# PD42-09
# Urine cell image analysis using a deep learning model

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# Conflict of Interest Disclosure

**I have no potential of interest to report.**

This is collaborative research with Kyocera Communiction System Co., Ltd. and Rist Co., Ltd.

# Urine cytology

- Used to search and follow-up UC.

- **Noninvasive** and **inexpensive** screening test.
- Can be performed **repeatedly**.

- **Low sensitivitiy** for low-grade UC.
- **Poor inter-observer reproducibility**.

# Clinical issues

There is **a great need** for tools for urine cytology **to reduce the workload** of pathologists and cytotechnologists and **to improve the reproducibility and accuracy**.

Recently, with **the advance of artificial intelligence (AI) technology** using a convolutional neural network (CNN) algorithm for image analysis, some studies reported promising results.

In urine cytology, image analysis using AI is expected to be a method that not only **improve the reproducibility** but also contributes to **reduction in the burden** on cytotechnologists and pathologists.

# Objectives

To develop AI for automated urine cell image analysis using deep learning model

# Materials

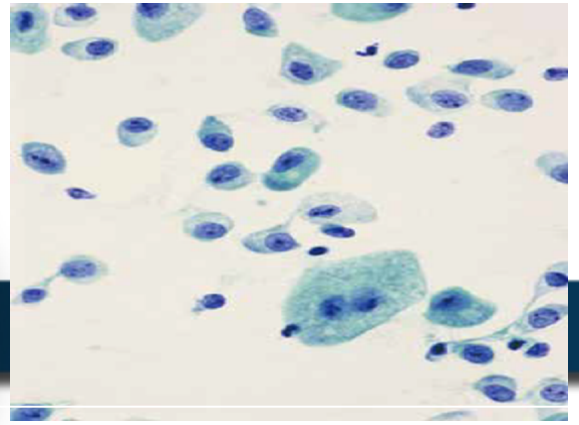
A total of 194 consecutive urine samples obtained from patients eventually histologically diagnosed with urothelial cancer in our hospital (University Hospital, Kyoto Prefectural University of Medicine) from January 2016 to December 2017.

**Negative** for high grade urothelial carcinoma (HGUC): 78 samples (40.2%)

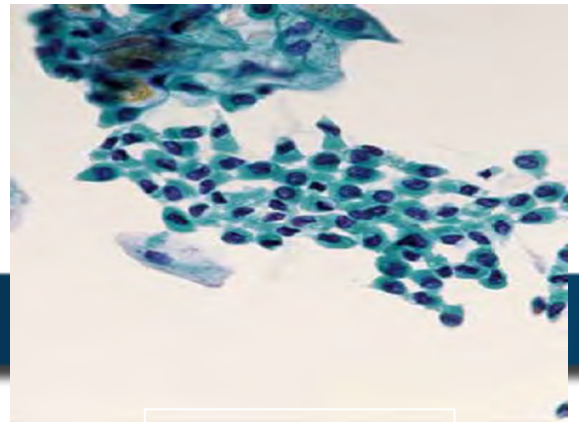
**Atypical** urothelial cells: 33 samples (17.0%)

**Suspicious for HGUC**: 20 samples (10.3%)

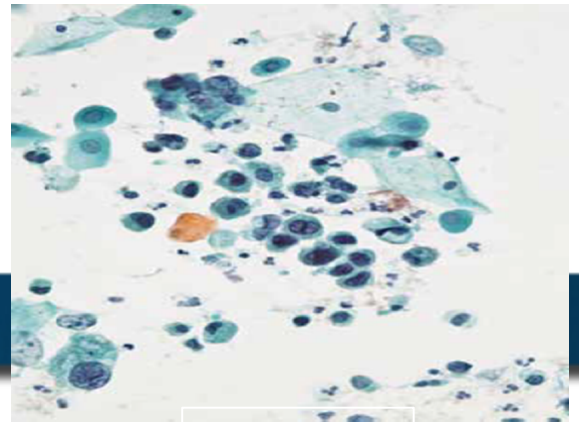
**HGUC, low-grade urothelial neoplasm (LGUN), and other malignancies**: 63 cases (32.5%)



Negative for HGUC



Atypical



HGUC

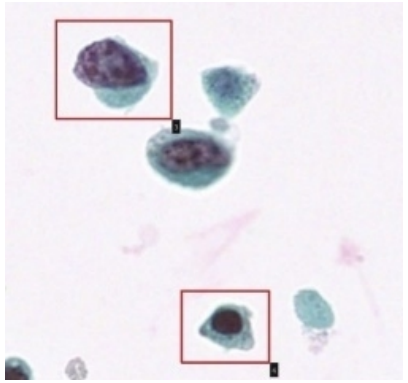
# Characteristics

| | Median (Interquartile range) |
|---|---|
| Age (year) | 75 (69 - 80) |
| | Number (%) |
| pTstage | |
| a | 125 (64.4) |
| 1 | 36 (18.6) |
| 2 | 12 (6.2) |
| cis | 21 (10.8) |
| grade (low/high) | |
| low | 89 (45.9) |
| high | 105 (54.1) |

# Methods

## Step 1. Whole slide imaging (WSI)

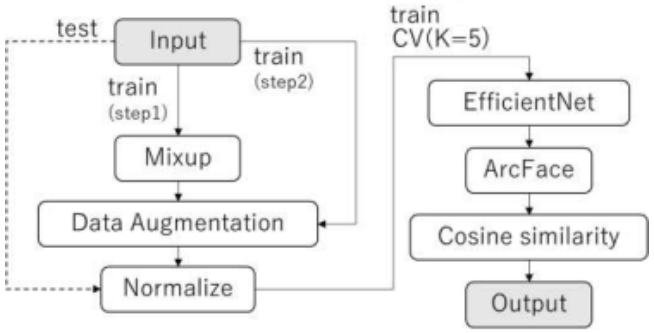
## Step 2. Labeling



4637 cell images

- 3128 benign cells
- 398 atypical cells
- 1111 malignant cells

## Step 3. Machine learning



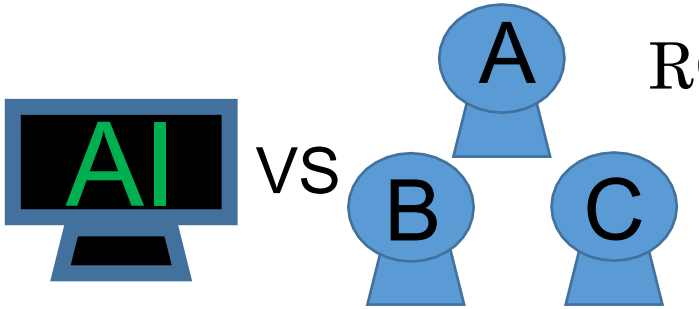

80% for training and validation (4:1)

20% for test data

5-Fold cross validation

Binary classification model

## Step 4. Evaluation

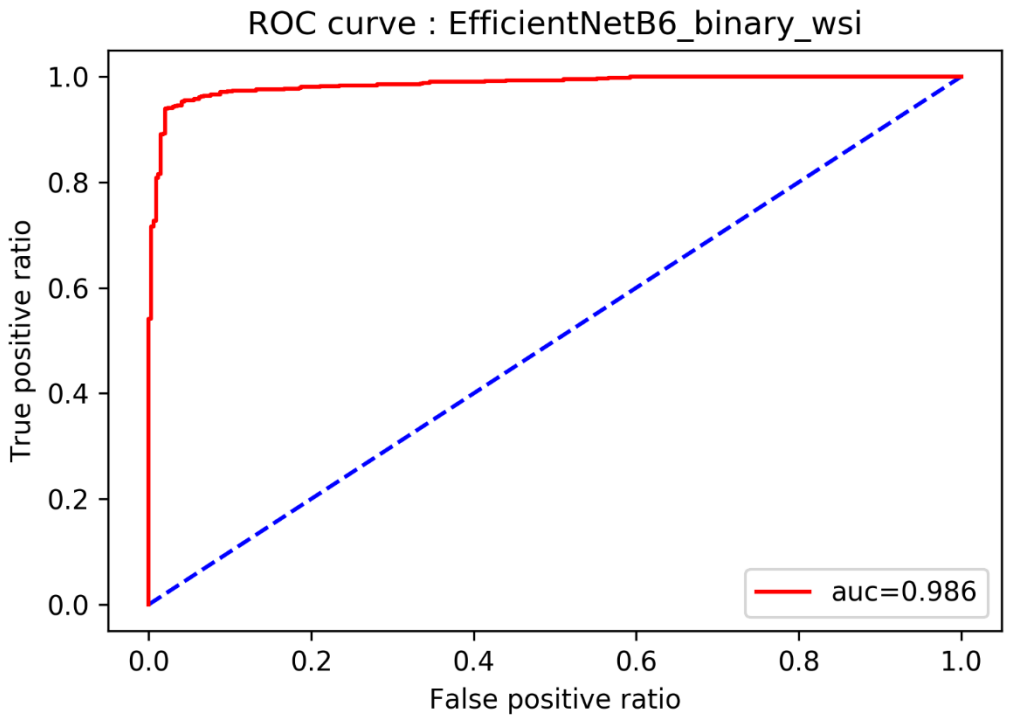


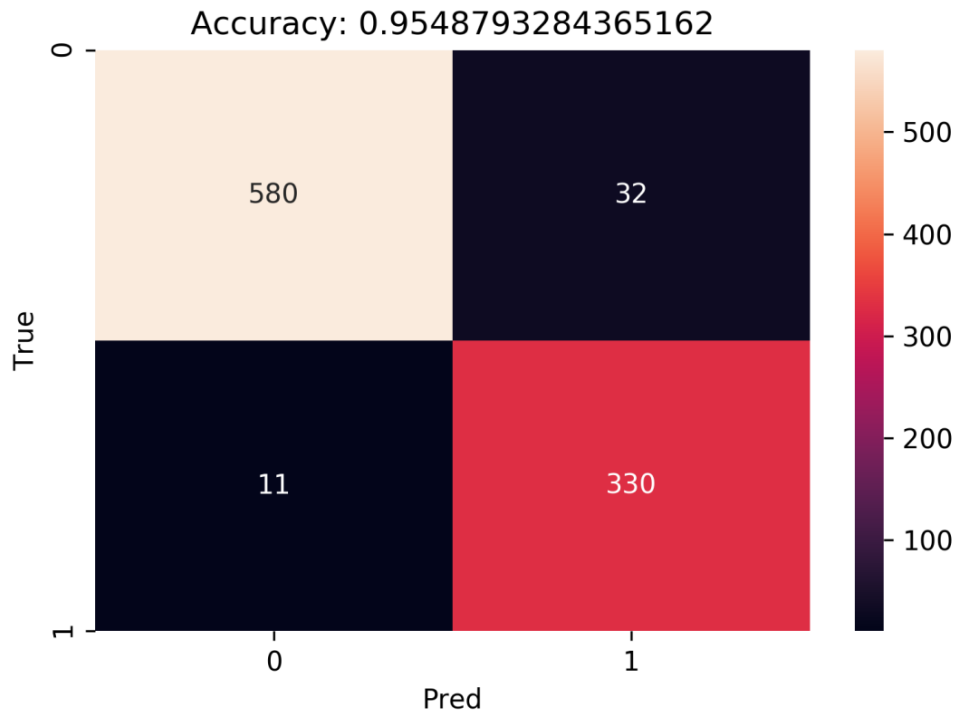

ROC analysis

3 Experienced Cytotechnologists (2, 28, and 25 years' experience)

# Result

## Average model AI




**Average AUC 0.986, Highest Accuracy 0.955, the sensitivity 97.1%, and the specificity 94.4%.**

# Comparison between AI and cytotechnologists

| | Accuracy | Sensitivity | Specificity |
|---|---|---|---|
| Cytotechnologist A | 0.846 | 0.941 | 0.793 |
| Cytotechnologist B | **0.824** | **0.522** | **0.992** |
| Cytotechnologist C | **0.938** | **0.971** | **0.92** |
| **AI (Highest accuracy model)** | **0.955** | **0.948** | **0.968** |
| **AI (Matched with C's sensitivity model)** | **0.954** | **0.971** | **0.944** |

AI achieved excellent accuracy which was comparable with expert cytotechnologists.

# Conclusions

Urine cell image analysis using deep learning model achieved **highly accurate automatic diagnosis.**

This **AI** can be a **useful and reproducible method** to assist cytotechnologists and pathologists.