AI FOR HEALTHCARE

Analysis on Depressive Social Media Texts

SCSE20-0985

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- Emotion Intensity Prediction
- Text Summarisation (Subtask)
- Emotion-cause Pair Extraction

04. Future Work

00

INTRODUCTION

&

OBJECTIVE

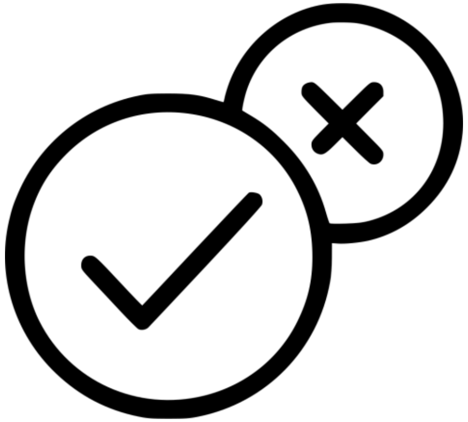
INTRODUCTION

Social Media Cube [2]

Depressed Silhouette Man [1]

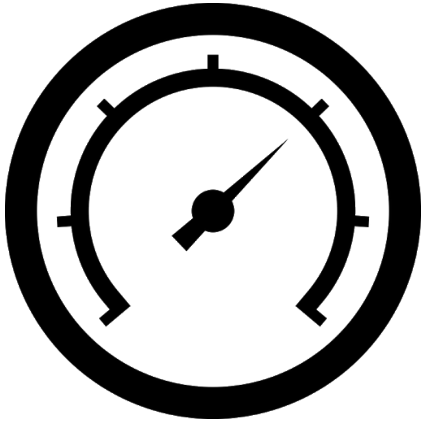
OBJECTIVE

To leverage on the use of Deep Learning and Natural Language Processing (NLP) to do an in-depth analysis on depressive social media contents



Yes/No Logo [3]

Predicting whether a particular piece of text contents sentiment of depression



Metre [4]

Creating a depression metric and predict depression scores for all data labelled as depressive content

Emotions [5]

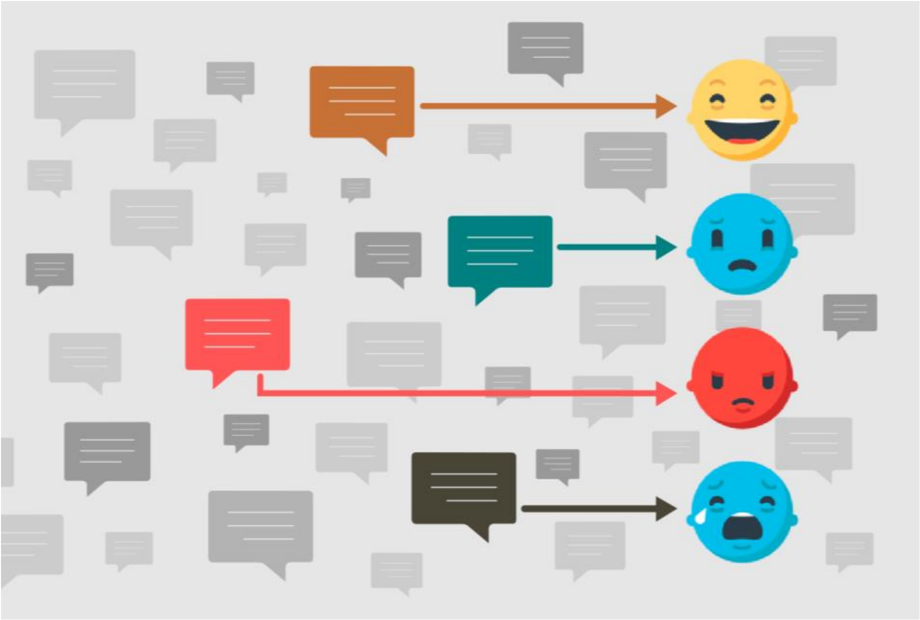
Determine how accurate the model can extract depressive emotion and the cause of depression from text clauses

01

CHALLENGES OF DETECTING DEPRESSION

SENTIMENT ANALYSIS VS EMOTION ANALYSIS

- Both differs in terms of how unstructured text data are being analysed
- Sentiment analysis merely separates the data points and determine whether the text conveys a negative, neutral or positive feeling
- On the other hand, emotion analysis consists of deeper analysis that dives down into the psychology of one's emotion and behaviour



Sentiment Analysis [6]

WHY IS DETECTING DEPRESSION FROM TEXT HARD?

- The labels of the text “depress/not depressed” cannot be directly equated with the labels “positive/negative”.
- Signs of depression are subtle and not obvious
- These subtle indications may be reflected in the nuances of someone’s language
- More in-depth psychological analysis should be conducted to assess the text data

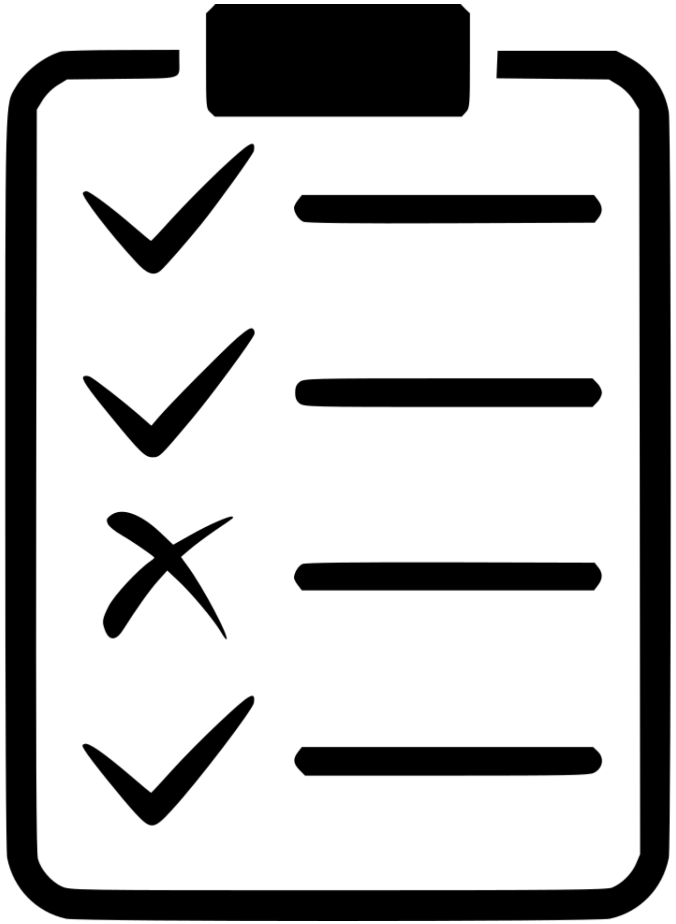
Expressions [7]

02

EXPLORATIONS

TASKS

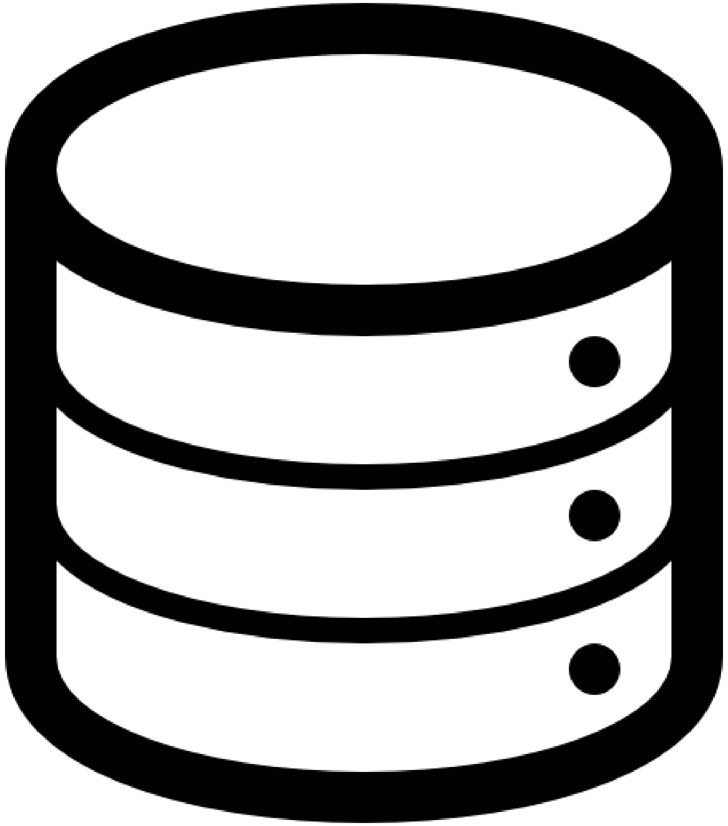
- Emotion Classification
- Emotion Intensity Prediction
- Text Summarisation (Subtask)
- Emotion-cause Pair Extraction



Tasks [8]

MAIN DATASETS

- **Toy Dataset**
  - 8000 : 2314 (non-depressive entries : depressive entries)
  - Used in Emotion Classification task
- **Twitter Dataset (Short Text)**
  - 2357 : 844 (non-depressive entries : depressive entries)
  - Used in all tasks
- **Reddit Dataset (Long Text)**
  - 1292 : 1437 (non-depressive entries : depressive entries)
  - Used in all tasks



Database [9]

WASSA 2017 EMOINT DATASET

- Obtained from the official competition website.
- In this project's context the datasets will be used solely as the training data for the Emotion Intensity Prediction task
- Emotions in these datasets
  - Anger
  - Fear
  - Sadness

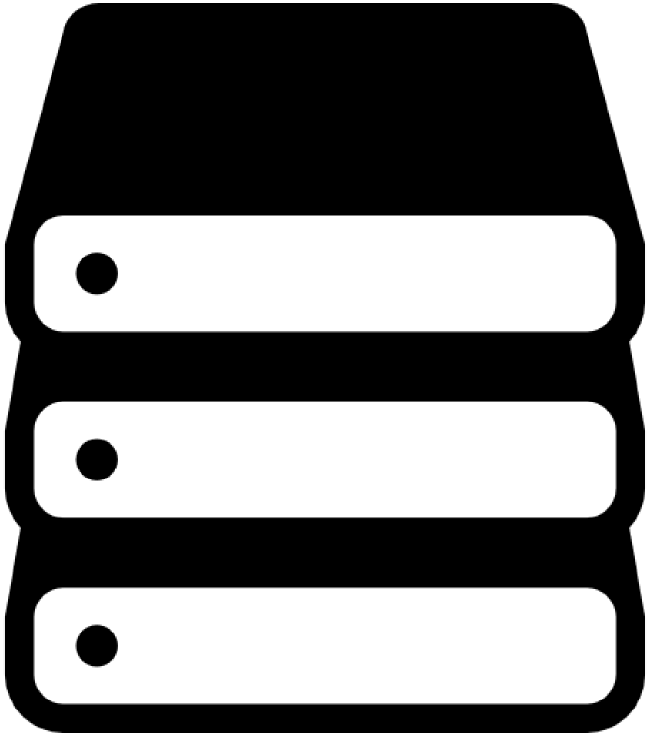
	Text	Label	Score
0	@ZubairSabirPTI pls dont insult the word 'Molna'	anger	0.479
1	@ArcticFantasy I would have almost took offens...	anger	0.458
2	@IllinoisLoyalty that Rutgers game was an abom...	anger	0.562
3	@CozanGaming that's what lisa asked before she...	anger	0.500
4	Sometimes I get mad over something so minuscul...	anger	0.708

	Text	Label	Score
0	I know this is going to be one of those nights...	fear	0.771
1	This is #horrible: Lewis Dunk has begun networ...	fear	0.479
2	@JeffersonLake speaking of ex cobblers, saw Ri...	fear	0.417
3	@1johndes ball watching & Rojo'd header wa...	fear	0.475
4	Really.....#Jumanji 2....w/ The Rock, Jack Bla...	fear	0.542

	Text	Label	Score
0	@1johndes ball watching & Rojo'd header wa...	sadness	0.583
1	A pessimist is someone who, when opportunity k...	sadness	0.188
2	A .500 season is all I'm looking for at this p...	sadness	0.688
3	Stars, when you shine,\nYou know how I feel.\n...	sadness	0.292
4	All I want to do is watch some netflix but I a...	sadness	0.667

THE NEED FOR MULTIPLE DATASETS

- Analysis of depressive text can be more generalised
- Twitter datasets are shorter in length due to the limitations on the number of characters that could be written and posted
- Reddit datasets are much longer as there are no restrictions on the number of characters that could be written and posted



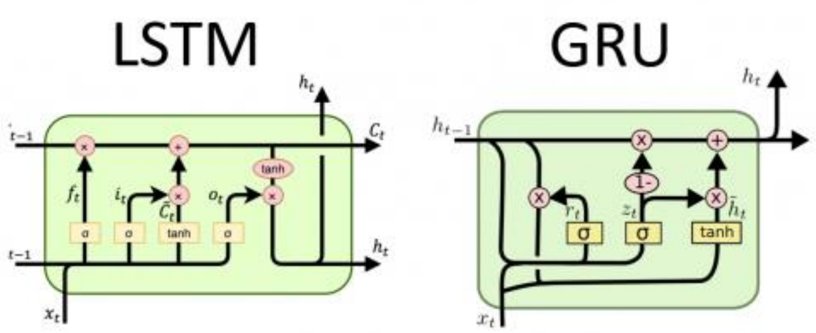
Database [10]

DATA CLEANING

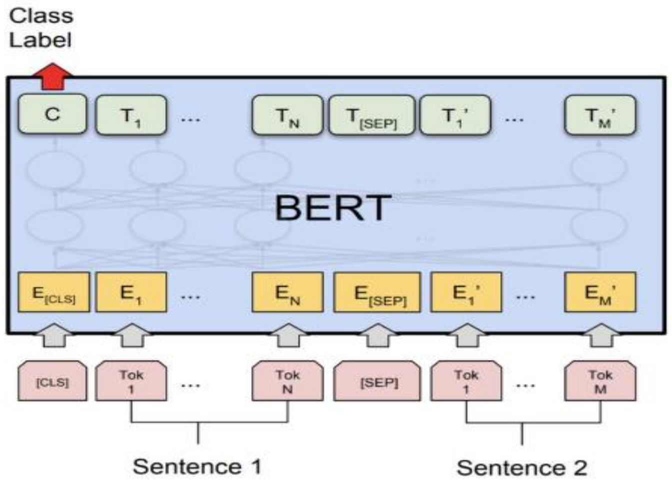
- Contraction removal
- Remove ‘@’ and ‘#’ from tweets
- Remove emojis
- Remove numbers
- Lowercase all letters
- Remove letters who appeared more than twice in the text.
- Remove stopwords
- Lemmatise the text

Data Cleaning [11]

MODELS, APIS & FRAMEWORK

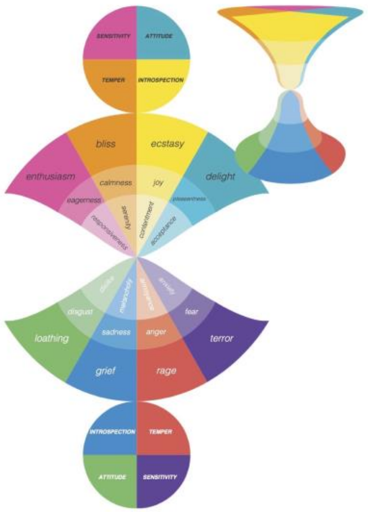


Sequential Models (LSTM, GRU) [12]



Transformer Architecture (BERT) [13]

DeepAI API [14]



Sentic API [15]
(Depression Identification)

PyTorch Framework [16]

03

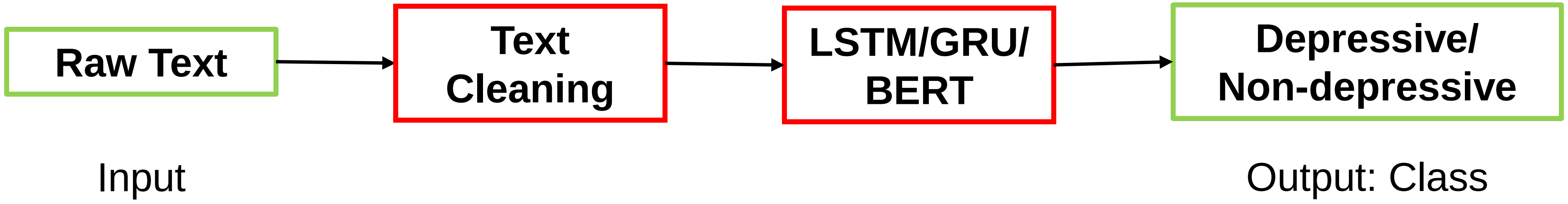
TASKS

03A

EMOTION CLASSIFICATION

PIPELINE

Aim: Classify if a text is depressive or non-depressive



HYPERPARAMETERS

Hyperparameters Held Constant (Sequence Model)

- Number of Epochs: 15
- Learning Rate: 5e-04
- Hidden Dimension: 512
- Number of RNN layers: 4
- Dropout: 0.5
- Batch Size: 32
- Optimiser: Adam

Hyperparameters Held Constant (Transformer Model BERT)

- Number of Epochs: 2
- Learning Rate: 5e-05
- Batch Size: 16
- Optimiser: AdamW

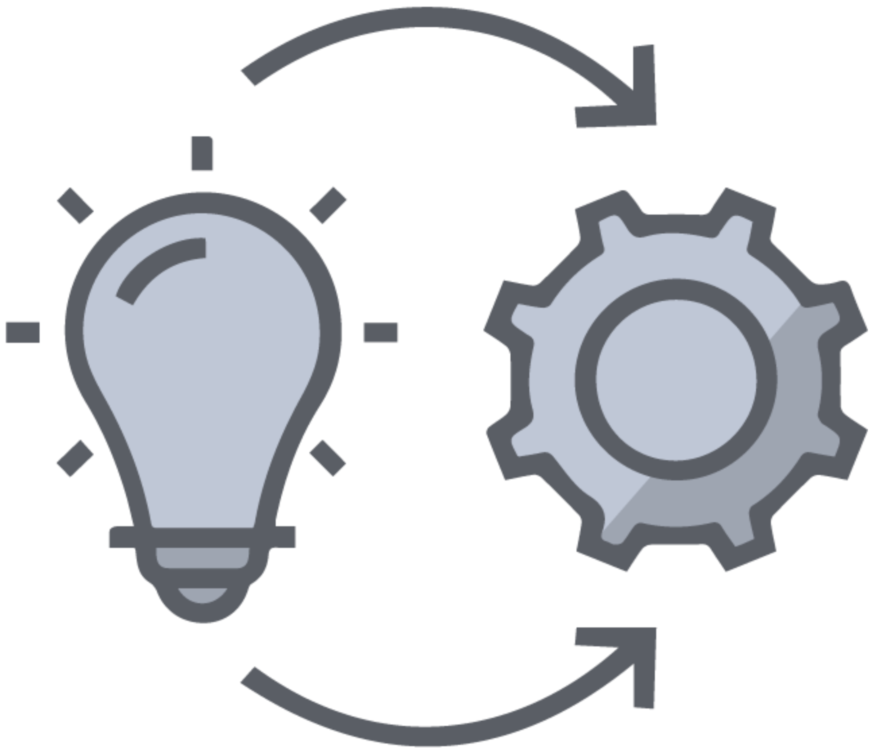
DATA CLEANING TECHNIQUES

1. Contractions removal
2. Keep alphabets only
3. Lowercase all letters
4. Remove letters who appeared more than twice in the text.
5. Remove stopwords
6. Lemmatise the text

Cleaning [17]

IMPLEMENTATION

- All datasets split into their corresponding train and validation sets
- 80% train data and 20% validation data
- Custom Data Loader classes were written to load the data for the sequence models and BERT
- Model building
- Compare model performances



Idea [18]

PERFORMANCE METRICS

- Validation Accuracy
  - Measures how well the model predicts by comparing the predictions with the ground truth values in terms of percentage
- F1-score
  - Measure of a model’s accuracy by combining the precision and recall of the model, and it is defined as the harmonic mean of the model’s precision and recall.
  - Defined as **F1 = (2 * Precision * Recall) / (Precision + Recall)**
- Area under the Curve (AUC)
  - Represents the degree of separability and it tells how much the model is capable of distinguishing between classes.

MODEL PERFORMANCES

Model	Validation Accuracy	F1 Score	AUC
LSTM	0.9834	0.9834	0.99234
Bi LSTM	0.9806	0.9801	0.99436
GRU	0.98168	0.9812	0.99267
Bi GRU	0.97953	0.979	0.98916
BERT	**0.9989**	**0.9989**	**1**

Toy Dataset

Model	Validation Accuracy	F1 Score	AUC
LSTM	0.72768	0.7222	0.80175
Bi LSTM	0.73539	0.7362	0.80849
GRU	0.70414	0.7036	0.78461
Bi GRU	0.70698	0.7063	0.79508
BERT	**0.7883**	**0.7874**	**0.8726**

Twitter Dataset

Model	Validation Accuracy	F1 Score	AUC
LSTM	0.8364	0.8272	0.89714
Bi LSTM	0.86642	0.8776	0.9408
GRU	0.81985	0.8072	0.90907
Bi GRU	0.85723	0.8679	0.93939
BERT	**0.8832**	**0.897**	**0.95**

Reddit Dataset

RE-EXAMINING THE TOY DATASET

- May have a flaw in the toy dataset due to the ‘near to perfect’ metric scores.
- Two methods to determine if the toy dataset is reliable and still can be used for other tasks ahead.
  - Rough Observation
  - Inter-annotator Agreement

Thinking man [19]

ROUGH OBSERVATION

Text	Label
The Oil that has the Potential to Fight Migraines, Depression, Anxiety, & Even Cancer http://www.healthy-holistic-living.com/oil-potential-cure-migraines-depression-anxiety-even-cancer.htmlÃ‚Â Ã¢Â€Â¦	1
@ the ppl on my TL that liked the tweet about how self-care will cure depression: which essential oils will stop my hallucinations & paranoid delusions?	1
I call BS if anyone deserves credit its president Obama for putting the brakes on the worse recession in our history that almost lead to a depression if not for Obama & his adms getting the economy that GWB & the reps had managed to almost demolish back on its tracks. #REALNEWS	1
my depression: https://twitter.com/kanyewest/status/989142253468708864Ã‚Â Ã¢Â€Â¦	1
Social support, rest, ritual, food, storytelling, and touch are all common among cultural practices for #postpartum #depression. F Parks #GOLDQuotes #PPD #PPMAD #maternalhealth	1

Text	Label
Good morning everyone	0
Busy rest of the day...meeting with prospective clients, college students who want to be "Collegepreneurs" . Later!	0
@kathrynryn not since friday but its all good its all good	0
@alecstanworth That's nothing: http://bit.ly/better-bragging-rights and she resigned too	0
slept too much, so, no school to me	0

INTER-ANNOTATOR AGREEMENT

Get 2 annotators to annotate a sample of the dataset and see how much agreement they have with each other and how much agreement they have with the ground truth labels by measuring the Cohen’s Kappa coefficient

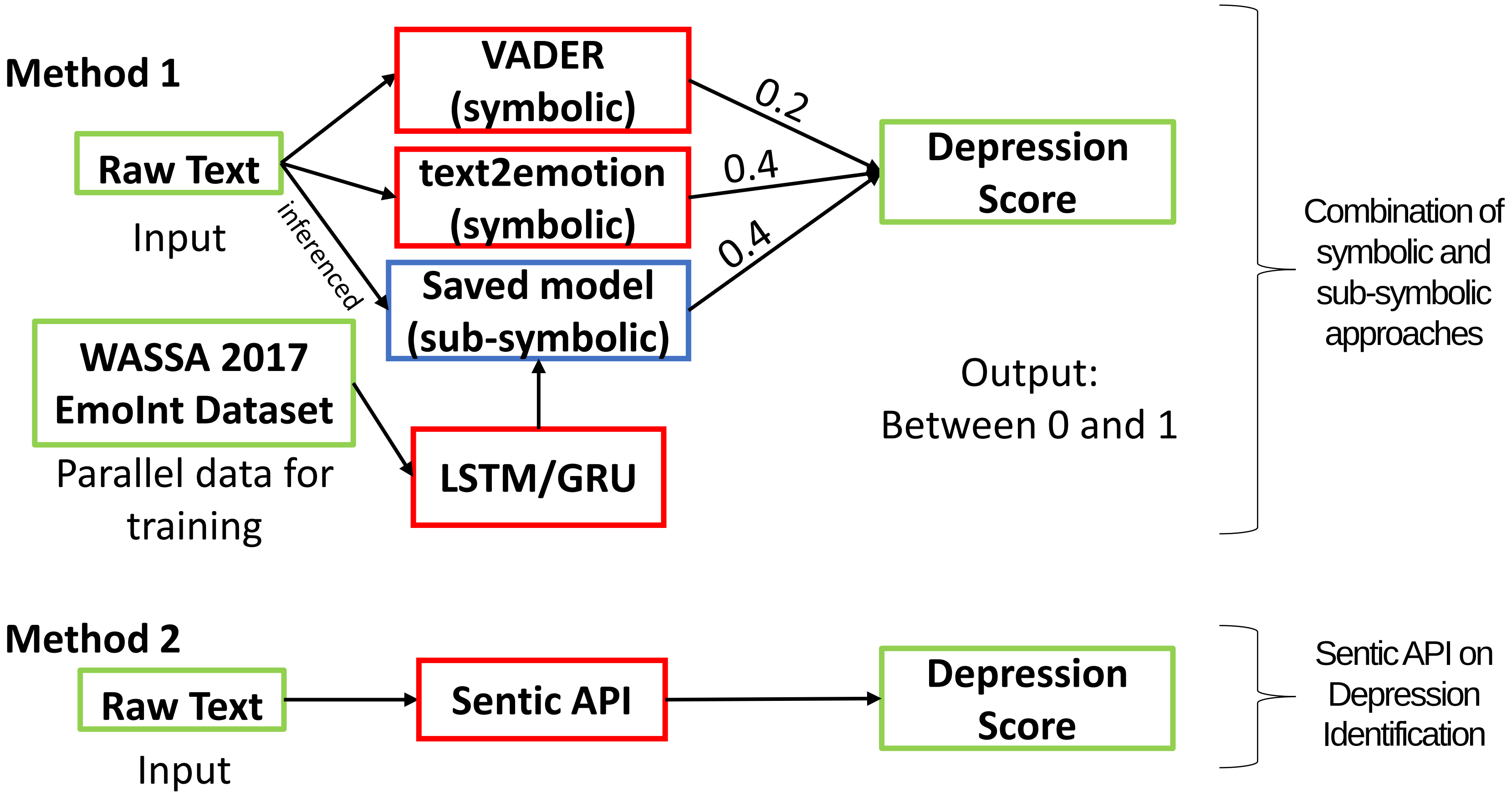
Annotator A	**Annotator B**	**Cohen’s Kappa Coefficient**
Annotator 1	Annotator 2	0.81073
Ground Truth	Annotator 1	**0.20354**
Ground Truth	Annotator 2	**0.19027**

03B

EMOTION INTENSITY PREDICTION

PIPELINE & IMPLEMENTATION

Aim: Estimate the magnitude of depression from text



DATA CLEANING TECHNIQUES

1. Contractions removal
2. Remove numbers
3. Remove letters who appeared more than twice in the text.
4. Lemmatise the text

Cleaning [17]

COMPARISON OF DEPRESSION INTENSITY SCORE

Text	Symbolic + Sub-symbolic	Sentic API
So alone so tired so bored so ugly so depressed.	0.66375	0.866
Feeling bummed out rn. Family is disappointing and friends are too far away??	0.38461	0.5
Why is it that everyone gets what I want, I guess whatever	0.21962	0.33

RE-EXAMINING THE TOY DATASET

- Time factor
- Lack of annotators from Psychology or Linguistics to give a golden depression score for individual entries in the dataset.
- No way to compare the losses and determine which method (Symbolic + Sub-symbolic or Sentic API) is better in producing the depression intensity score

Warning Sign [20]

03C

TEXT SUMMARISATION (SUBTASK)

TEXT SUMMARISATION (SUBTASK)

Extractive Text Summarisation

- Summarised text appears from their corresponding raw text
- Uses **DeepAI** Text Summarisation API
- API call
- **Used as a subtask for the emotion-cause pair extraction task**

Abstractive Text Summarisation

- Summarised text generates new sentences from the raw texts
- The summarised text might not appear in the corresponding raw text
- Uses Pre-training with Extracted Gap-sentences for Abstractive Summarisation (**PEGASUS**)
- Import PEGASUS libraries from HuggingFace
- Two variant: xsum and reddit tifu

03D

EMOTION-CAUSE PAIR EXTRACTION (ECPE)

INTRODUCTION TO ECPE

Aim: Focus on depressive emotion and the likely cause for it. Then extract the emotion and the cause pair accurately in the context of depression

Clause 1: Adele arrived at her apartment late in the afternoon after a long day of work.

Clause 2: She was still furious with her husband for not remembering her 40th birthday.

Clause 3: As soon as she unlocked the door, she gasped with surprise;

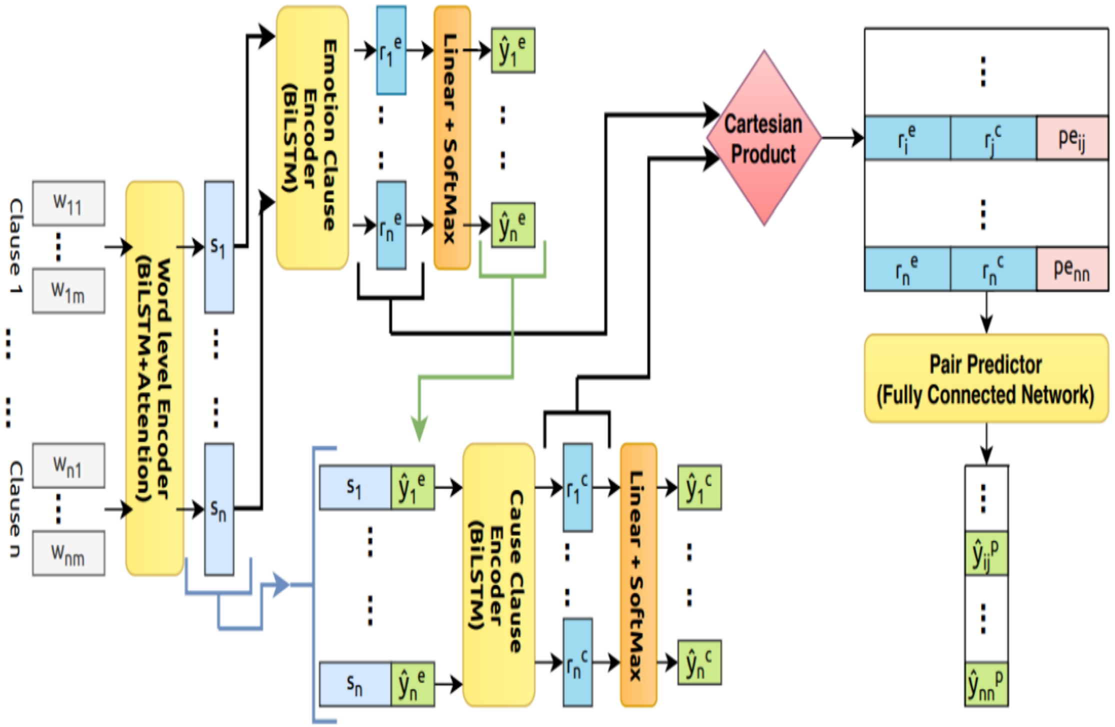
Clause 4: Mikhael and Harriet had organised a huge party for her.

- Above example paragraph contains two emotion-cause pairs
- Clause 2 is an emotion clause (anger) and also the corresponding cause clause (for not remembering her 40^{th} birthday)
- Clause 3 is an emotion clause (surprise)
- Clause 4 is its corresponding clause (organised a huge party for her)

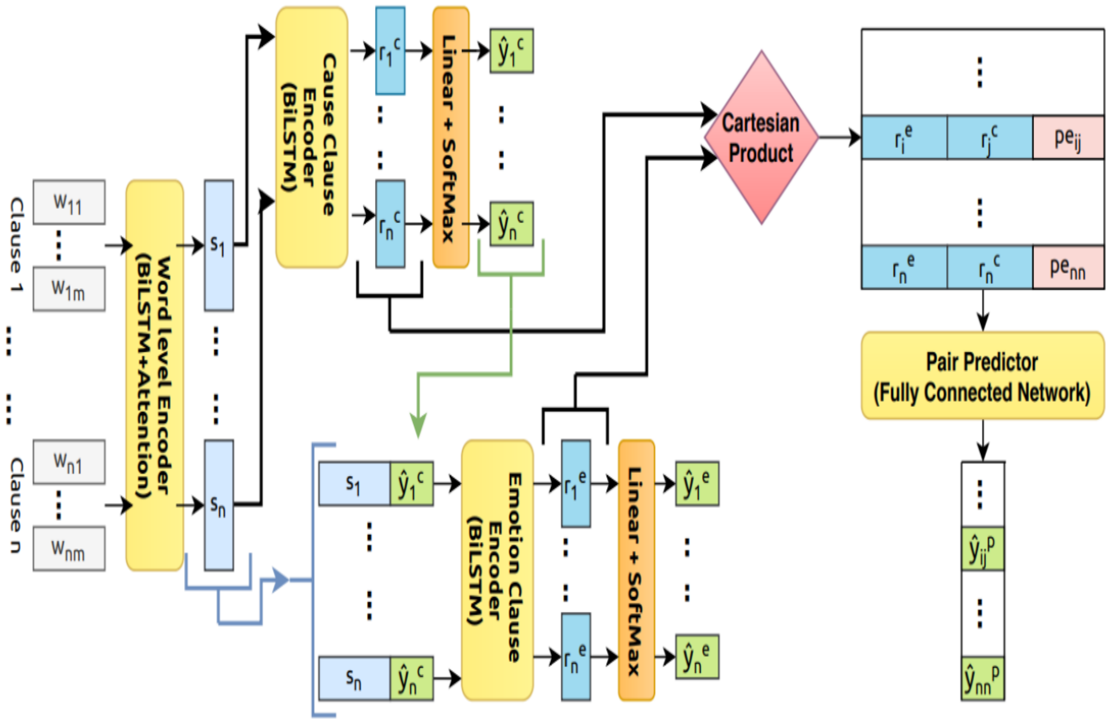
PREVIOUS RESEARCH ON ECPE

- Adopted from **“An End-to-End Network for Emotion-Cause Pair Extraction”** by A. Singh, S. Hingane, S. Wani, A. Modi et al. (https://arxiv.org/abs/2103.01544)
- Adopting the end-to-end model approach to demonstrate the effectiveness of joint training on the ECPE task
- Benchmark NTCIR-13 workshop dataset is used in their experiment with six emotions
  - Disgust, fear, anger, happiness, sadness and surprise

ARCHITECTURES



E2E-Pext(E) Architecture [21]



E2E-Pext(C) Architecture [21]

PERFORMANCES ON THE NTCIR-13 DATASET

Models	Emotion Extraction (%)			Cause Extraction (%)			Pair Extraction (%)		
	Precision	**Recall**	**F1 Score**	**Precision**	**Recall**	**F1 Score**	**Precision**	**Recall**	**F1 Score**
E2E-Pext(E)	71.63	67.49	69.43	66.36	43.75	52.26	51.34	49.29	**50.17**
E2E-Pext(C)	71.70	66.77	69.10	63.75	42.50	50.42	48.88	48.22	**48.37**

ADOPTING ECPE IN THIS PROJECT

- Architecture remains mostly the same as the ones used in the research paper, but hyperparameters will be tuned again as the datasets used are different
- Datasets used: Twitter dataset and Reddit dataset
- To perform ECPE in the context of depression

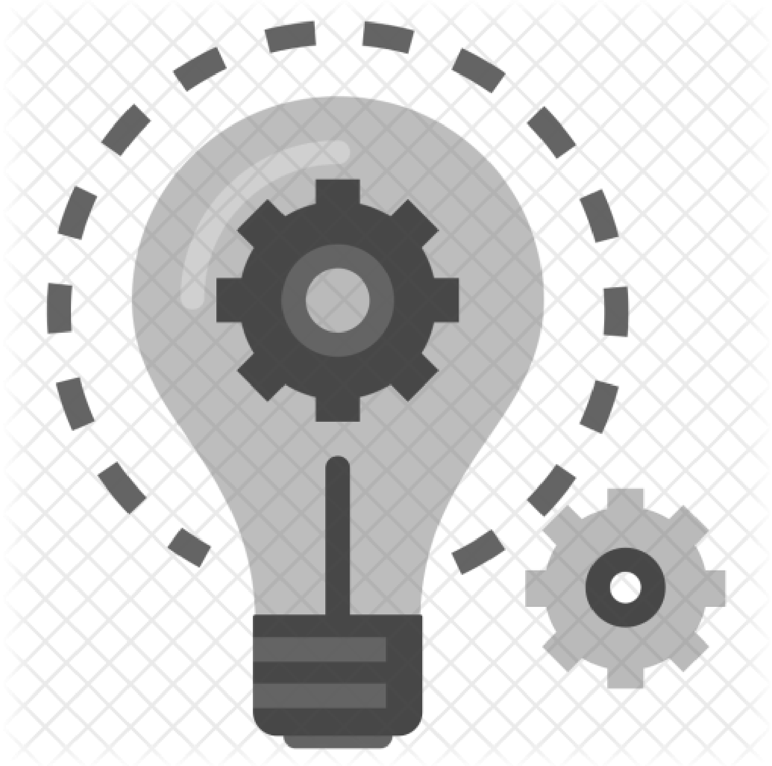
DATA PRE-PROCESSING

- Pre-process data to ensure that the data is presented in separate clauses for the ease of annotation for the emotion and the cause clauses
- The Reddit dataset exists entries with more than 200 clauses, making it computationally expensive for the models to train later
- Reddit data will be **summarised using extractive summarisation (subtask)** to reduce the number of clauses per text entry

Cleaning [17]

IMPLEMENTATION

- Manual annotation of the emotion and the cause for each of the data entry.
- Instead of six emotions in NTCIR-13, there is only one emotion in the annotated datasets which is labelled as “depressed”.



Lightbulb [22]

DATA ANNOTATION & FORMAT

```
77 6
 (6, 4),
1,null,null,My Anxiety Disorder  PTSD  Depression are real and
2,null,null,today I am battling
3,null,null,My happiness is fading and
4,null,null,my brain is messing with me
5,null,null,so badly  I have been trying hard not to cry  trying hard just to stay positive
6,depressed,struggling,but I am struggling
```

- 77 6 – The data has the index 77 and this piece of data contains 6 clauses
- (6,4) – This data's emotion is in clause 6 and the cause is in clause 4
- null – This clause does not contain any emotion or cause clause
- depressed, struggling – 'depressed' is the clause with the emotion and 'struggling' is the secondary emotion that can be found in the particular clause

MODEL PERFORMANCES

Variant	Dataset	Pair Extraction F1 Scores
E2E-PExt(E)	**Twitter**	**0.5150**
	Reddit	**0.5488**
	NTCIR-13 (benchmark)	0.5017
E2E-PExt(C)	**Twitter**	**0.5089**
	Reddit	**0.5333**
	NTCIR-13 (benchmark)	0.4837

LIMITATIONS

- Annotating the causes of depression might not be as straightforward as annotating the text as ‘depressive’ or ‘not depressive’
- Bias in annotation making the Pair Extraction F1-socre higher or lower than the values presented
- Need for experts to annotate the data but lack of time and cost, resulting in a compromise

Warning Sign [20]

04

FUTURE WORK

FUTURE WORK

- Model deployment on a website or phone application
- Additionally, a ‘report’ button can be created to inform the relevant authorities to take immediate and appropriate actions to prevent the worsening of one’s depression

Future [23]

THANK YOU

REFERENCES

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- [2] https://neilpatel.com/blog/essential-social-media-metrics/
- [3] https://pngimg.com/image/96242
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- [5] https://www.pinclipart.com/pindetail/xxmxwo_emotion-icon-packs-vector-svg-psd-emotions-png/
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Q & A