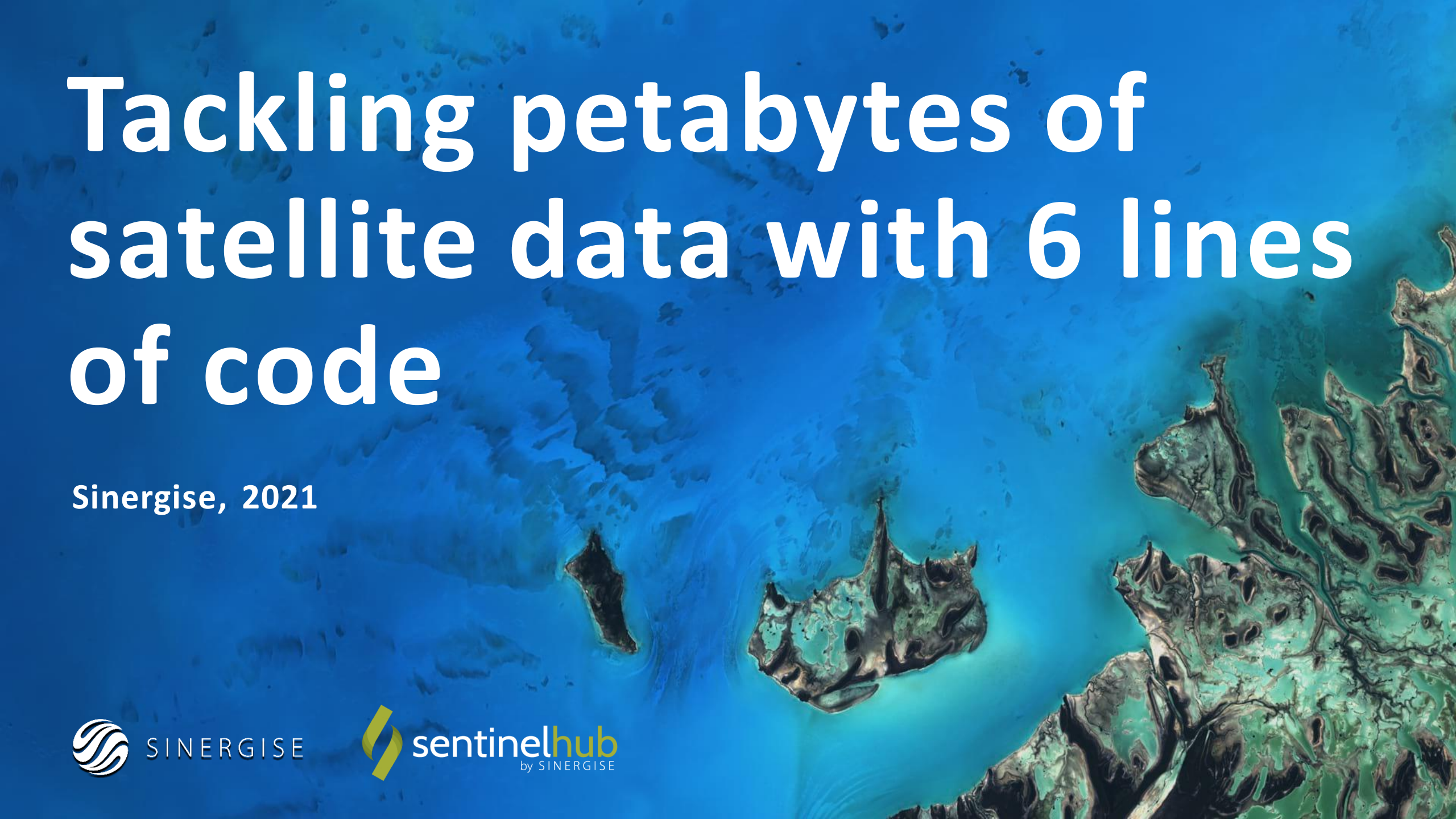
Tackling petabytes of satellite data with 6 lines of code

Sinergise, 2021



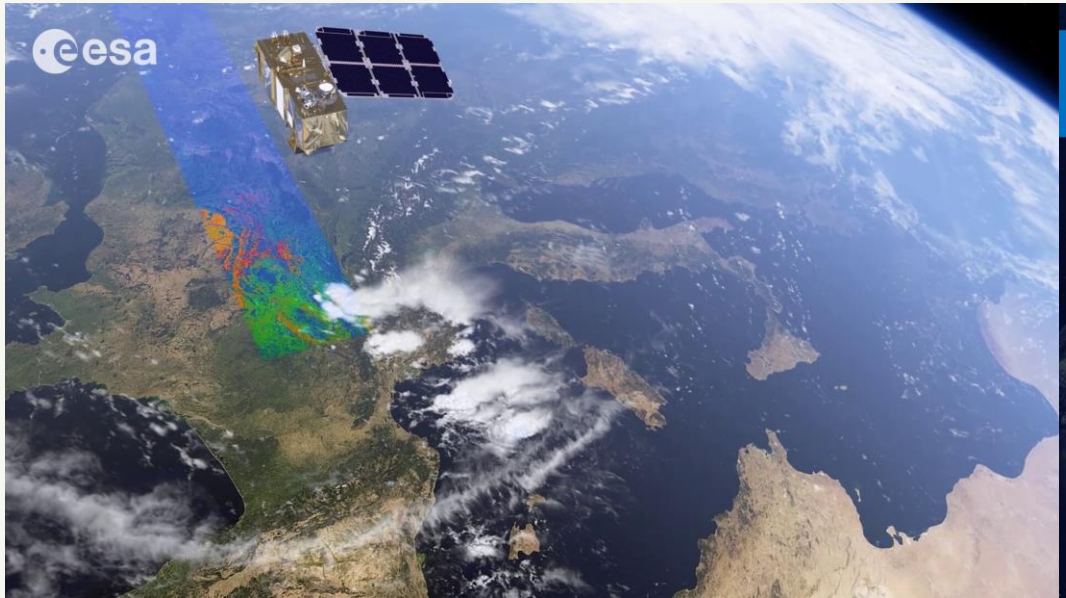
SINERGISE

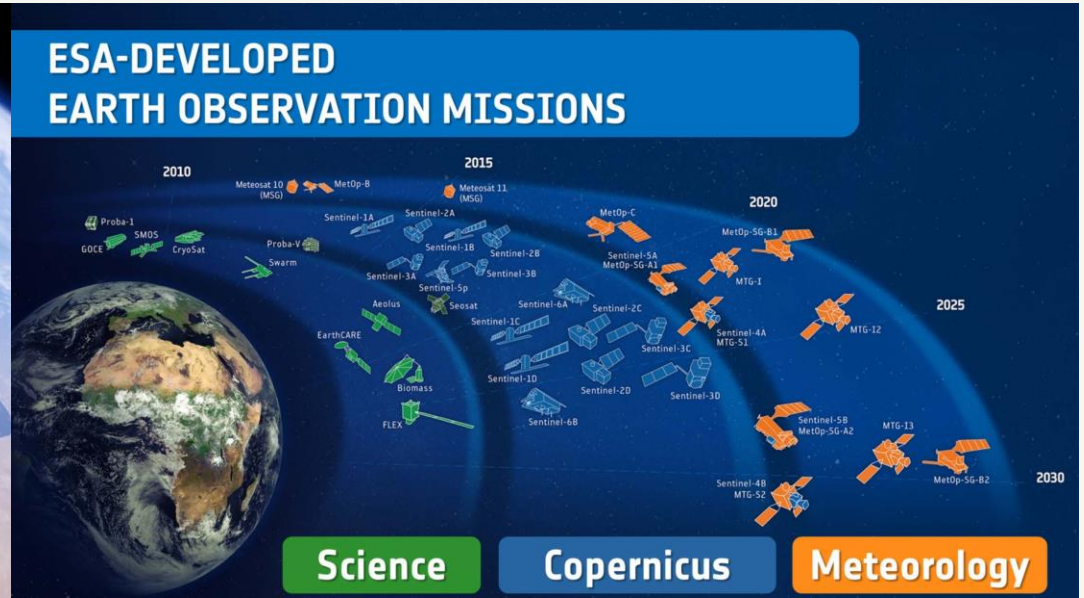
sentinelhub by SINERGISE

Earth observation & satellite imagery

Earth observation (EO) is the **gathering of information** about the physical, chemical, and biological systems of the planet **via remote-sensing technologies**, ... (Wikipedia)

Satellite imagery (also **Earth observation imagery**, **spaceborne photography**, or simply **satellite photo**) are images of Earth collected by imaging satellites ... (Wikipedia)





Sentinel Hub™ (sentinel-hub.com)

Q: How to allow users to seamlessly and reliably access and use > 2 PB of data?
A: With Sentinel Hub™!

What is it: World-first engine for archiving, processing and distribution of Sentinel / EO data which allows users to query global archive and produce resulting data in a matter of seconds.

In short: Group of APIs from which satellite data and images can be requested

Used by:
- web applications: Playground™, EO Browser™, BlueDot Water observatory, Digital Twin of News, …
- data science tasks: scene classification, land cover classification, cloud detection, landslide detection, parcel boundary detection, … (a lot more on our blog)

Web applications using Sentinel Hub

Sentinel Playground™	Simple GUI to navigate Sentinel-2 archive and play with spectral bands. Source code available on Github.
EO Browser™	Advanced browser for accessing complete archives of Sentinel-1,-2,-3, ESA's archive of LANDSAT-5,-7,-8, LANDSAT 8 USGS, Envisat Meris, MODIS, Proba-V and GIBS. Features advanced functionalities such as layer configuration, time-lapses and statistical analysis. Source code available on Github.
BlueDot	App for monitoring water bodies (lakes, rivers, ...) for floods and droughts. It uses ML and Sentinel-2 imagery.
Digital Twin of News	Demonstration of a fusion of multi-lingual news data, Earth observation imagery, machine learning, and remote sensing techniques, which can provide important context and an interactive experience.
Requests builder	App to help developers easily create requests for Sentinel Hub APIs.

Data

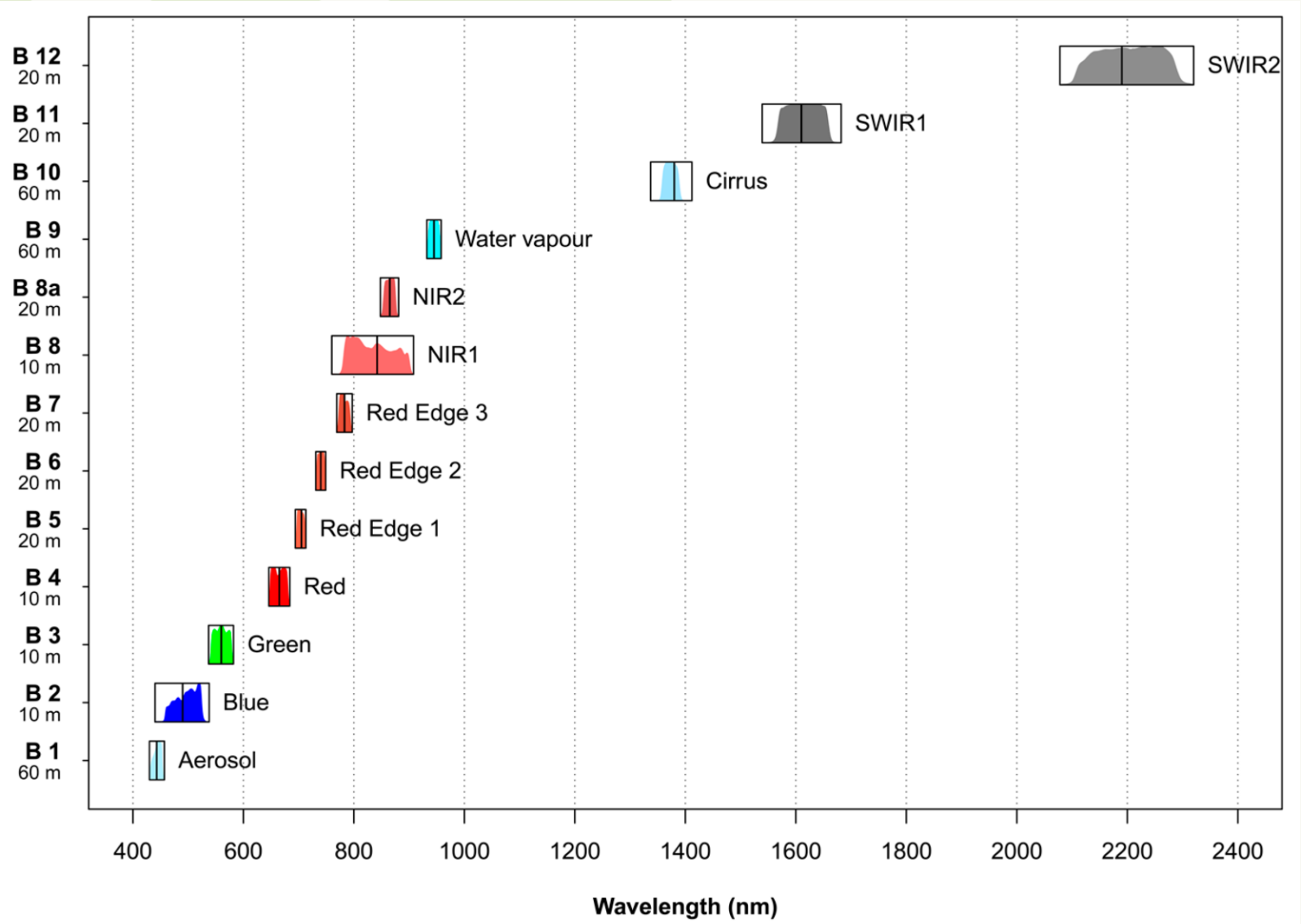
- Satellites (Sentinel-1, Sentinel-2, Sentinel-3, ...)
- Each satellite captures data in multiple bands (parts of light wavelengths)
- Each satellite captures data over some area on some date

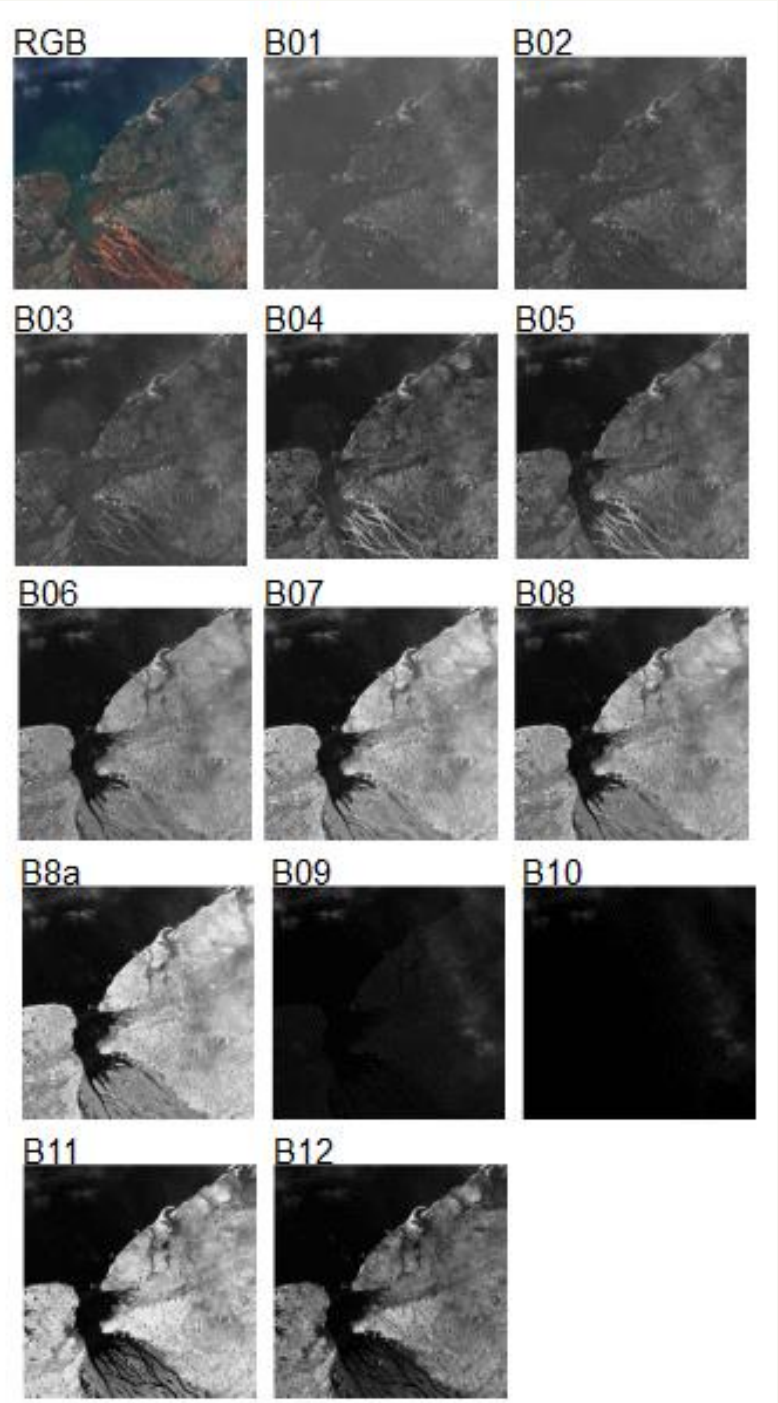
Users define which bands from which satellites are used and how with scripts.

Most common scripts (e.g. the most natural-looking visualization – true color) are available in SH Dashboard. Others are in Custom script repository. You can also write your own.

End result can be an image (visualization) or ”raw data” that can be used as an input for another algorithm.

Light wavelength - bands



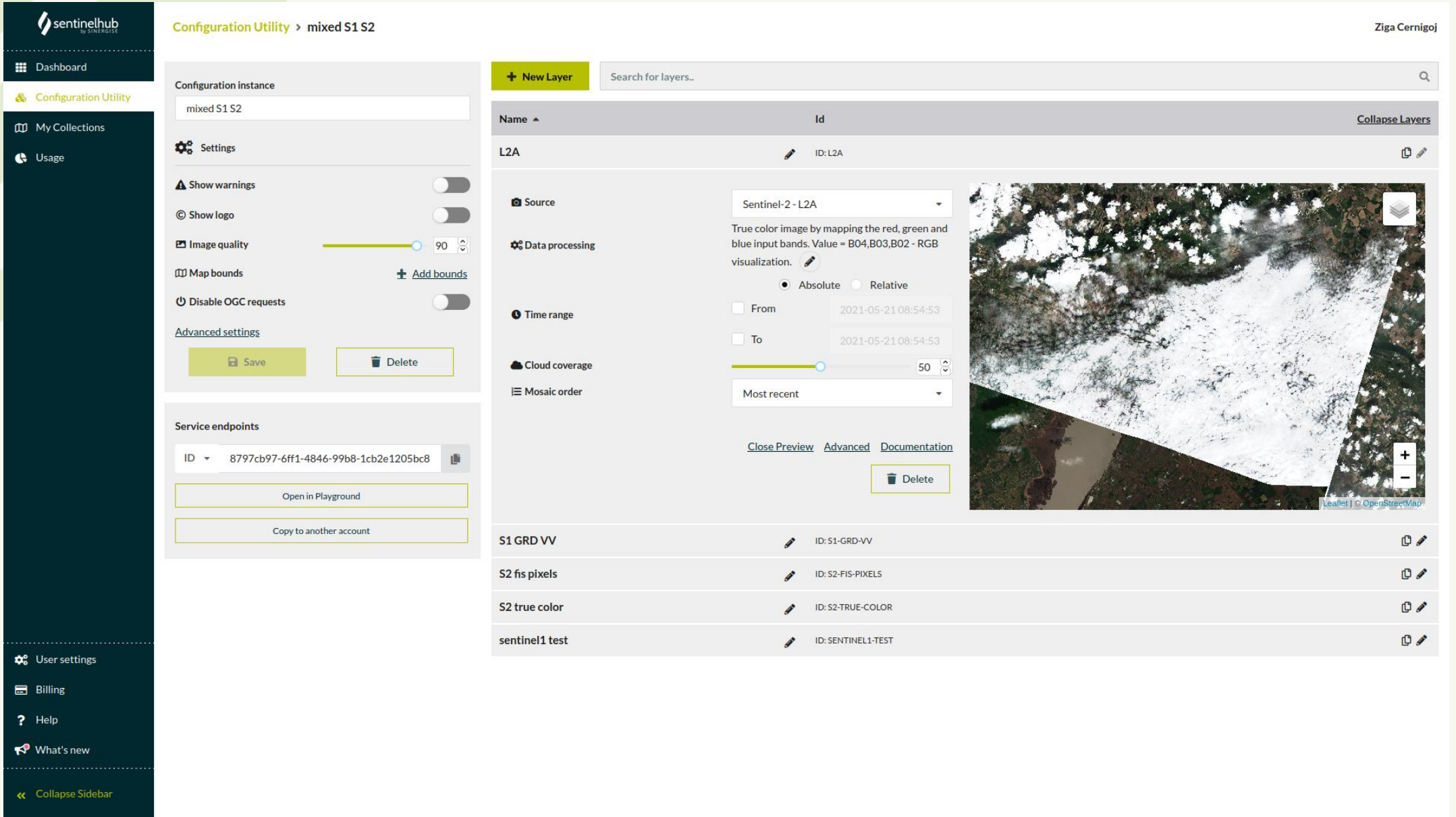


How to use Sentinel Hub

- Create a Sentinel Hub account
- OGC API (old, does not need authentication, has limitations)
  - Create a configuration instance in the Dashboard
  - Add layers to the instance (use predefined or custom scripts)
- Catalog, Process, Statistical APIs
  - Create OAuth client in the Dashboard (docs)
  - Use APIs to get the data (general info, images, statistical data)
- Ease up the work with `sentinelhub-py` or `sentinelhub-js` libraries

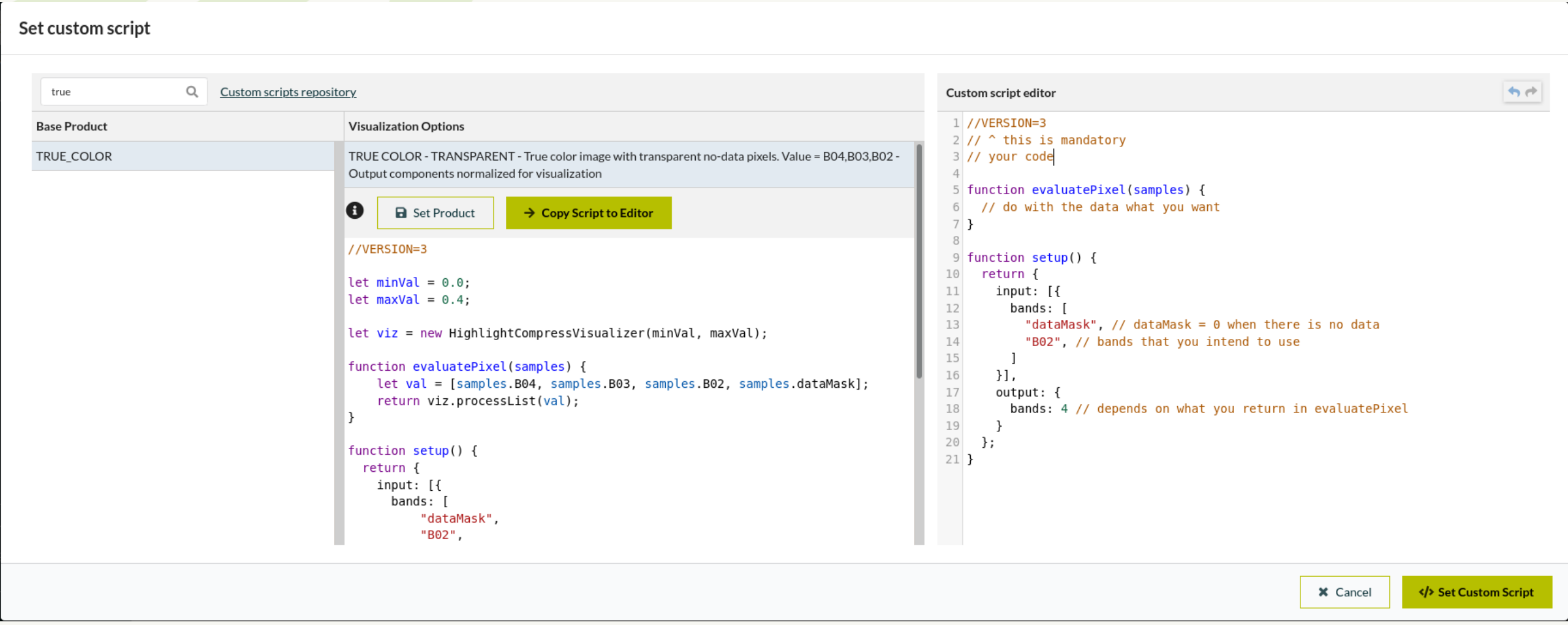
Create a configuration instance

Dashboard explained [here]



Create a layer

Set a predefined product or custom script to the layer.



Evalscript

Evalscripts work per pixel, meaning the code in the script runs for every pixel (if a requested image is 512 * 512 pixels big, it will execute 512 * 512 times)

Evalscript must contain 2 functions: `setup` and `evaluatePixel`

All about evalscript here

```
//VERSION=3
function setup() { // specifies inputs and outputs
  return {
    input: ["B02", "B03", "B04"], // input bands
      // (from the collection of bands for the selected satellite)
    output: { bands: 3 } // number of output bands (3 for JPG/PNG image - R,G,B)
  };
}
function evaluatePixel(sample) { // calculates the output values for each pixel
  // sample holds values for bands that are defined in setup()
  return [2.5 * sample.B04, 2.5 * sample.B03, 2.5 * sample.B02];
}
```

Simplifying the work

- Documentation for OGC API, Processing API and other APIs.
- Application Requests builder can help you build the correct requests or debug requests that are failing. Interactive examples for creating request are available here.
- Python (`sentinelhub-py`, `eo-learn`) libraries to ease work with SH and ML algorithms
- JavaScript (`sentinelhub-js`) library for frontend apps
- Custom scripts can be tested in Requests builder, Playground™, EO Browser™

Javascript examples

- Sentinel Hub Process API, Catalog API and Leaflet.js
- Sentinel Hub WMTS API and OpenLayers
- Sentinel Hub WMS and Leaflet.js example can be created in Playground, if opened from the Dashboard

Javascript example for authentication

```
async function getAuthToken() {
  const cID = encodeURIComponent(CLIENT_ID); // keep CLIENT_ID private
  const cS = encodeURIComponent(CLIENT_SECRET); // keep CLIENT_SECRET private

  const response = await fetch(
    "https://services.sentinel-hub.com/oauth/token",
    {
      method: "post",
      headers: { "Content-Type": "application/x-www-form-urlencoded" },
      body: 'grant_type=client_credentials&client_id=' + cID + '&client_secret=' + cS,
    }
  );

  const body = await response.json();
  return body["access_token"];
}

window.onload = async (event) => {
  // for example - get a token when the page is loaded
  token = await getAuthToken();
  console.log("token:", token);
};
```

Javascript example for Catalog API

```
let payload = {
  "bbox": [36, 38, 37, 39], // EPSG:3857 or EPSG:4326
  "datetime": "2021-01-01T00:00:00Z/2021-03-29T23:59:59Z", // ISO 8601
  "collections": ["sentinel-2-l1c"], // ids are in the documentation
  "limit": 50,
  "distinct": "date", // remove to get all info, not only the dates
};
let moreResults = true;
let allDates = [];

while (moreResults) {
  const response = await fetch("https://services.sentinel-hub.com/api/v1/catalog/search", {
    method: "post",
    headers: {
      Authorization: "Bearer " + authToken,
      "Content-Type": "application/json",
      Accept: "*/*",
    },
    body: JSON.stringify(payload),
  });

  const data = await response.json();
  if (data.context.next) {
    moreResults = true;
    payload.next = data.context.next;
  } else {
    moreResults = false;
  }
  // Dates are returned in the 'features' part of the response.
  // They are ordered from the oldest to the newest date.
  allDates.push(...data.features);
}
```

Sentinelhub-js

- `sentinelhub-js` is a JavaScript library that simplifies getting the data from Sentinel Hub in Javascript environment.
  - Available on npm. Documentation is available here.
  - Storybook examples showcasing some example usages are available in the repo when cloning from Github.
- Currently no simple way to use it in Javascript without using npm to install it.

Sentinelhub-py and eolearn

- `sentinelhub-py` is a Python library that provides Python wrappers around the WMS/WCS services for image processing within the Python environment.
  - Available through PyPI or on our Github repo. Documentation is available here.
  - Jupyter notebooks showcasing some example usages are available in the documentation and in example-notebooks repo on Github.
- `eo-learn` is a Python library developed on top of `sentinelhub-py` for preparing the data for machine learning
- After getting the imaging data, apply machine learning Python libraries (e.g. scikit-learn, TensorFlow) to it for classification/regression/clustering tasks.

Use cases

- Agriculture (determine when the crops are ready for harvest, which part of the field needs more fertilizer, …)
- Land change detection (detect deforestation, expansion of urban areas, …)
- Water resource monitoring (monitor water levels and predict water shortages, droughts, …)
- Disaster management (assess extent of wildfires, floods, earthquakes, volcano eruptions, tsunamis, landslides, … and plan solutions)
- Journalism, media (objective reporting on the events, disasters, …)
- Insurance industry (assess extent of the damage, risk level, …)
- Your idea …

Some real-life applications are listed on Sentinel Hub website

Ideas

Remote sensing ideas

- Precision farming applications
- Iceberg tracking for maritime route planning
- Landslides, floods, droughts monitoring (example)
- Change detection, e.g. wildfires, deforestation
- Enhancing images (example)
- Visualizations of travel data
- Predict when to go to holidays where (enough snow for skiing, big waves for surfing)

Resources 1/2

- Creating configurations and layers and defining data processing
- Creating WMS, WMTS and other requests
- Creating Processing API requests
- Using custom scripts
- Sentinelhub-py docs
- Sentinelhub-js docs
- Our Github

Resources 2/2

- Sentinel Hub (website)
- our Github
- Documentation (starting point)
- Youtube channel
- Medium blog posts (in-depth explanations, some code examples)
- Forum
- Faq page
- Twitter account
- Educational EO stuff (educational articles about Earth, EO, etc)
- ESA Copernicus
- Remotesensing indices

Thanks

Any questions?

Don't forget to also enjoy and have a great time.
The prize at the end is not the only important thing :)

Open positions