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Veterinary Clinics Accessibility Database

Do people near Madison, WI have access to affordable care for their pets?

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Problem Statement

This database was designed to investigate the limitations for people when accessing veterinary (vet) care near Madison, Wisconsin. This database combines census tract level data for demographics and socio-economic variables with vet locations and vet services combined with transit information. The goal is to identify barriers people face when getting to vet locations, or finding vet locations that provide a range of services, or finding vets with low cost options.

We are seeking to answer:

- How many census tracts have accessible vet care?
- Which census tracts have the highest access to vet care?
- Which census tracts have the lowest access to vet care?
- How many census tracts have vet clinics inside their boundaries?

Background

As domestic animal euthanasia rates decline in the US (ASPCA Pet Statistics), the animal welfare community can begin shifting focus from shelter overcrowding to keeping pets happy and healthy in their homes. In Madison, WI, local shelters have seen access to accessible vet care be a common reason owners have to consider surrendering their pet. As views on pet ownership evolve, more and more animal welfare groups are recognizing the importance of the human-animal bond for all, regardless of socio-economic barriers. This has led to an increase in programs aimed at assisting owners with pet supplies and accessible vet services (CAP Times Pets for Life). One challenge to these programs is identifying where their services could make the biggest impact and help those in need. By analyzing the vet services offered in the community, we can begin to see where accessible vet services could be the most helpful.

When defining accessible vet services, we've narrowed the definition to five main variables: location, operating hours, species treated, payment options, and cost/breadth of care.

1. Location is important because in a city environment many pet owners do not own personal vehicles. City buses in Madison, WI only allow animals small enough to fit in a carrier on the rider's lap. If an owner of a large animal needs to take a taxi/Uber/Lyft to

access a vet clinic, that can significantly add to the cost of care and deter an owner from pursuing preventative or non-emergency care.

2. Typically, vet clinics operate on normal business hours (M-F, 8/9-5) and may offer limited Saturday hours. This can be a barrier for those who work during these hours and cannot take a day off work for a vet visit. This can mean these owners may need to seek care at emergency clinics, which typically have longer operating hours but also higher costs.
3. The majority of vet clinics in Madison treat only cats and dogs. This can be a major barrier for owners of other species, such as rabbits, rodents, birds, and reptiles. Owners with these pets may need to seek care further away, meaning more time required and more transportation costs.
4. Payment options looks at the availability of direct payment plans or acceptance of alternative payment options, two of the most common being CareCredit and Scratchpay. These two alternative options are similar to using a credit card, but have grace periods with little or no interest rate, meaning they can be more affordable compared to using a traditional credit card. Offering payment plans or accepting one of these payment methods allows large bills to be broken into smaller payments, making expensive vet visits possible for those without a savings account.
5. The last factor is cost/breadth of care. The majority of clinics in Madison are full service clinics, which generally means they are not low cost. The few low cost clinics are able to offer routine services for lower costs but do not have the staffing or equipment to offer more comprehensive diagnostics or treatments for complicated situations. Low cost clinics also tend to have long waitlists and cannot guarantee emergency services.

Database Design

Description

Our database was created by combining geographical data of Madison bounds, Madison bus stops, and Madison road data with demographic data per census tract and Vet clinic information. These were gathered as separate data sources, either CSV or shapefile, and combined into a database with PostgreSQL with PostGIS extension. A summary of tables and attributes in the database follows:

Tables Summary

Table Name	File Type	Geometry Type	Projection	Data Source	Description
`vet_walk_polygons`	Shapefile	Polygons	UTM Zone 16N	Network Analysis by Sid	Stores 0.5, 1 mile walk polygons from veterinary clinics (Network Analysis)
`madison_demographics`	CSV	NA	NA	Wisconsin Food Project	Stores demographics and socio-economic information
`madison_census_tracts`	Shapefile	Polygon	UTM Zone 16N	GeoData@ Wisconsin	Stores latest census tracts information 2022 (Tiger line)
`madison_metro`	Shapefile	Point	UTM Zone 16N	City of Madison	Stores stops information of Madison Metro Bus routes
`madison_vet`	Shapefile	Point	UTM Zone 16N	Compiled by Kaitlyn Breaux	Stores information on veterinary clinics (dogs, cats, open days, services)
`madison_urban_bounds`	Shapefile	Polygon	UTM Zone 16N	GeoData@ Wisconsin	Stores urban bounds of city of Madison, WI
`dane_roads`	Shapefile	Line	UTM Zone 16N	GeoData@ Wisconsin	Stores road network (Elevation model) of Dane county

Table 1. Summary of Tables used in Vet Database

Attributes Summary

Table `madison_demographics` stores socio-demographic indicators which are retrieved from American Community Survey (ACS) 2016-20 describes economic conditions with the Gini Index of income inequality and median income which help analyze locations with low access to vet care in Madison, WI. The data is sourced from Applied Population Laboratory (APL).

- `noveh1620_est`: Households without vehicle, % (2016-20)
- `gini1620_est`: Gini Index of Income Inequality (2016-20)
- `medincacs1620_est`: Median household income (2016-20)
- `walkoth1620_est`: Workers walking or other non-vehicle, % (2016-20)
- `pubtrans1620_est`: Workers using public transportation, % (2016-20)
- `noncitizens1620_est`: Noncitizens, % (2016-20)
- `hispanic1620_est`: Hispanic or Latino, % (2016-20)

- `raceoth1620_est`: Other or multiple race, % (2016-20)
- `raceamind1620_est`: American Indian, % (2016-20)
- `raceasian1620_est`: Asian, % (2016-20)
- `raceaa1620_est`: African American, % (2016-20)
- `racewhite1620_est`: White, % (2016-20)

Table `madison_metro` stores information of metro transit stop names and routes connected to bus stops. The information is sourced from the City of Madison. The dataset helps in understanding public transit availability in each census tract to assess vet care accessibility.

- `stop_code`: Bus stop code for each stop provided by Madison metro bus service.
- `stop_name`: Name of the bus stop
- `primary_st`: Primary street where the bus stop is located
- `Route`: Other connected route codes from a bus stop
- `geometry`: Point geometry of bus stop

Table `madison_census_tracts` is useful in appending with madison_demographics to gain insights for spatial queries in understanding vet clinics availability, number of bus stops.

- `tractce`: Census tract code
- `geoid`: Census tract identifier which is combination of state(55), county(025) and tractce values
- `namelsad`: Translated legal/statistical area description
- `shape_leng`: Shape length
- `shape_area`: Shape area
- `geometry`: Polygon geometry of each census tract

Table `madison_vet` provides information on veterinary clinic addresses with range of service availability (weekends/weekdays) for various species of pet animals. Additional information on payment plans, full services are also added to complement the veterinary clinics data. The data is compiled by Kaitlyn Breaux.

- `name`: Name of veterinary clinic/hospital
- `hnum`: House number
- `street`: Street address of the clinic

- `city`: Location of city (Within Dane county)
- `open_wk`: Open on weekdays (Yes/No)
- `open_wkds`: Open on weekends (Yes/No)
- `cats`: Cats are treated (Yes/No)
- `dogs`: Dogs are treated (Yes/No)
- `others`: Other animals are treated (Yes/No/NA)
- `pplan`: Payment plan availability (Yes/No/NA)
- `full_srvc`: Full service availability (Yes/No)
- `low_cost`: Low cost clinic (Yes/No)
- `geometry`: Point location of veterinary clinic

Table `madison_urban_bounds` stores the geometry information on the limits of Madison, WI. The dataset is downloaded from city of Madison

- `name`: Name of shapefile
- `geometry`: Polygon geometry of Madison, WI urban bounds

Table `vet_walk_polygons` provides walk polygons of 0.5 mile and 1 mile distance from veterinary clinics points (using madison_vet datasest) and dane_roads shapefile which describes Dane county road network sourced from GeoData@Wisconsin website (2022). The dataset is computed by Chinna Subbaraya Siddharth (Sid) Ramavajjala by performing network analysis using ArcGIS Pro. The dataset helps in understanding of access to vet care by foot, for someone who may not be able to drive or take the public bus with their pet.

- `name`: Veterinary clinic from which walk polygons are computed
- `org_mile`: Origin mile value of the walk polygon
- `dst_mile`: Destination mile value of the walk polygon
- `shape_leng`: Shape length of polygon
- `shape_area`: Shape area of polygon
- `geometry`: Walk polygon geometry of 0.5 and 1 mile

Entity-Relationship Diagram

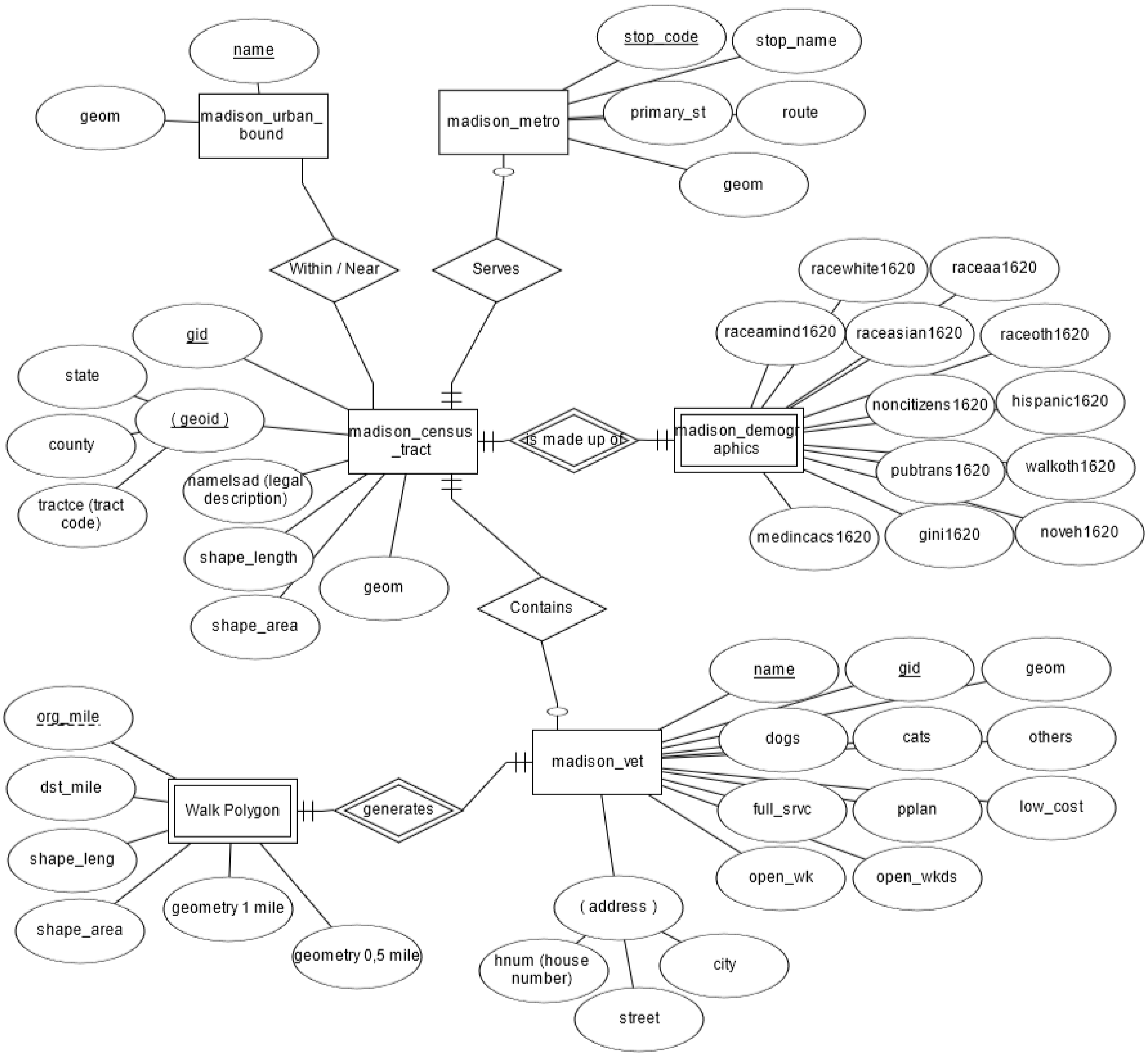

Figure 1. Entity-Relationship used to illustrate the Vet Database

Logical Schema Diagram

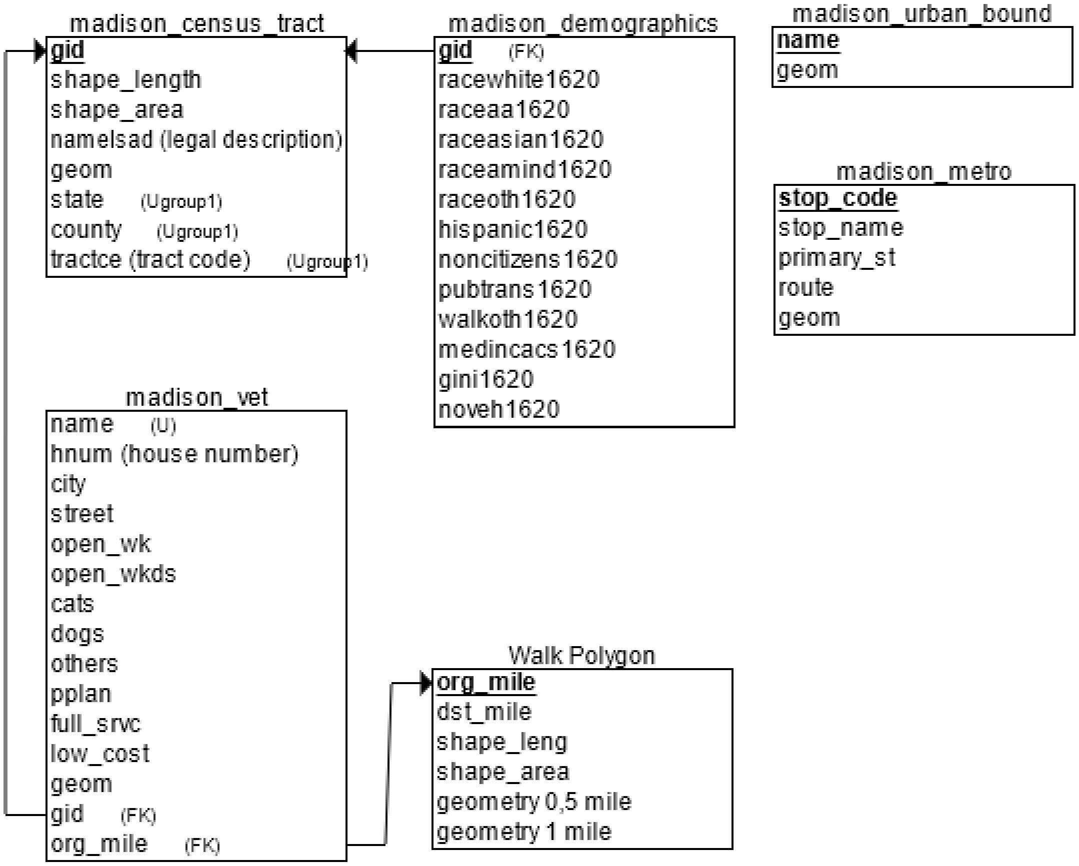

Figure 2. Logical Schema Diagram used to illustrate the Vet Database. The madison_urban_bounds geometry was used to clip the extents of census tract geometry, and madison_metro geometry was used to search against geometry of the connected census tract information.

Implementation and Manipulation:

The data stored in our vet database is a result of tailored pre-processing techniques using Python libraries like Geopandas, Pyproj and ArcGIS Pro 3.0 software. After downloading all necessary data from various sources, all the datasets were reprojected to **UTM Zone 16 N**. The Census tracts and Dane county road network were extracted based on intersection with the

Madison urban area boundary. The Madison veterinary clinics CSV dataset was geocoded manually to include latitude and longitude from Google Maps, which was then converted to shapefile using Geopandas and the coordinate system was converted to EPSG:4326. Lastly, all datasets were curated for redundancy of attributes and database loading. We hosted data on github (https://github.com/Sidrcs/vet_clinics_db) for communication between team members.

STEP 1: Use shapefile to SQL command line conversion (`shp2pgsql`) to create SQL file from shapefile.

Common syntax : `shp2pgsql -s (spatial reference) [EPSG_code] path_to_shapefile table_name > sql_file_name.sql`

1. `shp2pgsql -s 32616 madison_urban_bounds madison_urban_bounds > madison_urban_bounds.sql`
2. `shp2pgsql -s 32616 madison_census_tracts madison_census_tracts > madison_census_tracts.sql`
3. `shp2pgsql -s 32616 vet_walk_polygons  vet_walk_polygons > vet_walk_polygons.sql`
4. `shp2pgsql -s 32616 madison_metro madison_metro > madison_metro.sql`
5. `shp2pgsql -s 32616 madison_vet madison_vet > madison_vet.sql`

STEP 2: Load shapefiles into database

Common syntax: `psql -d [database_name] -U (username)` *`postgres`* `-f (file) filename.sql`

```
psql -d vet -U postgres -f madison_urban_bounds.sql
psql -d vet -U postgres -f madison_census_tracts.sql
psql -d vet -U postgres -f vet_walk_polygons.sql
psql -d vet -U postgres -f madison_metro.sql
psql -d vet -U postgres -f madison_vet.sql
```

STEP 3: Create a table to insert CSV data in vet database

```
CREATE TABLE madison_demographics(
     TRACTCE  int,
     GEOID    varchar(30),
     NAMELSAD varchar(30),
     racewhite1620_est real,
     raceaa1620_est real,
     raceasian1620_est real,
     raceamind1620_est real,
     raceoth1620_est real,
     hispanic1620_est real,
     noncitizens1620_est real,
     pubtrans1620_est real,
     walkoth1620_est real,
     medincacs1620_est int,
     gini1620_est real,
     noveh1620_est real
);
```

STEP 4: Load CSV into madison_demographics table (vet database)

- `psql -U postgres vet`
- `\copy madison_demographics(TRACTCE, GEOID, NAMELSAD, racewhite1620_est, raceaa1620_est, raceasian1620_est, raceamind1620_est, raceoth1620_est, hispanic1620_est, noncitizens1620_est, pubtrans1620_est, walkoth1620_est, medincacs1620_est, gini1620_est, noveh1620_est) FROM 'C:\Users\Sidrcs\Documents\Github\vet_clinics_db\processed_project_data\Madison_CT_Demographics.csv' DELIMITER ',' CSV HEADER NULL 'NA';`

STEP 5: Create index on geometries

```
CREATE INDEX madison_census_tracts_geom_gist ON madison_census_tracts USING GIST
(geom);
CREATE INDEX madison_metro_geom_gist ON madison_metro USING GIST (geom);
CREATE INDEX madison_vet_geom_gist ON madison_vet USING GIST (geom);
CREATE INDEX vet_walk_polygons_geom_gist ON vet_walk_polygons USING GIST (geom);
CREATE INDEX madison_urban_bounds_geom_gist ON madison_urban_bounds USING GIST
(geom);
```

STEP 6: Create a backup SQL file in core_database folder

```
pg_dump –U postgres vet > vet_db.sql
```

Case Studies and Results

Case Study 1

Jane, a new student at UW-Madison lives downtown with no car. She has a pet dog and needs to find care within 1 mile of walking distance. Her dog is most likely not allowed on buses. (*Her approximate location is -89.3882, 43.0775*).

Jane finds her coordinates from Google Maps, but our database is all UTM Zone 16N. In order to convert the Google Maps coordinates (WGS 84) to UTM Zone 16N, Sid Ramavajjala created a small function using Python.

Function converts point from WGS 84 to UTM Zone 16N WKT (Well-Known Text)

- Open Google Maps right on any location in Madison, WI. Copy the coordinates (lat, lon) as (lon, lat) and paste them as is into the function and it would give Well-Known Text (WKT) output which can be used for spatial querying in PostgreSQL.

[15]:
```
def point_wgs84_utm16N_wkt(lon, lat):
    input_crs = pyproj.CRS("EPSG:4326")
    output_crs = pyproj.CRS("EPSG:32616")
    transformer = pyproj.Transformer.from_crs(input_crs, output_crs, always_xy=True)
    lon_proj, lat_proj = transformer.transform(lon, lat)
    point = Point(lon_proj, lat_proj)
    wkt = point.wkt
    print(wkt)
```

[16]:
```
point_wgs84_utm16N_wkt(-89.3882, 43.0775)
```

```
POINT (305582.7152225829 4772189.289749355)
```

Figure 3. Screenshot of Python code used to convert coordinates from WGS84 to UTM Zone 16N

a) *Find veterinary clinics within 1609.34 meters (1 mile) from Jane's location*:

Query 1: `SELECT vet.name, vet.low_cost, vet.dogs, vet.open_wk, vet.open_wkds, vet.full_srvc FROM madison_vet as vet WHERE ST_DWithin(geom, ST_GeomFromText('POINT (305582.7152225829 4772189.289749355)',32616), 1609.34);`

Result 1:

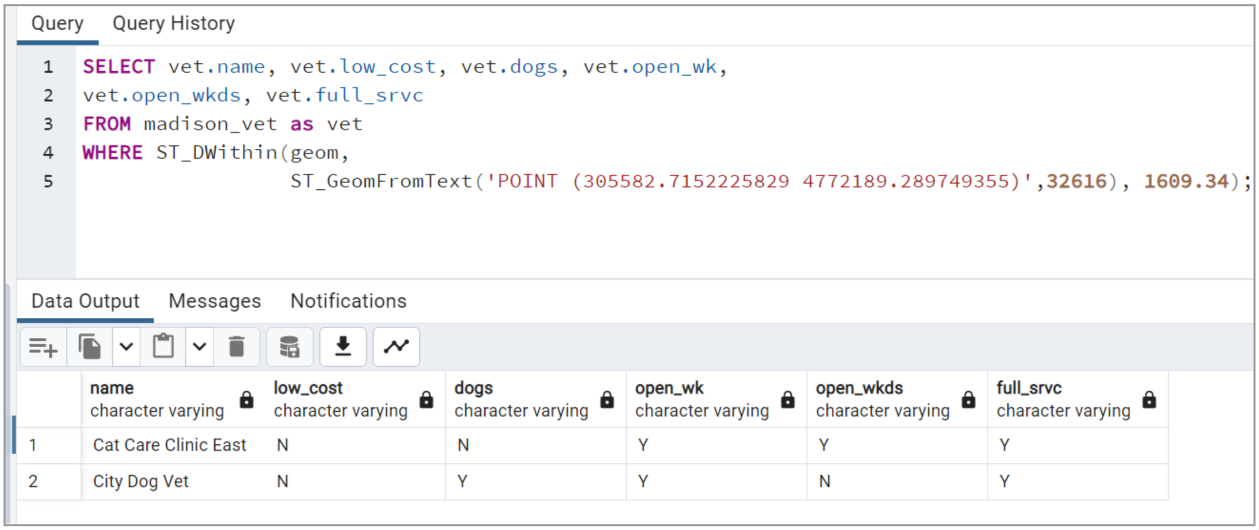

Figure 4. Screenshot of Query 1 for Case 1 (vet clinics 1 mile from Jane)

b) *Find bus stops within 100 meters from Jane's location?*

Query 2: `SELECT metro.stop_name, metro.route FROM madison_metro as metro WHERE ST_DWithin(geom, ST_GeomFromText('POINT (305582.7152225829 4772189.289749355)',32616), 100);`

Result 2:

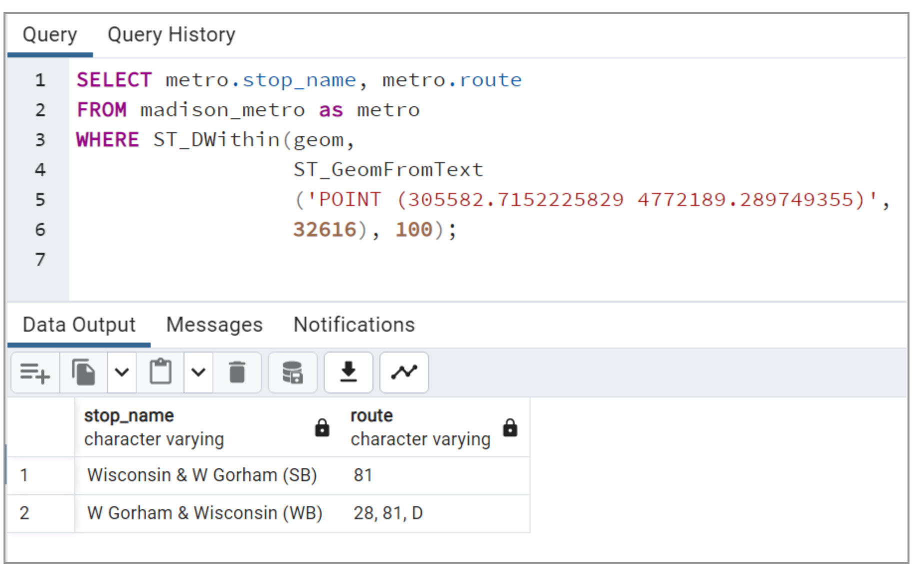

Figure 5. Screenshot of Query 2 for Case 1 (bus stops 100 meters from Jane)

c) *Find No Vehicle Ownership, median income, Gini index of income inequality of Jane's Census Tracts?*

Query 3:
```
SELECT msn_demo.geoid, msn_demo.noveh1620_est as No_vehicle_perc,
msn_demo.gini1620_est as Gini_index, msn_demo.medincacs1620_est as
Median_income
FROM madison_census_tracts as ct
JOIN madison_demographics as msn_demo
ON ct.geoid = msn_demo.geoid
WHERE ST_Within(ST_GeomFromText('POINT (305582.7152225829
4772189.289749355)',32616), ct.geom);
```

Result 3:

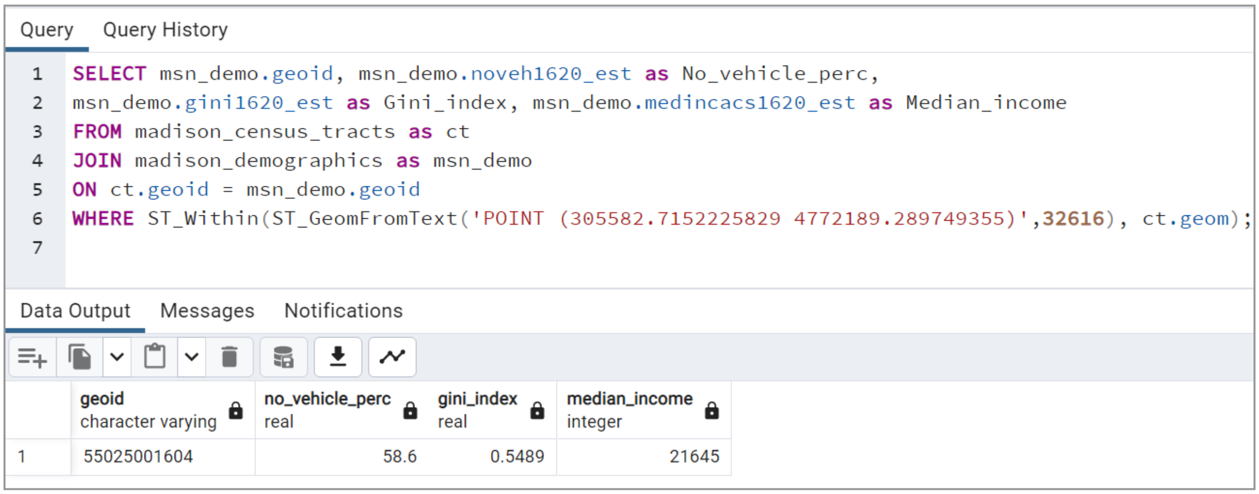

Figure 6. Screenshot of Query 3 for Case 1 (demographic data the Census Tract Jane lives in)

Case Study 2

An urban planner in the city of Madison is interested in finding the census tract with the most and the least vet locations.

a) *Find Census tracts with highest vet clinics?*

Query 4:
```
SELECT COUNT(vet.name) as vet_clinics, ct.geoid
FROM madison_vet as vet
JOIN madison_census_tracts as ct
ON ST_Intersects(vet.geom, ct.geom)
GROUP BY ct.geoid
ORDER BY COUNT(vet.name) DESC
LIMIT 7;
```

Result 4:

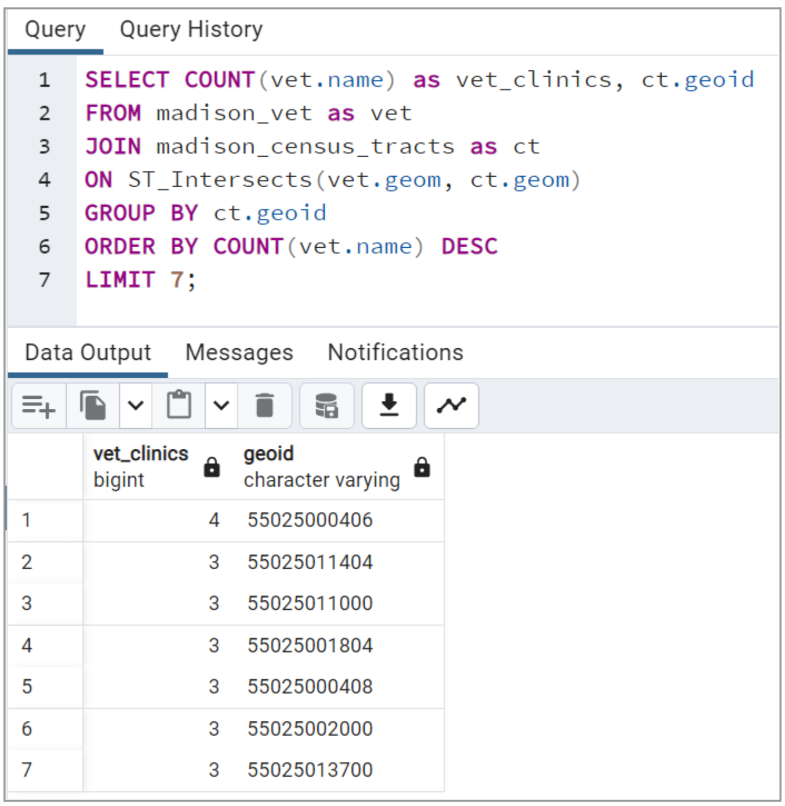

Figure 7. Screenshot of Query 1 for Case 2 (Census Tracts with the most vet clinics)

b) *Find Census tracts with no vet clinics?*

Query 5: `SELECT COUNT(vet.name) as vet_clinics, ct.geoid`

```
FROM madison_census_tracts as ct
LEFT JOIN madison_vet as vet
ON ST_Intersects(vet.geom, ct.geom)
GROUP BY ct.geoid
HAVING COUNT(vet.name) = 0;
```

Result 5:

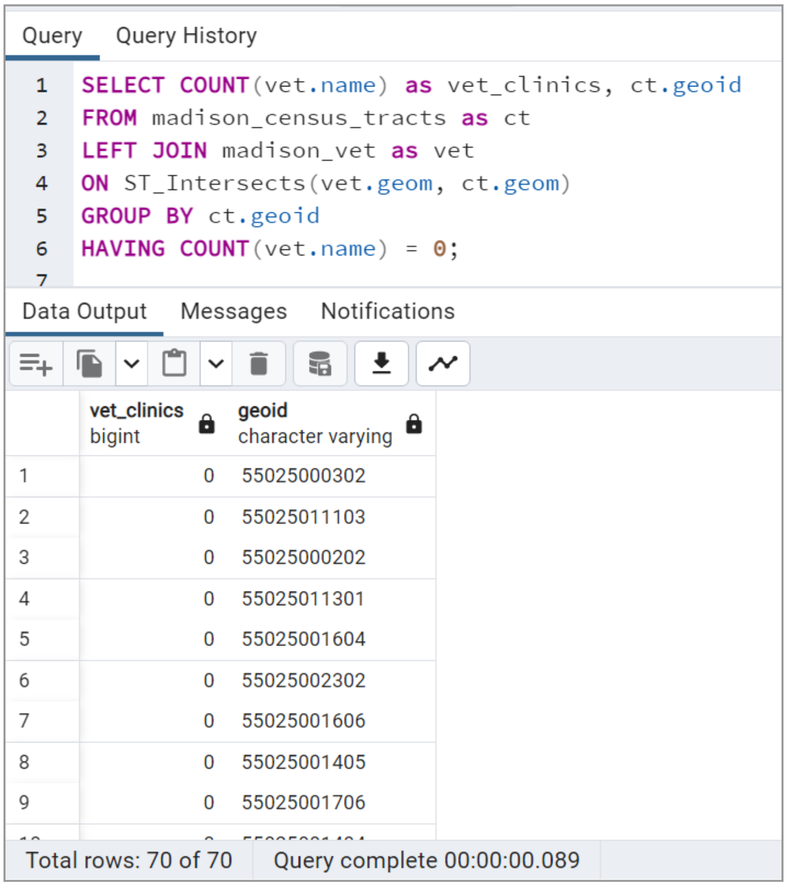

Figure 8. Screenshot of Query 2 for Case 2 (Census Tracts with the least vet clinics)

Case Studies Discussion

These case studies show how our vet database is useful for a private user looking to find vet care and a public user looking to analyze vet accessibility from a general perspective. The private user should be able to find their own coordinates, or any address and coordinates from Google Maps, and convert to compare that location to all the information in our database. In Jane's case, she was able to find two vet locations within a mile, but neither of them have low cost options, and only one of them is open during the weekends. If Jane needed to find a vet clinic with more options, she is close to two bus stops and a few bus routes, but she would need to check if the buses allow dogs, and if there are any special rules about dog size or keeping dogs in some kind of travel bag.

The public user is able to follow the example queries to view demographics of census tracts against vet locations and vet options. There are many census tracts with 0 vet locations, which indicates gaps in vet accessibility. A public employee or nonprofit group could evaluate the census tracts with 0 or few vet locations as key locations that need more support services for animal care. Similarly, they can identify the areas that have multiple vet clinics and can divert resources from the more well-served areas to areas that need more support.

Walk Polygon Map

The walk polygons for each vet clinic location were created to visualize the gaps in getting to vet locations. Below, we show the 0.5 and 1 mile walk polygons with vet clinics on an overview map of Dane county using ArcGIS Pro:

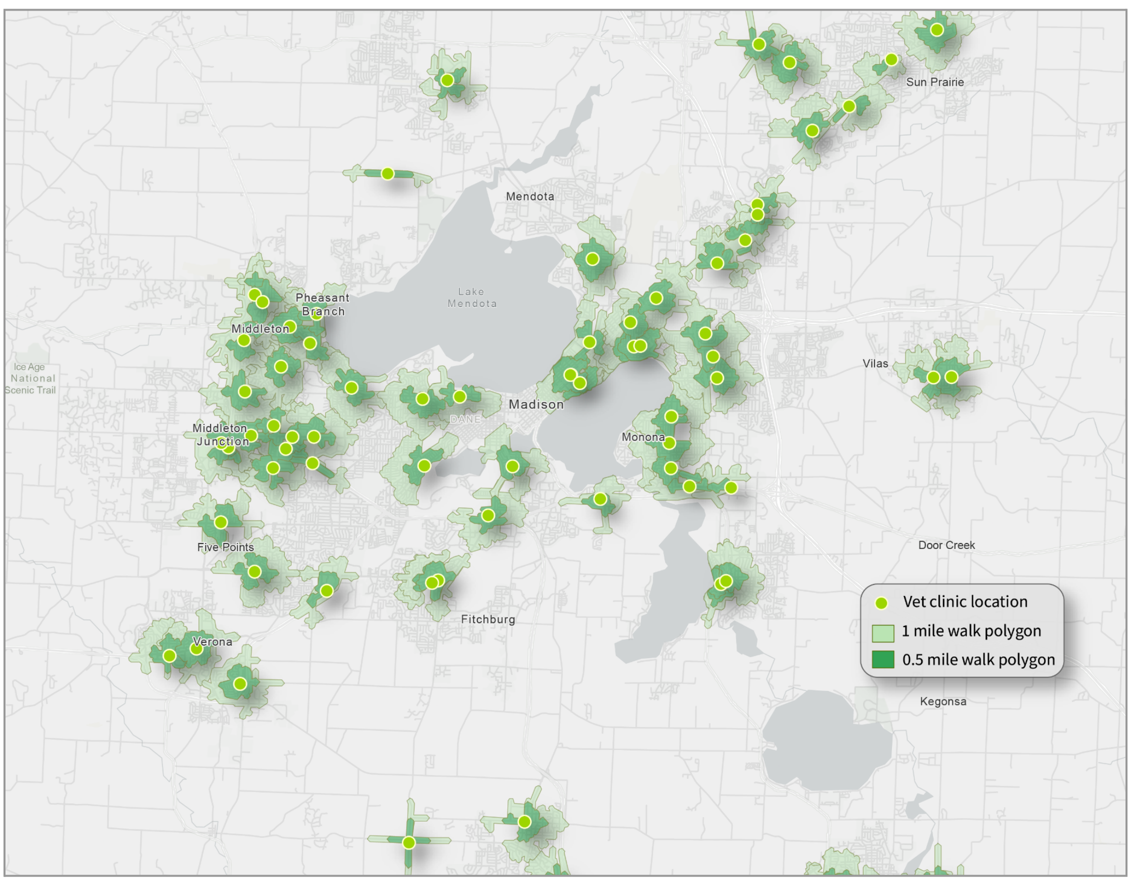

Figure 9. Map of Vet Clinic locations with 0.5-mile and 1-mile walk polygons in Dane County, WI

Since the walk polygons were created with ArcGIS Pro’s network analysis connected to Dane County road data, these polygons are representative of the actual roadway connectivity one might walk to access a vet clinic. The map shows there are significant gaps in walkability, particularly in an urban spot between Five Points, Fitchburg, and Madison proper. This location is also a census tract with low median income. There is a significant population within Dane County that does not own a car, and often buses do not allow dogs, so walking is the only option left for many. It would be a significant change for these people to provide more resources within walking distance.

Next Steps

This database could be taken further by incorporating an accessibility score for each vet clinic. We created a geometry with the walk polygons, but it would be worthwhile to inspect the walking networks and rate the walkability for each vet clinic. Further, there could be a score based on vet services offered. From these scores, a generalized “accessibility score” could be calculated. This information would be extremely valuable for a nonprofit organization looking to provide support services to underprivileged areas. It would also be useful for animal shelter or other adoption center employees to provide information to new pet owners.

Additionally, a next step for this database could be to incorporate actual costs of services. While we give an attribute for “low cost services” to indicate some level of cost flexibility, the reality is veterinary costs can vary wildly between clinics, and service price can often be a limiting factor in accessing care.

References

Literary

- American Society for the Prevention of Cruelty to Animals (ASPCA), “Pet Statistics”, https://www.aspca.org/helping-people-pets/shelter-intake-and-surrender/pet-statistics
- The CAP Times, “Pets for Life helps Madison pet owners survive the pandemic”, Natalie Yahr, 19 May 2020, https://captimes.com/news/local/neighborhoods/pets-for-life-helps-madison-pet-owners-survive-the-pandemic/article_d7ae8fd9-0939-5097-b308-87f6ad92d48e.html

Data

- City of Madison Open Data, Metro Transit Bus Routes, https://data-cityofmadison.opendata.arcgis.com/
- GeoData@Wisconsin, https://geodata.wisc.edu/
- Wisconsin Food Security Project, https://foodsecurity.wisc.edu/help

Github Repository Link

- Our vet database, source data, example queries, and processes can be found on github: https://github.com/Sidrcs/vet_clinics_db