About Neural Networking of Avatar-Based Modeling as an Intellectual Tool and Technology for Biomedical Study in Bioinformatics

Vsevolod Chernyshenko, Financial University under the Government of the Russian Federation, Moscow, Russian Federation

ABSTRACT

The article is devoted to the problem of an analytical analysis of neural networks with avatar-based modelling as an intellectual tool and technology for biomedical study in bioinformatics. This is with the use of convolutional and generative neural networks, as well as reinforcement training. An algorithm for predicting future moments of trend change under concrete market conditions based on a generative adversarial networks was developed. Special software was designed that realizes algorithms for predicting the future of study conditions changes, based on the mentioned above algorithms.

KEYWORDS

Avatar-Based, Bioinformatics, Biomedical Study, Intellectual Tool, Modelling, Neural Network, Technology

INTRODUCTION

Quality of multi-avatar (avatar-based) systems depends not only on an algorithm, which define behaviour of their constituent avatars, but also on nature of the interaction between the avatars. In modern intelligent systems, the avatars almost always are based on neural natural networks that allow them to learn. Nether less, the problem of creating special conditions for the functioning of the avatars, aimed at stimulating their learning, are rarely considered. Usually the avatars are designed to act independently in conditions, when the possibility of their cooperative self-learning (for example, by a mutual exchange of semantic information - “exchange of experience”) is not foreseen.

In this regard, populations of computer avatars (avatars) are still inferior to teams of human experts, operating in a certain social environment and interacting each other in many ways. In particular, this situation concerns a modelling of economic and financial processes, when the study of trends is extremely challenging for the reason of chaotic nature of indicators’ dynamics. Using avatar population not only for reflecting a structure of groups of real actors in the financial market, but also as an expert population with its own special internal structure, is promising being able to significantly increase predictive power of the multi-avatar model.

One of features of the classical intellectual feed forward neural natural networks (when avatars are considered as separate learning units) is that being universal classifiers, they are unable to generate

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sample data sets belonging to recognisable classes of objects. Deep multilayer perceptrons, for example, are capable to highlight fairly high-level features of images, which allow them to implement complex classification of images, that the network did not see at the training stage. In the same time, generating an image, that the network did not see during its training, is a task of another level. The generative models are aimed to solve it; in particular, it corresponds to the generative adversary natural networks, which have become very popular last years (Palazzo et al. 2018; Arakaki et al., 2018; Karras et al., 2017; Arora et al., 2017; Arjovsky, Bottou et al., 2017).

Neural generative-competitive network (Goodfellow et al., 2014) is a technology that is inherently focused on the interaction of the network with some parallel process, which can be neural network of another avatar. In this paper, results of a few numerical experiments with such “binary” avatars, using generative-competitive natural networks, are presented. The data obtained confirm the assumption that results of the work of a group of avatars exceed the simple sum of their individual contributions.

BACKGROUND

The idea of generative-adversarial natural networks (GANs) was proposed by J. Goodfellow of the University of Montreal (Goodfellow et al., 2014). During literally a couple of years, this method has found its application in the tasks of semantic image segmentation, medical information analysis, material recognition, time series analysis (Luc et al., 2016; Che et al., 2017; Erickson et al., 2017; Esteban et al., 2017; Chen et al., 2016; Hinton & Salakhutdinov, 2006; Mescheder et al., 2017; Dumoulin et al., 2016; Donahue et al., 2016; Li et al., 2017; Reed et al., 2016; Isola et al., 2016; Ledig et al., 2016; Ren et al., 2015; Lee et al., 2016).

The main idea of the generative adversarial natural networks is to train two natural networks (a generator and a discriminator) simultaneously. The generator accepts a random vector as an input (a source of entropy; sometimes it is interpreted as a one belonging to a “space of hidden variables” or “latent space”) and generates a certain image. An intellectual image, created by the generator, or an object of a real training sample is forwarded as an input of the discriminator. The last one is to distinguish the intellectual image from the real one. In theory, during the learning process, the generator learns a stochastic distribution of the original sample and begins to generate images more and more comparable to the real ones. Discriminator in its turn becomes more and more accurate in recognition of the input images.

GAN is not the first generative model; however, Goodfellow and co-authors proposed an original method of competitive training for such models, when two natural networks “compete” in solving opposite tasks.

Researchers identify several variations of the original idea of generative-adversarial natural networks:

1. **Fully connected GAN**: First proposed architecture, where the generator and discriminator are multi-layered feedforward natural networks (Creswell et al., 2018; Jost, 2018; van den Oord, Bethge, 2015);

2. **Convolutional GAN (deep convolutional GAN, DCGAN)**: Based on multilayer convolutional natural networks. They are a logical evolution of the GAN idea applied to image synthesis tasks. The disadvantage of convolutional generative adversarial natural networks is a rather long-term learning process (Radford et al., 2015);

3. **Conditional GAN (CGAN)**: An algorithm where both a generator and a discriminator have an additional input that is a vector indicating the class of the object. Such natural networks can generate a conditional sample distribution, with an indication of a particular class. Thus, they are used for modelling of multimodal distributions (Mirza et al., 2014);
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