Improving Seagrass Detection Through A Novel Method For Optically Deep Water Masking

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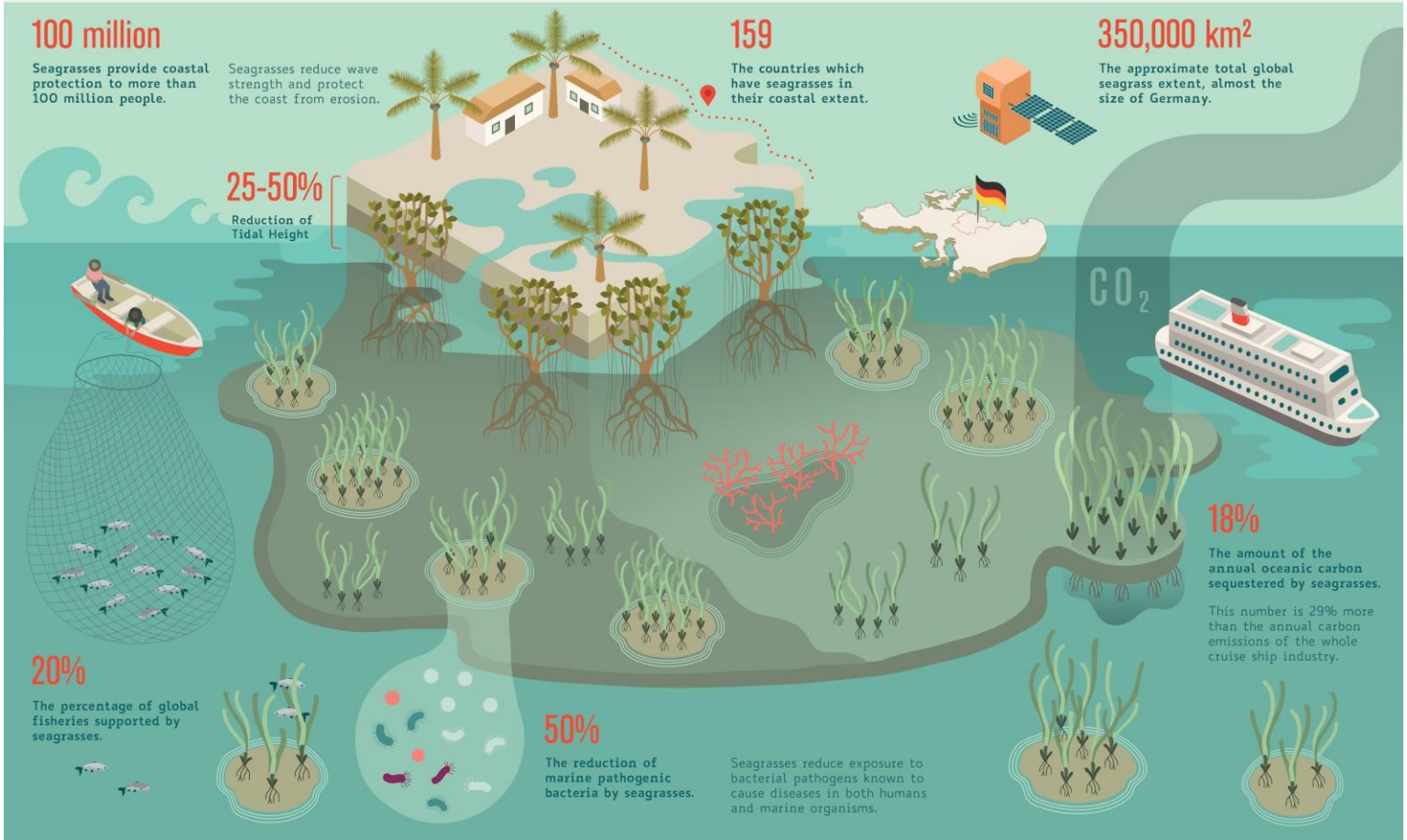
Aims

Commercialization of Cloud-native service for Seagrass Extent and Carbon Stock Mapping

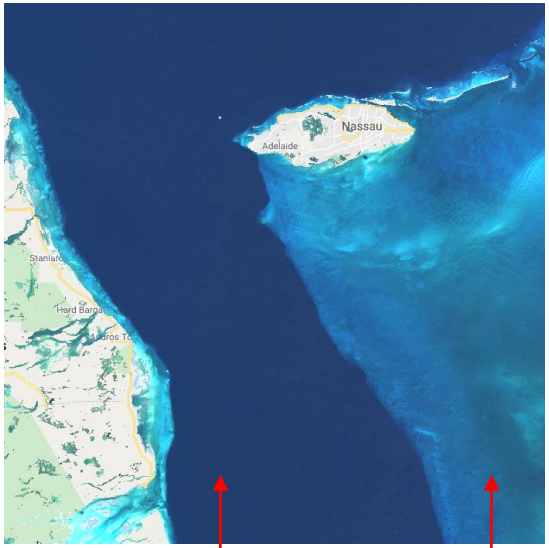
Methods and Applications:

- Cloud-native, Scalable and Operational Seascape Mapping
- Nature-based Solution for Climate Change Mitigation
- Sustainable Development Goals

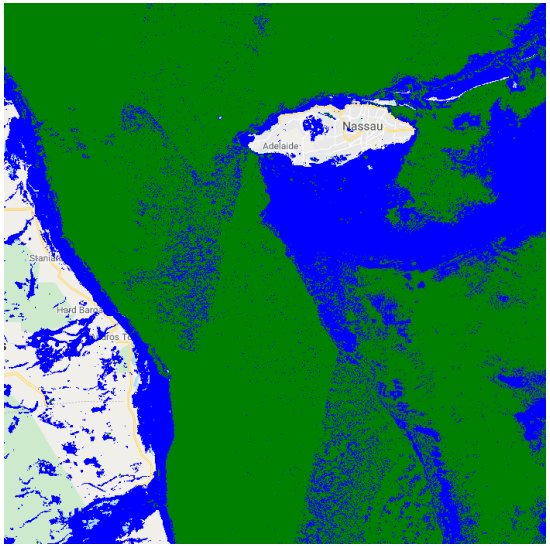


Seagrass mapping

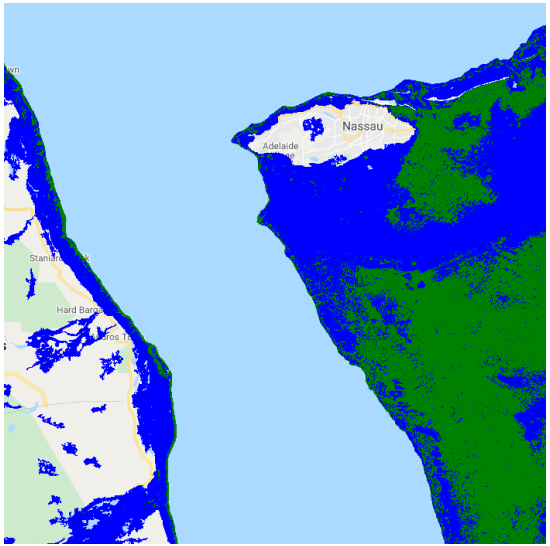
Sentinel-2 L1C RGB



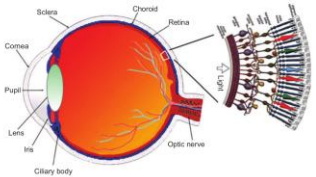
Seagrass map

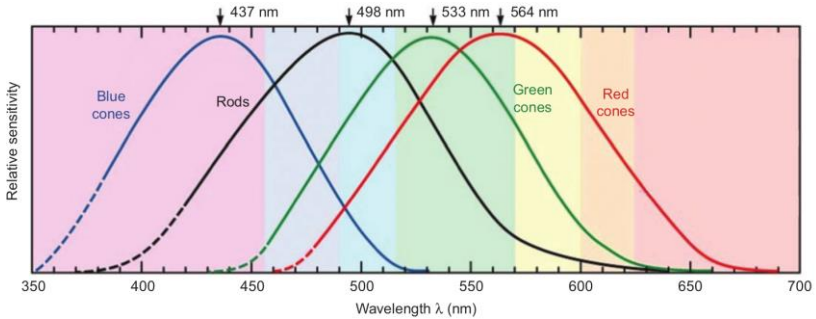


Seagrass map (masked)



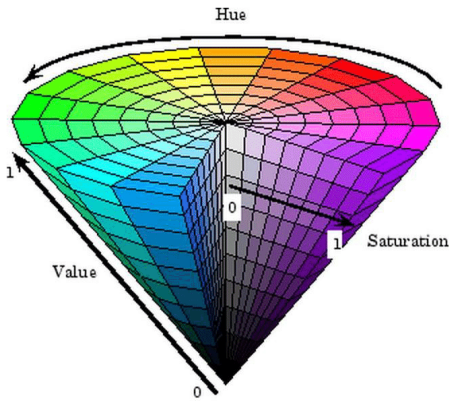
Colorimetry and colour spaces





RGB colour space

RGB to HSV transformation



HSV colour space

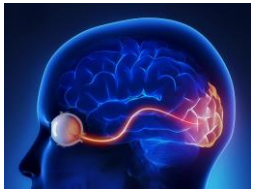


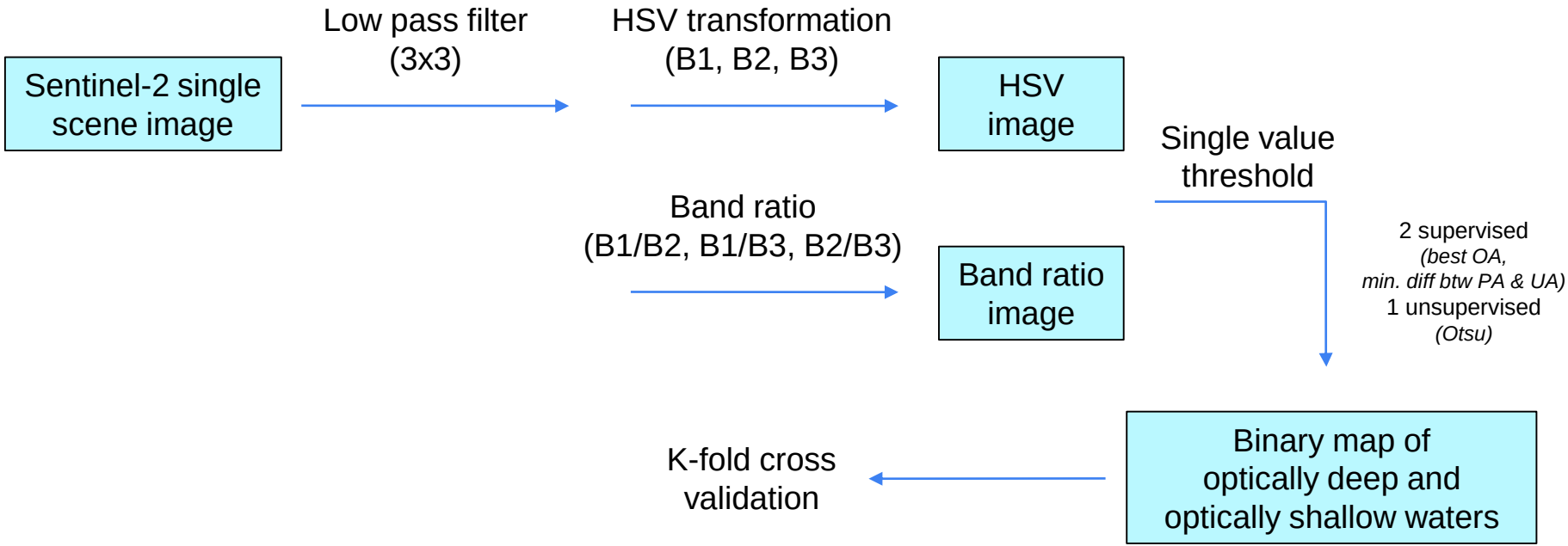
Image Sources:
(Cross-section of Eyes) *Color science of nanocrystal quantum dots for lighting and displays*, Erdem T & Demir H V (2013)
(Spectral sensitivities of rods & cones in the human eyes) *Color science of nanocrystal quantum dots for lighting and displays*, Erdem T & Demir H V (2013)
(HSV cone) *Shifting Colors to Overcome not Realizing Object Problem due to Color Vision Defiicency*, Erdoğan K & Yilmaz N (2014)
(Optical nerve) *Restoring Vision: Retinal Nerve Cell Regeneration*, Web Article (https://www.glaucoma.org/research/restoring-vision-retinal-nerve-cell-regeneration.php)

Combining concepts

HSV colour model + False colour image + Best penetration into water column: Ultra blue (B1), Blue (B2), Green (B3)

Could a false colour HSV image distinguish the optically deep from optically shallow waters in Sentinel-2 images?

Workflow


Sentinel-2 single scene image
Low pass filter (3x3)
HSV transformation (B1, B2, B3)
HSV image
Band ratio (B1/B2, B1/B3, B2/B3)
Band ratio image
Single value threshold
2 supervised
(best OA, min. diff btw PA & UA)
1 unsupervised
(Otsu)
Binary map of optically deep and optically shallow waters
K-fold cross validation

Results (Sentinel-2 L1C)

Site	Ranking by best overall accuracy (with 95% confidence interval)							
	1	2	3	4	5	6	7	8
Bahamas	B1B2 bestOA 0.985 ± 0.002	B1B2 crossPAUA 0.983 ± 0.004	Value bestOA 0.949 ± 0.019	Value crossPAUA 0.945 ± 0.028	Hue bestOA 0.944 ± 0.011	**Saturation** **bestOA** **0.932 ± 0.012**	B1B3 bestOA 0.932 ± 0.013	Hue crossPAUA 0.925 ± 0.016
Caspian Sea	B2B3 crossPAUA 0.788 ± 0.049	B2B3 bestOA 0.772 ± 0.047	**Saturation** **bestOA** **0.769 ± 0.064**	B1B3 bestOA 0.769 ± 0.064	**Saturation** **crossPAUA** **0.708 ± 0.056**	B1B3 crossPAUA 0.708 ± 0.056	B1B3 Otsu 0.659 ± 0.042	**Saturation** **Otsu** **0.616 ± 0.042**
Tanzania	**Saturation** **Otsu** **0.856 ± 0.035**	B1B2 Otsu 0.819 ± 0.035	B2B3 bestOA 0.81 ± 0.038	B2B3 Otsu 0.79 ± 0.043	B2B3 crossPAUA 0.788 ± 0.048	**Saturation** **bestOA** **0.786 ± 0.04**	B1B3 bestOA 0.785 ± 0.039	B1B3 crossPAUA 0.779 ± 0.043
Wadden Sea	B2B3 crossPAUA 0.942 ± 0.019	B1B3 crossPAUA 0.935 ± 0.02	**Saturation** **crossPAUA** **0.934 ± 0.021**	B2B3 bestOA 0.928 ± 0.019	**Saturation** **bestOA** **0.925 ± 0.017**	B1B3 bestOA 0.923 ± 0.016	B2B3 Otsu 0.91 ± 0.039	B1B2 bestOA 0.905 ± 0.02

bestOA – Supervised classification, using threshold from the best OA from the training dataset
crossPAUA – Supervised classification, using threshold from the minimum difference between PA & UA (shallow water) of the training dataset
Otsu – Unsupervised classification, similar to foreground-background classification

Results (Sentinel-2 L2A)

Site	Ranking by best overall accuracy (with 95% confidence interval)							
	1	2	3	4	5	6	7	8
Bahamas	**Hue** **bestOA** **0.98 ± 0.00**	**Hue** **crossPAUA** **0.97 ± 0.01**	B1B2 bestOA 0.97 ± 0.00	B1B2 crossPAUA 0.96 ± 0.01	B1B2 Otsu 0.96 ± 0.01	Value bestOA 0.95 ± 0.02	Value crossPAUA 0.93 ± 0.03	B1B3 best OA 0.90 ± 0.02
Caspian Sea	B2B3 bestOA 0.92 ± 0.02	**Hue** **bestOA** **0.91 ± 0.02**	B2B3 crossPAUA 0.91 ± 0.02	**Hue** **crossPAUA** **0.90 ± 0.02**	B1B3 crossPAUA 0.85 ± 0.04	B1B3 bestOA 0.84 ± 0.03	Value crossPAUA 0.66 ± 0.05	B1B2 crossPAUA 0.65 ± 0.06
Tanzania	**Hue** **bestOA** **0.87 ± 0.03**	B1B3 best OA 0.87 ± 0.03	**Hue** **crossPAUA** **0.85 ± 0.04**	B2B3 bestOA 0.85 ± 0.04	B1B3 crossPAUA 0.84 ± 0.04	**Hue** **Otsu** **0.83 ± 0.03**	B1B2 crossPAUA 0.82 ± 0.03	B2B3 crossPAUA 0.81 ± 0.04
Wadden Sea	Value crossPAUA 0.93 ± 0.02	B2B3 bestOA 0.93 ± 0.02	**Hue** **crossPAUA** **0.93 ± 0.01**	Value bestOA 0.93 ± 0.03	**Hue** **bestOA** **0.93 ± 0.01**	B2B3 crossPAUA 0.92 ± 0.01	B1B3 bestOA 0.90 ± 0.04	B1B3 crossPAUA 0.88 ± 0.03

bestOA – Supervised classification, using threshold from the best OA from the training dataset
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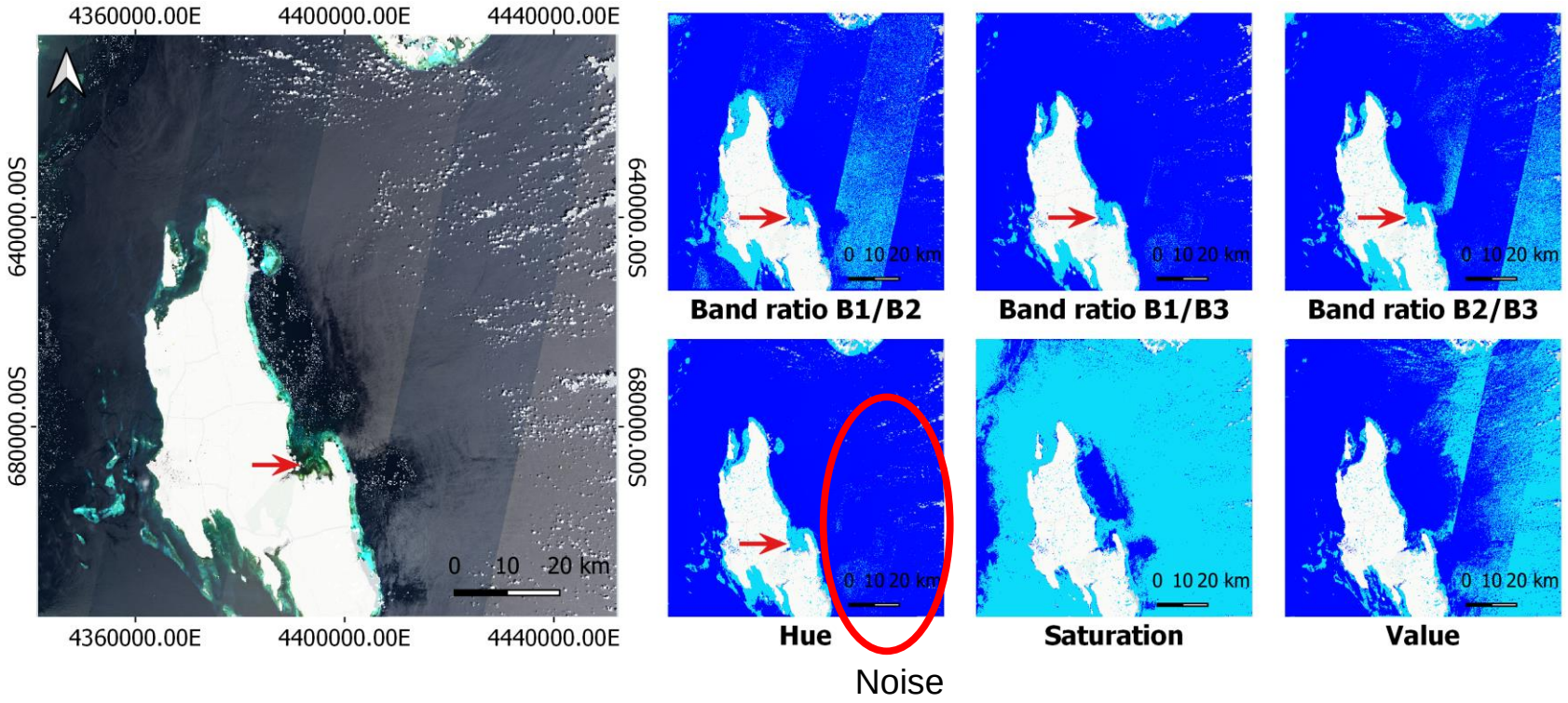
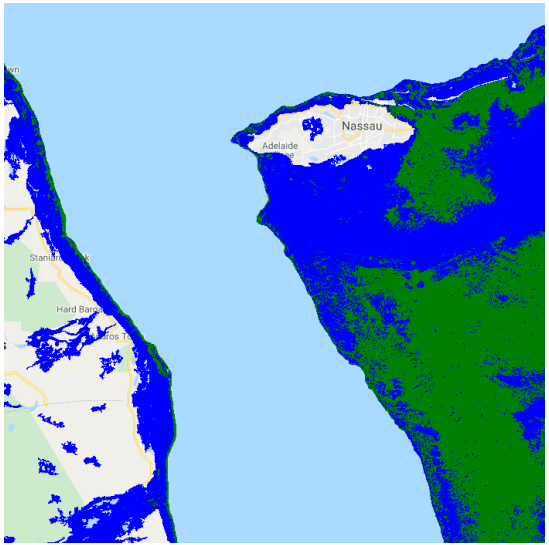
Otsu – Unsupervised classification, similar to foreground-background classification

Results (Sentinel-2 L2A)



Summary

- Thresholding a false colour HSV layer produces **consistently good** deep water mask **across different sites**
    - Saturation for Sentinel-2 L1C (Top of Atmosphere)
    - Hue for Sentinel-2 L2A (Surface Reflectance)



Thank you for your attention.

Any questions? Contact me at chengfa.lee@dlr.de!

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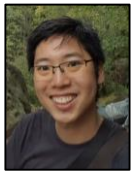

Benjamin Lee
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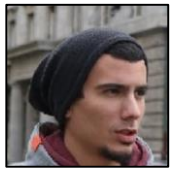

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