Knowing a Good HOG Filter When You See It: Efficient Selection of Filters for Detection

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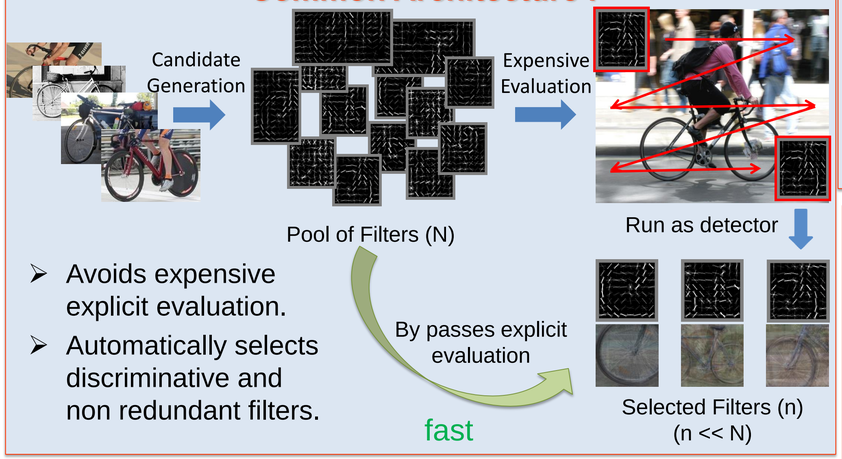
Problem :

- Fast automatic filter selection method.
- Selected filters should be discriminative and diverse.
- Learn universal model of filter “goodness”.
- Beneficial for large number of methods which rely on collection of filters.

Visual Categories as Collection of Filters :

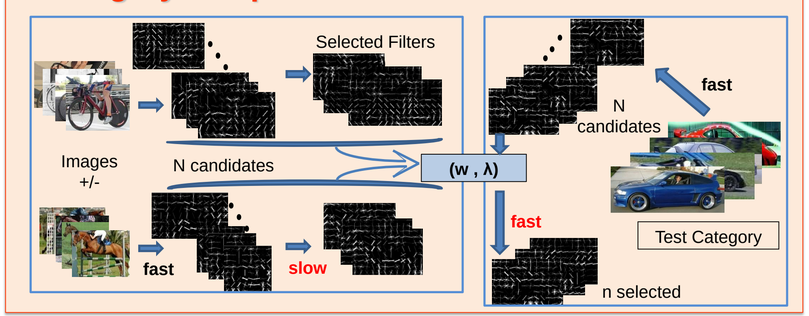
Poselets | Discriminative Patches | Exemplar SVMs

Common Architecture :



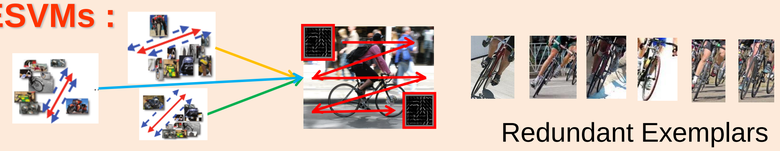
- Avoids expensive explicit evaluation.
- Automatically selects discriminative and non redundant filters.

Category Independent Model:

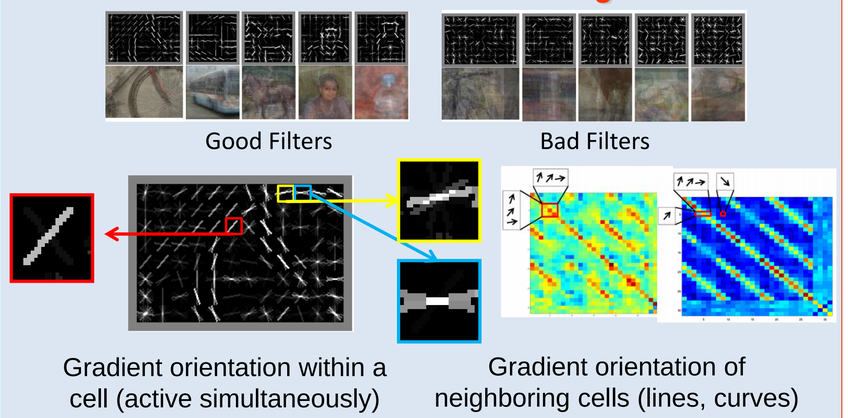


Poselets :

ESVMs :



Features for Filter Ranking :



Learning to Rank Filters:

- Model ranking score by a linear function $< w,\Phi(\boldsymbol{f})>$
- $y_{g,i}$ is estimated quality, obtained by expensive method.
- $\Delta_{g,i,j} = y_{g,i} - y_{g,j}$, for $i > j$ measures how much better $\boldsymbol{f}_{g,i}$ is from $\boldsymbol{f}_{g,j}$

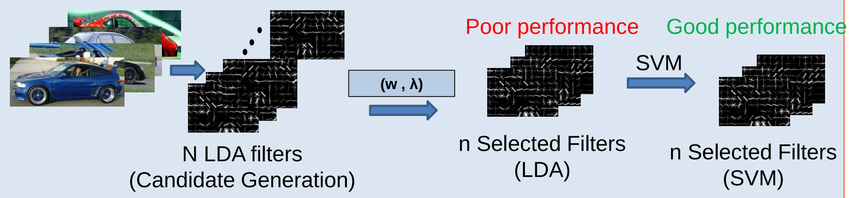
$$\min_{\mathbf{w}} \frac{1}{2}\|\mathbf{w}\|^2 + C\sum_{g=1}^{G}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\left[1-\langle \mathbf{w}, \delta\phi_{g,i,j}\rangle\right]_+ \Delta_{g,i,j}$$

Selecting a Diverse Set of Filters:

- $x_i \epsilon \{0,1\}, i \in \{1,\dots,N\}$ indicator variable
- A_{ij} similarity between filter i and j

$$\max_{\mathbf{x}\in\{0,1\}^N,\ \sum_i x_i = n} \sum_i \hat{y}_i x_i \ - \ \lambda \sum_i \max_{j\neq i} A_{ij} x_i x_j .$$

LDA Acceleration :



- Train SVM classifiers only for selected filters.

Results :

Poselets Detection	VOC 2007 test		Training sppedup		
Method	MAP	δMAP	Initial	Selection	Overall
Oracle	29.03				
Random	26.66	-2.37	8x	8x	8x
10%	27.78	-1.25	1x	4.4x	2.4x
Norm (svm)	27.38	-1.65	1x	8x	3x
Norm (svm) + Div	28.34	-0.69	1x	8x	3x
Σ-Norm (svm)	27.53	-1.50	1x	8x	3x
Σ-Norm (svm) + Div	28.51	-0.52	1x	8x	3x
Rank (svm)	27.81	-1.22	1x	8x	3x
Rank (svm) + Div	29.04	+0.01	1x	8x	3x
Rank (lda) + Div	28.19	-0.84	8x	8x	8x
Rank (lda) + Div (2x seeds)	29.46	+0.43	8x	8x	8x

Poselet Ranking				
Method	50	100	150	200
Norm (svm)	30.3	52.8	68.6	80.0
Σ-Norm (svm)	29.3	52.2	67.9	79.7
Rank (lda)	31.5	54.3	70.2	80.2
Rank (svm)	31.6	55.4	71.2	81.1

ESVM Detection	VOC 2007 test(MAP)
Method	
Oracle	21.89
Random	18.53
Freq	16.23
Rank(lda)	17.93
Rank(lda) + Freq	18.75
Rank(lda) + Freq + Div	19.62

Take Home Message:

Fast automatic filter selection method using intrinsic properties of filters