

Automatic 3D Atrial Segmentation from GE-MRIs using Volumetric Fully Convolutional Networks

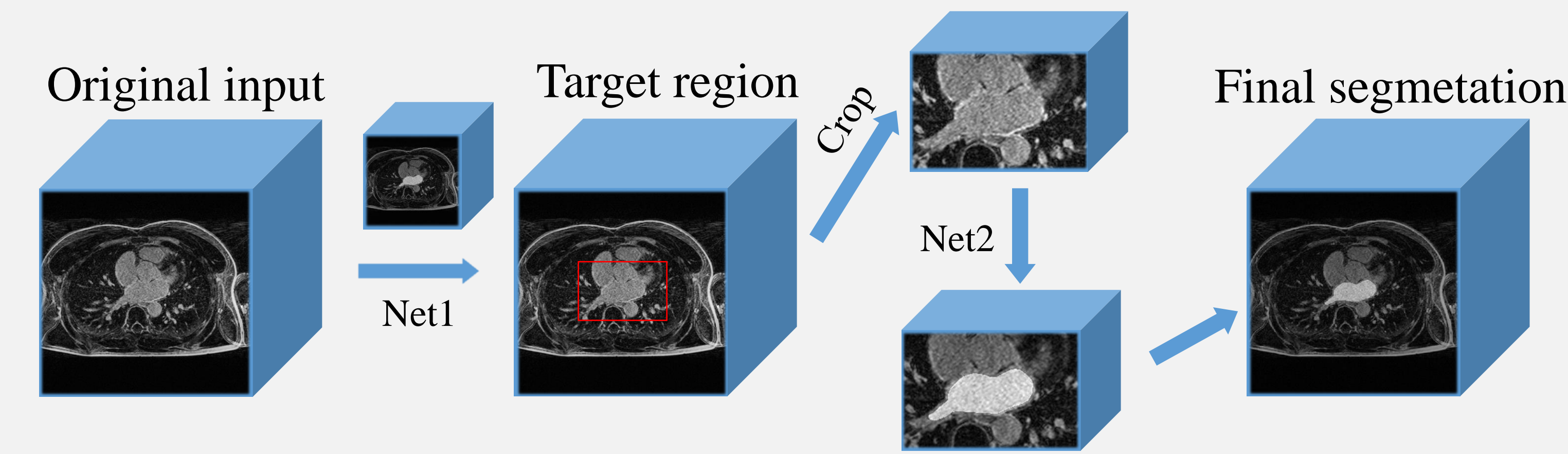
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Automatic LA Segmenation Framework

- Two-stage scheme (two segmentation networks)
 - Net1: coarse segmentation & localization
 - Segment LA in a downsampled version of input
 - Compute the barycenter of coarse LA
 - Crop a fixed-size cuboid from the original input centered with this barycenter
 - Net2: fine LA segmentation
 - Segment LA in the cropped cuboid
 - Map the mask to the original volume space

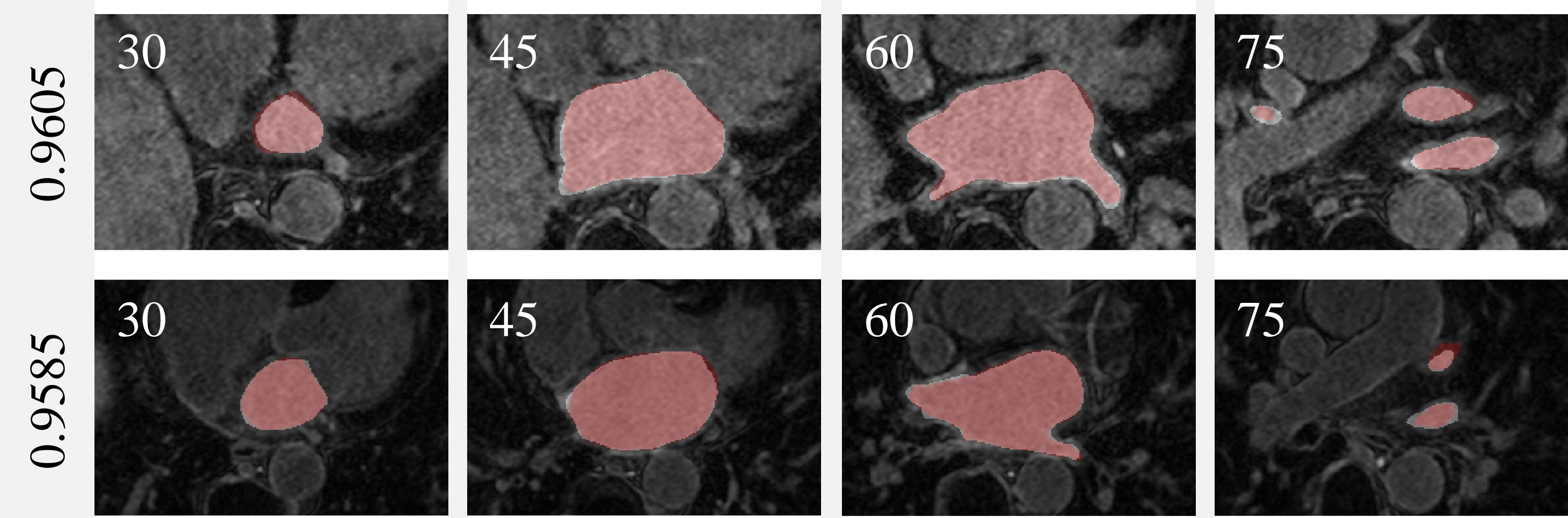


Data Preprocessing

- Input size
 - Center-crop & zero-pad all input to 576*576*96
 - Net1: downsample original input to 144*144*48
 - Net2: crop input with a cuboid 240*160*96 centered with mask's barycenter
- Intensity (only applied to Net2)
 - Contrast limited adaptive histogram equalization
 - Sample-wise normalization (mean = 0, std = 1)

Results

- Visual comparision to groundtruth (best two)
 - Red: groundtruth, gray: prediction
 - Dice coefficients are listed in the left most column

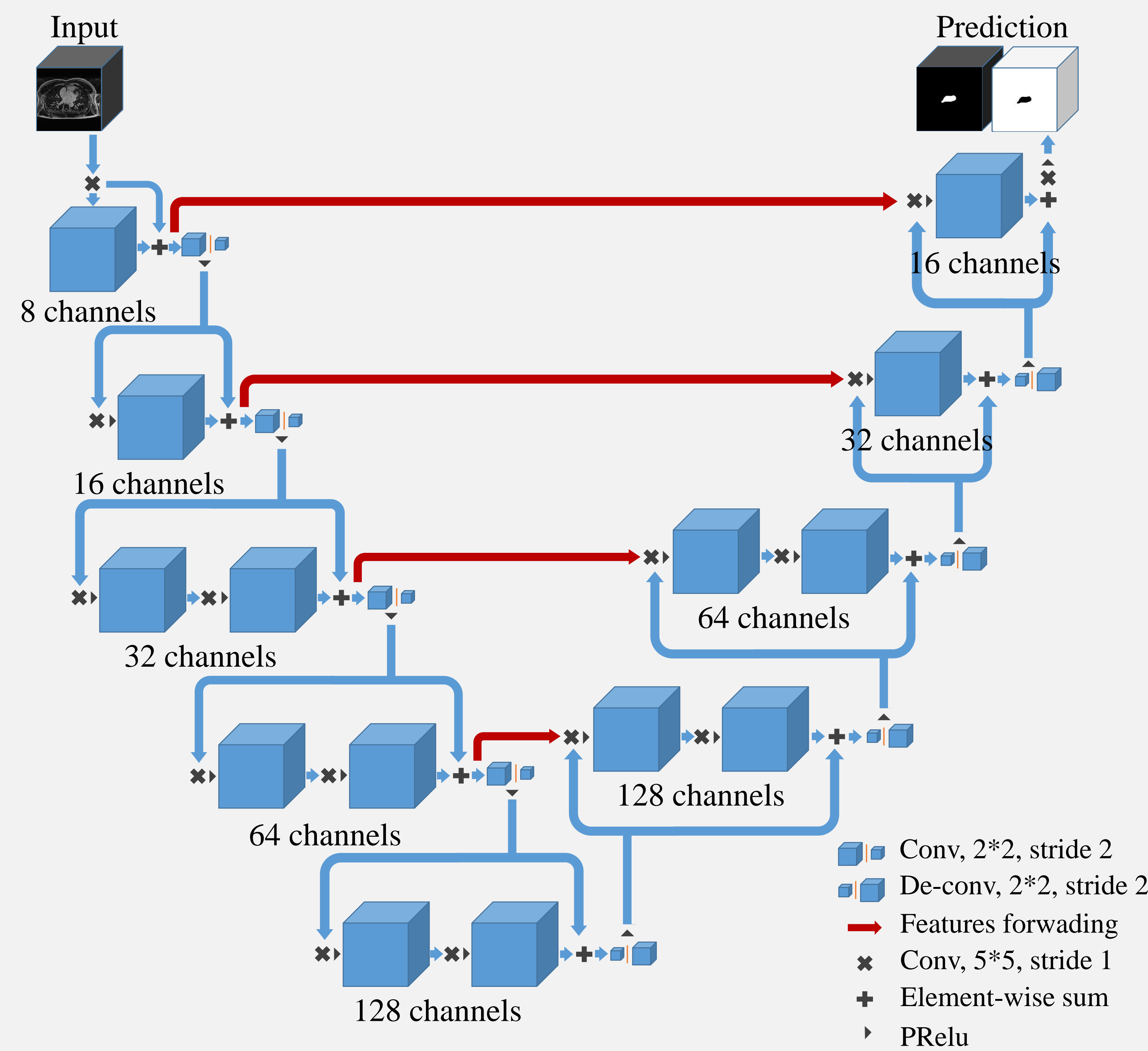


- Accuracy statistics
 - 5-fold cross-validation (0.923 in average)

Fold	BCE1	DC1	CE1	DC2	CE2	DC	CE
1	0.69, 0.21, 0.51	0.885	0.871	0.923	0.904	0.923	0.904
2	0.68, 0.44, 0.63	0.864	0.834	0.909	0.888	0.909	0.888
3	0.45, 0.34, 0.52	0.883	0.877	0.924	0.917	0.924	0.917
4	0.36, 0.27, 0.61	0.889	0.870	0.932	0.911	0.932	0.911
5	0.52, 0.27, 0.42	0.894	0.871	0.929	0.908	0.929	0.908
Avg	0.54, 0.31, 0.54	0.884	0.865	0.923	0.906	0.923	0.906

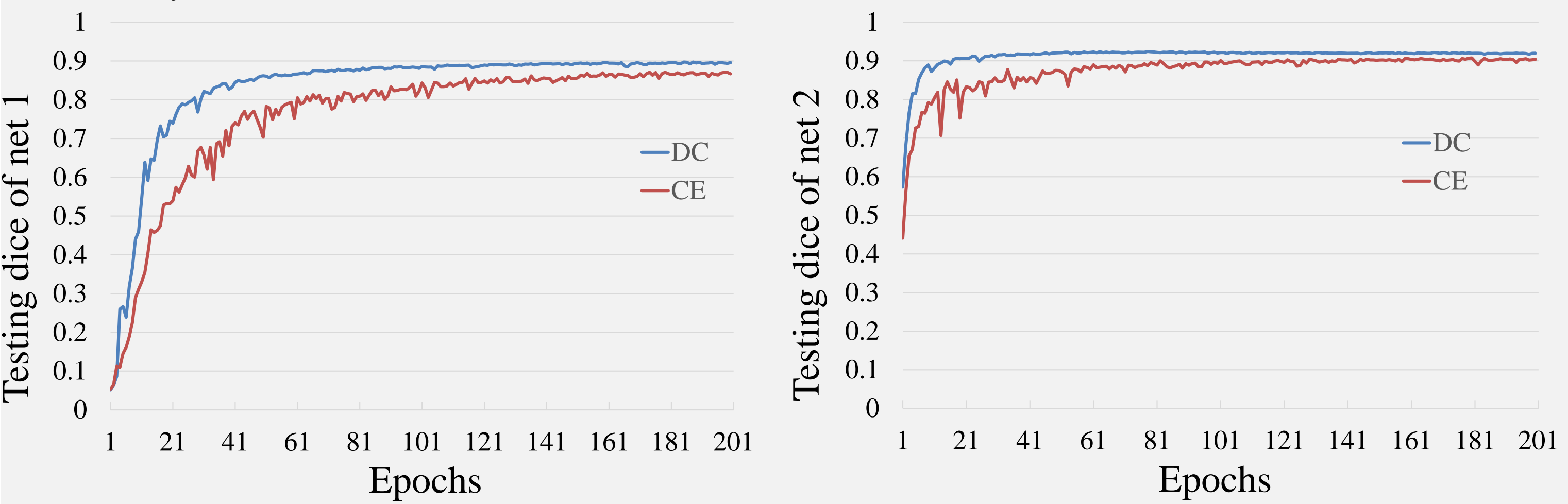
Network Architecture

- Segmentation network adapted from VNet



Loss Functions

- Soft dice loss (DC)
 - $$\text{loss} = \frac{2(a*b)}{a^2+b^2}$$
 - a : foreground probability, b : ground truth mask
- Cross-entropy loss (CE)
 - $$\text{loss} = -\sum y_i \log(y'_i)$$
 - y'_i : fore/background probability, y_i : ground truth indicator



Runtime Cost

- Memory
 - Training of Net1: ~4.2GB GPU mem (batch-size=4)
 - Training of Net2: ~4GB GPU mem (batch-size=1)
 - Testing: ~2.6GB GPU memory in total
- Time
 - Nvidia GTX 1060 6G + Intel Core i7 6700K @ 4.00 Ghz, PyTorch (cuDNN)
 - Training: ~4.7 hours (Net1), ~13.6 hours (Net2)
 - Testing: ~2s/patient in total