

MACHINE LEARNING TECHNOLOGY OVERVIEW IN TERMS OF DIGITAL MARKETING AND PERSONALIZATION

Anna Nikolajeva
Artis Teilans
Faculty of Engineering
Rezekne Academy of Technologies
Atbrivosanas aleja 115, Rezekne LV-4601, Latvia
E-mail: ann@gmz.lv

KEYWORDS

Machine learning, artificial intelligence, digital marketing, personalization.

ABSTRACT

The research is dedicated to artificial intelligence technology usage in digital marketing personalization. The doctoral theses will aim to create a machine learning algorithm that will increase sales by personalized marketing in electronic commerce website. Machine learning algorithms can be used to find the unobservable probability density function in density estimation problems. Learning algorithms learn on their own based on previous experience and generate their sequences of learning experiences, to acquire new skills through self-guided exploration and social interaction with humans. An entirely personalized advertising experience can be a reality in the nearby future using learning algorithms with training data and new behaviour patterns appearance using unsupervised learning algorithms. Artificial intelligence technology will create website specific adverts in all sales funnels individually.

INTRODUCTION

Personalization is the process of adjusting the website to individual users characteristics or preferences. Use to strengthen customer service and e-commerce sales. The website is customized to target each consumer. Personalization means meeting the customers needs more effectively and efficiently, making interactions faster and easier and, consequently, increasing customer satisfaction and the probability of repeat visits (Rouse 2007). There are several personalization software products available, including "Broadvision", "OptinMonster", "Monetate" and others.

Retargeting campaigns are advertising that can change in real-time based on user behaviour on the insights gathered from the data. Personalization improves clicks to the top position by 3.5% and reduces the average error in the rank of a click by 9.43% over the baseline (Yoganarasimhan 2019). A survey of 200 marketing leaders by "Forbes Insights" and "Arm Treasure Data" reveals that personalization is giving positive results. Two in five executives 40% report that their customer personalization efforts have had a direct impact on

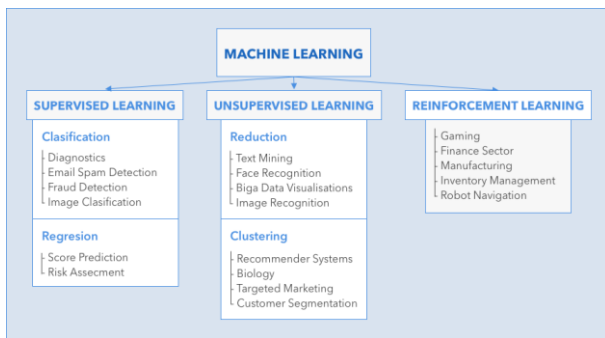
maximizing sales, basket size, and profits indirect channels. Another 37% pointed to increased sales and customer lifetime value through product or content recommendations. More than one-third of respondents have seen an increase in their transaction frequency as result of personalization strategy (Forbes Insights and Arm Treasure Data 2020).

Digital marketing is a form of marketing that focuses on marketing activities in the digital environment, meaning several key activity platforms - email marketing, web browser marketing, social network marketing, smartphone marketing. Each of these platforms uses different channels and technologies to reach its target market. At the heart of digital marketing is the classic marketing need to segment and reach potential or existing customers with a marketing message to drive sales of products or services (Yannopoulos 2011).

Machine learning is the scientific study of algorithms and statistical models that computer systems use to perform a specific task without using explicit instructions, relying on patterns and inference. It is a subset of artificial intelligence. Machine learning algorithms build a mathematical model based on sample data, known as "training data", to make predictions or decisions without being explicitly programmed to perform the task (Bishop 2006).

Machine learning tasks classified into several broad categories. In supervised learning, the algorithm builds a mathematical model from a set of data that contains both the inputs and the desired outputs. Classification algorithms and regression algorithms are types of supervised learning (Cheeseman et al. 1996). Classification algorithms use when the outputs are restricted to a limited set of values. For a classification algorithm that filters emails, the input would be an incoming email, and the output would be the name of the folder in which to file the email. For an algorithm that identifies spam emails, the output would be the prediction of either "spam" or "not spam", represented by the Boolean values true and false. Regression algorithms are named for their continuous outputs, meaning they may have any value within a range. Examples of a continuous value are the temperature, length, or price of an object (Ryan et al. 2015). Semi-supervised learning algorithms develop mathematical models from incomplete training data, where a portion of the sample input doesn't have labels (Zander et al.

2005). In unsupervised learning, the algorithm builds a mathematical model from a set of data that contains only inputs and no desired output labels. Unsupervised learning algorithms are used to find structure in the data, like grouping or clustering of data points. Unsupervised learning can discover patterns in the data, and can group the inputs into categories, as in feature learning. Dimensionality reduction is the process of reducing the number of "features", or inputs, in a set of data (Sugiyama 2016).



Figures 1: Machine learning classification

Active learning algorithms access the desired outputs for a limited set of inputs based on a budget and optimize the choice of inputs for which it will acquire training labels. When used interactively, these can be presented to a human user for labelling. Reinforcement learning algorithms are given feedback in the form of positive or negative reinforcement in a dynamic environment and are used in autonomous vehicles or in learning to play a game against a human opponent (Cohn et al. 1996). Other specialized algorithms in machine learning include topic modelling, where the computer program is given a set of natural language documents and finds other documents that cover similar topics. Machine learning algorithms can be used to find the unobservable probability density function in density estimation problems. Meta-learning algorithms learn their own inductive bias based on previous experience. In developmental robotics, robot learning algorithms generate their sequences of learning experiences, also known as a curriculum, to cumulatively acquire new skills through self-guided exploration and social interaction with humans (Hochreiter and Schmidhuber 1997).

Research tasks:

1. Explore machine learning technologies
2. What machine learning technologies can be used to personalize adverts

Research object: machine learning technologies.

The subject of research: machine learning technologies

Research methods: synthesis method, analysis method.

Theoretical background: Theoretical literature of foreign authors, materials published in

Internet resources, scientific articles of foreign authors, statistical data, and author personal experience were used in the work.

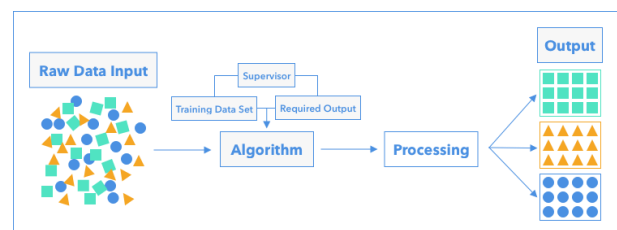
The empirical basis of the research: Worldwide

Study period: June 2019 – November 2020.

Machine learning in economics is still a new subject. Although machine learning is slowly gaining interest among economists, still we see a lack of information. What exactly machine learning entails, what makes it different from classical econometrics and, finally, how economists and businesses along with them can make the best use of it (Athey 2019). There are studies, where it is possible to see that data-driven and machine learning prediction in economics is happening. The study was training on 14 years of data, neural networks produce accurate 50-year forecasts. Gaps in these forecasts may reveal macroeconomic regime changes. Failures in otherwise accurate neural network forecasts may thus inform theoretical economic hypotheses through unsupervised machine learning (Chen 2020).

SUPERVISED LEARNING

Supervised learning algorithms include classification and regression. The classification problem is when the output variable is a category, such as "red" or "blue" or "disease" and "no disease". A classification model tries to draw some conclusions from observed values. Given one or more inputs a classification model will try to predict the value of one or more outcomes. Classification models include logistic regression, decision tree, random forest, gradient-boosted tree, multilayer perceptron. Used in fraud detection, email spam detection, diagnostics, image classification. For example, "Yelp" uses machine learning to organize images in the right categories. "American Express" processes \$1 trillion in a transaction and has 110 million cards in operation. They rely heavily on data analytics and machine learning algorithms to help detect fraud in near real-time, therefore saving millions in losses. Additionally, "American Express" is leveraging its data flows to develop apps that can connect a cardholder with products or services and special offers (Marr 2018).



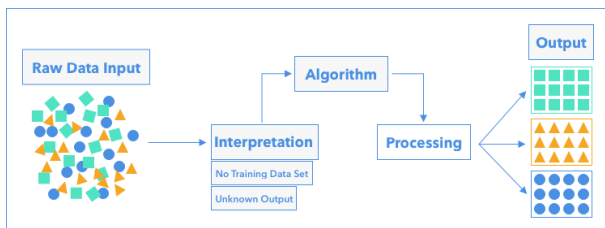
Figures 2: Machine learning classification: Supervised learning

A regression difficulty is when the output variable is a real or constant value, such as "salary" or "weight". Many different models can be used, the simplest is the

linear regression. It tries to fit data with the best possible points which go through the points. Used in risk assessment, score prediction. The difference between tasks is the fact that the conditional attribute is numerical for regression and categorical for classification (Weiss and Provost 2001). John Deere is getting data-driven analytical tools and automation into the hands of farmers. Advanced machine learning algorithms allow robots to make decisions based on visual data about whether or not a plant is a pest to treat it with a pesticide. The company already offers automated farm vehicles with pinpoint-accurate GPS systems and its Farmsight system is designed to help agricultural decision-making. Cars are increasingly connected and generate data that can be used in a number of ways. Volvo uses data to help predict when parts would fail or when vehicles need servicing, uphold its impressive safety record by monitoring vehicle performance during hazardous situations and to improve driver and passenger convenience (Marr 2018).

UNSUPERVISED LEARNING

Unsupervised learning algorithms combine clustering the task of grouping a set of objects in such a way that objects in the same group are more similar to each other than to those in other groups. It is the main task of exploratory data mining, and a common technique for statistical data analysis, used in many fields, including pattern recognition, image analysis, information retrieval, bioinformatics, data compression, and targeted marketing (Jain and Dubes 1988). The reduction is mainly used for text mining, face recognition, big data visualizations, image recognition. The North Face uses machine learning to help shoppers find the best outdoor recreation product. Starbucks uses machine learning to recommend drinks thru its app (Bhattacharya 2019).



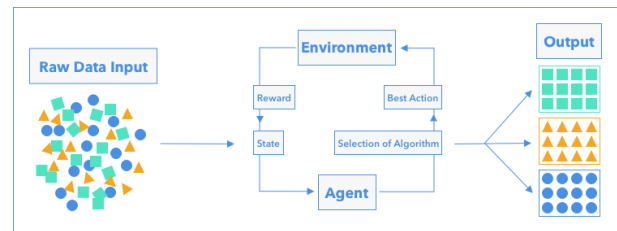
Figures 3: Machine learning classification: Unsupervised learning

Coca-Cola's global market makes it a large beverage company in the world prospect. The company creates a lot of data, but it has also embraced new technology and puts that data into practice to support new product development, capitalize on artificial intelligence bots and even trial augmented reality in bottling plants (Marr 2018).

REINFORCEMENT LEARNING

Reinforcement learning is an area of machine learning concerned with how program ought to take actions in an

environment to maximize some notion of cumulative reward. Due to its generality, the field is studied in many other disciplines, such as game theory, control theory, operations research, information theory, simulation-based optimization, multi-agent systems, swarm intelligence, statistics, and genetic algorithms. Many reinforcement learning algorithms use dynamic programming techniques. Reinforcement learning algorithms are used in autonomous vehicles, gaming, finance sector, manufacturing, inventory management, robot navigation (Qi and Davidson 2009).



Figures 4: Machine learning classification: Reinforcement learning

Bonsai, recently acquired by Microsoft, offers a reinforcement learning solution to automate and build intelligence into complex and dynamic systems in heating, ventilation, and air conditioning technology of indoor and vehicular environmental comfort, energy manufacturing, automotive and supply chains. The first application in which reinforcement learning gained fame was when AlphaGo, a machine learning algorithm, won against one of the world's best human players in the game Go. Now reinforcement learning is used to compete in all kinds of games (Marr 2018). Reinforcement learning is good for navigating complex environments. It can handle the need to balance certain requirements. Great example is Google's data centers. They used reinforcement learning to balance the need to satisfy our power requirements, but do it as efficiently as possible, cutting major costs (Marr 2018).

Semi-supervised learning falls between unsupervised learning and supervised learning. Many machine-learning researchers have found that unlabeled data, when used in combination with a small amount of labeled data, can produce a considerable improvement in learning accuracy (Kushmerick and Lau 2005).

ADVERTISING WITH MACHINE LEARNING

Self-learning as a machine learning was introduced along with a neural network capable of self-learning. It is learning with no external rewards and no external guides. The self-learning algorithm computes, in a crossbar fashion, both decisions about actions and emotions about consequence situations. It is a system with only one input, situations, and only one output, action. There is neither a separate reinforcement input or an information input from the environment. Exists in two environments, one is a behavioral environment where it behaves, and the other is a genetic

environment, wherefrom it initially and only once receives initial emotions about situations to be encountered in the behavioral environment (Braberman, D'Ippolito, Kramer, Sykes, Uchitel, 2015).

Association rule learning is a rule-based machine learning method for discovering relationships between variables in large databases. It is intended to identify strong rules discovered in databases. Rule-based machine learning is a general term for any machine learning method that identifies, learns, or evolves "rules" to store, manipulate or apply knowledge. The defining characteristic of a rule-based machine learning algorithm is the identification and utilization of a set of relational rules that collectively represent the knowledge captured by the system (Bernadó-Mansilla, Josep, Garrell-Guiu, 2003).

Personalized marketing is a method that utilizes consumer data to modify the user experience to address customers by name, present shoppers with tailored recommendations, and more. Mainly, this is targeted marketing at its most raw. Personalized marketing leverages consumer behavior to present buyers with customized offers (Chittaranjan, Blom, Gatica-Perez, 2013). Spotify has built within their platform daily personalized playlists, daily artist suggestions, and weekly recommendations based on your listening preferences. Customers can even rate the tracks on these playlists based on whether they enjoyed them or not. While this might not directly convert a lead into a sale, it does build brand loyalty and it provides a strong user experience (Perez, 2019). Burberry has been busy reinventing itself and use big data and machine learning to resist counterfeit products and improve sales and customer relationships. The company's strategy for increasing sales is to sustain deep, personal connections with its customers. They have reward and loyalty programs that create data to help them personalize the shopping experience for each customer. They are making the shopping experience at their brick-and-mortar stores just as innovative as an online experience (Marr & Co, 2019).

Marketing automation automatically manages multiple marketing campaigns across several channels. Marketing automation helps with lead generation, segmentation, lead nurturing, lead scoring, customer retention, and more. If it is done correctly, it will increase performance, segment database so users will become clients. For example, chatbots are a unique resource. Through a chatbot, it is quickly discoverable in what stage of the sales tunnel is a user navigating, tracking and analyzing the questions users ask. This allows sales teams to receive the most qualified leads possible. These attributes also can be related to new or returning visitor, temporal variations (time and day of week), channels (mobile and desktop), referral source (social media ad) (Kosinski, Stillwell, Graepel, 2013).

To completely personalize advertisements, it is very important to connect several sales tunnels. The author believes that the unsupervised machine learning algorithm should be used, with relatively large training

data. Training data will be collected using statistics, psychological properties, website-specific analytic data, and social media public data. The data amount and specifics will be different depending on websites. The data set will be very large, but it will be helpful, also not only for personalization but also for new pastern appearance. It is unquestionably, that after some amount of time machine learning algorithms will create its patters. The new patterns will be used for a more personalized experience in e-commerce, where consumers will be able to get what they want in relatively fast and entrepreneurs will be able to get most of the profit without any harm to their customers.

Performance optimization is one of the most valuable use cases for machine learning in advertising. Machine learning algorithms are used in commercial solutions to analyze ad performance across specific platforms and recommendations on how to improve performance. In the most exceptional cases, machine learning algorithms can automatically manage ad performance and spend optimization, obtaining decisions entirely on their own regarding whence best to reach advertising KPIs and recommending a fully optimized budget. An example is Google Ads it is possible to use advanced machine learning algorithms in PPC (pay-per-click) campaigns. In bidding, machine learning algorithms train on data at a vast scale to help make more accurate predictions across your account about how different bid amounts might impact conversions or conversion value. These algorithms use a wider range of parameters that impact performance than a single person or team could compute. Bid adjustments allow showing ads more or less frequently based on where, when, and how people search. For example, sometimes a click is worth more than usual if it comes from a smartphone, at a certain time, or from a specific location.

Click fraud is a challenging issue in advertising because it can negatively impact ad budget and harm the integrity of the online advertising market. To detect click fraud, an ensemble learning-based approach is proposed. Click fraud can damage an advertiser's return on investment significantly. It was found that 30% of ad revenue is wasted on click frauds (Choi, Lim, 2020).

Behavioral targeting is used to select the most relevant advertisements for consumers and is based on historical user behavior, such as identifying clicked links, pages visited, searches, earlier purchases from the users browsing history (Choi, Lim, 2020). With the popularity of search engines, such as Google, online searches and web browsing have become two of the most common online behaviours. Web browsing behaviour helps advertisers make assumptions regarding user interests and to define potential audience segments. User online behaviour strengthens the relevance and personalization of advertising messages to wanted consumers. User search queries also help conclude which ads should appear to the user by matching them to the advertiser's keywords.

CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis carried out in the research, the author's personal experience, the analyzes carried out and working on his doctoral thesis, the author came to the following conclusions and recommendations:

1. Machine learning algorithms build a mathematical model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to perform the task.
2. Supervised learning algorithms include classification and regression. Classification models include logistic regression, decision tree, random forest, gradient-boosted tree, multilayer perceptron. Used in fraud detection, email spam detection, diagnostics, image classification. Regression is used in risk assessment, score prediction.
3. Unsupervised learning algorithms combine clustering the task of grouping a set of objects in such a way that objects in the same group are more similar to each other than to those in other groups.
4. Reinforcement learning is an area of machine learning concerned with how program ought to take actions in an environment to maximize some notion of cumulative reward.
5. Semi-supervised learning falls between unsupervised learning and supervised learning. Many machine-learning researchers have found that unlabeled data, when used in combination with a small amount of labeled data, can produce a considerable improvement in learning accuracy (Kushmerick, Lau, 2005).
6. Self-learning as a machine learning was introduced along with a neural network capable of self-learning. It is learning with no external rewards and no external guides.
7. Many machine-learning researchers have found that unlabeled data, when used in combination with a small amount of labeled data, can produce a considerable improvement in learning accuracy.
8. Association rule learning is a rule-based machine learning method for discovering relationships between variables in large databases.
9. More detailed research should be perpetrated on artificial intelligence tool usage in digital marketing personalization.
10. The author recommends to research data types what can be possibly used in machine learning algorithm training.

Machine learning tasks are classified into several broad categories. In supervised learning, the algorithm builds a mathematical model from a set of data that contains both the inputs and the desired outputs. Unsupervised learning algorithms combine clustering the task of grouping a set of objects in such a way that objects in the same group are more similar to each other than to those in other groups. Reinforcement learning - how to program ought to take actions in an environment to maximize some notion of cumulative reward. Marketing automation automatically manages multiple marketing

campaigns across numerous channels. Marketing automation helps with lead generation, segmentation, lead training, lead scoring, customer retention, and more. If done correctly it will increase performance - user converts to clients. Personalization is the most essential thing in e-commerce, as people evaluate their time most. Money has value, but time nowadays is the most valuable thing as people learned to score their time and be productive in all things possible. People were always aimed to get what they want and as fast as possible. Using machine learning algorithms it is possible to create a personal shopping experience. It can be used not only for shopping but also for information. It is important to get relevant news or relevant sponsored adverts. Digitalization is happening now and that means that it is essential to establish new consumer's demands.

REFERENCES

- Athey, S. 2019. "The Economics of Artificial Intelligence: An Agenda". University of Chicago Press. USA. 507 – 547.
- Bernadó-Mansilla, E., and Josep, M., Garrell-Guiu. 2003. "Accuracy-based learning classifier systems: models, analysis and applications to classification tasks". *Evolutionary Computation*. Vol. 11 (No. 3) 209-238.
- Bishop, C., M. 2006. "Pattern Recognition and Machine Learning". *Springer. USA*. 10 - 50.
- Braberman, V, N, D'Ippolito, Kramer, J., Sykes, D., and Uchitel, S. 2015. "Morph: A reference architecture for configuration and behaviour self-adaptation". *International Workshop on Control Theory for Software Engineering. ACM*. 9-16.
- Chen, J., M. 2020. "Economic Forecasting With Autoregressive Methods and Neural Networks". *SSRN Electronic Journal*. 2 – 40.
- Cheeseman, P., and Strutz, J. 1996. "Bayesian Classification: Theory and Results. In Advances in Knowledge Discovery and Data Mining". *AAI/MIT Press. USA*. 20 - 25.
- Choi, J. A., & Lim, K. (2020). Identifying machine learning techniques for classification of target advertising. In *ICT Express* (Vol. 6, Issue 3, pp. 175–180). Korean Institute of Communications Information Sciences. <https://doi.org/10.1016/j.icte.2020.04.012>.
- Cohn, D., A, Ghahramani, Z., Jordan, M. 1996. "Active learning with statistical models". *Journal of artificial intelligence research*. Vol. 4 (No. 1). 129-145.
- Chittaranjan, G., Blom, J., Gatica-Perez, D. 2013. "Mining large-scale smartphone data for personality studies". *Personal and Ubiquitous Computing*. Vol. 17 (No. 3). 433-45.
- Forbes Insights and Arm Treasure Data. 2020. "Obstacles to Personalization" <https://www.forbes.com/sites/insights-treasuredata/2019/05/01/the-path-to-personalization/>, viewed 06.04.2020.
- Hochreiter, S., and Schmidhuber, J. 1997. "Long short-term memory". *Neural Computation*. Volume 9 (No. 8). 100 - 288.
- Jain, A., K., and Dubes, R., C. 1988. "Algorithms for Clustering Data". *Prentice Hall, Englewood Cliffs. USA*. 40 -78.
- Kushmerick, N., and Lau, T. 2005. "Automated Email Activity Management: An Unsupervised Learning Approach". *IUI. California*. pp. 67-74.

- Kosinski, M., Stillwell, D., and Graepel, T. 2013. "Private traits and attributes are predictable from digital records of human behavior". *Proceedings of the National Academy of Sciences*. Vol. 110 (No. 15).
- Marr, B. 2018. "27 Incredible Examples Of AI And Machine Learning In Practice" <https://www.forbes.com/sites/bernardmarr/2018/04/30/27-incredible-examples-of-ai-and-machine-learning-in-practice/#475b95975022>, viewed 12.03.2020.
- Marr, B. 2018. "Artificial Intelligence: What Is Reinforcement Learning - A Simple Explanation & Practical Examples" <https://www.forbes.com/sites/bernardmarr/2018/09/28/artificial-intelligence-what-is-reinforcement-learning-a-simple-explanation-practical-examples/#4bf86d94139c>, viewed 12.03.2020.
- Marr, B. & Co. 2019. "Burberry: How Big Data and AI is driving success in the fashion world" <https://www.bernardmarr.com/default.asp?contentID=1282>, viewed 12.03.2020.
- Perez, S. 2019. "Spotify expands personalization to its programmed playlists" <https://techcrunch.com/2019/03/26/spotify-expands-personalization-to-its-programmed-playlists/>, viewed 06.04.2020.
- Qi, X., Davidson, and B., D. 2009. "Web page classification: Features and algorithms". *ACM Computing Surveys*. Vol. 41 (No. 2). 1-31.
- Rouse, M. 2007. Definition: personalization <https://searchcustomerexperience.techtarget.com/definition/personalization>, viewed 02.02.2020.
- Ryan, M., Talabis, R., Martin, J., L., and Kaye, D. (2015). Information Security Analytics Finding Security Insights, Patterns and Anomalies in Big Data. *Syngress. USA*. 1 - 12.
- Sugiyama, M. 2016. "Introduction to Statistical Machine Learning". *Morgan Kaufmann. USA*. 375-390.
- Weiss, G., M., and Provost, F. 2001. "The Effect of Class Distribution on Classifier Learning: An Empirical Study". *Rutgers University. USA. Researchgate Electronic Journal* https://www.researchgate.net/publication/2364670_The_Effect_of_Class_Distribution_on_Classifier_Learning_An_Empirical_Study#fullTextFileContent, viewed 12.01.2020.
- Yoganarasimhan, H. 2019. "Search Personalization Using Machine Learning". *Management Science*. Vol. 66 (No. 3). 1-5.
- Yannopoulos, P. 2011. "Impact of the Internet on Marketing Strategy Formulation". *International Journal of Business and Social Science*. Vol. 2 (No. 18). 1-7.
- Zander, S., Nguyen, T., and Armitage, G. 2005. "Automated Traffic Classification and Application Identification using Machine Learning". *LCN'05. Australia*. 1 - 2.
- Zheng, Y. 2019. "Reinforcement Learning and Video Games. University of Sheffield". 10-20 <https://arxiv.org/pdf/1909.04751.pdf>, viewed 06.04.2020.

AUTHOR BIOGRAPHIES

ANNA NIKOLAJEVA was born in Rezekne, Latvia and went to the Rezekne Academy of Technologies, where she studied information technologies and obtained her master degree in 2019. She works in the electronic commerce and digital marketing field last six years and recently started to work as a guest lecturer at Rezekne Academy of Technologies. Her e-mail address is : ann@gmz.lv

ARTIS TEILANS was born in Riga, Latvia and graduated the Riga Technical University, where he studied automatic and remote control and obtained his doctor degree in 1999. In academic field he is a professor and senior researcher at the Rezekne Academy of Technologies. His professional interests include techniques of system modeling and discrete-event simulation. His e-mail address is : artis.teilans@rta.lv