

# Quantitative Analysis of Intensity, Saturation, and Hue in Vincent van Gogh's Paintings

Maya Chande

**In a Tortoiseshell:** *In her paper, Maya Chande pairs mathematical and historical analyses in order to provide a possible explanation for the higher concentrations of yellow in Vincent van Gogh's paintings. By conducting a **cross-disciplinary** analysis based on van Gogh's letters, biography, and a mathematical examination of van Gogh's use of color, Maya concludes that the higher concentrations of yellow can be attributed to shifts in van Gogh's personal life. This excerpt highlights the way Maya weaves together scholars from various disciplines in order to create a clear **scholarly motive** and then skips to Maya's conclusions.*

## *Excerpt*

### *1.2 Quantitative Analysis in Art*

Several papers have been written attempting to strengthen our understanding of the relationship between biographical experiences of an artist and his/her expression through painting. While offering significant insights on connections between biographical details and contemporaneous painting practices, for instance, with respect to the yellowing of his palette associated with a possible diagnosis of xanthopsia, these papers have only offered either only a qualitative approach to the question or a limited quantitative approach (Gruener 2013). The research presented diverges from previous studies by supplying an in-depth quantitative analysis of painting color for a single artist, namely van Gogh, to reveal possible associations between color metrics (i.e. saturation, intensity, hue) and the chronology of his life, substantiated by his letters.

### *1.3 Scholarly Background*

The quantitative analysis of paintings is not a novel endeavor. For instance, Haber et. al. developed a painting analysis program called "ColourVis" which they used to do a broad study of European art from the past six centuries. While they did not consider the progression of color metrics for individual artists, the results from their analysis corroborated with prevailing understanding of general trends in hue, giving a level of validity to our own studies. Moreover, these quantitative analyses have been used to make claims on biographical influences of artists. For instance, Kim and Kim demonstrated in their 2013 paper that image processing of paintings

allowed researchers to identify Ter Borch as a dominant influence on Johannes Vermeer's artistic style. While Kim and Kim's study utilized biologically motivated image processing techniques which were beyond the scope of our own study, their paper gives good insights into future directions that could provide greater accuracy of results. Beyond such biographical insights gleaned from quantitative analysis, biological insights have been shown to also be attainable from qualitative analysis of paintings. In 2013, Gruener made an argument for a "possible diagnosis of xanthopsia" due to the yellowing of Vincent van Gogh's vision "as shown from the qualitative analysis of hue" from his paintings as well as from analysis of excerpts from van Gogh's well-documented collection of letters (Gruener 2013). Building on this scholarly background, we find it fitting to extend our attention to the quantitative analysis of paintings throughout van Gogh's oeuvre by analyzing intensity and saturation of color as well as average hue to gain insights on potentially pivotal periods in his biography. We also look to his collection of letters as an avenue for further biographical investigation of particularly pivotal periods in his life.

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### **3 Conclusions**

#### *3.1 Overall Takeaways*

Through our analyses of average intensity, average saturation, average hue as well as letter frequency, we have demonstrated the ability of a diverse array of metrics to identify a particularly pivotal period in van Gogh's life from 1888-1889 which corroborates with significant biographical details such as his move to Arles in early 1888 and what is considered a particularly proliferative artistic period by van Gogh scholars (Arnold, 1993). This period was highlighted in each of our analyses on average intensity, average hue, and letter frequency.

Taking the average hue metric in particular, we qualitatively observed the greatest amount of yellowing in 1888-1889. This yellowing, based on the quantitative average hues measured during the period, may corroborate the findings in Gruener's study suggesting a diagnosis of yellowing vision or may suggest a less biological event, namely an artistic reaction to his move to Arles and the strengthening of certain artistic influences such as Theo van Gogh or Paul Gauguin. This provides an alternative to the cited study.

Through the identification of the period from 1888-1889 as particularly pivotal for van Gogh, we have shown that the coalescence of various metrics, both artistic and biographical, are relevant for connecting artwork to biographical periods in van Gogh's life, presenting analytic methods that may be able to be performed for other artists as well.

### *3.2 Future Directions*

Considering the nascent nature of the quantitative analysis of paintings, it is not surprising that there are many avenues for adding depth and rigor to our study. For instance, our initial groupings can be altered to accommodate alternative investigations (e.g. grouping by types of paintings to investigate characteristic values for painting metrics for particular painting types).

Moreover, general improvements in a painting analysis program can help increase the power of conclusions able to be made. Implementing the biologically-motivated image processing techniques employed by Kim and Kim in their study may help refine our results, for instance. Being able to account for wear of paintings between creation and imaging would also help make conclusions more precise. For instance, implementing available models for relevant pigment degradations would help make intensity, saturation, and hue metrics more applicable for making biographical conclusions. With such improvements, endeavors such as categorizing paintings and artists into certain artistic periods with established characteristics may be more feasible.

Regarding the study of average hues, implementing a more robust method through which to compare “yellowness” or analogous metrics between averages RGB values and assign a significance value to hue differences would allow a more rigorous approach to trends in hue. In addition, expanding efforts to more accurately chronologize the development process of each of van Gogh’s paintings along with deeper investigation of van Gogh’s letter collection could allow for more meaningful connections from artistic aspects to contemporaneous biographical details found in letters. These avenues are worthwhile to pursue in the effort to elucidate the role of an artist’s personal life on their artistic styles.

## *Author Commentary*

Maya Chande

I, alongside a sizable portion of my peers, was not affected with great joy at the notion of writing our R3 for Writing Seminar. As I became increasingly aware of the freedom within the constraints of my prompt, however, I grew genuinely excited to write the paper. As part of WRI 150: Your Life in Numbers, we were tasked to make an original argument about a cultural object or practice built on the mathematical representation of human beings that contributes to relevant scholarly conversations. As someone who enjoys the unique perspectives that interdisciplinary work provides, I am not sure I could have asked for a more inviting prompt.

Mathematics is highly effective at describing the physical world but is generally inconsistent in its applicability to the humanities. It was intrigue in this inconsistency that led me to pursue the application of mathematics to art. In this spirit, I had developed a program with a friend to analyze the intensity, saturation, and hue of paintings as a quantitative tool to make qualitative statements about the art and artist. I utilized this in analysis for my paper where I considered, in particular, the works of Vincent van Gogh divided into periods based on convention by art historians. Perusing a database of van Gogh's life works from paintings to letters, I wondered if patterns exist across van Gogh's oeuvre and the various metrics that one can use to analyze them and if these patterns can be telling of trends in van Gogh's art and life.

My writing process began with the gathering of copious amounts of data from all of the works on the van Gogh database and graphing patterns in metrics ascribed to these works. The direction I would take my analysis in the paper was a bit undefined until I noticed patterns in these data which directed me to consider a particular period during van Gogh's life. Homing in on this period yielded fascinating parallels in the metrics of intensity, saturation, and hue. I decided to also consider the frequency with which van Gogh corresponded with various interlocutors through letters to serve as a sort of link between his unique artistic behavior and his personal life in the period. Due to the sheer number of confounding variables involved with such analysis, the statistical rigor of the paper was likely not strong enough to make any high-confidence conclusions in any one metric, but considering several metrics and finding significant results in them during a single period seemed to be highly suggestive of an important period of time in van Gogh's life despite variability in individual metrics.

At its core, I found this paper illuminating to write as it allowed me to experience first-hand the applicability of the quantitative world of statistical and mathematical thinking to giving valuable insights on the very qualitative world of art and artists.

*Editor Commentary*

Malka Himelhoch

Analyzing sources can be daunting. Every discipline has its own approach to **analysis** and expectations about the “right” way to conduct the **analysis**. Switching between disciplinary approaches to analysis is challenging, even if those disciplines seem to be closely related. For instance, the kind of analytical work expected in a history paper is very different from the **analysis** conducted in an English paper. Juggling different analytical approaches while still establishing a clear **scholarly motive** and **thesis** is not easy. In this excerpt, Maya successfully melds together art history and mathematically based quantitative **analysis** by clearly placing her argument within an already extant scholarly conversation.

The excerpt begins with an explanation of how Maya’s paper fits in to the current work on quantitative analysis in the discipline of art history. The early emphasis on the gap that this paper fills helps prepare the reader for the cross-disciplinary analysis that is at the core of this paper. In the first section Maya sets up a dichotomy between qualitative and quantitative analysis that has already been conducted on pieces of art. She then introduces her own approach, a combination of quantitative analysis of hues and historical analysis of van Gogh’s letters, as a middle ground between the two extremes. By explicitly articulating the way that her argument differs from the other papers she discusses, Maya establishes a clear **motive** and purpose for the paper: her work is melding already established methods of quantitative and qualitative **analysis** to focus on one particular artist, Vincent van Gogh. The clarity that Maya uses to set up her analysis allows the reader to feel comfortable with the **interdisciplinary analytical work** that could otherwise be confusing.

Clarity again works to Maya’s advantage in the “Overall Takeaways” section near the end of the excerpt. In the first paragraph of this section Maya explicitly states the methods (both quantitative and qualitative) by which she came to the conclusion that van Gogh’s artistic shift was correlated with significant biographical developments in his life. By reiterating her methodological approach and then restating her **thesis**, Maya is able to effectively transition from in-depth qualitative analysis to more historically based claims. As a result of Maya’s continued clarity, readers feel comfortable shifting back and forth between different analytical approaches throughout this paper.

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## **Bios**

**Maya Chande, '24** is originally from Atlanta, Georgia. She is interested in studying mathematics and physics and is a member of Princeton PUZZLES, ballroom dance, and a board member for Undergraduate Women in Physics. Maya wrote this as a first-year.

**Malka Himelhoch, '21** is a senior in the Department of Religion interested in the ways law, religion, and the state intersect and how that intersection impacts women's lives. She loves swimming, reading, hiking, and writing poetry.