Advances in cloud computing technologies: an introduction

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In the modern society information, and its intelligent and efficient exploitation, has become a fundamental key to cultural and economic growth. As almost anything can become a source of data, thanks to the pervasiveness of current technologies (Di Martino et al., 2018), the volumes of data that companies handle every day has exponentially grown, together with their need of powerful computing and storage resources, which are essential to manage and exploit this *big data* phenomenon (Pop et al., 2016). Not all companies, especially newly established ones, can afford the expenses needed to acquire and maintain such resources. Cloud computing brings the promise of a virtually unlimited source of computing and storage capabilities, which can be simply loaned for an established price, according to plans which generally consider their real usage time. Cloud computing has enough flexibility and elasticity to provide resources to very heterogeneous kind of applications, including big data and internet of things focused ones (Basu et al., 2018; Lin et al., 2017). However, ensuring the correct distribution of resources, their balancing and on-demand delivery, is not an easy task. This is even more evident if we mention the high qualities standards which the cloud offerings need to adhere to: just consider the availability and security requirements that cloud providers need to provide to their customers. Furthermore, portability and interoperability issues can arise when different cloud services interact to deliver a complex functionality (Di Martino et al., 2015a, 2015b; Di Martino and Esposito, 2016). Cloud services composition and orchestration, that is the capability to efficiently combine cloud services to obtain more complex functionalities or to better exploit the shared resources, is a very desirable characteristics, thus studies have been carried out to develop tools and technologies which could ensure or at least support it (Di Martino et al., 2017b; Di Martino and Esposito, 2018). Semantic technologies have also been applied to try to reduce interoperability and portability issues (Di Martino et al., 2017c, 2015c), to enable cloud services discovery (Di Martino et al., 2010), or to reduce the difficulties encountered by companies during the migration of their applications to the cloud (Di Martino and Esposito, 2015; Cretella and Di Martino, 2015). Intense research has been also carried out to enhance the reuse of applications and code in the cloud, especially by exploiting well-established solutions: the development and adoption of cloud patterns (Fehling et al., 2014; Di Martino et al., 2017a), both by academic and commercial realities, go in this exact direction.

As a result, cloud computing represents one of the most challenging technological fields both for academic and business. Several projects are contributing to its rapid development, witnessing the great interest of the research

community on one side, and of the users on the other. The Cloud Computing Project and Initiatives (CCPI'16) workshop, co-located with the 30th International Conference on Advanced Information Networking and Applications (AINA-2016) held in Crans-Montana (CH) aimed to be a forum for exchanging ideas on different Cloud computing related topics and finding synergies between projects (especially EC funded ones, but not only) tackling similar challenges. Getting insight in ongoing Cloud-related projects can facilitate the exchanges of information among the researchers and enhance the communication of research results, avoiding unwanted duplication.

Several articles have been submitted to the workshop, and this special issue collects a selection of such papers, opportunely extended, which have been selected for their high quality informative content. Furthermore, two additional unpublished papers, not presented at the workshop, enrich this special issue.

We would like to thank all the authors, reviewers and journal staff, for the realisation of this work. Thanks to their contributions it has been possible to assemble this collection of research papers that, in our opinion, represents a step forward in the research on cloud computing.

Here is the list of papers included in this special issue:

- Panica et al. present a platform which simplifies the deployment and monitoring of cloud-based applications, through an almost automated process. Its integration as a module of an open-source platform for enforcing security controls by its users is also discussed.

- Kiourtis et al. address data interoperability issues in cyber-physical systems, by applying semantic techniques to data coming from different environments, and trying to use them in new environments. A three-stepped approach is being presented where, following the data-lifecycle, a known CPS dataset is firstly stored into domain-specific language, then it gets translated into domain-agnostic language, and finally, using the fitting function of an ANN, it is being compared with an unknown dataset, resulting to the translation of the unknown dataset into the first datasets domain.

- Aversa and Tasquier present an agent-based architecture and its prototypal implementation that aims at monitoring the users cloud environment provided by a federated cloud framework: the elasticity of the proposed architecture allows the configuration and customisation of the monitoring infrastructure to adapt it to the specific cloud application.

- Haji et al. describes a novel cloud architecture for the deployment of virtual appliances, which offer pre-packaged applications, preconfigured and encapsulated in virtual machine images running on virtualisation platforms. This type of service enables flexibility and easy deployment, while ensuring interoperability, reuse and migration of services.

- Di Martino et al. propose a semantic-based approach to the analysis of business process model and their translation to cloud applications. The presented representation aims at easing the mapping process and to suggest users the best suitable cloud services to compose. A case study which demonstrates the applicability and efficacy of the approach is also described.

- Amato et al. discusses some technical issues, which must be addressed to migrate mission-critical applications on public clouds. Moreover, by using a case study, an approach to broker cloud infrastructure needs to satisfy more restrictive critical requirements is presented.

- Amato et al. present a system for supporting medical decisions. It is based on semantic analysis of available medical data. The system implements an innovative methodology, which combines different semantic approaches in order to extract the representation of a given document expressed in natural language, and to associate it to a set of RDF triples.

- Pan et al. propose an improved clustering algorithm to solve parameter optimisation problem for PSO based on semi-supervised learning. The new approach is called APO SSPSO, which employs an adaptive strategy based on PSO to dynamically adjust the usage ratio of labelled and unlabelled samples for the clustering.

- Ji et al. propose the bag of little bootstraps attribute reduction algorithm (BLBAR), which combines the bag of little bootstraps with attribute discernibility, to guarantee the feasibility of attribute reduction of massive decision tables due to hard limitation.

- Jimenez-Peris et al. present the design of the transactional layer developed within the CoherentPaaS project, aiming at developing a common query language to access data across different data stores and provide transactional guarantees for operations updating data across heterogeneous data stores

References

Basu, S., Karuppiah, M., Kamalanathan, S., Li, K-C., Islam, S.K.H., Hassan, M.M. and Bhuiyan, M.Z.A. (2018) 'An intelligent/cognitive model of task scheduling for IoT applications in cloud computing environment', *Future Generation Comp. Syst.*, Vol. 8, pp.254–261.

Cretella, G. and Di Martino, B. (2015) 'A semantic engine for porting applications to the cloud and among clouds', *Software – Practice and Experience*, Vol. 45, No. 12, pp.1619–1637.

Di Martino, B. and Esposito, A. (2015) 'Automatic dynamic data structures recognition to support the migration of applications to the cloud', *International Journal of Grid and High Performance Computing*, Vol. 7, No. 3, pp.1–22.

Di Martino, B. and Esposito, A. (2016) 'Semantic techniques for multi-cloud applications portability and interoperability', *Procedia Computer Science*, Vol. 97, pp.104–113.

Di Martino, B. and Esposito, A. (2018) 'A tool for mapping and editing of cloud patterns: the semantic cloud patterns editor', *Studies in Informatics and Control*, Vol. 27, No. 1, pp.117–126.

Di Martino, B., Cretella, G. and Esposito, A. (2015a) *Cloud Portability and Interoperability – Issues and Current Trends*, Springer, Berlin.

Di Martino, B., Cretella, G. and Esposito, A. (2015b) 'Advances in applications portability and services interoperability among multiple clouds', *IEEE Cloud Computing*, Vol. 2, No. 2, pp.22–28, cited by 2.

Di Martino, B., Cretella, G., Esposito, A. and Carta, G. (2015c) 'An owl ontology to support cloud portability and interoperability', *International Journal of Web and Grid Services*, Vol. 11, No. 3, pp.303–326.

Di Martino, B., Cretella, G. and Esposito, A. (2017a) 'Cloud services composition through cloud patterns: a semantic-based approach', *Soft Computing*, Vol. 21, No. 16, pp.4557–4570.

Di Martino, B., Cretella, G. and Esposito, A. (2017b) 'A comparison between tosca and openstack hot through cloud patterns composition', *International Journal of Grid and Utility Computing*, Vol. 8, No. 4, pp.299–311.

Di Martino, B., Esposito, A. and Cretella, G. (2017c) 'Semantic representation of cloud patterns and services with automated reasoning to support cloud application portability', *IEEE Transactions on Cloud Computing*, October, Vol. 5, No. 4, pp.765–779.

Di Martino, B., Li, K-C., Yang, L.T. and Esposito, A. (2018) *Internet of Everything*, Springer, Singapore.

Di Martino, B., Petcu, D., Cossu, R., Goncalves, P., Máhr, T. and Loichate, M. (2010) 'Building a mosaic of clouds', in *European Conference on Parallel Processing*, Springer, pp.571–578.

Fehling, C., Leymann, F., Retter, R., Schupeck, W. and Arbitter, P. (2014) *Cloud Computing Patterns: Fundamentals to Design, Build, and Manage Cloud Applications*, Springer.

Lin, H-Y., Doong, J-G., Hsieh, M-Y. and Li, K-C. (2017) 'A real time vehicle management system implementation on cloud computing platform', *IJHPCN*, Vol. 10, No. 3, pp.168–178.

Pop, F., Koodziej, J. and Di Martino, B. (2016) *Resource Management for Big Data Platforms*, Springer, Singapore.