

# To What Scale are Conversational Agents used by Top-Funded Companies Offering Digital Mental Health Services for Depression?

Aishah Alattas<sup>1</sup>, Gisbert W. Teepe<sup>2</sup>, Konstantin Leidenberger<sup>3</sup>, Elgar Fleisch<sup>1,2,3</sup>, Lorraine Tudor Car<sup>4,5</sup>, Alicia Salamanca-Sanabria<sup>1</sup> and Tobias Kowatsch<sup>1,2,3</sup>

<sup>1</sup>*Future Health Technologies, Singapore-ETH Centre, Campus for Research Excellence And Technological Enterprise (CREATE), Singapore*

<sup>2</sup>*Department of Management, Technology, and Economics (D-MTEC), ETH Zurich, Zurich, Switzerland*

<sup>3</sup>*Institute of Technology Management (ITEM), University of St. Gallen, St. Gallen, Switzerland*


<sup>4</sup>*Family Medicine and Primary Care, Lee Kong Chian School of Medicine, Nanyang Technological University Singapore, Singapore*


<sup>5</sup>*Department of Primary Care and Public Health, School of Public Health, Imperial College London, London, United Kingdom*  
sharifah.aishah@sec.ethz.ch, gteepe@ethz.ch, konstantin.leidenberger@student.unisg.ch, efleisch@ethz.ch, lorraine.tudor.car@ntu.edu.sg, alicia.salamanca@sec.ethz.ch, tkowatsch@ethz.ch


**Keywords:** Conversational Agent, Depression, Mental Health, Venture Capital, Top-Funded


**Abstract:** There is strong support in the literature for the use of conversational agents (CAs) in digital mental healthcare along with a recent increase in funding within digital mental health, indicating the fast growth of the industry. However, it is unknown to what extent CAs are leveraged in these digital interventions for depression. The aim of this study is to therefore explore the scale of CA use in top-funded digital mental health companies targeting depression and describe what purposes they are used for. Companies were identified through searching venture capital databases and screened for the presence and purpose of use of CAs in their interventions for depression. It was found that only 7 out of the 29 top-funded companies used a CA in their intervention. The most common purpose of CA use was education, followed by assistance, training and onboarding. None of the interventions used CAs for elderly assistance, diagnosis or prevention. These results indicate that the industry uptake of CAs in digital interventions for depression within top-funded companies is low. Future work can look into using CAs in areas which this analysis found they are not currently used such as in tailoring to different target populations and in preventing depression.


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 <https://orcid.org/0000-0003-4777-900X>


<sup>a</sup>  <https://orcid.org/0000-0002-2264-9797>

<sup>b</sup>  <https://orcid.org/0000-0003-3304-6673>

<sup>c</sup>  <https://orcid.org/0000-0002-4842-1117>

<sup>d</sup>  <https://orcid.org/0000-0001-8414-7664>

<sup>e</sup>  <https://orcid.org/0000-0002-2756-5592>

<sup>f</sup>  <https://orcid.org/0000-0001-5939-4145>

# 1 INTRODUCTION

Conversational agents (CAs), also known as chatbots, are computer programs that use techniques from artificial intelligence and machine learning to mimic humanlike verbal, written and visual behaviours to be able to converse and interact with human users (Vaidyam et al., 2019). The first well-established CA, ELIZA, was designed in 1966 and programmed to emulate a Rogerian psychotherapist via typed text (Weizanbaum, 1966). Presently, over fifty years later, the use of CAs is widespread in healthcare and has been used in multiple points in the continuum of care such as in prevention through the modification of lifestyle behaviours, diagnosis and detection, and treatment and monitoring for a multitude of health conditions (Tudor Car et al., 2020; Schachner et al., 2020; Berube et al., 2020).

Since the days of ELIZA, interest in CAs have fluctuated; however, the boom in technological advancements together with the increasing focus on mental health in the past twenty years has seen a significant amount of research in the use of CAs particularly in mental health conditions (Gaffney et al., 2019). This is owing to the utility of CAs in bridging the gap in the perceived trade-off between barriers to receiving standard face-to-face therapies for mental illness such as waiting lists, costs, geography and stigma and the often static nature of self-guided digital mental health interventions that do not respond dynamically to individual needs and preferences (Miner et al., 2016). In this way, CAs have the potential to create a therapeutic alliance with the user, which is a key feature of the overall effectiveness of therapy on patient outcomes such as symptom severity, treatment compliance and patient satisfaction, without the involvement of a human therapist (Lopez et al., 2019).

In a recent review in the mental health setting, CAs were used for a variety of purposes including therapy, training, screening, self-management, counselling, education and diagnosing (Abd-alrazaq et al., 2019). Another review reported on the effectiveness of CAs for mental health applications which showed that they are effective in reducing levels of depression, anxiety and perceived stress as well as increasing levels of self-esteem and psychological wellbeing (Tudor Car et al., 2020). In terms of user experience, ratings of engagement, satisfaction, acceptance and helpfulness were in favour of the use of CAs in these mental health applications (Tudor Car et al., 2020). Moreover, it has also been found that the risk of harm from the use of CAs in mental health is extremely low, with

only 1 in 759 participants reported to have a related adverse event incident (Vaidyam et al., 2019). This particular incident involved a patient with schizophrenia developing paranoia and refusing to continue using a CA intended to promote antipsychotic medication adherence after a few days, which highlights the caution that may need to be taken when using CAs in those with psychotic presentations (Bickmore et al., 2010).

While mental health disorders in general account for a large proportion of global disease burden, depressive disorders are a particular area of concern as they are the third leading cause of all-age years lived with disability after low back pain and headache disorders (James et al., 2018). Depression is estimated to affect an estimated over 300 million people worldwide and can greatly impair functioning and quality of life both through the direct effects of depressive symptoms as well as through its association with poor physical health outcomes, resulting in increased morbidity and mortality (Liu et al., 2020). Furthermore, latest figures report an almost 50% increase in the global incident cases of major depressive disorder worldwide over the past thirty years, calling for urgent action to actively intervene and control its occurrence and exacerbation (Liu et al., 2020).

The manifestation and expression of depression is complex, with a large amount of heterogeneity both between and within individuals depending on the different contexts and challenges faced at different times. Longitudinal studies have shown that those experiencing depression may spend up to almost 40% of their time being asymptomatic, and that even when symptomatic, patients had a mean of 1 symptom severity level fluctuation per year with more fluctuations being associated with poorer function and quality of life (Vergunst et al., 2013). Currently, most digital health interventions targeting depression are modelled to be able to manage acute symptoms, but do not consider these important time and context specific aspects that can alter the experience, and therefore required intervention for depression (Kornfield et al., 2020). This mismatch has been cited as a possible reason for the high levels of dropouts and non-adherence rates to digital interventions for depression, presenting an opportunity for the adaptive nature of CAs to accommodate the temporal dynamics that are at play in efforts to increase retention and consequently effectiveness levels of such tools.

Although the evidence base for CAs in mental health has seen a steady increase over the past two decades with promising results on their ability to

provide effective, engaging and scalable digital mental health interventions, little is known on their actual uptake in the industry. In 2019 alone, venture capital companies invested a record high of 637 million US Dollars in over 60 mental health companies, a notable proportion of which went specifically into digital mental health (Shah and Berry, 2020). In fact, the latest reports show that a new record in the deal volume in digital mental health companies was reached with 68 deals in the third quarter of 2020 alone (CB insights, State of Healthcare Q3'20 Report). It thus piques an interest in the extent to which these new, highly-funded companies are leveraging CAs in their digital mental health interventions.

This paper aims to explore the scale at which CAs are used by top-funded digital mental health intervention companies and describe what purposes they are used for. To gain a deeper insight, the scope of analysis will be narrowed down to those top-funded companies with a main focus on targeting depression, seeing its high prevalence, burden and potential for CA technology to enhance therapeutic approaches in this area. On top of this, the literature also indicates depression as the most commonly targeted disorder in the use of CAs in mental health (Gaffney et al., 2019 ; Abd-alrazaq et al., 2019).

## 2 METHOD

### 2.1 Companies

Companies were searched using two venture capital databases, Crunchbase Pro and PitchBook, which have been identified to be among the most comprehensive and accurate of the commonly used venture capital databases in academic reports and articles as well as used by investors (Retterath and Braun, 2020). The search terms (*Depression OR Mental Health*) AND (*Health care OR Apps OR Digital health OR Big Data OR Artificial Intelligence*) were entered into Crunchbase Pro and (*Depression OR Mental Health*) AND (*Digital Health OR Application Software OR Big Data OR Artificial Intelligence & Machine Learning OR Mobile*) entered into PitchBook to identify the companies that were relevant to the field of digital mental health through October 24, 2020. The differences in search terms between the two venture capital databases are a reflection of the specific verticals that exist on their search options. A filter to only include the companies that received more than a million US dollars was also applied when

searching in both databases in order to limit the amount of companies returned that would not be eventually included in our list of top-funded digital mental health companies.

Figure 1 represents the company selection process based on an inclusion and exclusion criteria defined a priori. We excluded companies that did not primarily address depression, that is, for example, companies offering general health and wellness interventions in terms of diet and exercise which make unsubstantiated claims to be able to improve mood and help with depression. We also excluded companies where the end-user is not the "patient", where patient can be defined as the individual who will receive intervention for depressive symptoms. Hence, digital mental health solutions targeted at healthcare providers for managing their caseload remotely were excluded as the sphere of this study focuses on the use in CAs in the therapeutic engagement with individuals with depression.

For similar reasons, companies that only offered telehealth services such as triaging and matching between service users and service providers without any additional active components were excluded. Here, we take the definition of "active components" from the multiphase optimisation strategy which states a component is "active" if there is empirical evidence of its therapeutic effectiveness via measures including but not limited to statistical significance or effect size (Collins et al., 2007). Other excluded companies were those that required the use of a wearable device as this technology has been cited as being a barrier to the use of digital health interventions due to factors such as comfort, design, battery life and connectivity issues (Loncar-Turukalo et al., 2019), although companies in which the use of a wearable device was an optional add-on feature remained included. Those that were purely peer support or forum platforms and those that were not available in the English language were also excluded. The final list of companies was validated on their credibility, potential utility and validity as an intervention for depression by two experts with extensive industry and academic experience in the field of digital mental health. This was done to ensure that the major players within the digital mental health field were not overlooked, while remaining focussed on the specific area of depression that is being investigated in this study.

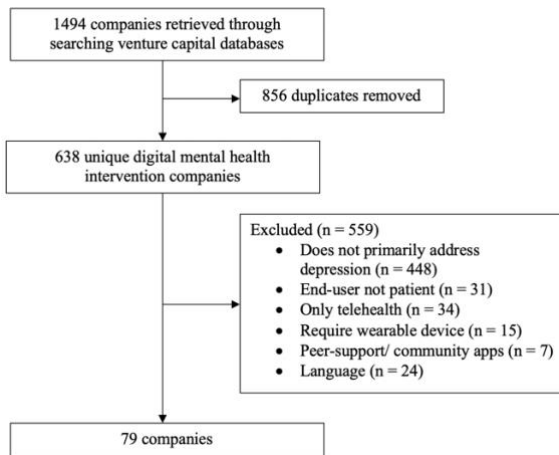


Figure 1: Flow chart of the company selection process.

## 2.2 Conversational Agent (CA)

A CA was coded to be present in the digital mental health intervention if there was evidence of the use of a dialogue system that processes and automatically responds to human language via text, speech or visual stimuli. For those interventions that could be accessed, the presence or absence of a CA was established through direct use of the platform and for those interventions that were unable to be accessed, this was established through reviewing the information provided by the intervention company on their website as well as in peer-reviewed literature. To determine the purposes that the CAs are used for, we have coded our findings based on an adapted version of a taxonomy of CAs in health proposed by Montenegro et al (Montenegro et al., 2019). Table 1 provides a description of the coded CA uses.

## 2.3 Analysis

The list of digital mental health companies to be included in our analysis, the presence or absence of a CA and the purposes that they serve in their respective interventions were evaluated independently by two authors (AA and KL) based on predefined criteria. Any disagreements were resolved through a discussion and eventual consensus between the two authors, or brought up to a third author for adjudication (GWT) where necessary.

Table 1: Coding framework used to classify the purpose of use of CAs present in digital mental health interventions.

Purpose of use of CA	Description
Assistance	The CA provides assistance to increase or improve a behaviour
Training	The CA trains the user in a health related behaviour
Elderly assistance	The CA improves a health condition in the elderly population
Diagnosis	The CA gives a mental health diagnosis
Education	The CA provides information to increase mental health literacy
Prevention	The CA aims to prevent the onset, a deterioration or a relapse of a mental health condition
Onboarding	The CA is used to facilitate the onboarding process
Questions and services	The CA is used for a support purpose such as technical support or answering frequently asked questions

## 3 RESULTS

Out of the 79 companies extracted from the venture capital databases that met our inclusion and exclusion criteria, we analysed the 30 top-funded companies as they accounted for 97.6% of the total funding in all 79 companies, giving a representative and comprehensive insight into the pattern of common features present in these interventions. During our analysis, one of the companies had put a temporary halt on the intervention being made available on the market until further notice and was excluded. This resulted in the final list consisting of 29 top-funded digital mental health companies.

7 of the 29 interventions (24%) used a CA, with the most common purpose of use being education, which was seen in 6 of the 7 (86%) of interventions that used a CA. This was closely followed by assistance, training and onboarding which were each seen in 5 of the 7 (71%) interventions that used a CA. Only 1 (14%) intervention used a CA for questions and services. None of the interventions used CAs for the purposes of elderly assistance, diagnosis or prevention. Besides the one intervention that used a CA solely for onboarding purposes, the other 6 out of 7 interventions used a CA for multiple purposes. The combination of purposes of use of CA of assistance, training and education were prevalent in 5 of the 6 interventions that used a CA for multiple purposes. Table 2 shows a list of the 7 digital mental health intervention companies that use a CA, a description of the intervention they offer and how the CA is used.

Table 2: Description of intervention and CA use of the 7 out of 29 top-funded digital mental health intervention companies for depression.

<b>Top-funded companies</b>	<b>Description</b>	<b>Purpose of CA</b>
Happify	The Happify platform provides engaging activities and games that target overcoming negative thoughts, stress and life's challenges for better overall mental health.	Assistance, Training, Education,
Woebot	Woebot is an artificial intelligence based chat tool that is used as a delivery mechanism for a suite of clinically-validated therapy programs including psychoeducation, mood monitoring and in-the-moment guidance that target behavioural health domains such as sleep, grief and financial worry as well as clinical domains like depression, anxiety and substance abuse.	Assistance, Training, Education, Onboarding
Unmind	Unmind is a workplace mental health platform that aims to empower employees to measure, understand and improve their mental wellbeing through self-guided programs and in-the-moment exercises.	Education, Onboarding, Questions and Services
Shine	Shine describes itself as a daily self-care app rooted in Acceptance Commitment Therapy which provides daily meditations, journaling, mood tracking and the option to connect to an online community of users.	Assistance, Training, Education
My Online Therapy	The My Online Therapy platform offers matching services with a clinical psychologist relevant to users' specific needs, symptoms and circumstances, video or chat therapy with the matched therapist and evidence-based self-care tools.	Onboarding
Wysa	Wysa is an artificial intelligence based chat tool that "will listen and ask the right questions to help you figure things out". The platform also includes self-care tool packs that users can choose based on specific issues they are facing such as mood, anxiety, trauma, body image, sleep and loneliness.	Assistance, Training, Education, Onboarding
Youper	Youper is an artificial intelligence based therapy platform that supports users' mental health anytime and anywhere through "talking to Youper like texting a therapist or caring friend". Users start by completing a Mental Health Checkup to personalize Youper to their needs. There are options to set daily check ins and track and monitor symptom reduction.	Assistance, Training, Education, Onboarding

## 4 DISCUSSION

### 4.1 Principal Findings

The results of this analysis indicate that the scale at which conversational agent and chatbot technology is utilised by the 29 top-funded digital mental health intervention companies is rather low at 24%. Some parallels can be drawn with previous reviews of the features of CAs in mental health, particularly that training was reported to be a common use of CAs in digital mental health interventions and that mental health diagnosis was reported to be on the rarer side of CA usage purpose, or in the instance of this exploratory analysis, not used for this purpose at all (Abd-alrazaq et al., 2019). Differences were also seen, one being that while education was the most common use of CAs in this analysis, other reviews report education to be among the least common use of CAs in mental health (Abd-alrazaq et al., 2019). It should be noted however that this difference is only striking with regards to ranking and that looking at absolute values, the difference becomes much less stark with this study reporting 6 interventions that use CAs for education and the other reporting 4 (Abd-alrazaq et al., 2019).

### 4.2 Target Population

Interestingly, the finding that none of the chatbots were used for the purpose of elderly assistance mirrors the landscape of a lack of interventions for depression targeted towards geriatric populations, despite the high prevalence, poor prognosis and unique features that contribute to depression in this demographic such as age related diseases and frailty, loss of freedom and social isolation (Parker, 2015). This brings up a discussion on target populations, where with the exception of 1 of the companies using a CA targeted towards employees, the other 6 companies are not targeted towards any specific demographic.

It is well-established that the factors influencing the aetiology, expression and prognosis of depression differ in different populations such as in women (Albert, 2015), adolescents (Cheung et al., 2018) and dependent on different cultural backgrounds (Haroz et al., 2017). Individually-tailored internet-based or computerised cognitive behavioural therapy for depression where users navigate by selecting among pre-defined response options through which subsequent content is

tailored has been shown to be effective in reducing depressive symptoms in naturalistic community settings (Twomey et al., 2017). CAs can build upon this evidence as a useful tool to tap into these differences than exist between populations, to give tailored intervention for depression that meets individuals unique contexts and needs in a way that also addresses the benefits of communicating digitally in a human-like manner.

### 4.3 Therapeutic Application

The combination of assistance, training and education that emerged as a core set of purposes that featured in the CAs in this study can also be thought of as key elements in popular, evidence-based psychotherapies for depression in face-to-face and remote virtual settings such as cognitive behavioural therapy and mindfulness. This is in that these psychotherapeutic paradigms are largely focused on *education* in terms of psychoeducating individuals on the consequences of certain habitual patterns of thoughts, feelings and behaviours, *training* them to notice these patterns and providing *assistance* in implementing techniques to change maladaptive patterns into more adaptive ones that can help alleviate symptoms of depression and improve functioning (Beck, 2011)( Segal and Teasdale 2018). Indeed, reviews have supported that it is common for chatbots in mental health to be used to deliver therapeutic components rooted in cognitive behavioural therapy, mindfulness and other therapies, which also aligns with our findings (Tudor Car et al., 2020; Gaffney et al., 2019).

The finding that none of the CAs were used for prevention purposes is also in line with the current landscape, where the prevention of depression has been largely neglected in comparison to detection and treatment (Ormel et al., 2019). Reports have identified reasons for this lack of focus on prevention to be due to lack of targeting of proximal determinants of depression such as negative affectivity, low self-control and poor social and problem-solving skills as well as prevention of depression not being structurally and socially embedded (Ormel et al., 2019). These barriers are areas that CAs can potentially help to overcome, for example, in targeting proximal determinants that exist in the general population, structurally embedding prevention strategies at national levels through ease and cost-effectiveness of scalability and socially embedding through the relatability that comes with CA communication styles.

In relation to communication styles, although the mimicking of human-like conversation is widely reported as a benefit that CAs possess, evidence exists that may reflect otherwise, especially when sensitive information is being disclosed such as would be within mental health and depression. Specifically, not only was it reported that face-to-face interviews garnered less accurate responses that are higher in social desirability compared to the same questions presented via CA, but that CAs that gave more relevant and tailored responses to user input also increased socially desirable response bias compared to CAs that gave generic responses regardless of user input (Scheutzler et al., 2018). Other studies have also supported this notion through findings more relevant to mental health in that participants who were told that they were talking to a computer displayed more intense expressions of sadness than those who were told that the CA was controlled by a human (Lucas et al., 2014).

These insights should be taken into consideration when CAs are being used for therapeutic applications for depression as it may not serve users in terms wellbeing and therapeutic outcomes to compromise on the accuracy of their input in the interest of tailoring efforts. The key in this instance would be to determine the minimum amount of tailoring required for users to develop a therapeutic alliance with the CA without the CA reaching conversational capability levels that are too high and thus elicit less accurate socially desirable responses (Scheutzler et al., 2018). Miner et al., (2017) has concisely described these considerations as gaining a better understanding of users' "imagined audience" when discussing mental health with CAs which is highly unclear as opposed to a traditional in-person consultation where there is a concrete, visible audience to which the service users' impressions and expectations are attached.

#### **4.4 Limitations**

The interpretation of the findings of this investigation into the extent of use of CAs in top-funded digital mental health companies with interventions targeting depression should be taken with caution as there is a high level of variability in the operationalisation of the terms used to classify the purposes for use of CAs. For example, Abd-alrazaq et al. (2019) makes a distinction between CAs that provide therapy versus training, based on whether the CAs function is rooted in an established therapeutic paradigm for the former rather than

general skills training such as social skills or job interview skills for the latter. The same was seen in a review of embodied CAs in clinical psychology conducted by Provoost et al. (2017), where in addition to social skills training, the specific framework of cognitive behavioural therapy was in a category of its own. A reasonable explanation for such differences could be that these two reviews included interventions for autism, of which many are more focused specifically on social skills training compared to depression which does not necessitate such a distinction.

Additionally, the scope of this observational investigation only focuses on the purpose of use of CAs in digital mental health interventions targeting depression. It does not account for the many other different aspects of CAs that work together and can influence how effective their integration is on clinical and user experience outcomes. These include design characteristics such as whether or not the CA is embodied, duration of interaction with the CA, its speech and/or textual output, personality and aesthetic features like resemblance to human figures versus other non-human characters (Stal et al., 2020; Scholten et al., 2017). Existing randomised-controlled trials tend to look at each of these features in isolation from the others, which may not be able to capture the full picture of what makes a CA effective for a certain person with a certain condition at a certain time. Making use of optimisation approaches such as factorial trials, micro-randomised trials or system identification experiments can be useful in answering such questions, in order to maximise the effectiveness and reach of the unique benefits that CAs can bring to digital mental health interventions (Hekler et al., 2020).

#### **4.5 Conclusions**

Although numerous reviews have provided compelling support for the added benefits that integrating a CA into digital mental health interventions for depression can bring, industry uptake, at least at the level of top-funded companies, seems to be relatively low. Despite this, due to the nascency and the rapidly evolving nature of the field of digital therapeutics for depression and CA technology, one could expect the scale at which these CA tools are implemented to increase over the coming years, especially with trends such as the increased number of people who solely use technology without any in-person visits to address mental health concerns (Miner et al., 2017).

Identified areas where CAs can be of particular benefit include in addressing the differing needs that exist in the intervention of depression between different demographic groups as well as addressing intra-individual fluctuations through tailoring and in preventing depression through targeting its proximal determinants and embedding prevention structurally and socially through ease of dissemination.

Future research should look into the establishment of a taxonomy for categorising the purpose of use of CAs depression in order to facilitate communication and comparison. Another important aspect is in integrating different elements of CA design features to address a wider scope of determining the efficacy of CAs in digital interventions. Emerging digital interventions for depression would benefit from a collaborative approach between research and industry, using best practices from each sector to leverage on the potential that CAs may have on digital mental health therapeutics. In this regard, the level of rigor that is encompassed within research settings combined with industry business models that allow for rapid and vast dissemination of products lends itself well to using iterative design processes to investigate, conceptualise and ultimately create solutions that can meet the needs of underserved populations.

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