DO PEOPLE CARE ABOUT OTHERS' OPINIONS OF PLACES?

UTILIZING DEEP LEARNING TO MODEL PEOPLES' REVIEW PATTERNS

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University at Buffalo The State University of New York

Agenda

- Introduction
- Background
- Methodology I
- Methodology II
- Conclusion

Introduction

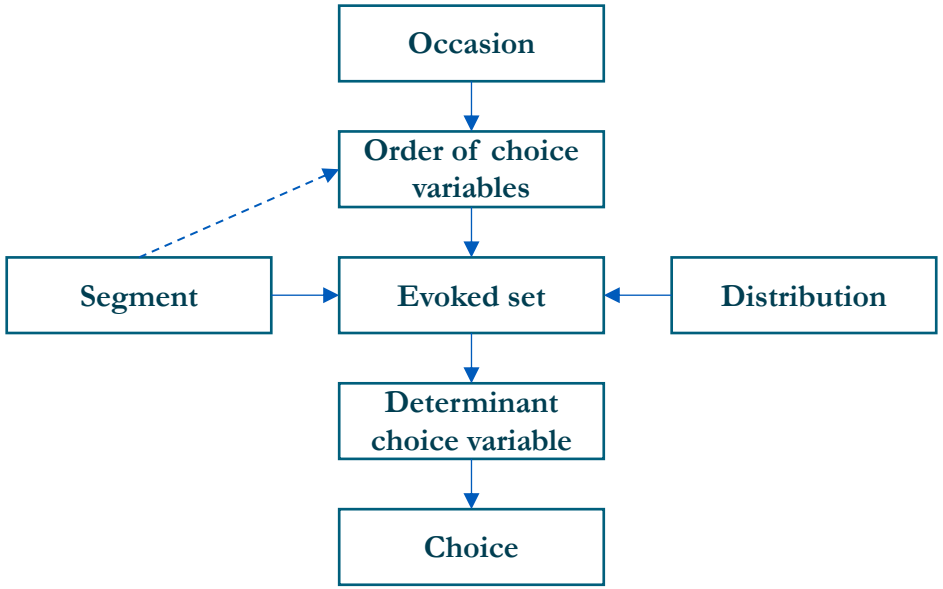
- People's opinions about places reflect their emotional attachment to places that hold meanings to them.
- With the rise of social media platforms such as Google Reviews, TripAdvisor, and Yelp, vast number of opinions about local businesses, including restaurants, have been published online.

How to utilize recent advancements in natural language processing (NLP) techniques to:

- **help identify key aspects that customers care about when choosing restaurants,**
- **understand the rationales behind customers' needs and preferences?**

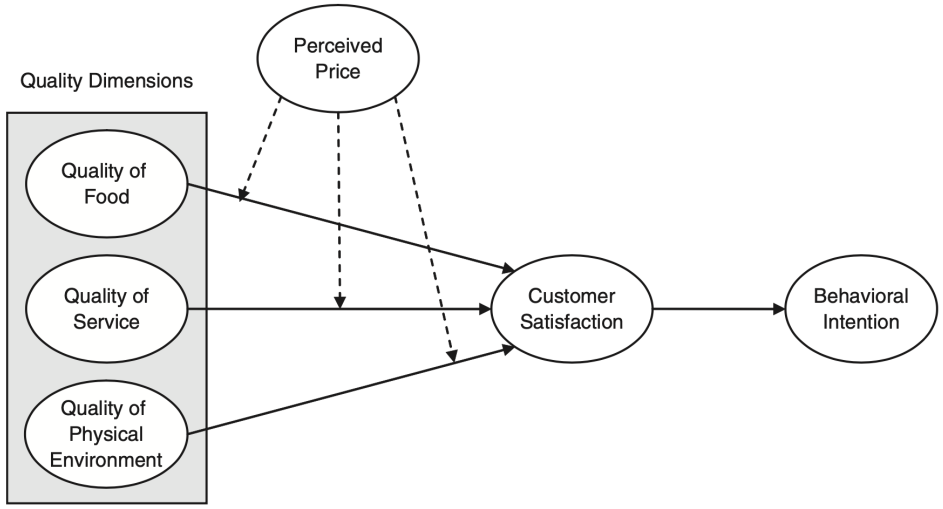
Background

- Numerous studies in the past have tried to identify restaurant quality attributes and investigate their effects on consumer decisions.



Influences of a consumer's choice of restaurant

Source: Auty, S. (1992). Consumer choice and segmentation in the restaurant industry. *Service Industries Journal*, *12*(3), 324-339.



Conceptual model showing the relationships between study variables

Source: Ryu, K., & Han, H. (2010). Influence of the quality of food, service, and physical environment on customer satisfaction and behavioral intention in quick-casual restaurants: Moderating role of perceived price. *Journal of Hospitality & Tourism Research*, 34(3), 310-329.

Background

- Existing studies utilized qualitative methods (survey, interview, and focus group) to collect and analyze responses from consumers, restricted to small sample sizes.

	Characterization of the studies	Number of studies	Frequency (% of total studies)
Type of research	Survey	41	91.1
	Qualitative	3	6.7
	Experimental	1	2.2
Nature of research	Exploratory	8	17.8
	Descriptive	37	82.2

Characterization of the Studies Analyzed Concerning the Choice of Food Services, Published in the Period from 1979 to August of 2011
Source: Medeiros, C. O., & Salay, E. (2013). A review of food service selection factors important to the consumer. *Food and Public Health*, 3(4), 176-190.

Background

- Existing studies utilized qualitative methods (survey, interview, and focus group) to collect and analyze responses from consumers, restricted to small sample sizes.
- Other studies (Do et al., 2019) have utilized NLP techniques to capture expressed sentiments or emotions in consumer reviews from online platforms.
- However, these computational methods tend to focus on improving their predictive power, overlooking theory implications.

Methodology: A Computational Approach

Part I

Aspect-Based Sentiment Analysis

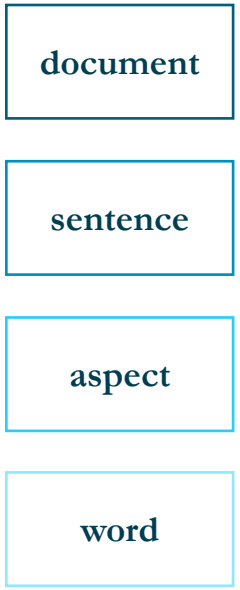
Part II

Agent-Based Modeling

Aspect-Based Sentiment Analysis

- Sentiment analysis aims to estimate subjective sentiments expressed through texts, images, and speeches.

Levels of sentiment analysis on texts



Aspect-Based Sentiment Analysis

- Sentiment analysis aims to estimate subjective sentiments expressed through texts, images, and speeches.

Levels of sentiment analysis on texts

- document
- sentence
- aspect
- word

Breaking News

VOL XI - no.4359 NEW ISSUE

Letters to the Editor

Get your letter to the editor printed...and help save buffalo!

Big news! BFC supporters from all over the world have written letters to the editors of their local newspapers. They have also gotten several national magazines to write feature articles about the plight of the last wild buffalo. Because of this, gazillions of other people became informed buffalo advocates and wrote letters to their government representatives. As a result, BFC is better positioned to advocate for the buffalo because the public officials know that "YOU, the people" are behind everything that BFC is pushing for to help protect the buffalo--now and into the future. BFC supporters from all over the world have written letters to the editors of their local newspapers. They have also gotten several national magazines to write

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Source: [Buffalo Field Campaign]

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Levels of sentiment analysis on texts

document

sentence

aspect

word

"Excellent effort guys! Loved your work."

Aspect-Based Sentiment Analysis

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Levels of sentiment analysis on texts

document

sentence

aspect

word

Aspect-Based Sentiment Analysis

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Levels of sentiment analysis on texts

Positive: good, great, love, awesome, …
Neutral: restaurant, think, movement, …
Negative: murder, poison, terrible, awful, …

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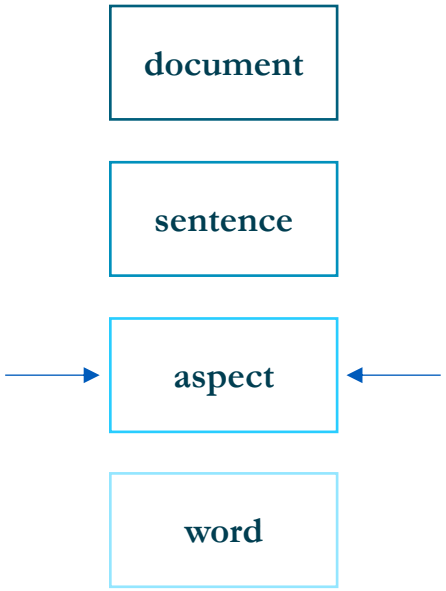

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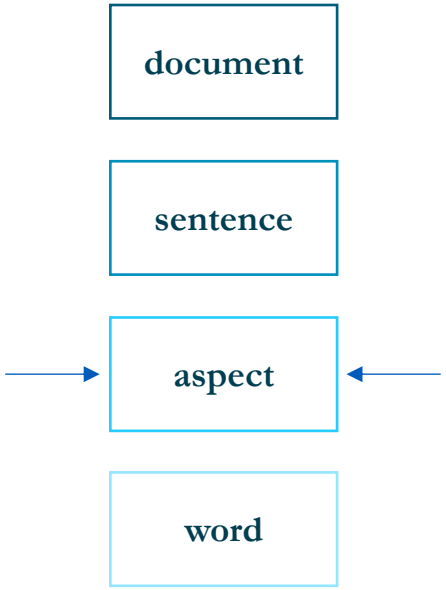

Main approaches

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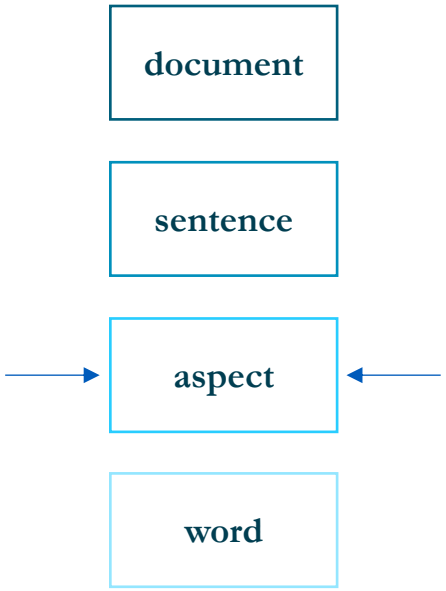
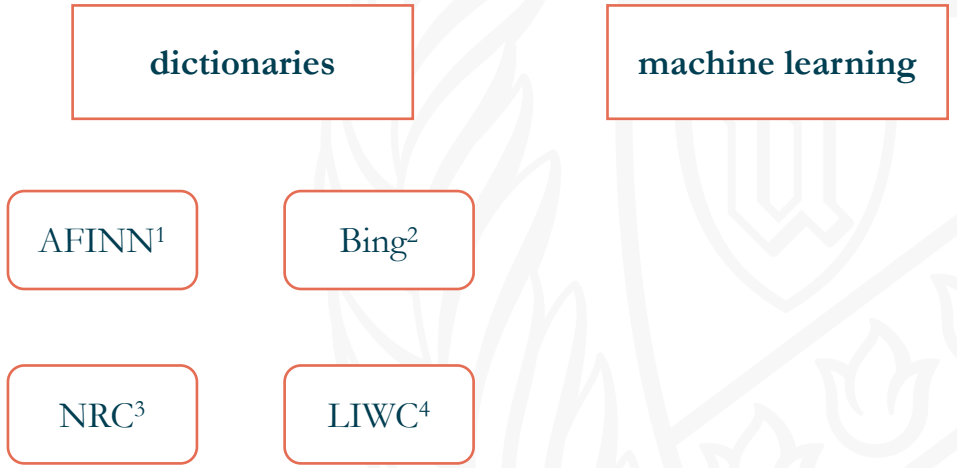
Levels of sentiment analysis on texts



Main approaches



[1] Nielsen, F. Å. (2011). A new ANEW: Evaluation of a word list for sentiment analysis in microblogs. arXiv preprint arXiv:1103.2903.
[2] Liu, B. (2015). Sentiment Analysis: Mining Opinions, Sentiments, and Emotions. Cambridge University Press.
[3] Mohammad, S., & Turney, P. (2010, June). Emotions evoked by common words and phrases: Using mechanical turk to create an emotion lexicon. In Proceedings of the NAACL HLT 2010 workshop on computational approaches to analysis and generation of emotion in text (pp. 26-34).
[4] Tausczik, Y. R., & Pennebaker, J. W. (2010). The psychological meaning of words: LIWC and computerized text analysis methods. Journal of language and social psychology, 29(1), 24-54.

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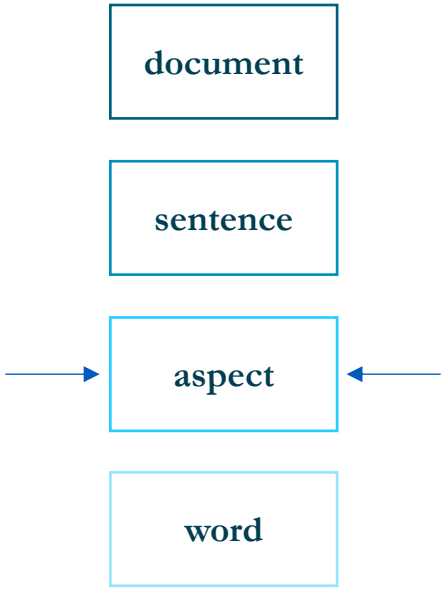
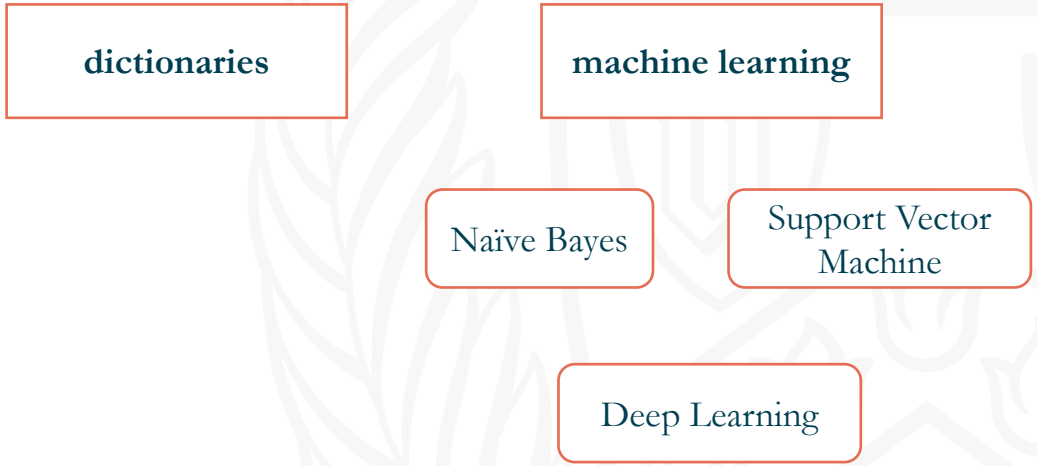


Main approaches



Aspect-Based Sentiment Analysis

Do, H. H., Prasad, P. W., Maag, A., & Alsadoon, A. (2019). **Deep learning for aspect-based sentiment analysis: a comparative review.** Expert systems with applications, 118, 272-299.

Application of the CNN model in the consumer

No	Study	Domain
Opinion target extraction		
1	Poria, Cambria, et al. (2016)	12 electronic products
		Laptop
		Restaurant
2	Feng et al. (2018)	Mobile phone
Aspect category extraction		
3	Toh & Su (2016)	Restaurant
		Laptop
4	Ruder et al. (2016)	Mobile phone
		Hotel
5	Gu et al. (2017)	Smartphone
		Shirt
6	Wu et al. (2016)	Smartphone
Sentiment polarity		
7	Gu et al. (2017)	Smartphone
		Shirt
8	Ruder et al. (2016)	Hotel
		Mobile phone
9	Du et al. (2016)	Electronics
		Movies and TV
		CDs and vinyl
		Clothing, shoes
		jewellery
10	Wu et al. (2016)	Smartphone
11	Xu et al. (2017)	Laptop
		Restaurant
12	Akhtar, Kumar, et al. (2016)	12 personal electronic produ

Application of RNN model in the consumer review domain.

No	Study	Domain	Dataset & Langua
Opinion target extraction			
1	Toh & Su (2016)	Restaurant	SemEval '16
2	T. Chen et al. (2017)	Restaurant	SemEval '16
		Restaurant	SemEval '16
		Restaurant	SemEval '16
		Restaurant	SemEval '16
		Restaurant	SemEval '16
		Restaurant	SemEval '16
3	Liu et al. (2015)	Laptop	SemEval '14
		Restaurant	SemEval '14
4	Jebbara & Cimiano (2016)	Restaurant	ESWC Challenge
		Laptop	2016
		Hotel	
5	Tay, Tuan and Hui (2017)	Restaurant	SemEval '14
		Laptop	SemEval '14
6	Al-Smadi, Qawasmeh, Al-Ayyoub, Jararweh, and Gupta (2017)	Hotel	SemEval '16
7	Yuan, Zhao, Qin, and Liu (2017)	Restaurant	SemEval '14
		Laptop	SemEval '14
8	X. Wang et al. (2016)	Restaurant	SemEval '14
		Laptop	SemEval '14
9	Ding, Yu, and Jiang (2017b)	Restaurant	SemEval '14 + '15
		Laptop	SemEval '15
		Digital device	(Kessler et al., 2010)
		Web service	(Toprak et al., 201
10	W. Wang, Pan, & Dahlmeier (2017)	Restaurant	SemEval '14
		Laptop	SemEval '14
		Restaurant	SemEval '15
11	Li & Lam (2017)	Laptop	SemEval '14
		Restaurant	SemEval '16
12	Li, Bing, Li, Lam, & Yang (2018)	Laptop	SemEval '14
		Restaurant	SemEval '14
		Restaurant	SemEval '15
		Restaurant	SemEval '16
13	Mai & Le (2018)	Mobile phone review	PM from Youtube
Aspect category extraction			
14	Tamchyna &	Restaurant	SemEval '16

No	Study	Domain			
18	Y. Ma et al. (2018)	Reviews	English		F1: 85.61%
19	Ding et al. (2017b)	Restaurar	English		F1: 71.46%
		Laptop	English		F1: 73.61%
		Digital de	Vietnamese	Bidirectional RNN + CRF	Precision: 68.12%
					Recall: 75.87%
		Web serv			F1: 71.79%
20	W. Wang et al. (2017)	Restaurar	Turkish	Binary classifier (deep LSTM) for	F1: 61.03%
		Laptop	Russian	each category	F1: 64.83%
		Restaurar			
21	Li & Lam (2017)	Laptop			
		Restaurar			
Sentiment polarity					
22	Tay, Luu, & Hui (2017)	Restaurar			
		Laptop			
23	Cheng et al. (2017)	Restaurar			
		Restaurar			
		Restaurar			
		Laptop			
24	Y. Wang et al. (2016)	Restaurar			
		Laptop			
25	Y. Ma et al. (2018)	Restaurar			
26	P. Chen et al. (2017)	Restaurar			
		Laptop			
27	R. Ma et al. (2017)	Restaurar			
		Laptop			
28	Tang, Qin, et al. (2016)	Restaurar			
		Laptop			
29	Peng et al. (2018)	Notebook			
		Car			
		Camera			
		Phone			

Application of RecNN in opinion target extra

No	Study	Domain
Opinion target extraction		
1	Nguyen & Shirai (2015)	Restaurant
		Laptop
2	W. Wang, Pan, Dahlmeier, & Xiao (2016)	Laptop
		Restaurant
3	Lakkaraju, Socher, & Manning (2014)	Beer
		Camera
Sentiment polarity		
4	Dong et al. (2014)	Twitter da
5	Vo & Zhang (2015)	Twitter da
6	Zainuddin et al. (2018)	Twitter da
7	B. Wang, Liakata, Zubiaga and Procter (2017)	Twitter da
	Tweets from 2015 UK general election campaign	PM

Application of hybrid models.

No	Study	Domain			Perfor
Opinion target extraction					
1	Ye et al. (2017)	Restaurant			ased F1: 83
		Laptop			winni F1: 75
2	Xue et al. (2017)	Restaurant			neural F1: 83
					BiLSTM and mode
					F1: 67
					F1: 72
Aspect category detection					
3	Xue et al. (2017)	Restaurant			neural F1: 88
					BiLSTM
					F1: 65
					F1: 76
Sentiment polarity					
4	P. Chen et al. (2016)	Phone	COAE2014 task3	Chinese	LSTM + CNN Acc: 9
		Car	COAE2012 task1 and the autohome website	Chinese	Acc: 7

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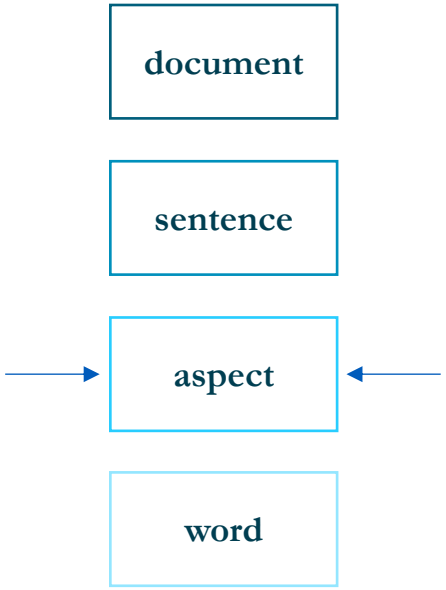
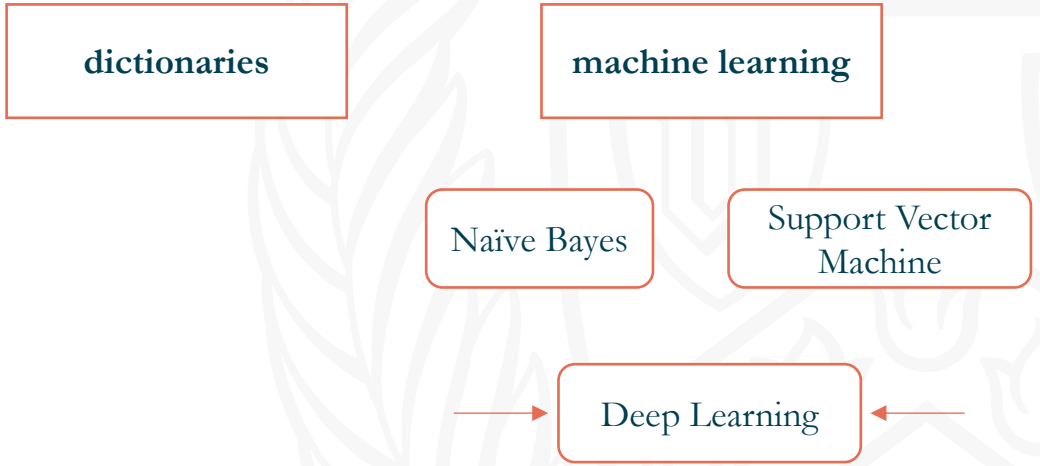
Levels of sentiment analysis on texts

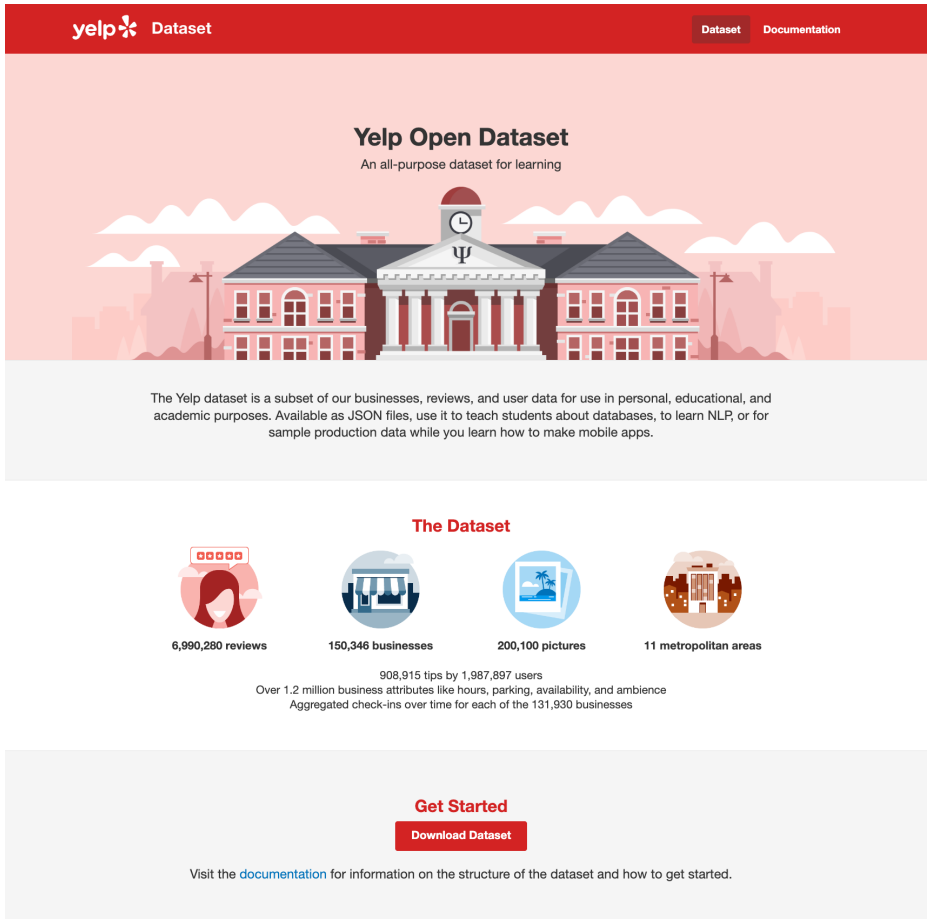


Main approaches



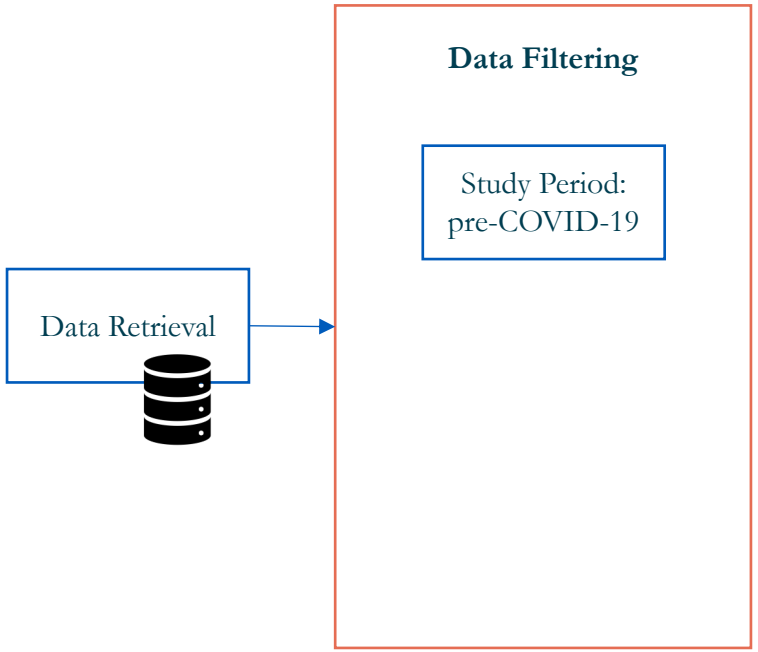
Aspect-Based Sentiment Analysis

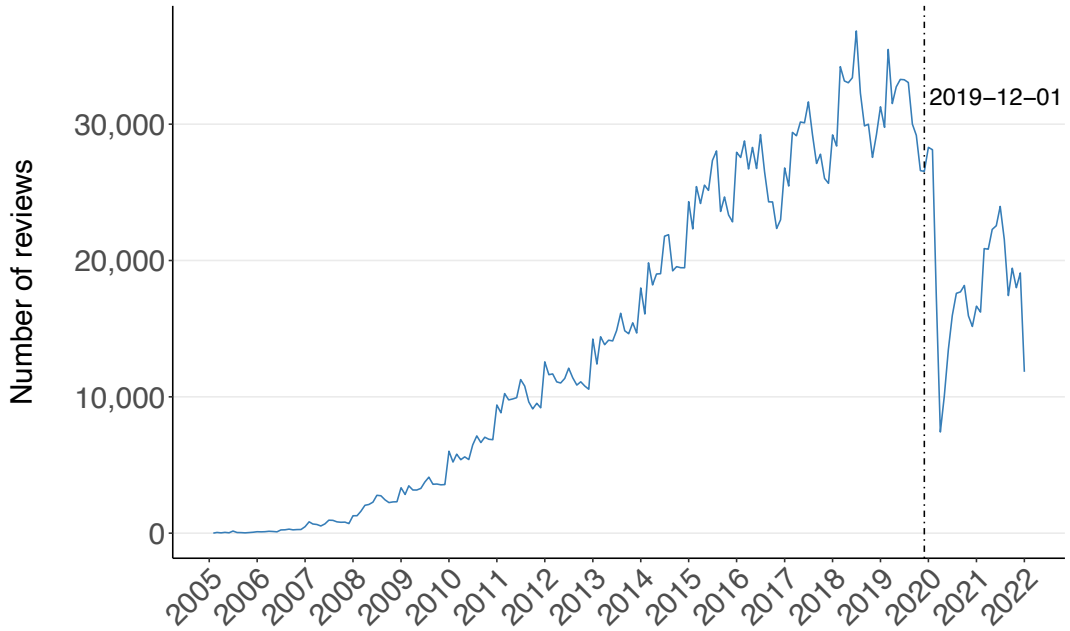
Data Retrieval



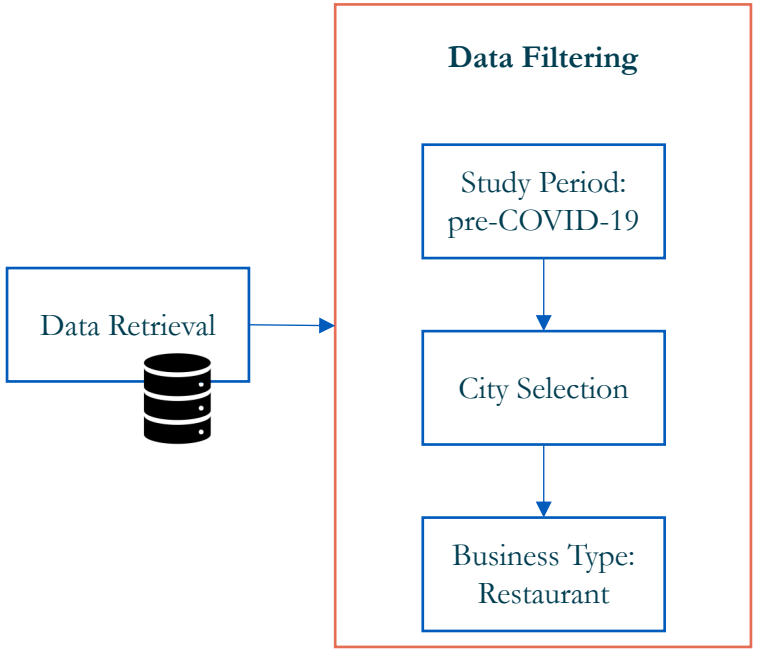
Source: https://www.yelp.com/dataset
Dataset version: 2022

Aspect-Based Sentiment Analysis

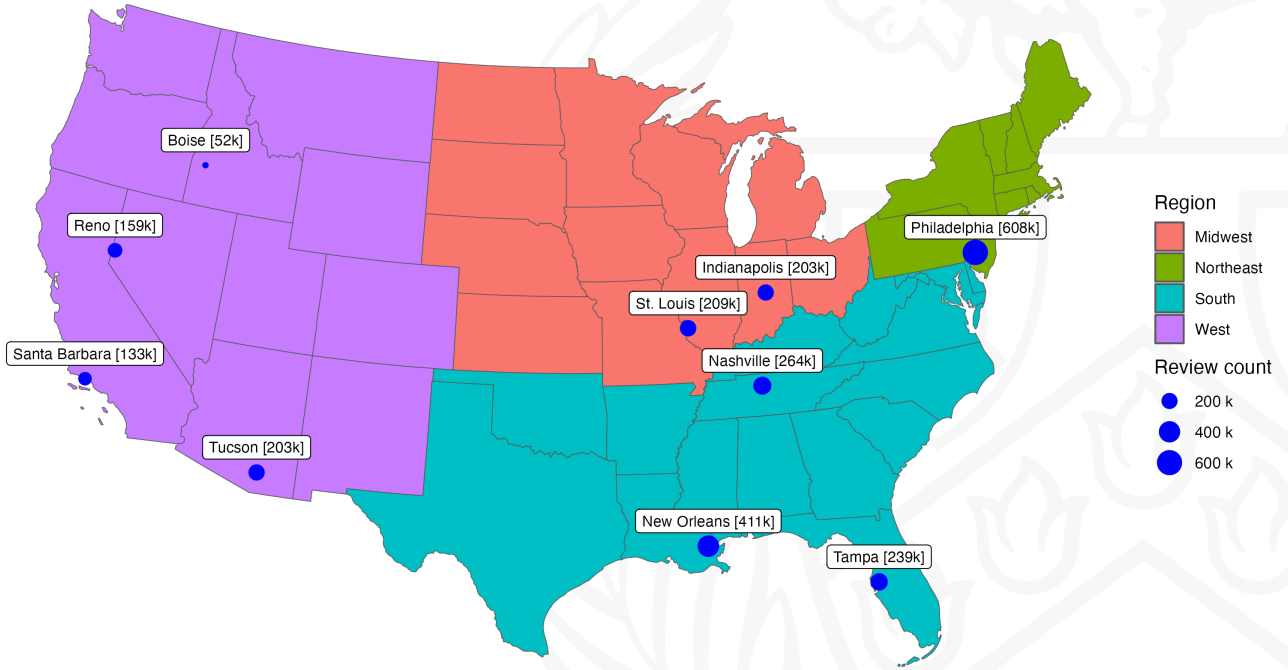




Aspect-Based Sentiment Analysis



Number of restaurant reviews in selected cities



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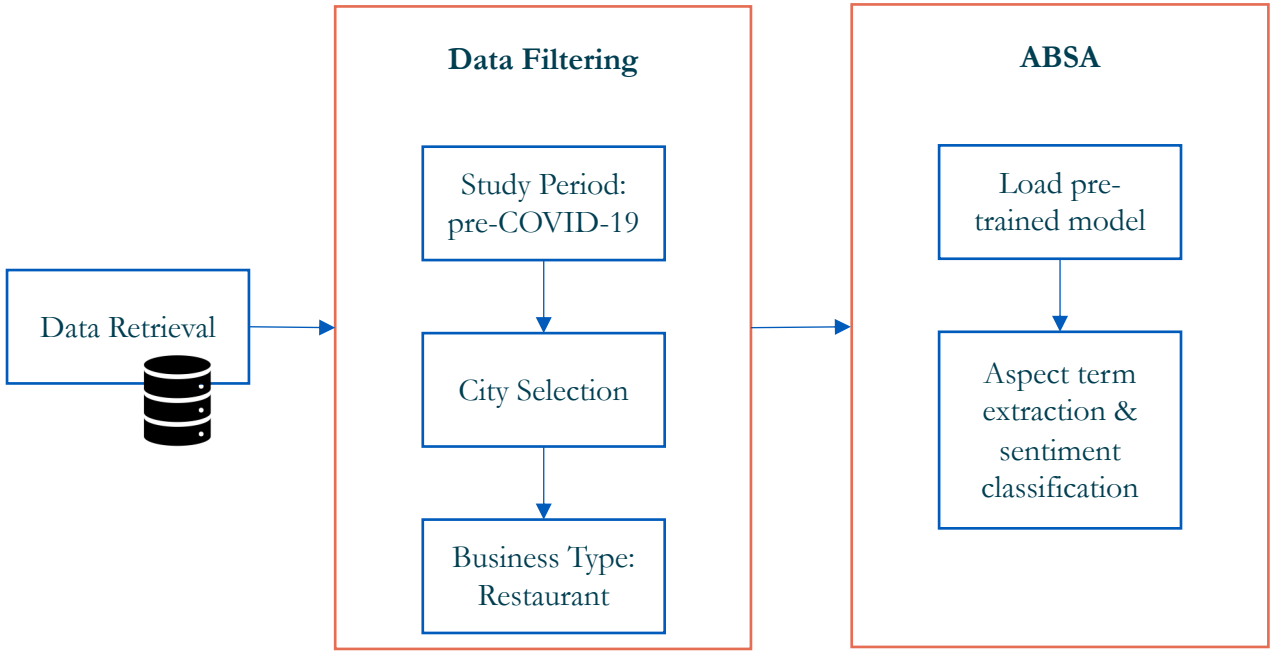

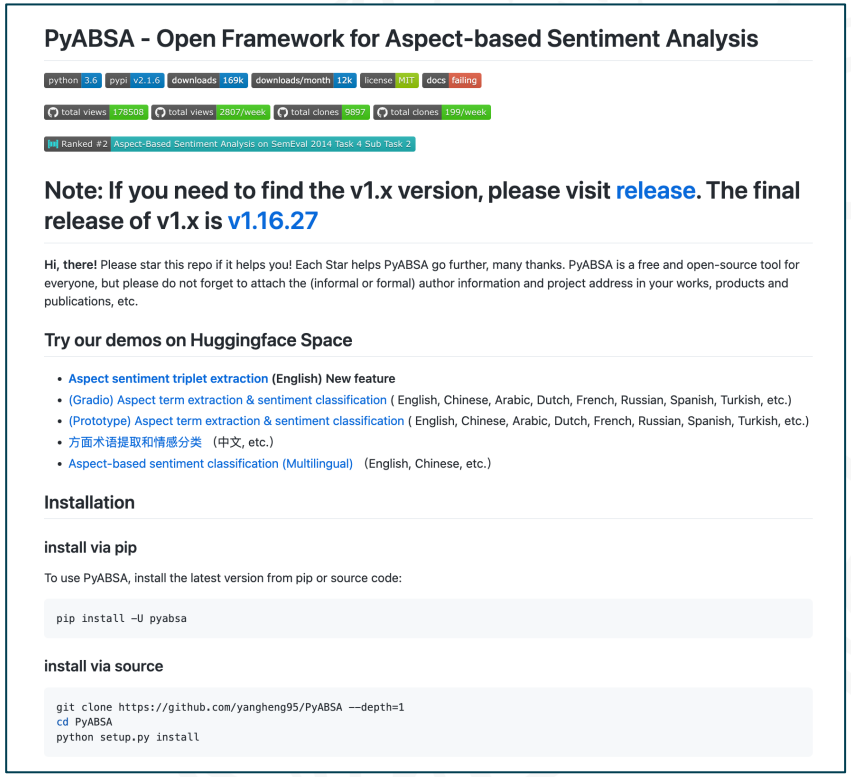

PyABSA - Open Framework for Aspect-based Sentiment Analysis

python 3.6 | pypi v2.1.6 | downloads 169k | downloads/month 12k | license MIT | docs failing

total views 178508 | total views 2807/week | total clones 9897 | total clones 199/week

Ranked #2 Aspect-Based Sentiment Analysis on SemEval 2014 Task 4 Sub Task 2

Note: If you need to find the v1.x version, please visit release. The final release of v1.x is v1.16.27

Hi, there! Please star this repo if it helps you! Each Star helps PyABSA go further, many thanks. PyABSA is a free and open-source tool for everyone, but please do not forget to attach the (informal or formal) author information and project address in your works, products and publications, etc.

Try our demos on Huggingface Space

- **Aspect sentiment triplet extraction (English) New feature**
- (Gradio) Aspect term extraction & sentiment classification (English, Chinese, Arabic, Dutch, French, Russian, Spanish, Turkish, etc.)
- (Prototype) Aspect term extraction & sentiment classification (English, Chinese, Arabic, Dutch, French, Russian, Spanish, Turkish, etc.)
- 方面术语提取和情感分类 （中文, etc.)
- Aspect-based sentiment classification (Multilingual) （English, Chinese, etc.)

Installation

install via pip

To use PyABSA, install the latest version from pip or source code:

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pip install -U pyabsa
```

install via source

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cd PyABSA
python setup.py install
```
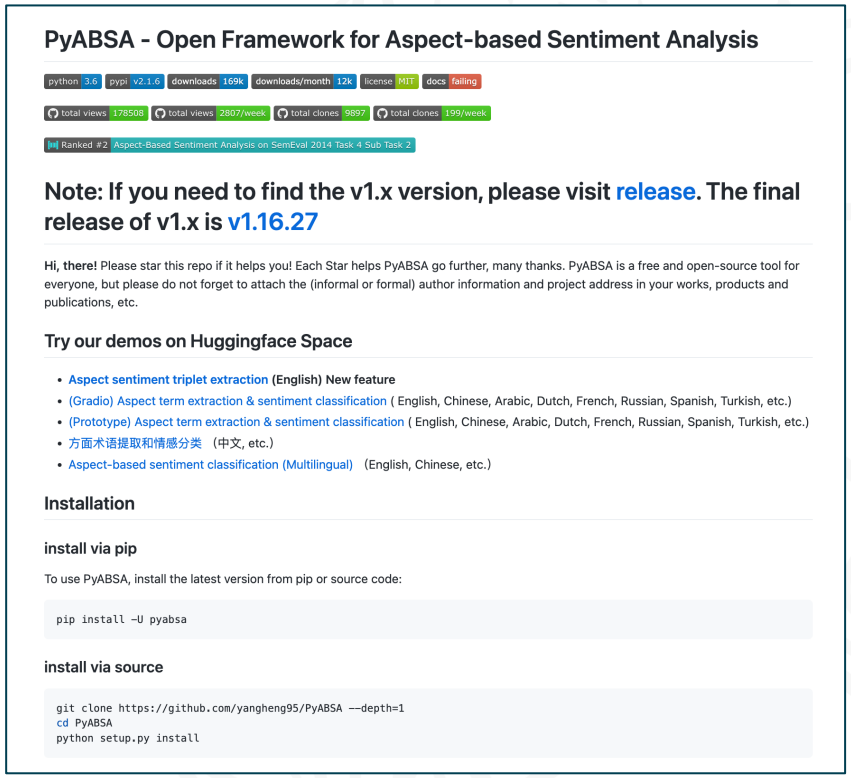

Source: https://github.com/yangheng95/PyABSA

Aspect-Based Sentiment Analysis

- One of the top performing models with open-source codebase
- Offer pre-trained models on MAMS (Multi Aspect Multi-Sentiment) dataset, a common benchmark dataset for ABSA
- Ease of use
- Well maintained (new functions, bug fixes, new versions, …)



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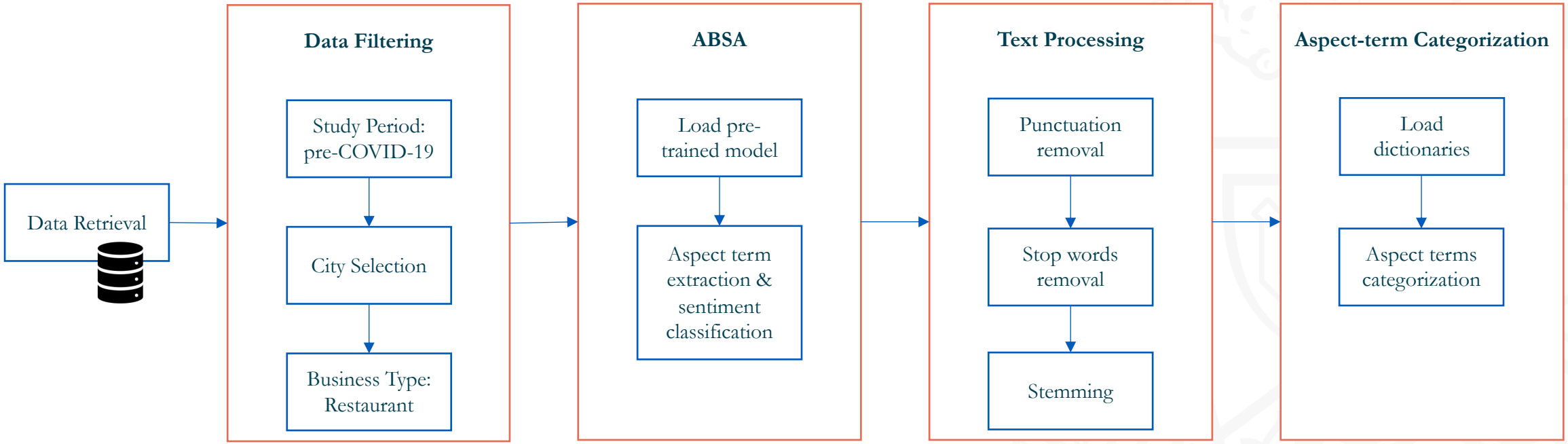

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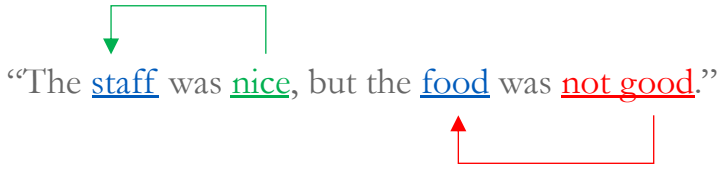


Aspect Term	Aspect Category	sentiment
staff	service	1
food	food	-1

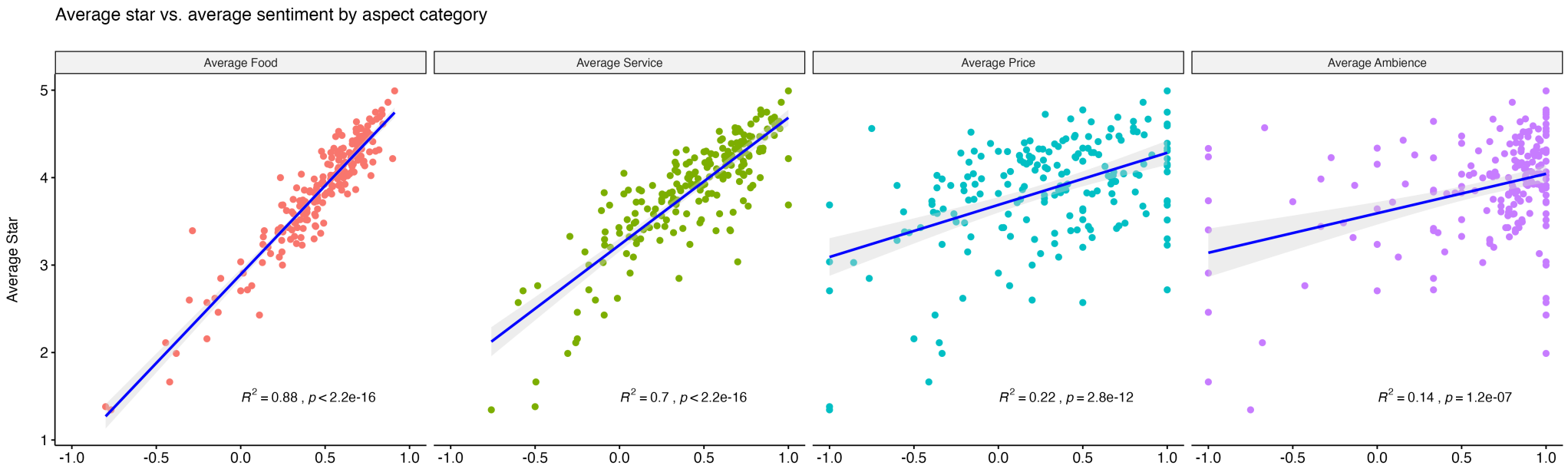
Yelp Review Data

Review ID	Restaurant ID	Review	Star
1	1	It has great sushi and …	5
2	1	The staff was nice but …	3
3	2	Super fresh delicious …	4
…	…	…	…

Aggregated Result

Restaurant ID	Average Star	Average Food	Average Price	Average Service	Average Ambience
1	4	0.6	0.56	0.7	0.6
2	3	0.2	0.6	-0.1	-0.3
…	…	…	…	…	…

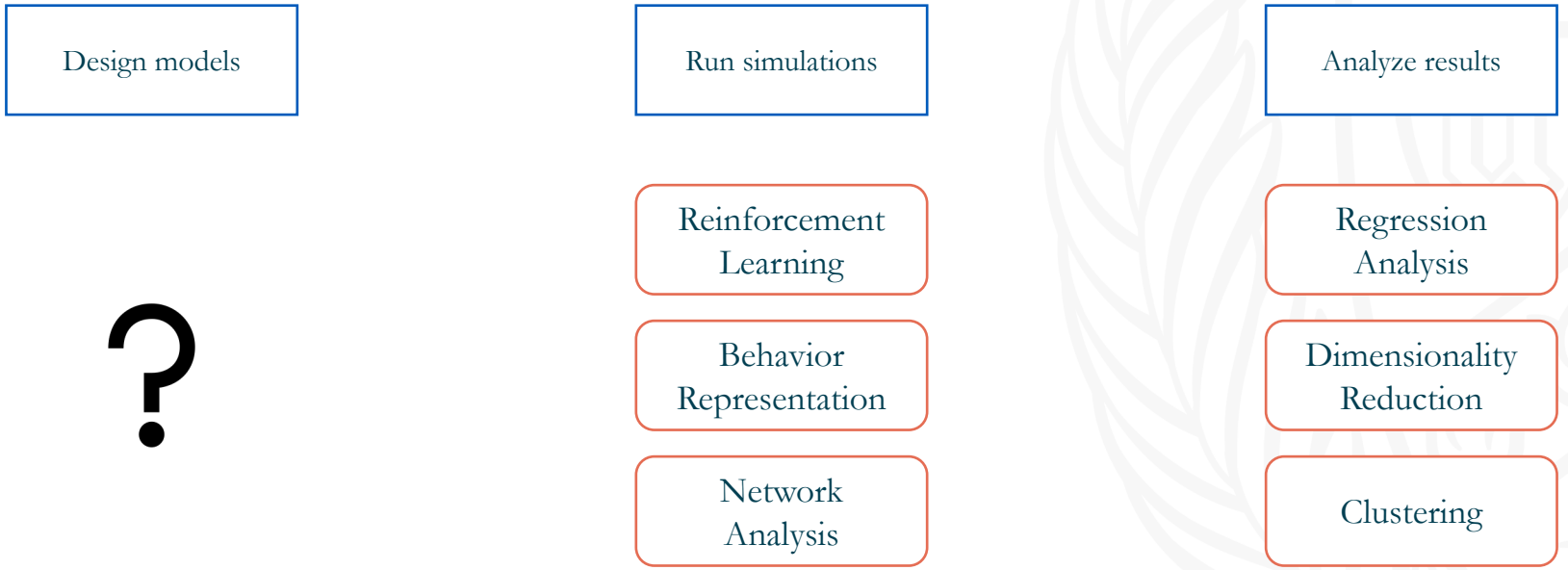
Aspect-Based Sentiment Analysis



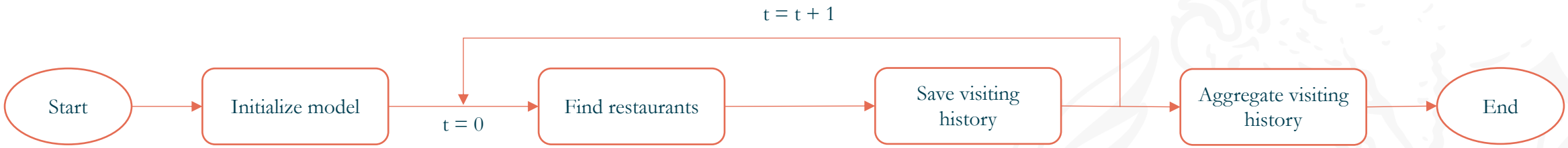
*Results based on 200 restaurants in St. Louis, MO.

Agent-Based Modeling

- Agent-based modeling: a computational modeling technique to simulate complex systems by modeling individual agents and their interactions.
- There have been a trend of integrating machine learning algorithms in and for agent-based modeling.



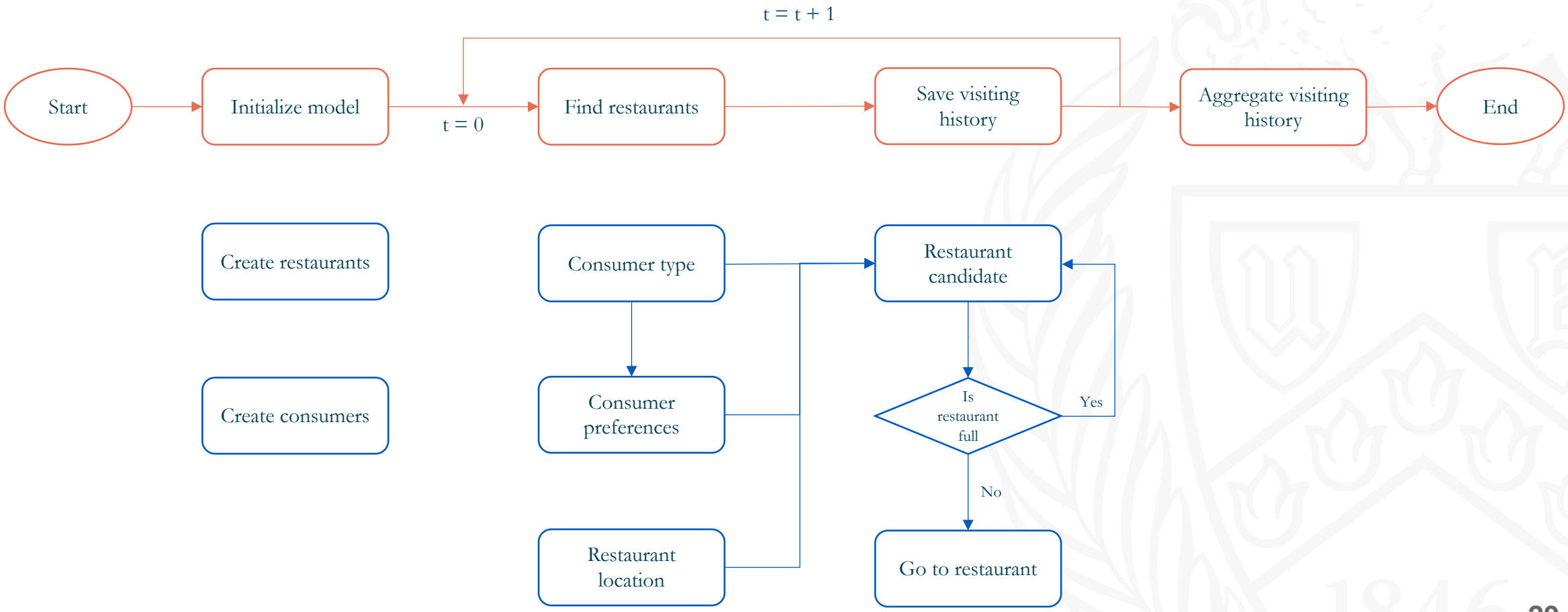
Agent-Based Modeling



Create restaurants ← restaurant location, average stars, average sentiments (food, service, price, ambience)

Create consumers ← census tract, consumer segments (students, middle-income, senior), restaurant preferences

Agent-Based Modeling

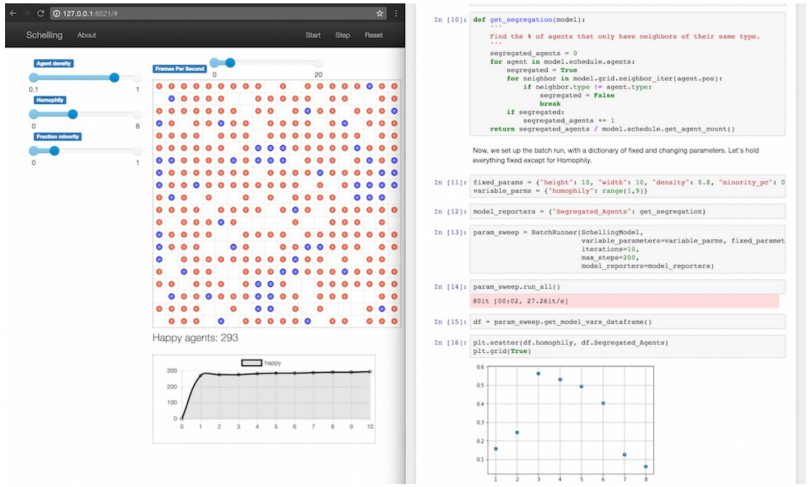


Agent-Based Modeling

Mesa: Agent-based modeling in Python 3+

build passing | codecov 82% | code style black | chat 28 users

Mesa allows users to quickly create agent-based models using built-in core components (such as spatial grids and agent schedulers) or customized implementations; visualize them using a browser-based interface; and analyze their results using Python's data analysis tools. Its goal is to be the Python 3-based alternative to NetLogo, Repast, or MASON.



Source: https://github.com/projectmesa/mesa

Mesa-Geo: GIS Extension for Mesa Agent-Based Modeling

build passing | docs passing | codecov 80% | code style black | pypi v0.5.0 | license Apache License Version 2.0 | downloads 224/week | chat 6 users | DOI 10.1145/3557989.3566157

Mesa-Geo implements a `GeoSpace` that can host GIS-based `GeoAgents`, which are like normal Agents, except they have a `geometry` attribute that is a Shapely object and a `crs` attribute for its Coordinate Reference System. You can use `Shapely` directly to create arbitrary geometries, but in most cases you will want to import your geometries from a file. Mesa-Geo allows you to create GeoAgents from any vector data file (e.g. shapefiles), valid GeoJSON objects or a GeoPandas GeoDataFrame.

Using Mesa-Geo

To install Mesa-Geo on linux or macOS run

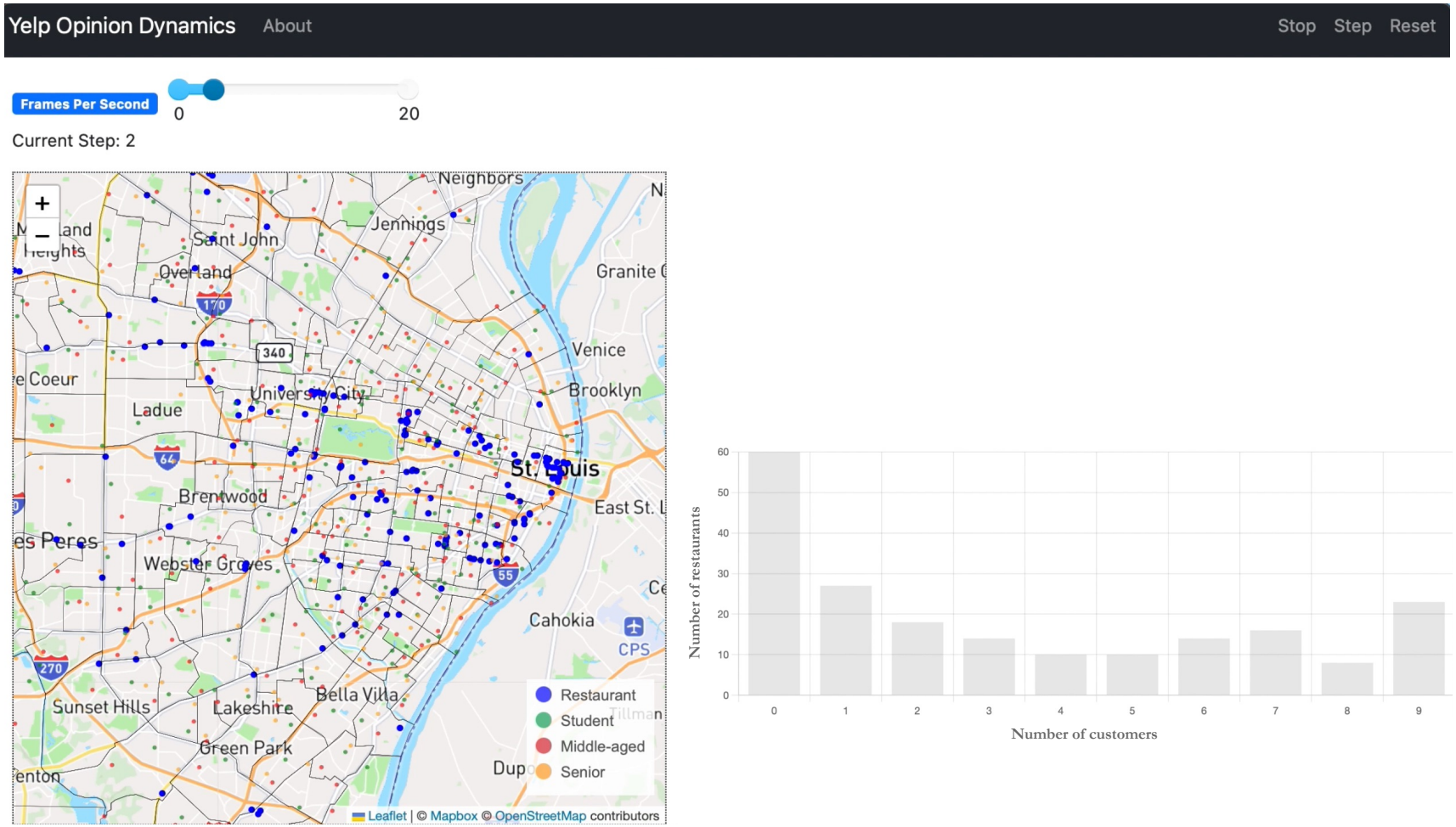
```
pip install mesa-geo
```

On windows you should first use Anaconda to install some of the requirements with

```
conda install fiona pyproj rtree shapely
pip install mesa-geo
```

Source: https://github.com/projectmesa/mesa-geo

Agent-Based Modeling



Current Work

Aspect-based sentiment analysis

- Replace the dictionary approach in categorizing aspect-terms with semi-supervised learning

Agent-based modeling

- Incorporate more census data when initializing consumer segments
- Set the time step in the simulation to be an hour.
- Calibrate model parameters and validate model results with restaurant check-in data from Yelp

Conclusion

- Online customer reviews can provide valuable insights into various aspects of people's dining experience, such as the quality of food and service.
- We utilize aspect-based sentiment analysis methods on Yelp dataset to extract and categorize reviewers' opinions on restaurants in urban areas.
- This work demonstrates how using deep learning techniques can help advance our understanding of people's decision-making processes.

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THANK YOU FOR LISTENING!

WELCOME COMMENTS, QUESTIONS AND SUGGESTIONS.

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