# Parameter adjustment experiment result record

In the ablation experiment in Section 4.3, the parameter adjustment records of different loss functions are summarized in Table 1-6. These loss functions are: DICE loss function, BCE loss function, DICE+BCE combined loss function, Focal loss function, Tversky loss function, and Focal Tversky loss function.

In the experiments in Section 4.7, for the comparative experiments on applying FC-Loss to different model architectures, the parameter adjustment records are summarized in Tables 7-11. The models involved in the comparison include: FCN-8s, Res-U-Net, Att-U-Net, U-Net++ and PSPNet.

Table 1 DICE loss function.

| Method | HyperParameter | | | | Validation | | Test | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LR | r | λ | p | Saved epoch | IoU(%) | Precision(%) | Recall(%) | F1(%) | IoU(%) |
| Baseline | 0.001 | - | - | - | 172 | 69.66 | 82.41 | 82.66 | 80.47 | 69.99 |
| Baseline+FC | 0.001 | 2 | 0.1 | - | 178 | 69.38 | | | | |
| | 0.001 | 4 | 0.1 | - | 182 | 69.66 | | | | |
| | 0.001 | 2 | 0.2 | - | 178 | 69.34 | | | | |
| | 0.001 | 4 | 0.2 | - | 157 | 70.27 | | | | |
| | 0.001 | 2 | 0.3 | - | 174 | 69.73 | | | | |
| | 0.001 | 4 | 0.3 | - | 143 | 70.30 | 82.93 | 82.26 | 80.76 | 70.48 |
| Baseline+Dropout | 0.001 | - | - | 0.1 | 179 | 69.34 | | | | |
| | 0.001 | - | - | 0.2 | 196 | 69.08 | | | | |
| | 0.001 | - | - | 0.3 | 185 | 69.61 | | | | |
| | 0.001 | - | - | 0.4 | 200 | 69.50 | | | | |
| | 0.001 | - | - | 0.5 | 200 | 69.68 | | | | |
| | 0.001 | - | - | 0.6 | 187 | 70.34 | 83.39 | 82.47 | 80.86 | 70.65 |
| | 0.001 | - | - | 0.7 | 194 | 69.55 | | | | |
| | 0.001 | - | - | 0.8 | 199 | 69.80 | | | | |
| | 0.001 | - | - | 0.9 | 196 | 69.50 | | | | |
| Proposed | 0.001 | 4 | 0.3 | 0.1 | 177 | 69.65 | | | | |
| | 0.001 | 4 | 0.3 | 0.2 | 183 | 69.86 | | | | |
| | 0.001 | 4 | 0.3 | 0.3 | 154 | 69.90 | | | | |
| | 0.001 | 4 | 0.3 | 0.4 | 174 | 69.85 | | | | |
| | 0.001 | 4 | 0.3 | 0.5 | 199 | 69.73 | | | | |
| | 0.001 | 4 | 0.3 | 0.6 | 127 | 70.37 | 83.32 | 83.08 | 81.56 | 71.18 |
| | 0.001 | 4 | 0.3 | 0.7 | 181 | 69.85 | | | | |
| | 0.001 | 4 | 0.3 | 0.8 | 185 | 69.86 | | | | |
| | 0.001 | 4 | 0.3 | 0.9 | 177 | 69.90 | | | | |

Table 2 BCE loss function.

| Method | HyperParameter | | | | Validation | | Test | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LR | r | λ | p | Saved epoch | IoU(%) | Precision(%) | Recall(%) | F1(%) | IoU(%) |
| Baseline | 0.001 | - | - | - | 119 | 69.38 | 83.41 | 81.75 | 80.40 | 69.92 |
| Baseline+FC | 0.001 | 2 | 0.1 | - | 159 | 69.68 | | | | |
| | 0.001 | 4 | 0.1 | - | 109 | 69.05 | | | | |
| | 0.001 | 2 | 0.2 | - | 184 | 68.88 | | | | |
| | 0.001 | 4 | 0.2 | - | 124 | 69.77 | 83.95 | 81.78 | 80.99 | 70.47 |
| | 0.001 | 2 | 0.3 | - | 155 | 69.49 | | | | |
| | 0.001 | 4 | 0.3 | - | 115 | 68.99 | | | | |
| Baseline+Dropout | 0.001 | - | - | 0.1 | 139 | 69.87 | | | | |
| | 0.001 | - | - | 0.2 | 148 | 69.35 | | | | |
| | 0.001 | - | - | 0.3 | 185 | 69.46 | | | | |
| | 0.001 | - | - | 0.4 | 143 | 70.05 | | | | |
| | 0.001 | - | - | 0.5 | 176 | 70.36 | 83.62 | 81.91 | 80.92 | 70.51 |
| | 0.001 | - | - | 0.6 | 175 | 70.35 | | | | |
| | 0.001 | - | - | 0.7 | 136 | 69.78 | | | | |
| | 0.001 | - | - | 0.8 | 196 | 69.99 | | | | |
| | 0.001 | - | - | 0.9 | 200 | 70.13 | | | | |
| Proposed | 0.001 | 4 | 0.2 | 0.1 | 184 | 69.72 | | | | |
| | 0.001 | 4 | 0.2 | 0.2 | 140 | 69.83 | | | | |
| | 0.001 | 4 | 0.2 | 0.3 | 169 | 69.61 | | | | |
| | 0.001 | 4 | 0.2 | 0.4 | 148 | 69.65 | | | | |
| | 0.001 | 4 | 0.2 | 0.5 | 152 | 70.11 | | | | |
| | 0.001 | 4 | 0.2 | 0.6 | 109 | 70.42 | | | | |
| | 0.001 | 4 | 0.2 | 0.7 | 129 | 70.52 | | | | |
| | 0.001 | 4 | 0.2 | 0.8 | 128 | 70.59 | 83.11 | 82.86 | 81.21 | 70.82 |
| | 0.001 | 4 | 0.2 | 0.9 | 124 | 70.05 | | | | |

Table 3 DICE+BCE combined loss function.

| Method | HyperParameter | | | | Validation | | Test | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LR | r | λ | p | Saved epoch | IoU(%) | Precision(%) | Recall(%) | F1(%) | IoU(%) |
| Baseline | 0.001 | - | - | - | 120 | 69.75 | 82.59 | 83.50 | 81.18 | 70.78 |
| Baseline+FC | 0.001 | 2 | 0.1 | - | 174 | 70.47 | 82.69 | 83.74 | 81.47 | 71.01 |
| | 0.001 | 4 | 0.1 | - | 184 | 69.78 | | | | |
| | 0.001 | 2 | 0.2 | - | 189 | 69.87 | | | | |
| | 0.001 | 4 | 0.2 | - | 173 | 70.15 | | | | |
| | 0.001 | 2 | 0.3 | - | 86 | 69.57 | | | | |
| | 0.001 | 4 | 0.3 | - | 167 | 70.22 | | | | |
| Baseline+Dropout | 0.001 | - | - | 0.1 | 175 | 69.74 | | | | |
| | 0.001 | - | - | 0.2 | 172 | 69.84 | | | | |
| | 0.001 | - | - | 0.3 | 179 | 69.61 | | | | |
| | 0.001 | - | - | 0.4 | 177 | 70.14 | | | | |
| | 0.001 | - | - | 0.5 | 174 | 70.15 | | | | |
| | 0.001 | - | - | 0.6 | 195 | 70.44 | | | | |
| | 0.001 | - | - | 0.7 | 184 | 70.48 | 82.75 | 83.81 | 81.42 | 71.10 |
| | 0.001 | - | - | 0.8 | 186 | 69.96 | | | | |
| | 0.001 | - | - | 0.9 | 199 | 69.96 | | | | |
| Proposed | 0.001 | 2 | 0.1 | 0.1 | 154 | 70.45 | | | | |
| | 0.001 | 2 | 0.1 | 0.2 | 122 | 69.99 | | | | |
| | 0.001 | 2 | 0.1 | 0.3 | 159 | 70.25 | | | | |
| | 0.001 | 2 | 0.1 | 0.4 | 163 | 70.18 | | | | |
| | 0.001 | 2 | 0.1 | 0.5 | 174 | 70.28 | | | | |
| | 0.001 | 2 | 0.1 | 0.6 | 149 | 70.45 | | | | |
| | 0.001 | 2 | 0.1 | 0.7 | 177 | 70.63 | 83.96 | 82.86 | 81.86 | 71.55 |
| | 0.001 | 2 | 0.1 | 0.8 | 174 | 70.55 | | | | |
| | 0.001 | 2 | 0.1 | 0.9 | 190 | 70.55 | | | | |

Table 4 Focal loss function.

| Method | HyperParameter | | | | Validation | | Test | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LR | r | λ | p | Saved epoch | IoU(%) | Precision(%) | Recall(%) | F1(%) | IoU(%) |
| Baseline | 0.001 | - | - | - | 148 | 69.35 | 81.38 | 84.07 | 80.86 | 70.21 |
| Baseline+FC | 0.001 | 2 | 0.1 | - | 189 | 67.59 | | | | |
| | 0.001 | 4 | 0.1 | - | 195 | 68.05 | | | | |
| | 0.001 | 2 | 0.2 | - | 189 | 67.20 | | | | |
| | 0.001 | 4 | 0.2 | - | 166 | 65.20 | | | | |
| | 0.001 | 2 | 0.3 | - | 189 | 68.37 | 81.88 | 82.32 | 79.99 | 69.16 |
| | 0.001 | 4 | 0.3 | - | 191 | 61.98 | | | | |
| Baseline+Dropout | 0.001 | - | - | 0.1 | 146 | 69.25 | | | | |
| | 0.001 | - | - | 0.2 | 143 | 69.67 | | | | |
| | 0.001 | - | - | 0.3 | 143 | 69.62 | | | | |
| | 0.001 | - | - | 0.4 | 185 | 69.45 | | | | |
| | 0.001 | - | - | 0.5 | 185 | 70.02 | | | | |
| | 0.001 | - | - | 0.6 | 185 | 70.11 | | | | |
| | 0.001 | - | - | 0.7 | 176 | 69.86 | | | | |
| | 0.001 | - | - | 0.8 | 185 | 70.20 | 84.34 | 81.51 | 81.18 | 70.68 |
| | 0.001 | - | - | 0.9 | 140 | 69.10 | | | | |
| Proposed | 0.001 | 2 | 0.3 | 0.1 | 189 | 66.82 | | | | |
| | 0.001 | 2 | 0.3 | 0.2 | 183 | 68.91 | | | | |
| | 0.001 | 2 | 0.3 | 0.3 | 191 | 68.02 | | | | |
| | 0.001 | 2 | 0.3 | 0.4 | 189 | 69.11 | | | | |
| | 0.001 | 2 | 0.3 | 0.5 | 144 | 67.44 | | | | |
| | 0.001 | 2 | 0.3 | 0.6 | 122 | 67.66 | | | | |
| | 0.001 | 2 | 0.3 | 0.7 | 175 | 68.96 | | | | |
| | 0.001 | 2 | 0.3 | 0.8 | 182 | 69.14 | | | | |
| | 0.001 | 2 | 0.3 | 0.9 | 175 | 69.49 | 82.52 | 81.82 | 80.22 | 69.68 |

Table 5 Tversky loss function.

| Method | HyperParameter | | | | Validation | | Test | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LR | r | λ | p | Saved epoch | IoU(%) | Precision(%) | Recall(%) | F1(%) | IoU(%) |
| Baseline | 0.001 | - | - | - | 142 | 69.10 | 79.97 | 84.75 | 80.46 | 69.69 |
| Baseline+FC | 0.001 | 2 | 0.1 | - | 192 | 69.80 | | | | |
| | 0.001 | 4 | 0.1 | - | 130 | 69.74 | | | | |
| | 0.001 | 2 | 0.2 | - | 189 | 70.15 | | | | |
| | 0.001 | 4 | 0.2 | - | 176 | 69.78 | | | | |
| | 0.001 | 2 | 0.3 | - | 154 | 69.90 | | | | |
| | 0.001 | 4 | 0.3 | - | 181 | 70.26 | 80.16 | 85.20 | 80.83 | 70.29 |
| Baseline+Dropout | 0.001 | - | - | 0.1 | 198 | 69.55 | | | | |
| | 0.001 | - | - | 0.2 | 193 | 69.98 | 79.19 | 86.45 | 80.80 | 70.28 |
| | 0.001 | - | - | 0.3 | 193 | 69.89 | | | | |
| | 0.001 | - | - | 0.4 | 195 | 69.56 | | | | |
| | 0.001 | - | - | 0.5 | 184 | 69.79 | | | | |
| | 0.001 | - | - | 0.6 | 193 | 69.40 | | | | |
| | 0.001 | - | - | 0.7 | 195 | 69.22 | | | | |
| | 0.001 | - | - | 0.8 | 198 | 69.31 | | | | |
| | 0.001 | - | - | 0.9 | 198 | 69.23 | | | | |
| Proposed | 0.001 | 4 | 0.3 | 0.1 | 186 | 70.01 | | | | |
| | 0.001 | 4 | 0.3 | 0.2 | 171 | 69.88 | | | | |
| | 0.001 | 4 | 0.3 | 0.3 | 175 | 70.40 | 80.71 | 85.79 | 81.52 | 71.04 |
| | 0.001 | 4 | 0.3 | 0.4 | 156 | 69.97 | | | | |
| | 0.001 | 4 | 0.3 | 0.5 | 177 | 70.22 | | | | |
| | 0.001 | 4 | 0.3 | 0.6 | 175 | 70.12 | | | | |
| | 0.001 | 4 | 0.3 | 0.7 | 176 | 70.12 | | | | |
| | 0.001 | 4 | 0.3 | 0.8 | 178 | 69.95 | | | | |
| | 0.001 | 4 | 0.3 | 0.9 | 124 | 69.50 | | | | |

Table 6 Focal Tversky loss function.

| Method | HyperParameter | | | | Validation | | Test | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LR | r | λ | p | Saved epoch | IoU(%) | Precision(%) | Recall(%) | F1(%) | IoU(%) |
| Baseline | 0.001 | - | - | - | 142 | 69.60 | 79.91 | 86.03 | 81.06 | 70.43 |
| Baseline+FC | 0.001 | 2 | 0.1 | - | 196 | 69.84 | | | | |
| | 0.001 | 4 | 0.1 | - | 176 | 69.38 | | | | |
| | 0.001 | 2 | 0.2 | - | 168 | 69.91 | | | | |
| | 0.001 | 4 | 0.2 | - | 138 | 69.74 | | | | |
| | 0.001 | 2 | 0.3 | - | 199 | 68.75 | | | | |
| | 0.001 | 4 | 0.3 | - | 186 | 69.95 | 78.80 | 86.40 | 80.74 | 70.11 |
| Baseline+Dropout | 0.001 | - | - | 0.1 | 185 | 69.13 | | | | |
| | 0.001 | - | - | 0.2 | 185 | 69.39 | | | | |
| | 0.001 | - | - | 0.3 | 186 | 69.78 | 79.29 | 86.96 | 81.28 | 70.73 |
| | 0.001 | - | - | 0.4 | 195 | 69.24 | | | | |
| | 0.001 | - | - | 0.5 | 198 | 69.30 | | | | |
| | 0.001 | - | - | 0.6 | 184 | 69.45 | | | | |
| | 0.001 | - | - | 0.7 | 198 | 68.78 | | | | |
| | 0.001 | - | - | 0.8 | 195 | 69.47 | | | | |
| | 0.001 | - | - | 0.9 | 198 | 69.39 | | | | |
| Proposed | 0.001 | 4 | 0.3 | 0.1 | 177 | 69.04 | | | | |
| | 0.001 | 4 | 0.3 | 0.2 | 181 | 69.98 | | | | |
| | 0.001 | 4 | 0.3 | 0.3 | 138 | 69.35 | | | | |
| | 0.001 | 4 | 0.3 | 0.4 | 198 | 69.89 | | | | |
| | 0.001 | 4 | 0.3 | 0.5 | 180 | 69.76 | | | | |
| | 0.001 | 4 | 0.3 | 0.6 | 181 | 70.33 | 80.14 | 85.98 | 81.23 | 70.59 |
| | 0.001 | 4 | 0.3 | 0.7 | 186 | 70.02 | | | | |
| | 0.001 | 4 | 0.3 | 0.8 | 176 | 69.80 | | | | |
| | 0.001 | 4 | 0.3 | 0.9 | 176 | 69.19 | | | | |

Table 7 FCN-8.

| Method(FCN-8s) | HyperParameter | | | | Validation | | Test | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LR | r | λ | p | Saved epoch | IoU(%) | Precision(%) | Recall(%) | F1(%) | IoU(%) |
| Baseline | 0.001 | - | - | - | 147 | 56.00 | 66.87 | 76.53 | 69.20 | 56.74 |
| Baseline+FC | 0.001 | 2 | 0.1 | - | 172 | 56.66 | | | | |
| | 0.001 | 4 | 0.1 | - | 154 | 56.60 | | | | |
| | 0.001 | 2 | 0.2 | - | 172 | 55.27 | | | | |
| | 0.001 | 4 | 0.2 | - | 192 | 56.88 | | | | |
| | 0.001 | 2 | 0.3 | - | 181 | 57.13 | 70.50 | 73.82 | 70.07 | 57.80 |
| | 0.001 | 4 | 0.3 | - | 177 | 56.60 | | | | |

Table 8 Res-U-Net.

| Method(Res-U-net) | HyperParameter | | | | Validation | | Test | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LR | r | λ | p | Saved epoch | IoU(%) | Precision(%) | Recall(%) | F1(%) | IoU(%) |
| Baseline | 0.001 | - | - | - | 166 | 68.47 | 81.99 | 81.85 | 79.82 | 69.40 |
| Baseline+FC | 0.001 | 2 | 0.1 | - | 162 | 68.60 | | | | |
| | 0.001 | 4 | 0.1 | - | 199 | 68.28 | | | | |
| | 0.001 | 2 | 0.2 | - | 94 | 67.05 | | | | |
| | 0.001 | 4 | 0.2 | - | 188 | 68.71 | 82.13 | 82.60 | 80.17 | 69.78 |
| | 0.001 | 2 | 0.3 | - | 94 | 65.48 | | | | |
| | 0.001 | 4 | 0.3 | - | 106 | 67.95 | | | | |

Table 9 Att-U-Net.

| Method(Att-U-net) | HyperParameter | | | | Validation | | Test | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LR | r | λ | p | Saved epoch | IoU(%) | Precision(%) | Recall(%) | F1(%) | IoU(%) |
| Baseline | 0.001 | - | - | - | 172 | 69.48 | 83.09 | 82.00 | 80.57 | 70.19 |
| Baseline+FC | 0.001 | 2 | 0.1 | - | 142 | 69.99 | | | | |
| | 0.001 | 4 | 0.1 | - | 126 | 69.19 | | | | |
| | 0.001 | 2 | 0.2 | - | 191 | 70.01 | 83.19 | 83.10 | 81.23 | 70.84 |
| | 0.001 | 4 | 0.2 | - | 185 | 69.79 | | | | |
| | 0.001 | 2 | 0.3 | - | 62 | 68.05 | | | | |
| | 0.001 | 4 | 0.3 | - | 79 | 69.25 | | | | |

Table 10 U-Net++.

| Method(U-net++) | HyperParameter | | | | Validation | | Test | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LR | r | λ | p | Saved epoch | IoU(%) | Precision(%) | Recall(%) | F1(%) | IoU(%) |
| Baseline | 0.001 | - | - | - | 200 | 69.69 | 82.83 | 82.82 | 81.02 | 70.72 |
| Baseline+FC | 0.001 | 2 | 0.1 | - | 136 | 70.15 | | | | |
| | 0.001 | 4 | 0.1 | - | 188 | 69.91 | | | | |
| | 0.001 | 2 | 0.2 | - | 142 | 70.26 | 84.35 | 82.16 | 81.54 | 71.21 |
| | 0.001 | 4 | 0.2 | - | 147 | 69.57 | | | | |
| | 0.001 | 2 | 0.3 | - | 185 | 70.00 | | | | |
| | 0.001 | 4 | 0.3 | - | 197 | 70.10 | | | | |

Table 11 PSPNet.

| Method(Segnet) | HyperParameter | | | | Validation | | Test | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LR | r | λ | p | Saved epoch | IoU(%) | Precision(%) | Recall(%) | F1(%) | IoU(%) |
| Baseline | 0.001 | - | - | - | 188 | 70.12 | 82.18 | 84.51 | 81.69 | 71.48 |
| Baseline+FC | 0.001 | 2 | 0.1 | - | 173 | 70.95 | | | | |
| | 0.001 | 4 | 0.1 | - | 183 | 71.05 | | | | |
| | 0.001 | 2 | 0.2 | - | 182 | 71.05 | | | | |
| | 0.001 | 4 | 0.2 | - | 172 | 71.19 | | | | |
| | 0.001 | 2 | 0.3 | - | 200 | 71.21 | 84.07 | 83.10 | 82.09 | 71.88 |
| | 0.001 | 4 | 0.3 | - | 134 | 69.75 | | | | |