Exemption Exam for ES2

Date/Time: October 15th, 2021 at 1:30pm

Instructions for Exemption Exam for ES2 (Fall 2021)

Exam Programming Language: You can complete the Exemption Exam for ES2 in any of the following languages. You must select a single language and complete all questions using code and syntax from that language.

- Matlab
- C
- C++
- Java
- Python

Coding IDE (Integrated Development Environment): You can use any coding environment you wish to complete the exam. If you have a local installation (e.g. Matlab) of software, you are welcome to use that. If you know of an online software you prefer, you are welcome to use that. If you need access to an IDE, then:

- For Matlab, Tufts Engineering students may use the Tufts School of Engineering Virtual Lab that has a current version of Matlab installed.
- For all other languages (C, C++, Java, Python), a CodingRooms Classroom has been created where you can work on completing the exam. See Using a CodingRooms Classroom information on the SoE First Year Courses website.
- REPLIT.com also is a free online editor that supports many languages.

Format of Code:

- For full credit on each problem (and to help us grade/provide partial credit), please comment your code, at least briefly.
- If a question is unclear to you, or you are not sure about the ***assumptions*** you can make, write a comment in the answer area stating ***HOW*** you interpreted the question and then answer the question following your interpretation.
- Problems may include a data structure used to store data values. Different programming languages may have different names/nomenclature for different data structures or types of data structures. This exam uses the generic term “array” for this, even though a particular language (e.g. the `list` data structure in Python) may implement storage in a different way. Use the appropriate language-specific method and the associated access and manipulation functions.

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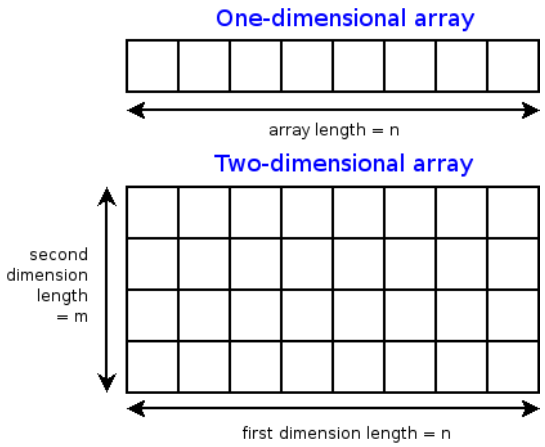

- The term “function” could also represent a function, subfunction, subroutine, or other process/procedure depending on the language. You should use the appropriate syntax for defining and calling functions.
- If a variable is unnamed in the problem statement, or it is presumed a value or data exists prior to your coded solution, simply state that and indicate the variable/data/etc that you’ll be using. (See “***assumptions***” statement above.) If you create new variables associated with a problem statement, please use good naming conventions so it is clear what that variable represents. We are looking for code blocks and code snippets that solve the specified challenges and problems presented (not necessarily start-to-finish completely working/compiled/running code).

Submitting Your Answers: You should submit your solutions to the questions as individual code files (one for each problem) or as a single ZIP file (compressed archive) of all files together. Use the following Google Form (log in using your ***first.last@tufts.edu*** email address and your Tufts username/password).

Submit answers here: https://forms.gle/eA8GjCe1S1Bsm48cA

Academic Honesty/Statement of Individuality: you must read the following and “sign” your name (part of the Google Form submission above) regarding your submission to the Exemption Exam for ES2.

> *For this exam, I make the following statement: I affirm that I have not given nor received any unauthorized help on this exam, and that all work is my own.*

Questions or Concerns: Leading up to the exam if you have any questions, concerns, or issues please visit the Tufts SoE First Year Courses site with information about the exam or email Prof. Ethan Danahy at ethan.danahy@tufts.edu. During the exam itself, please join the following Zoom session where Prof. Danahy will be available to answer questions about the content of the exam or solve real-time technical issues you might have.

https://tufts.zoom.us/j/95054981319?pwd=WEwwQUFNWWpwQmNIRDhieFpWZDM5UT09

(Meeting ID: 950 5498 1319, Passcode: 650018)

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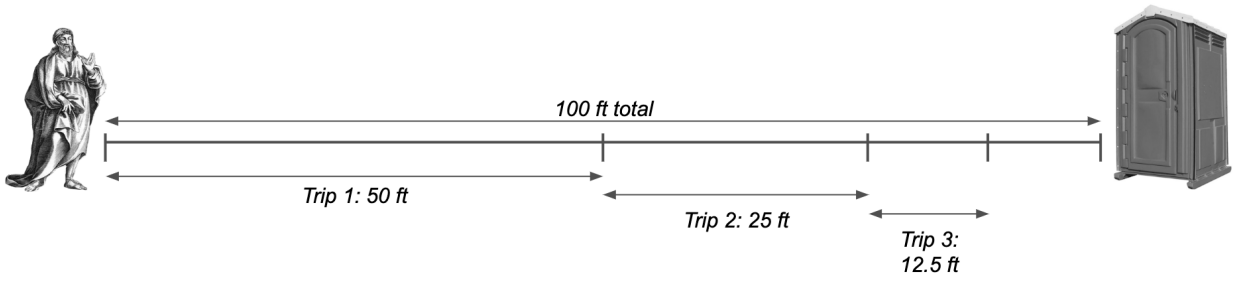
There are 4 (four) Exam Questions total.

Exam Question 1:

Zeno is on a journey that is 100 feet total in length (note: 12 inches in a foot). Towards completing his journey, he makes a series of smaller trips, with each trip bringing him ½ (one half) the remaining distance closer to his destination. Write code that determines what trip (which trip number) is the trip that will bring him ***within*** one-inch of his ultimate goal. Print the answer to standard output.



Exam Question 2:

Dr. E has invented a custom **`BINGO`** game that *first* randomly selects a letter (one of five letters, from "**`B`**", "**`I`**", "**`N`**", "**`G`**", or "**`O`**"), and *second* randomly selects a number (integers from 1 to 15, inclusive), and *third* pairs the letter and number together into a unique string combination (resulting in strings such as "**`B7`**" or "**`N13`**" or "**`G6`**").

He is now creating a computerized version of his game, and to facilitate this, he wants to initialize (pre-populate) a 1D array with all possible combinations of valid outcomes (e.g. 5 letters x 15 numbers = 75 total options) so he can then just randomly select an element later. Write code to efficiently and automatically create and initialize this array.

(**Note:** You are *NOT* being asked to randomly select an element. You are *NOT* being asked to create the game of **`BINGO`**. You are ***just*** being asked to set up the array.)

Bingo Array:

`B1`	`B2`	`B3`	`...`	`B14`	`B15`	`I1`	`I2`	`...`	`I15`	`N1`	`...`	`N15`	`G1`	`...`	`O14`	`O15`

Continue to Question 3 on the next page

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Exam Question 3:

A bridge is equipped with two sensors: (1) an accelerometer that continually collects data of the bridge's movement (shaking, in *mm/s*^{2}) once a second and (2) a photogate system that records the moment a vehicle passes (time, in *seconds*) by a certain point on the bridge. These two sensors are initialized simultaneously (so they have a common "zero point" in time) and their sets of data are stored in two separate arrays for analysis later by engineers back in the lab.

Acceleration Data:

Time (s):	0	1	2	3	4	5	6	7	...
Value (mm/s^2):	0.01	0.02	0.22	0.37	0.14	0.03	0.01	0.02	...

Photogate Data:

Vehicle (#):	1	2	3	4	5	...
Time (s):	3	17	32	77	86	...

The engineers now want to examine the bridge's shaking for different vehicles, but wish to average the accelerometer's sensor data over three points: (1) the point before, (2) the point during, and (3) the point after the exact moment the vehicle drove by. Write a function that takes in a vehicle number as an input parameter and passes back (returns) this average acceleration data calculation of the bridge for when the vehicle passes.

Continue to Question 4 on the next page

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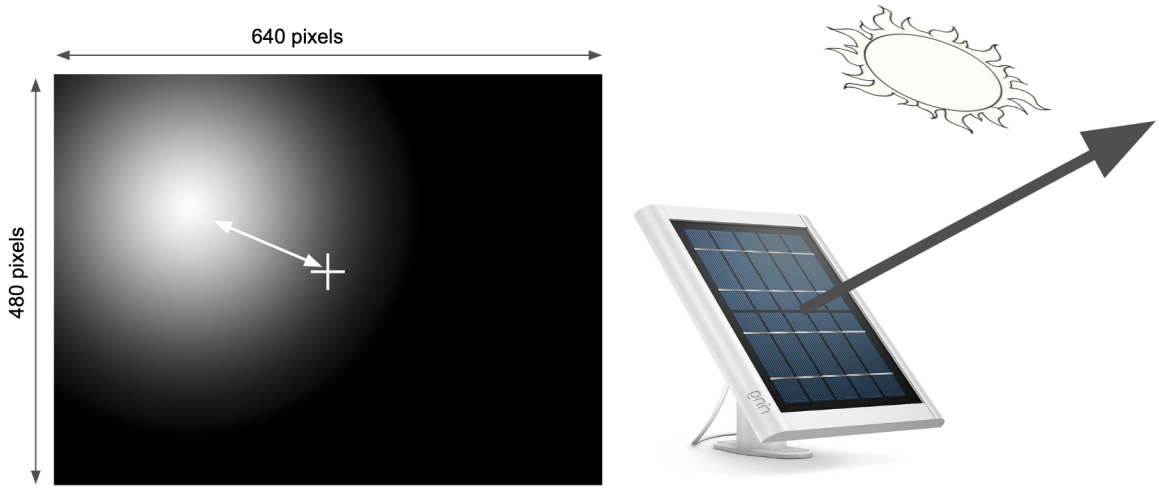
Exam Question 4:

A solar panel is equipped with a camera that takes a picture of the sky directly above (perpendicular to) the solar panel. The image captured is a grayscale image that is 640 pixels in width and 480 pixels in height. Each grayscale pixel is represented by a single integer in value ranging from a possible minimum of 0 (representing dark/black) to a possible maximum of 255 (representing light/white). When the sun is directly above the solar panel (generating the greatest amount of power), the brightest point in the image will be directly in the center. Thus, both the intensity and the distance of that brightest point from center is of interest to the engineers trying to predict the power efficiency of the panel for any given sun position.



Assuming the image data is stored in a 2D array, write code for processing a single image that (1) determines the location of the sun (e.g. brightest point within the image) and (2) calculates the distance from the center of this point. Print to standard output both the intensity (the grayscale value, from 0 to 255) and the absolute distance (in pixels) calculated, in the following form:

> “The brightest point is of intensity 237 and a distance from center of 23.7 pixels.”

Note: there might be multiple “brightest points” within the image. You only need to find/report out ONE of those points.

This is the end of the exam. There were 4 (four) questions total.

Submit answers (code files) here: https://forms.gle/eA8GjCe1S1Bsm48cA