



# **Machine Learning in Remote Sensing**

## **MUSA 650**

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## Structure of the Course

The course will be a mixture of background theory and practical applications.

We will cover a wide range of topics, such as: remote sensing, satellite imaging, data analysis and representation, image analysis, feature extraction and dimensionality reduction, fundamentals of machine learning, model selection, cross validation, performance evaluation, unsupervised and supervised learning, and deep learning.

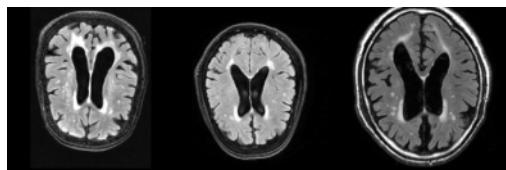
Practical examples will focus on illustrative machine learning applications using remote sensing data.

Assessment: Homeworks, term project and participation

# The Big Picture

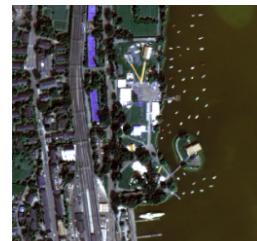
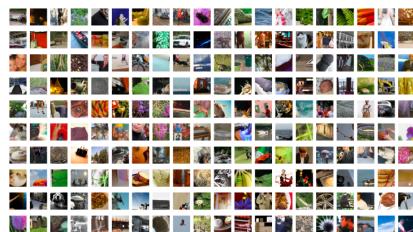
Large amount of **DATA** that requires automated processing to extract information !!!

Raw data

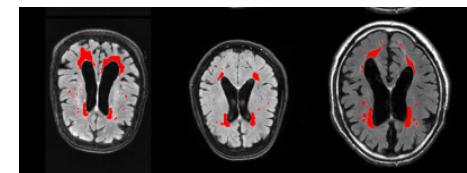


Voice  
signal

IMAGENET



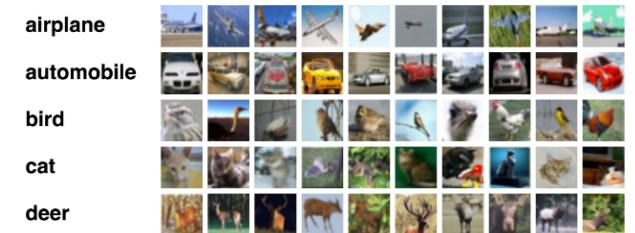
Information



Recognized  
Text



Suggestion /  
Action



# Lecture Plan

Introduction to remote sensing and satellite imaging

- Accessing satellite images;
- Visualization and analysis of multi-spectral data

Machine learning

- Basic concepts;

Machine learning in remote sensing

- Applications and case studies;
- Image segmentation, object detection, semantic segmentation

Deep learning

- Basic concepts;
- Convolutional neural networks, UNet

## Basic concepts

Remote sensing is the acquisition of the data remotely

Satellite imaging is the most common form of RS, but not only (aircraft, drones, etc...)

Applications of satellite imaging (commercial or non-commercial):

Land surface and usage;

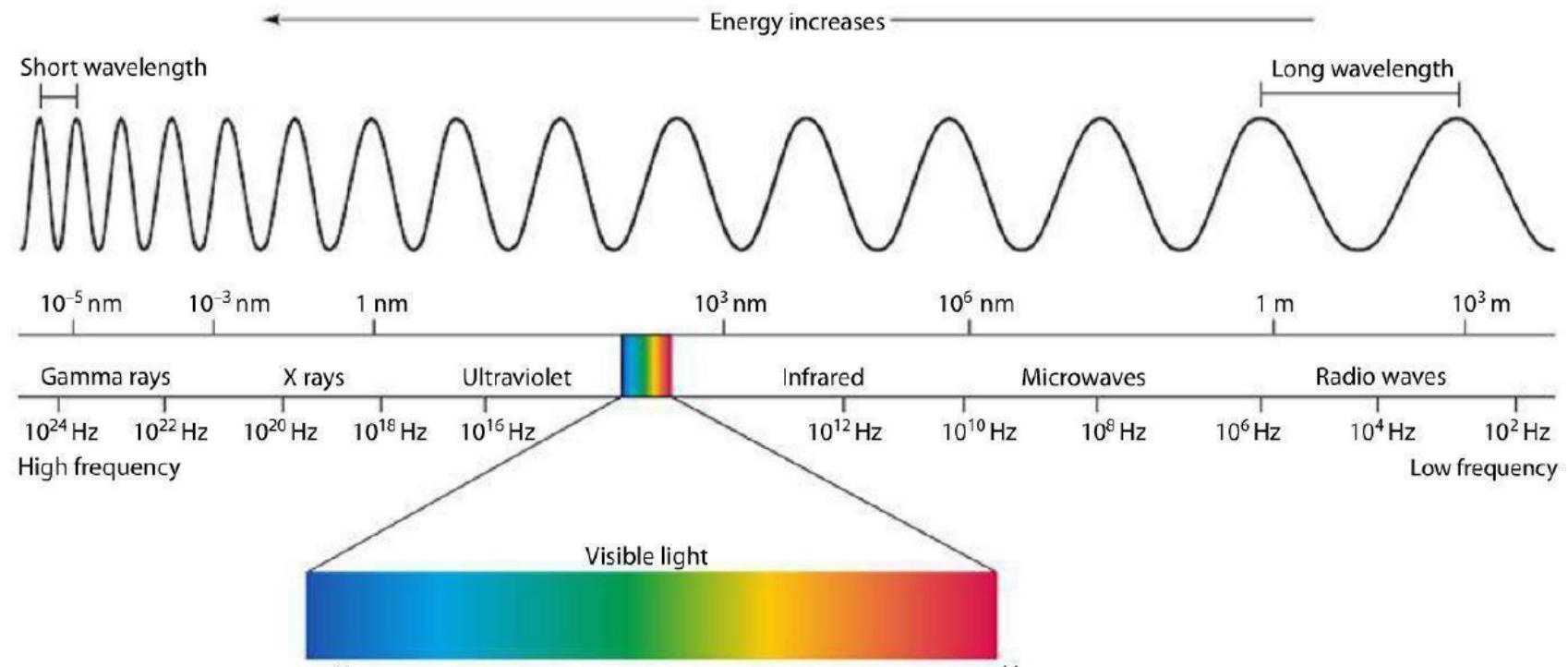
Climate research;

Weather, agricultural monitoring, city planning;

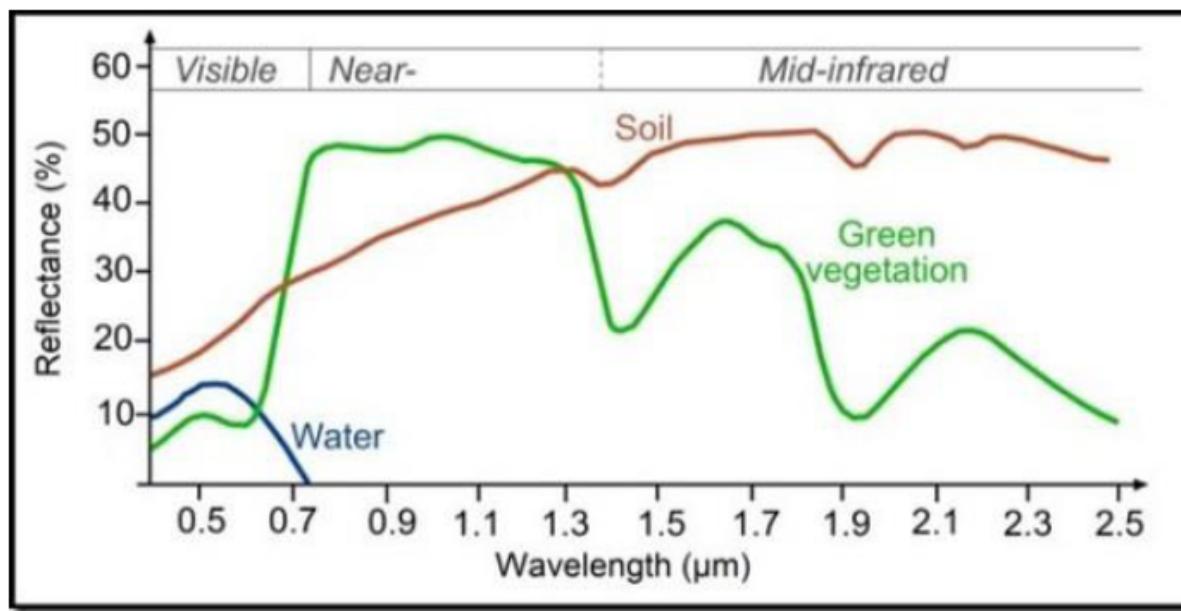
Disaster management

Important: The measurement is a surrogate variable  
(reflectance, brightness, temperature, etc.)

# Basic concepts: Electromagnetic Spectrum



## Basic Concepts: Spectral signatures of different objects



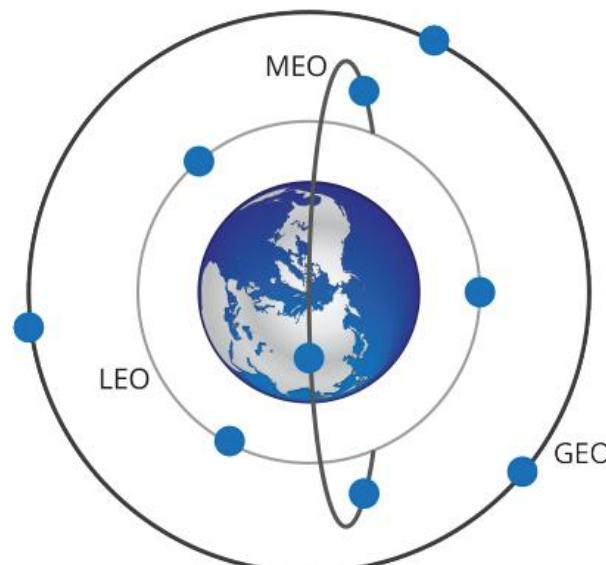
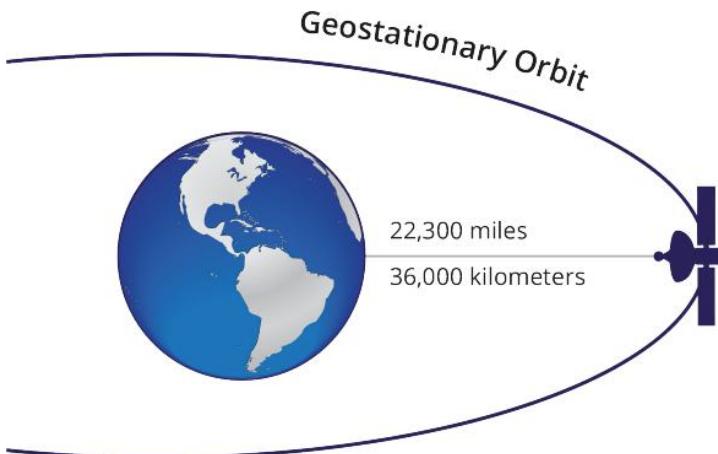
*Soil, water and green vegetation spectral signatures ([GrindGIS.com](http://GrindGIS.com))*

## Basic Concepts: Orbits

**Geostationary:**  
Fixed position to an earth-based observer

**Medium Earth Orbit:**  
Above low Earth orbit and below geostationary orbit.

**Low Earth Orbit:**  
Circular orbit about 400 to 900 kilometres above the earth's surface

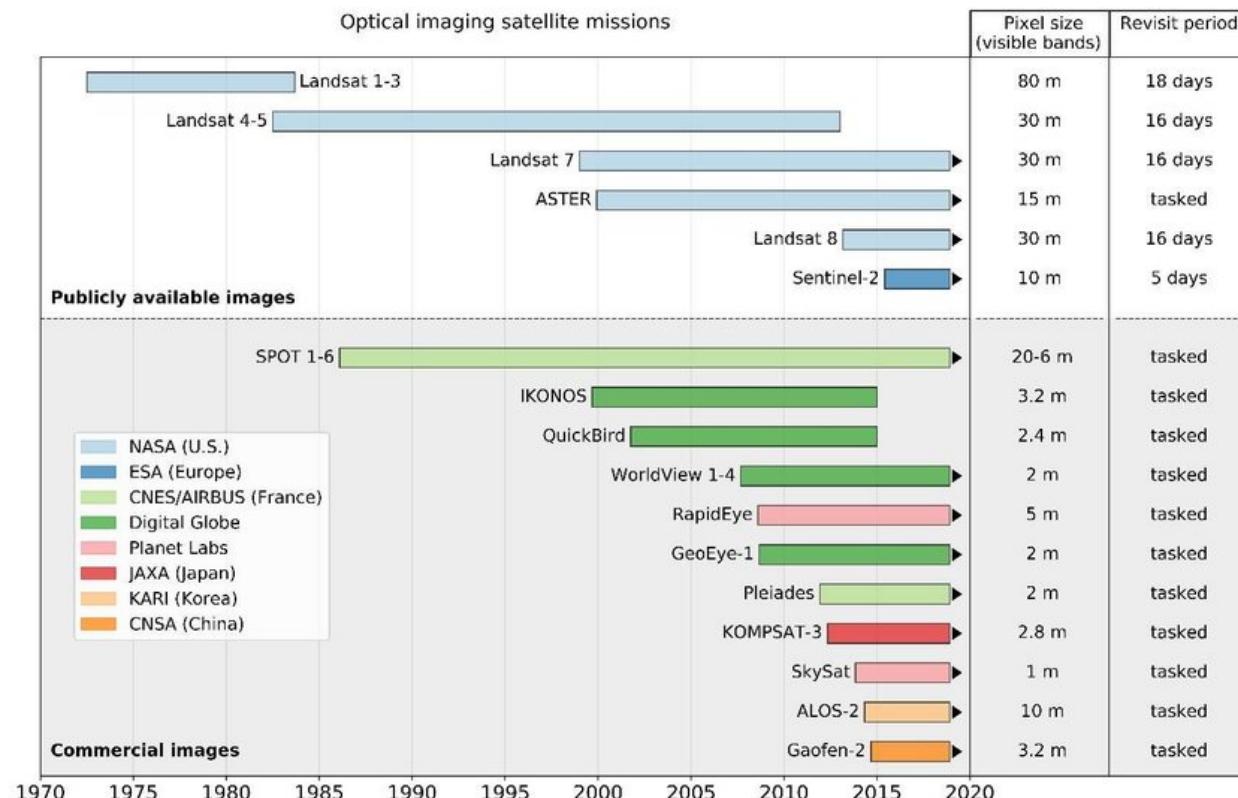


## Basic Concepts: Resolution

**Spatial:** 10cm to 100km

**Temporal:** Minutes to days

# Major programs



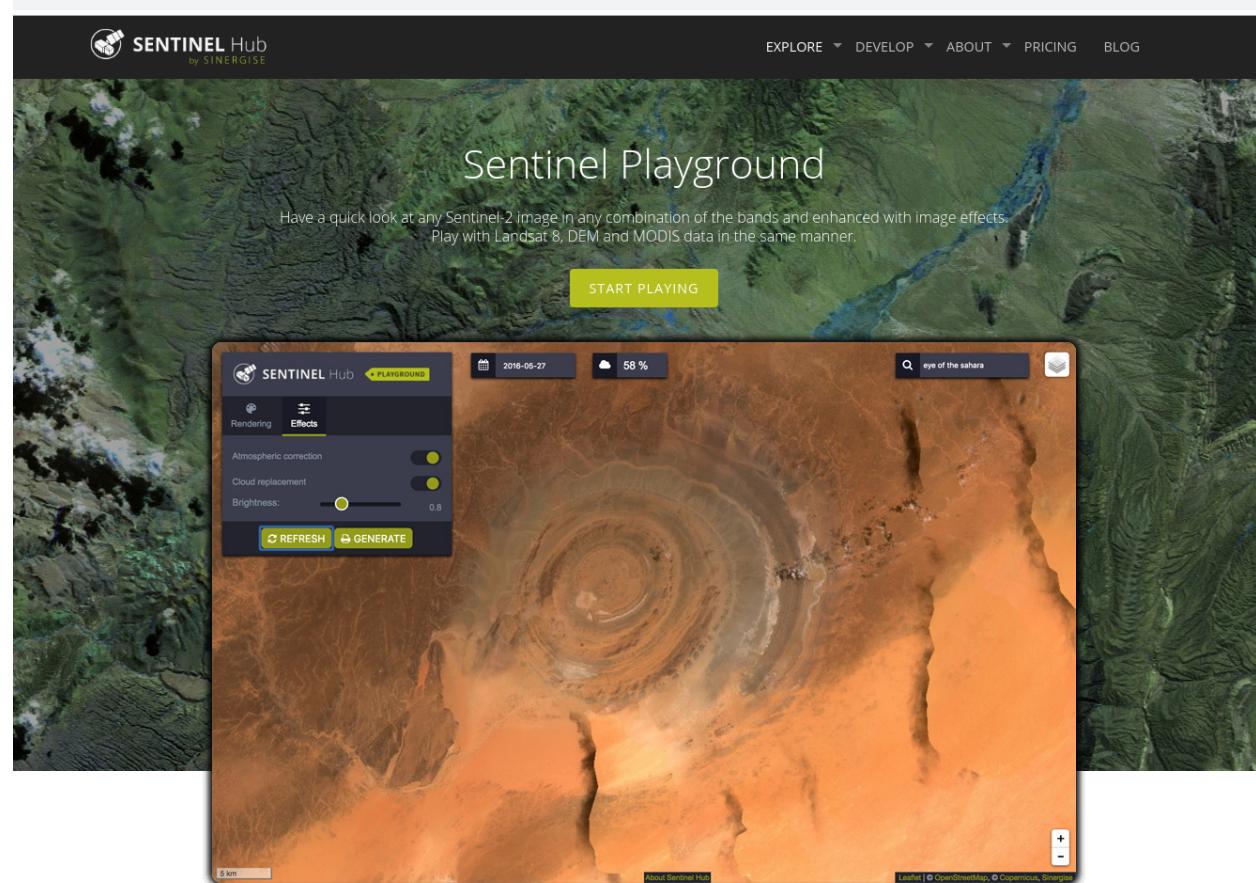
[https://www.researchgate.net/figure/Timeline-for-the-major-civilian-Earth-observation-satellites-operating-optical-imaging\\_fig1\\_332666408](https://www.researchgate.net/figure/Timeline-for-the-major-civilian-Earth-observation-satellites-operating-optical-imaging_fig1_332666408)

# Basic Concepts: Sentinel-2 bands

BAND		WAVELENGTH (min-max in micrometers)	SPATIAL RESOLUTION (meters) <sup>1</sup>
Band 1	Coastal Aerosol	0.421 – 0.457	60
Band 2	Blue	0.439 – 0.535	10
Band 3	Green	0.537 – 0.582	10
Band 4	Red	0.646 – 0.685	10
Band 5	Vegetation red edge	0.694 – 0.714	20
Band 6	Vegetation red edge	0.731 – 0.749	20
Band 7	Vegetation red edge	0.768 – 0.796	20
Band 8	NIR (near infrared)	0.767 – 0.908	10
Band 8a	NIR (near infrared)	0.848 – 0.881	20
Band 9	Narrow NIR	0.931 – 0.958	60
Band 10	Cirrus	1.338 – 1.414	60
Band 11	SWIR (Short wave infrared)	1.539 – 1.681	20
Band 12	SWIR (Short wave infrared)	2.072 – 2.312	20

<https://www.sentinel-hub.com/explore/education/custom-scripts-tutorial>

# Applications: Sentinel Playground



**Link :** [https://github.com/MUSA-650-Spring-2020/Week1/blob/master/w1\\_practice.ipynb](https://github.com/MUSA-650-Spring-2020/Week1/blob/master/w1_practice.ipynb)