

**Kaggle competition**

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# **HuBMAP + HPA - Hacking the Human Body**

Segment multi-organ functional tissue units

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# Summary

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## Description

- What is HuBMAP, HPA, FTUs ?
- Competition purpose
- Evaluation & Judges

## Works

- EDA
- Baseline

# Description



# Description

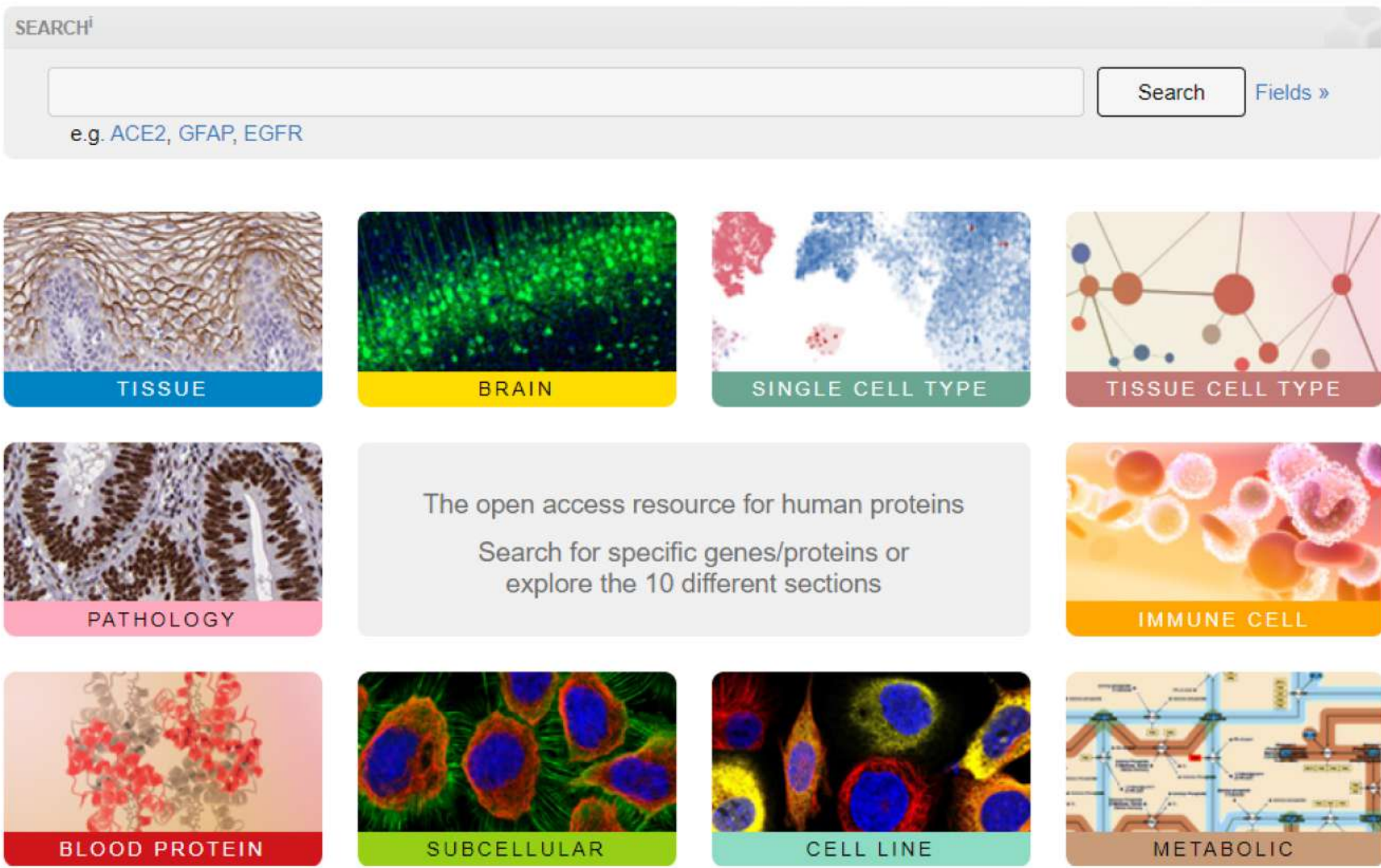
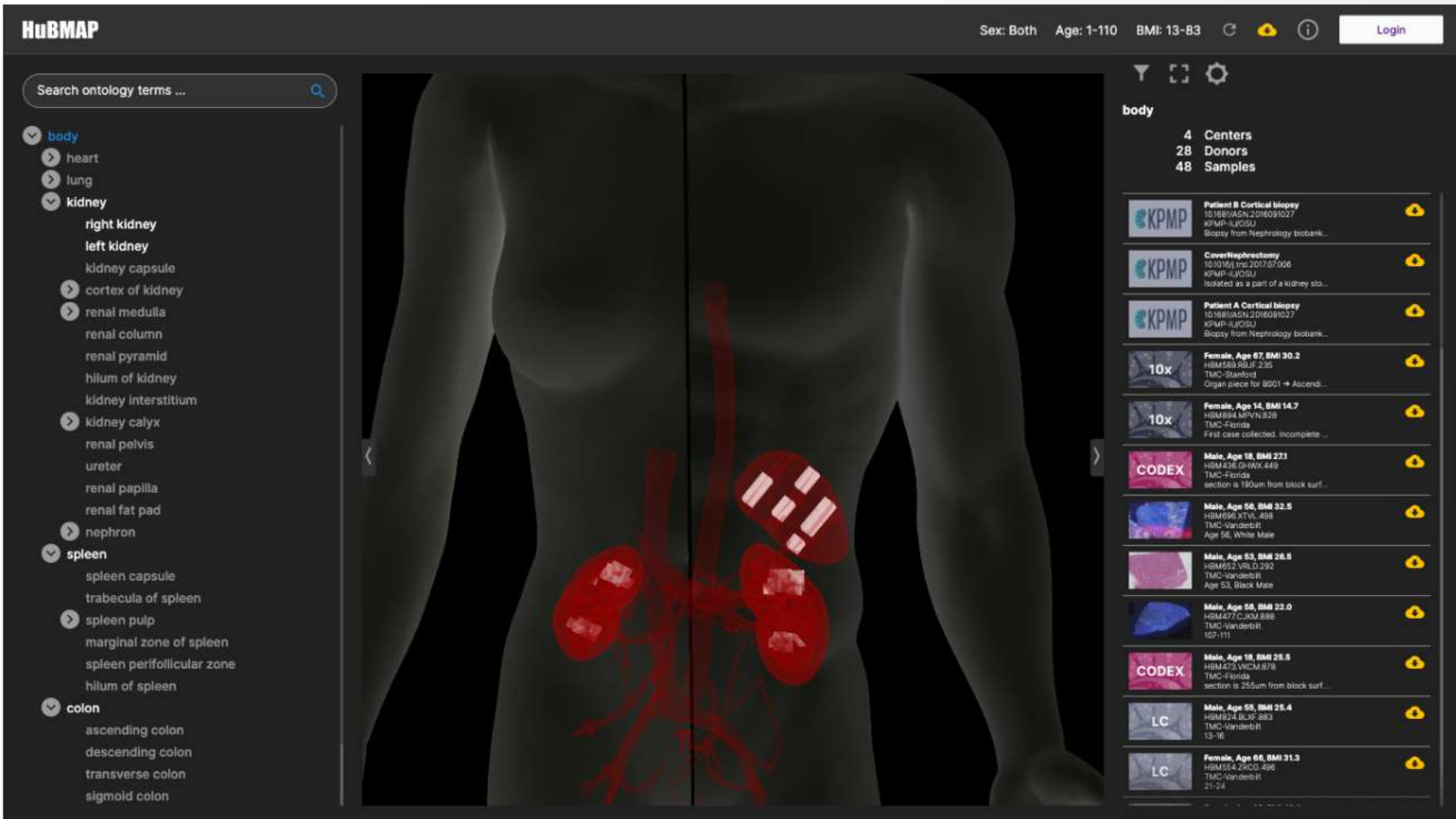
## What is HuBMAP, HPA, FTUs ?

### HuBMAP : Human BioMolecular Atlas Program

Central resource for discovery visualization, and download of single-cell tissue data generated by the consortium

### HPA : The Human Protein Atlas

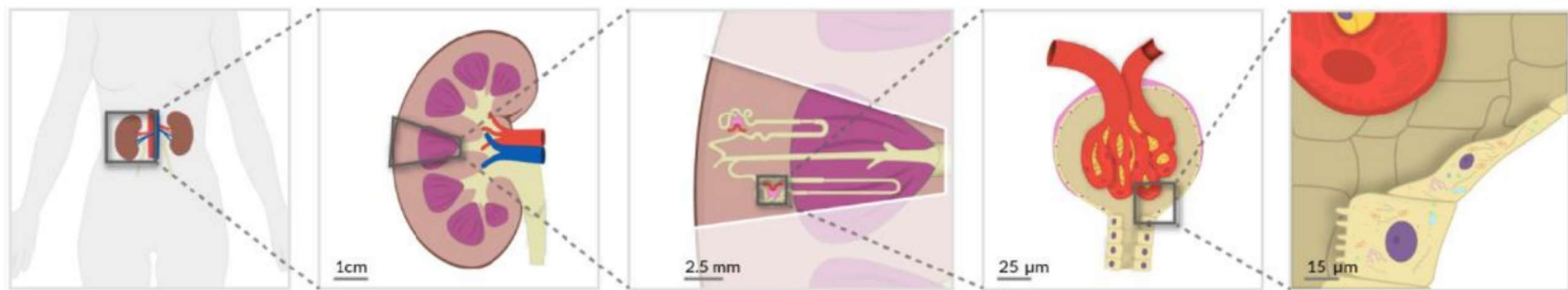
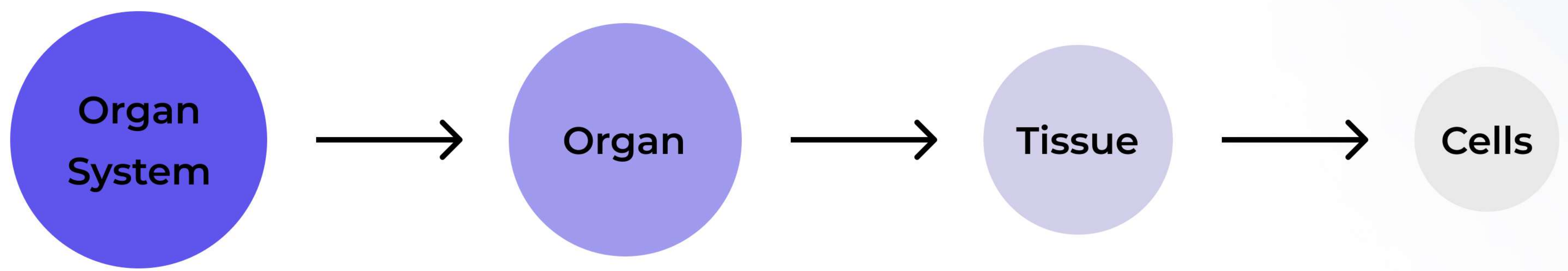
Mapping all the human proteins in cells.  
All the data is open access





# Description

FTU : Functional Tissue units



Body	Organ	Functional Tissue Unit	FTU Sub-structure(s)	Cellular
<ul style="list-style-type: none"><li>• Body</li><li>• Kidney (Left, Right)</li><li>• Aorta</li><li>• Renal artery</li><li>• Renal vein</li><li>• Ureter</li></ul>	<ul style="list-style-type: none"><li>• Renal capsule</li><li>• Renal pyramid</li><li>• Renal cortex</li><li>• Renal medulla</li><li>• Renal calyx</li><li>• Renal pelvis</li></ul>	<ul style="list-style-type: none"><li>• Nephron</li><li>• Renal corpuscle</li><li>• Proximal convoluted tubule</li><li>• Loop of Henle</li><li>• Distal convoluted tubule</li><li>• Connecting tubule</li></ul>	<ul style="list-style-type: none"><li>• Bowman's capsule</li><li>• Glomerulus</li><li>• Efferent arteriole</li><li>• Afferent arteriole</li></ul>	<ul style="list-style-type: none"><li>• Parietal epithelial cell</li><li>• Capillary endothelial cell</li><li>• Mesangial cell</li><li>• Podocyte</li></ul>



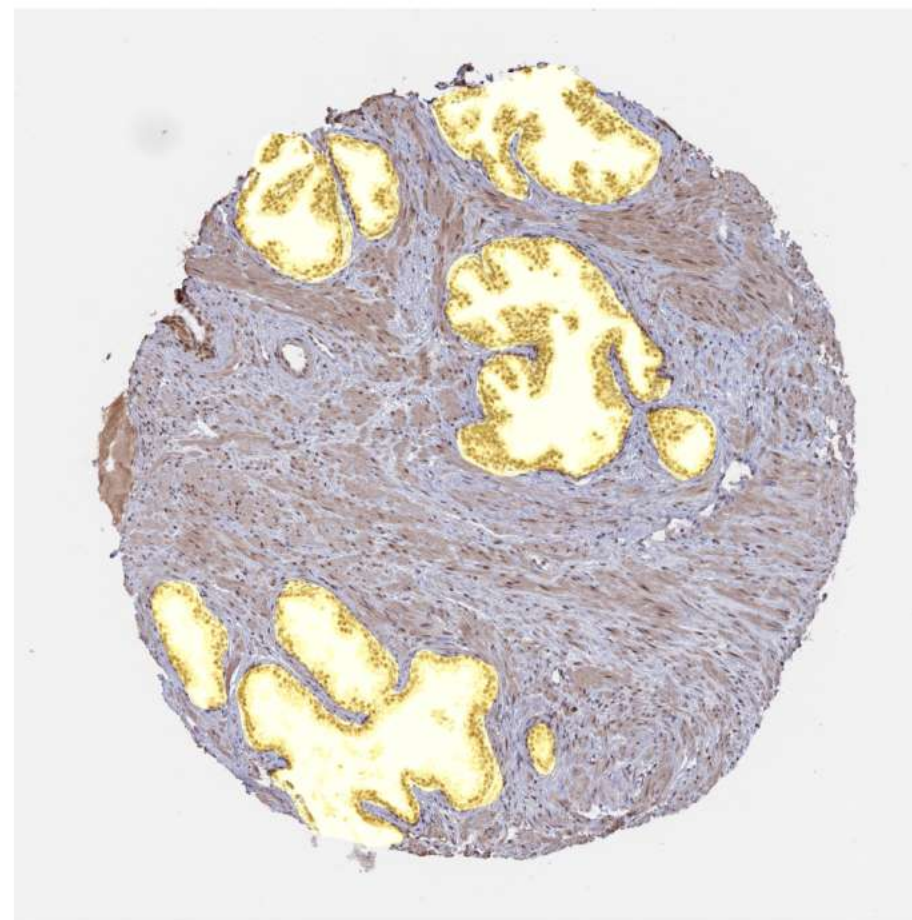
# Competition perpose

**Purpose** : Segment functional tissue units (FTUs) across five human organs

Accelerate the world's understanding of the relationships  
between cell and tissue organization

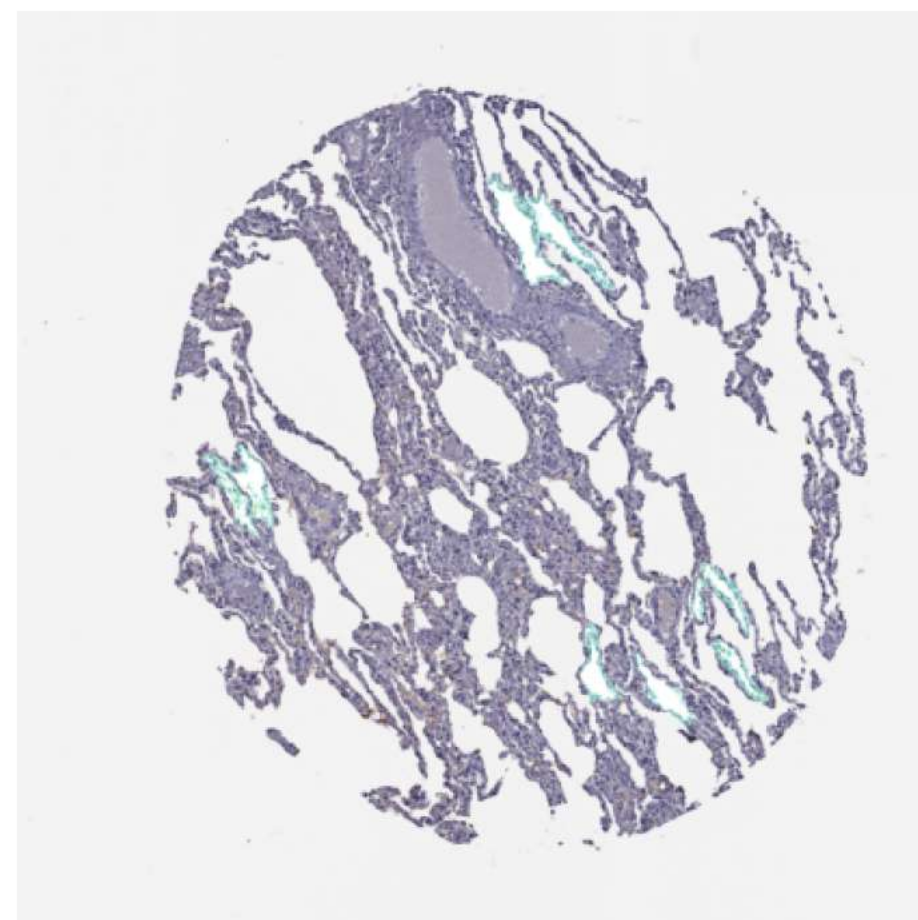
## Organ

prostate



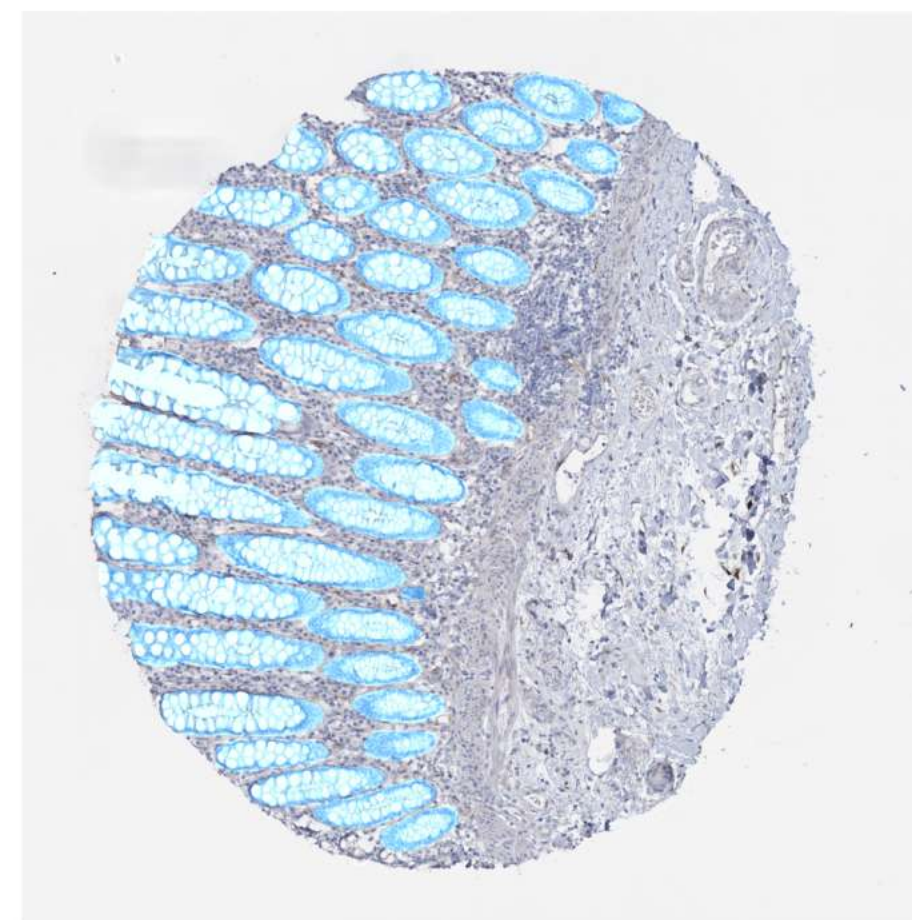
glandular

lung



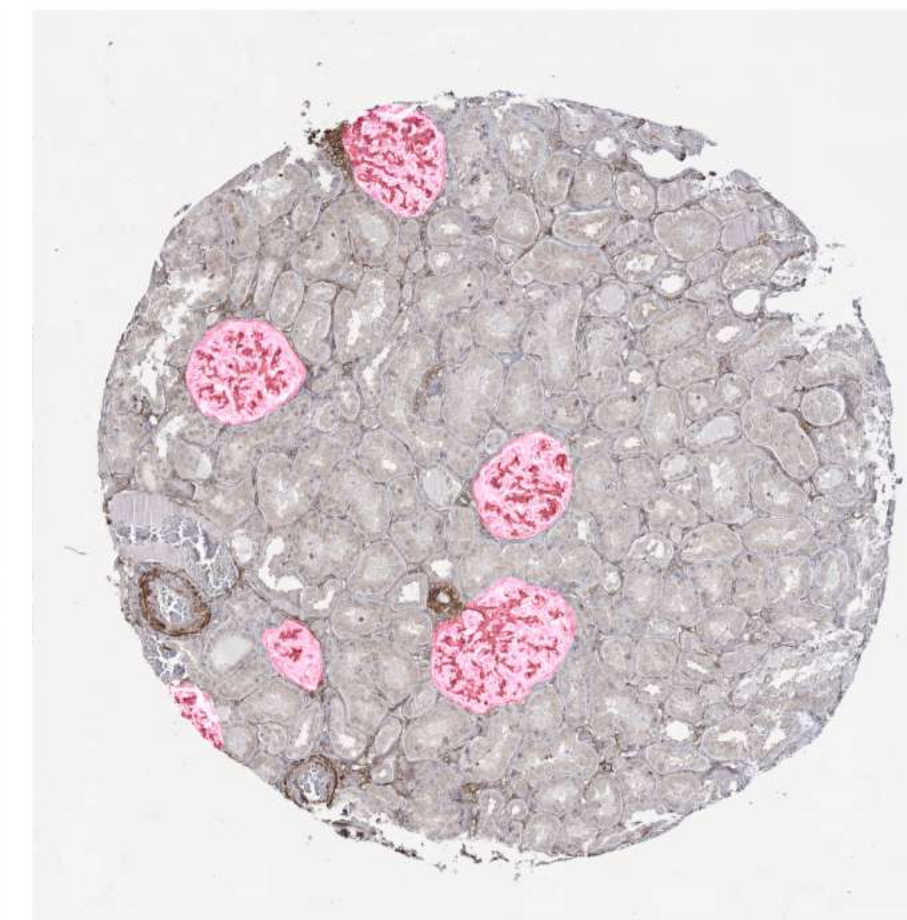
alveolus

largeintestine



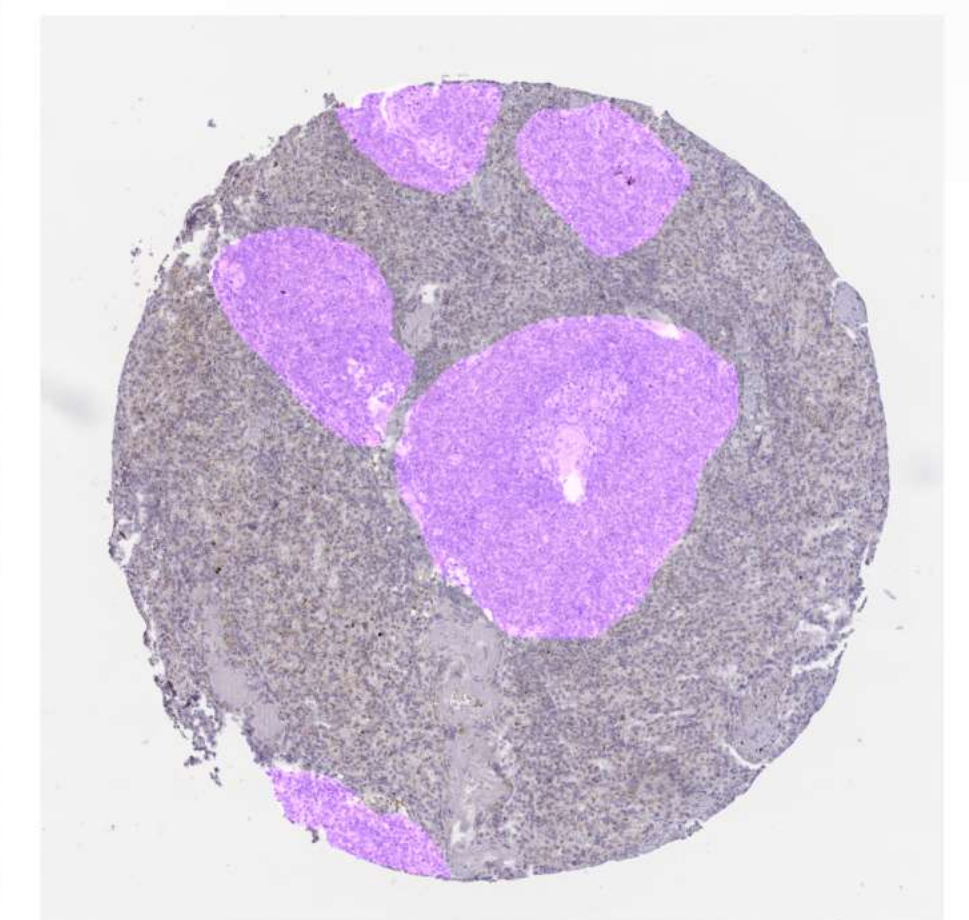
crypt

kidney



glomeruli

spleen



white pulp

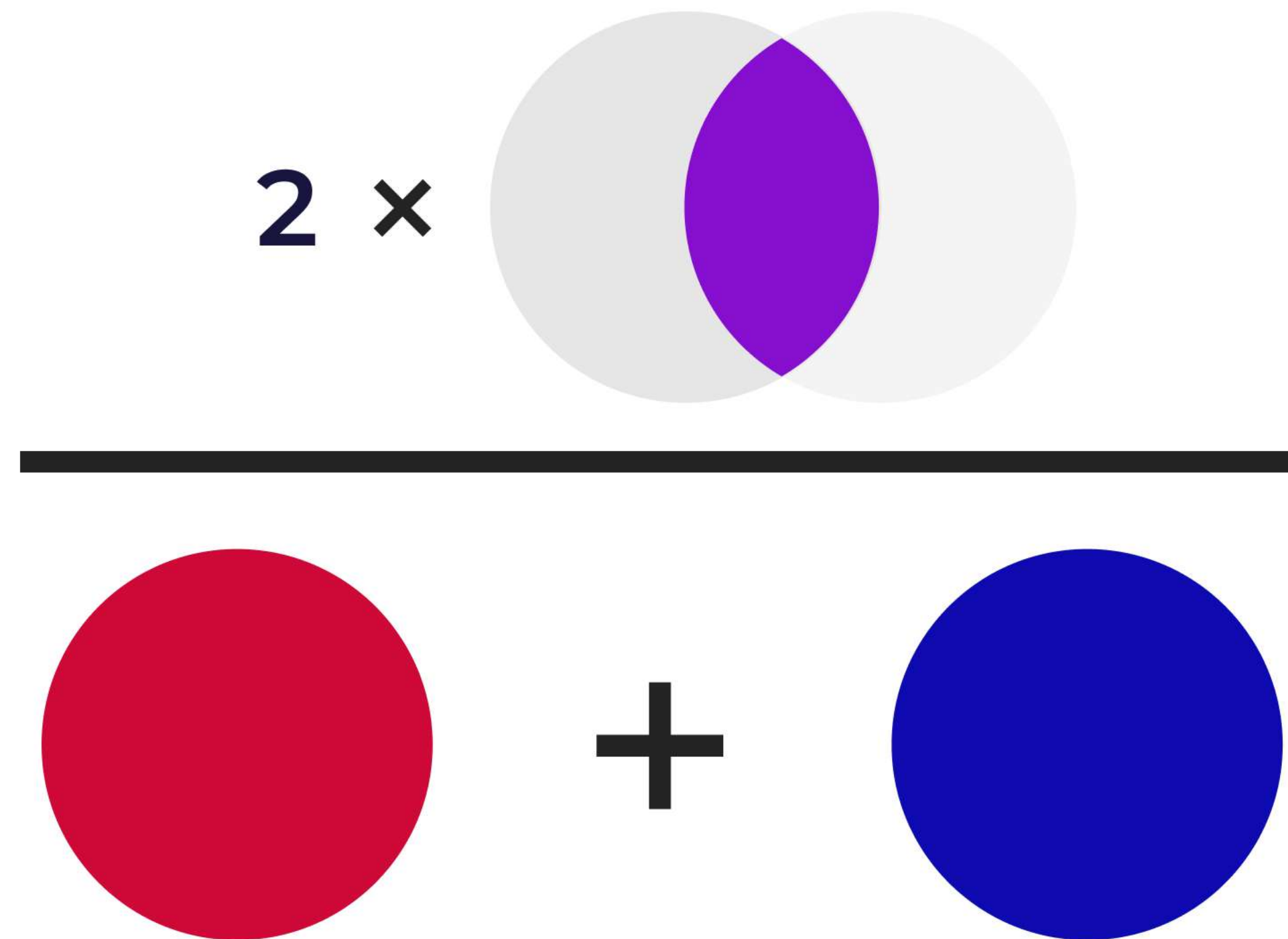
**FTU**



# Evaluation & Judges

## Model evaluation : Dice coefficient

The area of Overlap divided by the total number of pixels in both the images

$$\frac{2 \times \text{Overlap}}{\text{Red Circle} + \text{Blue Circle}}$$


The diagram illustrates the Dice coefficient formula. The numerator is represented by the expression  $2 \times$  followed by a Venn diagram of two overlapping circles, where the intersection is shaded purple. The denominator is represented by a horizontal line above the sum of two separate circles, one red and one blue, separated by a plus sign.

# Evaluation & Judges

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## Judges

### └ Methodology (80 points)

- Are the statistical and modeling methods appropriate for the task?
- Are metrics provided that help interpret the results achieved by the segmentation methods?
- Is the presented characterization of FTUs useful for understanding individual differences?
- Is it possible to predict FTU area size distribution, given age and sex info across all organs?
- Did the team validate their methods and algorithm implementations and provide information on algorithm performance and limitations?
- Did the team document their method and code appropriately?
- Did the team develop a creative or novel method to segment FTUs?
- Did the team provide insights that would be useful for generating reference FTUs for inclusion into a Human Reference Atlas?



# Evaluation & Judges

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## Judges

### └ Diversity and Presentation (30 points)

- Does the team embrace diversity and equity, welcoming team members of different ages, genders, ethnicities, and with multiple backgrounds and perspectives?
- Did the authors effectively communicate the details of their method for segmenting FTUs, and the quality and limitations of their results?
- Are the important results easily understood by the average person?

# Works



# EDA

## Data

### └ Train / Test .csv

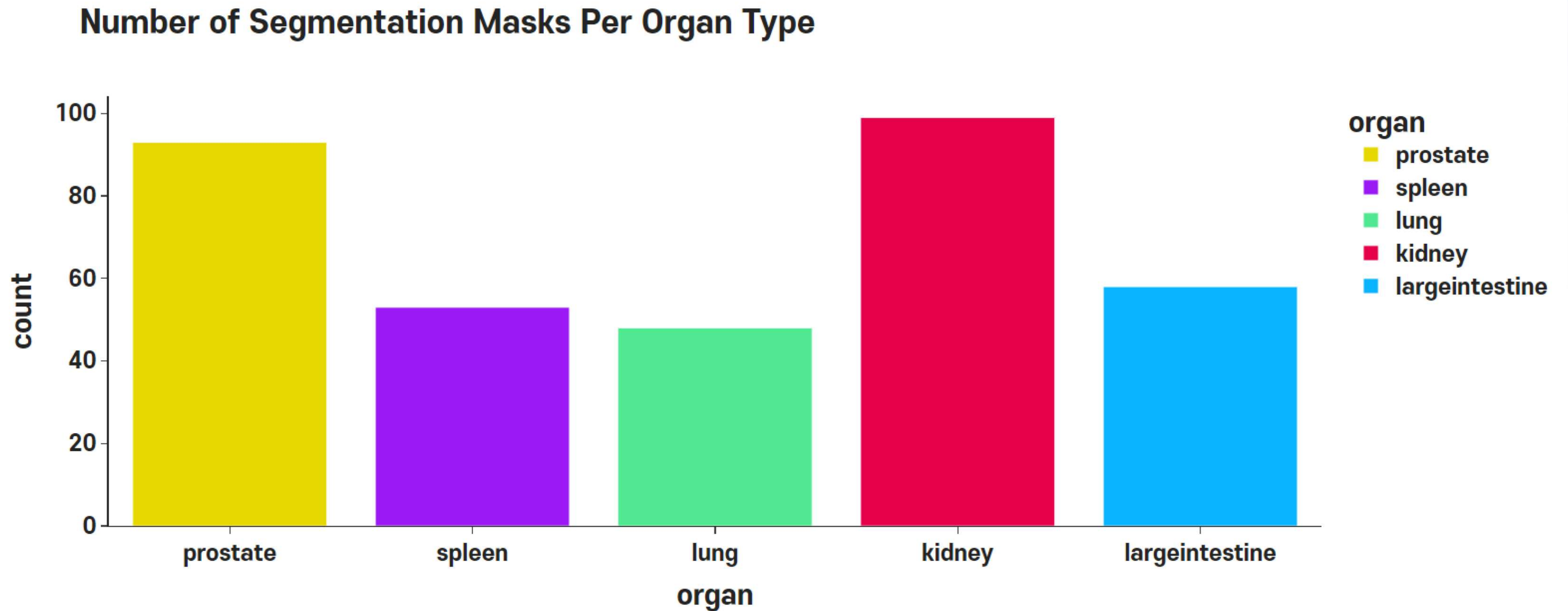
- Total data : 351
- id : image\_id
- organ : [kidney, large intestine, lung, spleen, prostate]
- img\_height, img\_width : [2300 ~ 3000], Height and width are same
- data\_sources : [HPA or HuBMAP], All data in dataframe are from HPA
- pixel\_size : [0.4( $\mu\text{m}$ )], The data in HuBMAP is different.
- tissue\_thickness : [4( $\mu\text{m}$ )], The data in HuBMAP is different.
- rle : Target (training set only)
- age : [20~84], Patient's age (training set only)
- sex : [Male, Female], Patient's sex (training set only)

### └ Submission .csv

- Total data : 1
- id : image\_id
- rle : Target

# EDA

## Frequency of data by organ

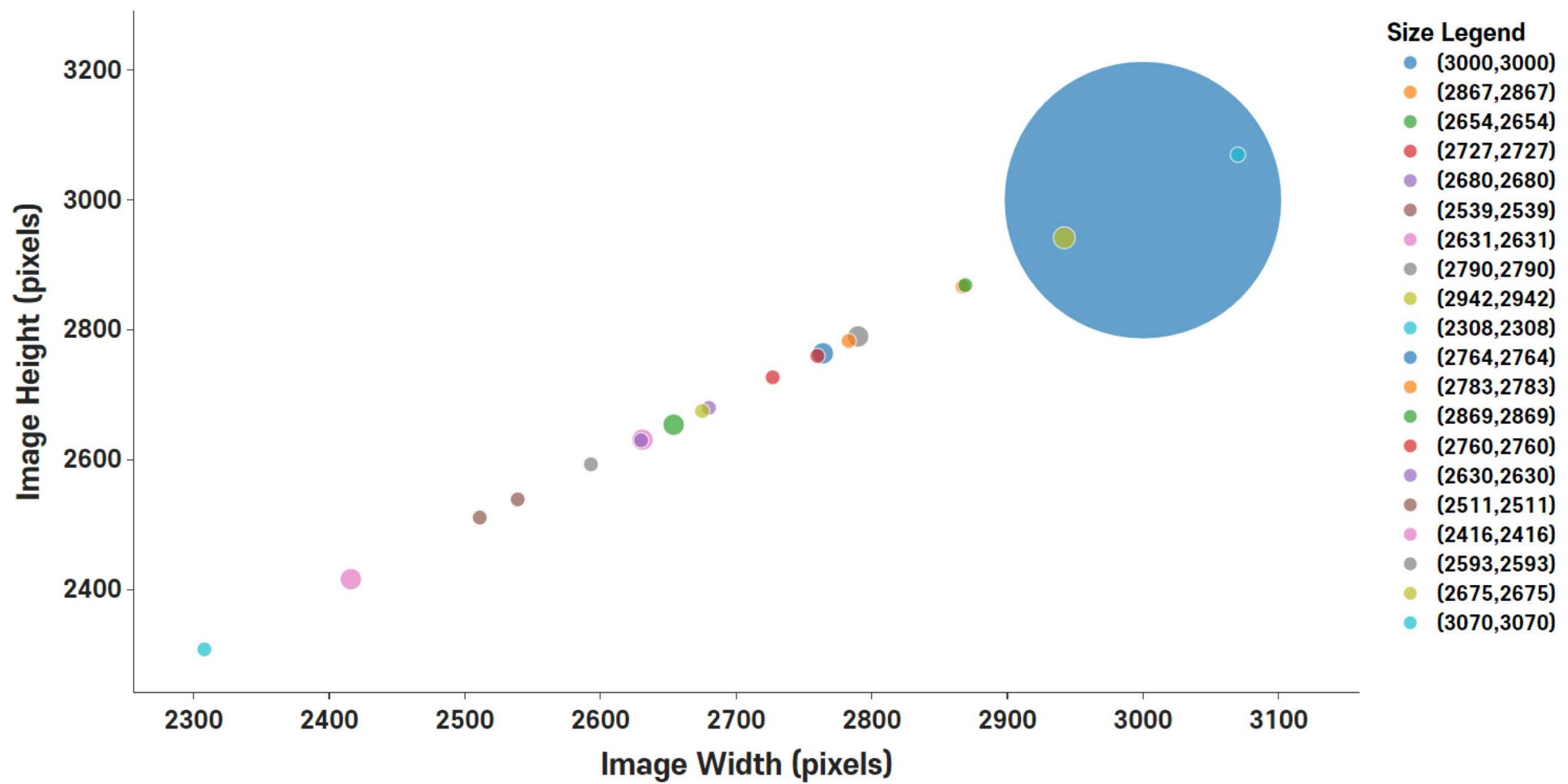




# EDA

## Image size distribution

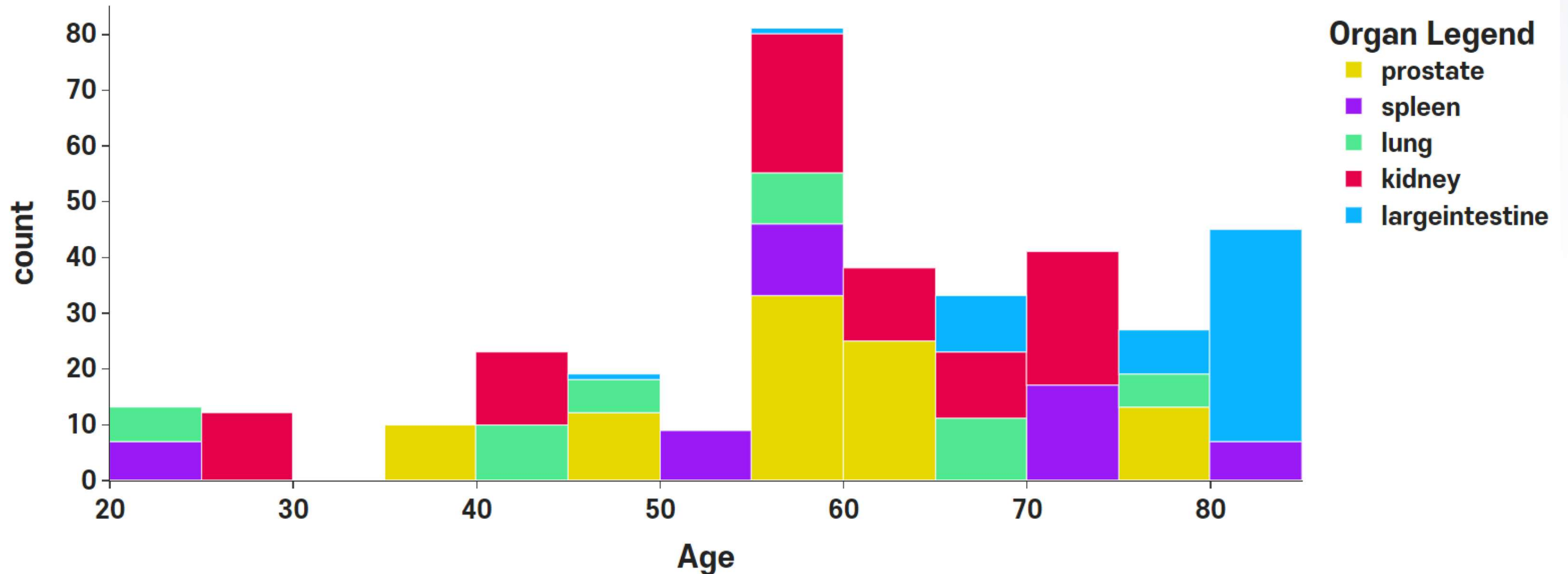
Bubble Chart Showing The Various Image Sizes



# EDA

## Age distribution

Number of Segmentation Masks Per Age Bin by Organ Type

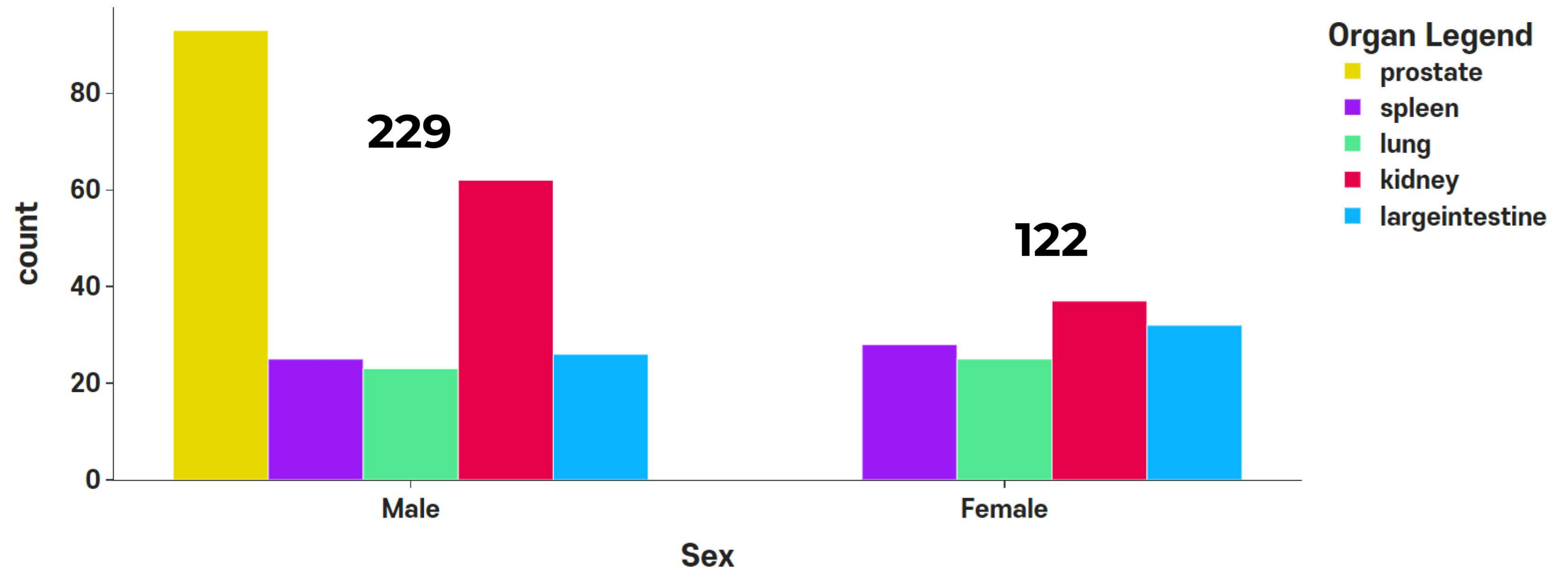




# EDA

## Sex distribution

Distribution of organ data by gender





# EDA

## FTU bounding box Crop by organ

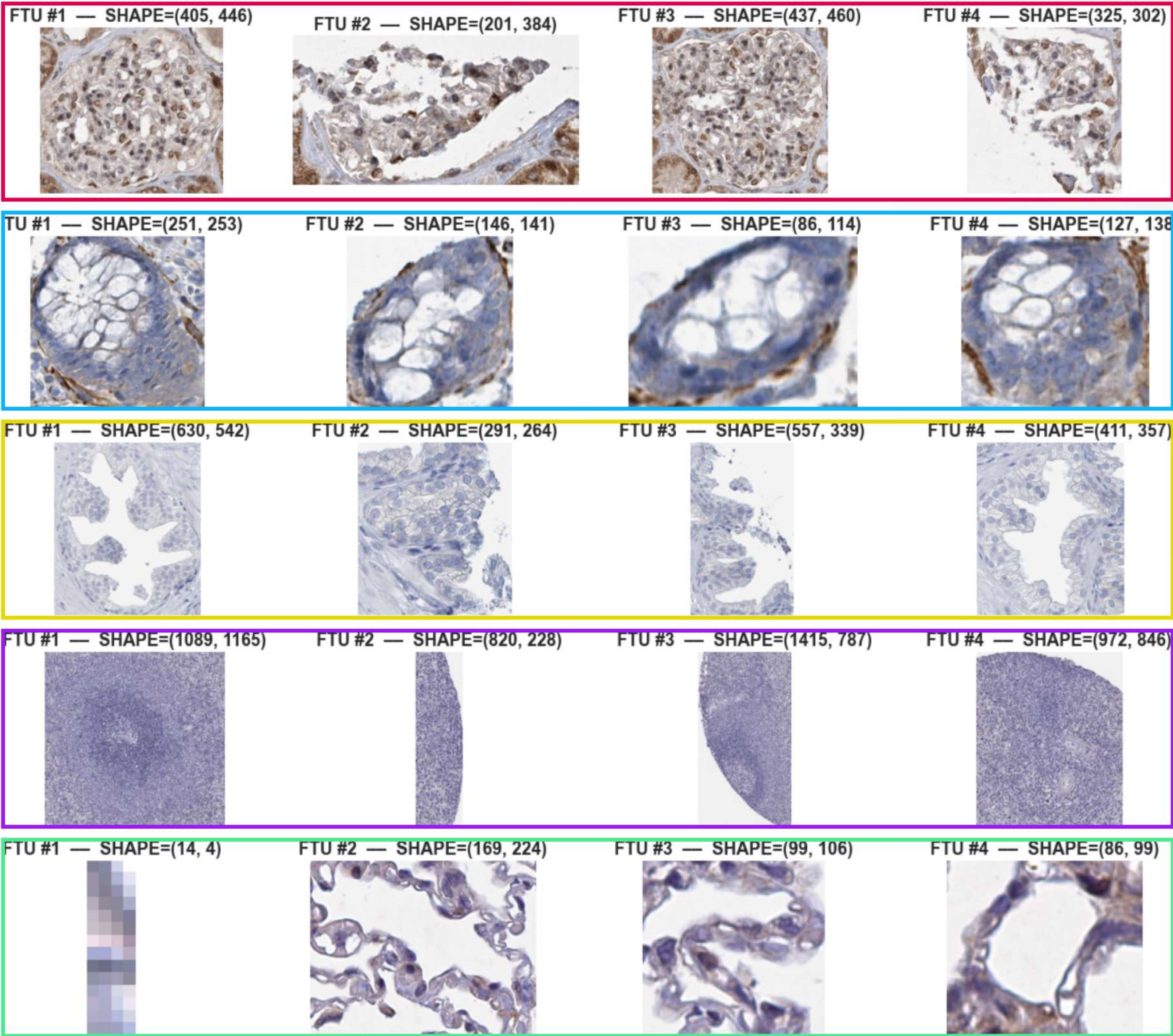
- Crop FTU images with json

- └ Kidney FTU image counts : 337
- └ largeintestine FTU image counts : 3117
- └ lung FTU image counts : 191
- └ prostate FTU image counts : 1097
- └ spleen FTU image counts : 167

- Remove very small images

- └ largeintestine FTU image counts : 14
- └ lung FTU image counts : 3

■ prostate  
■ spleen  
■ lung  
■ kidney  
■ largeintestine





# EDA

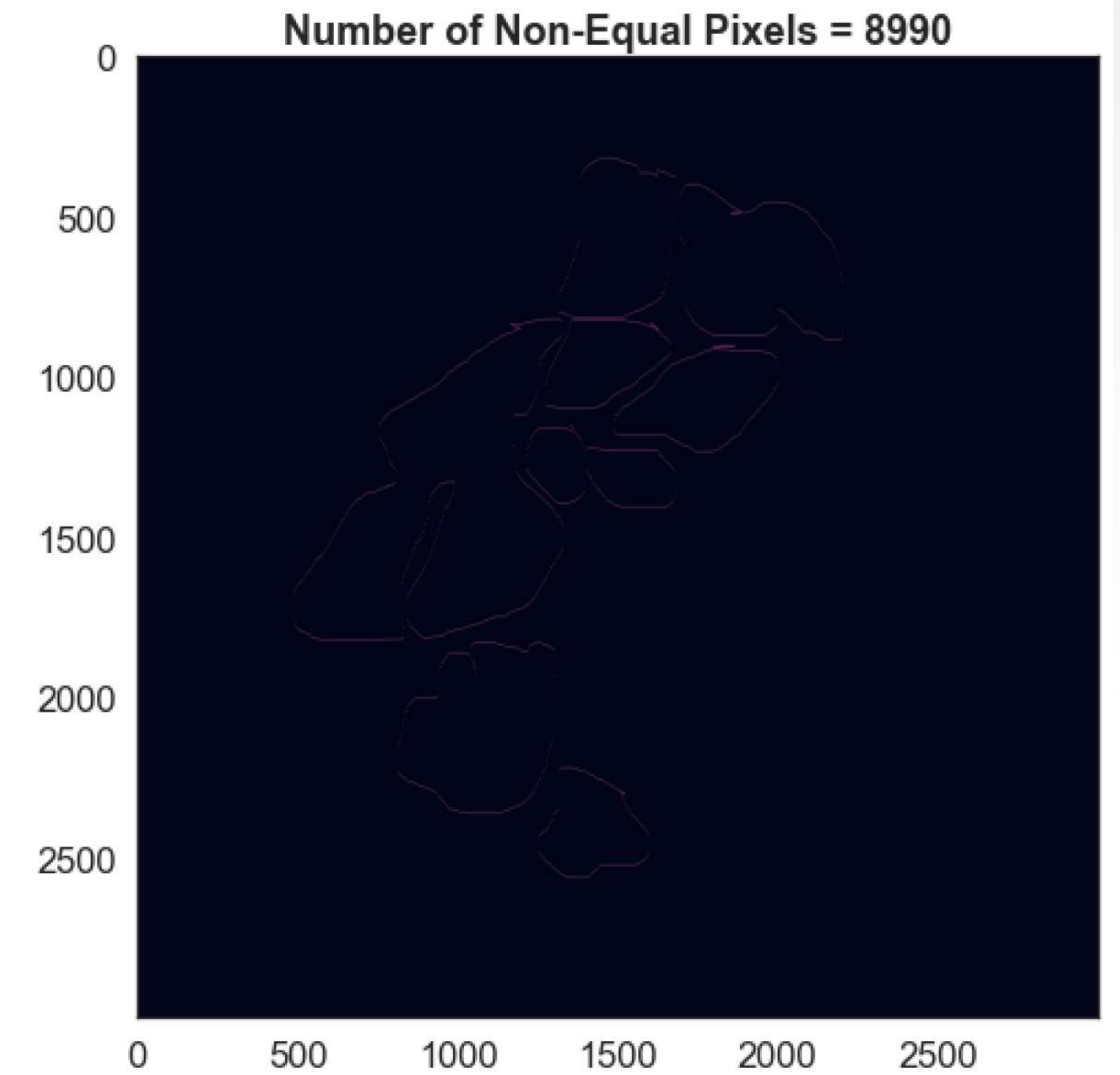
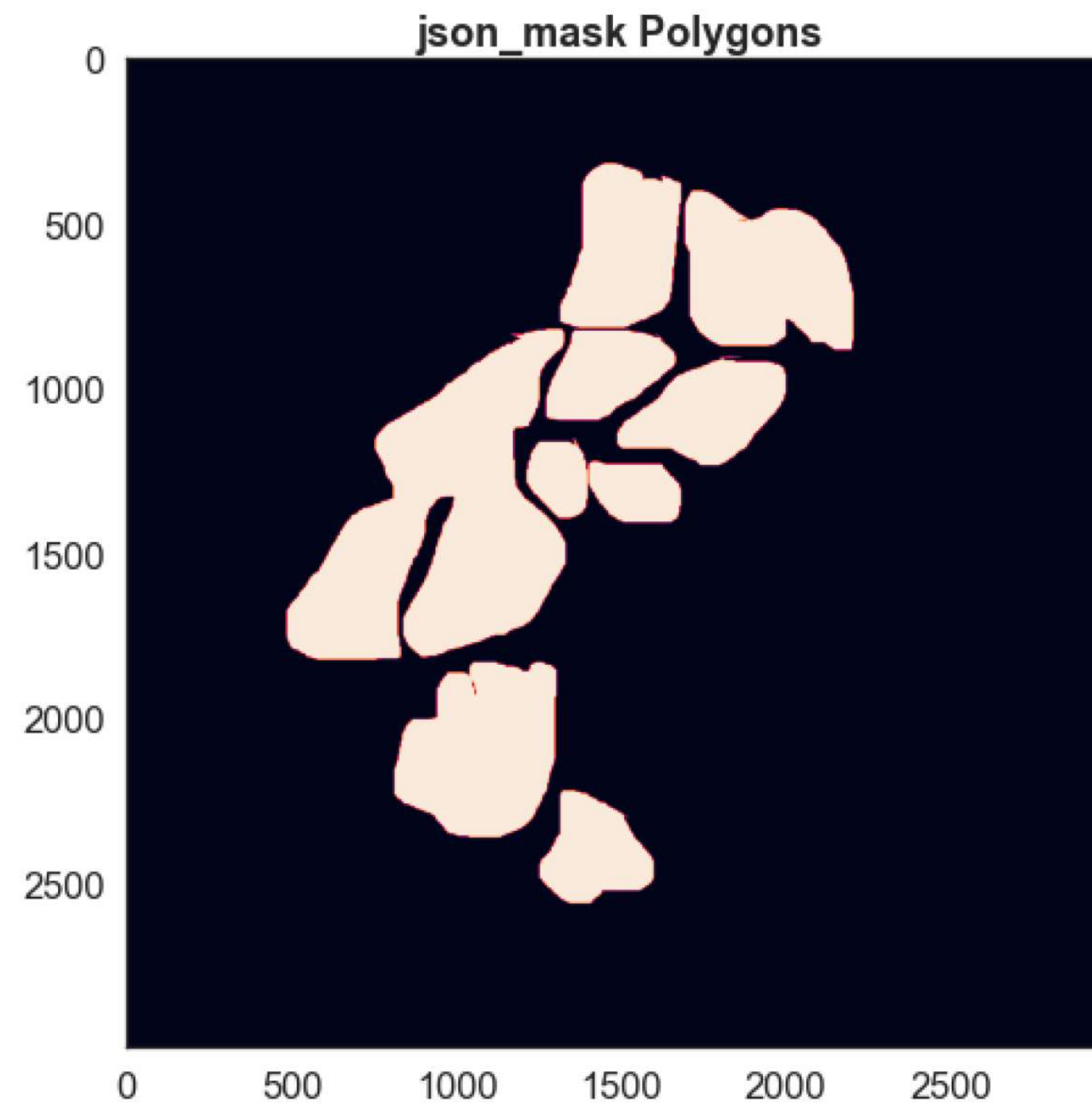
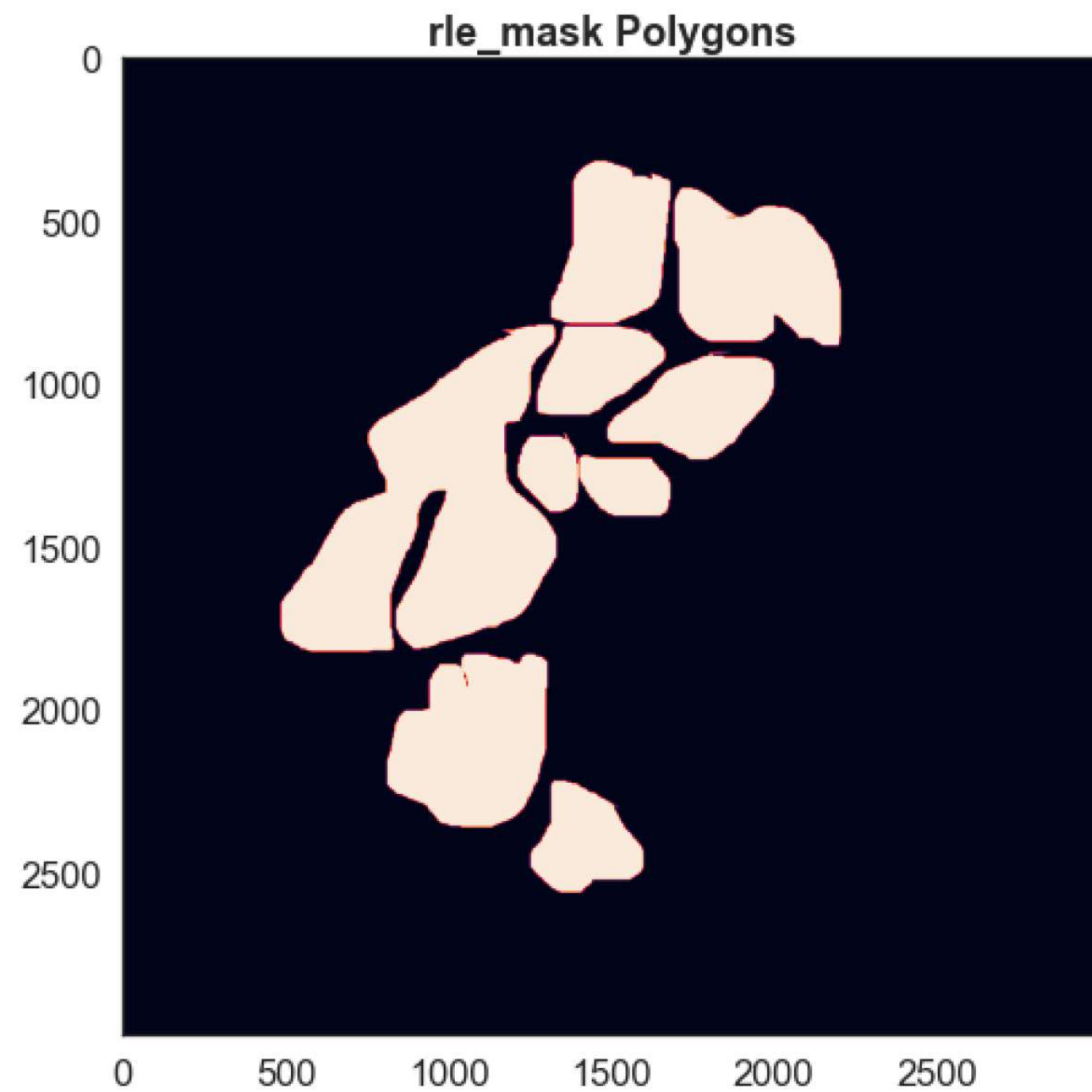
## Average FTUs bounding box size by organ

Organ	Avg_area	Avg_area_μm	Avg_height	Avg_width	Avg_shape_μm	Count
Kidney	106690.4	17070.4	456.5	303.5	(182.6, 121.4)	337
Largeintestine	50862.1	8137.9	357.0	143.5	(142.8, 57.4)	3103
Lung	119583.7	19133.3	299.5	140.5	(119.8, 56.2)	188
Prostate	193169.8	30907.1	421.5	433.5	(168.6, 173.4)	1097
Spleen	438419.0	70147.0	675.0	400.0	(270.0, 160.0)	167

- Is the presented characterization of FTUs useful for understanding individual differences?
- Is it possible to predict FTU area size distribution, given age and sex info across all organs?

# EDA

## Difference between rle\_maks and json\_mask





**Thank you**

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