Automatic Glomerulus Extraction in Whole Slide Images Towards Computer Aided Diagnosis

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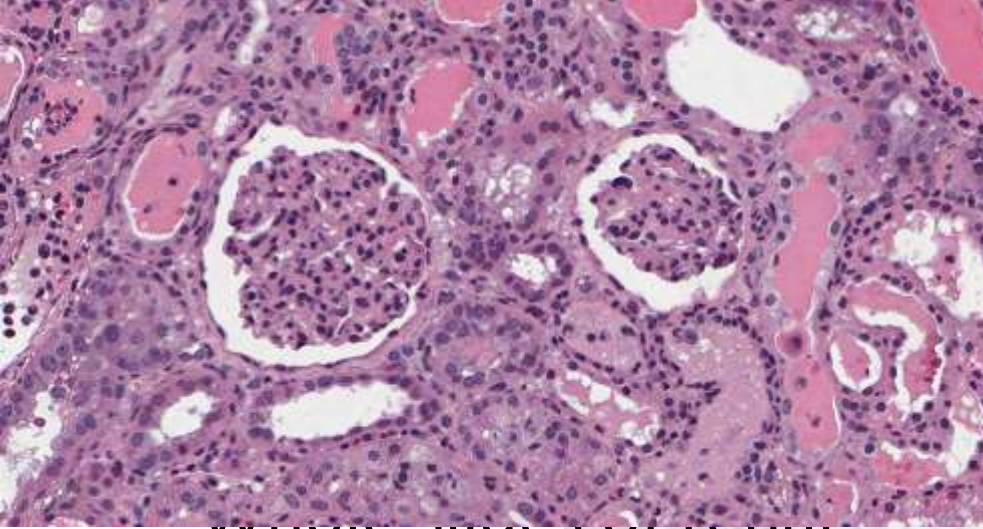
2 Diabetes Research Institute, University of Miami

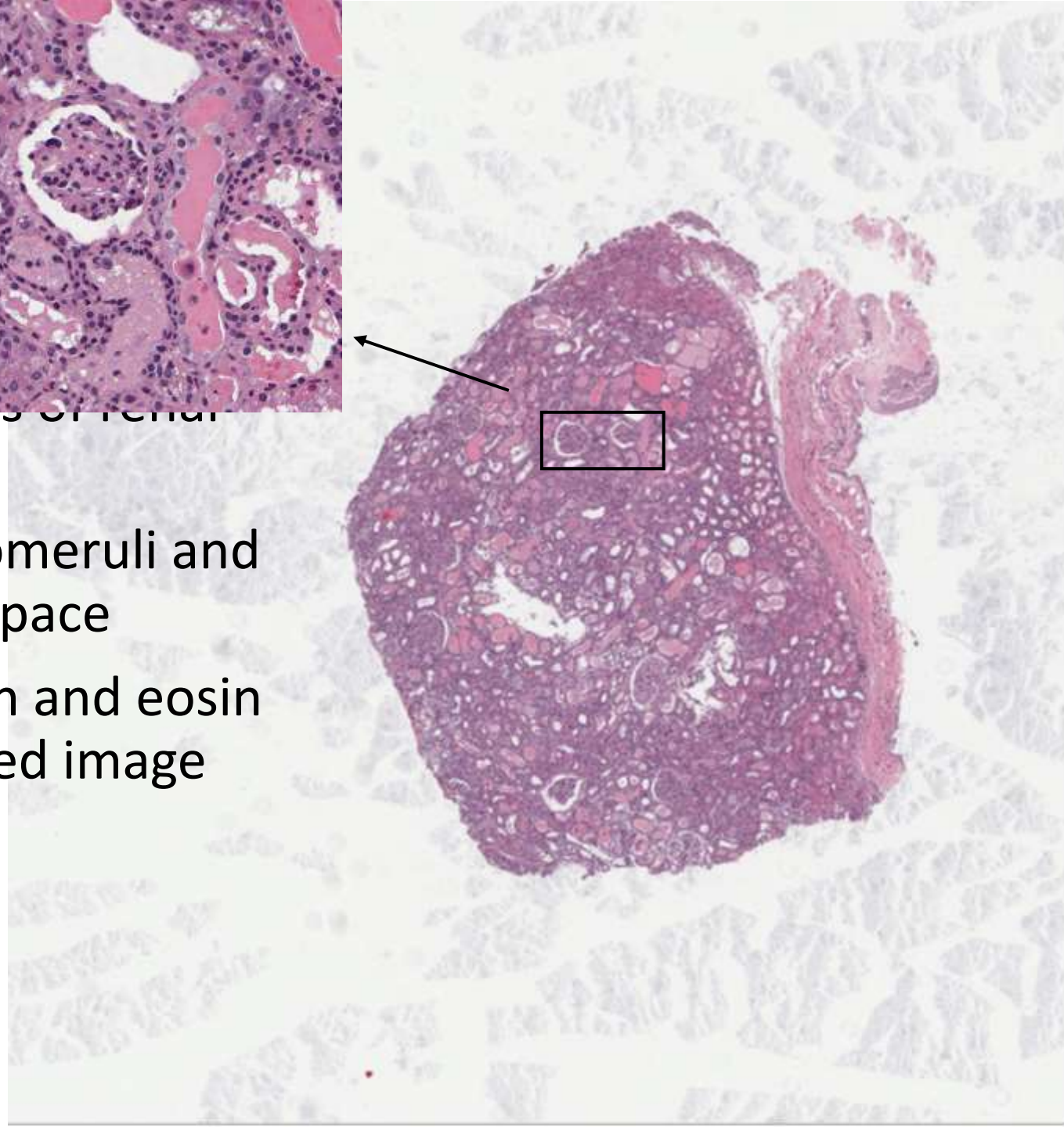3 Department of Surgery and Bioengineering University of Illinois at Chicago

NCSA

Outline

- ✓ Background
- Automatic Glomerulus Extraction
- Computer Aided Diagnosis
- BrownDog & conclusions

Whole slides of renal tissues

- Tubules, glomeruli and interstitial space

- Hematoxylin and eosin (H&E) stained image
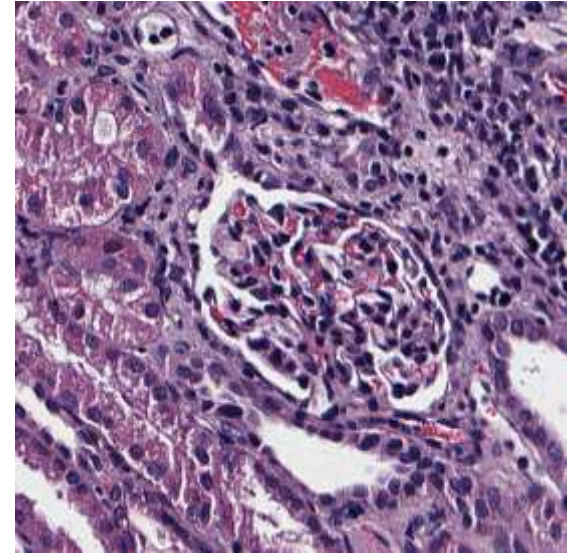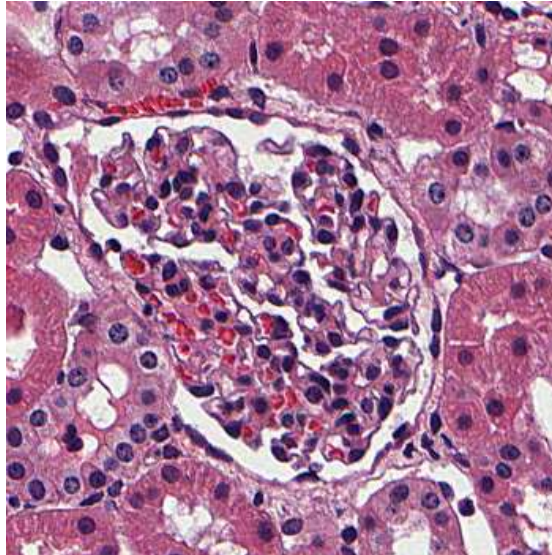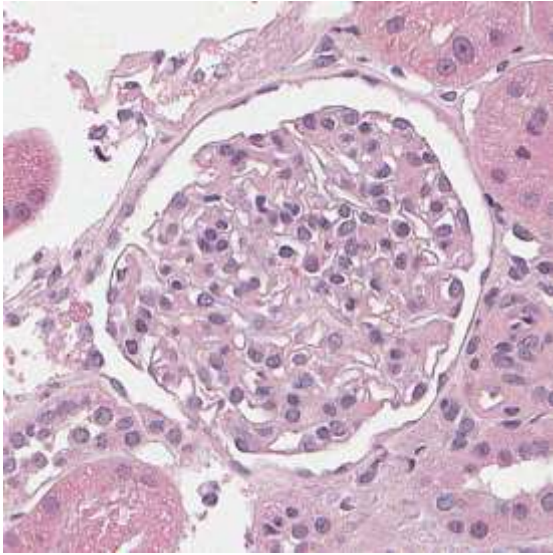
- Biomarkers

Outline

- Background
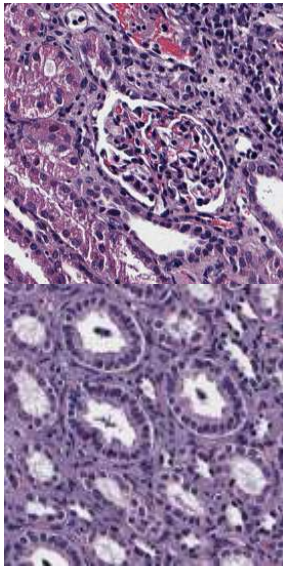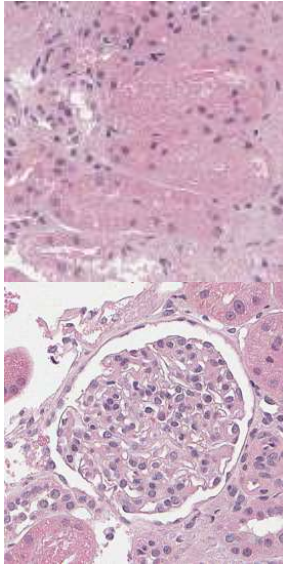- ✓ Automatic Glomerulus Extraction
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Glomerulus

- Bowman's capsule/ space
- Challenges: different color, different shape & size of glomeruli, incomplete and blur Bowman's space
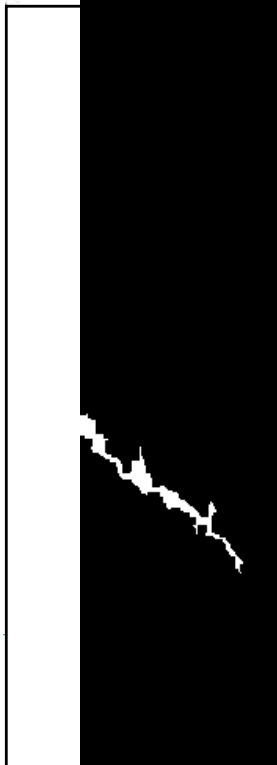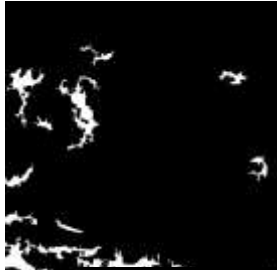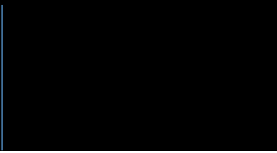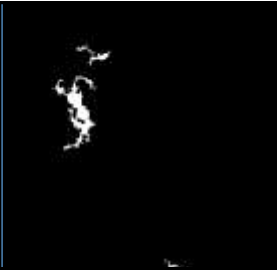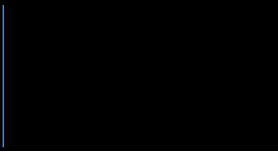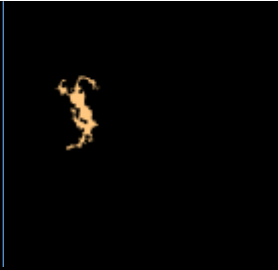
Automatic glomerulus extraction

Original Image	Object Generation	Morphological Classification	Perceptual Grouping	Glomerulus Segmentation
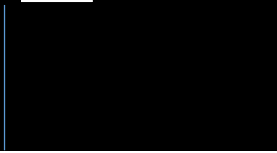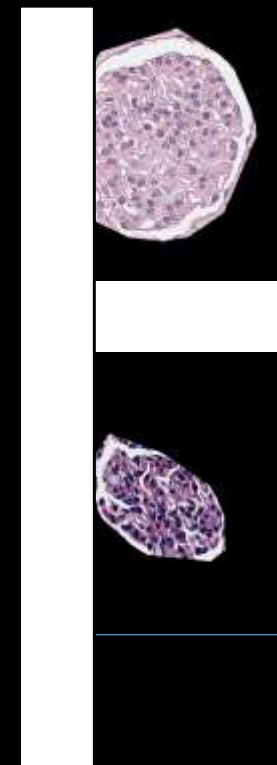
Evaluation

TABLE I: overall performance of glomerulus extraction

Parameters	CN8454	CN8452	CN8450	CN8383	CN8376
# Real Glomeruli	8	6	37	80	9
# Glomeruli Detected	5	4	23	73	5
Completeness(%)	80.6	100	91.6	96.9	73.0
# False Glomeruli	0	0	1	15	13
Time(s)	9.3	3.5	10.2	65.6	12.3

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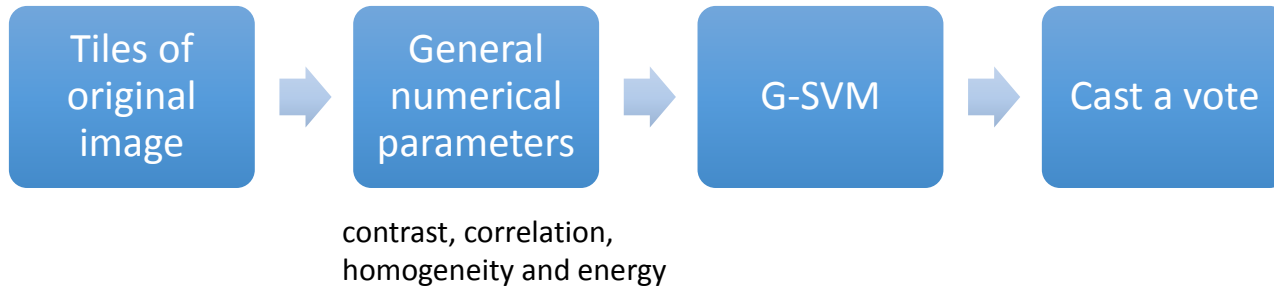# Post-transplant renal biopsies
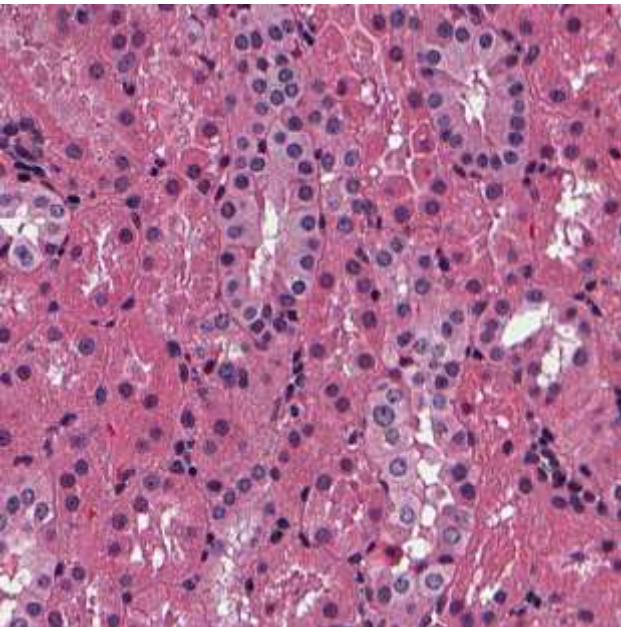
(a) Normal
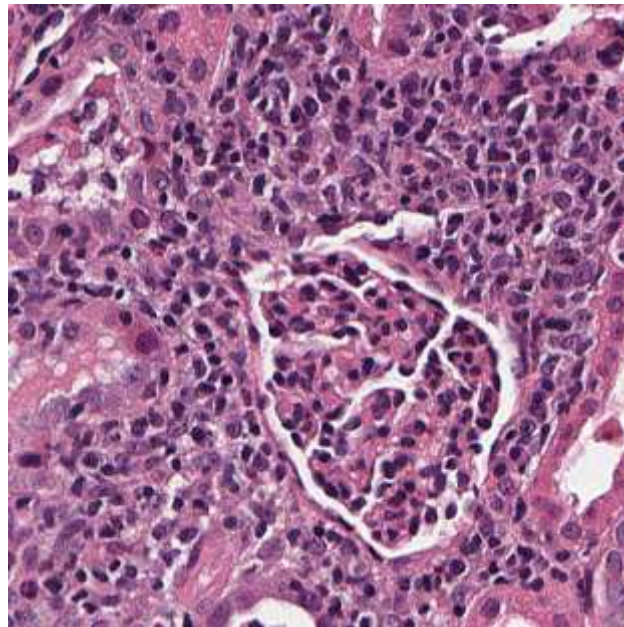
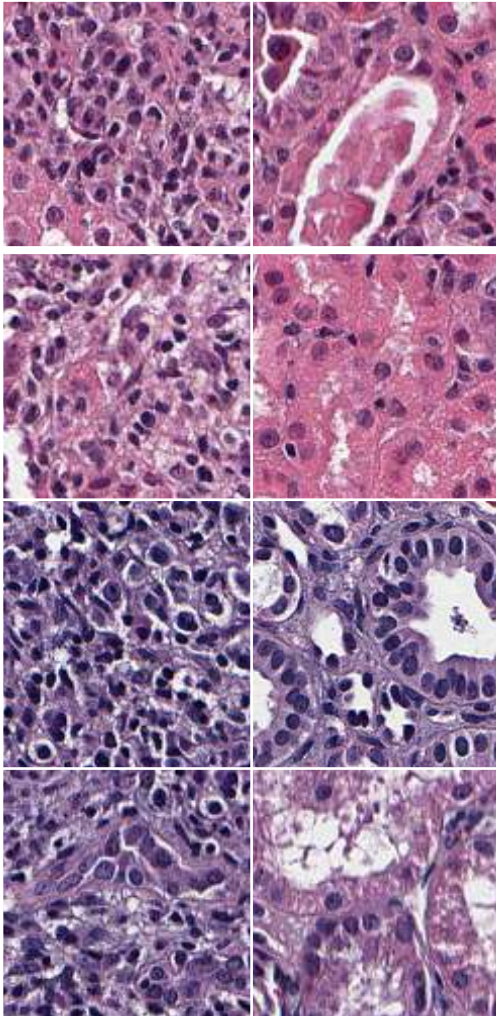(b) Interstitial inflammation
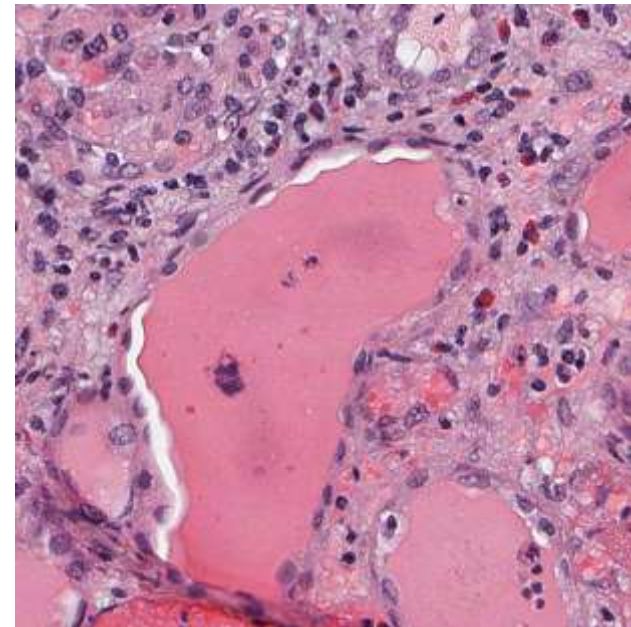
(c) Tubular cast

# Computer Aided Diagnosis

- *Pre-Screening*

| Tiles of original image | → | General numerical parameters | → | G-SVM | → | Cast a vote |

contrast, correlation, homogeneity and energy

- *Search the Biomarkers of Diagnosis*

| Tiles with positive votes | → | Specific numerical parameters | → | S-SVM | → | Cast a vote |

Experiment & Evaluation

Fig. TP and FP of Pre-screening

- 200 x 200 pixel
- Cell number (the number of pixels with weak color intensity with maximum length ranging from 3 to 30 pixel)
- The percentage of white area (light color area above 100 pixels)
- Correlation, cluster prominence, maximum probability and inverse difference moment normalized

- Precision as 98% for 6 samples.

Experiment & Evaluation

Fig. TP and FP of Pre-screening
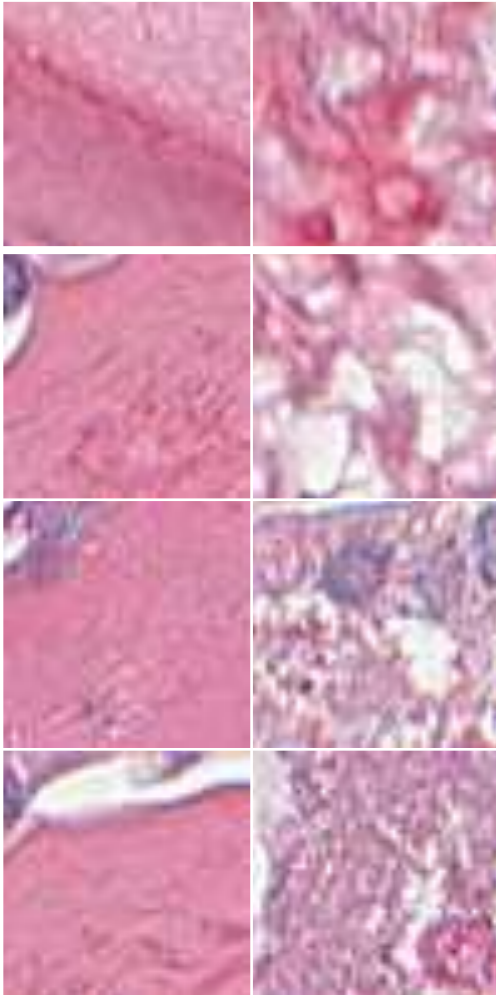
- 50 x 50 pixel
- Smooth degree (median of local range of color among 7*7 neighborhood in red and blue channel)
- Color saturation (median of hue and saturation channels)
- Information measure of difference variance, difference entropy and sum entropy

- Precision as 98% for 4 samples

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BrownDog Service

BrownDog Service

Conclusions

- Currently, renal biopsies are analyzed manually; the availability of fully automatic diagnosis framework is of immense benefit in leveraging the expertise and preventing graft loss.

- Computer Aided Diagnosis of Interstitial inflammation and tubular cast achieves precision as 90% in average. First work in this field.

- For glomerulus extraction, 110 out of 140 glomeruli from five WSIs are correctly extracted with average completeness over 90%.

- 46.1s for an 112MB-pixel-foreground image, make it possible for routine CAD process.

- The entire framework is integrated in Clowder as web service and demonstrated in CRI dataset. Open source code is available.