Chapter 13
Formalization and Discrete Modelling of Communication in the Digital Age by Using Graph Theory

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ABSTRACT

Globalization is an important characteristic of the digital age which is based on the informatization of the society as a social-economical and science-technical process for changing the information environment while keeping the rights of citizens and organizations. The key features of the digital age are knowledge orientation, digital representation, virtual and innovative nature, integration and inter-network inter-actions, remote access to the information resources, economic and social cohesion, dynamic develop-ment, etc. The graph theory is a suitable apparatus for discrete presentation, formalization, and model investigation of the processes in the modern society because each state of a process could be presented as a node in a discrete graph with connections to other states. The chapter discusses application of the graph theory for a discrete formalization of the communication infrastructure and processes for remote access to information and network resources. An extension of the graph theory like apparatus of Petri nets is discussed and some examples for objects investigation are presented.

INTRODUCTION

The Information Society is an organization of distributed information resources in the global network with remote access and information sharing. Each user could access different resources via Internet and use them in the virtual space in a centralized or decentralized manner. Different approaches for access to distributed objects via Internet are determined. For example, the research subject presented in (Kravets, 2018) is a maintenance service distributed organization possessing a network of affiliates and representatives. This paper considers some problems and peculiarities of modelling and efficient

development in social and economic monitoring and the obtained results could be applied both in static and dynamic configuration of distributed companies. Another proposal is a visible light communication as an alternative optical-based wireless communication is discussed in (Adiono, 2018) and the paper presents the design, implementation, and demonstration of the TCP/IP data-exchange over visible light.

The modern society has many opportunities of the contemporary digital world which can be used at the stage of preliminary description, conceptual modelling, initial formulation of the process or object, development and implementation. It should be known that each new digital technology has challenges for the security and privacy of the user's data (Romansky, 2017). On the other hand, the modern society proposes services as e-access, e-society, e-policy, e-democracy, e-voting, e-governance/e-government, e-learning, e-health, e-business/e-commerce, e-consultation, e-inclusion, etc., which could improve and extend the communications between citizens and institutions in the digital age (Kerr, 2013). This is possible on the base of the key features of the digital age – knowledge orientation, digital representation of the objects, virtual nature, molecular structure, integration and inter-network interactions, remote access to the information resources, innovative nature, economic and social cohesion, dynamic development, global scale, etc.

The modern society is built on the base of different information technologies (IT), including grid technology, social communications, cloud and mobile cloud computing, Internet of Things (IoT), Big Data Analysis (Kharchenko, 2018). The combination of some new technologies permits to create different new features. For example, a combination of smart homes with mobile communication is discussed in (Olawumi, 2017) and the authors (Yu, 2016) present several challenges that smart grids could be made for cyber-physical systems. Another problem – cloud speech recognition, can be applied in different areas. In this reason, the combination of cloud services, speech control and cyber-physical systems is the object of discussion in (Škraba, 2018). The article describes development of an algorithm for efficient harvesting of speech recognition cloud services with application to the cyber physical systems.

In the digital world all accessed and used resources should be regarded as an integration of information with technological and technical units. This point of view permits to describe the digital environments as formalized structures with separate objects and relations (connections) between them. For example, (Bolnokina, 2019) discusses multistage systems, at the input of which comes a stream of requests that require executing a set of serial-parallel jobs for their support. The purpose of the article is to make formalization (by nonlinear objective functions and recursive constrains) of the problem of assigning specialists to jobs and finding suitable algorithm to solve it.

The purpose of this chapter is to make a brief survey of the information basis of the modern society with realization of a global informatization and increasing effectiveness of the using information resources based on the components of the digital world. The purpose is to summarize the main key features and components of the modern society and to present the possibilities to apply the graph theory for discrete formalization of information processes and communications in the e-space. An investigation of a component of the digital space could be conducted by using designed model and preliminary phase must be formalization of the investigated objects. The graph theory proposes an extension in the sphere of discrete investigation by using the Petri Net (PN) apparatus which is discussed in end of the chapter.

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