Image Detection: Large and Small Feature Extraction

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Abstract

We present our progress on the comparison of different image recognition algorithms. We studied large feature extraction with a variation of the Viola-Jones face detection algorithm. This algorithm attempts to identify faces by comparing them to certain "**Haar features**." The most useful features are selected by a training algorithm called **Adaboost.** The detection time is then decreased through a specially trained "**cascaded classifier**." In some initial tests, our version of this algorithm is able to identify faces with up to 98% accuracy. Small feature extraction was studied with **principal component analysis** and the **Weyl representation**. Our goal is to compare how these two algorithms perform at identifying cancerous cells.

Haar Features

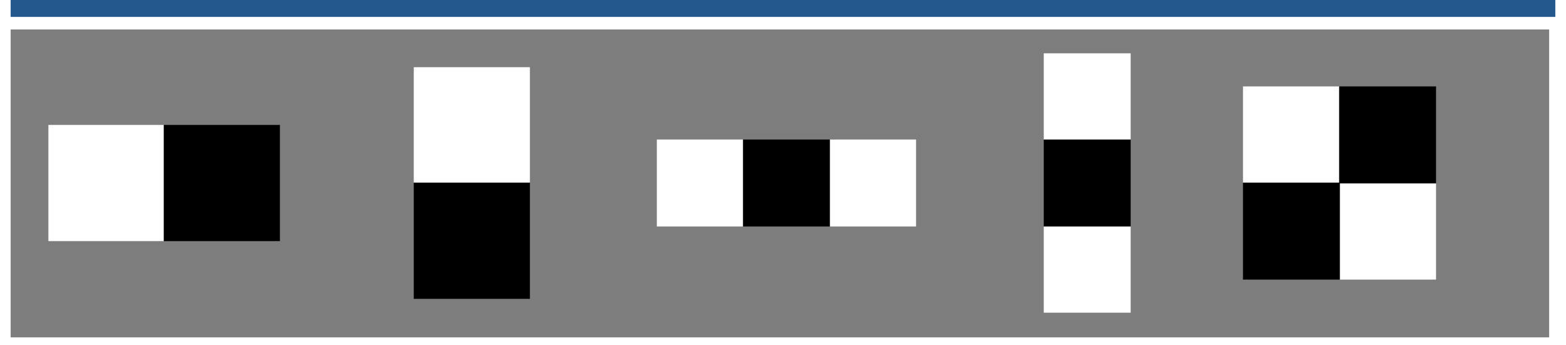

Fig 1: The five basic features used. All other feasters can be obtained by stretching these, and reversing the colors.

Fig 2: An example of how Haar features may be used to represent a face. [1]

A face detection algorithm uses Haar features to identify the large facial features. All of the Haar features necessary that are needed to identify a face may be derived by stretching and inverting the colors of the five features shown in figure 1, In a typical face detection application there are about 160,000 different features to consider![2] To narrow this down to a reasonable number we use Adaboost.

Adaboost

Adaboost is a machine learning algorithm that selects the best features to identify faces with. One starts out with a large number of **weak classifiers**. A weak classifier is given by $h(x, f, p, \theta) = 1\ if\ pf(x) < p\theta\ and = 0\ otherwise$. Where x is an image, f is a Haar feature, p is a polarity that equals 1 or -1, θ is a threshold, and $f(x)$ is how well the feature matches the image. 1 means there is a face and 0 means there is no face. A weak classier should be able to identify faces with slightly above 50% accuracy.

We want to create a **strong classifier**, basically a linear combination of the best weak classifiers which is more accurate than a single weak classifier. To do this we use Adaboost, which runs for T training rounds. For $1 \le t \le T$ we find the weak classifier which minimizes the weighted error: $\epsilon_t = \sum_i w_i |h(x_i, f_t, p_t, \theta_t) - y_i|$ where x_i, f_t, p_t minimize ϵ_t, and y_i=1,0 faces and non-faces respectively. The weights w_i are updated for the next training round. We define $h_t(x) = h(x, f_t, p_t, \theta_t)$ and $\alpha_t = log\left(\frac{1-\epsilon_t}{\epsilon_t}\right)$. Our strong classifier is then: $C(x) = 1$ if $\sum_{t=1}^{T} \alpha_t h_t(x) \ge \frac{1}{2}\sum_{t=1}^{T} \alpha_t$ and $= 0$ otherwise. [2]

Cascaded Classifiers

Unfortunately, evaluating a single strong classifier at every location on an image in search of a face is very inefficient, so we use a **cascaded classifier**. A cascaded classifier consists of many strong classifiers, called layers. The goal is for each layer to determine whether a sub-window is definitely not a face or maybe a face. [3] Each layer is trained to have a very high detection rate, but also a significant false positive rate.

The early layers contain only a few weak classifiers, so they are quick to evaluate. If a layer determines that a sub-window is possibly a face, it continues to the next layer. If a layer determines that a sub-window is definitely not a face, then the detector immediately proceeds to the next sub-window. So the vast majority of sub-windows are quick to evaluate.

References

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2. Viola, Paul, and Michael J. Jones. "Robust Real-Time Face Detection." *International Journal of Computer Vision* 57.2 (2004): 137-154.
3. Jensen, Ole Helvig. "Implementing the Viola-Jones Face Detection Algorithm." Diss. Technical U of Denmark, 2008. Web.

Detection Results

Isabelle Stuff

More Isabelle Stuff?