CareProfSys

Smart Career Profiler based on a Semantic Data Fusion Framework

Final Scientific Report

Project financed from the state budget

PN-III-P1-1.1-TE-2021

Contract NR. TE 151/ 2022

Start date: 13th of May 2022. Duration: 24 months

CONTENT

Executive Summary

The **main goal of CareProfSys** project (http://careprofsys.upb.ro/) is the validation and testing of the intelligent career profiler system concept by implementing it in an observed environment - the career development center within the National University of Science and Technology POLITEHNICA Bucharest. CareProfSys aims to provide career counselling to students and pupils using advanced analyses of user profiles, automatically extracted from various data sources, through occupation recommendations for people with similar profiles using ontological inferences and machine learning classification algorithms. The project has three phases: (1) System design and COR ontology development – in 2022, (2) System development and testing – in 2023, (3) Implementation of the CareProfSys at the UPB-CCOC center– in 2024.

The first Phase of the project consists in: the system design and technology choices and development of COR ontology and its exploitation tools. To establish the functionalities of the CareProfSys system, existing similar systems were studied, but online surveys were also conducted with 317 high school students and students to determine their interests. The results obtained were then concretized in the definition of use cases and user requirements. The taxonomy of Romanian occupations is the main pillar of the COR ontology of the project. In addition to the pillar of occupations, the ontology contains three more pillars: a) fields of study, thus connecting education with professions, b) characteristics related to the occupation (general activities, work context, work style, values, and needs) and c) necessary characteristics to fulfill a certain professional position (skills, aptitudes, and interests). The framework developed for the exploitation of the ontology is in the form of an API. **The second Phase** is the development and testing of the system. The CareProfSys system has a tier-based architecture. The data required for the system is extracted through the web interface, the users' access point to the system, the data being extracted from several sources, following an authentication process, and then processed. All users' information is saved in a MongoDB database. The development of the system services consisted of the development of career recommendation services, access to scenarios in virtual reality on the Web (WebVR) and the CareerBot conversational agent/chatbot. **The recommendation engine contains two recommendation methods: an ontological inference and a machine learning algorithm-based recommendation.** The professions indicated by both algorithms are offered as primary recommendations to our users, followed by all the other recommendations (indicated by any of the two algorithms), giving thus the user the possibility to explore as many careers as possible. Every time a user uses the CareProfSys system, answers questions, uploads a CV and indicates his social media profiles, an electronic profile is attached to him/ her in the system, and then an individual is instantiated within the COR ontology, an individual who, with the help of of the HermiT reasoner, will be classified as being of the type of a class that represents a profession from the COR ontology, which means that the respective user fits that profession. At the same time, using the *K-Nearest Neighbors* algorithm from the sklearn Python library, we trained a machine learning model that allowed the recommendation of professions, based on 8 features extracted from filling out the form by the authenticated CareProfSys user. Since the development of 3D animated scenarios is not easy, we chose to develop scenarios for only six professions, within the project, to exemplify the **concept of representing the recommended professions through VR**, all of which have a lot of gamification elements: specialist in computer networks, civil, industrial and agricultural construction engineer, web and multimedia systems designer, chemical engineer, university professor and similar, project manager. For the development of a VR application that can be executed directly from a Web browser, we used the Unity Engine game engine along with specific packages such as WebXR / VRTK Tilia. The virtual career advisor chatbot was developed using the Pandorabots platform and the AIML tag-based language. During development, we applied modular testing performed by our developers, alpha and beta functional testing. **The 3rd Phase** is the implementation of the CareProfSys system in the UPB-CCOC center, which consisted of the execution of two rounds of experiments with 47 users, in the UPB-CCOC Career Counselling and Guidance Center/ the laboratories of POLITEHNICA Bucharest, according to an internal protocol. The applied test procedure had 5 Phases, and the results of the experiments were measured by various tools: questionnaires, the performance recording module during VR simulations, interviews. The obtained data were analyzed, and system optimizations were carried out based on them. CareProfSys was very well received and considered useful both by the participants in the experiments and by the more than 65 pupils and students who were present at the final project dissemination workshop. Within the project, **6 deliverables were created** (5 technical and the description of the final workshop). **The results of the project were disseminated through 7 journal articles (5 ISI), 11 participations in conferences (9 with articles published in Proceedings), 1 book chapter and 5 popularization media articles**, through the creation of the **project website** and social media page, but also by participating in 3 educational fairs.

Introduction

The project aims to provide career counselling using advanced user profile analysis, automatically extracted from various data sources. CareProfSys users will receive recommendations of professional occupations, based on this data, using ontological inferences from the "Classification of occupations in Romania" (COR) ontology (developed in the project), aligned with the European list of qualifications and classification algorithms specific to automatic learning. A conversational agent will provide personalized advice on recommended occupations and necessary steps for the future, while virtual 3D scenes will help users visualize activities connected to a recommended profession. Apart from the direct benefits brought to students and high school students, the system will bring indirect benefits to career counselling centres, higher education institutions, the government, employing companies. The system will integrate the latest technologies: semantic web and ontologies, machine learning, social network connectors, web virtual reality (WebVR), recommender or conversational agents and modern programming interfaces (APIs). The main objective of CareProfSys is to validate and test the concept of an intelligent career profile system by implementing it in an observant environment, UPB-CCOC – the career counseling center within the National University of Science and Technology POLITEHNICA Bucharest.

The specific objectives of the project are: (a) building user profiles, in a fast and accurate manner - creating social connectors through current social network APIs, creating PDF extractors, web form processors and other modules for Web mining, combining and transforming all data sources into structured data, validating and analyzing this data with the help of expert psychologists; (b) creating the COR ontology and populating it with user profiles; (c) recommending occupations from the COR ontology to users (pupils, students and graduates who want to change careers), based on their profiles, through a customized algorithm; (d) providing additional information (based on text or 3D scenes) about recommended occupations; (e) providing support in advising users (students and pupils) through modern human-computer interaction tools, e.g. Web-VR based cameras or virtual cameras for interviews and conversational agents; (f) providing a flexible tool that can be easily customized to support career counselors and students in high schools and universities; (g) enabling the rapid development of several other modules in the future; (h) incorporating the product into a university ecology - pilot implementation in CCOC-UPB; (i) attracting potential users from other universities and high schools, through its intensive promotion; (j) providing an instrument of regional value.

Purpose of the document

This document contains the description of the scientific activities carried out within each Phase of the CareProfSys project, the results obtained and the result indicators.

At the same time, the ways of dissemination and the estimated impact of these results are highlighted, with the emphasis on the most significant result obtained.

CareProfSys Project Phases: Objectives and Activities

The project has three Phases: (1) Design of the system and development of the COR ontology - in 2022, (2) Development and testing of the system - in 2023, (3) Implementation of the CareProfSys system in the UPB-CCOC center - in 2024.

Phase I: System design and COR ontology development

The first Phase of the project consists in the design of the system and the development of the COR ontology and aims to fulfill the specific objectives from (a) to (j). The Phase has two main activities: (A1.1) Design and technology choices and (A1.2) Development of the COR ontology and exploitation tools, each with concrete tasks, the results of which are described below.

Within the activity (A1.1), six main tasks were performed, with the aim of fulfilling objectives (a)-(j): (T1.1) Literature analysis regarding career guidance practices and support tools; (T1.2) Online interviews and surveys: conducting and analyzing the results; (T1.3) Identification of system user requirements; (T1.4) Selection of technologies and development of necessary algorithms; (T1.5) Identification of system software requirements; (T1.6) Detailed system design. Details of the scientific results of activities T1.1, T1.2 and T1.3 can be found in Deliverableul 1 "Raport de analiză si cerințele utilizatorilor sistemului", and their results were disseminated in the conference paper (R2), listed in "Result Indicators". Details of the scientific results of activities T1.4, T1.5 and T1.6 can be found in Deliverableul 2 "Raport privind cerințele software ale sistemului și proiectarea acestuia", and their results were disseminated in conference papers (R2) and (R3). The analysis carried out to establish the functionalities of the CareProfSys system included both a thorough study of the specialized literature and existing similar systems, as well as the creation of online surveys with high school students and students (the main actors of the system) to determine their interests. The results obtained were then concretized in the definition of use cases and user requirements.

Within the activity (A1.2), two main tasks were performed, with the aim of achieving objectives (b, (f) and (g): (T2.1) Development of the COR ontology; (T2.2) Development of the framework of ontology exploitation Details of the scientific results of these activities can be found in Deliverableul 3 "Ontologia COR și descrierea acesteia", and the obtained results were disseminated in the conference article (R1) and in the journal article (R4).

Phase II: Development and testing of the system

The second Phase of the project consists in the Development and testing of the system and aims to achieve the specific objectives from (a) to (j). The Phase has only one main activity, but extremely important for the success of the project: (A2.1) Development, testing and optimization of the CareProfSys system. Within this activity, five main tasks were performed, with the aim of achieving objectives (a)-(j): (T3.1) Development of the data extraction method; (T3.2) Development of the data processing module; (T3.3) Development of system services; (T3.4) Web platform development; (T3.5) Testing and Optimization. Details about the scientific results of the activities carried out can be found in Deliverableul 4 "Raport tehnic de implementare și testare a sistemului". The results of the activities carried out at this Phase were disseminated in three ISI journal articles (R6, R8, R9), 2 BDI journal articles (R5, R7), 6 international conferences (R10, R11, R12, R13, R14, R15) and 1 media promotion article (R16).

Phase III: Implementation of the CareProfSys system in the UPB-CCOC center

The third Phase of the project consists in the Implementation of the CareProfSys system in the UPB-CCOC center and aims to achieve the specific objectives (f) and (h). The Phase has only one main activity, with the same name as the Phase: (A3.1).

Within this activity, four main tasks were performed, with the aim of achieving objectives (f) and (h): (T4.1) Preparation and execution of the first experiment; (T4.2) Evaluation of the first experiment and improvement of the system; (T4.3) Preparation and execution of the second experiment; (T4.4) Evaluation of the second experiment and improvement of the system. Details about the scientific results of the activities carried out can be found in Deliverableul 5 - Raport asupra experimentelor de exploatare și analiza rezultatelor. The results of the activities carried out at this Phase were disseminated in an ISI journal article (R24), 1 book chapter (R17), 2 articles presented at international conferences (R18, R19) and 4 media promotion articles (R20, R21, R22, R23).

Obtained Results

Within the project, 6 deliverables, the project website, the project's social media account and 24 dissemination papers were created. Deliverables and papers are available in the annexes to this report. The proposed objectives were 100% achieved.

Deliverable 1- Analysis report and system user requirements

The purpose of the first deliverable is to specify the results of the analysis performed to establish the functionalities of the CareProfSys system. This analysis included both a thorough study of the literature and existing similar systems, as well as the creation of online surveys with high school pupils and students (the main actors of the system) to determine their interests. The results obtained are then concretized in the definition of use cases and user requirements.

The literature review on career guidance practices and support tools consisted of two parts, depending on the degree of innovation of existing work counselling and referral approaches - traditional practices and modern practices, respectively. In traditional practices, the advisor-client relationship is the most important. Direct communication between them is a specific feature of the counselling process and depends on several characteristics such as the counsellor's attitude, the characteristics of the interaction environment, the counsellor's specific communication and support skills. Traditional counselling tools include methods of collecting data about the client (e.g. psychological or personality tests, such as the Holland Questionnaire [1], MBTI [2], INEM [3], etc.), communication methods, methods of investigating labour market, personal branding, career planning methods [4]. In the educational system in Romania, the number of school/university counsellors for career guidance is insufficient for the current need (one counsellor ends up being responsible for approximately 3000 pupils and 800 students, according to the Romanian Ministry of Education) [5], so there is a need of new, modern solutions that can improve the counselling and career guidance process. Among the modern practices on recommender systems, two main types are most common: recommendations based on content filtering and recommendations based on collaborative filtering [6]. There are also advanced approaches, for example based on machine learning algorithms. Neural networks are often used to capture a candidate's preferences for specific jobs as they evolve/change over time [7] [8]. A commonly used method is represented by ontologies [9][10] which can formally represent data through classes, attributes, rules, and relationships.

To establish the relevant principles and functionalities for a job recommendation system, we conducted two surveys using the Google Forms platform. The target group included both high school pupils (for the first survey) and university students (for the second survey), with a total of 317 respondents, including 209 high school students

and 108 students. The surveys are similar for both categories, including three main sections: 1. socio-demographic characteristics and studies, 2. principles of choosing the current educational institution, and 3. support tools for receiving job/profession recommendations. Students had an optional additional section related to work experience, a section completed only by those currently or previously employed.

As a result of the literature analysis regarding career guidance practices and support tools, as well as the analysis of surveys applied to high school students and students (possible users of the CareProfSys system), we have established the actors, the main use cases and the functionalities of the system, from the perspective actors, as seen in Figure 1.

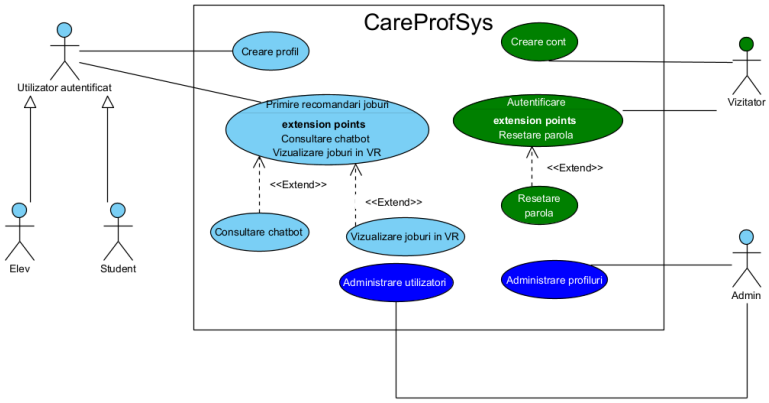

Figure 1. Use cases of the CareProfSys system

Deliverable 2 - System software requirements and design report

The purpose of the second deliverable is to present the technical details to properly implement the functionalities of the CareProfSys system. The technological choices for creating the web application, ontology, recommendation engine, automated extraction of user data, as well as the creation *of chatbot* and virtual reality scenes are justified. The document also provides a review of non-functional requirements, hardware and software components, as well as the architectural design of the system. A tiered microservices architecture will be used, where each module will run as a microservice in its own container, communicating with the others via HTTP requests: see Figure 2.

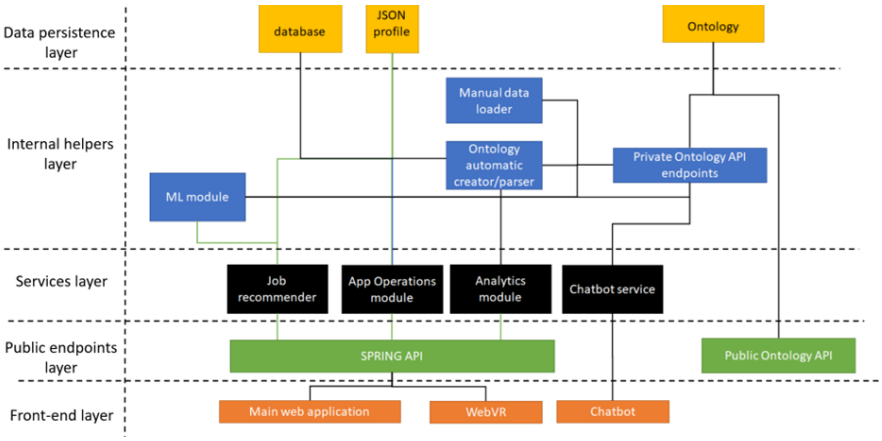

Figure 2. CareProfsys system architecture

Deliverable 3 - COR ontology and its description

The purpose of the third deliverable is to describe the development of the ontology that reflects the nomenclature "Classification of occupations in Romania" (COR) [11], within the CareProfSys project, as well as the API for its use. In order to achieve the development of ontology, aspects related to professionalization of work were studied: professional identity in Industry 4.0, relevant professional bodies, taxonomies and standards, then examples of *similar software* artifacts - ontologies were analyzed. *The professionalisation of work* is the process of transforming an occupation into a profession with a high degree of integrity and competence [12]. Professionalization implies the existence of professional qualification frameworks, professional associations that define and recommend to members of the professional community best practices, codes of professional conduct and professional certifications, to differentiate between competent and incompetent professionals. For all these processes to be properly aligned and carried out, standards and regulations need to be defined and the main actors in the labour market should respect them.

COR is a system for identifying and coding Romanian occupations regardless of their type and place, appeared in 1995, and the last revision and update was in 2022. Like many other national classifications of occupations, the Romanian classification follows the structure of the International Standard Classification of Occupations (ISCO-08). In the COR, each occupation is assigned a six-digit code and contains all the necessary details, including general activities, work context, work style, values and needs attached to that profession.

All data about occupations available on the Romanian labor market are stored in a conceptual system formally described by the COR ontology developed within the CareProfSys project, in OWL format, whose content can be managed through an API (Application Programming Interface) dedicated, developed in Java, also built within the CareProfSys project. API users can search the ontology by running a SPARQL query.

The COR ontology was created based on the content found at [11], considering the 9 major groups of occupations, except for the tenth in the military field (see Figure 3). The taxonomy of occupations in Romania is the main pillar of ontology. In addition to the pillar of occupations, ontology contains three more pillars: a) fields of study, thus connecting education with professions, b) occupation-related characteristics (general activities, work context, work style, values, and needs), and c) characteristics necessary to fulfil a particular position (i.e. skills, aptitudes and interests). All characteristics have a description, and the importance of the characteristic or associated field to be able to access a particular occupation is also indicated. Figure 3 shows the basic structure of the ROC ontology with its four pillars ("Skills and interests", "Occupation traits" in "Characteristics", "COR" and "Domains"). The last class in the list is "Value", which represents the importance of each characteristic to successfully pursue a particular profession.

The methods exposed by the COR ontology exploitation API are as follows: extracting the code of a particular profession; extraction of all professions together with their code; adding a new triplet in ontology, modifying a certain triplet, deleting a certain triplet, extracting all the details related to a particular occupation.

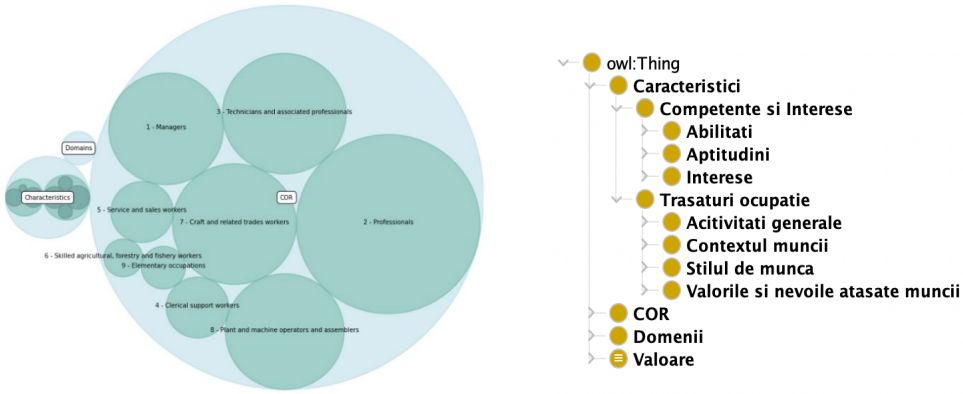

Figure 3. The structure of COR ontology from CareProfSys

Deliverable 4 - Report on the software requirements of the system and its design

The purpose of this deliverable is to describe the details regarding the development, testing and optimization of the CareProfSys system, which were based on Deliverables 1, 2 and 3, achieved in the previous Phase. The document describes aspects regarding data extraction and processing, profession recommendation, using ontological inferences, but also a machine learning algorithm, aspects regarding the presentation of recommendations in the form of virtual reality scenarios on the Web (WebVR) and aspects regarding the development of a conversational agent that can support career guidance. Both functional descriptions of the web platform that present recommendations, virtual reality scenes and chatbot to users, as well as detailed technical descriptions are provided.

The extraction of the necessary data for the system is done through the web interface, the data being extracted from several sources, following user authentication: Europass CV [13], social media accounts, answers to questions in a form. The questions in the form are similar to the Briggs Myers personality test [14], in that each user must rate themselves on a 5-point Likert scale on certain statements." The statements allow scaling the response also for the 8 categories of skills used by ESCO matrices [15] to characterize occupational profiles in The International Standard of Occupations (ISCO-08) occupational standard [16]. For each type of data extraction, we made a *controller.* All user information is saved in a MongoDB database [17].

After extracting/collecting data and building the user profile in JSON format, we will have both a static and dynamic profile for an authenticated user. The static profile will contain the CV and test data from the Web platform, and the dynamic profile will contain the data extracted through social connectors, from social networks (LinkedIn, Facebook, etc.). **The Phases of data processing are**: eliminating contradictory information from different data sources; identifying skills and interests useful for the recommendation process, according to the COR ontology developed within the project, which contains all professions in the Classification of occupations in Romania [11]; mapping natural language data into structured data.

The main **system services** are recommendation services, access to WebVR scenarios and the conversational agent/chatbot CareerBot.

<u>Development of the recommendation mechanism</u>

Currently, the recommendation mechanism contains two recommendation methods: ontological inference and recommendation by applying a machine learning algorithm. The professions recommended by both algorithms are offered as a result in the first positions, then, to allow the user to explore as many careers as possible, all other recommendations are given, coming from either of the two methods.

Both Apache Jena [18] and OWL API [19] are used in **the implementation of CareProfSys' ontology-based recommendation module**, enabling the execution of inferences (automated reasoning) based on the COR ontology, described in Deliverable 3 of the project. Each time a user uses the CareProfSys system, answers questions and is attached an electronic profile in the system, an individual is instantiated within the ontology, of the Person type, who, with the help of the HermiT reasoner [20], will be classified as being of the type of a certain *Job* (which represents a profession from the ROC ontology), which means that that person fits that profession, taking into account the description of the person and profession, e.g. skills, aptitudes, work style, occupational interests, important needs and values, etc. An example of classifying a new user, *careprofsys-user*, within *the "*Chemical Engineer" job can be seen in Figure 4 (image obtained with the help of the ontology editor Protégé [21])), which translates into that user receiving that profession as a recommendation.

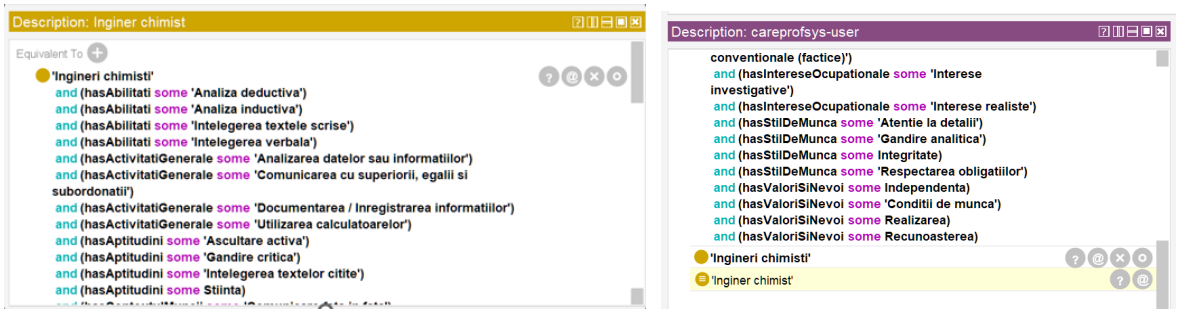

Figure 4. Career recommendations as deduced by the HermiT Reasoner in the ontology editor Protégé

HermiT is one of the reasoners used in classifying ontologies and surpasses others by using a hypertable-based mechanism and other techniques to optimize and improve the inference calculus, which should solve problems that arise due to the dimensions of ontology [22]. The classification algorithm implemented by HermiT works by extending the hypertable iteratively, with each new vertex and vertex representing the axioms of the ontology, until all the axioms have been found. In OWL, an axiom is the name given to restrictions or constraints about entities/concepts [23]. The classification algorithm of the HermiT reasoner begins by initializing the hypertable that will represent the entire OWL file. In this phase, the algorithm tries to avoid unnecessary tests so that the process is optimized [22]. For example, if a class A belongs to superclass S, and there are three other classes are copies of class A, then the algorithm decides that the three fulfill the constraint of A, and it is deduced that they are members of S. In the end, this phase should determine the initial knowledge of the relationships between classes and be able to proceed to the next step, automatic classification of an individual as a member of a class. As soon as the initialization phase is completed, the algorithm starts classification. It iteratively extends and refines class relationships, creating class hierarchy based on all existing relationships [23]. The reasoner is easily initialized by defining a new variable from the Reasoner class in Jena, which takes the ontology itself as an attribute. The reasoner will then apply the ranking algorithm, check if it is valid and then we will be able to

iterate through all the recommended classes of the individual for whom we want to verify the profiling results, saving each recommendation as a *Job object*.

After creating the user profile and creating the object with that profile, it is classified as close to a maximum of 8 professions, according to **the machine learning algorithm** used, which has the following steps: data collection; data preprocessing and cleaning; feature extraction and engineering; selection and training of the machine learning model; evaluation and fine-tuning of the machine learning model. For training and validating the machine learning algorithm, we used, as data sources: ESCO matrix tables [15] linking professions from the International Standard of Occupations (ISCO-08) [16] to ESCO European competences and a new *Google Form* survey completed by Romanian respondents (to give local color) and LinkedIn data collected in the first Phase; each respondent was asked to declare their job and self-assess the skills required to exercise optimal of that trade, using the same eight characteristics used in ESCO. According to ESCO tables, each profession is characterized by 8 characteristics, which can have values between 0 and 1, depending on how important they are for the successful exercise of that profession. The eight characteristics considered important are: handling and movement; information skills; computer work; building skills; managerial skills; work with specialized machinery and equipment; assistance and care; communication, collaboration and creativity. These characteristics have become variables of the machine learning model. We used the K-Nearest Neighbors (KNN) algorithm from the sklearn Python library [24]: predicts the values of new instances based on how close their features are to those already known; Therefore, professions are suggested according to how close their characteristics are to those in the user's profile. The model was trained with data from the ESCO professions and skills page and tested with data provided by our survey. The success of the model was assessed by how well it was able to discover jobs that matched the preferences and abilities of the people who filled out the form, with the current accuracy being 86.33%.

Developing and accessing WebVR scenarios

Once the names of the appropriate professions are received, following the recommendation mechanism, the user can try activities specific to the recommended professions by accessing VR scenarios. Because developing such scenarios is not easy, we chose to develop scenarios for only six professions within the project to exemplify the concept, all of which have many gamification elements. The scenario for **computer network specialist - COR 2523** is simulated in an office scene where the user has to reproduce and configure various network schemes, using elements such as PCs, servers, switches and routers. The virtual reality training process contains three difficulty levels (easy, medium and hard), each of which has a different network that needs to be replicated. The following scenario replicated in virtual reality aims to give an idea about some of the duties of a **civil, industrial, and agricultural engineering engineer – COR 214201.** The scenario focuses on the safety part of the workplace, within a construction site in progress. The goal of the "player" is to interact with as many workers as possible to activate certain interaction options that change the appearance of characters that are not properly equipped. This scenario is an open-ended one, allowing the player to interact with workers in any order. For the scenario involving the work of **web and multimedia system designers - COR 2513**, we chose to simulate work on the *front-end*, one of the possible duties of a web design specialist. The goal is to replicate the template provided in the left scene on the artboard in the right scene. The scenario for **chemical engineer - COR 2145** is carried out in a

hospital laboratory, in which the user must perform a series of chemical analyses, of various complexities. Specific elements such as test tubes, pipettes, reagents, analyser will be used. **Project Manager Scenario - COR 242101** is performed in a conference room, the user must make a Gantt diagram, a Work Breakdown Structure (WBS) diagram, or both depending on the chosen difficulty. The scenario for **university and assimilated teachers - COR 2310** takes place in a classroom equipped with desks, chair, computers, blackboard, projector. Students are seated in desks and carry out different activities (scheduling, talking, raising their hands to ask questions). The teacher must select the action to be performed by the students in various situations, from being attentive to evacuating the room in case of fire, depending on the level. For the difficult level, an artificial intelligence script is used **for the** movement of students during evacuation. Thus, students have attached a *NavMeshAgent* component that determines their automatic movement to the door once the teacher is in his proximity.

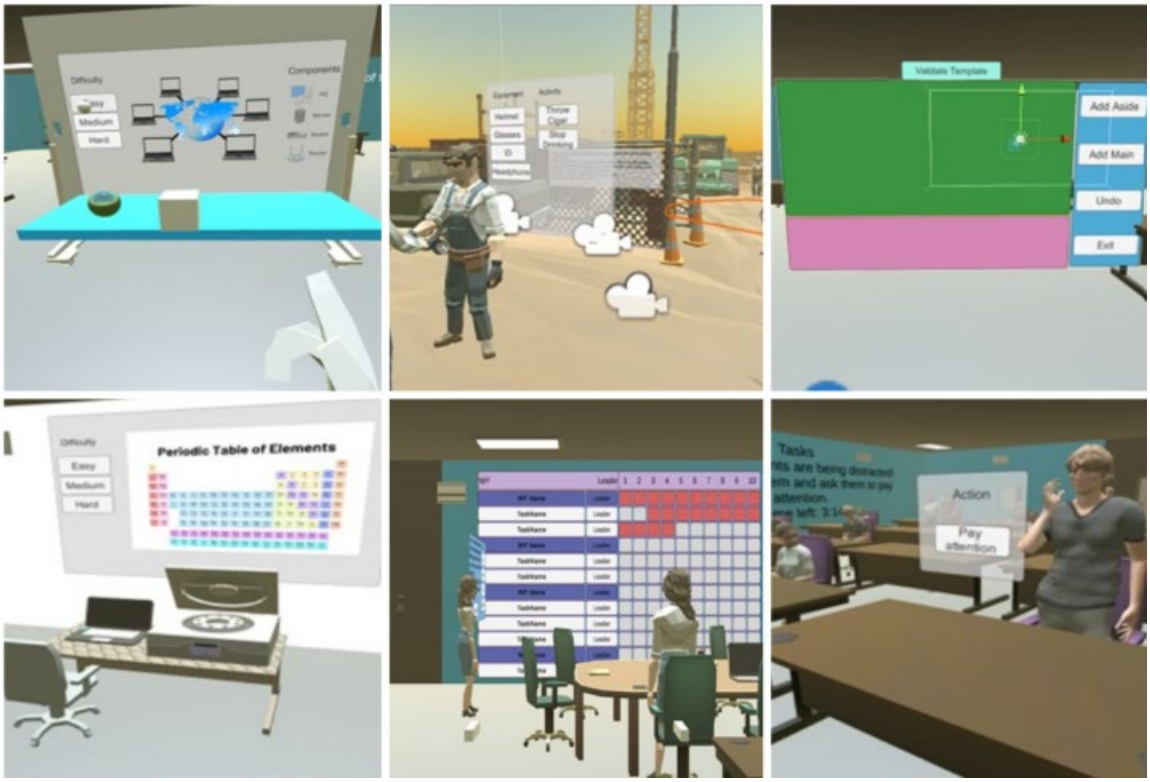

Figure 5. WebVR scenes from CareProfSys

To develop a virtual reality application that can be executed directly from a Web browser, we used the Unity Engine [25] game engine, along with specific packages such as WebXR or VRTK Tilia. An application can be hosted on a web browser (see Figure 5) if the build type of the application is WebGL. WebGL is a JavaScript API designed to render 3D graphics without the help of additional plugins. WebXR Exporter is a Unity package that allows the development of VR applications in WebGL format, compatible with browsers such as Mozilla Firefox, Google Chrome, Microsoft Edge on Windows, Oculus Browser and Firefox Reality on Oculus Quest. Thanks to the format, WebGL, the application is compatible with several models of VR equipment, as successful tests have been conducted with HTC Vive Cosmos Elite, Oculus Rift and Meta Quest (1 and 2).

Conversational agent development

The CareerBot chatbot service can be accessed from the CareProfSys web platform to learn about professions in the COR: it serves as an experienced advisor for people seeking guidance in their career search, being useful for two distinct types of users, each with their own specific requirements. The first type targets aspiring students, e.g. high school students or students, who want to practice a profession related to their field of study. The chatbot provides details about universities found in different cities across the country and admission requirements, helping users make informed choices regarding their educational path. The second type of users are those who want to make a career change. The conversational agent provided is an important source for these individuals, providing useful information on topics such as salaries and retraining requirements. In addition, it identifies companies that could hire people in the desired field and provides guidance for providing internships. Through relevant and useful guidance, the chatbot within CareProfSys supports these mature users in their specialized development, as well as in the desired career change, to reach the professions recommended by the system. The chatbot has the ability for multilingual interaction, suitable for discussions in both Romanian and English.

The conversational agent built by us is based on the Pandorabots platform [26]: the user enters the chatbot platform, chooses the conversation language (English or Romanian) and engages in a conversation; The replies received from the bot comply with rules previously created using the tag-based Artificial Intelligence Markup Language (AIML). A dialogue takes place according to the following flow: after entering the necessary information, the user asks questions, and the answers received from the chatbot are based on templates developed in AIML files on the basis of which the Pandorabots platform works. If questions are not found in the templates, an exception is thrown and a friendly message is displayed, asking the user to enter another question. Excerpts from a possible user-chatbot discussion are available in Figure 6, on the left, as well as excerpts from the AIML file behind the discussion.

AIML is based on template matching as the main mechanism and harnesses the power of retraction. AIML files define patterns to be found in the questions asked and the corresponding answers. These patterns act as triggers for the chatbot to identify user input, and corresponding responses are generated accordingly. AIML reproduces people's natural writing style. Recursion allows AIML to handle complicated conversational flows and generates responses dynamically. This empowers the chatbot to refer to its previous responses within a new response, leading to a continuous loop of pattern matching and pattern generation. This recursive approach improves AIML's ability to address various conversational scenarios while maintaining context throughout the interaction.

For creation, testing and optimization, we used Pandorabots, but for integrating the CareerBot chatbot into the CareProfSys system, we used the React JS and Node JS technology stack. Thus, we created a web interface for our chatbot (available in Figure 6, on the right), which can be accessed by the main CareProfSys web platform. To connect the bot's web interface with the Pandorabots platform, we used a RESTful API.

```
    </category>
<category>
    <pattern>HI</pattern>
    <template><srai>HELLO</srai></template>
</category>

<category>
    <pattern>HELLO THERE</pattern>
    <template><srai>HELLO</srai></template>
</category>

<category>
    <pattern>GREETINGS</pattern>
    <template><srai>HELLO</srai></template>
</category>
```

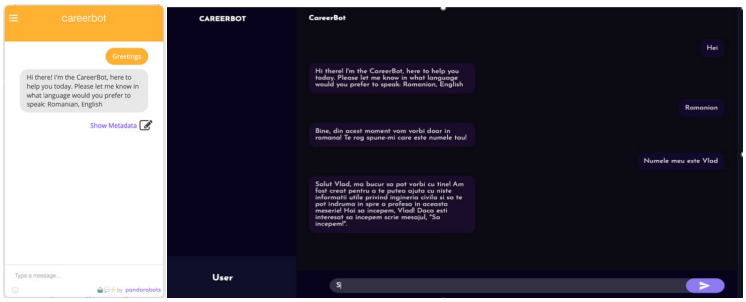

Figure 6. Excerpts from descriptive AIML files and Pandorabots interface for CareProfSys CareerBot chatbot

The Web platform is the user's access point to the CareProfSys system, which allows them to create an account, complete a profile, obtain recommendations based on the profile, view WebVR scenarios for recommended professions, and access the Career Bot chatbot for further advice (see Figure 7). Technically, the platform follows a Model-View-Controller (MVC) architecture.

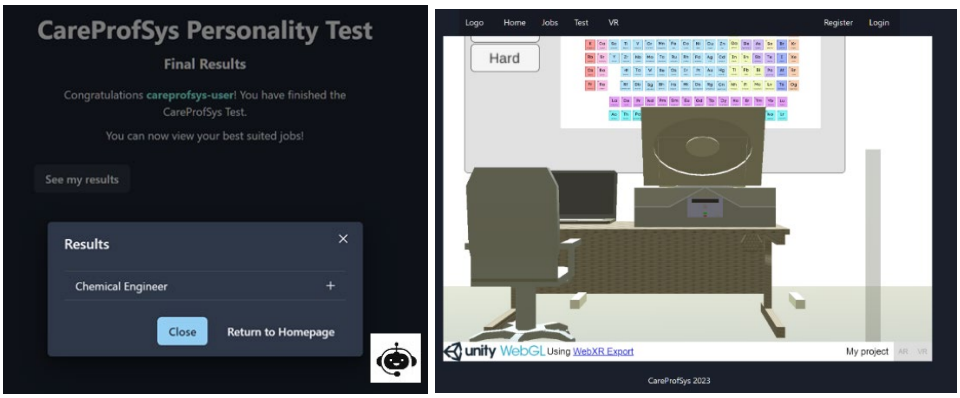

Figure 7. Screens from the CareProfSys Web Platform

For the *frontend*, HTML, CSS, Bootstrap, React technologies were used. In implementing *the backend*, a Maven project was created in which technologies such as Spring Boot, Apache Jena, OWL API and HermiT reasoner were installed to enable application implementation. The project was separated into different packages: the model, where primitive classes are found; service, where the implementation is written; the controller, where the RESTful interface is defined to allow data exchanges between the *backend* and *frontend*, accessing the machine learning algorithm in Python, etc. As for the controller, it will create mappings for HTTP requests so that ontology can be queried, managed, and classification will be accessible from a web interface.

During development, we applied modular testing, i.e. each component was tested individually. To do this, we used SwaggerUI [27] to test the various APIs in the system. In addition to the testing performed by the main developers of the modules (after implementing each functionality), 6 students who practiced in the university's laboratories were involved in **the alpha functional testing** process. Thus, a *black-box testing approach was used*. The system was also tested by 48 students from the university (between 27/03/2023-20/10/2023) and a group of 27 high school students from all over the country, participants in a summer school organized by POLITEHNICA Bucharest (between 15/07/2023-30/07/2023), during **beta functional testing**. Preliminary tests have been promising.

Deliverable 5 - Report on exploitation experiments and analysis of results

The purpose of this document is to describe the details of the experiments for exploiting the CareProfSys system, whose development can be found in Deliverable 4 – "Technical report for implementation and testing of the system". Both experiments were conducted according to a protocol, carried out as part of the project. Also, the participants signed an informed consent and a personal data processing agreement, both documents developed within the project. Since both Romanian and foreign users participated in the experiment, the documents for them were written bilingually. According to the established protocol, within this deliverable are described the two rounds of experiments with users, carried out in a controlled environment, ie in the UPB-CCOC Career Counseling and Guidance Center / laboratories within the National University of Science and Technology POLITEHNICA of Bucharest. The data obtained from user feedback were analyzed and system optimizations were carried out based on them.

The objectives for which experiments were conducted were: testing / utility analysis / user experience (UX) / prototype of the CareProfSys research project, including the web recommendation platform and, optionally, the virtual reality (VR) scene corresponding to the recommended career. VR simulations took place only if the user received after testing the web platform one of the following career recommendations: chemist, network administrator, project manager, web programmer, university professor or civil engineer. It was necessary to conduct experiments in two rounds to allow correction of shortcomings identified by users. Each of the two rounds had two days. The location of the experiments was in UPB-CCOC/ laboratories from POLITEHNICA Bucharest, the need being two rooms: room 1: experiments in VR; Room 2: Web experiments & Filling out feedback questionnaires.

The hardware & logistics required for experiments is listed below:

- 2 laptops / computers for experiments in web and VR;
- Oculus Rift or Meta Quest 2 virtual reality headset;
- room arrangement (a minimum free space of 1.5m x 2m without obstacles);
- RV guardian scan in the open space.

The software requirements for experiments are listed below:

- Web:
  - locally configured CareProfSys web application or internet access to use it;
- RV:
  - Oculus application installed on your computer/laptop;
  - version 2020.3.24f1 of Unity (when using the Oculus Rift headset);
  - CareProfSys application in VR installed and updated in Unity on test PC / laptop (in case of using Oculus Rift headset);
  - CareProfSys application in VR installed on Meta Quest 2 (in case of using Meta Quest 2 headset);
  - Meta Quest account and *casting* link accessed [28] (when using Meta Quest 2 headset).

The test procedure applied had 5 Phases, as shown in Table 1.

Table 1. Test procedure applied in CareProfSys experiments

ID Phase	Purpose	Activities	Estimated results	Duration
Phase 1	Experiment presentation and consent	- Explanation of procedure and duration of experiment -Fill in Informed consent to take part in the experiment - GDPR Agreement Completion -Filling in the introductory self-assessment form	- User feedback - Informed consent, GDPR form	5 minutes
Etapa 2	Testing the web recommendation platform	- Presentation of the web platform and its functionalities - CV upload, social media profile and feature exploration - Getting a career recommendation	- Career recommendations	5 minutes
Phase 3	(optional) VR Overview & Getting used with VR	(only for users who received one of the 6 career recommendations with scenarios in VR or who rated themselves as having affinities towards one of the 6 jobs) - Reading the Annex for obtaining basic theoretical knowledge for the recommended profession - System & hardware RV presentation - Helmet adjustment for users -Presentation of VR input for movement, action and functionality - Software configuration according to user profile (unique ID)	- Unique ID, tested scene	5-10 minutes (extra time may be needed for people with no previous experience using VR)
Phase 4	(optional) career testing in VR	(only for users who received one of the 6 career recommendations with scenarios in VR or who rated themselves as having affinities towards one of the 6 jobs) -The user must accomplish as many tasks as possible in the given time - All tests will start with the easy difficulty level (for levels with more difficulties); If a level is successfully completed, the user will then move on to the next difficulty level (medium, then hard)	- Score according to the logic of each game - Mistakes (errors) in game logic - Real-time feedback to identify bugs and suggestions for improvements	10 minutes
Phase 5	Final feedback	- Filling in the feedback questionnaire at the end of the	- User feedback	5-10 minutes

		tests and interview applied following the questionnaire.		

The experiments took place in UPB-CCOC/ laboratories from POLITEHNICA Bucharest, namely in the POLITEHNICA Library of Bucharest and the CJ building, in two rounds: the first round of experiments: February 14 and 15, 2024, 11:00-16:00; Second round of experiments: February 27 and 28, 2024, 14:00-18:00.

If in the first round we had as participants first-year students from various specializations and linguistic branches from POLITEHNICA of Bucharest, in the second round we tested the system with students in the third and fourth years from POLITEHNICA of Bucharest, from two specializations and linguistic branches. In the first round we had 30 participants (13 girls and 17 boys), and in the second round 17 third- and fourth-year students from two specializations and language pathways (11 girls and 6 boys). In total, we summarized 47 users who participated in the experiments.

The results of the experiments were measured by four tools: (1) the introductory self-assessment questionnaire, distributed to participants via a Google form; (2) the final feedback questionnaire, distributed to participants via a Google form; (3) VR simulation performance recording module, which exports useful information to txt files for each user simulation session; (4) interview with users, after completing the final feedback.

To be able to test the VR module, which contains specific scenarios for only 6 professions, we also applied an introductory self-assessment questionnaire, through which we gave users the chance to choose one of the 6 jobs for which we have scenarios in VR as the closest to their own profile. At the same time, we were able to evaluate the accuracy of the recommendations received in the web platform, through this questionnaire. The feedback questionnaire completed after testing the system targets the following evaluation dimensions: the tested VR environment, future projection regarding the choice of the tested / recommended profession, satisfaction with the activities carried out according to the scenario chosen for testing, appreciation on the interface (web, VR, etc.) - providing clear reasoning and explanations by the system, navigating menus, interacting with objects, accessing functionalities, clarity and immersiveness of the visual part of the system, self-assessment of the feeling of presence and immersion in the virtual environment, appreciation of the experience as realistic and immersive, identification of distractions and technical limitations that interrupted immersion in VR, promptness of the system to commands and movements of the user, variety of experiences to form a clear opinion about the job, comfort and safety in using VR equipment, general impression. The RV simulation performance recording module recorded, for each user, the tested scene, the level they reached, the score, the time spent in a certain level, etc. The final free interview resumed, through a free discussion, the pluses and minuses of the system, from the point of view of each user.

Analyzing the answers to the initial questionnaire, it was noticed that the same skills and interests were extracted from the activity on the CareProfSys web platform, ie the answers provided to the form on the platform, the information extracted from the CV and social profiles were consistent with those chosen by students in the self-assessment questionnaire.

It is worth noting, however, that in the first round of experiments, more than half of the participants (16 out of 30) received from CareProfSys recommendations of professions that were among their wishes, which means that the recommendation algorithm is correct. As for the other 14, the CareProfSys system raised questions and a desire to learn more about the recommended professions. **As a future profession**, the most desired for participants in the first round is that of programmer – 50% of respondents. **There is a correspondence between the options related to the future** most desired profession, that of programmer – 50% of respondents, which agrees with the recommendation made by CareProfSys: the profession with which most of the surveyed students identified is web programmer (66.7%). The post-test feedback questionnaire shows positive/satisfactory appreciation of the measured dimensions so that testing a profession becomes an excellent opportunity to better understand a profession in an interactive way, as well as projecting the user into a realistic scenario. Due to **the variety of experiences offered by the tested system to form a clear opinion about the job**, over 76% of respondents believe that they can relate to this experience for choosing a profession in the future. **The automatic recording of user performance** within CareProfSys has proven that very few users reach the difficult level, in a short time, as used in experiments, which means that there is no need for more complicated scenarios for such a career recommendation tool. The answers provided by participants to **the free interview** strengthened the answers given to the feedback questionnaire: most students were delighted with the experience, with only one student disappointed with the project manager scenario. This is also explained by the fact that he did not have the knowledge used in the script, but also that the script had some gaps in functionality. Following the first round of experiments, considering all the analysed dimensions, as well as the recommendations and motivations presented by respondents on the choices regarding the future profession, we can appreciate the system developed within the CareProfSys project as a useful, necessary and functional tool in guiding the career and future professional choices of students in this technical field. General impression: over 96% of respondents rated this experience of testing the proposed scenarios as positive. However, functionality or technical deficiencies noted during the experiments were noted and remedied by the second round of experiments.

The results obtained in **the CareProfSys** post-user feedback questionnaire were a better idea than in the first round of experiments: everyone considered the experiment a pleasant experience. **The performance recorded** by the system was slightly superior to that of the first round of experiments. Thus, in the first round of experiments 63.33% failed to pass the first level, while in the second round this percentage dropped to 52.94%. **The free interview** validated the answers given to the feedback questionnaire: most students were delighted with the experience and stated that the system has a friendly interface, and the idea of CareProfSys is useful and applicable in real life. The need for a mini-guide for users who reach the VR part, suggested in this round of experiments, was considered and implemented. The fact that the students failed to reach the difficult level during the experiments proves that more time was needed for each user, but our goal was to popularize the system as much as possible and to validate the idea of the tool through these tests with end users.

Deliverable 6 - Dissemination workshop report

The purpose of this document is to present the dissemination workshop of the CareProfSys project: date, location, agenda, participants, main activities and conclusions. The workshop took place on April 13, 2024, in the CB and CJ buildings

of the POLITEHNICA Campus București.La the workshop were invited project members, university teachers and high school teachers, as well as 65 students from 5 high schools in the country (C.N. Gheorghe Lazăr from Bucharest, C.N. Mihai Eminescu from Bucharest, C.N. Central School from Bucharest, Technical College of Aeronautics "Henri Coanda" Bucharest, High School "Aurel Rainu" Fieni) and students from POLITEHNICA Bucharest. The participants listened to the presentation of the CareProfSys project and participated in practical activities, i.e. they experienced the system: see Figure 8.

Figure 8. Project dissemination workshop

All participating students were very excited about the experience: although they had heard of virtual reality, most of them had not been exposed to the technologies typical of this concept. The students at the workshop did better than the students at using the system, helping them to carry out experiments as well. The feedback provided by students was also positive, especially appreciating the virtual reality exposure of professional recommendations. High school teachers found the idea of the project interesting, stating that their students often feel confused in choosing the faculty and, implicitly, the career to follow. Faculty professors were more interested in integrating emerging technologies from CareProfSys, but pleasantly impressed by their practical use.

Result indicators

The project result indicators are: **6 deliverables** (5 technical deliverables and dissemination workshop report), project website (https://www.careprofsys.upb.ro/), project social media account (https://www.facebook.com/CareProfSys.UPB), **7 journal articles** (5 in ISI journals, of which 2 Q2, 1 in SCOPUS journal and one in WorldCat journal; 6 already published and 1 sent for evaluation), **11 conference participations** (**9 with articles published** in Proceedings submitted for ISI indexing, 2 with indexing in SpringerLink, 2 with indexing in IEEE Xplore, 2 without publication), **1 book chapter** published in international publishing house and **5 articles of popularization in the media**. The achieved indicators far exceeded those proposed (6 deliverables, 4 articles submitted to journals, 5 articles submitted to conferences, 2 articles of media popularization). All results, except for the media outreach article accepted, but not published R23, contain *the project's acknowledgement*.

The articles developed within the project framework are:

(R1) M.I. Dascalu, I. Marin, I.V. Nemoianu, I.F. Puskás, A. Hang, *AN ONTOLOGY FOR EDUCATIONAL AND CAREER PROFILING BASED ON THE ROMANIAN OCCUPATION CLASSIFICATION FRAMEWORK: DESCRIPTION AND SCENARIOS OF UTILISATION*, 15th annual International Conference of Education, Research and Innovation, Sevilia (Spain), DOI: 10.21125/iceri.2022, ISBN: 978-84-09-45476-1, ISSN: 2340-1095, pg. 7386-7395, 7-9 November 2022 – dissemination of results from Activity 1.2, ISI conference article

(R2) I.C. Stanica, S.M. Hainagiu, S. Neagu, N. Litoiu, M.I. Dascalu, *HOW TO CHOOSE ONE'S CAREER? A PROPOSAL FOR A SMART CAREER PROFILER SYSTEM TO IMPROVE PRACTICES*

FROM ROMANIAN EDUCATIONAL INSTITUTIONS, ICERI2022, 15th annual International Conference of Education, Research and Innovation, Sevilia(Spain), DOI: 10.21125/iceri.2022, ISBN: 978-84-09-45476-1, ISSN: 2340-1095, pg. 7423-7432, 7-9 November 2022 – dissemination of results from Activity 1.1, ISI conference article

(R3) I.C. Stanica, I.A. Bratosin, D.A.Mitrea, C.N.Bodea, M.I. Dascalu, A.Hang, *BUILDING RELEVANT ELECTRONIC PROFILING FOR AUTOMATED CAREER RECOMMENDATIONS*, 40th IBIMA (International Business Information Management Association) Tech Conference 2022, Sevilia (Spain), ISBN: 979-8-9867719-1-5, ISSN: 2767-9640, 29-30 November 2022 – dissemination of results from Activity 1.1, ISI conference article

(R4) M.I. Dascalu, C.N.Bodea, I.V. Nemoianu, A.Hang, I.F. Puskás, I.C. Stanica, M. Dascalu, *CareProfSys – AN ONTOLOGY FOR CAREER DEVELOPMENT IN ENGINEERING DESIGNED FOR THE ROMANIAN JOB MARKET*, Rev. Roum. Sci. Techn.– Électrotechn. et Énerg. (RRST-EE), ISSN: 0035-4066, vol. 68 (2), WOS:001026628400016, DOI: https://doi.org/10.59277/RRST-EE.2023.68.2.16, pg. 212-217, 2023– dissemination results from Activity 1.2, carried out in phase I, updated in Phase II, ISI journal article

(R5) I.C. Stanica, I.A.Bratosin, D.A.Mitrea, C.N.Bodea, M.I. Dascalu, *Electronic Profiling in CareProfSys System for Career Recommendation*, Journal of Internet Social Networking & Virtual Communities, vol. 2023 (2023), Article ID 188953, 11 pages, ISSEN: 2166-0794, DOI: 10.5171/2023.188953, 2023 - diseminare rezultate din Activitatea 2.1, T3.1, BDI journal article (WorldCat)

(R6) C.G. Dragomirescu, R.M. Ciuceanu, M.I. Dascalu, I.V. Nemoianu, *THEORY OF CATASTROPHES REGARDING THE OPERATION OF A DC ELECTRIC MOTOR WITH SERIES EXCITATION*, Rev. Roum. Sci. Techn.– Électrotechn. et Énerg. (RRST-EE), ISSN: 0035-4066, vol. 68 (1), WOS:000973414700017, DOI: https://doi.org/10.59277/RRST-EE.2023.68.1.15, pg. 90-95, 2023 - diseminare rezultate din Activitatea 2.1, T3.2, article in ISI journal

(R7) M.I. Dascalu, A. Hang, I.F. Puskás, C.N. Bodea, *CareProfSys : a job recommender system based on machine learning and ontology to support learners' employability at regional level*, Issues in Information Systems, ISSN: 1529-7314, vol. 24(3), DOI: https://doi.org/10.48009/3_iis_2023_107, pg. 71-82, 2023 - diseminare rezultate din Activitatea 2.1, T3.2 și T3.3, article in BDI journal (Scopus)

(R8) M. Mitu, M. Dascalu, M.I. Dascalu, *ROMANIAN TOPIC MODELING – AN EVALUATION OF PROBABILISTIC VERSUS TRANSFORMER-BASED TOPIC MODELING FOR DOMAIN CATEGORIZATION*, Rev. Roum. Sci. Techn.– Électrotechn. et Énerg. (RRST-EE), ISSN: 0035-4066, vol. 68 (3), WOS:001087001200008, DOI: https://doi.org/10.59277/RRST-EE.2023.3.8, pg. 295-300, 2023 - diseminare rezultate din Activitatea 2.1, T3.2 și T3.3, article in ISI journal

(R9) C.N. Bodea, M. Paparic, R.I. Mogos, M.I. Dascalu, *Artificial Intelligence Adoption in the Workplace and Its Impact on the Upskilling and Reskilling Strategies*, Amfiteatru Economic, ISSN: 2247–9104, 26(65), Q2, DOI: 10.24818/EA/2024/65/126, pg. 126 - 144, 2024, https://www.amfiteatrueconomic.ro/RevistaDetalii_EN.aspx?Cod=1225 - dissemination results from Activity 2.1, T3.3 and T3.5, article in ISI Q2 journal

(R10) I.V. Nemoianuc V. Manescu (Paltanea), Gh. Paltanea, M.I. Dascalu, R.M. Ciuceanu, *Detailed Investigation of the Residual and Non-Symmetry Active and Reactive Power Flow for No-Neutral Three-Phase Nonlinear Circuits*, The 13th International Symposium on ADVANCED TOPICS IN ELECTRICAL ENGINEERING (ATEE2023), IEEE, Bucharest (Romania), ISBN: 979-8-3503-3193-6, ISSN: 2159-3604, DOI: 10.1109/ATEE58038.2023.10108343, 23-24 March 2023 - dissemination results from Activity 2.1, T3.2 and T3.3, ISI conference article

(R11) A. Hang, I. Puskas, M. Nitu, I.V. Nemoianu, M.I. Dascalu, *CareProfSys Recommender for Modern Engineering Roles based on Emergent Technologies*, The 13th International Symposium on ADVANCED TOPICS IN ELECTRICAL ENGINEERING (ATEE2023), IEEE, Bucharest (Romania), ISBN: 979-8-3503-3193-6, ISSN: 2159-3604, DOI: 10.1109/ATEE58038.2023.10108292, 23-24 March 2023 - dissemination results from Activity 2.1, T3.1, T3.2 and T3.3, ISI conference article

(R12) M.I. Dascalu, A. Hang, I.F. Puskás, C.N. Bodea, *CareProfSys : a job recommender system based on machine learning and ontology to support learners' employability at regional level*, 63th IACIS Annual Conference, Clearwater Beach, Florida, SUA, 4-7 October 2023 - dissemination of results from Activity 2.1, T3.2 and T3.3, conference oral presentation

(R13) M.I. Dascalu, R. Birzaneanu, C.N. Bodea, *An Ontology-based Recommendation Module for Optimal Career Choices*, Proceedings of 2024 Future of Information and Communication Conference (FICC), Springer series "Lecture Notes in Networks and Systems", vol. 921, ISBN: 978-3-031-54052-3, DOI: https://doi.org/10.1007/978-3-031-54053-0_23, Future of Information and Communication Conference (FICC), Berlin (Germany), pg. 318-331, 4-5 April 2024 - dissemination results from Activity 2.1, T3.2, T3.3, T3.4 and T3.5, ISI conference article

(R14) M.I. Dascalu, A.S. Bumbacea, I.A. Bratosin, I.C. Stanica, C.N. Bodea, *CareProfSys - Combining Machine Learning and Virtual Reality to Build an Attractive Job Recommender System for Youth: Technical Details and Experimental Data*, Engineering of Computer-Based Systems. ECBS 2023. Lecture Notes in Computer Science, vol 14390, ISBN: 978-3-031-49251-8, DOI: https://doi.org/10.1007/978, ECBS 2023: 8th International Conference on Engineering of Computer-based Systems, Västerås (Sweden), pg. 289–298, 16-19 Oct. 2023 - dissemination results from Activity 2.1, T3.2, T3.3, T3.4 and T3.5, ISI conference article

(R15) M.I. Dascalu, V.A. Brîndușescu, I.C. Stanica, B.I. Uta, I.A. Bratosin, A. Mitrea, *CHATBOT CAREPROFSYS POUR SOUTENIR LE CONSEIL ET L'ORIENTATION VERS UNE PROFESSION DANS UN DOMAINE D'INGENIERIE*, La 2ème édition du Symposium de la recherche scientifique francophone en Europe centrale et orientale, Bucharest (Romania), 27-28 Nov. 2023 - dissemination results from Activity 2.1, T3.3 and T3.5, conference article

(R16) Înregistrarea CareProfSys de la emisiunea @UPB-Euronews Romania pe canalul YouTube al Facultatii de Inginerie in Limbi Straine – POLITEHNICA București, https://www.youtube.com/watch?v=JwRik4zcUYk - dissemination results from Activity 2.1, T3.3, media article

(R17) M.I. Dascalu, C.N. Bodea, I.C. Stanica, D.A. Mitrea, S.M. Hainagiu, S.N. Neagu, T.M. Ursachi, *From Traditional Career Services to Intelligent Systems for Career Guidance: A Study of Career Services Diversity in Higher Education Institutions*, chapter in “Prioritizing Skills Development for Student Employability”, ISBN13: 9798369335710, IGI Global, DOI: DOI: 10.4018/979-8-3693-3571-0.ch004, pg. 89-119, 2024- dissemination results from Activity 3.1, book chapter in international publishing house

(R18) R. Birzaneanu, M.I. Dascalu, I.C. Stanica, I.A. Bratosin, A. Vasilateanu, T.M. Ursachi, R.E. Brezoaie, *RECOMMENDER SYSTEMS TO SUPPORT STUDENTS' EMPLOYABILITY: THE CASE STUDY OF CAREPROFSYS*, INTED2024 Proceedings, 18th International Technology, Education and Development Conference, pg. 7208-7217, 4-6 March 2024, Valencia, Spain- dissemination results from Activity 3.1, ISI conference article

(R19) M.I. Dascalu, V.A. Brîndușescu, I.C. Stanica, B.I. Uta, I.A. Bratosin, D.A. Mitrea, R.E. Brezoaie, *CHATBOTS FOR CAREER GUIDANCE: THE CASE OF CAREPROFSYS CONVERSATIONAL AGENT*, INTED2024 Proceedings, 18th International Technology, Education and Development Conference, pg. 6194-6204, 4-6 March 2024, Valencia, Spain- dissemination results from Activity 3.1, ISI conference article

(R20) Mention of CareProfSys at the TV show "Human Revolution. Human Resources - Partners in Building the Future" | RO3.0 Antena 3 CNN on the YouTube channel of the Faculty of Engineering in Foreign Languages, POLITEHNICA Bucharest, https://www.youtube.com/watch?v=RnZId5haIoM (min8:s43) - dissemination results from Activity 3.1, media article

(R21) Mention of CareProfSys from Euro Educatiea-Euronews Romania show on the YouTube channel of the Faculty of Engineering in Foreign Languages, POLITEHNICA Bucharest, https://www.youtube.com/watch?v=M0gzzH81SIQ (min25:s17)- dissemination results from Activity 3.1, media article

(R22) Mention of CareProfSys from News-Euronews Romania on the Facebook page of the Faculty of Engineering in Foreign Languages, POLITEHNICA Bucharest, https://www.facebook.com/fils.upb/posts/965806905552746?ref=embed_post - dissemination results from Activity 3.1, media article

(R23) Article "Cum influențează Inteligența Artificială (IA) piața muncii și alegerea joburilor", accepted for https://www.paginadepsihologie.ro/ - dissemination results from Activity 3.1, media article

(R24) M.I.Dascalu, I.C. Stanica, I.A. Bratosin, B.I. Uta, C.N. Bodea, *Virtual Reality for Career Development and Exploration: the CareProfSys Profiler System Case*, Electronics, ISSN: 2079-9292 - dissemination results from Activity 3.1, article in evaluation at ISI Q2 journal

Dissemination of results and project website

The results were disseminated through papers published in *the Proceedings of* 9 prestigious international conferences (which will be sent for evaluation and inclusion in Web of Science, 2 indexed IEEE Xplore, 2 indexed SpringerLink), 1 oral presentation at an international conference in the USA, 1 article presented at a francophone research symposium, 6 articles published in journals (4 indexed by ISI, of which 1 Q2 and another 2 BDI -1 Scopus, 1 WorldCat), 1 ISI Q2 journal article under evaluation, 5 media outreach articles. CareProfSys was presented or mentioned by its director, as well as by other members, on 3 TV shows of EuroNews Romania (@UPB, Euro Education, News), as well as on the show "Human Revolution. Human Resources - Partners in Building the Future" RO3.0 on Antena 3 CNN.

The project was also disseminated through ***its website*** (see Figure 9), continuously updated and available in two languages (English and Romanian) to ensure visibility of the results (http://careprofsys.upb.ro/) and through the dedicated social media page (Facebook) (https://www.facebook.com/CareProfSys.UPB). The publication of the news related to the project was also done on the social media profile (LinkedIn) of the project director (https://www.linkedin.com/in/mariaiulianadascalu/), as well as on the web page (https://fils.upb.ro/ro/2024/05/03/workshop-diseminare-careprofsys/) or facebook (https://www.facebook.com/fils.upb) of the Faculty of Engineering in Foreign Languages – POLITEHNICA of Bucharest. The project team also disseminated its results at 3 educational fairs POLIFEST 2023, ROBOFEST 2023 and POLIFEST 2024, organized by POLITEHNICA Bucharest, but also at conferences in the country, the European Union (ECBS, INTED, ICERI, IBIMA) and the USA (IACIS).

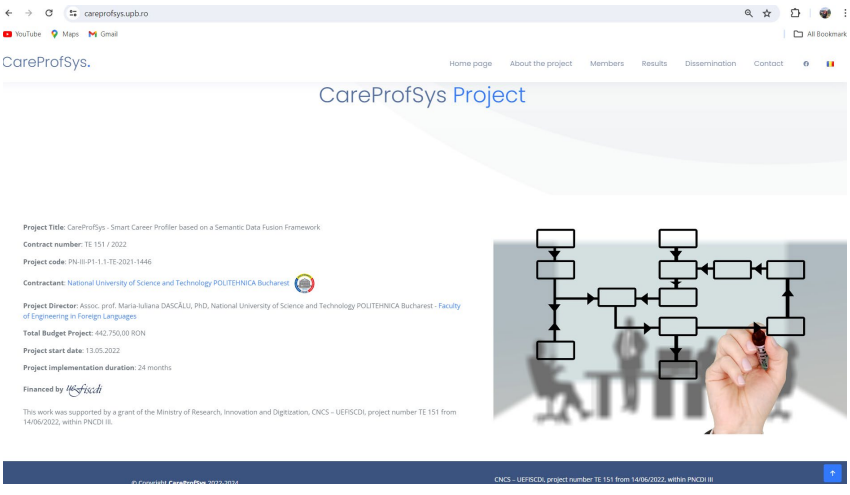

Figure 9. CareProfSys Project Website: http://careprofsys.upb.ro/

Estimated impact of results achieved

The CareProfSys project has a **significant scientific, technological, cultural, and socio-economic impact**. From a **scientific** point of view, CareProfSys has impacted not only the scientific field of applied informatics and information technology (it has made significant contributions to the combined application of ontological and machine learning algorithms in career recommendation, to the exploitation of social network

connectors, to the integration of virtual reality into recommendations, etc.), but also to that of psychology and educational sciences (it has contributed to the awareness of the importance of ICT tools support in career counselling). From **a technological** point of view, the project is impactful, as it exploits the integration of emerging technologies: virtual reality, semantic technologies, merged data mining technologies, technologies for conversational agents. From a cultural point of view, the project supports the communication values of today's society, mediated through social networks and ICT. **The biggest impact of the project is the socio-economic one**, as it demonstrates the importance of technology in human capital development: young people have the chance to benefit from profession recommendations, to explore those professions in virtual reality scenarios and thus to make appropriate career choices, reducing in time the school dropout rate and, implicitly, the financial pressure on the government, which will no longer unnecessarily finance the education of undecided young people; at the same time, career counsellors, now overworked, will have effective support in technology.

We consider **the most important result** to integrate virtual reality into the mechanism of recommending professions, thus transforming the CareProfSys system into a very suitable one for young people, a result appreciated by the participants in the organized experiments, by over 65 pupils and students at the dissemination workshop, as well as by the feedback obtained from appearances in 4 TV shows, participation in conferences in the EU and USA and publication in ISI journals.

Conclusions

The CareProfSys system – "Intelligent career profile system based on a semantic data fusion platform" aims to be a support for young people (high school students, students, professionals who want a professional reconversion) in finding the ideal profession and also an aid for counselors in career guidance centers. CareProfSys exploits current emerging technologies, trying to successfully integrate them: artificial intelligence, machine learning, ontologies, virtual reality on the Web, social web, chatbot technologies. The system architecture is tiered and highly modular, based heavily on APIs. The system was intensively tested, both in 2023 and 2024, when we conducted two rounds of experiments, with the aim of analyzing the usefulness / UX / prototype of the CareProfSys research project, including the web recommendation platform (which also contains the chatbot module) and, optionally, the virtual reality (VR) scene corresponding to the recommended career. The experiment was attended by 47 students from POLITEHNICA Bucharest, and the results were analyzed with the help of 2 career counselors from the UPB-CCOC Career Counseling and Guidance Center. The results were used to optimize the system, which was very well received by the participants in the experiments, both in terms of usability and functionality or performance.

As threats to the validity of experimental results, we note that the true usefulness of a profession recommendation system can be truly assessed over time, whether users choose their recommended profession or not. The experiments were conducted according to a protocol, and all participants signed a data protection agreement and an informed consent form: participants agreed that the experiments' data would be used for teaching or research purposes. There are no known or foreseeable risks associated with the experimental protocol we use. In the unlikely event that side effects caused by the use of virtual reality occur, participants were asked to inform the project member responsible for discontinuing the experiment. However, we have not had such

situations. We believe that the experiments conducted within UPB-CCOC were very useful for the success of the project and validated the idea of such an intelligent system that can support young people in making the right decisions for their future, career counselors in their professional activities, but, indirectly, also higher education institutions and the government (by decreasing school dropout) and employing companies (through more motivated and passionate employees).

The CareProfSys system is well received and considered useful by the scientific world and society in general, as proven by the opinion of over 65 participants, pupils, and students, at the project dissemination workshop, as well as by the publications made, media appearances and participation in educational fairs.

ACKNOWLEDGMENT

This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS–UEFISCDI, project number TE 151 from 14/06/2022, within PNCDI III: “Smart Career Profiler based on a Semantic Data Fusion Framework”.

Bibliography

1. Holland's theory of personality, https://www.scrigroup.com/educatie/psihologie-psihiatrie/TEORIA-PERSONALITATII-A-LUI-HO62718.php
2. Chestionar MBTI, https://www.jobtestsuccess.com/mbti-test/
3. Chestionar INEM, https://www.psihoprofile.ro/Content/Questionnaires/1/41/RaportdeconsiliereINEM2022.pdf
4. M. Jigau, “Career counselling. Compendium of methods and techniques”, *AFIR Publishing House*, Bucharest, 2007
5. Romanian Ministry of Education, Official Website, www.edu.ro
6. R. Burke, "Hybrid Recommender Systems:Survey and Experiments," User Model. User-Adapt. Interact, vol. 12, no. 4, pp. 331–370, 2002.
7. R. Mishra, S. Rathi, “Enhanced DSSM (deep semantic structure modelling) technique for job recommendation”, *Journal of King Saud University - Computer and Information Sciences*, 2021.
8. A. Nigam, A. Roy, H. Singh and H. Waila, "Job Recommendation through Progression of Job Selection," *2019 IEEE 6th International Conference on Cloud Computing and Intelligence Systems (CCIS)*, pp. 212-216, 2019
9. S. R. Rimitha, V. Abburu, A. Kiranmai and K. Chandrasekaran, "Ontologies to Model User Profiles in Personalized Job Recommendation," 2018 IEEE Distributed Computing, VLSI, Electrical Circuits and Robotics (DISCOVER), 2018, pp. 98-103, doi: 10.1109/DISCOVER.2018.8674084
10. May Fern Koh, Yew Choong Chew, Intelligent Job Matching with Self-learning Recommendation Engine, Procedia Manufacturing, Volume 3, 2015, Pages 1959-1965
11. Classification of occupations in Romania, https://www.rubinian.com/cor_1_grupa_majora.php, 2022
12. F. Garcia-Lopera, JM Santos-Jaén, M. Palacios-Manzano, D. Ruiz-Palomo, Exploring the effect of professionalization, risk-taking and technological innovation on business performance. PLoS ONE 17(2) (2022).
13. CV Europass, http://www.europass.eu/1.0
14. Personality Test Briggs Myers, https://www.truity.com/test/type-finder-personality-test-new
15. ESCO profession-skills tables, https://esco.ec.europa.eu/en/about-esco/data-science-and-esco/esco-skill-occupation-matrix-Tabeluls-linking-occupation-and-skill-groups
16. ISCO - International Standard Classification of Occupations https://www.ilo.org/public/english/bureau/stat/isco/
17. MongoDB, https://www.mongodb.com/
18. Apache Jena - Getting started with Apache Jena, https://jena.apache.org/getting_started/index.html, last accessed 2023/06/18
19. Horridge, M., Bechhofer, S.: The OWL API: A Java API for OWL Ontologies. Semantic Web Journal (2010), https://www.semantic-web-journal.net/content/owl-api-java-api-owl-ontologies
20. Glimm, B., Horrocks, I., Motik, B. et al. HermiT: An OWL 2 Reasoner. J Autom Reasoning 53, 245–269 (2014). https://doi.org/10.1007/s10817-014-9305-1
21. Protégé, https://protege.stanford.edu/
22. Glimm, B., Horrocks, I., Motik, B. et al. HermiT: An OWL 2 Reasoner. J Autom Reasoning 53, 245–269 (2014). https://doi.org/10.1007/s10817-014-9305-1
23. Horridge, M., Bechhofer, S.: The OWL API: A Java API for OWL Ontologies. Semantic Web Journal (2010), https://www.semantic-web-journal.net/content/owl-api-java-api-owl-ontologies
24. SCIKIT-Învățare automata în Python, https://scikit-learn.org/stable/
25. Unity, https://unity.com/
26. Pandorabots, https://home.Pandorabots.com/home.html

27. SwaggerUI, https://swagger.io/tools/swagger-ui/
28. Oculus Casting, https://www.oculus.com/casting/

Annexes: deliverables and publications in extenso

Annex 1. Deliverable 1 - Analysis report and user requirements of the system (phase I)
Annex 2. Deliverable 2 - Report on system software requirements and design (phase I)
Annex 3. Deliverable 3 - COR ontology and its description (phase I)
Annex 4. Deliverable 4 - Report on the software requirements of the system and its design (phase II)
Annex 5. Deliverable 5 - Report on exploitation experiments and analysis of results (phase III)
Annex 6. Deliverable 6 - Raport dissemination workshop (phase III)
Annex 7. R1 - Article in extenso - ICERI conference (phase I)
Annex 8. R2 - Article in extenso - ICERI conference (phase I)
Annex 9. R3 - Article in extenso – IBIMA conference (phase I)
Annex 10. R4 - Article in extenso – ISI journal Rev. Roum. Sci. Techn.– Électrotechn. et énerg. (sent in phase I and updated in phase II)
Annex 11. R5 - Article in extenso –BDI journal Journal of Internet Social Networking & Virtual Communities (phase II)
Annex 12. R6 - Article in extenso – ISI journal Rev. Roum. Sci. Techn.– Électrotechn. et Énerg. (phase II)
Annex 13. R7 - Article in extenso – BDI journal Issues in Information Systems (phase)
Annex 14. R8 - Article in extenso – ISI journal Rev. Roum. Sci. Techn.– Électrotechn. et Énerg. (phase II)
Annex 15. R9 - Article in extenso – ISI Q2 journal Amfiteatru economic (sent in phase II and updated in phase III)
Annex 16. R10 - Article in extenso – IEEE ATEE conference (phase II)
Annex 17. R11 - Article in extenso – IEEE ATEE conference (phase II)
Annex 18. R12 – Prezentare orală – IACIS conference (phase II)
Annex 19. R13 - Article in extenso – FICC conference (phase II)
Annex 20. R14 - Article in extenso – ECBS conference (phase II)
Annex 21. R15 - Article in extenso – RSF Conference (phase II)
Annex 22. R16 - Media outreach article (phase II)
Annex 23. R17 - Chapter in extenso – book chapter - IGI Global (phase III)
Annex 24. R18 - Article in extenso - INTED Conference (phase III)
Annex 25. R19 - Article in extenso - Conference - INTED (phase III)
Annex 26. R20 - Media outreach article - YouTubeFILS - Antena 3 CNN (phase III)
Annex 27. R21- Media outreach article - YouTubeFILS - EuroNews Euro Educatia (phase III)
Annex 28. R22 - Media outreach article - FacebookFILS - EuroNews News (phase III)
Annex 29. R23 - Media outreach article – Article accepted at https://www.paginadepsihologie.ro/ (phase III)
Annex 30. R24 – Article in extenso - ISI Q2 journal Electronics (phase III)

PROJECT DIRECTOR,

DASCĂLU, MARIA-IULIANA