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Digital Surrealism: Visualizing Walt Disney Animation Studios

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Abstract

There are a number of fruitful digital humanities approaches to cinema and media studies, but most of them only pursue traditional forms of scholarship by extracting a single variable from the audiovisual text that is already legible to scholars. Instead, cinema and media studies should pursue a mostly-ignored "digital-surrealism" that uses computer-based methods to transform film texts in radical ways not previously possible. This article describes one such method using the z-projection function of the scientific image analysis software ImageJ to sum film frames in order to create new composite images. Working with the fifty-four feature-length films from Walt Disney Animation Studios, I describe how this method allows for a unique understanding of a film corpus not otherwise available to cinema and media studies scholars.

"Technique is the very being of all creation" — Roland Barthes

"We dig up diamonds by the score, a thousand rubies, sometimes more, but we don't know what we dig them for" — The Seven Dwarfs

There are quite a number of fruitful digital humanities approaches to cinema and media studies, which vary widely from aesthetic techniques of visualizing color and form in shots to data-driven metrics approaches analyzing editing patterns. Despite their methodological differences, what all these approaches have in common is the reduction of the complex film or television text—image, sound, editing, production history, reception, paratext—to a smaller set of manageable variables: color palette, scripted dialogue, average shot length, budgets, box office results, social media presence. While any digital humanities project requires the reduction of a complex set of textual elements to a smaller set of abstracted variables, cinema and media

studies poses a special challenge to the digital humanist since film and television objects are in tangible respects more complex than literary or musical ones at the same time as they appear to be more easily accessible by methods of reduction and abstraction. That is, the apparent ease with which we can separate the media image from its soundtrack or the screenplay from a performance obscures for the digital humanist the real complexity of the film or television text. I am not making the argument that film or television texts are more complex intellectually or historically than literary ones, but that they are certainly more complex materially; for example, it is a significantly more difficult sensory task to experience an audiovisual text than a written one. While projects that perform textual analysis of a set of screenplays, or that map the relationships between actors and industrial figures, or that compare cutting rates across time periods all acknowledge the limitations of their approaches, they nonetheless reinforce the sense of film and television as a dis-integrated medium whose constituent parts can be analyzed discretely.

Before readers imagine that I have discovered a solution to this intractable problem, I need to admit that the film studies work which I describe here is also subject to the same criticism, for the same reason I began with: that the digital humanist must make an initial decision about which components to abstract and represent, and in doing so must by necessity omit others. There is not yet something like a "principal components analysis"[1] for the media text which can account for the inherent diversity of the physical object. But rather than only pursue digital forms of traditional methods that are already legible to the cinema and media studies scholar (like the projects described above that simply use computers to more efficiently analyze screenplays or editing patterns or industrial business histories),[2] what I propose instead is something weirder. To borrow from Stephen Ramsay's [2014] call for a "hermeneutics of screwing around," I propose a digital humanities project that is more aleatory and aesthetic than it is formal and constrained. Rather than reduce the film or television text to one of a well-established list of "components" such as the shot or the cut or the soundtrack in order to extract individual "elements," how might we abstract the film or television text so that it is presented to

us in a radically new way? How can we transform the object of study into something which retains the organic features of the original, but which is freed from the burdening over-recognition of form? How can we create something from cinema which is familiar but unrecognizable? (Figure 1: *Snow White* through a stacked Sobel filter)

Contexts

My approach, described in detail here, digitally sums film frames in order to discover unreal images that not only fabricate a new meaning for film texts but also draw out their latent mobile fragments. This project visualizes films in ways that were otherwise impossible for humans through most of the last century. As futuristic as this work might seem, it is in fact very much in line with mid-twentieth-century theories of literature which sought to treat the text not as the inspired culmination of an author's intellectual genius, but as an objective structure open to grounded analysis. In addition to contemporary digital humanists like Ramsay and Lev Manovich, and experimental media artists like Cory Arcangel and theater photographer Hiroshi Sugimoto, I am also inspired by what readers will no doubt recognize as a rather old-fashioned line of thought: "the structuralist activity" described by Roland Barthes in 1963, from which even he had moved on by 1970's *S/Z*. Barthes begins his essay by rejecting categorizations of "structuralism" as a school, movement, or even a set of vocabulary, and instead proposes that we understand structuralism more simply as an activity, a labor experienced by both artists and critics. In this formulation, the structuralist activity has as its goal to

> reconstruct an "object" in such a way as to manifest thereby the rules of functioning (the "functions") of this object. Structure is therefore actually a *simulacrum* of the object, but a directed, *interested* simulacrum, since the imitated object makes something appear which remained invisible or, if one prefers, unintelligible in the natural object. [Barthes 1972, 214–215]

To show how an object works is to reconstruct that object, to make a copy of that object that reveals something hidden or illegible in the original. Thus for Barthes, the structuralist activity of imitation requires an emphasis on technique over mere analysis: this activity is real, tangible labor that reconceives art and analysis as a paired activity, rather than see criticism as merely the lofty, disinterested contemplation of a work.

For this reason, Barthes does not propose one particular technique for structural analysis, but rather a useful methodology that I adopt as a framework: in analysis, "we recompose the object in order to make certain functions appear, and it is, so to speak, the way that makes the work" [Barthes 1972, 216]. In other words, the critic's technique of interpretation is the obverse of the artist's technique of creation: both imitate the world in a limited way, and in doing so express a particular set of interests and attentions that are evidence for an argument about how the world functions. This activity "involves two typical operations: dissection and articulation" [Barthes 1972, 216]. To "dissect" is to identify "certain mobile fragments" that differ enough from each other only in the most minimal way so that we may understand them both as part of the same paradigm and also as unique items in their category; a film example might be how viewers readily understand the Seven Dwarfs as a group of similar characters, while also understanding the respective differences that cause the characters to act the way they do [Barthes 1972, 216–217]. Next, to "articulate" is to discover "certain rules of association" which separate the work of art from the effects of chance, keeping "the contiguity of units from appearing as a pure effect of chance" [Barthes 1972, 216–217]. Thus for Barthes, this activity requires a "fabrication of meaning" that finds the natural in culture, seeking "less to assign completed meanings to the objects it discovers than to know how meaning is possible, at what cost and by what means" [Barthes 1972, 218]. Likewise my project does not intend to offer a definitive solution to a digitally-aided analysis of cinema, but rather to provoke inquiry into how meaning is possible and how different meanings arise from different means.

Barthes's proto-digital humanist approach foregrounds specific meaning-making techniques of dissection and articulation over abstract reasoning and the scrutiny of works previously endowed with meaning, and thus it offers a direction for critical analysis particularly appropriate for film and media studies. Because media texts are networked creations, quite often involving the labor and influence of a large number of individuals and institutions, they are of necessity particularly structured. Furthermore, popular media today, driven almost exclusively by commercial impulses, necessitate the refinement of narrow ranges of perceived generic markers in order to attract audiences, and thus these texts open easily to meaning-making approaches that refute the auteurist fantasy of a film or television show having one singular meaning waiting to be uncovered.

While they may prefer to avoid something as unfashionable as structuralism or semiotics, digital humanists would do well to reconsider the framework introduced in Barthes's essay. Indeed, Franco Moretti's lauded work on "distant reading" is in many ways a rewrite and amplification of Barthes; for example, in *Graphs, Maps, Trees,* Moretti proposes that we adopt a method whereby we "*reduce* the text to a few elements, and *abstract* them from the narrative flow, and construct a new, *artificial* object" [Moretti 2005, 53]. These steps of reduction, abstraction, and artificial construction are identical to Barthes's dissection, articulation, and fabrication of meaning. Stephen Ramsay's "screwmeneutics" also invokes Barthes, particularly the well-known distinction between the readerly and the writerly text. Ramsay connects this to another distinction in how we use libraries: we can do what we are mostly used to doing—search—or we can do something completely different—browse. When a person searches a library for bits of information, she invites texts to be readerly in order to be passively consumed, whereas when a person browses a library, "just screwing around," she hopes to encounter writerly texts that might offer "an invitation to community, relationship, and play" [Ramsay 2014, 119]. The activity of browsing, where "I do not know what I am looking for, really. I just have a bundle of 'interests' and proclivities" represents a strategy for dealing with the intractable

problem of too many books, too little time [Ramsay 2014, 115]. But rather than see this as a problem of "readerly" reading/searching, Ramsay's suggestion that we screw around invites a "writerly" reading/browsing strategy that abandons hopes of comprehensiveness in favor of discovery and play.

Last, I invite more readers to embrace the mostly-ignored tradition of film theory outlined by Robert B. Ray, who argues that around 1952 a decisive moment occurred where a Bazinian "Impressionist-Surrealist half of film theory fell into obscurity" and an Eisensteinian "semiotic," formalist film theory became the dominant approach [Ray 2001, 12]. Perhaps prompted by Barthes's own suggestion that surrealism "may well have produced the first experience of structural literature, a possibility which must some day be explored" [Barthes 1972, 214], Ray calls Barthes "the most obvious heir to the Surrealist concern" with the fragment and reads Barthes "resistance to the cinema" as a fruitful technique for approaching the cinema, "converting *fetishism*, with its overvaluation of apparently trivial details, into a research strategy, one that would enable its practitioner to enter a problem at other than the designated points" [Ray 2001, 100]. Along these lines, Ray connects Barthes's conscious decision to cite film stills when discussing the director Sergei Eisenstein—a strategy of "suppressing the movies' continuity"—with surrealist André Breton's "experiment of entering an unidentified film *in media res* and leaving when its point became too clear," or the game of "irrational enlargement" that only watches for one small detail, or the practice of placing hands in front of eyes to reframe the cinema image [Ray 2001, 100]. Playful surrealist viewing strategies like these make use of the physical body's presence in space, and they can be developed even further with digital tools. As Ray summarizes Barthes's *modus operandi*, "if the movies' relentless unrolling prevents your noticing anything except narratively underlined details, the only response is to stop the film" [Ray 2001, 100]. Unspooling a reel on a Steenbeck, pausing a VCR, stepping frames back and forth on a DVD, converting a movie into a folder of jpegs on a laptop: all of these ways to stop the film's oppressive narrative logic allow for renewed pursuit of an abandoned trajectory of

surrealist investigation. But whereas the Surrealists and Barthes were limited to working with modernist technologies such as the camera, photograph, or typewriter, the digital humanist can take advantage of more sophisticated computer-aided methods of stopping cinema.

Following Ray, I'll somewhat provocatively call my method digital-surrealist. Alongside Barthes's desire to "stop the film," surrealism offers a way to consider the stopped film's metaphoric unconscious. That is, I want to move beyond the initial step of using digital tools to pause, enlarge, slow down, or re-edit film texts, and towards a second step of using digital tools to modify the film text in a way that reveals its otherwise unintelligible facets. The surrealists in the 1920s were of course influenced by Freud's psychoanalysis and particularly his theory of dreams which described an unconscious part of the mind. The surrealists, privileging the unconscious as a more genuine site of creativity, followed Freud's lead in developing strategies to access this hidden part of the mind, emphasizing in particular "automatic" techniques to shortcut conscious perception and decision-making. Thus in my project, I attempt a computer-based form of automatism, a skrewmeneutical, playful, digital-surrealist method that extracts what we might metaphorically imagine as a film's "unconscious" visual field without conscious intervention. In computer programming terms, we might see this method as analogous to a black box approach: we want to perform an operation on a film without conscious knowledge or consideration of the algorithm used. The paired epigraphs at the beginning of this essay, from Barthes and The Seven Dwarfs, capture the usefulness of unconscious, motiveless labor, an emphasis on the refinement of a technique through repetition and the new creation which that technique engenders. The Seven Dwarfs are laboring automatons, projections of an unconscious work ethic that will not allow them to stop digging for precious stones although they have no conscious motive for their work ("we don't know what we dig them for"). But "technique is the very being of all creation" [Barthes 1972, 216] and since the dwarfs are excellent at their job, their mine will never run dry so long as they continue practicing their routine labor.

A Digital-Surrealist Method

Inspired by Lev Manovich's Software Studies Initiative, I use as my primary tool ImageJ, a public domain scientific image analysis software which was developed by the National Institute of Health and which works with an increasing library of user-created plugins. ImageJ "can display, edit, analyze, process, save and print" a variety of image types, facilitating simple tasks like scaling, rotation, and contrast adjustments as well as much more technical operations such as "morphological data mining," "trabecular geometry and whole bone shape analysis," and "comparison of intensity ratios between nuclei and cytoplasm" [Ferreira and Rasband 2010–2012]. ImageJ is customizable with any number of plugins and macros, and like other advanced image processing programs such as Photoshop even its basic menu can be bewildering. For the purpose of analyzing moving images, ImageJ's most useful functions are found in its Stacks menu; stacks are defined as "multiple spatially or temporally related images" displayed in a single window [Ferreira and Rasband 2010–2012, 12]. "The images that make up a stack are called slices" [Ferreira and Rasband 2010–2012, 12]. Imagine neatly cutting out each frame from a brief filmstrip and stacking them up in sequential order so that you are left with a three-dimensional volume. In effect, ImageJ does this digitally, but can also analyze each slice as it relates to the entire stack: "[i]n stacks, a pixel (which represents 2D image data in a bitmap image) becomes a voxel (volumetric pixel), i.e., an intensity value on a regular grid in a three dimensional space" [Ferreira and Rasband 2010–2012, 12]. That is, with stacks, ImageJ can not only analyze the two dimensions of an individual film frame, but can also analyze any slice or line through the third dimension of the stacked film frames. In effect, we are converting the dimension of time that we experience while watching a two-dimensional motion picture into a third spatial dimension that can also be analyzed.[3] (Figure 2: Visualizing a stack of slices as a cube)

To create a stack in ImageJ, users can import using a number of methods: a video file, an animated gif, or an image sequence. Due to processor memory limitations, most users will

find the simplest strategy is to create a folder of “stills” to import; I use Quicktime Player 7’s Export feature, selecting the option “movie to image sequence” to generate a folder of sequential jpegs. Users have an option to set the number of frames per second to export; experimentation shows that 24 frames per second is overkill, and that acceptable results can be found with settings as low as 0.10 frames per second. For this project, I created image sequences at 0.5 frames per second, or one frame every two seconds. For a 90-minute film, this results in an evenly-distributed sampling of 2700 frames. I removed errant black frames from the beginning and end as well as distributor and production logos that were later added for home video release (but kept production or studio logos that are integrated into the opening or closing credits). For example, here is a montage of all the frames I generated for *Frozen*. (Figure 3)

Once these slices are imported into ImageJ as a stack, there are any number of interesting manipulations users can perform on the film. Here I investigate only one—summed z-projections—which achieve the digital-surrealist aim of transforming the film texts into a new object of research. This method captures the extreme boundaries of the moving image: collapsing all the frames into a single space.

Remember that stacks are defined as spatially or temporally related images. One central application of summed z-projections are with spatially related images, like those produced by confocal microscopy, where a complete in-focus image of an object is built up from a stack of partially in-focus slices, and for various forms of medical tomography like PET or CAT scans where successive scans of slices of the interior of the body can be stacked to reveal a representation of a three-dimensional structure. In these examples, it is desirable for the captured object to remain as still as possible to get an accurate rendering. Applying these methods to large stacks of film frames which not only have moving objects but also numerous scene transitions and framings results in unpredictable results. Depending on the desired use, ImageJ offers five methods for creating a flattened, two-dimensional image from the three-dimensional stack: average intensity, maximum intensity, minimum intensity, sum slices,

standard deviation, and median. Each projection type works by performing a different mathematical operation on the RGB (red, green, blue) values of each voxel in the image.[4] Below is a simple demonstration of the five operations on a small five-frame stack. Of the five, Sum Slices produces the brightest images, and so I used this method exclusively. (Figure 4: twenty sample frames from a sequence in *Snow White*) (Figure 5: the six z-projection methods in ImageJ used on the *Snow White* sequence) (Figure 6: the six z-projection methods in ImageJ used on the entire film *Snow White*)

Texts

I took for my corpus the fifty-four animated feature films produced by what is now known as Walt Disney Animation Studios between 1937 and 2014.[5] These include well-known, wildly successful "classics" such as the first feature-length cel animation *Snow White and the Seven Dwarfs,* Disney's first original story *The Lion King*, and Disney's most successful film *Frozen*, as well as relatively unexamined films like the Latin American compilation *Saludos Amigos*, the commercial and critical failure of *The Black Cauldron*, and Disney's first full computer-animation *Chicken Little*. These fifty-four films offer a particularly rich corpus for digital-surrealist investigation: despite the often rocky and troubled history of the studio's management, Disney is and has been the most important, innovative animation studio ever, releasing a film on average every seventeen months over the last eight decades and pioneering many significant, innovative, and influential animation techniques like fully synchronized sound, three-strip Technicolor, the multiplane camera, multi-channel sound, CinemaScope, and numerous recent software engineering techniques. As a part of the larger Walt Disney Company media conglomerate (after Comcast, Disney is the second largest media conglomerate in the world by revenue), Walt Disney Animation Studios also plays a significant role in a global marketing juggernaut that continues to shape both multinational industrial media practices and the proliferation of American cultural exports (indeed, as early as 1934 Walt Disney worked with the

United States government to promote cultural exchange with Latin America through feature animation and “by 1943, 94 percent of all the footage produced by the Disney Studio was done under government contract” [Shale 1982, 24]). We can thus reasonably expect the corpus of Walt Disney Animation Studios to represent both a broad range of historical innovation in animation as well as a consistent, calculated, family-oriented production strategy. Indeed, Disney animated films have come to represent a transmedia genre as much as a brand. While I do not want to overlook the fundamental distinction between animated and live-action cinema, I was surprised that my particular digital-surrealist research strategy revealed very little difference between these two modes of narrative cinema. While there is not time to discuss it here, I have done similar research on a corpus of fifty live-action films from the western genre, and observed remarkably similar tendencies to those I found in the Disney corpus [Ferguson 2015b]. Thus, while one might expect digital manipulations of animated films to look profoundly different from live action films, this is not the case. (Figure 7: the Walt Disney Animation Studios corpus)

	Film	**Year**	**Directed by**
1	*Snow White and the Seven Dwarfs*	1937	Larry Morey, David Hand,Wilfred Jackson, Ben Sharpsteen, Perce Pearce, William Cottrell
2	*Pinocchio*	1940	Ben Sharpsteen, Hamilton Luske, Bill Roberts, Norman Ferguson, Jack Kinney, Wilfred Jackson, T. Hee
3	*Fantasia*	1940	Norm Ferguson, James Algar, Samuel Armstrong, Ford Beebe Jr., Jim Handley, T. Hee, Wilfred Jackson, Hamilton Luske, Bill Roberts, Paul Satterfield, Ben Sharpsteen
4	*Dumbo*	1941	Ben Sharpsteen, Norm Ferguson, Wilfred Jackson, Bill Roberts, Jack Kinney, Samuel Armstrong
5	*Bambi*	1942	David Hand, James Algar, Bill Roberts, Norman Wright, Samuel Armstrong, Paul Satterfield, Graham Heid
6	*Saludos Amigos*	1943	Norm Ferguson, Wilfred Jackson, Jack Kinney, Hamilton Luske, Bill Roberts
7	*The Three Caballeros*	1945	Norm Ferguson, Clyde Geronimi, Jack Kinney, Bill Roberts, Harold Young

8	*Make Mine Music*	1946	Jack Kinney, Clyde Geronimi, Hamilton Luske, Joshua Meador, Robert Cormack
9	*Fun and Fancy Free*	1947	Jack Kinney, Bill Roberts, Hamilton Luske
10	*Melody Time*	1948	Clyde Geronimi, Wilfred Jackson, Hamilton Luske, Jack Kinney
11	*The Adventures of Ichabod and Mr. Toad*	1948	Jack Kinney, Clyde Geronimi, James Algar
12	*Cinderella*	1950	Wilfred Jackson, Hamilton Luske, Clyde Geronimi
13	*Alice in Wonderland*	1951	Clyde Geronimi, Hamilton Luske, Wilfred Jackson
14	*Peter Pan*	1953	Hamilton Luske, Clyde Geronimi, Wilfred Jackson
15	*Lady and the Tramp*	1955	Hamilton Luske, Clyde Geronimi, Wilfred Jackson
16	*Sleeping Beauty*	1959	Clyde Geronimi
17	*One Hundred and One Dalmatians*	1961	Wolfgang Reitherman, Hamilton Luske, Clyde Geronimi
18	*The Sword in the Stone*	1963	Wolfgang Reitherman
19	*The Jungle Book*	1967	Wolfgang Reitherman
20	*The Aristocats*	1970	Wolfgang Reitherman
21	*Robin Hood*	1973	Wolfgang Reitherman
22	*The Many Adventures of Winnie the Pooh*	1977	Wolfgang Reitherman, John Lounsbery
23	*The Rescuers*	1977	Wolfgang Reitherman, John Lounsbery, Art Stevens
24	*The Fox and the Hound*	1981	Art Stevens, Ted Berman, Richard Rich
25	*The Black Cauldron*	1985	Ted Berman, Richard Rich
26	*The Great Mouse Detective*	1986	Ron Clements, John Musker, David Michener, Burny Mattinson
27	*Oliver & Company*	1988	George Scribner
28	*The Little Mermaid*	1989	Ron Clements, John Musker
29	*The Rescuers Down Under*	1990	Hendel Butoy, Mike Gabriel
30	*Beauty and the Beast*	1991	Gary Trousdale, Kirk Wise

31	*Aladdin*	1992	Ron Clements, John Musker
32	*The Lion King*	1994	Roger Allers, Rob Minkoff
33	*Pocahontas*	1995	Mike Gabriel, Eric Goldberg
34	*The Hunchback of Notre Dame*	1996	Gary Trousdale, Kirk Wise
35	*Hercules*	1997	Ron Clements, John Musker
36	*Mulan*	1998	Barry Cook,Tony Bancroft
37	*Tarzan*	1999	Chris Buck, Kevin Lima
38	*Fantasia 2000*	1999	James Algar, Gaëtan Brizzi, Paul Brizzi, Hendel Butoy, Francis Glebas, Eric Goldberg, Don Hahn, Pixote Hunt
39	*Dinosaur*	2000	Ralph Zondag, Eric Leighton
40	*The Emperor's New Groove*	2000	Mark Dindal
41	*Atlantis: The Lost Empire*	2001	Gary Trousdale, Kirk Wise
42	*Lilo & Stitch*	2002	Chris Sanders, Dean DeBlois
43	*Treasure Planet*	2002	Ron Clements, John Musker
44	*Brother Bear*	2003	Aaron Blaise, Robert Walker
45	*Home on the Range*	2004	Will Finn, John Sanford
46	*Chicken Little*	2005	Mark Dindal
47	*Meet the Robinsons*	2007	Stephen J. Anderson
48	*Bolt*	2008	Chris Williams, Byron Howard
49	*The Princess and the Frog*	2009	Ron Clements, John Musker
50	*Tangled*	2010	Nathan Greno, Byron Howard
51	*Winnie the Pooh*	2011	Stephen J. Anderson, Don Hall
52	*Wreck-It Ralph*	2012	Rich Moore, Phil Johnston, Jim Reardon
53	*Frozen*	2013	Chris Buck, Jennifer Lee
54	*Big Hero 6*	2014	Don Hall, Chris Williams

What is a Sum?

What does it mean to “sum” a film, to “add it up”? Cinema is excessive: there is too much, either along the diachronic or synchronic axes, for viewers to be able to process the moving image without recourse to a science like mathematics or an art like theory. While most audiences and reviewers would not think specifically of numbers while watching a film (outside of box office results), mathematical metaphors abound in discussions of film. For instance, contemporary reviews often “sum up” movies, resulting in an image of cinema as having unlike component parts that need to be added together in order to make sense: the acting was good, the dialogue worse, the soundtrack better. This is a pervasive logic built from the idea that artistic objects are difficult closed texts whose meaning is intentionally obscured by a creator in order to be deciphered later by audiences: surely the aesthetic object must mean something other than what it appears. An informal search of the film critic Roger Ebert’s website <http://www.rogerebert.com/> finds 74 uses of the phrase “doesn’t add up” to describe the failures of movies under review. Even Eisenstein, in famously explaining how hieroglyphics inform his theory of montage, resorts to math: “the point is that [the combination] of two hieroglyphs of the simplest series is to be regarded not as their sum, but as their product, i.e., as a value of another dimension, another degree” [Eisenstein 1949, 29–30]. Rejecting simple addition for complex multiplication, for Eisenstein cinema comes partly from the world of numbers: shots proportioned, framings balanced (or not), and all aspects directly measurable, as in his well-known audiovisual notation of a scene from his film *Alexander Nevsky* (1938). (Figure 8)

While my summed images erase montage and the possibility of two specific images colliding to produce a third dialectical meaning, they do democratize the film in a way that is impossible to imagine while watching, collapsing with a grander equation the important and unimportant, the major and minor, the dark and bright. In these images, all that is left is the trace of the filmmaker’s intentions; even a master like Eisenstein is unable to direct the viewer’s

attention to anything other than the sum of everything photographed, intentional or accidental. While collapsing the film text to a single frame might strike some as overly reductive, this process magnifies a cinematic experience that is otherwise entirely unnoticeable: the pure cumulative film effect on our eyes and brains without the distraction of narrative or image. Photographer Hiroshi Sugimoto, known for *Theaters*, a series of long-exposure photographs of movie theaters lit only by the light reflected off the screen, is also interested in trying to capture the time of a whole film in a single image.[6] Conceptually my work is similar to his, but his process results in black-and-white images with luminous, blank screens, whereas mine reveal color, shading, and depth. (Figure 9: Sugimoto's photographed films)

Here are the 54 sums I created. For the sake of visual comparison, here I have scaled all of these images to the Academy aspect ratio of 1.375:1, although obviously the films were initially released in a variety of aspect ratios.[7] They are presented in chronological order from upper left to lower right, and for the sake of reference I have included the film's number along with the title here and in the text below (thus, 25 *The Black Cauldron* can readily be found a little less than halfway through the montage at the beginning of row five). The images are also each labelled here, but for individual high resolution images without captions see [url]. (Figure 10: summed z-projections of the 54 feature films of Walt Disney Animation Studios scaled to Academy Ratio)

One aspect readers will likely notice immediately is the strong symmetry of these images. The majority of them feature a lighter, horizontally central shape on a differently-hued background with a degree of vignetting in the corners. For example, 22 *The Many Adventures of Winnie the Pooh* has a very recognizably Pooh-shaped blob smack in the center of a sky blue background and darkened corners and bottom. Likewise 14 *Peter Pan* has a glowing off-white central shape that falls off into blue hues on the left and brown ones on the right, with strong vignetting in the corners and along the top of the image. 43 *Treasure Island* shows a very distinct yellow central shape surrounded by deep blue with darker magenta in the lower corners.

But of the symmetrical center shapes, 13 *Alice in Wonderland* is the most remarkable: rather than the triangular pale blobbiness of the others, the central shape here appears actually to indistinctly show both Alice's straw hair and faint blue dress below. This becomes even more pronounced when increasing the contrast and saturation of the image, but it also evident in the numerous medium shots of Alice from the film, which show how often she is isolated on a dark background. (Figure 11)

Vignetting, a darkening of the periphery of an image, is most pronounced in 14 *Peter Pan*, 28 *The Little Mermaid*, 29 *Beauty and the Beast*, and 49 *The Princess and the Frog*. Compare those four images to 10 *Melody Time*, 33 *Pocahontas*, 35 *Hercules*, or 36 *Mulan*, which all have a central shape but a background that runs seamlessly to the edges without significant darkening. I attribute this difference both to the conventional wisdom of the cinematic dominant—that moviegoers' attention can be drawn to the most important subject by making it the best lit—and that the four unvignetted films take place primarily outdoors, while those with vignettes occur inside or in darker, secluded locations. *Pocahontas* and *Hercules* are nearly identical in this respect, and their sky-blue backgrounds are obvious, compared to the relatively shadowed and clouded undersea kingdom of *The Little Mermaid* or the forest and castle interiors of *Beauty and the Beast*. Vignetting is traditionally considered a problem in photography, with the ideal photograph showing a consistent range of tones all the way to the edge. Obviously, animated films need not suffer from this optical problem, and so many of the images that display strong vignetting do so intentionally in an attempt to imitate a vignetted "historical" look or more commonly to illustrate how a scene is artificially lit and to direct the spectator's attention to the privileged center of the frame. An example from *The Princess and the Frog* shows this common strategy, where the central characters in this shot are brightly lit while the background dancers and setting are increasingly (and unrealistically) darker as we move to the edges. (Figure 12)

Looking at the vignetted symmetry of so many of these images, 08 *Make Mine Music* stands out as an anomaly: is the dark gradient on the right side of the frame an example of something unusual about the film's visual strategy, or is it just an error in transferring the film print to a home video release? This image does not display vignetting, nor does it display a prominent central shape or even a symmetrical background: the image is unbalanced with a predominance of magenta hues on the left side and greenish ones on the right. Looking at the constituent frames (Figure 13), it appears that there is indeed a slight visible darkening error covering the right side of the digital copy, but that there are also frames like Figure 14 that are noticeably intentionally darker on the right. While much of the film features its characters in symmetrically centered compositions, the animation often uses a vibrant, gradient background, established in the title credits (Figure 15), that places characters in long shot on flat, brightly colored, and changing backgrounds. Thus, compared to the rest of the corpus, the gradient color shift of the *Make Mine Music* image is no doubt an unusual distinguishing quality. Readers already familiar with *Make Mine Music* will not be surprised by this, knowing that it is an anthology film produced during World War II originally with ten segments and with a strong emphasis on visualizing the interplay between animation and classical and popular music (Debussy, Prokofiev, Donizetti, Benny Goodman, The Andrews Sisters). The greater variety of animation styles, characters, and settings shows up in the rich mottled image. 08 *Make Mine Music* is not the only anthology film released by Walt Disney Animation; note how 07 *The Three Caballeros* is very similar both in the dark right side and lack of uniform background. Based on the gradient effect, can you identify the other anthology films?

There is one surprising wrong answer to that question: 34 *The Hunchback of Notre Dame*, which is not an anthology film but whose summed z-projection likewise stands out for its uneven composition and unbalanced colors. Much of the film takes place at night and there are numerous frames where the right side of the image is indeed completely black, so we can rule out a film transfer error (see Figure 16). Many sequences take place in candlelight and there is

a climactic fiery battle (as well as the orange and brown credits in Figure 17), so the warm red tones make sense, but what of the green dominating the left? I think there is a rather intuitive explanation for this which our digital-surrealist method confirms: throughout the film Quasimodo wears a drab green tunic, and since he himself is asymmetrical, with a hump on his right side, his characteristic features are best portrayed when he occupies the left of the frame facing frame right (see Figure 18). Closer investigation shows asymmetry is a visual theme in the film—for instance, Esmerelda wears only one hoop earring in her left ear with a hair scarf dangling on right and a thicket of bracelets on her left arm offset by a lone bracelet on her right wrist—and the summed image supports this strikingly by showing how often Quasimodo's back and hump occupies the left third of the frame, even as his face is centered. While we would expect the anthology films unintentionally to appear unbalanced given the varying range of source material, we can see clearly in the summed image from *The Hunchback of Notre Dame* how carefully the animators worked to create a dominant visual asymmetry for Quasimodo.

Is there a correlation between the size of the image's central lighter shape (an effect of lighting) and the way a spectator's gaze is controlled while watching? For instance, we might speculate that the smaller central shape seen in 14 *Peter Pan* means that that film directs the viewer's attention centrally much more than rather undirected films like 36 *Mulan*, 42 *Lilo & Stich*, or 52 *Wreck-It Ralph*. Tim Smith does interesting research using eye tracking to examine how film and television shows direct the viewer's attention. One line of his research creates "gaze heatmaps" to visualize which part of a moving image viewers are paying attention to [Smith 2015]. If the summed z-projections suggest to what degree filmmaker's locate brighter objects for spectators to pay attention to, it could be fruitful to compare those with viewers' actual experiences of the films over time.

I have remarked that most of the images have a symmetrical, centered shape, but one film in particular is much more defined than the blobbiness of the others' average: 03 *Fantasia*. The sharper definition of the shape here is obviously due to the repeated shots of the Master of

Ceremonies Deems Taylor and the conductor Leopold Stokowski, either of Taylor directly addressing the audience or Stokowski with his back turned preparing to lead the orchestra. (Figure 19). This is an unusual exception to the norm for these summed images, whose shapes are oval at best but often simply indiscernible. Fascinatingly, one other film also serves as an exception to the blobby central trend: 53 *Frozen* has two faint central shapes rather than only one (see the image in its original aspect ratio). While clearly one of Disney's "Princess Pantheon" films featuring a central female protagonist, *Frozen* visually breaks with the others with a preponderance of two-shots motivated by the fact that it revolves around the relationship between two orphaned sisters, a queen and a princess. While other Disney films have used wider aspect ratios, *Frozen*'s rather wide 2.24:1 aspect ratio easily allows for shots where both protagonists are framed in closeup. This is also true of two shots among other groupings of characters (Figure 20). While in some respects this is an effect of Disney's ability to know that today they would be able to successfully release a home video in widescreen format and not have to crop it as with widescreen films in the earlier days of hated letterboxing and squarish televisions, it is also evidence of *Frozen*'s strategy to visualize interactions between characters without relying on over-the-shoulder shots or needing to centrally frame speaking characters.

One other shape is apparent in many but not all of these images: the horizon or ground line. This is most visible, for example, in 05 *Bambi*, 22 *The Many Adventures of Winnie the Pooh*, 43 *Treasure Planet*, 45 *Home on the Range,* and 51 *Winnie the Pooh*, although readers will see faint examples in other films. Of these, *Bambi*'s darkened lower portion is the most pronounced, especially contrasted with the brightness of the center of the image and the lack of vignetting in the two upper corners. The dark lower portion in this film is not due to vignetting or lighting effects, but because the film has more long shots of characters that include the forest floor than it has medium or closeup shots of characters that do not include the ground. This makes some sense for a film like *Bambi*, focused on placing a young character in his woodland environment and detailing his interactions with smaller, ground-dwelling forest creatures. And

yet, the forest floor in *Bambi* is not completely black, and the film often captures a downward-looking perspective so that the forest floor occupies much of the frame, not just the bottom slice (Figure 21). Closer investigation better explains the dark bottom portion: the animators often occluded the foreground of the frame with brush, tree limbs, or other natural objects (see Figure 22). This is not only an excellent strategy to the problem of creating a perceived sense of depth in flat animation (so that including specific foreground shapes sets off the central characters from other visual planes), but it also generates a voyeuristic effect to make it seem as if viewers are peering through underbrush to watch Bambi's life unfold. We can readily see that the spectator's psychological distance from the non-human protagonist is encoded in the summed image.

A similar strategy is at work in another film focusing on non-human forest characters, 22 *The Many Adventures of Winnie the Pooh*. The animation here is much flatter, but as with 05 *Bambi*, the animators create many downward-facing shots and include darker objects in the foreground of the frame to provide spatial depth cues (Figure 23). Disney's second Pooh movie, 51 *Winnie the Pooh*, offers an interesting comparison since both films are about the same characters and animated in a very similar way. Here, though, there is a noticeable thick, darker ground line about a third from the bottom of the image, obscured by the central blob shape. It's difficult to see why *Winnie the Pooh*'s summed image looks so different from *The Many Adventures of Winnie the Pooh*, but I speculate that *Winnie the Pooh* has more shots that are level, revealing more of the sky and making the forest less wooded, and that its foreground objects are not darkened so that the overall image is evenly bright (see Figure 24).

The retro-future 43 *Treasure Planet* has a much more dazzling, dense, and vibrant animation style that appears in the summed image. But here I think we see less of a horizon line and more evidence of the fact that much of the film takes place on a horizonless spectacular flying ship and that our novice hero is often shown against the brown wood of the gunwale with blue sky in upper two-thirds (see Figure 25). The defining blue sky is also apparent in 45 *Home*

on the Range, which has a much different kind of horizon line, defined less by the foreground and more by the skyline. *Home on the Range* is a western, evoking the Monument Valley locations of John Ford's films, and we can clearly see how often the three cow heroines are drawn in bright exterior shots (Figure 26). *Home on the Range* most resembles 32 *The Lion King* in that the dominant presence of the blue sky clearly defines the film's majestic outdoor location. Both of these films' images are remarkably similar to a summed image that I produced for an initial exploration of this project using a corpus of fifty western films: John Ford's *The Searchers* (1956) [Ferguson 2015b]. (Figure 27) Many of the Disney films feature blue hues, but only a handful like *Home on the Range* and *The Lion King* contrast the blue sky with a different-hued lower two-thirds (for example, consider how 33 *Pocahontas* and 35 *Hercules* are almost all blue). In doing so, we can also see how much less defined a central shape becomes in these, instead (perhaps) emphasizing how the characters in films set in grand locations disappear into their surroundings or are balanced with numerous extreme long shots.

51 *Winnie the Pooh*, mentioned above, also brings us to the final noticeable shape of some of these frames: textual elements that remain on the screen and "burn" their way into the summed image. *Winnie the Pooh* illustrates the first version of this: in the lower right quadrant we can make out the letters "ooh left the conte," which indeed turn up in eleven of the slices used (0.59% of the total frames) (Figure 28). While much more indeterminate, we can also barely make out nondescript characters in the center of 23 *The Rescuers* and 21 *Robin Hood*. These two films do not have as much meta-textual play with writing as *Winnie the Pooh*, but what they do have in common is that they illustrate the second way that text appears in the summed images, namely, as title or closing credits. In the case of *The Rescuers* and *Robin Hood*, the fashion at the time was to list production credits at the beginning of the film rather than the end, and so the credits remain on the screen long enough to be amplified in the summed image; for instance in the case of *The Rescuers*, the phrase "With the voice talents of" remains for 16 slices (0.72% of summed frames) while the cast list changes. Interestingly, a film

with the same credit sequence strategy, 20 *The Aristocats*, does not visibly display text in the summed image, perhaps because the text is in black but on a darker background and thus less distinct (see Figure 29).

In 51 *Winnie the Pooh* we also see the second way production credits affect the summed image, where a very long list of names scrolls continually over either a static or moving background. *Winnie the Pooh* has well over 400 names listed in its closing credits in addition to song credits and other information; textual credits appear on 246 of the 1859 frames I generated, or a little more than 13% of the film. This shows up in the summed image as two varying width columns starkly separated by a thin stripe (Figure 30). This effect is noticeable as early as 28 *The Little Mermaid*, and has become more pronounced as credits become longer (I calculate the closing credits occupy 5.26% of *The Little Mermaid* versus 9.63% of Disney's most recent film 54 *Big Hero 6*).[8] Other rectangular shapes, such as in 44 *Brother Bear* or 45 *Home on the Range*, are caused by the film's narrative-driven shift of aspect ratio (this edge boxing is also visible in 01 *Snow White*, whose home video release slightly shifts aspect ratios after the opening credits).

Like many, 51 *Winnie the Pooh*'s credits take place over a moving and constantly varying background, but readers will no doubt be able to identify the fewer films with extensive credits that scroll over a relatively unchanging background. The most obvious of these are 25 *The Black Cauldron*, 37 *Tarzan,* and 54 *Big Hero 6*. In each of these, a particularly prominent shape is evident: *The Black Cauldron*'s manuscript borders, *Tarzan*'s tropical rainforest leaves, or *Big Hero 6*'s floating dirigibles. (see Figure 31) 26 *The Great Mouse Detective* has a slightly fainter but still visible image, since it adopts the common strategy of beginning the closing credits over a scenic establishing shot before switching to a black background to display secondary credits (Figure 32). Careful readers might also wonder about 47 *Meet the Robinsons*, which appears to have a window-shaped square in the upper right quadrant; however, we discover the credits are a scroll over a solid black background. In this unusual case,

investigation reveals that the window shape is from a scene early in the film, with a shot of our inventor hero inventing (Figure 33). In this scene, there is one cutaway, and then we return to the same camera setup for a total of 39 slices or 1.4% of the film's length. Further experimentation is required, but this figure gives some suggestion that there is a threshold for particular objects to appear and that the placement and brightness of those objects matters (for instance, other unmoving aspects of the shot such as the wallpaper or framed diplomas are not as prominent). Is this then the longest camera setup in the Disney canon? Or just the brightest?

While aesthetically I find the summed images more attractive without the closing credits, they are a striking reminder of how much longer the film's paratext has become due to the greater number of credited contributors. I also find something compelling about the strong central vertical line in images like 46 *Chicken Little* and 53 *Frozen*, which call to mind Abstract Expressionist painter Barnett Newman's "zip" paintings (Figure 34: *Onement, I* (1948) http://www.moma.org/collection/object.php?object_id=79601). In a 1970 interview with filmmaker Emile de Antonio, Newman describes his zips as a way to unite the parts of his painting and, in a phrase relevant to cinema, speculates on his thought process in creating them: "I suppose I thought of them as streaks of light" [O'Neill and Newman 1992, 306]. Mark Rothko, another well-known Abstract Expressionist painter whose work these summed images call to mind, also describes his paintings as having "their own inner light and if there is too much light [in the museum], the color in the picture is washed out and a distortion of their look occurs" [Breslin 1993, 412]. (Figure 35: *Untitled* (1968) http://www.moma.org/collection/object.php?object_id=37042) Art critic Clement Greenberg championed Rothko's work as part of a "color field" tradition, which used uninflected color to collapse traditional differences between figure and ground. The summed images I produced achieve in related ways this effect, but are built out of some of the most figural images available. I think the summed z-projections evoke Rothko and Newman's work with color, but on another version of a similar project, Kevin Oleary pointed out to me how similar these summed images

are to an earlier tradition—the paintings of English Romanticist J. M. W. Turner, such as his later work *Venice with the Salute* (c.1840-5) or *Landscape* (c.1840–c.1845). (Figures 36 and 37: http://www.bbc.co.uk/arts/yourpaintings/paintings/venice-with-the-salute-202458 and http://www.bbc.co.uk/arts/yourpaintings/paintings/landscape-97520)

So far I have discussed the shapes of these images, and with Turner and the Color Field painters in mind I want to conclude with a brief analysis of the color of these images. Below are two simple graphs of all the films created using ImageJ's ImagePlot macro, plotted by median hue on the x-axis and median brightness on the y-axis, and then by standard deviation hue on the x-axis with standard deviation brightness on the y-axis. We thus expect to see a horizontal distribution of images in the rainbow spectrum of hues (i.e., from red on the left through green in the middle to violet on the right), with brighter images moving upwards. While sourcing and creating digital copies of these texts from DVDs, I discovered that older, softer prints often resulted in lighter summed z-projections. I also question how accurately color was reproduced in transferring older films to home video format, particularly whether or not the color was balanced properly and whether the proper color saturation was achieved (and to that matter, who would be the authority on the "proper" color of an eighty-year-old print and what it means to speak of a film's projected brightness, which comes down to the age and brand of the light bulbs in the projectors which originally screened these films). So we should be careful not to read too much into our results when comparing films to each other, especially with some of the outliers. (Figure 38: Median hue and brightness, Figure 39: Standard deviation hue and brightness)

Looking at the first graph of median values allows us to spot some clusters of similarly hued films: the airy blue in the upper right corner that I have discussed, but also the surprising similarity in the upper left between comic western 45 *Home on the Range* and the video game world of 52 *Wreck-It Ralph*, which has long outdoors sequences in desert-like Sugar Rush Kingdom that influenced the hue. The majority of the films are clearly within the blue register, in a tall stack descending from 35 *Hercules* to 14 *Peter Pan*, but there is also quite a bit of

variance in hue that covers the spectrum almost completely. 02 *Pinocchio*, whose image looks rather plain and flat, is uniquely the most violet-hued, even more so than the brighter 36 *Mulan* which has clearer areas of purple. Many pairs of films are practically on top of each other, such as 40 *The Emperor's New Groove* and 34 *The Hunchback of Notre Dame,* 21 *Robin Hood* and 27 *Oliver & Company*, and 18 *The Sword in the Stone* and 31 *Aladdin*; remarkably, each of these pairings were separated by at least five other releases, suggesting that while the summed frames can be surprisingly similar this is not necessarily due to the same animators or production methods (for instance, *The Sword in the Stone* and *Aladdin* are nearly identical and yet were made nearly thirty years apart).

Plotting by standard deviation, rather than median values, allows us to quickly see some outliers: 33 *Pocahontas*, *36 Mulan*, and 44 *Brother Bear*. As noted, *Brother Bear* shifts aspect ratios from 1.75:1 to 2.35:1, so the first 28.7% of the film has black side pillarboxes which make it deviate predictably in terms of both hue and brightness. Excluding *Brother Bear*, the next film with the most deviation in brightness is 05 *Bambi*, which confirms what I suggested earlier about the strangeness of the dark bottom line versus the lightness of the top of the frame. Curiously, *Pocahontas* and *Mulan*, Disney's only two films about ethnic women, are both nearly equal in terms of brightness but completely opposite in terms of hue; that is, compared to the other films, *Mulan* displays much more deviation in the hues that make up its summed image, but very little deviation in its brightness. *Mulan* bears even more deviation than 51 *Winnie the Pooh*; this is difficult for me to tell at first given *Mulan*'s even brightness compared to *Winnie the Pooh*'s varied brightness. But just as we did with the summed z-projections, we can also create graphs of median hue and brightness for each individual film using our folder of slices. Here are three, plotting as I did before median hue on the x-axis and median brightness on the y-axis, illustrating how the brightness and hue of *Mulan*, *Pocahantas*, and *Bambi*'s individual slices do and do not contribute to the overall summed effect. (Figures 40–42)

We can quickly confirm our earlier results and see that *Bambi*'s frames are much more frequently distributed at the darker bottom of the graph than the other films, and that *Pocahontas*'s are very much concentrated in one band while *Mulan* has a wider range. While I will not discuss them in depth here, examining such plots for each individual film also allows researchers to compare signatures and see how internally consistent the films are: *Mulan*'s summed image makes it look almost entirely violet, but we see that a good percentage of the film is actually red–orange hued. Here are two such visualizations, first a montage plotting the median hue and brightness for each film, followed by a combined image plotting the median hue and brightness for every slice used in this project. The first graph shows how individual films' varying hue and brightness create a signature; the second shows the combined hue and brightness of the entire Disney corpus. (Figures 43–44)

Conclusion

Roland Barthes again: "Structural man takes the real, decomposes it, then recomposes it; this appears to be little enough . . . [y]et enough from another point of view, this 'little enough' is decisive: for between the two objects, or the two tenses, of structuralist activity, there occurs something new" [Barthes 1972, 215]. As I noted earlier, my project does make some of the same choices I criticized, most notably isolating the visual image as the object of study. What I hope, however, is that by pursuing a novel digital-surrealist technique that shortcuts expectations for analysis of the visual image (such as those that focus on costumes, mise-en-scène, or editing), that I can find the "little enough" to create something new: a form of digital humanities media research as both study and invention: "not man endowed with meanings but man fabricating meanings" [Barthes 1972, 218]. While I move back and forth between summed images and the text itself, this is not to reestablish the text's meaning-endowed authority, but to show the iterative process of making meaning, which requires speculation, experimentation, and art.

Recall that for Barthes both the artist and the critic followed an analogous practice, creating an "*interested* simulacrum" of reality. "The simulacrum is intellect added to object, and this addition has an anthropological value, in that it is man himself, his history, his situation, his freedom, and the very resistance which nature offers to his mind" [Barthes 1972, 215]. The anthropological value of summed film frames speaks very clearly to the contemporary challenges of using a digital humanities approach towards film and media studies: this project is in palpable ways a product of my history as a film obsessive, my situation as a developing scholar in a new field, my freedom to acquire and manipulate digital film, and the constant resistance I experience over the value of this project in its ability to contribute to the scholarly field. For the traditional film scholar, the anthropological value of these images poses a (hopefully liberating) threat to older methods of searching for narrative meaning in the cinema. For the digital humanist, these summed film frames show the resistance both of nature and of our technology, forcing us to confront again the possibility that our faith in the computer's excellence at producing rational evidence is a flatness we must leaven with a touch of surrealist play. To that end, I conclude with a final image that remains, to me, fruitfully illegible: the sum of all of the summed z-projections, the sum of 132,000 slices of Walt Disney Animation Studios. (Figure 45)

References

[Barthes 1972] Barthes, Roland. “The Structuralist Activity.” In Richard Howard (trans.), *Critical Essays*, Northwestern University Press, Evanston (1972), pp. 213–220.

[Breslin 1993] Breslin, James E. B. *Mark Rothko: A Biography*. University of Chicago Press, Chicago (1993).

[Eisenstein 1949] Eisenstein, Sergei. “The Cinematographic Principle and the Ideogram.” In Jay Leyda (ed. and trans.), *Film Form: Essays in Film Theory*, Harcourt, San Diego (1949), pp. 29–30.

[Ferguson 2015a] Ferguson, Kevin L. “Volumetric Cinema,” *[in]Transition: Journal of Videographic Film and Moving Image Studies*, 2.1 (2015). Available at: http://mediacommons.futureofthebook.org/intransition/2015/03/10/volumetric-cinema [Accessed 15 June 2015].

[Ferguson 2015b] Ferguson, Kevin L. “What Does A Western Really Look Like?” (2015). Available at https://medium.com/the-outtake/what-does-the-western-look-like-545981d93ae8 [Accessed 15 June 2015].

[Ferreira and Rasband 2010–2012] Ferreira, Tiago and Wayne Rasband. “ImageJ User Guide: IJ 1.46r” (2010–2012). Available at: http://imagej.nih.gov/ij/docs/guide/user-guide.pdf [Accessed 15 June 2015].

[Jockers 2013] Jockers, Matthew. *Macroanalysis: Digital Methods and Literary History*. University of Illinois Press, Champaign (2013).

[Moretti 2005] Moretti, Franco. *Graphs, Maps, Trees: Abstract Models for a Literary History*. Verso, London (2005).

[O’Neill and Newman 1992] O’Neill, John Philip and Barnett Newman. *Barnett Newman: Selected Writings and Interviews.* University of California Press, Berkeley (1992).

[Ramsay 2014] Ramsay, Stephen. “The Hermeneutics of Screwing Around; or What You Do with a Million Books.” In Kevin Kee (ed.), *Pastplay: Teaching and Learning History with Technology*, University of Michigan Press, Ann Arbor (2014), pp. 111–120.

[Ray 2001] Ray, Robert B. *How a Film Theory Got Lost and Other Mysteries in Cultural Studies*. Indiana University Press, Bloomington (2001).

[Shale 1982] Shale, Richard. *Donald Duck Joins Up: The Walt Disney Studio during World War II*. UMI Research Press, Ann Arbor (1982).

[Smith 2015] Smith, Tim J. “Read, Watch, Listen: A Commentary on Eye Tracking and Moving Images,” *Refractory: a Journal of Entertainment Media* (2015). Available at: http://refractory.unimelb.edu.au/2015/02/07/smith/ [Accessed 15 June 2015].

Notes

[1] Matthew Jockers [2013] defines principal components analysis, or PCA, as "a method of condensing multiple features into 'principal components,' components that represent, somewhat closely, but not perfectly, the amount of variance in the data" (67). For literary analysis, this means that the multi-dimensional variance between a large set of variables (such as word count, noun frequency, number of semicolons, named locations, year of publication, or whatever other variables the researcher has extracted) within a corpus of texts can be plotted in only two dimensions.

[2] For example, Yuri Tsivian and Gunars Civjans's excellent and often-discussed website *Cinemetrics* <http://www.cinemetrics.lv/> offers a digital method for calculating shot lengths; while this software approach is certainly much faster than calculating by hand, it is not specifically something that requires a computer, and thus it fits in a different class of digital projects from those that cannot be done (albeit slowly) by hand.

[3] I demonstrate this further in [Ferguson 2015a].

[4] The code for the z-projection is available here: http://imagej.nih.gov/ij/source/ij/plugin/ZProjector.java

[5] Walt Disney Animation Studios was formed as Disney Brothers Cartoon Studios before being called Walt Disney Productions and then Walt Disney Feature Animation. It was named Walt Disney Animation Studios in 2006 after Disney bought Pixar Animation Studios.

[6] Sugimoto describes his work on his website: <http://www.sugimotohiroshi.com/theater.html>.

[7] Aspect ratios were 1.37:1 from 1937–1953, then two films at 2.55:1, 1.75:1 from 1960–1981, one film at 2.20:1, 1.85:1 from 1986 to 2000, then a variety of ratios between 1.75:1 and 2.39:1 from 2002–present. Further complicating matters, home video releases quite often adopted a different aspect ratio from the theatrical presentations; usually following trends at the time.

[8] Over the last two decades, the length of closing credits has remained about the same, and so the varying percentages are a function of shorter or longer running times.