Fine-Grained Recognition as HSnet Search for Informative Image Parts

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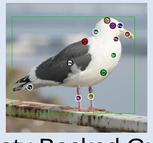
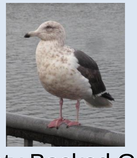
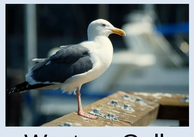
Problem: Fine-Grained Recognition

Goal: Classify and detect parts


Slaty Backed Gull


Slaty Backed Gull


Western Gull

Challenges

- Same classes with different appearances
- Different classes with similar appearances
- **Background clutter can hurt recognition**

Key Idea: Search for Informative Parts

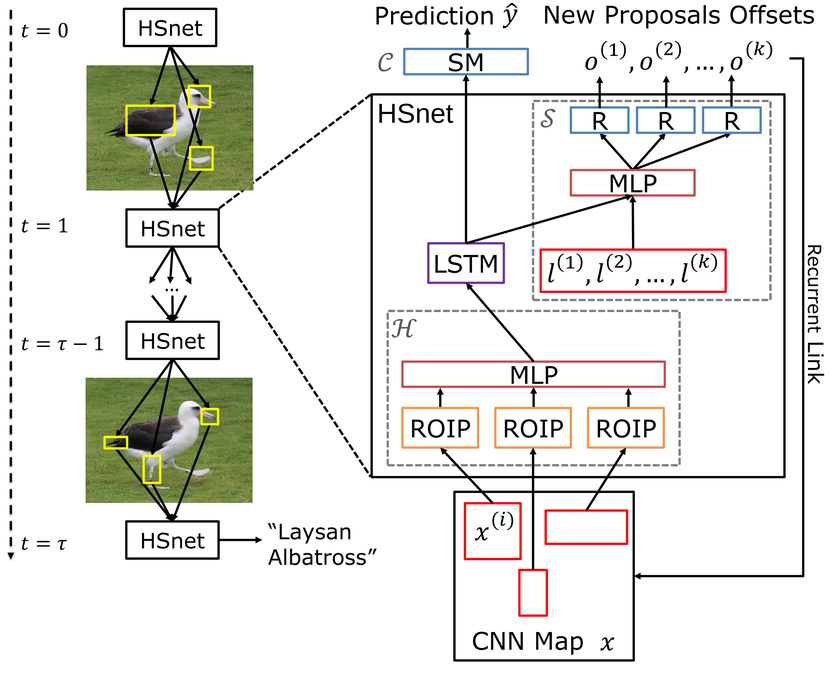
- Focus attention on informative parts
- Sequential search to find informative parts

→ **HSnet Search Framework**

Supervised vs. Weakly Supervised

- Part annotations available: train to minimize distance between predicted part locations and ground truth part locations
- Part annotations not available: use determinantal point process (DPP) to regularize bounding box positions for diverse candidates

Search Overview



HSnet Architecture

ROIP: Region of Interest Pooling
MLP: Multilayer Perceptron
SM: Softmax
R: Regression

x: CNN feature map
$x^{(i)}$: bounding box i features
$l^{(i)}$: bounding box i location
$o^{(i)}$: bounding box i offset
$\hat{y}$: class prediction

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Accuracy [%] on Birds and Cars

Caltech UCSD 2011 Birds

Method	Annotations	Accuracy
Krause et al. 2015	GT+BB	82.8
Jaderberg et al. 2015	GT	84.1
Xu et al. 2015	GT+BB+ parts+web	84.6
Lin et al. 2015	GT+BB	85.1
B1	GT	82.3
B2	GT+parts	83.1
B3	GT+parts	86.2
B4	GT+parts	85.7
Hsnet	**GT+parts**	**87.5**

Stanford Cars 196

Method	Annotations	Accuracy
Deng et al. 2013	GT+BB	63.6
Krause et al. 2013	GT+BB	67.6
Krause et al. 2014	GT+BB	73.9
Lin et al. 2015	GT	91.3
Krause et al. 2015	GT+BB	92.6
B1	GT	88.5
B4	GT	92.2
HSnet	**GT**	**93.9**

Qualitative Results

Parts Detection at Time Steps

Weak Supervision Learns Informative Parts on Cars