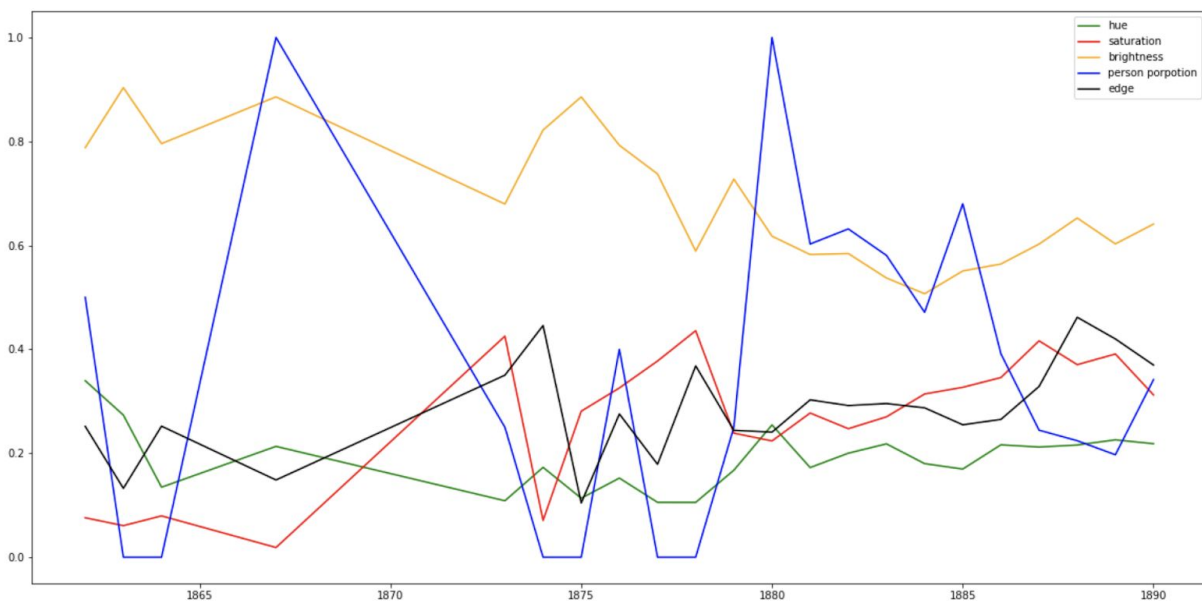
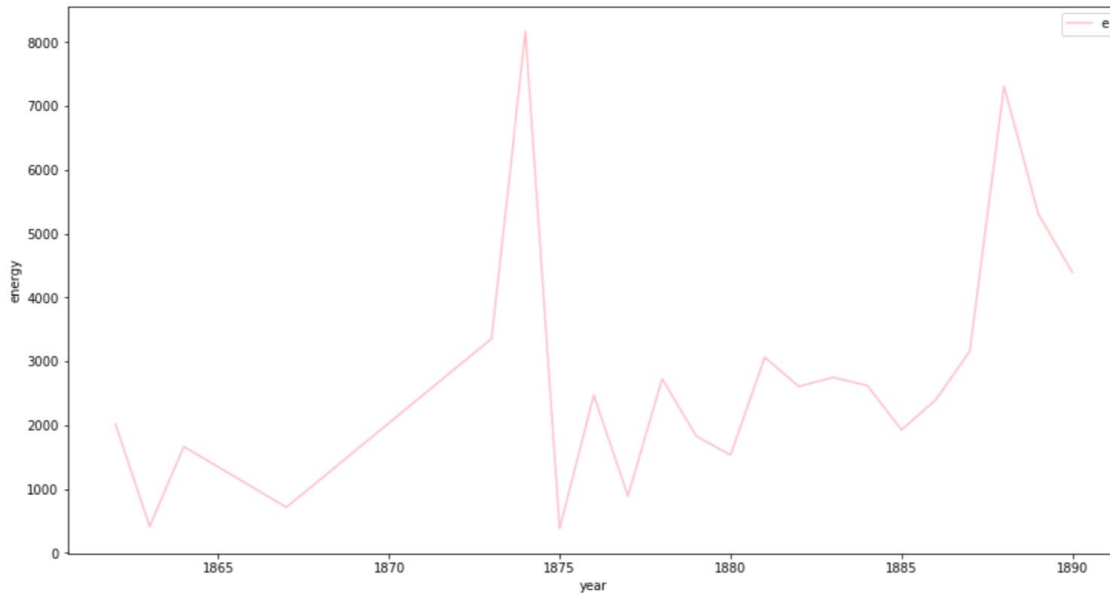


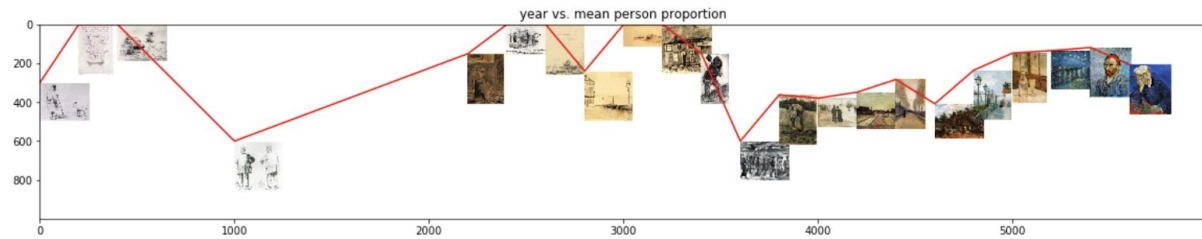
We plot some scatter plots and line charts to better understand our research for the Bitmap part. Firstly, we plot some scatter plots between year and some variables like mean hue, mean saturation, mean brightness, edges, energy, and the resolution. From those scatterplots, we can notice that there does not have a lot of artworks from Van Gogh before 1880. So we will mainly contrast the artworks before and after the 1880s. Then, we make some line charts for better showing changes in those variables in different years. In the Bitmap part, we will combine those line charts with our bitmap for bettering showing the trend of different variables by using different artworks at different times. But we do not make a bitmap for the resolution of artworks. Because the resolution of artwork just shows the result of photos' width times photos' height. This does not have any correlation with Van Gogh's artworks and his life experience. Then we decide to only show the resolution part as the line chart.



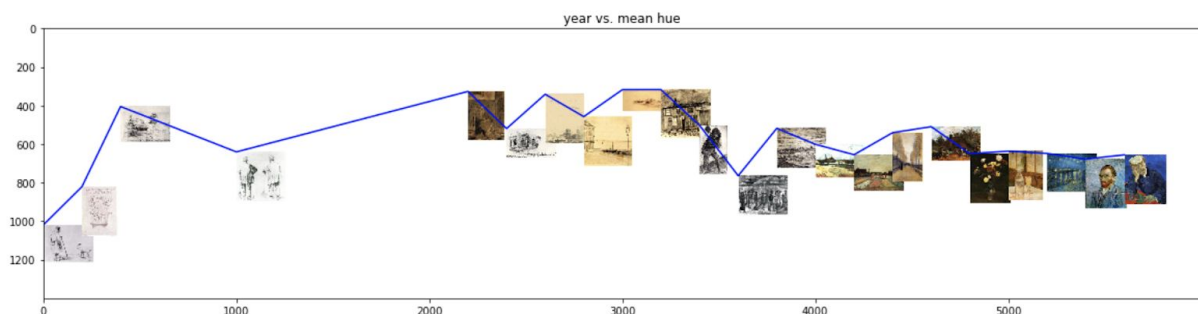


In general, we make a graph that shows most of the features, excluding energy (because energy is so high which can let other features show as a straight line), in different years starting from 1880. Here, we can see that the number of edges, saturation, brightness, and hue went from increasing during the period between 1880 and 1888 to decreasing from 1888 and onwards. This is explained by the several efforts of Van Gogh of trying to establish himself as a professional painter with the goal of making a living followed by the last two years of depression and loneliness. There is an uptick in the proportion of people because in his two-year stay in Nuenen, Van Gogh drew several paintings of still lifes of weavers. During his stay in the Arles in the last three years, his paintings involved more about nature and skies, and so the proportion of people was on a decreasing trend.

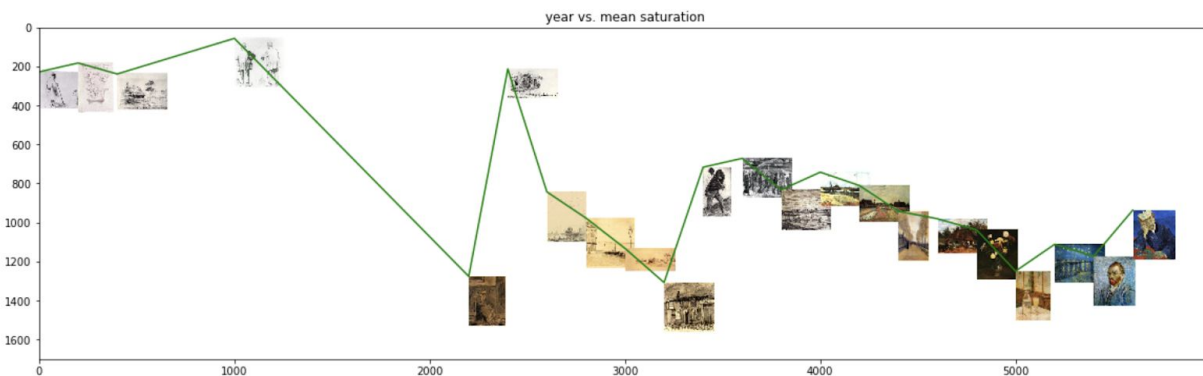
For the following bitmap results, the x-axis, which represents the year, does not correspond to the exact number, but instead a range between 0 to 5600. The number 0 represents the start year that Van Gogh produced his painting, which was 1862. For each year from 1862, we multiplied by 200. Thus, for instance, the year 1886 is 24 years from 1862, then we multiply this number by 200, and we get 4800 on the x-axis. We select the most representative image in each year corresponding to those features.



The first figure looks at the proportion of people in the paintings from different years. For increasing the accuracy, we use three methods (body detection by HOG, face detection and word detection) to detect people and add the results together to be our result as person detection. From the early period, like from 1862-1867, most of Van Gogh's artworks are sketches about people and gradually, from 1873 to 1879, he started to add a little color to his artworks. But most of his artworks are still sketches. From those points, we can know that prior to the 1880s, Van Gogh mainly drew sketches of people. Thus, the proportion of people in those years were much greater than those of later years. Beginning in 1880, Van Gogh turned to oil paintings and watercolor paintings whose protagonist started to become not just people, but also residential buildings and the surrounding environment. In the last two years where Van Gogh stayed in the asylum, his only companion was not people, but sights of nature and landscapes of the city. As shown in the figure, the proportion of people decreased during this period. One thing to notice is that within a short period after 1888, the proportion of people in his paintings reached the local maximum. This could potentially be traced down to the day when van Gogh cut his left ear off because of depression and arguments with his friend. Ever since this incident, Van Gogh started to portray himself in paintings a lot, which led to the increase of proportion of person to a local maximum.

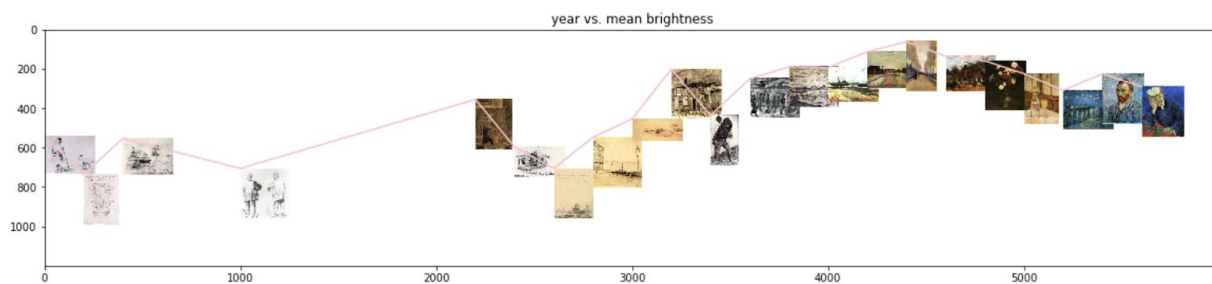


The second figure looks at the mean hue of the paintings in different years. Since Van Gogh began his career as a painter in 1880, there are only a small number of paintings before 1880, and they share similar traits as they were mostly low in color hue. Beginning from 1880, Van Gogh started to increase his production of paintings. In 1881, Van Gogh was accompanied by loneliness and depression after the rejection of his marriage proposal from his widowed cousin. Although it is true indeed the mean hue has increased compared to previous years due to scaling up of the production, the frustration and the loneliness he experienced in this year restricted Van Gogh's paintings to mainly composed of low hues. In 1882-1884, Mauve introduced Van Gogh to oil painting. As shown in the figure, we can see that the mean hue slowly increases. In the last two years of his life, Van Gogh spent his life in the asylum. During this period, his paintings incorporated a lot of the Impressionist style, and so Van Gogh was able to produce paintings with higher hues.



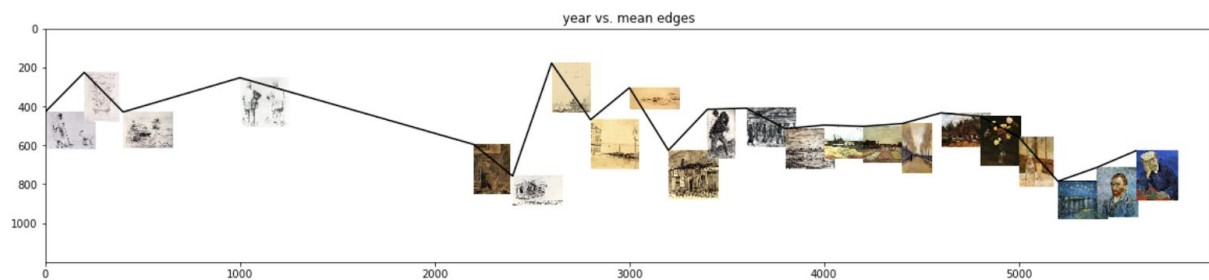
The third figure looks at the mean saturation of the paintings in different years. Between the 1860s-1870s, Van Gogh produced mostly black-and-white sketches, thus resulting in very little greyness. Between 1870 and 1880, Van Gogh used many rusty and yellowish colors, making the colors look more dull and greyish, thus lowering the mean saturation. Beginning from 1880, we can see some variations in terms of the saturation. The year 1881 was the year when Van Gogh proposed to his widowed cousin, in which she and her family all refused the marriage. Frustrated by such determination, Van Gogh threatened to burn his left hand with a lamp of flame. This figure shows that the saturation in this year is mostly clustered between 0.1 and 0.4, reflecting the frustration and darkness that Van Gogh felt during this period. In addition, during this period,

Van Gogh spent most of his time drawing still life and peasant workers with grey and dull colors to depict the never-changing landscape of rural life. Thus, there exists a greater proportion of greyness in his early works. In 1882-1884, Mauve introduced Van Gogh to oil painting, reducing the amount of greyness that we saw in his previous paintings. As shown in the figure, there is more variation in saturation, in which some of Van Gogh's paintings have a mean saturation of up to 0.6. Starting from 1886, Van Gogh enrolled in the Academy of Fine Arts in Antwerp, and from here he slowly adapted to the Impressionist paintings, sometimes incorporating the colorful elements into his own paintings. This uptick of the mean saturation in 1887 can largely be explained by such experience. Unfortunately, in the last three years from 1888-1890, Van Gogh experienced a series of depression, feeling of betrayal, and loneliness that eventually led him to commit suicide. As reflected in the figure, the mean saturation in these years dropped back to the same levels in the early 1880s.

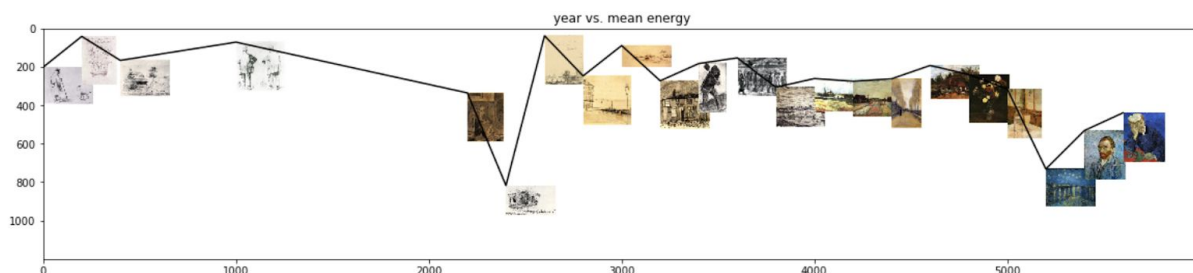


The fourth figure looks at the mean brightness of the paintings in different years. Up until the early 1880s, most of Van Gogh's paintings were black-and-white sketches, resulting in a relatively higher brightness. In 1882-1884, Mauve introduced Van Gogh to oil painting. As shown in the figure, the mean brightness decreased as a result of Van Gogh blurring the boundaries between the original color and ones he created. In 1885, Van Gogh drew several paintings of still life, which consisted mostly of sombre earth tones, in particular dark brown, thus explaining the relatively low brightness for that year. Starting from 1886, Van Gogh enrolled in the Academy of Fine Arts in Antwerp, and from here he slowly adapted to the Impressionist paintings, sometimes incorporating the distorted elements into his own paintings. This substantial decrease of the mean brightness ever since then can largely be explained by such experience. During his stay in 1888, Van Gogh produced 200 paintings that depicted the countryside and light. His works from this period were rich in yellow and mauve, thus the uptick

in the mean brightness. In 1889, the mean brightness decreased a little due to the immense hallucination and delusions of poisoning that resulted in the use of more sombre colors.



The fifth figure looks at the edge of the paintings in different years. Between the 1860s-1870s, Van Gogh produced mostly black-and-white sketches, thus there is quite a sharp contrast between the lines. Between 1870 and 1880, Van Gogh used many rusty and yellowish colors, making the colors look more dull and greyish, blurring the lines. The year 1881 was the year when Van Gogh proposed to his widowed cousin, in which she and her family all refused the marriage. Frustrated by such determination, Van Gogh threatened to burn his left hand with a lamp of flame. This figure shows that the edge has greatly increased, perhaps by showing the conflict in his emotions after getting rejected from possible long-term happiness. Starting from 1886, Van Gogh enrolled in the Academy of Fine Arts in Antwerp, and from here he slowly adapted to the Impressionist paintings, sometimes incorporating the colorful elements into his own paintings. This dramatic increase in the number of edges indicates that Van Gogh began to incorporate stark contrast of somber earth and fearsome colors. After years of smoking and overdrinking, Van Gogh had to seek refuge in Arles, accounting for the usual uptick in the number of edges in 1888.



The sixth figure looks at the energy of the paintings in different years. Until 1867, most of Van Gogh's artworks were sketches, so we can notice that the energy is low in 1867. However,

starting in 1867, he started to draw artworks with color, which we can also notice the increase in energy. And this energy reached its first peak point in 1873, because Van Gogh drew some paintings like, “old-woman-asleep-after-rops” by using the earthy yellow color. But after 1873, He started to draw sketches again, which caused a decrease in the energy. Beginning from 1880, we can see some variations in terms of the energy mainly due to the scaling up of the painting production. Unfortunately, in the last three years from 1888-1890, Van Gogh experienced a series of depression, feeling of betrayal, and loneliness that eventually led him to commit suicide. As reflected in the figure, the energy in these years reached a new high as Van Gogh turned himself toward more distorted emotions shown through distorted objects and colors.

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1868: family financial problem, left school and went to work

1873: proposed to landlady's daughter and got rejected; got fired

1878: became a Protestant missionary and voluntarily preached to the poor coal miners in a coal mine in southern Belgium (drawing of the miners and their families)

1880: began to study art in Brussels and began his career as a painter (financially supported by his brother Theo van Gogh)

1886: moved to Paris; inspired by the color and light by Impressionist art

1886- (since 1886): paintings were seldom noticed or liked by people in his time; suffered from psychotic episodes and delusions and became depressed gradually; drinking problem; lack of income

1888: moved to Arles, France; spent money on paint rather than food; argued constantly with Paul Gauguin who was paid by Theo to watch over him; one night he cut off his left ear, gave it to a paid prostitute and asked her to "keep this object carefully"

1889: released from the hospital; but still painting in the hospital garden (loneliness and depression)

1890: suicide (aged 37)