Knowledge Discovery by Data Analysis of Mobile Reviews

Team 6, Final Presentation

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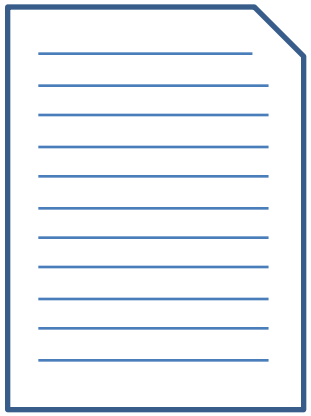
Objectives

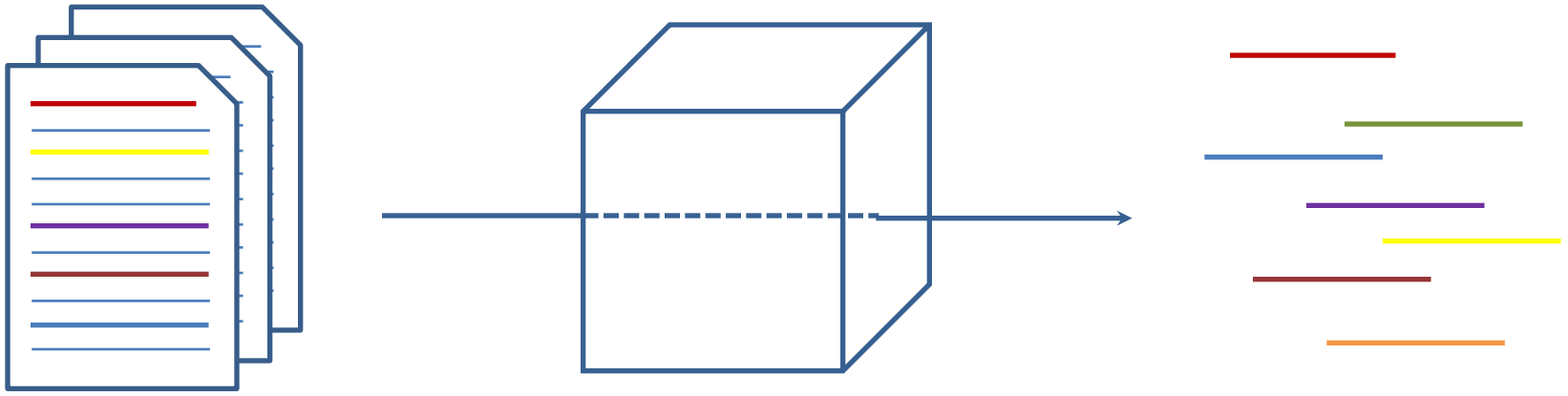
- By analyzing mobile phone reviews, we can achieve the following:
    1. Help costumers choose the best devices which fit their preferences
    2. Provide developers with insight for future product development
- Methods to utilize for data analysis:
    1. Sentiment Analysis
    2. Classification algorithms (Naïve Bayesian, KNN, Decision Tree, SVM)



Which phone should I buy?

What will be the phone of the next generation?

Preprocessing



Reviews

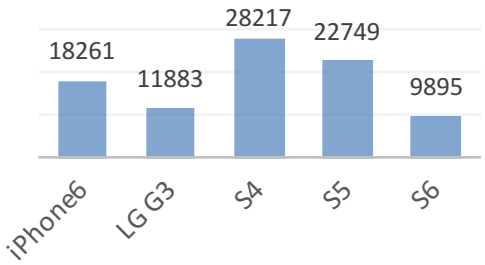
Preprocessing

Sentences

- Raw data obtained from GSM Arena
- Galaxy S4/S5/S6, LG G3, iPhone 6
- 33,572 reviews

- Using Python module : 'NLTK'
- Lowercase letters
- Correct spellings
- Remove Punctuation
- Split reviews to sentences

- 33,572 reviews → 91,005 sentences



<Graph 1> Number of sentences for 5 products

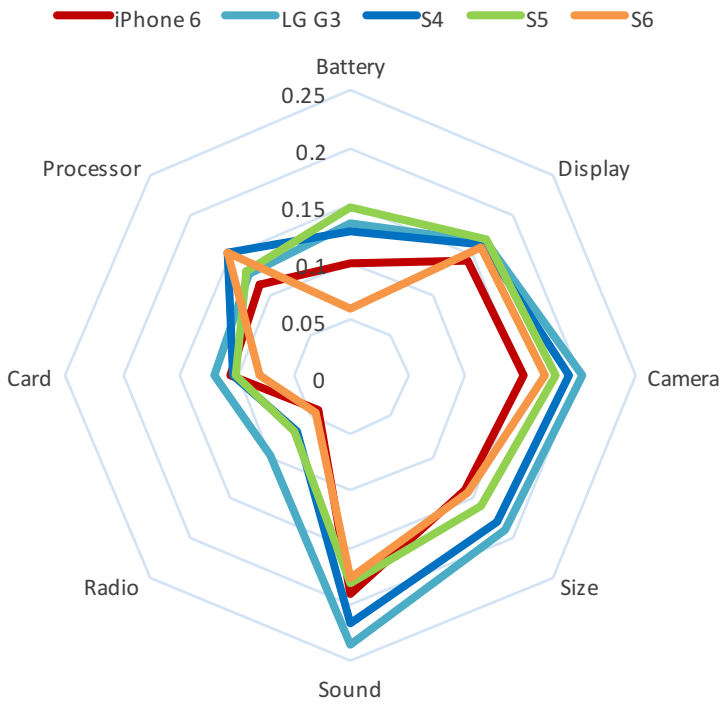
Sentiment Analysis: Product-based

- Used Python's web mining module, 'Pattern 2.6'
- 'Pattern 2.6' bundles a lexicon of adjectives (e.g., good, bad, amazing, ...) that occur frequently in product reviews, annotated with scores for sentiment polarity ∈ [-1.0, 1.0]
- Sentiment score for sentence = average of polarities for adjectives in sentence
- Use bundles of synonyms for each of 8 features to extract sentences with keywords

'This phone's camera is brilliant.'

Polarity of 'brilliant' : 0.9

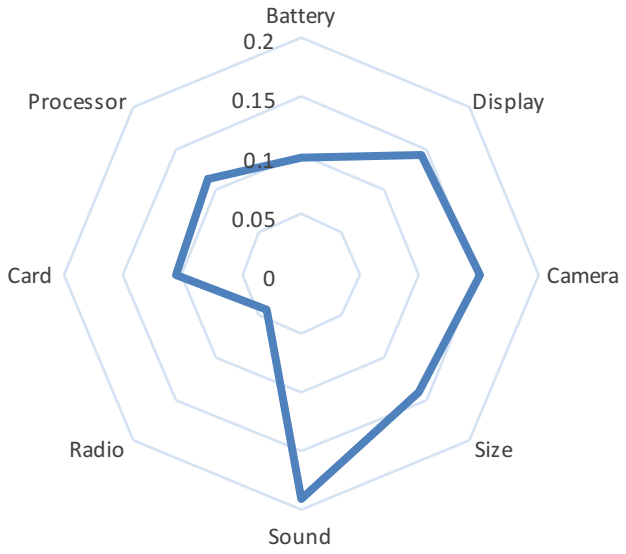
Sentiment score = 0.9



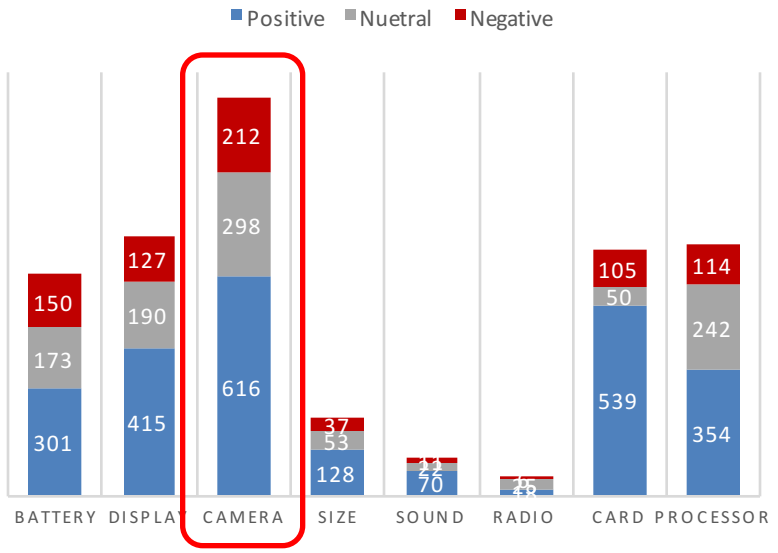
<Graph 2> Radar chart of sentiment scores of 5 products

Sentiment Analysis: iPhone 6

- # of comments: Camera > Display > Processor > Card > Battery > Size > Sound > Radio
- Scores: Sound > Camera > Display > Size > Processor > Card > Battery > Radio



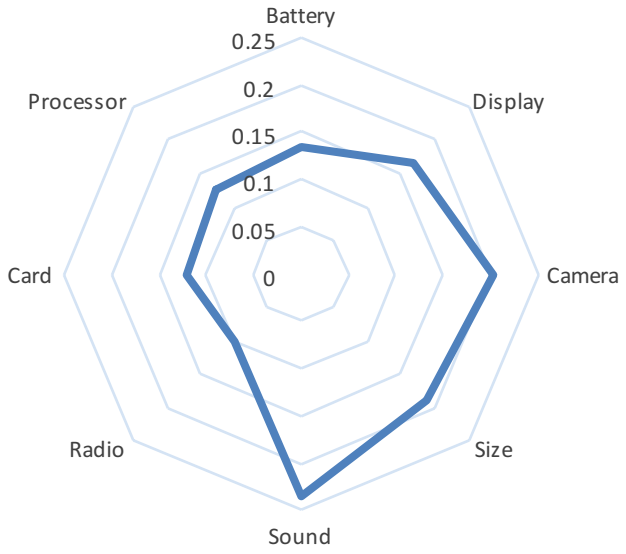
<Graph 3> Sentiment Scores for iPhone 6



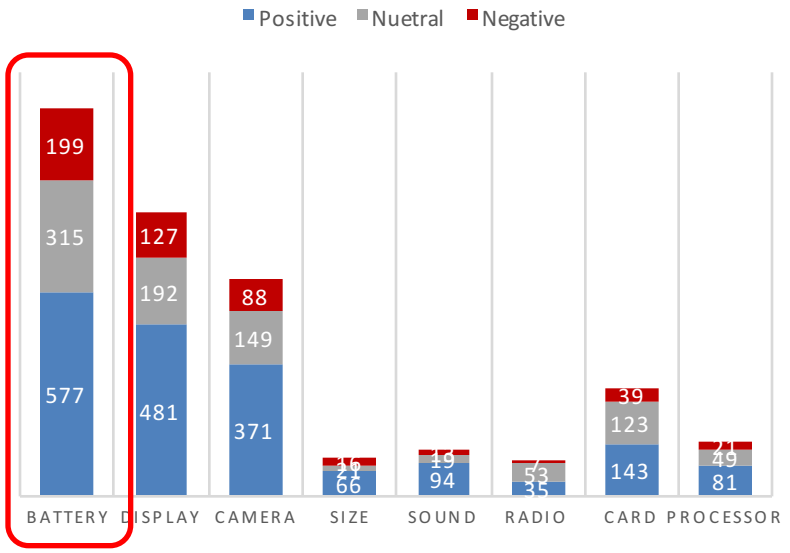
<Graph 4> # of comments on 8 features for 'iPhone 6'

Sentiment Analysis: LG G3

- # of comments: Battery > Display > Camera > Card > Processor > Sound > Size > Radio
- Scores: Sound > Camera > Size > Display > Battery > Processor > Card > Radio



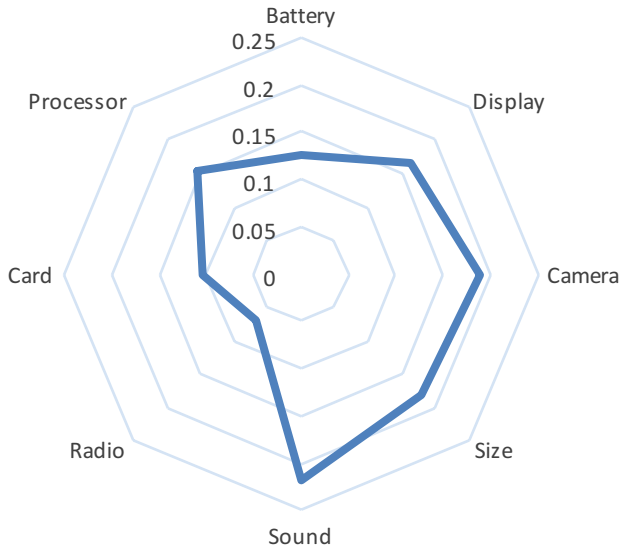
<Graph 5> Sentiment Scores for LG G3



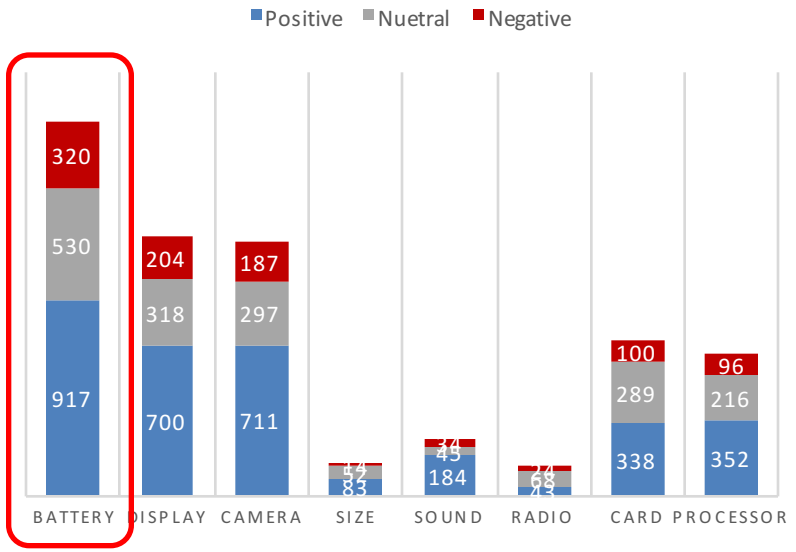
<Graph 6> # of comments on 8 features for 'LG G3'

Sentiment Analysis: Galaxy S4

- # of comments: Battery > Display > Camera > Card > Processor > Sound > Size > Radio
- Scores: Sound > Camera > Size > Display > Processor > Battery > Card > Radio



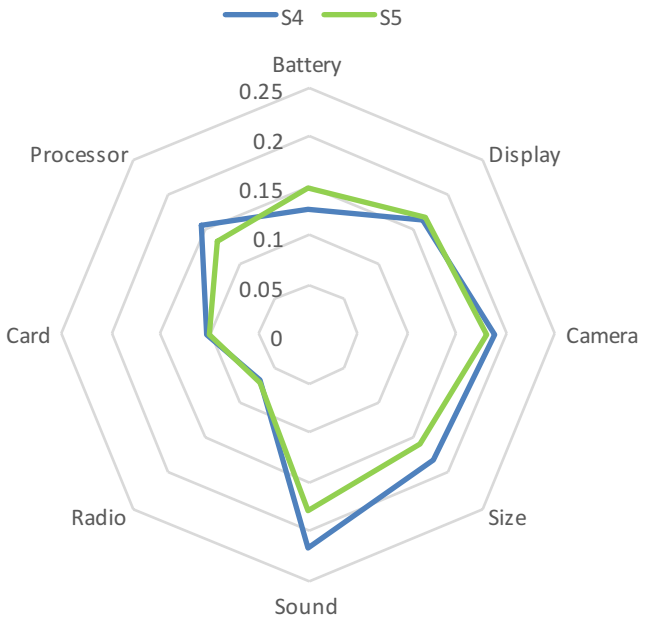
<Graph 7> Sentiment Scores for Galaxy S4



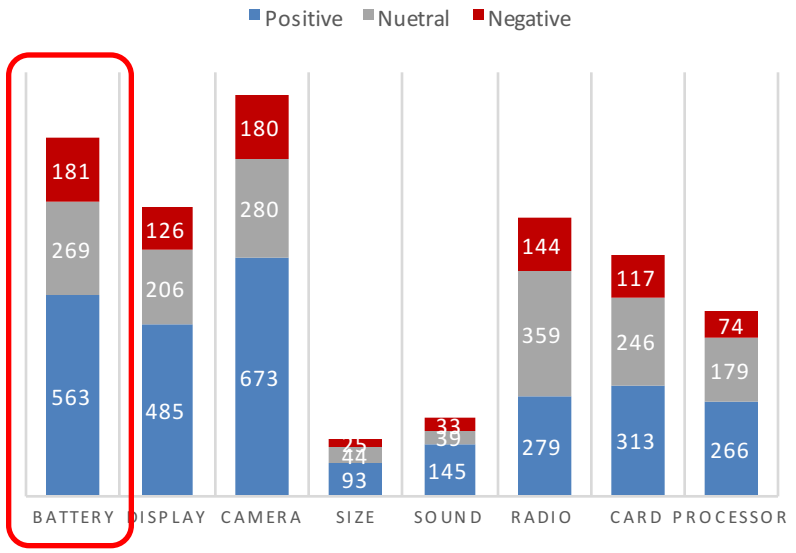
<Graph 8> # of comments on 8 features for 'Galaxy S4'

Sentiment Analysis: Galaxy S5

- # of comments: Camera > Battery > Display > Radio > Card > Processor > Sound > Size
- Scores: Sound > Camera > Size > Display > Battery > Processor > Card > Radio



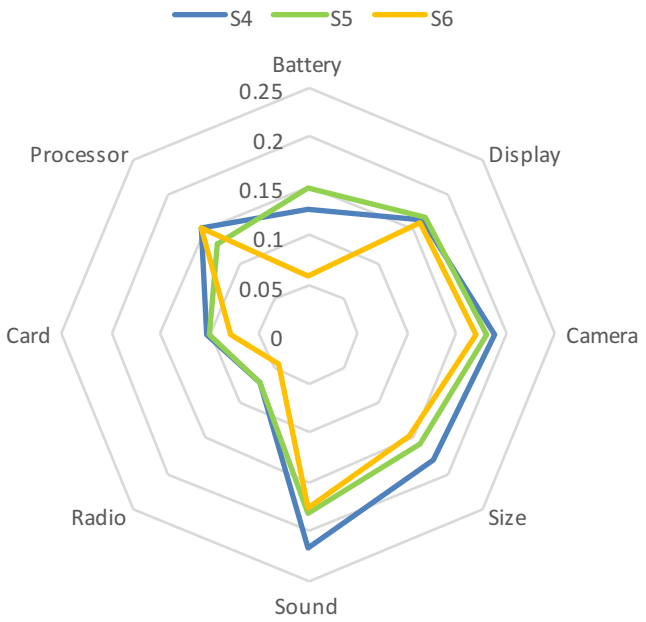
<Graph 9> Sentiment Scores for Galaxy S5



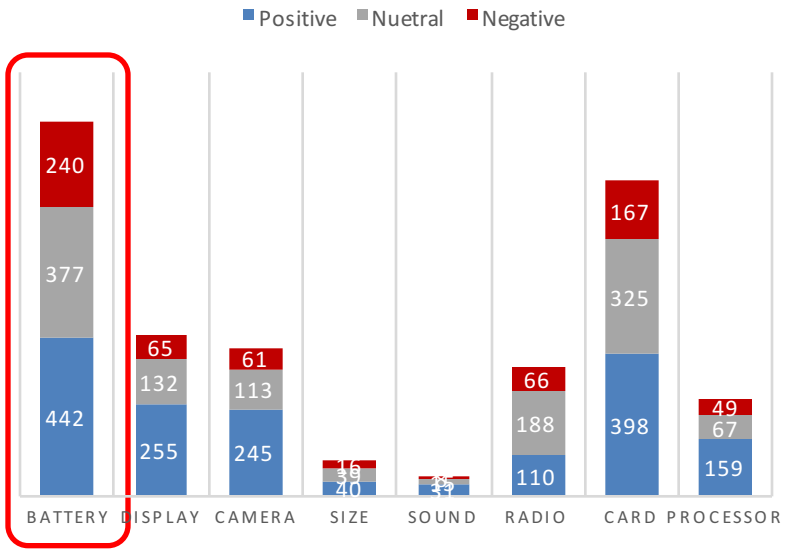
<Graph 10> # of comments on 8 features for 'Galaxy S5'

Sentiment Analysis: Galaxy S6

- # of comments: Battery > Card > Display > Camera > Radio > Processor > Size > Sound
- Scores: Sound > Camera > Display > Processor > Size > Card > Battery > Radio



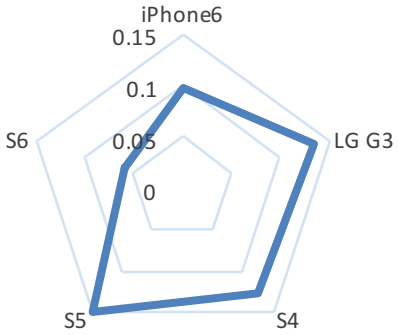
<Graph 11> Sentiment Scores for Galaxy Series



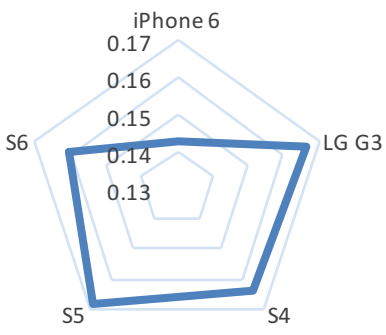
<Graph 12> # of comments on 8 features for 'Galaxy S6'

Sentiment Analysis: Feature-based

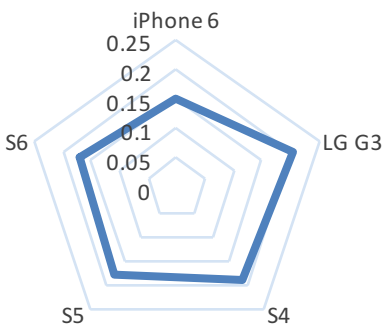
Battery



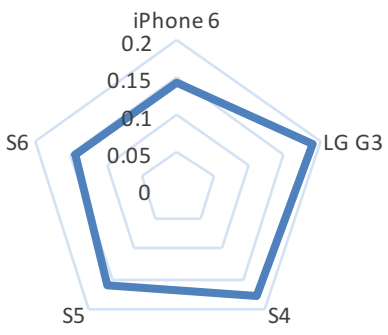
Display



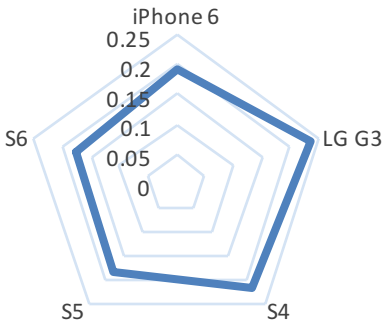
Camera



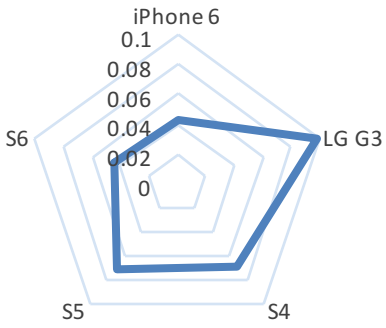
Size



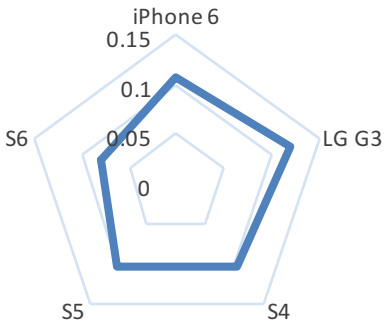
Sound



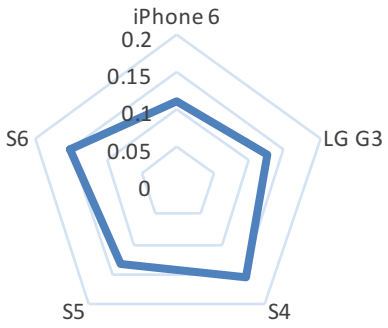
Radio



Card

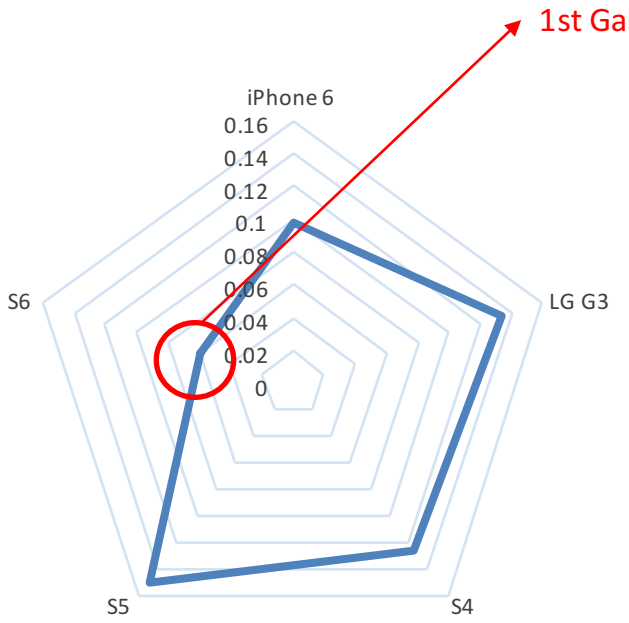


Processor

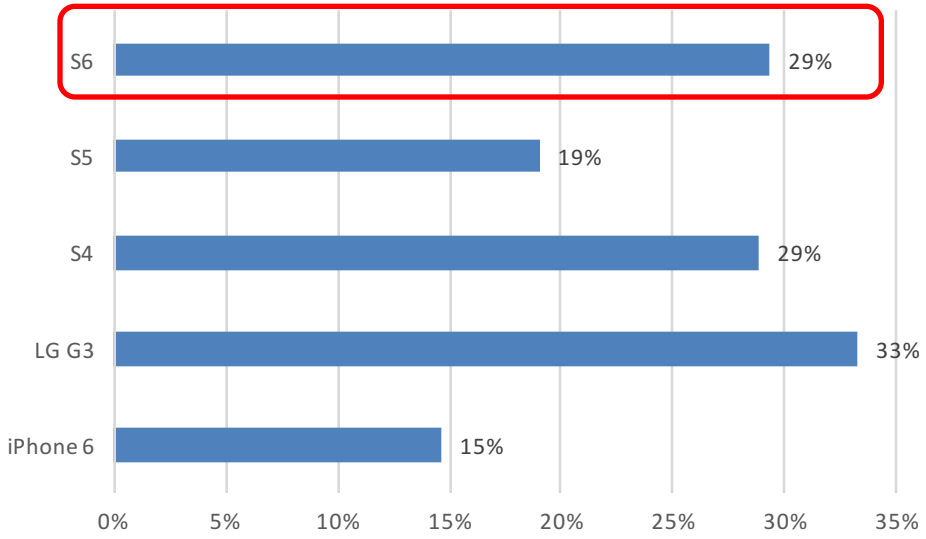


Sentiment Analysis: Battery

- Scores: Galaxy S5 > LG G3 > Galaxy S4 > iPhone 6 > Galaxy S6
- Low scores for ‘Galaxy S6’?
- High scores for ‘Galaxy S5’?



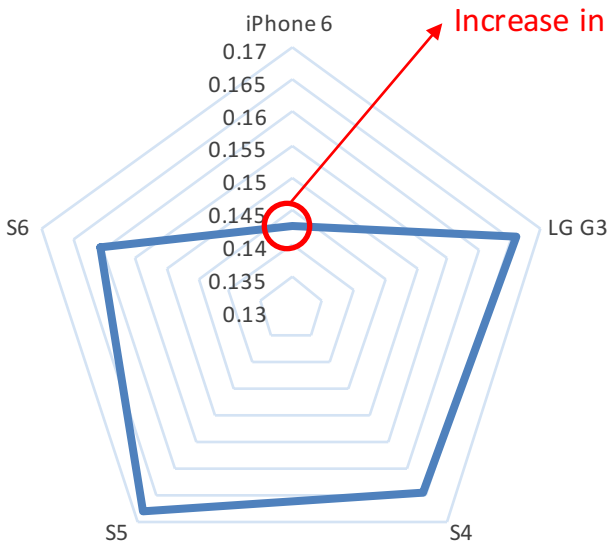
<Graph 13> Sentiment Scores for ‘Battery’



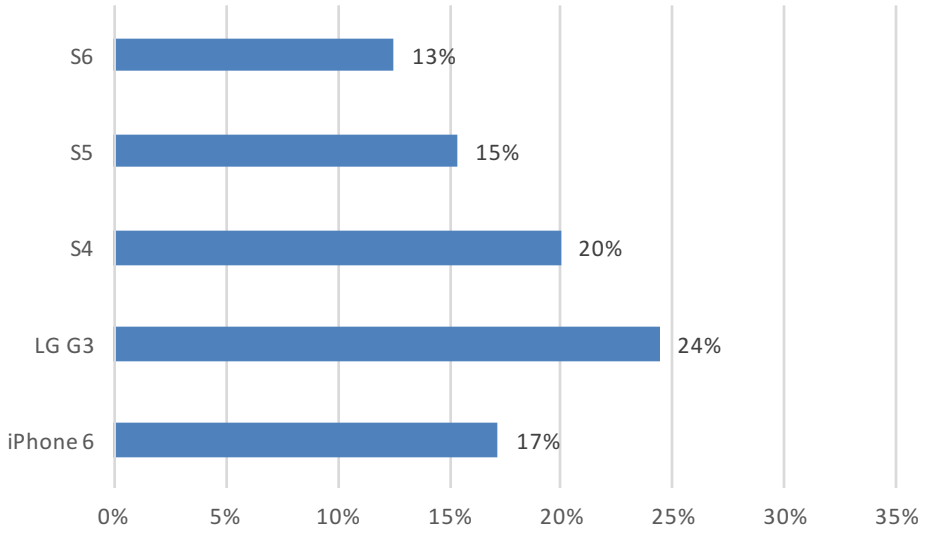
<Graph 14> Frequency of the word ‘Battery’ for products

Sentiment Analysis: Display

- Scores: Galaxy S5 > LG G3 > Galaxy S4 > Galaxy S6 > iPhone 6
- Low scores for 'iPhone 6'?
- High scores for 'Galaxy S5'?



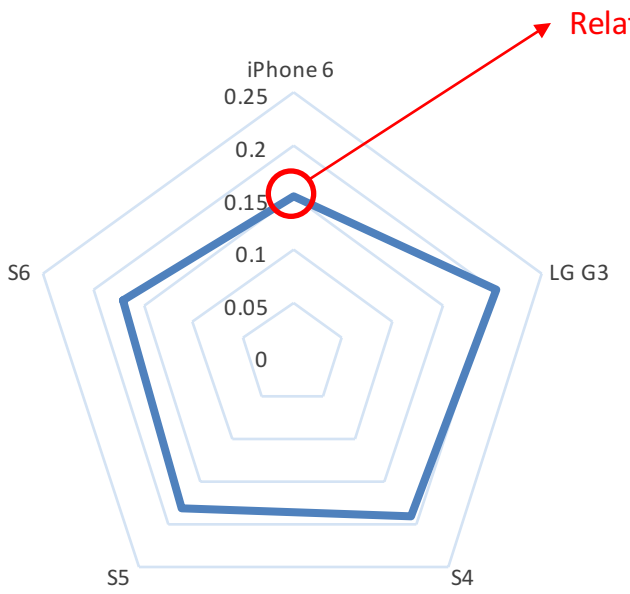
<Graph 15> Sentiment Scores for 'Display'



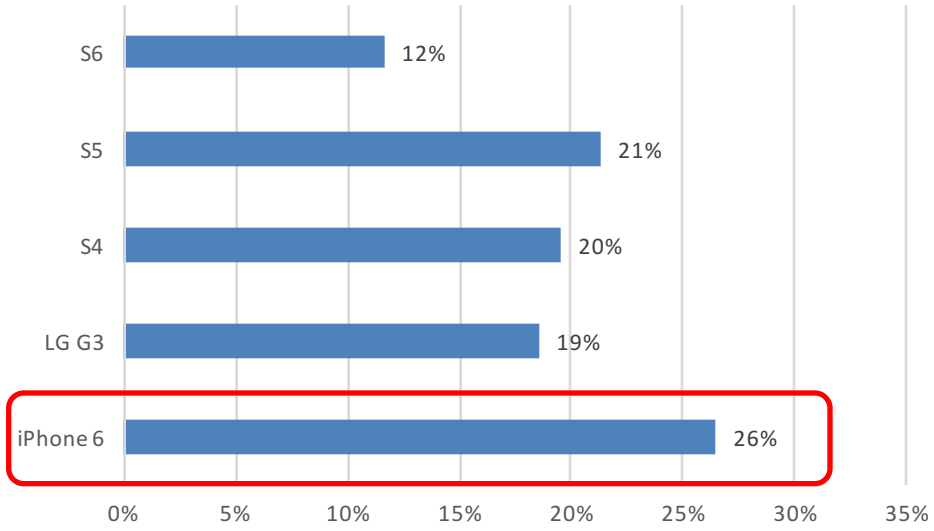
<Graph 16> Frequency of the word 'Display' for products

Sentiment Analysis: Camera

- Scores: LG G3 > S4 > S5 > S6 > iPhone 6
- Low scores for 'iPhone 6'?
- High scores for 'LG G3'?



<Graph 17> Sentiment Scores for 'Camera'

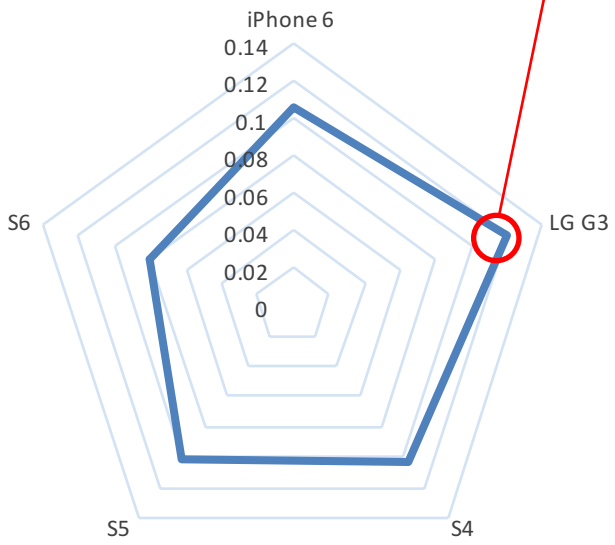


<Graph 18> Frequency of the word 'Camera' for products

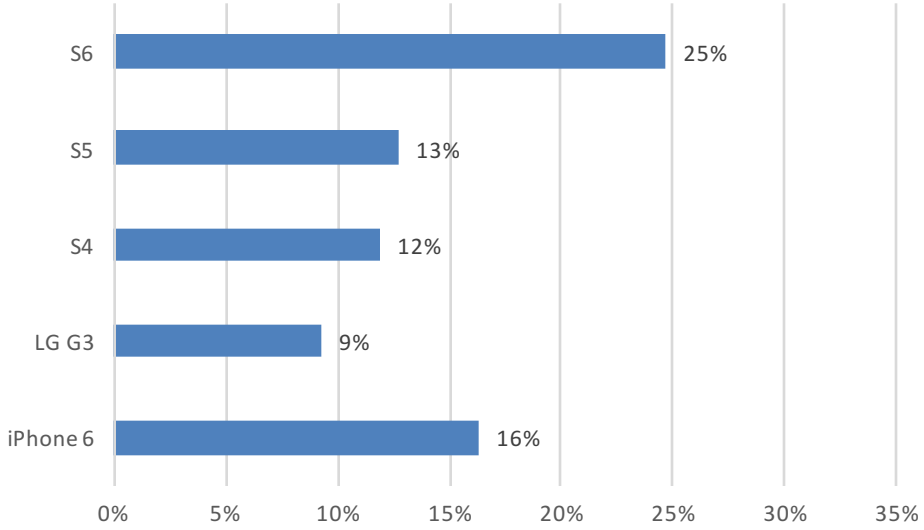
Sentiment Analysis: Card

- Scores: LG G3 > S5 > S4 > S6 > iPhone 6
- Low scores for ‘iPhone 6’?
- High scores for ‘LG G3’?

LG G3, Galaxy S4/S5 has card slots, while iPhone6 and Galaxy S6 does not.



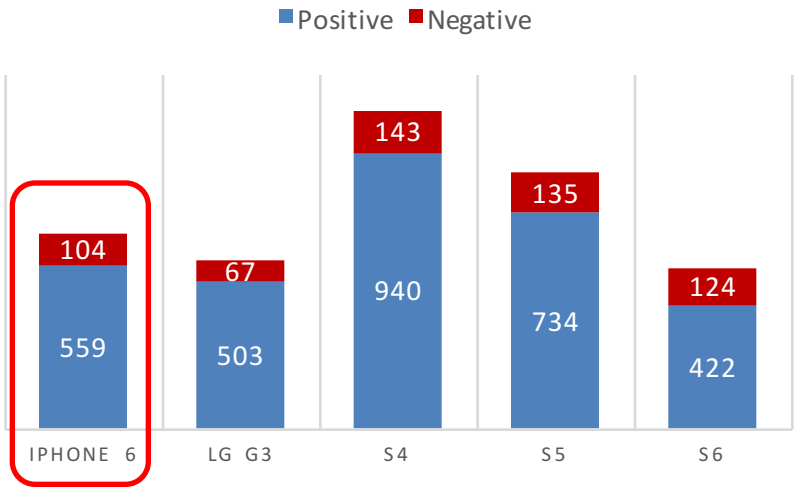
<Graph 19> Sentiment Scores for ‘Card’

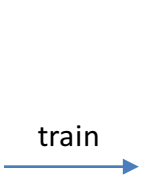


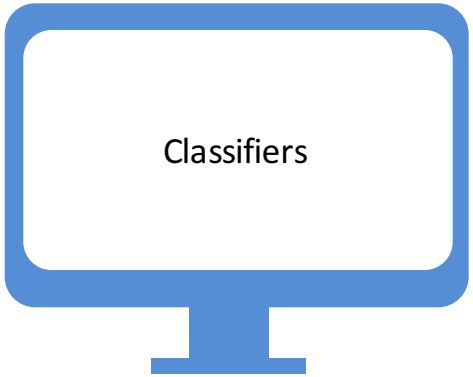
<Graph 20> Frequency of the word ‘Card’ for products

Classification: Training Data

- Classify sentences based on their individual sentiment scores
- Give 'positive' label if the sentiment score ≥ 0.5
- Give 'negative' label if the sentiment score ≤ -0.5
- Drop the sentences with -0.5 < sentiment score < 0.5
- Use the classified sentences to train classifiers respect to products







<Graph 21> # of positive & negative sentences for 5 products

Classification: Training Data

Sentences	Score	Label
Battery life is excellent.	1.0	**Pos**
Experience in streaming videos were superb.	1.0	**Pos**
Brilliant camera in terms of picture quality and speed.	1.0	**Pos**
…	…	**…**
Apple needs to get better camera or they will lose people to samsung.	0.5	**Pos**
Impressed with the OS itself for having it optimize to run on dual core.	0.5	**Pos**
Very smooth operation, the focus on the camera is very fast and the battery standby time is amazing.	0.46	
…	…	…
the battery again is terrible; requiring 3 complete charging within 24hrs.	-0.45	
Too bad it has 1gb ram, but anyway apple a8 is the fastest processor.	-0.7	**Neg**
This phone is a piece of crap with no changes in and out except screen and battery.	-0.8	**Neg**
Still one of the worst battery performance out there, even.	-1.0	**Neg**

<Table 1> Classification rule example for iPhone 6 training data

Naïve Bayesian Classifier: iPhone 6

- Training data was labeled with respect to sentiment scores; errors are possible
- Data Imbalance problems; # of positive reviews >> # of negative reviews
- Classifying negative reviews as negative is critical

Confusion Matrix		Predict	
		Negative	Positive
Actual	Negative	103	0
	Positive	555	2

<Table 2> Confusion matrix for Naïve Bayesian Classifier

Recall	1.0000
Precision	0.1565
Accuracy	0.1591
F1-measure	0.2707
Balanced correction rate	0.0036

<Table 3> Metrics for Naïve Bayesian Classifier

K-Nearest Neighbors Classifier: iPhone 6

- Training data was labeled with respect to sentiment scores; errors are possible
- Data Imbalance problems; # of positive reviews >> # of negative reviews
- Classifying negative reviews as negative is critical

Confusion Matrix		Predict	
		Negative	Positive
Actual	Negative	60	23
	Positive	26	419

<Table 4> Confusion matrix for K-nearest neighbors

Recall	0.7229
Precision	0.6978
Accuracy	0.9072
F1-measure	0.7101
Balanced correction rate	0.6807

<Table 5> Metrics for K-nearest neighbors

Classification Tree: iPhone 6

- Training data was labeled with respect to sentiment scores; errors are possible
- Data Imbalance problems; # of positive reviews >> # of negative reviews
- Classifying negative reviews as negative is critical

Confusion Matrix		Predict	
		Negative	Positive
Actual	Negative	21	82
	Positive	1	556

<Table 6> Confusion matrix for Classification Tree

Recall	0.2039
Precision	0.9545
Accuracy	0.8742
F1-measure	0.3360
Balanced correction rate	0.2035

<Table 7> Metrics for Classification Tree

Support Vector Machine: iPhone 6

- Training data was labeled with respect to sentiment scores; errors are possible
- Data Imbalance problems; # of positive reviews >> # of negative reviews
- Classifying negative reviews as negative is critical

Confusion Matrix		Predict	
		Negative	Positive
Actual	Negative	64	56
	Positive	0	672

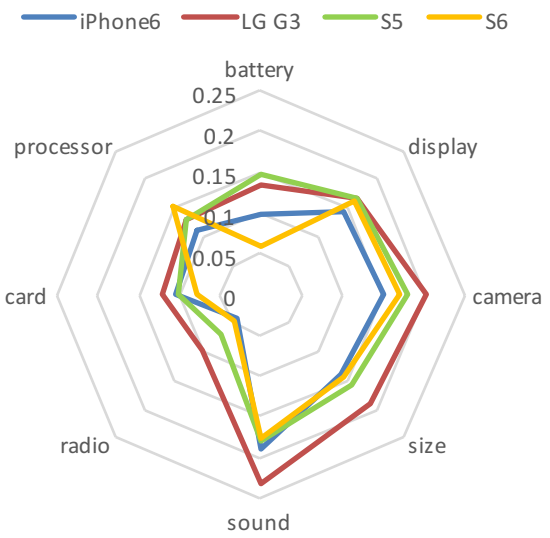
<Table 8> Confusion matrix for Support Vector Machine

Recall	0.5333
Precision	1.0000
Accuracy	0.9293
F1-measure	0.6957
Balanced correction rate	0.5333

<Table 9> Metrics for Support Vector Machine

Summary: Sentiment Analysis

- Compare results with 'Consumer Report' publicized on May, 2015
- Data : ~ April 2nd, 2015
- Ranks of analysis are similar to those of Consumer Report
- Make recommendations for customers within products, regarding the scores for each feature



<Graph 22> Sentiment Scores for 4 products

Ranking	Consumer Report	Scores	Analysis Results
1	Galaxy S5	79	LG G3
2	LG G3	78	S5
3	Galaxy S6, iPhone6	77	S6
4	-	-	iPhone6

http://www.consumerpost.co.kr/news/articleView.html?idxno=29313

Summary: Classification

1. Evaluation metric: Balanced Correction Rate(BCR)
    - K-Nearest Neighbors > Support Vector Machine > Classification Tree >> Naïve Bayesian
2. Evaluation metric: F1-measure
    - K-Nearest Neighbors > Support Vector Machine > Classification Tree >> Naïve Bayesian
3. Naïve Bayesian classifiers are especially susceptible to data imbalance problems

Classifier	BCR	F1-Measure
Naïve Bayesian	0.0036	0.2707
K-Nearest Neighbors	0.6807	0.7101
Classification Tree	0.2035	0.3360
Support Vector Machine	0.5333	0.6957

Further Research

- Various ways to preprocess raw data
  - Stemming, Lemmatizing, stopwords, ...
  - 'Sentence' units vs 'Review' units
  - Pos-tagging
- Application of other algorithms for sentiment analysis
  - Different ways for selecting features
  - Scoring sentences according pos-tags
- Raise accuracy of sentiment analysis
  - Raising accuracy yields better training data
- Classify reviews respect to their features
  - Give 'feature' labels to sentences
  - Help developers sort out customer reviews better

Thank You