Analyzing Social Distancing Based on Sensory Inputs

Open House Presentation
WINLAB Summer Internship 2021
The Team

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Background

March 20, 2020:

- The effectiveness of social distancing as a disease-slowing measure is dependent on the degree of compliance from the public.
- Our objective is to quantitatively measure compliance with social distancing measures implemented in New York City.

March 20, 2020:

We know the most effective way to reduce the spread of this virus is through social distancing and density reduction measures.

Governor Andrew M. Cuomo
Dataset

- Traffic camera images and dashcam images from Uber and Lyft vehicles
- Three main NYC boroughs -- Manhattan, Brooklyn, and Queens
- Focus on March to August 2020
- Images provided by Nexar
Project Pipeline

Nexar images

Natural Language Processing

Image Captioning Tool → Latent Dirichlet Allocation (LDA) → Hellinger Distance

Computer Vision

Brightness filter → People filter using YOLOv3 → Pairwise Distance Estimations, Count of People
Techniques & Tools

NLP Workflow:

Image-to-Caption:

LDA Model:

Computer Vision Workflow:

YOLO - You Only Look Once:

Distance Estimation:

Figure 4: Methodology of comparing topic distributions with Latent Dirichlet Allocation (LDA).
Hellinger Distance + Results

Example:

Hellinger (A, A) = 0
Hellinger (A, Z) = 0.967

Interesting Months: April, June, and July

Figure 5: Comparison between topic distributions from weekly images. Changes (cluster of green cells) are observed during April–May due to the newly imposed social distancing policy that shapes street activities.

Figure 6: Comparison between topic distributions from bi-weekly images. Sequences of green cells around June observed when phases 1 and 2 of reopening happened around the city.

Figure 7: Comparison between topic distributions from monthly images. A sharp change is July when phases 3 and 4 of reopening occurred, permitting social gatherings and recreation activities.
**Weekly Time Bin**

Figure 5: Comparison between topic distributions from weekly images. Changes (cluster of green cells) are observed during April-May due to the newly imposed social distancing policy that shapes street activities.

**Two-Week Time Bin**

Figure 6: Comparison between topic distributions from bi-weekly images. Sequences of green cells around June observed when phases 1 and 2 of reopening happened around the city.

**Monthly Time Bin**

Figure 7: Comparison between topic distributions from monthly images. A sharp change is July when phases 3 and 4 of reopening occurred, permitting social gatherings and recreation activities.
External Data Source (SafeGraph)

A Historical Timeline of COVID-19 in New York City

- March 14, 2020: First two COVID-19 deaths in NYS
- March 15, 2020: C.D.C. recommends no gatherings of 50+ in the U.S.
- March 16, 2020: NYC public schools close
- March 17, 2020: NYC bars and restaurants close, except for delivery
- March 22, 2020: NYS on Pause Program begins, all non-essential workers must stay home
- March 27, 2020: President signs the CARES Act
- March 30, 2020: U.S. reaches the most COVID-19 cases in the world
- March 28, 2020: Governor Cuomo halts all nonessential construction sites in NYS
- March 30, 2020: USNS Comfort arrives in NYC
- March 31, 2020: NYC passes 1,000 COVID-19 deaths
- April 6, 2020: Governor Cuomo extends NYS’s stay-at-home order and school closures to April 19
- April 10, 2020: Governor Cuomo extends NYS’s stay-at-home order and school closures to April 19
- April 13, 2020: Governor Cuomo requires face masks or coverings in public places
- April 15, 2020: Governor Cuomo extends NYS’s stay-at-home order and school closures to May 15
- April 30, 2020: Governor Cuomo announces NYC subway closures from 1 a.m. to 5 a.m.
- May 1, 2020: Governor Cuomo closes all schools for the remainder of the academic year
- May 14, 2020: Governor Cuomo extends PAUSE order to June 15, but will allow counties to open by May 15 if they meet qualifications
- May 14, 2020: Governor Cuomo extends PAUSE order to May 28 for NYC and regions not meeting requirements to reopen
- May 15, 2020: State of emergency for NYS extended to June 13
- May 15, 2020: Governor Cuomo allows drive-in theaters, landscaping, and low-risk recreational activities to reopen
- May 23, 2020: Governor Cuomo allows gatherings of up to 10 people with social distancing
- May 27, 2020: U.S. COVID-19 deaths pass 100,000
- June 8, 2020: NYC begins Phase 1 reopening
- June 22, 2020: NYC begins phase 2 of reopening
- June 22, 2020: NY opens some retail stores with social distancing
- June 22, 2020: N.Y.C. allows phase 2 of reopening
- June 24, 2020: N.J. and N.Y. require travelers to self-quarantine for 14 days if traveling from hot spots
- July 6, 2020: U.S. COVID-19 deaths surpass 130,000
- July 6, 2020: NYC begins Phase 3 of reopening, without indoor dining
- July 13, 2020: NYC begins Phase 4 reopening, excluding malls, museums and indoor dining/hotels
- July 24, 2020: NYC reports 227,517 COVID-19 cases and 22,934 deaths to date
People Count and Distancing
From Location Data

[Bar chart showing the popularity of POI categories, with 'Park' being the most popular and other categories such as 'School', 'Museum', 'Playground center', etc., listed along the x-axis and their counts along the y-axis.]
Comparison

Manhattan Daily Cases vs. Date

Daily Case Count

- 0
- 100
- 200
- 300
- 400
- 500
- 600
- 700

- 01-04-01
- 01-05-01
- 01-06-01
- 01-07-01
- 01-08-01
- 01-09-01
- 01-10-01
- 01-11-01
- 01-12-01
- 01-01-01
Future Plans

- Publish our findings with help from our advisors at the CPI Lab
- Our website and wiki are linked on SI-2021 Orbit page
- Celebrate successful completion of the internship!
Thank You!

Any Questions?