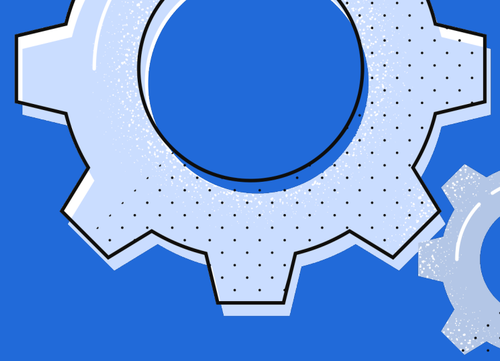
Using Deep Learning to Restore Cellulose Acetate Film

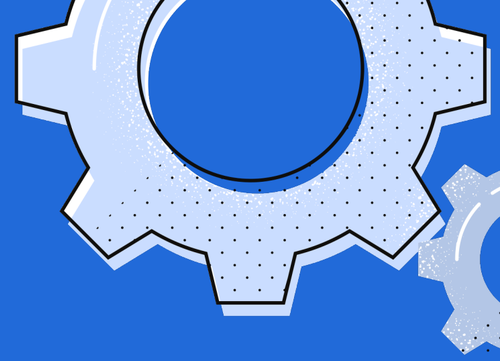
By Nolan Shaffer

What is Deep Learning?



- A paradigm within machine learning that uses neural networks with many layers to model complex patterns in data.
- Made possible with large amounts of data and computational resources
- Large body of research
- Unlocks a breakthrough in AI capabilities

What is Deep Learning?



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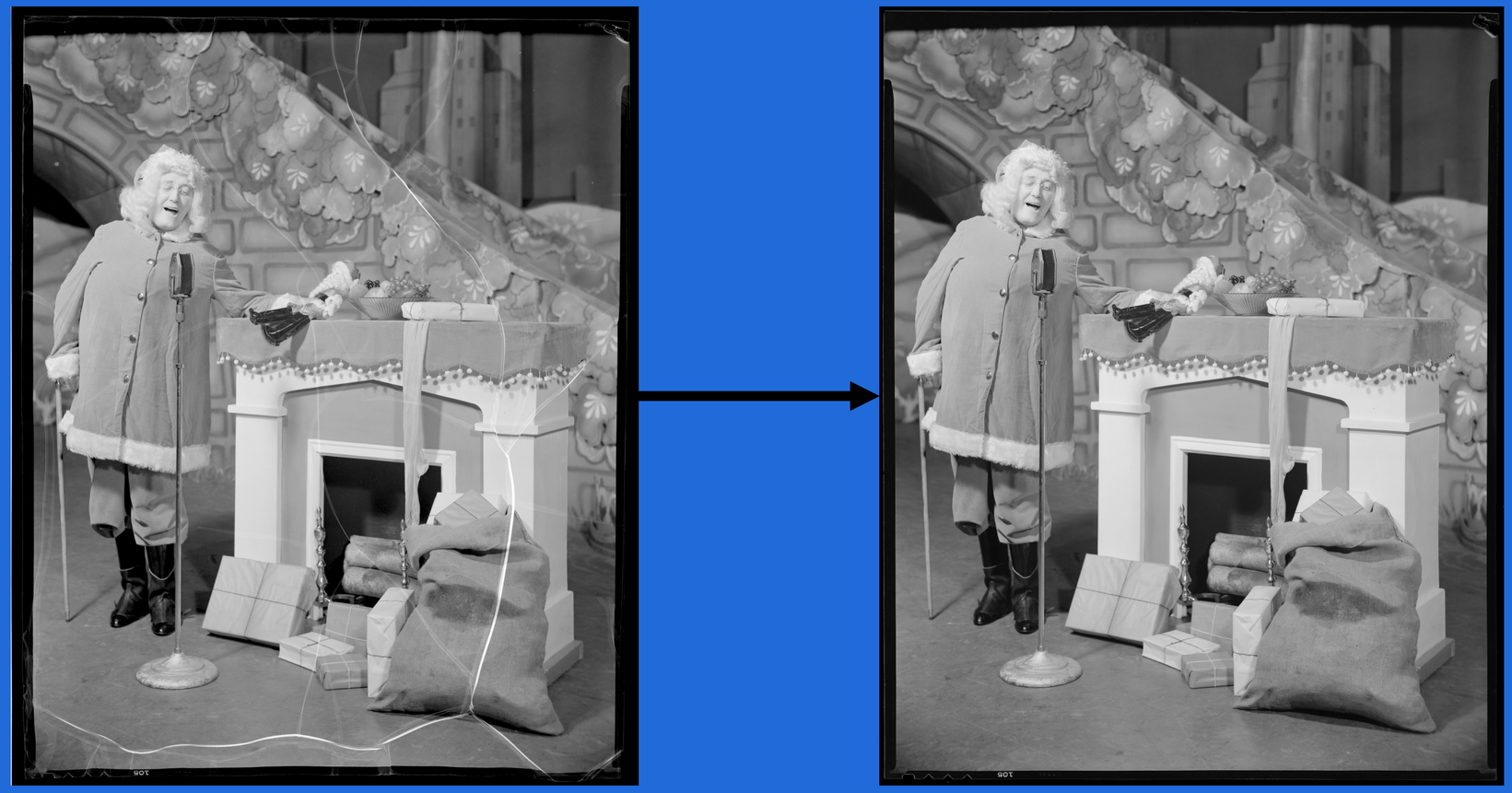
Why it’s a Good Fit

1. There is a large amount of “labeled” data



Why it’s a Good Fit

2. Similar data distribution in photos **and** damage

Why it’s a Good Fit

3. Lots of research - 317 papers published in the last 12 months alone

1. arXiv:2407.19139 [pdf, other] cs.CV

Multi-Expert Adaptive Selection: Task-Balancing for All-in-One Image Restoration

Authors: Xiaoyan Yu, Shen Zhou, Huafeng Li, Liehuang Zhu

Abstract: The use of a single image restoration framework to achieve multi-task image restoration has garnered significant attention from researchers. However, several practical challenges remain, including meeting the specific and simultaneous demands of different tasks, balancing relationships between tasks, and effectively utilizing task correlations in model design. To address these challenges, this pap... ▽ More

Submitted 26 July, 2024; **originally announced** July 2024.

2. arXiv:2407.18915 [pdf, other] eess.SP cs.LG

Learning-Based WiFi Fingerprint Inpainting via Generative Adversarial Networks

Authors: Yu Chan, Pin-Yu Lin, Yu-Yun Tseng, Jen-Jee Chen, Yu-Chee Tseng

Abstract: WiFi-based indoor positioning has been extensively studied. A fundamental issue in such solutions is the collection of WiFi fingerprints. However, due to real-world constraints, collecting complete fingerprints at all intended locations is sometimes prohibited. This work considers the WiFi fingerprint inpainting problem. This problem differs from typical image/video inpainting problems in several... ▽ More

Submitted 3 June, 2024; **originally announced** July 2024.

Comments: ICCCN2024

3. arXiv:2407.18613 [pdf] cs.CV eess.IV

Dilated Strip Attention Network for Image Restoration

Authors: Fangwei Hao, Jiesheng Wu, Ji Du, Yinjie Wang, Jing Xu

Abstract: Image restoration is a long-standing task that seeks to recover the latent sharp image from its deteriorated counterpart. Due to the robust capacity of self-attention to capture long-range dependencies, transformer-based methods or some attention-based convolutional neural networks have demonstrated promising results on many image restoration tasks in recent years. However, existing attention modu... ▽ More

Submitted 26 July, 2024; **originally announced** July 2024.

4. arXiv:2407.18035 [pdf, other] cs.CV cs.AI cs.CL

RestoreAgent: Autonomous Image Restoration Agent via Multimodal Large Language Models

Authors: Haoyu Chen, Wenbo Li, Jinjin Gu, Jingjing Ren, Sixiang Chen, Tian Ye, Renjing Pei, Kaiwen Zhou, Fenglong Song, Lei Zhu

Abstract: Natural images captured by mobile devices often suffer from multiple types of degradation, such as noise, blur, and low light. Traditional image restoration methods require manual selection of specific tasks, algorithms, and execution sequences, which is time-consuming and may yield suboptimal results. All-in-one models, though capable of handling multiple tasks, typically support only a limited r... ▽ More

Submitted 25 July, 2024; **originally announced** July 2024.

Why it’s a Good Fit

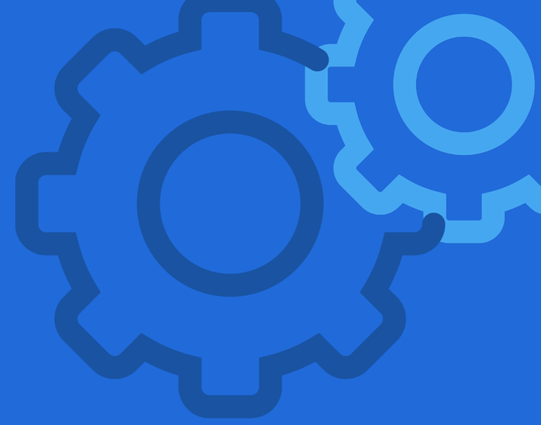
4. Low cost – all that’s needed is compute time

Steps

1. Literature review
2. Prepare data
3. Train model
4. Evaluate Results

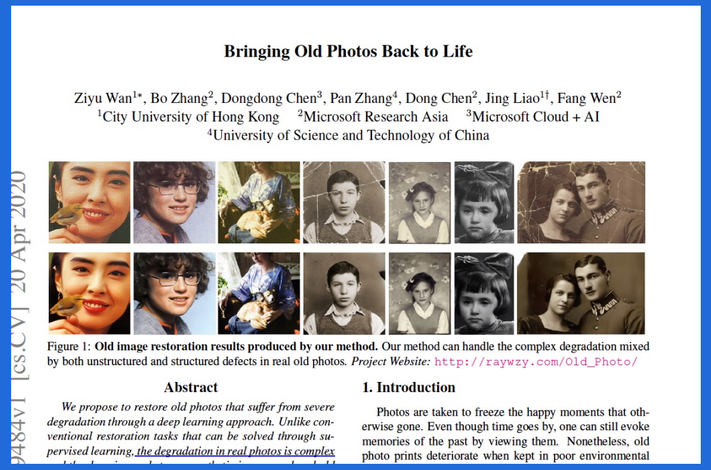
1 Literature Review

Literature Review



- 10+ papers published over the last five years consulted
- Narrowed down to three papers of interest
- Determined that a convolutional neural network would be the best fit due to simplicity and prevalence of features
- Solidified an understanding of the data requirements

Literature Review



Bringing Old Photos Back to Life

Ziyu Wan[1*], Bo Zhang[2], Dongdong Chen[3], Pan Zhang[4], Dong Chen[2], Jing Liao[1†], Fang Wen[2]
[1]City University of Hong Kong [2]Microsoft Research Asia [3]Microsoft Cloud + AI
[4]University of Science and Technology of China

Figure 1: **Old image restoration results produced by our method.** Our method can handle the complex degradation mixed by both unstructured and structured defects in real old photos. *Project Website:* http://raywzy.com/Old_Photo/

Abstract

We propose to restore old photos that suffer from severe degradation through a deep learning approach. Unlike conventional restoration tasks that can be solved through supervised learning, the degradation in real photos is complex

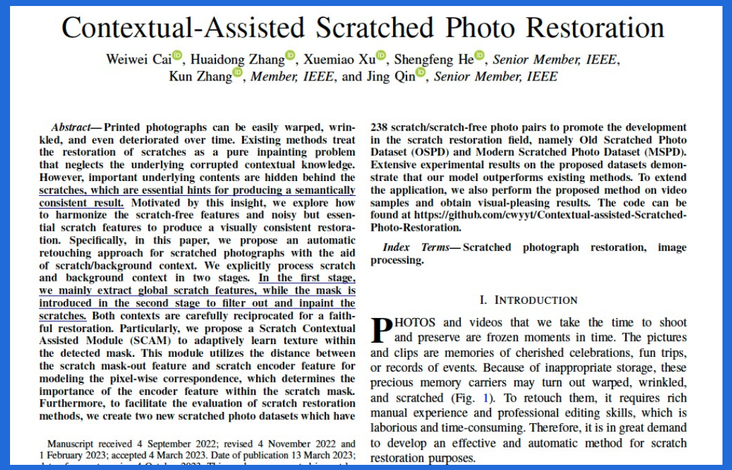
1. Introduction

Photos are taken to freeze the happy moments that otherwise gone. Even though time goes by, one can still evoke memories of the past by viewing them. Nonetheless, old photo prints deteriorate when kept in poor environmental

Wan et al. 2020: First successful deep learning photo restoration.

Novel methods but suboptimal due to domain gap problem not being an issue in our case. Complex methods.

Will use scratch detection architecture.



Contextual-Assisted Scratched Photo Restoration

Weiwei Cai, Huaidong Zhang, Xuemiao Xu, Shengfeng He, *Senior Member, IEEE*, Kun Zhang, *Member, IEEE*, and Jing Qin, *Senior Member, IEEE*

***Abstract*— Printed photographs can be easily warped, wrinkled, and even deteriorated over time. Existing methods treat the restoration of scratches as a pure inpainting problem that neglects the underlying corrupted contextual knowledge. However, important underlying contents are hidden behind the scratches, which are essential hints for producing a semantically consistent result. Motivated by this insight, we explore how to harmonize the scratch-free features and noisy but essential scratch features to produce a visually consistent restoration. Specifically, in this paper, we propose an automatic retouching approach for scratched photographs with the aid of scratch/background context. We explicitly process scratch and background context in two stages. In the first stage, we mainly extract global scratch features, while the mask is introduced in the second stage to filter out and inpaint the scratches. Both contexts are carefully reciprocated for a faithful restoration. Particularly, we propose a Scratch Contextual Assisted Module (SCAM) to adaptively learn texture within the detected mask. This module utilizes the distance between the scratch mask-out feature and scratch encoder feature for modeling the pixel-wise correspondence, which determines the importance of the encoder feature within the scratch mask. Furthermore, to facilitate the evaluation of scratch restoration methods, we create two new scratched photo datasets which have 238 scratch/scratch-free photo pairs to promote the development in the scratch restoration field, namely Old Scratched Photo Dataset (OSPD) and Modern Scratched Photo Dataset (MSPD). Extensive experimental results on the proposed datasets demonstrate that our model outperforms existing methods. To extend the application, we also perform the proposed method on video samples and obtain visual-pleasing results. The code can be found at https://github.com/ewyyl/Contextual-assisted-Scratched-Photo-Restoration.**

***Index Terms*— Scratched photograph restoration, image processing.**

I. Introduction

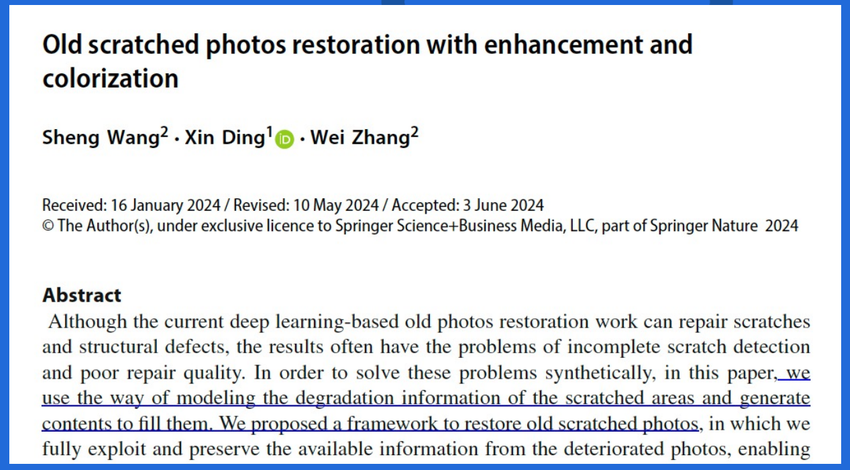
PHOTOS and videos that we take the time to shoot and preserve are frozen moments in time. The pictures and clips are memories of cherished celebrations, fun trips, or records of events. Because of inappropriate storage, these precious memory carriers may turn out warped, wrinkled, and scratched (Fig. 1). To retouch them, it requires rich manual experience and professional editing skills, which is laborious and time-consuming. Therefore, it is in great demand to develop an effective and automatic method for scratch restoration purposes.

Manuscript received 4 September 2022; revised 4 November 2022 and 1 February 2023; accepted 4 March 2023. Date of publication 13 March 2023;

Cai et al. 2023: Photo restoration that focuses on using context around degradation rather than pure infilling

Relatively straightforward methods, strong results, small amount of data used.

Will use restoration architecture.



Old scratched photos restoration with enhancement and colorization

Sheng Wang[2] · Xin Ding[1] · Wei Zhang[2]

Received: 16 January 2024 / Revised: 10 May 2024 / Accepted: 3 June 2024

Abstract

Although the current deep learning-based old photos restoration work can repair scratches and structural defects, the results often have the problems of incomplete scratch detection and poor repair quality. In order to solve these problems synthetically, in this paper, we use the way of modeling the degradation information of the scratched areas and generate contents to fill them. We proposed a framework to restore old scratched photos, in which we fully exploit and preserve the available information from the deteriorated photos, enabling

Wang et al. 2024: Uses diffusion to restore photos, avoiding the need for 100% accurate scratch detection.

Different kind of architecture and method that could solve a key problem.

Will use as backup restoration architecture.

2

Prepare Data

Prepare Data

Scratch Detection Stage

3.3 Defect Region Detection

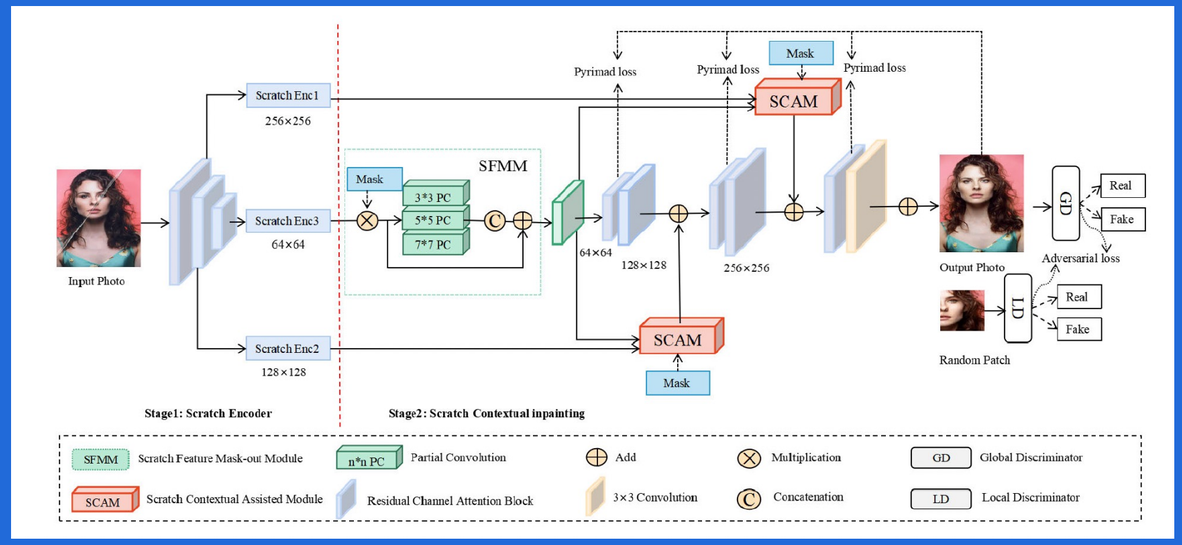
Since the global branch of our restoration network requires a mask m as the guidance, in order to get the mask automatically, we train a scratch detection network in a supervised way by using a mixture of real scratched dataset and synthetic dataset. Specifically, let $\{s_i, y_i | s_i \in \mathcal{S}, y_i \in \mathcal{Y}\}$ denote the whole training pairs, where s_i and y_i are the scratched image and the corresponding binary scratch mask respectively, we use the cross-entropy loss to minimize the difference between the predicted mask $\hat{y}_i$ and y_i,

$$\mathcal{L}_{CE} = \mathbb{E}_{(s_i,y_i)\sim(\mathcal{S},\mathcal{Y})} \Bigg\{ \alpha \sum_{h=1}^{H} \sum_{w=1}^{W} -y_i^{(h,w)} \log \hat{y}_i^{(h,w)} - (1-\alpha) \sum_{h=1}^{H} \sum_{w=1}^{W} (1 - y_i^{(h,w)}) \log(1 - \hat{y}_i^{(h,w)}) \Bigg\}. \tag{11}$$

Since the scratch regions are often a small portion of the whole image, here we use a weight α_i to remedy the imbalance of positive and negative pixel samples. To determine the detailed value of α_i, we compute the positive/negative proportion of y_i on the fly,

$$\alpha_i = \frac{[y_i = 1]}{[y_i = 1] + [y_i = 0]]}. \tag{12}$$

Image Restoration Stage



Prepare Data

Scratch Detection Model

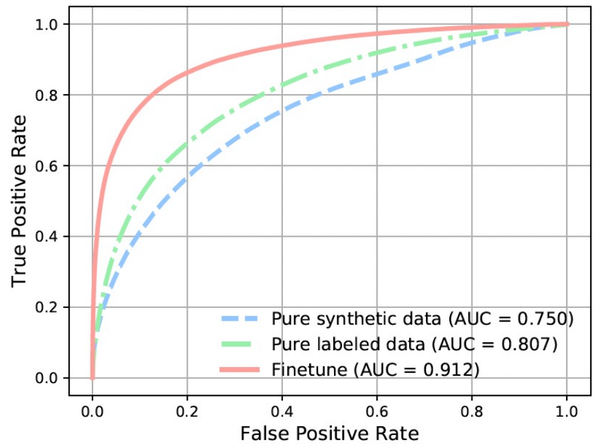
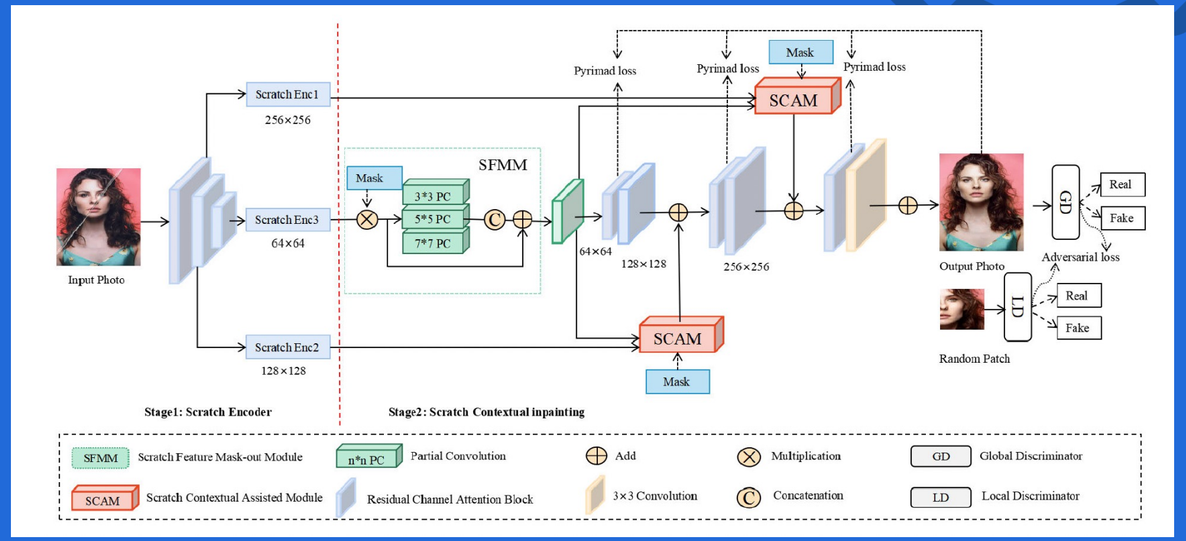


Figure 4: **ROC curve for scratch detection of different data settings.**

- Will need to create masks based off the 300 paired images we have.
- If finetuning is not sufficient, apply masks to ≈10,000 age similar images.

Prepare Data

Image Restoration Stage



- Will need to ≈3000 paired examples (basic photo adjustments)
- If not sufficient, apply masks to ≈10,000 age similar images.

Next Steps

1. Literature review
2. Prepare data
3. Train model
4. Evaluate Results

Sources

Wan, Z. *et al.* Bringing Old Photos Back to Life. in 2747–2757 (2020).

Cai, W. *et al.* Contextual-Assisted Scratched Photo Restoration. *IEEE Transactions on Circuits and Systems for Video Technology* **33**, 5458–5469 (2023).

Wang, S., Ding, X. & Zhang, W. Old scratched photos restoration with enhancement and colorization. *Multimed Tools Appl* (2024) doi:10.1007/s11042-024-19595-w.

Wan, Z. *et al.* Old Photo Restoration via Deep Latent Space Translation. Preprint at https://doi.org/10.48550/arXiv.2009.07047 (2020).