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 multi-scale 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.

1.1. Language

All manuscripts must be in English.

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>
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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.

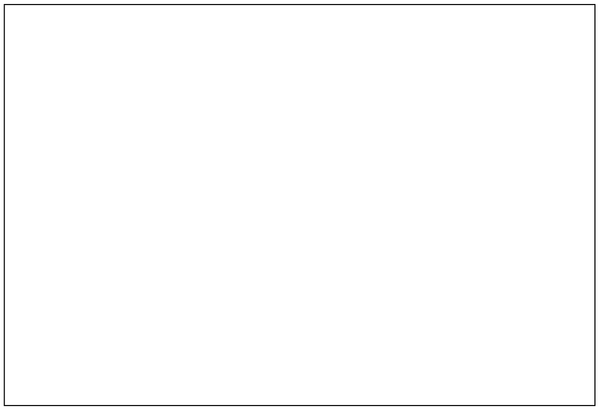

Figure 1. Example of caption. It is set in Roman so that mathematics (always set in Roman: $B \sin A = A \sin B$) may be included without an ugly clash.

> 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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1.7. Miscellaneous

Compare the following:

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

See The TEXbook, p165.

The space after *e.g.*, meaning "for example", should not be a sentence-ending space. So *e.g.* is correct, *e.g.* is not. The provided `\eg` macro takes care of this.

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\setcounter{page}{4321}
```

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Wherever Times is specified, Times Roman may also be used. If neither is available on your word processor, please use the font closest in appearance to Times to which you have access.

MAIN TITLE. Center the title 1-3/8 inches (3.49 cm) from the top edge of the first page. The title should be in Times 14-point, boldface type. Capitalize the first letter of nouns, pronouns, verbs, adjectives, and adverbs; do not capitalize articles, coordinate conjunctions, or prepositions (unless the title begins with such a word). Leave two blank lines after the title.

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.

The ABSTRACT and MAIN TEXT are to be in a two-column format.

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Figure and table captions should be 9-point Roman type as in Figures 1 and 2. Short captions should be centred.

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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.

FIRST-ORDER HEADINGS. (For example, **1. Introduction**) should be Times 12-point boldface, initially capitalized, flush left, with one blank line before, and one blank line after.

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References

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