Lecture Notes in Networks and Systems 278

Leonard Barolli
Kangbin Yim
Tomoya Enokido *Editors*

# Complex, Intelligent and Software Intensive Systems

## Proceedings of the 15th International Conference on Complex, Intelligent and Software Intensive Systems (CISIS-2021)

Springer

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Leonard Barolli · Kangbin Yim ·
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Editors

# Complex, Intelligent and Software Intensive Systems

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*Editors*
Leonard Barolli
Department of Information
and Communication Engineering
Fukuoka Institute of Technology
Fukuoka, Japan

Kangbin Yim
Department of Information
Security Engineering
Soonchunhyang University
Asan, Korea (Republic of)

Tomoya Enokido
Faculty of Bussiness Administration
Rissho University
Tokyo, Japan

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# Welcome Message of CISIS-2021 International Conference Organizers

Welcome to the 15th International Conference on Complex, Intelligent and Software Intensive System*s* (CISIS-2021), which will be held from July 1 to July 3, 2021, at Soon Chun Hyang (SCH) University, Asan, Korea, in conjunction with the 15th International Conference on Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS-2021).

The aim of the conference is to deliver a platform of scientific interaction between the three interwoven challenging areas of research and development of future ICT-enabled applications: software intensive systems, complex systems and intelligent systems.

Software intensive systems are systems, which heavily interact with other systems, sensors, actuators, devices, other software systems and users. More and more domains are involved with software intensive systems, e.g., automotive, telecommunication systems, embedded systems in general, industrial automation systems and business applications. Moreover, the outcome of web services delivers a new platform for enabling software intensive systems. The conference is thus focused on tools, practically relevant and theoretical foundations for engineering software intensive systems.

Complex systems research is focused on the overall understanding of systems rather than its components. Complex systems are very much characterized by the changing environments in which they act by their multiple internal and external interactions. They evolve and adapt through internal and external dynamic interactions.

The development of intelligent systems and agents, which is each time more characterized by the use of ontologies and their logical foundations, builds a fruitful impulse for both software intensive systems and complex systems. Recent research in the field of intelligent systems, robotics, neuroscience, artificial intelligence and cognitive sciences is a very important factor for the future development and innovation of software intensive and complex systems.

The CISIS-2021 is aiming at delivering a forum for in-depth scientific discussions among the three communities. The papers included in the proceedings cover all aspects of theory, design and application of complex systems, intelligent systems and software intensive systems.

We are very proud and honored to have two distinguished keynote talks by Dr. Jayh (Hyunhee) Park, Myongji University, Korea, and Dr. Antonio Esposito, University of Campania "Luigi Vanvitelli", Italy, who will present their recent work and will give new insights and ideas to the conference participants.

The organization of an international conference requires the support and help of many people. A lot of people have helped and worked hard to produce a successful CISIS-2021 technical program and conference proceedings. First, we would like to thank all the authors for submitting their papers, the program committee members and the reviewers who carried out the most difficult work by carefully evaluating the submitted papers. We are grateful to Honorary Co-Chairs Kyoil Suh, Soon Chun Hyang (SCH) University, Korea, and Prof. Makoto Takizawa, Hosei University, Japan, for their guidance and advices.

Finally, we would like to thank Web Administrator Co-Chairs for their excellent and timely work.

We hope you will enjoy the conference proceedings.

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# CISIS-2021 Keynote Talks

# Asking AI Why: Explainable Artificial Intelligence

Jayh (Hyunhee) Park

Myongji University, Yongin, Korea

**Abstract.** In the early phases of AI adoption, it was okay to not understand what the model predicts in a certain way, as long as it gives the correct outputs. Explaining how they work was not the first priority. Now, the focus is turning to build human interpretable models. In the invited talk, I will explain why explainable AI is important. Then, I will explain an AI model. Through this invited talk, I will discuss models such as ensembles and neural networks called black-box models. I will deal with the following questions.

- Why should we trust your model?
- Why did the model take a certain decision?
- What drives model predictions?

# Coevolution of Semantic and Blockchain Technologies

Antonio Esposito

University of Campania "Luigi Vanvitelli", Aversa, Italy

**Abstract.** Semantic technologies have demonstrated to have the capability to ease interoperability and portability issues in several application fields such as cloud computing and the Internet of things (IoT). Indeed, the increase in resource representation and the inference capabilities enabled by semantic technologies represent important components of current distributed software systems, which can rely on better information interoperability and decision autonomy. However, semantics alone cannot solve trust and reliability issues that, in many situations, can still arise within software systems. Blockchain solutions have shown to be effective in this area, creating data sharing infrastructure where information validation can be done without the necessity of third-party services. A coevolution and integration of semantic and blockchain technologies would at the same time enhance data interoperability and ensure data trust and provenance, creating undeniable benefits for distributes software systems. This talk will focus on the current state of the art regarding the integration of semantic and blockchain technologies, looking at the state of their coevolution, at the available and still needed solutions.

# Contents

# Bridging the Semantic Gap in Continuous Auditing Knowledge Representation

Sri Sulistyowati(✉), Indri Kartika, Imam Setijawan, and Maya Indriastuti

Universitas Islam Sultan Agung, Jalan Raya Kaligawe KM 4, Semarang, Indonesia
{sulistyowati,indri,imam.s,maya}@unissula.ac.id

**Abstract.** Due to its promised advantages, Continuous Auditing has become a research direction in the computer technology-assisted audit field. Unfortunately, auditors usually cannot thoroughly carry out the Continuous Auditing method because of their lack of Information Technology proficiency and inefficient communication as well as interaction with IT personnel and information system. Overcoming the "semantic gap" between heterogeneous information sources to facilitate an understanding of Continuous Auditing concept domain is a key challenge to support the Continuous Auditing implementation. The primary aim of this study is to bridge the "Semantic Gap" between auditors and information system in Continuous Auditing knowledge. It is necessary to narrow the semantic gap between high-level concepts employed by the auditor and low-level feature presentations of the system to create Continuous Auditing capacity.

**Keywords:** Continuous auditing · Knowledge representation · Semantic · Ontology

## 1 Introduction

The development of existing technology allows companies to publish financial reports in real-time; even the publication of the report can be done continuously throughout the accounting period [1]. As a result, auditing tasks are becoming more difficult as auditors must understand the relationship between a perturbation in an accounting system and its effects, which can be highly indirect because accounting system is becoming more complex [2]. Eventually, computer and information technology will continue to evolve and foster an improved audit process.

Related to the technology utilization in audit performance, Continuous Auditing is one of the emerging methodologies systems in the auditing process that has gained popularity [3]. This concept was first proposed by Groomer and Murphy in 1989 [4] and Vasarhelyi et al. in 1991 [5]. Ever since, researchers, auditors and software developers have given a great deal of attention to Continuous Auditing implementations. Numbers of studies have provided designs and models for CA [6–12].

Due to its promised advantages, Continuous Auditing has become a research direction in the computer technology-assisted audit field. Conventional auditing is


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generally focused on paper-based annual financial statement, while this condition is no longer relevant since financial information now can be provided in electronic invoices using blockchain infrastructure [13]. Continuous Auditing and Continuous Monitoring systems are likely to become particularly relevant in this technology era, transforming audit practice from time-consuming manual paper-based audit procedures into a real-time audit process. In this condition a statistical relationships between different business elements and processes may be monitored continuously in a real-time process to detect irregular events [14].

Research in Continuous Auditing [15] has increased rapidly in recent times both in internal auditing and external auditing as it allows accountants to produce timely information through continuous monitoring and continuous control. Although the approaches of the existing models differ slightly from each other, they all aim to produce outcomes as close as possible to real-time. However, auditors usually cannot thoroughly carry out the Continuous Auditing method due to their lack of information about Continuous Auditing [16]. Moreover, according to [17] most auditors who are not equipped with IT backgrounds have a great degree of difficulty in integrating computer-aided auditing system with their professional knowledge in auditing. This limitation greatly impairs the auditors' ability to independently and continuously perform tests in the CA environment. As a response to the increasing demand for timely and ongoing assurance over the effectiveness of risk management and control system, companies are moving toward a more automated control environment through the implementation of Continuous Auditing (CA) modules [18].

## 2 Continuous Auditing (CA)

Continuous Auditing (CA) is the development of a standard audit that currently applies in the business world. Typically, a financial audit process is performed manually or supported by technology after the company has finished preparing its annual financial statement [19]. However, technology developments have led auditors to consider conducting the financial audit process using Continuous Auditing.

Continuous Auditing is defined as.

> "*A methodology that enables the auditor to provide assurance on the subject matter simultaneously with, or very shortly after, the occurrence of events underlying the subject matter* (CICA and AICPA)."

There are two opinions about how to implement Continuous Auditing. Kogan believes that Continuous Auditing can be feasible only if implemented as a fully automated process [20]. On the other hand, Chan and Vasarhelyi [17] argue that the automation of all traditional audit procedures may not be immediately feasible. In fact, some audit procedures requiring complex judgment and professional skepticism will still require manual performance by the auditors in the Continuous Auditing environment [5]. For instance, auditor's justification to determine the level of professional materiality in the risk assessment procedure. Besides, the automation in Continuous Auditing implementations do not require since Continuous Auditing is about performing testing on a recurring basis to ensure the viability of control effectiveness [21].

Therefore, the implementation of Continuous Auditing may not be separated entirely from manual audit procedures. Some previous studies have provided evidence of the importance of Continuous Auditing; however, we acknowledge that the traditional annual audit currently still dominates the audit market in Certified Public Accountants [15] firms. In the meantime, auditors should recognize that Continuous Auditing methodology on some audit tasks is currently possible and can significantly contribute to the financial statements audit activity (Fig. 1).

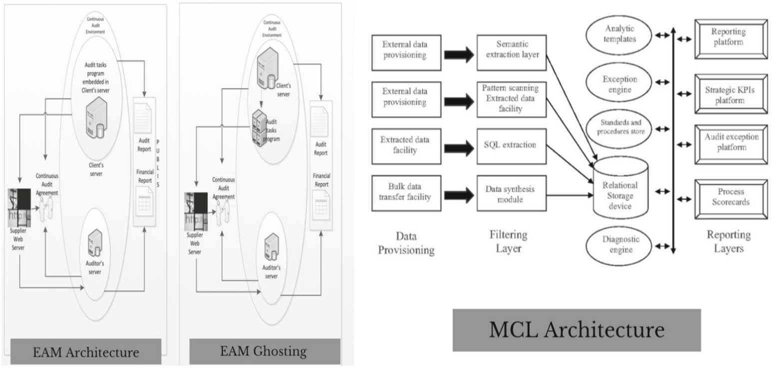


**Fig. 1.** Architecture of continuous auditing.

## 3 Lack of Formal Framework for Continuous Auditing

The notion of Continuous Auditing was proposed many years later, and current IT developments have made it possible for Continuous Auditing to be implemented. The concept of Continuous Auditing, its architecture, as well as its implementation theory have been extensively documented in various electronic journals and information. Also, the notion of Continuous Auditing was proposed many years later, and current IT developments have made it possible for Continuous Auditing to be implemented. As the use of information systems is getting more popular in organizations, the technology utilization in the audit performance gains more attention as well. However, most auditors who are not equipped with IT backgrounds have varying degrees of difficulty in integrating computer-aided auditing system with their professional knowledge in auditing [22]. The limitation due to the gap between IT backgrounds and professional expertise has affected the auditor's ability to perform audit tasks in the CA environment. Auditors have to provide a valid understanding of system procedures as well as AIS specific and programming skills [23].

In today's digital era, auditor should understand the intrinsic semantics of technology-assisted audit process such as the Continuous Auditing method, not only how to get a direct access to client's database and files. However, auditors usually cannot thoroughly carry out Continuous Auditing because of their lack of IT proficiency and inefficient communication and interaction with IT personnel and information system [24]. Techniques for preserving and sharing of information of CA implementation could face this challenge [23]. Therefore, overcoming the "semantic gap" between heterogeneous information sources to facilitate an understanding of Continuous Auditing concept domain is a key challenge to support the Continuous Auditing implementation. This may be done by developing tools that, using the latest software technology, are able to manage large complex models and have the necessary knowledge built-in [25].

The "Semantic Gap" can be defined as:

> "*the large disparity between the low-level features or content descriptors that can be computed automatically by current machines and algorithms, and the richness and subjectivity of semantics in user queries and high-level interpretations of auditing program* [24]"

To address the semantic gap in the Continuous Auditing concept, we propose to represent the Continuous Auditing knowledge semantically. The current development of audit software suffers from a semantic gap between the business (audit) level and the IT system level [25]. It needs a deep understanding of Continuous Auditing itself to create a useful semantic representation of the Continuous Auditing concept. Moreover, since Continuous Auditing uses the same set of data elements defined in a standard taxonomy, semantic heterogeneity becomes a problem in the context of exchanging, sharing and integrating data. Semantic heterogeneity is a general term referring to disagreement about the meaning, interpretation or intended use of the same, or related data [26]. An example of semantic heterogeneity is the use of synonyms, such as employees or staff, which are used to refer to the same concept in different information systems.

According to Chen et al. [24], it is necessary to narrow the semantic gap between high-level concepts employed by the auditor and low-level feature presentations of the system in order to create Continuous Auditing capacity. Moreover, some information systems conceptual models have been proven to be able to bridge between end-users and the information system since they provide richer semantic to assist auditors understanding the business processing capabilities of information systems [24].

## 4 Solution Overview

The semantics of Continuous Auditing information are usually implicitly described in auditing literature but not explicitly well stated. Moreover, the knowledge of Continuous Auditing is often difficult to understand among accountants. This is due to the fact that most Continuous Auditing studies and literature often contain a full of technological terms with many synonymous and acronyms which refer to the same concept. Although accountants are expected to be familiar with essential Continuous Auditing concepts, the inconsistent representation of terms can sometimes present difficulties in the retrieval and integration of information.

The existing studies of Continuous Auditing can be divided into two large research groups investigating different aspects. The first group is those from accounting domain expert who focuses on the development concept, principle and element of Continuous Auditing. While the other research group of Continuous Auditing is those from accounting, computer and information system domain expert, who focus on the technical implementation and architecture of Continuous Auditing. Due to the variations of the Continuous Auditing studies, it is difficult for auditors to get an understanding of Continuous Auditing implementation. A framework for Continuous Auditing knowledge representation is particularly important to provide unambiguous references to domain concepts.

## 5 Choice of Knowledge Representation Approach

There are several approaches to knowledge representation in accounting and auditing that can be used to represent accounting or auditing knowledge such as; Glossary of terms, PROLOG language, and Ontology [27].

**Glossary of Terms**

According to Wikipedia, a glossary, also known as a vocabulary, is an alphabetical list of terms in particular domain of knowledge with the definitions for those terms. However, a pure glossary of terms does not provide taxonomies or any kind of relations between different concept except synonyms and acronyms. Without taxonomies and relations, it is impossible to determine or even infer anything from the concepts provided [28]. Therefore, we cannot rely on this method to assist our research goal to represent the knowledge of Continuous Auditing.

**PROLOG Language**

The PROLOG programming language was explicitly developed for problems of artificial intelligence and can be used to represent many accounting knowledge, including procedural [29] knowledge [30]. However, the Prolog language would not assist us in achieving our goal here as Continuous Auditing defines some audit procedures that are not decidable and that involves auditor's professional judgement. The determination depends on the nature and extent of misstatements identified in previous audits and thus the auditor's expectations in terms of misstatements in the current period. This kind of definition cannot be described using Prolog as this assumes anything it cannot prove is false. Therefore, in Prolog programming language we must define a set of predicates where each predicate has its own clauses, and the clauses have to represent facts and rules that make the predicate to be true.

**Ontology**

Ontology is "a formal shared, explicit, but the partial specification of the commonly agreed upon intended meaning of a "conceptualization" [31]. Using an ontology, we can share knowledge with others who have similar needs for knowledge representation in that domain, thereby eliminating the need to replicate the knowledge analysis process [32]. According to Teller [33] ontology is a very powerful for representing the knowledge of a domain with concepts and relations between these concepts. These facts make ontology a good get to our requirement of representing knowledge. Therefore, we believe that developing a Continuous Auditing Ontology [34] could overcome the "semantic gap" issues in Continuous Auditing domain knowledge.

## 6 Knowledge Representation Technique in Accounting and Auditing domain knowledge

Some studies have provided the need for an ontology approach in accounting and auditing domain knowledge. Building an accounting ontology is a necessary first step in creating an organizational accounting repository that will allow storing domain knowledge and dissemination since new concepts in accounting quickly appear and develop [35]. Ontology, as knowledge representation technique, is the most appropriate to provide the semantic structures necessary at context information that will allow it to gather, manage and storage it efficiently in the CAS and applications [36].

Applications of ontologies are becoming particularly prevalent in Finance research domain including accounting and auditing science as more scholars are starting to adopt ontologies to model the accounting and auditing research domain. For instance, represent the whole knowledge of the accounting domain, [33] build an ontology of accounting notions. An enterprise ontology provided by [37], facilitates communication between partners in business and improves the organization's system engineering processes and creates interoperability between enterprise systems. Moreover, [38] have suggested auditor task ontology and audit application ontology in their agent-based architecture to explore the idea of collaborative continuous auditing. The proposed architecture is aimed to support the accepted auditing procedure with a spot focus on CA [38]. Beside, [39] presents the application and benefits of using an expressive, logic-based ontology for representing knowledge in a financial audit system.

In a financial audit domain, the use of ontology to represent audit knowledge have provided by [39] and [40]. Akinyemi and Ehikioya provided a financial audit ontology for the commercial sector designed with PoweloomTM, a description logic of financial audit based on knowledge representation system [39]. While, a conceptual system architecture for Continuous Process Auditing (CPA) based on domain ontologies, audit rules, knowledge learning techniques and audit report recommendation procedures have provided by [40]. These existing accounting and auditing ontologies show that ontologies became a common thing on finance research including accounting and auditing domain knowledge. Building an ontology for accounting as well as auditing domain will support knowledge management in that research domain as they promote knowledge sharing and reuse.

## 7 Methodology for Continuous Auditing Ontology Development

In order to address the "semantic gap" issues in Continuous Auditing domain knowledge, we have proposed Continuous Auditing Ontology [34], a formal framework for the description, organization and classification of Continuous Auditing [34]. There are some ontology development that can be used including: Knowledge Engineering Methodlogy, Uschold & King Methodlogy, TOVE Methodology, DOGMA Methodology, METHONTOLOGY, OnToknowledge, DILGENT Methodology, KACTUS Methodology, TERMINAE and SENSUS Methodology [41, 42].

Following an analysis of ontology development methodologies, Galliers concludes that none of the methodologies is fully mature against the IEEE standard in software developing [43]. However, Galliers believes that METHONTOLOGY is the most mature method with additional recommendations by the FIPA (Foundation for Intelligent Physical Agents) for the pre-development processes and certain activities and techniques should be specified in more detail [43]. The METHONTOLOGY approach allows us to design the ontology in an implementation independent way, thus allowing one choose the most appropriate and perhaps standardized language or most widely accepted language According to [27]. In addition, a survey to compare ontology development methodologies between 2015–2020 reveals a conclusion that TERMINAE and METHONTOLOGY are the appropriate methodologies for designing domain ontologies [42].

Using METHONTOLOGY approach as the methodology to develop CAO, the Continuous Auditing Ontology development covers four broad processes which are: Specifications, conceptualization, formalization and evaluation. Figure 2 below shows the view of the methodology for Continuous Auditing Ontology development.

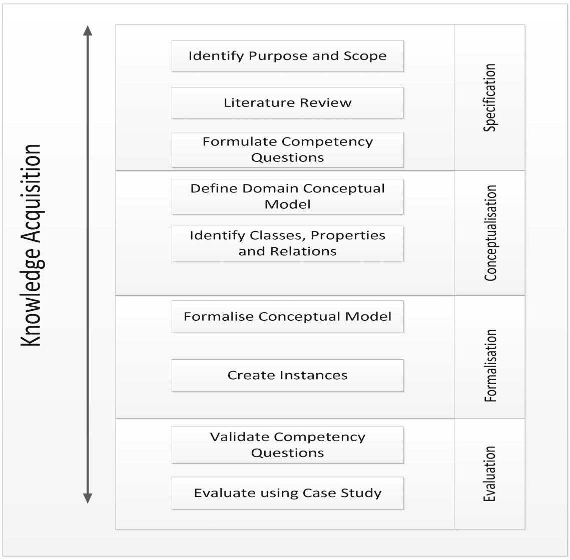


**Fig. 2.** Schematic view of the methodology for continuous auditing (Adopted from [44])

In the specification phase, the domain and the scope of the ontology are identified. What we need to do in the first step to developing an Ontology is to identify the key objective, followed by the purpose of the ontology [44]. This step then followed by extracting Continuous Auditing domain concepts by conducting a peer-review for journal articles, textbooks, and conference proceedings concerning Continuous Auditing. The formulation of the competency questions, as the last stage in the specification phase, supports the iterative of knowledge acquisition and also serves as a validation technique for the correctness and consistency of the Ontology [44]. Competency questions in the ontology are targets for what an ontology should be able to answer, given sufficient facts.

According to Jinsoo Park, the objective of the conceptualization activity is to organize and structure the knowledge acquired from the external representations that are independent of the knowledge representation and implementation [45]. Starting with converting informal data into semi-formal specification, this conceptualization stage use a set of intermediate representations based on tabular and graph notations provided by METHONTOLOGY. These IRs (i.e., concepts, attributes, relations, axioms, and rules) are valuable because they are easily understood by both domain experts and ontology developers [45].

To formalize the conceptual model of Continuous Auditing for Supreme Audit Institutions, we need to implement the concept using ontology language and its corresponding tool. Formalization refers to the translation of the conceptualized knowledge into a machine-readable and formal language [44]. We suggest Protégé as a tool for developing the Continuous Auditing Ontology. To implement the conceptual framework of CAO, Protégé is ideal due to its rapid prototyping features and its ability to export into commonly used languages such as RDF, XML Schema, and OWL.

Once the proper CAO has been developed, in the final phase we need to check its consistency, completeness, and conciseness to verify its constructs and validate its functions. The first step of the evaluation phase involved testing the complete Continuous Auditing Ontology against the competency questions that provided at the initial specification stage of CAO development. This was carried out in order to check that the model has successfully represented relationships in the initial documents or definitions. How well does the model perform when it is faced with information that is not explicitly in the scope of its design? I.e., What inferences can we draw from it? For this purpose, a case analysis evaluation is suggested using a sample of Continuous Auditing implementation. Case study research is accepted as a viable research strategy within the Information System research community [46]. Case study research is most likely to be appropriate to address "how" and "why" questions because these deal with operational links needing to be traced over time, rather than merely frequencies of incidence [47].

## 8 Conclusion

Technological challenges of CA implementation occur since the tool set of the audit practice should include various aspects of information and web technology to design and conducting CA practice [48]. In the semantic knowledge representation, ontologies have proven to be an essential element in many applications [49]. In general, ontology is used in artificial intelligence (AI) and for knowledge representation. Building a Continuous Auditing Ontology can provide a knowledge representation for Continuous Auditing domain to bridge the semantic gap between heterogeneous information sources to facilitate an understanding of Continuous Auditing concept domain.

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