Building Geo-aware Tag Features for Image Classification

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Images come with geo tags
Knowing where an image was taken may help predict what objects and scenes are present in the image.
Towards geo-aware image classification

• Geo k-nn classifiers [Moxley ICMR’08]
• GIS decoding via GeoNames [Joshi CIVR’08]
• Visual, geo, and temporal k-nn [Qian Neurocomp’13]
• Batch-mode tagging with geo cues [Cao TMM’09]
• Fusion of geo and visual classifiers [Li ICMR’12]
• ...

How to encode geo information at a feature level has not been well explored
Tag features for image classification

To represent an image as a histogram of tags
Building tag features by exploiting many socially tagged images
How to make the tag feature geo-aware?

Building tag features by visual knn
Tag propagation from geo neighbors?

Replace visual neighbors by geo neighbors
Geo neighborhood is sparse

For over 50% images, their 150 geo neighbors cannot be fully retrieved within a radius of 10 kilometers
Our proposal:
Tag propagation from visual/geo neighbors

geo-aware ⟷ geo-aware & content-aware
Visualizing changes in tag features

• Tags relevant to visual classes are enhanced
Questions to answer

• Are geo-aware tag features better?
  – when used alone
  – when used in combination with visual features
Experimental setup

• Source set
  • One million geo-tagged images from Flickr

• Geo-tagged part of NUS-WIDE[Chua CIVR’09]
  – Training set: 41,173 images
  – Test set: 27,401 images
  – 75 test concepts
Experimental setup

- **Tag features**
  - Vocabulary: 2000 top frequent tags in the source set
  - Number of visual/geo neighbors: 150

- **Visual feature**:
  - 1,204-d Bag of quantized SIFT [van de Sande TPAMI’10]

- **Classification models**
  - Fast intersection kernel SVMs [Maji CVPR’08]

- **Performance metric**
  - Average Precision
Results: Comparing different features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Method</th>
<th>mAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_{vnn}$</td>
<td>Tag propagation from visual neighbors</td>
<td>0.159</td>
</tr>
<tr>
<td>$T_{gnn}$</td>
<td>Tag propagation from geo neighbors</td>
<td>0.138</td>
</tr>
<tr>
<td>$T_{vnn \cup gnn}$</td>
<td>Tag propagation from visual/geo neighbors</td>
<td>0.271</td>
</tr>
</tbody>
</table>
Questions to justify

• Are geo-aware tag features better
  – when used alone
  – when used in combination with visual features?
Combining textual and visual classifiers

Visual neighbors

Geo neighbors

Tag feature \(T_{vnn&gnn}\)

Textual Classifier

Late Fusion

Final Classifier

Visual feature \(\text{Visual}\)
## System-level comparison

<table>
<thead>
<tr>
<th>System</th>
<th>mAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>GeoVisualKNN [Qian Neurocomp’13]</td>
<td>0.113</td>
</tr>
<tr>
<td>Visual</td>
<td>0.226</td>
</tr>
<tr>
<td>Visual + geoknn [Li ICMR’12]</td>
<td>0.251</td>
</tr>
<tr>
<td>Visual + $T_{vnn}$ [Wang CVPR’08]</td>
<td>0.236</td>
</tr>
<tr>
<td>Visual + $T_{vnn} \cup gnn$ (this work)</td>
<td>0.325</td>
</tr>
</tbody>
</table>
Conclusions

• Geo-aware tag features are useful
• A simple method to build geo-aware tag features

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