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feature article

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Upscaling Swedish Biograph

ABSTRACT

Following a boom of user-friendly artificial intelligence tools in recent years, AI-enhanced (or manipulated) films have been framed as a serious threat to film archives. The purpose of this article is to trace and critically evaluate how AI artists use algorithmic upscaling to modify early cinema, more particularly surviving films of the film company Swedish Biograph, and how fragments of this company's cinematic past circulate online today.

KEYWORDS

artificial intelligence
machine learning
archives
film restoration
digitization
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remix
reuse

Appropriation, remix and reuse of old footage is a well-known practice in both film and TV history as well as today on digital platforms. Online, each media asset becomes, 'at the instant of its release, an archive to be plundered, an original to be memorized, copied, and manipulated', media scholar Abigail de Kosnik argues in her book *Rogue Archives* (2016: 4). Such contemporary reuse, however, has a long media history. In 1964, for example, Swedish public service broadcaster Radio Sweden bought most of the old newsreels from the production company Svensk Filmindustri (SF). Dating from 1897 to 1960, the SF archive's 1 million metres of film promised extensive reuse and an array of forthcoming TV programmes (Eriksson et al. 2022). Among the material were some fifteen film fragments from 1911, produced by Svenska Biografteatern (Swedish Biograph), the film company that preceded SF.

The 1911 footage was the result of an unusual idea of Charles Magnusson, the CEO of Swedish Biograph at the time: to produce feature films in parallel, shot on specific urban and well-known locations, nationally as well as internationally (Snickars 2001: 189). Magnusson went so far as to finance a costly filming trip during the spring and summer of 1911. An ensemble of five Swedish film workers, including a director, two actors, cinematographer Julius Jaenzon and Magnusson himself, embarked on an international journey to shoot city scenes for a number of planned feature films, combining elements of fictional melodrama and documentary footage. The geographical strategy was to incorporate sequences of authentic, spectacular and exotic places in a variety of contexts, a type of *bricolage* where footage could be used (and reused) in and from several different films. Some titles were indeed later released, like *Två svenska emigranters äfventyr i Amerika* ('The adventures of two Swedish emigrants in America') (Malmberg 1912a) or the comedy *Kolingens galoscher: Den stora världsomseglingen eller Hvad skall Engström säga?* ('Kolingen's galoshes: The great circumnavigation of the world, or What shall Engström say?') (Malmberg 1912b). On film posters, the latter was advertised as a 'cosmopolitan comedy on two continents with Swedish actors. Filmed partly in Stockholm, and partly in Monte Carlo, Ostende, New York' (Snickars 2001: 162).

None of Swedish Biograph's rather unusual feature films shot during the 1911 trip have been preserved. While Jaenzon – later known for his work with Golden Age directors Victor Sjöström and Mauritz Stiller – filmed dramatic scenes with actors, he also shot thousands of metres of non-fiction material in Berlin and Venice, Paris and New York. SF released some of this material in the form of three non-fiction travel films: *Berlin* (Anon. 1911b), *Niagara* (Anon. 1911c) and *New York* (Anon. 1913). Jaenzon's footage survived in the SF archive, and later, during the 1930s and 1940s, was given rather obscure archival titles such as SF2082 (Berlin), SF2087 (Monte Carlo) and SF2088 (New York). Since these film fragments were of a relatively early date and depicted famous cities, Jaenzon's footage belonged to the most reused films from the SF archive, later appearing in hundreds of TV programmes (Eriksson et al. [2022] discuss the reappropriation and remix of the SF archive at length). It almost goes without saying that TV producers devoted scarce attention to the context or purpose of the footage; it was resolutely cut asunder and sometimes harshly re-edited, with sound added to the silent footage, all in order to prettify old films for televisual broadcast. It did not even matter that Jaenzon was a canonized cinematographer.

His skill is indeed apparent in the visually delightful film fragment from New York shot by Jaenzon during the summer of 1911. It begins with several beautiful scenes of Manhattan and the Statue of Liberty, filmed from a slowly moving ferry. Thereafter, the ten-minute film shows famous landmarks like New York Harbor, Battery Park and the John Ericsson statue, elevated trains at the Bowery, the Flatiron Building on Fifth Avenue as well as enticing scenes from everyday life: cars driving, trams passing by and a one-legged man going about his business. As always in early urban non-fiction films, some depicted people look back with curiosity at the cranking operator. For decades, Jaenzon's remarkable film existed only as the film fragment SF2088, buried in the vaults of Sveriges Television (SVT) within the SF archive. The film from New York was digitized in the early 2000s in a collaboration between SVT and Statens ljud- och bildarkiv (The Swedish National Archive of Recorded Sound and Moving Images) but was never made available online due to copyright

claims. However, in 2017, the Museum of Modern Art (MoMA) in New York digitized the film anew, this time from a nitrate print held in their collection. It had been acquired in 1962 from Einar Lauritzen, the head of Filmhistoriska Samlingarna (the Swedish Film Museum) in Stockholm. In all likelihood, Lauritzen had received the nitrate copy from SF before their newsreel archive was sold to Radio Sweden, a copy that Lauritzen forwarded to MoMA. Following digitization, they made Jaenzon's film available to the public on the MoMA webpage and YouTube channel (Trenor 2023: n.pag.).

If the afterlife of early cinema was once predominantly an archival issue, with some films being carefully restored and others cut up and re-edited for televisual reuse, today online platforms play a significant part in the rediscovery of our filmic past. In February 2020, video and AI artist Denis Shiryaev uploaded a manipulated digital copy of the MoMA version of *New York 1911* (as it was now called) to his YouTube channel. Shiryaev is very popular; with more than 70 million views on his channel he is one of the best-known upscaling filmmakers online. Shiryaev computationally adjusted the frame rate of Jaenzon's footage and upscaled it to 4K – that is, boosted the horizontal image resolution to 4000 pixels. He also stabilized the MoMA version and automatically added colour via the application DeOldify. Moreover, Shiryaev inserted some sound and cut the scenes with Swedish actors from Jaenzon's footage. He also altered his sequences temporally; shots of the steamer Rosedale, for example, were moved from the beginning of the original footage to the end of Shiryaev's film, which he now called *A Trip through New York City in 1911*.

Remixing visually stunning content more than a century old, Shiryaev's film soon went viral and rapidly gained millions of views on YouTube. Today, it constitutes his most watched video, with over 20 million views and more than 65,000 comments. It is by far the most watched Swedish Biograph film ever. Shiryaev's upscaled version has not only circulated on YouTube, but also through TikTok, Instagram and Facebook, where short snippets were cut out, reused and circulated independently. On YouTube, there are also several so-called reaction videos where people talk in-depth about their fascination with Jaenzon's footage. American genealogists have even made videos tracking down people who appear in the film and tracing their life stories. In one scene shot by Jaenzon from the back of a car driving in Manhattan, for example, a wealthy family is seen being driven by an African American chauffeur.

Figures 1–3: A trip through the film archive and computational restoration: Swedish Biograph's film fragment New York 1911, *shot by Julius Jaenzon, upscaled in 4K with 60 fps and algorithmic colourization by video artist Denis Shiryaev. Given the new title* A Trip through New York City in 1911 *(2020a), Shiryaev's version has received more than 20 million views on YouTube.*

Since the licence plate is visible, enthusiasts have been able to use the records of the Federal Highway Administration to identify Florian Lochowicz, his wife Antoinette Lochowicz and their children as the people in the car. Shiryaev's *A Trip through New York City in 1911* is an illustrative example of what happens when heritage institutions and film archives renounce control over historical material and instead let previously neglected films circulate, transform and gain new life online in unexpected ways.

The purpose of this article is to trace and critically evaluate how AI artists use algorithmic upscaling to modify early cinema, more specifically surviving films from Swedish Biograph, and how fragments of this company's cinematic past circulate online today. The article comprises two parts: first, we discuss the challenge of artificial intelligence to contemporary film and broadcasting archives, with a particular emphasis on the Swedish context; second, drawing on an uncommon academic collaboration that we have instigated with Swedish AI artist ColorByCarl (colourization artist Carl Hamnede), we investigate how early Swedish cinema is upscaled on his YouTube channel, where he presents, in his own words: 'historical films in a way you [have] never seen them before: restored and then digitally enhanced with AI. And with carefully created soundtracks added. [All films] are artistic interpretations of the original footage' (@ColorByCarl n.d.: n.pag.). In the conclusion, we discuss the perceived challenge that artificial intelligence and the AI-artist community pose to traditional archives and argue that this development warrants closer scrutiny.

THE CHALLENGE OF ARTIFICIAL INTELLIGENCE

In 2018, Peter Jackson's upscaled and colourized World War I film *They Shall Not Grow Old* sparked debates about authenticity and documentary ethics. With colour, adjusted frame rate and added audio – drawn from recorded audio testimonies – the film fascinated audiences yet also evoked an uncanny feeling. Moreover, Jackson's film drew sharp criticism from archivists and film historians for, among other things, erasing the work of the filmmakers who shot the footage in the first place, for the creative decisions involved in the 'modernization' of the film and the implication in the marketing that the footage used was in poor condition and in need of repair when in fact it had already undergone restoration by archivists (Napper 2018a, 2018b; Gopnik 2019).

Two years later, in 2020, Shiryaev's (2020b) AI-enhanced version of the Lumière Brothers' *L'Arrivée d'un train en gare de La Ciotat* (*Arrival of a Train at La Ciotat*) (1896) went viral on YouTube. Like his upscaled version of *New York 1911* made later the same year, Shiryaev's modified version of one of the first films ever made was also upscaled to 4K digital resolution and transformed from sixteen to 60 frames per second. Not everyone was pleased, however. The Institut Lumière posted a takedown request, claiming copyright to a 130-year-old film. Shiryaev argued (with the help of a lawyer) that since Louis Lumière passed away more than seventy years ago, the film was in the public domain. Yet, when he also received a Digital Millennium Copyright Act (DMCA) takedown notice from YouTube, which forthwith removed the video and gave Shiryaev a so-called 'channel strike', he simply stopped arguing (Shiryaev 2021: n.pag.).

Trying to curb asserted online piracy is usually to no avail – hence on YouTube there are today a number of other upscaled versions of the Lumière's

Arrival of a Train at La Ciotat. These types of enhanced videos have not only gained massive circulation online, but have also nurtured a vibrant community of AI enthusiasts who focus on early cinema in particular, most frequently posting on YouTube, TikTok and Instagram. Some notable examples include @DenisShiryaev (n.d.), with 578,000 subscribers on YouTube, @historycolored (n.d.a, n.d.b), with 2.1 million followers on Instagram and 374,000 followers on TikTok, and Nineteenth century videos (@XIXbacktolife n.d.), with 388,000 subscribers on YouTube. In the past year, AI tools such as the text-to-image generators DALL-E, Stable Diffusion and Midjourney have gained widespread impact, sparking a growing debate about human vs. computer-made art, intellectual property and the impact of generative AI in society (Wasielewski 2023). Similarly, the technology behind the 'enhancements' of early cinema carried out by AI enthusiasts relies on user-friendly tools and applications. Software packages include Adobe After Effects, used for noise reduction and removal of wear-and-tear and dust, Topaz Video Enhancement for upscaling to 4K, or Rife App for frame interpolation – that is, boosting the frame rate where AI creates new frames from pre-existing ones to create a smoother viewing experience, say from fifteen frames per second to 60. In other words, three-quarters of the video images are then entirely artificial. Finally, DeOldify, which uses Generative Adversarial Networks (GANs) to colourize and restore old images and film footage, is a very popular AI tool for colourizing videos. Notably, even the widespread Adobe Photoshop today has 'neural filters' as an ordinary and commonly used setting (like adding sharpness), where users with one click can add colour, resolution, 'superzoom' or make format transmissions. Toolboxes for image enhancement (or manipulation) are thus not a marginal phenomenon but have rather rapidly become a default.

The AI enhancement community relies primarily on (more or less) free tools and freely available film material digitized by traditional institutions. This, scholars have argued, can be interpreted as 'a sign of the democratisation of the medium and AI [resulting in] a moving away from institutional procedures, perhaps even a gesture of resistance against authorities, the official bearers of knowledge' (Božak Kavčič 2022: 249). To critics, however, the fondness among AI enthusiasts for neural networks is an anathema, especially for film archivists. In contrast to AI enhancements, most definitions of the practice of film restoration focus on the aim of restoring an archival film as closely as possible to its original form. For example, Paolo Cherchi Usai offers the following definition: 'Restoration is the set of technical, editorial and intellectual procedures aimed at compensating for the loss or degradation of the moving image artifact, thus bringing it back to a state as close as possible to its original condition' (2000: 66). Such practices can involve restoring a film on a textual level, for example by considering the editing of the film or restoring lost title cards, or on a material level, where prints may have survived in a different format than the original. Meanwhile, as Giovanna Fossati points out in her book, *From Grain to Pixel: The Archival Life of Film in Transition*,'being true to the original [when restoring a film] can mean a whole spectrum of different things' (2009: 71). Indeed, the toolset of film preservationists has been expanded in recent years, with traditional methods focusing on what can be achieved through photochemical means – physical cleaning of film negatives to remove dirt and dust, the physical repair of scratches and tearing or colour adjustment through grading to restore the tinting and toning in silent-era films – being supplemented with digital technology that effectively can fix, for example, the appearance of scratches in the emulsion.

While digital technology 'enables restorers to do things that were impossible before', as Fossati asserts (2009: 98), voices of criticism have been heard within the film archive community. Whereas certain archives like the EYE Film Museum (previously the Netherlands Film Museum) have been quick to embrace the potential of digital technologies, including digital grading, frame interpolation to adjust fps or the blending of different archival source elements, Grazia Ingravalle contends that other archives take a more cautious and critical approach (2024: 75–76).

Today, AI is a topic of conversation within the film archive community. In 'The Digital Statement Part III' (2023), published by the International Federation of Film Archives (FIAF), the authors highlight careless manipulation using digital tools as a major threat to their craft:

> Unfortunately, these same powerful tools provide the ability to obliterate the character and integrity of the original film and to erase any vestige of aesthetic or historical veracity. Improperly or carelessly applied digital tools afford the means to distort, reinterpret, and misrepresent the aesthetics – and content – of the cultural and historical materials that archives and other collecting institutions are duty-bound to preserve.
>
> (Byrne et al. 2023: n.pag.)

In this context, authenticity is at the heart of the debate. Yet, the argument around 'carelessly applied digital tools' usually falls short, since most upscaling filmmakers, like Shiryaev, are meticulous about what tools they use, always publishing a disclaimer concerning the exact ways films have been enhanced. Nevertheless, not all members of FIAF approve, and the criticism twenty years ago of all forms of digitization of the film heritage is now directed at AI enhancement. Oliver Hanley, film preservationist at the Deutsches Filminstitut & Filmmuseum, and Ulrich Ruedel, member of FIAF's technical commission, have for example taken notice of the growing use of AI tools for film enhancement and argue that traditional film restoration practices remain important:

> Powerful new digital tools that draw on Artificial intelligence (AI), readily available to a user group that could disparagingly be labeled 'enthusiastic amateurs', represents a challenge to proper, ethically grounded film preservation practice. […] This must be balanced by properly curated, contextualised access to unmanipulated heritage images of maximal authenticity, viewed in the best possible conditions, within given frameworks, if the public at large is to properly understand the images of the past.
>
> (Hanley and Ruedel 2022: 58–59)

Here, the *ethos* of the professional is put in sharp contrast with the *pathos* of the enthusiastic amateur. While digital manipulation using AI is presented urgently as a potentially problematic trend, this criticism ignores the fact that images of the past always have been the subject of remix. For example, consider the ways in which non-fiction films during the last 50 years have been re-edited in the context of television – with TV producers hardly being as open about their reusage as the upscaling filmmakers of today. Meanwhile, the criticism that AI tools are used to carelessly distort the past has also been coupled with a fear that 'prettified AI-enhanced digital objects' (Prelinger 2021: n.pag.) might completely replace original films. That is, audiences will lose

Figure 4: Screenshot from Denis Shiryaev's A Trip through New York City in 1911 *(2020a) of a comparison between source material and upscaled material (original to the left of the frame and upscale, with colour, to the right). Such sequences towards the end of Shiryaev's upscale serve as an open-minded indication of awareness of the archival images.*

interest in the original and material dimensions of film because of the refined aesthetic properties of the manipulated videos, and presumably also their lack of AI literacy. In fact, a recurring criticism of AI-enhanced films centres on aesthetic and/or ethical interventions. With a focus on aesthetics, film scholar Kristian Božak Kavčič has discussed the impression of authenticity in the work of Shiryaev, juxtaposing the technological sophistication associated with AI tools and algorithms with the only partially concealed imperfections in the process. For example, objects in the background can change colour, the added frame rate can leave traces such as unnatural movement or changes in facial expression, or the increasing resolution can make the images seem blurred or dimmed (Božak Kavčič 2022: 41). All these imperfections, the author argues, will most likely become visible retroactively, as AI techniques and tools continue to evolve.

Simultaneously, the prevalence of manipulated images, generative AI and deepfakes has prompted some commentators to warn of a further deterioration in the indexicality of images and an upcoming 'information apocalypse' (Schick 2020: 9; Dagar and Vishwakarama 2022). There are certainly noteworthy examples of AI artists causing an outcry by manipulating historical sources. One example is when *Vice* published colourized images of the Khmer Rouge killing fields victims. The artist Matt Loughrey had not only added colour to the mugshots, but also altered them to add smiles, an intervention that was perceived as deeply insulting to the victims (Ratcliffe 2021). Ethical interventions have also been voiced in relation to AI-enhanced films, though more frequently zooming in on historical imperfections in the colour of clothing, buildings or the environment, as well as the choice of music or added sound effects – the latter (again) hardly a novelty when considering usage of old footage in television. It should be noted, however, that this criticism has not

escaped the AI enthusiasts who produce these enhancements. While some audiences surely find the enhanced images more alluring than the 'originals', as critics like Prelinger note, the practitioners within this community do strive for transparency, highlighting the choices that have been made in the creative process. For example, concerning the *New York 1911* film, Shiryaev includes a disclaimer on YouTube reading: '⚠ Please, be aware that colorization colors are not real but fake, colorization made only for the ambience and do not represent real historical data' (2020a: n.pag.). Additionally, in the upscaled version Shiryaev includes a 30-second comparison between the source film and the new version. In this sense, rather than obscuring it, the artist draws attention to the fact that the images indeed have been manipulated.

Parallel to this development, the emergence of algorithmic ways of using media archives has gained a lot of attention within the archival sector, where computer vision, automatic speech recognition (Stjernholm 2022) and platforms that enable users to remix archival material have been seen as ways to expand the reach and societal relevance of film and broadcasting archives. As scholars have noted, the EYE Film Museum in the Netherlands is a frontrunner in this regard, spearheading initiatives like Jan Bot, which automatically produces short videos via the reuse of films from a found footage collection (Eriksson et al. 2022: 233–34), thereby ushering film heritage into an age of algorithms. Another state-of-the-art example is the Netherlands Institute for Sound and Vision's Media Suite, which serves as an online interface for an underlying media infrastructure that offers scholars the opportunity to explore, browse and compare content and metadata in a wide array of audio-visual archival collections, enabling use by journalists and scholars alike (Sanders et al. 2022). Moreover, the visual turn within digital humanities research has foregrounded audio-visual media as data. In recent years, the ability of machines to analyse images, video and audio has progressed significantly (Fickers et al. 2018; Burghart et al. 2020), with automated computer vision providing methods, tools and software to approach audio-visual media in new ways.

Indeed, besides questions about authenticity and manipulation, digitization and archival infrastructure, artificial intelligence and machine learning technologies raise questions about what epistemological, methodological and aesthetic challenges this brings to film and media studies. In the recent article 'On the altered states of machine vision' (2022), film theorist Antonio Somaini asks how artificial intelligence and machine learning technologies might impact our disciplines through the creation of a whole new category of images. By definition, generative image models operate by statistical induction and intimately mirror their training data, and by doing so create new images (Somaini 2022: 94). Here, Somaini challenges us to rethink not only what counts as historical evidence, but also how artificial intelligence transforms our understanding of our visual and audio-visual past. To answer these provocations, we argue that scholars need to take on the challenge to work and experiment with AI tools to better understand and explore their capabilities and potential, limits and biases. Meanwhile, the fact that media historical sources, not least audio-visual sources, have been shaped by their circulation, preservation and digitization evokes additional challenges. In this sense, our collaboration with ColorByCarl and his usage of archival AI enhancement tools has been a way to deepen our comprehension of upscaling filmmaking as well as to ask critical questions about the archival afterlives of Swedish Biograph and the tools that are used to remix and reshape our film heritage.

ColorByCarl

In order to test and understand what upscaling filmmakers actually do, we got in contact with ColorByCarl. On a few occasions, we talked to him on Zoom and we also paid him a small fee to make a pilot production of a 48-second Swedish Biograph sequence in different formats. On his YouTube channel, there are today some 30 upscaled versions of early Swedish non-fiction films, most of them produced by Swedish Biograph. The films are usually less than ten minutes long and often depict Swedish cities and towns (most notably Stockholm). ColorByCarl usually duplicates 'original' film versions from filmarkivet.se, which in turn uses copies taken from the SF archive. Like Shiryaev, he is meticulous with metadata, adding to each video both the 'source' (filmarkivet.se n.d.) and 'original source' (the SF number of a film). ColorByCarl has some 10,000 subscribers to his YouTube channel; his most popular video is 'Stockholm 1909', an eight-minute upscaled version of Swedish Biograph footage from the capital (SF2061A). The video has been seen 200,000 times and has received some 230 enthusiastic comments. A similar film depicting Göteborg and a tram trip through the city in 1907 has received almost 150,000 views and nearly 300 comments, both from Swedes and international audiences, including some fellow upscaling filmmakers: 'It is really amazing. I'm an editor and colorist and this is a superb job my friend. It's really cool to see how people were doing things 117 years ago' (@MrMolack 2021: n.pag.). In our talks with ColorByCarl he asserted that there is a loose online community of upscaling filmmakers that also tries to follow a common set of rules for enhancement. Consequently, in his channel description, ColorByCarl states that he perceives his work as artistic interpretations of the original footage and that 'color and sound is *not* historically accurate [but] added for ambience'. Even if he most frequently works with early cinema, he does acknowledge copyright issues: 'If the videos published on this channel infringe upon your rights, please reach out to me at [my e-mail address]' (@ColorByCarl n.d.: n.pag.).

Figures 5–7 highlight the way films are 'distorted' in various ways, not only by AI artists but also by institutions and archives during preservation and circulation, that is, during their entire life cycle. Figure 5 illustrates the low digital resolution and poor quality that the National Library of Sweden offers as default for film researchers. Figure 6, taken from filmarkivet.se, the joint film

Figures 5–7: Stills from sequences filmed on the beaches of Mölle in southern Sweden in 1911. To the left (Figure 5), actor Victor Arwidsson (with binoculars at the lower right of the frame) and others in Swedish Biograph's lost feature film comedy Kolingens galoscher *('Kolingen's galoshes') (1912b), directed by Eric Malmberg; centre (Figure 6), from Viking's non-fiction film* Badlif vid Mölle *['Swimming at Mölle'] (Anon. 1911a); and right, ColorByCarl's upscaled version of the latter (2023).*

portal of the Swedish Film Institute and the National Library, has somewhat better resolution. The excessive distortion of ColorByCarl's upscaled version (Figure 7) is due to the scarce pixel density of the original at filmarkivet.se. As he explains on YouTube, 'The source material I used to make this video was heavily damaged by compression artifacts and interlaced and duplicated frames. I have tried to restore it back to its former glory as best as possible' (@ColorByCarl n.d.: n.pag.).

We proceeded with our collaboration by giving ColorByCarl access to an MPEG-2-version of SF2059. In the early 2000s, the SF archive was digitized in collaboration with the National Archive of Recorded Sound and Moving Images in both low-resolution MPEG-1 – then standard for lossy compression of video – and in higher resolution MPEG-2 copies. The new database with all digitized films was called Journal Digital. This short film snippet contains non-fiction footage from the small city of Nyköping shot around 1910. We wanted ColorByCarl to upscale the short sequence and tint and tone it as well as automatically add colour and some sound. Our idea was that after the first steps, duplicating traditional film restoration practices, the sequence would resemble the original version. The second steps (colour and sound) would, accordingly, be the result of more novel digital enhancement. The particular sequence ColorByCarl was to upscale in these different ways depicts film audiences strolling out of a local cinema, most likely an early promotion stunt by Swedish Biograph to lure audiences to return and see themselves on-screen.

ColorByCarl started working with the short sequence and immediately noticed so-called duplicate ghost frames, a common result of early digitization practices, with film being copied on video and then digitized. To reduce the ghost frames, he split the sequence in 872 png-frames and then removed all ghost frames. Using the software Adobe Premiere, he then compiled the remaining 579 png-frames into a moving sequence, running with twelve frames per second for a smooth appearance. In Adobe Premiere he also used the plugin Neat Video to remove scratches on some frames. However, it also became apparent that the sequence jolted and bumped up and down, likely the result of the film operator using an unstable stand. In Adobe AfterEffects, ColorByCarl was able to pinpoint two fixed points in

Figures 8 and 9: Duplicate 'ghost' frames in the original version of SF2059, depicting cinema audiences leaving Swedish Biograph's local cinema in Nyköping around 1910. By fixating two small parts of the frame – the red circles in Figure 9 – ColorByCarl was able to steady the short sequence.

the sequence, the corner of a window and a letter above the entrance of the cinema, to steady the sequence and subsequently crop a minor part of the frame. Finally, by using the AI model Topaz Video Enhancer, image resolution was boosted to 4K and frame rate set to 60 frames per second. Almost all of ColorByCarl's upscales use this standard, with metadata stating that footage has been remastered to 4K 60 frames per second using various kinds of AI and software.

ColorByCarl then proceeded with tinting and toning the sequence following the traditional way such techniques were used in early cinema. As is well known, tinting coloured all the light areas in a sequence, while toning coloured the dark areas of a film print. Since the sequence from the Nyköping cinema was most likely shot during the daytime, ColorByCarl used the yellow colour for this daylight exterior. He even managed to get hold of an early Pathé scheme for different tinting colours and sampled *jaune* ('yellow'). For the toning process, he similarly used a brownish-orange copper colour. In addition, he produced yet another colour version, combining green toning with yellow tinting. The computational steps of colouring were essentially done in seconds, and as noted such abilities are nowadays becoming defaults in most imaging software. Though a standard procedure in digital film restoration, it is noteworthy that today it is widely used by amateurs online.

Regarding AI-based colour enhancement, ColorByCarl then used DeOldify, a software that has become the standard GAN (Generative Adversarial Network) for the colourization of old black-and-white photographs and film. DeOldify is based on a GAN machine learning framework that, in short, can learn to generate new data mirroring the limits and biases of the specific training set (Image-Net, for example, is a popular training set in machine learning). For example, according to ColorByCarl, DeOldify sometimes generates copies that are too purple and dark blue. Hence, he also extracted a few key frames and had an AI called Palette.fm suggest a colour; after adjusting the results, he used yet another AI model (Deep Exemplar based Video Colorization) to finish this semi-automatic colourization process. The final part of ColorByCarl's upscaling endeavour was using the professional video editing software Adobe Premiere Pro to smooth results and also to add sound, which is usually the most time-consuming part of his work. All in all, ColorByCarl made 24 versions of SF2059 that he sent us; a selection is available on YouTube (@modernatider1936 2023). Like most upscaling filmmakers,

Figures 10–12: ColorByCarl in action: cinema audiences in different colours. To the left (Figure 10), a tinted version using the sampled jaune *from a Pathé tinting colour scheme. Centre (Figure 11), an AI-coloured version using the software DeOldify. To the right (Figure 12), a final semi-automatic AI version, combining manual labour with software as Palette.fm and Deep Exemplar based Video Colorization.*

he also produced a video comparison between the original version and his final version, splitting the image in two.

Even if ColorByCarl considers himself to be an amateur filmmaker, as is apparent from our description, he puts in substantial work and makes numerous cautious decisions when working with early cinema. The results are often stunning, and he is always transparent about what he does. The previously cited concerns among FIAF representatives and their accusations and neglect of 'enthusiastic amateurs' regarding 'unmanipulated heritage' and lack of 'ethically grounded film preservation practice' are very far from the truth.

CONCLUSION

'Will prettified AI-enhanced digital objects made to draw in the eyeballs of distracted web surfers push the original, less attractive evidence out of view?', film archivist Rick Prelinger anxiously asked a few years ago (2021: n.pag.). For AI enthusiasts like Shiryaev, technology can bring old films to a new audience. To critics like Prelinger in the film archival community, however, AI enthusiasts' care for neural networks and their capabilities implies carelessness in the treatment of artefacts of film history.

This type of wariness of digital technology is not new. Around the turn of the new millennium, a shift from analogue to digital film distribution, production and preservation methods had a profound impact world-wide. In the introduction to film historian Paolo Cherchi Usai's provocatively entitled book *The Death of Cinema: History, Cultural Memory and the Digital Dark Age*, the author posed the question: 'Why is our culture so keen in accepting the questionable benefits of digital technology as the vehicle for a new sense of history?' (2001: 1). Ever since the medium's inception, the actual watching of a celluloid print has been associated with its gradual deterioration and destruction. This, Cherchi Usai argues, raises questions about the goal of film preservation and film history more broadly. In the discourse on the death of cinema at this time, digital media were hardly seen as saviours. Indeed, the transfer of film visuals to a different medium, critics aptly noted, gives rise to numerous other problems. In this sense, there is a striking parallel between the doomsday rhetoric surrounding the breakthrough of the digital and the contemporary debate on artificial intelligence, machine learning and generative AI. Here, it is worthwhile pointing out that so-called media panics surrounding new media phenomena – such as film, cartoons, video games and the internet – tend to be emotionally charged (Drotner 1999).

Meanwhile, dystopian worries are often coupled with utopian visions of the future, a phenomenon not least evidenced by the contemporary debate on AI. However, while critical of the gatekeeping of film history, this article does not necessarily advance an argument that is sanguine about technological developments. Our ambition has rather been to trace how early cinema, and the film company Swedish Biograph in particular, is modified by AI artists in a hands-on way, making it possible for fragments of this company's cinematic past to circulate online today. Swedish Biograph's footage shot in New York in 1911 is a curious case in point: first its extended archival life at SF, Radio Sweden, SVT and MoMA; then its subsequent afterlife online, on different platforms and in various AI enhanced or manipulated forms. Even if the debate on the impact of AI tools within the film archival community has only begun, it has tended to focus on aesthetic and ethical interventions. But the relation of film towards the digital has many more facets, too often dismissed

by organizations like FIAF. We argue that the debate on algorithmic manipulations, upscaling and the distortion of 'original film copies' tends to ignore that distortion has always been part and parcel of the afterlife of most film archives. A film's life cycle is all about continuous alterations, from the first time a piece of celluloid film is put into a film projector and begins to deteriorate materially, to when television broadcasters make alterations to the aspect ratio or use cultural heritage films as fillers in documentaries, and finally when audio-visual archives decide on (different) digital formats for preservation (most frequently lossy compression) and access.

Despite its title, film historian Jan Olsson's book *The Life and Afterlife of Swedish Biograph* (2022) does not say much about streams of upscaled early cinema on YouTube. The afterlife of Swedish Biograph, however, is nowadays increasingly a digital phenomenon – ColorByCarl has reached nearly 1 million views (most likely including a number of bots). The archive, Olsson states, is a site for practices 'aimed at safekeeping and reviving films from the past' (2022: 11). Such practices have changed from the early analogue days of 'pioneering film archivism in the 1930s to the digital culture that drives today's restorations, preservations, and screenings at archives' (Olsson 2022: 11). Cultural heritage institutions like the Swedish Film Institute have received much attention as key gatekeepers that negotiate how the past is accessed and understood. Parallel to established institutions and experts, however, there has been a rise of online amateur communities that produce and maintain collaborative archives online (de Kosnik 2016; Bareither 2021; Ekelund 2022). We argue that professional film archivists remain important, and so are institutions like SFI, safeguarding film heritage. Nevertheless, these online amateur communities deserve more attention in film and media scholarship. On YouTube, the upscaled non-fiction films of Swedish Biograph are celebrated and praised by millions. Drawing on our collaboration with ColorByCarl, who was tasked with using AI tools to enhance a film fragment from the same company, a lot can be learned, including a glimpse of the intricate procedures within the AI enhancement community behind the scenes. By highlighting ColorByCarl's meticulous upscaling work with enhancement, including the removal of ghost frames, attempts to steady the sequence and experimenting with tinting and toning, the article has offered a striking contrast to the commonly voiced accusations of careless manipulation. In this sense, ColorByCarl's endeavours seem to us a splendid way to bring Swedish Biograph to a new audience and reinstate film heritage into cultural circulation.

It is important to remember that the algorithmic manipulation of audio-visual and visual media extends far beyond the questions of the archival life of film. Automated computational processing techniques are not only integrated into popular tools such as Adobe Photoshop, but automated manipulation is also increasingly becoming an invisible part of our everyday media environment, for example when algorithmic ways of emulating the aesthetics of professional photography (e.g. simulation of a shallow depth-of-field or automated facial retouching) are being integrated in smartphones (Taffel 2021). While the social use of artificial intelligence and machine learning systems has drawn much attention, for example with regard to deepfakes and misinformation, less attention has been placed on their role in the sciences, including astronomy, medicine, chemistry, biology and more as 'engines of scientific speculation' (Offert 2021: 3). Among other things, AI methods have been used to produce bacteria mappings with dimensions in the nanoscale as well a highly controversial image of the M87* black hole, something that can

raise doubts about the images' epistemological status (Michos 2023). So, even though the debate on AI has focused largely on art and creativity, the potential problems in relation to science are 'less obvious but potentially more dangerous', as Konstantinos Michos recently contended (2023: 169).

One way to mitigate potential harm is to strive for transparency concerning both AI-generated images and other types of AI manipulation. As we have discussed in this article, the AI artists who have taken an interest in early cinema have come under attack from archivists and other commentators. Yet, both internationally known figures like Shiryaev and ColorByCarl from Sweden place great emphasis precisely on transparency by the inclusion of disclaimers, by including explanations of which AI tools have been used and by highlighting that the end result is an artistic interpretation rather than a restoration. The case of Swedish Biograph shows that the power relation between traditional audio-visual archival institutions and audiences online has shifted. Naturally, the latter also includes filmmakers who have gained access to vast quantities of digitized historical film material circulating online as well as new AI tools that allow them to freely experiment with the material by means of upscaling or colourization. We perceive this as a sign of democratization, not least due to AI's potential to encourage reuse, remix and rediscovery of our filmic past.

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REFERENCES

@ColorByCarl (n.d.), 'ColorByCarl', YouTube, https://www.youtube.com/@colorbycarl. Accessed 2 September 2024.

@DenisShiryaev (n.d.), 'Denis Shivyaev', YouTube, https://www.youtube.com/channel/UCD8J_xbbBuGobmw_N5ga3MA. Accessed 29 August 2024.

@historycolored (n.d.a), 'History in Color', Instagram, https://www.instagram.com/historycolored/. Accessed 29 August 2024.

@historycolored (n.d.b), 'History in Color', TikTok, https://www.tiktok.com/@historycolored. Accessed 29 August 2024.

@modernatider1936 (2023), 'Modern Times 1936', YouTube, https://www.youtube.com/@modernatider1936. Accessed 5 October 2023.

@MrMolack (2021), 'Göteborg 1907: Spårvagnsresa tvärs genom staden (1907) – Remastered 4k 60fps', YouTube, 11 December, https://www.youtube.com/watch?v=lTEDjaawSIk&t=327s. Accessed 5 October 2023.

@XIXbacktolife (n.d.), 'Nineteenth century videos. Back to life', YouTube, https://www.youtube.com/c/nineteenthcenturyvideosbacktolife. Accessed 29 August 2024.

Bareither, Cristoph (2021), 'Capture the feeling: Memory practices in between the emotional affordances of heritage sites and digital media', *Memory Studies*, 14:3, pp. 578–91.

Božak Kavčič, Kristian (2022), 'Now I can see! The enrichment of early cinema images with artificial intelligence', *KINO!*, 48, pp. 247–61.

Burghardt, Manuel, Heftberger, Adelheid, Pause, Johannes, Walkowski, Niels-Oliver and Zeppelzauer, Matthias (2020), 'Digital humanities and film: Analyzing the modalities of moving images', *Digital Humanities Quarterly*, 14:4, pp. 1–15.

Byrne, Robert, Fournier, Caroline, Gant, Anne and Ruedel, Ulrich (2023), 'The Digital Statement Part III: Image restoration, manipulation, treatment, and ethics', FIAF International Federation of Film Archives, https://www.fiafnet.org/pages/E-Resources/Digital–Statement-part-III.html. Accessed 6 August 2023.

Cherchi Usai, Paolo (2000), *Silent Cinema: An Introduction*, London: BFI.

Cherchi Usai, Paolo (2001), *The Death of Cinema: History, Cultural Memory and the Digital Dark Age*, London: BFI.

ColorByCarl [Carl Hamnede] (2022), 'Stockholm 1909', YouTube, 23 March, https://www.youtube.com/watch?v=PKCZLxl7Wis&t=8s. Accessed 1 September 2024.

ColorByCarl [Carl Hamnede] (2023), '*Badlif vid Mölle*', YouTube, 16 September, https://www.youtube.com/watch?v=EUqCUPY0Rbg. Accessed 1 September 2024.

Dagar, Deepak and Kumar Vishwakarma, Dinesh (2022), 'A literature review and perspectives in deepfakes: Generation, detection, and applications', *International Journal of Multimedia Information Retrieval*, 11:3, pp. 219–89.

Drotner, Kirsten (1999), 'Dangerous media? Panic discourses and dilemmas of modernity', *Paedagogica Historica*, 35:3, pp. 593–619.

Ekelund, Robin (2022), 'Fascination, nostalgia, and knowledge desire in digital memory culture: Emotions and mood work in retrospective Facebook groups', *Memory Studies*, 15:5, pp. 1248–62.

Eriksson, Maria, Skotare, Tomas and Snickars, Pelle (2022), 'Understanding Gardar Sahlberg with neural nets: On algorithmic reuse of the Swedish SF archive', *Journal of Scandinavian Cinema*, 12:3, pp. 225–47.

Fickers, Andreas, Snickars, Pelle and Williams, Mark (2018), 'Editorial', *VIEW Journal of European Television History and Culture*, Special Issue: 'Audiovisual Data in Digital Humanities', 7:14, pp. 1–4.

filmarkivet.se (n.d.), *Hundra år i rörliga bilder*, Stockholm: Svenska Filminstitutet and the National Library of Sweden.

Fossati, Giovanna (2009), *From Grain to Pixel: The Archival Life of Film in Transition*, Amsterdam: Amsterdam University Press.

Gopnik, Adam (2019), 'A few thoughts on the authenticity of Peter Jackson's *They Shall Not Grow Old*', *The New Yorker*, 14 January, https://www.newyorker.com/news/dailycomment/a-few-thoughts-on-the-authenticity-of-peter-jacksons-they-shall-not-grow-old. Accessed 25 August 2024.

Hanley, Oliver and Ruedel, Ulrich (2022), 'Never the twain shall meet? Technology and access and the question of "authentic" appearance', *Journal of Film Preservation*, 107:10, pp. 53–59.

Ingravalle, Grazia (2024), *Archival Film Curatorship: Early and Silent Cinema from Analog to Digital*, Amsterdam: Amsterdam University Press.

Kosnik, Abigail de (2016), *Rogue Archives: Digital Cultural Memory and Media Fandom*, Cambridge, MA: MIT Press.

Michos, Konstantinos (2023), 'AI in scientific imaging: Drawing on astronomy and nanotechnology to illustrate emerging concerns about generative knowledge', *IMAGE Zeitschrift für interdisziplinäre Bildwissenschaft*, 19:1, pp. 165–78.

Napper, Lawrence (2018a), '*They Shall Not Grow Old* (2): The abject archive... The sacred archive', At the Pictures, 12 October, https://atthepictures.photo.blog/2018/10/12/they-shall-not-grow-old-2-the-abject-archive-the-sacred-archive/. Accessed 29 August 2024.

Napper, Lawrence (2018b), '*They Shall Not Grow Old* (Peter Jackson, 2018) and the elephant in the room', International Association for Media and History Blog, 23 October, http://iamhist.net/2018/10/they_shall_not_grow_old/. Accessed 29 August 2024.
Offert, Fabian (2021), 'Latent deep space: Generative adversarial networks (GANs) in the sciences', *Media+Environment*, 3:2, pp. 1–20.
Olsson, Jan (2022), *The Life and Afterlife of Swedish Biograph: From Commercial Circulation to Archival Practices*, Madison, WI: University of Wisconsin Press.
Prelinger, Rick (2021), 'NFTs and AI are unsettling the very concept of history', *Wired*, 20 April, https://www.wired.com/story/nfts-and-ai-are-unsettling-the-very-concept-of-history/. Accessed 30 August 2024.
Ratcliffe, Rebecca (2021), 'Cambodia condemns *Vice* for edited photos of Khmer Rogue victims smiling', *The Guardian*, 21 April, https://www.theguardian.com/world/2021/apr/12/cambodia-vice-edited-photos-khmer-rouge-victims-smiling-tuol-sleng-prison-genocide. Accessed 19 November 2024.
Sanders, Willemien, Ordelman, Roeland, Wigham, Mari, Klein, Rana, Van Gorp, Jasmijn and Noordegraaf, Julia (2022), 'Developing data stories as enhanced publications in digital humanities', *DH Benelux 2022*, 8, pp. 1–14.
Schick, Nina (2020), *Deepfakes: The Coming Infocalypse*, New York: Hachette.
Shiryaev, Denis (2020a), '[4k, 60 fps] *A Trip through New York City in 1911*', YouTube, 23 February, https://www.youtube.com/watch?v=hZ1OgQL9_Cw&t=205s. Accessed 29 August 2024.
Shiryaev, Denis (2020b), '[OC] I have made 60 fps 4k version of 1896 movie *Arrival of a Train at La Ciotat* with several neural networks', Reddit, https://www.reddit.com/r/videos/comments/eyoxfb/oc_i_have_made_60_fps_4k_version_of_1896_movie/?rdt=65052. Accessed 18 November 2024.
Shiryaev, Denis (2021), '🕶 hello all', YouTube, 1 July, https://youtube.com/post/Ugx12JVrya1kEsgBxLN4AaABCQ. Accessed 29 August 2024.
Snickars, Pelle (2001), *Svensk film och visuell masskultur 1900*, Stockholm: Aura.
Somaini, Antonio (2022), 'On the altered states of machine vision: Trevor Paglen, Hito Steyerl, Grégory Chatonsky', *ICON: Studies in Environmental Images*, 1:I, pp. 91–112.
Stjernholm, Emil (2022), 'Audiovisual media, automatic speech recognition and corpus analysis: A methodological reflection', *Lychnos*, 86:1, pp. 195–208.
Taffel, Sy (2021), 'Google's lens: Computational photography and platform capitalism', *Media, Culture & Society*, 43:2, pp. 237–55.
Trenor, Katie (2023), e-mail to E. Stjernholm, 14 June.
Wasielewski, Amanda (2023), *Computational Formalism: Art History and Machine Learning*, Cambridge, MA: MIT Press.

FILM REFERENCES

Anon. (1911a), *Badlif vid Mölle*, Sweden.
Anon. (1911b), *Berlin*, Sweden.
Anon. (1911c), *Niagara*, Sweden.
Anon. (1913), *New York*, Sweden.
Jackson, Peter (2018), *They Shall Not Grow Old*, UK/New Zealand.
Lumière, Auguste and Lumière, Louis (1896), *L'Arrivée d'un train en gare de La Ciotat*, France.
Malmberg, Eric (1912a), *Två svenska emigranters äfventyr i Amerika*, Sweden.
Malmberg, Eric (1912b), *Kolingens galoscher: Den stora världsomseglingen eller Hvad skall Engström säga?*, Sweden.

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