

Ph.D. Thesis Position 2021

Title: RECTORAT - ExtRaction automatique dE ConfiguraTiOn Réseau sAtisfaisant les contrainTes client (Automatic extraction of network configurations satisfying client constraints).

Host laboratory: LISTIC, Polytech Annecy-Chambéry, 5 Chemin de Bellevue, 74940 Annecy-le-Vieux

Advisor(s):

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External Collaborators:

The supervision involves a collaboration between the Université Savoie Mont Blanc and the company CELESTE (Archamps, France). The registration will be done at the USMB SISEO doctoral school.

Description. A problem faced by Internet Service Providers offering services to customers in a territory consists in transforming the needs and functional constraints of customers into a technical solution able to meet them, while validating the operational constraints specific to the operator. Today, this matching is done by the technical sales staff who must transform the needs expressed by the customer into a solution proposal. This operation is complex and requires a strong technical and operational expertise to propose viable and efficient solutions, in terms of cost, resource consumption, and more.

This thesis aims to develop machine learning solutions to learn from past configurations rules and apply them to future cases. This will allow to break the deadlock generated by the current requirements of expert knowledge driven extraction. Many problems in artificial intelligence can be interpreted as problems of projection from an input data space to an output space, *e.g.*, facial recognition transforms data defined in the pixel space of an input image into person identities defined in the space defined by the user database. Configuration design problems are of a similar nature and it would seem that the methods used in the context of machine learning, in particular representation learning, can be applied in this context.

Nevertheless, in order to design such approaches, it is necessary to be able to model the technical knowledge underlying the operational management of communication infrastructures, and to extract the relevant knowledge from the technical experts as well as to represent it in a format usable by a recommendation algorithm. This requires the development of ontologies related to the technical constraints of telecommunication infrastructures. But these ontologies are tedious to build [2]. It will therefore be necessary to develop methodologies for the automatic construction of ontologies adapted to the particular context of network operators, which would rely on examples of past configurations to build new rules [1]. This is one of the challenges of this thesis.

The second dimension is related to the expression of needs. Customer requirements are sometimes not very well specified and elements of uncertainty may frequently exist in their expression. It is therefore necessary to develop methods to describe these needs by means of flexible indicators that can describe the broad spectrum of these needs. This theme is one of the areas of expertise of the LISTIC which has a long history of work in the fusion of uncertain and heterogeneous information.

A third dimension of the thesis lies in the development of methods for projecting the space of requirements into the space of operational constraints. These methods, which are derived from deep neural network learning approaches, will allow, in fine, to design the configuration or design recommendation systems that are at the heart of the thesis project.

Within the framework of this project, we combine the three components described above in order to

develop an expert system allowing to automatically validate, well in advance, the technical solutions that the salesmen propose to the customers. This would allow to propose better quality solutions and to overcome the lack of technical expertise and the complexity of taking into account the wide variety of operational parameters. But also to develop a self-service window allowing customers to evaluate by themselves network architectures defined by an assembly of standard bricks. It will then be necessary to evaluate the systems developed in operational contexts in order to validate their relevance.

Candidate Requirements.

- The candidate should have completed a qualifying program by the starting date of the thesis.
- Comfortable speaking English or French (French is not required).
- Good understanding of at least one between computer networks protocols and systems or machine learning methods (preferably both)

What to submit. An up to date CV, university transcripts, and a letter of motivation clearly stating what the motivations to work on the described subject.

References

- [1] L. Drumond and R. Girardi. Extracting ontology concept hierarchies from text using markov logic. In *Proceedings of the 2010 ACM Symposium on Applied Computing*, pages 1354–1358, 2010.
- [2] Q. Zhou et al. *Ontology-driven knowledge based autonomic management for telecommunication networks: theory, implementation, and applications*. PhD thesis, Heriot-Watt University, 2018.