

CS101
Spring 2018

Instructor: Ashley Taylor
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Final Exam

NAME (LAST, FIRST): _____

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Problem	1	2	3	4	5	6	TOTAL
Score							
	21	9	12	30	20	25	117

Instructions:

- The time for this exam is **3 hours**, 180 minutes total. There are 117 points total, so you should spend a little more than 1.5 minutes per point, though your pacing may be different on different problems.
- You are only allowed a pencil, pen, and eraser. Any other materials are strictly prohibited. You may not use any digital devices other than a clock for timing. You may ask the proctors for blank scratch paper.
- A **reference sheet** is included as the last page. You may detach it for your reference during the exam.
- For coding problems, we will forgive minor syntax errors (such as missing semicolons, etc.).
- For any problems involving calculations, we will accept an expression (that could be plugged into a calculator) in lieu of the numerical answer.
- Problem 4b is overweighted by points compared to the time it will take. That might be a good place to start.

Please sign *before* beginning the exam:

I agree to abide by the spirit and letter of the Honor Code, and to follow the instructions above.

(Signature)

(Date)

1. Course Themes

- a) (6 points) Name two different examples of shared resources in computer science. For each example, describe how that resource is managed.

A non-CS example of a shared resource would be the washing machines in your dorm, which are managed by RAs (who have authority to instruct the users on how to use them) and the mailing list (which uses public shame to encourage the desired behavior).

RAM is shared among all the programs in your computer. It is managed by the operating system. Each program gets its own space in RAM.

Permanent storage is shared by all files and programs in your computer. This is managed as a file system by your operating system.

- b) (4 points) Describe one area in computer science where standardization is effectively implemented, and describe why standardization was necessary. Describe another area where standardization was not completely implemented; what is the impact of the lack of standardization in that case?

Standardization is effectively implemented in TCP/IP. This is necessary so that separate computers can talk to each other.

Standardization is not implemented in rendering engines. This causes internet browsers to (annoyingly) display websites differently across browsers.

- c) (8 points) In class, we discussed layers of abstraction in regard to two different systems. What are these two systems? For each system, which layer is the most abstract, which layer is the least abstract, and describe the purpose of one of the layers.

Computer Hardware/Software

Most abstract: applications

Least abstract: transistors

Transistors are the actual hardware, the 1s and 0s of the computer.

Internet Protocols

Most abstract: Application layer

Least abstract: Link layer

Link layer is responsible for sending and receiving the actual signals (1s and 0s) between computers.

- d) (3 points) What is a graph? What are two different graphs we described in class?

A graph is a representation of data in computer science consisting of nodes connected by edges. We discussed Facebook as a graph, where the nodes are people and edges are friendships. We also discussed disease outbreaks, road networks, and the internet as graphs.

2. Web and the Internet

- a) (2 points) Why do changes to CSS through Google Chrome inspector, as we did in class, only affect how the website looks on your computer, but not on everyone else's computer?

Changes through Google Chrome inspector change the way the website is displayed in your browser. It does not affect the source code of the webpage. When other users visit that page, they will receive the original source code without your changes.

- b) (4 points) Describe the three frontend components. How do they work together to display webpages?

HTML is responsible for the content of the webpage. CSS decides how that content is displayed stylistically. JavaScript provides the ability to respond to user input (clicks, keyboard input, or anything else).

- c) (3 points) Name 3 factors that influence the ordering of search results in Google?

If that page contains the search terms.
If many other websites point to that webpage.
The importance of the websites pointing to that webpage.

3. Security

- a) (4 points) What is public-key encryption? Describe two uses for public-key encryption.

Public-key encryption works as follows: A website has a private key and gives out its public key. The public key allows a user to check that the website is actually who they say they are. These public keys are issued by a certificate authority to stop impersonators. Private keys are used to create a shared key for the actual encryption. Public-key encryption is useful for cryptocurrency and to prevent man-in-the-middle attacks.

- b) (2 points) What is the difference between security and privacy?

Security refers to protecting data from malicious attackers. Privacy refers to when a user is willingly using a service (like Facebook or Google) and how that service uses and gathers information and data on the user.

- c) (2 points) What is a password manager? How does it make your passwords stronger?

A password manager is a program that stores passwords. It allows you to make passwords unique and long since you no longer have to memorize all of them.

- d) (4 points) Describe two different kinds of attacks (or "hacks"). How can either computer scientists or users protect against each type?

Two examples include:

Dictionary Attack - when a hacker tries countless different possibilities trying to guess a password. To prevent this, users should use unique, long passwords.

Man-in-the-Middle Attack - When a hacker impersonates a website in order to place him or herself in between a user and the website. In this way he or she can intercept all of the traffic between a user and a website. To prevent this, use HTTPS whenever possible.

4. Potpourri

- a) (3 points) Describe a dark pattern. How could you as a user subvert this pattern?

A dark pattern is a UI trick to make users do what the company wants. Examples include Google placing Ads at the top of searches, or airlines make it difficult to choose the cheapest flight option. As a user, with knowledge of these dark patterns, you can simply ignore the ads, or have due diligence to find how to buy the cheapest flights.

- b) (10 points) What is a checksum? In what context is it used, and why is it necessary?
Note: this question is overweighted by points compared to how long it will take you to complete. 3-4 sentences should suffice.

A checksum is bits added to the end of a message in order to ensure accuracy of that message after it has been received. It is used in the TCP/IP stack to check packets. It is necessary because errors can occur during transmission of information.

- c) (5 points) Describe how the code you write is understood by a computer. What steps are involved?

Code starts by a user writing code in a high-level programming language similar to english. This code is then interpreted or compiled to machine code (1s and 0s). The machine code is then run on the CPU.

- d) (2 points) What is the analogous element in JavaScript to a single cell in a spreadsheet? Name one other similarity between spreadsheets and JavaScript.

A single cell in a spreadsheet is like a variable in JavaScript. They both store one piece of information. Another similarity is that they both have functions to manipulate data.

- e) (4 points) Describe the P vs. NP question. Name two implications if P equals NP?

The P vs. NP question is, "Is it just as fast to solve a problem (NP) as it is to check that the solution is correct (P)?" If P equals NP, then encryption would break, but we would be able to quickly solve problems (like creating the ideal network of roads).

- f) (4 points) Describe two types of data that are stored in computers. How is each type stored?

Integers are stored in binary format.
Characters are stored in ASCII format.

g) (2 points) What is a design change you would make to the CS101 website?

Answers will vary.



5. Code Reading/Comprehension

- a) (8 points) Below is the code from edge detection as we talked about in class. Edit it so that edges are colored blue and non-edge pixels are colored yellow. Additionally, we will add the constraint that an edge cannot be on the left border of the image, so all left border pixels should be considered non-edges. You can cross out or add code as necessary, but please use arrows to clearly indicate your edits. Hint: you don't need to edit any of the first four lines of code.

```
image = new SimpleImage("striped-fish-green.jpg");
back = new SimpleImage("yosemite.jpg");
back.setSameSize(image);
back.setZoom(0.5);

for (pixel : back) {

    pixel.setRGB(255, 255, 0);

}

for (pixel : image) {

    for (neighbor : image.getNeighbors(pixel)) {

        red = neighbor.getRed();
        green = neighbor.getGreen();
        blue = neighbor.getBlue();

        if (!pixel.isSimilarTo(red, green, blue, 20) && pixel.getX() != 0)
        {

            backPixel = back.getPixel(pixel.getX(), pixel.getY());

            backPixel.setRGB(0, 0, 255);

        }

    }

}

print(back);
```

- b) (6 points) Below is a snippet of code with several bugs. It attempts to increase contrast in red by rescaling the red values (for example, if an image only had red values between 50 and 100, we could increase the separation by scaling the pixels with a red value of 50 to 0, those with a red value of 100 to 255, and the rest would be in between). Identify and correct one syntax error and two logic errors, clearly identifying which is which:

```

image = new SimpleImage("5b.jpg");
maxRed = 0;
minRed = 0;
for (pixel : image) {
    if (pixel.getRed() < maxRed) {
        maxRed = pixel.getRed();
    } else if (pixel.getRed() < minRed) {
        minRed = pixel.getRed();
    }
}

for (pixel : image) {
    pixel.setRed(getRed() - minRed * 255 / (maxRed - minRed));
}
print(image);

```

Some Errors are shown below.

Syntax Errors:

```

pixel.setRed(getRed() - minRed * 255 / (maxRed - minRed));
pixel.setRed(pixel.getRed() - minRed * 255 / (maxRed - minRed));

```

Missing ending } for the first for loop

Logic Errors:

```

maxRed = 0;
minRed = 255;

```

```

if (pixel.getRed() < maxRed) {
if (pixel.getRed() > maxRed) {

```

```

pixel.setRed(getRed() - minRed * 255 / (maxRed - minRed));
pixel.setRed((getRed() - minRed) * 255 / (maxRed - minRed));

```

c) (6 points) Below are the first two rows of a sample spreadsheet. Describe how you would determine which team has the highest average number of players per year (note: you do not need to use any commands, though you may do so if those would help you explain). Your description should be detailed enough that a novice Excel user could determine which functions in which order they should use.

Year	Team	Number of Players	Number of Points
2001	Giants	31	139
...

Use UNIQUE to create another column of unique team names.
Use AVERAGEIFS to average the number of players for a particular team.
Compare this new column of averages using MAX. This will be the highest average.
Find the team that corresponds to this average.



6. Code Writing

- a) (6 points) Color the 3x3 square at the bottom-left corner of an image yellow. Your solution must use a for loop.

```
img = new SimpleImage("6a.png");
height = img.getHeight();
for (pixel : img) {
    x = pixel.getX();
    y = pixel.getY();
    if (x <= 3 && y >= height - 4) {
        pixel.setRGB(255,255,0)
    }
}
```

OR

```
img = new SimpleImage("6a.png");
height = img.getHeight();
centerPixel = img.getPixel(1, height - 2);
for (neighbor : img.getNeighbors(centerPixel) {
    pixel.setRGB(255,255,0);
}
```

```
print(img);
```

- b) (7 points) We learned about steganography, a way of hiding messages in plain sight. You will write code to unveil a hidden image inside another image.

One way of hiding an image is to slightly modify the green value of a pixel - an odd green pixel in the original image corresponds to a black pixel in the hidden image, and an even green value in the original image corresponds to a white pixel in the hidden image. You should write code that converts the original image to the hidden image.

You can use the code building block `isOdd(value)`, which is true if value is odd.

```
img = new SimpleImage("6b.png");
for (pixel : img) {
    if (isOdd(pixel.getGreen())) {
        pixel.setRGB(0,0,0);
    } else {
        pixel.setRGB(255,255,255);
    }
}
```

```
print(img);
```

- c) (7 points) Make the following image entirely grayscale, except for a purple diagonal offset by a height of 2 (from the bottom left corner to the top right). For example, the pixels marked by an X below should be purple:

		x
	x	
x		

```
img = new SimpleImage("6c.png");
for (pixel : img) {
    brightness = (pixel.getRed() + pixel.getGreen() +
        pixel.getBlue()) / 3;
    pixel.setRGB(brightness,brightness,brightness);
    if (pixel.getY() == img.getHeight() - 3 - pixel.getX()) {
        pixel.setRGB(255,0,255);
    }
}
```

```
print(img);
```


- d) (5 points) Write code to flip an image horizontally, as shown in the example below. Note: this question is underweighted by points compared to how long it will take you to complete. You should work on it last.

example.png

red	green	blue
blue	white	red
green	blue	black

expected output

blue	green	red
red	white	blue
black	blue	green

```
img = new SimpleImage("6d.png");
width = img.getWidth()
for (pixel : img) {
    if (pixel.getX() < width / 2) {
        red = pixel.getRed();
        green = pixel.getGreen();
        blue = pixel.getBlue();
        swapPixel = img.getPixel(width - pixel.getX() - 1,
                                pixel.getY())
        swapRed = swapPixel.getRed();
        swapGreen = swapPixel.getGreen();
        swapBlue = swapPixel.getBlue();
        pixel.setRGB(swapRed, swapGreen, swapBlue);
        swapPixel.setRGB(red, green, blue);
    }
}
```

```
print(img);
```

This page is intentionally left blank.

```
pixel.getX()
pixel.getY()
pixel.getRed()
pixel.getGreen()
pixel.getBlue()
pixel.setRGB(red, green, blue)
pixel.isSimilarTo(red, green, blue, threshold)
```

```
image = new SimpleImage("image.png")
image.countNeighbors(pixel)
image.getHeight()
image.getWidth()
image.getPixel(row, column)
```

```
for (pixel : image) {
    // your code here
}
```

```
for (neighbor : image.getNeighbors(pixel)) {
    // your code here
}
```

```
if (condition) {
    // your code here
} else {
    // your code here
}
```

```
&& => and
|| => or
! => not
!= => is not equal
== => is equal
```

```
1TB = 1000GB
1GB = 1000MB
1MB = 1000KB
1KB = 1000 bytes
```

Bit: 0 is "off", 1 is "on"