TECHNOLOGY REVIEW

A technical review of chatbot and automated robot technologies for the FinTech project

AUDIENCE

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Purpose

Before commencing development on a project, software engineering teams should perform an assessment of the technology to understand the historical landscape, the current trends and any technical constraints.

This document is intended to provide a technical review of chatbot technology for the FinTech research team at Newcastle University. The document content has been guided by initial discussions with Aad van Moorsel, Kovila Coopamootoo, Magdalene Ng and the rest of the FinTech team. In addition to providing relevant technical information, it will propose an initial technology stack and roadmap, and highlight potential lines of enquiry for the future.

This review will also act as an internal reference document for the author and the wider Newcastle University RSE team.

Chatbot Definition

A chatbot is an artificial intelligence application that can imitate a real conversation with a human in their natural language. Chatbots enable communication via text or audio on websites, messaging applications, mobile apps, or telephone.

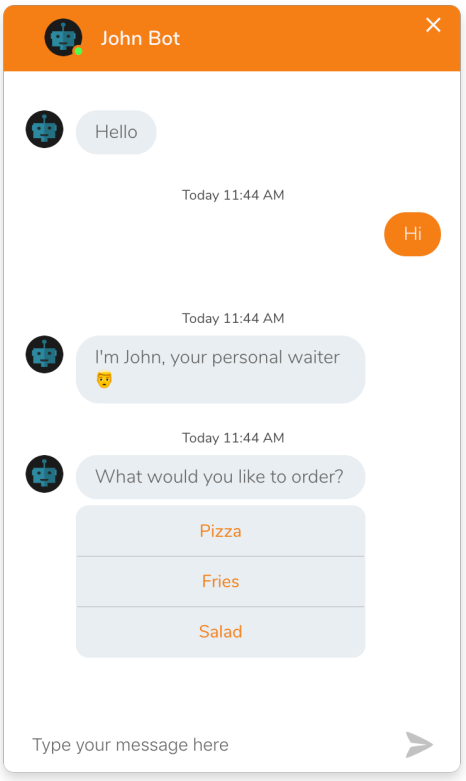
Types of Chatbot

Chatbots primarily use artificial intelligence (AI) to talk to people and give relevant content or suggestions. They can function based on a set of instructions or use natural language processing (NLP) and machine learning (ML). A chatbot that works based on fixed rules and instructions is usually quite limited. If a person asks the wrong thing, the bot will not understand what the question means and therefore, it will not provide an appropriate response. The intelligence of the bot solely depends on how it is programmed.

Chatbots are still relatively new technology. There is debate on the classification of types however, it is useful to define three broad types - each of which is discussed below.

Button-based chatbots

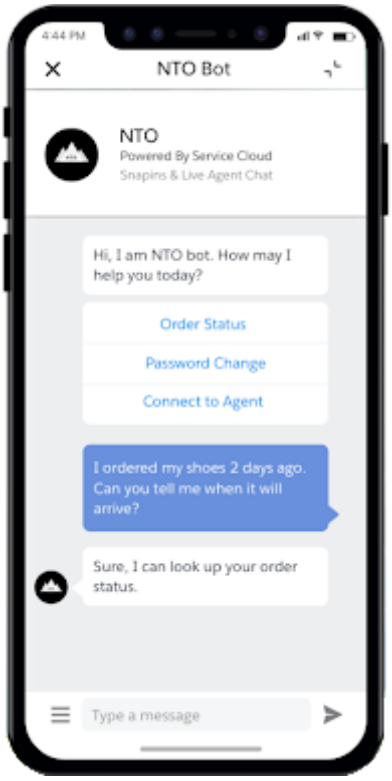
The purpose of a button-based bot is to lead a user through a predefined scenario tree. This type of bot resembles a text-based decision tree hierarchy, where the bot offers choices and asks for data. For example, the bot might say “I’m a bot that can help you order food, what would you like to order? X, Y, Z…”



While these chatbots are sufficient for answering that handful of nagging FAQs that make up most support queries; they fall well short in more advanced scenarios in which there are too many variables or too much knowledge at play to predict how users should get to specific answers with confidence. It’s also worth noting that menu/button-based chatbots are the slowest in terms of getting the user to their desired value.

Keyword recognition-based chatbots

A hybrid bot is a button-based bot with an option to ask a question on natural language. Usually, it says: “I’m a bot that can help you with the following issues; please press the relevant button X, Y, Z or type your question in the field below”.



Unlike menu-based chatbots, keyword recognition-based chatbots can listen to what users type and respond appropriately, or at least try to. These chatbots utilize customizable keywords and AI to determine how to serve an appropriate response to the user.

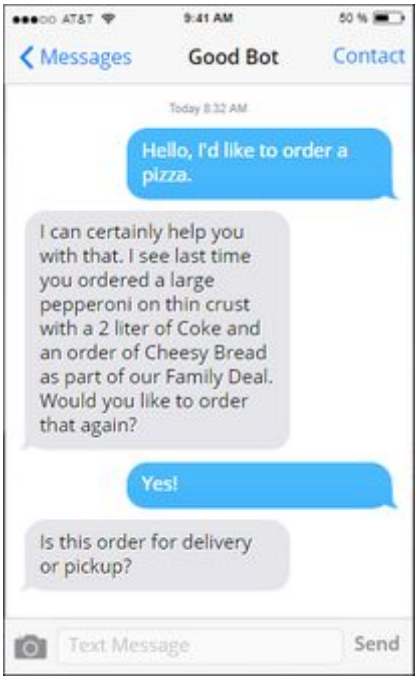
For example, if a user asked the question ‘*I ordered my shoes 2 days ago. Can you let me know when it will arrive*?’, the bot would likely use the keywords ‘ordered’, ‘shoes’, and ‘arrive’, to best determine which answer to respond with.

It is becoming quite popular to see chatbots that are a hybrid of keyword recognition-based and menu/button-based. These chatbots provide users with the choice to try to ask their question directly or use the chatbot’s menu buttons if the keyword recognition functionality is yielding poor results or the user requires some guidance to find their answer.

Frequently, the NLU (natural language understanding) in these bots duplicates the buttons. A hybrid bot is a transitional stage between the button-based and an AI bot.

AI contextual chatbots

An AI bot can automate complex simultaneous communication with multiple users, covering many loosely connected topics. Contextual chatbots are by far the most advanced of the three bots discussed in this post. These chatbots utilize Machine Learning (ML) and Artificial Intelligence (AI) to remember conversations with specific users to learn and grow over time. Unlike keyword recognition-based chatbots, contextual chatbots are smart enough to self-improve based on what users are asking for and how they are asking it.



For example, a contextual chatbot that allows users to order pizza will store the data from each conversation and learn what the user likes to order. The result is that eventually when a user chats with this chatbot, it will remember their most common order, their delivery address, and their payment information and merely ask if they'd like to repeat this order. Instead of having to respond to several questions the user just has to answer with 'Yes' and the order is placed. For a contextual chatbot to be useful, a data-centric focus is imperative.

Chatbot Interfaces

Chatbot applications have two interfaces for conversations — text and voice.

Text conversations

A text-based chatbot is the one that interacts and communicates through text messaging. The conversation might also include media (images and videos) and User Input (UI) elements such as buttons.

Voice activation

Voice-activated chatbots are the ones who can interact and communicate through voice. They are capable of accepting the command in an oral or written form and can reply through voice.

Chatbot Avatars

A recent extension to the chatbot interface is to implement a human-like avatar that responds to the user and adapts to their emotions. Although Chatbot UI (CUI) is considered a new phenomenon, the technology has been popular in countries like Japan and China for a few years. When Didi Dache integrated with WeChat's CUI in 2014, the company quickly got over 700,000 taxi bookings a day.

In a recent interview, Stephen Meadows, CEO of Botanic Technologies, explained why he believes adding an embodied avatar to voice assistants will increase trust, enhance branding, and improve the efficacy of these interactions.

A number of software design articles discuss techniques for designing chatbot avatars. Luis Rodriguez writes the best bots are those that design their avatars with personality attributes that complement the user's personality as expressed through their needs and reflected in the interaction styles of the services offered.

Brief History of Chatbots

Eliza

Wiki | **Emulator**

The first chatbot was developed by MIT professor Joseph Weizenbaum in 1966, and was called ELIZA. It uses pattern matching and substitution methodology to simulate conversation. The program was designed in a way that mimics human conversation, and worked by passing the words that users entered into a computer and then pairing them to a list of possible scripted responses. It uses a script that simulated a psychotherapist. The script proved to be a significant impact on natural language processing and unnatural intelligence.

PARRY

Wiki

PARRY was constructed by American psychiatrist Kenneth Colby in 1972. The program imitated a patient with schizophrenia. It attempts to simulate the disease. It is a natural language program that resembles the thinking of an individual. PARRY works via a complicated system of assumptions, attributions, and "emotional responses" triggered by changing weights assigned to verbal inputs. To validate the work, PARRY was tested using a variation of the Turing test. A group of experienced psychiatrists analysed a combination of real patients and computers running PARRY through teleprinters. The psychiatrists were able to make the correct human identification only 48 percent of the time.

Jabberwacky

Wiki | **Emulator**

The chatbot was created by developer Rollo Carpenter in 1988. Its stated aim is to "simulate natural human chat in an interesting, entertaining and humorous manner". It is an early attempt at creating artificial intelligence through human interaction. The stated purpose of the project was to create an artificial intelligence that is capable of passing the Turing Test. The chatbot is considered to use an AI technique called "contextual pattern matching."

Dr. Sbaitso

Wiki | **Emulator**

Dr. Sbaitso is a chabot created by Creative Labs for MS-Dos in 1992. It is one of the earliest efforts of incorporating A.I. into a chatbot and is recognized for its full voice operated chat program.

The program would converse with the user as if it was a psychologist. Most of its responses were along the lines of “Why do you feel that way?” rather than any sort of complicated interaction.

A.L.I.C.E.

Wiki

A.L.I.C.E. (Artificial Linguistic Internet Computer Entity) is a universal language processing chatbot that uses heuristic pattern matching to carry conversations. In 1995, Richard Wallace pioneered the construction of ALICE. It was formerly known as Alicebot because it was first to run on a computer by the name of Alice. The program works with the XML schema known as artificial intelligence markup language (AIML), which helps specify conversation rules. In 1998, the program was edited in Java, and in 2001 Wallace printed an AIML specification. From there, other developers drafted free and open sources of ALICE in different programming languages and a variety of foreign languages. The program simulates chatting with a real person over the Internet. Alice is a young-looking woman in human years and tells a user her age, hobbies and other fascinating facts, as well as answering to the user’s dialog.

SmarterChild

Wiki

The SmartChild was in many ways a precursor of Siri and was developed in 2001. The chatbot was available on AOL IM and MSN Messenger with the strength to carry out fun conversations with quick data access to other services.

Siri

Wiki

Siri was formed by Apple for iOS in 2010; it is an intelligent personal assistant and learning navigator that uses a natural language UI. It paved the system for all AI bots and PAs after that.

Emerging Trends in 2020

Some of the more advanced chatbots are powered by AI, helping them to solve problems, send personalized messages and improve their interactions over time. I have selected some of the main emerging chatbot trends for further discussion.

Steady adoption of chatbots

According to IBM, 265 billion customer requests are recorded per year and businesses spent nearly $1.3 trillion to address them. Using chatbots could help save up to 30% of this cost. Oracle surveyed more than 800 marketing professionals on the adoption of chatbots, and found that 80% of brands expect to serve customers through chatbots by 2020.

Chatbots driven by AI

AI-powered chatbots are now capable of delivering a personalized experience to users. For example, the Bank of America's chatbot is capable of handling any customer query. With predictive analytics, the bot can anticipate customers needs and guide them through complex banking procedures – helping customers make payments, check balances, save money, and so on.

Chatbots becoming more human-like

The ability to converse freely in natural language is one of the hallmarks of human intelligence, and considerable efforts have been made in humanizing chatbot interactions. A chatbot with personality allows the user to solve queries in a way that is fluid and natural. However, it is interesting to note that we need to make sure that a bot's behavior and personality is consistent throughout, not just in one instance of the conversation. We don't want a bot with multiple personalities showing up because of inconsistent responses to chat queries. It is also important that users know when they are communicating with a machine and not an actual human. This is discussed further later in the ethical considerations section of this document.

While older consumers still have trouble identifying the true value of chatbots, millennials have fewer concerns about the technology.

Emotional intelligence and empathy

In another effort to humanize chatbots, Madhumitha Loganathan - senior developer at Intuit - published an article on making bots emotionally intelligent. In the article she concludes that by using the right choice of words and adding facial expressions with adequate intensity, we can make chatbot avatars empathetic, expressive, and socially acceptable.

Another interesting project is Replika, which is an AI companion for mental wellness. The agent has self-reflection built-in and it discusses emotions and memorable periods in life. It often seeks for your positive qualities and gives affirmation around those.

Rich user insights

Chatbots store valuable user data for analysis, and artificial Intelligence helps to automate data collection. The analysis requires proper attention from a dedicated team, which can then focus on improvement areas, optimizing processes, and minimizing errors. Advanced chatbots are even able to improve themselves by learning over time.

Sentiment analysis

Chatbots have dialogue with real people with feelings. An empathic chatbot is not only entertaining but can also generate insights into the emotional coloring of different dialogue topics. In neurolinguistics programming, words which describe emotions can get evaluated either by categories or by numerical values. This technique can generate a statement regarding the emotional perspective of the user within the conversation. Positive and negative conversations can be identified regardless of content or aims and can be used for optimization and training purposes.

Voice experiences becoming mainstream

According to eMarketer research, more than 111 million Americans use voice activated personal assistants at least once a month. Recently, industry giants such as Google and Amazon have been pushing the “smart speakers” market and the AI that comes with it. For instance, as The Verge reports, Amazon has already sold 100 million devices with Alexa built in. Google is taking this further by trying to make voice-activated assistants available on all Android-powered devices, including smartphones, wearables, and smart TVs.

The rise of conversational bots

There are a growing number of conversation APIs, which allow machines to speak to humans using natural language processing. Conversational bots are intelligent software designed to make you feel as though you’re talking to a real person. Chatbots are able to automate human tasks by translating fluidly between unstructured language and structured data. In the most complex form, these systems are neural networks meshed with deep learning.

Natural language processing

Natural Language Processing (NLP) is a blanket term used to describe a machine's ability to ingest what is said to it, break it down, comprehend its meaning, determine appropriate action, and respond back in a language the user will understand. Natural Language Understanding (NLU) is a subset of NLP that deals with the much narrower, but equally important facet of how to best handle unstructured inputs and convert them into a structured form that a machine can understand and act upon. While humans are able to effortlessly handle mispronunciations, swapped words, contractions, colloquialisms, and other quirks, machines are less adept at handling unpredictable inputs. Natural Language Generation (NLG), is what happens when computers write language. NLG processes turn structured data into text.

Social and Ethical Considerations

As chatbots become ubiquitous in our daily lives, they are used in various industries including customer service, education, medicine, and entertainment. As these tools increasingly permeate various social domains, Conversational Agents can have a direct impact on an individual's life and on social discourse in general. The topic of chatbot ethics is complex and spans a wide area including privacy, data ownership, abuse and transparency. Rob High, CTO of IBM Watson highlights the emerging ethical issues and suggests ways for chatbot designers and owners to approach development with the goal of responsible development.

> *"AI, like most other technology tools, is most effective when it is used to extend the natural capabilities of humans instead of replacing them. That means that AI and humans are best when they work together and can trust each other."*
>
> ***— Rob High, CTO IBM Watson***

Rob High argues that ethics form the foundation of how a bot is built, and more importantly, dictate how a bot interacts with users. How a bot behaves has the potential to influence how an organization can be perceived and unethical behavior can lead to consumer mistrust and litigation issues. He also proposes a code of code of ethics for AI and chatbots that every brand should follow.

Code of ethics key points:

- Businesses often overlook important issues related to morals and ethics of chatbots and AI
- Customers need to know when they are communicating with a machine and not an actual human
- Ownership of information shared with a bot is another key ethical consideration and can create intellectual property issues
- The privacy and protection of user data is paramount in today's interconnected world

Chatbots in Finance

Robots are being used by many financial firms to cut down labour costs and make other operational efficiencies. Many of the world's leading banks have launched chatbots to service their customers.

Bank of America (BofA) has launched Erica, a voice and text enabled chatbot for its customers. Erica is an intelligent digital assistant designed to help customers make smarter banking decisions. Erica sends customers notifications, identifies areas where they can save money, provides updates on their credit score, and facilitates bill pay within the BofA app.

Digibank by DBS, Asia's only digital-only bank, offers customers a 24/7 virtual assistant within the bank's mobile app. Marketed as a personal banker, DBS Digibank is a mobile banking app that aims to make banking simpler, smarter, faster and more secure.

Customers of **HSBC** can connect with the bank's virtual assistant, "Amy," which provides instant support to customers' inquiries.

American Express offers an Amex bot for Facebook Messenger and its updated chatbot will enable US consumers to ask certain queries related to their account and card information.

Mastercard announced Masterpass-enabled bots in 2017 to drive more seamless shopping on Facebook Messenger with Subway, FreshDirect, and The Cheesecake Factory. The bots use AI technology to enable consumers to interact with the retailers, build their order and securely checkout using Masterpass, all without leaving the Messenger app.

In the asset-management industry, "**robo-advisors**" are digital investment managers that leverage the Internet to offer customised investment portfolios to clients by employing algorithms. In a June 2015 report, **McKinsey** estimated the potential value of personal financial assets that could be served by virtual advice (which includes robo-advice) at USD 13.5 trillion.

In a 2017 report, **Accenture** said 79% of banks surveyed agree that AI will revolutionise the way they gain information from and interact with customers while 76% believe that, in the next three years, the majority of organisations in the banking industry will deploy AI interfaces as their primary point for interacting with customers.

Data exposure security concerns

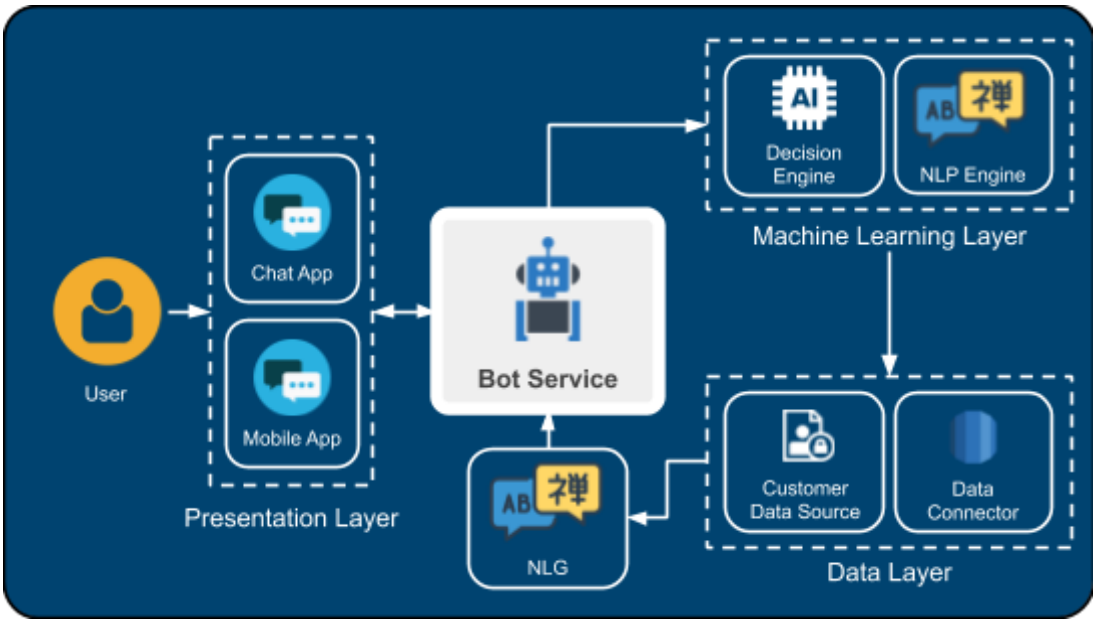
When considering any technology or architecture that bridges the space between customers and organisations, data exposure should be a primary concern. This is especially true for the financial sector.

Software Development Frameworks

There are a large number of existing development frameworks and platforms that can be used for designing and developing bots. These are written in a variety of languages and aim to serve different needs.

Architecture design

The following is an initial high-level design that highlights the core concepts required for a functioning chatbot.



Presentation layer

The presentation layer consists of public facing web applications that act as the primary interface with the user. The chat app is likely to be an embedded applet in a website that can be optionally used by the user for support and assistance. The presentation layer may also include integration with other third party services such as Facebook Messenger or Slack, etc.

Bot service

The bot service is the central module that mediates and organises communication between the other elements in the system architecture. It will process input from the user through the presentation layer, then send it to the machine learning layer for processing. It will also receive the response back from the NLG module and forward as appropriate to the user via the presentation layer.

Machine learning layer

The machine learning layer is where the unstructured language input from the user is converted into a structured format on which response decisions can be made.

Data layer

After the user input has been converted and processed, it will probably be necessary to access a customer data source to retrieve information that will be used in the response to the user. For example, if the user has asked for an update on an order then details of the order will be required to generate the necessary response.

The original input from the user may also be stored and audited for further processing or learning.

NLG (Natural Language Generation)

The NLG module is used to generate the language response that will be returned to the user.

Bot platforms and frameworks

Open source options for core bot engine and presentation layer

In order to retain control and flexibility of the development of the chatbot, it is important to have full access to source code and deployment pipeline. There are several mature open-source chatbot frameworks that can be used for this project. The following have been selected based on language, maturity and scalability.

- BotMan - PHP
- ChatterBot - Python
- BotPress - NodeJS
- BotKit - NodeJS

External options for AI/ML/NLP layer

By integrating with an external service provider it is possible to quickly leverage powerful AI/ML/NLP capabilities within the FinTrust project. The following four platforms demonstrate some of the more comprehensive frameworks that are available.

- Google Dialogflow is an end-to-end, build-once deploy-everywhere development suite for creating conversational interfaces for websites
- Microsoft Bot Framework is a comprehensive framework for building enterprise-grade conversational AI experiences
- Amazon Lex is a conversational interface for applications powered by the same deep learning technologies as Alexa
- IBM Watson Assistant is a conversation AI platform that helps provide customers fast, straightforward and accurate answers to their questions

Internal options for AI/ML/NLP layer

Moving forward we may wish to explore bringing the AI/ML/NLP capabilities back into the internal infrastructure. This decision may be influenced by security concerns of exposing user data to external provider APIs, or may be driven by a requirement for greater control and flexibility in this area of the system. The following is a list of open source NLP engines and parsers.

- Spacy - Python
- Natural Language Toolkit (NLTK) - Python
- Stanford CoreNLP - Java
- Apache OpenNLP - Java
- Duckling Wit - Haskell

Proposals

Consistent with best practise and Newcastle RSE guidelines, the following is proposed;

1. The internal bot service and presentation layer is built using the BotMan framework, which is a Laravel PHP application.
2. The source code should be stored in a private GitHub repository within the Newcastle University RSE Team organisation.
3. The testing and deployment pipelines will be automated using GitHub Actions CI/CD processes.
4. The internal bot service and presentation layers will be containerized using Docker.
5. The containerized apps will be built and deployed to the Azure account belonging to the Newcastle University RSE Team.
6. Google Dialogflow will be initially used as the AI/ML/NLP layer to speed up development of the first conversational chatbot for the FinTech project.

References and Further Reading

Chatbot definitions, discussions & history

- The History of Chatbots
- The 3 Types of Chatbots & How to Determine the Right One for Your Needs
- What is a Chatbot: Definition and Guide
- Voice-Enabled Chatbots V/S Messenger Bots
- 11 Chatbot Trends that Help Grow Your Business
- Salesforce: How are Chatbots Changing Customer Experience?
- Alan Turing at 100: Turing Tests, Parlor Games, and ChatterBots
- ChatBots — The Rise of Conversational UI
- The Best Innovative Chatbot Examples by Industry
- A Closer Look at Chatbot ALICE
- The Rise of Conversational AI: Why Businesses Keep Falling Short
- Chatbots: Customer Service, Business Automation & Scalability

Chatbot software development

- Chatbots: Metrics For Generating Customer Insights
- How to Make Empathetic Bots with Emotion Technology
- 5 metrics every chatbot developer needs to track
- On Designing The Right Bot Avatar
- Best Design Practices for Chatbots
- On Designing The Right Bot Avatar

Emotion, ethics and trust

- The code of ethics for AI and chatbots that every brand should follow
- Are emotionally intelligent bots the future of AI?
- What Would Make You Trust an AI Assistant? How About a Face?
- Guardian: Why are we reluctant to trust robots?
- Observer: People Are More Likely to Open Up to a Talking Computer Than a Human Therapist
- BBC: Truth be told, we're more honest with robots
- People more likely to trust machines than humans with private information
- Your Customers Still Want to Talk to a Human Being
- Will Robots Change Human Relationships?
- Should Chatbots Appear Human?
- Why Design a Bot with Personality?

Finance and robo-advisors

- Virtual financial advisor: Delivering personalized advice in the digital age
- How Chatbots Are Creeping Into The Finance Industry
- Masterpass-enabled chatbots launch on Facebook Messenger
- American Express Previews New Amex Bot for Messenger