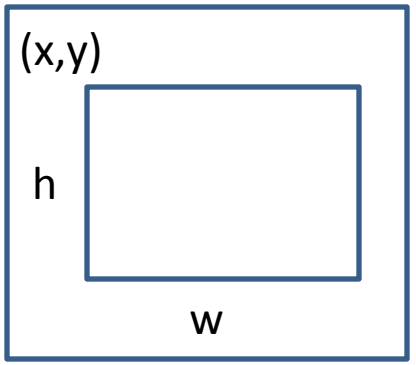
Assignment 4

Face Detection

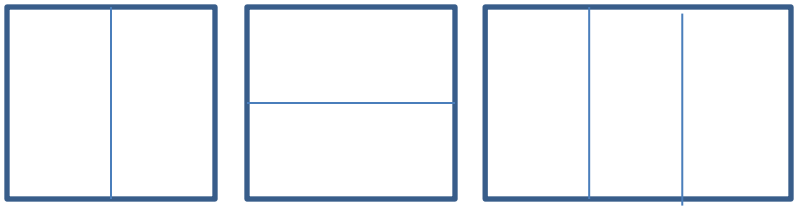
Overview

- large number of initial weak classifiers
- each weak classifier computes one rectangular feature
- the program computes the best threshold and polarity for each weak classifier
- Adaboost selects a subset of these classifiers and assigns a weight to each one
- Final classifications of boxes in test images are based on a combination of the selected ones.

Initializefeatures



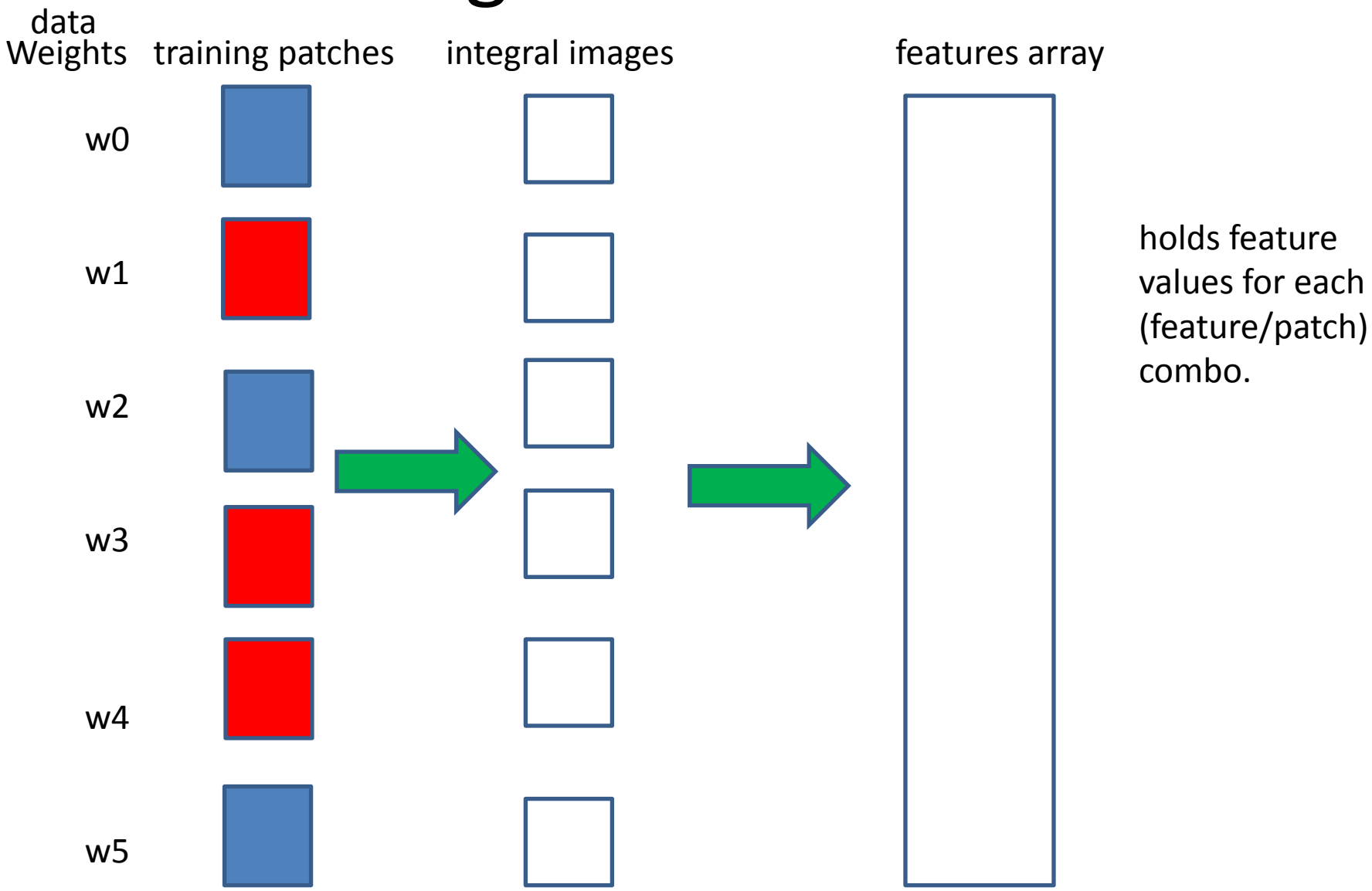
- Given in the code base
- Initializes all weak classifiers
- Chooses the upper left corner (x,y) and the height and width h and w randomly (but from 0 to 1)
- Chooses type of box
  - vertical 2-box
  - horizontal 2-box
  - vertical 3-box
- Sets area



ComputeTrainingSetFeatures

- Given in the code base as a shell
- Calls two methods that you code
  - IntegralImage: computes the integral image for each training patch
  - ComputeFeatures: uses the integral image for each training patch to compute features for that patch, one for each weak classifier, and puts them in an array called features.

Training Data and Features



AdaBoost

- Given in the code base
- Starts with uniform weights on training patches
- For each weak classifier
  - sorts the feature values in ascending order
  - results of sort go in featureSort and featureSortIdx
  - selects numWeakClassifiers weak classifiers through calling **FindBestClassifier** for all candidates and selecting the ones with lowest errors
- updates weights on patches in dataWeights
- computes current total error for the training data and scores for each sample for debug purposes

Initializing features

Function ComputeTrainingSetFeatures

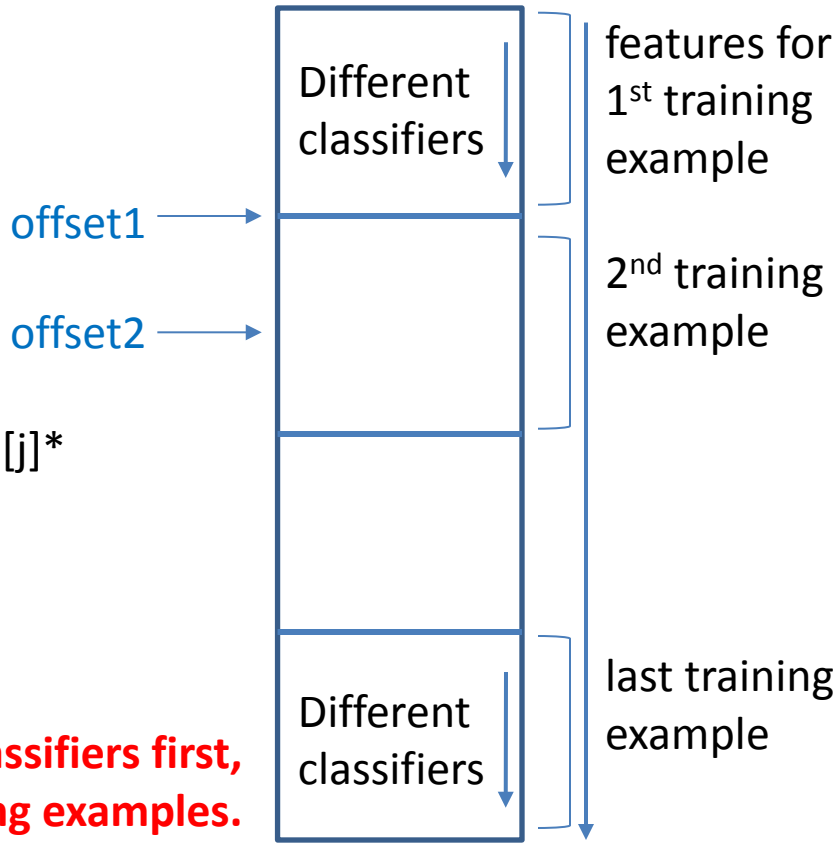
```
for(i=0;i<numTrainingExamples;i++)
  {          .....
        ComputeFeatures(integralImage, 0, 0, patchSize,
        &(features[i*numWeakClassifiers]), weakClassifiers, numWeakClassifiers,
        patchSize);
  }
```

feature offset1: i * numWeakClassifiers

Function ComputeFeatures

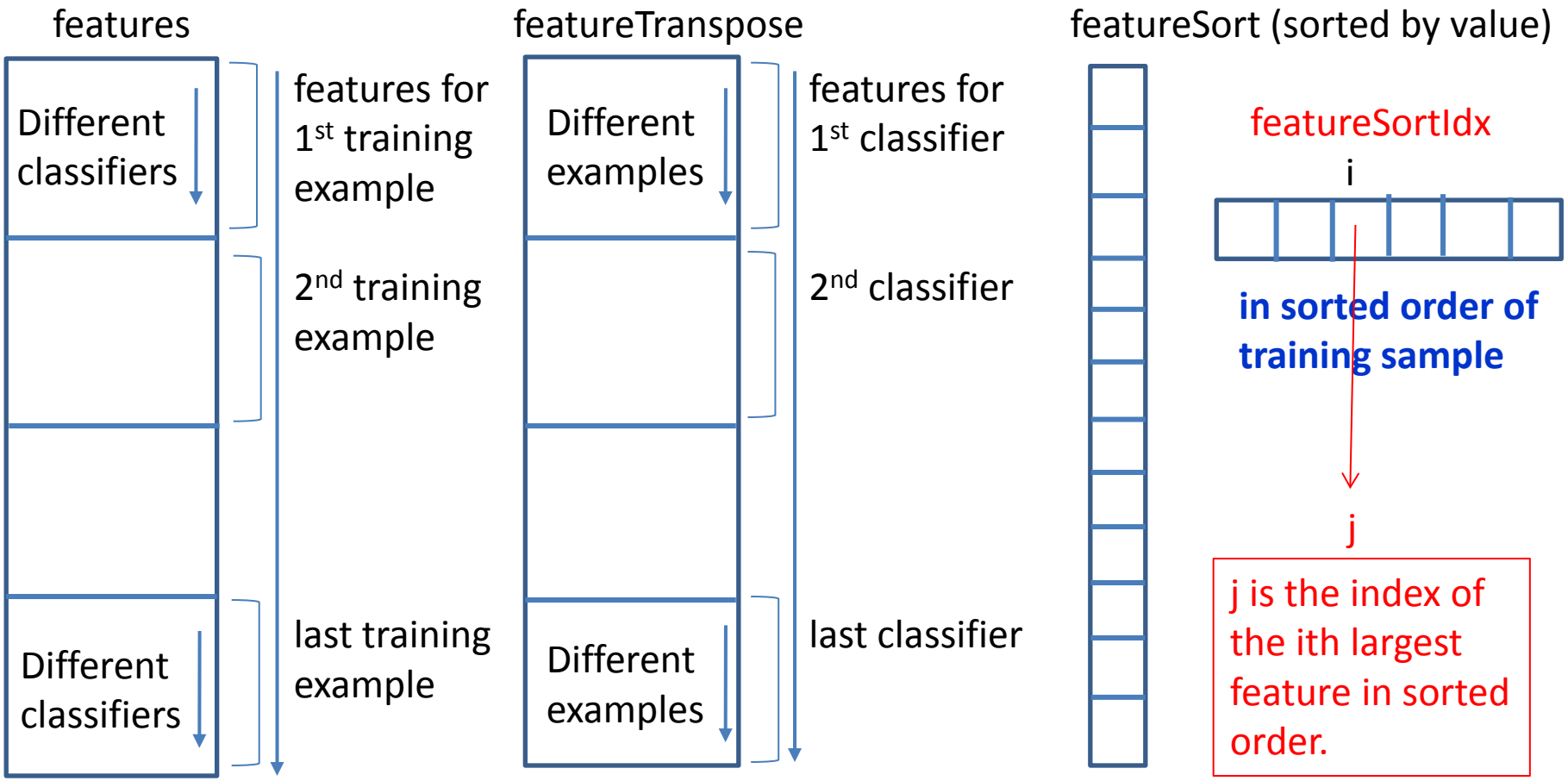
```
for(i=0;i<numWeakClassifiers;i++)
  {          ......
     features[i] += weakClassifiers[i].m_BoxSign[j]*
        sum/((double) (size*size));
  }
```

feature offset2: offset1 + i



features iterates over classifiers first, and then training examples.

Feature Sorting

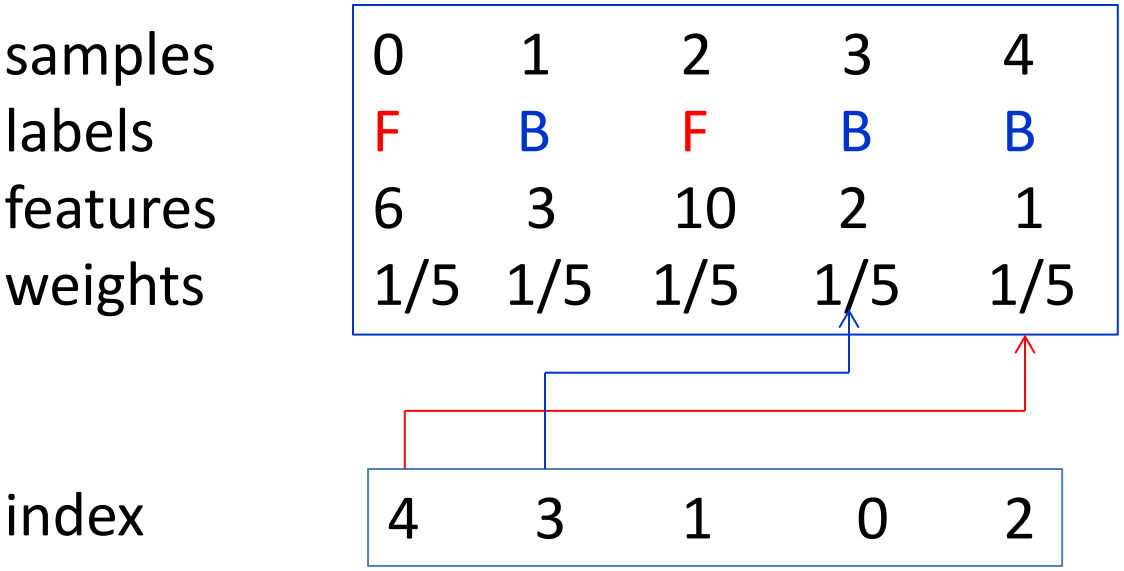


featureSort is only for ONE classifier at a time.

findBestClassifier

- you write it
- It is called by AdaBoost with a candidate classifier
- It is given the sort index which indexes into
  - features
  - weights
  - training labels
- Use it to go through the training samples (in sorted order), compute error for the classifier using the formula from the lecture (slides 30-32).
- Return threshold, classifier weight, and polarity

Using the Sort Index: Example



The feature values are for one particular feature (classifier).

The index tells you the sorted order of the features.

Setting the Polarity

error = min (BG + (AFS – FS), FS + (ABG –BG))
left right

- When left < right, set polarity to 0
- Else set polarity to 1

Threshold and Polarity Example

error = min (BG + (AFS – FS), FS + (ABG –BG))

samples	0	1	2	3	4
labels	F	B	F	B	B
features	6	3	10	2	1
weight	1/5	1/5	1/5	1/5	1/5
index	4	3	1	0	2

initialize
AFS = 0
ABG = 0
besterr = 999999

AFS becomes sum of face sample weights = 2/5; ABG = 3/5

step 0: idx = 4; FS stays 0; BG = 1/5
error = min(1/5 + (2/5-0), 0 + (3/5-1/5))= 2/5
besterr = 2/5; bestpolarity = 1; bestthreshold=1

step 1: idx = 3; FS stays 0; BG = 2/5
error = min(2/5 + (2/5-0), 0 + (3/5-2/5))= 1/5
besterr = 1/5; bestpolarity = 1; bestthreshold=2

Threshold and Polarity Example

error = min (BG + (AFS – FS), FS + (ABG –BG))

samples	0	1	2	3	4
labels	F	B	F	B	B
features	6	3	10	2	1
weight	1/5	1/5	1/5	1/5	1/5
index	4	3	1	0	2

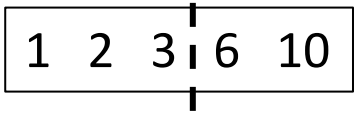
initialize
AFS = 0
ABG = 0
besterr = 999999

step 2: idx = 1; FS stays 0; BG = 3/5
error = min(3/5 + (2/5-0), 0 + (3/5-3/5))= 0
besterr = 0; bestpolarity = 1; bestthreshold=3

step 3: idx = 0; FS = 1/5; BG = 3/5
error = min(3/5 + (2/5-1/5), 1/5 + (3/5-3/5))= 1/5
NO CHANGE

step 4: idx = 2; FS = 2/5; BG = 3/5
error = min(3/5 + (2/5-2/5), 2/5+ (3/5-3/5))= 2/5
NO CHANGE

RESULT



θ > 3