Facilities Location Project

George Barmakian
Jenine Davignon
Adam Ginsburg
Sevag Khatchadourian
Bethany Quigley

Acknowledgements

SSYMCA

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  Ralph Yohe
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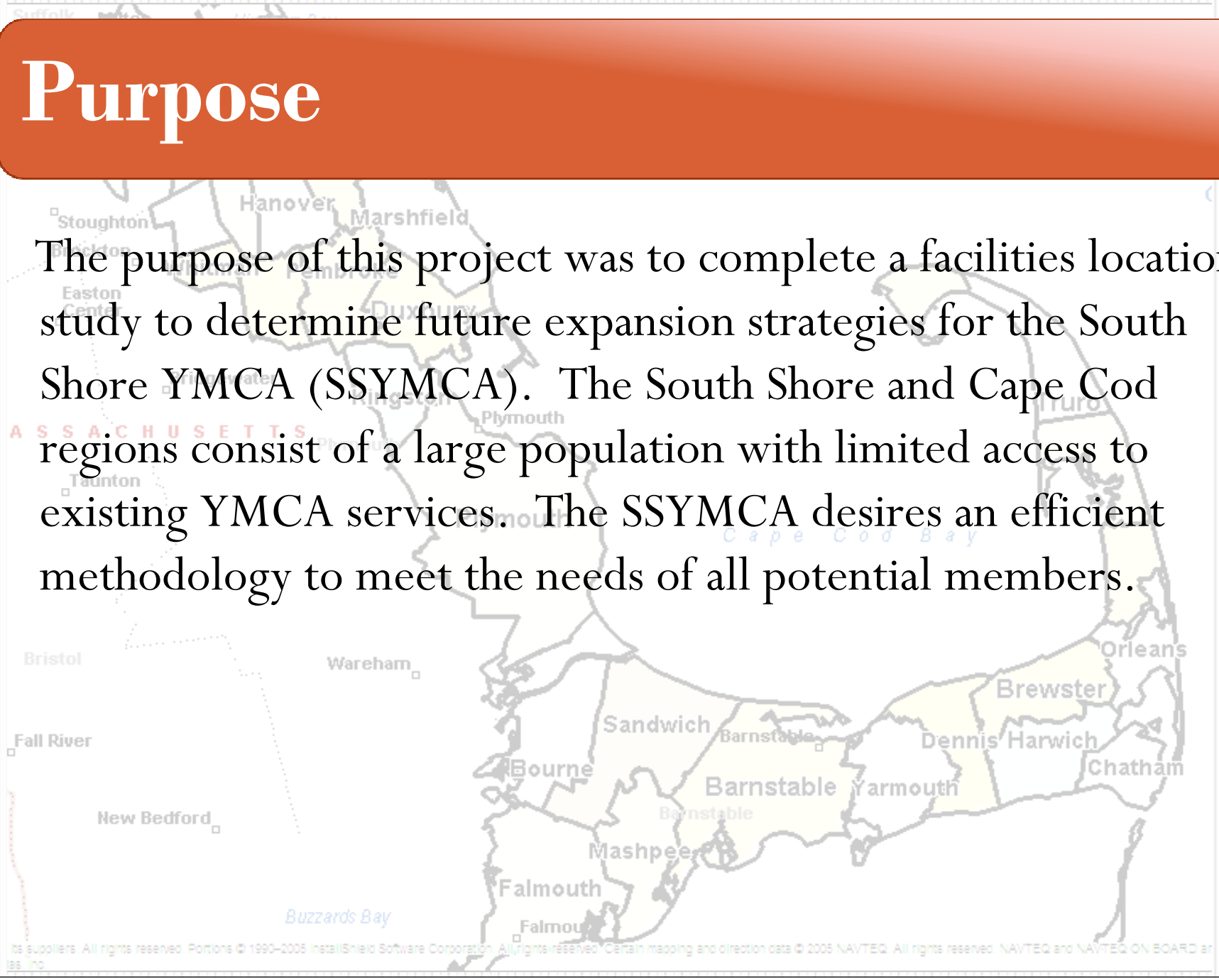
Purpose

The purpose of this project was to complete a facilities location study to determine future expansion strategies for the South Shore YMCA (SSYMCA). The South Shore and Cape Cod regions consist of a large population with limited access to existing YMCA services. The SSYMCA desires an efficient methodology to meet the needs of all potential members.

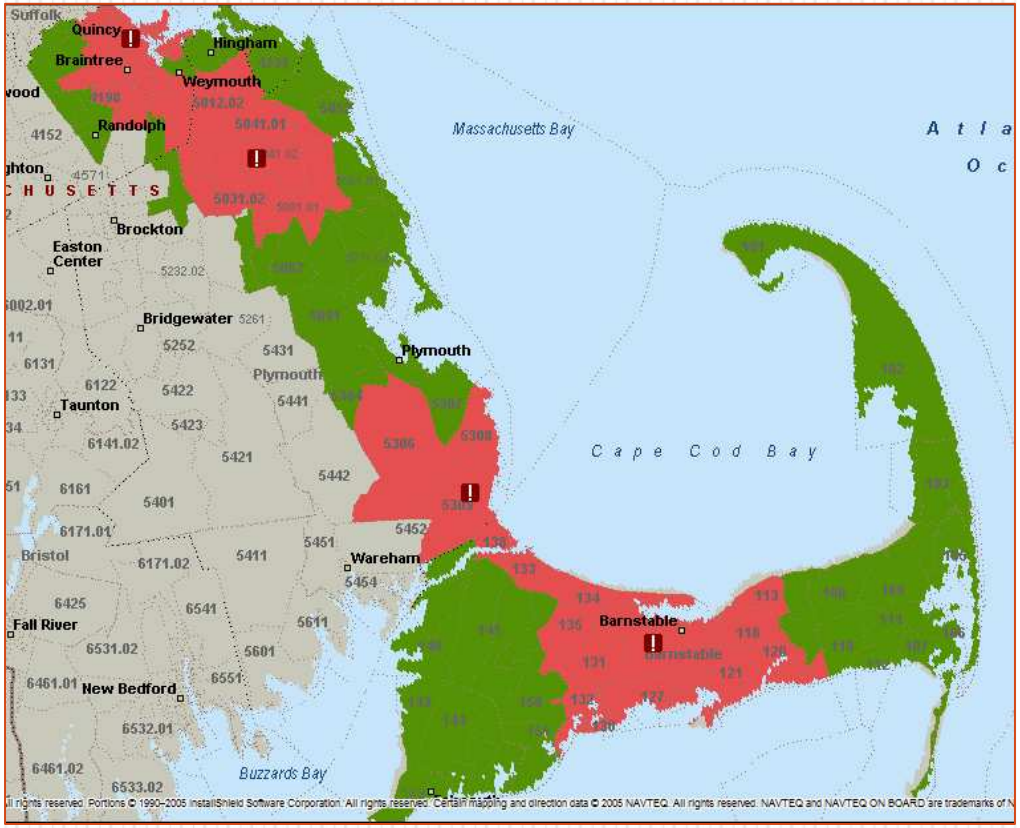


YMCA Background

- Largest not-for-profit organization in America
- 2,617 locations nationwide, 20.2 million members
- Community Based and Driven
- Variety of Programming for Every Age
- Helping Raise America's Children
- Beyond Health and Fitness
- More than a Gym - a Community

Present Locations

- Mill Pond Branch (Hanover)
- Quincy Facility
- Barnstable Branch
- Plymouth Branch (planned facility)

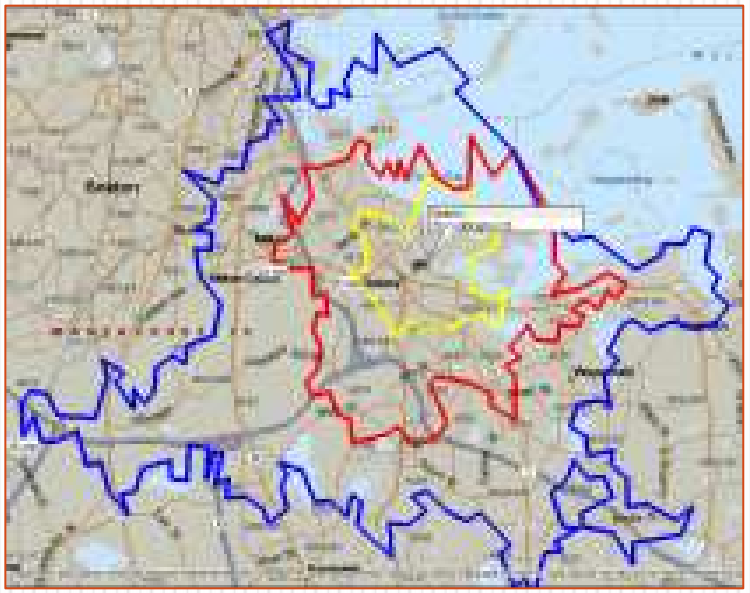


Needs & Requirements

- Identify target customers and areas of need
- Determine relative location and accessibility
- Minimize cannibalization between facilities
- Develop long term strategic vision
- Activities and services

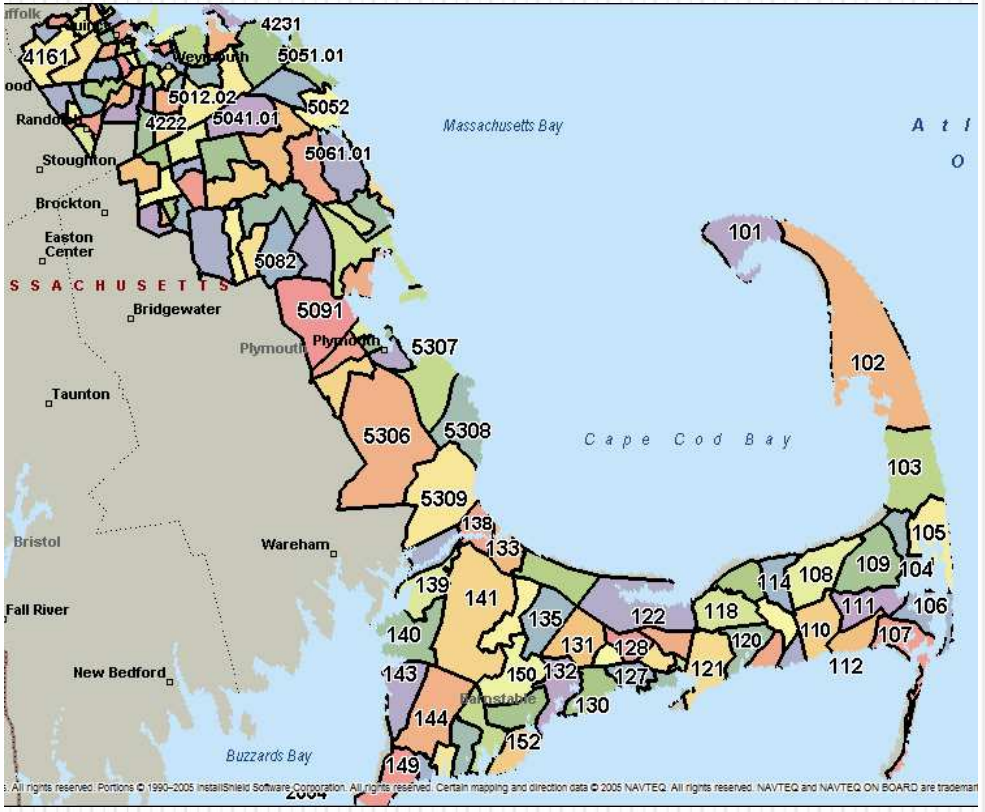
Data Collection

- Determining potential locations
  - Accessibility
    - Reduce distance between potential facilities and demands
  - Traffic data
    - Identified heavy traffic areas
  - 15 minute drive time requirement
    - Validated by membership data and survey
  - Public transportation
    - Insignificant presence in region



Data Collection

- Defining demand
  - Census – Segmenting population into census tracts
  - SEER/PMA Studies – Establishing market penetration
  - Survey – Reasons for joining
  - Member Database – Activity enrollment



Research

- Types of Models
  - Set covering – Minimize facilities to cover all demand
  - Accessibility – Minimize distance between facility and demand
- Characteristics of the Model
  - Network vs. planar mapping
  - Capacitated vs. uncapacitated constraint
  - Deterministic vs. probabilistic input data
  - Inelastic demand, static locations
  - Single vs. multiple facility model
  - Output vs. input number of facilities

Bi-Objective Minimization Model

Inputs:

w = scaling factor

h_j = demand at node *j*

d_{ij} = distance from candidate site *i* to demand node *j*

Decision Variables:

X_i = candidate site *i*

Y_{ij} = demand node *j* assigned to candidate node *i*

Minimize Objective Function:

$$Z = \sum_i wX_i + \sum_i \sum_j h_j d_{ij} Y_{ij} \qquad (1)$$

Bi-Objective Minimization Model

Minimize:

$$Z = \sum_i wX_i + \sum_i \sum_j h_j d_{ij} Y_{ij} \qquad (1)$$

Subject to:

$$\sum_i Y_{ij} = 1 \qquad \forall j \qquad (2)$$

$$Y_{ij} - X_i \leq 0 \qquad \forall i, j \qquad (3)$$

$$\sum_j Y_{ij} h_j \leq c_i X_i \qquad \forall i \qquad (4)$$

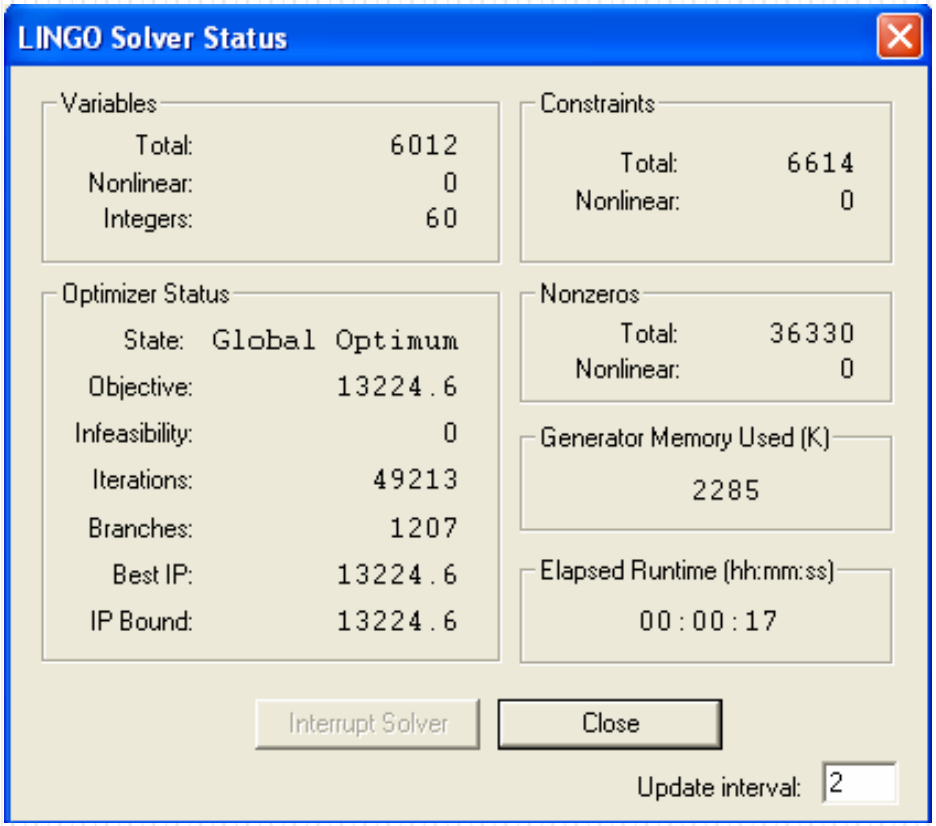
$$X_i = 0,1 \qquad \forall i \qquad (5)$$

$$Y_{ij} = 0,1 \qquad \forall i, j \qquad (6)$$

Implementing the Model

Automation and Integration:

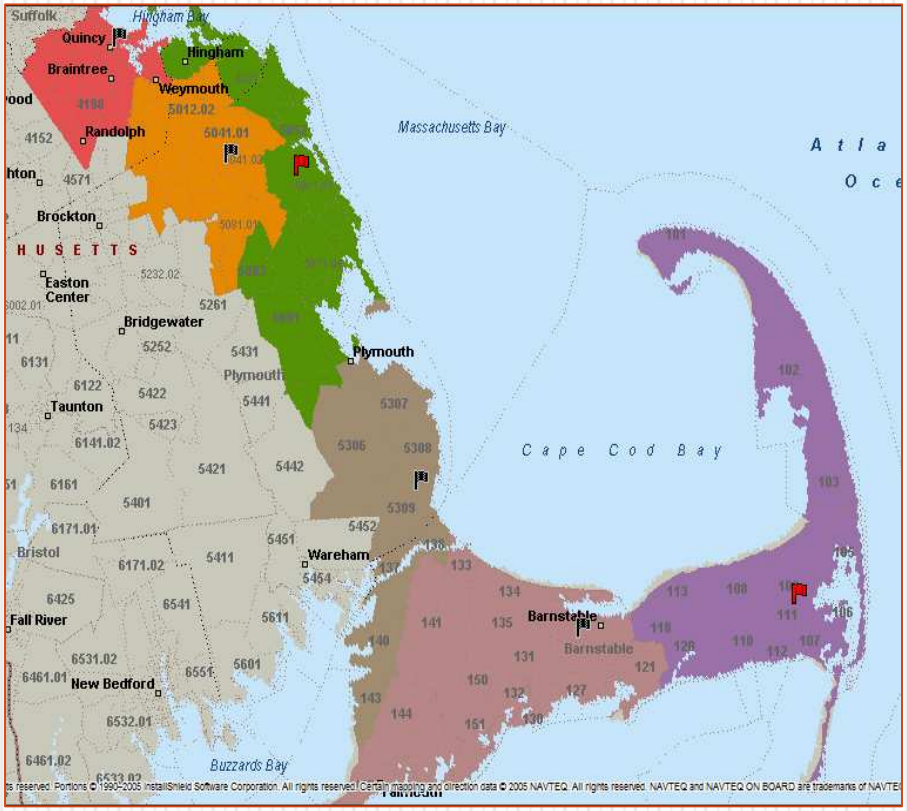
- Excel-Data Management
- Lingo-Optimization Application
- MapPoint-Data Mapping Software



Model Results

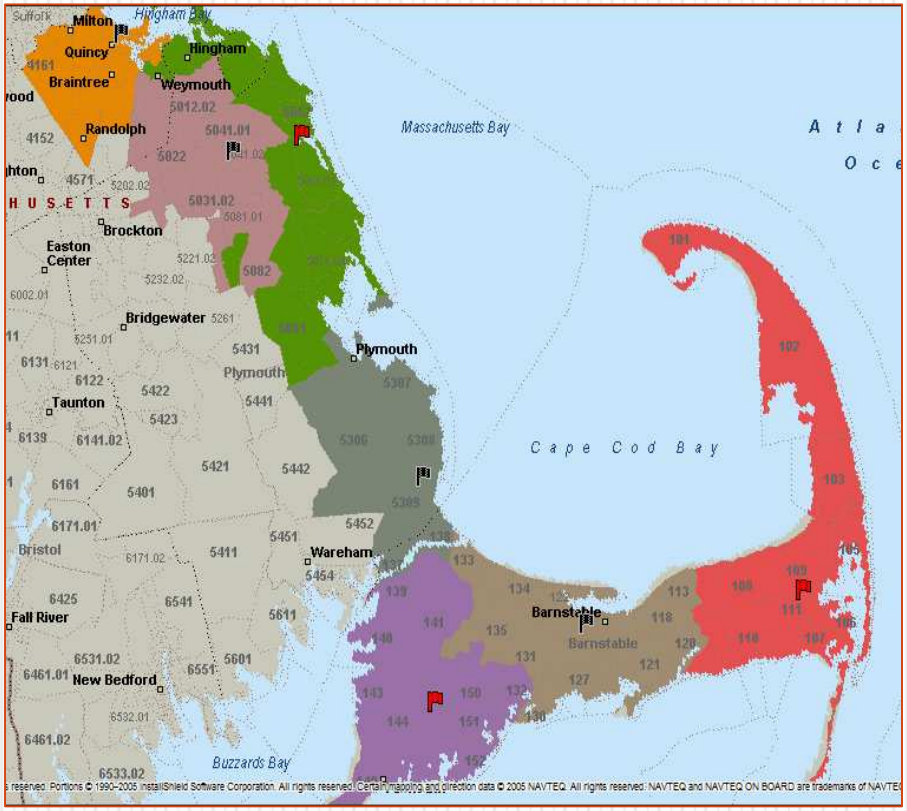
- Four Approaches
  1. Maximized Set Covering Approach
  2. Weighted Set Covering Approach
  3. Weighted Accessibility Approach
  4. Maximized Accessibility Approach
- Activity Recommendations
  - Compared to existing regional facilities
  - General suggestions of activities at each facility

Maximized Set Covering Approach



- Minimize number of facilities used to cover demand
- Locations
  1. Marshfield
     - Route 3 & Pine Street
  2. Harwich
     - Route 6 & Route 137

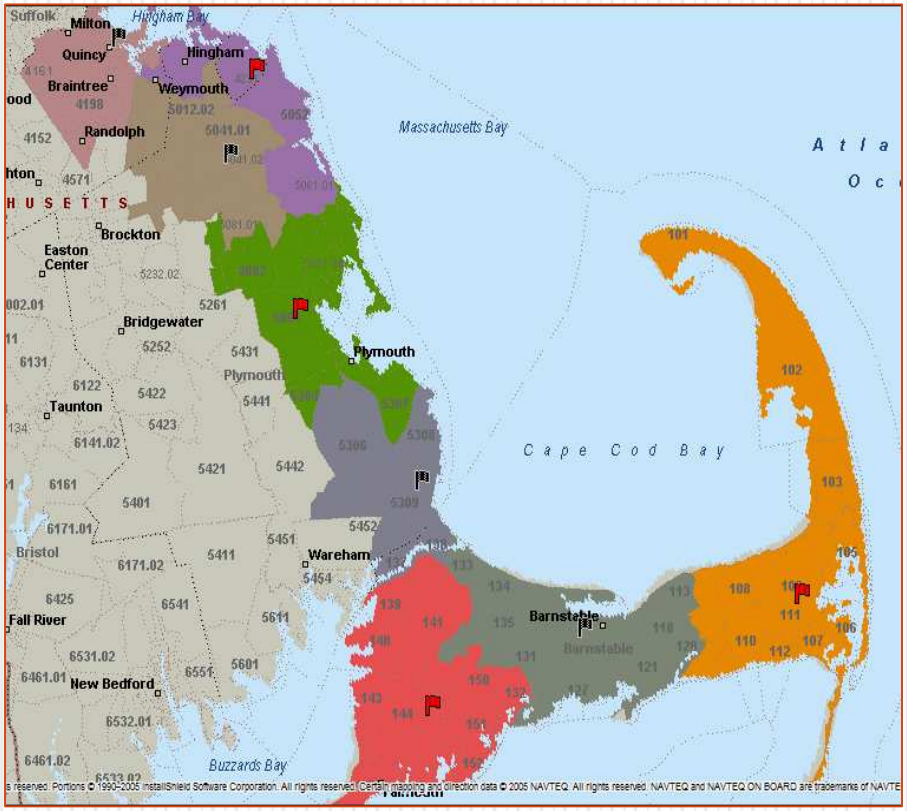
Weighted Set Covering Approach



- Reduce number of facilities while giving some weight to accessibility

- Locations
  1. Marshfield
     - Route 3 & Pine Street
  2. Falmouth
     - Sandwich Rd & Hayway Rd
  3. Harwich
     - Route 6 & Route 137

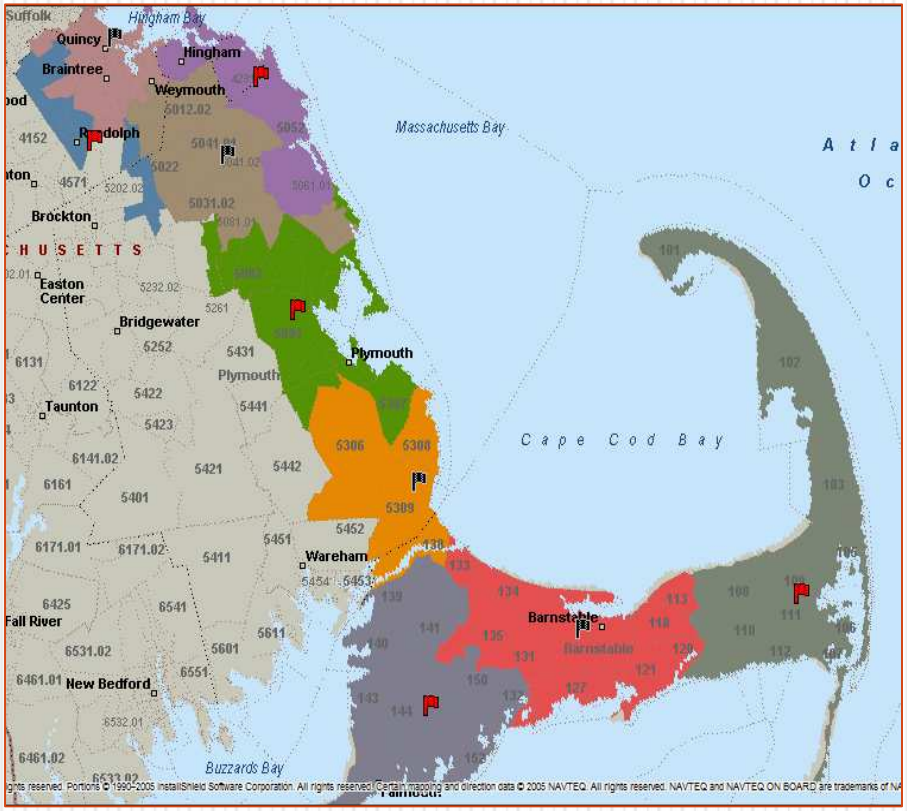
Weighted Accessibility Approach



- Maximize accessibility to demand nodes with some weight to minimizing facilities

- Locations
  1. Kingston
     - Route 27 & Route 106
  2. Cohasset
     - Route 3A & Beechwood St
  3. Falmouth
     - Sandwich Rd & Hayway Rd
  4. Harwich
     - Route 6 & Route 137

Maximized Accessibility Approach



- Maximize accessibility of facilities to demand nodes
- Locations
  1. Kingston
     - Route 27 & Route 106
  2. Falmouth
     - Sandwich Rd & Hayway Rd
  3. Harwich
     - Route 6 & Route 137
  4. Scituate
     - Route 3A & Henry Turner Bailey Rd
  5. Randolph
     - Route 139 & Mill Street

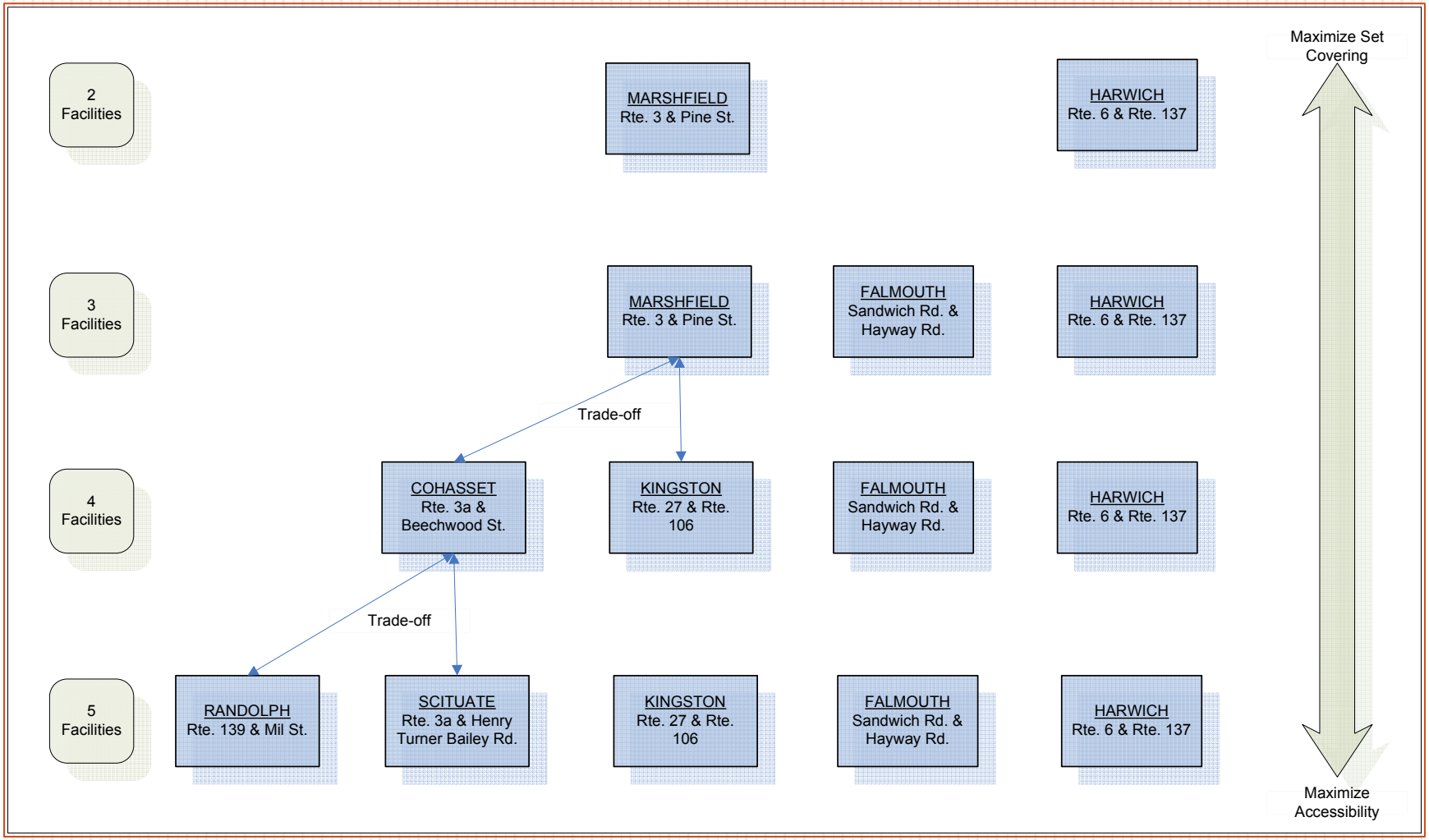
Projected Membership & Recommended Services

- **Falmouth**

Suggested Activities	Total	6054
Adult Fitness	Age	Percentage
Aquatics	0 to 9	11.4%
Arts & Humanities	10 to 19	12.3%
Family	20 to 29	7.5%
Teen	30 to 39	13.6%
Teen Fitness	40 to 49	15.4%
Vacation Camp	50 to 59	13.5%
Youth Sports/Fitness	60 to 69	11.5%
	70 to 79	9.9%
	80 and up	4.8%

- Recommended Services
- Projected Membership Demographics
- Relative Facility Size

Sensitivity Analysis



Recommended Expansion

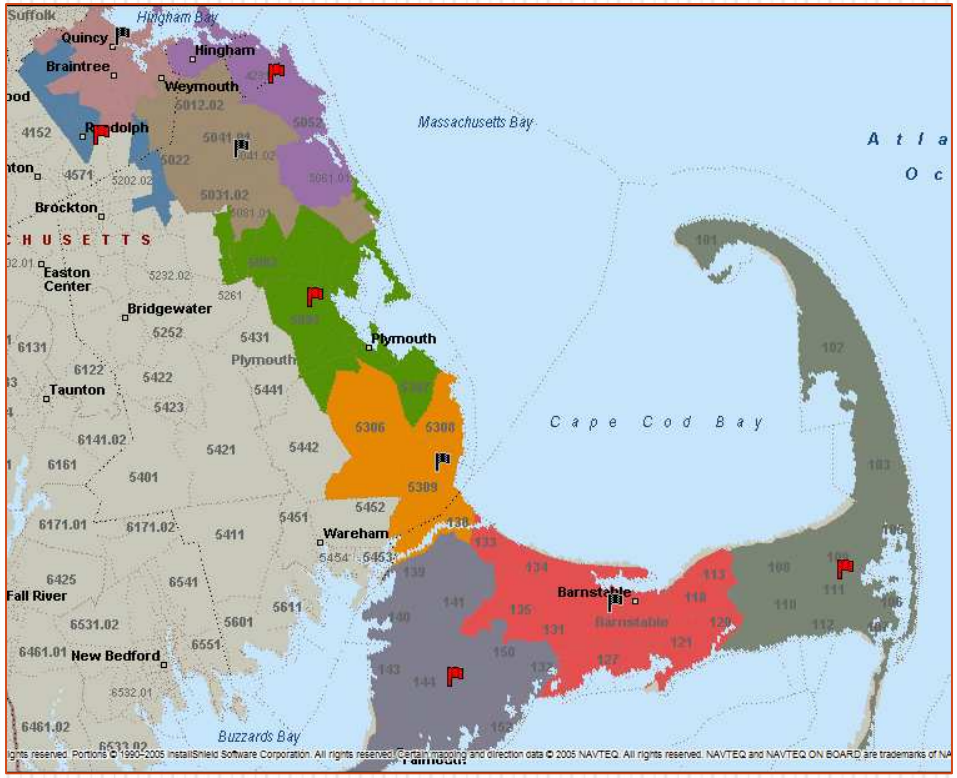
- **Kingston**

Suggested Activities	Total	7882
Adult Fitness	**Age**	**Percentage**
Aquatics	0 to 9	14.6%
Arts & Humanities	10 to 19	13.9%
Family	20 to 29	8.8%
Gymnastics	30 to 39	15.9%
Teen	40 to 49	17.0%
Teen Fitness	50 to 59	13.6%
Vacation Camp	60 to 69	6.9%
Youth Sports/Fitness	70 to 79	5.4%
	80 and up	4.0%

- Greatest need
- Between Hanover and Plymouth facilities
- Full-scale facility
- Minimal cannibalization potential

Conclusions

- Suggested new facility in Kingston, MA
- Falmouth & Harwich facilities for underserved Cape Cod demand
- Strong cannibalization concerns for Cohasset/Scituate and Randolph regions



Future Considerations

- Computational Efficiency and Tools
  - Software selection
- What-if Scenarios
  - More usability in model
- Interchangeability & Scalability
  - Transfer of model to any region

Questions?

Bi-Objective Minimization Model

Minimize:

$$Z = \sum_i wX_i + \sum_i \sum_j h_j d_{ij} Y_{ij} \qquad (1)$$

Subject to:

$$\sum_i Y_{ij} = 1 \qquad \forall j \qquad (2)$$

$$Y_{ij} - X_i \leq 0 \qquad \forall i, j \qquad (3)$$

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Weight Factor Table

Weight Coefficient	Number of Additional Facilities	Estimated Solver Run Time
0-40	13	0 - 5 sec
40-85	12	0 - 5 sec
85-135	11	0 - 5 sec
135-215	10	0 - 5 sec
215-230	9	5 - 10 sec
230-265	8	5 - 10 sec
265-335	7	5 - 15 sec
335-400	6	5 - 15 sec
400-700	5	20 sec - 2 min
700-1375	4	50 sec - 6 min
1375-1550	3	5 - 8 min
1550-4000	2	45 sec - 5 min
>4000	1	0 - 50 sec

Survey

YMCA Demographic Survey

The South Shore YMCA is working with a group of five Northeastern University Engineers on their Senior Capstone Project. They are looking to collect data from real YMCA members as to what motivated you to join the YMCA instead of another organization.

Please take a moment to help these students with their project.

Age: _____ **Gender:** M F **(please circle one)**

Town you live in: _____

Town you work in: _____

Years as an YMCA Member: _____

Type of Membership: Household Adult Junior Senior Youth
(please circle one)

Where do you travel from most frequently to use the YMCA?

School Work Home Other: _____
(please circle one)

How long do you travel to get to the YMCA: (please circle one)

0-10 minutes 11-20 minutes 21-30 minute 30+ minutes

Primary reason for joining YMCA: (please check as many as apply)

___Family Friendly

___Nearby/Accessible

___Affordability

___Other: _____

Program/Service you use the most at the YMCA: