Two-Class Weather Classification

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Based paper: Lu C, Lin D, Jia J, et al. Two-class weather classification[C]//Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. 2014: 3718-3725.

Problem

- Classifying a single outdoor image as sunny or cloudy.

Sunny

Cloudy

Weather Feature

- A 621-D feature vector with 5 components: sky, shadow, reflection, contrast, haze.

$$[f_{sk};f_{sh};f_{re};f_{co};f_{ha}]$$

- Since not all outdoor images contain these features, the existence vector:

$$[v_{sk}\ v_{sh}\ v_{re}\ v_{ha}]^T$$

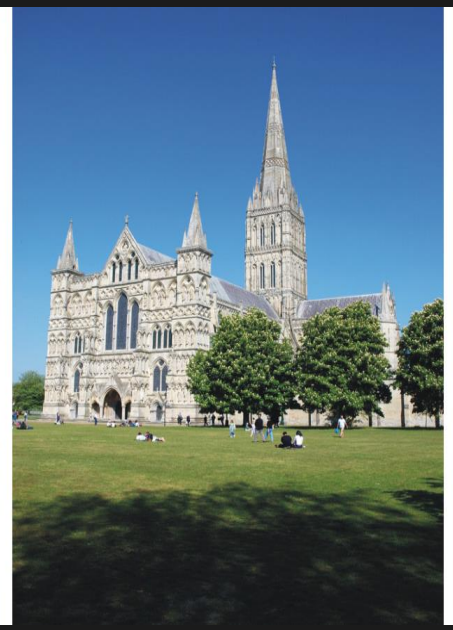
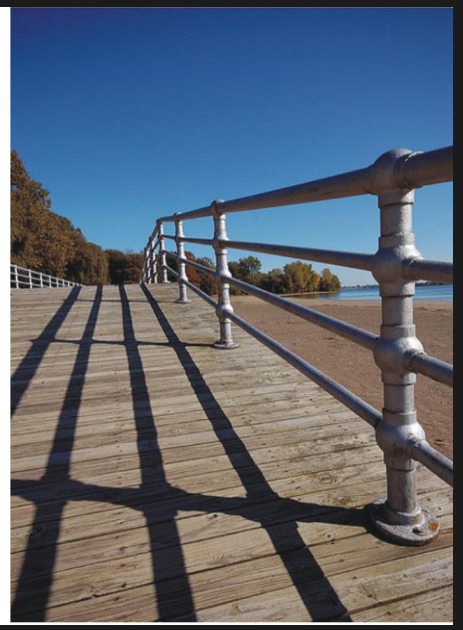
Weather Feature

- Sky(256-D): Segment sky region by extracting a 131-D feature (SIFT + mean HSV) and using a random forest classifier. f_{sk} is defined with color-pair dictionary coding.
- Shadow(10-D): Using shadow detection tool to obtain top 10 most confident shadow boundaries and computer their likelihood.
- Reflection(100-D): Apply image matting at the detected white pixels, then compute the alpha matte distributions.
- Contrast(171-D): Utilizing image saturation percentile ratios, this paper used C channel of LCH color space.
- Haze(84-D): Using dark channel prior.

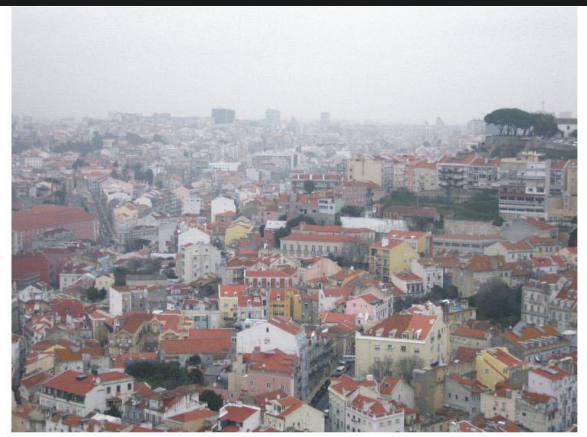
Collaborative Learning with Homogeneous Voters

- Traditional classifiers such as SVM cannot achieve good performance on weather feature because they assume all components to present simultaneously in all images. But outdoor images do not always contain all weather cues(for example, sky).
- Partition trainings images into disjoint clusters of homogeneous voters according to the existence vector of each image. Images belonging to the same cluster are said to be homogeneous.
- Partitioned sets correspond to different weather cue patterns, such as “sky + shadow”, “sky + haze”.

Collaborative Learning with Homogeneous Voters

“sky + shadow”


“sky + haze”

Collaborative Learning with Homogeneous Voters

- In the testing phase, the classifier is based on weighted voting scheme:

$$h(x,e)=sign\left[\sum_{i=1}^{M} s(\hat{e}_i,e)\hat{h}_i(x)\right]$$

- x: weather feature.
- e: existence vector.
- sign[·]: the function outputting 1(resp. -1) for non=negative(resp. negative) input.
- $s(\hat{e}_i,e)$: similarity function.
- $\hat{h}_i(\cdot)$: the trained homogeneous voter.

- This classifier gives a larger weight to the homogeneous voter whose existence vector pattern is similar to that of the testing data.

Dataset

- Weather dataset: 14K labelled images.
- Sunny and cloudy, roughly 50% each.
- Three sources: Sun Dataset, LabelMe Dataset and Flickr.

Future Work

- The framework can include more useful weather cues.
- The performance of shadow and haze detection need to be improved.
- Generalizing to labeling more weather types.
- This approach rely on handcrafted features, may adopt some deep learning based approaches to improve it.

Thank you.