

# Enabling New Interactions with a Library's Digital Collections: Automatic Gender Recognition in Historical Postcards via Deep Learning

Research Story Essay

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The Walter Havighurst Special Collections from University Archives & Preservation at Miami University's King Library has a growing collection of over 600,000 historical postcards, with approximately 30,000 digitized, primarily from the Midwest during 1890-1919. This collection supports various lines of inquiry from users, such as analyzing the evolution of gender portrayal in popular media in the United States; however, manually separating the collection into postcards of males and females would take thousands of hours, preventing the library from supporting sociological analyses at scale. To support further advanced analysis of the collection, I proposed using modern computer vision and machine learning techniques to automatically detect people and classify them as male or female. However, modern computer vision algorithms perform best on recent, high-resolution images, raising the research question: can we effectively leverage modern computer vision techniques to automatically detect people and classify them as male or female in historical postcards to support further advanced analysis of the growing collection?

As part of CSE 4/532 Machine Learning during the Fall 2022 Semester, I lead a team of undergraduates on this project under the supervision of Dr. Phillippe Giabbanelli in the computer science department and collaborated with Amber Bales and Alia Wegner at the Walter Havighurst Special Collections. At the beginning of the semester, I had a few in-person meetings with Amber and Alia to facilitate access to the collection and metadata, discuss the potential applications of computer vision to the collection of historical postcards, and determine objectives for the project. Without the hard work of Amber, Alia, and the Walter Havighurst Special Collections staff, undertaking this project would have been impossible. They did an excellent job of digitizing nearly 30,000 postcards, clearly scanning the front and back of each postcard, meticulously collecting metadata (e.g., was the postcard postmarked? If so, when?), and naming and organizing all of the images. The structure and quality of the collection were essential to supporting this research project. Amber and Alia were interested in analyzing the evolution of gender portrayal in the United States over time through the collection of historical postcards. After our initial meetings, I realized that such a complex analysis is currently well beyond the scope of computer vision and machine learning; however, I informed them detecting people in an image and gender recognition is a problem that has been thoroughly addressed in the field of computer vision, so we could try to automatically detect people in the postcards and classify them as male or female to support further analysis of the collection.

I first applied modern off-the-shelf computer vision algorithms for gender recognition and realized they performed horribly on historical postcards; they rely primarily on high-resolution facial features to determine gender. Historical cameras, and hence postcards, could not capture the level of detail required for traditional approaches, and not everyone's face is visible in some of the historical postcards. As a result, I decided we should apply object detection algorithms to consider the entire person and their clothing before making a classification. Object detection is a computer vision task that detects and labels objects in images, including people, and has numerous applications (e.g., self-driving cars). Object detection algorithms do not detect gender by default; they only detect and label people and other items like cars. As a result, I needed to teach an object detection algorithm what a male and female are. Because object detection algorithms already know what a person is, they just need to be trained to distinguish between males and females.

A lot of high-quality, labeled data that resembles the application domain is required to train an algorithm. As a result, I could not use just any images of people to train the algorithm; I had to find historical images with people that closely resembled historical postcards. Moreover, once I had the images, I had to enclose each person in the image with a box and label them as male or female, so the algorithm could learn to identify someone in the image and whether they are male or female. My group in the machine learning class helped with gathering images and labeling males and females in the images to train the algorithm to detect and classify people as male or female.

After I trained the algorithm (see research paper for more details), I needed an objective measure of its performance. As a result, I needed a set of historical postcards with males and females in them from outside the collection. Amber, Alia, and the Walter Havighurst Special Collections team were once again crucial to the success of this project and quickly created a set of historical postcards not in the digitized collection with males and females in them to assess the model's performance. Applying the trained model to this set of postcards confirmed I had created a model that can accurately detect and classify females and confidently detect and label males for historical postcards, streamlining further analysis such as the evolution of gender portrayal over time.

This experience was also personally impactful. It provided me with an incredible opportunity to further my knowledge of machine learning, computer vision, and coding and strengthen my research and writing abilities by preparing and submitting a manuscript for publication at a journal while helping Amber, Alia, and the Walter Havighurst Special Collections. Moreover, it further solidified my passion for research and desire to pursue a Ph.D. in computer science and conduct machine learning research post-graduation. I would not have been able to complete this project without the help of Amber, Alia, the Walter Havighurst Special Collections, Dr. Giabbanelli, and my group. I am grateful for all the support and help on this project.