Classification aided two stage localization
Hedi Harzallah, Cordelia Schmid, Frédéric Jurie, Adrien Gaidon

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Classification aided two stage localization

Hedi Harzallah, Cordelia Schmid, Frederic Jurie, Adrien Gaidon

INRIA, LEAR project team

PASCAL VOC2008 challenge workshop
Introduction

- Detection task on PASCAL VOC2008 challenge
- Method with sliding windows (Each window is classified as containing or not the targeted object)

- Learn a classifier by providing positive and negative examples
Training outline

Training windows

Shape

Filtering classifier: Linear
Training outline

Training windows

Shape

Filtering classifier: Linear

Appearance

Scoring classifier: Non-linear
Generating training windows

Training windows

Shape

Filtering classifier: Linear

Appearance

Scoring classifier: Non-linear
Generating training windows

- Adding positive training examples by shifting and scaling the original annotations [Laptev06]

- Negative examples randomly extracted from background

- Training an initial classifier

- Retraining 4 times by adding false positives

Examples of false positives
Image representation

- **Training windows**
  - Shape
    - Filtering classifier: Linear
  - Appearance
    - Scoring classifier: Non-linear
Image representation: Histogram-of-Gradients (HOG)

- Tiling optimized per class (around 100 overlapping tiles)

- Computed with integral histograms

- With 16 orientations
Image representation: Dense SIFT

- Computed over dense patches (shift step 6 pixels, scale step 1.2)
- Discretized into 100 visual words using k-means
- Used as BOW with a spatial pyramid [Lazebnik06]
Learning procedure

- Training windows
  - Shape
    - Filtering classifier: Linear
  - Appearance
    - Scoring classifier: Non linear
Learning procedure

• Training one classifier per view (Side, Front/Rear, Unspecified)

• Linear SVM classifier
  • HOG only (combining with SIFT gives minor gain at high cost)

• Non Linear SVM classifier
  • We use non linear $X^2$ kernel SVM [Zhang et al 2007]
  • Training with:
    • Examples used in the linear case (positives + shifted positives + hard false positives)
    • Additional random 70K negative examples
Testing outline

- Test images
  - Generate hypotheses
    - Sliding windows
    - HOG
    - Apply filtering classifier
  - Score hypotheses
    - HOG + SIFT
    - Apply scoring classifier
  - Non maxima suppression
    - Reweighting using classification
Evaluation of linear/non linear SVM

- Using HOG only to learn the non linear classifier
- Linear classifier used not only for filtering but also for scoring

<table>
<thead>
<tr>
<th></th>
<th>Linear</th>
<th>Linear + $X^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>All classes</td>
<td>0.139</td>
<td>0.220</td>
</tr>
<tr>
<td>aeroplane</td>
<td>0.039</td>
<td>0.184</td>
</tr>
<tr>
<td>horse</td>
<td>0.249</td>
<td>0.435</td>
</tr>
<tr>
<td>diningtable</td>
<td>0.096</td>
<td>0.108</td>
</tr>
<tr>
<td>pottedplant</td>
<td>0.100</td>
<td>0.118</td>
</tr>
</tbody>
</table>
Evaluation of linear/non linear SVM

Precision recall curve for the class horse using HOG features

linear + chi2, AP=0.435
linear, AP=0.249
Evaluation of descriptors

• Scoring classifiers learned with different features
• Applied on the same hypotheses

<table>
<thead>
<tr>
<th></th>
<th>HOG</th>
<th>SIFT</th>
<th>HOG+SIFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>All classes</td>
<td>0.220</td>
<td>0.231</td>
<td>0.264</td>
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<tr>
<td>aeroplane</td>
<td>0.184</td>
<td>0.298</td>
<td>0.338</td>
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<tr>
<td>car</td>
<td>0.475</td>
<td>0.425</td>
<td>0.511</td>
</tr>
<tr>
<td>train</td>
<td>0.318</td>
<td>0.344</td>
<td>0.291</td>
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<tr>
<td>bus</td>
<td>0.432</td>
<td>0.397</td>
<td>0.423</td>
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</tbody>
</table>
Evaluation of descriptors

Precision recall curve for the class car

- HOG + SIFT
- HOG
- SIFT
Combining localization and image classification

- Provides contextual information
- Results are more reliable in image classification
- Transform scores into probabilities
- New score = P(det) * P(cls)
Influence of the use of image classification score

- We use the Lear_flat submission [Gaidon and Marszalek]

<table>
<thead>
<tr>
<th></th>
<th>HOG+SIFT</th>
<th>HOG+SIFT plusclass</th>
</tr>
</thead>
<tbody>
<tr>
<td>All classes</td>
<td>0.264</td>
<td>0.290</td>
</tr>
<tr>
<td>cow</td>
<td>0.240</td>
<td>0.309</td>
</tr>
<tr>
<td>sheep</td>
<td>0.212</td>
<td>0.273</td>
</tr>
<tr>
<td>car</td>
<td>0.511</td>
<td>0.518</td>
</tr>
<tr>
<td>motorbike</td>
<td>0.417</td>
<td>0.427</td>
</tr>
</tbody>
</table>
Example of results: cars

Top true positives

First false positives

Missed
Example of results: cow

Top true positives

First false positives

Missed
Example of results: chair

Top true positives

First false positives

Missed
Summary

• Two stage classification (hypotheses prediction, hypotheses verification)
• Image representation combination
• Reweighting with classification score
• Worse performance on some articulated classes (part models more suited)
• Outperform other competitors on most of the rigid classes
Thank you