Geographical Social Interaction Patterns and their Usage

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Societies are highly connected

Societies are polarized and fragmented
Structure of societies is heterogeneous
Structure of societies is heterogeneous

Real gross domestic product (GDP) in metropolitan areas in 2016

https://howmuch.net/articles/gdp-by-metro-2017
Importance of Geographical Social Patterns

- Spread of innovation
- Changes in business and culture
- Development of regional and national events
- Flow of information
- Spread of disease
Mobility Patterns

Mobility patterns can be characterized in three overarching concepts:

- Short distance movements (grocery shopping, walking)
- Medium distance movements (travel to neighborhood cities for job or fun)
- Long distance movements (travel to other cities for vacation or visiting families).

Combination of these habits in a self-organized manner form multi-scale movement patterns.
Adaptability of communication and mobility patterns

Twitter Data of USA

Similarity of the Networks by Communities

Average of three scores (Purity, Adjusted Rand and Fowlkes-Mallows) for different values of resolution parameter in both networks.
Content Similarity of Communities

Mobility Network

Communication Network
Strategizing COVID-19 Lockdowns Using Mobility Patterns

CellPhone Data and COVID-19 Cases of USA

https://www.endcoronavirus.org/mobility-maps

NSF Award Number: 2032536
Multi-scale Mobility Patterns

Polygon Map

April 5-11
2020

a. All multiscale communities together

b. Megacommunities

c. Main communities

d. Sub-communities
Interesting Facts About the Maps

Deviation from administrative borders
Interesting Facts About the Maps

Deviation from administrative borders
Interesting Facts About the Maps

Isolated Communities

Universities

Cornell and SUNY Cortland Universities
Interesting Facts About the Maps

Isolated Communities

Vacation spots

Catskill Mountains

Poconos
Interesting Facts About the Maps

Sub-Communities within Other Sub-Communities

Rochester Institute of Technology
Sub-communities in City areas

1) Areas of Queens
2) Northern Brooklyn
3) Central Brooklyn
4) Around Prospect Park
Interesting Facts About the Maps

Sub-communities in City areas
Socio-Economic Characteristics of Communities
COVID-19 Risk Exposure in Mobility Patches
COVID-19 Risk Exposure in Mobility Patches
Relationships between Communities

![Map showing relationships between communities across the United States.](image)
Dynamics of Mobility Patterns
Movements between Communities

- Feb 23-29, 2020
- Mar 1-7, 2020
- Mar 8-14, 2020
- Mar 14-21, 2020
- Mar 22-28, 2020
- Mar 29-Apr 4, 2020
- Apr 5-11, 2020
- Apr 19-26, 2020
- Apr 27-May 2, 2020
- May 24-30, 2020
- Sep 27-Oct 3, 2020
- Feb 28-Mar 6, 2021
COVID-19 Spreading Simulation

SEIR model:

\[ \frac{dS_i}{dt} = -\beta \frac{S_i I_i}{N_i} - \eta_i S_i + \sum_j \frac{A_{ij} \eta_j}{k_j} S_j \]

\[ \frac{dE_i}{dt} = \beta \frac{S_i I_i}{N_i} - \alpha E_i - \eta_i E_i + \sum_j \frac{A_{ij} \eta_j}{k_j} E_j, \]

\[ \frac{dI_i}{dt} = \alpha E_i - \gamma I_i - \eta_i I_i + \sum_j \frac{A_{ij} \eta_j}{k_j} I_j, \]

\[ \frac{dR_i}{dt} = \gamma I_i - \eta_i R_i + \sum_j \frac{A_{ij} \eta_j}{k_j} R_j, \]

\[ \frac{dN_i}{dt} = -\eta_i N_i + \sum_j \frac{A_{ij} \eta_j}{k_j} N_j, \]
COVID-19 Spreading Simulation

Before Lockdown
Feb 23 - Feb 29
COVID-19 Spreading Simulation

During national Lockdown
March 29-April 04
Thanks!

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