Model of Urban Sustainability

A Computational-Based Project By:
Section 02, Group 5
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NEEDS ASSESSMENT AND PROBLEM FORMULATION

Design Statement:

Create a model population based on user input about their state, water usage, and electricity consumption. Then, evaluate the model population, grade it for sustainability, and provide the user suggestions to improve their grade.

NEEDS ASSESSMENT AND PROBLEM FORMULATION

Step 1	Step 2	Step 3	Step 4	Step 5
Gather online data on water usage, electricity consumption, CO2 emission, and a state's population to create a .txt file of state data values.	Create 3 functions to calculate the annual amount of resources for a model population in the user's selected state. -PopulationWater.m -PopulationElectricity.m -PopulationCO2.m	Create a GUI, sustainabilityTool.m that takes in user input about their state, water and electricity usage. The GUI should also have static text boxes to display grading and evaluations.	Create a grading scale using set equations (defined in the mathematical model) and use conditions to determine what evaluations and suggestions need to be displayed in the GUI.	Input all functions and grading scale into the GUI under GUI Callbacks. Test and Verify the GUI to see if program meets expectations.

ABSTRACTION AND SYNTHESIS

Equations and Mathematical Model

- 3 functions compute total water, electricity, & CO2 usage using Eqn 1 & 2 below:

*Activity Usage= (user input) * (amount of resource needed for the activity)* **(Eqn 1).**

Total Annual Resources= (sum of activity usages) x (365 days) x (state's population) **(Eqn 2).**

- Sustainability score was calculated by creating an index of 3 scores based on the 3 variables.

The electricity and water score each weighed 35% of the grade. The CO2 score weighed 30% of the grade. Each score was calculated using Eqn 3, Eqn 4, and Eqn 5:

Upper bound = 1.5(average)* **(Eqn 3).**

Lower bound = 0.5(average)* **(Eqn 4).**

(Upper bound - input) / (upper bound - lower bound) **(Eqn 5).**

ABSTRACTION AND SYNTHESIS

Algorithms/Strategies

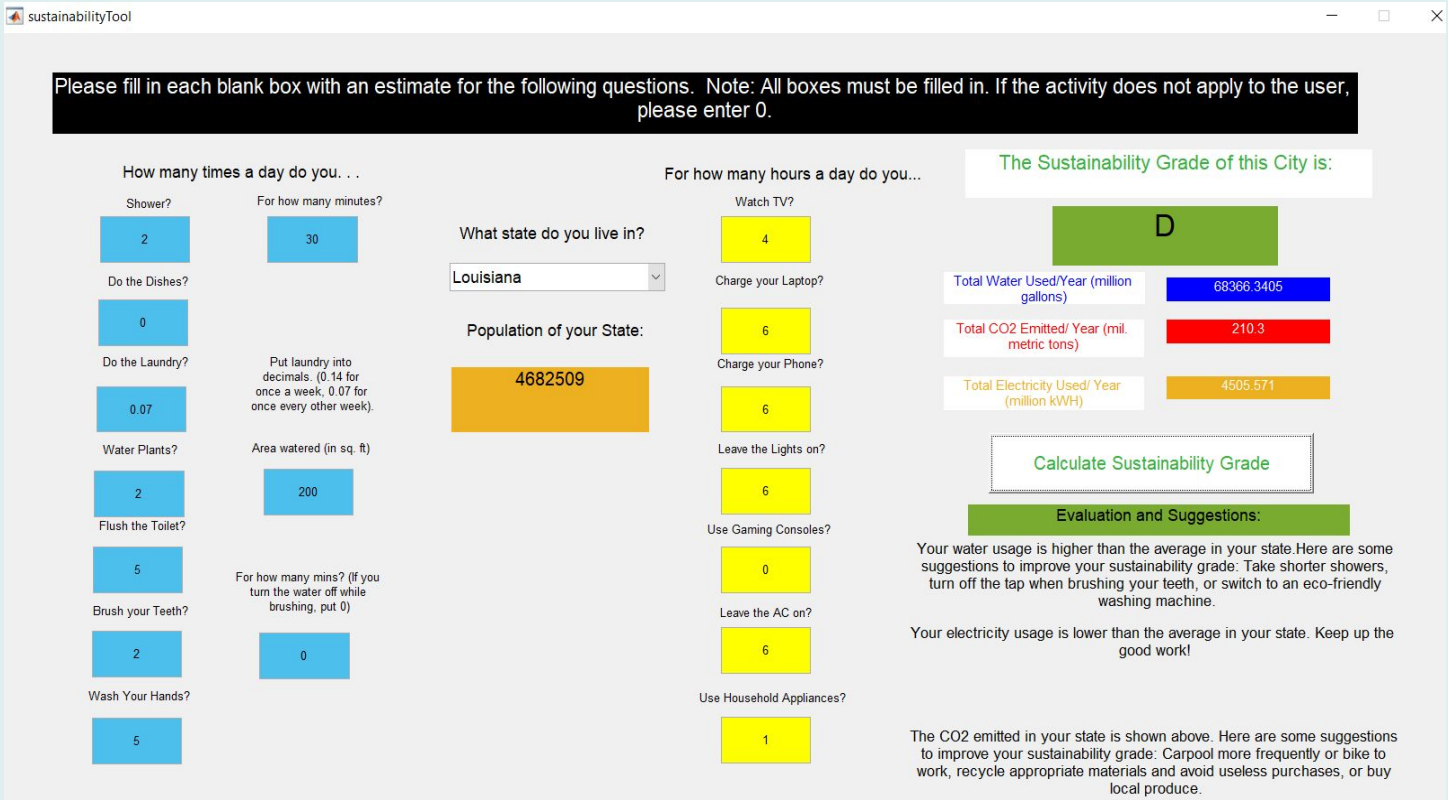
- Load .txt file as an array of researched data values for every state.
- If and else statements used to:
  - Output a grade and evaluation based on user input
  - Display population based on state chosen
- Tested by increasing/decreasing value of each variable and checking if the outputted grade correlated with input and made logical sense

ABSTRACTION AND SYNTHESIS

Assumptions and Limitations

- User input is compared to general, overall statistics for their state.
- Not all variables that impact usage are included.
- No simply-defined equations that calculate sustainability.
- Limited amount of suggestions.
- Sustainability grade generalizes an entire city based on user input and state.

HOW THE PROGRAM WORKS



Implementation

Results and Verification

- Group 5 tested a minimum of 100 scenarios in which a person was considered “more or less” sustainable. When the user input was low (used little resources), the grade outputted resulted in an A. When input was high, the grade was lower, meaning that the program’s grading system was coherent.
- Because the program modelled an entire city based on one user’s input, the results were not precise or exact when comparing the model to a real city’s sustainability. Additionally, many of the assumptions and limitations to the model prevented perfectly accurate results to be determined.

Implementation

Ways Group 5 met design goals:

- The 3 functions coded properly calculated and created a model population based on the chosen variables to be considered.
- The functions and GUI without error.
- Made an index of states' data and compared it to the user's data for grading.

Ways Group 5 did not meet design goals:

- Grading scale was difficult to define, and some grades were higher or lower than expected.
- Suggestions were slightly vague general statements.
- Evaluation and suggestions were not entirely accurate.

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Final Executive Summary
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Model of Urban Sustainability Project

This project aimed to create a model of urban sustainability within a population based on data given by the user. The program mainly consisted of one large Graphical User Interface (GUI) and three functions. The finalized design statement for this project is to create a model population based on user input about their state, water usage, and electricity consumption. It should then evaluate the created population, grade it for sustainability, and provide the user with suggestions on how to improve their grade.

The final completed program focused on analyzing data on three main variables: electricity usage, water usage, and CO_2 production. The user's data for each of these variables was collected by prompting the user to answer a series of questions asking the user how often they complete daily tasks that affect their usage of each of these variables. Once the user selects the state they live in, a sustainability grade can be calculated for a model population of this state based on the user's data. This grade is calculated using an index created by the group, comparing the user's values to values in a .txt file, which was created using online data. Below the grade, suggestions on how to improve one's sustainability are displayed. Figure 1 shows the working GUI after a user has inputted data and calculated their sustainability grade.

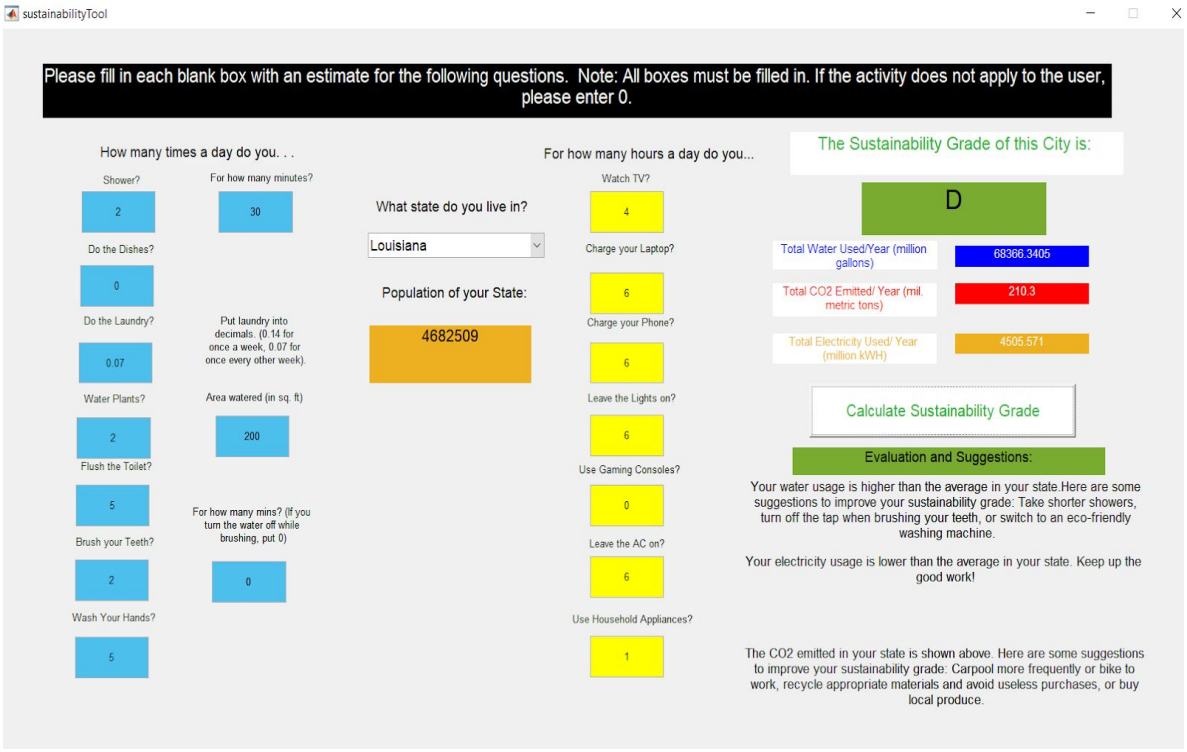

Figure 1. Group 5's sustainablityTool.m GUI

The final project achieved most of the design goals. To begin with, a model population was successfully created using the three functions: PopulationWater.m, PopulationCO2.m, and PopulationElectricity.m. All three functions properly calculated how much of a certain resource was used based on the user's input for the variables included in the GUI. Additionally, the index of each state's data was made on Excel and loaded into MATLAB as planned so that the model population could be compared to real life data. Another design goal that was met was creating a grading scale that met Group 5's expectations. Over 100 scenarios were tested, in which some cases had higher numeric input than others. It was expected that the higher numeric user inputs, meaning higher amount of resources used, would result in a lower sustainability grade. When testing different scenarios with low input, the grades were much better and resulted in "A" or "B," and when input was high, the grade could go down to an "F."

However, some design goals were not met, such as accuracy of the grading and evaluations. For most cases, the grades and results correlated with Group 5's expectations, but there were also some outliers where the grading was not accurate. For instance, some of the evaluations would tell a user to "Keep up the good work!" for using less than the average amount of water or electricity of their state, but still give the user an "F." When outputs like these were presented, it became apparent that the evaluations and grades from the GUI were not precise or exact. It was concluded that these errors could be attributed to the assumptions and limitations of Group 5's model, and the online data on each state that was inputted. Because the model generalized an entire population based on one user's input and only had a limited amount of variables contributing to resource usage, the model was unable to be completely accurate in comparison to real life cities.

The project could use further work in order to make it more user-friendly, useful, and better functioning. One main aspect of the project that could use improvement is the grading system used to scale the user's sustainability output. The scale used to grade the user is currently subjective because there was no previous data on the ideal outputs for a sustainable person that Group 5 could find. To improve this, more research could be conducted as to what a model sustainable person and city would look like. Then, using this information, Group 5 could create a scale personalized to each state, in order to make the grading more accurate. This improvement will help the overall project by creating a more accurate comparison for the user.

Another feature that could be more refined is the evaluation portion of the project. Based on user input, there would ideally be a list of suggestions that could pinpoint the user in the direction of improving their sustainability grade. However, the suggestions were very general,

and therefore were not as useful as they could have been. To enhance this section, Group 5 could input specific suggestions for specific areas that the user needs to improve. For example, instead of saying that the user needs to improve on his or her water usage as a whole, the suggestion would rather output “take shorter showers” if the user takes longer showers than the average person, or “turn off the water when brushing your teeth” if the user leaves the water on. To do this, more “if” statements would be used in the code so that each user input value will have a corresponding suggestion that will display if the user is above average in his or her usage. This improvement will help the overall project by giving more relevant suggestions for the user’s usage, depending on what he or she needs to work on the most in order to become more sustainable.