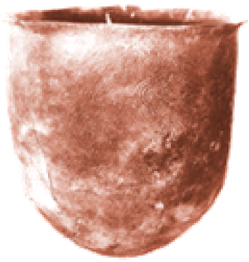
INFORMATION & PROBABILITY



P(R)

INFORMATION THEORY

Information

Computational Biology
- system
- observation, experiment
- abstraction
- analysis/modeling/simulation

PROBABILITY

System, States

(*e.g.*, particles in 'ideal gas' with v = 2 ms^{-1}
savannah elephants with 6 teeth)

initially G states available, $P(j)_i = 1 / G$

finally H states available, $P(j)_f = 1 / H$

LOGARITHMS

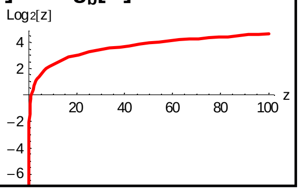
$\text{Log}_b[Z]$: the exponent that base b must be raised to obtain Z

e.g., $\text{Log}_{10}[100] = 2$; $\text{Log}_2[32] = 5$

$\text{Log}_b[G / H] = \text{Log}_b[G] – \text{Log}_b[H]$

$\text{Log}_b[1] = 0$

$\text{Log}_b[b] = 1$



INFORMATION

Binary Information Unit (bit)

1 bit = the information that is required to choose between 2 equiprobable events

bits received	P(j)
1	G / 2
2	G / 4
…	…
I	$G / 2^I$

PROBABILITY & INFORMATION

$G / 2^I = H$

$2^I = G / H$

$I = (\text{Log}_{10}[G] / \text{Log}_{10}[2]) - (\text{Log}_{10}[H] / \text{Log}_{10}[2])$

$I = - \Sigma (P(j)_i \text{Log}_2[P(j)_i]) + \Sigma (P(j)_f \text{Log}_2[P(j)_f])$

$S = - \Sigma (P(j) \text{Log}_2[P(j)])$

$I = -\Delta S = S_i - S_f$

A FLIPPING FAIR COIN

e.g., $P(H)_i = 0.5$ $P(T)_i = 0.5$

$P(H)_f = 1$ $P(T)_f = 0$

$I = -\Delta S = S_i - S_f$

$I = Log_2[2] + Log_2[1] = 1bit$

1 bit is required to reduce the initial state to the final state

MINIMUM INFORMATION

Maximum Ignorance I

maximise $I = \Sigma (P(j) Log_2[P(j)])$**, sum over G**

$\Sigma P(j) = 1$**, sum over G**

$P(G) = 1 - \Sigma P(j)$**, sum over G – 1**

$I = \Sigma (P(j) Log_2[P(j)]) + P(G) Log_2[P(G)]$

MAXIMUM IGNORANCE

$I = \Sigma (P(j) Log_2[P(j)]) + P(G) Log_2[P(G)]$

$(\delta / \delta P(k)) I =$
$(\delta / \delta P(k)) (P(k) Log_2[P(k)] + P(G) Log_2[P(G)])$

$0 = Log_2[P(k)] + 1 - Log_2[P(G)] + -1$

$0 = Log_2[P(k)] - Log_2[P(G)]$

$P(k) = P(G)$

INFORMATION & PROBABILITY

Equiprobable states entail that

P(k) = P(G)

all Ps are equal at the minimum information configuration

to weight any P differently would require information

(*e.g.*, flipping a biased coin)