BOBCATSSS 2025
The 33rd International Symposium on Artificial Intelligence in Library and Information Science: Exploring the Intersection

From Chatbot to a Social Robot Prototype Using AI for Information Services in the Library - Experiences of a 5-year development process

Peter Linde, Kristoffer Lindström, Lasse Bourelius

Blekinge Institute of Technology, Sweden. Peter.linde@bth.se, kristoffer.lindstrom@bth.se

Abstract

This article is an account of a 5-year-long process of creating an AI-based tool for use in our university library to support work at the information desk, especially when it is unmanned. Our first idea of creating a machine that could answer recurring simple questions at the library's information desk developed out of frustration. Information desk work was increasingly being reduced to questions such as "do you have this book?" or "how can I get a library card". We started out 2019 by creating a chatbot that embraced Artificial Intelligence (AI) and natural language processing (NLP), which was connected to several database sources.

In 2021, we purchased a "social robot head" that mimics human faces, and dialects, and can be set to imitate different accents. It was challenging converting from chatbot-typed questions to speaking to voice recognition. The problems of misunderstandings and misinterpretations are extensive, but at the same time the advantage of using natural language is significant for the user.

During a student survey, we realized that the rules processed in the Microsoft Luis natural language system often interfered with the intentions received from the Microsoft QnA maker. This problem was solved in 2023 when we were able to integrate Chat GPT into our project. This move improved the performance of our social robot. It is now faster, more reliable, can respond much better to "social" questions". It searches successfully for book titles, authors, subjects, can filter out digital or physical books according to preference and help students with library cards and related questions.

During our study, we noted that students can be hesitant to ask questions out loud to a robot in the library. We therefore would recommend using a social robot in a closed environment, like a pod, while simultaneously offering students the opportunity to ask questions via a keyboard.

Keywords: AI; University Library; Chatbot; Artificial intelligence; AI; Information Desk; Social Robot; Chat GPT

1. Background and related works

Today, researchers and university staff, in most cases, solve their information needs themselves. Students, on the other hand, still need support for navigating the library systems and other study-related systems offered by the university. They need guidance in using the library catalogue, obtaining a library card, or setting up a print account, etc. Furthermore, today, the library premises and resources are being utilized around the clock, often with no staff available to answer questions.

Spurred by these insights and the ongoing discussion about artificial intelligence (Massis, 2018; McNeal & Newyear, 2013; Yao, Zhang, Chen, 2015), we wrote a proposal and received a grant from the Swedish Library Association in 2018 to build a prototype for a chatbot, which included AI, capable of answering some of these questions in the library information desk.

1.1 Chatbots and robots in Libraries

Although libraries offer an environment that should be suitable for chatbot automation, there are not many examples of chatbot projects in the library world.

The few examples of chatbots in libraries originate from either the US or Europe. One of the European pioneers was the Staats- und Universitätsbibliothek Hamburg with the "Stella" project, which started in 2004 and ended in

2015. Text-based Stella suggested catalogues and databases and explained the access conditions for electronic full texts (Thoms, 2015). In 2010, the library at the University of Wolverhampton introduced the chatbot LISA, intended to help patrons navigate and find information on the library's web pages (Dowd, 2011). The engine in LISA was based on chat transcripts, which were reduced to keywords linked to a standard response, according to a specific syntax that also contained a URL. LISA is currently decommissioned. In the US, the chatbot Emma, created by the Mentor Public Library in Ohio and operating between 2009 and 2012, is well known, as is Pixel, operated by the University of Nebraska-Lincoln Libraries between 2010 and 2014. Both systems answered general questions and assisted with searches in the library catalogue or other databases, and both were based on the program AIML (Artificial Intelligence Markup Language), an XML dialect that can be used to create natural language via software. Both Emma and Pixel are discontinued (Vincze, 2017).

1.2 A chatbot for BTH

There have been relatively few studies of the use of robots in libraries. In a study published by Asemi, Ko, & Nowkarizi (2021), they found only 15 articles on the topic “Librarian robot” published between 2007–2017. Searches in databases like Web of Science or Scopus show a similar trend over the last five years. Development of chatbots in libraries seems to be declining. We now see that chat services are being developed all around us by authorities, banks, travel companies, and others instead. Virtual assistants such as Apple's Siri, Google Home or Amazon Alexa have become commonplace. From the examples of chatbots in libraries that we have studied we have learned that a successful chatbot service must be easy to administer and possibly partly self-learning (Young, 2019). Our choice of system was therefore based on a mixture of components that allowed a minimum of text input. Both Swedish and English can be easily implemented in a system that uses both text and voice communication.

2. Method and System

2.1 Description of the first prototype and input system

In 2019, we decided not to base our prototype on the old XML dialect AIML, because it is difficult to maintain and does not offer any opportunities for self-learning. Instead, we invested in new technology that was based on both fixed and dynamic rules and intentions.

We built our chatbot to both exploit and test the possibilities of using existing tools to process text and extract intentions, with the aim of finding the most suitable answer to a question. However, this was not enough to create a fluid conversation, in which you should also be able to get help in several steps. Therefore, we utilized two components that are part of Microsoft's cloud-based AI services on the Azure platform. Other suppliers operating in the same area are Amazon and Google.

The chatbot has a dynamic control module consisting only of strings sent to a Microsoft LUIS service. Then, the chatbot tries to interpret intent from this information and dynamically builds a tree-like structure from it. It asks questions based on regulatory requirements and considers previous question and answer formats.

According to the left panel in Figure 1, the following happens

1. The chatbot receives a query from a user.
2. It examines the issue and tries to identify whether a title of a book is included.
3. Sends the query as it was written to QnA maker.
4. Translates into English (if needed).
5. The system sends a modified version of the original question to a Microsoft Luis database, adapting it to the typical design of library issues. Luis can then distinguish whether you want to "acquire" something (Acquire) or if you, for example, "Searching" for something (Search).
6. If the chatbot considers that the user is looking for something, it will search / ask for a title and then search the library directory, eg. Summon or similar.

If the user searches for something, it can then lead to a loan or a reservation, based on the intention “Acquire,” which uses the regulator to know what questions to ask the user. The rule engine interprets to divide the rules into intentions and conditions based on the text. An example of this is the rule "To print you must have a print account", which has the intention "print" and the condition "print account".

Description of the two prototypes

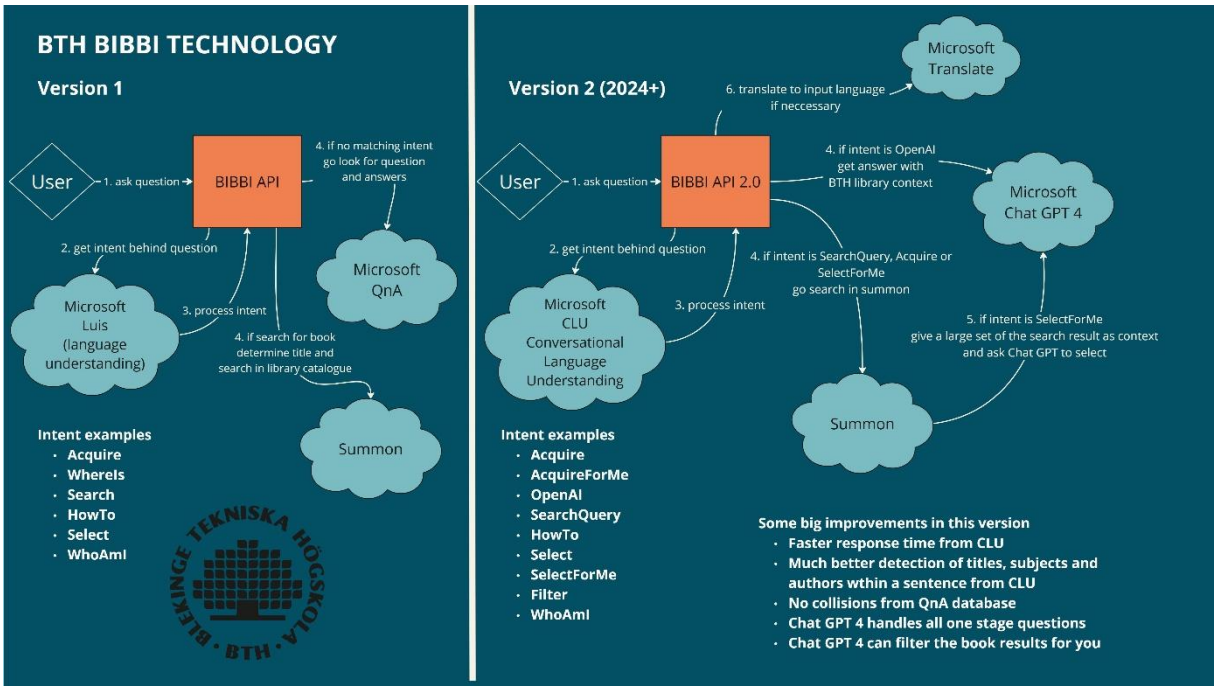

Figure 1. To the left the first prototype and to the right the second and last prototype finalized 2024

The chatbot can dynamically change the answers and questions, but it is not about active learning at this stage. Since the tree structure is created dynamically, there are great opportunities to adapt and change the chatbot according to local needs without having to change static structures.

In 2021, our chatbot project, took a new turn when we had the opportunity to purchase a social robot head that communicated via speech and was equipped with interaction modalities such as facial expressions, head and eye movements. This new social robot listens, shows emotions, and returns eye contact. It was developed by a spin-off company from The Royal Institute of Technology in Stockholm, called “Furhat Robotics” (Furhat Robotics, 2025). We baptized our robot “Bibbi”.

It was a challenge going from typed questions to spoken questions and voice recognition. The risk for misunderstandings and misinterpretations is far higher, but at the same time, the advantage of using natural language for the user is so much greater.

Converting our chatbot system to suit Bibbi we ended up focusing on our old scenarios:

- Questions that are primarily about finding books, loans or reserving specific books.
- Questions about getting library cards and using library resources and localities.

3. User study 2022

Between June and September 2022, a user study was carried out. Twelve BTH students (7 men and 5 women) from 7 different programs were selected. The group of students was set up to reflect the distribution of programs, gender frequency, and frequency of foreign students at the university.

The test subjects were given a short oral summary of the test (approximately 10 minutes) and handed a paper with 4 different types of questions they were supposed to ask Bibbi. Then, they were asked to sit down with Bibbi and ask for her help. All subjects were filmed. Our aim was to get an answer to the following six research questions:

• How well does Bibbi understand the students' questions?
• How often does she answer the questions asked correctly?
• Is there a difference in correctly answered questions between English and Swedish?
• Which questions are more troublesome and why?
• How does it feel to interact with a robot?
• How do the students react when Bibbi does not understand?

After studying the video clips and the survey answers we found:

1. When the questions are limited to loans, book searches, and library cards, Bibbi answers the questions well, but it is often necessary for the user to reformulate questions. When question scope is less defined or based on Q&A, the answer becomes more random and often wrong.

2. Our estimate was that Bibbi answers approximately 50% of the questions correctly the first time at best. The percentage increases depending on the student's patience and ability to reformulate and start a new session.

3. We believe that Bibbi answers questions in Swedish a little better. This is because English is rarely the students' first language. The pronunciation is not always perfect, and the flow of speech is sometimes discontinuous.

4. Sometimes it is not really the questions as such that cause trouble. The problems consist of handling errors such as students asking questions before a session has started, or Bibbi failing because questions are too long, too short, or single words are misinterpreted.

5. Judging from the video clips, the students are very patient when they get confusing answers, perhaps because they are used to the chatbot environment. We also notice that they look at Bibbi during the conversation and that Bibbi's "human interface" seems to help them persevere. Most survey responses indicate that students find this exciting and that they do not mind interacting with a robot if the responses and functionality make at least some sense. Their patience might in part also be dependent on the surroundings where the student sits alone with Bibbi, and nobody can hear them communicate. This positive attitude is in line with findings from museums where social robots were introduced. Especially, visitors under 30 years of age showed greater willingness to accept help from social robots (Fuentes-Moraleda et al, 2022). No student in our study was above 30 years of age, which is consistent with most students at the university.

So based on these findings we started work to upgrade Bibbi accordingly.

4. Results 2023

After making improvements, we agreed with the librarians, to give Bibbi a probationary position in the library for the last two months of the spring term. We mounted Bibbi on a cart with wheels, along with a computer screen and a laptop. All three devices were secured with steel cables to the cart to reduce the risk of theft. We wanted to make it easy for the librarians to roll Bibbi out, hook her up, and roll her back in. In a few simple steps, a librarian could make Bibbi ready for use. With equally simple steps (turn on/off the power, pull out the cord), they could end her session in the library and wheel her back into her room. Bibbi's cart was placed behind the information desk next to one of the library's regular search computers. We promoted her debut in the library in the university's usual information channels and used a sign next to the cart to invite students to test her ability to find books and assist with library cards. There was also a short instruction on how to proceed on the cart.

Deployment of Bibbi – First version and last version

Figure 2. To the left Bibbis cart. To the right permanent presence with smart screen and bluethooth.

Initially, we had some problems with Bibbi's inability to switch between Swedish and English during a conversation. A side effect of that was probably that the students, after the initial curiosity subsided, now seemed to avoid Bibby's help. After listening to the experiences of the librarians, we concluded that location is very important and that being situated in the middle of the library alongside other search computers and right next to shelves and reading areas was not optimal. Obviously, students experience discomfort when those around them can hear everything they say, and they may also have to repeat things when Bibbi is unable to interpret correctly, which is irritating. In connection with this we had read reports of students finding social robots scary in a library environment (Mubin, Kharub, Khan, 2020; Vlachos, Hansen, Holck, 2020).

Our users also seemed to prefer to ask staff at the information desk before asking Bibbi.

Based on these experiences, we spent the summer and fall of 2023 improving old skills and developing a few new:

- Bibbi is supplemented with a keyboard because the students have hesitated to approach her and ask verbally.
- The university now has access to ChatGPT; therefore, we replaced the Microsoft QnA Maker with ChatGPT.
- The use of Chat GPT facilitates improvement of Bibbi's social capacities. She can now converse in a more natural way.
- Arranged so that Bibbi can distinguish between searches for books about authors and books by authors.
- Enabling Bibbi to search for e-books.
- Improved response time.

5. Results 2024

Bibbi is now faster, more stable, and easier to administer. We have added the ability to search for subjects or books by or about specific authors and made the interface more informative. Different colour codes indicate whether the book is an e-book or a physical book or whether it is available or not. If you choose to borrow an e-book, you receive a QR code that links to the page where the book can be downloaded. The QnA part is replaced by an integration with Chat GPT. We have used information from the library's web site that deals with opening hours, loan times, requirements, and information about the library's rules and resources, as well as where toilets, group rooms, and similar premises are located. We have collected a selection of the library's information texts and created special pages for Chat GPT. Improving answers based on Chat GPT requires improving the text material used by Chat GPT so that answers are embedded in the text in a logical way. By updating text material, already used on the library web pages, we improved Bibbi's ability to answer common questions about copying, opening hours, reading and writing support, location of bathroom facilities, etc.

Now, Bibbi basically consists of two improved parts. The first is partly in language comprehension, which is much better than before. We now use "Conversational Language Understanding (CLU)" from Microsoft (See Figure 1, right panel).

The second part is "Chat GPT." Bibbi will choose whether to ask Summon, i.e., the library catalogue, or Chat GPT the question. We have tried to teach her how questions are phrased for the two different systems. What is distinctive about a question concerning the borrowing of books, and how does it differ from questions regarding group rooms, loan times, and toilets? Since the last version, we have shortened all answers as much as possible to clarify responses.

We included Microsoft Azure's new language detection services, which make Bibbi able to answer in the correct language when students change from Swedish to English. We improved the interface, making it more obvious which titles are physical books found on the shelves or e-books. Bibbi is also now able to filter out physical books or e-books if you ask her.

Screenshot of a user conversation with Bibbi

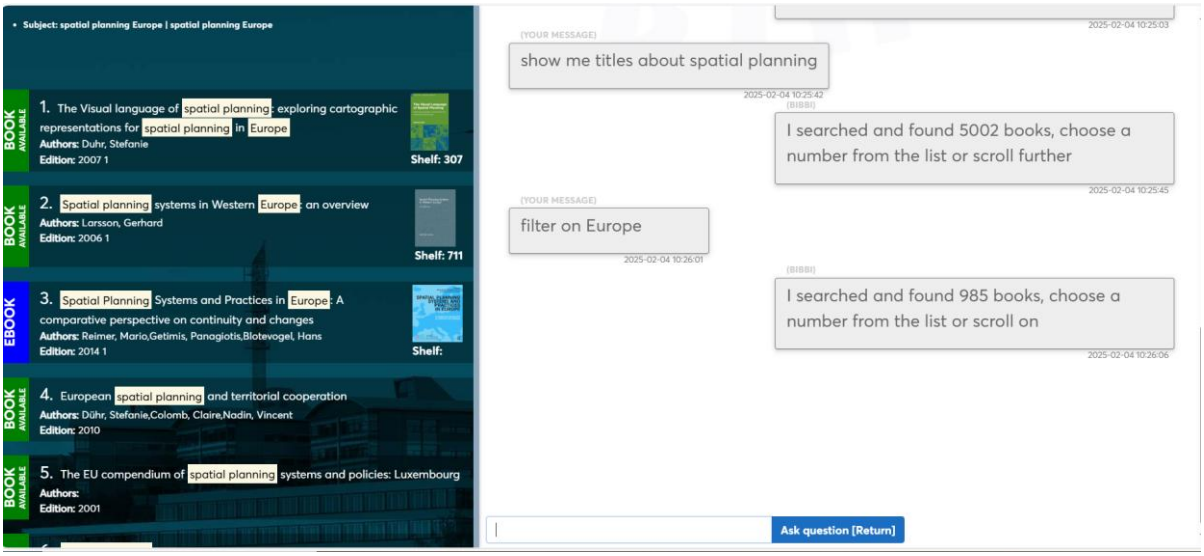

Figure 3. Part of the screen during a user conversation with Bibbi illustrating a Boolean search

Above, in figure 3, is an example of a user wanting to see what titles the library can offer in the subject area of Spatial Planning. The user is presented with over five thousand titles. On the screen, the first twelve titles are presented. Books available on the library shelves are marked with a green label. Ebooks have blue labels. A red colour indicates that the book is checked out. The user typically does not want to scroll through a large number of hits. In this case, the user asks Bibbi instead to find only books on Spatial Planning in Europe. The search has now been narrowed down to about one thousand titles, after Bibbi has made a Boolean search combining "Europe" with the first result. It is not shown in figure 3, but the user can now continue to narrow the result by asking for only books available on the shelves or only e-books.

6. Discussion and future work

It is estimated that the probability of computerization of the library profession in the future is 65% (Frey & Osborne, 2013). We don't see that as unlikely considering the automation of the profession that has been going on for the last 30 years, especially in the research library area. Even though the most important application of AI in libraries is the use of recommender systems, few examples exist of using social robots (Mahdi et al., 2022).

We have also noticed stress and uncertainty among library staff concerning what it means to use a robot (Cox, Rutter, Pinfield, 2019). Will they give relief, or will they just make problems worse and increase the technology stress? To avoid unnecessary worry, we have tried to increase the involvement of the library staff in the project. Over the years we have demonstrated Bibbi and discussed her tasks with her future "co-workers" multiple times. We have tried to be open to suggestions and questions.

We recently added a feature to the system in which a user can ask Bibbi to recommend a title on a particular subset of a subject, for example, the subset "parks" of the subject "city planning". This will yield a Boolean search where Bibbi selects the first 200 records. Using these records, Chat GPT will find one book based on the record's title and abstract and present it for the user. Such a feature must, of course, be carefully monitored and evaluated before permanent inclusion because of the non-transparent AI element involved in singling out one book that a student might consider to be the perfect title.

After more than five years of development, we are now, (February 2025), in the process of putting Bibbi to work in the library. Our focus has been on answering commonly asked questions in the library information desk, and we are confident that Bibbi can deliver answers to these questions. Our deployment of the system will occur in two stages at the library of the Blekinge Institute of Technology. Firstly, we will let students use the system as a chat-device only, placing a keyboard and an all-in-one screen on a table, only allowing communication with the system via the keyboard. After we are satisfied that this service runs smoothly, we will add the robot head (Bibbi) to the setup. She and the screen will be connected to the internet via Wi-Fi. There is no longer any need to roll her in or out of the library on a cart. The only connection needed is to the power grid, as shown in Figure 2, the right picture.

We know that students can be hesitant about being vocal in a quiet environment. Therefore, we are discussing about the use of two access points for the service. There is one method using a screen and a keyboard for textual communication and another where we put Bibbi separately with a small screen in a type of quiet booth, called a silent pod, where students can communicate without being anxious about being overheard or disturbing anybody (USF Libraries, 2023). In our experience, the location of the robot is crucial. Verbal communication with Bibbi is more prone to misunderstandings, and interruptions, and being one-on-one is obviously a more comfortable situation for a student, as we understand it.

During the first months of introduction, we plan to track all conversations with the system that indicates either a positive or a negative result. This will, hopefully, enable us to pick up possible bugs or questions that remain unanswered.

After more than five years of development, we are convinced that she will be before long an important resource in the library. She will not be able to answer all questions, but she will relieve staff at the information desk, and she will make a vast difference in the level of service when the library is unmanned.

References

Asemi, A., Ko, A., & Nowkarizi, M. (2021). Intelligent libraries: A review on expert systems, artificial intelligence, and robot. *Library Hi Tech, 39*(2), 412-434. https://doi.org/10.1108/LHT-02-2020-0038

Cox, A. M., Pinfield, S., & Rutter, S. (2019). The intelligent library: Thought leaders' views on the likely impact of artificial intelligence on academic libraries. *Library Hi Tech, 37*(3), 418-435. https://doi.org/10.1108/LHT-08-2018-0105

Dowd, J. (2011). I just want my website to talk to me: Implementation and trial of a chatbot at the university of wolverhampton. *SCONUL Focus,* (51), 35-42.

Frey, C. B., & Osborne, M. A. (2013). *The future of employment: How susceptible are jobs to computerisation?*. Oxford Martin School, Univ. of Oxford.

Fuentes-Moraleda, L., Lafuente-Ibañez, C., Fernandez Alvarez, N., & Villace-Molinero, T. (2022). Willingness to accept social robots in museums: An exploratory factor analysis according to visitor profile. *Library Hi Tech, 40*(4), 894-913. https://doi.org/10.1108/LHT-07-2020-0180

Furhat Robotics. (2024) https://www.furhatrobotics.com/

McNeal, M., & Newyear, D. (2013). Streamlining Information Services Using Chatbots. Chapter 1 of *Library Technology Reports,49(8).*

Mahdi, H., Akgun, S. A., Saleh, S., & Dautenhahn, K. (2022). A survey on the design and evolution of social robots — past, present and future. *Robotics and Autonomous Systems, 156*, 104193. https://doi.org/10.1016/j.robot.2022.104193

Massis, B. (2018). Artificial intelligence arrives in the library. *Information and Learning Science, 119*(7/8), 456-459. https://doi.org/10.1108/ILS-02-2018-0011

Mubin, O., Kharub, I., Khan, A., & Assoc Comp Machinery. (2020). Pepper in the library" students' first impressions. Paper presented at the 1;LBW162;-9;LBW162;. https://doi.org/10.1145/3334480.3382979

Thoms, M.(2015). Universität Hamburg. Chatbot Stella. https://www.sub.uni-hamburg.de/bibliotheken/projekte-der-stabi/abgeschlossene-projekte/chatbot-stella.html

USF Libraries. (2023). Introducing New State-of-the-Art Quiet Booths for Enhanced Library Experience. University of Florida Libraries. News and Blog. Posted November 17th, 2023. https://library.ucf.edu/news/new-quiet-booths/

Vincze, J. (2017). Virtual reference librarians (chatbots). *Library Hi Tech News, 34*(4), 5-8. https://doi.org/10.1108/LHTN-03-2017-0016

Vlachos, E., Hansen, A. F., & Holck, J. P. (2020). a robot in the library. In M. Rauterberg (Ed.), *Culture and computing* (pp. 312-322). Springer International Publishing AG. https://doi.org/10.1007/978-3-030-50267-6_24

Yao, F., Zhang, C., & Chen, W. (2015). Smart talking robot xiaotu: Participatory library service based on artificial intelligence. *Library Hi Tech, 33*(2), 245-260. https://doi.org/10.1108/LHT-02-2015-0010

Young, J. R. (2019) . Bots in the Library? Colleges Try AI to help researchers (but with caution) *Edsurge*,. https://www.edsurge.com/news/2019-06-14-bots-in-the-library-colleges-try-ai-to-help-researchers-but-with-caution