



# GA PROJECT 3

# NLP CLASSIFICATION FOR AD TARGETING

R/CODINGBOOTCAMP VS R/CSMAJOR



MARY-ANNE, RIFQI, SHAWN, TING WEI, WEI ZHE



# BACKGROUND

There is increased competition in the space for coding bootcamps.



# BACKGROUND

There is an increased competition in the space for coding bootcamps.



If no action is taken, General Assembly may face...



**DECLINE IN MARKET SHARE**



**LOWER MARKETING ROI**



**POORER LEAD GENERATION**

# BACKGROUND



**GENERAL  
ASSEMBLY**

MARKETING TEAM

- ✓ Better identify the online presence of a **bootcamp seeker** as opposed to that of a computer science major to aid in targeted advertising.
- ✓ Considering the two topics have quite a bit in common, efforts to further segregate the two could yield **better advertising ROI**.



Keywords are an important aspect of digital advertising |

<https://www.keywordsrock.com> :

## Keywords allow for targeted strategies at all levels of the marketing funnel

**Keywords** guide marketing teams on the sort of advertising content that is required.

E.g. Google ads, one of the most effective platforms for generating leads and sales works well due to its ability to target users with high buying intent based on the keywords they use.

[SEO Keywords](#) · [Google Ad](#) · [General Assembly](#) · [Coding Bootcamps](#)



Bootcamp, Coding|

Google Search

I'm Feeling Lucky

Current classifying model using straightforward **keywords** such as 'bootcamp' and 'coding' yields around **79% accuracy**.



## PROBLEM STATEMENT

Build a model with **>90% accuracy** that helps to identify between **those who are looking for bootcamp style learning** vs computer science majors/prospective students **based on the words they use** online.

# WORKFLOW



SCRAPE



PRE-  
PROCESS



ANALYSE



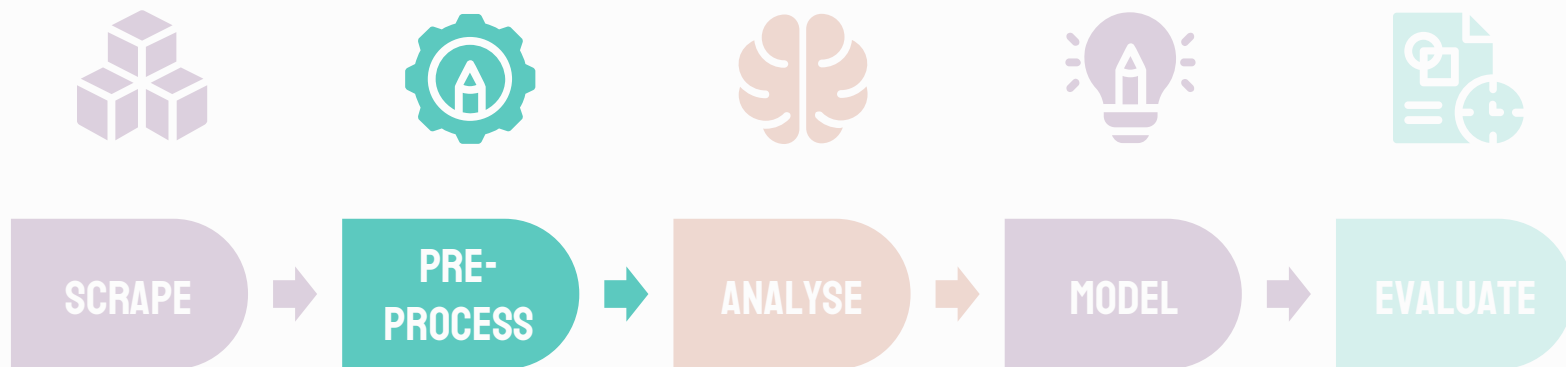
MODEL



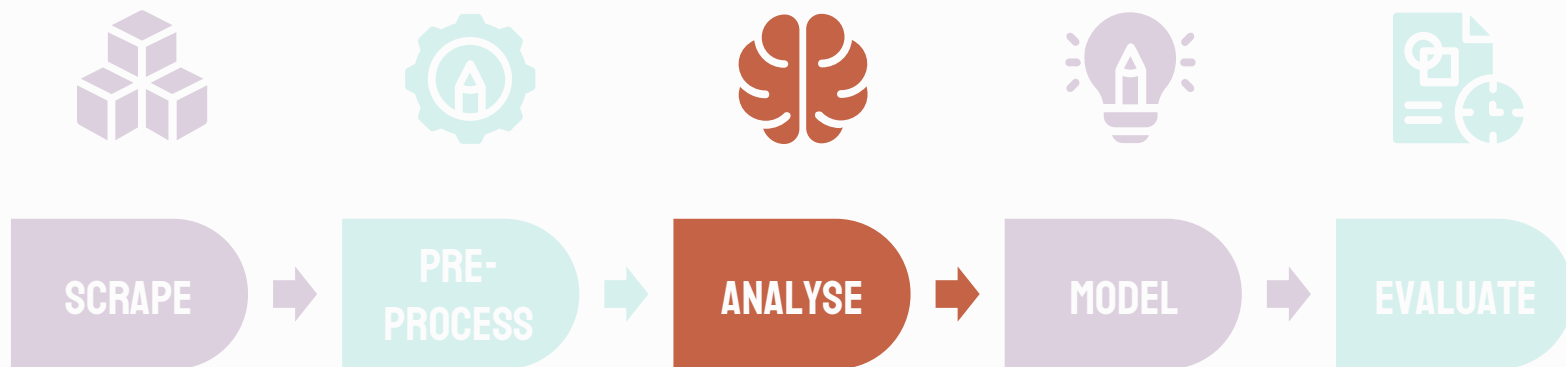
EVALUATE



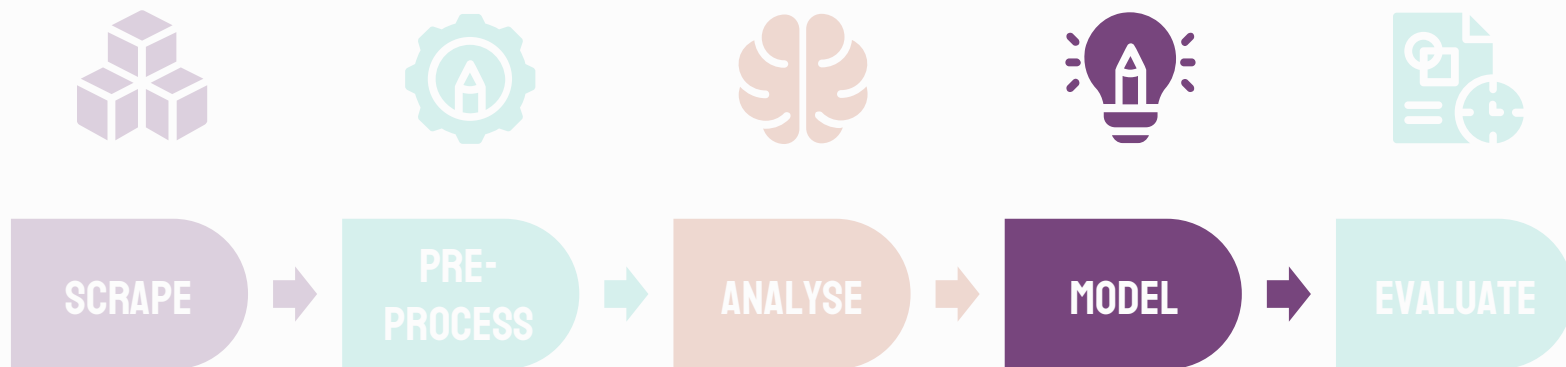
# WORKFLOW



# WORKFLOW



# WORKFLOW



# WORKFLOW



SCRAPE



PRE-  
PROCESS



ANALYSE



MODEL



EVALUATE

# WHAT METHODS ARE WE USING TO CLEAN?

- Web Scraping
- Remove Null/Duplicate values
- Remove punctuations



# WHAT METHODS ARE WE USING TO CLEAN?



- Tokenization
- Remove stopwords
- Stem / Lemmatize





## WEB SCRAPING

# Reddit API vs Pushshift API

- Easier retrieving data
  - 5 times greater object limit
- 
- 

# WHERE DO WE SCRAPE FROM?



## Coding Bootcamp

r/codingbootcamp

Join

22.3k  
Members



## Students of Computer Science!

r/csMajors

Join

153k  
Members



# REMOVED & DELETED

- - 
  - Removed & Deleted posts are not beneficial to our case
- 
- They are replaced with an empty string

[deleted] • 6h

🎁 1 Award

[removed]

... 🎁 ⬅ Reply ⬆ 1.8k ⬇

[deleted] • 6h

[removed]

... 🎁 ⬅ ⬆ 519 ⬇

```
# Remove the words [removed] and [deleted] from selftexts
df['selftext'] = df['selftext'].replace('[removed]', '')
df['selftext'] = df['selftext'].replace('[deleted]', '')
```

# REMOVE PUNCTUATION & TOKENIZATION

	Removed Punctuation	Tokenization
body_text	body_text_clean	body_text_tokenized
I've been searching for the right words to tha...	Ive been searching for the right words to than...	[ive, been, searching, for, the, right, words,...]
Free entry in 2 a wkly comp to win FA Cup fina...	Free entry in 2 a wkly comp to win FA Cup fina...	[free, entry, in, 2, a, wkly, comp, to, win, f...]
Nah I don't think he goes to usf, he lives aro...	Nah I dont think he goes to ust he lives aroun...	[nah, i, dont, think, he, goes, to, usf, he, l...]
Even my brother is not like to speak with me. ...	Even my brother is not like to speak with me T...	[even, my, brother, is, not, like, to, speak, ...]
I HAVE A DATE ON SUNDAY WITH WILL!!	I HAVE A DATE ON SUNDAY WITH WILL	[i, have, a, date, on, sunday, with, will]

# LEMMATIZATION

01. What?

02. How?

03. Why?

body_text_stemmed	body_text_lemmatized
[ive, search, right, word, thank, breather, pr...]	[ive, searching, right, word, thank, breather,...]
[free, entri, 2, wkli, comp, win, fa, cup, fin...]	[free, entry, 2, wkly, comp, win, fa, cup, fin...]
[nah, dont, think, goe, usf, live, around, tho...]	[nah, dont, think, go, usf, life, around, though]
[even, brother, like, speak, treat, like, aid,...]	[even, brother, like, speak, treat, like, aid,...]
[date, sunday]	[date, sunday]

EDA



## EDA : REMOVING ADDITIONAL STOPWORDS

### Coding Bootcamp top 50 words

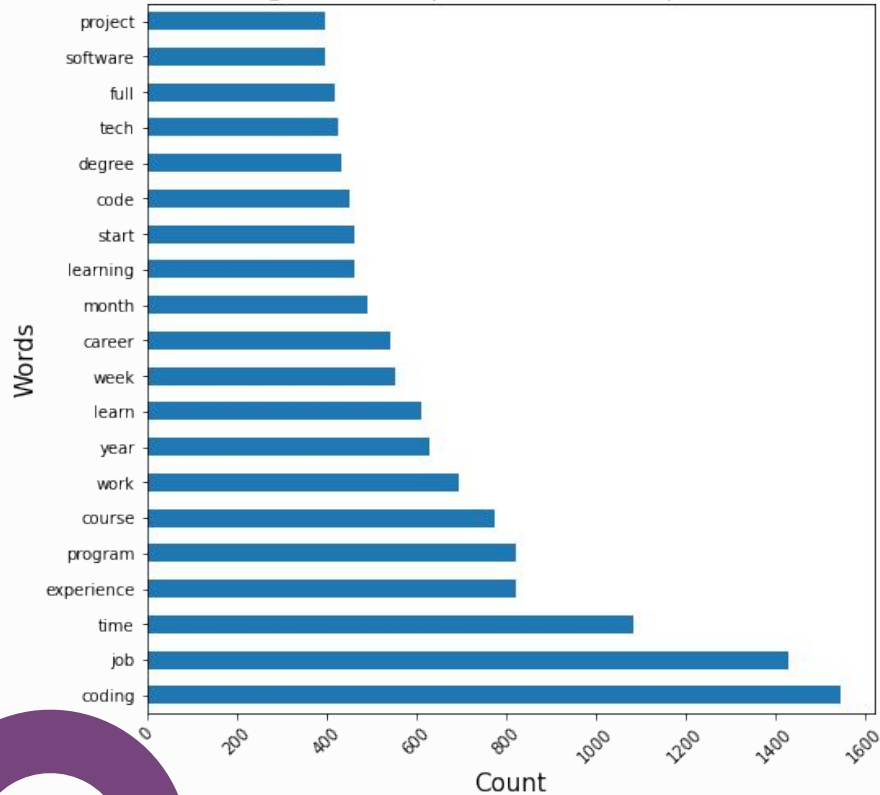
✗	bootcamp	2207	✗	really	566
	coding	1544		week	554
	job	1427	✗	help	553
✗	would	1238		career	542
✗	get	1149		month	491
✗	im	1117	✗	ive	483
✗	like	1095	✗	need	482
	time	1083		learning	463
✗	know	900		start	462
	experience	824	✗	make	458
	program	823		code	453
✗	camp	788	✗	dont	450
	course	774	✗	question	437
✗	want	756		degree	432
✗	anyone	738	✗	go	431
✗	one	720		tech	428
✗	boot	710		full	418
	work	697	✗	going	398
✗	looking	658		software	397
✗	bootcamps	633		project	396
	year	629	✗	lot	395
✗	good	618		academy	381
	learn	610	✗	much	376
✗	also	574	✗	take	374
✗	people	571	✗	feel	368

### CS Majors top 50 words

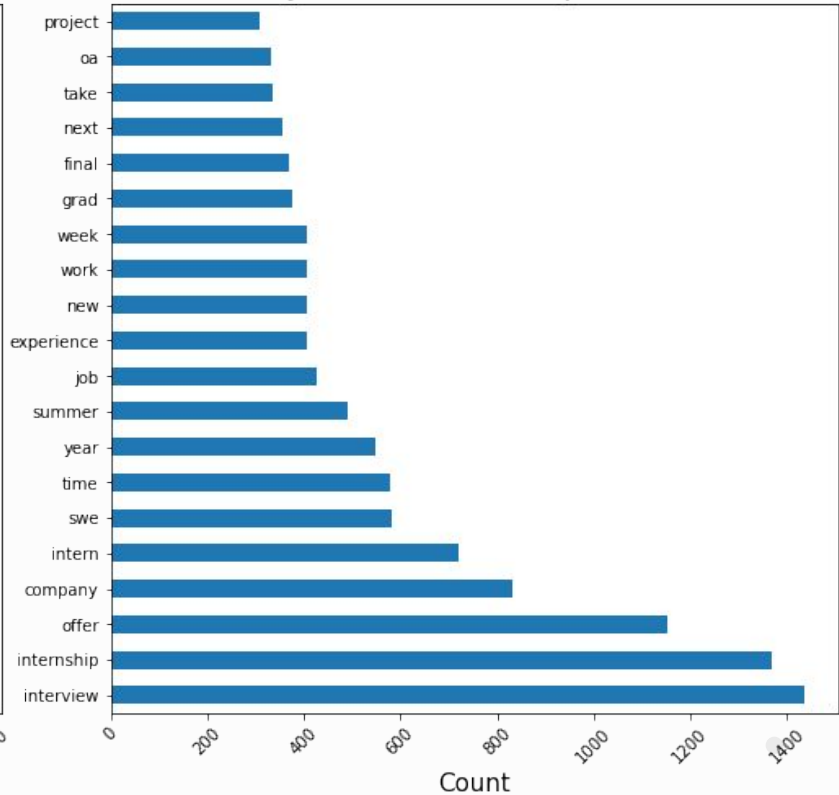
	interview	1435	✗	really	404
	internship	1368		view	398
	offer	1152	✗	back	390
	company	832	✗	want	383
✗	would	831		grad	375
✗	anyone	812		final	369
✗	im	808	✗	good	368
✗	get	758		next	356
✗	like	736		take	336
	intern	720		oa	331
✗	know	650	✗	people	321
✗	got	635	✗	dont	314
✗	question	614		first	313
✗	one	590		recruiter	307
	swe	582		project	307
	time	578	✗	think	299
	year	547	✗	still	292
	summer	492		tech	292
✗	also	434		resume	291
	job	427		school	284
	round	425	✗	even	283
	experience	407	✗	getting	278
	work	406	✗	much	278
	new	406	✗	feel	275
	week	405		class	275

## EDA : TOP 20 WORDS

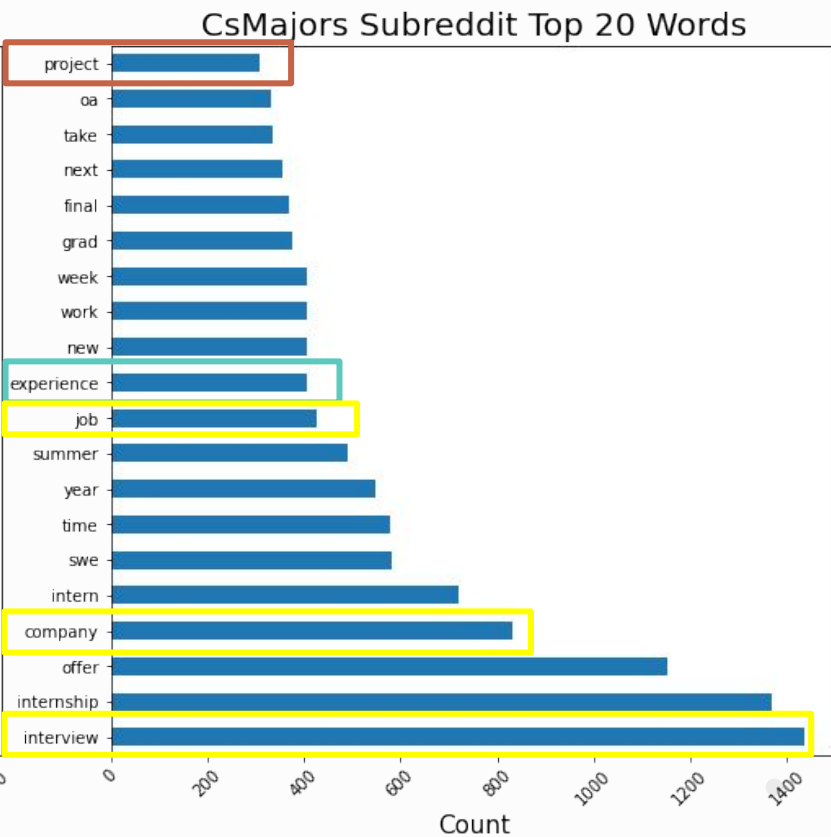
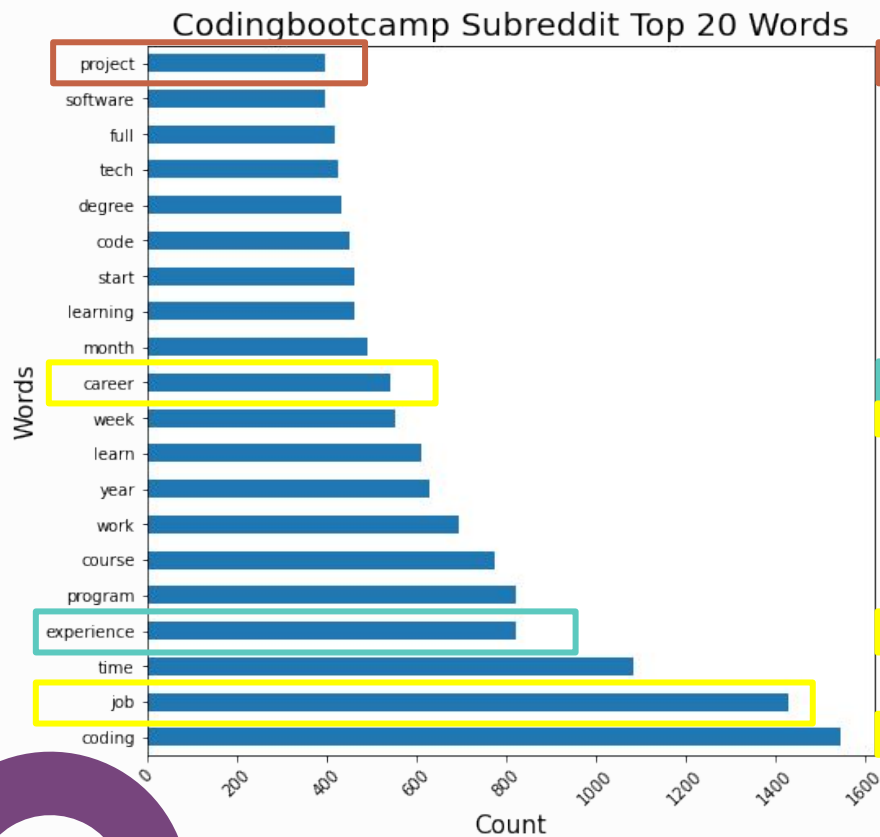
Codingbootcamp Subreddit Top 20 Words



CsMajors Subreddit Top 20 Words

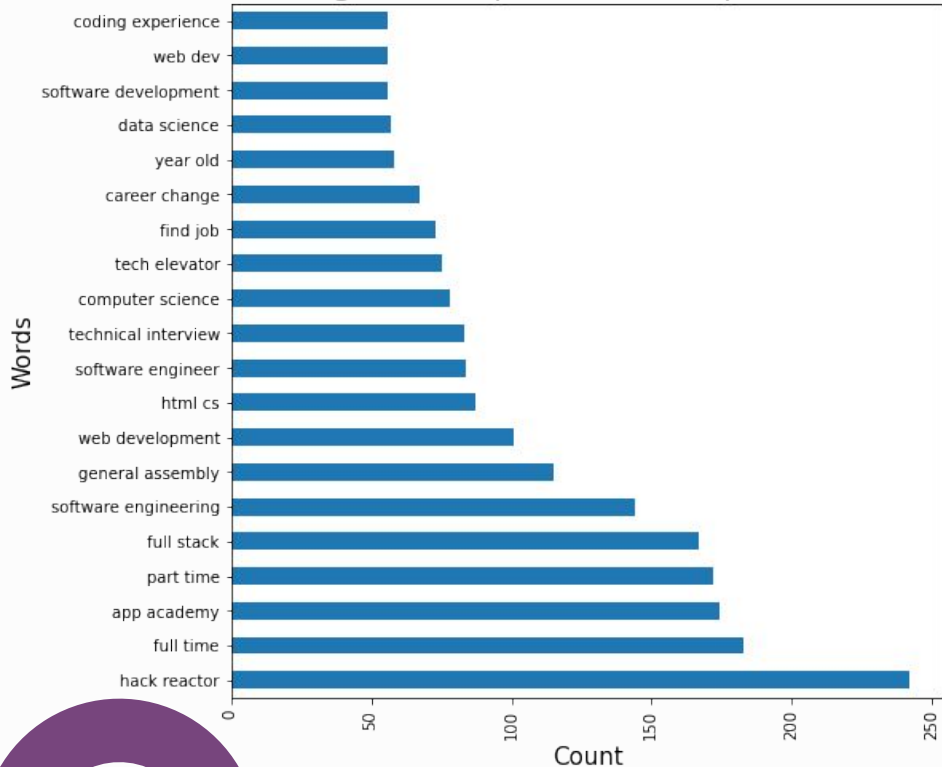


## EDA : TOP 20 WORDS - SIMILARITIES

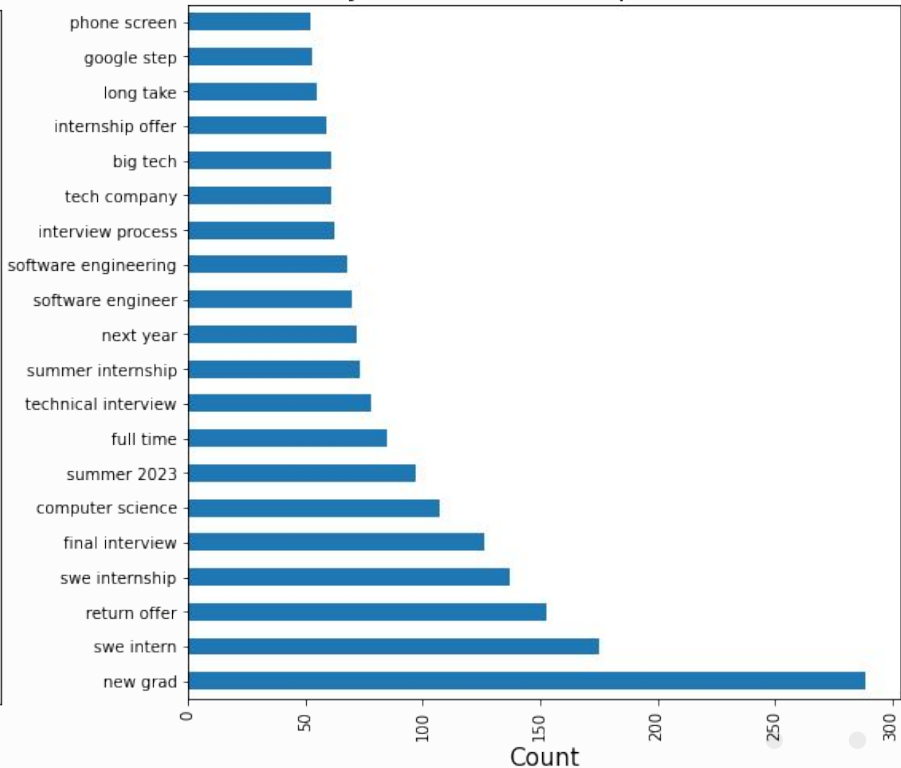


## EDA : TOP 20 2-WORDS

Codingbootcamp Subreddit Top 20 2-Words



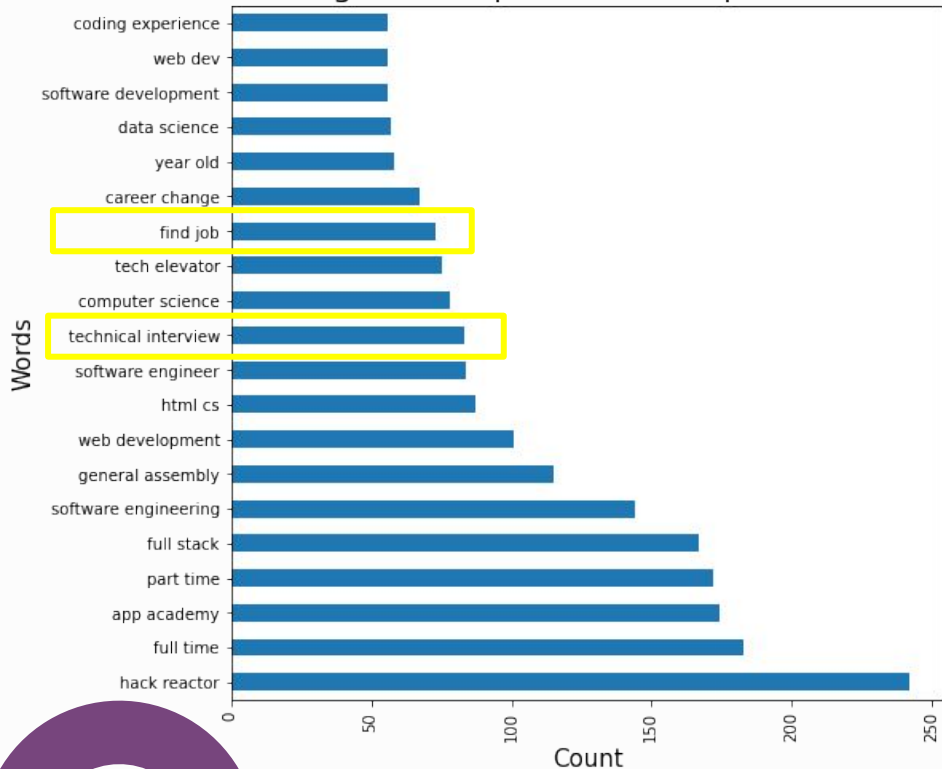
CSMajors Subreddit Top 20 2-Words



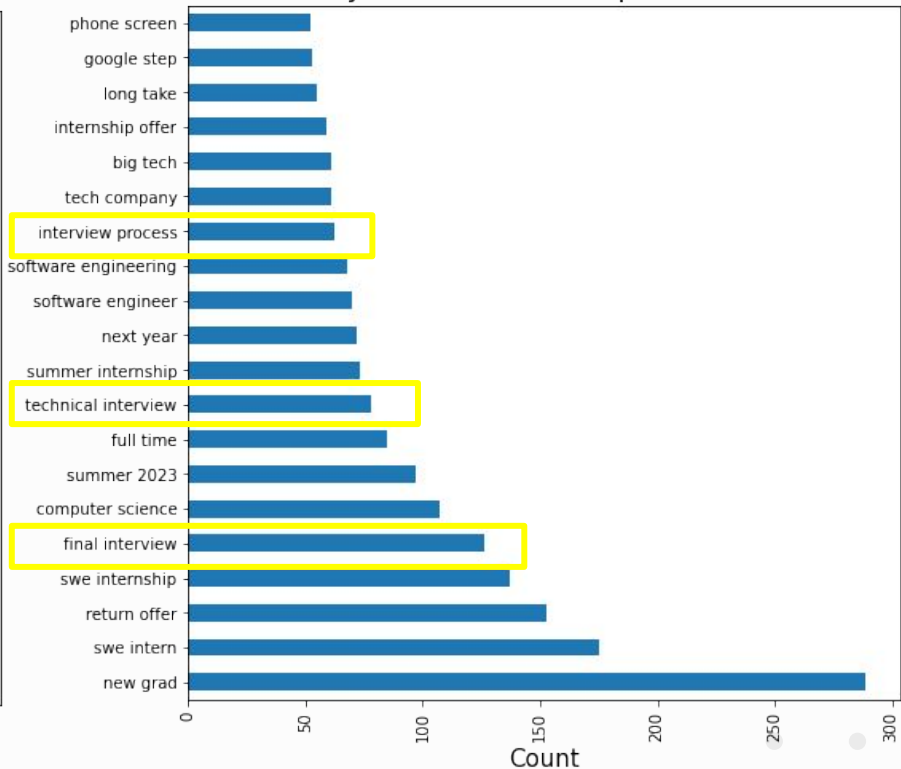


## EDA : TOP 20 2-WORDS - SIMILARITIES: CAREER

Codingbootcamp Subreddit Top 20 2-Words

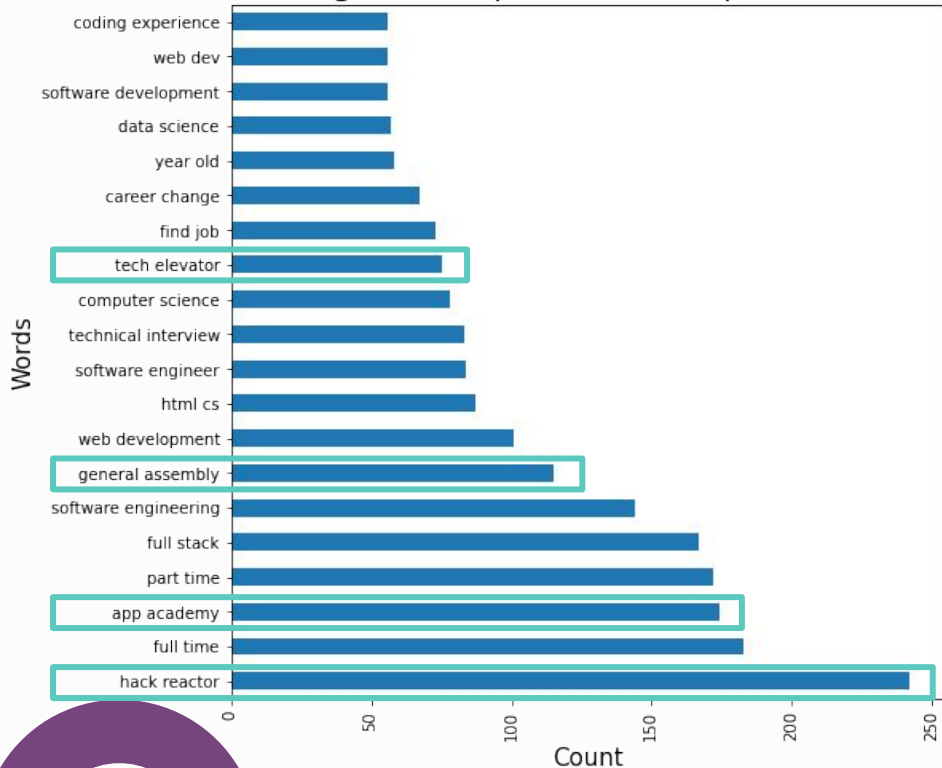


CSMajors Subreddit Top 20 2-Words

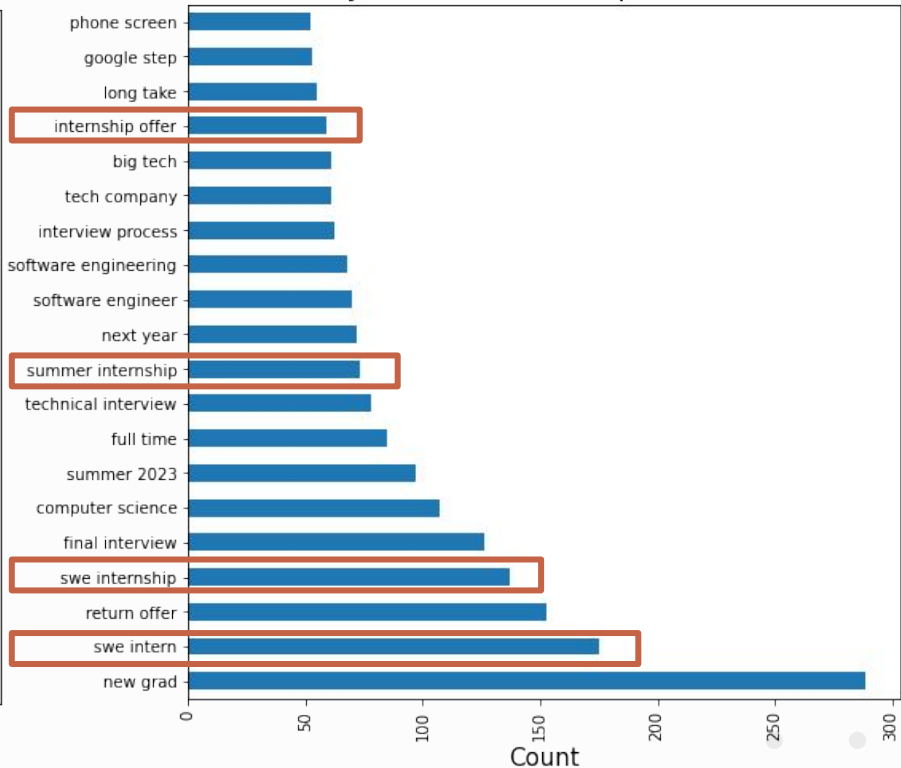


## EDA : TOP 20 2-WORDS - DIFFERENCES: SCHOOLS VS INTERNSHIPS

Codingbootcamp Subreddit Top 20 2-Words

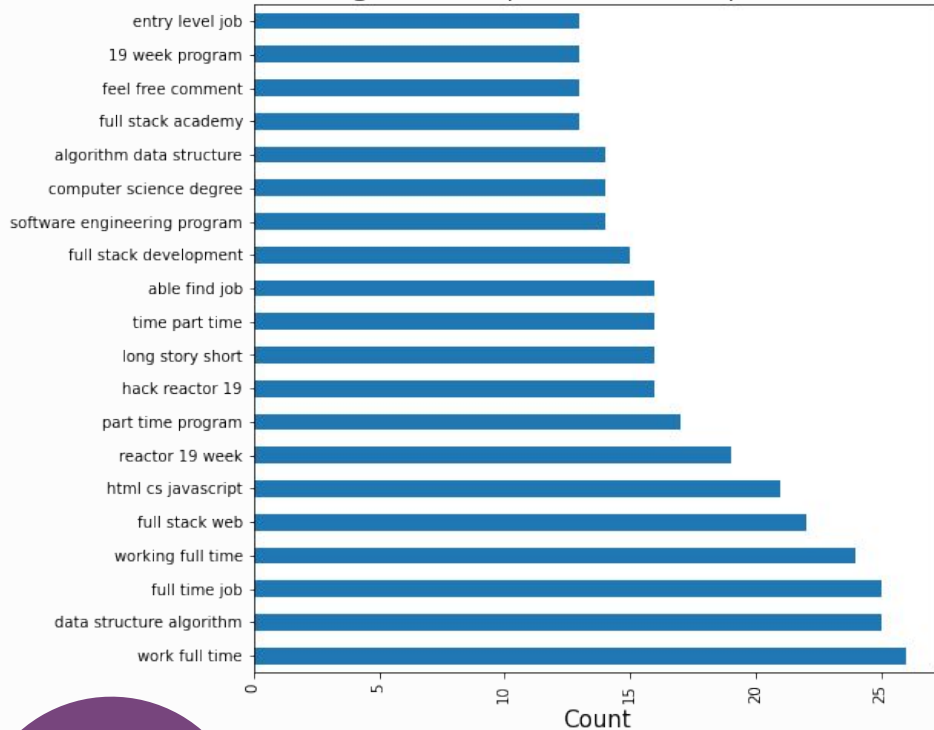


CSMajors Subreddit Top 20 2-Words

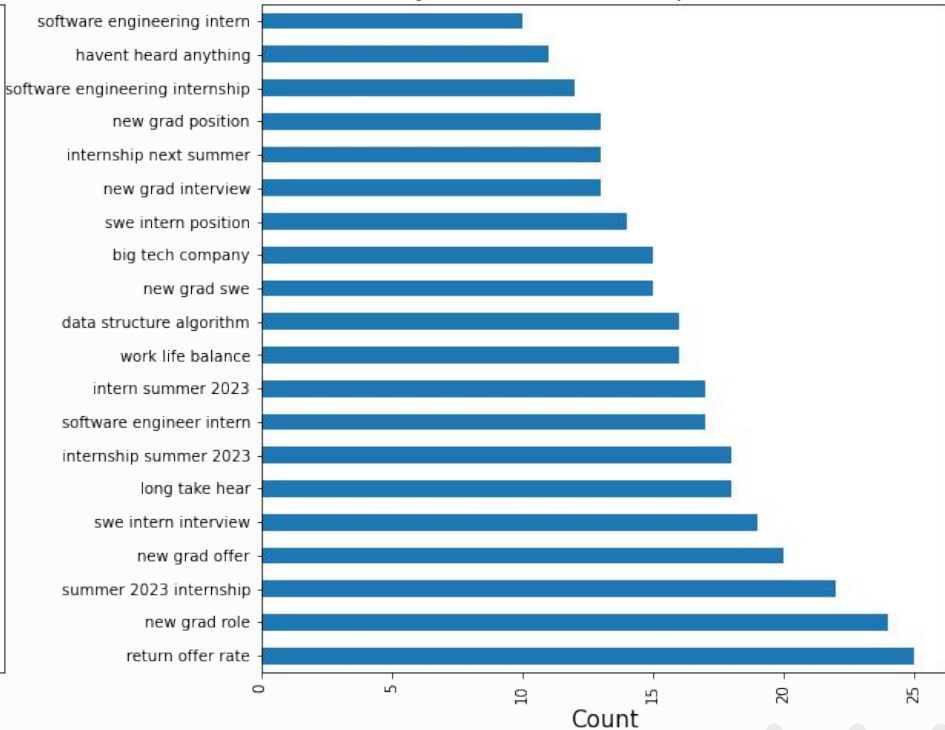


## EDA : TOP 20 3-WORDS

Codingbootcamp Subreddit Top 20 3-Words

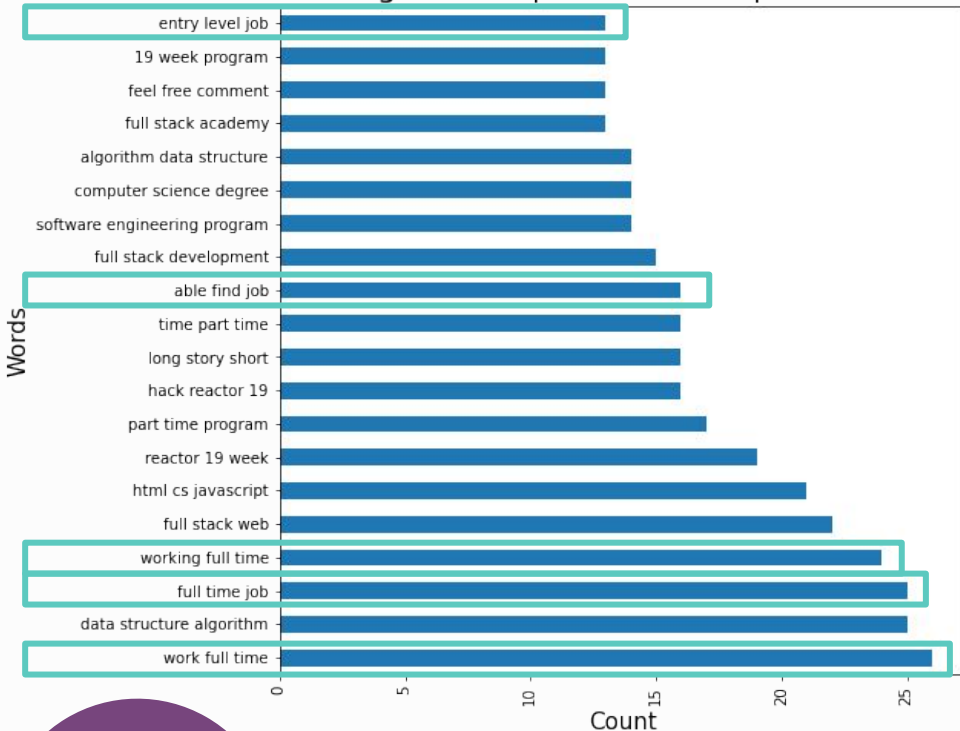


CSMajors Subreddit Top 20 3-Words

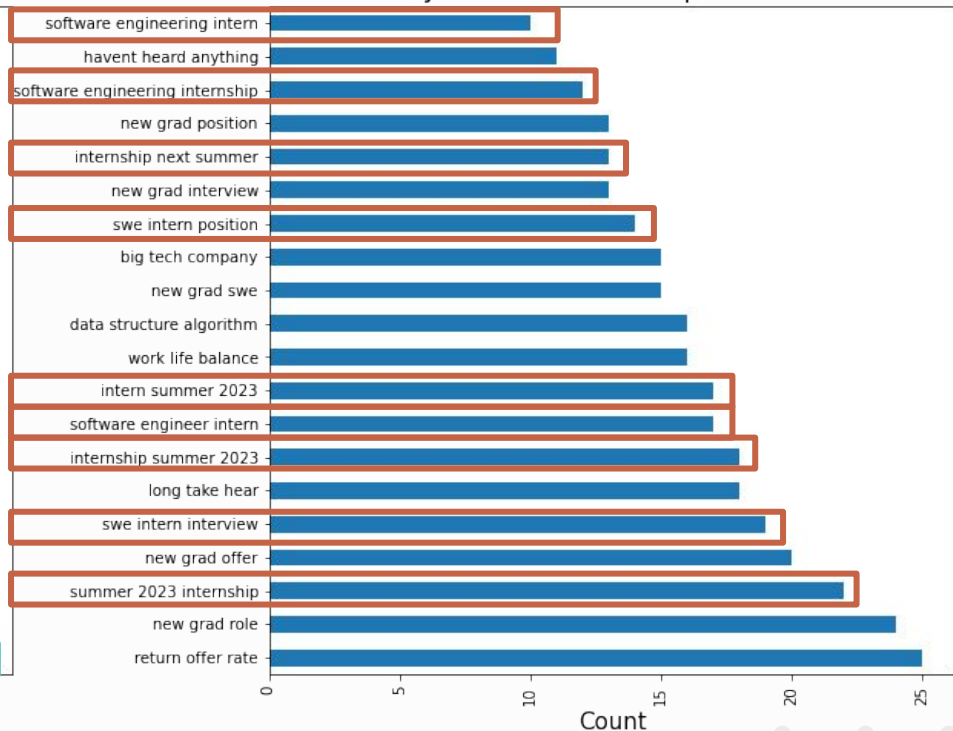


# EDA : TOP 20 3-WORDS - DIFFERENCES: FULL TIME JOB VS INTERNSHIP

Codingbootcamp Subreddit Top 20 3-Words

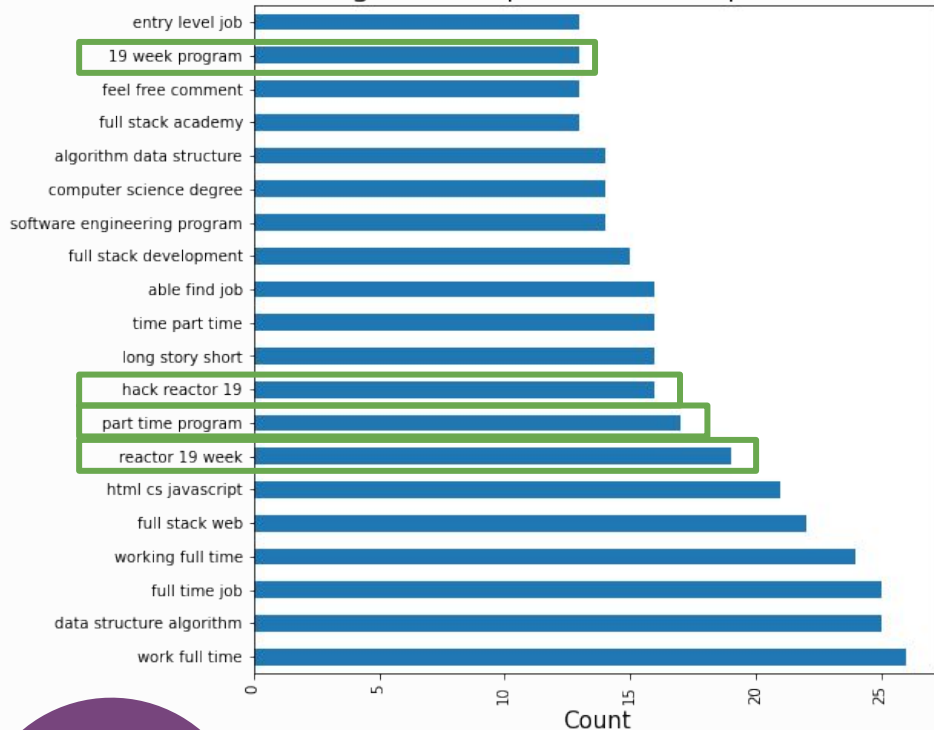


CSMajors Subreddit Top 20 3-Words

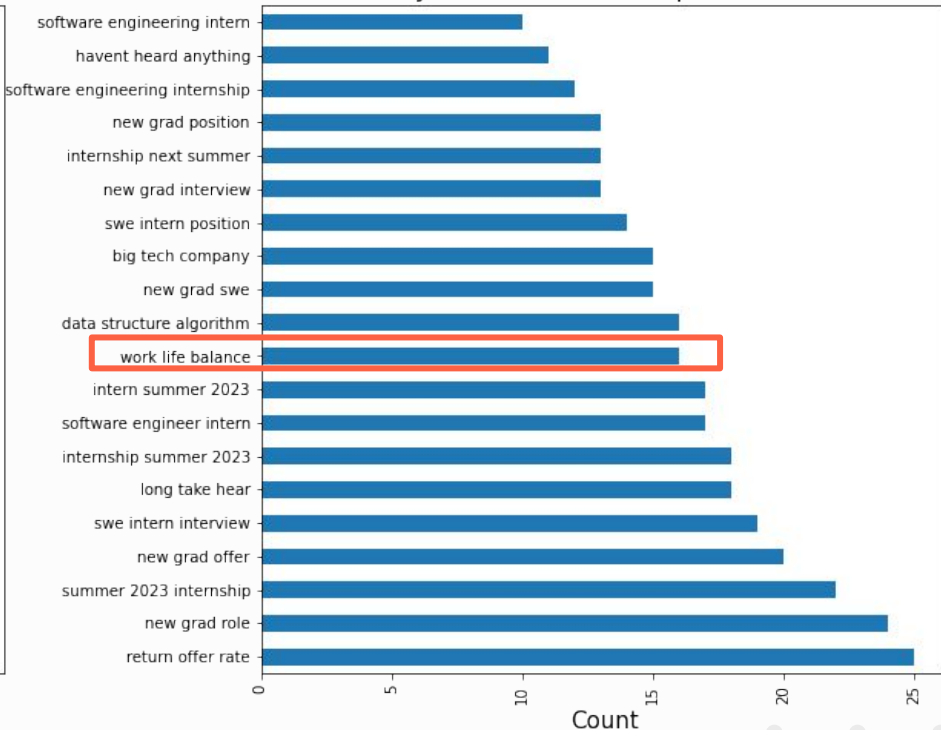


# EDA : TOP 20 3-WORDS - DIFFERENCES: TIME VS BALANCE

## Codingbootcamp Subreddit Top 20 3-Words



## CSMajors Subreddit Top 20 3-Words

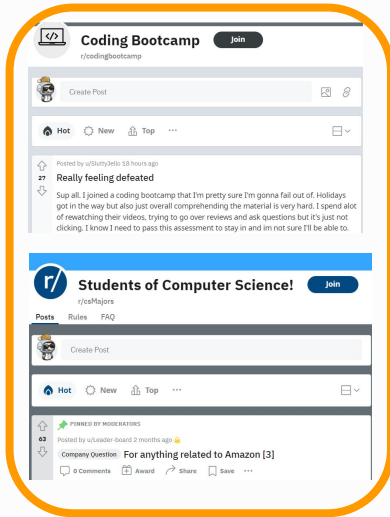




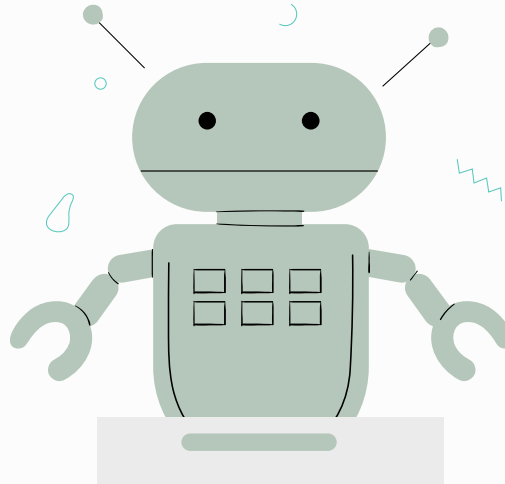
# MODELLING

# PURPOSE OF MODEL

## Reddit Posts



## Model



>90%  
accuracy

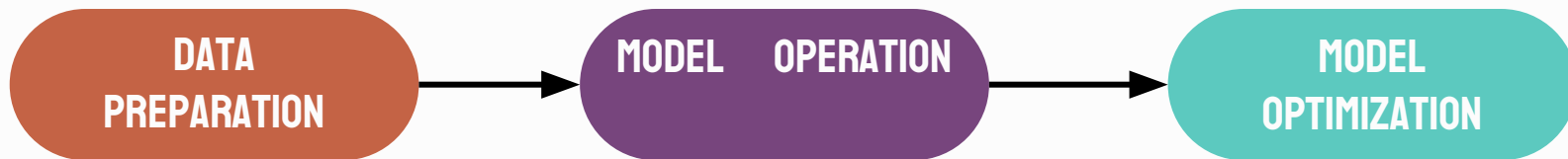
## Bootcamp Style



## 4 years uni course



# BUILDING A CLASSIFICATION MODEL



Converting text to numerical representation

Classification model selection

Improving model accuracy

Methods used:

- Countvectorizer
- N-grams
- TF-IDF (Term Frequency-Inverse Document Frequency)

Models used:

- Bernoulli Naive Bayes
- Multinomial Naive Bayes
- Logistic Regression

Optimization:

- Hyperparameter tuning



# MODEL SELECTION

VECTORIZATION TYPE	CLASSIFICATION MODEL	TRAIN ACCURACY SCORE	TEST ACCURACY SCORE
Baseline		0.78039	0.78646
Countvectorizer	Bernoulli Naive Bayes	0.84611	0.84215
Countvectorizer	Multinomial Naive Bayes	0.93214	0.93149
Countvectorizer	Logistic Regression	0.98678	0.93429
N-Gram*	Bernoulli Naive Bayes	0.90435	0.86057
N-Gram*	Multinomial Naive Bayes	0.98464	0.90545
N-Gram*	Logistic Regression	0.94416	0.875
TF-IDF	Bernoulli Naive Bayes	0.95698	0.92548
TF-IDF	Multinomial Naive Bayes	0.95431	0.92748
TF-IDF	Logistic Regression	0.96193	0.94231

\*Only the best train-test result between Bi-Gram & Tri-Gram for the model is shown.

# TERM FREQUENCY-INVERSE DOCUMENT FREQUENCY (TF-IDF)

- Vectorization method that penalizes terms that occur multiple times across different documents.

Text 1	i love natural language processing but i hate python
Text 2	i like image processing
Text 3	i like signal processing and image processing

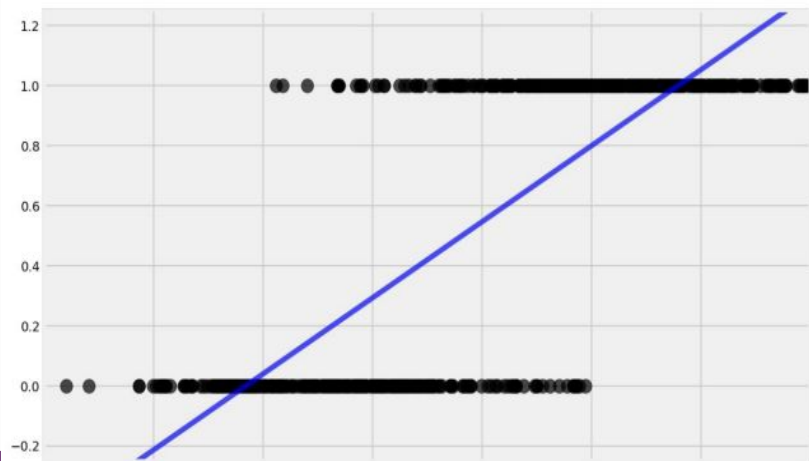
	and	but	hate	i	image	language	like	love	natural	processing	python	signal
Text 1	0	1	1	2	0	1	0	1	1	1	1	0
Text 2	0	0	0	1	1	0	1	0	0	1	0	0
Text 3	1	0	0	1	1	0	1	0	0	2	0	1

Term	and	but	hate	i	image	language	like	love	natural	processing	python	signal
IDF	0.47712	0.47712	0.4771	0	0.1760913	0.477121	0.1760913	0.477121	0.47712125	0	0.477121	0.477121

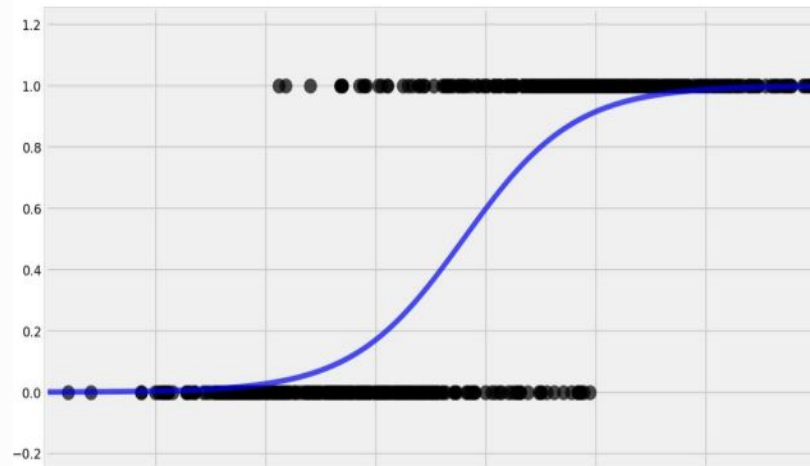
# LOGISTIC REGRESSION MODEL

- Logistic regression “bends” our best fit line, to match the range or set of values.
- Useful in predicting binary outcomes.

Linear Regression



Logistic Regression

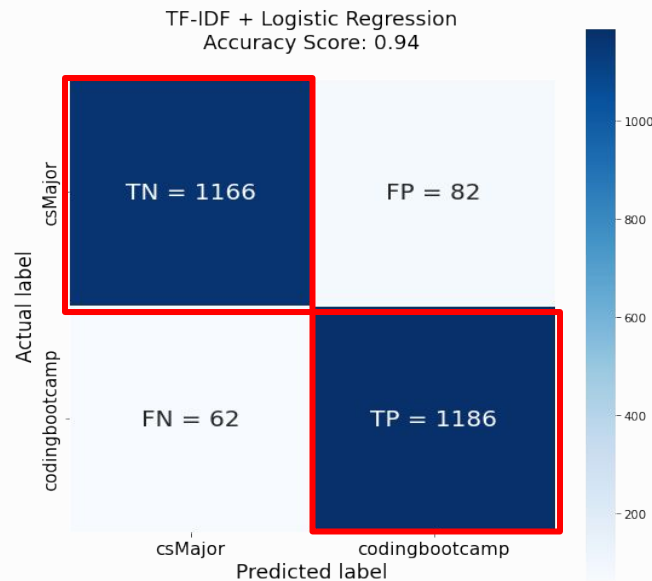
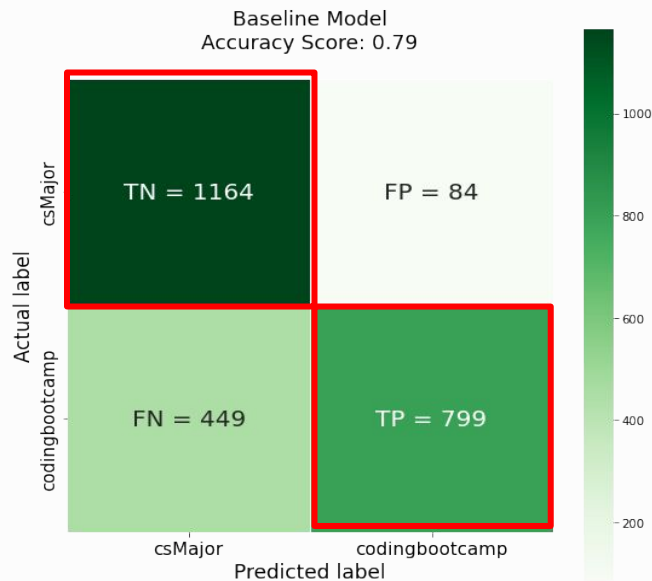


# MODEL OPTIMIZATION

VECTORIZATION + MODEL TYPE	PARAMETERS OPTIMIZED	IMPROVEMENT
TF-IDF + Logistic Regression	max features min_df max_df lg_solver	~0.04%



# CONFUSION MATRIX - HIGHER ACCURACY FOR MODEL



- TN: **True** Negative, TP: **True** Positive → Predictions are correct, for either classes
- FN: **False** Negative, FP: **False** Positive → Predictions are wrong, for either classes
- Positive class: codingbootcamp, Negative class: csMajor.
- Accuracy = True Predictions / Total Predictions.

# CLASSIFICATION REPORT - HIGHER F1-SCORE

## BASELINE

Baseline

	precision	recall	f1-score
csMajor	0.72	0.93	0.81
codingbootcamp	0.90	0.64	0.75
accuracy			0.79
macro avg	0.81	0.79	0.78
weighted avg	0.81	0.79	0.78

## TF-IDF + LOGISTIC REGRESSION

TF-IDF + Logistic Regression

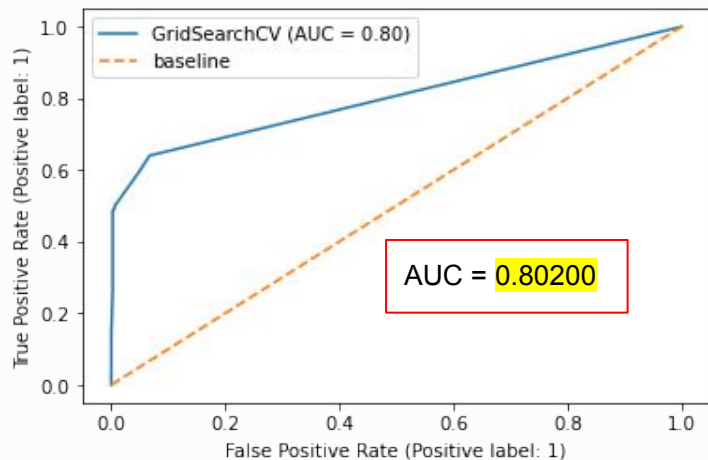
	precision	recall	f1-score
csMajor	0.95	0.93	0.94
codingbootcamp	0.94	0.95	0.94
accuracy			0.94
macro avg	0.94	0.94	0.94
weighted avg	0.94	0.94	0.94

- **Precision** =  $TP / (TP + FP)$
- **Recall** =  $TP / (TP + FN)$
- **F1-Score** = Weighted Average of Precision and Recall
  - Offers a better overall measure of performance

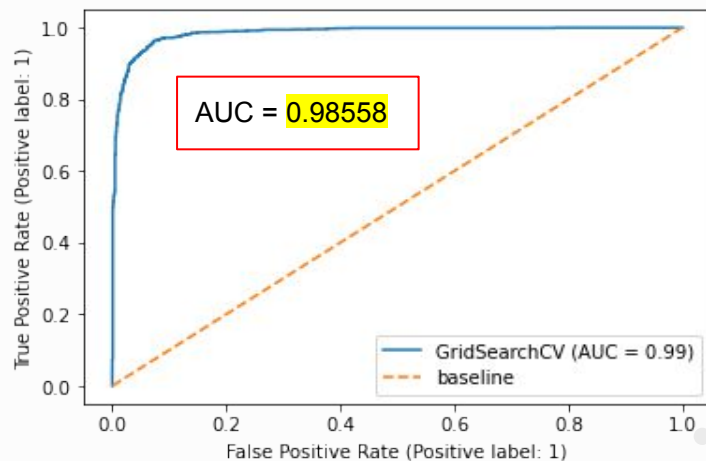
# ROC CURVE - HIGHER AUC SCORE

- ROC - Receiver Operating Characteristic Curve
- AUC - Area Under the Curve

Baseline



TF-IDF + Logistic Regression



Higher AUC score



Better differentiation between categories



# MOVING FORWARD



## TIME & RESOURCES

Gather more data to train the model, using information from various platforms



## WEB LINGO

Train the model to better understand acronyms and abbreviations being used



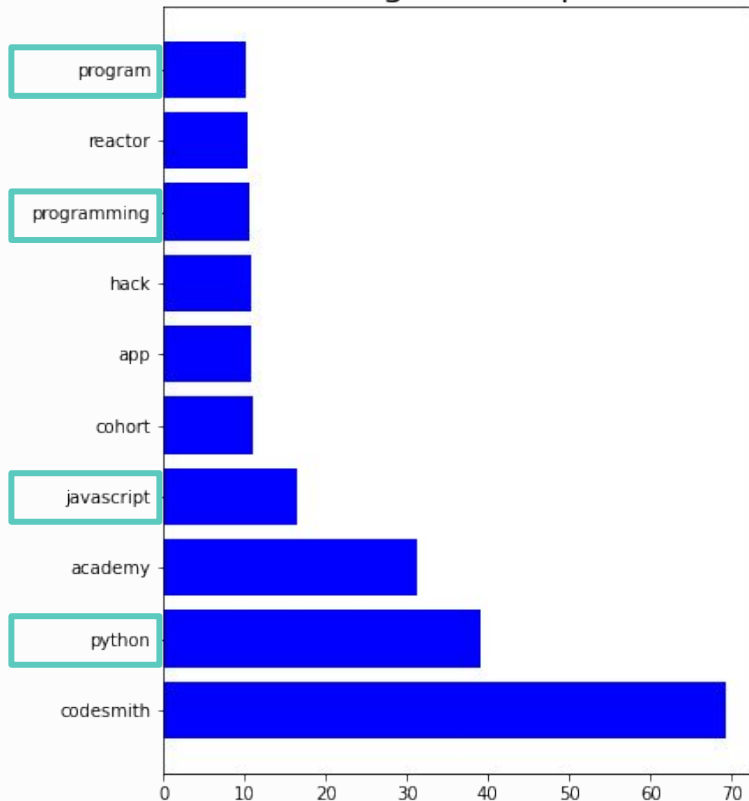
## SENTIMENT ANALYSIS

Expand the model to understand the sentiments behind the posts



## Top 10 Features

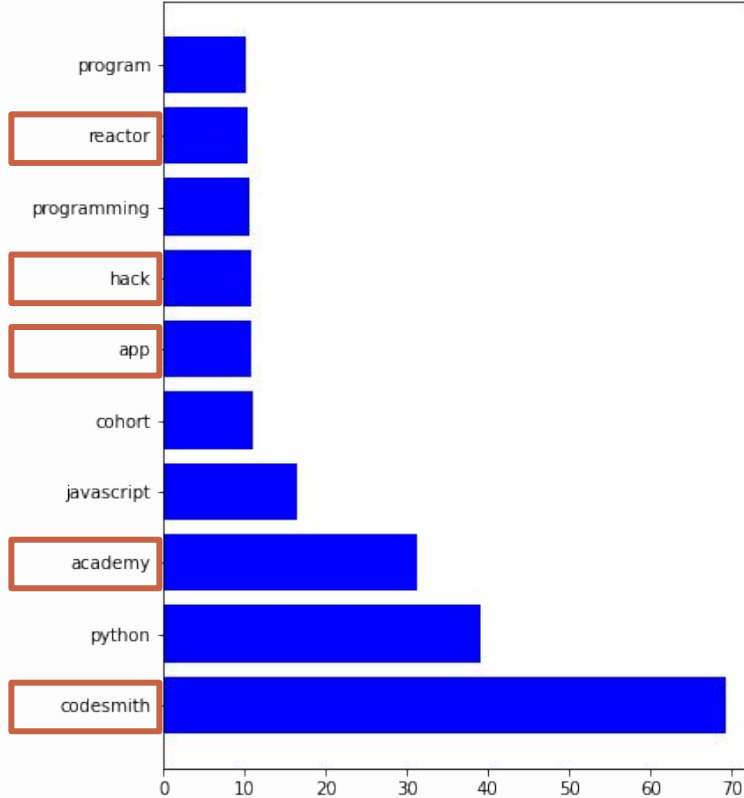
(Positive: Contributes to r/codingbootcamp, exclude baseline keywords)



- Skill related features that we can focus on based on courses offered at General Assembly

## Top 10 Features

(Positive: Contributes to r/codingbootcamp, exclude baseline keywords)



- Competitors are mentioned more frequently on Reddit
- Creates opportunity for GA to market towards these users



# SAMPLE PREDICTIONS

## Machine Learning App with Flask

### Subreddit Post Classifier

This is a demo of a classifier trained using posts from two different subreddits: r/codingbootcamp and r/csMajors.

Enter Your Post Below:

Advice on coders camp ?  
I am thinking to join coders camp. Anyone has any  
experience with them please lemme know. They gurantee  
a job with IS. <https://www.coderscampus.com/>

Predict

**r/codingbootcamp**

Tokens: advice coder thinking join coder experience lemme gurantee job

# RECOMMENDATIONS



## KEYWORDS

Features produced by our model will allow the team to better identify suitable posts to engage with.



## AUTOMATION

Deployment of the model to automatically scan our social media interactions.



## MARKETING

Boost marketing across channels to increase visibility compared with our competitors.

# CONCLUSION

01.

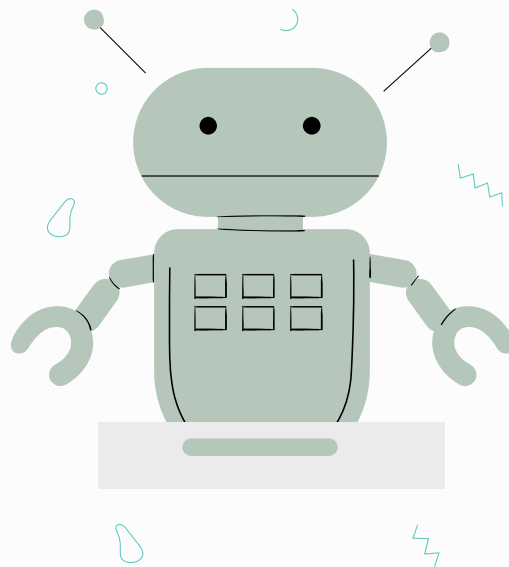
## INCREASING VISIBILITY AND RESPONSE

GA needs to stand out from our competitors and speed is also essential in being able to act before our competitors.

02.

## SEGMENTING AND TARGETING THE RIGHT AUDIENCE

Maximise our marketing ROI and increase our conversion rate.



# THANK YOU

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