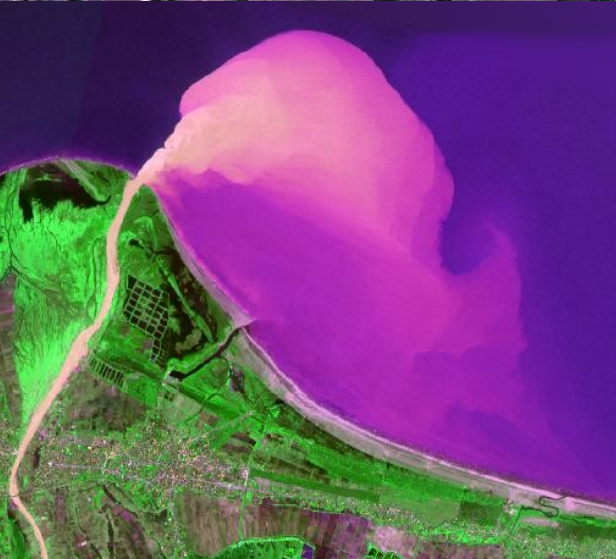


Image Processing, Analysis and Classification for Remote Sensing

Thales Sehn Körting
<http://youtube.com/tkorting>

Remote Sensing applications



How to write algorithms to deal with images?



How to write algorithms to deal with images?

We create
algorithms to read
and write numbers,
stored in matrices

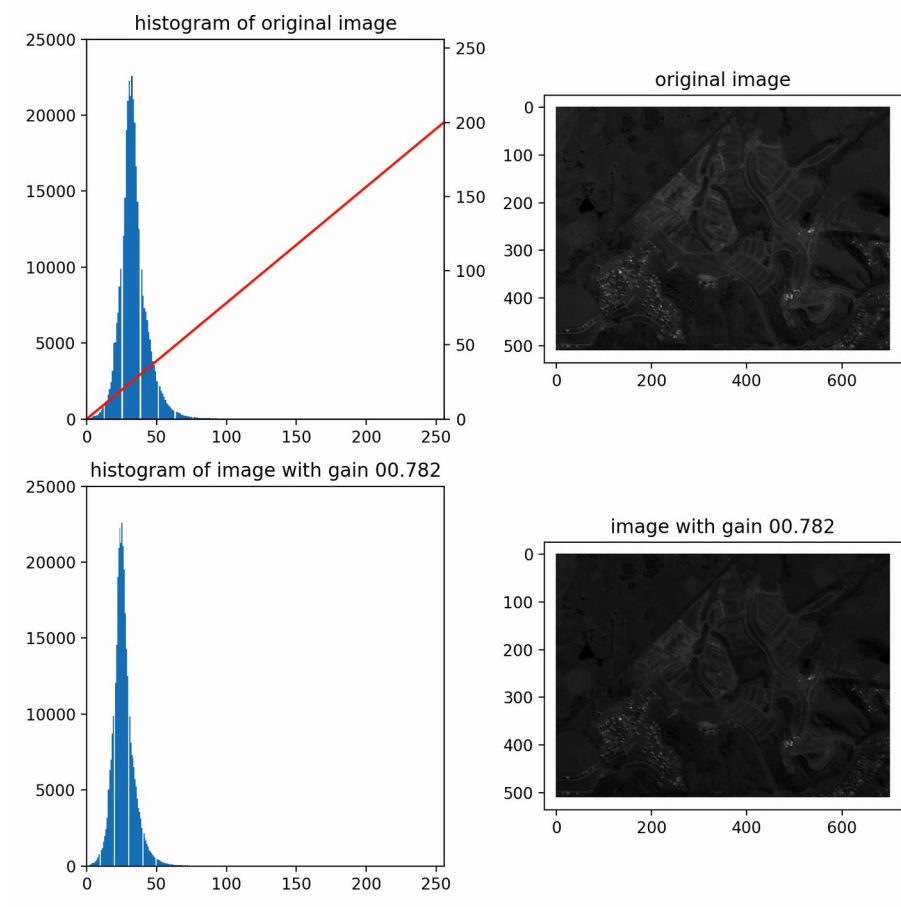
```
[ [ 54 49 49 48 48 48 48 48 51 51]
  [ 45 46 46 43 43 45 45 45 44 44]
  [ 45 46 46 43 43 45 45 45 44 44]
  [ 61 90 90 82 82 48 42 42 47 47]
  [138 139 139 122 122 78 47 47 46 46]
  [138 139 139 122 122 78 47 47 46 46]
  [144 144 144 140 140 144 144 144 140 140]
  [144 144 144 140 140 144 144 144 140 140]
  [146 144 144 142 142 146 144 144 142 142]
  [146 144 144 142 142 146 144 144 142 142]
```

```
[ [ 20 23 23 22 22 20 20 20 21 21]
  [ 40 41 41 37 37 21 21 21 18 18]
  [ 40 41 41 37 37 21 21 21 18 18]
  [ 60 96 96 86 86 24 19 19 21 21]
  [210 199 199 173 173 74 38 38 22 22]
  [210 199 199 173 173 74 38 38 22 22]
  [220 206 206 200 200 129 65 65 24 24]
  [220 206 206 200 200 129 65 65 24 24]
  [220 211 211 207 207 167 84 84 25 25]
  [220 211 211 207 207 167 84 84 25 25]]
```

```
[ [ 22 20 20 19
  [ 9 11 11 7
  [ 9 11 11 7
  [ 25 54 54 46
  [ 86 90 90 74
  [ 86 90 90 74 74 41 10 10 22 22]
  [ 92 94 94 90 90 86 33 33 25 25]
  [ 92 94 94 90 90 86 33 33 25 25]
  [ 93 93 93 91 91 108 43 43 22 22]
  [ 93 93 93 91 91 108 43 43 22 22]]
```

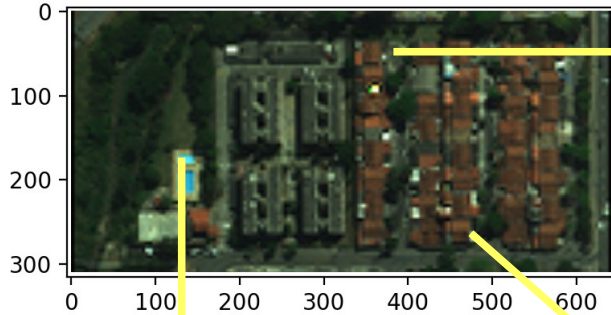
Techniques to improve visualization

example:
multiply all
values to a
constant

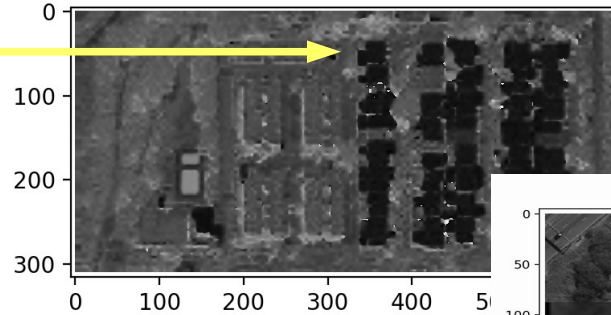


Preprocessing in Remote Sensing

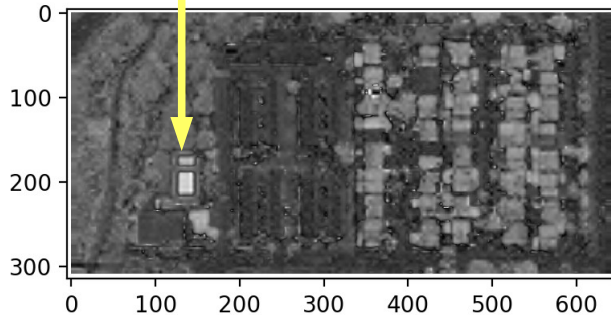
Color image



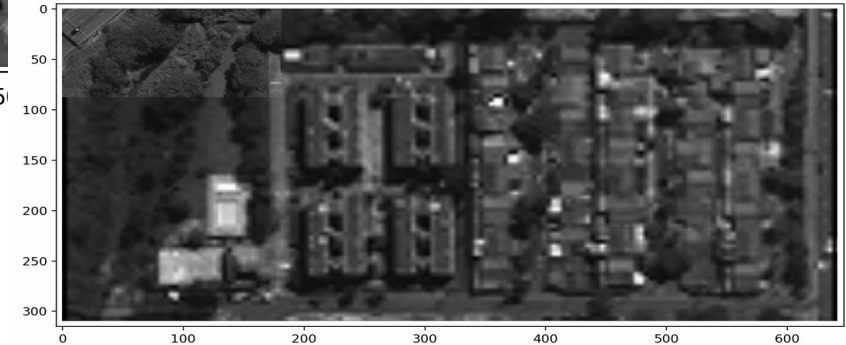
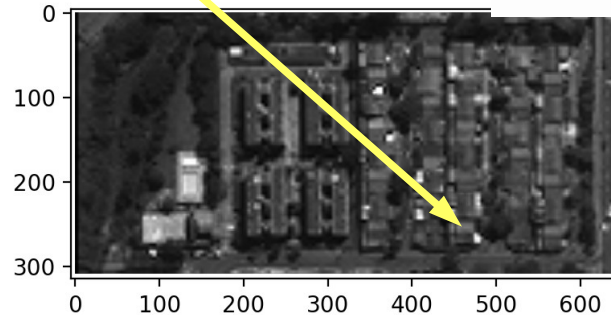
Hue



Saturation



Value



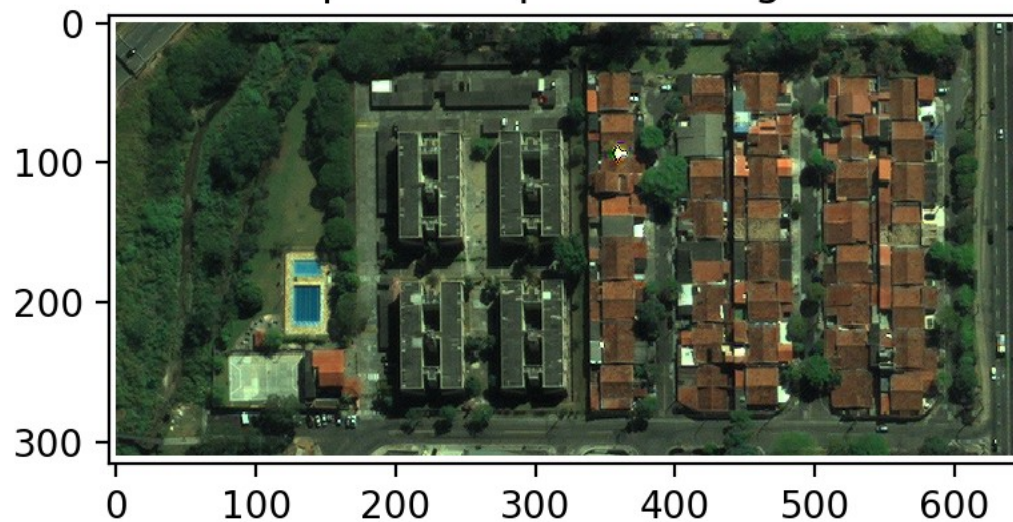
Replace
Value by
Panchromatic

Preprocessing in Remote Sensing

Original Color image



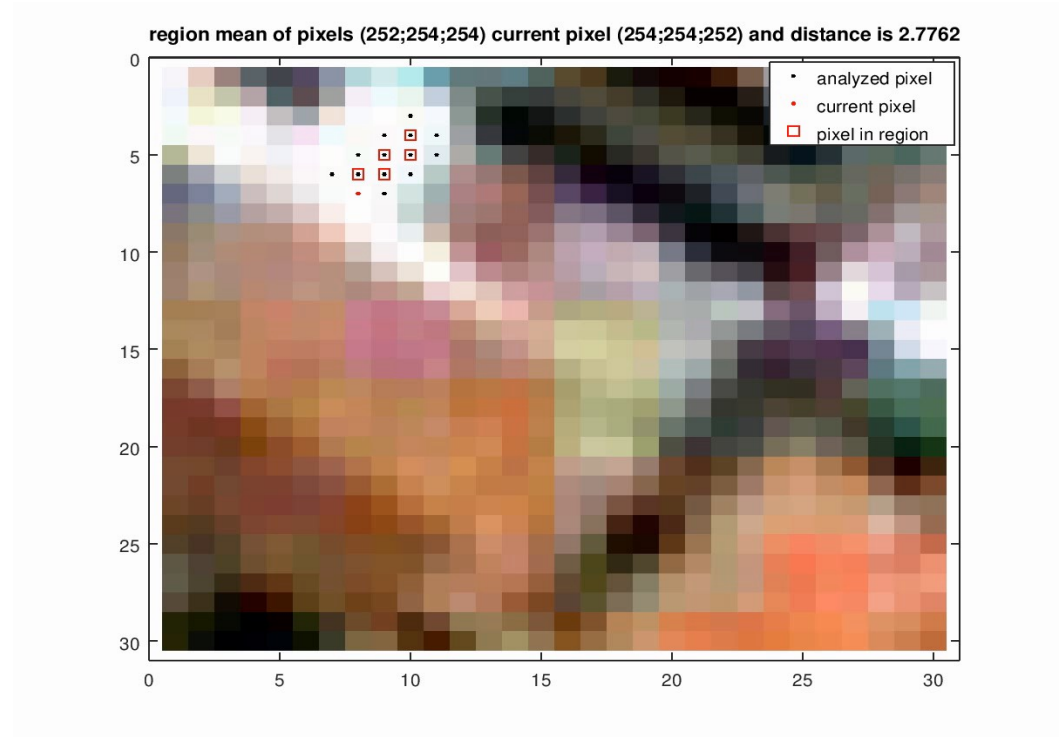
pan-sharpened image



From pixels to objects

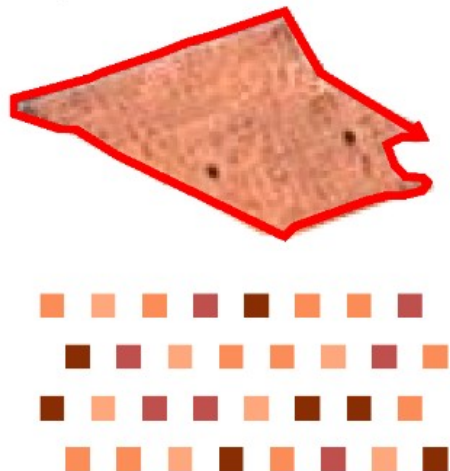


Segmentation
separates the image
into simple regions with
homogeneous behavior

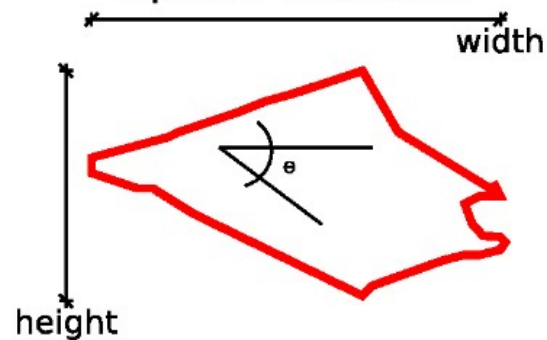


From pixels to objects

Spectral Features

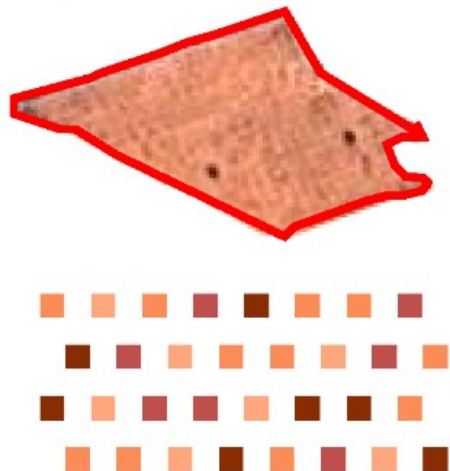


Spatial Features

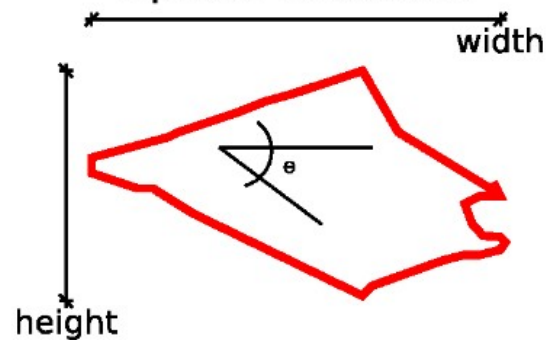


From pixels to objects

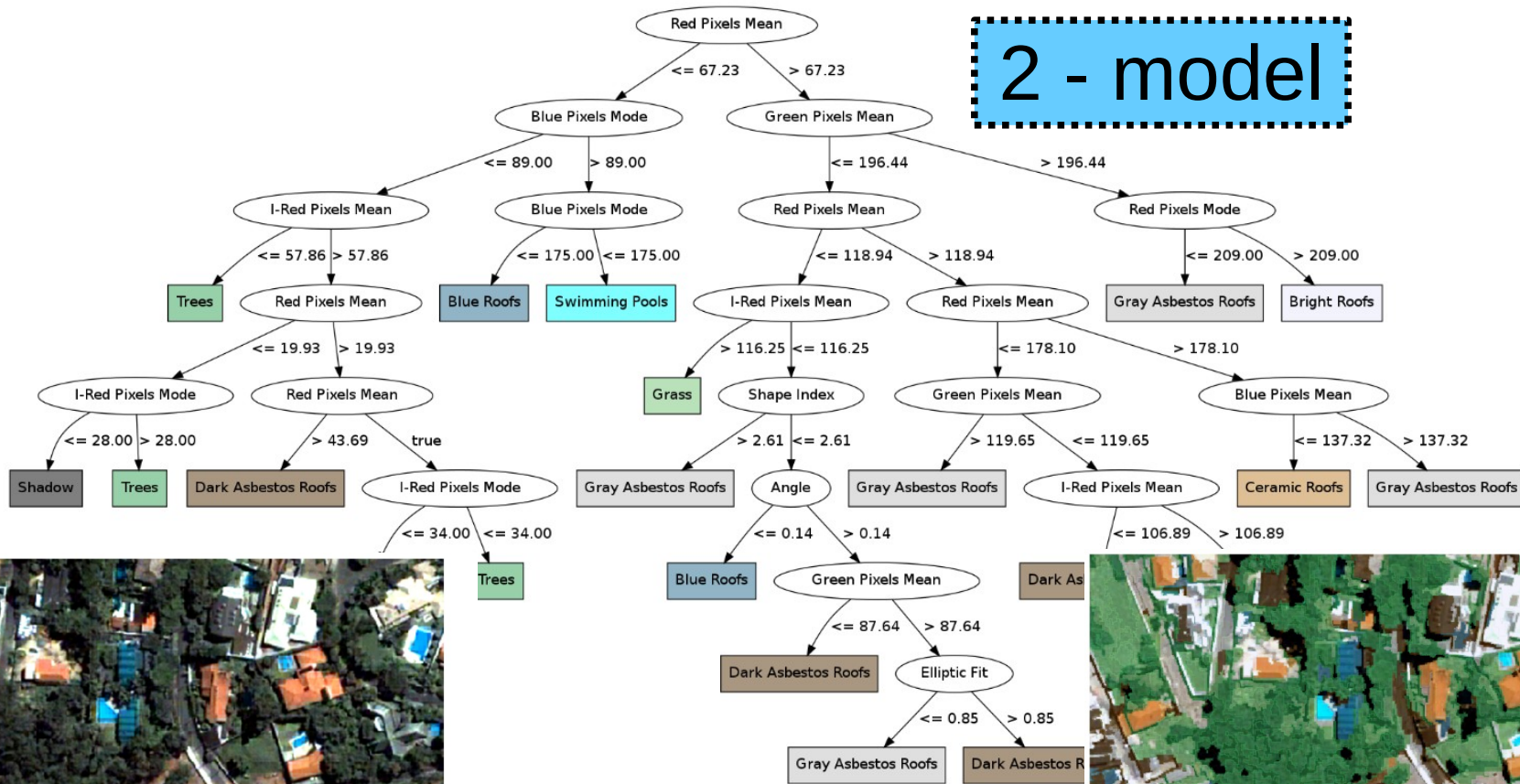
Spectral Features



Spatial Features



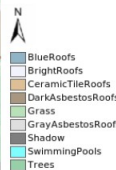
2 - model



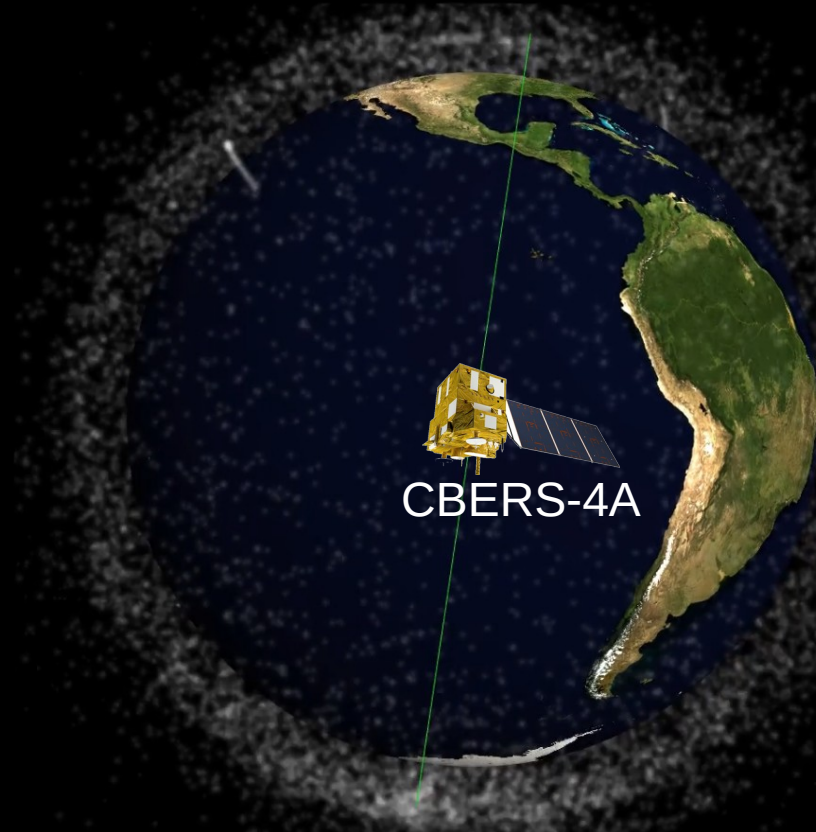
1 - input

The accuracy of the model depends on the analyst

3 - output



State-of-the art: Image Time Series

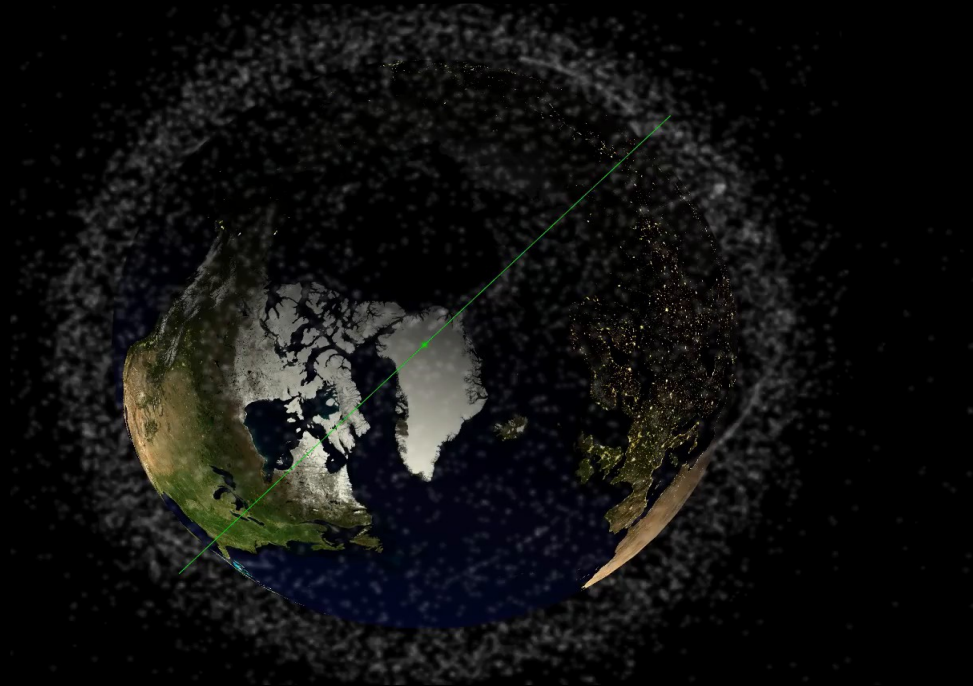


CBERS-4A

CBERS 4A	
Find all objects from this launch...	
Int'l Designator	2019-093E
Type	PAYLOAD
Apogee	630 km
Perigee	628 km
Inclination	97.93°
Altitude	632.28 km
Velocity	7.54 km/s
Period	97.13 min



State-of-the art: Image Time Series

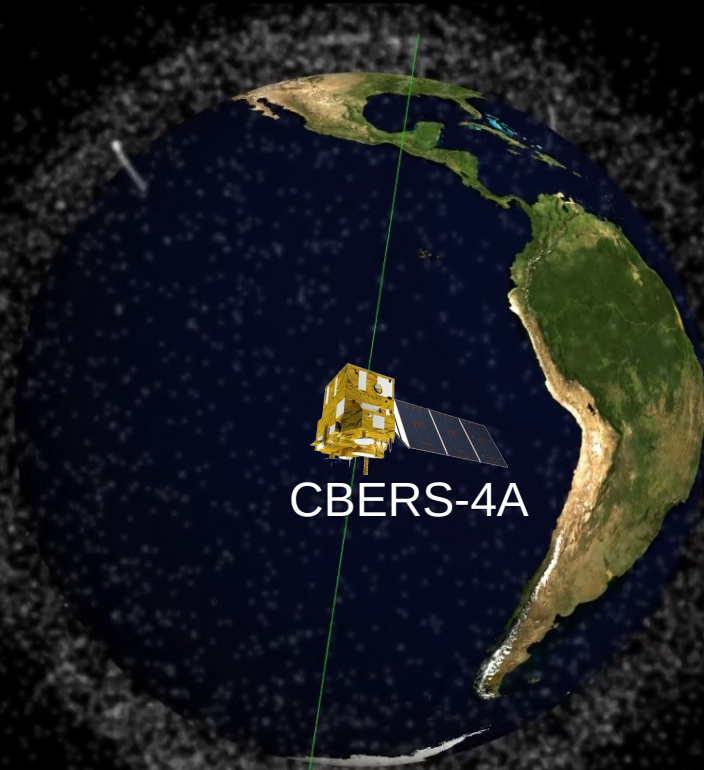


CBERS 4A	
Find all objects from this launch...	
Int'l Designator	2019-093E
Type	PAYLOAD
Apogee	630 km
Perigee	628 km
Inclination	97.93°
Altitude	636.72 km
Velocity	7.55 km/s
Period	97.13 min



State-of-the art: Image Time Series

After 26 days
(the temporal
resolution),
CBERS-4A
captures a new
image of the
same place



CBERS 4A	
Find all objects from this launch...	
Int'l Designator	2019-093E
Type	PAYLOAD
Apogee	630 km
Perigee	628 km
Inclination	97.93°
Altitude	632.28 km
Velocity	7.54 km/s
Period	97.13 min

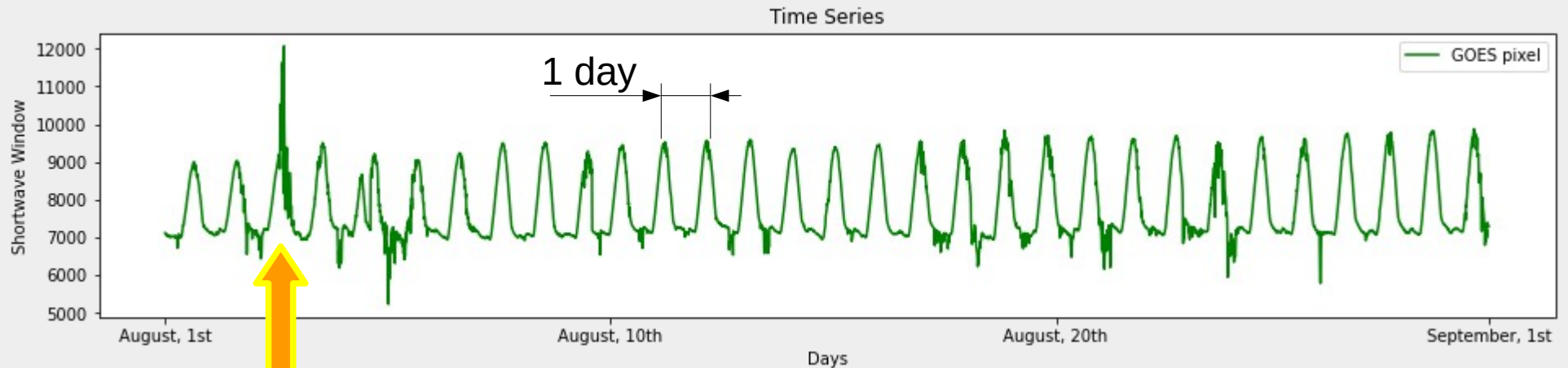
source: <http://stuffin.space/>

Spatial x Temporal resolution

GOES

1 pixel = 1km x 1km

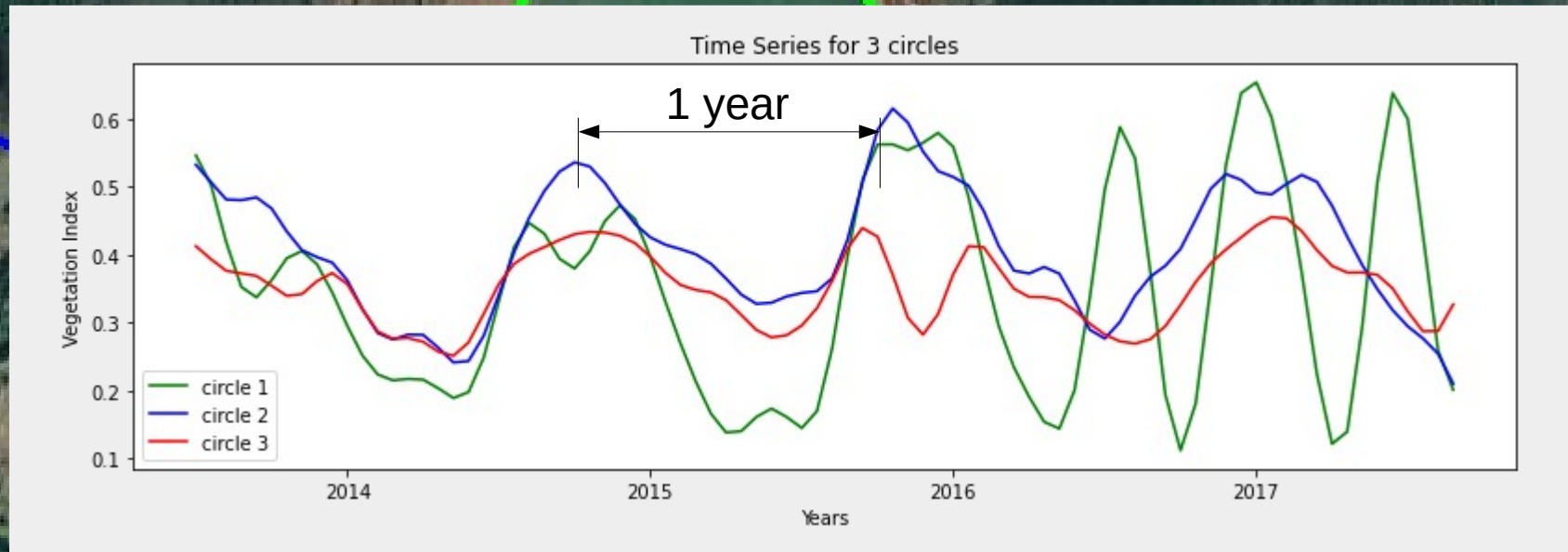
1 observation every 10 minutes



MODIS

1 pixel = 250m x 250m

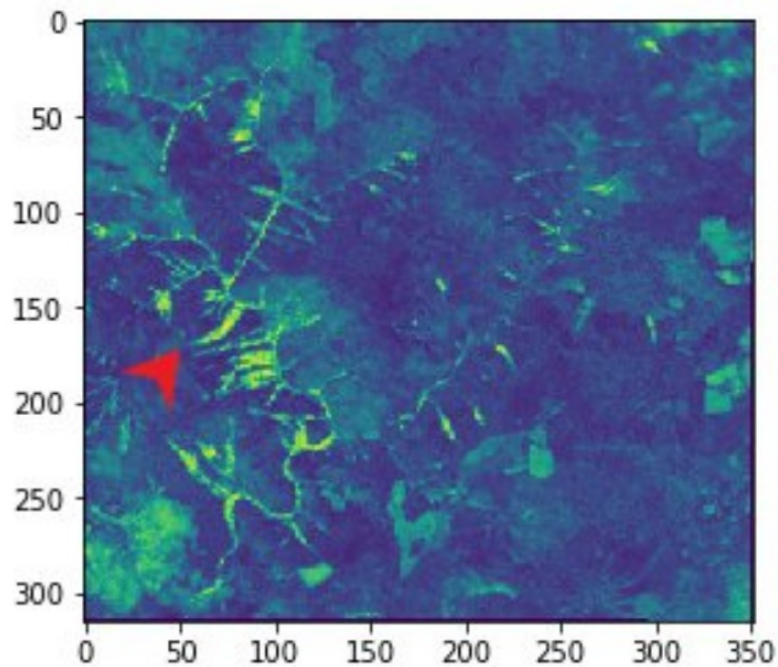
1 observation every 8 days



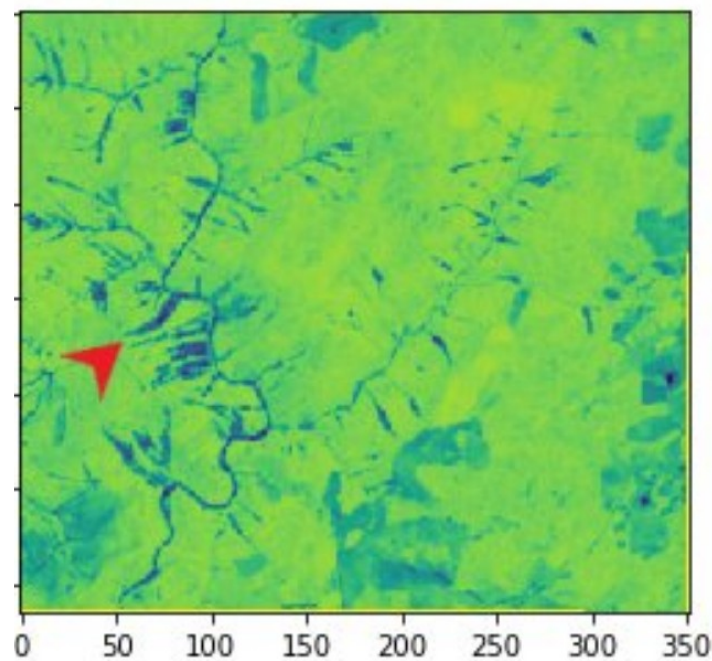
Sentinel

1 pixel = 10m x 10m

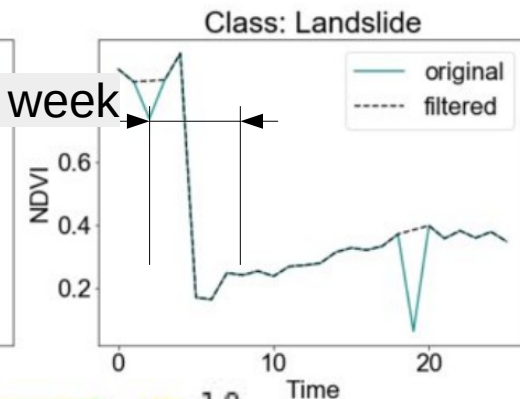
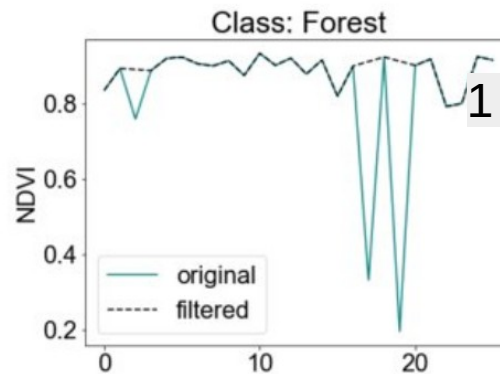
1 observation every 5 days



Amplitude

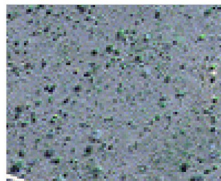


Mean

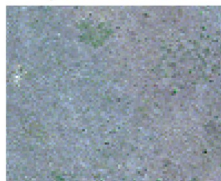


WorldView-2 - 1 pixel = 2m x 2m

Shrub Grassland



Open Grassland



Gallery Forest



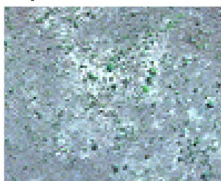
Humid Open Grassland



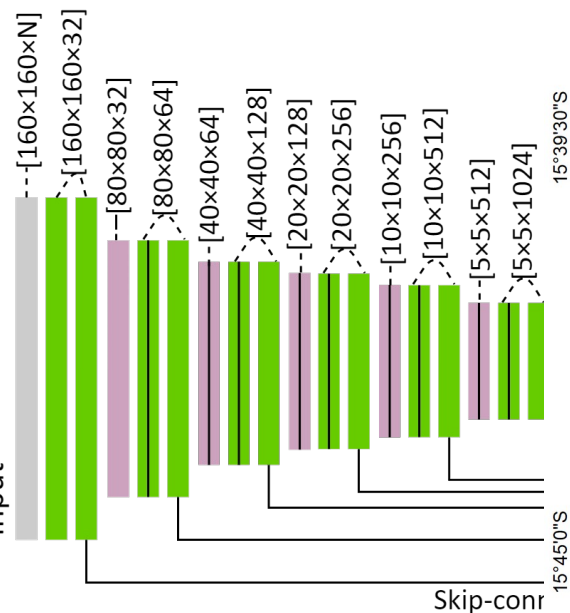
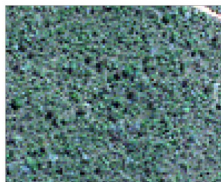
Vereda



Rupestrian Grassland



Woodland Savanna



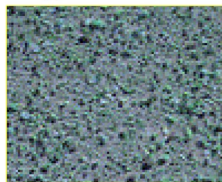
3x3 Convolution, ReLU

2x2 Max-Pooling

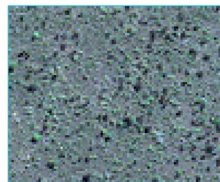
Batch normalization, 3x3 Convolution, ReLU

2x2 Max-Pooling, Dropout p=0.25

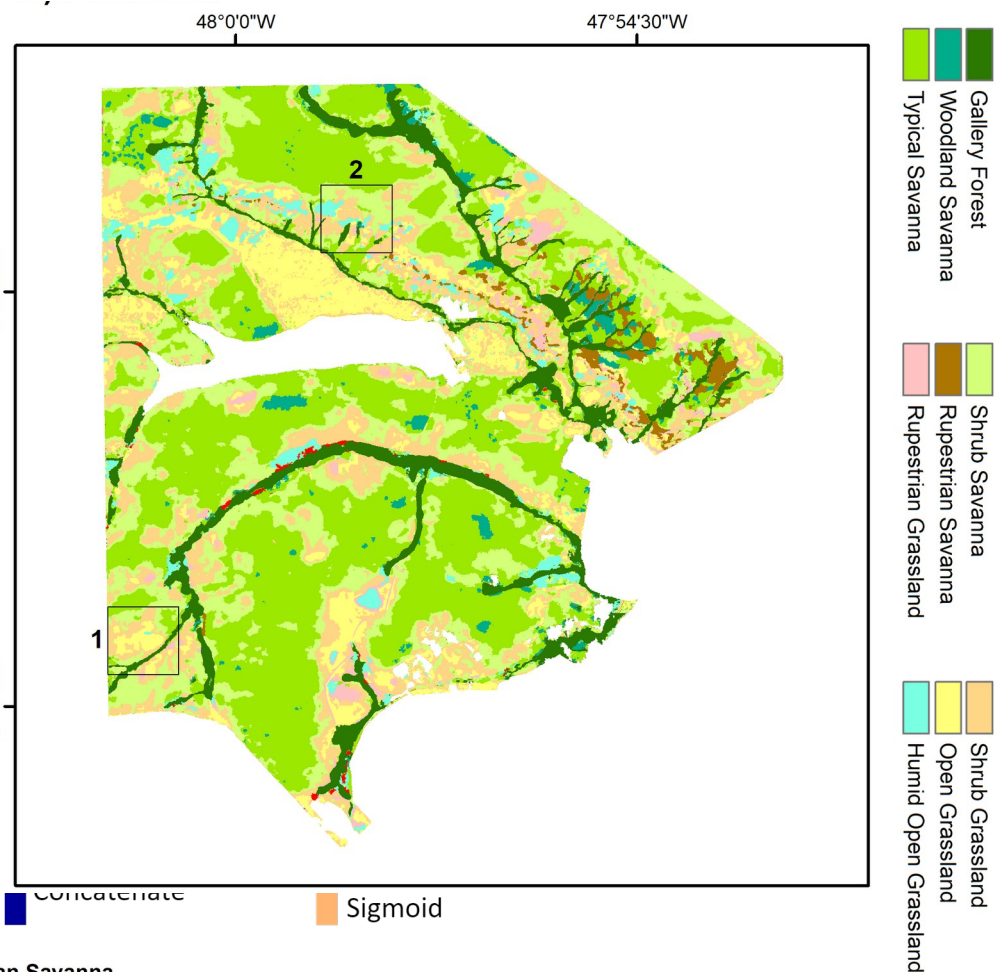
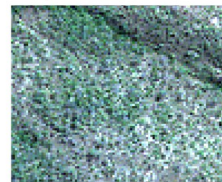
Typical Savanna



Shrub Savanna



Rupestrian Savanna



Satellite Image Classification

- Deep Learning → https://prezi.com/n_r8p1ytanyh/
- KNN → <https://prezi.com/9h9amupckjjn/>
- KNN *in action* → <https://prezi.com/bf7r0vaasqim/>
- Random Forest → <https://prezi.com/nue3i0jqhwdp/>
- Random Forest *in action*

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