Towards an automated classification method for ureteroscopic in vivo kidney stone images using machine learning techniques

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1. Medical Context and Motivation

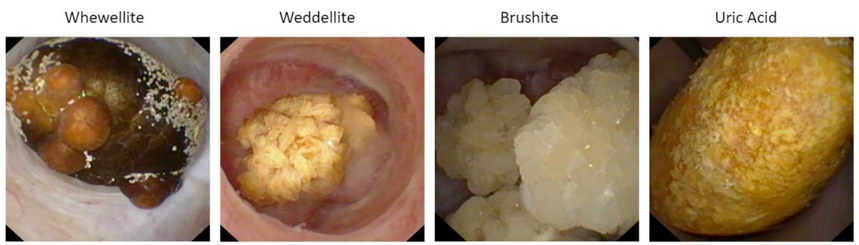
Urolithiasis disease is the formation of kidney stones

Morphological information provides very valuable information for diagnosis purposes

But this component it is lost in an endoscopic intervention known as **“dusting” (laser lithotripsy)**

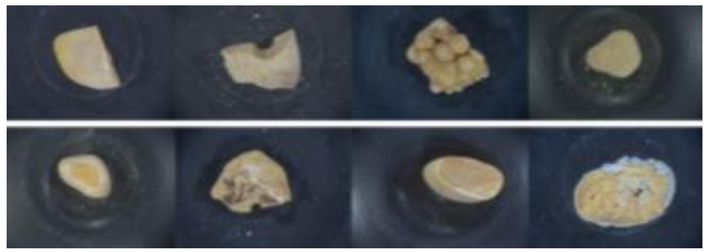
Automated image analysis could alleviate these issues!!!

Not a trivial problem: ureteroscopy images are characterized by poor lighting and images from kidney stones present high **inter-class similarities and intraclass variations**



In this work we present an initial framework for automatically classifying **ureteroscopic in vivo kidney stones**

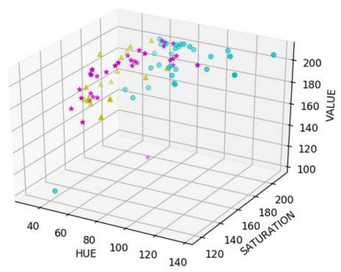
The study was carried by a group of machine learning and urology specialists from the institution listed below:



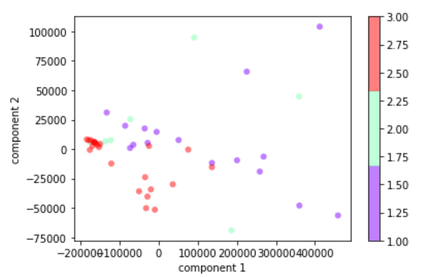
Most recent works in make use of **extracted (ex vivo)** kidneys stones, captured under highly controlled lighting conditions: **not very representative of clinical settings!**

2. Materials and Methods

We build a **dataset** containing 74 surface and 46 cross section (CS) images from 3 classes and extended the dataset by “sampling” non-overlapping patches → **1465 samples**.



eHSV applied on surface images
Weddelite → Magenta
Whewelite → Cyan
Uric Acid → Yellow

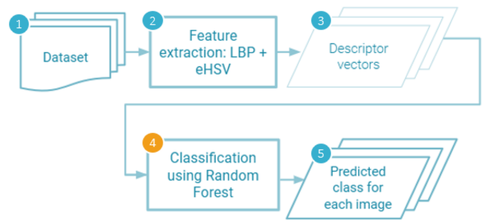


LBP & eHSV applied on CS images
Weddelite → Red
Whewelite → Blue
Uric Acid → Green

We performed several ablation and **feature selection** studies to assess which information from the image provide the highest variance. We chose the **hue channel information** and **Locally Binary Patterns** (LBP)

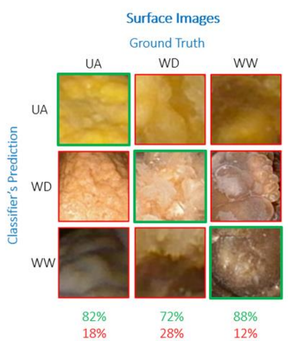
Results and Discussion

We trained several ML algorithms with the selected features. However, random Forest yielded the best results



Features in Section images	Average Accuracy	Features in Surface images	Average Accuracy
eHSV + LBP	89%	eHSV + LBP	79%
eH + LBP	88%	eH + LBP	75%

Nonetheless, as the confusion matrix below shows, there is still areas of improvement, next→ deep learning!



But! We demonstrate that is possible to classify **in vivo kidney stones** reliably!

More info