Eng Int Syst (2021) 2: 109–116

Engineering
Intelligent Systems

A 5G Network-Oriented Mobile Edge Computing Offloading Strategy and Cloud Computing Network Security

Yang Yuxue*, Yang Huifeng, Wang Jing, Liu Ruiying and Nie Xiangqian

State Grid Hebei Information & Telecommunication Branch; Shijiazhuang, Hebei 050000, China

With the continuous development of Internet technology, communication technology in use is constantly being upgraded. Based on the development of the third-generation communication technology, fourth-generation and fifth-generation communication technologies have been gradually developed. In the current social development process, fifth-generation communication technology has matured, bringing more convenience to people's daily lives. However, the upgraded communication technology still faces the problem of processing a large amount of data, and the traditional network system may not be able to bear the current data processing pressure. The emergence of cloud computing technology has created opportunities for the upgrade and development of communication technology. It can process a variety of complex data concurrently and provide assistance for the smooth operation of network systems. The widespread use of cloud computing technology can also effectively improve the battery life of new communication technology terminal devices, and provide strong support for new technologies. This article analyzes the development status of fifth-generation communication technology, introduces the principle and specific operation of mobile edge computing offloading strategy, and uses cloud computing technology to provide assistance for the safe operation of the network system.

Keywords: 5G network; Mobile edge computing; Cloud computing; Network security

1. INTRODUCTION

In the current social development process, fifth-generation communication technology has gradually matured, bringing more convenience to people's daily lives. However, the upgraded communication technology still faces the problem of processing a large amount of data, and the traditional network system may not be able to bear the current data processing pressure. Although the new communication technology has brought people an improved network communication experience, this technology is still in the process of development, and many data processing problems need to be further studied and resolved. In the application of new communication technologies, the consumption speed of data traffic is also increasing, and traditional communication systems are facing great challenges [1]. For traditional communication systems, the operating speed of the Internet platform continues to increase with the upgrading of communication technology, and traditional systems may not be able to withstand the pressure of rapid system operation. In addition, the increase in the amount of data may put higher requirements on the endurance of terminal equipment, and new communication technologies need terminal equipment that can support intensive calculation and data transmission. Through long-term research and practice, people have become proficient in using mobile edge computing technology to support the

*Address for correspondence: Yang Yuxue, State Grid Hebei Information & Telecommunication Branch; Shijiazhuang, Hebei 050000, China, Email: yyx20201210@126.com

development of the fifth-generation communication technology [2]. This new technology can process multiple types of data at the same time and ensure the speed of system operation during the process of data processing. This new technology will also not affect the normal operation of the system, so it is the main supporting technology for the development of the fifth-generation communication technology. The emergence of cloud computing technology has created opportunities for the upgrade and development of communication technology. It can process a variety of complex data information at the same time and provide help for the smooth operation of network systems. The widespread use of cloud computing technology can also effectively improve the battery life of new communication technology terminal devices, and provide strong support for new technologies [3]. This article analyzes the development status of the fifth-generation communication technology, introduces the principle and specific operation of the mobile edge computing offloading strategy, and uses cloud computing technology to provide assistance for the safe operation of the network system.

2. OVERVIEW OF RELATED THEORIES OF EDGE COMPUTING AND NETWORK SECURITY

2.1 Overview of Task Offloading in Edge Computing

2.1.1 Offloading Model

In order to utilize mobile edge computing technology, it is first necessary to establish a relevant offloading model in the system. This step is an important operation step for using this technology. In the process of establishing the model, the offloading state of the system can be divided into two types, either a static offloading state or a dynamic offloading state [4]. When the system is in a static offloading state, the data and the total amount of data that need to be offloaded in the system will not change, and the data offloading will not change due to changes in the users of the network platform. On the contrary, if the task offloading data in the system changes with the user or data resource changes, then the system is in a dynamic offloading state.

(1) Binary offloading

This offloading model is the initial model that people use when studying the types of model. The data offloading in the system can only be operated locally on the computer; otherwise it is necessary to offload all of the data to the edge processor for unified processing.

(2) Partial offloading

This offloading model can divide multiple tasks into many subtask modules when processing and computing tasks. In the process of data offloading, the subtask modules can perform data processing operations locally on the computer or directly offload data [5]

(3) Probability/random offloading

This offloading method combines the main features of the previous two current models. In the process of task offloading, the data processing server and specific processing methods can be selected according to the user's requirements for data offloading.

2.1.2 Offloading Decision

The internal network management or base station server has cost and hardware defects, and its processing resources are far inferior to cloud computing technology. Due to the internal limitations of the server and the strong needs of users, it is particularly important to establish an effective offloading decision-making mechanism [6]. The offloading decision mechanism is used to consider two aspects: one is whether the task needs to be offloaded; the other is the location of the offloading task and the resources required for the offloading decision.

When implementing the decision-making task, the server must consider whether the offloading is necessary from the aspects of resource consumption and cost. Therefore, the decision-making of offloading must be based on many aspects such as resource consumption, cost, efficiency, profit and timeliness, and the decision-making is divided into two types: centralized and distributed.

(1) Centralized control

This decision-making method regards the edge server as the main responsible part of the data offloading decision, and analyzes the use and distribution of various resources of the network system from an overall perspective [7]. This method can be used to select edge service units in a targeted manner for data processing.

(2) Distributed control

The distributed control structure can give the database the ability to individually identify and process data. In the process of data offloading, the distributed control method can specify the subject of decision-making as the terminal equipment in the computer system or the edge server that performs data offloading. The data offloading decision and selection process will vary according to different decision-making subjects [8]. Therefore, the offloading strategy is formulated under the premise of considering the interests of multiple subjects, and the maximum benefit may not be obtained.

2.1.3 Offloading Process

This article studies and analyzes the existing centralized offloading model, and puts forward certain research ideas. The situation of the unloading process studied in this article is shown in the figure below.

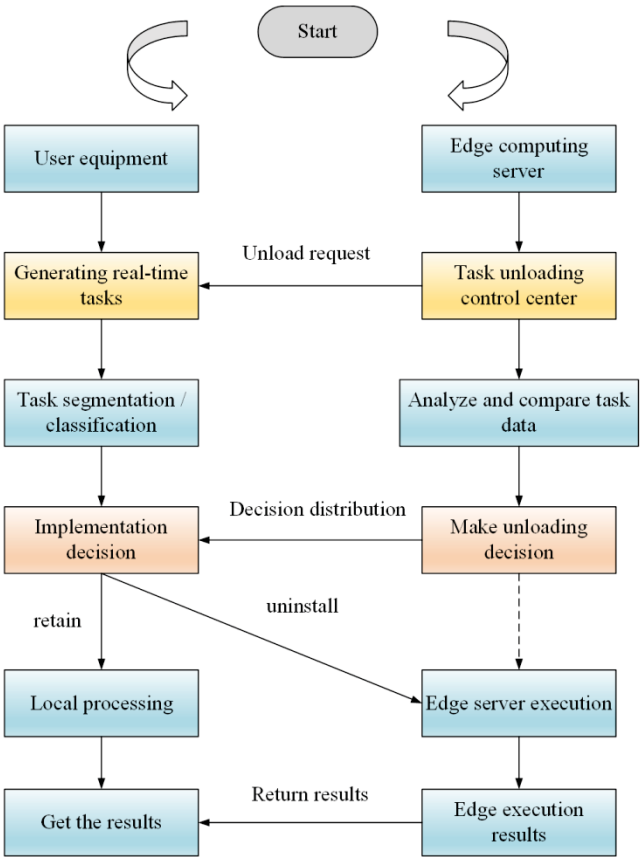

Figure 1 Task offloading flow chart.

2.2 The Main Manifestations of the Security Issues of Cloud Computing

The cloud computing method can perform unified analysis on a large amount of data and provide people with intuitive data analysis results. The operation process of cloud computing can be divided into five layers, of which the most basic is the physical layer. As the name suggests, the physical layer is a combination of physical hardware and various physical facilities, as well as various physical machine operation settings and systems, such as computers and the Internet. The next layer is the virtualization layer, which supports virtualization technology in cloud computing [9]. The main components of this layer are virtual machines and virtual machine operating systems. The core technical idea of the virtual layer is to separate the physical storage of data and the electronic data image, and present a spliced and simplified virtual view for the system administrator. The next layer is the data layer, which is responsible for storing the massive data and various kinds of data in cloud computing. The data layer also handles the storage of index information, so as to ensure that various computing applications do not have insufficient data supply, and is composed of various software and systems. The service layer is used to provide various services for cloud computing users through the cloud platform and the final application layer is the cloud. The highest level of computing is through the close co-operation and effective operation of the first few layers to combine all the basic forces into a specific application model and extend a series of process-oriented business systems tailored for users [10]. In the process of using cloud computing technology, users have a certain degree of uncertainty in the control of data information. Therefore, it is necessary to analyze the use of this technology in detail to improve the security of network data processing.

2.2.1 Data storage

During the user's data transfer operation, if the user agrees to transfer the data to the cloud terminal, then some users are likely to lose control over their personal information, which may cause the loss of important data, affecting the user. Management of information has an important impact, so it is necessary to strengthen the security monitoring of cloud terminals.

2.2.2 Data Transmission

After the user agrees to transmit the data to the cloud terminal, the data takes time to be transmitted [11]. During this period, the data can be attacked by hackers, which will affect the security of the data.

2.2.3 Data Access

Some users will use improper means to attack the cloud terminal to obtain the data resources they want. Therefore, when allowing users to access data resources, it is necessary to perform data access behaviors of some users in order to

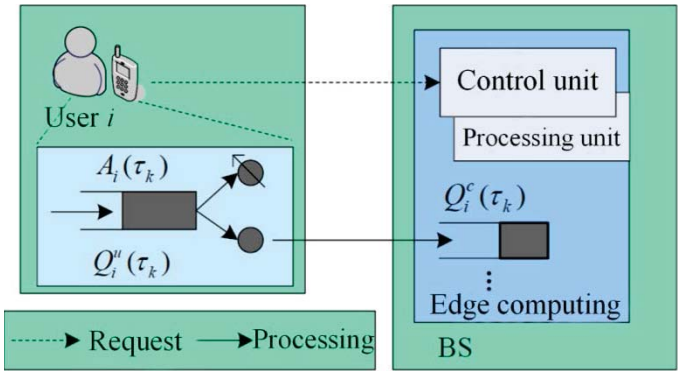

Figure 2 Edge computing network scene diagram.

identify and prevent these users from affecting the operation of the cloud terminal.

2.2.4 Laws and regulations

As the use of cloud computing is supported by a powerful network platform, the use of some data information has not been supported and regulated by laws and regulations [12]. In the future development process, relevant laws and regulations should be established to improve the security of computer network platform operation and provide a strong support for the development of computer network technology in our country.

3. MOBILE EDGE COMPUTING OFFLOADING STRATEGY BASED ON 5G NETWORK

3.1 System Model Design

The system model designed in this article is shown in Figure 2:

3.1.1 Communication Model

To ensure the smooth operation of the communication network, the operating efficiency of the spectrum resources provided by the network operator must be calculated and analyzed. The calculation formula for the instantaneous transmission rate is as follows:

$$r_i(\tau_k) = x_i(\tau_k) B \log_2(1 + S_i) \tag{1}$$

Transform the above formula to get:

$$\sum\nolimits_{i \in N} \alpha_i(\tau_k) x_i(\tau_k) \leqslant 1 \tag{2}$$

In order to ensure that users can quickly collect data resources in the process of using the network, it is necessary to specify the minimum rate of offload transmission, which is expressed as follows:

$$r_i(\tau_k) \geqslant r_n, \forall i \in N \tag{3}$$

3.1.2 Calculation Model

When using a calculation model to analyze data, the data needs to be processed according to the distribution of task modules. Each task module and device has a certain buffer time when they are handed over. The queue update process can be represented using the following formula:

$$r_i(\tau_k) \geqslant r_n, \forall i \in N \tag{4}$$

Through analysis, the specific update expression can be expressed as:

$$Q_i^c(\tau_{k+1}) = \left[Q_i^c(\tau_k) - y_i(\tau_k) \frac{f_c}{\rho} + \alpha_i(\tau_k) r_i(\tau_k) \right] \tag{5}$$

In the process of assigning tasks, the amount of computing resources allocated to the edge server cannot be greater than the system storage capacity of the edge server terminal:

$$\sum\nolimits_{i \in N} \alpha_i(\tau_k) x_i(\tau_k) \leqslant 1 \tag{6}$$

The expression of the queue needs to meet certain conditions, which are expressed by the following formula:

$$\lim_{k \to \infty} \sup \frac{1}{K} \sum_{k=0}^{K} E\left[Q_i^u(\tau_k) + Q_i^c(\tau_k) \right] < \infty \tag{7}$$

Through the above calculation and analysis, it can be concluded that the edge computing server provides users with no wireless resources and computing resources. The specific optimization steps are shown in Table 1:

3.2 Experimental Simulation and Result Analysis

The simulation situation and analysis results of the experiment are shown in Table 2:

(1) Effectiveness evaluation chart

In order to better analyze the results of the experimental simulation, this article analyzes the specific conditions of the effectiveness evaluation chart. The specific conditions of the evaluation chart are shown in the following figure:

Table 1 Edge service resource optimization algorithm.

Step	Content
1	Initialization: k←0, Ai(τk), Qi(τk)←0,$\forall i \in N$
2	Initialize the multiplier variables: $\eta 0$, β, $0\sigma 0$; the maximum allowable error Δ; n.
3	For $k = 0.1$, ..., $K^{\max} - 1$, do
4	Substitute the current multiplier variables $\eta 0$, β, and $0\sigma 0$ into (3.17) and (3.18) to obtain the local optimal allocation strategy xi(τk), yi(τk).
5	Substitute xi(τk), yi(τk) into the Lagrangian multiplier update equation, update $\eta 0$, β, $0\sigma 0$
6	Update the queue equation: $Q_i^U(\tau_{k+1}) = [Q_i^U(\tau_k) - (1 - \alpha_i(\tau_k) f_u/\rho) - \alpha_i(\tau_k) r_i(\tau_k) + A_i(\tau_k)]^+$ $Q_i^U(\tau_{k+1}) = [Q_i^U(\tau_k) - y_i(\tau_k) f_u/\rho + \alpha_i(\tau_k) r_i(\tau_k)]^+$
7	if $\|L^{n+1}(\tau_k) - L^n(\tau_k)\| \geqslant \Delta$ do
8	$n = n + 1$
9	Go back to Step 3
10	Else
11	Output $Q_i(\tau_k)$, $x_i(\tau_k)^+$, $y_i(\tau_k)^+$
12	End if
13	End for

Table 2 Simulation parameter table.

Parameter name	Parameter value
System bandwidth	15MHz
Gaussian white noise density	−174dBm/Hz
Signal to interference noise ratio	16
User equipment transmit power	0.4W
Local execution CPU frequency	0.5 ∼ 1.5G cycles/s
Edge server execution frequency	15G cycles/s
Task processing density	75 cycles/bit

When the value of the trade-off parameter is 2 or 4, the performance of the algorithm proposed in this article is the best. The specific situation is shown in Figure 4. Figure 5 demonstrates that as the running time increases, the stability of the algorithm does not change.

(2) Performance comparative analysis

After evaluating the effectiveness of the algorithm, it is necessary to optimize the time average cost of different algorithms and compare and analyze the performance of different algorithms [13]. The specific analysis is shown in the following figure.

4. CORRESPONDING SECURITY MEASURES AND STRATEGIES USED BY CLOUD COMPUTING TECHNOLOGY

4.1 Strengthen the Development of Network Technology and Promote the Development of Cloud Computing Technology

By analyzing the development process of China's network technology, it can be seen that the development of cloud computing and some network technologies need to rely on the operation of the network platform, so the development of new communication technologies is required. In the development of recent years, the development of the fifth-generation communication technology has created a broader development space for the development of cloud computing and other technologies [14]. The main means of improving the security of network technology is through specific research and practice of large-scale antenna technology in communication technology. Therefore, this technology can be vigorously developed to better ensure the effective use of cloud computing and other technologies.

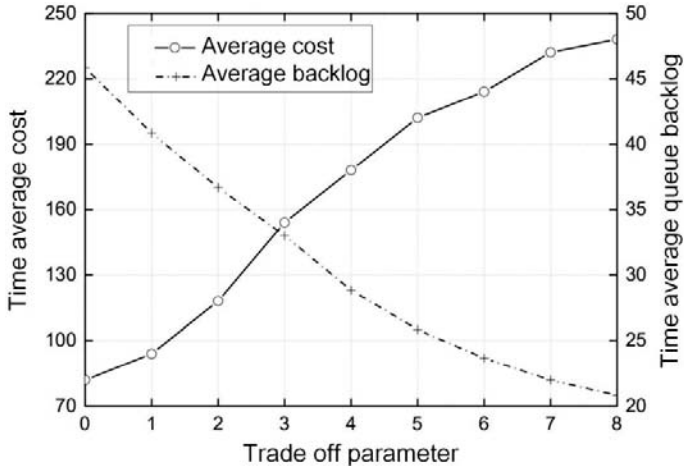

Figure 3 The relationship between time average cost and time average queue backlog and trade-off parameter.

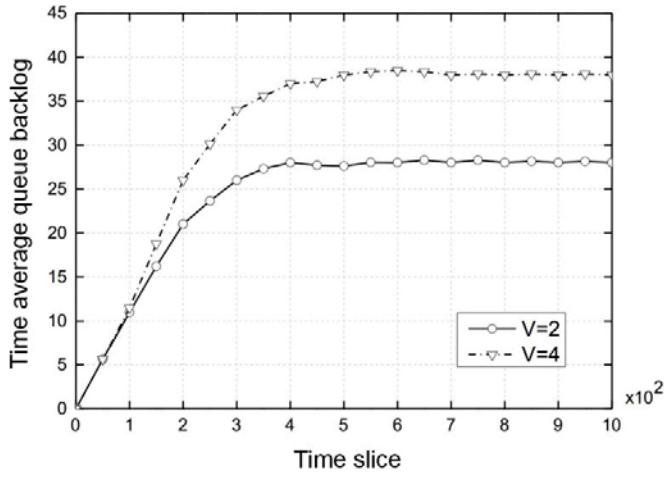

Figure 4 The relationship between time average queue backlog and time slice.

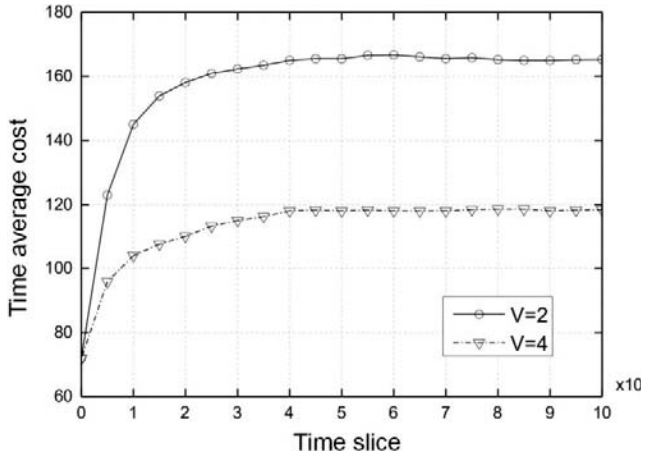

Figure 5 The relationship between time average cost and time slice.

4.2 Formulate Reasonable Legal Measures

Advanced technology is the basis for the smooth implementation and normal use of cloud computing technology. This advanced technology foundation also includes the internal technology of cloud computing technology. At present, in the process of implementing cloud computing technology in China, it is necessary to provide correct guidance on the application of cloud computing technology, to consider the scientificity and rationality of the implementation process, and also to carry out comprehensive planning and management [15]. At the same time, the implementation of cloud computing requires strict monitoring and management by relevant national units, as well as a timely understanding of

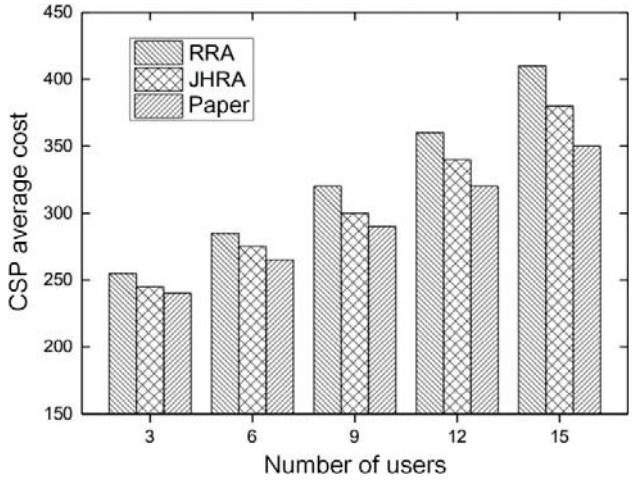

Figure 6 The relationship between the average cost of edge computing systems and the number of users.

international policy support for cloud computing technology, which fully reflects the country's importance and strong confidence in cloud computing technology. Without the supervision of the state and relevant laws and regulations, the safety of the process may not be ensured in the implementation of cloud computing technology [16]. A complete and mature legal system can effectively ensure the continuity and stability of the communication between users, but China's e-commerce laws are not currently sufficient, so China's current e-commerce market has certain irregularities, which is very unfavorable. Supervision of the e-commerce market is conducted by relevant state departments, because of this, in order for cloud computing technology to be implemented smoothly, relevant laws and regulations need to be improved, and at the same time, China's network security inspections must be strengthened to improve the security in the use of cloud computing technology, so that cloud computing technology can prosper with legal support and supervision. Legal protection can also be obtained in the event of potential safety hazards.

4.3 Adopt a Cloud Computing Service Model With Commercial Insurance

The convenience and risk of cloud computing technology in the use of this process has been universally recognized, so the most important thing now is how to improve the security of cloud computing technology itself. The study found that a more feasible solution to improve security is to use a service model with a commercial insurance system [17]. This model allows both parties to sign a corresponding risk-based contract, and users can then follow the commercial insurance's participation regulations that provide corresponding compensation for any corresponding incident. The beneficiary of the insurance compensation may be either a user or a company or organization that uses cloud computing technology. According to the research on the service model with a commercial insurance system, this model can protect the user's assets, because this model has been developed over a long period and can introduce the user's relevant data in real time. When private data is leaked, it can be compensated in time [18]. At present, China does not have the relevant laws and regulations in regard to the leakage of personal information data on the Internet, other laws somewhat contain provisions to protect users' Internet information, but they are not comprehensive. If the user's personal information is leaked, the existing laws cannot fully protect the legitimate rights and interests of citizens. Therefore, China must establish a comprehensive legal system to protect citizens' personal information so that users can reduce their worries when using information.

4.4 Strengthen the Internal Organization and Operation Management of Cloud Computing Service Providers

Talented employees are the most important asset of an organization, no matter what field or industry they are in. This is especially true in the context of the rapid development of artificial intelligence today, the improvement of the personal quality of employees is of great significance to the development of cloud computing technology [19]. Therefore, no matter what management model the company adopts, it must focus on the cultivation of company talents. In the use of cloud computing technology, the data transmission process is closely monitored, so relevant technical talents are indispensable in the development of cloud computing technology. The development of this technology requires Internet technical talents to continuously innovate [20]. Optimization is crucial, in order to enable the cloud computing technology in the era of big data to comprehensively collect all relevant information, reform its own related software and hardware facilities, and to maximize corporate profits and efficiency. Due to the urgent need for high-quality talents, companies must improve and optimize the recruitment and training process of employees, strengthen supervision of employees, include safety agreements when signing employment contracts, and provide support when accidents occur due to the personal errors of employees.

5. CONCLUSION

This article analyzes the development status of the fifth-generation communication technology, introduces the principle and specific operation of the mobile edge computing offloading strategy, and uses cloud computing technology to provide certain assistance for the safe operation of the network system. When designing the system, the researchers fully considered the task characteristics of data offloading and the load-bearing characteristics of the server, and used the strategy of mobile edge service cost to improve the resource allocation efficiency of the computer network system. In the process of analysis, this research evaluates the effectiveness of specific algorithms by establishing a cost and expenditure model. There are still many problems in the development of cloud computing technology within China. Some technical problems have not been solved yet, and a stronger network technology background is needed to support them. In the future development process of science and technology, the continuous use of various new technologies is the main trend, but some problems are also inevitable in the process of technological development. In order to ensure the smooth operation of the cloud computing platform, we need to continue to strengthen various areas. The research and development and application of network technology will fundamentally improve the security performance of cloud computing platforms and improve the level of computer network technology in our country.

REFERENCES

1. K. Kim, An improved semi-supervised dimensionality reduction using feature weighting: Application to sentiment analysis. Expert Syst Appl 1091 (2018), 49–65.
2. L. Kong, C. Li, J. Ge, et al., Leveraging multiple features for document sentiment classification. Inf Sci 518 (2020), 39–55.
3. V. Kumar, R. Venkatesan, W. Reinartz, Knowing what to sell, when, and to whom. Harvard Bus Rev 20 (2006), 131–137.
4. B. Li, S. Xu, J. Zhang, Enhancing clustering blog documents by utilizing author/reader comments. In: Proceedings of the 45th annual southeast regional conference 45(1) (2007), 426-438.
5. B. Liu, Text sentiment analysis based on CBOW model and deep learning in big data environment. J Ambient Intell Human Comput 11 (2020), 451–458.
6. B. Liu, M. Hu, J. Cheng, Opinion observer: analyzing and comparing opinions on the web. In: Proceedings of the 14th international conference on World Wide Web 28(3) (2005), 269–273.
7. Y. Liu, JW. Bi, ZP. Fan, Multi-class sentiment classification: the experimental comparisons of feature selection and machine learning algorithms. Expert Syst Appl 801 (2017), 323–339.
8. N. Mekawie, A. Hany, Understanding the factors driving consumers' purchase intention of over the counter medications using social media advertising in Egypt: (A Facebook advertising application for cold and Flu products). Proced Comput Sci 164 (2019), 698–705.
9. JC. Na, C. Khoo, PHJ. Wu, Use of negation phrases in automatic sentiment classification of product reviews. Lib Collect Acquis Tech Serv 29(2) (2005), 180–191.
10. T. O'Keefe, I. Koprinska, Feature selection and weighting methods in sentiment analysis. In: Proceedings of the 14th Australasian document computing symposium 53(5) (2009), 729–736.
11. H. Ogura, H. Amano, M. Kondo, Comparison of metrics for feature selection in imbalanced text classification. Expert Syst Appl 38(5) (2011), 4978–4989.
12. B. Pang, L. Lee, S. Vaithyanathan, Thumbs up?: sentiment classification using machine learning techniques. In: Proceedings of the ACL-02 conference on empirical methods in natural language processing, vol 10 (2002), 79–86.
13. M. Simeon, R. Hilderman, Categorical proportional difference: a feature selection method for text categorization. In: Proceedings of the 17th Australasian data mining conference 35(6) (2008), 201–208.
14. NK. Singh, DS. Tomar, AK. Sangaiah, Sentiment analysis: a review and comparative analysis over social media. J Ambient Intell Human Comput 11 (2020), 97–117.
15. S. Tan, J. Zhang, An empirical study of sentiment analysis for Chinese documents. Expert Syst Appl 34(4) (2008), 2622–2629.
16. H. Tang, S. Tan, X. Cheng, A survey on sentiment detection of reviews. Expert Syst Appl 36(7) (2009), 10760–10773.
17. S. Wang, D. Li, X. Song, et al., A feature selection method based on improved fisher's discriminant ratio for text sentiment classification. Expert Syst Appl 38(7) (2011), 8696–8702.
18. C. Whitelaw, N. Garg, S. Argamon, Using appraisal groups for sentiment analysis. In: Proceedings of the 14th ACM conference on information and knowledge management 72(9) (2005), 625–631.
19. CH. Wu, ZJ. Chuang, YC. Lin, Emotion recognition from text using semantic labels and separable mixture models. ACM Trans Asian Lang Inf Process 5(2) (2006), 165–182.
20. Q. Ye, Z. Zhang, R. Law, Sentiment classification of online reviews to travel destinations by supervised machine learning approaches. Expert Syst Appl 36 (2009), 6527–6535.