Personalized Photograph Ranking and Selection System Considering Positive and Negative User Feedback

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Outline

- Introduction
- Related Work
- System Overview
- Rule of Aesthetics
- Aesthetic Learning
- Experiments and User Study
- Discussion
- Conclusion

Motivation

- How would you select photos?

By Time

Gordon's Photo

Gordon's Photo

LOTTERIA
200円
牛丼
吉野家
YOSHINOYA
Gordon's Photo

By Event

By People

By Visually Pleasing

- Discover the visual aesthetics in photos
- Can this be an automatic process?

Computational Aesthetics

- Measure aesthetic using computational approaches
- Challenge—extremely subjective task

Computational Aesthetics

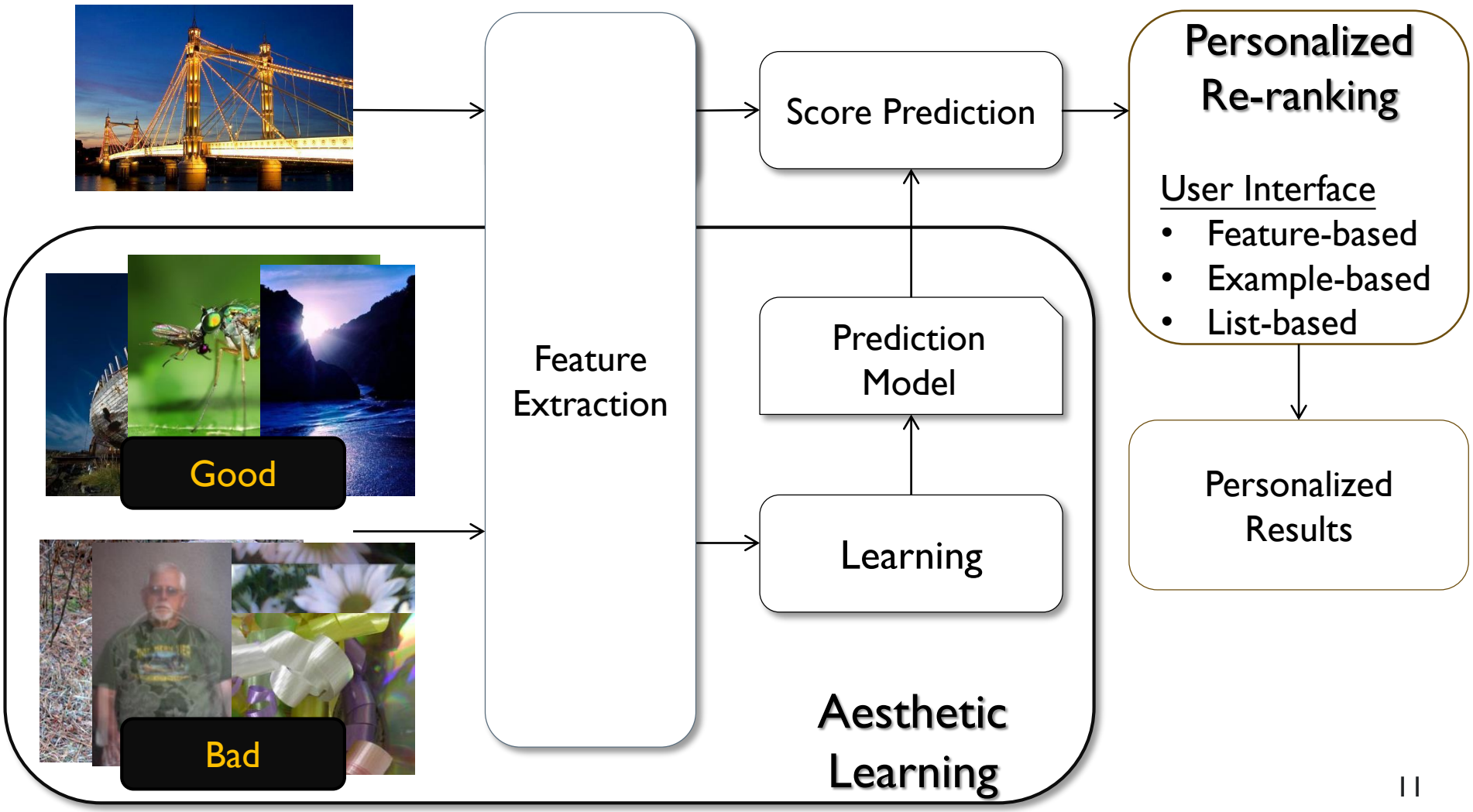
- Photograph Assessment

- Photograph Enhancement

Motivation—Photograph Assessment

- Rank photos according to aesthetic pleasing
- Re-rank the photos according to each individual's preference

System Framework



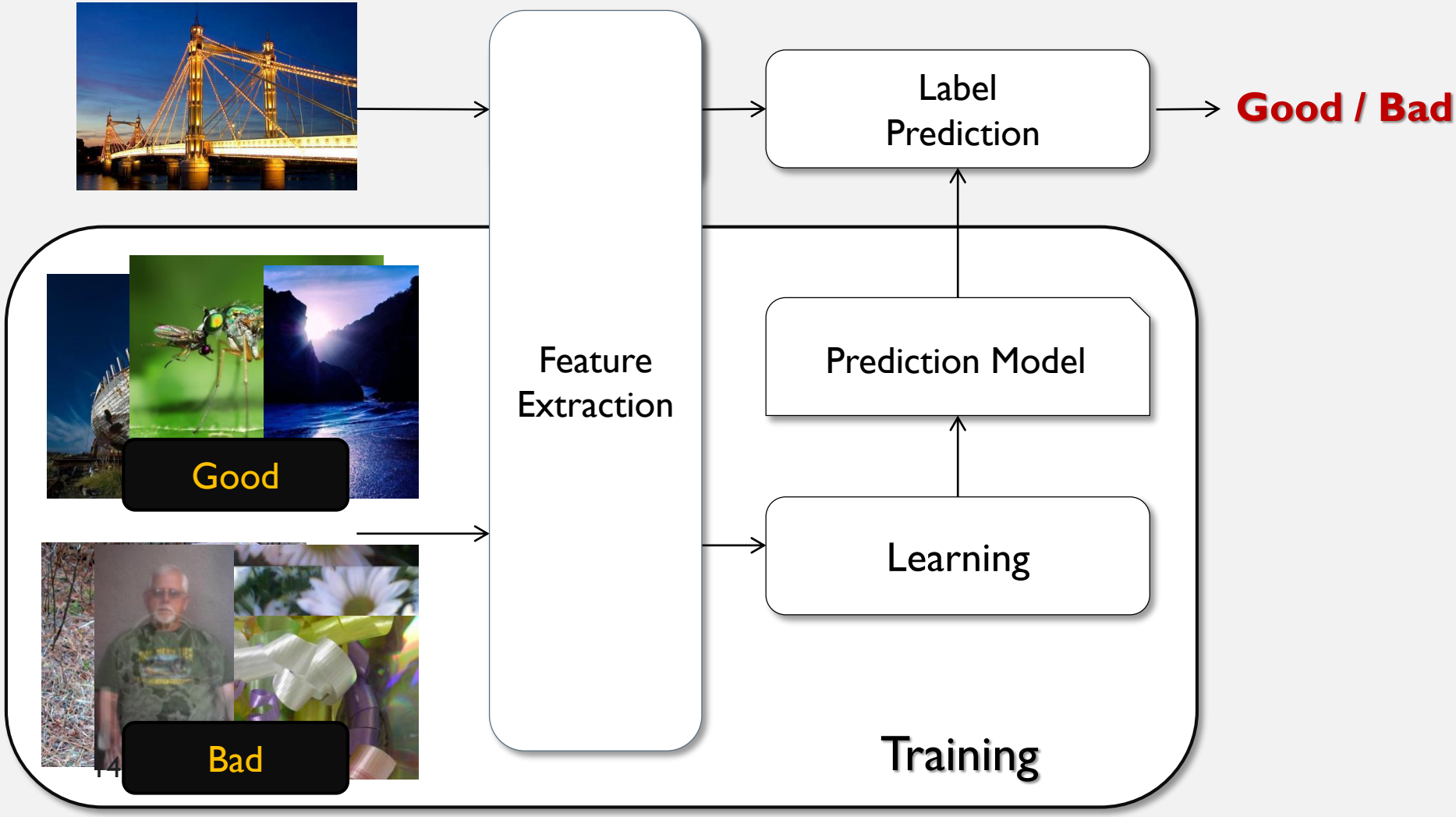
Related Work

Related Work

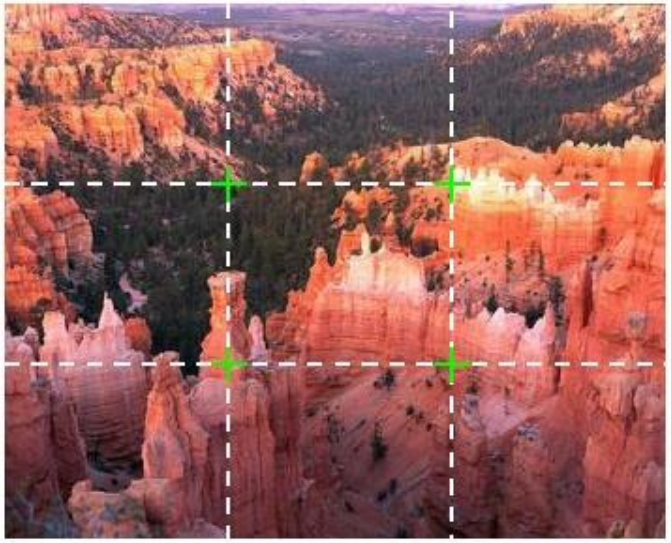
- Photograph Assessment
- Photograph Cropping
- Photograph Enhancement

Photograph Assessment

- Treated as a typical binary classification problem



Photograph Assessment 1/3



- Low Level Features
  - *Intensity*
  - *Color, Saturation, Hue*
  - *Size and Aspect Ratio*
  - *Familiarity Measure*
  - *Shape Convexity*
  - *Depth of Field*
  - *The Rule of thirds*

Ritendra Datta, Dhiraj Joshi, Jia Li, and James Z. Wang. Studying aesthetics in photographic images using a computational approach. (ECCV 2006)

Photograph Assessment 2/3

- Simplicity
  - *Spatial Distribution of Edges*
  - *Hue Count*
- Realism
  - *Color Distribution*
- Basic photographic technique
  - *Blur*
- Low Level Features
  - *Contrast & Brightness*

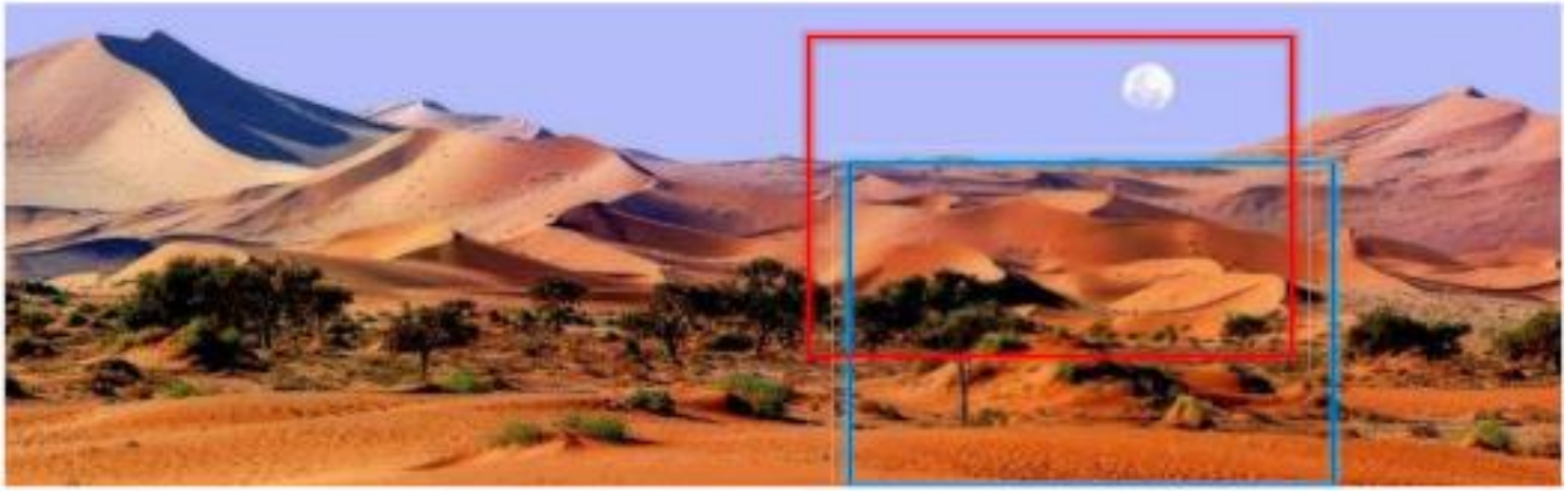
Yan Ke, Xiaoou Tang, Feng Jing. The Design of High-Level Features for Photo Quality Assessment. (CVPR 2006)

Photograph Assessment 3/3

- Features based on the subject and background division
  - *The Rule of Thirds*
  - *Simplicity*
  - *Color Harmony*
  - *Clarity contrast*
  - *Lighting*
- The state-of-the-art

Yiwen Luo and Xiaoou Tang. Photo and Video Quality Evaluation: Focusing on the Subject. (ECCV 2008)

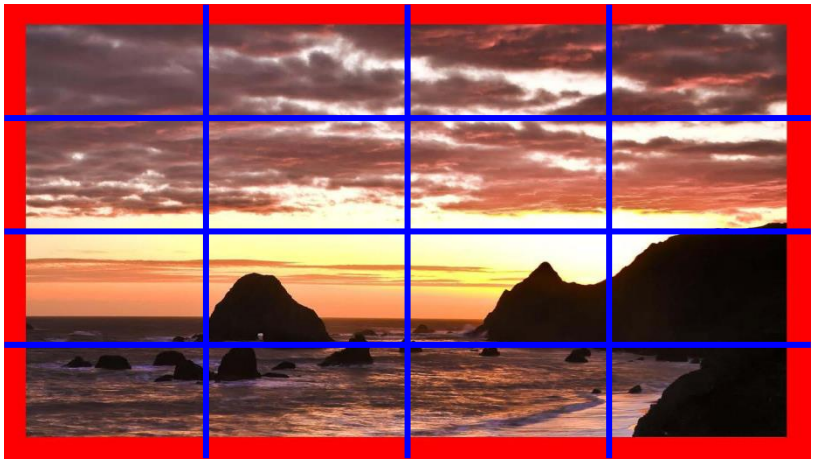
Photograph Cropping 1/2

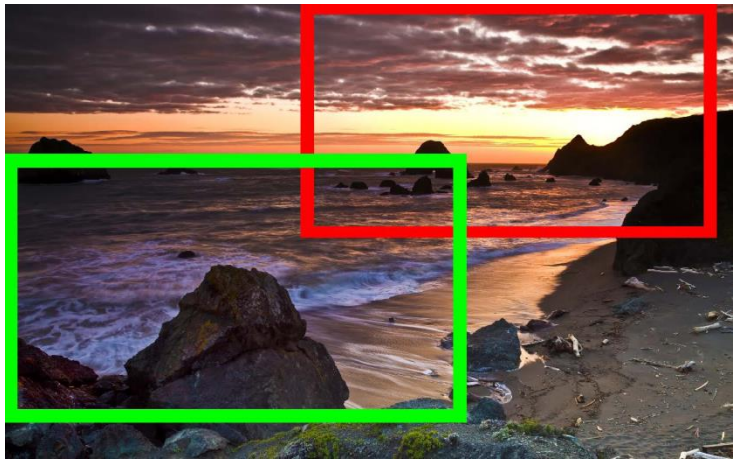


- Joint distribution of image segments are mined from training dataset
- Find MAP (maximum a posterior probability) for cropping

Bin Cheng, Bingbing Ni, Shuicheng Yan, and Qi Tian. Learning to photograph. (ACM MM 2010).

Photograph Cropping 2/2





- Bag-of-features
  - Take patch-wise operations to generate bag-of-features
  - Each feature is regarded as a weak classifier
  - Focus on scenic photos

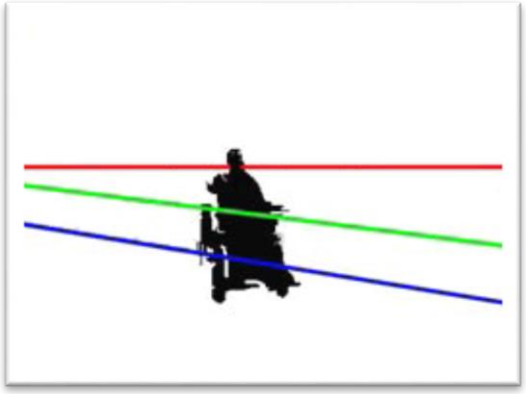
Hsiao-Hang Su, Tse-Wei Chen, Chieh-Chi Kao, Winston Hsu, Shao-Yi Chien. Preference-Aware View Recommendation System for Cameras Based on Bag of Aesthetics-Preserving Features. (IEEE Trans. on Multimedia 2012)

Photograph Enhancement 1/2

- Enhance the photo according to aesthetic rules
  - Cut & Paste
  - Rules
    - *The Rule of thirds*
    - *Golden ratio*

Subhabrata Bhattacharya, Rahul Sukthankar, and Mubarak Shah. A framework for photo-quality assessment and enhancement based on visual aesthetics. (ACM MM 2010)

Photograph Enhancement 2/2

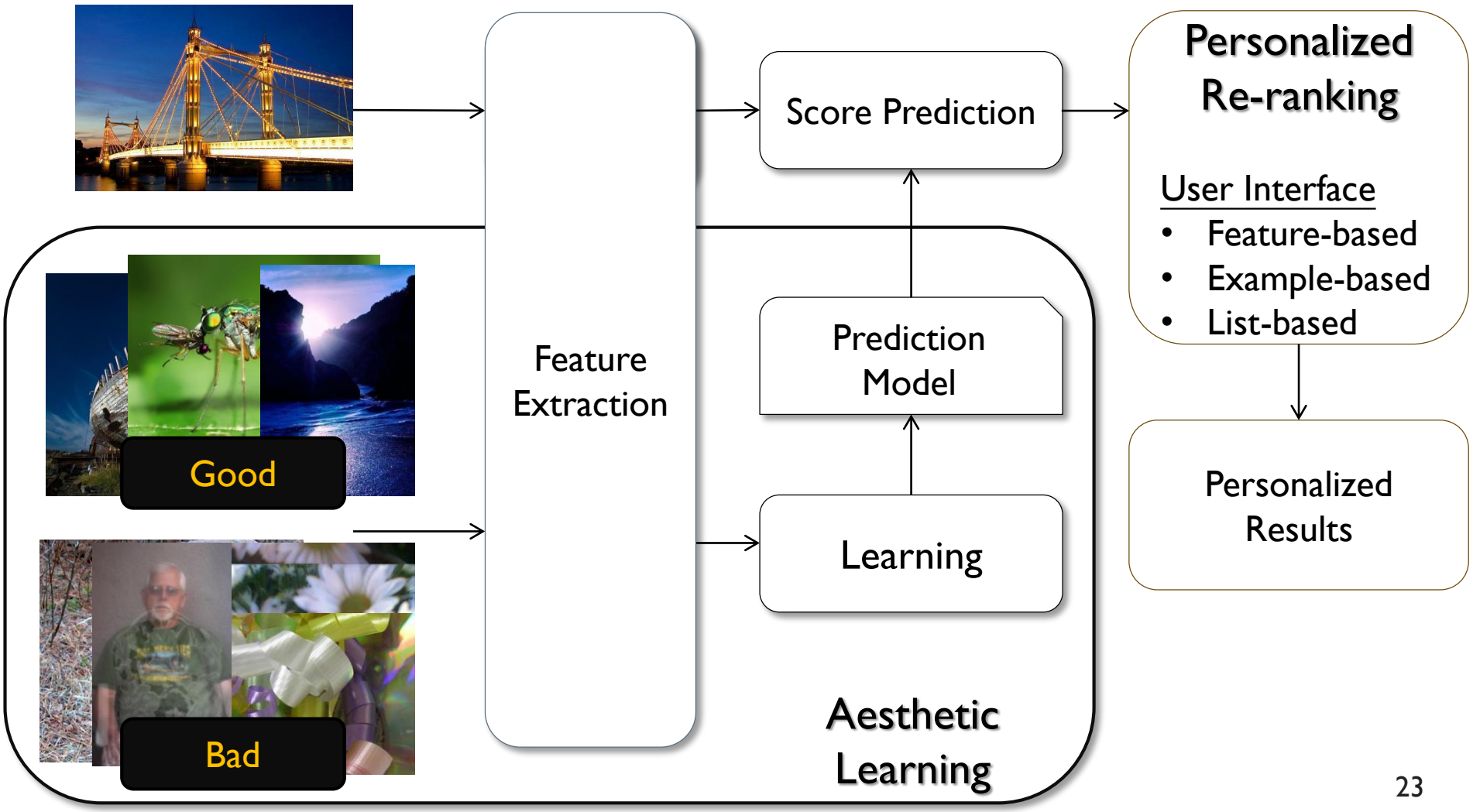


- Retargeting and Cropping
- Rules
  - *The Rule of thirds*
  - *Visual balance*
  - *Diagonal dominance*

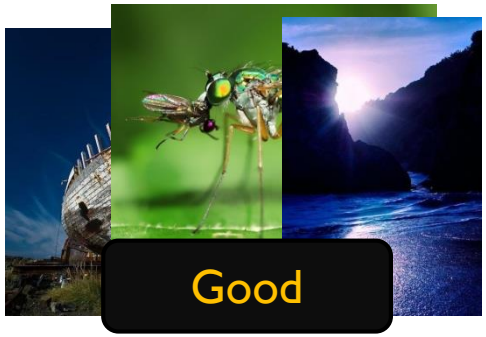
Ligang Liu, Renjie Chen, Lior Wolf, Daniel Cohen-Or
Optimizing Photo Composition. (EG 2010)

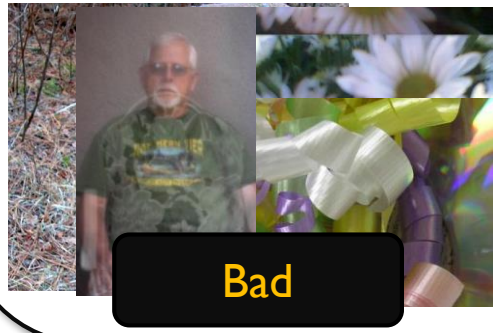
System Overview

System Framework



System Framework





Feature Extraction

Score Prediction

Prediction Model

Learning

Aesthetic Learning

Personalized Re-ranking

User Interface

- Feature-based
- Example-based
- List-based

Personalized Results

Rule of Aesthetics

Feature Descriptors

- Combination of high and low level image descriptors
  - Low level features
    ex: Contrast, Intensity, Color
  - High level features
    ex: Simplicity, Focus, Depth of field, Color Harmonization

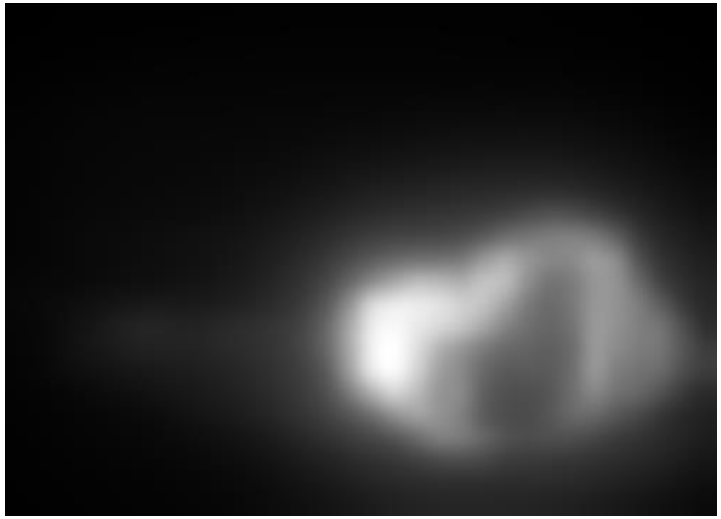
- Intuitive for human perception
  - An important factor for customized ranking

Feature Descriptors

- Photo Composition
  - *ROI Size and Position*, *Rule of Thirds*, *Simplicity*, *Line Patterns*
- Color and Intensity Distribution
  - *Texture*, *Focus*, *Depth of Field*, *Color Harmony*, *Intensity Balance*, *Contrast*
- Features for Personal Preferences
  - *Intensity*, *Saturation*, *RGB*, *Black-and-White detection*, *Portrait detection*

Photo Composition 1/5

- Preprocess
  - Region of Interest (ROI) Extraction



ROI map: Graph-Based Visual Saliency
(Harel et al., NIPS 2006)

Photo Composition 2/5

- Rule of Thirds

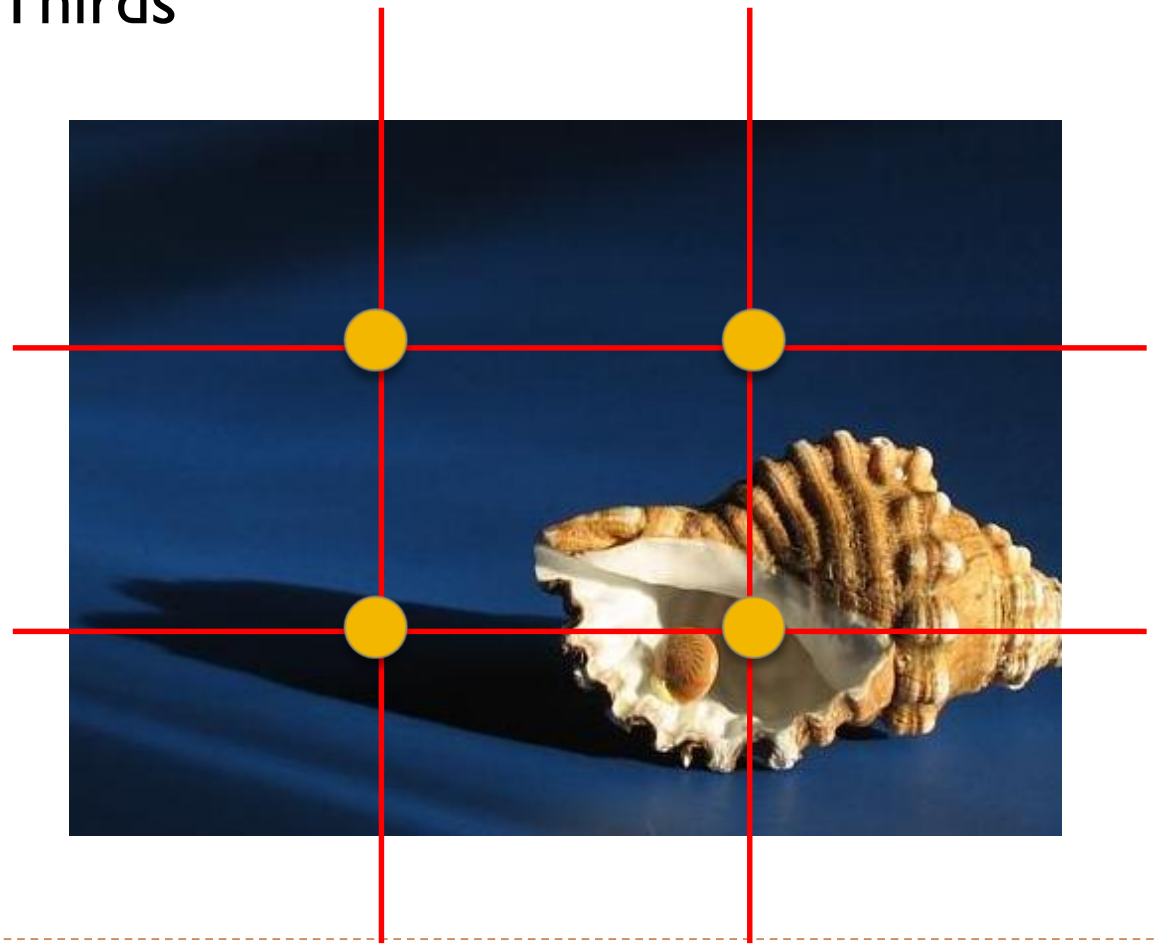


Photo Composition 3/5

- Size of ROI

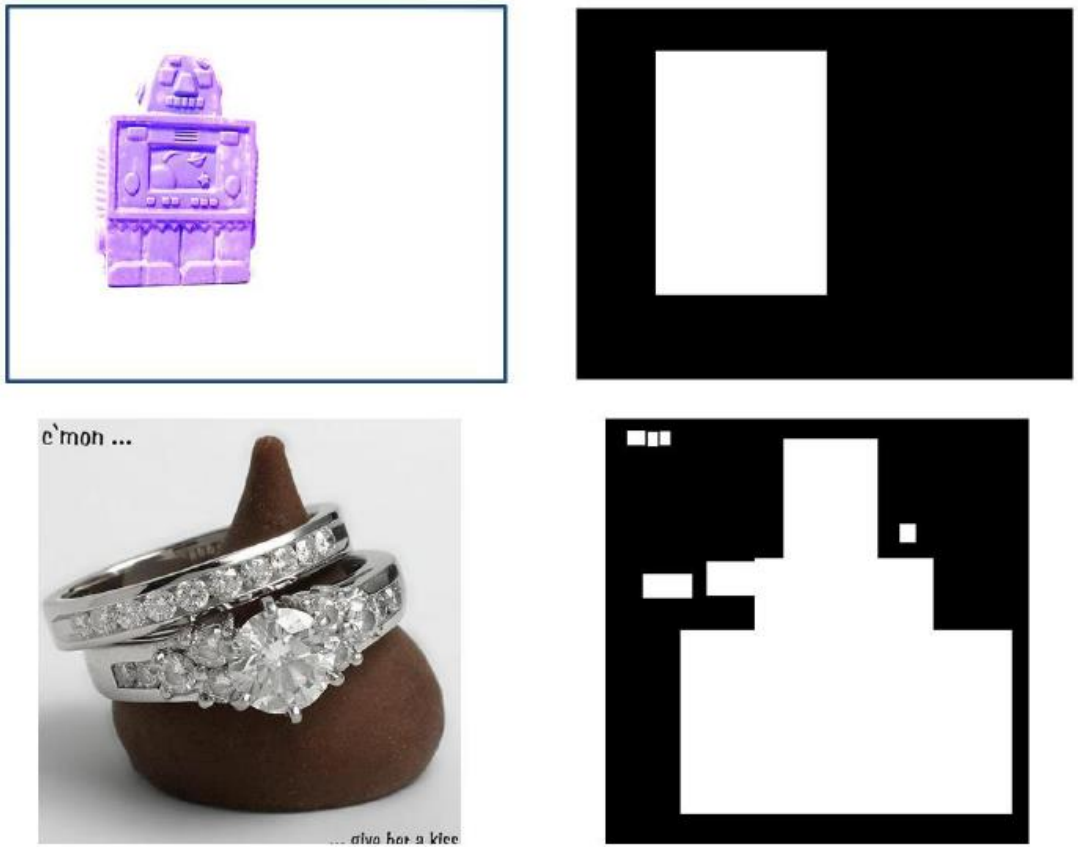
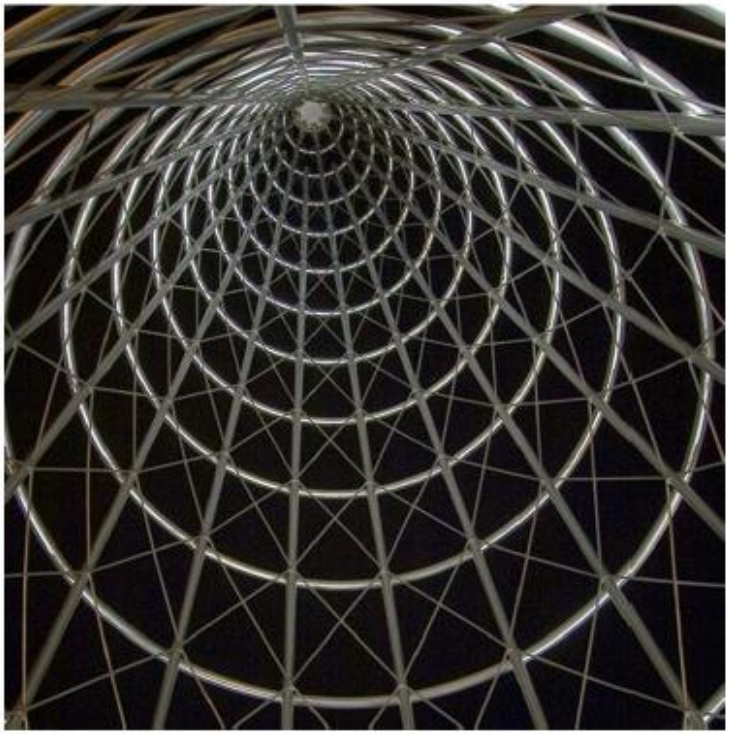


Photo Composition 4/5

- Simplicity
  - Simplicity is related to the "attention distraction of the foreground from the background".

Photo Composition 5/5

- Line Patterns



Canny Edge Detector + Hough Transform

Color & Intensity Distribution 1/5

- Texture

MPEG-7 texture descriptor

Color & Intensity Distribution 2/5

- Focus

Measured by Fast Fourier Transform

Color & Intensity Distribution 3/5

- Depth of field
  - A typical skill used by SLR camera to emphasize on major objects

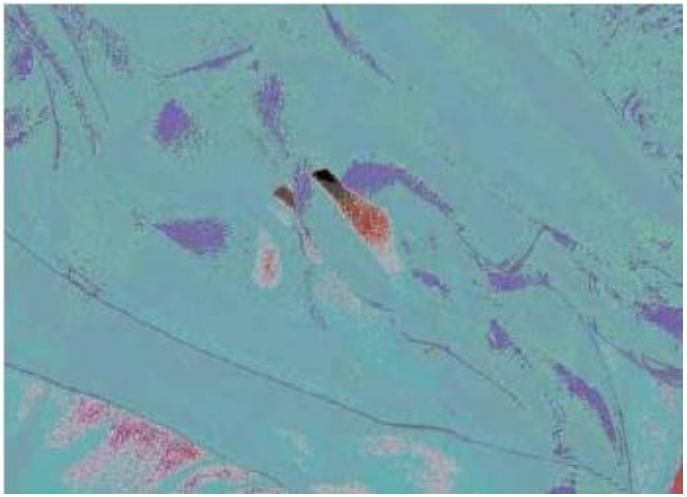
Color & Intensity Distribution 4/5

- Color Harmony

Color Harmonization [Cohen-Or et al. 2006]

Color & Intensity Distribution 5/5

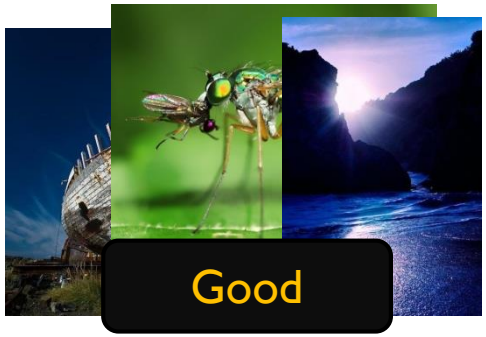
- Contrast
  - Weber & Color contrast

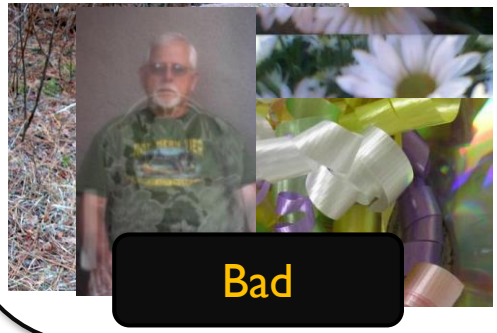


Features for Personal Preferences

- Intensity & Saturation
- Red, Green, and Blue
- Black-and-white
- Portrait

System Framework





Feature Extraction

Score Prediction

Prediction Model

Learning

Aesthetic Learning

Personalized Re-ranking

User Interface
- Feature-based
- Example-based
- List-based

Personalized Results

Aesthetic Learning

Learning to Rank

- Classification
  - Train a model to predict a label for each data
- Ranking
  - Train a model to predict an ordered list of data

- Learning algorithms
  - ListNet
  - RBF-ListNet

ListNet

- Make predicted score close to input score
  - Take cross-entropy as the loss function

$$L(\mathbf{Y}, \mathbf{S}) = -\sum_{i=1}^{N} P(y_i) log(P(s_i))$$

  - Score prediction function

$$s_i = f(\mathbf{x}_i) = \mathbf{w} \cdot \mathbf{x_i}$$

  - Training for obtaining **w**

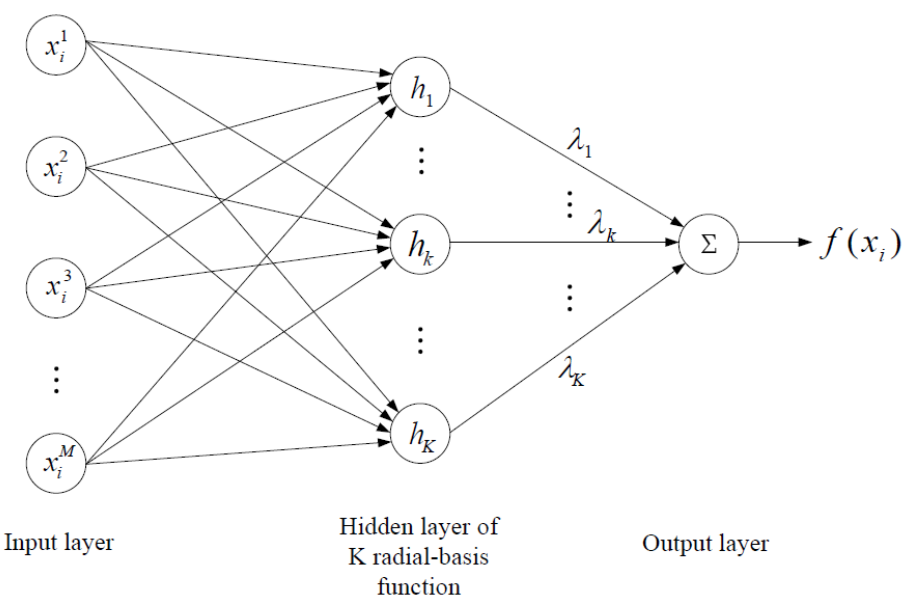
RBF-ListNet

- ListNet oversimplifies the assumption of score function
  - Linear weighting function: $s_i = f(\mathbf{x}_i) = \mathbf{w} \cdot \mathbf{x_i}$

- Use radial basis function (RBF) neural network for the score function
  - A RBF neural network can approximate well any function under certain mild conditions

$$f(\mathbf{x}_i) = \sum_{k=1}^{K} \lambda_k h_k(\mathbf{x}_i)$$

$$h_k(\mathbf{x}_i) = \frac{\alpha_k}{(||\mathbf{x}_i - \mathbf{v}_k||^2 + \alpha_k^2)^{1/2}}$$

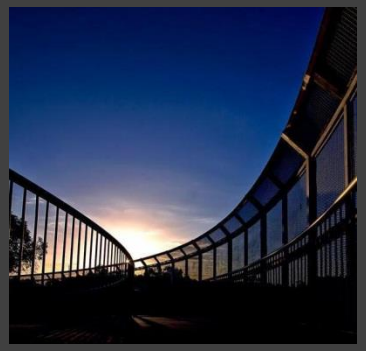


Personalized Ranking

- A score for each photograph after prediction
- The score can be scaled by the proposed three approaches
  - Feature-based
  - Example-based
  - List-based

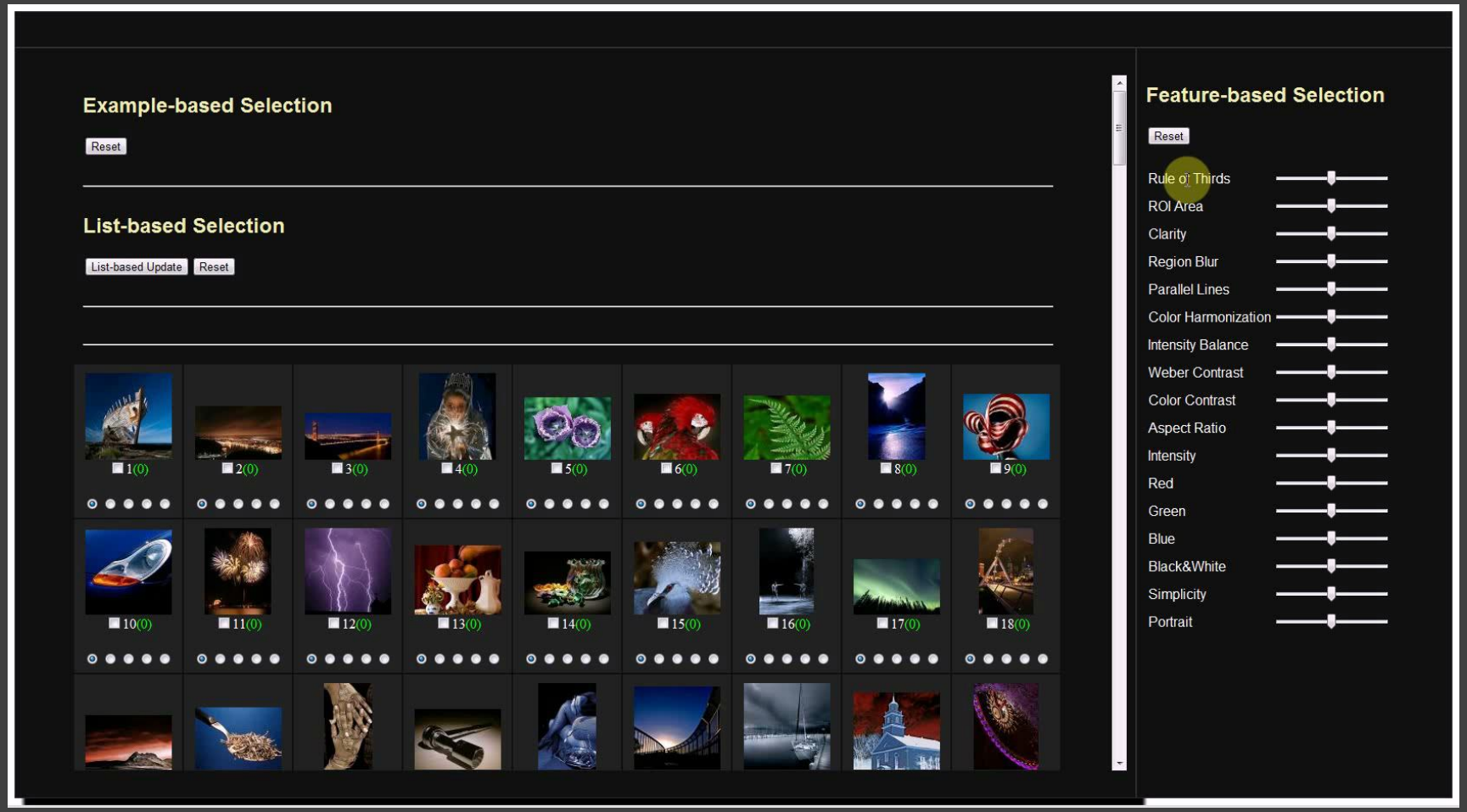
Feature-based

- Re-rank photos by specified features
  - A weight for each feature, and all are equal initially
  - The score is scaled according to feature strengths (z-score)



Rule of Thirds

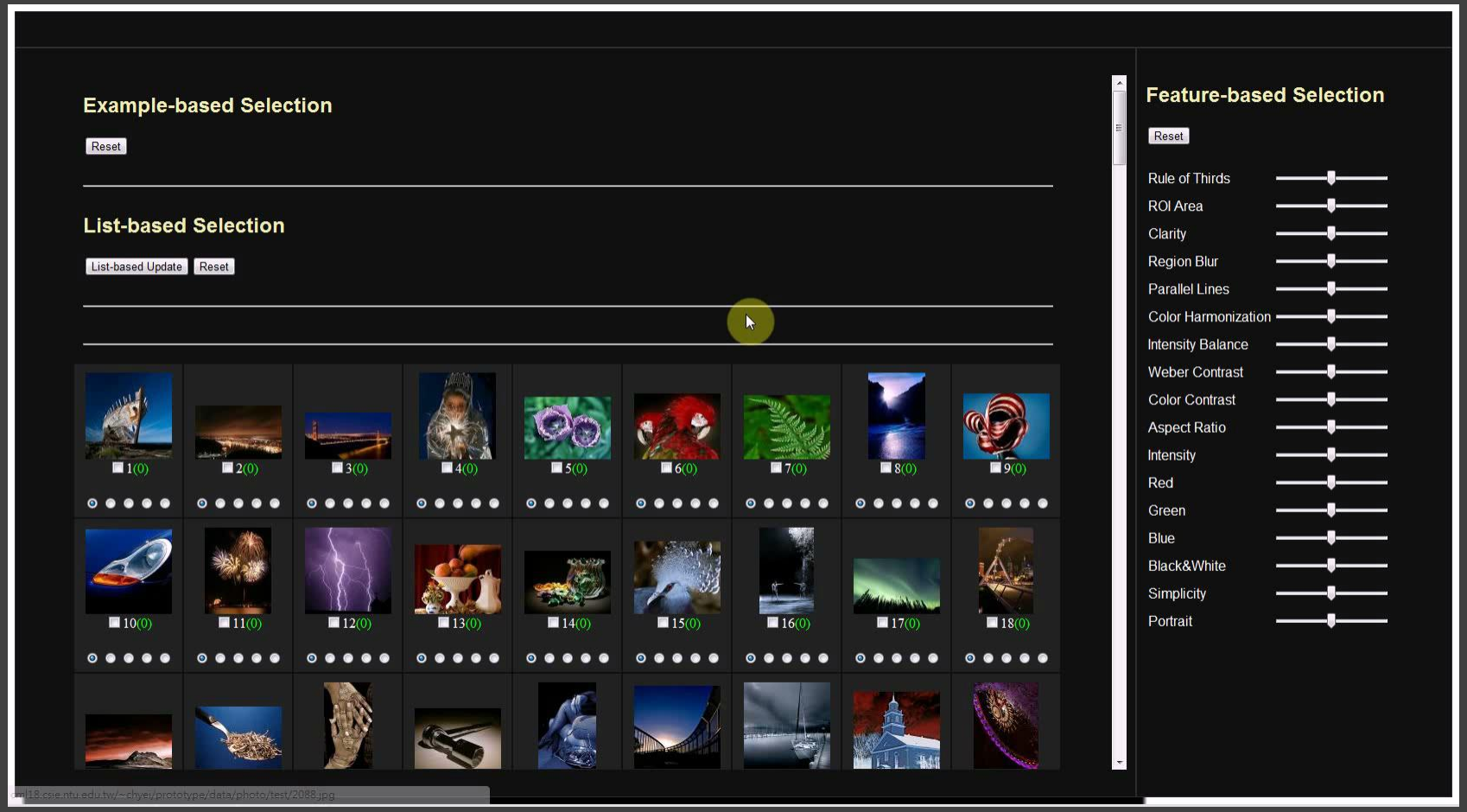
Feature-based



Example-based

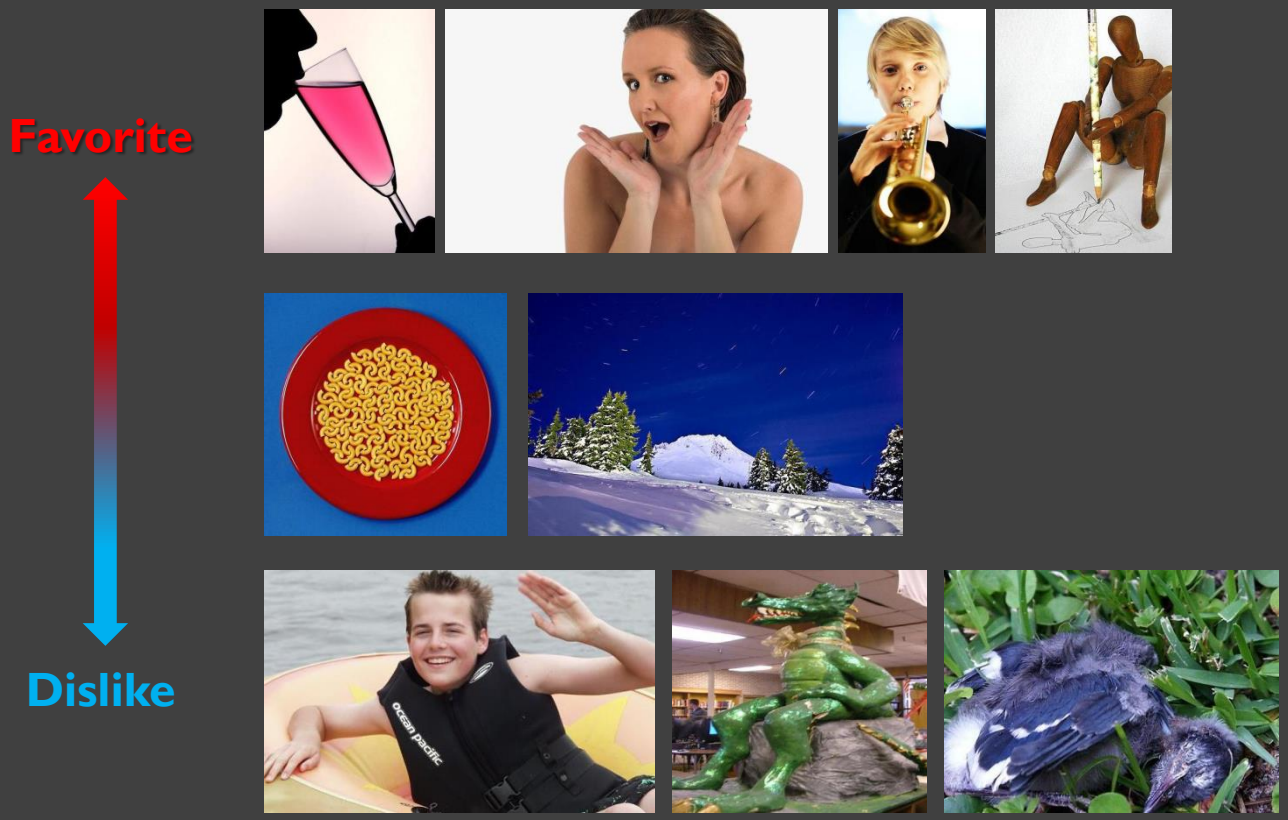
- Re-rank photos by selecting examples
  - The feature weightings are proportional to feature strengths of examples

Example-based

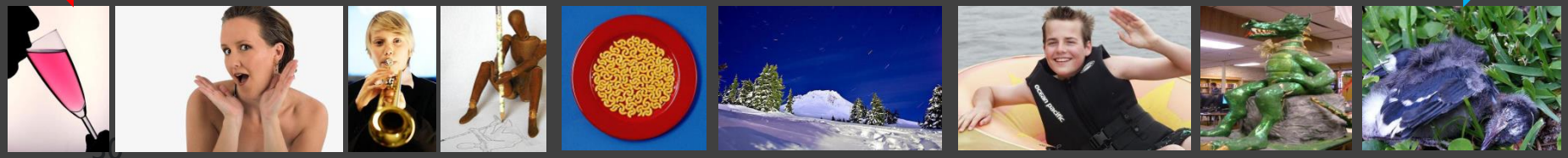


List-based

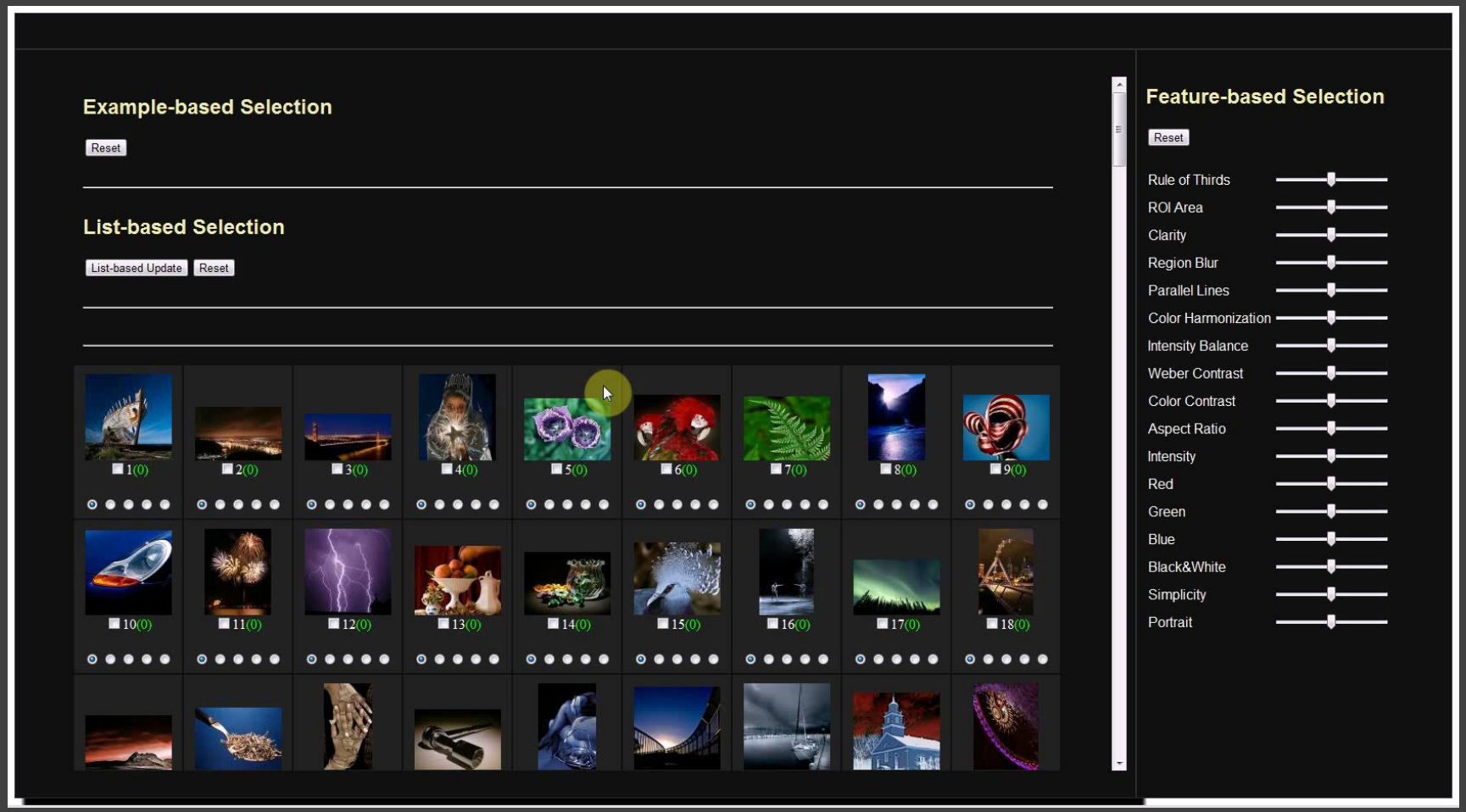
- Re-rank photos by personal ranking lists
- Train a customized prediction model according to both personal and public ranking list



List-based



List-based


Example-based Selection
Reset
List-based Selection
List-based Update
Reset
1(0)
2(0)
3(0)
4(0)
5(0)
6(0)
7(0)
8(0)
9(0)
10(0)
11(0)
12(0)
13(0)
14(0)
15(0)
16(0)
17(0)
18(0)
Feature-based Selection
Reset
Rule of Thirds
ROI Area
Clarity
Region Blur
Parallel Lines
Color Harmonization
Intensity Balance
Weber Contrast
Color Contrast
Aspect Ratio
Intensity
Red
Green
Blue
Black&White
Simplicity
Portrait

Experiments and User Study

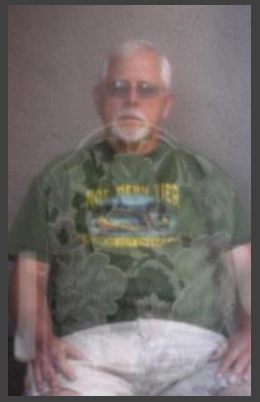
Dataset

- DPChallenge.com
- 12,000 rated photographs
  - 6,000 Good
  - 6,000 Bad

Statistics	Voting Breakdown (your vote is highlighted in red)
Place: 1 out of 122 **Avg (all users):** 8.2500 **Avg (commenters):** 9.3684 **Avg (participants):** 8.1412 **Avg (non-participants):** 8.3206 **Views since voting:** 30731 **Views during voting:** 459 **Votes:** 216 **Comments:** 130 **Favorites:** 245 (view)	1 0 2 0 3 1 4 3 5 8 6 26 7 34 8 35 9 37 10 72

Top Ranked Results

Bottom Ranked Results



Evaluation

- Rank Correlation
  - Kendall's Tau Coefficient
- Precision Recall Curve
- Binary Classification Accuracy
- User Study

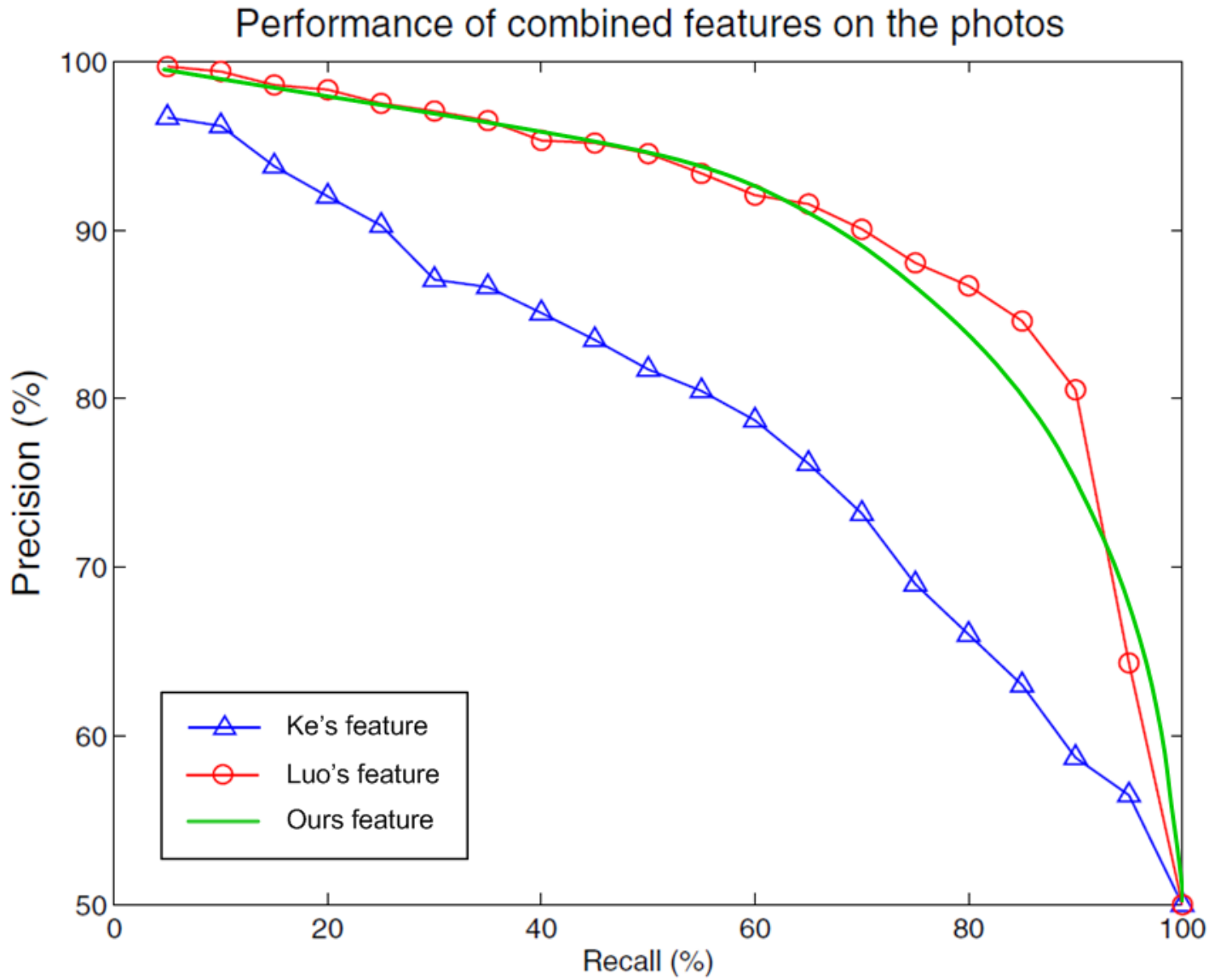
Kendall's Tau
Rank Correlation Coefficient

- Measure the association between two ranking list

Value	Association
1	Perfect agreement
-1	Total disagreement
0	Independent

Method	Kernel Function	Value
SVR	Linear	0.384
SVR	RBF	0.402
ListNet	Linear	0.423
RBF-ListNet	RBF	0.434

Precision-Recall Curve



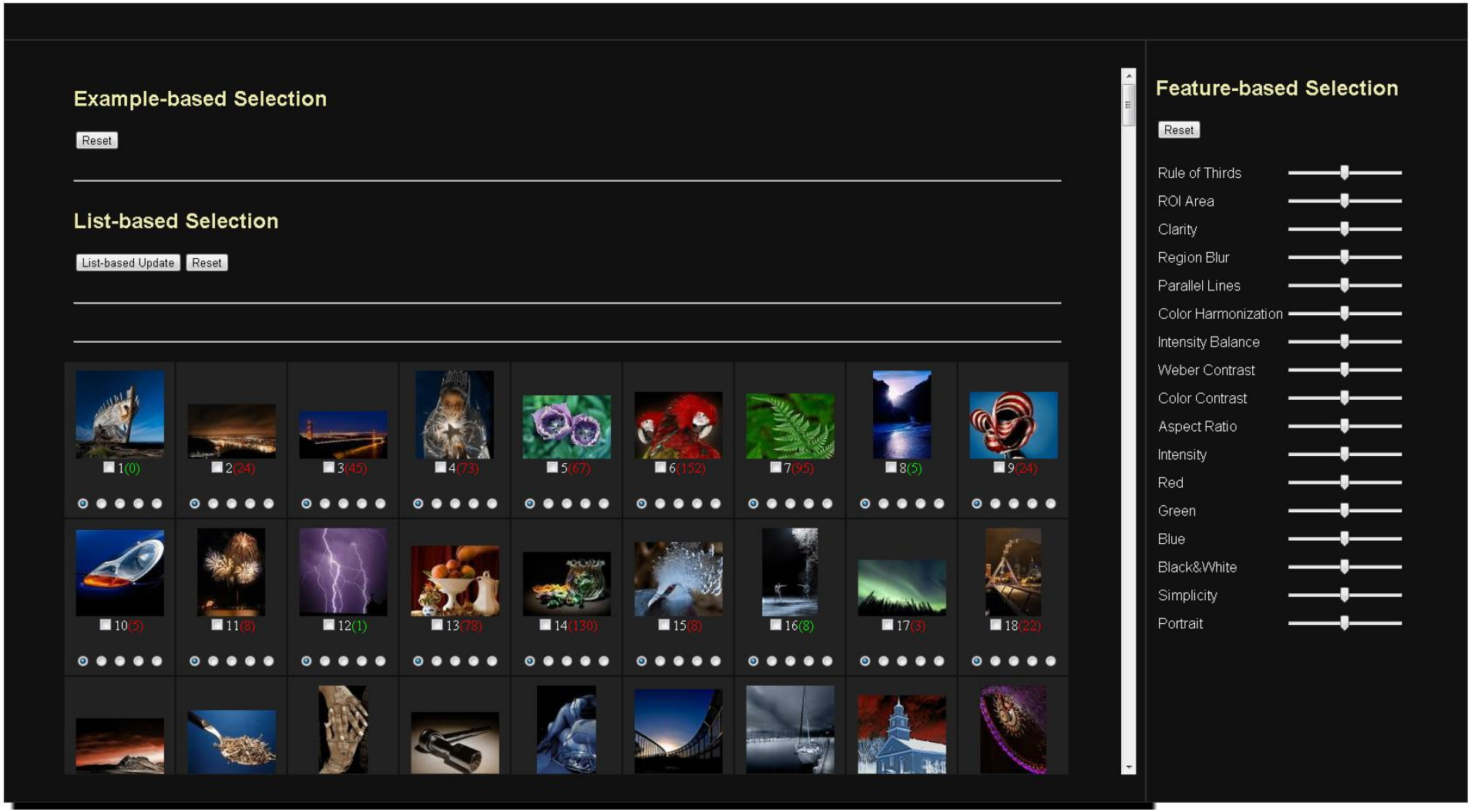
Binary Classification

Luo's features	Accuracy
Composition	79%
Clarity	77%
Simplicity	73%
Color Combination	71%
Lighting	62%

Our features	Accuracy
Simplicity	89.5%
Texture	84.2%
Contrast	84.1%
Intensity Average	75.2%
Region Blur	71%

Combined Features	Accuracy
Datta (ECCV 2006)	76%
Ke (CVPR 2006)	77%
Luo (ECCV 2008)	93%
Ours	93%

User Study

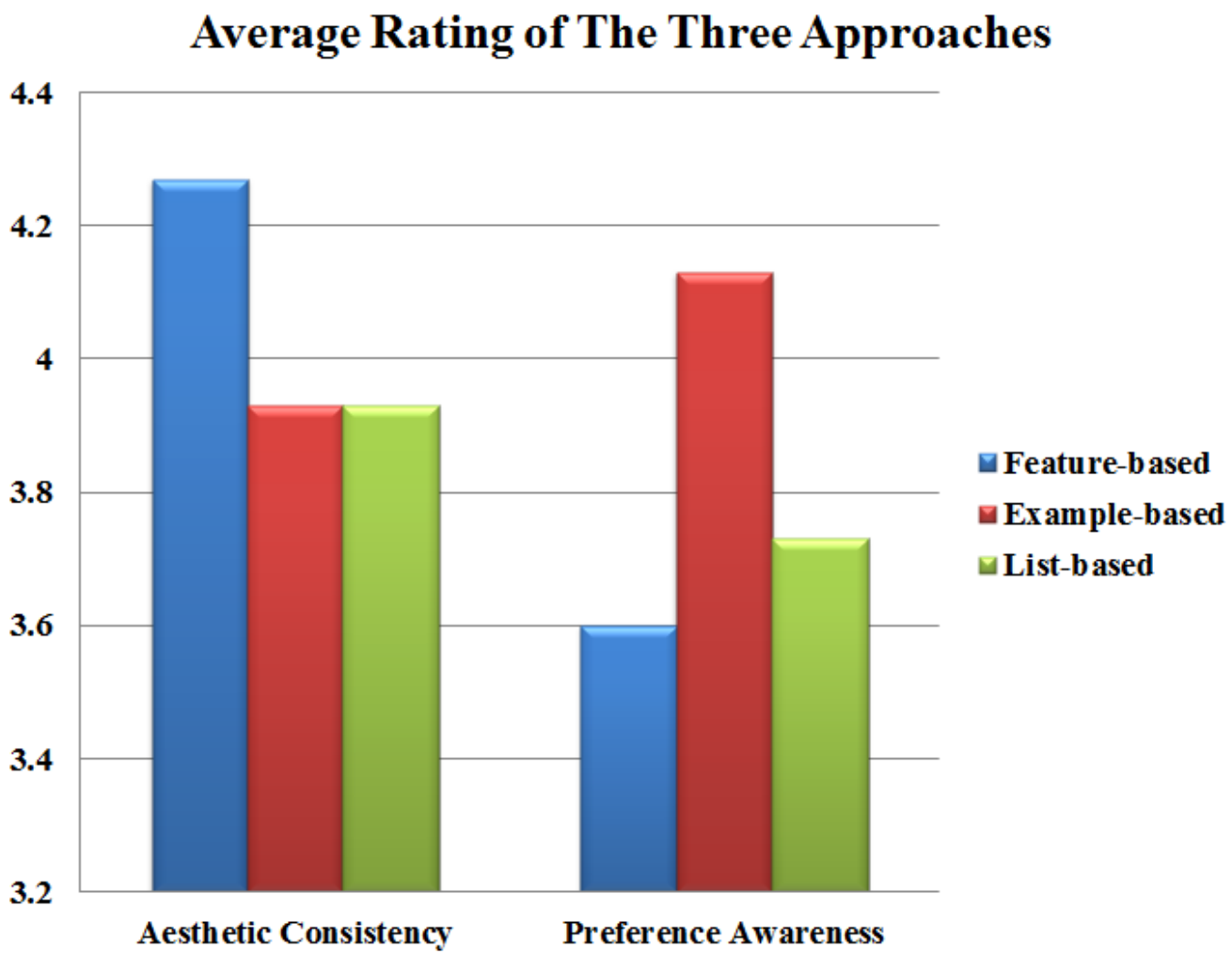

Example-based Selection
Reset
List-based Selection
List-based Update
Reset
1(0)
2(24)
3(45)
4(73)
5(67)
6(152)
7(95)
8(5)
9(24)
10(5)
11(8)
12(1)
13(78)
14(130)
15(8)
16(8)
17(3)
18(22)
Feature-based Selection
Reset
Rule of Thirds
ROI Area
Clarity
Region Blur
Parallel Lines
Color Harmonization
Intensity Balance
Weber Contrast
Color Contrast
Aspect Ratio
Intensity
Red
Green
Blue
Black&White
Simplicity
Portrait

User Study

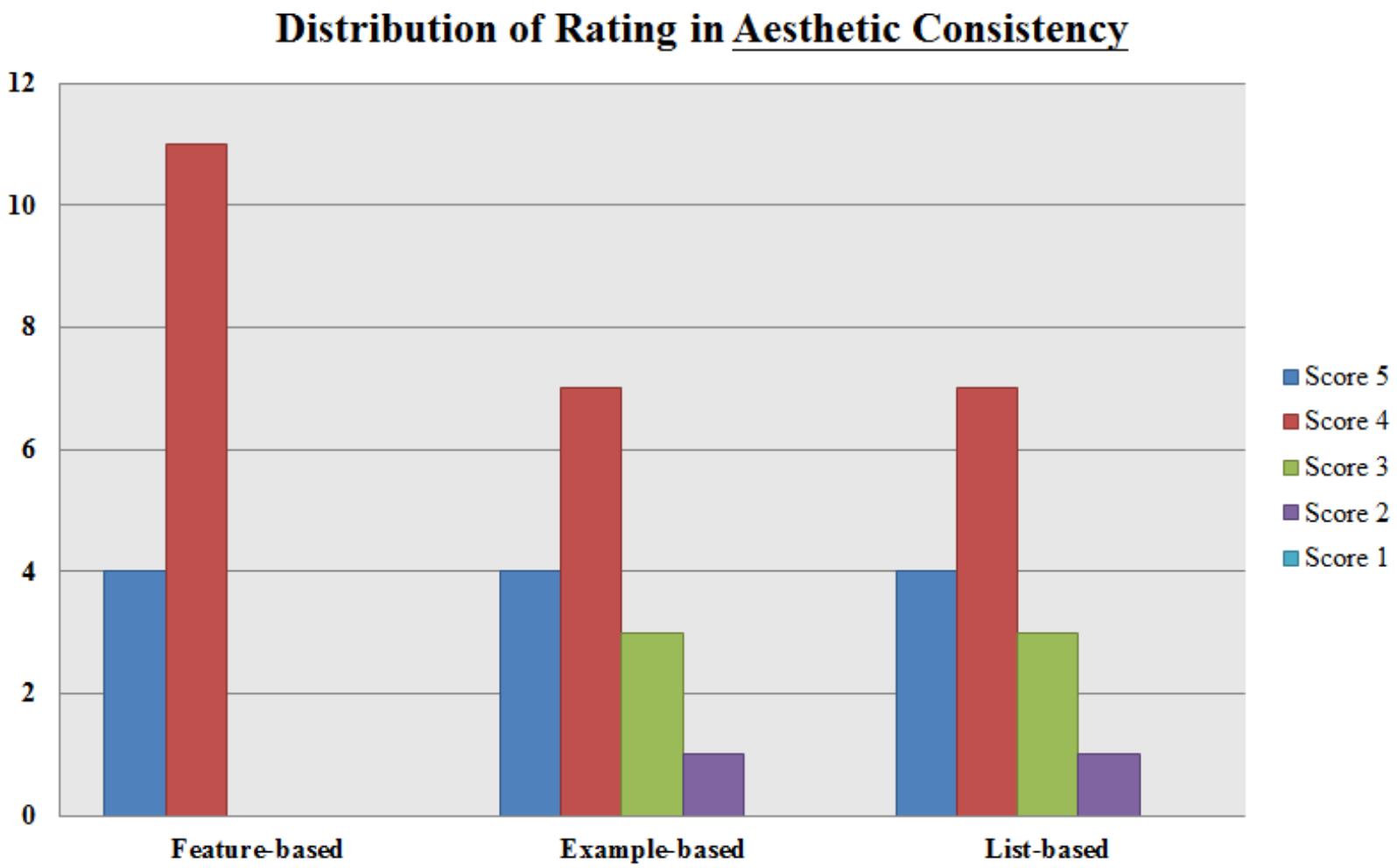
- For each approach
  - Aesthetic Consistency
  - Preference Awareness

- 15 participations
- 1~5 rating for each item

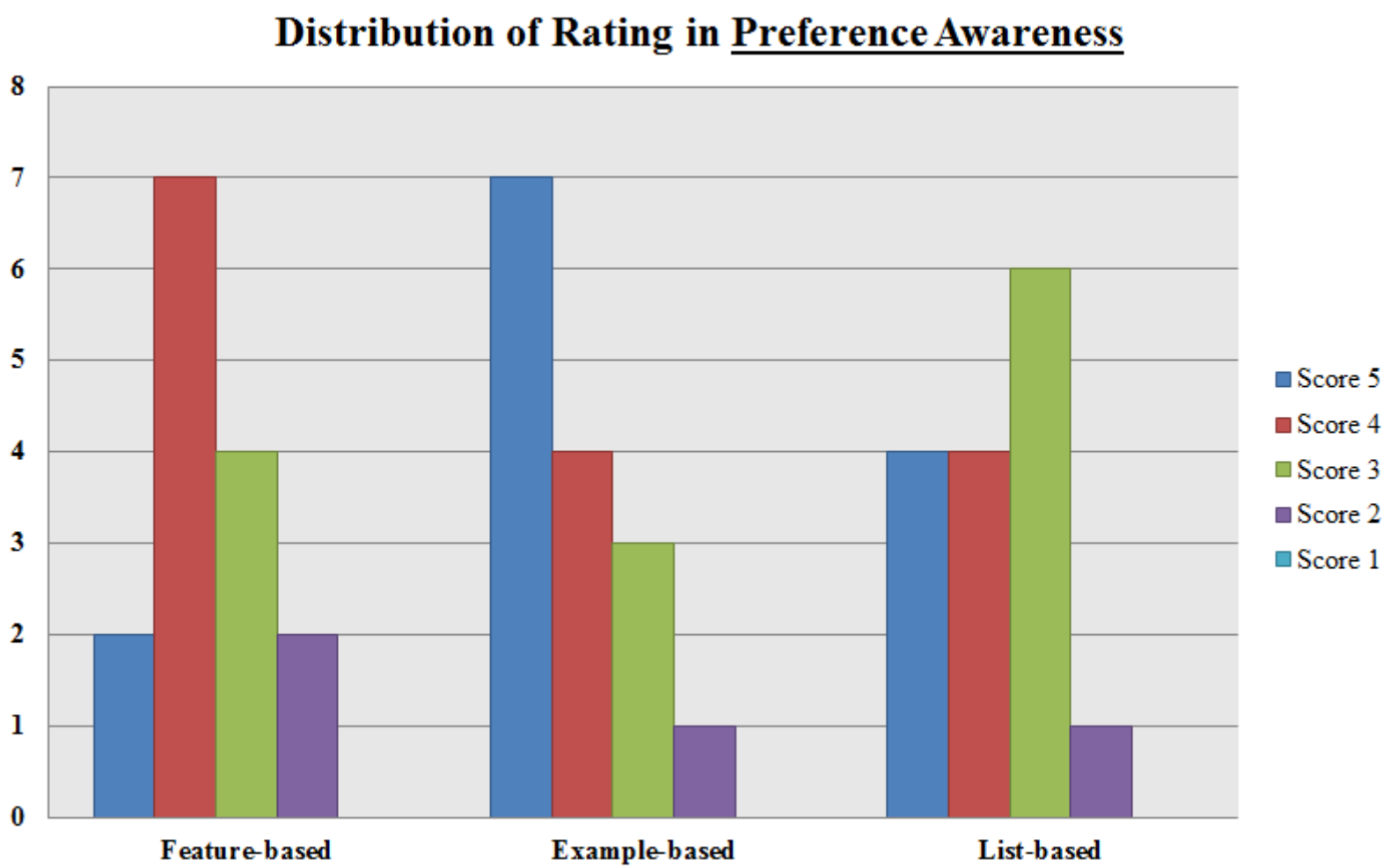
User Study


Average Rating of The Three Approaches
4.4
4.2
4
3.8
3.6
3.4
3.2
Aesthetic Consistency
Preference Awareness
Feature-based
Example-based
List-based

User Study


Distribution of Rating in Aesthetic Consistency
12
10
8
6
4
2
0
Feature-based
Example-based
List-based
Score 5
Score 4
Score 3
Score 2
Score 1

User Study


Distribution of Rating in Preference Awareness
8
7
6
5
4
3
2
1
0
Feature-based
Example-based
List-based
Score 5
Score 4
Score 3
Score 2
Score 1

Observations

- Feature-based
  - The highest average rating in aesthetic consistency
  - The lowest average rating in preference awareness.
  - Our preferences are usually based on multiple aesthetic rules.

- Example-based
  - The highest rating in preference-awareness
  - The most intuitive way

- List-based
  - We usually only focus on the top ranked photos

Discussion

Applications

- Photograph management
- Wallpaper selection
- Cooperation with other application
  - Image search

Limitation

- Computational Complexity
  - 2.4 GHz CPU (Q6600), single thread, 4GB RAM
  - 24 seconds for feature extraction
- Rule-based approach
  - Computational expensive
  - Heuristics
- Non rule-based approach
  - Less computational complexity
  - **Difficult to be used for personalization**

Limitation

- Difficult to re-rank photos by the rules excluded in the proposed features ???

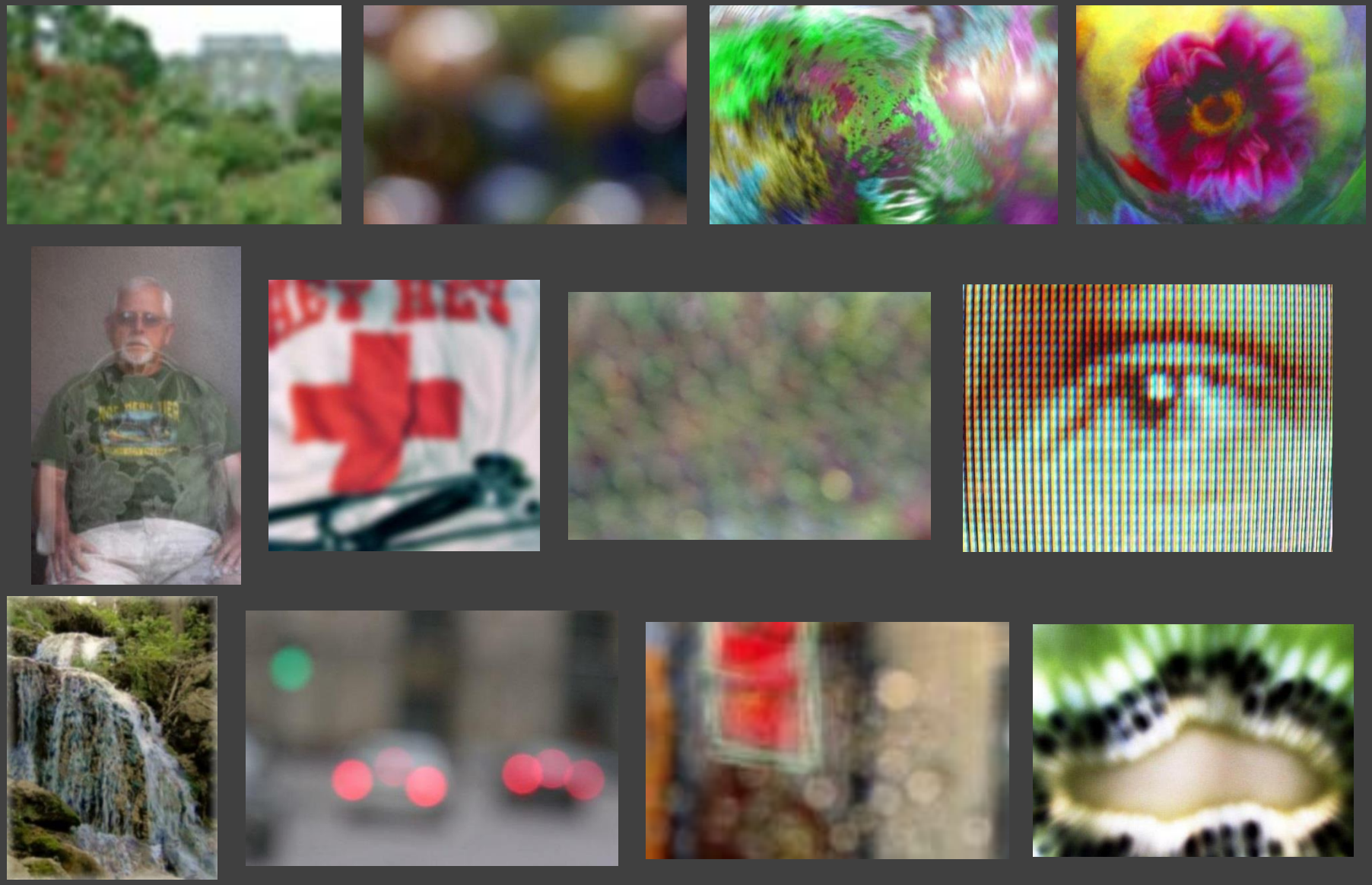
Conclusions

- We proposed a framework to rank photographs according to personal preferences.
- Three approaches are proposed for re-ranking photos
  - *Feature-based*
  - *Example-based*
  - *List-based*
- The experiments and user studies show the effectiveness of the proposed system.

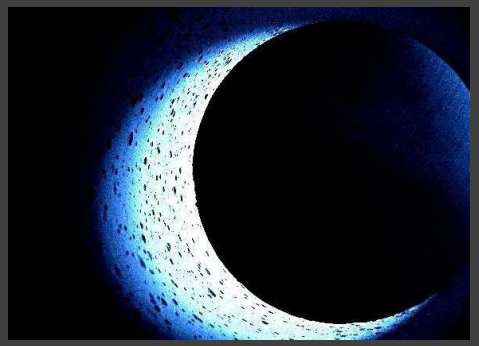
Any Questions

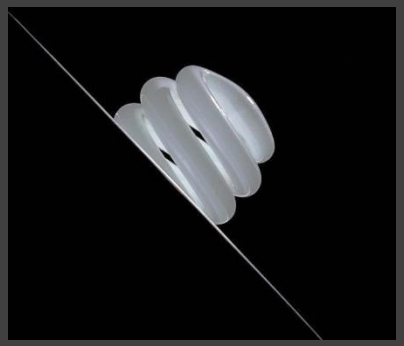
Top Ranking Results by ListNet

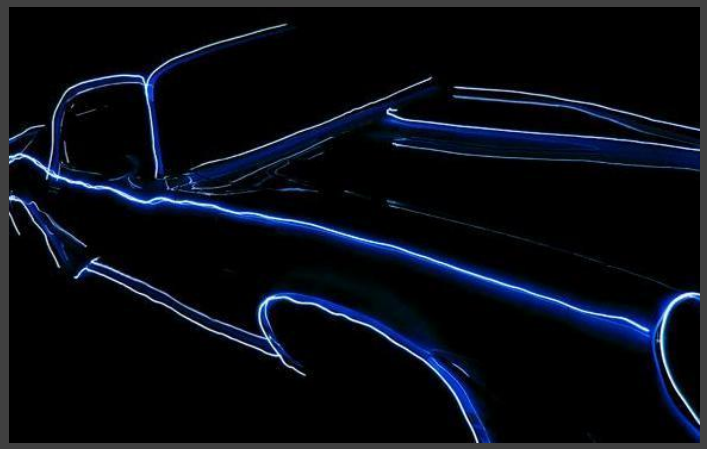
Bottom Ranking Results by ListNet



Feature-based

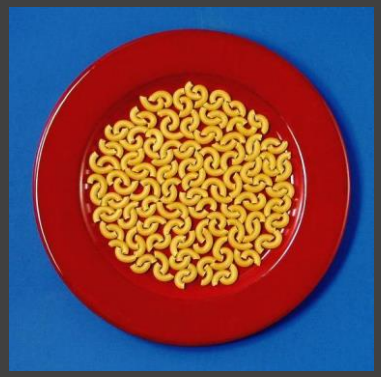






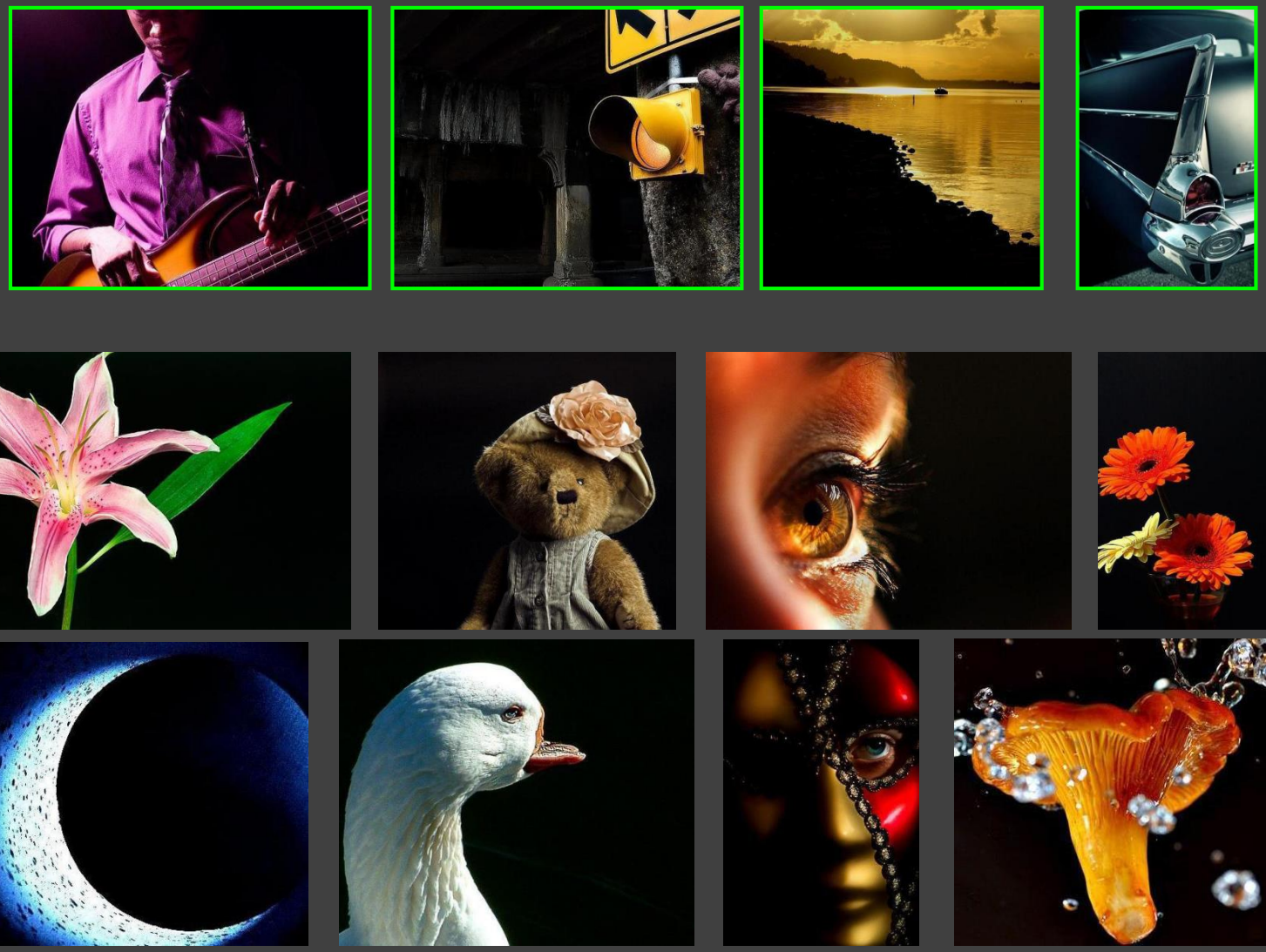
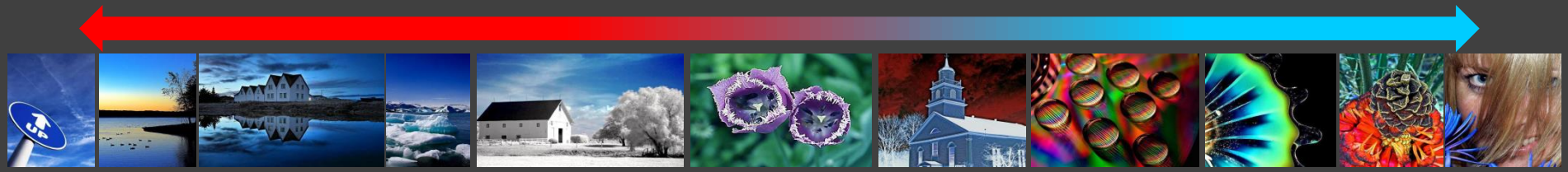
High Color Contrast

Feature-based



Low Color Contrast

Example-based



List-based