Outline

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Multi criteria decision making

Background

- Configuration parameters:
  - Spreading Factor (SF)
  - Coding Rate (CR)
  - Transmission Power (P^{tx})
  - Bandwidth (BW)
  - Payload size (PS)
- Configuration metrics:
  - Data Rate (DR)
  - Packet delivery ratio (PDR)
  - Round-Trip Delay (RTD)
  - Time on Air (ToA)

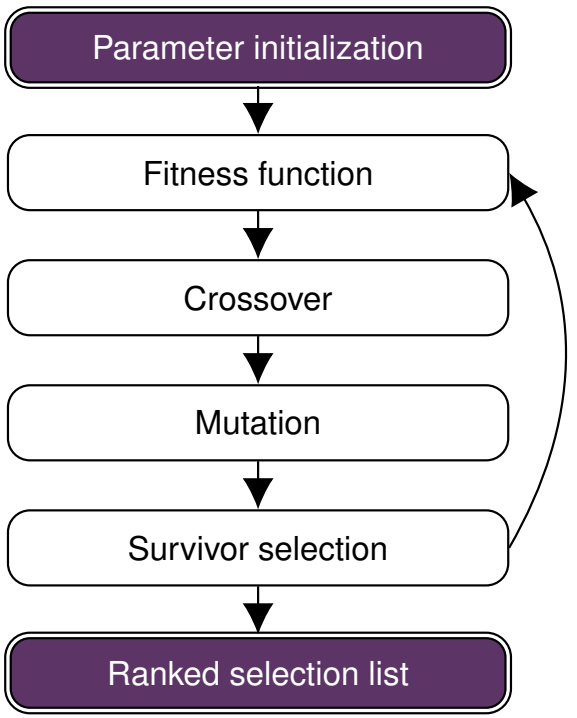
$$Qn,m = \begin{array}{c} \\ \textit{Configuration } 1 \\ \textit{Configuration } 2 \\ \vdots \\ \textit{Configuration } N \end{array} \begin{array}{c} \begin{array}{cccc} \textit{Metric } 1 & \textit{Metric } 2 & \dots & \textit{Metric } M \end{array} \\ \begin{pmatrix} q_{11} & q_{12} & \dots & q_{1M} \\ q_{21} & q_{22} & \dots & q_{2M} \\ \vdots & \vdots & \ddots & \vdots \\ q_{N1} & q_{N2} & \dots & q_{NM} \end{pmatrix} \end{array}$$

Outline

Genetic Algorithm

Background [1]

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 is met



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Fuzzy Logic

Assign a degree of membership between 0 and 1

- We have a temperature value (16°) , and we want to represent this value with 3 weighted vales.
  - 0% hot
  - 0.4% warm
  - 0.6 % cold

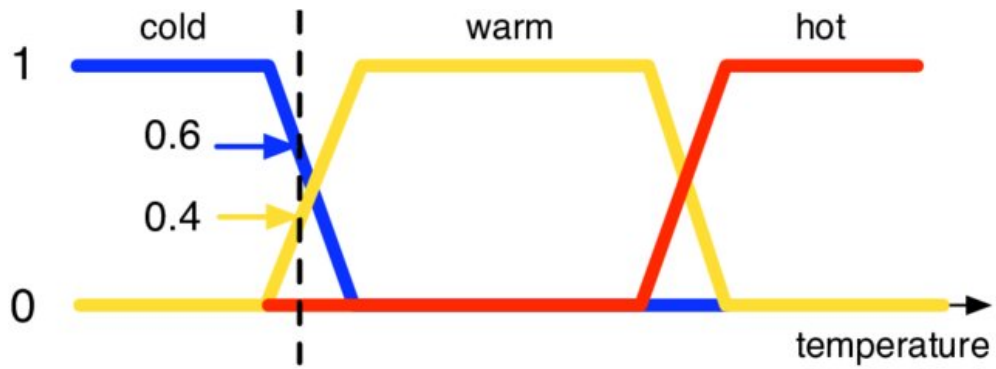

Figure 1. Temperature example.

Outline

Selection framework

Methods

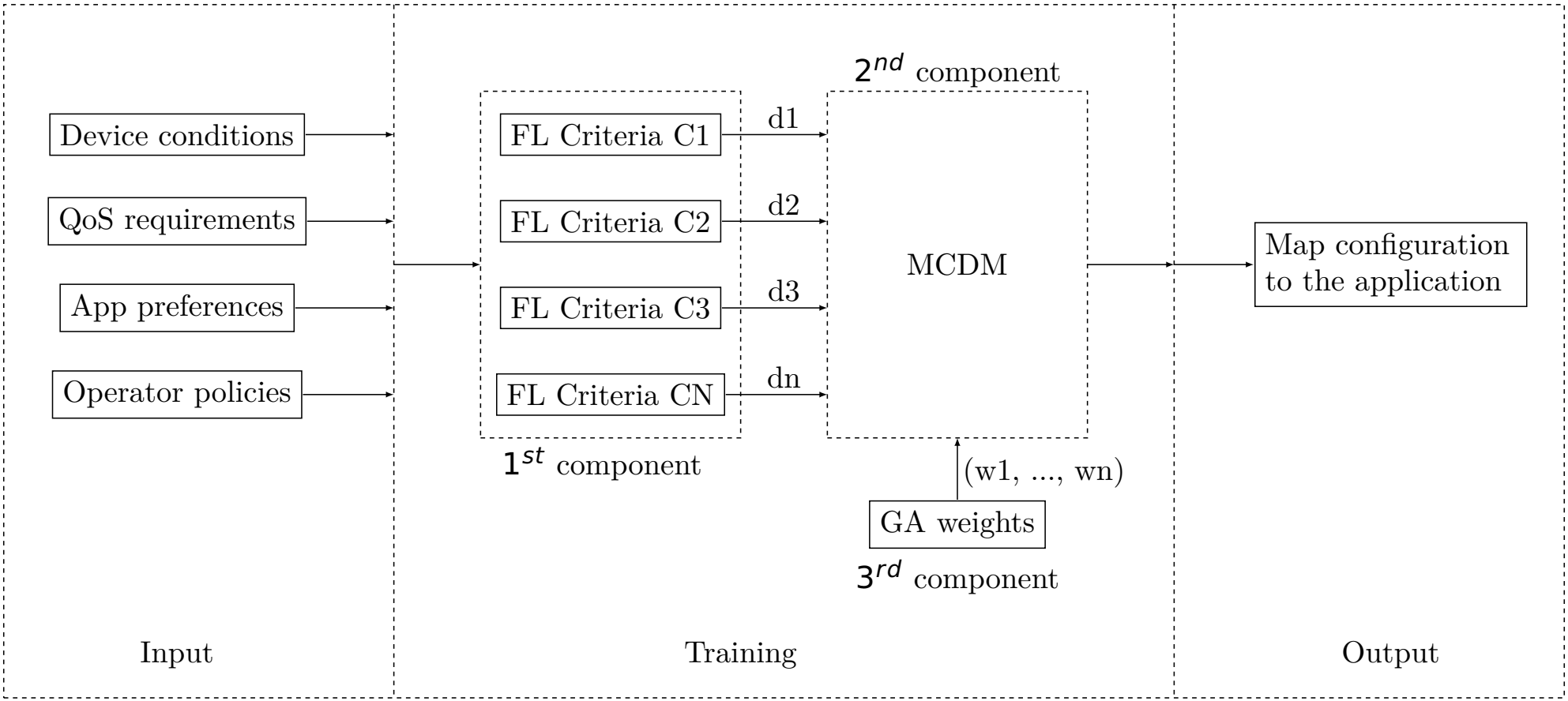

Figure 2. The proposed scheme for LoRa transmission parameters selection based on *GA*, *FL* and *MCDM*..

Outline

Experimentation

Experimentation

- **Inputs:**
  - Data structure
    - Voice, Images and Text transmission.
  - Environment conditions
    - Rural/Urban
    - Static/Mobile
    - Temperature
    - Interference/Noise
  - QoS metrics:
    - User layer: Cost
    - Network metrics: DR, Payload length.
    - Radio metrics: Receiver sensitivity, SNR, DR, Air time,
  - MAC configuration (SF, CR, BW, Tx)
- **Outputs:**
  - (SF_i, CR_j, BW_k, Tx_l) optimal

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Results

Comparison

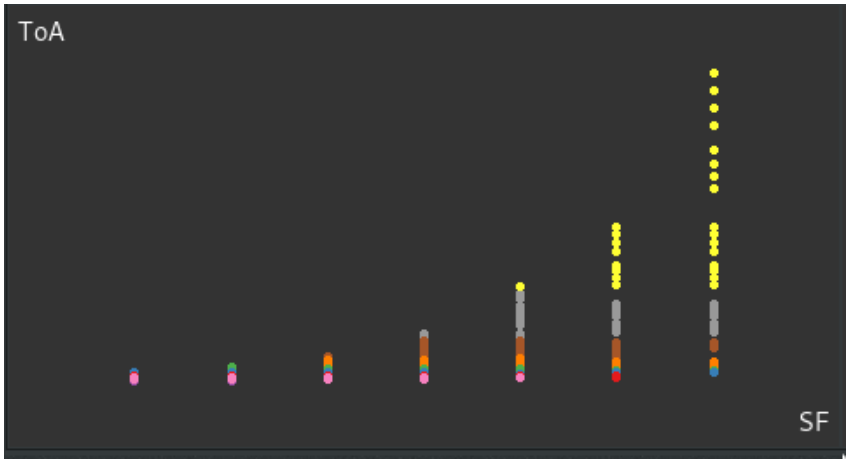

Figure 3. Impact of SF on ToA.

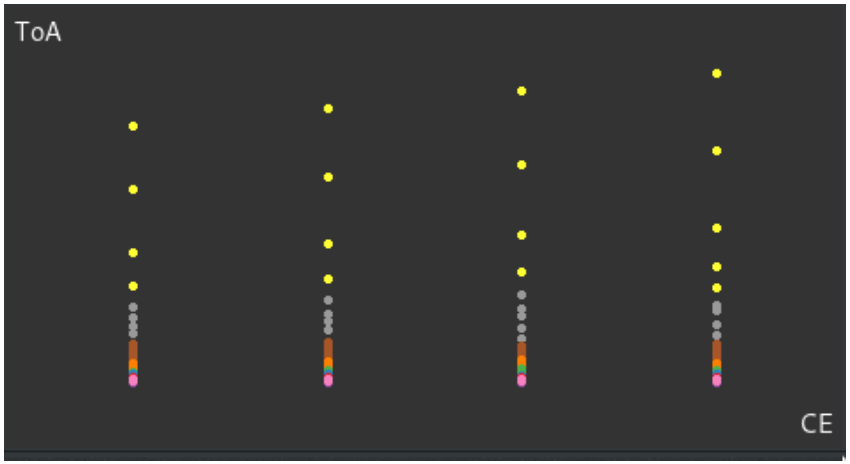

Figure 5. Impact of CR on ToA.

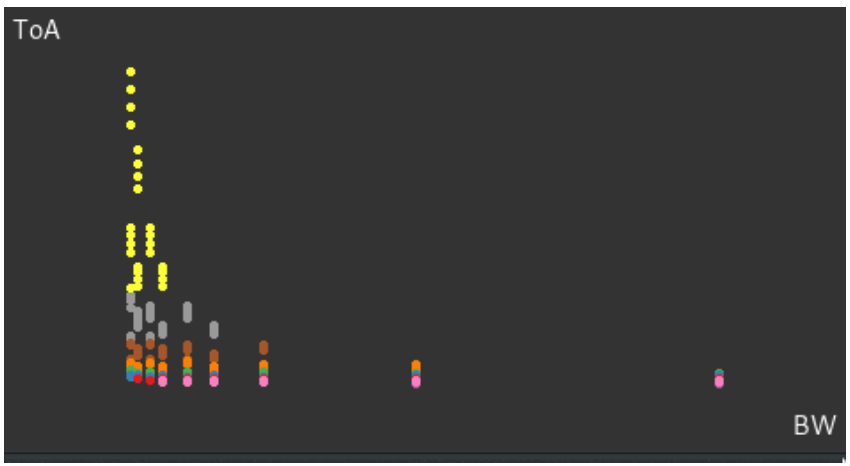

Figure 4. Impact of BW on ToA.

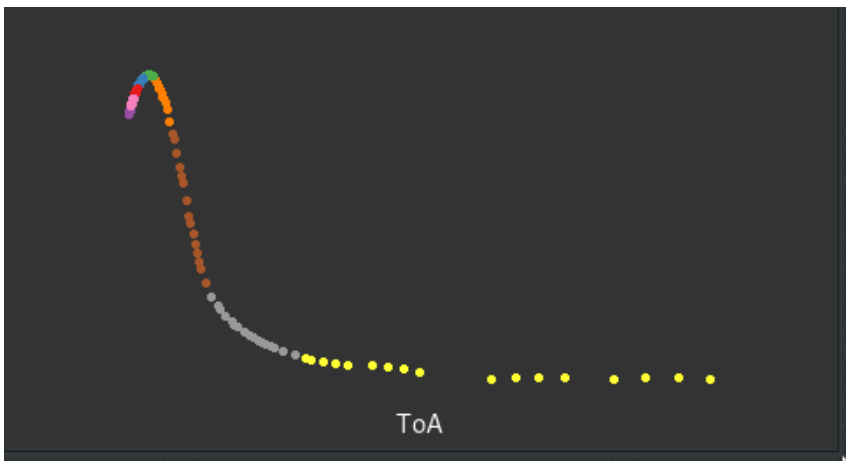

Figure 6. ToA distribution.

Outline

1. Genetic Algorithm For LoRa

Multi criteria decision making

Layer	Maximize (Reward)	Minimize (Cost)
Application	Sec security	Service Cost (*SC*)
Network	Range *PDR* *PS* *DR*	Jitter (*Jit*) Traffic congestion (*TC*) *RTD* Packet Error Rate (*PER*) Time Complexity (O_{time}) Space Complexity (O_{space})
Radio	Mobility (*Mob*) Symbol Rate (*SR*) Bit Rate (*BR*) Sensitivity (*Sen*) Received Signal Strength Indication (*RSSI*) Signal-to-interference & noise ratio (*SINR*) Signal Noise Rate (*SNR*) Signal-to-Interference Ratio (*SIR*)	Bit Error Rate (*BER*) P^{tx} Co-channel Interference (*CCI*) Duty cycle (*DC*) *ToA* Path loss (*PL*)

Table 1. Network selection inputs and classification of parameters [2] [3]

References

[1] M. Alkhawlani and A. Ayesh, “ Access Network Selection Based on Fuzzy Logic and Genetic Algorithms ”, *Advances in Artificial Intelligence*, vol. 2008, pp. 1–12, 2008, 00089.

[2] F. Bendaoud, M. Abdennebi, and F. Didi, “ Network Selection in Wireless Heterogeneous Networks: A Survey ”, *Journal of Telecommunications and Information Technology*, vol. 4, pp. 64–74, Jan. 2019, 00000.

[3] A. Chowdhury and S. A. Raut, “ A Survey Study on Internet of Things Resource Management ”, *Journal of Network and Computer Applications*, vol. 120, pp. 42–60, Oct. 15, 2018, 00002.