

Automated Content Detection for Cassini Images

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Third Planetary Data Workshop

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Goal: Content-based search for planetary images

Planetary Image Atlas

[NEW SEARCH](#)[DATA PORTAL](#)[ABOUT](#)[HELP](#)[FEEDBACK](#)[HOME](#)**Data Search** ⓘ

Current Selection

(click to remove selection)

remove all
(x) ATLAS_MISSION_NAME:cassini
(x) PRODUCT_TYPE:edr
(x) CASSINI_IMAGE_CLASS:horizon

► Mission

► Spacecraft

► Instrument

► Target

► Product Type

► Lighting Geometry

► Filters

► Lat/Lon Bounding Box

► Time Constraints

► Orbital Mission Constraints

► PDS Archive Constraints

▼ Cassini ISS Image Content ☀

Results: 24

Page:

< 1 2 3 ... 670 671 > displaying 1 to 24 of 16084



Grid View

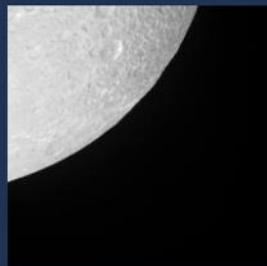


Sort View

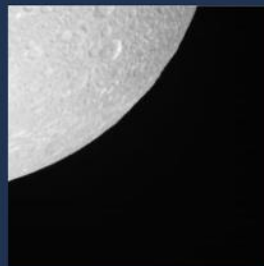
Add field to sort by:

-- select an option --

Clear



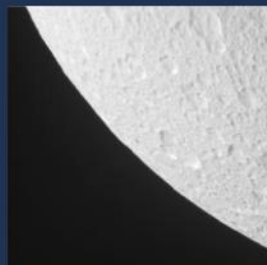
N1820408509_1



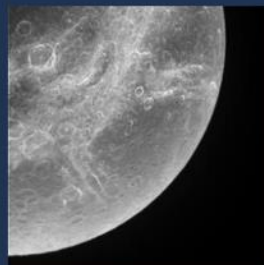
N1820408476_1



N1820408543_1



N1662201428_1



N1807488343_1



N1820411954_1

**PDS: 27.5 million****Cassini: 575,000**

Content-based search for Earth images



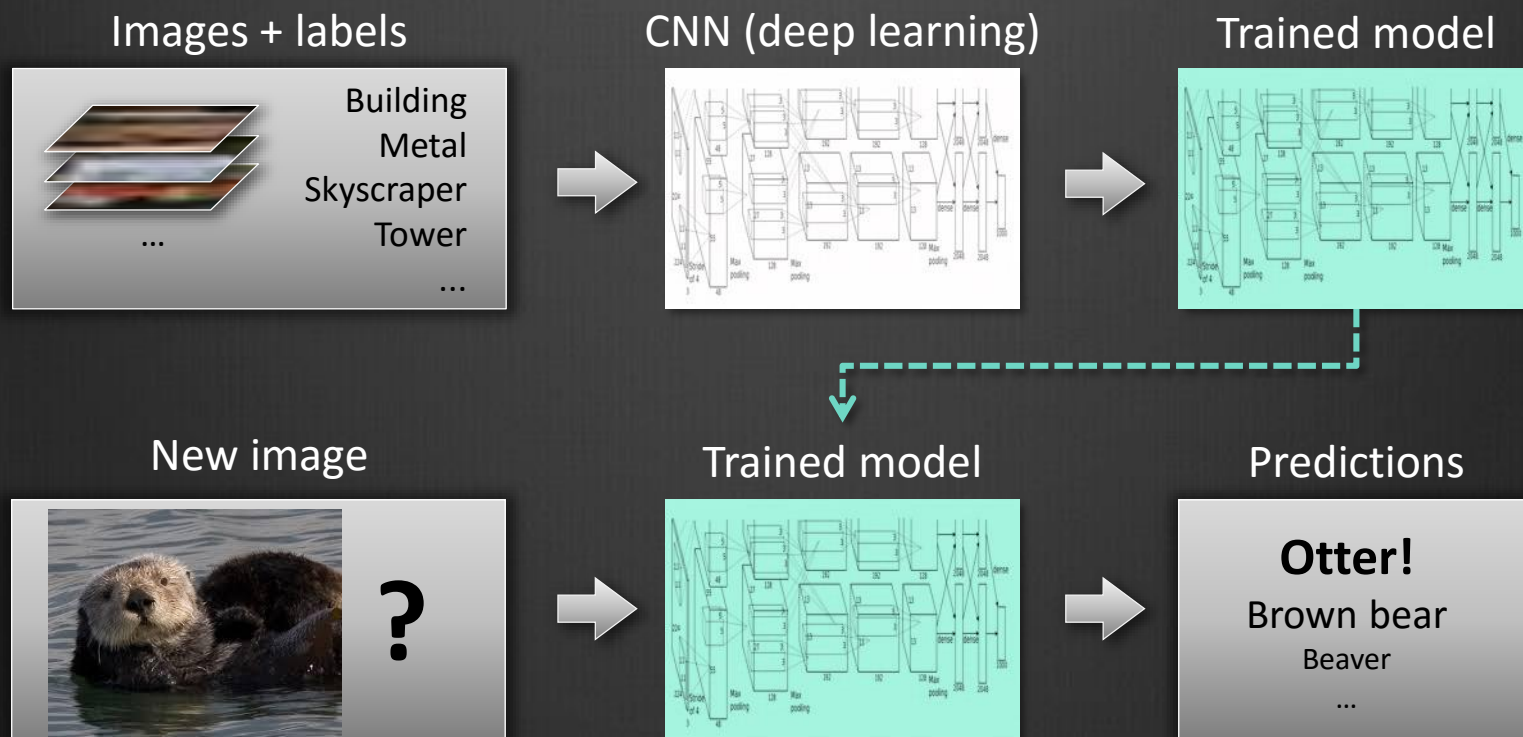
Skyscraper
Tower
Office building



Snowy mountain
Tree farm
Ski slope

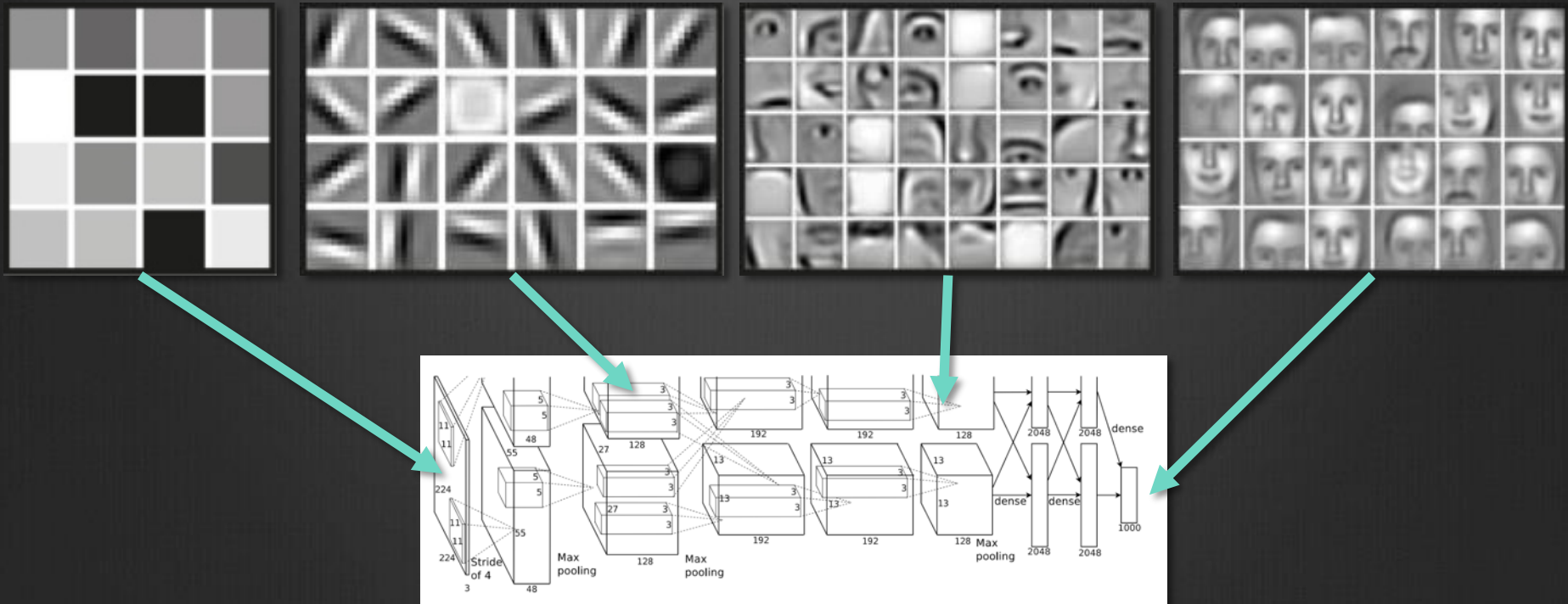
Convolutional neural networks for image classification

- ★ State of the art for image classification
- ★ Provides posterior probability (confidence) for each prediction
- ★ Transfer learning to quickly adapt existing model instead of training from scratch



CNN architecture

pixel > motif > part > object



ImageNet



Pre-trained on GPUs for weeks
Using >15,000,000 labeled high res images
with ~22,000 categories

[Sutskever et al., 2012]

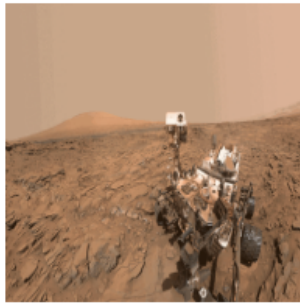
What about images from other planets?

Caffe Demos

The [Caffe](#) neural network library makes implementing state-of-the-art computer vision systems easy.

Classification

[Click for a Quick Example](#)



Maximally accurate

Maximally specific

aquatic bird

0.35283

wading bird

0.34741

bird

0.34045

stork

0.31565

white stork

0.31018

CNN took 0.063 seconds.

Provide an image URL

Classify URL

Or upload an image:

Choose File

no file selected

<http://demo.caffe.berkeleyvision.org/>

What about images from other planets?

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Classification

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Maximally accurate

Maximally specific

spider web

1.55445

web

1.53161

trap

1.35291

device

0.33349

invertebrate

0.28893

CNN took 0.064 seconds.

Provide an image URL

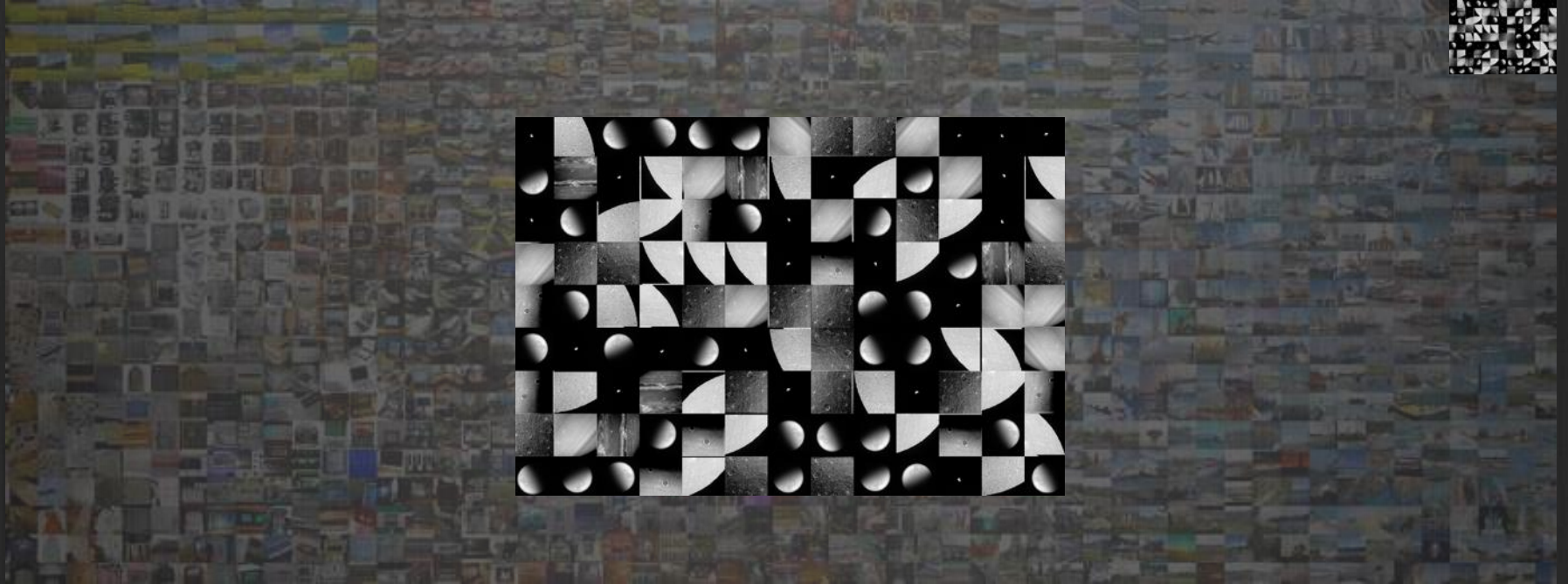
Classify URL

Or upload an image:

[Choose File](#) no file selected

<http://demo.caffe.berkeleyvision.org/>

Cassini ImageNet



Refined the ImageNet classifier
using Caffe [Jia et al., 2014]
on GPUs for hours
with ~10,000 Cassini images
with 19 categories

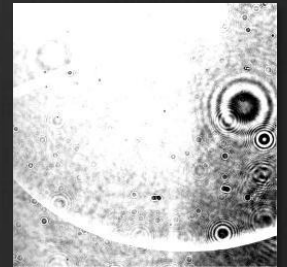
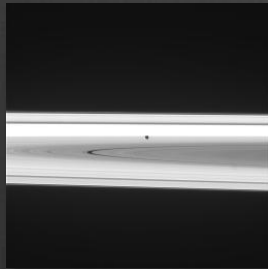
Vocabulary for planetary images

craters clouds horizon rings plume sky view starfield surface

body types camera distance multiple objects phases

artifact eclipse haze noise over exposure transients ripple

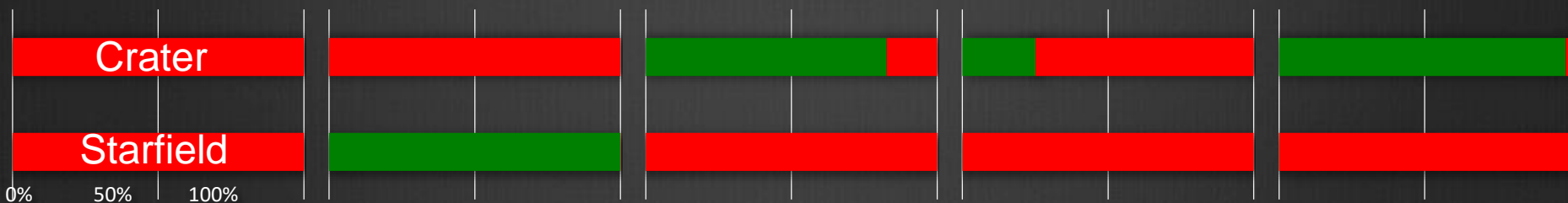
19 categories



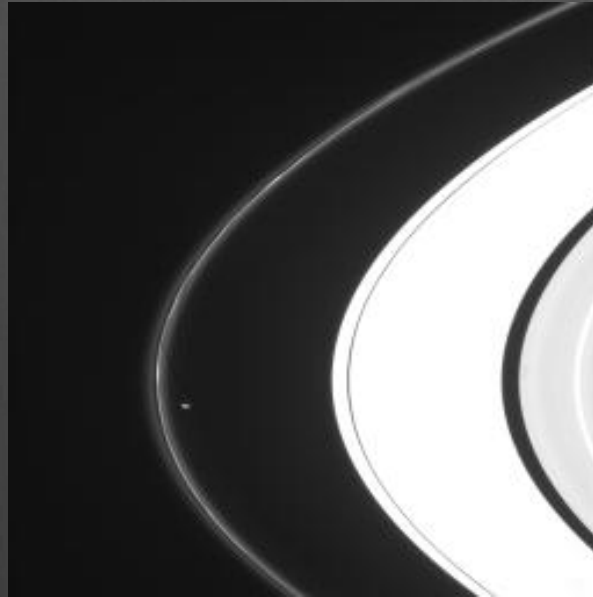
Cassini ImageNet predictions

YES

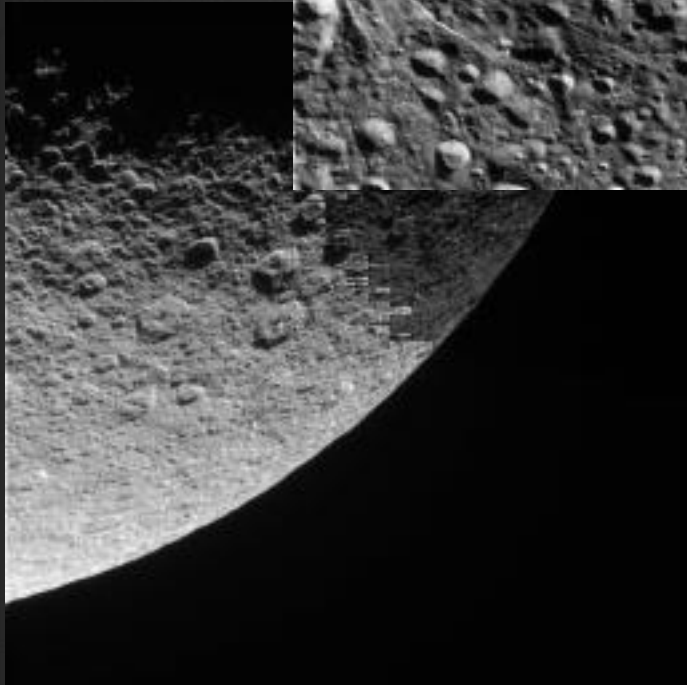
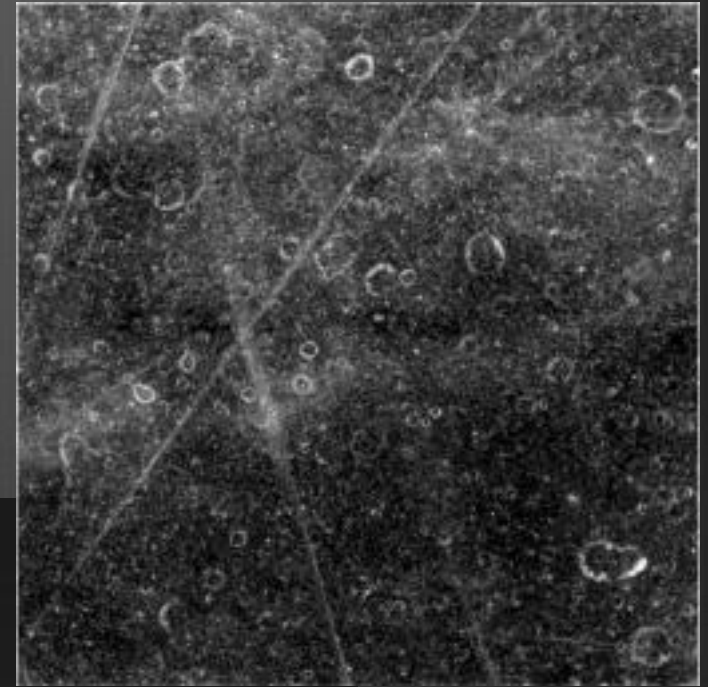
NO



Example predictions: Rings



Example predictions: Crater



Planetary Image Atlas

▼ Cassini ISS Image Content 

Image Class

artifact (13157)
body - full (26867)
body - partial (40610)
body - rock (12839)
clouds (13256)
crater (12908)
eclipse (39820)
haze - clear (12859)
haze - unk (148257)
haze - visible (15937)
horizon (12845)
multiple objects (38194)
noise - clear (12948)
noise - unk (151388)
noise - visible (12839)
object distance - closeup (10176)
object distance - large (26923)
object distance - medium (8060)
object distance - orbit (104145)
object distance - small (12017)
object distance - tiny (15626)
over exposure (14264)
phase - crescent (13205)
phase - full (12949)
phase - gibbous (23365)
phase - none (135305)
phase - quarter (14003)
plume (13322)
rings (151505)
ripple (12918)
sky - full (40043)
sky - none (50406)
sky - partial (84686)
starfield (13043)
surface (47206)
transient - multiple (12841)
transient - one (13140)



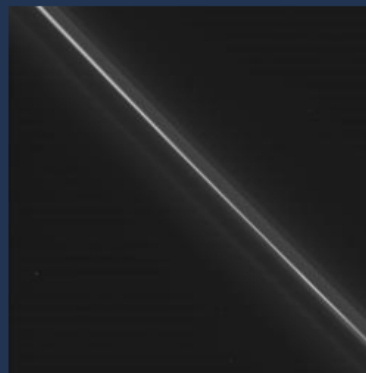
N1805078832_1



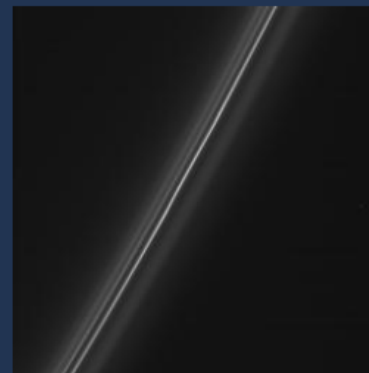
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N1805078669_1



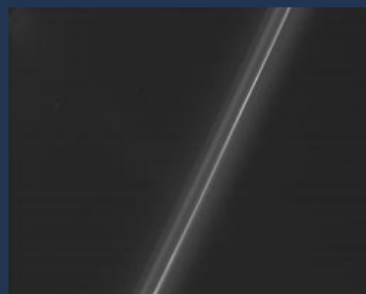
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N1610577726_1

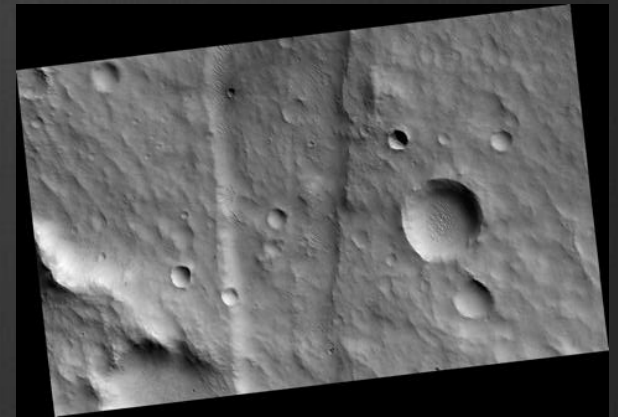
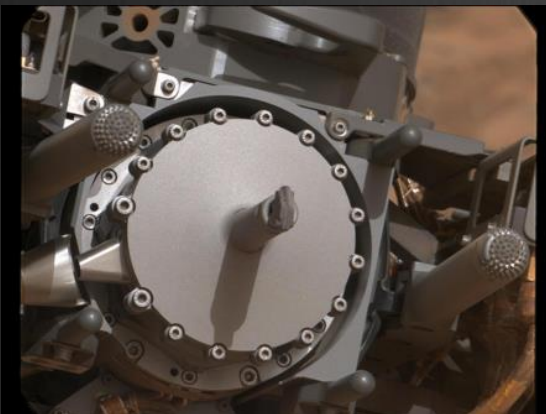
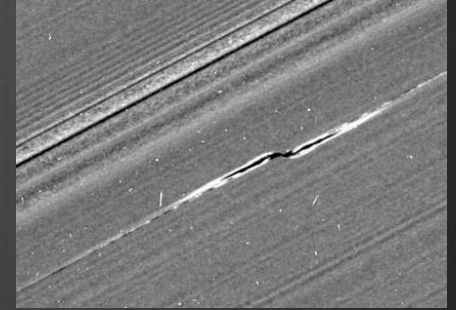


N1743638703_1



Summary

- ★ Goal: use state-of-the-art image classification to enable **content-based search** for planetary images
 - ★ Transforms how we interact with mission archives
 - ★ Next step: refine image categories – e.g., propellers
- ★ Try it yourself:
<http://pds-imaging.jpl.nasa.gov/search/>
- ★ Easy to augment with new classes or new instruments
 - ★ Similar results with MSL rover parts and HiRISE Mars surface features



Thank you: MGSS (AMMOS) and PDS Imaging Node

Backup slides

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no file selected