Deeply Unsupervised Segmentation of Single Image with Pyramid Pooing

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Abstract

Convolutional neural networks (CNNs) have been widely applied to image segmentation, yielding excellent performance. Most of the algorithms are supervised methods, which relies on large manual annotations for a good performance. CNNs have great potential for extracting detailed features which make it possible to apply in unsupervised image segmentation. However, efficient methods of the unsupervised image segmentation with high accuracy are still remaining as a challenge. In this paper, the usage of spatial pyramid pooling(SPP) for unsupervise image segmentation based on CNNs was investigated. First, we introduce a novel end-to-end network on the basis of an existing ones called differentialbe feature clustering. Second, we insert the layers consists SPP into the network to extract multiscale feature. Compare to the method without SPP, ours achieves higer accuracy (0.602 verus 0.284) and faster convergence (35 versus 323 seconds).

1. Introduction

Image segmentation is the scheme of dividing an image into several meaningful areas and it has a great significance in image processing and computer vision[5]. Owing to the development of deep learning technology, deep segmentation methods can achieve good results. However, most of these methods are supervised which rely on many manual annotations. Thereby, unsupervised methods based on deep learning have risen researchers' concerns. Existing deep segmentation methods make use of the powerful feature representation capabilities of CNN, one of the most important works is FCNs (Fully convolutional networks)[3], which recovers the category of each pixel from the abstract feature. After that, a network based on encoder-decoder architecture called U-net[4] was proposed, which can be trained end-to-end from very few images and achieve great success in the field of medical image. Recently effective network such as PSPNet (Pyramid scene parsing network)[6], DeepLab[1], Mask R-CNN[2] were proposed and improved the segmentation efficiency.add

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>
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[1] Removed for blind review

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>
> In this paper we present a performance analysis of the paper of Smith *et al*. [1], and show it to be inferior to all previously known methods. Why the previous paper was accepted without this analysis is beyond me.
>
> [1] Smith, L and Jones, C. "The frobnicatable foo filter, a fundamental contribution to human knowledge". Nature 381(12), 1-213.

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> We describe a system for zero-g frobnication. This system is new because it handles the following cases: A, B. Previous systems [Zeus et al.
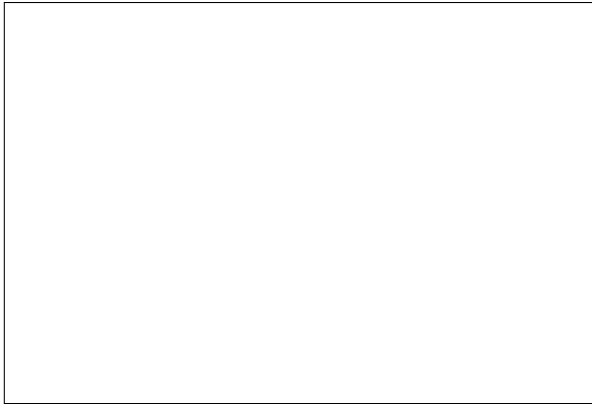
Figure 1. Example of caption. It is set in Roman so that mathematics (always set in Roman: $B \sin A = A \sin B$) may be included without an ugly clash.

> 1968] didn't handle case B properly. Ours handles it by including a foo term in the bar integral.
>
> ...
>
> The proposed system was integrated with the Apollo lunar lander, and went all the way to the moon, don't you know. It displayed the following behaviours which show how well we solved cases A and B: ...

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Compare the following:

| `$conf_a$` | $conf_a$ |
| `$\mathit{conf}_a$` | $conf_a$ |

See The TeXbook, p165.

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\setcounter{page}{4321}
```

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AUTHOR NAME(s) and AFFILIATION(s) are to be centered beneath the title and printed in Times 12-point, non-boldface type. This information is to be followed by two blank lines.

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Figure 2. Example of a short caption, which should be centered.

Method	Frobnability
Theirs	Frumpy
Yours	Frobbly
Ours	Makes one's heart Frob

Table 1. Results. Ours is better.

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References

[1] L. C. Chen, G. Papandreou, I. Kokkinos, K. Murphy, A. L. J. I. T. o. P. A. Yuille, and M. Intelligence. Deeplab: Semantic image segmentation with deep convolutional nets, atrous convolution, and fully connected crfs. 40(4):834–848, 2018.

[2] K. He, G. Gkioxari, P. Dollar, R. Girshick, and Ieee. *Mask R-CNN*, pages 2980–2988. IEEE International Conference on Computer Vision. 2017.

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[1]This is what a footnote looks like. It often distracts the reader from the main flow of the argument.

[3] J. Long, E. Shelhamer, T. Darrell, and Ieee. *Fully Convolutional Networks for Semantic Segmentation*, pages 3431–3440. IEEE Conference on Computer Vision and Pattern Recognition. 2015.

[4] O. Ronneberger, P. Fischer, and T. Brox. U-net: Convolutional networks for biomedical image segmentation. In *International Conference on Medical Image Computing and Computer-Assisted Intervention*.

[5] P. Zhang, F. Wang, G. Teodoro, Y. Liang, M. Roy, D. J. Brat, and J. Kong. Effective nuclei segmentation with sparse shape prior and dynamic occlusion constraint for glioblastoma pathology images. *Journal of medical imaging*, 6(1):17502, 2019.

[6] H. Zhao, J. Shi, X. Qi, X. Wang, J. Jia, and Ieee. *Pyramid Scene Parsing Network*, pages 6230–6239. IEEE Conference on Computer Vision and Pattern Recognition. 2017.