# COMPARISON OF DEEP LEARNING AND SHAPE MODELING FOR AUTOMATIC CT-BASED LIVER SEGMENTATION

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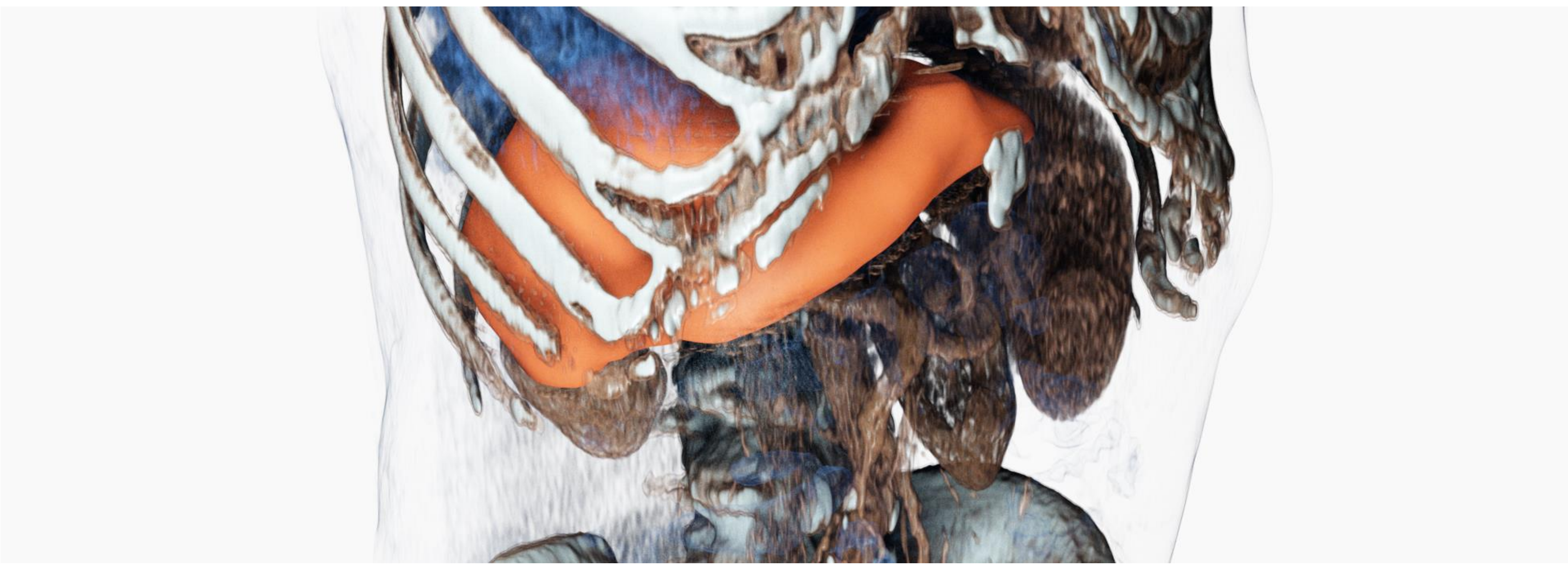

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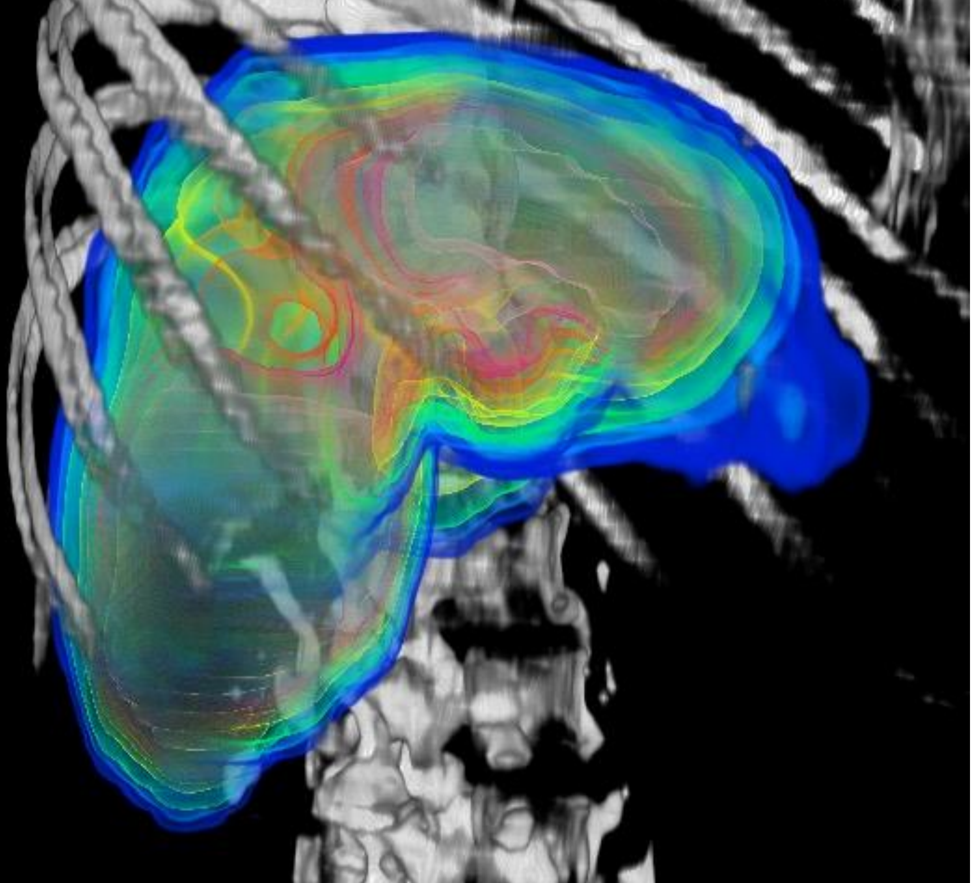
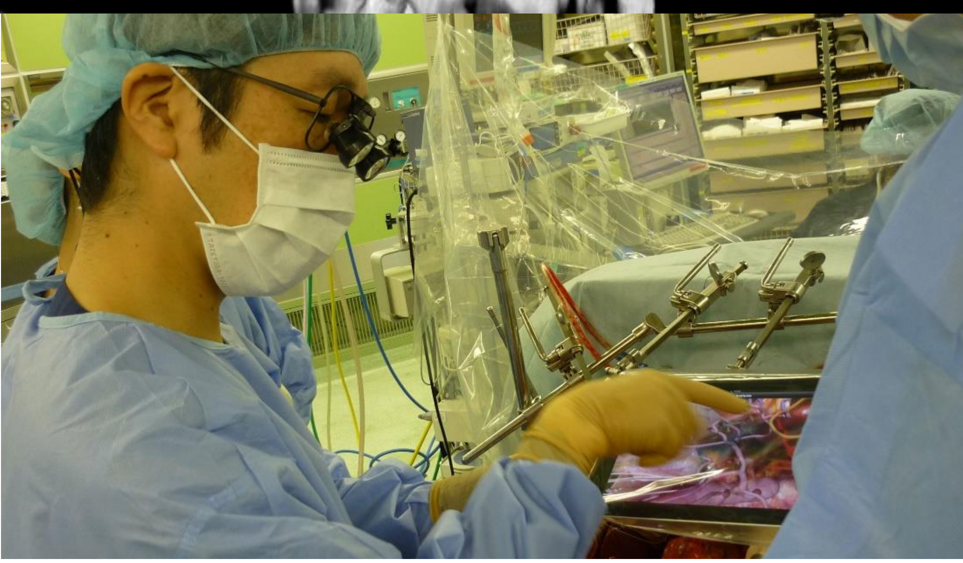
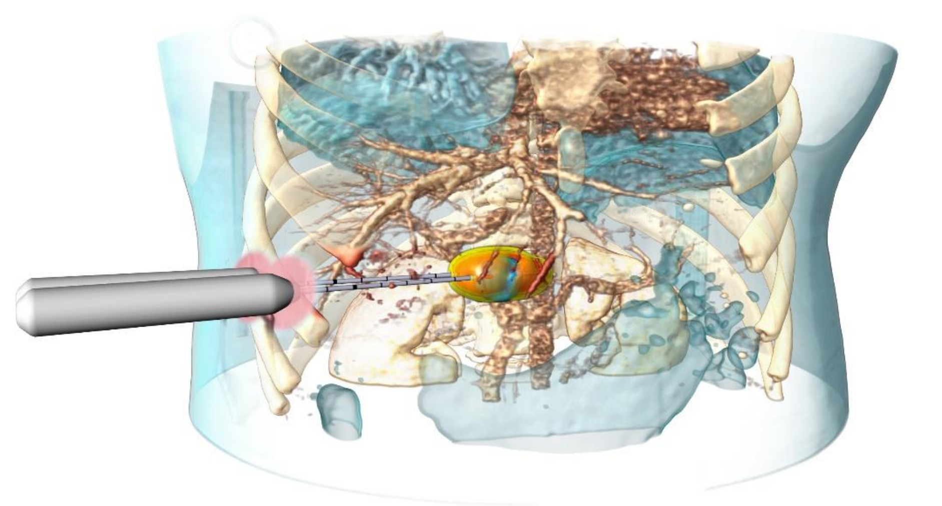
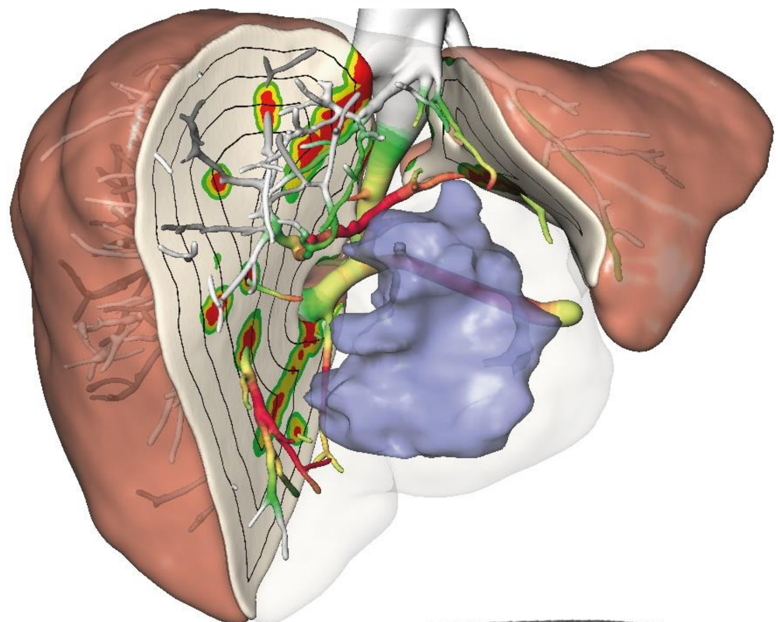
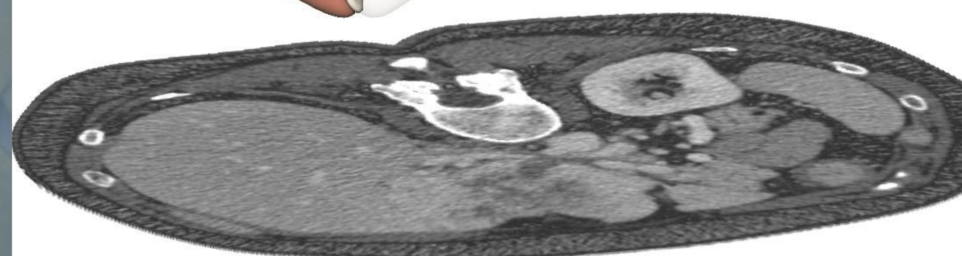
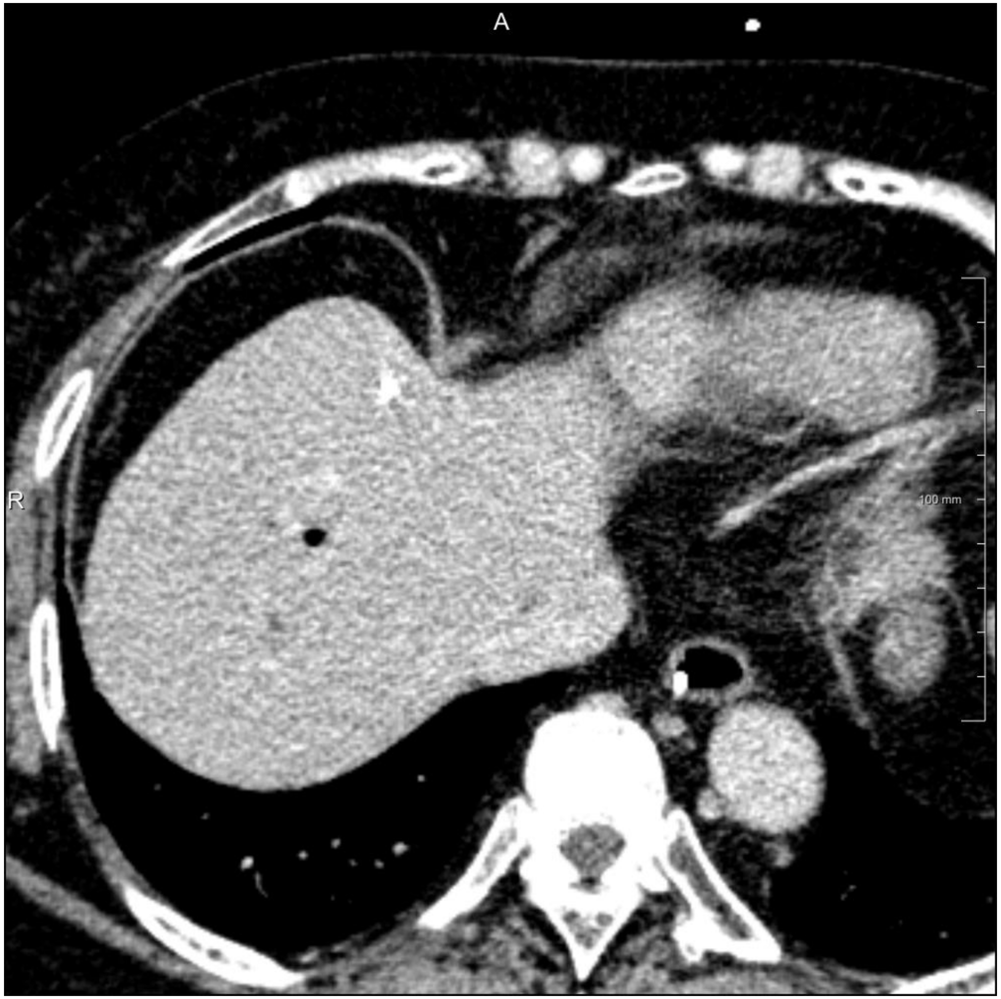






# The Challenge

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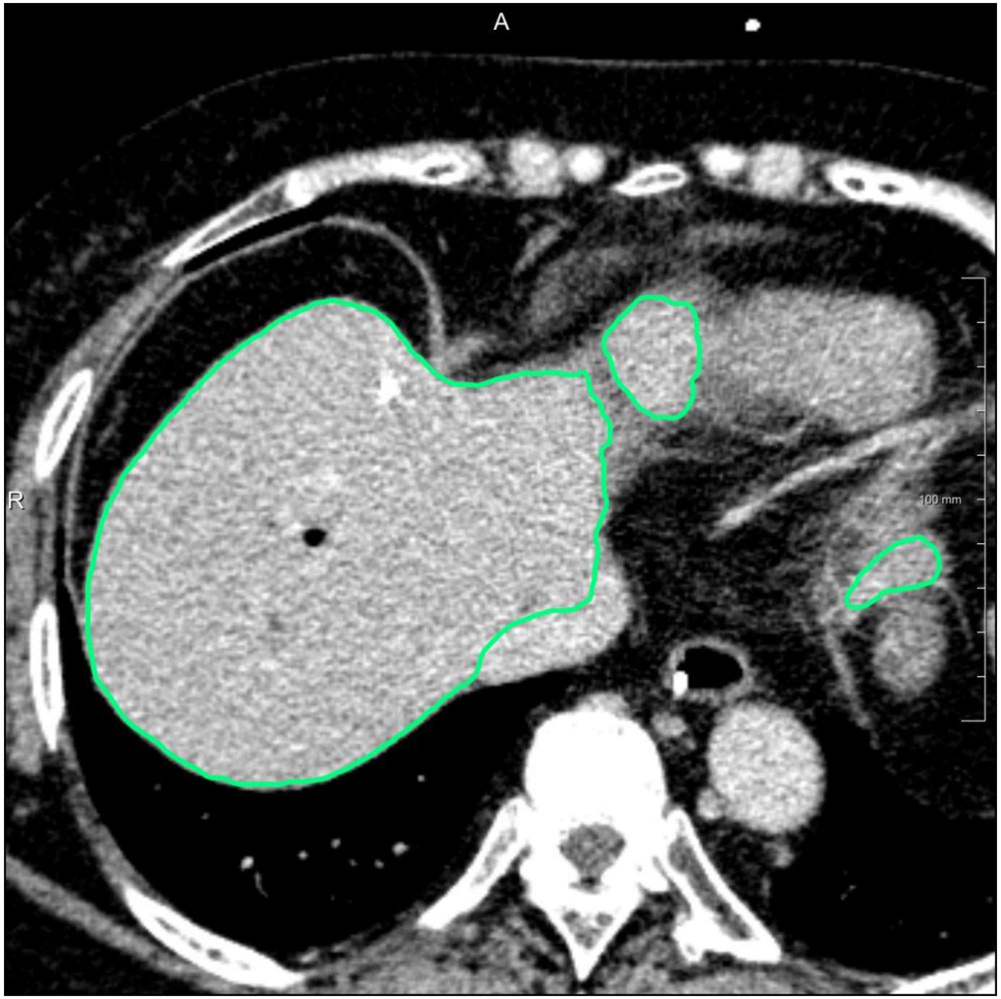

# The Challenge


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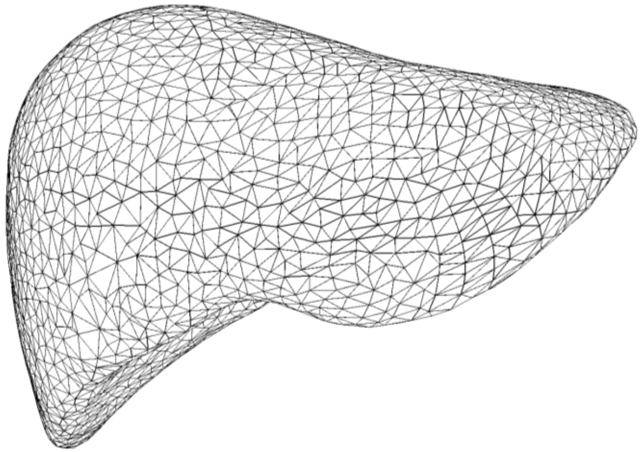
# Statistical Shape Model (SSM)

- SSM captures:
  - Mean shape
  - Shape variation modes



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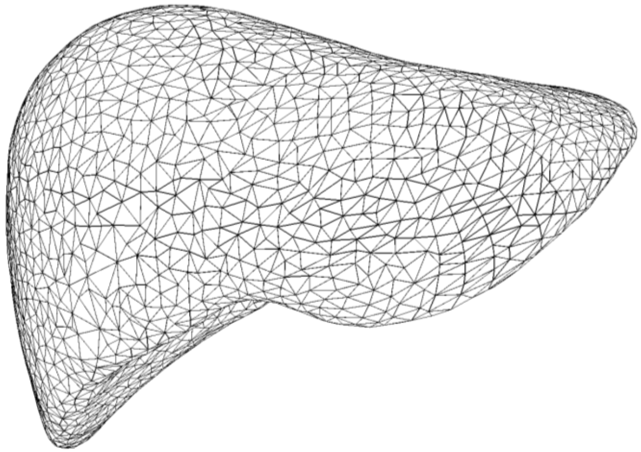

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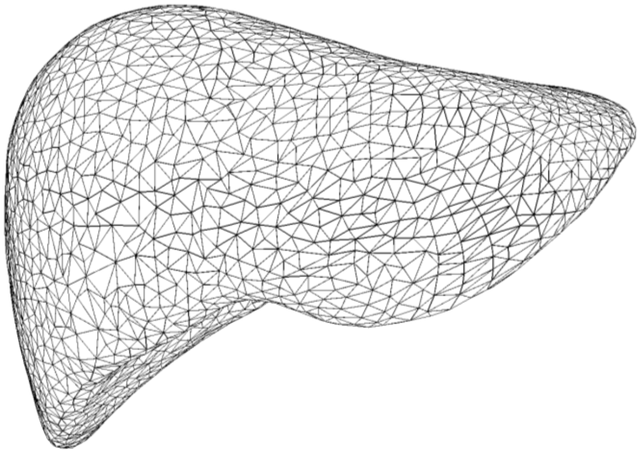

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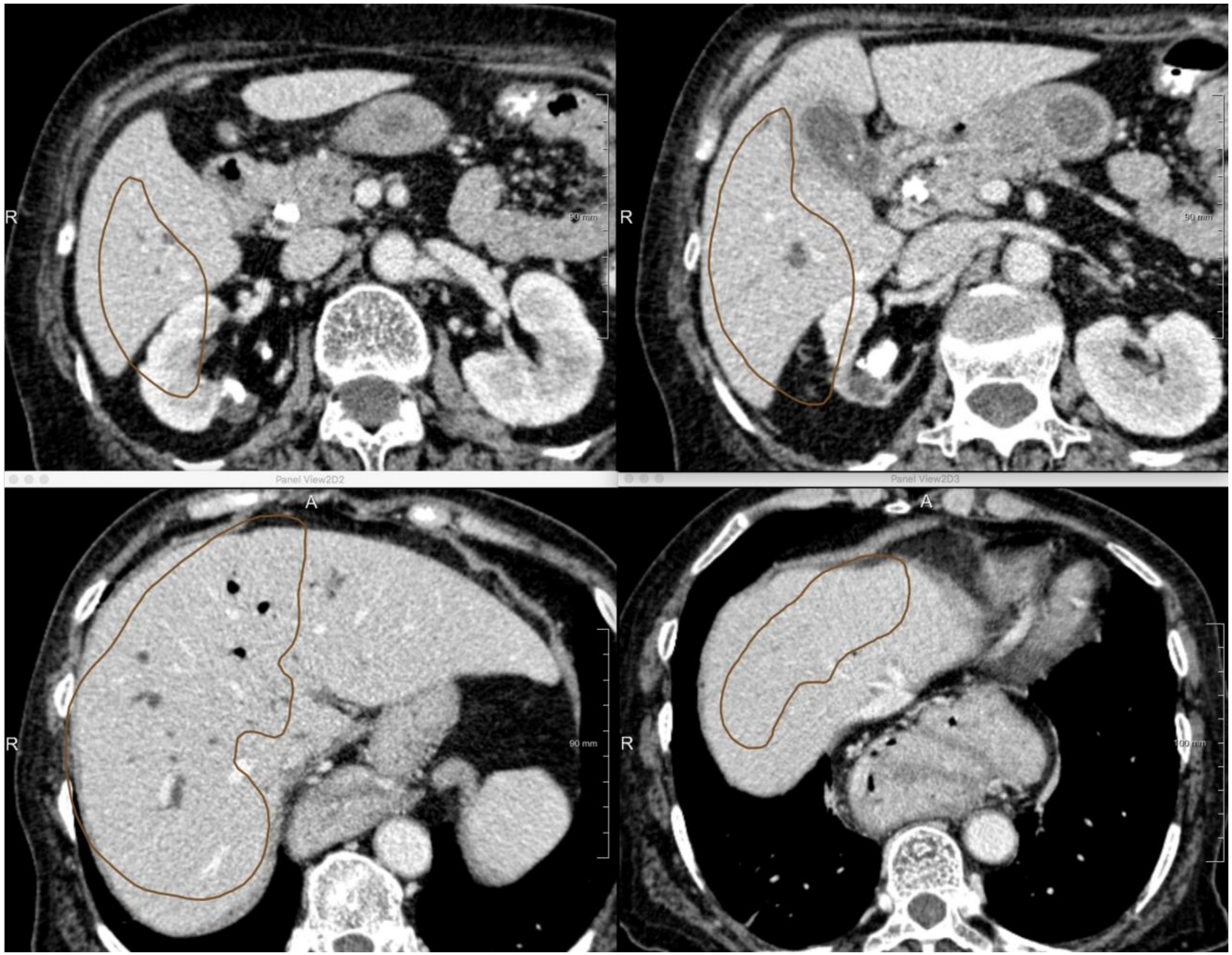
- SLIVER07 [1] - liver segmentation challenge
  - Best automatic methods employ SSM [2]

[1] SLIVER07 - Segmentation of the Liver 2007 Challenge, www.sliver07.org

[2] T. Heimann et al., Comparison and Evaluation of Methods for Liver Segmentation From CT Datasets, 2009.

# Statistical Shape Model

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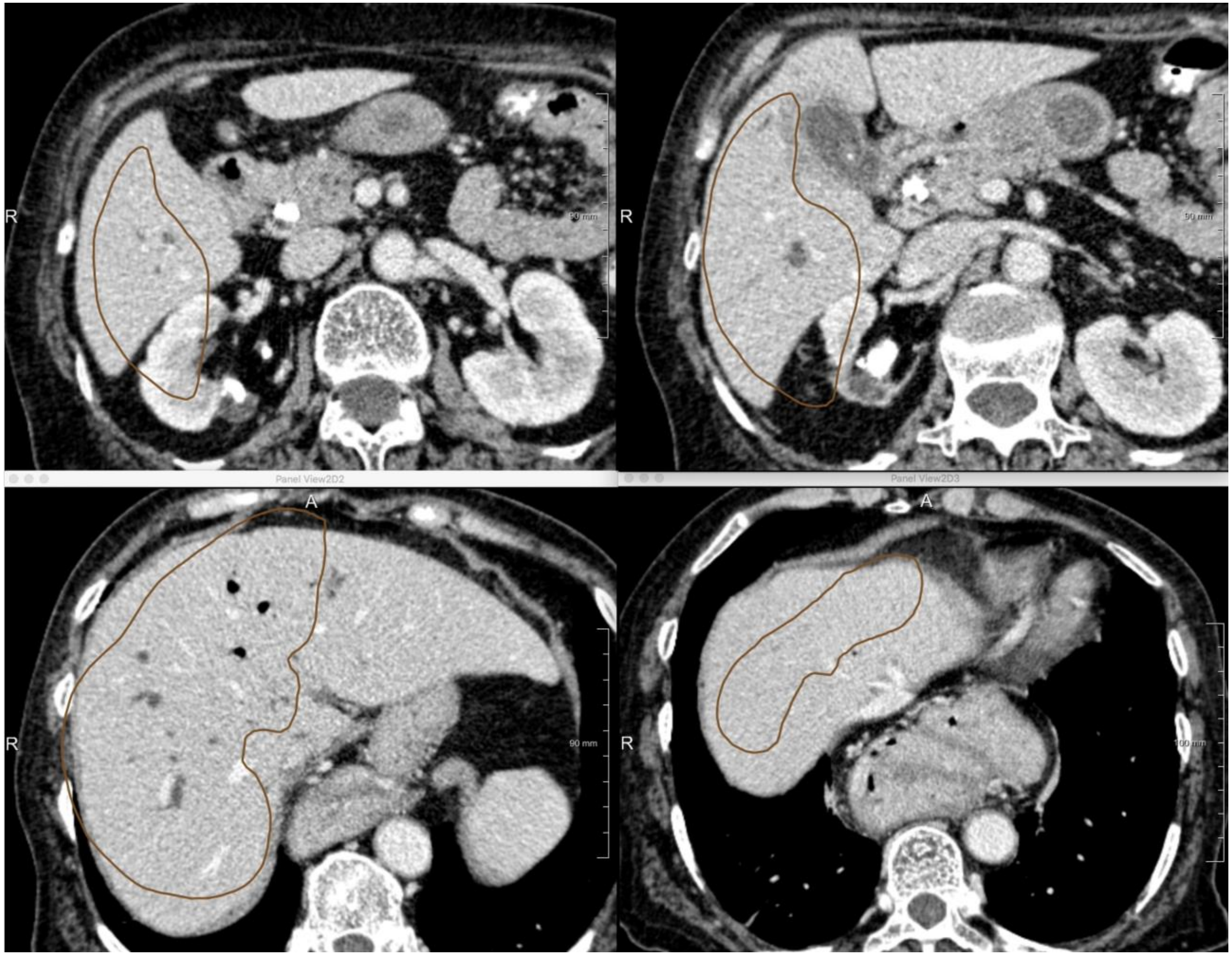

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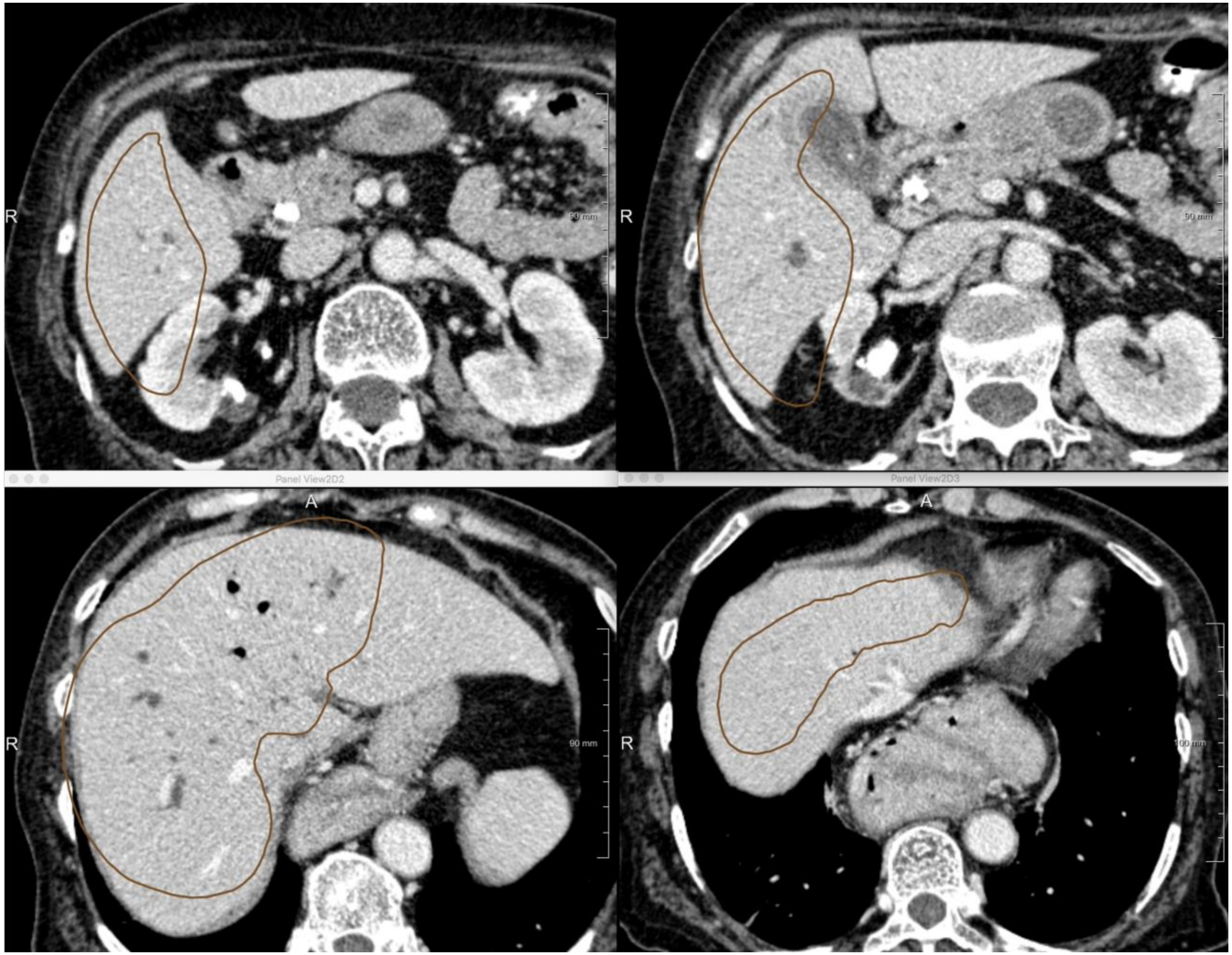


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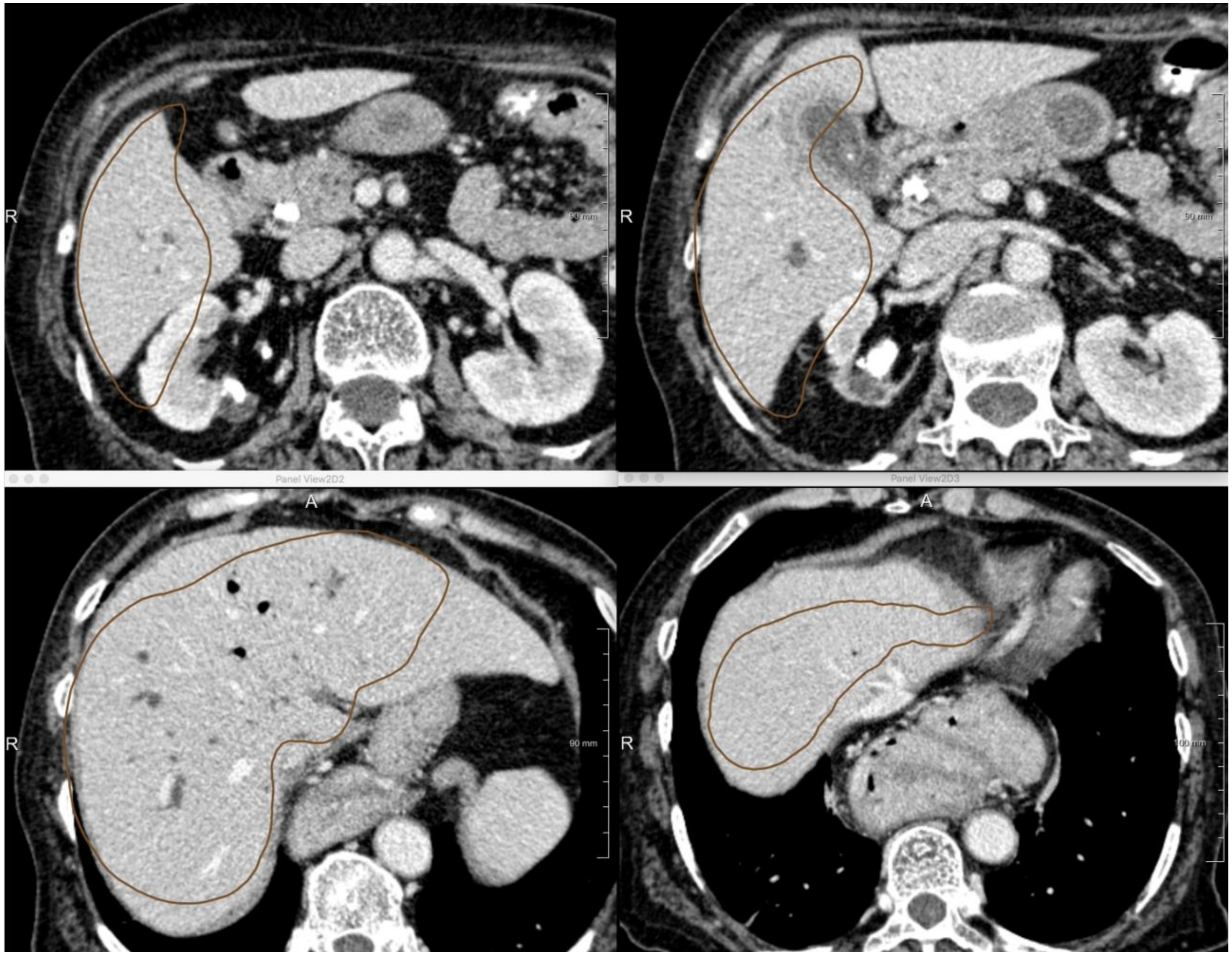


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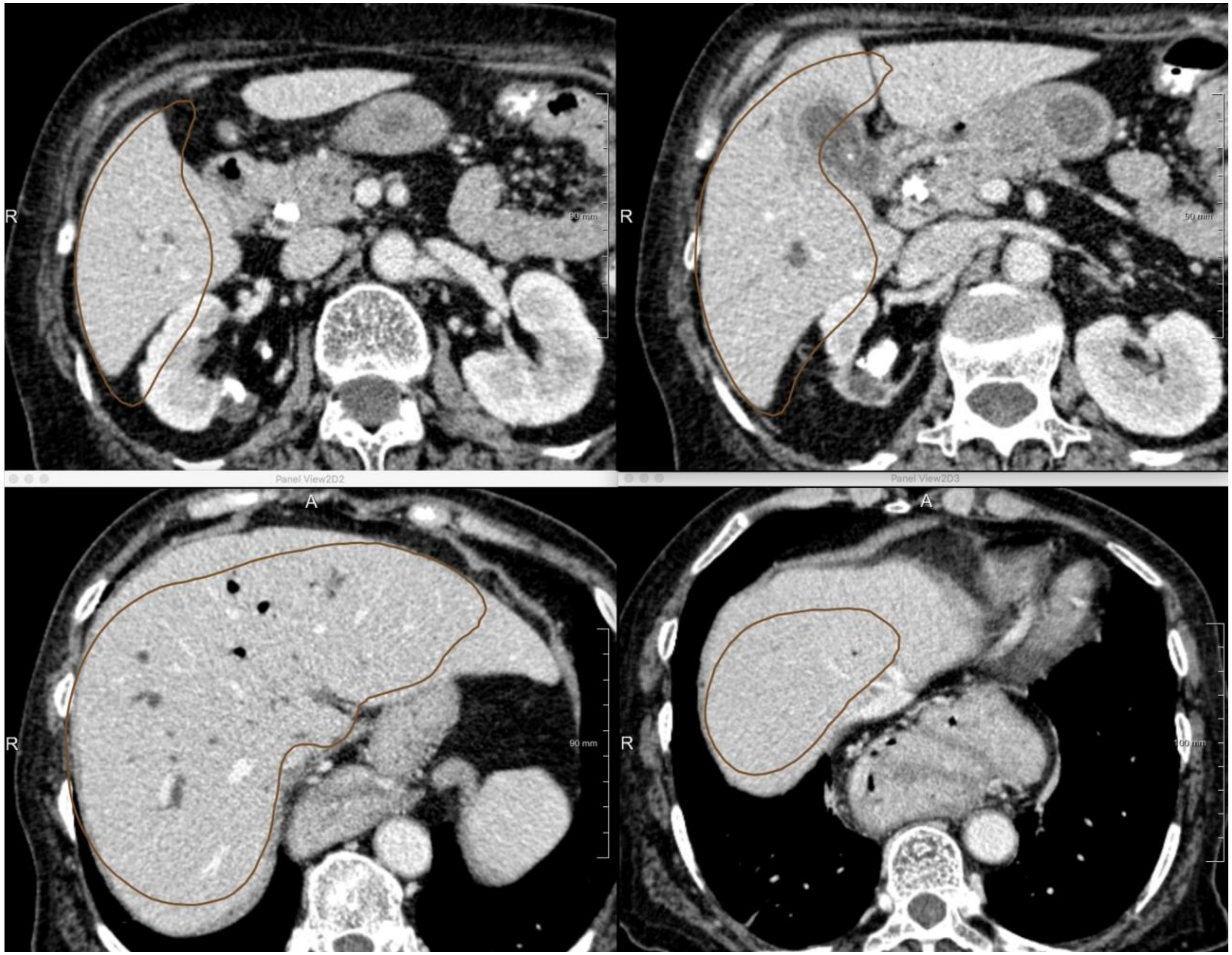






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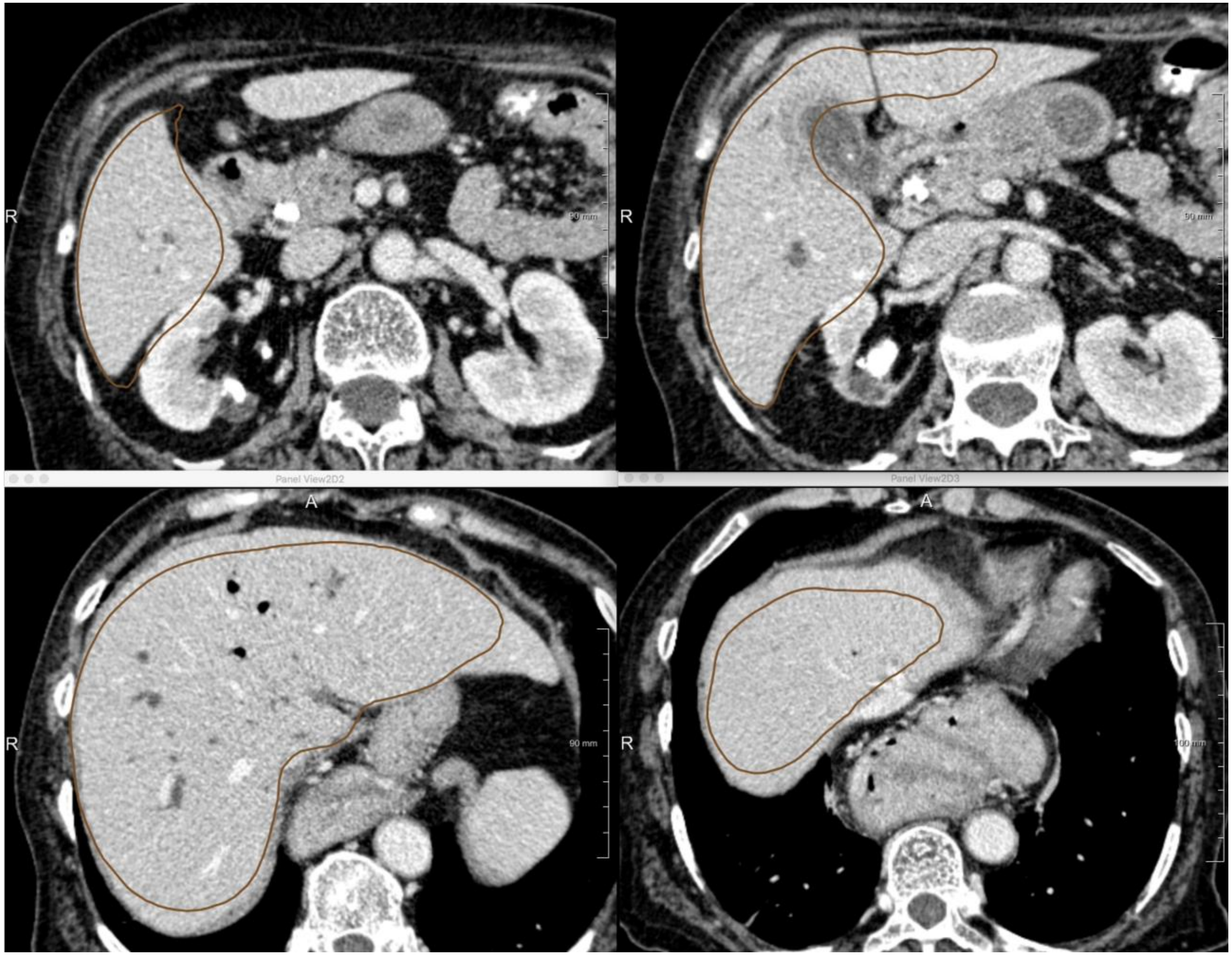

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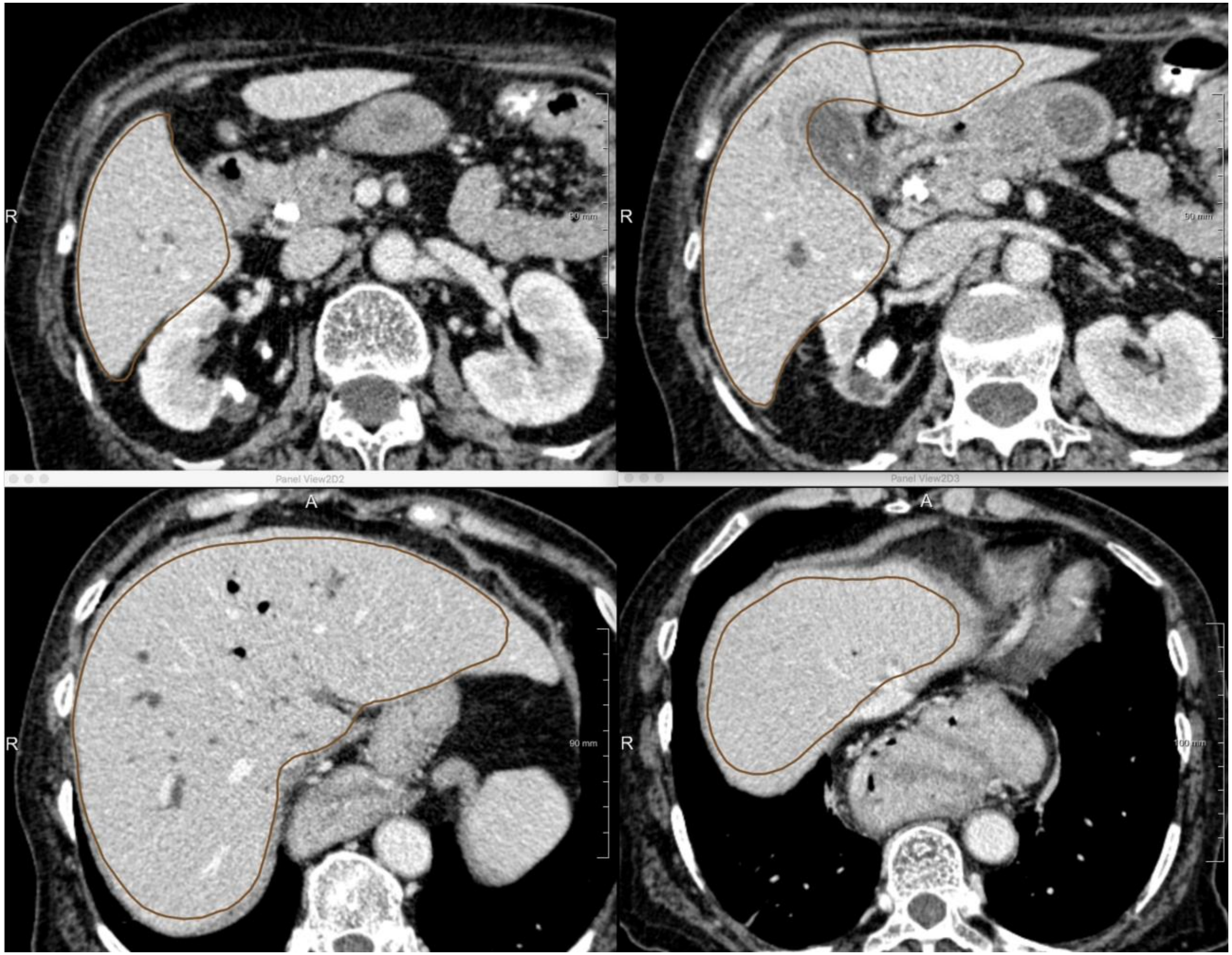


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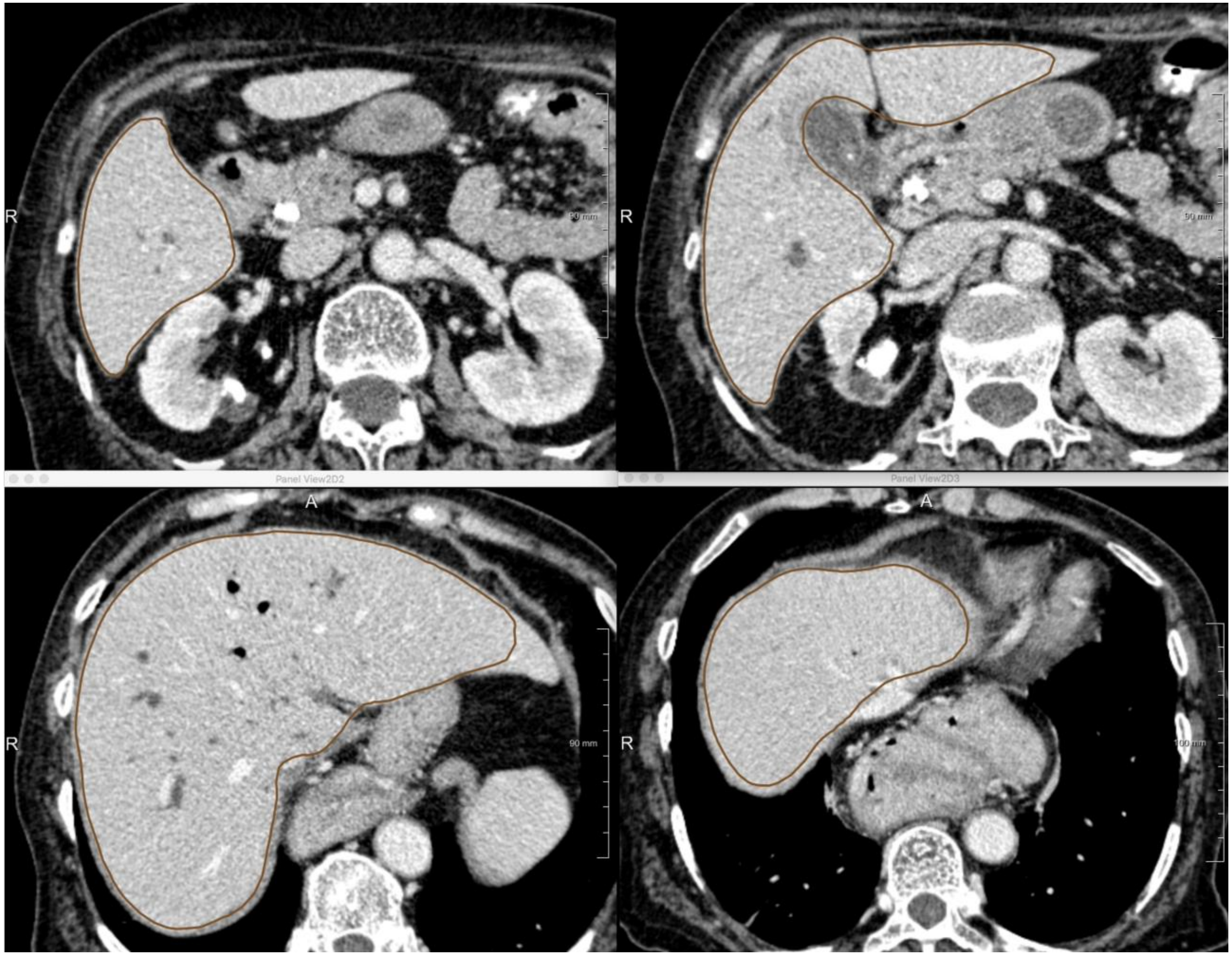

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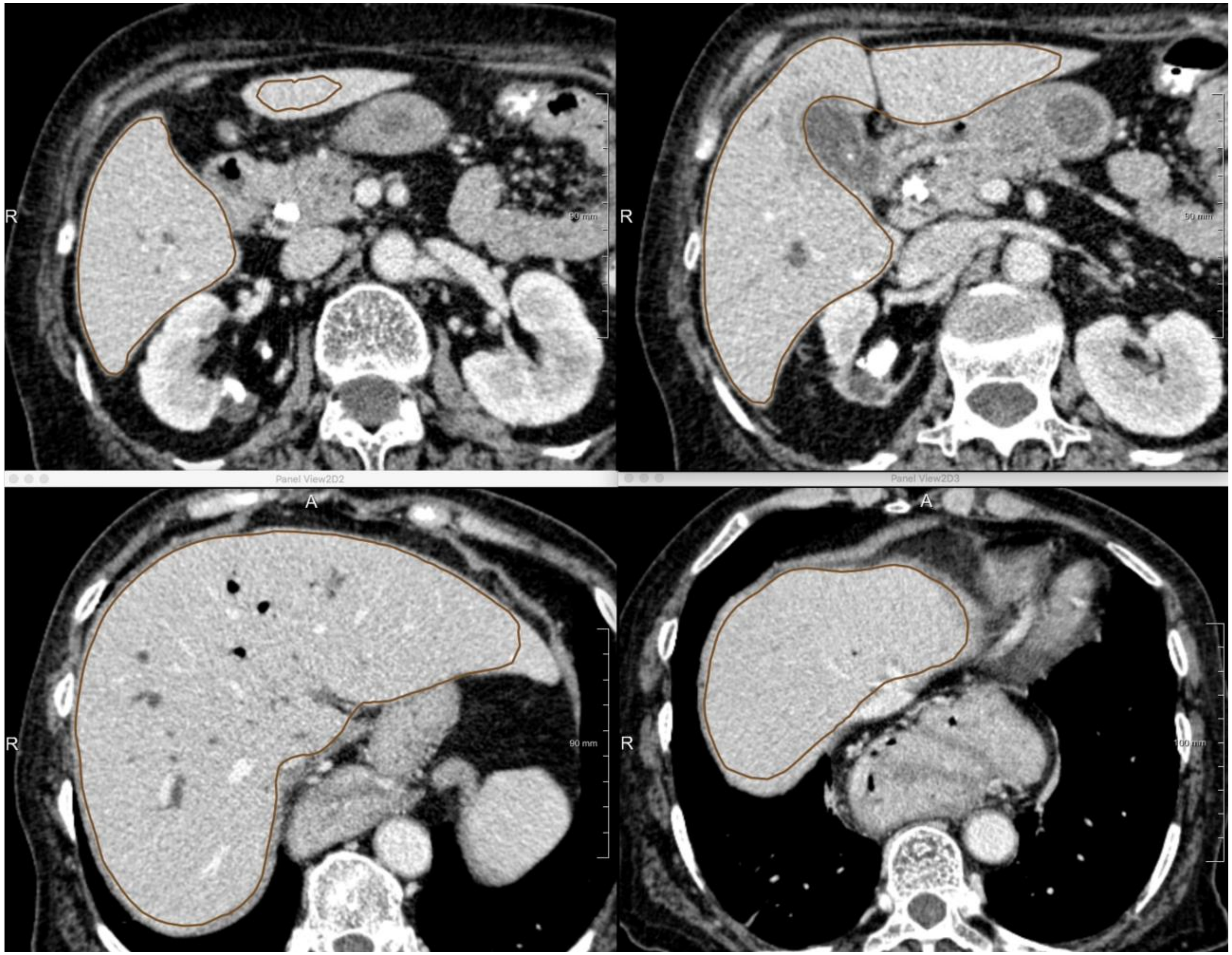
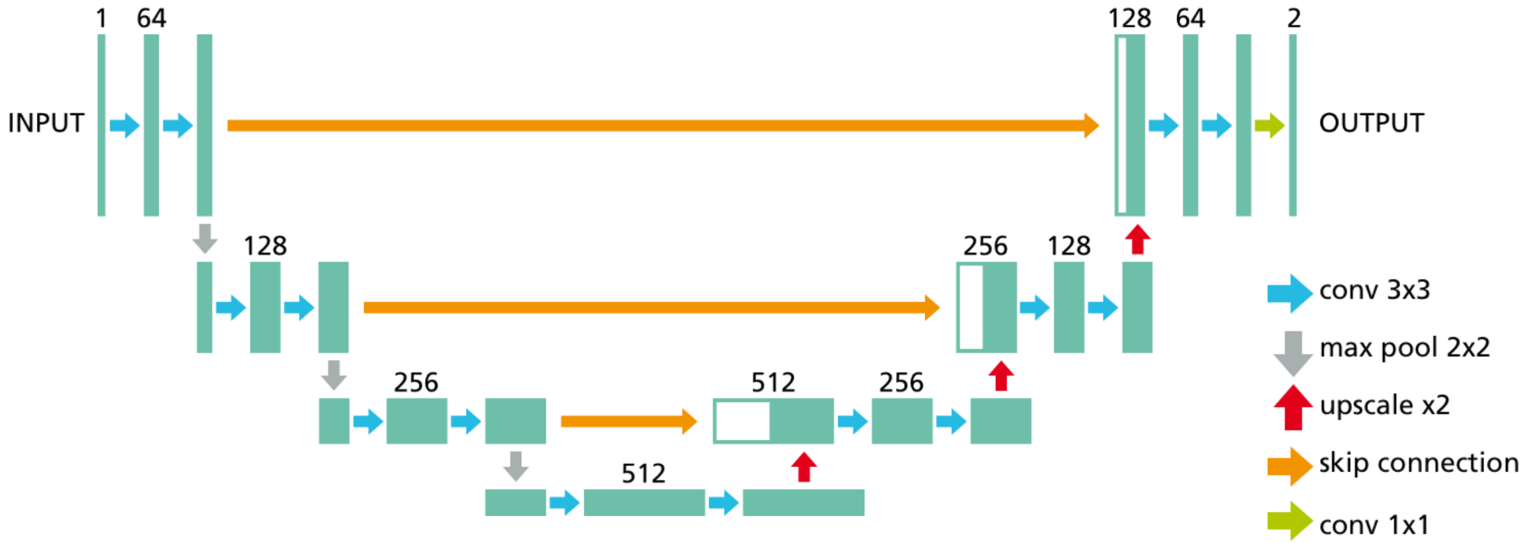


# Fully Convolutional Neural Network (FCNN)

- FCNN based on the U-Net [1] architecture
  - 4 resolution levels
  - Input images resampled to 2 mm




[1] O. Ronneberger et al., U-Net: Convolutional Networks for Biomedical Image Segmentation, 2015.

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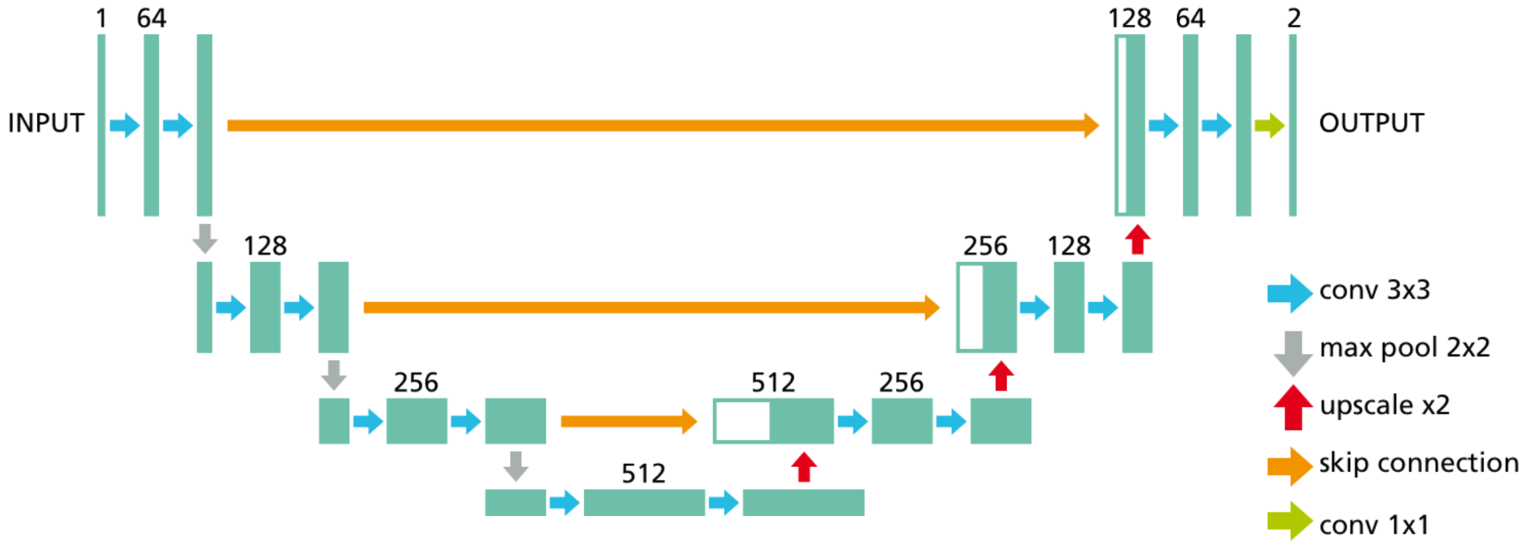


- LiTS: Liver Tumor Segmentation Challenge 2017 [2]


[1] O. Ronneberger et al., U-Net: Convolutional Networks for Biomedical Image Segmentation, 2015.

[2] Liver Tumor Segmentation Challenge: www.lits-challenge.com

# Dataset

- 219 CTs from liver surgery planning
- ~0.6 mm in plane-resolution
- ~0.8 mm slice thickness
- Livers segmented by radiological experts with a semi-automatic tool [1]

- Case partitioning
  - 147 training
  - 32 validation
  - 40 evaluation

[1] A. Schenk et al., Efficient Semiautomatic Segmentation of 3D objects in Medical Images, 2000.

# Evaluation

- Metrics
  - Relative volume error
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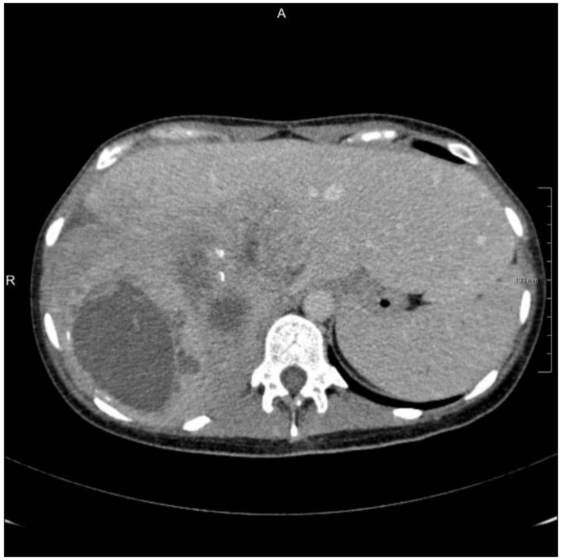
- 3 cases left out due to SSM failure



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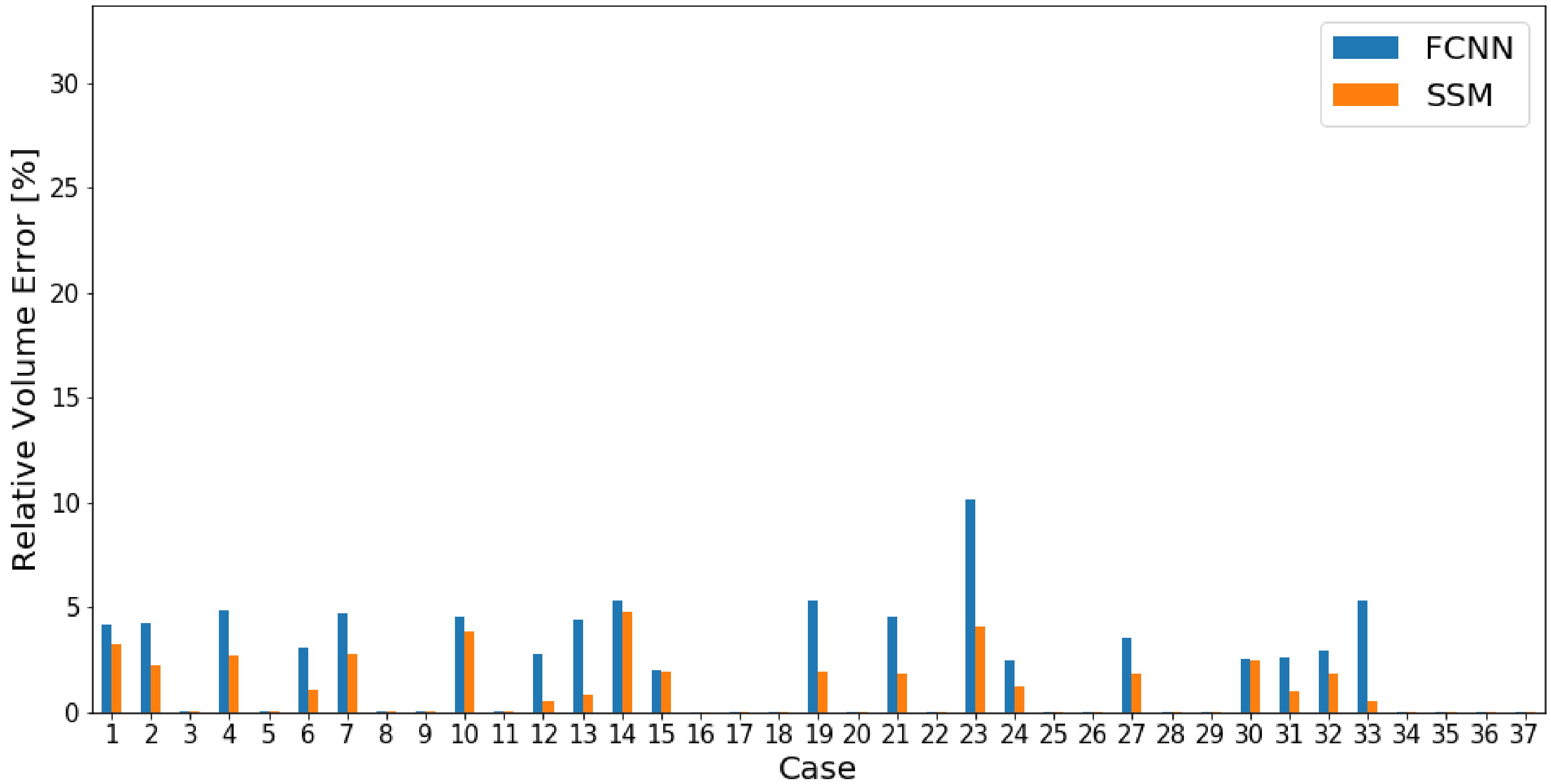

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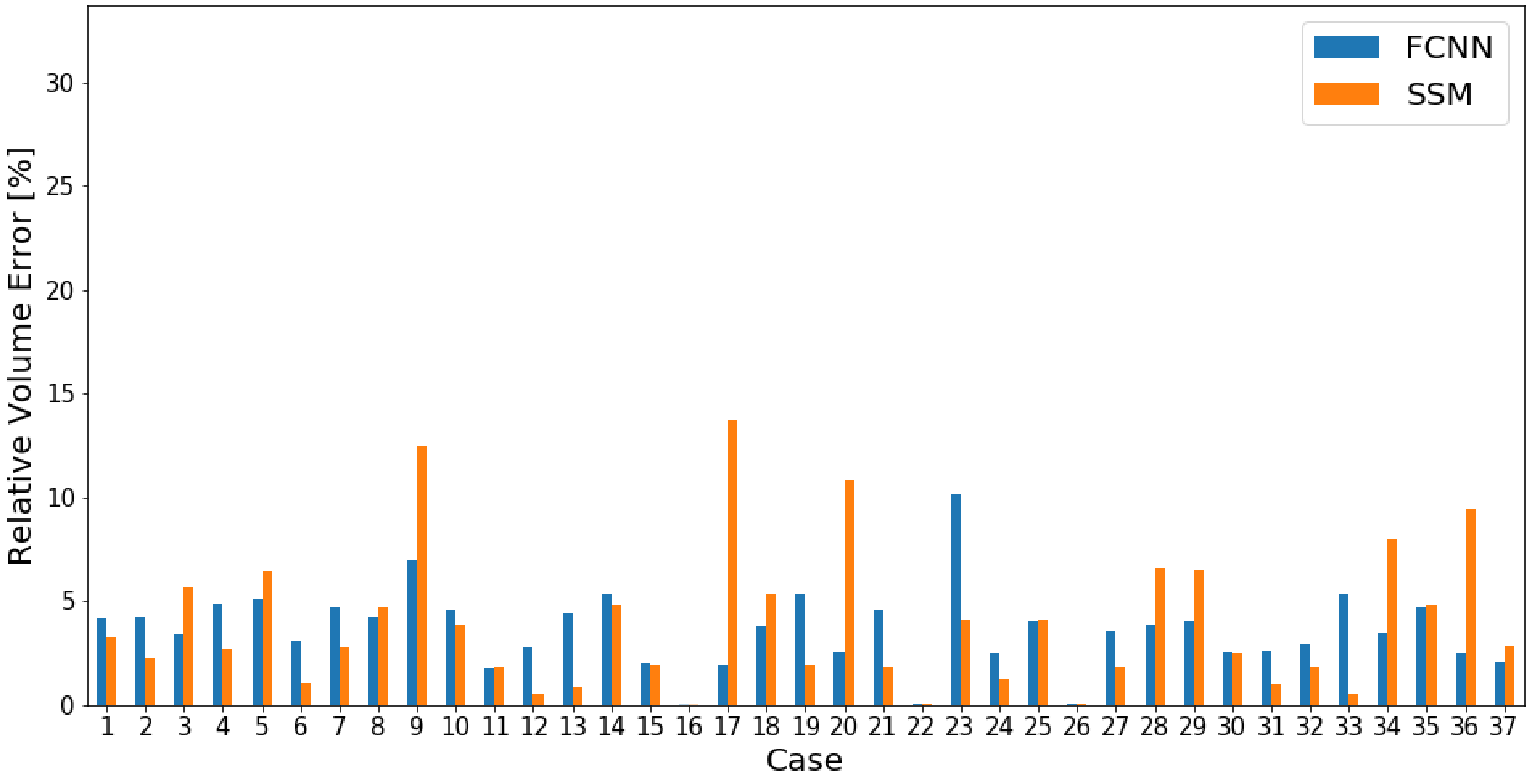

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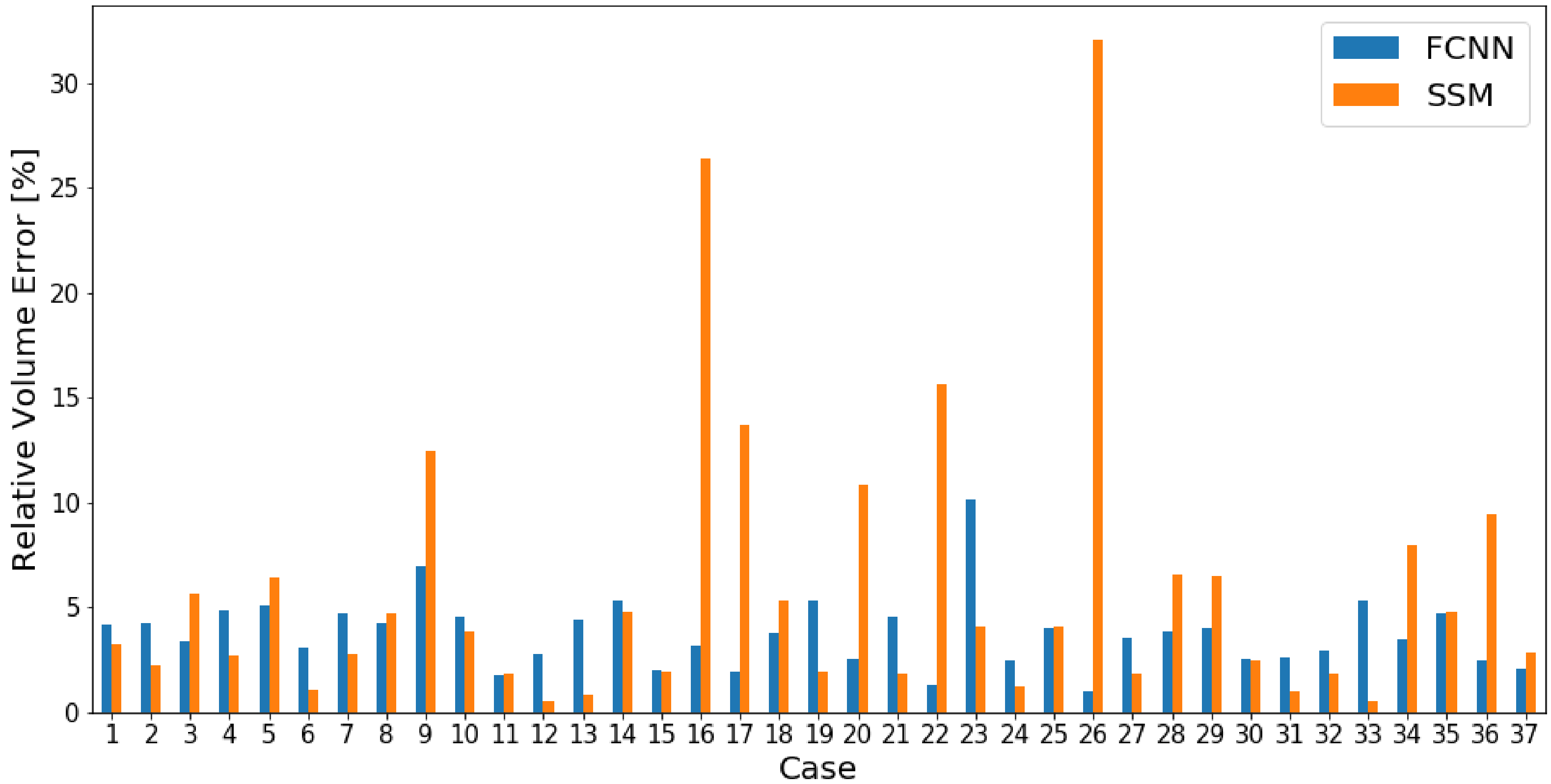

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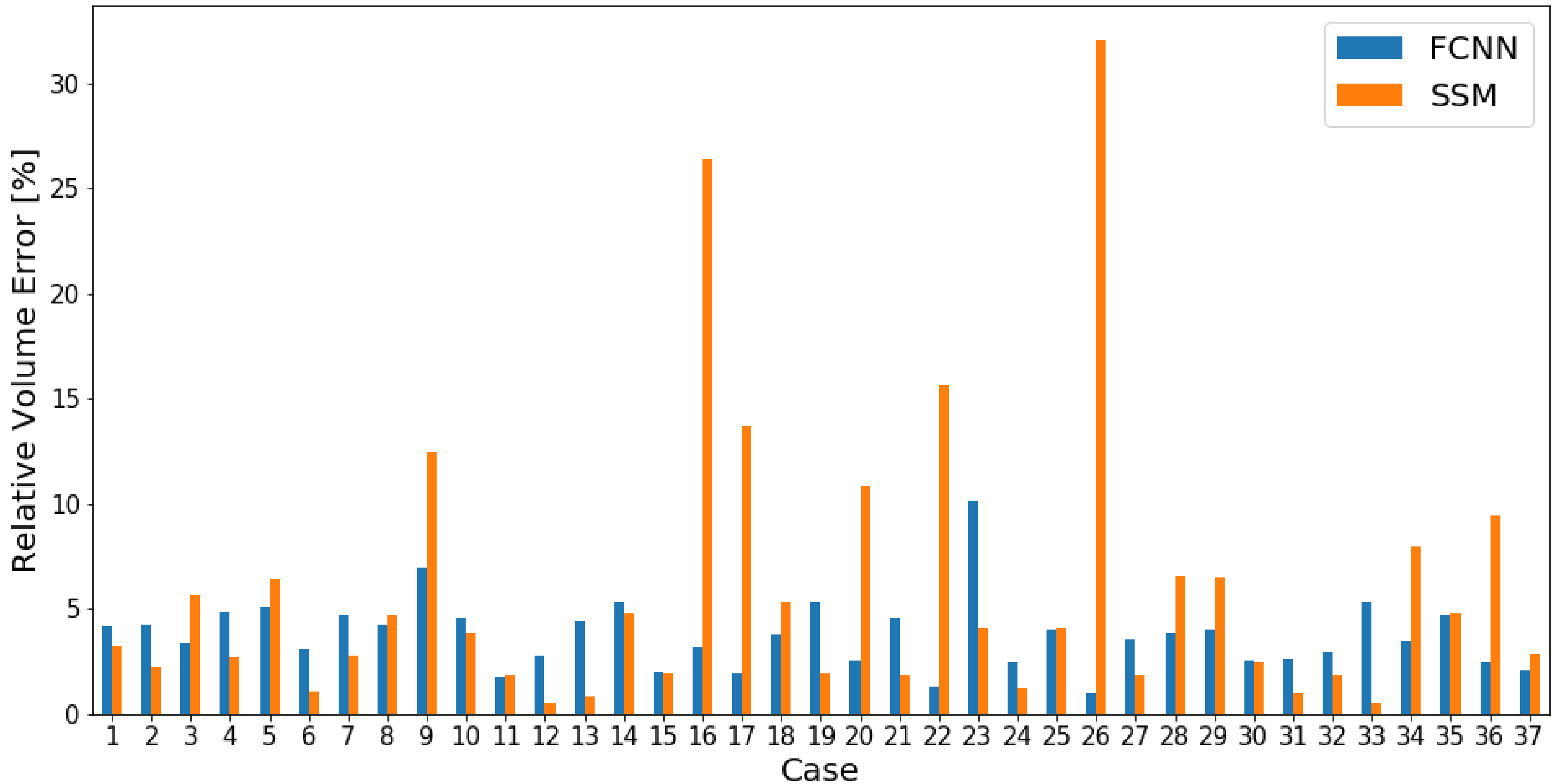


Rel. volume error: FCNN ~4%, SSM ~6%


A
R
100 mm
REFERENCE
SSM
FCNN


A
R
100 mm
REFERENCE
SSM
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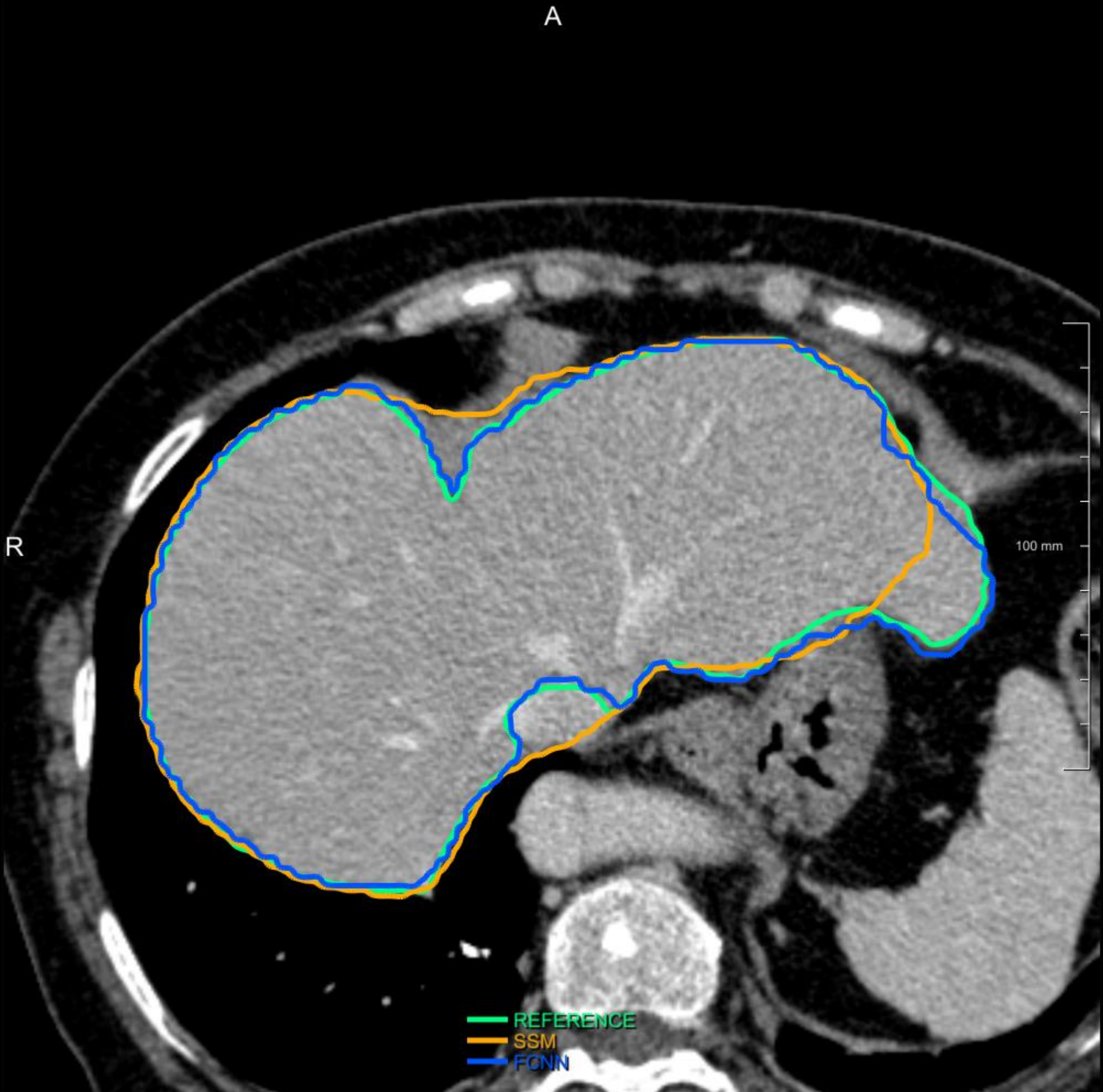
A
R
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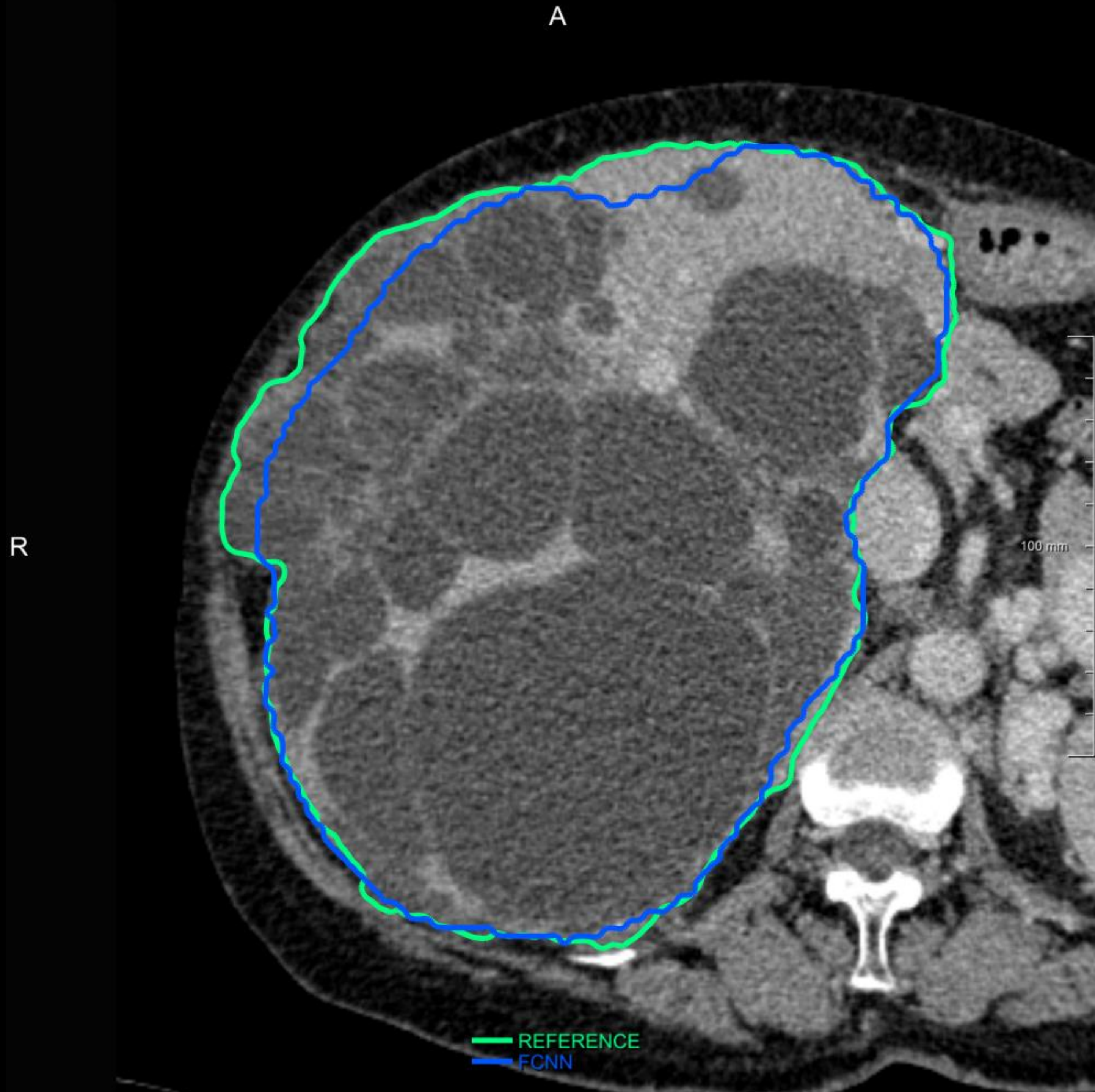
A
R
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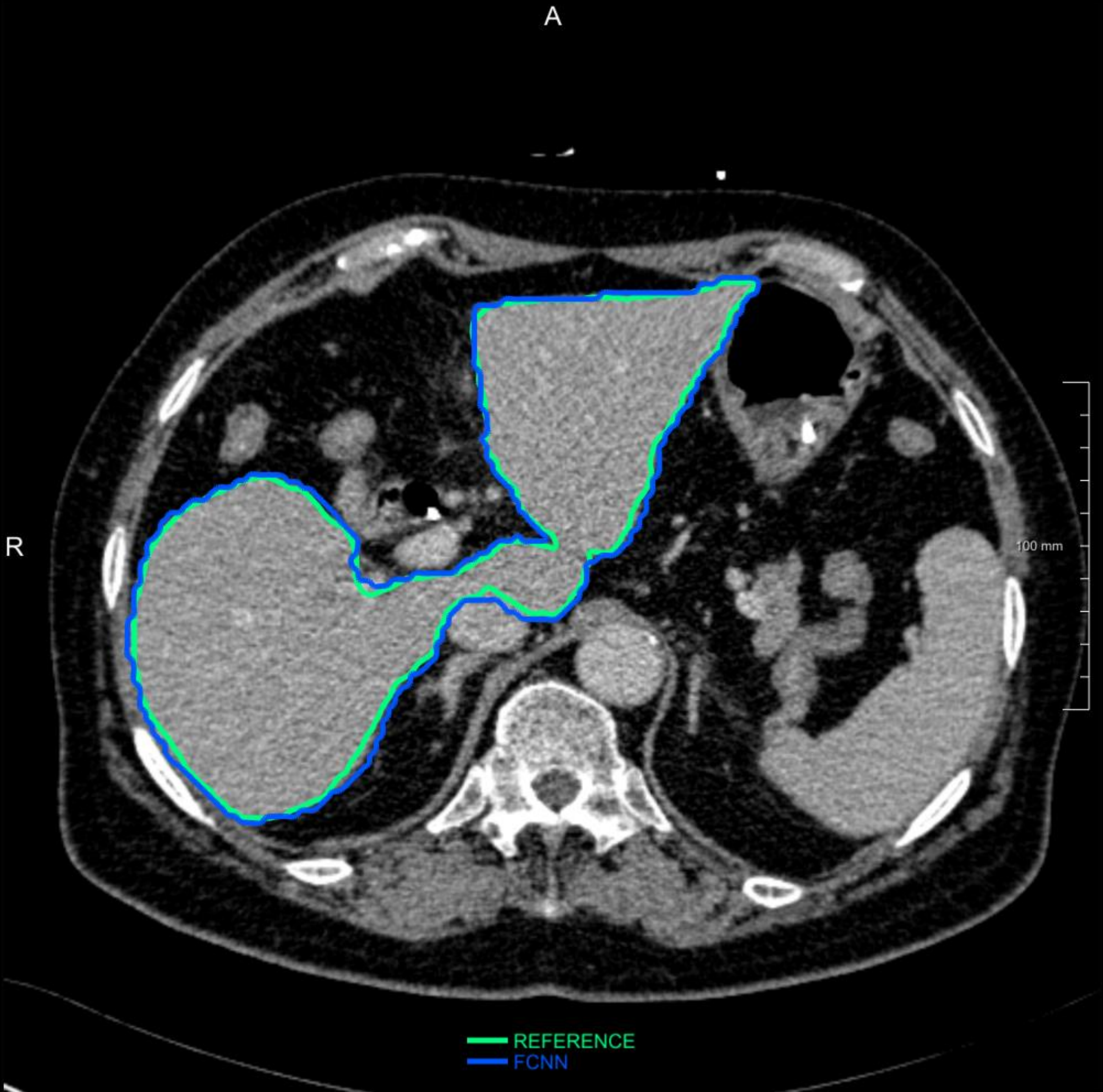
A
R
100 mm
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**Thank you for your attention ☺**

**Questions?**