A View from Above: Exploratory Visualizations of the Thomas Walther Collection

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The use of quantitative analysis and visualization for the study of cultural visual data allows us to view cultural artifacts in new ways, to confirm and describe more precisely the existing understanding of historical developments, and, potentially, to reveal previously unnoticed patterns. This essay presents visualizations of photographs in the Thomas Walther Collection at The Museum of Modern Art, New York, in relation to the greater MoMA photography collection. To the best of our knowledge, this is the first time that historical patterns in a large photography collection have been analyzed and visualized using quantitative computer techniques.

We present two types of visualization. The first type (figs. 5, 7–9) uses familiar line plots and scatter plots, with photographs represented as points and trends represented as lines. The second (figs. 1–4, 6) was created with methodologies and tools developed in our lab specifically to explore large digitized image and video collections. Our method has two main steps. First, we use custom image-processing software to automatically measure the characteristics of the digitized photographs, such as tonality, contrast, color palette, texture, line orientation, and the presence and position of faces. In the second step, we use our visualization tools to create high-resolution images showing all the pictures in a collection sorted by their visual properties and/or their metadata (date, dimensions, artist, place of origin, etc.).[1] Visualizations presented in this essay use two characteristics: average tonality and average saturation.[2] We also explore historical patterns in representations of faces, bodies, and body parts, and compare the prevalence of photographs taken outdoors and indoors. Available metadata for each photograph included the artist's name, nationality at time of death, and place of birth, when different than nationality; the date (or date range) when the photograph's negative was made; and the photographic process used to make the print.[3] The visualizations allow us to explore patterns in the photographs' metadata and in their visual form and content. We have created many views of the collection, organizing the images in different ways: by selected visual characteristics, for example (fig. 1), or by creation date (fig. 2).

THE DATA SETS

We divided the MoMA photography collection into three non-exclusive groups:

Data set 1: Works in the Museum's photography collection: 18,941 photographs, made between 1837 and 2012.[4]

Data set 2: Works in the Museum's collection by artists represented in the Walther Collection: 2,648 photographs, made between 1844 and 1989.

Data set 3: Works in the Walther Collection: 337 photographs, made between 1898 and 1963.[5]

QUANTITY

We started by looking at the three data sets from above, as it were, comparing the quantities of photographs in the collections in different historical periods. Figure 1 visualizes data set 1, with photographs arranged by average tonality and year of creation in a circular layout. Figure 2 is a visualization of data set 2; the photographs are also
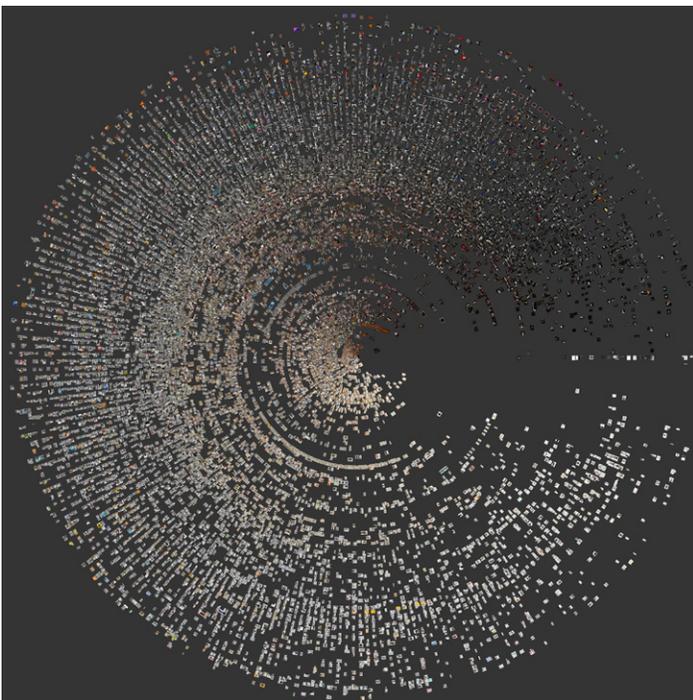
fig. 1 Radial visualization of data set 1, plotted by average tonality and year of creation. Photographs are represented by thumbnail images of themselves. The distance of a photograph from the center is determined by its year of creation; the newer the photograph, the farther it is from the center. The degree of a photograph's placement in the circle is determined by its average tonality; tonality increases counterclockwise from 90 degrees.
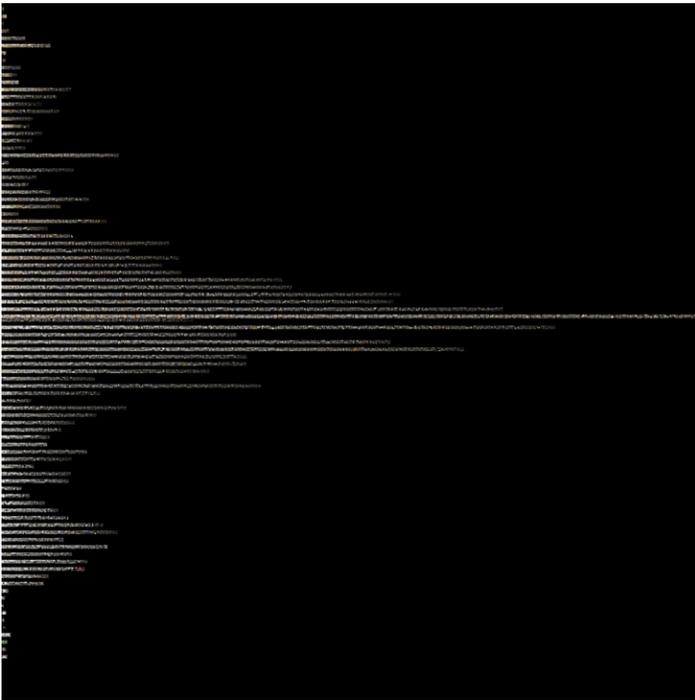
fig. 2 Visualization of data set 2, sorted by average tonality (horizontal axis, decreasing from left to right) and year of creation (vertical axis, ascending from top to bottom). Photographs are represented by thumbnail images of themselves.
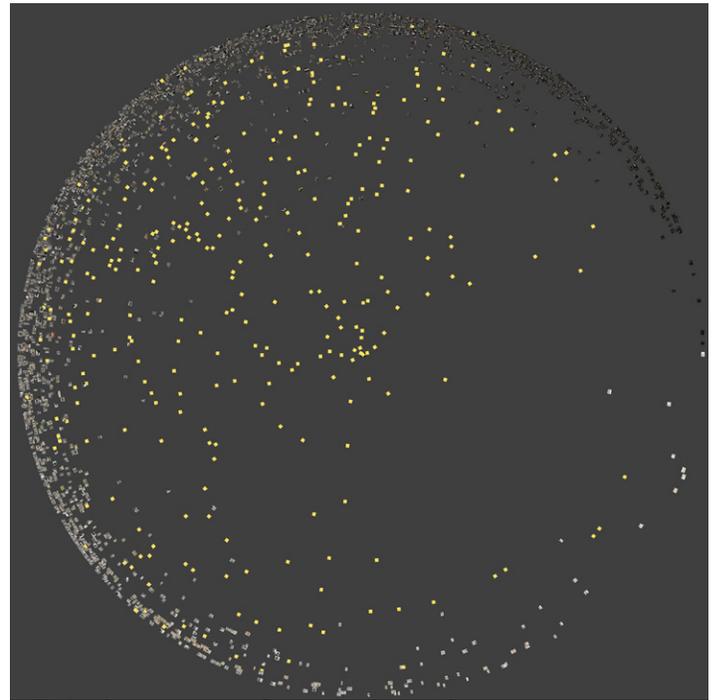
fig. 4 Radial image plot of data set 2. Photographs are represented by thumbnail images of themselves; yellow rectangles represent photographs in the Walther Collection. The works of each artist are plotted in a ring, moving outward from artists with the smallest number of works to artists with the largest number. The degree of each photograph's placement in the circle is determined by its average tonality; tonality increases counterclockwise from 90 degrees.

fig. 3 Visualization of data set 3, sorted by year of creation (vertical axis, ascending from top to bottom). Photographs are represented by thumbnail images of themselves.

arranged by average tonality and year of creation, in a layout that allows for easy comparison of the quantity of photographs taken each year. Figure 3 visualizes data set 3, again with photographs sorted vertically by year.[6] We can also compare the representation of Walther Collection photographers in the Museum's overall photography collection and the smaller Walther Collection. In figure 4 the photographs in data set 2 are arranged in rings, one for each artist, moving outward from artists with the smallest number of works to artists with the largest number. Photographs in the Walther Collection (data set 3) are represented as yellow rectangles. The overlap between the two collections is concentrated in the works of a small number of artists, represented in the outer rings of the circle. This visualization demonstrates the role the Walther Collection has played both in introducing new artists into MoMA's collection and in significantly expanding the representation of others.

PHYSICALITY

We can also analyze the collection to connect the patterns we find with sociocultural and economic trends. For example, figure 5 shows data set 1, with photographs plotted by year of creation and dimensions. The overall trend is clear: the dimensions of the works remain fairly stable until the 1970s, after which we see a rapid and continuous increase in size.
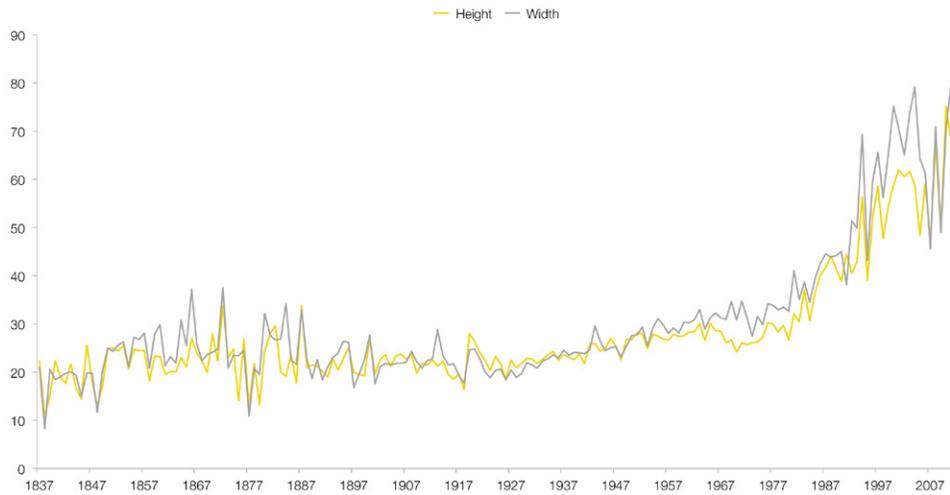
fig. 5 Graph showing the height and width of the photographs in data set 1 (vertical axis, in inches), plotted by year of creation (horizontal axis).
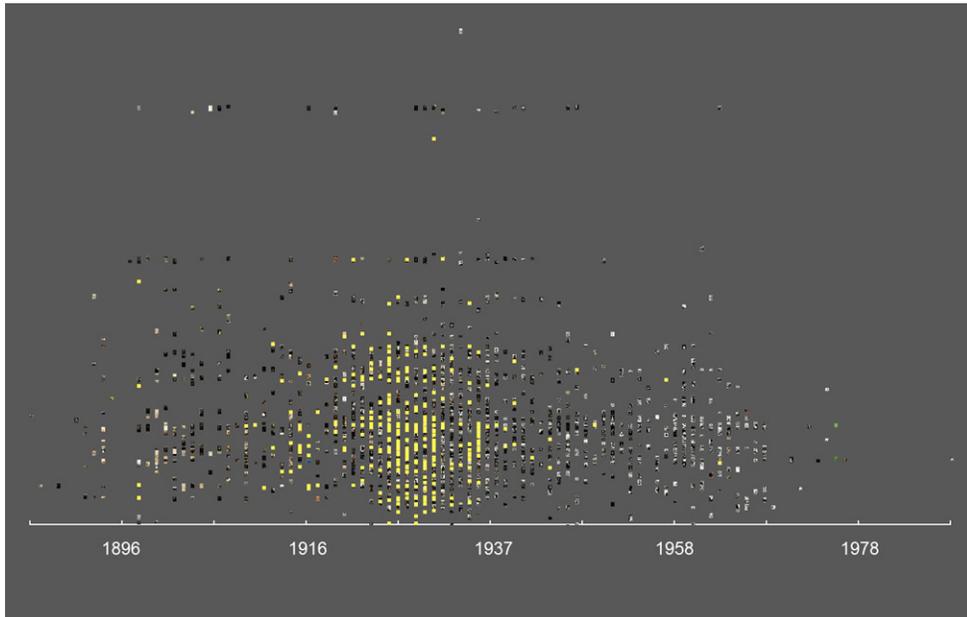
fig. 6 Image plot of data set 2, arranged by year of creation (horizontal axis) and height (vertical axis). Photographs are represented by thumbnail images of themselves; yellow rectangles represent Walther Collection works.

Visualizing the data allows us to see additional details: the exact shape of the pattern (when and how size starts to increase) and the amount of difference (the average size after 1989 is three times larger than the average size earlier in the century). This pattern may be explained by the fact that in the 1970s photographers started more actively to exhibit and sell their works in galleries, which encouraged them to make much larger prints. Examining the graph more closely, we notice other subtle patterns. For instance, photographs' width and height are very similar early on (1927–40), while in a later period width is larger than height (1995–2004). This makes sense given the turn of photographers to the commercial art world, away from magazines and other publications where squarer photos were common. The explosion of art biennials in the 1990s may also be significant. Figure 6 is a visualization of data set 2, sorted
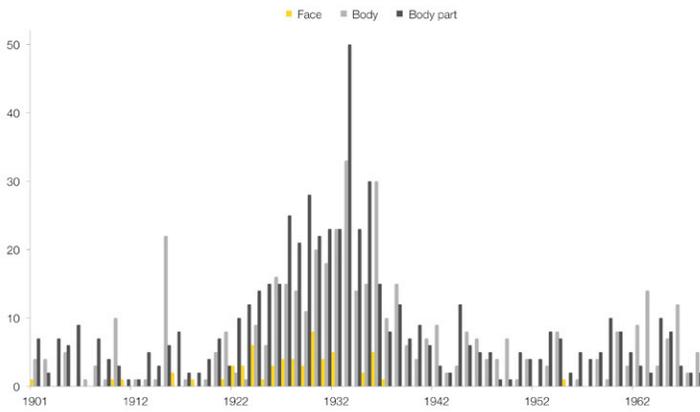
fig. 7 Graph of the 1,143 works in data set 2 featuring just a face (yellow), a full human body (light gray), or a body part or parts (dark gray), organized by year of creation (horizontal axis) and number of works (vertical axis). There is no data for 1909.

by year of creation and height. It points to a number of conventions in the works' sizes and their change (or stability) over the years. Photographers' use of standard paper sizes is evidenced in the alignment of images in this chart along horizontal rows.

VISUAL CONTENT

We can also segment the photography collections using categories not available in the metadata. Dividing the collection by content type, for example, might confirm what we sense in going through the works one by one. Figure 7 plots works in data set 2 that feature a full face (from the forehead to the chin, or shoulders), a full body (legs to head), or a body part (a portion of a face or body), comparing the prevalence of these three content types over time.[7] While there is no distinct pattern in the use of full body or body parts, the number of photographs featuring full faces strongly increases between 1920 and 1935, between the two world wars. But before and after, we see very few photographs with full faces from these artists. This finding is surprising, given the overall popularity of portraits in the history of photography, from nineteenth-century *cartes de visite* to contemporary "selfies"; photographic portraits are also central to twentieth-century photojournalism, represented by illustrated magazines and newspapers. So why do we find so few in our data set? Perhaps the deliberate omission of the full face was one way for modernist photographers to distance their artwork from vernacular photography and pictures taken for the press.

TONES AND COLORS

The tonality of images (the distribution of dark, medium, and light tones) is a significant dimension of historical image collections. Another important dimension is image saturation. Saturation is the intensity of color: a black-and-white image has zero saturation; an image that only contains pure

primary colors—red, green, and blue, for example—has maximum saturation.

Figure 8 plots the average tonality and average saturation of photographs in data sets 1 and 2, sorted by year. Figure 8a shows the saturation of the photographs in data set 1. The graph shows how saturation gradually increases before around 1925, significantly decreases until around 1970, and then starts to increase again. Regular attendees of contemporary photography exhibitions will not be surprised by data pointing to the high saturation of photographic prints in recent decades, but a high saturation level in photographs from the end of the nineteenth century and the early twentieth century may be unexpected. In that period, photography was mostly monochrome, but it was not black and white: the different printing processes produced particular color signatures, and this is reflected in figure 8a.

Dividing the photographs into two groups—those taken indoors (within a studio, building, etc.) versus those taken outdoors (in the open air)—reveals even more dramatic historical changes.[8] Figure 8b compares patterns in tonality for indoor and outdoor photographs in data set 2. We see a decrease in the tonality of indoor photographs around 1930 (perhaps related to the Great Depression). After that, tonality gradually increases until about 1937; then we see
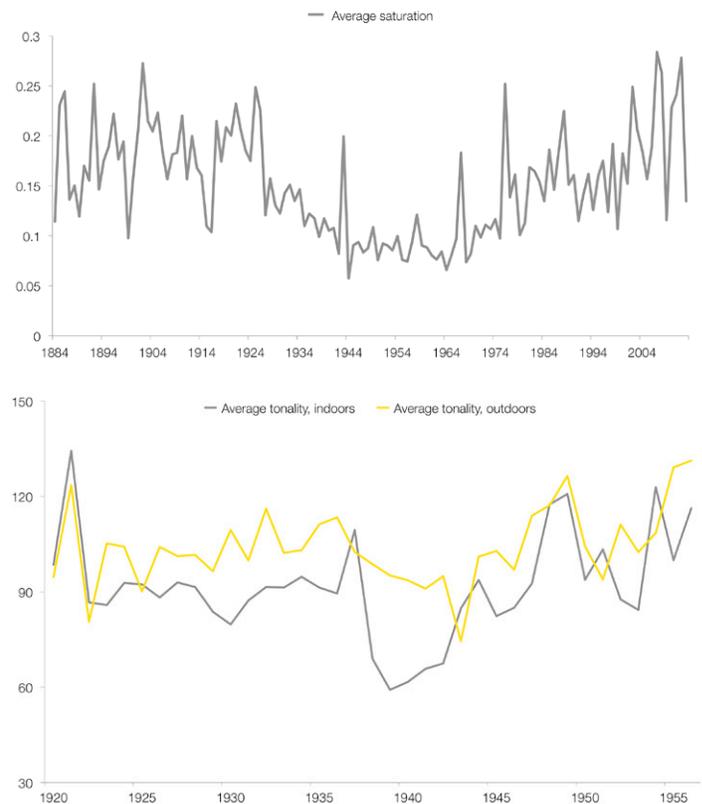
fig. 8 a: Graph showing data set 1, plotted by year of creation (horizontal axis) and average saturation (vertical axis); b: Graph showing photographs in data set 2 taken indoors and outdoors, plotted by year of creation (horizontal axis) and average tonality (vertical axis).
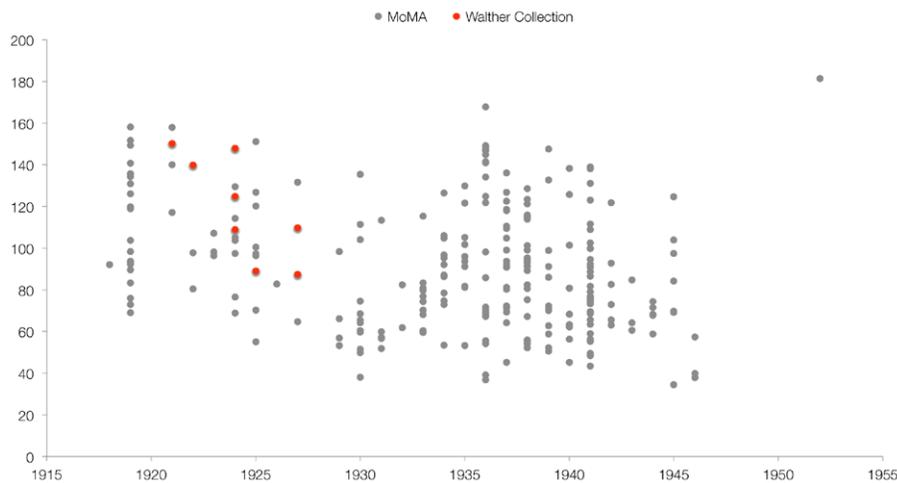
fig. 9 All works by Edward Weston in MoMA's photography collection, plotted by date of creation (horizontal axis) and average tonality (vertical axis). Each of the 263 photographs is represented by a dot; red dots indicate works in the Walther Collection.

an immense drop during the World War II period, followed by a systematic recovery in tonality levels in postwar years. Although we can't conclude from this single example that patterns in photography always follow the larger social and economic trends, in this case the correspondence between the photographs' tonality and social conditions is quite striking.

Finally, we can zoom in even further and examine particular artists in the collection. Figure 9 shows tonality patterns in works by Edward Weston in the Walther Collection compared with his works in the larger MoMA collection. For the 1920s, the photographer's works in the Walther Collection generally represent the range of totalities in his work in the MoMA collection overall, though remaining well above the lowest tonality of the period.

CONCLUSION

In this short visual essay we illustrated a few ways in which patterns across large numbers of photographs can be analyzed and visualized using computational and graphical techniques. We saw how visualizations of photographs and their metadata may confirm our intuitions and also reveal new patterns. Moving from the thousands of photographs in the MoMA photography collection to a few works by a single artist in the Walther Collection, we can bridge the quantitative and the qualitative and supplement other already well-established modes of describing cultural artifacts and processes.

NOTES

1. These tools were developed in our Software Studies Initiative research lab, in San Diego and New York, and are distributed using an open-source license. See http://lab. softwarestudies.com/p/software-for-digital-humanities.html. This project was developed during Nadav Hochman's research residency in the Department of Conservation at The Museum of Modern Art, New York, in July 2013. Other members of the Software Studies Initiative

research lab contributed at various stages, performing data preparation and image processing. All visualizations were created by the essay's authors, who wish to thank their colleagues at MoMA for their support and encouragement.

2. Images are first transformed from RGB (red-green-blue) format to HSV (hue-saturation-value) format. In HSV format, each pixel is still represented by three numbers, but instead of

indicating amounts of red, green, and blue they indicate the hue, saturation, and gray-scale value. To measure the average tonality of an image, the algorithm reads the gray-scale value of every pixel, sums these values, and divides the result by the number of pixels. Average saturation is calculated in the same way.

3. Research on the Thomas Walther Collection since July 2013 has led to adjustments in the metadata for some of the objects

that is not reflected in this study. For example, in some cases more precise negative dates have been assigned. Where MoMA records gave a date range for the creation of a negative, we used the upper bound of the range.

4. The data sets include digital images and information available from the Museum's collection database in July 2013; works in MoMA's collection that had not been digitally photographed at that time are not included. Some

of the visualizations show the full historical range of a given data set; in other cases (see figs. 6–8), only part of the range is shown, in order to make patterns easier to see.

5. This data set includes digital images and information available from the Museum's collection database in July 2013. Evolution in the cataloguing of the Walther Collection accounts for the differences between data set 3 (337 photographs) and the number of works now counted in the collection (341).

6. At the time of this study, the latest negative date given for a work in the Walther Collection was 1963 (for Hans Richter's untitled still from *Film Study* [*Filmstudie*]; MoMA 1819.2001), as reflected in figure 3. Subsequent research has shown that this picture was taken in 1927.

7. The authors manually tagged each of the 2,648 images in data set 2. They found 598 photos showing a full figure, 484 photographs showing a body part or parts, 61 photographs showing just a face, and 1,505 photographs with no figurative imagery at all.

8. The authors manually tagged each of the 2,648 images in data set 2. They found 524 photos taken indoors and 1,347 photographs taken outdoors. The remaining 777 photographs were tagged as taken neither indoors nor outdoors since the exact location could not be determined by their content.

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