SESUG Paper 062-2025

# Geocoding with the Google Maps API: Using PROC FCMP To Call User-Defined SAS® and Python Functions That Geocode Coordinates into Addresses, Calculate Routes, and More!

Troy Martin Hughes

## ABSTRACT

Software interoperability describes the ability of software systems, components, and languages to communicate effectively with each other, and must be prioritized in today's multilingual and open-source development environments. PROC FCMP, the SAS® Function Compiler, enables Python functions to be wrapped in (and called from) SAS user-defined functions (and subroutines), and the full panoply of SAS environments supports FCMP—including SAS Display Manager, SAS Enterprise Guide, SAS Studio, SAS Viya, and the latest Cary show pony, SAS Workbench. Productivity and the pace of development are maximized when existing open-source code—such as Python user-defined functions—can be run natively from a Python interactive development environment (IDE) rather than having to be needlessly recoded into the Base SAS language. This text demonstrates SAS and Python user-defined functions that collaboratively call the Google Maps Platform APIs to geocode street addresses into latitude/longitude coordinates, and to calculate driving distances between locations. The scenarios in this text demonstrate the application of the Google Maps Platform for clinical trials research, and the technical concepts are adapted from Chapter 8 of the renowned SAS Press book: *PROC FCMP User-Defined Functions: An Introduction to the SAS® Function Compiler*. (HUGHES, 2024)

## INTRODUCTION

*Geocoding* describes the act of ascribing geolocational coordinates (e.g., latitude and longitude) to a location, typically a street address. Coordinates are often required (in lieu of an address) to perform certain analyses, such as a geospatial join of data (in which attributes, like population density or average socioeconomic status of residents, are attributed to a set of coordinates). In other cases, coordinates are required to perform a point-in-polygon geospatial analysis, through which the attributes of some bounded region (like a city, county, or state) are applied to points (locations) inside that region. For example, in the realm of clinical trials, given a subject's home address, geocoding that address would yield the corresponding latitude/longitude coordinates, which in turn could be geospatially joined to evaluate the population density, socioeconomic status, obesity rates, and other potentially indicating or contributing health factors for that region.

Consider a real-world example and patient—let's call him *Q*—who suffers from purulent rashes—ew! It's no fun having Q-goo, but rather than sit and merely stew, our hero Q joins the pharmacological clinical trial queue for a topical ointment to treat his Q-goo. And with any luck, in a month or two, his pus-filled skin that drips *au jus* will be restored to health and born anew.

The clinical research organization (CRO) needs as much environmental data as possible to understand any effects that Q's location might have on either the severity of his Q-goo (e.g., rate your pus on a scale of 1 to 10) or the success of his treatment (e.g., is your goo less moist after a month of treatment?) Geocoding Q's street address—converting it to latitude/longitude coordinates—is required to ascribe the socioeconomic status of Q's neighborhood (retrieved from US Census data, although not demonstrated in this text) to his patient record. Geocoding is also required (directly or indirectly) to calculate the distance between Q's home and various clinics where he receives treatment—to understand whether and how subject proximity (to service location) is correlated with missed visits, adherence to treatment regimens, or treatment success. For example, a principal investigator might hypothesize that subjects willing to travel greater distances for treatment are more invested in their treatment and have better outcomes.

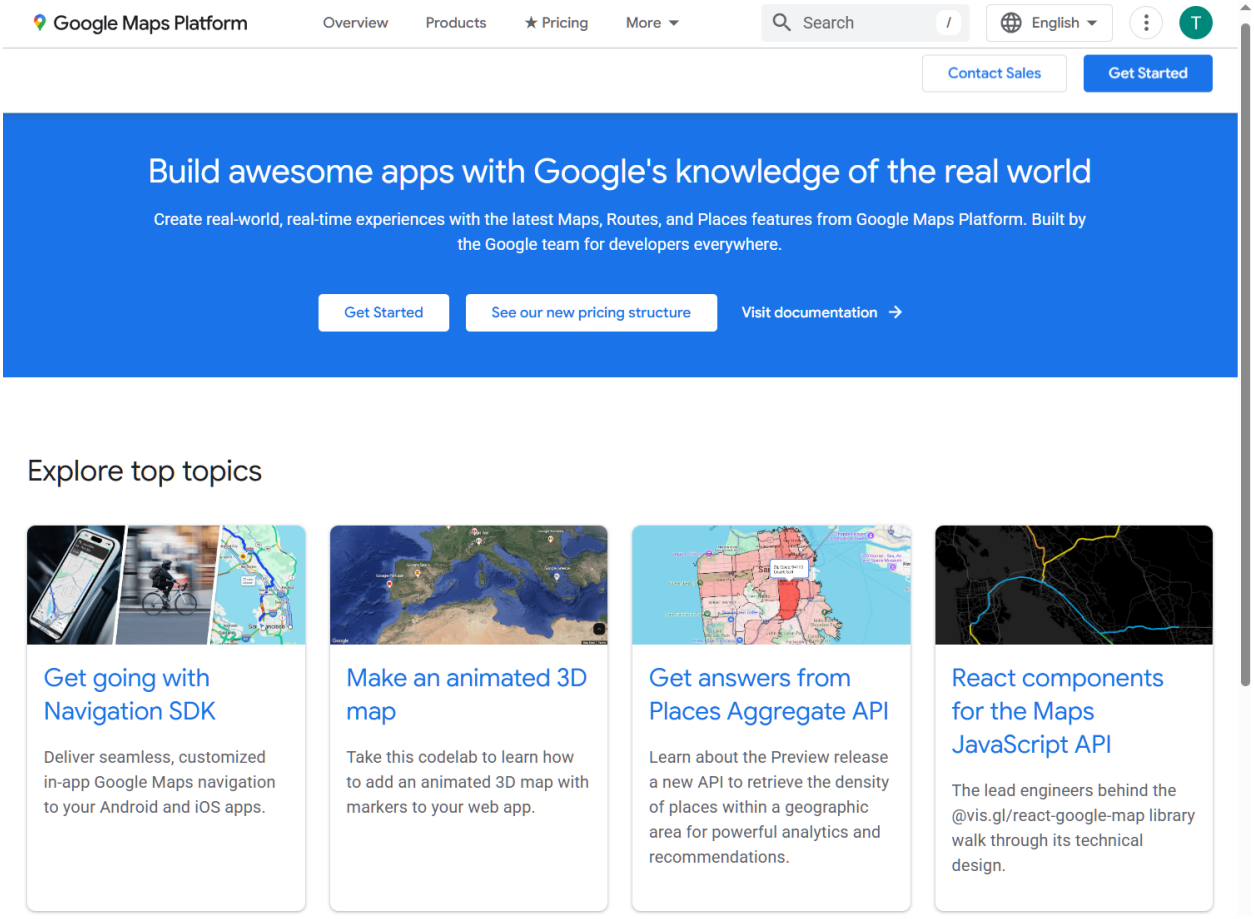
The Google Maps API offers unfettered access not only to Google's rich tapestry of geolocational data but also to its array of built-in operations that evaluate and transform these data. And because the API can be accessed via Python methods (among other open-source languages), it is understandable that further

development would occur in Python, and not in proprietary software like SAS. So, what to do about a SAS-loving CRO that must incorporate an API like Google Maps to ingest and analyze geolocational data?

To facilitate this software interoperability—between proprietary SAS and open-source Python—and to do so smartly and efficiently, the SAS function compiler—PROC FCMP—enables Python functions to be called from (and run inside) the SAS application. Espousing this interoperability enables SAS practitioners to build SAS solutions and Python developers to build Python solutions, and for these systems to work cohesively while being maintained and modified independently.

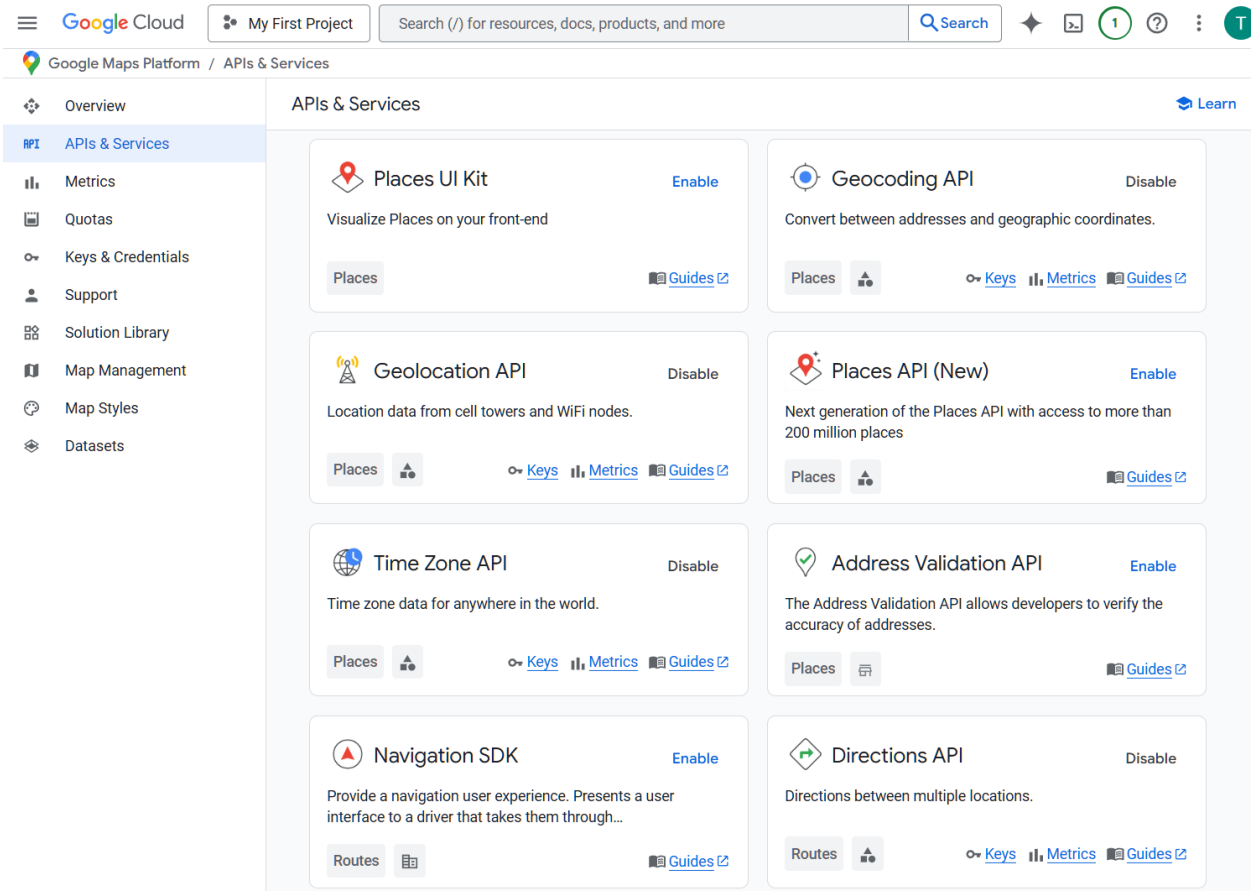
## INTRODUCING THE GOOGLE MAPS (DEVELOPER) PLATFORM

The Google Maps Platform is the development portal for accessing Google geospatial offerings, including Google APIs (and supporting code) that geocode addresses (into coordinates), reverse geocode coordinates (into street addresses), generate walking or driving directions, generate 2D and 3D maps, and so much more. (Google, 2025)

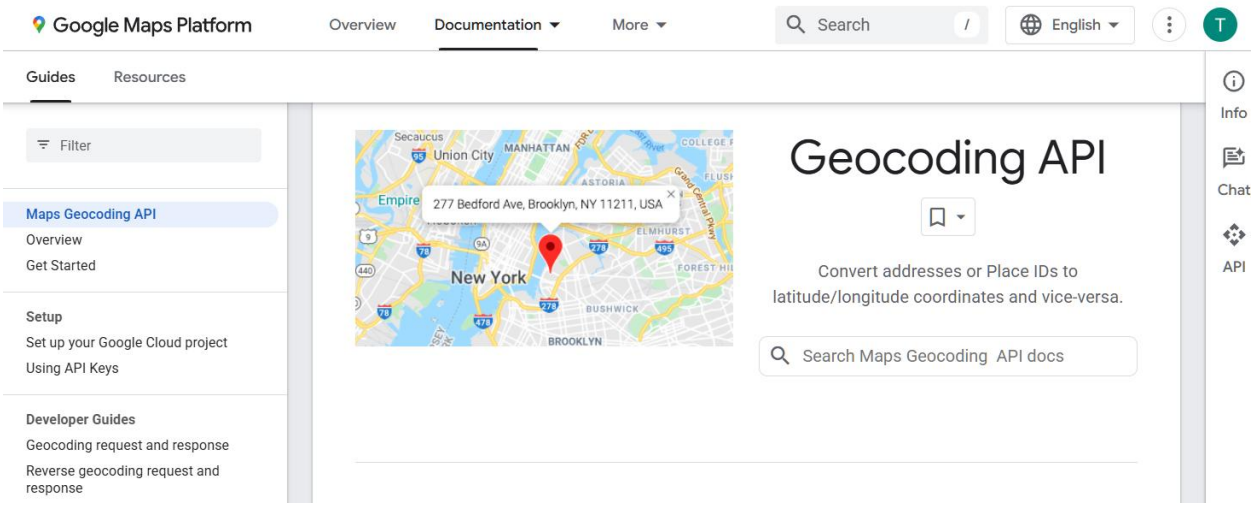



Within the overarching Google Maps Platform, numerous APIs support varied functionality, and because access to the Google Maps Platform requires a Google Cloud account (so that API usage can be billed once it surpasses established thresholds), developers are able to select only those services of interest, and can opt in or opt out of all APIs to customize functionality and ensure accurate billing. The Google Cloud account imparts a Google Maps API key, which is utilized in Python calls to track which user (or application or organization) should be billed for webservices. This key tracks calls to the API from a specific account, and if the threshold of free calls (per month) is surpassed, it facilitates billing for these API services. For this reason, it is critical that your Google Maps API key be privately and securely maintained.

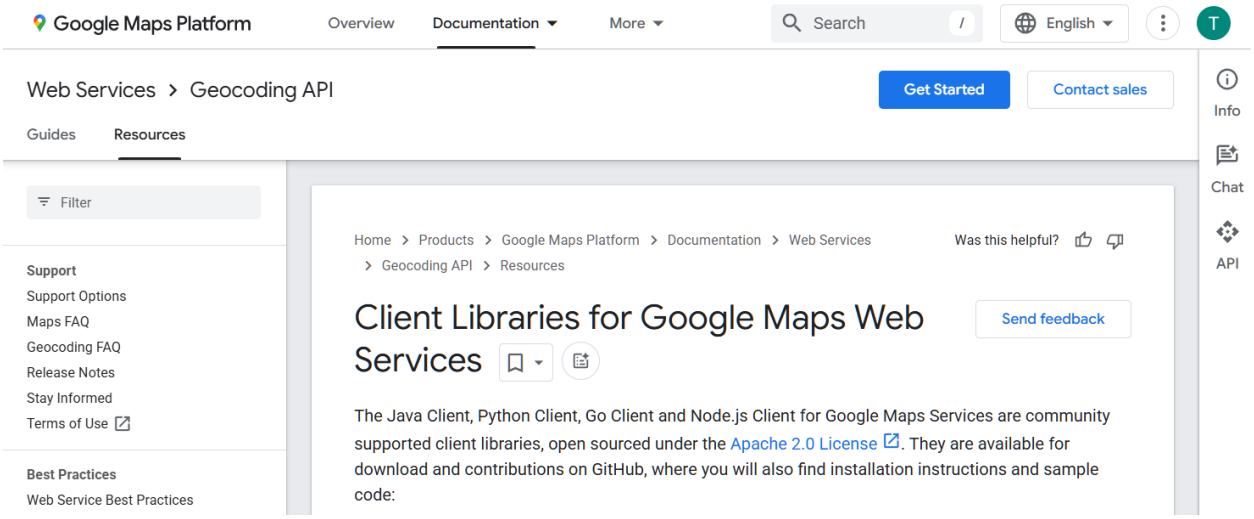
The Google APIs and Services page lists available APIs, including some that have been deprecated and are being transitioned to newer versions. (Google, 2025) In the following screen capture, note that Geocoding and Geolocation are optionally enabled, whereas Places UI and Places are optionally disabled.



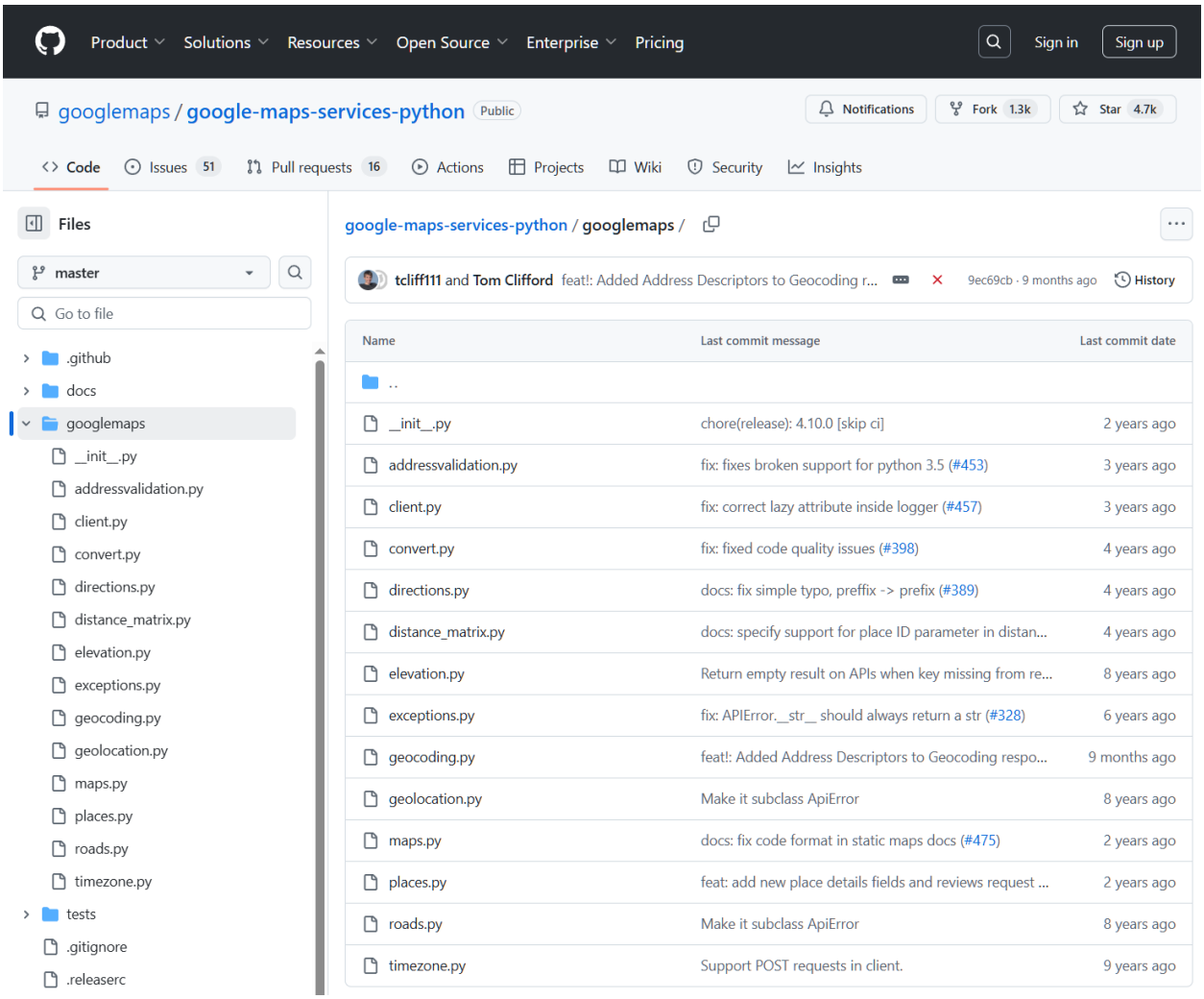

Each API has corresponding usage instructions as well as developer guides, such as Client Libraries for Java, Python, Go, and Node.js. Only Python libraries are discussed in this text. For example, the Google Maps Geocoding API is the landing zone for developers who need to geocode addresses into geospatial coordinates. (Google, 2025)



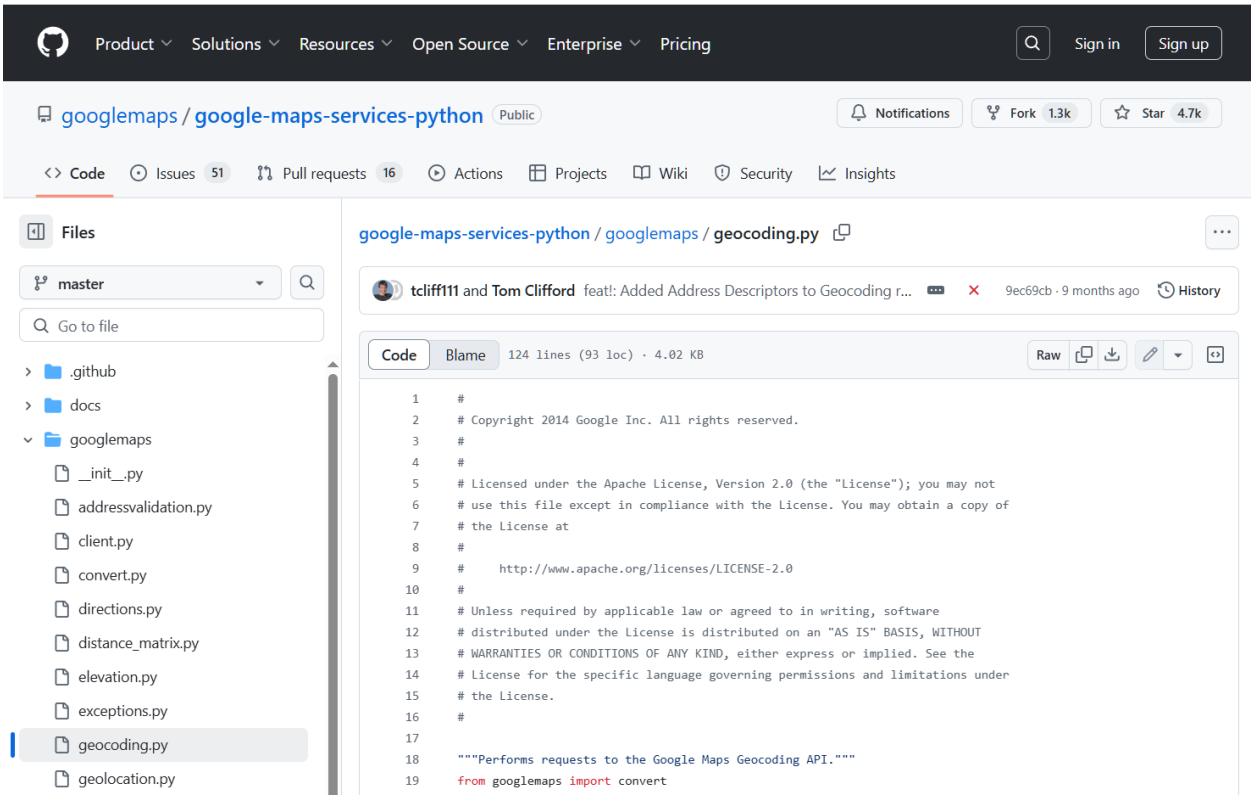
The documentation for Google Client Libraries is hosted on the Google Maps Platform, and includes information about usage, as well as links to language-specific repositories. (Google, 2025)




For example, from this Client Libraries page, the google-maps-services-python GitHub repository can be accessed, in which the API methods and other code are documented and maintained. (GitHub, 2025)



And finally, the **`geocoding.py`** source file can be viewed to further understand the webservices provided by the Geocoding API. (GitHub, 2025)




With this introduction to the Google Maps Platform, the remainder of this text leverages Python methods within the Google Maps libraries to geocode street addresses and to calculate the distance between two locations. In all instances, only Python methods are calling Google webservices, and those methods are in turn called by user-defined Python functions, which are called by user-defined SAS functions and subroutines, compiled in the FCMP procedure. That is, FCMP empowers SAS practitioners to construct multiple levels of abstraction that facilitate calling open-source code natively from the SAS DATA step.

## GEOCODING A LOCATION USING GOOGLE MAPS

To protect Q's home address, for this analysis, let's say that Q, our hapless, pus-filled subject, lives in the Navy Lodge on Naval Base San Diego. In only a few lines of Python code, his address is geocoded into coordinates using the **`geocode`** method (after first passing the Google Maps API key):

```
# import the Google Maps package
import googlemaps

# initialize the Google Maps key
gmaps_key = googlemaps.Client(key="YOUR_SECRET_KEY_GOES_HERE")

# initialize subject address to Navy Lodge, Naval Base San Diego
pt_addy = 'Naval Base San Diego Bldg #3526, San Diego, CA 92136'

# geocode the address
geo = gmaps_key.geocode(pt_addy)
```

The data structure for **`geo`**, the resultant geocoded output, is demonstrated:

```
[{'address_components': [{'long_name': '3455',
    'short_name': '3455',
    'types': ['street_number']},
   {'long_name': 'Senn Street', 'short_name': 'Senn St', 'types': ['route']},
```

```
   {'long_name': 'Barrio Logan',
    'short_name': 'Barrio Logan',
    'types': ['neighborhood', 'political']},
   {'long_name': 'San Diego',
    'short_name': 'San Diego',
    'types': ['locality', 'political']},
   {'long_name': 'San Diego County',
    'short_name': 'San Diego County',
    'types': ['administrative_area_level_2', 'political']},
   {'long_name': 'California',
    'short_name': 'CA',
    'types': ['administrative_area_level_1', 'political']},
   {'long_name': 'United States',
    'short_name': 'US',
    'types': ['country', 'political']},
   {'long_name': '92136', 'short_name': '92136', 'types': ['postal_code']}],
  'formatted_address': '3455 Senn St, San Diego, CA 92136, USA',
  'geometry': {'location': {'lat': 32.6848432, 'lng': -117.1300151},
   'location_type': 'ROOFTOP',
   'viewport': {'northeast': {'lat': 32.6861158302915,
     'lng': -117.1287738197085},
    'southwest': {'lat': 32.6834178697085, 'lng': -117.1314717802915}}},
  'navigation_points': [{'location': {'latitude': 32.684517,
     'longitude': -117.130137},
    'restricted_travel_modes': ['WALK']},
   {'location': {'latitude': 32.6849949, 'longitude': -117.13018},
    'restricted_travel_modes': ['DRIVE']}],
  'partial_match': True,
  'place_id': 'ChIJ402zjVZS2YARgJhRq5k14dI',
  'plus_code': {'compound_code': 'MVM9+WX San Diego, CA',
   'global_code': '8544MVM9+WX'},
  'types': ['establishment', 'point_of_interest']}]
```

To elucidate this data structure, the following code demonstrates the keys of the resultant dictionary:

```
print(list(geo[0]))
```

```
['address_components', 'formatted_address', 'geometry', 'navigation_points',
'partial_match', 'place_id', 'plus_code', 'types']
```

Latitude and longitude coordinates are accessed via the **`geometry`** key:

```
print(geo[0]['geometry'])
```

```
{'location': {'lat': 32.6848432, 'lng': -117.1300151}, 'location_type': 'ROOFTOP',
'viewport': {'northeast': {'lat': 32.6861158302915, 'lng': -117.1287738197085},
'southwest': {'lat': 32.6834178697085, 'lng': -117.1314717802915}}}
```

The **`location`** key contains key-value pairs for latitude and longitude (**`lat`** and **`lng`**), and the following code extracts these values:

```
lat = geo[0]['geometry']['location']['lat']
lon = geo[0]['geometry']['location']['lng']
```

Thus, a user-defined function can be built that extracts only latitude and longitude values from a geolocated address, and returns these values as a tuple:

```
# function evaluates street address and extracts lat/lon coords
def get_coords(addy):
    geo = gmaps_key.geocode(addy)
    lat = geo[0]['geometry']['location']['lat']
    lon = geo[0]['geometry']['location']['lng']
    return lat, lon
```

When **`get_coords`** is called, **`pt_lat`** and **`pt_lon`** are initialized, respectively, to the latitude and longitude values returned (in a tuple) by the function:

```
# geocode address
pt_lat, pt_lon = get_coords(pt_addy)

print(pt_lat, pt_lon)

32.6848432 -117.1300151
```

But if the CRO maintains its subjects' addresses inside a SAS data set, how do these data reach the nifty **get_coords** user-defined Python function? In other words, for any development or analytic shop relying solely or primarily on SAS, how are open-source methods, functions, and other code incorporated into SAS software, and how are data maintained so they can be transferred between (and consumed by) not only SAS but also other applications? As demonstrated in the next section, the elegance of the FCMP procedure facilitates this software interoperability and data transferability.

## CALLING A PYTHON FUNCTION USING PROC FCMP

The FCMP procedure supports the Python Component Object, a SAS construct that enables Python functions to be imported into (or imbedded inside) a SAS user-defined function. (SAS Institute, 2025) To use the Python Component Object, first consult relevant SAS documentation to initialize the **MAS_M2PATH** and **MAS_PYPATH** environment variables. (SAS Institute, 2025)

After the system environment variables have been modified, one additional line of code must be added to the Python program file (saved as **get_coords.py**) that contains the user-defined **get_coords** function:

```
# import the Google Maps package
import googlemaps

# initialize the Google Maps key
gmaps_key = googlemaps.Client(key="YOUR_SECRET_KEY_GOES_HERE")

# function evaluates street address and extracts lat/lon coords
def get_coords(addy):
    "Output: lat_key, lon_key"
    geo = gmaps_key.geocode(addy)
    lat = geo[0]['geometry']['location']['lat']
    lon = geo[0]['geometry']['location']['lng']
    return lat, lon
```

The **Output** statement conveys the one or more keys that will be returned from Python (to SAS) when the **get_coords** function executes. Thus, the **lat** return value is mapped to **lat_key** and the **lon** return value is mapped to **lon_key**. With this minor change, the **get_coords** function can now be called from the FCMP procedure.

Simulated subject data are maintained in the Subjects data set, and the following DATA step creates Q's record, which includes his street address (anonymized to the Navy Lodge):

```
* sample subject data set with addresses;
data subjects;
   length name $20 pt_addy $100 lat lon 8;
   name = 'Q';
   pt_addy = 'Naval Base San Diego Bldg #3526, San Diego, CA 92136';
run;
```

Subsequently, the **sas_get_coords** subroutine is defined (and compiled) using the FCMP procedure:

```
* define the folder location of Python program files;
%let loc_file=c:\goo\

* call get_coords Python function;
proc fcmp outlib = work.funcs.py;
   subroutine sas_get_coords(sas_addy $, sas_lat, sas_lon);
      outargs sas_lat, sas_lon;
      declare object py(python);
      rc = py.infile("&loc_file.get_coords.py");
```

```
      rc = py.publish();
      rc = py.call("get_coords", sas_addy);
      sas_lat = py.results["lat_key"];
      sas_lon = py.results["lon_key"];
      endsub;
quit;
```

A user-defined subroutine is declared using the SUBROUTINE statement and is terminated with the ENDSUB statement. SAS subroutines differ from SAS functions in that subroutines do not return a value and must be called using the CALL statement, whereas functions always return a value and can be called directly (without CALL). Although subroutines cannot *return* a value (because the RETURN statement is allowed only inside function definitions), both functions and subroutines can leverage the (optional) OUTARGS statement to modify one or more arguments in the calling program (through *call by reference*). Arguments not specified by OUTARGS are, by default, *called by value*.

The INFILE method specifies the Python program file in which the Python function is defined.

The PUBLISH method submits Python code to the Python interpreter.

The CALL method executes the Python function, so it passes the **`sas_addy`** variable to **`get_coords`**. At this point, **`get_coords`** executes, and returns a tuple containing the keys defined therein.

The RESULTS method extracts the latitude value from **`lat_key`** (and initializes the **`sas_lat`** variable), and extracts the longitude value from **`lon_key`** (and initializes the **`sas_lon`** variable).

Finally, because both **`sas_lat`** and **`sas_lon`** are specified in the OUTARGS statement, when the **`sas_get_coords`** subroutine terminates, the latitude and longitude values are available in the *calling program*—that is, in the DATA step that called the subroutine.

The following DATA step calls the **`sas_get_coords`** subroutine and initializes the **`lat`** and **`lon`** variables to the latitude and longitude, respectively, of Q's street address, maintained in the **`pt_addy`** variable:

```
options cmplib=work.funcs;

data analyze_pts;
   set pts;
   call sas_get_coords(pt_addy, lat, lon);
   put lat= lon=;
run;
```

Note that the OPTIONS CMPLIB statement is required and must specify the two-level name (i.e., library and data set) in which the subroutine is compiled (as previously specified by the OUTLIB option). Thus, although OUTLIB denotes **`work.funcs.py`** (and must include the **`py`** package), OPTIONS only specifies **`work.funcs`**.

When the DATA step executes, the latitude and longitude values are generated—geocoded from the street address—and printed to the log:

```
lat=32.6848432 lon=-117.130015
NOTE: There were 1 observations read from the data set WORK.PTS.
NOTE: The data set WORK.ANALYZE_PTS has 1 observations and 4 variables.
```

With this new functionality, the CRO can now begin to analyze its subjects with regard to their locations. And, importantly, the user-defined geocoding function **`get_coords`** did not need to be recoded in SAS, and could run natively in Python by adding only one line of code (the **`Output`** statement) to the Python function's definition. This flexibility empowers SAS practitioners to maintain clinical data and analyses in SAS while Python developers separately maintain the geocoding function that interacts with the Google Maps API—or, in today's multilingual world, savvy developers adroitly maneuver in both environments.

## CALCULATING ROUTE DISTANCE USING GOOGLE MAPS

At this point, the CRO is able to evaluate the geospatial coordinates of the addresses of its study subjects, which it can use in further analyses or to obtain additional information about the subjects or their respective

environments. For example, as mentioned previously, a principal investigator at the CRO is interested in analyzing client location with respect to various treatment locations to understand whether “distance from treatment” correlates with illness severity or treatment outcomes.

For example, consider that the CRO has partnered with various In-N-Out Burger establishments to offer treatments for the clinical trial in its parking lots. That is, Q can drive to one of three participating San Diego restaurants to receive his weekly regimen of the topical ointment to treat his Q-goo:

- 1900 E Plaza Blvd, National City, CA 91950
- 2910 Damon Ave, San Diego, CA 92109
- 10370 Friars Rd, San Diego, CA 92120

And, after all, who wouldn’t want to be lathering up your throat with a hot Double-Double® or 4x4® while the clinician is lathering up your rash? As the CRO is primarily a SAS shop, treatment center data are maintained in the **`treatment_centers`** data set:

```
data treatment_centers;
   length center_name $50 center_addy $100;
   call missing(lat, lon);
   center_name = 'National City In-N-Out';
   center_addy = '1900 E Plaza Blvd, National City, CA 91950';
   output;
   center_name = 'Pacific Beach In-N-Out';
   center_addy = '2910 Damon Ave, San Diego, CA 92109';
   output;
   center_name = 'Mission Valley In-N-Out';
   center_addy = '10370 Friars Rd, San Diego, CA 92120';
   output;
run;
```

To calculate routes (or route distance) programmatically using Google Maps, the origin and destination addresses (or their corresponding geospatial coordinates) are required, so although end users of Google Maps are accustomed to navigating on their phone using only street addresses, the API also accepts latitude and longitude (or Google Place IDs, not discussed in this text). Where a street address is provided to the Python method, Google first automatically geocodes this address into coordinates. Thus, directly or indirectly, geocoding is required for navigation and distance calculation.

To geocode the In-N-Out street addresses, the **`sas_get_coords`** subroutine (and Python **`get_coords`** function) can be called again:

```
data treatment_centers_coords;
   set treatment_centers;
   length lat lon 8;
   call missing(lat, lon);
   call sas_get_coords(center_addy, lat, lon);
   put lat= lon=;
run;
```

The log demonstrates that **`sas_get_coords`**, assisted by the Google Maps API, successfully geocoded the addresses for the three delicious treatment centers:

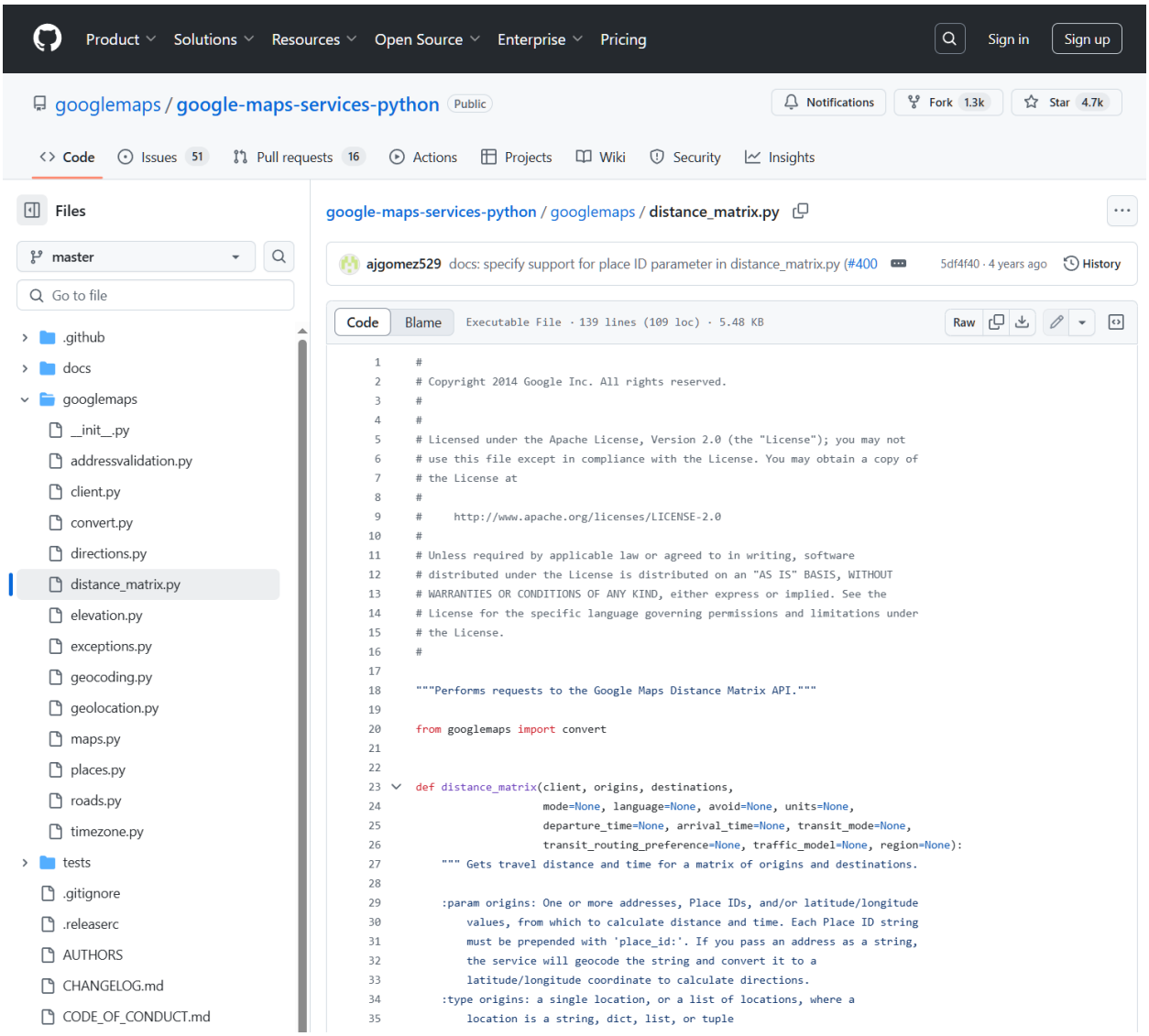
```
lat=32.6763009 lon=-117.085868
lat=32.8089241 lon=-117.2189284
lat=32.7909035 lon=-117.1001831
NOTE: There were 3 observations read from the data set WORK.TREATMENT_CENTERS.
```

It is not necessary to first recompile the **`sas_get_coords`** subroutine (by running the FCMP procedure) or to reuse the OPTIONS CMBLIB statement, as long as the current SAS session is maintained. However, both steps are required if SAS has been terminated and the subroutine needs to be reused in a new session.

And with this feat, the first instance of software reuse has been achieved, demonstrating one of the many ways that user-defined functions and subroutines undeniably improve the quality of software. That is, the

**`sas_get_coords`** subroutine, as well as the underlying **`get_coords`** Python function that it called, were designed to geocode subject data, but were later *reused* to geocode the addresses for treatment centers!

Whereas the Google Maps Geocoding API geocodes street addresses into latitude/longitude coordinates, the Google Maps Distance_Matrix API (i.e, **`distance_matrix`** Python method) calculates distances between two locations—with the origin and destination entered either as street addresses or latitude/longitude coordinates. The API is described in the Google Maps GitHub Repository. (GitHub, 2025)




For example, to calculate the distance between Q's anonymized "residence" at the Navy Lodge (Naval Base San Diego Bldg #3526, San Diego, CA 92136) and the National City In-N-Out "treatment center" (1900 E Plaza Blvd, National City, CA 91950), either the street addresses or their geocoded equivalent coordinates could be passed to the **`distance_matrix`** method. The following example first initializes Q's house address and the treatment center address, after which the **`distance_matrix`** method calculates (or retrieves) data about the route:

```
# manually initialize subject home address coords
pt_lat = 32.6848432
pt_lon = -117.1300151
coords_origin = (pt_lat, pt_lon)
```

```
# manually initialize National City treatment center address
center_lat = 32.6763009
center_lon = -117.085868
coords_dest = (center_lat, center_lon)

# initialize the Google Maps key
gmaps_key = googlemaps.Client(key="YOUR_SECRET_KEY_GOES_HERE")

# calculate driving distance
dist = gmaps_key.distance_matrix(coords_origin,
                                 coords_dest,
                                 mode='driving')
```

The data structure of the resultant **dist** dictionary is demonstrated:

```
print(dist)
```

```
{'destination_addresses': ['1900 E Plaza Blvd, National City, CA 91950, USA'],
'origin_addresses': ['3455 Senn St, San Diego, CA 92136, USA'], 'rows': [{'elements':
[{'distance': {'text': '5.1 km', 'value': 5142}, 'duration': {'text': '11 mins',
'value': 675}, 'status': 'OK'}]}], 'status': 'OK'}
```

Note that the most precise distance is returned from the method in meters in the **value** key, so the following code extracts only **value**:

```
print(dist['rows'][0]['elements'][0]['distance']['value'])
```

```
5142
```

Equivalent results can be calculated instead by passing street addresses, rather than latitude/longitude coordinates, although this method is not further explored in this text:

```
# this example demonstrates the equivalent calculation instead using street addresses
pt_addy = 'Naval Base San Diego Bldg #3526, San Diego, CA 92136'

center1_addy = '1900 E Plaza Blvd, National City, CA 91950'

dist_v2 = gmaps_key.distance_matrix(pt_addy,
                                 center1_addy,
                                 mode='driving')

print(dist_v2['rows'][0]['elements'][0]['distance']['value'])
```

```
5126
```

With this quick introduction to **distance_matrix**, a Python function can be engineered to return the driving distance (in miles, rounded to the nearest tenth of a mile) between two locations:

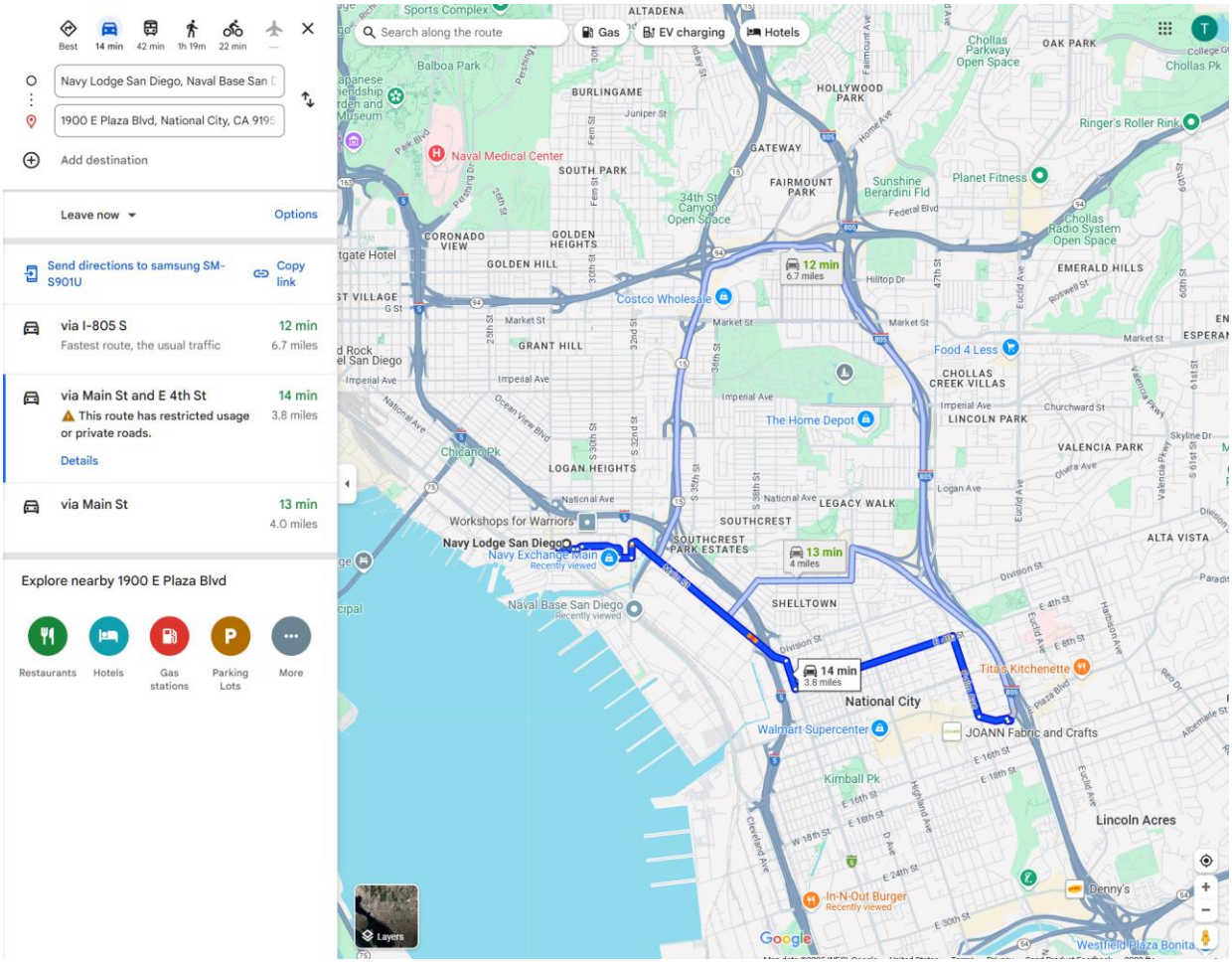
```
# calculate driving distance between two locations
def get_distance(lat_start, lon_start, lat_end, lon_end):
    coords_origin = (lat_start, lon_start)
    coords_dest = (lat_end, lon_end)
    # generates distances in meters
    dist = gmaps_key.distance_matrix(coords_origin, coords_dest,
                mode='driving')['rows'][0]['elements'][0]['distance']['value']
    # converts meters to miles
    dist = round(dist * 0.000621371, 1)
    return dist
```

Thus, when the **get_distance** Python function is called and passed the coordinates for Q's lodging and the National City In-N-Out, the distance is again shown to be 3.2 miles:

```
q_dist = get_distance(pt_lat, pt_lon, center_lat, center_lon)
print(q_dist)
```

```
3.2
```

This is nearly identical to the route distance produced through a manual Google Maps query.




The **`get_distance`** user-defined Python function is now operational, but must be modified so it can be called in SAS through the FCMP procedure. The following program file should be saved as **`get_distance.py`**, noting that the **`Output`** statement was required so that the **`dist_key`** key would be passed back to the SAS session:

```
# import the Google Maps package
import googlemaps

# initialize the Google Maps key
gmaps_key = googlemaps.Client(key="YOUR_SECRET_KEY_GOES_HERE")

# calculate driving distance between two locations
def get_distance(lat_start, lon_start, lat_end, lon_end):
    "Output: dist_key"
    coords_origin = (lat_start, lon_start)
    coords_dest = (lat_end, lon_end)
    # generates distances in meters
    dist = gmaps_key.distance_matrix(coords_origin, coords_dest,
                mode='driving')['rows'][0]['elements'][0]['distance']['value']
    # converts meters to miles
    dist = round(dist * 0.000621371, 1)
    return dist
```

And with the **`get_distance.py`** program file saved, the user-defined SAS function **`sas_get_dist`** can call the **`get_distance`** Python function:

```
proc fcmp outlib = work.funcs.py;
   function sas_get_dist(origin_lat, origin_lon, dest_lat, dest_lon);
      declare object py2(python);
      rc = py2.infile("&loc_file.get_distance.py");
      rc = py2.publish();
      rc = py2.call("get_distance", origin_lat, origin_lon, dest_lat, dest_lon);
      dist_miles = py2.results["dist_key"];
      return(dist_miles);
      endfunc;
quit;
```

Because only one value (distance) is returned, a user-defined function is declared using the FUNCTION statement, as opposed to the previous declaration of a subroutine using the SUBROUTINE statement. Similarly, in lieu of relying on the OUTARGS statement to pass values *by reference* (to the calling program, the DATA step), the RETURN statement now returns **`dist_miles`** to the calling program *by value*.

Note that Python Component Object names must be unique within a SAS session, so whereas **`py`** was declared in the **`sas_get_coords`** subroutine, **`py2`** is declared in the **`sas_get_dist`** function.

The following DATA step demonstrates calling the **`sas_get_coords`** subroutine to geocode Q's address, calling the **`sas_get_coords`** subroutine to geocode the National City In-N-Out's address, and calling the **`sas_get_dist`** function to calculate the distance between these two locations:

```
data test_distance;
   length pt_addy center_addy $100 pt_lat pt_lon center_lat center_lon dist_miles 8;
   pt_addy = 'Naval Base San Diego Bldg #3526, San Diego, CA 92136';
   center_addy = '1900 E Plaza Blvd, National City, CA 91950';
   call missing(pt_lat, pt_lon, center_lat, center_lon, dist_miles);

   * geocode subject address;
   call sas_get_coords(pt_addy, pt_lat, pt_lon);

   * geocode center address;
   call sas_get_coords(center_addy, center_lat, center_lon);

   * calculate distance between origin and destination coords;
   dist_miles = sas_get_dist(pt_lat, pt_lon, center_lat, center_lon);
   put pt_lat= pt_lon= center_lat= center_lon= dist_miles=;
run;

pt_lat=32.6848432 pt_lon=-117.1300151 center_lat=32.6763009 center_lon=-117.085868
dist_miles=3.2
```

The results are identical to calling the Python functions directly in Python, and demonstrate that Q needs to drive 3.2 miles to reach his primary treatment center. In a more complete demonstration of this scenario, subject treatment data would likely be maintained across multiple observations, with each observation mapped to the associated treatment center for that visit, facilitating the longitudinal analysis of distance-to-treatment for each subject.

Moreover, this DATA step demonstrated that all subject and center data can be maintained in SAS, and yet passed to (and transformed by) user-defined Python functions that are called by FCMP user-defined functions and subroutines. Thus, SAS practitioners are able to leverage existent user-defined Python functions and, by modifying only one line of code in each function, to call them from the DATA step.

## CONCLUSION

By leveraging the power and flexibility of the FCMP procedure, SAS practitioners do not need to abandon the comfort of developing in the Base SAS language, but can augment their SAS experience by calling Python functions using the native Python interpreter of their choice. For CROs and other organizations who may rely almost exclusively on SAS software, and yet who are concerned that they are missing out on bleeding-edge, open-source advancements and solutions (such as the Google Maps Platform and its expansive API library), the FCMP procedure effortlessly bridges this gap—by delivering and maximizing software interoperability and data transferability.

## REFERENCES


GitHub. (2025). *Google Maps GitHub*. Retrieved from google-maps-services-python: https://github.com/googlemaps/google-maps-services-python/tree/master/googlemaps

GitHub. (2025). *Google Maps GitHub Repository*. Retrieved from Geocoding.py: https://github.com/googlemaps/google-maps-services-python/blob/master/googlemaps/geocoding.py

GitHub. (2025). *Google Maps GitHub Repository*. Retrieved from distance_matrix.py: https://github.com/googlemaps/google-maps-services-python/blob/master/googlemaps/distance_matrix.py

Google. (2025, 4 1). *Client Libraries for Google Maps Web Services*. Retrieved from Google Maps Platform: https://developers.google.com/maps/web-services/client-library

Google. (2025). *Google Maps Platform*. Retrieved from Google Maps Platform: https://developers.google.com/maps

Google. (2025). *Google Maps Platform*. Retrieved from APIs and Services: https://console.cloud.google.com/google/maps-apis/api-list

Google. (2025). *Google Maps Platform*. Retrieved from Geocoding API: https://developers.google.com/maps/documentation/geocoding

Google. (2025). *Google Maps Platform*. Retrieved from Client Libraries for Google Maps Web Services: https://developers.google.com/maps/documentation/geocoding/client-library

Hughes, T. M. (2024). *PROC FCMP User-Defined Functions: An Introduction to the SAS® Function Compiler.* Cary, NC: SAS Press.

SAS Institute. (2025). *SAS® 9.4 Administration*. Retrieved from Configuring SAS to Run the Python Language: https://go.documentation.sas.com/doc/en/bicdc/9.4/biasag/n1mquxnfmfu83en1if8icqmx8cdf.htm

SAS Institute. (2025). *SAS® 9.4 and SAS® Viya® 3.5 Programming Documentation*. Retrieved from Using PROC FCMP Python Objects: https://documentation.sas.com/doc/en/pgmsascdc/9.4_3.5/lecompobjref/p18qp136f91aaqn1h54v3b6pkant.htm


## CONTACT INFORMATION

Your comments and questions are valued and encouraged. Contact the author at:


Name: Troy Martin Hughes
E-mail: troymartinhughes@gmail.com