A comparison of image segmentation methods
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Goal: Image segmentation with limited data
In the last decade, the traditional method of PDE-based image segmentation has been replaced by techniques using deep convolutional neural networks (DCNN). However, DCNN methods require large amounts of labeled training data; in many industrial problems, such training data is difficult and costly to obtain. This contrasts the previous PDE methods, which required little or no training data.

DCNN methods ⇐⇒ PDE methods ⇐⇒ Training with less data

Metric of comparison
Using data from the MICCAI 2017 LiTS challenge, we compare the performance of the PDE-based level set equation to a standard deep convolutional UNet, with and without skip connections. Models are scored by the Dice similarity coefficient (DSC):
\[
DSC(S_{\text{true}}, S_{\text{pred}}) = \frac{2 |S_{\text{true}} \cap S_{\text{pred}}|}{|S_{\text{true}}| + |S_{\text{pred}}|}
\]

Conclusions
- Level sets require significant tuning but no training.
- DCNN provides accurate liver boundary segmentation.
- No method excels at tumor identification.
- Complicated architectures are not always better!

Future Work
- Implement 2-stage process for tumor segmentation
- Compare with other DCNN architectures, e.g., ResNet
- Develop optimal control formulation for level set equation

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