

## LECTURE 3

## I, ENTROPY

## RELATIVE ENTROPY

- MEASURE OF PROGRESS

IN ANALYSIS OF EXPERT ALGS

## II, LINEAR REGRESSION

- DERIVING UPDATES WITH

SQUARED EUCLIDEAN DISTANCE

AND RELATIVE ENTROPY AS

REGULARIZER

## III, LEARNING W. LINEAR THRESHOLD FUNCTIONS

## IV, LOGISTIC REGRESSION

WANT TO SEND SYMBOL  $X$  ON CHANNEL

$X$	$P(X=x_i)$	$-\log P(x_i)$	} BITS
$x_1$	$\frac{1}{2}$	1	
$x_2$	$\frac{1}{4}$	2	
$x_3$	$\frac{1}{8}$	3	
$x_4$	$\frac{1}{8}$	3	



MEASURE OF SURPRISE

$$-\log 1 = 0 \quad \text{NO SURPRISE}$$

$$-\log 0 = \infty \quad \text{INFINITE ''}$$

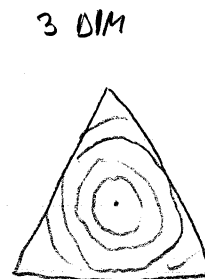
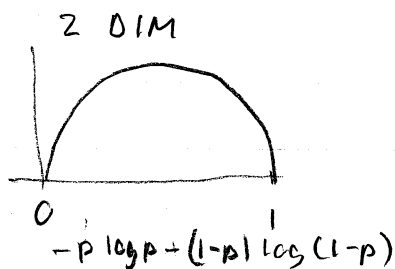
$$-\log 2^i = i \quad \text{BITS}$$

ENTROPY EQUALS EXPECTED SURPRISE

$$H(X) := \sum_i p(x_i) \log_2 \frac{1}{p(x_i)}$$

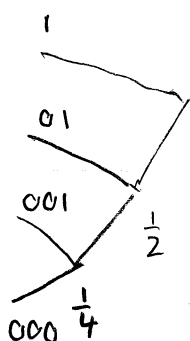
$$= \frac{1}{2} \cdot 1 + \frac{1}{4} \cdot 2 + \frac{1}{8} \cdot 3 + \frac{1}{8} \cdot 3$$

$$= 1 \frac{3}{4}$$

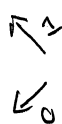


HUFFMAN CODE

$x_1$	$\frac{1}{2}$
$x_2$	$\frac{1}{4}$
$x_3$	$\frac{1}{8}$
$x_4$	$\frac{1}{8}$



LOOP



PICK SMALLEST TWO  
COMBINE BOTH INTO ONE  
SUM THEIR PROBS

ENTROPY = EXPECTED CODELENGTH

X

$x_1$	$\frac{1}{3}$
$x_2$	$\frac{1}{3}$
$x_3$	$\frac{1}{3}$



$$H(X) = \log_2 3 = 1.58 \text{ BITS}$$

$$\text{EXPECTED CODELENGTH} = \frac{1}{3} (1 + 2 + 2)$$

$$= \frac{5}{3}$$

$$= 1.66 \text{ BITS}$$

