Capturing aesthetic complexity in art using compression ensembles

https://cudan.tlu.ee

Andres Karjus¹ Tillmann Ohm¹ Mar Canet Solà¹ Sebastian Ahnert^{2,3} Maximilian Schich¹ (1) Tallinn University (2) University of Cambridge (3) The Alan Turing Institute Culture Conference 2021 ► Questions/comments ► Join us on Zoom during poster session, visit the poster website, and/or check out the Twitter thread.

- → Goal: Quantification of visual aesthetics and artistic expression. [cf. 1-4]
- → *Previous research:* Complexity approximated via compression (gif, png).
- → Here we propose a novel method, compression ensembles, using multiple compression ratios of the image, its various transformations^[5], embedded in a latent vector space (using PCA). Simultaneous comparison of multiple artworks in multiple dimensions of complexity captures polymorphic family resemblance.^[6]
- → Pipeline:
- ∘ import as bitmaps;
- 79 transformations;
- compress all;
- record size ratios;
- run PCA.
- → Example:

Same 4 transforms of 2 different artworks; Arrows show position within the PCA model on the right: 23k images from art500k/Wikiart.





→ Preliminary results: The possibility space of aesthetic complexity has expanded over time. Below: time series of bootstrapped stdev of PCA components 1-5, based on the 23k image sample, balanced by year, 1400-2018. The upper panel shows the distribution of 6 most frequent (style) categories plus other. Both plots 1800 onwards (zoom in for detail).



- → Evaluation (1): MultiPic human visual complexity judgements in 6 languages. Regression predicting human ratings (scale of 1-5). Out-of-sample absolute prediction error ≤0.24 (less than differences between languages). R²=0.71 (full), 0.61 (top 5 PCs), 0.37 (just gif).
- → Evaluation (2): Artist and genre retrieval (PCA trained on 23k artworks, LDA+KNN classifier). Test set of 23 artists with 100±20 artworks each, model correctly predicts artist ~65% of the time (cross-validated out-of-sample kappa; i.e. accounting for the random baseline accuracy of 4%). Similar for genre, art movement, and artist's nationality. Dating prediction error within ~50 years.
- → Our method outperforms previous human judgement correlations, is cognitively plausible, and captures differences between artists' styles.



- PC1: pixel complexity from jpeg&png compressions; edge detection based on comparison to blur & local adaptive thresholding
- → *Future work:* Trace artists' trajectories in the complexity space. And the general ensemble approach should also be applicable in other domains beyond visual art, in particular, cf. the complexity-expressivity trade-off literature in linguistics.^[7,8]

References: [1] Birkhoff, G.D. (1933). Aesthetic Measure. Harvard University Press. ¶ [2] Rigau, J., Miquel F., and M. Sbert (2007). "Conceptualizing Birkhoff's Aesthetic Measure Using Shannon Entropy and Kolmogorov Complexity". In: Proc. of the 3rd Eurogr. Conf. on Computational Aesthetics in Graphics, Visualization and Imaging. pp. 105–112. ¶ [3] Lee, B., M.K. Seo, D. Kim, I. Shin, M. Schich, H. Jeong, and S.K. Han (2020). "Dissecting landscape art history with information theory". In: PNAS 117.43, pp. 26580–26590. ¶ [4] Forsythe, A., M. Nadal, N. Sheehy, C. J. Cela-Conde, and M. Sawey (2011). "Predicting Birkhoff's Aesthetic Imagination theory". In: PNAS 117.43, pp. 26580–26590. ¶ [4] Forsythe, A., M. Nadal, N. Sheehy, C. J. Cela-Conde, and M. Sawey (2011). "Predicting Birkhoff's Catultary Fractal Dimension and Visual Complexity in Art". Br. J. Psychol 102.1. ¶ [5] Tran, L.T., K Park, P. Lee, J. West, and M. Schich (2018). "Chromatic Structure and Family Resemblance: Studies in the internal structure of categories". In: Cognitive psychology 7.4, pp. 573–605. ¶ [7] Kinby, S.M. Tamariz, H. Cornish, and K. Smith (2015). "Compression and Communication in the Cultural Evolution of Linguistic Structure". In: Cognitive psychol. ¶ [8] Kemp, C., Y. Xu, and T. Regier (2018). "Semantic Typology and Efficient Communication". In: Annual Review of Linguistics 4.1. ¶ *Acknowledgements*: This work is funded through the European Union's Horizon 2020 research and innovation program (Grant No. 810961).