More unlabelled data or label more data?

A study on semi-supervised laparoscopic image segmentation

Yunguan Fu1,2, Maria R. Robu1, Bongjin Koo1, Crispin Schneider3, Stijn van Laarhoven3, Danail Stoyanov1, Brian Davidson3, Matthew J. Clarkson1, and Yipeng Hu1

1Wellcome/EPSRC Centre for Interventional & Surgical Sciences and Centre for Medical Image Computing, University College London, London, UK
2InstaDeep, London, UK
3Division of Surgery & Interventional Science, University College London, London, UK
Could unlabelled data challenge labelled data?

The performance of deep neural networks in medical imaging is often limited due to the lack of data. Improvements could be achieved by adding more labelled or unlabeled data. But neither data acquisition nor expert labelling is trivial in most of clinical cases.
Liver segmentation in laparoscopic images

Compared to open surgery, laparoscopic surgery provides equivalent curative results with minimal body invasion and results in faster recovery.

Automated image segmentation could help reduce surgery-related stress and risk and increase the number of eligible patients for laparoscopic surgeries.
Laparoscopic images were collected from 13 patients.
- 2,209 labelled images from experts.
- 41,994 unlabelled images from laparoscopic videos.
U-Net

- 3x3 conv + layer norm + relu
- 3x3 conv + sigmoid
- 2x2 max-pooling
- 2x2 deconv
- skip connection
- concatenation
- multi-scale inputs
- output prediction
Mean Teacher

There are two copies:
- Student
- Teacher

The teacher is an average of student and its prediction is used as pseudo-label for the unlabelled image.
Different labelled data set size

![Graph 1: Dice Score vs. Labelled Data](image1)

- **Supervised**
- **Mean Teacher**

![Graph 2: Hausdorff Distance vs. Labelled Data](image2)

- **Supervised**
- **Mean Teacher**
Different unlabelled data set size
The semi-supervised method also helps.

Apart from the additional unlabelled data, the specific semi-supervised training method is also responsible for performance improvement.
Unlabelled data could be as good.

It is observed that adding more unlabelled data potentially could provide similar performance improvement compared to using more labelled data.
Thank You

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