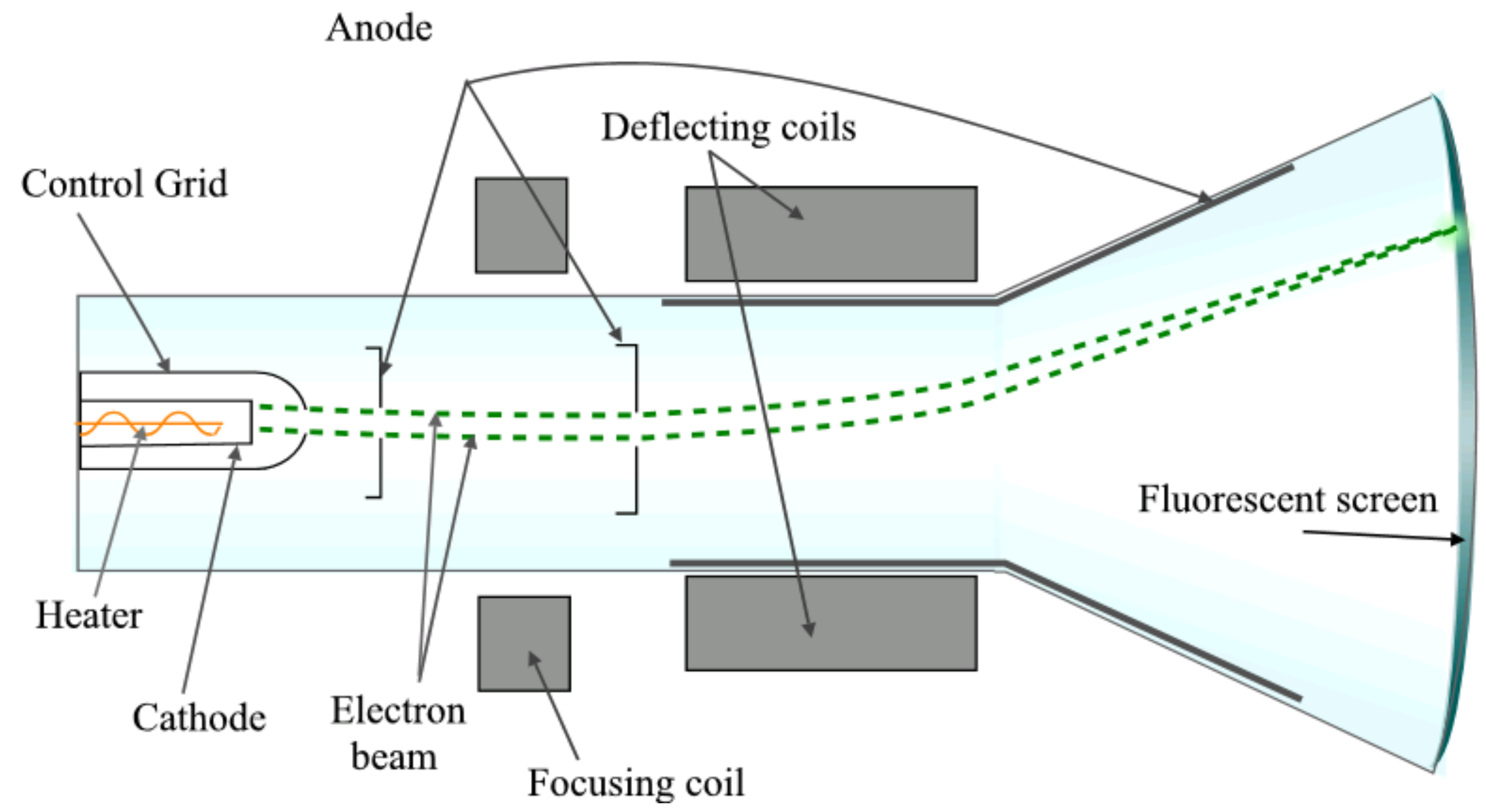
# Lesson B2

# Image processing + geometric aspects

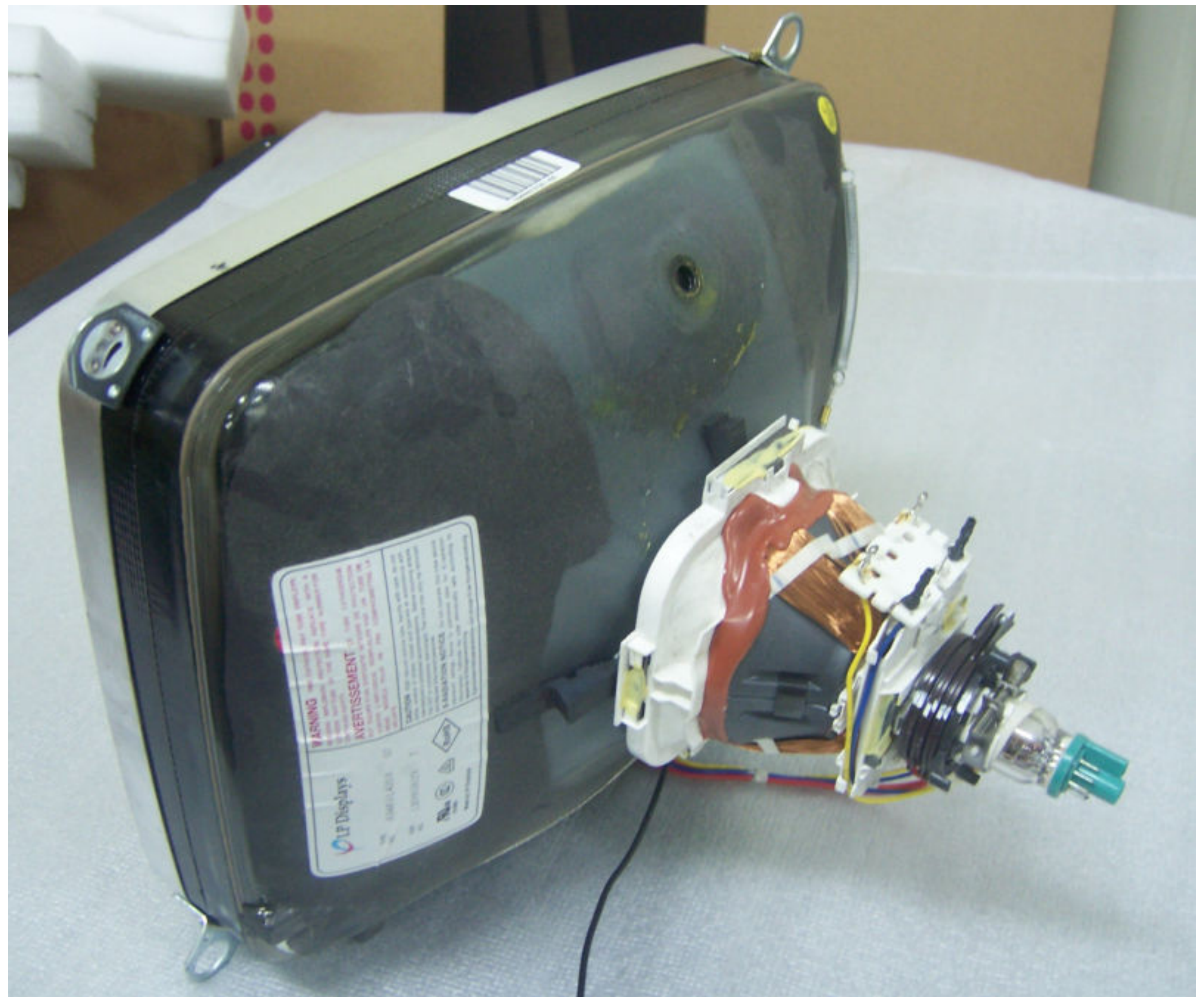
# GEO1001.2020

Hugo Ledoux

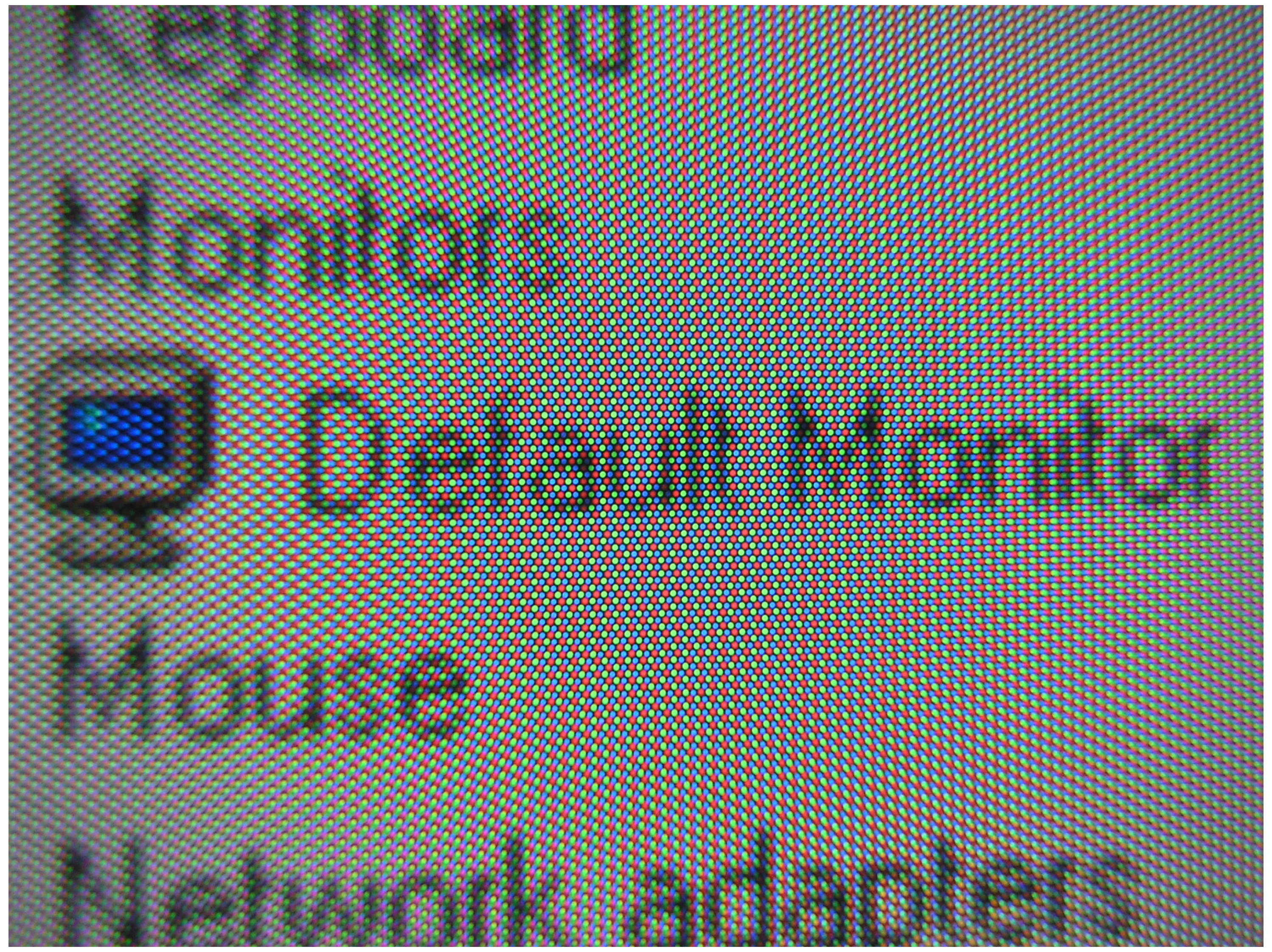
# Cathode-ray tube (CRT), eg old television and computer screens




https://commons.wikimedia.org/wiki/File:Cathode_ray_Tube.PNG



https://commons.wikimedia.org/wiki/File:Cathode_ray_Tube.PNG



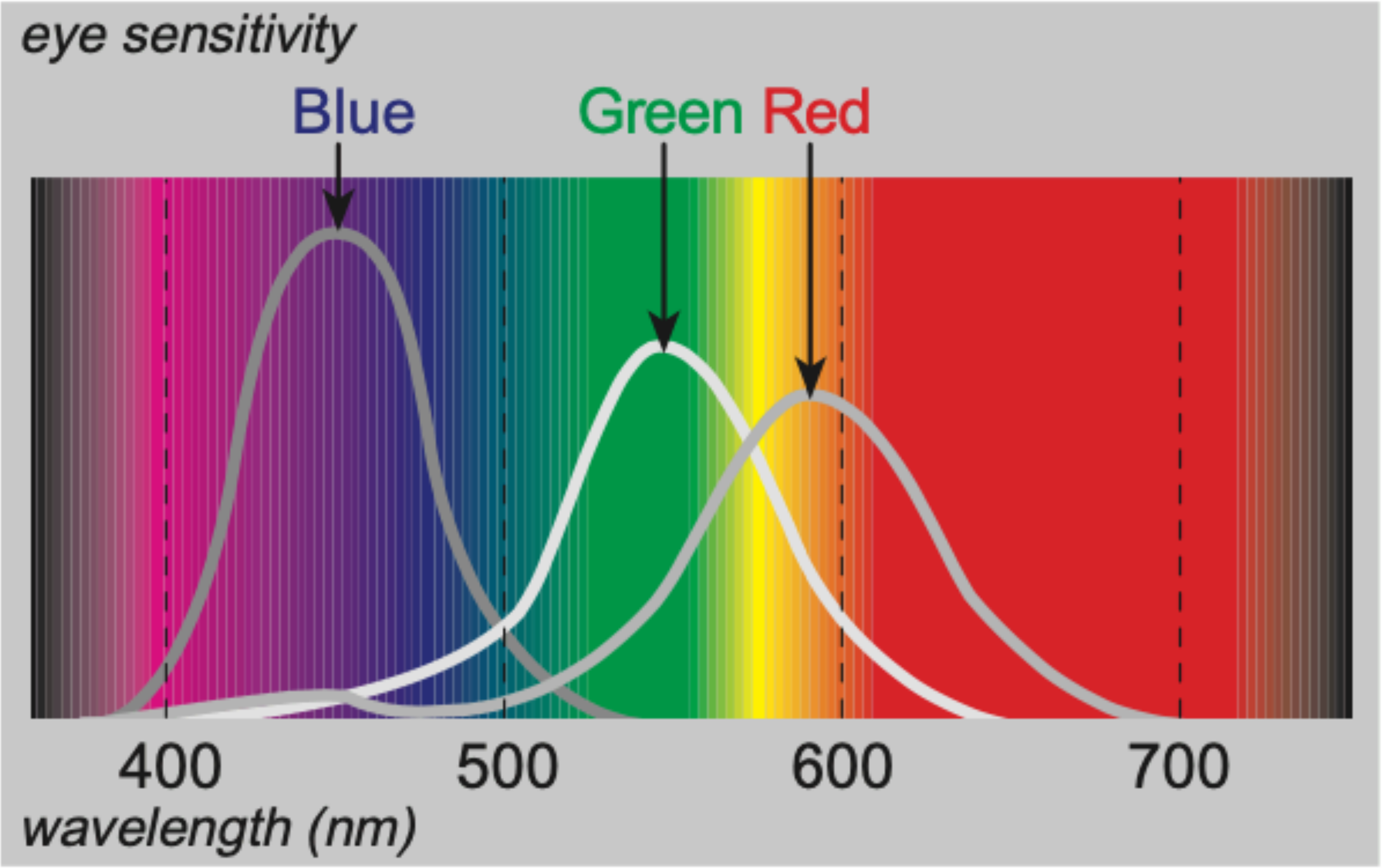

https://commons.wikimedia.org/wiki/File:Cathode_ray_Tube.PNG

# Perception of colours

- Colour perception takes places in human eyes and brain
- It’s not completely known how human works
- But we have models that are accepted

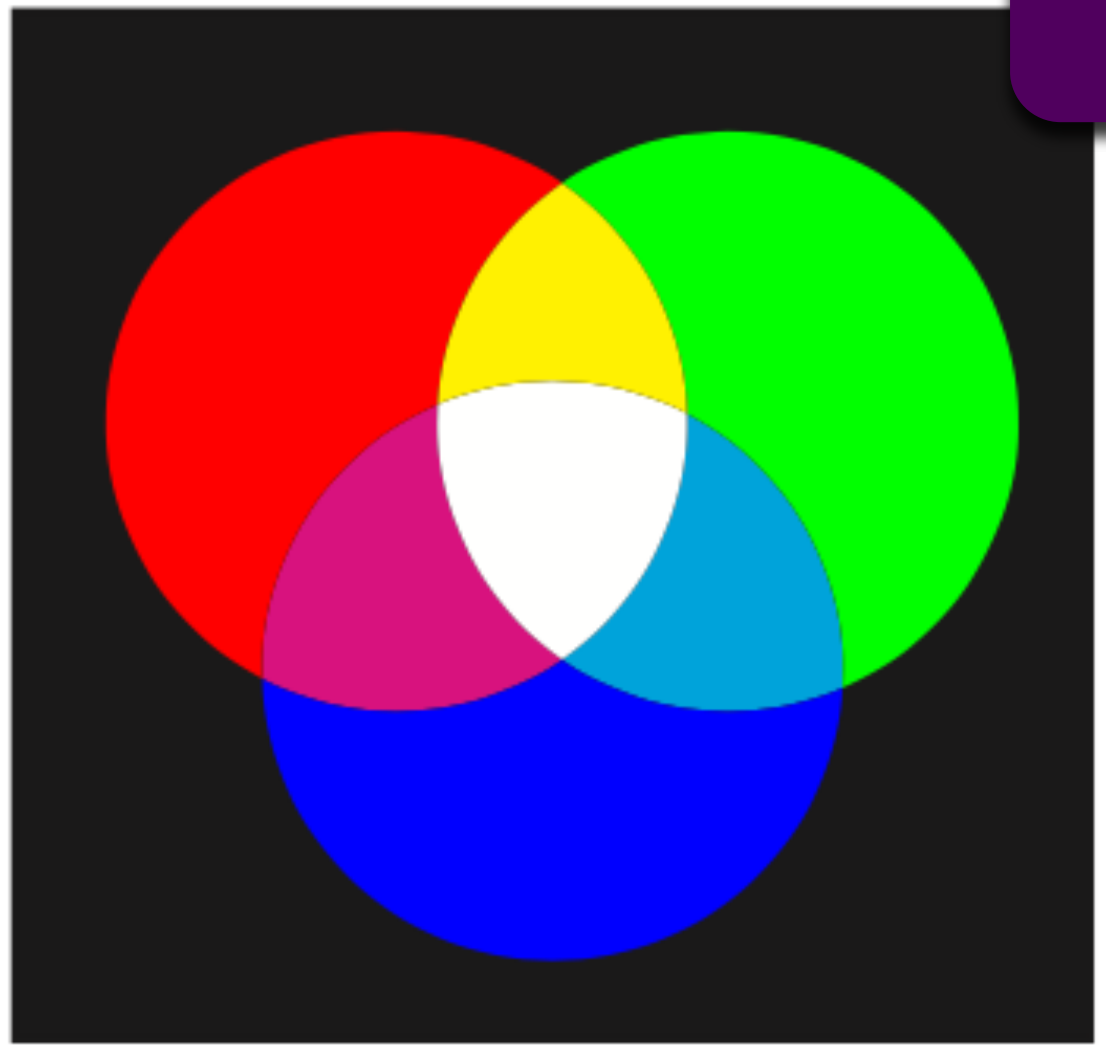
# Tri-stimuli model

- The eye's general sensitivity is to wavelengths between 400–700 nm
- The retinas in our eyes have *cones* (light-sensitive receptors) that send signals to the brain when they are hit by photons with energy levels that correspond to different wavelengths in the visible range of the EM spectrum
- 3 diff kinds of cones, responding to **blue**, **green** and **red** wavelengths
- 3 colour spaces (or models):
    1. RBG *[additive]*
    2. Intensity Hue Saturation (IHS)
    3. Yellow Magenta Cyan (YMC) *[subtractive]*

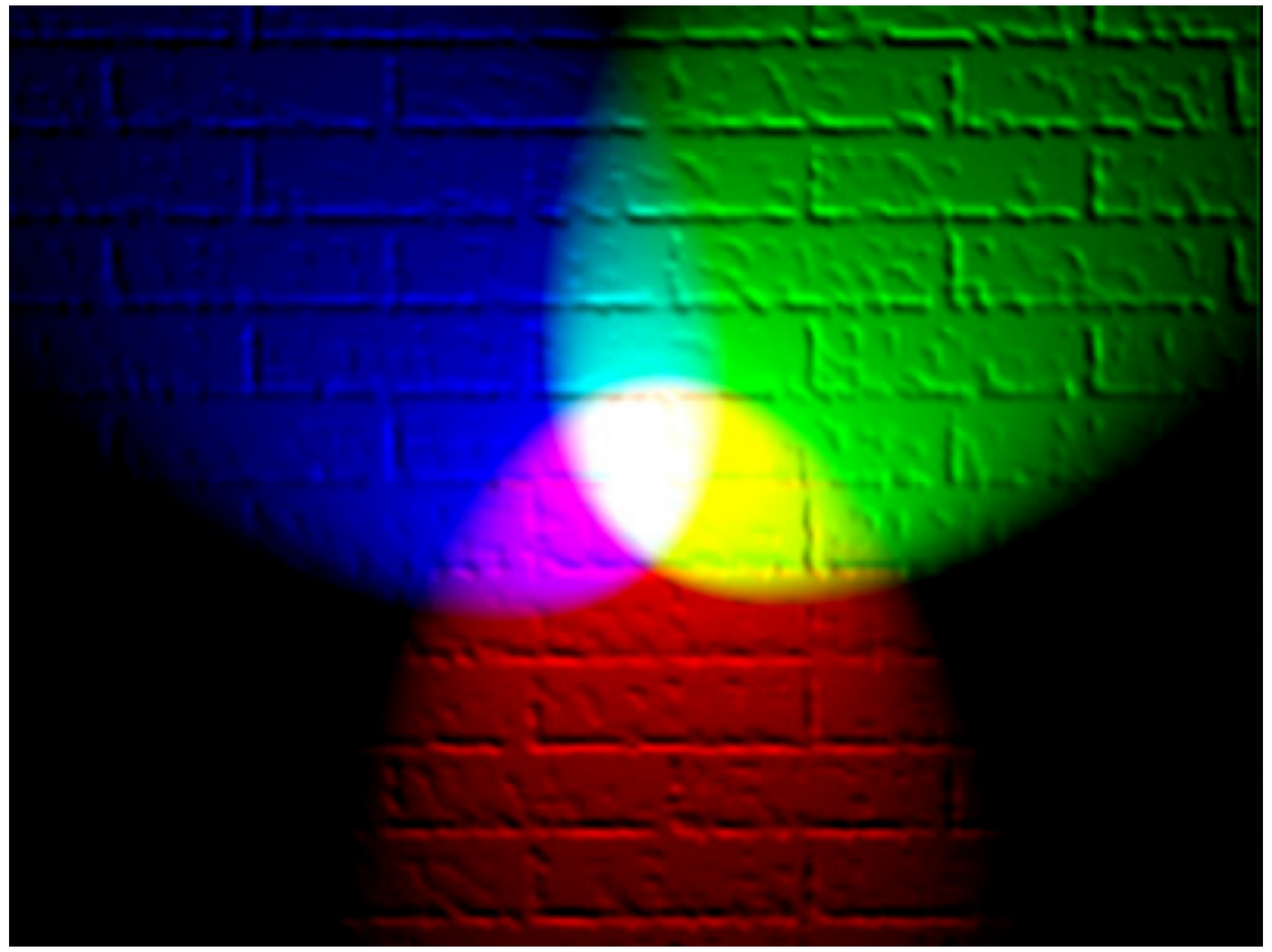


# RGB model (Red Green Blue)

Additive



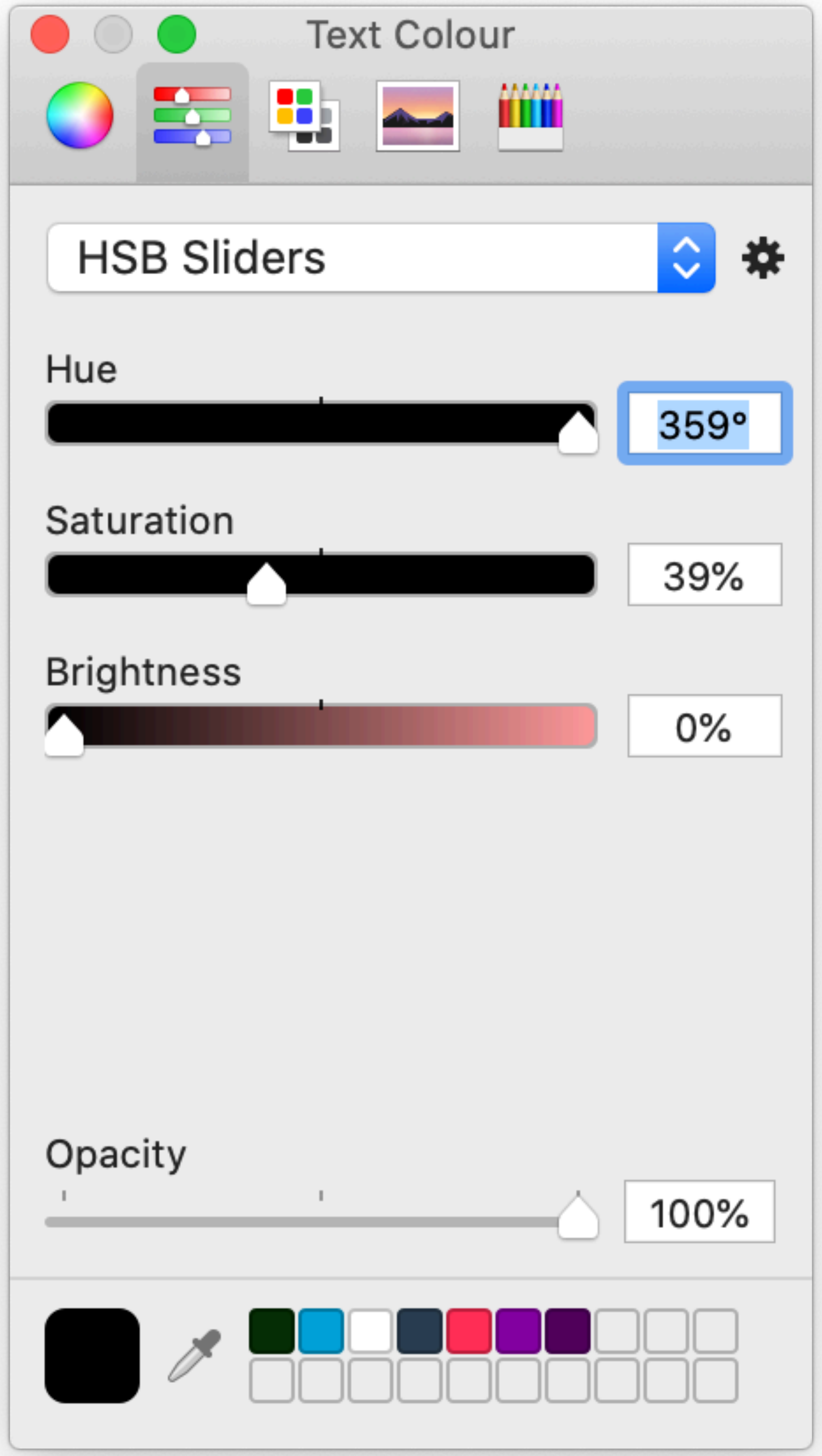
- Additive model
- 3 sources
- When we look at the result, our brain combines the stimuli from the red, green and blue dots and enables us to perceive all possible colours from the visible part of the spectrum.
- During the combination, the three colours are added.
- Our computer screens work this way



https://commons.wikimedia.org/wiki/File:Cathode_ray_Tube.PNG

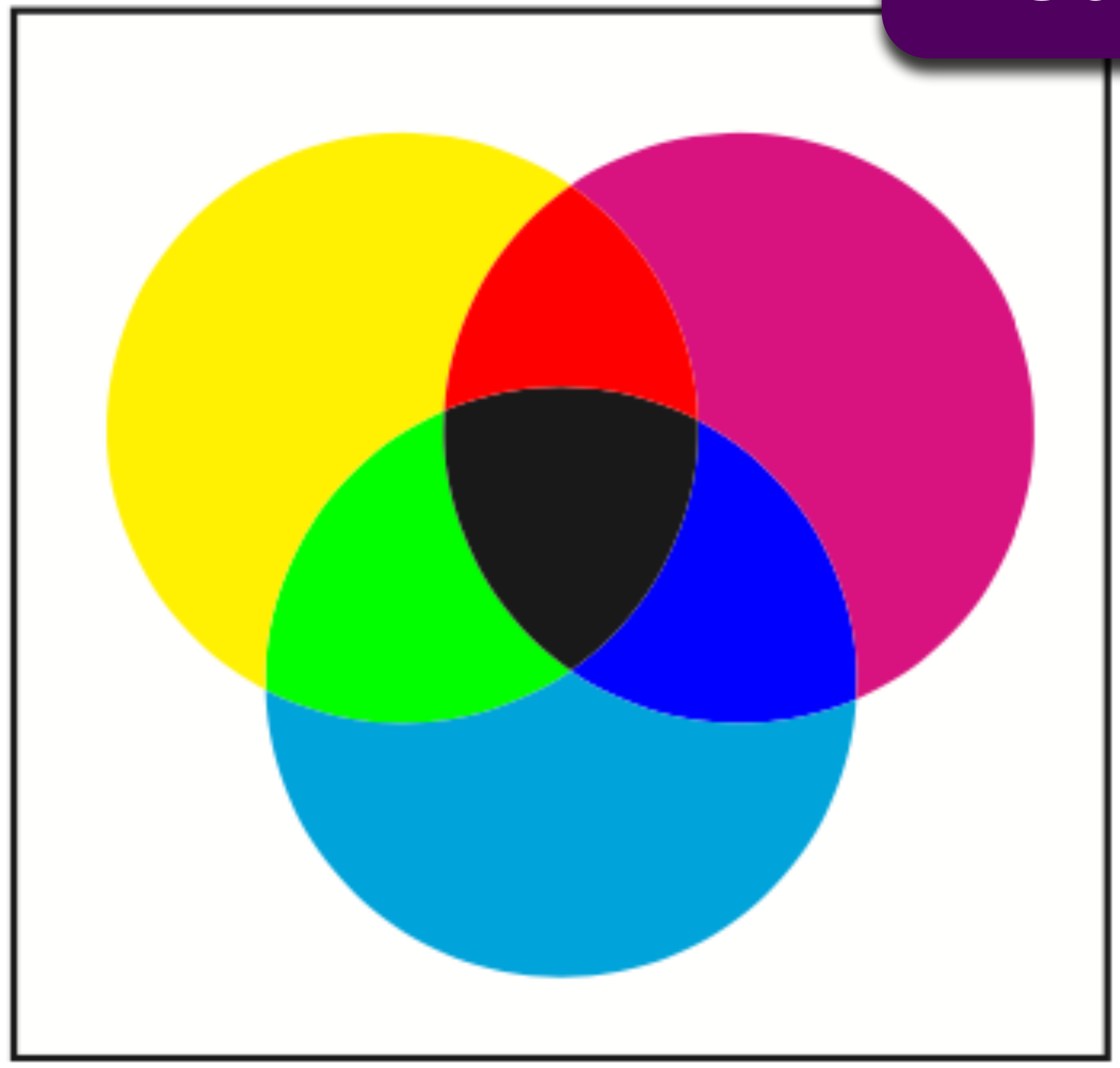
# IHS (Intensity Hue Saturation)

- **Intensity** describes whether a colour is light or dark
- **Hue** refers to the names that we give to colours: red, green, yellow, orange, purple, etc.
- **Saturation** describes a colour in terms of *pale* versus *vivid* (pastel colours have low saturation)
- In daily speech we do not express colours in the red, green and blue
- "*Light, pale red*" is easier to imagine than "*a lot of red with considerable amounts of green and blue*"
- Also 3 values, RGB can be transformed to IHS, and vice-versa



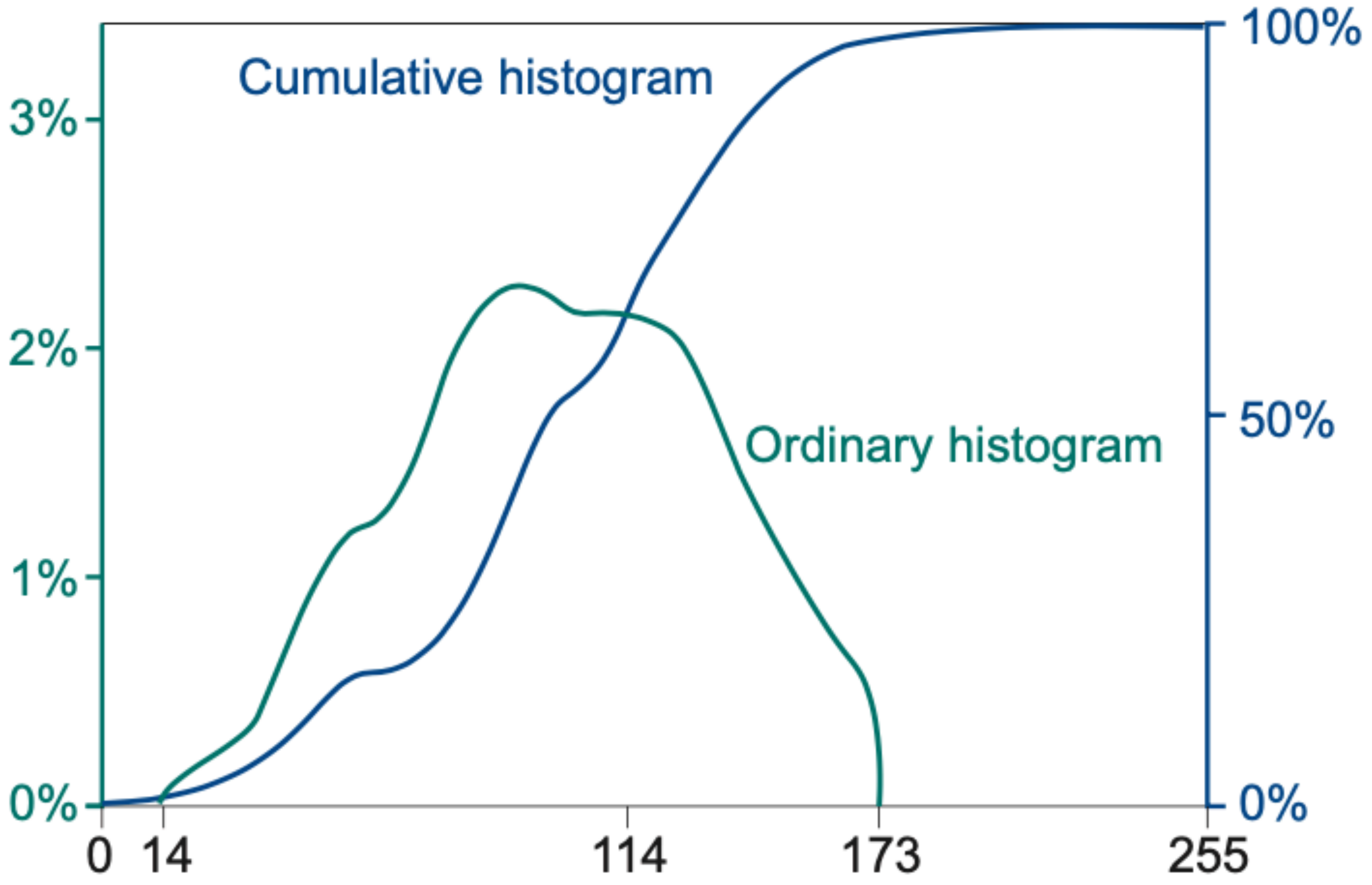
# YMC (Yellow Magenta Cyan)

Subtractive



- YMC colour description is used in colour definition on hard copies (printers)
- each component can be seen as a coloured filter
- the filters are yellow, magenta and cyan
- each filter subtracts one primary colour from the white light: the magenta filter subtracts green, so that only red and blue are left; the cyan filter subtracts red, and the yellow one blue.

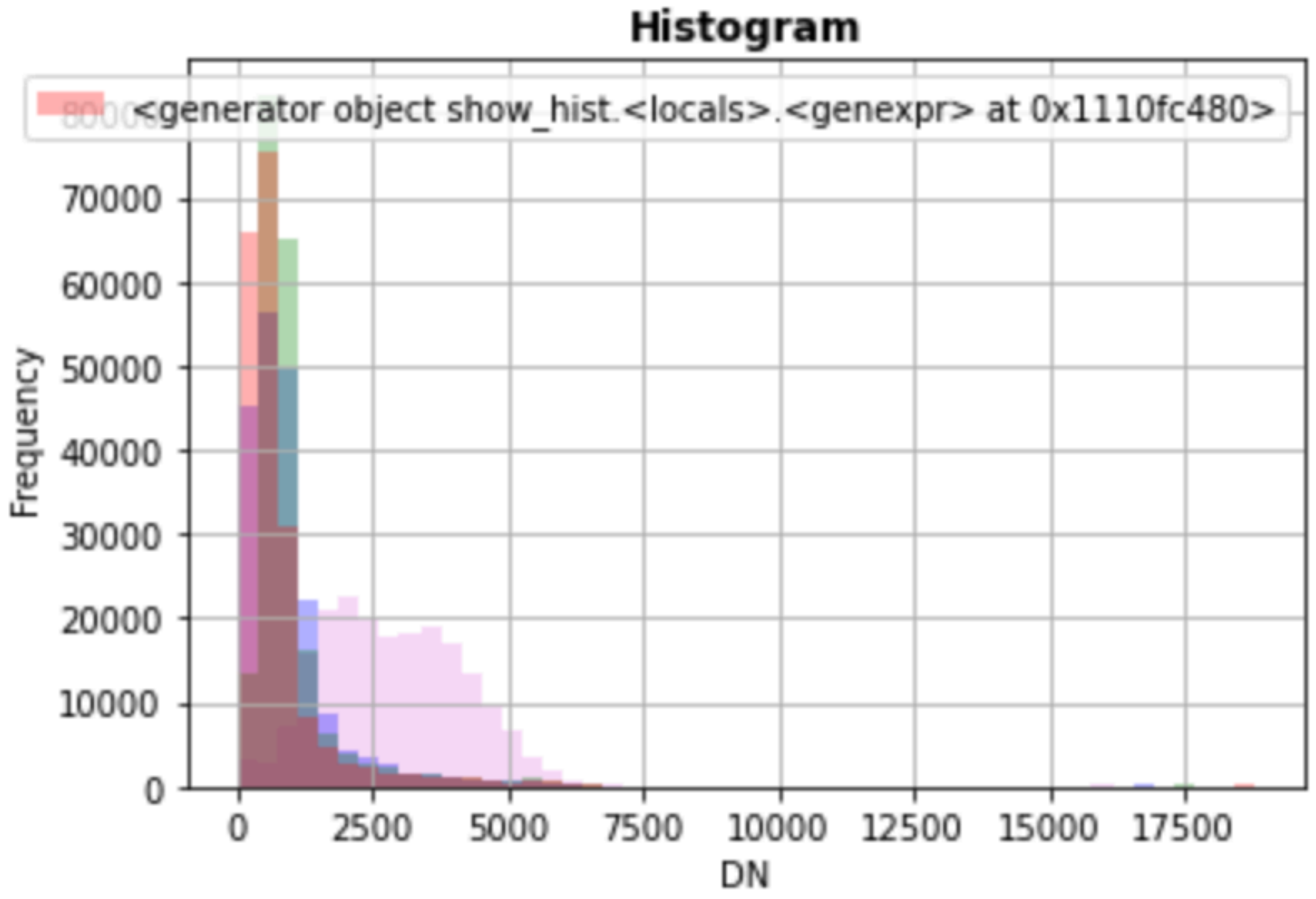
# Histograms



Cumulative histogram
Ordinary histogram
3%
2%
1%
0%
100%
50%
0%
0
14
114
173
255

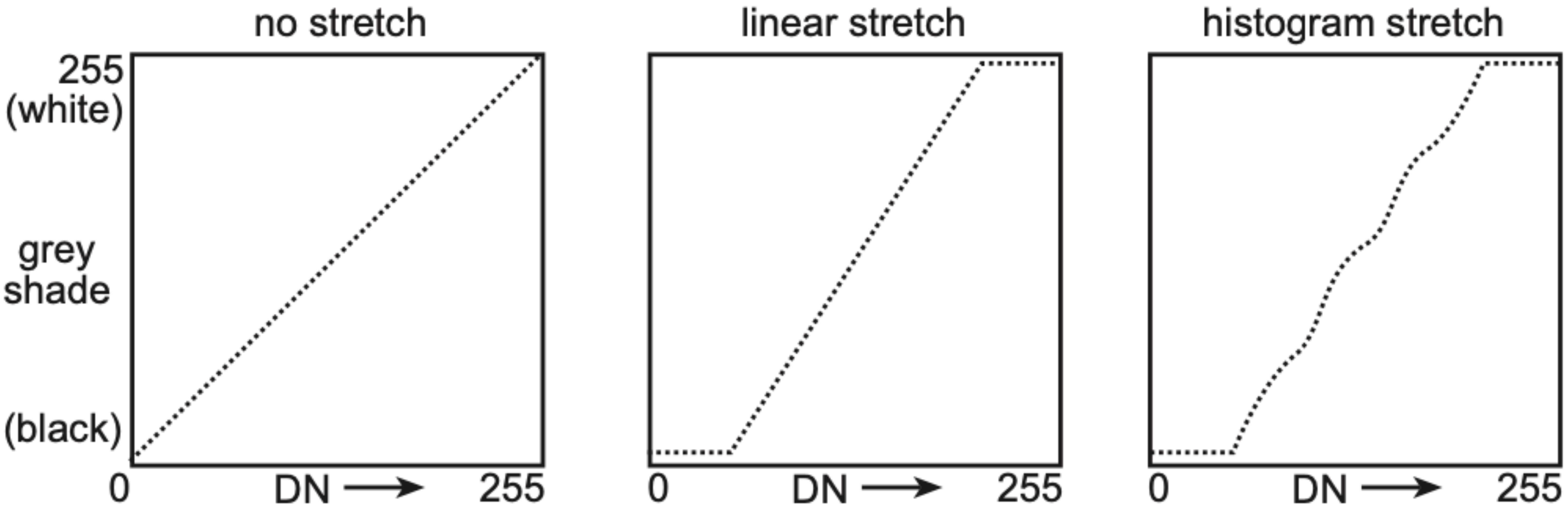
# Histograms

In [4]:
```
from rasterio.plot import show_hist
show_hist(bands, bins=50, lw=0.0, stacked=False, alpha=0.3, histtype='stepfilled', title="Histogram")
```



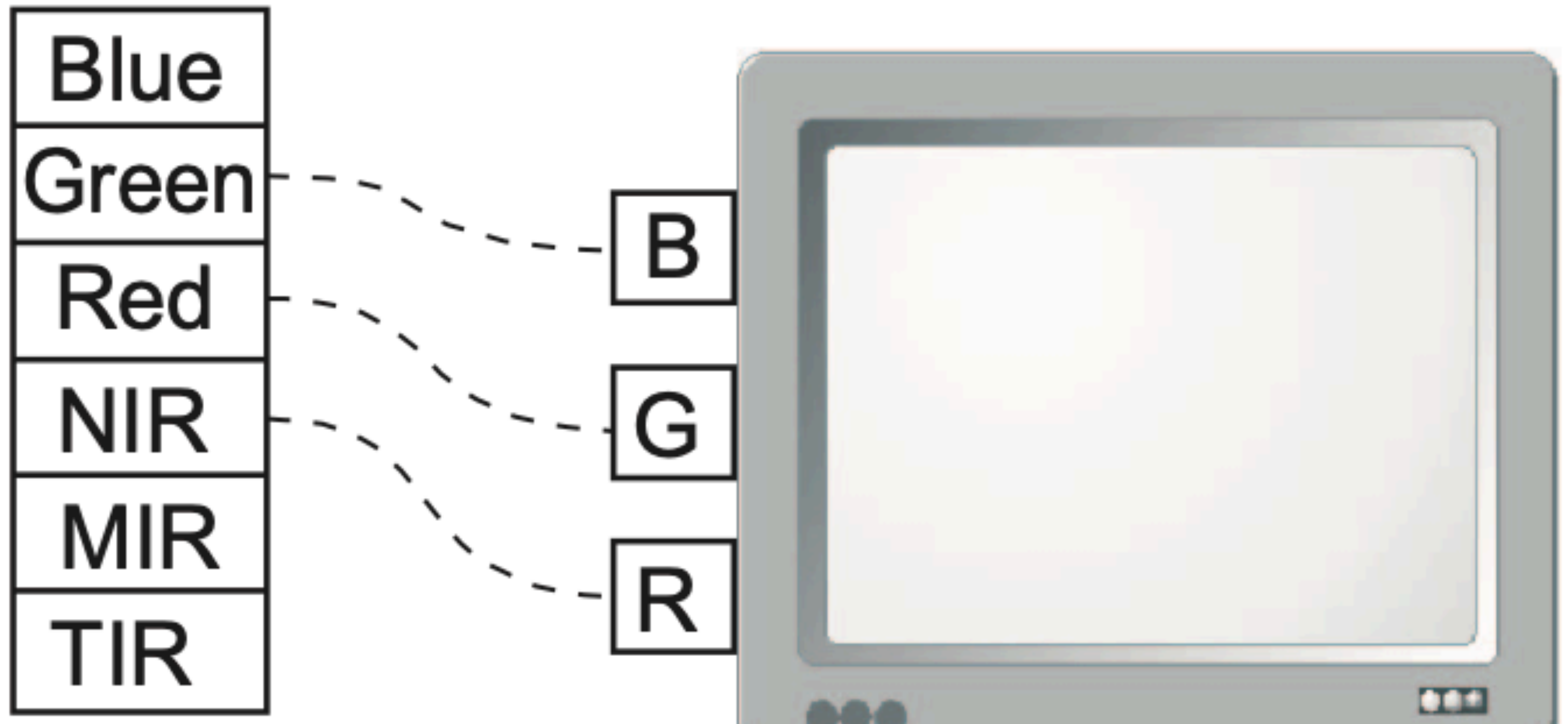
# Single-band display

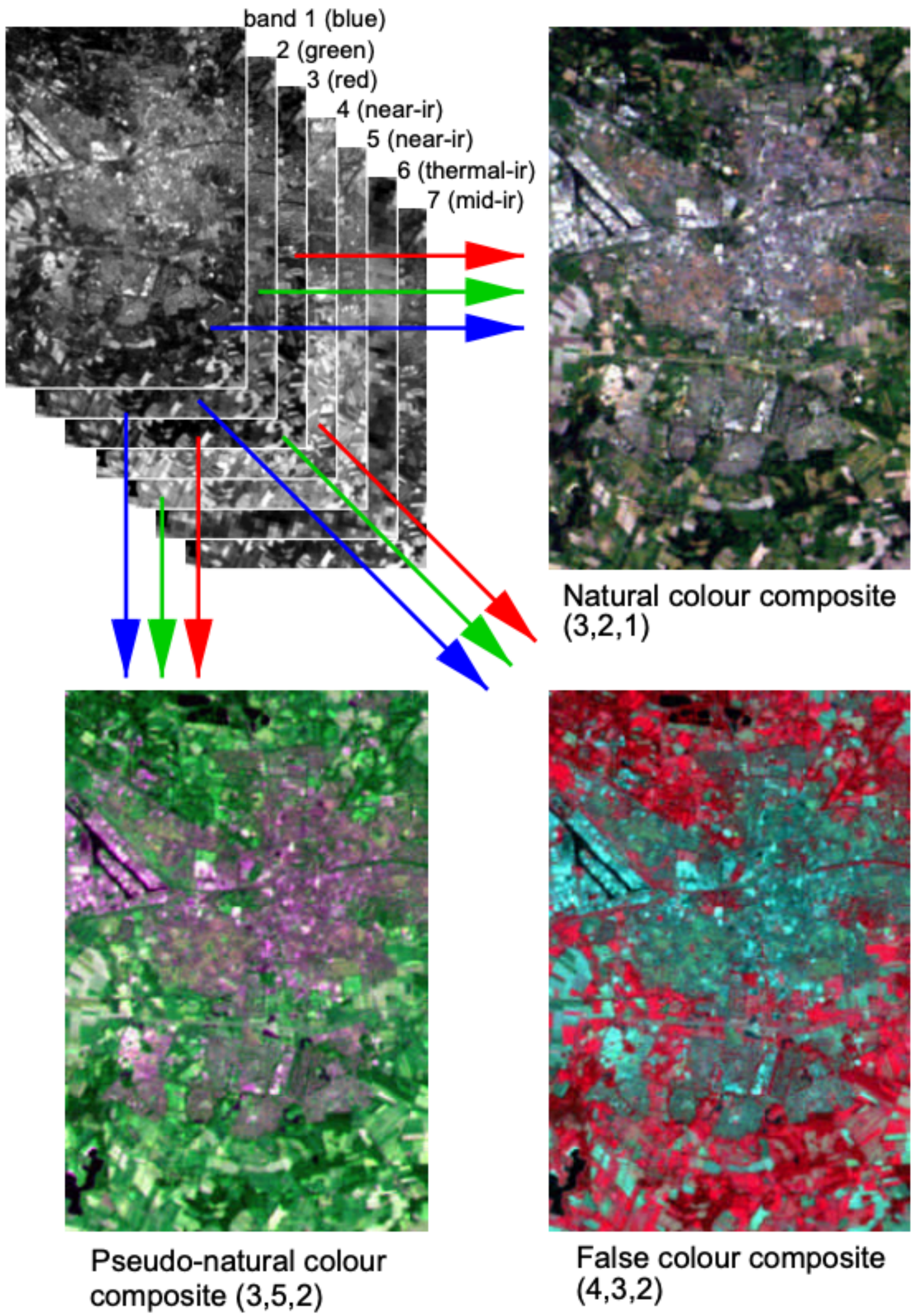
Transfer function maps the values for one band into (grey) shades



# Colour composites

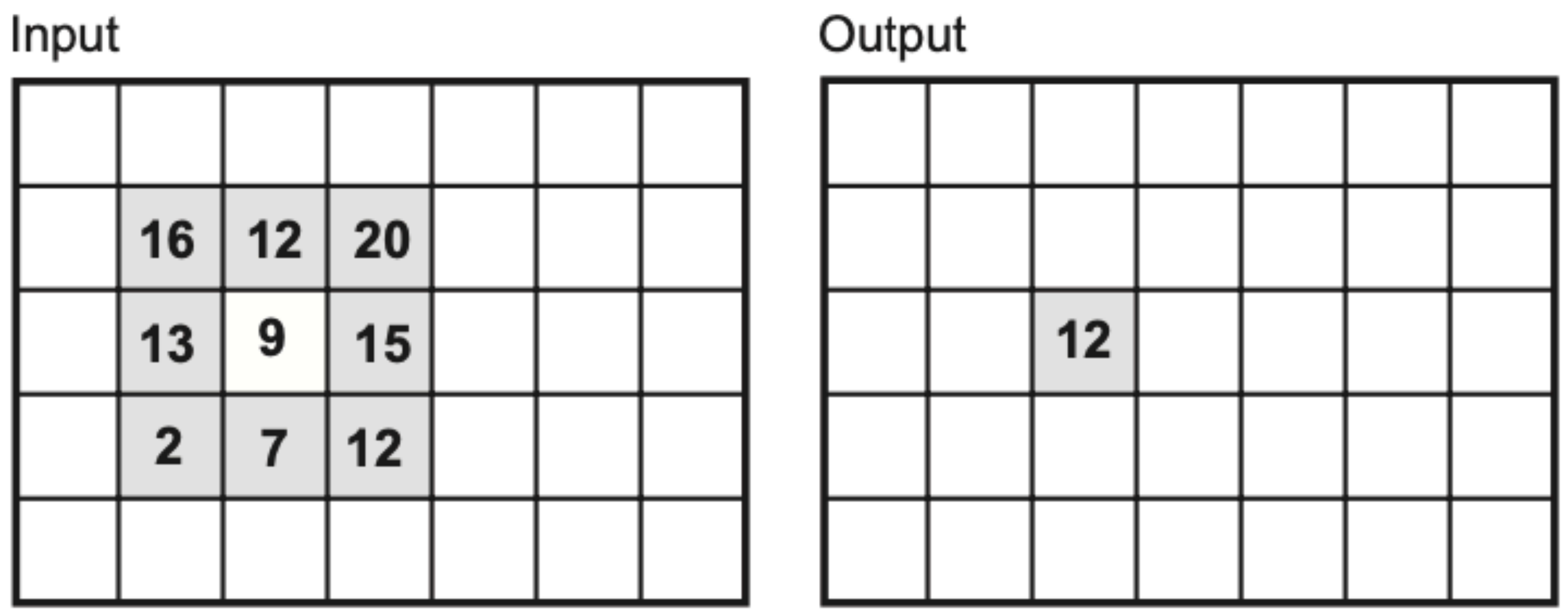
- True colour composite
- False colour composite



# Filter operations

- local image transformations: a new image is calculated and the value of a pixel depends on the values of its former neighbours.
- like focal operators in Map Algebra (GEO1002)
- **kernel** is used: 3x3, 4x4 or larger




| | | |
|---|---|---|
| 1 | 1 | 1 |
| 1 | 1 | 1 |
| 1 | 1 | 1 |

Smoothing 3x3 filter (average)
eg to remove noise

| | | |
|---|---|---|
| -1 | -1 | -1 |
| -1 | 16 | -1 |
| -1 | -1 | -1 |

Edge enhancement
filter (3x3)

to emphasise local diffs

# Filter operations

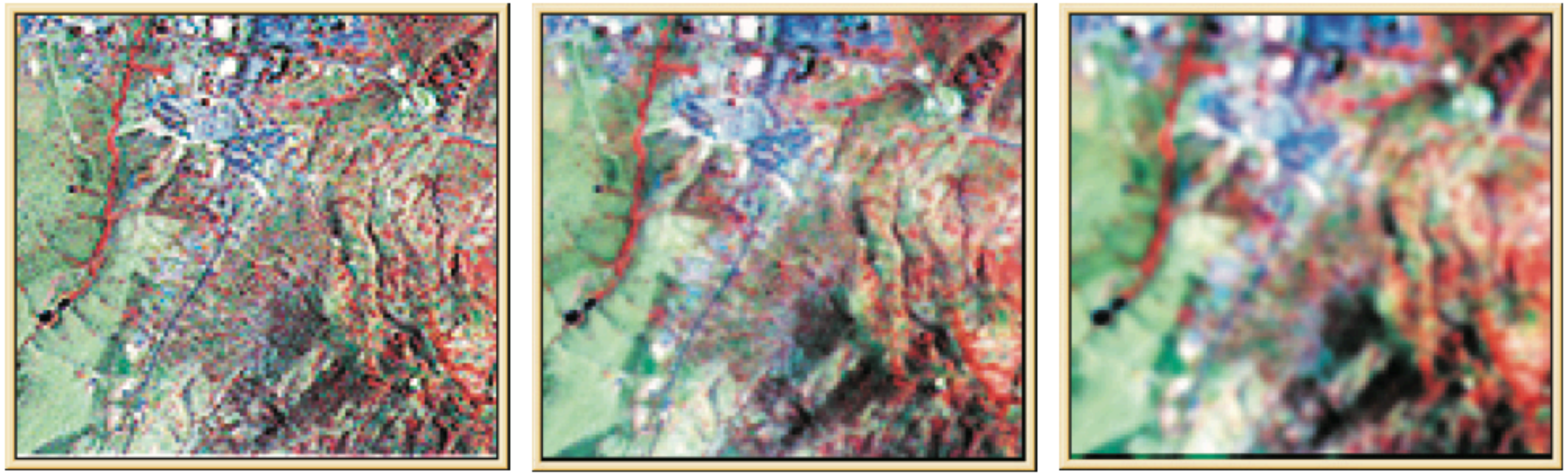
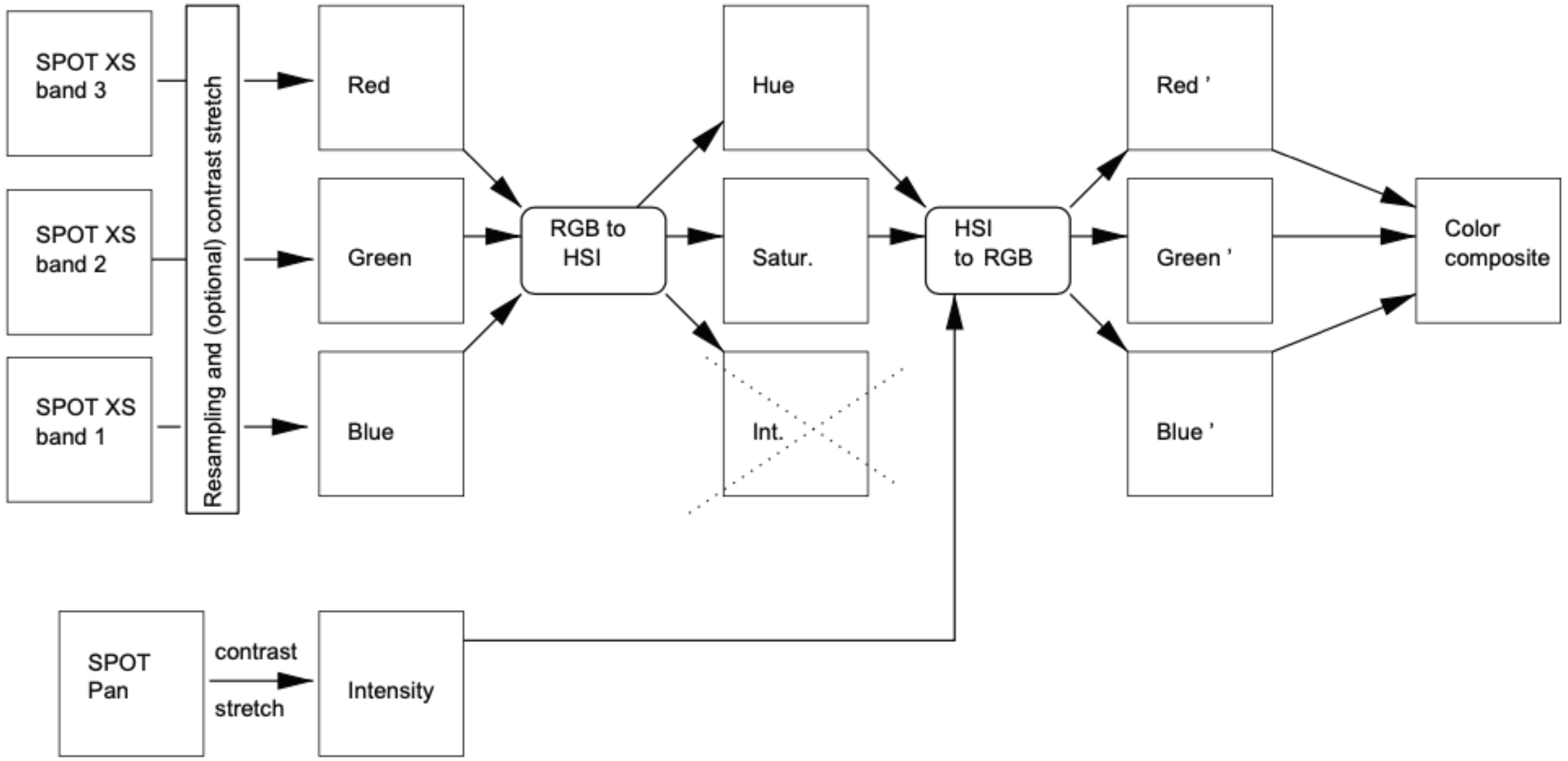
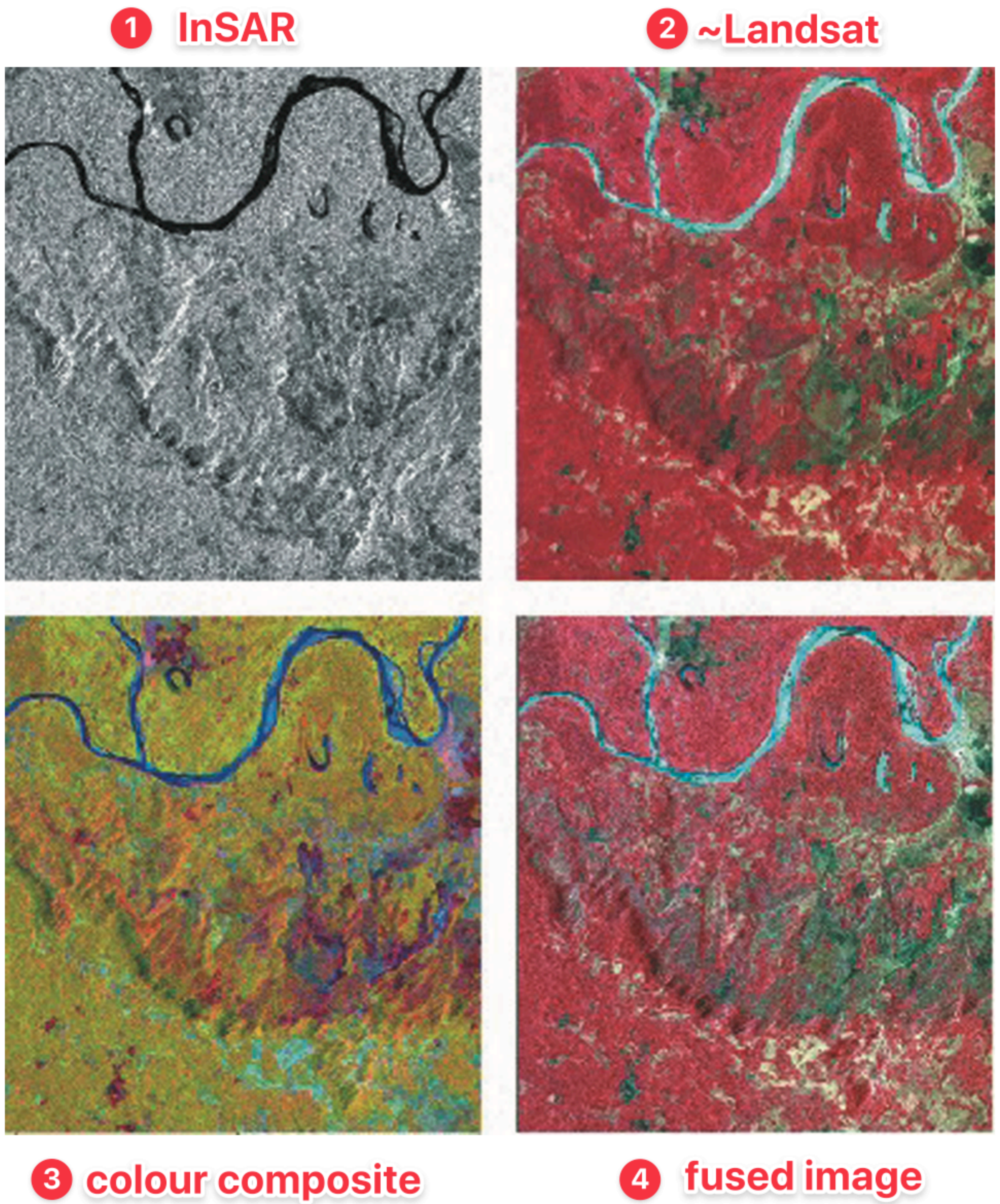


**Figure 10.10**: Original image (middle), edge enhanced image (left) and smoothed image (right).

# Colour composites: intensity substitution

- Image fusion: displaying images from diff sensors (and diff resolutions) to enhance display



# Coordinate system

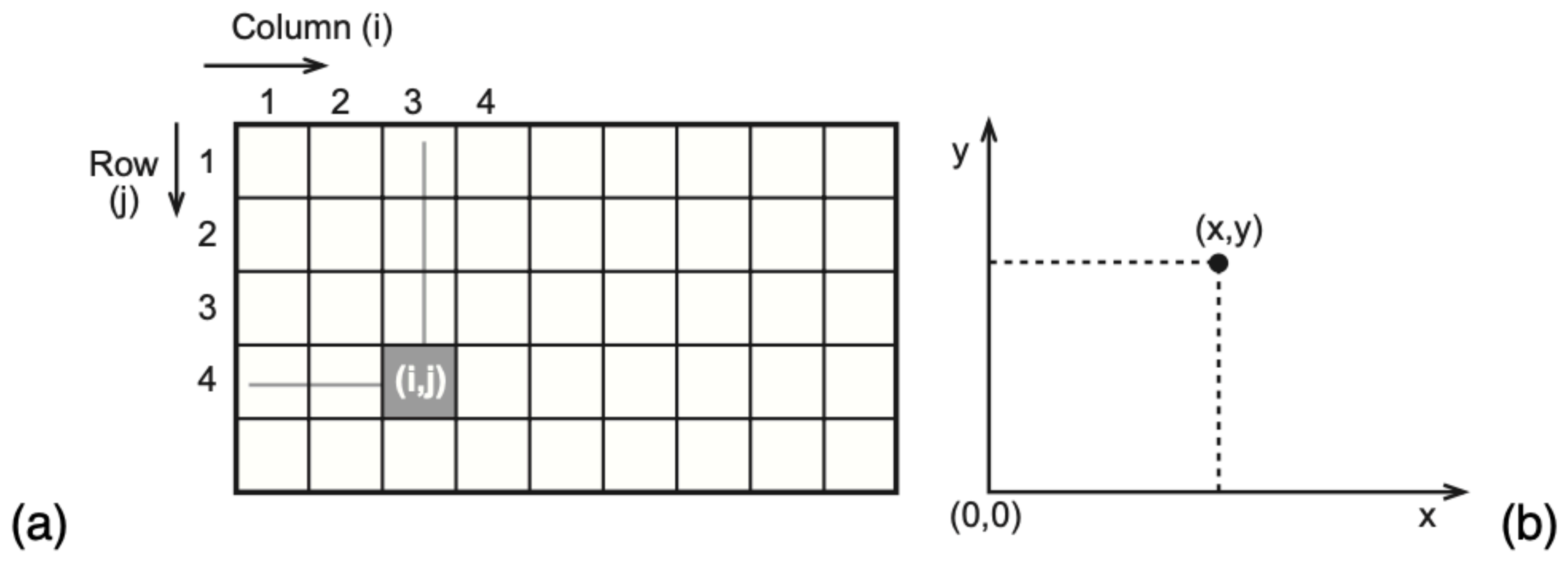
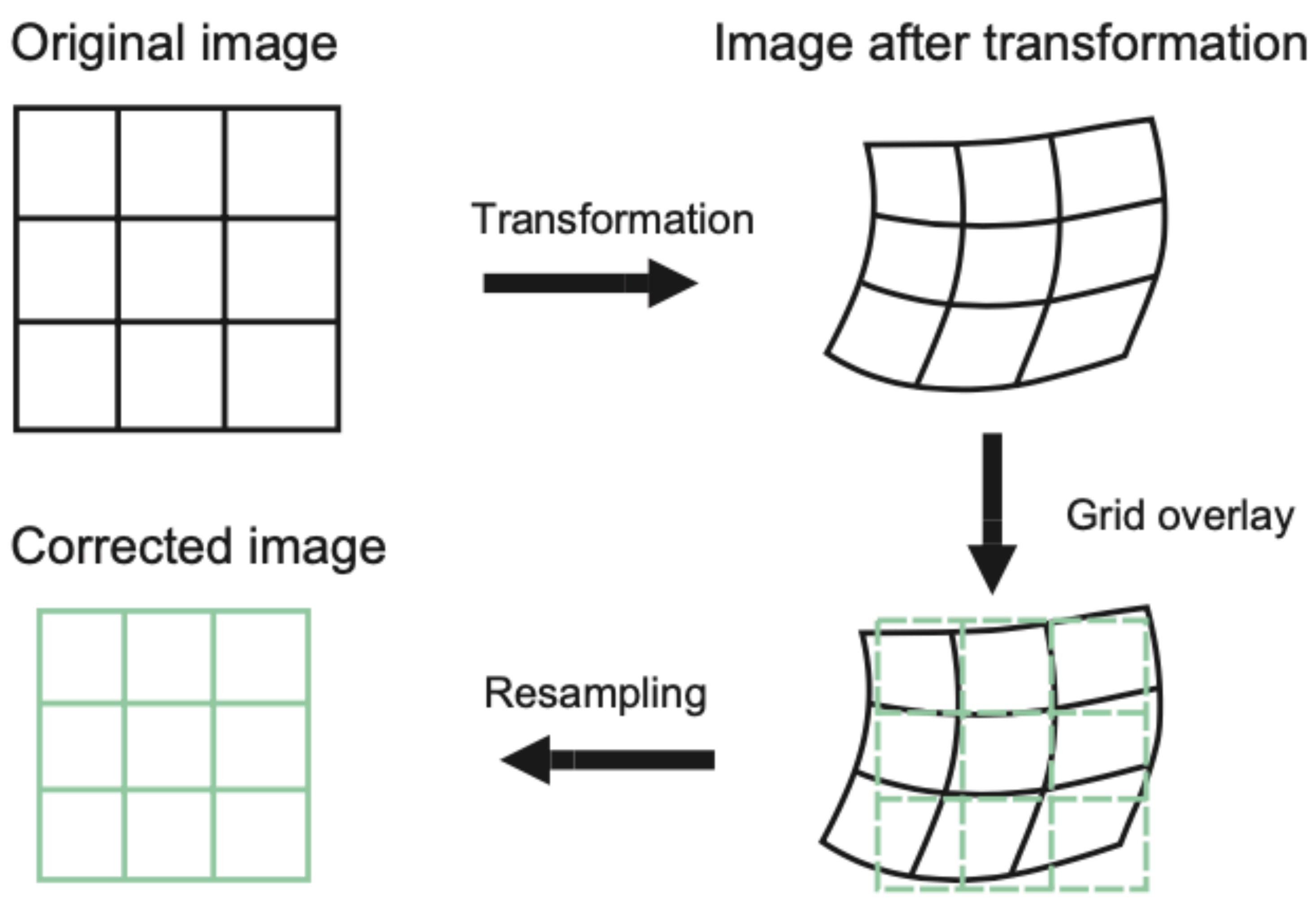
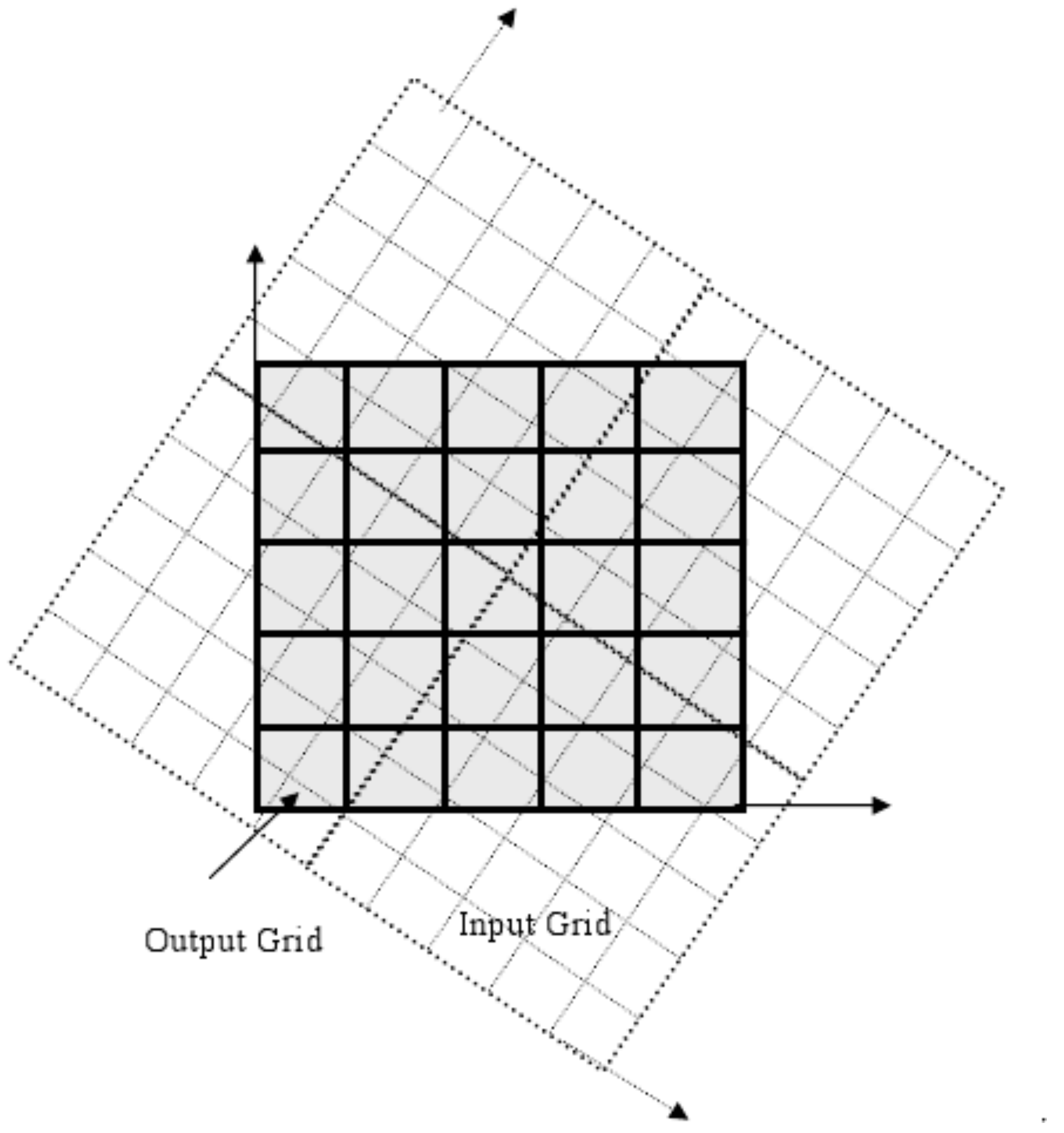
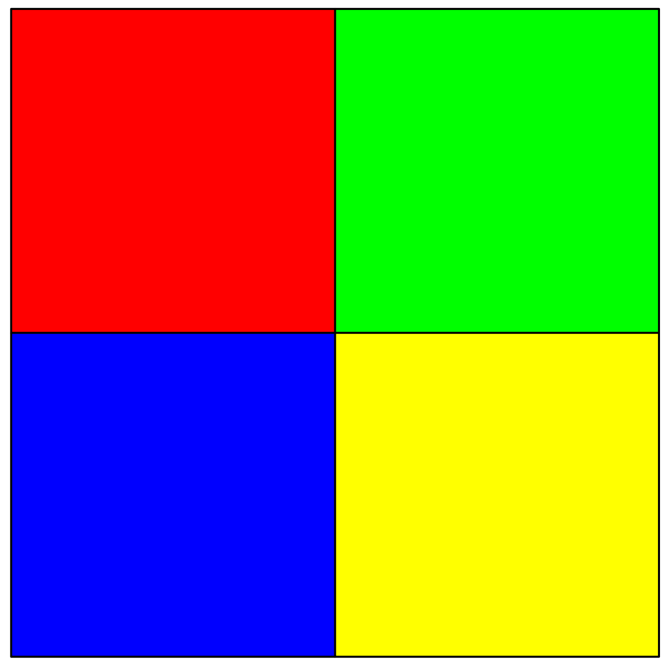


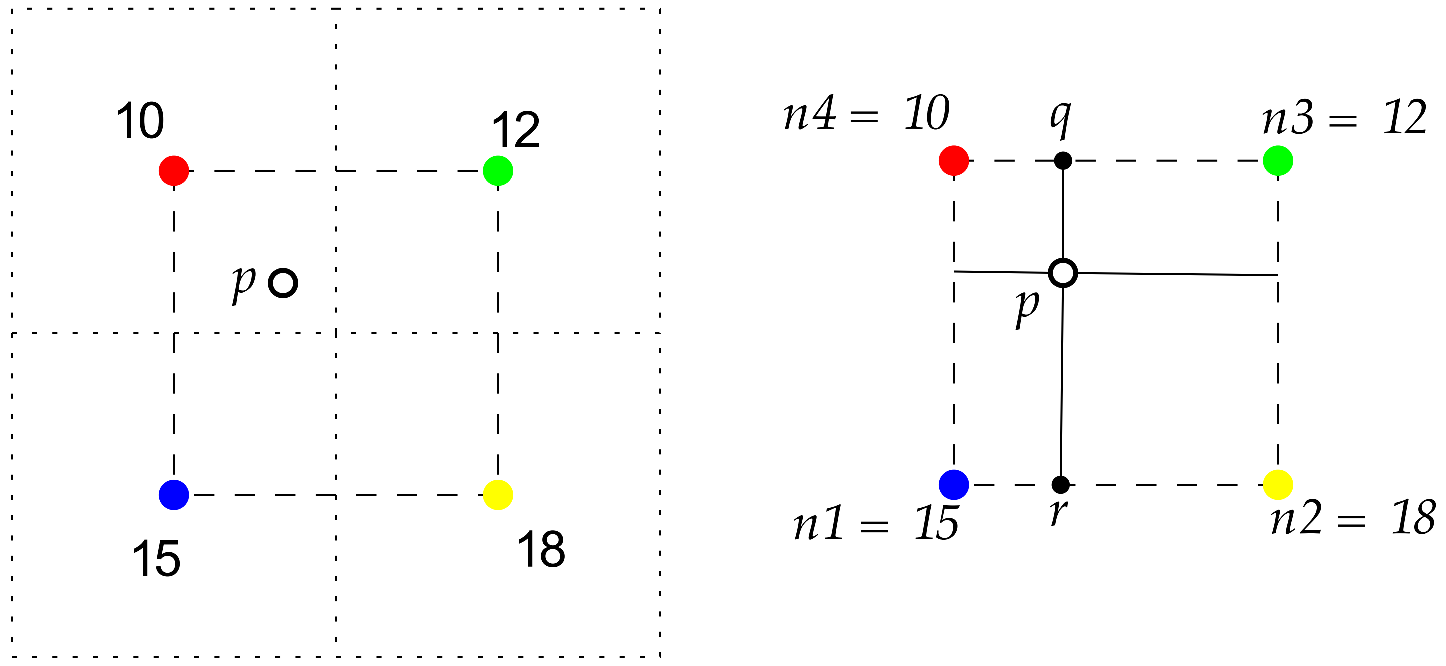

**Figure 9.1**: Coordinate system of the image defined by rows and columns (a), and map coordinate system with $x$- and $y$-axes (b).

# Transformation of an image and resampling

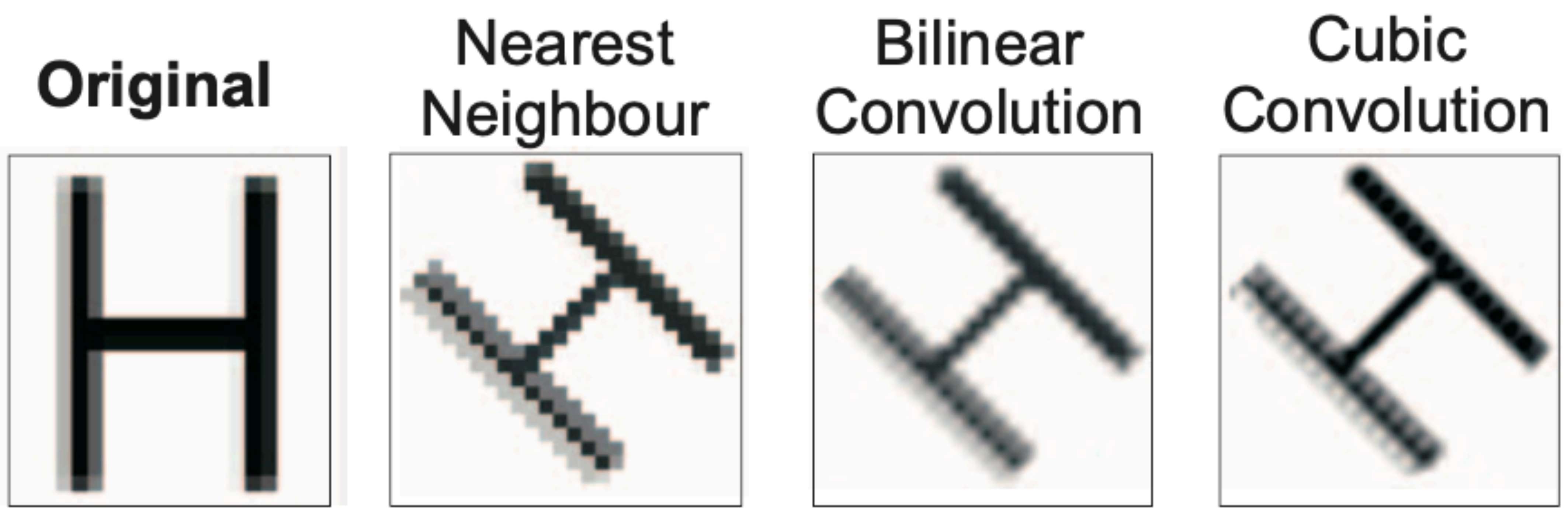





bilinear interpolation == GEO1015



https://3d.bk.tudelft.nl/courses/geo1001/