EGU24

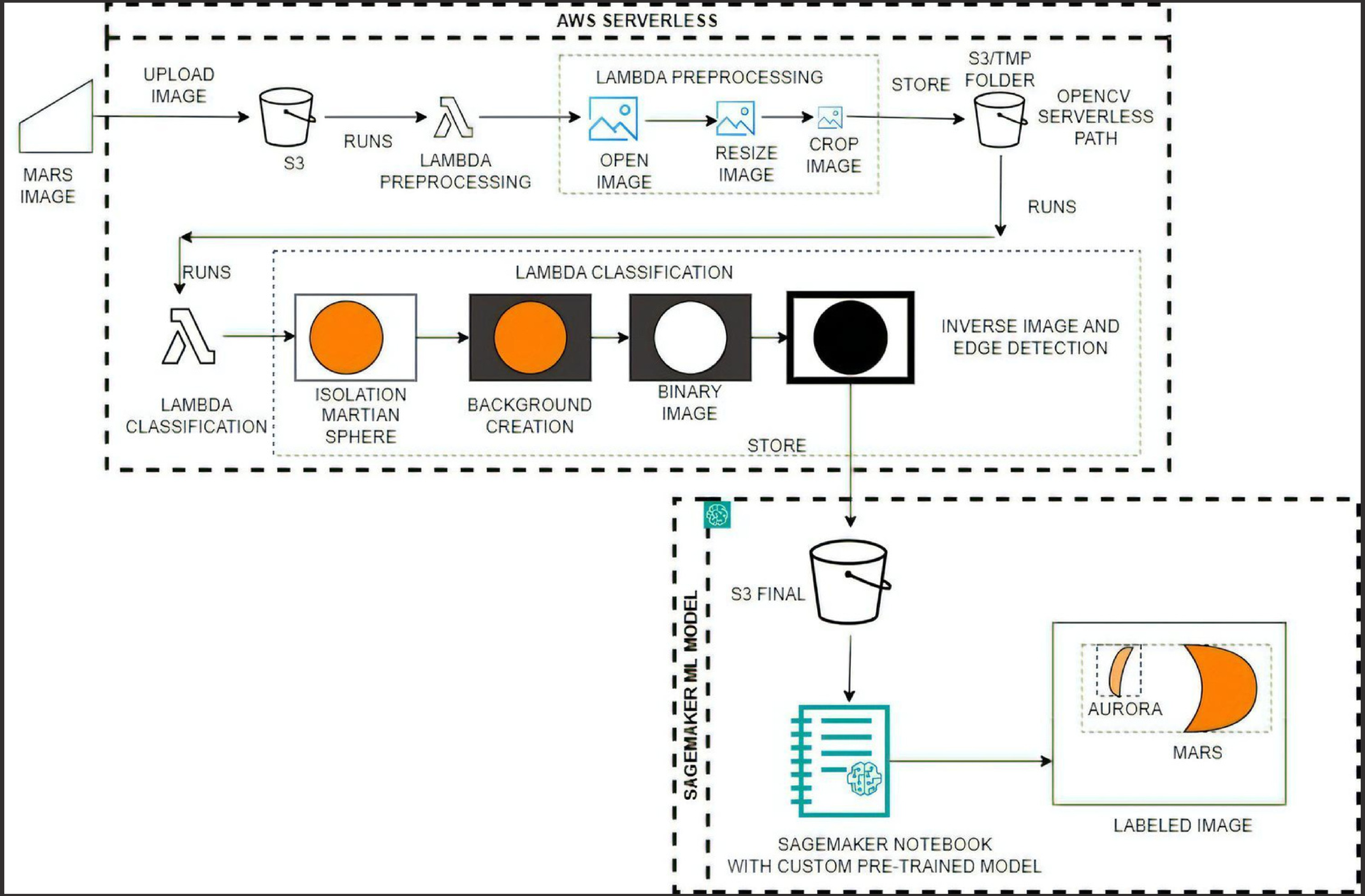
UNIVERSIDAD COMPLUTENSE DE MADRID

SERVERLESS COMPUTING ARCHITECTURE FOR ENHANCED MARTIAN AURORA DETECTION IN THE EMIRATES MARS MISSION

David Pacios, José Luis Vázquez-Poletti, Dattaraj B. Dhurri, Dimitra Atri, Rafael Moreno Vozmediano, Robert J. Lillis, Nikolaos Schetakis, Jorge Gómez-Sanz, Alessio Di Iorio, and Luis Vazquez

SERVERLESS ARCHITECTURE

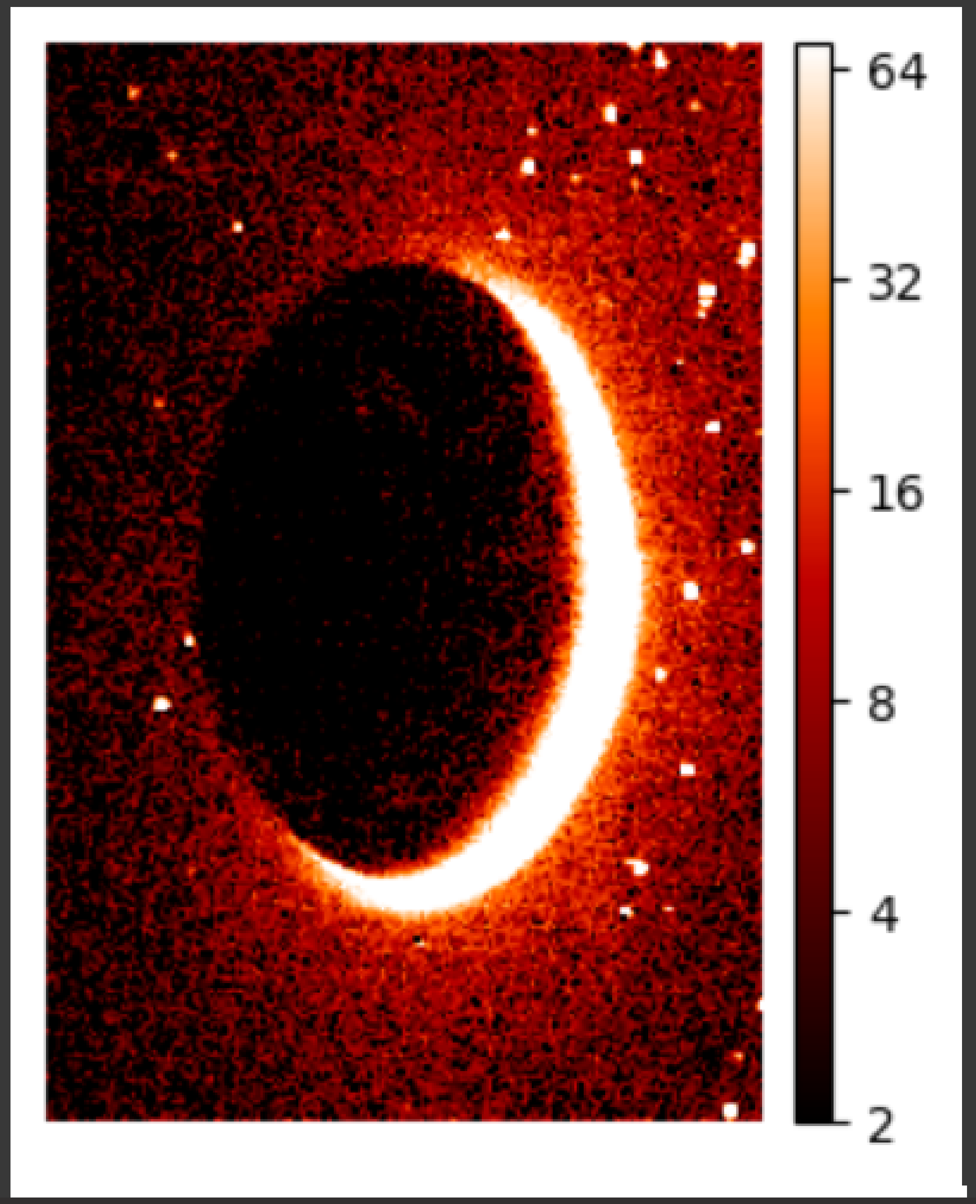
WE'RE USING A HOPE FOLDER, ALL REFERENCES ARE FROM THIS FOLDERS



STEP 1 - DOCKER MODEL TO GENERATE GRAPHS

FOLDER: 1 - COMPOSE

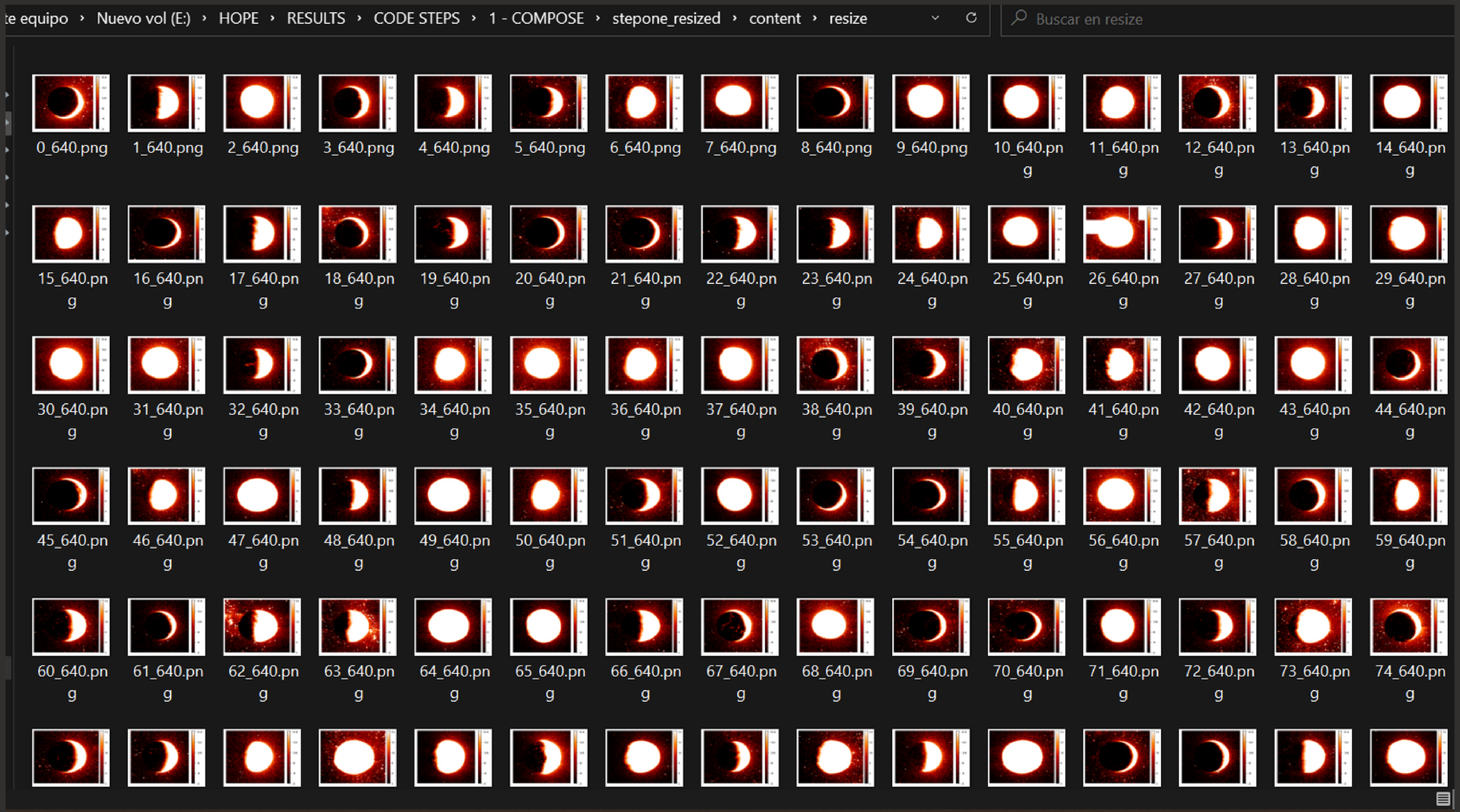
- stepone_resized
- 1_Compose.ipynb
- stepone_resized.zip



ACCORDING TO THE PERFECT SIZE FOR OPENCV DETECTION, IT'S MANDATORY TO RESIZE ALL GRAPHS TO NORMALIZE THE COMMON SIZE

THE FIRST STEP CONTAINS A DOCKER IMAGE WITH ASTROPY LIBRARY AND OPENCV/PILLOW TO NORMALIZE ALL IMAGES AND COMPRESS TO USE IN NEXT STEP

STEP 2 - DOCKER MODEL TO GENERATE GRAPHS



FOLDER OF STEP ONE'S RESULTS, SAVING FOR PROOF

FOLDER: 1 - COMPOSE

- stepone_resized
- 1_Compose.ipynb
- stepone_resized.zip

STEP 2 - OPENCV MATH MODEL

```
adding: content/intermediodos/ (stored 0%)
adding: content/intermediodos/0_640_cropped.png (deflated 0%)
adding: content/intermediodos/113_640_cropped.png (deflated 0%)
adding: content/intermediodos/41_640_cropped.png (deflated 0%)
adding: content/intermediodos/230_640_cropped.png (deflated 0%)
adding: content/intermediodos/172_640_cropped.png (deflated 0%)
adding: content/intermediodos/204_640_cropped.png (deflated 0%)
adding: content/intermediodos/45_640_cropped.png (deflated 0%)
adding: content/intermediodos/116_640_cropped.png (deflated 0%)
adding: content/intermediodos/92_640_cropped.png (deflated 0%)
```

FOR BEGINNING WE'VE TO CROP THE WHITE PART OF GRPAH TO MAKE A COLOR - PREPROCESSING

FOLDER: 2 - CROP SAVE

- steptwo_binary
- steptwo_final
- steptwo_mascara
- steptwo_preprocesado
- steptwo_resized_and_crop...
- 2_Crop_save_and_crop_ag...
- steptwo_binary.zip
- steptwo_final.zip
- steptwo_mascara.zip
- steptwo_preprocesado.zip
- steptwo_resized_and_crop...

STEP 2 - OPENCV MATH MODEL

FOLDER: 2 - CROP SAVE

- steptwo_binary
- steptwo_final
- steptwo_mascara
- steptwo_preprocesado
- steptwo_resized_and_crop...
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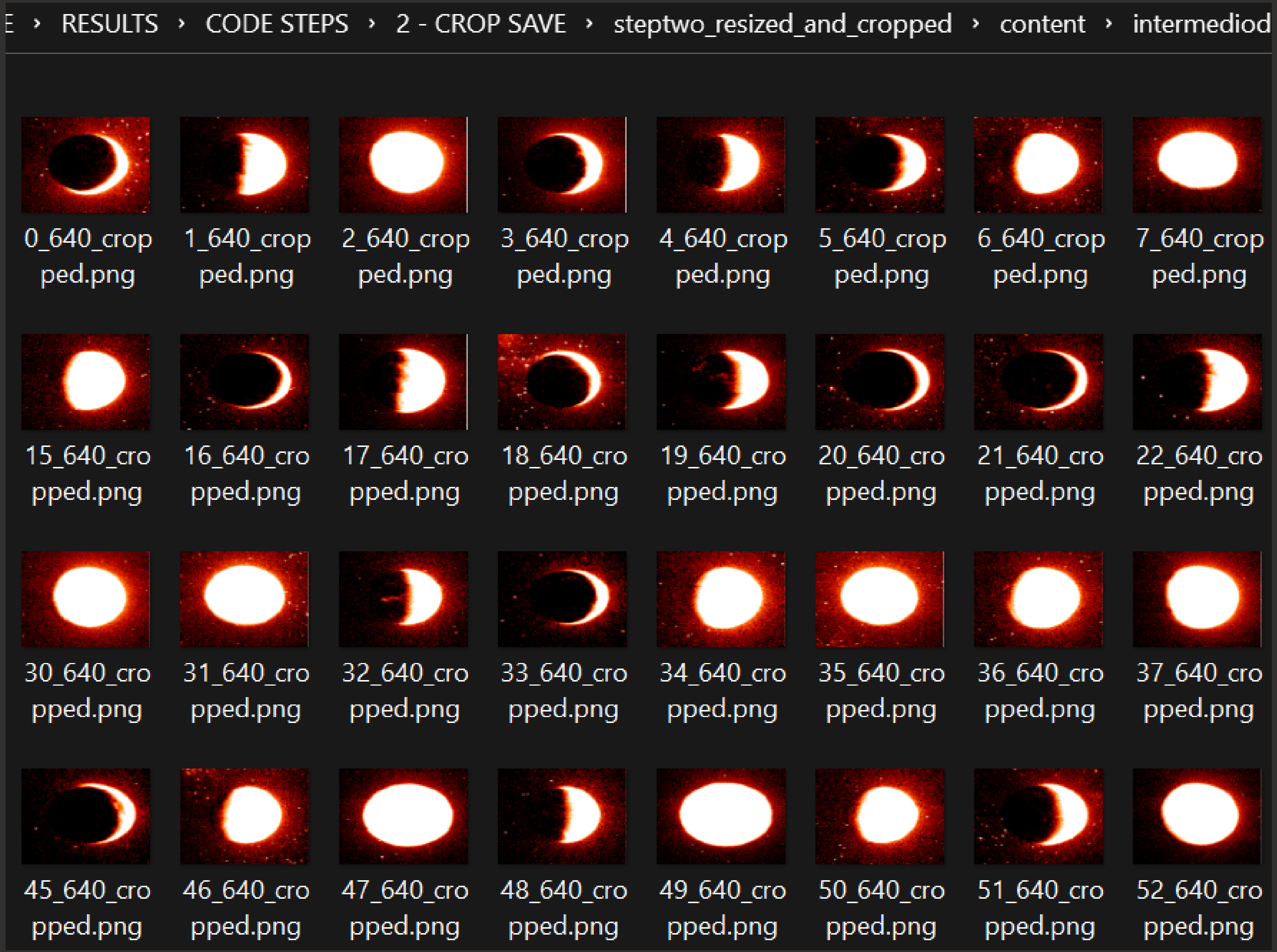
- steptwo_binary.zip
- steptwo_final.zip
- steptwo_mascara.zip
- steptwo_preprocesado.zip
- steptwo_resized_and_crop...



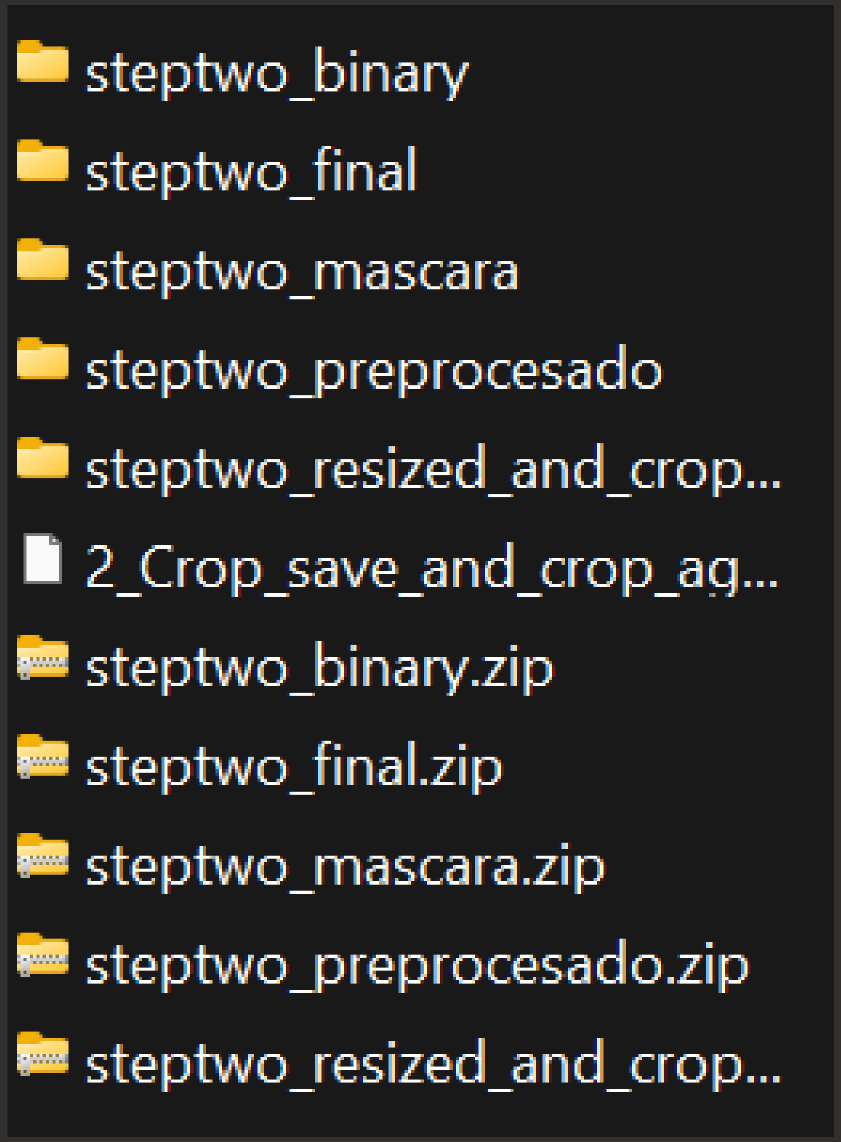
PREPARING RESULTS TO MAKE NEXT BINARY ROUNDED MASK

STEP 2 - OPENCV MATH MODEL

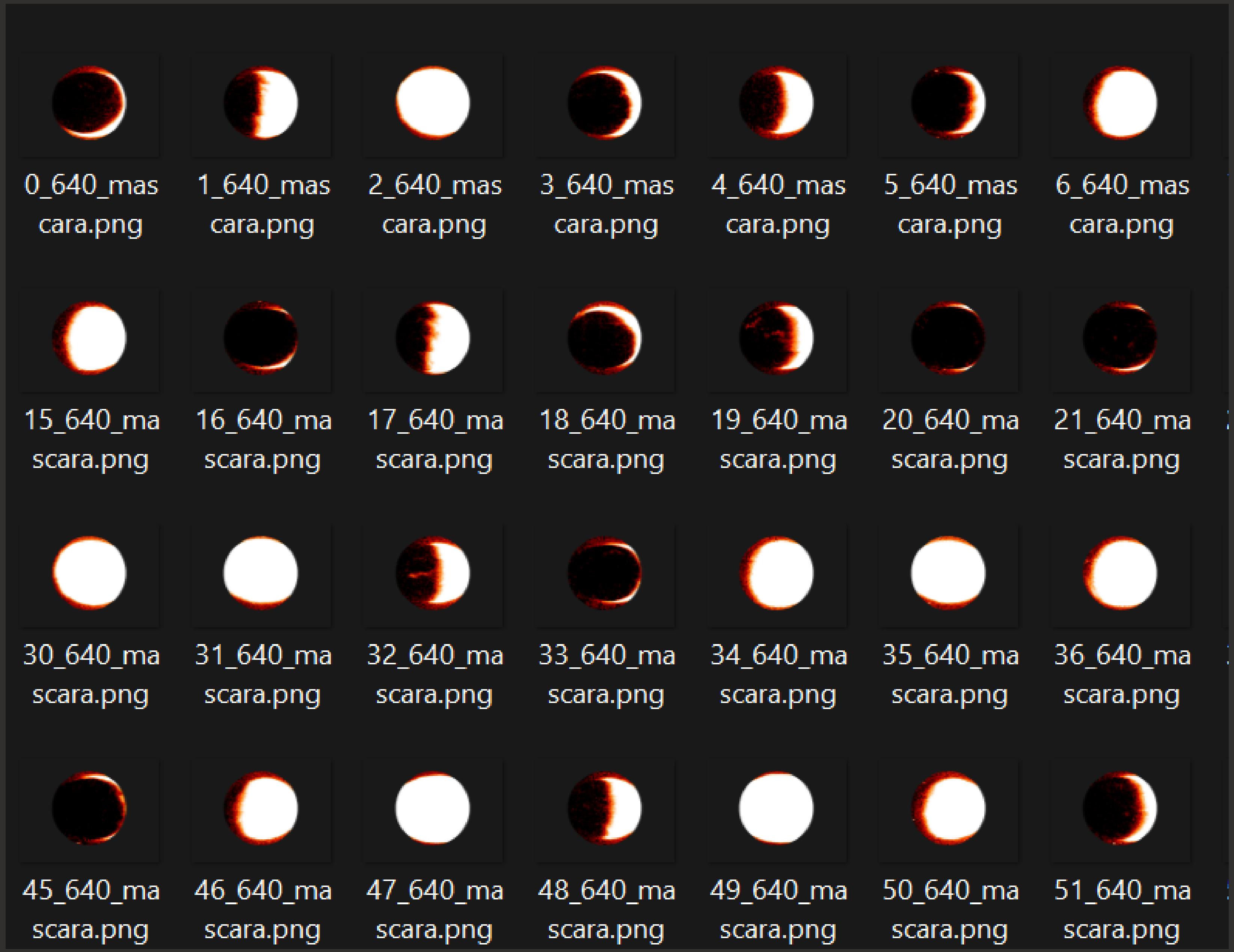
```
xc = 320
yc = 230

# draw filled circles in white on black background as masks
mask2 = np.zeros_like(img)
mask2 = cv2.circle(mask2, (xc,yc), radius2, (255,255,255), -1)

# subtract masks and make into single channel
mask = mask2

# put mask into alpha channel of input
result = cv2.cvtColor(img, cv2.COLOR_BGR2BGRA)
result[:, :, 3] = mask[:,:,0]
```

CODE TO ROUNDED MASK INTO IMAGES

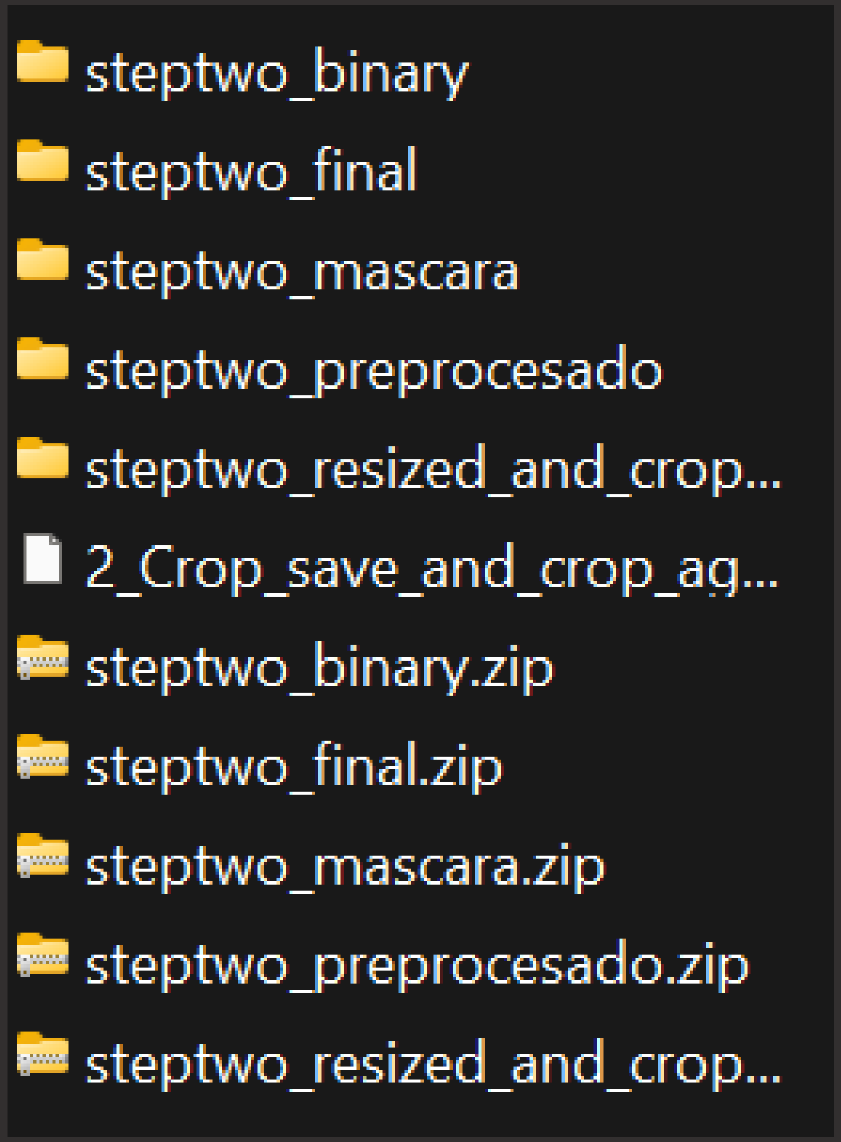
FOLDER: 2 - CROP SAVE



STEP 2 - OPENCV MATH MODEL



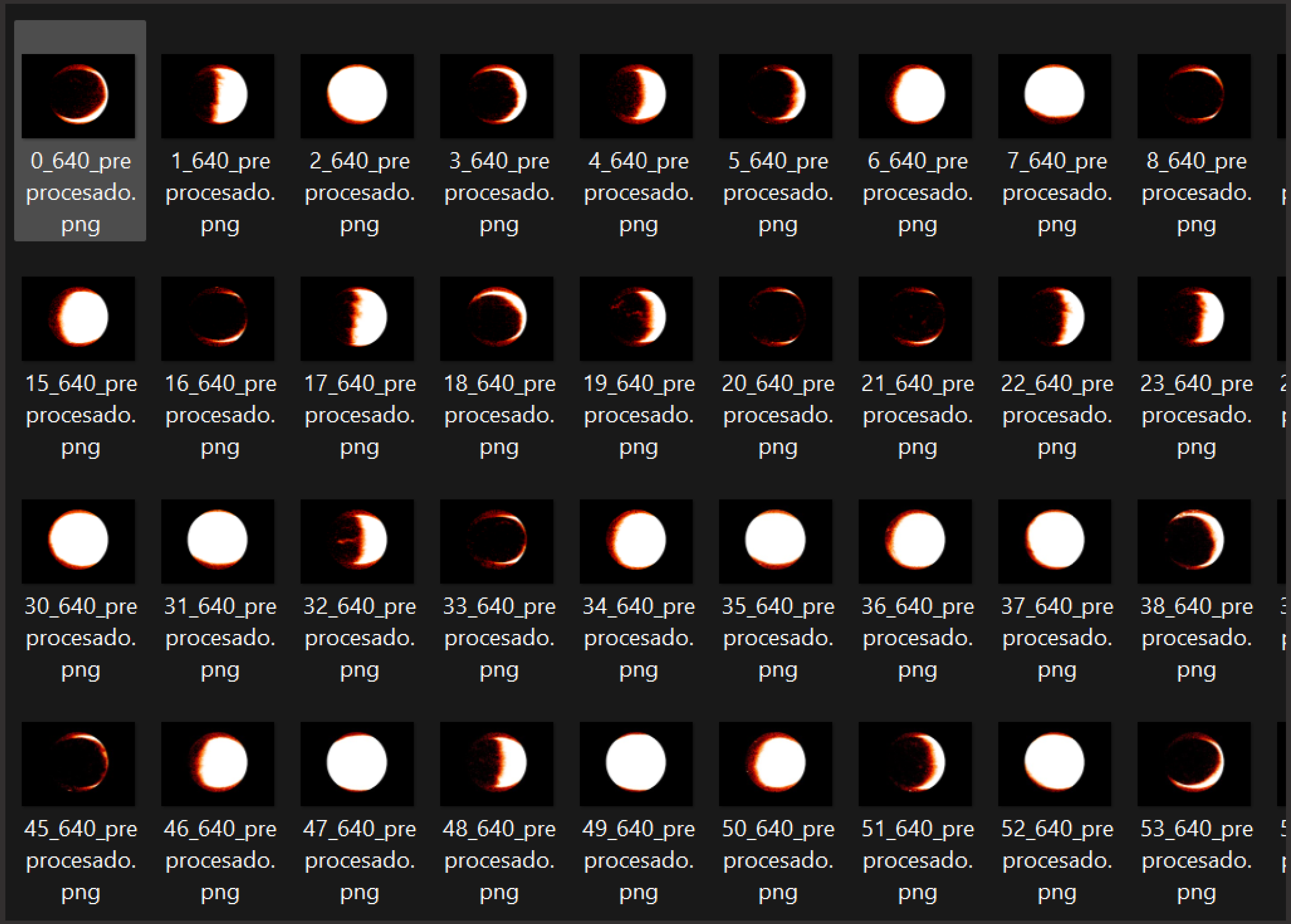
FOLDER: 2 - CROP SAVE

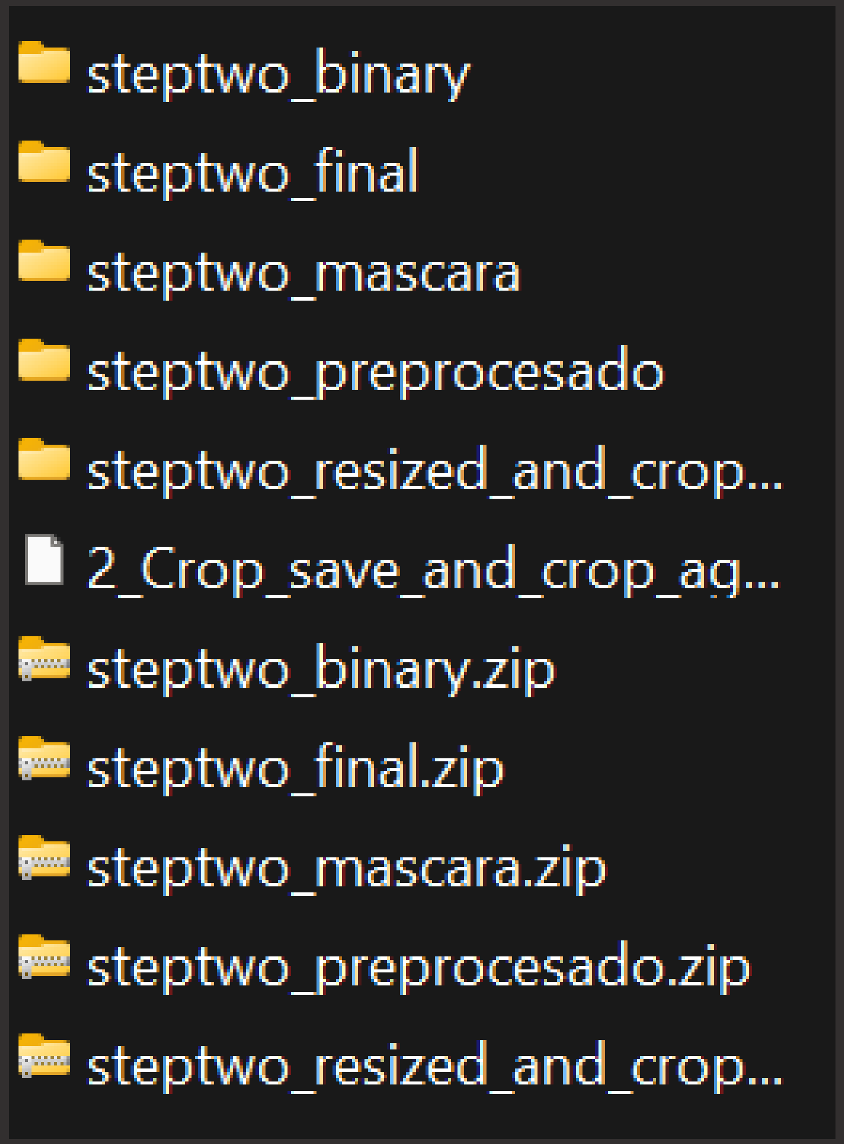


ROUNDED MASK FOR CENTER MARS ANIMALITIES
IMPORTANT: IT CONTAINS AN ALPHA CHANNEL WITH MORE INFORMATION.

STEP 2 - OPENCV MATH MODEL

FOLDER: 2 - CROP SAVE



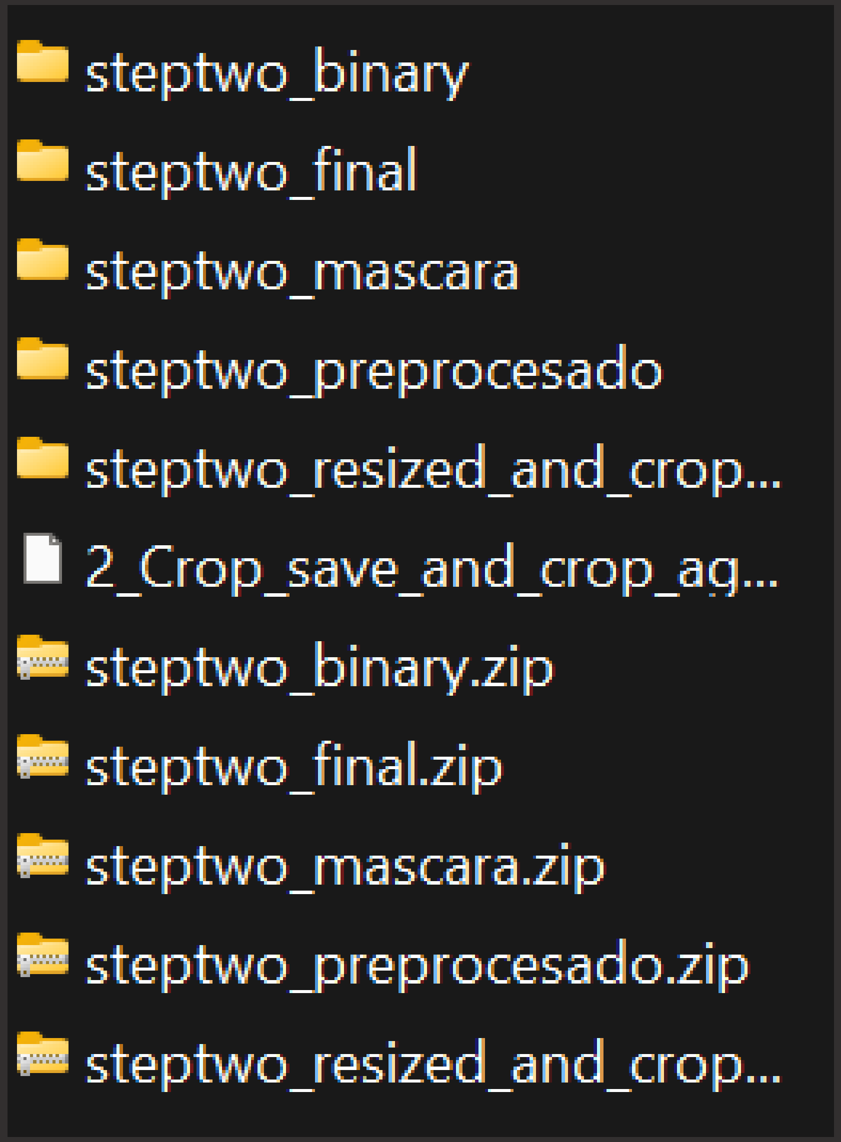


IT NEEDS A PROFESSIONAL IMAGE SHAPING WITH ALPHA CHANNEL REMOVING FOR USSING ON OPENCV

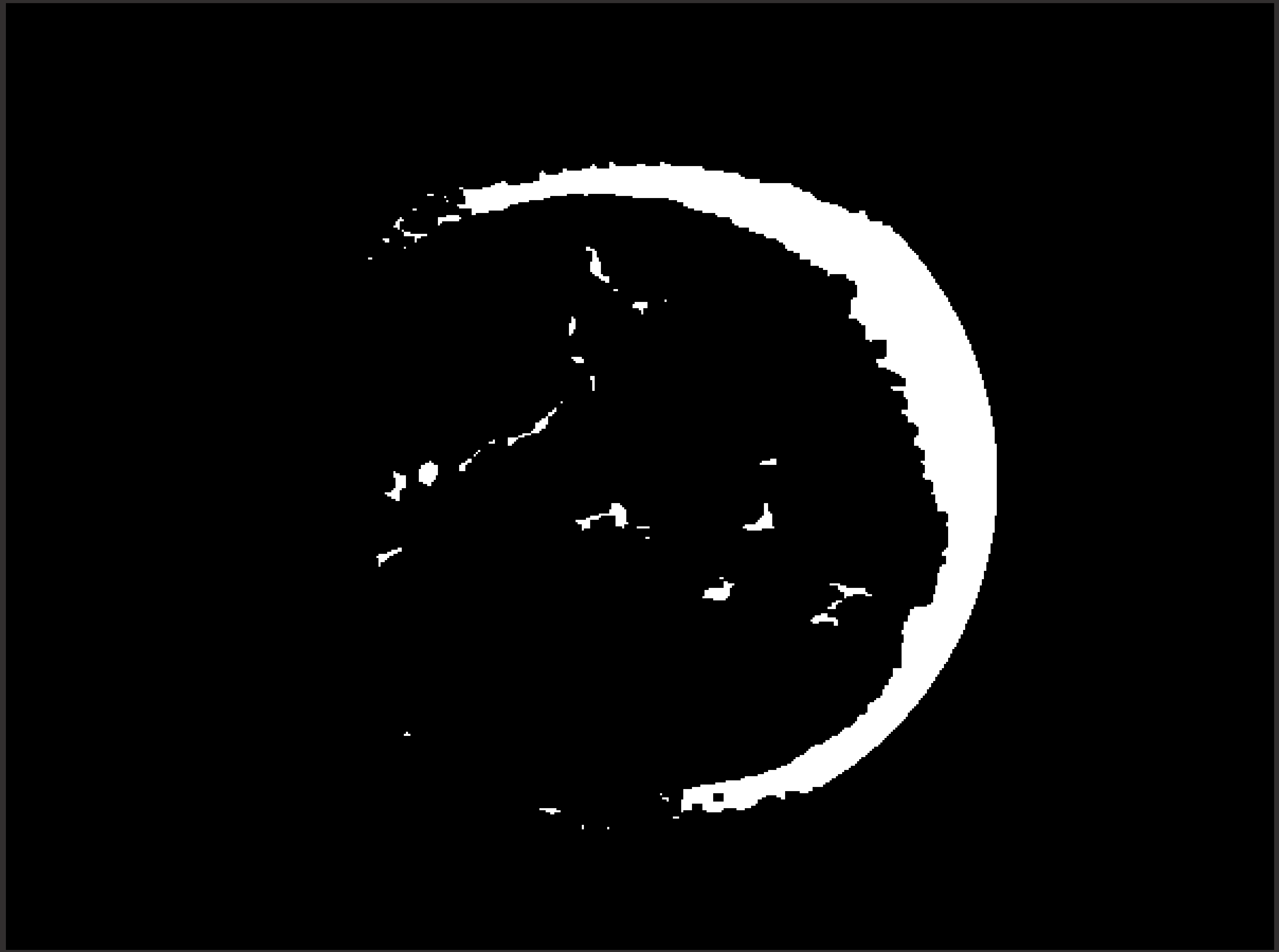
STEP 2 - OPENCV MATH MODEL

NOW, IT'S GOING TO PASS THROUGH AN ALGORITHM TO DETECT SHAPES AND MAKE IT BINARY TO AVOID SMALL GRAINS

FOLDER: 2 - CROP SAVE



STEP 2 - OPENCV MATH MODEL

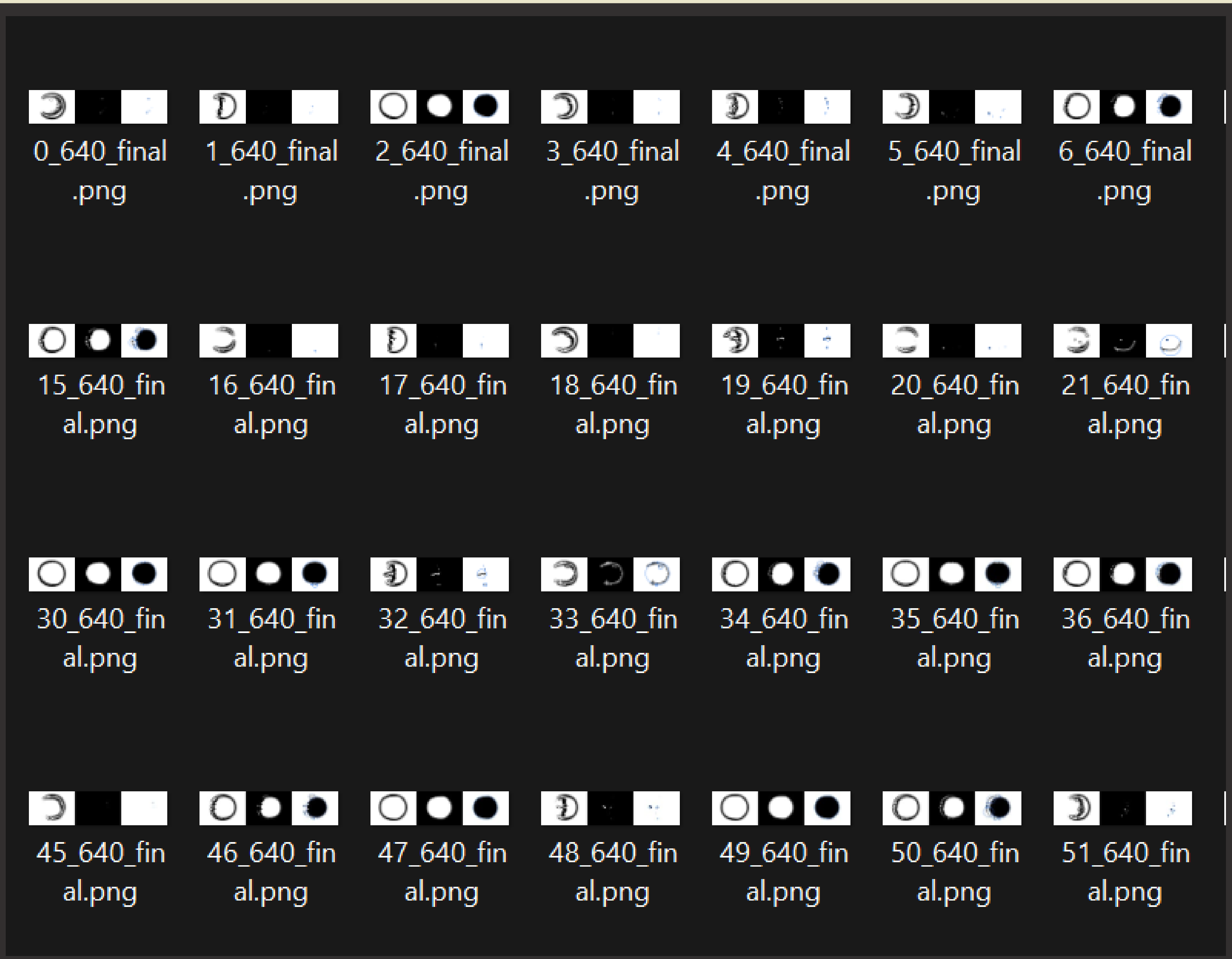


AN EXAMPLE OF FUTURE AURORA DETECTION SHAPE

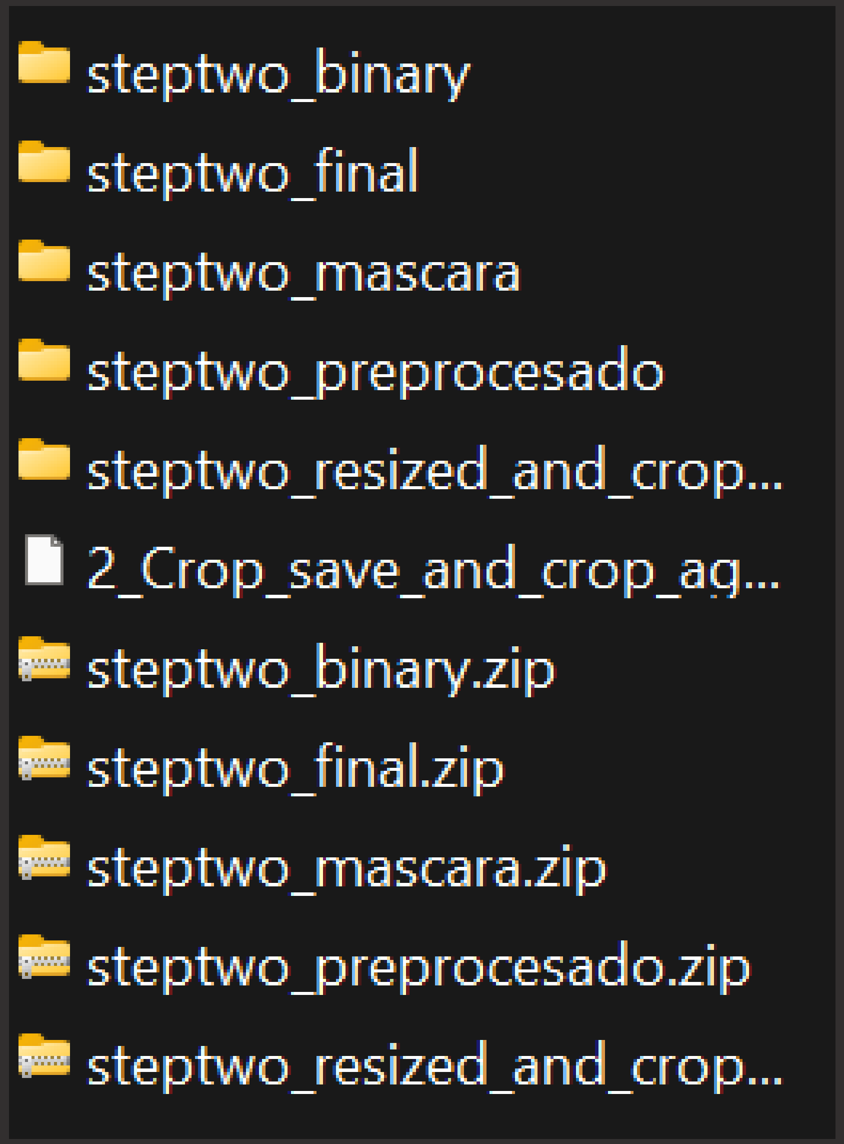
FOLDER: 2 - CROP SAVE

- steptwo_binary
- steptwo_final
- steptwo_mascara
- steptwo_preprocesado
- steptwo_resized_and_crop...
- 2_Crop_save_and_crop_ag...
- steptwo_binary.zip
- steptwo_final.zip
- steptwo_mascara.zip
- steptwo_preprocesado.zip
- steptwo_resized_and_crop...

STEP 2 - OPENCV MATH MODEL



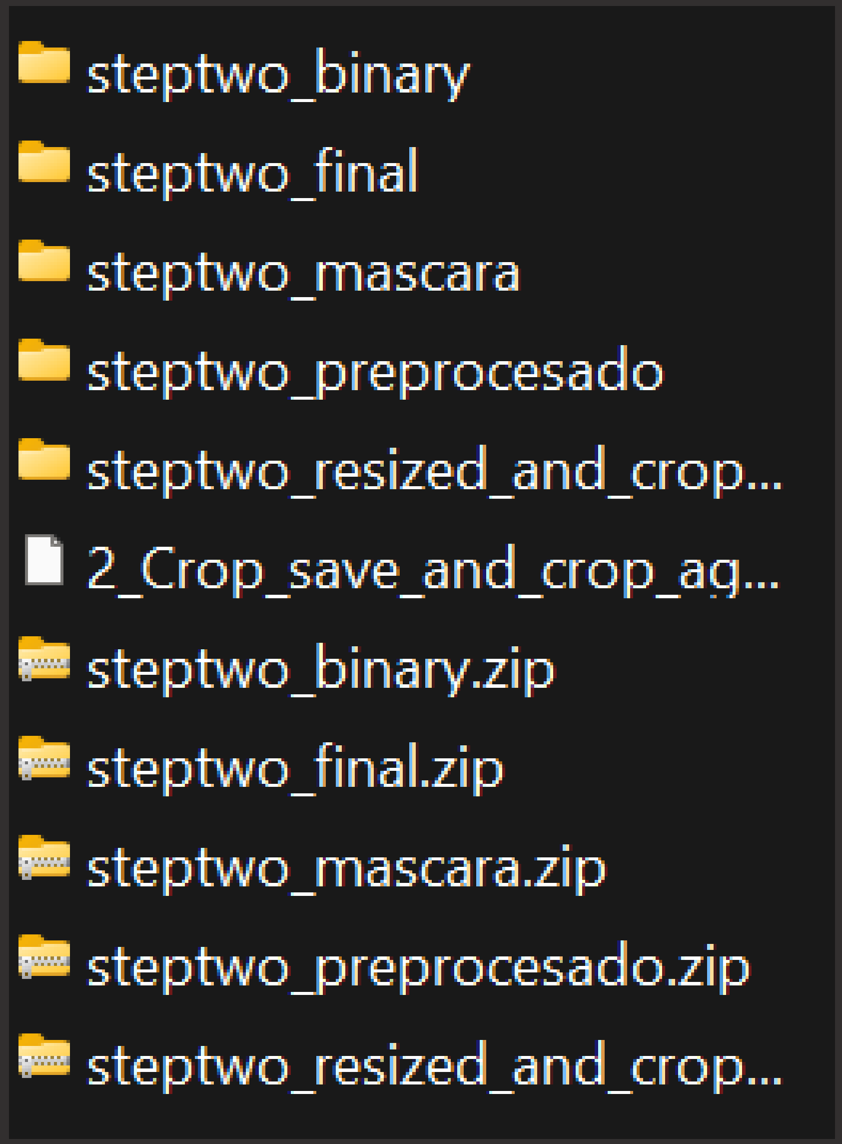
FOLDER: 2 - CROP SAVE

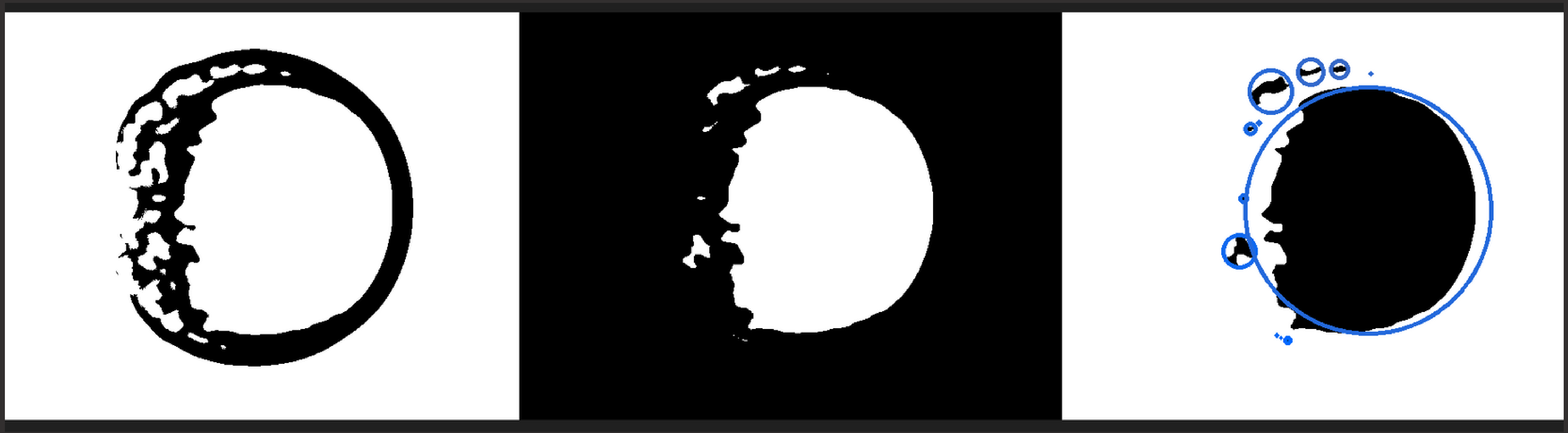


THE SHAPE IS GOING TO MAKE ANOTHER TRAVEL INTO THIS LAMBDA FUNCTION TO MAKE A TRIPLE-DETECTION OF TYPE OF OBJECTS

STEP 2 - OPENCV MATH MODEL

FOLDER: 2 - CROP SAVE

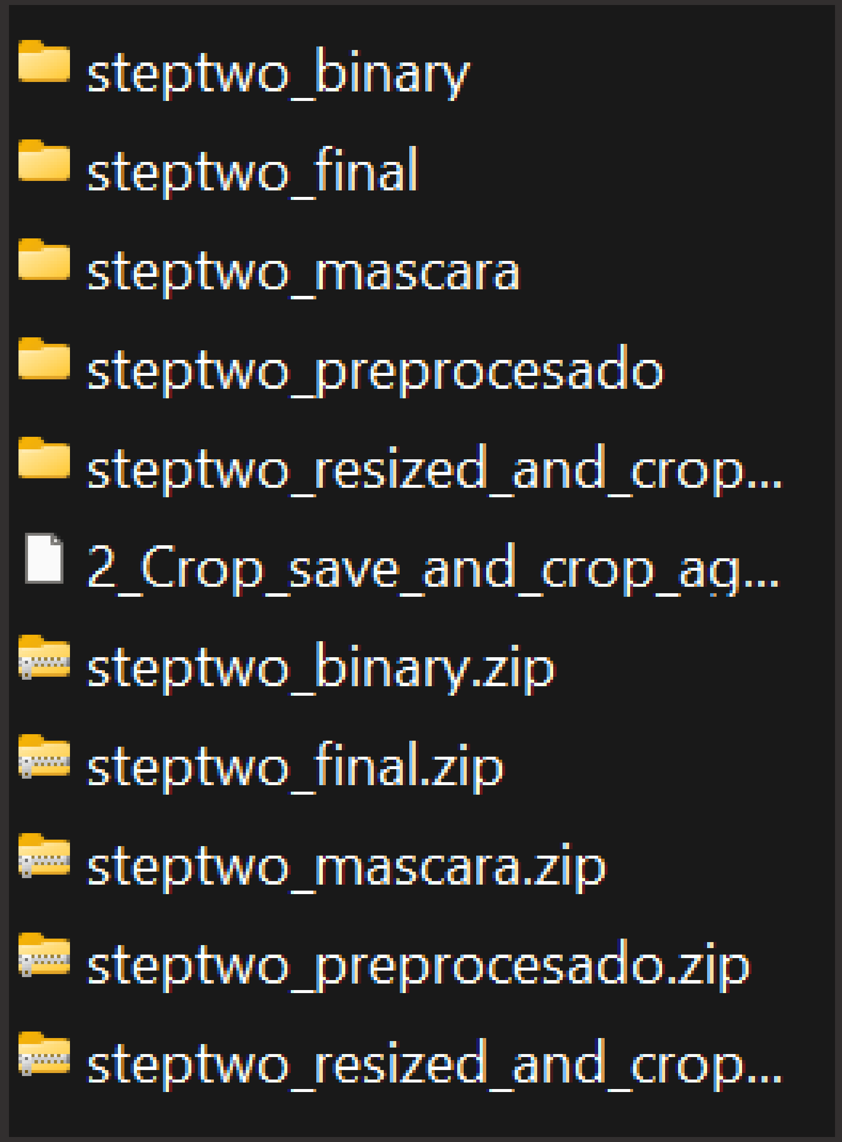


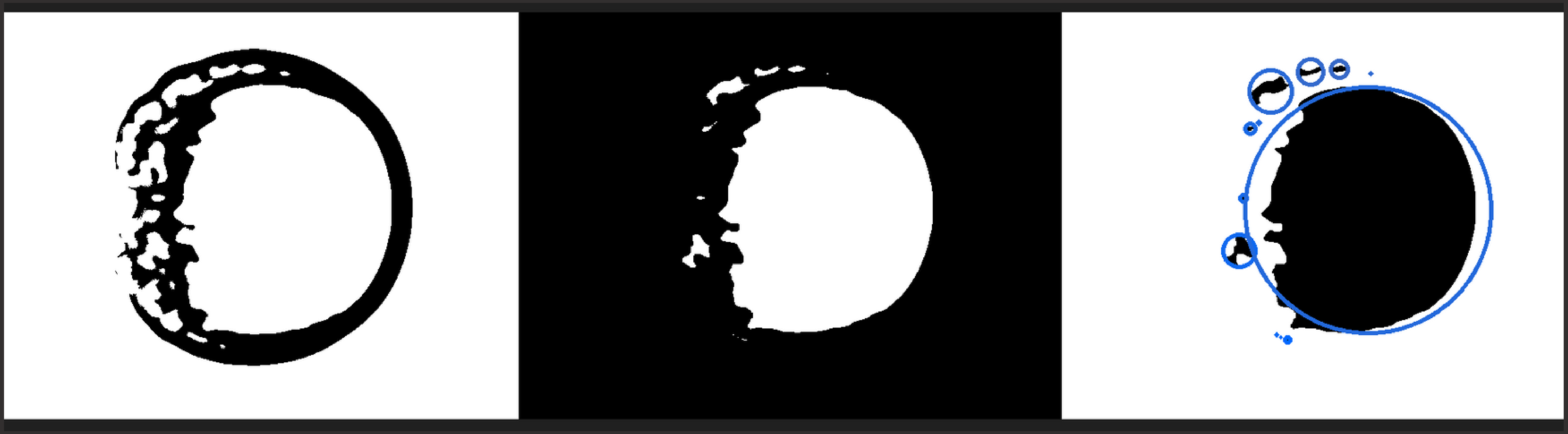


ITiS COMPLICATED TO EXPLAIN, FIRST OF ALL WE MAKE A SMOOTH IMAGE AND MAKE A NOT BINARY MODE TO MAKE THE IMAGE INTO AN ARRAY TO DETECT NEAREST SMALL-MEDIUM OBJECTS AND MARS

STEP 2 - OPENCV MATH MODEL

FOLDER: 2 - CROP SAVE

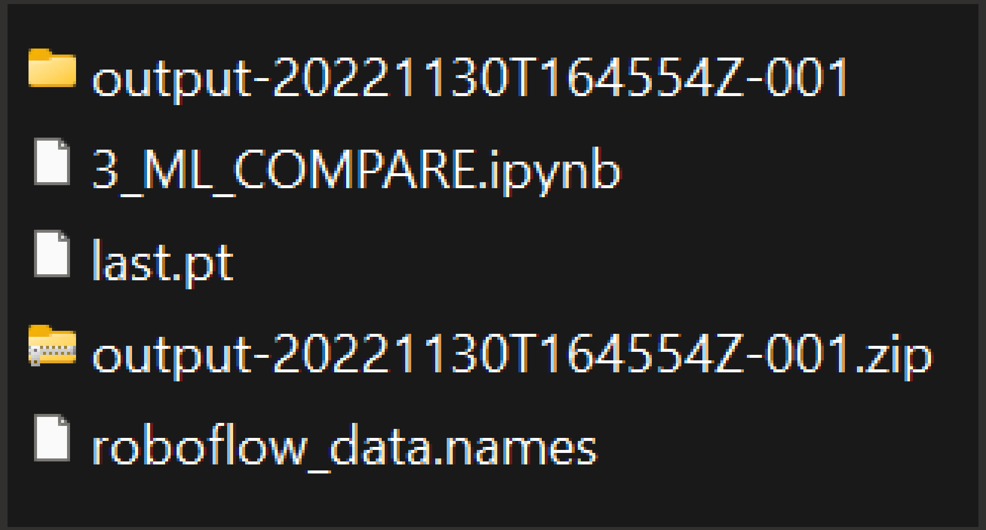


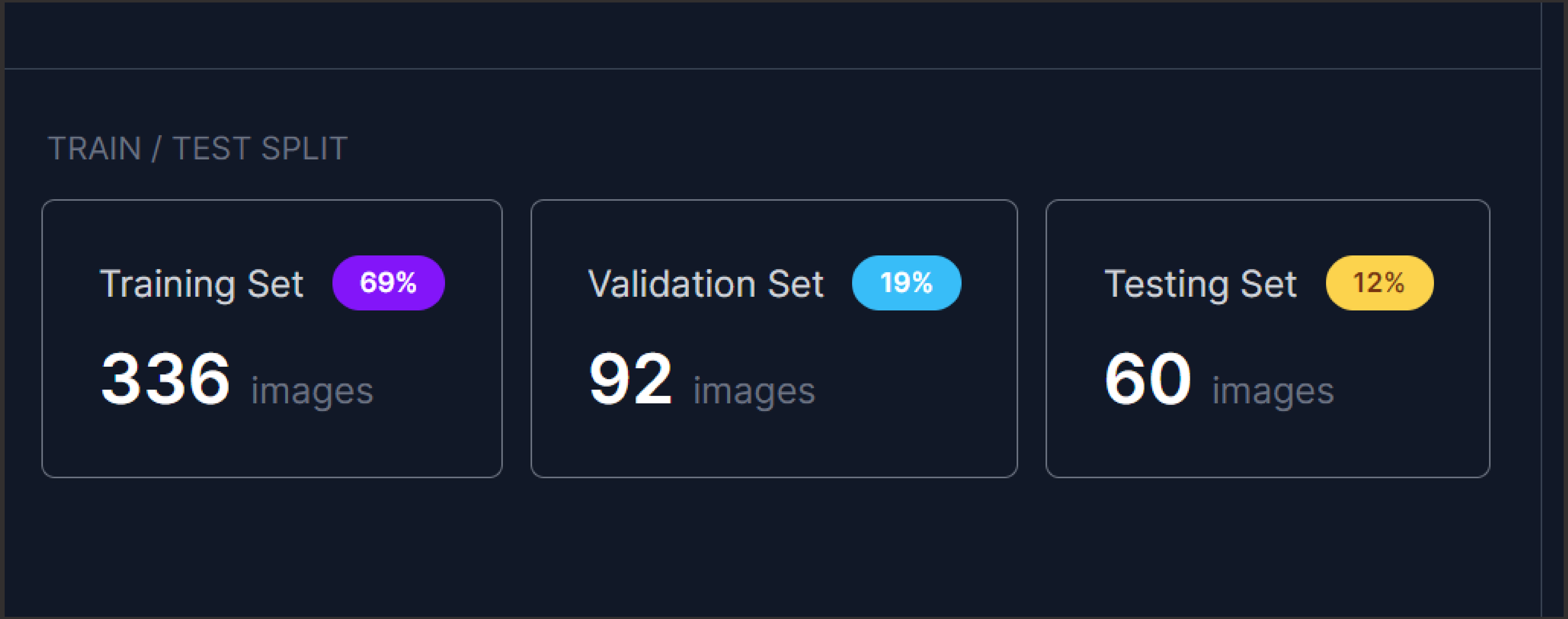


NOW, IF THE DETECTION SHOWS > 1 CLOSE OBJECTS IS A POSSIBLE MARTIAN AURORA, SO WE PUT THIS RESULT INTO A ML CUSTOM MODEL (ML IS A COST FUNCTION, THIS STEPS ARE ONLY FOR REDUCE THE AMOUNT OF IMAGES TO PROCESS)

STEP 3 - MACHINE LEARNING MODEL

FOLDER: 3 - ML COMPARE





MACHINE LEARNING CUSTOM MODEL WITH CUSTOM DATASET. MADE BY HAND.

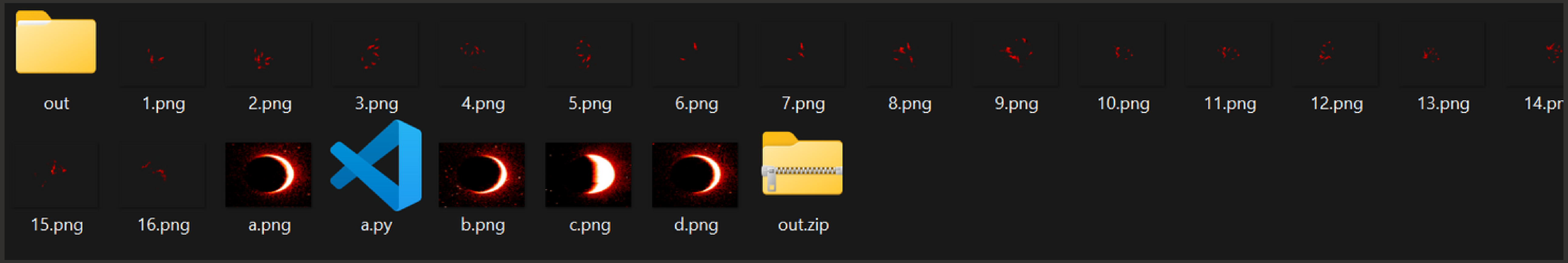
WE HAVE A CUSTOM MODEL WITH >500 IMAGES.

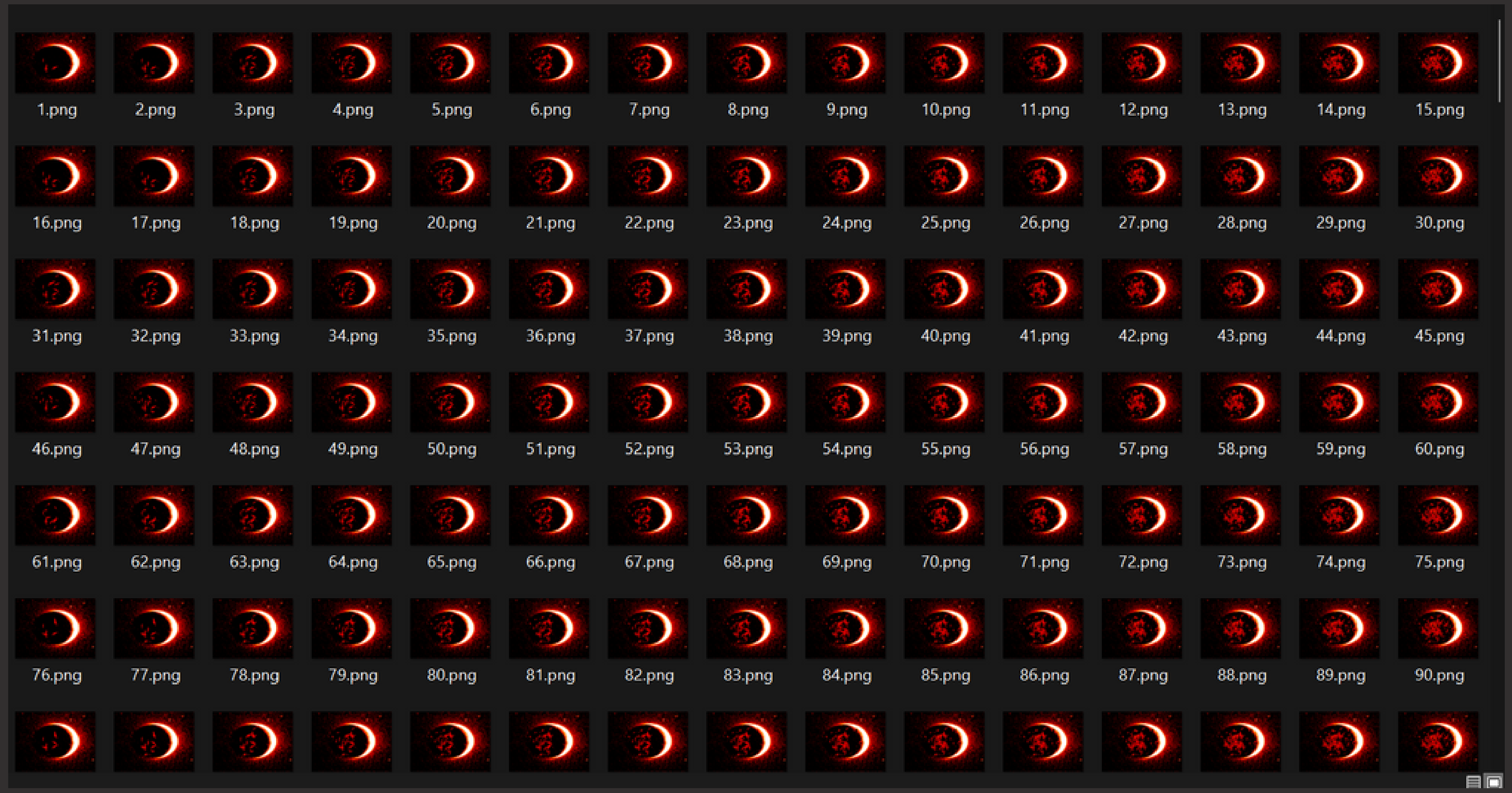
BUT ALL PROOFS ARE MADE WITH A SMALL DATASET (<64 IMAGES OF TRAINNING)

STEP 3 - MACHINE LEARNING MODEL

FOLDER: 3 - ML COMPARE

- output-20221130T164554Z-001
- 3_ML_COMPARE.ipynb
- last.pt
- output-20221130T164554Z-001.zip
- roboflow_data.names





WE MADE A CUSTOM ARCHITECTURE TO CREATE THE CUSTOM AURORAS TO TRAIN THE MODEL

STEP 3 - MACHINE LEARNING MODEL

FOLDER: 3 - ML COMPARE

- output-20221130T164554Z-001
- 3_ML_COMPARE.ipynb
- last.pt
- output-20221130T164554Z-001.zip
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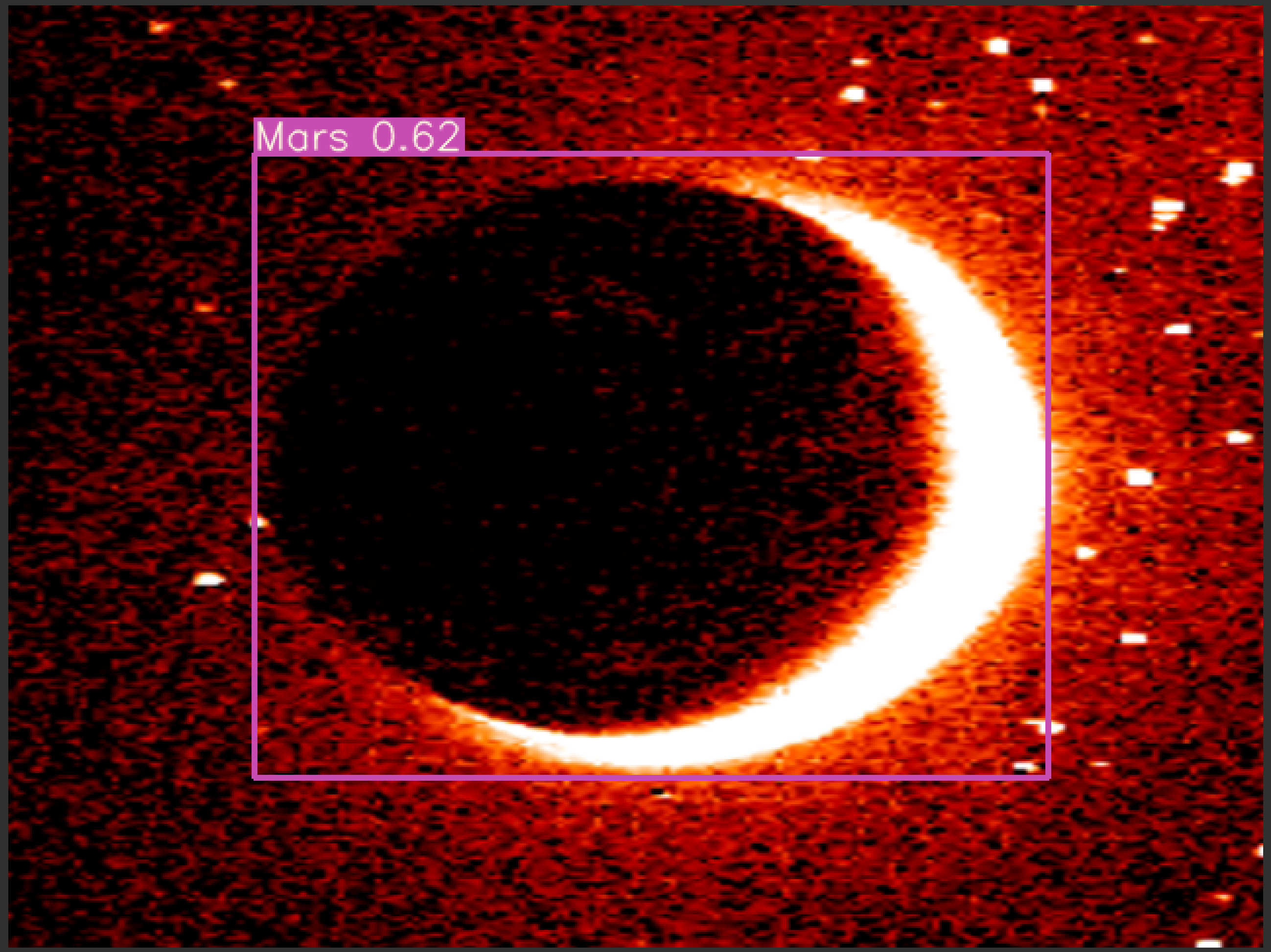

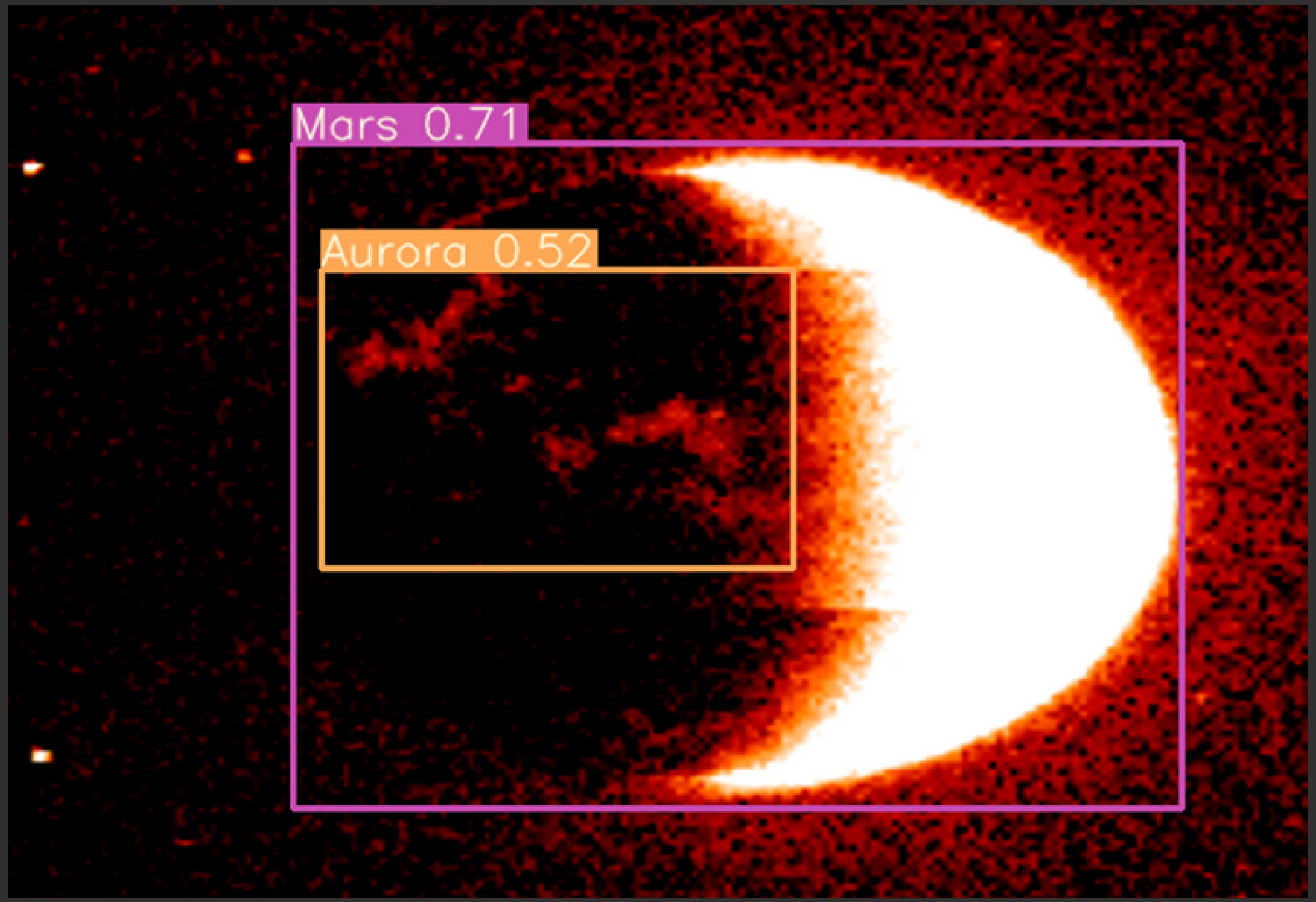

AURORA DETECTION RESULTS WITH 64 IMAGES DATASET:

MARS DETECTION: 100%
AURORA DETECTION: > 95% (ONLY 2 ERRORS)
FAKE DETECTION: 0

- 0_640_cropped.png
- 1_640_cropped.png
- 2_640_cropped.png
- 3_640_cropped.png
- 4_640_cropped.png
- 5_640_cropped.png
- 6_640_cropped.png
- 7_640_cropped.png
- 8_640_cropped.png
- 9_640_cropped.png
- 10_640_cropped.png

COST - TIMMING

COST EQUIPMENT : AROUND 3K LOCAL

TIME IN SERVERLESS: < 1 MIN (ALL PROCESS, 1000 IMAGES PER MINUTE)

TIME INTO COMPUTER: 3 MINUTES PER 153 IMAGES

SERVERLESS COST: 0.23€ PER BATCH (N = 1000)

ABOUT

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Extra Material for Poster: This work introduces a novel serverless computing architecture designed to analyze Martian auroras for the Emirates Mars Mission (Hope probe). Utilizing OpenCV and machine learning algorithms, the architecture offers efficient and scalable image classification, object detection, and segmentation. It leverages cloud computing's scalability and elasticity, handling large volumes of image data and adapting to varying workloads. Our study highlights the system's capacity to process and analyze images of Martian auroras swiftly while maintaining cost-effectiveness. The application of this technology within the HOPE Mission not only addresses the complexities involved in detecting Martian auroras but also sets a precedent for future remote sensing applications. Our results demonstrate the potential of serverless computing in enhancing the analysis of extraterrestrial phenomena and contributing significantly to planetary science.

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