STA 160 Group 6

A Deep Dive into Andy Warhol's Shot Marilyns

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Abstract

Using the *Shot Marilyns* as a data source [1], we evaluated and examined Andy Warhol's techniques and methodology closely using both qualtitative and quantitative methods of analysis. Color analysis reveals how Warhol effectively conveys a story and evokes a response in one picture. Using the grabcut algorithm with decision trees, we appreciate Warhol's skilled manipulation and focus on Marilyn's iconic features, immortalizing her. K-means clustering allows us to explore how one uses color to describe the complex facades of a celebrity. The aforementioned methods are all instrumental in effectively reflecting Monroe's presence in media and the plight with which fame can bring. Our study unveils Warhol's techniques in conveying messages about mass media, stardom, and repetition within the *Shot Marilyns*.

1 Introduction

In the realm of art, understanding the artist's motivations and reasoning has always been of utmost importance. In Andy Warhol's case, many critics were unsure at the time of why he used certain techniques within his paintings. His work was seen "as peculiar and not very artistic because his use of tertiary colors" [2]. In modern times though, the way he utilized colors has lead to him becoming one of the most influential and celebrated pop artists in history.

Warhol grew up in Pittsburgh, Pennsylvania and started his life from humble beginnings. As a child, he developed a deep fascination with popular culture and consumerism, which he later incorporated into his artwork. Warhol was of Austrian-Hungarian descent, and his parent's working-class background instilled in him a sense of thriftiness and resourcefulness, shaping his artistic approach. His early career as a commercial illustrator in New York City allowed him to experiment with techniques and embrace the concept of mass production, foreshadowing his later works. The Factory was home to a plethora of diverse characters of New York City, and this in turn also led to Warhol's bright, playful world. Warhol's upbringing and experiences in the his art studio, The Factory, laid the foundation for his unique and revolutionary pop art style, where he transformed everyday objects and celebrities into vibrant, mass-produced images that both celebrated and critiqued consumer culture. Examples include the Velvet Underground's Banana, the acrylic portrait of *Debbie Harry*, *Campbell's Soup Cans*, and the *Shot Marilyn's*.

The *Shot Marilyn's* are a series of silkscreen paintings of Marilyn Monroe. These paintings are based on a picture of Monroe in the 1953 film *Niagara*, as seen in figure 1, a movie that revolves around the dynamics of an unhappy couple vacationing in Niagara Falls. Fascinated by the fame and glamour of Hollywood, Andy Warhol hoped to capture some of that underlying sentiment by depicting Monroe in many vibrant colors. By using such vibrant colors to depict the same photo, Warhol hoped to capture the audience's attention and analyze the relationship between celebrity status and self-expression.

Figure 1: Marilyn Monroe Publicity Photo for *Niagara* (1953)

It's important to note that this is not the first work of art Warhol made involving Marilyn's likeness. Warhol's works involving Marilyn had a direct correlation with the rapid fame and status she gained [3]. In 1962 after Monroe's death, Andy made the *Marilyn Diptych*. Diptychs are arts made in two parts, often joined by hinges. They are traditionally used for religious works [4], which helps to emphasize Monroe's cult-like fandom and larger than life persona. This particular painting is especially effective at emphasizing the jubilant facade Marilyn portrayed to the rest of the world, while internally struggling with her own demons, which lead to her untimely demise. This work coupled with the Shot Marilyn's emphasizes Warhol's fascination and expert usage of color in evoking emotion.

The aim of this project is to elucidate the ways in which Warhol used color, and why he did as such. Treating this as a case study into the mind of Warhol, we wish to understand the motivations behind his work, appreciate the craft and care he took with his paintings, and discern between the artist and character of Andy Warhol. By applying a lens of that of a data scientist, we can attempt to make critical, meaningful analysis similar to that of a connoisseur of art.

(a) The Shot Marilyn's | Orange, Red, Turquoise, Blue, Sage

(b) The Marilyn Diptych

Figure 2: Comparison of Marilyn Artworks

2 Exploratory Data Analysis

2.1 Understanding Color

To begin, we first want to explain how the data was collected. The images were downloaded from *The Interior Review*. From there, we used various Python libraries to read each pixel's RGB value. To understand each image's RGB distribution, we utilized the Matplotlib package in order to graph each pixel, with RGB values acting as the x, y, and z axis respectively. With the different shots, we saw the most plentiful colors being portrayed in our plots, which was as expected. However, we didn't have an exact percentage or name for each individual color.

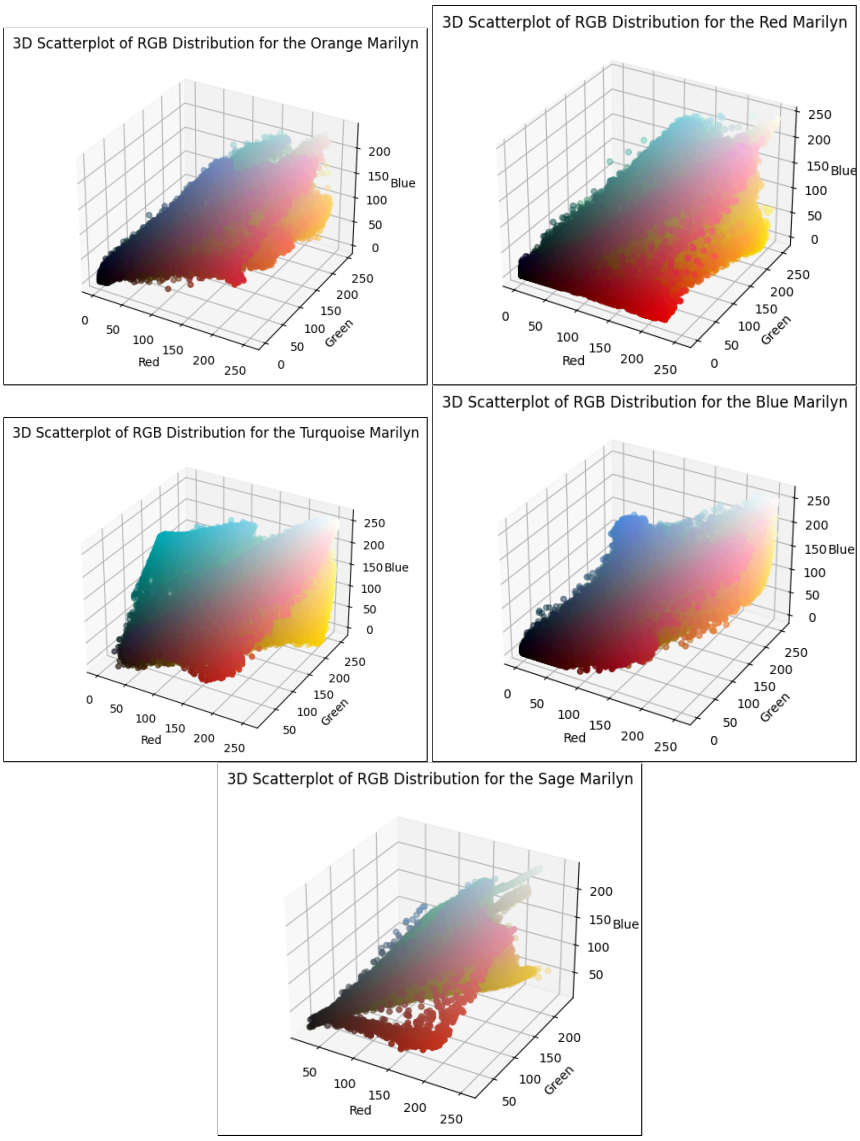

Figure 3: 3D RGB Distributions

In order to counter this, we used a color extractor function found from a *TowardsDataScience* article [5] that allowed us to see the hexadecimal color codes within each painting, but also the percentage of each color. Looking at all of the palettes, we can note a few key observations. Firstly, the background color dominates the percentages throughout each shot. All of the Marilyns are above 30% in regards to the background, except for the Red Marilyn **??**. The Red Marilyn exhibits a bigger shaped Marilyn, and a smaller background. Had we not conducted the palette, we probably would not have noticed the aberrant nature of the shot. From the palettes, another important observation to make is within the

hair of Marilyn. We see that the yellow that Warhol used was slightly different in each shot, yet he still wanted to use a shade of yellow regardless. This is important to note, as Marilyn's blonde hair was one of if not the biggest part of her character. Championed as the bombshell blonde, Monroe was actually not a natural blonde [6]. Warhol's choice to use these surreal shades of yellow are instrumental in portraying Marilyn Monroe, as a different shade might confuse the viewer. We can see how multiple shades of yellow affects the overall image by calculating and plotting the color composition of each portrait in the *Shot Marilyns* series, as seen in figures below.

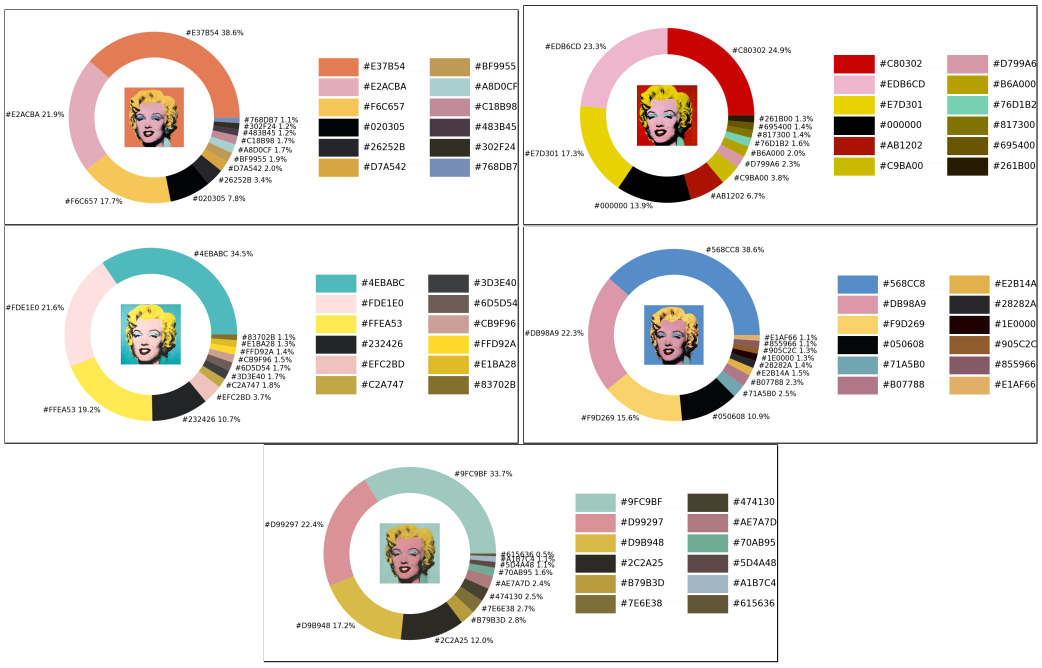

Figure 4: Hexadecimal Color Palettes

Another important observation we can make, is in the vibrancy of the colors. It's no secret that Warhol was a giant advocate for bright, convivial colors — and the Marilyns are an affirmation of this characteristic. Converting the images to black and white, we extracted the colors to check the brightness of each shot. From there, we created gradient spectrums for each shot. The gradients display the different shades of black and white from the converted picture. In pictures that have darker hues, the black tones will span a longer portion of the strip; the converse is true in lighter hues as well. From our gradient strips, we can make a couple observations. The stronger colors will exhibit darker hues, as seen in our red and blue gradients 7. However, we generally observe the paintings to have less dominating darker shades, indicating the presence of lighter tones. These lighter tones are notably evidenced in the face and hair of Monroe, meaning the background is the determinant for hue in the painting.

When we examine the RGB values of each painting individually, we observe Warhol's use of bright colors. The RGB value intensity plots show that throughout almost every painting, all values of red, green, and blue were relatively high which produces vibrant colors. Additionally, the backgrounds, eyeshadow, lips, and hair of each paintings show very high values of RGB, notably higher than other regions of the paintings. This strong focus on the vibrancy of these regions shows Warhol's intent to highlight the notable features of Marilyn.

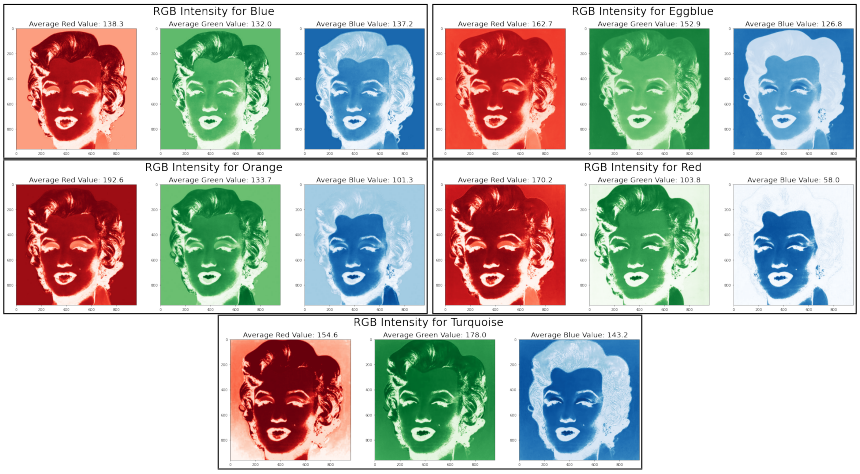

Figure 5: RGB Value Vibrancy

Additionally, we find high average saturation values throughout most of the paintings. Examining the saturation values shows that most paintings are around 50% saturation. However, we find that sage is lower at 34% and red is higher at 70%. The relatively high average saturation values of most of the paintings further indicates the bright and vibrant intent of the colors used.

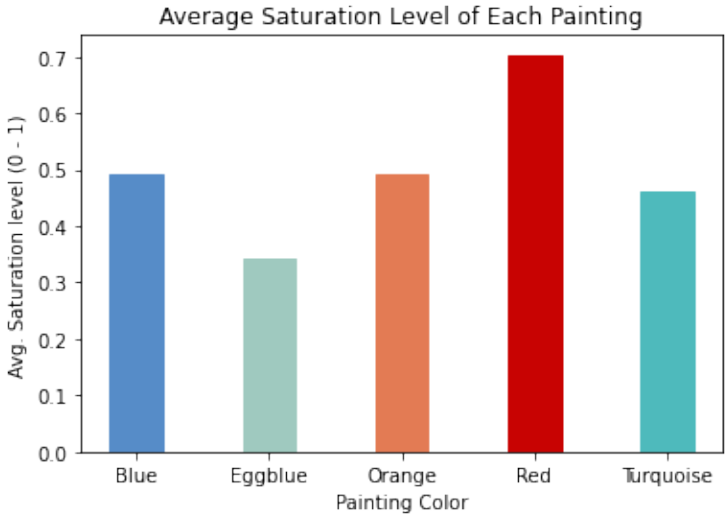

Figure 6: Saturation Levels of Each Painting

Moreover, the brightness of color also affects the mood of the painting. The five shots that are taken can reflect different emotions during the process. In the *Interior Review's* analysis of the Shot Marilyns, they describe a setting in which "you could imagine a day of shooting with Marilyn and these were the selects at the end of the day". The color Warhol chooses helps to illustrate this interpretation, with lighter hues coming off across as more jovial, whilst the darker tones might indicate a dilapidated state of being. Additionally, this might be Warhol's attempt at portraying the many faces of Marilyn Monroe. As we mentioned before, Monroe had a darker side to her and this wasn't always represented of her character. Warhol's usage of color is able to clearly enunciate the ways in which Monroe wore her persona to the outside world. We can learn more about how Warhol used color by employing K-Means clustering to group the data by similar features.

Figure 7: Gradient Spectrums of Each Marilyn

3 K-Means Clustering

In order to gain further insight into the color composition of Warhol's *Shot Marilyns* paintings, we used K-Means clustering to identify the most dominant color clusters, which will help us obtain a better understanding of Warhol's color choices and the color composition of each painting. K-Means clustering is an unsupervised machine learning technique that groups points together into k clusters based on the color values of each pixel. The initial location of each cluster is selected randomly within our color space as we calculate the euclidean distance (d) between each pixel's color value and the cluster to determine the appropriate cluster of each pixel. The euclidean distance is defined as $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$. Next, we calculate the mean value of all the pixels in each cluster, and we update the cluster center to be that calculated mean. This process is repeated iteratively until the cluster centers stop changing by a significant amount. Via rigorous experimentation, we decided that using eight clusters would be sufficient when applying K-Means clustering to the portraits. Figure 8 depicts the color space of each portrait in the *Shot Marilyns* series, where each data point's color indicates the cluster that it was assigned to.

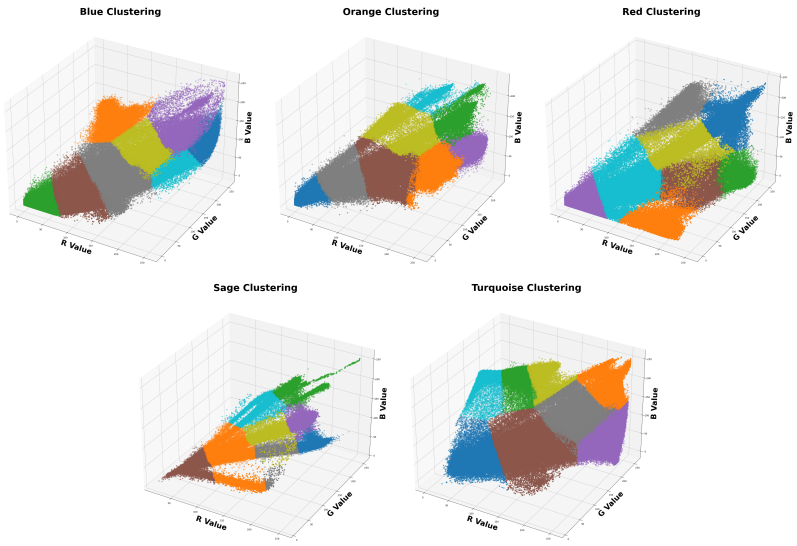

Figure 8: 3D Scatter Plot of K-Means Clustering

Looking at the plots, we can see some similarities between the distributions of the different color spaces as they all contain a very similar base photo. However, the turquoise portrait has a wider variety of blue and green hues in it compared to the other paintings, whereas the sage portrait has a more limited and extreme green distribution. These vast differences in the color spaces of each painting can be attributed to Warhol's silkscreen printing method, which involves using a mesh screen to transfer ink onto a canvas. While this printing method accounts for some variation in the distribution of color that is observable in figure 8, other variations in the distribution of color may have been done intentionally by Warhol. Overall, there is a wide distribution of color, but the green color values are more extreme, which may have been done intentionally by Warhol. Typically, green represents growth, nature, and freshness. By using a very limited spectrum of green, Warhol may have been trying to express Monroe's ever-growing status as a celebrity, even in death. It is also possible that Warhol could have been using extreme green hues to try and draw the audience's attention to the Marilyn Monroe's lips, since red and green are complementary colors. We can expand on these ideas by looking at the top eight colors obtained from clustering our data, as seen in figure 9.

Figure 9: Top 8 colors on Portraits

The variety of colors observed in figure 9 reveals few differences between the most important colors in each painting. The diverse color palette utilized by Andy Warhol draws people in, stealing their attention away from the outside world. Typically, portraits are done with colors that are considered more neutral and are designed to capture the likeness of the subject, such as shades of brown, red, and gray. While brown is a common color in all of the *Shot Marilyn* portraits, Warhol's use of colors that are considered unconventional in a painting, such as pink, yellow, and blue allow him to convey Monroe in a light that had not been seen at the time. Rather than only capture her likeness, Warhol seeks out to share a deeper understanding of Monroe with his audience. We can use the colors that we extracted from K-Means Clustering to recreate each portrait in the *Shot Marilyns* series using only those colors to see if there are any underlying messages that can be seen from simplifying each portrait. Figure 10 displays the reconstructed images using K-Means Clustering.

Figure 10: Reconstructed Images using K-Means Clustering | Blue, Orange, Red, Sage, Turquoise

While the photos in 10 look very similar to the photos in figure **??**, there are some noticeable differences between the two. For example, the dot that was caused by a bullet hole originally present in Monroe's forehead in the blue portrait is no longer there. Additionally, using clustering allows for some new inferences to be made based on Monroe's facial expression. For example, Monroe's smile looks much more forced in the blue and red portraits compared to the others. The lack of eyeshadow in the turquoise photo show how heavy-handed Warhol was when he was painting Monroe's eyeshadow

on her face (as it was not originally present in the photo that Warhol took inspiration from figure 1). Without the eyeshadow, Monroe's eyes look joyless as they point in two slightly different directions, creating a sense of detachment and introspection. This depiction of Monroe goes against the general public's perception of her, as many people saw Monroe as a symbol of beauty and glamour. However, these reconstructed K-means photos introduce a different perspective to Monroe; one of sadness and exhaustion. While Marilyn Monroe may be considered an iconic actress and performer, it is important to remember that Monroe was also known for having a troubled personal life, as she suffered from mental health issues and struggles with her personal relationships. Warhol's depiction of Monroe captures the inner turmoil that Monroe experienced beyond the scope of her life as a celebrity. The slight changes in Monroe's smile along with the depressed eyes could imply some weariness and vulnerability within her, allowing us to get a glimpse into the struggles that someone who is often seen as a personification of beauty and glamour in the 1940s and 1950s. Warhol's series *Shot Marilyns* presents us with a reminder of how complex people can be, as those who are considered embodiments of fame and beauty still struggle with their own demons.

In order to further analyze the complexities of the *Shot Marilyns* series, we will use the Grabcut algorithm and decision trees to conduct a more comprehensive analysis of the series.

4 Background Segmentation: Felzenszwalb, Grabcut, and Decision trees

In order to separate the background and foreground, we tested different methods to find which works best.

Before showing the results of this it would be better to explain how we did it. We used the GrabCut and Felzenszwalb algorithms to feature select the data from identifying the background/foreground and even hair. GrabCut uses decision tree for its algorithm, and uses something called the energy function, the energy function decision trees relate to the energy function in GrabCut, by providing the necessary input for the data terms.

4.1 Energy Function

$E(S) = \sum_i D(I_i, F_i) + \sum_{(i,j)} * V(S_i, S_j)$

where:

- $E(\mathbf{S})$ represents the energy of the graph cut.
- $\mathbf{S}$ denotes the segmentation labeling of the nodes.
- $D(\mathbf{I}_i, \mathbf{F}_i)$ is the data term measuring the similarity between pixel $\mathbf{I}_i$ and the foreground/background models $\mathbf{F}_i$.
- $V(\mathbf{S}_i, \mathbf{S}_j)$ is the smoothness term that encourages smooth transitions between neighboring pixels with labels $\mathbf{S}_i$ and $\mathbf{S}_j$.

4.2 What is GrabCut

The GrabCut algorithm is an interactive foreground/background segmentation technique that was introduced by Carsten Rother et al. in 2004. It combines the concepts of graph cuts and statistical models to achieve accurate and efficient image segmentation.

The algorithm starts by taking an initial bounding box or rectangle that roughly encloses the object of interest in an image. This region is known as the Region of Interest (ROI). The GrabCut algorithm then iteratively refines this initial segmentation by employing the following steps:

The GrabCut algorithm can be related to decision trees through the use of probability estimation for pixel classification. During the algorithm's execution, each pixel is assigned a label indicating whether it belongs to the foreground or the background. These labels are determined based on the pixel's color information and the models built during the iterations.

In decision tree-based approaches, the pixel classification can be seen as a classification problem where the decision tree is trained using features derived from the pixel's color and location. The decision tree learns to make decisions based on these features and assigns the pixel to the foreground or background class.

In summary, while GrabCut primarily utilizes graph cut techniques and statistical modeling for image segmentation, the pixel classification step can be analogous to decision tree-based classification, where decision trees are used to make decisions based on pixel features and assign them to the foreground or background class.

4.3 What is the Felzenszwalb algorithm

The Felzenszwalb algorihtm is a minimum spanning tree (MST)-based clustering algorithm introduced by Pedro Felipe Felzenszwalb. It uses edge length of MSTs to determine where to define a cluster.

The algorithm produces an MST and cuts the longest edges on a set threshold. This threshold is a function of the parameter k, which controls the size of each cluster, i.e. a larger value of k indicates a preference for larger clusters. After the cutting the edges, clusters are determined by collections of nodes that are connected.

One important property set by Felzenszwalb is that for any graph G, there is a value of k such that no cluster is too fine nor too coarse. In order to achieve this, much testing of parameterization is required. However, this property allows the algorithm to segment images accurately.

Figure 11: Segmentation with Felzenszwalb Algorithm

4.4 Background and Foreground Analysis

Andy Warhol's Marilyn Monroe paintings feature a captivating interplay between the background and foreground elements. The vibrant, solid colors in the background emphasize Monroe's central figure, drawing viewers' attention. In the foreground, Warhol's signature silkscreen technique repeats Monroe's image, highlighting her ubiquity in popular culture. The dynamic combination of background and foreground elements challenges traditional notions of authenticity, inviting reflection on the cult of celebrity and the impact of mass media.

Based on the accuracy of background cutting that we have found between the two algorithms, we have chosen to use the GrabCut algorithm. Through scrupulous data analysis we will be isolating the background and foreground and analyze them separately. From the background model histograms, we can clearly see that the foreground is the most dominant part of the picture hence its outstandingly high frequency rate given the pixel values.

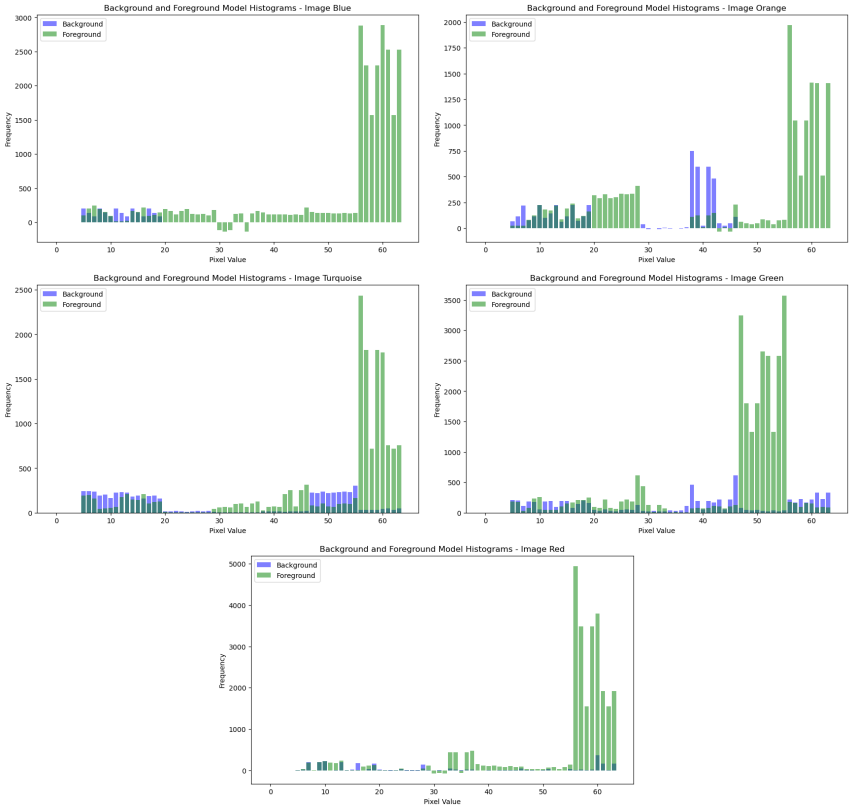

Figure 12: Background Foreground Model Histograms

4.4.1 Background Mask

After performing foreground/background segmentation using the GrabCut algorithm and creating a binary mask that identifies the background and probable background regions in the image, we obtained a clear boundary between the foreground and background.

GrabCut is utilized with the Marilyn Monroe Shot Image, to create the initial mask, bounding rectangle, and model parameters. The algorithm iteratively estimates the foreground and background regions based on the bounding rectangle. The resulting mask is then processed to create a binary mask where the background and probable background regions are assigned a value of 1, while the foreground and probable foreground regions are assigned a value of 0. This binary mask effectively separates the foreground object from the background. The resulting mask is displayed as an image using matplotlib, providing a visual representation of the segmented foreground. In a nutshell this is the idea of separating the background and foreground

Figure 13: Masked Image

4.5 Images with No Background

Figure 14: No background Marilyn

5 RGB Frequency

RGB frequency histograms are graphical representations that show the distribution of pixel intensities in an image based on their red, green, and blue color channels. They provide valuable insights into the color composition and tonal distribution of an image. Each channel of the histogram represents the range of pixel intensities for that particular color channel, with the x-axis indicating the intensity values and the y-axis representing the frequency or the number of pixels at each intensity level.

These histograms are important for several reasons. First and foremost, they provide a visual summary of the overall color balance in an image. By analyzing the histogram, you can determine whether an image is predominantly red, green, or blue, or if it has a balanced distribution of colors. This information is crucial for photographers, designers, and image processing professionals to evaluate the color composition of an image and make adjustments as needed.

5.1 RGB Frequencies of unaltered pictures

These histograms are important for several reasons. Since they are the histograms of the unaltered *Shot Marilyns* pictures with the background included.

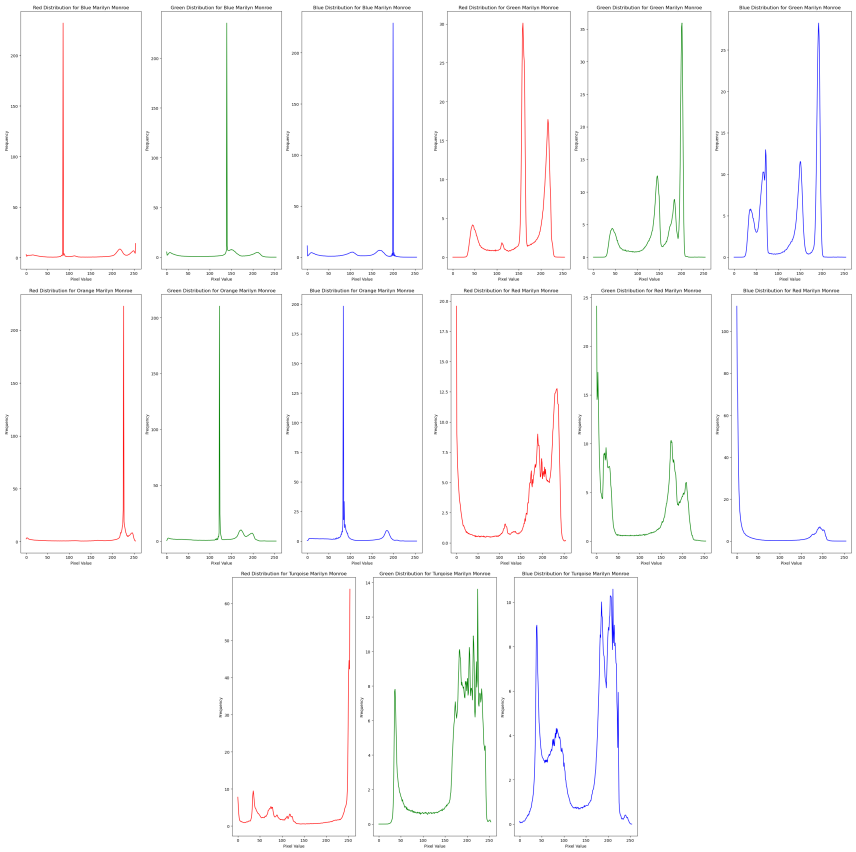

Figure 15: RGB Distribution: Blue, Green, Orange, Red, Turquoise

5.2 RGB Frequency of Pictures with Background Removed

These histograms are important for several reasons. Since they are the histograms of the altered *Shot Marilyns* pictures with NO background included.

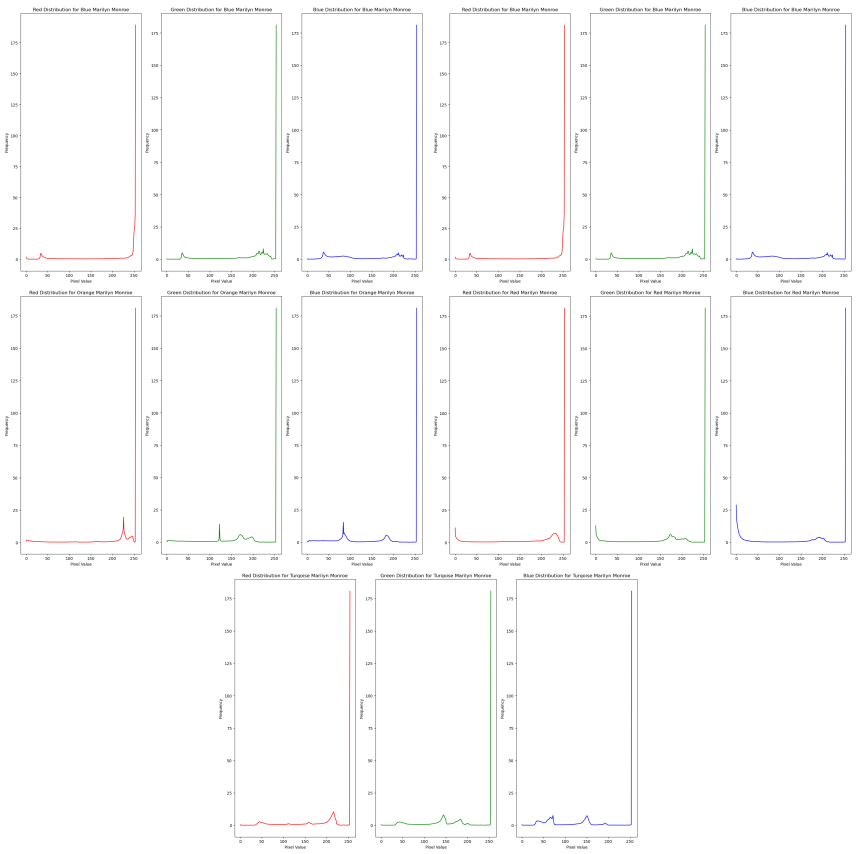

Figure 16: RGB Distribution Blue, Green, Orange, Red, Turquoise

5.3 Analysis

When comparing the RGB plots of images with and without the background removed, it is observed that the Shot Marilyn Monroe with the background removed had much tamer peaks and valleys compared to the unaltered pictures (the ones with the background in tact). This is probably can be attributed to the removal of the background, which alters the overall color distribution in the image.

The background of Shot Marilyn although does not take as much as the foreground still consists of a relatively fair-ish amount of space in the image. So when removing the background the dominant RGB color are eliminated therefore it results to a more tame and balanced distribution of the pixel intensity across the foreground. Therefore removing the background removes the influence of color on its color distribution.

5.4 Artistic Interpretation

This relates back to the EDA done in section 2. When the background is removed from an image, it often results in a dramatic change in the tone of the picture. The tone refers to the overall mood, atmosphere, and perceived brightness or darkness of an image. The removal of the background can significantly alter these visual characteristics, ultimately impacting the interpretation and emotional impact of the image.

The background of an image can contribute to its tone in several ways. Since the background of Shot Marilyn contains a single dominant color, such as Red or Blue dramatically changes the tone from energetic to melancholic. By removing the background, these dominant elements that influence the tone are eliminated or reduced, thereby changing the overall tone of the picture.

Secondly, the background plays a crucial role in establishing the contrast and dynamic range within an image. It provides a visual context against which the foreground or subject is perceived. The presence of a dark or light background can create a contrast that enhances the visibility and prominence of

the subject, thus influencing the tone of the image. When the background is removed, the contrast between the foreground and the surrounding environment may be altered, resulting in a shift in the perceived tone. Warhol's use of an establishing background is able to frame Monroe front and center, laying the foundation for the art piece.

The impact of background removal on the tone of the image can be related back to the tamer appearance of the RGB frequency histogram. As mentioned earlier, the removal of the background leads to a more balanced distribution of pixel intensities in the foreground or subject. This balanced distribution can result in a more neutral or average tone, where extreme peaks and valleys in the RGB histogram are reduced. Consequently, the overall tonal range may become narrower, and the image may appear more uniform or subdued in its tone.

6 Conclusion

Art is subjective, and different people may interpret different pieces of art differently. We combined qualitative and quantitative analysis to look for a deeper meaning behind the artwork Andy Warhol produced. Using color analysis, we can clearly see the way in which Warhol was able to tell a story and illicit a response from the viewer. Employing the grabcut algorithm with decision trees, we were able to appreciate the masterful manipulation and autonomy of Warhol's portraits. Removing the background and isolating Marilyn's iconic features allows us to fully understand why Warhol chose to portray Monroe in the manner he did; firmly cementing and memorializing the cultural icon. Finally, with K-means clustering we were able to emulate the repetitive nature that Warhol loved to use in his artwork. This repetition is important in reflecting Marilyn Monroe's pervasive presence in popular media, but also the toxic environment that fame invites. In our study, we've discovered the way in which Warhol employed his techniques on the *Shot Marilyns* to convey a profound message about mass media, stardom, and repetition.

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Figure 17: Applying Common Colors obtained from K-Means Clustering on Professor's Portrait [7]