NYU Center for Urban Science + Progress

CAPSTONE PROJECTS OVERVIEW

SPRING 2020

Please be advised that projects are subject to change or revision.

Table of Contents

Urban Dynamics of Bird Migration

Organization: Cornell Lab of Ornithology

The project aims to characterize the migration of songbirds in Washington Square Park between the years 2016 and 2019. Students will analyze data from two sensor networks: SONYC (Sounds of New York City) and NEXRAD (Next-generation Radar). By applying machine listening software on SONYC recordings, they will measure the abundance of vocalizing songbirds in the park as well as the intensity of urban noise pollution. Furthermore, they will process NEXRAD scans to estimate the total number of birds flying over New York City on a daily basis. Lastly, they will combine audio and radar modalities to produce a daily index of habitat attractiveness, and complement it with crowdsourced observations from the eBird citizen science platform. At the end of their project, students will present a research website integrating an open-source implementation of their methodology, an interactive map to visualize their data, and a qualitative discussion of their main findings.

Nutritional Assistance: A Tool to Evaluate Program Participation

Organization: NYU-Coleridge Initiative and USDA-ERS

The USDA provides Nutritional Assistance programs (such as SNAP and WIC) with the goal of ending hunger. There are many considerations for how to administer those programs, including what stores to approve, how households are using their benefits, and the overall cost of the program. This capstone will use the IRI retail scanner data to evaluate purchasing patterns of households and build an evaluation and simulation tool that could be used by States administering these programs.

The USDA provides Nutritional Assistance programs (such as SNAP and WIC) with the goal of ending hunger. There are many considerations for how to administer those programs, including what stores to approve, how households are using their benefits, and the overall cost of the program. These considerations are frequently handled at local offices; for example, in the case of SNAP “local FNS field offices are responsible for the licensing and monitoring of retail food stores participating in SNAP.” (https://www.fns.usda.gov/snap/retailer/faq) The distributed nature of administering these programs means that it is difficult to evaluate a given program and compare those evaluations across States.

This capstone will build on the ongoing Cooperative Agreement between USDA ERS and the Coleridge Initiative to enhance the usefulness of USDA’s datasets in setting policy and improving USDA’s programs. While the capstone team will scope the specifics of the project once it begins, there are two expected components of this project: (1) use the IRI retail scanner data to evaluate participation in the WIC and SNAP programs and (2) build an analytical tool which State program administrators or FNS could use for evaluating program participation.

By working with ERS to create a replicable analysis and tool, this capstone will support the effort to evaluate programs in a more standardized manner.

Security Analysis of Trajectory Data

Organization: NYU CUSP

As one of the most sensitive data of individuals, the mobility/trajectory data is collected by various devices. We have to be aware that publishing trajectory data imposes a severe privacy risk to everyone in the dataset. Thus how to publish data to preserve maximum usability and leak minimum privacy of individuals becomes a critical question for the data publisher. Although most of the agencies have tried to anonymize the dataset when they are posting the data online, it is still unclear how effective the data anonymization schemes are.

People enjoy the convenience brought by smart cities, but they usually overlook the risks associated with the data-driven approaches used in the applications. As one of the most sensitive data of individuals, the mobility/trajectory data is collected by various devices, e.g., smartphones and cameras. Trajectory data is also precious for researchers and policymakers to understand how people move so that they can propose better solutions or policies to make everyone's life better. However, we have to be aware that publishing trajectory data imposes a severe privacy risk to everyone in the dataset. Thus how to publish data to preserve maximum usability and leak minimum privacy of individuals becomes a critical question for the data publisher. Although most of the agencies have tried to anonymize the dataset when they are posting the data online, it is still unclear how effective the data anonymization schemes are.

In this research project, we would like to take an adversarial approach to understand how much privacy is leaked after applying data anonymized schemes on trajectory data. We will act as an attacker to recover the original trajectories given an anonymized trajectory dataset and the mobility profiles of individuals. The human mobility pattern can be interpreted as a Markov model. Based on this theory, we can conduct our experiments in the following steps: (1) extract prior knowledge of each user; (2) generate anonymized datasets; (3) recover the original dataset from the anonymized datasets by using the prior knowledge.

Digital CEQR 2.0: Real-Time Prediction of City Planning Proposals' Environmental Impact

Organization: inCitu (by DRAW Brooklyn LLC)

City planning is too slow, too expensive, too obscure, and too inaccurate for the pace of change required in cities today. Facing climate change, mass-urbanization, increasing inequalities and displacement, cities in the 21st Century must adapt FAST, and EFFECTIVELY. In order to do so, we have to make city planning SMART.

This Capstone project provides students with the opportunity to work at the core of urban change. We will build an innovative, data-driven, automated framework that accurately assesses planning proposals' impact as we put together a real-world rezoning, making city planning iterative and productive.

Last Spring (2019), DRAW Brooklyn hosted a 10-weeks internship of ten CUSP + Cornell tech graduates to build the digital, smart platform of cities' environmental assessments. We used the framework of the NYC City Environmental Quality Review, or "CEQR," as a baseline. The CEQR is the process by which agencies of the City of New York review proposed discretionary actions to identify and disclose the potential effects those actions may have on the environment.

We identified available, relevant data to each planning environmental aspect and built algorithms that acquire and analyze these data.

The CEQR analysis, including 19 different chapters, is very time consuming; it is done AFTER a zoning proposal is conceived. By digitizing the analysis of environmental outcomes of a proposal, the environmental assessment can be completed in real time. This has the effect of transforming what is a disclosure document into a design tool which can be used to iteratively modify proposals while tracking their predicted outcomes.

With this year's Capstone team, we will develop the next phase of the tool to effectively predict the possible environmental outcomes and neighborhood impact of planning proposals. You will work alongside architects, community developers and data scientists as we put together a rezoning proposal. You will acquire the skills to play your part in shaping the city, and improving the process through the use of data. This is a unique opportunity to apply data science to the very core of city planning process to make it iterative, accurate, and transparent.

The Bronx Work Zone Interagency Traffic Data, Modeling, and Analysis

Organization: HDR

This project will analyze the cumulative mobility and safety impacts of concurrent roadway construction work zones in The Bronx for NYSDOT. Existing approaches to work zone coordination only analyze work zone impacts as isolated events. This project is unique in that it will analyze concurrent work zones for all agencies with roadway construction projects in the The Bronx (e.g., NYSDOT, NYCDOT, PANYNJ, and MTA B&T). The goal of this project is to allow agencies to better coordinate decisions related to construction work zones, including work zone schedules, traffic control design, and traffic monitoring needs, by analyzing the cumulative network effects of concurrent work zone closures throughout The Bronx.

Temporary work zones for roadway construction projects have the potential to significantly impact mobility and safety for all roadway users. Detours for work zones can impact routes for people driving, taking transit, and bicycling. Increased numbers of people using local streets as a result of work zone diversion plans may increase the likelihood of crashes, including crashes involving vulnerable populations (e.g., people walking and bicycling, older adults and children, and individuals with disabilities). Current best practices in mitigating roadway construction work zone impacts are deficient as the models used to assess impacts use small datasets (e.g., limited count data usually gathered with physical Automatic Traffic Recorders) and do not assess the cumulative impacts of concurrent work zones in a regional network. For instance, in a typical

existing approach to modeling work zone impacts, two adjacent work zones may plan to divert people driving onto the same alternative route. Individually, each work zone plan may not have a significant adverse effect on the network, but their cumulative effect may result in unsafe and avoidable conflict.

This project targets the long-standing gap in work zone coordination analysis by using a regional network to model concurrent planned work zones. By doing so, agencies can optimize construction schedules to improve safety and mobility and can adjust travel diversion plans when schedule overlap is unavoidable.

Mapping Sustainable Mobility in NYC Nightlife Culture

Organization: VibeLab

There is a growing understanding of the urban night—especially culture-centered nightlife—as an often-overlooked area of urban opportunity. Bringing together NYC's commitment to achieving the UN 2030 Sustainable Development Goals (with the world's first SDG Voluntary Local Review), and VibeLab's 2018 Creative Footprint report for New York City, this project will utilize multiple datasets to analyze how New York travels to and from nightlife events—and ultimately, to make recommendations to the multi-stakeholder coalition working to achieve a greener, more sustainable New York City.

"NYC's music ecosystem is a powerful industry. It produces an estimated $21 billion in economic output annually, supports nearly 60,000 jobs, and is home to nearly 500 venues, which host thousands of events per year.

One of the most important focus areas for urban sustainability is transportation - in New York, on-road vehicles make up 30% of NYC's greenhouse gas emissions. With thousands of artists, nightlife workers, and audiences traveling to and from venues nightly, small changes to their mobility patterns can have a significant impact.
The key question: How "green" are transportation patterns to and from NYC's cultural & nightlife events—and how can NYC get closer to its OneNYC SDG goals?

CUSP team will overlay data sets (venue map, mobility patterns from taxi, rideshare, and CitiBike trips, public transportation lines, and ticketing data) to gain an initial understanding of how New Yorkers travel to and from music venues at different times of night. Key questions to answer:

- What does rideshare/TLC usage look like around music venues in various parts of the city? How does this change for specific events?
- What correlation exists between rideshare/TLC dropoff/pickups, and venues' distance from public transit (subway/bus)? Citi Bike data?
- What correlations exist between specific train or bus line frequencies at certain times of night, and a rise in rideshare/TLC usage?

- What patterns exist for different venues (ex: are Citi bike rides markedly higher for certain venues, neighborhoods, or certain performance dates? Are riders more likely to UberPool/LyftLine from certain venues or neighbourhoods?)
- Based upon rideshare/TLC data, what might a transportation carbon footprint for several sample events look like in NYC?

Getting It Right: Building Age and Typology for NYC's Buildings

Organization: NYC Department of Buildings

Getting a better approximation of the age of a NYC's building can improve assigning the building to a structural type that includes type of construction and relevant building code in effect. Mapping the age and type of building would help NYC DOB and the City on a number of fronts, which include enabling NYC DOB to be more effective in enforcing building and construction safety and evaluating risk when adjacent or nearby subsurface construction is proposed. Furthermore, the more precise characterization of NYC buildings will improve efforts by the City to craft policies aimed at energy efficiency (TWG) as it drives to 80% GHG reductions by 2050 (80X50) and determining natural disaster vulnerability of its building stock (HAZUS).

This project will focus on Brooklyn with the purpose of developing a map of building age and associated original building materials using Sanborn maps, 2-D digitized historic real estate and insurance maps, open NYC data (Pluto, HPD, LPC, DOB), and other data sources that collectively provide a richer source of information than what is reflected in other data systems presently in use. Once this project demonstrates the proof of concept, the methodology created by the student team could then be expanded across all areas of the city.

Building age data (DATE BUILT) in the City's PLUTO database/map (at https://www1.nyc.gov/site/planning/data-maps/open-data/dwn-pluto-mappluto.page) for buildings initially constructed before WWII is often imprecise, if not wrong, and hampers understanding the original building's age and associated constructed characteristics for NYC DOB's building safety enforcement activities and for the City's energy policies and laws in connection with its 80X50 initiative. This imprecision has been transferred to the building characteristics portion of the HAZUS predictive model for NYC building failure rates for hurricane and earthquake scenarios.

Applying Multi-Agent RL to SLAM with Graph Pose for Sampled-Data MPC and CPN of Autonomous Drone Swarms

Organization: RiskEcon® Lab for Decision Metrics @ Courant NYU

The collaborative CUSP Capstone project we would like to propose involves the simultaneous location and mapping (SLAM) and graph pose for sampled-data model-predictive control (MPC) and cooperative path navigation (CPN) of autonomous drone swarms by applying multi-agent Reinforcement Learning and other relevant algorithms to data fusion of state-specific

dynamics (e.g. IMUs, accelerometry), environmental (wind, imaging, acoustic) and contextual (topographical, topological mesh, GIS grid-graph) data. Multiple drones adopt an ad hoc proximity-based graph topology mesh network while independently navigating a spatial grid. Group task roles among nearest neighbors within the swarm can be assigned as a function of relative proximity on the graph (nearest neighbors) jointly conditioned on grid location.

The primary focus of the project is to explore the application of sampled-data compression and sensor-stream data fusion algorithms in conjunction with reinforcement learning (and other estimation or optimization algorithms) to multi-agent simultaneous location and mapping (SLAM) with graph pose state estimation. The SLAM problem which can be differentiated by the fundamental type of spatial sensor measurements available for filtering (typically referred to as "landmarks"), commonly is challenged by inconsistency in the association between vehicle pose and map variables, landmark measurements and state landmarks, and the corresponding dimensionality of range-only, bearing-only or range-and-bearing SLAM. The simulations and experiments would involve sensor-based SLAM estimation of the grid map and individual vehicle pose, as well as relative grid map and proximity between nearest neighbors within a swarm of autonomous agent drones. The proposed project assignment focuses on the simultaneous location and mapping (SLAM) and graph pose problem for sampled-data model-predictive control (MPC) and cooperative path navigation (CPN) of autonomous drone swarms. The objective involves applying multi-agent Reinforcement Learning and other relevant algorithms (e.g. extended Kalman Filters, Rao-Blackwell particle filters, compressed sensing) to data fusion of state-specific dynamics (e.g. IMUs, accelerometry), environmental (wind, imaging, acoustic) and contextual (topographical, topological mesh, GIS grid-graph) data. Multiple drones adopt an ad hoc proximity-based graph topology mesh network while independently navigating a spatial grid where respective group task roles among nearest neighbors within the swarm can be assigned as a function of relative proximity on the graph (nearest neighbors) jointly conditioned on grid location. The simulations and experiments would explore implementing Multirobot SLAM, in which the drone swarm jointly produces and maintains a rudimentary minimalist map of the environment, to reduce the load on the communication bandwidth by augmenting data from somewhat more efficient visual inertial odometry. A five-person student team would work closely with team members of RiskEconLab and ARPL in the design and implementation of the simulation, lab experimentation and field trials involving programming, training and calibration of the algorithms.

Visualization of Water Quality Data as it Flows into the NYC Drinking Water Distribution System

Organization: New York City Department of Environmental Protection + Town+Gown

DEP will endeavor to build a framework to animate past, present, and future data since each serves an important role in practice and policy development. Near real-time water quality data is used to guide its day-to-day operations (i.e., the selection and routing of water) to achieve optimum quality for consumers. Historical data is used to evaluate the effectiveness of watershed protection programs, and model predictions of future water quality are used to

understand potential impacts to the water supply under different infrastructure and climate scenarios. Animation of DEP's data will allow a rapid multi-dimensional review that will aid decision-making.

Specifically, the objective of this project will be to build a 3D schematic diagram of the six Catskill and Delaware system reservoirs, which account for 90 % of the City's drinking water, and the flowpath to Kensico Reservoir and into distribution. This will be done using existing bathymetric data in ARCGIS. Fluctuations in reservoir volume will be included in the animations according to data on reservoir elevations. The physical framework of reservoirs will then be used to display water quality data and its changes over time as water flows through each of the reservoirs. The water quality data will be either a specified analyte (such as turbidity, fecal coliform bacteria, UV254, or ASU) or an index calculated from several analytes. The time period will be selected for each animation run and may be from hours to decades. Input data for analytes will be derived from past, current, or future predictions from model runs. Concentration changes will be scaled to show increases as higher intensity in color. Once the physical framework, designated sample sites, and water quality changes over time are coordinated, the input can be from past data, current data, or future predictions. A visualization tool will allow a large number of sample sites to viewed simultaneously and over time, which will aid water supply management.

Mapping Construction+Demolition Waste Flows to Re-Use C+DW in the City's Capital Program

Organization: Construction+Demolition Waste (CDW) Working Group of Town+Gown

The State regulates CDW—its generation, recycling and reuse—and collects all data on CDW. There is no city source of data for CDW. For the city to innovate policy with respect to CDW by leveraging its capital program as one way to close material loops, which would generate environmental sustainability and financial sustainability benefits, understanding where CDW goes from the demolition process through the recycling process is the most important single step.

The City is always building. As a part of this growth, materials are brought to and from private and public construction sites. Movement of CDW components, such as concrete, soil and gypsum, represents a significant portion of the waste and transit associated with construction in NYC. Currently, this material is reused in an untracked manner between project sites or sent to landfills. Opportunities exist for City agencies to reuse CDW components between sites for a myriad of benefits. NYS Department of Environmental Conservation (DEC) is responsible for the state's solid waste management regulations, which apply to all CDW consisting of materials from the construction and demolition of buildings and infrastructure. These regulations apply to all local governments in New York State, including New York City. CDW can be separated on construction sites into various components, such as concrete, steel, glass, gypsum, and soil, all of which can be recycled and reused as permitted by the regulations.

The environmental benefits of closing the CDW loops include expanded reuse of CDW with fewer emissions from trucking new materials into the city from outside the metropolitan area and reduction of transportation of materials to landfills for disposal and associated reductions in environmental impacts due to reduction in landfills use and transportation of materials to landfills; and financial benefits include reduction in construction costs due to the reuse of some CDW components and reduction of transportation costs due to transport from outside the city for new materials. In addition, the ability for CDW recycling to move as a resource toward higher value uses, with the aid of engineering technology, also depends on understanding the pathways of CDW as a resource.

The CDW Working Group needs to understand from available NYS DEC the CDW material flows in this region—where, when, how much and what type of CDW materials are available for reuse—which is the basis for the research question underlying this project. What are the patterns of CDW generation, processing and recycling within the City (Region 1) and what recycled CDW materials are available for reuse on construction projects within the City (Region 1) to help New York City close material loops by leveraging its capital program? Developing a data visualization of the CDW waste flows from generation to recycling is critical for the CDW Working Group as it moves ahead with its goal of increasing reuse of recycled CDW elements on New York City's capital projects and thus helping to close material loops. While LEED and Envision frameworks do contain credits for re-use of recycled CDW, there is no systemic citywide plan to support efforts in these areas, including economic and market efforts, so that more CDW ends up in landfills than might be feasible under the right citywide supportive plan.

Documenting the Economic Impacts of New York City's Investment in Water Supply: A Data Visualization Foundation for Economic Analysis

Organization: New York City Department of Environmental Protection

NYC DEP has previously analyzed economic impacts associated with its watershed protection programs but has never synthesized the data sets. The goal of this project is to replicate and update these efforts, thereby illustrating economic changes over time. The project would involve documenting these investments spatially and temporally as well as mapping indicators thought to relate to economic development such as demographic changes, jobs created, land value, economic multipliers and personal income growth since the initial investments. The student team would perform general correlation analyses, most likely at the watershed level (possibly by county), between the investments and demographic and economic indicators. This final product would be the foundation for a more sophisticated hedonic regression, which could be started in the capstone by focusing on nearby property sales values for selected case study investments or other proxies.

New York City has built an iconic water system to serve the continued growth and dynamism of "The City That Never Sleeps" that supplies over one billion gallons of water a day to 9 million people (including 1 million in the greater NYC region). The vast majority of this water is unfiltered, which is a testament to its superior quality and the investments NYC has made over

the centuries in infrastructure, watershed protection, operations, and research.

On January 21, 1997, the NYC Watershed Memorandum of Agreement was signed by the Mayor and 43 other signatories representing State, Federal and local governments, as well as non-governmental stakeholders which set in motion a globally unparalleled source water protection effort. Over two decades later, the City has invested over $2 billion into a myriad of programs including land acquisition, agricultural and community partnerships, operational support systems, water quality monitoring programs and watershed rules and regulations to safeguard the water supply. There have also been major public works enhancements to infrastructure in the watershed including, but not limited to, the Cat/Del UV Treatment Plant, repair and rehabilitation of the Delaware and Catskill Aqueducts, construction of the Shaft 4 interconnect and upgrade of all City-owned wastewater treatment plants in the watershed.

This project will first involve review of data collected over the years in the form of specific (unpublished or incomplete) reports specifically on this topic, numerous analyses conducted as part of environmental impact statements, records of expenditures by NYC. Using place-based investment data from DEP, the next step would involve mapping these investments in space and in time as well as mapping indicators thought to relate to economic development such as population increases, jobs created and personal income growth since the initial investments. The student team would perform general correlation analyses, most likely at the county level, between the investments and demographic and economic indicators. This map would be the foundation for a more sophisticated hedonic regression, which could be started in the capstone by focusing on nearby property sales values for selected case study investments. All of these investments can be mapped as a first order, to which nearby property sales data can be added, so that hedonic regression can be done to evaluate quantitatively the economic impact of the investments in the surrounding area.

Smart Monitor for Accelerating Regional Transformation (SMART)

Organization: US Ignite

US Ignite propose a new approach to economic development modeling -- Smart Monitor for Accelerating Regional Transformation (SMART) -- that integrates federal data sources for economic, demographic, and household indicators with city-level sensor data for tracking pedestrians, traffic, and other data in real-time. These combined datasets, coupled with this new economic modeling approach, will also serve as the basis for new, real-time mapping and data visualization tools, giving city leaders, small businesses, and researchers immediate access to new insights to improve their ability to attract and retain small businesses.

This new economic development research framework, Smart Monitor for Accelerating Regional Transformation or SMART, was developed by US Ignite in conjunction with our urban and rural community stakeholders to support underserved communities and small businesses. The multi-community, city-university-industry collaboration creates an accurate economic model to help underserved communities and small businesses. The analysis will be created by using openly

available federal datasets coupled with community and industry smart city datasets that will help provide snapshots of development potential on a property-by-property basis.

Data collected through this research will inform municipal leaders, small businesses, and researchers of the impact of policy decisions and facilitate objective and data-driven decision making in areas such as the following:

- Calculate the economic and social impacts of different development scenarios on a property.
- Explore snapshots of development potential on a property-by-property basis, based on zoning, development standards, infrastructure requirements, and funding options.
- Analyze land-use scenarios in the context of building healthier neighborhoods, such as multimodal transportation, walkability, and ease of access to complementary services.

Over the next three years, this research could provide one online destination for municipal, private, and community information to be uploaded, analyzed and visualized, creating a more informed and coordinated approach to economic development. The new approach will enable local policies to support smart development decisions, enhance the quality of life for residents, and provide a value that far outstrips any system maintenance costs.

Ultimately, economic development data could be coupled with new technologies and applications to create a new approach for cities. Capabilities such as augmented reality informed by this web of information will soon enable networks and devices offering an immersive experience that can transform a simple camera view into a visualization of future economic development plans. Citizens, businesses, city leaders, researchers, and private-sector developers could become better aligned with access to city and neighborhood data, civic and developer planning information through such a real-time data exchange.

Assessing the Circular Economy Opportunity in NYC

Organization: New York City Economic Development Corporation (NYCEDC) and New York City Department of Sanitation (DSNY)

In Mayor de Blasio's OneNYC vision to make the city more sustainable and resilient, he commits the city to accelerate the transition toward a circular economy. Deviating from traditional supply chain models and the linear take-make-waste business model, the circular economy creates new business models and innovations to eliminate and re-use materials and waste products. It involves shifting systems in business, government, and individuals to design out waste and to extend products and material lifecycle through re-use and re-invention.

Despite financial, social, and environmental benefits of the circular economy, over 90% of global production still occurs through linear models. Adoption of circular business models is challenged by a lack of coordinated policy innovation, limited resources to help circular startups thrive, and deeply rooted linear supply chains for existing firms. It can also be abstract and difficult concept

to translate in a manner that resonates with a wide variety of stakeholders. A transition to a circular economy would drive $380B in cost savings for businesses worldwide and could reduce carbon emissions by 70%. While Europe is leading in circular economy adoption, New York City could set the standard for circular economy innovation in North America by leveraging EDC's unique strengths in leading the development of new industries and business practices.

This project will be comprised of three main components:

1. Conduct an analysis of the existing circular economy ecosystem in NYC, including a map of key startups, industry players, academic institutions, and corporate entities that are engaging in this industry.

2. Post landscape analysis, provide a more specific "metabolism analysis" for NYC to understand which of the city's resource flows are generating the most waste. Metabolism analysis is an academic process for understanding resource flows. This involves looking at all in-flows by type, then seeing how they are transformed in a certain area/radius and turned into outputs. These resource flows are likely physical, but may also be intangibles like data, money or people. By looking at the outputs, the analysis can surface what waste materials are most available and which are best positioned for reuse in the context of NYC's economy. After identifying key outflows (waste streams) in NYC and the contributing industries, conduct an analysis of which cause the biggest losses of economic value.

3. Next, the researchers will provide a set of recommendations for business model innovation and cross sector collaboration that may solve for that value loss. Researchers should consider emerging technologies as one potential solution/catalyst for these recommendations.

Pathways to Legal Occupancy: Preserving Nightlife Cultural Spaces

Organization: Office of Nightlife, NYC Mayor's Office of Media and Entertainment

This project will involve research and planning to preserve and protect the small businesses and cultural venues that enrich New York's world-famous nightlife. The research team will work with Office of Nightlife staff, advocates, and nightlife stakeholders to develop a roadmap for grassroots cultural spaces to thrive in New York City, including concepts for technical and financial assistance; pilot programs for special zoning districts, conditional occupancy, and temporary event permitting; and "legacy business" designation.

New York City is and has been home to many culturally significant nightlife venues that have played pivotal roles in society, ranging from launching social justice movements to birthing new genres of music. The confluence of rising rents and high costs of living pose significant challenges for the city's local creative communities and significant cultural venues. Do-it-yourself (DIY) venues that host nightlife programming with cultural value often operate at the margins of regulatory oversight, lacking either financial resources to achieve code

compliance, or expertise to navigate City processes. This can lead to these establishments driving further "underground," and mistrust between enforcement agencies and operators of unlicensed spaces. Advocates have cited the need for better pathways to safe, legal occupancy, and for access to guidance and assistance through that process for small, culturally significant nightlife operators.

The Office of Nightlife will work with the Capstone team to develop policies and programs that support this community through precedent research, data analysis, stakeholder meetings and co-design workshops, that will assist new and unlicensed venues to help sustain New York City's vital cultural spaces.

Crowdsourced Security Cameras Enabling a Real-time Scaled Response to Crime

Organization: The City of Paterson NJ

Security cameras are destined to be a game changer in public safety if we can surmount obstacles preventing their scaled deployment.

Efficiency: Paterson lacks sufficient resources to review video feeds and computer vision lacks discernment. Therefore, we seek to deploy a crowdsourcing model whereby residents will be invited to earn micro-payments to review feeds and report suspicious activity.

Accuracy: As individuals might "game" the system, we seek to determine the optimal deployment of crowd resources to prevent bad behavior and ensure efficacy.

Procurement: We seek to determine the benefits of leveraging private security cameras. In determining the effectiveness of a crowdsourced solution in reviewing video surveillance, we propose recorded video security feeds be reviewed by a team of residents to identify Incidents of Suspicious Activity (ISAs) resulting in an ISA Dataset.

Predictive Policing: The ISA Dataset would be heat mapped using Geographic Information Software. Actual crime statistics will also be heat mapped. The comparison of heat maps will determine if the ISA Dataset is useful in predictive policing and perhaps even superior.

Police Dispatch: We would simulate the use of crowdsourcers to determine if they could identify ISAs fast enough to enable the effective deployment of police resources considering, for example, the time to identify and track license plate numbers to deploy law enforcement to the residences of perpetrators.

Procurement and Placement of Cameras: We would also assess the efficacy of microwave based cameras versus alternatives. We will also assess the value of leveraging private cameras including Nest and Ring doorbell cameras. Finally, we will suggest the optimal location of cameras both spatially (ex. light post level, stop sign level, etc.) and geographically across the city.

Optimal Configuration of Crowdsourcers: How many crowdsources should review a feed to prevent gaming and ensure accuracy? At what level of accuracy should we provide a micro-payment? Do we need an adjudicator when crowdsourcers disagree? How many verified incidents should we plant in the feed to determine the rate of false negatives? What incentives are most effective? What confidence levels are appropriate relative to dispatching law enforcement resources?

Mapping Economic Change in Telecom Industry

Organization: New York City Department of Information Technology & Telecommunications

Getting a visual sense of the city's telecom market as it undergoes continual change due to changes in technology and economics forces would help inform DoITT's policy making function. In particular, it would assist DoITT to encourage new participants in markets that are currently experiencing effective monopoly pricing and support advocacy for new legislation permitting the City of New York to develop and enforce more thorough consumer protection measures in natural monopoly services.

The telecom industry constantly changes as telecom technology changes, with corporate consolidations underway that could undermine competition. In other instances, a few larger companies are moving to provide a wider range of services, which could increase competition for those product lines (most notably mobile services) into which they are expanding. Given the relationship between price and competition, DoITT is interested in better understanding and quantifying the demand curve for telecommunications services and how the number of providers of any particular service impacts pricing. DoITT believes that the most effective manner in which to lower prices and improve customer service is to increase competition. As a result, one of DoITT's major goals is to encourage competition in the cable/broadband market. New York City has more providers of home broadband/cable than many places in the US, and therefore, presumably, more competition then any American market for telecommunications services. Despite this DoITT has found that in both the wired/home and the wireless markets for telecommunications services, telecommunications providers seem to increase the cost of service at will. Certainly, monthly charges in New York City exceed those in major European markets, particularly for broadband service.

DoITT seeks to better quantify the competitive forces at play in the local telecommunications market. DoITT and other entities at various levels of government have significant, if imperfect, data on the availability and pricing of telecommunications products. What other publicly-available data could help provide insight into competition in the telecommunications industry? How much does having access to additional ISPs help consumers, and how can and should that benefit be measured? Finally, what is the benefit to the typical New York City-resident telecommunications customer?

Initially, the student team would use publicly available data from the FCC for wired and wireless providers in New York City and their authorized service areas (by census tracts) and price data

provided by the cable companies to DoITT (the rate card, which represents the as-current upper limit for price) and establish and visualize a baseline condition. Then, the student team would develop a methodology to identify the market rates offered by these providers as a second layer to the visualization and calculate the slope of the demand curve and the impact of the number of providers on the price for telecommunications services in New York City. Ideally, DoITT seeks to identify the minimum number of service providers of a service in New York City to create a competitive market.