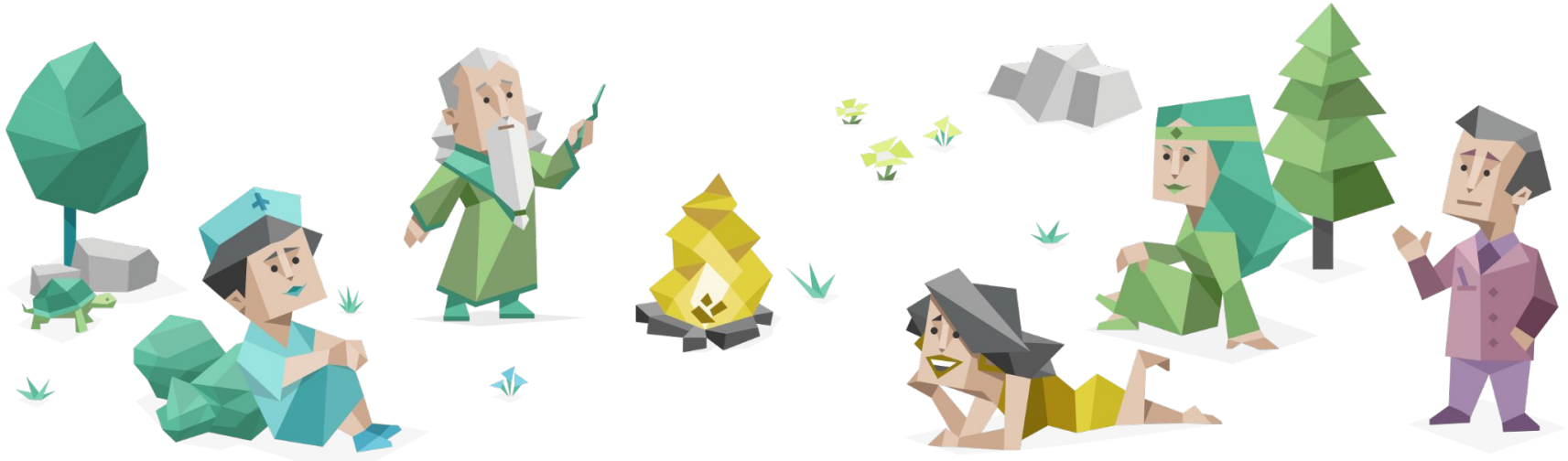
Personality Prediction From Text Based on the MBTI Model

Andrel Chew



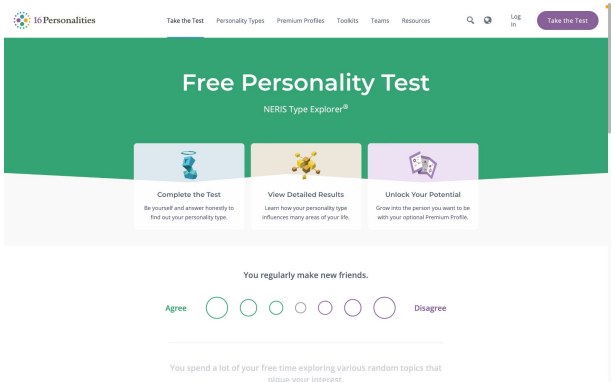
Introduction

- Myer Briggs Type Indicator - 16 personality types
- 4 Dimensions:
  - I/E Dimension: Introvert(I) or Extrovert(E)
  - N/S Dimension: Intuition(N) or Sensing(S)
  - T/F Dimension: Thinking(T) or Feeling(F)
  - J/P Dimension: Judging(J) or Perceiving(P)
- Applications:
  - Recommender Systems
  - Improve interpersonal relationships and job satisfaction
  - Criminal Profiling
- Other personality models: OCEAN, HEXACO, DiSC

Problems

- Questionnaires are used to determine personality
- Biased Results:
  - Answering based on intended personality
  - Response bias in job interviews → fabricated answers
- Data quality issues for online vs offline respondents

16Personalities



Objective & Scope

- Experiment with deep learning for automated personality prediction
- Mitigate shortcomings faced in online assessments.
  - Beyond Machine Learning - Comparing performance of neural networks, fine-tuned transformers models, multi-task learning etc.
- Implementation of an MBTI prediction tool
  - Purpose: to conveniently predict personality
  - Alternative to existing online personality assessments (eg. 16Personalities)

Data

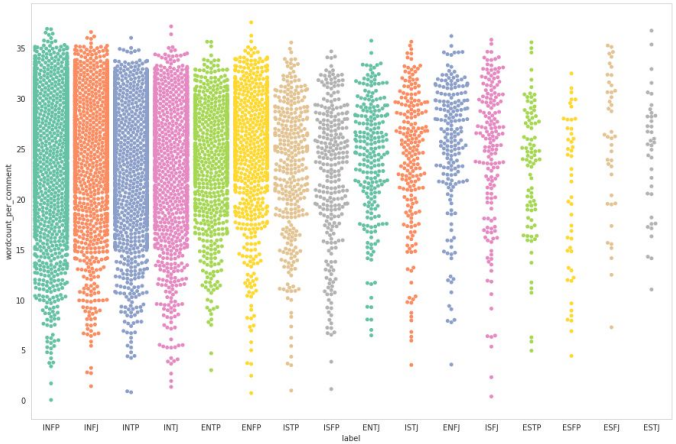
Data Extraction

- Personality Cafe Forum dataset from Kaggle
- Reddit comments in 2019 from Google’s Bigquery

PersonalityCafe Data

- 8.6k rows of comments
- 50 comments per row, splits by “|||”

	text	label
0	'http://www.youtube.com/watch?v=qsXHcwe3krw|||...	INFJ
1	'I'm finding the lack of me in these posts ver...	ENTP
2	'Good one _____ https://www.youtube.com/wat...	INTP
3	'Dear INTP, I enjoyed our conversation the o...	INTJ
4	'You're fired.|||That's another silly misconce...	ENTJ



Reddit Data

- 2 million rows of comments
- Requires extraction of MBTI types from Reddit flairs

	flair	text	subreddit	user
0	eStJ gAnG	I didn't reach puberty until I lead my Empire's armies on a series of conquests. Vanquishing all who stood in my path.	shittyMBTI	ggggggggee
1	ESTJ: The Supervisor	I didn't reach puberty until I lead my Empire's armies on a series of conquests. Vanquishing all who stood in my path.	shittyMBTI	ggggggggee
2	INFP: The Dreamer	This map is fucking swell compared to Euphrates Bridge. \n\nThat map is an abomination through and through.	modernwarfare	DankMatter3000
3	INFP: The Dark Lady	>I definitely had the thought that it would be nice if rustc knew that the way I was blocking should make my code race-free\n\nWell, there's Rice's Theorem. Informally, any program that decides whether a program has a particular property must have at least one flaw:\n\n* it can't analyze all programs\n* it sometimes makes mistakes\n* it sometimes fails to find an answer\n\nIf you *do* manage to write a flawless analyzer, then the property must be "trivial" - always true or always false. It's kinda like the Second Law of Compiledynamics.\n\nSafe Rust is intended to have two of those flaws:\n\n* it sometimes rejects programs that would be safe (a "soundness bug" is when it does the opposite - that's *not* intended but does happen)\n* type-checking isn't guaranteed to terminate and can even be tricked into performing arbitrarily complex computation, such as this [fractal type error](http://www.treblig.org/daveG/rust-mand.html). \n\nSo the "no data races" guarantee comes with the...	rust	claire_resurgent
4	INFP: The Dreamer	Or just has long hair...	memes	Sgt-Thunder-3

	text	label
0	Hitman please! Favorite game is Persona 5	INFJ
1	If there were a dedicated ARAM mode people wou...	INFJ
2	It's obscure game, but Starmade might be more ...	ENTP
3	I can't even count the reasons why it's comple...	INTP
4	Thanks for the tip. Please forgive me, I am st...	ENTJ

Data Cleaning

- Duplicated rows
- Lowercasing
- Punctuations
- URLs
- Numbers
- Special symbols (eg. emojis)
- Stopwords
- Lemmanization (NLTK)

	text	label
0	intj moment play experience life repeat today ...	INFJ
1	find lack post alarm sex boring position often...	ENTP
2	good course say know absolutely positive good ...	INTP
3	dear rule arbitrary construct create dear entj...	INTJ
4	silly misconception approach logically go key ...	ENTJ

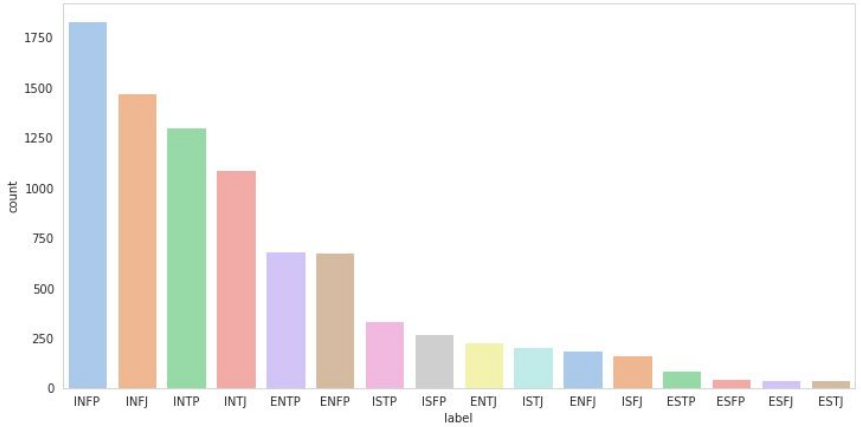
PersonalityCafe Dataset Cleaned

	text	label
0	favorite game persona	INFJ
1	dedicated mode people would stop play mode	INFJ
2	obscure may alley actually fly fight ship buil...	ENTP
3	even count reason completely insane	INTP
4	thank tip forgive stupid	ENTJ

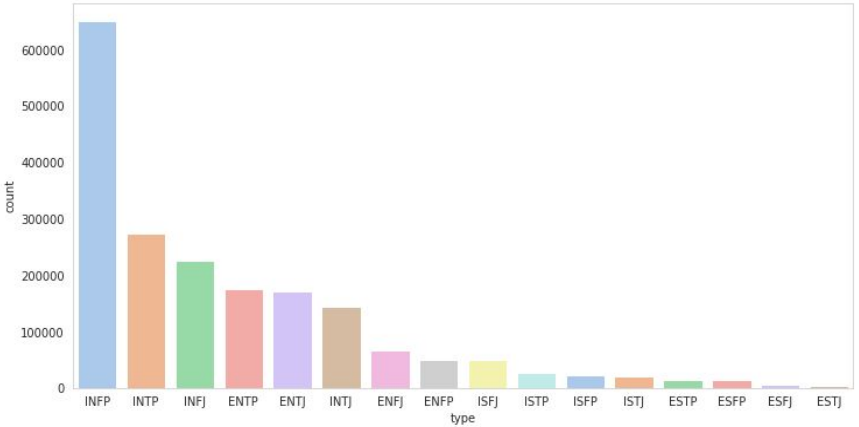
Reddit Dataset Cleaned

Analysis

PersonalityCafe vs Reddit

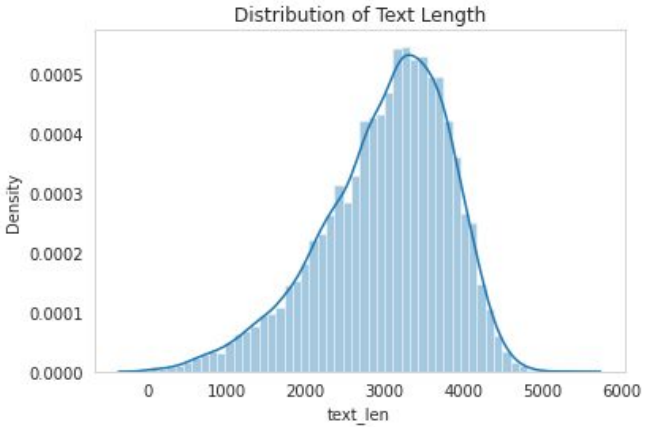


Distribution of PersonalityCafe Dataset

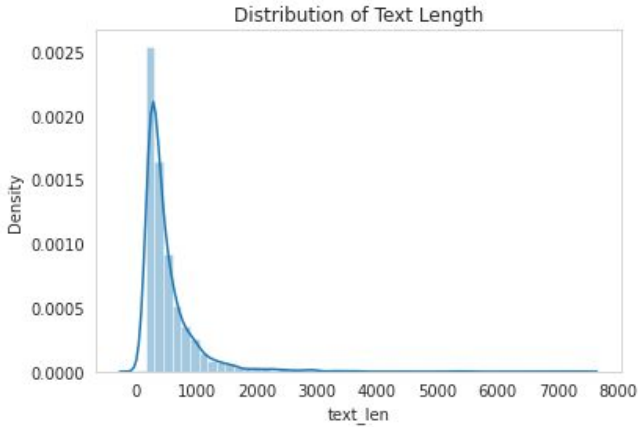


Distribution of Reddit Dataset

PersonalityCafe vs Reddit



Distribution of PersonalityCafe Dataset



Distribution of Reddit Dataset

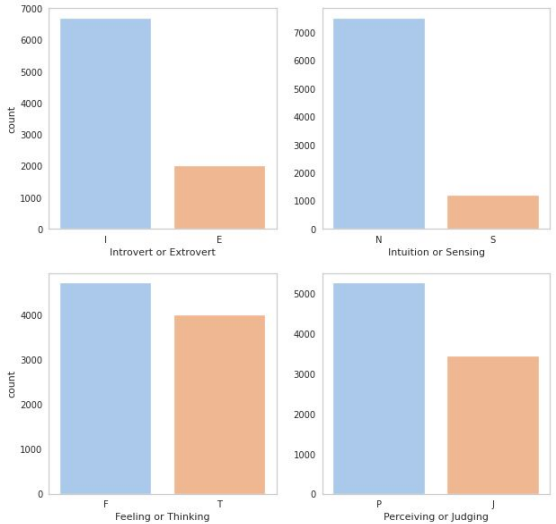
Exploratory Classification Comparison

Proceeding with P.Cafe dataset!

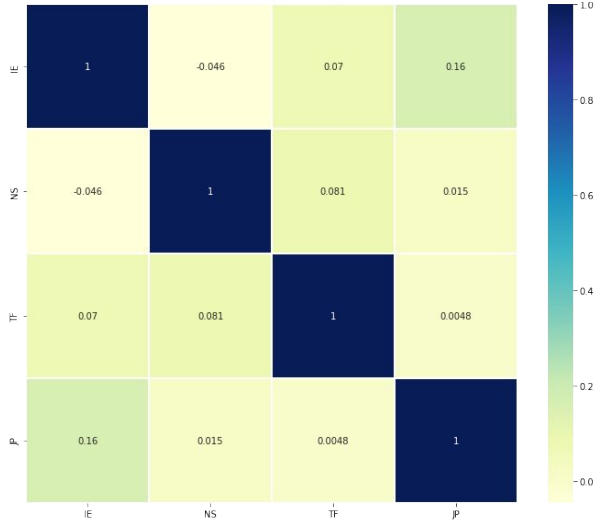
Model	16 Types Multiclass (PersonalityCafe Dataset)	16 Types Multiclass (Reddit Dataset)
Adaboost	0.2324	**0.0865**
CatBoost	0.2422	0.0843
Logistic Regression	**0.2715**	0.0842
Naive Bayes	0.2635	0.0849
Random Forest	0.2091	0.0740
XGBoost	0.2406	0.0813

Exploratory Classification With Bag of Words

Data Analysis on PersonalityCafe Data



Distribution of 4 Dimensions



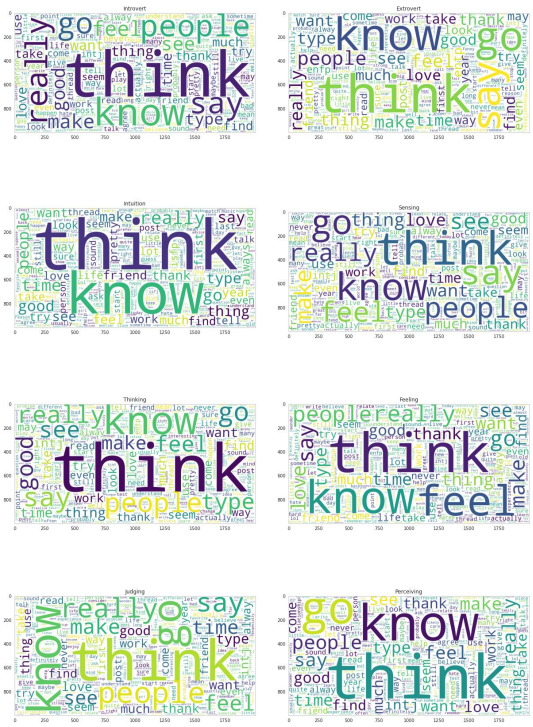
Correlation Matrix of the 4 Dimensions

Before Cleaning

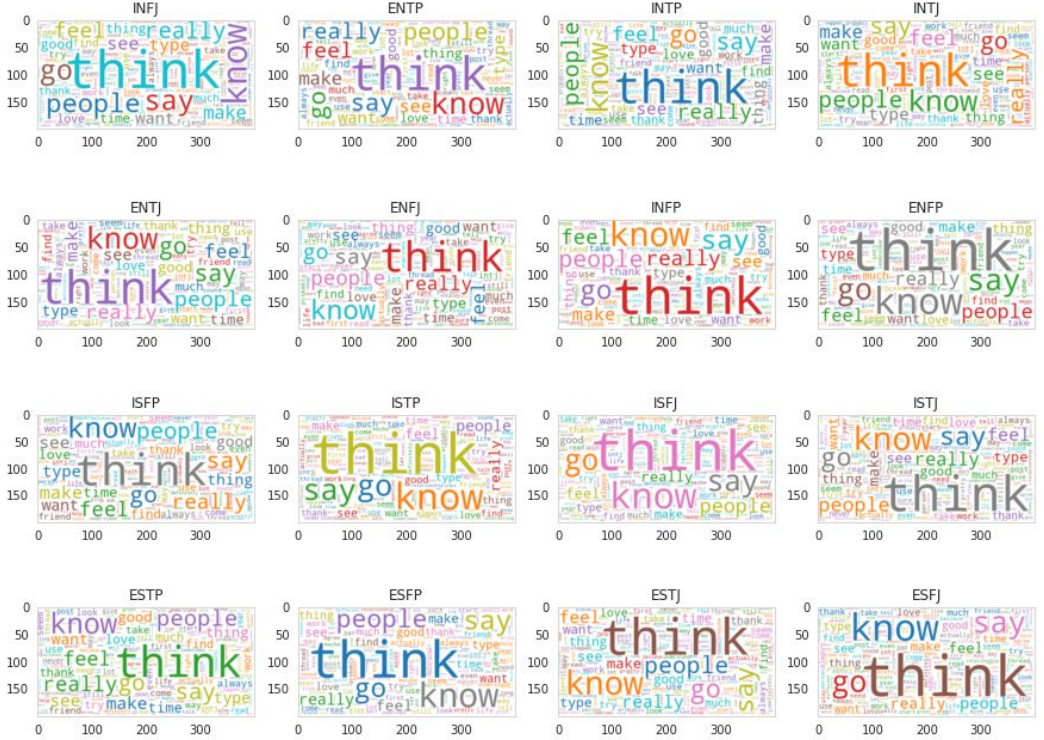
Before Cleaning

After Cleaning

After Cleaning

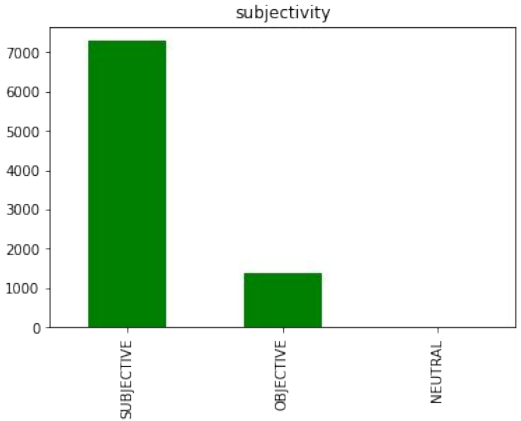


4 Dimensions

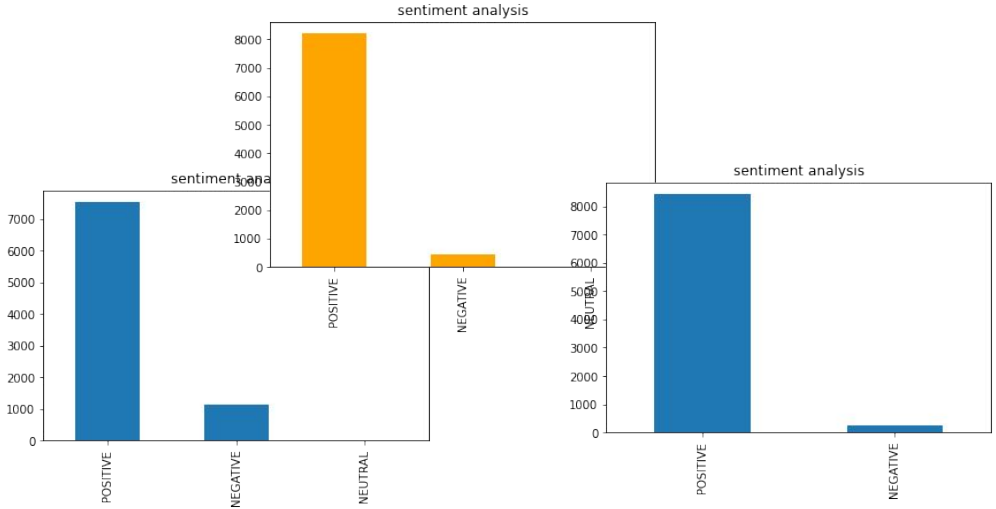


16 Personalities

Subjectivity Detection

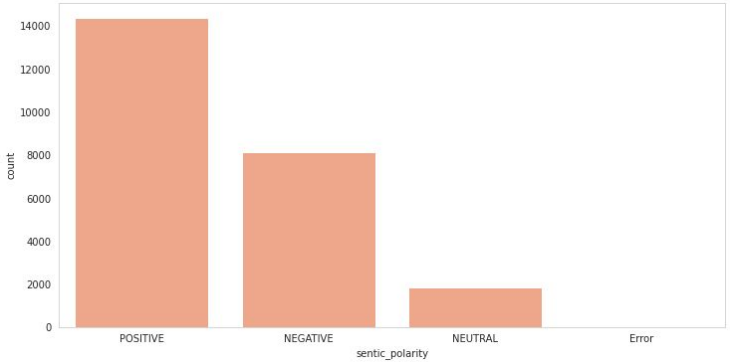


Sentiment Analysis

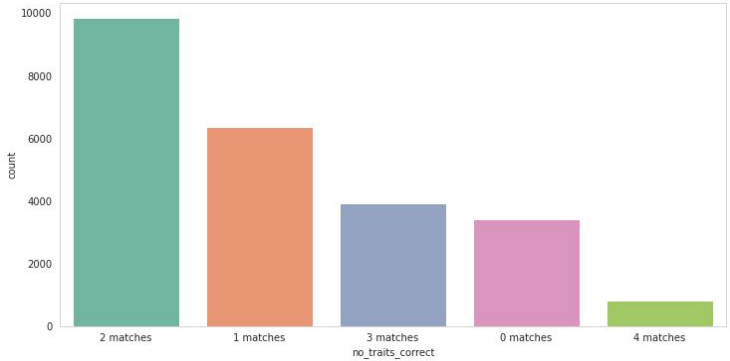


Processing using SenticNet, NLTK & TextBlob

Analysis of SenticNet APIs (with 24k Reddit Data)



SenticNet's Polarity Classification



Matches of SenticNet's MBTI Prediction

```
print(sentic['sentic_polarity'][sentic['sentic_polarity'].str.contains('414 Request-URI Too Long')])
```

```
1938     <!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">\n<html><head>\n<title>414 Request-URI Too Long</title>\n</head><body>\n<h1>Request-URI Too Long</h1>
11627    <!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">\n<html><head>\n<title>414 Request-URI Too Long</title>\n</head><body>\n<h1>Request-URI Too Long</h1>
23659    <!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">\n<html><head>\n<title>414 Request-URI Too Long</title>\n</head><body>\n<h1>Request-URI Too Long</h1>
Name: sentic_polarity, dtype: object
```

URL Error for long text

Methodologies

Methods

Machine Learning

LDA, SMOTE Experiment,
16 Classification Models

1

2

Transformers & Transfer Learning

BERT, DistilBERT,
ZeroShot Pipeline

Neural Networks

GloVe Embeddings with
CNN, LSTM, GRU etc.

3

4

Ensemble Learning

Binary & Multiclass
Neural Network Ensemble

Multi-task Learning

MBTI, Sentiment, Subjectivity

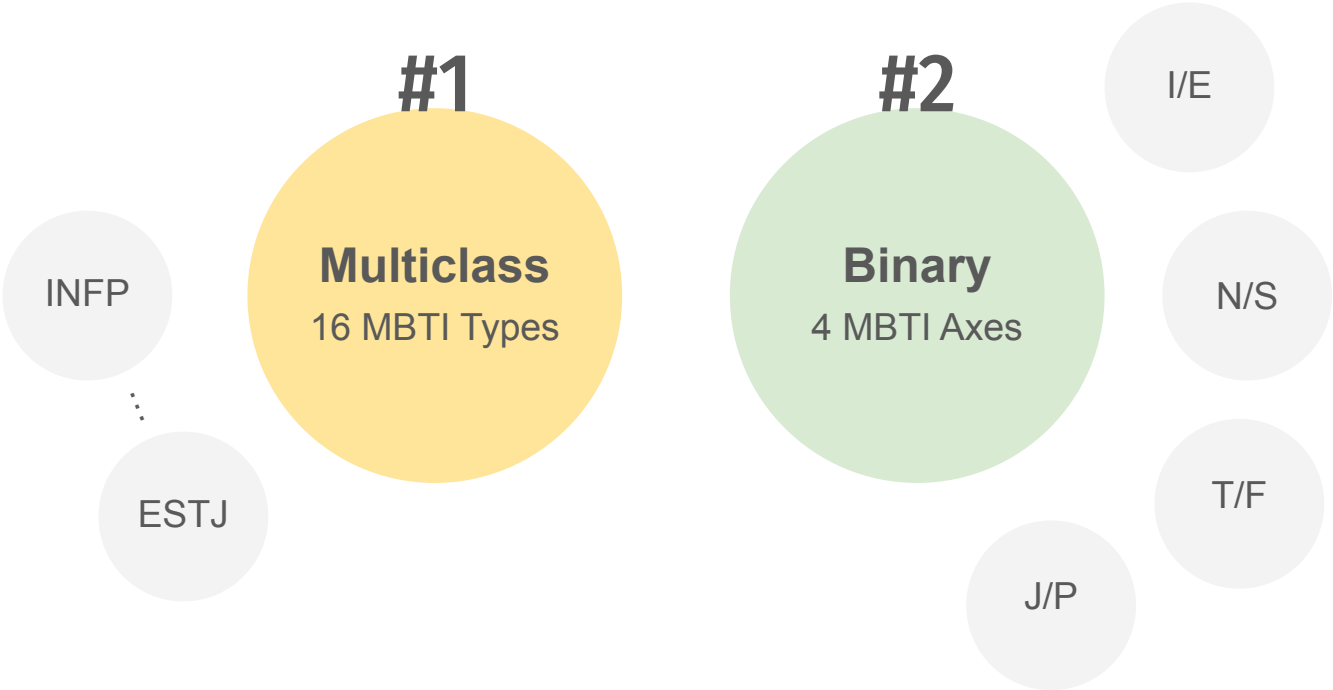
5

6

Hybrid Model

DistilBERT Embeddings,
Self-Attention Mechanism

Types of Classification



Machine Learning

- LDA Topic Modelling on 4 topics
- Class Balancing techniques:
  - SMOTE, Random Oversampling, Random Undersampling & SMOTEENN
- 16 Machine Learning Models with Pycaret
  - Best models: Logistic Regression, Naive Bayes, SVM

	text	label	IE	NS	TF	JP	Topic_0	Topic_1	Topic_2	Topic_3	Dominant_Topic
0	intj moment play experience life repeat today ...	INFJ	I	N	F	J	0.001276	0.695496	0.159435	0.143793	Topic 1
1	find lack post alarm sex boring position often...	ENTP	E	N	T	P	0.299757	0.366157	0.305049	0.029037	Topic 1
2	good course say know absolutely positive good ...	INTP	I	N	T	P	0.246211	0.495362	0.123393	0.135034	Topic 1
3	dear rule arbitrary construct create dear entj...	INTJ	I	N	T	J	0.254627	0.000650	0.728423	0.016300	Topic 2
4	silly misconception approach logically go key ...	ENTJ	E	N	T	J	0.117287	0.440013	0.442000	0.000700	Topic 2

Latent Dirichlet Allocation (LDA)

	Topic_0	Topic_1	Topic_2	Topic_3	IE	Label
0	0.551252	0.286153	0.162140	0.000454	I	I
1	0.269050	0.005653	0.724851	0.000446	I	I
2	0.520067	0.077223	0.168415	0.234296	E	I
3	0.288667	0.202691	0.508182	0.000461	I	I
4	0.393778	0.604691	0.000765	0.000765	I	I

Example of predicted results for I/E Axis (Logic Regression)

Transformers & Transfer Learning

- Fine-tuning of pre-trained models
  - BERT-Base
  - DistilBERT-Base
- Zero-Shot Learning
  - BART-large-mnli model pipeline

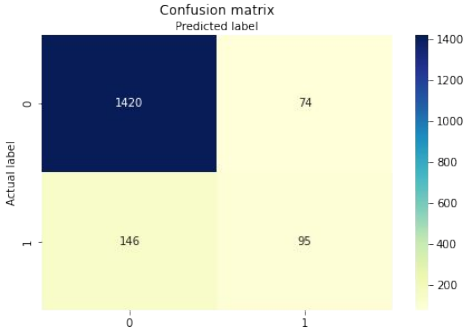
```
***** Running training *****
  Num examples = 6244
  Num Epochs = 3
  Instantaneous batch size per device = 16
  Total train batch size (w. parallel, distributed & accumulation) = 16
  Gradient Accumulation steps = 1
  Total optimization steps = 1173
```

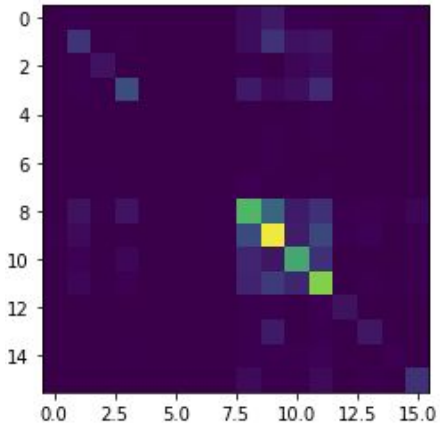
[1173/1173 30:09, Epoch 3/3]

Step	Training Loss
500	1.967200
1000	1.393800

Fine-tuning DistilBERT

Neural Networks





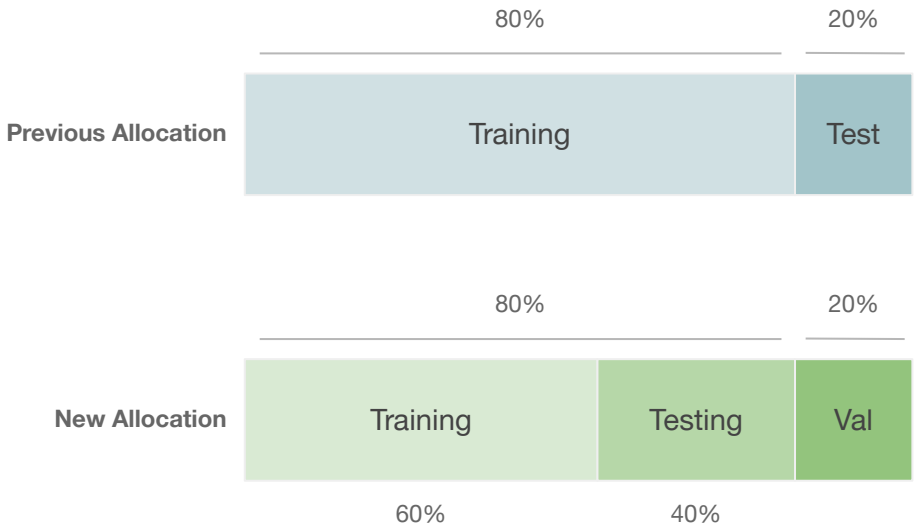
- 6 Models
  - CNN
  - GRU
  - Bi-GRU
  - LSTM
  - Bi-LSTM
  - MLP
- Training on 4 Binary & 1 Multiclass Classifiers
  - GloVe word Embeddings
  - Binary model - sigmoid activation function, binary cross-entropy
  - Multiclass model - softmax activation function, categorical cross-entropy
  - Dropout layers to prevent overfitting
- Best Model: CNN

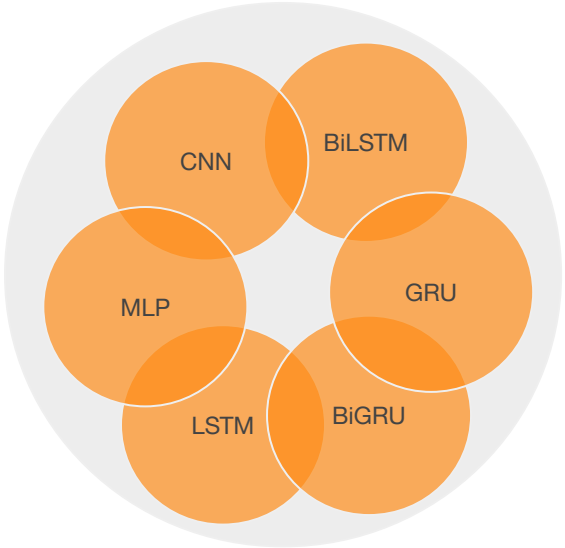
Model Enhancements

Ensemble Learning

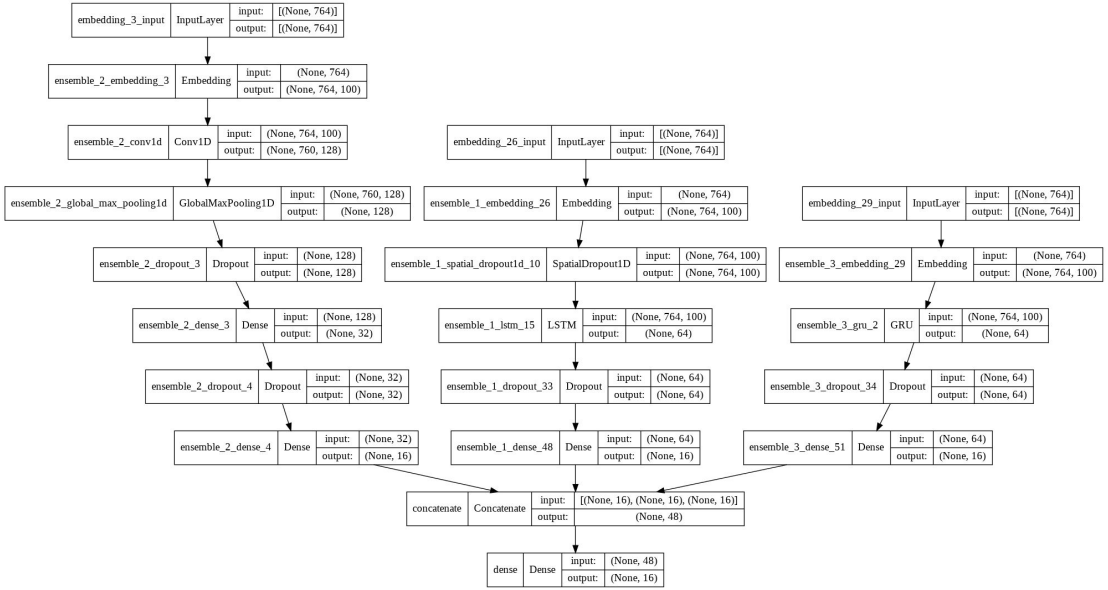
- Stacking Ensemble Approach
- Ensemble of top 3 models in both multiclass & binary classifiers
- Requires model retraining
  - Used non-independent data when training DNN
  - New data allocation with holdout dataset
  - Controlled random states of training data

Data Allocation with Controlled Random States

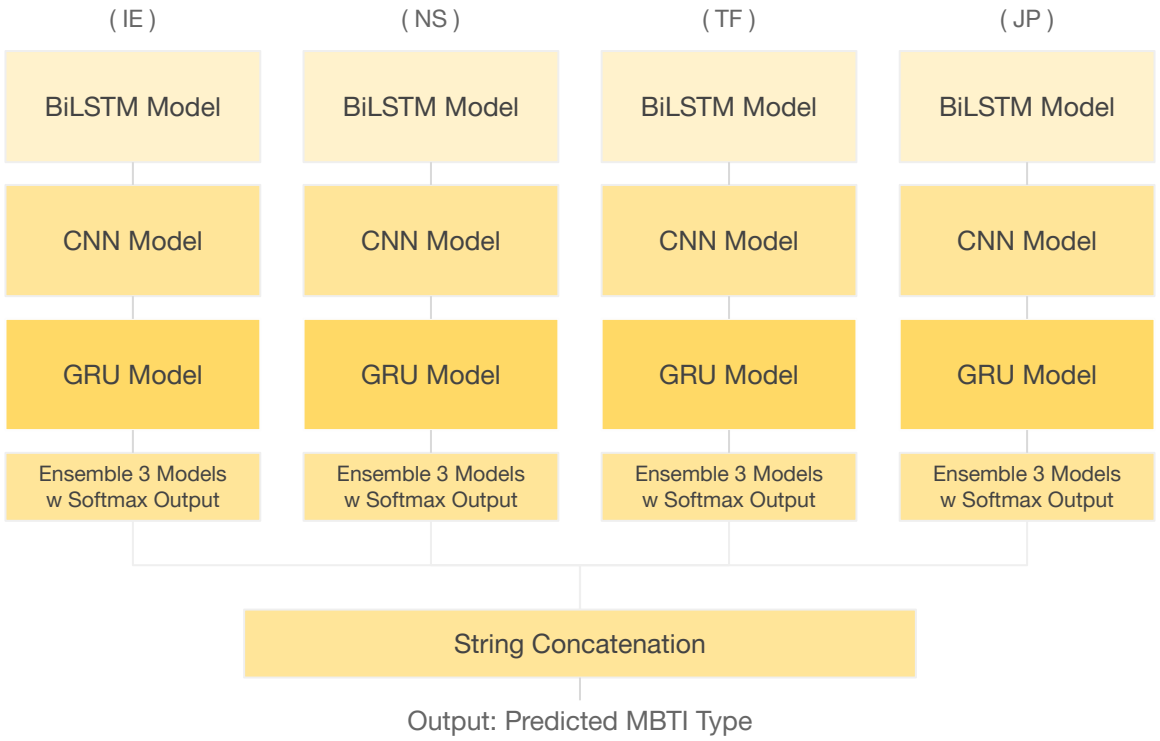




Stack Ensemble with Multiclass Classifiers



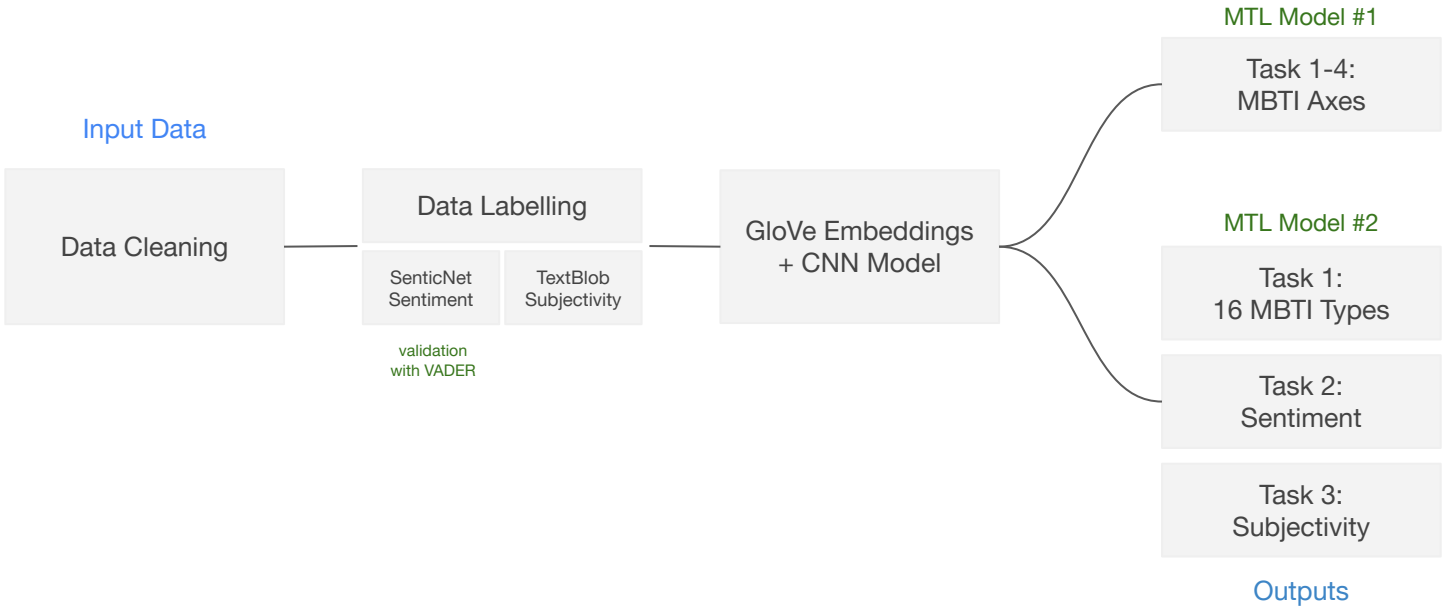
‘Multi-Task’ Ensemble with Binary Classifiers



Multi-Task Learning

- Hard-parameter sharing MTL
- Learn tasks simultaneously to increase efficiency
- 2 groups of MTL Tasks
  - 1: MBTI with 4 dimensions
  - 2: MBTI with 16 types, Sentiment & Subjectivity
- 2 Models
  - Keras Tokenizer + MLP
  - GloVe Embeddings + CNN

Multi-Task Learning



Data Labelling for MTL

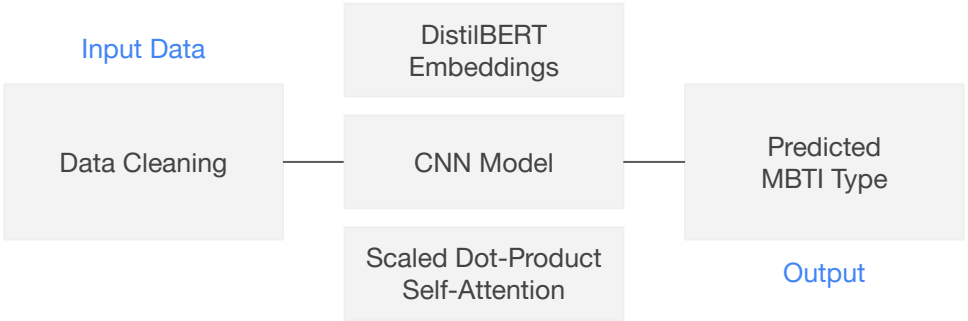
- Sentiment
  - Fill undetected sentiment when processing with VADER (server was down)
  - Checking SenticNet with VADER → 82.76% similarity
- Subjectivity
  - Single Row of Data with Neutral Subjectivity will cause issues with training
  - 2 classes instead of 3 classes (either Subjective or Objective)

	text	mbti	sentiment
0	intj moment play experience life repeat today ...	INFJ	POSITIVE
1	find lack post alarm sex boring position often...	ENTP	POSITIVE
2	good course say know absolutely positive good ...	INTP	POSITIVE
3	dear rule arbitrary construct create dear entj...	INTJ	POSITIVE
4	silly misconception approach logically go key ...	ENTJ	POSITIVE

```
text            suppose must live election night ad
mbti                                            INTP
sentiment                                   POSITIVE
subjectivity                                 NEUTRAL
Name: 6277, dtype: object
```

Hybrid Model with Self-Attention Mechanism

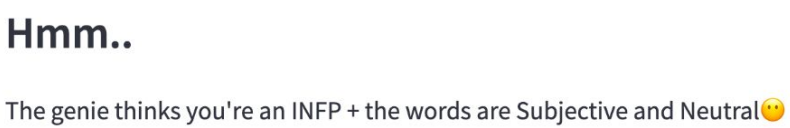
- DistilBERT had performed the best when fine-tuned
- Self-Attention Mechanism can help to retain semantic information
- 2 Hybrid Models
  - DistilBERT embeddings + CNN
  - DistilBERT embeddings + CNN + Scaled Dot Product Self-Attention



MBTI Prediction Tool

MBTI Prediction Tool

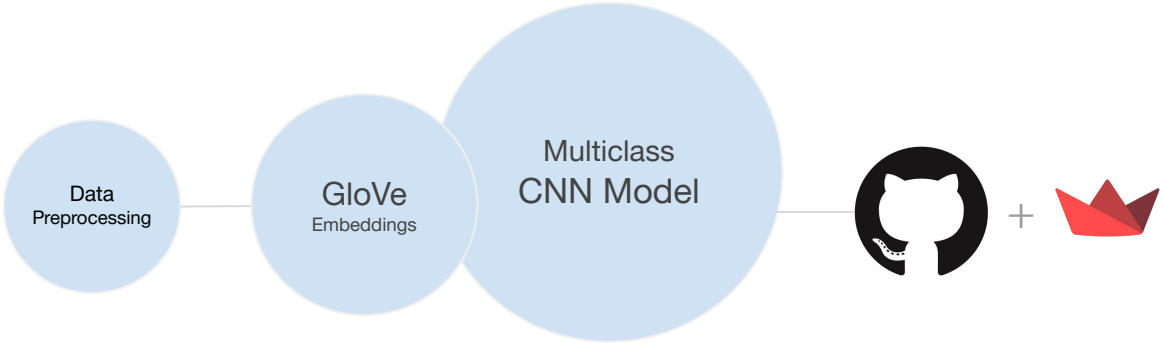
- Build with Streamlit
  - Prediction Tool & Data Visualization pages
- 2 Models trained on 2 different datasets:
  - GloVe + CNN on PersonalityCafe dataset
  - GloVe + CNN on Reddit dataset
- Simple text processing: remove digits, punctuations, lowercase
- Returns MBTI + Subjectivity (TextBlob) + Sentiment (VADER)
  - Multitask Model did not perform well



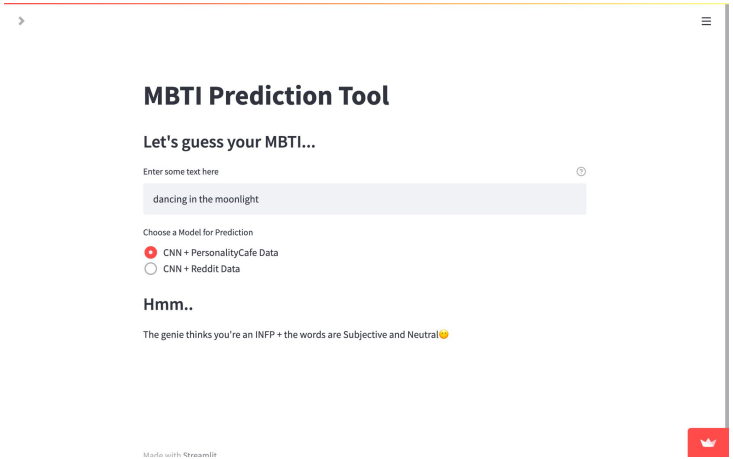
Available:
https://share.streamlit.io/ackw/mbti-prediction-tool/main/app.py

SCAN ME

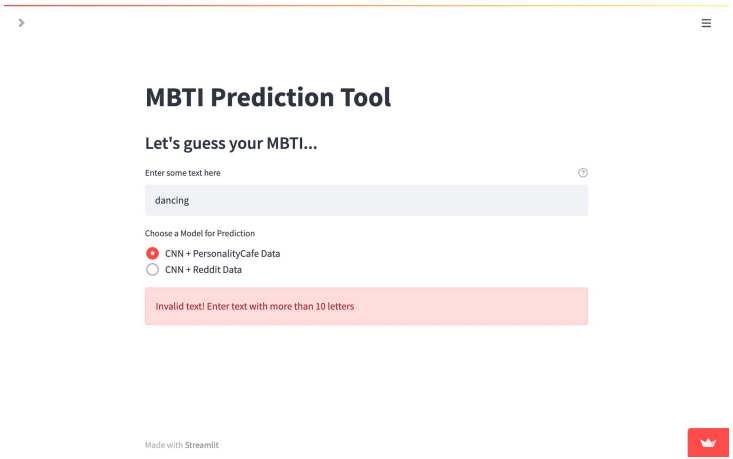
Deployment


Data
Preprocessing
GloVe
Embeddings
Multiclass
CNN Model

MBTI Prediction Page

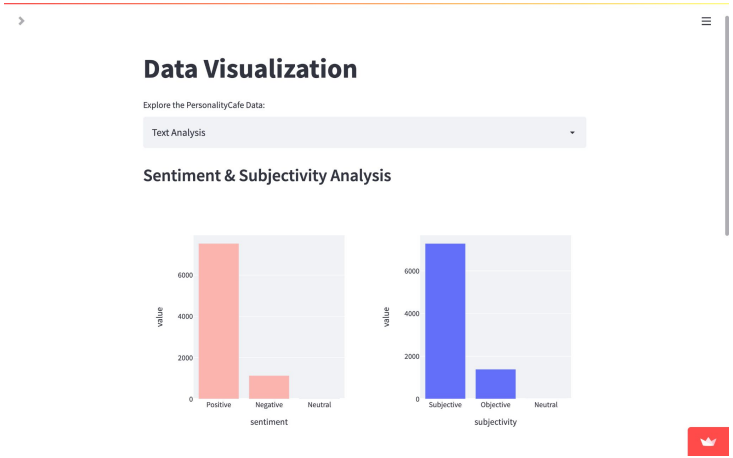


MBTI Prediction

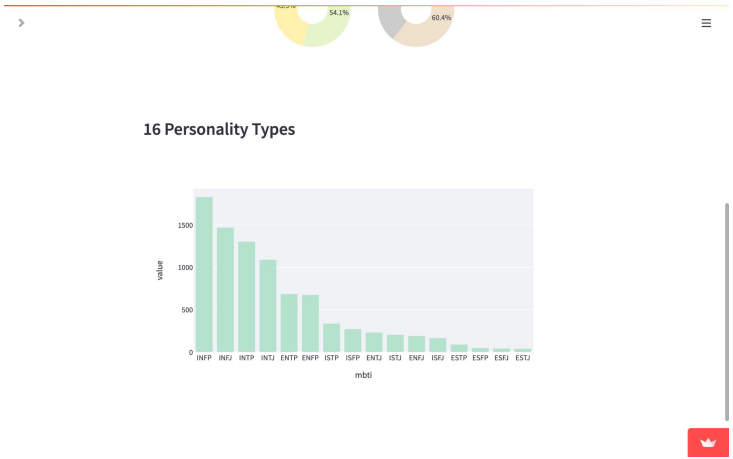


Error Handling:
for text length < 10

Data Visualization Page



Option 1: Text Analysis



Option 2: Personality Types

Evaluation on Crawled Tweets

- 3K Crawled Tweets with mention of ‘food’
- Predictions on both CNN models deployed
- Results:
  - Reddit Model had predictions from all 16 MBTI types
  - PersonalityCafe model had predictions from 11 different MBTI types (all undetected are extroverts - probably not enough training data)
  - 4.897% of rows have identical matches

	text	prediction_pcafe	prediction_reddit
0	recipe of the day creamy parmesan baked acorn ...	INFP	INTJ
2	this restaurants service felt very much racist...	INTJ	ENFJ
3	food pics and ambience is captured as well goo...	INTJ	ESFJ
4	ktla lapublichealth why do you guys keep raid...	INFP	ENFP
5	what a performance diggins says she fought ...	INFP	ENTP

```
food_df.prediction_pcafe.value_counts()
```

```
INFP    1637
INTP     785
ENFP     520
INFJ     478
INTJ     451
ENTP      48
ISTP      32
ENTJ      12
ISTJ      11
ISFJ       5
ISFP       3
Name: prediction_pcafe, dtype: int64
```

```
food_df.prediction_reddit.value_counts()
```

```
ENTJ    1183
INTJ     657
ENFP     519
INFJ     370
INTP     218
ESFP     160
ESFJ     155
ENFJ     151
ISTJ     133
INFP     100
ESTJ      83
ISFJ      72
ISTP      70
ESTP      54
ISFP      45
ENTP      12
Name: prediction_reddit, dtype: int64
```

- Conclusion: Imbalanced dataset gives more accurate (eg. INFP with the most data), but fragmentary predictions (with 5 unpredicted classes)

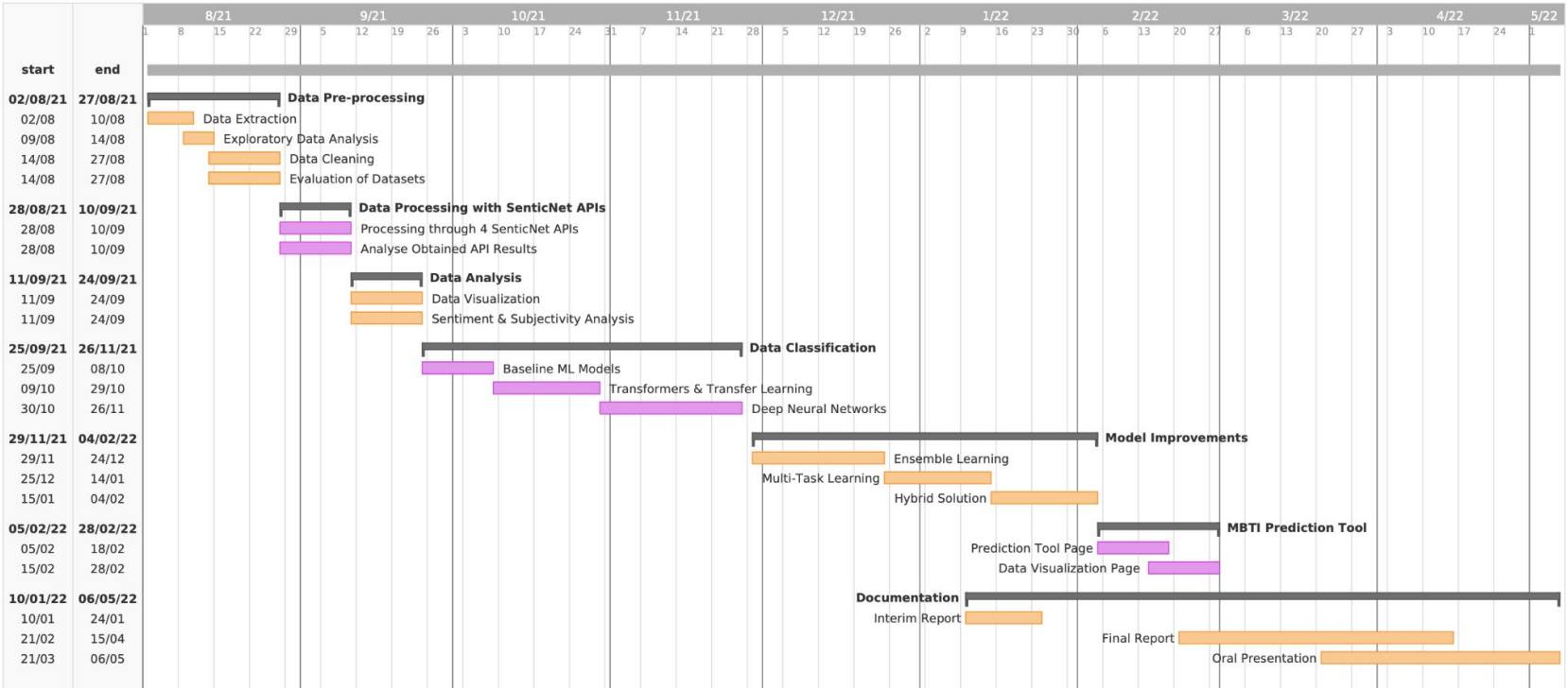
Conclusion

Conclusion: Summary of Findings

- Fine-tuned DistilBERT produced the best results
- DistilBERT embeddings are not as suitable than GloVe embeddings
- Imbalanced data caused the classes with more data (INFP) to have better accuracy, but for classes with less data (ESFJ), it cannot learn efficiently
- Use of 4 dimensions may be better in this case

Model	I/E Axis	N/S Axis	T/F Axis	J/P Axis
Pre-trained DistilBERT	0.836	0.899	0.832	0.774
Neural Network CNN	0.8	0.873	0.749	0.691
Multi-Task CNN	0.763	0.847	0.538	0.548

Project Gantt Chart



Limitations

- Class Imbalance of PersonalityCafe Data
  - Consideration of Reddit Dataset → lower accuracy in exploratory classification
  - No holdout data → model retraining for ensemble learning model
- Memory/GPU limitations
  - Used several google colab notebooks for classification
  - Unable to use entire Reddit dataset for processing (contains 2 mil rows)

Future Work

- Multi-task Learning with other NLP tasks
  - Eg. Aspect-Based Sentiment Analysis (ABSA), Part of Speech (POS) Tagging, Named Entity Recognition (NER).
- Advanced state-of-the-arts transformers / word embeddings for improvements
  - Eg. GPT-NEO with text-generation may predict words choices of each personality type
  - Allows better understanding of human psychological aspects
- Other MBTI datasets
  - Labels with MBTI, Big Five, horoscopes, relationships, career paths etc.
  - Eg. INFP x ENFP relationship compatibility

Thank You 🙂

MBTI Characters Reference: 16Personalities. “Free Personality Test,” 16personalities.com. [Online]. Available: https://www.16personalities.com. [Accessed: 20-Mar-2022].