

# Deep Learning Improves Speed and Accuracy of Prostate Gland Segmentations on MRI for Targeted Biopsy

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## INTRODUCTION

- Targeted biopsy improves prostate cancer diagnosis. Accurate prostate segmentation on MRI is critical for accurate biopsy.
- Manual gland segmentation is tedious and time-consuming.

## OBJECTIVE

- To develop a deep learning model (**ProGNet**) to rapidly and accurately segment the prostate on MRI and to evaluate this approach for MR-US fusion biopsy.

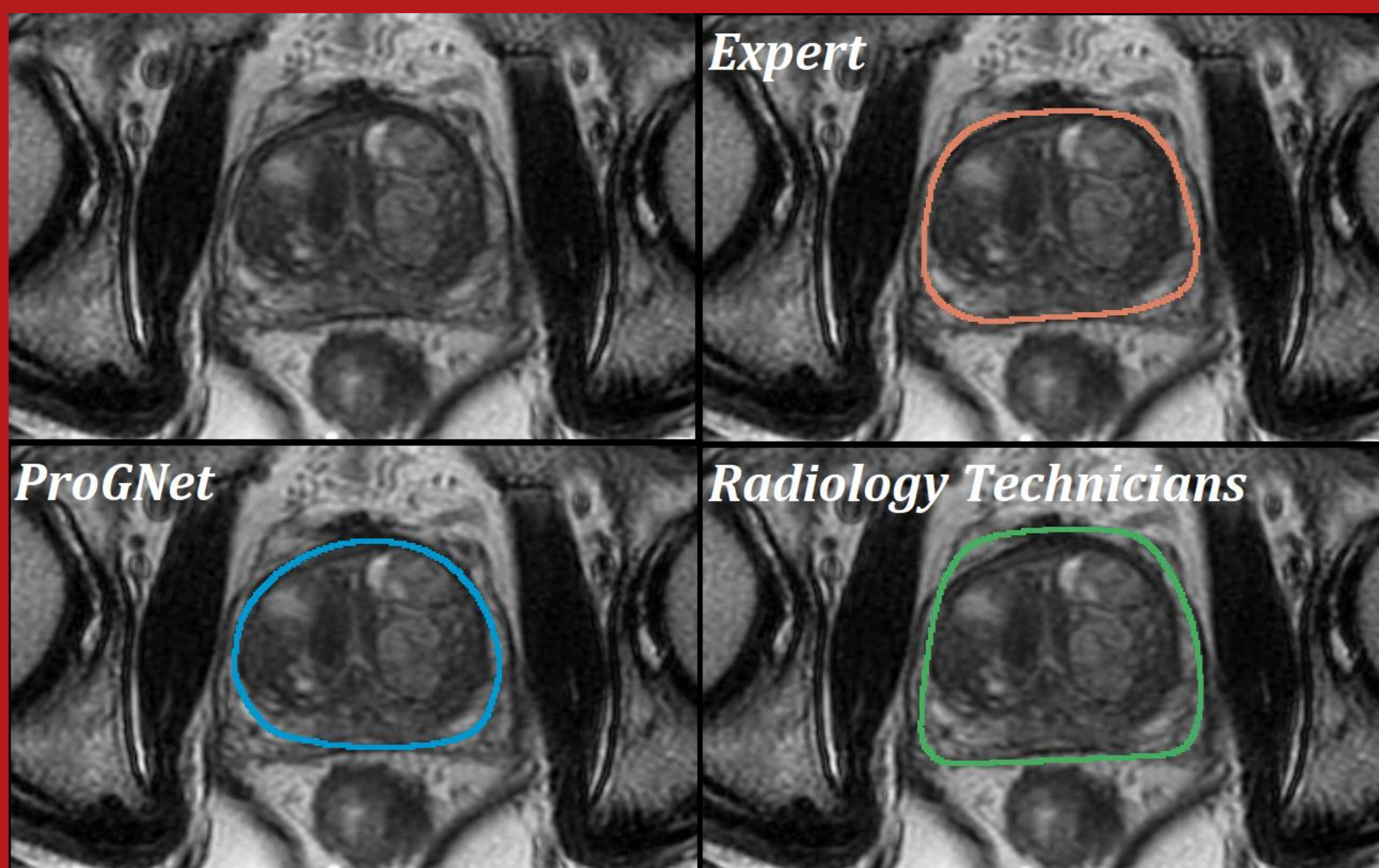
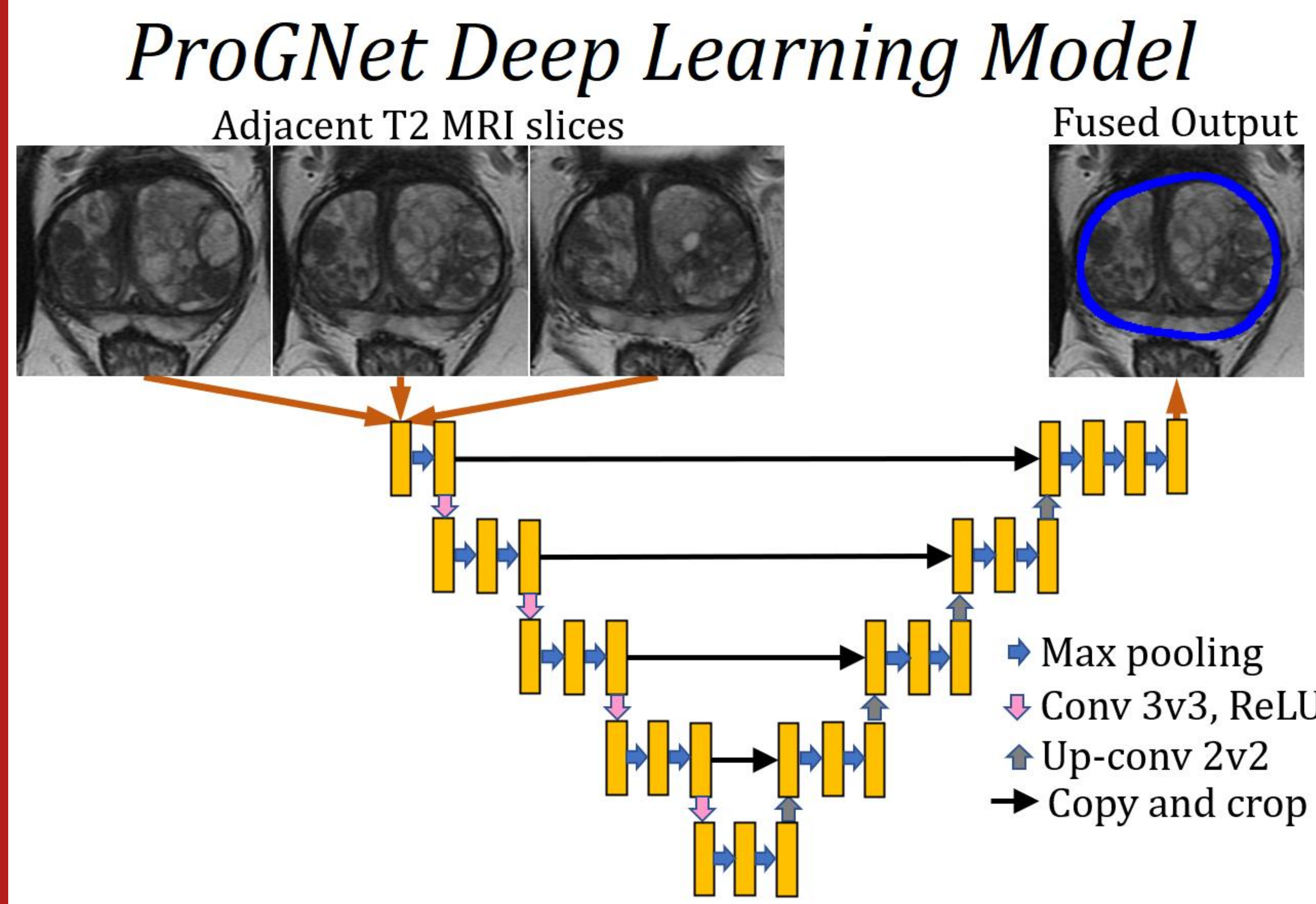
## METHODS

- 916 subjects underwent MRI at 29 academic and private practice institutions followed by MR-US fusion biopsy at Stanford University.
- A urologic oncology expert with 7 yrs of experience segmented all MRIs.
- We trained a deep learning model, ProGNet, on 805 of the cases and tested it on an internal retrospective test set (n = 100) & on two external test sets (n = 26 & n = 30).
- We explored whether our model would improve performance over radiology technicians by comparing segmentation overlap with the urologic oncology expert using the Dice similarity coefficient (DSC).
- We compared ProGNet performance to two deep learning networks, the U-Net and the HED models.
- We worked with the biopsy vendor (Eigen, Grass Valley, CA) to enable model outputs to be usable on the clinical biopsy system and then utilized the model on a **prospective 11 patient cohort** of men undergoing biopsy.

**Speed of segmentation:**  
*ProGNet 1200 times faster than trained radiology technicians*

**Accuracy:**  
*ProGNet more accurate than two deep learning networks & radiology technicians*

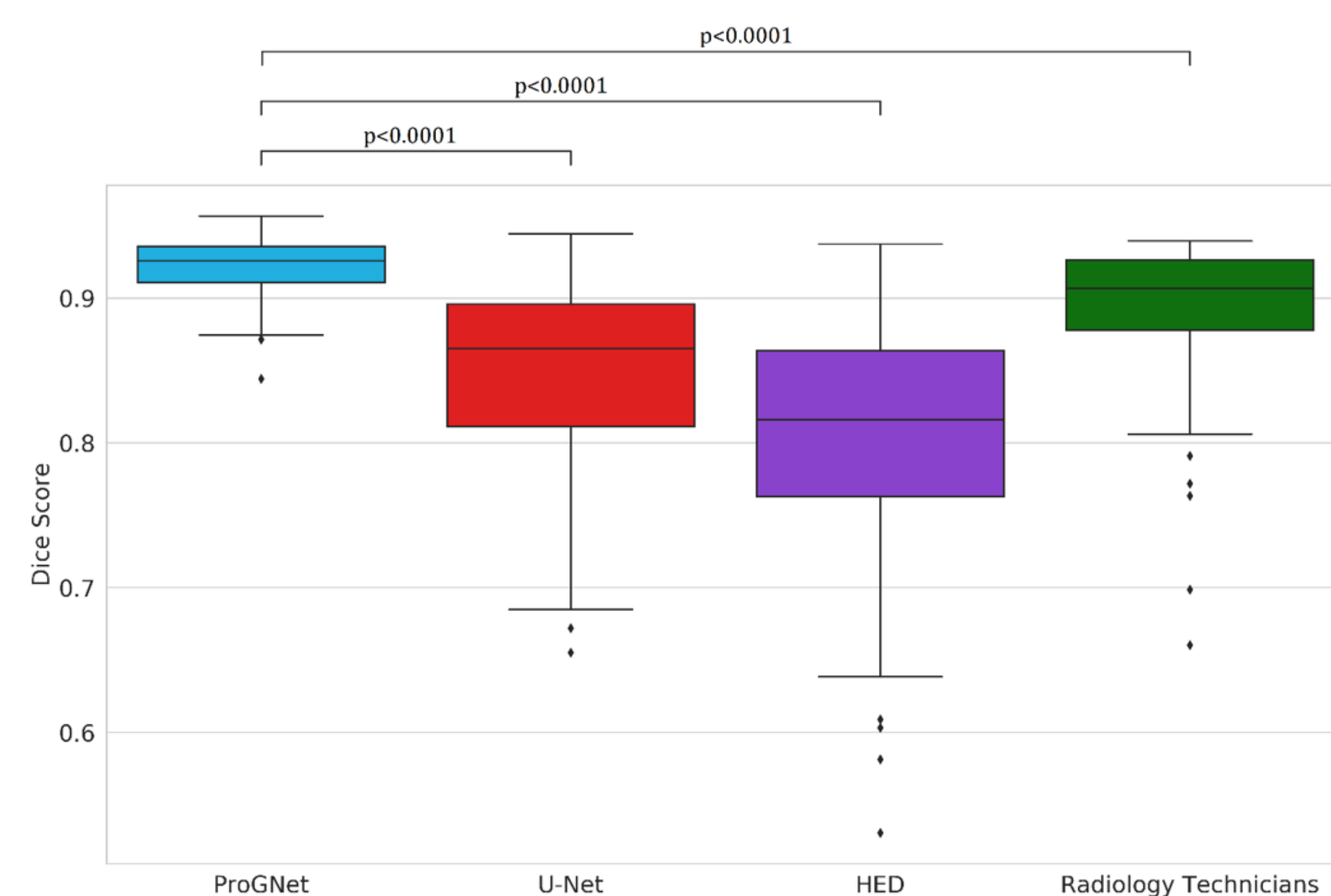
**Implementation:**  
*1<sup>st</sup> to validate a prostate segmentation deep learning model in a prospective study*



## RESULTS

Performance:

- ProGNet (DSC=0.92) outperformed U-Net and HED (DSC=0.85, p<0.0001 and 0.80, p<0.0001) in the retrospective test set.
- ProGNet performance was closer to expert segmentation compared to radiology technicians in both the retrospective (DSC=0.92 vs. 0.89, p<0.0001) and prospective (DSC=0.93 vs. 0.90, p=0.0004) test sets.



Speed of segmentation:

- ProGNet took just 0.5 seconds to segment each prostate on MRI. Radiology technicians averaged 10 minutes per case.

Clinical utilization:

- This is the first study to employ a deep learning model for prostate gland segmentation for MR-US fusion targeted biopsy in **routine urologic clinical practice**.

*Subgroup analysis:*

Performance (mean DSC ± SD) in the Retrospective Internal Test Set.	Scans acquired at Stanford (n = 88)	Scans acquired outside of Stanford (n = 12)
ProGNet	0.92 (±0.02) *	0.93 (±0.02) *
U-Net	0.84 (±0.07) *	0.89 (±0.04) *
HED	0.80 (±0.08) *	0.84 (±0.06) *
Radiology Technicians	0.89 (±0.05) *	0.91 (±0.03) *

\* p<0.05