

# Group Assignment 2

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The aim of this assignment is to start thinking about images as a collection of functions of the pixels, as a matrix of pixels, how to work with those and apply some convolution to images.

What you need to do:

**1) You need 2 images. You can take new images or use your previous images. (a suggestion: try to use images where you think you will see something new in different color spaces).**

```
arcaid = imread("ARCAid.jpg");
carter = imread("carter.jpg");

imshow(arcaid)
title("ARCAid Sign")
```

ARCAid Sign



```
imshow(carter)
title("Our dear friend, Carter (and Ayush in the background with verbal consent)")
```

**Our dear friend, Carter (and Ayush in the background with verbal consent)**



## 2) Pixel Processing

### a) Change brightness of your image

```
arcaid_bright = arcaid + 128;  
imshow(arcaid_bright)  
title("ARCAid Sign Brightened")
```

## ARCAid Sign Brightened



```
carter_bright = carter + 128;  
imshow(carter_bright)  
title("Carter Brightened")
```

**Carter Brightened**



```
arcaid_dark = arcaid - 128;  
imshow(arcaid_dark)  
title("ARCAid Darkened")
```

ARCAid Darkened



```
carter_dark = carter - 128;  
imshow(carter_dark)  
title("Carter Darkened")
```

Carter Darkened



**b) Change contrast of your image**

```
arcaid_contrast = arcaid * 1/2;  
imshow(arcaid_contrast)  
title("ARCAid with Contrast")
```

## ARCAid with Contrast



```
carter_contrast = carter * 2;  
imshow(carter_contrast)  
title("Carter with Contrast")
```

**Carter with Contrast**



**c) Change brightness of alternating pixels of the image**

```
arcaid_apb = arcaid;  
  
arcaid_apb(1:2:end, 1:2:end, :) = arcaid(1:2:end, 1:2:end, :) + 128;  
  
imshow(arcaid_apb)  
title("ARCAid with Alternating Pixel Brightness")
```

## ARCAid with Alternating Pixel Brightness



```
carter_apb = carter;  
  
carter_apb(1:2:end, 1:2:end, :) = carter(1:2:end, 1:2:end, :) + 128;  
  
imshow(carter_apb)  
title("Carter with Alternating Pixel Brightness")
```

Carter with Alternating Pixel Brightness



### 3) Color Spaces (more about color spaces [here](#) and [here](#))

a) Show your images in the different color spaces we discussed.

ARCAid RGB

```
arcaid_red = zeros(size(arcaid), "uint8");
arcaid_red(:,:,1) = arcaid(:, :, 1);
imshow(arcaid_red)
title("Red ARCAid")
```

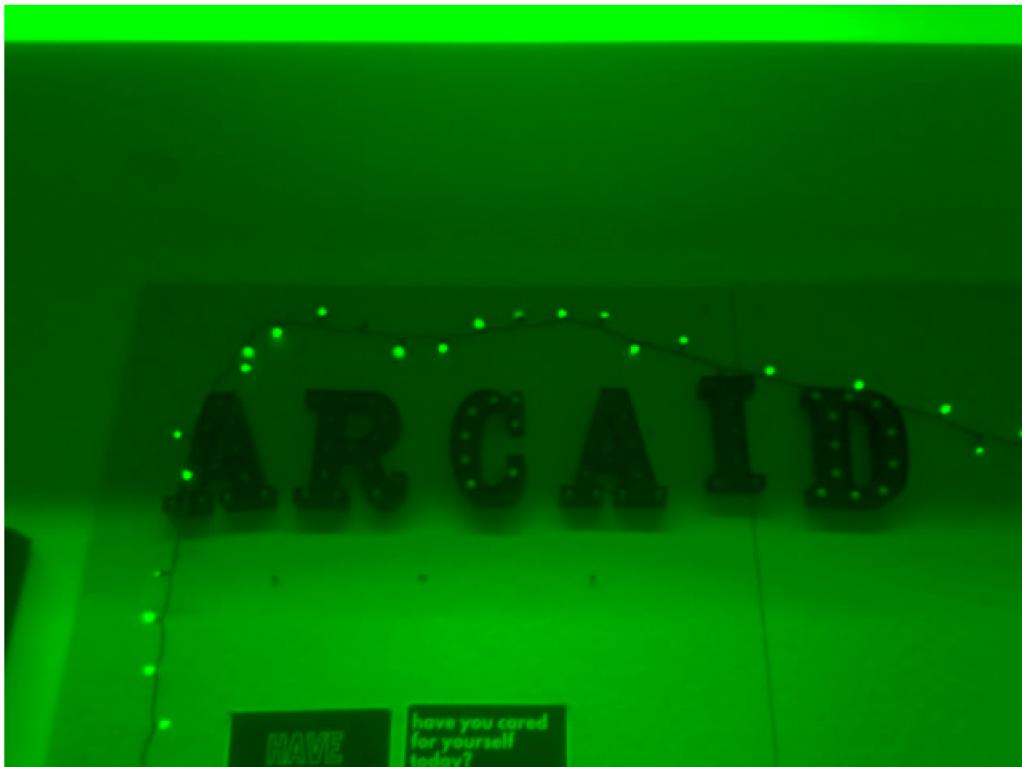
## Red ARCAid



```
arcaid_green = zeros(size(arcaid), "uint8");
arcaid_green(:, :, 2) = arcaid(:, :, 2);

imshow(arcaid_green)
title("Green ARCAid")
```

## Green ARCAid



```
arcaid_blue = zeros(size(arcaid), "uint8");
arcaid_blue(:, :, 3) = arcaid(:, :, 3);

imshow(arcaid_blue)
title("Blue ARCAid")
```

Blue ARCAid



### Carter RGB

```
carter_red = zeros(size(carter), "uint8");
carter_red(:,:,1) = carter(:, :, 1);
imshow(carter_red)
title("Red Carter")
```

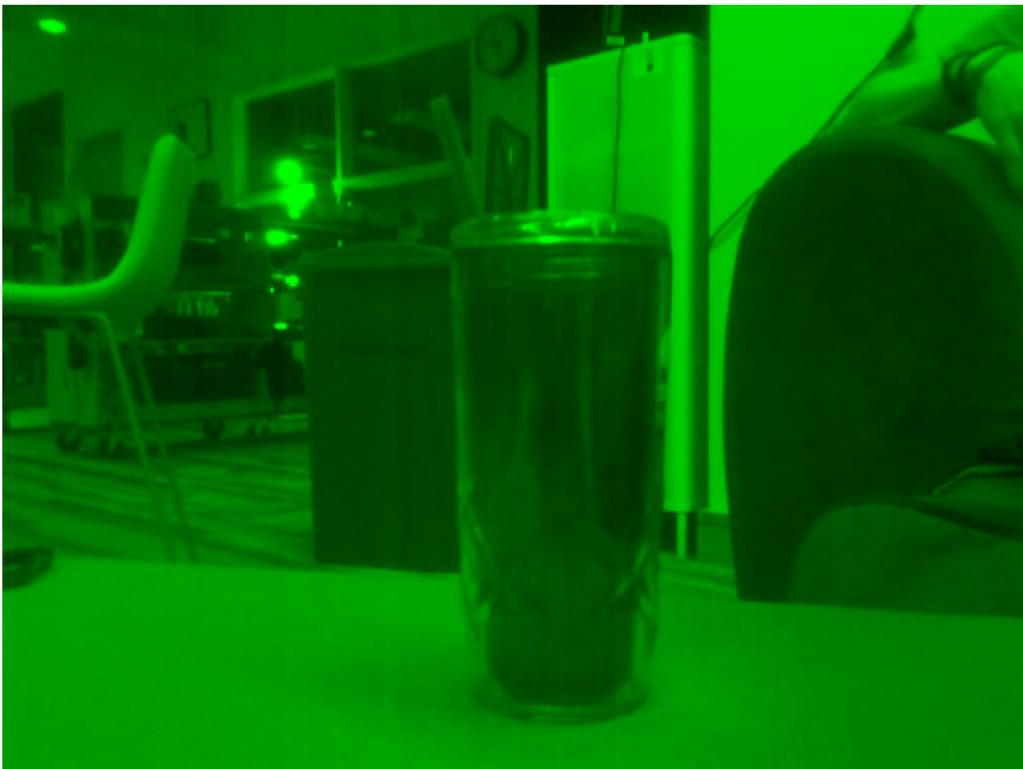
**Red Carter**



```
carter_green = zeros(size(carter), "uint8");
carter_green(:, :, 2) = carter(:, :, 2);

imshow(carter_green)
title("Green Carter")
```

**Green Carter**



```
carter_blue = zeros(size(carter), "uint8");
carter_blue(:,:,:,3) = carter(:,:,3);

imshow(carter_blue)
title("Blue Carter")
```

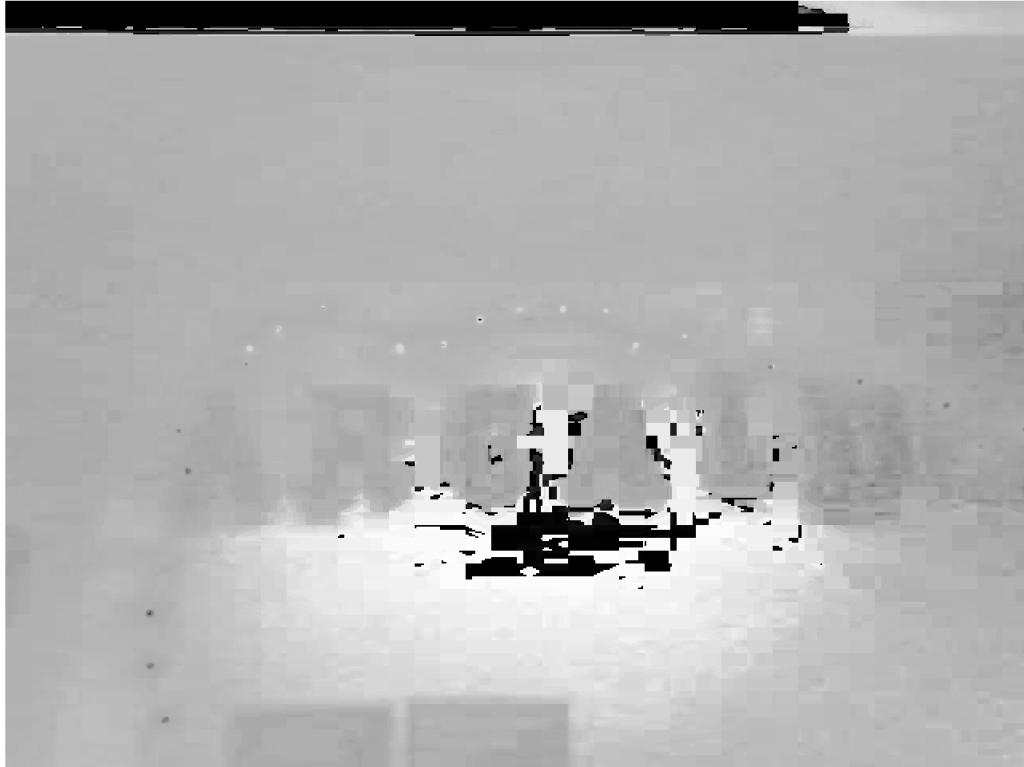
**Blue Carter**



#### **ARCAid HSV**

```
arcaid_hsv = rgb2HSV(arcaid);
imshow(arcaid_hsv(:,:,1))
title("ARCAid Sign in Hue")
```

ARCAid Sign in Hue



```
imshow(arcaid_hsv(:, :, 2))
title("ARCAid Sign in Saturation")
```

ARCAid Sign in Saturation



```
imshow(arcaid_hsv(:,:,3))
title("ARCAid Sign in Value")
```

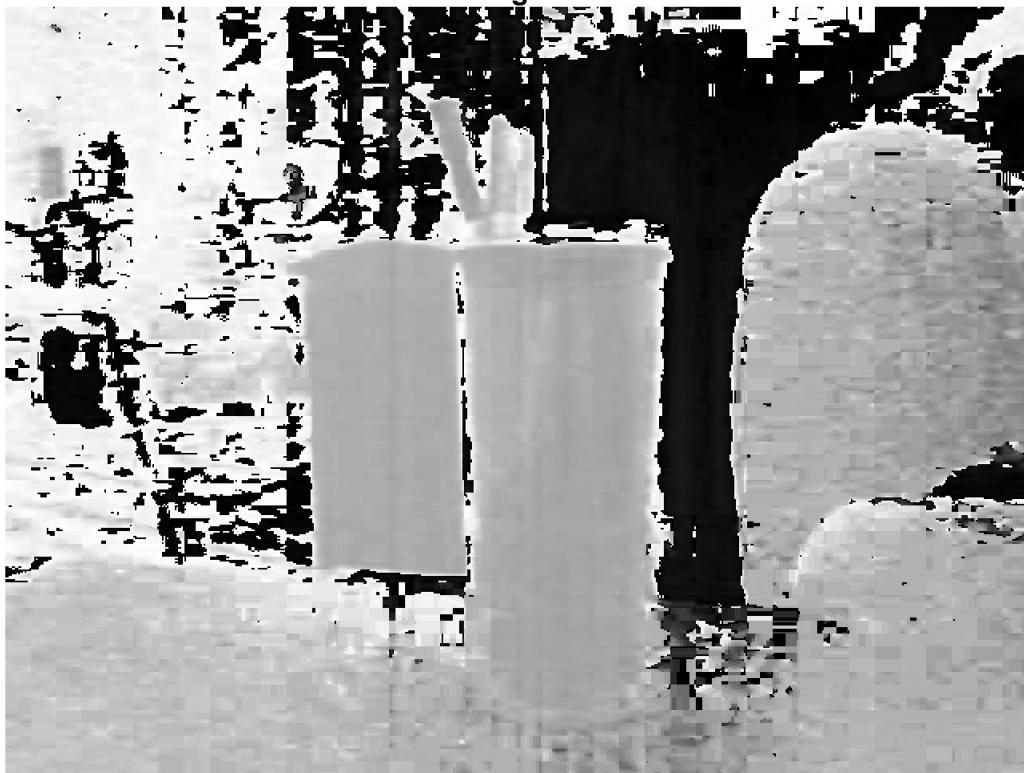
### ARCAid Sign in Value



### Carter HSV

```
carter_hsv = rgb2HSV(carter);
imshow(carter_hsv(:, :, 1))
title("Carter Sign in Hue")
```

Carter Sign in Hue



```
imshow(carter_hsv(:, :, 2))
title("Carter Sign in Saturation")
```

Carter Sign in Saturation



```
imshow(carter_hsv(:, :, 3))
title("Carter Sign in Value")
```

Carter Sign in Value



b) Plot at least 4 different histograms for each image from the various color spaces (e.g. you can do red, green, saturation, value).

#### Arcaid Histograms

```
figure
subplot(1, 3, 1)
imhist(arcaid_red)
title("Red ARCAid")
xlabel("Red")
ylabel("Number of Pixels")
ylim([0 1e4])

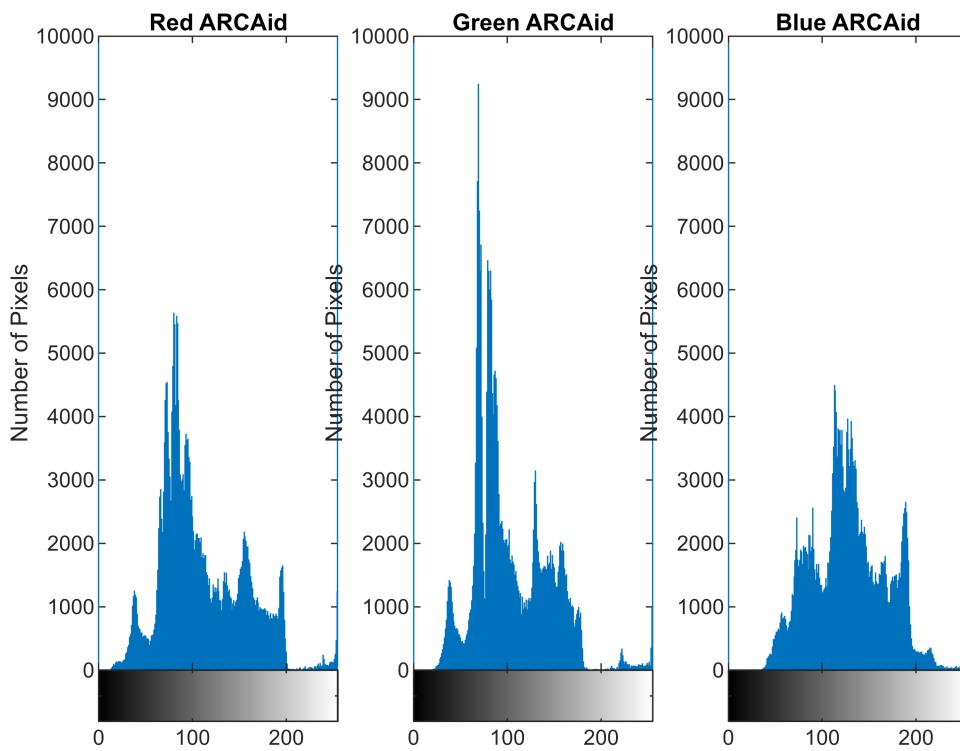
subplot(1, 3, 2)
imhist(arcaid_green)
title("Green ARCAid")
xlabel("Green")
ylabel("Number of Pixels")
ylim([0 1e4])

subplot(1, 3, 3)
imhist(arcaid_blue)
title("Blue ARCAid")
```

```

xlabel("Blue")
ylabel("Number of Pixels")
ylim([0 1e4])

```



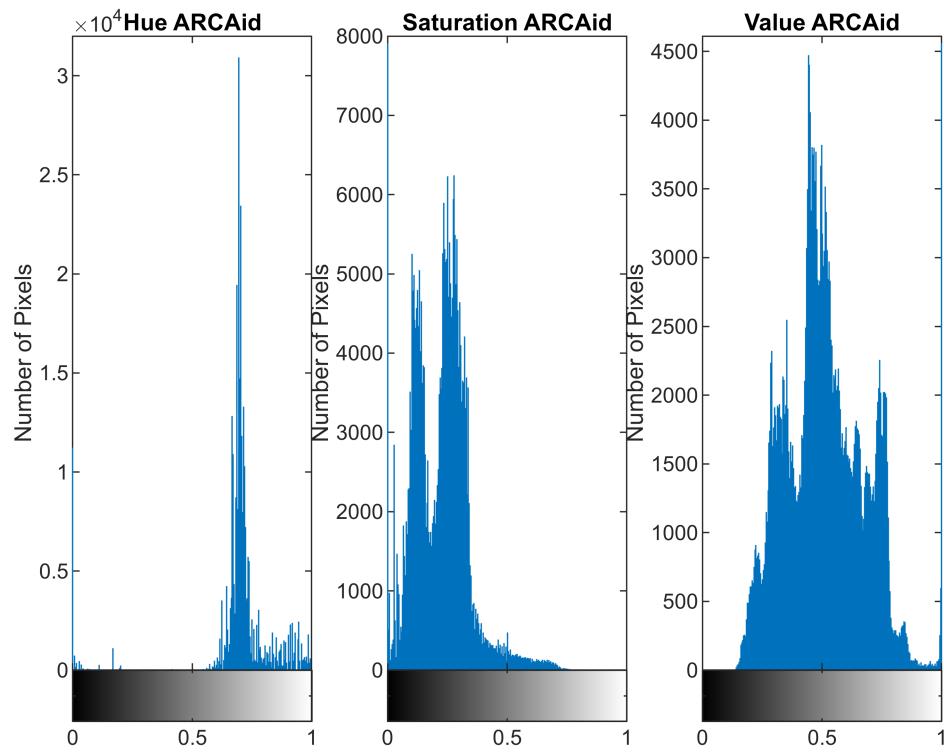
```

figure
subplot(1, 3, 1)
imhist(arcaid_hsv(:, :, 1))
title("Hue ARCAid")
xlabel("Hue")
ylabel("Number of Pixels")
ylim([0 3.2e4])

subplot(1, 3, 2)
imhist(arcaid_hsv(:, :, 2))
title("Saturation ARCAid")
xlabel("Saturation")
ylabel("Number of Pixels")
ylim([0 8e3])

subplot(1, 3, 3)
imhist(arcaid_hsv(:, :, 3))
title("Value ARCAid")
xlabel("Value")
ylabel("Number of Pixels")

```



## Carter Histograms

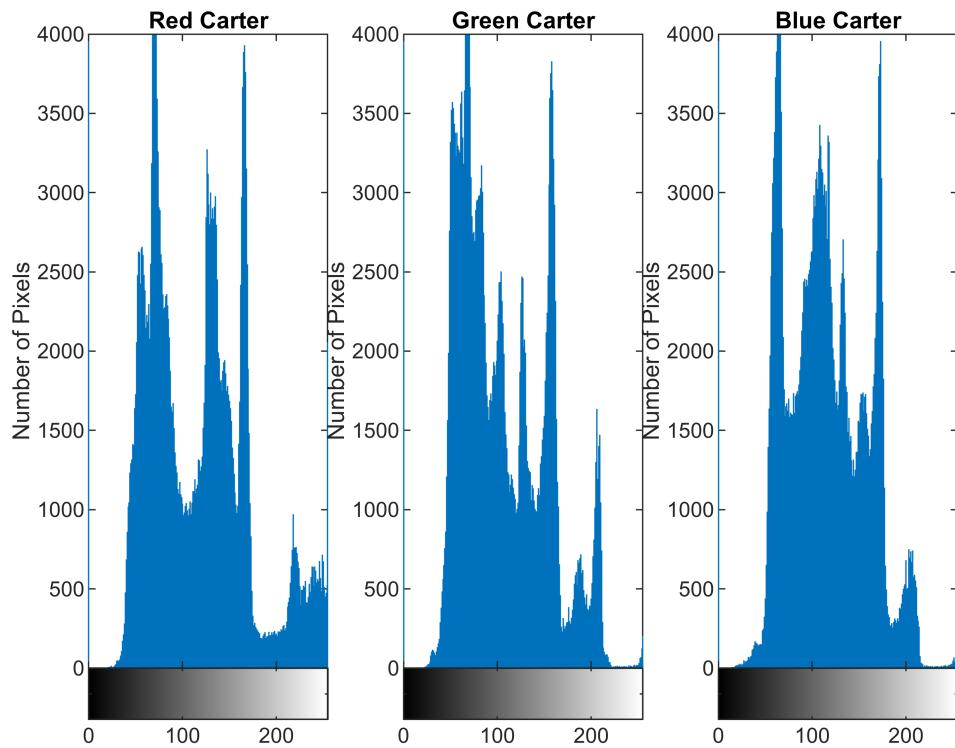
```

figure
subplot(1, 3, 1)
imhist(carter_red)
title("Red Carter")
xlabel("Red")
ylabel("Number of Pixels")
ylim([0 4e3])

subplot(1, 3, 2)
imhist(carter_green)
title("Green Carter")
xlabel("Green")
ylabel("Number of Pixels")
ylim([0 4e3])

subplot(1, 3, 3)
imhist(carter_blue)
title("Blue Carter")
xlabel("Blue")
ylabel("Number of Pixels")
ylim([0 4e3])

```



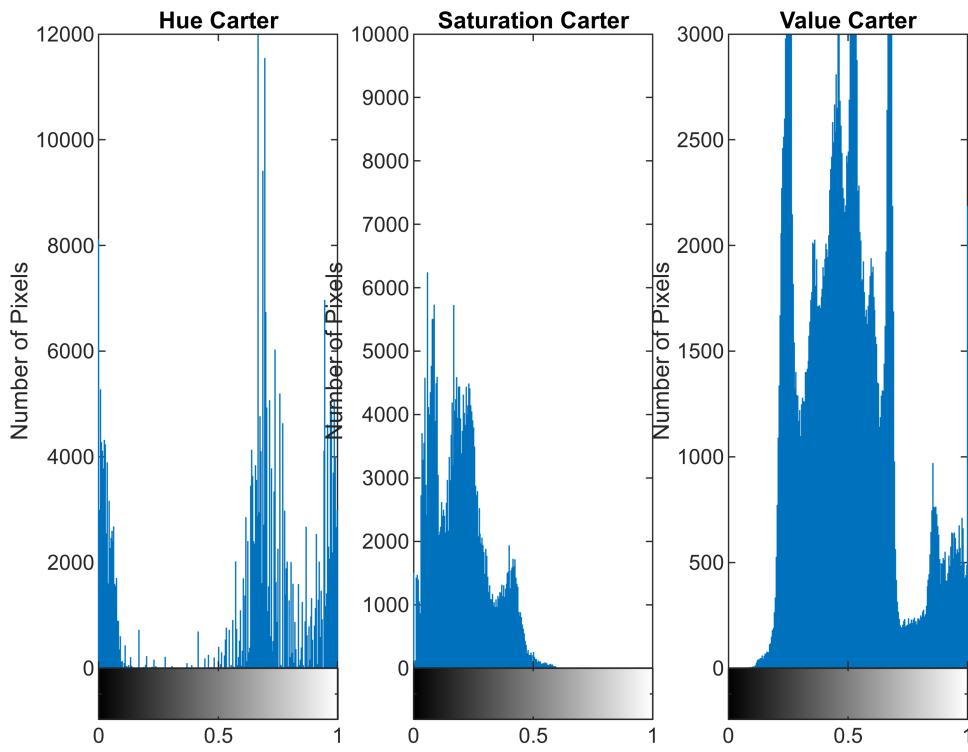
```

figure
subplot(1, 3, 1)
imhist(carter_hsv(:, :, 1))
title("Hue Carter")
xlabel("Hue")
ylabel("Number of Pixels")
ylim([0 1.2e4])

subplot(1, 3, 2)
imhist(carter_hsv(:, :, 2))
title("Saturation Carter")
xlabel("Saturation")
ylabel("Number of Pixels")
ylim([0 1e4])

subplot(1, 3, 3)
imhist(carter_hsv(:, :, 3))
title("Value Carter")
xlabel("Value")
ylabel("Number of Pixels")
ylim([0 3e3])

```



**c) Were these color spaces useful for your chosen image? Did they show something that you would not see in a color or grayscale image? Did the histograms show something useful?**

Generally no but the saturation space was good at highlighting lit areas. This can especially be seen in the ARCAid saturation image. The HSV did not highlight much that cannot be seen in color or gray but highly lit areas are well highlighted. The histograms for color show similar distributions however in the HSV spaces peaks seem more concentrated which is notable.

## 4) Convolution/linear filtering

**a) Again, use 2 images - these can be same as before or different - your choice**

**b) Apply identity filter to both images, show results**

Arcaid

```
identity = [
0 0 0;
0 1 0;
0 0 0
];

arcaid_identity = imfilter(arcaid, identity);

figure
```

```
imshow(arcaid_identity)
title("ARCAid with Identity Filter")
```

ARCAid with Identity Filter



## Carter

```
carter_identity = imfilter(carter, identity);

figure
imshow(carter_identity)
title("Carter with Identity Filter")
```

Carter with Identity Filter



c) Apply box filter of 2 different sizes to both images, show results (that would be 4 images).

```
box_nine = 1 / 81 * ones(9, 9);
box_twenty = 1 / 20.^2 * ones(20, 20);

arcaid_box_nine = imfilter(arcaid, box_nine, "symmetric");
arcaid_box_twenty = imfilter(arcaid, box_twenty, "symmetric");

figure
subplot(2,1,1)
imshow(arcaid_box_nine)
title("ARCAid with 9x9 Box and Symmetric Padding")
subplot(2,1,2)
imshow(arcaid_box_twenty)
title("ARCAid with 20x20 Box and Symmetric Padding")
```

**ARCAid with 9x9 Box and Symmetric Padding**



**ARCAid with 20x20 Box and Symmetric Padding**



```
carter_box_nine = imfilter(carter, box_nine, "replicate");
carter_box_twenty = imfilter(carter, box_twenty, "replicate");
```

```
figure
subplot(2,1,1)
imshow(carter_box_nine)
title("Carter with 9x9 Box and Replicate Padding")
subplot(2,1,2)
imshow(carter_box_twenty)
title("Carter with 20x20 Box and Replicate Padding")
```

**Carter with 9x9 Box and Replicate Padding**



**Carter with 20x20 Box and Replicate Padding**



**d) Box filter was a blurring filter. Think about what a sharpening filter would look like and apply it to your 2 images.**

```
sharp = -ones(26, 26);
sharp(13, 13) = 26^2 + 26^2;
sharp = 1 / 26^2 * sharp;

arcaid_sharp = imfilter(arcaid, sharp);
figure
imshow(arcaid_sharp)
title("Sharpened ARCAid")
```

## Sharpened ARCAid



```
carter_sharp = imfilter(carter, sharp);
imshow(carter_sharp)
title("Sharpened Carter")
```

Sharpened Carter



e) Design a Gaussian filter with your choice of variance. Apply this to your 2 images. Please mention what variance you used in the image.

```
arcaid_gauss = imgaussfilt(arcaid, 4);
imshow(arcaid_gauss)
title("ARCAid with Gaussian Filter with \sigma = 4")
```

**ARCAid with Gaussian Filter with  $\sigma = 4$**



We used a variance of 4 in this image. We started with a value of 20 which made the image indecipherable so we toned it down so we could make out the arcaid sign while blurring the poster.

```
carter_gauss = imgaussfilt(carter, 3);
imshow(carter_gauss)
title("Carter with Gaussian Filter with \sigma = 3")
```

Carter with Gaussian Filter with  $\sigma = 3$



**5) Submit your images, results and reflection as a single file. (since you are working in groups, one submission is fine. Please write the names of the members of your group at the top of your submission file or as a comment.)**