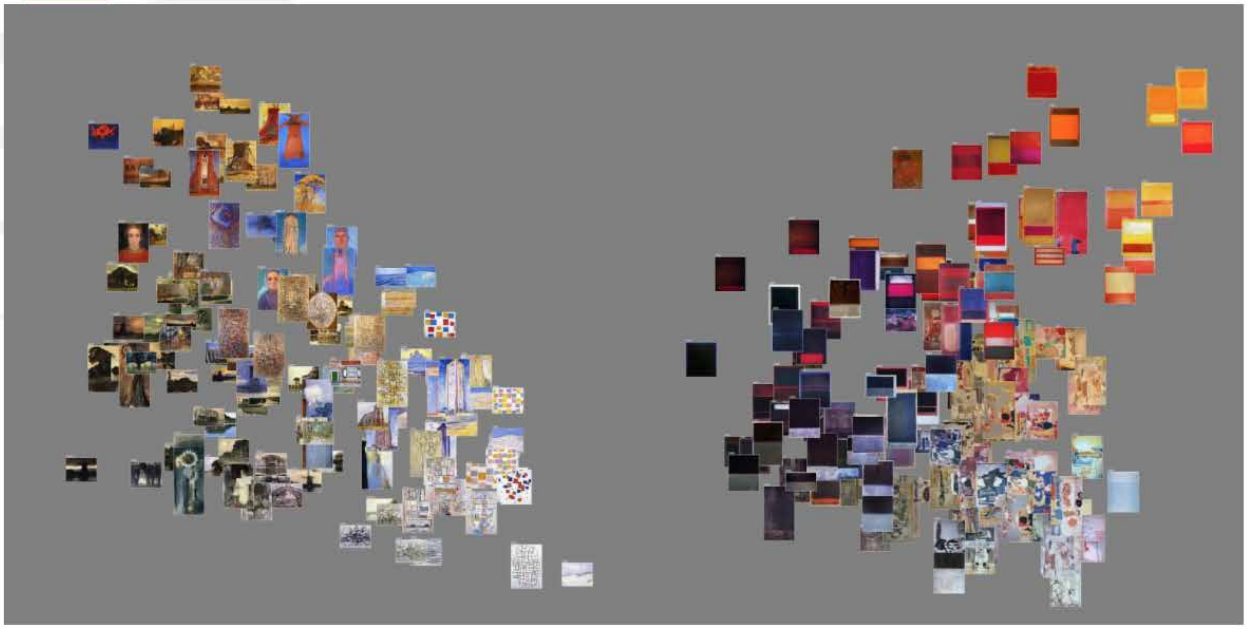
Mondrian vs Rothko: Revealing the Comparative "Footprints" of the Modern Painters

Salva Tweet



Data: 128 paintings by Piet Mondrian (1905 - 1917) and 151 paintings by Mark Rothko (1944 - 1957). Mapping: X-axis: brightness mean, Y-axis: saturation mean. This visualization demonstrates how image plots can be used to compare multiple data sets. In this case, the goal is to compare similar number of paintings by Piet Mondrian and Mark Rothko (produced over comparable time periods of 13 years) along particular visual dimensions. See the full size image on Flickr.

Figure 1: Lev Manovich; a comparison of brightness and saturation of a selection of about 130 paintings by Mondrian and Rothko. Screenshot from: http://lab.culturalanalytics.info/2016/04/mondrian-vs-rothko.html

Digital Art History and the Computational Imagination

Giacomo Mercuriali

Abstract: This essay explores the parallel development of computer vision technology and digital art history, examining some of the current possibilities and limits of computational techniques applied to the cultural and historical studies of images. A fracture emerges: computer scientists seem to lack in the critical approach typical of the humanities, a shortfall which sometimes condemns their attempts to remain technological curiosities. For their part, humanists lack the technical knowledge that is needed to directly investigate large archives of images, with the result that art historians often must limit digital research to databases of text or metadata, a task that does not necessarily facilitate the study of the images themselves. A future dialogue between the two areas is required to foster this new branch of knowledge.

Keywords: Computer vision, digital art history, computational imagination.

Alternative Futures

Let us think for a moment about the futuristic world conceived by Isaac Asimov in some novels and short stories. In this narrative universe, the Multivac, a supercomputer kept by the United States in a secret location, is employed by the public administrators to make the most critical decisions about the state of war, public health and scientific problems. Multivac acquires data thanks to the work of a selected group of engineers, who fill it with information and pose questions in natural language. The machine responds via text strings. In some short novels, which prefigure the Internet, every citizen can employ the Multivac in almost the same way, posing questions through private terminals and receiving personalized answers. In *The Last Question* (1956) the most intriguing story among the series, Multivac's potentialities coincide with all Earth's computing power: it has now acquired a kind of intellectual supremacy over humans, who use it to direct their interstellar expansion towards the limit of the universe.[1]

In our reality, it was mostly the work of individuals has provided the world network with multitudes of data and metadata, available in different states of aggregation, the biggest of which are known as *big data*. We then find ourselves in a specular position compared to that devised by Asimov as the initial episode of the Multivac saga: an immense quantity of data is available through the Internet, and yet any artificial intelligence technology is nowadays able to coherently and

autonomously operate on the total mass of information. In the field of information technology, futurologists multiply their cabalistic prophecies, striving in attempts to determine the "point of no return", when the ultimate self-improving artificial intelligence will be born, finally merging with our biological body.[2]

It is interesting to notice that in Asimov's fiction the Multivac acquires and hands out information only in the form of text strings; his epoch didn't know about the graphical interfaces that today mediate the interaction between users and software. By contrast, George Orwell's *1984* (1949) constitutes a milestone of modern science-fiction precisely because it stages the appearance of an iconotechnical knowledge based on the continuous and pervasive analysis of large amounts of images which condemns the dim inhabitants of the state of Oceania, transformed in an enormous panopticon, to follow the totalitarian form of life imposed by the government's Party.[3] Orwell's novel can, therefore, be inserted inside a millennial line of thought that, starting with Plato, has suspected the social role of images. As a result, we are accustomed to think that, on the one hand massive computing based on linguistic information seems to naturally facilitate social development; on the other hand, large-scale elaboration of iconic data is primarily thought as a form of danger for humankind.

Imagination and algorithms

This presupposed dystopic scenario is indeed already part of our reality: we use facial-recognition software to classify the images stored in our PCs or social networks when they prompt automatic tags for persons that recur a certain number of times within our digital photo albums. In 2016, a Russian firm developed a system that identifies individual faces (morphology, gender, age, emotions) comparing the images taken by public CCTVs and photo albums uploaded in Vkontakte (a Russian social media platform).[4] If the police force implements this technology in its surveillance system—as it is already the case in China—it will be almost impossible for citizens to anonymously move in urban areas—at least without disguises or anti-recognition camouflages, such as those developed since 2010 by the artist Adam Harvey.[5] Automatic face-detection systems based on the computation of iconic big data will be presumably added fast (if they have not yet been implemented) to the telecommunication systems employed by the USA for combat and forensic objectives, as recently revealed by Edward Snowden.[6]

We are therefore crossing the threshold of an epoch in which the prosthetic delocalization of the imaginative faculty, our capacity for thinking images and operate with them, moves towards the progressive demonstration of what

Charles Baudelaire affirmed in a letter which attracted the attention of Walter Benjamin while he was working on his unfinished essay on the 19th century: "Imagination is the most scientific of the faculties".[7] The economic and intellectual efforts of the IT industry is preparing a future in which the irreducibility of language and image, which had seemed partitioned for a thousand years, will be torn down by algorithms which manipulate pixels: machine vision is leading to self-driving vehicles, identification of tumors, bombing and special effects in the visual arts. As we await the oft-heralded bodily reabsorption of technical prostheses through biotechnologies, our current moment is marked by the exponential growth of automatic imaginative faculties that are stemming from new methods of automated calculus, statistical analysis of enormous databases, and production of novel hardware .

From the perspective of "artistic" production, the frontier of the computational imagination is rapidly expanding: we need only to name a few of the artistic applications, such as the generators of actor-avatars employed in cinema since the end of the '90s or the program designed by Robbie Barrat which "paints" in different styles via neural networks.[8]

What would happen if an ideal Multivac were utilized by a group of historians, rather than police states or marketing firms? What would result if this kind of artificial intelligence would direct its efforts not to the identification of potential terrorists or our tastes about furniture and fashion,[9] but rather to the analysis of the history of visual culture? This possibility is grounded in recent acquisitions in information technology: Google's research of images *through* images has been implemented just in 2011, and there is still a lot of space for the improvement of the relative algorithm.[10]

The development of a new research field

The multidisciplinary field of digital art history tries to integrate the mathematical and statistical expertise of information technology scientists with art history and visual culture studies. For the moment, the rift that still separates the competences of those who were trained in each of those disciplines is quite large and the effects of this situation can be perceived in the distinctive features of the publications and research projects that are currently holding the label of digital art history.

As an emerging subfield of digital humanities, the discipline nowadays is fostered by the recently born *International Journal for Digital Art History*. Among the authors who published their researches in the review, Lev Manovich is one of the most representative. Manovich, professor of theory and history of media at the City University of New York, has

been processing iconic big data at the "Cultural Analytics Lab" for the past decade. His image sources come from museums, movies, videogames, social networks, and magazines.[11]

On some epistemological problems in digital art history

In his paper *Data Science and Digital Art History*,[12] Manovich describes his methodology, as part of a "quantitative turn" that the humanities as a whole have experienced in the 20th century: the digital version of an image contains certain kinds of information that can be employed as a yardstick, allowing well-designed algorithms to automatically compare a vast number of documents, a task unachievable by a human mind with its limited memory. Big iconic data sets—an artist's oeuvre, the shots of a movie, the covers of *Time* magazine—are filtered through a computing process that selects only certain features of the source document; then each object gets assigned coordinates that locate each of them in an n-dimensional "feature space". This space of virtually infinite dimensions is subsequently flattened into one or various bi-dimensional graphics where the relative distances of the objects (measures that stem from the criteria chosen by the experimenter at the beginning of the process) become perceivable to our eye.

We can now grasp in a glimpse, for example, the differences in brightness and saturation between the corpus of Piet Mondrian and Mark Rothko, thus evaluating general characteristics that only well-experienced connoisseurs of their work might appreciate.[13] At the same time, we ask ourselves if Manovich's conclusions ("Projecting sets of paintings of these two artists into the same coordinate space reveals their comparative 'footprints'—the parts of the space of visual possibilities they explored. We can see the relative distributions of their works—the denser and the more sparse areas, the presence or absence of clusters, the outliers, etc. The visualizations also show how Mark Rothko—the abstract artist of the generation which followed Mondrian—was exploring the parts of brightness/hue space which Mondrian did not reach») can give fundamental insights to the art historian. Moreover, they contain some epistemological problems.

First of all, the features analyzed are, strictly speaking, the photographic reproductions of the paintings and not to the artworks themselves. The phenomenical attributes of paintings strongly depend on the illumination to which they are exposed (not to say about the position—distance, nearness, parallax, relative movement—of the perceiver) and in many cases—such as Rothko's *Seagram* series—are relevant to the conception of the artwork itself. Secondly, dealing with numbers of reproductions, in the probable case of a lack of a careful normalized process in the shooting procedures that generate

the digital photographs of the study set, a certain quantity of error will affect the relative positions of the objects in the feature space of optical values such as brightness and saturation. This error will not presumably be so discriminant as to impede high-level considerations—we could easily think of a fast and efficient visualization of "color-periods" inside the production of an artist (e.g., Picasso's "pink" and "blue" periods)—but, in the case of further employment of this map, we must remember that errors expand exponentially. Lastly, it is questionable whether the inclusion of a reduced number of documents and not all the catalogue of the artists in the calculus leads to a neutral scatter of the images on the table or, rather, to a biased result (the "visual possibility" insight being then compromised).

Manovich's enthusiasm is also shared by other research groups. In 2014, a team led by Babak Saleh at Rutgers University published a paper entitled *Toward Automated Discovery of Artistic Influence*.[14] The scientists, committed, like Google, to the challenge of automatizing the semantic description of images, have developed an "influence" algorithm that works on certain formal similarities between the images of the initial data set. The team reported that the program they wrote was able to spot a never-before-seen connection between two paintings: one from 1870 by Frédéric Bazille and the other from 1950 by Norman Rockwell. This result was harshly criticized by the art historian Griselda Pollock, that accused the computer engineers of utilizing an anachronistic methodology: the reductionist paradigm of connoisseurship.[15] Saleh's supervisor, Ahmed Elgammal, replied some months later explaining that the new research field of "computer vision" is only at its beginning and that its long-term objectives are the realization of a program that could pass what he names a "visual Turing test".[16]

This statement is interesting because it seems to widen the classical proof of computational intelligence that computer engineers have been trying to attain for more than half a century. In the original version, the test consists in a linguistic game in which the computer is required to mimick the communicative abilities of a human being. Elgammal's suggestion indicates that nowadays the research on AI is aware that language is only half of the moon, the bright one. The discovery of the dark side corresponds to the project of providing the machine with an imaginative capacity.[17]

Multivac's paradigm remains the foundation of computer sciences; as a matter of fact, Elgammal continues with a consideration on the digitalization of archives: "Perhaps there will be a day when the technology could evolve to look at the historical, social, and personal context of art—a day when computers could mine these vast stores of heterogeneous data to conduct an analysis of artistic influences that goes beyond the connoisseurial approach".[18] To overcome such approach, with a view on a *Bildwissenshaft* 2.0, it would

however be necessary to automatize the critical analysis carried out by human researchers, who comprehend typologies of resemblance (e.g. anthropomorphism, pseudomorphosis, the informal) which can complicate the induction of relationships (of influence) on strictly mimetic similarities.[19]

Blending big iconic data

Different approaches, which aim instead to present large numbers of images inside graphics or navigable 3D virtual spaces in aesthetically pleasing ways, are currently being explored by Google. The big firm, compared to other research teams, can avail itself

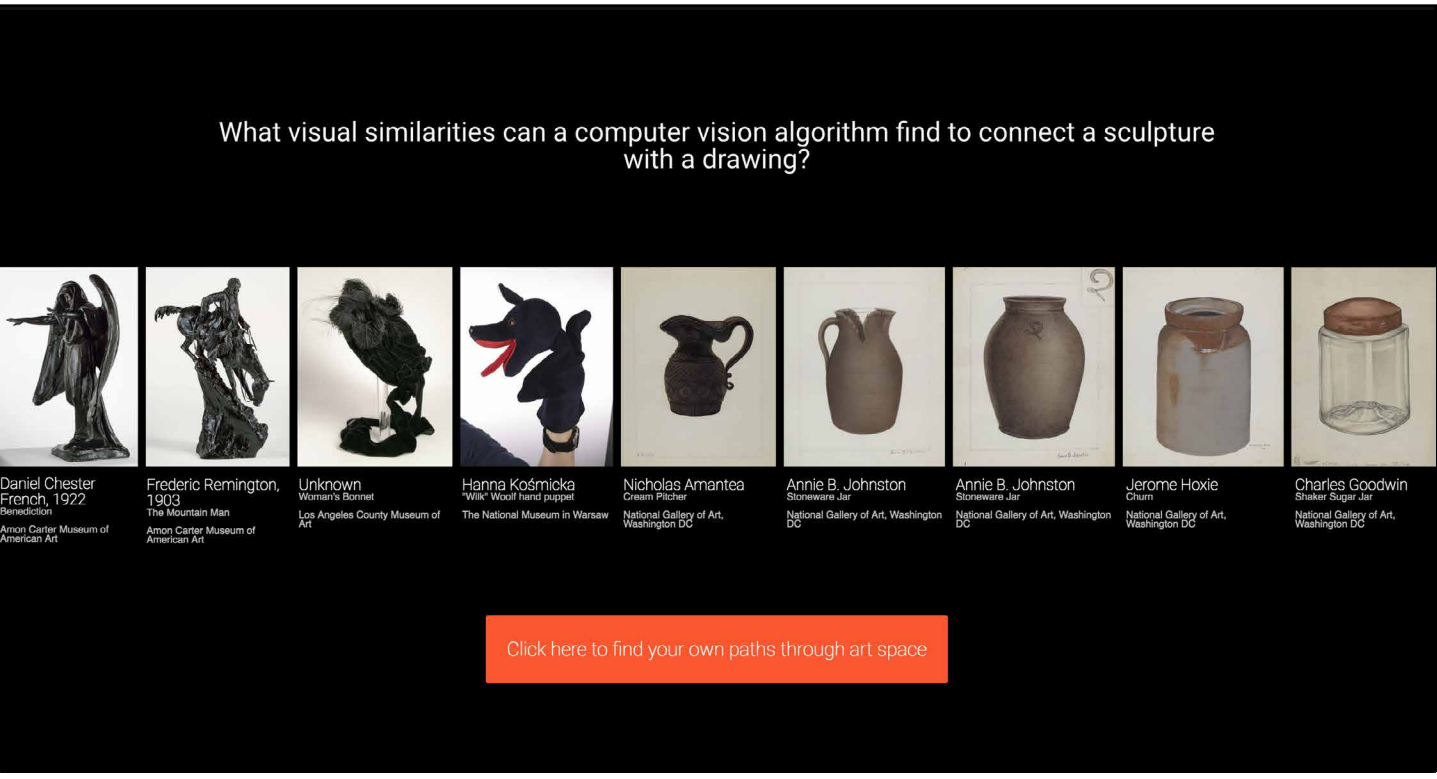


Figure 2: The “degrees of separations” that relate a symbolistic sculpture wich a drawing of a glass jar for X Degrees of Separation. Screenshot from: https://artsexperiments.withgoogle.com/xdegrees/8gHu5Z5RF4BsNg/BgHD_Fxb-V_K3A.

of the quality of the data gathered via its Art Project, which brought the cameras of Street View inside the major museums of the world. The online application *X Degrees of Separation* is presented as such: "Using Machine Learning techniques that analyze the visual features of artworks, X Degrees of Separation finds pathways between any two artifacts, connecting the two through a chain of artworks. This network of connected artworks allows X Degrees of Separation to take us on the scenic route where serendipity is waiting at every step: surprising connections, masterful works by unknown artists or the hidden beauty of mundane objects".[20] It may be superfluous that such paths are limited by the initial set since, for the moment, a universal catalog of (so-called) artistic objects does not yet exist. It is nevertheless certain that Google's projects could be integrated,

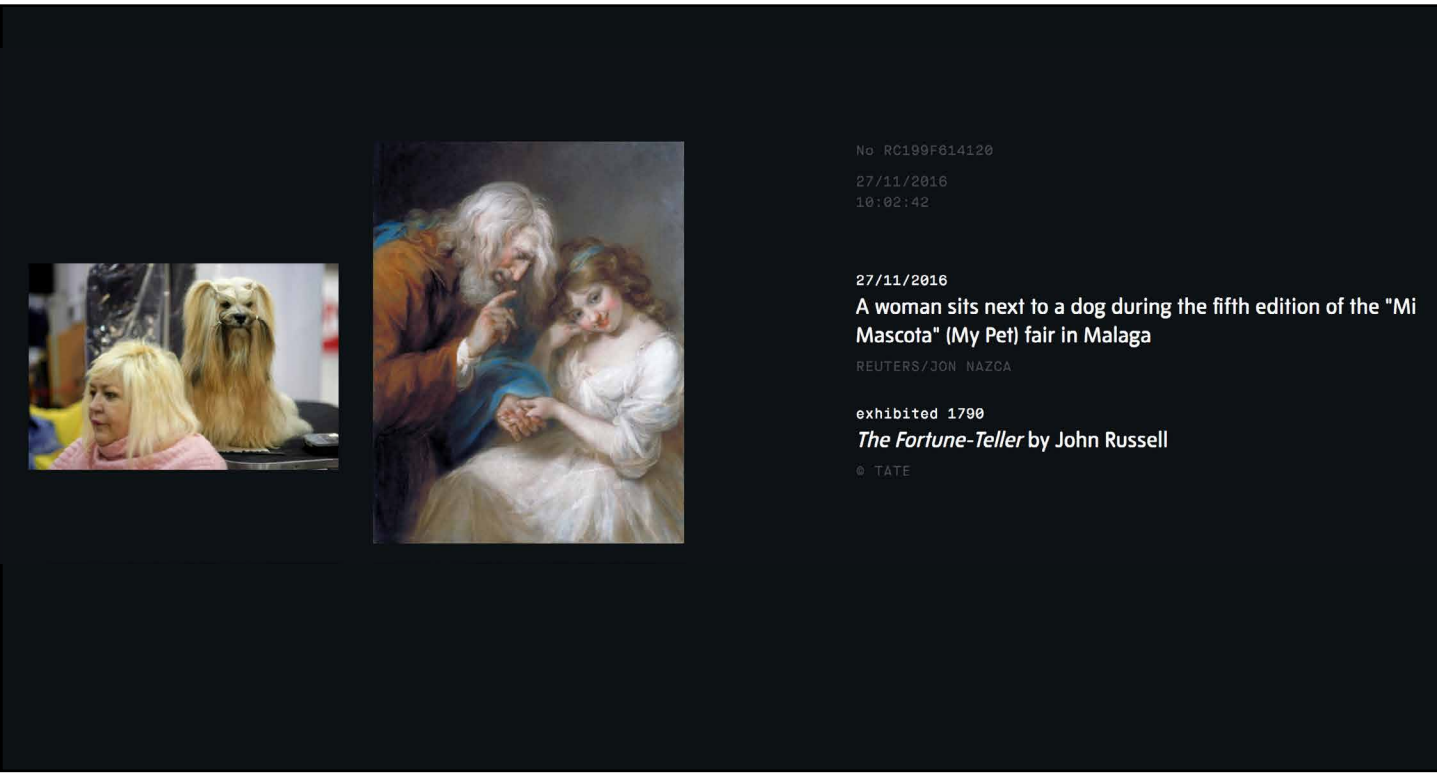


Figure 3: The photography of a pet competition is related by *Recognition* to a XVIII century painting. Screenshot from: http://recognition.tate.org.uk.

in the near future, with systems of iconographic classification such as Iconclass.[21] What research possibilities would be opened performing semantic researches on big sets of images that were not previously carefully cataloged by human archivists—that is to say, the vast majority of the cultural heritage which is currently undergoing a process of digitalization around the world? An essay is given, again, in Google's experiment *Tags*, which nonetheless retains amusing censorship since it does not allow one to search for "nudes", while other search terms such as "rifle", "gun" or "guillotine" are currently allowed.[22]

An essay similar to Google's was that one performed by Recognition, a program developed at the Italian innovation center Fabrica, winner of Tate Gallery's 2016 IK Prize.[23] An algorithm automatically compares photographs coming from international press agencies with the artworks held by the important English collection. The similarities are chosen through criteria of formal and metadata resemblance; unfortunately, it remains unclear whether any specific knowledge could be gained by such operations.

The quest for interdisciplinarity

For the moment, traditional art historians can continue to sleep tight. As long as the strong separation between data sets and algorithms or AIs will be maintained, it is impossible that some computer will steal their job. Nevertheless, some departments of art history and architecture are developing study programs and research centers whose aim is to gather the competences of humanists and computer scientists under one roof. Institutions such as the Getty Research Institute, the Courtauld Institute of Art and the Frick Collection are preparing for the future of digital art history.[24] These initiatives reflect the slow reception of this new discipline whose origins are to be found in the late '80s.[25]

Nowadays, the digital art history projects fostered by humanists can be divided into three areas that, contrary to the projects based on computer vision and AIs, apply the new technological possibilities to information that are external to the images themselves and, interestingly, often present their research in the form of another image.[26] The first class employs digitized text databases to develop statistical approaches; one possible application is the analysis of archival material related to collections: such is the case of the Medici archive recently digitized by the Fondazione Memofonte.[27] These second kind of process facilitated by digital technologies is the architectural rendering of historical sites; such is the case of *Visualizing Venice*, which aims to build a virtual 3D model of the Serenissima that should be navigable at its different time periods.[28] Finally, the third type of research, an expansion of social history of art, is the so-called "network analysis" which, applied to

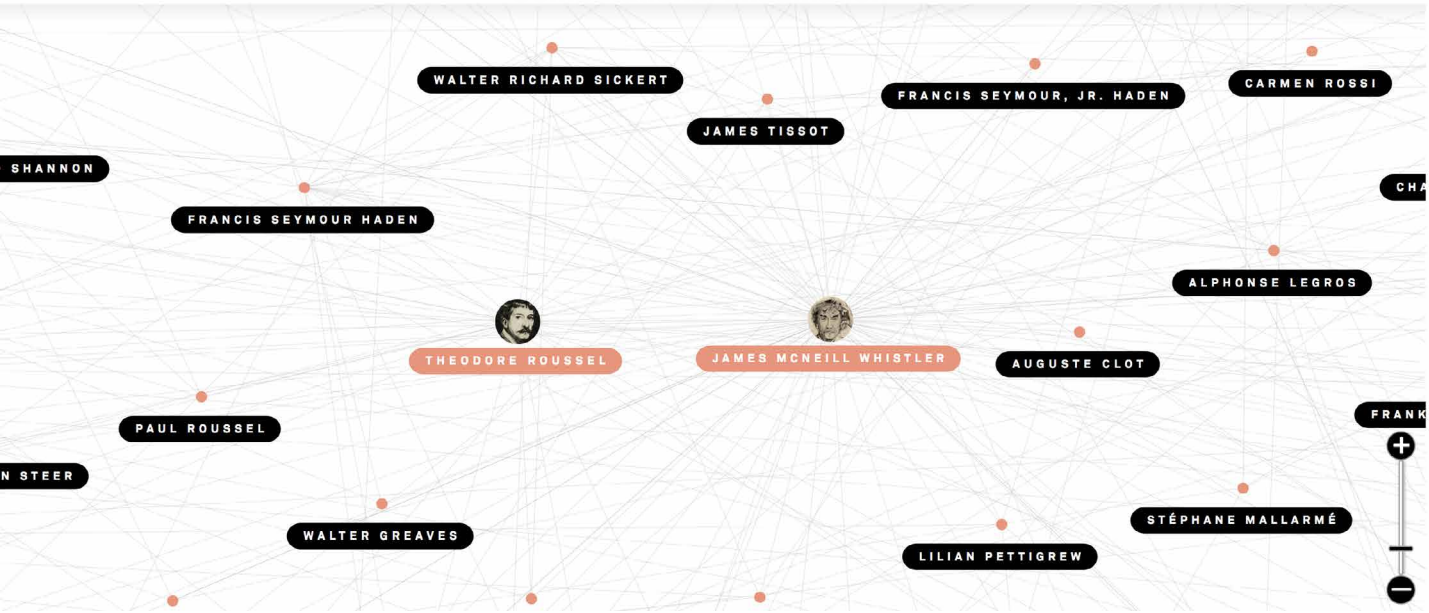


Figure 4: The relational network of Theodore Roussel and James Whistler: models, patrons, artists, pupils and family members. Screenshot from: http://linkedvisions.artic.edu/network.php

art circles, galleries and the art market, visualizes different kinds of social realtions.

In this overview, I tried to trace the borders of two areas of research which still await coherent overlap. For the moment, a fracture emerges: those who study images with methods of computer science seem to omit a certain epistemological problems, with results that, from the perspective of the art historian, are more curiosities than new knowledge. At the same time, their work expands the awareness of the need for imaginative capacities for the future AIs, which should have a high level of image comprehension in order to interact with "intelligence" with the world. On the other hand, the humanists who try to update their practices, tend not to possess the technical programming skills that would be necessary to apply a critical approach to the study of images themselves, and, for the moment, they investigate information of another kind, which reside in the contextual appearance of the data.

If in the future new scholars with a double competence will be trained, maybe we could progress a little towards the goal of an intelligent computational imagination, that will let us not only to drive cars, identify diseases and monitor our neighbor but also to glance with a new perspective towards our past.[29]

Notes

[1] Isaac Asimov, "The Last Question," Science Fiction Quarterly 4, no. 5 (November 1956), 6–15.

[2] Ray Kurzweil, The Singularity Is Near: When Humans Transcend Biology (New York: Viking, 2005).

[3] George Orwell, Nineteen Eighty-Four: A Novel (London: Secker & Warburg, 1949).

[4] "FindFace Pro", https://findface.pro; cfr. Shaun Walker, "Face recognition app taking Russia by storm may bring end to public anonymity", The Guardian, May 17, 2016, https://www.theguardian.com/technology/2016/may/17/findface-face-recognition-app-end-public-anonymity-vkontakte.

[5] Tom Phillips, "China testing facial-recognition surveillance system in Xinjiang", The Guardian, January 18, 2018, https://www.theguardian.com/world/2018/jan/18/china-testing-facial-recognition-surveillance-system-in-xinjiang-report. Adam Harvey's "CV Dazzle", https://cvdazzle.com.

[6] Matteo Pasquinelli, "Arcana Mathematica Imperii: The Evolution of Western Computational Norms", Former West: Art and the Contemporary after 1989, ed. M. Hlavajova and S. Sheikh (Cambridge, MA: MIT University Press, 2017), 281–293; Grégoire Chamayou, Théorie du drone (Paris: La Fabrique, 2013), trans. A Theory of the Drone (New York: The New Press: 2015).

[7] Charles Baudelaire, letter to A. Toussenel, 21st January 1856, cit. in Walter Benjamin, Das Passagen-Werk, Gesammelte Schriften, Band V, ed. R. Tiedemann (Frankfurt am Main: Suhrkamp, 1982), trans. The Arcades Project (Cambridge, MA, London: Harvard University Press, 1999), 241.

[8] "Massive", http://www.massivesoftware.com: a software specifically developed for filming The Lord of the Rings and now employed also to simulate the efficacy of way outs in architectural modelling. For the work of Barrat see: https://github.com/robbiebarrat. An extended list of examples is given by Glenn W. Smith and Frederic Fol Leymarie, "The Machine as Artist: An Introduction", Arts 7, no. 2 (2017), doi: 10.3390/arts6020005.

[9] Andrew Zhai, "Introducing a New Way to Visually Search on Pinterest", Pinterest Engineering, November 8, 2015, https://medium.com/@Pinterest_Engineering/introducing-a-new-way-to-visually-search-on-pinterest-67c8284b3684.

[10] Since 2014, Google has given birth to an AI project that outputs natural language captions for images: Simon Shallue, "Show and Tell: Image Captioning Open Sourced in TensorFlow", Google Research Blog, September 22, 2016; https://research.googleblog.com/2016/09/show-and-tell-image-captioning-open.html.

[11] "Cultural Analytics Lab", http://lab.culturalanalytics.info.

[12] Lev Manovich, "Data Science and Digital Art History", International Journal for Digital Art History, no. 1, 2015, doi: 10.11588/dah.2015.1.21631.

[13] Lev Manovich, "Mondrian vs Rothko: Revealing the Comparative "Footprints" of the Modern Painters", Cultural Analytics Lab, 2016, http://lab.culturalanalytics.info/2016/04/mondrian-vs-rothko.html.

[14] Babak Saleh, Kanako Abe, Ravneet Singh Arora, Ahmed Elgammal, "Toward Automated Discovery of Artistic Influence", Multimedia Tools and Applications 75, no. 7 (August 2014): 3565–3591.

[15] Griselda Pollock, "Computers can find similarities between paintings—but art history is about so much more", The Conversation, August 22, 2014, http://theconversation.com/computers-can-find-similarities-between-paintings-but-art-history-is-about-so-much-more-30752.

[16] Ahmed Elgammal, "Computer science can only help—not hurt—art historians", The Conversation, December 4, 2014, http://theconversation.com/computer-science-can-only-help-not-hurt-art-historians-33780.

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[19] On these themes, see: Andrea Pinotti, "Chi ha

paura dello pseudomorfo?", Rivista di Estetica, no. 62, 2016, 81–98; Georges Didi-Huberman, La ressemblance informe ou le gai savoir visuelle selon Georges Bataille (Paris: Macula, 1995).

[20] "X Degrees of Separation"; https://artsexperiments.withgoogle.com/#/x_degrees. See also: "Google AutoDraw" and "Quick, Draw!", two ludic experiments which acquire data for improving the performance of Google's image recognition algorithms (https://aiexperiments.withgoogle.com).

[21] "Iconclass", http://www.iconclass.nl/home.

[22] "Tags"; https://artsexperiments.withgoogle.com/tags.

[23] "Recognition"; http://recognition.tate.org.uk.

[24] See: the Getty's "Digital Art History Initiative" of 2014 (http://getty.edu/research/scholars/digital_art_history/index.html); the Courtauld's "Digital Art History Research Group", active since 2016; (http://courtauld.ac.uk/research/research-forum/research-groups-and-projects/digital-art-history-research-group); the Frick's "Digital Art History Lab" (http://www.frick.org/research/DAHL). In Italy, to my knowledge, there is only one introductory course offered by Elisabetta Molteni, Maria Chiara Piva and Stefano Riccioni at the Università Ca' Foscari of Venezia since the academic year 2015/16, entitled "Digital Art History" (http://www.unive.it/data/insegnamento/224320/programma).

[25] Johanna Drucker, Anne Helmreich, Matthew Lincoln, Francesca Rose, "Digital Art History: The American Scene", Perspective [Online], no. 2 (2015), http://perspective.revues.org/6021.

[26] Pamela Fletcher, "Reflections on Digital Art History", caa.reviews, June 18, 2015, http://www.caareviews.org/reviews/2726#fnr6.

[27] "Fondazione Memofonte", http://www.memofonte.it/ricerche/collezionismo-mediceo-inventari.html.

[28] "Visualizing Venice", http://www.visualizingvenice.org

[29] Harald Klinke's 2017 "Coding Dürer Workshop" goes in this direction; http://codingdurer.de. Another interesting essay is: Leonardo Impett and Sabine Süsstrunk, "Pose and Pathosformel in Aby Warburg's Bilderatlas", Computer Vision – ECCV 2016 Workshops, ed. G. Hua e H. Jégou (Amsterdam: Springer, 2016), 888–902.

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