easyRights

DELIVERABLE

D1.2 Technological State of the Art and Mockup solutions

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Statement of Originality

This Deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

Table of Contents

List of Figures

List of Tables

Executive Summary

This deliverable reports about the work done in easyRights WP1 “Project Perimeter and Methodologies” on documenting “Technological State of the Art and Mockup solutions”.

The goal of this task was to develop a common understanding among project partners and EU Commission on the technology challenges being addressed in this project and define baselines for comparison.

These challenges cover three outstanding pillars: language technologies, personalization technologies and gamification strategies for establishing a human-in-the-loop process in order to exploit user feedback and further instruct and tune the proposed technologies.

This document, also, presents the initial mockups of three technologies namely i) a generator of easy instructions to lower the bureaucracy level for migrants that we called pathway generator; ii) a vocabulary course generator, and iii) a pronunciation training platform. The three are put in perspective through a functional diagram that gives an overview of the interconnections among them and gives a first formal representation of the easyRights digital platform.

LINKS Foundation led the conceptualization of this deliverable, editing an initial version of the document, then acquired and valorized inputs from partners 21C, UTH, NTNU, IED, CAP, and POLIMI providing an advanced draft and addressing comments and questions from internal reviewers in the final version.

1. Introduction

Migration is a worldwide phenomenon, as according to UNHCR around 70.8 million people were registered as migrants in 2019.[1] As a result, there is a need for a better understanding of this phenomenon and for tools to support migrants. Migrants encounter, among others, information poverty (Caidi et al., 2010), cultural barriers and limited proficiency in the local language (Brown and Grinter, 2016). Some technological solutions have been developed to help migrants address these challenges (Brown and Grinter, 2016; Talhouk et al., 2017; Shankar et al.,2016) as technology facilitates a sustainable integration of refugees in their new place.

Digital literacy and Information Computer Technology (ICT) skills, are part of the 21st century set of skills that modern educational systems have incorporated in their curricula, since they are expected to help learners in their effective communication, life-long learning and professional career (World Economic Forum, 2015; Brown et al., 2019). Current and future professionals need a strong knowledge of digital skills, since nowadays labour has been affected by a digital transformation, whereby digital technologies, such as automation, digitalization, robotics, artificial intelligence, the Internet of Things (IoT), web-based platforms and location-based applications have changed the landscape of economic transactions and social processes (Biagi et al., 2017 p.6; Berg et al., 2018).

The field of migration could not have remained unaffected by this wave of digital technology in almost every sector of human life. According to OECD (2019), digitalization presents several implications for migration, since migrants are required to deal with automated jobs, in which they may lack prior knowledge and training and at the same time it impacts the protection of migrant workers through the use of digital migration management platforms that simplify administrative procedures and remittance transfers, in respect of data protection laws, through the considerate use of biometric tools..

Within the European Union's H2020 Programme, Innovation Actions such as NADINE[2] and MICADO[3] aim at incorporating intelligent technological solutions in an effort to improve administrative procedures and guidance for migrants. Within this framework, in the EASYRIGHTS project an attempt is made to pilot current technological solutions and artificial intelligence tools that will be presented in the sections that follow, with the purpose of facilitating migrants to exercise their rights and achieve full integration through simplified local administration procedures.
The reminder of this document is structured as follows:

- Section 2 provides the mockups of the technology components that will be part of the easyRights platform;

[1] https://www.unhcr.org/data.html
[2] http://www.nadine-project.eu
[3] https://www.micadoproject.eu

- Section 3 introduces the whole easyRIghts technology platform;
- Section 4 provides a background of the chosen language technologies necessary for the massive and automated analysis of the large bulk of textual information available in welcome organizations and public authorities. This information is usually available in languages not known by migrants, thus we will report about the tools for course generation and the execution of pronunciation exercises.
- Section 5 provides a background of automated personalization techniques in order to tailor the communication with a migrant.
- Section 6 reports of existing approaches on gamification for enabling a human-in-the-loop experience to foster a feedback channel with the migrant meant to instruct the learning language and personalization technologies.
- Section 7 concludes the document.

2. Mockup solutions

In a scenario in which a migrant is looking for a job, he/she first looks for the necessary information and documents in order to apply for the job and be able to handle an interview. However, he/she would need the necessary understanding of the language and lexicon utilized in that job in order to be able to hold an interview, and likewise being able to speak in a comprehensible manner.

This is a typical scenario we aim to address with the technologies proposed in easyRights by implementing an AI-based system that generates automatically easy instructions to migrants starting from a bulk of textual information available in an unstructured manner. A topic-specific course generator relying on automated technologies for language processing, will support the learning of the semantics and will be followed by pronunciation exercises tailored on the words of the course.

Such a scenario is utilized as a use case for motivating the application of the easyRights technology solutions that are described individually below. We have envisioned several other use cases, such as applying for a family reunion and residence permit. A list of these use cases is supplied in D1.3.

The difficulty of the heterogeneity of these cases and the documents ruling the interactions between migrants, authorities and organizations make necessary the implementation of technologies as proposed below.

2.1. Automated easy instruction pathway generator

In order to facilitate the retrieving of information for immigrants, it is required a technology that is easy to use and widely distributed.

An example of this is a conversational agent that represents a powerful tool both for users and companies, as described in Section 4.2: it allows to insert a highly intuitive element that greatly simplifies the user interaction with the platform. Moreover, it can be implemented with instant services such as Telegram: in a few simple steps, by simply chatting, it can be done numerous operations.

Figure 2.1: The first information we need is the one about the country in which the migrant wants to apply: in fact, depending on the country, the operations that have to be done and the documentation requirements are different

In an example of how the user experience can be in such a context, you can first of all choose the country you want to have information about (Figure 2.1).

Hereafter, the next question is about the request of the action that has to be performed (Figure 2.2). In this case, the menu that will be presented will depend on the choice made in the previous question.

Depending on that choice, it will be possible to request more information in order to be more precise in the response (for example, for family reunification may be requested the size and the nationality of the family).

Furthermore, from the system usage data it will be possible to predict, from the preliminary information entered by the migrant, the possible actions that he/she will want to perform by utilizing a recommender system (very useful for this kind of problems that present several repeated questions and described in Section 5), so that the conversational agent's efficiency is optimized even more.

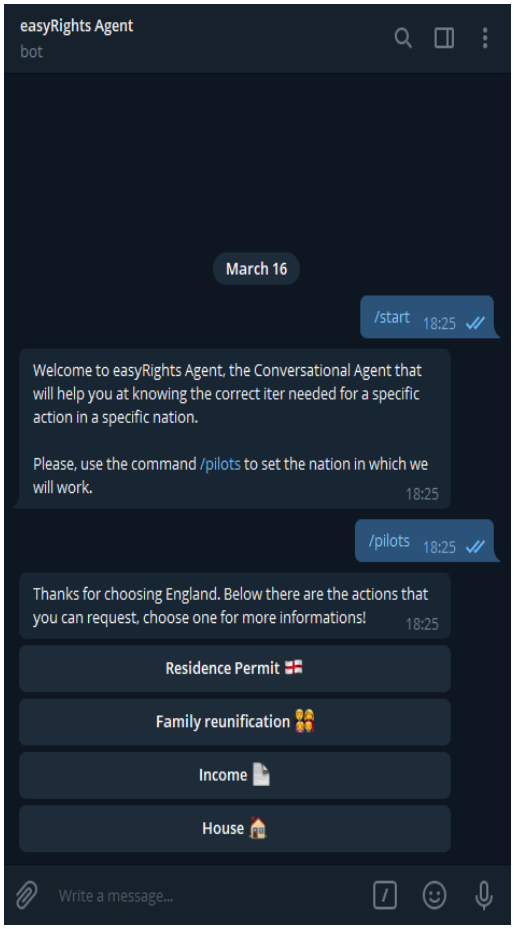

Figure 2.2: different options will be displayed in the form of buttons to choose from: these are the specific actions that can be carried out by the migrants in that country

Here we introduce the concept of *pathway*: it is a sort of generated entity that encompasses the actions and information that are necessary in order to carry out a specific request. We have 4 attributes:

- *WHERE*: this contains the web pages or addresses (if the action requires the presence of a person) where it is possible to submit the request for the chosen action.
- *WHEN*: this contains the possible deadlines for the request in question; for some actions this field will not be displayed as they do not have an expiry date.
- *HOW*: this contains the information necessary for the submitting; for example, it will contain the lists of documents that the migrant needs to apply for.
- *WHAT*: this contains the information about the specific request.

After the question asked, we define what we called *WHAT*. This will help us optimize the pathway generation process, the result of which will have to contain all the information needed (Figure 2.3).

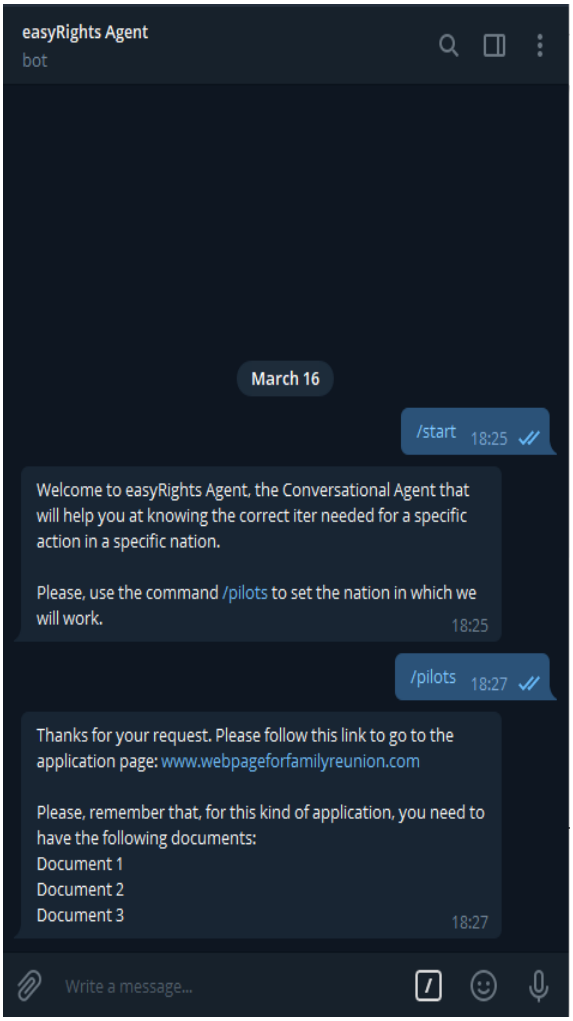

Figure 2.3: Once all the information is obtained, the conversational agent, which is connected to the AI module through APIs, will generate a response containing the pathway for the request

In order to do that, it is appropriate to use Natural Language Processing methodologies (detailed description on Section 4.1), capable of extrapolating information from textual documents and then structure the result in a *pathway*.

In Figure 2.4, we have a basic diagram that summarizes the concepts expressed so far.

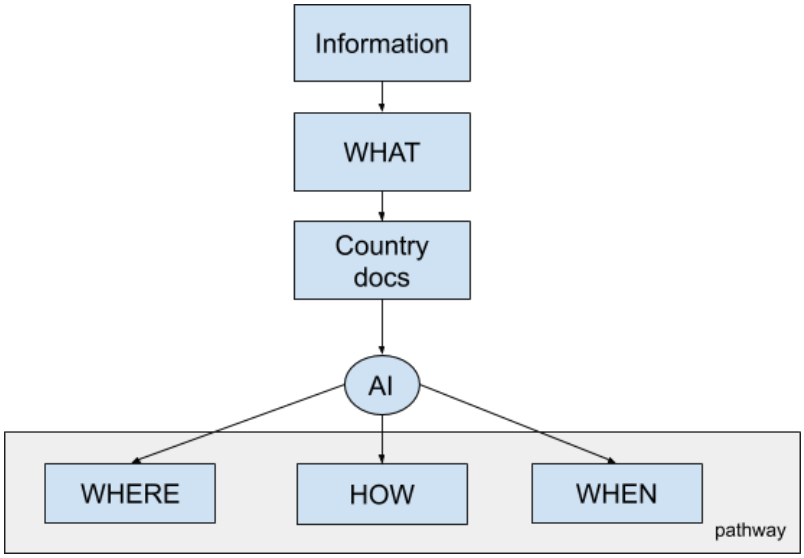

Figure 2.4: Workflow of the pathway generation process

2.2. Domain-specific course generator

Capeesh will offer tailored vocabulary training in the four languages spoken in the pilot communities: Greek, Italian, Spanish and English. The tailored courses will help migrants overcome language barriers when dealing with local bureaucracy and therefore enable migrants to access their rights easier. Artificial intelligence will be used to analyze the relevant documents provided by pilots and extract the most crucial vocabulary, selecting the words and phrases that are essential to memorize in order to successfully accomplish the tasks specified by the pilot communities. This selected vocabulary will be taught to the main migrant groups in their native languages through a gamified app. The exercises are arranged with increasing difficulty according to the principles of spaced repetition to ensure maximal retention of the vocabulary. First of all the users train on writing, reading and recognizing the words individually, and then also in the domain relevant context.

Capeesh course creator is an online tool[4] allowing teachers or domain experts to automatically approve preselected words and sentences. The automatic translations into users' languages are checked by human translators in the online tool. Furthermore, the online course creation platform allows creation of illustrated custom lessons and challenges. Users' progress is stored and analyzed with the reporting tools, so that full data is collected both on the time users spend in the app, their progress, and performance on different types of quizzes. This data is continuously used for improvement and optimization of the learning progress.

[4] https://www.capeesh.com

The current NLP tools for selecting and analyzing the relevant words and contexts, described in Section 4.3, will be improved for English and Spanish and additional NLP tools will be developed for Italian and Greek. In order to select the relevant words and appropriate contexts, adapted to learners language level and needs, Capeesh uses NLP tools for lemmatization, part of speech tagging, morphological and syntactic analysis, translation disambiguation, phrase detection and difficulty level evaluation of both words and sentences. While many of these tools are available and already well developed for English, the NLP tools for the other three languages are less developed, and less corpus data is available, so these will require significant testing and optimization.

Gamification when applied to training situations has the potential to greatly increase learners motivation, help achieve a better long-term learning effect and generally increase the learning efficiency. This is the reason why most education and serious applications today strive to implement gamification features such as experience points, levels, achievements, streaks and leaderboards (Section 6.1) and will be an essential pillar of the easyRights interaction with migrants for course learning.

2.3. Language mapping and pronunciation

The easyRights project focuses on migrants in Greece, Italy, Spain and the UK. CALST[5] will therefore offer pronunciation training for the four languages spoken in these countries. Sound contrast exercises in CALST are already available for British English (Standard Southern English). CALST will be extended to Greek, Italian and (Castilian) Spanish. This requires a phonological analysis of the sound systems of these languages, which will be used to determine which contrasts must be implemented in exercises. For example, Greek shows a large, mostly free variation in the allophonic realization of voiced consonants [b,d,g], which can be realized with or without prenasalization (except at the beginning of a word or if the preceding syllable in the same word contains a coda consonant, in which case prenasalization is never used). To understand Greek and pronounce it correctly, it is important that learners become aware of this variation and learn that for instance [mb] is not a sound *cluster* but is functionally equivalent with [b]. Each of the three new target languages in CALST will be analysed linguistically to determine how best to develop exercises for language learners.

In Section 4.4, we also explained that the pronunciation training in CALST takes the learner's native language into consideration. In the project, we shall therefore inventorize the native languages and lingua franca spoken by the migrant groups in the different pilot cities. If they are not yet available in the system, languages of larger migrant groups will be added to L1-L2*map*, so that these migrants will receive tailored exercises in CALST.

[5] https://calst.hf.ntnu.no

For the five main migrant groups, we aim to also supply instructions in CALST in a language which they already are familiar with. This can be five native languages of groups that are strongly represented, but it may also be a lingua franca which several migrant groups speak to increase the reach of CALST.

CALST logs all user results. This is important to further tailor the pronunciation training to the learner's needs. It also allows the learner to see his/her progress, to remind the migrant user that improved oral skills will help to be understood in oral communication with administrators and other native speakers alike.

3. easyRights technology platform

easyRights technology platform is designed to provide tools to facilitate the access to complex administrative services in a way that mediates, within a co-creation approach, between migrants and public administrations and, in particular, help those newly arrived to more easily exercise their rights, whilst improving language skills.

easyRights platform will have three outputs that are anyway strongly related each other and they are:

- Simplified version of administrative pages presented in actionable sentences, what we defined being a pathway;
- Mobile domain-specific course;
- Web-learning platform for pronunciation exercises.

These three outputs utilize the technology components described in Section 4. In Figure 3.1, we provide an illustration of the functional diagram of the components as part of the easyRights technology platform we have envisioned.

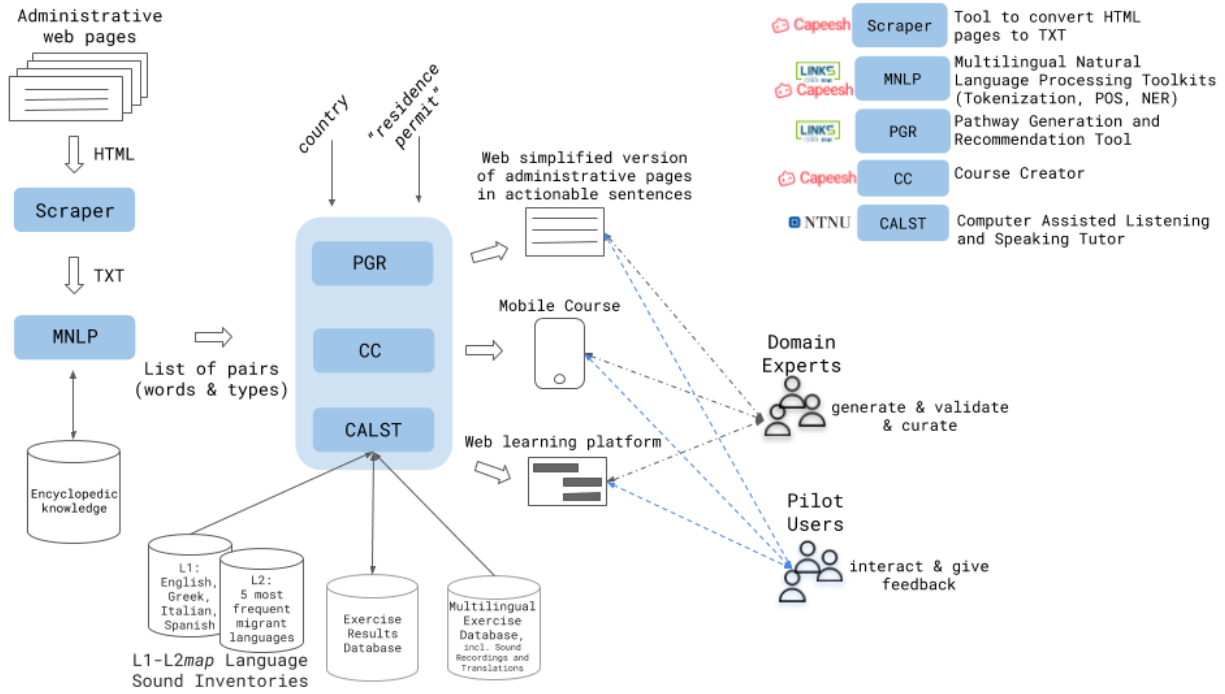

Figure 3.1: Functional Diagram of the easyRights technology solutions. Three outputs will offer tangible tools to migrants and administrations. The innovation of the solution stands in the adaptive technology that is built utilizing artificial intelligence and foreseen a human-in-the-loop intervention

The outputs will then be assessed by both experts and pilot users in hackathons. This procedure of having a human-in-the-loop will grant necessary information about the output of the solutions and the feedback will be then utilized in a learning fashion to improve their outputs in further iterations.

4. Background on language technologies

Language is a means of communication consisting of the use of words in structured and conventional ways (syntax) to deliver multifarious meanings (semantics) as reported in Rizzo and Van (2020). Numerous technologies have been investigated for processing automatically language to structure meanings and capture phonetics, as well as for generating courses meant to give basics on language learning and in a more and more personalized fashion (Section 5). Artificial intelligence is offering valuable approaches for addressing these challenges, all these require a large bulk of examples generated by users, having thus a human-in-the-loop contribution as illustrated in Section 6.

4.1. Fundamentals of natural language processing

Text processing is a staging process, which requires filtering text according to an end-to-end pipeline. This pipeline comprises tokenizing raw text, cleaning punctuations and other signs, vectorizing text into numbers to be processed by algorithms, applying the desired model for training, validating model and filtering desired results. We often refer to this pipeline as illustrated in Figure 4.1 as a multi-stage procedure of natural language process (NLP).

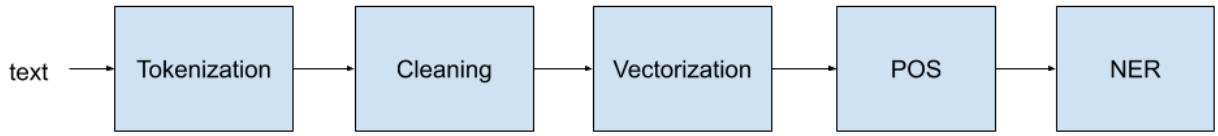

Figure 4.1: Multi-stage procedure of natural language processing

Tokenization: it is a very useful process before applying NLP methods. It is simply breaking a stream of text into words, phrases or meaningful symbols known as tokens. Many built-in methods are used for splitting sentences of clinical notes based on spaces, punctuations, medical notations and symbols. It is also known as lexical analysis.

Cleaning: After the text is split, some most commonly repeated words which are known as stop words are removed. These tokens do not contain much contextual meaning and are often repeated for grammatical purposes.

Stemming and Lemmatization are known as text normalization techniques. Stemming removes suffixes, prefixes and extra additions to words. These words are normally inflected with addition to the present form of the verb.

Lemmatization is similar to Stemming with the difference that it brings context to the words. So it links words with similar meaning to one word.

Text preprocessing includes both Stemming as well as Lemmatization. Many times people find these two terms confusing. Some treat these two as the same. Actually, lemmatization is preferred over Stemming because lemmatization does a morphological analysis of the words.

Vectorization: software tools can only understand and process numbers but texts. So these cleaned tokens need to be converted into vectors of numbers in a reasonable way. This process of converting text into numbers is known as vectorization or embedding. There are various techniques available for this task.

One-hot encoding is an integer encoding or frequency-based encoding suffers from many problems such as long-tail or distributional bias. Some tokens may appear very regularly whereas some may be less common. This creates a need to present words in a one-dimensional vector. This form of vectorization takes categorical data and returns numerical binary data for it. Here (1) shows the presence and (0) poses the absence.

For example:
“Black” = [1,0,0,0]
“White” = [0,1,0,0]
“Red” = [0,0,1,0]
“Blue” = [0,0,0,1]

0ne-hot encoding eliminates the tokens distribution disparity and is most appropriate for shorter documents with fewer repetitive words.
Bag-of-Word (BOW) is the crudest model available in Natural Language Processing. It predicts the current word based on context. This representation is formed based on the occurrence of words in a document. It involves a vocabulary of known words and the total count of the presence of known words. Order of words or information is lost, that is why it is called a “bag”.

For example: “It is the best time. It is the time when we have the technology.”

Here we have 9 unique words. We will make a frequency vector with one-position for the corresponding word.

“It” = [1 0 0 0 0 0 0 0 0]
“is” = [0 1 0 0 0 0 0 0 0]
“the” = [0 0 1 0 0 0 0 0 0]

"best" = [0 0 0 1 0 0 0 0 0]
"time" = [0 0 0 0 1 0 0 0 0]
"when" = [0 0 0 0 0 1 0 0 0]
"we" = [0 0 0 0 0 0 1 0 0]
"have" = [0 0 0 0 0 0 0 1 0]
"technology" ===>[0 0 0 0 0 0 0 0 1]

Now to vectorize the sentence, we present the count on the corresponding position in the frequency vector thus "It is time when we have technology" becomes [1 1 0 0 1 1 1 1 1].

There comes a problem when corpus increases and we have a large vocabulary that results in a vector with a higher dimension and a lot of zeros for less frequent words. It requires memory resources and makes computation inefficient. A different approach of k-gram can be used in this case to combine multiple common recurring words and use on position for them (Tomas Mikolov et al, 2013).

Term Frequency (TF) has been popular for a long time because it is simple to use. It consists in counting the number of times a word appears in a document. A concern with scoring word frequency is that in the text, highly common words tend to dominate (e.g., greater score), but may not contain as much "information content" as rare but perhaps domain-specific words to the model.
The inverse document frequency is used to re-scale the frequency of terms by how often they occur in a document, in order to penalize the scores for commonly used words such as "the," which are also common across all documents.

TF-IDF is the product of two statistics, namely term frequency and inverse document frequency. There are various ways of determining the exact values of both statistics.

$$\text{TF-IDF}(t,d,D) = \text{TF}(t,d) * \text{IDF}(t) = \frac{f_{t,d}}{|d|} \times \log \frac{|D|}{|\{d : t \in d\}|}$$

t is the term, d the document and D the set of documents, |D| is the number of documents, and $|\{d : t \in d\}|$ are the number of documents that contain term t. The result of each term is within the range [0,1] where term closer to 1 is more meaningful and vice versa.

Word embeddings are efficiently generally formed the pre-trained models for large corpus. It is a faster approach that follows the property of cosine similarity. The most frequent problem in these models is out-of-vocabulary words and the use of language in which similar distribution in language has a similar meaning. These similarities are either paradigmatic like things which co-occur, bee and amp; honey, light, and bulb. And syntagmatic similarities for things that are similar and used to extract some kind of word from a vector. We will describe some of those models here such as Word2vec (Tomas Mikolov et al.,

2015), GloVe (Jeffrey Pennington et al., 2014) and FastText (Bojanowski, P. et al., 2017). Figure 4.2 shows how these models form the space for similar words.

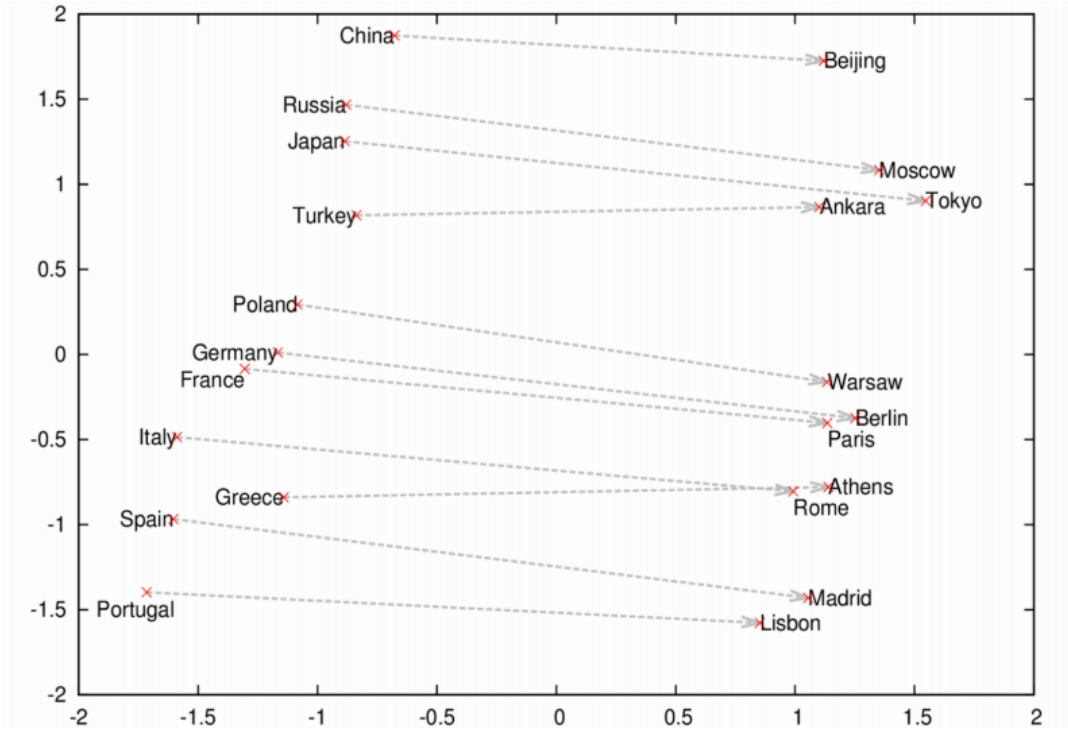

Figure 4.2: Projections in 2D of terms referring to countries and capitals. We can observe how countries are grouped on the left hand side of the plot while capitals on the right hand side

Part-of-speech (POS) tagging: (DeRose, Steven J, 1988) is an information extraction technique, also called grammatical tagging, to mark up each word in textual documents as corresponding to a particular part of speech such as noun, verb, article, adjective, preposition, pronoun, adverb, conjunction, and interjection.

There are other categories and subcategories that can be considered and this varies from language and from the objective of the analysis. This is usually offered as a parameter to be configured in systems.

POS tagging has been developed and studied in its aspects with rule-based approaches first and, now, mostly with machine learning tools. As of today, the overall task of POS tagging is considered as a basic block in all approaches that aim to process automatically text to extract and understand text meanings.

Named Entity Recognition (NER): (Ralph Grishman and Beth Sundheim, 1996), also known as entity extraction or identification, is an information extraction technique that aims to locate and classify information units such as the names of a Person or an Organisation, a Location, a Brand, a Product, a numerical expression including Time, Date, Money and Percent found in a textual document.

NER has been developed and studied in its aspects with knowledge-based systems, unsupervised systems to feature engineered supervised or semi-supervised learning algorithms. In the latest years, the achievements obtained over NER, as many other NLP sub-task, increased greatly thanks to the implementation of supervised learning techniques that use deep learning technologies taking as inputs work vector representations such as embeddings.

As of today, the overall task of NER is a foundational step in all approaches that aim to extract relevant information with semantics from text.

4.2. Fundamentals of automated conversational agents

Starting from the formulation of the Turing test (Turing, A.M., 1950), the problem of human-machine interaction has been analyzed and different solutions have been advanced to implement a conversational, fluent, interface. The terms that are commonly used for those kinds of systems may vary (e.g chatbots, conversational agents, virtual assistants), but the substance does not change: one interlocutor is not of human nature.

After the mobile-first wave that led to a development of thousands of applications for devices that people pass the day with (e.g. smartphones, tablets, wearable devices and smart watches), a second wave is the transition to intelligent interactions that put the emphasis on natural and seamless interactions with automated systems. The interaction means shifts from using well-designed and sometimes complicated interfaces made of buttons and paged procedures to textual or vocal dialogue. Asking questions naturally has many advantages with respect to traditional app interactions. The main one is that the user does not need to know how the specific app works, everyone knows how to communicate and in this case the system is coming towards the user to make the interaction more natural.

The evolution of these systems started a long time ago with first systems that were built to emulate a natural conversation, and has led to today's assistants that live on our smartphones and are ready to complete tasks for us.

The approaches that have been used have evolved through time to fit different needs and to overcome challenges that arise while developing such systems. The choice depends on the application: they can be designed to entertain the user in a conversation or can be designed to provide information on a specific field.

Conversational Agents can be applied in all situations where there is a repetitive exchange of information with the user. The advantages can be both for users and companies.

On the side of the user, using applications can be quite frustrating sometimes. Every company has a different application that needs to be installed, configured and learned to be used. The usage itself may result in cumbersome. User interface forces us to fill up information in a form-like structure. When finally you try to submit, you find out that you missed one required field. A conversational agent could simplify a lot this process, even though the system is simply doing slot-filling and asking one input after the other.

Other advantages of conversational agents can be found when interacting with structured data whose criterion of navigability and search are not well known. Having an interlocutor that progressively helps refining our search, instead of filling a large form in an app, can help being more productive. Furthermore,

interactions through voice can be used also without the need to look and use hands, for situations where our attention is needed for completing other tasks.

From the point of view of the companies, the relationship with a customer is the main channel to acquire and maintain customers. It is where the effort to understand users' needs should be maximum, and in many cases opting for offshore call centers may not be good and not very cheap. In these situations, having an automated responder could provide the service in the way you want in a scalable manner.

Conversational agents are also used in the field of virtual assistants. Using voice or text, we can interact with something that can quickly do things for us: adding events to the calendar, making phone calls and searching information on the Web. Virtual assistants provide a fast way to interact with the device, useful in situations where the users cannot interact in the visual way, for example while driving. The assistant can help with a set of user intents on pre-determined domains (such as agenda management, weather, sending messages) or also with external domains integrated by third-party apps such as Alexa Skills,[6] Cortana integration.[7]

There are numerous classifications that provide information related to conversational agents. In this document, we focus on the type of information that is generated by the agents for categorizing them into: chit-chat, goal-oriented and knowledge-based.

The first type of content, **chit-chat**, corresponds to the native setting of the turing test because the goal is to entertain the user making him believe that the machine really understands the conversation and the history of chatbots of this type is quite long.

The first chatbot ELIZA (Weizenbaum, J.Eliza, 1966), that was built in 1966, is of this kind. It was created mainly to demonstrate the superficiality of communications and the illusion to be understood by a system that is simply applying a set of pattern-matching rules and a substitution methodology.

ELIZA simulates a psychotherapist and, thanks to the trick of presenting again to the interlocutor some contents that have been previously mentioned, keeps the conversation without having an understanding of what really is said.[8] At the time when ELIZA came out, some people even attributed human-like feelings to the bot. A lot of other computer programs have been inspired by ELIZA. Even the Artificial Intelligence Markup Language (AIML) has been created to express the rules that drive the conversation.

A competition has been created to reward the progresses in this field: the Loebner Prize, an annual challenge that stands in the format of the Turing tests, but restricting the topics of conversation. Judges

[6] https://developer.amazon.com/alexa-skills-kit
[7] https://developer.microsoft.com/en-us/cortana
[8] ELIZA can be easily tested inside the text editor Emacs with the command doctor meta-x doctor.

keep parallel conversations, one with a human and one with a computer program. Judges are chosen with the criterion that they should respond naturally, as they would in a conversation with another person, in a way to avoid excessive sophistication. At the end the winner is the computer program that mostly convinced the judges (even without passing the Turing test). There are two more prizes in this competition: one is for the Turing test in text only interactions, the last one (the biggest one) is for passing the Turing test including visual and auditory inputs. This competition was first held in 1991, and with the years advancing the challenges have become more and more complex.

The Loebner Prize has been criticized by experts in the field because it rewards the usage of some tricks (Shieber, S.M., 1994), pointing the focus on imitation instead of intelligence. The commonly used tricks are, according to Mauldin, M (1994):

- Let the conversation be driven by the interlocutor. This works because most people like to talk about themselves and only want someone who listens;
- Give the illusion to be listening and understanding, by including substrings of the user input;
- Change the topic when not understanding, that sometimes can be seen as paranoid;
  \item Simulated typing, delaying the responses.

The evolution of chit-chat agents has recently evolved from a rule-based one to a generative approach. The key idea is to imitate existing conversations, and generate a response in a way that reflects both the training corpus and the current user turn (used as a stimulus). This approach has its roots in using Statistical Machine Translation. The importance of the dialogue corpus, that dynamically establishes how the responses are generated, makes their availability a key element for a successful agent. For this reason these models are trained on few datasets publicly available: tweets, reddit discussions, ubuntu dialog corpus.

An example of this kind of agent is the mobile application Replika,[9] that wants to provide a chat companion for its users. The conversation has no specific goals, and the system entertains the user with long discourses and games.

Focused on psychological support, an example of a conversational agent is Woebot.[10] Entertaining the user with dialogues, it analyses the user mood and provides tips to feel better against depression and anxiety (Fitzpatrick, K.K et al., 2017).

Another completely different type of agent is the **goal-oriented** that provides a service on a restricted domain. It can be a natural language interface to a set of static Frequently Asked Questions, or can be

[9] https://replika.ai
[10] https://woebot.io

linked to some dynamic content using some defined APIs. Those agents need to define the list of things they can do, and in some way map the user's requests to some actions.

Using those agents, the user should be aware of what the system can do and what cannot. A goal of the ideators should be to let the user know that the bot can provide information only on the domain it is built for. Responses for a little chit-chat conversation can also be added to the system, but they should be used only to avoid a general “I don't know” or “I didn't understand”'.

Those kinds of agents can provide a more natural way of interacting with companies, both in the field of customer support and in search for information. The information can be statically defined as pairs of questions-answers. In this case the bot has to classify the user requests and provide the answer that mostly fits it. Or there can be some dynamic information that needs to be extracted from the request. In this case, in addition to sentence classification, a parameter extraction needs to be performed. These tasks are the ones that this thesis will later focus on, and are the main part of a Natural Language Understanding process. The NLU resides in utilizing text tokenization and classification of word meanings such as Named Entity Recognition. What characterizes the conversational agents that provide this kind of content is the presence of a goal from the user: this is the reason that makes them called goal oriented agents.

Finally, **knowledge-based** conversational agents are considered a richer version of goal-oriented agents. Instead of limiting on a very restricted domain and predetermining the abilities with a static design of intents (classes of the requests), this type of agent tries to provide a natural language interface towards a knowledge base, or in other words a richer database with typed information across the different records. This schema-based approach for understanding intents seems not to be optimal when the number of possible intents is very high and cannot be predetermined. If the agent allows questions with a high level of complexity, requiring the linking of information, the number of intents quickly can explode.

Instead of doing a classification of sentences on some predefined intents, the goal of those systems is to transform the user sentence in a database query (for structured knowledge) or also to extract information from unstructured knowledge (such as documents expressed in natural language). This requires a strong relation between a Natural Language Understanding component and the Information Retrieval module. Structured knowledge can be composed of entities and relations between them.

The sentences are analyzed using some parsers and are mapped to a set of linguistic patterns. After this translation (from human natural language to computer-understandable queries), the interrogation is performed using the content of a knowledge base. Those Question-Answering systems are actually very complex and involve different tasks and challenges (Höffner, K. et al., 2017).

A commonly used system that provides this kind of content is the Google Knowledge Graph, which explores the queries done on the search engine and provides linked information. Another example of them is the Wolfram Search, to which questions like "who is the USA president". The focus here is not on managing complex dialogues, but understanding complex queries and exploring knowledge graphs.

There are, however, examples of encyclopedic knowledge agents that try to convey the conversational abilities of chit-chat dialogues empowering them with richer contents. This content ingestion is at the basis of the prototypes participating in the Alexa Prize.[11] The goal that participants should try to achieve in this prize is to reach 20 minutes of dialogue with the user. Given a set of services, the teams have to design the dialogues and make it possible to carry on the conversation for the longest amount of time. Keeping such a long dialogue cannot be done by only providing simple responses using the tricks of ELIZA. Reasoning on topics requires having knowledge of them, so this kind of conversational agents are connected to knowledge bases.

[11] https://developer.amazon.com/alexaprize

4.3. Language course generation

Language course generation in 2020 is driven by personalization and an aim to mimic a personal tutor experience for the learner. While language courses a decade ago were built with a scalable one-size-fits-all mentality and the global market was heavily dominated by brick-and-mortar language courses and a few major digital providers, language course creation in 2020 is much more focused around the unique learner in terms of their interests, unique goals, abilities, preconditions and preferred learning style.

While language course creation is heavily dependent on human input and verification due to the high precision and accuracy required in education, the last decade has led to massive digitalization of brick-and-mortar language courses and the open source publication of large data models and large data sets, which has enabled the development of AI-based customization, machine learning systems for adaptive learning and scalable online tutoring services. This section describes state-of-the-art within language course creation in 2020 in terms of the human mentor in language course creation, the role of microlearning in language course creation, domain-specific language course creation, adaptive learning techniques in language course creation.

4.3.1. The human tutor in language course generation

For the last century the human teacher has played the most important role in the creation of language courses based upon the highly acknowledged individual's authority, know-how and expertise in the field. In 2020 the human teacher is still highly regarded in the language training process because of the interpersonal communication skills required to master a language, the learning of cultural lingo and cultural references, and the ability to personalize lessons to the unique learner's needs.

While the tutor-based brick and mortar language courses have historically been the main source of income in the language course market, the drive for personalization in connection with increased remote learning and globalization has shown a rise in the demand for online access to language tutoring services over the last decade. New entrants within online language course services like Open English, Tandem, VIP Kid, Verbling, iTalki, HelloTalk and Inlingua are now taking over market shares from existing offline players due to the release of online peer-to-peer solutions that offer learners highly personalized and human-built language courses at scale. Online tutored language courses have made personalized learning more accessible, and with the new expectation of just-in-time content delivery, the offering of microlearning options have enabled online tutors to appeal to a wider demographic of language learners, particularly if short-term tutoring programs are offered in conjunction with conventional long-duration programs (Technavio, 2019).

4.3.2. The role of microlearning in language course creation

An increased demand for and an emphasis on personalization and adaptive learning in language learning has increased the popularity of microlearning in language course creation. Microlearning is defined as access to learning resources which may happen at the time of breaks or gaps in learners' daily work/life activities (T. H. Hug et al., 2006). State-of-the-art within microlearning in language course creation includes digital and mobile-based language quizzes, games and just-in-time content delivery. The demand for solutions that provide just-in-time language learning courses has exploded the last decade, particularly driven by the freemium open access to consumer-based language learning courses, such as Duolingo and Memrise, but also from subscription-based online language course providers such as Babbel, Voxy, Speexx and Rosetta Stone.

Figure 4.3 below shows a differential analysis of language learning providers for the B2B (business-to-business) and B2C (business-to-consumer) market performed by Brighteye Ventures, 2019.

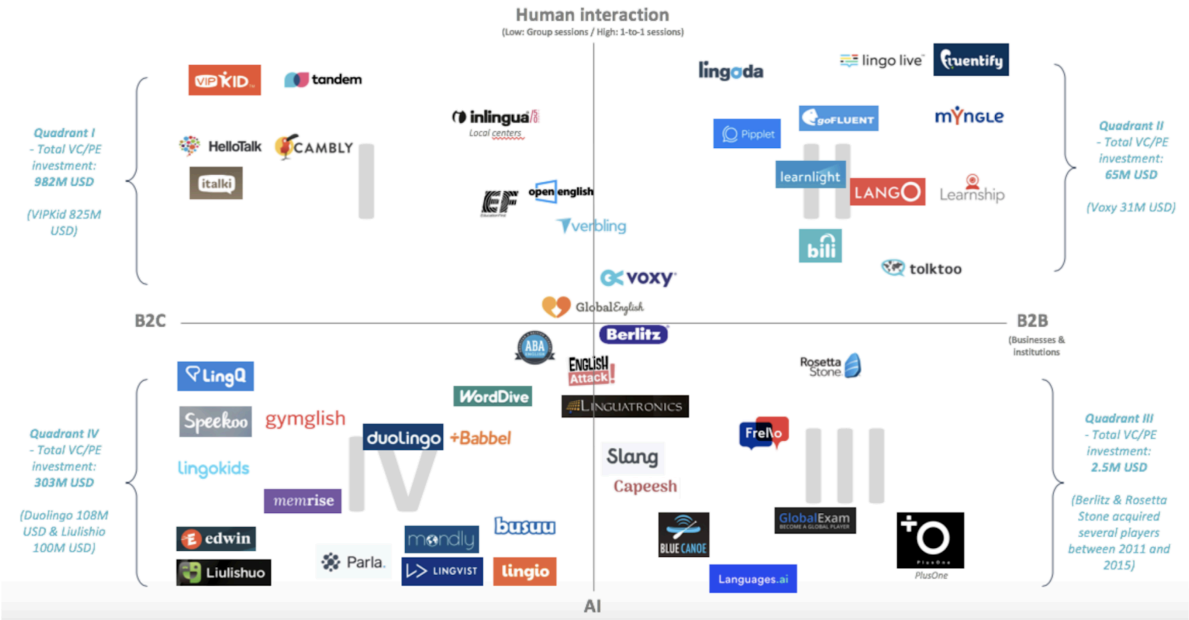

Figure 4.3: Analysis of language learning providers for the B2B and B2C

Microlearning is offering concise and relevant content that helps bridge the knowledge gap among language learners, and is therefore expected to be a key trend in the global online language learning market (Technavio, 2019).

While microlearning in language learning has manifested itself with the access to digital language courses, the consumer based solutions like Duolingo are being criticized for not being able to teach the holistic language, and business focused language course providers are now starting to implement novel technologies in order to provide more tailored and adaptive learning material. State-of-the-art within

adaptive and tailored language course generation includes extensive use of natural language processing technology, spaced-repetition learning and artificial intelligence.

4.3.3. Domain-specific language course creation

Domain-specific language course creation has until now been driven by manual and human-built language course creation, and have often been built and launched as silo-based content. Examples are “English for customer service” or “Spanish business language”. The last few years the open access of natural language processing (NLP) models has enabled existing players and new entrants to create domain-specific language courses at a higher pace and at a higher customization level than ever before.

While some new entrants, like Lingvist and Voxy, are now using natural language processing to allow learners to customize their language course by entering search words in order to match interests with the companies’ wide range of existing language learning content, other players, like Capeesh and Slang, are using natural language processing to provide highly targeted language learning courses based upon the analysis of a unique source of content provided by a company or a learner.

Natural language processing (NLP) tools allow for a much deeper targeted intervention in the language course generation, by allowing the language course creators to extract unique content, detect and separate compound words, domain-specific words, nouns, verbs, adjectives, short sentences and relevant content from the original source document within the specific domain of the language learning course that is being created as introduced in Section 4. State-of-the-art tools in this field include an open source natural language processing model, such as SpaCy, which is an open-source software library for advanced natural language processing.

With domain-specific language course creation, it is equally important to provide this content as state-of-the-art microlearning, and today a range of novel technologies not only enables a language course to be published as a domain-specific and digital micro lesson, but also enables a language course to be adaptive to the learner’s unique goals, abilities, preconditions and preferred learning style.

4.3.4. Adaptive learning in language course creation

Adaptive learning plays a central part in the state-of-the-art user centered and personalized approaches to language learning, made possible by the technological advances. Now courses can intelligently adapt to learners’ native language, language level and progression speed.
Spaced repetition learning has become the golden standard in the language learning, used, for example, by such companies as Duolingo, Memrise, Fluent Forever and Capeesh. The forgetting curve and the effect of spaced repetition on learning was discovered in the late 1800s by Hermann Ebbinghaus, who performed a series of memorization experiments on himself. He tried to memorize random syllables, and

then he tested himself at different intervals to see how much he could recall. The result was Ebbinghaus' Forgetting Curve, illustrated below, and the importance of his work has carried over until today.

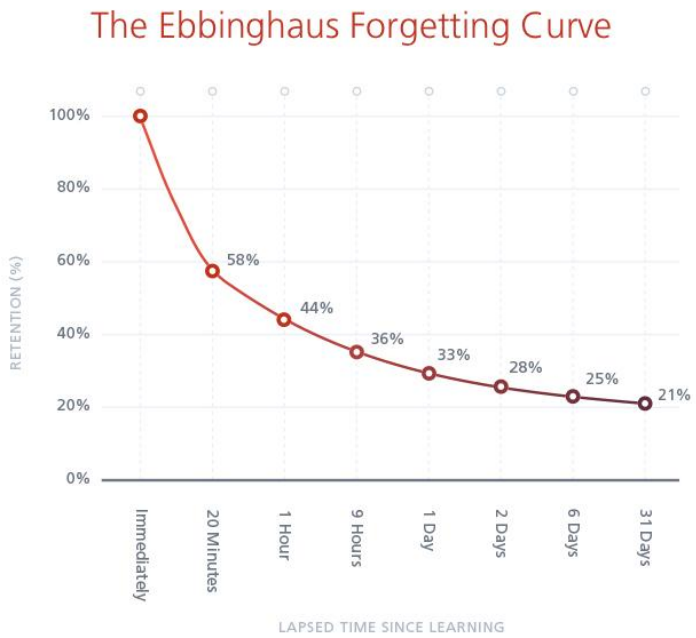

Figure 4.4: The Ebbinghaus' forgetting curve as reported in Ebbinghaus H. (2013).

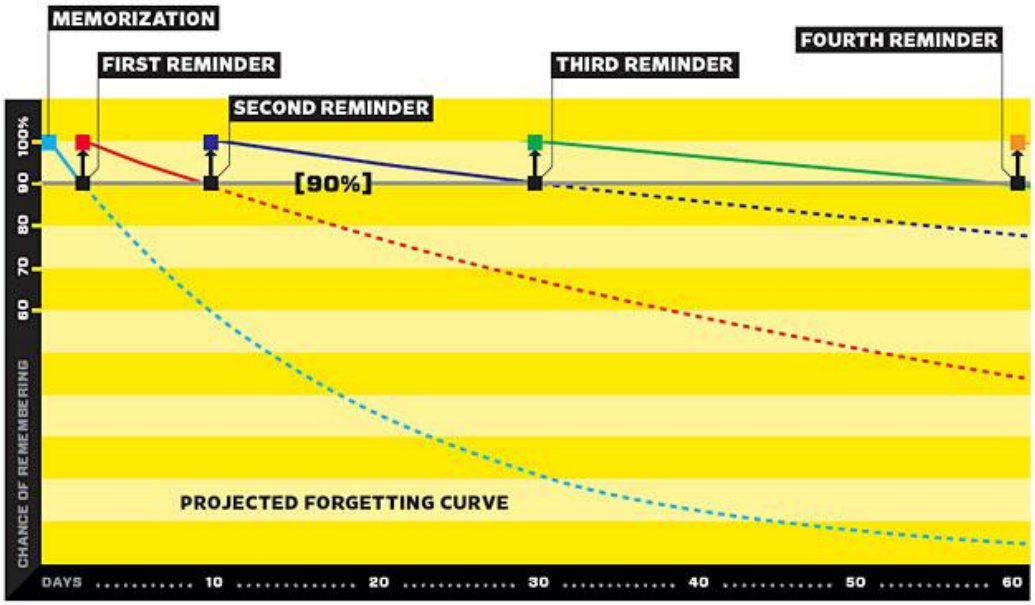

Figure 4.5: Forgetting curve with spaced repetition[12]

[12] Source: https://www.wired.com/2008/04/ff-wozniak/?currentPage=all

Figure 4.4 illustrates the rate of forgetting when the information is presented once. As we see, less than half is retained as soon as after an hour. Figure 4.5, on the other hand, illustrates the forgetting curve with the spaced out reminders, where the information is reintroduced everytime the exponential forgetting curve approaches 10% information loss. Each reminder restarts the forgetting curve, and with each reminder the forgetting happens slower, so that after two months and four reminders 90% of the vocabulary thus trained on is retained in long term memory.

While the learning curve has been discovered over a hundred years ago, the recent advances in technology made it possible to apply the learning curve in practice. Now it is possible to trackthe exercises performed by the individual learners and words introduced to them, which makes it possible to calculate the optimal time for the next repetition for each individual learner, and serve the next iteration just in time before the forgetting curve predicts the word may be getting forgotten.

Adaptive learning and AI: as the course creation process is becoming more user oriented, and machine learning technologies are becoming more advanced, more companies start to use them to deliver customized resources and learning activities to address the unique needs of each learner, for example, by Sana Labs and Knewton. Recommender systems (Section 5) play an important part in adaptive learning in order to tailor personalized contents to the students language level and progression speed.

Alta, the technology used by Knewyon, adapts to students' proficiency levels with each interaction. As opposed to traditional placement tests, the students don't have to complete a formal assessment or diagnostic to get the instruction and practice they need — it's provided just-in-time as students work to complete assignments. Continuously measuring students proficiency makes it possible to adapt the progression speed individually.

These innovative techniques move away from the more traditional scales for measuring language ability, such as CEFR, which are also widely used, and play an important role in providing language testing and the language courses at the appropriate level.

Adaptive learning and CEFR: The Common European Framework of Reference for Languages (CEFR) is the international standard for describing language ability, put together by the Council of Europe as the main part of the project "Language Learning for European Citizenship" between 1989 and 1996.
It describes language ability on a six-point scale, from A1 for beginners, up to C2 for those who have mastered a language. This makes it easy for anyone involved in language teaching and testing, including language learning companies, to see the level of different qualifications.

The CEFR score[13] is the state of the art measure of language ability, used both in developing and aligning language programmes, and in language proficiency evaluation and accreditation.

Common European Framework of Reference for Languages - Self-assessment grid

		A1 Basic User	A2 Basic User	B1 Independent user	B2 Independent user	C1 Proficient user	C2 Proficient user
Understanding	Listening	I can understand familiar words and very basic phrases concerning myself, my family and immediate concrete surroundings when people speak slowly and clearly.	I can understand phrases and the highest frequency vocabulary related to areas of most immediate personal relevance (e.g. very basic personal and family information, shopping, local area, employment). I can catch the main point in short, clear, simple messages and announcements.	I can understand the main points of clear standard speech on familiar matters regularly encountered in work, school, leisure, etc. I can understand the main point of many radio or TV programmes on current affairs or topics of personal or professional interest when the delivery is relatively slow and clear.	I can understand extended speech and lectures and follow even complex lines of argument provided the topic is reasonably familiar. I can understand most TV news and current affairs programmes. I can understand the majority of films in standard dialect.	I can understand extended speech even when it is not clearly structured and when relationships are only implied and not signalled explicitly. I can understand television programmes and films without too much effort.	I have no difficulty in understanding any kind of spoken language, whether live or broadcast, even when delivered at fast native speed, provided I have some time to get familiar with the accent.
	Reading	I can understand familiar names, words and very simple sentences, for example on notices and posters or in catalogues.	I can read very short, simple texts. I can find specific, predictable information in simple everyday material such as advertisements, prospectuses, menus and timetables and I can understand short simple personal letters.	I can understand texts that consist mainly of high frequency everyday or job-related language. I can understand the description of events, feelings and wishes in personal letters.	I can read articles and reports concerned with contemporary problems in which the writers adopt particular attitudes or viewpoints. I can understand contemporary literary prose.	I can understand long and complex factual and literary texts, appreciating distinctions of style. I can understand specialised articles and longer technical instructions, even when they do not relate to my field.	I can read with ease virtually all forms of the written language, including abstract, structurally or linguistically complex texts such as manuals, specialised articles and literary works.
Speaking	Spoken interaction	I can interact in a simple way provided the other person is prepared to repeat or rephrase things at a slower rate of speech and help me formulate what I'm trying to say. I can ask and answer simple questions in areas of immediate need or on very familiar topics.	I can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar topics and activities. I can handle very short social exchanges, even though I can't usually understand enough to keep the conversation going myself.	I can deal with most situations likely to arise whilst travelling in an area where the language is spoken. I can enter unprepared into conversation on topics that are familiar, of personal interest or pertinent to everyday life (e.g. family, hobbies, work, travel and current events).	I can interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible. I can take an active part in discussion in familiar contexts, accounting for and sustaining my views.	I can express myself fluently and spontaneously without much obvious searching for expressions. I can use language flexibly and effectively for social and professional purposes. I can formulate ideas and opinions with precision and relate my contribution skilfully to those of other speakers.	I can take part effortlessly in any conversation or discussion and have a good familiarity with idiomatic expressions and colloquialisms. I can express myself fluently and convey finer shades of meaning precisely. If I do have a problem I can backtrack and restructure around the difficulty so smoothly that other people are hardly aware of it.
	Spoken production	I can use simple phrases and sentences to describe where I live and people I know.	I can use a series of phrases and sentences to describe in simple terms my family and other people, living conditions, my educational background and my present or most recent job.	I can connect phrases in a simple way in order to describe experiences and events, my dreams, hopes and ambitions. I can briefly give reasons and explanations for opinions and plans. I can narrate a story or relate the plot of a book or film and describe my reactions.	I can present clear, detailed descriptions on a wide range of subjects related to my field of interest. I can explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.	I can present clear, detailed descriptions of complex subjects integrating sub-themes, developing particular points and rounding off with an appropriate conclusion.	I can present a clear, smoothly-flowing description or argument in a style appropriate to the context and with an effective logical structure which helps the recipient to notice and remember significant points.
Writing	Writing	I can write a short, simple postcard, for example sending holiday greetings. I can fill in forms with personal details, for example entering my name, nationality and address on a hotel registration form.	I can write short, simple notes and messages. I can write a very simple personal letter, for example thanking someone for something.	I can write simple connected text on topics which are familiar or of personal interest. I can write personal letters describing experiences and impressions.	I can write clear, detailed text on a wide range of subjects related to my interests. I can write an essay or report, passing on information or giving reasons in support of or against a particular point of view. I can write letters highlighting the personal significance of events and experiences.	I can express myself in clear, well-structured text, expressing points of view at some length. I can write about complex subjects in a letter, an essay or a report, underlining what I consider to be the salient issues. I can select a style appropriate to the reader in mind.	I can write clear, smoothly-flowing text in an appropriate style. I can write complex letters, reports or articles which present a case with an effective logical structure which helps the recipient to notice and remember significant points. I can write summaries and reviews of professional or literary works.

Common European Framework of Reference for Languages (CEF): © Council of Europe

Figure 4.6: The table above indicates, for each of the skills that identify the knowledge of a language, the level (according to the standard) and a brief description of what a person is able to do with such a level.

Adaptive learning in pronunciation: the recent progress in voice recognition has made it possible to use artificial intelligence to evaluate the students' pronunciation as well. Among these is ELSA Speak, which uses AI tools to teach English pronunciation by automatically creating an individual learning path based on the results of students' pronunciation tests.
Sana Labs is another company to use speech recognition technologies for perfecting pronunciation, in addition to personalized learning paths.
While these two companies are only adapted to learning English so far, Hello Chinese uses speech recognition tools for learning Chinese pronunciation.

While much of the progress has been made in the field of speech recognition in the past years, making it precise enough to provide some form of a valuable feedback to a learner, it is hard to define the precise problem area for each learner. Also, the amount of data that must be collected for each language makes it more time consuming to expand to new languages.

CALST, on the other hand, adapts the pronunciation training to the native language of the learner in order to anticipate the problem areas.

[13] https://www.coe.int/en/web/common-european-framework-reference-languages/level-descriptions

4.4. Listening and pronunciation training

Language is the key skill which migrants need for integration in the host community. Even in the initial stage immediately after arrival, much of the interaction between migrants and local authorities takes place through oral communication. This requires that migrants can communicate in the language of the host country or in a lingua franca, often English. Understanding spoken language and pronouncing unfamiliar sounds in a foreign language are often a big hurdle to communication. The Computer-Assisted Listening and Speaking Tutor (CALST[14]) supports migrants in developing listening and pronunciation skills.

It has been shown that early exposure to a native language adapts the infant's brain to recognize the sounds in that specific language better and better (Kuhl, Conboy, Padden, Nelson & Pruitt, 2011). The other side of the coin is that the infant at the same time loses its ability to discriminate between sounds that are not part of the native language inventory. This has consequences when we learn a native language later in life, as most migrants are required to do. Sounds that do not occur in the migrant's native language are difficult to perceive, so that different words may sound the same. They will also be difficult to articulate, and this may cause communication problems when interacting with native speakers of a foreign language (Derwing & Munro, 1997; Derwing & Munro, 2009). CALST creates an awareness of the problems and offers practical help to understand and pronounce a foreign language, enabling learners to communicate successfully in oral interaction.

4.4.1. Changing focus in pronunciation teaching

In foreign language courses, pronunciation training has traditionally focused on an accent-free, near-native pronunciation: the aim for language learners was to sound just like native speakers of the target language. This focus has now changed to intelligible (but not necessarily accent-free) pronunciation as a goal, as for example reflected in the development of pronunciation guidelines for English as an International Language (Jenkins, J., 2000). The development of these guidelines is driven by the role of English as a lingua franca for international communication. The guidelines, called the lingua franca core (LFC), concentrate on properties that have a high communicational load, i.e. on properties that can easily cause misunderstandings. The (inter)dental fricatives in English thin, then, are not included in the lingua franca core of English. These sounds are not part of the sound inventories of many languages, and for that reason they are often substituted by non-native speakers with other sounds which do occur in their mother tongue. The lingua franca core reflects an approach in which the rules are determined by the challenges which are common across many languages and are related to the concept of linguistic markedness. Another example of admissible variation in the LFC is the use of a trilled [r] (as in Italian) for the English r-sound [ɹ]. Despite the very different realizations of these r-sounds in Italian (or French or Norwegian or Dutch) and English, all these different versions of the r-sound are functionally equivalent. Their equivalence is also marked by the identical orthographic character that is used in the two languages,

[14] https://www.ntnu.edu/isl/calst

and although substitution of the English r-sound by another r-sound clearly "betrays" a foreign accent, this does not affect intelligibility (Best & Tyler, 2007). In the view of the research field of English as an international language, variation introduced by non-native speakers is just an additional source of variation to the variation across different dialects of English, and in fact some dialects may be harder to understand than foreign-accented speech even for native speakers.

English as an international language is a widely researched area. No lingua franca core has been developed for other languages than English. Additionally, in many communities English is not used as a lingua franca. As a result, either another lingua franca is used or, most often, migrants are forced to use the native language of the host country. Since no lingua franca core is available for other languages than, there is no set of guidelines to follow in language courses.

4.4.2. Pronunciation training in the classroom

In most language courses for migrants, teaching focuses mainly on vocabulary and grammar. Pronunciation is addressed, but it is often not a planned part of the teaching. There are several reasons for this.

The first reason is that pronunciation is a language skill which requires a lot of repetition to develop. Therefore pronunciation training is time-consuming, like the training of any other skill, for example in sports or a professional skill.

The second reason is the heterogeneity of the migrant groups. In language courses for example at a university, many students with the same native language learn the same foreign language. They will have similar challenges, which are well known to the teachers, who are usually familiar with the students' native language, and may even be speakers of that language themselves. Compare this with language classes for migrants: they usually have widely differing language backgrounds and as a result they also have different challenges.

The third reason is that language teachers often have little knowledge of phonetics (Levis J-M and McCrocklin, S, 2018a, Levis, J.M. and Wu, A. 2018b). Without a formal framework in which to explain pronunciation challenges and instruct learners, it is very hard to cater for the different needs of learners. Teachers hear their students' pronunciation through the same native language filter (Bohn, O.-S., 2017) as other speakers. Without sufficient phonetic knowledge of the relevant phonetic differences across languages, this means they may not be as observant of all the different pronunciation problems that would be necessary to give the language learners the help they need. As a result, teachers often address the main problems that learners may encounter (this is in some ways similar to the lingua franca core approach to English), but this does not recognize the different needs of the learners. In the next section, we show how differences in the sound systems across languages can be taken into account to tailor

pronunciation training. Although it is possible to explain the possible pronunciation problems in language courses, the learners can train their skills outside the classroom.

4.4.3. Individualizing pronunciation training

The problems that learners run into are highly dependent on their native language (Flege, 1995; Best & Tyler, 2007; Bohn, 2017). To take this into account, an approach is chosen which is based on language typology, i.e. the structural patterns in pronunciation in the languages of the world. The CALST pronunciation training platform used in easyRights does this by making use of L1-L2map[15] (see also Koreman et al., 2017); L1-L2map is a tool for contrastive analysis of language pairs. L1 stands for «Language 1» or native language, while L2 stands for «Language 2» or second/foreign language. L1-L2map uses a database containing the sounds inventories of over 500 languages. These are the languages described in Maddieson, I. (1980, 1984), and the database was extended by us with a number of additional languages. The description of the sound inventories lists all sounds that can distinguish meaning in a given language (phonemes). If, as learners typically do, an unfamiliar sound is substituted by a sound from the learner's native language, this may change the meaning of the word and therefore lead to misunderstandings.

In Figure 4.7 (left), the language pair L1:Arabic–L2:Greek is compared; in the right part of the figure, the same is done for the pair L1:Kurdish–L2:Greek. Only the consonants in the two languages are shown; similar comparisons are made for the vowels in each language pair. L1-L2map uses a colour-coding to show which sounds are likely to cause problems in perception and production of the foreign language. As the figure shows, the challenge caused by unfamiliar sounds are different for Arabic-speaking and Kurdish-speaking migrants, and thus the pronunciation training that these learners get should be tailored.

[15] https://l1-l2map.hf.ntnu.no

Figure 4.7: Comparison of the consonant inventories of Arabic and Greek (left) and Kurdish and Greek (right). Sounds on a blue background only occur in Arabic/Kurdish, sounds on a red background occur only in Greek, and sounds on a green background occur in both Greek and Arabic/Kurdish. It is the sounds on a red background that can present challenges to Arabic/Kurdish migrants to Greece

A multilingual approach based on the comparison of native and target languages using L1-L2*map* reduces the number of exercises and tailors the learning trajectory to the native language of the migrant, avoiding exercises for familiar sounds – as these will be different for speakers with different native languages. The contrastive analysis does not solve all problems in selecting exercises.

First, some substitutions may cause a learner to have a clear foreign accent without affecting their intelligibility. Best & Tyler (2007) give the example of French and English /r/ which was also mentioned above. Despite the different realizations of the r-sound across languages, the sounds are functionally equivalent. Although this particular problem is not addressed in L1-L2map in its present form, a mechanism for functional equivalence has been built into the system where it is possible to select "base consonants only". We will investigate and implement functional equivalence between the main migrant languages in the project and the target languages (Greek, Italian, Spanish and British English).

Speakers with different native languages differ in the sounds they substitute for unfamiliar sounds in the target language. This phenomenon is called "differential substitution". For instance, German speakers generally substitute /s,z/ for English "th", while Dutch or Norwegian speakers often substitute /t,d/. Since it is not possible to predict the substitution from the L1 sound inventory, a contrastive analysis cannot help to decide which contrast needs to be practised by a learner with a given native language. Exercises must be offered for all likely substitutions (based on phonetic principles and knowledge of L2 acquisition), while only some of them are actually used by speakers with a given native language.

4.4.4. Online pronunciation training

Pronunciation training in easyRights makes use of an online platform, the Computer-Assisted Listening and Speaking Tutor (CALST[16]). Most online pronunciation courses or apps focus on a single target language and do not take the specific language background of the learner into consideration *or* they focus on a specific pair of native and target language. CALST is a platform which is tailored to the learner's native language background (*any* language). New target languages, as will be implemented in the easyRights project, will automatically make use of the tailoring provided by the use of L1-L2*map*, as described in the previous section.

There are four exercise types in CALST. These are very simple exercises which focus exclusively on the pronunciation of unfamiliar sounds. Note that you can try out these exercises for Norwegian or English on CALST to get some hands-on experience. Other pronunciation training systems often only use pronunciation exercises (see below), but note that the ability to perceive a sound contrast is an important basic skill that needs to be mastered first.

a) Discrimination exercise

Generally, it can be said that a learner must be able to hear the difference between two sounds in the target language before s/he can pronounce the sounds correctly. Therefore, each sound contrast as discussed in the previous section starts with a discrimination or ABX-exercise. These exercises make use of "minimal pairs", i.e. pairs of words with different meanings which are differentiated by only one sound (like think – sink, cf. the Berlitz advertisement[17]). Such exercises help the learner to focus on the acoustic properties of the sounds that are different. In these exercises the user hears two words (the minimal pair), after which one word is repeated. The learner's task is to decide whether the last word is the same as the first or the second word that was presented. This type of exercise allows the learner to compare the two pronunciations in his/her acoustic memory, and help to increase the awareness of the acoustic differences between the sounds that are being contrasted.

b) Identification exercise

After the discrimination exercise for a give sound contrast, the learner automatically proceeds to an identification exercise. In an identification exercise, only a single word is played (e.g. "think") and the learner has to decide whether s/he heard "think" of "sink". This exercise requires that the learner has an internalized representation of the acoustic difference between the two sounds, since no direct comparison is possible as in the discrimination task. This task is therefore substantially more difficult than the previous listening task.

[16] http://www.calst.no
[17] https://www.youtube.com/watch?v=6zkZ3f8DnKs

c) Pronunciation exercise

Once a learner can hear the difference between two contrasting sounds, s/he can learn to pronounce the sounds. CALST plays a word which the learner then repeats, and uses self-evaluation so that the learner can compare his/her own pronunciation with that of the tutor (system). Of course, a major step is to actually apply what the user has learned in CALST in conversations outside the learning environment.

d) Writing exercise

Since the societies in the target countries are literate, it is important to learn the relationship between pronunciation and written words. In some languages, there is a close correspondence between pronunciation and spelling (e.g. Spanish and Italian), while there is a much weaker correspondence in Greek and English. In the writing exercises, the learner hears a word containing one of the two contrasting sounds (as in the previous exercises) and writes down the word. In languages where there is a weaker link between pronunciation and spelling, care has been taken that the variation in spelling is represented in the exercise material.

In all exercises except the pronunciation exercise (which uses self-evaluation), the user is given feedback about the correctness of his/her reply, with a correct spelling of the word in the writing exercise when the user misspelled the word.

In Discrimination excercise, we explained how the result of a comparison between the sound inventories of the migrant's native language and the target language (also second/foreign language) is used to select exercises in CALST. As we explained, CALST overgenerates exercises. To delete unnecessary exercises, user results are logged. If the first small set of users with a given native language do not have any difficulty with an exercise, that exercise is dropped from the learning trajectory so that new users with the same native language do not have to do these exercises. This not only helps migrants to focus their language learning efforts to sound contrasts that are actually hard for them. This reduction of effort is important in a situation where migrants have to meet many requirements, not just to learn the language of the host country, but also to deal with administrative procedures, job search and many other challenges.

5. Background on personalization technologies

Since the advent of the Internet, it has been easier acquiring and having access to an ever increasing amount of data. However, accessing this multitude of data requires efficient methods both for search and for suggesting the most suitable data for the user. For this reason recommendation systems were born.

5.1. Basic definitions of recommender systems

A recommendation system is an information filtering system subclass, with the aim of predicting the "preference" a user would give to an item, so that it can recommend something that the user may find useful or pleasant [Figure 5.1].
Nowadays, we can find many implementations of this concept in the biggest e-commerce or media streaming platforms, becoming in fact an important part of our everyday online user experience.

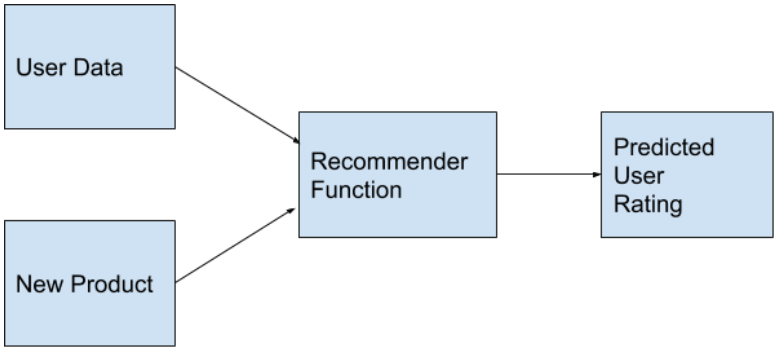

Figure 5.1: Basic schema of a recommender system: the recommender function takes information about the user and predicts the rating that this user might assign to a product. Predicting user ratings, even before the user has actually provided one, makes recommender systems a powerful tool applicable in various contexts (e-commerce, media streaming, news and personalized ads)

When we talk about recommendation systems, you should not make the mistake of thinking that everything depends on data; in fact, relationships are also very important, and there are three types of these:

- User-Product Relationship: this relationship occurs when users have a preference for a specific type of product. For example, a tennis player might have affinity towards tennis-related items, thus the e-commerce will build a user-product relation of player->tennis
- Product-Product Relationship: in this case we can build a relationship between two entities that are similar in nature. This concept can be applied to books, music or films of the same genre, to newspapers on the same topic, or even on dishes from a specific country.
- User-User Relationship: User-User relationships occur when customers have the same preferences towards a specific type of product or service. Examples include similar backgrounds, similar age or mutual friends.

Product similarity is the most useful system for suggesting products or services based on how much the user would like the product. It is particularly useful when we do not know much about the user yet, but we do know what products or services they are using.

However, in many domains, the relevance of a recommendable item not only depends on the users' general preferences, but also on their current situation and their short-term intents and interests. Context-aware recommenders take such additional types of information into account.
Typical contextual factors in literature include the user's geographical position, the current weather, or the time of the day (Adomavičius, G and Tuzhilin, A., 2011).

Since data can be provided in different ways, it is necessary to understand how to retrieve them and there are basically two important methods.

Explicit Ratings are provided by a user. In this case we use mechanisms such as reviews, feedback, star-ratings and so on. The problem here is that a large variety and quantity of data is not always available because users do not always leave feedback.

Implicit Ratings are provided through user interactions with an item. This type of information is much easier to obtain because users browse and use products and services by interacting with simple clicks.
In this situation, it is good to underline that views and purchase can be a better entity to recommend as users will have spent time and money on what is most crucial for them.

Depending on the characteristics of the problem and the availability of historical data we have different context categorization.

Therefore, the period of time in which the information is obtained is defined as memory, which coincides with the period of time the user has interacted with the items.
There are different approaches both in terms of the information that will be used and in terms of the amount of information availability. Some of them are described in Table 5.1.

Last-N interactions based recommendation	This approach is based on considering only the last N actions performed by the user. It can be useful when facing problems where there is not enough information about past actions of the same type or when the others actions are not predictive for the next action. A typical problem setting is that of predicting the next location (or check-in) in a location-aware recommender system.
Session-based recommendation	A session-based recommender system can use as information only actions made by users belonging to a unique session. This approach, being able to analyze only a limited time window of data, brings with it the disadvantage of having a lack of information about the user over a long period, and for this reason it is usually used for e-commerce, news or websites that do not require registration.

Session-aware recommendation	The session-aware recommendation system brings together the two previously mentioned. In fact, it uses the knowledge both about the users' actions in the last session and about their past behaviour. Therefore, we can use this type of system with a combination of long-term and short-term memory models, for example in e-commerce settings or for app recommendation.
Trend Detection	The detection of trends in a given sequence dataset is another potential, but less explored, goal that can be accomplished by recommender systems. In this case we can distinguish two types of information that can be extracted from sequential log information to be used in the recommendation process. 1. Community trends: considering the popularity of items within a user community can be important for successful recommendations in practice, e.g. in streaming media recommendation. Recommenders can aim to detect and utilize popularity patterns in the interaction logs to improve. Such trends can be long-term or one-time popularity peaks (Gomez-Uribe, C.A and Hunt, N, 2015). 2. Individual trends: changes in the interest in certain items can also happen at an individual level. These interest changes can be caused when there is a "natural" interest drift, e.g., when users grow up, or when their preferences change over time, e.g., due to the influence of other people, due to exceptional events, or when they discover something new. In the news domain, for example, individual interests change over time and are influenced by global and local news trends (Liu, J. et al., 2010).
Repeated Recommendation	In some application domains, recommending items that the user already knows or has purchased in the past can be meaningful. We can identify the following categories of repeated recommendation scenarios. 1. *Identifying repeated user behavior patterns*: Past interaction logs can be used by recommenders to identify patterns of repeated user behavior. In this context, patterns of repeated user behavior can be used to provide shortcuts to applications that are frequently launched in a certain sequence by the user. An example is to suggest launching the "email" or "calls" app after opening the "contacts" app. The general goal here is to enhance the user experience with the device (Baeza-Yates, R. et al., 2015). 2. *Repeated recommendations as reminders*: In a different scenario, repeated recommendations can help to remind users of things they found interesting in the past (Lerke, L. et al., 2017).

	In both mentioned scenarios, besides the selection of items to repeatedly recommend, a recommender has to reason about the timing of the recommendations.
Sequence-aware	In the session-based recommender systems environment, there is often confusion between the terms session and sequence. In this case, by session we mean the general information that is collected in a certain period of time. When these information are structured and, above all, ordered by time (therefore, we must have this information on all data), then we are talking about sequences. In session-based recommendation, the users' short term intents, which can be estimated from their very last actions, can represent an important piece of context information to be taken into account when recommending. The sequence-aware consider time information that is associated with past user actions to adapt the recommendations accordingly. The focus of sequence-aware recommenders is however often less on the exact point of the time of past user interactions, but on the sequential order of the events (Quadrana Massimo et al., 2018).

Table 5.1: Different cases and different approaches that are used for the implementation of recommender systems

5.2. Sequence-aware recommenders

In this section we provide a focus on sequence-aware recommenders being them designed to be exploited in easyRights.

Many scenarios cannot be addressed by something like Matrix Completion (that is the task of filling in the missing entries of a partially observed matrix) due to the impossibility to retrieve certain type of information: for example, we can have only one single user-item interaction pair and we often have only one type of interaction (e.g, ratings).

Sequence-aware recommendation systems are a family of recommenders that uses different input data, often bases the recommendations on certain types of sequential patterns in the data and addresses the mentioned practical problem settings.

a) Inputs

First of all, the first thing that distinguishes these systems is the input format, which in this case must be ordered. The single input will therefore have such a structure:

Information label	**Information value**
timestamp	datetime
user_id	number
action_type	string
item	string

Table 5.2. An excerpt of one of the possible information records in the dataset: here, *timestamp* specifies the date and time of the action performed, the *user_id* identifies the user that performed the action, and finally the *action_type* defines the action performed (for example, add-to-wishlist or purchase) and that is offered by a specific *item* (with some exceptions like search terms)

In addition to these, we can add other attributes in order to better characterize the information such as additional information about the user.

Unlike traditional recommender systems, we have for each user that all sequences contain a single action (item) and, for each user, we have one single sequence with several actions (one action per item).

b) Outputs

The output we have in this case is made up of one or more ordered lists of items. The list can have different interpretations, based on goal, domain and application scenario: we can have a usual item-ranking tasks (list of alternatives for a given item), suggested sequence of actions (for example, the next-track music recommendations) or a strict sequence of actions.

U: Users
I: items
L: ordered list of items of length **k**
L*: set of all possible lists **L** of length up to **k**
f*(u,L)**: utility function, with **u** ∈**U** and **L** ∈**L

$$\square_{\square} = \square\square\square\square\square\square_{\square\in\square^*}\square(\square,\square)$$

The task is to learn ***f*(u, L)** from sequences **A** of past user actions.

The utility function is not limited to scoring individual items but the design of this function depends on the purpose of the system (Quadrana Massimo et al., 2018).

Sequence-aware recommenders are often built on implicit feedback signals, but the problem formulation is however not based on matrix completion.

In addition, sequence-aware recommenders are often a special form of context-based aware systems. Researchers often are not explicit about the purpose: traditionally, could be information filtering or discovery, with conflicting goals: for sequence-aware recommenders however the aim is to predict the next action.

Furthermore, sequence-aware recommenders do not necessarily need explicit timestamps, as it does for time-aware recommenders, that have the goal of detecting long-term user drifts.

5.3. Evaluation approaches for Recommender Systems

In academic environments, the evaluation of recommender systems is dominated by simulation-based experiments on historical rating of implicit feedback datasets.
The common offline evaluation methodology is to split the given preference data into training and test splits, use training data to learn a model and predict the held-out preferences based on this model.

The quality of the output is measured through different evaluation metrics, which must be chosen carefully on top of system requirements, as they are the ones that subsequently will define the quality of the model obtained. Examples of these are Mean Squared Error, Precision and Recall.

An alternative to offline evaluation is User (laboratory) studies. Such studies are often used to assess the potential impact of recommendations on the behavioral intentions of users, which cannot be determined based on simulation studies.

Finally, field studies (for example, in the form of A/B tests) are used to analyze the effects of recommenders on their users in real-world environments (Quadrana Massimo et al., 2018).

6. Background on gamification and human-in-the-loop approaches

Pronunciation training is the development of a skill (you can compare it to skills you have to develop to play ports at a high level). It takes time, it is repetitive and it can therefore be often tedious. It would be interesting if the hackathons would lead to implementations of CALST exercises in the form of mini-games. This may take the focus off the language learning, which becomes a "side effect" of playing a game. The option of the exercises as presently implemented in CALST should still be available. Also, carrying out exercises or games together with other learners would be of interest.

6.1. Gamification for course training

Generally speaking the state of gamification for training purposes in 2020 mostly consists of a mix of multiple choice tests in varying formats. Either by giving the user a question where the goal is to select the right option out of X number of options, where we call the wrong option distractors. Another popular approach to course training being gamified has been to utilize digital characters and an interactive dialogue format.

The usage of simulation, both 2D and 3D, is becoming increasingly popular for corporate training material. In these applications the aim is usually to re-create workplace situations for employees to train on in a virtual environment. By combining a 3D environment with AR/MR/VR, this creates a very immersive training experience.

We see more and more social features such as leaderboards and tasks you solve together. There is a huge potential in social learning and trends today show that this is an area with huge investments.

An interpretation of gamification and its effects is grounded in Yu-Kai Chou's Octalysis framework, detailed in Actionable Gamification (Chou, Yu-Kai 2015). Briefly stated, Chou proposes the existence of eight "core drives", motivating impulses that can be triggered by the use of various game mechanics. These core drives cover both intrinsic and extrinsic motivating factors, and are separated into categories known as either "white hat" or "black hat" motivators. Respectively, such mechanics are based on making interactions feel meaningful in and of themselves, or predicated on manipulating the user through FOMO (fear of missing out), scarcity, or other negatively tinged motivators.

Figure 6.1: The Octalysis framework represents one of the most modern frameworks for gamification

6.2. How game design is used in language training?

Game design is the art of applying design and aesthetics to create a game for entertainment or for educational, exercise, or experimental purposes. Increasingly, elements and principles of game design are also applied to other interactions, in the form of gamification.

a) Streaks

The best known use case for gamification in the language learning space is arguably Duolingo.[18] DuoLingo shows the usage of Streaks, which they claim is the most successful implementation of gamification features in an app. They give you a fear of missing out if you do not log in and play a session every day to regain your streak. The danger of such mechanics is that they become too risk heavy as they build up, and in the end can produce a negative motivator. Streaks can be a great motivational tool and combined with an implementation seen in games such as Pokémon Go. Here you could have Streaks reset after 7 days with a reward for a successful streak, they could provide a motivational factor that has less of a downside when the user fails to perform the needed action, thus keeping the focus on positive reinforcement.

[18] https://www.duolingo.com

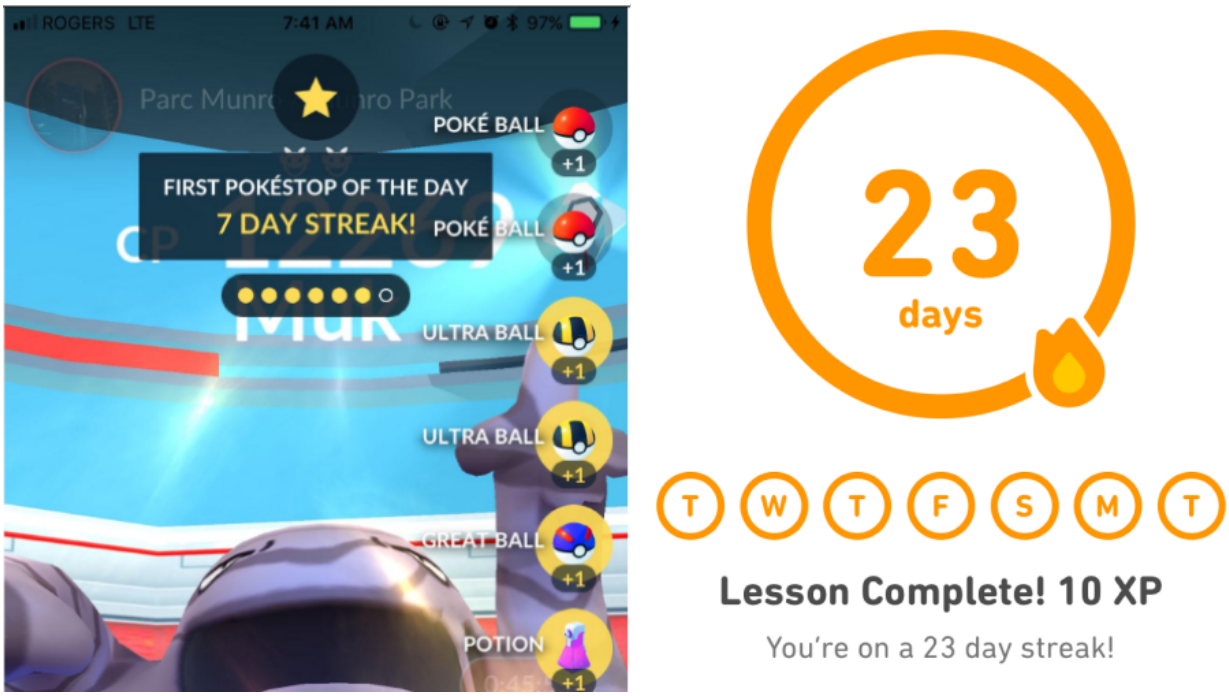

Figure 6.2: Streaks systems in Pokemon Go (left) and Duolingo (right)

b) Characters and a living world

The usage of digital characters and avatars is changing the way we learn digitally as it creates a more immersive and friendly learning environment, more closely resembling how we learn in real life. You don't learn by being programmed to know something, you interact with the living world, which then reacts back to you. Users no longer feel alone while learning, even though the animated characters are just digital 1s and 0s. Other applications also implement this with success, as Duolingo receives lots of positive feedback on their own mascot, Duo, and other characters which now also are animated.

c) Visual representations & Spaced Repetition Learning

With the rise in popularity of spaced repetition learning in educational software, many designers have used gamification to explain the rather complex topic in a way that users understand, and in turn motivate their users. Memrise is a good example of this, using a plant's life cycle as an analogy for language acquisition. Each new word or concept starts off as a seed, before growing into a sprout, seedling and then eventually flowering when the user has practiced the word or topic enough. Even though the users might not understand the intricacies of spaced repetition learning, they are motivated by the cute plants and want to keep them healthy and watch them grow.

In a 2014 research project by Anant Vaibhav and Pooja Gupta titled "Gamification of MOOCs for Increasing User Engagement" (Vaibhav, A and Pooja G, 2014), using the gamified learning platform Quizlet, the authors claim to have measured a 28% increase of a passing grade in a group of students who took a 3-day language course using Quizlet (72% pass rate, 50 participants), compared to a test group taking a language course without the use of this platform (44% pass rate, 50 participants). The latter group were given a word list the participants had to memorize. Furthermore, the amount of students who showed up to take the final test in the course increased by 14% - 30% in the gamified environment vs. 16% in the non-gamified environment.

c) Leaderboards

Leaderboards, performance tracking and rewards based on merit is very common in today's online video games. Educational software tends to shy away from these methods of gamification, perhaps due to the fact that being constantly reminded of your performance compared to others can be discouraging for some students. However there are ways to turn this concept on its head, and instead foster collaboration and team spirit. Instead of focusing on the merit of a single user, a group of users can be given a goal to reach together in addition to highlighting the top performers. Such a system will reward the entire cohort, not discouraging the weaker students, and still providing a special treat for the students going the extra mile.

Duolingo's implementation of such a system is called "Duolingo Leagues". In Duolingo Leagues, the users are matched with 50 other users, who all contribute to a shared pool of points. If the total points accumulated by the group meets the required amount, all of the users are rewarded with a prize. The top performers however, are placed in a new group with top performers from other groups, who then again pool their efforts together to earn more prizes. This system works wonders because it not only rewards everyone for participating, but also naturally teams up users with a similar amount of motivation and skill which fosters healthy competition within the groups.

6.3. Use case of gamification for social inclusion: the OPEN MIND project

As depicted above, gamification applies in many topics and fields for course training. But apart from the specific topic and course, which were explored in the previous section for the case of language training, another important factor to take into consideration is its social dimension, and more particularly how gamification can optimize social inclusion for groups in need. As an illustration, the project "OPEN MIND[19]: Gamified platform and open online course in Social Entrepreneurship for female learners and students

[19] http://open-mind-project.eu/

from diverse fields of study" is presented below; a project that was recognized as a Good Practice by the Bulgarian National Agency.

OPEN MIND was a two-year project, co-funded by the Erasmus+ programme of the European Union, which concluded in 2018. Through an online platform, it developed and piloted an innovative gamified open course[20] in social entrepreneurship for women and students from non-business studies. It aimed to promote social inclusion and mainstream education opportunities for learners from all fields of study. More in particular, the project fostered inclusion of two groups of participants who are disadvantaged and underrepresented in entrepreneurship, namely women and youth.

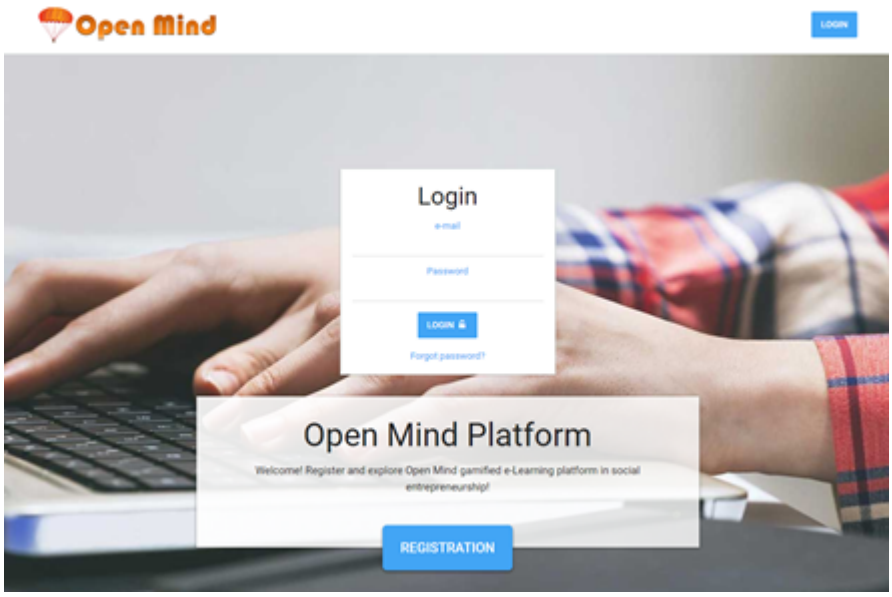

Figure 6.3: Screenshot of the Login page of the OPEN MIND platform

The project sought to improve the access to entrepreneurship training and ensure that the participants had the opportunity to acquire entrepreneurial skills and mindset and subsequently potentially consider start-up or self-employment. It also addressed gender gaps and promoted more gender-balanced career choices by attracting female students from different studies to social entrepreneurship. As far as the gamified platform is concerned, the features of the game design, which included among others collaboration, sharing, feedback and awards, provided a highly participative and user-friendly learning environment, where students could obtain generic entrepreneurship skills and specific business competences, while solving specific social problems in supportive, cross-disciplinary teams and competing to achieve better results.

[20] http://platform.open-mind-project.eu

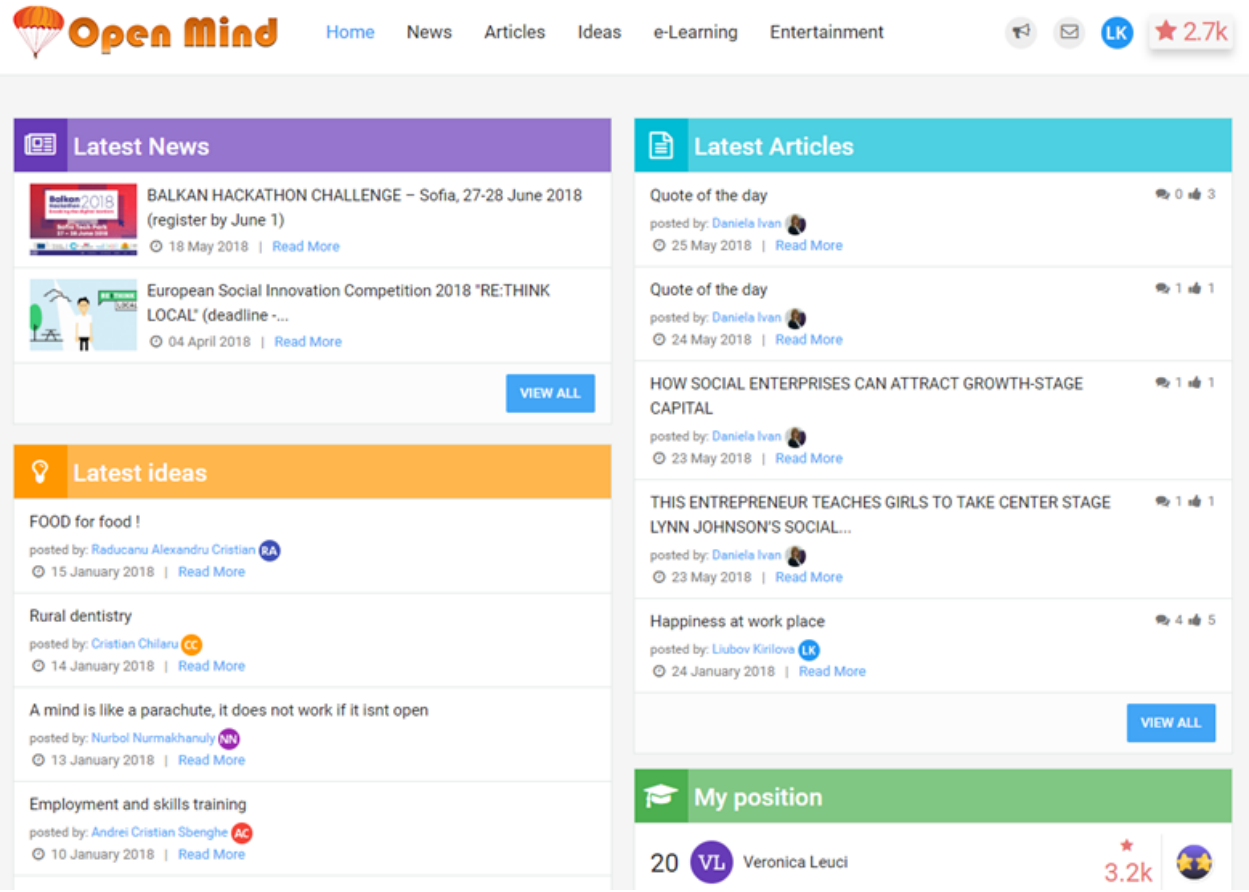

Figure 6.4: Screenshot of the Main page of the OPEN MIND platform

In this framework, during the pilot testing, the OPEN MIND gamified platform provided the opportunity for an interactive and engaging e-learning process, which involved more than 1000 learners from the participating countries (Bulgaria, Greece, Poland, Romania and the UK), while more than 60 trainers and mentors provided mentoring and counselling services.

The pilot testing also yielded some highly noteworthy results regarding the impact on learners, which was assessed with the use of ex-ante and ex-post surveys. Among other conclusions, the surveys showed an astonishing increase in the number of students who reported that the course affected positively their knowledge of social entrepreneurship and multidisciplinary and soft skills. In addition, a positive impact was noted in regards to the promotion of social, civic and entrepreneurship competences, active citizenship, critical thinking and ICT skills, while the project's methodology and outcomes encouraged the international cooperation, exchange of experience and development of innovative teaching and training mentors.

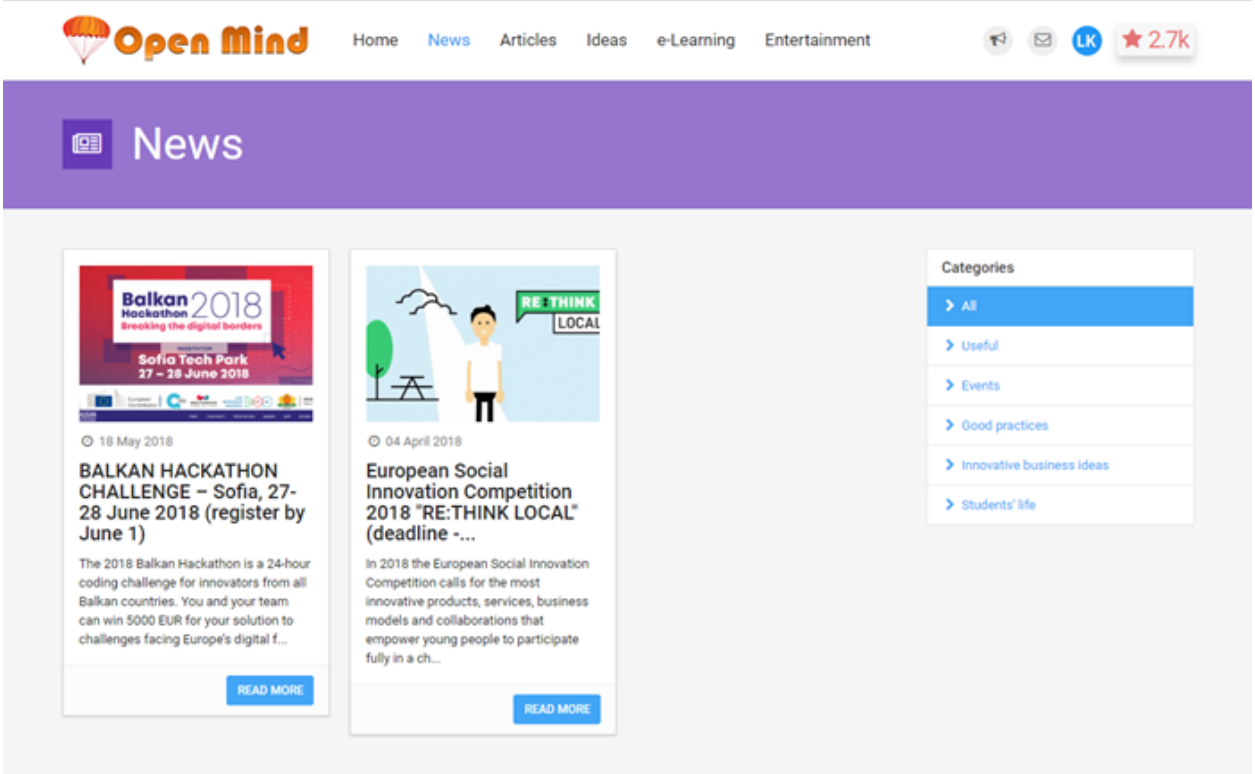

Figure 6.5: Screenshot of the News page of the OPEN MIND platform

The OPEN MIND project was a unique opportunity to explore the strengths of introducing gamification in the learning process for social inclusion. The primary target groups, i.e. women and young people, were the focus not only of the content, but also of the platform features. More specifically, learners who lived in remote areas, or had no access to training in social entrepreneurship or who might had faced economic obstacles regarding their education, or are parents, had the opportunity to participate in the course in their national language, by immersing in the topic with the use of real cases of the local and national reality for entrepreneurship.

While the online dimension of the platform ensured the participants would have access remotely regardless of their geography, the gamification approach was the element that inspired commitment, thus involving students in a novel learning journey. The variety of features the gamified platform provided made it attractive, suitable and effective for different kinds of users, depending on their motivation and preferred mode of learning. Instead of traditional classroom teaching, the students focused on the problems, which were of importance to them, elaborated on meaningful projects and developed business plans for their own ideas. Additionally, the gamified platform enabled active participation and experiential learning, helping participants to not only receive new information and knowledge, but also, and more importantly, develop the key entrepreneurship skills and competences and demonstrate them. What is more, the OPEN MIND platform offered official recognition to the learners through a transparent

evaluation system, which led to ECTS / ECVET points. As learners progressed, they received points for each creditable activity and for each successfully implemented task.

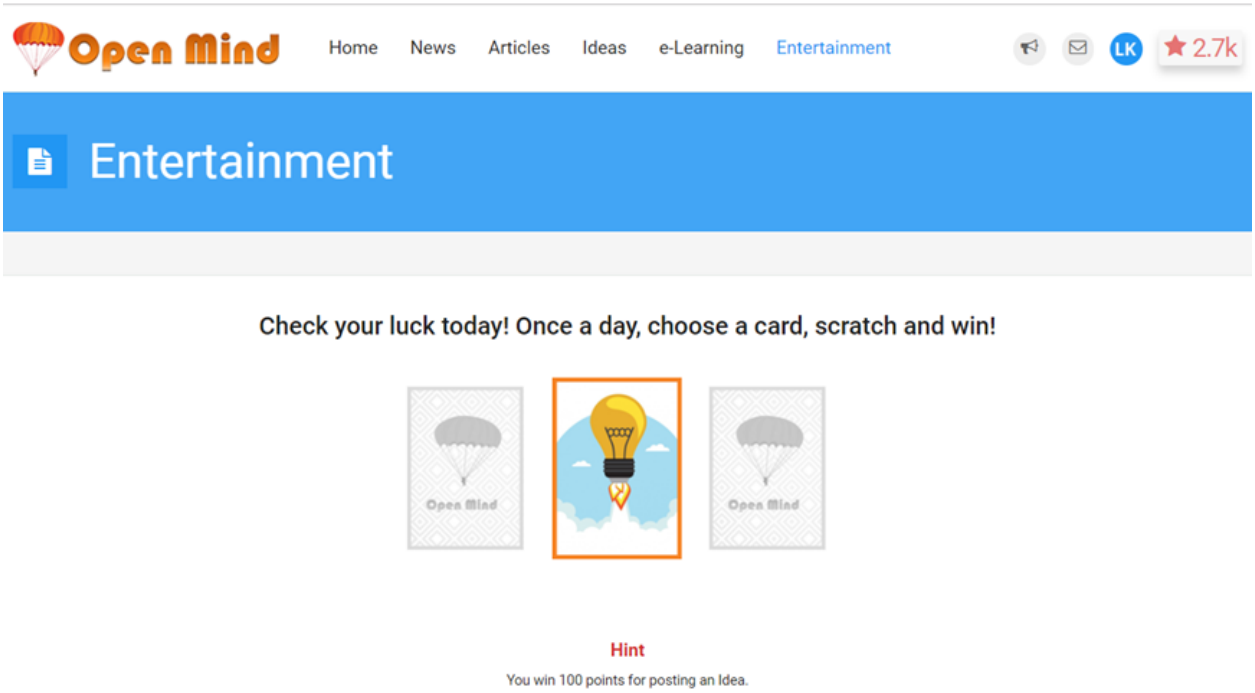

Figure 6.6: Screenshot of the Entertainment page of the OPEN MIND platform

In this context, gamification proved a valuable proponent of social inclusion by providing out-of-the box alternatives for the provision of knowledge and skills, by taking into consideration the special circumstances the target group has to face. By translating these circumstances into a participative, interactive and interesting gamified course, OPEN MIND succeeded also in raising awareness about social issues and entrepreneurship both on a systemic and national level.

7. Conclusions

This deliverable helps stakeholders, let them be technical or laypersons, have an initial understanding of the technologies as well as the components that will be used for the easyRights platform. Furthermore for ease of representation mock-ups were prepared. D1.2 will be supported by the creation of marketing collateral, such as postcards and roll-ups, where clear and concise messages will be transmitted.

Furthermore, this deliverable and the marketing collateral, can be downloaded from the deliverables' dedicated section on the project's website: https://www.easyrights.eu/deliverables respectively from the media section https://www.easyrights.eu/media.

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