EC5.102: Information and Communication

Module: Modulator + Channels

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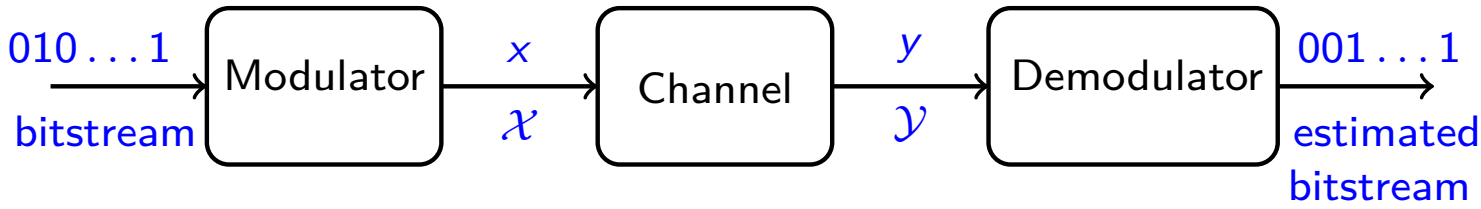
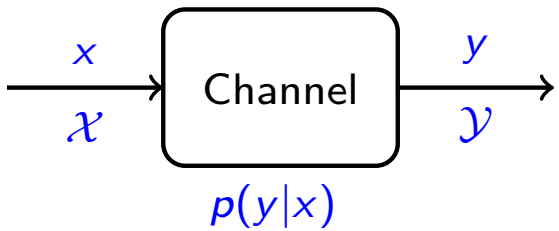
Channels

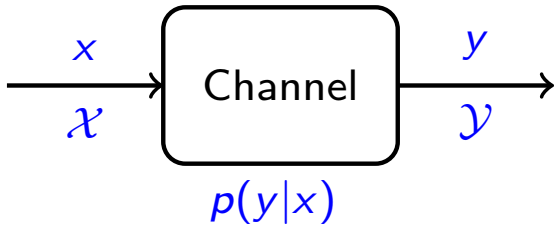
Modulator + Channels



- When I say the word "channel" what comes to your mind? Can you give examples?
- $x \rightarrow$ channel $\rightarrow y$
- How to model a channel mathematically using "probability"?
- Focus on channels:



Discrete memoryless channel (DMC)



- Examples of DMC: BSC, BEC
- Discrete channel: A discrete channel, denoted by $(\mathcal{X}, p(y|x), \mathcal{Y})$, consists of two finite sets $\mathcal{X}$ and $\mathcal{Y}$ and a collection of probability mass functions $p(y|x)$, for each $x \in \mathcal{X}$.
- Memoryless channel: The channel is said to be memoryless if the probability distribution of the output depends only on the input at that time and is conditionally independent of previous channel inputs or outputs.
- For DMC we have,

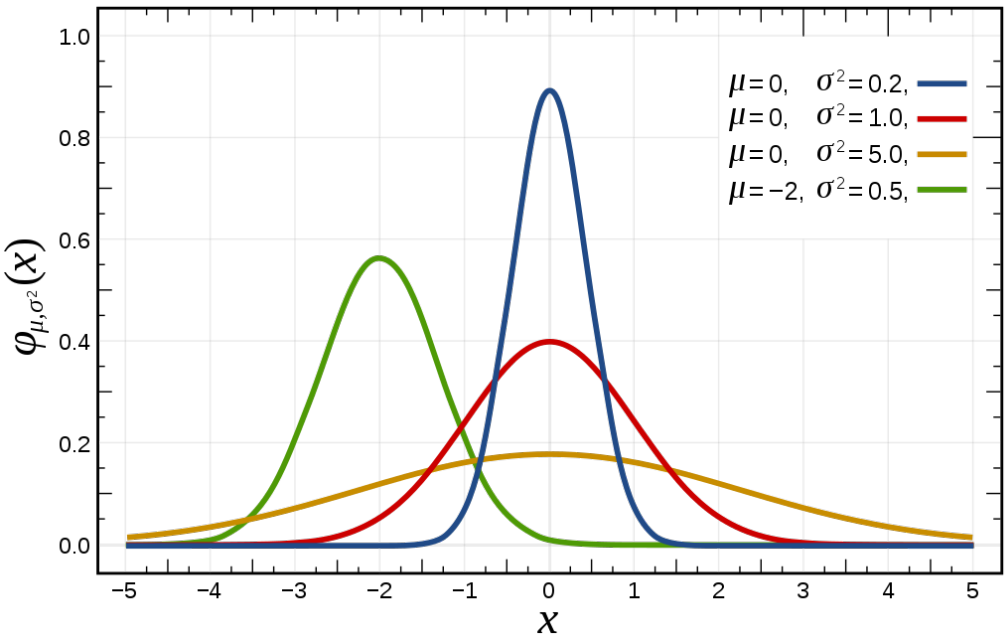
$$\mathbb{P}(\mathbf{y}|\mathbf{x}) = \prod_{i=1}^{n} p(y_i|x_i)$$

- AWGN is a continuous channel, not discrete. AWGN is a memoryless channel.

Additive white Gaussian noise (AWGN) channel

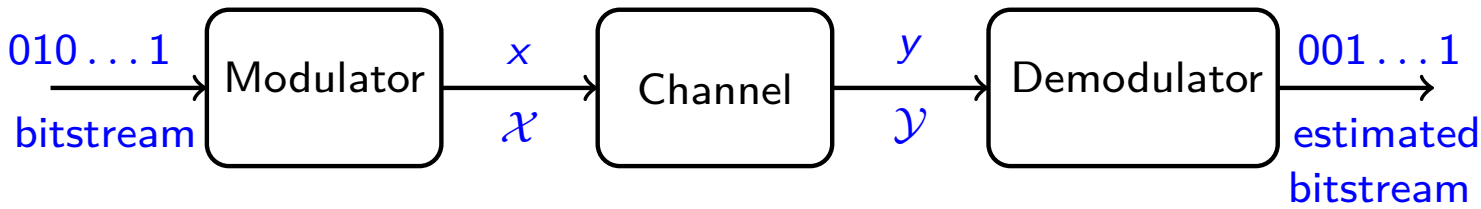
- For AWGN channel: $Y = X + Z$ where $Z \sim \mathcal{N}(0, \sigma^2)$
- Support set of X depends on the underlying modulation scheme.
- Recall: PDF of a Gaussian r.v. $\mathcal{N}(\mu, \sigma^2)$ with parameters μ and σ is given by

$$f_Z(z) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{(z-\mu)^2}{2\sigma^2}}$$



Modulation

BPSK Modulator



- BPSK modulator: Binary phase shift keying modulator
  - 0 is mapped to $+1$ Volts
  - 1 is mapped to -1 Volts
- Can I consider two bits together and assign a symbol to it? Yes!
- For BPSK we have: $\mathcal{X} = \{+1, -1\}$
- Binary-input AWGN (BI-AWGN) channel: BPSK + AWGN channel
- Idea behind demodulator (without derivation)
- Relation between BSC and BI-AWGN channel