



# **Fruit Inspection**

## **Apple's defects identifications**

**Anthea Silvia Sasdelli**

Project Work in Computer Vision and Image processing





**01**



# Introduction



# OBJECTIVES

The goal of this project work was to develop a system aimed at locating defects and imperfections in a given dataset of apples.

In the specific, the tasks required were:



## First Task

- Outline the fruit by generating a binary mask
- Search for the defects on each fruit



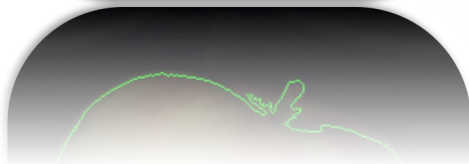
## Second task

- Russet detection



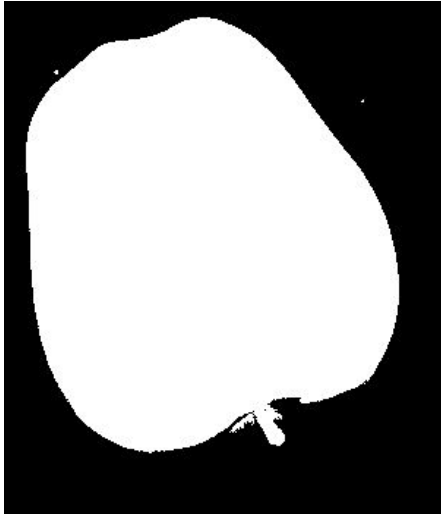
02

# First Task

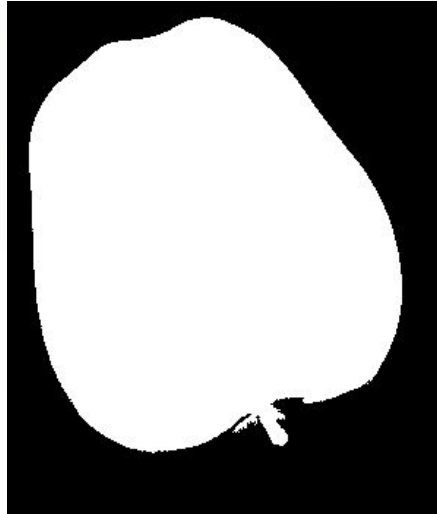


# PROJECT TIMELINE

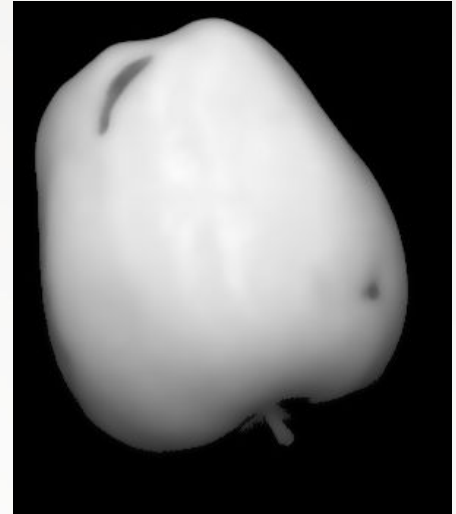
**Step 1**  
Binarization



**Step 2**  
Segmentation

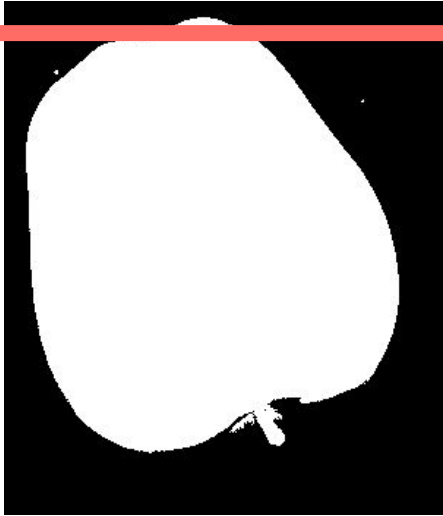


**Step 3**  
Smoothing

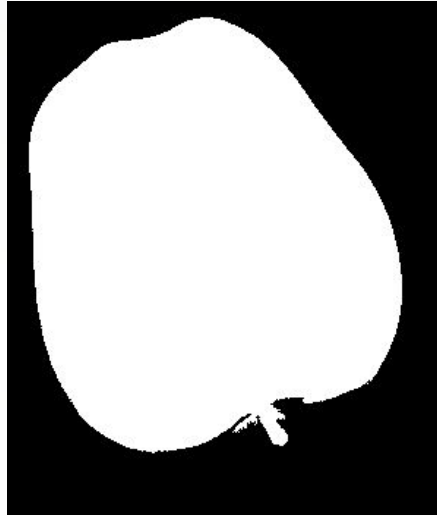


# PROJECT TIMELINE

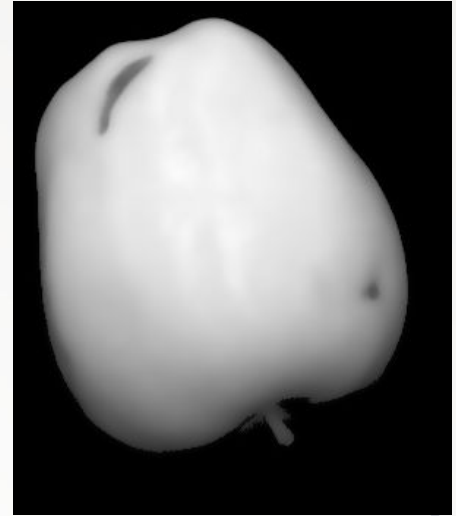
**Step 1**  
Binarization



**Step 2**  
Segmentation



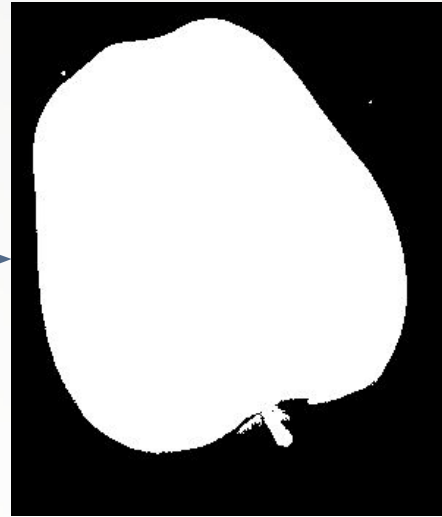
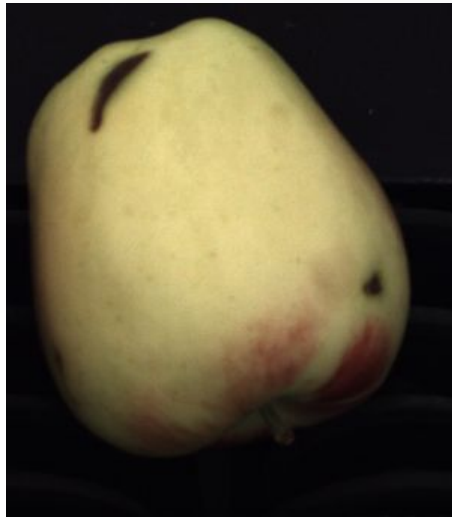
**Step 3**  
Smoothing



# PROJECT TIMELINE

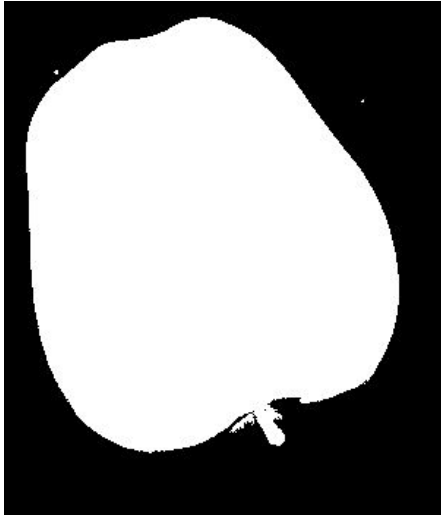
## Step 1 Binarization

- Foreground/background separation
- Dynamic threshold  $\rightarrow \frac{\text{median}}{2}$

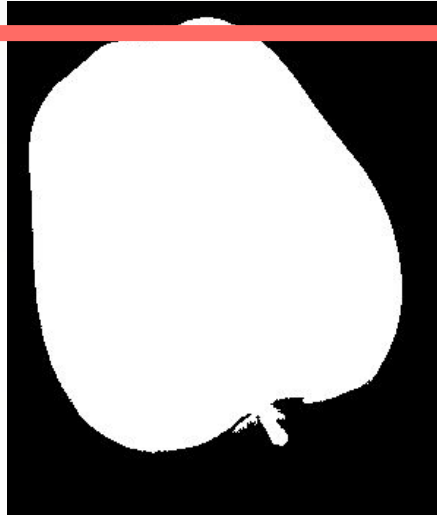


# PROJECT TIMELINE

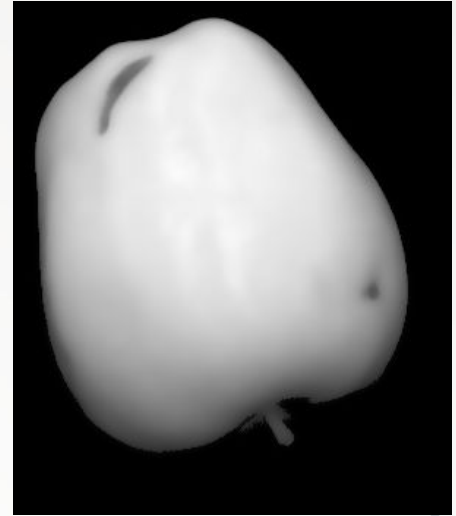
**Step 1**  
Binarization



**Step 2**  
Segmentation



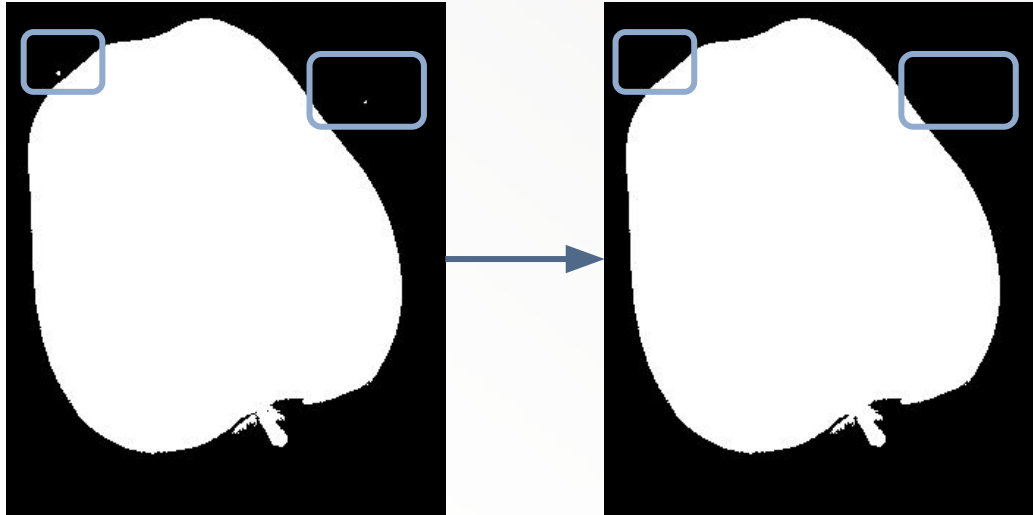
**Step 3**  
Smoothing





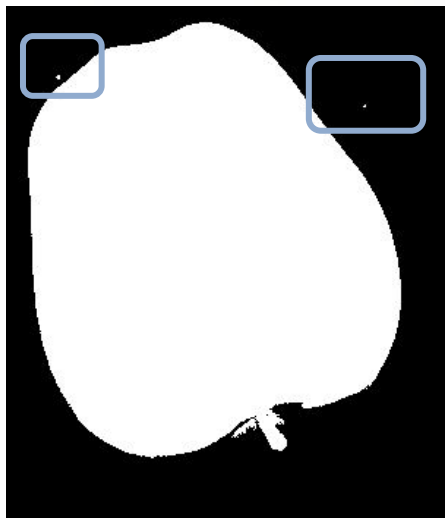
# PROJECT TIMELINE

## Step 2 Segmentation

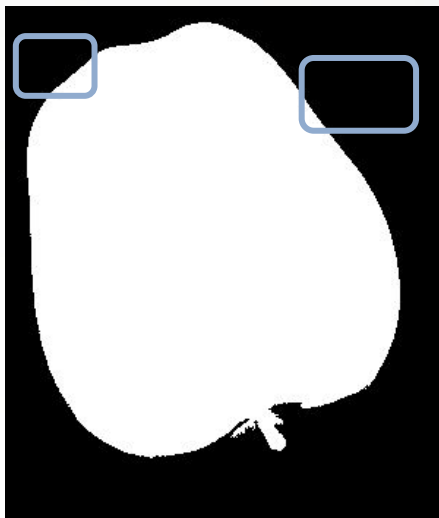


# PROJECT TIMELINE

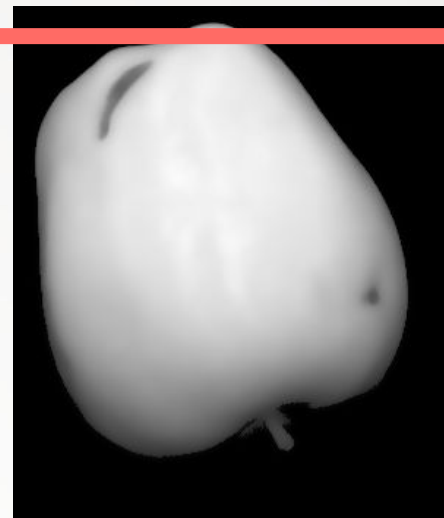
**Step 1**  
Binarization



**Step 2**  
Segmentation



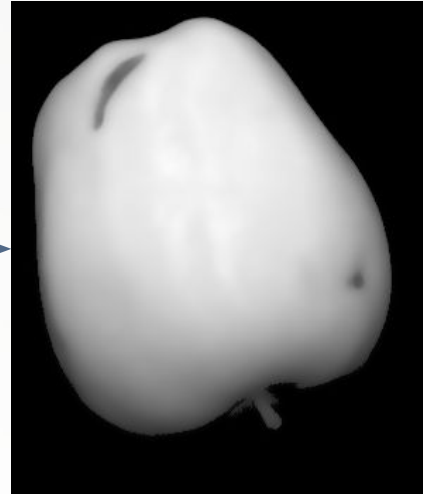
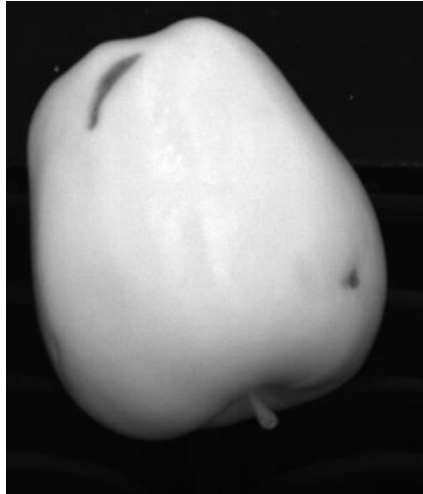
**Step 3**  
Smoothing



# PROJECT TIMELINE

**Step 3**  
Smoothing

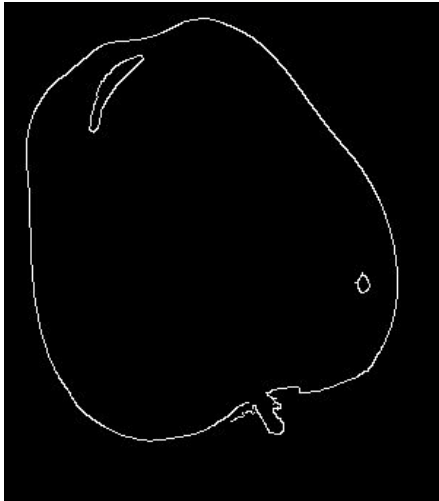
**Bilateral filter**



# PROJECT TIMELINE

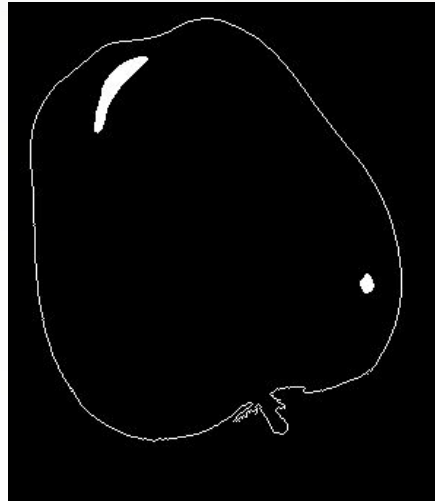
## Step 4

Edge detection



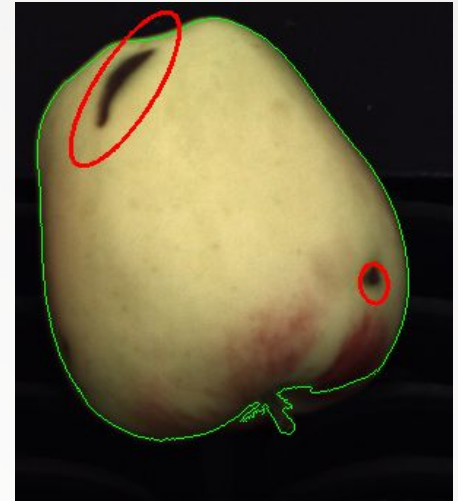
## Step 5

Fruit isolation



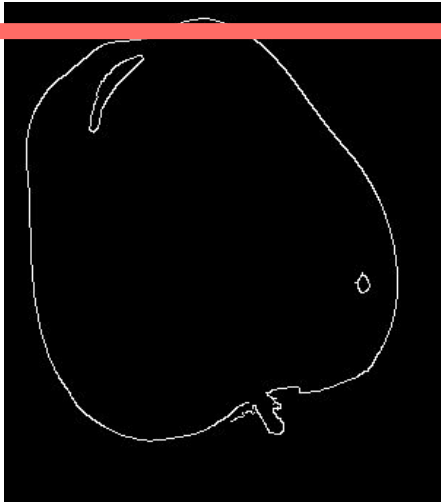
## Step 6

Defects identification

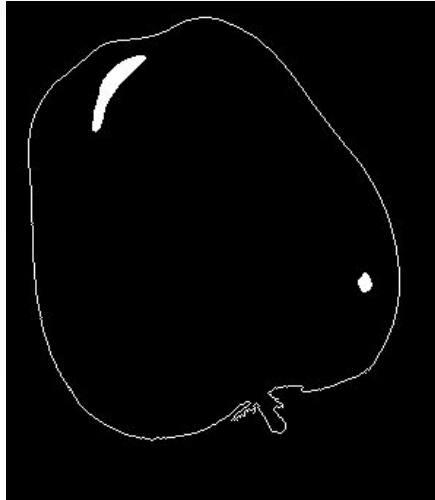


# PROJECT TIMELINE

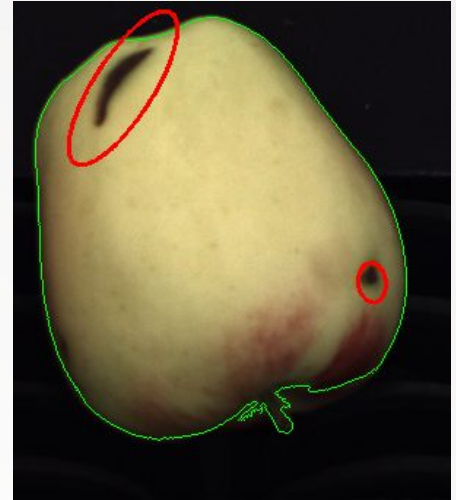
**Step 4**  
Edge detection



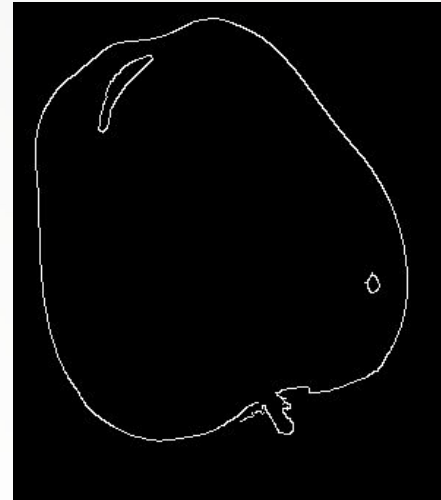
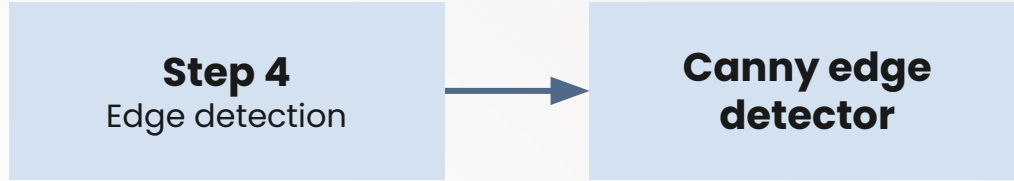
**Step 5**  
Fruit isolation



**Step 6**  
Defects identification

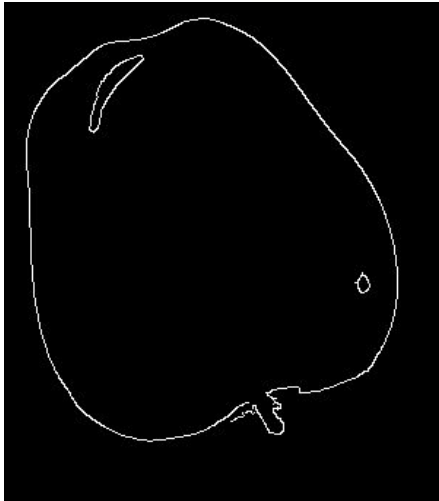


# PROJECT TIMELINE

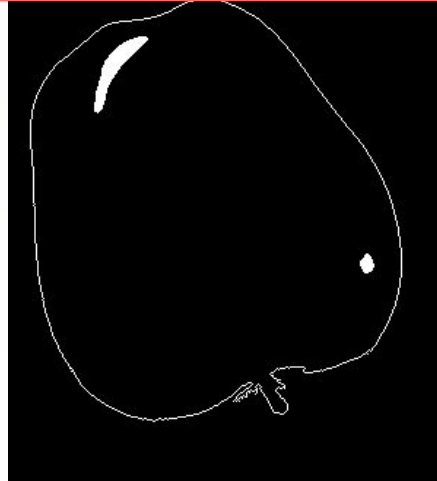


# PROJECT TIMELINE

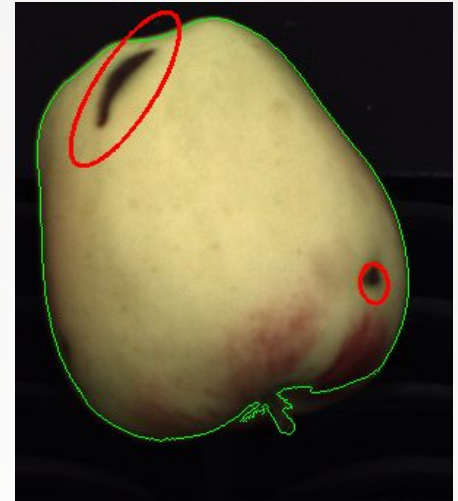
**Step 4**  
Edge detection



**Step 5**  
Fruit isolation

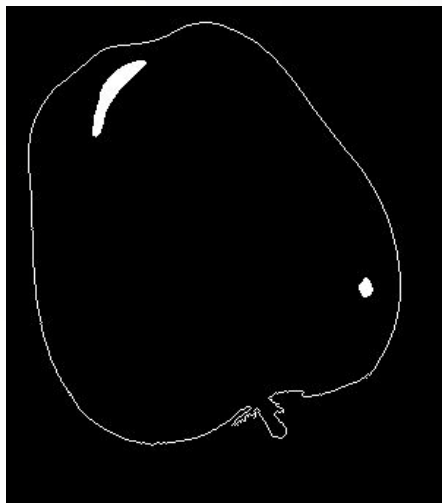


**Step 6**  
Defects identification



# PROJECT TIMELINE

## Step 5 Fruit isolation

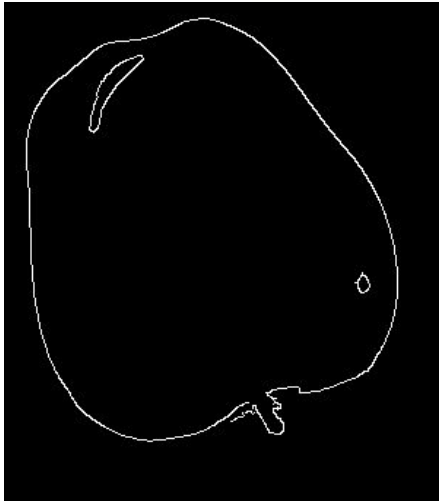


- **Invert Fruit Mask**  
to create a background mask
- **Dilate Background Mask**  
to remove the external edge using a 5x5 kernel.
- **Remove External Contour**  
by subtracting the dilated background mask from the Canny edge image
- Apply morphological closing to the result and finalize the edges creating **Close Figures**

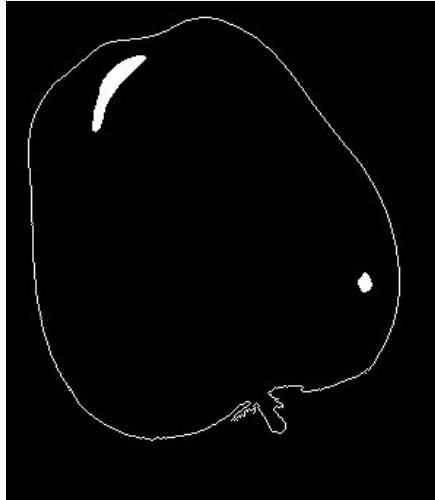


# PROJECT TIMELINE

**Step 4**  
Edge detection



**Step 5**  
Fruit isolation



**Step 6**  
Defects identification



# PROJECT TIMELINE

## Step 6

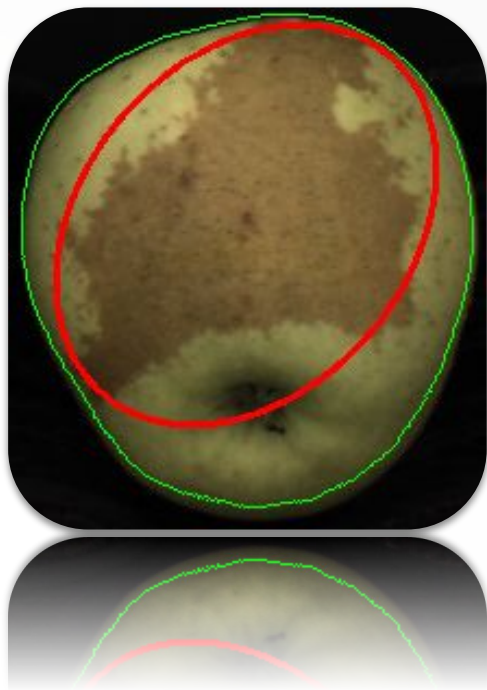
Defects identification



- Detect defects by **labeling connected components** in the processed image
- Draw the **fruit outline** on the image using the binary mask
- Iterate over detected components to **identify and isolate defects**, then count and highlight defects on the image.



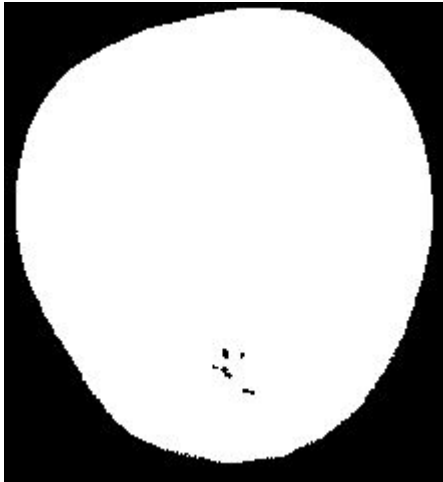
03



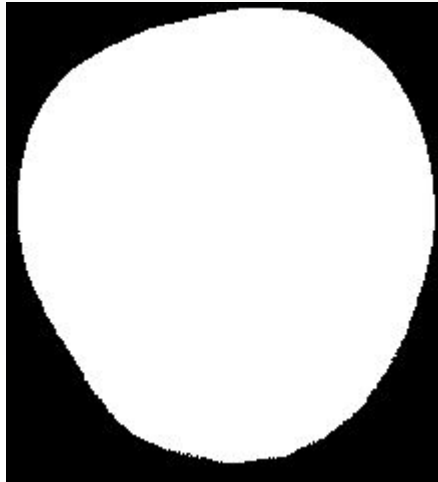
## Second Task

# PROJECT TIMELINE

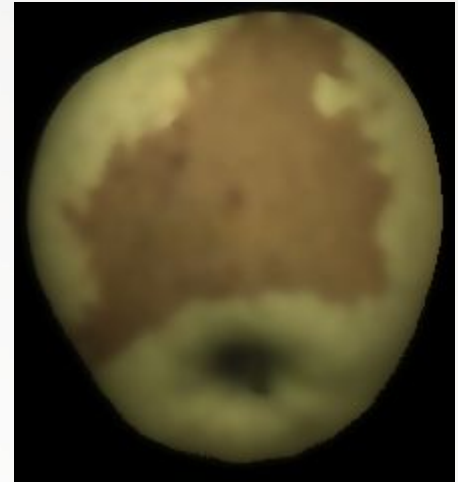
**Step 1**  
Binarization



**Step 2**  
Segmentation



**Step 3**  
Smoothing

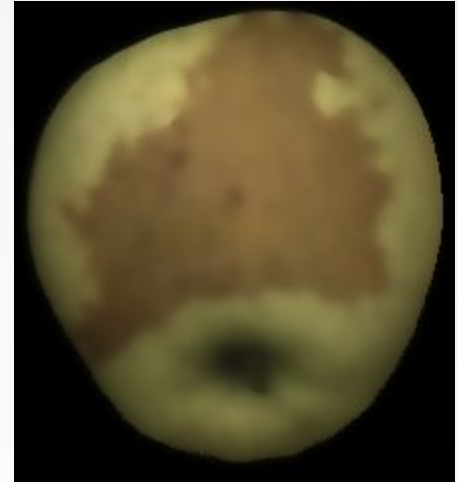
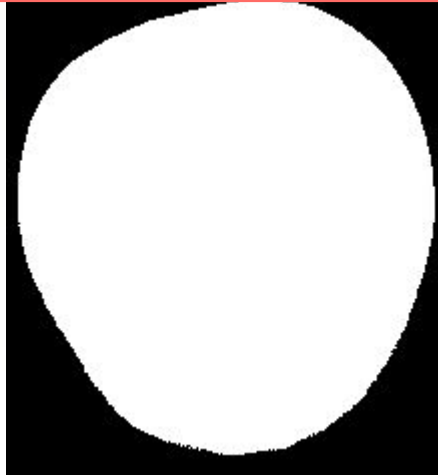
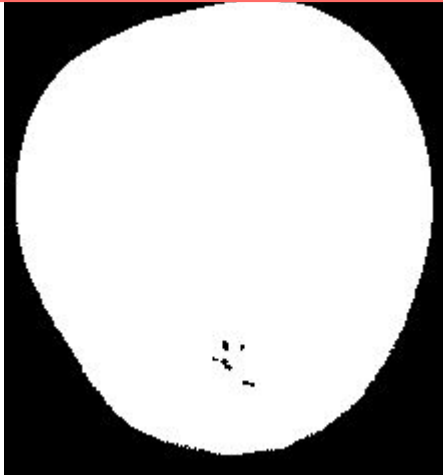


# PROJECT TIMELINE

**Step 1**  
Binarization

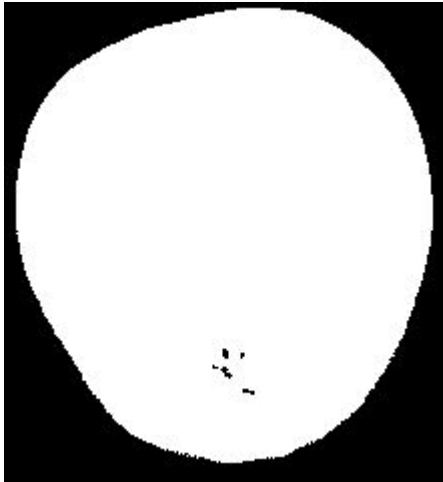
**Step 2**  
Segmentation

**Step 3**  
Smoothing

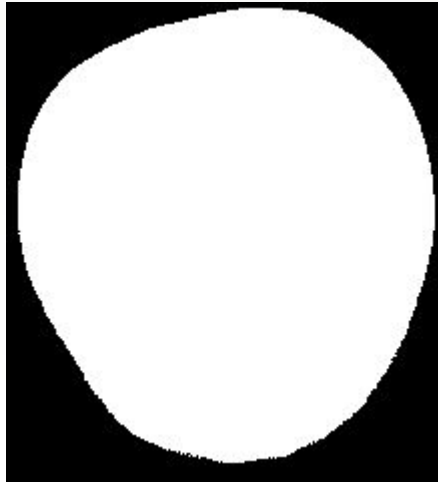


# PROJECT TIMELINE

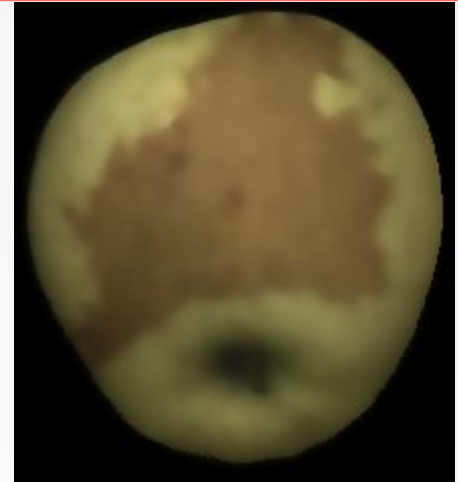
**Step 1**  
Binarization



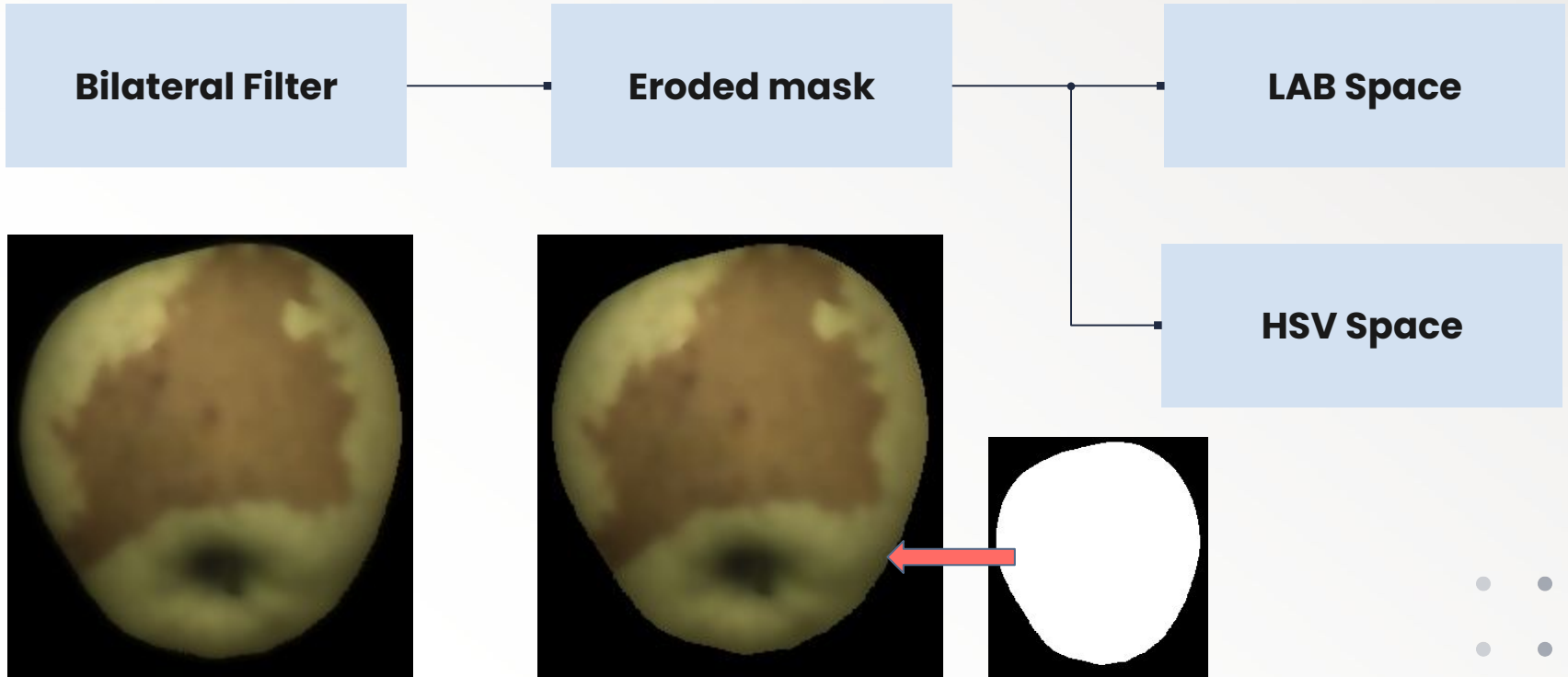
**Step 2**  
Segmentation



**Step 3**  
Smoothing



# PROJECT TIMELINE

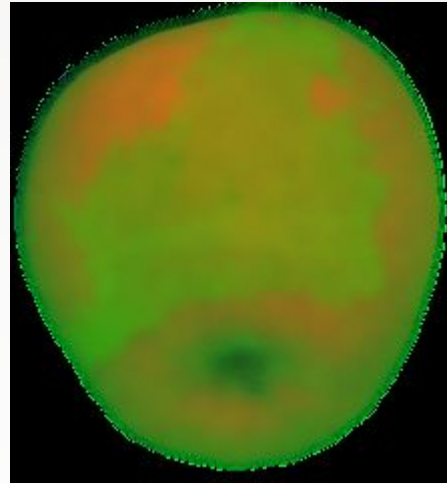


# PROJECT TIMELINE

**Step 3**  
LAB Space

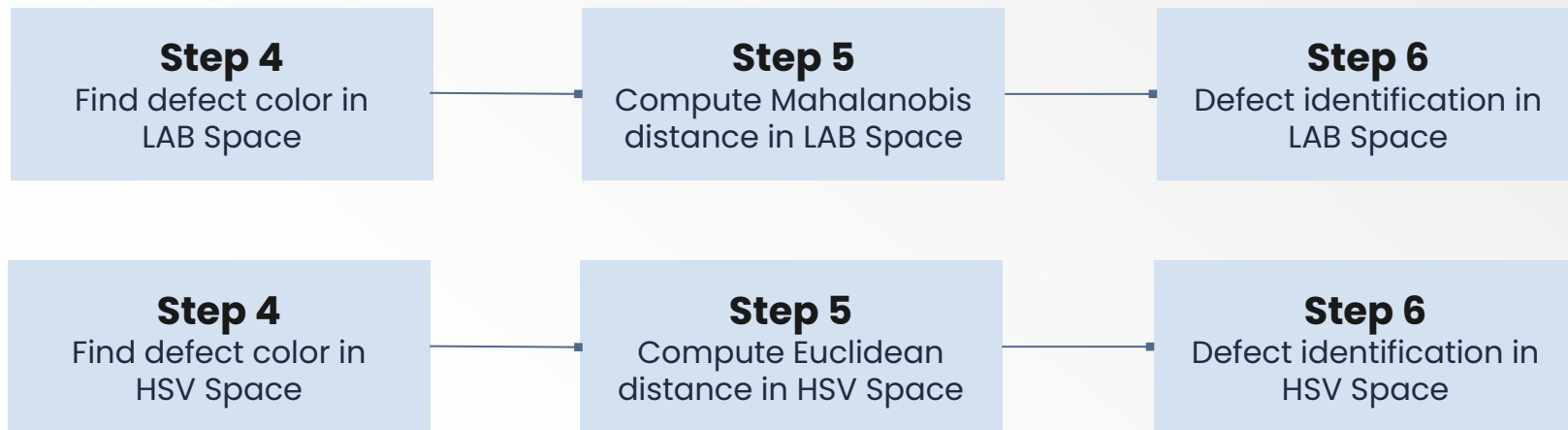


**Step 3**  
HSV Space

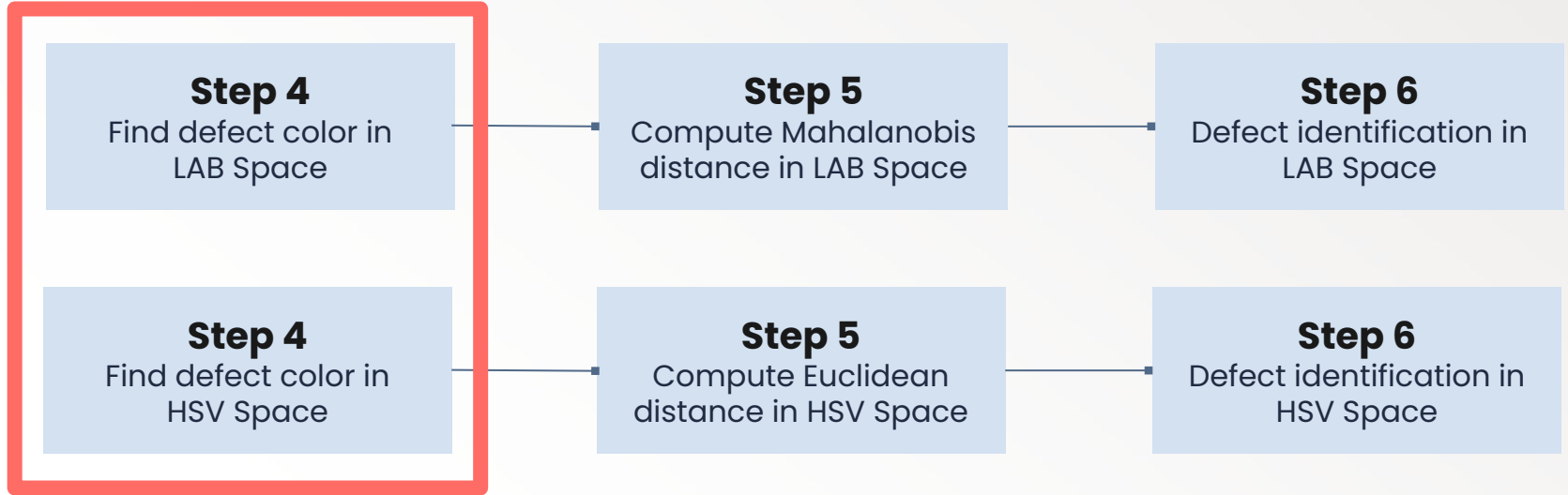




# PROJECT TIMELINE



# PROJECT TIMELINE

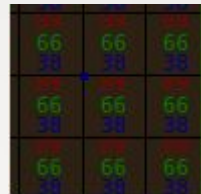
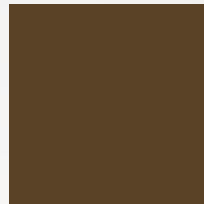


# PROJECT TIMELINE

**Step 4**  
LAB Space



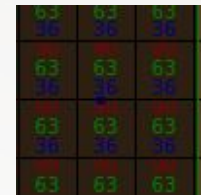
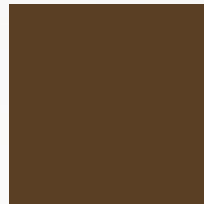
**Find color defect  
with samples**



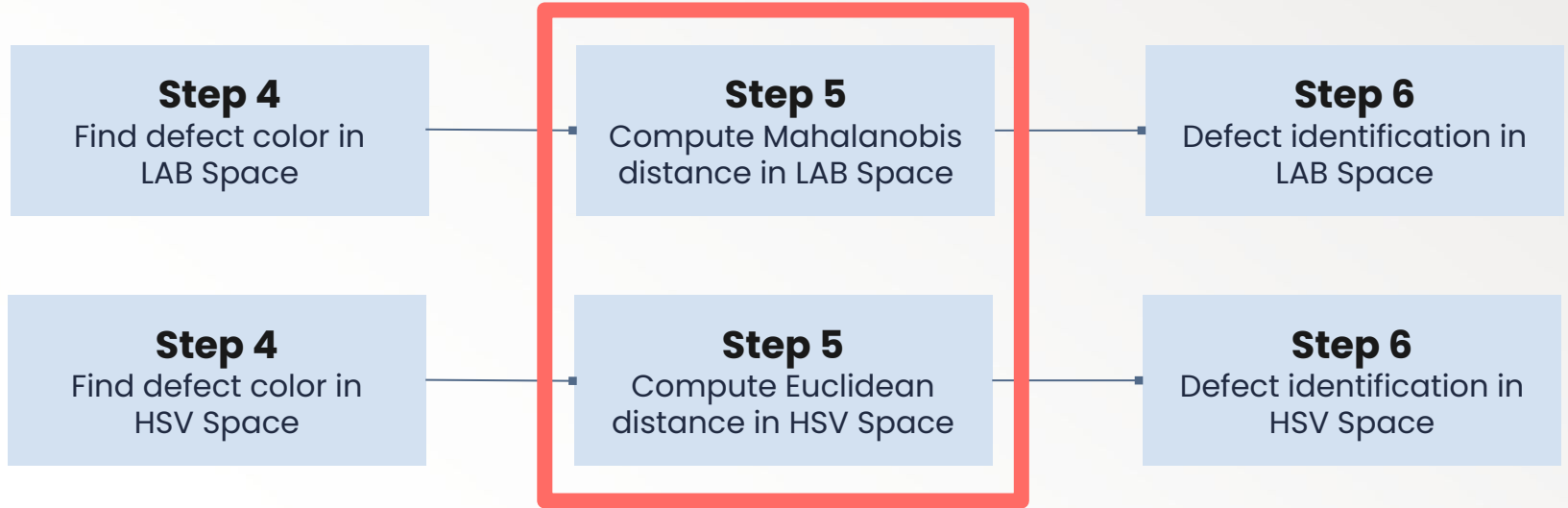
**Step 4**  
HSV Space



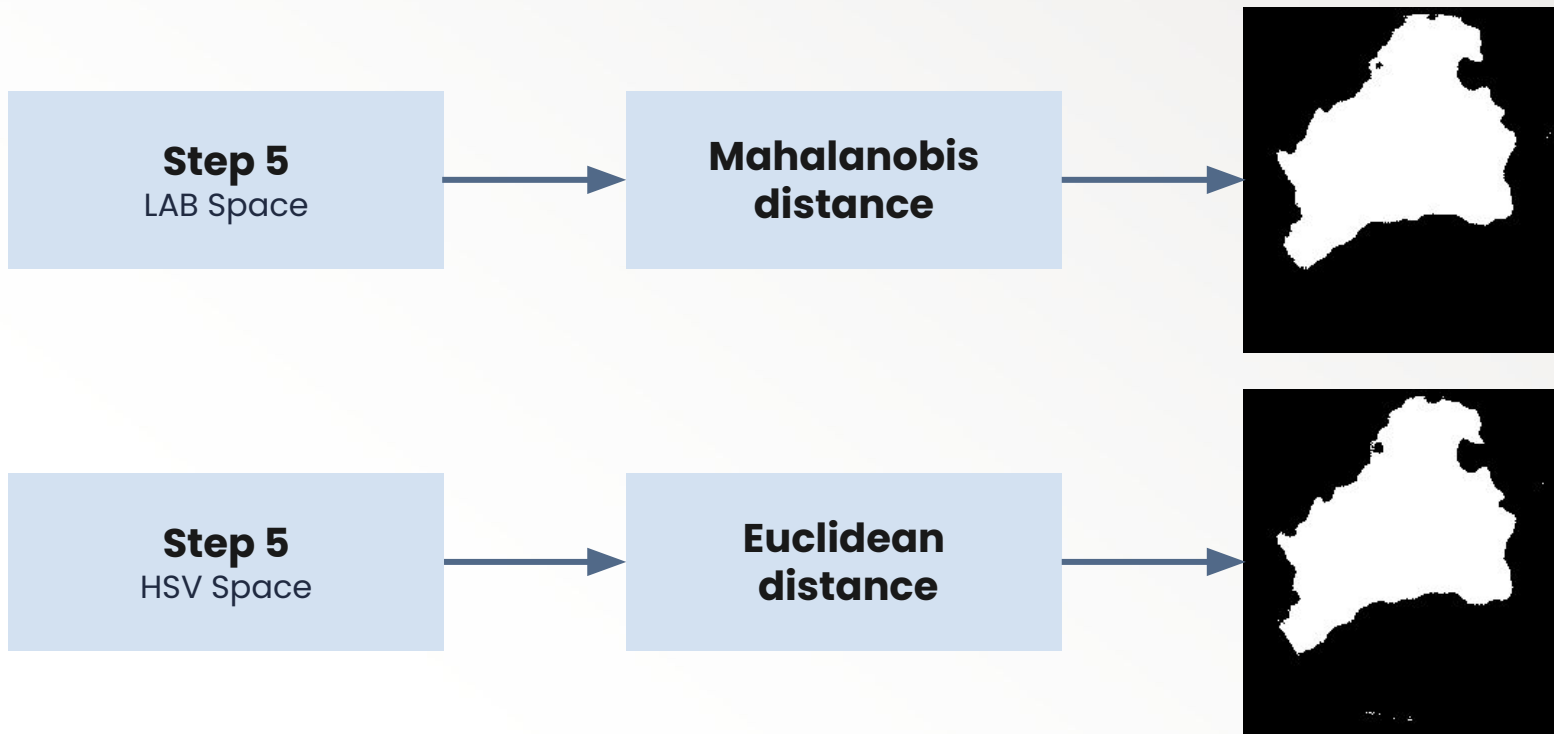
**Find color defect  
with samples**



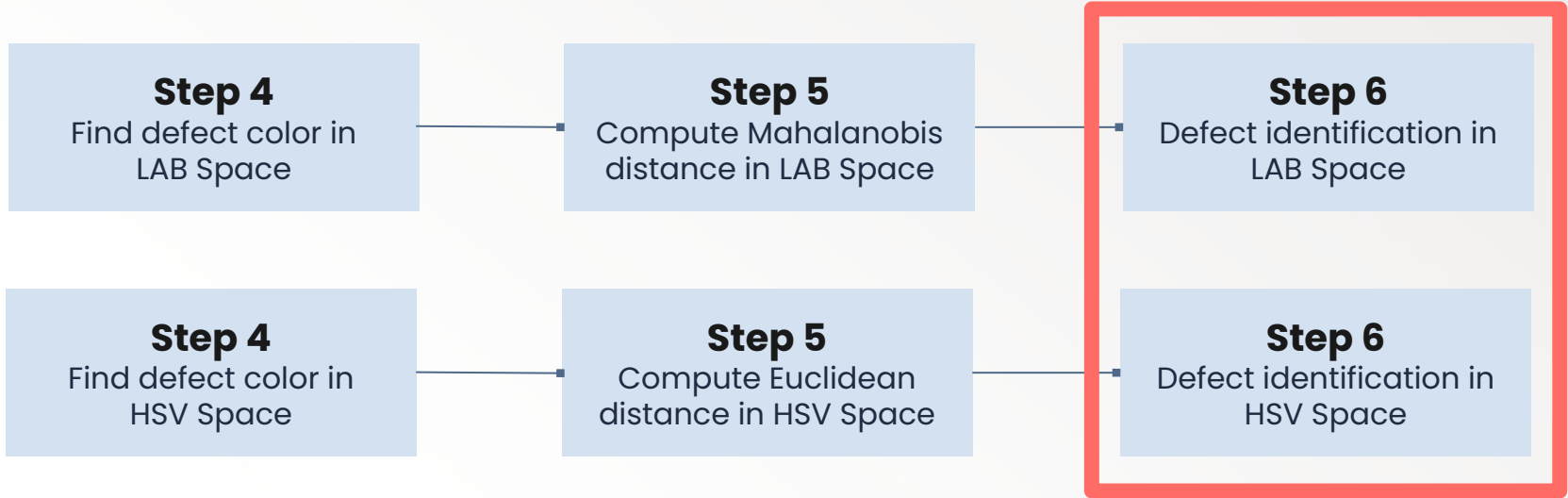
# PROJECT TIMELINE



# PROJECT TIMELINE



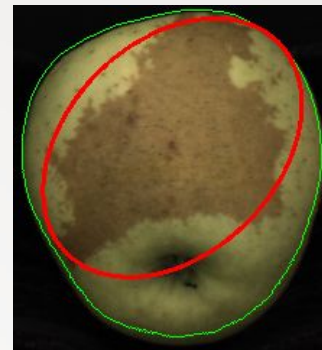
# PROJECT TIMELINE



# PROJECT TIMELINE

## Step 6 LAB Space

Identify, isolate and  
mask LAB defects



## Step 6 HSV Space

Identify, isolate and  
mask HSV defects



# Conclusion

The **first task** was successfully completed.

It was indeed possible to:

- delineate the edge of each apple
- identify defects and highlight them in the original photo

This **second task** encountered more problems: the first sample in particular caused several errors in both color spaces.

- In LAB Space the whole apple is identified as an error
- In the HSV Space, the same error occurred but the larger areas of the russet were replaced with smaller defects

Overall, though, the color space that produced the best result was the **LAB Space**.





**Thanks for your  
attention!**

