

## CSC372 Homework 3: Computational Geometry and FFT

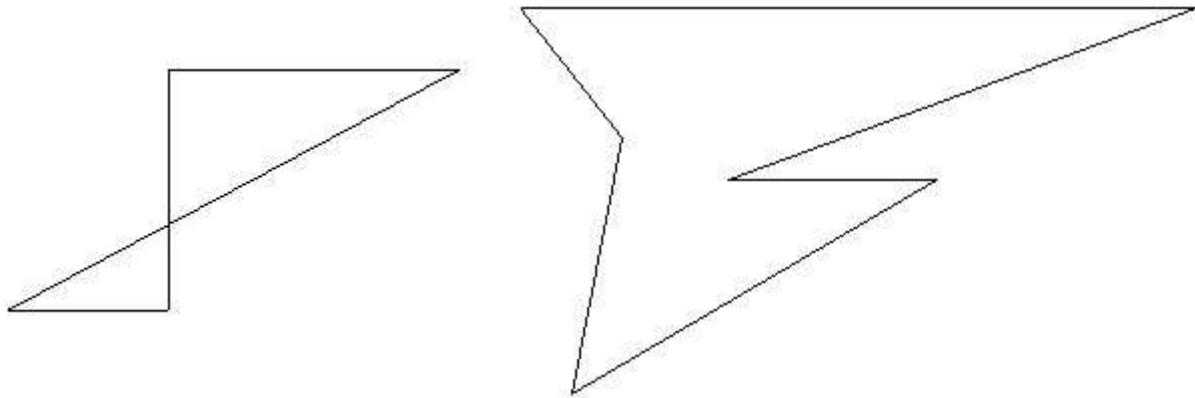
**DUE: Thursday, November 14th, at 8AM**

***The purpose of this assignment is to give you practice with coding geometric algorithms; the math behind the RSA, DFT, and FFT; and their conceptual applications.***

[35 points] Coding

Polygon Convex Check

The purpose of this assignment is to demonstrate the use of the cross product in computational geometry. A simple polygon is one for which no two edges cross. For example,



Not simple

Simple

Write a program that reads polygons from a file whose name is given on the command line as the only parameter. [File format given below.] For each polygon, print whether or not it is a simple polygon. If it is not a simple polygon, go on to the next polygon on the file. If it is a simple polygon, print whether or not it is convex. (A convex polygon is one in which any line segment connecting two points on or inside the polygon lies completely on or inside the polygon. The simple polygon pictured above is not convex.) If convex, print whether the points are listed in clockwise or counterclockwise order.

Input format and example:

The input file will have a sequence of polygons. A polygon will be represented as an integer  $n > 2$  followed by  $n$  pairs of real numbers indicating the  $x$  and  $y$  coordinates of the  $n$  points to be connected to form the polygon. Note that there is an implied connection from the last point to the first point in the list. The End of File will be signaled by an  $n$  value less than 3. No polygon will have more than 30 points.

Example:

```
4
0 0
1 1
1 0
0 1
4
0 0
2 0
2 3
0 3
1
```

Output format and example:

For each polygon in the input file, print the number of the polygon and the answers to the questions asked in the statement of the problem. Be sure to match the format so that a file compare can be used to check answers.

Example:

```
Polygon 1
Not simple
Polygon 2
Simple
Convex [the other possibility would be Not convex]
Counterclockwise [the other possibility would be Clockwise]
```

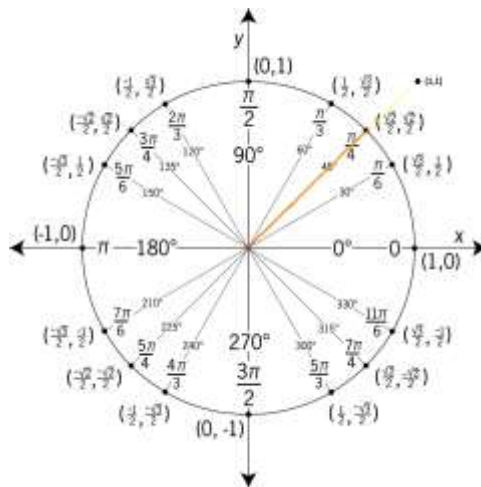
You may NOT use OS or computer specific C++ libraries (e.g. no Linux/Mac/Win MACROs or new libraries you may have installed). This MUST compile on Visual Studio 2019. In theory, MSVS 2015 and 2017 should compile without issue.

**See submission guidelines at the end of the document**

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## Application

1. [10 points] Use the RSA algorithm. If  $p=11$  and  $q=17$ ,  $e=3 \dots$ 
  - a. [1 point] What is  $n$ ?
  - b. [1 point] What is  $\varphi(n)$ ?
  - c. [1 point] Name an invalid  $e$  for this problem.
  - d. [3 points] What is  $d$  (you MUST show your work for credit)?
  - e. [4 points] Use the above values to encode 5 with  $e$  (use the MOD-Exp function and show the values for each iteration)/



2. [12 points] Compute the DFT (not FFT) of  $f(x) = 2x^2 - 2x + 1$ . You must show your work for credit, and I highly suggest using the table method used in class to track your work as the table makes it easier for me to give partial credit. Your answers must be in  $a+bi$  format.
3. [28 points] Compute the FFT for  $f(x) = x^7 + 4x^5 + 3x^4 - x^3 + 2x^2 + 1$ . Note the missing powers! It must be clear that this is the FFT and not the DFT (so a tree-like structure would be best). You **must** show your work for credit. Your answers must be in  $a+bi$  format.

## Concepts

1. [10 points] Suppose you have a black and white image of character to despeckle (0 for white, and 1 for black). To depsecakle you can use the example of the convex hull, and then test if setting a black pixel to white will greatly decrease the size. Assume you will remove a pixel if the size decreases by a threshold percentage. Describe an algorithm in pseudocode that would produce the result desired. An example of the process is below:

0000000000000000	0000000000000000
0010000000000000	0010000000000000
0000000010000000	0000000010000000
0000000111000000	0000000111000000
0000001101100000	0000001101100000
000011000110000	000011000110000
000011000110000	000011000110000
000011111110000	000011111110000
000011000110000	000011000110000
000011000110000	000011000110000
000011000110000	000011000110000
000011000110000	000011000110000
0000000000000001	0000000000000001
0000000000000000	0000000000000000

2. [5 points] RSA concept question. We discussed how to encrypt numbers and ASCII characters using the RSA algorithms in class. Describe a method to encrypt an image using the RSA algorithm.

## Submission instructions

You may upload as many times as you please, but only the last submission will be graded.

1. Double check that you are not in violation of any additional deductions as posted in the main assignment tab.
2. Put your name, class, and homework number at the top of the PDF.
3. Collect your .cpp and .h files, only, to submit.
4. Zip up your .cpp and .h files along with **one** PDF of the written portion. Name and **TITLE** your PDF lastname\_firstname (so mine would be rebenitsch\_lisa). If the compressed folder opens with 7-zip **with a single unzip**, you're good.

*Paper submissions are no longer allowed. Either use the scanner in the Library, Surbeck, or take readable pictures with your phone.*

5. Submit this to D2L under the associated folder.

If you have any trouble with D2L, please email me (with your submission if necessary).
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## Rubric

Task	Points
Other deductions	
Code	35 Total
Able to read in polygons and output something for each	3
First 4 tests passed (3pt each)	12
Second 4 tests passed (3pt each)	12
Last 4 tests passed (2pt each)	8
Application	50 Total
1) RSA	10
2) DFT*	12
3) FFT*	28
Concepts	15 Total
1) Speckled letter <ul style="list-style-type: none"> <li>a. 2pt: Storage</li> <li>b. 3pt: Main geo alg used appropriately</li> <li>c. 3pt: Pulling out the speckle appropriately</li> <li>d. 2pt: Good pseudocode</li> </ul>	10
2) RSA (-2 points for a minor issue)	5
Total	100

\*Each step has an associated points value, but given the likelihood of math errors, the max points off per step is not listed.