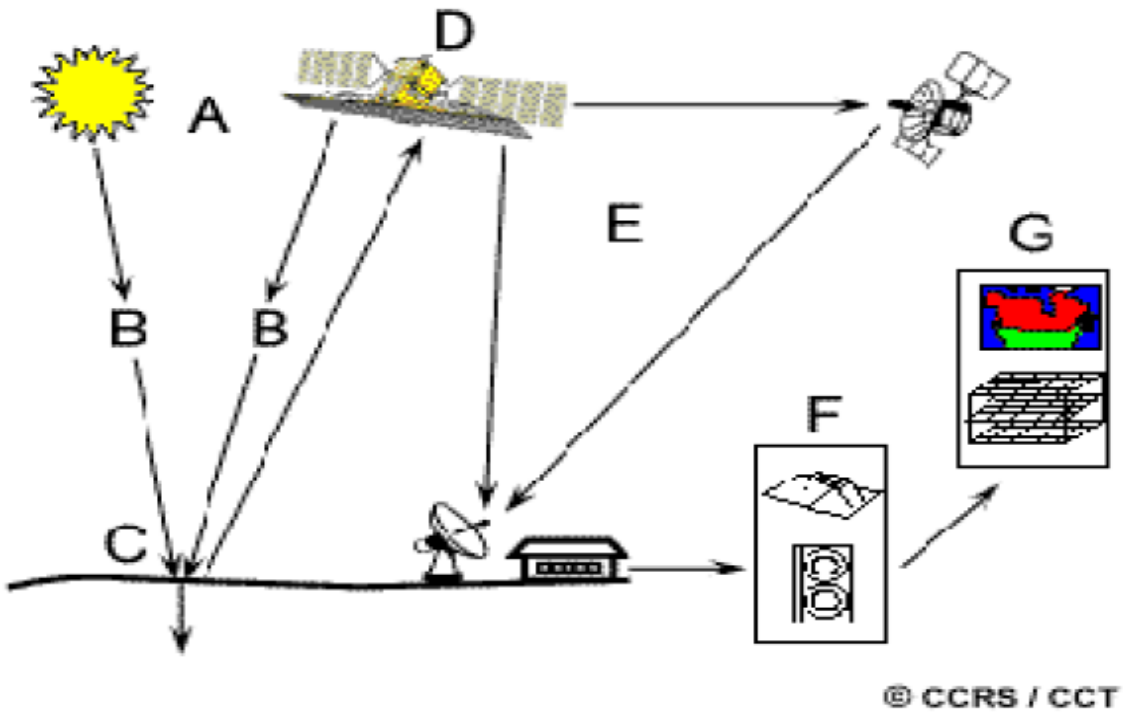
What is Remote Sensing?

"Remote sensing is the science (and to some extent, art) of acquiring information about the Earth's surface without actually being in contact with it. This is done by sensing and recording reflected or emitted energy and processing, analyzing, and applying that information."



1. Energy Source or Illumination (A) - the first requirement for remote sensing is to have an energy source which illuminates or provides electromagnetic energy to the target of interest.

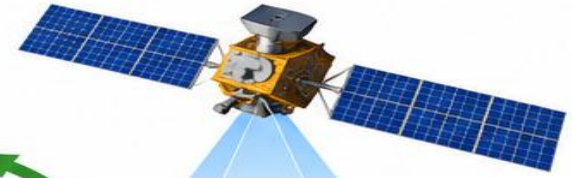
2. Radiation and the Atmosphere (B) - as the energy travels from its source to the target, it will come in contact with and interact with the atmosphere it passes through. This interaction may take place a second time as the energy travels from the target to the sensor.

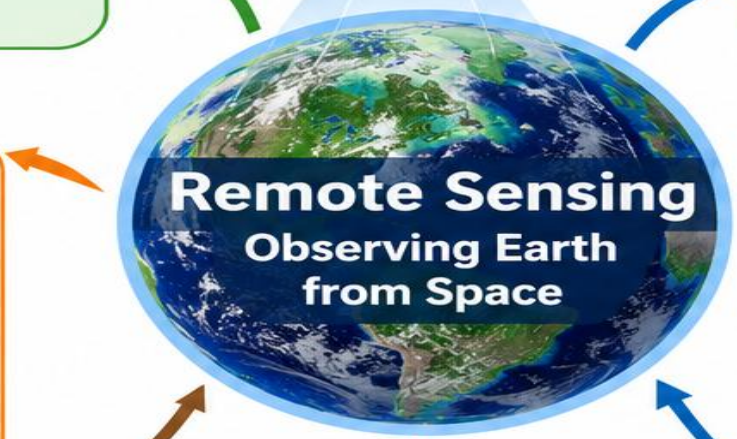
Remote Sensing

Observing Earth from Space

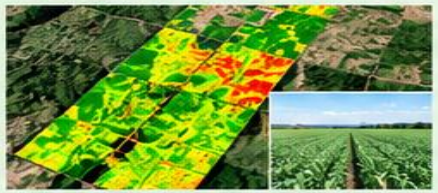
Satellites + Sensors

Capture • Process • Analyze • Apply



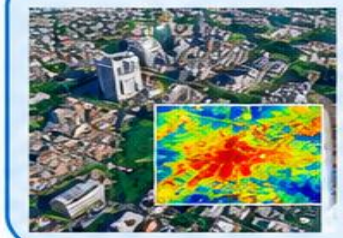


Agriculture



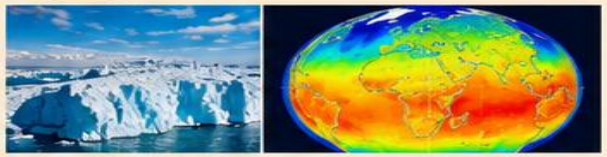
- Crop monitoring
- Yield estimation
- Soil health
- Irrigation management
- Pest & disease detection

Urban



- Land use / land cover
- Urban growth
- Infrastructure monitoring
- Heat island analysis
- Disaster response

Climate Change



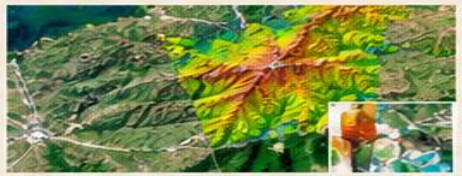
- Temperature trend
- Greenhouse gas monitoring
- Sea level rise
- Extreme weather
- Carbon cycle

Environment



- Ecosystem monitoring
- Biodiversity assessment
- Pollution tracking
- Forest health
- Habitat mapping

Land



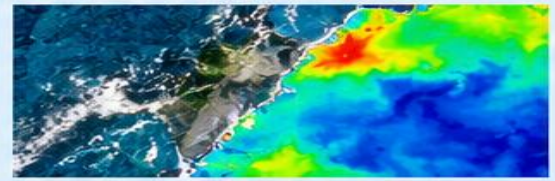
- Topography / DEM
- Geological mapping
- Soil moisture
- Land degradation
- Mineral resources

Water



- Water quality
- Water quantity
- Flood monitoring
- Drought assessment
- Watershed management

Marine Environment



- Sea surface temperature
- Marine ecosystems
- Fishery resources
- Coastal zone monitoring
- Marine pollution

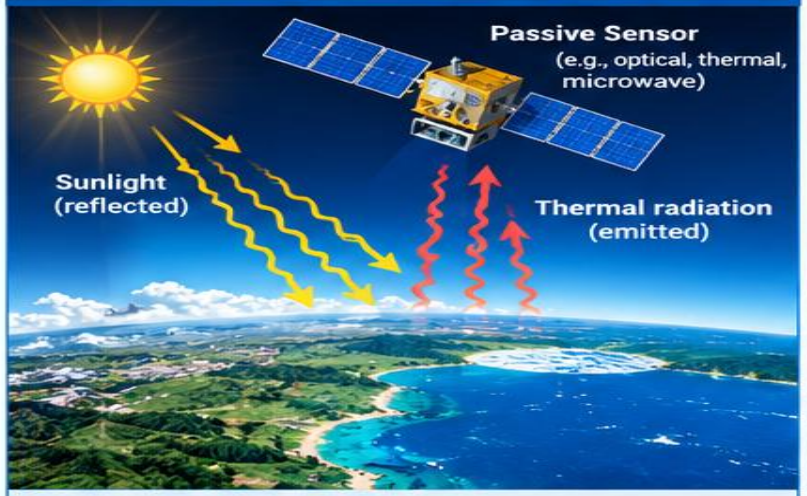
Better Information | **Smarter Decisions** | **Sustainable Development** | **A Healthier Planet**

Remote Sensing from Space

Different Sensors, Different Ways, Same Goal: Observe Our Earth

Passive Sensor

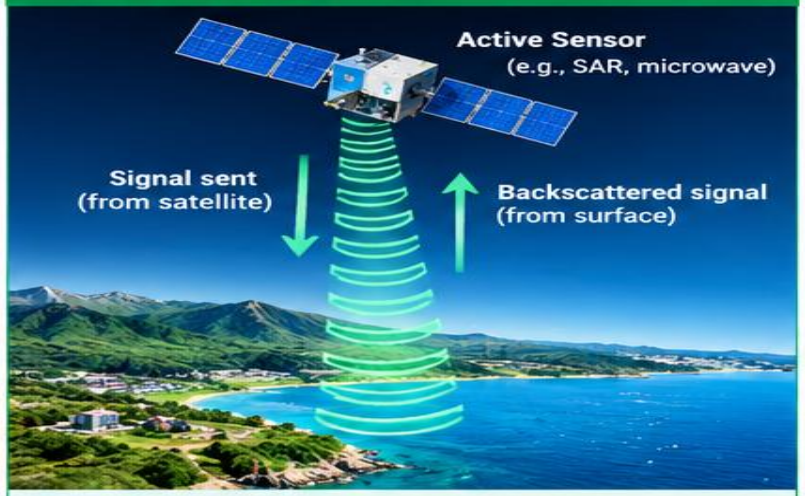
Detects natural radiation from the Earth



- Uses sunlight (reflected) or thermal radiation (emitted) from the Earth
- **Examples:** optical (visible/IR), thermal, microwave
- **Good for:** land cover, vegetation, sea surface temperature, temperature, etc.

Active Sensor

Sends its own signal and measures the return



- **Actively emits energy** (microwave, radar, etc.)
- Measures the reflected signal
- **Examples:** SAR (Synthetic Aperture Radar), microwave radar
- **Good for:** cloud-penetration, surface roughness, soil moisture, ocean waves, etc.

LiDAR

Measures distance using laser pulses



- Sends laser pulses and measures the time it takes for the signal to return
- Provides precise 3D information (elevation)
- **Examples:** spaceborne LiDAR (e.g., ICESat-2), airborne LiDAR
- **Good for:** topography, forest height, building structure, coastal bathymetry, etc.

Key Features at a Glance

Feature	Passive Sensor	Active Sensor	LiDAR
Energy source	Natural (sunlight / thermal)	Emitted by sensor (microwave/radar)	Emitted by sensor (laser)
How it works	Detects reflected/emitted radiation	Measures backscattered signal	Measures time-of-flight of laser pulses
Main data	Radiance / temperature	Backscatter intensity	Distance / 3D elevation
Best for	Land cover, vegetation, SST, temperature	Cloud-penetration, soil moisture, surface roughness, ocean waves	High-resolution topography, forest height, coastal bathymetry

From the sky to the ground, satellites give us a clearer picture of our planet.

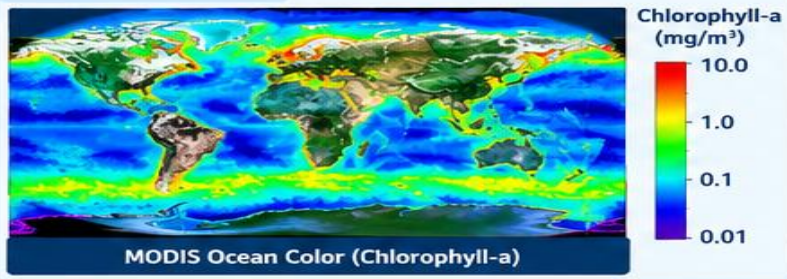
Satellite Sensors for Ocean Observation

NOAA MODIS | Landsat | Ocean Colour

NOAA MODIS
(Moderate Resolution Imaging Spectroradiometer)



Agency	NOAA / NASA
Spatial Resolution	250 m, 500 m, 1 km
Spectral Bands	36 (visible to thermal IR)
Swath Width	~ 2,330 km
Temporal Resolution	1–2 days (global)
Key Features	• Global ocean color and SST • High temporal frequency • Long-term climate record
Main Products	Chlorophyll-a, SST, ocean color, sea ice, aerosols, etc.



MODIS Ocean Color (Chlorophyll-a)

Landsat
(Land Remote Sensing Satellite)



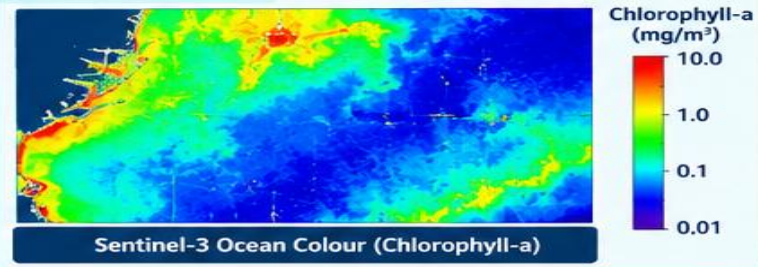
Agency	USGS / NASA
Spatial Resolution	15 m (panchromatic), 30 m (multispectral), 100 m (thermal)
Spectral Bands	11 (visible to thermal IR)
Swath Width	~ 185 km
Temporal Resolution	16 days (each satellite)
Key Features	• High spatial detail • Land and coastal environment • Long-term time series (since 1972)
Main Products	Land cover, coastal water quality, vegetation, temperature, etc.


Landsat True Color (Coastal Zone)

Ocean Colour
(Ocean Color Satellites)



Agency	ESA (Sentinel-3), ESA (Sentinel-2)
Spatial Resolution	300 m (OLCI), 10–60 m (MSI)
Spectral Bands	~ 21 (OLCI), 13 (MSI) (visible to near IR)
Swath Width	~ 1,270 km (OLCI), 290 km (MSI)
Temporal Resolution	1–2 days (Sentinel-3), 5 days (Sentinel-2)
Key Features	• High-quality ocean color • Chlorophyll, water quality, CDOM • Coastal and open ocean monitoring
Main Products	Chlorophyll-a, turbidity, CDOM, water quality indicators, etc.



Sentinel-3 Ocean Colour (Chlorophyll-a)

Key Strengths of Each Satellite

NOAA MODIS
- ✓ Global coverage
- ✓ High temporal frequency
- ✓ Climate change monitoring

Landsat
- ✓ High spatial detail
- ✓ Land–ocean interaction
- ✓ Long historical record

Ocean Colour
- ✓ Accurate ocean color
- ✓ Water quality & ecosystem
- ✓ Coastal and open ocean

Together, They Provide a Comprehensive View

MODIS + Landsat + Ocean Colour

Better Understanding of Our Ocean and a Healthier Planet

Satellite Sensors and Image Formation

Each satellite has one main sensor → One image per sensor | RGB (Red, Green, Blue) bands are combined to make a *natural color* image.

NOAA MODIS
(Moderate Resolution Imaging Spectroradiometer)



One sensor → One image

- 36 spectral bands
- Spatial resolution: 250 m, 500 m, 1 km
- Swath width: ~ 2,330 km

Example: MODIS Bands for RGB

Band 1 (Red)	620–670 nm	
Band 4 (Green)	545–565 nm	
Band 3 (Blue)	459–479 nm	



Natural Color Image (RGB composite)

Landsat
(Land Remote Sensing Satellite)

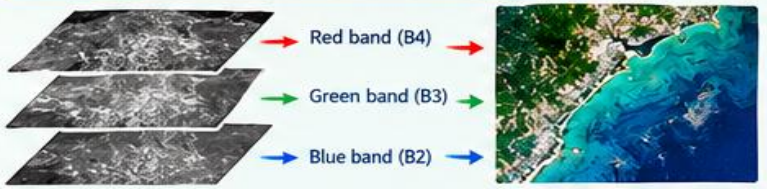


One sensor → One image

- 11 spectral bands
- Spatial resolution: 15 m (panchromatic), 30 m (multispectral), 100 m (thermal)
- Swath width: ~ 185 km

Example: Landsat 8 OLI Bands for RGB

Red	Band 4	(655–675 nm)
Green	Band 3	(533–590 nm)
Blue	Band 2	(450–515 nm)



Natural Color Image (RGB composite)

Ocean Colour
(Ocean Color Satellites)



One sensor → One image

- Multiple spectral bands (e.g., 8–20+ bands)
- Spatial resolution: ~ 300 m (OLCI), 10–60 m (MSI)
- Swath width: ~ 1,270 km (OLCI), 290 km (MSI)

Example: Sentinel-3 OLCI Bands for RGB

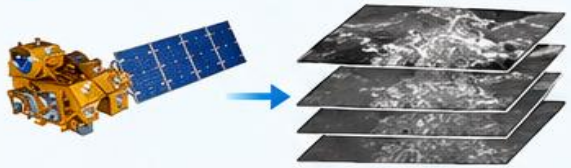
Red	Band 4	(664–681 nm)
Green	Band 6	(510–560 nm)
Blue	Band 8	(443–483 nm)



Natural Color Image (RGB composite)

How RGB Bands Create a Natural Color Image

1 One Sensor = One Image



Each satellite sensor captures data in multiple spectral bands, and produces one image per sensor (per band).

2 RGB Bands from the Same Sensor



Red (R)	Green (G)	Blue (B)
(e.g., 620–670 nm)	(e.g., 545–565 nm)	(e.g., 459–479 nm)

The R, G, and B bands are from the same sensor and the same location (aligned in space and time).

3 Combine RGB → Natural Color Image

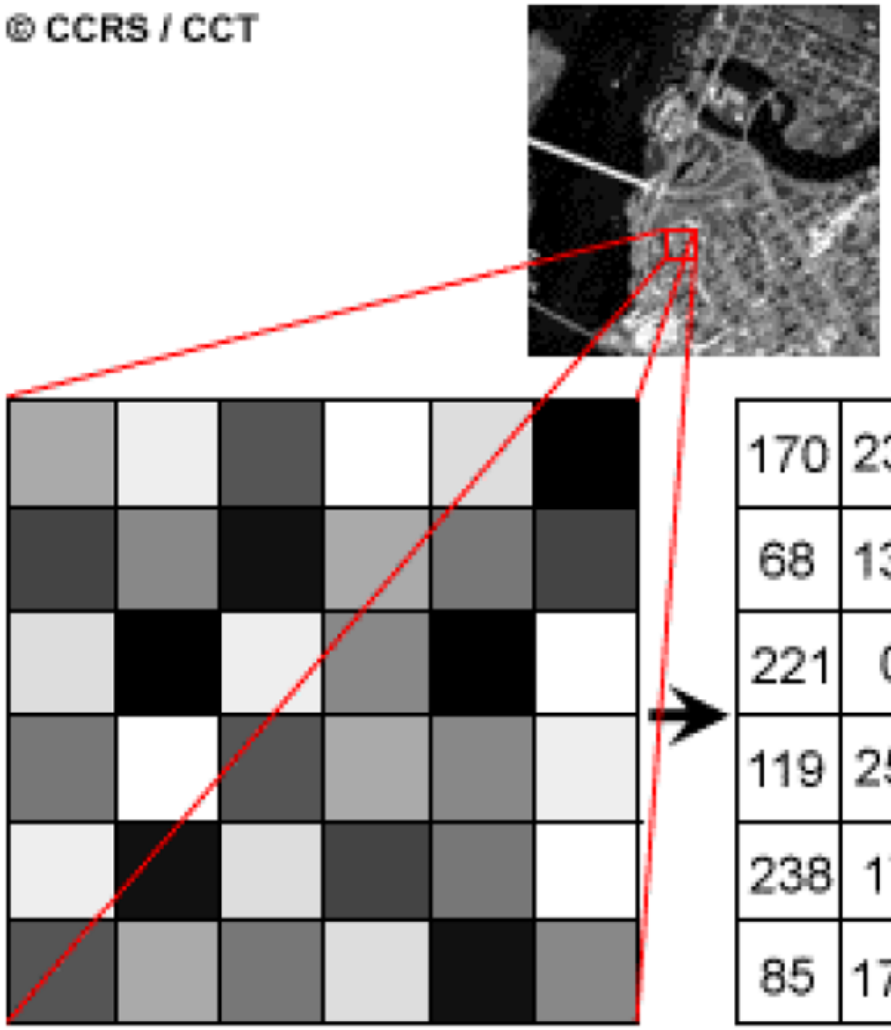


Natural Color (True Color) Image

Key Points

- ✓ One satellite sensor = one image (per band).
- ✓ RGB bands are combined to create a natural color image.
- ✓ Different satellites have different sensors and band ranges, but the principle is the same.

© CCRS / CCT

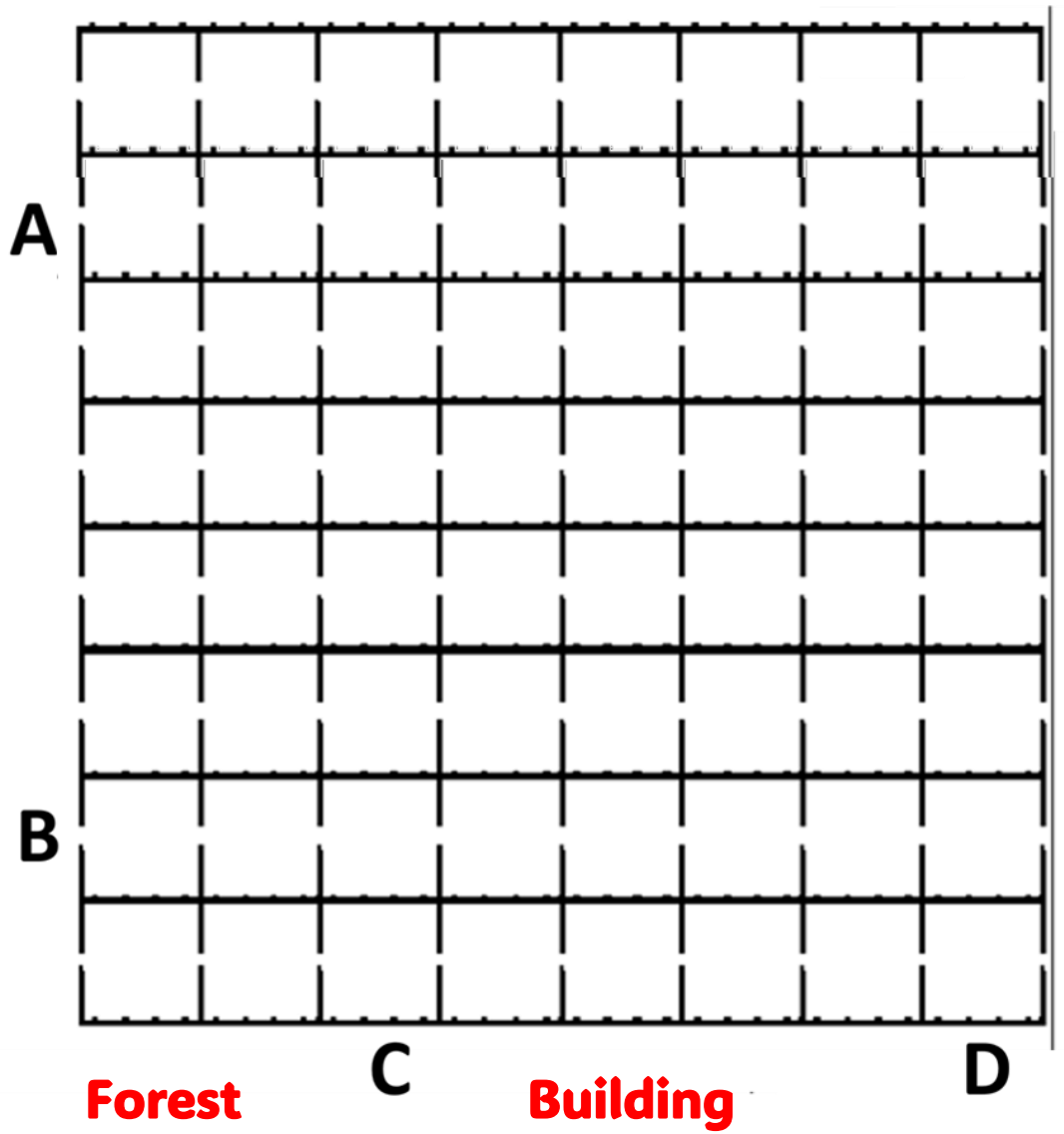


170	238	85	255	221	0
68	136	17	170	119	68
221	0	238	136	0	255
119	255	85	170	136	238
238	17	221	68	119	255
85	170	119	221	17	136

A photograph could also be represented and displayed in a **digital** format by subdividing the image into small equal-sized and shaped areas, called picture elements or **pixels**, and representing the brightness of each area with a numeric value or **digital number**. Indeed, that is exactly what has been done to the photo to the left. In fact, using the definitions we have just discussed, this is actually a **digital image** of the original photograph! The photograph was scanned and subdivided into pixels with each pixel assigned a digital number representing its relative brightness. The computer displays each digital value as different brightness levels.

Marking Black Grey White colour

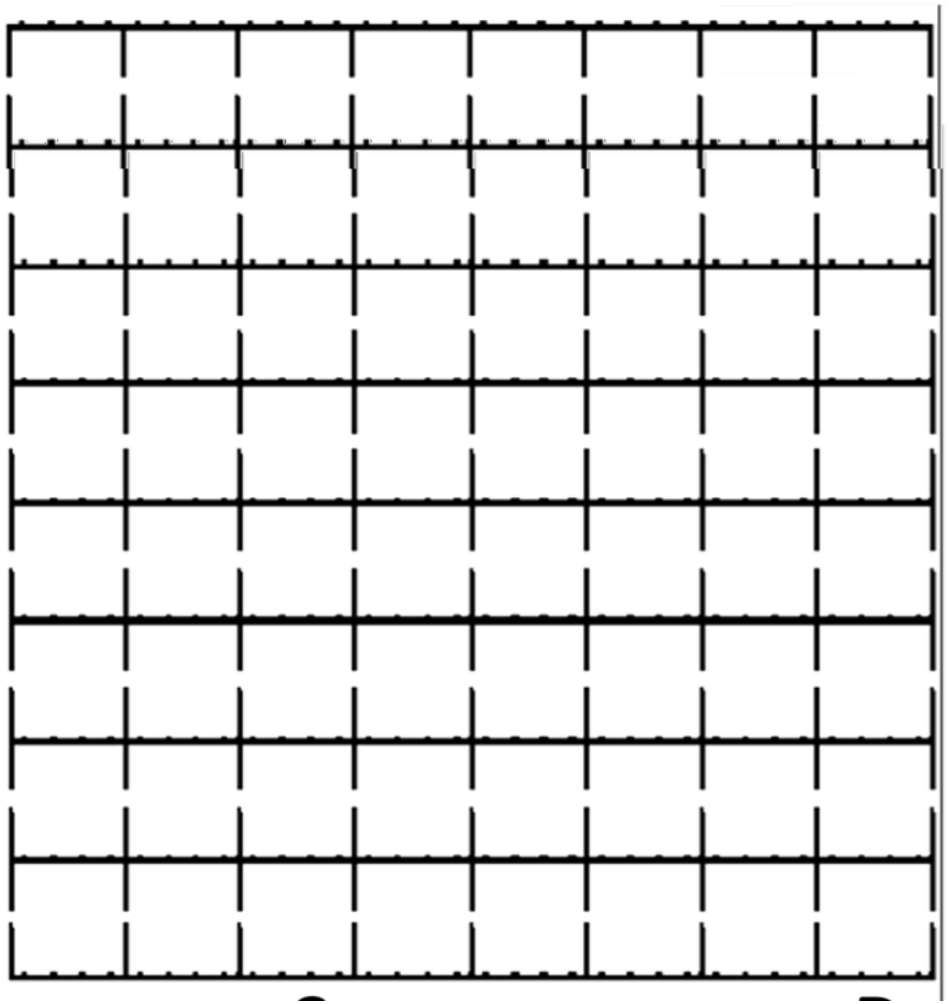
0	0	0	0	2	2	2	2
0	1	1	2	2	2	4	4
1	1	2	2	3	4	4	4
2	2	2	3	4	4	4	4
2	3	3	4	4	6	2	2
3	3	3	4	5	6	1	1
3	5	5	5	6	1	0	0
5	5	5	6	2	1	0	0



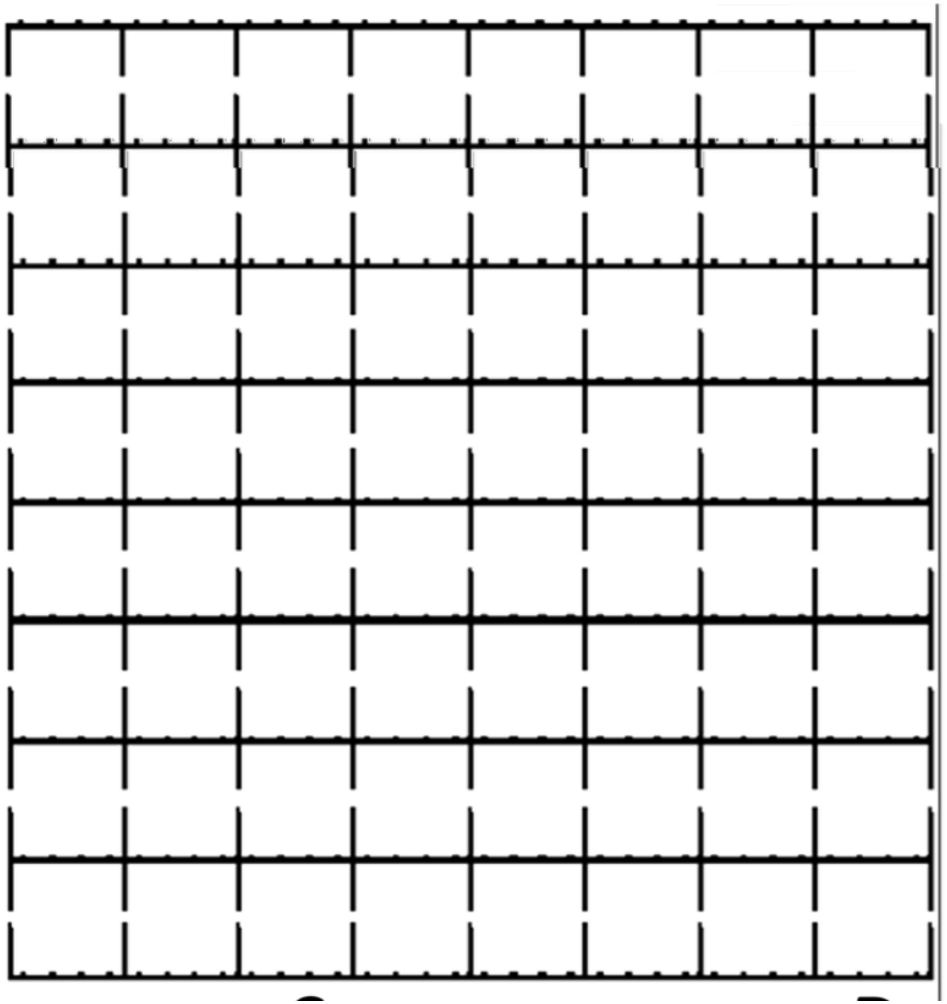
Sea Forest Building

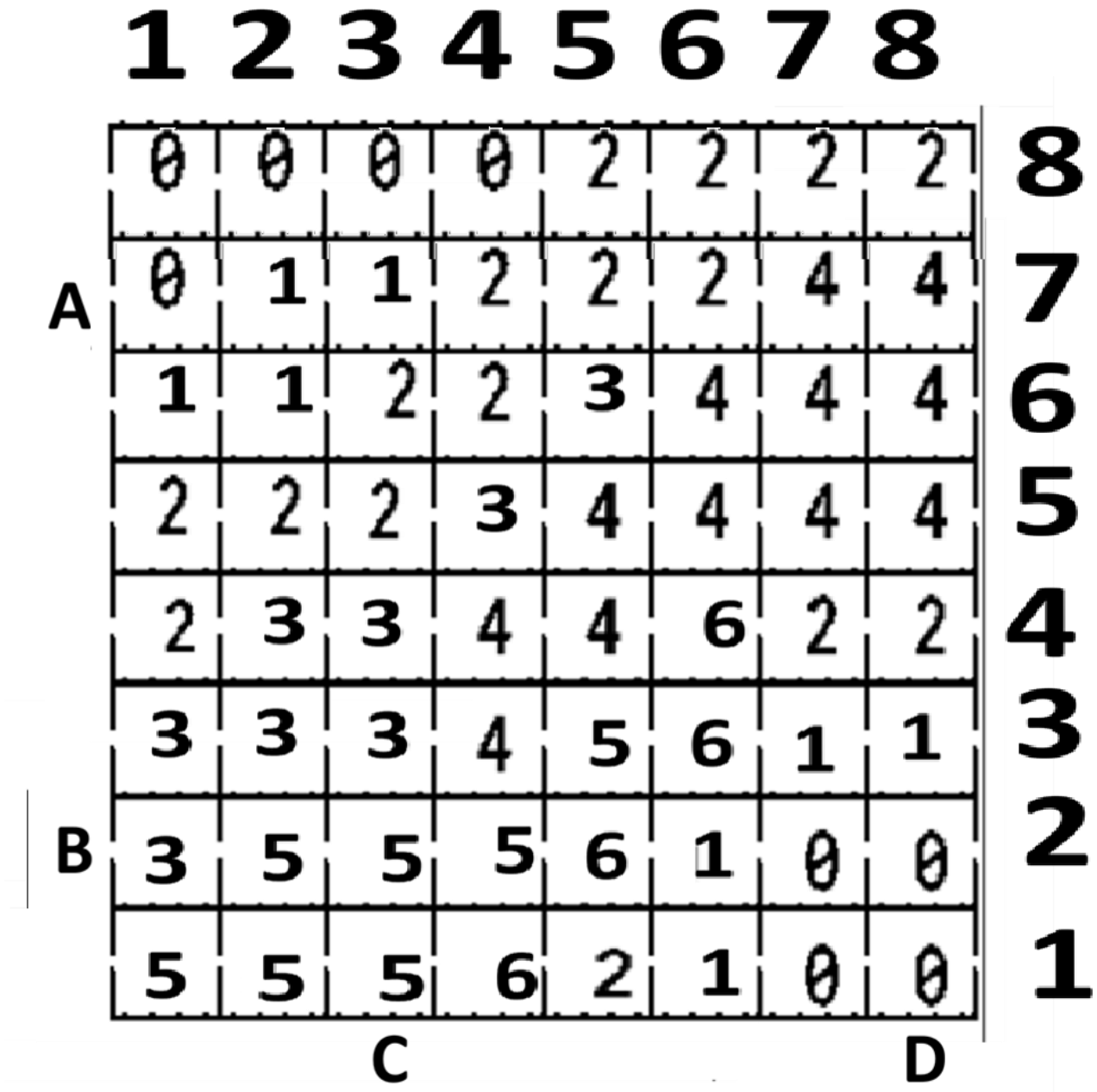
012 34 56

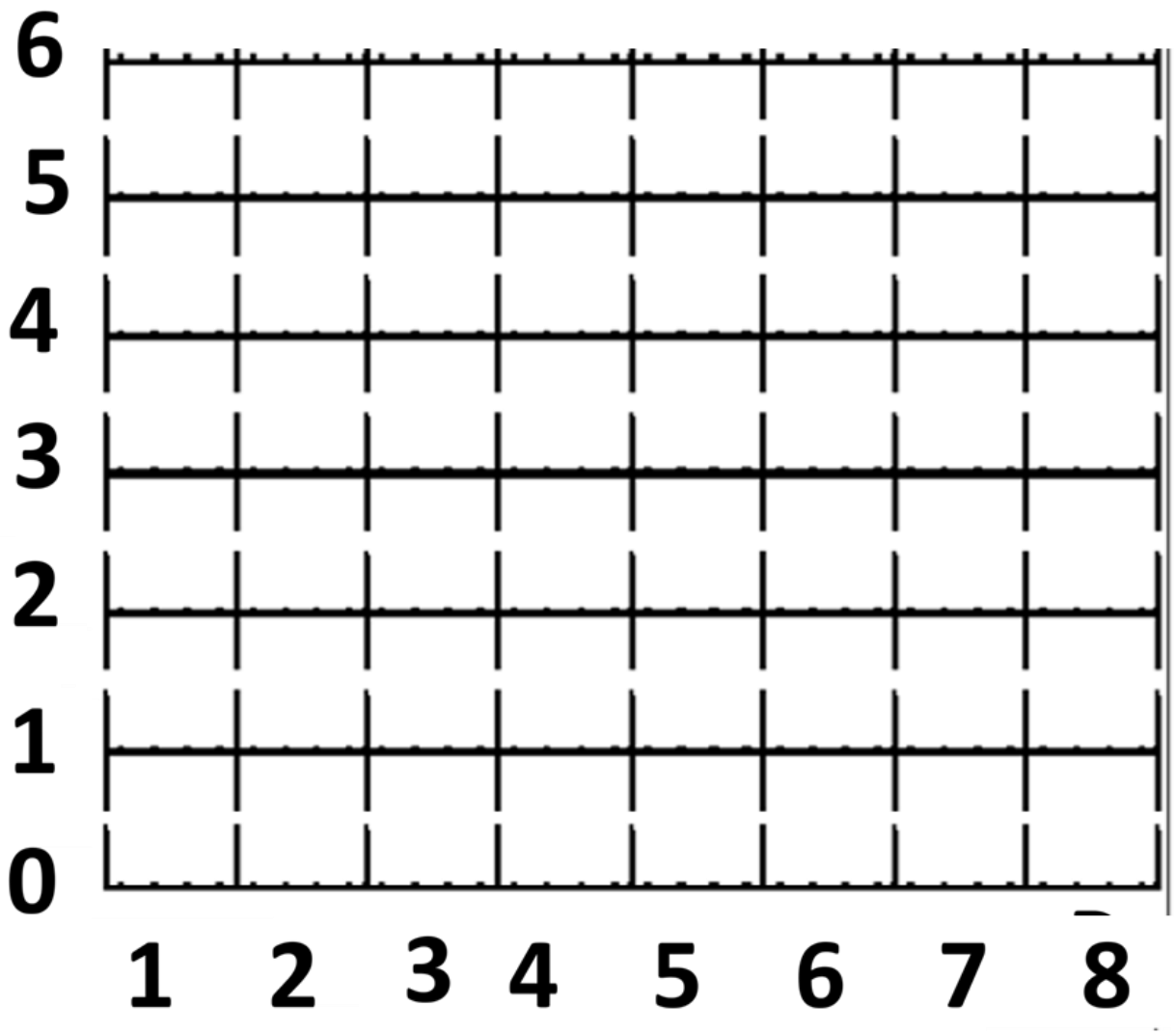
Put the Numbers



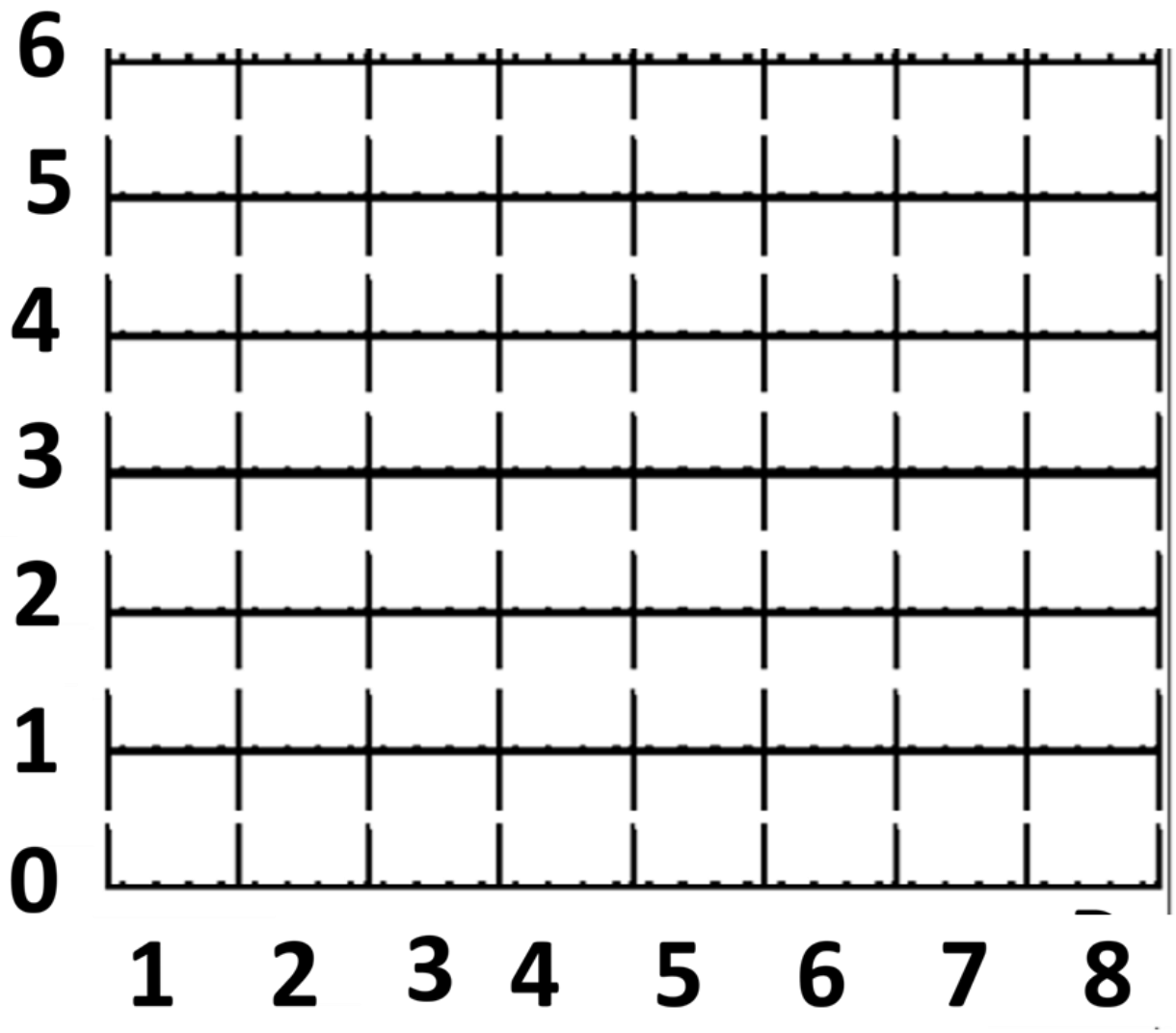
Fill it with colours of Black Grey and White




1 2 3 4 5 6 7 8
0 0 0 0 2 2 2 2 8
A
0 1 1 2 2 2 4 4 7
1 1 2 2 3 4 4 4 6
2 2 2 3 4 4 4 4 5
2 3 3 4 4 6 2 2 4
3 3 3 4 5 6 1 1 3
B
3 5 5 5 6 1 0 0 2
5 5 5 6 2 1 0 0 1
C
D



A



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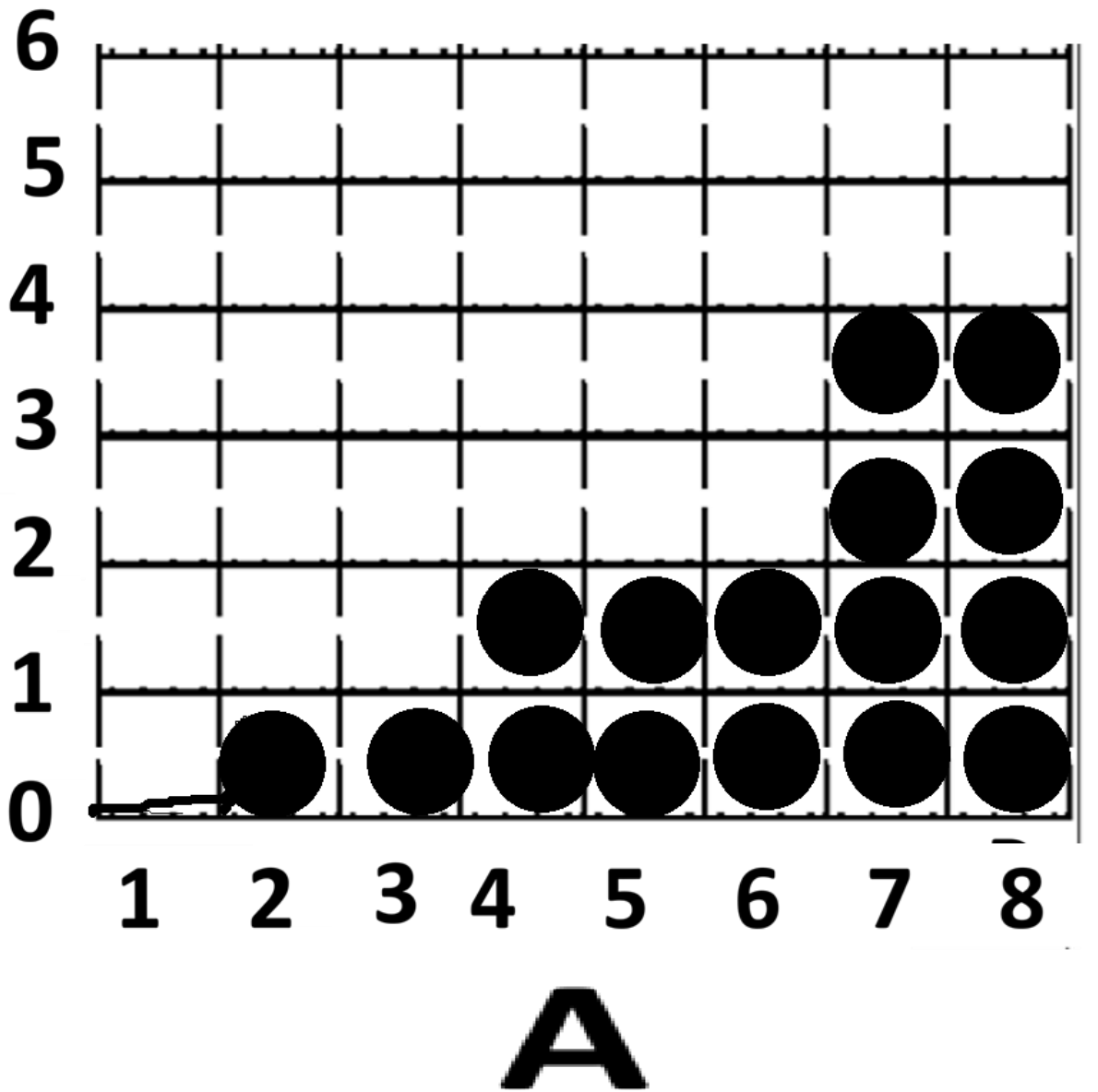

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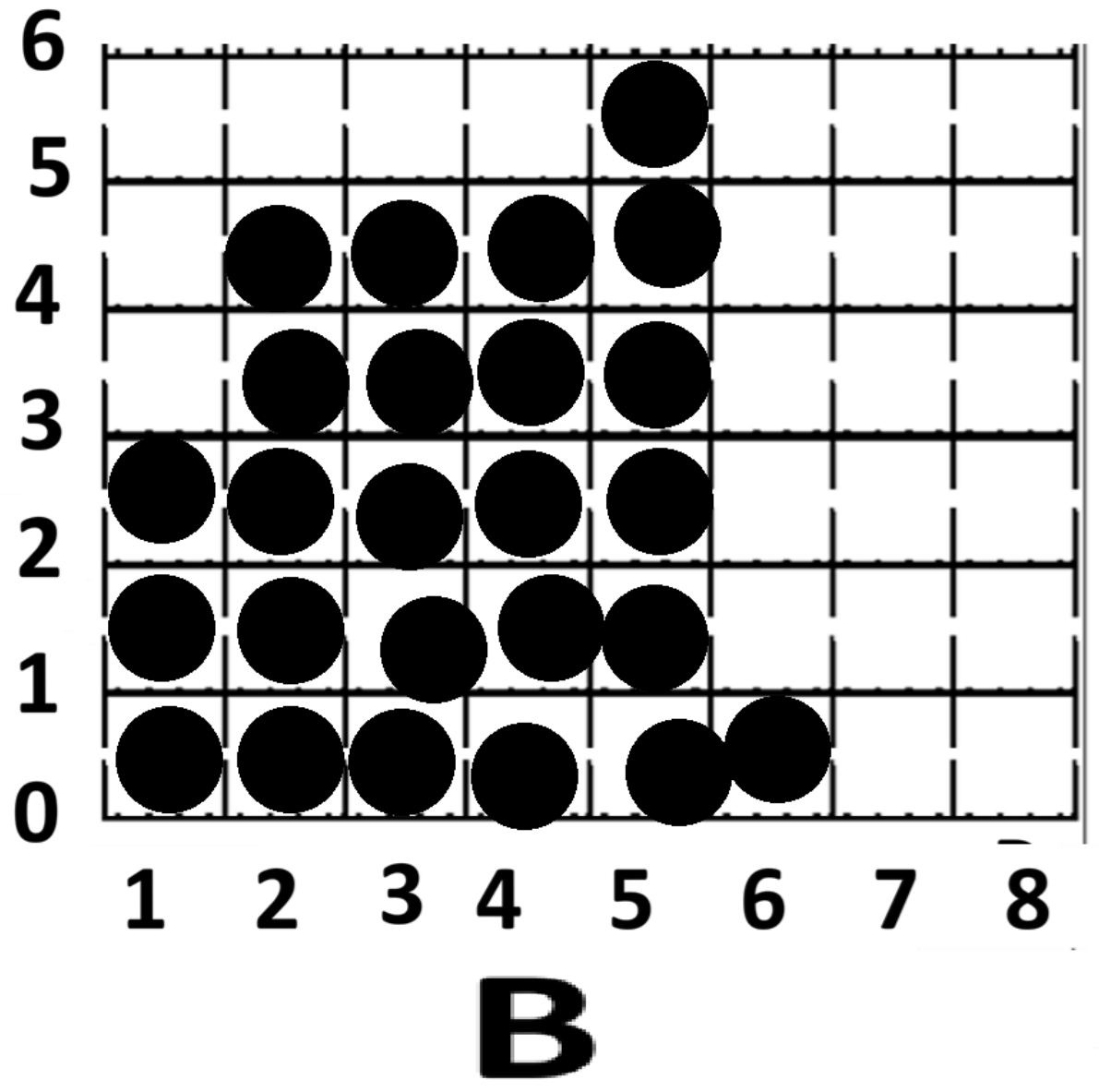

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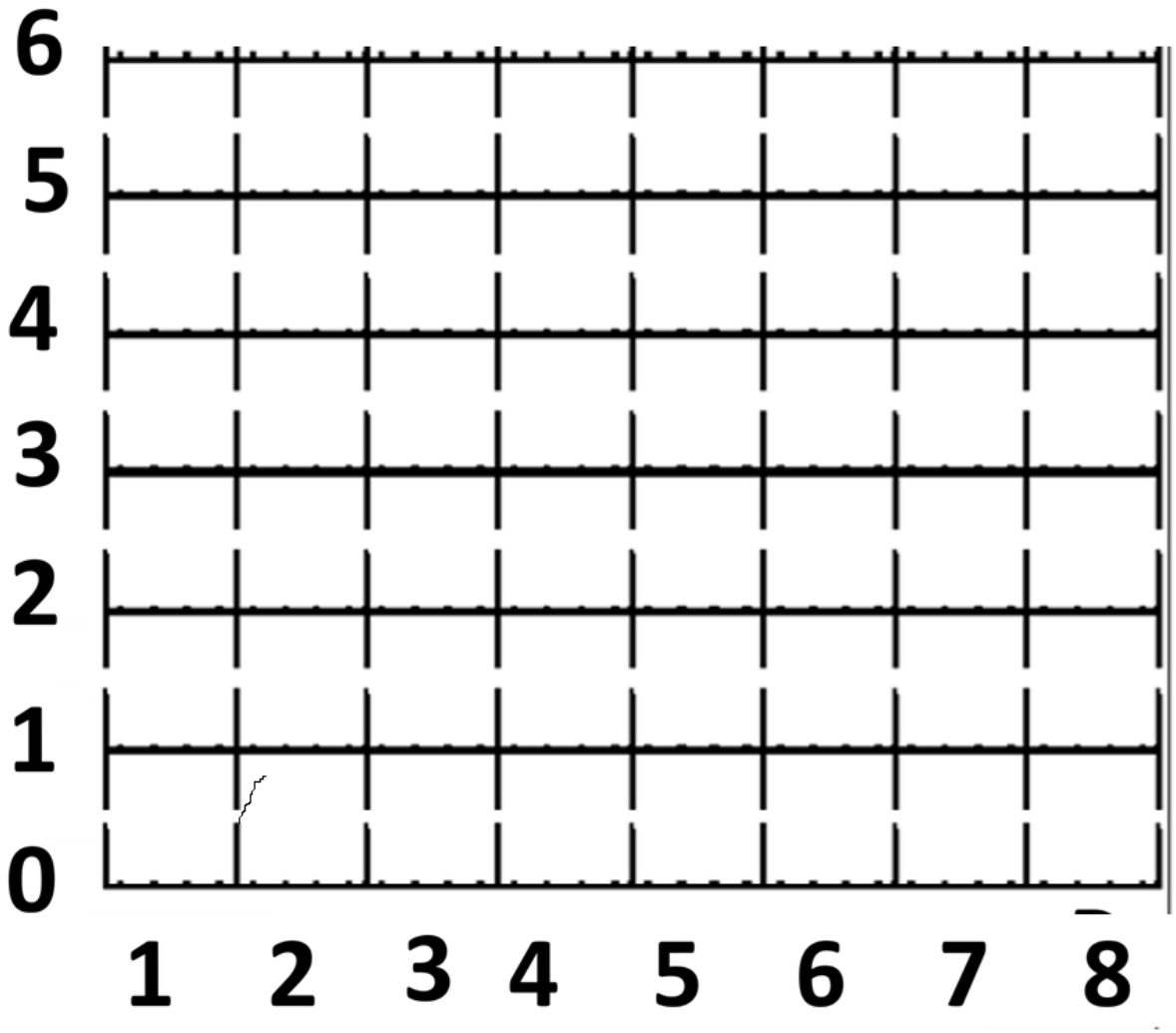

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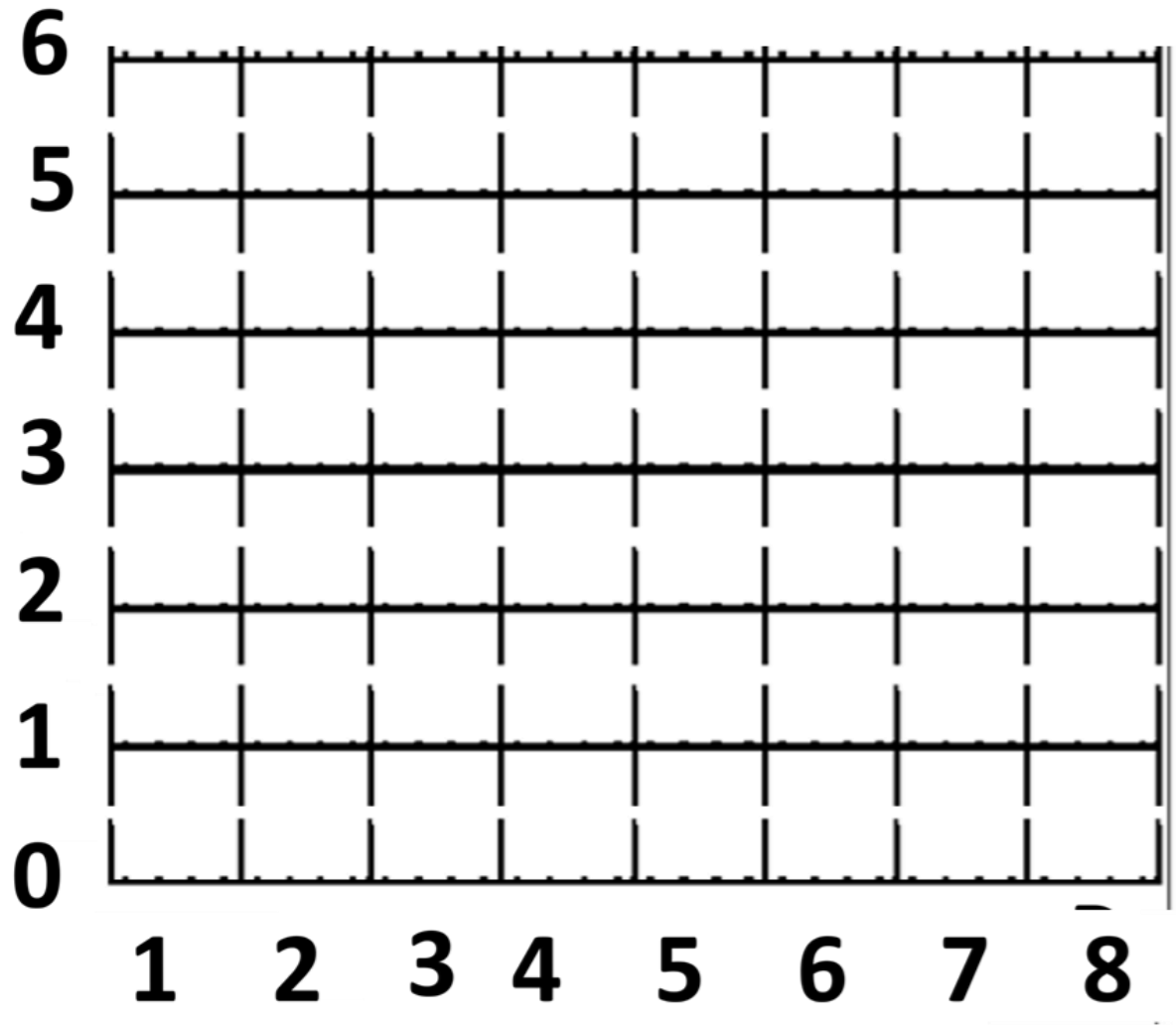
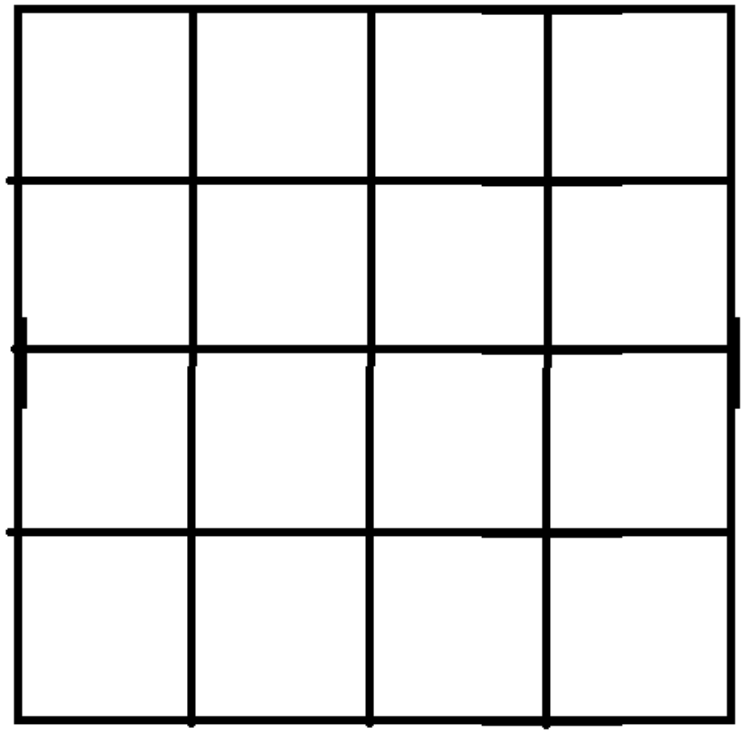
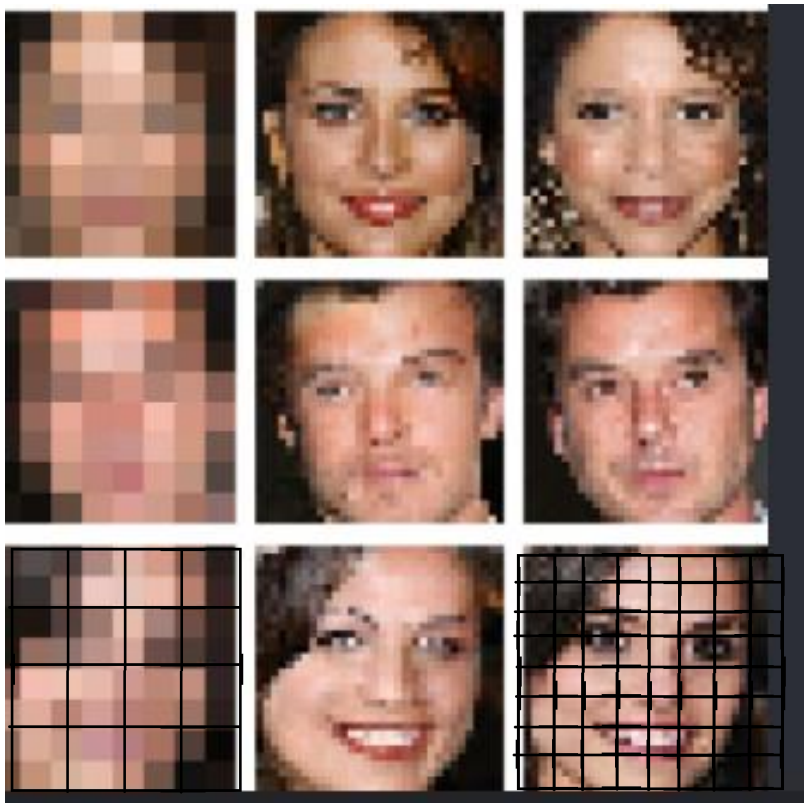


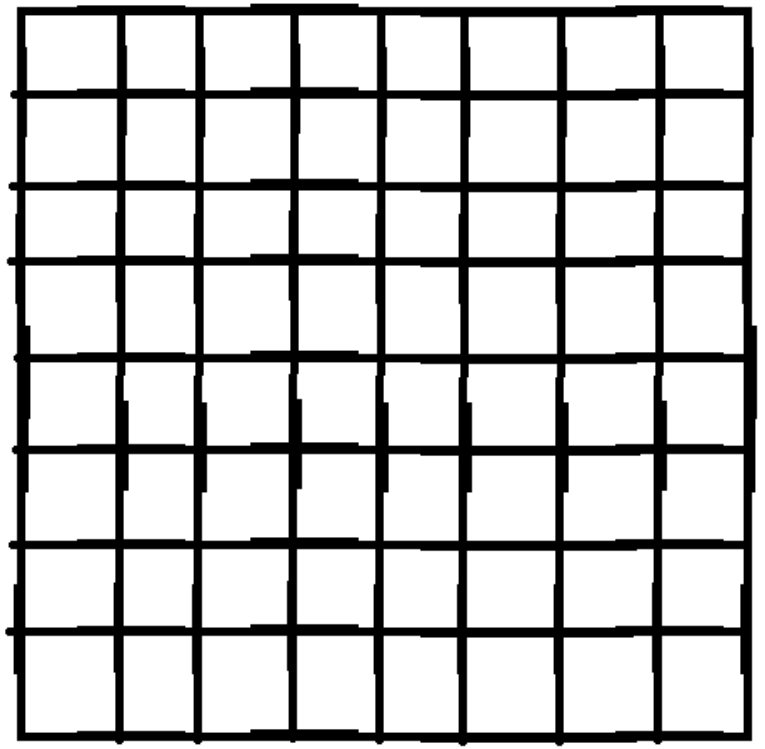
D

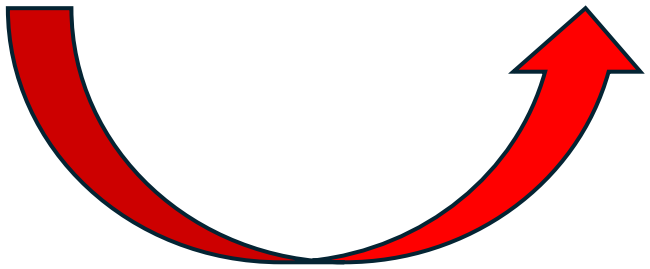
Low Resolution

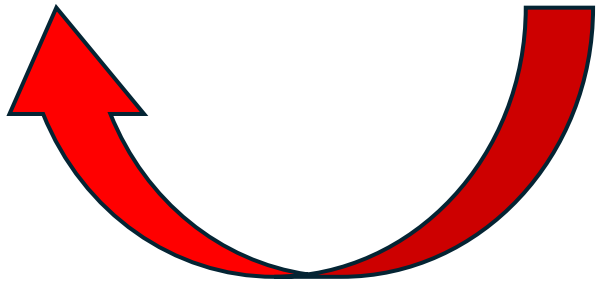


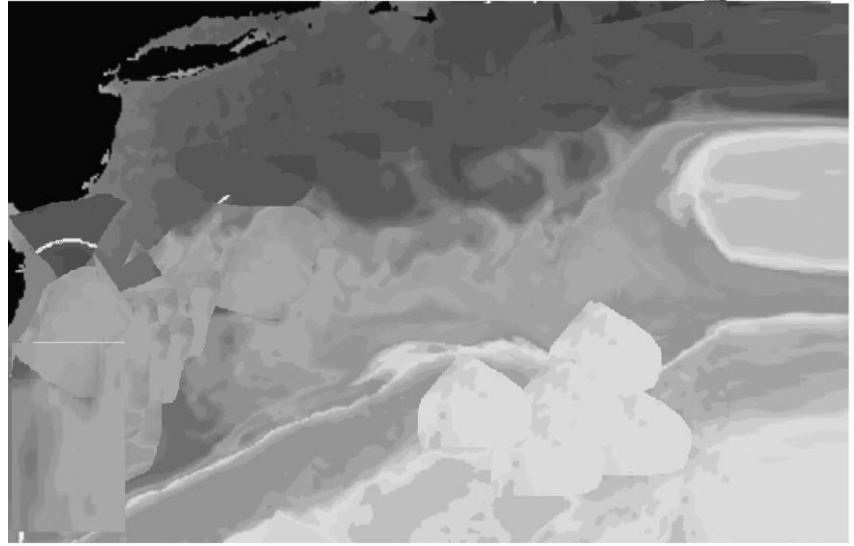


High Resolution









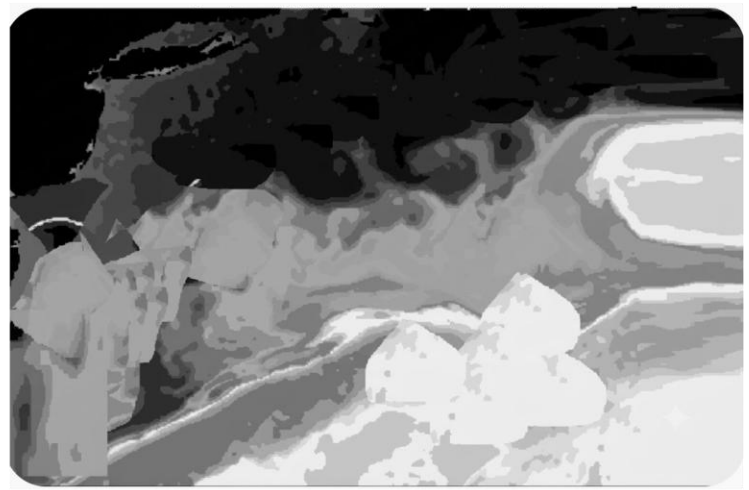


Original





Supervised



Unsupervised

Q&A

https://www.youtube.com/watch?v=Hau_ZCmN8eU&t=2s