Detecting Depression from Text

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Hello!

I’m Varun!

I am a data scientist.

Depression is a common mood disorder, and in severe cases can be debilitating.

What Characterizes Depression?

- Excessive Sadness
- Anhedonia
- Insomnia
- Anxiety
- Appetite Loss
- Loss of self-worth
- Difficulty thinking/concentrating
- Thoughts of suicide

Mental Health is Worsening in 2020

Depression Rates are Increasing

62% increase in voluntary screenings for depression over 2019, with 8 out of 10 screened scoring moderate-severe

Suicidal Ideation is Increasing

Over 460,000 from last year on the same dataset

Mental Health Among Young People is at its Worst

Screening for depression and anxiety has increased, as have rates of severe depression.

Depression Effects are Non-Uniform

Disproportionately high rates among LGBTQ+ youth and youth who identify as mixed race

Many cases may be undiagnosed.

1. How We Can Help

What can we do to address this issue?

We may be able to detect these from text

- Excessive Sadness
- Anhedonia
- Insomnia
- Anxiety
- Appetite Loss
- Loss of self-worth
- Difficulty thinking/concentrating
- Thoughts of suicide

We want to

Better understand what depression sounds like from the patient-perspective

Find insights into the causes of depression

Use machine learning to detect depression from text

This is happening right now

- **“The Distress Analysis Interview Corpus of human and computer interviews,”** USC Institute for Creative Technologies
- **“Text-based depression detection on sparse data,”** Heinrich Dinkel, Mengyue Wu, Kai Yu
- **“82% of people believe robots can support their mental health better than humans can,”** a survey by Oracle and Workplace Intelligence

2. Data

We need real text corpi to investigate depression

Datasets

- **Reddit training corpus:** 30,000 posts scraped from Reddit's Depression community, and another 30,000 neutral text from r/happy and r/CasualConversation.
- **DAIC-WOZ:** An interview-based text corpus created during a study conducted by USC to support diagnostic methods for psychological distress
- **Time to Change:** A UK-based blog sharing real posts and stories from people struggling with depression

3. Building a Model

Let's teach a machine to understand depression!

Capturing Semantic Meaning

bERT word embeddings

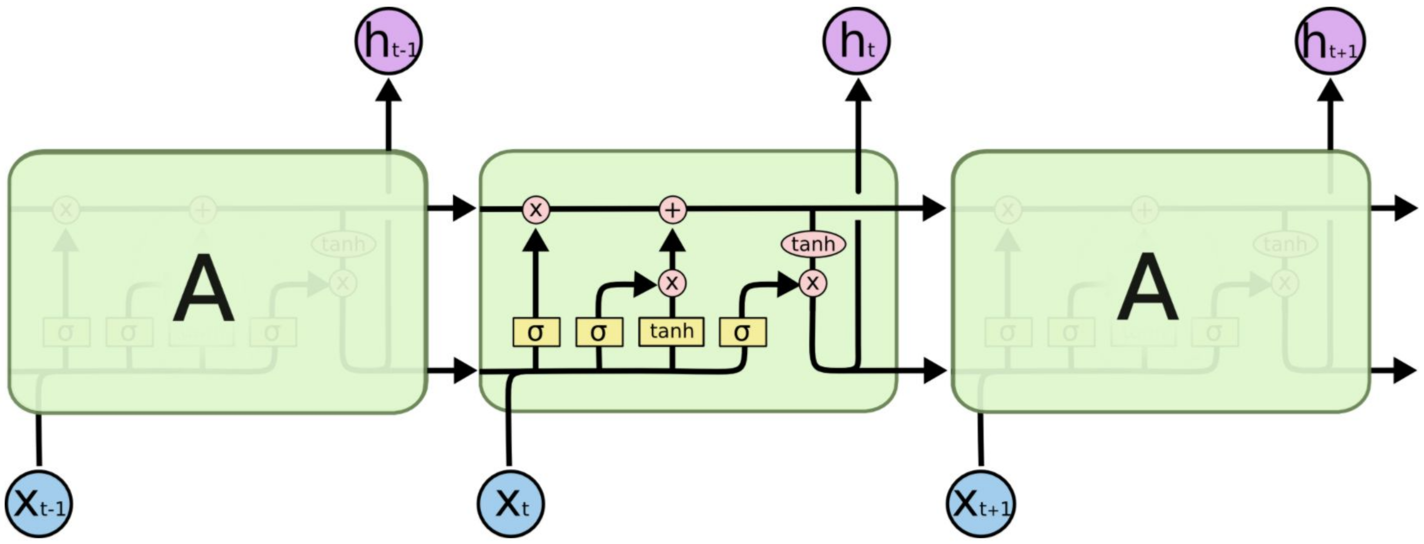
+

Bidirectional Long-Short-Term Memory Network

bERT: Bidirectional Encoder Representations

- Representations of text that go beyond word count → semantic meaning
    - “Apple pie is delicious”
    - “Apple stocks are up”

Long-Short-Term-Memory Network



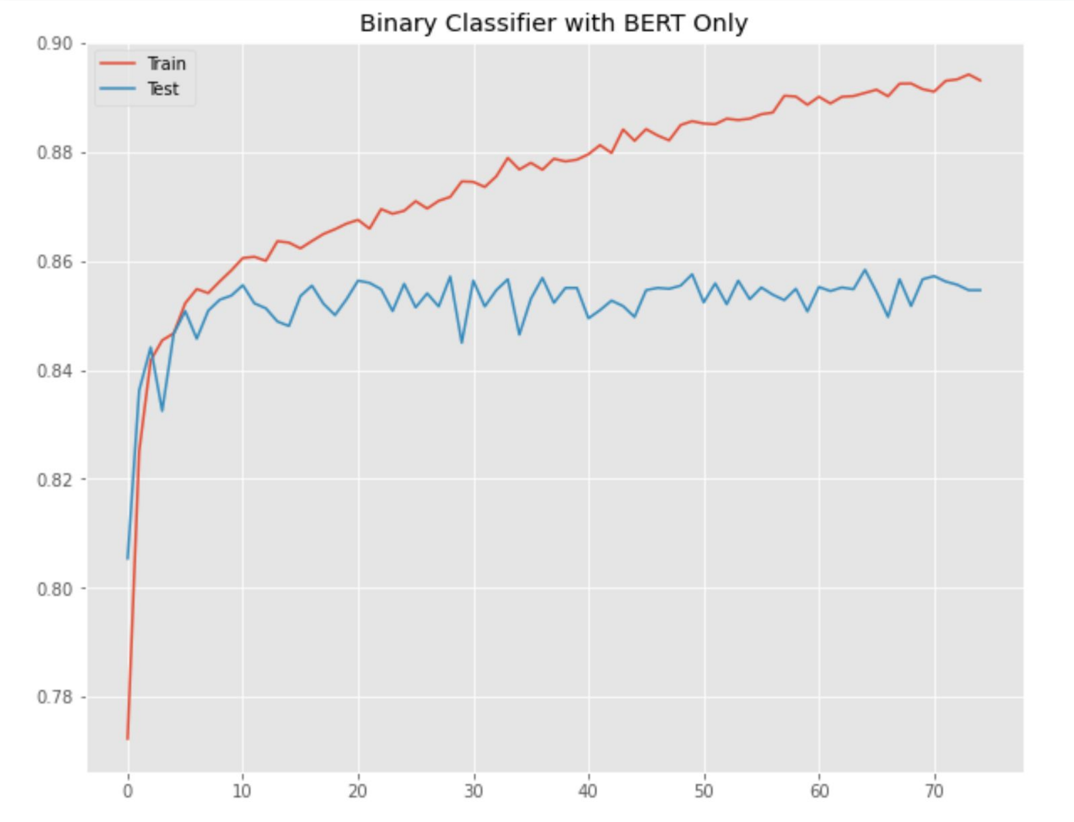
The repeating module in an LSTM contains four interacting layers.

Bi-LSTM

“I grew up in France... I speak fluent French.”

Bi-LSTM processes in both directions, and accounts for long-term dependencies.

Model Performance: Accuracy



Integrating a Second Model

- **vaderSentiment** scores were correctly accounting for basic linguistic negation
- A classifier was built on sentiment scores; this had a slightly clearer/**more observable disparity** between classes.
- This made it better for **basic/shorter** sentences, but also led to more **misclassification** for more complex sentences

Weighted Average

preds = (0.7 * preds_l) + (0.3 * preds_s)

*plus a rule to default to sentiment when the other model gets confused

Model	Accuracy	Recall
bERT-BiLSTM	0.85	0.86
vaderSentiment	0.78	0.78
Combined	0.86	0.87

Demo!

Key Takeaways: Analyzing Depression

More Verbose = More Signal

In particular with the more complex Bi-LSTM model, more verbose text gives the semantic analysis/LTD more to work with

Simpler Text, Simpler Model

A simple sentiment-based model performs better with less text, when less information needs to be extracted from the text.

How Can We Use This?

Part of Therapy Schedule

Patients can use the application to track mood/likelihood of depression over periods of time; sent directly to psychiatrist

Holistic Analysis Over Many Users

If deployed to an open platform, then with consent and permission, we could anonymously analyze factors that correlate with higher rates of depression

The Good News

- Depression is **treatable**
- Most successful treatments include therapy **combined** with some form of antidepressant
- **Early detection** can potentially help prevent cases from getting worse and refine treatment techniques

Thank You!

Questions?

Appendix

bERT + BiLSTM Model Architechture

```
model_l = Sequential()

model_l.add(Conv1D(32, 7, activation = 'relu'))
model_l.add(MaxPooling1D())
model_l.add(Bidirectional(LSTM(24)))
model_l.add(Dense(64,activation='relu',kernel_regularizer=l2(0.001)))
model_l.add(Dropout(0.5))
model_l.add(Dense(64,activation='relu',kernel_regularizer=l2(0.001)))
model_l.add(Dropout(0.5))
model_l.add(Dense(32,activation='relu',kernel_regularizer=l2(0.001)))

model_l.add(Dense(1,activation='sigmoid'))
```

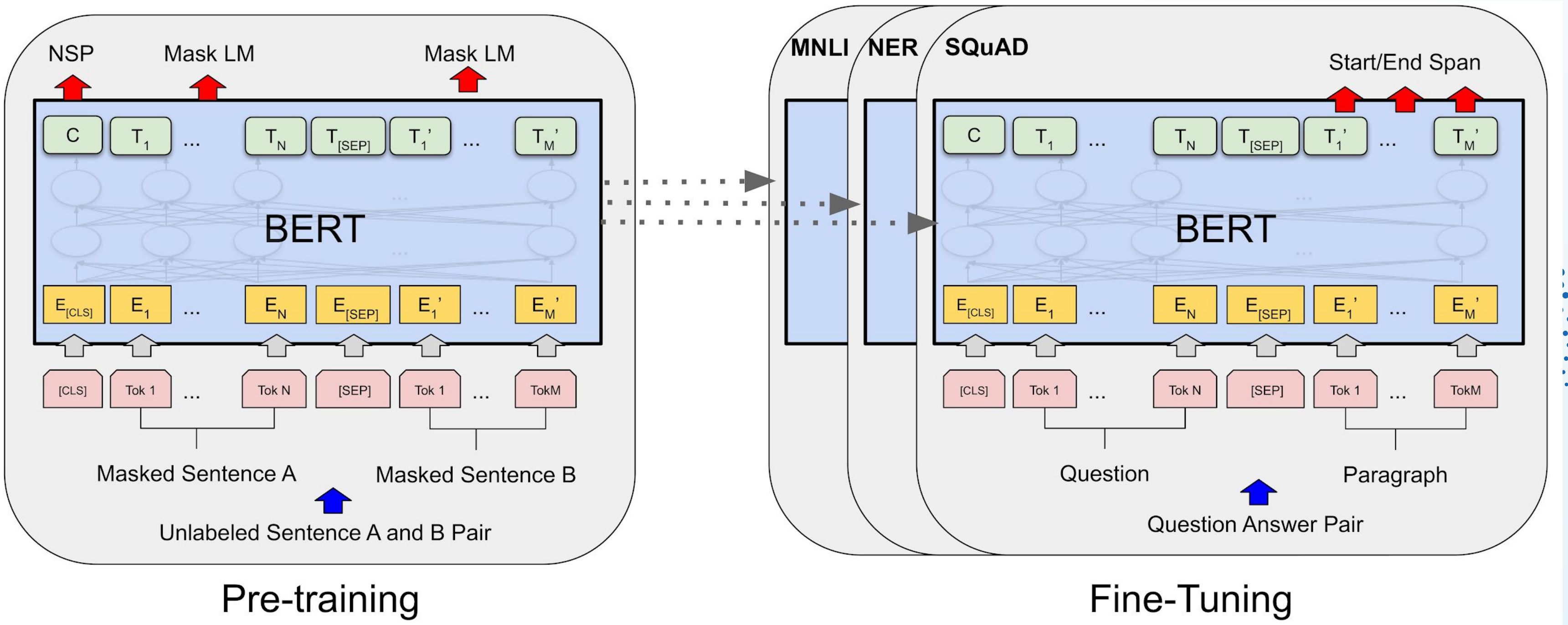
Sentiment Model Architecture

```
model_s = Sequential()

model_s.add(Input(shape=(X_train.shape[1],)))
model_s.add(Dense(64,activation='relu'))
model_s.add(Dropout(0.5))
model_s.add(Dense(64,activation='relu'))
model_s.add(Dropout(0.5))
model_s.add(Dense(32,activation='relu'))

model_s.add(Dense(1,activation='sigmoid'))
```

bERT


NSP
Mask LM
Mask LM
C
T1
TN
T[SEP]
T1'
TM'
BERT
E[CLS]
E1
EN
E[SEP]
E1'
EM'
[CLS]
Tok 1
Tok N
[SEP]
Tok 1
TokM
Masked Sentence A
Masked Sentence B
Unlabeled Sentence A and B Pair
Pre-training
MNLI
NER
SQuAD
Start/End Span
Question
Paragraph
Question Answer Pair
Fine-Tuning

Frequently Occurring Words in Depression Corpus

job

friends

work

life

year

parents

school

family

Confusion Matrix: Combined Model