

Introduction

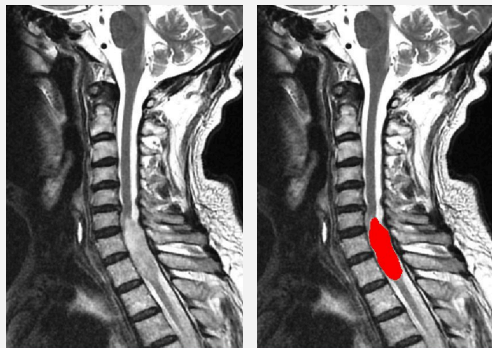
Metadata (*disease type or severity, demographics, scanner vendor, acquisition parameters*) can improve segmentation models.

FiLM (Perez et al., 2018), a general-purpose conditioning method, enables flexible integration of metadata.

The metadata modulates the model generating different outputs tailored to the input information.

Material and method

Spinal cord tumor segmentation



Metadata

Tumor type:
"Astrocytoma"
"Ependymoma"
"Hemangioblastoma"

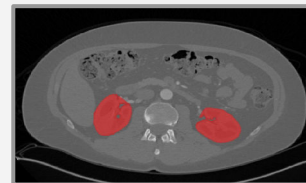
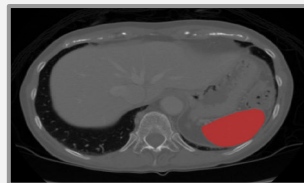
343 MRI scans

💡 IDEA: Input tumor type during training to improve model performance.

Multi-organ segmentation

Spleen, liver: Medical Seg. Decathlon

Kidney: KiTS19



Metadata

Organ: "Spleen"

Metadata

Organ: "Liver"

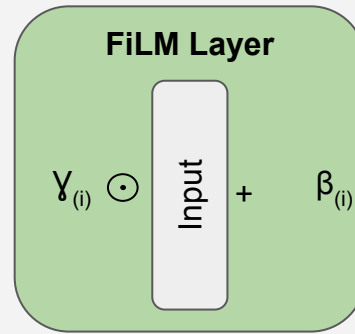
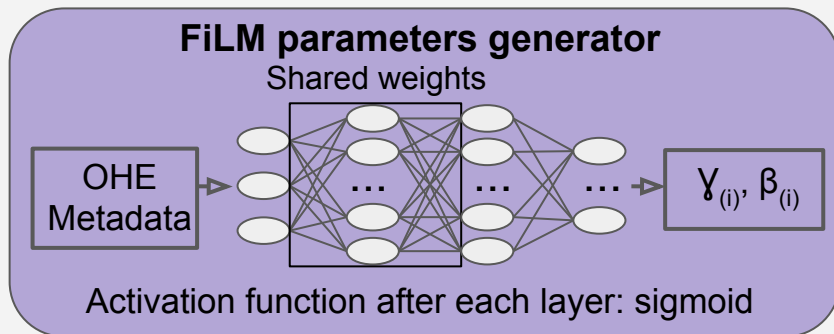
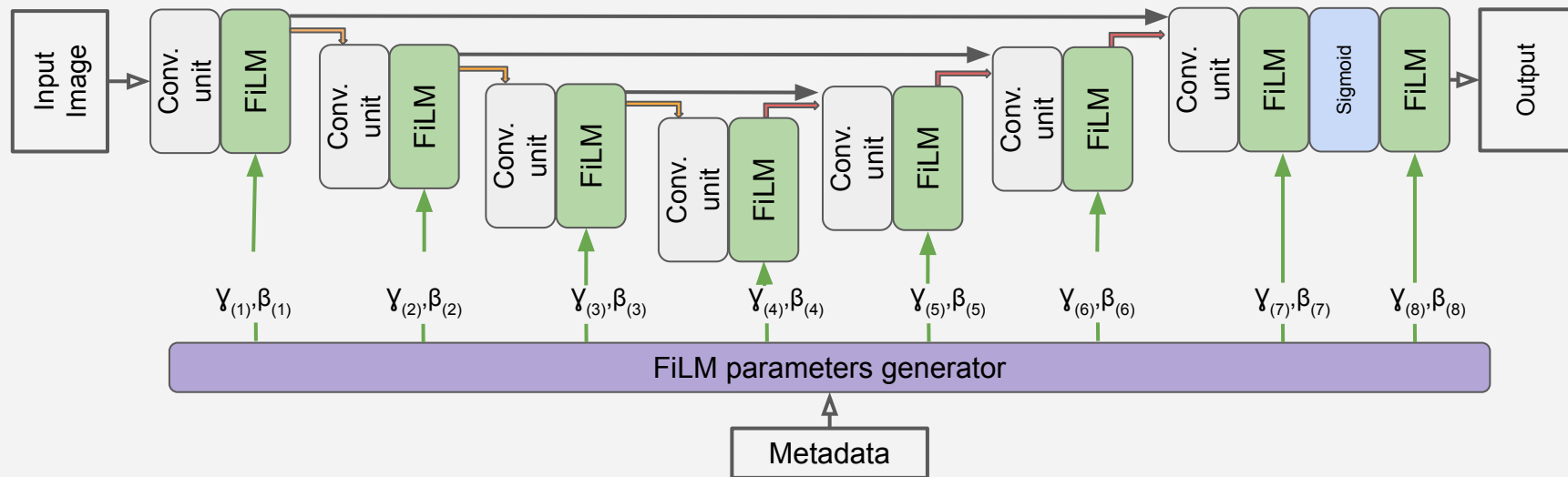
Metadata

Organ: "Kidney"

A multiclass model was trained with missing labels: only one organ type was segmented per image.

💡 IDEA: Enable training with missing segmentation by feeding the organ type present in the ground truth as metadata.

Key idea of FiLM: Feature maps are modulated based on prior knowledge (i.e., metadata)



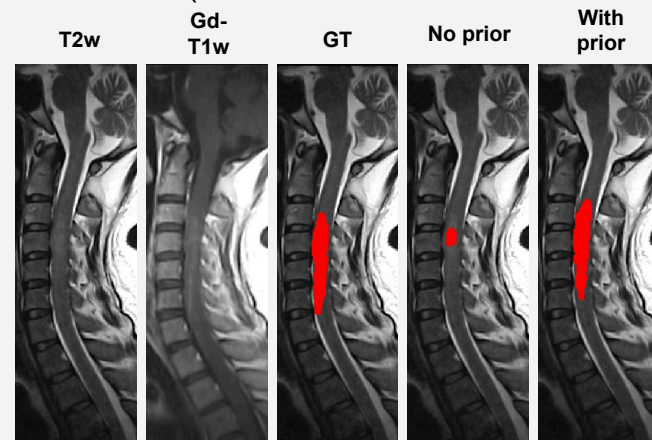
Each feature map of the input is scaled and shifted by a distinct by a γ and β factor, respectively.

Computational cost of FiLM is **not** proportional to the image resolution.

Results

Table 1: Spinal cord tumor core segmentation performance for regular and FiLMed U-Net (mean \pm STD % for 10 random splits). **p-value < 0.05 for one-sided Wilcoxon signed-rank test.

| Tumor type | Dice score [%] | |
|------------------|----------------|-------------------------------------|
| | No prior info. | Prior info. |
| Hemangioblastoma | 51.2 \pm 4.0 | 61.7 \pm 3.7 ** |
| Ependymoma | 57.2 \pm 3.2 | 57.7 \pm 2.4 |
| Astrocytoma | 53.3 \pm 4.8 | 57.8 \pm 4.9 ** |
| All | 54.0 \pm 2.2 | 59.1 \pm 2.3 ** |



Astrocytoma: Average 5-6 vertebral bodies

Table 2: Multiple-organ Dice score with FiLMed, multi-class and single-class U-Nets (mean \pm STD%).

| Task | Multi-class 2D U-Net | Single-class 2D U-Net | Multi-class FiLMed U-Net |
|--------|-------------------------|--------------------------|-----------------------------|
| Liver | 50.3 \pm 18.3 | 95.1 \pm 1.4 | 94.1 \pm 1.6 |
| Spleen | 35.6 \pm 14.2 | 91.7 \pm 6.3 | 92.2 \pm 5.3 |
| Kidney | 39.2 \pm 13.1 | 90.4 \pm 9.3 | 90.7 \pm 8.1 |

Conclusion

Metadata can improve segmentation predictions

Flexible option to integrate metadata: FiLM

Open-source code: <https://ivadomed.org/>