UNIVERSIDAD COMPLUTENSE DE MADRID

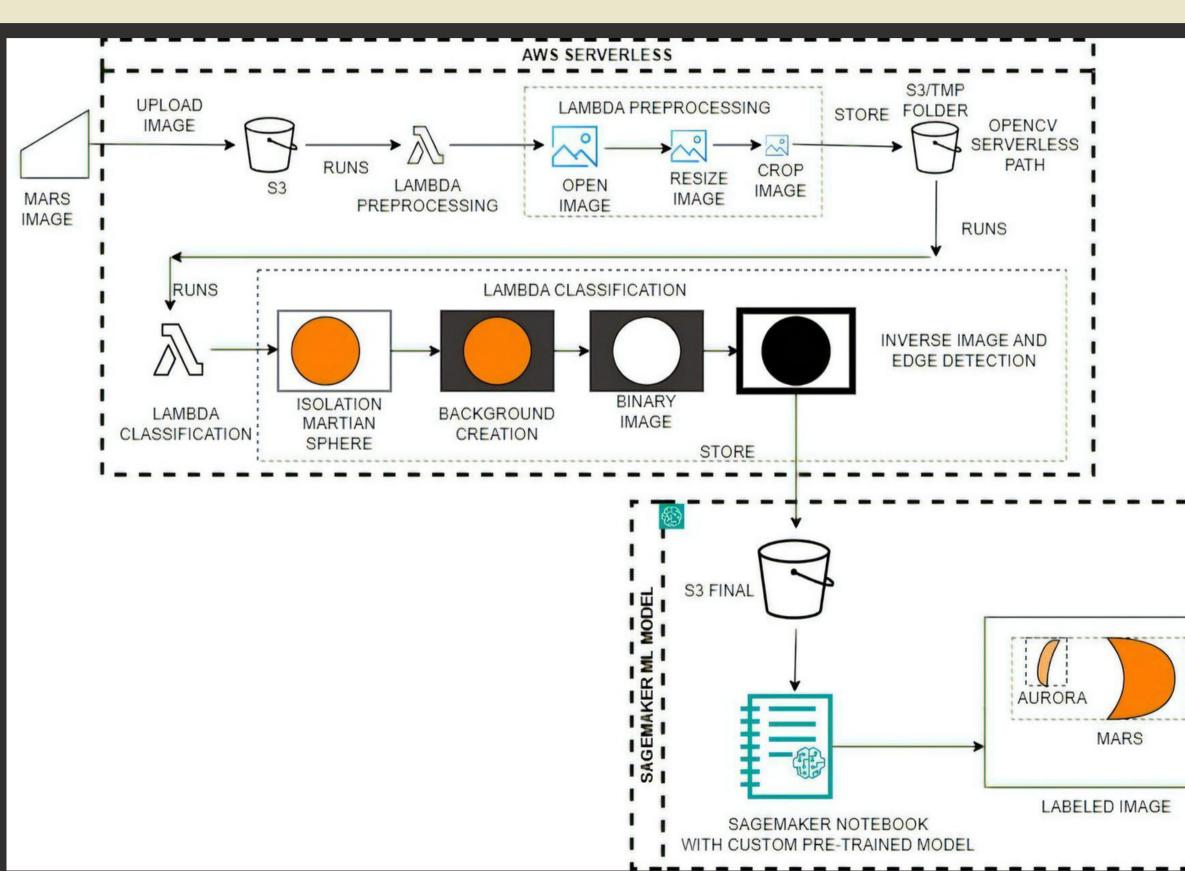
SERVERLESS COMPUTING **ARCHITECTURE FOR** ENHANCED MARTIAN AURORA DETECTION IN THE EMIRATES MARS MISSION

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



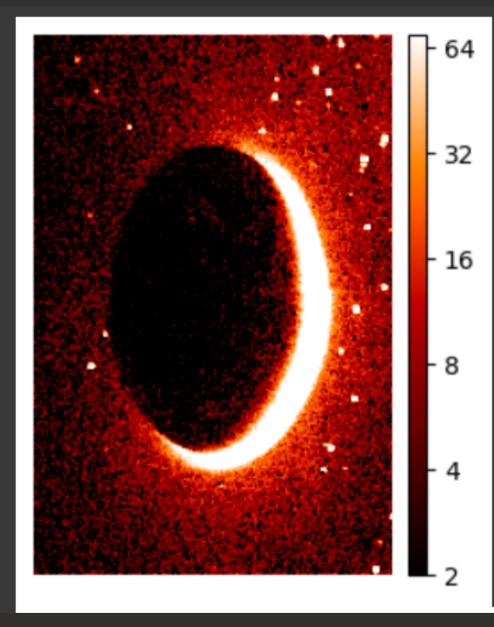
EGU24

SERVERLESS ARCHITECTURE



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

STEP 1 - DOCKER MODEL TO GENERATE GRAPHS



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

FOLDER: 1 - COMPOSE

stepone_resized
 1_Compose.ipynb
 stepone_resized.zip

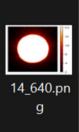
STEP 2 - DOCKER MODEL TO GENERATE GRAPHS

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45_640.pn 46_640.pn 47_640.pn 48_640.pn 49_640.pn 50_640.pn 51_640.pn 52_640.pn 53_640.pn 54_640.pn 55_640.pn 56_640.pn 57_640.pn g g g g g g g g g g g g g g g g g g g	58_640.pn g
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FOLDER OF STEP ONE'S RESULTS, SAVING FOR PROOF

FOLDER: 1 - COMPOSE

stepone_resized
1_Compose.ipynb
stepone_resized.zip













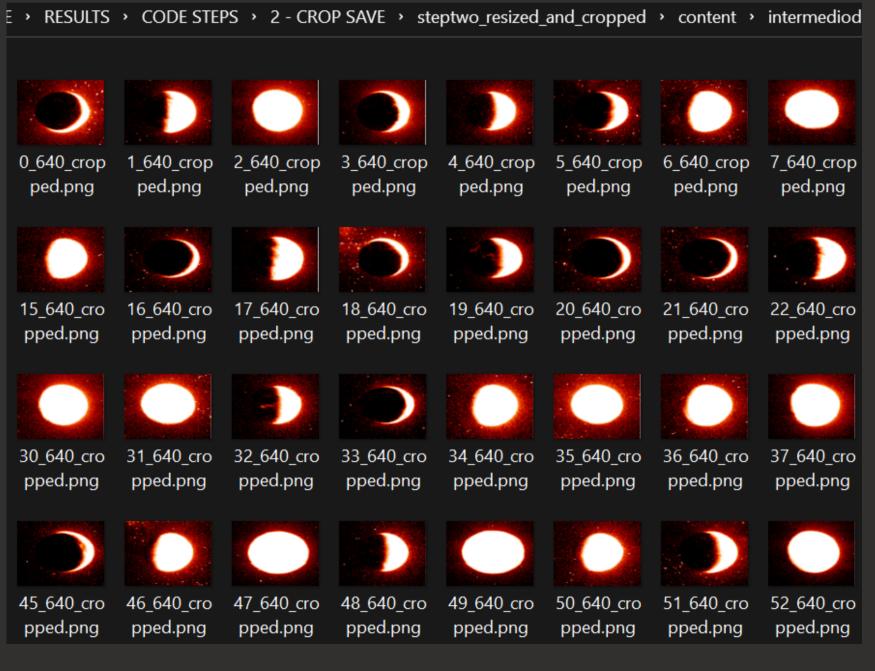


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adding: content/intermediodos/41_640_cropped.png (deflated 0%)
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adding: content/intermediodos/116_640_cropped.png (deflated 0%)

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

- 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...



PREPARING RESULTS TO MAKE NEXT BINARY ROUNDED MASK

- 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...

xc = 320yc = 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

steptwo_binary

steptwo final

steptwo_mascara

steptwo_preprocesado

steptwo_resized_and_crop...

2 Crop_save_and_crop_ag...

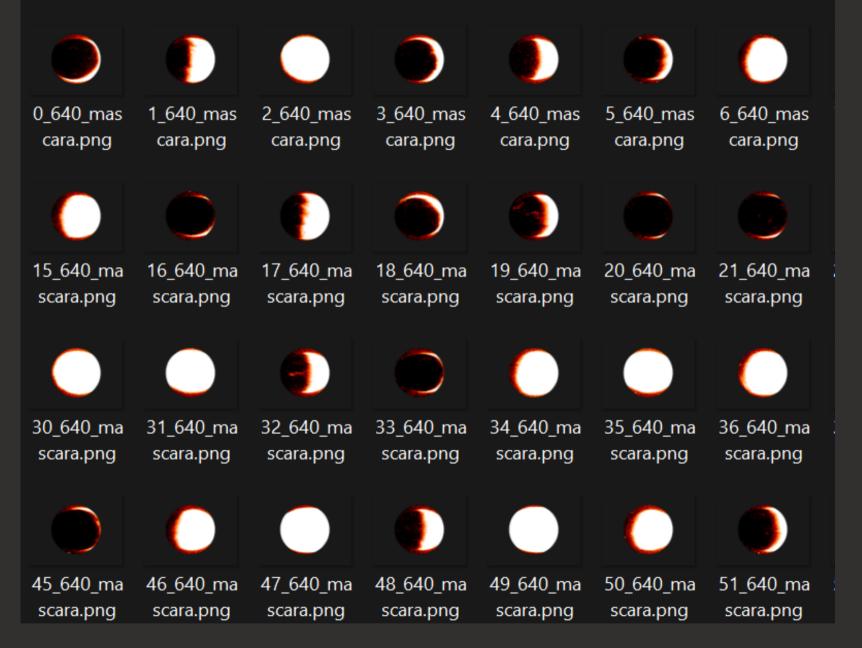
steptwo_binary.zip

🟁 steptwo_final.zip

🔤 steptwo_mascara.zip

steptwo_preprocesado.zip

steptwo_resized_and_crop...



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

- 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...



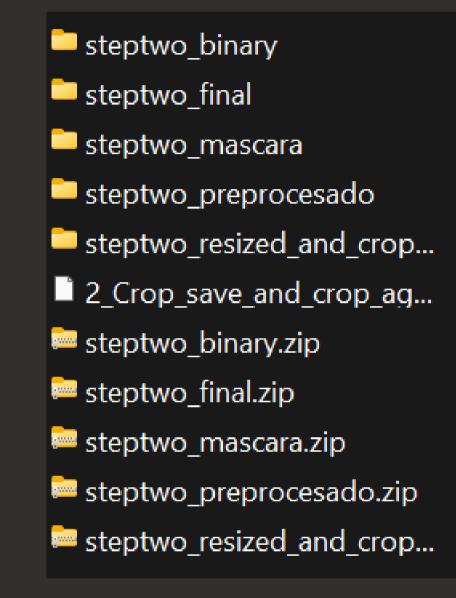
IT NEEDS A PROFESSIONAL IMAGE SHAPING WITH ALPHA CHANNEL REMOVING FOR USSING ON OPENCV





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

FOLDER: 2 - CROP SAVE



14 640 bin ary.png

29 640 bin

ary.png

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ary.png

44_640_bin

59 640 bin ary.png

74_640_bin ary.png

()



AN EXAMPLE OF FUTURE AURORA DETECTION SHAPE

- 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...

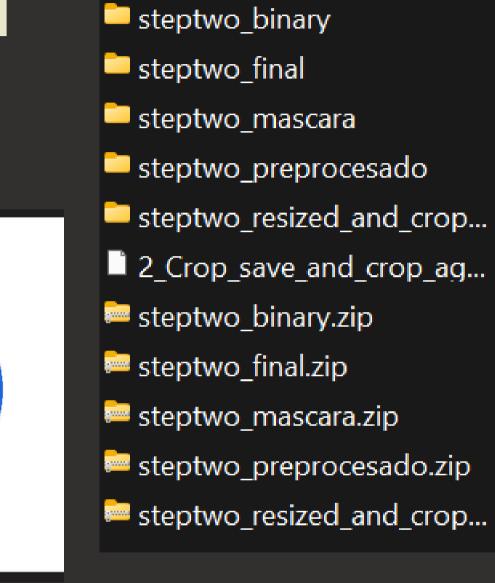
⊘ 0_640_final .png	D 1_640_final .png	OO 2_640_final .png	⑦ 100 100 100 100 100 100 100 100 100 10	2 4_640_final .png	5_640_final	OO 6_640_final .png
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THE SHAPE IS GOING TO MAKE ANOTHER TRAVEL INTO THIS LAMBDA FUNCTION TO MAKE A TRIPLE-DETECTION OF TYPE OF OBJECTS

- 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...



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

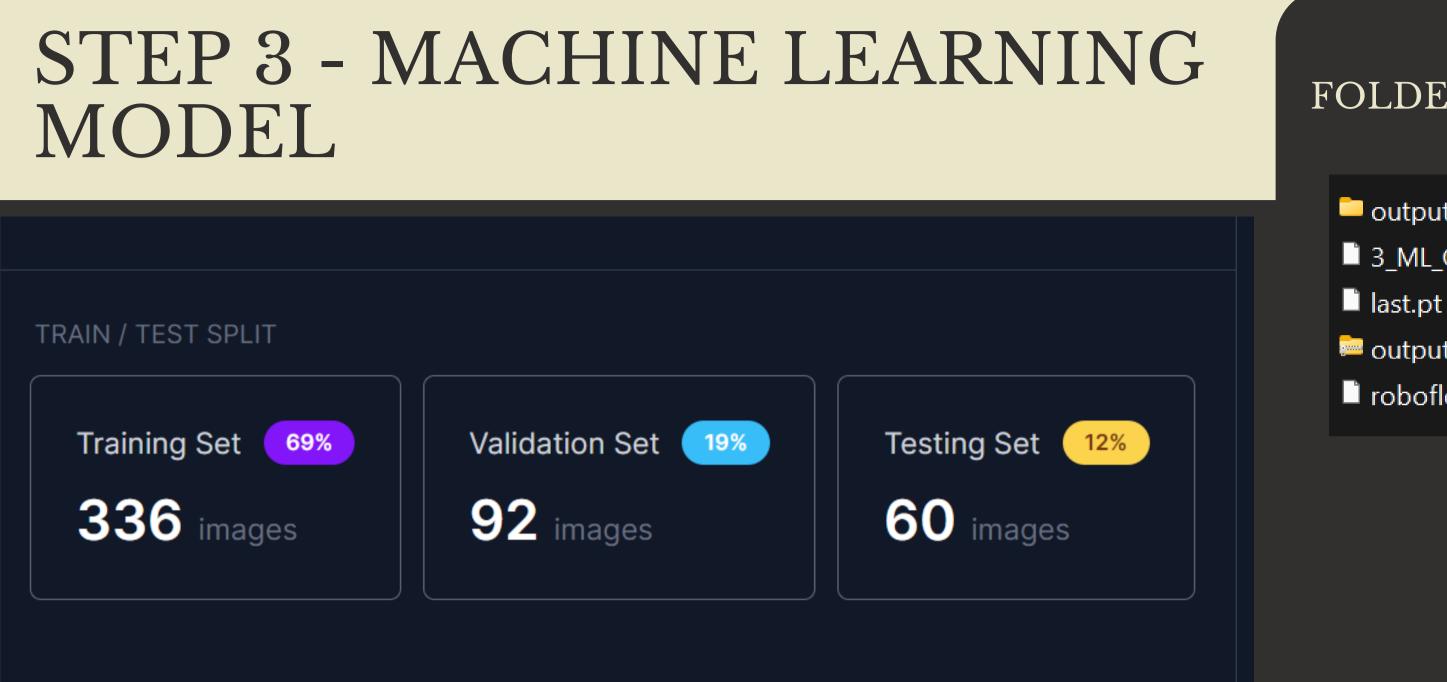




NOW, IF THE DETECTION SHOWS > 1 CLOSE OBJECTS IS A POSSIBLE MARTIAN AURORA, SO WE PUT THIS RESULT INTO A ML CUSTOM MODEL (ML IS A COST FUNCTION, THIS STEPS ARE ONLY FOR REDUCE THE AMOUNT OF IMAGES TO PROCESS)

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...



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

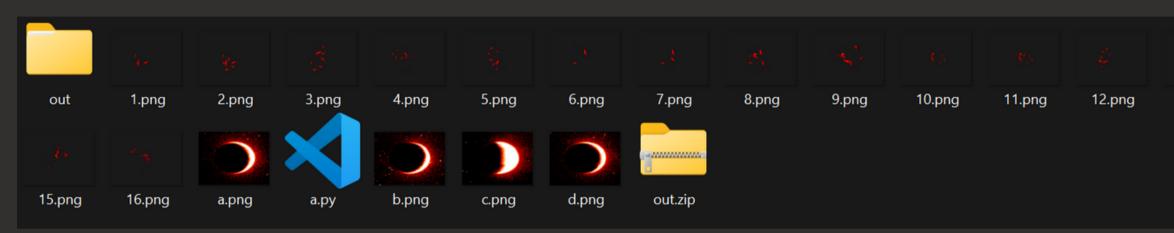
WE HAVE A CUSTOM MODEL WITH >500 IMAGES.

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

FOLDER: 3 - ML COMPARE

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

STEP 3 - MACHINE LEARNING MODEL

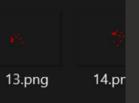


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31.png	32.png	33.png	34.png	35.png	36.png	37.png	38.png	39.png	40.png	41.png	42.png	43.png	44.png	45.png
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61.png	62.png	63.png	64.png	65.png	66.png	67.png	68.png	69.png	70.png	71.png	72.png	73.png	74.png	75.png
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76.png	77.png	78.png	79.png	80.png	81.png	82.png	83.png	84.png	85.png	86.png	87.png	88.png	89.png	90.png
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WE MADE A CUSTOM ARCHITECTURE TO CREATE THE CUSTOM AURORAS TO TRAIN THE MODEL



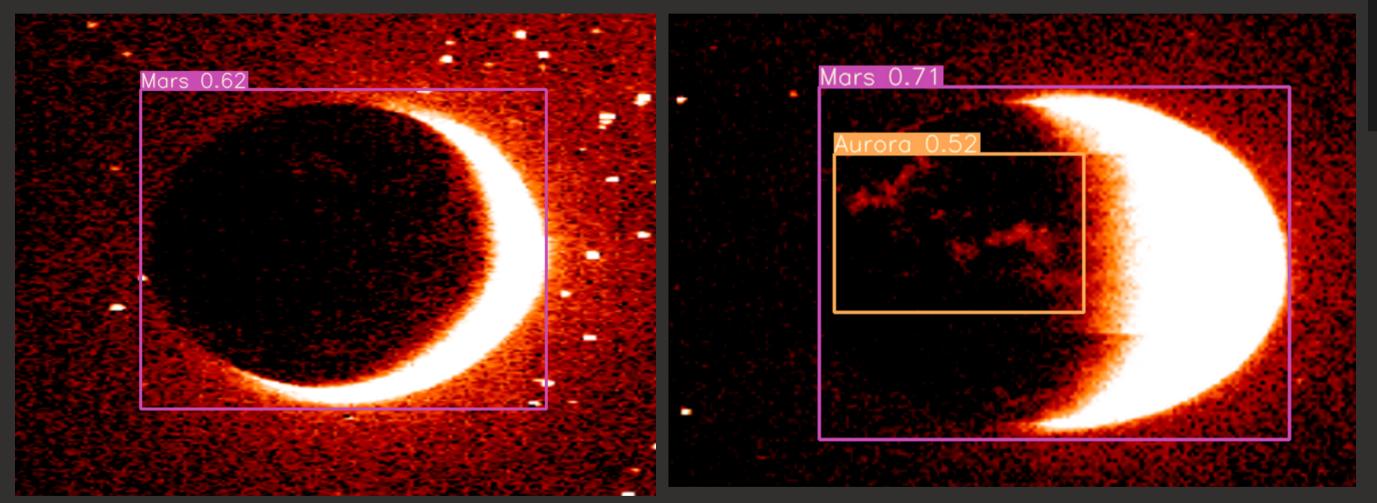
FOLDER: 3 - ML COMPARE



output-20221130T164554Z-001

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

STEP 3 - MACHINE LEARNING MODEL



AURORA DETECTION RESULTS WITH 64 IMAGES DATASET:

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

FOLDER: 3 - ML COMPARE

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

This contribution has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No.101007638 (Project EYE -Economy bY spacE).