Sub-project 1: "Experimental development of emerging technologies in the field of referral systems (deep learning on big data) at the level of online social networks and the study of their impact at the level of users (AI Media)"

- Sumary 2019-

Activity 1-2-2 Achieving the methodology for testing and evaluating AI Media application modules

As part of this activity, a test plan was developed for the functions implemented in the AI Media application and presented their testing methodology.

To assess the reconnaissance efficiency of the services implemented in the AI Media application, the *F-score* measure was used to assess the accuracy of a test applied to an implemented recognition/classification system. The *F-score* calculation is based on two terms, precision *p* and recall *r*, in which *p* represents the number of correctly identified results divided by the number of results considered correct returned, and *r* represents the number of correctly identified results divided by the number of results that are actually correct.

For each of the images and videos uploaded to the AI Media app, the recognition service is applied and the actual time from the moment the service is released until the result is received is being retained.

Deliverable: *Study 1*

Activity 1-2-3: Conducting qualitative research to determine the functionality and utility problems of the platform

Increasing use of image location and social context recognition in social media posts provides companies that plan to use the AI Media platform with opportunities to post relevant content on each social network and induce personalization of distributed digital content. The research aims to identify and analyze feedback from potential users of the AI Media platform in terms of its geo-recognition capabilities and social context.

Through a comparative-qualitative analysis, marketers from the FutureWeb research team propose different causal configurations of the capabilities of the AI Media platform. Increase visibility through photos or videos associated with a brand on social media; Free advertising by labeling a location while social media users add an image containing a brand logo; incentives for those who associate images uploaded to social media the location where they were made; Richer behavioral data provided by social context recognition features associated with images posted on social media and harnessing location-based image recognition to predict consumer behaviour and improve services are analyzed as a history of intent to test the AI Media platform.

Deliverable: *Study 2*

Activity 1-2-4: The purpose of making improvement specifications for the AI Media application was aimed at identifying possible developments in the AI Media application. Thus, the purpose of the research was, inter alia, to identify those aspects of the recognition of logos which do not result in functions existing in the AI Media application.

These were highlighted in the chapter "Possible extensions in logo recognition". A chapter is dedicated to feeling analysis, which provides a more comprehensive view of the brand's audience as it could measure the brand's reputation, or track customer support performance. Another important chapter is dedicated to detecting the context of a post and identifying a functionality that would make AI Media continuously recognize the context through the sound of a posted video and provide a customizable trigger mechanism that takes action when a particular context is detected.

Deliverable: *Study 3*.

Activity 1-2-5: Development of the AI Media app: Developing a functional model of the AI Media app with 2 modules for recognizing brand or company logos in images posted on social media and media clips

The app for recognition of the logos of brands or companies in images posted on social media and media clips used CNN's convolutive neural networks. In the training stage of the neural network are necessary very large sets of images, very high time and high-performance computing systems. In the case of our application, bearing in mind

that we use a small set of images, training from scratch is not recommended. Thus was used the variant called transfer learning, i.e. a deep learning technique by which a previously developed neural network is trained for a new task. In this way we can use neural networks with extremely complex architectures, previously trained and made available to developers.

The performance of three types of neural networks were analyzed in this activity: *R-CNN*, *Fast R-CNN* and *Faster R-CNN*. The following data sets were chosen for testing, out of the 15 previously identified: BelgaLogos, FlickrLogos-27, Logos-32plus, QMUL-OpenLogo, TopLogo-10. Pre-trained networks identified in this study are the following: *alexnet, squeezenet, cifar10Net, densenet201,googlenet, inceptionresnetv2, inceptionv3, mobilenetv2, nasnetlarge, nasnetmobile, resnet101, resnet18, resnet50, shufflenet, vgg16, vgg19, xception*. Most of these pre-trained networks are trained on the basic subset of the dataset *ImageNet.* These networks have been trained on more than one million images and can classify images into 1000 categories of objects. For each of the three types of neural networks the convolutions *R-CNN, Fast R-CNN* and *Faster R-CNN*, performance was tested, thus resulting the data presented in the Tests section of ***Study 4***, attached to the report. Also in the *Conclusions* section of the same study are given some observations on the performance of neural networks considered.

Finally, in the Implementation section of the study conducted are given screenshots of the steps taken for the deployment and use of convolutive neural networks within the AI Media application, as well as the performance achieved. A significant result obtained is shown in Figure 1, where the recognition of Adidas' logo was made. Please note that the AI Media app is available at: http://195.34.77.2:12181.

Training a neural network requires a large number of annotated images, which is sometimes difficult to obtain. This was called for the construction of a data set from existing ones. This way you can increase the number of images per cluster and the number of clusters. The main problem that occurs is how to annotate images, each date set having its own style. Another aspect to consider is how images are organised. To overcome these impediments, all images were organized into a unitary structure and annotation files were organized in a specific format. Thus, within Activity 1-2-5 ***AI-Media Logo database*** was build. This database consists of 335 clusters/ logos and 27837 annotated images.

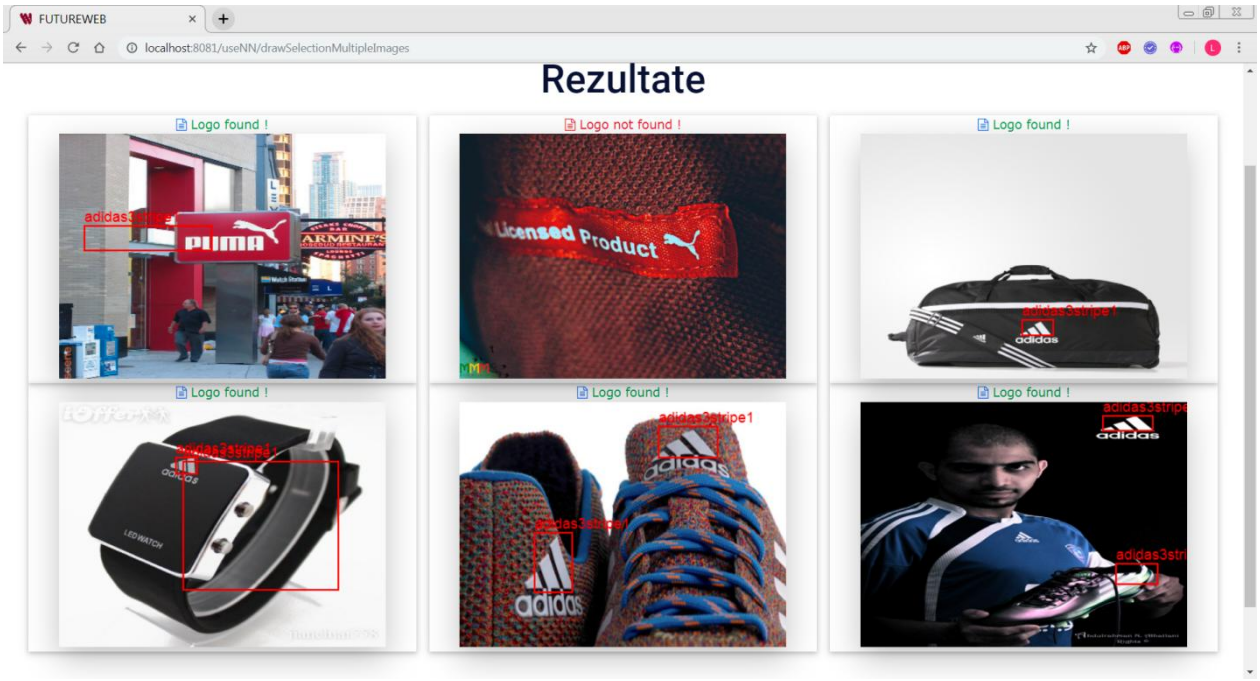

Figure 1: Recognition of Adidas' logo using convolutive neural networks

Deliverable: *Study 4*

Activity 1-3-1: Developing and implementing options and services (subsystems) for the AI Media platform: Developing the geo recognition service for the location where pictures were taken or for the media clips containing the logo of a brand or a company.

The GeoEstimate method was used to geo-recognize the location. Thus, location recognition in the photo using convolutive networks CNN addresses the division by geographic cells. The approach used in the study involves: a) deep networks that are trained separately with images from distinct scene categories; b) multi-task network with both geographical labels and scenes. The algorithm used treats the issue as a classification. Divide the planet into multiple *Ci* cells that contain a similar number of images, and assign a label to each image. The *ResNet152* network is used to assign image tags, with more than 16 million images trained in the model. In order to introduce the stage information, individual networks are built to recognise them.

The *MediaEval Placing Task 2016* dataset, which contains approximately 5 million geo-tag images, was used. Evaluation approaches are done on two sets of public reference data for geo localization estimation: the *Im2GPS* data set, which contains 237 photos, and the *Im2GPS3k* data set, which contains 3,000 images.

As additional methods of recognizing the geo location were used:

- *IP geolocation*: *GeoIP* is used, which is a way to find information about an IP address. Has the advantage that you can use the online API, which is up-to-date and does not require storage;
- *Metadate from pictures*: the process of adding geographic information to a photo is known as geotagging, with most smartphones include this function;
- *Checkin*: *Nominatim* is a tool for searching for *OSM* data by name and address and to generate synthetic addresses of *OSM* points.

In ***Study 5,*** attached to this report, screenshots of the steps taken to implement and use geo location recognition within the AI Media application are given in the Implementation section of the study. Both the main method, based on neural networks, and the alternative methods mentioned above are presented. Figure 2 shows an example of the use of neuronal networks in the determination of the geo location.

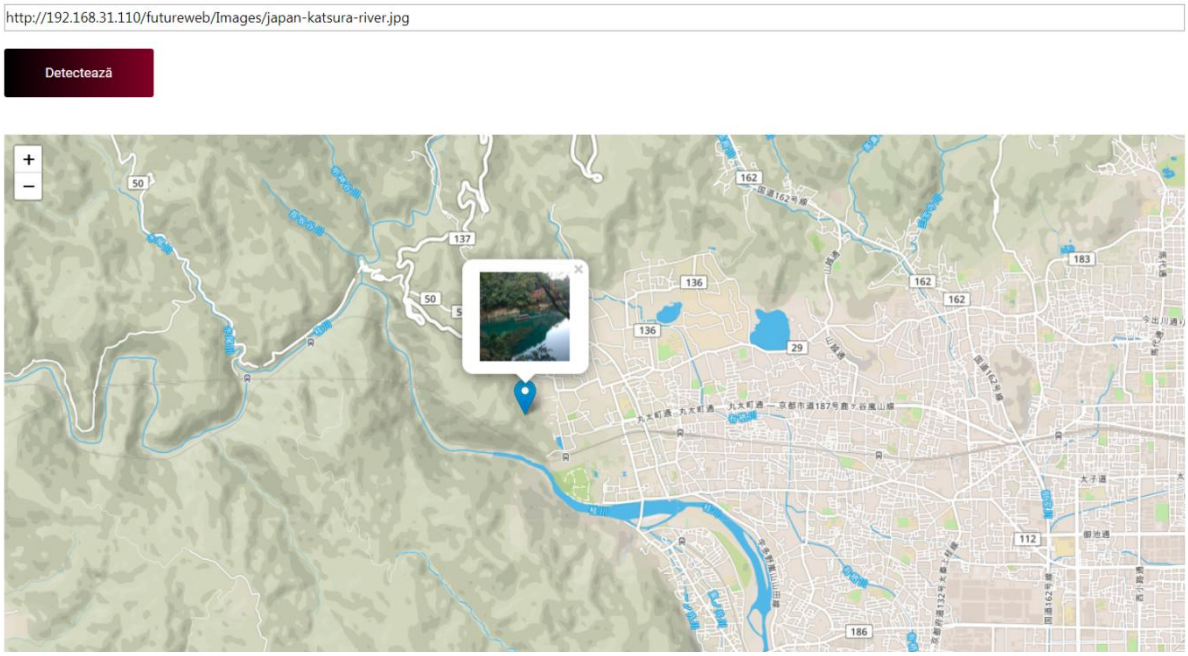

Figure 2: Example of use of neural network in geo location determination

Deliverable: *Study 5*

Activity 1-3-2: Development and implementation of options and services (subsystems) for the AI Media application: Development of the social context recognition service for the photos or media clips in which the logo of a brand or company appears

In order to identify the social context in which the logos appear, four categories of interest have been defined: family environment; business environment; institutional environment and recreational environment. As with the recognition of logos in given images, in order to obtain better accuracy, the *transfer learning* technique was used. Thus, the pre-trained *GoogleNet* network was used on the *Places365* dataset. *GoogleNet* is a pretrained convolutive neural network that has a depth of 22 layers, with 144 layers in total and 170 connections. This model was created for use on smart mobile devices. *Places365* contains JPEG images and has two *Places365-Standard* versions, which contains 1,803,460 drive images, 36,500 images for validation and 328,500 images for testing, and *Places365-Challenge*, which contains 6.2 million images in addition to the *Places365-Standard* dataset.

In the *Implementation* section of ***Study 6***, attached to this report, screenshots are given presenting the steps taken to implement and use *GoogleNet*'s convolutive neural networks within the *AI Media* application. Thus, from the screenshots presented, the recognition of the social context is observed in two cases presented.

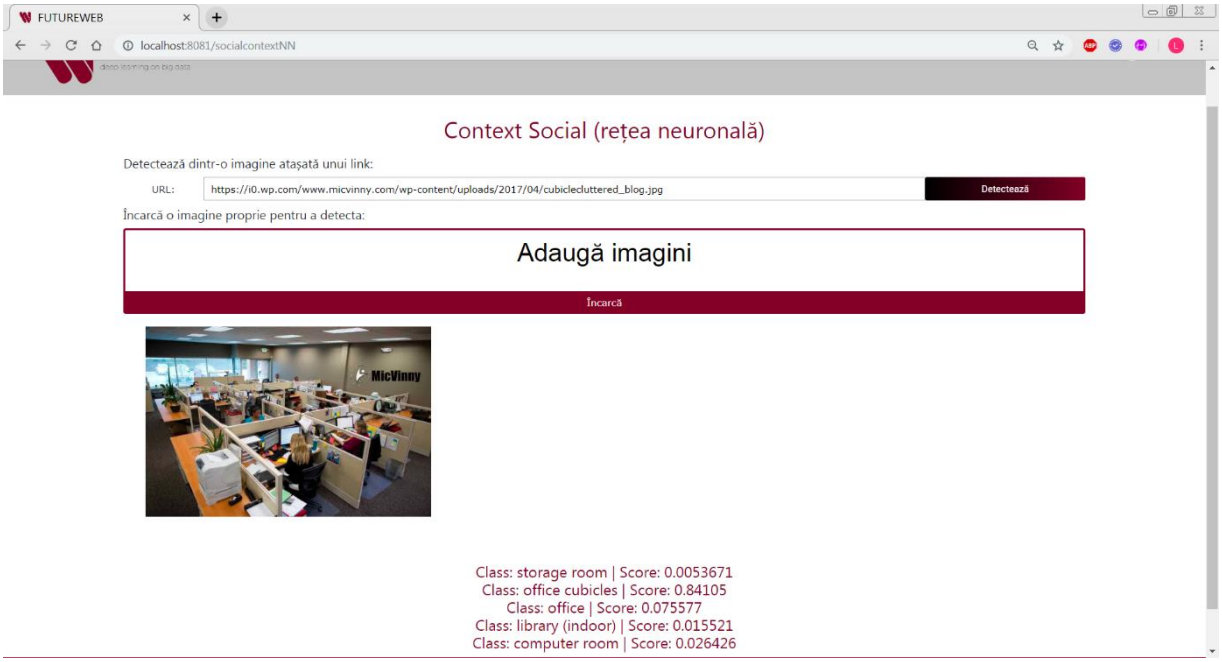

Figure 2: Example of use of neural network in determining the social context

Deliverable: *Study 6*