INTERNSHIP

MASTER
ENGINEER
PROJET DE FIN D'ETUDES

Controlling Computer Cluster overload intelligent control with nonsupervised learning

Advisers :

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in collaboration with:
Eric Rutten (eric.rutten@inria.fr) INRIA Rhone Alpes
Olivier Richard (LIG) and Bruno Bzeznik (Cluster GriCad Grenoble) for the experimental set-up

Place of the internship: GIPSA-lab, Grenoble, France
Length of the internship: 5 to 6 months, possibility to continue with a PhD afterwards

Context:

High Performance Systems (HPC) who deal with large amount of data in parallel (such as parallel computing) are facing more and more variability in their behavior related to performance and power consumption. Because they are less predictable their administration requires a more complex management. This can be done by monitoring the information in the systems then analyzing this data in order to activate appropriate feedback mechanisms for the whole system or only for the applications (e.g., dismissing jobs, down-clocking CPUs) [5], [4].

In this work we are interested about implementing feedback mechanisms which rely on the monitoring and analysis of output signals and involve decisions through the control signals [4]. Such feedback loops, in the domain of Computer Science, are the object of Autonomic Computing [1], which emerged mainly from distributed and Cloud systems. The approach in designing feedback loops is using Control Theory techniques, which is extremely widespread in all domains of engineering, but only quite recently and scarcely applied to regulation in computing systems [2], [5]. It can bring to the systems designers methodologies to design and implement feedback loops with well-mastered and guaranteed behavior in order to obtain automated management while optimizing the resources or the avoidance of crashes and overloads.

Expected work

The research work will consist in proposing feedback loops for the runtime management of resources, targeting the particular computation platform CiGri [3], a lightweight, scalable and fault tolerant grid system which exploits the unused resources of a set of computing clusters. It interacts with the computing clusters through a batch scheduler software.

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The design of the feedback loops will build upon existing work of a 3rd year engineer student from INP [5] and a 2nd year MISCIT student. Until now the students used Kalman filtering techniques for finding the model and build simple control laws.

In this internship we will need to do:

1. After an analysis of the system and the problems to be tackled we need to design a controller which will maximize the utilization of the cluster (number of jobs processed per second). We will start from an existing PI regulation and an approach using Kalman filters, the control objective being to maximize cluster utilization while avoiding overload. Optimal of other robust control techniques could be used based on student preferences.
2. Implementation and experimental validation will be done first in simulation and then on a system emulating existing environment. Help for coding in Python can be provided form researchers at LIG.
3. Based on student preference he/she can also propose another model for the system to be controlled either by trying machine learning algorithms (K-nearest neighbor, random forest …) or adaptive modelling. Since the system we want to model and control is not very intuitive non-standard identification techniques will need to be employed.

According to this sequence of steps, new characteristics of the platform will be considered, e.g., other problems of overload concerning storage architecture. Help from Computer Science scientists form INRIA and LIG Grenoble will be provided for the implementation and testing.

The internship student will work in a multidisciplinary team containing researchers from control engineering and also from computer engineering. Ideally, another student from computer science master will work on the implementation and testing so a joint work can be possible.

Keywords : data mining, resource management, optimal control, identification

Monthly salary around 500 €/month

[1] J. O. Kephart and D. M. Chess. The vision of autonomic computing. IEEE Computer, 36(1):41–50, Jan. 2003.

[2] M. Litoiu, M. Shaw, G. Tamura, N. M. Villegas, H. A. Müller, H. Giese, R. Rouvoy and E. Rutten. What can control theory teach us about assurances in self-adaptive software systems? In R. de Lemos, D. Garlan, C. Ghezzi, and H. Giese, editors, Software Engineering for Self-Adaptive Systems, volume 9640 of LNCS, Springer.

[3] http://ciment.ujf-grenoble.fr/CiGri/dokuwiki/doku.php

[4] Emmanuel Stahl, Agustín Yabo, Olivier Richard, Bruno Bzeznik, Bogdan Robu, et al.. Towards a control-theory approach for minimizing unused grid resources. AI-Science'18 - workshop on Autonomous Infrastructure for Science, in conjunction with the ACM HPDC 2018, Jun 2018, Tempe, AZ, United States. pp.1-8,

[5] Ioan Doré Landau, Jaime Saavedra, Sophie Cerf, Bogdan Robu, Nicolas Marchand, et al.. Can Adaptive Feedforward Control Improve Operation of Cloud Services?. 2018 26th Mediterranean Conference on Control and Automation (MED), Jun 2018, Zadar, Croatia. IEEE

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