

Valorisation de publication

Pourquoi faire une these ?

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Outline

1. Genetic Algorithm For LoRa

1. Problem statement
2. Related work
3. Background
4. Method
5. Experimentation

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Problem statement

Introduction² ?

Parameters

- ➡ Bandwidth (BW)
- ➡ Spreading Factor (SF)
- ➡ Coding Rate (CR)
- ➡ Transmission Power (Tx)

Metrics

- ➡ Receiver Sensitivity (RS)
- ➡ Signal Noise Rate (SNR)
- ➡ Data Rate (DR)
- ➡ Air Time (AT)
- ➡ Payload length ($PktL$)

Setting	Values	Rewards	Costs
BW	7.8 ➡ 500kHz	DR	RS , Range
SF	2^6 ➡ 2^{12}	RS , Range	DR , SNR , $PktL$, Tx
CR	4/5 ➡ 4/8	Resilience	$PktL$, Tx , AT
Tx	-4 ➡ 20dBm	SNR	Tx

Table 1: ¹

¹Marco Cattani, Carlo Boano, and Kay Römer. "An Experimental Evaluation of the Reliability of LoRa Long-Range Low-Power Wireless Communication". In: *Journal of Sensor and Actuator Networks* 6.2 (2017). 00042, p. 7.

²B. Di Martino et al. "Internet of Things Reference Architectures, Security and Interoperability: A Survey". In: *Internet of Things* 1-2 (Sept. 2018). 00006, pp. 99–112.

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1. Bandit Algorithm
2. Genetic Algorithm
3. Marcov chain
4. Game theory

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Multi-Armed-Bandit Algorithm

Related work

- ⇒ Arms: $K = 1, \dots, K$
- ⇒ Decision: $T = 1, \dots, T$
- ⇒ Reward: X_t^k with $\mu_t^k = E[X_t^k]$
 - ⇒ Best reward: X_t^* with $\mu_t^* = \max_{k \in K} \mu_t^k$

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Genetic Algorithm

Related work [[alkhawlani_access_2008a](#)]

- ➡ Heterogeneous wireless network: ($RAT_1, RAT_2, \dots, RAT_n$)
- ➡ Criteria up to i (c_1, c_2, \dots, c_i) the operators, the applications, and the network conditions.
- ➡
- ➡ The different sets of scores (d_1, d_2, \dots, d_i) are sent to the MCDM in the second component.
- ➡ GA component assigns a suitable weight (w_1, w_2, \dots, w_i)

Genetic Algorithm

Related work



➡ S = SF12, BW125, 4/8, 17 dBm

➡ Input:

➡ Problem: $f(x) = \max(x^2)$, $x \in [0,32]$

* $x_1 : 01101_b$

* $x_2 : 11000_b$

* $x_3 : 01000_b$

* $x_4 : 10011_b$

➡ Method: Genetic algorithm

➡ Generate a set of random possible solution

➡ Test each solution and see how good it is (ranking)

* Remove some bad solutions

* Duplicate some good solutions

* Make small changes to some of them (Crossover, Mutation)

➡ Output:

➡ $x_1 : 01101 (169) (14.4)$

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Marcov chain

Related work

$$V(s, \pi) = \mathbb{E}_s^\pi \left(\sum_{k=0}^{\infty} \gamma^k \cdot r(s_k, a_k) \right), s \in \mathbb{S} \quad (1)$$

$$r(s_k, a_k) = G_k \cdot PRR(a_k) \quad (2)$$

$$\pi^* = \arg \max_{\pi} V(s, \pi) \quad (3)$$

$$PRR = (1 - BER)^L \quad (4)$$

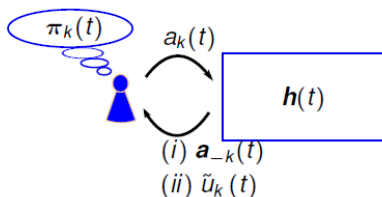
$$BER = 10^{\alpha} e^{\beta SNR} \quad (5)$$

Marcov chain

Related work

Learning Iterative Steps:

- **Choose** action $a_k(t) \sim \pi_k(t)$.
- **Observe** game outcome, e.g.,
 $\mathbf{a}_{-k}(t)$
 $u_k(a_k(t), \mathbf{a}_{-k}(t))$.
- **Improve** $\pi_k(t+1)$.



Thus, we can expect that: $\forall k \in \mathcal{K}$,

$$\pi_k(t) \xrightarrow{t \rightarrow \infty} \pi_k^* \quad (1)$$

$$\bar{U}_k(\pi_k(t), \pi_{-k}(t)) \xrightarrow{t \rightarrow \infty} \bar{U}_k(\pi_k^*, \pi_{-k}^*) \quad (2)$$

where, $\pi^* = (\pi_1^*, \dots, \pi_K^*)$ is a NE strategy profile.

Figure 1: .

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Game theory

Related work

- ⇒ Players: $K = \{1, \dots, K\}$
- ⇒ Strategies: $S = S_1 \times \dots \times S_K$
 - ⇒ S_k is the strategy set of the k^{th} player.
- ⇒ Rewards: $u_k : S \rightarrow R_+$ and is denoted by $r_k(s_k, s_{-k})$
 - ⇒ $s_{-k} = (s_1, \dots, s_{k-1}, s_{k+1}, \dots, s_K) \in S_1 \times \dots \times S_{k-1} \times S_{k+1} \times \dots \times S_K$

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... (step 2)

Methods

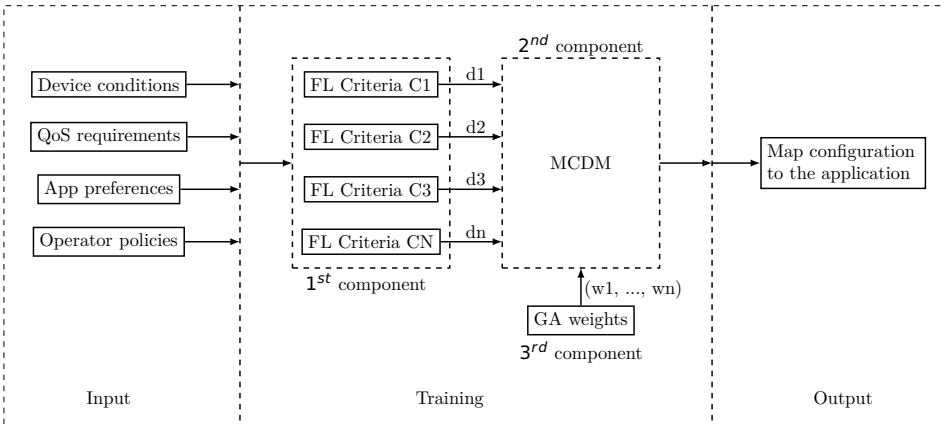


Figure 2: HH.

... (step 3)

Methods



... (step 4)

Methods



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Contribution

Contributions

⇒ Use cases (Application Requirements)

- ⇒ Smart building: Voice, Images, Text.

⇒ Environments

- ⇒ Rural/Urban
- ⇒ Static/Mobile
- ⇒ Temperature

⇒ Scenarios

- ⇒ Application protocol (MQTT, COAP, XMPP)
- ⇒ Network protocol (Start, Mesh)
- ⇒ MAC protocol (LoraWan, Sigfox, ...)

⇒ Input:

- ⇒ Service QoS metrics requirements
- ⇒ MAC configuration (SF, CR, BW, ...)
- ⇒ Network QoS metrics

⇒ Algorithms:

⇒ MADM

- * Ranking methods
- * Ranking & weighted methods

⇒ Game theory

- * Users vs users
- * Users vs networks
- * Networks vs network

⇒ Fuzzy logic

- * as a score method
- * another theory

⇒ Utility function

- * 1
- * 2

⇒ Outputs:

- ⇒ Ranked networks

Technical choice

Implementation

➡ ZOLERTIA RE-MOTE

- ➡ Low consumption component
- ➡ ADC port for placing sensors on it

➡ CONTIKI OS

- ➡ Operating system for wireless and low power development
- ➡ Support for newer standards (6LowPAN, RPL, CoAP, MQTT)

➡ 6LowPAN

- ➡ Based on IPv6 and IEEE 802.15.4
- ➡ IPv6-based network with low power consumption
- ➡ Ability to create a mesh network

➡ Sending packages

- ➡ UDP in the 6LowPAN network
- ➡ MQTT between the cloud platform and the router

Experimentation

Experimentation

➡ a

➡ b

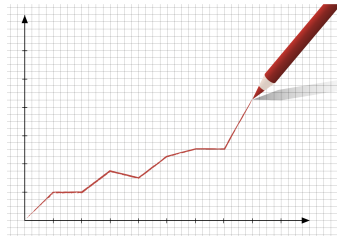


Figure 3: .

References

- [2] B. Di Martino et al. " Internet of Things Reference Architectures, Security and Interoperability: A Survey ". In: *Internet of Things* 1-2 (Sept. 2018). 00006, pp. 99–112.
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