

(Street) Lights Will Guide You: Georeferencing Nighttime Astronaut Photography of Earth

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¹Jacobs Technology

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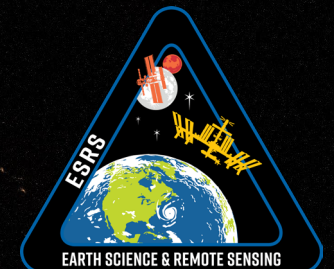
Jacobs



Project Page

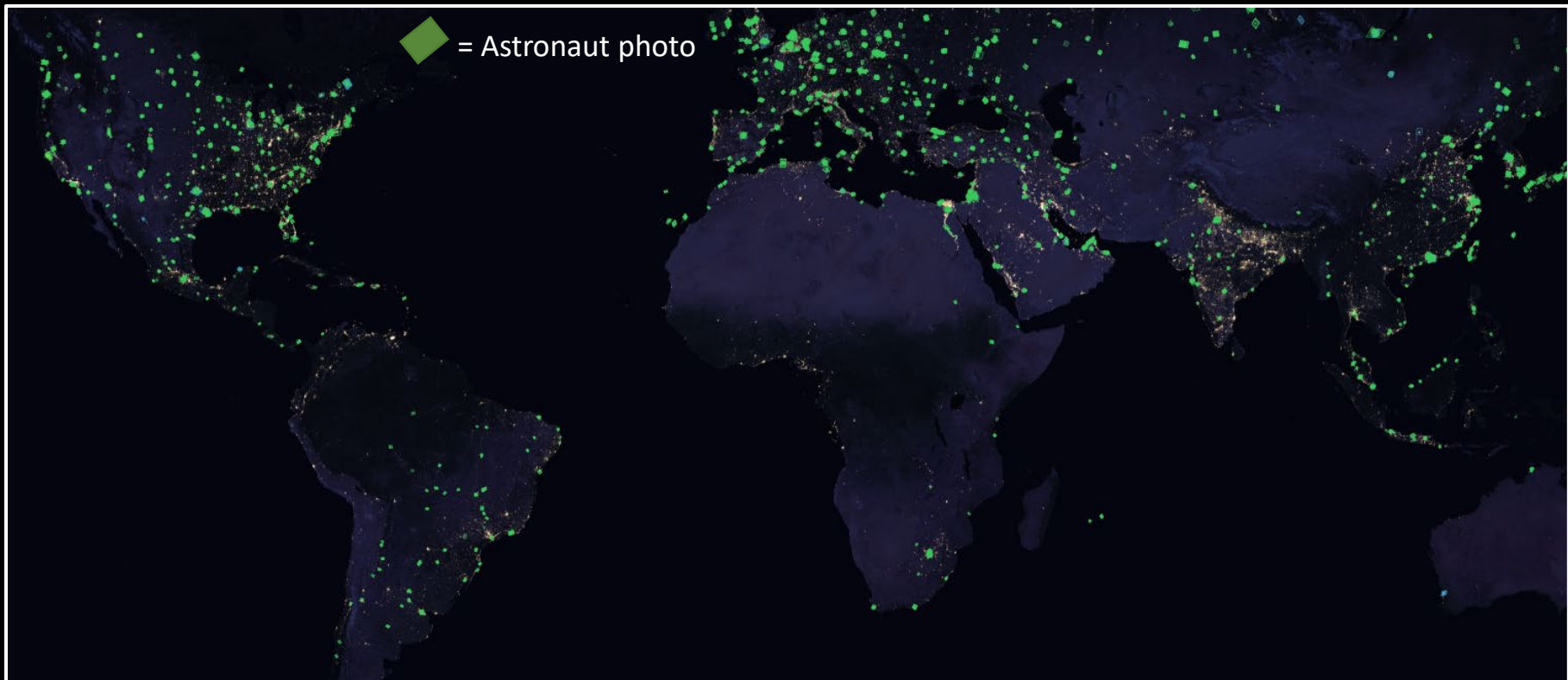


Explore Nighttime Photos



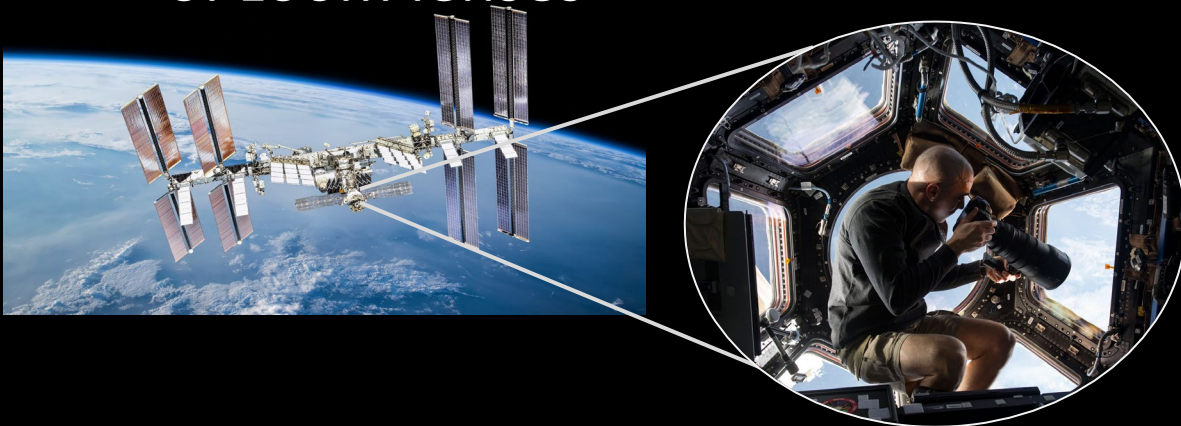
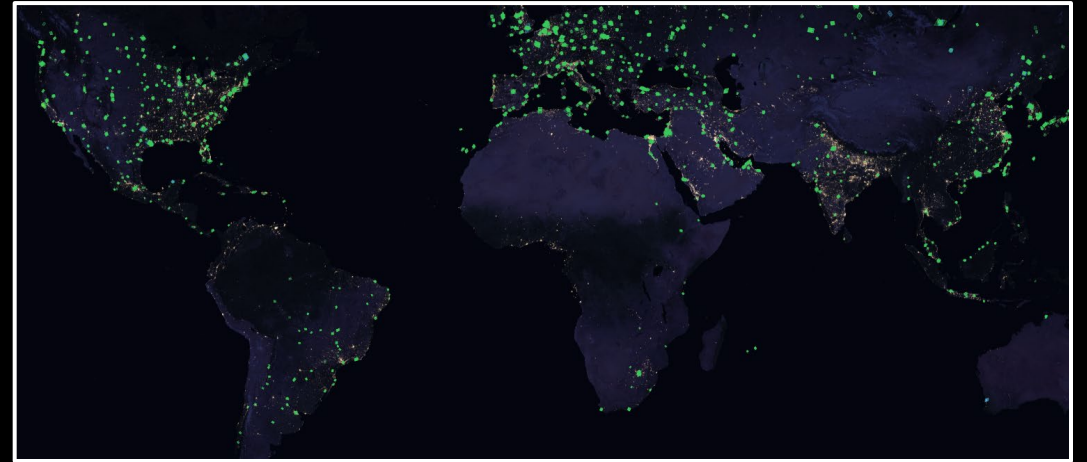
Nighttime astronaut photography of Earth...

- is a collection of over 1.9 million photos spanning from 1960 to present day



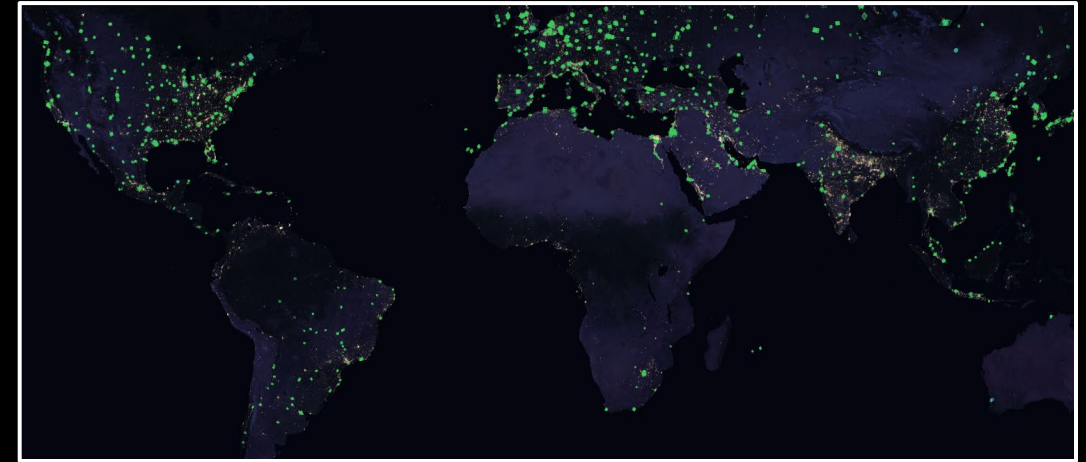
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- is taken *by humans* in space, using handheld cameras and a variety of zoom lenses

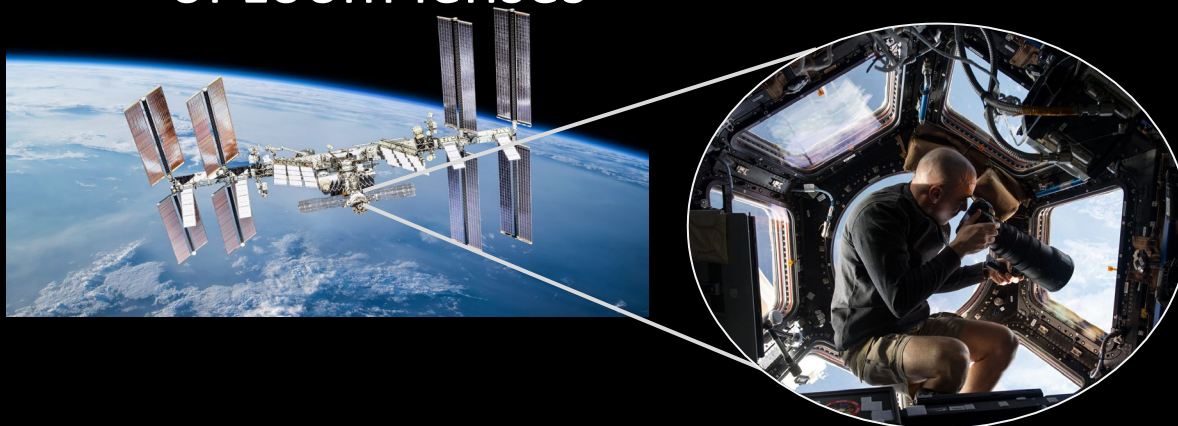


Nighttime astronaut photography of Earth...

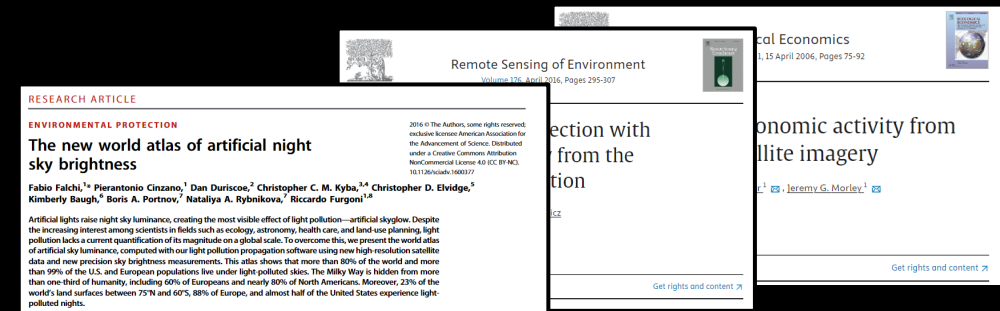
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- is taken *by humans* in space, using handheld cameras and a variety of zoom lenses



- is used by researchers to study urban development, the effects of artificial light, and more

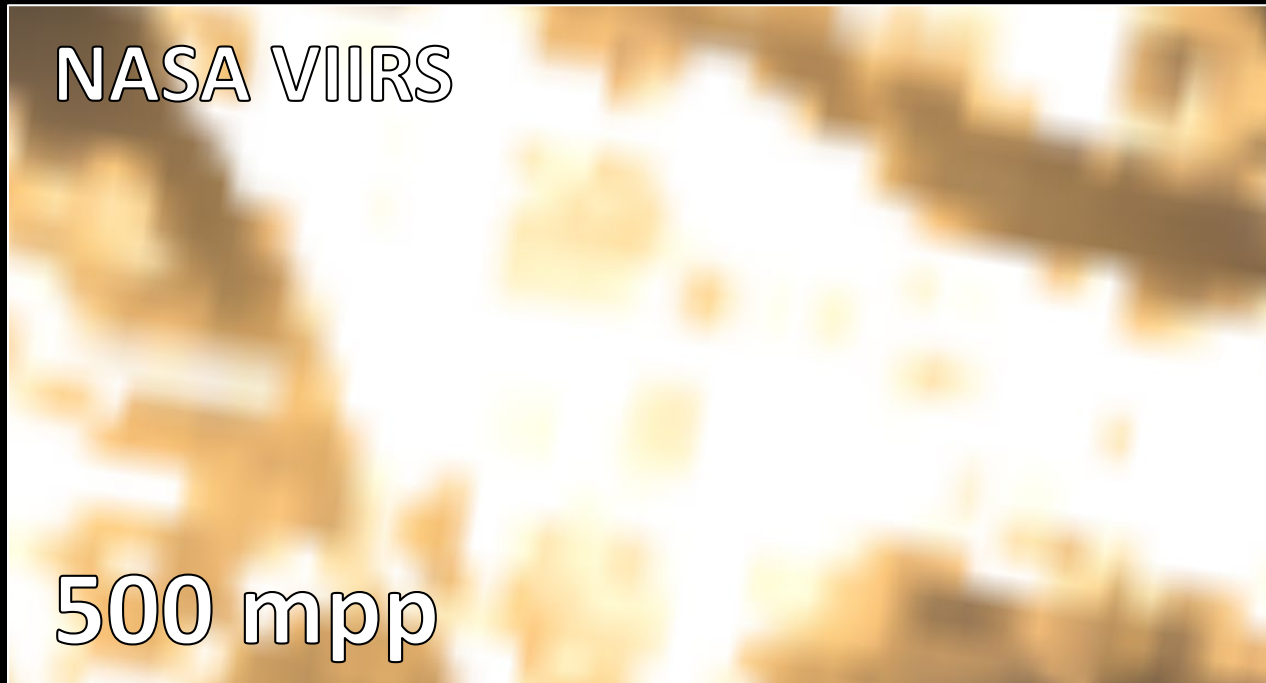


Nighttime astronaut photography of Earth...

- offers the highest spatial resolution nighttime Earth observations data publicly available

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NASA VIIRS

500 mpp

Astronaut Photo

7.05 mpp (70x higher)

Nighttime astronaut photography of Earth...

**Lacks inherent geolocation metadata that would make it
analysis ready**



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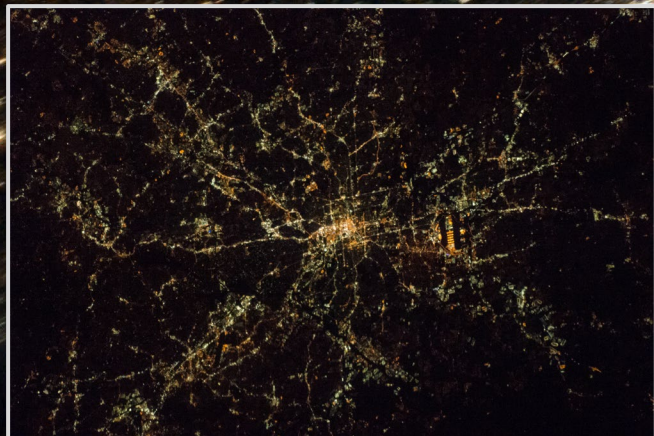
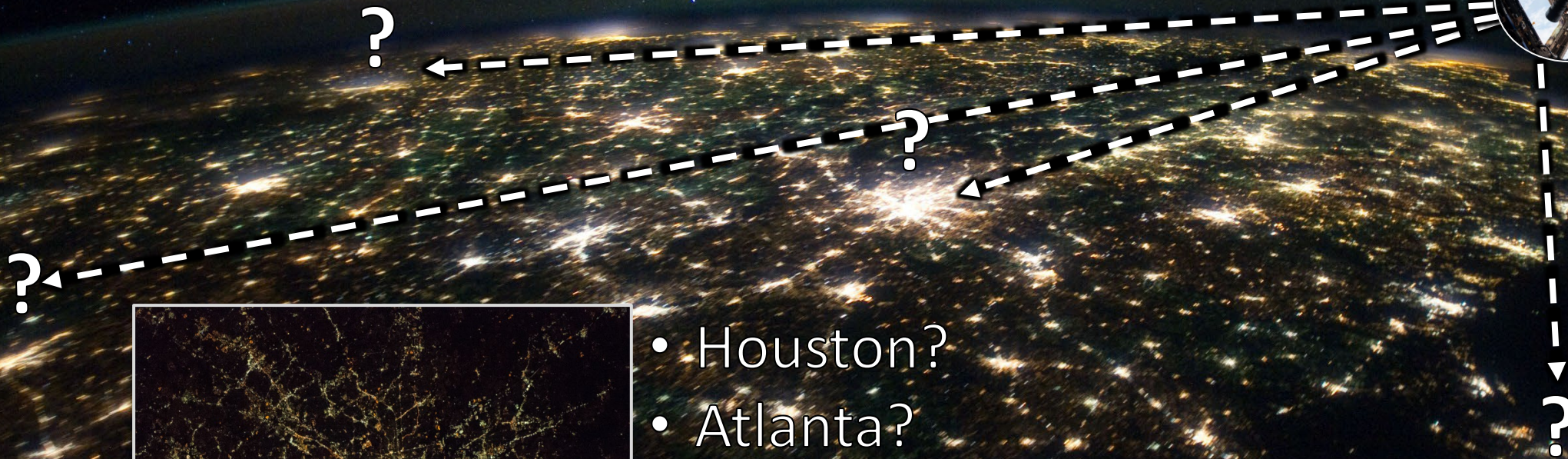
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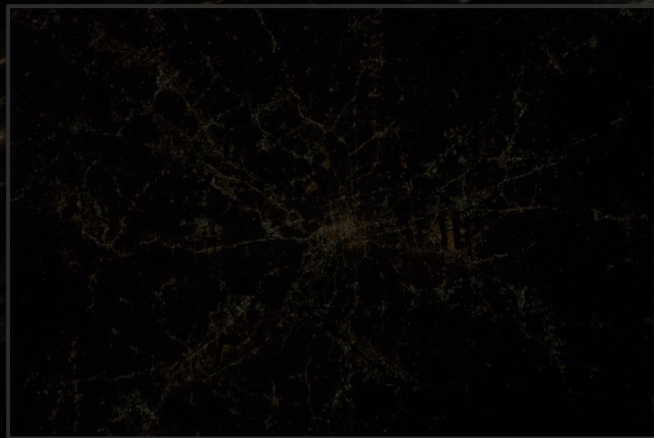
- Houston?
- Atlanta?
- Dallas?
- Nashville?

Nighttime astronaut photography of Earth...

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How can we determine what area is in a photo?



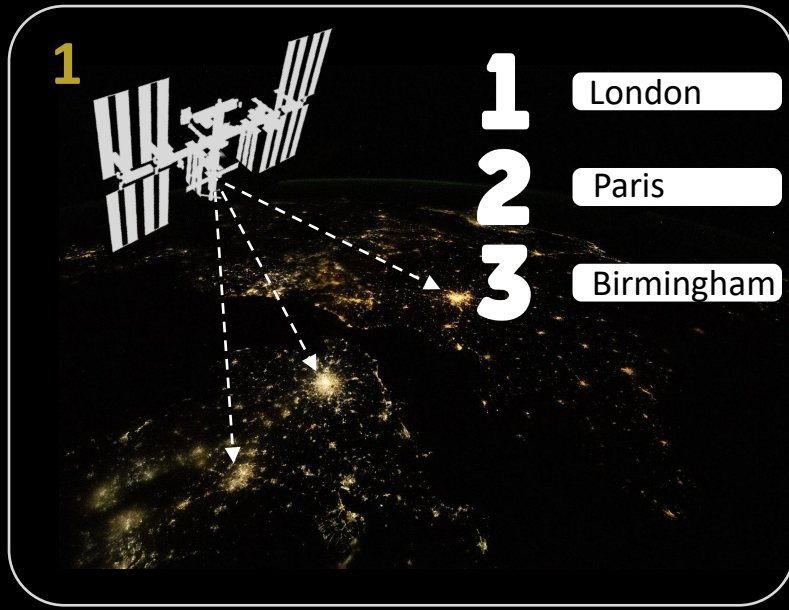
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NightMatch

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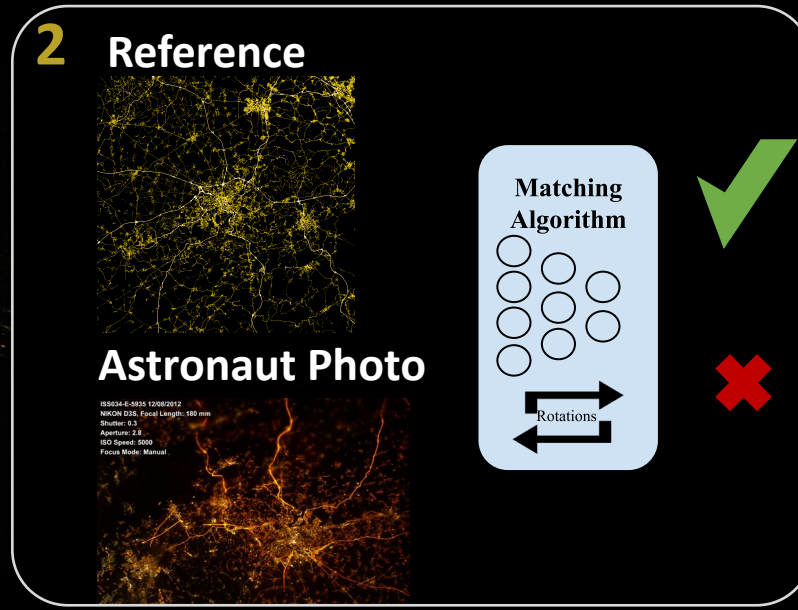
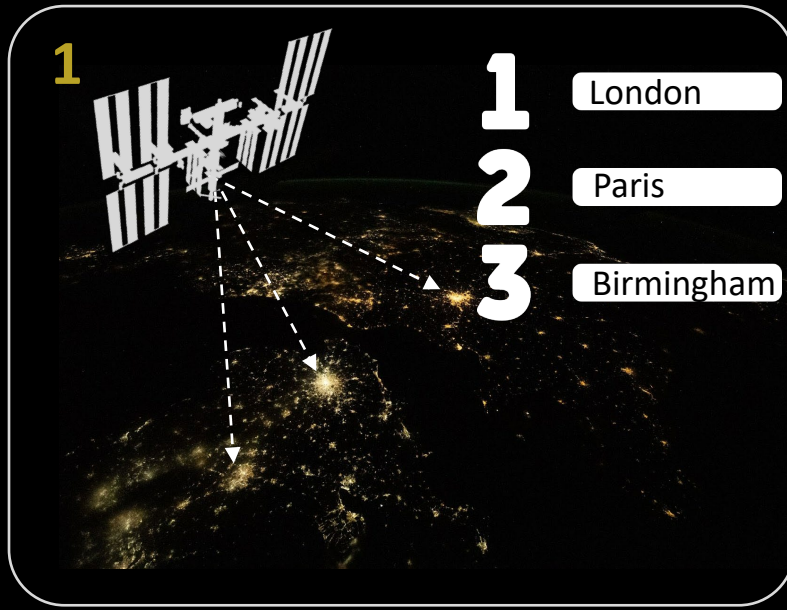


NightMatch



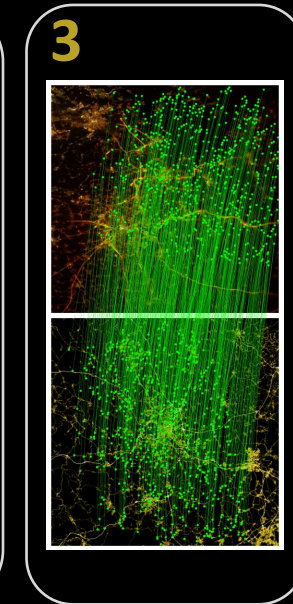
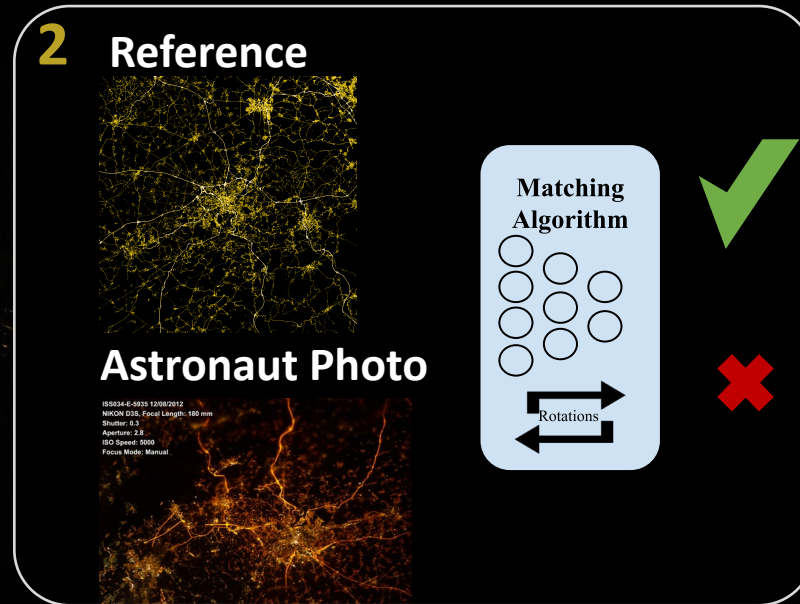
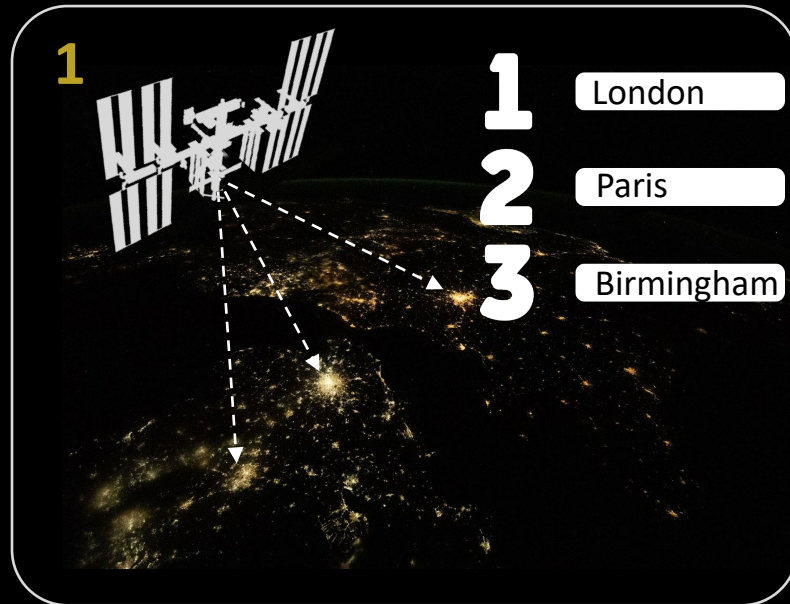
1. Construct a queue of visible cities for a given ISS location

NightMatch



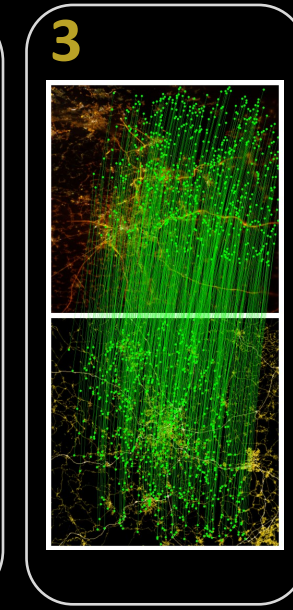
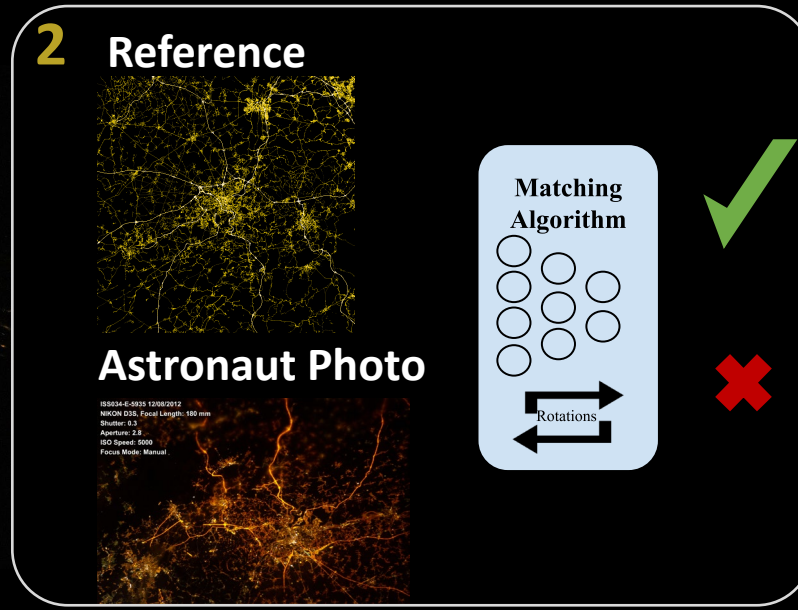
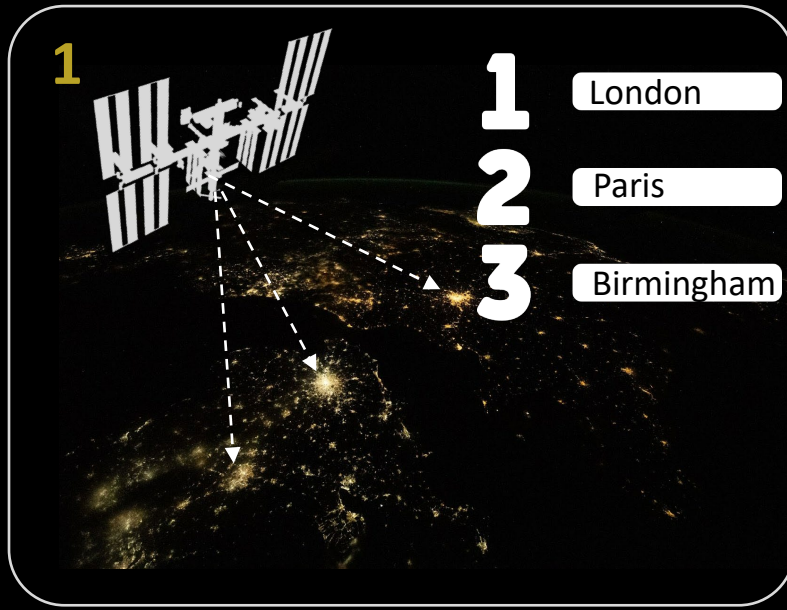
1. Construct a queue of visible cities for a given ISS location
2. Generate a reference image of a city from the queue and determine if it matches the astronaut photo

NightMatch



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3. Establish point correspondences between astronaut photo and reference

NightMatch



1. Construct a queue of visible cities for a given ISS location
2. Generate a reference image of a city from the queue and determine if it matches the astronaut photo
3. Establish point correspondences between astronaut photo and reference
4. Use correspondences to transfer geocoordinates for tiepoints

NightMatch investigates and answers...

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1. How can we order our queue to promote more likely cities to the top?

Queue Method	Average Correct City Placement	
	2000 km	1200 km
✘ Distance	25.8	21.9
✘ Population	34.8	13.9
✔ $d/population_rank^4$	9.8	7.1

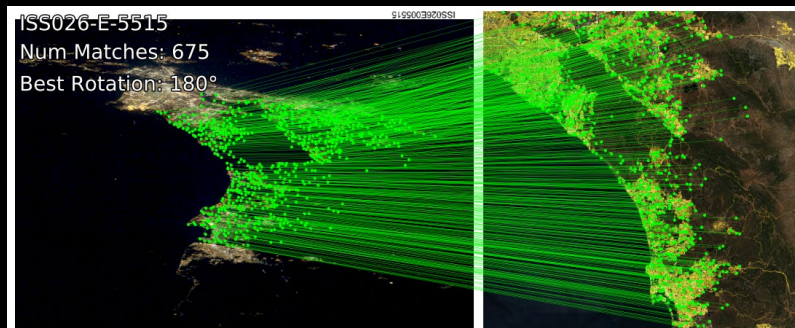
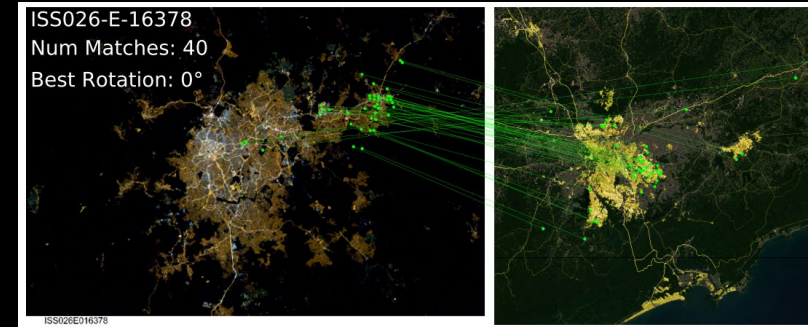
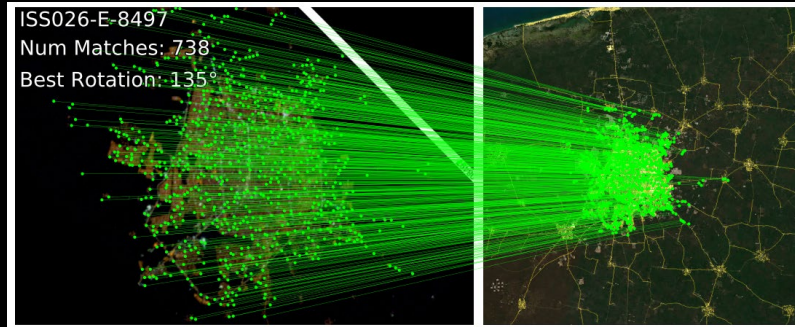
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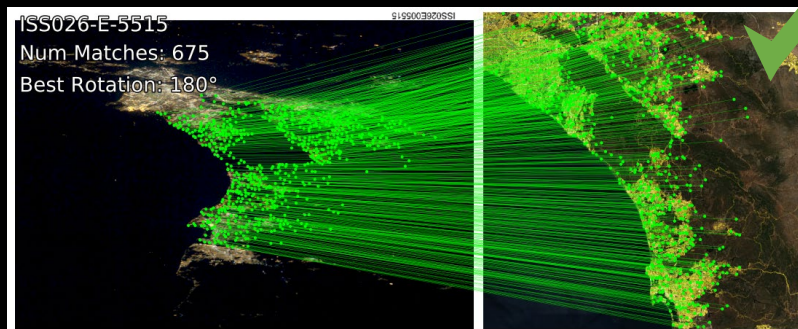
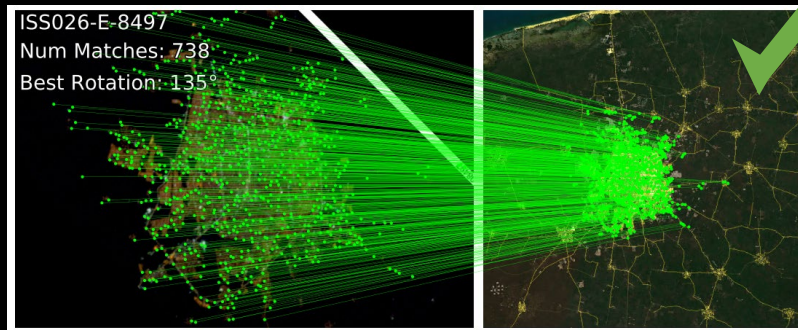
inlier keypoints > thresh



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NightMatch investigates and answers...

1. How can we order our queue to promote more likely cities to the top?
2. How can we determine if a city is a good match, with high precision?
3. What's the best reference image we can create to enable high recall?

Daytime Satellite Image



Rasterized Street Map



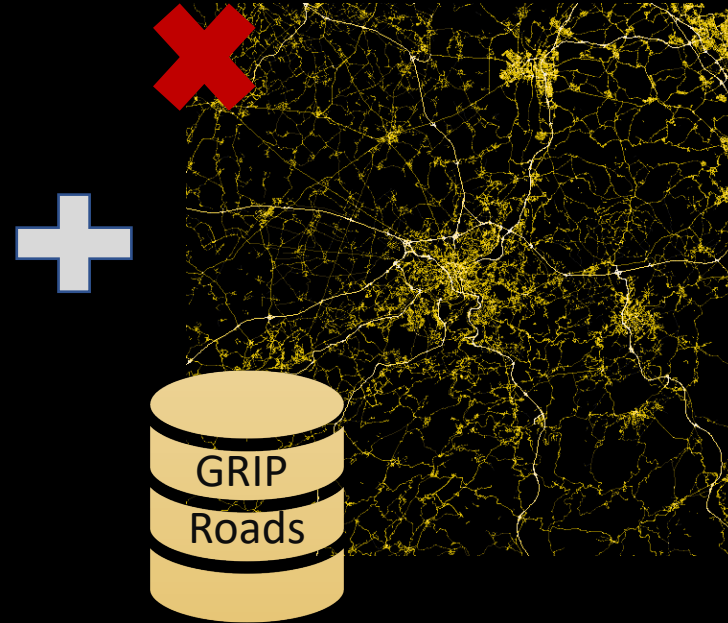
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Daytime Satellite Image (Sentinel 2)



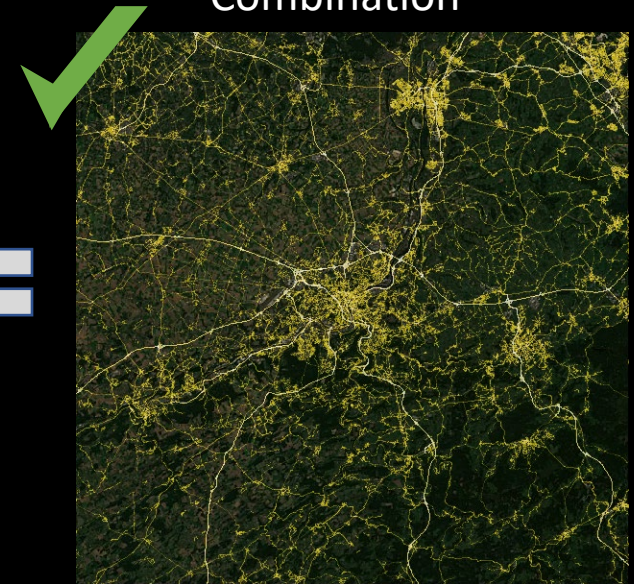
Rasterized Street Map



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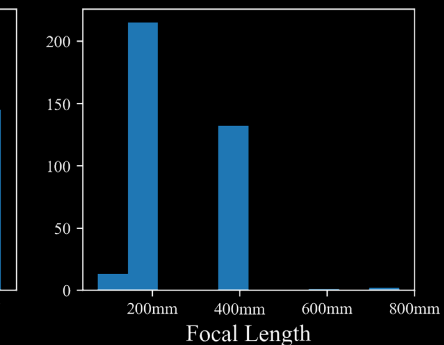
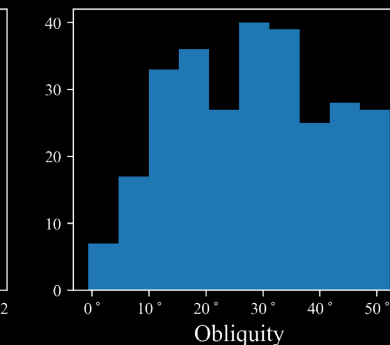
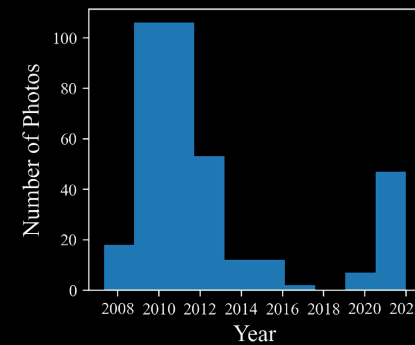
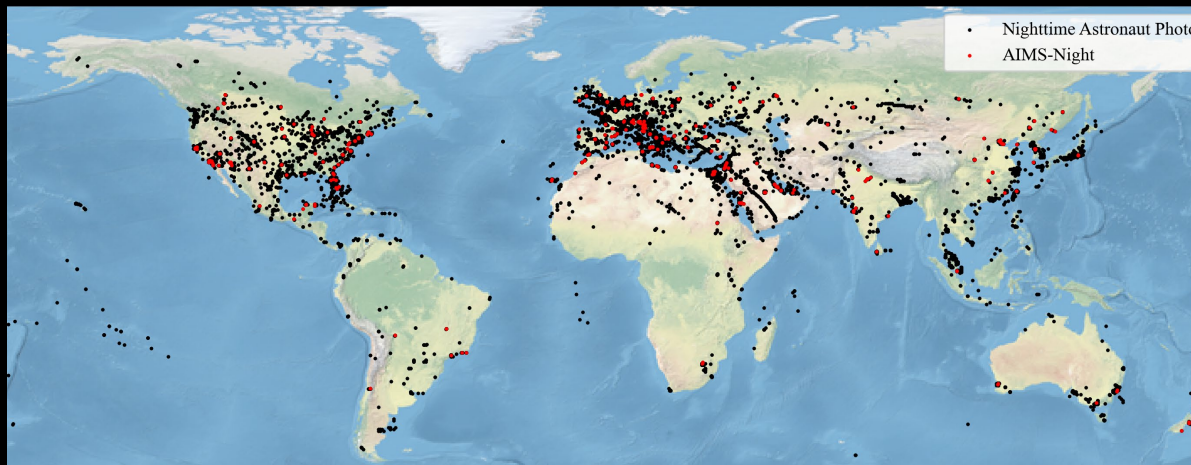
Combination



NightMatch investigates and answers...

1. How can we order our queue to promote more likely cities to the top?
2. How can we determine if a city is a good match, with high precision?
3. What's the best reference image we can create to enable high recall?
4. How can we properly evaluate our choices?

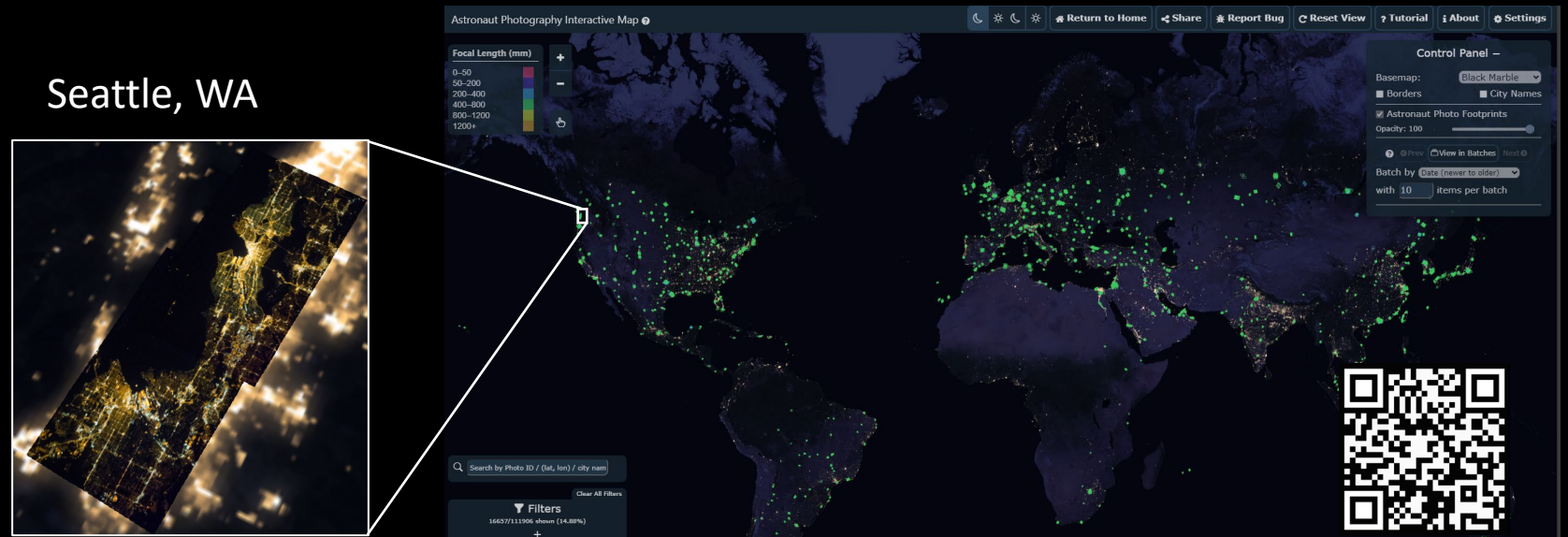
Astronaut Image Matching Subset (AIMS)-Night



363 representative images for evaluation of future techniques!

A new era of nighttime astronaut photography

- **16,000+** nighttime astronaut photographs now available as geospatial data product to use in your research!
- Public release of **AIMS-Night dataset** to encourage future work on this problem
- Interact with the data via our **ExplorePhotos** map tool



Project Page



Explore Nighttime Photos