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Virtual information assistants on mobile app to serve visitors at Helsinki Central Library Oodi

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Abstract:

A big challenge for library visitors has always been the great amount of information and how to find new interesting and available content quickly and easily. From libraries' point of view, the challenge is how to offer different kinds of reader profiles with reading suggestions in a fast, efficient and entertaining way. Library classification rigorously guides the search for information but doesn't serve all user profiles that well. Many users want to discover content across genre boundaries but at the same time stick to interesting themes.

Headai created mobile application with six distinctive, AI-based recommenders for the Helsinki Central Library Oodi. Based on their own areas of interest, these virtual assistants provide visitors with interesting reading suggestions. The service design goes hand in hand with Oodi's modern architecture and the role of forerunner of libraries in Finland harnessing new technology to serve visitors. To support the idea of virtual assistants, it was natural to use chat-like user interface. Every recommender was designed to have their own personality.

AI-assisted book recommenders act as great enthusiasts in serving reading suggestions. At the same time, they utilize many available APIs to enrich the visitor's experience. The intuitive user interface makes the use very fast and easy. An artificial-intelligence-based book suggesting is a good example of a new technology that can add value to library content and automate repetitive information routines.

Keywords: libraries, chatbots, ontologies, natural language processing, data mining

1. Introduction

A big challenge for library visitors has always been the huge amount of information and how to find new interesting and available content quickly and easily. From libraries' point of view, the challenge is how to serve different kinds of reader profiles with reading suggestions in a fast, efficient and entertaining way. Library classification rigorously guides the search for information but doesn't serve all user profiles too well. Many users want to discover content across genre boundaries but at the same time stick to interesting themes.

Headai signed an innovation partnership with Helsinki Central Library Oodi in the spring of 2018. Oodi particularly wanted to develop new service models using robotics and artificial intelligence and Headai was chosen as the provider of an intelligent content suggesting service. This paper describes the project, its result and the lessons learned. As the result, Headai created a mobile application with six distinctive, AI-based recommenders for Oodi. Based on their own areas of interest, these virtual assistants provide visitors with interesting reading material. The application (Android and iOS) is free and can be downloaded to mobile devices to get suggestions of library content. It uses library system (Sierra API) as a channel to get real-time information of available books in Oodi. It also utilizes Oodi's IoT (sensor) data, as well as Linked Events API for information on local events. The goal is to compile relevant information for Oodi's visitors.

The service design of the application goes hand in hand with Oodi's modern architecture (Image 1) and the role of forerunner of libraries in Finland, harnessing new technology to serve customers. According to IFLA Public Libraries Section Blog (2019) Oodi was shortlisted out of 16 applicants into final four in the competition of IFLA/Systematic Public Library of the Year Award. This was announced during the writing process of this paper and the winner will be published in IFLA World Library and Information Congress, on 27 August in Athens Greece. In addition to all other media attention Oodi has gained so far, this shows that it is a well-recognized and respected new flagship library of Finland.

Image 1. Oodi Library - Helsinki, Finland - Black and white street photography. Picture by Giuseppe Milo is licensed by CC 2.0. Available at https://flic.kr/p/2eeDzAt.

The Oodi mobile application was named Obotti. It allows users to find interesting reading anywhere, anytime and with minimum effort. Hammais, Ketamo & Koivisto (2014) state that taking learning out of the classroom can significantly boost the motivation of the learner. The same applies to finding books – the motivation can be higher when books can be discovered outside the library. The user interface (UI) is chatbot-like but without a need from user to input any text in chat view. The communication with bot flows forward by clicking. Abdul-Kader & Woods (2015) describe chatbots as following: "Chatbots can assist in human computer interaction and they have the ability to examine and influence the behaviour of the user by asking questions and responding to the user's questions."

Budiu (2018) notes that "Far from being 'intelligent', today's chatbots guide users through simple linear flows, and our user research shows that they have a hard time whenever users deviate from such flows." In Obotti chat UI, it was decided not to include option to input free text. This keeps the user always in fast track getting content and doesn't enable deviating from the desired flow. From the content point of view, the flow will always be non-linear, i.e. user never gets same books in a row. According to Koivisto, Ketamo & Hammais study on The Literature Race library game (2014), "The non-linear story will always be different, i.e. chain of books will never be the same." However, a text search exists in Obotti and can be found by clicking the search icon. It gives user the important feeling of freedom to search anything specific in his/her mind. When a desired book is found this way, the user can check the details of the book and is eventually led back to chat view where the book can be used as a basis for next bot recommendations.

Oodi recommenders were designed as stylish characters, whose building material, like in the library itself, is mostly wood. To support the concept of virtual assistants, it was natural to pick chat-like approach. Every recommender was designed to have an own personality. Each one was trained with specific vocabulary to personalize the reading suggestions they give. A possibility to create new recommenders was also brought for library staff. This enables e.g. creating new bots for season-specific suggestions.

2. The Phases of the Development Project of Obotti Mobile Application

The project kick-off was in April 2018. The general guidelines of the project were decided together with the client. Unlike the original idea to use existing human characters (Image 2) and their reading profiles as a basis for recommendation bots (software robots), it was decided to use more neutral kind of approach in planning the characters. It was also decided not to collect personal user data. The target was to make the application as easy as possible where user wouldn't need to log in.

Image 2. The original installation & visualization idea from Headai featuring some well-known public figures. This idea was not taken into production.

The initial definition of the data sources that would be used was made. The more detailed explanation of the sources can be found in Chapter 4. Using APIs is a natural and modern way of collecting information to a service or mobile application. It makes the end user client light and changes and updates on data can be made without updating the mobile application itself. Evans and Basole (2016, 26–27) state that while the possibility to connect to digital resources using APIs has been there for decades, the rise of digital platforms and mobile computing, lower cost of data storage space, and just the sheer usefulness of automating how digitally encoded information can be made available and exchanged has helped the growth of API ecosystems.

A workshop on reviewing the plan for UI (user interface) with its elements (Image 3) and creating the base for bot characters was held with customer representatives in Helsinki in August 2018. The purpose of the workshop was to review the principles of material recommendation and to get a common understanding between the customer and Headai. The

aim was to open the library user profiles and think about the dialogue between the different user segments and bots. As a result, five different prototypes of characters with their special interest areas was textually described. This way of working served Headai well in further development of the characters' visual look, verbal output and personalities. It was also noticed that using an external service designer worked fine even though the subject was as challenging as implementation of artificial intelligence in library context.

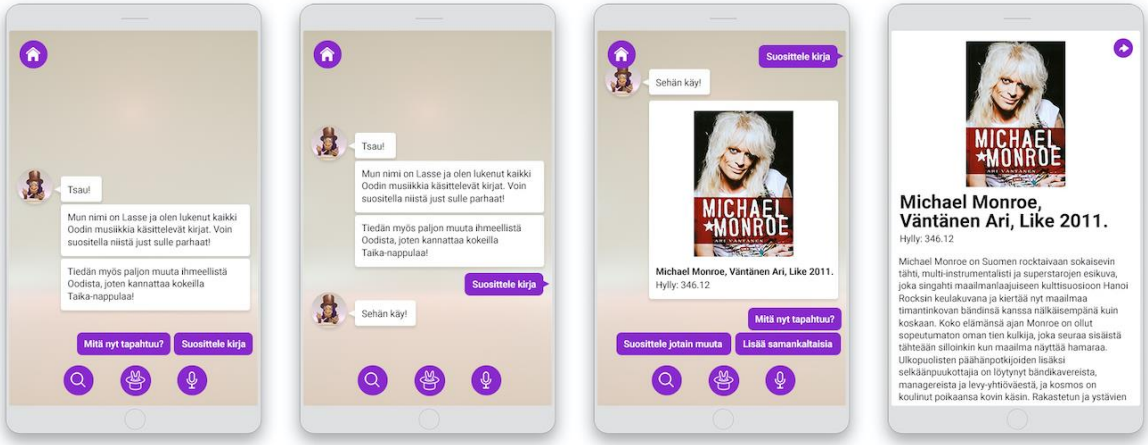

Image 3. The plan for chat-like UI. It didn't change much during the project and was taken into final version with only small fixes.

Headai chose to use Fuse technology to produce the application. Fuse Open website (2019) describes it as "a set of user experience development tools for Windows and macOS that unify design, prototyping and implementation of high-quality mobile apps on iOS and Android." Fuse introduces UX Markup (User Experience Markup), an XML-based language to create native, responsive and interactive components for iOS and Android. For an end user, it gives e.g. fluent and smooth animations and transitions inside the application. Another reason to use Fuse was that Headai had an extensive experience on the technology in-house.

Basically, the application is kept simple with only a small number of different screens (Image 4). In the main screen, user can choose the desired bot character by swiping horizontally. Starting the bot takes user to chat view where the interaction with the bot happens.

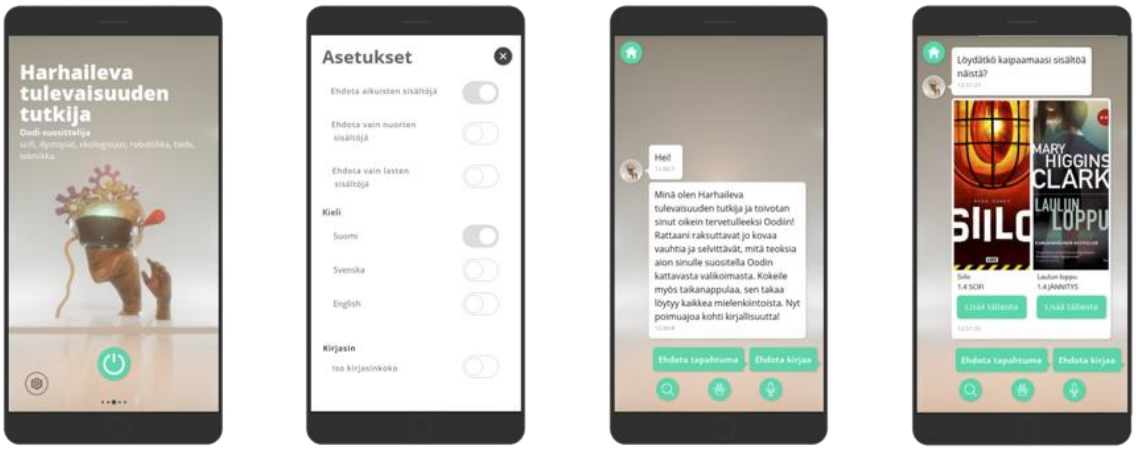

Image 4. The first four screens of the application. Start by choosing the desired recommender, check the settings and start the interaction.

Obotti includes also a text search and a voice search. Both of them can be used to search specific content. Voice search uses the native speech recognition technologies of Android and iOS. The big development in the speech recognition technology in recent years has made this kind of implementation possible. According to Corbett & Weber (2016), “Voice interactions on mobile phones are most often used to augment or supplement touch-based interactions for users’ convenience.” Voice search (Image 5) is a good way to improve Obotti’s accessibility for people with limited hand dexterity or visual impairment. It gives the user possibility to use the application without inputting any text. The voice search in Obotti works in all current operation languages, Finnish, Swedish and English.

During the project it was noted that using voice search could lead into using different kind of search words than when using normal text search. One of the reasons could be that with voice search it’s easier and faster to describe multiple desired topics compared to text search. For future research, it would be interesting to study, how does the search words differ from each other when using text search and voice search.

The “magic button” in the bottom center of the screen will serve surprises for visitors. It can be interesting textual facts about Oodi, IoT-data like how many visitors there have been on the current day or a local event taking place in the near future.

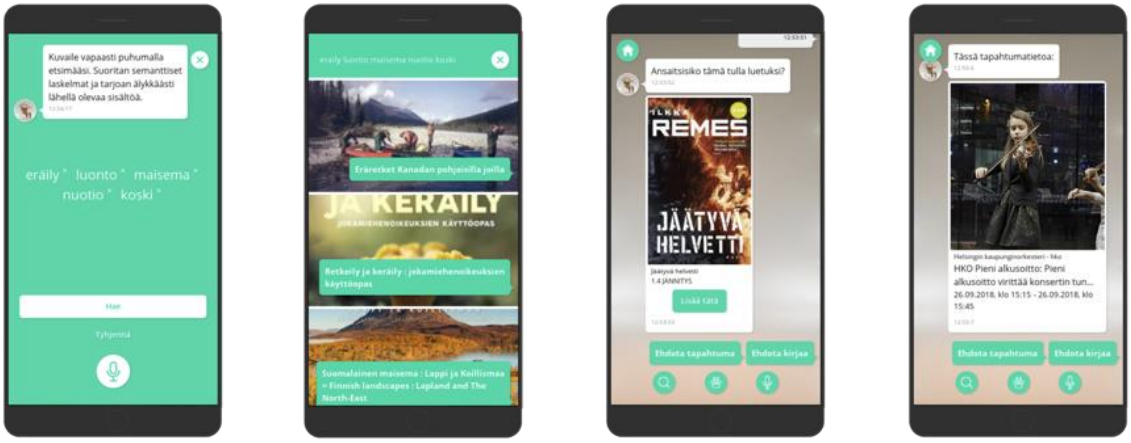

Image 5. Voice search lets user to vocally express the desired topics. The results are shown as a scrollable list with book covers. The chosen book is taken back to chat view. In the rightmost picture, a user has asked the bot to suggest a local event.

After the prototype with initial versions of the bot characters was accepted by the customer, Headai started focusing on improving the usability and tackling the small issues that were noted in testing the prototype. The options menu located in the application main screen was updated with new features. The option to choose content for children, young and adults was added. It’s possible to choose only one, two or all of the material. Also, an option to choose big font size for application texts was added to further improve accessibility.

The full dialogue lines for each bot character was written. To avoid repetition, a lot of variants for each line was made. This gave great possibility to deepen the characters. During the writing process it was discovered that only 5 to 7 variations of each dialogue line was enough to avoid the feeling of repetition. When the number of variations was raised up to 15,

it gave more leeway to play with the word choices and spice up the characteristics (Image 12, in the Chapter 5).

Bancroft (2016, 16) states, “Once you have the personalities of the characters in your head, you will know the direction to take when you sit down to draw them.” The same applies in creating the dialogue of a bot character. It’s becomes easier to imagine the words that will come out of the character’s mouth after his or her true personality is clearly defined. A good method to get started with a character is to write a short biography or history of him/her. This way, the word choices come more naturally when they reflect the history of the character.

After the iteration rounds the MVP (Minimum Viable Product) was accepted. It was prepared to be released in December 2018, the same time Oodi was opened. The customer decided to soft launch it first and make a marketing campaign a bit after the grand opening of Oodi, in 2019 when there would more time and space for marketing the application. Also, this gave some time for the implementation of the Admin tool for library staff to edit the bots. The Admin Tool is gone through in Chapter 5.

The version to be released included five basic bots (Image 6) that represented very different kind of areas of interest. In addition to them, a so-called community bot was added to the application. She was named *Lizzie* and was added sixth in the main screen. The idea behind her content recommendations is to offer material based on recently searched words by all of the application users. After the first release, the customer wanted to update the visual appearance of the application to match Helsinki look (Image 7). It was done as the first after-release update.

Image 6. The first characters ready. They were named in Finnish, the translations from left to right: *The Romantic Cynic*, *The Gardening Punk*, *The Wandering Futurologist*, *The Epicurean Sewage Diver* and *The Adventuring Granny*.

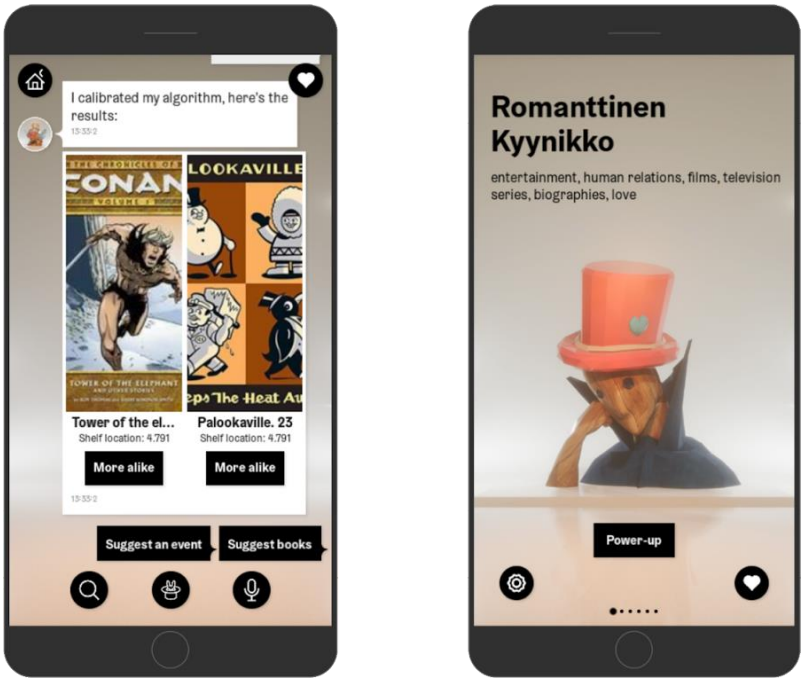

Image 7. The new look of Obotti is based on Helsinki visual guidelines. It is recognizable from its black and white colours and rectangle shaped elements with sharp edges.

3. Previous research

Previous library related Natural Language Processing (NLP) applications, developed by the Headai team, have been evaluated as 'too scientific' and so not optimal for all users (e.g. Ketamo 2015). In this study, the main focus was in User Experience (UX) development, without losing completely the possibilities of computational intelligence in readings suggestion. Semantic networks-based approach is used to model a user's personal interests in order to optimise the recommendations the user gets. The focus of this section is on describing the known challenges from existing research: 1) Challenges in tagging/key-wording/labelling the content, 2) challenges in adaptive media, 3) challenges in behaviour modelling and 4) known work in connecting media objects to digital systems.

Tagging is very subjective and numerous researches is done in order to improve user experiences and information retrieval in social media (e.g. Agichtein et al. 2008; Heymann, Koutrika & Garcia-Molina 2008; Sigurbjörnsson & van Zwol 2008) Unclear, or in worst case misleading, tagging leads to information loss in social media. Furthermore, tagging/key-wording/labelling can be seen as a one key element when building platforms for personalised services, but understanding semantics brings new dimension to text analytics.

Adaptive and/or personalised media can be divided into two main groups: indirect (static) adaptation and direct (dynamic) adaptation. In indirect adaptation the rules are fixed beforehand by developers. Indirect adaptation is based on statistical rules, decision trees, state machines or the cumulative effects of several fixed functions. In dynamic adaptation the system tracks the user and optimise the content according to a user's behaviour. In other words, dynamic adaptation is based on machine learning. Dynamic adaptation requires at the very least 1) a user model and 2) a context model. The machine learning algorithms has been implemented with various methods, starting from statistical machine learning and ending to deep learning applications. (Manslow 2002; Brusilovsky 2001; Eklund & Brusilovsky 1999).

Semantic networks, also known as conceptual graphs, are knowledge representations constructed with directed or undirected graphs (Sowa 1987; Sowa 2008). Semantic neural networks (SNN) are generally used for processing natural languages (Shuklin 2001). However, Semantic neural networks as knowledge representations are relatively extensible and they have been used, for example, to model medical and psychological disorders (Geva & Peled 2000). On the other hand, SNN can be utilised to model the characteristics of users, profiles, patterns of behaviour, and skill levels in order to support or challenge the performance of individuals.

Parallel methods, such as behaviour recording (Houlette 2003) and behaviour mining (Mukkamala, Xu & Sung 2006; Kuo et al. 2005) have been studied and used in the game industry for some time. Behaviour recording refers to game development and behaviour mining usually refers to intrusion detection in networks, etc. Because the idea of adaptive educational systems is to produce individual and optimised learning experiences (Brusilovsky & Peylo 2003; Ketamo 2010) high end user models, as well as methods, are relatively complex. In the high-end solutions intelligence is based on neural, semantic, or Bayesian networks, as well as genetic algorithms (Reye 2004; Kim, Hong & Cho 2007; Lucas 2005).

4. Data Mining, Natural Language Processing & AI features used

The project started from mining multiple sources. Firstly, Finna was read (https://www.finna.fi). Finna is an information retrieval service that provides free access to digital materials and catalogs of about 100 Finnish archives, libraries and museums. The service has been established as a part of the National Digital Library project of the Ministry of Education and Culture. Finna has more than 13 million material information. From Finna all books related to Oodi library was read and after the first read updated constantly in order to get all the newest books and remove books that are no longer valid. After the basic information from Finna was gathered Headai team started to enrich the data using Sierra API (https://developer.iii.com/). From Sierra API it is possible to get more library specific information from the books including library's own keyword lists and lending situation. Sierra API is RESTful API that enables to harvest records and from specific library. With these two sources it was possible enough information to Headai AI algorithm to start making recommendations.

Headai's AI is strongly based on Natural Language Processing. NLP is a technology used to aid computers to understand the human's natural language. AI finds meaningful words from given text and removes "noise" (like prepositions) in order to get best results from given data sets (in this case books). By creating connections between books AI can then show best matching results and explain the reason why it ended up to the decision (showing the explanation wasn't needed in the particular project). In NLP solutions there is usually stemming or lemmatization included as it is in our NLP machine. Our team has created own stemming functions in order to make better relations between words. Stemming is a process of reducing derived words to their word stem, base or root form. E.g. with Finnish language it's very important procedure. The book offering through Obotti shows always two books. The first two books come from the interest area of the current bot (Image 8). User can ask similar reading than one of the previous books. Two books are once again served: first one is the best match to the data on the previous book and the other one is considered to be

something which is little bit more unexpected result (Image 9). This way, user can be introduced to new and hopefully interesting learning material.

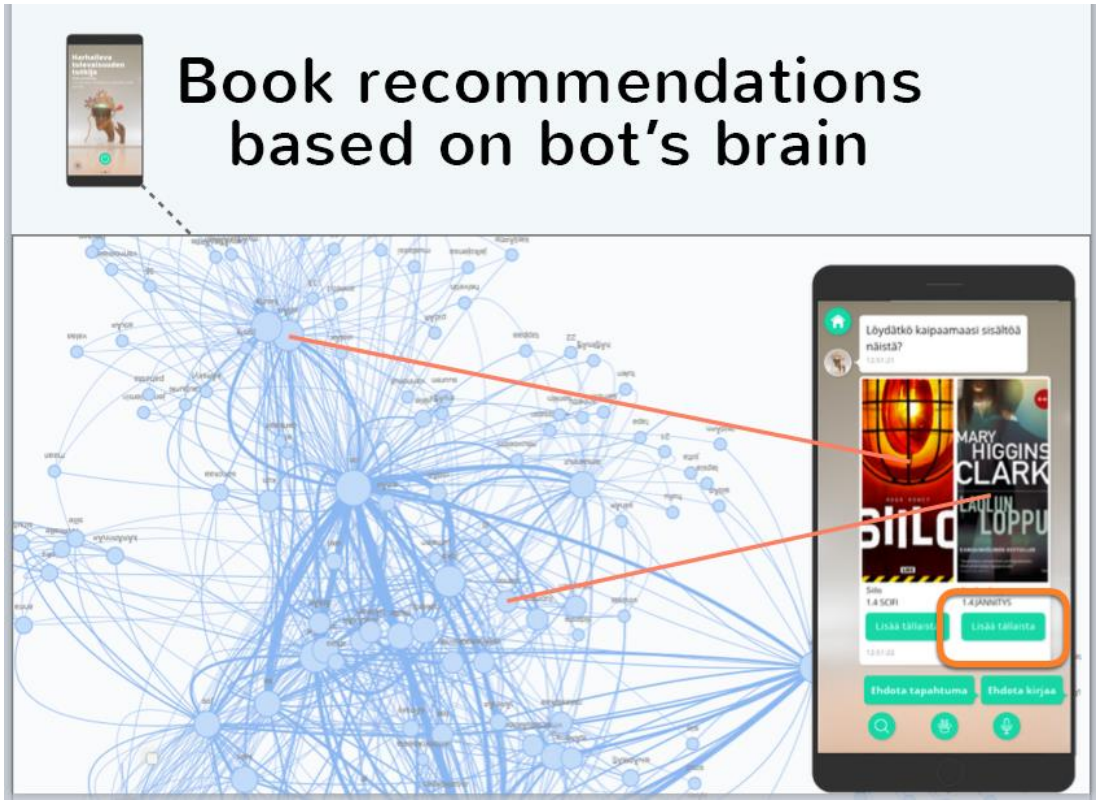

Image 8. Illustration of how two books are served from the "bot's brain".

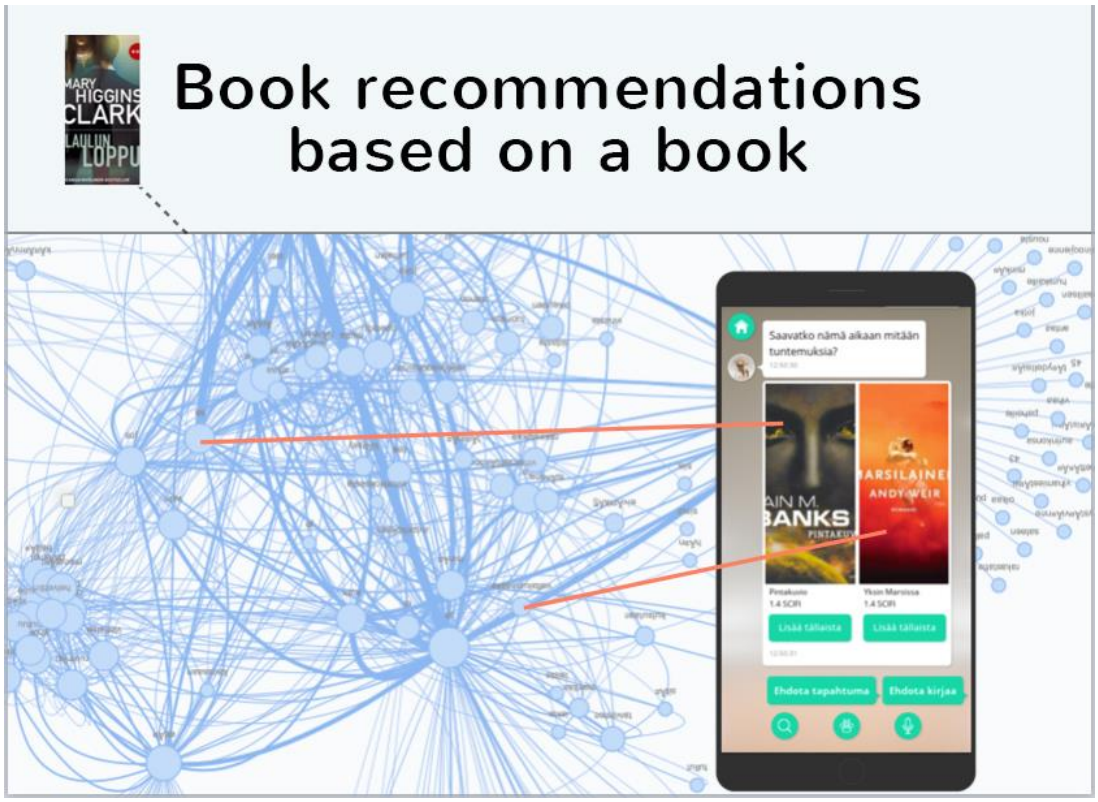

Image 9. Illustration of two books being served based on previous book's data. The left one hits very close to base book and the right one can offer something new but interesting.

For book offering Headai uses Markov's chain. In Markov chain, the results depend only on the state attained in the previous event (Gagniuc 2017; Oxford Dictionaries 2017). This was used in two reasons. It has been found out in other Headai's library implementations that if all previous data is used to offer future results, user often thinks that there are no relations between the given data. In other words, the relations get too fuzzy. Another reason is that Headai's AI calculates all results in real time and the time between new book recommendations would naturally grow in each step if all the data from the previous steps was stored.

As in many (or all) libraries content is given in multiple languages. Headai's NLP machine needs to know in what language stemming needs to be done, as this is somewhat different in each language. Also, AI needs to know in which language user wants the results. For this Headai has created its own language detection AI. This is based on reading news articles for over ten years and created semantics and ontologies based on news.

Headai also reads IoT (Internet of Things) data from Oodi library. Currently only port sensors are read but IoT data sources will grow in the future when Oodi implements more sensors to their system. IoT data offers some interesting points of view to the user and breaks the book browsing from time to time. Another available IoT source is available rental city bikes near the Oodi library. This was added thinking that user might want to take a bike trip to see other local attractions between Obotti sessions. Bike rental information is read through Helsinki city REST API.

Oodi library wanted Headai to create also one "community bot" which was based on the Obotti users. This was done by storing part of search history from each week. From that data Headai could create one bot brain of which context (vocabulary) would change each week.

5. Admin Tool to Edit and Create New Bots

Last part of the project was to implement an easy tool for the Oodi staff to edit and create new recommender bots to the application. This would enable developing the already existing bots's stories and e.g. season-specific recommending: Before Christmas time the library staff could plan and publish a new assistant bot with Christmas theme. On Valentine's day, a friendship-centered character would suit well. Most importantly, the changes made by the library staff wouldn't affect the use of the actual mobile app – only publishing a new bot or hiding an old one would update the bot roster when a user starts the mobile application next time. The Admin tool was given to Oodi in the early 2019.

The Admin tool is like a normal webpage where the Oodi staff can login to be able to make modifications on current bots and create new ones. The main screen (Image 10) presents all the public bots that can currently be found in the application and the ones that are still private and under editing.

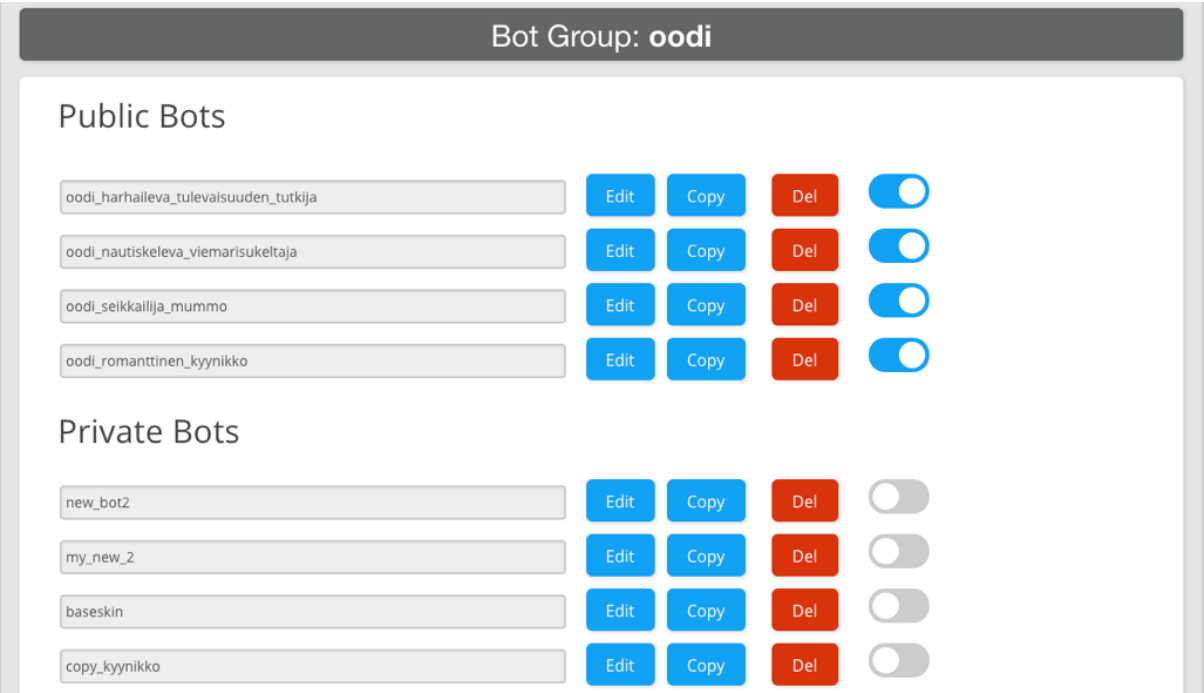

Image 10. The main screen of the bot editor. Public bots can be seen in the Obotti mobile application. Private bots can be edited and published to Obotti on the fly.

The bot editor (Image 11) shows every bot's editable details, e.g. name, description, avatar, background images, colors, etc. The important part is the bot brain. It is a collection of words that describe the interest areas of the bot. As the mobile app can be used in Finnish, Swedish and English, the brain should cover at least some words from every one of the languages. This way users can get content in all of the operating languages.

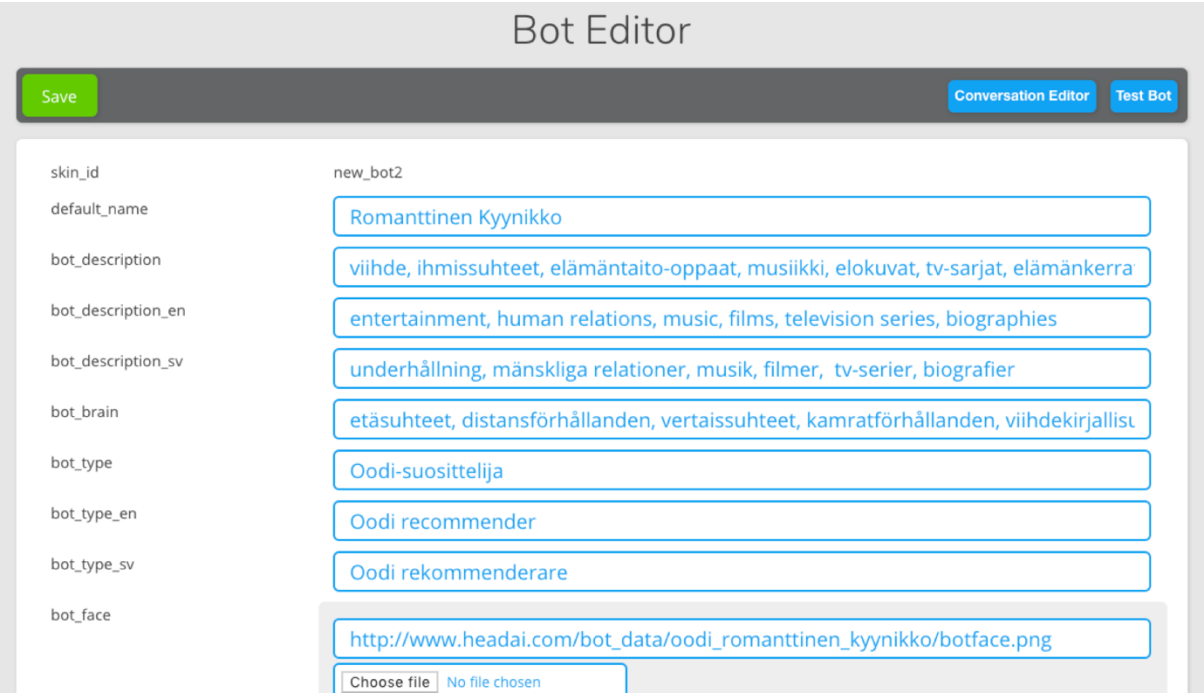

Image 11. The Bot Editor. Bot brain (in the middle) is the collection of words that are used as a basis for content recommendations.

Conversation Editor (Image 12) opens up all of the dialogues written for the current bot. Every situation, like serving a new pair of books, has an own line and its variants. To make the bots speak differently Headai wrote the lines using the results of the bot workshop kept earlier during the project. The different backgrounds helped in choosing the right words for each situation. In the future, Oodi's staff can edit or change the way they speak. The editing is quick and easy as the lines are all in plain text and copy-pasteable.

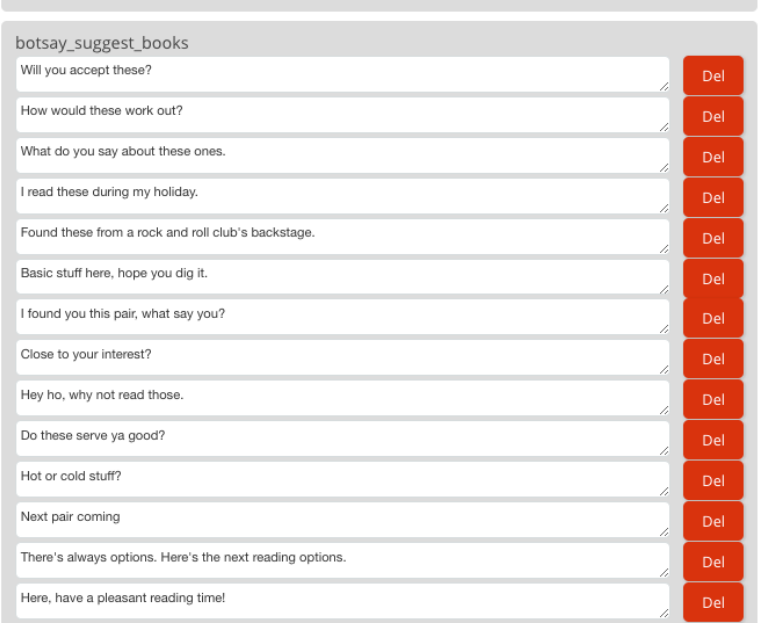

Image 12. In Conversation Editor, a customer can add, edit and remove variations of each conversation line for each bot. The lines for bot recommending new pair of books can be seen in the picture.

The appearance of a bot consists of only three images: The main menu image, bot face and the bot background image in the chat view. To help the library staff's work Headai made template files (Adobe .psd-files) which can be used to create new bot visuals with correct layout and dimensions. Delivering these kinds of templates is a common way to hand over the control of the graphical content in customer projects and enable easy editing in the future. Bigger customers can usually handle the graphical work with own media and communication department. In case of a public library, the editing can be done e.g. by library communications officer or the city communications unit.

Test Bot tool (Image 13) enables testing what content does the bot serve. If the suggested books don't represent the desired outcome, bot brain can be easily modified by inputting new words and deleting bad ones that lead the suggestions out from desired field.

Image 13. Test Bot tool offers a reduced version of the actual mobile app conversation. The idea is to quickly enable testing book offering with the current vocabulary in bot's brain. On the left, the corresponding JSON code can be seen.

When the book suggestions correspond the desired result, the bot can be published. It will appear in the mobile app when the user starts the application next time.

6. Conclusions

The service design process gave Headai lot of experience on implementation process of a chat-style mobile app for library content recommendation. Before Obotti, Headai had already done e.g. BookAI and Älypolku mobile applications for library use, so the playground was familiar. With Obotti, the approach was more user-centered and the potential user groups were studied carefully. Library staff made it clear that it would be one of the key issues for successful application to understand the different user profiles and create the characters to suit their needs. It is important to plan and align the visual appearance of the application with the customer's brand already in the early stage of the project. For public libraries, this can lead to using city communications visual guidelines. If the changes are made at the end of the project, this can delay the release of the application.

Based on agreement not to collect any personal user data, we won't state any empirical or quantitative results on the mobile app usage so far in this paper. For future research with anonymous data, it's possible to study e.g. the usage of the bots – which one is used most, the usage time per session and the books that are clicked and opened for seeing their details inside the application. Also, worth studying would be which words are searched the most and which books are stored into the reading list by the users.

Collecting together information to application from multiple APIs is a today's way of building dynamic solutions for users. However, the more sources are used the bigger is the

risk of some of the sources are not working properly. Particularly in the pilot testing phase and right after the application is released to end-users, it's important to monitor the data sources. The trouble in source data API is often perceived as an error in the application itself, at least from the application user point of view. All in all, the data source error handling is crucial when providing mobile applications that fetch information from multiple APIs.

When using real-time AI calculation, Markov chain with only is a good choice to keep the application fast enough. Not being guided too much by history data allows user to "drift" into new directions because the long-term user behaviour won't affect the coming books – only the latest action.

AI-assisted book recommenders act as great enthusiasts in serving reading suggestions. At the same time, they utilize many available APIs to enrich the visitor's experience. The intuitive user interface makes the use very fast and easy. An artificial-intelligence-based book suggesting is a good example of a new technology that can add value to library content and automate repetitive information routines.

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