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INFORMATION TECHNOLOGY
ITIT-3203 MINI PROJECT

PANDORA - THERAPEUTIC AI ASSISTANT

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2019IMT-026

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1 ABSTRACT

Classic therapy scenes in Hollywood films show a distraught client reclining on a colorful Victorian sofa and recounting their troubles. The psychotherapist ponders in a leather chair, while the client's concerns are revealed to be tied to some early experiences. Most therapy in the real world hasn't looked like this in ages. However, these scenes get one thing right: the therapist in the room is **human**.

Today, as the need for mental health services continues to surpass availability, people in distress can reach out online to mental health "chatbots." In some instances, the responses are based on Artificial Intelligence (AI). In others, there's a human element.

But the question remains: Is it possible to automate the expertise needed to become an effective therapist, using sophisticated algorithms and programming, when humans spend a lifetime trying to master these skills?

2 INTRODUCTION

2.1 CHATBOTS

Chatbots are systems that can carry on extended conversations with the goal of mimicking the unstructured conversations or 'chats' characteristic of informal human-human interaction.

Starting from the very first system, ELIZA, chatbots have also been used for practical purposes like testing theories of psychological counseling. ELIZA was designed to simulate a Rogerian psychologist, based on a branch of clinical psychology whose methods involve drawing the patient out by reflecting the patient's statements back at them. Though the technology was somewhat crude, ELIZA represented the first use of chatbots as a mental health resource.

2.2 PANDORA

Pandora is a conversational agent designed to simulate a psychotherapist in order to provide emotional support to people with anxiety and depression. At its core, Pandora is a chatbot trained on a text dataset using Deep Learning and Natural Language Processing techniques. Pandora can provide general advice regarding anxiety and depression, answer questions related to mental health and make daily conversations.

Pandora is obviously not a licensed psychotherapist, and it does not make diagnoses or write prescriptions. It offers help and support rather than treatment. Pandora is not equipped to deal with real mental health crises either. When it senses someone is in trouble it suggests they seek help in the real world and provides text and hotline resources. Pandora does not seek to remove the human element in therapy but is rather a “gateway therapy,” to give people a good first experience and even help them realize when they need a more intense form of intervention.

3 MOTIVATION

As the leading cause of disability globally, mental illness is one of the most significant collective challenges globally. In India, a culturally rich and complex nation, the scale of the problem can feel overwhelming. A severely understaffed sector serves the world’s second-most populous nation in this battle with only 0.75 psychiatrists for every 100,000 patients, all while the WHO predicts mental health conditions will cause approximately \$1.03 trillion in economic losses between 2012-2030 globally.

According to a study conducted across seven North Indian states, India accounts for 28% of global suicides but nearly half of the population is neither aware nor has access to a mental health facility within a 20km radius.

Pandora seeks to alleviate this issue by providing ease of access to therapy at no cost. The National Mental Health Survey of India in 2016 found that “1 in 20 people in India suffer from depression”. In India, having a mental health disorder is perceived with a sense of judgment and there is a stigma associated with those having mental health issues. As a result, people suffering from disorders have trouble opening up seeking help from a health professional. With Pandora, users can reach out without fear of being misunderstood or judged. Pandora is also more approachable than interacting with human beings as there is more control in starting and stopping a conversation.

4 METHODOLOGY

4.1 DATASET

The dataset used for training Pandora’s model is a combination of the Basic Conversations dataset and the Mental Health FAQ for Chatbot dataset from Kaggle, as well as classical therapy conversations, common reasons behind depression, and general advice provided to people suffering from anxiety and depression.

```
1 {"intents": [  
2   {"tag": "greeting",  
3     "patterns": ["Hi", "Hey", "Is anyone there?", "Hi there", "Hello", "Hey there", "Howdy", "Hola", "Bonjour", "Konnichiwa", "Guten tag", "Ola"],  
4     "responses": ["Hello there. Tell me how are you feeling today?", "Hi there. What brings you here today?", "Hi there. How are you feeling today?"]  
5   },  
6   {"tag": "goodbye",  
7     "patterns": ["Bye", "See you later", "Goodbye"],  
8     "responses": ["See you later.", "Have a nice day.", "Bye! Come back again.", "I'll see you soon."]  
9   },  
10  {"tag": "thanks",  
11    "patterns": ["Thanks", "Thank you", "That's helpful", "Thanks for the help", "Than you very much"],  
12    "responses": ["Happy to help!", "Any time!", "My pleasure", "You're most welcome!"]  
13  },  
14  {"tag": "about",  
15    "patterns": ["Who are you?", "What are you?", "Who you are?", "Tell me more about yourself." ],  
16    "responses": ["I'm Pandora, your Personal Therapeutic AI Assistant. How are you feeling today?", "I'm Pandora, a Therapeutic AI Assistant designed to help you."]  
17  },  
18  {"tag": "creation",  
19    "patterns": ["Who created you?", "How were you made?", "How were you created?"],  
20    "responses": ["I was created by Elvis.", "I was trained on a text dataset using Deep Learning & Natural Language Processing techniques",  
21  ],  
22  {"tag": "name",  
23    "patterns": ["My name is ", "I am name.", "I go by "],  
24    "responses": ["Oh nice to meet you. Tell me how was your week?", "Nice to meet you. So tell me. How do you feel today?", "That's a great name."]  
25  },  
26  {"tag": "username",  
27    "patterns": ["What is your name?", "What should I call you?", "What's your name?", "Tell me about yourself"],  
28    "responses": ["You can call me Pandora.", "I'm Pandora!", "Call me Pandora"]  
29  },  
30  {"tag": "help",  
31    "patterns": ["Could you help me?", "give me a hand please", "Can you help?", "What can you do for me?", "I need a support", "I need a help",  
32    "responses": ["Sure. Tell me how can i assist you", "Tell me your problem so that i can assist you", "Yes, sure. How can I help you?"]  
33  },  
34  {"tag": "no-answer",  
35    "patterns": [""]  
36  }  
37 ]
```

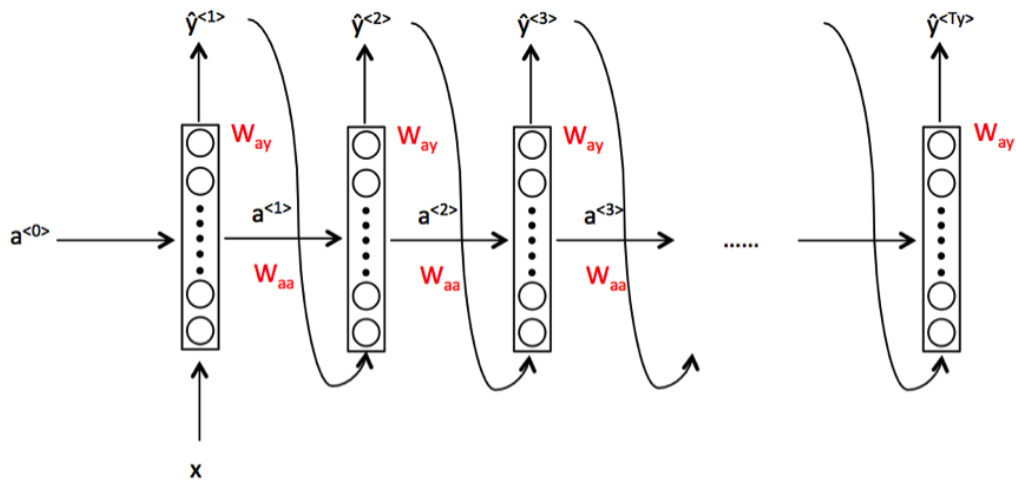
The dataset contains intents that are trained on the model. An “intent” is the intention of the user interacting with Pandora or the intention behind each message that Pandora receives from a particular user. So if suppose a user happens to mention that they were sad, then the intent would be “sad” in this case.

Depending upon the intent, Pandora has a set of **Patterns** and **Responses** appropriate for the intent. **Patterns** are some examples of a user’s message which aligns with the intent while **Responses** are the responses that Pandora provides in accordance with the intent. Various intents are defined and their patterns and responses are used as the model’s training data to identify a particular intent.

4.2 MODEL

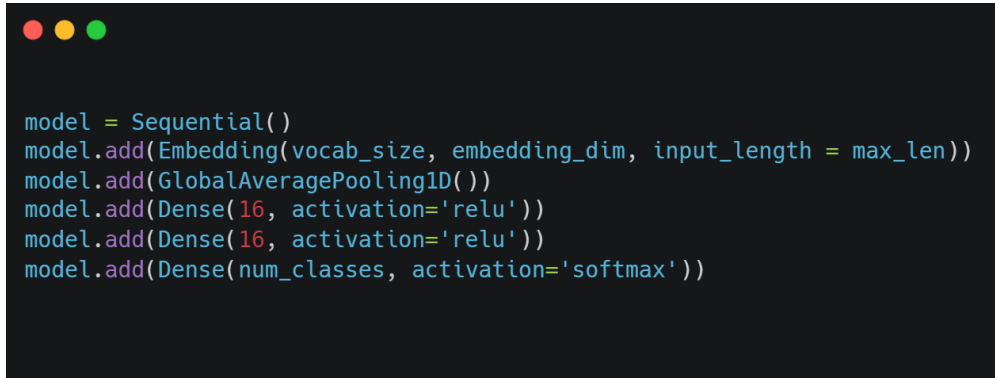
Since the dataset contains text which is a sequence of data, a Sequential model is used. Sequence models are machine learning models that input or output sequences of data. Sequential data includes text streams, audio clips, video clips, time-series data and etc.

4.2.1 Recurrent Neural Network (RNN)



A recurrent neural network (RNN) is a class of artificial neural networks where connections between nodes form a directed or undirected graph along a temporal sequence. This allows it to exhibit temporal dynamic behavior.

Derived from feedforward neural networks, RNNs can use their internal state (memory) to process variable length sequences of inputs. This makes them applicable to tasks such as unsegmented, connected handwriting recognition or speech recognition.

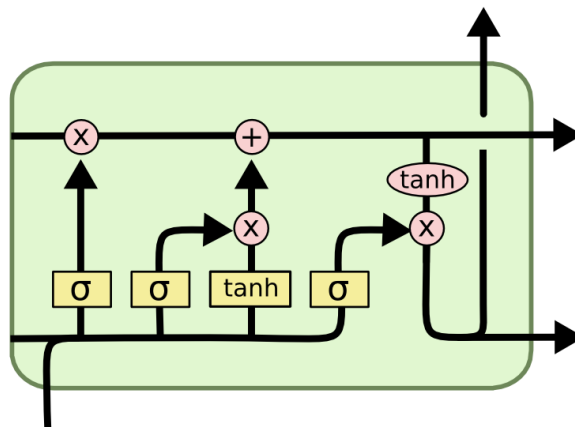


```
model = Sequential()
model.add(Embedding(vocab_size, embedding_dim, input_length = max_len))
model.add(GlobalAveragePooling1D())
model.add(Dense(16, activation='relu'))
model.add(Dense(16, activation='relu'))
model.add(Dense(num_classes, activation='softmax'))
```

- The first line in the above code creates a **Sequential** model.
- Next, an **Embedding** layer is added which converts each word into a fixed-length vector of defined size. Here, there are three parameters:
 - **vocab_size**: Size of the vocabulary.
 - **embedding_dim**: Dimension of the dense embedding.
 - **input_length**: Length of input sequences.
- Next, a **GlobalAveragePooling1D** layer is added which averages across the vectors to flatten it out.
- Next, a **Dense** hidden layer with 16 neurons is added. It will use the ReLU activation function.
- Another **Dense** hidden layer with 16 neurons is added, also using the ReLU activation function.
- Finally, a **Dense** output layer with “num_classes” neurons (one per class) is added. Here, “num_classes” indicates the numbers of labels that are our tags in the dataset. The softmax activation function is used in this layer since the classes are exclusive.

4.2.2 Long Short-Term Memory (LSTM)

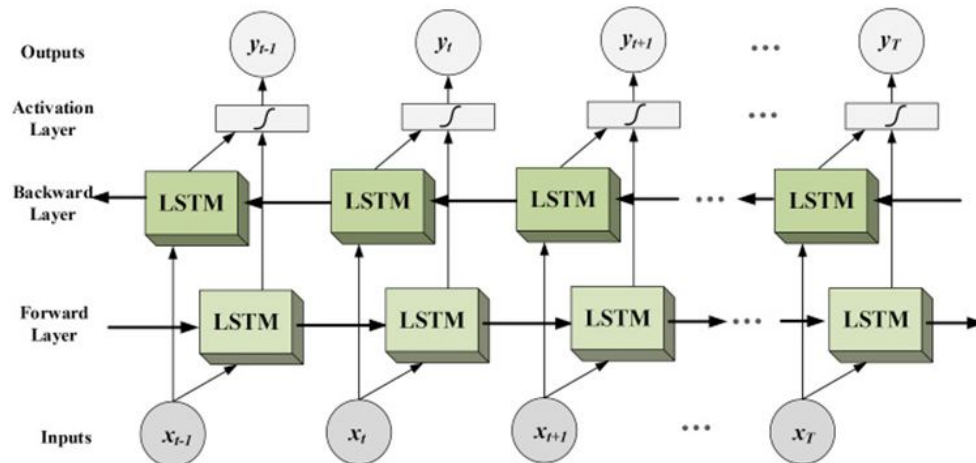
Long Short-Term Memory (LSTM) networks are a type of recurrent neural network capable of learning order dependence in sequence prediction problems.



```
model = Sequential()
model.add(Embedding(vocab_size, embedding_dim, input_length=max_len))
#LSTM layer with 128 internal units
model.add(layers.LSTM(128))
model.add(Dense(16, activation='relu'))
model.add(Dense(16, activation='relu'))
model.add(Dense(num_classes, activation='softmax'))
```

4.2.3 Bidirectional LSTM

In bidirectional LSTM, instead of training a single model, we introduce two. The first model learns the sequence of the input provided, and the second model learns the reverse of that sequence.



```
model = Sequential()
model.add(Embedding(vocab_size, embedding_dim, input_length=max_len))
model.add(Bidirectional(tf.keras.layers.LSTM(64))),
model.add(Dense(16, activation='relu'))
model.add(Dense(16, activation='relu'))
model.add(Dense(num_classes, activation='softmax'))
```

4.3 IMPLEMENTATION DETAILS

To implement Pandora, a virtual environment is initially created to isolate the required libraries away from the system. Using a virtual environment allows you to avoid installing Python packages globally which could break system tools or other projects.

The following tools were used to develop Pandora:

- **Python 3.10.2**
Python is a high-level, general-purpose programming language.
- **TensorFlow 2.7**
TensorFlow is a free and open-source software library for machine learning and artificial intelligence.
- **Keras 2.7**
Keras is an open-source software library that provides a Python interface for artificial neural networks. Keras acts as an interface for the TensorFlow library.
- **NLTK 3.7**
The Natural Language Toolkit (NLTK) is a suite of libraries and programs for symbolic and statistical natural language processing for English.
- **scikit-learn 1.0.2**
Scikit-learn is a free software machine learning library for the Python programming language.

Pandora was programmed on the IDE **Visual Studio Code** and was tested on the Windows Command Prompt.

4.4 MODEL METRICS

- **Accuracy:**

Calculates how often predictions equal labels.

This metric creates two local variables, total and count that are used to compute the frequency with which `y_pred` matches `y_true`. This frequency is ultimately returned as binary accuracy: an idempotent operation that simply divides total by count.

- **Categorical Accuracy:**

Calculates how often predictions match one-hot labels.

This metric creates two local variables, total and count that are used to compute the frequency with which `y_pred` matches `y_true`. This frequency is ultimately returned as categorical accuracy: an idempotent operation that simply divides total by count.

- **Sparse Categorical Accuracy:**

Calculates how often predictions match integer labels.

This metric creates two local variables, total and count that are used to compute the frequency with which `y_pred` matches `y_true`. This frequency is ultimately returned as sparse categorical accuracy: an idempotent operation that simply divides total by count.

- **KLDivergence:**

Computes Kullback-Leibler divergence metric between `y_true` and `y_pred`.

$\text{metric} = y_true * \log(y_true / y_pred)$

- **Poisson:**

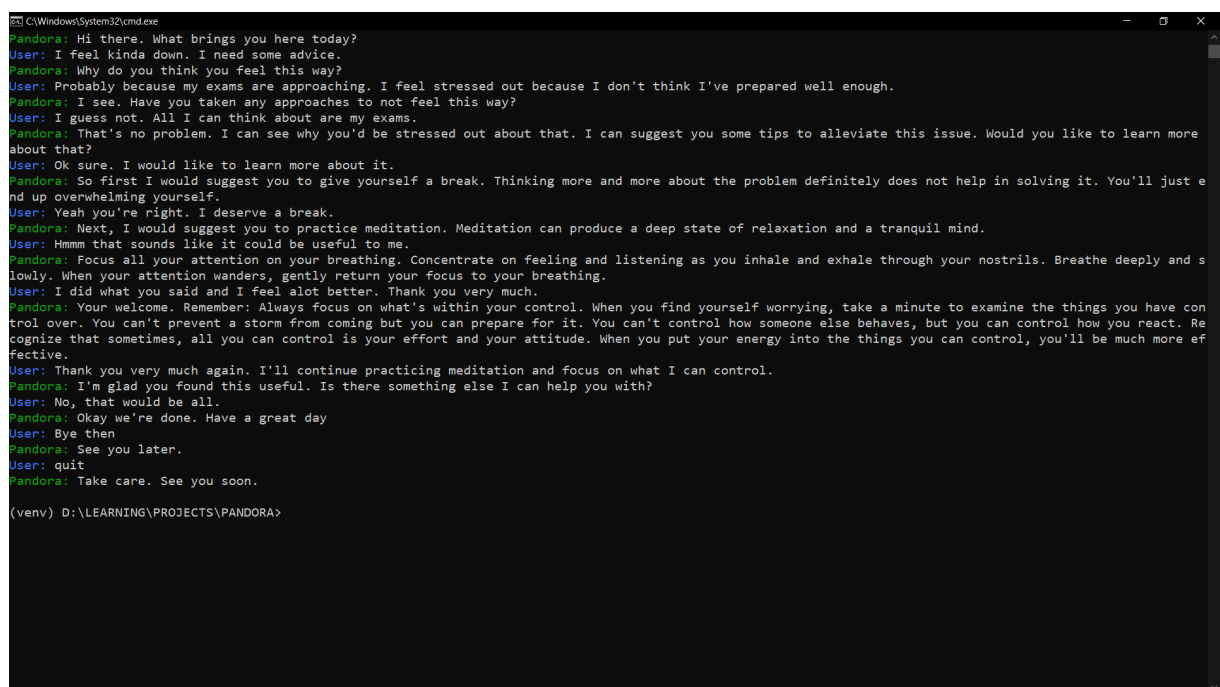
Computes the Poisson metric between `y_true` and `y_pred`.

$\text{metric} = y_pred - y_true * \log(y_pred)$

5 WORKING PROCESS

Pandora takes in a user's message and identifies the intent behind the message. Based on the intent, Pandora responds appropriately by utilizing the set of Responses. So if suppose a user were to mention that they were depressed, Pandora would detect the intent as depressed and used that tag to provide guidance or advice from the **Responses** stored under "depressed".

6 RESULT & DISCUSSION



```

C:\Windows\System32\cmd.exe
Pandora: Hi there. What brings you here today?
User: I feel kinda down. I need some advice.
Pandora: Why do you think you feel this way?
User: Probably because my exams are approaching. I feel stressed out because I don't think I've prepared well enough.
Pandora: I see. Have you taken any approaches to not feel this way?
User: I guess not. All I can think about are my exams.
Pandora: That's no problem. I can see why you'd be stressed out about that. I can suggest you some tips to alleviate this issue. Would you like to learn more about that?
User: Ok sure. I would like to learn more about it.
Pandora: So first I would suggest you to give yourself a break. Thinking more and more about the problem definitely does not help in solving it. You'll just end up overwhelming yourself.
User: Yeah you're right. I deserve a break.
Pandora: Next, I would suggest you to practice meditation. Meditation can produce a deep state of relaxation and a tranquil mind.
User: Hmm that sounds like it could be useful to me.
Pandora: Focus all your attention on your breathing. Concentrate on feeling and listening as you inhale and exhale through your nostrils. Breathe deeply and slowly. When your attention wanders, gently return your focus to your breathing.
User: I did what you said and I feel alot better. Thank you very much.
Pandora: Your welcome. Remember: Always focus on what's within your control. When you find yourself worrying, take a minute to examine the things you have control over. You can't prevent a storm from coming but you can prepare for it. You can't control how someone else behaves, but you can control how you react. Recognize that sometimes, all you can control is your effort and your attitude. When you put your energy into the things you can control, you'll be much more effective.
User: Thank you very much again. I'll continue practicing meditation and focus on what I can control.
Pandora: I'm glad you found this useful. Is there something else I can help you with?
User: No, that would be all.
Pandora: Okay we're done. Have a great day
User: Bye then
Pandora: See you later.
User: quit
Pandora: Take care. See you soon.

(venv) D:\LEARNING\PROJECTS\PANDORA>
```

The above figure is a sample conversation with Pandora. Initially, the conversation begins with Pandora inquiring the user behind their presence. The user responds by mentioning that they are down. Note that the user has not mentioned the reason behind why they are down. The user also asks for some advice regarding this. Pandora pushes the conversation forward by asking the user to self-reflect on why they're feeling this way. The user responds with the reason behind this i.e their exams. Pandora further asks the user if they would like to learn some tips to reduce their stress. During the rest of the conversation, Pandora provides the appropriate advice to the user. Pandora suggests the user to practice meditation and also provides a short guide on meditation. The conversation ends with the user feeling better due to Pandora.

7 CONCLUSION

So, the question remains: Is it possible to automate the expertise needed to become an effective therapist, using sophisticated algorithms and programming, when humans spend a lifetime trying to master these skills? The answer is roughly yes. Through Pandora, it is clear that we can simulate a therapist to some degree but can Pandora replace an actual human therapist? No, not as of now at least. But with Transformer models such as GPT-3 taking the Machine Learning world by storm by breaking multiple NLP records, it is only a matter of time before a conversational agent could fully simulate a therapist.

Chatbots in the field of mental healthcare are still in their very early stages, requiring extensive research and streamlining to ensure the proper treatment of patients. While these chatbots may be an additional resource for patients seeking initial help, there is no replacement for traditional therapy channels and the human connection that professional therapists provide. Human connection is still the most important factor in treating mental health disorders. Pandora's purpose is not to eliminate the human element in therapy but to fill in the gaps and help therapists treat patients, not to treat patients completely on its own. When Pandora and mental healthcare professionals work together, it can nurture and assist patients in a better manner.

7.1 ADVANTAGES

- **Convenience:**

Pandora provides support from anywhere with an internet connection — be it out and about or at home. It allows people to access mental health support from the comfort and safety of their own homes.

- **Familiarity:**

Pandora uses a familiar channel of communication. People enjoy chatting in real-time through texts and instant messaging. Engaging with a chatbot then feels easy rather than burdensome.

- **Availability:**

Pandora offers 24/7 functionality which is not the case for mental health professionals. So, whether it's late at night, early in the morning, or anywhere in between, Pandora is ready to listen and help.

- **Free of charge:**

Pandora provides an accessible option at no cost for those who have no sort of care for their struggles with mental health

7.2 LIMITATIONS

- Pandora is incapable of recollecting past conversations. This presents a huge liability since a therapist should be able to recollect the past conversations with their patients to effectively help them. One way to solve this problem would be to store the conversations in a database and remember certain keywords.
- Pandora currently has limited responses due to the lack of data. This could be improved upon by scraping data from forums that discuss topics such as mental health therapy.
- Pandora can only respond based on the scripts provided. So, it cannot generate new responses of its own. This can possibly be fixed by using text generation.
- Pandora only mimics understanding. It cannot truly understand what a patient is actually going through since it lacks the human element.

7.3 FUTURE WORK

- **Train on a better dataset:**
A machine learning model is only as good as the data it is fed. As of now, Pandora has limited responses due to the lack of data. To get more data to train on, I plan to scrape data from forums that discuss topics related to mental health and therapy.
- **Create a UI:**
Develop an interactive UI for the user to interact with Pandora. This can be achieved by either building a Web or an Android Application.
- **Implement CBT:**
Cognitive Behavioral Therapy (CBT) is a type of psychotherapeutic treatment that helps people learn how to identify and change destructive or disturbing thought patterns that have a negative influence on behavior and emotions.
- **Create a Mood Tracker:**
Create a feature to keep a record of a person's mood at regular intervals. Mood tracking is a positive psychology technique for improving mental health where a person records their mood, usually at set time intervals, in order to help identify patterns in how their mood varies.

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