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# **MODERN PROBLEMS AND THE LATEST THEORIES OF DEVELOPMENT**

Abstracts of XXXVI International Scientific and Practical Conference

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# **ANALYSIS OF EXISTING IMAGE CLASSIFICATION PROBLEMS USING CONVOLUTIONAL NEURAL NETWORKS**

**Kotykhin Stanislav,**

Master in informatics

Kharkiv National University of Radio Electronics,

In recent years, the field of computer vision has undergone a transformative evolution, largely driven by the emergence of Convolutional Neural Networks (CNNs). These sophisticated deep learning architectures have redefined the landscape of image analysis and classification, enabling machines to approach or even surpass human-level performance in a multitude of complex tasks [1-5]. As CNNs continue to evolve and diversify, it becomes increasingly crucial to conduct a comprehensive analysis of their effectiveness across various image classification challenges [6-9].

This work aims to make introduction to world of neural networks, highlight current scenarios and opportunities of CNN-based image classification [10-15].

Artificial neural network is a mathematical model, as well as its software or hardware implementation, built on the principle of organization and functioning of biological neural networks – networks of nerve cells of a living organism (particularly, the brain).

Artificial neural networks consist of several layers – input, hidden, and output layers. There can be multiple hidden layers, in which case the network will be considered as multilayer. Each layer has several nodes, neurons, which are connected to all other nodes in the network by means of links and have their own “weights”. The weight in this case is the “importance” of each feature to that neuron. Coming out of this, there will be a different list of weights for each neuron.

This architecture allows parallel processing of data and constant comparison with the results of processing at each stage. Neural networks are initially trained on labeled datasets with obvious patterns, and then use the skills gained to self-learn and achieve results.

The work of a neural network is comparable to the actions of a human: when faced with an unfamiliar object, it recognizes its properties and makes conclusions. Similar processes happen in the nodes of neural networks, when solving a certain problem; they use the gained experience for further learning.

A Convolutional Neural Network (CNN), also known as ConvNet, is a class of multilayer neural network specifically designed for processing structured grid data, such as images and video. The network architecture got its name because of the presence of convolution operation, which idea is that each image fragment is multiplied by the convolution matrix (kernel) element by element, and the result is summarized and recorded in a similar position of the output image.

The CNN consists of different kinds of layers: convolutional (convolutional) layers, pooling layers, and layers of a “regular” neural network – a perceptron, according to Fig. 1.

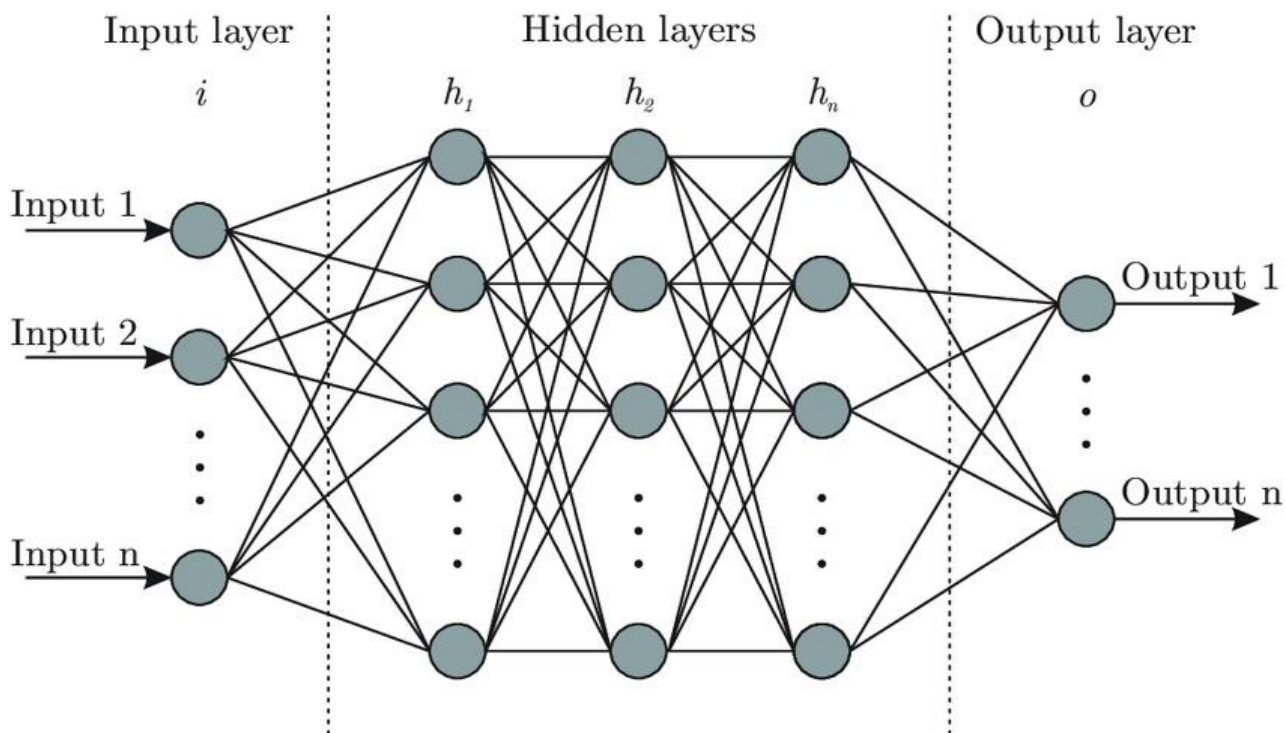


Figure 1 – Structure of default multilayer neural network – perceptron

The work of a convolutional neural network is usually interpreted as a transition from specific features of an image to more abstract details, and further to even more abstract details up to the selection of high-level concepts. In this case, the network self-adjusts and develops itself the necessary hierarchy of abstract features (sequences of feature maps), filtering out minor details and selecting significant ones.

Nowadays, image classification using convolutional neural networks are used for a large number of well-intentioned purposes. One of them is definitely the diagnosis of diseases from medical images. Medical images defined as X-rays, CT scans, MRIs, or any other image that can reveal some clear signs of disease.

CNN will use dataset of medical images that includes both positive cases (images of patients with the disease of interest) and negative cases (images of patients without the disease) for training. However, it's crucial to provide insights into the model's decision-making process. Techniques such as Grad-CAM (Gradient-weighted Class Activation Mapping) can highlight regions of an image that contributed most to the model's diagnosis, helping healthcare professionals understand and trust the model's recommendations. That's the reason why it's critical to approach this classification with diligence, ensuring rigorous validation and adherence to medical standards and regulations.

The other widespread image classification usage is known to most drivers around the world. It's cars license plate recognition. The main reason of this task to automate tolls or fines payments. This CNN problem is a direct successor of the classic task of recognizing handwritten digits firstly proposed by Y. LeCun and his colleagues.

However, classifying car license plates presents a multifaceted challenge due to the varied plate designs, fluctuating lighting conditions, and potential issues like blur, noise, and character occlusion. License plates may contain diverse characters, languages, or alphabets, necessitating a comprehensive and diverse training dataset. Real-time processing requirements in applications like toll collection demand both speed and accuracy. Moreover, privacy and ethical concerns loom large, demanding compliance with regulations and responsible data handling. Addressing these challenges often involves a combination of data preprocessing techniques, robust CNN architectures, post-processing algorithms, and careful system integration.

Among the most popular classification tasks, the classifying human emotions problem is a common one. It serves diverse purposes across various domains. For example, this task enhances human-computer interaction by enabling empathetic responses in virtual assistants and gaming. In market research, it helps businesses analyze consumers' emotional responses to products and advertisements. Education benefits from tracking students' emotional engagement to improve teaching methods. The entertainment industry leverages emotion recognition for personalized content and recommendations.

Despite its potential, emotions are highly subjective and context-dependent, making accurate recognition complex. Subtle expressions and cultural variations further complicate the task. Additionally, high-quality, labeled datasets are crucial but resource-intensive to create. Privacy concerns arise when analyzing sensitive emotional data, emphasizing the need for ethical and responsible practices. Yet the significance of emotion recognition in enhancing user experiences, decision-making, and personalization cannot be ignored.

In conclusion, the analysis of existing image classification problems using Convolutional Neural Networks (CNNs) underscores the transformative impact of deep learning in the field of computer vision. While these networks have demonstrated remarkable strengths in automating image classification, they also face the nuances of real-world challenges, ranging from variable lighting conditions to cultural variations in image content. Nevertheless, the constant evolution of CNN architectures, coupled with ongoing research in data collection and model interpretability, holds the promise of further expanding the boundaries of image classification in domains as varied as healthcare, security, and entertainment.

### **References:**

1. LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. *Nature*, 521(7553), 436-444.
2. Bishop, C. M. (1995). *Neural networks for pattern recognition*. Oxford university press.
3. De Marchi, L., & Mitchell, L. (2019). *Hands-On Neural Networks: Learn how to build and train your first neural network model using Python*. Packt Publishing Ltd.
4. Krizhevsky, A., Sutskever, I. & Hinton, G. E. (2012). Imagenet classification with deep convolutional neural networks, *Adv. Neural Inf. Process. Syst.*, pp. 1097-1105.

5. Sarvamangala, D. R., & Kulkarni, R. V. (2022). Convolutional neural networks in medical image understanding: a survey. *Evolutionary intelligence*, 15(1), 1-22.

6. Cun, Y. Le et al. (1990). Handwritten digit recognition with a back-propagation network, *Adv. Neural Inf. Process. Syst.*, pp. 396-404.

7. Shivakumara, P., Tang, D., Asadzadehkaljahi, M., Lu, T., Pal, U., & Hossein Anisi, M. (2018). CNN-RNN based method for license plate recognition. *CAAI Transactions on Intelligence Technology*, 3(3), 169-175.

8. Гороховатський В., Творошенко І., Сидоренко Д. (2021) Класифікація зображень із використанням кластерного подання, Міжнародний науковий симпозиум «Інтелектуальні рішення-С». Обчислювальний інтелект (результати, проблеми, перспективи). Теорія прийняття рішень: праці міжн. наук. симпозиуму (Вересень 29, 2021). Київ – Ужгород, С. 44-45.

9. Gorokhovatskyi V., Gadetska S., Ponomarenko R. (2020) Recognition of Visual Objects Based on Statistical Distributions for Blocks of Structural Description of Image. Proc. of the XV Int. Scientific Conference “Intellectual Systems of Decision Making and Problems of Computational Intelligence” (ISDMCI’2019), Ukraine, May 21–25, 2019, pp. 501-512.

10. Tvoroshenko, I., & Zarivchatskyi, R. (2020). Analysis of existing methods for searching object in the video stream.

11. Daradkeh, Y. I., Gorokhovatskyi, V., Tvoroshenko, I., & Zeghid, M. (2022). Tools for fast metric data search in structural methods for image classification. *IEEE Access*, 10, pp. 124738-124746.

12. Творошенко, І. С. (2018). Особливості застосування сучасних принципів штучного інтелекту до розробки ефективних механізмів моделювання складних систем. *Science and Technology of the Present Time: Priority Development Directions of Ukraine and Poland*, С. 118-121.

13. Gorokhovatskyi, V., Tvoroshenko, I., Kobylin, O., Vlasenko, N. (2023) Search for Visual Objects by Request in the Form of a Cluster Representation for the Structural Image Description. *Advances in Electrical and Electronic Engineering*, 21(1), pp. 19-27.

14. Pomazan V., Tvoroshenko I., and Gorokhovatskyi V. (2023) Development of an application for recognizing emotions using convolutional neural networks, *International Journal of Academic Information Systems Research*, 7(7), pp. 25-36.

15. Gorokhovatskyi, V., Peredrii, O., Tvoroshenko, I., Markov, T. (2023) Матриця відстаней для множини компонентів структурного опису як інструмент для створення класифікатора зображень. *Advanced Information Systems*, 7(1), С. 5-13.