CS 145 Images and Imagination

Exam 2 Solutions

1. (14 pts total) For the following function

```
float calcGray(int r, int g, int b) {
        float gray = 0.3*r + 0.59*g + 0.11*b;
        return gray/255.;
}
```

   a. (2 pts) What is the return type? _____float___

   b. (2 pts) How many parameters are there? _____3 _____

   c. (2 pts) What is the type of each parameter? _____int ____

   d. (2 pts) What are the names of each of the parameters? ___r, g, and b

   e. (6 pts) What needs to go into the two println statements:

```
 void setup() {
   int myRed   = random(255);
   int myBlue  = random(255);
   int myGreen = random(255);

println( "For red = " + myRed + ", green = " + myGreen + ", and blue = " + myBlue);

println("The gray scale value is " + calcGray(myRed, myGreen, myBlue));
 }
```

   to print the output below (note, the choice of numbers written below may be different since we don't know ahead of time what random numbers will be chosen).

```
For red = 241, green = 100, and blue = 16
The gray scale value is .5218
```

   You should make use of the calcGray() function.

2. (3 pts each, 18 pts total) Complex Number Representation:

   a. Place the following in standard form a + b i.

      i. $3\ i^3 + 7\ i^4$ _____7 - 3 i_____

      ii. $-6\ i^2 + i\sqrt{-16}$ _____2_____

   b. What is the standard form for the complex numbers whose values in polar coordinates are

      i. $(r, \theta) = (\sqrt{2}, 45°)$ ____1 + i_____

      ii. $(r, \theta) = (3, 270°)$ ___- 3 i_____

   c. What is the polar coordinate representation (r, θ) for the following complex numbers

      i. -3 (r, θ) = _____(3, 180°)_____

      ii. $-2\ i$ (r, θ) = _____(2, 270°)_____

3. (4 pts each, 24 pts total) Complex numbers: Given $z_1 = -8 + 2\,i$ and $z_2 = (1 - 3\,i)$. Calculate the following, placing the result in standard form
   a. $z_1 + z_2 =$ _____ $-7 - i$

   b. $z_1 - 2\,z_2 =$ _____ $-10 + 8\,i$

   c. $z_1\,z_2 =$ _____ $-2 + 26\,i$

   d. $\bar{z}_1 + z_1 =$ _____ -16

   e. $\bar{z}_1 z_1 =$ _____ 68

   f. Length of $z_1 = |z_1| =$ __ $\sqrt{68}$

4. (8 pts total) Class syntax:
   a. (3 pts) How would you create a new Complex object with real component equal to 4.2 and imaginary component equal to 5.8 ?

```
Complex c = new Complex(4.2, 5.8) ;
```

   b. (5 pts) In Processing, suppose you have created complex numbers c1, c2, and c3. How do you compute (i.e. what is the syntax of) for computing

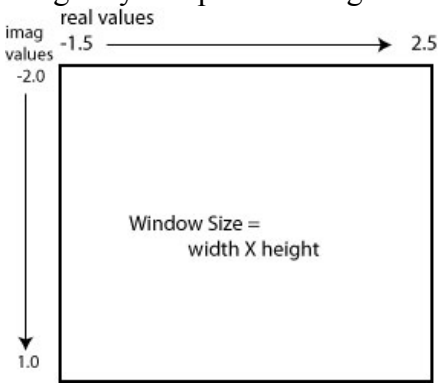
$$c3 = c1/c2 + c1*c2$$

```
c3 = Complex. cAdd(  Complex.cDiv(c1,c2) , Complex.cMult(c1,c2) ) ;
```

5. (10 pts) Functions and Classes: Write a Processing function called `zSquared` that takes a Complex number *as a parameter* and *returns a float* which is equal to the square of the Complex number's real part plus the square of its imaginary part. That is, if z = a + b i, then the function will return $a^2 + b^2$ (of course, you need to put this all in Processing syntax).

```
float zSquared(Complex c) {
   float sq = c.real*c.real + c.imag*c.imag;
   return sq;
}
```

6. (4 pts each, 8 pts total) Rescaling: Given a region of the complex plane where the real and imaginary components range as shown in the figure below:



   a. How does one use the map function to determine the pixel location of the complex number
   z = -0.25 + 0.43 i.

```
int pixeli = map(-.25 , -1.5, 2.5, 0, width);

int pixelj = map(.43, -2.0, 1.0, 0, height);
```

   b. How does one use the map function to determine the complex number corresponding to the pixel (i,j)

```
int real = map( i, 0, width , -1.5, 2.5);

int imag = map( j, 0, height, -2.0, 1.0);
```

7. (8 pts) The following `for-loop` computes the sum of the numbers from 10 to 100. Write a while-loop that does the same thing.

```
int sum = 0;
for (int i =10; i <= 100; i++) {
    sum = sum + i;
}

int sum = 0;
int i =  10;
while (i <=100) {
    sum = sum + i;
    i++;
}
```

8. (10 pts) Recursion: Write a ***recursive*** function called multNums that will multiply the numbers from 1 to n, for some value of n. It could be called from the setup() function as follows:

```
void setup() {
        int n = random(20);
        int product = multNums(n);
        println("The product is " + product);
}


int multNums(int n) {
  if ( n <= 1) {
         return 1;
  } else {
         return multNums(n-1)*n ;
  }
}
```