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Introduction to Google Earth Engine

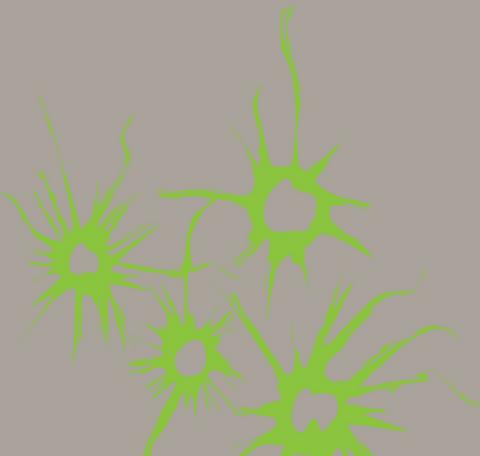
Mahdi KHODADADZADEH

February 2022

*With some materials from Nick Clinton
Google Earth Engine Developer Relations*



FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

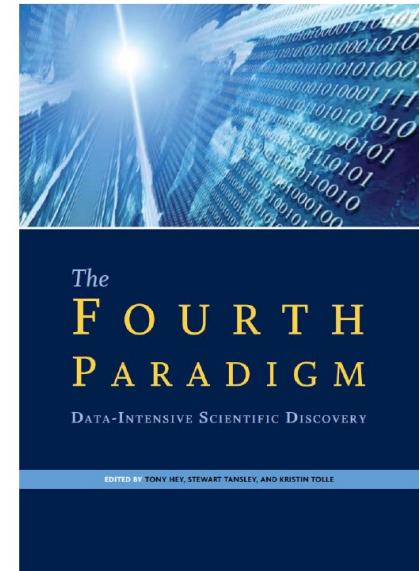


What is Google Earth Engine?

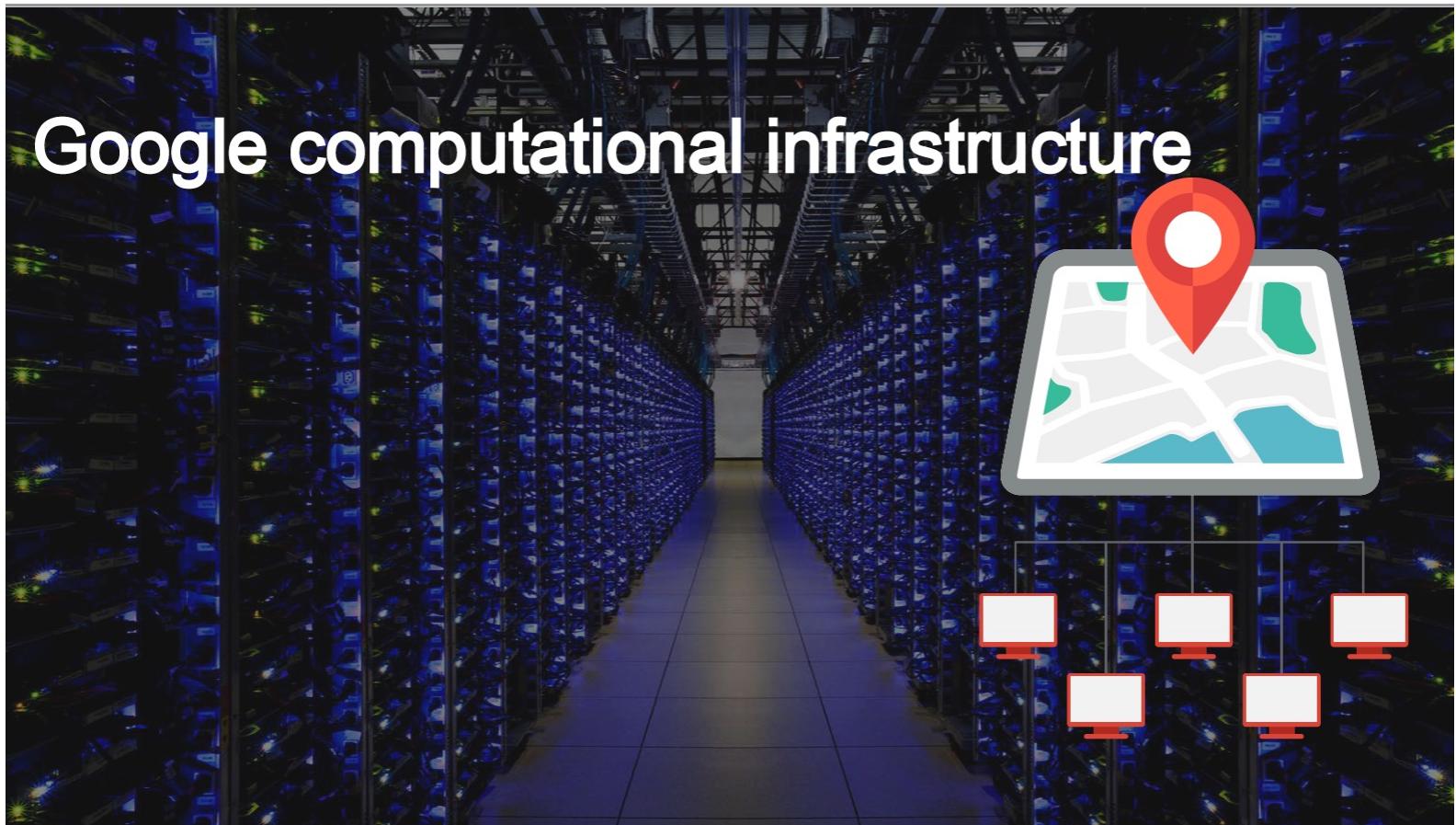
- Cloud-based platform for geospatial data analysis with a multi-petabyte catalog of satellite imagery and geospatial datasets
- Access + Process

“Often it turns out to be more efficient to move the questions than to move the data.”

-Jim Gray (1944-2007)



Google data center



The Earth Engine Data Catalog



Landsat & Sentinel 1, 2
10-30m, weekly



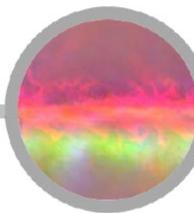
MODIS
250m daily



Vector Data
WDPA, Tiger



**Terrain &
Land Cover**



Weather & Climate
NOAA NCEP, OMI, ...

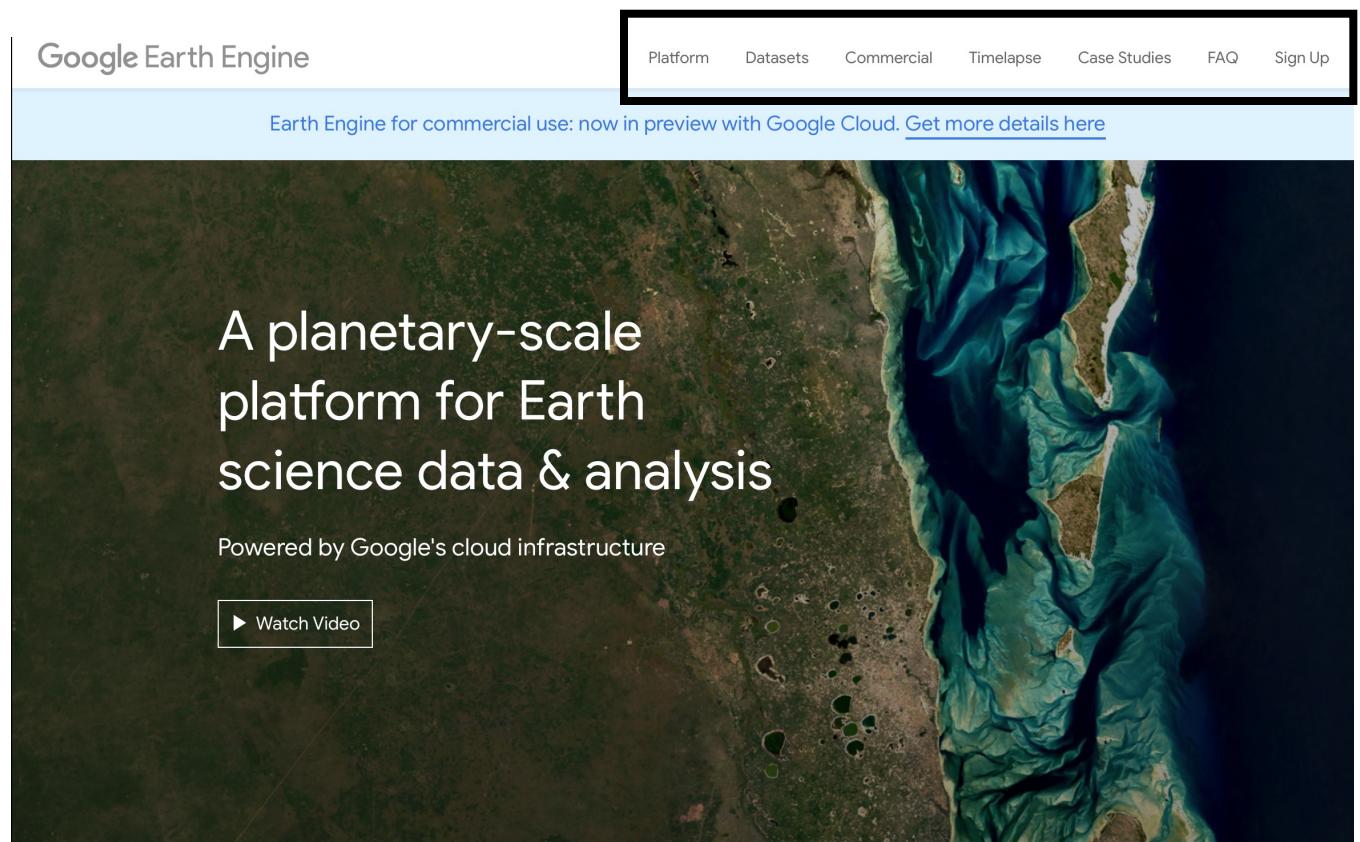
... and upload your own vectors and rasters

> 200 public datasets
> 5 million images

> 4000 new images every day
> 7 petabytes of data

Home page

- <https://earthengine.google.com/>



Sign Up

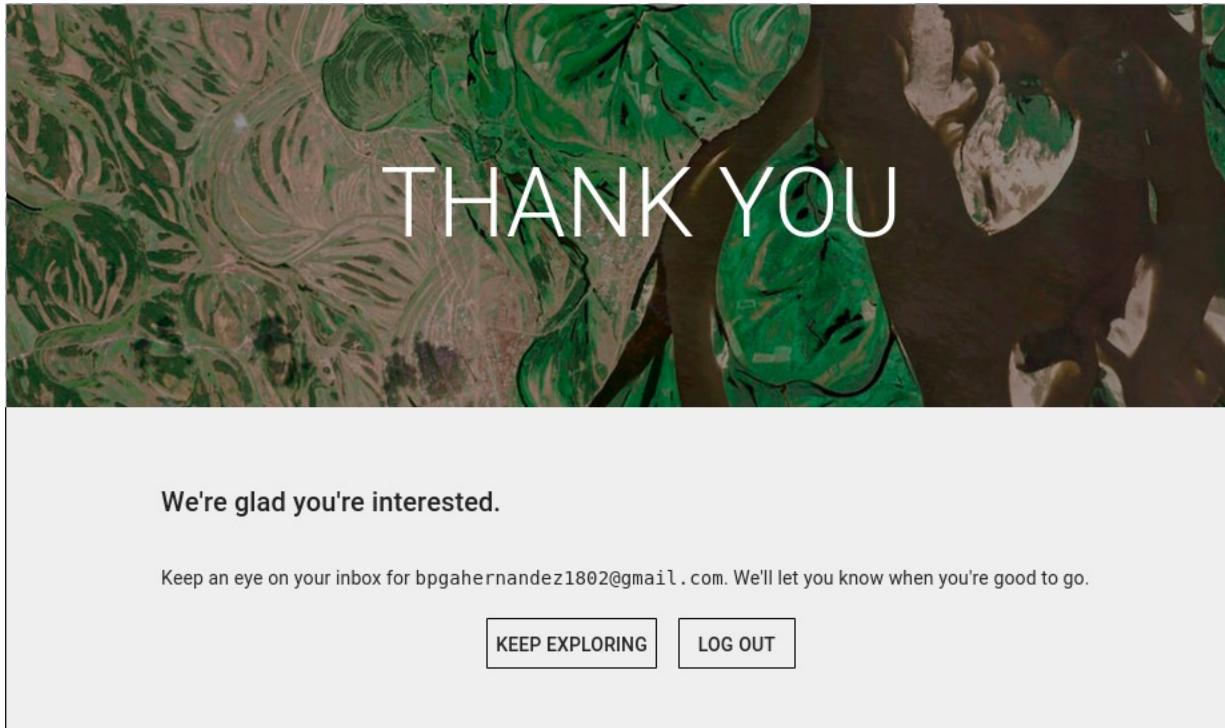
- Go to <https://code.earthengine.google.com/>
- Create or link your current email account to a new account of google earth engine.
- Fill all data that asks you in the forms.

The screenshot shows a web browser window for 'Earth Engine Signup'. The URL in the address bar is <https://signup.earthengine.google.com/#!/>. The page contains several input fields:

- Email: bpgahernandez1802@gmail.com
- Full name *: Please tell us your first and last name.
- Affiliation/Institution *: Which organization are you a part of? Give a homepage URL if possible.
- Country/Region *: United States
Please tell us where you live.
- Institution type *: Select the best description for your institution, or choose Other and clarify.
- What would you like to accomplish with Earth Engine? *
Please describe in a few sentences how you intend to use Earth Engine.

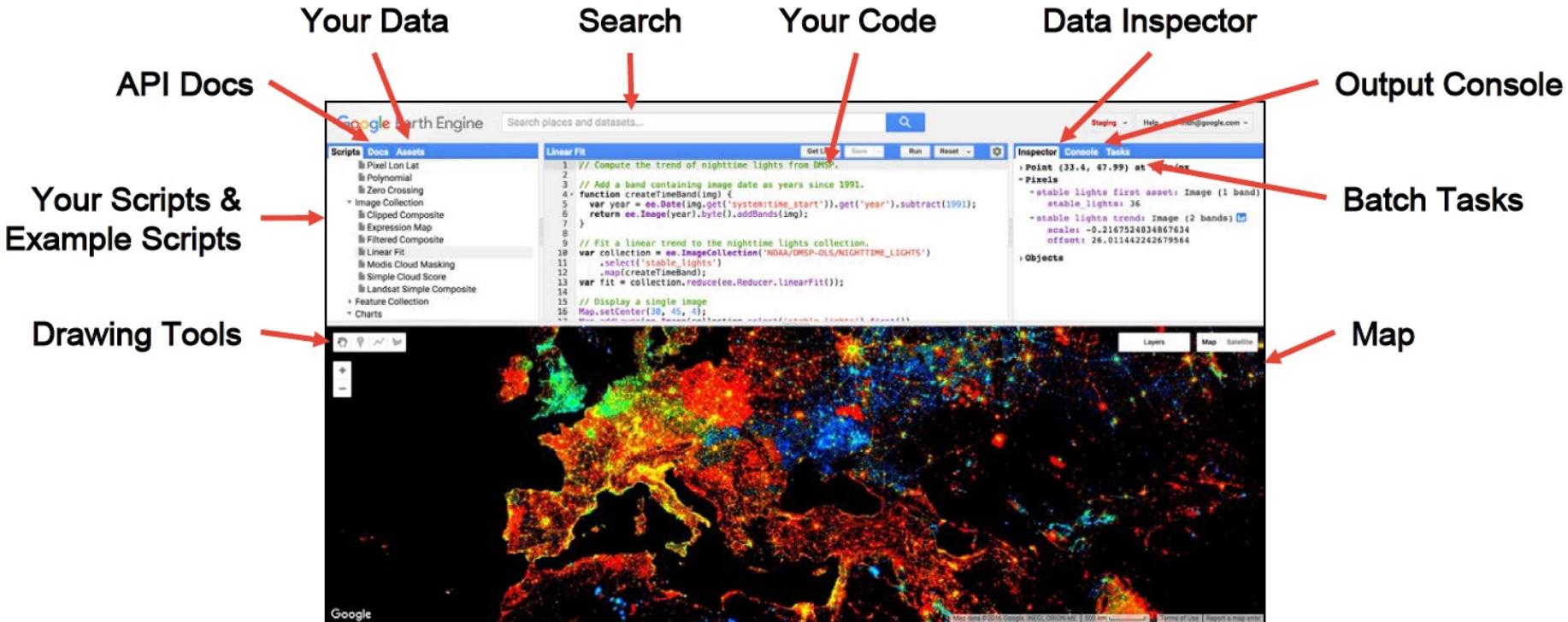
Sign Up

- Once you successfully complete the form, you will have the following screen.



The Earth Engine Code Editor

- <https://code.earthengine.google.com/>



Python API

- GEE also offers an API using Python that leverage the development of applications that do not fully depend on the Google infrastructure
- API solves some of the difficulties of using the browser based Code Editor

```
import ee

# Trigger the authentication flow.
ee.Authenticate()

# Initialize the library.
ee.Initialize()
```

- Check out: <https://developers.google.com/earth-engine/tutorials/community/intro-to-python-api-guiattard>

Python API

TABLE I: Some common syntax differences between *JavaScript* and *Python* (source *GEE* user guide).

Description	<i>JavaScript</i>	<i>Python</i>
Function definition	<code>function fun(){}</code>	<code>def fun():</code>
Variable definition	<code>var a = "value"</code>	<code>a = "value"</code>
Logical operators	<code>and()</code> <code>or()</code> <code>not()</code>	<code>And()</code> <code>Or()</code> <code>Not()</code>
Multi-line method chain	<code>fa() .fb() .fc();</code>	<code>fa()\\ .fb()\\ .fc()</code>
Dictionary keys	<code>{“key”: “value”} or {key: “value”}</code>	<code>{“key” : ”value”}</code>
Boolean	<code>true</code> <code>false</code>	<code>True</code> <code>False</code>
Null values	<code>null</code>	<code>None</code>
Comment	<code>\\"</code>	<code>#</code>

Processing

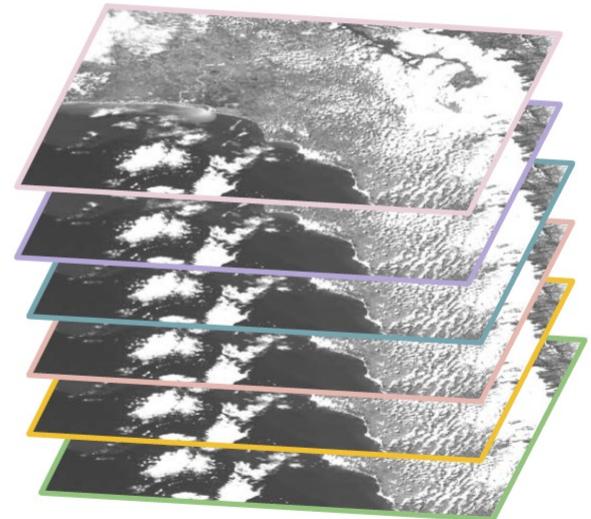
Data Types and Geospatial Processing Functions

- **Feature** - buffer, centroid, intersection, union, transform ...
- **Feature Collection** - aggregate, filter, flatten, merge, sort ...
- **Image** - band math, clip, convolution, neighborhood, selection ...
- **Image Collection** - map, aggregate, filter, mosaic, sort ...
- **Filter** - by bounds, within distance, date, day-of-year, metadata ...
- **Reducer** - mean, linearRegression, percentile, histogram ...
- **Join** - simple, inner, outer, inverted ...
- **Kernel** - square, circle, gaussian, sobel, kirsch ...
- **Machine Learning** - CART, random forests, bayes, SVM, kmeans, cobweb ...
- **Projection** - transform, translate, scale ...

over 1000 data types and operators, and growing!

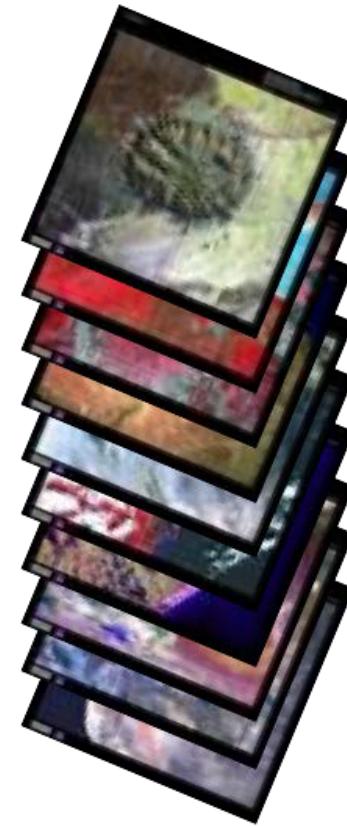
Data Models

- **Feature**
 - Line/Point/Polygon
- **Image**
 - Stack of Georeferenced bands
 - Each band has its own: Mask, Projection, Resolution
 - List of Properties: Date, Boundingbox,...



Data Models

- **Collection**
 - Bag of Elements
 - Table of Features
 - Directory of Images
 - Filter, Sort, Join, Map, Reduce



Map

Apply a function to each element of a collection

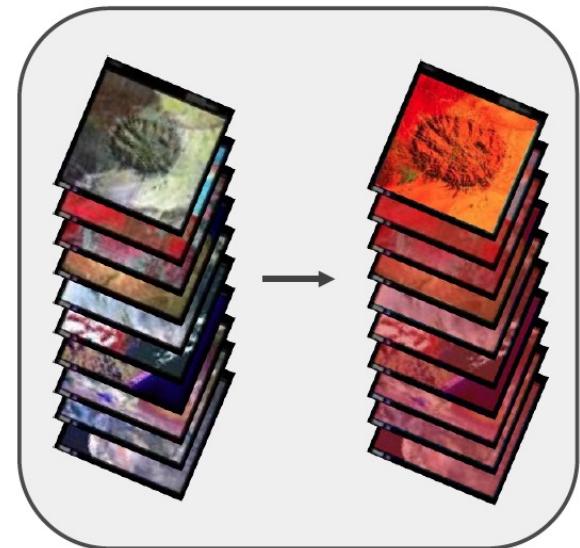
A "map" (for -each) operation

Examples

Compute area of each feature

Cloud cover of each image

Mosaic for each month



Reduce

Aggregate everything in a collection

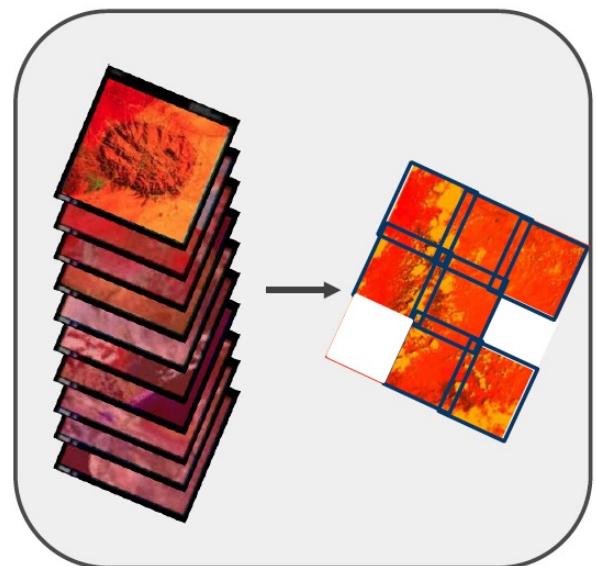
"Reduction"

Examples

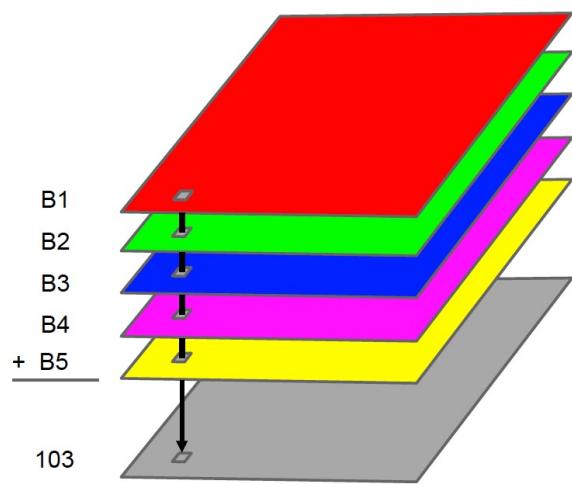
Summed area over all features

Median-pixel composite

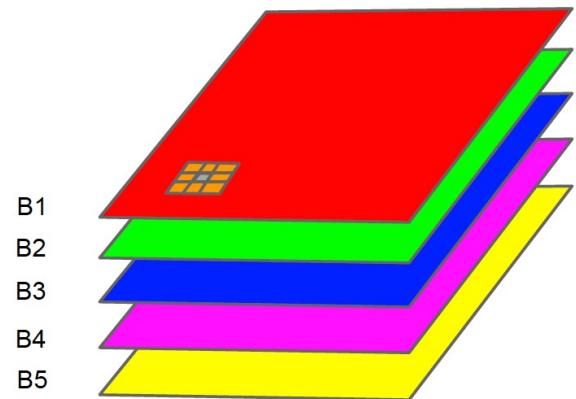
Train a classifier



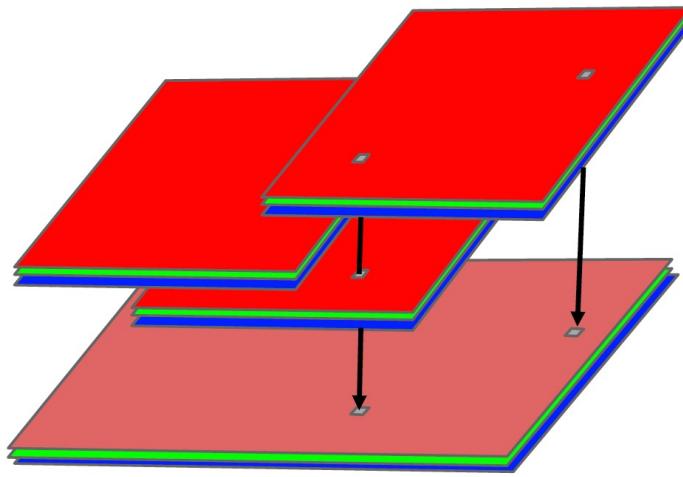
Reduce



Reduce Bands

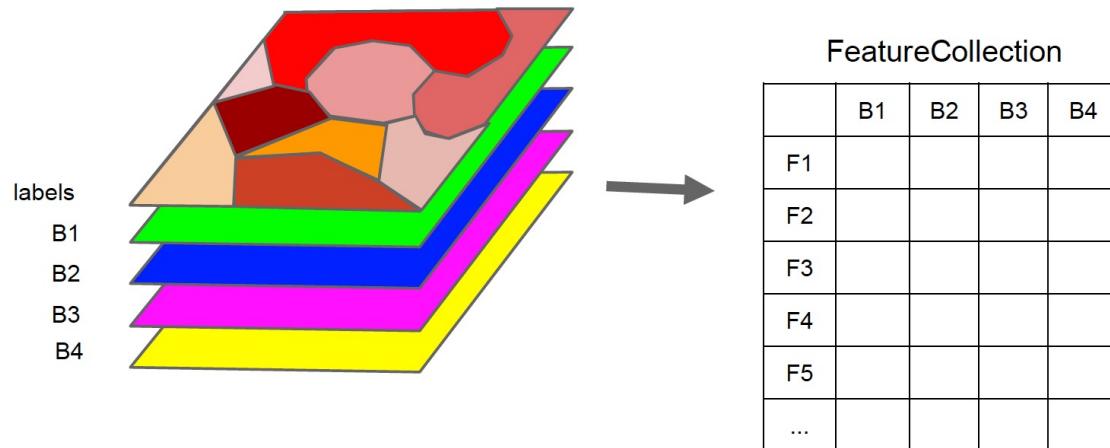


Reduce Neighborhood

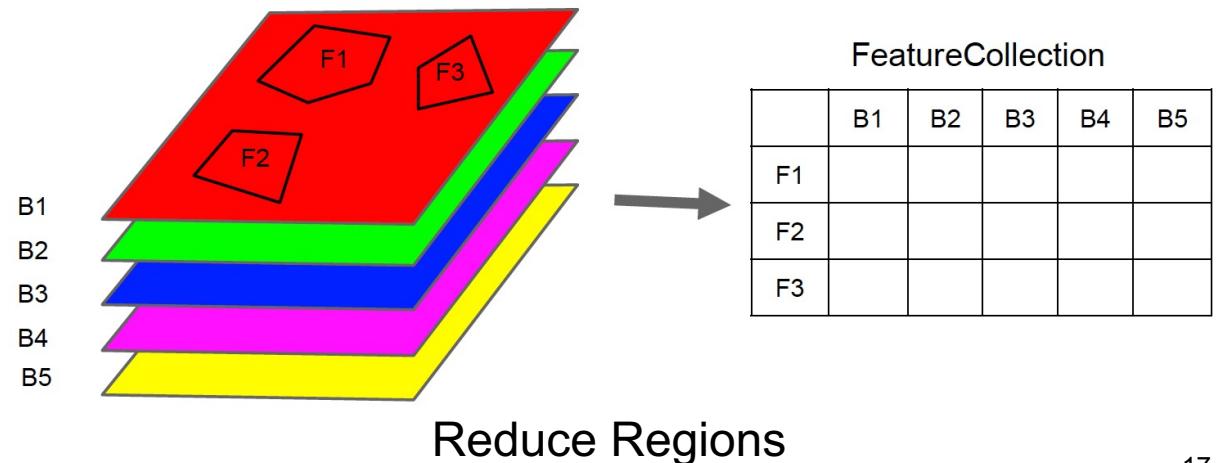


Reduce Image Collection

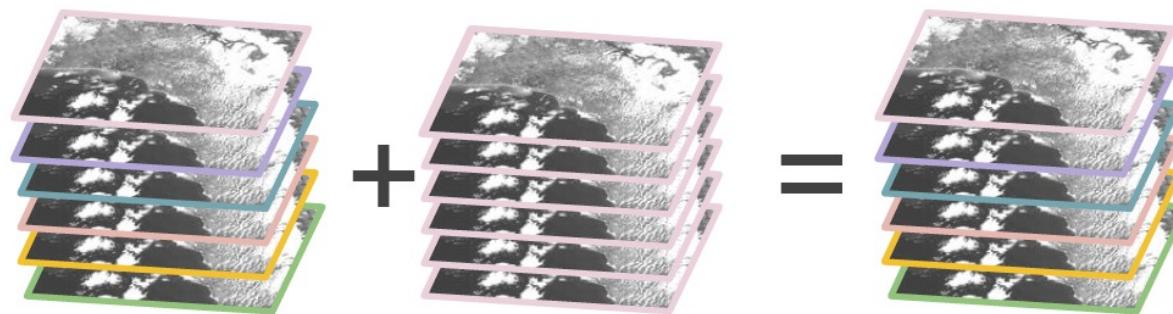
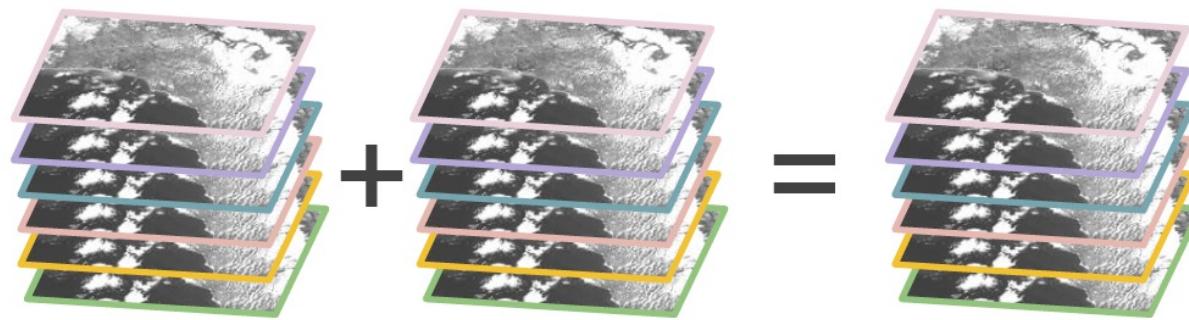
Reduce



Reduce To Vectors



Band Math



geemap

- It is a Python package for interactive mapping with Google Earth Engine.
- For utilizing the Python ecosystem of diverse libraries and tools to explore Google Earth Engine.
- Free software: MIT license
- 360+ GEE notebook examples
- 50+ GEE Tutorials on YouTube

The image shows two screenshots side-by-side. On the left is a screenshot of the geemap.org website, featuring a navigation bar with links like Home, Installation, Get Started, Usage, Cheat Sheet, and Geemap Tutorials. The main content area is titled 'Welcome to geemap' and describes it as 'A Python package for interactive mapping with Google Earth Engine, ipyleaflet, and ipywidgets.' On the right is a screenshot of a YouTube channel page for 'geemap'. The channel has over 47,000 views and 59 videos. The top video is titled 'Google Earth Engine and geemap Python Tutorials' and has 131,020 views. Below it are five more tutorial videos, each starting with 'GEE Tutorial #'. The channel bio provides a detailed explanation of what geemap is and its purpose in the geospatial community.

<https://geemap.org>

geemap

Welcome to geemap

A Python package for interactive mapping with Google Earth Engine, ipyleaflet, and ipywidgets.

geemap

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Get Started
Usage
Cheat Sheet
Geemap Tutorials

Search

GitHub | 10.9.2 | 1.4x | 613

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YouTube Channel

YouTube

Search

PLAY ALL

Google Earth Engine and geemap Python Tutorials

59 videos • 47,532 views • Last updated on May 1, 2021

Introducing the geemap Python package for interactive mapping with Google Earth Engine and ipyleaflet. More information about the geemap package can be found at <https://geemap.org>

Subscriptions

Quisheng Wu

SUBSCRIBE

1 Google Earth Engine and geemap workshop at GeoPython Conference 2021 1:31:02 Quisheng Wu

2 GEE Tutorial #0 - New website for geemap user guide and API reference 0:31 Quisheng Wu

3 GEE Tutorial #1 - Introducing the geemap Python package for interactive mapping with Earth Engine 0:24 Quisheng Wu

4 GEE Tutorial #2 - Using basemaps in geemap and ipyleaflet for interactive mapping with Earth Engine 12:14 Quisheng Wu

5 GEE Tutorial #3 - Introducing the Inspector tool for Earth Engine Python API 6:23 Quisheng Wu

6 GEE Tutorial #4 - Creating a split-panel map for visualizing Earth Engine data 8:20 Quisheng Wu

3-forge/geemap
hub.com/giswqs/earthengine-py-notebooks
youtube.com/c/QuishengWu

mapping with Google Earth Engine (GEE), which is a te catalog of satellite imagery and geospatial become very popular in the geospatial community tal applications at local, regional, and global scales. s for making computational requests to the Earth nside documentation and interactive IDE (i.e., GEE t API, the GEE Python API has relatively little sualizing results interactively. The geemap Python upon ipyleaflet and ipywidgets, and enables users s interactively within a Jupyter-based environment.

Reference paper

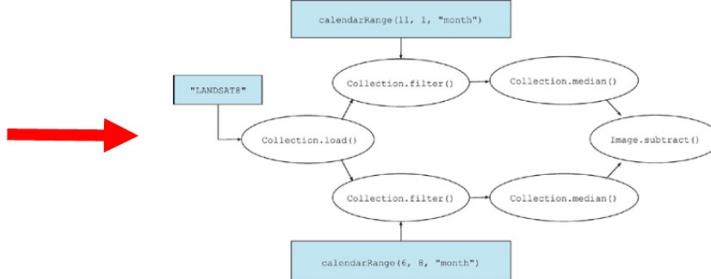


Google Earth Engine: Planetary-scale geospatial analysis for everyone

Noel Gorelick ^{a,*}, Matt Hancher ^b, Mike Dixon ^b, Simon Ilyushchenko ^b, David Thau ^b, Rebecca Moore ^b

<https://www.sciencedirect.com/science/article/pii/S0034425717302900>

```
collection = ee.ImageCollection("LANDSAT8")
winter = collection.filter(ee.Filter.calendarRange(11, 1, "month"))
summer = collection.filter(ee.Filter.calendarRange(6, 8, "month"))
diff = summer.median().subtract(winter.median())
```



[HTML] Google Earth Engine: Planetary-scale geospatial analysis for everyone

N Gorelick, M Hancher, M Dixon, S Ilyushchenko... - *Remote sensing of ...*, 2017 - Elsevier

Abstract **Google Earth Engine** is a cloud-based platform for **planetary-scale** geospatial analysis that brings **Google's** massive computational capabilities to bear on a variety of high-impact societal issues including deforestation, drought, disaster, disease, food security ...

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