# Quantifying the associations of social infrastructure on human networks

THE UNIVERSITY OF TEXAS AT DALLAS

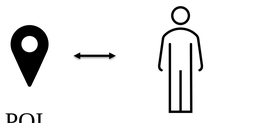
**Yalin Yang, Yanan Wu, May Yuan PhD**
**Geospatial Information Sciences, EPPS, The University of Texas at Dallas**

## Introduction

**Assumption**: Assumption: POI (points of interest) afford social actives. And social events raise new relations.

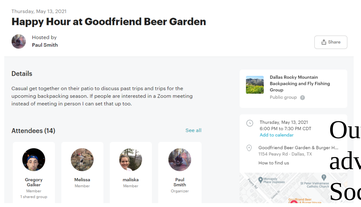
In this study, we ask the **following research question**: Does the built environment have spatial associations with social events? If so, how to quantitatively measure it.
We employ POI data from Maptitude to describe the site characteristics and utilize the social events records from meetup to address the spatial associations between human activities and surrounding physical facilities.

## Data

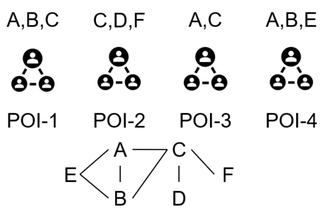



Literatures:

People who visited a place at the same time **repeatedly** are likely to be socially related.




People: A,B,C,D,E,F




8371 Social events in 24 categories from meetup.com from Feb 26, 2020, to Jan 30, 2021, at 1434 locations (unique Lat/Long pairs)


Book, Sci-Fi& Games, Writing

School area

Health & Wellness, Career, Business.

store, office, restaurant

Outdoors & adventure, Social: Park, natural preserve

62 types (pre-classified by Maptitude) of POI have been reclassified into 13 categories

Business: 1,247
Car: 10,508
Education: 19,686
Finance: 12,663
Food: 9,037

Hotel: 3,254
Medical: 4,307
Appearance: 16,833
Parking: 515
Party: 7,348

Public-Transportation: 205
Shopping: 20,633

## Methods

### Data Preparation

1. Data collecting by **web crawling**
2. Geo-coding and referencing

### Spatial Association

1. **Monte Carlo simulation** for background probability calculation
2. Spatial association mining between POI and social events using **Apriori algorithm**
3. Measure the interestness of discovered rules using the **lift** metric

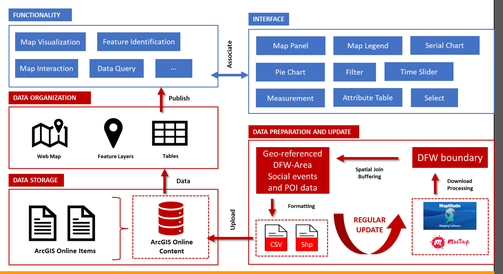
### Open to public developing

1. Build a **REST API** Cdata (up to date)
2. Build the Client interface using **ArcGIS Webapp builder** and **experience builder**

$$Support\{X \to Y\} = \frac{Records\ containing\ both\ X\ and\ Y}{Total\ number\ of\ Records}$$

$$Confidence\{X \to Y\} = \frac{Records\ containing\ both\ X\ and\ Y}{Records\ containing\ X}$$

$$Lift\{X \to Y\} = \frac{Support(X,Y)}{Support(X) * Support(Y)} = \frac{Cof(X \to Y)}{Sup(Y)}$$




## Results

### Co-location Analysis

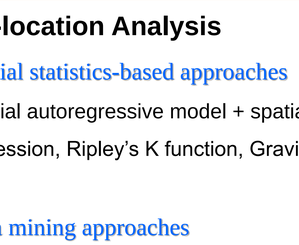
Spatial statistics-based approaches

Spatial autoregressive model + spatial regression, Ripley's K function, Gravity model, etc.

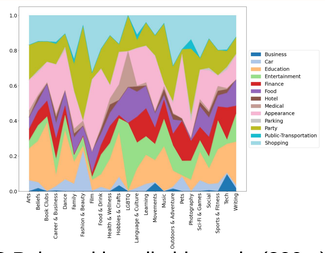
Data mining approaches

Association rule mining

$X \to Y(p, cp)$, Both X and Y can be set of items

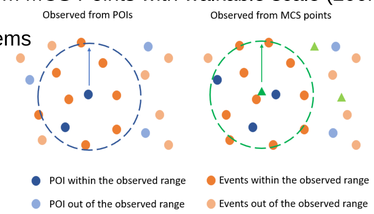



Social events as X-axis



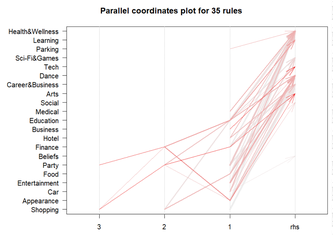

POI as X-axis

Buffer from MCS Points with walkable scale (200m)




### Spatial Association Rules

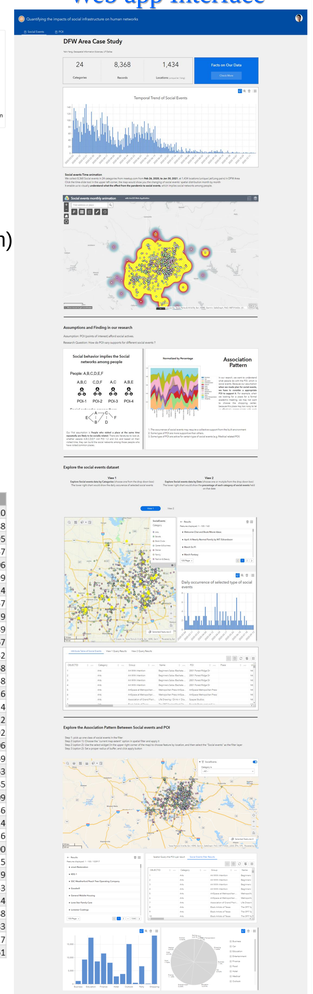
- Detect **35 rules** with $Support_{treshold} = 1\%$ and $Confidence_{treshold} = 10\%$
- The popular Lift measure in literature suggests 29 significant among the POI and social events




*Width arrow: support (0.01-0.05)*
*Color: confidence (0.1-0.22)*
*lift: 1.07-3.8*

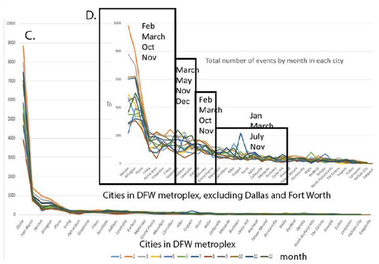
| lhs | Column2 | rhs | support | confidence | lift | count |
|---|---|---|---|---|---|---|
| {Business} | => | {Tech} | 0.0131 | 0.2259 | 3.8030 | 110 |
| {Finance, Party, Shopping} | => | {Arts} | 0.0105 | 0.1082 | 3.4051 | 88 |
| {Appearance, Finance, Party} | => | {Arts} | 0.0114 | 0.1005 | 3.1625 | 95 |
| {Education, Finance} | => | {Learning} | 0.0176 | 0.1061 | 2.3922 | 147 |
| {Finance, Party, Shopping} | => | {Dance} | 0.0127 | 0.1304 | 2.3718 | 106 |
| {Education, Finance, Shopping} | => | {Dance} | 0.0118 | 0.1200 | 2.1830 | 99 |
| {Parking} | => | {Health&Wellness} | 0.0136 | 0.2036 | 2.1700 | 114 |
| {Medical} | => | {Health&Wellness} | 0.0188 | 0.1990 | 2.1212 | 157 |
| {Food, Shopping} | => | {Dance} | 0.0214 | 0.1108 | 2.0162 | 179 |
| {Entertainment} | => | {Dance} | 0.0345 | 0.1105 | 2.0104 | 289 |
| {Hotel} | => | {Health&Wellness} | 0.0200 | 0.1813 | 1.9329 | 167 |
| {Appearance, Finance} | => | {Dance} | 0.0182 | 0.1059 | 1.9269 | 152 |
| {Hotel} | => | {Career&Business} | 0.0201 | 0.1824 | 1.8962 | 168 |
| {Education, Party} | => | {Dance} | 0.0177 | 0.1027 | 1.8684 | 148 |
| {Car} | => | {Dance} | 0.0151 | 0.1021 | 1.8575 | 126 |
| {Appearance, Party, Shopping} | => | {Social} | 0.0136 | 0.1019 | 1.8216 | 114 |
| {Appearance, Party, Shopping} | => | {Dance} | 0.0134 | 0.1001 | 1.8208 | 112 |
| {Education, Finance, Party} | => | {Tech} | 0.0110 | 0.1059 | 1.7825 | 92 |
| {Car} | => | {Health&Wellness} | 0.0246 | 0.1669 | 1.7795 | 206 |
| {Party} | => | {Health&Wellness} | 0.0441 | 0.1538 | 1.6396 | 369 |
| {Food} | => | {Sci-Fi&Games} | 0.0314 | 0.1227 | 1.4755 | 263 |
| {Appearance} | => | {Career&Business} | 0.0460 | 0.1247 | 1.2960 | 385 |
| {Education, Shopping} | => | {Sci-Fi&Games} | 0.0250 | 0.1065 | 1.2801 | 209 |
| {Car} | => | {Beliefs} | 0.0163 | 0.1102 | 1.2651 | 136 |
| {Education} | => | {Health&Wellness} | 0.0507 | 0.1186 | 1.2646 | 424 |
| {Car} | => | {Sci-Fi&Games} | 0.0151 | 0.1021 | 1.2276 | 126 |
| {Entertainment} | => | {Health&Wellness} | 0.0359 | 0.1147 | 1.2229 | 300 |
| {Finance} | => | {Career&Business} | 0.0376 | 0.1174 | 1.2200 | 315 |
| {Party} | => | {Career&Business} | 0.0333 | 0.1163 | 1.2089 | 279 |
| {Food} | => | {Career&Business} | 0.0290 | 0.1134 | 1.1787 | 243 |
| {Food} | => | {Health&Wellness} | 0.0280 | 0.1092 | 1.1640 | 234 |
| {Entertainment} | => | {Career&Business} | 0.0344 | 0.1101 | 1.1448 | 288 |
| {Finance} | => | {Health&Wellness} | 0.0338 | 0.1054 | 1.1240 | 283 |
| {Appearance} | => | {Health&Wellness} | 0.0379 | 0.1027 | 1.0943 | 317 |
| {Shopping} | => | {Career&Business} | 0.0431 | 0.1035 | 1.0762 | 361 |

### Web app Interface




## Future Work


Safegraph Building footprints (June 2020).
Aggregated POI footprints to buildings:55,846 buildings had POIs
POIs in August 2020 appeared in 51,893 buildings
Meetup events were within 730 buildings.




Temporal trends of social events
25,000 social events data for over 2 years (2020-now)
Address the impact from pandemic to local social networks

## Conclusions

- Distinctive association patterns between different types of social events and POI
- Food, shopping and party related POI actively contribute to the occurrence of social events.
- Pandemic and related policy have dramatically altered the distribution of social events, which implies the local social networks among participants

## References

*Agrawal, R., Imieliński, T., & Swami, A. (1993). Mining Association Rules Between Sets of Items in Large Databases. ACM SIGMOD Record, 22(2), 207–216. https://doi.org/10.1145/170036.170072*

*Aldrich, D. P., & Meyer, M. A. (2015). Social Capital and Community Resilience. American Behavioral Scientist, 59(2), 254–269. https://doi.org/10.1177/0002764214550299*

*Boessen, A., Hipp, J. R., Butts, C. T., Nagle, N. N., & Smith, E. J. (2018). The built environment, spatial scale, and social networks: Do land uses matter for personal network structure? Environment and Planning B: Urban Analytics and City Science, 45(3), 400–416. https://doi.org/10.1177/2399808317690158*

*Cao, Q., Dabelko-Schoeny, H. I., White, K. M., & Choi, M. S. (2020). Age-friendly communities and perceived disconnectedness: the role of built environment and social engagement. Journal of Aging and Health, 32(9), 937–948. https://doi.org/10.1177/0898264319865421*

*Disaster Risk Reduction for the Built Environment | Wiley. (n.d.). Retrieved April 22, 2021, from https://www.wiley.com/en-us/Disaster+Risk+Reduction+for+the+Built+Environment-p-9781118921494*

*Kirmayer, L. J., & Whitley, R. (2009). Community Resilience: Models, Metaphors and Measures. In Journal of Aboriginal Health.*

*Metaxa-kakavouli, D., Maas, P., & Aldrich, D. P. (2018). How Social Ties Influence Hurricane Evacuation Behavior. 2, 122. https://doi.org/10.1145/3274391*

*Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. American Journal of Community Psychology, 41(1–2), 127–150. https://doi.org/10.1007/s10464-007-9156-6*

*Written Statement of Craig Fugate Administrator Federal Emergency Management Agency Evolution of Emergency Management and Communication. (2011).*

*Ye, X., & Liu, X. (2018). Integrating social networks and spatial analyses of the built environment. In Environment and Planning B: Urban Analytics and City Science (Vol. 45, Issue 3, pp. 395–399). SAGE Publications Ltd. https://doi.org/10.1177/2399808318772381*