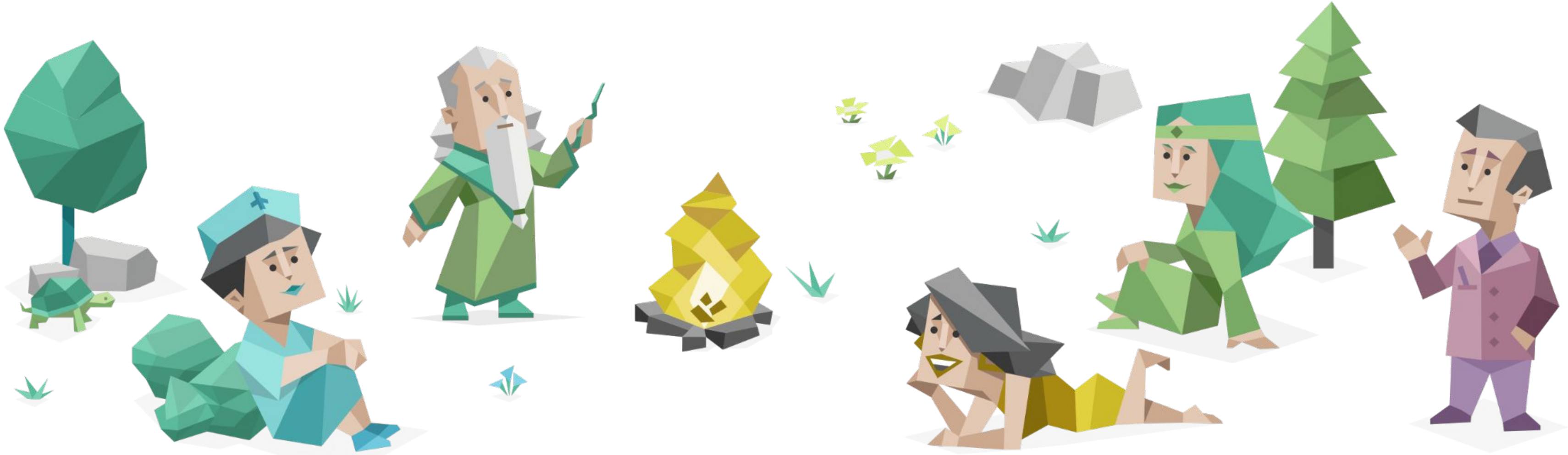
Personality Prediction From Text Based on the MBTI Model

Andrel Chew



Overview

1 Introduction

2 Data

3 Methodologies

4 MBTI Prediction Tool

5 Conclusion

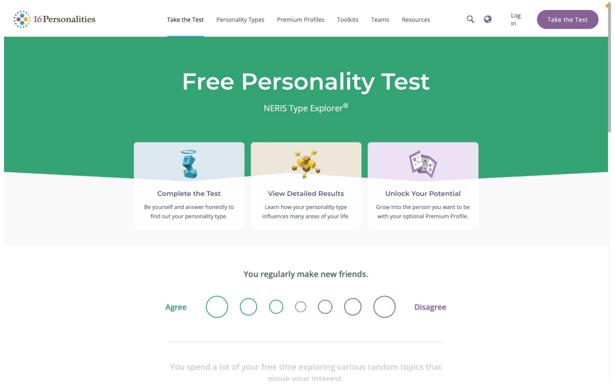
Introduction

- 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 in online surveys

16Personalities



Free Personality Test

NERIS Type Explorer®

Complete the Test

Be yourself and answer honestly to find out your personality type.

View Detailed Results

Learn how your personality type influences many areas of your life.

Unlock Your Potential

Grow into the person you want to be with your optional Premium Profile.

You regularly make new friends.

Agree ○ ○ ○ ○ ○ ○ ○ Disagree

You spend a lot of your free time exploring various random topics that pique your interest.

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

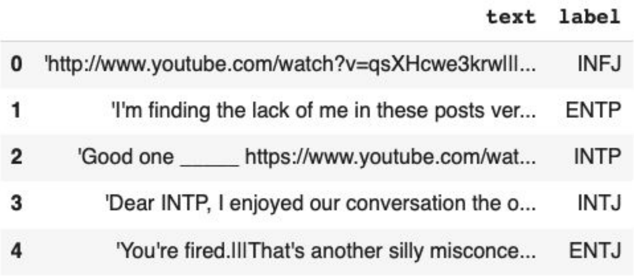
kaggle

Google BigQuery

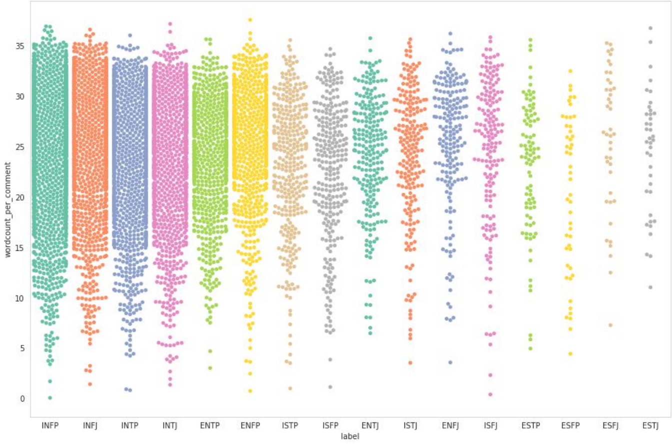
- Personality Cafe Forum dataset from Kaggle
- Reddit comments in 2019 from Google's Bigquery

PersonalityCafe Data

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

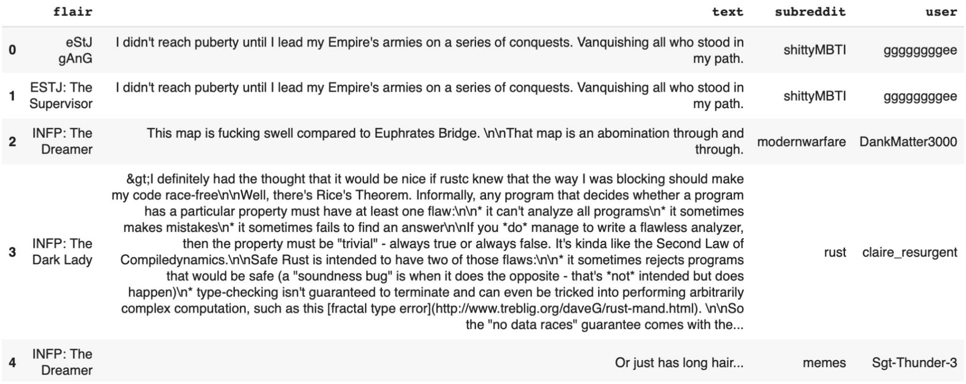


	text	label
0	'http://www.youtube.com/watch?v=qsXHcwe3krw|||...	INFJ
1	'I'm finding the lack of me in these posts ver...	ENTP
2	'Good one _____ https://www.youtube.com/wat...	INTP
3	'Dear INTP, I enjoyed our conversation the o...	INTJ
4	'You're fired.|||That's another silly misconce...	ENTJ

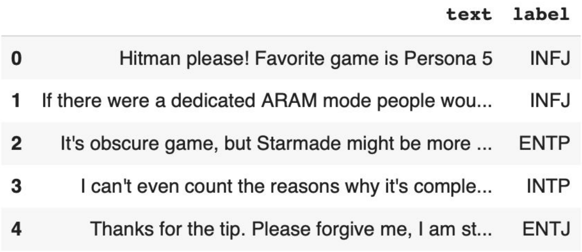


Reddit Data

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



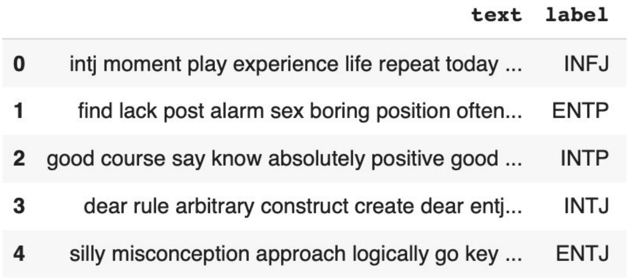
	flair	text	subreddit	user
0	eStJ gAnG	I didn't reach puberty until I lead my Empire's armies on a series of conquests. Vanquishing all who stood in my path.	shittyMBTI	ggggggggee
1	ESTJ: The Supervisor	I didn't reach puberty until I lead my Empire's armies on a series of conquests. Vanquishing all who 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	&gt;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

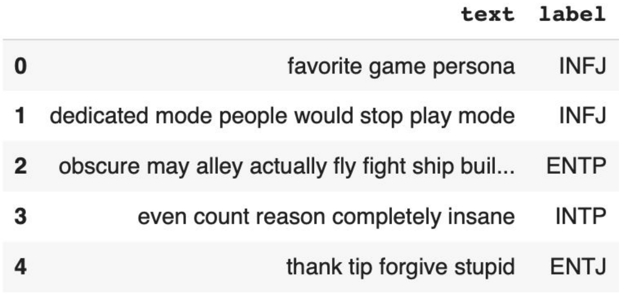
Data Cleaning

- 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

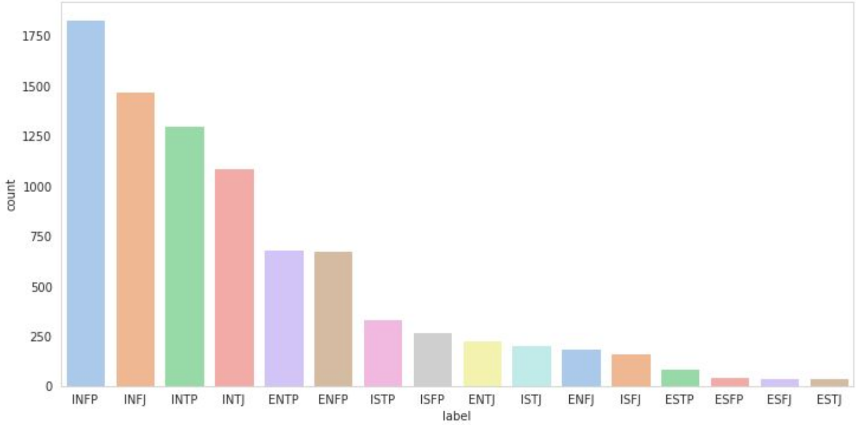


	text	label
0	favorite game persona	INFJ
1	dedicated mode people would stop play mode	INFJ
2	obscure may alley actually fly fight ship buil...	ENTP
3	even count reason completely insane	INTP
4	thank tip forgive stupid	ENTJ

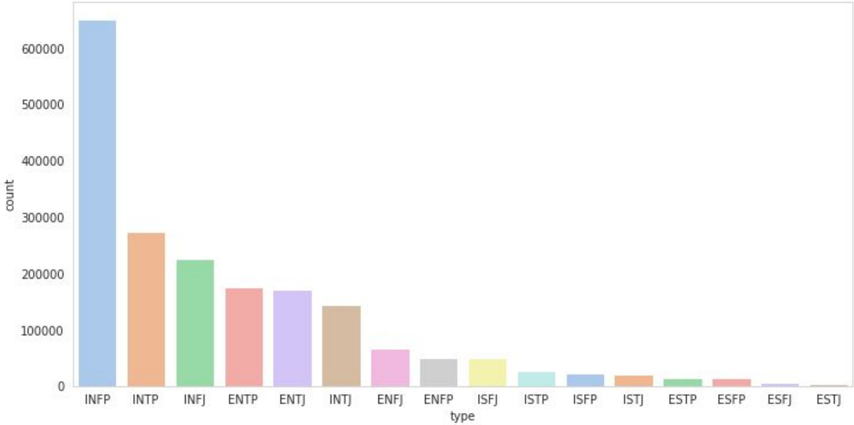
Reddit Dataset Cleaned

Analysis

PersonalityCafe vs Reddit

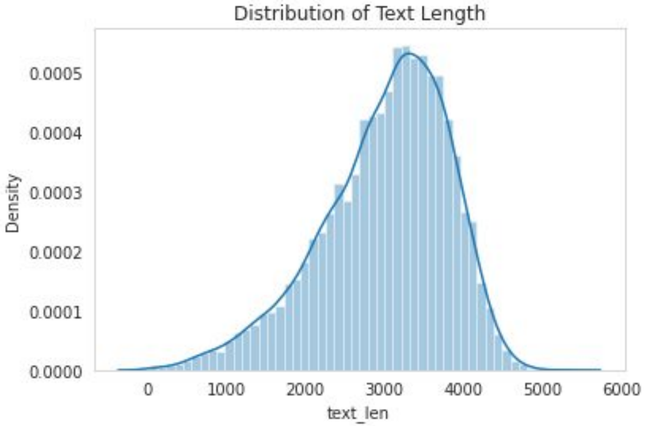


Distribution of PersonalityCafe Dataset

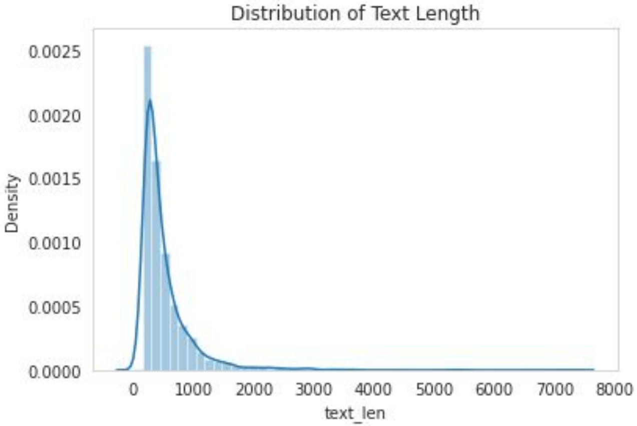


Distribution of Reddit Dataset

PersonalityCafe vs Reddit



Distribution of PersonalityCafe Dataset



Distribution of Reddit Dataset

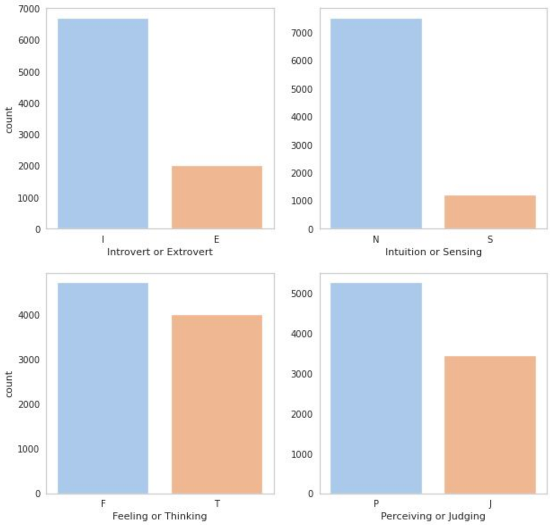
Exploratory Classification Comparison

Proceeding with P.Cafe dataset!

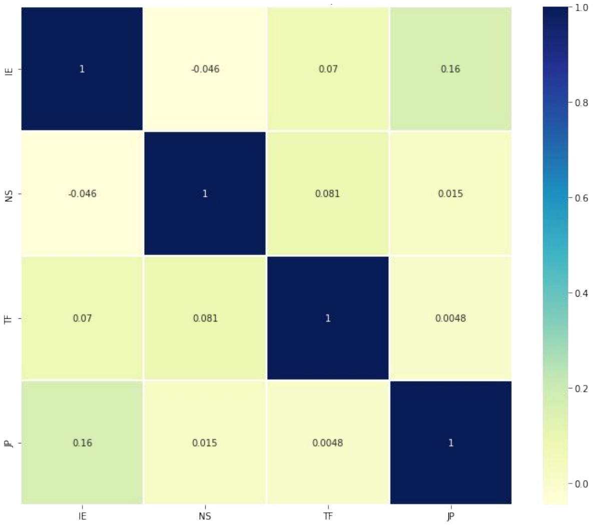
Model	16 Types Multiclass (PersonalityCafe Dataset)	16 Types Multiclass (Reddit Dataset)
Adaboost	0.2324	**0.0865**
CatBoost	0.2422	0.0843
Logistic Regression	**0.2715**	0.0842
Naive Bayes	0.2635	0.0849
Random Forest	0.2091	0.0740
XGBoost	0.2406	0.0813

Exploratory Classification With
Bag of Words

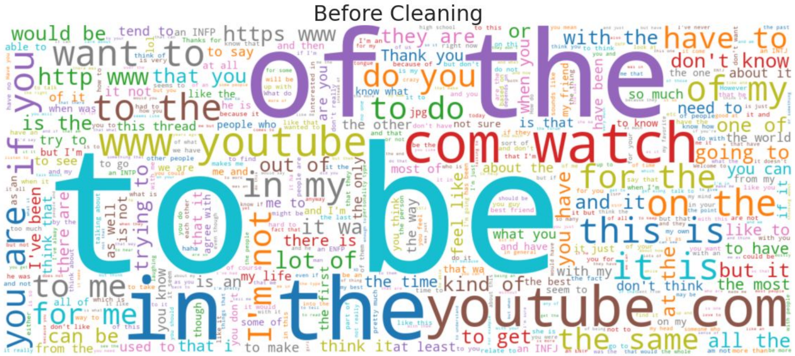
Data Analysis on PersonalityCafe Data



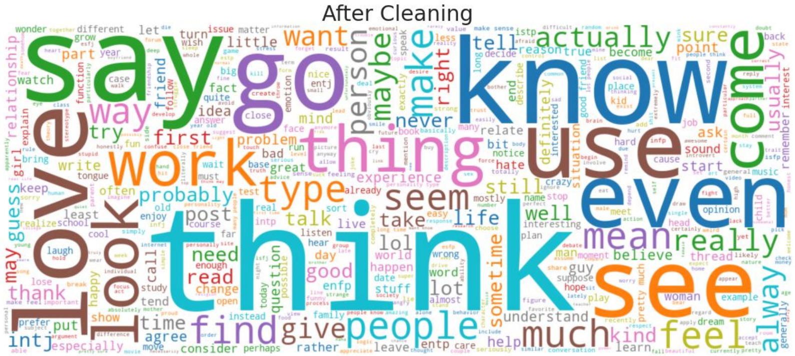
Distribution of 4 Dimensions



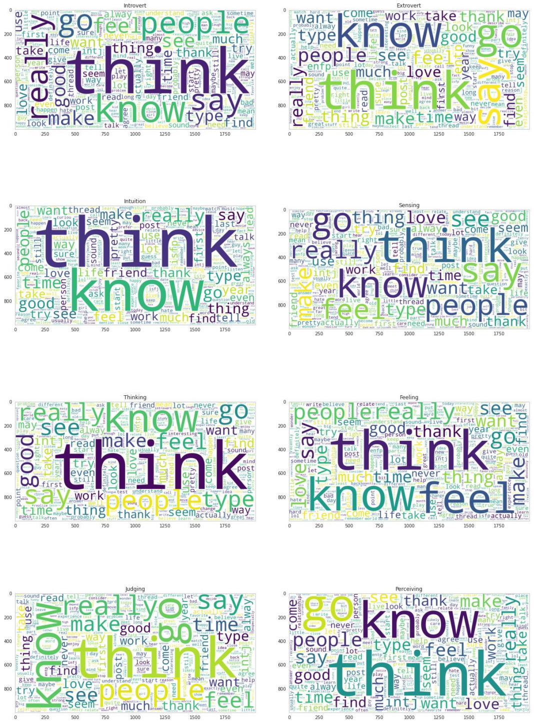
Correlation Matrix of the 4 Dimensions



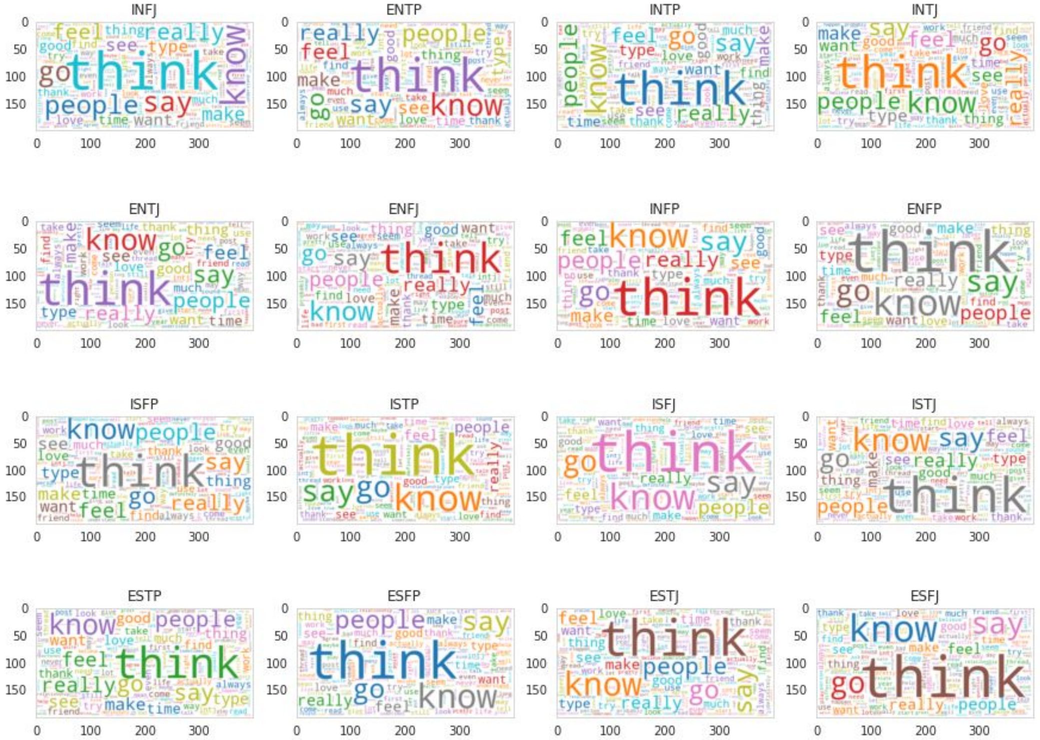
Before Cleaning



After Cleaning

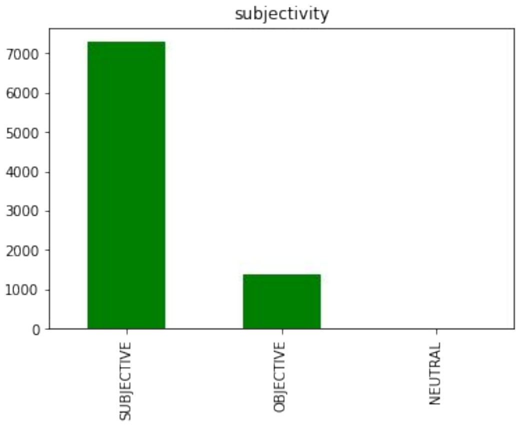


4 Dimensions

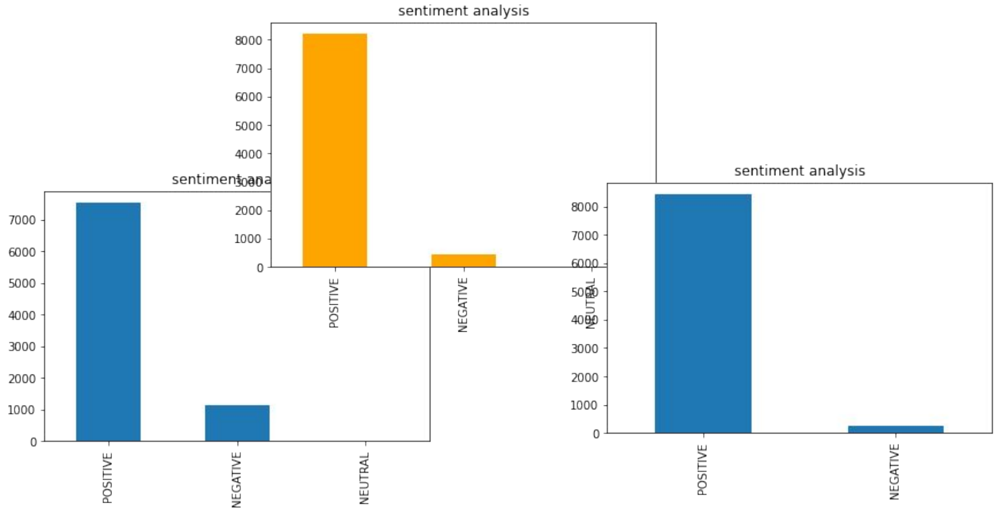


16 Personalities

Subjectivity Detection

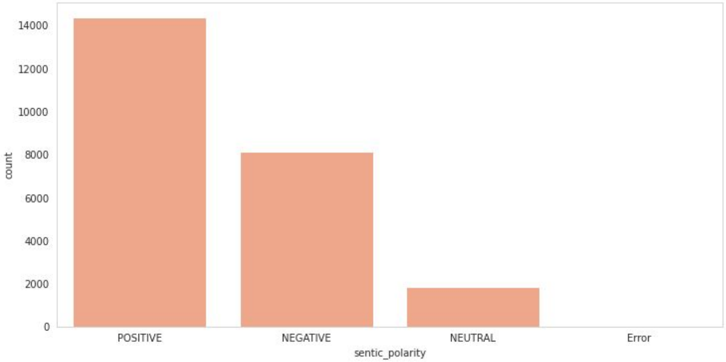


Sentiment Analysis

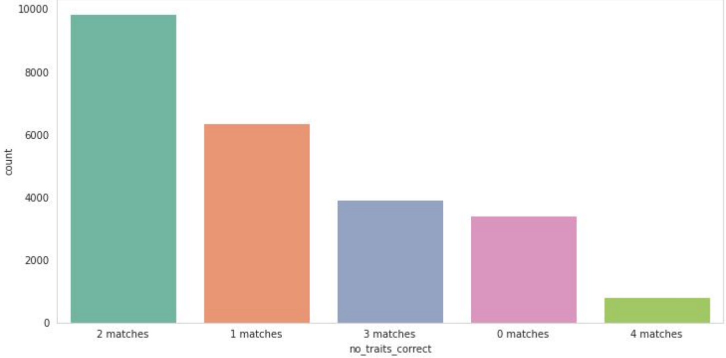


Processing using SenticNet, NLTK & TextBlob

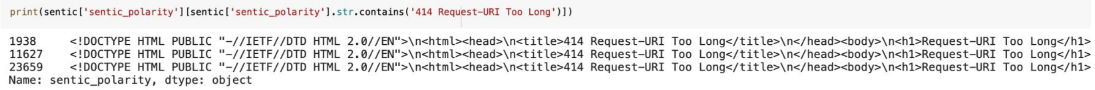
Analysis of SenticNet APIs
(with 24k Reddit Data)



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

1

Machine Learning

LDA, SMOTE Experiment,
16 Classification Models

2

Transformers & Transfer Learning

BERT, DistilBERT,
ZeroShot Pipeline

3

Neural Networks

GloVe Embeddings with
CNN, LSTM, GRU etc.

4

Ensemble Learning

Binary & Multiclass
Neural Network Ensemble

5

Multi-task Learning

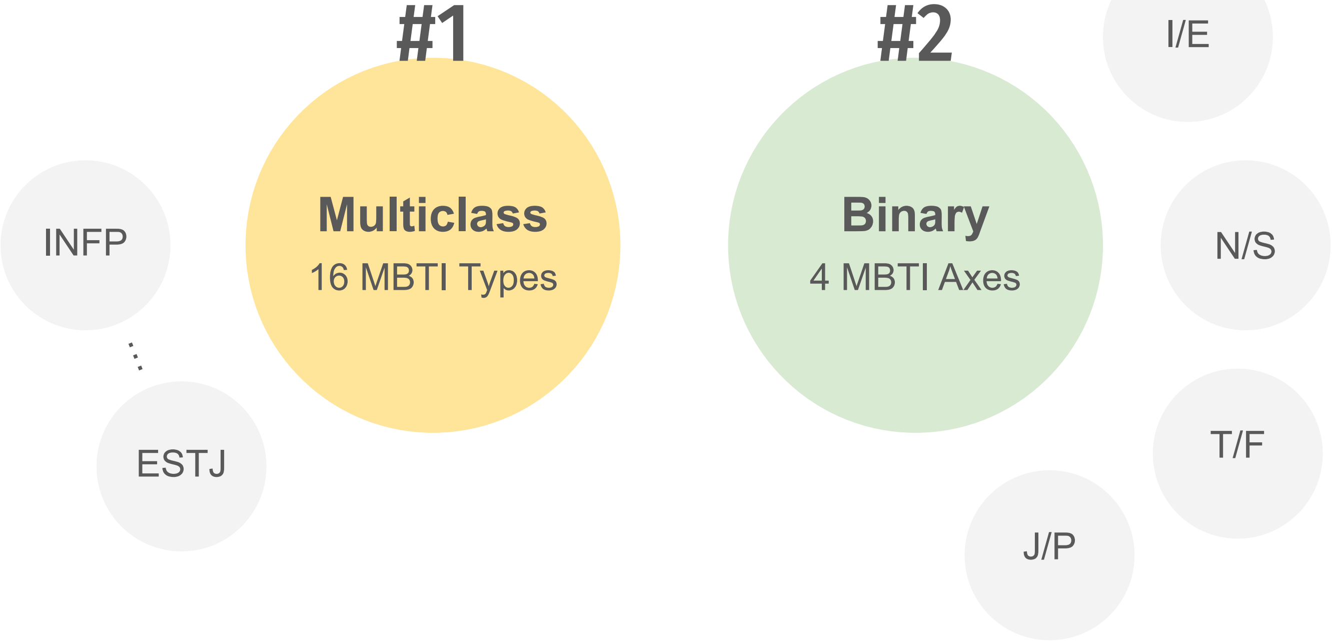
MBTI, Sentiment, Subjectivity

6

Hybrid Model

DistilBERT Embeddings,
Self-Attention Mechanism

Types of Classification



#1

Multiclass

16 MBTI Types

INFP

⋮

ESTJ

#2

Binary

4 MBTI Axes

I/E

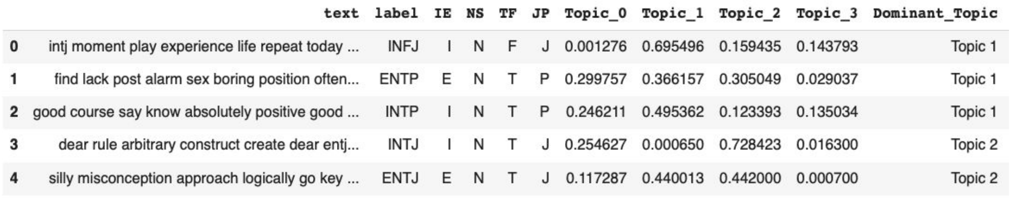
N/S

T/F

J/P

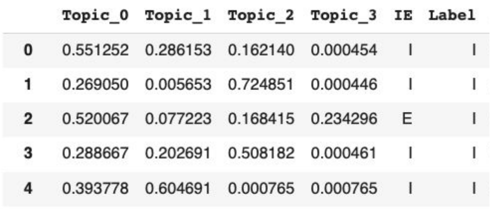
Machine Learning

- 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)

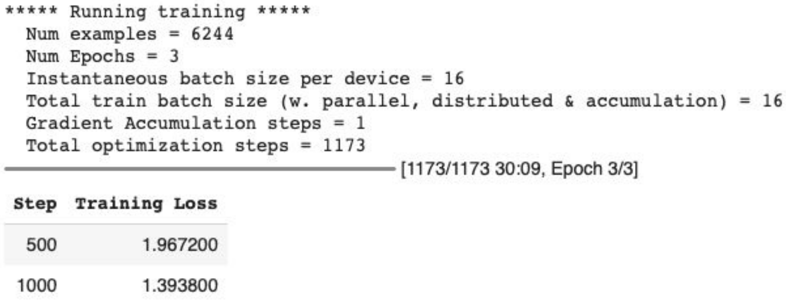


	Topic_0	Topic_1	Topic_2	Topic_3	IE	Label
0	0.551252	0.286153	0.162140	0.000454	I	I
1	0.269050	0.005653	0.724851	0.000446	I	I
2	0.520067	0.077223	0.168415	0.234296	E	I
3	0.288667	0.202691	0.508182	0.000461	I	I
4	0.393778	0.604691	0.000765	0.000765	I	I

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

Transformers & Transfer Learning

- Fine-tuning of pre-trained models
  - BERT
  - DistilBERT -- best model
- 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
```

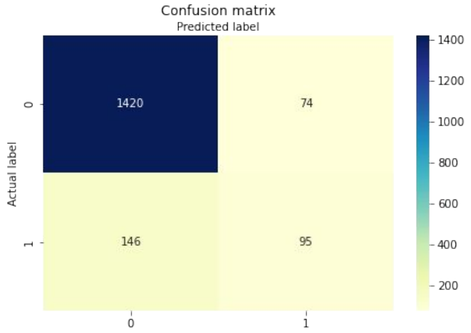
[1173/1173 30:09, Epoch 3/3]

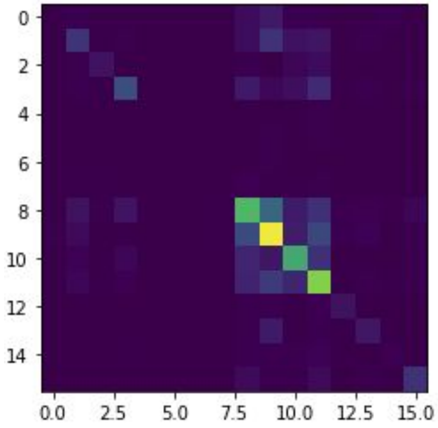
Step	Training Loss
500	1.967200
1000	1.393800

Fine-tuning DistilBERT

Neural Networks

- 6 Models
  - CNN -- best model
  - 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
- Difficulty in predicting personality on dataset with class imbalance



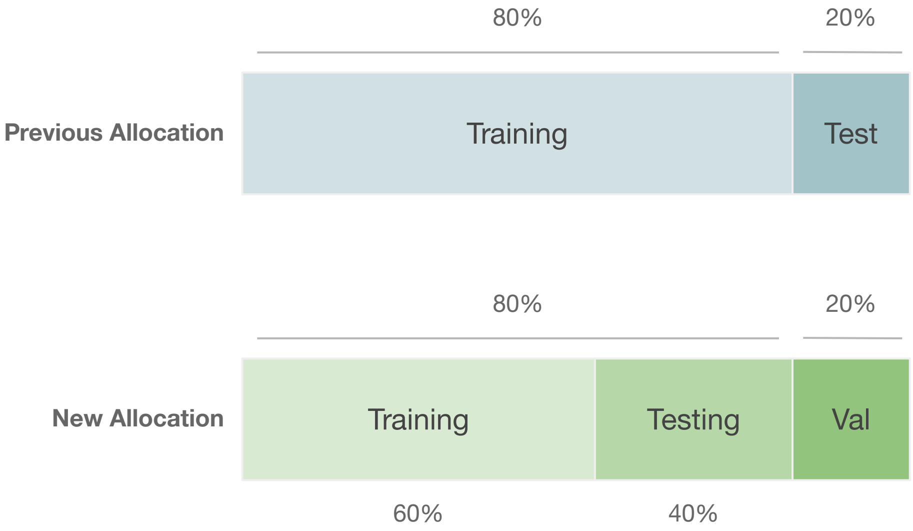


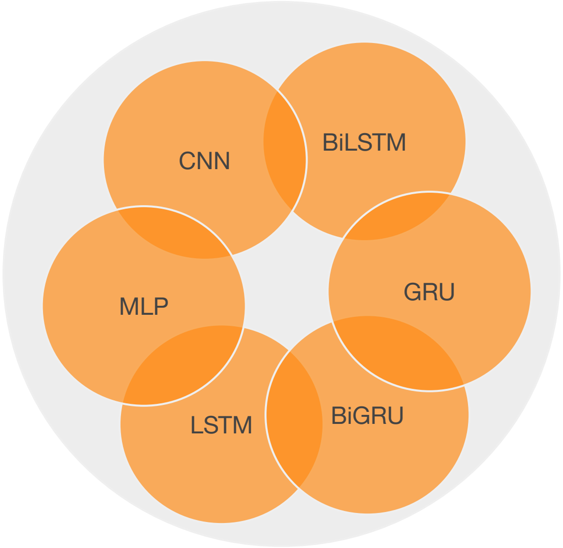
Model Enhancements

Ensemble Learning

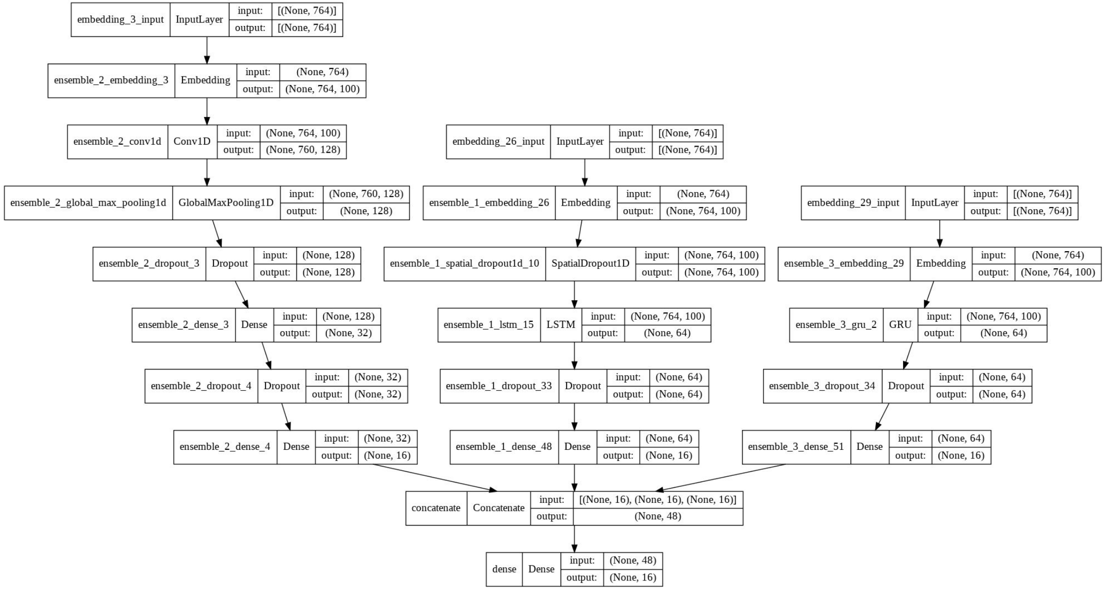
- Stacking Ensemble Approach
- Ensemble of top 3 models in both multiclass & binary classifiers
- Requires model retraining
  - Used non-independent data when training DNN
  - New data allocation with holdout dataset
  - Controlled random states of training data
- Observed better performance with standalone models
  - Due to weak base classifiers < 50% accuracy
  - Lesser training data with new allocation

Data Allocation with Controlled Random States





Stack Ensemble with Multiclass Classifiers



embedding_3_input InputLayer input: [(None, 764)] output: [(None, 764)]

ensemble_2_embedding_3 Embedding input: (None, 764) output: (None, 764, 100)

ensemble_2_conv1d Conv1D input: (None, 764, 100) output: (None, 760, 128)

ensemble_2_global_max_pooling1d GlobalMaxPooling1D input: (None, 760, 128) output: (None, 128)

ensemble_2_dropout_3 Dropout input: (None, 128) output: (None, 128)

ensemble_2_dense_3 Dense input: (None, 128) output: (None, 32)

ensemble_2_dropout_4 Dropout input: (None, 32) output: (None, 32)

ensemble_2_dense_4 Dense input: (None, 32) output: (None, 16)

embedding_26_input InputLayer input: [(None, 764)] output: [(None, 764)]

ensemble_1_embedding_26 Embedding input: (None, 764) output: (None, 764, 100)

ensemble_1_spatial_dropout1d_10 SpatialDropout1D input: (None, 764, 100) output: (None, 764, 100)

ensemble_1_lstm_15 LSTM input: (None, 764, 100) output: (None, 64)

ensemble_1_dropout_33 Dropout input: (None, 64) output: (None, 64)

ensemble_1_dense_48 Dense input: (None, 64) output: (None, 16)

embedding_29_input InputLayer input: [(None, 764)] output: [(None, 764)]

ensemble_3_embedding_29 Embedding input: (None, 764) output: (None, 764, 100)

ensemble_3_gru_2 GRU input: (None, 764, 100) output: (None, 64)

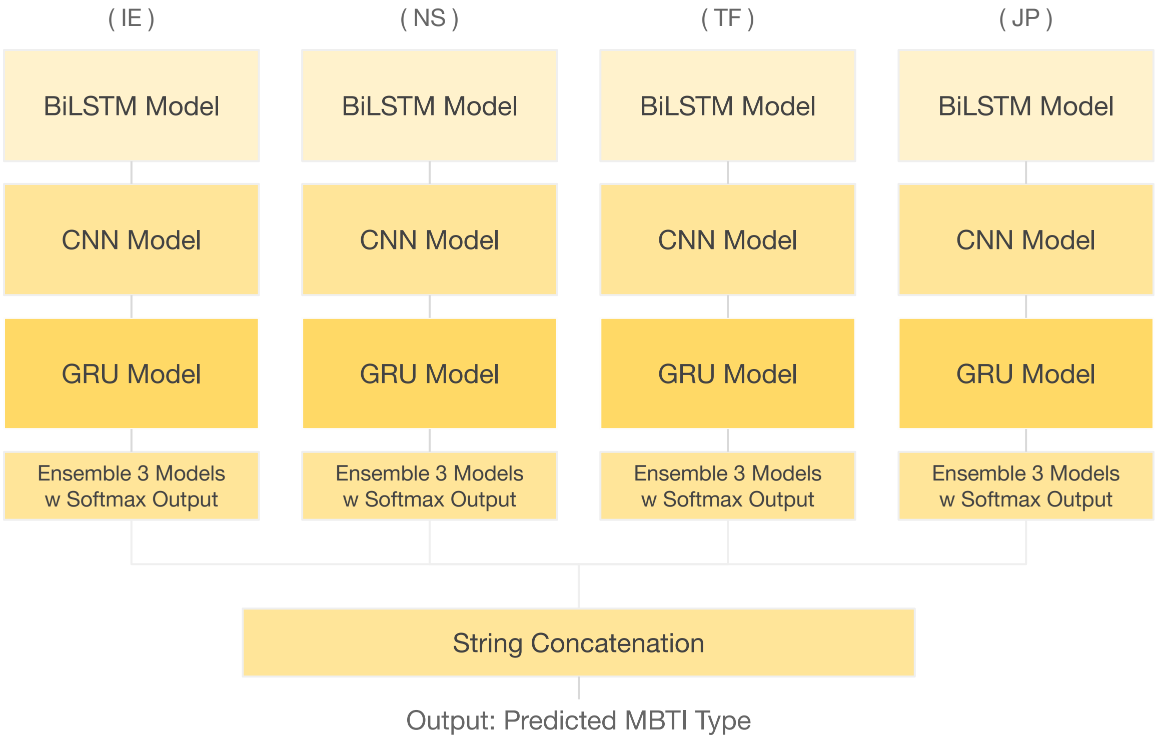
ensemble_3_dropout_34 Dropout input: (None, 64) output: (None, 64)

ensemble_3_dense_51 Dense input: (None, 64) output: (None, 16)

concatenate Concatenate input: [(None, 16), (None, 16), (None, 16)] output: (None, 48)

dense Dense input: (None, 48) output: (None, 16)

‘Multi-Task’ Ensemble with Binary Classifiers



(IE)

BiLSTM Model

CNN Model

GRU Model

Ensemble 3 Models w Softmax Output

(NS)

BiLSTM Model

CNN Model

GRU Model

Ensemble 3 Models w Softmax Output

(TF)

BiLSTM Model

CNN Model

GRU Model

Ensemble 3 Models w Softmax Output

(JP)

BiLSTM Model

CNN Model

GRU Model

Ensemble 3 Models w Softmax Output

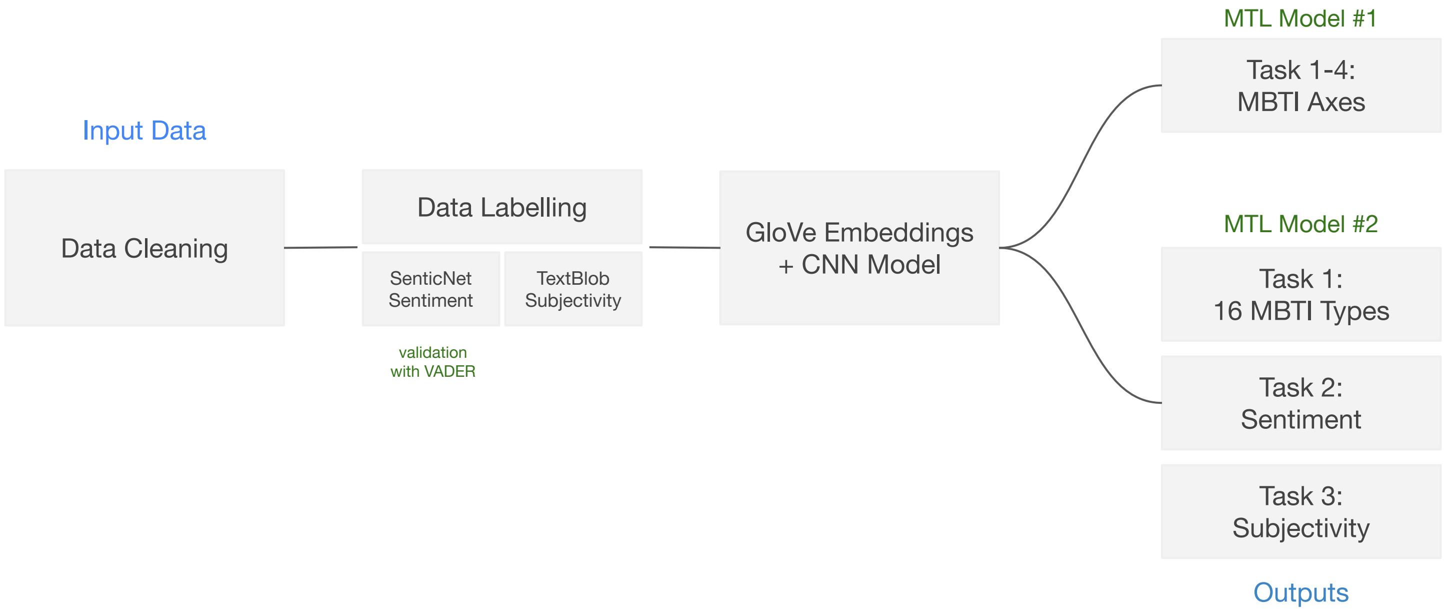
String Concatenation

Output: Predicted MBTI Type

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



Input Data

Data Cleaning

Data Labelling

SenticNet Sentiment

TextBlob Subjectivity

validation with VADER

GloVe Embeddings + CNN Model

MTL Model #1

Task 1-4: MBTI Axes

MTL Model #2

Task 1: 16 MBTI Types

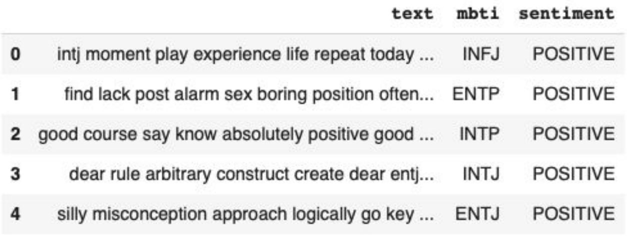
Task 2: Sentiment

Task 3: Subjectivity

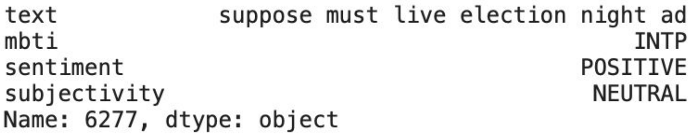
Outputs

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)



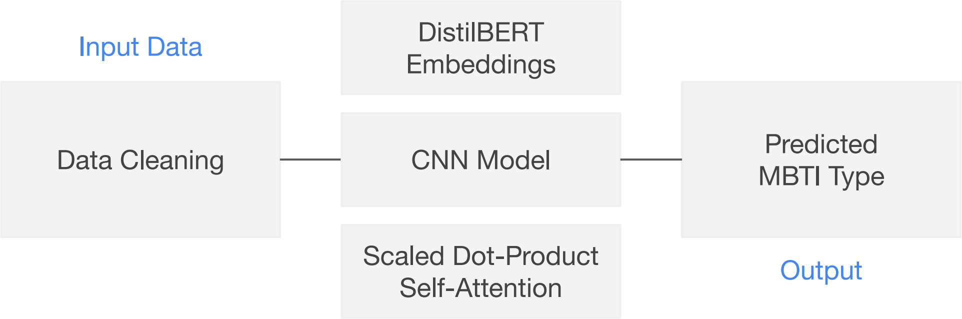
	text	mbti	sentiment
0	intj moment play experience life repeat today ...	INFJ	POSITIVE
1	find lack post alarm sex boring position often...	ENTP	POSITIVE
2	good course say know absolutely positive good ...	INTP	POSITIVE
3	dear rule arbitrary construct create dear entj...	INTJ	POSITIVE
4	silly misconception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

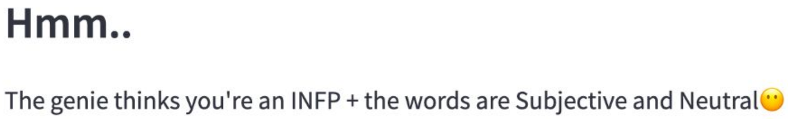
- Using best models: DistilBERT fine-tuned, GloVe-CNN Neural Network
  - With a Self-Attention Mechanism - help to retain semantic information
- 2 Hybrid Models
  - DistilBERT embeddings + CNN
  - DistilBERT embeddings + CNN + Scaled Dot Product Self-Attention
- Better Accuracy + More classes predicted with GloVe-CNN
  - Therefore GloVe > DistilBERT embeddings



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



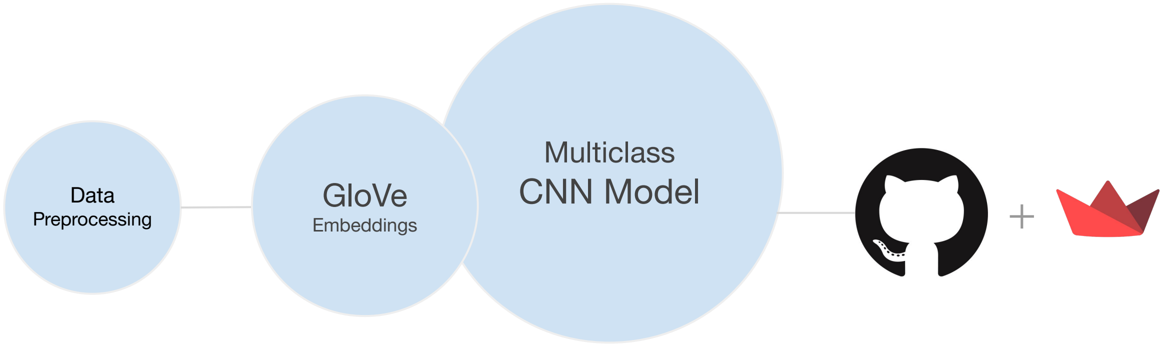
Hmm..

The genie thinks you're an INFP + the words are Subjective and Neutral😶

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

SCAN ME

Deployment



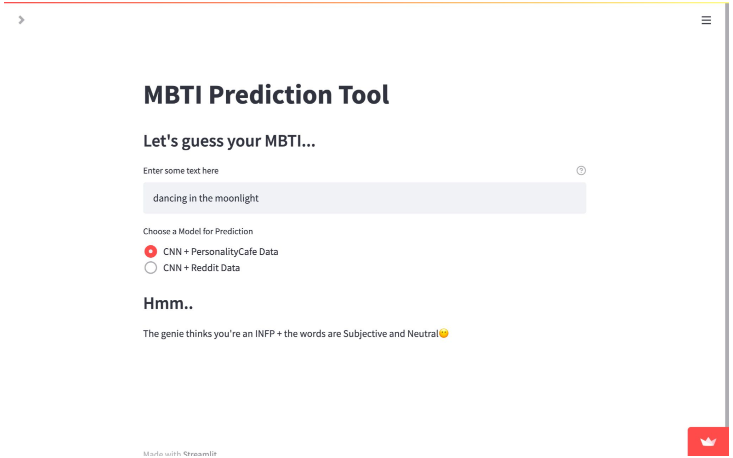
Data Preprocessing

GloVe
Embeddings

Multiclass
CNN Model

+

MBTI Prediction Page



MBTI Prediction Tool

Let's guess your MBTI...

Enter some text here

dancing in the moonlight

Choose a Model for Prediction

● CNN + PersonalityCafe Data

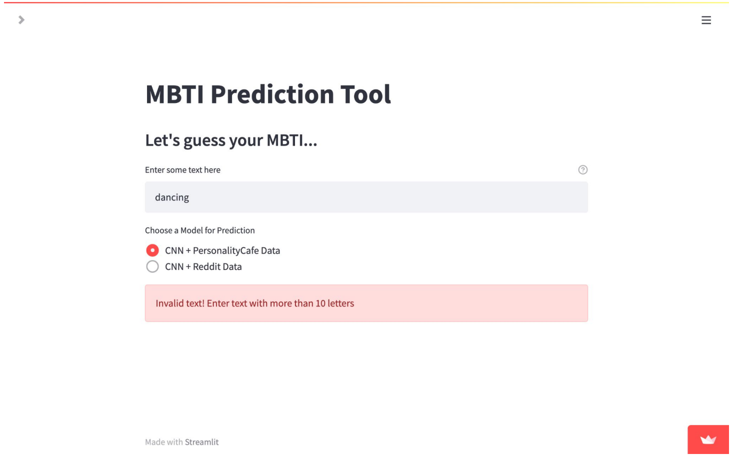
○ CNN + Reddit Data

Hmm..

The genie thinks you're an INFP + the words are Subjective and Neutral😐

Made with Streamlit

MBTI Prediction



MBTI Prediction Tool

Let's guess your MBTI...

Enter some text here

dancing

Choose a Model for Prediction

● CNN + PersonalityCafe Data

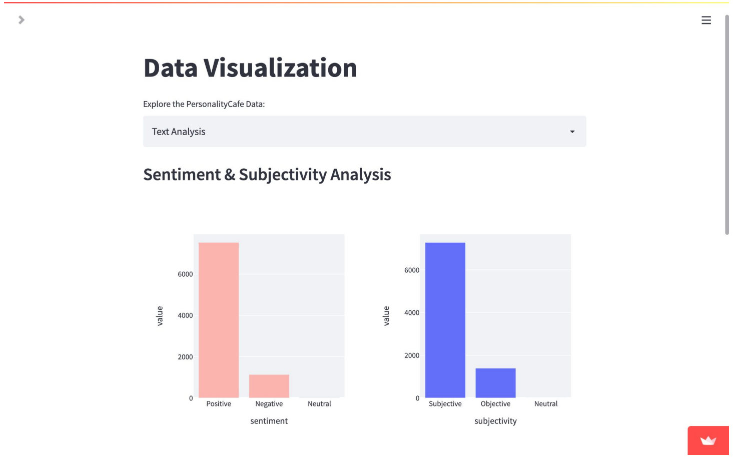
○ CNN + Reddit Data

Invalid text! Enter text with more than 10 letters

Made with Streamlit

Error Handling:
for text length < 10

Data Visualization Page



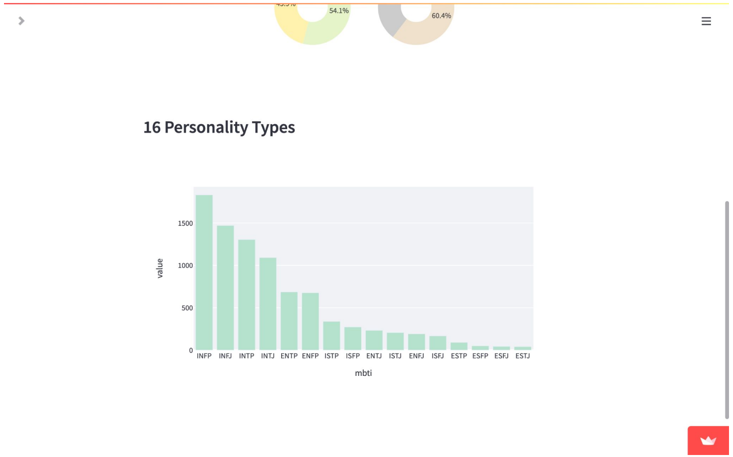
Data Visualization

Explore the PersonalityCafe Data:

Text Analysis

Sentiment & Subjectivity Analysis

Option 1: Text Analysis

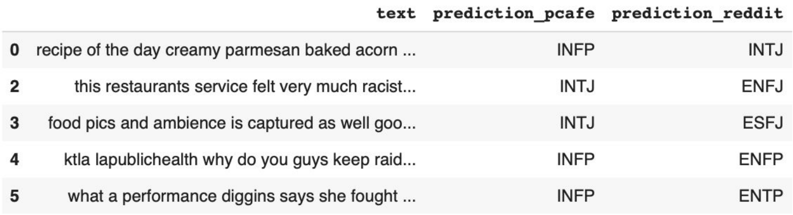


16 Personality Types

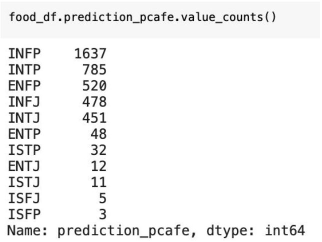
Option 2: Personality Types

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

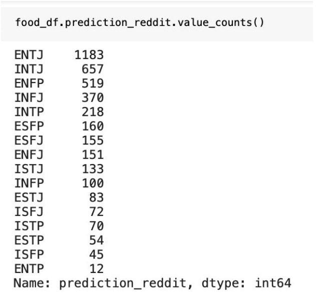


	text	prediction_pcafe	prediction_reddit
0	recipe of the day creamy parmesan baked acorn ...	INFP	INTJ
2	this restaurants service felt very much racist...	INTJ	ENFJ
3	food pics and ambience is captured as well goo...	INTJ	ESFJ
4	ktla lapublichealth why do you guys keep raid...	INFP	ENFP
5	what a performance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

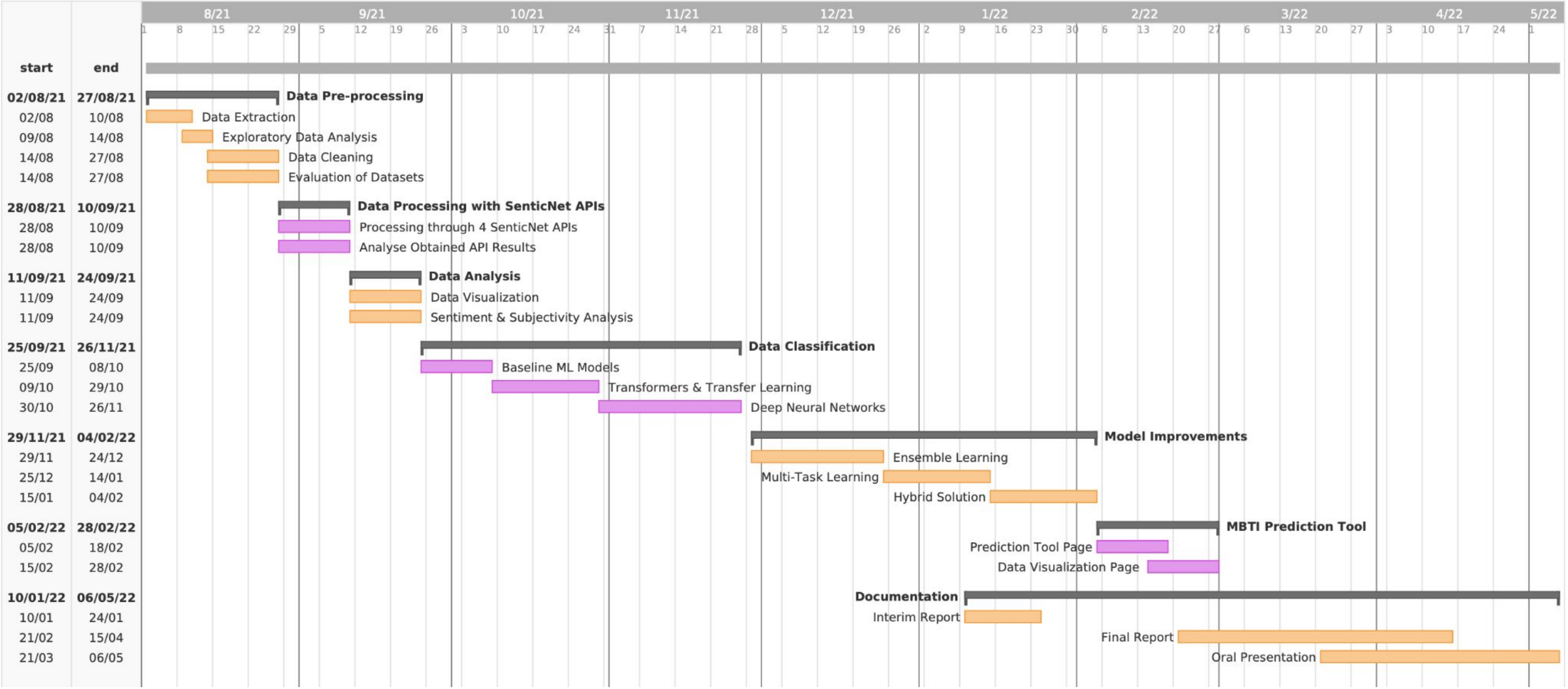
Conclusion: Summary of Findings

- 6 Classification Approaches + MBTI Prediction Tool
  - Dataset with class imbalance issue - difficult to learn efficiently (INFP vs ESFJ)
  - Option of using 4 dimensions may offer better analysis for class imbalance datasets
- Findings
  - Best Binary: Fine-tuned DistilBERT; Multiclass: GloVe-CNN neural network
  - MTL can boost efficiency in saving time: training more tasks with similar accuracy
  - Hybrid Model Results: GloVe > DistilBERT embeddings
- Future Work: MTL with other NLP tasks (eg. NER, POS) & new datasets

Binary Models	I/E	N/S	T/F	J/P	Acc. (%)	**Multiclass Models**	Acc. (%)
Fine-tuned DistilBERT	83.6	89.9	83.2	77.4	**48.4**	Glove-CNN (NN)	**43.6**
Glove-CNN (NN)	80.0	87.3	74.9	69.1	36.1	Glove-LSTM (NN)	40.2
Glove-CNN (MTL)	76.3	84.7	53.8	54.8	19.1	DistilBERT-CNN (Hybrid)	33.6

Better than Random Guessing of 1/16 = 6.25%

Project Gantt Chart



start	end	
02/08/21	**27/08/21**	**Data Pre-processing**
02/08	10/08	Data Extraction
09/08	14/08	Exploratory Data Analysis
14/08	27/08	Data Cleaning
14/08	27/08	Evaluation of Datasets
28/08/21	**10/09/21**	**Data Processing with SenticNet APIs**
28/08	10/09	Processing through 4 SenticNet APIs
28/08	10/09	Analyse Obtained API Results
11/09/21	**24/09/21**	**Data Analysis**
11/09	24/09	Data Visualization
11/09	24/09	Sentiment & Subjectivity Analysis
25/09/21	**26/11/21**	**Data Classification**
25/09	08/10	Baseline ML Models
09/10	29/10	Transformers & Transfer Learning
30/10	26/11	Deep Neural Networks
29/11/21	**04/02/22**	**Model Improvements**
29/11	24/12	Ensemble Learning
25/12	14/01	Multi-Task Learning
15/01	04/02	Hybrid Solution
05/02/22	**28/02/22**	**MBTI Prediction Tool**
05/02	18/02	Prediction Tool Page
15/02	28/02	Data Visualization Page
10/01/22	**06/05/22**	**Documentation**
10/01	24/01	Interim Report
21/02	15/04	Final Report
21/03	06/05	Oral Presentation

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

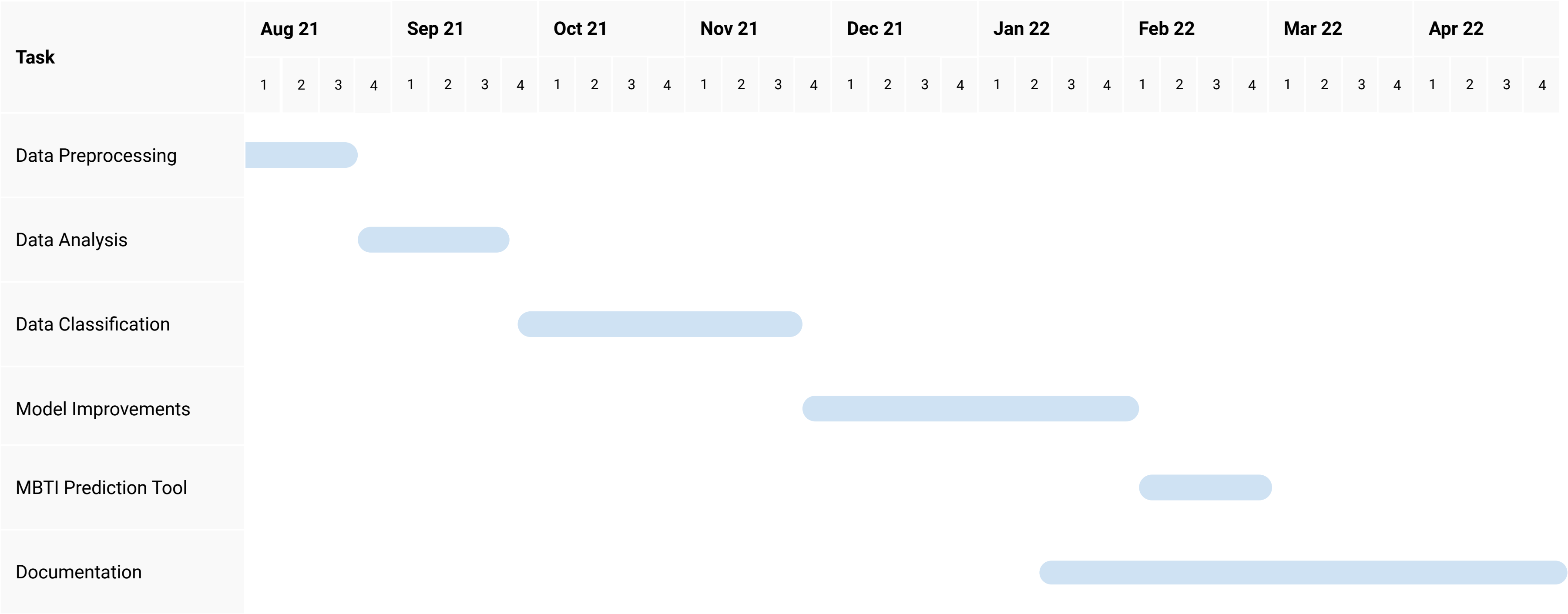
- Multi-task Learning with other NLP tasks
    - Eg. Aspect-Based Sentiment Analysis (ABSA), Part of Speech (POS) Tagging, Named Entity Recognition (NER).
- Advanced state-of-the-arts transformers / word embeddings for improvements
    - Eg. GPT-NEO with text-generation may predict words choices of each 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].

ARCHIVED

Gantt Chart


Task
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Oct 21
Nov 21
Dec 21
Jan 22
Feb 22
Mar 22
Apr 22
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4
Data Preprocessing
Data Analysis
Data Classification
Model Improvements
MBTI Prediction Tool
Documentation