

C-Journal: A Journaling Application for Detecting and Classifying Cognitive Distortions using Deep- Learning based on a Crowd-sourced Dataset



Nada Elsharawi, Alia el Bolock

LREC-COLING 2024



What are Cognitive Distortions?



Cognitive Distortions

Cognitive distortions are **self-statements** that are **wrong** which frequently are followed by **logical errors** in one's own internal reasoning.*



Cognitive distortions can be experienced by **healthy** individuals

Cognitive Distortion Types

Emotional Reasoning

Fallacy of Change

Global Labeling

Always Being Right

Jumping to Conclusions

Polarization

Catastrophizing

Control Fallacies

Fallacy of Fairness

Shoulds

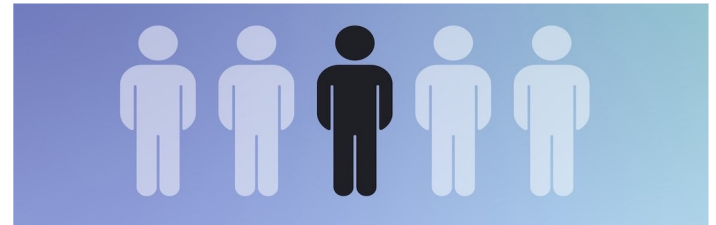


Mental Health and Well-being

- *Mental health*: person's condition with regard to their emotional, psychological, and social well-being
- 20% of the world has mental illness according to World Health Organization
- According to Martin. Prince 14% of the global burden of disease is due to mental disorders and their chronically disabling nature. *
- Mental health is very important for living a stable, and healthy life.



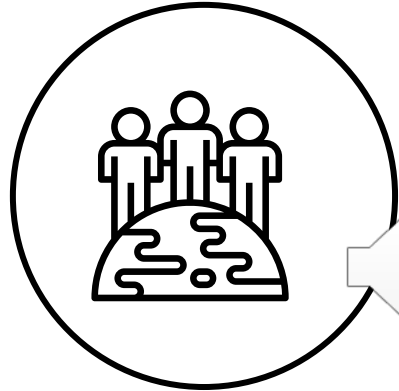
Prince, M., Patel, V., Saxena, S., Maj, M., Maselko, J., Phillips, M. R., & Rahman, A. (2007). No health without mental health. *Lancet (London, England)*



Life-Coaching & Cognitive Distortions



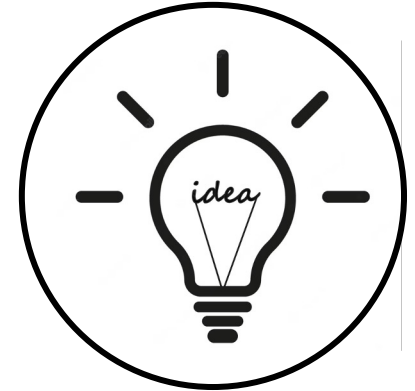
Traditionally, **one-on-one paper-and-pen** diaries used for raising awareness of and reducing cognitive distortion



Given the number of individuals seeking help from a mental health professional. **It's important to find an aiding tool**



Not easy for psychologists to provide consistent **monitoring**



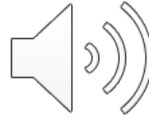
C-Journal Aiding Tool
Helps both

- **Psychologists**
- **Individuals**

Related Work

Dataset Collection Methodologies

- **Social media APIs**
Online blogs and communities
- **Online Appointments**
- **Mobile Applications**
- **Research participant**
- **Sensors**



Technological Aiding Tools for Psychologist

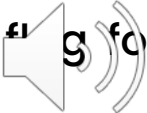
- **Web platforms**
- **Mobile Applications**
- **Chatbots**
- **Virtual Mental Health Assistants**
- **Augmented Reality system**

Best Performing Models with Psychological Data

- **Support Vector Machine SVM**
Logistic Regression
- **Deep Transfer Learning**
- **Convolutional Neural Network**
- **with BERT, LSTM**

Main Aim

Mobile Application for identifying cognitive distortions from journaling texts of the individuals in English natural language.

This application will just raise a  for the user to check their train of thoughts **not a diagnosing tool**.

Disclaimer: This application **is not meant to replace** the psychologist, but to help monitoring the individuals.

Approach

Dataset Collection & Annotation

- Collecting a **novel dataset** in cognitive distortions
- Filtering of the dataset
- Annotation of the dataset



Training Deep Learning Models

- Training baseline and main models for classifying sentences exhibit cognitive distortions or not
- Then classified to one of the 14 cognitive distortions



Developing C-Jornal Mobile Application

A mobile journaling and mood tracking application built on the basis of the **best-performing** cognitive distortion classification model. The application **identifies** and raises awareness to **potential cognitive distortions** in the users' daily **journaling** texts

Dataset

Dataset Collection & Annotation

- Collecting a **novel dataset** in cognitive distortions
- Filtering of the dataset
- Annotation of the dataset

Training Deep Learning Models

- Training baseline and main models for classifying sentences exhibit cognitive distortions or not
- Then classified to one of the 14 cognitive distortions

Developing C-Jornal Mobile Application

A mobile journaling and mood tracking application built on the basis of the best-performing cognitive distortion classification model. The application identifies and raises awareness to potential cognitive distortions in the users' daily journaling texts

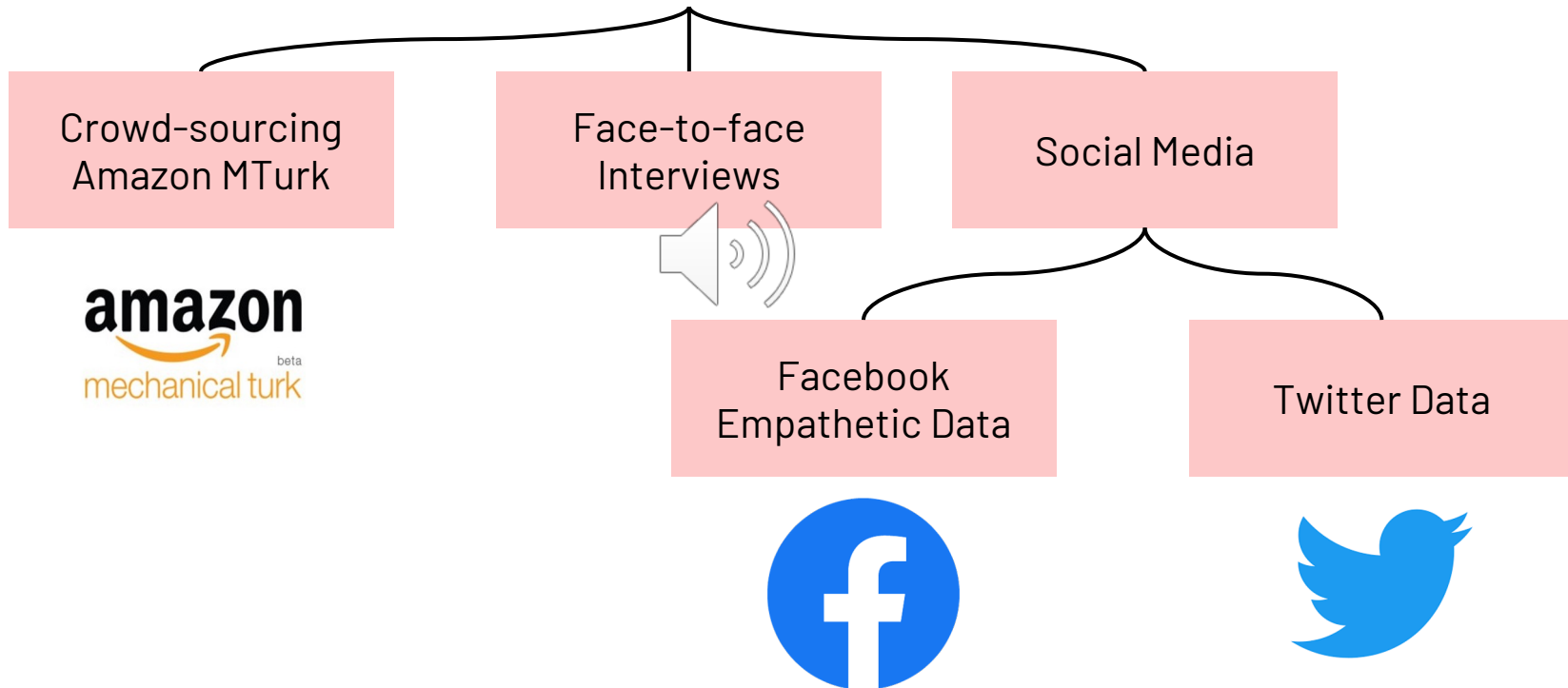
Ethics of Psychological Data Collection

We followed the following ethics guidelines:

- Participants' **permission** was acquired.
 - Making sure they read and understand what they are signing up for.
- Maintaining **anonymity**.
 - The identity of the participant was kept anonymous.




Dataset Collection Methodology



Dataset Statistics

Source	Number of Sentences
Facebook Empathetic Data	18509
Twitter Data	2477
Crowd-sourcing	10199
Interviews	3188

A speaker icon with sound waves is positioned over the Twitter Data row of the table.

Dataset available on Open Science Framework: osf.io/e4hbr

Filtering Crowd-sourcing and Interviews

We collected **20 batches** with **1500 entry per batch** which were **self-labeled**




Example of Raw Data Filtered in the First Stage

Delete all the redundant or irrelevant entries

It's performance review time at My company, My manager complimented My coworker was previously My coworker was previously nice. To I speak up at a team meeting, and Your partner comes home looking Catastrophizing is relat	1) I can't believe there was something I was called out on.	1) If I don't get this job it mea	1) Everyone takes advantage of me	1) I always ruin good things!		
2) I thought I was doing well with work until now.	2) My boss proposed remote	2) I do everything wrong	2) Nothing ever gets better for me	2) Nothing ever gets better for me		
3) I am not a good worker, I may get fired.	3) I thought I nailed that inter	3) I am a failure at everything	3) Everything is always the same	3) Everything is always the same	Example of jumping to conclusio	Example of catastroph
very nice	very nice	very nice	very nice	very nice	very nice	very nice
"I don't think I'm good enough for this role", "it seems like no matter "since I didn't get it today, I'll i "why other people can't do that and I c "why does it never work out?", "it "what did I do?", "maybe the boss "Will I get a raise?", "I c	yes	None	Yes	Yes	None	None
Good example: My supervisor says he has a bone to pick with me a It's either I will have this last I an weight it leve yday whi I will always and forever love you. I saw that text you got good morn What if I care and love	I left my review feeling not that great, once I was told my voice carri My hair is curly but unmanag Your me to dry by it is pretty. If y Seems like lately I cant catch a bi My wife has anxiety, I always thin What if she doesnt real	Mental filtering is draining and straining all positives in a situation an Things are either all bad or al Things are either all bad or all good. You think, "Nothing ever goes my confirmation bias, the tendency to In this case, you jump t	When I was 22, I received a mostly positive performance review fro As a new nurse, I was fired fr As a new nurse, I was fired from a jo I did poorly on a recent job intervi One time I tripped in a really emb I called a good friend in	I was accepted to a prominent university but worried about what it w As a high school student, I worked r One person in a large group of ac My friend has taken a long time to A nursing assistant I jus	I delayed applying for a new job that would advance my career bec A nurse coworker was nice tc A nurse coworker was nice to other c My friend seemed to want to get c I had an awkward casual convers I am afraid to take a nu	When speaking with my significant other about fixing our relationship I cant go to church so now i r This is a repeat of question 2, but I tr I was told that I have never come My partner jumps to conclusions I they must have called
they make improment survey so will take 10 minutes (good exampl she should mentally depress bad examples			bad examples	bad examples	bad examples	bad examples
Mental filtering is draining and straining all positives in a situation an My coworker was previously Today, she ate my sandwich. I don't i I speak up at a team meeting, and Your partner comes home looking Catastrophizing is relat	yes the are pressure	there is no thinking	all are nothing to worry	always never	conclusions	catastrophising
Why cant I stop thinking about what my boss said. it made me so up I try every day to eat a health When I have had arguments with my Why cant I stop thinking about wh When I talk to my sister before I c When I talk to my sister	1)	2)	3)	4)	5)	6)
my manager was shouted for my mistake and at last he appreciate f . I've decided to eat protein fo I've decided to eat protein food . But i was running late for work and or Your partner comes home looking I get fired after I've wor	its good survey	its good survey	its good survey	good jap	its good survey	its good survey
good	good	good	good	no	good	good
mental filter a term used to describe one type of cognitive distortion, thinking all about yourself ai thinking all about yourself and work when people overgeneralize , the is a symptom of an underlying co is a way of thinking call						
Even with frequent praise from coworkers I worry I'm not doing my t I ate something unhealthy to c				I never get recognized in my work My wife isn't looking at me or spe My wife hasn't come fro		
In absence of any comments positive or negative, assume that mea My child had moments at the				I always get stuck in traffic on my Because my child always wants r I'm running late to get t		
No one spoke up in my team call, they must have hated the meeting I started my day on by being Same as above				My wife seems to always get ann My boss was very short in conver What if someone break		
yes	yes	yes	yes	yes	yes	yes
1- Pensei que a pessoa estava sendo ingrata ao fazer um almoço e 1 - Estou fazendo cross fit a 1- Quando não passei em concurso 1 - Tenho azar, logo faço tudo ant 1 - Na verdade, sinto exatamente						
2- Pensei que a pessoa não aceitava uma outra forma de resolver 2 - Por não respeitarem as 2 - Quando conclui a faculdade e vi 2 - Quando eu digo aos meus filh 2 - Quando se amigam me veã						

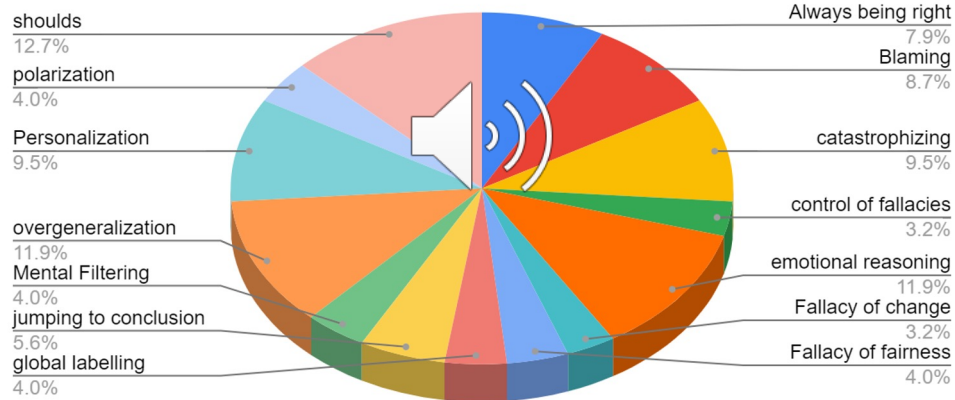
Second Filtration Stage

Filter and **Annotate** the data by the **life-coach** and the **psychologist**

Sentence	Self-annotation	Life-coach Annotation	Psychologist Annotation	Source
I'm always expected to do everything	Overgeneralization 	Neutral	Neutral	Crowd-sourcing
In the end, they make one improvement suggestion. I left the meeting feeling miserable and dwell on that one suggestion all day long.	Mental filtering	Mental filtering	Mental filtering	Crowd-sourcing
I don't belong anywhere	Shoulds	Emotional Reasoning	Emotional Reasoning	Crowd-sourcing
I should look super fit since I am a CrossFit coach and a nutrition coach	Shoulds	Shoulds	Neutral	Crowd-sourcing

Data Statistics

Distorted Thoughts Distribution



As shown, the **data bins** are of **approximate sizes**. Which will **not bias the model** to certain unbalancing.

Data Preprocessing

1. Converting all text to **lowercase**.

1. **Removing** special characters, numerals, patterns, and punctuation.

1. Removing the **stopwords**.



Stopwords are words in any language that contribute little meaning to a phrase. They can safely be ignored without sacrificing the meaning of the sentence.

1. **Stemming** the words using the **Porter Stemmer** in the NLTK package.

The stemming operation bundles together words of the same root, e.g., **"eaten"** and **"eating"** are bundled into a common **"eat"**.

Model Training

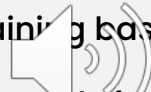
Dataset Collection & Annotation

- Collecting a **novel dataset** in cognitive distortions
- Filtering of the dataset
- Annotation of the dataset



Training Deep Learning Models

- Training baseline and main models for classifying sentences exhibit cognitive distortions or not
- Then classified to one of the 14 cognitive distortions



Developing C-Jornal Mobile Application

A mobile journaling and mood tracking application built on the basis of the best-performing cognitive distortion classification model. The application identifies and raises awareness to potential cognitive distortions in the users' daily journaling texts

Naive Bayes Baseline

We introduced as an **initial baseline Naive Bayes with Countvectorizer**

Vectorizer	Accuracy	Precision	Recall	f1
count vectorizer	0.73	0.73	0.72	0.72



Experiments

CNN with different Word Embeddings

Word Embedding	Accuracy	Precision	Recall	F1 Score
Bert	85.84 %	89 %	77.1 %	84 %
Word2vec	83.34 %	84 %	72.1 %	80.1 %
Glove-300	82.7 %	85 %	73 %	73 %
Glove-100	81.4 %	84.4 %	72 %	72 %
Word Embeddings	65 %	69 %	68 %	69 %
Universal Sentence Encoder	50 %	54 %	45 %	41 %
Doc2vec	41 %	27 %	41 %	24 %
TF-IDF	40 %	25 %	40 %	26 %
Count Vectorizer	40 %	19 %	40 %	23 %

Experiments

LSTM with different Word Embeddings

Word Embedding	Accuracy	Precision	Recall	F1 Score
Glove 300	80.4 %	72.1 %	86.4 %	75.12 %
Word2vec	79.9 %	83.2 %	81.2 %	82 %
GloVe-100	77.3 %	71.2 %	80.1 %	81.1 %
Universal Sentence Encoder	69.4 %	82.2 %	57.5 %	67 %
BERT	48.5 %	60.3 %	23.3 %	33.7 %
Doc2vec	41 %	17 %	41 %	24 %
Count Vectorizer	40 %	16 %	40 %	26 %
TF-IDF	40 %	16 %	40 %	23 %
Word Embeddings	44 %	0.00 %	0.00 %	0.00 %

Best Performing Models

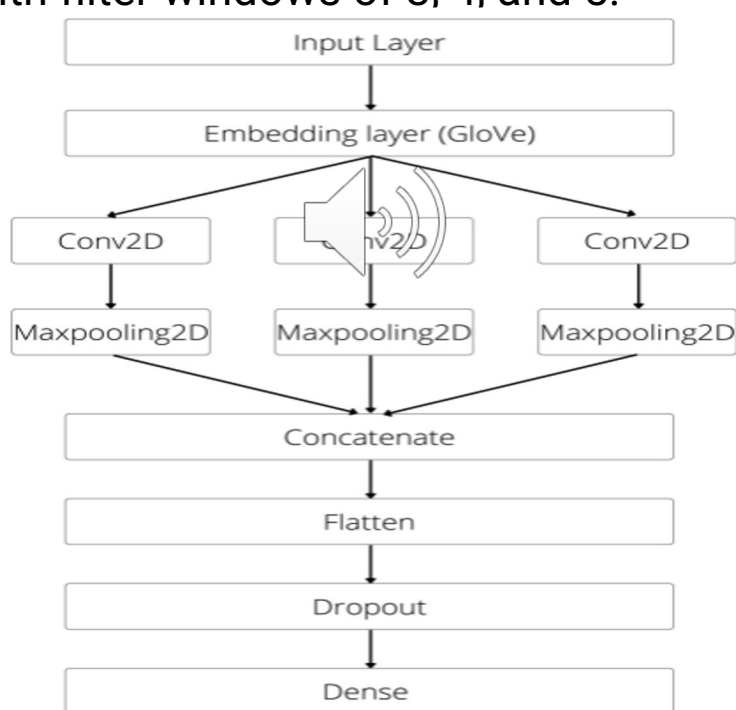
Model	Vectorizer	Accuracy	Recall	Precision	F1 Score
CNN	Bert	85.64 %	77.1 %	89 %	84 %
Lstm	Glove 300	80.4 %	72.1 %	86.4 %	75.12 %
DNN	Bert	78.13 %	69.1 %	83.7 %	77.54 %
RNN	BERT	77 %	61.06 %	78.2 %	68.3 %
SVM	TF-IDF	65 %	97.2 %	67.2 %	79.3 %
Random Forest	TF-idf	64 %	94 %	68 %	79 %
RNN	Word-Embeddings	61.39 %	61.06 %	61.38 %	62.3 %
Naive bayes	count vectorizer	61 %	87.7 %	70 %	78.4 %
Random Forest	Doc2vec	60 %	60.55 %	41 %	46.7 %

After hyperparameter tuning

CNN Architecture

The CNN architecture with BERT Embedding has the best accuracy **85.6%**

We used 512 filters with filter windows of 3, 4, and 5.



C-Journal Mhealth App

Dataset Collection & Annotation

- Collecting a **novel dataset** in cognitive distortions
- Filtering of the dataset
- Annotation of the dataset



Training Deep Learning Models

- Training baseline and main models for classifying sentences exhibit cognitive distortions or not
- Then classified to one of the 14 cognitive distortions



Developing C-Journal Mobile Application

A mobile journaling and mood tracking application built on the basis of the best-performing cognitive distortion classification model. The application identifies and raises awareness to potential cognitive distortions in the users' daily journaling texts

Application Purpose & Goal

Aiding tool for:

- **Individuals** to **track** their own thinking patterns.
- **Life-coaches** and **psychologists** to **better track** and help large groups of patients.



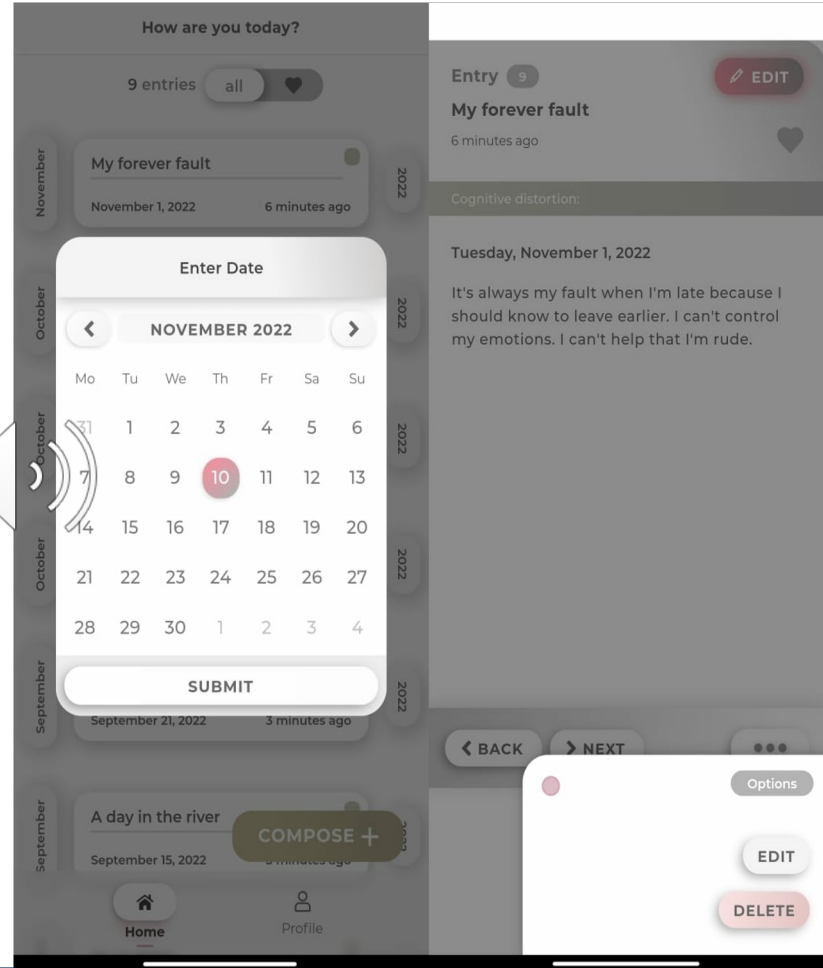
C-Journal Features

C-Journaling Mobile Application Features:

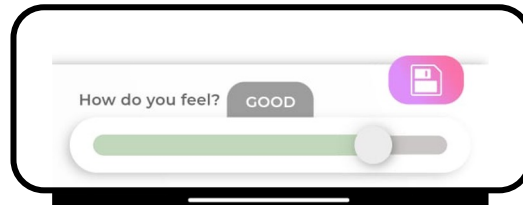
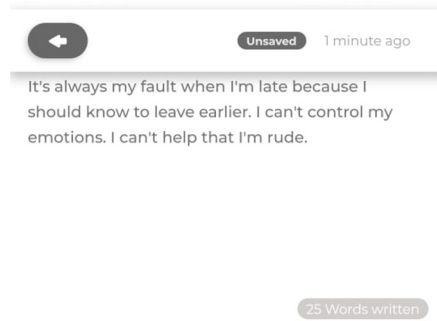
- ★ Journaling for therapy
- ★ Mood tracker
- ★ Immediate distortions detection
- ★ Detailed feedback about journaling history and average mood for the month



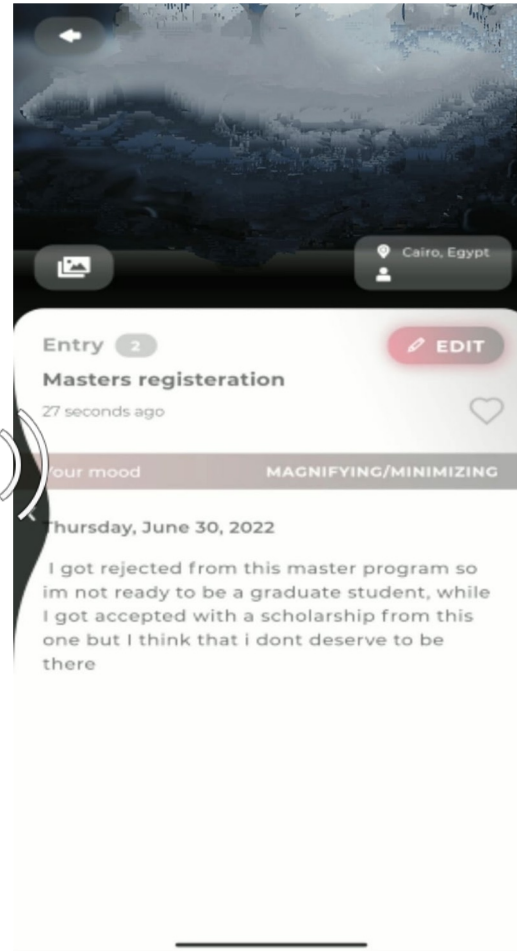
Journaling Entries Creation Feature



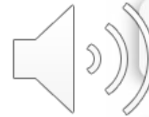
Mood Tracking Feature



Cognitive Distortions Detection Feature



General Feedback Feature



How are you today?

NADA

Created on
September 30, 2022

CHANGE NAME

9 Diary entries	Alright Average mood
226 Words written	25.11 Words per entry
63 Most words at once	11 Fewest words at once
0 Entries this week	1 Entries this month
November 1, 2022 Latest entry	September 3, 2022 First entry

Home Profile


Data Privacy Policy

- Interpretation and Definitions
- Collecting and Using the Personal Data
 - Types of Data the Collected
 - Use of Personal the Data
 - Retention of the Personal Data
 - Disclosure of the Personal Data
 - Legal Requirement
- How to contact us



Data Privacy Policy: <https://github.com/nadahesham/C-journalApp#readme>

C-Journal Initial Testing

- Small **pilot study** to evaluate the **usability** of C-Journal was conducted on a **small sample of 15 individuals**.
- **The results** were used to **update the prototype** and remove the non-usable features.
- The recommendations included : 
 - Adding **daily reminder** prompt, which was requested by 14 out of the 15 users.
- The users were given a short version of the System Usability Scale which showed the following:
 - **All users found the application highly usable and the features easy to use.**
- **13 out of the 15** said they would **recommend it** to others and would use it on a daily basis.
- In the future, more rigorous testing of the usability and design features will be conducted

Conclusion

- Dataset with **28,250 training sentences and 7,062 testing sentences.**
- **BERT (Contextual Word Embedding)** with **CNN** achieved the **best classification accuracy** which is **85.64.**
- **C-Journal** app for pointing out **potential** cognitive distortions



**Dataset Collection
&
Annotation**

**Training Deep
Learning Models**

**Developing C-
Journal Mobile
Application**

Future Work



Recommendation 1

The dataset can be constantly extended with more sentences and more languages.

Recommendation 2

The implemented classification models can be further enhanced for achieving better accuracy

Recommendation 3

The C-Journal app

- To be tested in real life scenario through a longitudinal study
- Use the mood-tracker feature for further analysis and add more and more features

Thank  you!