CMPS 1500 Introduction to Computer Science I – Spring 2019

Lab 5

Due **Wednesday 2/27/19** at 11:59 p.m. on Zybook and Canvas

Please follow the usual lab guidelines (file naming rules, honor code, comment requirements). **Read the entire assignment before you begin working on it.** Make sure you understand the .ppm format before you start coding.

0. We are going places, `lab5pr0.py`

   In this exercise you will write a program that automatically generates image files for flags of different countries.

   A computer image is a two-dimensional grid of pixels. Each pixel represents the smallest undivisible part of the computer screen. An image file is an assignment of color to each pixel. Pixels are referred to by their Cartesian coordinates. The top left corner of an image has the coordinates $(0, 0)$. The bottom right corner has the coordinates (n, m) where n is the width of the image in pixels (the number of columns) and m is the height of the image in pixels (the number of rows).

   .ppm format explanation The *Portable Pixel Map (.ppm)* file format is a simple format for storing graphical images. Here is a sample .ppm file on the left; the image is visualized on the right.

```
P3
4 3
255
0   0   0     0   15 175    0   15   175   255   0   255
0   0   0     0 255 175   255 255 255   255 255 255
255 0 255   0 255 175   255 255 255   255 255 255
```

   The first few lines are called the *image header*. They provide an overview of the contents of the image. Headers of .ppm files consist of four entries, which will be defined using the example:

```
P3
4 3
255
```

   - `P3` defines the image format; that is, what type of .ppm (full color, ASCII encoding) image this is. For this assignment it will always be `P3`.
   - Next comes the number of columns and the number of rows in the image. The example is a 4 pixel by 3 pixel image
   - Finally, we have the maximum color value. This defines the scale of values possible for the color intensities. This can be any value, but a common value is 255, meaning the red, green, and blue values for a pixel can range from a value of 0 to 255.

The way you see the header presented in this example is how it should appear in your image files, too, except you will use your own dimensions.

The *image body* comprises the remainder of the image file after the image header. The image body contains the actual picture information as a series of RGB values. Each pixel of the image is a tiny, colored square. In the .ppm file, each pixel is defined by a triplet of values representing how much red, green, and blue (RGB) are present. So, the first pixel, which has a value of `0 0 0`, is black, and the last pixel, `255 255 255`, is white. By varying the levels of the RGB values you can come up with any color in between. You can search the Internet to find nice colors for your images in this assignment.

Note that color values must be separated by a space, but after that any additional whitespace is ignored by the image viewer. In the sample .ppm file above we used additional whitespace to format the pixel values so that it is easy for a human to understand, but the computer doesn't care if everything is on one line, if there is one line of RGB values per row of the image, or some mix. You should not assume one line in the file corresponds to one row in the image.

Viewing .ppm files Your Python program will create .ppm files and write to them just like you wrote to text files. However, to view the result as an image, you'll likely need to install a viewer program, because standard picture viewers (such as Picasa, MS Paint, etc) do not recognize the .ppm format. Freeware (i.e., free software) picture viewers exist. One such viewer, XnView can be downloaded from `http://www.xnview.com/en/xnview.html`

(a) Write a function `get_header(width, height)` that takes in the desired image dimensions and returns a string with the .ppm file header, as described above. Remember to specify the desired input and output types of the function in the docstring.

(b) Your first image is a flag of the Netherlands. The flag of the Netherlands consists of three equal-sized horizontal fields. The colors (top-to-bottom) are red, white and blue. Write a function `netherlands(width, height)` that takes in the dimensions of the flag and returns a string containing all the pixels of the flag. For simplicity you can assume that the value of the height is evenly divisible by 3.

For example,

```
netherlands(4, 3)
```

should return one long string containing the following values (here you see this string broken into three lines to fit the screen).

```
255 0 0 255 0 0 255 0 0 255 0 0
255 255 255 255 255 255 255 255 255 255 255 255
0 0 255 0 0 255 0 0 255 0 0 255
```

(c) Now write a `main()` function that you will use to test the above two functions. It will be responsible for interacting with the user and calling `get_header()` and `netherlands()`. It should ask the user for the dimensions of the desired

flag and the name of the output file that is to contain the image. Then it should generate a header and write it to the output file, and then generate the image body and write it to the output file. Don't forget to close the file after you are done writing to it. Below is a sample output:

```
Please, enter width: 400
Please, enter height: 300
Please, enter output file name: netherlands.ppm
The output has been written to netherlands.ppm
View the result in XnView.
```

View the resulting file in XnView and make sure that it looks like the flag of the Netherlands.

Note that the results of the computation performed by this function **are not directly displayed to the user**. It is a nice gesture on the program's part to inform the user that the computation is completed and how to view the results. Please adapt this practice in your own programs that write the results to a file or which otherwise don't display results directly.

(d) Next is the flag of Nigeria. It's flag consists of three equal vertical sections, green-white-green. Write a function `nigeria(width, height)` that generates the flag. You can assume the value of width is evenly divisible by 3. Remember to specify the desired input and output types of the function in the docstring.

(e) Modify your main function to use `nigeria()` instead of `netherlands()`. You shouldn't need to modify anything else in your main function. Use it to generate a .ppm file with the Nigerian flag.

(f) The next image is the flag of the United Arab Emirates. The flag consists of a vertical red field at the hoist (the left side of the flag), and three horizontal fields of equal height at the fly (the right side of the flag). The colors of the horizontal fields are from top to bottom: green, white, black. The width of the red field is a quarter of the flag's width. Write a function `uae(width, height)` that generates the flag. You can assume that the value of the width is evenly divisible by 4 and the height is evenly divisible by 3. Remember to specify the desired input and output types of the function in the docstring.

(g) Modify your main function to use `uae()`. Use it to generate a .ppm file with the flag of the United Arab Emirates.

Make sure your code is well-documented and well-formatted.

Optional extra credit problems: generate flags of Finland, Scotland, or another country of your choice with a more sophisticated flag pattern than those described above (consider Switzerland, Bangladesh, Republic of Congo, Seychelles, Greece or similarly complex flags); up to 20 points per flag, for the max of 100 points per 5 different flag patterns. You may need to use nested loops in your program. Each flag image should be generated in its own function. Submit the resulting file `lab5pr0ec.py` on Canvas.

1. Elements of computer organization, `lab5pr1.pdf`

   In the following exercise you will practice working with binary numbers and with creating digital circuits. Your answer to this problem should be submitted electronically. You can write your answer into a Word file, insert pictures of the drawings into it, and finally save it as a .pdf file. You can produce the drawings by hand and then take a photo / scan your drawing. But the most preferable way would be for you to use the *LogiSim software* to generate your circuits (then Export to a .png file, which you can insert into the Word file); use google to find LogiSim.

   (a) Hexadecimal numbers are numbers in base 16. They use the following sixteen digits: $0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F$. They are widely used in computing, for example, to represent colors or network addresses of computers.

      i. Convert $B42A_{16}$ to decimal. Show your work.

      ii. Convert 6789_{10} into hexadecimal. Show your work.

      iii. Convert 0011010101001110_2 to hexadecimal. Explain how can you use the fact that $16 = 2^4$?

      iv. If you convert a 64-bit binary number into hexadecimal, how many hexadecimal digits does it have? Explain.

   (b) In this exercise you will design part of a circuit for adding three bits x, y and c_{in}, resulting in two outputs c_{out} and z that represent the addition $x+y+c_{in}$. This is the same as the full adder that we covered in class. You have already designed a circuit for computing z, the odd parity function corresponding to the sum bit, and now you'll make one for computing c_{out}, the carry bit. You can design your own truth table for c_{out} or find it on the slides. Then you should write a corresponding minterm expansion logical formula, and then draw a corresponding circuit.

2. Diversity in tech `lab5pr2a.txt, lab5pr2b.pdf`

   You may notice that your Intro to Computer Science course has more men than women. The same gender gap exists in the computer science industry. This gender gap has nothing to do with skills. There's no difference in technical abilities between men and women. Women earn the same grades men do, and perform just as well in programming and other technology-related jobs. But fewer women go into CS and engineering fields because fewer women are exposed to them, there are fewer female role models, some ways in which women are conditioned to behave (be modest, avoid risks) are counterproductive in a changing tech environment, and those who are actually interested may anticipate challenges in functioning effectively in a male-dominated field. This gender gap limits progress in the industry and it limits progress in equality for women. All people should have the opportunity to learn about this exciting and lucrative field. From a practical standpoint, companies today need a diverse workforce with individuals offering various perspectives. Of course, binary gender is just one basis of diversity, and other types of identity diversity (e.g., ethnic, sexual orientation, physical ability) also need careful consideration. In this assignment, we'll use (binary) gender diversity as an example.

Part a Watch the TED talk by Facebook COO Sheryl Sandberg "Why we have too few women leaders" (15 minutes)

`https://www.youtube.com/watch?v=18uDutylDa4`

In her talk Ms. Sandberg discusses leadership roles in general, but the talk is even more true in fields like tech. While she talks about women, many of the issues she raises are also applicable to men. Write down at least 3 actions (more are welcome, max is 10) that you in particular can do (for yourself or for others) to address the issues that Ms. Sandberg raises in her talk, and to create a friendly climate for diversity in CS.

Part b This part explores current women playing various roles in the computer science field. It should help us become familiar with current notable women, showcase some interesting projects, and touch on work done to improve the representation of women in the field. Hopefully we'll discover some common characteristics between these leaders and ourselves, and be able to relate their experiences to our own.

- In academia / promoting women in tech
  Maria Klawe: First female president of Harvey Mudd
  Anita Borg: Computer scientist, founded multiple major programs for women in tech
  Lucinda Sanders: CEO, co-founder: National Center for Women and Information Technology
  Danah Boyd: Principal Researcher at Microsoft Research
  Jane Margolis: wrote Unlocking the Clubhouse, on college women in CS

- Usability / accessibility / tech for improving lives
  Chieko Asakawa: IBM researcher on accessibility for visually impaired, blind since 14
  Ruzena Bajcsy: director emerita of Center for Information Technology Research in the Interest of Society
  Nancy Leveson: created "software safety" field: systems that save lives

- Software / programming
  Barbara Liskov: first woman in the US to receive a Ph.D. in CS! MIT professor.
  Fran Allen: programming languages, compilers; only woman to win Turing award ("Nobel Prize" of CS)

- CS Faculty / academics
  Parisa Kordjamshidi: Machine learning and natural language processing
  Anastasia Kurdia: Computer science education, algorithms and optimization
  Brent Venable: Artificial intelligence
  Diane Souvaine: Computational geometry; current chair of the National Science Board

- Robotics / hardware
  Susan Eggers: co-inventor of influential processor technology
  Helen Greiner: co-founder of iRobot (makers of Roomba)
  Grace Hopper: developed the first compiler for a programming language

- Businesswomen in tech / startup founders
  Judy Estrin: entrepreneur, startups, Cisco systems, Sun Microsystems,
  Padmasree Warrior: CEO of NIO, former CTO of Cisco, Motorola
  Mitchell Baker: CEO of Mozilla

- Blogs / entertainment
  Caterina Fake: Founder, photo-sharing site Flickr
  Arianna Huffington: Founder, news blog Huffington Post
  Meg Hourihan: Founder, blogging site Blogger
  Mena Trott: Co-Founder, SixApart, a blogging software company which formerly owned LiveJournal
  Jade Raymond: video game producer, TV show host

Pick one person from the list and make a short presentation page of her. The page should contain a photo and information as described below. In this assignment bullet points are fine (a minimum of five bullet points is expected). Look for the following:

- Context: What is your subject's educational and career background? Who influenced her? What drew her to her field? Did any specific characteristics enable her to become a significant contributor?
- Accomplishments: What contributions did she make to technology? What areas of business/life does her work impact? What does her research / company / personal mission entail? Did she work to change the view of women in science? What kind of recognition has she received for her work?
- Characteristics: What traits does/did she possess that you admire? What similarities do you see between this computer scientist and yourself? What does it take to impact the tech field today?

Since most of these women are currently active (and some are young), limited information may be available online. If you can't find all of the details listed above, just bring whatever interesting facts you do find; the point is to become familiar with these women and their work. Pay attention to details including spelling, grammar, and links. You can prepare your presentation page in a word processor or slide maker (e.g., Powerpoint). For submission, convert it to .pdf.

Some additional resources:

- O'Reilly Network's Women in Technology: First-hand accounts from current women in tech

  `www.oreillynet.com/womenintech/`

- Women in Technology International Hall of Fame: short bios on 11 years of award winners

  `http://www.witi.com/center/witimuseum/halloffame/`

Acknowledgement This assignment was created using course materials for CSE 190a: Women in Computing Seminar from University of Washington.