Important Information Theory And Coding Formulas PDF

Formulas
Examples
with Units

List of 15
Important Information Theory And Coding Formulas

1) Continuous Channels Formulas

1.1) Amount of Information Formula

Evaluate Formula

Formula	Example with Units
$I = \log2\left(\frac{1}{P_k}\right)$	$2\,\text{bits} = \log2\left(\frac{1}{0.25}\right)$

1.2) Channel Capacity Formula

Evaluate Formula

Formula	Example with Units
$C = B \cdot \log2\left(1 + SNR\right)$	$14.9339\,\text{b/s} = 3.4\,\text{Hz} \cdot \log2\left(1 + 20\,\text{dB}\right)$

1.3) Data Transfer Formula

Evaluate Formula

Formula	Example with Units
$D = \frac{F_S \cdot 8}{T}$	$36.3636\,\text{s} = \frac{5\,\text{bits} \cdot 8}{1.1\,\text{b/s}}$

1.4) Information Rate Formula

Evaluate Formula

Formula	Example with Units
$R = r_s \cdot H[S]$	$1800\,\text{b/s} = 1000\,\text{b/s} \cdot 1.8\,\text{b/s}$

1.5) Maximum Entropy Formula

Evaluate Formula

Formula	Example with Units
$H[S]_{max} = \log2\left(q\right)$	$4\,\text{bits} = \log2\left(16\right)$

1.6) Noise Power of Gaussian Channel Formula

Evaluate Formula

Formula	Example with Units
$N_o = 2 \cdot P_{SD} \cdot B$	$8.2E{+}22\,\text{pW} = 2 \cdot 1.2e10 \cdot 3.4\,\text{Hz}$

1.7) Noise Power Spectral Density of Gaussian Channel Formula

Evaluate Formula

Formula

$$P_{SD} = \frac{2 \cdot B}{N_o}$$

Example with Units

$$1.2E{+}10 = \frac{2 \cdot 3.4\,\text{Hz}}{578\,\text{pW}}$$

1.8) Nth Extension Entropy Formula

Evaluate Formula

Formula

$$H[S^n] = n \cdot H[S]$$

Example with Units

$$12.6 = 7 \cdot 1.8\,\text{b/s}$$

1.9) Nyquist Rate Formula

Evaluate Formula

Formula

$$N_r = 2 \cdot B$$

Example with Units

$$6.8\,\text{Hz} = 2 \cdot 3.4\,\text{Hz}$$

1.10) Symbol Rate Formula

Evaluate Formula

Formula

$$r_s = \frac{R}{H[S]}$$

Example with Units

$$1000\,\text{b/s} = \frac{1800\,\text{b/s}}{1.8\,\text{b/s}}$$

2) Source Coding Formulas

2.1) Coding Efficiency Formula

Evaluate Formula

Formula

$$\eta_c = \left(\frac{H_r[S]}{L \cdot \log2\left(D_s \right)} \right) \cdot 100$$

Example

$$0.081 = \left(\frac{1.13}{420 \cdot \log2\left(10 \right)} \right) \cdot 100$$

2.2) Coding Redundancy Formula

Evaluate Formula

Formula

$$R_{\eta c} = \left(1 - \left(\frac{H_r[S]}{L \cdot \log2\left(D_s \right)} \right) \right) \cdot 100$$

Example

$$99.919 = \left(1 - \left(\frac{1.13}{420 \cdot \log2\left(10 \right)} \right) \right) \cdot 100$$

2.3) R-Ary Entropy Formula

Evaluate Formula

Formula

$$H_r[S] = \frac{H[S]}{\log2\left(r \right)}$$

Example with Units

$$1.1357 = \frac{1.8\,\text{b/s}}{\log2\left(3 \right)}$$

2.4) Source Efficiency Formula

Evaluate Formula

Formula

$$\eta_s = \left(\frac{H[S]}{H[S]_{max}} \right) \cdot 100$$

Example with Units

$$45 = \left(\frac{1.8\,\text{b/s}}{4\,\text{bits}} \right) \cdot 100$$

2.5) Source Redundancy Formula

Evaluate Formula

Formula

$$R_{\eta s} = \left(1 - \eta \right) \cdot 100$$

Example

$$30 = \left(1 - 0.7 \right) \cdot 100$$

Variables used in list of Information Theory And Coding Formulas above

- **B** Channel Bandwidth *(Hertz)*
- **C** Channel Capacity *(Bit per Second)*
- **D** Data Transfer *(Second)*
- D_s Number of Symbols in Encoding Alphabet
- F_S File Size *(Bit)*
- $H_r[S]$ R-Ary Entropy
- $H[S^n]$ Nth Extension Entropy
- **H[S]** Entropy *(Bit per Second)*
- $H[S]_{max}$ Maximum Entropy *(Bit)*
- **I** Amount of Information *(Bit)*
- **L** Average Length
- **n** Nth Source
- N_o Noise Power of Gaussian Channel *(Picowatt)*
- N_r Nyquist Rate *(Hertz)*
- P_k Probability of Occurrence
- P_{SD} Noise Power Spectral Density
- **q** Total Symbol
- **r** Symbols
- **R** Information Rate *(Bit per Second)*
- r_s Symbol Rate *(Bit per Second)*
- $R_{\eta c}$ Code Redundancy
- $R_{\eta s}$ Source Redundancy
- **SNR** Signal to Noise Ratio *(Decibel)*
- **T** Transfer Speed *(Bit per Second)*
- η Efficiency
- η_c Code Efficiency
- η_s Source Efficiency

Constants, Functions, Measurements used in list of Information Theory And Coding Formulas above

- Functions: **log2**, log2(Number)
  The binary logarithm (or log base 2) is the power to which the number 2 must be raised to obtain the value n.
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Power** in Picowatt (pW)
  Power Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Data Storage** in Bit (bits)
  Data Storage Unit Conversion
- Measurement: **Data Transfer** in Bit per Second (b/s)
  Data Transfer Unit Conversion
- Measurement: **Sound** in Decibel (dB)
  Sound Unit Conversion

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