Exercise

Authors:

Abate Kevin: **10812892**

Pigato Lorenzo: **10766953** [Team Leader]

EQ1

A LoRaWAN network in Europe (carrier frequency 868 MHz, bandwidth 125 kHz) is composed by one gateway and 50 sensor nodes. The sensor nodes transmit packet with payload size of L byte according to a Poisson process with intensity lambda = 1 packet / minute. Find the biggest LoRa SF for having a success rate of at least 70%. Hint: use https://www.thethingsnetwork.org/airtime-calculator to compute the airtime of a packet.

- Goal of the fist exercise is to find the **biggest LoRa SF** for having a **success rate** of at least 70%

Libraries

```
import math
from google.colab import files
from IPython.display import Image
```

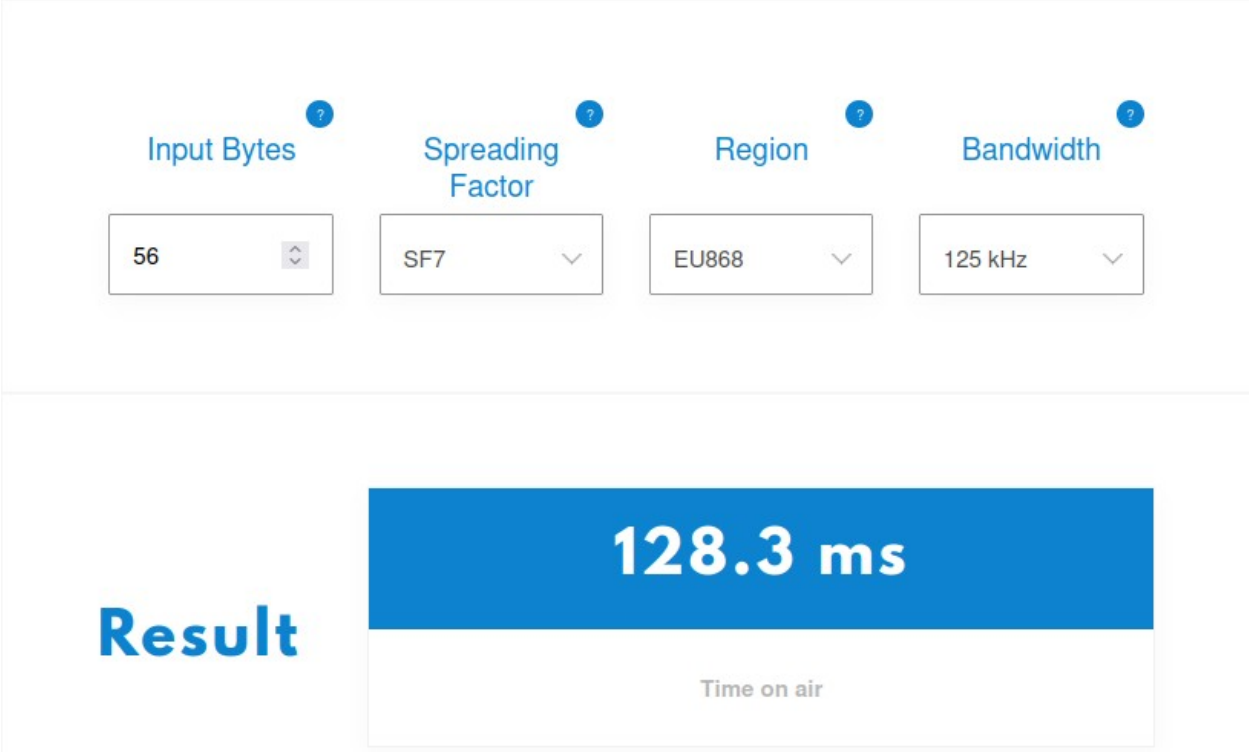
Variables of the system

```
frequency = 868 #MHz
bandwidth = 125 #kHz

sensorNodes = 50
payload = 3 + 53 #Byte
Lambda = 1 #packet/minute
Lambda_s =  Lambda * 60 #packet/s

LambdaSystem = sensorNodes / Lambda_s #packet/s
```

We'll implement ALOHA to handle the communiation of our system

In this case the calcus are done with the hypotesis of SF7. The air time of the packet is calculated with the suggested site on the description.

```
Image("/content/SP7.png")
```

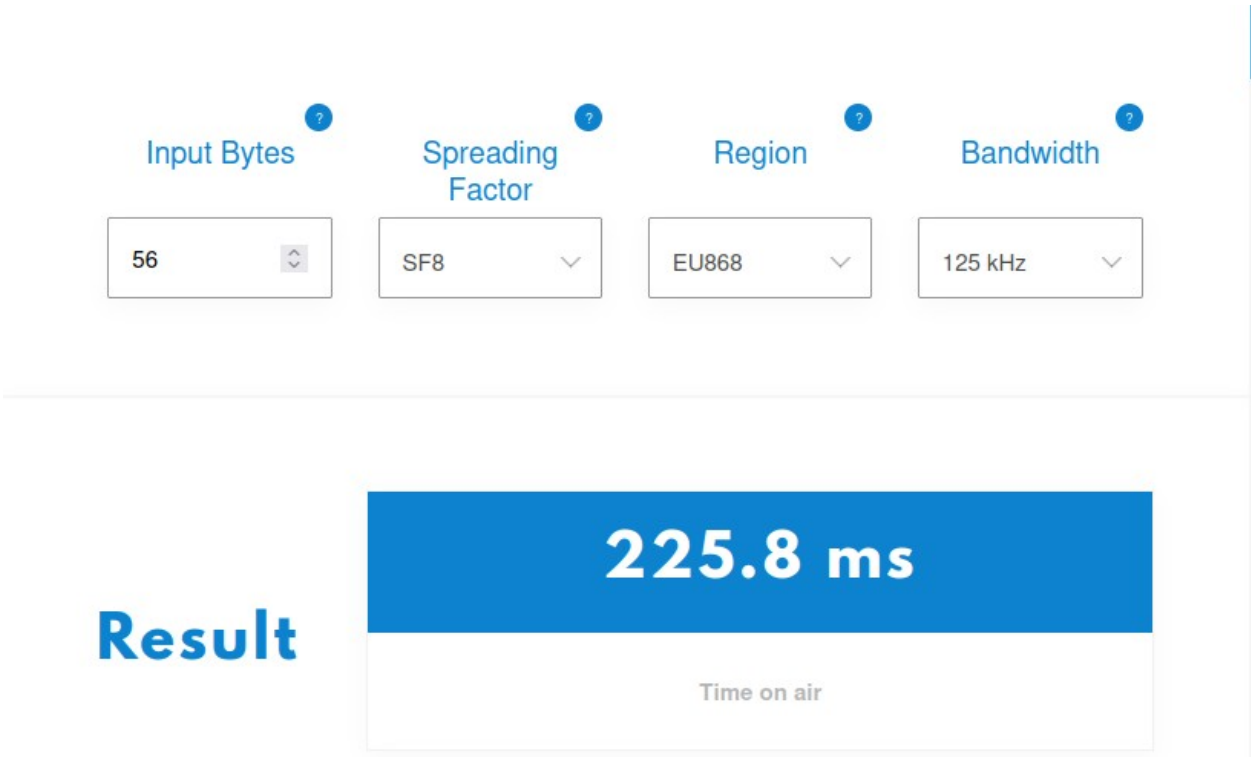



```
airtime_PacketS7 = 128.3 / 1000 #s
traffic = airtime_PacketS7 * LambdaSystem

Probability_Packet_retrasm = math.exp(-2 * traffic)

print("In this ways is possible to notice that the probability of
retrasmit a packet with a Spreading Factor 7 is: ",
Probability_Packet_retrasm)
```

```
In this ways is possible to notice that the probability of retrasmit a
packet with a Spreading Factor 7 is:  0.8074829543006469
```

Now we'll try to implement it with SF8

```
Image("/content/SP8.png")
```




```
airtime_PacketS8 = 225.8 / 1000 #s
traffic = airtime_PacketS8 * LambdaSystem

Probability_Packet_retrasmS8 = math.exp(-2 * traffic)
print("In this ways is possible to notice that the probability of
retrasmit a packet with a Spreading Factor 8 is: ",
Probability_Packet_retrasmS8)
```

```
In this ways is possible to notice that the probability of retrasmit a
packet with a Spreading Factor 8 is:  0.6863735037382898
```

We can notice that the probability is below the treshold, so the optimal spreading factor is equal to 7.

EQ 3

Using the paper "Do LoRa Low-Power Wide-Area Networks Scale?" by M. Bor et al. and the LoRa simulator available at LoRaSim, your task is to reproduce **Figure 5 and Figure 7** from the paper Instructions: 1.Read the Paper Carefully study the relevant sections of the paper to understand the experimental **setup, parameters, and key findings**, especially those associated with Figures 5 and 7. 2.Explore LoRaSim Familiarize yourself with how the LoRaSim simulator works. Understand its configuration options and how to run experiments that model LoRa network behavior. 3.Reproduce the Figures

1. Use LoRaSim to replicate the simulations that produced Figure 5 and Figure 7.

2. Ensure your simulation parameters (e.g., number of nodes, spreading factors, traffic load, transmission power, etc.) match those used in the original experiments as closely as possible.
3. Present your results in the same format as the original figures for easy comparison.“