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What Are Conversational Bots?

**An Introduction to and Overview
of AI-Driven Chatbots**



Jon Bruner & Mike Barlow



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“Bots are
the new apps.”

—Satya Nadella, Microsoft CEO

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Beijing • Boston • Farnham • Sebastopol • Tokyo

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What Are Conversational Bots?

Introduction to Bots

In March, Microsoft CEO Satya Nadella declared that “bots are the new apps.” Venture capitalist Benedict Evans **writes** that bots might become the “third runtime, after the Web and native apps.”

Artificial intelligence (AI) has evolved to the stage where it can parse intentions and churn out useful responses to practical queries. And after a decade of texting and messaging on smartphones, we’ve become comfortable with conversational interfaces. Will 2016 be remembered as “The Year of the Bot”?

Bots promise to inject information, intelligence, and online services into just about any scenario. Bots could give workers superpowers, make networks more accessible, reorder user experiences, and build new ecosystems. They offer developers a faster way into users’ pockets **as the app economy matures**.

What exactly are bots? Here’s a good working definition: bots are AI-driven pieces of software that converse in human terms. They’re not quite ready to pass the **Turing test**, but ready enough for many forms of commerce and messaging.

Bots are able to automate human tasks for which APIs don’t exist, translating fluidly between unstructured language and structured data. They promise to bring a new level of sophistication and convenience to interactions between humans and computers. Let’s break that idea into two key elements:

1. Artificial Intelligence makes it possible for bots to parse human language, understand intent, and compose replies. AI of some sort is a key component of most bots, but many bots also have humans underneath them—this is called “human in the loop.” Bots may rely on humans to train them, or bots may act as filters and qualifiers, gathering information to help humans work more effectively.
2. Bots communicate in human language through a variety of interfaces—IM, email, and voice are the platforms of greatest interest now. This is a crucial aspect because bots can reach their users anywhere, and they’re easy to install; instead of downloading a new app, you just add a new contact in your IM client. And unlike apps, which are almost all subject to the control of Apple and Google, the field for bots is much more open (for now, at least).

Making the Business Case for Bots

Bots can revolutionize the way we interact with computers by blending artificial intelligence into human conversations, adding an element of computation to many scenarios that don’t involve computation now.

Customer Relationship Management

Consumer-facing bots can assist customers with difficult transactions, make recommendations, and gather data. For instance, a bot incorporated into an airline’s website could answer questions about fees, rebook flights, and suggest add-ons like hotel and car reservations. Even if the bot isn’t able to finish these exchanges, it could still gather preliminary information (customer’s name, reservation number, etc.) and pass it on to a customer service representative, saving considerable time for the company’s call center. Matched to a sophisticated data-mining backend, the bot builds up data profiles that the airline can use to market vacations, travel deals, and additional services.

Productivity

Specialized bots can make professional tasks easier. For instance, a bot connected to an electronic medical record system could retrieve

information faster than a conventional lookup; just ask “what was the patient’s blood pressure during his January visit?”

Productivity bots like [x.ai](#) are already able to schedule meetings through email, posing as a human assistant. The bot thus interjects automatic scheduling into a scenario where automation might otherwise be awkward.

Entertainment and Wellness Coaching

Bots can take advantage of the intimate, low-friction environment of messaging to provide coaching, healthy reminders, or entertainment. For instance, a wellness bot, popping up inside the IM client that you’re accustomed to using all day, could encourage you to exercise or meditate. Game bots are already widespread.

Why Bots Loom Large

Bots have become an area of intense focus in the technology community for three primary reasons:

Reason #1: Artificial intelligence has progressed enormously in the last couple of years. At the high end, very sophisticated AI—like that in Amazon’s Alexa, Apple’s Siri, Google’s Now, and Microsoft’s Cortana—is now becoming available to developers through APIs.

At the moment, only Alexa and Cortana are completely open to developers, but Google and Apple have signaled that they’re planning to make their conversational platforms and AI engines available as services.

At the lower end, accessible tools and libraries are democratizing AI, putting very basic AI within reach of reasonably advanced generalist developers. An individual can’t create something as sophisticated as Siri, but he or she can use a library like TensorFlow or scikit-learn to train and deploy a basic neural network.

Human in the loop is still a huge part of most well-funded bot efforts. Humans train the bot, act as a fallback, or help in both areas. In many cases, bots aren’t intended to replace humans; they’re intended to augment humans, taking care of dull preliminaries and sending the matter onward to a human, who can then be more effective.

Reason #2: People enjoy conversational interfaces, and companies want to use the interface that will capture the attention of their customers. Messaging applications are ubiquitous. Facebook Messenger is the most popular free app in the Google Play store; it and WhatsApp, also owned by Facebook, have each been installed more than a billion times on Android alone. Consumers spend more than 4 hours per week in communication apps, according to Nielsen. More than half of WhatsApp users use the app more than once a day; over 80% use it at least once daily. Line is similarly dominant in Japan, as is WeChat in China.

Reason #3: The conventional app economy is stagnating. It's getting harder to break through with new apps, and even once they're installed it's hard to get users to return to them. As recently noted in *The Economist*:

The 20 most successful developers grab nearly half of all revenues on Apple's App Store. Building apps and promoting them is getting more costly. Meanwhile, users' enthusiasm is waning, as they find downloading apps and navigating between them a hassle. A quarter of all downloaded apps are abandoned after a single use.

The majority of smartphone users have 20 or fewer apps on their phones, and, according to the Pew Research Center, “almost half of app downloaders report that they use five or fewer apps at least once per week.” Five apps account for 88% of the time that the average US smartphone owner spends on his or her phone. Most apps aren't kept longer than a day after users download them. Just over 3% of apps are still active 30 days after being downloaded.

In light of those stats, the outlook for apps doesn't look especially promising. Now that our collective love affair with apps has apparently cooled, bots present an appealing way to reach users.

Bots as the Ultimate Source of Cheap Labor

If you're running a customer contact center, you're probably already considering the idea of using bots to replace or augment human workers. In a sense, bots represent the final step in a downward spiral of cost reduction.

The good news is that industry experts believe that using bots to replace or help humans working in call centers will actually improve customer service. Companies with call centers now work to discourage their customers from contacting them because the cost of servic-

ing customers with humans is high. Lower-cost customer service could mean more customer service. And since the bots will have access to much more information than any human worker could possibly have, ideally, the bot will “know” the answer to your question before you even ask it.

But bots aren’t just about replacing workers. They promise to make workers more productive by taking care of time-consuming repetitive tasks like scheduling meetings, coordinating team discussions, and updating databases. Nearly any simple, well-defined human office task could be addressed by a bot, freeing humans for more complex work.

Challenges to Consider

Despite its promise, the rise of the bots is by no means a done deal. There are **plenty of open questions**.

- Can generalist AI become sophisticated enough to support legions of bots operating across multiple industries and various markets? Many bot developers working now report that AI-as-a-service offerings aren’t sufficient beyond very early prototypes.
- From the perspective of user experience, what are bots good for? That question is driving lots of experimentation. Some of the most commonly discussed bots (such as bots for ordering pizzas) are actually quite difficult to implement in ways that are useful and appealing to users.
- How will user expectations and interaction models change? Bots are in a very early stage of development now, and most users see bots as experimental. Two decades ago, users were uncomfortable formulating search queries—hence Ask.com, which allowed Internet neophytes to search using well-formed questions. Now, of course, we’ve adjusted our behavior to use Google search. How much will users be willing to change their behavior in order to accommodate bots?
- How will bots blend human and artificial intelligence? Most complex bot applications currently involve humans in the loop. Will these humans remain core components of bots?
- How will bot discovery work? One problem with mobile apps that’s driving developers to bots is that users don’t browse app

stores very much to discover new apps. So we can't expect them to browse bot stores to discover new bots. Platforms like Facebook Messenger and Slack might eventually be able to suggest bots based on context, but that needs to be handled very carefully to avoid irritating users.

- Finally, what does the commercial model look like? The current generation of consumer bots includes many that make money on affiliate fees: when the bot recommends, say, an air travel itinerary, it gets a kickback from the issuing airline. Is that sustainable? How will the bot platforms cash in? And can they cash in without compromising their neutrality?

In the next section, we'll look at some of the players and platforms in the emerging bot landscape.

Industry Overview: The Ecosystem at a Glance

The bot ecosystem is developing quickly, but its contours have begun to emerge in the abundant platforms and frameworks available to bot developers. Here are brief descriptions of the most notable.

Platforms and Frameworks for Messaging and Agent Communication

Bots live on these platforms.

Amazon Alexa

Alexa is the voice service behind Amazon's Echo, a voice-controlled speaker. Developers can write plug-ins (Amazon calls them “skills”) that enable users to interact with services using voice commands. Skills use the Alexa Skills Kit, a bundle of tools provided by Amazon.

The Alexa Skills Kit includes a [step-by-step checklist](#) for getting started, designing voice user interfaces, building, hosting, and reviewing code, and submitting skills for certification. It also includes the [Smart Home Skill API](#), which allows developers to teach Alexa how to control lighting and thermostat devices. All of the code runs in the cloud.

Apple Siri

In a move that would have been unimaginable a few years ago, Apple announced in June 2016 that it would open Siri to developers. The move makes it possible to integrate Siri deeply into iOS apps.

SiriKit enables iOS 10 apps to work with Siri. Developers can build extensions that communicate with Siri and register with specific domains that define the tasks that the app can perform. Siri handles voice and natural language recognition and can work with your extension to get information and handle user requests.

In addition, SiriKit enables messaging, photo search, phone calls to other apps, ride booking, and personal payments.

Facebook Messenger

Facebook, which owns WhatsApp as well as Messenger, is by far the world's largest messaging platform, available on nearly any mobile or desktop device (outside of China, that is, where WhatsApp works but Messenger is usually blocked).

The Facebook Messenger Platform enables developers to build bots with three main capabilities:

1. An API for sending and receiving text, images, and rich bubbles with CTA (call-to-action) buttons;
2. The ability to create generic structured message templates with CTAs, horizontal scroll, URLs, and postbacks, and;
3. The tools to create a welcome screen and null state CTAs.

Facebook also offers natural language assistance through its wit.ai bot engine. This enables ongoing training of bots using sample conversations that effectively turns natural language into structured data. See the wit.ai entry in the AI Platforms section.

With Facebook Messenger you can use web plugins, **Messenger Codes**, **Messenger Links**, and **Messenger Usernames**.

The platform additionally provides access to various Messenger tools, including Shopify, Twilio, and Zendesk. Facebook also enables businesses (such as restaurants or ride services) that use SMS for real-time communication (“Your food has arrived” or “Your ride is here”) to transfer those conversations to Messenger.

Facebook provides **some basic information** about users to bot developers, but notably does not give Facebook profile information to Messenger bots.

Google Now and Google Assistant

There has been much speculation about when and how Google will formally unveil developer tools for bot builders, but so far nothing has been released. However, it seems likely that Google will follow in the footsteps of Microsoft and Apple, both of which provide support for bot developers.

Google Now is the search giant's answer to Siri: a voice-controlled, context-aware assistant available on Android. Now uses a **natural language user interface** “to answer questions, make recommendations, and perform actions by delegating requests to a set of web services.” In addition to answering user-initiated queries, it delivers information that predicts what users might want, based on their search habits.

Now can handle basic tasks like setting timers and alarms, and it has made some of this functionality available to app developers through a handful of pre-defined triggers. Plus, it can draw other search-based insights from the pervasive intelligence layer called Google Assistant.

At Google I/O 2016, Google clarified the structure of its intelligent conversational services: **Google Assistant** is an overarching intelligence layer accessible through the forthcoming voice-enabled wireless speaker **Google Home** (a device similar to Amazon's Echo); the new Android Wear watches, and the **Allo** and **Duo** apps, which allow text chatting and video chatting, respectively.

Microsoft

Microsoft is making perhaps the most comprehensive bid to compete seriously in the bot ecosystem, with two important bot platforms of its own as well as tools that connect bots to any other major platform.

Cortana, Microsoft's voice assistant, is **available to developers through an SDK**, and Skype **acts as a messaging platform for bots**. Microsoft has also published **Bot Framework**, an open-source library for developing bots on SMS, email, Skype, Slack, Messenger,

GroupMe, Telegram, Kik, and any other platform through a direct API.

Slack

Slack is uniquely positioned as a workplace messaging platform, which has made it attractive for **a wide variety of productivity-oriented bots**. These bots act as “**bot users**,” a term that Slack uses to differentiate them from human users. There are custom bots and app bots, each serving a different purpose and offering different functionality.

Unlike some other major platforms that restrict bots to one-on-one conversations, Slack bots are able to participate in the group conversations that are the basis of Slack collaboration.

“Bot users have many of the same qualities as their human counterparts...with profile photos, names, bios...and can connect to Slack to allow users to converse with them in **real-time via websockets**,” Slack explains.

Slack has two different kinds of bot users: custom bots and app bots. Each serves a different purpose and offers different functionality. For more details, read Slack’s **bot user documentation**.

Kik

What Slack is to the workplace, Kik is to teenagers: a specialized platform with a relatively focused demographic. **Kik’s bot platform** offers a clear value proposition: “On Kik’s chat platform, developers can build, grow, and (soon) monetize for a highly engaged teen audience...There’s nothing to download, no icons to add to the homescreen, and no memory hogging...About 40 percent of U.S. teens use Kik...Your bot could have direct access to more than 300 million registered users.”

Kik appeals directly to marketers, noting that people spend more of their mobile time in chat and that 1.4 billion people—many of them teens—used a chat app in 2015.

Line

Line dominates messaging in Japan, where it’s installed on **80% of Android devices** and has become a cultural phenomenon, and is also popular in Indonesia and Singapore.

Line's BOT API allows you to send and receive messages with Line users through either a Line official account or a Line@ account.

Snapchat

The ephemeral-messaging service Snapchat has become spectacularly popular despite a user interface that's impenetrable to anyone over 25. It's never offered an official API for bot developers, though a handful of efforts to reverse-engineer an unofficial API, like [Casper](#), have briefly gained traction at points. Snapchat does offer an API for advertisers called [Snapchat Partners](#).

Telegram

Berlin-based Telegram emphasizes security, offering “secret chats” with end-to-end encryption and [completely public source code](#). Telegram [presents itself](#) as a nonprofit dedicated to security and privacy, though, as the *Washington Post* wrote in 2015, its origins are murkier than that.

Telegram's [Bot API](#) provides access to the platform for third-party developers. “Bots are simply Telegram accounts operated by software—not people—and they'll often have AI features. They can do anything—teach, play, search, broadcast, remind, connect, integrate with other services, or even pass commands to the Internet of Things,” says Telegram.

See bots built by the platform's beta testers at [Telegram's Bot Store](#).

Twilio

SMS was the messaging platform that started it all. Until Twilio came along in 2008, developers had to rely on messy, inconsistent integrations to send text messages; now sending a text (or placing a voice call) is as simple as writing a couple of API calls.

WeChat

WeChat is dominant in China—not only in messaging, but also as a payments, voice, file sharing, and location platform. It's home to a robust bot and conversational-application ecosystem, including Microsoft's immensely popular [Xiaoice](#) bot.

Businesses usually establish “**official accounts**,” which offer user-management tools and can send updates to subscribers. A **comprehensive API** offers access to official account functions.

WeChat’s popularity in China has led many observers to **wonder** whether it’s a glimpse of the future of bots and messaging in North America and Europe. Others, like **Sarah Guo on our Bots Podcast**, point out that WeChat arose in a computing environment that’s very different from the computing environment in the West.

AI Platforms

Bots are interfaces to artificial intelligence, and the sophistication of a bot is directly linked to the sophistication of its AI model. Fortunately for bot developers, several companies provide “artificial intelligence as a service,” making it easy to implement very basic AI.

Api.ai

Api.ai is a platform for conversational voice interfaces aimed at mobile devices, web interfaces, and embedded systems. It’s the company behind **Assistant**, a popular conversational assistant app with more than 20 million users.

The platform provides SDKs and helper libraries for Android, iOS/Watch OS/Mac OS X, Ruby, Webkit HTML5, JavaScript, Node.js, Cordova, Unity, .NET (WP8, W10), C++, Xamarin, Python, and PHP (community supported).

IBM Watson Conversation

Developers can now tap into the resources of Watson—IBM’s large-scale cognitive system for understanding, reasoning and learning—for developing bots and virtual agents.

Using Conversation requires signing up for a Bluemix account. (To encourage interest, IBM offers a **free 30-day trial**.)

IBM’s **Watson Developer Cloud** (WDC) offers “one-stop shopping” for developers, providing basic but essential cognitive capabilities such as **Speech to Text**, **Text to Speech**, **Natural Language Classifier**, **Dialog**, and **Visual Recognition**.

Wit.ai

Wit.ai is a natural language platform for developers. In addition to using it as a platform for building chatbots, developers can also use it to build apps for mobile devices, home-automation systems, wearable devices, and robots. Wit.ai says it's currently used by 45,000 developers.

The free platform was acquired last year by Facebook, which puts it front and center in the emerging bot development ecosystem. The platform's value proposition is straightforward: "Your users give us voice or text, you get back structured data."

For newcomers, the platform offers a "quickstart" process consisting of eight relatively simple steps. Wit.ai's [FAQ](#) is worth reading even if you don't plan to build your own bots.

Roll Your Own AI

AI as a service may be enough to get started with bots, but many bot developers find that they need to build their own artificial intelligence engines to make sense of specialized use cases. Fortunately, open source machine-learning libraries, often supported by big technology companies, have improved immensely in the last couple of years, becoming more powerful and easier to implement. Nevertheless, using any of these libraries to build bots requires a fundamental understanding of machine-learning techniques.

Among the most popular deep learning frameworks are [TensorFlow](#) (developed and open sourced by Google), [scikit-learn](#), [Theano](#) (popular in academic AI research), and [Torch](#) (supported by Facebook, Twitter, and Google, among others).

Bot Platforms and Toolkits

Tools, platforms, and resources that make it easy to deploy chatbots.

Automat

Automat¹ offers a platform and a set of approachable WYSIWYG tools for building bots that learn over time. Its AI goes beyond traditional tree-building tools: it incorporates understanding of entire conversations, not just single inputs, and can improve through use with minimal intervention from a bot's creators. Automat also includes mechanisms for bringing humans into the loop.

Automat initially supports Messenger, Kik, and Slack.

BotKit

Developed by Austin-based Howdy.ai, BotKit is an open-source framework for messaging. It offers built-in calls for Slack, Facebook Messenger, and Twilio, with a particular emphasis on Slack.

Chatfuel

Chatfuel is an easy-to-use toolkit that promises “a full-featured chatbot in 7 minutes.” It's the platform behind several news-media bots, including those from **Forbes** and **TechCrunch**. Among Chatfuel's features: the ability to import data through plugins, turning static information like RSS feeds into interactive bots.

Pandorabots

Pandorabots was co-founded by Richard Wallace, the computer scientist who created **AIML**. The company offers chatbot development tools through its **Playground** development environment, an artificial-intelligence-as-a-service API, and bot hosting services.

Pandorabots supports integrations with Twilio, Hubot, Slack, Twitter, Telegram, and Firebase.

¹ Disclosure: Automat is a portfolio company of O'Reilly AlphaTech Ventures, a venture capital firm affiliated with O'Reilly Media.

Sequel

Sequel offers “write once, publish everywhere” tools for building bots, with particular emphasis on games and entertainment and on bots that convey personality. An example: the Sequel **Stories** bot publishes interactive fiction through messaging.

Real-World Examples

Bots are already in use in a variety of applications—from internal productivity boosters to outward-facing automated customer-service assistants.

Personal Finance

Fidelity

Fidelity Investments enables Echo users to get market updates and quotes through Alexa. While it's not quite a bot, it's certainly a major step in the direction of providing voice-enabled interactivity with Fidelity's automated systems. **Fidelity is reportedly** working on extending the service to add more functionality, including authentication for Fidelity account holders.

Trim

Trim is a bot that analyzes your online subscriptions and helps you cancel the ones you're paying for but don't really want. It scans through huge amounts of credit and debit card data to identify recurring charges, then offers to initiate the cancellation process.

Travel

KLM Royal Dutch Airlines

KLM offers a **Messenger bot** that provides automatic flight reminders, updates, and access to boarding passes. Passengers can register for the Messenger service during booking. For questions that go beyond the bot's automated capabilities, passengers are seamlessly connected with a human agent through the chat interface.

Lola

Lola is a travel app that blends artificial intelligence and human agents, using software to manage logistics and build customer profiles, and people to make decisions that have to do with taste. Lola was co-founded by Paul English, who started Kayak in 2004.

Alterra.ai

Alterra is a completely automated messenger bot that can serve as a virtual AI travel agent, making recommendations on where to go and what to see and booking flights and hotels. It is currently live on Facebook and Telegram.

Productivity

Amy (x.ai)

Amy, currently in pre-release, is an AI-powered personal assistant designed to help you schedule meetings. Users can add amy@x.ai or andrew@x.ai to any email thread about scheduling, and the service takes over as a human assistant would.

Clara

Clara is also an AI-powered personal assistant and virtual scheduling agent. It is a hybrid system combining human and machine capabilities. Clara's human component is "a global distributed workforce of remote assistants" that provides "reliability, contextual awareness, and empathy," writes Olga Narvskaya, who runs Product Operations and Growth at Claralabs.

Cobalt

Cobalt's CRM Bot, which is currently in its preview stage, promises to provide "All the CRM, with none of the clicks." Instead of searching for a record in a conventional UI, an account manager might simply say "Find Sarah Connor." You wouldn't have to create a new item manually, you would just say, "Create lead Sarah Connor." Rather than going through the steps of attaching a file, you would say, "Attach to lead Sarah Connor as PowerPoint presentation."

Viv

Built by much of the same team that created Siri, Viv is a unified personal assistant that can look up information and make transactions. It will be accessible to developers to build additional functionality on top of the assistant-as-platform.

Viv's breakthrough is what its creators call **dynamic program generation**—a type of sophisticated artificial intelligence that trains itself on new functions.

Viv **has been demonstrated in public**, but is not yet available to download.

Retail

Macy's

Macy's On Call, **currently in pilot testing**, can answer **the kinds of basic questions that customers inside a Macy's store might have**, like where to find specific products, in English or Spanish. It can also provide fast access to live Macy's salespeople, who, in theory, should have more time to help customers now that a bot can take care of simple questions. Macy's On Call is built on top of IBM's Watson AI engine.

Whole Foods Market

As Nichele Lindstrom, director of digital marketing at Whole Foods, **points out**, "over 50% of recipe searches happen in an aisle, in a store." Customers want to know what they can make with an ingredient they're thinking of buying.

The **Whole Foods Messenger bot** makes recipe search fast and natural for people who might be standing in a grocery aisle, using both free-text input and Messenger buttons to narrow options.

Burger King

The fast-food chain Burger King has introduced a Facebook Messenger chatbot that shows nearby locations, displays menu choices, takes orders, suggests upgrades ("Make it a meal?"), confirms orders, estimates when your order will be ready, and lets you pay—all through your mobile device. (If you don't want a burger, try **TacoBell's TacoBot**, which is accessed through Slack.)

Burger King's app is only available at limited locations, but it represents an important step in the evolution of the QSR (quick service restaurant) industry. Retailers will be watching closely to see how smoothly the mobile payment component works when the bot is rolled out to the larger market.

About the Authors

Jon Bruner, director of IoT, hardware, and now bots at O'Reilly Media, is a data journalist who approaches questions that interest him by writing and coding. He previously served as data editor at *Forbes Magazine*.

Mike Barlow is an award-winning journalist, author, and commentator. He is the author of *Learning to Love Data Science* (O'Reilly Media, 2015), and the coauthor of *The Executive's Guide to Enterprise Social Media Strategy* (Wiley, 2011), and *Partnering with the CIO: The Future of IT Sales Seen Through the Eyes of Key Decision Makers* (Wiley, 2007). He is also the writer of many articles, reports, and white papers on numerous topics such as smart cities, social networking, cloud computing, IT infrastructure, predictive maintenance, data analytics, and data visualization.

Over the course of a long career, Barlow was a reporter and editor at several respected suburban daily newspapers, including *The Journal News* and the *Stamford Advocate*. His feature stories and columns appeared regularly in *The Los Angeles Times*, *Chicago Tribune*, *Miami Herald*, *Newsday*, and other major US dailies. He has also written extensively for O'Reilly Media.

A graduate of Hamilton College, he is a licensed private pilot, avid reader, and enthusiastic ice hockey fan.