# DxO Contrast

Retro-Engineering of PhotoLab 7 Contrast Settings

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# What is contrast?

Original image

# What is contrast?

More contrast adds more punch to the image

# What is contrast?

Less contrast makes the image softer

# What is contrast?

Advanced contrast emphasizes certain elements within the image

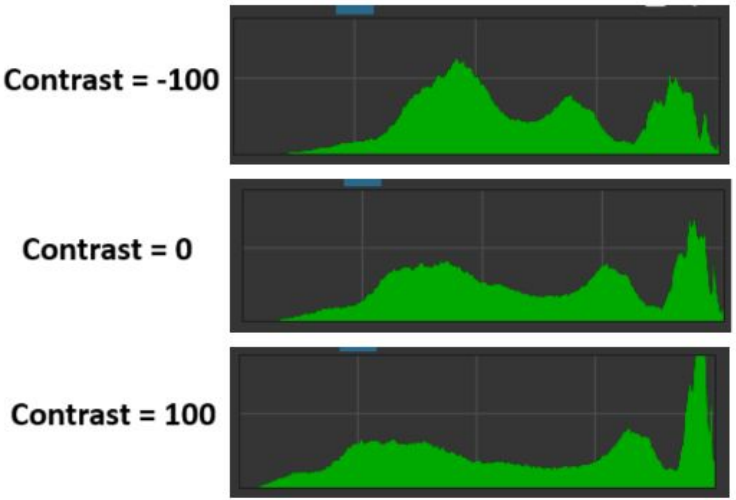
# What are the contrast settings?

- **Contrast:** The difference in **brightness** between the **light** and **dark** parts of an image.
- **Micro Contrast:** Small-scale variations in contrast, enhancing **very fine** details.
- **Fine Contrast:** Small-scale contrast variations, enhancing **fine** details.
- **Highlights:** The **brightest areas** where details might be overexposed.
- **Midtones:** Areas that lie between the highlights and the shadows (usually **main subject**).
- **Shadows:** The **darkest areas** where details might be obscured.

# How does the contrast settings work?

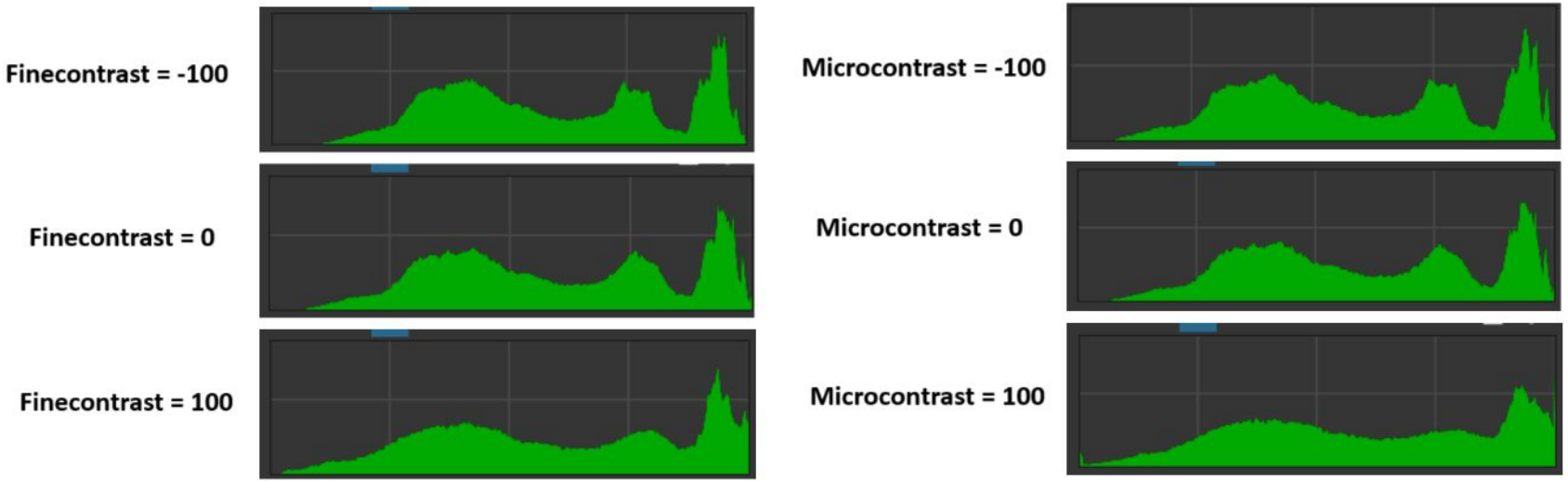
- All the previous contrast setting works by applying **modifications** on the **RGB histogram**
- The algorithm first does image processing by **analyzing** the **histogram** of **RGB channels**
- Then the algorithm applies **local modifications** to the **histograms** following the settings
- Finally the algorithm applies tone mapping by **limiting extreme values** and smoothing tones

# How does the contrast work?



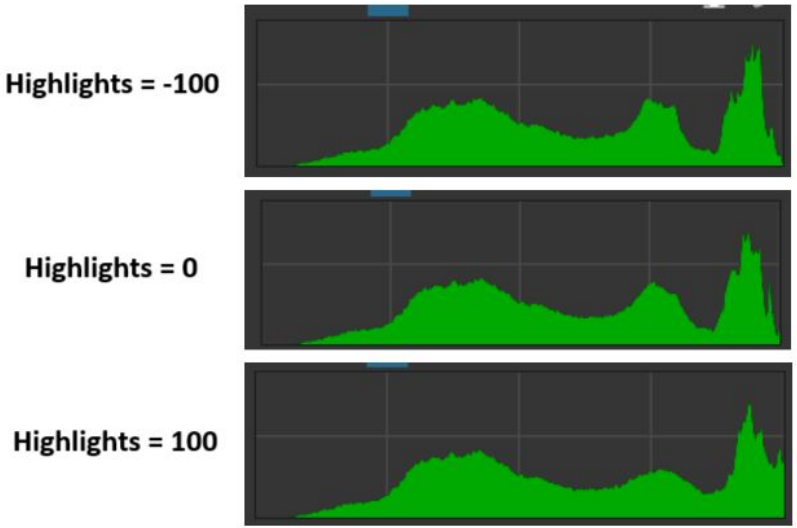

- When you increase contrast, you expand between the brightest and darkest parts
- Which results in a wider spread of tonal values across the RGB histogram
- The brighter areas become brighter, and the darker areas become darker
- As a result, the histogram spread out more towards both extremes, with peaks forming at the edges

# How does the micro and fine contrast work?



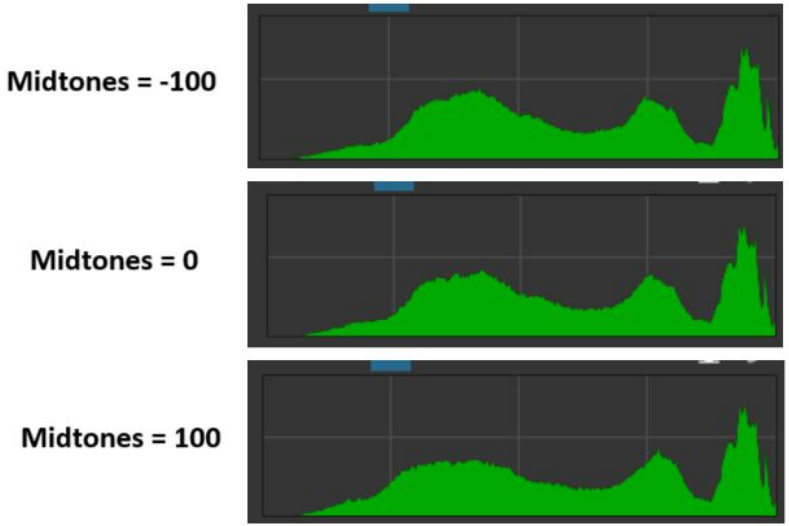

- It affects the mid-range of the histogram, emphasizing subtle differences between adjacent tones.
- Slight increase in the mid-range values, making the transitions between tones more pronounced.

# How does the highlights work?



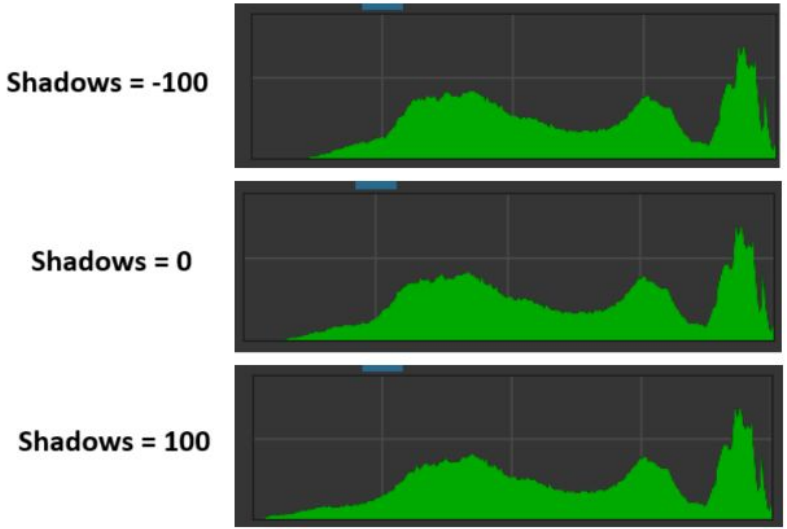

- Increasing the highlight can shift the histogram towards the right side emphasizing the peak
- It could compress the range by reducing the peak's width while intensifying the bright areas

# How does the midtones work?



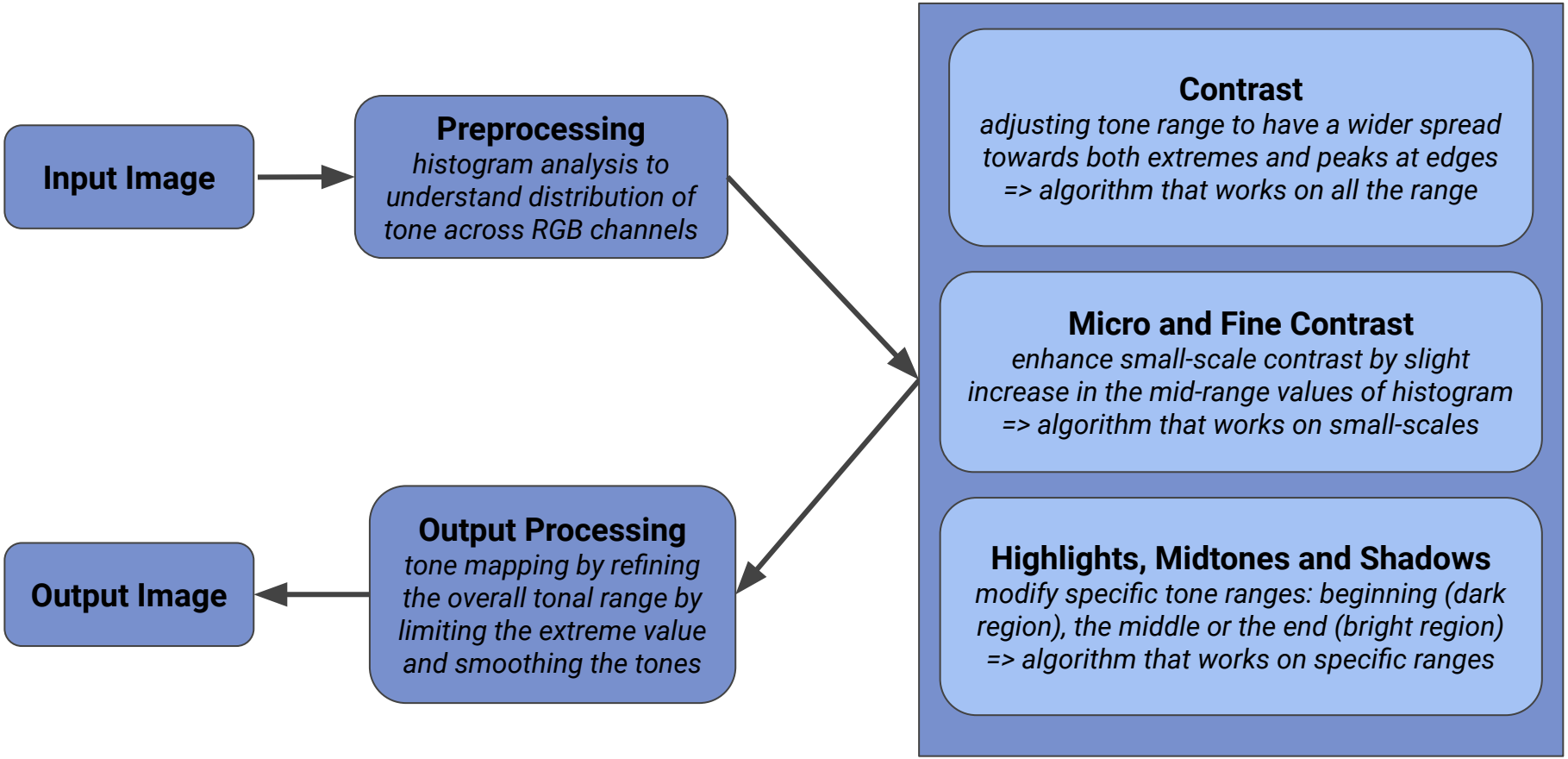

- Modifying midtones can slightly shift the central portion of the histogram and flatten it
- Increasing midtones might elevate the middle values by lifting the central portion of the histogram
- Enhancing the visibility and prominence of the main subject

# How does the shadows work?




- Adjusting shadows can shift the histogram towards the left side, accentuating the peak
- Increasing shadow adjustments might expand this area, bringing out more details in darker parts

# Block Diagram



# How did we try to implement contrast?

- We used a function that **blends two images** by adjusting their contribution
- We blend our original image with a **full black image** (zero value for each pixel)
- **alpha:** the contribution (i.e weight) of the original image in the contrast adjustment
- **gamma:** the scalar added to each pixel after contrast adjustment to control brightness
- Both are found using the following **formulas** (the numerical values are found empirically)

$$\alpha = \frac{131 \times (contrast\_level + 127)}{127 \times (131 - contrast\_level)} \qquad \gamma = 127 \times (1 - \alpha)$$

# How did we try to implement micro-contrast?

- We used a function that **blends two images** by adjusting their contribution
- We blend our original image with a **blurred version of the original image**
- **alpha:** the contribution (i.e weight) of the original image in the contrast adjustment
- **gamma:** the scalar added to each pixel after contrast adjustment to control brightness
- Both are found using the following **formulas** (the numerical values are found **empirically**)

$$\alpha = 1 + micro\_contrast\_level \qquad \gamma = -micro\_contrast\_level$$

# How did we try to implement fine-contrast?

- We first convert the image from **RGB** to **LAB**
- **L:** lightness encodes information about how bright or dark a color appears
- **A:** represents color on a green to red axis
- **B:** represents color on a blue to yellow axis
- Then it applies contrast to the **L channel using CLAHE**
- Finally we convert back the image from **LAB** to **RGB**

*CLAHE = (Contrast Limited Adaptive Histogram Equalization)*

# How did we try to implement highlights, midtones and shadows?

- We first convert the image from **RGB** to **HSV**
- **H:** hue is the type of color by measuring the degree around a color wheel from 0 to 360
- **S:** saturation describes the amount of grey in proportion to the hue
- **V:** value represents the brightness of a color
- Then it applies a **curve** that modifies the **brightness values**
- By **modifying the curve** we can apply modification on **bright or dark parts**
- Finally we convert back the image from **HSV** to **RGB**

# Why our implementation does not perfectly works?

- The **formulas** used for alpha and gamma maybe **not be accurate**
- We apply a global transformation to the all the pixels so we **lack local adaptation**
- We do **not take into account the content** of the image (portrait, landscape…)
- **Human perception is non-linear** so applying linear adjustment may not be the best idea
- Global contrast adjustments can **unevenly** affect individual color channels, causing **color shifts**
- Convert images to LAB or HSV may not lead into using some details or information

# Time for the demo!