Prostate Cancer Diagnosis and quantification using AI-enabled Software (SW)

Wei Huang, MD[1], Samuel Hubbard[1], Parag Jain[2] and Ramandeep Randhawa[2]

[1]Department of Pathology and Laboratory Medicine, University of Wisconsin – Madison, [2]PathomIQ, Inc, California

Background

Gleason scoring system is widely used in prostate cancer grading. Cancer volume is also known to predict patient's outcome and is used for decision-making process [1] Accurate quantification of each Gleason Pattern (GP) is important and is demanded in pathology practice. [2,3] There are some challenges:

- Evaluation of prostate biopsy slides is time-consuming
- High inter-observer variability [4,5]
- Discordance of diagnosing a minor component of GP5 in prostate biopsy is reported at 48.7% between general pathologists an expert GU pathologists [6]

Our goal: Develop a universal and standardized platform for Gleason grading and GP quantification trained by GU pathologists to achieve accurate and reproducible diagnosis

Materials

1000 H&E prostate biopsy slides from the University of Wisconsin-Madison pathology archive were scanned with Aperio CS2 (Leica) at 40x.

- Slides were split into training set (800) and test set (200).
- Training slides were annotated by GU pathologist
- Balanced dataset of varied morphologies, including GP3, GP4, GP5 cancer, high-grade prostatic intraepithelial neoplasia (HGPIN), perineural invasion (PNI), vessels and lymphocytes

Disclosures

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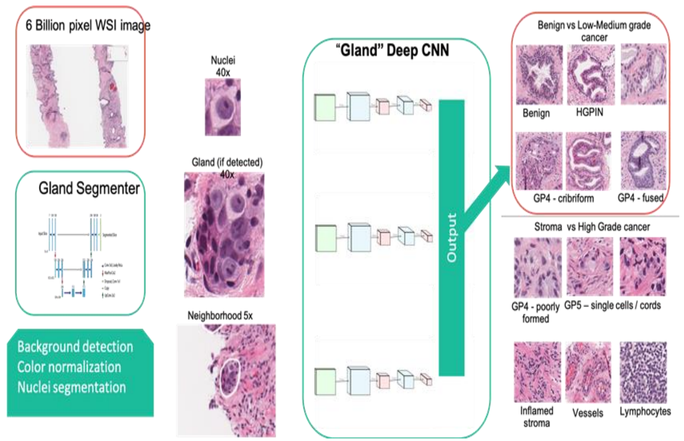
Methods

- Deep Convolutional Neural Networks
- Hybrid Architecture optimized for Grading
- Combination of Classification and Segmentation Networks
- Multiple nets:
  - Gland segmentation, Epithelial detection, Gland-based and nuclei-based grading.
- Multi-scale model: multiple patch sizes at 5x to 40x resolution to capture nuclear detail as well as glandular context



- Fine-Tuned Model
  - Sensitive to very small amount of high-grade cancer
- Intelligent data selection for training
  - ensures balanced learning across various pattern types within and across imbalanced labels
- Annotation Assistant: Pathologist only needs to review <5% of the data for annotations

Results

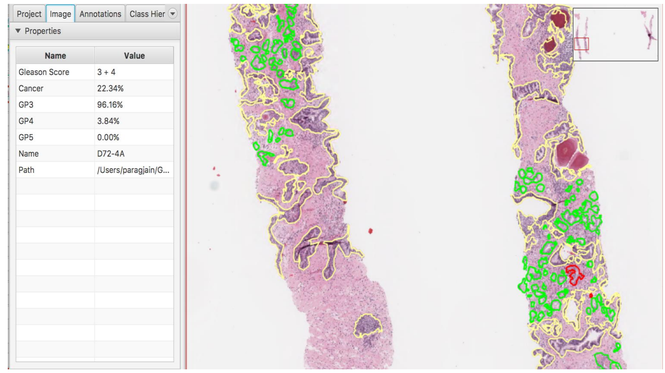
Software Predicted Grade

GU Pathologist Grade		Group 1 <= 6	Group 2 3 + 4	Group 3 4 + 3	Group 4 8	Group 5 9 - 10
Group 1	<= 6	29	2	0	0	0
Group 2	3 + 4	2	64	1	0	0
Group 3	4 + 3	0	0	21	0	0
Group 4	8	0	0	2	20	1
Group 5	9 - 10	0	0	1	0	57

191 (95.5%) Correct

5 (2.5%) Under-graded by Software

4 (2%) Over-graded by Software



SW assisted diagnosis

Time	<1 min
Accuracy	95+%
Reproducibility	High
Quantification	Precise

Summary

- Deep learning enabled cancer-grading software offers objectivity, greater efficiency and precision in prostate cancer scoring and quantification
- Potential to help pathologists to minimize inter-observer variability and to increase efficiency and accuracy in their practice

References

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