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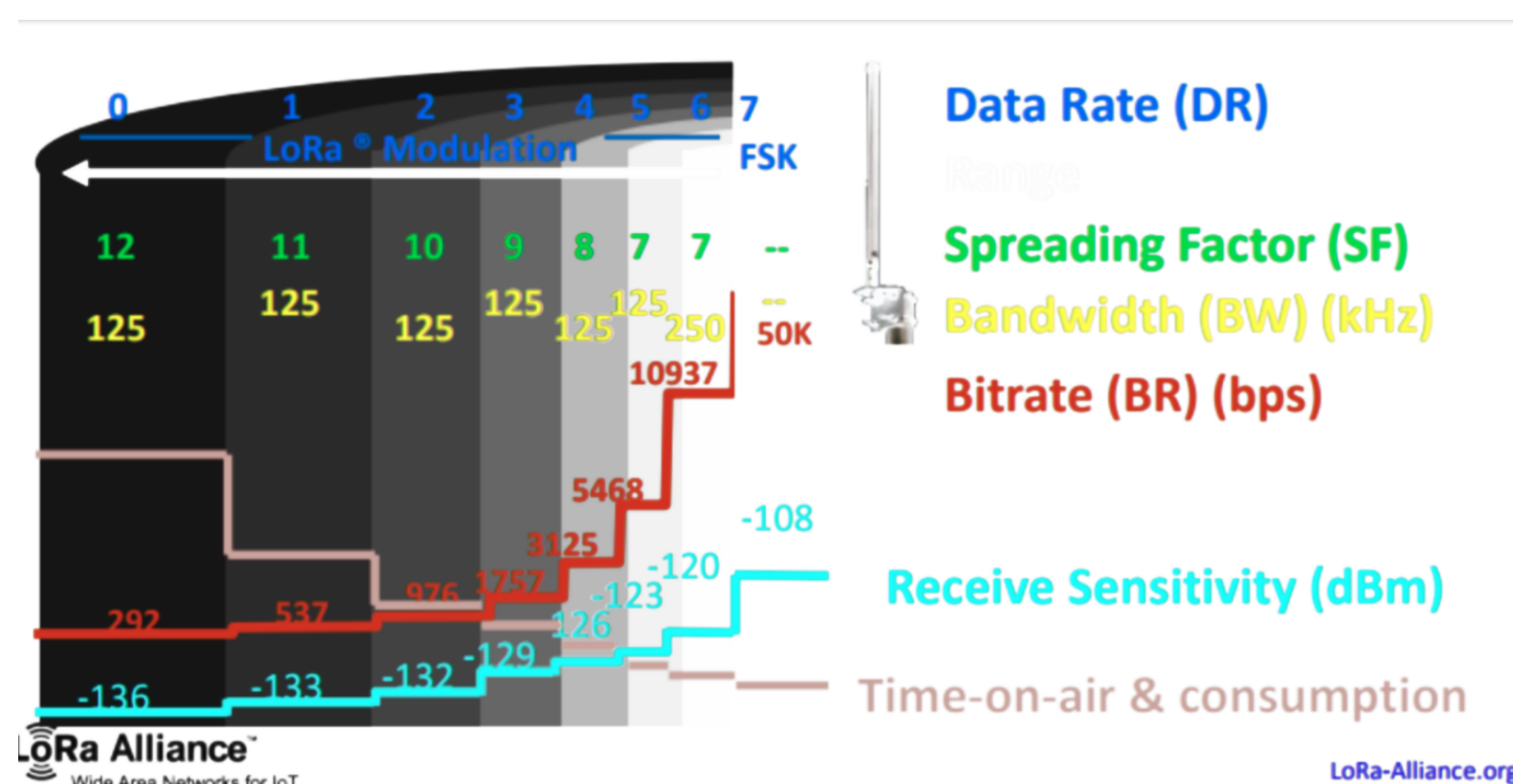
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 **ECE PARIS**  
ÉCOLE D'INGÉNIEURS

The need of new kind of wireless communication that could send data far away with limited resource constraints emerged recently to support IoT application like smart building smart environment monitoring. **LoraWan** is one of this emerging wireless network [1], it allows sensors to reach the gateway with start topology in a range up to 5Km. Unlike other technologies LoraWan is the best versatile solution to deploy IoT application in both urban and rural area where there is no communication infrastructure.

The physical layer of Lora technology (Semtech SX1276) has 4 parameters which make 6720 possible settings [2]:

- ➡ **SF:** Spreading factor [SF7 - SF12]
- ➡ **CR:** Coding rate [4/5 - 4/8]
- ➡ **BW:** Bandwidth [7.8Khz - 500Khz]
- ➡ **Tx:** Transmission power [-4dBm +20dBm]



A genetic algorithm is a heuristic search that is used to deal with selection and ranking problems [3]. This algorithm reflects the process of natural selection where the fittest configurations are selected for reproduction in order to produce offspring of the next generation.

- ▀ **Gene:** QoS metric.
- ▀ **Chromosome:** QoS of one configuration.
- ▀ **Population:** QoS of all configurations.

The diagram illustrates the concept of a gene and a chromosome in a population. On the left, a population of four individuals (A1, A2, A3, A4) is shown. Each individual has a chromosome represented by a row of six boxes. A1's chromosome is [0, 0, 0, 0, 0, 0], A2's is [1, 1, 1, 1, 1, 1], A3's is [1, 0, 1, 0, 1, 1], and A4's is [1, 1, 0, 1, 1, 0]. A red box highlights the last box (the 6th position) of A1's chromosome, labeled 'Gene'. A green box highlights the entire chromosome of A2, labeled 'Chromosome'. The entire group is labeled 'Population'. On the right, a vertical red line separates the population from a set of alleles. The alleles are shown as rows of six boxes: A1 [0, 0, 0, 0, 0, 0], A2 [1, 1, 1, 1, 1, 1], A5 [1, 1, 1, 0, 0, 0], and A6 [0, 0, 0, 1, 1, 1]. Green arrows point from the 6th position of each chromosome in the population to the corresponding allele in the set on the right.

- [1] Wael Ayoub, Abed Ellatif Samhat, Fabienne Nouvel, Mohamad Mroue, and Jean-Christophe Prevotet. Internet of Mobile Things: Overview of LoRaWAN, DASH7, and NB-IoT in LP-WANs Standards and Supported Mobility. 21(2):1561–1581. 00007.
- [2] Mahda Noura, Mohammed Atiquzzaman, and Martin Gaedke. Interoperability in Internet of Things: Taxonomies and Open Challenges. 00004.
- [3] Eleni I. Vlahogianni, Matthew G. Karlaftis, and John C. Golias. Optimized and meta-optimized neural networks for short-term traffic flow prediction: A genetic approach. 13(3):211–234. 00506.

The diagram illustrates the interaction between an HTTP Client, Servers, a CoAP/MQTT Broker, and a Constrained Network (IoT) cloud. The HTTP Client (represented by a laptop and a desktop computer) communicates with two Servers (represented by server racks) via HTTP (blue arrows). The top Server communicates with the CoAP/MQTT Broker (represented by a wireless router) via HTTP (blue arrow) and CoAP (green arrow). The bottom Server communicates with the CoAP/MQTT Broker via MQTT (red arrow) and CoAP (green arrow). The CoAP/MQTT Broker communicates with various IoT devices (represented by icons like a light bulb, microcontroller, camera, traffic light, and thermometer) within the Constrained Network (IoT) cloud via CoAP (green arrows) and MQTT (red arrow). The cloud is labeled "Constrained Network (IoT)".

**Definition:** stopping criteria, population size  $P$ , and mutation probability  $p_m$

**Generate** randomly the initial configurations

**repeat:**

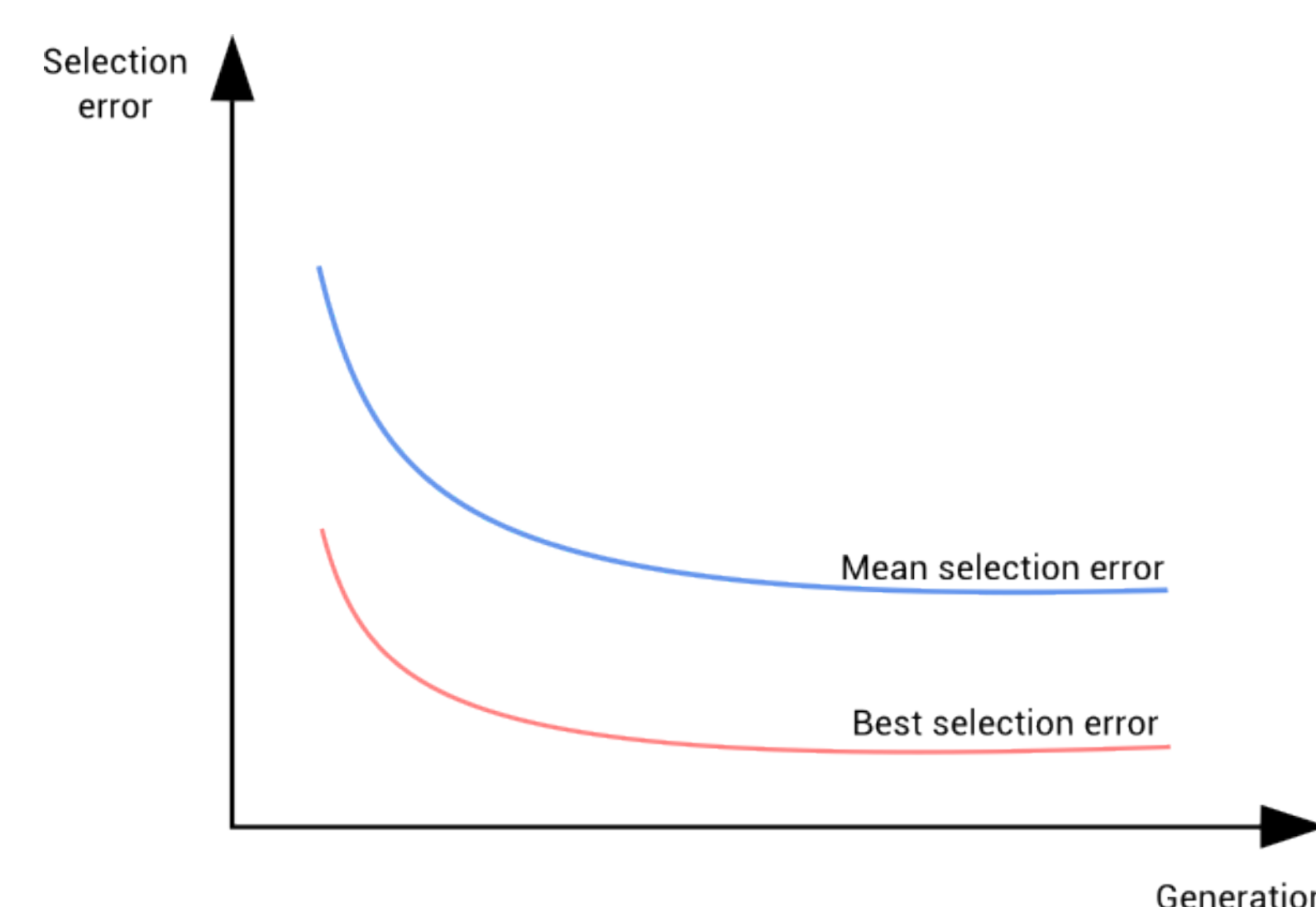
- ... **for** each configuration do
- ... Train a model & compute configuration's fitness
- ... **end**
- ... **for** each reproduction 1 ...  $P/2$  do
- ... **Select:** 2 configurations based on fitness
- ... **Crossover:** Produce 2 child configurations
- ... **Mutate:** child configurations with  $p_m$
- ... **end**

**until** stopping criterion are met

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graph TD
    A[Parameter initialization] --> B[Fitness function]
    B --> C[Crossover]
    C --> D[Mutation]
    D --> E[Survivor selection]
    E --> B
    E --> F[Ranked selection list]
    
```

In order to generate all the required metrics of each Lora configuration we use both simulation and real environment. We use ns3 simulator with 2 nodes and one gateway, the distance between each node and the gateway is set to 1km.



Setup	Selection error	Rank	Fitness
1	0.9	1	1.5
2	0.5	3	4.5
3	0.7	2	3
n	0.5	4	6

- ➡ **Advantages:** Genetic algorithms can manage data sets with many features. They don't need specific knowledge about the problem under study. These algorithms can be easily parallelized in computer clusters.
- ➡ **Drawbacks:** Genetic Algorithms might be very expensive in computational terms, since evaluation of each configuration requires building a predictive model. These algorithms can take a long time to converge, since they have a stochastic nature.
- ➡ **Conclusion:** Genetic algorithms can select the best subset of variables for our predictive model, but they usually require a lot of computation but edge computing could solve this problem.