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From Yarns to Canvas: Modelling as a Path to Knowledge in Van Gogh's Creative Process

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Abstract
Scientific modelling is widely used to simplify and understand complex phenomena, yet its role in artistic practices remains underexplored. This study examines how Vincent Van Gogh's engagement with colour theory and cognitive modelling parallels scientific methodologies. By analyzing historical records, including letters to his brother Theo, Émile Bernard's writings, and Van Gogh's paintings from the Van Gogh Museum's digital archive, I investigate how his "box of yarns" functioned as an experimental tool and model for studying colour interactions. Despite being limited to a specific period of Van Gogh's painting, this method played a fundamental role in the artist's evolution, facilitating the development of his expressive and highly textured brushstrokes. This investigation also reveals that the box of yarns represents the culmination of Van Gogh's cognitive and creative journey, situated within the dynamics of complex adaptive systems. In particular, the Lotka–Volterra model provides a useful framework for interpreting the fluctuations in his painting production as the result of interactions between internal and material resources, emotional states, and environmental stimuli. These dynamics are further connected to the Four C Model of Creativity, mapping the artist's work from experimental exploration to a lasting cultural impact. By reframing Van Gogh's work through the use of modelling, this study challenges the conventional view of him as purely intuitive or tormented, positioning modelling as a key cognitive bridge between scientific reasoning and artistic creation.

Keywords Scientific modelling · Cognitive modelling · Complex adaptive systems · Lotka-Volterra · Creativity development

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1 Introduction

Modelling plays a central role in representation and visualization across all forms of learning, particularly in scientific disciplines (Harrison & Treagust, 1998). It is a fundamental scientific approach (Rosenblueth & Wiener, 1945), used to simplify and represent complex phenomena and realities (Frigg & Hartmann n.d.).

Historically, modelling has provided scientists with a way to conceptualize the invisible, as seen in Bohr's simplified visualisation of the atom (Bohr, 1913). Though the quantum theory of atomic structure did not validate Bohr's atomic model as a faithful depiction of reality, it remains a useful educational and scientific tool, demonstrating how even simplified models of reality serve as enduring frameworks for scientific inquiry (White, 2025).

At its core, modelling is a process of abstraction and simplification, guiding the scientific mind to recognise and organise patterns in natural phenomena (Berry & Houston 1995). However, the philosophical significance of modelling goes beyond mere utility: models, while not exact replicas of reality, are powerful epistemic tools that mediate between theory and the world, offering both scientists and learners an approach to grasping the complexity of nature. In this sense, modelling sits at the intersection of scientific practice and philosophy (Knuuttila et al., 2024), as it raises critical questions about how we come to know and represent reality through abstractions.

The rise of computational science has further transformed the modelling process, reflecting broader shifts in scientific methodology. Jay Forrester's System Dynamics (Forrester, 2007), pioneered in the 1960 s, introduced a novel way to model complex systems by integrating visual representation and simulation, allowing users to map and understand dynamic interactions with greater precision. This transition to virtual models and computerized simulations marks a key moment in the history of scientific modelling of complex systems. It reflects changing philosophical conceptions of what to"model"a system means, moving from abstract model formulation through mathematical equations to using graphical objects to represent mathematical operators and variables. These visuals, such as arrows for flows, valves for regulators, and boxes for stocks, leverage familiar objects found in the real world to convey meaning intuitively and make the process of learning and modelling complex systems accessible even to non-scientists (Lukyanenko et al., 2024; Perissi, 2019).

Yet, modelling represents a universal cognitive approach that extends beyond the sciences into the realms of artistic creation and cultural practice. The capacity to create world phenomena representations (Kirsh, 2010) whether through images, diagrams, or symbolic systems has long been a key part of human cognition and creativity (Forbus et al., 2017).

This crossover is particularly evident in the work of Vincent van Gogh, whose methodical approach to colour theory exemplifies the use of models in artistic experimentation. In this paper, I explore Van Gogh's creative process through the lens of modelling. Drawing from a systematic review of his paintings and historical correspondence, I examine how the artist's use of the colour wheel and the box of yarns functioned as analogue modelling tools, enabling structured experimentation with colour relationships. I argue that Van Gogh's approach to colour exemplifies a form of modelling that, while intuitive and artistic, aligns with core epistemic practices found in scientific inquiry. Moreover, the use of colours' models not only helps explain how Van Gogh developed his distinctive palette but also sheds light on the underlying mechanisms of his creative process and contributed to

making him one of the most prolific artists of his time, with hundreds of paintings produced in just nine years.

By bridging scientific and artistic modelling, this analysis highlights modelling as a general cognitive strategy that underpins discovery, problem-solving, and creativity across disciplinary boundaries.

2 Methods: Cataloguing Van Gogh's Paintings

The research and cataloguing of Vincent van Gogh's paintings followed a systematic, multi-step process that utilised key resources to ensure accuracy. The primary resource was the Van Gogh Museum's official digital catalogue, an open-access platform maintained by the Van Gogh Museum in Amsterdam. This resource provides high-resolution access to Van Gogh's paintings, drawings, and sketches, along with essential metadata, provenance information, and academic references, making it indispensable for this study.

In addition to the museum's catalogue, I employed Jan Hulsker's "The Complete Van Gogh: Paintings, Drawings, Sketches" (Hulsker 1984) to establish a chronological framework. Recognized for its precise chronology of over 2,100 works, Hulsker's comprehensive reference helped to further check and organize the analysis of Van Gogh's paintings over time.

Additional context regarding the development of Van Gogh's techniques and style was drawn from Ingo F. Walther and Rainer Metzger's "Vincent van Gogh: The Complete Paintings" (Walther & Metzger 1993). This source provided thematic and geographical insights that complemented the chronological data.

To gain deeper insight into Van Gogh's creative process particularly his engagement with colour, I reviewed his letters to his brother Theo. Rich direct references to his artistic practices, these letters offered valuable insights into his approach to colour and related works.

After integrating these resources, I focused my analysis on 717 paintings, excluding sketches that primarily featured character studies, as they contributed less to understanding Van Gogh's development of colour theory.

I selected paintings from 1881 to 1890 sourced from the Van Gogh Museum's online catalogue to visualise the evolution of Van Gogh's painting style. The catalogue reports only 217 paintings of the 717 investigated, however, it shows a selection of paintings from all 9 years in a sufficient number to be representative of the Van Gogh colour techniques evolution, with the advantage of being an open access gallery.

The key evidence of the existence and use of Van Gogh's"box of yarns"comes from documents of Émile Bernard, a contemporary younger associate of Van Gogh, who first mentioned the"box of yarns"in his writings Les Hommes d'aujourd'hui (Bernard, 1891). Bernard's letters and published accounts, such as Souvenirs sur Vincent Van Gogh (Bernard, 1925) and articles in Mercure de France (1891), were examined, offering descriptions of Van Gogh's use of this tool during their time together in Paris (1886–1888) and providing crucial details about its role in his colour studies. This is the main source about the use of the box: unfortunately, during the two years Van Gogh spent in Paris, there were no letters to his brother, as he lived with him. In Letter to Theo, we have the last evidence or correspondence from Antwerp in January 1886 and the next one from Arles, April 1888, so Van Gogh himself doesn't mention this box explicitly in any correspondence available today.

3 Results: Van Gogh's Use of Colour Theory and Modelling in His Artistic Development

Results are structured in three parts.

Section 3.1 explores how Van Gogh was embedded within a broader mid-19th-century artistic movement that engaged with scientific treatises on optical colour phenomena, particularly through the use of the colour wheel—an abstract, illustrative model for organizing hues. This theoretical framework provided a foundational tool for Van Gogh's early experiments aimed at enhancing the visual impact of his work.
Section 3.2 moves into a more material and tactile dimension, analysing Van Gogh's use of the "box of yarns" during his Paris years. Likely inspired by the weaving culture he observed in Nuenen, this tool allowed Van Gogh to experiment with complex colour harmonies in a predictive and iterative manner, serving as a tactile modelling asset that guided the development of his original palette.
Section 3.3 investigates how tools like the colour wheel and the box of yarns can be understood as forms of internalised capital that translate perceptual and emotional resources into artistic output. Rather than viewing Van Gogh's path to knowledge as linear or solely driven by psychological states, this approach frames his creativity as the result of dynamic feedback loops between physical, cognitive, and emotional resources, external stimuli, and environmental conditions.

Taken together, the three sections aim to offer an interdisciplinary understanding of how modelling, both conceptual and material, served as catalysts in Van Gogh's prolific artistic development.

3.1 Van Gogh's Use of Colour Wheel Model

Van Gogh studied Charles Blanc's colour principles in 1884, when he lived in Neunen. Blanc's works, Grammaire des Arts du Dessin (Blanc 1867) and Grammaire des Arts Décoratifs (Blanc 1882), which detail the theories on colour among other artistic principles, were widely studied by artists of that time, including Van Gogh, Gauguin, and Seurat. He expressly mentioned the books by Blanc in a letter to Theo of the middle of October 1885, asking his brother to send him any book he came across on colour theory, as he was far from having complete knowledge of the subject and sought to learn more every day.

Notably, Blanc was influenced by the scientific work of the chemist and physicist Michel Eugène Chevreul (Lee, 2025), whose colour wheel (Heila, 1991) served as a tool to explore the principle of simultaneous contrast: colours placed side by side intensify each other. The colour wheel is a "model" for the visual representation of colour relationships, typically based on the tri-chromatic model. It organises colours into primary, secondary, and tertiary hues, forming a basis for understanding colour harmonies and mixing. Based on this, Blanc emphasised that the optical mixing of colours creates more vibrant and purer colours than traditional pigment mixing, providing painting with new emotional and psychological effects. This pivotal point raised by Blanc, enabled Van Gogh to approach colour not just intuitively but with a deeper understanding of its systematic application.

Eugène Delacroix's works were also the basis of Van Gogh's study of colours interaction. Delacroix (Delacroix 1948) revolutionized painting through his bold contrasts, expressive brushwork. His dynamic approach shaped Romanticism and laid the groundwork for modern artistic movements. Delacroix travelled to Morocco and Algeria in 1832 (Delacroix & Hannoosh, 2019; EA Declar, 2019), deepened his understanding of colour, inspiring radiant tones drawn from Oriental textiles, ceramics, and landscapes. Rather than blending meticulously, he paired colours in swift, allowing light and shadow to interact dynamically. This technique, later embraced by the Impressionists (Gervais, 2000), gave his works a luminous intensity that struck Van Gogh's imagination. Delacroix explored the expressive and emotive capabilities of colour and focused on the dynamic effects of complementary colours, which he described as creating "vibrancy" when placed side by side. This idea was grounded in Delacroix understanding of simultaneous contrast, i.e. the concept that colours placed next to each other appear brighter and more intense due to mutual influence. Again, this idea was based on Chevreul's colour wheel scientific model.

In this context, both Blanc and Delacroix had the merit of taking Chevreul's wheel model and further developing the theory of simultaneous contrast for addressing an audience of artists. Van Gogh acknowledged the influence of both Blanc and Delacroix in a letter to his brother Theo in August 1884, when he reported reflections on the expressive potential of complementary colour contrast. He suggested that such contrast could be used to capture the spirit of the seasons, for example, representing summer through the contrast of yellow wheat fields against blue skies, a first seed that preludes to the future painting "Siesta" (1888).

That Van Gogh started to experiment with contrasts from 1884–1885 is detectable even with a qualitative visual comparison of the earliest works (Fig. 1) with the paintings in Nuenen and Antwerp (Fig. 2).

In comparison to his earlier muted tones between 1881–1883, Van Gogh's paintings in Antwerp (Fig. 2, between 1885 and the beginning of 1886) demonstrate a marked shift toward the use of brighter colours, with a more varied palette that includes yellows, reds, and greens. In some of his paintings, Van Gogh also begins to explore contrasts, particularly complementary colours such as red and green or blue and orange, like in *Houses Seen from the Back*. The contrasts add dynamism to Van Gogh's compositions, making figures and elements stand out more vividly against their backgrounds (Defeyt et al., 2020). Additionally, his treatment of light and shadow becomes more nuanced, creating a sense of depth and



Fig. 1 Van Gogh's earliest painting between 1881–1883. From Left to right (Credits: Van Gogh Museum, Amsterdam (Vincent van Gogh Foundation).): Cottages (September–November 1883), Women on the Peat Moor (October 1883), Farm with Stacks of Peat (October 1883), Still Life with Cabbage and Clogs (November–December 1881), View of the Sea at Scheveningen (August 1882); Peasant Burning Weeds (October 1883) (Credits: Van Gogh Museum, Amsterdam/Drents Museum, Assen (purchased with support from the VriendenLoterij, Mondriaan Fund, Rembrandt Association (with the additional support from its Themafonds Impressionisme/Claude Monet Fonds, its Hendrickje Fonds and the Cultuurfonds), Vincent van Gogh Stichting, Province of Drenthe, Stichting Beringer Hazewinkel, Stichting Steunfonds Drents Museum and Stichting Vrienden van het Drents Museum))



Fig. 2 Van Gogh's paintings in Antwerp between 1885 and the very beginning of 1886**.** From Left to right: Portrait of an Old Woman (December 1885), Head of a Woman (December 1885), Portrait of an Old Man (December 1885), Head of a Skeleton with a Burning Cigarette (January–February 1886), Houses Seen from the Back (December 1885-February 1886), Portrait of a Woman (December 1885) (Credits: Van Gogh Museum, Amsterdam (Vincent van Gogh Foundation).)

texture in the scenes. The light is used strategically to evoke warmth or emphasise specific areas, like in the back of the *Head of a Skeleton with a Burning Cigarette*. Furthermore, Van Gogh's brushwork during this period became more expressive, in contrast to the tighter strokes of his earlier works. This shift reflects his growing engagement with the wheel model, as evidenced by the exceptional rise in his output, with more than 100 paintings completed in 1885.

3.2 From the Colour Wheel to the Box of Yarns

The engagement with colour experimentation also followed during the two years in Paris. It is Van Gogh's friend, Emile Bernard, who reported the existence of a "Box of Yarns", shortly after the painter's death. Bernard says that it was in Paris, when he met and worked with Van Gogh and that he saw the box for the first time.

Even though we have this report from Bernard, it is still difficult to make a hypothesis on when Van Gogh would have started to use the box as a model for enhancing his learning of colour mixing to achieve the desired colours. And why would he have thought to do it using yarns?

To answer this question, we need to go back to the Nuenen years when Van Gogh observed the world of rural weavers. Rural weaving, often a supplementary and seasonal occupation, remained prevalent in Nuenen, as industrialization made such crafts increasingly rare. Despite the hardships and poverty of these artisans, Van Gogh saw beauty and dignity in their work (Pollock, 1987). In a letter to Theo of April 1884, Van Gogh expressed the challenge of depicting weavers in his work, he was aware of very few existing drawings of them. He mentioned having created three watercolour studies of weavers but found them particularly difficult due to the confined spaces in which the weavers worked. He observed that the small size of the rooms made it hard to step back far enough to fully capture the looms.

Van Gogh's fascination with weavers extended beyond mere documentation of their trade. He admired the interplay of light and shadow within their workspaces and the patterns and coloured yarns they used to create the textiles. It is in this environment that we can make the hypothesis that Van Gogh remembered the approach of weavers in realising a textile pattern, trying to resemble the same approach in his painting techniques during the years in Paris. Up to 1886, his works demonstrated disciplined studies rooted in a naturalist style. The surfaces remain smooth and unified, with no indication of fragmented or sketch-like



Fig. 3 A selection of Van Gogh's paintings in Paris during 1887 early 1888. Self-Portrait as a Painter (December 1887-February 1888), Self-Portrait with Grey Felt Hat (September–October 1887), Café Table with Absinthe (February–March 1887), Dish with Citrus Fruit (February–March 1887), Grapes (September–October 1887), Wheatfield with Partridge (June-July 1887) (Credits: Van Gogh Museum, Amsterdam (Vincent van Gogh Foundation))



Fig. 4 In the middle, Van Gogh's Box of Yarns at the Van Gogh Museum, Amsterdam. Paintings: left, Grapes Paris, September–October 1887; right: Apples, Paris, September–October 1887 (Credits: Van Gogh Museum, Amsterdam (Vincent van Gogh Foundation))

forms. By 1887, his exploration of colour deepened, producing still lifes and floral compositions characterised by connected brushstrokes similar to contiguous yarn threads (Fig. 3), especially in painting the background, revealing a controlled and repetitive approach.

It also recognised that Van Gogh utilised the yarns to define specific colour palettes for individual paintings (Helvey 2009). Certain balls of yarn can be directly linked to specific works. For example, a ball of harmonized yellow tones aligns closely with Still Life like "Grapes", while another ball of yellow, green, and red yarns resembles the palette used in "Apples" (Fig. 4).

However, from the latter half of 1887 to the spring of 1888, a further clear shift emerges. The beauty of his floral works intensifies, while his technique undergoes a transformation marked by the fragmentation of the brushstroke, breaking the compositional unity, particularly in landscapes. The brushstrokes change in size and start to be more rounded and shorter. It looks like Van Gogh dominated the painting techniques recording, in 1888, another impressive number of paintings by year, a peak of production of more than 150 paintings, including the most famous like "Sunflowers".

This latest change is often considered a consequence of Van Gogh's psychosis that emerges (Wolf, 2001), especially after his leaving of Paris for Arles. However, a recent study from Voskuil (Voskuil, 2020) recognised that just a few paintings were likely realised during the painter's crises. In Letters to Theo of January 1889, Van Gogh wrote that he experienced a renewed clarity of mind for his work. He says that ideas emerged, some impossible to fully realise, but this did not trouble him. He described how his brushstrokes moved with mechanical precision, as if following an unstoppable rhythm. Despite the disease, the latest months in Auvers were a time of intense artistic reflection. He conveyed a growing

confidence in his technique, feeling more assured in his brushwork than before his time in Arles. However, in Auvers, he found himself physically exhausted, almost losing his grip on the brush. Nevertheless, with a clear vision of what he wanted to achieve, Van Gogh writes that he completed three large canvases and a portrait, demonstrating determination, lucidity and artistic mastery until the last days of his life.

3.3 Modelling Creativity: Van Gogh's Output as a Complex Adaptive System

Excluding that the main component of Van Gogh creativity is mainly due to a gift or a psychosis, the question is if Van Gogh could have found in the modelling tools (i.e. the colour wheel and its box of yarn) effective "assets" that allowed for improving his creativity process, make him experiments with those models to develop hundreds of paintings in relative short lapse of time of 9 years. To answer this question, I investigated Van Gogh's 717 paintings, which are considered in this study, as a function of time (Fig. 5).

Figure 5 reveals clear fluctuations in painting production, with notable peaks in 1885 and 1888, followed by a marked decline in 1889, before a further increase, truncated by the artist's death. To interpret these dynamics, I draw on a framework inspired by ecological modelling, particularly the generalised Lotka–Volterra (LV) model. A hallmark of the LV model is its ability to explain oscillatory dynamics in biological systems. Indeed, LV was originally developed by the mathematician Vito Volterra to study preys and predators fish stocks fluctuations in the Adriatic Sea (D'Ancona 1942). However, LV represents a dynamic

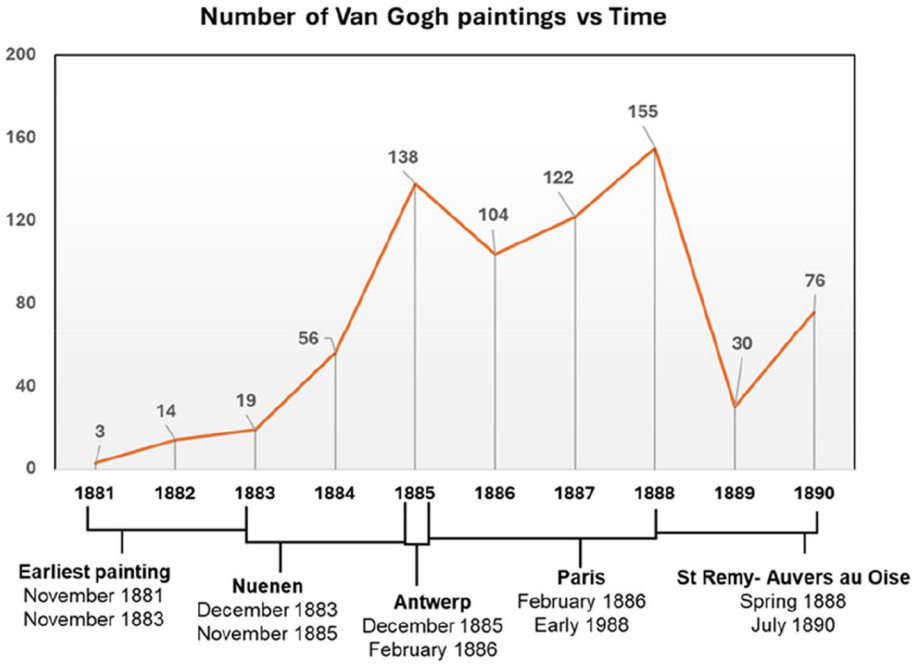


Fig. 5 Van Gogh's number of paintings versus time. The first peak of painting production was in 1885 when the painter engaged with the colour theory of Blanc and Chevreul. The second peak, which occurred in 1888, reflects the period when he employed the"box of yarn", leading to canvases that resemble textile patterns

archetype that has found applications in diverse systems like chain reactions (Perissi & Bardi, 2022), macroeconomics (Gandolfo, 2007; Perissi & Bardi 2021), environmental sustainability (Ruan et al., 2023; Xing et al., 2021), resources exploitation (Perissi et al., 2023, 2017), and cultural phenomena (Perissi & Bardi, 2021; Sprott, 2004), just to cite a few.

This versatility is due to the LV model's capability of describing Complex Adaptive Systems (Lansing, 2003) that are dynamic systems composed of interacting elements that adapt and evolve in response to internal and external stimuli (Holland, 2006), leading to behaviour patterns. This makes LV a useful tool also for qualitatively interpreting Van Gogh's artistic productivity reported in Fig. 5. In this context, the system is based on five interacting elements: resources, capital, production (Perissi et al., 2017), recovery and resources' depletion (Fig. 6).

Resources include skills and emotional and environmental factors available to the artist, such as landscapes, moods, and social contexts. Capital consists of internalised assets like visual memory, aesthetic sensibility and material assets like colours, canvases and modelling tools such as the colour wheel or the box of yarns. Artistic production, measured by the number of paintings per year, reflects how efficiently capital converts resources into creative output. Rather than exhibiting steady growth, LV describes oscillations driven by internal feedback loops between resources, capital, and production, recovery and resources' depletion. In periods of resource abundance, when emotional energy, perceptual stimuli, and intellectual inputs converge, capital becomes more effective, translating those inputs into elevated artistic output. However, such phases are inherently self-limiting. Sustained productivity places increasing pressure on the resources that fuel creation, whether through emotional exhaustion, cognitive overload, or environmental depletion. As resources decline, capital's transformative capacity also diminishes, resulting in a contraction of production.

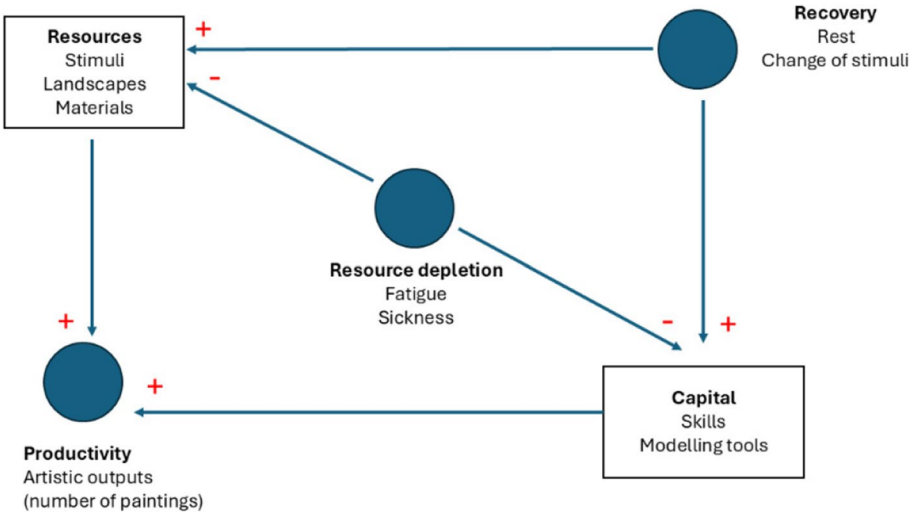


Fig. 6 A simplified causal diagram illustrating the dynamics of Van Gogh's creative process as an adaptive system. The blue circles represent the human dimension, encompassing physical, cognitive and emotional resources. The rectangular elements denote accumulable stocks that are influenced by both internal regulation and external stimuli, such as new artistic inputs, environmental conditions, or tools. Internal and external dimensions interact in a feedback relationship that drives, sustains, or diminishes artistic production over time

Recovery is not merely a matter of rest, but of systemic regeneration: the emergence of new stimuli, shifts in social or spatial context, or the reconstitution of emotional and cognitive equilibrium and new modelling tools. When these conditions are met, the system reactivates, capital adapts, and a new productivity cycle begins.

This perspective opens the way for a reinterpretation of Van Gogh's creative trajectory as the dynamic result of recursive interactions among evolving resources, internalised capital, and artistic production. The first significant peak in Van Gogh production, occurring in 1885, corresponds to the period when Van Gogh deeply engaged with Blanc's interpretation of Chevreul's colour theory and the systematic application of the colour wheel. These models acted as a newly activated form of capital, allowing Van Gogh to reframe his perceptual experience and translate it into a burst of creative output. This phase aligns with a classical LV dynamic: once the resources are abundant and the capital structure to process them is in place, production rises. The steep increase in paintings is thus not random but boosted by reinforcing loops between resources and assets. A second, even higher peak appears in 1888, following a similar mechanism but based on a more evolved form of capital: the box of yarns. Unlike the abstract conceptual model of the colour wheel, the yarns were tactile and combinatory, allowing Van Gogh to simulate and experiment with complex colour arrangements before applying them to canvas. This can be interpreted as a form of predictive modelling. In cognitive neuroscience, Friston's free energy principle conceptualises perception and action as processes of minimising prediction error through internal generative models (Friston, 2010). Van Gogh's practice, in this light, reflects a dynamic interplay between perceptual hypotheses and sensory feedback, with colour experiments acting as externalised tools for refining internal models of visual harmony. This makes the box of yarns a leap in modelling colours, coinciding with the highest rate of painting transformation in Van Gogh's career.

What follows, the dramatic fall in 1889 and the partial resurgence in 1890, can also be interpreted within this framework. The collapse in output is not due to a loss of capital but rather a severe depletion or destabilization of resources, primarily caused by Van Gogh illness. Yet in 1890, with a change of environment in Auvers and some recovery of perceptual and emotional resources, production partially rebounded. Letters from this time describe his mind as lucid, his ideas as plentiful, and his brushwork as automatic: his capital was still functioning, but the system had entered its final oscillation.

In this view, Van Gogh's artistic journey is best understood not as a linear progression or a product of psychological pathology, but as the output of a complex adaptive system where tools like the colour wheel and box of yarns played the role of internalized assets enabling creative transformation.

4 Discussion

As outlined in the results, the oscillatory pattern of Van Gogh's artistic productivity exhibits characteristics of a complex adaptive system, conceptually aligned with the LV model. Rather than revisiting its formal structure, this discussion focuses on the implications of adopting such a framework for understanding artistic creativity.

It is important to acknowledge that the application of the LV model in this context is qualitative in nature. Among the five core elements of the system, only production is empiri-

cally accessible, as evidenced by the quantifiable number of paintings produced per year. In contrast, resources (e.g., emotional, perceptual, and environmental stimuli), capital (e.g., internalised tools, technical mastery, cognitive scaffolds), recovery and resources depletion are difficult to measure and often inferred through contextual or archival evidence. As such, limitations must be acknowledged: first, ecological models, like the LV model, are inherently abstract, and their application to cognitive or artistic processes requires metaphorical interpretation rather than quantification (Holyoak, 2024). Second, human creativity involves higher-order consciousness, memory, and subjective meaning-making (Wood & Conway, 2006), dimensions not present in biological predator–prey systems. For these reasons, the LV model employed here is not intended to function as a predictive tool but rather as a conceptual scaffold, useful for articulating the recursive, adaptive nature of creativity and for understanding how material and cognitive assets (like modelling tools) shape productive cycles in artistic practice. Future studies could investigate further LV dynamic in creative process through psychometric instruments, thematic analysis, thereby contributing to the understanding of how all variables of the system quantitatively co-evolve with artistic production over time. Here, I aim to provide a methodological bridge between humanities-based interpretations of creativity and systems-based approaches drawn from the natural and social sciences.

As a further point of discussion, I argue the proposed LV modelling of creativity is neither purely mental nor entirely physical. This mediating role has deep philosophical relevance (Williamson 2017). As I premised in the study, models help us understand the world, but they never represent it fully (Levy, 2015). They simplify, highlight certain features, and ignore others, creating what's called an "epistemological gap", a space where the model and reality don't fully match (Woods, 2014). Nevertheless, Van Gogh's use of yarns aligns with the idea of model-dependent realism, which suggests that our understanding of reality is always filtered through internal models (Friston, 2010), and that different models can reflect the same world reality (Hesse 2008). If reality can be represented through multiple, even partial, models, then the epistemological gap may never be fully or unambiguously closed, and perhaps it need not be.

This also points to the metaphysical role of modelling, as something that helps connect our internal ideas with the external world. Just as ontologies in information systems define the structure of a domain (Herre, 2013), artistic models like Van Gogh's yarn box offer a personal but structured way of organizing a domain of information with the purpose of developing and boosting creative choices.

In this sense, having a well-structured model (such as Van Gogh's colour ontology through his yarns) helped him to operate across the spectrum of the Four C Model of Creativity (Kaufman & Beghetto, 2009). Van Gogh's early phase corresponds to Mini-C and Little-C, characterised by exploratory experimentation and engagement with established theories, such as Chevreul's colour harmonies. By the late 1880 s, particularly with the introduction the box of yarns, his practice transitioned into Pro-C, marked by sustained originality and internalised systems of production. His later recognition and lasting cultural impact situate his art within the domain of Big-C creativity, defined by transformative contributions to collective knowledge and aesthetic sensibility.

Table 1 demonstrates how Van Gogh's creative evolution, when synchronised with his modelling practices and production output, reflects the theoretical dynamics of both the LV framework and the Four C model. The convergence of these perspectives offers a compel-

Table 1 Chronological overview of key creative phases in relation to the four C model of creativity and the LV model

Years	Key event	Relation to four C model of creativity	LV model parallel	Impact on productivity
1881–1884	Early works, dark naturalistic tones	Mini-C: Personal exploration and learning through practice	Capital formation begins; internal resources accumulate, but transformation is limited	Gradual skill development, lower production rate
1885	First peak in painting production, engagement with Blanc's and Chevreul's colour theories	Little-C: Application of learned theories, experimentation with new techniques	Resources become abundant; capital (colour theory) activates high production	Increased output as external models inform artistic decisions
1886–1887	Exposure to Impressionism in Paris	Pro-C: Refinement of techniques, synthesis of external influences	Stable growth; capital adapts to enriched resources; feedback loops sustain productivity	Transition to a more structured and expressive use of colour
1888	Second peak in production, development of the'box of yarns'as a modelling tool	Pro-C to Big-C: Self-developed systematic approach to colour, independent creative breakthroughs	Advanced capital (modelling tool) enables maximum transformation of abundant resources	Significant increase in productivity, paintings resembling textile patterns
1889–1890	Final works, emotional intensity and controlled colour interactions	Big-C: Groundbreaking artistic vision, lasting influence on modern art	Resource depletion (emotional, environmental); capital intact but underused due to system stress	High output despite personal struggles, the ultimate transformation of artistic style

ling interdisciplinary narrative that places Van Gogh's creativity as the outcome of recursive adaptation, cognitive modelling, and systemic transformation within a complex dynamic.

Moreover, Van Gogh's artistic process provides a strong parallel to scientific modelling, particularly through his engagement with the textile world and his evolving application of colour theory. His exposure to weaving traditions in Nuenen and subsequent use of coloured yarns as a means of studying colour harmonies reveal a structured approach to visual representation, one that mirrors scientific practices of modelling in its synthesis of empirical observation, theoretical principles, and iterative refinement.

While Van Gogh's exploration of textile production in Nuenen provided a thematic and formal foundation, his move to Paris in 1886 marked a pivotal transition in his approach to colour. The appearance of paintings with colour schemes comparable to textile shows yarns functioned as an analogue model, an experimental tool through which he could explore chromatic relationships before committing them to canvas, relying on limited physical resources against the use of temperas for trials: this is analogous to how scientists use simulations and theoretical models before conducting costly or resource-intensive experiments. As a theoretical physicist refines equations before committing to experimental tests, Van Gogh refined colour compositions with yarns. It's remarkable what Van Gogh wrote to his brother Theo in a Letter from Nuenen in April 1885, when he explains that.

> "*…there are (rather than individuals) rules, principles, or fundamental truths, both for drawing and for colour, which are proven to be inevitably encountered when a real truth is discovered*."

Van Gogh's statement aligns closely with scientific epistemology, particularly the idea that underlying principles govern artistic and scientific exploration. The assertion parallels the epistemic foundation of science, where theories and models are refined through repeated encounters with empirical reality.

Debora Silverman (Silverman 1994) noted that Van Gogh's stroke patterns and layered application of paint recall both the physical qualities of woven fabric and the aesthetic of contemporary tapestry. The conceptual parallels between textile production and Van Gogh's evolving technique reveal an implicit model of visual composition, one that is iterative, structured and informed by empirical study. Furthermore, Van Gogh's box of yarns can be seen as an intuitive precursor to modern colour models: his practice of arranging yarns to explore colour relationships mirrors the fundamental principles behind the RGB model(Westland & Cheung 2016), now widely implemented in electronic image representation on televisions and computer screens.

Building on the previous observations, the box of yarns emerges as a central interpretive thread in this thesis. However, it is important to recognize that our understanding of its role is primarily shaped by Émile Bernard's recollection and the funding of the box of yarns after Van Gogh's death. As such, this investigation should be read as a reflective proposition, grounded but not conclusive, that offers a compelling lens to explore how tangible, embodied tools like the yarns may have shaped Van Gogh's visual thinking and artistic development.

5 Reflection and Conclusion

This study has proposed that Vincent van Gogh's artistic process can be understood through the conceptual lens of modelling, not merely as a visual or technical exercise, but as a structured cognitive strategy. Central to this interpretation is the box of yarns' in creating the painter's distinctive palette and the application of the Lotka–Volterra model to provide a framework for viewing Van Gogh's creative trajectory as a dynamic and adaptive system.

By paralleling Van Gogh's colour to simulations or prototypes in scientific practice, this analysis highlights how artistic tools can function as epistemic instruments. In doing so, this offers a broader methodological insight: modelling, whether in science or art, constitutes a form of thinking with and through representations. This reframing contributes to modelling theory by demonstrating that model-based reasoning need not be confined to formal systems or predictive computation; it may also emerge through tactile, embodied, and materially grounded practices, as exemplified by Van Gogh's yarn arrangements.

The fluctuations in his artistic output, marked by distinct peaks and periods of decline, are not arbitrary, but emerge from the recursive interactions between human dimension and the environment. These cycles of acceleration and exhaustion, followed by phases of reorganisation, reflect the behaviour of complex systems governed by feedback, non-linearity, and phase-dependent change. In this view, the artist's use of yarns prefigures principles of model construction found in scientific epistemology: abstraction, iteration, minimisation of uncertainty, and the output refinement based on the ranges of inputs. Importantly, this interpretation offers a qualitative structure for understanding how artistic productivity might respond to internal and external conditions. Van Gogh's creative process, in this light, becomes a case study in how cognitive, affective, and environmental variables may interact over time,

suggesting a broader applicability of system-based models including cognitive and sensory modalities not typically foregrounded in the sciences. Van Gogh's yarn also highlights a metaphysical function of modelling: as a bridge between internal ideas and external realities, it offers personal but structured frameworks for organising creative choices.

Van Gogh's modelling practices link the artistic and the scientific not only in method but in their shared aspiration: to comprehend, represent, and reimagine the world, through an adaptive mechanism with which human beings explore complexity and convert perception into understanding.

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Declarations

Competing interests The authors declare no competing interests.

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