# ITC Sem IV Tutorial 1

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Q1) Define Self information.

→ It is defined as the amount of information that gives knowledge about outcome of a certain event, adds to someone's overall knowledge. The amount of self information is expressed in the unit of information : a bit and is represented by symbol I.

- The smaller is the probability of an event, the larger is the self information associated with receiving the information that the event indeed occured.

- The self information $I(W_n)$ associated with the outcome $W_n$ is :

$$I(W_n) = \log_2\left(\frac{1}{P_x(W_n)}\right) = -\log_2(P_x(W_n))$$

Q2) The information source can output 4 possible symbols $S = \{S1, S2, S3, S4\}$ with corresponding probabilities p1, p2, p3, p4 given below. Show that entropy is highest when all S have equal probability.

(a) $P = \{0.1, 0.2, 0.3, 0.4\}$
(b) $P = \{0.2, 0.3, 0.3, 0.2\}$
(c) $P = \{0.25, 0.25, 0.25, 0.25\}$

i) $P = \{0.1, 0.2, 0.3, 0.4\}$

$\therefore P(A_1) = 0.1 \quad P(A_2) = 0.2$
$P(A_3) = 0.3 \quad P(A_4) = 0.4$

From the above formula,

$$H(A) = 0.1 \log_2 \frac{1}{0.1} + 0.2 \log_2 \frac{1}{0.2} + 0.3 \log_2 \frac{1}{0.3} + 0.4 \log_2 \frac{1}{0.4}$$

$$= 0.1(3.32) + 0.2(2.32) + 0.3(1.74) + 0.4(1.32)$$

$$= 0.332 + 0.464 + 0.522 + 0.528$$

$$\boxed{H(A) = 1.846 \text{ bits/symbol}} \quad \text{---(i)}$$

ii) $P = \{0.2, 0.3, 0.3, 0.2\}$

$P(A_1) = 0.2 \quad P(A_2) = 0.3$
$P(A_3) = 0.3 \quad P(A_4) = 0.2$

From the above formula,

$$H(A) = 0.2 \log_2 \frac{1}{0.2} + 0.3 \log_2 \frac{1}{0.3} + 0.3 \log_2 \frac{1}{0.3} + 0.2 \log_2 \frac{1}{0.2}$$

$$= 0.464 + 0.522 + 0.522 + 0.464$$

$$\boxed{H(A) = 1.972 \text{ bits/symbol}} \quad \text{---(ii)}$$

iii) $P = \{0.25, 0.25, 0.25, 0.25\}$

$P(A_1) = P(A_2) = P(A_3) = P(A_4) = 0.25$

From the above formula,

$$H(A) = 0.25 \log_2 \frac{1}{0.25} \times 4$$

$$= \log_2 \frac{1}{0.25}$$

$$\boxed{H(A) = 2 \text{ bits/symbol}} \quad \text{——— (iii)}$$

From (i), (ii), (iii) we observe that, $H(A)$ of (iii) is highest when all events have equal probability.