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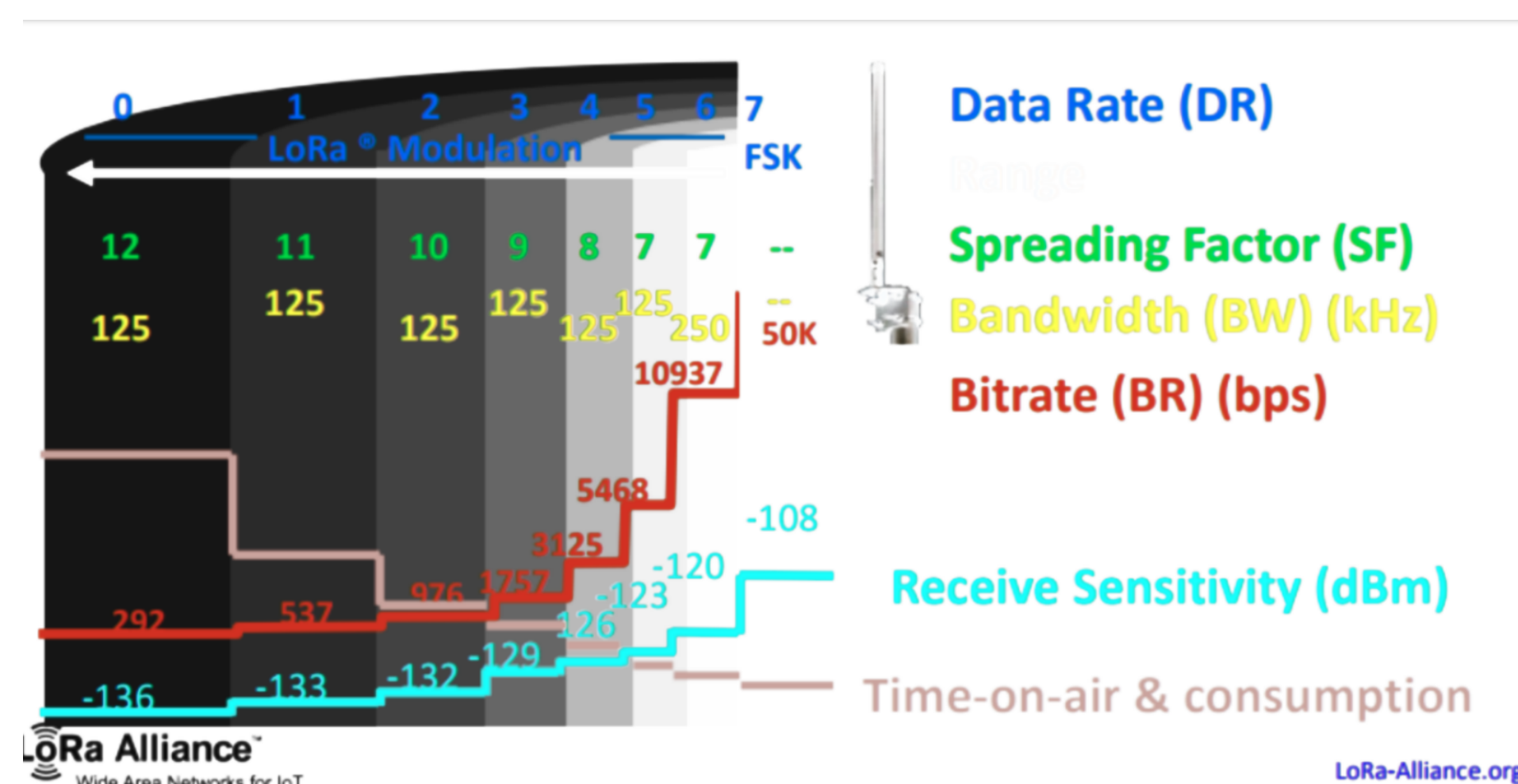


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ÉCOLE D'INGÉNIEURS

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 communication [1], it allows sensors to reach the gateway 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 search heuristic that is inspired by [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.

Diagram illustrating the concept of a gene in a population. The population consists of four individuals (A1, A2, A3, A4) represented by binary strings (0s and 1s). A specific bit position (the 6th bit) is highlighted as a "Gene" across all individuals. The entire set of individuals is labeled "Population".

Individuals and their genotypes:

- A1: 0 0 0 0 0 0
- A2: 1 1 1 1 1 1
- A3: 1 0 1 0 1 1
- A4: 1 1 0 1 1 0

Labels:

- Gene (red text)
- Chromosome (green text)
- Population (purple text)

On the right, a similar diagram shows a population of six individuals (A1 to A6) with a vertical red line indicating a crossover point between the 3rd and 4th bits. Green arrows point to the crossover point for A1 and A2.

Individuals and their genotypes:

- A1: 0 0 0 0 0 0
- A2: 1 1 1 1 1 1
- A5: 1 1 1 0 0 0
- A6: 0 0 0 1 1 1

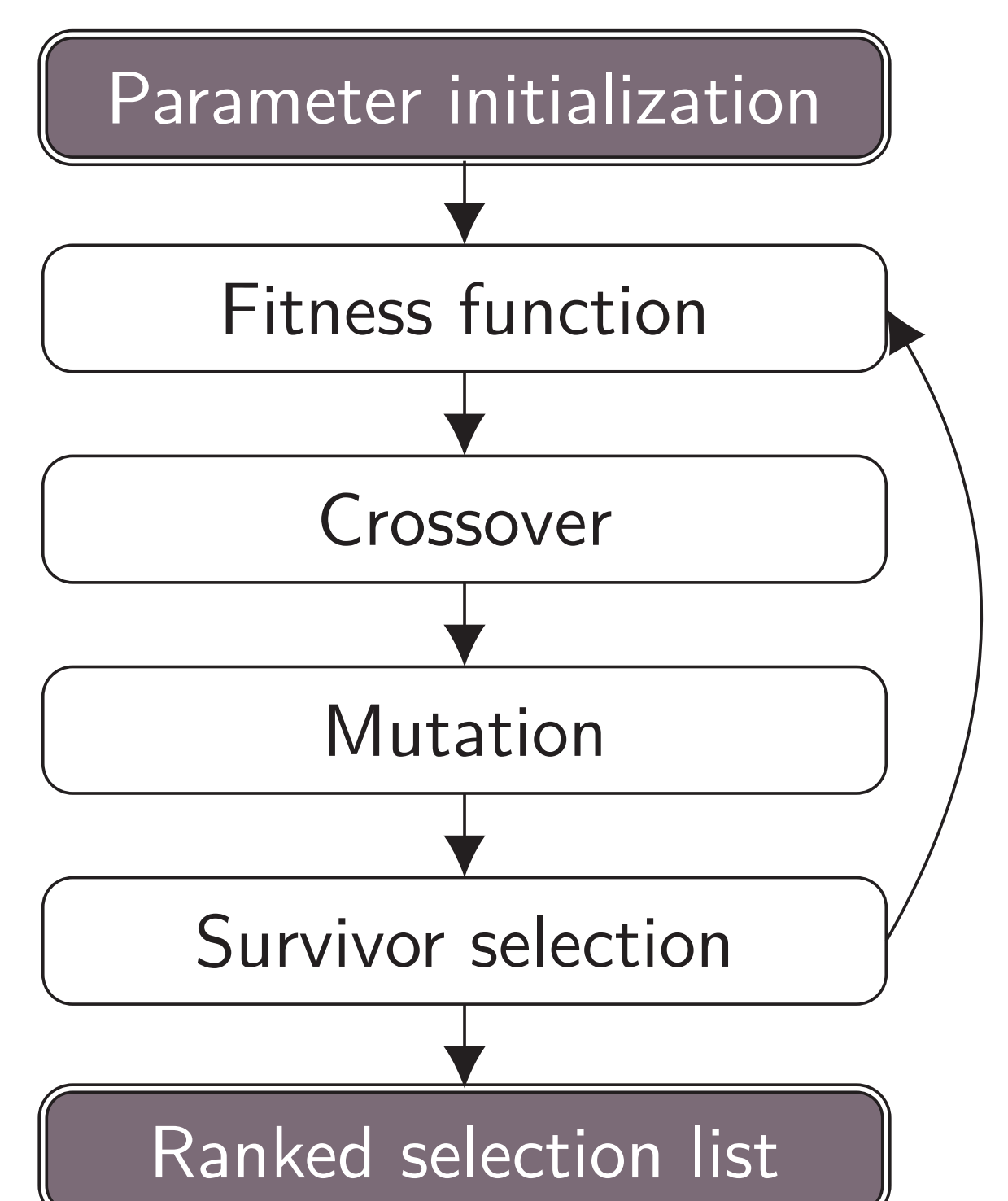
- [1] Wael Ayoub, Abed Ellatif Samhat, Fabienne Nouvel, Mohamad Mroue, and Jean-Christophe Prevotet. Internet of Mobile Things: Overview of LoRaWAN, DASH7, and NB-IoT in LP-WANs Standards and Supported Mobility. 21(2):1561–1581. 00007.
- [2] Mahda Noura, Mohammed Atiquzzaman, and Martin Gaedke. Interoperability 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.

Figure 1 illustrates the LoRaWAN network architecture. The network consists of various IoT devices (represented by icons like a car, washing machine, light bulb, camera, drone, fan, watch, camera, monitor, and drill) communicating with two LoRa Gateways. The gateways are connected to the Internet via Ethernet. The Internet is connected to a LoRa Network Server, which is connected to an Application Server. The legend indicates that dashed arrows represent LoRa modulation and solid arrows represent Ethernet.

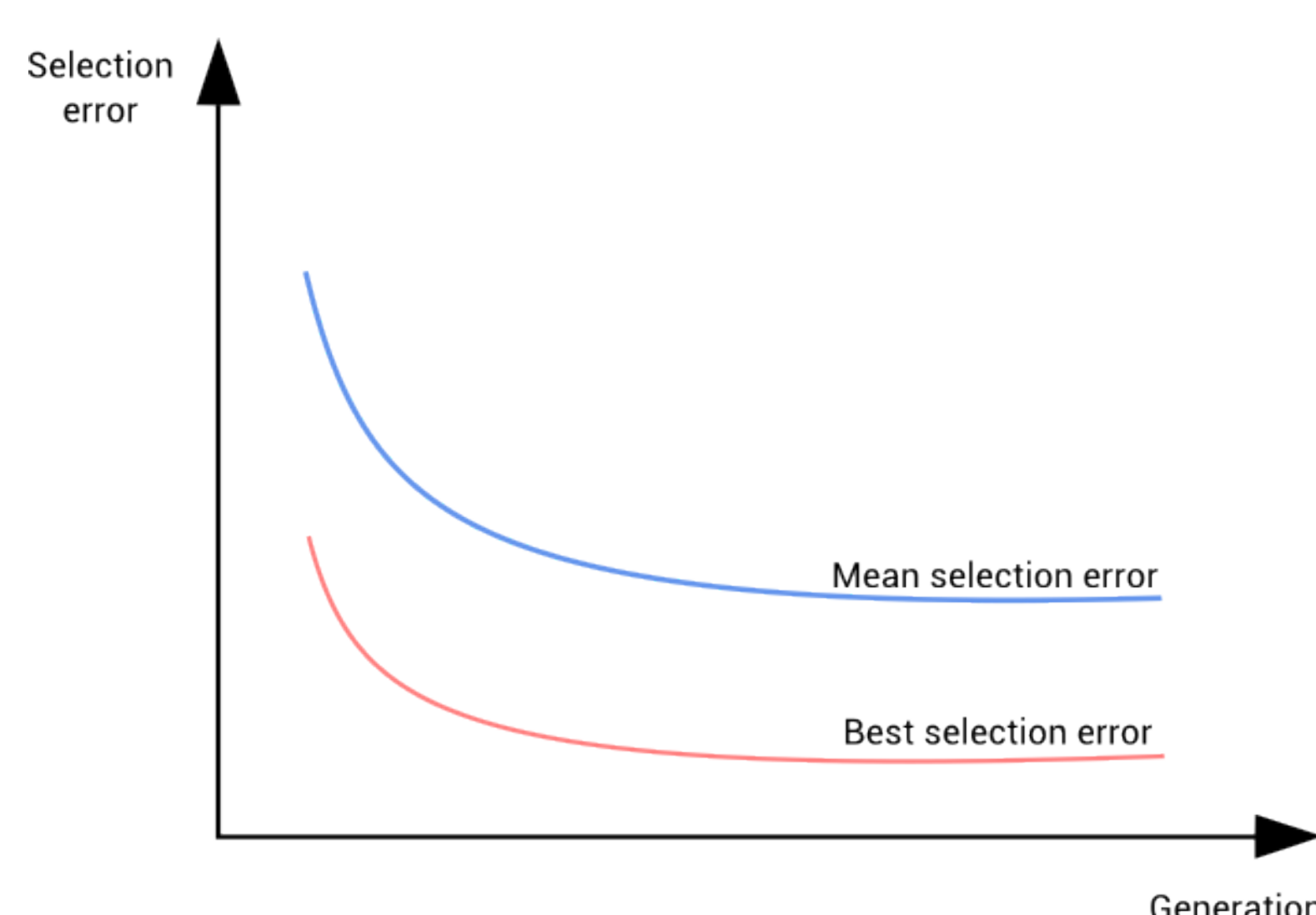
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Definition: stopping criteria, population size P, and mu-
tation probability pm
Generate randomly an initial configurations
repeat:
. . . for each configuration do
. . . . . Train a model & compute configuration's fitness
. . . end
. . . for each reproduction 1 ... P/2 do
. . . . . Select: 2 configurations based on fitness
. . . . . Crossover: Produce 2 child configuration
. . . . . Mutate: child configurations with pm
. . . end
until stopping criterion are met

```



In order to generate all the required metrics of each Lora configuration we use both simulation and real enviroment. 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

Results show that genetic algorithm select the configuration that match beter the requiered QoS by the application.

► **Advantages:**

They usually perform better than traditional feature selection techniques. 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.