#### Automatic Survey Understanding (A NLP & Al Case Study)



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### About George



 Migacore Technologies uses NLP and AI to forecast travel patterns.

- Palantir, Google, Groupon

George Brova сто MIGACORE

 Research: Graph Mining + applied ML at Univeristy of Illinois

## About Ling



Ling Zhang Software Engineer



 aiden.ai is an Al powered virtual colleague for marketers.

- Ex-founder @ Entrepreneur First 8.
- Palantir, Facebook
- NLP, Speech Recognition, Machine Learning

#### Talk Overview Part 1: Problem and Solution

#### **Part 2:** Preprocess the Data

#### **Part 3:** Machine Learning & Analysis

**Part 4:** Results

#### Part 1: Problem and Solution

The Problem

### Long Surveys

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#### (Real BestBuy.com Survey)

#### Some Random Responses "It is just garbage collect for Pete's sake!"

"i dont know"

"Person(s) who answered my calls were not very friendly. Very cold."

"it can't be."

**Imagine analyzing this x6000** 

### They don't even read it!

"Many shared stories about having huge datasets of qualitative responses but not touching it **because it's too wild to clean and interpret manually**"

"Some said it's their single biggest painpoint and overhead and they walk away from projects or leave the data untouched" **2 Part Solution:** A Better Survey + Machine Learning Analysis

### New Survey

#### Satisfaction Survey

What did you think?

Your answer

#### Rate your overall satisfaction



#### SUBMIT

Never submit passwords through Google Forms.

## Comparison

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## Which would you rather do?

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## Why no simple surveys today?

<u>Problem:</u> We need to pay someone to read each and every response, and summarize the 'big' picture:

- 1. Difficult
- 2. Expensive
- 3. Vulnerable to bias

Solution: Machine Learning saves your from your labour intensive problems!

## Combining a few ideas

## The Big Picture



### **Part 2:** Preprocess the Data

## Bag of Words

CC There should be more staff at the service counter.



## Bag of Words



### Weaknesses (1)





In practice

bow = document
 .lowercase()
 .split([' '])
 .split([punctuation\_characters])
 .words\_to\_ids()

### Word normalization (1)

walk walked walks walking

### Word normalization (1)

walk walked walk walks walking Use **stemming** for fast word normalization

#### Word normalization (2)

"He found his true **calling** in life"

"He is **calling** her on the phone"

### Word normalization (2)

"He found his true **calling** in life"

[Noun]

"He is calling her on the phone"

[Verb]

Use lemmatization for context-sensitive normalization

## Language detection

"The service was very fast"

"Le service était très rapide"

## Language detection



In practice

bow = document

.lowercase()
.split([' '])
.split([punctuation\_characters])
.words\_to\_ids()

In practice

bow = document

#### .filter(is\_english)

- .lowercase()
- .split([' '])
- .split([punctuation\_characters])
- .lemmatize()
- .words\_to\_ids()

### **Part 3:** Machine Learning & Analysis

### Introducing LDA

Wikipedia: Latent Dirichlet Allocation (LDA) is a generative statistical model that allows sets of observations to be explained by unobserved groups that explain why some parts of the data are similar.

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Wikipedia: Latent Dirichlet Allocation (LDA) is a generative statistical model that allows sets of observations to be explained by unobserved groups that explain why some parts of the data are similar.

Generative: Data and labels distribution is jointly learned P(x,y) instead of discriminative P(y|x)
Observations: Using a training corpus
Unobserved: Without labels (unsupervised)
Similar: In order to cluster similar topics

## LDA High Level

**Input:** List of free text documents (Bag of Words encoded), without labels.

Method: Training over n generations

**Output:** Scores for each topic per document

## LDA By Analogy



### LDA By Analogy



#### LDA By Analogy **1. Init:** Randomly give every word a topic - guess P(tk|wi)



LDA By Analogy **1. Init:** Randomly give every word a topic - guess P(tk|wi)

 $P(t_k|d_j) = P(t_k|w_i) * P(w_i|d_j)$ 



#### LDA By Analogy

Init: Randomly give every word a topic - guess P(tk|wi)
 Train: For a given word wi assign a new topic tk by throwing a weighted die with probability P(wi∈tk) = P(tk|dj) \* P(wi|tk)



#### LDA Problems!

#### Noise! Every sentence gets a list of topic scores that sum to 1.

Response	"Ok, whatever this survey was lame"	"We need more highly trained staff in hospitals"		
Topic 4 (Healthcare) LDA	75%	70%		
Topic 7 (Transport) LDA	15%	10%		
Topic 10 (Staff) LDA	10%	20%		

#### LDA: Rank Relevance

New Idea: Score every response with a "relevance score". It's the normalized sum of the square probabilities of the words in the topic-word distribution.

Rel(doc, topic) = ( $\sum$ word  $\in$  topic P(word | topic)<sup>2</sup>) / (wordcount)

# LDA: Rank Relevance Score

Response	"Ok, whatever this survey was lame"	"We need more highly trained staff in hospitals"
Topic 4 (Healthcare) LDA	75%	70%
Topic 4 Rank Relevance	0.00003	0.2
Topic 7 (Transport) LDA	15%	10%
Topic 7 Rank Relevance	0.000001	0.00002
Topic 10 (Staff) LDA	10%	20%
Topic 10 Rank Relevance	0.0000008	0.01

### LDA: Rank Relevance Quality

Less good data is better than more noisy data.

Filtering Method:1. Sort documents for each topic by rank relevance score.2. Take top X% (dependent on data set ~25%-50%)

#### **Document Summarization**

Goals:

ShortMost essential ideasNatural language









### Sentences = Bag of Words



### **Compute Strength of Interaction**



### Node Centrality - PageRank



#### **Document Summarization**

Goals:

- Short top-k sentences
- Most essential ideas
- Natural language

Only

Node centrality Full sentences **Part 4:** Results

### Example Topics discovered by LDA









#### Summarization of Topics

### **Example Topics - Human Labels**

Topic 4

Topic 6

Topic 8



**Medical Services** 

Examples of good services

Waiting time

# Summarization

Topic 4: Medical Services Topic 6: Examples of good services

#### **Topic 8: Waiting time**

They take too much time

to come. Have staff

#### WE NEED MORE **DOCTORS**, **NURSES**, AND **HOSPITAL**

**FACILITIES**. How to improve provincial government needs to get/pay more **doctors** in the province, they deserve it. Provide more after hours **clinics** for working families. I do not know how to improve the service, unless they have more people working in the office. It was a good service and did not need any improvement. I don't there is anything currently that could help this service to be improved. I thought that the service I got was very good. A

few more people on staff, but

overall service was good.

lunches/breaks at other times. Easier contact info, shorter wait times on phones, being called back on time. Next time I use this service, I will definitely use the internet option as I don't have time to wait in long lines.

#### Statistical Analysis of Satisfaction



**Medical Services** 

Examples of good services

Waiting time

#### Sentiment Analysis



**Medical Services** 

Examples of good services

#### Waiting time



## Using This



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### To This

#### Satisfaction Survey

What did you think?

Your answer

#### Rate your overall satisfaction



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#### **Pros:**

Automatic analysis • Cheaper • Less Bias • Survey less frustrating Not all responses equal  $\circ$  More writing = More impact **Cons:** 

• Niche topics can be missed

## Questions? (P.S. We are both hiring!)



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