When Was That Made?

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In this work, we explore deep learning methods for estimating when objects were made. Toward this goal, we both utilize features from existing deep networks and fine-tune new networks for temporal estimation and provide several analyses of what our networks have learned compare to the visual pattern discovery method.

Contributions

- Deep learning approaches to temporal estimation
- Two datasets of dated photographs of clothing items.
- Analyses of what the fine-tuned networks for objects temporal estimation have learned, and comparison to the midlevel patterns learned by Lee et al.

Dataset

- Flickr clothing dataset: 58350 images
- Museum clothing dataset: 9421 images

The distribution over time of Flickr clothing and Museum dataset
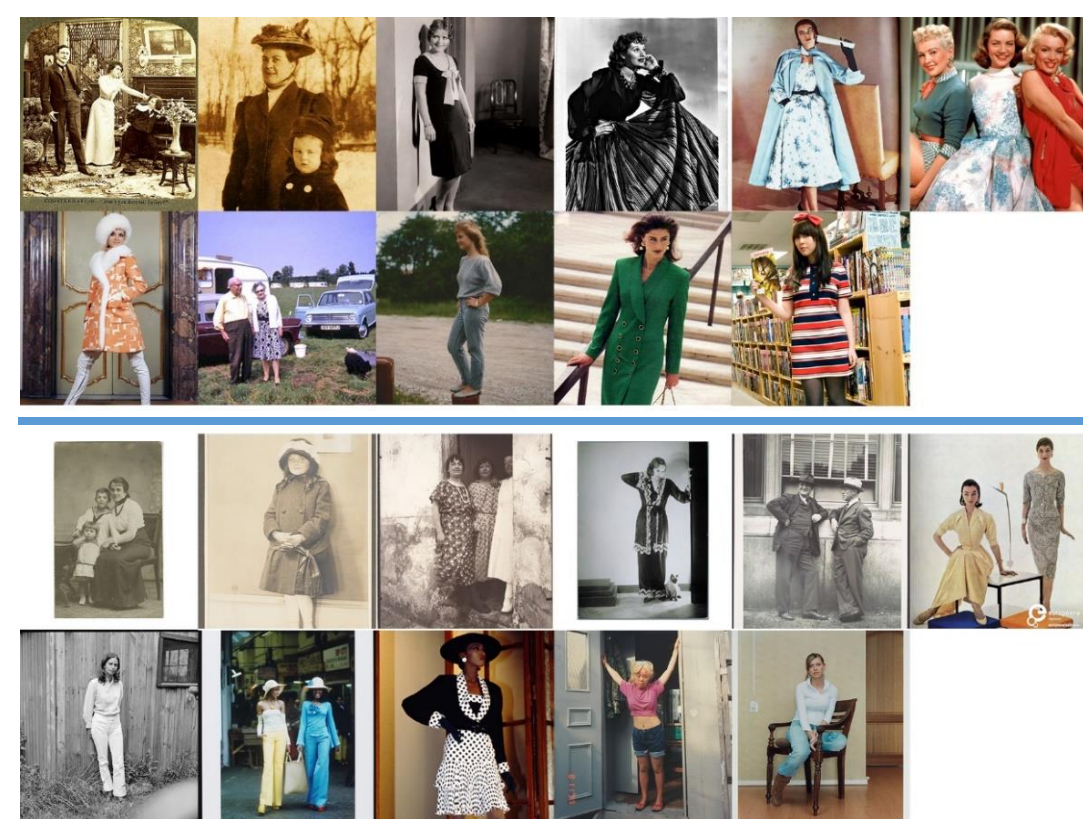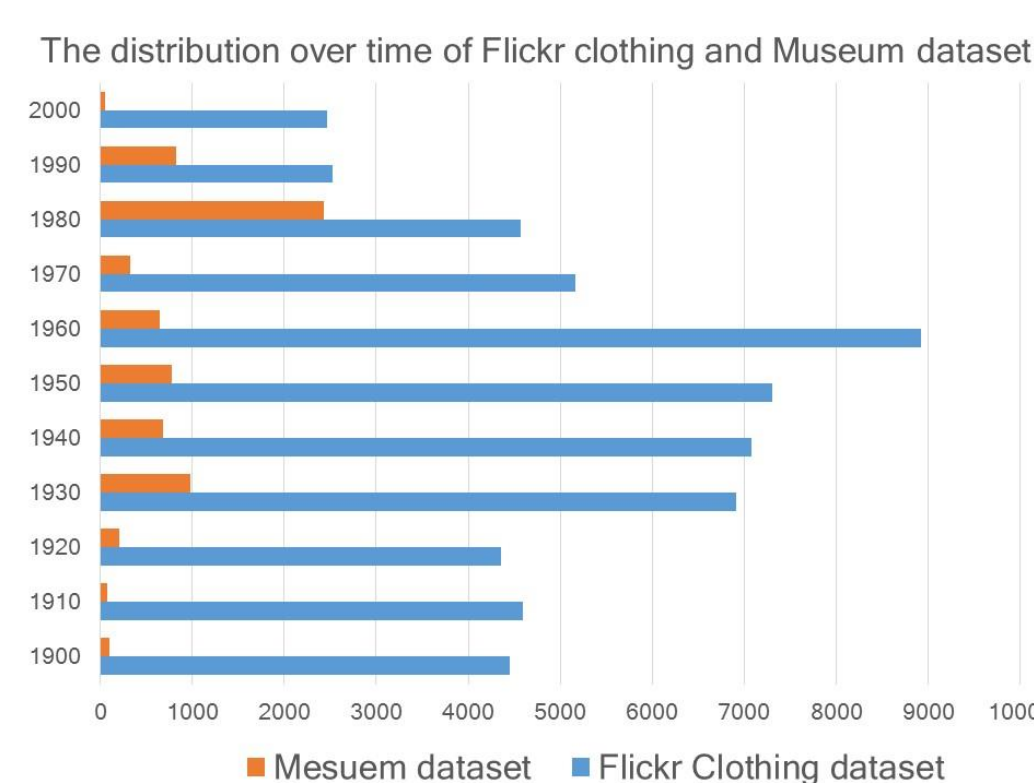
Temporal estimation approaches

- Pre-trained network: Alexnet
- Fine-tuned network
    - fine-tuning and testing on CarDb

Methods	ACC (%)	MAE (years)	Methods	ACC (%)	MAE (years)
Lee et al.	48.96	8.56	Fc7 + SVM	50.11	7.77
Fc6 + SVM	53.78	7.24	Fc7 + SVR	50.16	8.10
Fc6 + SVR	51.57	7.80	Fine-tuned	65.04	4.91

Lee et al.	1930	1950	1940	1930
Alexnet	1920	1920	1940	1950
Fine-tuned	1920	1920	1940	1950

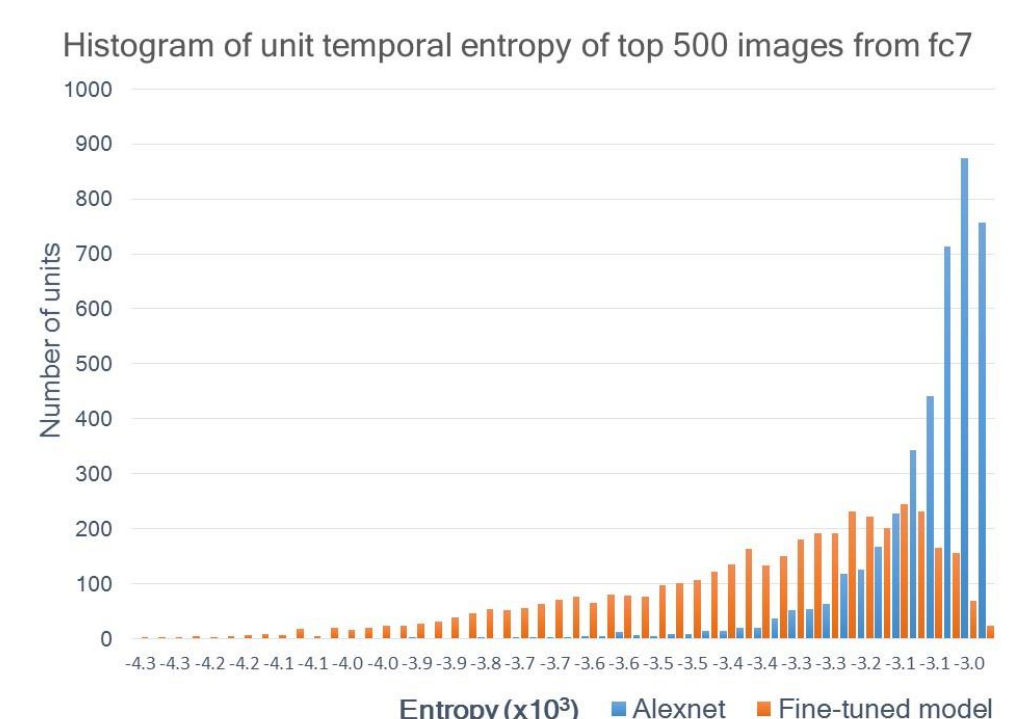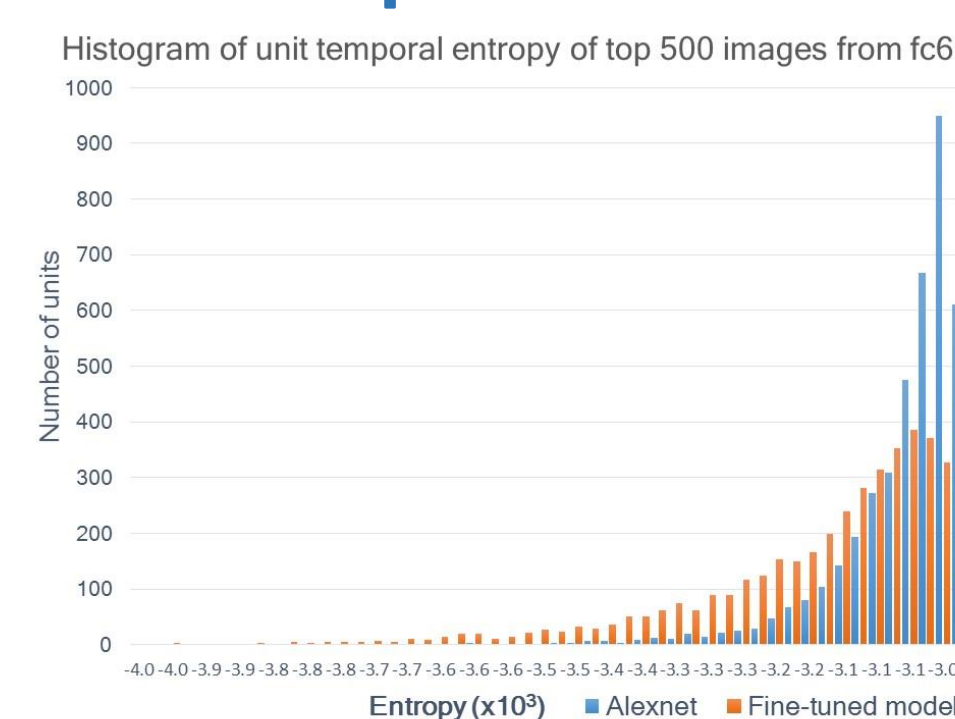| Lee et al. | 1920 | 1970 | 1960 | 1960 |
| Alexnet | 1950 | 1970 | 1960 | 1990 |
| Fine-tuned | 1960 | 1970 | 1980 | 1990 |

- fine-tuning on Flickr clothing dataset and testing on both Museum dataset and held out Flickr clothing dataset.
- fine-tuning 2 different models: color images and black/white images.

Methods	Museum dataset		Flickr clothing dataset	
	ACC (%)	MAE (years)	ACC (%)	MAE (years)
F.Palermo et al.	26.82	20.66	27.85	17.21
Fc6 + SVM	32.06	17.15	36.99	12.84
Fc6 + SVR	32.57	15.47	31.79	15.46
Fc7 + SVM	31.30	17.60	37.01	12.97
Fc7 + SVR	32.39	15.67	31.41	15.28
Fine-tuned(B/W)	43.11	13.89	37.23	13.12
Fine-tuned	45.89	11.01	42.57	11.10

1900/1900 1910/2000 1920/1920 1930/1930 1940/1940 1950/1950
1960/1960 1970/1970 1980/1980 1990/1990 2000/2000
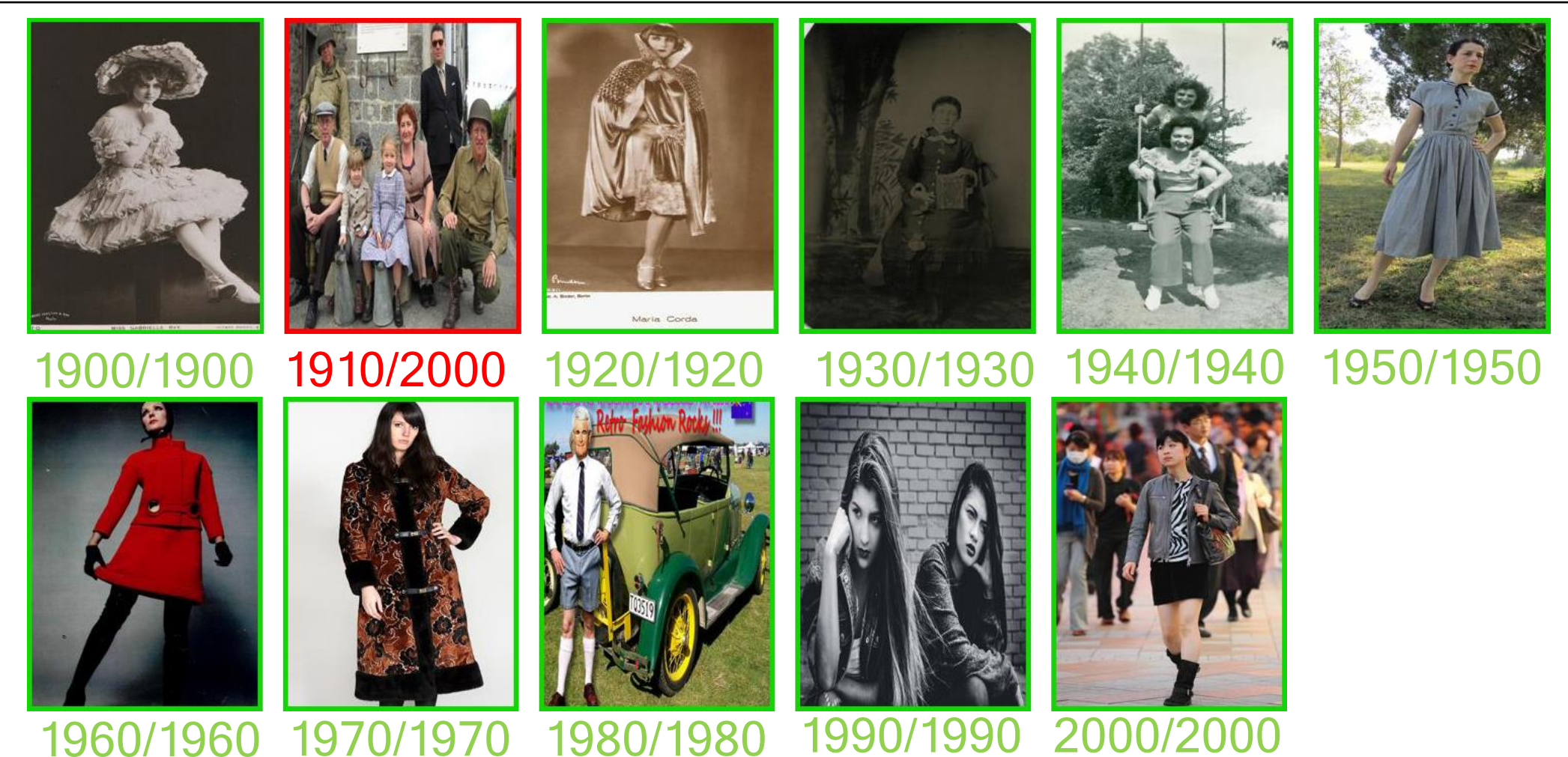
Deep network analyses

• Temporal – sensitive units

Histogram of unit temporal entropy of top 500 images from fc6

Histogram of unit temporal entropy of top 500 images from fc7

• Unit activation analysis

(a) 1920   (b) 1930   (c) 1940   (d) 1950

(e) 1960   (f) 1970   (g) 1980   (h) 1990

(a) 1900   (b) 1910   (c) 1920   (d) 1930

(a) 1940   (b) 1950   (c) 1960   (d) 1970
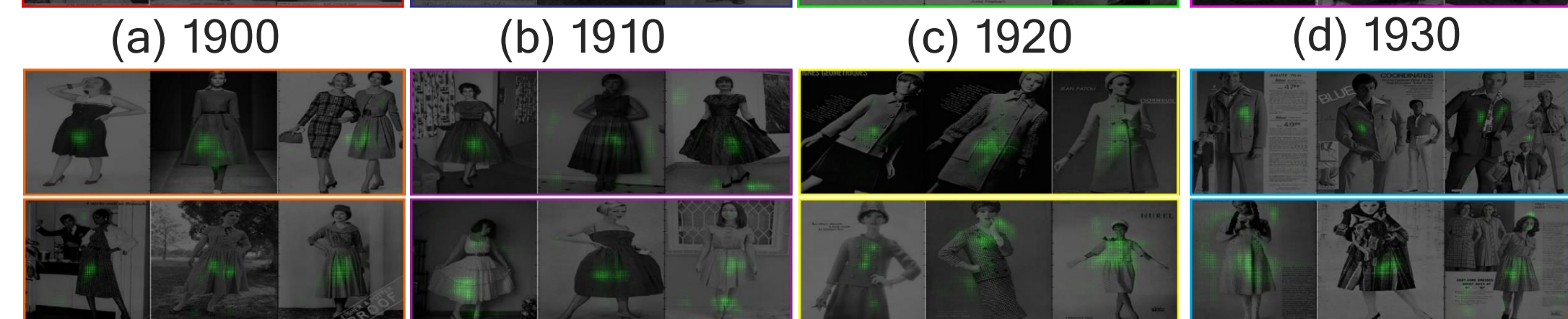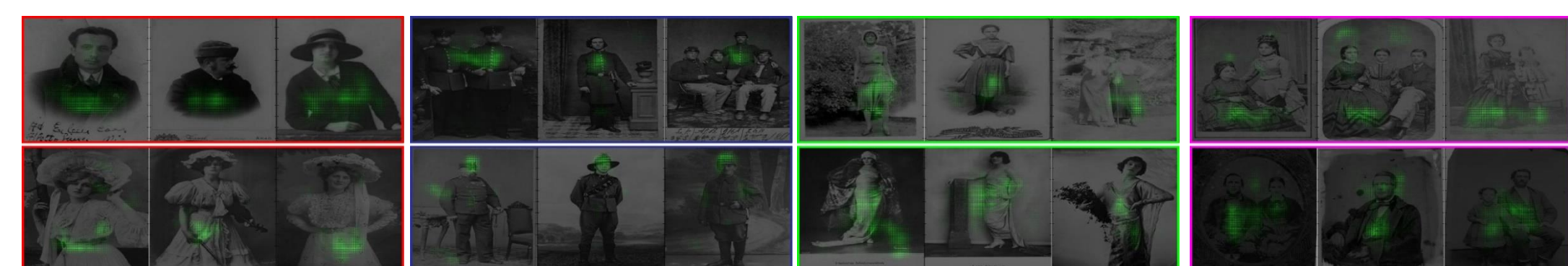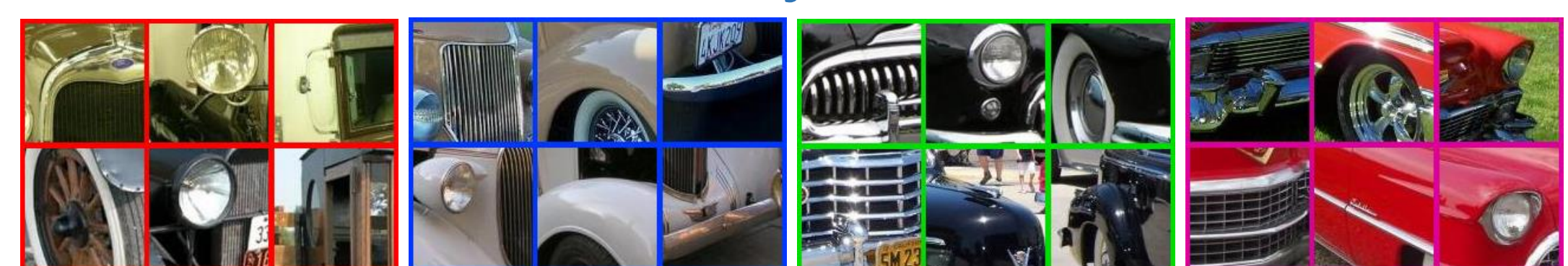
• Discriminative part correlation

High correlation   Low correlation