More unlabelled data or label more data?

A study on semi-supervised laparoscopic image segmentation

Yunguan Fu[1,2], Maria R. Robu[1], Bongjin Koo[1], Crispin Schneider[3], Stijn van Laarhoven[3], Danail Stoyanov[1], Brian Davidson[3], Matthew J. Clarkson[1], and Yipeng Hu[1]

[1]Wellcome/EPSRC Centre for Interventional & Surgical Sciences and Centre for Medical Image Computing, University College London, London, UK
[2]InstaDeep, London, UK
[3]Division 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.
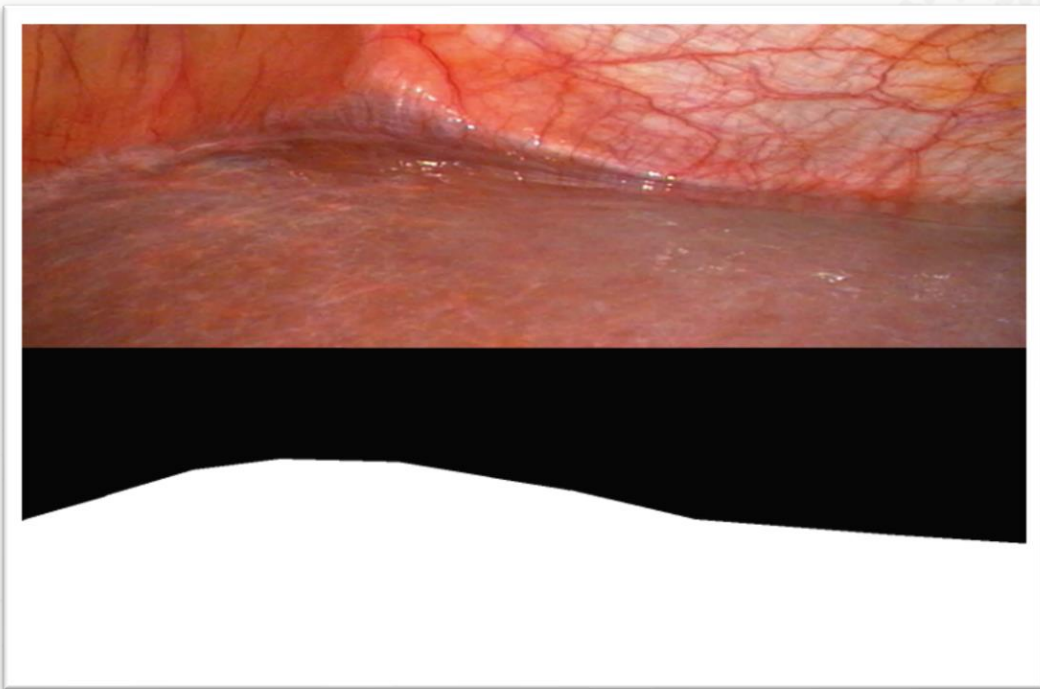
Liver segmentation in laparoscopic images
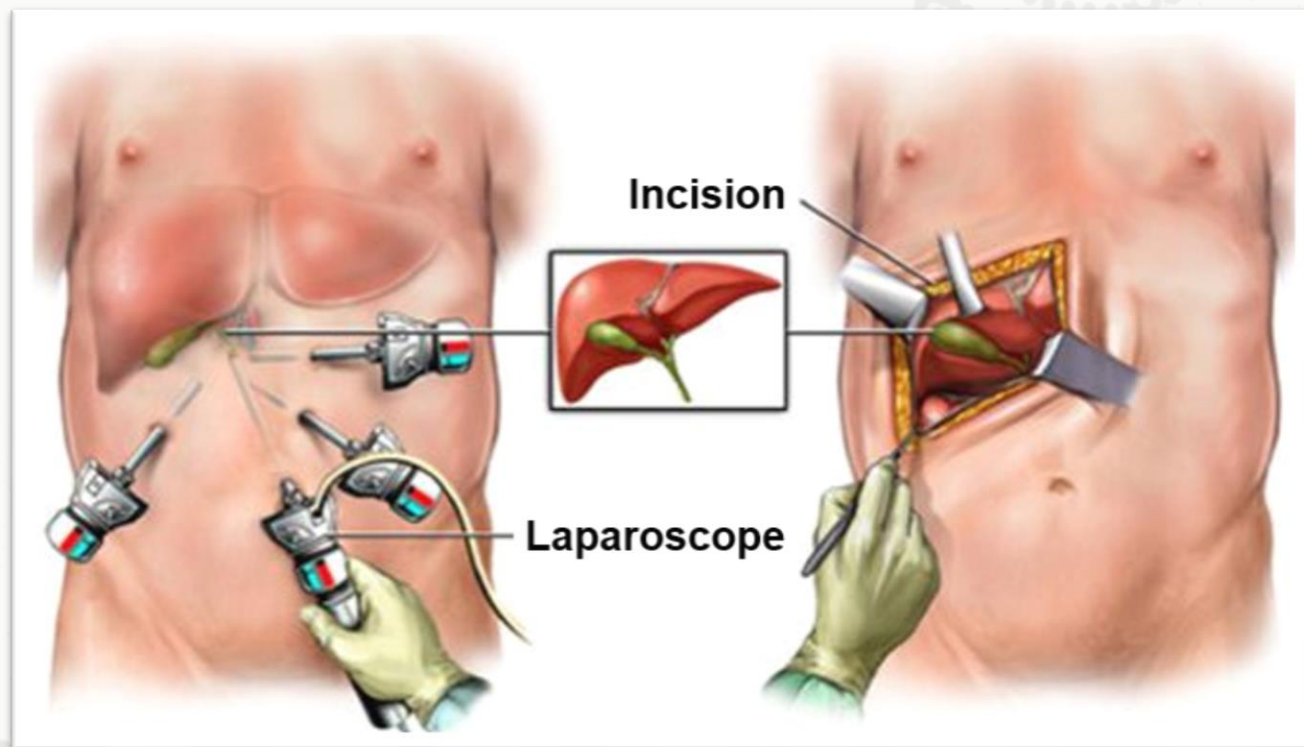
Compared to open surgery, **laparoscopic surgery** provides equivalent curative results with minimal body invasion and **results in faster recovery**.

Automated image segmentation could help reduce surgery-related stress and risk and **increase the number of eligible patients** for laparoscopic surgeries.
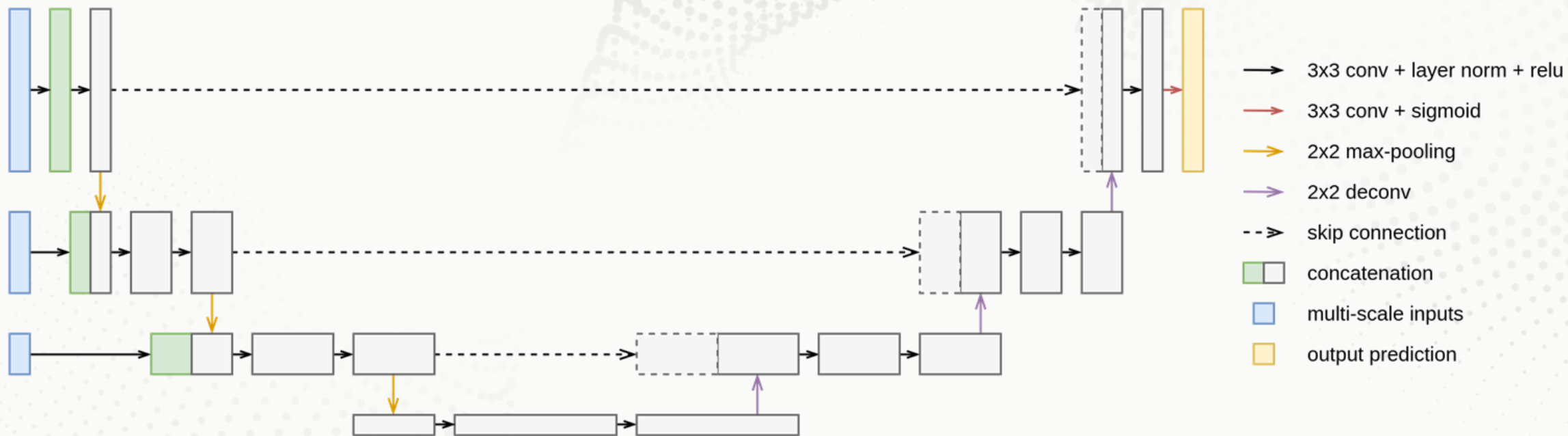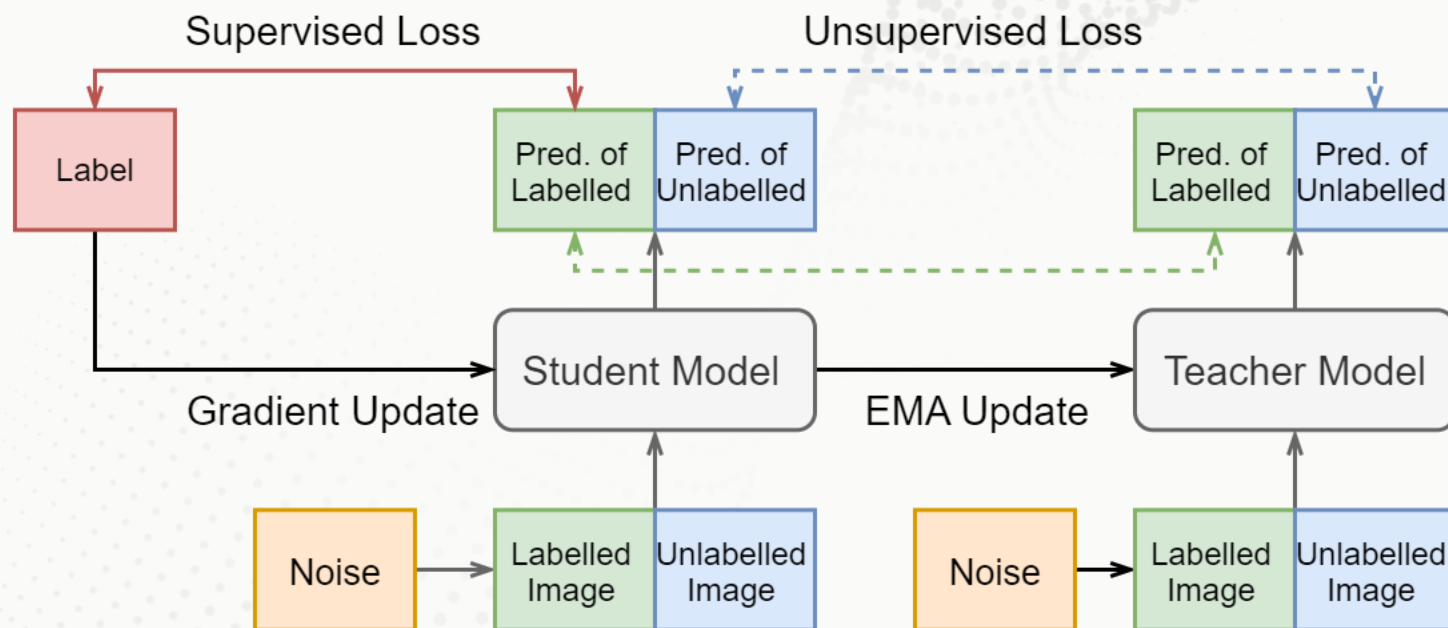
Data Set

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
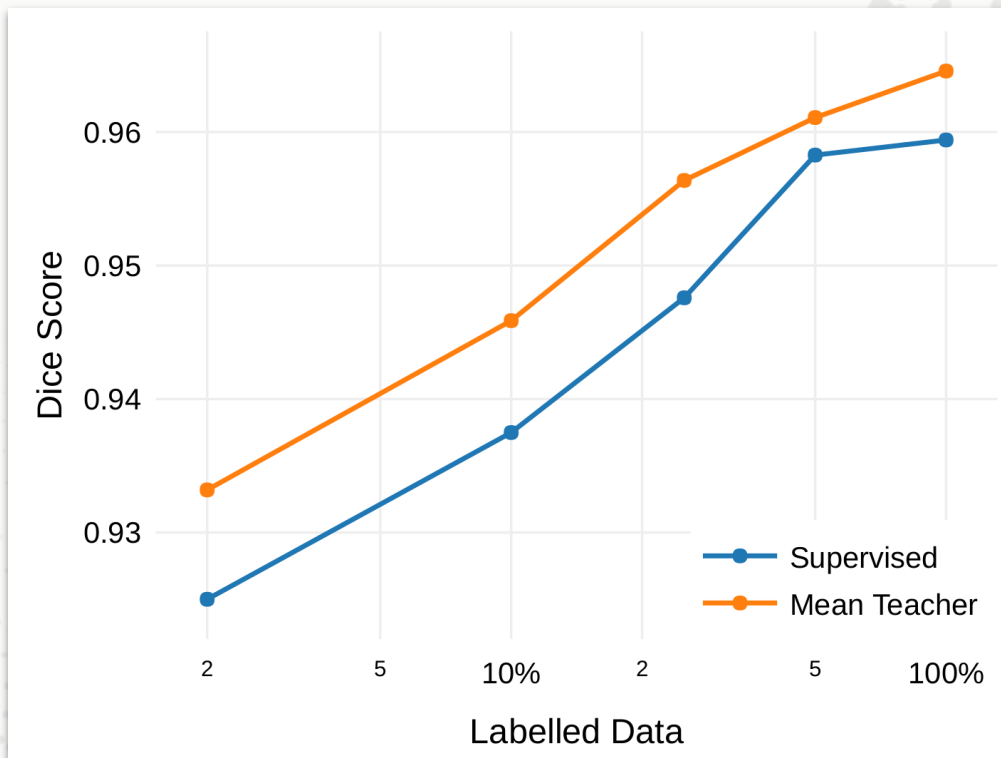multi-scale inputs
output prediction
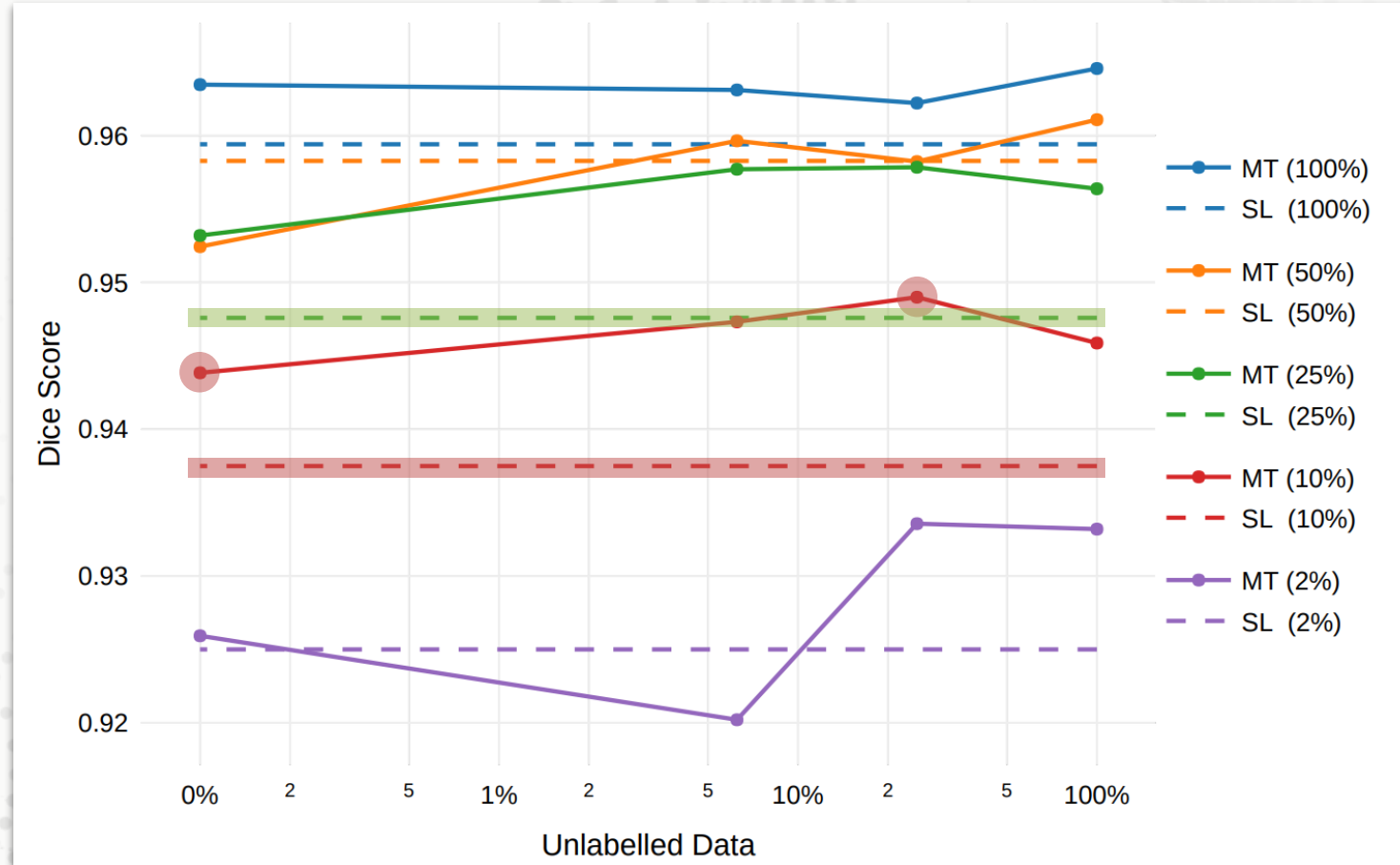
Mean Teacher

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
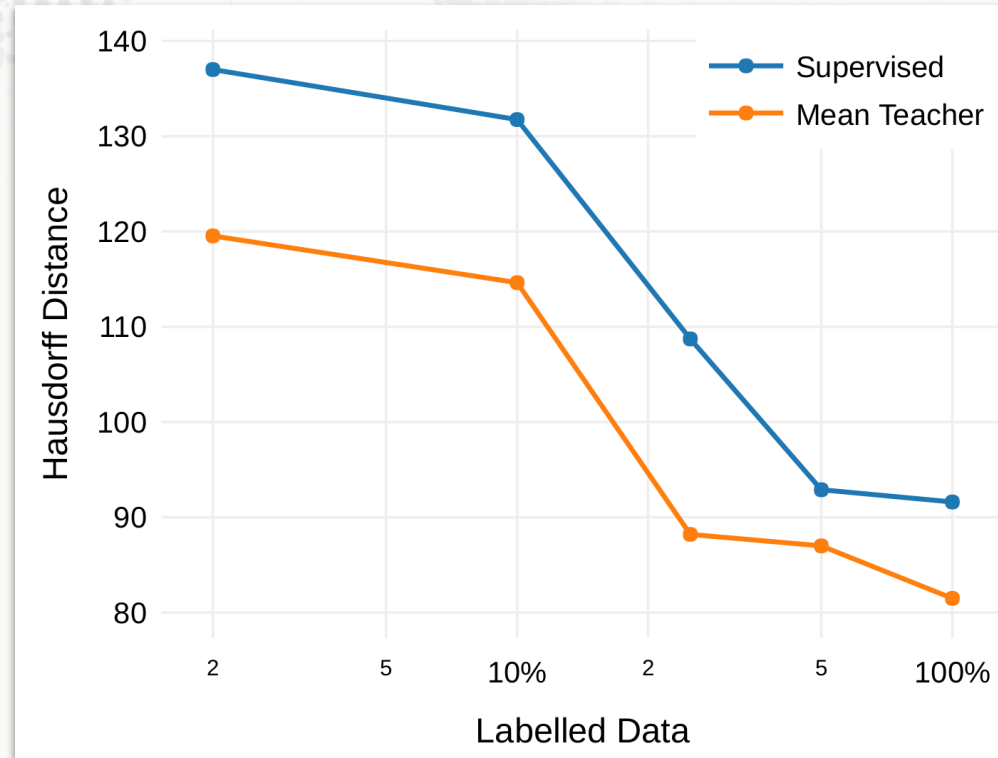
Different unlabelled data set size

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