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# Superpixel-based Refinement for Object Proposal Generation

## Motivation

**Object Proposal Generation:**
Class-agnostic localization and segmentation of all objects

**Problems**
- State-of-the-art systems segment proposals on coarse resolution feature maps (e.g. 10 × 10 pixels) ➤ object boundaries are not well captured
- Hundreds of proposals per image ➤ CRFs etc. are not applicable

**Proposed Idea**
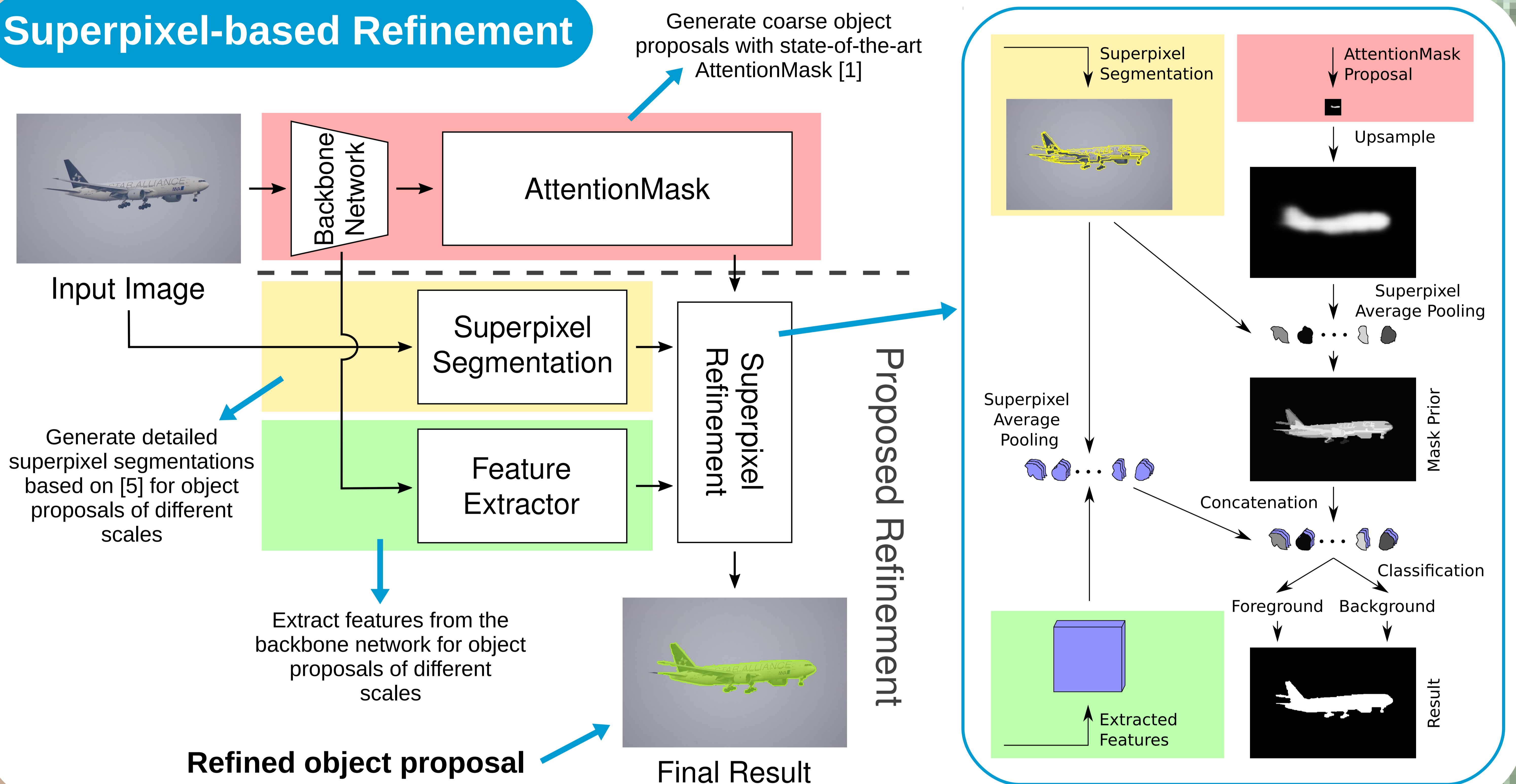Superpixel refinement: Combine coarse DL-based proposals and fine-grained superpixels using superpixel pooling


Without our refinement


With our refinement

## Superpixel-based Refinement

Generate coarse object proposals with state-of-the-art AttentionMask [1]



Input Image

Backbone Network

AttentionMask

Superpixel Segmentation

Feature Extractor

Superpixel Refinement

Proposed Refinement

Generate detailed superpixel segmentations based on [5] for object proposals of different scales

Extract features from the backbone network for object proposals of different scales

**Refined object proposal**

Final Result

### Proposed Refinement



Superpixel Segmentation

AttentionMask Proposal

Upsample

Superpixel Average Pooling

Mask Prior

Superpixel Average Pooling

Concatenation

Classification

Foreground    Background

Extracted Features

Result

## Results

- Improved object proposal results
- Better adherence to object boundaries
- Superpixels can be helpful in combination with DL!
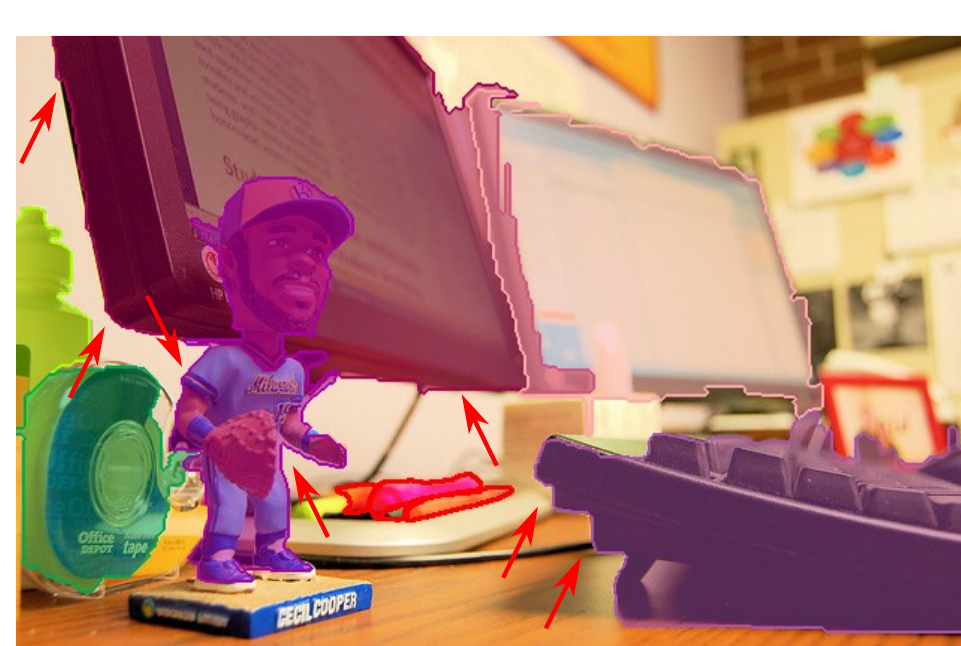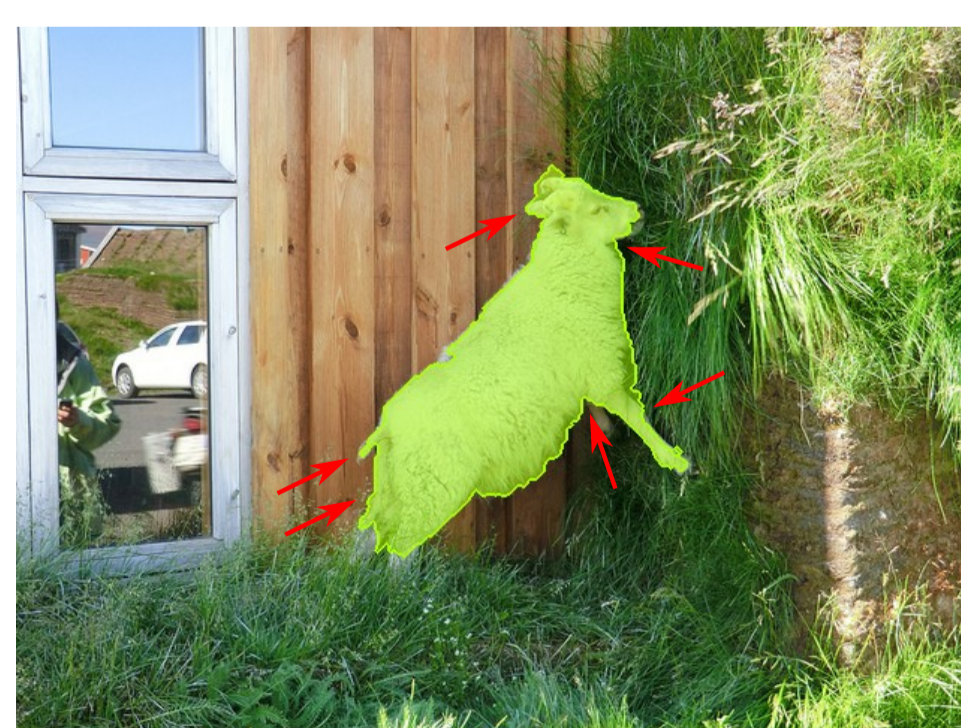
FastMask [2]     AttentionMask [1]     Ours



## Evaluation on LVIS Dataset

- **AR@N**: Average Recall for first N proposals
- **BR**: Boundary Recall
- **UE**: Undersegmentation Error

| Method | Object Proposal Generation | | Segmentation Quality | |
| --- | --- | --- | --- | --- |
| | AR@10 | AR@100 | BR↑ | UE↓ |
| DeepMask [4] | 0.069 | 0.147 | 0.488 | 0.087 |
| SharpMask [3] | 0.073 | 0.154 | 0.561 | 0.080 |
| FastMask [2] | 0.069 | 0.161 | 0.510 | 0.084 |
| AttentionMask [1] | 0.073 | 0.189 | 0.568 | 0.070 |
| Ours | **0.092** | **0.206** | **0.681** | **0.068** |

## Paper + Code

## References
[1] Wilms, C.; Frintrop S.: AttentionMask: Attentive, efficient object proposal generation focusing on small objects. In: ACCV (2018)
[2] Hu, H.; Lan, S.; Jiang, Y.; Cao, Z.; Sha, F.: FastMask: Segment Multi-scale Object Candidates in One Shot. In: CVPR (2017)
[3] Pinheiro, P.; Lin, T.; Collobert, R.; Dollár, P.: Learning to refine object segments. In: ECCV (2016)
[4] Pinheiro, P.; Collobert, R.; Dollár, P.: Learning to segment object candidates. In: NIPS (2015)
[5] Felzenszwalb, P.F.; Huttenlocher, D.P.: Efficient graph-based image segmentation. In: IJCV (2004)