Assignment 1:

Advanced Color-to-Gray Conversion

Computer Vision

National Taiwan University

Fall 2018

Color Conversion

- RGB2YUV
  - Read https://en.wikipedia.org/wiki/YUV for more details

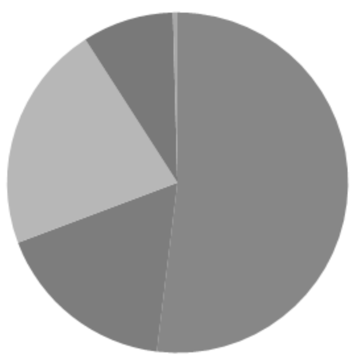
$$\begin{bmatrix} Y' \\ U \\ V \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.14713 & -0.28886 & 0.436 \\ 0.615 & -0.51499 & -0.10001 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix},$$

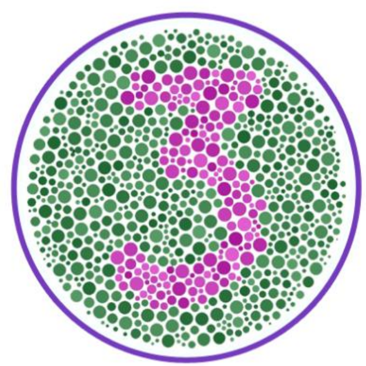
$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1 & 0 & 1.13983 \\ 1 & -0.39465 & -0.58060 \\ 1 & 2.03211 & 0 \end{bmatrix} \begin{bmatrix} Y' \\ U \\ V \end{bmatrix}.$$

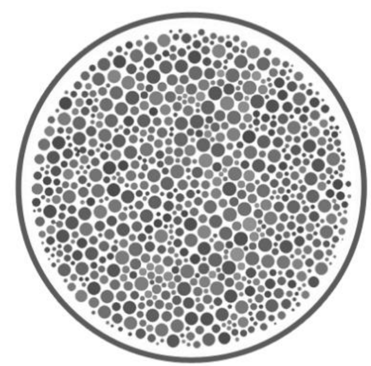
- Many vision systems only take the Y channel (luminance) as input to reduce computations

RGB to Gray

Problems





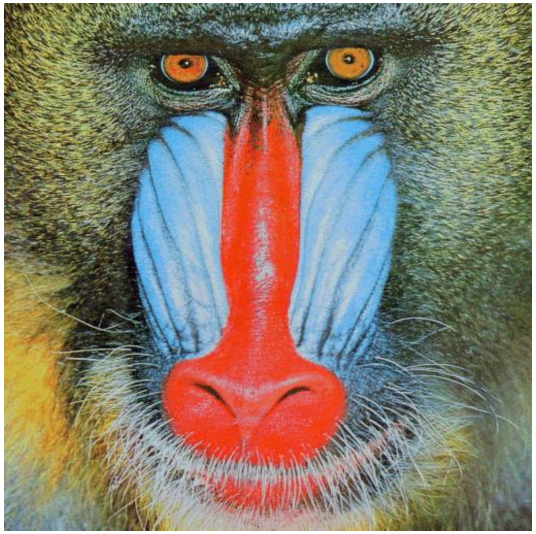


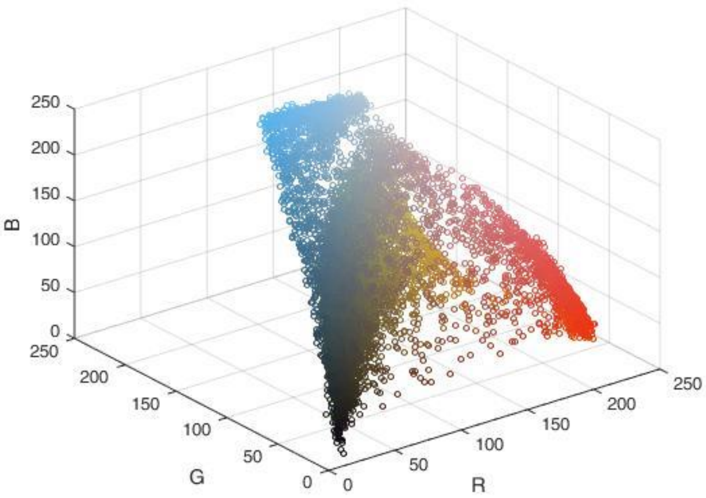
What happened?

- Dimensionality reduction

$$Y = 0.299R + 0.587G + 0.114B$$

- Another view:
  - The conversion is actually a plane equation! All colors on the same plane are converted to the same grayscale value.





Finding a better conversion

- The general form of linear conversion:

$$Y = w_r \cdot R + w_g \cdot G + w_b \cdot B$$

$$w_r, w_g, w_b >= 0$$

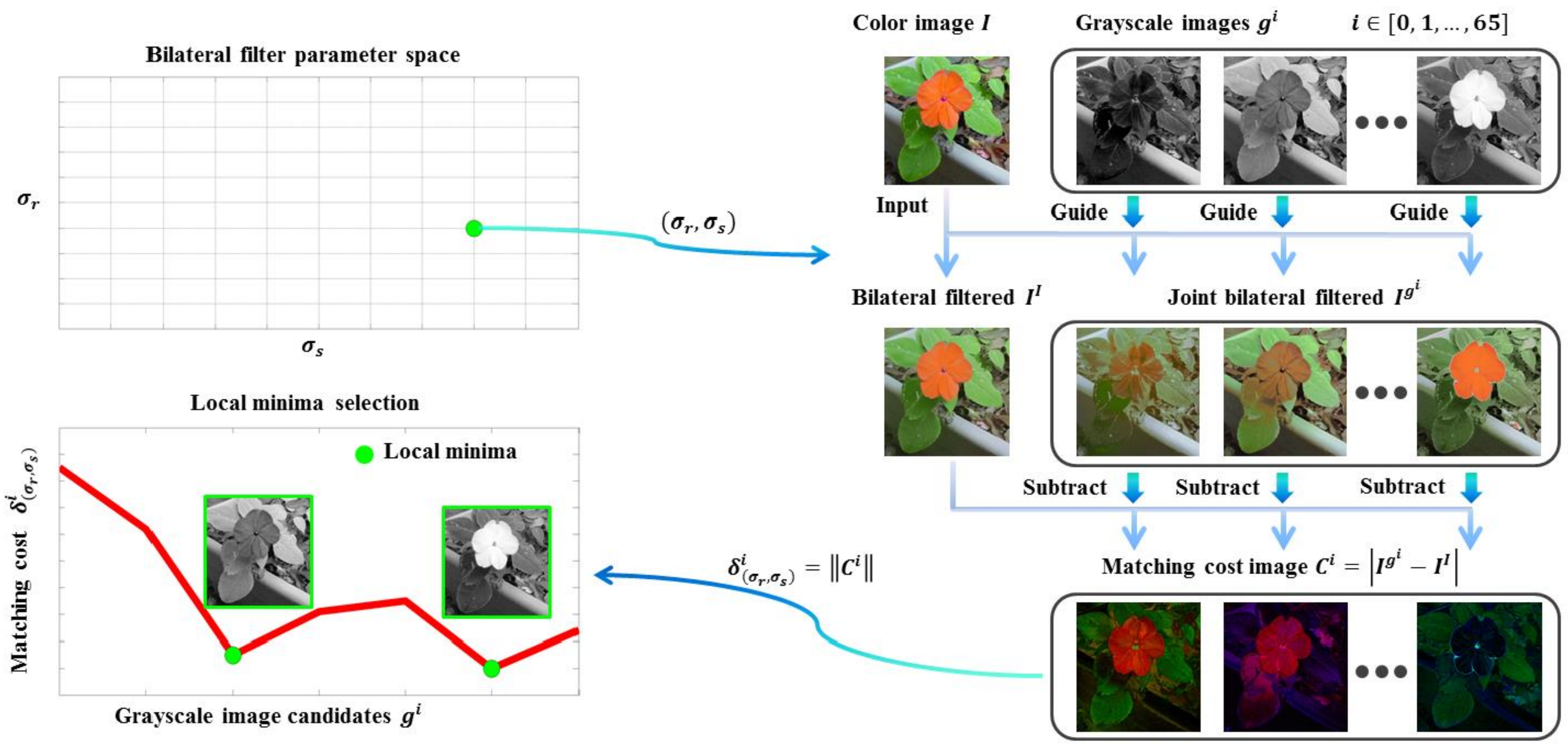
$$w_r + w_g + w_b = 1$$

- Let's consider the quantized weight space $w \in \{0, 0.1, 0.2, ..., 1\}$
  - For example: $(w_r, w_g, w_b) = (0, 0, 1)$
    $(w_r, w_g, w_b) = (0, 0.1, 0.9)$
  - Given a color image, a set of weight combination corresponds to a grayscale image candidate.
  - We are going to identify which candidate is better!

Yibing Song, Linchao Bao, Xiaobin Xu, and Qingxiong Yang. **Decolorization: is rgb2gray() out?**. In *SIGGRAPH Asia 2013 Technical Briefs*

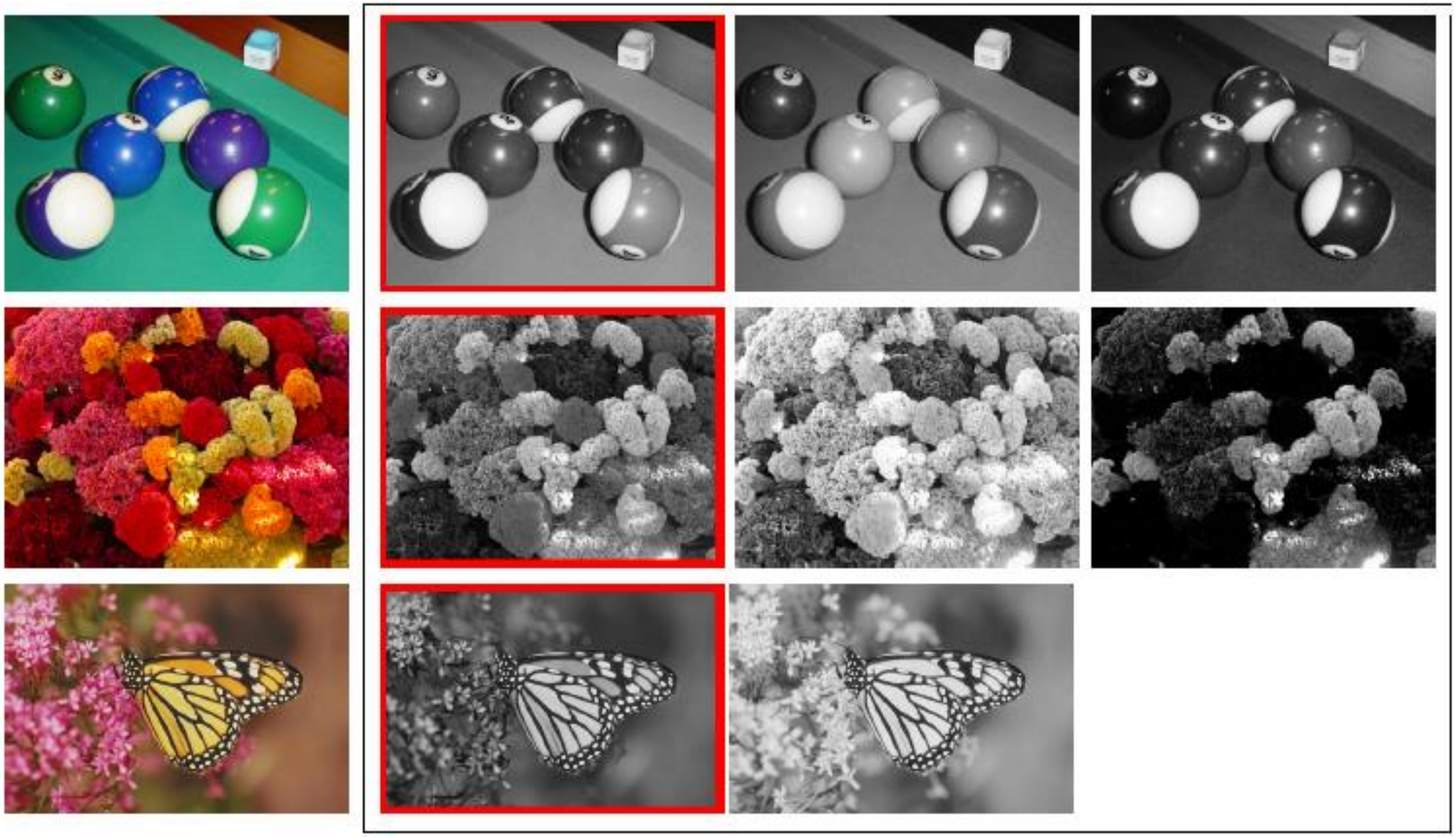
Measuring the perceptual similarity

- Joint bilateral filter (JBF) as the similarity measurement



Multiple Local Minima

- Keep the 3 most voted



Color Image Guided Bilateral Filter

- Given T as the guidance, the bilateral filter is written as:

$$F^T(I) = \frac{\sum_{q \in \Omega_p} G_s(p,q) G_r(T_p, T_q) I_q}{\sum_{q \in \Omega_p} G_s(p,q) G_r(T_p, T_q)}$$

- If T is a single-channel image:

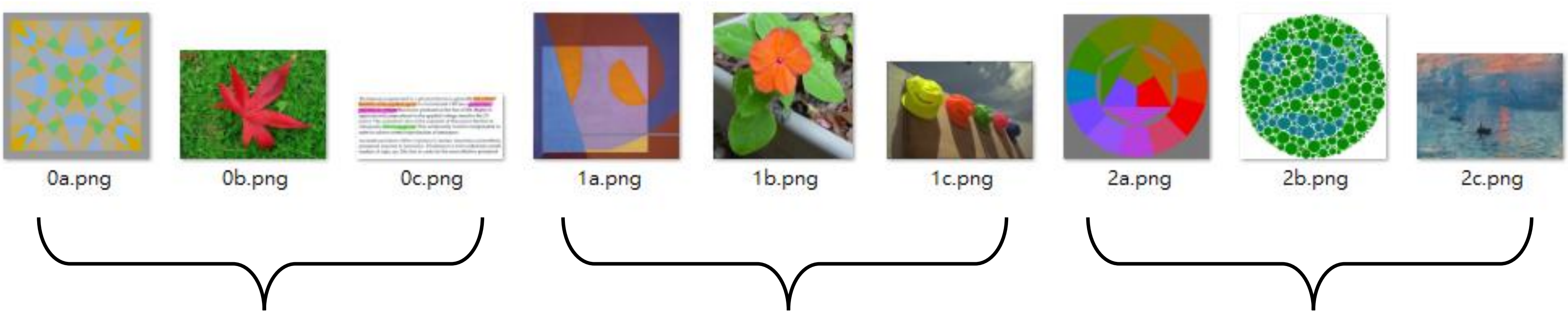
$$G_r(T_p, T_q) = e^{-\frac{(T_p - T_q)^2}{2\sigma_r^2}}$$

- If T is a color image:

$$G_r(T_p, T_q) = e^{-\frac{(T_p^r - T_q^r)^2 + (T_p^g - T_q^g)^2 + (T_p^b - T_q^b)^2}{2\sigma_r^2}}$$

Assignment Description

- Test images
  - 學號末三碼除以三之餘數



Group 0 Group 1 Group 2

Assignment Description

- Implement the conventional rgb2gray conversion
- Implement the joint bilateral filter
- Implement the advanced rgb2gray described above
  - Quantize the weight space as in p6 (hint: totally 66 combinations)
  - Consider the 9 bilateral parameters $\sigma_s \in \{1, 2, 3\}$ and $\sigma_r \in \{0.05, 0.1, 0.2\}$ *255
  - Find the cost local minima on the 2D plane $w_r + w_g + w_b = 1$
  - Vote the candidates for each set of bilateral parameter
  - Return the top 3 most voted candidates for each input image

Submission

- Code: *.py
- Output images (assume the input is 0a.png)
  - Conventional rgb2gray: 0a_y.png
  - Advanced rgb2gray: 0a_y1.png, 0a_y2.png, 0a_y3.png
- A PDF report, containing
  - Your student ID, name and input images
  - Describe how to run your code
  - Describe how you implement the local minima selection
  - Show your output images and the corresponding weight combinations
  - Any other trick you want to share or comments to this assignment are welcome
- Compress all above files in a zip file named StudentID.zip
  - e.g. R07654321.zip
- Submit to CEIBA
- Deadline: 10/16 11:00 pm