

# Lab Assignment – Data Transmission

## Multimedia Networks

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Monday 10<sup>th</sup> February, 2025

This document is subjected to change, please consult the most recent version at: <https://github.com/GillesC/Data-Transmission---Multimedia-Networks>.

Adhere to the policies and guidelines of KU Leuven concerning the use of GenAI.

# 1 Introduction

Claude Shannon, an engineer at Bell Telephone Laboratories, and Warren Weaver sought to identify the quickest and most efficient way to get a message from one point to another. As a result of their studies, they developed their model of communication.

In these **three lab sessions** you are going to simulate a **communication model** as presented in Figure 1. This model is a simplified version of the Shannon-Weaver model of communication. The model will be implemented via **Python**. Through this model, the beneficial effects of source and channel coding are studied.

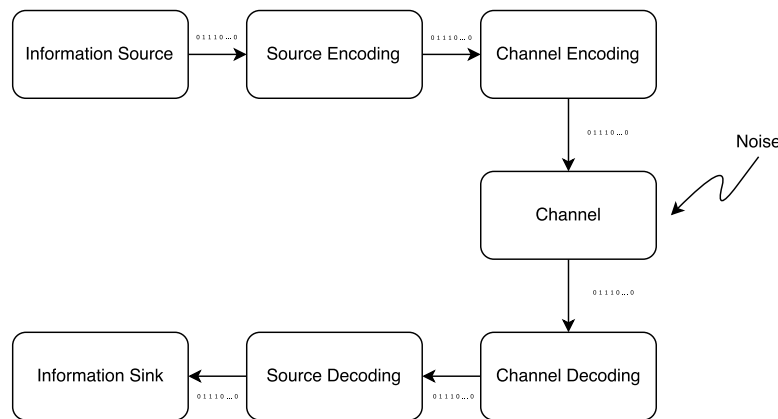


Figure 1: Simplified Model of Communication

## 2 Communication Model

An **image** will serve as the **information source**. To facilitate interoperability between the communication blocks, we suggest using a **bit stream** or a **byte stream** to **exchange** data between these blocks, i.e. every block will receive and send a bit or byte stream to the next one.

A Python template –and additional library functions– can be found in the the following Github repository: <https://github.com/GillesC/Communication-Model-Python>.

## 2.1 Source Encoding and Decoding

Use **Huffman** and **Lempel-Ziv-Welch** as a **source encoding** mechanism. Prior to using the provided template code, study the Huffman and Lempel-Ziv-Welch algorithm.

### Question 1

What is the purpose of source encoding? Try to find an example of a real-life scenario where the effect of absence of source encoding would be clearly noticeable.

### Question 2

Why does the Lempel-Ziv-Welch Algorithm not group the first occurrences of symbols when a combination of the symbols is present in the dictionary?

### Question 3

What are the disadvantages of Huffman coding with respect to LZW-coding?

### Question 4

What is the correlation between entropy and the number of bits per symbol in the context of compression?

## 2.2 Channel Encoding and Decoding

**Reed-Solomon** (RS) coding will be used for **channel encoding**. In this assignment modulation and channel characteristics can be neglected. After applying Reed-Solomon encoding,

- Simulate storing to disk
- Hence, simulate bit errors (and define an error rate)
- check if Reed-Solomon is able to resolve the introduced errors and compare with the theoretical limit (Singleton bound).
- burst errors
- erasures

#### Question 5

Experiment with the code-word length of an RS message, and conclude.

#### Question 6

Calculate the number of resolved and unrecoverable errors after introducing the bit errors and or erasures.

## 3 Objectives

- Build data transmission blocks via Python.
- Enable and disable blocks to determine their impact on the model.
- Measure the transmitted bit stream size of each block and conclude.
- Measure the operation duration of each block and conclude. For instance, why is Huffman decoding slower than Huffman encoding?

## 4 Evaluation – Quiz and Code

### 4.1 Quiz

The student will be evaluated using an intermediate quiz and source code. To prepare, consult the questions in this assignment and conduct the “experiments” and programming yourself. The quiz will assess that the student has **understood** the **communication model**, based on the aforementioned objectives.

### 4.2 Source Code

- All Python **code** must be well **documented**.
- The code has to be send to `gilles.callebaut@kuleuven.be` before the deadline communicated with you during the lab sessions or Toledo.
- Do **not** include your environment folder.
- Use the following file name format: `<firstname>_<lastname>_MMN_code.zip`.