

Emotional Landscapes: Mapping Urban Park Sentiments Using Natural Language Processing

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Motivation:

- Role of Urban Parks:
 - promoting *physical* activity
 - reducing *mental* health issues
 - offering a space for *community* engagement
- Public Health Impact:
 - green spaces reduce *stress*
 - mitigate *urban heat*
 - improve *air quality*



example of two extreme parks (from ChatGPT)

Motivation:

- Limitations of Traditional Surveys
 - resource-intensive, time-consuming (**Dony & Feteke 2020**)
 - results can become quickly outdated
- Leveraging Social Media Data
 - **real-time** (**Cui et al. 2021**)
 - cost-effective
 - extensive data
- However,
 - can we capture public sentiment on park use and perceptions (?)
 - is social media representative (!?)



Relevant Work

- Social Media in Urban Studies
 - Google Reviews, Twitter, and Instagram are valuable data sources in urban research
 - in the context of parks → visitor behavior and preferences
 - **Marti et al. (2019), Chen et al. (2018)**
- sentiment and emotion analysis in urban spaces (**Cui et al. 2021**)
- natural language processing [NLP] → interpret text data
- derive public sentiment and emotional insights
- emotional cartography (**Griffin and McQuoid 2012, Caquard and Griffin 2018, Acedo et al. 2022, Feng et al. 2024, Shukla and Pujara 2025**)



Hugging Face

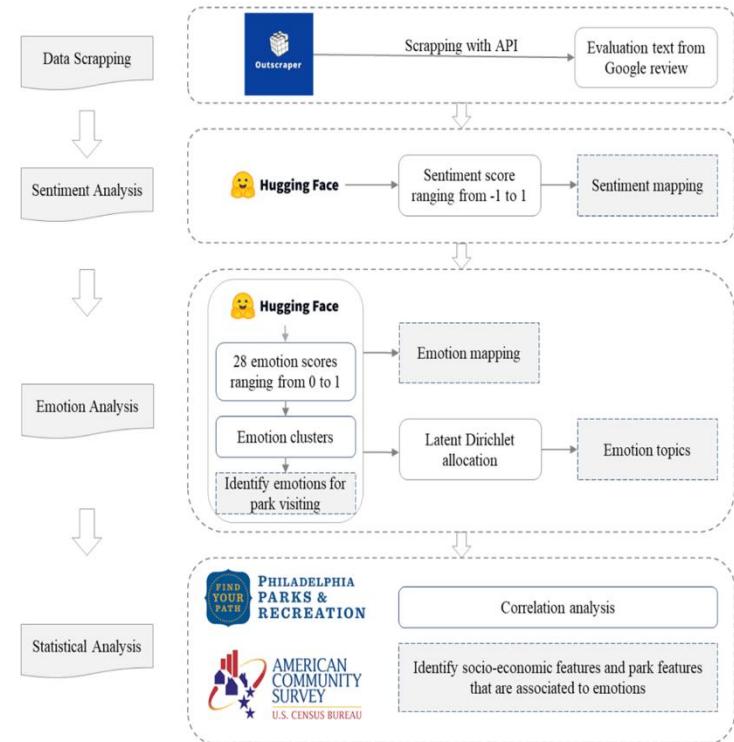
Research Questions

- What are the *temporal, functional* and *spatial* trends in emotional sentiments and visitation patterns at urban parks?
- What are the *features* frequently mentioned in reviews for different park visiting emotions?
- **Methodology:** NLP algorithm to detect emotions
- **Data:** Google Reviews scraped for all parks in Philadelphia



Methodology

- Sentiment Analysis
 - Hugging Face's NLP transformer models to classify sentiment as positive or negative
- Emotion Analysis
 - Categorize emotions into six types **Inspiration, Relaxation, Engagement, Discovery, Frustration & Annoyance, and Sorrow**
- Data Processing
 - Emotions categorized using **k-means** clustering to identify meaningful groups

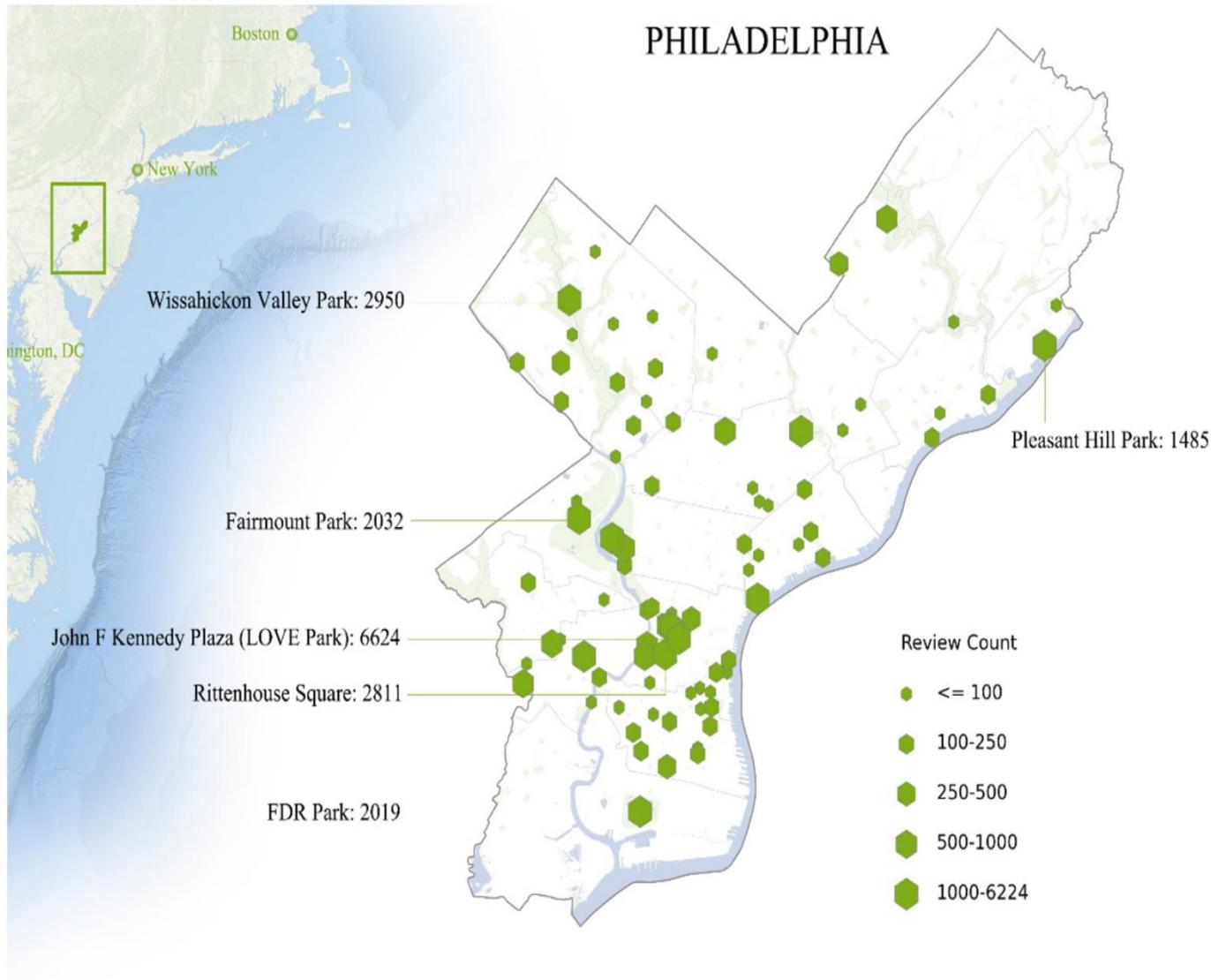


Data

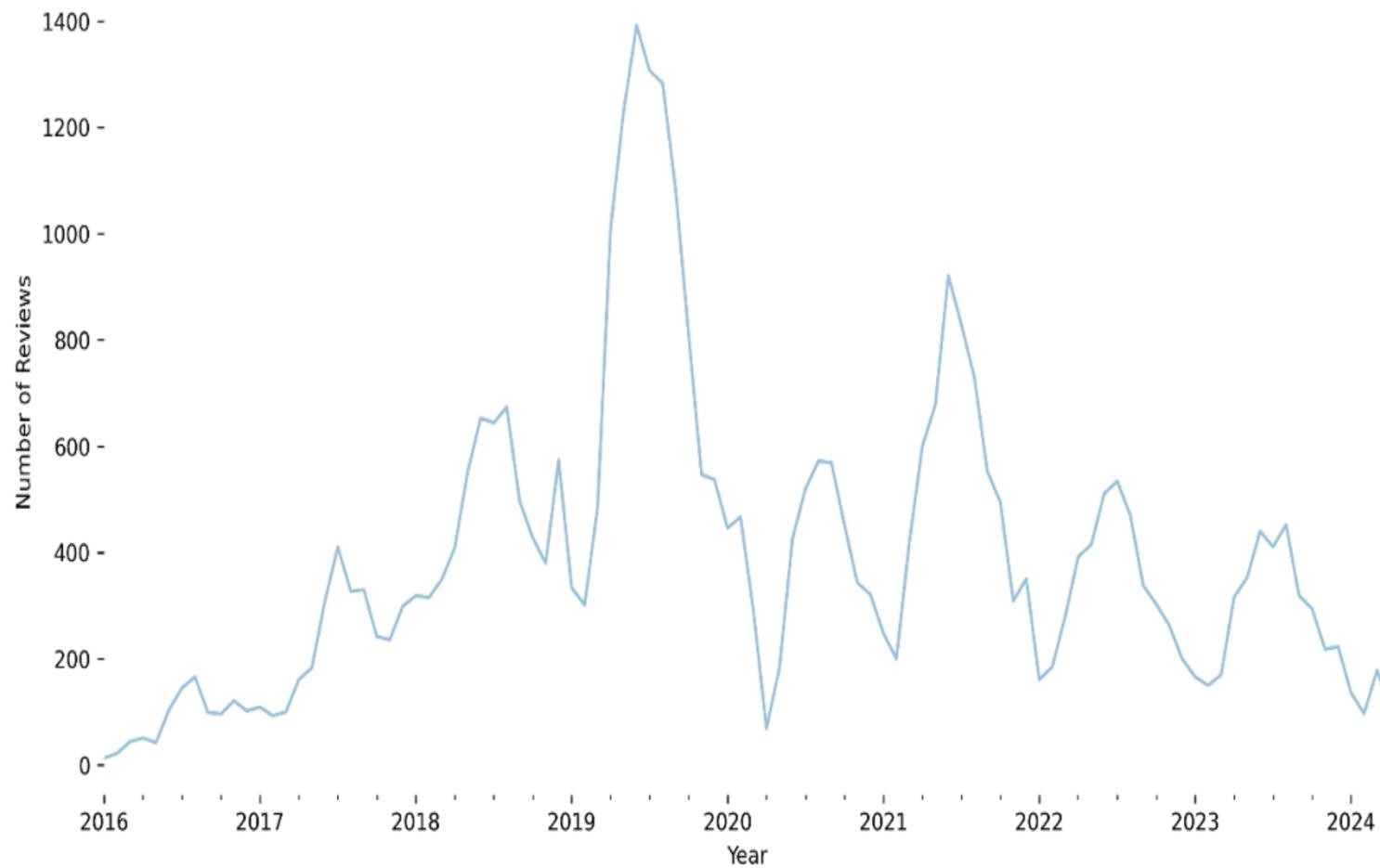
- **Source**
 - Google Reviews for Philadelphia parks, covering data from 2016 to 2024
- **Data Preparation**
 - Scraping with Outscraper, data cleaning and integration with PPR to remove duplicates and ensure accuracy
- **Review Filtering**
 - Only parks with over 25 reviews were analyzed, resulting in a sample of 92 parks and over 37,000 reviews



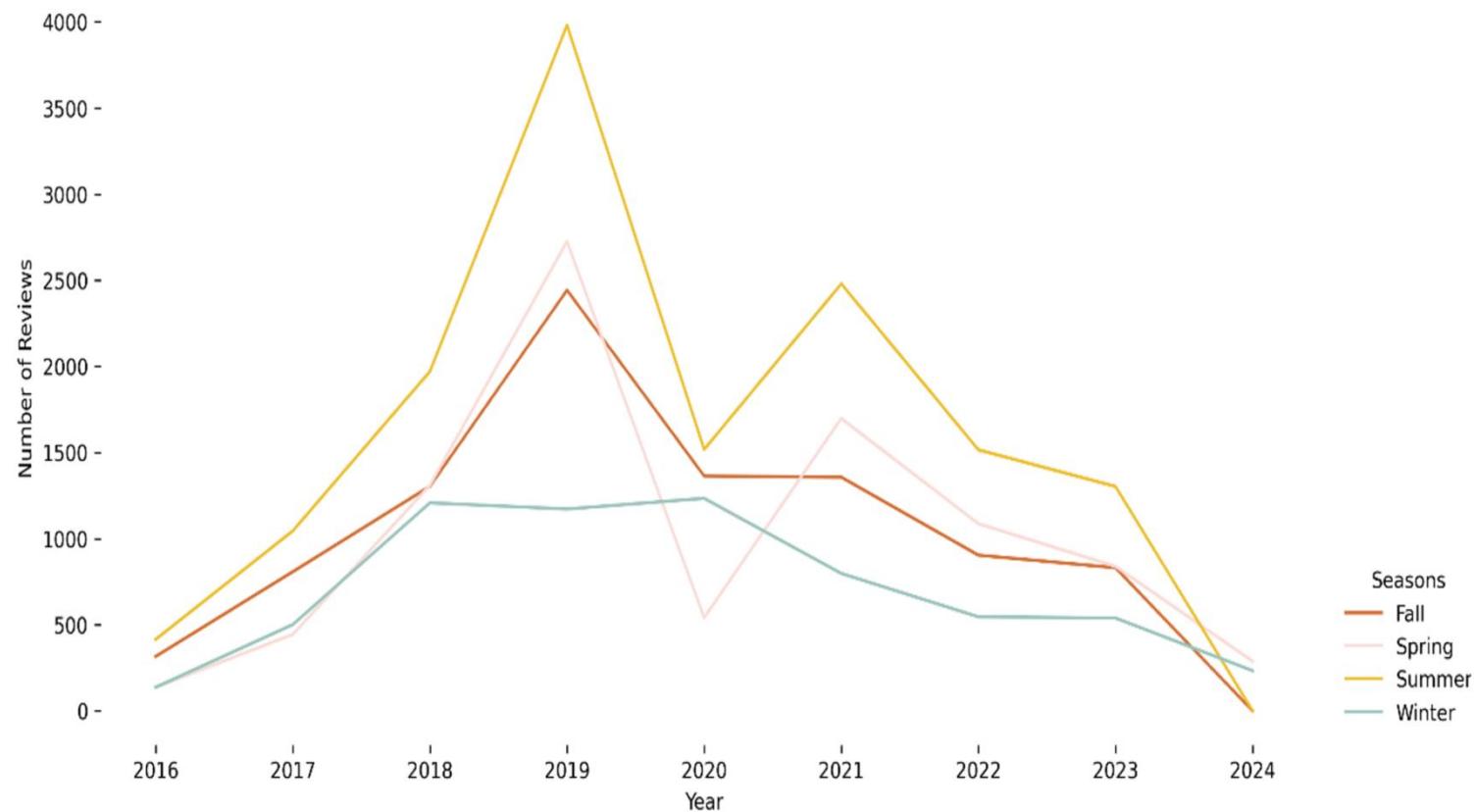
Data: spatial distribution of reviews



Data: temporal distribution (1)



Data: temporal distribution (2)



Data: What do these reviews look like?

review_datetime_utc	author_title	author_id	review_text	review_rating
04/13/2024 22:24:35	Matt McCorm	103695489705227565879	Best trails in Philly	5
04/12/2024 00:38:20	??	108101934735094350531	👉	5
04/10/2024 18:02:42	Pete Rhein	118156100062911374661	The best wilderness inside Philadelphia. A few hundred feet from the entrance and the city will disappear. There will be other Philadelphians enjoying it, but if you try a little you can get lost and alone. (That's meant to be posi	5
04/10/2024 16:41:18	K Sims	117218483857784577156		5
04/09/2024 18:05:42	BKDE33	102415564780274071811		5
Wissahickon Valley Park in PA is a serene oasis with scenic trails along Wissahickon Creek. Nature lovers will appreciate its diverse landscapes and historic charm. Great for hiking, biking, and unwinding amid lush greenery. ↴				
There are a lot of really great trails here. A great place to take your dog as well				
Undoubtedly one of the best urban parks in the country! It feels like you're in the mountains and yet you're just minutes from the train station. What a gem!				
It is a great place to visit and an even better place to live! A diverse and accepting community.				
Beware, common place for robberies. Came back to my windows broken and my stuff gone.				
My car and other cars got broken into. Don't leave anything in your car cause your windows will get smashed and your stuff will get stolen.				
03/29/2024 15:05:34	Grant Wise	116511380164676876113		5
03/29/2024 16:18:49	Stan Bailey	115752685075166053229		5
02/25/2024 00:52:12	Kelsey Marbach	106203679903469218112		5
02/24/2024 15:20:19	Stephen Gross	104054778833587020358		5
02/22/2024 04:01:23	Millard Reeves	114806221153145731366		4
02/20/2024 20:08:43	Anna K.	103785513088177903224		5
02/20/2024 18:03:00	Miranda Burg	106871435478485371985		5
02/18/2024 23:38:25	Nicholas F	110074995323527938318		4
02/20/2024 18:03:00	Miranda Burg	106871435478485371985	My car and other cars got broken into. Don't leave anything in your car cause your windows will get smashed and your stuff will get stolen.	5
02/18/2024 23:38:25	Nicholas F	110074995323527938318		5
02/18/2024 21:41:45	Allison Beck	113094145738603402686		4
02/18/2024 00:51:35	UPTOWNGORILLA MUZIK	103902883410521159643		5
02/13/2024 18:46:35	Armeno P	11328016645944134252	An absolute gem, one of the best parts of living in Philadelphia is having access to such amazing nature. Beautiful year round and full of biking and hiking trails.	5
02/11/2024 03:01:00	kelly brooks	103080696753391568425		4
02/09/2024 02:09:06	Bunyod Gonibekov	114619171940070336981	Incredible!	5
02/08/2024 15:56:43	Kaitlin Silver	10197659526971219035		5
02/05/2024 20:28:24	Jon Deutsch	10897875983725718174		5
02/05/2024 16:03:33	Jose Pozo	10349776365923074505		3
02/05/2024 01:07:49	Paul Butler	11651025677857262802	Preserved when Philadelphia was but a fledgling town to protect the water source for this soon to be great town, the park has been the focus of Philadelphians for generations. Many of the trails and buildings throughout the	5

snapshot of reviews for Wissahickon Valley Park

Data: example from a frequent (?) contributor

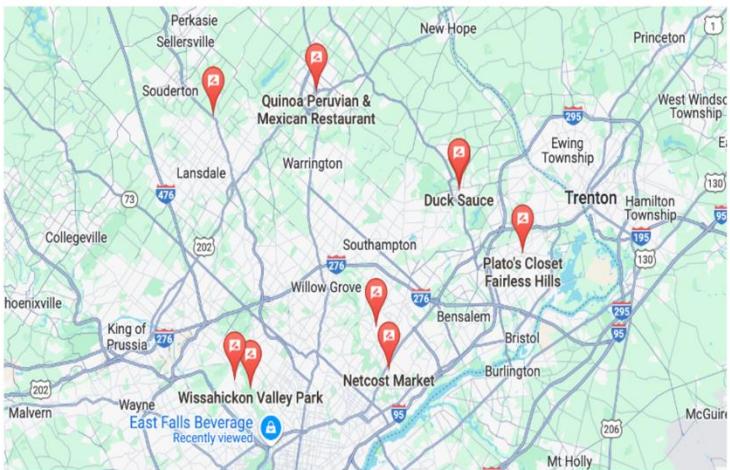


Anna K.

Local Guide · 23 reviews · 19 photos

★ ★ ★ ★ 8 months ago

Beware, common place for robberies. Came back to my windows broken and my stuff gone.



⋮



Review from Anna K.

Data: example from a less frequent (?) contributor

M Miranda Burg
1 review
★☆☆☆☆ 8 months ago

My car and other cars got broken into. Don't leave anything in your car cause your windows will get smashed and your stuff will get stolen.

2

King of Prussia
Wissahickon Valley Park
West Chester
Philadelphia

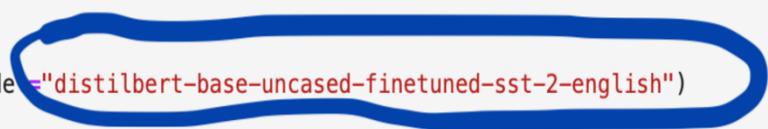
Review from Miranda Burg

Sentiment Analysis

- Sentiment Scoring Approach
 - each review assigned a sentiment score (0-1 scale) and a sentiment label (positive / negative)
 - scores close to 0 indicating more neutral sentiment and scores near 1 indicating stronger sentiment
 - Hauthal, E., & Burghardt, D. (2016)
- Example

- “Unfortunately this park is not what it used to be the area has become a known high traffic drug area but there is police getting the areas trying to do what they can but has a lot of work to go would not recommend taking your dog are children here lot of used syringes everywhere especially on the park in Grass area” - negative 0.97

```
from transformers import pipeline

# Load the sentiment analysis pipeline
pipe = pipeline("sentiment-analysis", mode="distilbert-base-uncased-finetuned-sst-2-english")  # Make sure all entries in the 'text' column are strings
reviews_df['review_text'] = reviews_df['review_text'].astype(str)

# Apply the pipeline to each review
reviews_df['review_predictions'] = reviews_df['review_text'].apply(lambda x: pipe(x, truncation=True))

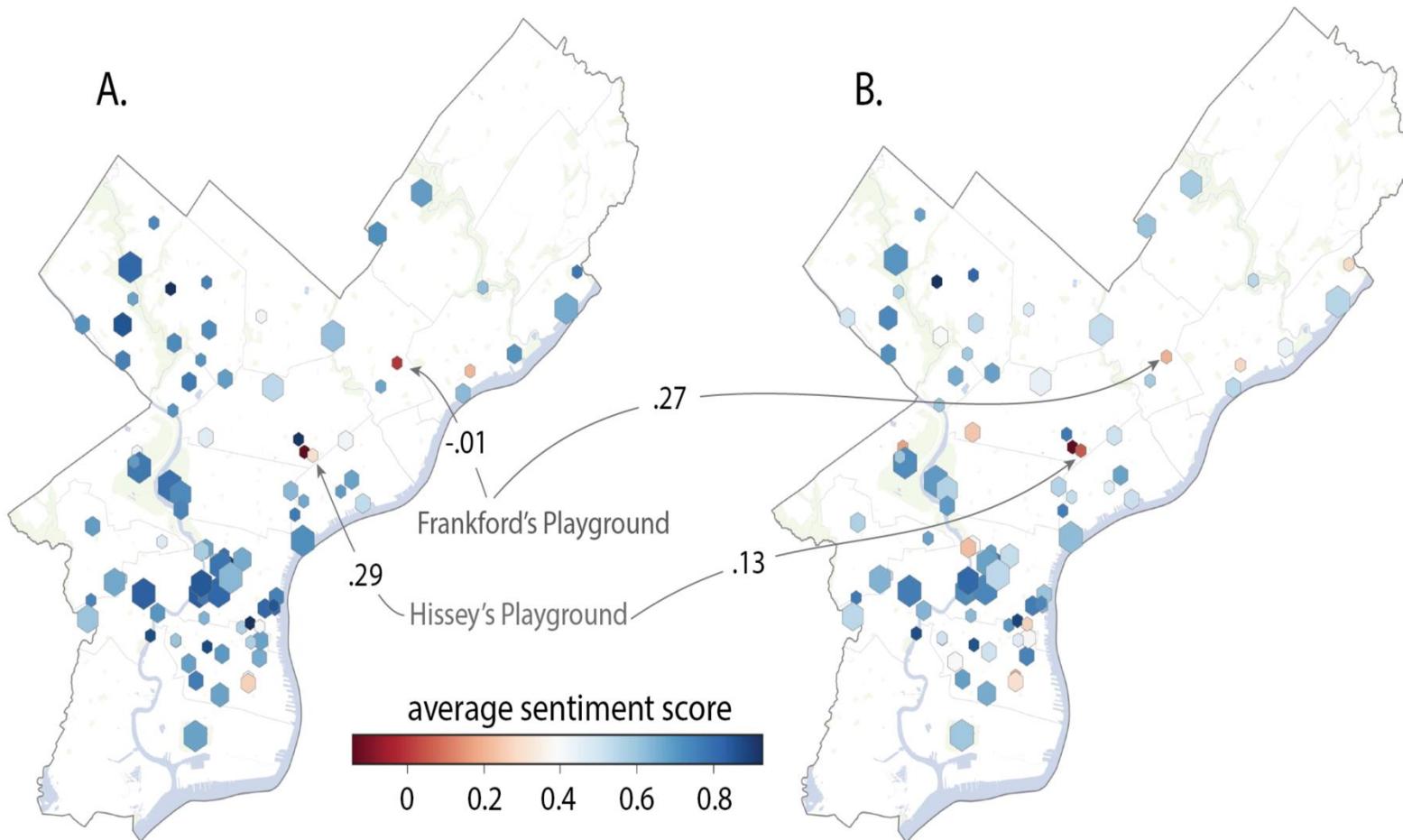
# Extract the label and score from the predictions
reviews_df['review_label'] = reviews_df['review_predictions'].apply(lambda x: x[0]['label'])
reviews_df['review_score'] = reviews_df['review_predictions'].apply(lambda x: x[0]['score'])
```

Distilbert

Temporal variation of sentiment scores

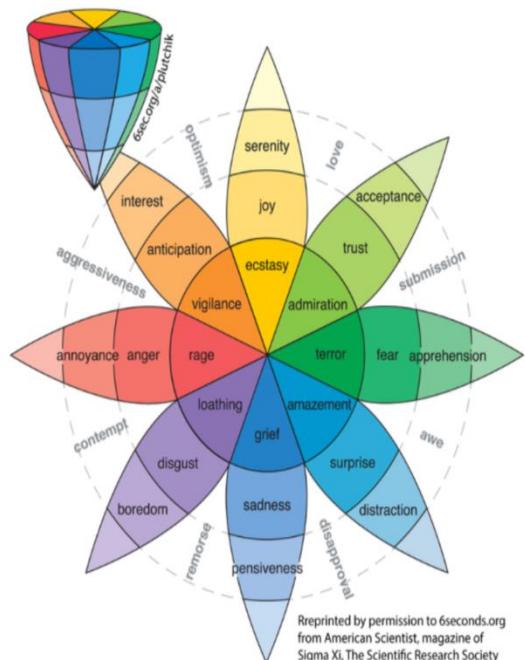


Aggregated scores per park



Emotion Analysis (1)

- Plutchik model
- Emotion Categorization Process
 - pretrained model from Hugging Face (“[roberta-base-go_emotions](#)”)
 - classify reviews into a broader range of emotions



Emotion Analysis (2)

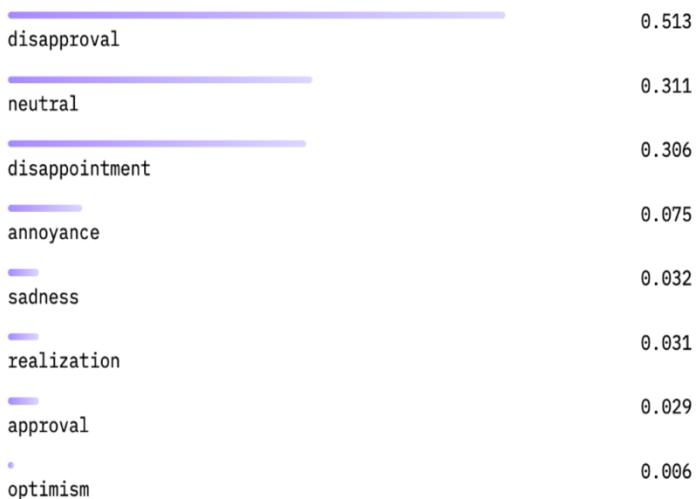
My car and other cars got broken into. Don't leave anything in your car cause your windows will get smashed and your stuff will get stolen

Compute

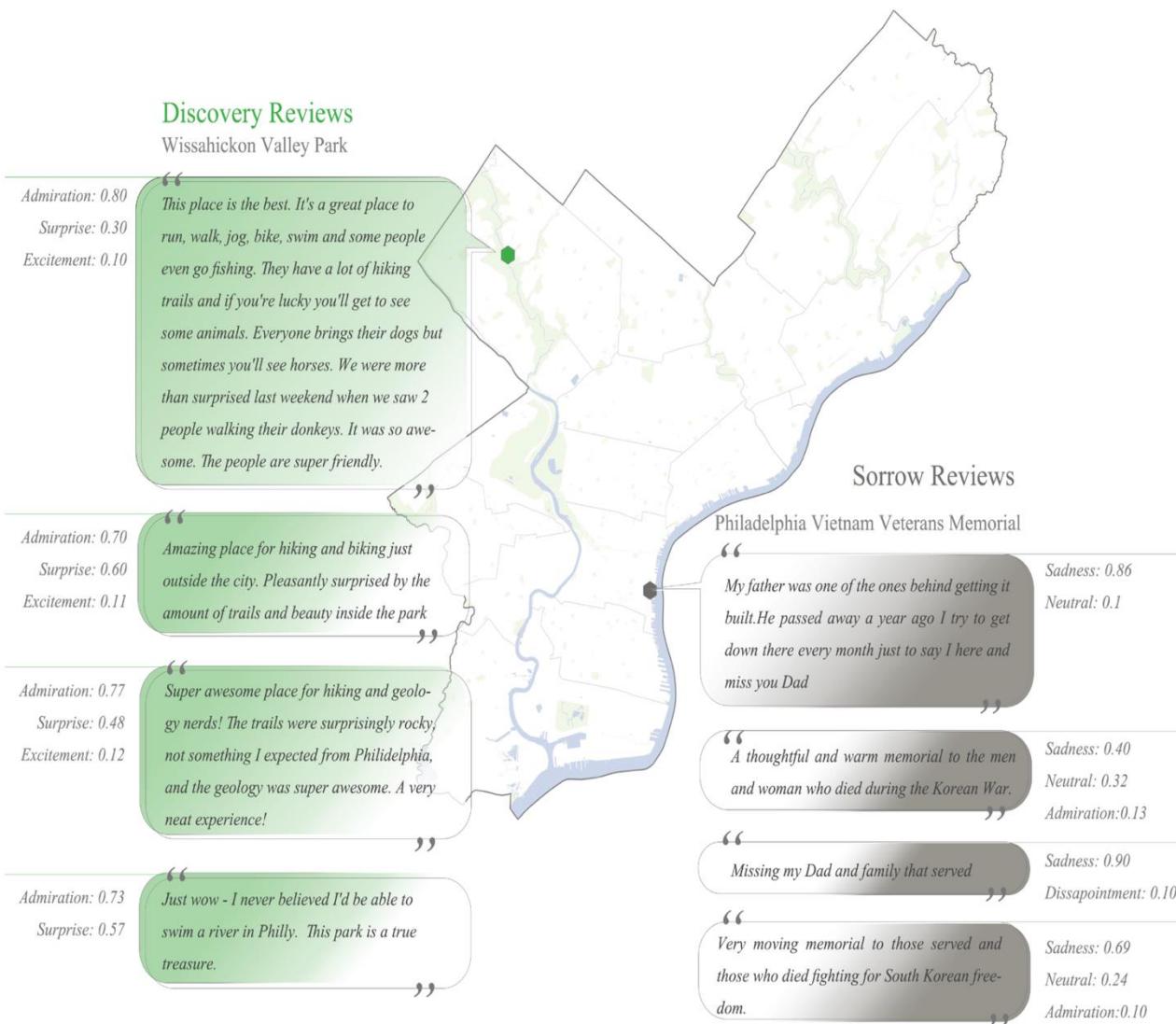


Unfortunately this park is not what it used to be the area has become a known high traffic drug area but there is police getting the areas trying to do what they can but has a lot of work to go would not recommend taking your dog are children here lot of used syringes everywhere especially on the park in Grass area

Compute

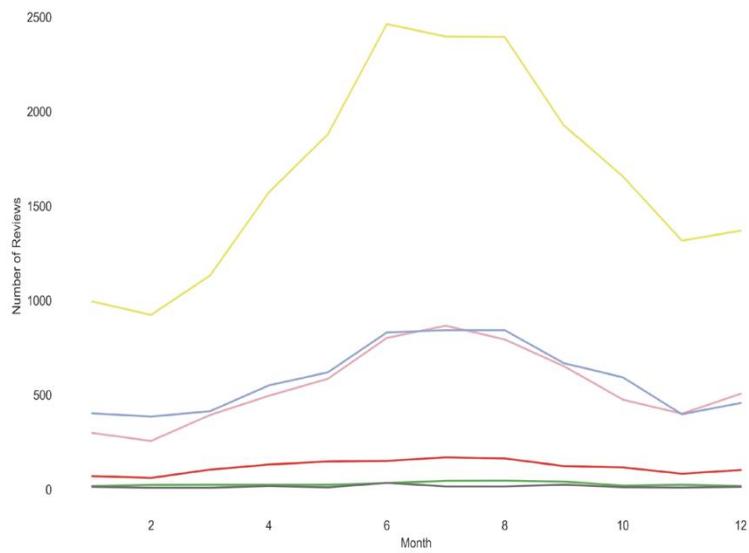
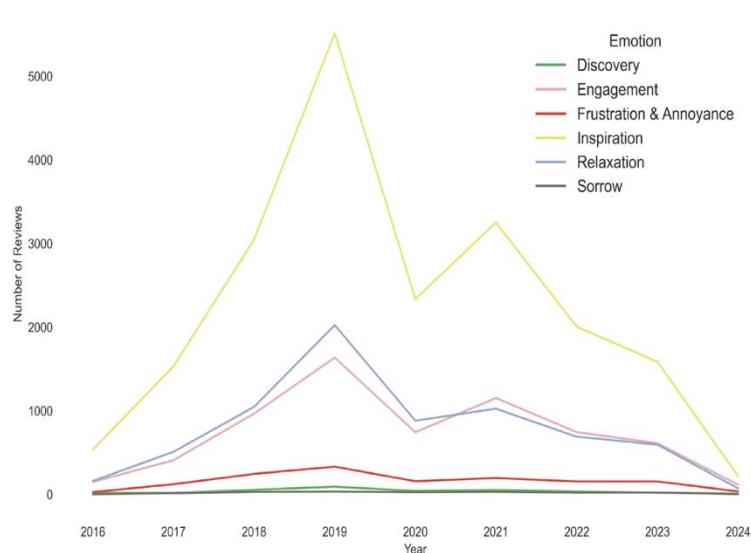


Emotion Analysis (3)

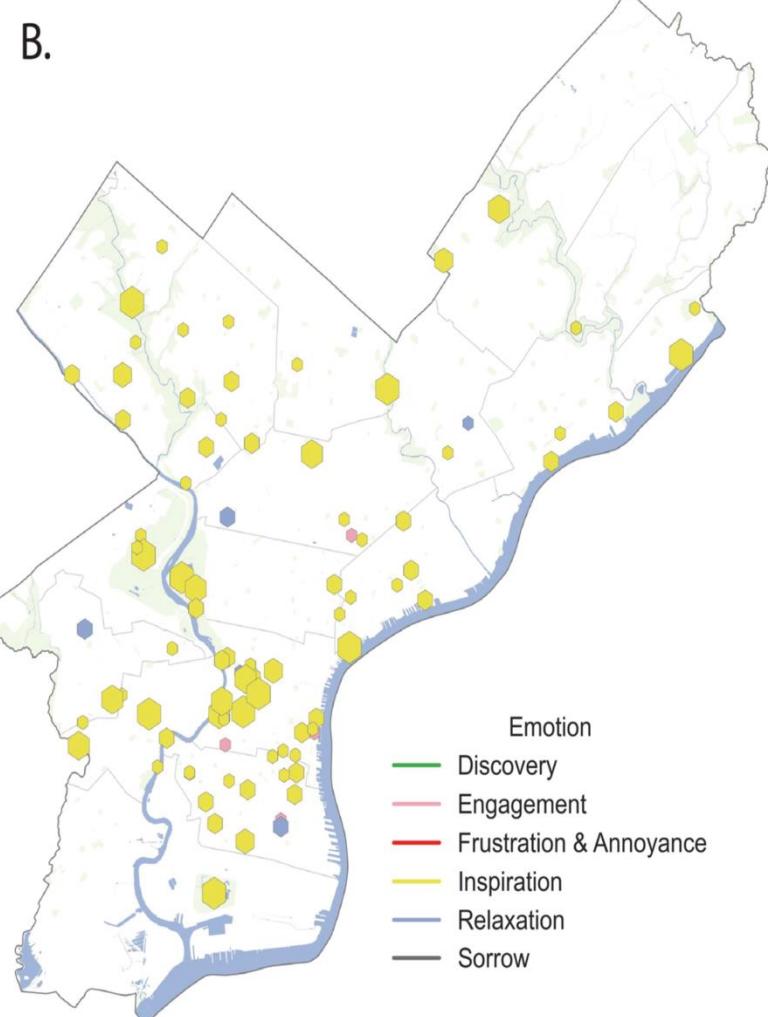
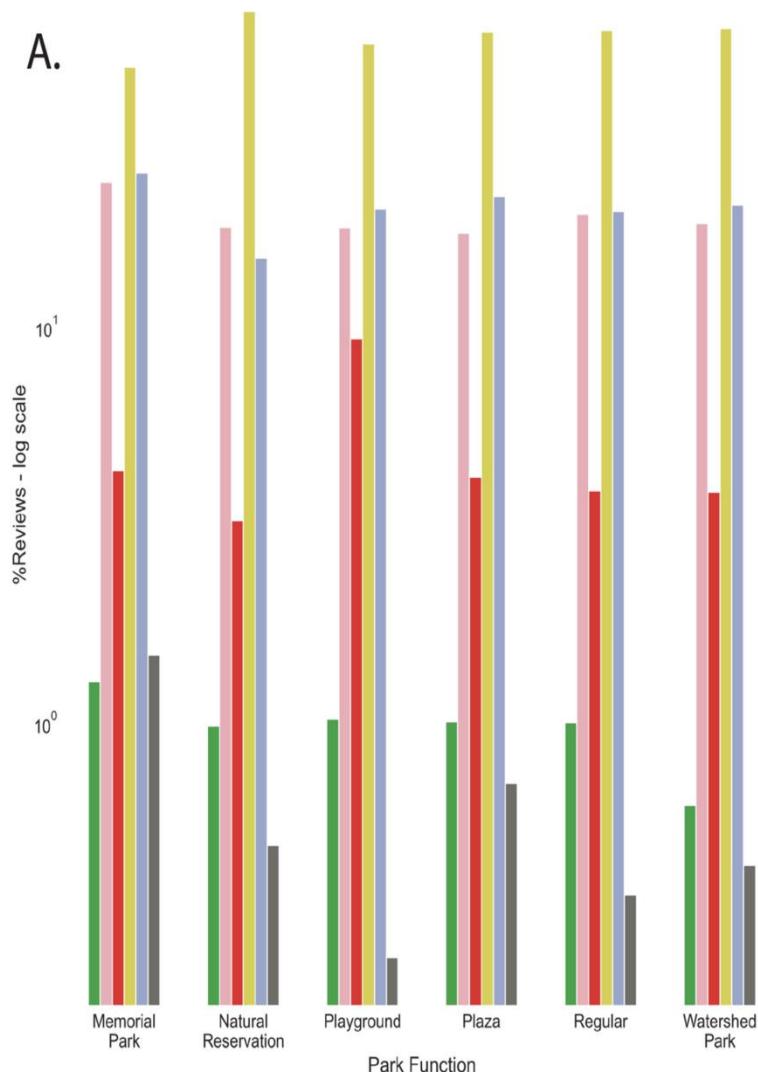


Emotion breakdown (counts)

- variation per year (left) and month (right)
- choice of color from Kushkin et al. (2023).



Emotion breakdown per park type

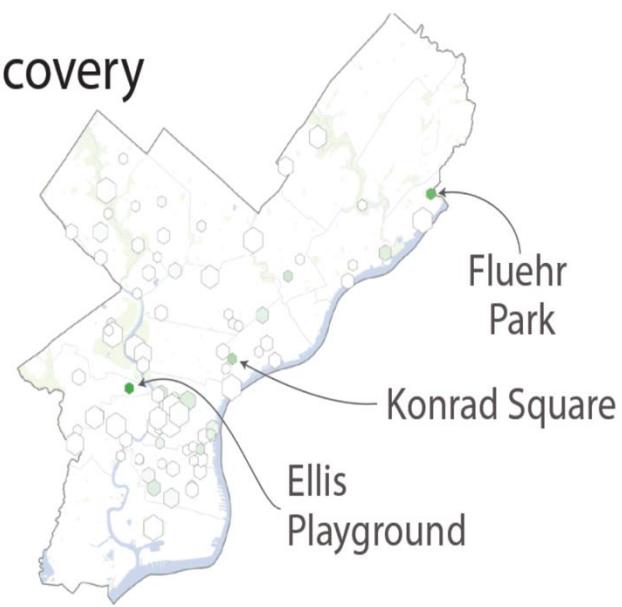


Emotion mapping

Inspiration



Discovery

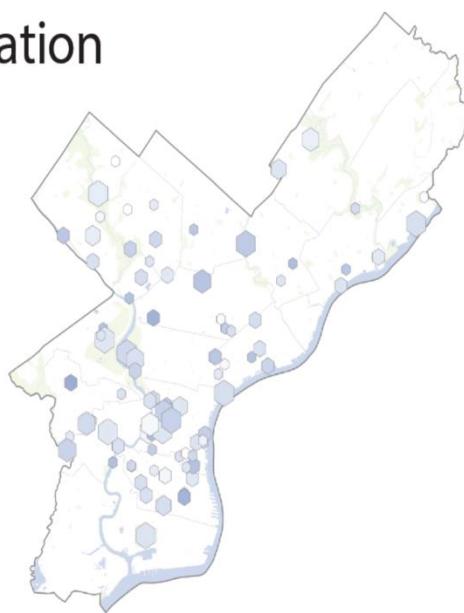


20 30 40 50 60 70 80

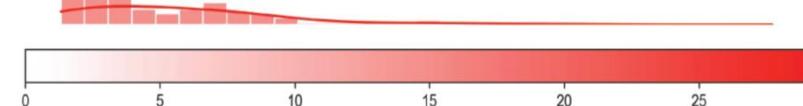
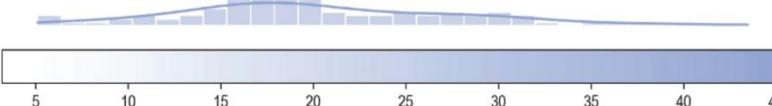
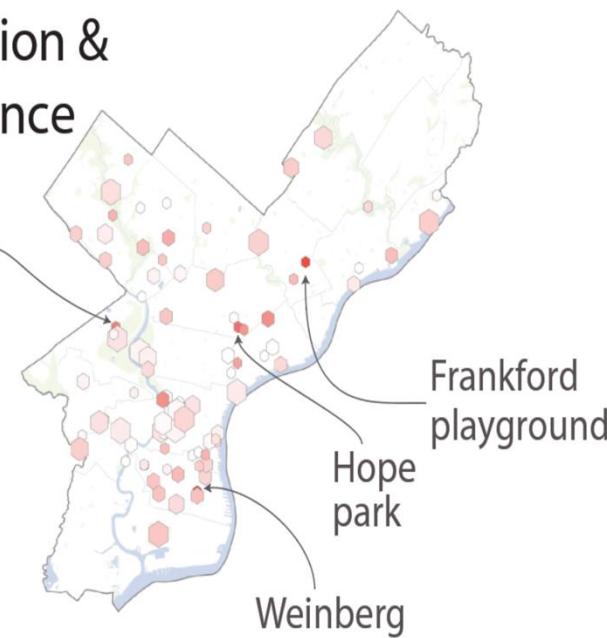
0 5 10 15 20 25 30

Emotion mapping

Relaxation

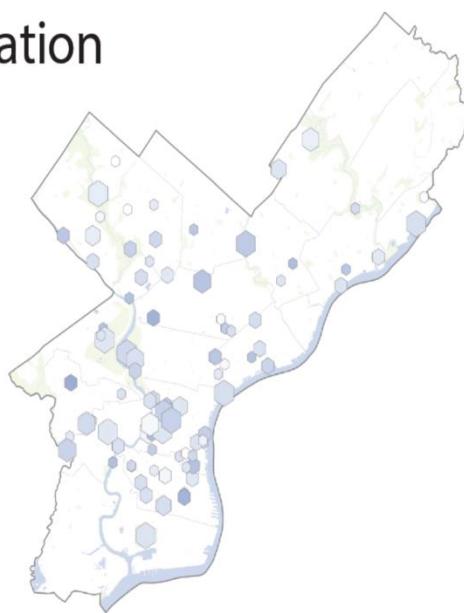


Frustration & Annoyance

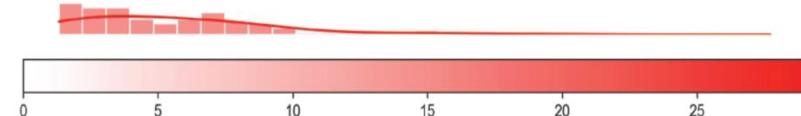
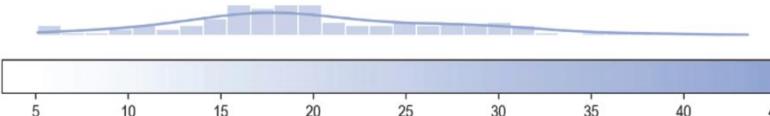
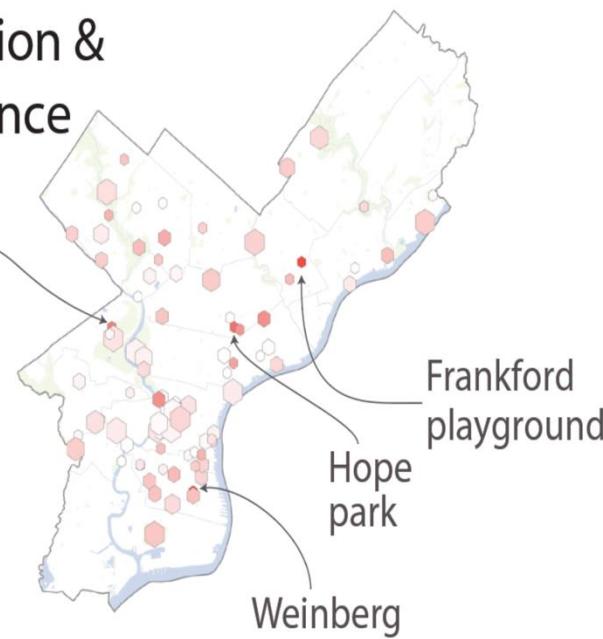


Emotion mapping

Relaxation

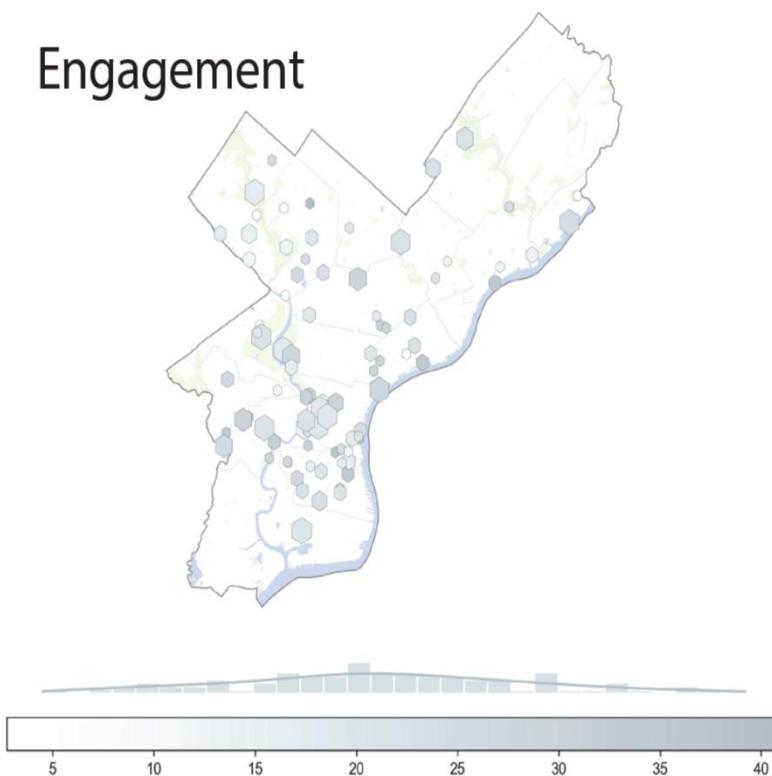


Frustration & Annoyance

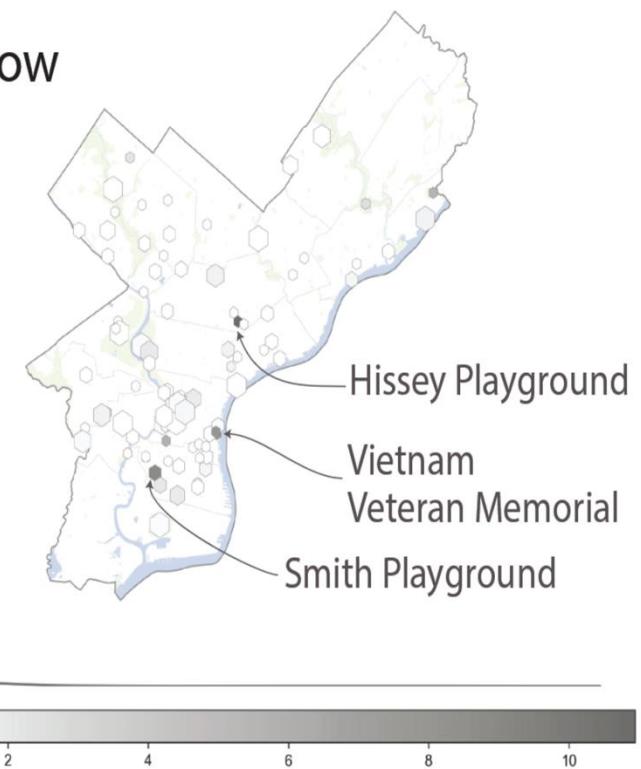


Emotion mapping

Engagement



Sorrow



Discussion and Limitations (1)

- **Representativeness**
 - reviews may not capture the full demographic spectrum (Marti et al. 2019)
 - overrepresentation of younger or tech-savvy individuals
- **Temporal Bias**
 - reviews are not always posted immediately after visits, potentially diluting real-time sentiment
- **Single Platform Limitation**
 - using only Google Reviews could introduce bias
 - combining with data from other platforms (e.g., Instagram) may yield a broader picture



Discussion and Limitations (2)

- Ethical Considerations
 - Data was collected with respect to privacy, without identifying individual reviewers
- Contributor Weight/Reliability
 - reliability of sentiment may vary between platform “super contributors,” who post frequently and may have a more balanced perspective, versus casual users who leave only one or two reviews



References (1)

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thank you
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