ELL 788
Computational Perception & Cognition

July – November 2015

Module 12

Memorability of images

What makes a photo memorable?

- Personal context
  - Photo of a friend
  - Photo of the house where you live
  - Photo of an event witnessed, etc.
- Are there some intrinsic parameters, that makes a photo 'memorable' even without a personal context?
- Can the memorability be predicted (computationally) from the image features?

Why study of memorability is important ?

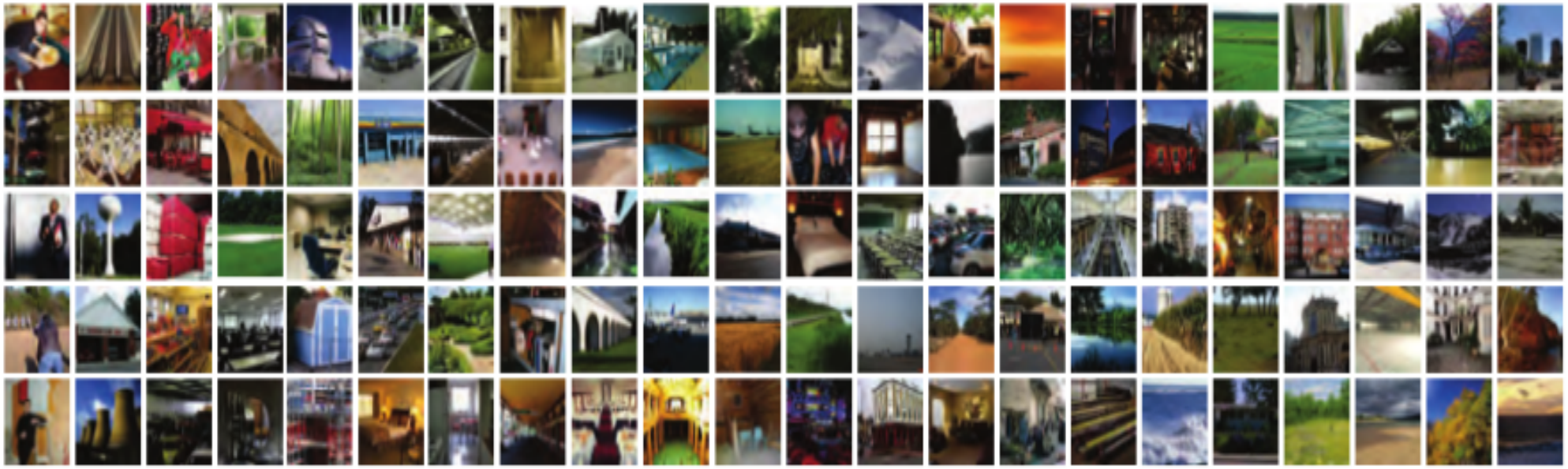
- Memoribility $\rightarrow$ utility of a photo in everyday usage
- Can help in creating memorable
  - Educational diagrams
  - Logos and advertisements
  - Desktop icons
  - Book / CD covers
  - Labels for medicine jars

Definition of memoribility

- Probability that an observer will detect repetition of a photo when presented amidst a stream of photos
  - With different delays
- Can vary across observers, depending on motivation, attention, etc.
  - Use relative (rank) scores

Psychological experiment: Visual Memory game

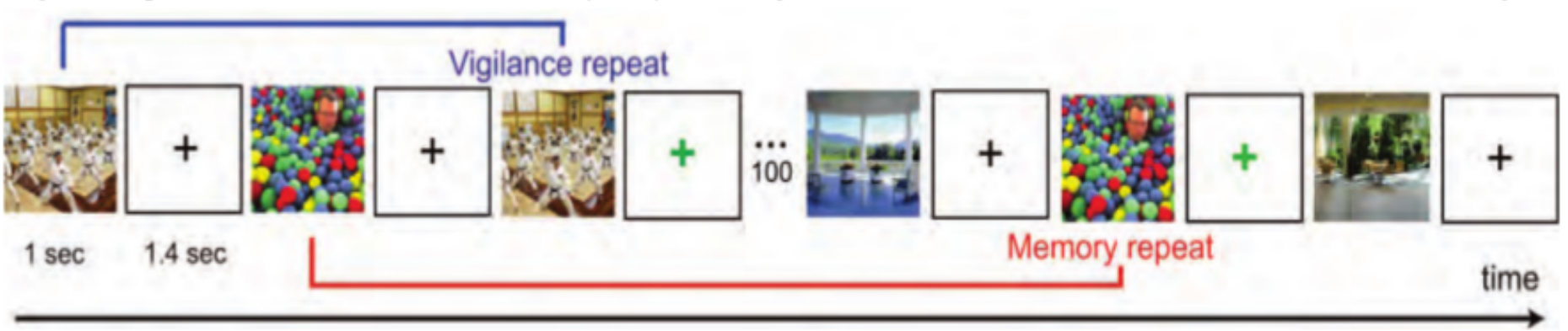
- ~10,000 images from public dataset (SUN)
  - ~2000 'target' images + ~8000 'fillers'
  - All images scaled / cropped to 256 x 256 size



Sample entries from image database

... contd

- Crowd-sourced on Amazon Mechanical Turk
  - Random crowd – no demographic control
- One 'level' – 120 images – 4.8 minutes
  - Each image shown for 1 sec, gap of 1.4 sec before next image
  - Max 30 levels for each subject
- Target images repeated at intervals
  - Vigilant repeats (filler images) to confirm attention
- People asked to spot 'repeat' images
  - Correct hits, false hits and misses are counted
- Game abandoned if user makes many errors



The visual memory game

Source: Isola

Some general observations

- Average memorability of all target images ~ 67%
- Low false alarm rate ~ 10%
- False alarms do not correlate with hit rates

- False memory does not significantly affect the memorability score

Specific observations

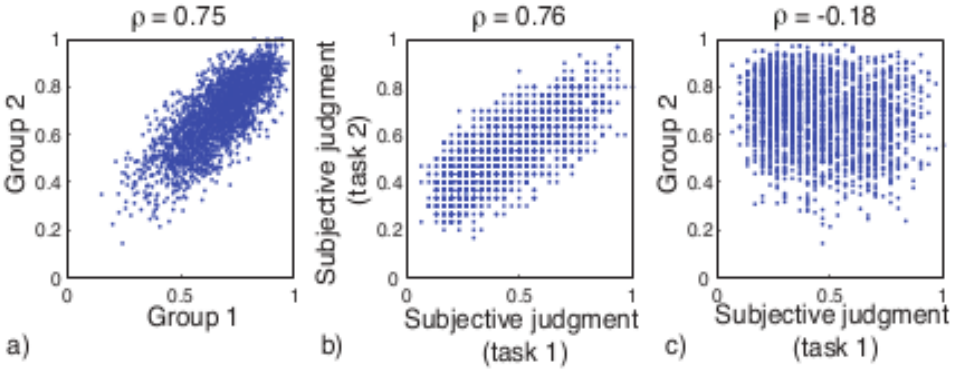
- **Is memorability consistent across observers?**
  - Do all people tend to remember / forget the same photos
  - Averages for two independent groups were found to be quite consistent
  - *Should be possible to computationally predict memorability*
- **Is memorability consistent over time?**
  - Memorability consistently decreases over time
  - More memorable photos (than others) in shorter term were found to be more memorable in longer term
- **Does memorability depend on context ?**
  - Intercahnging sequence did not affect memorability scores
  - Inconclusive? Nature of collection mattered?

Subjective judgments do not predict memorability

- Participants were asked to 'judge' memorability:
  - Two trials with differently worded expectation
- Judgment compared with memory game result

a) Predicted by participants as being most memorable images

b) Predicted by participants as being least memorable images



- Memorability scores were consistent
- Judgments scores were consistent
- Judgment scores and memorability scores did not correlate

What makes a photo memorable?

- Experiments prove that there are some intrinsic image features towards memorability
  - What are them?
- Try to predict with various features
- Use regression technique
- Divide images in two equal sets – training and testing
- Divide subjects in two groups – to check consistency of features across groups

Aesthetics, interestingness ?

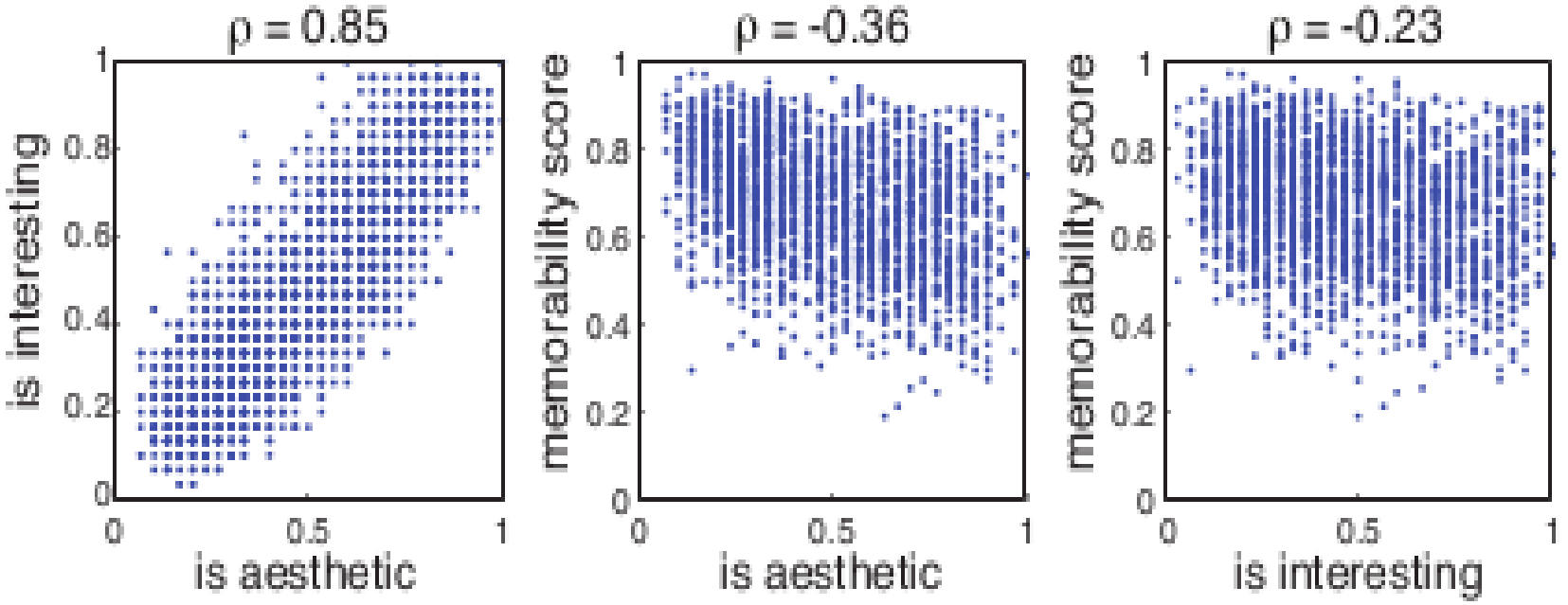
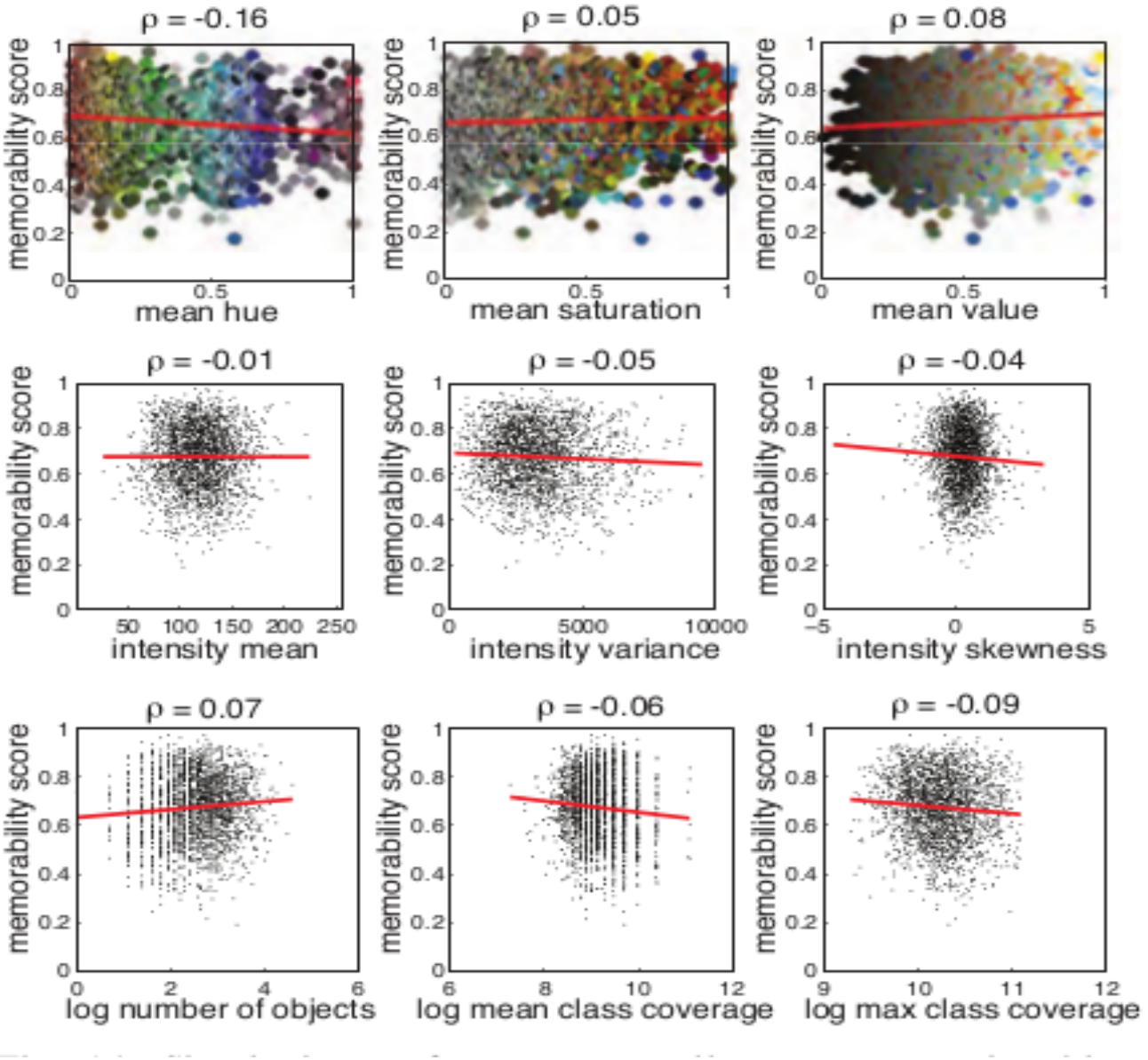


Image features ? Objects ?

Color

Intensity

Object statistics



Scene semantics

- Object labels and other semantic attributes
- 127 semantic attributes
  - Spatial layout (open, close, ...)
  - Emotions (e.g., frightening, funny, ...),
  - Actions (e.g., people walking, standing, sitting, ...)
  - Demographics (e.g., clothing, accessories, ...)
  - ...
- Labelled 'Multiscale Object Area'
  - Concatenating pixel coverage on the entire image with pixel coverage per quadrant
- Provided good correlation with memorability

Visualizing objects that contribute to memorability

Effect of a semantic object a_i on memorability

$$
\begin{aligned}
m_1 &= f(a_1, \cdots, a_i, \cdots, a_n) \\
m_2 &= f(a_1, \cdots, 0, \cdots, a_n) \\
s_i &= m_1 - m_2
\end{aligned}
$$

Object occupies a significant area on the image

m: memorability score
f: learnt regression function
a_i: labelled multi-scale object area for object i

a) Predicted as highly memorable (79%)

c) Predicted as unmemorable (52%)

Predicting memorability
(with machine extracted features)

- Several global / local features that characterize scene, color distribution, local changes, etc. Were used
- Good correlation for top memorable photos
- Different performance for photos of different types
  - Humans
  - Nature
  - General

Modifying memorability of face

Tweaks to make a face more or less memorable

- Maintaining other characteristics, e.g. Identity, emotion, etc.

MIT 2013

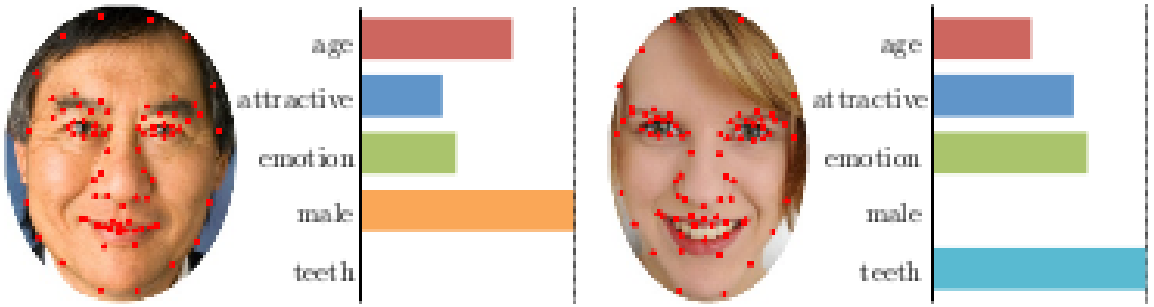
Memorability of faces

- Faces are more memorable than scenes
  - Also has a high false alarm rate
- *True* hit count measure
  - $T = \frac{H - F}{N}$
  - Adjusted to lie in range [0,1]
- Provides better results for trained SVR

N: Number of subjects
H: Hit rate
F: False hit rate

Additional annotations

- Additional annotations
  - Facial landmark locations (77)
    - Which are to be moved for generating new images through warping (with changed memorability)
  - Facial attribute (e.g., attractiveness, emotion) ratings that need to kept constant.



10k US Adult Faces

Modifying memorability

- Given an image $I\hat{}$
  - Goal is to synthesize a new image I
  - That has a specified memorability score of M, and
  - That preserves the identity and other facial attributes of $I\hat{}$
- Define high-level features (x), like is_male, $have\_makeup$, etc.
  - find memorability sore $m_i(x)$ for each.

Attribute-feature correlation

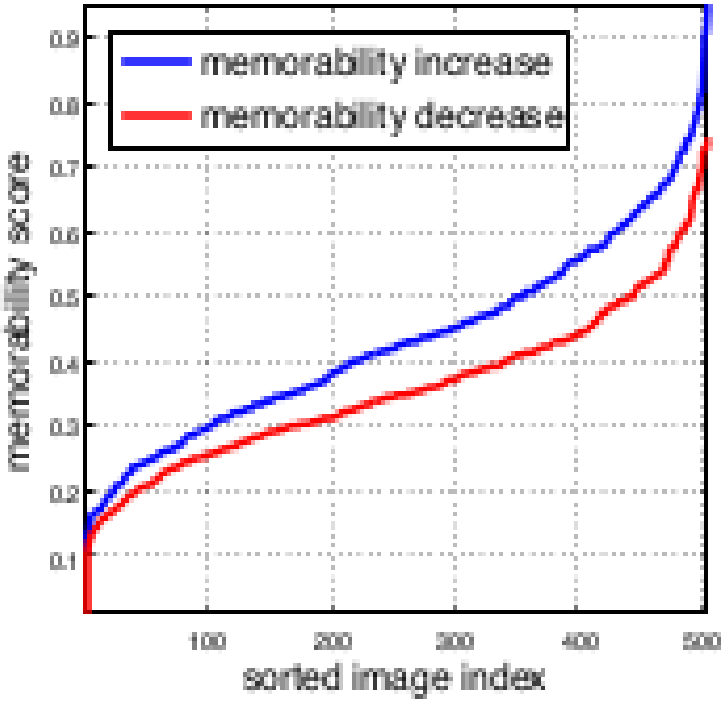
	Color [25]	LBP [20]	HOG [6]	SIFT [19]	Shape
age (0)	0.52	0.64	0.72	**0.77**	0.68
attractive (0)	0.46	0.51	0.59	**0.62**	0.54
emoteMag (0)	0.49	0.64	0.80	0.83	**0.88**
makeup (3)	0.80	0.81	**0.84**	**0.84**	0.80
is male (2)	0.86	0.89	0.93	**0.94**	0.91
teeth (3)	0.56	0.58	0.71	0.72	**0.77**
memorability	0.27	0.23	**0.51**	0.49	0.36

Global features like HOG and SIFT outperforms the other features for most of the attributes.

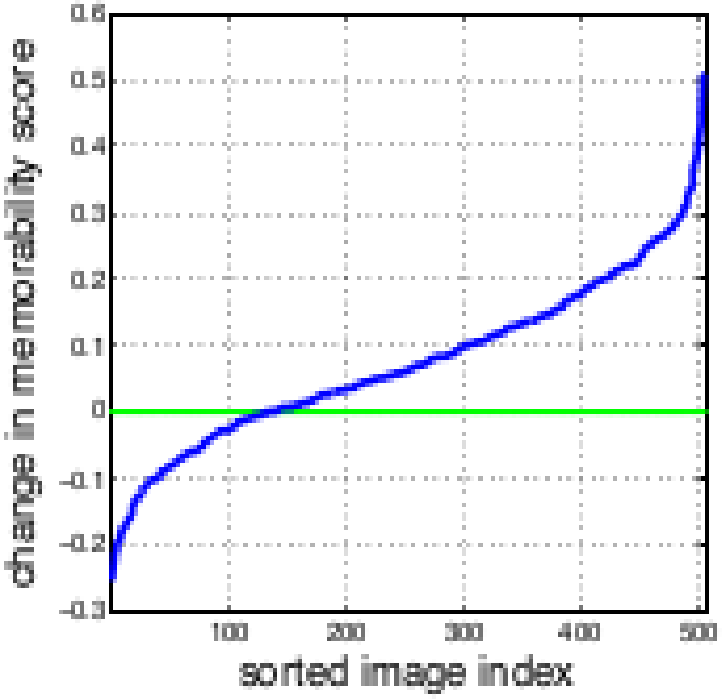
Modifying face memorability

- Face representation (x)
  - Shape (x_s) and appearence (x_a)
- Cost functions
  - C_{id}: Cost of modifying the identity of the person
  - C_{mem}: Cost of not achieving the desired memorability score,
  - C_{attr}: Cost of modifying other attributes
- Modeled as a minimization problem with OF
  - $min_x\left(C_{id}\left(x\right)+\lambda C_{mem}\left(x\right)+\gamma C_{attr}\left(x\right)\right)$
  - Optimization (hill-climbing algorithm) used

Results



(a) Overall memorability scores



(b) Individual images

- Mean memorability score ‘memorability increase’ images is significantly higher than that of the ‘memorability decrease’ images.
- We find that the expected increase in memorability occurs in about 74% of the images.

References

- Isola, et al. What makes a photograph memorable? IEEE Trans PAMI
- Khosla, et al. Modifying the Memorability of Face Photographs. ICCV 2013