Autonomic controllers for the self-adaptation of micro-services in Fog/Edge and Cloud computing".

Level of qualifications required: PhD or equivalent
Fonction: Post-Doctoral Research Visit

About the research centre or Inria department

Inria, the French National Institute for computer science and applied mathematics, promotes “scientific excellence for technology transfer and society”. Graduates from the world’s top universities, Inria’s 2,700 employees rise to the challenges of digital sciences. With its open, agile model, Inria is able to explore original approaches with its partners in industry and academia and provide an efficient response to the multidisciplinary and application challenges of the digital transformation. Inria is the source of many innovations that add value and create jobs.

Context

Partnership

Collaboration between 2 Inria teams: Stack @ Nantes and Ctrl-A @ Grenoble

Cloud systems (Cloud and now Fog/Edge computing) are becoming so complex that they cannot be handled manually in an efficient way. This concerns not only the base configuration and monitoring activities, but also the way Cloud systems should behave at runtime in order to guarantee certain QoS (Quality of Service) levels and expected SLA (Service Level Agreement) contracts. Autonomic Computing [1] has been largely adopted to tackle that kind of dynamic environments. In order to achieve well-tuned Autonomic controllers (ACs), we need for design methods for well-behaved adaptation control.

The topic of this proposal is to work on design methods for such systems, following approaches based on behavioral models and control techniques. The goal is to obtain ACs that ensure safety of the system executions and correct fulfillment of the SLA objectives.

In the general context of Autonomic Computing, explicitly designed feedback loops are performing the management of adaptations at hardware and software levels. To go beyond the difficult and error-prone hand writing of management rules, some approaches explored controller design methods based on models of the dynamics of the platform [2, 4]. Another way to address the issue of achieving ACs is to use declarative programming describing what computation should be performed and not how to compute it. In a recent work [3], we complied with SLA contracts and Cloud internal constraints (e.g., maximum capacity of given resources) and we designed an AC – based on a constraint solver -- that can find the optimal configurations based on these objectives. However, these constraints-based loops reason on relations between variables at a given moment and do not take into account feedback values, history of past values or decisions, dynamics of the system, predictive decision or apprenticeship.

Assignment

The topic of this post-doctorate position is to work on defining more general and powerful Autonomic controllers, by combining several modeling and decision approaches, in a framework of coordination of multiple autonomic loops [1, 2].

The motivation stems from the fact that complex Cloud and Fog systems present a variety of regulation problems of different natures, to be solved together, and for which different formalization and solving techniques are required (e.g., how to address Cloud elasticity oscillations, how to address edge node failure).

The person recruited will be in charge of considering combinations of controllers involving constraints-based approaches, behavioral models such as discrete controllers or continuous models from Control Theory. He will define methods that enable to ensure safety of the combined complementary control loops, by proposing coordination patterns. For example, constraint-solving can be applied on variables, some if which are computed in a control feedback loop.

The recruited person will be under the supervision of Thomas Ledoux (Stack@Nantes) for constraints-based loops and in connection with Eric Rutten (Ctrl-A@Grenoble) for feedback loops.


Main activities

The work will be organized around several axes:

- identification, analysis and description of important decision and control problems in Cloud and Fog/Edge computing, in order to focus the research work on relevant applicative problems;
- design of generic methods for their decomposition into complementary sub-problems, formalized in the appropriate models, among the approaches mentioned above;
- composition of the sub-controllers by coordination patterns insuring the absence of interferences between the loops;
- validation of the proposed methods in a simulator of distributed applications in heterogeneous distributed environments (such as SimGrid). The use case will be a medical emergency scenario in the context of Fog computing. The application will be based on the micro-services paradigm.

Skills

Technical skills and level required:

The candidate must hold a PhD in Computer Sciences with advanced knowledge on Cloud architectures and Control techniques.

Languages:

Strong oral and written communication skills in English, including the ability to publish the results of scientific research in scientific journals

Relational skills:

Curiosity, autonomy and social capabilities

Other value appreciated:

Good programming knowledge

Benefits package

- Subsidised catering service
- Partially-reimbursed public transport
- Social security
- Paid leave
- Flexible working hours
- Sports facilities
Remuneration
Monthly gross salary amounting to 2653 euros