Finding the Error Probability
Monte Carlo Simulation

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Decoding error

Definition (Decoding error)

A decoding error occurs when the decoder output $\hat{\mathbf{m}}$ is different from the transmitted message $\mathbf{m}$.

- The Hamming Code is small and simple
  - able to determine the probability of decoding error analytically
- Practical coding systems can be exceedingly complex
  - defeats analysis
- How else can we determine the probability of decoding error?

  Monte Carlo Simulations and Statistical estimation.

Why simulation?

- Statistics provide inferences from empirical data.
- Where do we get the empirical data?
  1. field data — real data from real life
  2. simulation — synthetic data simulation real life
- Field data is often a scarce resource
- Simulation synthesises data at will

Monte Carlo Simulation

A Monte Carlo simulation is a simulation using (pseudo)-random processes.

Simulator Output

- Run the simulator N times.
- Count the number of decoding errors X.
  - $0 \leq X \leq N$
- We get an error rate $R = X/N$.

  NB *The error rate is not the error probability.*
  We get back to that.

Closure

Exercise

Implement a Monte Carlo Simulator for the coding system

1. *Implement a function to generate random message*
2. *Implement a function to generate random noise (BSC)*
3. *Take the encoder/decoder functions from the web pages*
4. *Integrate the above function to a system to generate a random message, simulate transmission, and check for errors.*
5. *Implement a simulator iterating the above integrated system, counting the number of decoding errors.*

- There is a video to help you with the random generation.
- We will get back to the statistical analysis later.

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