A study on the Construction and Optimization of a User Mental Health Application Based on the Background of Big Data

Min Tan[1,2], Xijing Chen[1, 2, *]

mailminmin@yeah.net;*chenxijing@psych.ac.cn

[1] Key Laboratory of Mental Health, Institute of Psychology, Chinese Academy of Sciences, Beijing, 100101, China.

[2] Department of Psychology, University of Chinese Academy of Sciences, Beijing, 101408, China.

Abstract. As digital technology continues to evolve and mature, mobile technology in particular is increasingly being adopted. Research is emerging on mobile applications that use mobile technology to provide mental health information to the population or for therapeutic intervention services for mental disorders. In the context of the development of Internet technology, mobile mental health services, which belong to the field of e-healthcare, refer to the provision of health care services or support on mobile devices such as cell phones and tablets, through text messaging or specialized apps to individuals with health problems such as stress, anxiety, depression, substance abuse, and so on. This paper argues from the urgency in the use of mobile apps for mental health education and mental disorder intervention, the current problems facing the development of mental health apps, the programs that have been used, and the possible programs to explore ways to improve the user engagement of mental health apps. And at the same time combined with the basic performance of big data algorithms for the study of research support, in the context of the existing Internet, the computer's big data base data support for psychological research to play a role in promoting the role.

Keywords- Internet technology; Big data support; Program building; Mental health; Program research

1 Introduction

Mobile mental health, as part of an eHealth care program, can facilitate the delivery of mental health services, in addition to the ease of use of mobile apps, which can be downloaded and installed for use by mental health care followers and patients anytime, anywhere [1]. Relevant studies have shown that professional psychological organizations and commercial companies have begun to provide mobile apps, however, user engagement, long-term usage, and the degree of matching the apps to the market demand are the key factors constraining the development of mental health apps. Combined with related research, mental health apps are apps that use mobile technology on mobile devices to provide professional mental health knowledge or therapeutic intervention programs for individuals who want to get mental health support and help [2].

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2 Technical support for related applications

2.1 Deep Learning Basic Concepts

2.1.1 Artificial neuron model

A neural network is a bionic technology that mimics the neural network of the human brain with a view to enabling artificial intelligence [3]. Schmitt R. Arbib et al. believe that the neural network of the human brain interacting with the outside world for information consists of three stages: perception, neural network and feedback [4]. The perception stage receives external stimuli through various human sensory cells and transmits them to neurons by means of bioelectricity; the neural network receives the input, learns from the external information, extracts the information and makes a decision; and finally reacts to the external world through feedback. Figure 1 illustrates the process of feedback from the human neural network to the outside world.

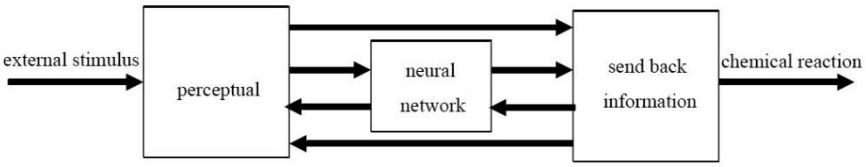

Figure 1. Human Neural Network Feedback Process

Among the three stages mentioned above, the biological neural network is the most crucial, realizing the extraction, learning and understanding of external information. Biologists have known that the basic building blocks of neural networks are neurons and sketched their constituent structures in the early 20th century [5]. A neuron contains multiple dendrites, an axon and multiple axon terminals [6]. In this, multiple dendrites act as signal inputs, axons act as signaling channels, and axon endings convert pulsations passing through the axon into excitatory or inhibitory signals, which act as signal outputs, as shown schematically in Figure 2. Complex neural networks are made up of large numbers of neurons, which enable the understanding of the external world.

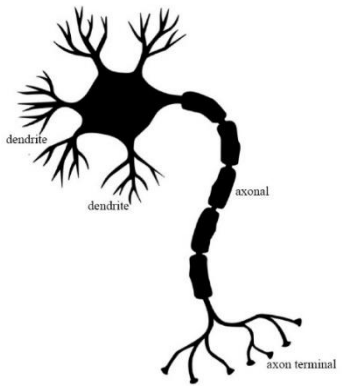

Figure 2. Schematic diagram of biological neuron structure

In order to model the functioning of biological neural networks, the first biological structures to be mathematically modeled are neurons [7]. In 1943, McCulloch, a psychologist, and Pitts, a mathematician, referred to the structure of biological neurons and proposed an abstract artificial neuron model (McCulloch-Pitts Model, MP model). After years of development, the mathematical model of artificial neurons has become quite mature [8]. Figure 3 illustrates the schematic structure of an artificial neuron.

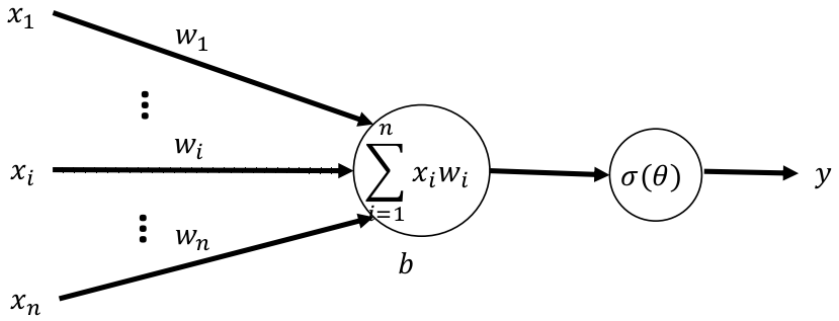

Figure 3. Schematic diagram of the structure of an artificial neuron

Assuming that the input dimension of an artificial neuron is n, the input vector is $x = \{x_1, x_2, \dots, x_n\}$, the weight matrix is a one-dimensional vector $\omega = \{\omega_1, \omega_2, \dots, \omega_n\}$, and the bias is b, the output y of this neuron can be expressed as:

$$\boldsymbol{y = \sigma(\theta) = \sigma(\sum_{i=1}^{n} x_i \omega_i + b)} \quad (1)$$

where σ is the artificial neuron activation function and θ is a variable parameter of the neuron, represented here as a weighted sum of input vectors with bias sums. In contrast to the original MP model, the model weights in Eq. (1) are variable between 0∼1, and the b bias value is added. This model is also known as Perceptron. The activation function in an artificial neuron model is generally taken as a nonlinear function, which allows the model to simulate more functions during training. In order to adapt to the requirements of different application scenarios on the model, the activation function σ is also extended from the threshold function (symbolic function) of the MP model to the more commonly used nonlinear functions such as the Simgoid function $\sigma_s(x)$, the tanh function $\sigma_t(x)$, and the ReLU function $\sigma_r(x)$. The mathematical representation is shown below:

$$\boldsymbol{\sigma_s(x) = \frac{1}{1+e^{-x}}} \quad (2)$$

$$\boldsymbol{\sigma_t(x) = \frac{e^{x}-e^{-x}}{e^{x}+e^{-x}}} \quad (3)$$

$$\boldsymbol{\sigma_r(x) = \begin{cases} x, x > 0 \\ 0, x < 0 \end{cases}} \quad (4)$$

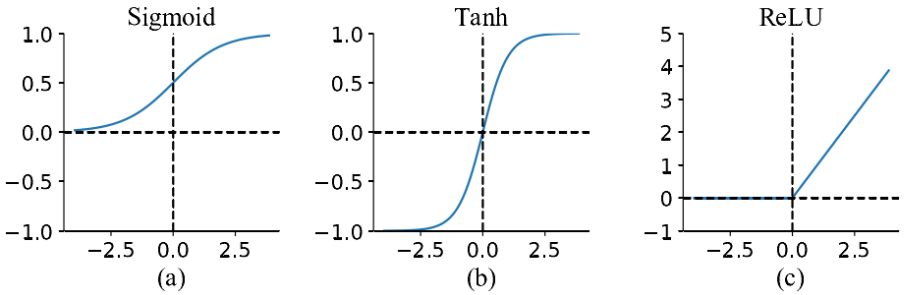

Figure 4. Three common activation functions (a) Sigmoid function; (b) Tanh function; (c) ReLU function

Based on Eqs. (2), (3) & (4), Figure 4 shows the waveforms of three common activation functions. The use of activation functions mainly considers the effect on data transformation and the change of gradient. In order to more intuitively judge the nonlinear transformation effect of the three activation functions on the data, this paper introduces two-dimensional data with dimensions D_1 and D_2 obeying the average distribution of [-10,10]. As shown in Figure 5, the data points are evenly distributed in the two-dimensional plane.

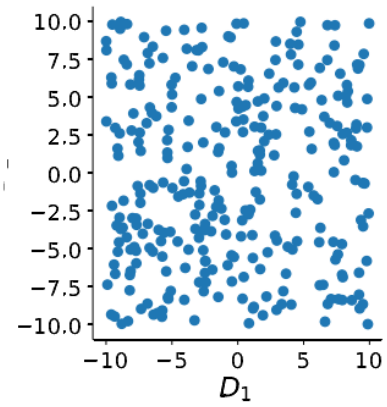

Figure 5. Scatterplot of 300 2D data obeying an average distribution

The 2-D data of the above figure is converted using Sigmoid, Tanh and ReLU activation functions respectively and the conversion is obtained as shown in Figure 6. As can be seen from Figure 6, the Sigmoid function has a more balanced distribution of data points compared to the other two functions, but the range of values is limited to between 0~1, while Tanh is sparse but has a wider range of values between -1~1. The distribution of ReLU is very balanced and takes a wide range of values after the conversion of the data points in the first quadrant, however, in the other quadrants the data points are pushed to zero, resulting in a great compression of the data. This shows that different activation functions have different effects on the conversion of data points. In addition, the gradient of different activation functions during neuron training needs to be taken into account [9].

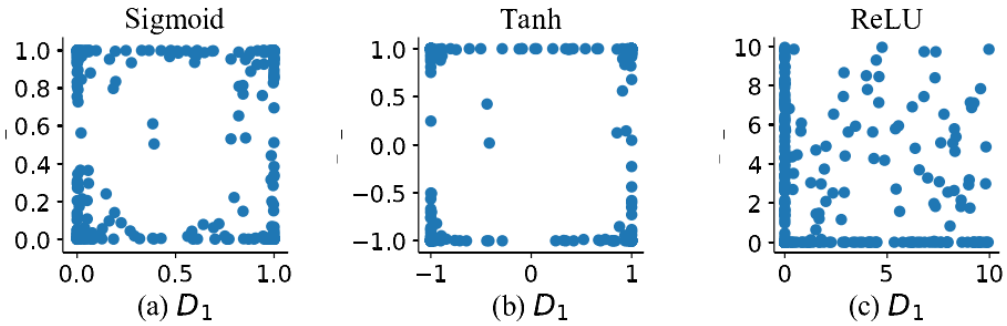

Figure 6. Effect of activation functions on data (a) Sigmoid function; (b) Tanh function; (c) ReLU function

3 Ways to increase user engagement

The ongoing status of the app can be demonstrated by (1) full integration of the app into eHealth cases and provider workflows, (2) a stable budget for app advertising, and (3) the number of downloads and versions of the app, which is likely to grow over time as well as the number of downloads and interactions.

Relevant research suggests that user engagement can be improved by (1) supporting real-time participation, (2) providing timely notifications of usage, and (3) providing gamified interactions.

A study on user engagement in mental health apps noted that effective ways to increase user engagement include:

(1) Within the application, health education information is provided;

(2) Involvement of users in the development of the application concept, application design and testing process;

(3) Ensure that clinician, or peer support is an integral part of the application;

(4) Embedding applications in different systems and settings where participants interact can increase user engagement and compliance;

(5) Allow users to easily download and install applications;

(6) Challenging tasks within the app that are set for a sufficient period of time to be psychotherapeutic and, in some cases, to help the user develop the habit of using the app, thus helping to produce a change in the user's behavior [10].

As the development of mobile application technology is becoming more mature and business applications are becoming more sophisticated, mental health apps can be used to increase user engagement not only by improving their own professionalism, accessibility, but also by referring to methods that have already been proven in the marketplace, which can be used in the following ways:

3.1 Big data combined with psychology

The arrival of the era of artificial intelligence and big data has opened a whole new door for psychological research. With the popularity of the Internet and a variety of smart wearable devices, virtual environments and real life continue to merge, and a variety of psychological and behavioural phenomena of people in the real world can be electronically recorded into big data to be saved, such as Internet access behaviour, social emotions, social attitudes, mental health problems and so on. Researchers use these data left by users to predict their personality traits or behaviours. Gosling et al. correlated the measurement of big-five personality (big-five) with Facebook-based self-reporting of online behaviours using personality results observed on online social networking sites and found that different dimensions of the big-five personality were significantly correlated to online behaviours; meanwhile, the Relying on modern lifestyles, especially online information dissemination and interpersonal interaction, has profoundly influenced and even changed people's psychological and behavioural characteristics, generating a series of brand new issues that need to be solved urgently, such as rumour dissemination, online instigation of group events, and internet addiction, etc. Zhou et al., in their study on predicting the development trend of social events by using social media in China, found that the group anger emotion would have an impact on collective behaviour, and that opinion leaders, participants, and the public would be more likely to be angry than the public. and that opinion leaders, social attitudes of participants, and the duration of events all play an important role in predicting the trend of online social events.

Big data not only brings new topics for psychologists in terms of research content, but more importantly, the combination of big data and artificial intelligence allows us to use ecological behavioural data, combined with artificial intelligence technology, to achieve automatic recognition of people's psychological indicators, i.e., ecological recognition, thus greatly expanding the scope of psychological research and application. Conroy et al. analysed the relationship between artificial intelligence big data and political participation and found that the use of new media on the Internet can increase the turnout rate and promote the enthusiasm of citizen participation. In addition, a researcher used the digital footprints left by users on the Internet to make predictions about their psychological traits and tried to push different types of advertisement graphs of uniform advertisements for users with different personalities, and the results showed that the click rate of advertisements pushed in this way increased by 40%.

Ecological identification refers to a non-contact psychological trait measurement method, using machine learning, to build a prediction model of psychological indicators, so as to achieve the automatic identification of psychological indicators of the subject. Compared with traditional psychological research methods, ecological identification has the following advantages: firstly, due to the characteristics of the data itself, longitudinal tracking at different time granularities becomes possible; secondly, the psychological state and behavioural performance of subjects before and after the occurrence of a major event and its changing law can be obtained through time retrospection, so as to conduct a quantitative research on the impact of the event, e.g. the use of social media to explore the impact of domestic violence on mental health, and understand the negative impact of domestic violence on mental health by analysing the mental health status in different time periods before and after domestic violence; finally, ecological identification does not rely on the subjective report of the subjects or the manipulation of the main subjects, so that the errors brought by the experimental conditions can be effectively avoided, and the

internal validity and external validity of the results of the study can be improved. In the following, we will introduce how to apply AI big data to psychology research mainly from the establishment of personality prediction models, then introduce the application in psychology practice through active suicide intervention as well as public opinion analysis, and finally discuss the ethical issues that need special attention.

4 Conclusion

The use of artificial intelligence big data technology can help us study the psychological and behavioural laws of individuals and groups in a more ecological way. Using behavioural big data to study people's cognitive, emotional and behavioural laws, combined with artificial intelligence to build psychological prediction models based on real-time social perception data, forming a correlation architecture between individual psychological and behavioural characteristics prediction and group psychological and behavioural analysis and decision support. The proposal of ecological recognition (ecological recognition) provides psychologists with new research tools and perspectives. It provides new possibilities for understanding personality, happiness, suicide intervention and even the analysis of hot social events in the network era. By penetrating into the behaviour and psychology of individuals and groups in different environments, it can help to achieve large-scale, real-time description, prediction, interpretation and control of people's mental health or social attitudes, so as to effectively prevent risks.

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