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Recent Developments in the Transmission of Human Life

Endometrial Live Imaging Analysis

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Endometrial Live Imaging Analysis

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Israel

Faculty Disclosure

I am the CEO and a co-founder of
Fertigo Medical Ltd.,
a shareholder and an option holder

Why?

in-vivo (live) and (realtime) analysis

As opposed to ex-vivo/in-vitro

As opposed to off-line analysis

- React to the image in real time, while imaging continues
- Live imaging: get dynamics too –
  correlate with other (realtime) parameters
- No need to wait for results (e.g., histology)

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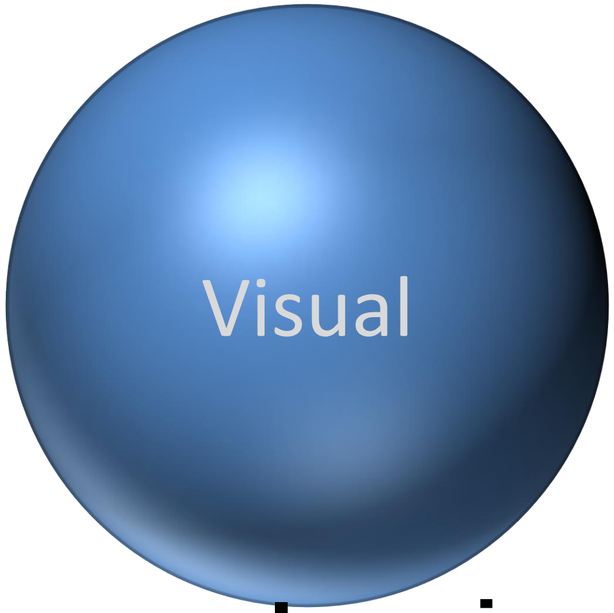
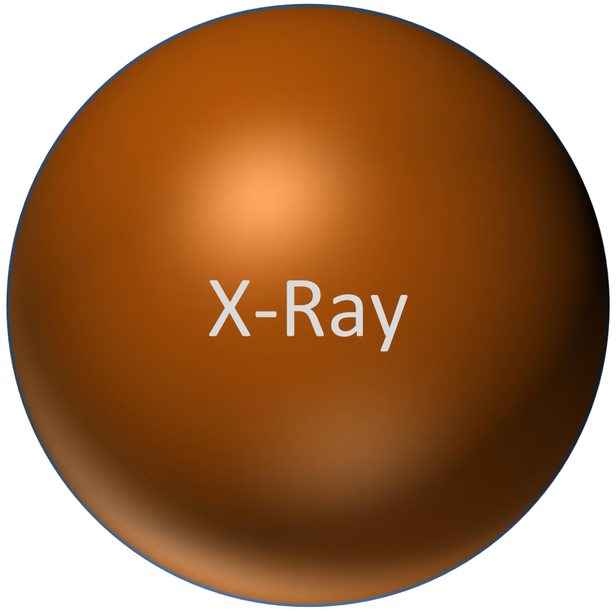
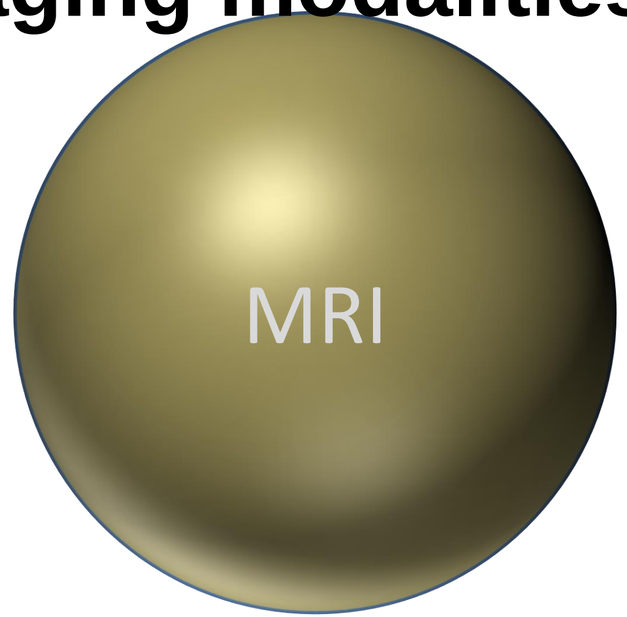


Imaging modalities





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Electro-magnetic waves

Visual

Sound waves

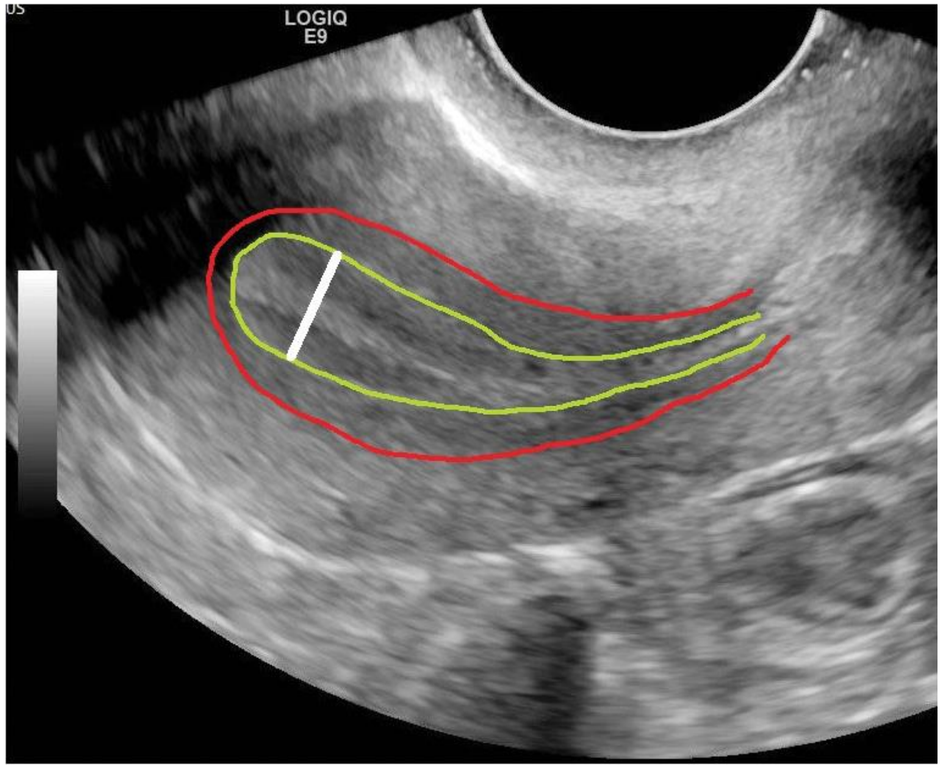
Ultrasound

OCT

MRI

X-Ray

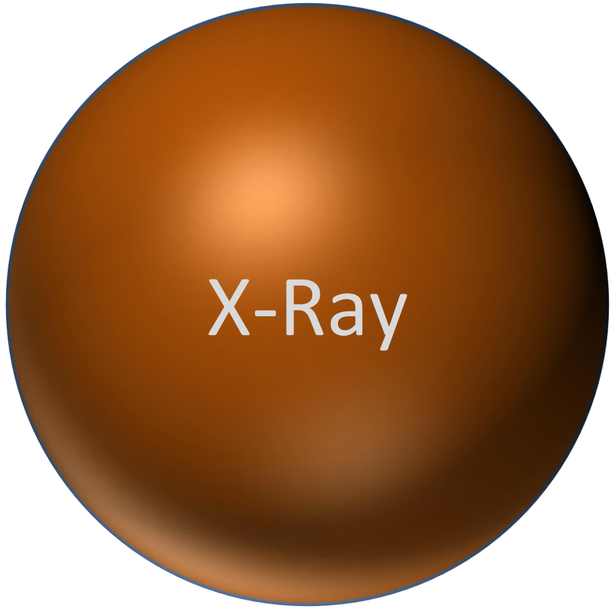
Sensitive to tissue refractive index (“hardness”)
Main limitation: >~1mm resolution



From Zagoria RJ, Brady CM, Dyer RB. *Genitourinary Imaging: the Requisites* , ed 3. Philadelphia: Elsevier; 2016.

Sensitive to tissue water content (“softness”)
Main limitation: >~1mm resolution

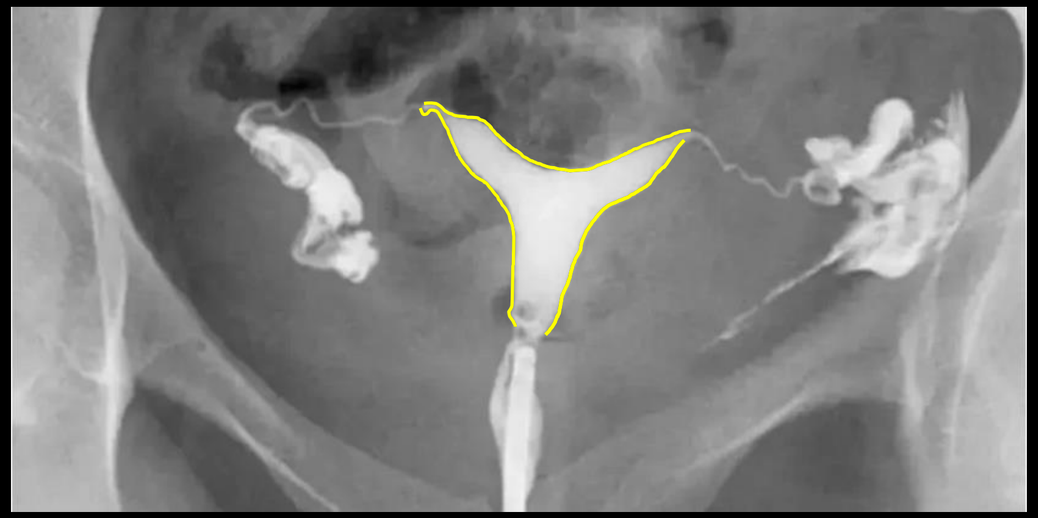
From Zagoria RJ, Brady CM, Dyer RB. *Genitourinary Imaging: the Requisites* , ed 3. Philadelphia: Elsevier; 2016.



Sensitive to radiation absorption

Main limitations:

- Usually needs introduction of a contrast agent
- Single line (if not CT)

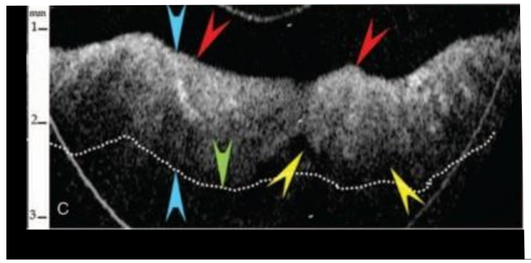


Low, 1D resolution

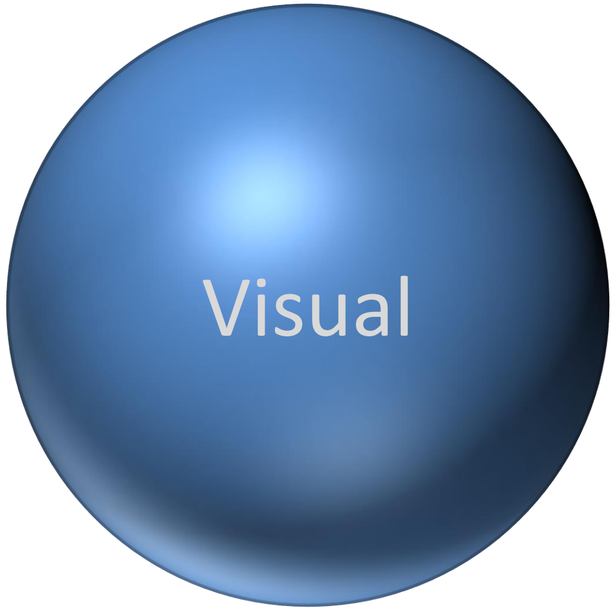
Either white or laser light, interference.

Main limitations:

- Long procedure duration, cumbersome acquisition
- No color
- **Currently, none in-vivo**



From: Law TSM, Wu F, Xu H, Wang CC, Li TC. Endometrium imaging using real-time rotational optical coherence tomography imaging system: A pilot, prospective and ex-vivo study. Medicine (Baltimore). 2019



Either white or broadband (filter) light, optics.

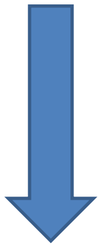
Main limitations:

- (minimally) invasive
- Distention
- Usually fiber-bundle, proximal end camera

From: Law TSM, Wu F, Xu H, Wang CC, Li TC. Endometrium imaging using real-time rotational optical coherence tomography imaging system: A pilot, prospective and ex-vivo study. Medicine (Baltimore). 2019

“Regular” (common) Hysteroscopy

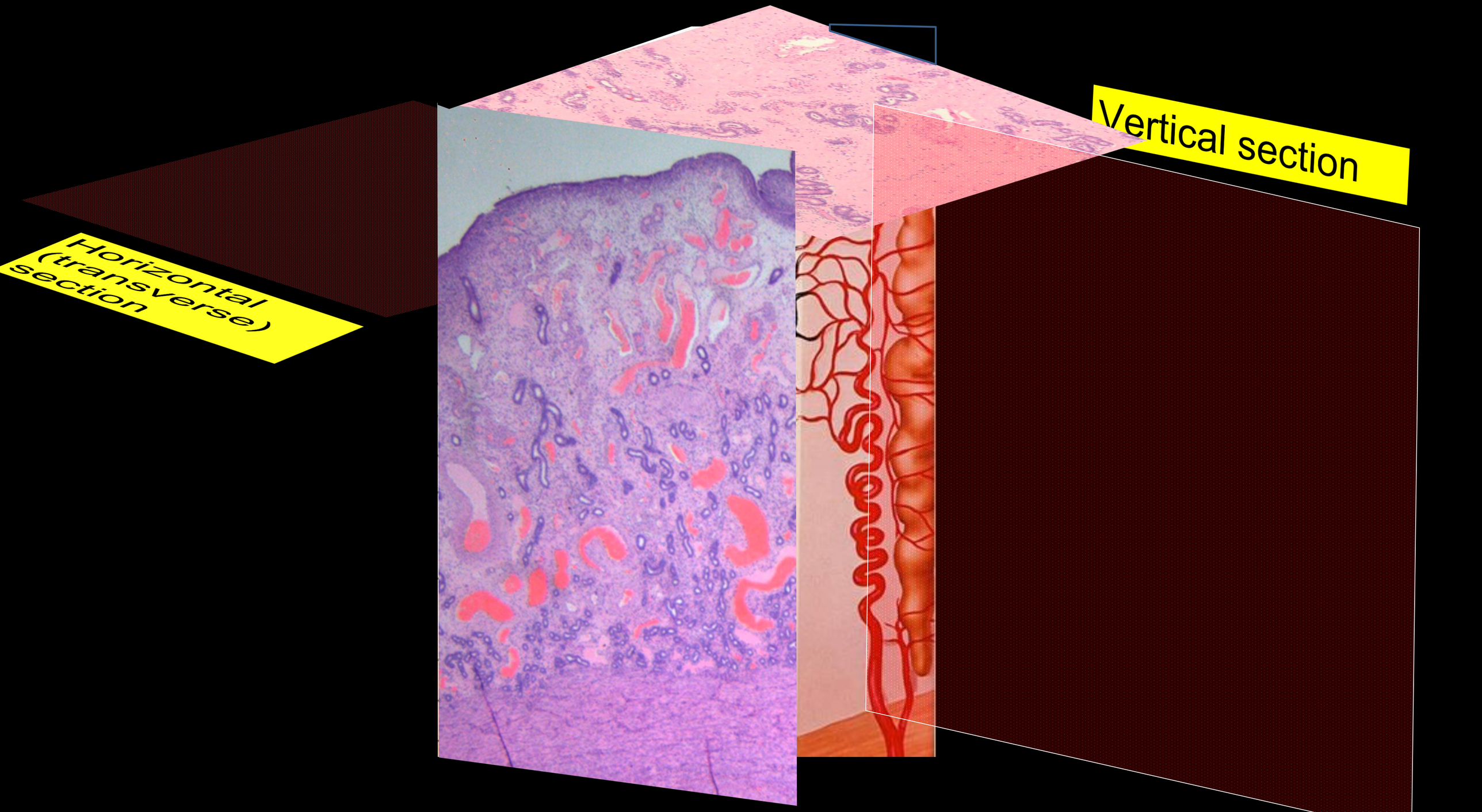
- General view of the uterus
  - Sensitive to topographical features of the endometrium (usually > 2-5 mm)
- Anatomy rather than morphology

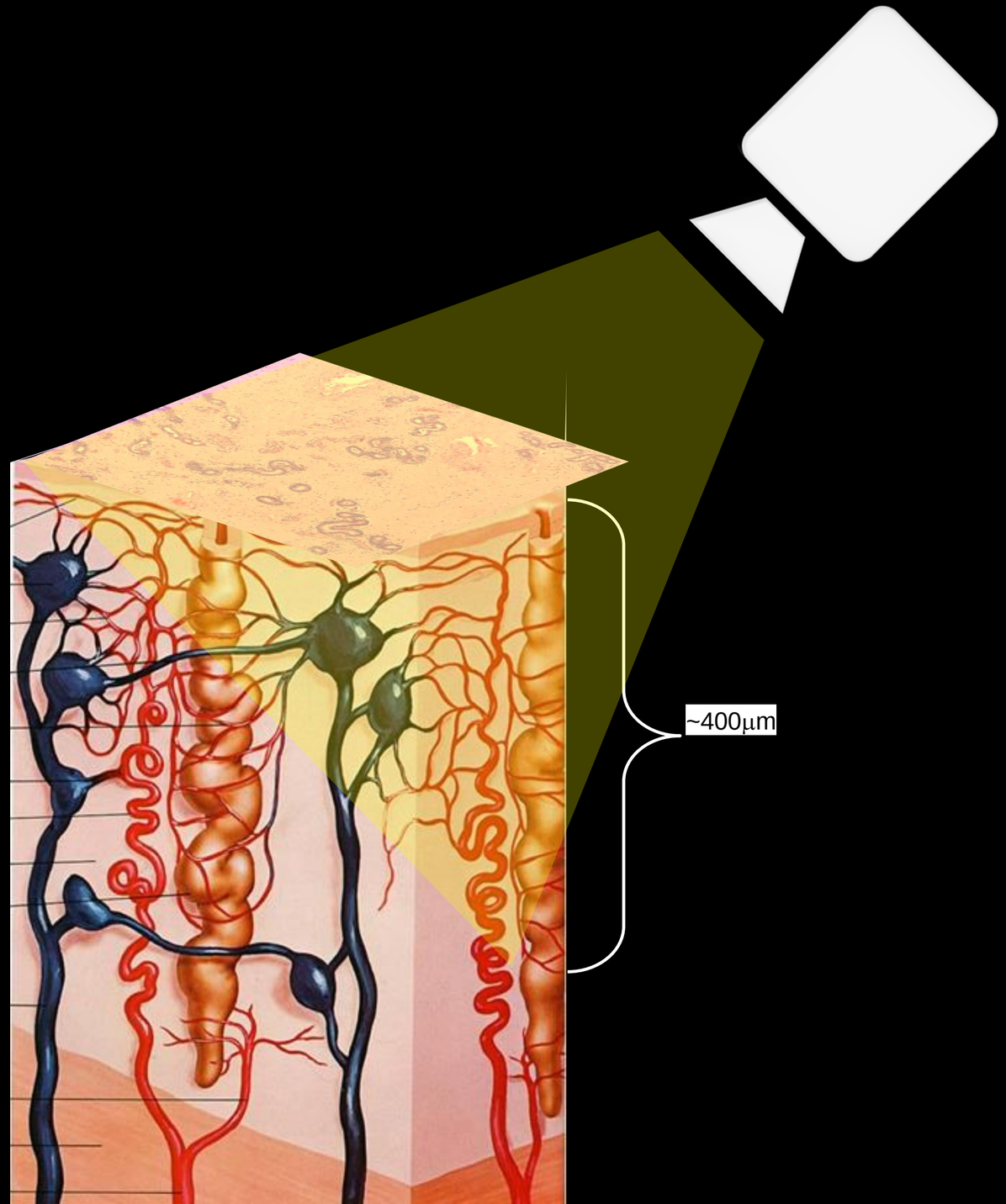


Identify **big** anomalies
(structural irregularities, pathologies: adhesions, strictures, polyps, etc.) always on the anatomical level

Micro-Hysteroscopy

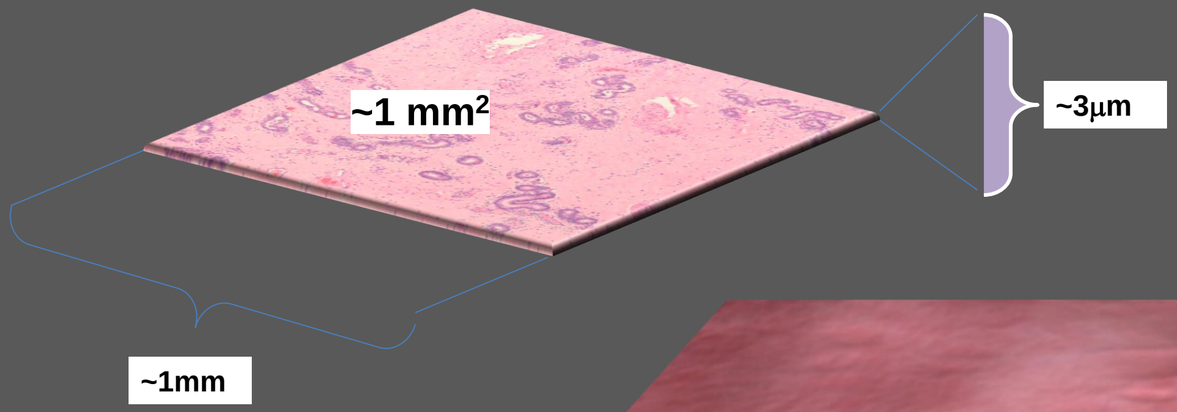
The fine structure (morphology) of the endometrium

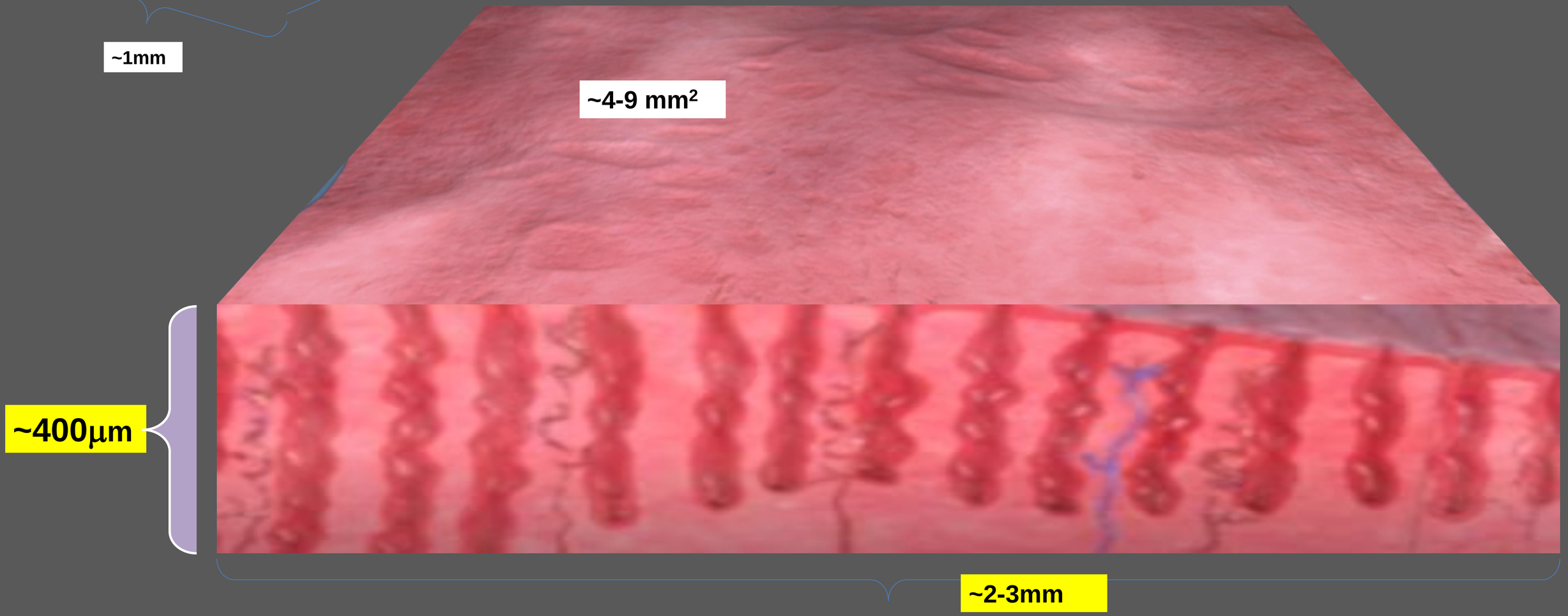

Horizontal
(transverse)
section
Vertical section


~400μm

Histology

In-vivo (visual)

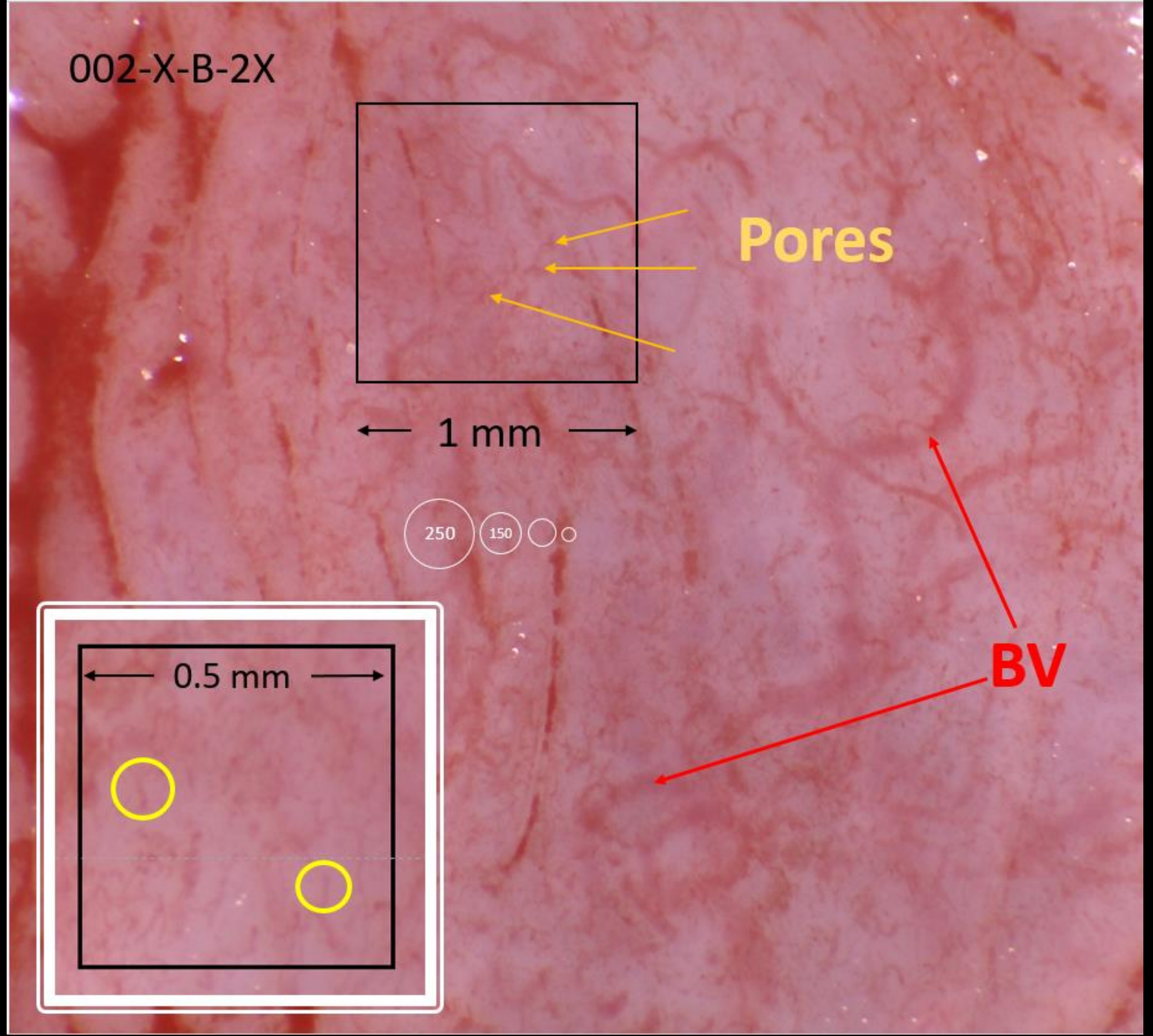


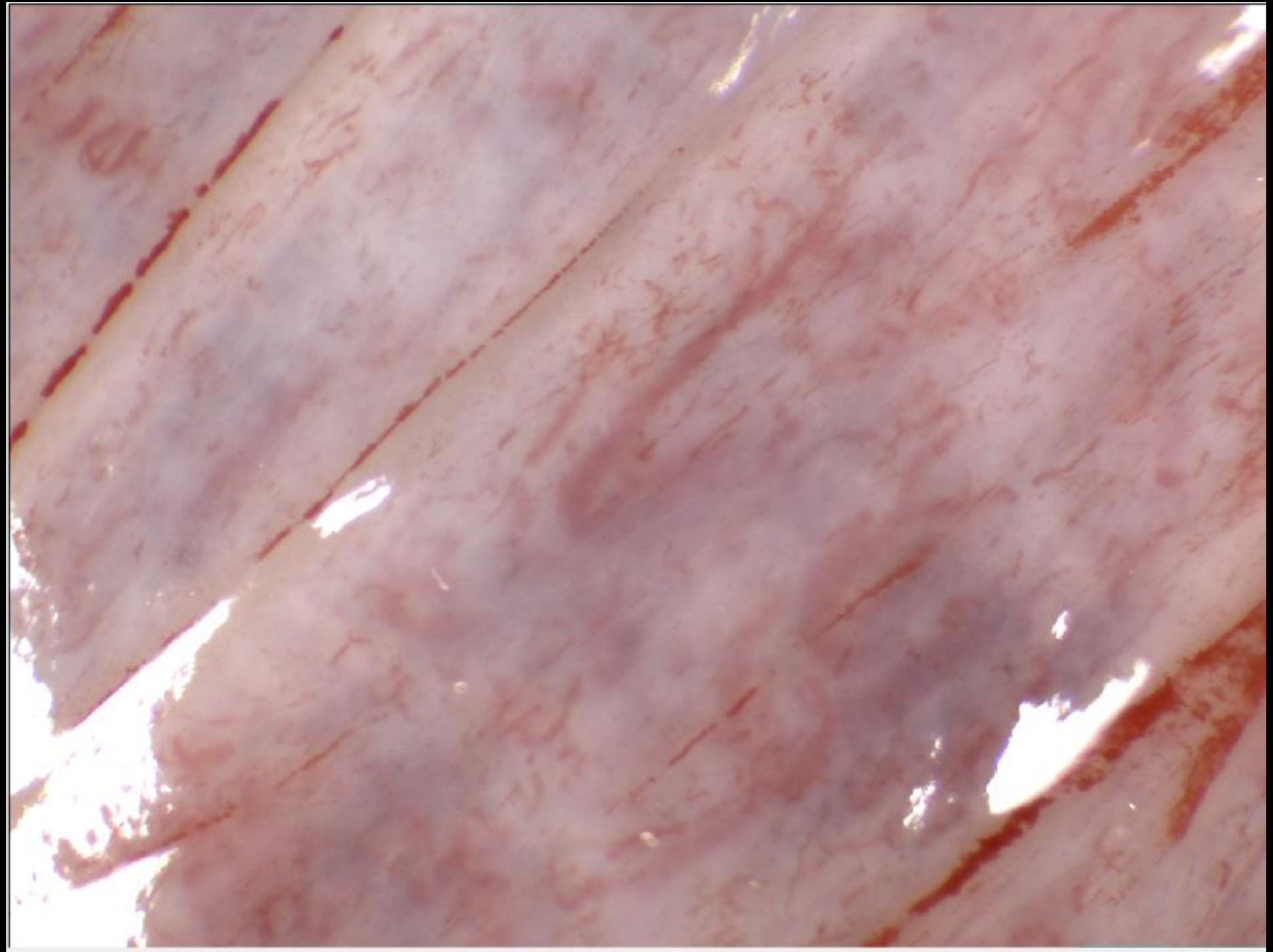


Analysis

Almost **non-existent** in “regular” hysteroscopy

Essential in mini-hysteroscopy


002-X-B-2X
Pores
1 mm
250
150
0.5 mm
BV



~~Artificial~~ **Intelligent** Image Analysis

The fine structure (morphology) of the endometrium

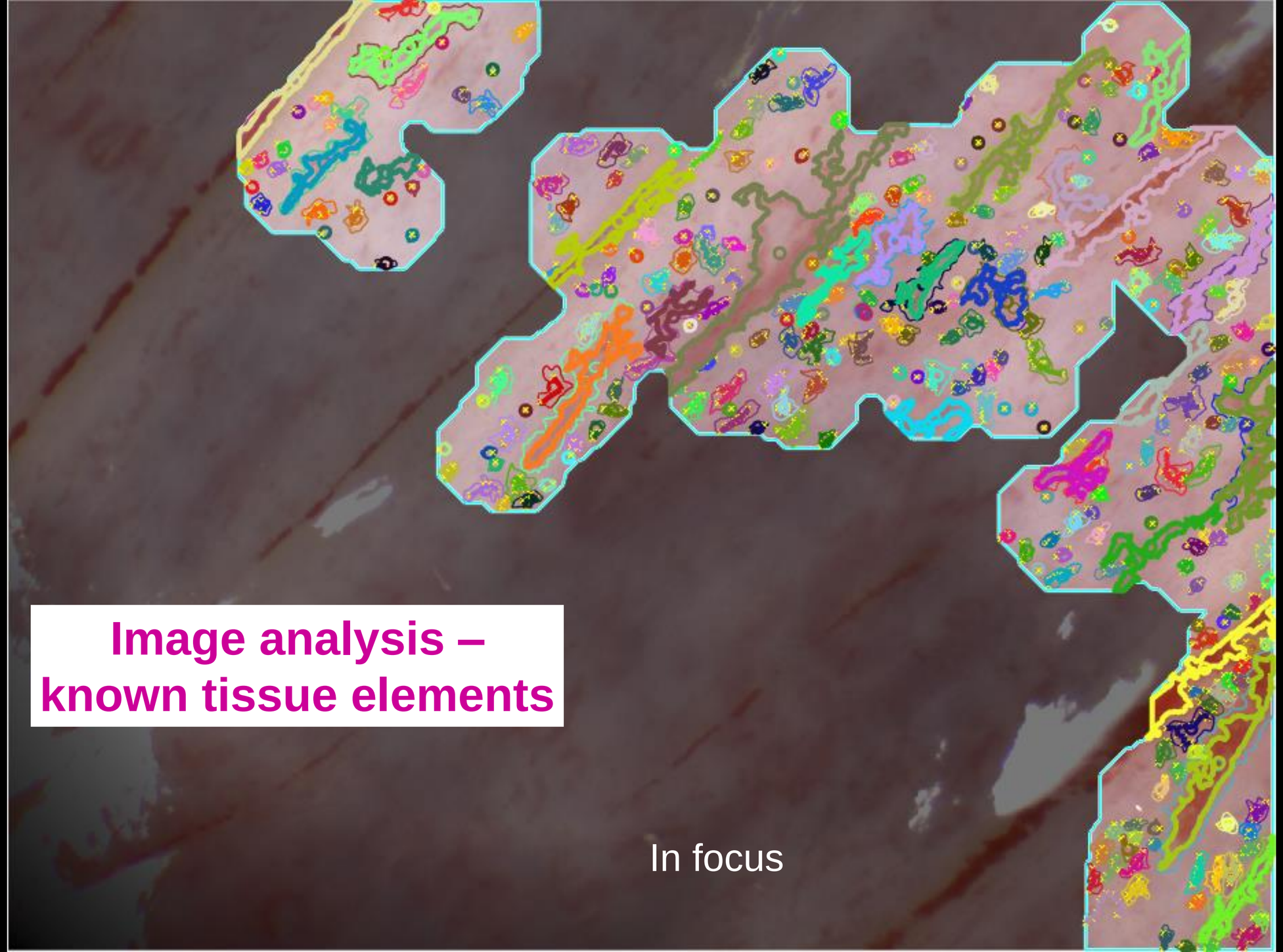


Image analysis –
known tissue elements
In focus

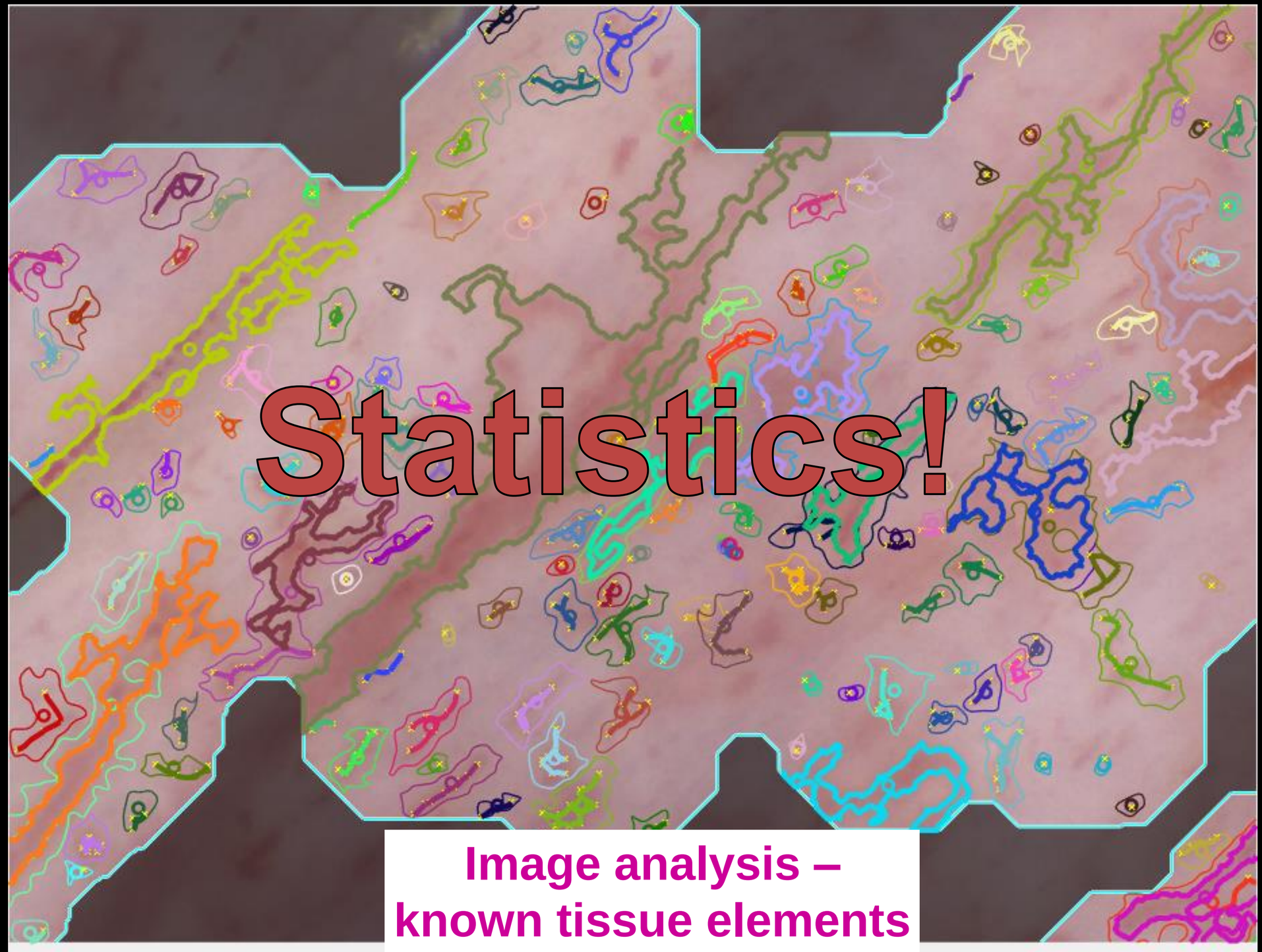


Image analysis –
known tissue elements

Two types of tasks

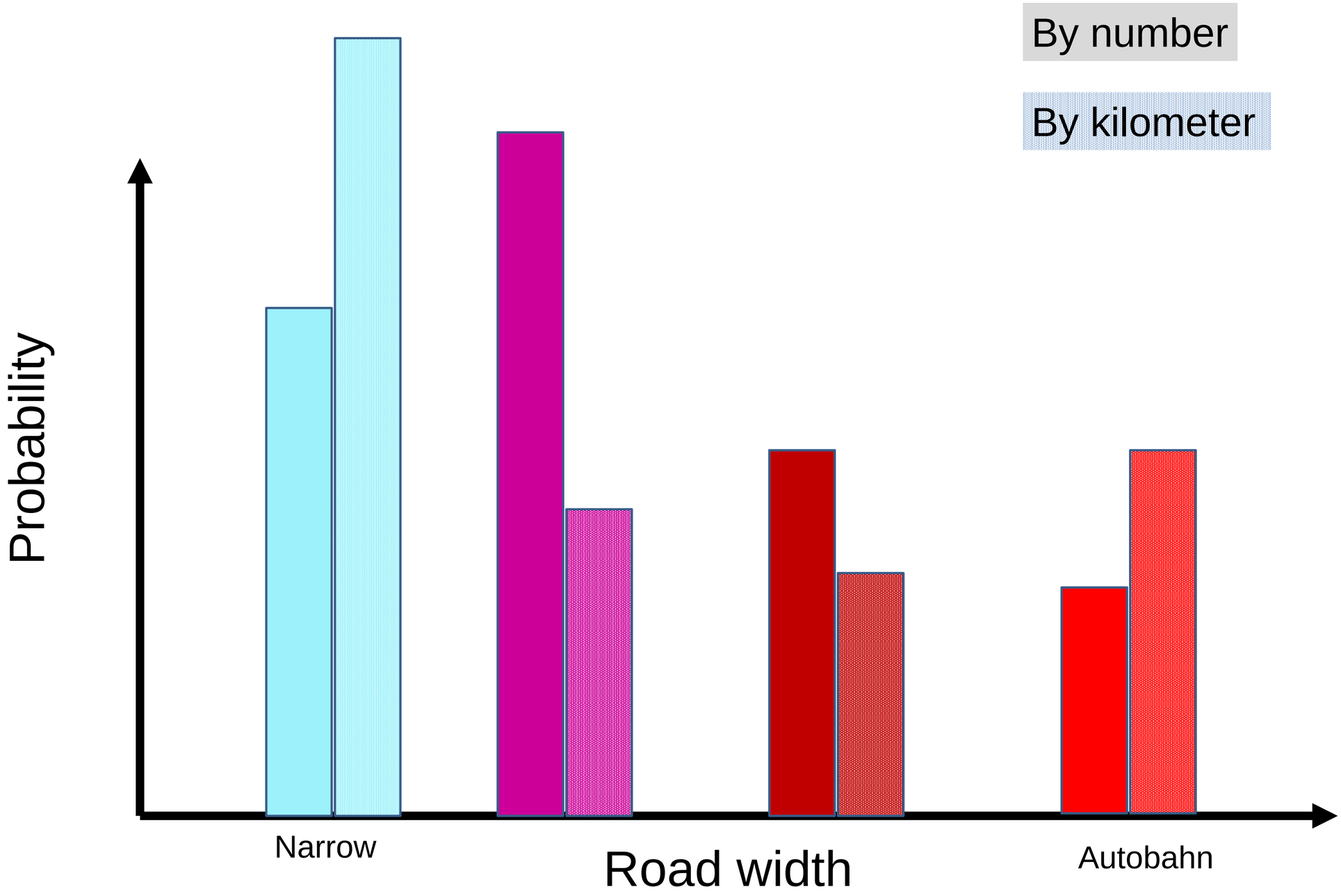
Tissue (endometrium) general status & characterization

Identify anomalies

Mathematical representation: statistics

Mathematical representation: structures

What do we mean by “Statistics”?



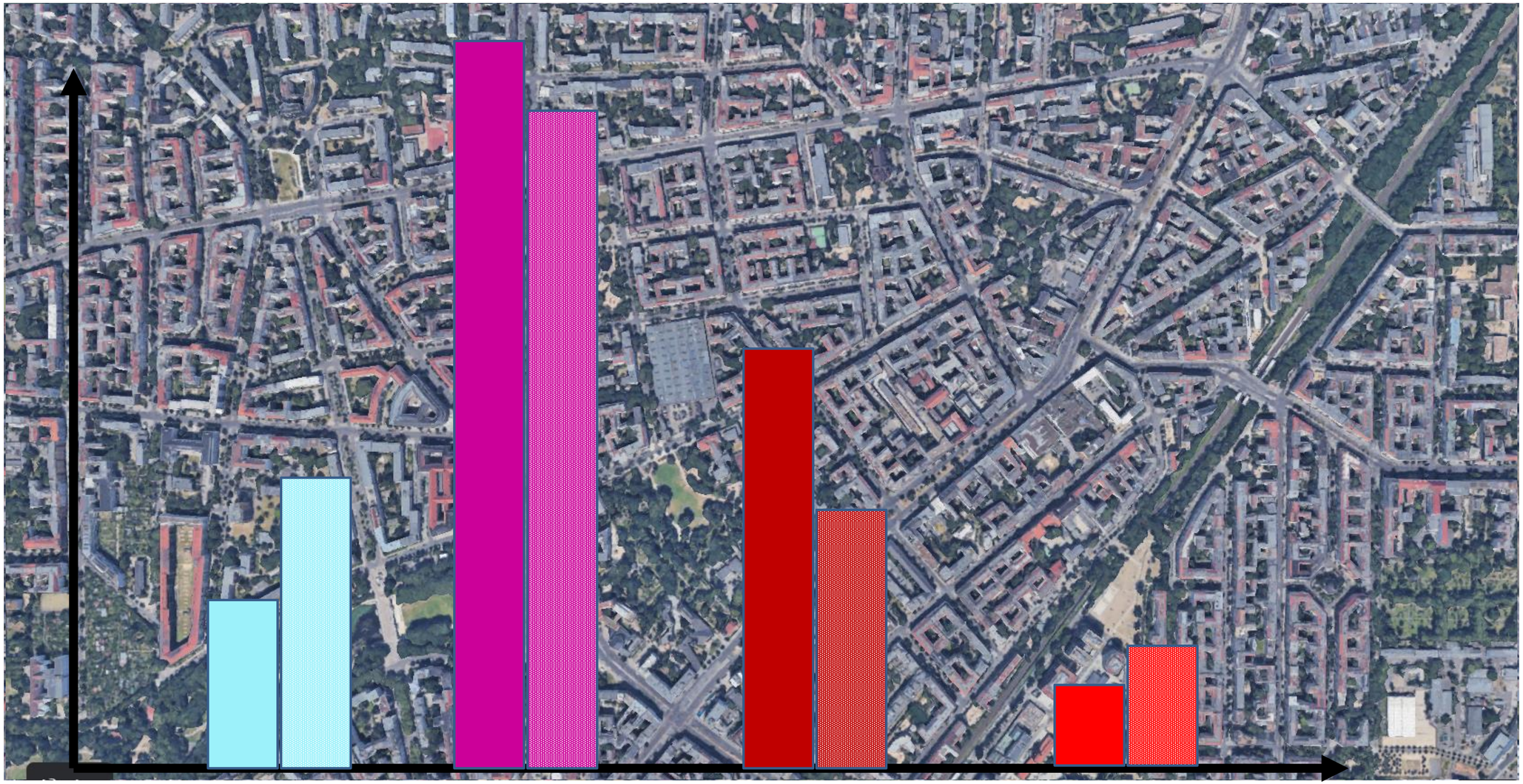
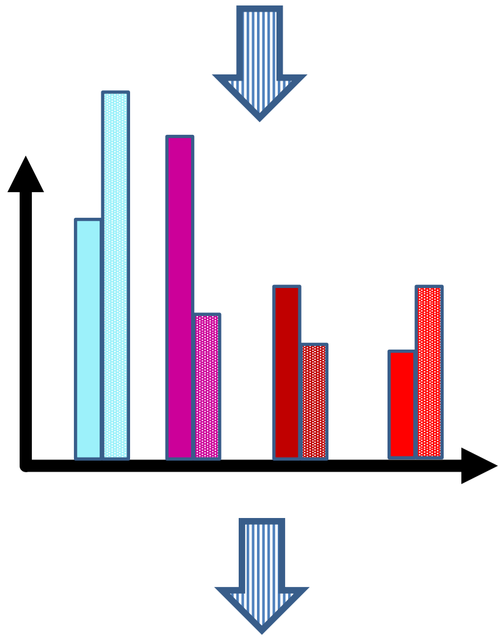
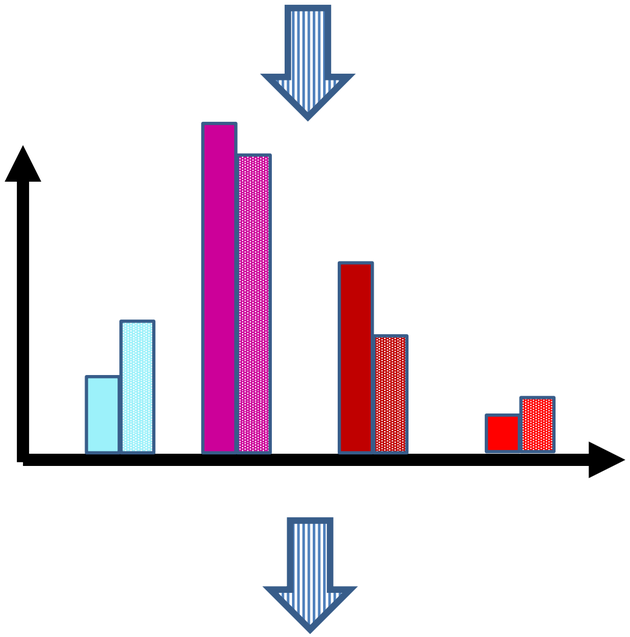


Image:

Calculate:



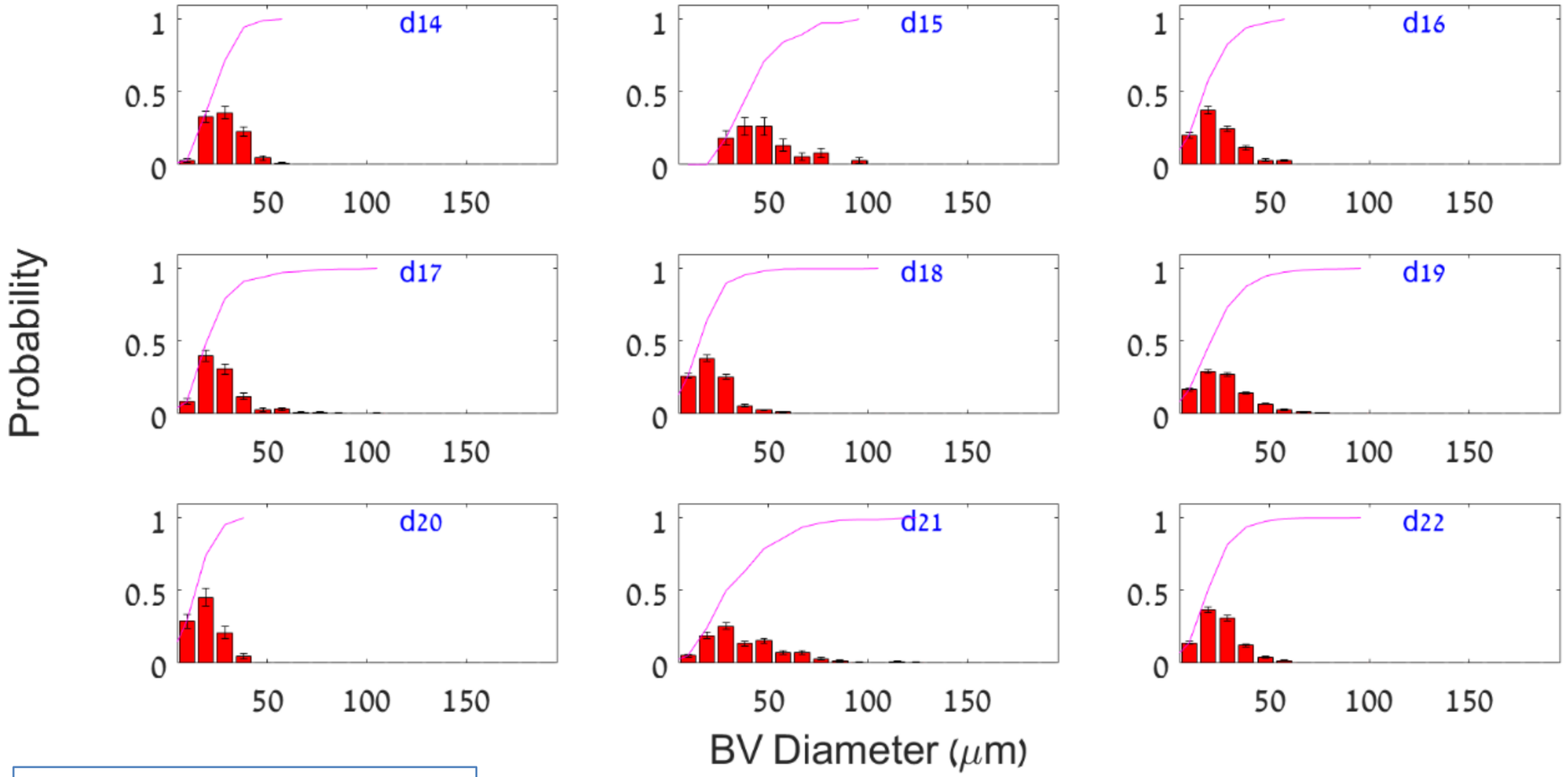


Diagnose:

Industrial

Residential

Endometrium blood vessel diameter distribution day by day



Or et al., 2023, submitted

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AI

Artificial Intelligence Image Analysis

The fine structure (morphology) of the endometrium

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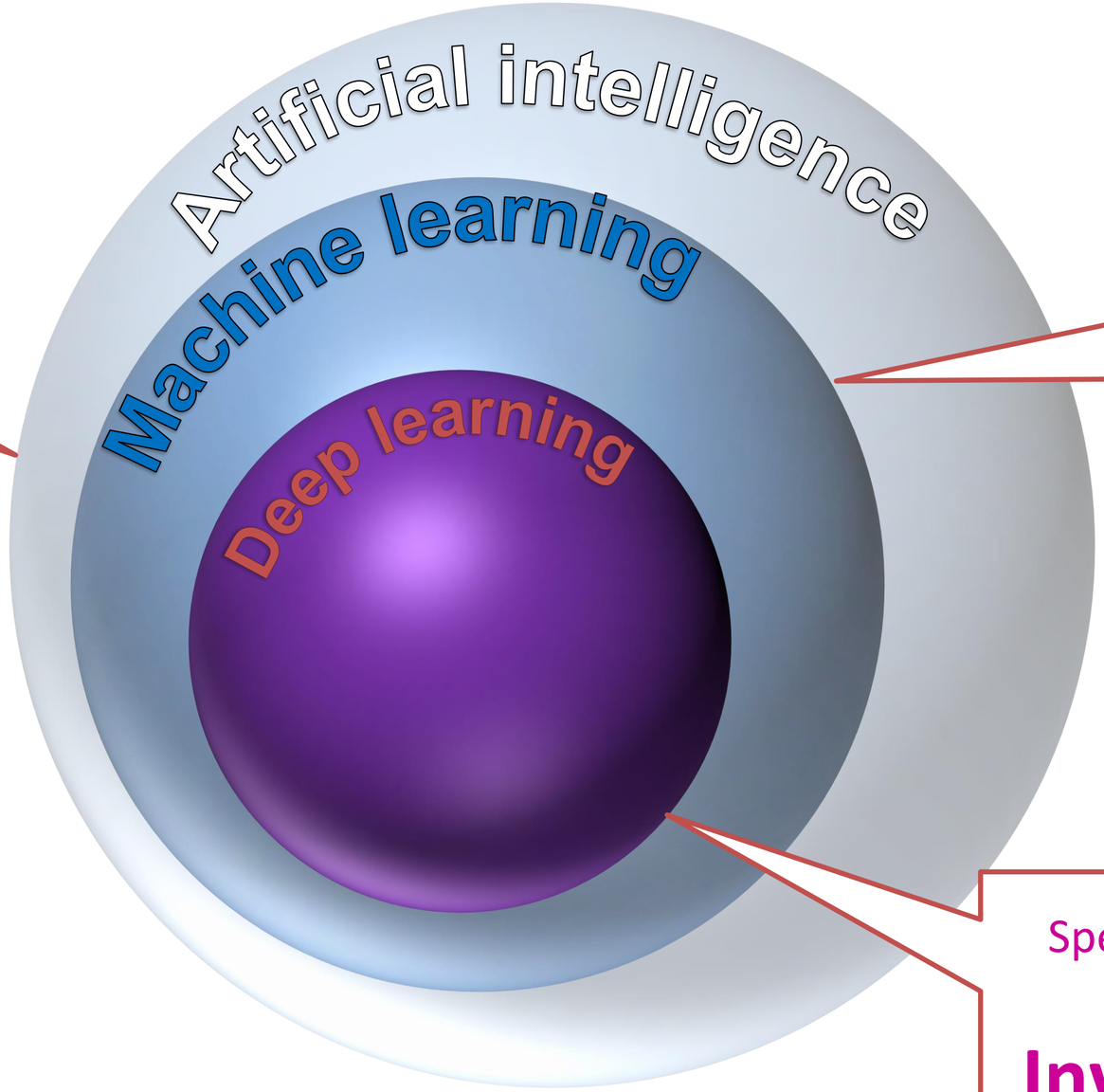
Abstraction,
Generalization,
Draw conclusions



Get examples –
find rules

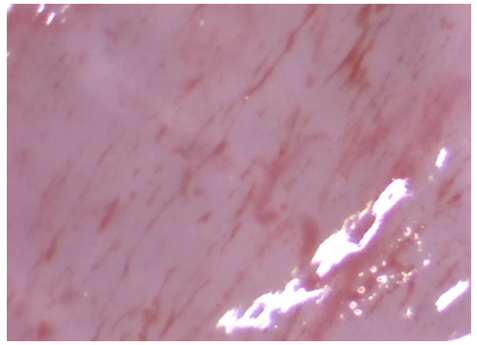
Specific algorithm
family

Invent rules

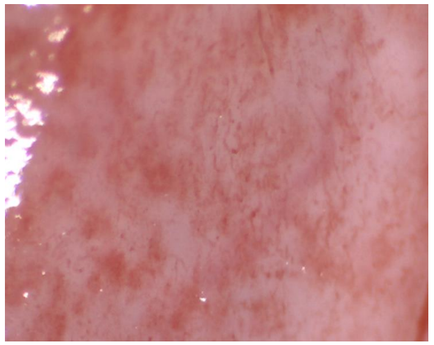
Supervised Vs. Unsupervised

E.g.

Edema



“Other”
or “inflammatory”



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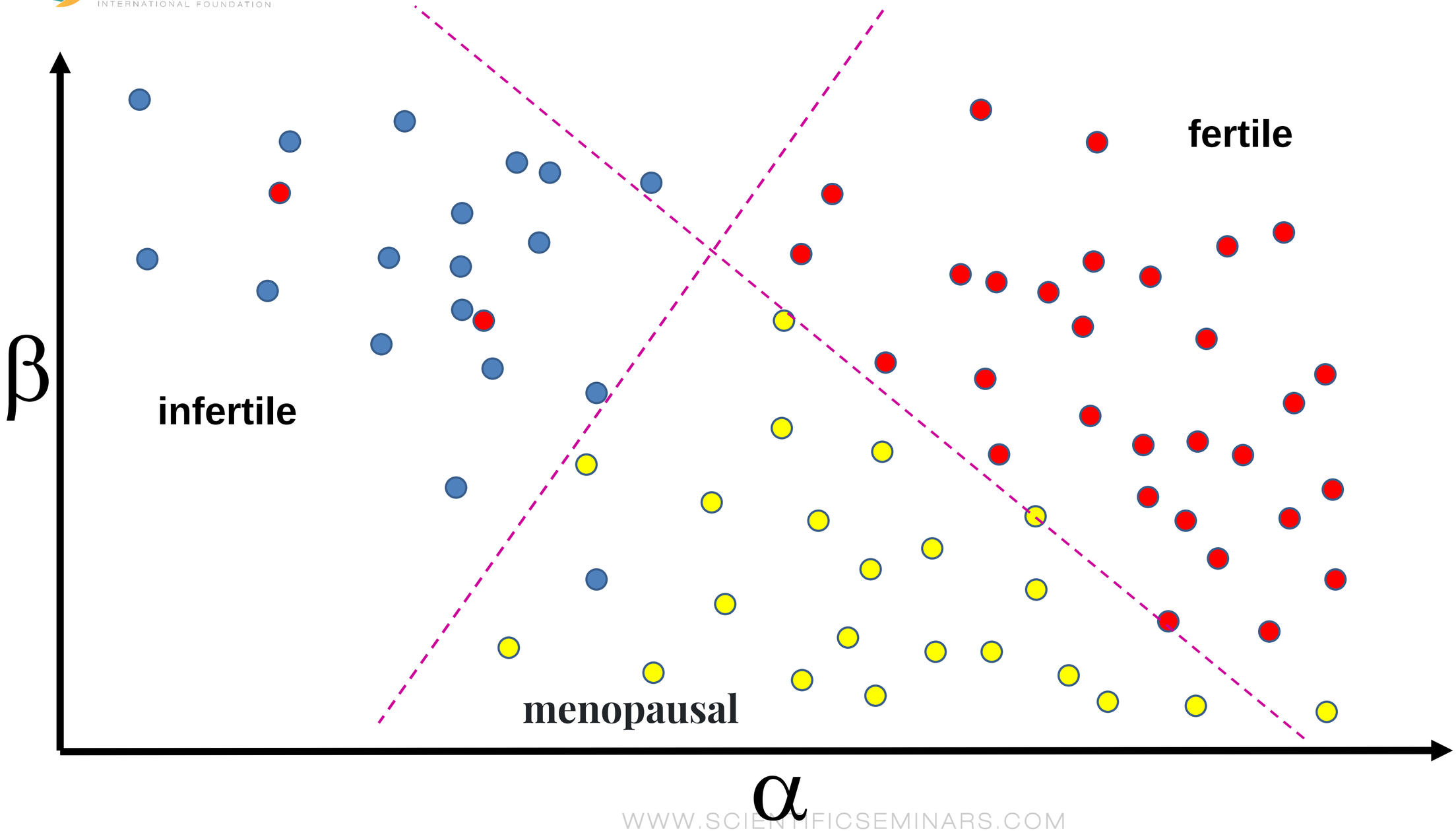
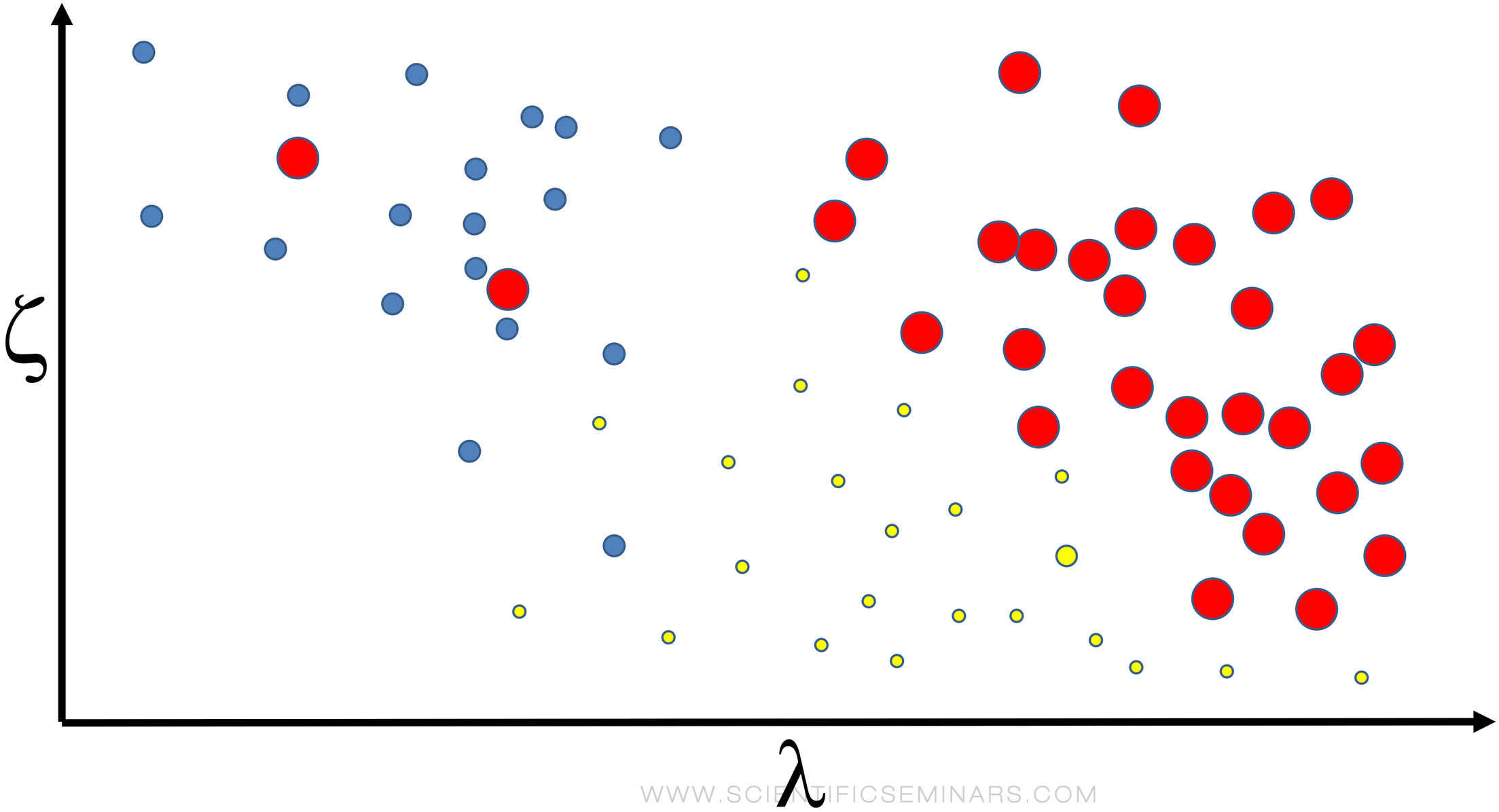
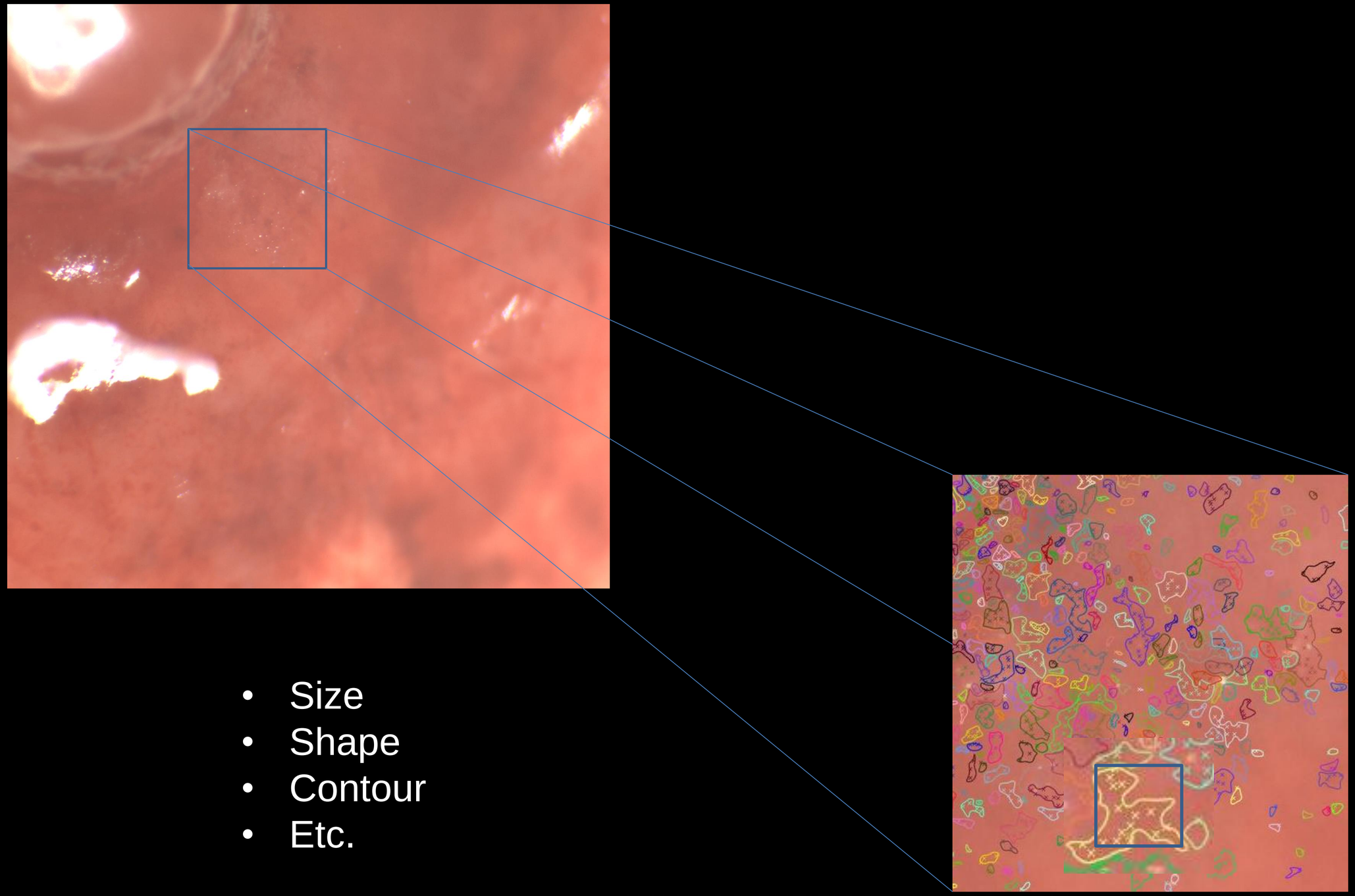
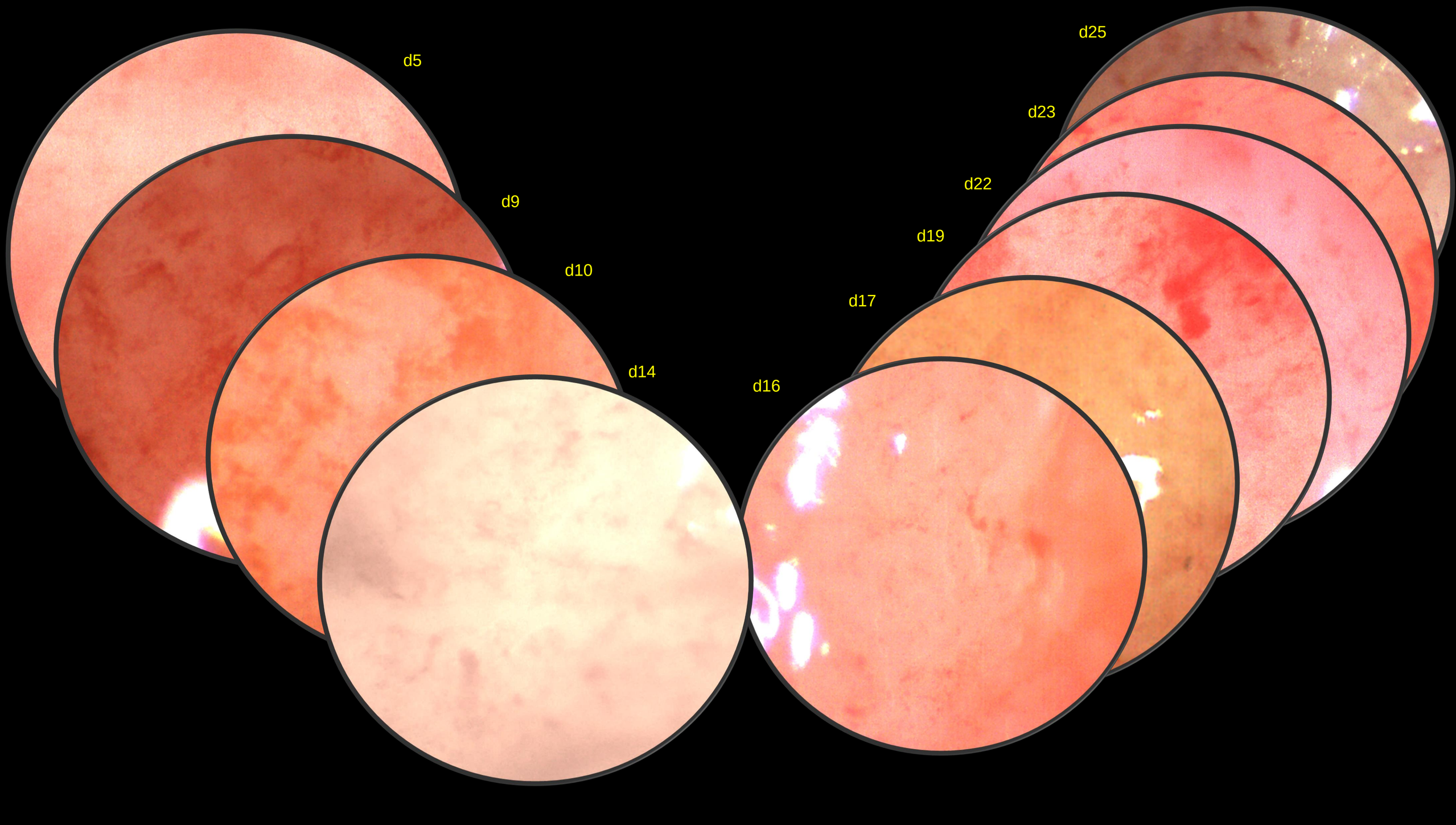
Labeled (supervised)

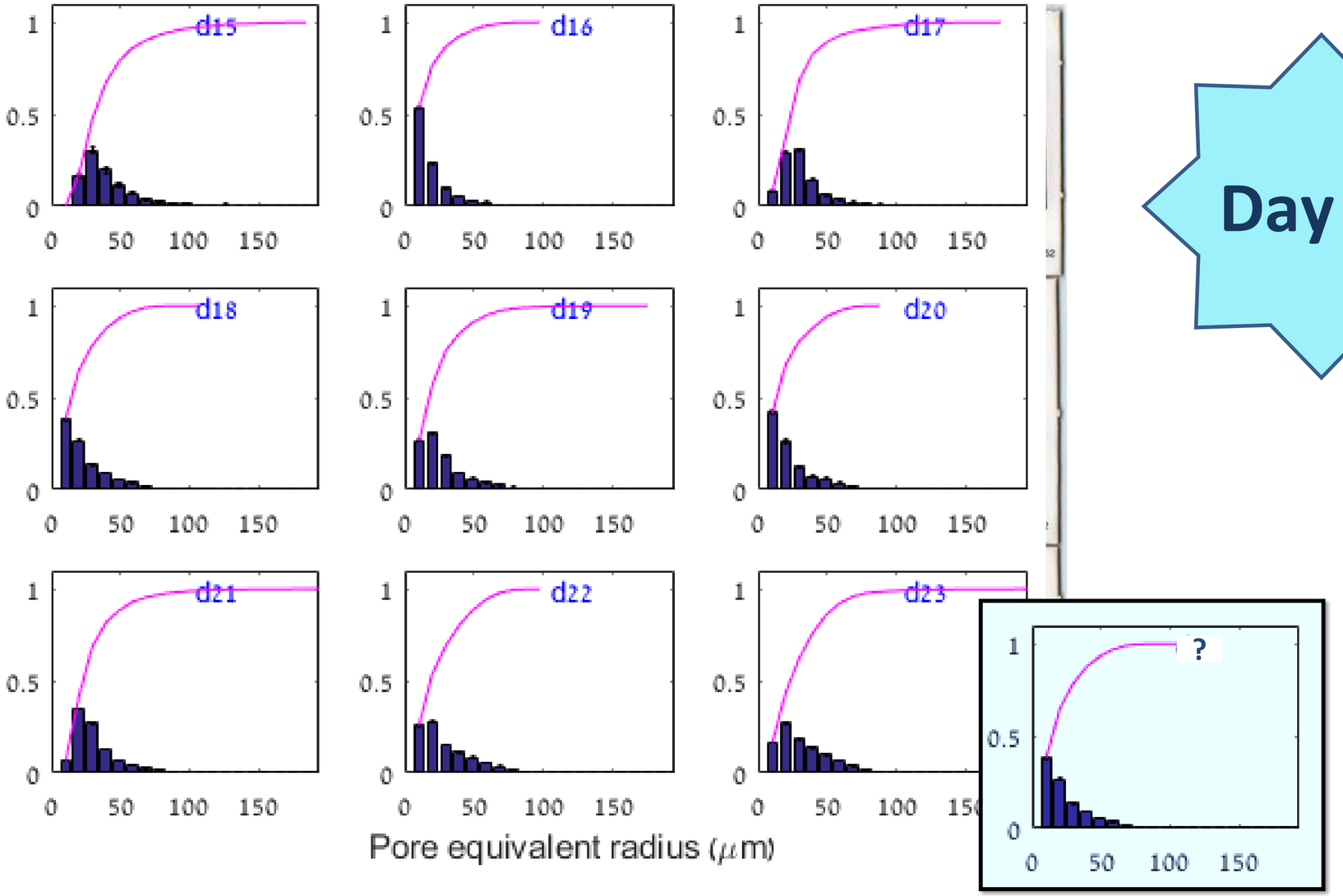






- Size
- Shape
- Contour
- Etc.


d5
d9
d10
d14
d16
d17
d19
d22
d23
d25


d15
d16
d17
d18
d19
d20
d21
d22
d23
?
1
0.5
0
0
50
100
150
Pore equivalent radius (μm)

Day 18

Unsupervised



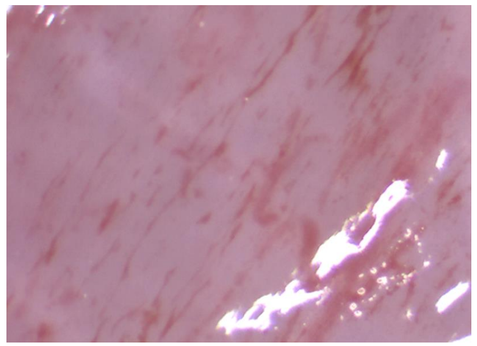




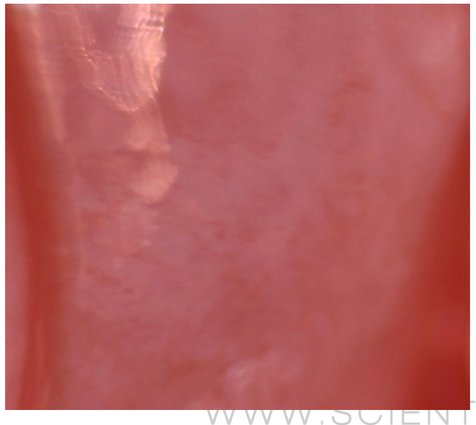

Unsupervised

E.g.,

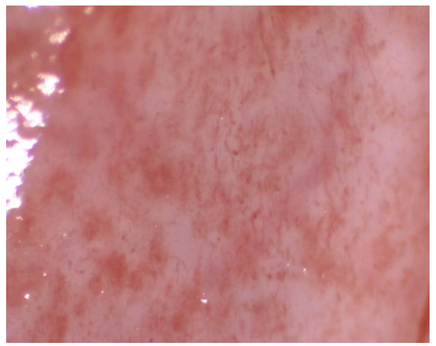
Purple



Red



Pink



Shortcomings and perils in AI use

Needs Enablers:

- Computetional power
- Big data

Interpretation:

- The features (especially “deep features”) may be opaque:
  - What does it mean?
  - To what does it correspond?
  - How does one judge if indeed meaningful?

- “Big data”
  - How big is big enough (convergence?) rare cases?

- Repeatability and consistency
- Dependence on the Number of “buckets” (categories)

- Over-fitting

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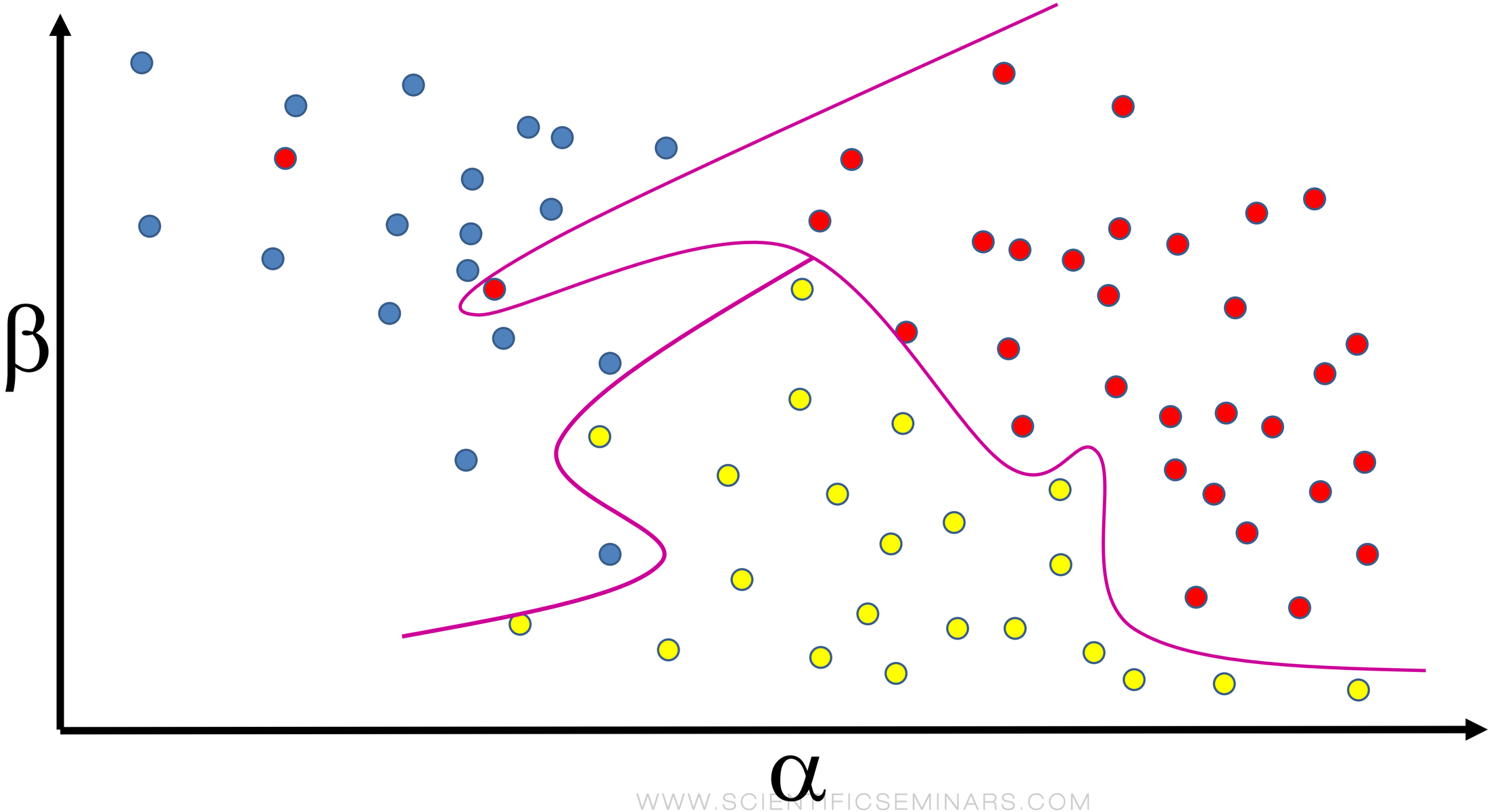
Over-fitting



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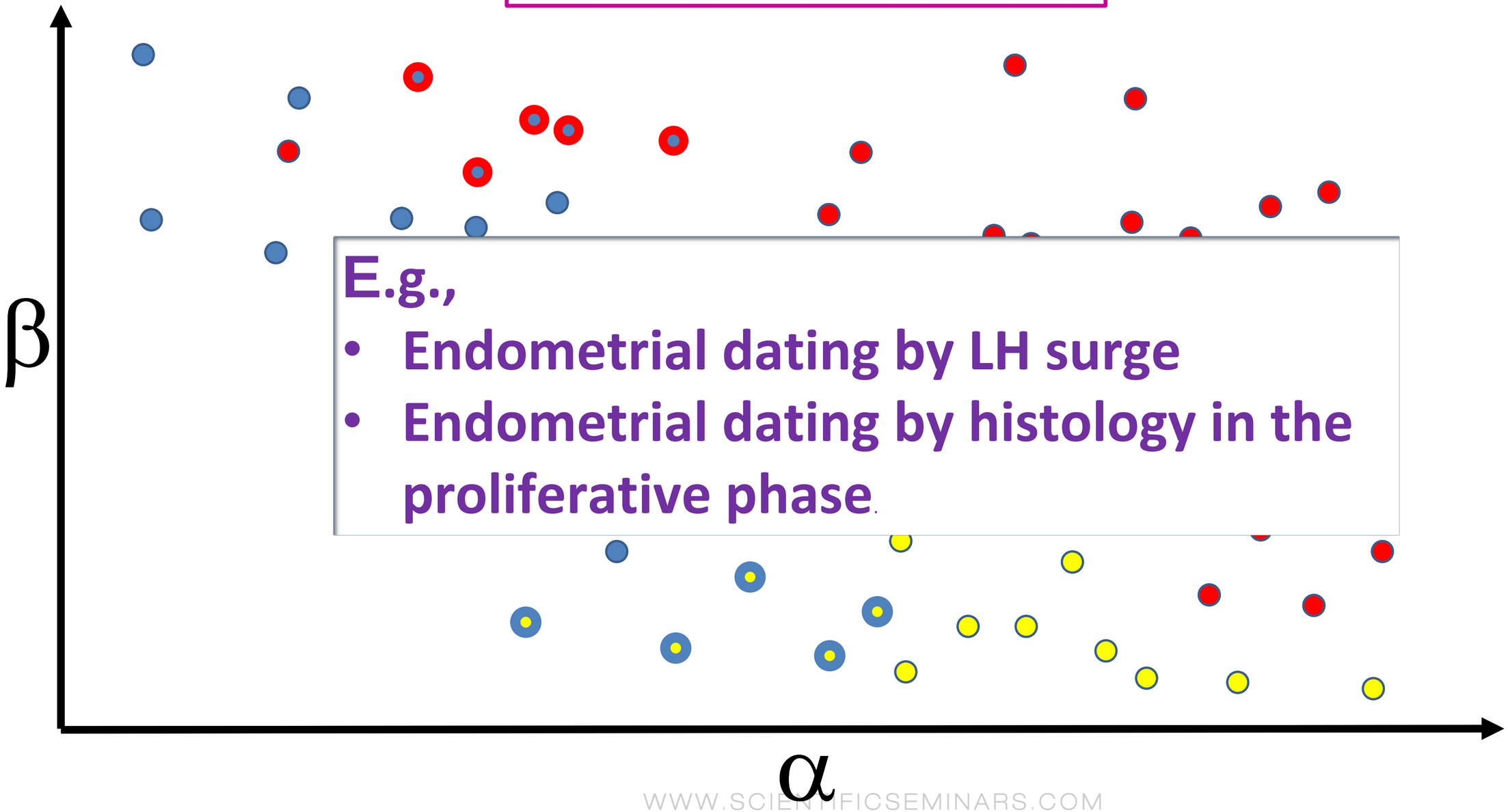
Labeled data: mislabel



E.g.,

- Endometrial dating by LH surge
- Endometrial dating by histology in the proliferative phase.

In short:

ex nihilo nihil fit

Nothing comes from nothing

Garbage in - Garbage out

Can’t make something out of nothing (ex-nihilo)

Gottfried Wilhelm Leibniz

1646-1716

Diagnostic utilization of (mini-hysteroscope) endometrial analysis

Examples:

- Endometrial dating
- Hyperplasia identification
- Subclinical endometritis

….and so much more

Take-home messages

- ✓ Visual (mini)-hysteroscopy is most suitable for endometrial morphology in-vivo exploration
- ✓ There is plenty of medical information in in-vivo endometrial mini-hysteroscopy
- ✓ Information extraction involves statistical approach
- ✓ Traditional (explicable) approach combined with AI tools is the best strategy to extract the information for medical diagnosis purposes

THANK YOU

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