‘WeNeverMeetEachOther’

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Predicting Satisfaction from Text Reviews

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Background

ImageNet moment of NLP - Transfer Learning

Recent Breakthroughs

IMAGENET

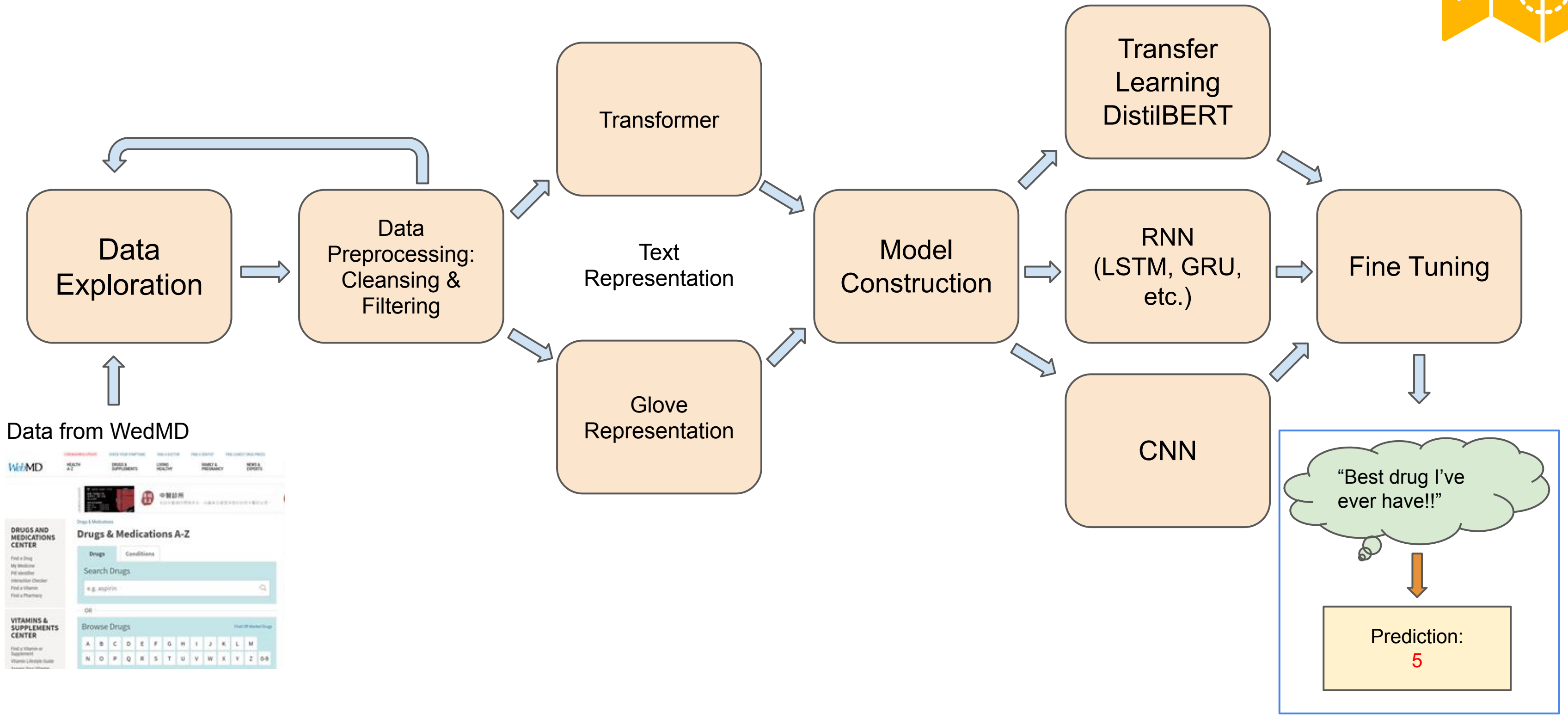
- Breakthrough in NLP in the last few years
    - Attention and Transformer (Vaswani et. al., 2017)
    - Contextualized Embeddings (Peters et. al. 2018)
    - GPT-2, BERT, ULMFit

" It is very likely that in a year's time NLP practitioners will download pretrained language models rather than pretrained word embeddings "

Aims and Objectives

- Aim
  - Build a model at predicting the sentiment polarity of reviews
  - Positive - Neutral - Negative class labels
  - Compare baseline model, CNN, RNN, BERT

- Objective
  - Achieve a high F1 score relative to baseline models
  - F1 score (aggregate of precision and recall)


Transformer
Transfer Learning DistilBERT
Data Exploration
Data Preprocessing: Cleansing & Filtering
Text Representation
Model Construction
RNN (LSTM, GRU, etc.)
Fine Tuning
Glove Representation
CNN
Data from WedMD
WebMD
DRUGS AND MEDICATIONS CENTER
Drugs & Medications A-Z
Drugs
Conditions
Search Drugs
VITAMINS & SUPPLEMENTS CENTER
Browse Drugs
“Best drug I’ve ever have!!”
Prediction:
5

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Data Exploration & Processing

Keyword: WedMD, Bot Data, Undersampling

WebMD Drug Reviews Dataset

- The data was scraped from the WebMD website
- We accessed it through Kaggle, where it had already been gathered and made available.
- There are *362,806* entries in the dataset and each one has 12 features

	Age	Condition	Date	Drug	DrugId	EaseofUse	Effectiveness	Reviews	Satisfaction	Sex	Sides	UsefulCount
0	75 or over	Stuffy Nose	9/21/2014	25dph-7.5peh	146724	5	5	I'm a retired physician and of all the meds I have tried for my allergies (seasonal and not) - this one is the most effective for me. When I first began using this drug some years ago - tiredness as a problem but is not currently.	5	Male	Drowsiness, dizziness , dry mouth /nose/throat, headache , upset stomach , constipation , or trouble sleeping may occur.	0

Data Cleaning

- To begin with we removed any entries with null or blank reviews.
- Upon exploration of the reviews in the dataset it was clear there was a large amount of duplication.
- There were two main kinds of duplication:
    - Review submissions generated through some automatic process such as a bot
    - Data entries mistakenly duplicated by the website or during the scraping

Automatically Generated Reviews

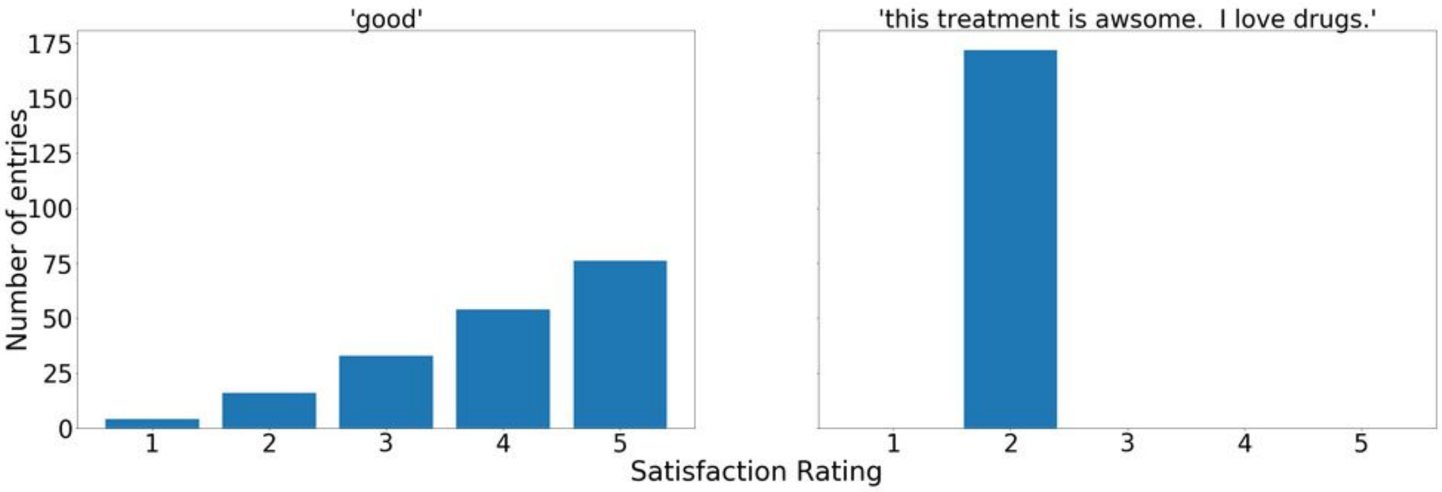
- When we examine the the most repeated reviews, we can see the difference between genuine and non-genuine

```
Number of entries with review "good": 183

Number of unique items in Age              10
Number of unique items in Condition        73
Number of unique items in Date             134
Number of unique items in Drug             144
Number of unique items in DrugId           112
Number of unique items in EaseofUse        5
Number of unique items in Effectiveness    5
Number of unique items in Reviews          1
Number of unique items in Satisfaction     5
Number of unique items in Sex              2
Number of unique items in Sides            91
Number of unique items in UsefulCount      12
```

```
Number of entries with review "this treatment is awsome.  I love drugs.": 172

Number of unique items in Age              1
Number of unique items in Condition        1
Number of unique items in Date             4
Number of unique items in Drug             167
Number of unique items in DrugId           160
Number of unique items in EaseofUse        1
Number of unique items in Effectiveness    1
Number of unique items in Reviews          1
Number of unique items in Satisfaction     1
Number of unique items in Sex              1
Number of unique items in Sides            132
Number of unique items in UsefulCount      3
```

Automatically Generated Reviews

- Here we can see the difference clearly in the distribution of ratings

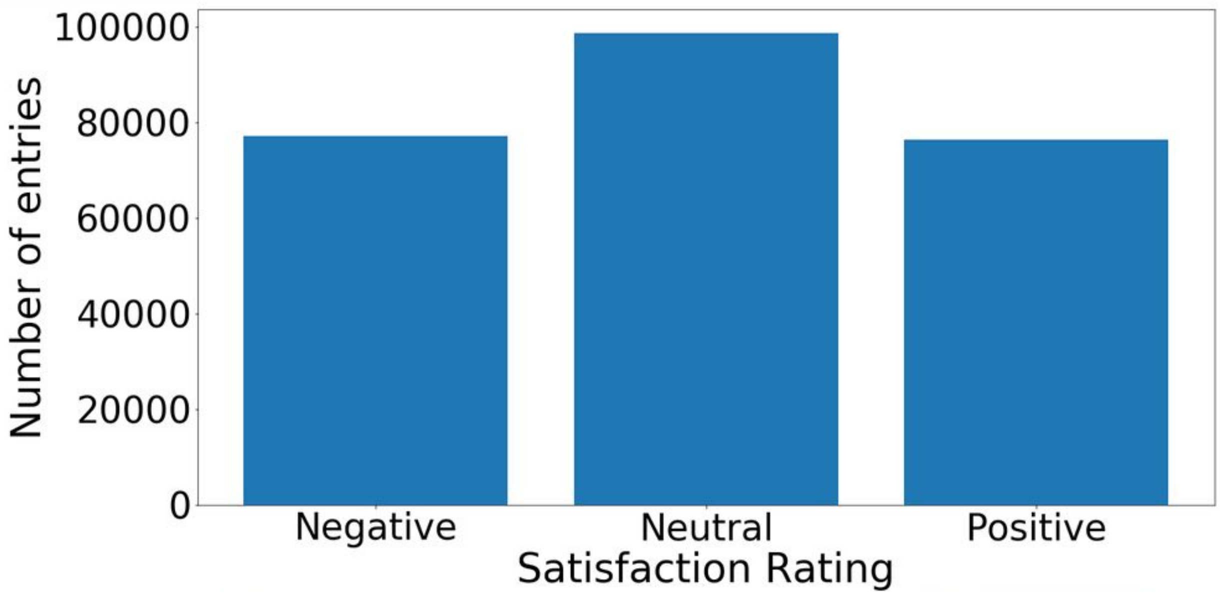


Final Cleaning and Preprocessing

- The accidentally duplicated entries were all identical, so we picked one randomly out of each set of duplicates to keep
- There were two invalid entries of 6 and 10 in Satisfaction which we removed
- And finally as our model assumes reviews have either positive, negative or neutral sentiment we binned the satisfaction ratings into these categories.

Cleaned Dataset

- The final valid dataset we used contained 252072 unique entries, with the satisfaction ratings distributed as below



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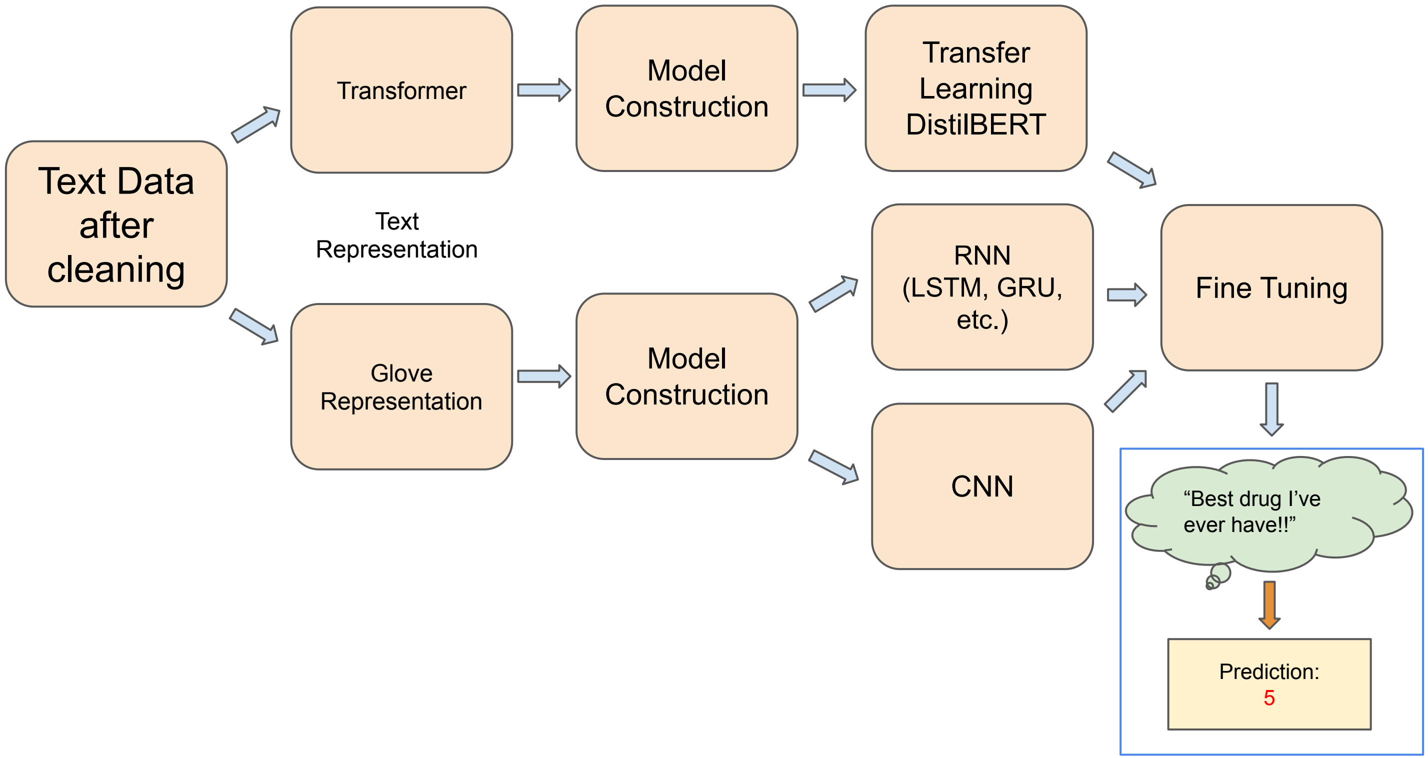
Text Preprocessing & Word Embedding

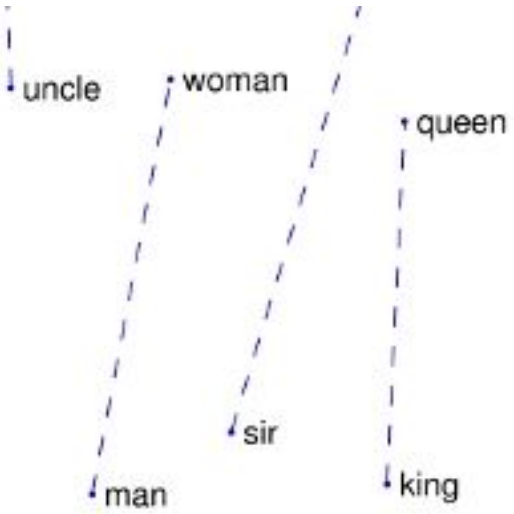
Keyword: Transformer, GloVe, Coverage_Checking, Misspell



Text Data after cleaning
Transformer
Model Construction
Transfer Learning DistilBERT
Text Representation
Glove Representation
Model Construction
RNN (LSTM, GRU, etc.)
CNN
Fine Tuning
“Best drug I’ve ever have!!”
Prediction:
5

Global Vector (GloVe)

- By Stanford NLP project team (2014)
- **Assumption**: word-word co-occurrence has underlying meaning
- Trained on the non-zero entries of a global word-word **co-occurrence matrix**
- **Dimensions** options: 50, 100, 200, 300



GloVe: Preprocessing of Text to Fit

- **Assumption**: as long as it is captured by GloVe, it does not have to be processed
- **Steps**: preprocess to increase text coverage until satisfied:
  - Vocab Coverage
  - All-text Coverage

	Vocab Coverage	All-text Coverage
First check	9.73%	75.91%
Clean Special char	18.93%	86.00%
Lower Text	25.87%	97.96%
Replace Number	26.62%	98.24%
Spell Check (word freq>60)	26.72%	98.59%

Method inspired by competitors in Kaggle: *Quora Insincere Questions Classification*

BERT-specific Embedding

- Specifically used for BERT
- Two additional embeddings:
  - **Segment**: classify sentence in pair
  - **Position**: state position of word
- BERT will be focused in later section

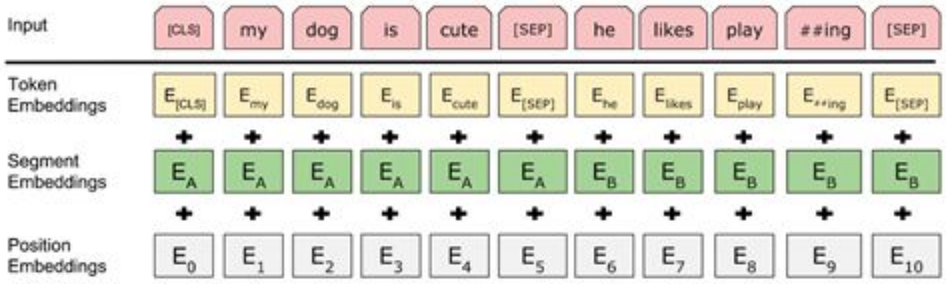


Figure 2: BERT input representation. The input embeddings is the sum of the token embeddings, the segmentation embeddings and the position embeddings.

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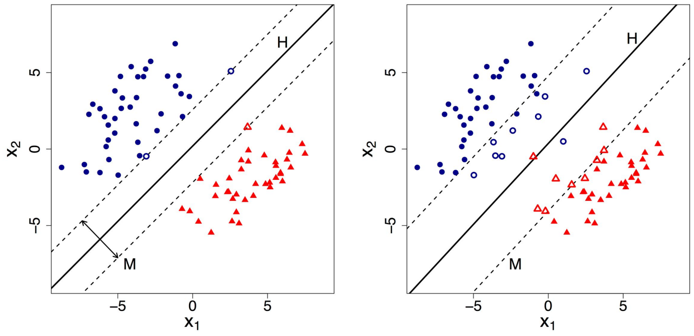
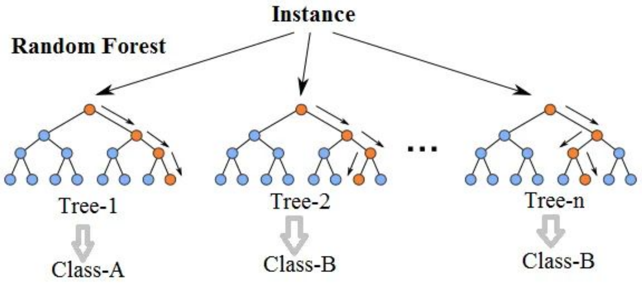
Model Overview

Keyword: CNN, RNN, LSTM, BERT

Base Model: Random Forest & SVM

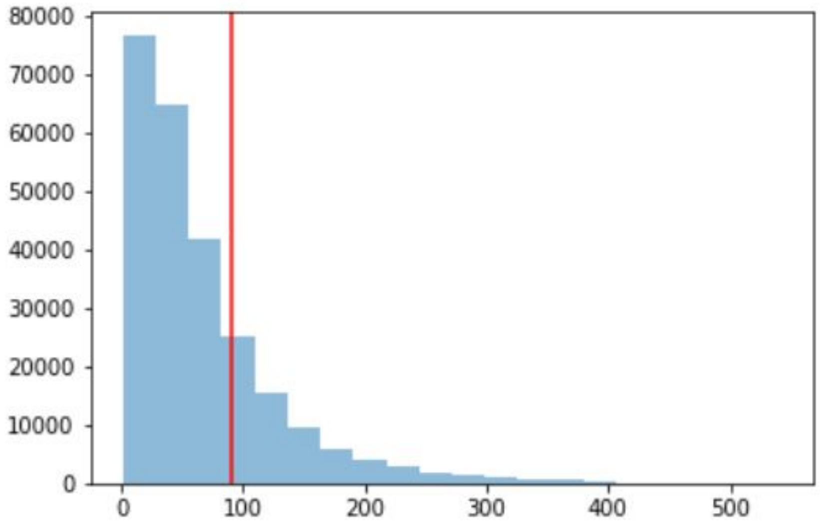
- Baseline Model:
  - Random Forest
  - Support Vector Machine
- **Objectives**: baseline to compare performance with advanced model





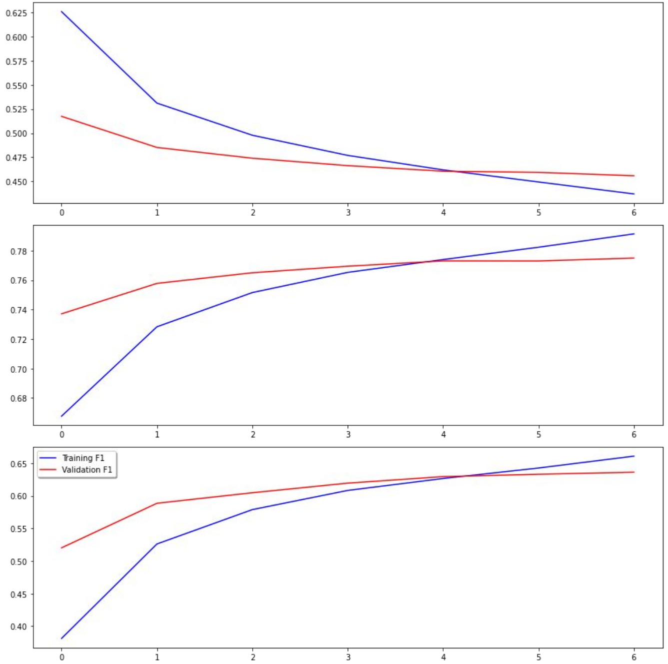
Further Model: CNN, RNN

- Window size: **90**
- **Layer** involved:
  - Dropout
  - Global pooling
  - ConV_filter
  - Bidirectional
  - LSTM
  - GRU
  - Concatenate
  - etc..
- **Technique** involved:
  - Decaying learning rate



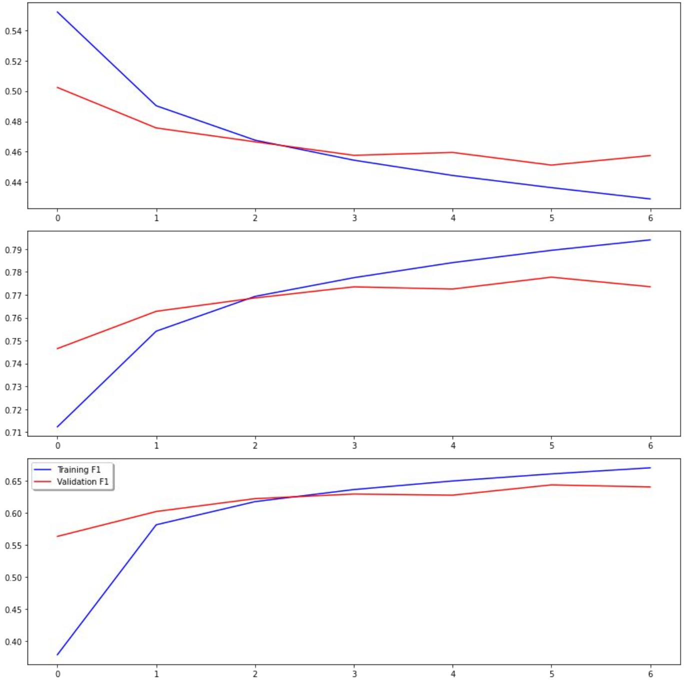
Convolutional Neural Network

```
Layer (type)                     Output Shape         Param #     Connected to
==================================================================================================
input_22 (InputLayer)            (None, 90)           0
__________________________________________________________________________________________________
embedding_24 (Embedding)         (None, 90, 300)      45954300    input_22[0][0]
__________________________________________________________________________________________________
spatial_dropout1d_22 (SpatialDr (None, 90, 300)      0           embedding_24[0][0]
__________________________________________________________________________________________________
reshape_22 (Reshape)             (None, 90, 300, 1)   0           spatial_dropout1d_22[0][0]
__________________________________________________________________________________________________
conv2d_85 (Conv2D)               (None, 90, 1, 36)    10836       reshape_22[0][0]
__________________________________________________________________________________________________
conv2d_86 (Conv2D)               (None, 89, 1, 36)    21636       reshape_22[0][0]
__________________________________________________________________________________________________
conv2d_87 (Conv2D)               (None, 88, 1, 36)    32436       reshape_22[0][0]
__________________________________________________________________________________________________
conv2d_88 (Conv2D)               (None, 86, 1, 36)    54036       reshape_22[0][0]
__________________________________________________________________________________________________
max_pooling2d_85 (MaxPooling2D) (None, 1, 1, 36)     0           conv2d_85[0][0]
__________________________________________________________________________________________________
max_pooling2d_86 (MaxPooling2D) (None, 1, 1, 36)     0           conv2d_86[0][0]
__________________________________________________________________________________________________
max_pooling2d_87 (MaxPooling2D) (None, 1, 1, 36)     0           conv2d_87[0][0]
__________________________________________________________________________________________________
max_pooling2d_88 (MaxPooling2D) (None, 1, 1, 36)     0           conv2d_88[0][0]
__________________________________________________________________________________________________
concatenate_22 (Concatenate)     (None, 4, 1, 36)     0           max_pooling2d_85[0][0]
                                                                  max_pooling2d_86[0][0]
                                                                  max_pooling2d_87[0][0]
                                                                  max_pooling2d_88[0][0]
__________________________________________________________________________________________________
flatten_22 (Flatten)             (None, 144)          0           concatenate_22[0][0]
__________________________________________________________________________________________________
dropout_22 (Dropout)             (None, 144)          0           flatten_22[0][0]
__________________________________________________________________________________________________
dense_22 (Dense)                 (None, 3)            435         dropout_22[0][0]
==================================================================================================
Total params: 46,073,679
Trainable params: 46,073,679
Non-trainable params: 0
__________________________________________________________________________________________________
```



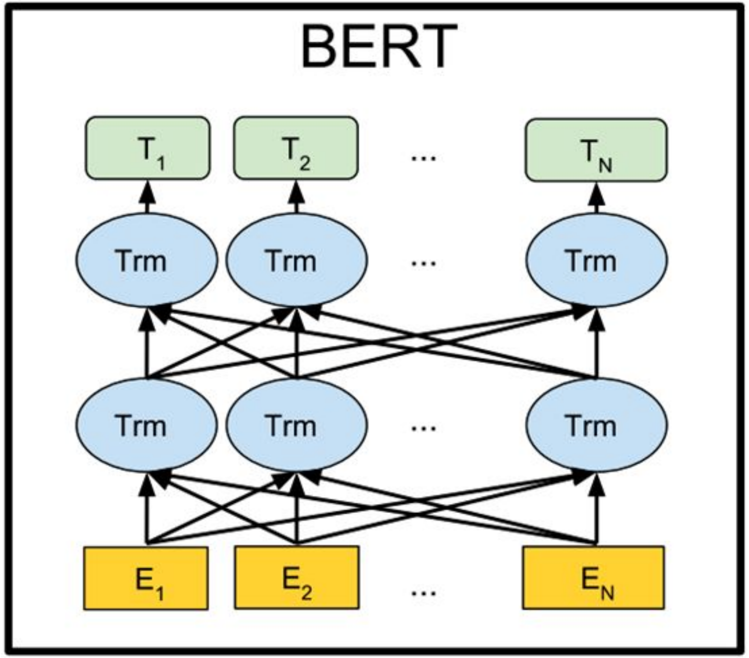
Recurrent Neural Network

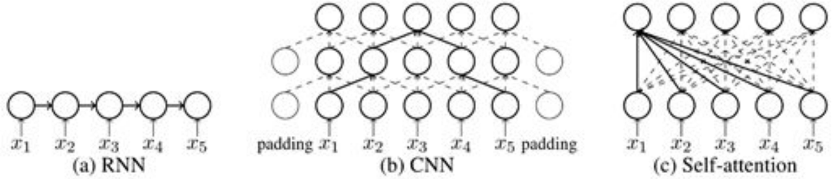
```
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
input_3 (InputLayer)            (None, 90)           0
__________________________________________________________________________________________________
embedding_1 (Embedding)         (None, 90, 300)      45954300    input_3[0][0]
__________________________________________________________________________________________________
spatial_dropout1d_3 (SpatialDro (None, 90, 300)      0           embedding_1[2][0]
__________________________________________________________________________________________________
bidirectional_5 (Bidirectional) (None, 90, 128)      186880      spatial_dropout1d_3[0][0]
__________________________________________________________________________________________________
bidirectional_6 (Bidirectional) (None, 90, 128)      74112       bidirectional_5[0][0]
__________________________________________________________________________________________________
global_average_pooling1d_3 (Glo (None, 128)          0           bidirectional_6[0][0]
__________________________________________________________________________________________________
global_max_pooling1d_3 (GlobalM (None, 128)          0           bidirectional_6[0][0]
__________________________________________________________________________________________________
concatenate_3 (Concatenate)     (None, 256)          0           global_average_pooling1d_3[0][0]
                                                                 global_max_pooling1d_3[0][0]
__________________________________________________________________________________________________
dense_5 (Dense)                 (None, 16)           4112        concatenate_3[0][0]
__________________________________________________________________________________________________
dropout_3 (Dropout)             (None, 16)           0           dense_5[0][0]
__________________________________________________________________________________________________
dense_6 (Dense)                 (None, 3)            51          dropout_3[0][0]
==================================================================================================
Total params: 46,219,455
Trainable params: 265,155
Non-trainable params: 45,954,300
__________________________________________________________________________________________________
```



BERT: Bidirectional Encoder Representations from Transformer

- Invented by Google (2017)
- Based on *transformer*
- Outperform RNN & CNN
- Advantage above traditional NN: <u>any position can attend to all position</u>





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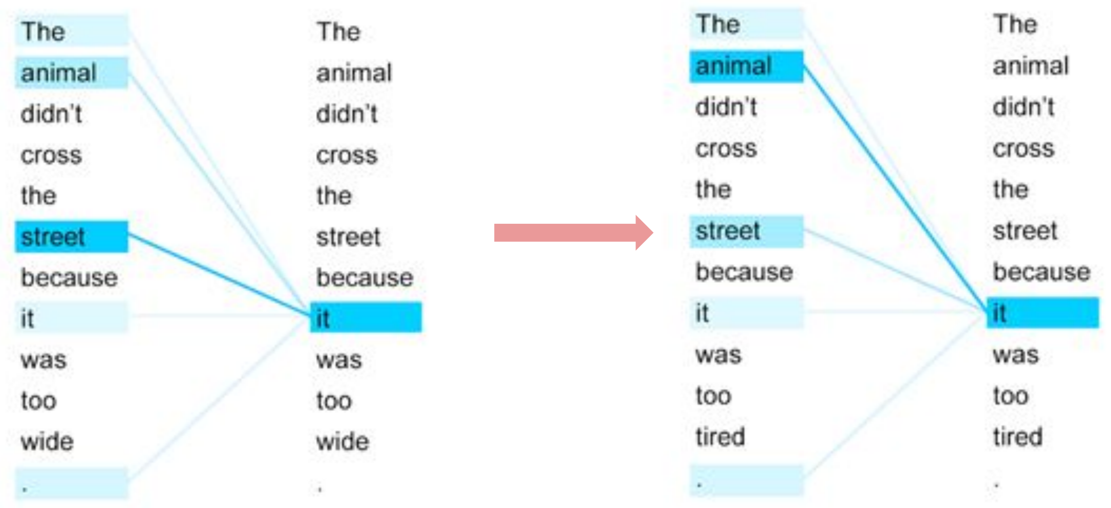

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Result

Keyword:

Result of Baseline model

	Accuracy	F1_Score (Marco)	Train_Time
Random_Forest_90	40.242%	0.3964	248s
Random_Forest_1000	40.244%	0.3958	2615s
SVM	40.756%	0.2697	17362s

Result of Advanced model

	Accuracy	F1_Score (Marco)	F1_Score ('Negative')	F1_Score ('Neutral')	F1_Score ('Positive)
CNN	66%	0.66	0.70	0.62	0.62
RNN	66%	0.66	0.70	0.63	0.66
DistillBERT	68%	0.68	0.76	0.66	0.63

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Conclusion & Reflection

Keyword: Pre-Trained Language Model,
Know your data, Task-Specification,

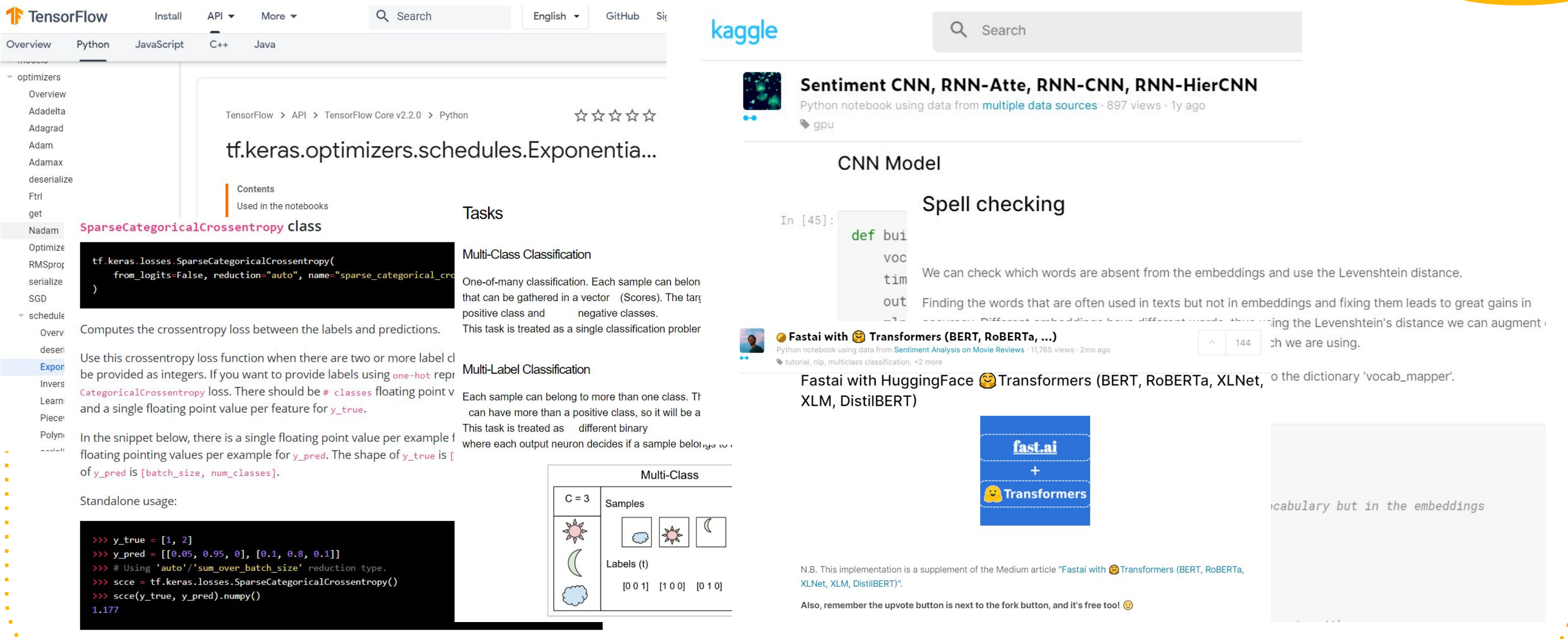
Key Points

- Know your data
  - Bot data
  - Missing values
  - Repeated reviews

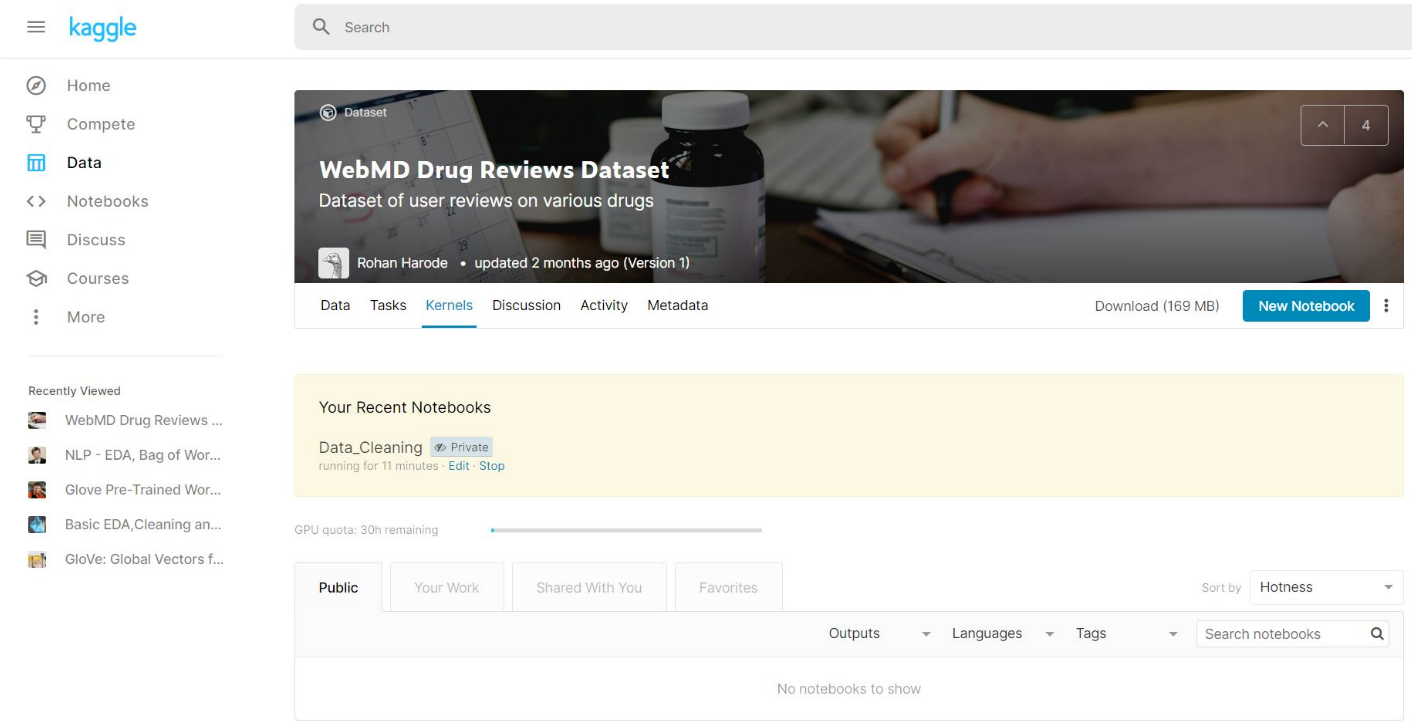
- Task Specification - fine-grain vs coarse-grain

- Pre-Trained Language Model
  - Accessible SOTA research for all

Unlimited Classroom - Give & Take



Unlimited Classroom - Give & Take



Thanks!

Any questions?

Credits

Special thanks to all the people who made and released these awesome resources for free:

- Presentation template by SlidesCarnival
- Photographs by Unsplash