University of California, Berkeley
E177 – Advanced Programming with MATLAB
Spring 2017 Final Project
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DRINK MORE TAP WATER

SPRING 2017 FINAL PROJECT

An aesthetically pleasing and intuitive MATLAB User interface that enables users in the UC Berkeley area to save and load personal user data, analyze EBMUD water quality reports and compare data, and directions to the nearest water source through Google Maps API integration.

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Personal Responsibilities

- Tushar Malik: UserData Class, UserDataGUI Class, MasterGUI Class (1/2)
- Micah Cox: WaterData Class, WaterDataGUI Class, MasterGUI Class (1/2), Report Compilation (1/2)
- Lichang Xu: MapData Class, MapDataGUI Class, google_map.m, Report Compilation (1/2)

Project Description

This project was designed to give users an interactive experience and guide to help them drink proper amounts of water, utilize on-campus water sources, determine chemical attributes of the water, and help guide them to water sources. The program is broken down into three main components: User Data, Water Data, and Map Data. The User Data component saves and loads user data, makes recommendations to the user, and keeps a running tally of plastic saved by using a refillable bottle. The Water Data component provides the user with historical plots of each attribute found in tap water, search capabilities, and other external features that provide the user with additional resources. Finally, the Map Data component utilizes Google Map static API to guide the user to the closest water source, generates relevant google map plots, and provides pertinent information including UC Berkeley campus hall hours.

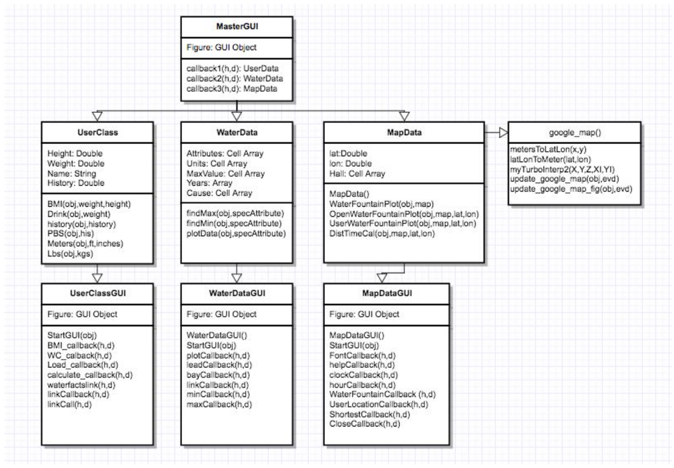
Getting Started

The user must have internet access to take advantage of the Google Map plot functionality of the program since each map plot queries Google's map server. To begin, place the entire "DrinkMoreTapWater" file in the MATLAB path along with all its sub folders (this step is required for MATLAB to correctly read the .xlsx data files). In the command window, type the following:

```
>> obj = MasterGUI();
>> obj.StartMasterGUI();
```

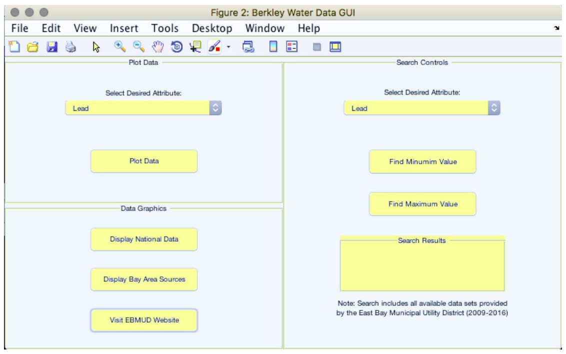
These commands should open the main GUI window. To navigate through the programs features, please see the follow class descriptions for instructions.

UML Diagram



Water Data Implementation Description

This program is also equipped with the capability to read Microsoft Excel data files (.xslx format) that have been correctly populated with data provided by the East Bay Municipal Utility District (EBMUD) in their yearly water



Note: Search includes all available data sets provided by the East Bay Municipal Utility District (2009-2016)

quality reports. These reports are required to be publicly released by law and provide users with information about the quality and contents of their tap water. Since EBMUD is the provider of nearly all tap water in the East Bay/San Francisco areas, this information is relevant to all customers within that region. However, since the data is provided by EBMUD in PDF format, it must first be converted into .xlsx format using widely available software including Adobe Acrobat.

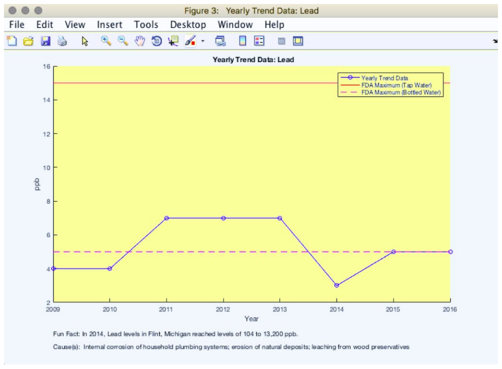
WaterDataGUI Class

This class is a dedicated GUI class that manages all user interactions with water data inside the Drink More Tap Water program. The user interface is divided into three main sections: Plot Data, Data Graphics, and Search Controls. It is also a subclass of WaterData, inheriting all its properties along with one unique property called Figure.

Functionality

- **Plot Data:**

This class allows the user to select a content attribute present in tap water and display its history throughout the period that data is publicly available (2009-2016). The user can select an attribute from a drop-down menu and click "Plot Data" to visual data history. "Lead" is shown below:

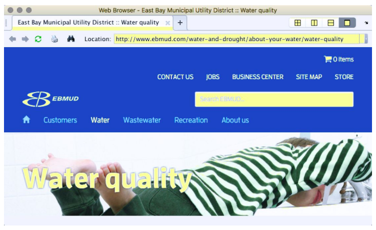


Fun Fact: In 2014, Lead levels in Flint, Michigan reached levels of 104 to 13,200 ppb.

Cause(s): Internal corrosion of household plumbing systems; erosion of natural deposits; leaching from wood preservatives

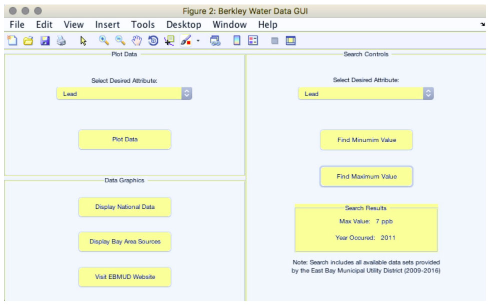
- **Data Graphics:**

First, this section allows the user to plot a data map of the United States that displays in color all regions with unhealthy amounts of Lead and Copper present in the public tap water systems. The user can quickly determine that the Bay Area is a "safe zone." Second, the user can display an image map provided by EBMUD that will allow users to determine which water treatment plant specifically handles their own water supply, based on the zone where they live. Third, the last button opens a direct link to the EBMUD website using MATLAB's built in web browser. This allows the user to browse for more information, check for update water quality reports, or contact EBMUD directly with any questions or concerns.


Web Browser - East Bay Municipal Utility District :: Water quality
East Bay Municipal Utility District :: Water quality
Location: http://www.ebmud.com/water-and-drought/about-your-water/water-quality
0 items
CONTACT US
JOBS
BUSINESS CENTER
SITE MAP
STORE
EBMUD
Customers
Water
Wastewater
Recreation
About us
Water quality

- **Search Controls:**

This section of the WaterDataGUI provides the user with the ability to search for a specific value of an attribute within the available data. For example, the user can select "Lead" from the drop-menu and click "Find Maximum Value." The program will return the maximum value of that attribute and what year it occurred.



Max Value: 7 ppb

Year Occured: 2011

Note: Search includes all available data sets provided by the East Bay Municipal Utility District (2009-2016)

WaterData Class

This class is completing all calculations behind the scenes through callback functions from the GUI class. It contains one constructor method which utilizes MATLAB's built in "xlsread" function to read Excel files that contain all available data. Each of its five properties are populated from the Excel data files into MATLAB cell arrays, which are then manipulated by the methods, depending on the user's query. WaterData contains three main methods:

- **findMax**: Takes in an object of class WaterData and a desired attribute, and returns the maximum value, the year that maximum value occurred, and the correct units of that attribute.
- **findMin:** Also takes in an object of class WaterData and a desired attribute, and returns the minimum value, the year that minimum value occurred, and the correct units of that attribute.
- **plotData:** Takes in an object of class WaterData and a desired attribute, and return a plot that includes the data of that attribute for all available years. The plot also includes a line showing the legal limit for comparison, and a note describing the source of that attribute and how it gets into the water supply. Some plots include addition data (ie. The "Lead" plot also displays a note on Flint, Michigan for comparison).

User Data Implementation Description

UserData Class

This class consists of 4 properties (Height, Weight, Name, and History) and 6 functions.
Six functions are:

- **BMI** (It calculates the BMI of the user by taking in their Height and weight)

- **Drink** (It calculates the recommended amount of water a user should drink according to their weight)
- **History** (It keeps track of the history of drinking water of a particular user)
- **PBS** (This function calculates the amount of plastic bottles that the user is saving by taking in the user history of drinking water)
- **Meters** (This function takes in length in feet and inches and converts it into meters)
- **Lbs.** (This function takes in weight in Kilograms and converts it into Pounds.)

UserDataGUI Class

This Class consists of a Figure property, a Start GUI function and 8 Callback functions. It is a handle class to the User Class. 8 Call back functions:

- **BMI Callback:** It is activated when the calculate BMI button is pressed. It displays BMI of the user (Calculated from BMI function in user class) and a button which takes the user to a website which talks about BMI facts. It also opens up a new figure which displays the the Water recommendation for the users (Calculated from Drink function in user class) and a button which takes the user to a website with talk about water facts.
- **WC Callback:** It is activated when the History of water button is pressed. It displays the user history of water (Calculated using history function in user class), number of Plastic Bottles saved (Calculated from PBS function in user class) and a button which takes the user to a website with talk about bottled water facts.
- **Load Callback:** It is activated when the Load button is pressed. It loads the User data that is saved when the BMI or the Water History Button in clicked.
- **Conversion Callback:** It is activated when the Units Calculator button is pressed. It opens a new figure with options for user to put in their height in feet and inches and cover it into meters and also to put in their weight in kilograms and convert that to pounds.
- **Calculate Callback:** It is activated when the calculate button in pressed. It uses Meter and Lbs functions in User class to calculate the height and weight of the user in meters and pounds respectively.
- **Waterfacts Link:** It is activated when the water facts button is pressed which can be found within the figure which is displayed when BMI Calculate button is pressed. It takes you to a website which tells you facts about Water.
- **linkCall:** It is activated when the BMI facts button is pressed which is displayed when BMI Calculate button is pressed. It takes you to a website which tells you facts about BMI.
- **linkCallback:** It is activated when the Bottled water facts button is pressed which is displayed when History of water consumed button is pressed. It takes you to a website which tells you facts about Bottled water.

These two classes combined allow the User to Calculate Their BMI, convert Units from feet and inches to Meters and Kgs to lbs, get a recommendation of amount of water you should drink every day, save and load history of water consumed by a particular User. Each user's history of water consumed, weight, and height is saved as a .mat file under their name in the directory. We can load the User data by entering the username and clicking the load button on the GUI.

Map Data Implementation Description

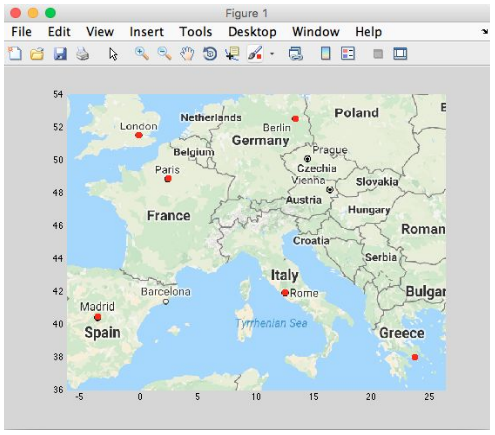
The map folder of this project contains three main files:

- **google_map.m**: a helper function to query the google map server and plot an auto-freshed google map on the current axes using the open-sourced Google Static Maps API
- **MapData.m:** a class to process the location data extracted from Tang Center website, generate three different google map plots, and calculate the shortest distance between user location and the closest water fountain together with the approximate walking time

- **MapDataGUI.m**: a subclass of MapData to provide an organized and intuitive GUI for the user to interact with and obtain useful information about water fountains at UC Berkeley main campus

➢ google_map.m (type help google_map for more details)

- This helper function can be called as the following:
  - H = google_map(Property, Value,...) will plot a google map on the given axes and a handle to the plotted map will be returned. This function can also be called without any specified output.
  - [lonVec latVec imag] = google_map(Property, Value,...) returns parameters of the map without plotting it. lonVec is a vector of longitude coordinates (WGS84) of the image; latVec is a vector of latitude coordinates (WGS84) of the image; imag is an image matrix (height, width,3) of the map.
- Type help google_map to see how to set properties of this helper function.
- An example to use this function to plot a map showing some capitals in Europe:
  - Lat = [48.8708   51.5188   41.9260   40.4312   52.523   37.982]; Lon = [[2.4131   -0.1300   12.4951   -3.6788   13.415   23.715];



plot(Lon,Lat,'.r','MarkerSize',20); google_map();

➢ MapData.m

- The class has the following private properties:
  - **lat** - the array of latitudes of the tap water fountain locations on campus
  - **lon** - the array of longitudes of the tap water fountain locations on campus
  - **Hall** - the cell array of campus hall names that have refill water fountains
- The class has the following methods:
  - **function obj = MapData()** - the class constructor that initializes the three aforementioned properties to default values based on the extracted fountain information from Tang Center website
  - **function WaterFountainPlot(obj,map_type)** - a method to plot all the water fountain locations on Berkeley main campus via the google_map helper method
    @Input: obj is a MapData object, map_type is the specific map type used to generate the plot. Google map static API allows four different types to choose from: 'satellite','roadmap','terrain','hybrid'
  - ❖ **function OpenWaterFountainPlot(obj,map_type,user_lat,user_lon)** - a method to plot possibly open water fountain locations based on each hall's operating hours

@Input: obj is a MapData object, map_type is the specific map type choosing from 'satellite','roadmap','terrain','hybrid', user_lat is the latitude value of user's current location, user_lon is the longitude value of user's current location

- ❖ **function UserWaterFountainPlot(obj,map_type,user_lat,user_lon)** - a method to plot water fountain locations and current user location
  @Input: obj is a MapData object, map_type is the specific map type choosing from 'satellite','roadmap','terrain','hybrid', user_lat is the latitude value of user's current location, user_lon is the longitude value of user's current location
- ❖ **[sd,t] = DistTimeCal(obj,map_type,user_lat,user_lon)** - a method to plot current user location and the closest water fountain location; the Euclidean distance between user location and the closest water fountain and the approximate walking time to that fountain are returned
  @Input: obj is a MapData object, map_type is the specific map type choosing from 'satellite','roadmap','terrain','hybrid', user_lat is the latitude value of user's current location, user_lon is the longitude value of user's current location
  @Output: sd is the Euclidean distance between current location and the closest water fountain location, t is the approximate walking time to that water fountain
  function dist = DistConverter(lat1,lon1,lat2,lon2) - a subroutine to calculate Euclidean distance between the first geographical point having latitude lat1 and longitude lon1, and the second point having latitude lat2 and longitude lon2
  - ■ **function rad = deg2rad(deg)** - a helper method to convert degrees to radians

➢ MapDataGUI.m (a subclass of MapData)

- ○ The class inherits the properties of MapData and has one extra property:
  - ■ **Figure** - a graph handle to the overall GUI
- ○ The class inherits the methods of MapData and has two extra methods:
  - ■ **function obj = MapDataGUI()** - the class constructor; it calls its upper class constructor to initialize relevant properties
  - ■ **function StartGUI(obj)** - the method that draws the GUI, initializes the GUI, and handles all functionalities in the GUI
    @Input: obj is a MapDataGUI object
    function FontCallback(h,d) - the callback method that handles the slider bar used to adjust the overall font size of the GUI
    function helpCallback(h,d) - the callback method that handles the help push button that displays help dialog box and directs the user to a geodata website where the user can find the latitude and longitude values of his/her current location
    function clockCallback(h,d) - the callback method that handles the time toggle button that displays the current time when user clicks it and hides the time when the user clicks again
    function hourCallback(h,d) - the callback method that handles the show push button that opens a quest dialog box that displays the operating hours of the selected hall from the popup menu, allows the user to see the image of the selected hall, and to visit the hall website for more details
    function WaterFountainCallback(h,d) - the callback method that handles the 'UC Berkeley Water Fountain Map' push button that loads and plots all the water fountain locations on google map with the selected map type

function UserLocationCallback(h,d) - the callback method that handles the 'User Location Map' push button that loads and plots current location of the user obtained from the user input section and all the water fountain locations on google map with the selected map type

function ShortestCallback(h,d) - the callback method that handles the 'Closest Water Fountain Map' push button that loads and plots current location of the user obtained from the user input section and the closest water location on google map with the selected map type; the method also displays the calculated distance (mile) to the closest water fountain and the approximate walking time (minute) to the fountain in the calculated results section

➢ GUI Operation Manual (with graphical illustrations)

- ➔ To open the GUI, create a MapDataGuI object and call StartGUI() method:

```
>> ui = MapDataGUI;
>> ui.StartGUI;
```

- ➔ A dialog box with a customized 'I Love Tap Water' icon is displayed:

Welcome!

Drink Tap Water and Stay Healthy!

OK

- ➔ Click OK to enter the main GUI, which should look like this:

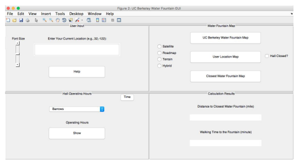
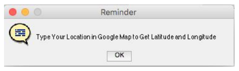


Figure 2: UC Berkeley Water Fountain GUI
File Edit View Insert Tools Desktop Window Help
User Input
Font Size
Enter Your Current Location (e.g., 32,-122):
Help
Water Fountain Map
Satellite
Roadmap
Terrain
Hybrid
UC Berkeley Water Fountain Map
User Location Map
Closest Water Fountain Map
Hall Closed?
Hall Operating Hours
Time
Barrows
Operating Hours
Show
Calculation Results
Distance to Closest Water Fountain (mile)
Walking Time to the Fountain (minute)

- ➔ Enter your current location as a 2-tuple in the format of latitude,longitude (space is allowed). If you are not sure what is latitude and longitude of your current location, click Help and a reminder dialog box will pop up:

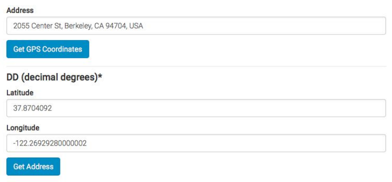


Reminder

Type Your Location in Google Map to Get Latitude and Longitude

OK

- ➔ Click OK and you will be directed to a geodata website where you can type your address and obtain the corresponding latitude and longitude:



Address

2055 Center St, Berkeley, CA 94704, USA

Get GPS Coordinates

DD (decimal degrees)*

Latitude

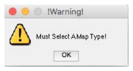
37.8704092

Longitude

-122.26929280000002

Get Address

- ➔ Select the map type you want to use to generate the google map. Note that if no map type is selected and you accidentally click one of the three map buttons, a warning will appear on the right:



!Warning!

Must Select A Map Type!

OK

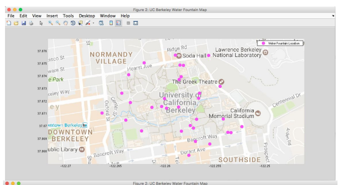
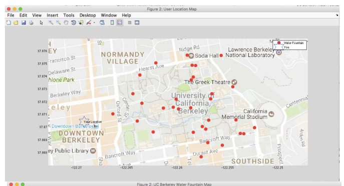
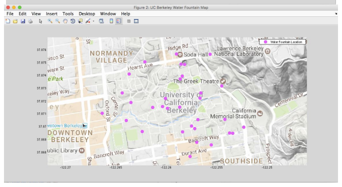
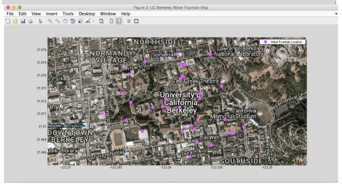
- ➔ If you select more than one map type to generate the plots, another warning will appear on the right:

!Warning!

Cannot Select More Than One Map Type!

OK

- ➔ Click 'UC Berkeley Water Fountain Map' to see water fountain locations on campus. A progress bar will appear and the map should be ready in few seconds.
- ➔ Feel free to explore different map types and compare the resulting plots:
- ➔ Click 'Closest Water Fountain Map' to see your current location and the closest water fountain to you plotted in the same map.

- ➔ Close the map and you will find your distance to the closest water fountain and the approximate walking time to the fountain are calculated automatically and displayed in the calculation results section:

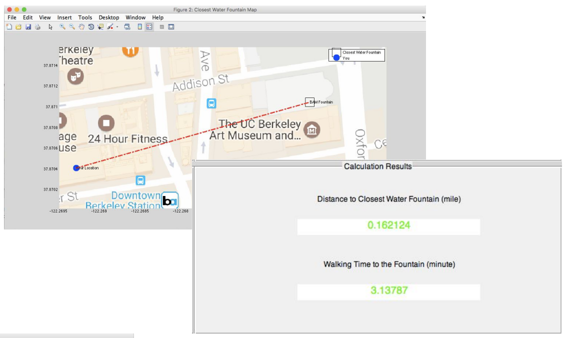


Figure 2: Closest Water Fountain Map
Addison St
24 Hour Fitness
The UC Berkeley Art Museum and...
Downtown Berkeley Station

Calculation Results

Distance to Closest Water Fountain (mile)

0.162124

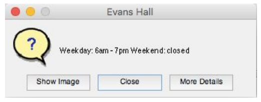
Walking Time to the Fountain (minute)

3.13787

➔ You can check the operating hours of each hall to make sure the water fountain is currently open. To do this, select the hall name from the pop up menu first

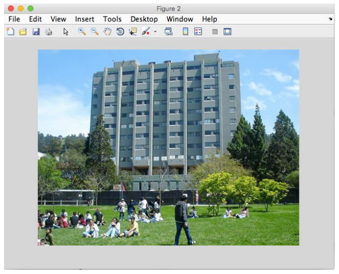
➔ If you are unsure about the current, click on the toggle button 'Time' and the current date and time will be displayed. Click again to hide it

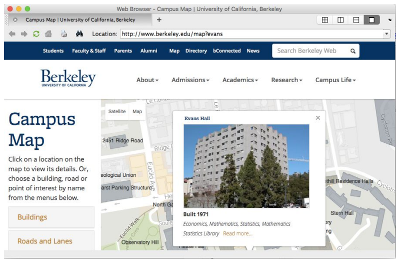
➔ Click the 'Show' button below 'Operating Hours' and a quest dialog box will appear:



Evans Hall

Weekday: 6am - 7pm Weekend: closed




Web Browser - Campus Map | University of California, Berkeley
http://www.berkeley.edu/map?evans
Berkeley
Campus Map
Evans Hall

Click on a location on the map to view its details. Or, choose a building, road or point of interest by name from the menus below.

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➔ The operating hours is displayed. Click 'Show Image' to see the hall image:

➔ If you want to see more information about the hall, click 'More Details' and the hall website of the hall will pop up for your reference:

➔ If the hall is currently closed, click 'Hall Closed?' at Water Fountain Map section, a progress bar will appear and a map plot with possibly open water fountains will appear:

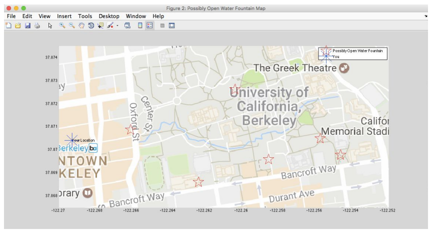
Figure 2: Possibly Open Water Fountain Map
The Greek Theatre
University of California, Berkeley
California Memorial Stadium
Bancroft Way
Durant Ave
Oxford St
Center St

➔ You can always adjust the font size of the GUI by sliding the slider under 'Font Size', in User Input section

➔ Exit the GUI by simply closing the figure. Drink tap water and stay healthy!

Github Source Code

https://github.com/LichangLovesCS/E177-Final-Project

Acknowledgement

Thank you Professor Michael Frenklach and GSI Zhenyuan Liu for your time and energy spent in teaching this course and for your great help for the project!