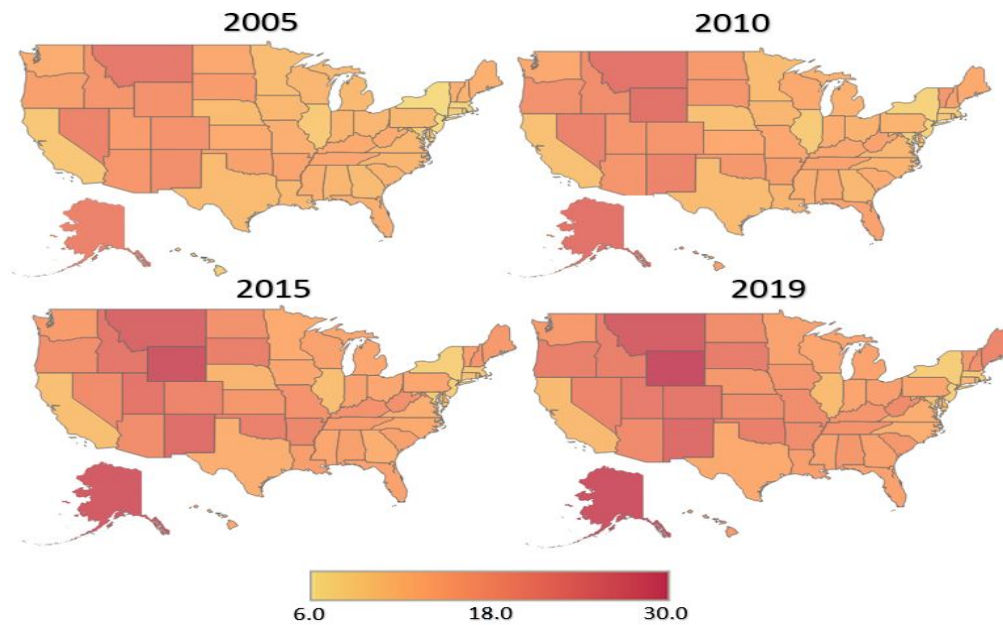# Predicting Depression and Anxiety on Reddit: a Multi-task Learning Approach

Shailik Sarkar, Abdulaziz Alhamadani, Lulwah Alkulaib, and Chang-Tien Lu

Background

❑ Mental health crisis through the years

Reddit

- Anonymity
- Long form submissions
- Topic specific subreddit

37 I'm cripplingly embarrassed of myself all the time

I usually have to be on my phone constantly or playing a game to not think of embarrassing done. I've stopped drawing because my mind always tends to brings up embarrassing mem myself and it hurts to think about. Not just memories but my existence in general is embarr me. I don't like reaching out to others because I feel creepy and socially inept and I feel hyst the time. I do the weirdest shit like zone out when someone talks to me all the time and che the middle of a conversation. I cant work a normal job because i get exhausted at least 2 ho cant form comprehensive sentences to co workers often. I cant really connect to others. I ca make friends or have the energy to make new ones or maintain any other than my one frier

5 Comments

10 they feel sorry when someone commits suicide

But they don't understand that they should be happy for them.

A friend of mine, his friend's father commited suicide. Drowned himself in a flood. They only know he killed himself because he said sorry in a diary. Missed opportunity in my opinion.

He shouldn't have left any evidence of his suicide. Made it look like an accident. They wouldn't have doubted it since it was a flood. But now they know he did it on purpose.
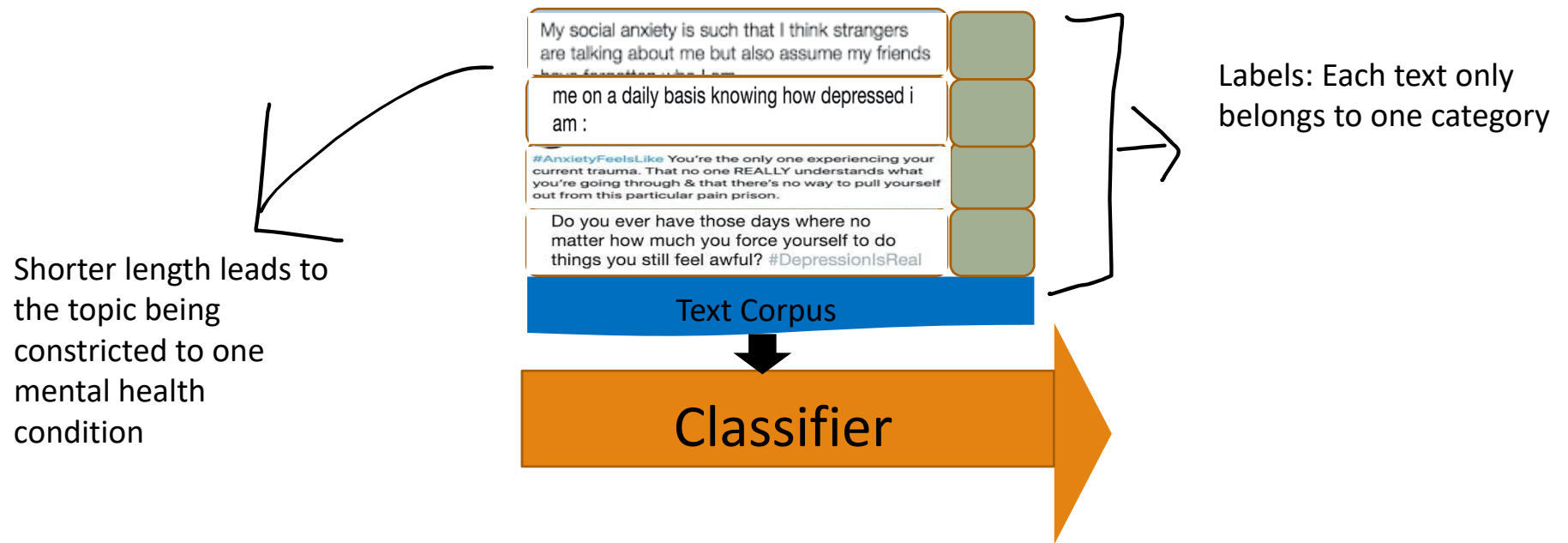
I like to think I'm just waiting for an opportunity like that. A chance to make it look like an accident. I'm not really sure if I'll go through with it, but my hourly thought is "I want to die."

My friend came to me sad about his death. I was tempted to tell him not to be sad. He should be happy for him. He's not suffering anymore. But he wouldn't understand. Noone could really tell who is suicidal. My friend doesn't know I'm suicidal.

I'm hoping for a chance to end my life with minimal heartaches for those who will care. Coz I'm damn sure they will start blaming themselves, when all they need to do is be happy for me.

Posted by u/EpilepticDentist 2 hours ago

4 Getting harder every day man

Keep getting more anxious by the night. Because of my poor performance in school due to my own mistakes and just keep digging a deeper hole for myself by not addressing my shortcomings sooner or better. I try to push back against it. Setting short term goals for myself every other day and week but im scared that ill easily fall back into it if im not careful. Unlike some here I (think I) have a support group to rely on but i just dont want to burdern or distract them. I have a family than i cant confess to out of shame and a friend that outright told me that she was there for me when I have suicidal thoughts but i just quitely brush her aside for some reason. Maybe out of spite? Or i just dont want her to worry idk. Right now this is the best i can do. Just ranting to strangers in the middle of the night to let it all out.

Background

❑ Most works deals with Short-form text like twitter

Shorter length leads to the topic being constricted to one mental health condition

Text Corpus

Labels: Each text only belongs to one category

Classifier

Background

❑Topic Modeling
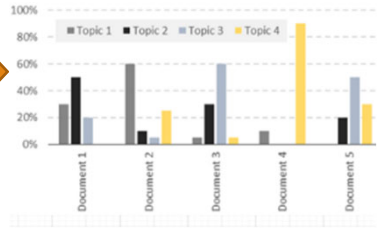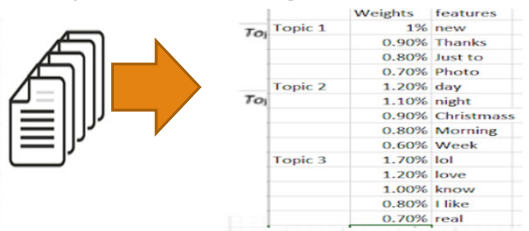
Documents

Topic Creation

Topic Allocation to Documents

❑Word Embedding

Source: https://nlp.stanford.edu/projects/glove/
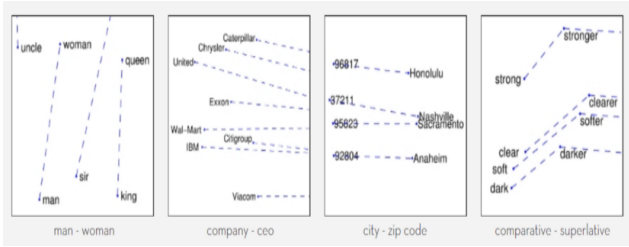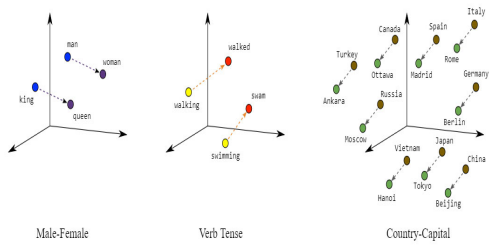
Source: https://developers.google.com/machine-learning/crash-course/embeddings/translating-to-a-lower-dimensional-space
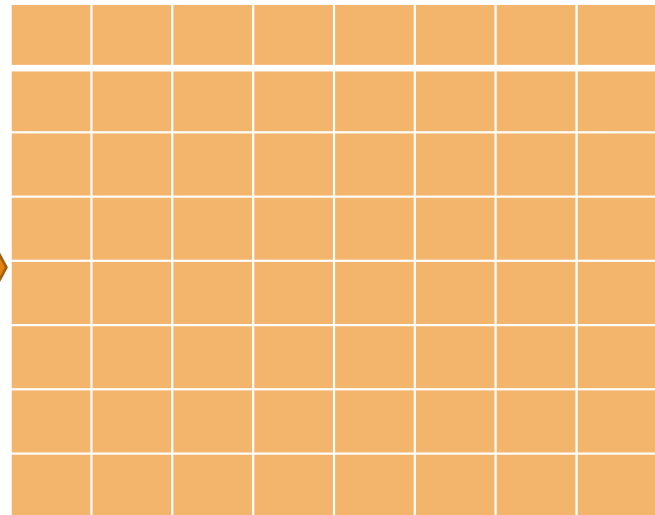
Embedding Vector

Background

❑ What are the key insights? Reliable lables?

1. For long form text: no consideration for presence of multiple conditions

2. For Reddit dataset: Over-reliance on subreddits

3. No model-level explainability despite using features like topic distribution or LIWC

4. A lack of suitable framework to reduce the cost of labeling

Challenges we address

❑How to alleviate labor inducing labeling process for large form texts like Reddit?

❑How to account for the different types of mental health conditions during modeling?

❑How to explain the prediction without a post-hoc method and gain insight ?

Solution?

❑How to alleviate labor inducing labeling process for large form texts like Reddit?- Active Learning

❑How to account for the different types of mental health conditions during modeling?

❑How to explain the prediction without a post-hoc method and gain insight ?

Solution?

❑How to alleviate labor inducing labeling process for large form texts like Reddit?- Active Learning

❑How to account for the different types of mental health conditions during modeling?- Multi-task Learning Framework

❑How to explain the prediction without a post-hoc method and gain insight ?

Solution?

❑How to alleviate labor inducing labeling process for large form texts like Reddit?- Active Learning

❑How to account for the different types of mental health conditions during modeling?- Multi-task Learning Framework

❑How to explain the prediction without a post-hoc method and gain insight ?-Topic Level Feature Explanation

Framework
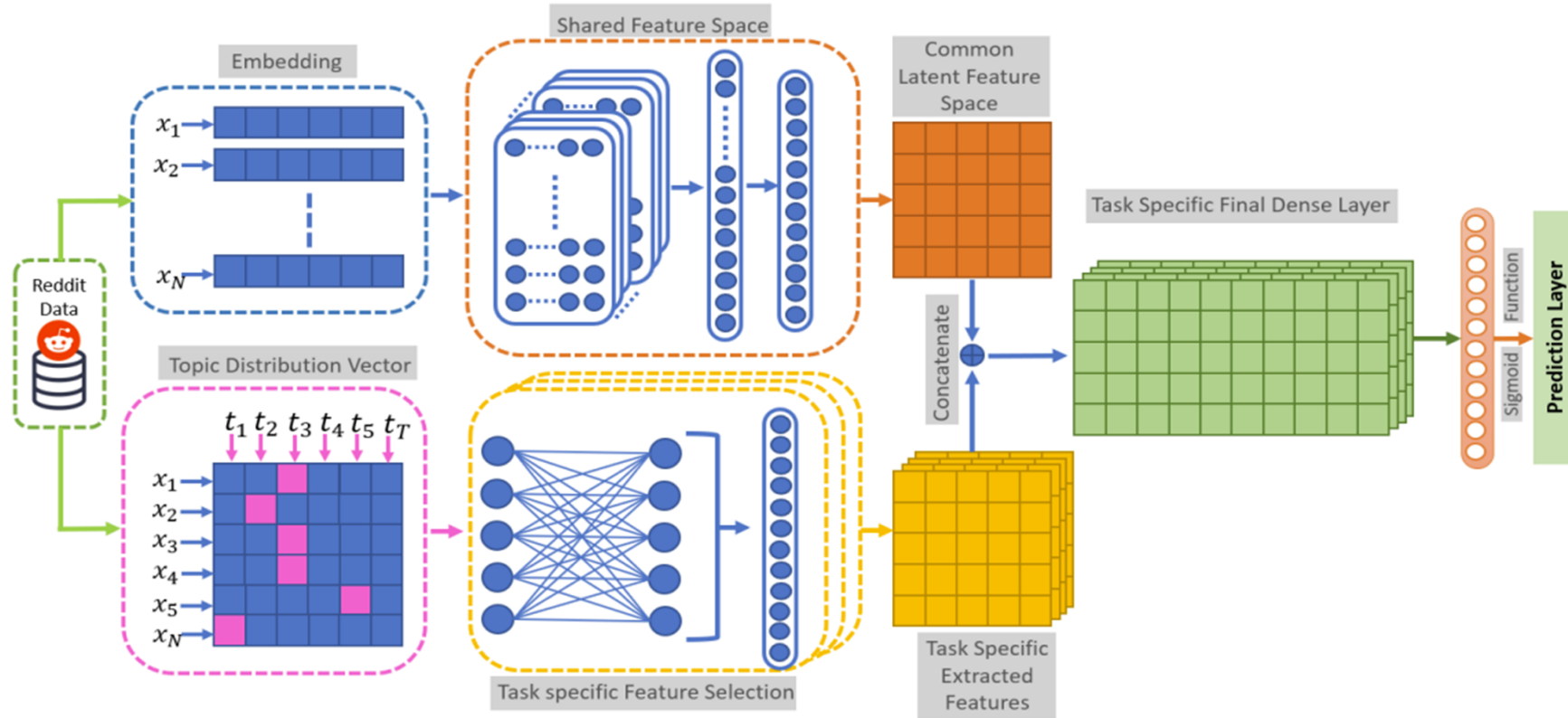
Active learning

Algorithm 1 Active Learning strategy for MTL

Input: Set of m Learners $[L_1, L_2, L_3...L_m]$, Initial Labeled Training Set of n $x = [x_1, x_2, x_i...x_n]$ set of unseen data points $x_{unseen} = [x_{n+1}, x_{n+2}...x_s]$ number of instances to pick after each iteration $= n_{poolsize}$

    while $i \neq iteration$ **do**
        $i = i + 1$
        $P = []$ /Probability Score
        while $j <= m$ **do**
            $model = Train(x)$
            $Y_{pred} = $ model.predict(x_{unseen})
            get probability score for each prediction and add them to P
        end while
        $Q = $ average over all probability score for consensus
        Calculate $D_{KL}(P||Q) = \sum_i P(i) \ln \frac{P(i)}{Q(i)}$ where i is a single instance of data
        Select top $n_{poolsize}$ from x_{unseen} and update x
    end while

AMMNet Training with different subset of initial training dataset in each of the m iteration

P is the prediction of individual learners and Q is the overall consensus

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Active learning

TABLE III: Active Learning training of AMMNet from initial labeled dataset of 2000

Training size	Accuracy
2000	0.832
2300	0.841
2600	0.839
2900	0.840
3200	0.842
3500	0.856
3800	0.869
4100	0.874
4400	0.871
4700	0.876
5000	0.875

- Labeling the dataset from initially curated dataset of 2000
- At each iteration the data instances for which the model is least confident or has the largest disagreement, are chosen
- Significant improvement in accuracy

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Multitask Learning Framework

☐ Use document level embedding for shared feature space and topic level for task specific

Shared Latent Feature

Task Specific Feature Learner (for explainability)

Each mental health condition is treated as a different task
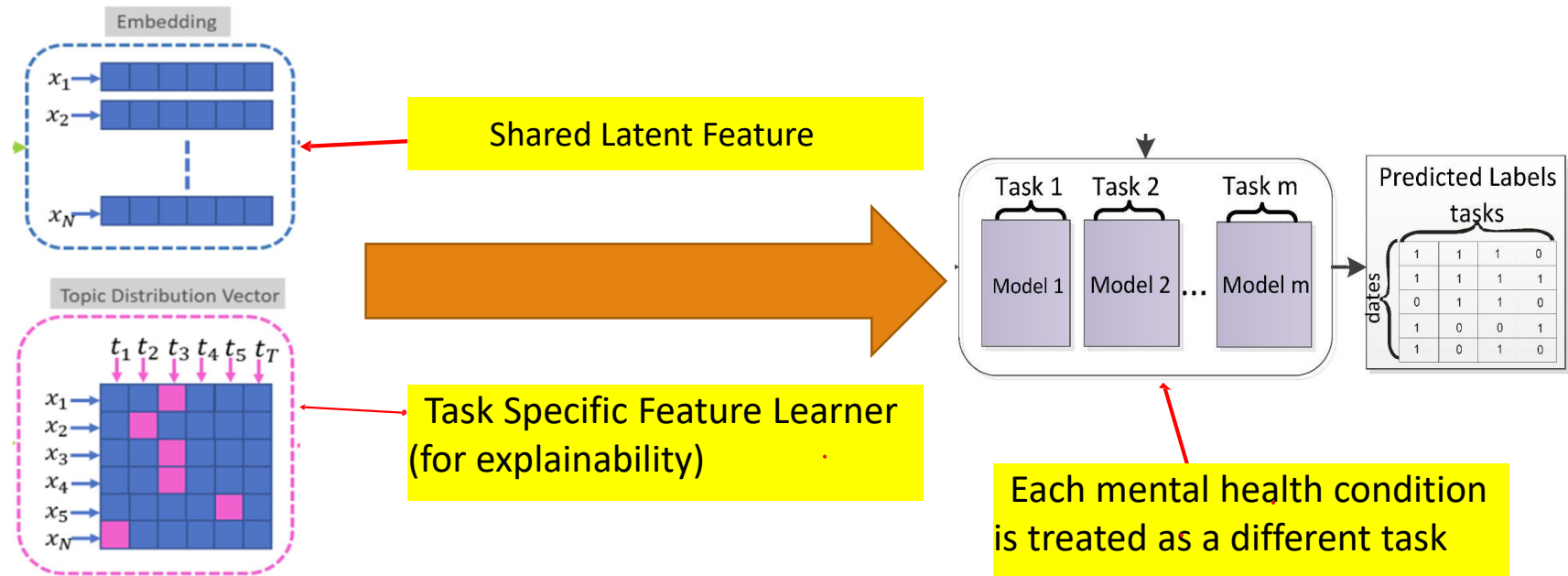
Multitask Learning Framework

$$\text{penalty} = \sum_{i=1}^{d} \|W_i\|_2$$

❑ Group Lasso penalty on topic distribution vector results in matrix sparsification

Task specific Feature Selection
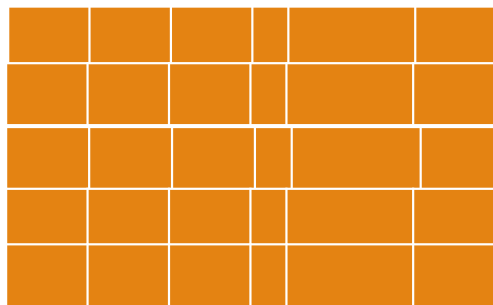
Weight Matrix with each row corresponding to a topic
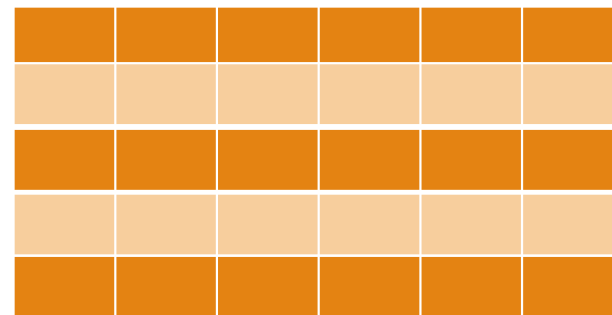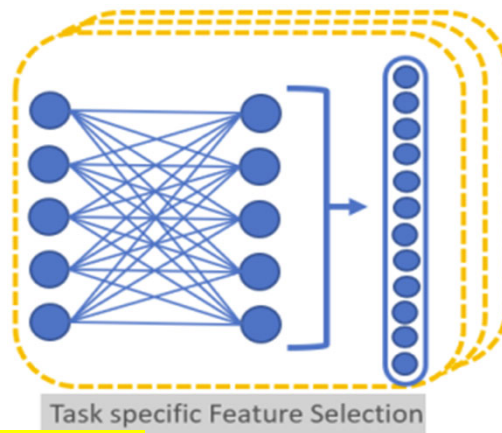
Sparsified Weight Matrix with the weight vector for non-important features reduced to a very small value

Training

Algorithm 2 Multi-task Learning Model

Input: $X_{embedding} \in R^{N \times D1}$, $X_{Topic} \in R^{N \times T}$, $Y \in R^{N \times tasks}$;

Initialize parameters: W, Θ_1, Θ_2;

   while t $<=$ epoch **do**

      $H_{shared} = F_{\Theta_1}(X_{embedding})$

      while i $<=$ tasks **do**

         $H_{topic} = X * W + bias$

         $H_{final} = Concat(\mathbf{H}_{topic}, \mathbf{H}_{shared})$

          $\hat{Y_i} = \mathbf{Dense}_{\Theta_2}(H_{final})$

      end while

      $E_{loss} = \sum_{j=1}^{n_{task}} \alpha_j (E_{BCELoss}(\hat{Y}, Y) + \beta \sum_{i=1}^{d} \|W_i\|_2)$

      Loss.backward()

      Update $W, \Theta 1, \Theta 2$

   end while

Experimental Results

TABLE I: Overall performance of baseline methods in comparison to our method on 5,000 Reddit submissions for Depression, Anxiety and Rest. Embedding(Emb), Percision (P), Recall (R), and micro-F1 (F1)

Emb	Logistic			Naive Bayes			KNN			SVM			Random Forest			MLP			AMMNet		
	P	R	F1	P	R	F1	P	R	F1	P	R	F1	P	R	F1	P	R	F1	P	R	F1
TF-IDF	0.732	0.748	0.739	0.732	0.715	0.723	0.708	0.721	0.714	0.781	0.768	0.774	0.749	0.724	0.736	0.794	0.805	0.794	-	-	-
BERT	0.761	0.752	0.756	0.718	0.695	0.706	0.713	0.738	0.720	0.819	0.801	0.809	0.742	0.726	0.733	0.817	0.841	0.828	-	-	-
LDA	0.749	0.738	0.743	0.741	0.729	0.735	0.762	0.745	0.753	0.827	0.807	0.816	0.761	0.738	0.749	0.819	0.833	0.825	-	-	-
BERTopic	0.750	0.739	0.744	0.729	0.715	0.722	0.761	0.740	0.750	0.826	0.815	0.820	0.771	0.752	0.761	0.847	0.826	0.836	-	-	-
LDA+BERT	0.769	0.751	0.759	0.756	0.732	0.743	0.752	0.763	0.757	0.851	0.839	0.845	0.758	0.773	0.765	0.875	0.861	0.868	0.876	0.865	0.870
BERTopic+BERT	0.785	0.771	0.778	0.741	0.727	0.734	0.745	0.728	0.736	0.879	0.863	0.869	0.779	0.765	0.772	0.873	0.859	0.866	**0.881**	**0.867**	**0.874**

Experimental Results

TABLE I: Overall performance of baseline methods on approximately 5,000 Reddit submissions for Depression, Anxiety and Rest. Embedding(Emb), Percision (P), Recall (R), and micro-F1 (F1)

Performance improves with Neural Networks

Emb	Logistic			Naive Bayes			KNN			SVM			Random Forest			MLP			AMMNet		
	P	R	F1	P	R	F1	P	R	F1	P	R	F1	P	R	F1	P	R	F1	P	R	F1
TF-IDF	0.732	0.748	0.739	0.732	0.715	0.723	0.708	0.721	0.714	0.781	0.768	0.774	0.749	0.724	0.736	0.794	0.805	0.794	-	-	-
BERT	0.761	0.752	0.756	0.718	0.695	0.706	0.713	0.738	0.720	0.819	0.801	0.809	0.742	0.726	0.733	0.817	0.841	0.828	-	-	-
LDA	0.749	0.738	0.743	0.741	0.729	0.735	0.762	0.745	0.753	0.827	0.807	0.816	0.761	0.738	0.749	0.819	0.833	0.825	-	-	-
BERTopic	0.750	0.739	0.744	0.729	0.715	0.722	0.761	0.740	0.750	0.826	0.815	0.820	0.771	0.752	0.761	0.847	0.826	0.836	-	-	-
LDA+BERT	0.769	0.751	0.759	0.756	0.732	0.743	0.752	0.763	0.757	0.851	0.839	0.845	0.758	0.773	0.765	0.875	0.861	0.868	0.876	0.865	0.870
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Experimental Results

TABLE I: Overall performance of baseline methods in comparison to our method on 5,000 Reddit submissions for Depression, Anxiety and Rest. Embedding(Emb), Percision (P), Recall (R), and micro-F1 (F1)

When used as the only feature, performance suffers

Emb	Logistic			Naive Bayes			RNN			SVM			Random Forest			MLP			AMMNet		
	P	R	F1	P	R	F1	P	R	F1	P	R	F1	P	R	F1	P	R	F1	P	R	F1
TF-IDF	0.732	0.748	0.739	0.732	0.715	0.723	0.708	0.721	0.714	0.781	0.768	0.774	0.749	0.724	0.736	0.794	0.805	0.794	-	-	-
BERT	0.761	0.752	0.756	0.718	0.695	0.706	0.713	0.738	0.720	0.819	0.801	0.809	0.742	0.726	0.733	0.817	0.841	0.828	-	-	-
LDA	0.749	0.738	0.743	0.741	0.729	0.735	0.762	0.745	0.753	0.827	0.807	0.816	0.761	0.738	0.749	0.819	0.833	0.825	-	-	-
BERTopic	0.750	0.739	0.744	0.729	0.715	0.722	0.761	0.740	0.750	0.826	0.815	0.820	0.771	0.752	0.761	0.847	0.826	0.836	-	-	-
LDA+BERT	0.769	0.751	0.759	0.756	0.732	0.743	0.752	0.763	0.757	0.851	0.839	0.845	0.758	0.773	0.765	0.875	0.861	0.868	0.876	0.865	0.870
BERTopic+BERT	0.785	0.771	0.778	0.741	0.727	0.734	0.745	0.728	0.736	0.879	0.863	0.869	0.779	0.765	0.772	0.873	0.859	0.866	**0.881**	**0.867**	**0.874**

Results with both topic distribution and BERT as features

Observation: Most Important Topic discovery

TABLE IV: Most Important Topics for Each Task

Topic id	Category	Top Phrases/Words
23	Anxiety	"take" "medication" "doctor" "day" "meds" "taking" "panic_attacks
8	Depression	"help" "really" ïve" "depression" "therapy" "need" änyone" "therapist" "Struggling"
3	Depression	"cant" "life" "dont" änymore" "dont_want" "die" everything
14	Other	"work" "job" "home" "go" "day" "covid
6	Anxiety	änxious" "feeling" "calm" öften" "lot" älso" älways" "worrying"

Observation: Most Important Topic discovery

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14	Other	"work" "job" "home" "go" "day" "covid
6	Anxiety	änxious" "feeling" "calm" öften" "lot" "älso" älways" "worrying"

General Vent

Really struggling at the moment. I cant tell if my depression is getting bad again, or if its the start of burnout from my job or my iron as im exhausted ALL the time. My house is filthy because i just have no motivation, i have stopped talking to all my friends and family and I'm just really struggling.

Any tips on pulling yourself out of a slump? Or at least coping tips to try and give myself more motivation

Original Class: Depression, Predicted: Depression
Contributing Topic: 8("depression, struggling")

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Observation: Most Important Topic discovery

TABLE IV: Most Important Topics for Each Task

Topic id	Category	Top Phrases/Words
23	Anxiety	"take" "medication" "doctor" "day" "meds" "taking" "panic_attacks
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3	Depression	"cant" "life" "dont" "ánymore" "dont_want" "die" "everything
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6	Anxiety	"änxious" "feeling" "calm" "öften" "lot" "älso" "always" "worrying"

1 I'm so, so tired of this particular fight.

nsfw

I've been fighting depression for more than half of my life. I'm exhausted. I'm on leave from work. I tried, after a month, going back part-time and tried for a few weeks but couldn't sustain it. I'm exhausted. My head is a neighborhood I don't want to live in. I've gone through so many new med trials, SSRIs, an anti-psychotic, Wellbutrin, anxiety meds. I tried TMS. I've tried ketamine.

I'm currently pursuing ECT but the particular combination of a disorganized psychiatrist and a VERY disorganized ECT program means that I'm having to shove everyone each half-step forward.

My psych has been seeing me every two weeks for the past couple mont[...] for suicidality (chronic SI) and repeatedly tells me that she doesn't trust [...] knows I know what to say to keep myself out of the hospital.

But even with that, I still have to call and text and scramble to get anyon[...] I am so. Fucking. Tired.

I cut (NSSI) for the first time in many months last night. I didn't try to co[...] anything, somewhere along the way I just found strategies to reserve it f[...] apart. I feel like I'm back-sliding.

I feel like I'm drowning. Like I'm thrashing around, calling out for help, everyone sees it happening and knows I'm drowning but they're asking me to hire and train the lifeguards.

I don't know how long I can keep this going.

Thanks for the space to share.

Comments   Award   Share   Save   ...

Subreddit: r/Depression
Label: Depression-1 Anxiety-1
Predicted: Depression-1, Anxiety-1

Anxiety Contributing Topic:23("medication,doctor,taking")

Depression Contributing Topic:3("therapist, doctor, anymore, life, can't ")

TABLE IV: Most Important Topics for Each Task

Topic id	Category	Top Phrases/Words
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6	Anxiety	änxious" "feeling" "calm" öften" "lot" "älso" älways" "worrying"

Why?

I sometimes wonder what I did wrong to have such a terrible life. My childhood wasn't good; which affected my adulthood. I suffer from severe depression and anxiety. I don't deserve the bs I go through. I look at other people and see how happy and successful they are; they have a good life, and I wonder why. Why do some people suffer and others don't? Why do some people go through trauma and abuse and others don't? Why do some people have mental health problems and others don't? Why do some people live the good life and others don't? WHY!?

These questions also play a big part in my lack of faith in god. I tried really really hard to [...] god. I started a journey a year ago and recently ended it because there's so much that d[...] sense to, so much that seems unfair, and it was making my depression worse! I have so [...] questions that no one has the answers to. I can't believe in something I don't understand[...]

I just know life is unfair.

Subreddit: r/Depression
Label: Depression-1 Anxiety-1
Predicted: Depression-0, Anxiety-1

Anxiety Contributing
Topic:6("anxious,worrying,feeling")

Conclusion

❑ Expands mental health prediction on Reddit from a subreddit-specific approach to a more general versatile input space

❑ A novel Active Multi-task learning model AMMNet, that extracts task-specific features in the form of topics and learns from a shared feature space of document-level embedding

❑ Data paucity issue in this domain can be solved by successfully adopting an active learning approach for less labor intensive labeling.

❑ Significant insight into the importance of different topics for predicting a given category of mental health conditions.

❑ A future direction of this work could be to look into specific mental disorders like "OCD" "BPD," or "bipolar" and try to predict or detect such conditions with explainability, as shown in this paper

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Thank You!

Welcome any related questions and suggestions