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Evaluating Veteran Access to Eye Care Services Using Facility Location Models

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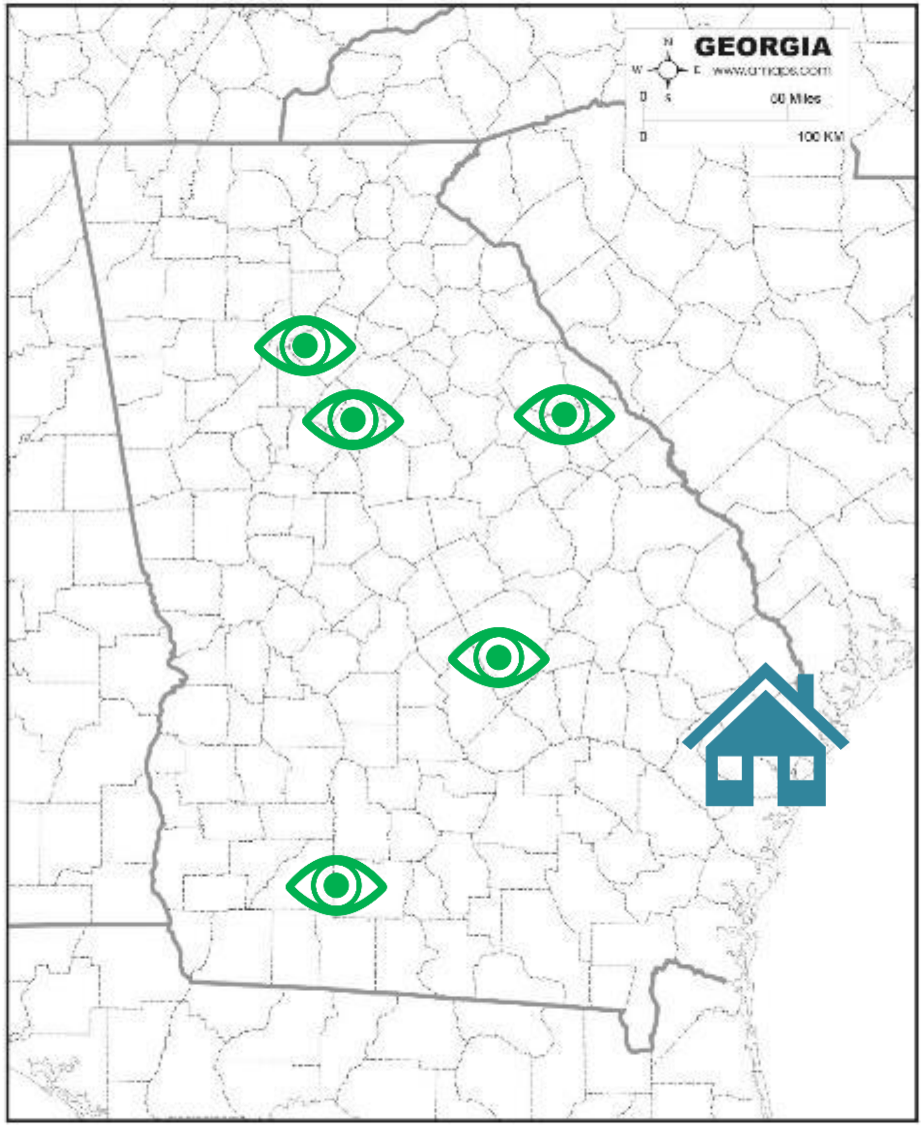
UNIVERSITY OF MICHIGAN

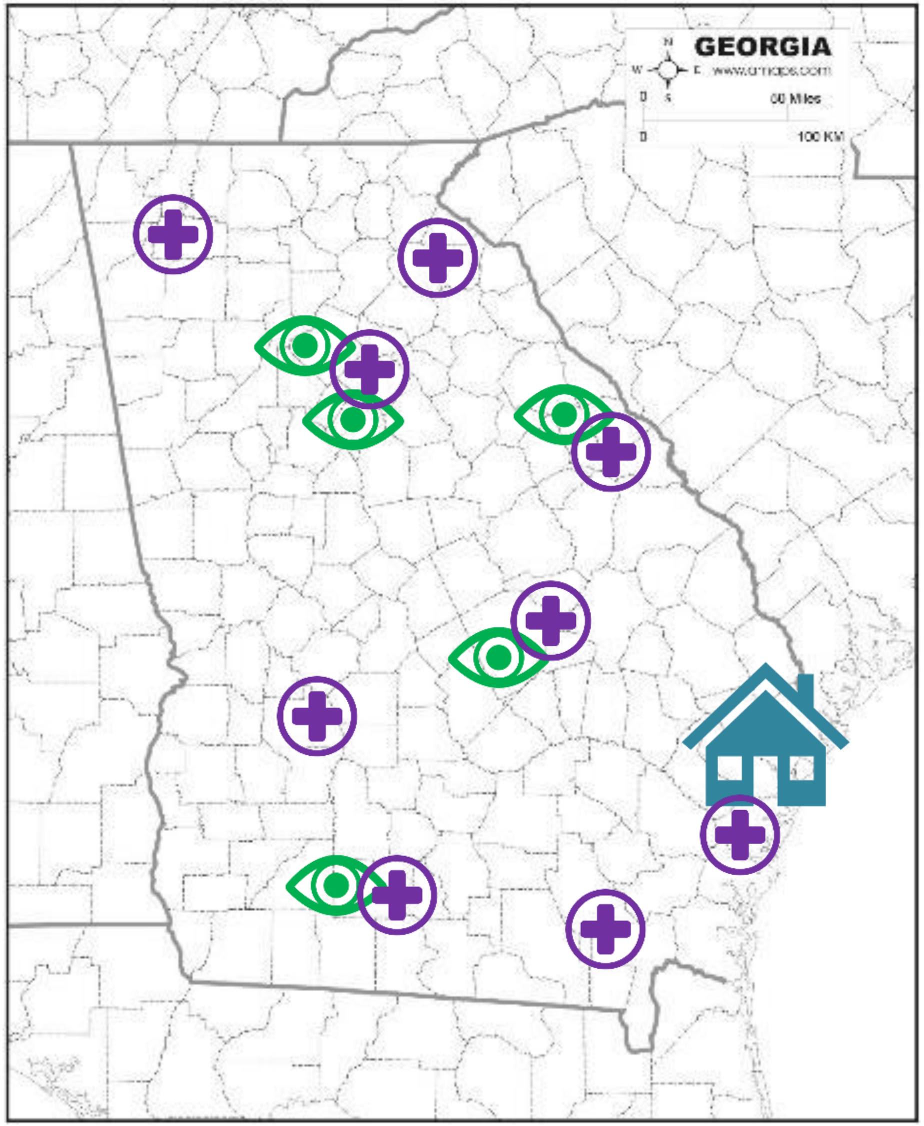
Regional Telehealth Services

VA HEALTH CARE | Defining EXCELLENCE in the 21st Century

Veteran Eye Care in Georgia



Add Screening Options



What are we trying to solve?

Primary care visit

Tech performs eye screening

What kind of problem is this?

- Combinatorial matching problem
  - Deciding locations to offer eye care and how to staff those locations
- Constrained resources
- Multi-criteria decision
  - Consider cost, distance traveled, number of patients seen, etc.

Problem Statement

- Goal: Evaluate **which locations** to offer eye care screenings and **what providers types** to staff each eye care location
- Assumptions:
  - Patients go to "assigned" clinic for eye care screening
  - One-year time frame
  - Patients have homogeneous screening need (one screening every other year)
- Limitations:
  - Considering eye care screening only (follow-up care not included)
  - No consideration for patients' provider preferences

General modeling approach

Possible eye care locations

- 25 VA locations in Georgia

Decide:

- At which locations do we offer eye care?
- What kind(s) of provider should staff each location?

"Assign" patients

- Each zip code to clinic location(s)

Consider scenarios

- Start from current state
  - 15 established locations
- Start from scratch

Model Overview: Feasibility Constraints

- Patient Capacity
  - Number of patients assigned to clinic cannot exceed clinic capacity
    - Capacity subject to type/number of providers at each clinic

$$\sum_{z\in Z} x^t_{zc} \leq v^t * y^t_c \qquad \forall\, c \in C,\ \forall t \in T$$

- Demand
  - Percent of patients assigned per zip code should be between a lower and upper required percent

$$\sum_{t\in T}\sum_{c\in C} x^t_{zc} \geq n_l * p_z \qquad \forall\, z \in Z$$

$$\sum_{t\in T}\sum_{c\in C} x^t_{zc} \leq n_u * p_z \qquad \forall\, z \in Z$$

- Provider Capacity
  - Each clinic can hold a maximum number of providers

$$y^t_c \leq g^t_c \qquad \forall t \in T, \forall c \in C$$

$$\sum_{t\in T} y^t_c \leq g_c \qquad \forall c \in C$$

Model Overview: Three objective functions

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I. Maximize patients assigned

+ constraints:
Budget, distance

$$Maximize \sum_{z \in Z} \sum_{c \in C} \sum_{t \in T} x^t_{zc}$$

II. Minimize overall costs

+ constraints:
Patients, distance

$$Minimize \left[\sum_{c \in C} \sum_{z \in Z} \sum_{t \in T} (a^t_c * x^t_{zc} + (d_{zc} * x^t_{zc}) * r + f^t_c * y^t_c)\right] + h * \sum_{z \in Z} (n_u * p_z - \sum_{t \in T} \sum_{c \in C} x^t_{zc})$$

III. Minimize maximum furthest distance traveled

+ constraints:
Budget, Patients

$$Minimize\ m$$

Data Overview

- Patients accessing Georgia VA for (any) care in 2017
  - Approximately 200,000 patients considered
  - Group patients by zip code
- Clinic locations
  - 25 VA clinics in Georgia
    - 15 currently offer some type of eye care
- Driving distance from center of each zip code to each clinic location calculated via Google API
- Budget/costs, provider capacities, and other clinic-specific values obtained from VA
- Model implemented in CPLEX

Results: Maximize Patients Assigned

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From scratch			
	min % seen		
Budget	0%	5%	10%
$20 Million	28980	27720	26450
$21 Million	45360	44100	44100
$22 Million	60480	60480	60480

From current			
	min % seen		
Budget	0%	5%	10%
$20 Million	inf	inf	inf
$21 Million	23928	23340	22080
$22 Million	40980	39720	39720

(max dist: 150 miles)

Results: Minimize Cost

From scratch			
	min % seen		
Max Travel Distance (Miles)	0%	5%	10%
100	$19,053,900	$19,731,600	$19,879,100
150	$19,095,500	$19,344,000	$19,641,200
200	$18,737,000	$19,000,000	$19,568,300

From current			
	min % seen		
Max Travel Distance (Miles)	0%	5%	10%
100	$20,610,700	$20,832,300	$20,930,500
150	$20,610,700	$20,755,300	$20,916,500
200	$20,610,700	$20,697,600	$20,954,000

(min 5000 total screen)

Results: Minimize Maximum Distance Traveled

From Scratch			
	Min % seen		
Min Total Patients	0%	5%	10%
10000	5	87	87
20000	8	87	87
30000	inf	inf	inf

From Current			
	Min % seen		
Min Total Patients	0%	5%	10%
10000	6	87	87
20000	14	87	87
30000	inf	inf	inf

(budget: $21M)

Conclusions & next steps

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- Maximizing number of patients assigned to screening is objective of most interest to clinical collaborators
- Incorporate stochasticity
  – Consider patients not visiting their "assigned" clinic
- Consider implications for follow-up care
  – How are ophthalmologist/optometrist case mixes impacted?
- Generalize beyond Georgia
  – Apply to other VA regions considering robust eye care options

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