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Everardo Reyes, Lev Manovich

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Cultural Viz: An Aesthetic Approach to Cultural Analytics

Everardo Reyes and Lev Manovich

Everardo Reyes
Associate Professor
Université Paris 8
Information Sciences
Department
2, rue de la Liberté
93526 Saint-Denis, France
ereyes-garcia@univ-paris8.fr

Lev Manovich
Professor
The Graduate Center
City University of New York
365 Fifth Ave
New York, NY 10016, U.S.A.
lmanovich@gc.cuny.edu

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ABSTRACT

Cultural Analytics (C.A.) is an approach for analyzing media and digital culture using data methods and visual computing techniques. This article explores the aesthetic value of C.A. by approaching cultural visualizations as digital artworks. The authors present a variety of techniques developed since 2007 by members of the C.A. lab for creating visualizations of media artifacts and collections of images. Through a series of projects conducted by them, the authors discuss the artistic meaning of media visualizations and their experience in art exhibitions, workshops and seminars.

Cultural Analytics (C.A.) was introduced by Lev Manovich 15 years ago as an approach to the analysis of culture using data methods and visual computing techniques [1]. C.A. involves designing exploratory methods and visualization models appropriate for different kinds of visual cultural data; assembling cultural data sets; applying the methods to these data sets; and describing and interpreting the results. By "cultural data," we mean creative artifacts produced by both professionals and nonprofessional members of the public (for example, Instagram photos) and also data about cultural events and processes (such as dates and locations of music festivals, art exhibitions and design weeks). The resulting projects combine new insights about the data and aesthetic value along with innovative organizations of 2D/3D spaces and interactive techniques. While a C.A. project can be considered as an analytical map or as a knowledge representation that helps in questioning a topic and seeing it from different angles, in this article we focus on the aesthetic roles of cultural visualizations, as well as their expressive and interpretative value.

Through a series of projects, exhibitions and workshops conducted by us, we discuss relationships between the subjective vision of cultural analysts—who try to express aesthetically a cultural data set—and the possibilities/limits of representation with computing technologies. Overall, we highlight the importance of presenting cultural visualizations projects in art exhibitions in order to give the audience opportunities to see differently contemporary processes of digital culture.

Cultural Analytics: Methods and Tools

In 2007, when Cultural Analytics research started, the number of social media posts generated by users already counted in the millions, media software was already popular and computing technologies were already being used in social sciences and humanities. At the same time, visual analysis of cultural data using digital techniques was still in its infancy. First, the available image repositories were constituted of mainly canonical samples, thus leaving out user-generated content. Second, some visual computing techniques were accessible only in specialized software outside the media realm, for example, in scientific applications. And third, the visualization models that were being used to map collections of images excluded the images themselves in favor of dots and lines symbolization.

Since 2007, the C.A. approach has consolidated itself as the research program of a lab at the California Institute for Telecommunications and Information Technology (Calit2). The lab's members and collaborators combine skills in art, humanities, sciences and computer science. Together, we have developed more than 50 projects, several of them funded by NSF, NEH, Singapore Ministry of Education and University of Tyumen, among other international institutions. Since its inception, one of the steering objectives of the lab has been to elaborate visual models and to develop easy-to-use open access software and data sets for exploratory media analysis. Below we describe the principles of this software and provide examples of visualizations applied to image collections and media artifacts. All this work has been developed by a number of the lab's members over the years.

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Visual Models

Among the techniques elaborated within the context of C.A., there are a number of models for the analysis of image collections. We call them "media visualizations" because they allow us to analyze media by constructing new visual images [2,3]. These models are illustrated in Fig. 1. The figure presents a schematized version of image pixelation (color summarization), image averaging (*z*-visualization), image montage (image mosaicking), image slice (orthogonal views), image plot, image/slice histogram, growing entourage plot and radial image plot.

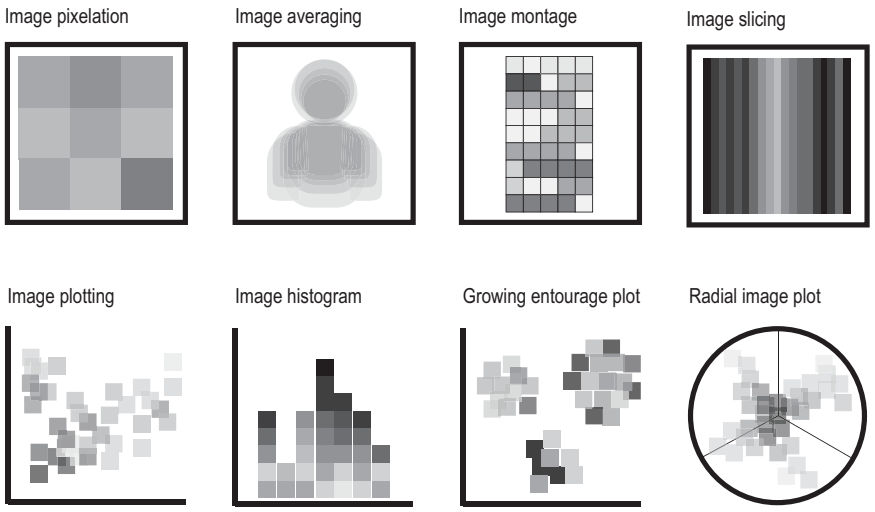


Fig. 1. Schematized version of media visualization models developed within the Cultural Analytics paradigm. (© Everardo Reyes)

Technical Framework

The typical workflow to produce a media visualization uses techniques from data science and visual computing. We start by assembling a collection of raster images. This can be done by digitizing analog materials, segmenting digital films/videos into image sequences or downloading digitized images from cultural institutions or social networks.

The next step is to structure a data set using available metadata enriched with low-level visual descriptors such as color and shape features. This phase uses batch processing to extract features from each image in the collection. Depending on the type and size of the collection, we have used custom-made scripts for MATLAB, Python, OpenCV and ImageJ. We describe colors as numerical chromatic values according to color modes (RGB, HSL, HSV), while we quantify shapes by geometrical features (compactness, aspect ratio, rectangularity, circularity) [4]. All extracted features are stored in general-purpose CSV, TSV or JSON files.

We created GUI dialogs to run scripts in ImageJ for two visual models: image montage and image plot. For other models, like image histogram and growing entourage plot, we customized the parameters directly in the development environment, for example, in a Jupyter Notebook. New models were also implemented on the Web using JavaScript libraries, including a combination of jQuery, three.js, d3.js, p5.js, CSS3 and HTML5.

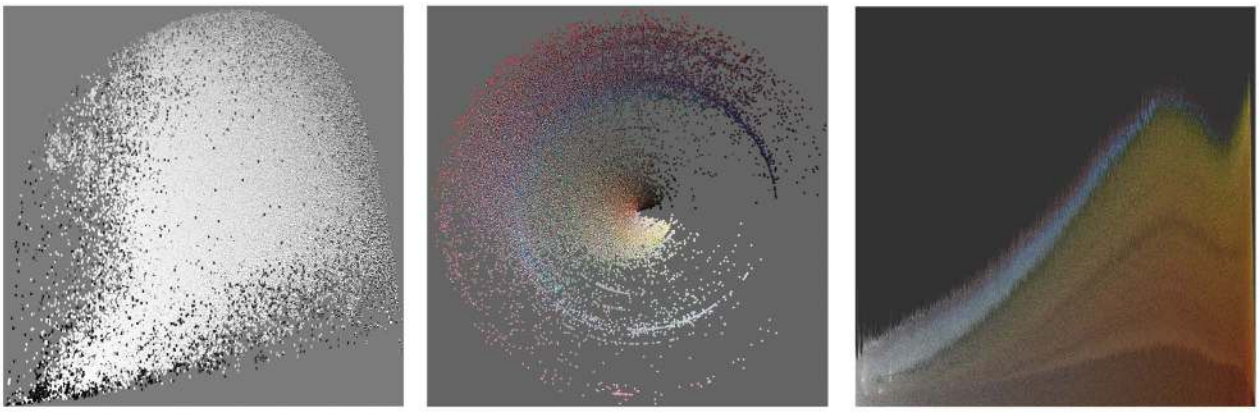
Projects and Exhibitions

The kinds of visual media that have been the subjects of study in C.A. projects include painting, photography, cinema, posters, magazine covers and pages, newspapers, comics, websites, motion graphics and video. An image data set can be assembled around a single topic or theme (for example, all the paintings of an artist, or all the covers from a single magazine), but it can also contain heterogeneous samples (as in the case of studying diverse periods or social contexts). For instance, Fig. 2a gathered one million manga pages in a 2D image plot (the *x*-axis represents the mean of standard deviation of grayscale values, and the *y*-axis is the mean of entropy measured over all grayscale values). Figure 2b is a 2D radial plot containing 50,000 Instagram photos, and Fig. 2c is a chromatic histogram of over two million slices of Flickr photos tagged "autumn" between 1994 and 2014.

The work of the C.A. lab has been included in more than 25 international exhibitions in art and design museums, architecture biennals and galleries, including at the New York Public Library, the Contemporary Art Center in Riga, the National Taiwan Museum of Fine Arts, the West Bund Biennial of Architecture and Art in Shanghai, the Somerset House in London, the Fondation EDF in Paris, and the online exhibition *Designing Knowledge*, curated by the ACM SIGGRAPH Digital Arts Community in 2018.

Related Work

The graphical representation of a series of images has a long tradition in the sciences and arts. In the last decades of the twentieth century, Eadweard Muybridge and Étienne-Jules Marey pioneered innovative photographic techniques such as, respectively, "simultaneous photography" and "chronophotography." Subsequent groundbreaking contributions were



2a. One million manga in a 2D image plot

2b. 50,000 Instagram photos in a 2D radial plot

2c. Two million slices of Flickr photos in a hue histogram

Fig. 2. Media visualizations by the C.A. lab using different image sets. 2D images are rendered in high resolution (over 10,000 pixels on one side). (Fig. 2a © Douglass, Huber, Manovich and Zepel, 2009. Fig. 2b © Manovich, Hochman and Chow, 2013. Fig. 2c © Damon Crockett, 2015.)

made by modernist artists such as László Moholy-Nagy, El Lissitzky, Dziga Vertov and early-twentieth-century art historian Aby Warburg.

More recently, digital artists in the late 1990s and early 2000s developed projects that provided to be significant inspiration for our work. Our pixelation model is related to pixel art as introduced by Goldberg and Flegal in 1982 [5]; image averaging is related to projects by Sirovich and Kirby on Eigenfaces in 1987 [6] and to Jason Salavon's series of special moments in 1997 [7]. Regarding visualization of motion and 3D space, we can refer to the works of Art+Com [8], Waliczky and Szepesi [9], Camille Utterback [10], Masaki Fujihata [11] and Jeffrey Shaw [12].

Today, an increasing number of artworks and technological experiments use image data sets as source materials. The images provided by ImageNet, samples of user-generated content in social networks, and digital collections of museums and archives constitute the training scope for machine learning algorithms. Visual displays of image collections based on neural networks can be seen in artworks by Trevor Paglen [13], Mario Klingemann [14], Héctor Rodríguez [15] and Pilar Rosado [16] and also at various university labs and platforms such as Google Arts & Culture.

Cultural Viz Explorations

To illustrate the expressive and interpretative value of cultural visualizations, we next discuss a few of the projects we have developed. These projects have been presented in design and art exhibitions, as well as in workshops, seminars, and graduate and undergraduate courses that we have designed and conducted.

Video Art as Motion Objects

In 2011, we started a project called Motion Structures to develop new models for visual exploration and interaction with time-based media, such as film, video and motion graphics. Our idea was to represent the spatial and temporal transformations of a moving image sequence in the form of a 3D shape. This shape encodes the changes of the objects within the frame, their movements and spatial-temporal relations. The result of the process consists of surface meshes that can be explored digitally or even 3D-printed.

We created a macro script for ImageJ that performs sequential image processing routines and outputs the result in Java3D format. The left-side diagram in Fig. 3 shows the general flowchart of our program and, on the right, it shows more details of the 3D Viewer plug-in.

We have applied our model to a number of seminal video artworks by Charles Csuri, Bill Viola and Peter Weibel. Our intention was to propose a move from an aesthetics of contemplation to an aesthetics of exploration. The original contemplative experience of these artworks was transformed into qualities of our interactive objects. They show a rhythm that alternates between simplicity and complexity. At different phases of an animated sequence, elements evolve in time, increase in number and occupy more or less space on the frame's surface. The study of transformations of space and time within the boundaries of a frame also allows us to pay more attention to the plastic properties of visual media (patterns, rhythm, movement traces), as well as software operations that normally may be unnoticeable.

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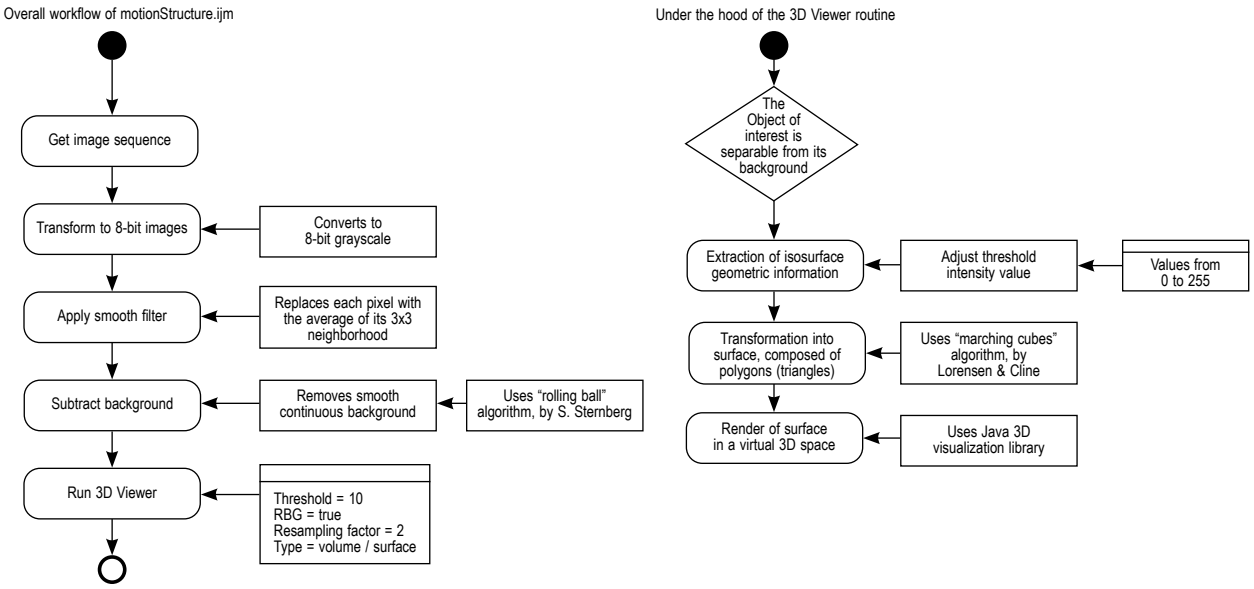

Fig. 3. Left: the flowchart of the program motionStructure.ijm. Right: the program part that calls the Java 3D library. (© Everardo Reyes)

We made our program available as open source and encouraged others to modify it. We also tested our visualization model with other kinds of images during seminars and workshops. Figure 4 shows 3D shapes produced from video artworks (top and bottom left), from a video performance (top right) and from a series of screenshots of Google.com's home page retracing salient traits in its evolution from 1998 to 2015 (bottom right).

The Colors of Pop Culture: Visualizing Nirvana

In 2013 we initiated a series of projects that took pop-rock music culture as the input to investigate new forms of representation and interaction with images. Contrary to motion structures, here the principal visual feature that we wanted to explore was the chromatic value, as it usually conveys music genres and is more noticeable in heterogeneous corpora.

In the first project, we chose as our source the complete videography of the rock band Nirvana, to produce a series of image slice visualizations. We processed each official video clip released by the band that was broadcast by leading TV channels in the 1990s. Figure 5 shows each video as a 1D arrangement of image slices ordered by their position in time. The visualization allows us to identify narrative passages and montage rhythm, but our main goal here was to privilege the aesthetic experience over functionality. We consider these visualizations as second-order aesthetics, created using other images (such as video clips, in this case) as material.

One of our strategies has been the exploration of the aesthetics of digital media through "visual disruptions"—changing how visual information is organized and represented. For example, the horizontal organization of image slices was used to generate a new visualization based on Cartesian and polar transformations. Not only do these visualizations recall dendrochronology techniques, they also recall the circular shape of vinyl and compact discs. Following a similar strategy, in the second project we performed "visual disruption" through the direct

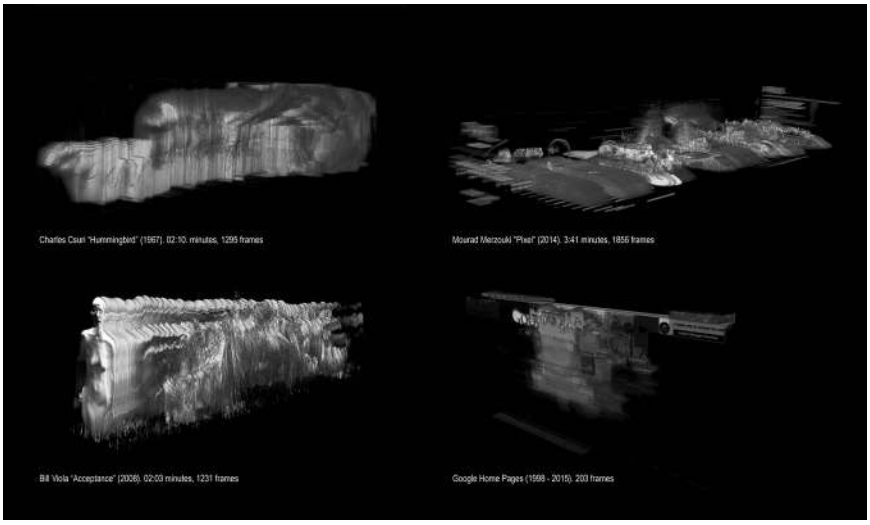

Fig. 4. Motion structures generated from different sources: Charles Csuri's *Hummingbird* video artwork (left-top), Bill Viola's *Acceptance* video artwork (left-bottom), Mourad Merzouki's *Pixel* video performance with visuals generated by Adrien M and Claire B (right-top), Google homepage screen captures from 1998 to 2015. (© Everardo Reyes, 2013–2016)

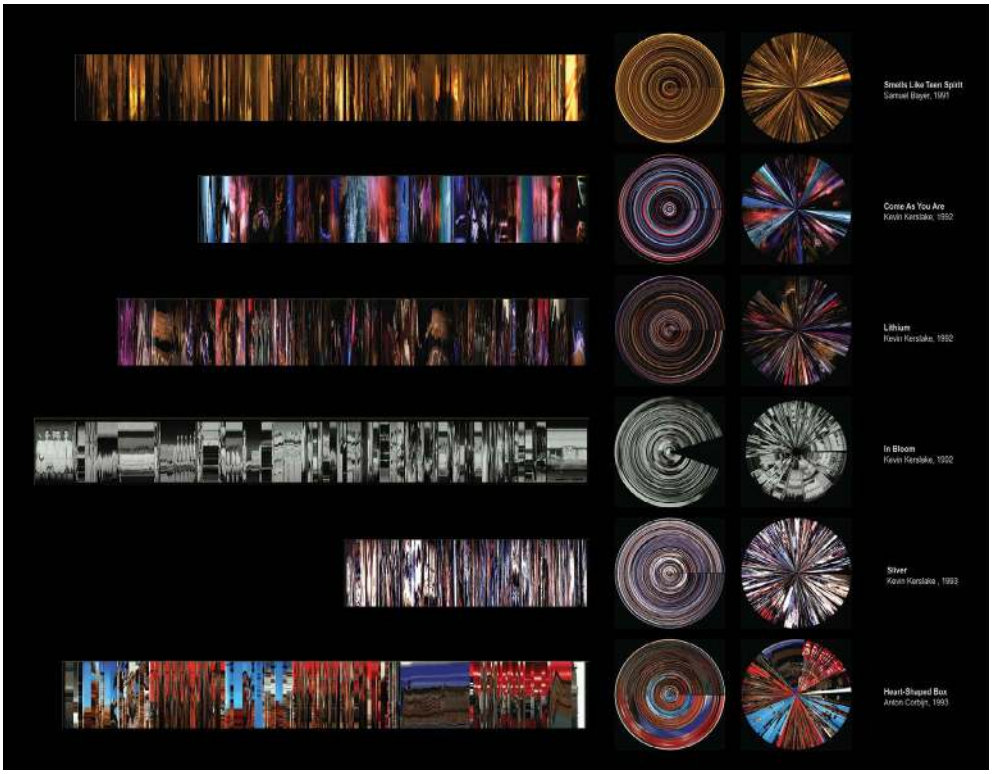

Fig. 5. Media visualizations of Nirvana's videography. Each video is represented as a 1D sequence of image slices. (© Everardo Reyes, 2014)

intervention in the Polar coordinates formulae in order to investigate how images could be visualized according to different geometrical figures. We first sketched several variations using Processing programming language software; we then adapted our algorithm using GREL scripts in Open Refine to generate HTML/CSS code. We used 2,000 rock-and-roll album covers, gathered from the AllMusic.com platform, that were ranked as the "most significant" by the editors in 2014. The results show a series of dense visual spaces that form chromatic clusters (Fig. 6). While some color trends can be seen (such as shades of violet and gray, splashes of red and blue, the delicate presence of green), the organization of images implies the subjective choice of the producer, but also the selection of editors in terms of rank and notes. Cultural visualizations suggest a virtual/potential space at the crossroads of multiple personal and technical choices.

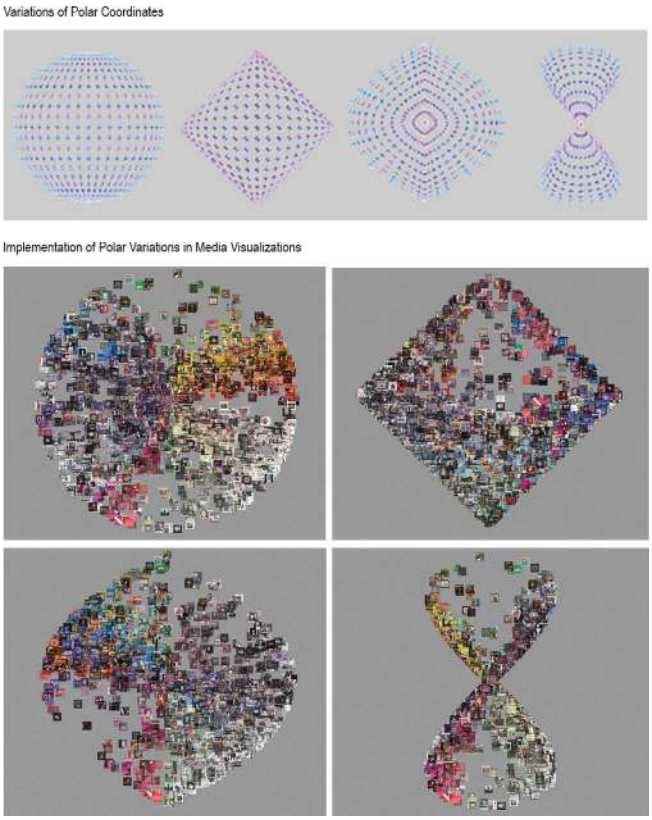

Fig. 6. Media visualizations with different options using a 2,000 images data set. (© Everardo Reyes, 2014)

Reception, Interaction and Insights from the Public

By presenting cultural visualizations in art exhibitions, we can give audiences opportunities to see differently contemporary processes of digital culture. For example, our visualizations of "motion objects" abstract the visual structure of various genres of video and disrupt their standard ways of organizing information. By applying particular image processing operations, transforming data into new visualizations, and making aesthetic decisions, we remind the viewers about the challenges of being able to see and reflect on the massive numbers of images that surround us in everyday life.

Artworks and exhibitions show us how artists, designers, scientists and curators see the underlying characteristics of our time. In our case, our artistic visualizations and exhibitions are reflections on contemporary media genres and their structures (such as types of editing, composition, movements, color palettes, etc.).

Lectures, talks, demos and workshops associated with artistic events are useful instruments to gain insights from the public. Within a practical context, we give special attention to the relationship between a visual representation and the software behind its production. In this context, visual disruptions and software glitches function as ruptures that demand to understand how software operates, not only at the surface level but also at lower layers comprising file formats, programming code, algorithms and data structures.

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Fig. 7. ***Digital Insights of 20th Century Painting*** **exhibition, held at the Winchester School of Art in 2017. (Photo © Everardo Reyes)**

In regard to media data sets and visual models, we encourage the reuse and remix of image collections by experimenting with new tools and workflows. The idea is to move from basic technical skills to the design of innovative and reflective visualization models that act as critical artifacts. This is one of the intentions of our disruptive strategy, described in the section "The Colors of Pop Culture," above. We invite users to see the software as an aesthetic machine, in order to experiment with the tools beyond their primary functions.

For example, the exhibition *Digital Insights of 20th Century Painting* (Fig. 7), designed by MA students as their final project at Winchester School of Art in 2017, was devoted to our cultural visualization techniques and presented new visual models conceived as curatorial tools for digital art. We ran a hands-on workshop, at which participants were invited to work on their own collections of images. As in other workshops we conducted in Paris and Turin in 2019, we found that an enormous variety of sources and themes appealed to users: from food design to graffiti, fashion and CGI short films.

Conclusions and Further Work

Just as modernist artists, designers and architects investigated new forms relevant to the industrial revolution, C.A. is an opportunity to investigate the characteristics of contemporary culture through data analysis and visualization leading to the creation of new visual images. As demonstrated by the projects presented in this article, our visualization models can make visible the variability of forms in contemporary media; they can also help to see differently elements that normally we may not notice (patterns, rhythm, movement traces).

By combining analytical methods with art and design practices, we intend to continue exploring digital media culture while reflecting on the variety of materials, processes, techniques and contexts associated with digital productions. Such

characteristics vary according to times and places, but they maintain an indexical relationship with the situation in which they were imagined.

We plan to continue creating new cultural visualization methods and showing new works in different contexts and cultural settings. We also seek to expand our methods by adding "experimental categorizations," our term to describe innovative and speculative dimensions (numerical or categorical) that describe visual media in new ways. In particular, this track allows us to think about more qualitative dimensions that can be added to our data sets, such as emotions, social identities and thematic roles.

Another future direction we want to pursue is the development of concepts and methods of "deep visualization." This is our term for making evident underlying and often real-time processes of software operations that are generally taken for granted by nonspecialist users. These operations include sorting and filtering algorithms, color quantization, reading and writing data in particular file formats, database structures, computer vision algorithms and operations of neural networks.

Acknowledgments

Cultural Analytics Lab was established in 2007 at the California Institute for Telecommunications and Information Technology (Calit2), located on the campus of University of California, San Diego (the lab was initially named Software Studies Initiative). In 2003, the lab expanded to a second location at the Graduate Center, City University of New York (CUNY). We are thankful to all the lab's members and collaborators who have contributed throughout the years to the research and development of projects, software and exhibitions.

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