

# Relative Attributes

**Team mob-psycho**

Kanav Gupta

Anurag Mehta

Parth Partani



# Introduction



# Introduction

When dealing with recognition tasks, human-nameable visual "attributes" can be beneficial, but:

- Sometimes it is hard to make a binary decision on whether an image satisfies an attribute.

- **Comparisons are easier.**



Natural



?



Not Natural



Smiling



?



Not Smiling

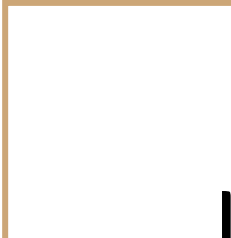
# Introduction

## Relative Attributes

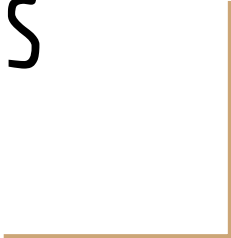
- Great to describe and compare objects in the world.
- Indicate the strength of an attribute in an image with respect to other images.
- Allow relating images and categories to each other.



**A is more natural than B**  
**C is less natural than B**



# Learning Relative Attributes



# Learning Relative Attributes

**Model Relative Attributes:** Learn ranking function for each attribute

For each attribute  $a_m$ , **open**

Supervision is

**Set of ordered pair of images**  $\rightarrow$

$$O_m: \left\{ \left( \begin{array}{c} \text{Image 1} \\ \text{Image 2} \end{array} \right) \succ, \dots \right\},$$

**Set of unordered pair of images**  $\rightarrow$

$$S_m: \left\{ \left\{ \begin{array}{c} \text{Image 1} \\ \text{Image 2} \end{array} \right\} \sim, \dots \right\}$$

# Learning Relative Attributes

Learn a scoring function  $r_m(\mathbf{x}_i) = \mathbf{w}_m^T \mathbf{x}_i$

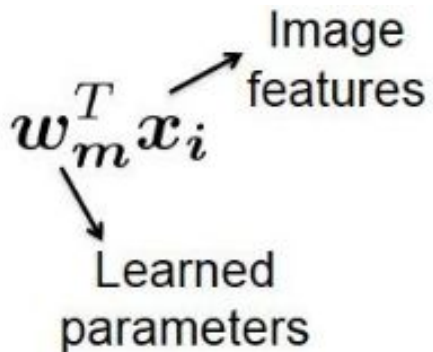


Image features

Learned parameters

that best satisfies constraints:

$$\forall (i, j) \in O_m : \mathbf{w}_m^T \mathbf{x}_i > \mathbf{w}_m^T \mathbf{x}_j$$

$$\forall (i, j) \in S_m : \mathbf{w}_m^T \mathbf{x}_i = \mathbf{w}_m^T \mathbf{x}_j$$

# Learning Relative Attributes

## Max-margin learning to rank formulation

$$\min \left( \frac{1}{2} \| \mathbf{w}_m^T \|_2^2 + C \left( \sum \xi_{ij}^2 + \sum \gamma_{ij}^2 \right) \right)$$

$$\text{s.t. } \mathbf{w}_m^T (\mathbf{x}_i - \mathbf{x}_j) \geq 1 - \xi_{ij}, \forall (i, j) \in O_m$$

$$| \mathbf{w}_m^T (\mathbf{x}_i - \mathbf{x}_j) | \leq \gamma_{ij}, \forall (i, j) \in S_m$$

$$\xi_{ij} \geq 0; \gamma_{ij} \geq 0$$

Based on [Joachims 2002]

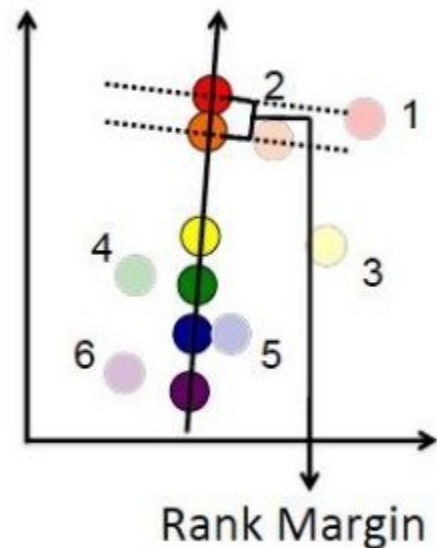
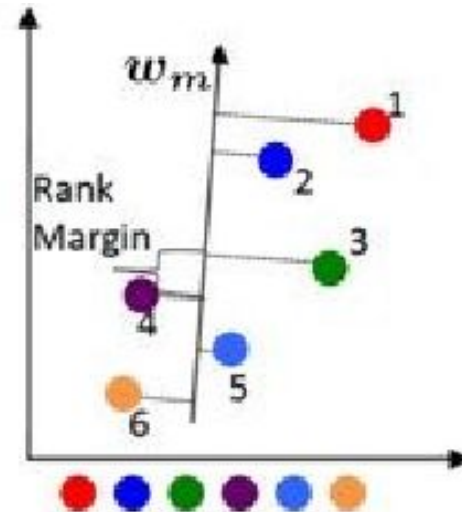
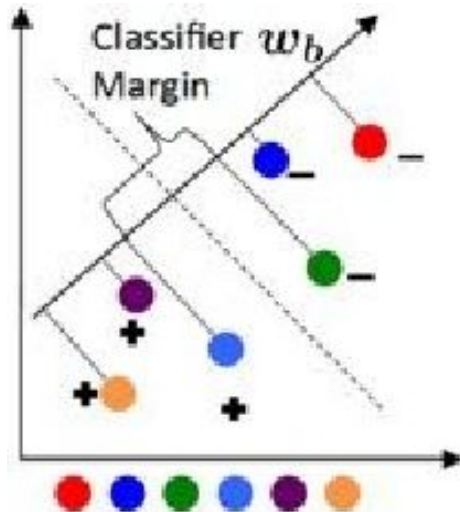


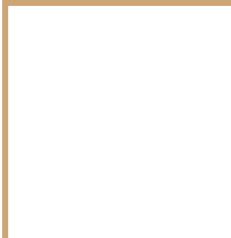
Image  $\rightarrow$  Relative Attribute Score




# Learning Relative Attributes

Wide-margin **binary classifier** VS Wide-margin **ranking function**





# Results Obtained



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- Obtained weights for each attribute after training PubFig dataset with Rank-SVM
- These weights can be used to compare two images for specific attributes (like smile, color etc)

# Results Obtained - Smiling Attribute



**Value = 0.2403**

**>**



**Value = 0.0882**



Whats Next?



# Whats Next?

- **Zero Shot Learning:** Train a generative model (like GMM) to predict values for new class based on its relationship with current classes and no training images
- **Describing Images:** Automatically generating relative description of the images (like a particular image is more smiling and young than other image)



Thank  
You

