Automatic fetal brain segmentation using convolutional neural networks

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intro:
To analyse a brain we want to divide the brain into its separate regions such as white matter grey matter etc. this act is called brain segmentation. To manually perform such a brain segmentation can take a lot of time and is difficult even for experts. For this reason, we would like to make this an automatic process.
To do this we aim to use a from-off AI known as deep-learning with an UNet architecture, this architecture is very common in medical image segmentation because it uses down and up layers to first identify simple features and move up to more complex ones and based on that make a prediction for which brain region a pixel belongs too.
Method:
We created 2 deep-learning algorithms a standard UNet and a UNet++, the UNet++ uses skip connections which helps us prevent data loss which can happen during the downsampling of the standard UNet.
We tested these 2 UNets on 2 datasets, the first dataset we used was the YOUth data set which originates from patients from the maxima children's hospital which had 76 patient scans, we ended up using 26 of the 76 because the scans were in multiple imaging directions and we found that taking only 1 imaging direction helped the algorithm learn more complex brain regions, such as the cerebellum and the brainstem a bit better.
We also trained on the FeTA dataset. This dataset consists of 80 patient scans.
All scans were turned into 2d slices for training to expand the relative size of the dataset.
The results are evaluated using the standard dice metric and the mean surface distances in order to properly evaluate using multiple metrics.
Results:
The results were good on the FeTA dataset able to get results competitive with the grand challenge, the results on the YOUth set were not great this is likely due to noise and intensity inhomogeneities.
Conclusion:
The algorithm is capable of consistently making good predictions on grey/white matter, however, it would be struggling with more difficult cases like the cerebellum and brainstem, however, it is expected that using denoising or other forms of intensity inhomogeneity correction are likely to greatly improve the results as it would take a form resembling the FeTA dataset. This algorithm is a strong start in being able to perform segmentation on the fetal brain, however further improvements such as 3d reconstruction can help either further improve the algorithms result to further research into different types of algorithms or using different types of metrics to see if any improvements to the problematic classes.