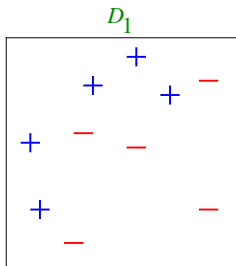
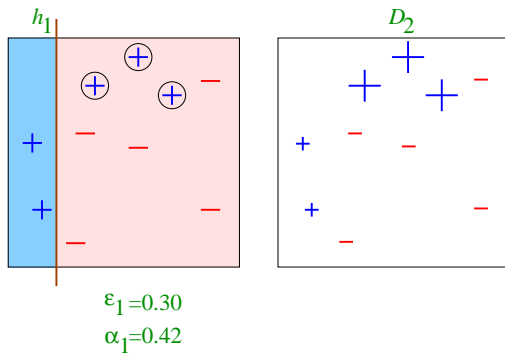


Toy Example

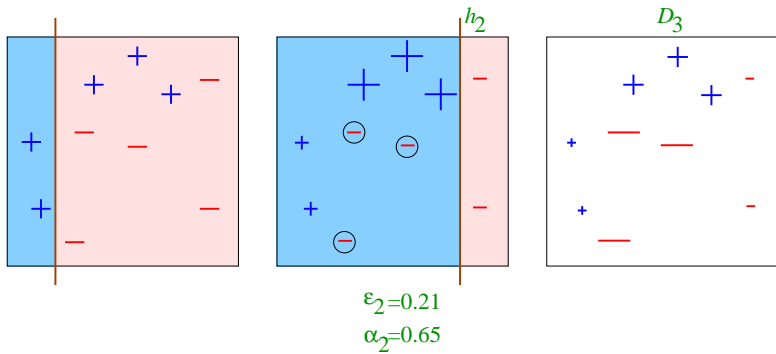


weak classifiers = vertical or horizontal half-planes

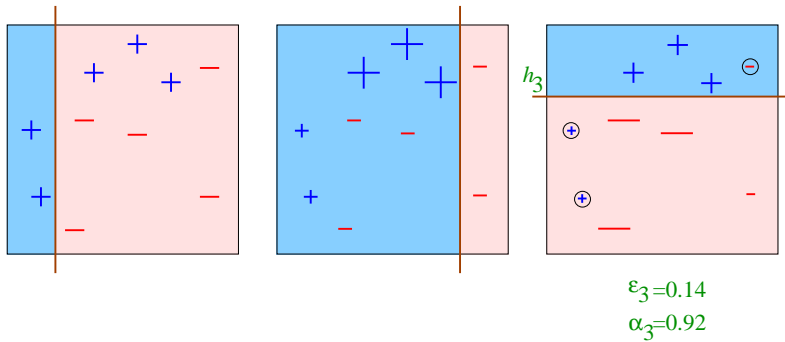
Round 1



Round 2



Round 3



Final Classifier

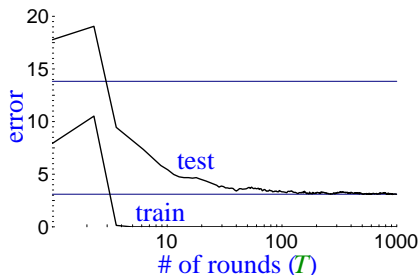
$$H_{\text{final}} = \text{sign} \left(0.42 \begin{array}{|c|} \hline \text{blue} \\ \hline \end{array} + 0.65 \begin{array}{|c|} \hline \text{blue} \\ \hline \end{array} + 0.92 \begin{array}{|c|} \hline \text{blue} \\ \hline \end{array} \right)$$

$$= \begin{array}{|c|} \hline \begin{array}{|c|} \hline \text{blue} \\ \hline \end{array} \\ \hline \end{array}$$

The diagram illustrates the final classifier's decision boundary. It shows a 2D space partitioned into regions by three vertical lines. The regions are colored blue or red based on the sign of the weighted sum of the three weak classifiers. The regions are labeled with '+' (blue) and '-' (red) signs.

Region	Color	Label
Leftmost	Blue	+
Top-middle	Blue	+
Bottom-middle	Red	-
Rightmost	Red	-

Actual Typical Run



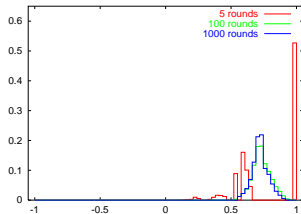
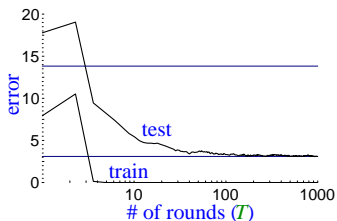
- test error does **not** increase, even after 1000 rounds
 - (total size > 2,000,000 nodes)
- test error continues to drop even after training error is zero!

	# rounds		
	5	100	1000
train error	0.0	0.0	0.0
test error	8.4	3.3	3.1

- Occam's razor **wrongly** predicts "simpler" rule is better

The Margin Distribution

- margin distribution
= distribution of margins of training examples

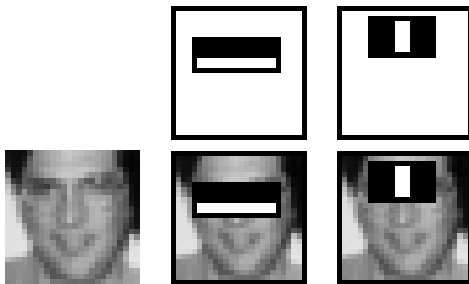


	# rounds		
	5	100	1000
train error	0.0	0.0	0.0
test error	8.4	3.3	3.1
% margins ≤ 0.5	7.7	0.0	0.0
minimum margin	0.14	0.52	0.55

Application: Detecting Faces

[Viola & Jones]

- **problem**: find **faces** in photograph or movie
- **weak classifiers**: detect light/dark rectangles in image



- many clever tricks to make extremely fast and accurate