Preface

In the recent agenda of advanced computational methods related to Artificial Intelligence and Cognitive Computing there is an interesting niche at the intersection with Learning and Decision-Making domains. Within this context many open research issues gain more interest from diverse scientific communities, including educators, computer scientists, researchers, data scientists, psychologists and innovators.

In Table 1, a non-exclusive list of topics of interest is summarized with an emphasis in the Learning Analytics Domain:

In our approach we define the value proposition of Artificial Intelligence and Cognitive Computing in learning as an integration of three unique value containers namely:

1. Cognitive Computing Aspects as presented in previous section including:
    a. Cognitive Assistants
    b. Machine Learning & Artificial Intelligence
    c. Sentiment Mining and Social Network Analysis
    d. Reasoning &Logic capabilities
    e. Semantics & Syntactic Data interpretation

The overall idea is that technology enhanced learning and learning analytics research is entering in a new era, where Artificial Intelligence will provide new unforeseen capabilities for the provision of services. The key question remains if this technology-driven innovation can respond to the new challenges of higher education, especially in the context of the real delivery of educational content to learners.

2. Learning as a student and faculty centric constructive process with main emphasis to be paid on the facilitation and provision of:
    a. Content
    b. Context
    c. Collaboration
    d. Engagement
    e. Impact

Table 1. An open research agenda for cognitive computing for learning with an emphasis on learning analytics

■ Cognitive Computing to Learning Systems ■ Machine Learning approaches to personalized Learning systems ■ Deep Learning and Reinforcement Algorithms for Learning Innovation ■ Scholarly and Scientific research customized for academic researchers to leverage Big Data Computations, Collaboration, and Data-intensive Processing in the Cloud ■ The Internet of Everything (IoE) Campus Infrastructure through Analytics Deployment ■ Architecting University, Library, and Research Digital Repositories ■ *e*-research, *Data* Curation, Management of Scholarly Identity ■ Innovations for Improving Student Retention through Predictive Modeling ■ Innovative Solutions for Student-retention Models, KPIs, Data dashboards, and Mobile Alerts to Identify At-risk Students ■ Case Studies of Ethical Use of Student Data for Learning Analytics ■ Data-driven Learning and Assessment ■ ***Data Science with the aim of Learner Profiling*** ■ Novel approaches to Analyze ***Individual Student Interactions in Online Learning Activities*** ■ ***Integrating Analytics with Online Texts, Courseware, and Learning Environments to Measure Student Progress and Interaction*** ■ Data Analytics Platform for Detailed Reporting, Assessment, and Collaboration ■ Analytical Models on Students Data on Library use, Attendance, and Grades ■ Intelligent Student Progress Dashboard ■ Cloud-based audio and video creation tools to capture important human gestures, including voice, eye contact, and body language, which all foster an unspoken connection with learners ■ Predictive Analytics Reporting (PAR) Framework, Learning, and Transfer Data Repository in Higher Education	■ Analytics, Business Intelligence, and Data Management for Higher Education ■ ***Cutting-edge Asynchronous and Synchronous Tools to Advance the State of Online Learning*** ■ Data-driven Evidence of Effective Blended Learning ■ Stimulated Social Activities and Critical Thinking within an Online Environment ■ The Effect of Analytics on Learning Outcomes and Advanced Learning Tasks ■ Advanced Learning Labs Powered by Analytics ■ ***Project-based Interactions with Attention to Mobility, Flexibility, and Multiple Device Usage*** ■ Integration of Semantic Web Approaches in Educational Learning Systems ■ Case Studies of Personalized Learning Using Analytics: ***range of educational programs, learning experiences, instructional approaches, and academic-support strategies intended to address the specific learning needs, interests, aspirations, or cultural backgrounds of individual students.*** ■ ***Advances in Online Learning Environments and Adaptive Learning Technologies*** ■ Visual Analytics to Identify Patterns and Processes for Mining Large Educational Datasets ■ Social Media Technologies in Education: Collaborative Environments, Collective Intelligence, Crowdfunding, Crowdsourcing, Digital Identity, Social Networks, and Tacit Intelligence ■ Visualization Technologies in Education: Case Studies on Utilizing 3D Printing/Rapid Prototyping, Augmented Reality, Information Visualization, Visual Data Analysis, Volumetric and Holographic Displays. ■ Modeling Students in Massive Open Online Course

Learning nowadays seems to be challenged by several key developments. One of them is related to the multidisciplinary context of learning. The provision of learning content in various formats, the personalization of learning context based on advanced learners' profiling and the enhancement of collaboration and social engagement justifies the new impact of higher education linked to social responsibility and key social challenges and objectives. In the same context the integration of

Learning in Academia for promoting long term social inclusive economic growth set the new scene for technology enhanced learning. Towards this direction Learning Analytics research establishes a new data-driven layer of policy making based on aggregation and processing of educational data related to learning content, learners, and administration.

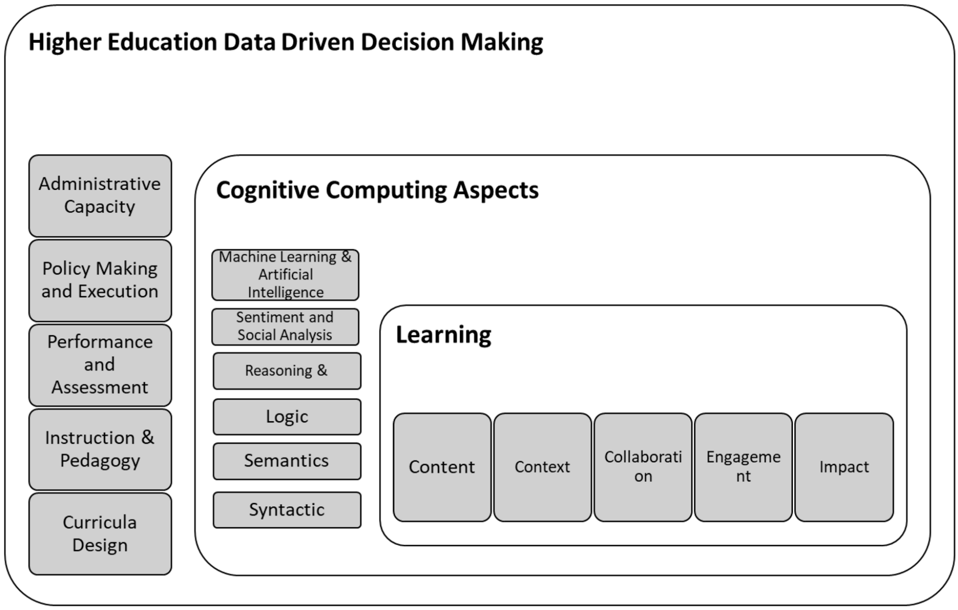
3. Higher Education Data Driven Decision Making as an evolving continuous improvement process that is promoting enhanced:
    a. Administrative Capacity
    b. Policy Making and Execution
    c. Performance and Assessment
    d. Instruction & Pedagogy
    e. Curricula Design

A new data-driven era has emerged in higher education. The availability of various systems and the provision of various types of structured and unstructured data as well as microcontent permits the adoption of machine learning and Artificial Intelligence techniques. Supervised and unsupervised learning algorithms, social mining and engineering, sentiment analysis, soft computing and Fuzzy logics, as well as neural networks considerations can be used to process this data providing useful insights for the Higher Education Administration as well as for the quality of education in its various aspects and components. A new research domain related to Key Performance Indicators (KPis) and Learning Analytics that will be justified, supported, collected and analyzed for decision making is well defined.

In Figure 1, we provide a contextual framework for the integration of Cognitive Computing aspects in the context of Higher Education with a focus on Learning Analytics. A variety of new qualitative and quantitative criteria, in various dimensions of decision making and learning can be defined. The interpretation of this contextual framework it is multifold:

First of all, it can unfold the diverse and complementary aspects of the phenomenon. The integration of Cognitive Computing to learning in comparison to other domains has a critical human, and behavioral components, which makes any effort of modelling, and predicting behavior difficult. Additionally, the lever of uncertainty and the degree of complexity in the design of cognitive systems for learning is higher. In simple words any cognitive and Artificial Intelligence enabled service in higher education must take into consideration several unpredictable aspects of behavior and cognition. Furthermore, the required data-aggregation level of diverse educational data has to take in to account delicate and sensitive ethical issues related to human participants.

Figure 1. The value proposition of cognitive computing and artificial intelligence to learning



Beyond these problematic areas for the adoption of Cognitive Computing for learning there are also significant challenges with potential great impact. The adoption of Cognitive Computing services and the provision of advanced Learning Analytics will challenge decision making capabilities.

- **Administrative Capacity:** The data collected from learning management systems, social media, ERPs, and 3rd party applications, will provide new kinds of meaningful reports for higher administration.
- **Policy Making and Execution:** Cognitive Computing research and its integrated components, can also promote the design, the execution and the monitoring of educational policies at local, national, and international levels. Standardizations issues, educational processes modelling, design of services mapped and aligned to educational policies, will allow the provision of a holistic ecosystem of data-processes-decision making integrated capabilities.
- **Performance and Assessment:** The perception about quality in higher education has many aspects: student-centric, process-centric, resources-centric, objectives-centric. With the evolution and adoption of Artificial Intelligence in higher education we will realize a shift in the classical performance and assessment strategies. New content-rich, policy-integrated,

innovation and industry focused approaches will be adopted. Universities and colleges will use diverse methodologies and tools to align their competencies and skills development plans with industry innovation driven requirements. The key question though remains: Which is the mission of the educational system and higher administration as a pillar of social inclusive economic growth and development?

- **Instruction and Pedagogy:** In this domain Cognitive Computing will provide novel insights and services. The discovery of codified learning content based on profiling and interpretation or learners' needs will offer unforeseen capabilities for dynamic construction of meaningful learning modules. The packaging and the flow of instruction will also be redesigned. Matching algorithms together with neural networks and social mining services will also promote team-learning and team-led skills and competencies. This is for sure a bold challenge for higher education: Which is the proper strategy for the promotion of group learning, and team skills building in 21st century? Which are the proper mode of technology-enhanced learning for group and active learning?
- **Curricula Design:** It seems that we are entering a new era, where the critical bet for higher education administration will be to launch timely, multidisciplinary curricula. Cognitive Computing can also promote interesting services towards this direction such as peer-matching, automatic learning modules integration, development of dynamic learning paths as well as composition of learning networks.

In the next section we summarize the interpretation of our proposed framework for the adoption of Cognitive Computing for learning with a special focus on learning analytics research. This is one more bold contribution of this edited book.

A ROADMAP FOR THE INTEGRATION OF COGNITIVE COMPUTING TO LEARNING

The direct interpretation of the various Cognitive Computing and Artificial Intelligence aspects defines the roadmap for their adoption in the higher education. The evolution will be slower than predicted but it is evident that two critical phases will be realized:

- An era of early adoption, with pilot, exclusive and not integrated implementations, in some of the areas highlighted in our framework in the previous section.

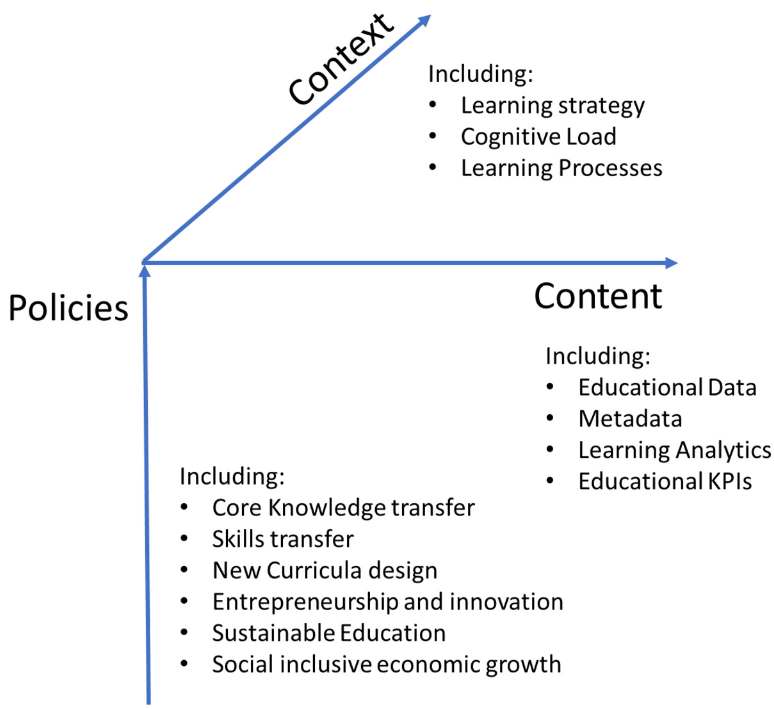
- An era of streamline integration, where commercial learning systems and sophisticated successful outcomes of advanced research projects, will offer a wide-spread realization of the benefits of Cognitive Computing in higher education.

In both cases the question remains: Which are the required skills and competencies of teachers and faculty to exploit the promises and the added value of technology? And vice versa how students and learners can exploit sophisticated services for measurable outcomes with impact for their lives, careers and the society?

In Figure 2, we summarize a three-dimensional value space for Cognitive Computing for learning defined by three axes:

- **Content:** Including: Educational Data, Metadata, Learning Analytics, Educational KPIs. In this context Artificial Intelligence, and in the current evolution most of the approaches are focusing on the standardization of educational data and metadata and the establishment of dynamic reference layers to this content for the provision of dynamic and personalized learning

Figure 2. The era of early adoption of cognitive computing and artificial intelligence to learning



spaces. This is for sure not something novel. The novelty emerged from the fact that in parallel the construction of learning analytics strategies and standards permits a fine tuning of the educational process based on well-defined scientific contributions.
- **Context:** Including: Learning strategy, Cognitive Load and Learning Processes: The Cognitive Computing implementations in this context set dynamic contexts for learning exploitation based on learning processes with different cognitive load and increased capabilities for personalization. In this era of early adoption, it seems that the key trend is the integration of the learning space to include as a context all the micro-and-macro learning activities of students in classroom and out of it, in social media, portable devices, or huge learning networks.
- **Policies:** Including: Core Knowledge transfer, Skills transfer, New Curricula design, Entrepreneurship and innovation, Sustainable Education, Social inclusive economic growth: The support of various, educational policies, is in the current stage of adoption, one more typical Cognitive Computing initiative. In most of cases some advanced systems promote skills and competencies transfer, justify sustainability in Education based on measurable analytics and KPIs.

This simplistic abstraction for sure does not provide an exhaustive approach to the complicated phenomenon of Cognitive Computing for learning. It provides though a reference model for the on-going research in the domain as well as a concrete context for the justification and mapping of diverse learning analytics. In the next section we provide this simplistic model to map the main contribution and the published research in this edited book.

We would love to thank all the contributors and reviewers in this edited volume. The quality of their intellectual work and research is evident in every chapter of this volume. We want also to thank all the IGI-Global people for their trust to our work and for their commitment in delivering high quality peer reviewed progressive content to global audiences.

ORGANIZATION OF THE BOOK

The book is organized into 12 chapters. In this book authors discuss different aspects of cognitive computing and learning analytics as well as innovative methods and strategies for technology enhanced learning:

A brief overview of each of the chapters follows:

Section 1: Foundations of Cognitive Computing and Learning Analytics

Chapter 1: Understanding Students Learning Behavior and Predicting Their Performance
Chapter 2: Enhancing the Credibility of the Decision-Making Journey Through Serious Games Learning Analytics
Chapter 3: Computer-Supported Collaborative Learning (CSCL) and Hybrid Learning: Fostering Online Interactions Between Learners
Chapter 4: Principal Component Analysis on the Students' Perception of a Cognitive Assistant for Content Reinforcement in Higher Education

Section 2: Applications and Approaches of Cognitive Computing and Learning Analytics

Chapter 5: Managing the Learner Model With Multi-Entity Bayesian Networks in Adaptive Hypermedia Systems
Chapter 6: Virtual and Augmented Reality in Medical Education and Training: Innovative Ways for Transforming Medical Education in the 21st Century
Chapter 7: Eye Tracking Applications for E-Learning Purposes: An Overview and Perspectives
Chapter 8: The Exploration of Automated Image Processing Techniques in the Study of Scientific Argumentation
Chapter 9: Evaluation of Mobile Apps for Chinese Language Learning
Chapter 10: Modern Health Management With Cognitive Computing and Big Data Analytics
Chapter 11: Smart MM: Smart Movie Management System
Chapter 12: Virtual Reality in Visual Analytics of Large Datasets

Chapter 1 discusses topical issues in Understanding Students Learning Behavior and Predicting their Performance. Despite the increase in the adoption of online educational platforms, students' retention is still a challenging task with a number of students having low performance margins during these courses. This study intends to predict students' performance based on their learning behavior on the basis of their logging data history, using the publicly available Open University Learning Analytics Dataset. To model this problem, Logistic Regression (LR) is used as a baseline technique. Additionally, Random Forest (RF), Multiple Layered Perceptron with multiple activation functions, and Gaussian Naïve Bayes are also deployed. Our results demonstrate that RF outperforms the baseline LR and other models with 89% accuracy, 89% precision, 88% recall and 88% F1-score. Finally, authors conclude that using the above-mentioned models, students ‘at-risk’ can be identified which can be managed by an alert mechanism to improve students’ success rate by making timely interventions.

Chapter 2 discusses the enhancement of the credibility of the decision-making journey through serious games learning analytics. This chapter proposes a specific Learning System and a combined method to devise the Learning Analytics component as an envisioned solution to inform the development of other digital learning resources which are built for meeting specific, predefined learning objectives. Authors acknowledge the critical challenges of distinguishing between decision-making and decision- taking on the outcomes of learning. Their key objective is to assess learning performance by means of unstructured interviews with participants using a digital marketing simulation game and how this has helped them attain job success working on real digital marketing projects. Their contribution relies on the support of decisions taken on real or realistic business conditions provided by a simulated learning environment should enrich the learning experience with insights (influences, constructs & variables), unstructured knowledge representation and rule-based decisions which learners will utilize and be alert and react to in real markets.

Chapter 3 is devoted to ideas related to Computer Supported Collaborative Learning (CSCL) and hybrid learning: Fostering online interactions between learners. Authors state Learning has abandoned his conventional and traditional knowledge acquisition style; he started breaking the limited information channels, flowing in all possible directions, while seeking and absorbing the intelligence of his choice. The thing that reduced the social interactions between different learners. All this due to technology that offers every day more endless possibilities in various fields, it makes it possible to fill this void created by these learning styles. Computer Supported Collaborative Learning (CSCL) is an educational approach in which learning is based on social interaction between learners through the Internet. Sharing, the construction of knowledge and skills development, are part of the characteristics of this type of learning while pulling a better profit from technology. The CSCL approach can be implemented in online learning environments. This chapter provides an innovative pedagogical scenario, which aims to promote online interactions between learners in a hybrid learning device while basing on CSCL approach.

Chapter 4 delivers a Principal Component Analysis on the Students’ Perception of a Cognitive Assistant for Content Reinforcement in Higher Education. The study in this chapter presents Training by Highly Ontology-oriented Tutoring Host (THOTH), a cognitive assistant applied to students of higher education. It was developed to provide a reinforcement of contents, aiming to reach a high level of interactivity between users and interfaces. THOTH is based on the theoretical assumption that knowledge is organized in the form of ontologies constructed in the ORAV model, in regard to the Ausubel‘s meaningful learning. THOTH processes the required objects of the ontology in order to facilitate the formulation of standard questions based on the attributes. After one session, students gave its perceptions in a Likert-scale, questionnaire with 13 questions. A principal component analysis was performed with 35 questionnaires revealing 8 different categories of grouped questions, ranging from the degree of functionality in the learning process to featuring how users were accepting the conversations. The evaluation of the categories is explained quantitatively, highlighting relationships between the elements of each category of study.

Chapter 5 summarizes authors' contribution related to a cognitive computing application in learning domain related to the customization of a Learner Model with Multi-Entity Bayesian Networks in Adaptive Hypermedia Systems. It's important to note that the chapter presented here lies within the modeling part of the learner in an adaptive educational system construed as computational modeling of the learner. Modeling the learner in adaptive systems involves different information. There are several methods to manage the learner model. They do not handle the uncertainty in the dynamic modeling of the learner. The main hypothesis of this chapter is the management of the learner model based on multi-entity Bayesian networks. This chapter focuses on modeling the learner model in a dynamic and probabilistic way, the authors propose in this work the use of the notion of fragments and M-theory to lead to a Bayesian multi-entity network. The use of this Bayesian method can handle the whole course of a learner as well as all of its shares in an adaptive educational hypermedia.

Chapter 6 tries to determine how virtual technology can be integrated in Medical Education and Training through Innovative Ways for Transforming Medical Education in the 21st Century. This is a new context for cognitive computing exploitation and enhancement. Virtual and Augmented Reality (VR & AR) with its various computer-based virtual simulations and teaching aids have already begun to transform the Medical Education and Training. The use of virtual labs and anatomy lessons including the use of virtual learning environments (VLEs) as in the delivery of lectures and surgery operations are explored. The purpose of this study is to promote the role of VR & AR in the context of Medical Education as an innovative, effective, and cost reasonable solution for the provision of better and faster practical training. This chapter overall, investigates and explores the potential of VLEs in terms of the necessary concepts and principles that allow students to develop a more direct and meaningful experiential understanding of the learning goals and outcomes of courses and of the practical and transferable skills required. A business model related to Cloud Active Learning in Medical Education and Training is proposed in line with the idea of an Open Agora of Virtual Reality Learning Services.

Chapter 7 addresses the use of Eye Tracking Applications for e-Learning Purposes: An Overview and Perspectives. E-Learning becomes a fundamental part of child education, higher education and corporate training. In the design of adaptive e learning environments, it's important to track and analyze learners' behavior and preferences, and this is possible by recording their eye movements. Eye tracking is a technology developed to monitor eye movements allowing us to analyze the recorded gaze data. The main goal of this chapter is to determine the potentials of eye tracking in the field of e learning, and the various applications of eye movement analysis for e learning platforms. Results can be used to design an adaptive e learning environment able to collect, analyze and understand learner's online behavior, preferences and needs, and then offer an educational content adapted to each learner's needs by generating new customized learning situations.

Chapter 8 provides a study about the use and the Exploration of Automated Image Processing Techniques in the Study of Scientific Argumentation. Scientific argumentation is an epistemic practice where scientific theories are proposed, refined, and refuted and also a language-based practice where evidence is provided in support of claims. This chapter explores how techniques of computerized image processing can help researchers to identify relationships between features of images and the quality of written artifacts used in scientific argumentation.

Chapter 9 discusses an Evaluation of Mobile Apps for Chinese Language Learning with an emphasis also on sophisticate cognitive computing features. Nowadays, more and more people around the world choose to learn Chinese as a foreign language, however, due to its specifics, people often encounter difficulties in learning it. As a result of technological development, there are a number of useful tools that can improve the learning process, including various learning mobile applications (apps). Considering the huge amount of language learning applications and the lack of a unified evaluation system, it is possible to get lost in the options offered. The purpose of this study was to create criteria for evaluating Chinese language learning mobile apps that would help users with finding effective apps for learning Chinese as a foreign language.

Chapter 10 introduces the study of the integration of cognitive computing and analytics research with emphasis on a Modern Health Management with Cognitive Computing and Big Data Analytics approach. Big data analytics is an refined advancement for fusion of large data sets that include a collection of data elements to expose hidden prototype, undetected associations, showcase business logic, client inclinations, and other helpful business information. Big Data Analytics involves challenging techniques to mine and extract relevant data that includes the actions of penetrating a database, effectively mining the data, querying and inspecting data committed to enhance the technical execution of various task segments . The capacity to synthesize a lot of data can enable an association to manage impressive data that can influence the business . In this way, the primary goal of big data analytics is to help business relationship to have enhanced comprehension of data, and subsequently, settle on proficient and very much educated decisions.

Chapter 11 deals with the design, creation and implementation of a Smart MM- Smart Movie Management System as an Artificial Intelligence primer. Rapid advancements have been made in the field of Artificial Intelligence in recent years. This has resulted in its adoption in various technologies from medicine to search engines. Existing media management systems have however not yet fully leveraged the power of Artificial Intelligence (AI) to give users enhanced information apart from basic media metadata. This chapter proposes a Smart movie management system which works mainly offline and uses AI to deliver optimum information to the users on four vital tasks. These tasks are: Multilevel Phrase level Review Polarity, Plot and Review keywords, a content-based recommendation system and an emotion recognition system. The complete system works in near-real time with a user-friendly presentation to maximize a user's information gain.

Chapter 12 presents the importance and necessity of combination of Virtual Reality in Visual Analytics of Large Datasets. Visual Analytics can be defined as a representation of data in form of diagrams, charts, pictures, graphs etc whereas the virtual reality is a term used for the simulated interactive environment which exploits multiple sense organs of human beings to perceive information. Both of these techniques are merged to create an interactive environment for data visualization and analysis. Often it happens that a large volume of data is complex to represent, so to represent large, congested and complex data in a manageable and comprehensive form visual analytics is the need of an hour. Rest of the chapter discusses the scope of visual analytics, the role of virtual reality in visual analytics, challenges in VA using VR, tools used to implement it, use and applications.

Miltiadis D. Lytras
Deree – The American College of Greece, Greece & Effat University, Saudi Arabia

Naif Aljohani
King Abdulaziz University, Saudi Arabia

Linda Daniela
University of Latvia, Latvia

Anna Visvizi
Deree – The American College of Greece, Greece & Effat University, Saudi Arabia