Semi-Supervised Learning in Topic Modelling

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Problem Statement

Suppose you are a new hire at XYZ company and it's your first day at work, after a routine orientation with HR, your boss summons you to his office.

Problem Statement

Thinking that this is a basic unsupervised learning task with the well-established LDA and NMF, you get down to work, only to realise that these don't work very well for multi-label classification. Further, there seems to be nothing much you can do further to improve the model's accuracy.

Luckily, you remember your lessons from DSI and decide to combine supervised and unsupervised methods to build a model that can perform decently well.

Problem Statement

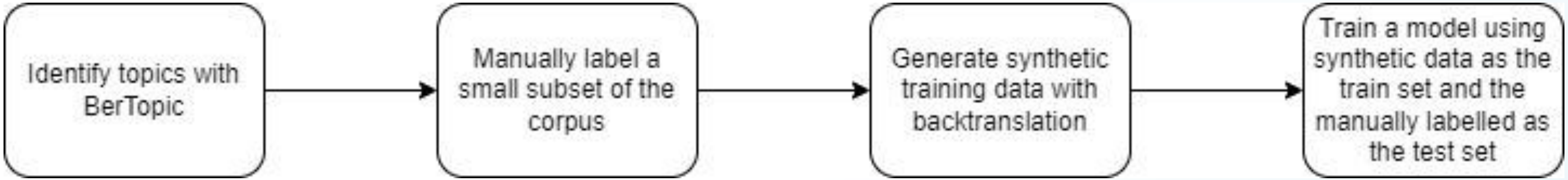
Intended outcome:

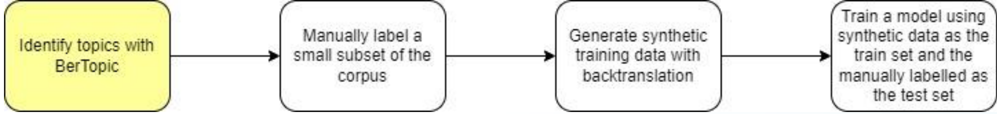
Text	Price	Flavor	Packaging
I think it's delicious and affordable!	1	1	0
The design could be more well thought out	0	0	1

Data:

- ~10,000 documents in corpus
- No labels; no information on latent topics at all

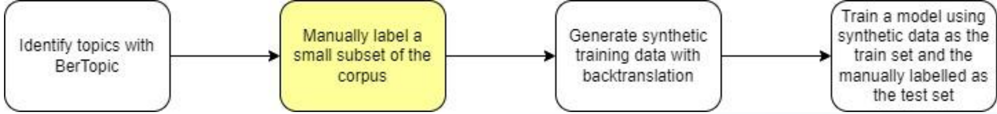
Pipeline Overview





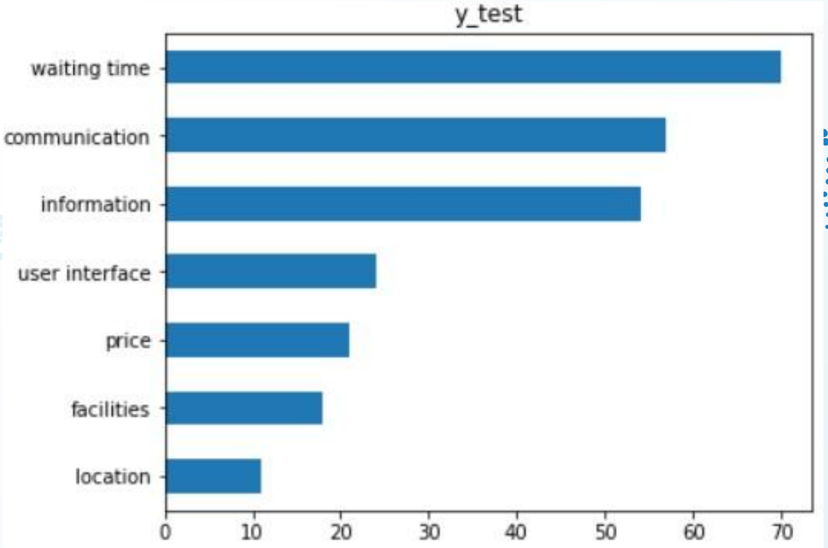
BerTopic

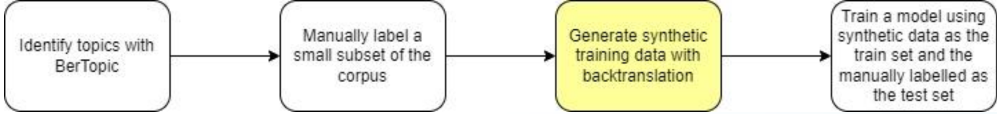
- Uses BERT sentence embeddings to vectorize text, unlike LDA and NMF which uses statistical methods
- Stochastic process, therefore results are not reproducible
- Does not do well in multi-label problems; insufficient as standalone topic modelling tool
- Produced > 100 topics, condensed to 7 topics



Manual Labelling

- Important to guide downstream modelling
- Labelled ~200 records, with each topic having at least 10 rows
- Act as test dataset

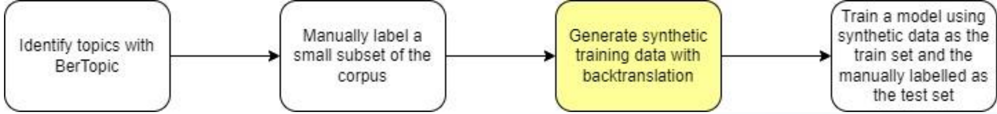




Data Augmentation

The chicken was delicious

The poultry was tasty



BackTranslation

- Translates text into another language and back

Identify topics with BerTopic → Manually label a small subset of the corpus → Generate synthetic training data with backtranslation → Train a model using synthetic data as the train set and the manually labelled as the test set

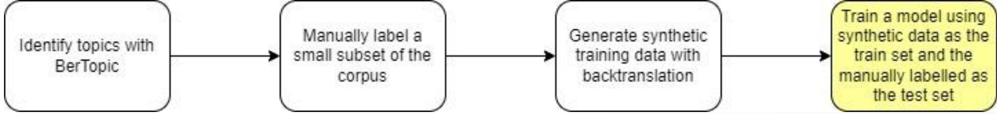
BackTranslation

- “Softer” way of altering text
- Better to use languages that are more different from English
- However, this leaks information into training data

The language used by partners is very friendly and polite and easy to understand, the connection is also smooth

Backtranslation, ContextualWordEmbs, Sometimes

- His words are very friendly, polite, and understandable, and my manner proceeds smooth.
- My partner's words sound very friendly and easy, easy will understand, and smooth to connect.
- His words are very friendly, polite, and understandable, and his communication is smooth.

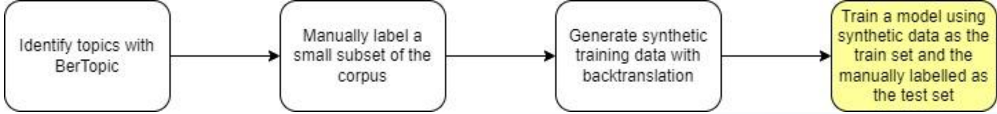


Model Training

- Baseline model → Zero Shot Classification

```
{'sequence': '\nThe language used by partners is very friendly and polite and easy to understand, the connection is also smooth\n',
 'labels': ['communication',
  'information',
  'facilities',
  'user interface',
  'location',
  'price',
  'waiting time'],
 'scores': [0.9803360104560852,
  0.7030088901519775,
  0.671905815601348 9,
  0.6212607622146606,
  0.3871709108352661,
  0.33242109417915344,
  0.13848033547401428]}
```

Weighted F1 score = 54%



Model Training

- Multi-label classification → OneVsRestClassifier
- SVC as default classifier due to superior performance

Expt	Vectorizer	Weighted F1-score (test set)
1	Word2Vec	88%
2	BERT	80%
3	BERT with PCA	92%
4	BERT (fine-tuned)	72%
5	BERT (fine-tuned) with PCA	90%

- Much more whitespace to finetune compared to LDA/NMF/BerTopic alone!

Further Evaluation (Holdout set)

Expt	Vectorizer	Weighted F1-score (holdout set)
1	Word2Vec	63%
3	BERT with PCA	54%
5	BERT (fine-tuned) with PCA	35%

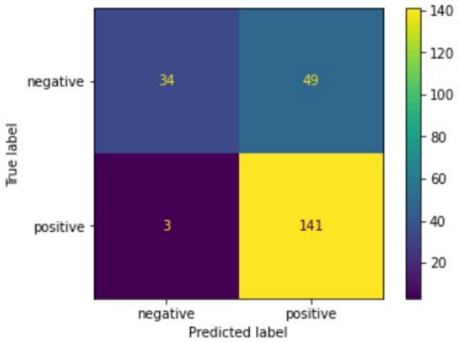
Limitations

- Volatile changes in %
- Language is subjective; could have multiple interpretations how a text should be labelled

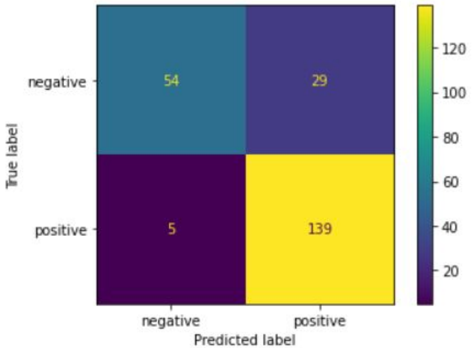
Further Evaluation (Inspecting "Others")

sequence		w2v	bert_untuned	bert_tuned
my problem is now 6 weeks old an		others	information	waiting time
as to the staff it really varies per br		others	others	others
there was clearly a language barrie		others	information, waiting time	waiting time
the space was small and in the mid		others	waiting time, information	waiting time
i think that the call agents can be m		others	others	waiting time
I had an excellent experience with		information, user interface	information	others
The person at the counter mention		information, price	others	others
Very good way of explaining what		information	others	others
Repair notification process: becaus		waiting time	others	others
I have a [REDACTED] Smart TV Wh		information	others	others
I took my phone in after a update a		information	others	waiting time
For me I am satisfy with the service		price	others	others
I walked into Harvey Norman with		information	others	waiting time
When I first called the retail shop t		communication, price	others	waiting time
Because from the original, the sma		information, user interface,	others	information

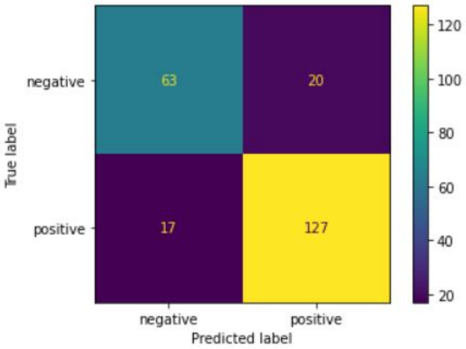
Sentiment Analysis



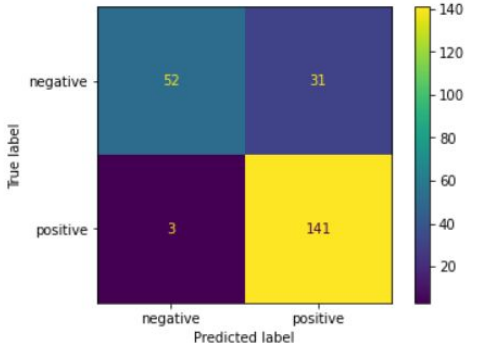
cardiffnlp/twitter-roberta-base-sentiment (F1-weighted = 74%)



facebook/bart-large-mnli (F1-weighted = 84%)

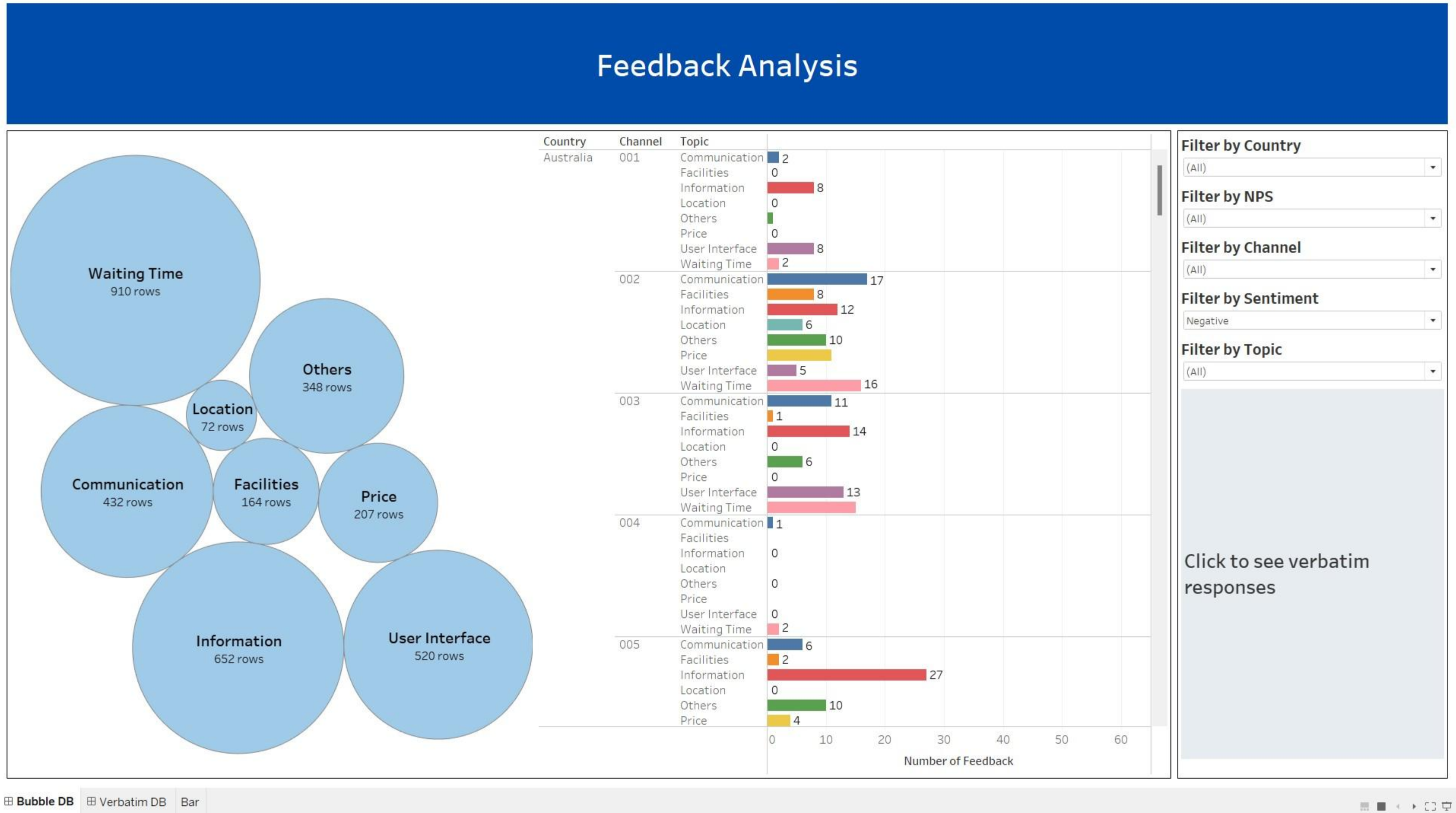


distilbert-base-uncased-finetuned-sst-2-english (F1-weighted = 84%)



Majority Vote (F1-weighted = 84%)

Presentation



Deployment

Text Classification for Service Feedback

Type your text here

The website was user friendly and the agent provided good solutions

Click for predictions!

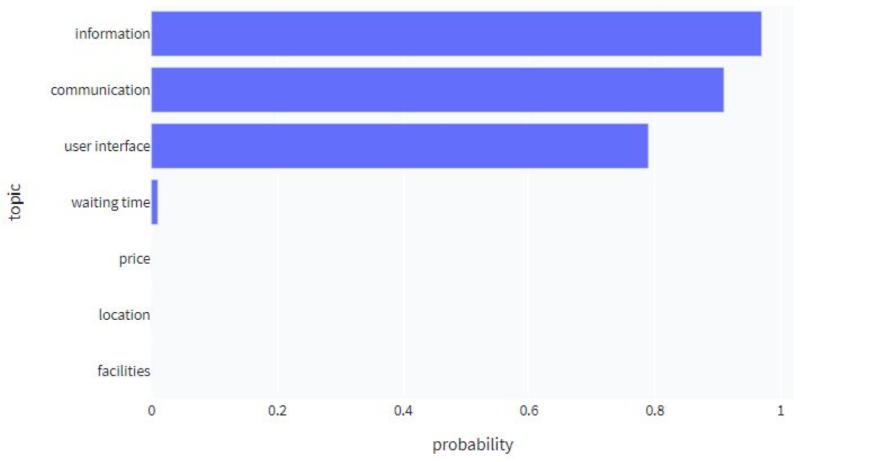
Or... Upload a csv file if you have a file instead.

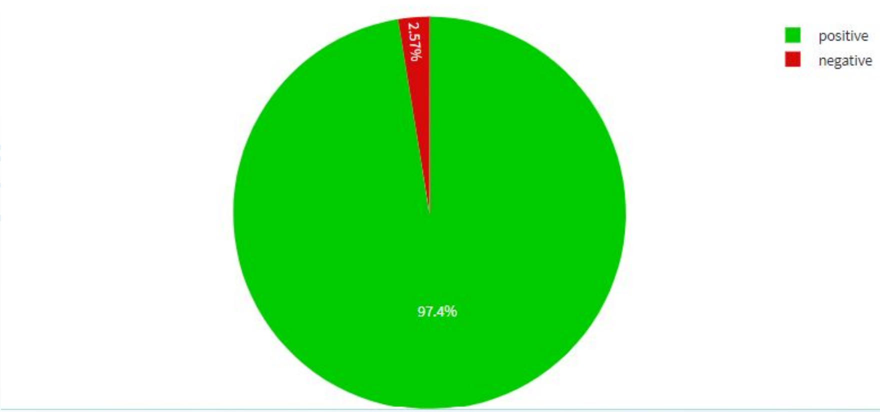
Download sample file here

Please upload a csv file with only 1 column of texts.

Drag and drop file here
Limit 200MB per file

Browse files





Conclusion

- Even with advancement of technology, topic modelling is notoriously hard to gauge model effectiveness without sufficient labelled data.
- With this pipeline, despite its theoretical flaws, the model performed decently.
- Also provided much whitespace to fine-tune to the context of the task, which is typically limited in topic modelling.

Future Work

- Test out the pipeline on labelled dataset with multi-labels

Credits

- Instructors Shilpa and Leo
- TAs Mark, Samuel and Jun Kai
- My project groupmates and classmates who have made the course more enjoyable with all the nonsense and jokes :)

Thanks!

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