Ira A. Fulton Schools of Engineering
Arizona State University

CSE 535: Mobile Computing

Mobile Power and Energy Assignment

Purpose

A key consideration in mobile computing is the issue of power and energy usage. These properties are affected by various factors including the specific device, the device's battery, and the application itself. Applications can consume various amounts of energy depending on the resources being used (e.g., network vs. disk) and how those resources are being used. The ability to measure and analyze such data is valuable in ensuring your mobile application can be supported by a variety of consumer mobile devices. By the end of this assignment, you will write Python code to compute statistics and sensitivities related to energy and power for various applications that use various resources for a given amount of time.

Objectives

Learners will be able to:

- Compute values related to energy and power for a given mobile device and application.
- Discuss the different mechanisms of measuring power and energy.
- Compare mobile applications with respect to power and energy.

Technology Requirements

- Python 3.10.6
- NumPy 2.2.2
- pandas 2.2.3

Description

One of the supplemental readings given in the Power and Energy module is "Energy-Efficiency Comparison of Mobile Platforms and Applications: A Quantitative Approach" by G. Metri, W. Shi, and M. Brockmeyer. In this article, the authors explain the challenges of comparing energy efficiency across mobile platforms and applications. Through case studies involving browsers, video and music

streaming, and social networking apps on Windows, iOS, and Android, the authors identify insights into platform providers' energy-performance tradeoffs, app design strategies, and developers' practices. The article highlights the importance of improved tools and standardized methodologies to support developers in creating energy-efficient applications while acknowledging that the study offers more detailed discussions of these findings and their implications for future research.

In this assignment, a simulated assortment of data is provided that includes information on runtime and usage of several metrics: CPU, Memory, Network, and Disk. Using that data, you will compute energy and power statistics as well as the sensitivities of each metric for energy and power.

Directions

1. All methods should be defined within a class named A3 (and therefore take as input self as an additional first parameter. If an instruction requests two parameters, you would have self and then those two. Please name your file a3.py.
2. Define a method read_dataset. In this method, you should open the CSV file dataset.csv and store it for later use in a class-level variable. The CSV file will be made available to you in the same directory as your executing code. You can create a sample to test it locally.
    a. Sample dataset.csv:

    Application,CPU_Usage_Percent,Memory_Usage_MB,Network_Activity_KB,Disk_IO_MB,Execution_Time_s

    App_1,30,200,500,10,5

    App_2,50,300,700,20,10

    App_3,70,400,1000,30,8

    App_4,20,100,200,5,3

    App_5,40,250,600,15,6

    App_6,60,350,800,25,12

    App_7,80,450,1200,35,15

    App_8,10,50,100,2,2
3. Define a method generate_energy_statistics that takes as input a list of weights $[w_1, w_2, w_3, w_4]$ and computes and returns the following statistics as a 3-tuple: average energy consumption across all applications, application with the highest energy consumption, application with the lowest energy consumption. You should use the following equation to compute the energy consumption of each application. Round your numerical result to two (2) decimal places.

a. $Energy\ (J) = \sum_{i=1}^{4} w_i \cdot a_i$ where:

b. $a_1 = CPU\ Usage\ (\%)$

c. $a_2 = Memory\ Usage\ (MB)$

d. $a_3 = Network\ Activity\ (KB)$

e. $a_4 = Disk\ IO\ (MB)$

4. Define a method calculate_energy_sensitivites that takes as inputs the list of weights $[w_1, w_2, w_3, w_4]$ and computes and returns the sensitivities of the following four (4) metrics on the energy consumption as a 4-tuple: CPU Usage, Memory Usage, Network Activity, Disk IO. You should multiply your values by 100 if necessary to ensure the percentages are in the range 0 to 100 (instead of 0.0 to 1.0). Note that sensitivities should sum to approximately 100%, though slight rounding errors may occur and are expected. As such, please round your result to two (2) decimal places after you multiply by 100 as instructed above.
    a. $Sensitivity\ of\ Metric = Sum\ of\ Metric's\ Contributions\ /\ Total\ Energy\ Consumption$
5. Define a method generate_power_statistics that takes as input the list of weights $[w_1, w_2, w_3, w_4]$ and computes and returns the following statistics as a 3-tuple: average power consumption across all applications, application with the highest power consumption, application with the lowest power consumption. You should use the following equation to compute the power consumption of each application. The above energy equation should be used to compute energy. Round your numerical result to two (2) decimal places.
    a. $Power\ (W) = Energy\ (J)\ /\ Execution\ Time\ (s)$
6. Define a method calculate_power_sensitivites that takes as inputs the list of weights $[w_1, w_2, w_3, w_4]$ and computes and returns the sensitivities of the following four (4) metrics on the power consumption as a 4-tuple: CPU Usage, Memory Usage, Network Activity, Disk IO. You should multiply your values by 100 if necessary to ensure the percentages are in the range 0 to 100 (instead of 0.0 to 1.0). To adjust for rounding errors, please round your result to two (2) decimal places after you multiply by 100 as instructed above.
    a. $Power\ Contribution\ of\ Metric = Weight\ of\ Metric \cdot Metric\ Value\ /\ Execution\ Time\ (s)$
    b. $Total\ Power\ Contribution\ of\ Metric = \sum_{all\ applications} Power\ Contribution\ of\ Metric$
    c. $Sensitivity\ of\ Metric = Total\ Power\ Contribution\ of\ Metric\ /\ Total\ Power\ Consumption$

Submission Directions for Deliverables

You are given an unlimited number of attempts to submit your best work. You must submit your Mobile Power and Energy Assignment deliverable through Gradescope. Carefully review submission directions outlined in this overview document in order to correctly earn credit for your work. Learners may not email or use other means to submit any assignment or project for review, including feedback, and grading.

The Mobile Power and Energy Assignment includes one (1) deliverable:

- **a3.py:** Source code name must match exactly. Ensure you match the class and method naming conventions described in the directions.

Submitting to Gradescope

You must submit your work into Gradescope to receive credit for the course:

After completing work in GitHub, you must submit your work into Gradescope to receive credit for the course:

1. Go to the Canvas Assignment, "**Submission: Mobile Power and Energy Assignment**".
2. Click the "**Load Submission…in new window**" button.
3. Once in Gradescope, select the assignment titled "**Mobile Power and Energy Assignment**" and a pop-up window will appear.
4. In the pop-up:
    a. Submit your Python file “**a3.py**”.
    b. Click “**Upload**” to submit your work for grading.
5. If needed: to resubmit the assignment in Gradescope:
    a. Return to the Canvas submission and open Gradescope.
    b. You will be navigated to the "Autograder Results" page (if it is not your first submission).
    c. Click the "**Resubmit**" button on the bottom right corner of the page and repeat the process from Step 3.

Your submission will be reviewed by the course team and then, after the due date has passed, your score will be populated from Gradescope into your Canvas grade.

Evaluation

Your submission will be auto-graded. Please review the Evaluation Criteria for how your source code will be assessed. Submissions will be evaluated based on the criteria and will receive a total score. Submissions missing any part of the project will be graded based on what was submitted against the evaluation criteria. Missing parts submitted after the submission deadline will **not** be graded.

Review the course syllabus for details regarding late penalties.

Evaluation Criteria

Your submission will be evaluated and scored based on these criteria:

- Your code will be tested against a series of eleven (11) increasingly difficult test cases.
- Each test case will verify your generate_energy_statistics, calculate_energy_sensitivites, generate_power_statistics, and calculate_power_sensitivites.
- To ensure reasonable partial credit, the first test gives 20 points per method.
- The latter ten (10) test cases offer 0.5 points per method.