Automatic Detection of Brain Aneurysms: segmenting CT scans using CNNs
Jason Qin (jzqin), Harry Emeric (harryem)
CS230: Deep Learning

**MOTIVATION**

Brain aneurysms affect 1-3% of adults, and rupture is often fatal. CT scans can contain hundreds of images so detection is a lengthy process; in an emergency setting this delay may prove deadly. Automatic detection with a prediction model would be a valuable tool to address this.

![Figure 1: Schematic of aneurysm localization and bursting. Sources: Shutterstock, Mayo Clinic](image)

**METHODS**

- **INPUT**
- **ENCODER**
- **DECODER**
  - Convolutional
  - PPM
  - UPerNet
- **OUTPUT Prediction**

**OBJECTIVE**
- pixel-wise labels
- vary decoder, fine-tune encoder
- Training/test split of 51/49 patients
- Seek to minimize NLL over 2 classes (aneurysm, background)

\[ \ell(x, y) = L = [l_1, \ldots, l_N]^\top, \quad l_n = -W_{xy}X_{xy}, \quad W_{xy} = \frac{1}{\text{pixels per class e}} \]

**Evaluation metric:**

\[ \text{IOU} = \frac{|X \cap Y|}{|X \cup Y|} \]

**Parameters:**
- Adam, $\beta_1 = 0.9, \alpha = 0.02$
- 20 epochs, 500 iterations each

**DISCUSSION OF RESULTS**

<table>
<thead>
<tr>
<th>Encoder</th>
<th>Decoder</th>
<th>Eval IOU</th>
<th>Time per Epoch (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resnet50</td>
<td>Conv</td>
<td>0.0018</td>
<td>270</td>
</tr>
<tr>
<td>PPM</td>
<td>0.0013</td>
<td>360</td>
<td></td>
</tr>
<tr>
<td>UPerNet</td>
<td>0.0141</td>
<td>540</td>
<td></td>
</tr>
</tbody>
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- Random chance IOU:
  \[ \frac{\# \text{Aneurysm Pixels} \cdot P(\text{Aneurysm})}{2 \cdot \# \text{Aneurysm Pixels}} \approx 10^{-5} \]
- UPerNet ~10x better than conv, PPM
- We are over-labeling aneurysms pixels
- In practice, would rather overdetect than miss aneurysm

**CONCLUSIONS AND FUTURE WORK**

- Semantic segmentation ~1000x better than random at detecting aneurysms
- Significant resampling of aneurysms required to correct class imbalance
- In future, can further tune resampling level, loss function weights
- More data to prevent overfitting

**REFERENCES & ACKNOWLEDGEMENTS**


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