Lab Assignment – Data Transmission

Multimedia Networks

Gilles Callebaut

Monday 23rd March, 2020

Lab session 1	21/02/2020 13h30 - 16h30
Lab session 2	06/03/2020 13h30 - 16h30
Lab session 3	20/03/2019 13h30 - 16h30
Deadline	04/04/2020 - 20h00

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

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.

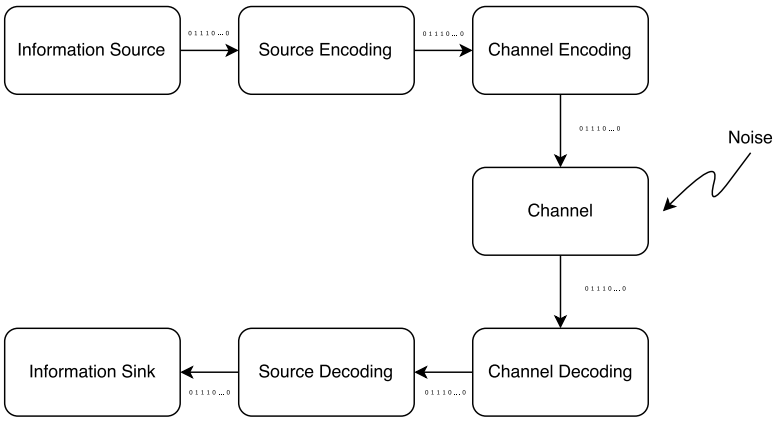

Figure 1: Simplified Model of Communication

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`. How to install the Python environment and the template code is discussed in the Appendix.

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 noticable.

Question 2

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

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 Report

Each student writes an **individual report**. This report must contain the **realization** of the aforementioned **objectives**. It must **demonstrate** that the student has **understood** the **communication model**.

All Python **code** must be well **documented**. The report and the code has to be send to `gilles.callebaut@kuleuven.be` and a printed version needs to be handed in. The **code** itself does **not** need to be **included and discussed** in the **report**. The report is expected to be structured and styled as described in [1, 2].

The report needs to be **submitted** before 04/04/2020 - 20h00.

File name format `<firstname>_<lastname>_MMN_report.pdf`

Language Dutch or English (recommended)

Number of pages Write your report in a compact but concise way, following the strategies presented in [1, 2].

A Install Python Environment and Template Code

- Install Python 3.X (be sure to install the 64-bit version if applicable)
- Install PyCharm or Visual Studio Code or your favorite edittor/IDE
- Download the template code from Github: `https://github.com/GillesC/Communication-Model-Python`.
- Navigate to the project directory
- Create a virtual environment in the project directory: `python -m venv .venv`
- Activate the virtual environment: `.\venv\Scripts\activate`
- Install the packages through: `pip install -r requirements.txt` (in the project folder).

References

[1] Barbara J Hoogenboom and Robert C Manske. How to write a scientific article. *International journal of sports physical therapy*, 7(5):512, 2012.

[2] Elena D Kallestinova. How to write your first research paper. *The Yale journal of biology and medicine*, 84(3):181, 2011.