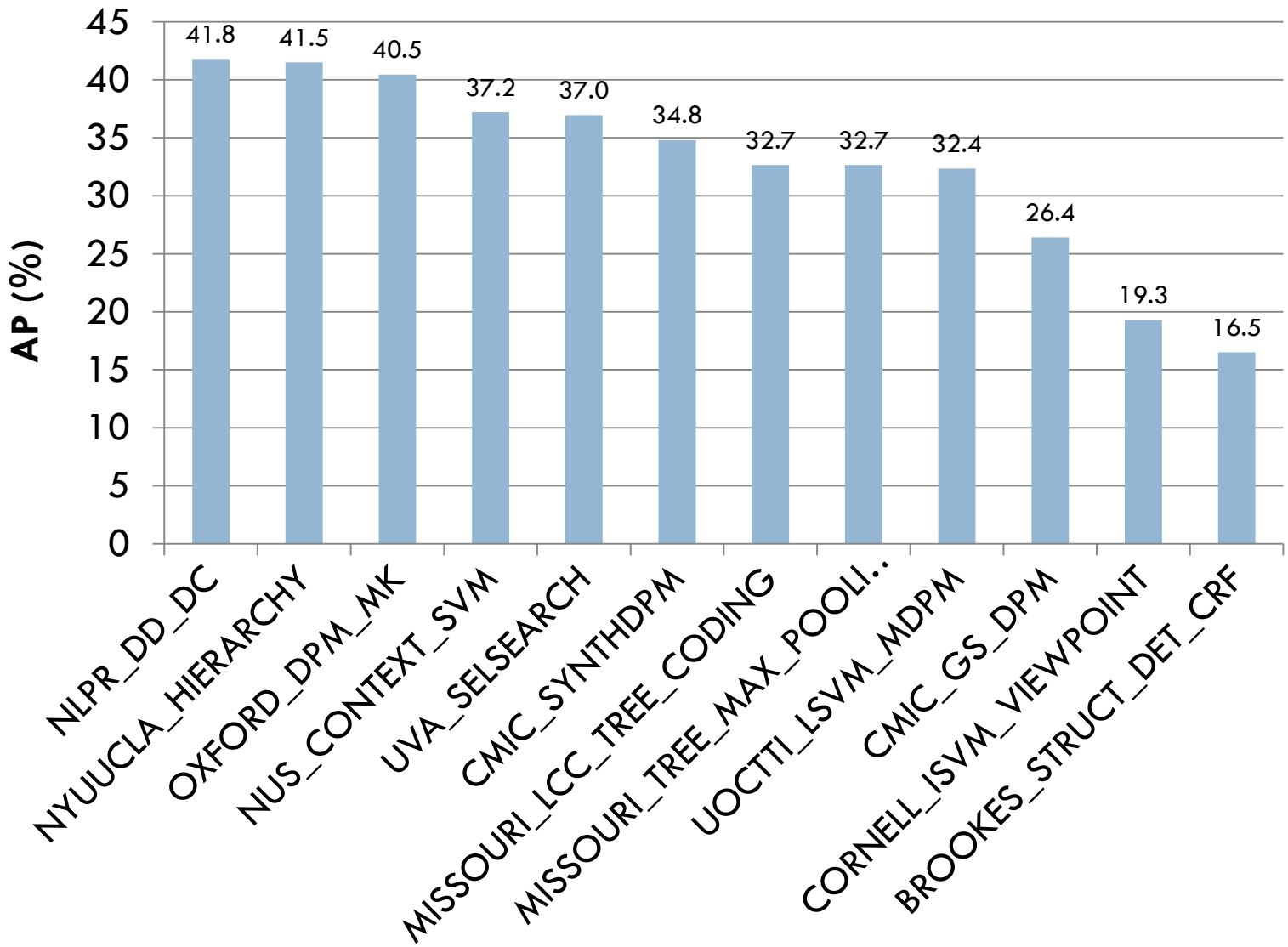


AP by Class



- Max AP: 58.3% (motorbike) … 16.2% (potted plant)

Median AP by Method



“True Positives” - Person

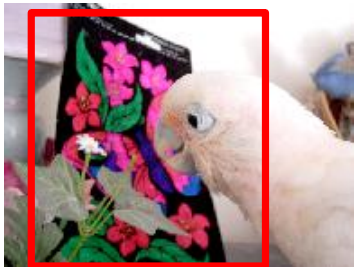
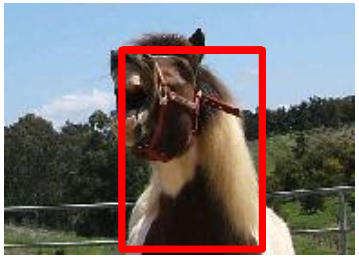
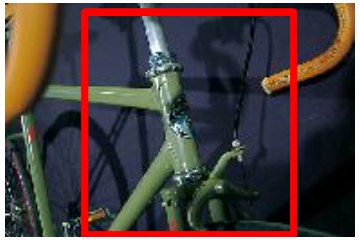
NLPR_DD_DC

UOCTTI_WL-SSVM_GRAMMAR

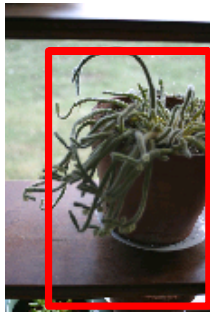
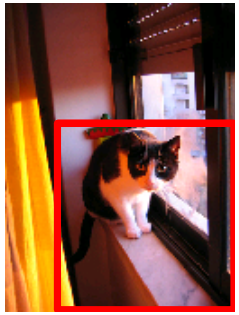
UOCTTI_LSVM_MDPM

“False Positives” - Person

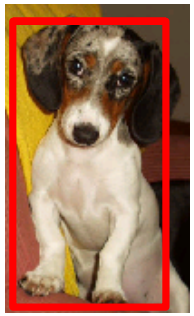
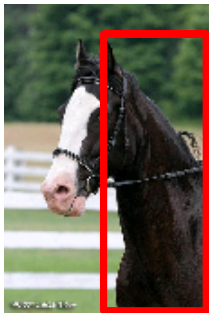
NLPR_DD_DC

UOCTTI_WL-SSVM_GRAMMAR

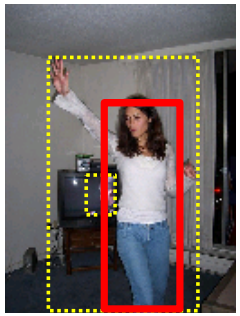



UOCTTI_LSVM_MDPM

“Near Misses” - Person

NLPR_DD_DC



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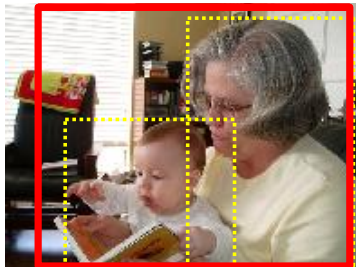
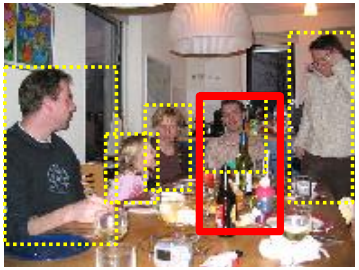
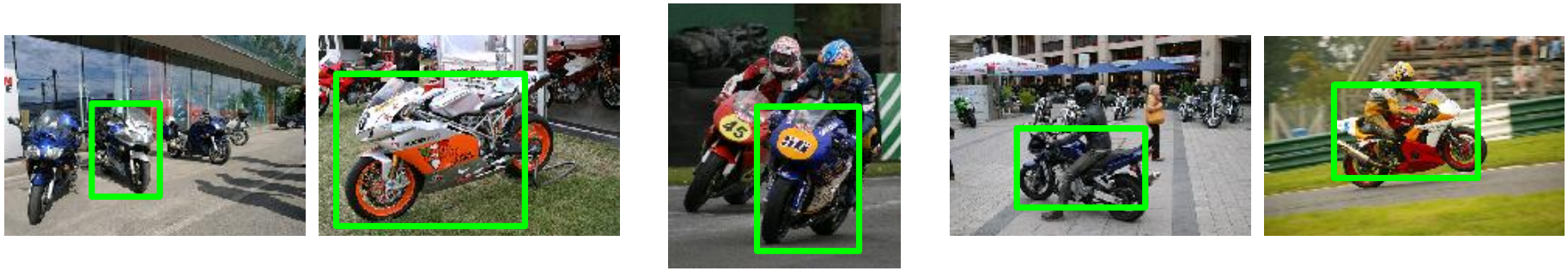




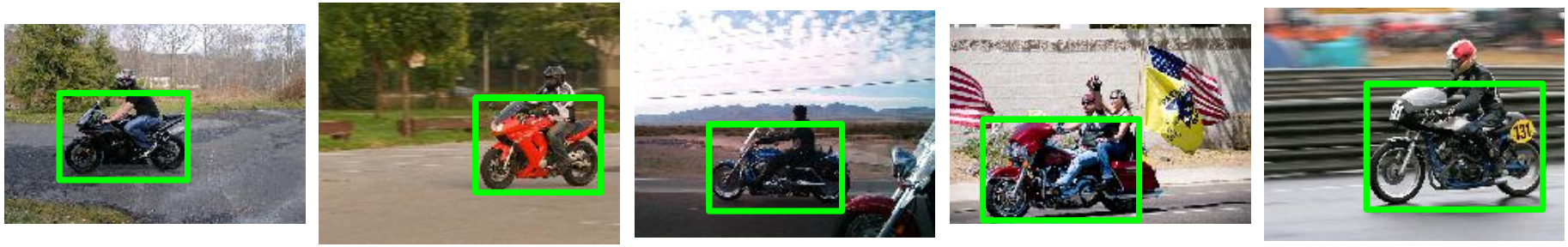
UOCTTI_LSVM_MDPM

“True Positives” - Motorbike

NLPR_DD_DC



NYUUCLA_HIERARCHY



OXFORD_DPM_MK

“False Positives” - Motorbike

NLPR_DD_DC

NYUUCLA_HIERARCHY

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“True Positives” - Cat

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UVA_SELSEARCH

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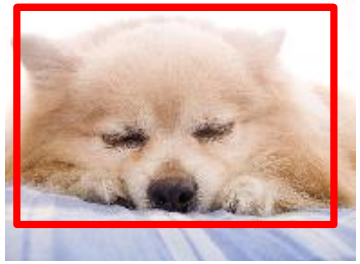

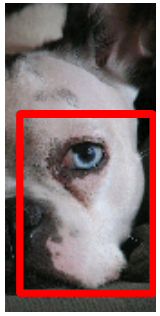

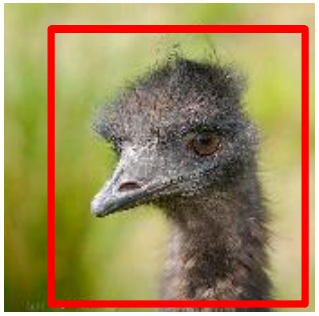

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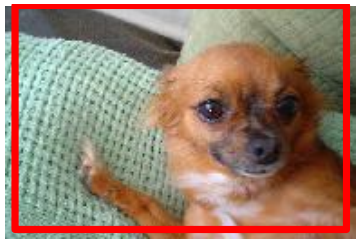
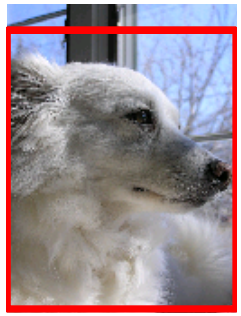
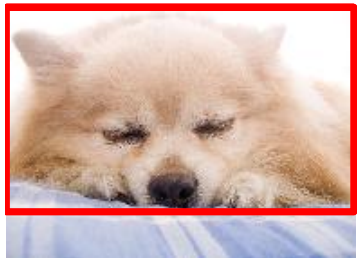




UVA_SELSEARCH



“Near Misses” - Cat

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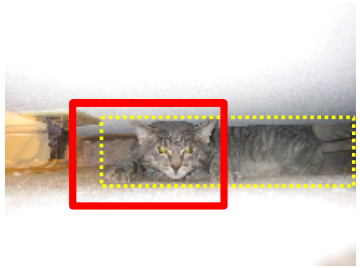
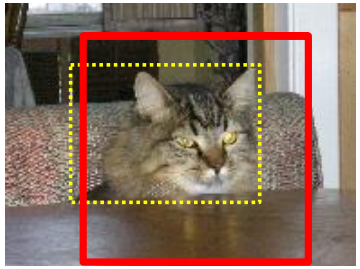
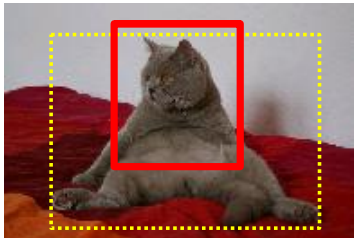
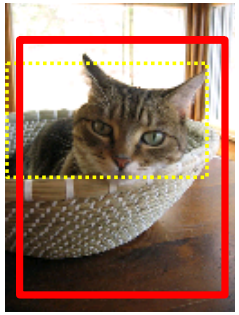
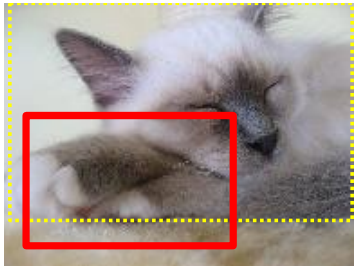
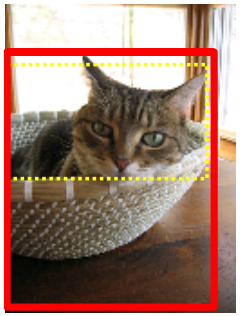
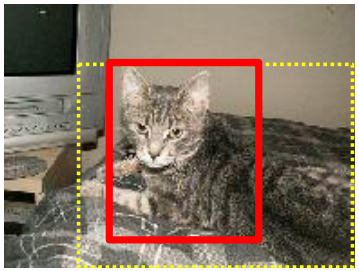
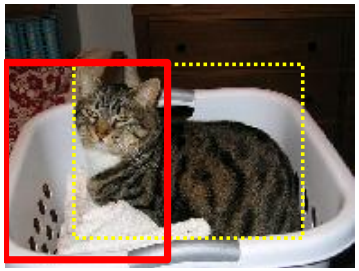
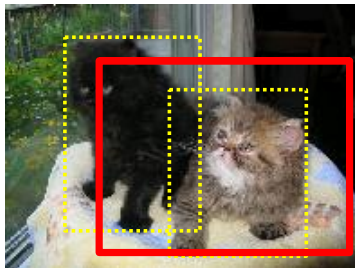






OXFORD_DPM_MK

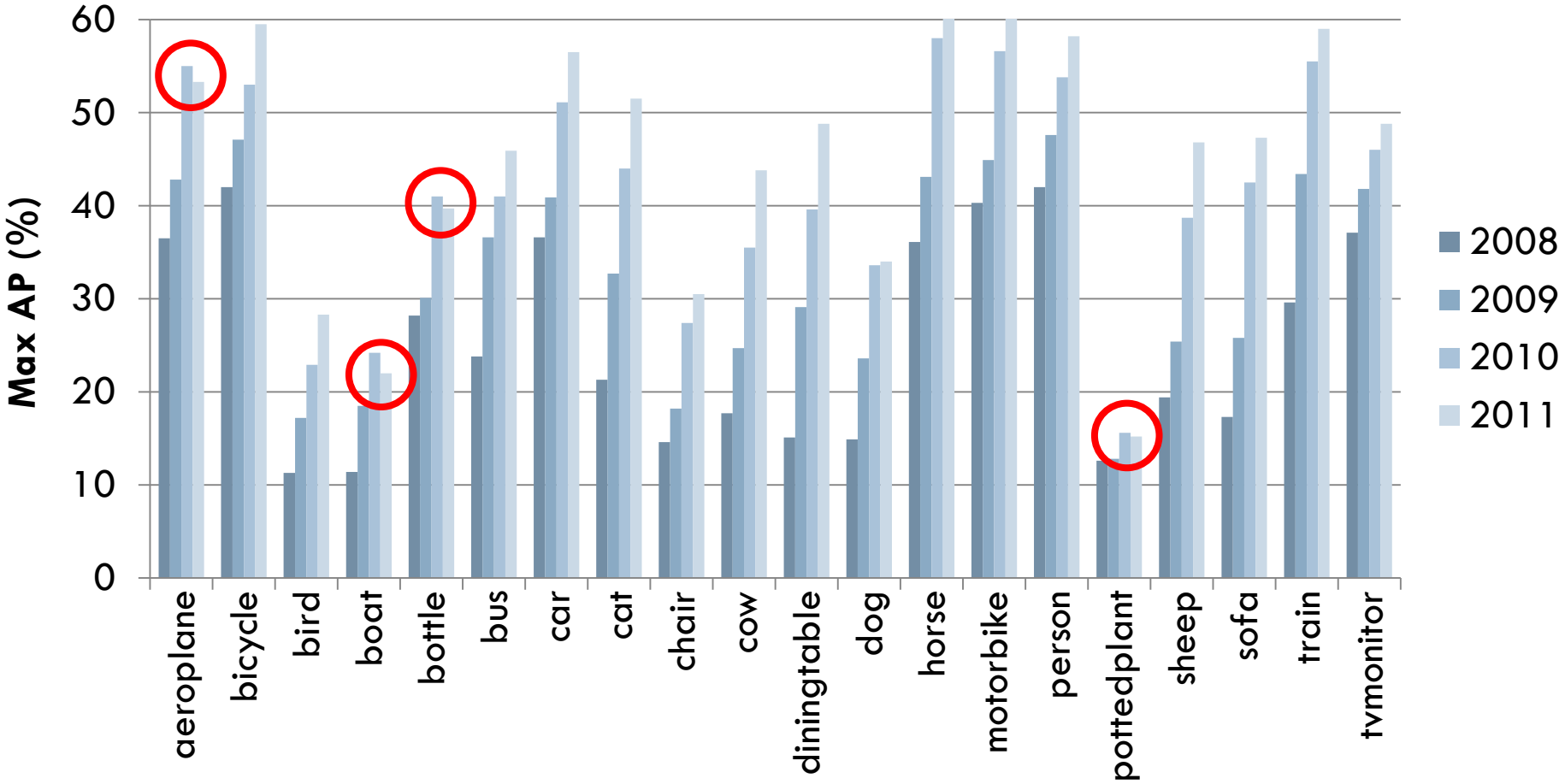


UVA_SELSEARCH

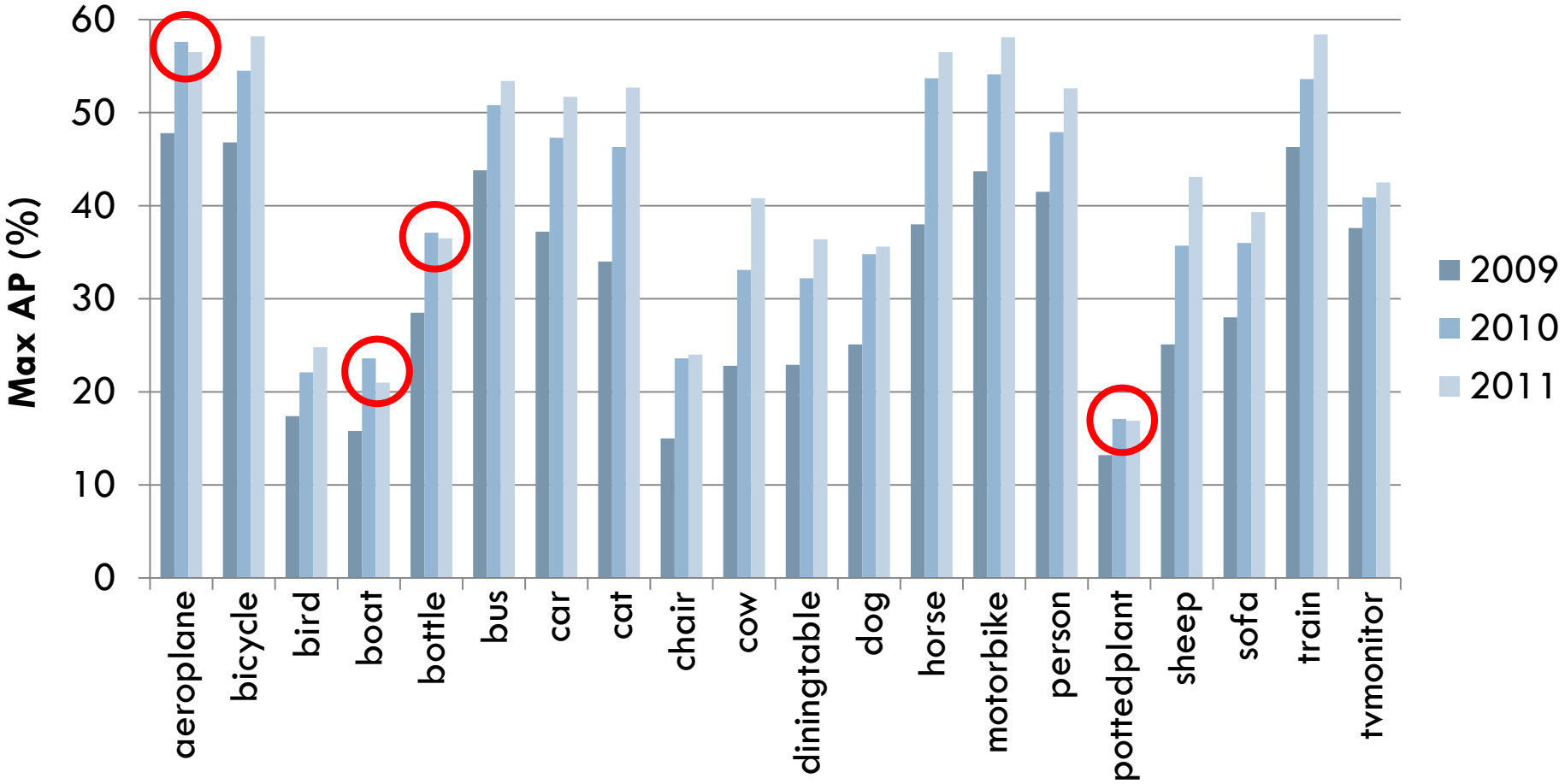


Progress 2008-2011



- Results on 2008 data improve for best methods 2009-2011 for almost all categories
  - Caveats: More training data + re-use of test data

Progress 2009-2011



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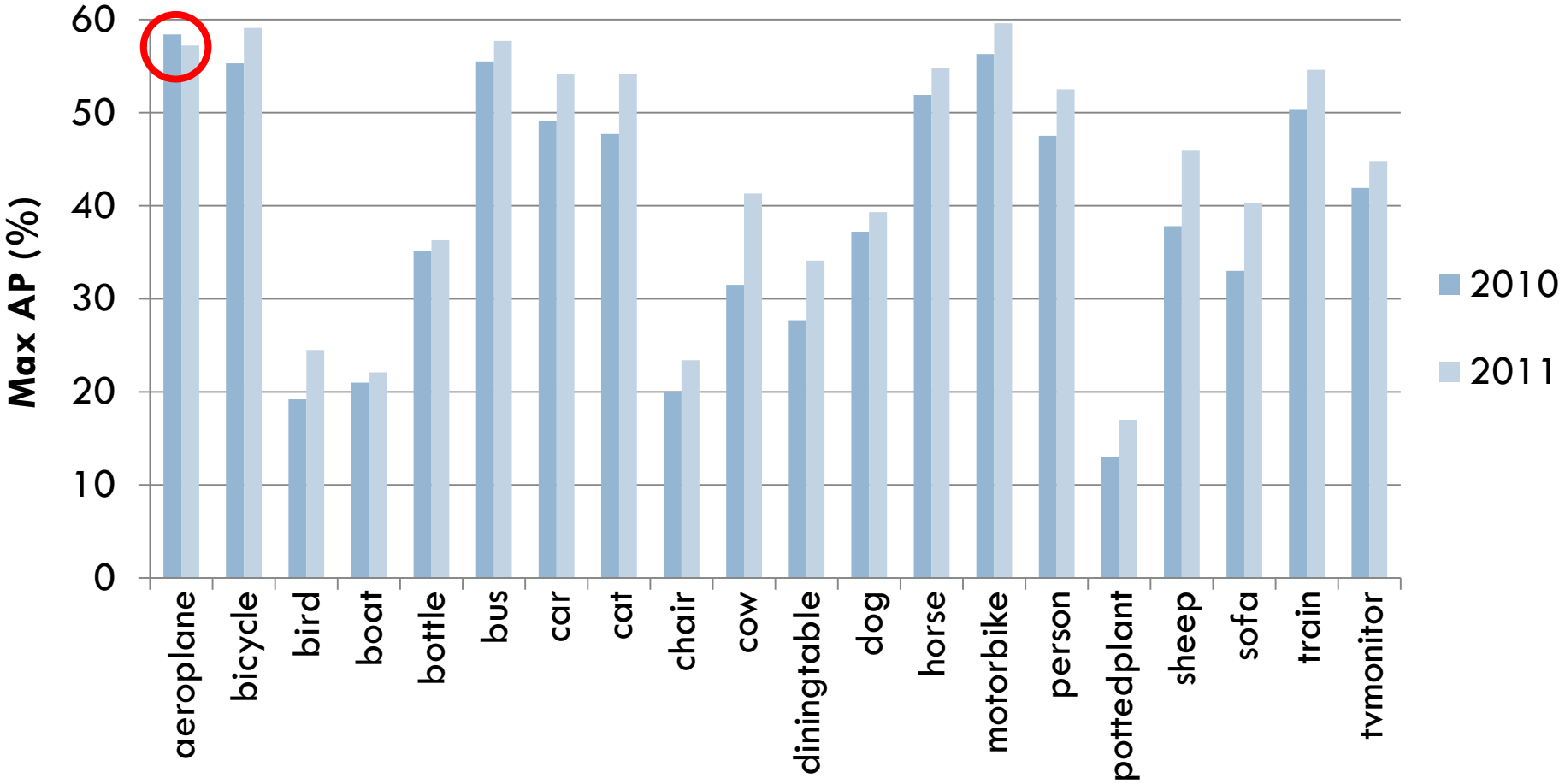
Progress 2010-2011



- Results on 2010 data improve for best 2011 methods for all but one category (aeroplane)
  - Caveats: More training data + re-use of test data

Prizes

- Joint Winners:
  - **NLPR_DD_DC**
    Junge Zhang, Yinan Yu, Yongzhen Huang, Chong Wang, Weiqiang Ren, Jinchen Wu, Kaiqi Huang, Tieniu Tan
    National Laboratory of Pattern Recognition, Institute of Automation, Chinese Academy of Sciences
  - **NYUUCLA_HIERARCHY**
    Yuanhao Chen, Li Wan, Long Zhu, Rob Fergus, Alan Yuille
    NYU, UCLA
- Honourable Mention (Novelty):
  - **CORNELL_ ISVM_VIEWPOINT**
    Joshua Schwartz, Noah Snavely, Daniel Huttenlocher
    Cornell University