

Chase Bank Branch Optimization and Coverage Analysis

This notebook selects which bank branches to keep open to minimize weighted distance to customers, while covering all branches. Closed branches are assigned to the nearest open branch.

Load Data and Handle Missing Values

Read first 500 rows, check for missing lat/long, fill missing values using county averages, track which were imputed.

```
In [1]: import pandas as pd
from pulp import *
from haversine import haversine

# Read branch data
df = pd.read_csv("database.csv").iloc[:500].copy()
print(df.info())
print(df[["Latitude", "Longitude"]].isna().sum())

# Track missing Lat/Long
df["location_imputed"] = df["Latitude"].isna() | df["Longitude"].isna()

# Fill missing Lat/Long using County average
df["Latitude"] = df.groupby("County")["Latitude"].transform(lambda x: x.fillna(x.mean()))
df["Longitude"] = df.groupby("County")["Longitude"].transform(lambda x: x.fillna(x.mean()))

print(df[["Latitude", "Longitude"]].isna().sum())

# Compute recent average deposits
recent_years = ["2014 Deposits", "2015 Deposits", "2016 Deposits"]
df["recent_avg_deposits"] = df[recent_years].mean(axis=1)
```

```

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 500 entries, 0 to 499
Data columns (total 20 columns):
 #   Column           Non-Null Count  Dtype  
--- 
 0   Institution Name    500 non-null   object  
 1   Main Office        500 non-null   int64  
 2   Branch Name        500 non-null   object  
 3   Branch Number      500 non-null   int64  
 4   Established Date   500 non-null   object  
 5   Acquired Date     396 non-null   object  
 6   Street Address     500 non-null   object  
 7   City               500 non-null   object  
 8   County              500 non-null   object  
 9   State               500 non-null   object  
 10  Zipcode             500 non-null   int64  
 11  Latitude            491 non-null   float64 
 12  Longitude            491 non-null   float64 
 13  2010 Deposits      500 non-null   float64 
 14  2011 Deposits      500 non-null   float64 
 15  2012 Deposits      500 non-null   float64 
 16  2013 Deposits      500 non-null   float64 
 17  2014 Deposits      500 non-null   float64 
 18  2015 Deposits      500 non-null   float64 
 19  2016 Deposits      500 non-null   int64  
dtypes: float64(8), int64(4), object(8)
memory usage: 78.3+ KB
None
Latitude    9
Longitude   9
dtype: int64
Latitude    0
Longitude   0
dtype: int64

```

Compute Nearby Branches and Set Up Optimization

Compute 10 closest branches for each branch. Define decision variables: `x` = (open/closed) and `y` = (assignments). Minimize weighted distance to open branch. The constraints are assign once, assign only to open, and exactly K open.

```
In [2]: branches = df.index.tolist()
nearest = {}
for i in branches:
    dists = [(j, haversine((df.loc[i, "Latitude"], df.loc[i, "Longitude"]),
                           (df.loc[j, "Latitude"], df.loc[j, "Longitude"])))
              for j in branches]
    nearest[i] = sorted(dists, key=lambda x: x[1])[:10]

K = 200
model = LpProblem("Branch_Selection", LpMinimize)
x = LpVariable.dicts("open", branches, cat="Binary")
y = LpVariable.dicts("assign", [(i,j) for i in branches for (j,_) in nearest[i]], c
```

```
# Objective: minimize weighted distance
model += lpSum(df.loc[i, "recent_avg_deposits"]*dist*y[(i,j)] for i in branches for j in y)
model += lpSum(y[(i,j)] for j in y) == K

# Constraints
for i in branches:
    model += lpSum(y[(i,j)] for j in y) == 1
for (i,j) in y:
    model += y[(i,j)] <= x[j]
model += lpSum(x[j] for j in y) == K

# Solve
model.solve()
print("Status:", LpStatus[model.status])
```

Status: Optimal

Extract and Summarize Results

Mark open/closed branches, assignment, branches served, and total deposits. Save results.

```
In [3]: df["Open"] = df.index.map(lambda i: x[i].value() == 1)
assignments = {i:j for (i,j) in y if y[(i,j)].value()==1}
df["Assigned_To"] = df.index.map(lambda i: assignments.get(i,i))
df["Branches_Served"] = df.groupby("Assigned_To")["Assigned_To"].transform("count")
df["Deposits_Served"] = df.groupby("Assigned_To")["recent_avg_deposits"].transform("sum")

open_branches = df[df["Open"]]
for _, row in open_branches.iterrows():
    print(f"{row['Branch Name']}: Serves {row['Branches_Served']} branches, Deposit ${row['Deposits_Served']}")

df.to_csv("branch_consolidation_results.csv", index=False)
```

JPMorgan Chase Bank Main Office: Serves 1 branches, Deposits 1085719666.67
Vernon Hills Scarsdale Branch: Serves 4 branches, Deposits 885121.67
Lawrence Rockaway Branch: Serves 2 branches, Deposits 272204.67
Mount Vernon Branch: Serves 4 branches, Deposits 674276.33
Riverdale Branch: Serves 6 branches, Deposits 878695.33
Bay Parkway and 85th St Branch: Serves 2 branches, Deposits 448808.00
Chinatown Branch: Serves 6 branches, Deposits 2338582.33
Yorkville Branch: Serves 7 branches, Deposits 2506958.33
Empire State Branch: Serves 6 branches, Deposits 9111565.00
Fit Seventh Avenue Branch: Serves 4 branches, Deposits 1641036.67
Exxon Building Branch: Serves 2 branches, Deposits 2697220.33
Bay Terrace Branch: Serves 2 branches, Deposits 380109.00
Downtown Flushing Branch: Serves 3 branches, Deposits 1431083.67
Columbia University Branch: Serves 4 branches, Deposits 1212797.33
Steinway and Broadway Branch: Serves 5 branches, Deposits 1104331.33
Pelham Branch: Serves 2 branches, Deposits 397110.33
Rockville Centre Branch: Serves 2 branches, Deposits 722854.67
Woodbury Branch: Serves 1 branches, Deposits 475814.33
Plainview Branch: Serves 1 branches, Deposits 289271.33
Thornwood Branch: Serves 2 branches, Deposits 334392.00
Garment Center Branch: Serves 2 branches, Deposits 1575611.67
White Plains Branch: Serves 3 branches, Deposits 826813.33
Water Street Branch: Serves 3 branches, Deposits 1228930.00
Babylon Branch: Serves 4 branches, Deposits 466974.67
Center Moriches Main St Branch: Serves 2 branches, Deposits 166810.67
Deer Park Grand Blvd Branch: Serves 2 branches, Deposits 239452.67
Bar Harbour Branch: Serves 3 branches, Deposits 504151.33
Melville Branch: Serves 1 branches, Deposits 241310.67
Southampton Driveup Branch: Serves 1 branches, Deposits 339388.67
South Huntington Branch: Serves 1 branches, Deposits 212421.33
North Massapequa Branch: Serves 2 branches, Deposits 544978.33
West Bay Shore Branch: Serves 1 branches, Deposits 162252.67
Huntington Branch: Serves 1 branches, Deposits 667091.00
Mineola Court House Branch: Serves 4 branches, Deposits 719141.33
East Farmingdale Branch: Serves 1 branches, Deposits 156632.00
Hauppauge Branch: Serves 3 branches, Deposits 550979.33
Macarthur Airport Vets Hwy Branch: Serves 2 branches, Deposits 252208.67
Smithtown Branch: Serves 1 branches, Deposits 248420.33
Stony Brook Branch: Serves 1 branches, Deposits 219697.00
Nanuet Driveup Branch: Serves 2 branches, Deposits 233750.00
New York North Branch: Serves 1 branches, Deposits 173902.67
Valley Cottage Branch: Serves 1 branches, Deposits 150307.33
Jefferson Valley Mall Branch: Serves 2 branches, Deposits 308005.67
Morris Park Branch: Serves 9 branches, Deposits 1123800.33
Tottenville Branch: Serves 1 branches, Deposits 150747.33
Lake Ronkonkoma Branch: Serves 3 branches, Deposits 165612.00
Bellmore Branch: Serves 3 branches, Deposits 497276.33
Concourse Branch: Serves 9 branches, Deposits 676096.67
Melrose Branch: Serves 6 branches, Deposits 377045.67
Boro Park Branch: Serves 4 branches, Deposits 1297343.67
Brooklyn Trust Branch: Serves 4 branches, Deposits 831773.33
Havemeyer and Broadway Branch: Serves 4 branches, Deposits 649067.00
Park Slope Branch: Serves 4 branches, Deposits 998696.33
Sheepshead Bay Branch: Serves 4 branches, Deposits 1242515.33
University Place Branch: Serves 8 branches, Deposits 2708899.67
Madison Avenue & 72nd Street Branch: Serves 5 branches, Deposits 2252112.00

Madison Ave Abd 48th St Branch: Serves 3 branches, Deposits 83978662.00
Astoria Broadway and 21st St Branch: Serves 14 branches, Deposits 3289427.67
Glen Oaks Branch: Serves 2 branches, Deposits 277575.33
Ridgewood Branch: Serves 4 branches, Deposits 539691.00
Tysens Lane Branch: Serves 2 branches, Deposits 423721.67
Port Washington Branch: Serves 1 branches, Deposits 564799.00
Bedford Village Branch: Serves 2 branches, Deposits 169836.00
Valley Stream Branch: Serves 2 branches, Deposits 325004.00
Croton Branch: Serves 1 branches, Deposits 120397.67
Greenpoint Branch: Serves 2 branches, Deposits 546005.67
Mount Sinai Branch: Serves 1 branches, Deposits 223112.00
Selden Branch: Serves 1 branches, Deposits 209053.67
Great Neck Plaza Branch: Serves 2 branches, Deposits 916205.67
Hartsdale Branch: Serves 4 branches, Deposits 559757.67
Throggs Neck Branch: Serves 3 branches, Deposits 432389.00
Mill Basin Branch: Serves 3 branches, Deposits 557548.33
Bay Ridge Third Avenue Branch: Serves 1 branches, Deposits 251535.00
Grand Central Place: Serves 3 branches, Deposits 2709039.00
73rd Street & Broadway Branch: Serves 5 branches, Deposits 1924477.67
Third Avenue and 56th Street Branch: Serves 5 branches, Deposits 3039451.00
Ozone Park Branch: Serves 5 branches, Deposits 619545.33
Rockaway Park Branch: Serves 1 branches, Deposits 169645.67
Whitestone Branch: Serves 1 branches, Deposits 350224.00
West New Brighton Branch: Serves 2 branches, Deposits 406386.67
Syosset Branch: Serves 1 branches, Deposits 270104.00
Yorktown Heights Branch: Serves 1 branches, Deposits 144339.33
Midwood Branch: Serves 3 branches, Deposits 822649.67
Millwood Branch: Serves 1 branches, Deposits 185005.67
Jamaica Estates Branch: Serves 5 branches, Deposits 739477.00
Cross River Branch: Serves 1 branches, Deposits 165247.67
East Hills Branch: Serves 1 branches, Deposits 239189.67
Monroe Branch: Serves 1 branches, Deposits 157203.67
Brewster Branch: Serves 2 branches, Deposits 132918.33
Halston and Harrison Branch: Serves 4 branches, Deposits 375537.67
Larchmont Branch: Serves 2 branches, Deposits 461036.33
Mount Kisco Satellite Express Branch: Serves 1 branches, Deposits 216389.33
Peekskill Branch: Serves 1 branches, Deposits 174285.33
Rye Branch: Serves 1 branches, Deposits 535911.00
Thruway Branch: Serves 2 branches, Deposits 283264.00
Somers Branch: Serves 1 branches, Deposits 101986.00
Islip Branch: Serves 1 branches, Deposits 246721.33
East Meadow Branch: Serves 1 branches, Deposits 346229.00
Munsey Park Branch: Serves 1 branches, Deposits 418620.33
Hicksville Branch: Serves 1 branches, Deposits 272945.67
Metrotech Branch: Serves 6 branches, Deposits 788561.67
Tower Branch: Serves 6 branches, Deposits 682919.33
Dewitt Branch: Serves 4 branches, Deposits 245498.67
Oneida Branch: Serves 1 branches, Deposits 29663.00
Oswego Branch: Serves 1 branches, Deposits 50032.67
Lincoln Center Branch: Serves 6 branches, Deposits 434021.67
Brighton Monroe Branch: Serves 2 branches, Deposits 195670.00
Brockport Branch: Serves 1 branches, Deposits 59899.00
Canandaigua Branch: Serves 1 branches, Deposits 69626.33
East Rochester Fairport Road Branch: Serves 5 branches, Deposits 415791.00
Rochester Medical Center Branch: Serves 5 branches, Deposits 426591.33
Liverpool Branch: Serves 2 branches, Deposits 158520.00

Greece Long Pond Branch: Serves 3 branches, Deposits 170431.67
Webster Branch: Serves 3 branches, Deposits 199242.67
Arden Heights Branch: Serves 1 branches, Deposits 219305.33
Ny Presbyterian Branch: Serves 5 branches, Deposits 721525.67
Fairfield Center Branch: Serves 4 branches, Deposits 493157.67
Stony Hill Branch: Serves 2 branches, Deposits 171655.00
Newtown Branch: Serves 1 branches, Deposits 90970.33
Darien Branch: Serves 2 branches, Deposits 219859.00
Shelton Branch: Serves 1 branches, Deposits 87124.33
Westport Main Street Branch: Serves 2 branches, Deposits 352029.33
New Haven Church Street Branch: Serves 1 branches, Deposits 151392.33
Stratford Barnum Avenue Branch: Serves 4 branches, Deposits 343284.67
Monroe Ct Branch: Serves 2 branches, Deposits 148774.33
New Canaan Branch: Serves 1 branches, Deposits 370571.67
Wilton Center Branch: Serves 2 branches, Deposits 333058.33
Ridgefield Branch: Serves 1 branches, Deposits 150673.33
Greenwich Financial Center Branch: Serves 1 branches, Deposits 344271.67
Stamford Prospect Street Branch: Serves 1 branches, Deposits 283062.33
South Street Branch: Serves 3 branches, Deposits 363410.00
Lake Hiawatha Branch: Serves 1 branches, Deposits 176384.67
Denville Branch: Serves 2 branches, Deposits 227290.67
Madison Waverly Branch: Serves 2 branches, Deposits 558174.67
Parsippany Road Branch: Serves 1 branches, Deposits 195568.33
Watchung Plaza Branch: Serves 8 branches, Deposits 696527.33
West Caldwell Branch: Serves 1 branches, Deposits 181680.00
Short Hills Branch: Serves 3 branches, Deposits 584362.33
River Edge Branch: Serves 5 branches, Deposits 603758.33
Wyckoff Branch: Serves 3 branches, Deposits 337553.00
Westfield Branch: Serves 1 branches, Deposits 311122.33
Ridgewood Branch: Serves 1 branches, Deposits 190286.00
Fort Lee Branch: Serves 2 branches, Deposits 493340.33
Chase Plaza Branch: Serves 5 branches, Deposits 3323683.00
Northport Village Drive-In Branch: Serves 4 branches, Deposits 396558.33
Houston Main Office: Serves 9 branches, Deposits 67466686.00
Woodlands Branch: Serves 2 branches, Deposits 185095.67
Stafford Branch: Serves 1 branches, Deposits 335037.67
Katy Freeway Branch: Serves 1 branches, Deposits 338649.67
Cypress Station Branch: Serves 1 branches, Deposits 174204.67
Champions Branch: Serves 1 branches, Deposits 257264.67
Airline Branch: Serves 1 branches, Deposits 197880.00
Kirby Motor Bank Branch: Serves 2 branches, Deposits 517645.33
Reagan Motor Bank Branch: Serves 1 branches, Deposits 409032.67
Medical Branch: Serves 3 branches, Deposits 646297.67
Tanglewood Branch: Serves 1 branches, Deposits 348743.33
Richmond/Sage Branch: Serves 2 branches, Deposits 543922.67
Lakeside Branch: Serves 1 branches, Deposits 555784.33
North Freeway Branch: Serves 1 branches, Deposits 193621.33
Cyfair Branch: Serves 1 branches, Deposits 199377.33
Bay Area Boulevard Branch: Serves 3 branches, Deposits 201019.33
West Little York Branch: Serves 1 branches, Deposits 234290.67
Eldridge Parkway Branch: Serves 2 branches, Deposits 429647.00
Westwood Branch: Serves 3 branches, Deposits 282678.00
Kingwood Branch: Serves 1 branches, Deposits 273722.00
Conroe Branch: Serves 1 branches, Deposits 229069.00
Sugar Land Branch: Serves 1 branches, Deposits 276890.33
Friendswood Branch: Serves 1 branches, Deposits 205013.00

Mcallen Neuhaus Tower Branch: Serves 2 branches, Deposits 567319.67
Bear Creek Branch: Serves 1 branches, Deposits 187384.67
Almeda Genoa Branch: Serves 3 branches, Deposits 400269.33
Gulfgate Branch: Serves 2 branches, Deposits 310355.67
Clear Lake City Boulevard Branch: Serves 1 branches, Deposits 184881.00
Humble Branch: Serves 1 branches, Deposits 131393.33
Panther Creek Branch: Serves 1 branches, Deposits 216507.67
San Marcelo Branch: Serves 2 branches, Deposits 339349.00
West Anderson Branch: Serves 2 branches, Deposits 172052.33
Research Branch: Serves 1 branches, Deposits 100430.33
Downtown Dallas Branch: Serves 4 branches, Deposits 364021.00
South Preston Royal Branch: Serves 6 branches, Deposits 301511.33
Casa Linda Branch: Serves 2 branches, Deposits 326736.33
Garland Broadway Branch: Serves 1 branches, Deposits 220477.00
Irving Boulevard Branch: Serves 5 branches, Deposits 318683.33
Hillcrest Branch: Serves 2 branches, Deposits 300622.67
Downtown Arlington Branch: Serves 3 branches, Deposits 416060.67
Plano and Preston Branch: Serves 1 branches, Deposits 142617.33
Farmers Branch: Serves 2 branches, Deposits 217342.67
Richardson Branch: Serves 2 branches, Deposits 413423.33
Colleyville Branch: Serves 2 branches, Deposits 361684.00
Forest Hill Branch: Serves 1 branches, Deposits 64663.00
Lewisville Branch: Serves 1 branches, Deposits 124491.00
Castell Motor Bank Branch: Serves 1 branches, Deposits 156336.67
Oak Park Branch: Serves 2 branches, Deposits 176691.33
Highland Park Branch: Serves 1 branches, Deposits 64553.33
El Paso - Downtown Branch: Serves 3 branches, Deposits 636397.00
Northgate Branch: Serves 1 branches, Deposits 111392.33
El Paso - East Branch: Serves 2 branches, Deposits 167685.67
El Paso - West Branch: Serves 2 branches, Deposits 271678.00
Kings Crossing Branch: Serves 1 branches, Deposits 169745.00
William Cannon and Mopac Branch: Serves 3 branches, Deposits 289979.00

Interactive Dashboard

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