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# Chatbots in the Library: is it time?

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**Introduction**

Technology is changing the way we communicate. Today's students thrive on social networking tools like Tweeter, Facebook and Foursquare. Chatbots are not usually included in this grouping but they engage users with a playful interface that is familiar to a generation that grew up with online games. On a recent posting by Beloit College about the incoming class of freshmen who will graduate in 2015 (http:// http://www.beloit.edu/mindset/2015/): "They've always had the privilege of talking with a chatterbot." Libraries that are seeking ways to engage this generation should consider the chatbot as another tool for reaching users who expect more than a flat website.

This paper is about adapting artificial intelligence technology for reference services. AI has come a long way as IBM's Watson demonstrated when it won "Jeopardy" in February of 2011. The advances in artificial intelligence (AI) combined with the availability of online resources make it time to consider artificial intelligence as a tool for the library.

Chatbots (also known as conversational agents, artificial conversation entities, or chatterboxes) are computer applications that imitate human personality. A chatbot is interactive, responding in sentences that track the conversation in a way that is meaningful to humans. This characteristic of mimicking discourse appeals to library users who want a more interactive library experience, something livelier than a search engine, and fits well with the socially directed students we are seeing on our campuses.

One of the selling points for these bots is their ability to handle common directional and predictable questions. They excel at routine, repetitive tasks that can free librarians from the most common questions. Bots flatten a website, when someone chats with a bot they don't need to

know the layout of the website, or the resources available to them.  The chatbot is programmed with that information and pulls together the necessary information, reformatting and presenting it in a manner that meets the needs of the information seeker.

Can a chatbot truly replace the experience someone gets in a reference interview?  Is it even possible to identify the best characteristics of a reference experience and develop a program algorithm that will reproduce that experience?  In a 1996 study undertaken by Nardi and O'Day (Nardi, O'Day 1996), the authors analyzed the activities of face-to-face reference sessions to determine the best characteristics of "human agents."  They identified two major characteristics of the reference session:  personalization of searches with respect to the client's specific activity (they must know something about the client), and collaboration with the client to clarify and adjust the search.  They further identified the types of searches they thought were best suited for a computer agent:  monitoring (searches based on terms provided by the searcher and are often repeated for updates), planned (multi-step information seeking that involves several searches) and exploratory (undirected searches).

Chatbots can handle known repetitive searches by programing the searches into the bot responses.  Chatbots can also handle basic multi-step searches through a more complex series of questions and answer algorithms.  Exploratory searches are more challenging but a chatbot can provide general guidance and make referrals to librarians for more additional assistance.

Text messaging and chat services are becoming popular reference services in libraries, and both are similar to a chatbot experience in that neither are face to face and involve a technology interface.  For this reason, we may be able to apply lessons from human chat session to the design of a chatbot.  A 2010 analysis of a chat log at the University of Nebraska-Lincoln revealed some interesting patterns.  This study of over 500 chat sessions (see chart 1) indicate that 35% of the

searches were inquiries about database subjects or look-ups for specific titles, which approximates the monitoring category in the Nardi/O'day study. The next highest percentage, 16% involved questions about services (how do I renew a book, etc.), the next category was 15% for research questions that would equate with the exploratory and planned searches in the Nardi and O'Day article. Reference (ready reference), which Nardi and O'Day decided not to explore, was 11% of the chat questions. Ten percent of the queries were about system problems (login authentication issues, etc.). The last three categories were simple answer questions (6%), personal (4%) questions that involved non-library issues, and directional inquiries about where to find something (4%). A deeper analysis of the logs shows evidence of the personalization and refocusing behavior noted by Nardi and O'Day that was important in the reference interview. Overall, the chat questions in the UNL log appeared to be quite varied and sometimes resulted in referrals to librarians when the question appeared to be too difficult or complex.

Why do people select chat over reference services? A 2005 study by Ward (Ward 2005) found chat services were used by graduates and undergraduates for a variety of reasons: it was quicker (48%), the library was too far away (16%), had heard good things about the service (10%), didn't like asking question in person (5%), was the only place to go (4%), and other (15%). These reasons were independent of the type of question so Ward concluded libraries planning to offer chat should expect to "field all types of questions." Whether or not we approve, clearly any chat service must be able to handle just about any type of question. Fortunately, the availability of on-line resources makes it possible to program a chatbot with this functionality.

Returning to the first two characteristics in the Nardi and O'Day article, it would be difficult with current technology to satisfy the personalization of the search process, or the collaborative refining of searches that occurs in one-on-one reference sessions with software,

however through the use of a conversation agent, such as an artificial intelligent chatbot, it is possible to come close.  The artificial intelligence in a chatbots is built using concepts from Natural Language Interaction (NLI) that are designed to simulate a conversation.  The advantage of NLI processing is the additional ability to use the phrasing (verbs, nouns, adjectives, etc.) from the input to supply an answer that is more sensitive to the intent of the question.  There are two different types of NLI, text-based chatbots where the interaction is supplied through a text input and output, and embodied conversational agents, where the interface is represented by a figure with a body and or face that interacts with the user, and may include audio, for example, there is a talking chatbot for practicing English in the EFL Classroom 2.0 (http://eflclassroom.com/bots/ebot2.html).  In either case it is possible to include conversational elements that simulate a real conversation.

The web holds valuable information that a chatbot can search, libraries subscribe to databases that hold dynamic information that is readily available to chatbots.  The new bots can tap into siloed resources, retrieve information and repackage in much the same way as a discovery tool, but with the ability to seem more human than a search engine.

Chatbot technology has been around for some time, but libraries have been slow to adopt the technology.   Rubin and Chen reported in 2010 that among Canadian libraries, "none of the top 20 surveyed libraries employed embodied conversational agents for any of their ion-line accessible services.  As for text-based NLI applications, there was one approximation."(Rubin, Chen & Thorimbert 2010)  This was from the University of Western Ontario which used a text-based agent "Ask Western Libraries" to retrieve the best matched answers from FAQs, which replaced the scrolling lists that came back from search engines.

Europeans libraries were the first to explore chatbots, most notably the Stella experiment (http://www.sub.uni-hamburg.de/bibliotheken/projekte/chatbot-stella.html ) at Bibliothekssystem Universität Hamburg.  The Stella chatbot is under renovation and at the time of this article is inaccessible.  Two public libraries in the US, (Mentor Public Library (MPL) and Akron-Summit County Public Library (ASCPL), are cooperating on the development of chatbots (they call catbots) to provide help and guide users to the catalog to answer questions about the availability of materials, and user accounts.  They used AIML metadata to create the bots using the Pandorabots (http://www.pandorabots.com/botmaster/en/home) hosting service.  The success of the MPL chatbot inspired the development of the Ohio Virtual Reference Project (OVRP), which is a partnership between public libraries in Ohio.  Chart 3 contains a listing of library chatbots.

### The University of Nebraska "Pixel" Project

Academic libraries in the US have been slow to adopt chatbots.  The University of Nebraska-Lincoln chatbot is the first to go into production.  The chatbot, pixel (http://pixel.unl.edu)  began development in the fall of 2010.  Pixel is hosted locally in a SQL database and is being develop using the open source PHP interpreter designed for AIML called Program-O (http://www.program-o.com/launch/).  AIML was selected for two reasons: first, the metadata structure is flexible to accommodate the variety of questions coming from library users, and secondly, because of the availability of AIML files that have been contributed by the open source community.  These community files provided the basis for development of the library specific metadata, but in some cases were revised to better fit the purpose of the UNL chatbot.

Pixel supplies answers to user questions entered in natural language in brief text responses. These answers are formulated by a match on keyword and keyword combinations from a database of AIML categories.  The categories supply answers to specific questions, and make referrals to

library staff.   The latter is important because we are far from the time when software can provide the level of support (both knowledge and emotional) that a reference staff member can provide. The key for this project is to find the balance between the users need for a quick answer (the machine's efficiency) and the need for the chatter to understand the research process (librarian's knowledge).

Pixel provides an interactive experience that mimics a human conversation, while giving immediate answers to questions about library services and resources.  Pixel flattens the website so users do not need to interpret the website and navigate through pages to find the specific information they are seeking.  It is also designed to guide researchers to appropriate resources and help them solve problems in a similar way as the more conventional FAQ.   The major difference between Pixel and more conventional tools is that Pixel simulates a reference interview and provides direct responses based on the syntax of the query that can pull together library resources.

The Libraries provides access to licensed databases, Innovative Interfaces (http://www.iii.com/) products that include: Encore (discovery tool), ResearchPro (aggregate search engine), and webpac.  The Libraries also managed DigitalCommons (Institutional Repository for UNL), and ContentDM for image collections.  All of these resources are integrated into Encore, but there are other resources like LibGuides (http://www.springshare.com/libguides/) and the main website at http://libraries.unl.edu , which are not harvested into Encore.  The chatbot Pixel incorporates all of these resources into the context sensitive responses "she" generates.

The user interface designed for Pixel is basic.  It consists of a typewriter like response to the questions entered with a keyboard.  An "iframe" window will display the contents of the first link in a response in a box that appears below the chat session.  A user enters her question and a query is sent to the database which finds, or doesn't find a match, and then responds either with

the match or a pickup line.   The metadata supports the ability to "chain" a conversation.  This is accomplished when Pixel asks a follow-up question in response to the initial input.  Based on the user's answer, additional information is provided, and so for.  Using this Q&A approach surprisingly complex conversations can be held between the bot and the chatter.  Figure one demonstrates the QA system of query and response.

**Pixel Development Phase**

The development phase occurred from Oct. 2010 through January 2011.  During this time the software, which consisted of the PHP based Program-o application and SQL database to store the categories.  The following list describes the process for building the answer database:

1.   Install Program-o.

2.  Load open source contributed AIML files into the database.

3.  Evaluate and revise the contributed files.  This included removing the personal references that were contributed by members for social conversations.  These responses included categories like, "what's you sign", or "do you enjoy being a women".  The "pickup lines" (responses developed to keep people interacting with the bot) were also revised into open ended statements to suggest appropriate library related topics, for example changing "Oh, you are a poet." to "Are you are looking for a specific title, say lookup followed by the title and I can check for you."

4.  Examining the library website and extracting facts that were turned into categories. For example, the circulation policies were dissected into specific question and answers.

5.  Examining chat logs from the reference department and adding categories for questions and answers.

6. Examining Google Analytic logs for Encore and Classic Catalog to include frequent searches.

7. Examining FAQ's from other libraries to identify and include frequently asked questions.

8. Daily monitoring of the Chatbot logs to identify and correct omissions or improve question answers.

Pixel went public in February 2011 and was introduced to the UNL community through the "What's New" and "BetaZone" pages on the libraries' website http://libraries.unl.edu.  In addition, staff periodically "tweeted" about the chatbot and publicity information was added to the libraries' Facebook account (http://www.facebook.com/pages/UNL-Libraries-University-of-Nebraska-Lincoln-Libraries/87086676278).  The goal of the first six months was to build the database so Pixel could answer 95% of the questions.  The chat log was a valuable source for refining and supplementing the database and resulted in modifications of the pick-up lines and topic areas.

We discovered that Pixel is particularly appealing to social chatters, who often prefer to chat with the bot on a "personal" level over asking library related questions.   This required some modification of the categories to accommodate their need to "play" with the bot, and attempt to redirect their conversations into library related areas.   In turn, these strategies lead to improvements in the chatbot responses by adding suggestions that would help the chatter state their request in successful terms the Chatbot could follow.  Chart two is an example of a chatbot session where Pixel's response leads the chatter to enter a follow-up request (or refinement in their question).

**Pixel's Metadata**

AIML is a metadata scheme proposed by Dr. Richard Wallace and has been adopted by a large open source community of users under the stewardship of the A.L.I.C.E A.I. Foundation (http://www.alicebot.org/aiml.html ). AIML file sets are text files identified by the file extension AIML, and consist of categories (question and answer metadata) that are usually grouped by content into associated filenames. With the exception of two files, atomic.aiml and default.aiml , the file naming convention is only important in managing workflow as they keep like categories together in one file. For example, we put all the categories about subject content into one file named subjects.aiml. Categories in atomic.aiml match before categories in default.aiml, and both take precedence in matching before other file categories.

Each AIML set consists of a metadata tag group that opens and closes with "category". The question matching section has the opening and closing tags of "pattern", the answer part is framed with opening and closing tags of "template". The answers can include URLs that have the capability to pass questions directly to a search engine. In the following example it passes the subject of the question "what articles do you have on this history of [subject]" to the UNL discovery tool, Encore:

```
<category>
<pattern>WHAT ARTICLES DO YOU HAVE ON THE HISTORY OF  _</pattern>
<template><think><set name="it"><set name="topic"><star/></set></set></think>
I can search <![CDATA[<a target="_new"
href="http://encore.unl.edu/iii/encore/search/&#67;&#124;&#83;<star/>;&#124;&#79;righ
tresult&#124;&#85;1?lang=eng&amp;suite=pearl">]]>Encore<![CDATA[</a> for
<star/>.]]> <srai>xfind <person/> </srai>
 </template></category>
```

The above example includes the optional topic metadata which sets the topic for subsequent use. The "_" and "*" are important symbols that store the content of input into variables for later use and are also used for global matches. They are repeatable and function like

a wildcard accepting any value.  The "_" is used with caution in matching since it overrides all other matches.  The "*" is a soft match and will match only when nothing else matches more exactly.

There are several predicates useful in forming replies.  The person predicate reverses personal pronouns so the bot seems to be following conversations.  The "star" acts as a variable and stores the input from a "*" or "_" as a variable.   When there are multiple variables that are matched, it is possible to assign each variable independently by referring them with the index taf.  For example, in the pattern "how does * *" can be referenced <star index="2"> to indicate the value in the second asterisk.  Set name and set topics provide a means to tailor responses to the context of the conversation, enabling the chatbot to follow conversations.  It can reduce the ambiguity that occurs in lengthy conversations where following the topic is important in understanding the content of the conversation.  In the previous example, the question "What articles do you have on the history of Nebraska," will match on "Nebraska" and be will be stored as the variable for "star", which is set as the topic.  The term "Nebraska" will be retained until the chatter enters a phrase that sets new content for the "topic" variable.

The reduction category is similar to a cross reference; it is used to reference user input to a single category.  The main purpose of the reduction categories is to map the user's language into the language of the category pattern field, as the following example depicts:

<category><pattern>* BOOK  REVIEW *</pattern><template><srai>*  BOOK REVIEWS</srai></template></category>

Srai is the field designator for a reduction and when "I'm looking for a book reviews on Gone with the wind" is entered the system will supply the response matching the " _ BOOK REVIEW *" pattern.   Likewise the query, "Do you have a book review on Gone with the wind?"

will match the same category and supply the same response   Using reductions it is possible to create only one answer to multiple ways the question might be answered.

The primary algorithm in Pixel is simple question and answer.  The chatter asks a question and the bot responds from the database.  However, when appropriate as in the case of context sensitive questions, for example, "where is the bathroom" the bot responds with additional questions, in this example, "which Library are you in", and then as appropriate, "which floor?"

For more complex situations, the topic can be used to create conversations that are unique to a particular context.  A topic is a classification for the conversation and matches on other categories with the same topic.  Topics are useful when the context of the conversation would result in different answers.  Pixel employs topics for different user groups.   Distance education students, community users and pre-college students will get different answers when Pixel has that information.

Another tool for maintaining conversations is the "that" field designator.  It contains a match point from the bot's previous response.  This is particularly useful when the chatbot needs additional information to clarify the user's question, or to provide a follow-up response.  For example, the input is a question about interlibrary loan and the bot responds with basic information on how to use it, where it is, etc.   The user replies that she is missing some information that the ILL request form requires and doesn't know what to do.  The question matches another category that provides additional information on completing the form because of a match (from the initial bot response) on the "that" field.

Pixel is not being designed to answer complex research questions – those will be referred to subject librarians.  Pixel is designed to answer directional questions, questions about services and policies, and to direct chatters to general purpose resources.  It is primarily a tool for

undergraduates and researchers looking for quick information and tips on searching databases and conducting research.  As such, Pixel sends factual questions, (what is the population of the US) to Google.

One of the greatest challenges in building the database is getting chatters to make requests that have the best possibility of matching the database.  This isn't too dissimilar to the opening question in a reference query where the user starts with a question that from his perspective seems reasonable, but from the librarian's viewpoint needs clarification, for example, "I'm looking for something  about … "  This is where the pickup lines become useful.  The original open source file responses were changed to questions that relate to the library.  This simple list of pick-up lines is designed to guide the chatter back to a topic Pixel can answer:

1. Let me know if you are looking for books or articles.
2. Let me know if you need information about a library service.
3. Let me know if you are looking for a person who works in the libraries.
4. Are you are looking for a specific title, say lookup followed by the title and I can check for you.
5. Are you are looking for a database, let me know the field of study.
6. If this is your first research project, ask me about getting started.
7. Are you working on a class assignment, you are probably looking for reserves.
8. If you need peer reviewed articles, let me know.
9. If you are looking for pictures or images, try searching the image collection ContentDM.

Pickup lines are not helpful when the chatter enters misspellings, or uses the wrong word.  These cases can even be challenging for the most informed librarian, for example, "That book with penguins on it" (an O'Reilly book on Programming Collective Intelligence), or when the patron is convinced that "alien weeds" come from another planet.

When the chatter enters information that doesn't match a category, Pixel responds with a pickup line, which attempts to get additional information that will match.  Other useful devises are XFIND and <sr/>, which add the ability join responses from multiple categories.   This devise is

used when we want to prompt a social chatter to ask a question that is relevant to the library. For example, when the chatter asks Pixel for her name, the bot responds "Pixel," and because <sr/> is added to the response template, one of the pickup lines is randomly selected and added to the response.

XFIND and <sr/> are added to join two separate categories when the question can be interpreted in multiple ways. The question, "what do you know about _," is an open ended question that could mean many things. It could be a simple request for factual information or require more probing. The initial response includes a link to search Google with the user input. However, because the input could match another category, the XFIND addition will provide both categories. For example the question "what do you know about chemistry" returns the Google link that will search the term "chemistry" in Goggle, but it also matches a category Chemistry which adds links to a LibGuide, databases, Encore, and the name of the subject specialist. The reduction <srai> tags can also be added to a response to join two separate but related categories, however the <srai> tag requires a named category, while the XFIND and <sr/> tags will accept the first variable of user input.

The ability to randomize answers is another feature of AIML that keeps the responses fresh. This is important for the social aspects of Pixel, when a particular answer isn't important. When people ask the same question, Pixel will select a random answer from a list of possible responses. For example, if the chatter asks "what is your favorite database?" Pixel will select a random response from the database list. Using this random feature, a degree of unpredictability can be added to the Pixel's responses to maintain chatters interest. Figure 1 provides a simple flowchart of the question and answer process.

**Conclusions**

We have learned that it is impossible to predict what Chatters will say to Pixel and because they know they are chatting with a bot, they will say things they would never say to a human. Looking through logs with profanity gets tiresome so we developed a topic area when Pixel will refuse to respond until the chatter apologizes.  The responses of the Chatbot have  improved as the logs were mined, but  the challenge has been  keeping people interested enough to come back again and again when their first experience may not have given them the answer they needed.  We hope the "personality" aspect of the bot will entice chatters to return as the bot "learns."

Pixel is still like a small child, learning with every interaction, gradually improving both in quality and complexity.   Pixel will work 24x7 with less than 1% downtime, and will provide consistent answers.    It searches across varies sources and brings together information in a similar way a librarian would work with a patron.  If we are successful in this phase we will have a chatbot that can tap into a basic level of expertise compiled from subject experts (by mining Libguides and other information provided by the experts), search hidden databases and suggest resources to bring together the best combination of answers to service questions with tips on research.  Pixel will refer more complex questions to librarians, who can spend more time on the complex issues and less on basic questions.  There may come a time in the future, when we can reduce the amount of time we staff the reference desk, freeing librarians for more complex duties that require the skills that are unique to humans.  It is doubtful that many reference librarians will cheer that day; librarians like most people are reluctant to see technology take over even a small part of their jobs.  Blacksmiths mocked the first automobiles, but we know how that ended.  Should reference librarians be afraid of chatbots like Pixel?   I doubt that it makes a difference; technology consumes jobs and the race is on to build the better bot.  In March of 2011 Google

announced Google Talk Guru (http://guru.googlelabs.com/), an experimental service that allows

people to chat with a bot to get information from Google.

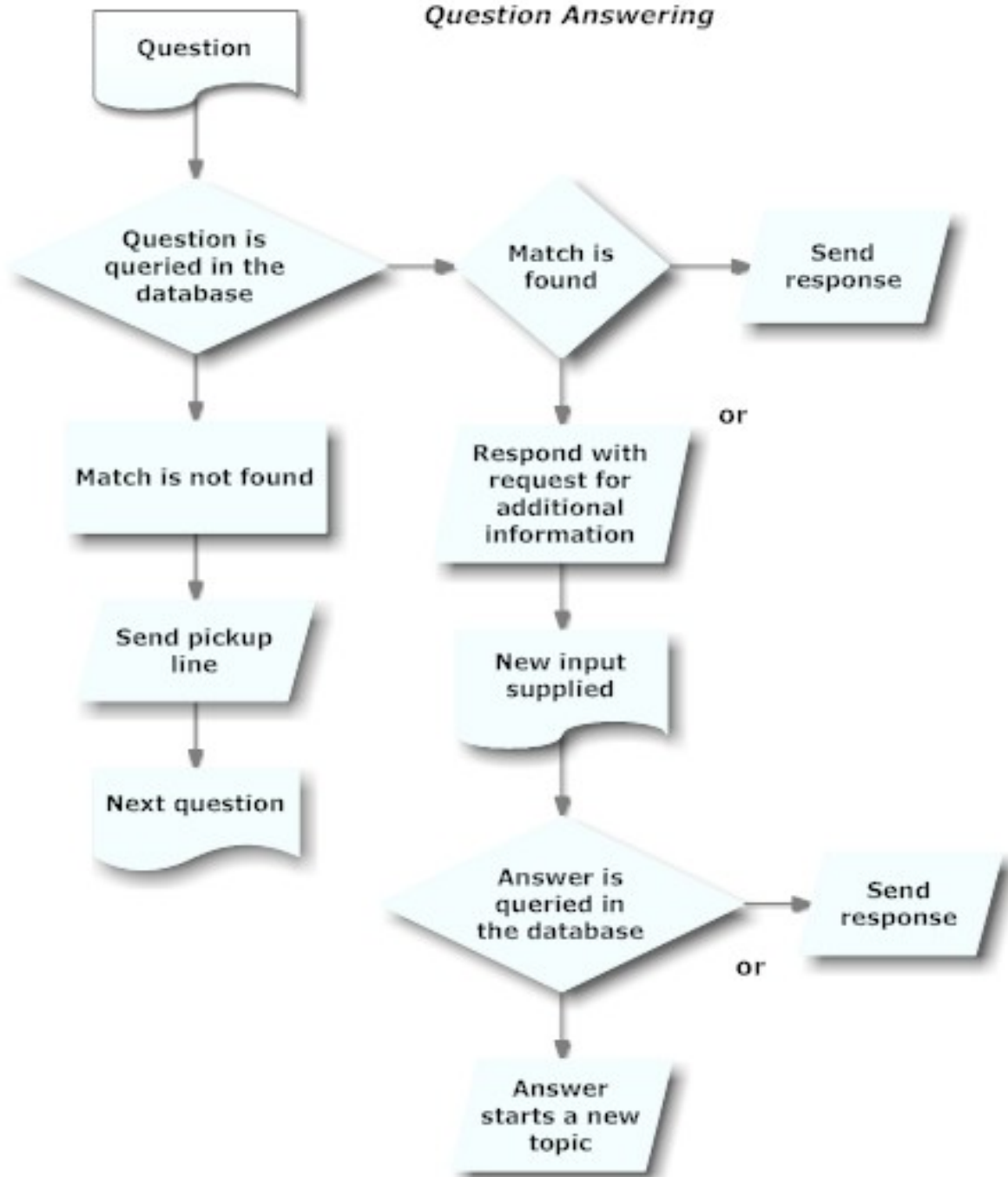# Chart 1
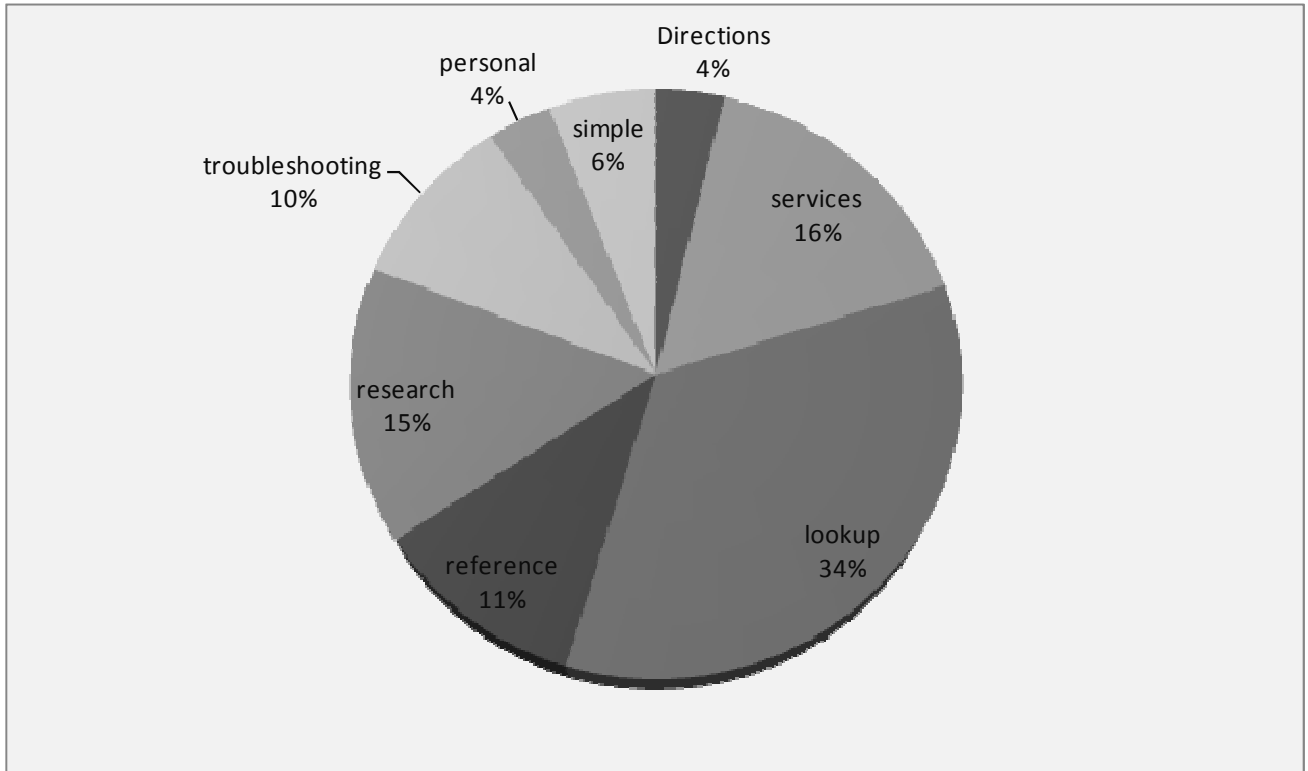
# Figure 1



Question Answering

## Chart 2

You: do you have the journal nature
Bot: Looking for a magazine? If you know some of the citation information (title, ISSN, etc.) you can try Article Finder You can also search the classic catalog by your journal title. . If you feel lazy, say **lookup** followed by the title and I will search for you. If you are just starting out and don't have a journal title, or citation, the best place to begin is the E-resources webpage of online indexes. If you need more help, tell me the subject area you are interested in, and don't forget that you can request an article through our InterLibrary Loan (Illiad) service, use the WebBridge button to transfer your information into a form, or you can complete the request form after you logon to Illiad
You: lookup nature
Bot: OK, you want me to check this for you, right Click here to Search for nature Look for ➡️OR ↗️ which is a link to any fulltext we have. By the way, if you don't find what you are looking for there is always Interlibrary Loan so if you don't find what you are looking for say "that was not helpful"

## Chart 3

| Library site | Bot name | Chatbot URL |
|---|---|---|
| Akron-Summit County Public Library | dewey | http://www.akronlibrary.org/dewey.html |
| Free University of Bozen | | http://web.inf.unibz.it/bob/?popup=yes&language=en |
| Kornhaus Bibliotheken | | http://www.kornhausbibliotheken.ch/index.php?option=com_wrapper&view=wrapper&Itemid=64 |
| Library of Dresden | Slub | http://www.slub-dresden.de/ |
| Mentor Public Library | | http://www.mentorpl.org/catbot.html |
| Mentor Public Library | Emma | http://www.mentorpl.org/catbot.html |
| Staats- und Universitätsbibliothek Hamburg | Stella | http://www.sub.uni-hamburg.de/ |
| Universität Dortmund | ASKademicus | http://www.ub.uni-dortmund.de/chatterbot/ |
| Universitäts- und Stadtbibliothek Köln | Albot | http://www.ub.uni-koeln.de/nmIQ/Albot_html.jsp |
| University of Nebraska-Lincoln Libraries | Pixel | http://pixel.unl.edu |
| University of Wolverhampton Library | Lisa | http://lisweb.wlv.ac.uk/chatbot/ |

| Library site | Bot name |
|---|---|
| Akron-Summit County Public Library | dewey |
| Free University of Bozen | |
| Kornhaus Bibliotheken | |
| Library of Dresden | Slub |
| Mentor Public Library | |

Nardi, B.A. & O'Day, V. 1996, "Intelligent agents. What we learned at the library", *Libri: International Journal of Libraries & Information Services,* vol. 46, no. 2, pp. 59-88.

Rubin, V.L., Chen, Y. & Thorimbert, L.M. 2010, "Artificially intelligent conversational agents in libraries", *Library Hi Tech,* vol. 28, no. 4, pp. 496-522.

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