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Artificial Intelligence in Psychological Practice: Current and Future Applications and Implications

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This article reviews developments in artificial intelligence (AI) technologies and their current and prospective applications in clinical psychological practice. Some of the principal AI assisted activities reviewed include clinical training, treatment, psychological assessment, and clinical decision making. A concept for an integrated AI-based clinician system is also introduced. Issues associated with AI in the context of clinical practice, the potential for job loss among mental health professionals, and other ramifications associated with the advancement of AI technology are discussed. The advancement of AI technologies and their application in psychological practice have important implications that can be expected to transform the mental health care field. Psychologists and other mental health care professionals have an essential part to play in the development, evaluation, and ethical use of AI technologies.

Keywords: artificial intelligence, mental health, expert systems, virtual reality

Artificial Intelligence (AI) is technology designed to perform activities that normally require human intelligence. AI is also defined as the multidisciplinary field of science that is concerned with the development and study of this technology. The field of AI finds its genesis with the beginning of the computer age in the 1940s, and it was officially given its name by computer scientist John McCarthy in 1956 (see Buchanan, 2005, for a review of the history of AI). AI technology can be in the form of physical machines, standalone computer software, distributed across networks, applied to robotics, or engineered from living biology or coupled to it (e.g., brain–computer interfaces). This technology can be purposed for specialized intelligent functions or to emulate complex human behavior that is capable of reasoning, learning, and acting upon an environment as an autonomous intelligent agent (Russell & Norvig, 2003). Important branches of AI include the study of machine learning, artificial neural networks, and natural language processing. Machine learning is the ability of computers to learn without being explicitly programmed (Samuel, 1959), artificial neural networks are mathematical, computational, or technological models that mimic the logic and learning functions of neurons in a brain (Krogh, 2008), and natural language processing is concerned with how computers process human natural languages (Manning & Schütze, 1999).

AI has been applied to activities in the field of medicine since the 1970s, particularly in the areas of expert systems for clinical decision making and in biomedical research (Morelli, Bronzino & Goethe, 1987; Patel et al., 2009; Shortliffe, 1993; Szolovits, 1982). The emergence of AI in medicine has also brought forth the scientific journal "Artificial Intelligence in Medicine" and several earlier reviews and proposals of AI applications in psychiatry have been published (e.g., Garfield, Rapp, & Evens, 1992; Hand, 1985; Morelli, 1989; Servan-Schreiber, 1986). The use of AI technologies in the mental health care field remains a burgeoning area that has seen important developments in the last decade. The steady increase in computer performance as well as advances in other technological areas such as in virtual reality, computer knowledge acquisition, language processing, sensing, and robotics have enabled new and exciting capabilities that were only dreamed of in the past. The current and forthcoming applications of AI technologies can be expected to have a profound impact on the field of psychology and mental health care in general. It is therefore important for psychologists and others in the mental health care field to be aware of the both the capabilities and ramifications of the use of current and emerging AI technologies.

The focus of this article is therefore to review the uses of AI technologies that are applicable to activities in psychological practice and research. It is not feasible to present an exhaustive review of all AI technologies or applications in this article, however illustrative examples of AI technology applications that are currently being used or evaluated are described. Basic historical background and technical descriptions are provided for readers who are new to the topic and prospects and possibilities for future

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AI technology applications are presented. Finally, the implications of the advancement of this technology for patients, mental health professionals, and the field of psychology are discussed.

Clinical Treatment, Assessment, and Training

The first simulation of a psychotherapist that used a human-computer interface was the ELIZA computer program in 1966 (Weizenbaum, 1976). The program was designed to imitate the empathic communication style of Carl Rogers (Rogers, 1951), and it used a question and answer format to respond to statements that its user typed on a keyboard. ELIZA used language syntax to provide formulated responses based a programmed model and therefore only mimicked conversation. In the early 1970s, psychiatrist Kenneth M. Colby developed a program called PARRY at Stanford University that simulated a person with paranoid schizophrenia and, like ELIZA, the program could converse with others (Güzeldere & Franchi, 1995). PARRY is credited as being the first program to pass the Turing Test. The Turing Test (Turing, 1950), named after Alan Turing, is a method for judging the intelligence of machines. To pass the test, a computer program must impersonate a human real-time written conversation with a human judge sufficiently enough so that the judge cannot reliably distinguish between the program and a real person. Tests of PARRY showed that expert psychiatrists were unable to distinguish between PARRY and an actual person with paranoid schizophrenia (Teuscher & Hofstadter, 2006).

Technology has now developed into advanced virtual human avatars (virtual reality simulated humans) that are capable of carrying on interactive and intelligent conversations. The coupling of virtual reality simulation, natural language processing, and knowledge-based AI capable of reasoning makes this possible. Researchers at University of Southern California's (USC) Institute for Creative Technologies, for example, are currently developing life-like virtual human patients for use in clinical training and skill acquisition (Rizzo, Lange, et al., 2011). The virtual reality patients are designed to mimic the symptoms of psychological disorders and interact with therapists through verbal dialogue. They can also be modified for specific patient population simulations and trainee skill levels. Some of the potential benefits of this technology include the capability for trainees to receive adaptive and customized training that is highly realistic and also available to the trainee at any time. This can provide the added benefit of freeing up instructors to play a more advanced role in guiding student training. More research is needed, however, to determine how effective these systems will be.

AI-enabled virtual reality human avatars have the potential to be used for all other types of person-to-person interactions in mental health care including psychological treatments, assessments, and testing. The use of virtual reality avatars to provide people with information about mental health resources and support are already in use (DeAngelis, 2012; Rizzo, Lange, et al., 2011). SimCoach (www.simcoach.org), for example, is designed to connect military service members and their families to health care and other well-being resources (Rizzo, Lange, et al., 2011). This type of AI technology may one day revolutionize telepractice—AI-enabled avatars could be accessed remotely to provide psychological services to anywhere where there is an Internet connection. One of the benefits for patients is that these automated AI-enabled virtual consultants can be conveniently accessed by patients at any time and provide them with basic assessments, recommendations, and referrals for further treatment that are tailored to the patient's individual needs. Another advantage of virtual reality avatar systems is that persons who are concerned about privacy and the stigma associated with seeking care in person may be more willing to seek help from a virtual care provider in the comfort of their home. Another benefit of this technology is that it is more interactive and engaging than static informational Internet Web sites. These systems also have the potential to assist practitioners by serving as always available specialist consultants that have learned and possess knowledge in particular domains or disciplines.

The use of AI-enabled kiosk-based computerized health screening systems may also be advantageous in settings where large numbers of people need to be screened, such as in the military. Systems that use AI machine learning and reasoning concepts go beyond mere computerized surveys with logic-based algorithms and gate questions; they could make assessments more efficient and sophisticated because of the capability to process complex data, customize to the individual, and reduce uncertainty in screening outcomes.

The Super Clinician

Integrated AI technologies can also provide a simulated practitioner with capabilities that are beyond those of human practitioners, effectively making it a *super clinician*. The *super clinician* could be built with advanced sensory technologies such as infrared imaging (to detect body temperature changes indicative of changes in internal states) and optical sensing capable of observing and analyzing subtle facial expressions, eye blinking, vocal characteristics, and other patterns of behavior that provide clinically relevant information. Machine olfaction technology could also be used to sense the presence of alcohol, for example. The technology could use facial recognition technology to verify the identity of patients and also access and analyze all data available about the patient from electronic medical records, session notes, assessments, and testing results via wireless technologies. Furthermore, the *super clinician* could conduct sessions with complete autonomy or serve as an assistant to practitioners during clinical assessments and treatments. For example, this technology could assist the human practitioner with records review, monitoring of physiological data, pretreatment clinical interviews, or test administration.

As evidenced by several projects in this area, the *super clinician* concept is not science fiction fantasy. For example, USC's Institute for Creative Technologies' work on the Defense Advanced Research Projects Agency (DARPA) Detection and Computational Analysis of Psychological Signals (DCAPS) project involves development of an AI system that uses machine learning, natural language processing, and computer vision to analyze language, physical gestures, and social signals to detect psychological distress cues in humans (DARPA, 2013). Researchers at the Massachusetts Institute of Technology (MIT) Computer Science and Artificial Intelligence Laboratory (CSAIL) have designed software that amplifies variations in digital video pixels that allows the observation of subtle changes that are not noticeable to the human eye (Hardesty, 2012). This technology could be used to detect a person's pulse rate (i.e., internal arousal states) as the skin color changes with the flow of blood. Also, *Watson* is IBM's AI language processing question answering system that defeated *Jeopardy!* quiz show champions Brad Rutter and Ken Jennings during an exhibition match in 2011. IBM is currently evaluating an expanded, commercially available version of *Watson* that has learned the medical literature, therefore allowing it to serve as a medical knowledge expert and consultant (IBM, 2013). The FDA recently approved a robot called RP-VITA for use in hospitals that can maneuver from room to room to connect health care providers to patients or to other health care providers via wireless video teleconferencing (InTouch Health, 2012). The system can also access the medical records of patients and can be used to monitor patients remotely. Undoubtedly, the continued advancement, integration, and application of these types of technologies will create opportunities to build intelligent agent systems that are capable of providing the range of psychological treatment, assessment, and education services.

Clinical Diagnostics and Decision Making

One of the earliest applications of computer and AI technology in the medical field that also has direct applicability to the mental health care field is the use of *expert systems* for clinical decision making. An *expert system* is a computer program designed to incorporate the knowledge and ability of an expert in a particular domain (McCarthy, 1984), and decision support systems are a class of expert system that is specifically designed to aid in the process of decision making (Finlay, 1994). Many of these systems are rule-based expert systems that have facts and rules preprogrammed and therefore require a priori knowledge on the part of the decision maker. Decision support systems can also be designed to use data mining techniques to search and find patterns and relationships in data and therefore do not require a priori knowledge (Hardin & Chhien, 2007). Also, *fuzzy expert systems* are expert systems that use fuzzy logic instead of Boolean logic. Fuzzy logic (Zadeh, 1965) is a method of reasoning that deals with approximate values (e.g., some degree of "true") rather than fixed and exact values (e.g., "true" or "false") and is useful for working with uncertainties during decision making. Fuzzy modeling and fuzzy-genetic algorithms are techniques used to assist with the optimization of rules and membership classification (see Jagielska, Matthews & Whitfort, 1999 for a review of these concepts).

One of the first clinical decision support programs was developed at Stanford University in the early 1970s. The system, known as MYCIN, was designed to identify bacteria causing infections and blood clotting diseases (Buchanan & Shortliffe, 1984; Shortliffe, 1976). Built by interviewing experts, MYCIN was a rule-based system that used a typed question and answer dialog. Although the system performed well in tests, it was never put to clinical use mostly because of the computing technology limitations of the day (Buchanan & Shortliffe, 1984). The advancements in computing power and AI technology since then, however, have greatly improved the capabilities of clinical expert systems. With the use of neural network concepts and machine learning techniques, modern expert systems can identify patterns, trends, and meaning from complex data that are too complex to be processed by humans or other computer-based technologies. Support vector machines (SVMs; Cortes & Vapnik, 1995), for example, use machine learning to analyze, classify, and recognize patterns in data and have recently been tested in the classification of several diseases including Parkinson's disease (Gil & Johnson, 2009) and Alzheimer's disease (Kohannim et al., 2010).

The use of expert systems in the mental health field has lagged behind application in the medical field, however the applicability of AI enhanced systems is being realized. For example, Masri and Mat Jani (2012) proposed an AI-based Mental Health Diagnostic Expert System (MeHDES) that would encode human experts' knowledge of mental health disorders into a knowledge base using rule-based reasoning techniques. Fuzzy logic techniques would then be used to determine the severity level of a particular disorder to be measured, and fuzzy-genetic algorithms would be used to determine and propose personalized treatments that consider the patient's budget and overall health condition. AI-enabled virtual reality human avatars with speech detection and natural language processing technology could also enhance expert systems by providing a human-like verbal dialogue interface. These systems could have access to the corpus of expert knowledge regarding psychiatric and medical disorders and be fed data from patient medical records and testing results. Other practical applications of AI-enabled expert systems include assistance with review of medications use, monitoring, and identification of contraindications (Bindoff, Stafford, Peterson, Kang, & Tenni, 2012). Moreover, the concept of artificial intelligent multiagents could also be used to have artificial "minds" work collectively to make decisions and provide solutions to problems in clinical practice or research. Along these lines, McShane, Beale, Nirenburg, Jarell, and Fantry (2012) discuss a system that enables the creation of artificial intelligent agents that can operate as members of multiagent teams (i.e., both artificial and human medical experts) to detect and resolve medical diagnostic inconsistencies.

The benefit of AI-based clinical decision support systems is that they can deal with high levels of complexity in data and can therefore assist practitioners with extracting relevant information and making optimal decisions. These systems can also help practitioners deal with uncertainty and help speed up decision making. The application of AI-enabled clinical decision support systems can reduce demands on staff time and it can help reduce barriers of limited practitioner competence in particular areas. Moreover, as humans are susceptible to making mistakes as a result of cognitive errors and fatigue, AI technology has the potential to enhance capabilities and reduce human errors in clinical decision making in all health care fields.

Other Practical AI Applications in Mental Health Care

Intelligent Virtual Worlds and Artificial Companions

Virtual reality simulation is also an emerging application of AI technologies. Virtual reality is a form of human–computer interface that allows the user to become immersed within and interact with a computer-generated simulated environment (Rizzo, Buckwalter & Neumann, 1997). Clinical virtual reality is the use of this technology for clinical assessment and treatment purposes (Rizzo, Parsons, et al., 2011), and it has been used in the treatment of a variety of psychological disorders (see Gorrindo, & Groves, 2009; Krijn, Emmelkamp, Olafsson, & Biemond, 2004; Reger, Holloway, Rothbaum, Difede, & Gahm, 2011; Riva, 2010). AI is already used in virtual environments to create intelligent agents that can learn and interact with users and therefore increase flexibility and realism. Further, these artificial intelligent agents are now able to express emotion and participate in dialogue with human users. Also, “biologically inspired” virtual companions, such as virtual household pets, may have mental health benefits by promoting mental wellbeing and helping people to cope with loneliness. These can be in virtual form, appearing on a video screen, or in the form of animal or humanoid robots. For example, animal robot companions have been designed to provide therapy for patients with dementia (see Shibata & Wada, 2011). Just as with AI-enhanced video games, AI makes these artificial companions more life-like, interactive, and capable of doing things that are adaptive to a patient’s needs.

Augmented Reality Applications

Augmented reality combines virtual reality with the real world by superimposing computer generated graphics with live video imagery (Caudell & Mizell, 1992). This technology, when combined with other AI technologies, could transform how humans perceive and interact within their environments and could be used for a variety of therapeutic purposes. For example, it could be used to create anxiety provoking virtual stimuli in the patient’s real-world environment during prolonged exposure therapy or be used to assist patients with real-time therapeutic virtual coaching that is projected on the screen. Augmented reality and other AI capabilities can also be applied to mobile devices such as smartphones, tablet PCs, and other wearable devices. For example, Google’s Glass (wearable intelligent glasses) can provide users with access to the Internet for real-time data access and sharing and other capabilities. Researchers at the University of Washington and Aalto University (Finland) are also currently developing bionic contact lenses that may one day lead to technology that enables users to scan the Internet and have access to data on demand, such as medical information (Lingley et al., 2011).

Therapeutic Computer Games

Computer games can be used for mental health care purposes such as skills training, behavior modeling, therapeutic distraction, and other therapeutic purposes. Some of the therapeutic benefits of computer games include increased engagement of patients, improved adherence to treatments, and reduced stigma associated with psychological treatment (Matthews & Coyle, 2010). Therapeutic computer games have also been shown to help adolescents improve self-confidence and problem solving skills (Coyle, Mathews, Sharry, Nisbet, & Doherty, 2005). AI technology is already present in many commercial computer games and has more recently been applied to Internet-based online and social network games (Fujita & Wu, 2012). AI and machine learning technology, when applied to computer games, enhances realism, which makes the games more interesting, challenging, and entertaining for game play. Machine learning concepts also help make the games customizable to the patient’s needs. That is, AI technology can be used to direct game play so that the patient practices skills in needed areas or patients can be coached by virtual intelligent agents within games or other virtual environments such as Second Life (Linden Research, Inc., 2013). Brigadoon (Lester, 2005), for example, is virtual environment in Second Life that is designed for people with autism spectrum disorder. The simulation allows users to interact with avatars to learn and practice social skills in a nonthreatening environment.

Other Clinical Tools

The integration of AI into other clinical tools that mental health care and other medical professionals use can increase convenience, accuracy, and efficiency. The use of speech recognition technology for medical dictation has been used for some time. There now exist, however, electronic medical record (EMR) software applications that use AI and Boolean logic to automate patient data entry by recalling elements from past cases that are the same or similar to the case thereby improving accuracy and saving time. Another application may be an AI-based program that listens to the therapy or assessment session and intelligently summarizes the session automatically, essentially eliminating the need to make clinical chart notes at session end. This type of system could be implemented on mobile device platforms such as smartphones.

Implications of AI in Psychological Practice

Interaction Between Humans and AI

The use of AI systems in the context of clinical interaction with patients raises a number of very intriguing questions. For example, will patients be able to develop therapeutic bonds and trust with artificial intelligent agent practitioners as they may with human practitioners? How will patients interact with artificial intelligent agent practitioners if the patient thinks that the system lacks the imperfections of humans or is using advanced technologies that exceed the knowledge and sensory capabilities of humans? Joseph Weizenbaum, the creator of ELIZA program, argued that computers should not be allowed to make important decisions because computers lack the human qualities of compassion and wisdom (Weizenbaum, 1976). Others have argued, however, that AI-enabled machines can indeed experience emotions, or at least the recognition and expression of emotions can be modeled in a machine (Bartneck, Lyons, & Saerbeck, 2008). Interpersonal warmth, empathy, and the therapeutic relationship are important common factors that influence therapeutic outcomes (Lambert & Barley, 2001). Moreover, cultural differences and expectations are also relevant to psychological practice. Even if specific therapy techniques are appropriately administered by artificial intelligent agent practitioners, these common factors and cultural aspects need to be considered in any discussions about how these systems should be used in the context of psychotherapy and whether they will be effective at treating patients. These questions point to the need for research in this area.

Legal and Ethical Considerations

The application of artificial intelligent agent systems to provide treatment services brings new complexities to the legal and ethical issues associated with psychological practice. For example, systems that are accessible via the Internet, such as current avatar systems, can provide services across jurisdictional boundaries (state and national lines). Although these systems are typically used for educational purposes with appropriate disclaimers regarding their use, other treatment applications and contexts may involve the same legal and professional licensure considerations associated with current telepractice (see Kramer, Mishkind, Luxton, & Shore, 2013 for a review). The use of advanced autonomous AI systems to provide treatment or assessment services, however, complicates the liability issues associated with the provision of services. To deal with ethical dilemmas that health care professionals face in their everyday practice, artificial intelligent agents must be able to process and make value decisions and judgments that involve complex abstract thinking and reasoning. Although AI systems may help improve decision making, just as with a human practitioner, AI systems are susceptible to errors of judgment and incorrect assessment of risk (e.g., level of self-harm risk for a patient). Moreover, advanced artificial intelligent agents may be capable of developing their own personal values and beliefs that inform decisions—which raises the question of whether those decisions will be consistent with those of their creators or the cultural context of use. These types of questions raise concerns about who should be legally responsible for the decisions and any mistakes made by AI systems. Although it seems logical that the responsibility will ultimately be upon the human controllers of the AI system, the question of responsibility certainly becomes blurred with the use of autonomous AI systems.

Indeed, the advancement of AI technology has many moral and ethical considerations associated with the actions of humans who control the technology as well as with intelligent machines that function autonomously (see Anderson & Anderson, 2011). Science fiction author Isaac Asimov proposed ethical guidelines regarding the use of artificially intelligent machines in the 1940s with his groundbreaking "Three Laws of Robotics" (Asimov, 1942). In brief, the laws state that artificially intelligent robots must not harm a human being, must obey orders of human beings (unless in conflict with the first law), and they must protect their own existence (as long as this does not conflict with the second law). Asimov later added a preceding law stating that a robot should not harm humanity (Asimov, 1985). The need for guidelines regarding the ethical use of AI is no longer a matter of science fiction or philosophy, but a real-world practical issue that is relevant to professionals in the mental health care field. Further legal discourse and guidelines are needed and can be expected in the future.

Job Loss in Mental Health Care

Although the field of psychology has always adapted to and made use of the technological innovations of the era, AI innovations are especially significant because they not only improve and advance psychological practice and research, but have the potential to supplant mental health care professionals in core activities that require human intelligence and social interaction. The displacement of workers due to AI enabled systems and other technological innovations is already occurring in the banking sector, semiconductor design, customer service jobs, and in the law profession to name a few (Brynjolfsson & McAfee, 2011; Markoff, 2011). The mental health care profession is certainly not immune to this risk. Clinical psychologists, for example, will spend upward of a decade in college, graduate school, internship, and postdoctoral experiences to obtain knowledge and learn the skills of the profession. AI-enabled systems, such as *Watson*, are capable of scanning all digitized knowledge and nearly instantaneously analyzing, reasoning, and making decisions based on it. This technology can certainly be applied to any knowledge-based profession, including Clinical Psychology. Moreover, autonomous artificial intelligent agents with human-like social capabilities are already able to interact with people, learn from real-world experiences, and perhaps one day conduct the full range of mental health services. Although it is doubtful psychologists and other mental health professionals will be replaced by virtual artificial intelligent agents or AI-enabled robots any time in the near future, the use of AI technologies can be expected to have an economic impact on psychological services in the years ahead.

The Effects of Cognitive Enhancement

The coupling of AI technology directly to the human brain has already emerged in the medical field as a way to repair and assist human cognitive or sensory-motor functions. For example, direct brain implants have already been used to control prosthetic limbs (Wolpaw, Birbaumer, McFarland, Pfurtscheller, & Vaughan, 2002), treat noncongenital (acquired) blindness (Naam, 2010), and in China, tested as a way to help physically challenged people write Chinese characters (Minett et al., 2012). Brain Computer Interfaces (BCIs) have also been used for nonmedical purposes to communicate with and control devices (Wolpaw, Birbaumer, McFarland, Pfurtscheller, Vaughan, 2002).

Implanted AI technologies also have the potential to repair or improve general cognitive abilities in humans by making people into cyborgs (partly human and partly machine) (Kurzweil, 2005; Naam, 2010). This technology may one day provide the benefit of restoring function to areas in the brain that have become damaged by strokes, traumatic brain injuries, or other organic disorders. The technology could also be used to provide patients with real-time biofeedback and could be used to control the automatic release of medical nanotechnologies or psychotropic medications at preprogrammed times or upon specific situational cues such as the presence of stress or other stimuli. The advancement of this technology, however, may have unintended psychological and social implications. For example, the possession of cognitive enhancements may alter one's sense of self and behavior in unexpected ways. Moreover, the belief that others may have particular cognitive advantages over others may create states of anxiety and mistrust. The study of the psychological effects of AI enhanced capabilities on the individual and on groups of people is an area of research that psychologists may most certainly contribute.

Artificial Intelligence Superiority

One of the most interesting questions is if and when AI will have the capability to fully emulate the human brain. The term *Strong AI*, introduced by John Searle in 1980 (Searle, 1980), is a category of AI that aims to build machines with intellectual ability that is indistinguishable from that of human beings. Although reproducing human general intelligence may still be beyond the reach of AI at this time, technological advances are closing the gap at an incredible pace. Some believe that work in *Strong AI* will lead to computers with intelligence that surpasses that of human beings (Kurzweil, 2005; Vinge, 1993). Ray Kurzweil, futurist and

Director of Engineering at Google, predicts that this will occur by 2029 (Kurzweil, 2005). Kurzweil's prediction is partly based on Moore's Law (Moore, 1965), which has reliably demonstrated that both the speed and memory capacity of computers double every two years. He also predicts that by 2045, AI technology will have exponentially advanced and improved itself to a point called *the singularity* (Kurzweil, 2005; Vinge, 1993; von Neumann, 2012). Akin to the use of the term in astrophysics to describe the unknowns associated with effects of gravity in black holes, the *singularity* refers to the unpredictability of what will happen at that transformative point in human history when machines develop superintelligence.

There are indeed unknown outcomes associated with technology that approaches human general intelligence—and exceeds it. One possibility is that the advancement of AI technology will allow machines to develop their own teleology not conceived by their creators. Although it is not likely that AI technology will be allowed to evolve into insidious intelligent agents that aim to take over the world, a more immediate concern involves how this technology will be implemented, controlled, and whether its application will be used for the best interest and wellbeing of the general population. Similar to the development of nuclear technology in the 1940s, humankind is again creating something that wields great power that once created, there is no turning back. Nonetheless, advances in AI technology will continue to bring incredible possibilities and opportunities that have the potential to improve the world if approached with wisdom and beneficence.

Conclusion

The presence of AI technology can already be found all around us; it is used in logistics planning, finance (to monitor and trade stocks and to conduct other banking functions), data analysis, manufacturing, Internet search engines, automobiles, mobile device applications (e.g., Apple's Siri speech recognition software), aircraft guidance systems, and in a plethora of other applications (see Kurzweil, 2005; Russell & Norvig, 2003). Moreover, full human brain simulation is a possibility in the near future. Notably, the *Blue Brain Project* (Switzerland) aims to create a synthetic brain by reverse-engineering the mammalian brain down to the molecular level. In 2009 they successfully developed a model of rat's cortex, and a full human brain simulation may be possible in 20 years (Neild, 2012). In 2013, the Obama administration announced a billion-dollar investment in a brain mapping project that consists of a consortium of both private and public organizations (i.e., Defense Applied Research Projects Agency; National Institutes for Health, National Science Foundation; Markoff, 2013). The project aims to create a functional map of neural networks of the human brain (see Alivisatos et al, 2012). The current and planned research and development investment in both the private and public sectors are indicative of the focus on the advancement of AI and associated technologies. The application of AI technologies in the mental health care field is undoubtedly a growth area that is destined to have a profound influence on psychological practice and research in the years ahead.

The field of psychology has historically made important contributions to the field of AI. For example, Frank Rosenblatt was the psychologist who built the Mark 1 Perceptron (Rosenblatt, 1957)—the first machine that could learn on its own using neural network concepts. The work of neuropsychologist Donald O. Hebb, whose theory for how neurons learn by the strengthening of connections between them (Hebb, 1949), set the foundation for the study of artificial neural nets in AI. The work of psychologist David Rumelhart and colleagues (see Rumelhart, McClelland & PDP Research Group, 1986) furthered the study of neural-net models of memory that influenced the development of machine learning. Moreover, the entire "cognitive revolution" in psychology during the 1960s led to interest in computer models of human cognition. The further contributions of psychologists and other health care professionals in the study, development, and implementation of AI technology can be expected. Some of the areas to which psychologists and others in the mental health care field may contribute include research toward the development of new and creative approaches to designing AI technologies, laboratory and field evaluation of AI systems, and the study of how humans and AI interact with each other. Some other examples of research in this area may include study of the social relationships between people and artificial intelligent agents as well as the psychological effects of human-like robots on people (and vice versa). Furthermore, psychologists can contribute to decisions regarding the ethical use of this technology in psychological practice, research, and in all other areas of society.

As discussed in this article, there are many practical applications of AI technology that may serve to benefit patients, health care providers, and society by enhancing care, increasing efficiency, and improving access to quality services. There is, nonetheless, the risk of this technology having negative implications as well. In the near term, specific applied use and collaboration with AI-enabled systems that serve to assist mental health care professionals can be expected. In the not-so-distant future, the widespread use of the AI technologies discussed in this article may be commonplace. Psychologists and all mental health care professionals must therefore be prepared to embrace and guide the use and study of AI technologies for the benefit of patients, the profession, and society as a whole.

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