Module 2 - Lung Fibrosis

Team Members:

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Project Title:

Computational Analysis of Idiopathic Pulmonary Fibrosis by Lung Depth

Project Goal:

This project seeks to analyze—using computation and statistical methods—how pulmonary fibrosis varies throughout the lungs at different depths. Specifically, the team is looking to model lung fibrosis as a function of depth, and whether or not this analysis will allow for interpolation of fibrotic development at different lung depths.

Disease Background:

Prevalence & incidence

- Prevelence: Estimated to be 4 cases per 100,000 persons aged 18 to 34 and 227.2 cases per 100,000 persons 75 years of age or older.
- Incidence: Estimated to be 1.2 to 76.4 cases per 100,000 persons.

Risk factors (genetic, lifestyle)

- Age: Getting older increases the risk for IPF as most cases are diagnosed between 60-70 years old.
- Lifestyle: Smoking is a common risk factor for developing IPF.
- Genetics: There are 10 different genes linked to increased risk of IPF and having direct family members with IPF increases ones risk factor for the disease.

Symptoms

- shortness of breath
- dry cough
- tiredness
- aching muscles and joints
- widening and rounding of fingertips and toes (clubbing)

Standard of care treatment(s)

- There is no repair that can be done to the lungs that can treat IPF, and there is no treatment that prevents the disease from getting worse overtime. Mecication can be used to slow the progress of the disease and treat symptoms when they are particularly bad. Oxygen therapy is a common treatment to help with symptoms especially during sleep or exercise. There are some breathing techniques and rehabilitation methods that can improve symptoms, but these do not stop the progress of the disease. A last resort treatment would be a lung transplant; however, this is a complicated procedure and is not a common treatment.

Biological mechanisms (anatomy, organ physiology, cell & molecular physiology) *

Sources: https://pubmed.ncbi.nlm.nih.gov/16809633/, https://www.nhlbi.nih.gov/health/idiopathic-pulmonary-fibrosis/causes, https://www.mayoclinic.org/diseases-conditions/pulmonary-fibrosis/symptoms-causes/syc-20353690, https://www.mayoclinic.org/diseases-conditions/pulmonary-fibrosis/diagnosis-treatment/drc-20353695

Data-Set:

The data set consists of 78 black and white images collected at different depths into the lung of rodent-models. In this study, mice were treated with Bleocymin, a chemotherapy drug that induces lung injury and subsequent fibrosis. Sections of the treated mice lung's were harvested and immunostained with desmin, a marker of myofibroblasts (an indicator of fibrosis).

Finally, 78 slices were imaged and processed using ImageJ into black and white, with white pixels representing fibrotic lesions and black pixels representing healthy lung. Depths of lung images were measured in micrometers.

All information on methodolgy and the data-set were provided by Dr. Shayne Pierce-Cottler

Data Analyis:

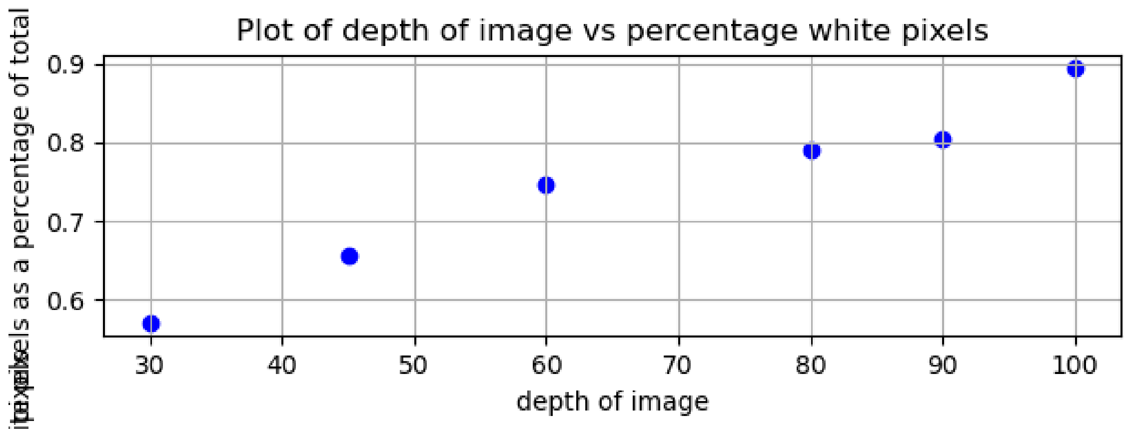
In [ ]:
```
'''Module 2: count black and white pixels in a .jpg and extrapolate points''

from termcolor import colored
import cv2
import numpy as np
import matplotlib.pyplot as plt
from scipy.interpolate import interp1d
import pandas as pd

# Load the images you want to analyze
```

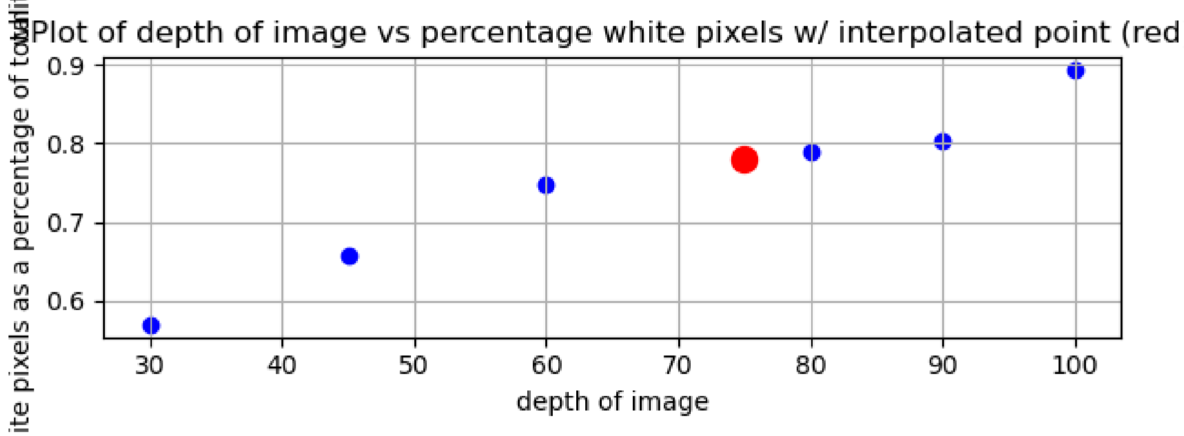
```
filenames = [
    "MASK_Sk658 Llobe ch010017.jpg",
    "MASK_Sk658 Llobe ch010018.jpg",
    "MASK_Sk658 Llobe ch010019.jpg",
    "MASK_Sk658 Llobe ch010021.jpg",
    "MASK_Sk658 Llobe ch010022.jpg",
    "MASK_Sk658 Llobe ch010023.jpg"
]

# Enter the depth of each image (in the same order that the images are liste

depths = [
    45,
    90,
    60,
    30,
    80,
    100
    ]

# Make the lists that will be used

images = []
white_counts = []
black_counts = []
white_percents = []

# Build the list of all the images you are analyzing

for filename in filenames:
    img = cv2.imread(filename, 0)
    images.append(img)

# For each image (until the end of the list of images), calculate the number

for x in range(len(filenames)):
    _, binary = cv2.threshold(images[x], 127, 255, cv2.THRESH_BINARY)

    white = np.sum(binary == 255)
    black = np.sum(binary == 0)

    white_counts.append(white)
    black_counts.append(black)

# Print the number of white and black pixels in each image.

print(colored("Counts of pixel by color in each image", "yellow"))
for x in range(len(filenames)):
    print(colored(f"White pixels in image {x}: {white_counts[x]}", "white"))
    print(colored(f"Black pixels in image {x}: {black_counts[x]}", "black"))
    print()

# Calculate the percentage of pixels in each image that are white and make a

for x in range(len(filenames)):
    white_percent = (100 * (white_counts[x] / (black_counts[x] + white_count
```

```
    white_percents.append(white_percent)

# Print the filename (on one line in red font), and below that line print th

print(colored("Percent white px:", "yellow"))
for x in range(len(filenames)):
    print(colored(f'{filenames[x]}:',"red"))
    print(f'{white_percents[x]}% White | Depth: {depths[x]} microns')
    print()

'''Write your data to a .csv file'''

# Create a DataFrame that includes the filenames, depths, and percentage of
df = pd.DataFrame({
    'Filenames': filenames,
    'Depths': depths,
    'White percents': white_percents
})

# Write that DataFrame to a .csv file

df.to_csv('Percent_White_Pixels.csv', index=False)

print("CSV file 'Percent_White_Pixels.csv' has been created.")

'''the .csv writing subroutine ends here'''

# Interpolate a point: given a depth, find the corresponding white pixel per

# interpolate_depth = float(input(colored("Enter the depth at which you want
# had to hard code in the Jupyter notebook but this code works in a .py file
interpolate_depth = 75.0

x = depths
y = white_percents

i = interp1d(x, y, kind='linear')  # You can also use 'quadratic', 'cubic',
interpolate_point = i(interpolate_depth)
print(colored(f'The interpolated point is at the x-coordinate {interpolate_d

depths_i = depths[:]
depths_i.append(interpolate_depth)
white_percents_i = white_percents[:]
white_percents_i.append(interpolate_point)

# make two plots: one that doesn't contain the interpolated point, just the
fig, axs = plt.subplots(2, 1)

axs[0].scatter(depths, white_percents, marker='o', linestyle='-', color='blu
axs[0].set_title('Plot of depth of image vs percentage white pixels')
axs[0].set_xlabel('depth of image')
axs[0].set_ylabel('white pixels as a percentage of total pixels')
axs[0].grid(True)


axs[1].scatter(depths_i, white_percents_i, marker='o', linestyle='-', color=
```

```python
axs[1].set_title('Plot of depth of image vs percentage white pixels w/ inter
axs[1].set_xlabel('depth of image')
axs[1].set_ylabel('white pixels as a percentage of total pixels')
axs[1].grid(True)
axs[1].scatter(depths_i[len(depths_i)-1], white_percents_i[len(white_percent


# Adjust layout to prevent overlap
plt.tight_layout()
plt.show()
```

```
Counts of pixel by color in each image
White pixels in image 0: 27561
Black pixels in image 0: 4166743

White pixels in image 1: 33746
Black pixels in image 1: 4160558

White pixels in image 2: 31331
Black pixels in image 2: 4162973

White pixels in image 3: 23900
Black pixels in image 3: 4170404

White pixels in image 4: 33151
Black pixels in image 4: 4161153

White pixels in image 5: 37508
Black pixels in image 5: 4156796

Percent white px:
MASK_Sk658 Llobe ch010017.jpg:
0.6571054458618164% White | Depth: 45 microns

MASK_Sk658 Llobe ch010018.jpg:
0.8045673370361328% White | Depth: 90 microns

MASK_Sk658 Llobe ch010019.jpg:
0.7469892501831055% White | Depth: 60 microns

MASK_Sk658 Llobe ch010021.jpg:
0.5698204040527344% White | Depth: 30 microns

MASK_Sk658 Llobe ch010022.jpg:
0.7903814315795898% White | Depth: 80 microns

MASK_Sk658 Llobe ch010023.jpg:
0.8942604064941406% White | Depth: 100 microns

CSV file 'Percent_White_Pixels.csv' has been created.
The interpolated point is at the x-coordinate 75.0 and y-coordinate 0.779533
3862304688.
```





Verify and validate your analysis:

(Describe how you checked to see that your analysis gave you an answer that you believe (verify). Describe how your determined if your analysis gave you an answer that is supported by other evidence (e.g., a published paper).

Conclusions and Ethical Implications:

(Think about the answer your analysis generated, draw conclusions related to your overarching question, and discuss the ethical implications of your conclusions.

Limitations and Future Work:

(Think about the answer your analysis generated, draw conclusions related to your overarching question, and discuss the ethical implications of your conclusions.

NOTES FROM YOUR TEAM:

10/2/2025 - Introductions and checkups on confidence with Python coding skills. Getting a background of the problem we will be investigating.

10/7/2025 - Learning about inteprolation with a data set, practicing code in Python for interpolating and graphing. Getting started with our Jupyter notebook for the first check-in (Title, Project goals, Data-set details, Data analysis code)

QUESTIONS FOR YOUR TA:

We have no questions for our TA at this time.