

# AI in Psychology

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**Abstract:** *In the world of psychology, diagnosis is the most important, time consuming and difficult activity. Diagnosis of mental health cannot have a fixed procedure or some tests that could always be run to get conclusive output. Without timely knowledge of the impairment, it is difficult to advise treatment. In some cases, the delay may worsen the situation. The speed of diagnosis is decided by the amount of experience a psychologist has in the field. Even so, it takes time for even highly experienced professionals to come to a conclusion on what exactly the patient is facing. Unlike other medical sciences, the data gathered by psychologists is almost always in words and experiences rather than numbers. This adds an additional layer of difficulty. Numbers are easier to look at while reading past reports and they provide a clear picture of any situation. The luxury of numeric data is scarce in the field of psychology. Artificial Intelligence systems are able to work on contextual data and can have the ability to 'Learn'. It is this ability that makes Artificial Intelligence systems the best option in aiding mental health diagnosis. It can be used as a tool to enhance and speed up the process of diagnosis with its ability to use historical data to make decisions and provide possible solutions. This paper gives an idea of how AI can be used to aid in diagnosis as well as treatment of mental health issues.*

**Keywords:** Treatment, Artificial Intelligence, Mental Health, Learning, Diagnosis, Data, Psychology, Psychotherapy, Pattern Recognition, EmotivEpic

## 1. Introduction

Psychology is the science of behaviour, mind, thought, and emotion. It deals with understanding the different processes of the human mind in various situations. It deals with conscious and unconscious phenomena. All these attributes of the mind are difficult to measure and keep track off. Even if they are measured, the results are uncertain and inconclusive. Psychotherapists explore behaviour and mental processes like perception, cognition, attention, emotion, intelligence, motivation and personality. They usually have sessions with the patient in which they gather data by talking to them about their problems and experiences. It takes quite a few sessions before a decision about diagnosis can be made. [1] In the "Handbook of psychotherapy and behaviour change" chapter "The efficacy and effectiveness of psychotherapy", Michael Lambert reviews relevant publications and concludes (p.204) "Therapy is highly efficient for a large minority of clients, perhaps 30% of whom attain a lasting benefit after only three sessions." and when monitoring for "reliable improvement ... it appears 50% of patients respond by the 8th session and 75% are predicted to need at least 14 sessions to experience this degree of relief." The terms used here "lasting benefit" and "reliable improvement". These terms are analogous to "feeling better" and not "full recovery" which may take even more time to accomplish.

There may not be a way to reduce the number of sessions a person may need because that is entirely a personal choice for that person after a certain point in time. However, the experience of both the patient and the psychologist can be enhanced by using an AI tool. The time to diagnose can also be reduced. AI deals with Fuzzy Logic which makes it an optimal way to deal with the data being generated by diagnosis. Over time the system will become smarter, and will be able to offer much more precise solutions to the user. Pattern recognition and historical data analysis will further help the cause. With networked intelligence, the

system may also be used to collect the experiences of all professionals using the system. These experiences can then be shared so that the user can get an overview of similar cases his peers might have faced. The system can be made to be extremely scalable using cloud technology. All in all, the system can continuously grow over time.

### 1.1 Literature Review

AI systems are used in limited capacity in the field of psychology. Chat Bots are used in helping patients relax and have someone to talk to. These bots have limited functionality and can only help so much. This paper proposes a solution which can easily have Chat Bots as an add-on to it. The data that will be gathered by the system can be used in great measure to create different tools to help in various fields of psychology. It will be a step further in understanding the wonder that is the human mind. Various aspects of psychology like research, medication, and therapy will be benefitted from such a system. It will also provide a central platform for all related activities as the community continues to grow. The possibilities are endless when AI technology is used in conjunction with Data Mining and Pattern recognition techniques.

## 2. Problems with mental illness diagnosis

Diagnosing mental illnesses is a difficult task as each patient has a unique background. Each patient's past experiences, personality traits and treatment history factor into the process. Due to the diverse nature of the cases, there is no single best practice or methodology for psychological diagnosis. The vast amount of contextual parameters makes it even more difficult to analyse. It also depends in what condition is the patient is in while being diagnosed or tested. Each professional ultimately has their own take in diagnosing mental illnesses which comes by experience.

## 2.1 Artificial Intelligence

Artificial Intelligence technologies allow machines to learn and make decisions based on that information in real time. AI technology was made to imitate the human mind in machines. Since the base of AI itself is the human mind, it becomes that much easier to make a system which helps one understand the human mind. The most important feature of an AI system is its ability to learn. An AI will never make the same mistake again. It remembers the way things are done and finds an optimal way to do them over time. AI technology works on Fuzzy Logic which makes it an excellent choice for mental illness diagnosis as the data it produces is essentially fuzzy.

### Fuzzy Logic

[2]Fuzzy Logic is a form of many-valued logic in which the truth values of variables may be any real number from 0 to 1. Basically it handles the concept of partial truth. In Fuzzy Logic, the truth values range from completely true to completely false. Classical logic only permits conclusions which are either true or false. However, there are also propositions with variable answers, such as one might find when asking a group of people to identify a colour. In such instances, the truth appears as the result of reasoning from inexact or partial knowledge in which the sampled answers are mapped on a spectrum.

Both degrees of truth and probabilities range between 0 and 1 and hence may seem similar at first, but fuzzy logic uses degrees of truth as a mathematical model of vagueness, while probability is a mathematical model of ignorance. While variables in mathematics usually take numerical values, in fuzzy logic applications non-numeric values are often used to facilitate the expression of rules and facts. A linguistic variable such as age may accept values such as young and its antonym old. Because natural languages do not always contain enough value terms to express a fuzzy value scale, it is common practice to modify linguistic values with adjectives or adverbs. For example, we can use the hedges rather and somewhat to construct the additional values rather old or somewhat young.

Fuzzification operations can map mathematical input values into fuzzy membership functions. And the opposite defuzzifying operations can be used to map a fuzzy output membership functions into a "crisp" output value that can be then used for decision or control purposes.

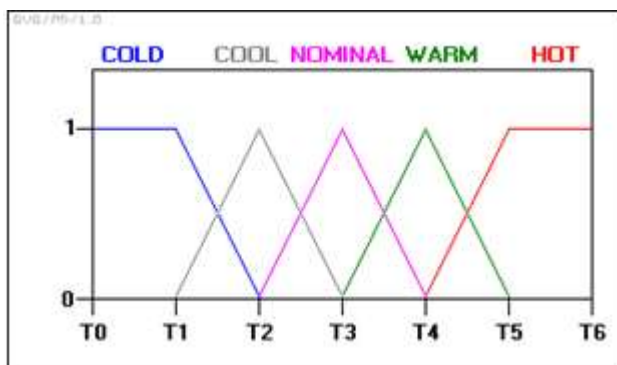


Figure 1: Fuzzy Temperature values

As shown in the above diagram, the temperature values are divided into the linguistic variables of Cold, Cool, Nominal, Warm and Hot.

### Fuzzy Logic in Psychology

The data generated in by a psychologist is almost completely textual information. This information can be used as linguistic variables in Fuzzy Logic.

For example, a patient may be asked a question such as "Are you afraid of darkness?" to which, the answers obtained could be:

- Not Really
- A bit, yes
- Yeah a little
- Yes
- Yes very much!
- Cannot bear the thought of darkness

Using Fuzzy Logic will greatly enhance the way data is processed and it can also be used as a quantifier for textual data.

## 2.2 Artificial Intelligence in Psychological Diagnosis

[3]Current estimates indicate that 50% of the population experience at least one mental disorder in their lifetime and that at least 25% have suffered a mental disorder in the past year. Recognition, diagnosis, treatment, and referral depend overwhelmingly on general practitioners, at least one third of whose consultations have a direct and explicit psychological component. Yet despite this intensive familiarization with the presentation of mental pathology, and the appropriateness of the primary care setting to its management, even the most recent surveys indicate that performance is best described by the rule of diminishing halves: only half the patients with a thresh-old disorder are recognized; only half of those recognized are treated; and only half of those treated are effectively treated. There is no single solution to this problem, only multiple solutions, which must be aimed, consistently and simultaneously, at the patient, practitioner, practice, and research levels.

AI systems can be used to recognize and remember patterns and also make decisions on them. This feature is extremely useful while diagnosing mental illness. Over time, the data collected by the AI can be used to make quick decisions as the pattern recognition system becomes stronger and stronger.

For example, consider a patient suffering from Schizophrenia. Schizophrenia is a mental disorder which causes hallucinations. A person suffering from Schizophrenia will almost always believe that their hallucinations are reality and that they do not need psychological aid. There are a series of common questions that may be asked to a person suspected to be facing Schizophrenia. The answers to these questions and the observation of the psychologist decide whether the case is true or not. Many variables factor into this and also decide the severity of the case.

In this case, the AI will be able to figure out with precision how severe the case is and can also suggest steps to help out

the patient. It will also improve the diagnosis time. Over time, as few as a single session will be needed for the diagnosis of the problem.

### 2.3 Pattern Recognition

Pattern Recognition combined with AI can help in predictive analysis of mental health issues. All mental illnesses have symptoms that more or less form a pattern. These patterns can be fed to the AI in training stage so that it is able to classify the illnesses that can result from the symptom patterns.

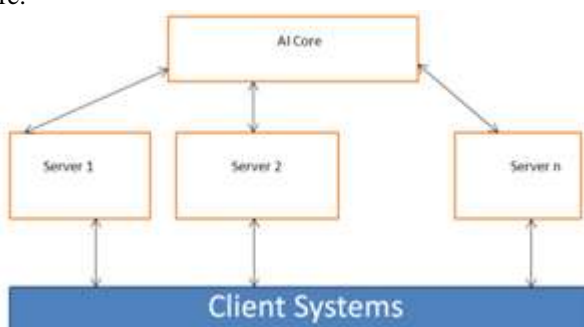
Most symptoms of mental illnesses can overlap. This is where the precise and continuously evolving nature of AI pattern recognition shines. As more and more cases are recorded, solutions are produced faster. Comparing past cases with the ones at hand can give the psychologist a clear idea about what he/she is dealing with. Although not completely similar, it can reduce the work and analysis required by a great factor. In short, the psychologist will not have to start from scratch every time.

The system proposed can be implemented as a website and a web service for ease of access. This also enables data gathering from many sources which will allow the AI to develop faster. The AI will learn from its users and provide the processed information gathered. Information from all users can be used as a training set in the initial stages of implementations. As the training will proceed, the AI will be able to provide more and more precise solutions to its users based on data it has already gathered and learned from.

### 2.4 Architecture of Proposed System

The AI Core will be a central system working independent of the servers. The AI will receive data from the servers and provide information based on client requests. The data received from the servers will be anonymous to protect patient identity. The AI Core itself will be running on a dedicated server to improve performance. The more users there are in the system, the faster it will grow. The AI Core server will contain applications which will service requests for the AI core based on its data and also to gather data from the servers.

The servers which communicate with the client will have an application responsible for the system that will be visible to the user and another which will communicate with the AI Core.



**Figure 2:** Overview of the System

### 2.5 Helpful Devices

Many devices have been developed to scan brain activity in the past few years. These devices aim to make brain scanning activities more accessible. Earlier the only way to perform a brain scan was MRI. MRI is an extremely costly setup and is cumbersome to use. New devices in the market are much smaller, portable and cheap.

[4]Emotive Epoc+

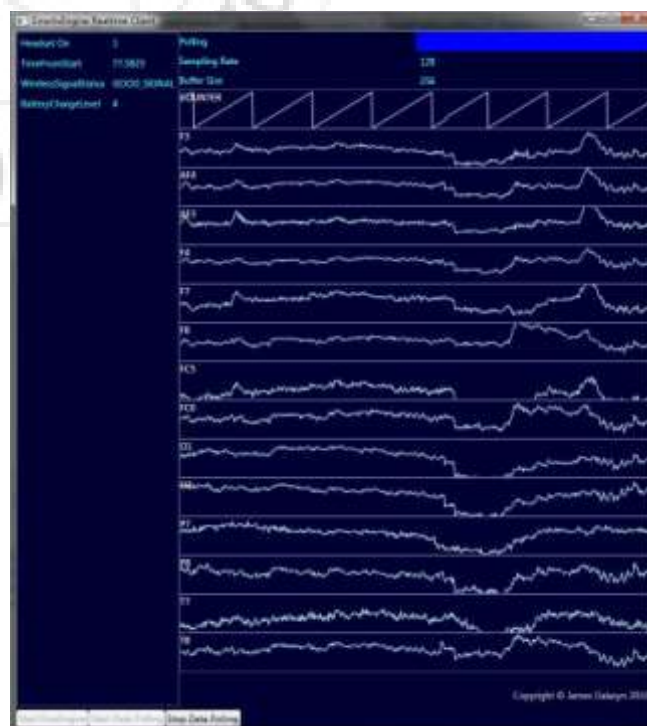
Emotive Epoc+ is a Neuroheadset and Scientific Contextual EEG offering high resolution and full spatial resolution. It is designed for contextualized research and advanced brain computer interface (BCI) applications.

#### The Emotive Epoc+ headset



**Figure 3:** The Emotive Epoc+ Device

Emotive Epoc+ has its own subscription based API which can be used to integrate the application into various programming software. It provides a visual feed across all its sensors in a graphical format. This is an ideal way to gather data and create patient cases based on them. The data can then be converted and packaged into an optimized data structure which the AI will be able to work upon. The most important feature this data will give is the ability to compare and contrast different cases on a deeper level. It will help the AI sort out the miniscule differences in different cases and why they are present.



**Figure 4:** EmotivEpoc Real-Time output

### Visual output from the Emotive Epoc Client

Each node represents a different part of the brain. Different parts of the brain are responsible for different thought processes. This is invaluable in the case of Psychology and can give a deeper understanding of the patient's condition. Having an AI harvest all this data and record it will provide additional functionality to the system. The data can then be mined for patterns and hidden information. The data can also be associated with a specific symptom or illness and can be attached to a patient's case. This will allow the AI to further contrast and compare symptoms, impact and progress rate of a patient.

### Proposed Ways to utilize device:

- Use the device at each session if possible.
- The device should be active and recording data in psychotherapy sessions
- The data gathered by the device should then be sent to the AI system to record and process it based on its learning algorithms.
- As time goes by, the AI will be able to provide solutions by comparing the person's brain activity per assessment by the Psychologist.
- The data can be visualized to further help the Psychologist to track the status of the patient throughout his/her treatment.
- Through this, the psychologist may also be able to answer the question of "How many sessions are enough?" for a particular patient based on the readings.

When used properly, devices such as the EmotiveEpoc+ can generate large amounts of useful data which can then be used for mining and comparison by the AI. The more people use the system, the smarter the AI will become.

The AI will work on 2 data sets which will be produced per session.

- 1) The Psychologist's evaluation data
- 2) Data produced by the device

The system will keep track of sessions as well. The sessions for a particular person will be stored in such a way that they can be identified by Case ID. There will be no mapping in the system for Case ID ->Person to protect patient anonymity. Only the concerned professional will have that data stored for him in encrypted format. The data used by the AI will always be anonymous.

### 2.6 Challenges

The main challenge faced in this solution is coding the AI properly. The AI should have the capability to mine data, recognize patterns and provide precise decisions based on the data sets it will be receiving. For this purpose, an optimized data structure will have to be decided upon which can help the AI achieve these goals. As in all AI Systems, the system will need a training period in which it will simply collect data and learn. After the training period, it will have to be examined by professionals on a regular basis even after being put into production mode. Corrections may have to be made in between to further optimize the AI. The infrastructure needed to house the AI will have to be maintained properly.

### 3. Conclusions

Artificial Intelligence was made so that machines could mimic human thoughts and decision making. This makes them the perfect solution to a problem such as this. Using the AI, we may yet uncover even more secrets of the Human Mind. This newly found information could also be used to improve AI and a cycle of continuous improvement can be made possible.

The system proposed is designed to be scalable and extensible. Chat bots could be introduced into the system which can use the vast data gathered by the system to help patients with their problems. This could be helpful when a professional isn't available to said person. With AI, the possibilities are endless. Upgrades to hardware as well as the AI software can be used to make the system even more efficient and precise.

An environment can be created where all the tasks a psychologist needs to perform can be done by the environment and all the patient has to do is sit in a chair and talk. Automatic data recording will further speed up the process. Speech recognition programs may also be able to point out the emotion in the patient's voice such as desperation and fear. They can be added as a 3rd dataset to enhance the capabilities of the AI.

### 4. Acknowledgement

The authors can acknowledge any person/authorities in this section. This is not mandatory.

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