Learning from Noisy Label Statistics: Detecting High Grade Prostate Cancer in Ultrasound Guided Biopsy

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Challenge

- Learning from noisy and not finely annotated histopathology data as the ground-truth label is an issue for building computer-aided diagnosis models for prostate biopsy guidance.

![Figure 1](Image)

**Figure 1.** Illustration of noisy and not finely annotated ground-truth label. The exact location of the cancerous ROI in the core, the ratio of the different Gleason grade, and the exact location of the Gleason grades are unknown and noisy. The vectors show one of the possible multi-label binarization approaches.

Material and Methods

- Overview of the method. After accurate detection of presence of cancer in a target using the method proposed in [1], on the second stage, the goal is to assign a pathological score to a sample. To mitigate the problem of noisy labels, we embed the length of the cancer in the ground-truth probability vector as a soft label.

![Figure 2](Image)

**Figure 2.** Overview of the method. After accurate detection of presence of cancer in a target using the method proposed in [1], on the second stage, the goal is to assign a pathological score to a sample. To mitigate the problem of noisy labels, we embed the length of the cancer in the ground-truth probability vector as a soft label.

- Temporal Enhanced Ultrasound (TeUS), (left) TeUS data generation, (right) preprocessing and Region of Interest (ROI) selection from the biopsy region on the prostate. We divide each target location into \( 80 \) equally sized ROIs of size \( 0.5 \times 0.5 \) mm\(^2\) and generate the TeUS RF sequence \( x^{(t)} = \{x_1^{(t)}, \ldots, x_8^{(t)}\} \).

![Figure 3](Image)

**Figure 3.** Temporal Enhanced Ultrasound (TeUS). (left) TeUS data generation, (right) preprocessing and Region of Interest (ROI) selection from the biopsy region on the prostate. We divide each target location into \( 80 \) equally sized ROIs of size \( 0.5 \times 0.5 \) mm\(^2\) and generate the TeUS RF sequence \( x^{(t)} = \{x_1^{(t)}, \ldots, x_8^{(t)}\} \).

![Figure 4](Image)

**Figure 4.** (left) Cancer probability map overlaid on B-mode image, along with the projected needle path in TeUS data (GS 4+4) and centered on the target. ROIs for which we detect the Gleason grade of 4 and 3 are colored in red and yellow, respectively. The non-cancerous ROIs are colored as dark blue (right) The corresponding uncertainty map. The level of uncertainty is color-coded using a blue-red spectrum where the blue shows a low level of uncertainty and the dark red indicates the highest level of uncertainty.

![Figure 5](Image)

**Figure 5.** Scatter plot of the reported tumor in core length in histopathology vs. the predicted tumor in core length. Correlation Coefficient = 0.95, Mean Squared Error (MSE) = 0.12.

![Figure 6](Image)

**Figure 6.** The comparative performance of the proposed methods measured by average AUC (mean of inter-class AUCs) for: (BL-1) 2-stage multi-label binarization, (BL-2) 1-stage multi-label binarization (BL-3) 1-stage weighted multi-label binarization, DBN features + GMM clustering proposed by [2], LSTM features + GMM clustering based on methods [1,2].

Contributions

- Model uncertainty estimation using stochastic dropout [3]

![Figure 7](Image)

**Figure 7.**

References

