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BIG DATA, CONNECTIONISM AND SERVICE PERSONALIZATION

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Abstract: *During the last 5 years it becomes increasingly obvious, that information has become a crucial component of competitive differentiation. Companies started to optimize algorithms for search technologies using therefore Big Data processing and machine learning, to improve search results for a specific terms or items. They started to understand that those techniques can be also used for personalization purposes. Based on historical data models it is possible to generate statistical models to personalize the results for individual users. Accurate data-driven models become a key success factor to achieve effective business decision making. Companies especially, have discovered benefits of using Big Data for personalized marketing campaigns to better reach customers. This paper will give insights into Big Databased personalisation, the role and function of prediction algorithms and will present case studies concerning big data-driven business.*

Key Words: ***Big Data, Personalization, Artificial Neuronal Networks, AI, Predictions, Connectionism***

1. INTRODUCTION

Are we really helping somebody with personalization? Or do we restrict the resourcefulness and creativity of the persons with the use of personalization possibilities? No matter what the answer is, we are today in the middle of the personalization era, which becomes reinforced by the coming up of the Big Data era. Nowadays it is not very complicated to find out a user's location, past history or job title, etc. supplying her or him with documents or advertisements that were based on personalization factors. Comparing the state of the art of the personalization ten years ago with the current status, we can, thanks to the Big Data availability, state the things in regard of personalisation have been changed dramatically. Based on the historical development over the last decade, we are able to relying on [1, 2, p. 24] the four different trends:

1. Google sets the trends. It means that whatever Google does, the rest of the search world follows.
2. Consumers are nowadays designing personalized results into their consumer interfaces. "Personalization is becoming a requirement".
3. Budget/spending change for personalization increases.
4. With the help of Big Data, results of the personalization and optimization of the statistically valid processes are improving. The creation of valid and confidential mathematical models that improve the user's experience and deliver positive returns of investment are now possible.
5. Creation of predictive and own relevancy models, putting those directly into the search engine (with custom search operators) is possible. Such results, served from the engine, are robotically sorted by probability of relevancy. While not obtainable in all devices, these relevancy models have become gradually more influential and refined.

No longer are they modest ADD, SUB, MUL, DIV, MOD etc. operators, known by assembler. Also the functions are not based on relatively simple functions as term frequency or inverse document frequency measures, whereby they are used in so called information retrieval for the judgement of the relevance of terms in in documents of a document collection, as a base for the weighting of a word with regard to the document. Now we have to deal with different sorts of mathematical functions, including the so called vector comparisons. With it we enter the stage of personalized examination, Big Data based and so called matching engines, as the essential software and hardware element of an electronic exchange. According to [3] it matches up offers and bargains to wide-ranging trades. Such engines use one or several algorithms to assign trades among opposing bids and bargains at the identical rate.

In the following, the different prediction algorithms and their functions will be explained, as well as the new models used in the Big Databased personalization.

2. PREDICTIONS AND ALGORITHMS BASED ON MACHINE LEARNING

Besides, origins and areas of application of the artificial intelligence (AI), representation procedures and searching procedures of the AI as well as advanced problem solutions AI as i.e. with PROLOG and LISP, the AI also describes bases and advanced problems of the symbolic-based, connectionism based and social-

emergent machine learning [4]. The basic component of the AI is the biologically inspired artificial creation of the main components of the human brain, so called artificial neurons, or networks of such artificial neurons, so called artificial neuronal networks (ANN). A good insight into the bases of ANN, but also descriptions of complicated mathematical connections of the connectionist expert systems and neuro-fuzzy systems is given by [5]. The use of ANN started to increase at the end of the 80's as the first solutions to, until unsolved problems, based on ANN have been presented. The inventory of the research relevant primary, secondary and tertiary literature, shows that the subject of ANN plays still a colossal role in various areas oriented to the research and application oriented areas of the technology, as wells as in various other non-technological areas [6]. The range of application and area of application for ANN is striking. Previously, started with the ANN based AI solutions to the technical clarification as for example credit card deception, forecasts on stock markets, OCR, state of health supervision and state of health diagnosis, recently optimised ANN based AI solution become used for the determination of behaviour patterns of people, and prediction of their purchase decisions.

2.1. Formats of the Simple Machine Learning

According to [4, 7] machine learning can be classified into the three different groups: symbol based, social and emergent and connectionist machine learning. A central aspect of the symbolic-based learning beginning exists in the application of symbols for the designation of the objects and relations of the domain. Social and emergent learning models of the machine learning are inspired by the evaluation of the basic processes, trying to reproduce them. However, connectionist models reject the explicit application of symbols for the problem solutions and orientate themselves to the biological model. Namely, they state that intelligence arises from systems of easy, interacting components (biological or artificial neurons) by a process of the learning or the adaptation, by which the connections and their weightings are changed between the components of the artificial neuronal networks, the neurons. Such an ANN is above all the other tools used to solve problems; that is, to find optimum solutions for problems that have already appeared in the past or have appeared only in similar form. Simply put, ANN is build up as presented in the following figure:

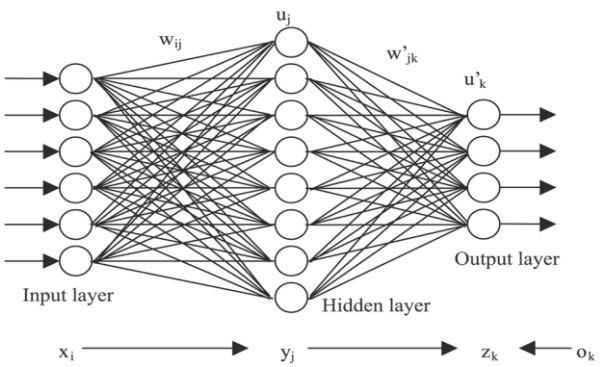

Fig. 1. *Basic construction of the simple feed-forward ANN, Source [17]*

This means that based on experience values, such an ANN has to be able to classify problems of similar format correctly and to solve them. An example is can be represented through an ANN, with the help of certain input data (typical variables) as for instance atmospheric pressure change, wind force change and solar irradiation, to forecast the precipitation probability. In the case of feed-forward ANN, the signal propagation takes place, outgoing from the input neurons, over the concealed (hidden) neurons up to the output neurons in which the data spent by the ANN become afterwards processed to the output or can be passed to the "down-streamed technical system, and be evaluated there" [8, p.144]. To understand the function of the optimized ANN, we but want to state, that optimal function of the ANN is only given, of the certain amount of the input data (typical input variables) and the expected output variables, must be obtainable successfully to train (learn) the ANN to work appropriately. In the past, those input and output data, have been a huge problem in the machine learning, leading to the development of the sub-optimal solutions, which have been able to solve some problems, but not to solve general problems. The term "generalisation" (generalisation ability) of the ANN is understood as the process to exemplarily the data; with those, the ANN was not trained. Generalization is known as probably the most essential quality measure of artificial neural networks.

2.2. Basics of Predictions

How to predict the state, based on previous or current information? Neural networks own considerable degrees of freedom in the modelling, which permit a problem and data specific configuration of its architecture in varied applications of unsupervised and supervised, homo-associative as well as hetero-associative learning tasks. Also Multilayer Perceptron (MLP) permits the modelling of dynamic explanation and forecast models as a hetero-associative learning task of the causal-analytic or time-analytic regression.[11, p. 226]. The hetero-associative teaching model is the MLP based model, with which the number of neurons must not be the same in the input and output layer and with which the adjustment of the connecting weights occurs between the units as well as their threshold, in order to train a desirable behaviour of the system. The modelling of ANN for the predictions of time series is based on the forecast of an endogenous variable from the time wise delayed realization of the same variables out of the preliminary moments. According to [12] a Multilayer Perceptron model analogue with a non-linear autoregressive $AR(p)$ model, and the number of the autoregressive terms is equal to the number of the input units, and the number of the endogenous variables is equal to the number of output units correspondently. In the sense of the time series analysis, an autoregressive $AR(p)$ model of the order p of a regression corresponds by using of of p time-delayed realizations of the endogenous variables [11]. The basic principle of the simplest model of a Multilayer Perceptron to time-analytic one step predictions is presented in the following figure.

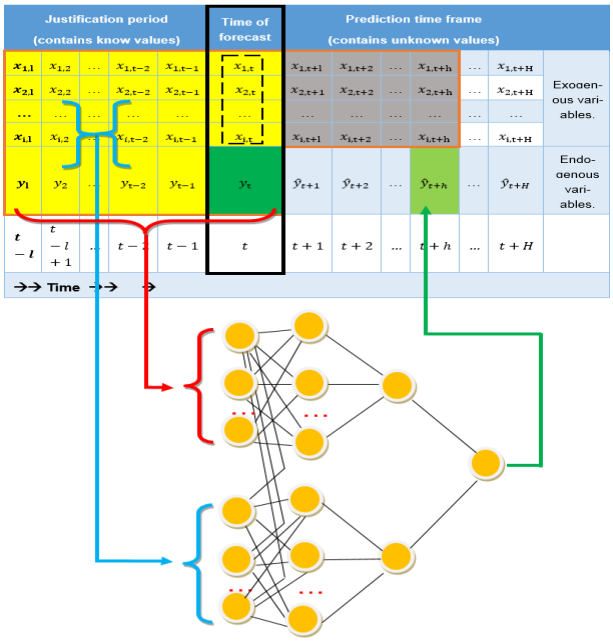

Fig. 2. *Time-analytic ANN based one step predictions, Source [6]*

Behind the simple one-step prediction model, there are existing more-step prediction models, decision-analytic models and causal-dynamic models. For more details about those models we refer to [6, 11]. For the personalization purposes, the causal-dynamic models are of great importance.

3. PAST ANN VS. NEW ANN BASED PROCESS OF PERSONALIZATION

What is the main difference between the previous and new prediction models, which can be used for personalization purposes? The big difference is the amount of data available today and the higher possibilities for calculation of the prediction algorithms, because of the better computing power. According to [1] there are two steps towards implementing personalization, based on big data:

1. Step 1: Use Past Data to Generate Statistical Models
2. Step 2: Implement Personalization

Looking on the previous described time-analytic model, it means that the proceeding principle is almost the same. It means that the following steps for the personalization are necessary:

1. Gather previous user's data
2. Make data usable for statistic modelling (conversion)
3. Use machine-learning principles to create valid statistical prediction models
4. Combine the statistical prediction models with the (internet) search intention of the user
5. Provide personalized results

The difference with the Big Data and without it is that the amount of input and output variables in the machine learning model, based on ANN, is much bigger, compared to the realizations made 20-30 years ago. Therefore, not only simple single-dimensional scalars, or instance salary, age, number of items purchased by user etc. as an input variable, are obtainable for training of the ANN, but also complex, multi-dimensional scalars, like activity from external sources as social media, public information, pages viewed, items viewed, office location of the user etc. With such data, much more exact causal-dynamic prediction models can be created, so that exact personalization of the offer can be easily made. How exactly this can be made is well described, by so called TensorFlow, an open source machine-learning framework [13]. Especially, we refer to the function of co called convolutional ANN, which use mathematical principles of the functional analysis, for creation of the functions based on two or more different functions [14].

4. SOME PRACTICAL IMPLICATIONS IN PERSONALISATION

There are many practical implications of the machine learning based personalization and resulting developments. Some of them are:

4.1 Scalable Marketing Campaigns and Web Personalization

Many brands are generating personalized online content to better influence their clienteles. It would not be attainable without recent developments in Big Data analytics. As stated in [16] "One recent poll found that nine out of ten marketers believe that personalization is the future. This should come as no surprise, because 48% of customers spend more with brands that deliver a personalized web experience. Nearly 80% of customers state that they will share their personal data with a brand that promises a more personalized mobile experience."

4.2 "No-Internet search" Search

Over time, we have gone from inquiries with hundreds of characters down to inquiries with just a few characters. It is possible because of the implementation of the machine-learning based so-called ranking by relevancy. According to [1] it is done in two procedural steps:

1. Gathering input variables (user's data) from other sources (other than the internet search box).
2. Creating a truly functional algorithm used to deliver ranking by relevancy, based on big data and resulting personalization.

In this way, it is possible to provide search results without any search at all. This is how we get down today to doing internet searches without inquiries. Nowadays, users no longer enter internet inquiries at all. As an alternative, the machine merely ranks the complete database, with every sole file in it for the user, and gives them the desirable results.

5. CONCLUSION

In this paper, we have presented the principles of the intelligent forecasting based on machine leaning solutions. The core element of the connectionist machine learning principles, the artificial neuronal network has been presented, as well as the importance of the

obtainable data for the training purposes of such artificial neuronal networks have been highlighted. We explained the past ANN compared with new ANN based Process of Personalization and implications of Big Data on it. Future work will be oriented towards the influence of the big data-based personalisation on the resourcefulness and creativity of the users. This will raise the following question that needs to be carefully considered: Are we really helping somebody with personalization?

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