Team Blob

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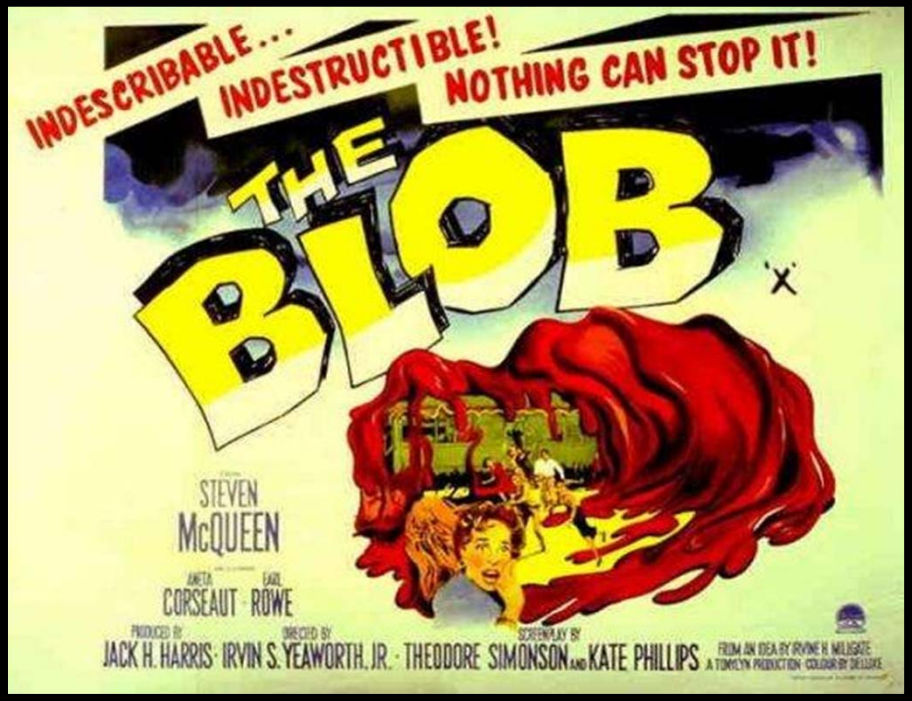


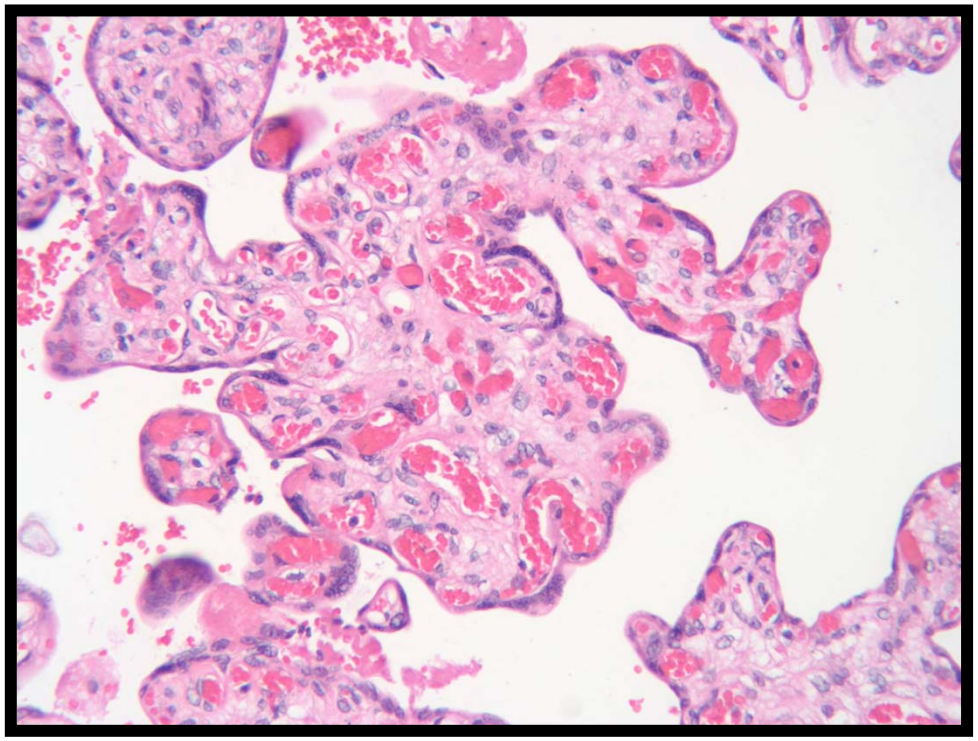
Our Project

Develop an algorithm to study a histological data set, automatically identify different tissue structures within each image, and reliably report statistics on the histology slides.

Project Break Down:

- Find individual cells in image
- Find Villi in each cell
- Record all numbers for later use

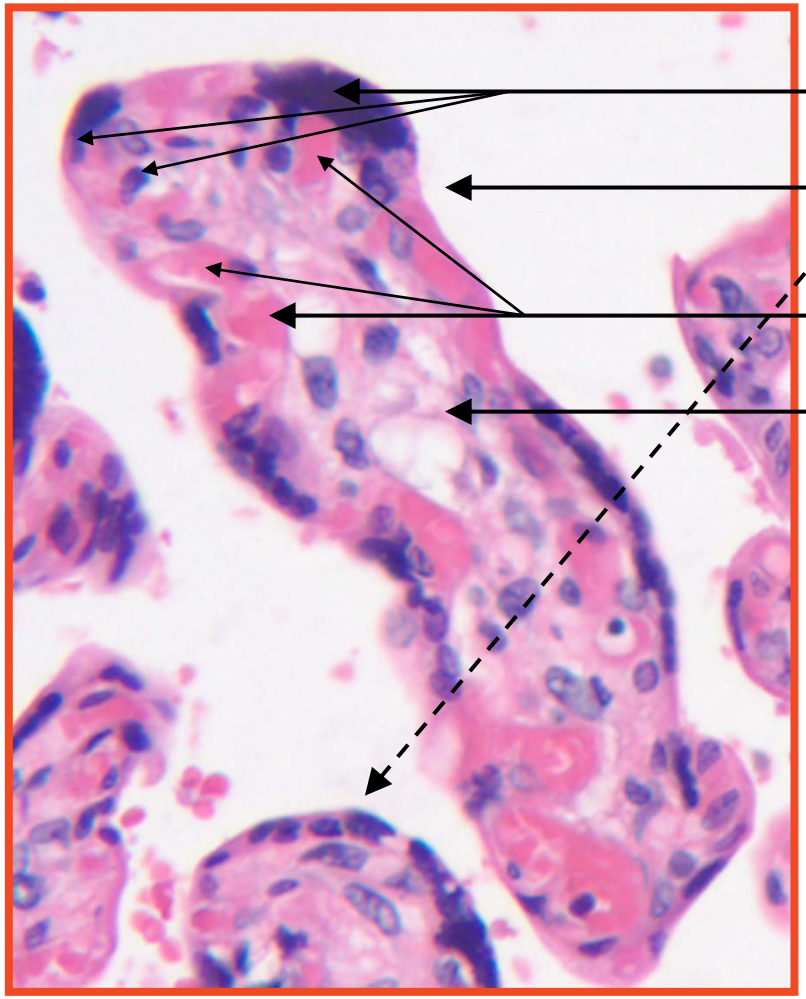
What is a Histology Slide?



A random histology slide

Preparation

To prepare a slide, a Histologist takes a placenta drains it from the maternal side, and cuts it into perpendicular bisections. This then portrays the fetal blood vessels and surrounding tissues as 2-D cross-sectional “blobs”. Finally the tissue is dyed to color code different tissue structures and a microscopic digital image is taken.



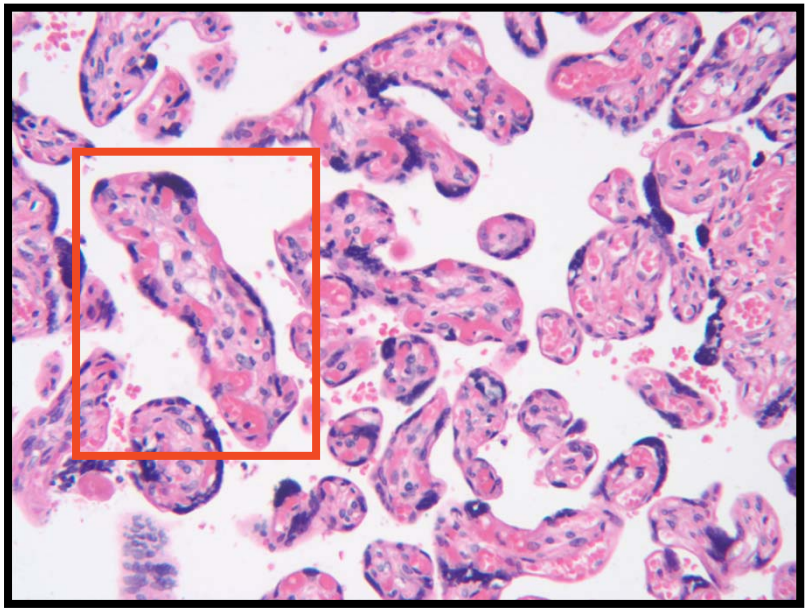
Cell Nuclei (Blue dots)

Villi

Fetal Blood Vessels (Reddish dots)

Connective Tissue (Pinkish blobs)

Zoomed in



A histology slide

Dream On

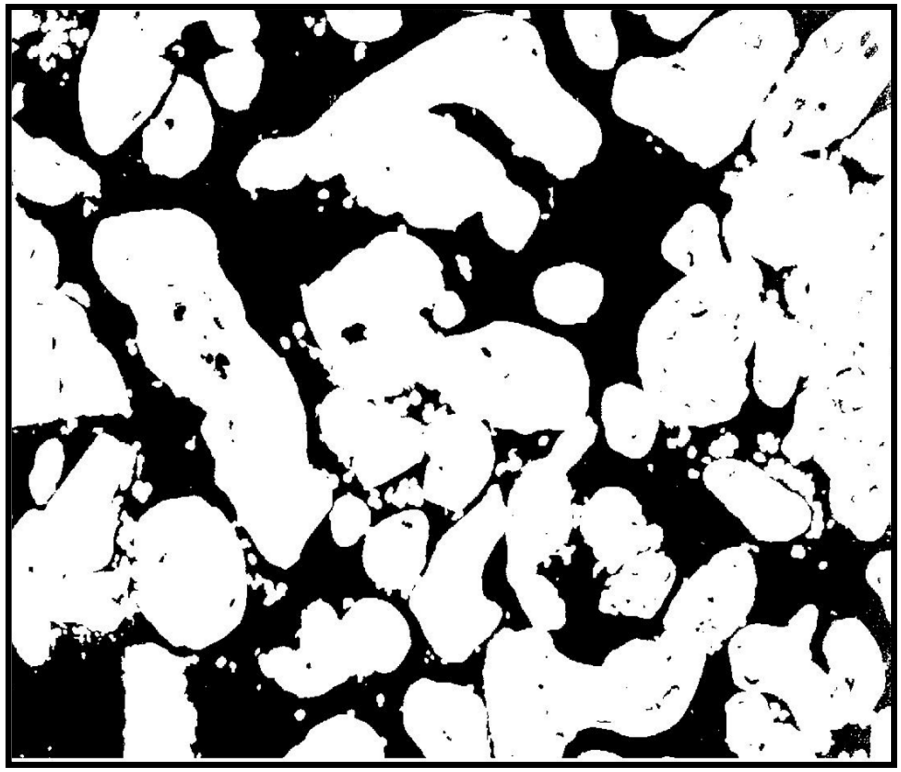
What we want to accomplish:

Image Segmentation

Implementation Using:

- Histogram methods
- Edge detection
- Watershed transform

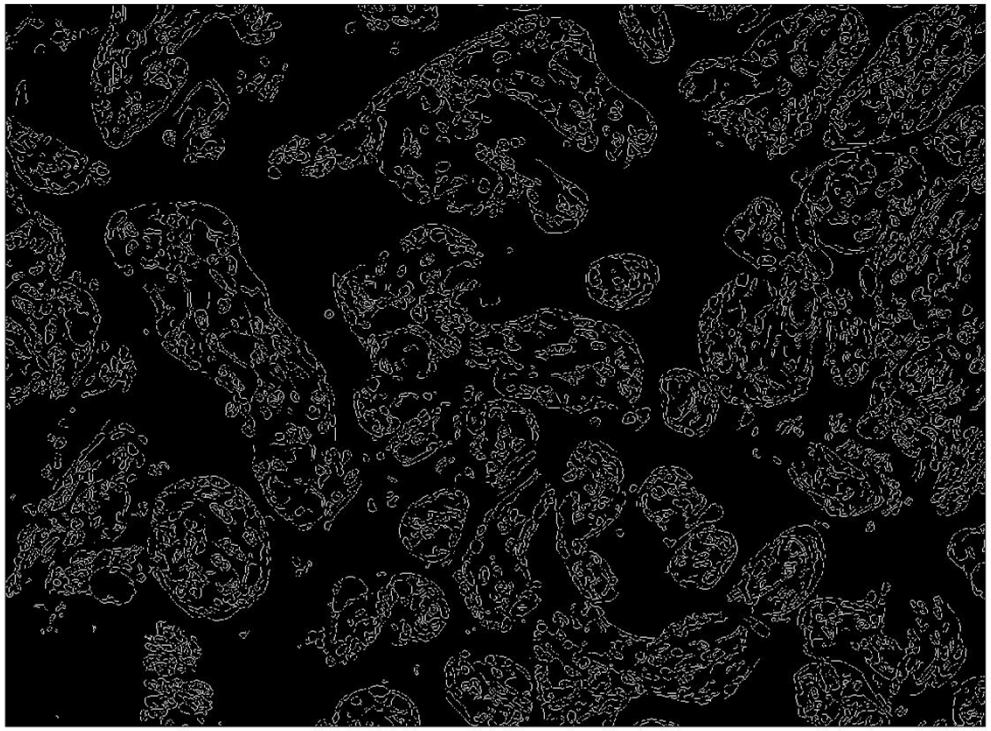
Histogram Methods



Threshold image based on histogram

- Keep everything in a certain range of intensity values
- Very efficient, not so accurate

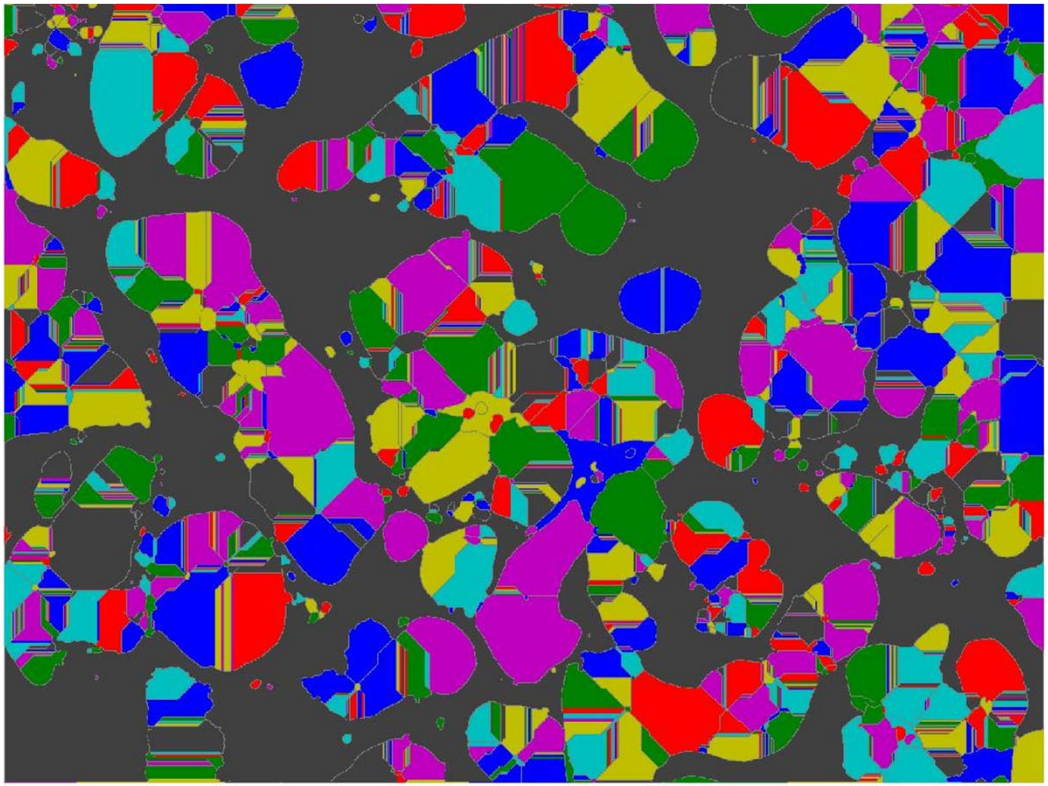
Edge Detection



Canny Method for finding edges of blobs

- Find edges based on gradient info
- Good at separation, bad at closing objects

Watershed Transform



Watershed Transform of Blobs

- Segments based on local minimums
- Has a tendency to over-segment

What's yours is mine

Methods Others Have Tried

Research we have focused on:

- K-means Segmentation using Mahalanobis Distance
- Morphological Transformation
- Wavelet Based Methods in Image Processing in Edge Detection

K-means Segmentation and Morphological Transformation

***Quantifying clinically significant features of placental histology images: a method*,**

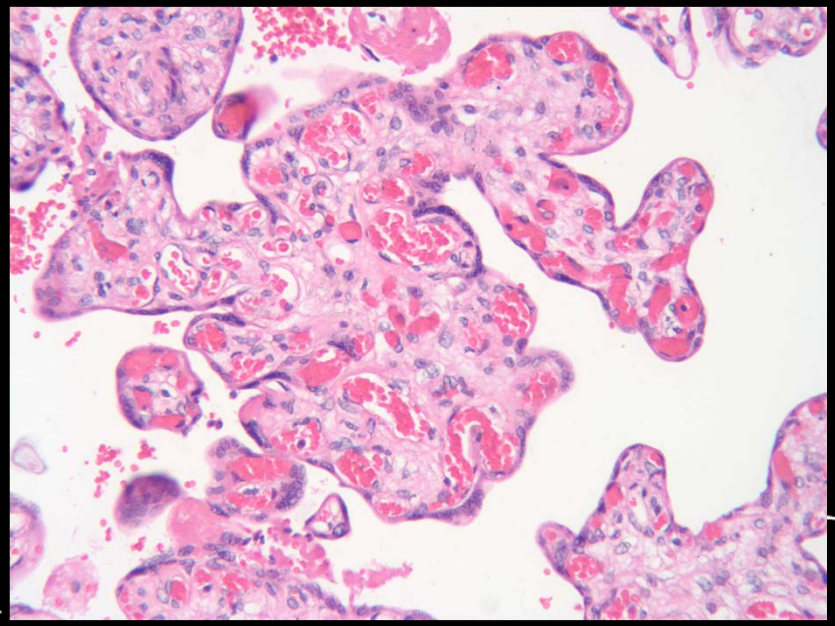
Morten Andersen , David Belangery, Radina Droumevaz, Jenny Lix, Gilbert Moss, Gabriela Palauk August, 2008

- K-means Segmentation with Mahalanobis Distance Metric
  - Predefined absolute color markers
- Morphological Operations
  - Opening and Closing
- Feature Statistics Computation
  - Blob perimeter and area, eccentricity of ellipse

Using K-means Segmentation and Morphological Transformations

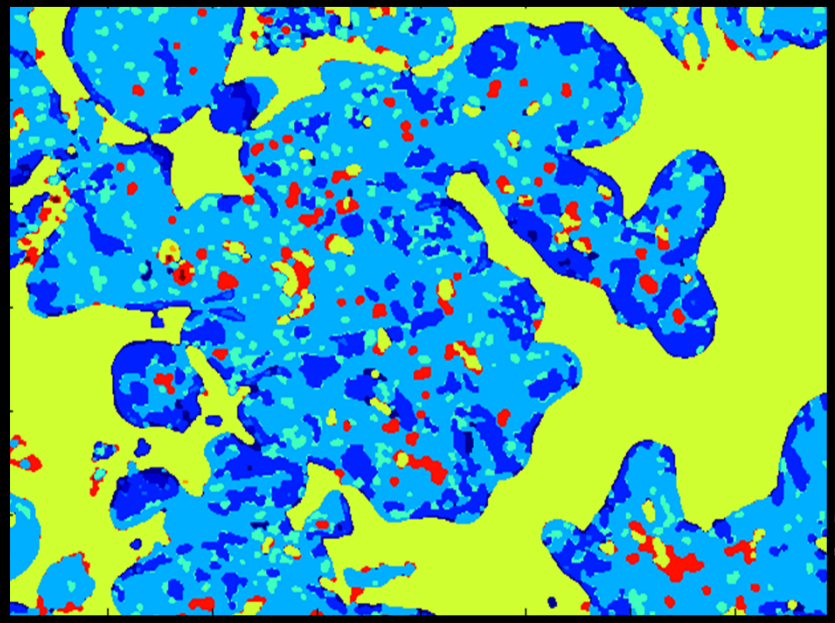
Baseline Algorithm – Code Replication

Figure 1 (A)



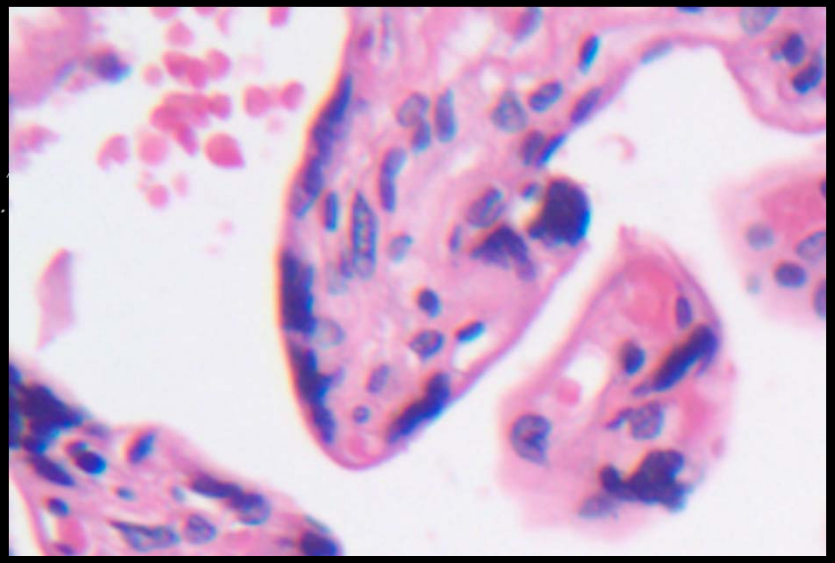
Original Histology Slide

Figure 1 (B)



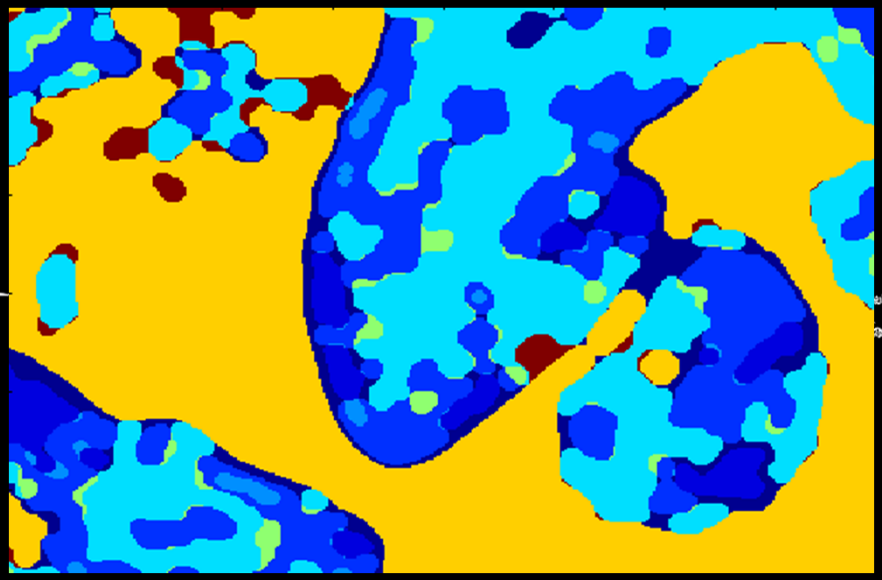
Slide after being run through algorithm

Figure 2 (A)



Pictured: Top right corner of Figure 2 (cropped)

Figure 2 (B)

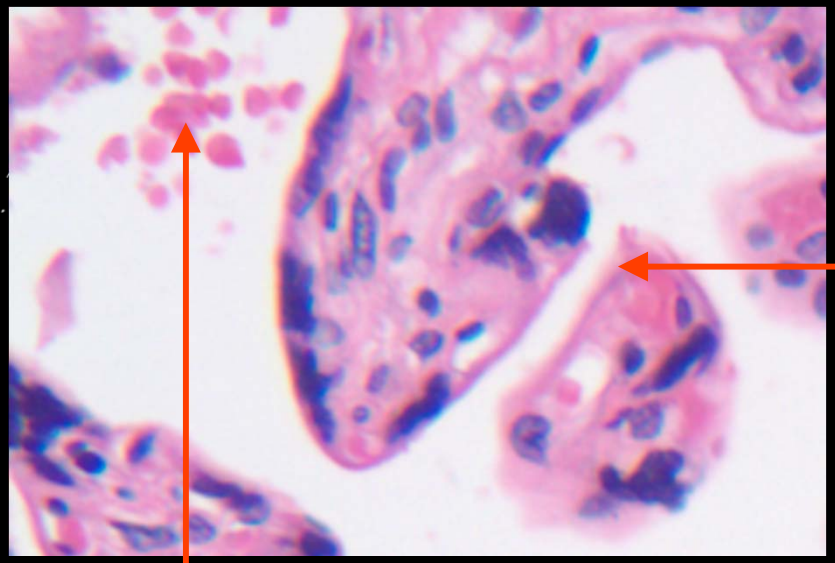


We all have Problems

Issues with the K-means, morphological method:

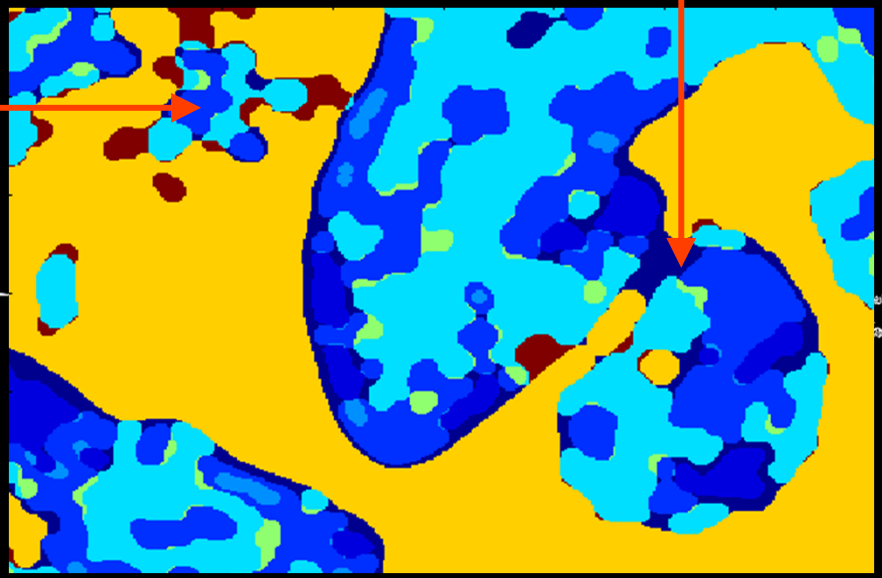
- Using RGB color scheme:
  - more difficult to separate shades of color (LIGHT PINK FROM DARK PINK)
- Automation:
  - requires specified color markers for each histology slide
- Accuracy
  - the K-means segmentation has difficulties separating connected Villi blobs
  - sensitive to blob boundaries

Figure 2 (A)



Sensitive to blob boundaries

Figure 2 (B)



Difficulties separating pink and reddish blobs

Sensitive to blob boundaries

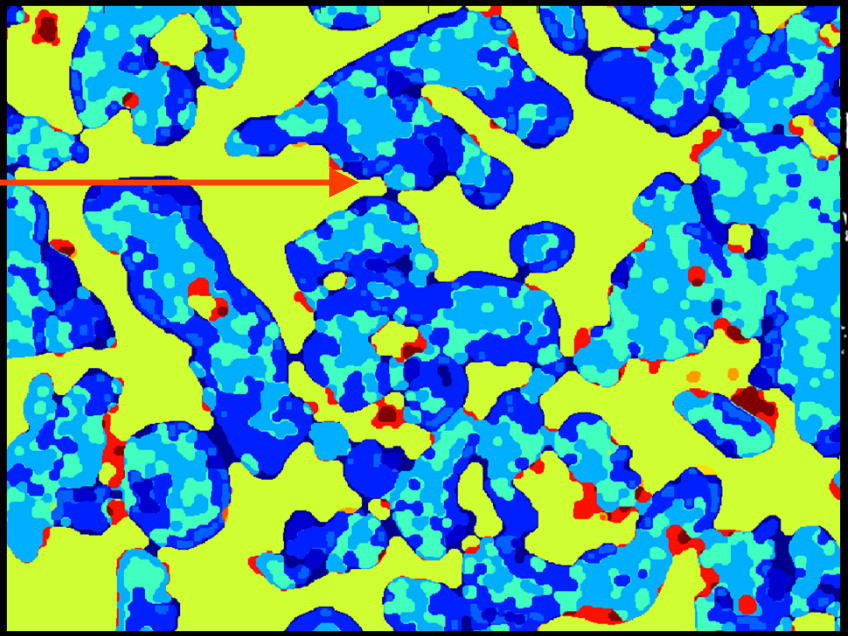
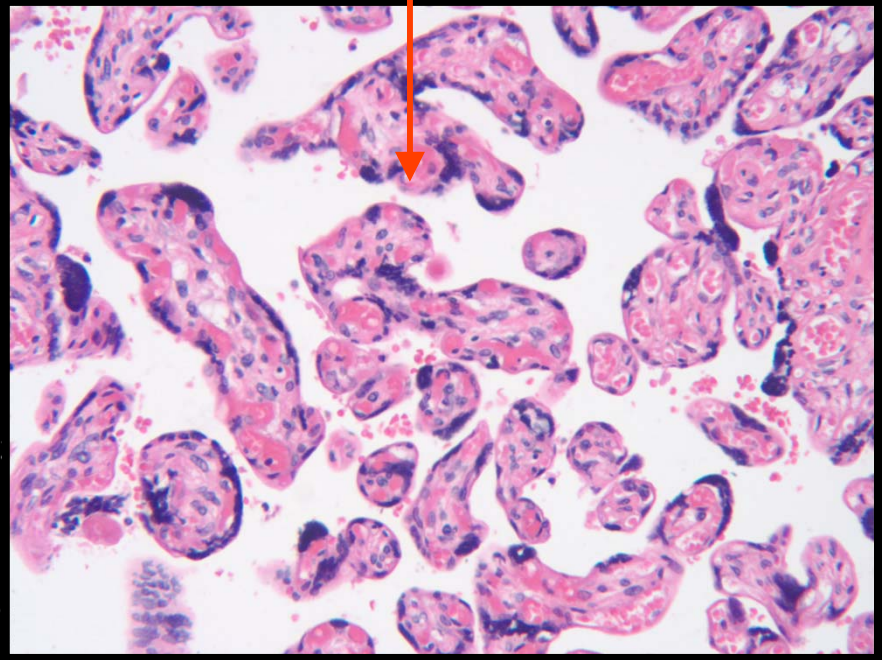


Figure 3 (B)

Figure 3 (A)



Team Blob Algorithm

Conceptual Framework

- Produce better results than Baseline Algorithm –
  - Expert CSULB Art Department Approved Hand Tracings Standard
- Explore Deviations from Baseline Algorithm
  - Change Order of Operations (e.g. remove extraneous information first)
  - Bifurcate Operations (separate tissue identification from blob detection)
  - Color Space Transforms
  - More sophisticated Edge Detection – Wavelets, Watershed, Histogram Methods

How do you spend your time?

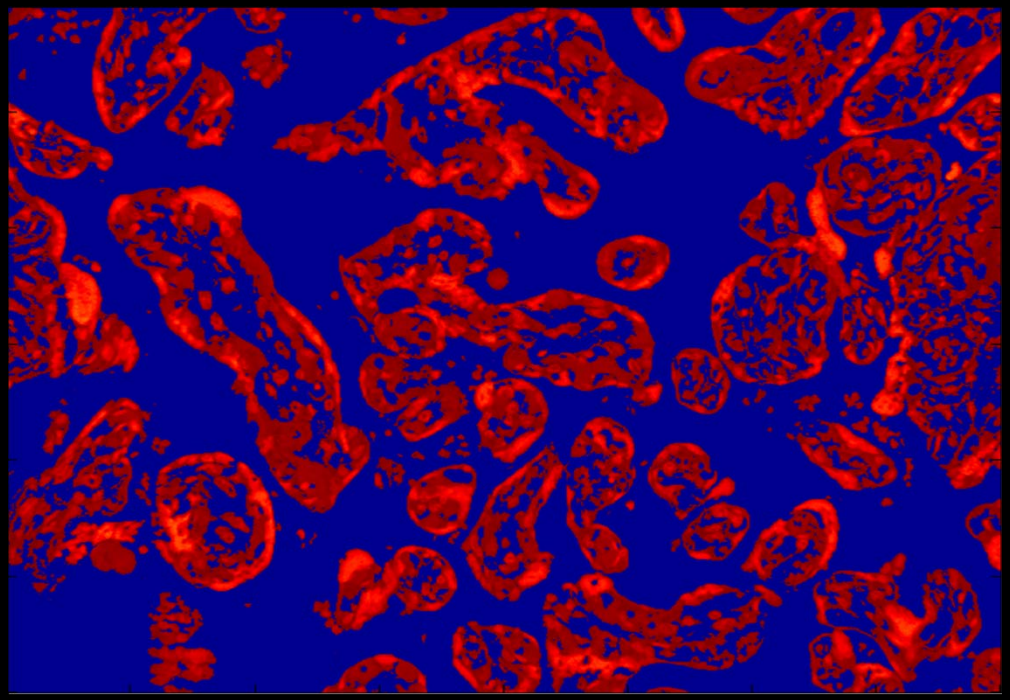
What Team Blob has Done

- Baseline Code Replication, Experimentation
    - Change size of structuring element for morphological operations
    - Change Color Marker Set
- Color Separation Ideas
    - Lab Intensity Corridoring Technique
        - Transform to Lab Color Space, isolate Luminance region of interest
        - Make it easier to automatically isolate relevant Villi structures by removing extraneous information first, from color luminance value alone.
- Edge Detection Techniques
- Create Hand Traced Images Data Set

What team blob has done

Method:

Lab Intensity Corridoring

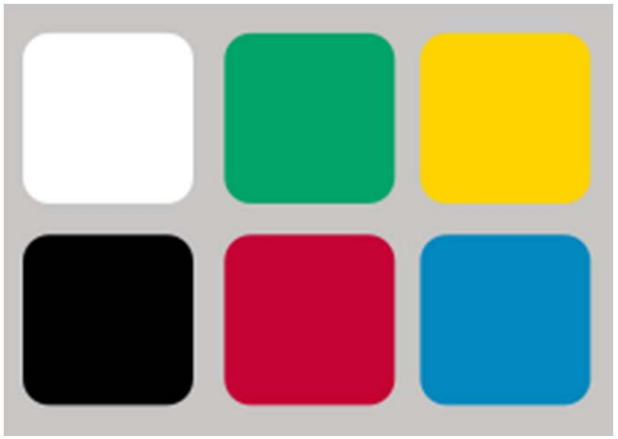


Histology Slide Using Lab

(freq: 70-87)

What is Lab?

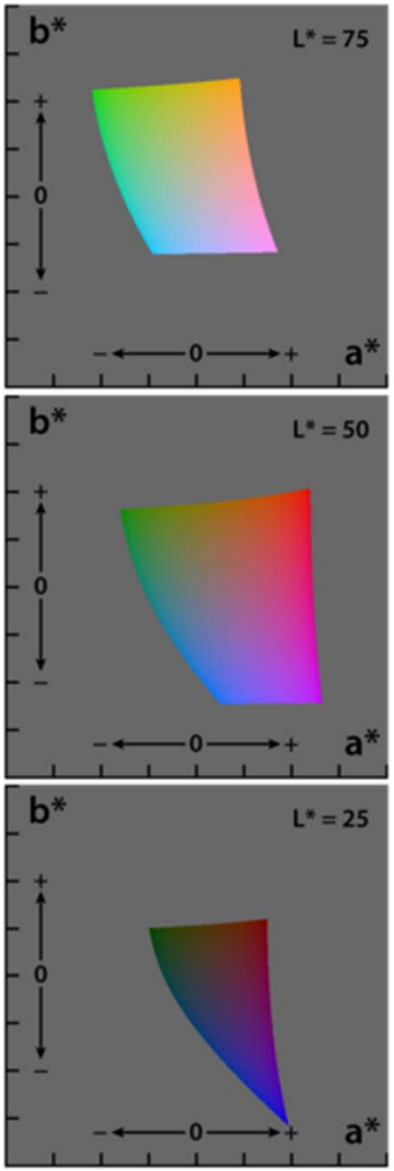
Lab is a color space based on how the rods and cones in the human eye perceive color.



Human eye perceives color:

- redness to greenness
- yellowness to blueness
- non-chromatic white/black luminance quality

What is Lab?



L: Luminance Matrix

0 ≤ L ≤ 100

0 = black

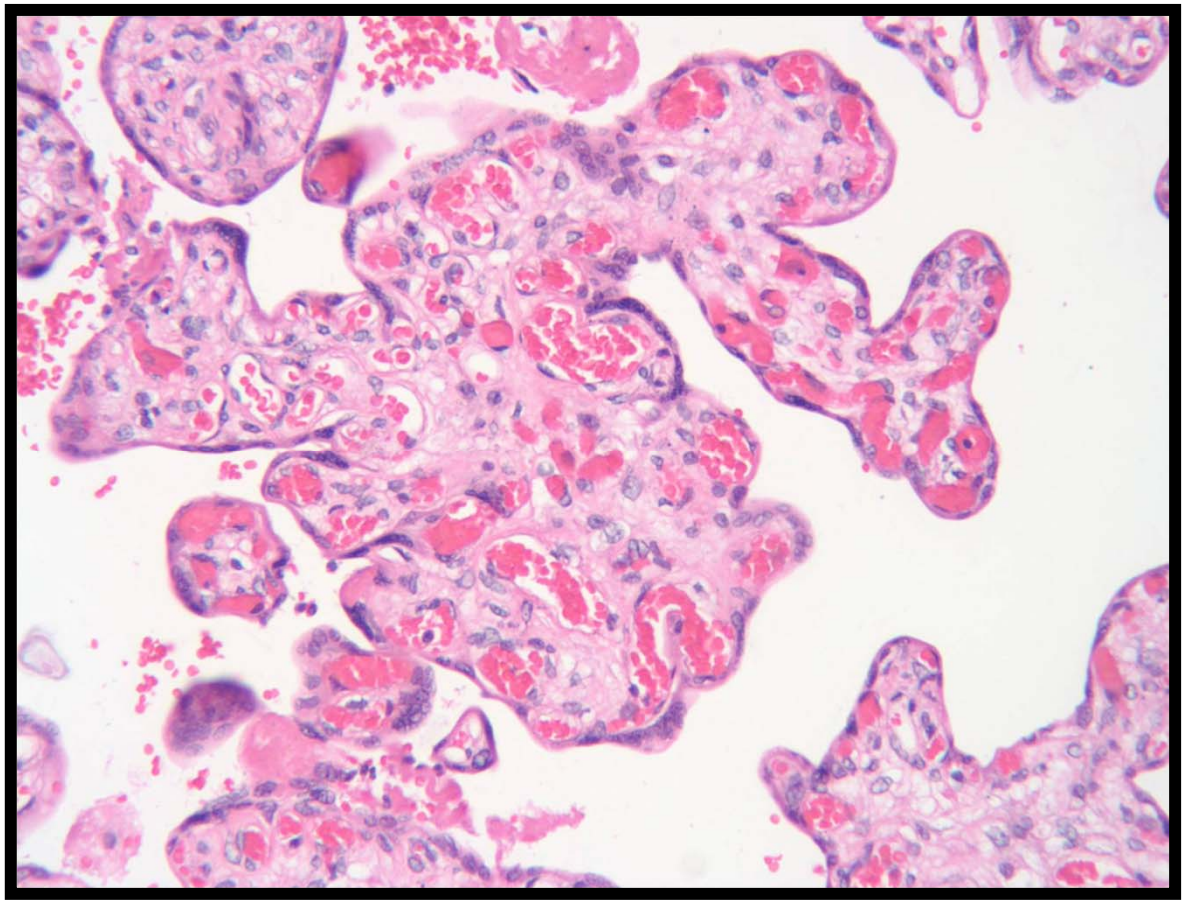
100 = white

a*: Red/Green Channel

b*: Yellow/Blue Channel

a* and b* depend on the original converting color space

Histology Slide Revisited



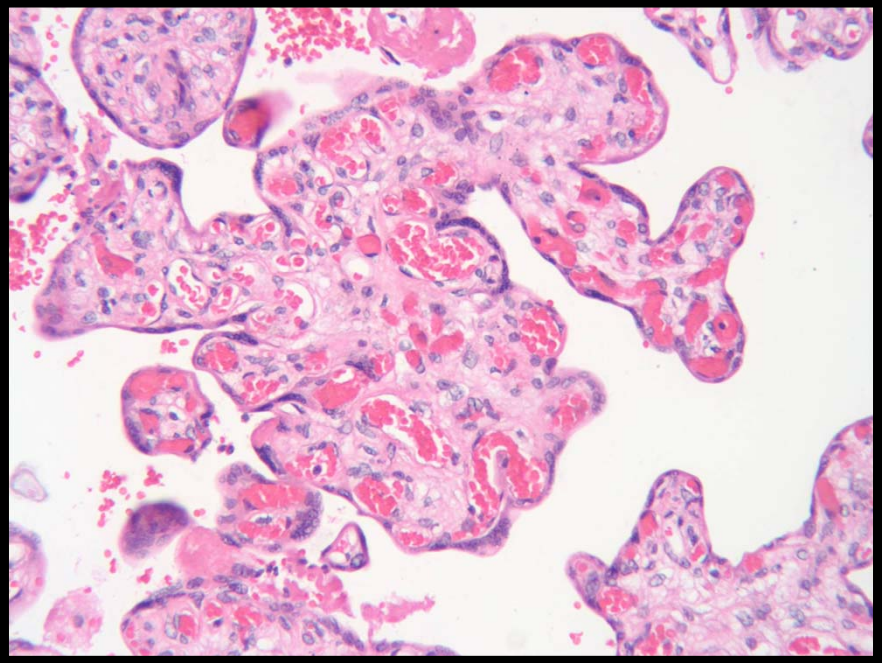
Histology Slide

Main Structure of Interest –

Dark pink blood vessels

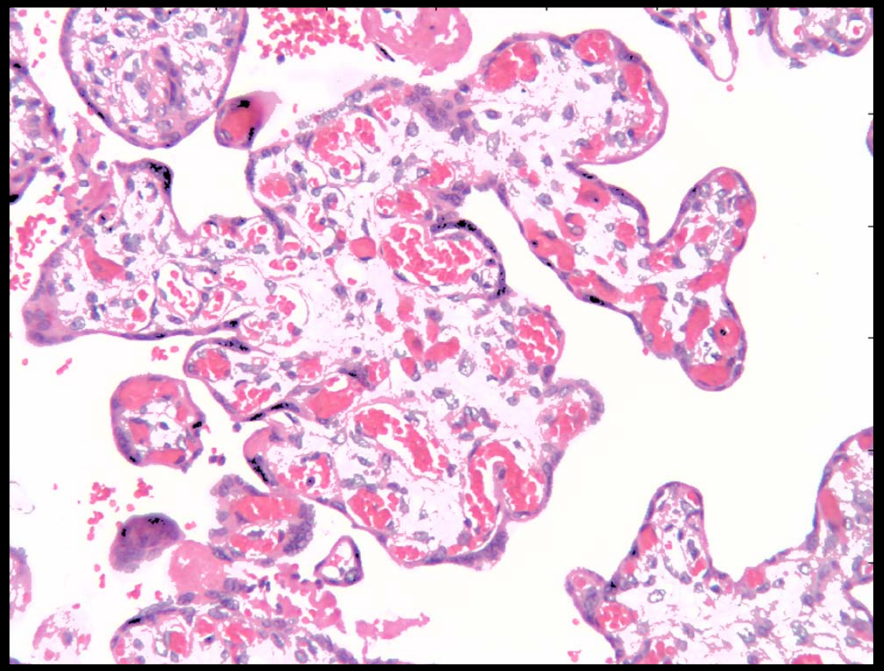
Lab Intensity Corridoring – Results

Figure 4 (A)



Original Histology Slide

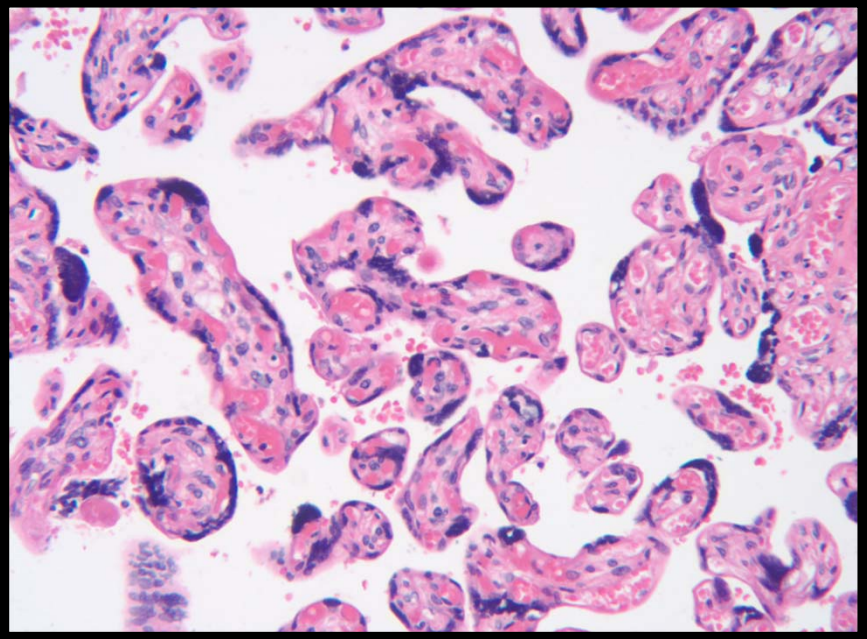
Figure 4 (B)



Slide after being run through algorithm

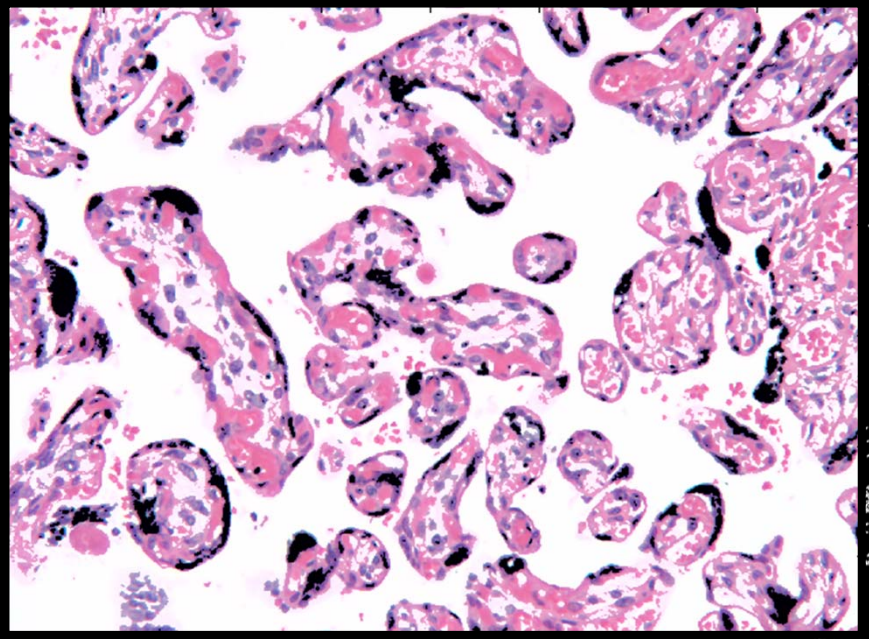
Lab Intensity Corridoring – Results

Figure 5 (A)



Original Histology Slide

Figure 5 (B)

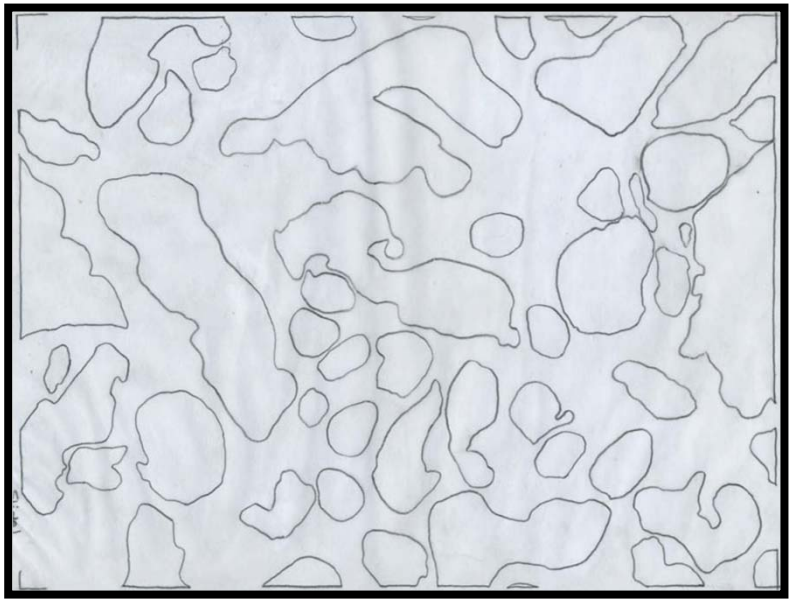


Slide after being run through algorithm

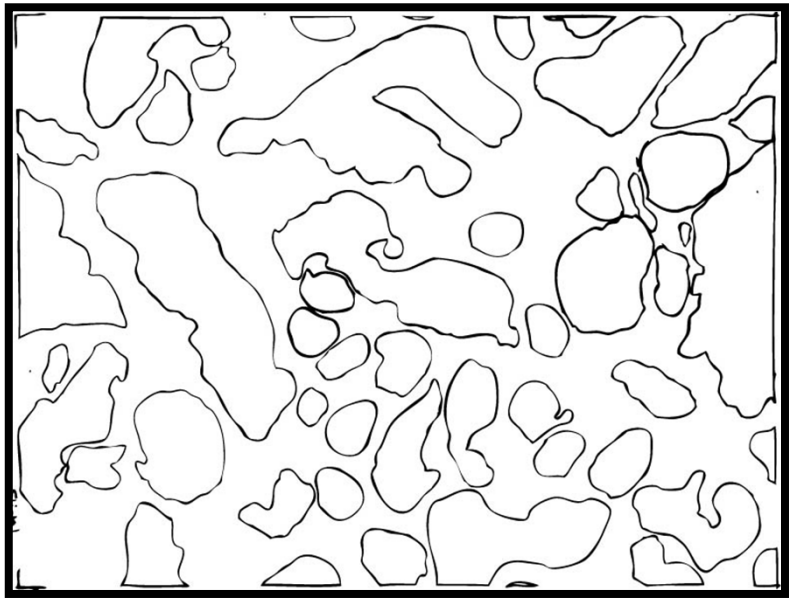
More to love

The Final Touches

Compare our method with hand sketches of Histology Slides

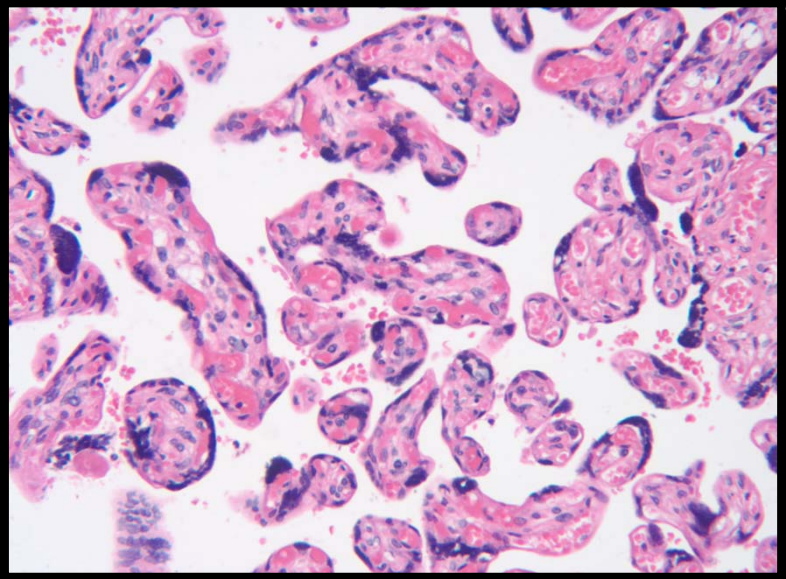


Hand Traced Image of a Histology Slide

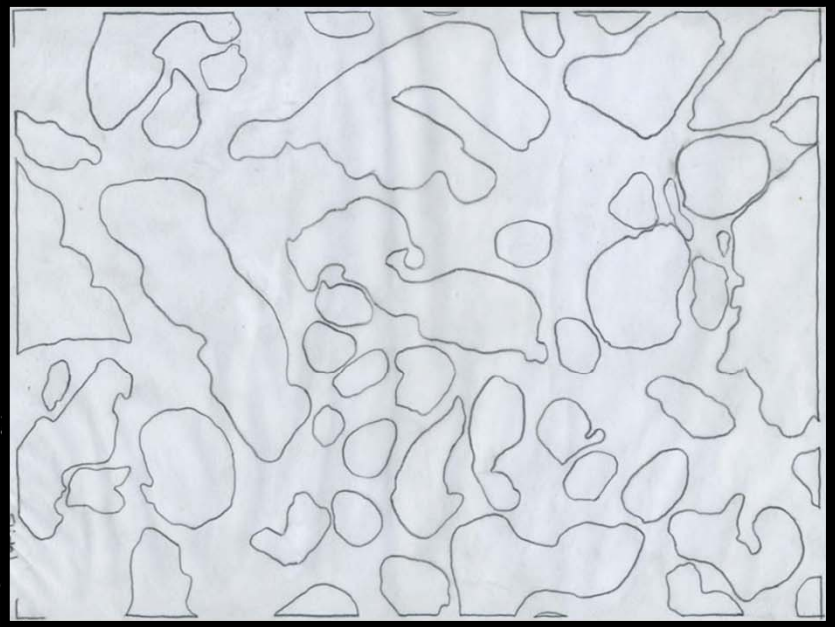


Live Scanned Image of a Histology Slide

Histology Slide



Hand Traced Version



Live Scan Version

All good things must come to an end

References

[1] Morten Anderson, David Belanger, Radina Droumeva, Jenny Li, Gilbert Moss, and Gabriela Palau. Quantifying clinically significant features of placental histology images: a method. Technical report, RUC, Denmark Harvard University, USA Simon Fraser University, Canada Tecnologico de Monterrey, Mexico, 2008.

This report discusses the use of K-means segmentation and Mahalanobis distance to classify pixels. It also gives ideas for future improvement. This is basically what we are trying to do exactly. We want to improve this method and try some others to see how much our results improve.

[2] Prashant Athaval, Luminita Vese, and Carolyn Salafia. Villous structural study based on multilevel registration. Technical report, University of California, Los Angeles, United States Placental Analytics, LLC, United States, 2010.

Another paper by Dr. Salafia we think will be helpful in understanding the medical side of what we are trying to do. We included it just so we can justify what we are doing.

[3] Bhabatosh Chanda and Dwijesh Dutta Majumder. Digital Image Processing and Analysis. Prentice-Hall of India Pvt. Ltd, 2004.

This book will help us try various methods for image segmentation and understand what we are doing. We will see how much it actually gets used.

[4] University of Regina Department of Computer Science. Intensity transformations and spatial filtering, November 2010.

Lecture providing tools, methods and exercises in intensity transformations and spatial filtering.

[5] Steve Eddins. A lab-based uniform color scale. blog, May 2006.

Describes and provides a code to form an LAB color space designed to enhance image resolution. We will probably use this to better distinguish light pink from dark pink in the blob images. This way we will actually be able to exclude the background and just focus on the vacuoles.

References

[6] Amara Graps. An introduction to wavelets.

A report on wavelet methods, analysis, and transforms. We want to try image segmentation using this method to find the edges of each blob in the image. It is just one of many image segmentation methods we are going to try.

[7] Steve Hanov. Wavelets and edge detection. April 2006.

Report on wavelet analysis with specific examples for edge detection. More examples included on how to actually and an edge in an object using wavelets. Edge detection will be used to segment the images into distinct blobs.

[8] Kishore Mosaliganti, Tony Pan, Randal Ridgway, Richard Sharp, Lee Cooper, Alex Gulacy, Ashish Sharma, Okan Irfanoglu, Tahsin Kurc Raghu Machiraju, Alain de Bruin, Pamela Wenzel, Gustavo Leone, Joel Saltz, and Kun Huang. An imaging workflow for characterizing phonotypical change in large histological mouse model datasets.

This paper provides a specific application designed to quantitatively characterize 3D structural attributes of a microscopic image. Only able to conclusively provide results for a few images, but discussed why so few worked. We do not know how useful this is going to be, but it looks promising

[9] Sokol Petushi, Fernando U Garcia, Marian M Haber, Constantine Katsinis, and Aydin Tozeren. Large-scale computations on histology images reveal grad-differentiating parameters for breast cancer. BMC Medical Imaging, 6:14, 2006.

Though this article is specific to breast cancer, it provides computations and methods relative to histology slides. We like the different ideas they had and hope to try several similar ones.

[10] Aqua Phoenix. Matlab 10 lecture.

Provides image processing methods specific to Matlab. It is a useful learning tool. Useful to get everyone up to speed and understand some basic image processing in Matlab.

[11] S. A. S. Allen Broughton. Wavelet based methods in image processing. Seminar, 1998.

Gives powerpoint presentations for applying wavelet based methods to extract images. More wavelet based ideas for image segmentation, probably not too useful except for the pictures.