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Vienna at the crossroads of art and science

While its museums are adorned by the masterpieces born from the brushes of Klimt and Schiele, the steps of prominent scientists like Hess, Boltzmann, and Schrödinger still echo in the halls of its university. Vienna can be rivalled by few cities in the world for artistic and scientific heritage, and that commits to continue its tradition as a melting pot of art and science.

The connection between science and art is rooted in human history: simple geometric forms and simple sketches are recurrent motifs in primordial forms of art, born from an attempt to represent and conceptualize nature. Examples of the connection between art and science are present through different centuries, like the anatomic paintings of Leonardo Da Vinci or the surrealistic universe depicted by Salvador Dalí, strongly inspired by quantum physics[1]. More recently, the progress in imaging technology, such as high-resolution microscopy, enabled and inspires artists to explore and capture the beauty of the nanoscopic realm. Through digital art and photography, the intricacies of molecular structures, biological processes, and other microscopic phenomena have become accessible to a broader audience.

This tradition of art and science keeps evolving and adapting as science drifts towards treating problems with growing complexity and the involvement of large data. A very contemporary example of this evolution is the aesthetic, conceptual and meaningful representation of extensive databases. Artists are increasingly drawn to the challenge of translating complex information into visually compelling artworks. Not differently to what happens in complex science, where appropriate computational methodologies are developed and employed to generate and process data, the aesthetic representation of datasets calls for individuating and blending art techniques to maximize the visual impact of the representation.

Scientific inspiration and techniques

Within the halls of the University of Vienna, the city acted once more as a melting pot of art and science in occasion of the international conference NetSci2023 organised by the Complexity Science Hub Vienna. In addition to the classic exposure of scientists and their research, Alberto Pino-González gave a new life to the plots we are accustomed to see lying flat in scientific papers. Inspired by the scientific works of several of the attendees of NetSci2023, the artist tackled the challenge of individuating the most suitable techniques in his arsenal of engraving and printing expertise to produce artworks out of complex science.

The work "Socially disruptive periods and topics from information-theoretical analysis of judicial decisions"[2], co-authored by our editorial board member Marta Sales-Pardo, explores the impact of major social events in judicial records via an information-theoretic methodology. Some of the main results (Fig. 1a) have inspired the artist to produce the artwork (Fig. 1b) via reduction linocut. The technique is a low-pressure printing technique adapted from xylography (woodcut), best suited to represent complex and layered information, mirroring the intricacies of the original judicial data. Here, linoleum blocks are carved with a gouge to create a negative of the image, and mineral oil-based inks are deposited on the carved blocks by a

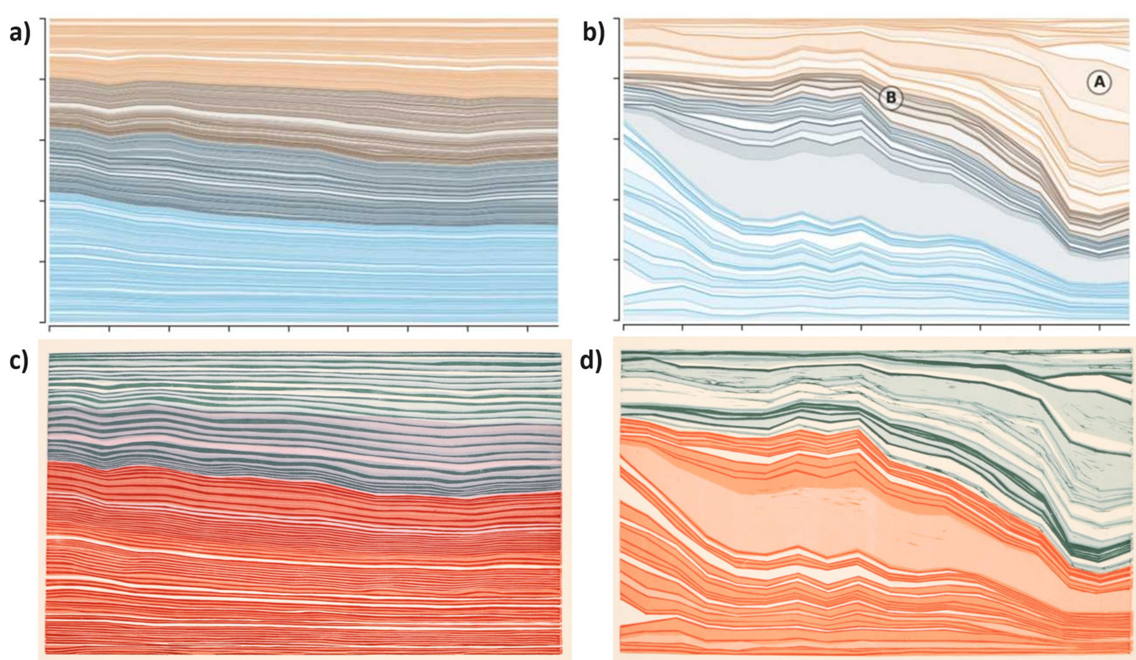

Fig. 1 | Artistic reproduction of the time evolution of word topics and legislation topics. Example of time evolution of word (**a**) and legislation (**b**) topics, reproduced after ref. [2] (Digitalized version of the artworks realised via reduction linocut based on the original plots. Credits for (**c**, **d**): Alberto Pino-González.

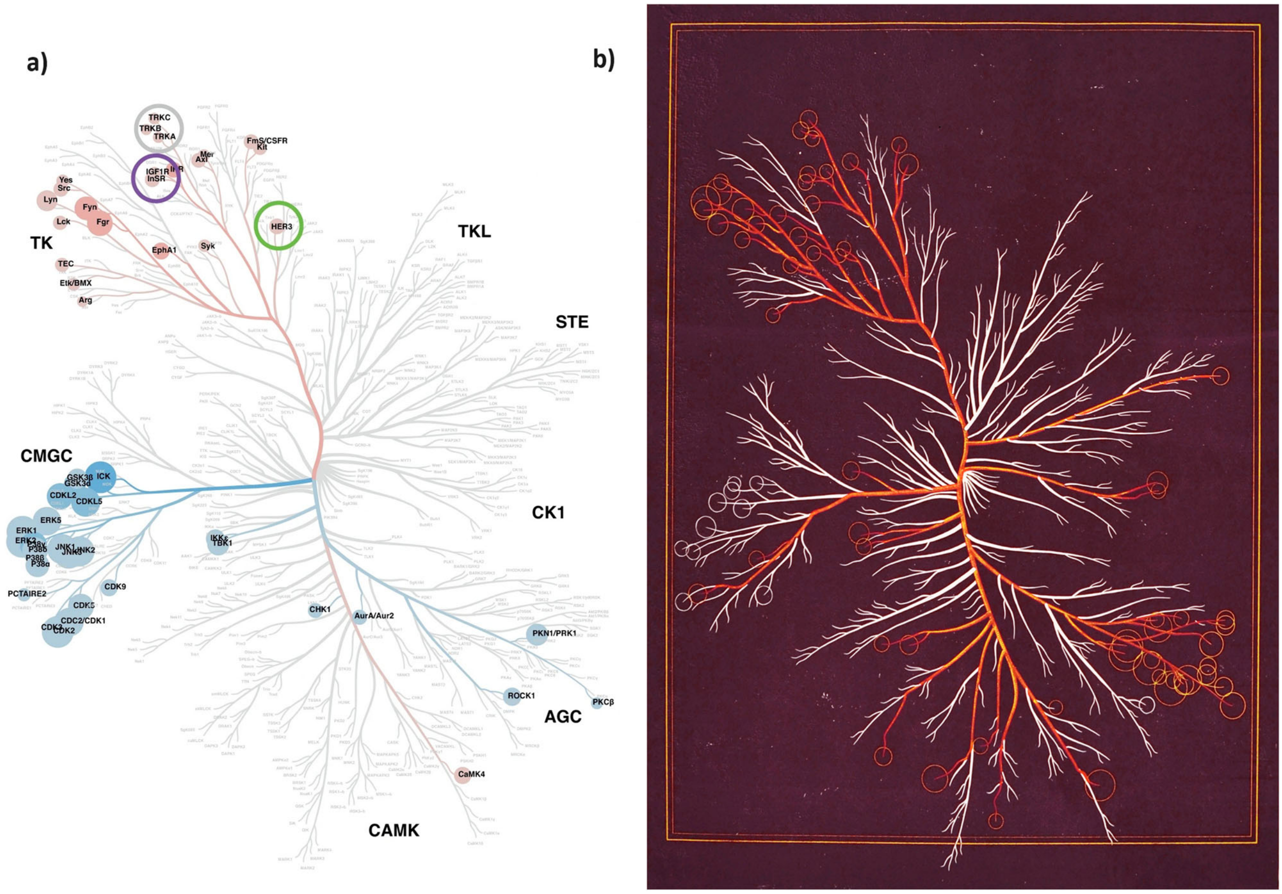

Fig. 2 | Artistic reproduction Kinase activity channels. a Kinase activity map, reproduced after ref. [3] where blue and red identify enriched pathways. **b** Digitalized version of the artwork realised via a combination of linocut and two-dyes serigraphy based on the original plots. Credits for (**b**): Alberto Pino-González.

brayer. The first layer of colour is then deposited on the paper by printing, leaving white areas corresponding to the carvings. The final reproduction of Fig. 1a has been obtained by numerous superpositions of just four colours. Each shade is created by a different stratification of the colour on the paper, obtained through subsequent carvings and printings of the same linoleum blocks.

In stark contrast to software development, that often allows for version control and revisiting of the previous stages, reduction linocut is irreversible. It is impossible to repristinate the former version of the linoleum blocks. The irreversibility of reduction linocut, where each layer of the negative is carved away, reflects the irreversible behaviour of dynamical open systems, making it an ideal candidate to celebrate the mutual inspiration of art and science.

The second inspiration comes from the work in ref. [3] presented during Net-Sci2023 by one of its co-authors, Nataša Pržulj. The work aims at understanding how cancer cells evade senescence (aging) to optimise the clinical benefits of the currently available therapeutic approaches. This valuable insight has been obtained by the authors via a careful analysis of the Kinase activity under the combined action of two inhibitors. A visual representation of the Kinase profiling is reported in Fig. 2a. To grasp the essence of such a complex map where preferential channels are activated, the artist combined a linocut printing with two-dyes inks serigraphy (screen printing). Serigraphy is a permeographic technique that in its contemporary adaptation benefits from the scientific advance in photosensitive polymers. The image is hand-drawn on a transparent screen (acetate) with ink. Separately, a layer of photosensitive polymer is applied on a canvas. The acetate screen is then superposed to the polymer layer and irradiated with UV light. Upon UV irradiation the polymer solidifies, while the UV light is blocked by the ink on the acetate screen, leaving removable liquid polymer in correspondence of the drawn image.

When the remaining polymer is washed away, the stencil for serigraphy is obtained. By scraping permeographic ink on the stencil, the ink permeates the channels corresponding to the open spaces. The work in Fig. 2b has been realized by subsequently printing the first layer using the linocut negative (black background and white channels in Fig. 2b) and finalized by two applications of serigraphy (red and golden lines, Fig. 2b) to highlight the active channels. The integration of negative white space with linocut and serigraphy is not only aesthetic, but it contributes to add a conceptual layer representing the selectivity of Kinase channels. This combination of different techniques in realizing the artwork mirrors the scientific trend to tap into interdisciplinary collaborations to rationalize complex mechanisms.

Helped by the numerous initiatives of the Complexity Science Hub Vienna, the city continues to be a beacon for the convergence of art and science. Among others, the artistic interpretations illustrated here serve as a reminder that the development of science and art is intertwined. While science drives the progress on materials and technological support to enable new art, the challenges posed by scientific exploration are mirrored in the realization of artworks. Similarly to scientific projects, creating artworks encounters both conceptual and technical problems, that can often be overcome by combining different backgrounds, expertise, and techniques. As the ability of conveying complex scientific results to a broad public becomes more determinant in the academic career, the collaboration with artists can offer three main advantages. Firstly, it acts as a benchmark on the clarity of the message to convey. Secondly, it creates a visual language to translate the technical language of science to non-specialised audience. Finally, it becomes a powerful tool for imprinting scientific results in a landscape of exceedingly vast scientific production, ensuring that the scientific narrative is not only understood but also retained.

The artist

Alberto Pino-González received his bachelor's degree in fine arts at Universidad Complutense de Madrid and he specialized in lithographic techniques and graphic design during the Máster in Engraving at the Real Fábrica de Moneda y Timbre. His works were already acknowledged by the community, with an invitation to collective exposition "Certamen de Grabado Nacional José Caballero Villa de Las Rozas 2020" and with the award "Premio Intenacional de Grabado Jesús Nuñez 2022". The project has been realized in collaboration with OraLabora Studio in Madrid and the Complexity Science Hub Vienna, is composed by 7 pieces inspired to network science articles, showcased on the artist´s personal webpage. The works have been exposed during several events, including the "Visualizing Complexity Science Workshop" organised by the Complexity Science Hub Vienna.

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