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RESEARCH OF THE TEXT PROCESSING METHODS IN ORGANIZATION OF ELECTRONIC STORAGES OF INFORMATION OBJECTS

The **subject** matter of the article is electronic storage of information objects (IO) ordered by specified rules at the stage of accumulation of qualification thesis and scientific work of the contributors of the offered knowledge exchange system provided to the system in different formats (text, graphic, audio). Classified works of contributors of the system are the ground for organization of thematic rooms for discussion to spread scientific achievements, to adopt new ideas, to exchange knowledge and to look for employers or mentors in different countries. The **goal** of the work is to study the libraries of text processing and analysis to speed-up and increase accuracy of the scanned text documents classification in the process of serialized electronic storage of information objects organization. The following **tasks** are: to study the text processing methods on the basis of the proposed generalized model of the system of classification of scanned documents with the specified location of the block of text processing and analysis; to investigate the statistics of change in the execution time of the developed parallel modification of the methods of the word processing module for the system with shared memory for collections of text documents of different sizes; analyze the results. The **methods** used are the following: parallel digital sorting methods, methods of mathematical statistics, linguistic methods of text analysis. The following **results** were obtained: in the course of the research fulfillment the generalized model of the scanned documents classification system that consist of image processing unit and text processing unit that include unit of the scanned image previous processing; text detection unit; previous text processing; compiling of the frequency dictionary; text proximity detection was offered. **Conclusions:** the proposed parallel modification of the previous text processing unit gives acceleration up to 3,998 times. But, at a very high computational load (collection of 18144 files, about 1100 MB), the resources of an ordinary multiprocessor-based computer with the shared memory obviously is not enough to solve such problems in the mode close to real time.

Keywords: information system; parallelism; word processing; linguistic programming; library; acceleration; method.

Introduction

The paper [1] offers the system of young scientists from different countries knowledge exchange, that provides for communication of the specialists and interested people on the one of available topics. The topic is defined on the basis of qualification thesis and scientific work of the system participants, that prescribes the previous stage of the data collection in database, their analysis to classify and identify topical and scientific and practical directions and authors who are interested in and look into specified directions. Classified works of contributors of the system are the ground for organization of the thematic rooms for discussion to spread scientific achievements, to adopt new ideas, to exchange knowledge and to look for an employers or mentors in different countries.

In the thesis [2] it was offered the organization model of the storage system [3-6] and access to the scientific thesis of the researchers, lecturers and university students within electronic storage IO. Both stages are working with different types of input documents: graphic, text and audio-files (the last format is used only on the data access stage). That is why applicability of the research in the scanned documents classification field for the classification and structured storing in electronic storage of the scientific knowledge exchange system is reasonable.

Analysis of last achievements and publications

Scanned documents processing is a complex process as it represents the combination of the methods of the work with the image and text processing, that was noted in

thesis [7-9]. Further, a lot of works are addressed to the text processing methods [10-14], and realization of methods is performed in numerous linguistic programming libraries – CoreNLP, NLTK, TextBlob, Spacy, Spark NLP etc. The specific feature of a library is a possibility to use different hardware (massive parallel system, general memory systems etc). Processing libraries analysis and text analysis is the goal of the given work. It will provide fast and accurate detected text processing for the further classification.

In the sphere of natural language processing there are many libraries, but the libraries with the limited functionality and operate for the specific cases will not be productive for solving the given task. For instance, NLP gensim library was originally created for thematic modeling and can not be used for complete NLP pipeline construction as a collection of basic and additional functions (fig. 1).

The analysis of the NLP libraries expended features about text processing revealed that the following libraries with the open code meet the necessary requirements: Spark NLP; spaCy; OpenNLP; Stanford CoreNLP., NLTK [15-17]. The comparison of the NLP libraries features is given in table 1.

Although most NLP libraries support learning new models by users it is important that any NLP library was able to provide available pre-trained high-quality models. However, most libraries only support general pre-trained models (POS, NER etc.). Some do not allow the use of their pre-trained models for commercial purposes because of the way they are licensed (table 2).

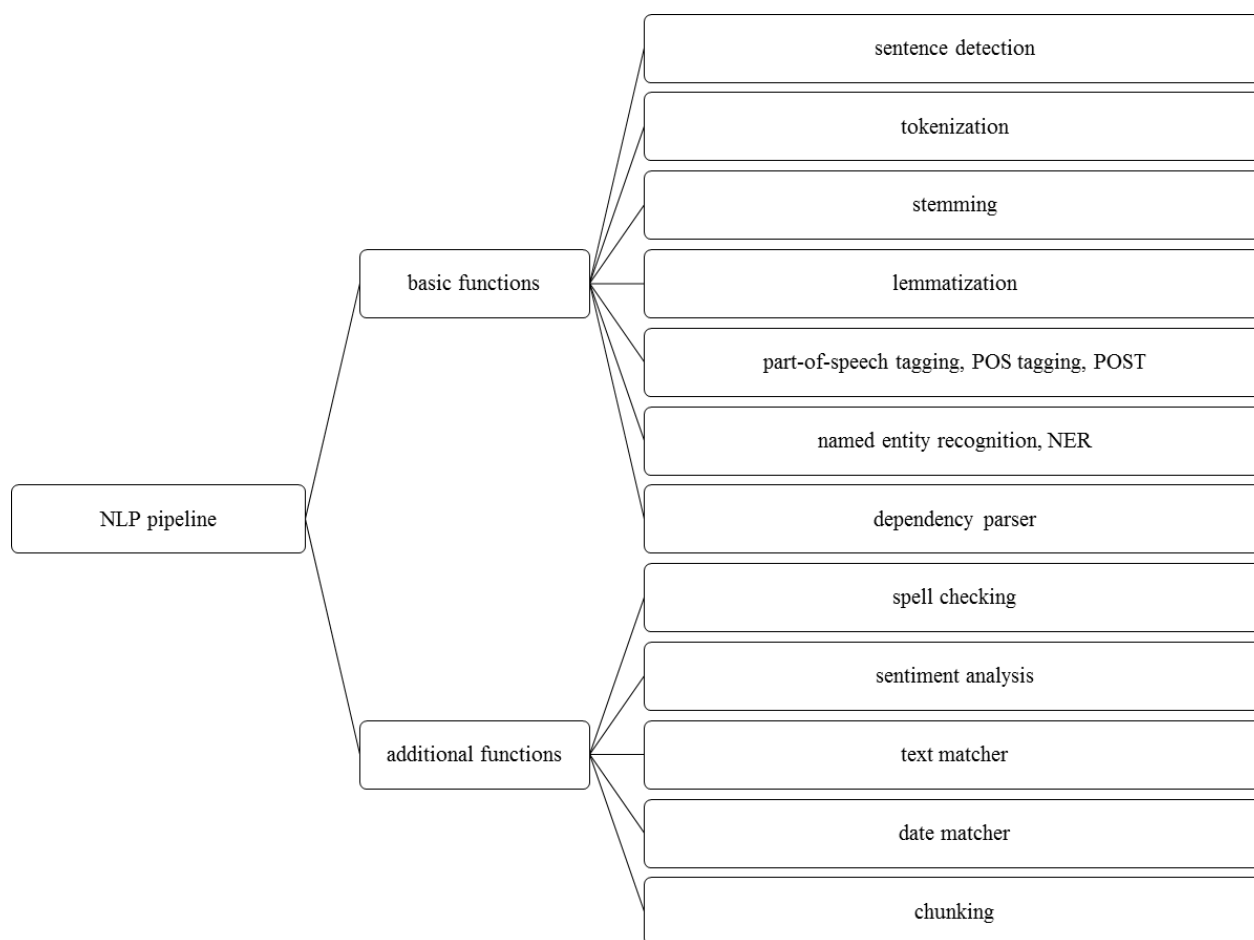


Fig.1. Definition of basic and additional functions of NLP pipeline

Table 1. The comparison of the NLP libraries features

Name of the text processing method	NLTK	Spark NLP	spaCy	CoreNLP
Sentence detection	+	+	+	+
Tokenization	+	+	+	+
Stemming	+	+	+	+
Lemmatization	+	+	+	+
POS tagging	+	+	+	+
NER	+	+	+	+
Dependency parser	+	+	+	+
Text matcher	—	+	+	+
Date matcher	—	+	—	+
Chunking	+	+	+	+
Spell checking	—	+	—	—
Sentiment analysis	—	+	—	+
Pre-trained models	+	+	+	+
Trained models	+	+	+	+

Table 2. Comparison of NLP libraries with the support of pre-trained models

Name	Pre-trained models (general)	Pre-trained models (subject-oriented)	Free license to use pre-trained models commercially
NLTK	+	—	+
Spark NLP	+	+	+ (partially)
spaCy	+	+	+ (partially)
CoreNLP	+	—	—
OpenNLP	+	—	+

The conducted analysis of the linguistic programming libraries, the functionality of which is focused on natural language processing with ready-made pre-trained models of neural networks, conveyors and

vector representations of words, as well as supporting the learning of their own models, showed that Spark NLP and spaCy are the leaders, therefore, these libraries can be successfully used for research and experimentation in order to reduce the operating time of the text unit in the proposed generalized model of the scanned documents classification system.

Comparing Spark NLP and spaCy, it should be noted that spaCy is the most documented library and possesses an extended training course, as well as the wide industrial application. In the research [18] the above mentioned libraries were analyzed on the accuracy of training, model size, time forecast, F-measures on the same data sets for all libraries in the process of training and testing. The spaCy library provided the most efficient performance and the highest results of the accuracy of training in comparison with the other models. Therefore, the experimental part of this work was performed using the spaCy linguistic library.

Aim of the study is to study the text processing and analysing libraries with the aim to speed up and increase the accuracy of the scanned text documents classifications when organizing an orderly electronic storage of the information objects.

Achieving the goal is possible by solving the following tasks:

- to perform the analysis of the modern linguistic programming libraries for sequential and parallel

implementations of the most common methods of text processing and analysis;

- to offer the generalized model of the scanned documents classification system with the specified place of the block of processing and the analysis of the text;

- to provide a modification of the methods of the pre-processing module for the system with shared memory;

- to obtain statistics of the time spent on the work of the pre-processing module for the collections of the text documents of different sizes;

- to analyze the obtained results.

Materials and methods

The topicality of the research lies in reducing the time of organizing the new information resources entering the storage by increasing the speed of processing methods and analysis of the recognized text in the original image.

Figure 2 shows the place of the methods of text processing and analysis on the generalized model of the scanned documents classification system, which consists of the following units – image and text processing units, which in their turn include the modules of the scanned image pre-processing; text detection; text pre-processing; creating the frequency dictionary; defining the textual proximity. The mentioned units work in the sequence shown in fig. 2, that is the final result (the accuracy and time of classification) depends on all methods used.

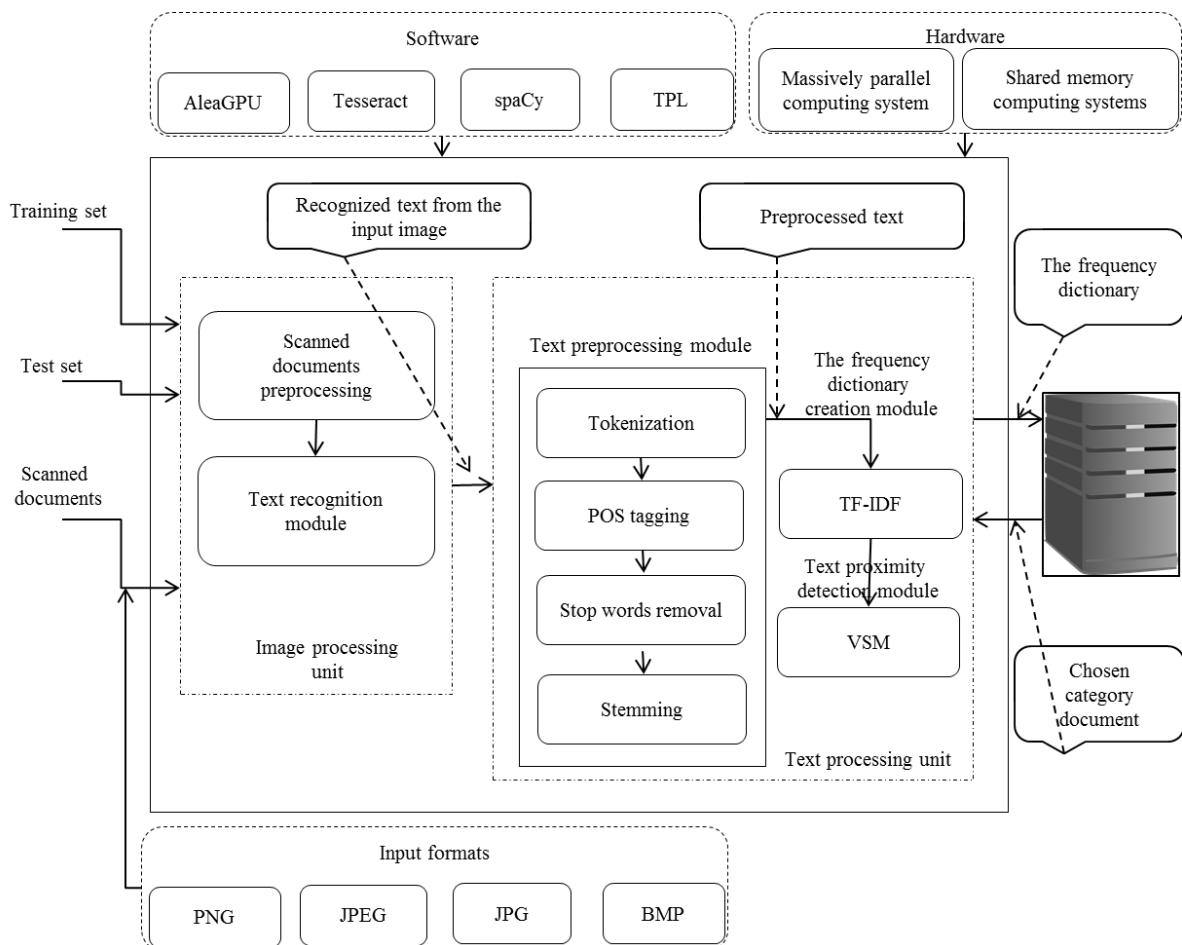


Fig. 2. The scheme of the text processing and analysis methods on the generalized model of the scanned documents classification system

Linguistic pipeline components, represented in the text pre-processing module, are called in order. The tokenizer is launched at the first stage in the NLP-block and as a result leads to breaking a paragraph of the text into smaller parts (tokens), for example, words or sentences.

The original text, on which the components of the conveyor were tested, are given below:

['We will protect our players and I will protect my players always.', 'He played against Everton as a number 6, a number 9 and as a wing-back.', 'Is that fair to him?']

Full breaking of the paragraph into words in the text form is given below:

['We', 'will', 'protect', 'our', 'players', 'and', 'I', 'will', 'protect', 'my', 'players', 'always', '.', 'He', 'played', 'against', 'Everton', 'as', 'a', 'number', '6', ',', 'a', 'number', '9', 'and', 'as', 'a', 'wing-back', '.', 'Is', 'that', 'fair', 'to', 'him', '?']

Removing noise words as such that do not convey any semantic load in the text, for example, "the", "a", "at", "for", "above", "on", "is", "all" is an important step, that influences the accuracy of the original documents classification as well as the speed of the result obtaining by reducing the amount of the text processed. In spaCy in order to remove such words it is necessary to create the noise words list and filter the list of tokens from these words.

The full result of the filtered sentence after removing the noise words from the tokenized sentence is given below in the text form:

['We', 'protect', 'players', 'I', 'protect', 'players', 'always', '.', 'He', 'played', 'Everton', 'number', '6', ',', 'number', '9', 'wing-back', '.', 'Is', 'fair', '?']

Lexical rationing takes into account another noise type in the text. For example, the words "connection", "connected", "connecting" are the derivatives of the general word "connect". Such rationing reduces related word forms to a common root word. The process of shortening a word to the base by discarding auxiliary parts such as an ending or a suffix is stemming. The results of stemming are sometimes very similar to finding the root of a word, but its algorithm is based on other principles. That's why a word after processing by the stemming algorithm can be different from its morphological root.

The result of the filtered sentence stemming (stemmed sentence):

['We', 'protect', 'player', 'I', 'protect', 'player', 'alway', '.', 'He', 'play', 'everton', 'number', '6', ',', 'number', '9', 'wing-back', '.', 'Is', 'fair', '?']

Based on the format of the original data – collection of the text documents – and obtained in the process of their reading string variables with their contents, stream processing of the texts is more effective than processing them one by one in the traditional sequential form.

In this case, one of the documents of the collection is sent for processing by the stream. Testing was done on the system with general memory AMD Ryzen 5 2600 3.4GHz, having 6 cores and a maximum number of streams – 12. SpaCy recommends joblib library for parallel processing of the NLP conveyor units. To

parallelize the workflow, it is necessary to identify a few more auxiliary methods.

Study results and their discussion

In order to analyze the operation of the text processing methods without the use of the parallelization procedure and with the help of it, collections of the documents of different sizes were used (table 3):

- 1 file of 10 thousand words, about 5 MB;
- collection of 25 files of 225 thousand words, about 120 MB;
- collection of 3024 files, about 200 MB;
- collection of 9072 files, about 600 MB;
- collection of 18144 files, about 1100 MB.

The case that was used for testing consists of the files that represent classical works of literature in the plain text format, and in particular:

- A Tale of Two Cities – A Story of the French Revolution;
- Alice's Adventures in Wonderland;
- Fairy Tales by the Brothers Grimm;
- Frankenstein; or, the Modern Prometheus;
- Moby-Dick or, the Whale;
- Pride and Prejudice by Jane Austen;
- The Adventures of Sherlock Holmes;
- The Adventures of Tom Sawyer;
- The Iliad of Homer;
- The Romance of Lust by Unknown writer;
- War and Peace by Leo Tolstoy etc.

For each of the methods listed in the word processing module testing was conducted on each of the five collections. The testing included 10 application launches to determine the average execution time of the methods.

Fig. 3 represents the block diagram with parallel modification of the methods of the pre-processing module for the system with shared memory.

For the systems with shares memory the programme model for the decomposition of the traditional sequential approach is the fork-join model, which involves generation of parallel flows, their independent performance, combination of the results in the main stream. Thus, the operating time of the module is significantly reduced and instead of the sum of the processing times of all documents the area of preparation of the original text for the creation of the frequency dictionary is equal to the time of the longest processing, which corresponds to the most voluminous original text.

The time, given in the table in the line without acceleration, is the sum of the time of tokenization methods, removal of stop words, POS tagging and steaming. Here is an example for a file of 10 thousand words: the time of tokenization is 0,054 seconds, the time of the stop words removal is 0,012 seconds, the time for POS tagging is 0,583 seconds and the time for stamming is 0,1524 seconds. That is, the total operating time of the pre-processing module without acceleration and use of nlp.pipe is 1,3964 seconds for the collection including only one file with the volume of 10 thousand words.

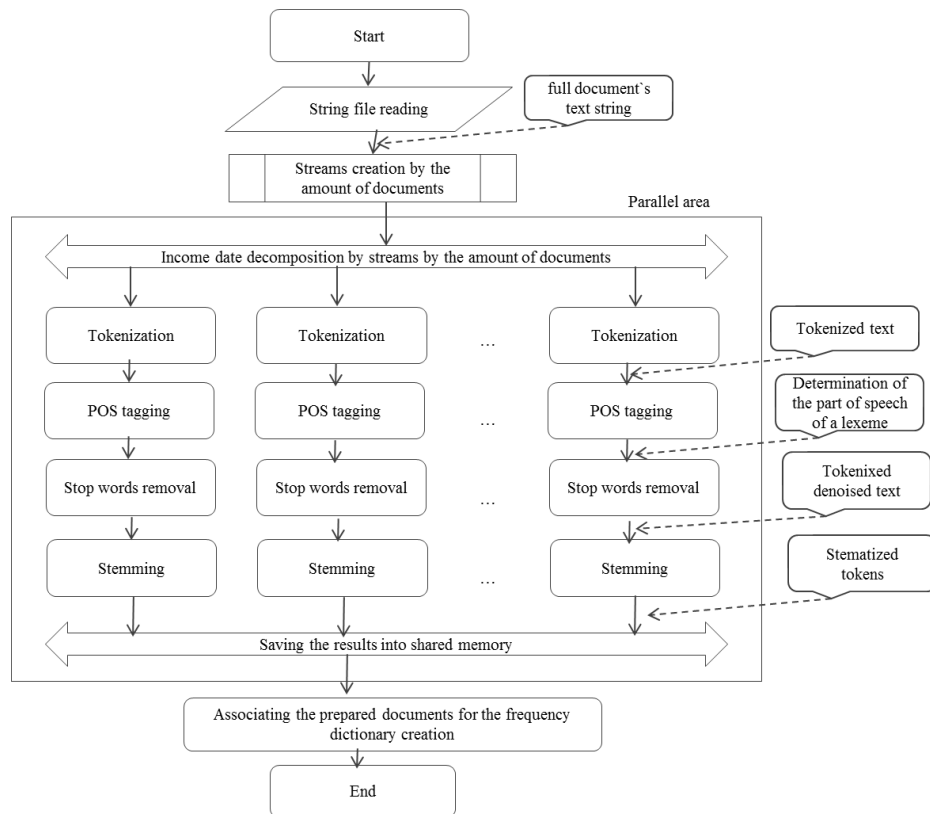


Fig.3. Block diagram with parallel modification of the preprocessing methods for the shared memory systems

Table 3. Statistics of the time spent on the operation of the text pre-processing module

Method		Number of files				
		1	25	3024	9072	18144
Without acceleration		1,3964 sec	8,42 sec	758,7 sec	1956,78 sec	5894,6 sec
nlp.pipe		1,781 c	6,354c	620,35c	1604,9c	5691,4c
Paralleling	2 streams	1,413 c	3,247c	350,4c	821,3c	3854,8M
	4 streams	1,348 c	2,87c	192,7c	443,46c	2310,7c

According to the results depicted on the graph (fig. 4), we can observe the tendency of acceleration but the resources of an ordinary multiprocessor-based computer with the shared memory obviously is not enough to solve such problems in the mode close to real time. Parallel

algorithm for several streams has an advantage only in case of presence of a large number of documents, and the higher the number of streams the greater the acceleration. If it is necessary to analyze a small amount of text it is better to divide the data into parts and transfer to nlp.pipe.

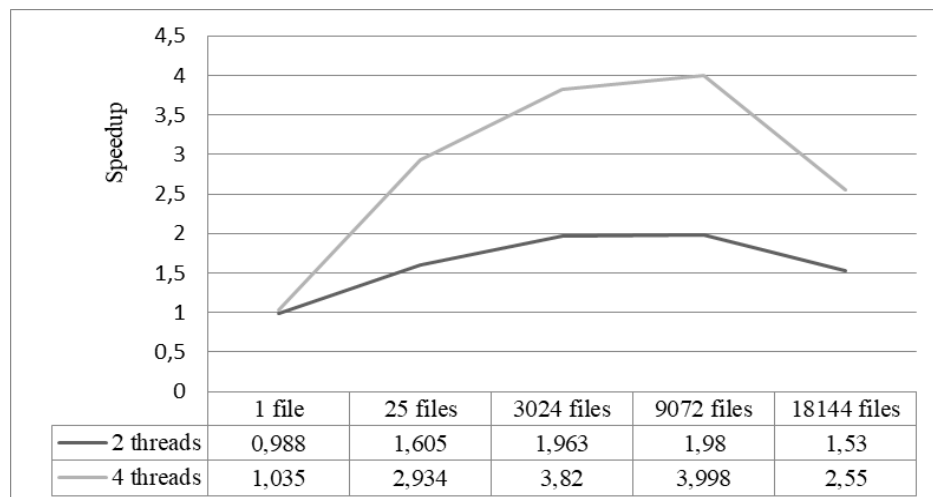


Fig.4. Graph of the text preliminary processing methods acceleration

The next step of the functioning of the text processing unit is the work on the creation of the frequency dictionary module and the module of determining the textual proximity. As the compilation and organization of the frequency dictionary is given in the article of the authors of this survey [2], further research will be related exactly to the definition of the textual proximity which is an important step for the efficient storage of documents and its organization. Determining the percentage of similarity between the texts in the given generalized classification system of the scanned documents is proposed to avoid duplication of documents, that is resaving of an existing document with a different name.

Conclusion

In the course of the research it was proposed a generalized classification system of the scanned documents, which consists of the image and text processing units, which in their turn include the modules of the scanned image pre-processing; text detection; text pre-processing; creating the frequency dictionary; defining the textual proximity. As the given units operate in the sequence, that is the final result (the accuracy and time of classification) depends on all methods used, the reduction of the time for classification and arrangement of the new information resources entering the system is possible by increasing the speed of processing methods and analysis of the recognized text in the original image.

Therefore, in the research it was proposed the parallel modification of the methods of the pre-processing module for the system with the shared memory and conducted its software testing with the definition of the obtained acceleration depending on the different number of the computational streams used.

Analysis of the libraries of linguistic programming, the functionality of which is focused on the processing of natural language with ready-made pre-trained models of neural networks, conveyors and vector representations of the words as well as the support of learning their own models, showed that Spark NLP and spaCy are the leaders, although, such advantages as the best documentation, industrial application, high productivity and accuracy of learning compared to other libraries determined the experimental research using the spaCy linguistic programming library.

The results showed a tendency to accelerate up to 3,998 times but, at a very high computational load (collection of 18144 files, about 1100 MB), the resources of an ordinary multiprocessor-based computer with the shared memory obviously is not enough to solve such problems in the mode close to real time. If it is necessary to analyze a small amount of text it is recommended to divide the data into parts and transfer to nlp.pipe.

Perspectives of further development

Future research will be further concentrated on reducing the time required to prepare text documents for classification, focusing the attention on large collections (more than 200 thousand words). Besides, significant is the time of the method of determining the textual proximity, which is an important step for efficient storage and organization of documents.

To achieve greater acceleration, it is planned to conduct the experiments with the application of the mass parallelism computer systems and various approaches to the original data decomposing – ordinal distribution, sentence distribution, adaptive distribution.

References

1. Barkovska, O., Kholiev, V., Pyvovarova, D., Ivaschenko, G., Rosinskiy, D. (2021), "International system of knowledge exchange for young scientists", *Advanced Information Systems*, No. 5 (1), P. 69 – 74. DOI: <https://doi.org/10.20998/2522-9052.2021.1.09>
2. Barkovska, O., Pyvovarova, D., Kholiev, V., Ivashchenko, H., Rosinskiy, D. (2021), "Information Object Storage Model with Accelerated Text Processing Methods", *Proceedings of the 5th International Conference on Computational Linguistics and Intelligent Systems (COLINS 2021)*, No. 2870, P. 286 – 299.
3. Koroteev, M. (2020), "On the Usage of Semantic Text-Similarity Metrics for Natural Language Processing in Russian", *13th International Conference "Management of large-scale system development" (MLSD)*, P. 1 – 4. DOI: <https://doi.org/10.1109/MLSD49919.2020.9247691>
4. Liu, Y. Sheng, Wei, Z., Yang, Y. (2018), "Research of Text Classification Based on Improved TF-IDF Algorithm", *IEEE International Conference of Intelligent Robotic and Control Engineering (IRCE)*, P. 218 – 222. DOI: <https://doi.org/10.1109/IRCE.2018.8492945>
5. Zhang, Y. (2021), "Research on Text Classification Method Based on LSTM Neural Network Model", *IEEE Asia-Pacific Conference on Image Processing, Electronics and Computers (IPEC)*, P. 1019 – 1022. DOI: <https://doi.org/10.1109/IPEC51340.2021.9421225>
6. Jindal, R., Shweta, (2018), "A Novel Method for Efficient Multi-Label Text Categorization of research articles", *International Conference on Computing, Power and Communication Technologies (GUCON)*, P. 333 – 336. DOI: <https://doi.org/10.1109/GUCON.2018.8674985>
7. Martínek, J., Lenc, L., Král, P. (2020), "Building an efficient OCR system for historical documents with little training data", *Neural Computing and Applications*, No. 32, P. 17209 – 17227. DOI: <https://doi.org/10.1007/s00521-020-04910-x>
8. Pawar, N., Shaikh, Z., Shinde, P., Warke Y. (2019), "Image to Text Conversion Using Tesseract", *International Research Journal of Engineering and Technology (IRJET)*, No. 6 (2), P. 516– 519.
9. Revathi, A., Modi, N. A. (2021), "Comparative Analysis of Text Extraction from Color Images using Tesseract and OpenCV", *8th International Conference on Computing for Sustainable Global Development (INDIACom)*, P. 931 – 936. DOI: <https://doi.org/10.1109/INDIACom51348.2021.00167>

10. Burns, S. (2019), *Natural Language Processing: A Quick Introduction to NLP with Python and NLTK (Step-by-Step Tutorial for Beginners)*, Amazon KDP Printing and Publishing C, 123 p.
11. Lane, H., Hapke, H., Howard, C. (2019), *Natural Language Processing in Action: Understanding, analyzing, and generating text with Python*, Manning; 1st edition, 544 p.
12. Jurafsky, D., Martin, J.H., "Speech and Language Processing", available at: <https://web.stanford.edu/~jurafsky/slp3/> (last accessed: 16.02.2022)
13. Kim, J., Hur, S., Lee, E., Lee, S. (2021), "NLP-Fast: A Fast, Scalable, and Flexible System to Accelerate Large-Scale Heterogeneous NLP Models," *30th International Conference on Parallel Architectures and Compilation Techniques (PACT)*, P. 75– 89. DOI: <https://doi.org/10.1109/PACT52795.2021.00013>
14. Berko, A., Matseliukh, Y., Ivaniv, Y., Chyrun, L., Schuchmann, V. (2021), "The Text Classification Based on Big Data Analysis for Keyword Definition Using Stemming," *IEEE 16th International Conference on Computer Sciences and Information Technologies (CSIT)*, P. 184– 188. DOI: <https://doi.org/10.1109/CSIT52700.2021.9648764>
15. Sakthi vel, S. (2021), "Pre-Processing techniques of Text Mining using Computational Linguistics and Python Libraries," *International Conference on Artificial Intelligence and Smart Systems (ICAIS)*, P. 879–884. DOI: <https://doi.org/10.1109/ICAIS50930.2021.9395924>
16. Al Omran, F. N. A., Treude, C. (2017), "Choosing an NLP Library for Analyzing Software Documentation: A Systematic Literature Review and a Series of Experiments," *IEEE/ACM 14th International Conference on Mining Software Repositories (MSR)*, P. 187– 197. DOI: <https://doi.org/10.1109/MSR.2017.42>.
17. Vasiliev, Y. (2020), *Natural Language Processing with Python and SpaCy: A Practical Introduction*, No Starch Press, 217 p
18. Naseer, S., Mudasar Ghafoor, M., Alvi, S. bin K., Kiran, A., Shafique Ur Rahmand, Ghulam Murtazae, & Murtaza, G. (2022), "Named Entity Recognition (NER) in NLP Techniques, Tools Accuracy and Performance", *Pakistan Journal of Multidisciplinary Research*, No. 2 (2), P. 293– 308.

Received 25.02.2022

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ДОСЛІДЖЕННЯ МЕТОДІВ ОБРОБКИ ТА АНАЛІЗУ ТЕКСТУ ПРИ ОРГАНІЗАЦІЇ ЕЛЕКТРОННИХ СХОВИЩ ІНФОРМАЦІЙНИХ ОБ'ЄКТІВ

Предметом дослідження в статті є електронне сховище інформаційних об'єктів, впорядковане за визначеними правилами на етапі накопичення кваліфікаційних та наукових робіт учасників запропонованої системи обміну знаннями, наданими до системи у різних форматах (текстові, графічні, аудіо). Класифіковані роботи учасників системи є підставою для організації тематичних кімнат для обговорення із метою розповсюдження наукових досягнень, запозичення нових ідей, обміну знаннями та пошуку роботодавців або менторів у різних країнах світу. **Мета** роботи – дослідження бібліотек обробки та аналізу тексту із метою прискорення та збільшення точності класифікації сканованих текстових документів при організації впорядкованого електронного сховища інформаційних об'єктів. В статті вирішуються наступні **завдання**: дослідити методи обробки та аналізу тексту на базі запропонованої узагальненої моделі системи класифікації сканованих документів із зазначеним місцем блоку обробки та аналізу тексту; дослідити статистику зміну часу виконання розробленої паралельної модифікації методів модулю попередньої обробки тексту для системи із загальною пам'яттю для колекцій текстових документів різного розміру; проаналізувати отримані результати. Використовуються такі **методи**: паралельні чисельні методи сортування, методи

математичної статистики, лінгвістичні методи аналізу тексту. Отримано наступні **результати**: в ході виконання досліджень, було запропоновано узагальнену модель системи класифікації сканованих документів, яка складається з блоку роботи із зображенням та блоку роботи із текстом, які, в свою чергу, включають модулі попередньої обробки сканованого зображення; модуль розпізнавання тексту; попередньої обробки тексту; побудови частотного словнику; визначення текстової близькості. **Висновки**: запропонована паралельна модифікація модулю попередньої обробки тексту дає прискорення до 3,998 разів. Але, при дуже високому обчислювальному навантаженні (колекція з 18144 файлів, близько 1100Мб), ресурсів обчислювача на базі багатопроцесорного ЦПУ із загальною пам'яттю не достатньо для вирішення подібних задач у режимі, наближеному до реального часу.

Ключові слова: інформаційна система; паралелізм; обробка тексту; лінгвістичне програмування; бібліотека; прискорення; метод.

ИССЛЕДОВАНИЕ МЕТОДОВ ОБРАБОТКИ И АНАЛИЗА ТЕКСТА ПРИ ОРГАНИЗАЦИИ ЭЛЕКТРОННЫХ ХРАНИЛИЩ ИНФОРМАЦИОННЫХ ОБЪЕКТОВ

Предметом исследования в статье является электронное хранилище информационных объектов, упорядоченное по определенным правилам на этапе накопления квалификационных и научных работ участников предлагаемой системы обмена знаниями, поступающими в систему в различных форматах (текстовые, графические, аудио). Классифицированные работы участников системы являются основанием для организации тематических комнат для обсуждения с целью распространения научных достижений, заимствования новых идей, обмена знаниями и поиска работодателей или менторов в разных странах мира. **Цель** работы – исследование библиотек обработки и анализа текста с целью ускорения и увеличения точности классификации сканированных текстовых документов при организации упорядоченного электронного хранилища информационных объектов. В статье решаются следующие **задачи**: исследовать методы обработки и анализа текста на основе предложенной обобщенной модели системы классификации сканированных документов с указанным местом блока обработки и анализа текста; исследовать статистику изменения времени выполнения разработанной параллельной модификации методов модуля предварительной обработки текста для системы с общей памятью для коллекций текстовых документов разного размера; проанализировать полученные результаты. Используются следующие **методы**: параллельные численные методы сортировки, методы математической статистики, лингвистические методы анализа текста. Получены следующие **результаты**: в ходе выполнения исследований была предложена обобщенная модель системы классификации сканированных документов, состоящая из блока работы с изображением и блока работы с текстом, которые, в свою очередь, включают модули предварительной обработки сканируемого изображения; модуль распознавания текста; предварительной обработки текста; построения частотного словаря; определение текстовой близости. **Выводы**: предложенная параллельная модификация модуля предварительной обработки текста дает ускорение в 3,998 раза. Но, при очень высокой вычислительной нагрузке (коллекция из 18144 файлов, около 1100Мб), ресурсов вычислителя на базе многопроцессорного ЦПУ с общей памятью недостаточно для решения подобных задач в режиме, приближенном к реальному времени.

Ключевые слова: информационная система; параллелизм; обработка текста; лингвистическое программирование; библиотека; ускорение; метод.

Бібліографічні описи / Bibliographic descriptions

Барковська О. Ю., Хомич В. М., Настенко О. С. Дослідження методів обробки та аналізу тексту при організації електронних сховищ інформаційних об'єктів. *Сучасний стан наукових досліджень та технологій в промисловості*. 2022. № 1 (19). С. 5–12. DOI: <https://doi.org/10.30837/ITSSI.2022.19.005>

Barkovska, O., Khomych, V., Nastenko, O. (2022), "Research of the text processing methods in organization of electronic storages of information objects", *Innovative Technologies and Scientific Solutions for Industries*, No. 1 (19), P. 5–12. DOI: <https://doi.org/10.30837/ITSSI.2022.19.005>