Space, Scale and Scaling in Art

art through the lens of physics

A workshop hosted by INI and sponsored by the NSF

Organizers:

David Abrahams, University of Cambridge (UK)
Paul Glendinning, University of Manchester (UK)
Andrzej Herczyński, Boston College (US)

I. Scope and goals

Works of art in all media vary in the levels of detail and graininess, and are calibrated to be perceived at certain implied distances. Indeed, some pieces, like pointillist paintings, are meant to be seen from the distances that obscure individual colour specs, whereas many other artworks depend for their impact on their fine structures. Within any particular object, there may be several levels of patterns (a bough, a branch, a twig) and within a given technique, different levels of texture (impasto, relief, brushstrokes). For viewers, a variety of perspectives may be available depending on the position and distance to the work – from afar, a few steps away, or from a changing vantage point.

Furthermore, artists often use different scales in their various pieces; the sculptures of Anthony Gormley, for example, range from miniatures, as in his terracotta figures, to immense, such as the Angel of the North. These different levels, their connections, and their scaling properties, can be described mathematically (e.g., via scaling analysis, topological invariants, or entropy) and physically (e.g., using optometry or principles of visual perception). They may also encompass well-defined artistic functions, and are engaged by the artists intentionally, in anticipation of their effects.

This workshop will aim to explore space, scale and scaling of art – in painting, sculpture, installations, and music – identifying common themes, artistic strategies dependent on scale, as well as differences in the role played by the scale of patterns and the resulting impact on viewers. It will bring together physicists, mathematicians, neuro-scientists, art historians, and artists and foster cross-disciplinary dialogue and new research initiatives.

II. Place and timing

The workshop will be hosted by, and held at the Isaac Newton Institute (INI) in Cambridge, UK, on April 2-5, 2024. This timing has been chosen to coincide with the programme on *New Equivariant Methods in Algebraic and Differential Geometry* (EMG) at INI, which is planned for 3 January – 28 June 2024.

As the Organizers of EMG programme at INI note, "The aim […] is to bring together a broad spectrum of researchers in diverse areas of algebraic and differential geometry to collaborate on possible new applications […]" A workshop focused on geometrical aspects of art will thus complement the EMG programme, providing opportunities to explore connections between geometry and art and a broader context for the cross-disciplinary exchange of mathematical ideas.

III. Themes and questions

The workshop will endeavor to address a broad range of questions and methods related to the role of scale, scaling, size, and geometrical properties in visual art and in music. A few suggested broad themes and examples of related questions follow.

1. Size in art

As the title of a 2005 exhibition at the Art Council Collection in London suggests, *size matters*. But what is the artistic role and significance of the size – when is it central to the artistic intent and the impact of artworks, when incidental, and when does it simply imply the constrains imposed by the materials used? Could a Richard Serra's sculpture be scaled down without sacrificing its impact? Would illuminated miniature illustrations in the book of hours retain their intended meaning if they were enlarged?

2. Scale and vision

How does our perception of art depend on the scale of the artwork, and does it matter if the work is figurative or abstract? Is the impact of a small sculpture from a close-up comparable to that of a large one from a distance? Is it the same for a painting, or is the dimensionality of the object critical for its perception and impact?

3. Scaling in visual Art

Are scaling regularities in artworks always intentional, or may they emerge (or imitate) multiscale patterns of the natural world? What is the role of fractal patterns in Western paintings and sculptures, African art, Persian, and in Islamic art and architecture? Can a single index, such as the Hurst exponent, serve as a useful measure of complexity?

4. Geometry and Art

What are the roles of geometrical features and topology of forms in two- and three-dimensional artworks, and how do these aspects contribute to the perception of artworks – whether explicitly "geometrical" (as in the work of Paul Klee) or not? Does geometry operate in different ways in planar artworks which evoke three-dimensions or render multiple stages or points of view, as in cubist paintings? How do various geometrical features, like contour curvatures and their statistical distribution affect the neuro-cognitive decoding of the image. Can topological invariants contribute to the interpretation of artworks?

5. Space and kinetic art

What is the function of size, geometry, and dynamics in mobiles, folding and unfolding sculptures, origami structures, interactive art, and art which evolves in time (whether by design or due to corrosive processes). How does this differ from artworks which evoke motion and the passage of time, or render multiple stages or points of view, like cubist paintings?

6. Scaling in music

What do statistical methods and statistical indexes (auto-correlation, Hurst exponent) reveal about the nature of music as a time-series and the composer's technique or intention? What does self-similarity in music mean, and what is its role? Are fractal patterns providing a paradigm for a "natural" complexity in music?

IV. Plans and logistics

The workshop is deliberately planned as a small and welcoming 3–4-day meeting, and will be in person to encourage informal exchanges and impromptus interactions. It will, however, be accessible via a live broadcast, and as a recording on the project's website (https://art-math-science.net/). The number of participants is expected to be in the range 15-20, with a judicious mix of mathematicians, physicists, cognitive scientists**,** art historians, and artists. A more formal workshop dinner is planned, likely in one of the University of Cambridge colleges, and other ancillary events may be organized.

V. Selected bibliography

1. L. Lamp, Design in Art: Scale and Proportion, Sophia (sophia.org)
2. H. M. Sheets, Shahzia Sikander: Maximalist Miniatures, ARTnews, April 13, 2013
3. J. Kee and E. Lugli, Eds., Art History, vol. 38, Issue 2, *Special Issue: To Scale*, April 2015
4. P. De Bolla, Art Matters, Harvard University Press, 2003
5. R. Wells, *Scale at any size: Henry Moore and scaling up* (Tate Research)
6. R. Wells, Scale in contemporary sculpture: enlargement, miniaturization, and the life size, Routledge, 2013
7. Henry Moore, *Some notes on space and form in sculpture*, 1951 (Tate Archive)
8. Claes Oldenburg, I am for art, in Anthologie Kulturpolitik, Transcript Verlag, 2019
9. M. Howlett, Ed., *Working with monumental sculptures: Claes Oldenburg and Coojse van Bruggen*, Scholastic art Magazine, 2002
10. A. Herczyński, C. Cernuschi, and L. Mahadevan, *Paintings with drops, jets and films*, Physics Today, **64**(6), 31-36 (2011).
11. J. Alvarez-Ramirez, C. Ibarra-Valdez, E. Rodriguez, *Fractal analysis of Jackson Pollock's painting evolution*, Chaos Solitons and Fractals, vol. 81, 97-104 (2016)

12. E. M. de la Calleja and R. Zenit, “Topological invariants can be used to quantify complexity in abstract paintings,” Knowledge-Based Systems, 126, 48-55 (2017).
13. J. Alvarez-Ramirez, E. Rodriguez, F. Martinez-Martinez, J.C. Echeverria, *Fractality of Riopelle abstract expressionism paintings (1943-1953): A comparison with Pollock’s paintings*, Physica A, vol. 526, 121131 (2019)
14. M. Bigerelle, R. Guibert, A. Mironova, F. Robache, R. Deltombe, L. Nys, and C. A. Brown, “Fractal and statistical characterization of brushstroke on paintings,” *Surf. Topogr.: Metrol. Prop.* 11, 015019 (2023).
15. A. Patuano and M, F. Lima, *The fractal dimension in Islamic and Persian four-folding gardens*, Humanit. Soc. Sci. Commun., vol 8, No. 86 (2021)
16. H. Y. D. Sigaki, M. Perc, and H. V. Ribeiro, *History of art paintings through the lens of entropy and complexity*, PNAS, volume 115 No 37 (2018)
17. D. Hockney and C. M. Falco, *Optical insights into Renaissance art*, Optics & Photonics News **11**, 52 (2000).
18. F. Fiorani, *The shadow drawing: how science taught Leonardo how to paint*, Farrar, Straus and Giroux, New York, 2020.
19. P. Machado, J. Romero, M. Nadal, A. Santos, J. Correla, Adrian Carballal, Computerize measures of visual complexity, Acta Psych., vol. 160, 43-57 (2015)
20. A Marantan, I. Tolkova, and L. Mahadevan, *Image cognition using contour curvature statistics*, Proc. R Soc. A **479**, 20220662 (2023).
21. J. McDonough and A. Herczyński, *Fractal patterns in music*, Chaos, Solitons, and Fractals, vol. 170, 113315 (2023)
22. G. Gündüz, *Entropy, energy, and instability in music*, Physica A, Vol. 609, 128365 (2022)