トヨタ自動車株式会社 御中

定例資料 PQSコメント解析

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Overview

1.Exploratory Data Analysis

2.Steering Wheel Classification

3.Simple Method using Rule-Based Method

4.Complex Method using BERT

5.Evaluation

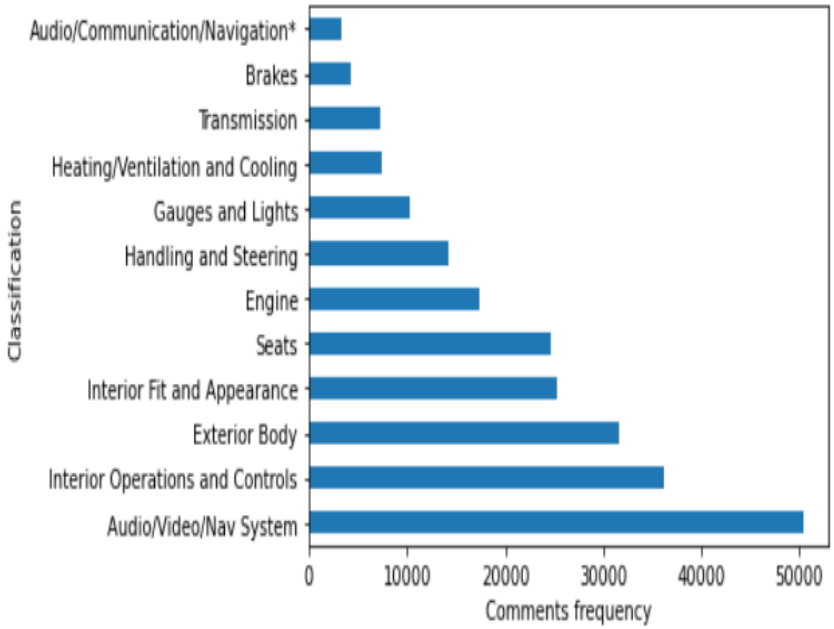
6.Conclusion

Exploratory Data Analysis

Classification

- Classification has described 12 different parts of the cars.
- Bar graph for comments distribution in each classification value in the left.

- Table in the right side displayed the number of comments per classification value.
- Audio/Video/Nav System contains maximum number of comments which is 50392.
- And *Handling and Steering* classification described as steering wheel. the Number of comments is 14161.

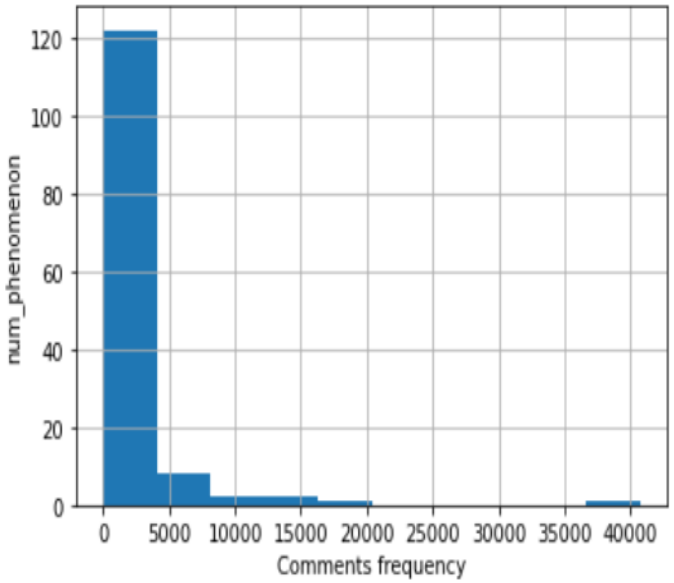


Classification	Number of Comment
Audio/Video/Nav System	50392
Interior Operations and Controls	36161
Exterior Body	31669
Interior Fit and Appearance	25238
Seats	24618
Engine	17380
Handling and Steering	14161
Gauges and Lights	10344
Heating/Ventilation and Cooling	7440
Transmission	7210
Brakes	4312
Audio/Communication/Navigation *	3344

Theme④ Exploratory Data Analysis for Classification, Item, Phenomenon, and Comment(EDA)

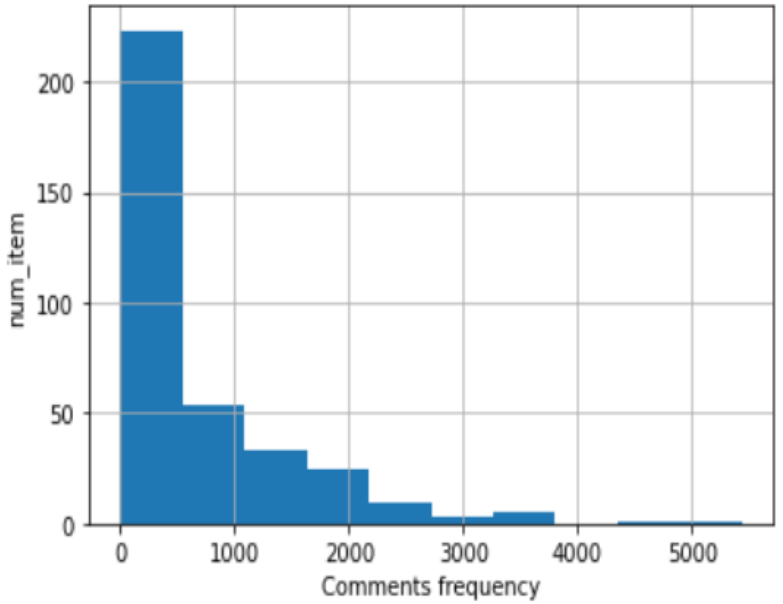
Phenomenon

- Phenomenon have 135 different parts of the cars.
- Histogram in the righ side for phenomenon distribution respected to the comments.
- Nearly 40000 comments in a single phenomenon value
- More than 120 phenomenon value has contained less than 5000 comments.



Item

- 355 unige values in Items columns.
- Nearly 5000 commens belong to a single item value.
- Nearly 250 Item values have 500 comments.



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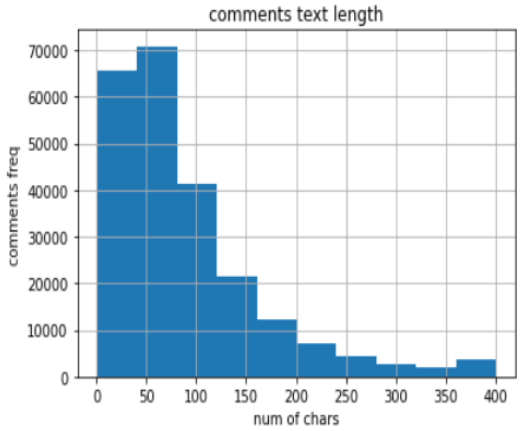
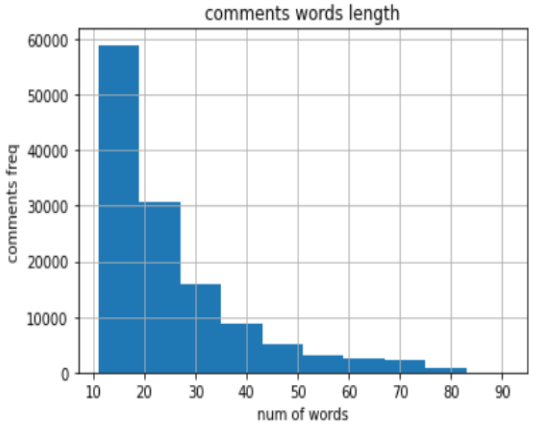
Comment



- Histogram shows that hight char length of the comment is 400.
- Most of the comment length is less than 150



- Histogram shows that hight word length of the comment is 85.
- Most of the comment word length is less than 40.

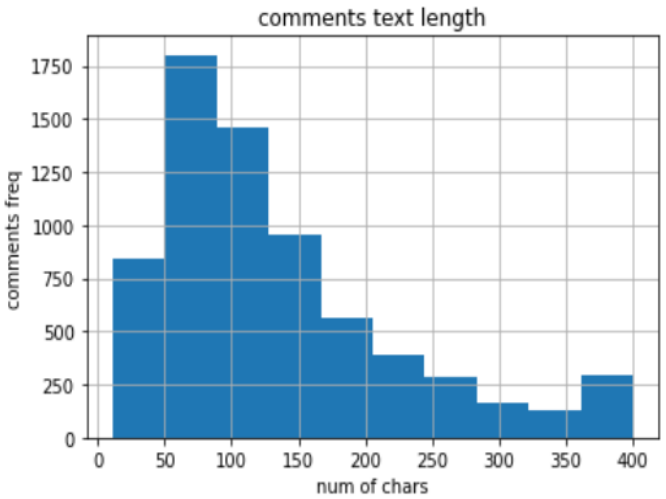
Number of comments corresponding word length.

Number of words	Number of Comments	Number of words	Number of Comments
>=2	228303	2<	3966
>=3	220726	3<	11543
>=4	210166	4<	22103
>=5	198717	5<	33552
>=10	138403	10<	93866
>=12	118494	12<	113775
>=15	94170	15<	138099
>=20	63822	20<	168447
>=25	44032	25<	188237
>=30	31169	30<	201100
Missing values	996		

Steering Wheel Location Classification

EDA for Steering Wheel

- 14161 comments are related to steering wheel.
- Below in the left histogram represented the steering wheel comments frequency in vertically and comment length in horizontally .



- Classification : 'Handling and Steering' described the steering wheel parts of the car.
- Phenomenon : 'LE Locatin' for phenomenon column is the most relavent location related value.
- Classification = 'Handling and Steering' & phenomenon = 'LE Location'
  - In the above condition, we found 64 steering wheel related comments.
  - This 64 comments included the maximum number of location related comments for steering wheel in any given condition.

- Below are given two example of positive and negative commnets
  - Because of the position of the steering wheel, the Apps, Sound, and Home buttons are obscured so that I have to lean over to see them – Positive
  - Tires rubbing in fender - Negative

Steering Wheel Classification

Data preparation for Steering Wheel

- We prepared the dataset following two different approaches.
  - Manual annotation
  - Automatic annotation

- Manual annotation
  - At first, we filtered 60 location-based comments with the given condition.
  - Making annotations by manual process.

- Automatic annotation
  - We consider all 60 comments as a positive location-based comments
  - And then we choose another 60 other conditions which are not location based steering wheel comments.

Rule-Based Model for Steering Wheel

Why Rule-Based approach?

- Easy and simple
- Training data is not required
- To extract labelled dataset using predefined given rules from unlabelled datasets
- Reducing the amount of risk in terms of system accuracy.
- Easy to implement and easy to explain.
- High precision
- Can be a good way to collect data as one can start the system with rules and let data come by naturally as people use the system.
- Sometimes a rule-based system works handy even if data is available.
    - E.g : NER.

Predifined Rules

- We built a key-word based dictionary for steering wheel location.
- Extracting steering wheel key-words from classification column.
- Extracting location based key-words from phenomenon column and some are from location-based comments.

Key-word Dictionary

Key	Words
Steering wheel	'steering', 'wheel'
Locations	'tilt', 'telescopic', 'center', 'locations', 'location', 'where', 'position', 'left', 'right', 'lower', 'too close', 'pull right', 'pull left', 'pulls left', 'pulls right', 'too far', 'far away', 'farther away', 'height', 'too high', 'too low', 'positions'

Cont.

For Rule-Based method we proposed three different model

- Steering Wheel classification
- Steering Wheel Location Classification
- All kinds of Location classification

Why three?

Initially as an experiment, our goal is to classify the "location of the steering wheel". We proposed the other two model so that we can understand and observe the upper limit of the performance of the steering wheel location compared to the other two models.

Rule-Based Model Evaluation matrix

Steering Wheel

TP 5 45.45%	FN 2 18.18%
FP 0 0.0%	TN 4 36.36

	precision	recall	f1-score	support
0	0.67	1.00	0.80	4
1	1.00	0.71	0.83	7
accuracy			0.82	11
macro avg	0.83	0.86	0.82	11
weighted avg	0.88	0.82	0.82	11

Steering Wheel Location

TP 2 18.18%	FN 4 36.36%
FP 1 9.09%	TN 4 36.36%

	precision	recall	f1-score	support
0	0.50	0.80	0.62	5
1	0.67	0.33	0.44	6
accuracy			0.55	11
macro avg	0.58	0.57	0.53	11
weighted avg	0.59	0.55	0.52	11

All kinds of Location

TP 8 72.72%	FN 2 18.18%
FP 0 0.0%	TN 1 9.09%

	precision	recall	f1-score	support
0	0.33	1.00	0.50	1
1	1.00	0.80	0.89	10
accuracy			0.82	11
macro avg	0.67	0.90	0.69	11
weighted avg	0.94	0.82	0.85	11

BERT Model for Steering Wheel

Why we choose BERT?

- BERT means Bidirectional Encoder Representations from Transformers.
- SOTA(State of the Art) model.
- BERT achived signification performance in NLP field.
- Open source

Evaluation Matrix of BERT Model

Manual annotated model

TP 5 45.45%	FP 2 18.18%
FN 0 0.0%	TN 4 36.36%

	precision	recall	f1-score	support
0	0.67	1.00	0.80	4
1	1.00	0.71	0.83	7
accuracy			0.82	11
macro avg	0.83	0.86	0.82	11
weighted avg	0.88	0.82	0.82	11

Automatic annotation

TP 6 54.55%	FN 0 0.0%
FP 2 18.18%	TN 3 27.27%

	precision	recall	f1-score	support
0	1.00	0.60	0.75	5
1	0.75	1.00	0.86	6
accuracy			0.82	11
macro avg	0.88	0.80	0.80	11
weighted avg	0.86	0.82	0.81	11

Explaination of False Detection

Comments	Actual Label	Rule-Based Prediction	BERT Prediction
can't frind the spare tire	0	0	0
POOR LOCATION FOR CONTROL SWITCH	1	0	0
I find the tilt / telescope to be awkward with my having to reach under the steering wheel to find the lever. I'm spoiled with the electric mechanism on my Cadillac.	1	1	1
Position not very good for small person.	1	0	0
It makes it just a bit difficult to get into or get out of the driver's seat. I am tall, and 86 years old.	0	0	0
it sucks ! it takes too long to heat and when it does it is only in the center and not the entire steering wheel, i had a toyota highlander before this one and it heated the entire steering wheel and much faster... than this one	1	1	1
Prefer the spare tire on back door, made car distinguishable from other models	0	0	0
The steering wheel is to close to the seat. When I get in the steering wheel gets in the way of my legs and I have to move them sideways to get in.	1	0	1
Thought entire steering wheel would be heated not just the sides.	1	0	1
See previous comment about inconvenient control location.	0	0	0
The heated steering wheel control is in an inconvenient location and is hard to know if its turned on.	1	1	1

Explaination of False Detection

Comments	Actual Label	BERT Prediction
After reading the manual we were disappointed that every time you change a tire you need to go to the dealer to get this gauge reset I may not always want this inconvenience or be in an area where this is convenient We are not even sure if this is essential The spare tire is not convenient if it is the low pressure tire and needs air	1	1
Its bouncy in the back seat especially	0	1
Felt every bump in the road	0	0
not enough steering wheel angle range up down	0	0
The controls for opening tailgate heated steering wheel etc are difficult to access as are the driver seat memory controls	1	1
It makes it just a bit difficult to get into or get out of the driver s seat I am tall and 86 years old	1	1
Very rough on the slightest bump in the road Sounds like front end will break	0	0
The rims are badly located so it is nearly impossible to check tire pressure or add air on some tires	1	1
Only had this for three weeks but I am not sure that the steering wheel is exactly where I will want it to be	1	1
The steering wheel squeaks a little It s very quiet Sometimes we think the radio is on almost too quiet to hear but it s the steering wheel	0	1
Location is strange I am afraid I am going to hit the rear hatch button by mistake while driving	1	1

Evaluation Comparison for Both Model

Below tables compared the different evaluation matrix between two model

Rule-Based Model

train datasets	test datasets	accuracy	precision	recall	F1-score
Not required	11	0.545	0.666	0.33	0.44

BERT Model

train datasets	test datasets	accuracy	precision	recall	F1-score
44	11	0.818	1.0	0.714	0.833

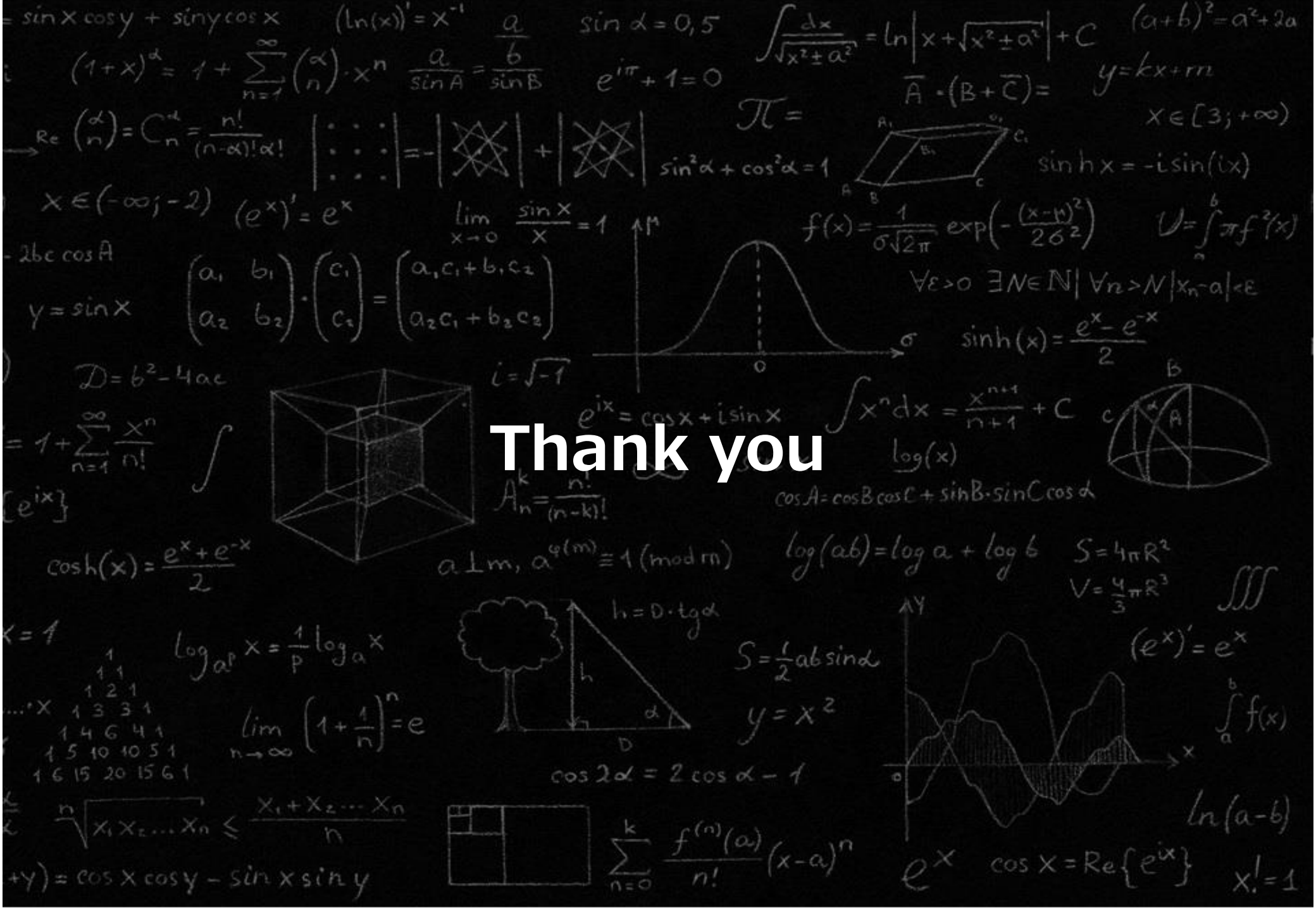
Next Phase Plan & Conclusion

Conclusion

After comparing the two model's performance we can come to conclude that BERT is performed well for this task. It generated more 80% accuracy for both approaches.

Next Phase Plan

So far, our previous experiment leads us to choose BERT for the next phase experiment. Because it worked quite well in two different approaches.


Thank you