

Resolution Harmonization of PET Imaging Using 3D Convolutional Neural Networks

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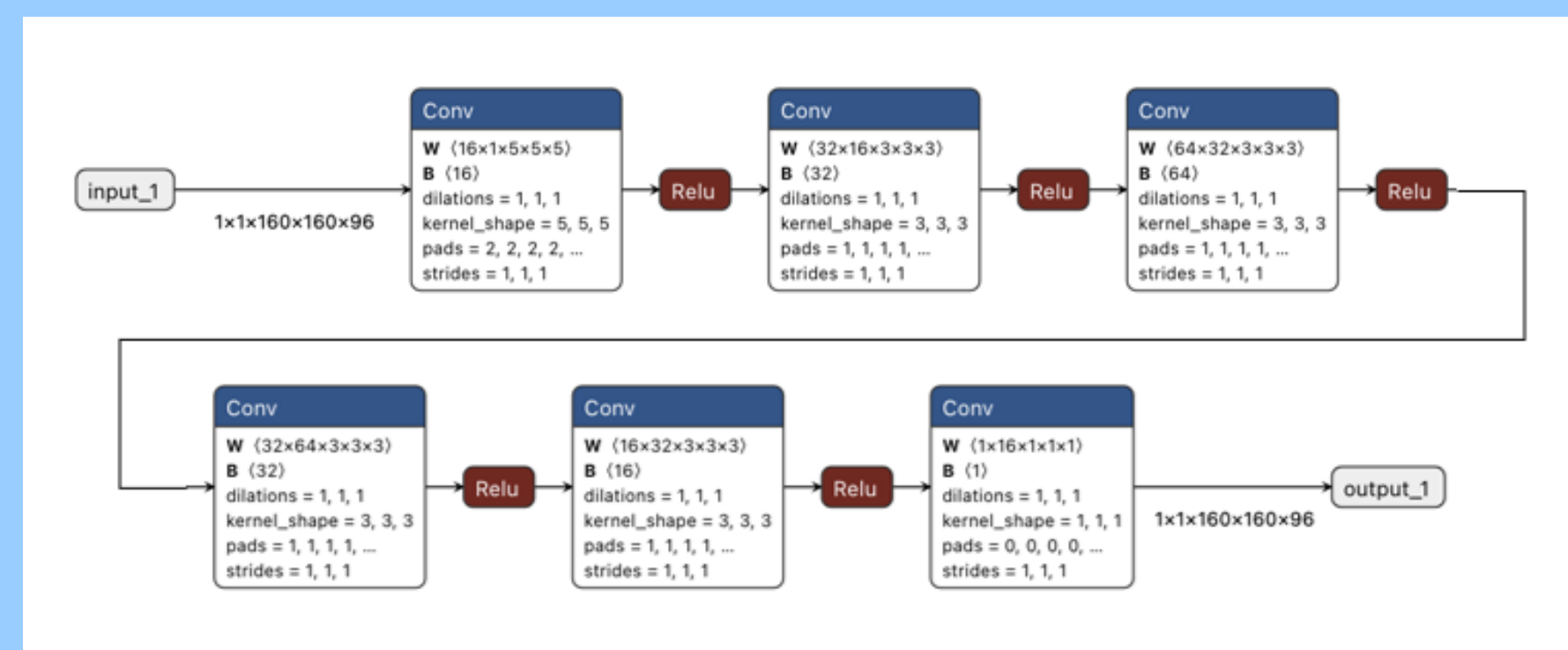
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Background

- Variability in PET image resolution arising from differences in scanner characteristics and reconstruction algorithms limit cross-study comparability and affects downstream quantitative analysis.
- We propose a deep learning-based PET resolution harmonization framework that is agnostic to native scanner resolution and does not require prior knowledge of scanner or reconstruction parameters.
- A deep 3D convolutional neural network (3DCNN) is used to directly predict standardized 8mm full width at half maximum (FWHM) PET images from native scanner-resolution inputs.
- Harmonization performance is evaluated using SPM12-derived mean cortical standardized uptake value ratios (MCSUVR) and amyloid- β positivity classification to assess quantitative and clinical agreement between predicted and reference scans.

Method

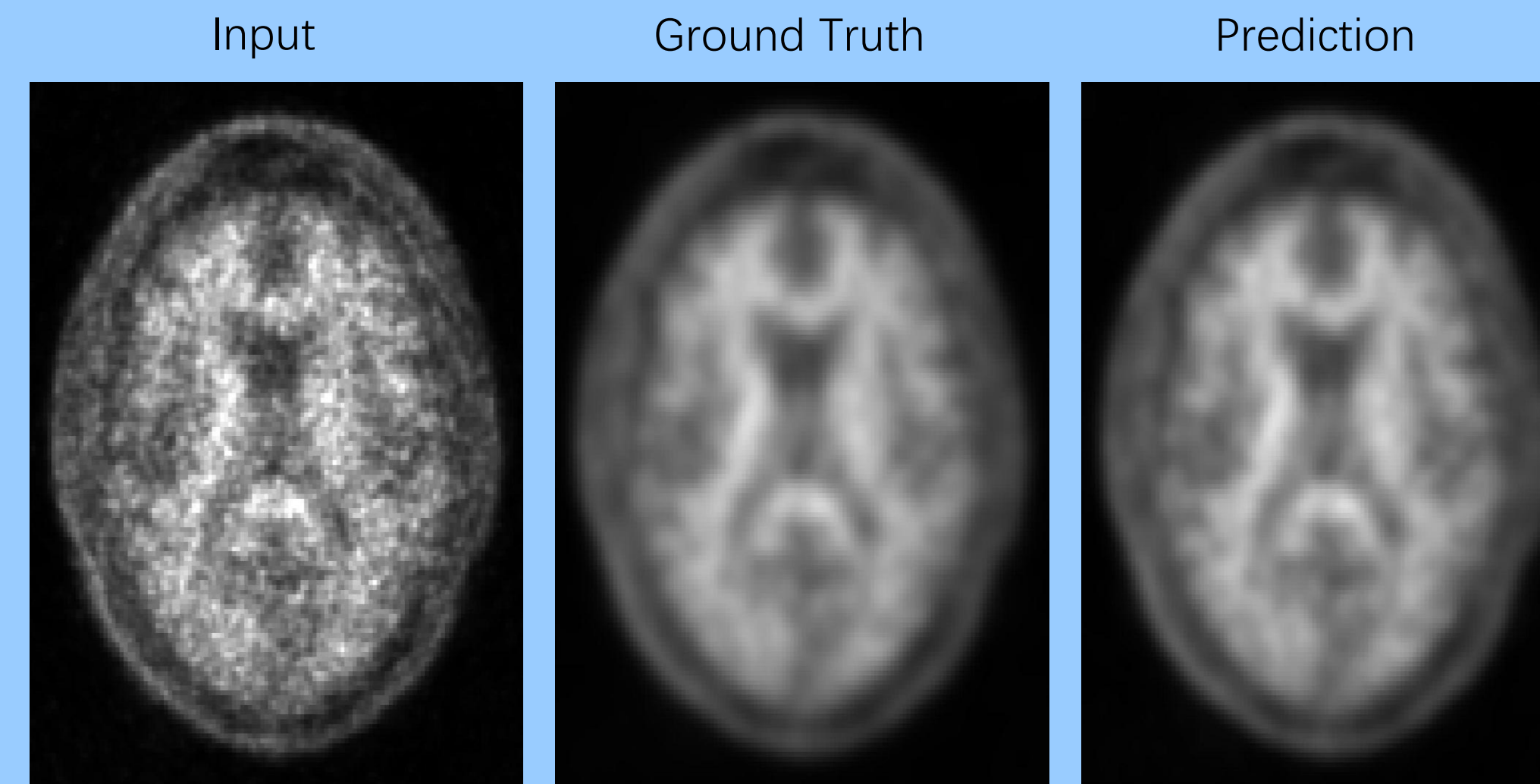
- Training and Testing Data: 2833 paired AV45 PET scans from ADNI.
 - Native scanner-resolution and 8mm resolution (Ground Truth)
 - Training = 1700 scans; Evaluation= 567 scans; Testing = 566 scans
- Independent Testing Data: 110 paired AV45 PET scans from Banner Alzheimer's Institute APOE study.
 - Native scanner resolution and 8mm resolution (Ground Truth)
- A fully convolutional deep 3DCNN consisting of six 3D convolutional layers with batch normalization and ReLU activations was trained to learn voxel-wise resolution transformations from native scanner resolution to 8 mm targets using voxel-wise mean squared error loss optimized with Adam (learning rate= 5×10^{-4}) for 50 epochs.
- The network preserves image matrix size and performs filtering without explicit downsampling or upsampling.



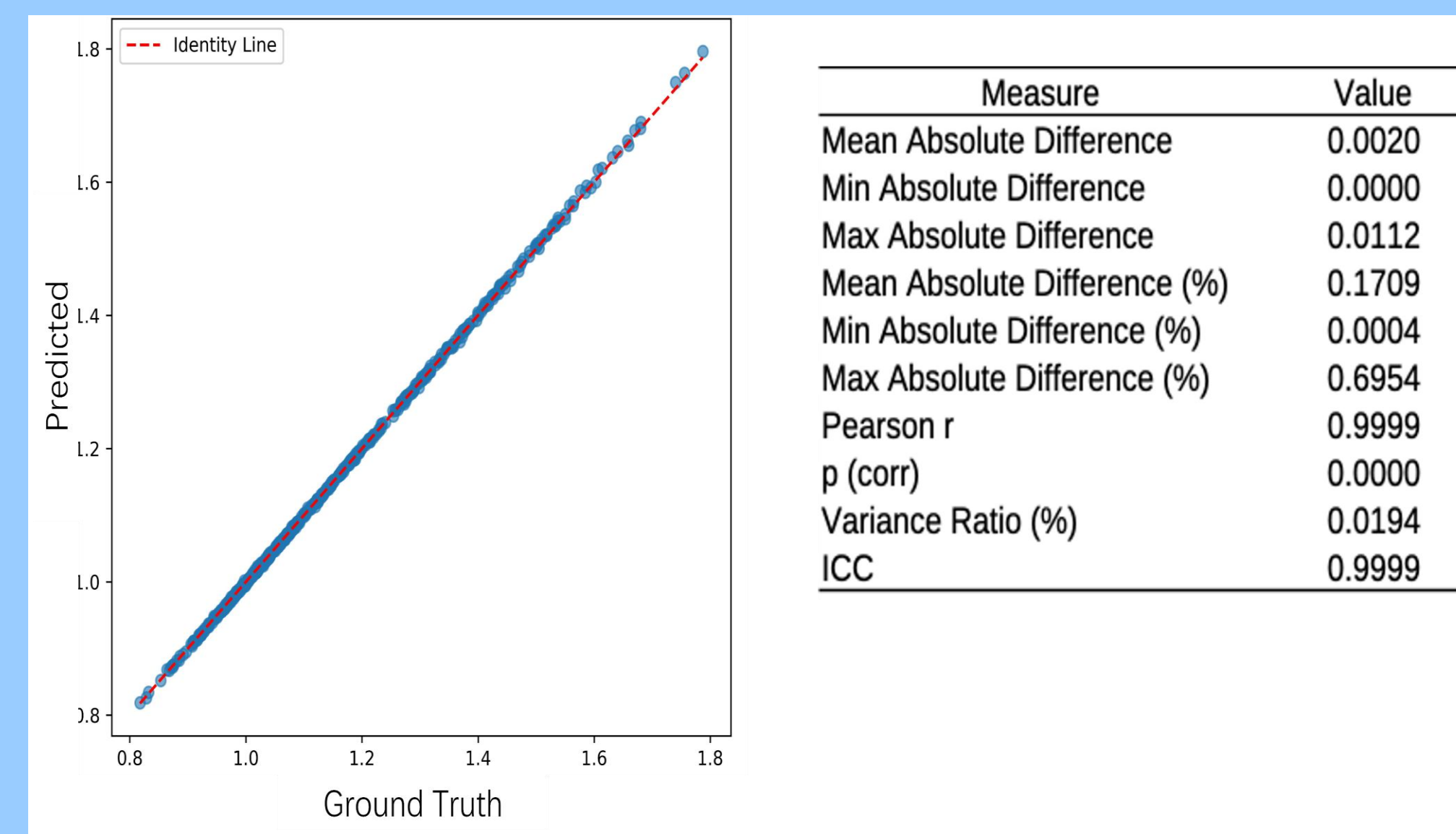
- Predicted and reference images were processed using SPM12 for spatial normalization and MCSUVR computation, and amyloid- β positivity was assessed using an MCSUVR threshold of 1.17.

Results

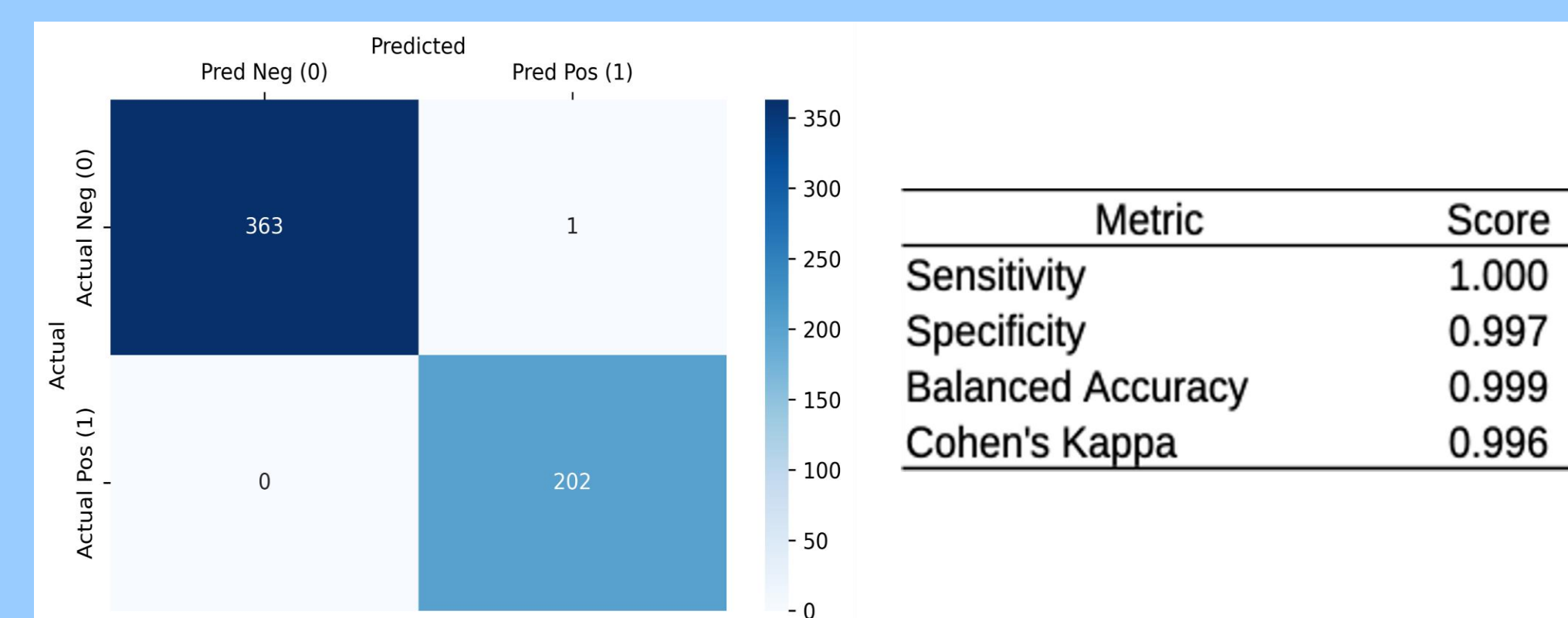
- Training and Testing on ADNI data:
 - Predictions from native scanner-resolution to 8mm resolution demonstrated strong qualitative agreement with ground truth



- MCSUVR from predicted images showed significant correlation with MCSUVR from ground truth images.

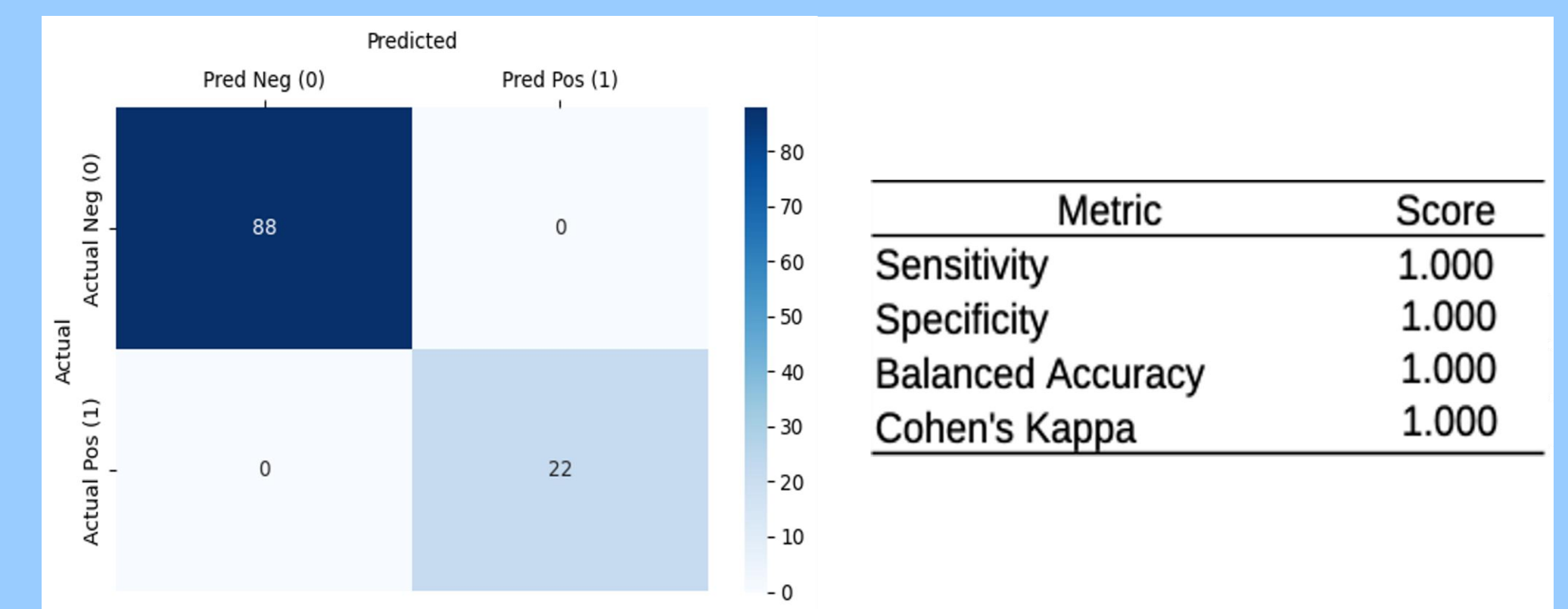
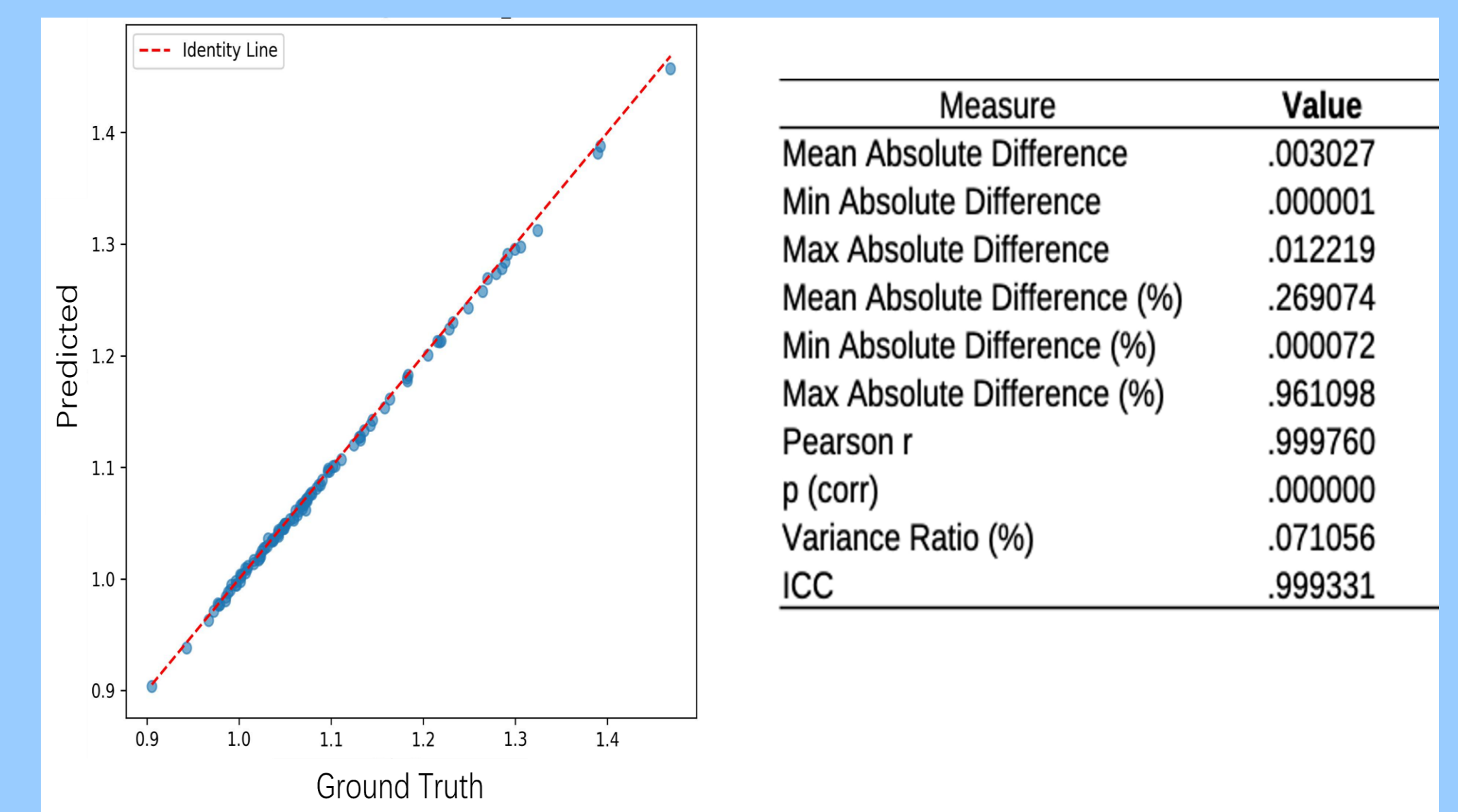
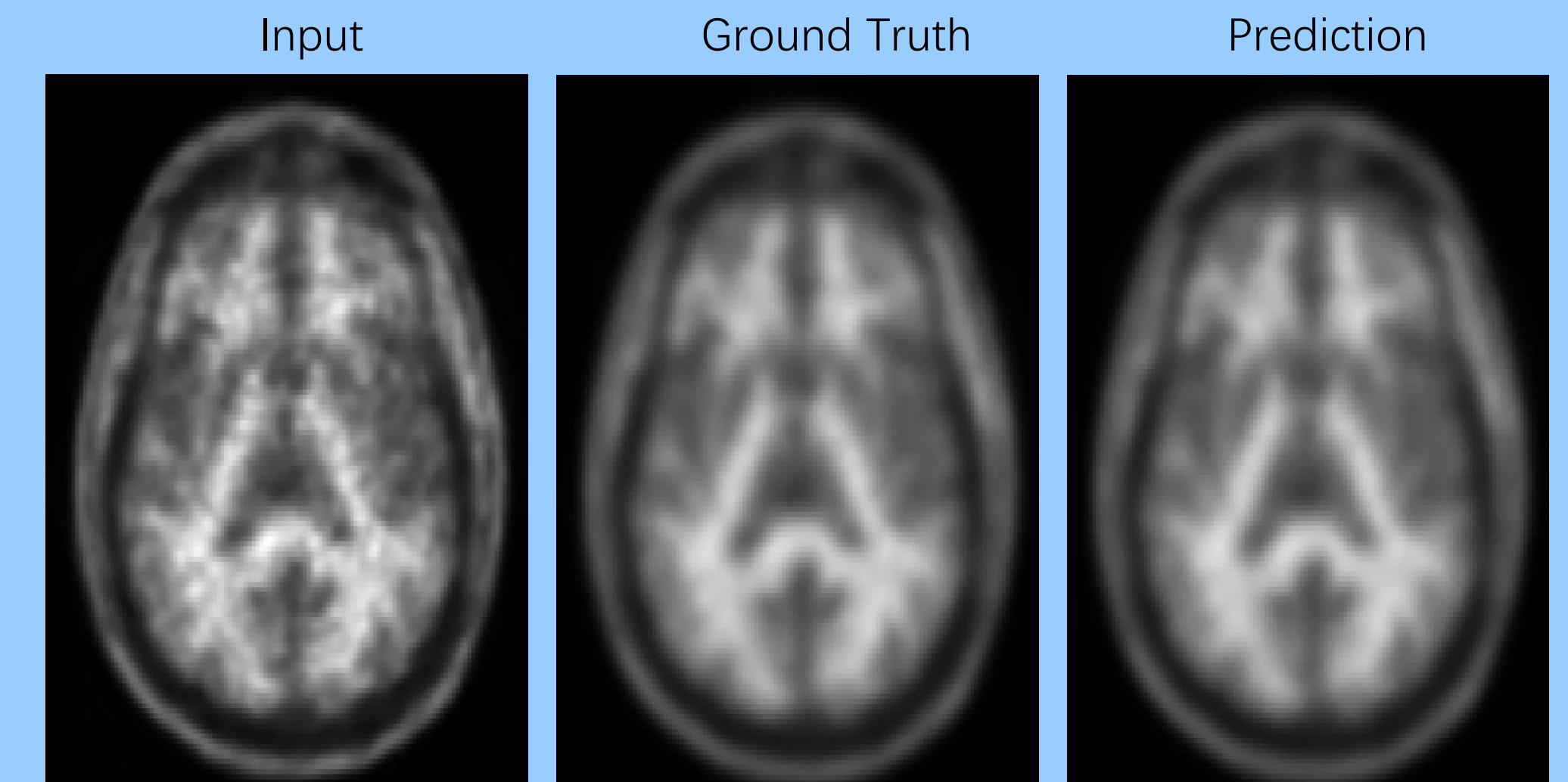


- Amyloid- β positivity classification based on predicted MCSUVR showed high agreement with ground truth MCSUVR-based positivity.



Results

- Independent testing on APOE data:
 - Demonstrated qualitative and quantitative performance consistent with the ADNI data.



Conclusion

- A scanner-agnostic fully convolutional 3D CNN enables robust PET resolution harmonization to standardized 8mm FWHM while preserving MCSUVR, amyloid- β positivity classification, and supporting scanner-independent and cross-study comparable PET analysis.

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