# Post-doctoral position on Distributed embedded reasoning for the Web of Things

## Postdoc position, LabHC

### Keywords

Web of things, Semantic Web, Rule-based reasoning, Embedded, Distributed, Edge computing

### Context

This Postdoc position is in the context of the CosWot project ("Constrained Semantic Web of Things" https://coswot.gitlab.io/), funded by the French National Research Agency. CoSWoT considers semantic web technologies for the Web of things (WoT). The objectives of the project are to propose a distributed WoT-enabled software architecture embedded on constrained devices with two main characteristics: 1) it uses ontologies to declaratively specify the application logic of devices and the semantics of the exchanged messages; 2) it adds rule-based reasoning [1, 2, 13, 14] functionalities to devices, so as to distribute processing tasks among them. Doing so, the development of applications including devices of the WoT will be highly simplified: our platform will enable the development and execution of intelligent and decentralised smart WoT applications despite the heterogeneity of devices.

The main objectives of this Postdoc are to provide contributions to distributed reasoning on the Web of Things.

### Research Lab

The Postdoc will be a member of the LabHC Laboratory, St-Etienne, France.

Lab. Hubert Curien (https://laboratoirehubertcurien.univ-st-etienne.fr/en/index.html) is a joint research unit of CNRS (UMR 5516), Université Jean Monnet in Saint-Etienne, and the Institut d'Optique Graduate School, working on topics related to optics, photonics and microwave, computer science, telecom and image. The members from LaHC involved in the CoSWoT project include researchers of its team named as Data Intelligence. They specialise in AI and data processing.

Close collaboration will also be necessary with the LIRIS Lab. team where a PhD student works on incremental and embedded reasoning.

### Objectives

The objective of the Postdoc is to design and implement an efficient distributed reasoner for the Web of Things (WoT). The reasoner should be able to work on constrained (with limited processing capacity, memory and energy, i.e., sensor nodes and other embedded devices with microcontrollers) and autonomous devices. The target architecture is based on edge computing: main components, including sensors and actuators as well as intermediate nodes and gateways of various computing capabilities.

## Expected Contributions

There are some existing works paving the way for such reasoners, including [1-12]. However, they are not suitable for WoT and diversely constrained objects. Such devices are not all capable of performing all reasoning tasks. We aim for edge intelligence where incremental reasoning concerns both sensor data streams and contextual data. As it is probable that all constrained objects will not be able to execute all reasoning tasks, distributing these data and tasks optimally over a network of WoT nodes will also be necessary [8-9].

The postdoc will define a method for the distribution of reasoning tasks among the edge and devices, where each device collaboratively performs a part of the reasoning tasks. At runtime, reasoning tasks must be distributed in an efficient manner and to the appropriate locations. This will be done while considering WoT constraints including proximity to the data source, capabilities and resources constraints, current computational load, bandwidth, etc.

## Candidate Profile

- PhD in computer science.
- Skills in semantic web knowledge representation, rule-based reasoning and distributed algorithms are required.
- Proficiency in the English language for speaking, writing and reading are necessary.
- Programming skills in C, JavaScript are a plus.
- French language skills are not a prerequisite.
- Depending on the candidate native language, French or English will be the working language.

Salary:  around 2192 € net per month during 1 year
There will also be an option to teach in the university.

Expected starting date: End of 2021 or later

## Place of work

LabHC, University St-Etienne, France
short missions at other partner's locations will be required.

## To apply

Candidates should send the following:
- A motivation letter

- A CV
- All documents attesting the required skills and knowledge
- 2 selected publications
- Contact information of 2 professors who can provide recommendation on the candidate

The applications should be sent to singh.d.kamal@gmail.com

References

[1] Nenov, Y., Piro, R., Motik, B., Horrocks, I., Wu, Z., & Banerjee, J. RDFox: A highly-scalable RDF store. In ISWC: 3-20, 2015.
[2] Terdjimi, M., Médini, L., Mrissa, M. HyLAR: Hybrid Location-Agnostic Reasoning. In ESWC Devs Workshop 2015.
[3] Terdjimi, M., Médini, L., Mrissa, M. HyLAR+: Improving Hybrid Location-Agnostic Reasoning with Incremental Rule-based Update. In WWW 2016, companion volume.
[4] Terdjimi, M., Médini, L., Mrissa, M. Web Reasoning using Fact Tagging. In WWW 2018, companion volume
[5] Chevalier, J., Subercaze, J., Gravier, C., Laforest, F. Slider: an Efficient Incremental Reasoner. In SIGMOD 2015.
[6] Chevalier, J., Subercaze, J., Gravier, C., Laforest, F. Incremental and Directed Rule-Based Inference on RDFS. In DEXA 2016.
[7] Jacopo Urbani and Ceriel Jacobs. 2020. Adaptive Low-level Storage of Very Large Knowledge Graphs. In Proceedings of The Web Conference 2020 (WWW '20). Association for Computing Machinery, New York, NY, USA, 1761–1772. DOI:https://doi.org/10.1145/3366423.3380246
[8] Seydoux, N., Drira, K., Hernandez, N., & Monteil, T. EDR: A Generic Approach for the Dynamic Distribution of Rule-Based Reasoning in a Cloud-Fog continuum. In Semantic Web Journal, 2019. http://semantic-web-journal.net/system/files/swj2238.pdf
[9] Su, X., Li, P., Riekki, J., Liu, X., Kiljander, J., Soininen, J. P., ... & Li, Y. (2018, March). Distribution of semantic reasoning on the edge of internet of things. In 2018 IEEE International Conference on Pervasive Computing and Communications (PerCom) (pp. 1-9). IEEE.
[10] Maarala, A. I., Su, X., & Riekki, J. (2017). Semantic reasoning for context-aware Internet of Things applications. IEEE Internet of Things Journal, 4(2), 461-473.
[11] Ren, X., & Curé, O. Strider: A hybrid adaptive distributed RDF stream processing engine. In International Semantic Web Conference (pp. 559-576). Springer, Cham (2017).
[12] Su, X., Gilman, E., Wetz, P., Riekki, J., Zuo, Y., & Leppänen, T. (2016, June). Stream reasoning for the Internet of Things: Challenges and gap analysis. In Proceedings of the 6th Int. Conf. on Web Intelligence, Mining and Semantics (p. 1). ACM.
[13] Charles L Forgy. Rete: A fast algorithm for the many pattern/many object pattern match problem. InRea-dings in Artificial Intelligence and Databases, pages 547–559. Elsevier, 1989.
[14] William Van Woensel and Syed Sibte Raza Abidi. Optimizing semantic reasoning on memory-constrained platforms using the rete algorithm. In European Semantic Web Conference, pages 682–696. Springer, 2018