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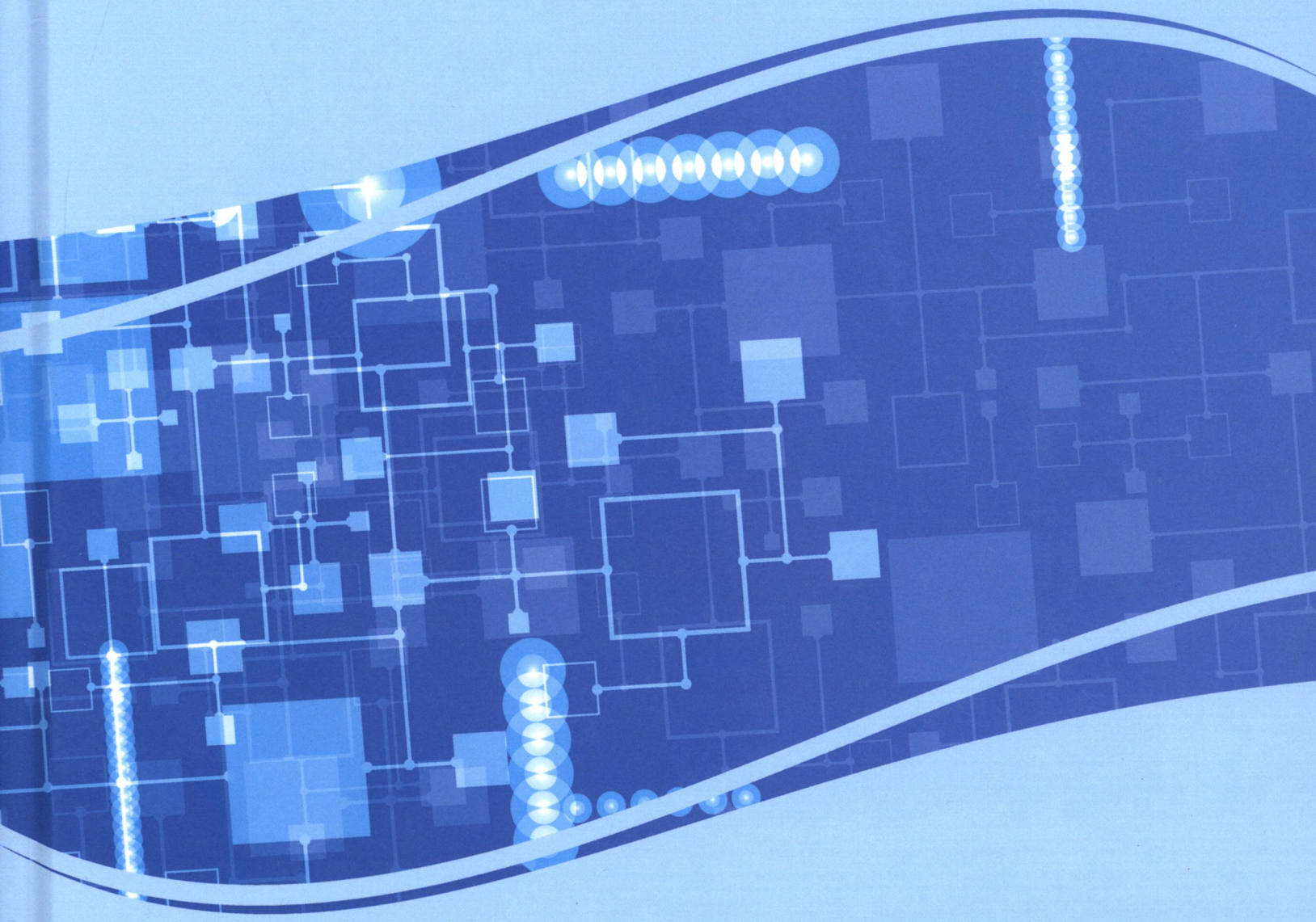

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Developments and Trends in Intelligent Technologies and Smart Systems

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Developments and Trends in Intelligent Technologies and Smart Systems

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A volume in the Advances in Computational Intelligence and Robotics (ACIR) Book Series

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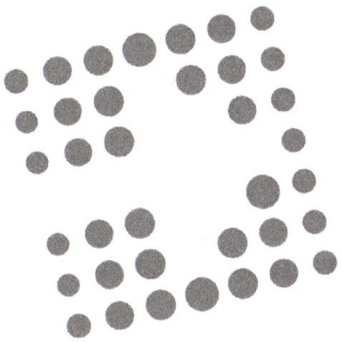

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Preface

INTRODUCTION

In today's informatics age, there is a vast amount of information, from biomedical and genetic reports to environmental and lifestyle information, often stored as text or in different databases that are rarely communicating with each other and are often difficult to mine. Unfortunately, this severely limits our ability to fuse information from multiple sources and identify large-scale patterns that affect human health. Currently, there is a huge body of biomedical text and their rapid growth makes it impossible for researchers to address the information manually. The Research, Condition, and Disease Categorization (RCDC) project gets data from 7 databases (all containing well over 4 terabytes of content) that gets routed, processed, grouped, validated and ultimately used for regular reports and on-demand queries. It follows a pattern matching approach for categorization of diseases. This project by NIH allows research information in medical records to be explored proactively on homogeneous data. Other projects on clinical and medical mining focus on gene manipulation, EHR interpretation, personalized medicine recommendation based on EHR of individuals, Drug recommendation based on linked open data. To summarize the happening in the healthcare domain, all the systems focused on homogeneous data and suggested diagnostic and prescriptive medicine. The underlying interaction between the various data that is available, their side effects and disease propagations has not been researched on.

Evidence-based medicine (EBM) is becoming common in today's healthcare delivery. EBM requires an integrated system where the clinician can gain access to not only the best practices and evidence in assessing the benefits and risks of a treatment, but also the patient information that might be scattered across the healthcare organization. Clinical data integration is the need of the hour, which has been accomplished with very limited success. Designing an integrative system would provide consolidated information mined and correlated using heterogeneous medical data to help healthcare professionals in making effective decisions and improve healthcare delivery.

Extracting evidence and integrating appropriate patient data is a major research challenge. While hospitals are investing heavily in infrastructure where disparate systems can be seamlessly connected to facilitate data integration, no gold standard exists. One system is the METEOR system developed at Houston Methodist Hospital. This system attempts to integrate data from internal and external sources into an enterprise clinical and research data warehouse. However, this solution is specific to the hospital and is not scalable or easily transferable to other healthcare organizations. A new generation of interoperable system architecture has to be designed to create generic, flexible and scalable systems with open architecture which have the potential to secure a large market share.

Limited amount of work in linking medical data mined from the web with medical databases and medical Linked Open Data has been carried out. Lifestyle recommendations from social media has also been implemented. Fundamental work on text mining and NLP processing of domain oriented scientific Literature mining has been undertaken. However, information fusion from heterogeneous sources for Discovering Diagnostic and Predictive Measures, Disease Progression Models and investigating correlations between conditions and monitor changes over time is still in the idea stage. Current strategies to mine genetic information employ an integrated approach of genetics, biomedical data, and text mining to identify risk probabilities of developing diseases and predicting responses to cures for diseases with a clear single-gene association.

INTERACTIVE BIOMEDICAL SYSTEM

Other work on healthcare have dealt with one source of data that is terabytes in size. Integrating all sources of medical data like EHR, literature mining, gene mining is new and has never been tried upon. Here we carry out information fusion from heterogeneous sources for Discovering Diagnostic and Predictive Measures, Disease Progression Models and investigating correlations between conditions and monitor changes over time. Current strategies to mine genetic information employ an integrated approach of genetics, biomedical data, and text mining to identify risk probabilities of developing diseases and predicting responses to cures. While powerful for the analysis of mendelian diseases, this approach is still limited when dealing with complex diseases which are the result of the interaction of multiple factors, genetic and environmental. The focus on a single disease at a time is preventing our ability to identify commonalities among diseases that might be triggered by similar genetic or environmental backgrounds. To address both the above issues, a new interactive system is needed that will allow medical practitioners and researchers to explore factors that are shared by multiple conditions.

Such an interactive system should aim to capitalize on machine learning oriented integrated information fusion mining to provide up-to-date clinical decision support for diagnosis of diseases, and Lifestyle Recommendations. The system should be accessible through a web-interface and should use a combination of genetic/biomedical literature, census data (e.g., socioeconomic status, geographical region), and social media data. The goal should be to provide a flexible interface to show current diagnostic measures and investigate correlations between conditions and monitor changes over time (longitudinal studies). The focus should be on diseases such as cancer, diabetes and cardio-vascular diseases and on drug resistance and host infection strategies in pathogens.

To address the above-mentioned issues, a novel biomedical interactive system should be developed which is accessible through a web-interface. It should be based on machine learning methodology and use a combination of data about humans and human-pathogens from genetic/biomedical literature, census data (e.g., socioeconomic status, geographical region), gene related databases with gene functions, EHR data and social media data. The goal should be to provide a flexible interface to carry out information fusion of diagnostic terms and relations using heterogeneous data and investigate correlations between conditions and monitor changes over time (longitudinal studies) using heterogeneous data. The system could focus on a limited number of disease categories: systemic diseases (cancer, diabetes and

cardio-vascular diseases) and infectious diseases (focusing on the pathogenicity and drug resistance of human pathogens). I designing such a system, emphasis should be placed on information fusion of the following: a) literature mining of diagnostic terms and relations and lifestyle issues and correlating with Gene context data and Linked Open Data by deriving patterns from genes associated with diseases, their intensity, and predicting gene interactions for new diseases; b) personalized database for medical researchers interested in testing significant correlations between multiple diseases and environmental factors; and c) identify gene functions that are most commonly related to changes in pathogenicity, due to mutations that increase or decrease infection rates or mutations involved in the emergence of drug resistance with Apicomplexa as a model system.

IMPLEMENTATION AND COMMERCIALIZATION

The new system should integrate information from a number of heterogeneous data sources. Integrating structured and unstructured data is a non-trivial task and the system should employ state of the art in machine learning, big data management and analytics, natural language processing and semantic technologies. This will enable easy access to the right information at the right time on demand and can make the clinical as well as managerial decision-making process quite effective. Such a new system would have tremendous appeal and garner considerable market share since every healthcare organization is attempting to become more efficient in terms of day to day operations as well as improve the quality of care provided. The market for an integrated system is wide open and thus, the new system has the potential to capture a big market share.

It can easily be seen that the ability to build a personalized database will be a valuable tool for medical researchers interested in testing significant correlations between multiple diseases and environmental factors. Doctors could use it also an aid to visualize consolidate report of patients in a multi-perspective view and as a tool to observe and monitor interaction of the disease-causing genes and their possible side effects to offer preventive care for their patients. It could act as a quick reference for junior doctor trainees during their internship. Limited access could be given to patients to understand the cause and effect of their diseases and their intensity.

In order to commercialize the new system described above, the "Strategic Alliances" approach to commercialization can be adopted. This strategy requires forming partnerships with customers for the purpose of R&D, marketing, testing, licensing, etc. Since Pharmacists and Medical representatives, Doctors and Hospitals/Patients are potential users of the system, a core group of these stakeholders can be identified and form a strategic partnership with them. The user requirements for the web-based applications can be elicited from these partners. Based on the requirements, working prototypes can be developed through agile software development and eventually turned into a production system. The stakeholders identified can also be used for eventually testing the applications. The need and the use of the web applications will be emphasized to patients to get their medical records in the initial stages. This could serve as an entry point for getting acquainted with a group of doctors/specialists and hospitals. In this manner some hospitals, doctors and patients can become aware of the system. These Doctors in turn could contact pharmaceutical companies who could use medical representatives to advertise this system in addition to advertising a particular brand of medicine.

ORGANIZATION OF THE BOOK

This book is organized into three sections. The first section discusses semantic technologies and agent based systems as well as their application in recommender systems, multi-label image annotation, knowledge services, and topic ontology construction. The second section discusses application of computational intelligence techniques in various domains such as healthcare, cluster analysis, intrusion detection, and distributed predicate detection. The third section discusses web-based smart systems in different areas such as public service delivery, self-service banking, enterprise systems and internet of things. A brief description of each of the chapters is provided below.

Section 1: Semantic Technologies and Agent-Based Systems

The first chapter of the book is titled "Exploratory News Recommendation," contributed by Jon Atle Gulla, Özlem Özgöbek, and Xiaomeng Su. This chapter presents an exploratory news recommender system under development in the SmartMedia program. In exploratory news recommendats the reader can compose his own recommendation strategies on the fly and use deep semantic content analysis to extract prominent entities and navigate between relevant content at a semantic level. The readers are more likely to read a larger share of the relevant recommended articles, as there is no need to browse long tedious lists of articles or post explicit queries. The assumption is that more active and exploring readers will make implicit feedback more complete and more consistent with the readers' real interests. Tests show a 5.14% improvement of accuracy when our collaborative filtering component is enriched with implicit feedback that combines correlations between explicit ratings with the reading times of articles viewed by readers.

The second chapter is titled "Beyond Service-Oriented Architectures: Knowledge Services?" written by Ghassan Beydoun, Alexey Voinov, and Vijayan Sugumaran. In this chapter, the authors point out that unforeseen challenges have often emerged in Service Oriented Architecture (SOA) adoption. They fall into two categories: technical issues stemming from service components reuse difficulties and organizational issues stemming from inadequate support or understanding of what is required from the executive management in an organization to facilitate the technical rollout. This chapter first explores and analyses the hindrances to the full exploitation of SOA. It then proposes an alternative service delivery approach that is based on even a higher degree of loose coupling than SOA. The approach promotes knowledge services and agent-based support for integration and identification of services. To support the arguments, this chapter sketches as a proof of concept the operationalization of such a service delivery system in disaster management.

The third chapter is titled "A Multi-Label Image Annotation With Multi-Level Tagging System," contributed by Kalaivani Anbarasan, and Chitrakala S. The authors contend that the lack of performance in the content based image retrieval system is due to the semantic gap. Image annotation is a solution to bridge the semantic gap between low-level content features and high-level semantic concepts Image annotation is defined as tagging images with a single or multiple keywords based on low-level image features. The major issue in building an effective annotation framework is the integration of both low level visual features and high-level textual information into an annotation model. This chapter focus on new statistical-based image annotation model towards semantic based image retrieval system. A multi-label image annotation with multi-level tagging system is introduced to annotate image regions with

class labels and extract color, location and topological tagsof segmented image regions. The proposed method produced encouraging results and the experimental results outperformed state-of-the-art methods.

Subramaniyaswamy Vairavasundaram and Logesh R. have contributed the fourth chapter titled "Applying Semantic Relations for Automatic Topic Ontology Construction." The authors develop an automatic topic ontology construction process for better topic classification and present a corpus based novel approach to enrich the set of categories in the ODP by automatically identifying concepts and their associated semantic relationships based on external knowledge from Wikipedia and WordNet. The topic ontology construction process relies on concept acquisition and semantic relation extraction. Initially, a topic mapping algorithm is developed to acquire the concepts from Wikipedia based on semantic relations. A semantic similarity clustering algorithm is used to compute similarity to group the set of similar concepts. The semantic relation extraction algorithm derives associated semantic relations between the set of extracted topics from the lexical patterns in WordNet. The performance of the proposed topic ontology is evaluated for the classification of web documents and obtained results depict the improved performance over ODP.

The fifth chapter titled "Norms-Adaptable Agents for Open Multi-Agent Systems," is written by Moamin A Mahmoud and Mohd Sharifuddin Ahmad. This chapter shows that norms and normative multi-agent systems have become the subjects of interest for many researchers. Such interest is caused by the need for agents to exploit the norms in enhancing their performance in a community. In open agent systems, an agent is not usually and explicitly given the norms of the host agents. Thus, when it is not able to adapt the communities' norms, it is totally deprived of accessing resources and services from the host. Such circumstance severely affects its performance resulting in failure to achieve its goal. While several studies have addressed this issue, their detection mechanisms are restricted to the use of sanctions by third party enforcement. Consequently, this chapter attempts to overcome this deficiency by proposing a technique that enables an agent to detect the host's potential norms via self-enforcement and update its norms even in the absence of sanctions from a third-party. The technique is called the Potential Norms Detection Technique (PNDT).

Section 2: Application of Computational Techniques

The sixth chapter is contributed by C. Sweetlin Hemalatha and V Vaidehi and titled "A Pattern-Mining Approach for Wearable Sensor-Based Remote Health Care." The authors assert that rapid advancement in Wireless Sensor Network (WSN) technology facilitates remote health care solutions without hindering the mobility of a person using Wearable Wireless Body Area Network (WWBAN). Activity recognition, fall detection and finding abnormalities in vital parameters play a major role in pervasive health care for making accurate decision on health status of a person. This chapter presents the proposed two pattern mining algorithms based on associative classification and fuzzy associative classification which models the association between the attributes that characterize the activity or health condition and handles the uncertainty in data respectively for an accurate decision making. The algorithms mine the data from WWBAN to detect abnormal health status of the person and thus facilitate remote health care. The experimental results on the proposed algorithms show that they work par with the popular traditional algorithms and predicts the activity class, fall or health status in less time compared to existing traditional classifiers.

Parvathavarthini S., Karthikeyani Visalakshi N., S. Shanthi, and Lakshmi K. present the seventh chapter titled "Crow-Search-Based Intuitionistic Fuzzy C-Means Clustering Algorithm." This chapter points out that data clustering is an unsupervised technique that segregates data into multiple groups based on the features of the dataset. Soft clustering techniques allow an object to belong to various clusters with different membership values. However, there are some impediments in deciding whether or not an object belongs to a cluster. To solve these issues, an intuitionistic fuzzy set introduces a new parameter called hesitancy factor that contributes to the lack of domain knowledge. Unfortunately, selecting the initial centroids in a random manner by any clustering algorithm delays the convergence and restrains from getting a global solution to the problem. To come across these barriers, this work presents a novel clustering algorithm that utilizes crow search optimization to select the optimal initial seeds for the Intuitionistic fuzzy clustering algorithm. Experimental analysis is carried out on several benchmark datasets and artificial datasets. The results demonstrate that the proposed method provides optimal results in terms of objective function and error rate.

The eighth chapter is titled "Intelligent Radial Basis Function Neural Network for Intrusion Detection in Battle Field," written by Kirupa Ganapathy. This chapter begins by highlighting that defense at boundary is nowadays well equipped with perimeter protection, cameras, fence sensors, radars etc. However, in a battlefield there is more feasibility of entering of a non-native human and unknowing stamping of the explosives placed in the various paths by the native soldiers. There exists no alert system in the battlefield for the soldiers to identify the intruder or the explosives in the field. Therefore, there is a need for an automated intelligent intrusion detection system for battlefield monitoring. This chapter proposes an intelligent radial basis function neural network (RBFNN) technique for intrusion detection and explosive identification. The proposed intelligent RBFNN implements some intellectual components in the algorithm to make the neural network think before learning the training samples. Involvement of intellectual components makes the learning process simple, effective and efficient. The proposed technique helps to reduce false alarm and encourages timely detection thereby providing extensive support for the native soldiers and save the life of the mankind.

Eslam Al Maghayreh has contributed the ninth chapter titled "A Genetic-Algorithms-Based Technique for Detecting Distributed Predicates." This chapter posits that one way to enhance the dependability of distributed applications is the detection of distributed predicates techniques (also referred to as runtime verification). Several techniques are used to verify that a given run of a distributed application satisfies certain properties (specified as predicates). Due to the existence of multiple processes running concurrently, the detection of a distributed predicate can incur significant overhead. Several researchers have worked on the development of techniques to reduce the cost of detecting distributed predicates. However, most of the techniques presented in the literature work efficiently for specific classes of predicates, like conjunctive predicates. This chapter presents a technique based on genetic algorithms to efficiently detect distributed predicates under the possibly modality. Several experiments have been conducted to demonstrate the effectiveness of the proposed technique.

The tenth chapter is titled "Clustering Mixed Datasets Using K-Prototype Algorithm Based on Crow-Search Optimization," written by Lakshmi K, Karthikeyani Visalakshi N, Shanthi S, and Parvathavarthini S. They point out that clustering is one of the data mining techniques for knowledge discovery and it is the unsupervised learning method and it analyses the data objects without knowing class labels. The k-prototype is the most widely used partitional clustering algorithm for clustering the data objects with mixed numeric and categorical type of data. This algorithm provides the local optimum solution due to its selection of initial prototypes randomly. Recently, there are a number of optimization algorithms

introduced to obtain the global optimum solution. The Crow Search algorithm is one such population based meta-heuristic optimization algorithm. This algorithm is based on the intelligent behavior of the crows. In this chapter, k-prototype clustering algorithm is integrated with the Crow Search optimization algorithm to produce the global optimum solution.

Section 3: Web-Based Smart Systems

The eleventh chapter is titled "Smart City Portals for Public Service Delivery: Insights from a Comparative Study," contributed by Christoph Peters, Axel Korthaus, and Thomas Kohlborn. The authors argue that the future cities of our societies need to integrate their citizens into a value-co-creation process in order to transform to smart cities with an increased quality of life for their citizens. Therefore, administrations need to radically improve the delivery of public services, providing them citizen- and user-centric. In this context, online portals represent a cost effective front-end to deliver services and engage customers and new organizational approaches as back-ends which decouple the service interface from the departmental structures emerged. The research presented in this book chapter makes two main contributions: Firstly, the findings of a usability study comparing the online presences of the Queensland Government, the UK Government and the South Australian Government are reported and discussed. Secondly, the findings are reflected in regard to a broader "Transformational Government" approach and current smart city research and developments. Service bundling and modularization are suggested as innovative solutions to further improve online service delivery.

Fouad Omran Elgahwash presents the twelfth chapter titled "A Quantitative Study of Factors Affecting Value of Adopting Self-Service Banking Technology (SSBT) Among Customers in Developing and Developed Countries." This chapter focuses on the factors affecting the value of adopting self-Service banking technology (SSBT) among customers. It is believed that the successful usage of self-service banking technology will be increasingly advantageous for all (banks & customers). This chapter's purpose is an extension to the technology acceptance model (TAM) and views customer responses to technology as an integrated part of SSBT. The sample used for this study was selected from users of banks in both Libya and Australia, with a total size of 141 respondents. Reliability and validity of the data collection instrument was tested using Cronbach Alpha. Descriptive and regression tests for data analysis were used. The domains in which subjects were tested were "ease of use of SSBT", "Usefulness of SSBT", "Quality of SSBT", "privacy of information" and "Trust of SSBT".

The thirteenth chapter is contributed by Simon Polovina, Hans-Jurgen Scheruhn, and Mark von Rosing titled "Modularizing the Complex Meta-Models in Enterprise Systems Using Conceptual Structures." The authors indicate that the development of meta-models in Enterprise Modelling, Enterprise Engineering, and Enterprise Architecture enables an enterprise to add value and meet its obligations to its stakeholders. This value is however undermined by the complexity in the meta-models which have become difficult to visualize thus deterring the human-driven process. These experiences have driven the development of layers and levels in the modular meta-model. Conceptual Structures (CS), described as "Information Processing in Mind and Machine", align the way computers work with how humans think. Using the Enterprise Information Meta-model Architecture (EIMA) as an exemplar, two forms of CS known as Conceptual Graphs (CGs) and Formal Concept Analysis (FCA) are brought together through the CGtoFCA algorithm, thereby mathematically evaluating the effectiveness of the layers and levels in these meta-models. The work reveals the useful contribution that this approach brings in actualizing the modularizing of complex meta-models in enterprise systems using conceptual structures.

The fourteenth chapter is titled "Communication Trends in Internet of Things," written by Bharathi N Gopalsamy. This chapter submits that the central hypothesis of Internet of Things is the term "connectivity". The IoT devices are connected to the Internet through a wide variety of communication technologies. This chapter explains the various technologies involved in IoT connectivity. The diversity in communication raises the query of which one to choose for the proposed application. The key objective of the application needs to be defined very clearly. The application features such as the power requirement, data size, storage, security and battery life highly influence the decision of selecting one or more communication technology. Near Field Communication is a good choice for short-range communication, whereas Wi-Fi can be opted for a larger range of coverage. Though Bluetooth is required for higher data rate, it is power hungry, but ZigBee is suitable for low power devices. There involves always the tradeoff between the technologies and the requirements. This chapter emphasizes that the goal of the application required to be more precise to decide the winner of the IoT connectivity technology that suits it.

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Section 1
Semantic Technologies and Agent-Based Systems