

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)

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Leonard Barolli · Kangbin Yim ·
Tomoya Enokido
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Complex, Intelligent and Software Intensive Systems

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Conference on Complex, Intelligent
and Software Intensive Systems (CISIS-2021)

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Welcome Message of CISIS-2021 International Conference Organizers

Welcome to the 15th International Conference on Complex, Intelligent and Software Intensive Systems (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 distributed 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

Four Grade Levels-Based Models with Random Forest for Student Performance Prediction at a Multidisciplinary University	1
Tran Thanh Dien, Le Duy-Anh, Nguyen Hong-Phat, Nguyen Van-Tuan, Trinh Thanh-Chanh, Le Minh-Bang, Nguyen Thanh-Hai, and Nguyen Thai-Nghe	
The Role of Collective Engagement to Strengthen Organizational Identity	13
Olivia Fachrunnisa, Ardian Adhiatma, and Ken Sudarti	
A Novel Structural and Semantic Similarity in Social Recommender Systems	23
Imen Ben El Kouni, Wafa Karoui, and Lotfi Ben Romdhane	
Trustworthy Explainability Acceptance: A New Metric to Measure the Trustworthiness of Interpretable AI Medical Diagnostic Systems . . .	35
Davinder Kaur, Suleyman Uslu, Arjan Durresi, Sunil Badve, and Murat Dundar	
Entity Relation Extraction Based on Multi-attention Mechanism and BiGRU Network	47
Lingyun Wang, Caiquan Xiong, Wenxiang Xu, and Song Lin	
Time Series Prediction of Wind Speed Based on SARIMA and LSTM	57
Caiquan Xiong, Congcong Yu, Xiaohui Gu, and Shiqiang Xu	
Dimensionality Reduction on Metagenomic Data with Recursive Feature Elimination	68
Huong Hoang Luong, Nghia Trong Le Phan, Tin Tri Duong, Thuan Minh Dang, Tong Duc Nguyen, and Hai Thanh Nguyen	

The Application of Improved Grasshopper Optimization Algorithm to Flight Delay Prediction–Based on Spark	80
Hongwei Chen, Shenghong Tu, and Hui Xu	
Application of Distributed Seagull Optimization Improved Algorithm in Sentiment Tendency Prediction	90
Hongwei Chen, Honglin Zhou, Meiyong Li, Hui Xu, and Xun Zhou	
Performance Evaluation of WMNs by WMN-PSOSA-DGA Hybrid Simulation System Considering Stadium Distribution of Mesh Clients and Different Number of Mesh Routers	100
Admir Barolli, Shinji Sakamoto, Leonard Barolli, and Makoto Takizawa	
A New Scheme for Slice Overloading Cost in 5G Wireless Networks Considering Fuzzy Logic	110
Phudit Ampririt, Ermioni Qafzezi, Kevin Bylykbashi, Makoto Ikeda, Keita Matsuo, and Leonard Barolli	
COVID-Prevention-Based Parking with Risk Factor Computation	121
Walter Balzano and Silvia Stranieri	
Coarse Traffic Classification for High-Bandwidth Connections in a Computer Network Using Deep Learning Techniques	131
Marek Bolanowski, Andrzej Paszkiewicz, and Bartosz Rumak	
A Privacy Preserving Hybrid Blockchain Based Announcement Scheme for Vehicular Energy Network	142
Abid Jamal, Sana Amjad, Usman Aziz, Muhammad Usman Gurmani, Saba Awan, and Nadeem Javaid	
Prediction of Wide Area Road State Using Measurement Sensor Data and Meteorological Mesh Data	152
Yoshitaka Shibata and Akira Sakuraba	
A Coverage Construction and Hill Climbing Approach for Mesh Router Placement Optimization: Simulation Results for Different Number of Mesh Routers and Instances Considering Normal Distribution of Mesh Clients	161
Aoto Hirata, Tetsuya Oda, Nobuki Saito, Yuki Nagai, Masaharu Hirota, Kengo Katayama, and Leonard Barolli	
Related Entity Expansion and Ranking Using Knowledge Graph	172
Ryuya Akase, Hiroto Kawabata, Akiomi Nishida, Yuki Tanaka, and Tamaki Kaminaga	
Zero Trust Security in the Mist Architecture	185
Minoru Uehara	

Blockchain Based Authentication for End-Nodes and Efficient Cluster Head Selection in Wireless Sensor Networks 195
 Sana Amjad, Usman Aziz, Muhammad Usman Gurmani, Saba Awan, Maimoona Bint E. Sajid, and Nadeem Javaid

The Redundant Active Time-Based Algorithm with Forcing Meaningless Replica to Terminate 206
 Tomoya Enokido, Dilawaer Duolikun, and Makoto Takizawa

A Novel Approach to Network’s Topology Evolution and Robustness Optimization of Scale Free Networks 214
 Muhammad Usman, Nadeem Javaid, Syed Minhal Abbas, Muhammad Mohsin Javed, Muhammad Aqib Waseem, and Muhammad Owais

Implementation of an Indoor Position Detecting System Using Mean BLE RSSI for Moving Omnidirectional Access Point Robot 225
 Atushi Toyama, Kenshiro Mitsugi, Keita Matsuo, Elis Kulla, and Leonard Barolli

A Survey on Internet of Things in Telehealth 235
 Komal Marwah and Farshid Hajati

Alexnet-Adaboost-ABC Based Hybrid Neural Network for Electricity Theft Detection in Smart Grids 249
 Muhammad Asif, Ashraf Ullah, Shoaib Munawar, Benish Kabir, Pamir, Adil Khan, and Nadeem Javaid

Blockchain and IPFS Based Service Model for the Internet of Things 259
 Hajra Zareen, Saba Awan, Maimoona Bint E Sajid, Shakira Musa Baig, Muhammad Faisal, and Nadeem Javaid

Building Social Relationship Skill in Digital Work Design 271
 Ardian Adhiatma and Umi Kuswatun Hasanah

How to Push Digital Ecosystem to Explore Digital Humanities and Collaboration of SMEs 279
 Marno Nugroho and Budhi Cahyono

IOTA-Based Mobile Application for Environmental Sensor Data Visualization 288
 Francesco Lubrano, Fabrizio Bertone, Giuseppe Caragnano, and Olivier Terzo

Electricity Theft Detection in Smart Meters Using a Hybrid Bi-directional GRU Bi-directional LSTM Model 297
 Shoaib Munawar, Muhammad Asif, Beenish Kabir, Pamir, Ashraf Ullah, and Nadeem Javaid

Developing Innovation Capability to Improve Marketing Performance in Batik SMEs During the Covid-19 Pandemic 309
Alifah Ratnawati and Noor Kholis

Muthmai'annah Adaptive Capability: A Conceptual Review 324
Asih Niati, Olivia Fachrunnisa, and Mohamad Sodikin

Interaction Model of Knowledge Management, Green Innovation and Corporate Sustainable Development in Indonesia 332
Siti Sumiati, Sri Wahyuni Ratnasari, and Erni Yuvitasari

The Impact of Covid-19 Pandemic on Continuance Adoption of Mobile Payments: A Conceptual Framework 338
Dian Essa Nugrahini and Ahmad Hijri Alfian

An Analysis in the Application of the Unified Theory of Acceptance and Use of Technology (UTAUT) Model on Village Fund System (SISKEUDES) with Islamic Work Ethics as a Moderating Effect 347
Khoiril Fuad, Winarsih, Luluk Muhimatul Ifada, Hendry Setyawan, and Retno Tri Handayani

MOC Approach and Its Integration with Social Network and ICT: The Role to Improve Knowledge Transfer 357
Tri Wikaningrum

An Integrated System for Actor Node Selection in WSANs Considering Fuzzy Logic and NS-3 and Its Performance Evaluation ... 365
Yi Liu, Shinji Sakamoto, and Leonard Barolli

Design of an Intelligent Driving Support System for Detecting Distracted Driving 377
Masahiro Miwata, Mitsuki Tsuneyoshi, Yoshiki Tada, Makoto Ikeda, and Leonard Barolli

Detection of Non-Technical Losses Using MLP-GRU Based Neural Network to Secure Smart Grids 383
Benish Kabir, Pamir, Ashraf Ullah, Shoaib Munawar, Muhammad Asif, and Nadeem Javaid

Synthetic Theft Attacks Implementation for Data Balancing and a Gated Recurrent Unit Based Electricity Theft Detection in Smart Grids 395
Pamir, Ashraf Ullah, Shoaib Munawar, Muhammad Asif, Benish Kabir, and Nadeem Javaid

Blockchain Enabled Secure and Efficient Reputation Management for Vehicular Energy Network 406
Abid Jamal, Muhammad Usman Gurmani, Saba Awan, Maimoona Bint E. Sajid, Sana Amjad, and Nadeem Javaid

Religious Value Co-Creation: A Strategy to Strengthen Customer Engagement 417
 Ken Sudarti, Olivia Fachrunnisa, Hendar, and Ardian Adhiatma

Environmental Performance Announcement and Shareholder Value: The Role of Environmental Disclosure 426
 Luluk Muhimatul Ifada, Munawaroh, Indri Kartika, and Khoirul Fuad

Integrating Corporate Social Responsibility Disclosure and Environmental Performance for Firm Value: An Indonesia Study 435
 Maya Indriastuti and Anis Chariri

Financial Technology and Islamic Mutual Funds Investment 446
 Mutamimah and Rima Yulia Sueztianingrum

Towards Spiritual Wellbeing in Organization: Linking Ihsan Achievement Oriented Leadership and Knowledge Sharing Behaviour 455
 Mohamad Sodikin, Olivia Fachrunnisa, and Asih Niati

Tax Avoidance and Performance: Initial Public Offering 464
 Kiryanto, Mutoharoh, and Zaenudin

Knowledge Sharing, Innovation Strategy and Innovation Capability: A Systematic Literature Review 473
 Mufti Agung Wibowo, Widodo, Olivia Fachrunnisa, Ardian Adhiatma, Marno Nugroho, and Yulianto Prabowo

The Determinant of Sustainable Performance in Indonesian Islamic Microfinance: Role of Accounting Information System and Maqashid Sharia 484
 Provita Wijayanti and Intan Salwani Mohamed

The Role of Digital Utilization in Accounting to Enhance MSMEs' Performance During COVID-19 Pandemic: Case Study in Semarang, Central Java, Indonesia 495
 Hani Werdi Apriyanti and Erni Yuvitasari

The Role of Confidence in Knowledge and Psychological Safety on Knowledge Sharing Improvement of Human Resources in Organization 505
 Arizqi

A Model of Agency Theory-Based Firm Value Improvement Through Cash Holding with Firm Size and Profitability as Control Variable 514
 Ibnu Khajar and Ayu Rakhmawati Kusumaningtyas

The Model of Tax Compliance Assessment in MSMEs 524
 Devi Permatasari, Naila Najihah, and Mutoharoh

Survival and Sustainability Strategies of Small and Medium Enterprises (SMEs) During and After Covid-19 Pandemic: A Conceptual Framework 534
 Naila Najihah, Devi Permatasari, and Mutoharoh

Bridging the Semantic Gap in Continuous Auditing Knowledge Representation 544
 Sri Sulistyowati, Indri Kartika, Imam Setijawan, and Maya Indriastuti

Comparison of Financing Resources to Support Micro and Small Business Sustainability 555
 Mutoharoh, Devi Permatasari, and Naila Najihah

The Mediating of Green Product Innovation on the Effect of Accounting Capability and Performance Financial of MSMEs in the New Normal Era 565
 Winarsih, Khoirul Fuad, and Hendri Setyawan

Supply Chain Management Quality Improvement Model with Adaptive and Generative Relationship Learning 573
 Lutfi Nurcholis and Ardian Adhiatma

Company’s Characteristics and Intellectual Capital Disclosure: Empirical Study at Technology Companies of Singapore 580
 Dista Amalia Arifah, Anis Chariri, and Pujiharto

The Influence of Sustainability Report on Islamic Banking Performance in Indonesia 590
 Muhammad Jafar Shodiq

The Antecedent and Consequences of Commitment to the Environment in Environmentally Friendly Automotive Products 598
 Tanti Handriana, Praptini Yulianti, and Decman Praharsa

Towards a Trustworthy Semantic-Aware Marketplace for Interoperable Cloud Services 606
 Emanuele Bellini, Stelvio Cimato, Ernesto Damiani, Beniamino Di Martino, and Antonio Esposito

Toward ECListener: An Unsupervised Intelligent System to Monitor Energy Communities 616
 Gregorio D’Agostino, Alberto Tofani, Beniamino Di Martino, and Fiammetta Marulli

Semantic Techniques for IoT Sensing and eHealth Training Recommendations 627
 Beniamino Di Martino and Serena Angela Gracco

PrettyTags: An Open-Source Tool for Easy and Customizable Textual MultiLevel Semantic Annotations	636
Beniamino Di Martino, Fiammetta Marulli, Mariangela Graziano, and Pietro Lupi	
Supporting the Optimization of Temporal Key Performance Indicators of Italian Courts of Justice with OLAP Techniques	646
Beniamino Di Martino, Luigi Colucci Cante, Antonio Esposito, Pietro Lupi, and Massimo Orlando	
Semantic Techniques for Automated Recognition of Building Types in Cultural Heritage Domain	657
Beniamino Di Martino, Mariangela Graziano, and Nicla Cerullo	
Semantic Representation and Rule Based Patterns Discovery and Verification in eProcurement Business Processes for eGovernment	667
Beniamino Di Martino, Datiana Cascone, Luigi Colucci Cante, and Antonio Esposito	
Research on the Development of Programming Support Systems Focused on the Cooperation Between Activity Diagrams and Scratch	677
Kazuhiro Kobashi, Kazuaki Yoshihara, and Kenzi Watanabe	
Research on the Development of Keyboard Applications for Reasonable Accommodation	686
Reika Okuya, Kazuaki Yoshihara, and Kenzi Watanabe	
Development of a Teaching Material for Information Security that Detects an Unsecure Wi-Fi Access Point	694
Kazuaki Yoshihara, Taisei Iwasaki, and Kenzi Watanabe	
A Study of Throughput Drop Estimation Model for Concurrently Communicating Links Under Coexistence of Channel Bonding and Non-bonding in IEEE 802.11n WLAN	700
Kwenga Ismael Munene, Nobuo Funabiki, Hendy Briantoro, Md. Mahbubur Rahman, Sujana Chandra Roy, and Minoru Kuribayashi	
Dynamic Fog Configuration for Content Sharing with Peer-to-Peer Network Using Mobile Terminals in a City	715
Takuya Itokazu and Shinji Sugawara	
Voice Quality Change Due to the Amount of Training Data for Multi- and Target-Speaker WaveNet Vocoders	727
Satoshi Yoshida, Shingo Uenohara, Keisuke Nishijima, and Ken'ichi Furuya	
Web-Based Collaborative VR Training System and Its Log Functionality for Radiation Therapy Device Operations	734
Yuta Miyahara, Kosuke Kaneko, Toshioh Fujibuchi, and Yoshihiro Okada	

Action Input Interface of *IntelligentBox* Using 360-Degree VR Camera and OpenPose for Multi-persons' Collaborative VR Applications 747
Bai Yu, Wei Shi, and Yoshihiro Okada

Author Index. 759



Bridging the Semantic Gap in Continuous Auditing Knowledge Representation

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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

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).

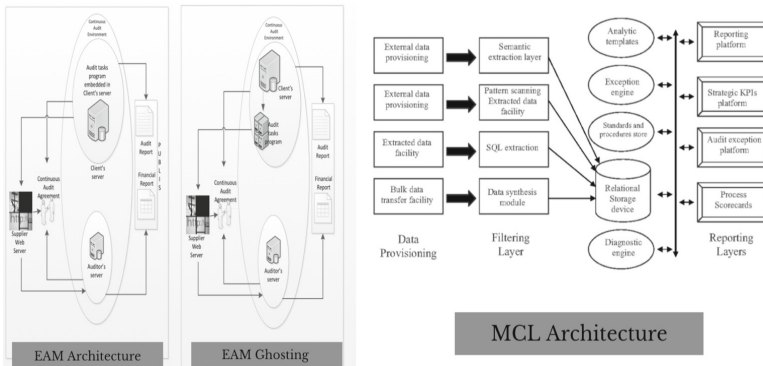


Fig. 1. Architecture of continuous auditing.

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 Methodology, Uschold & King Methodology, 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.

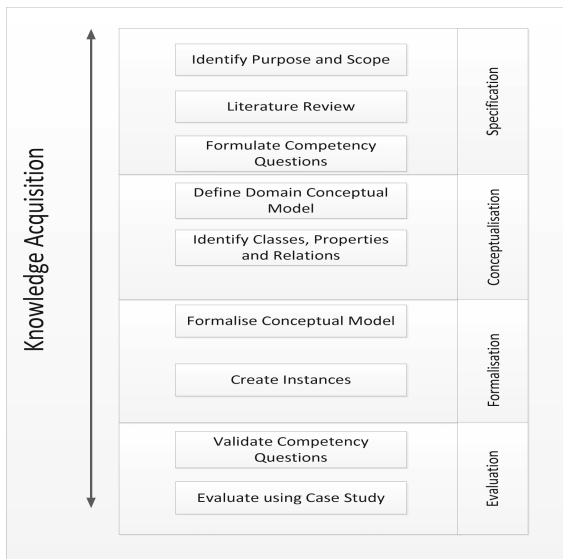


Fig. 2. Schematic view of the methodology for continuous auditing (Adopted from [44])

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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