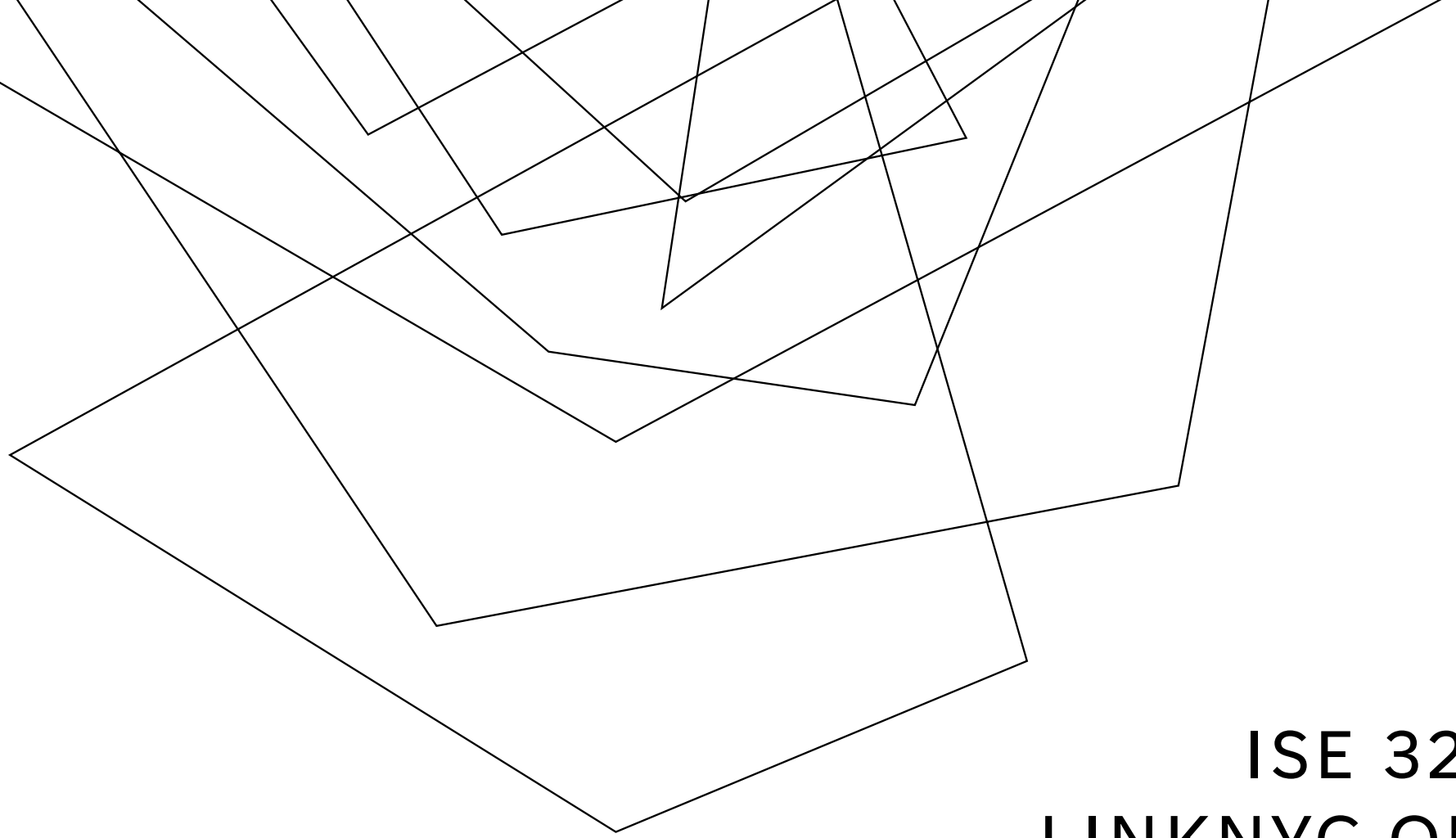

ISE 3230 PROJECT: LINKNYC OPTIMIZATION

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INTRODUCTION

- LinkNYC is communication network in New York City providing free Wifi, phone calls, maps, device charging, and more to residents with over 1,869 kiosks as of 2020, with an eventual plan for 7,500 kiosks.
- This program costs approximately $200 million, primarily funded through advertising.
- A persistent challenge is the addition and site selection of new kiosks to ensure equitable services for everyone.
- Our goal is to **optimize the number of kiosks while minimizing cost by determining how many to add to each census tract** using population data, points of interest, and existing kiosks.

FORMULATION & MODEL

Objective function & Decision Variables

$$\text{Minimize } Z = \sum_{i}^{2327} c_i \cdot x_i$$

x_i: Number of new kiosks to install

Constraints

$$\frac{P_i}{\rho} \leq K_i + x_i \quad \forall i$$

$$x_i \leq \frac{P_i}{\rho} \cdot k \quad \forall i$$

$$x_i \leq \frac{\text{POI}}{\text{MinPOI}} \cdot k \quad \forall i$$

$$0 \leq x_i \leq k, \quad x_i \in \mathbb{Z}$$

CODE

Constants & Variables

```
# Get vectors and change nan pois to 0
geoid = df['GEOID']
kiosks=df['kiosks'].to_numpy()
pop=df['population'].to_numpy()
pois=df['pois'].to_numpy()
cost=df['Cost'].to_numpy()
borough=df['COUNTYFP']

pois = np.nan_to_num(pois, nan=0, posinf=1, neginf=0)
```

```
# Constants
n = len(geoid)
min_pois = 15
max_kiosks = 2000
min_pop = 10000
max_ct_kiosks = 25
borough_pop = 5000
```

```
X = cp.Variable(n, integer=True)

# Minimize total cost
obj_fun = cp.sum(cp.multiply(cost, X))
```

Constraints

```
constraints = []
constraints.append(X>=0)
constraints.append(X<=max_kiosks) # Can have maximum of 2000 kiosks total ($2 million max budget)
constraints.append(X <= pois/min_pois*5) # For every 15 pois can have max 5 kiosks in CT
constraints.append(X <= pop/min_pop*10) # For every 3000 people can have max 7 kiosks CT

for b in [5, 47, 61, 81, 85]: # For Each borough
    lt = len(geoid[borough==b]) # numer of CT in burough
    # average population in the borough divided by 5000 <= average total kiosks
    # On average over each CT in a borough 1 total kiosk for 5000 people
    constraints.append(sum(pop[borough==b]/borough_pop)/lt <= cp.sum(kiosks[borough==b]+X[borough==b])/lt)



problem = cp.Problem(cp.Minimize(obj_fun), constraints)
problem.solve(solver=cp.GUROBI, verbose=True)


print("Solver status:", problem.status)
print("X values:", X.value)
print("Objective Function", obj_fun.value)
```

RESULTS

	The Bronx	Brooklyn	Manhattan	Queens	Staten Island	***Total***
Existing Kiosks	362	339	1220	355	50	2,306
# to Add	**82**	**204**	**0**	**124**	**49**	**459**
Cost	**$123,000.00**	**$204,000.00**	**$0.00**	**$186,000.00**	**$53,900.00**	**$566,900.00**

NEW LINKNYC KIOSKS BY CENSUS TRACT