

# CSC317 Computer Graphics Tutorial 1

September 13, 2023

# Assignment 1: Raster Images

- Due Date: September 20 @ 11:59 pm
- Assignment description can be accessed through [course github page](#), under “Lecture Schedule”

## Lecture Schedule

Week	Topic / Event
1	<a href="#">Introduction, Assignment 1 (Raster Images)</a> waitlisted ? zip assignment and email to TAs due 20/09
2	Lecture 2, Assignment 2 Ray Casting due 27/09
3	Lecture 3, Assignment 3 Ray Tracing due 04/10

# Assignment 1: Raster Images

- If you need help:
  - “Issues” page on github for A1
  - E-mail TA: [csc317tas@cs.toronto.edu](mailto:csc317tas@cs.toronto.edu)

# Assignment 1: Raster Images

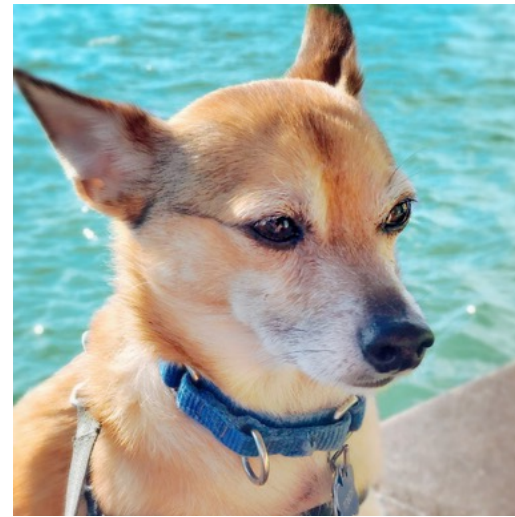
- Task1: rgba to rgb
  - Alpha channel: transparency of each pixel location
  - $\text{width} * \text{height} * 4 \Rightarrow \text{width} * \text{height} * 3$
- Input: `const std::vector<unsigned char> & rgba`
  - Getting size of vector: `rgba.size()`
  - Accessing  $i^{\text{th}}$  element: `rgba.at(i)` or `rgba[i]`
  - Debug: convert to *int* and output to console

# Assignment 1: Raster Images

- Task2: write ppm
  - Output result to a .ppm file
  - Support both rgb and grayscale images
- PPM
  - Uncompressed format
  - Header magic number (text-based): P2/P3
  - Output can be directly opened with a text editor

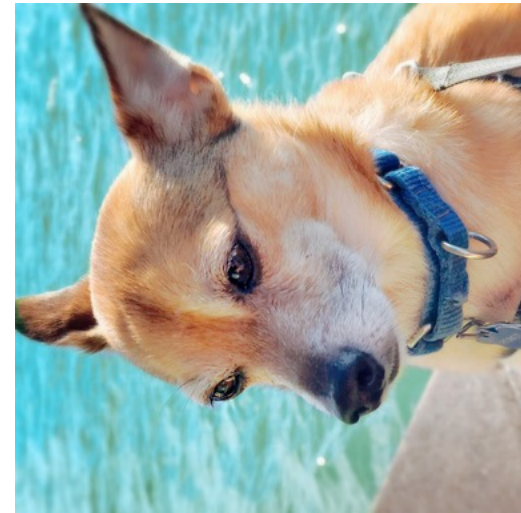
# Assignment 1: Raster Images

- Task3: image reflection



# Assignment 1: Raster Images

- Task4: image rotation (90 degrees CCW)



- Note: width/height swap

# Assignment 1: Raster Images

- Task5: rgb to gray



$$i = 0.2126r + 0.7152g + 0.0722b$$

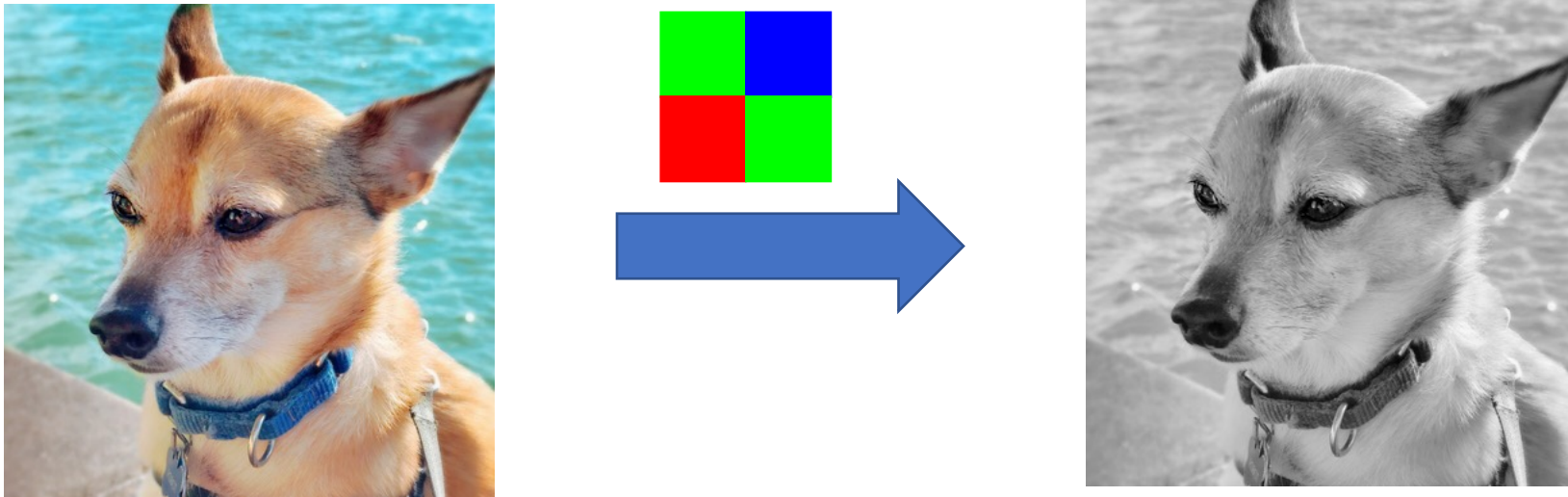


- 3 channels (width\*height\*3) to 1 channel (width\*height)



# Assignment 1: Raster Images

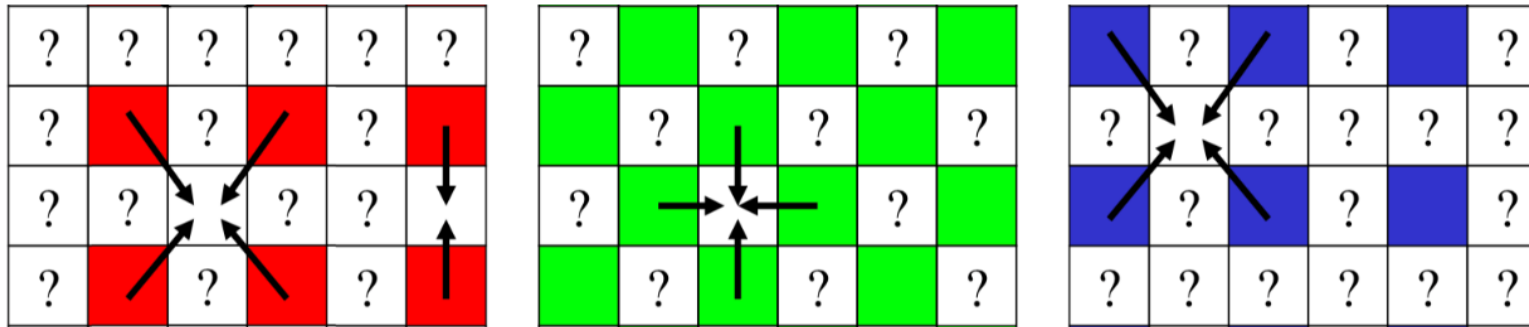
- Task6: simulate bayer mosaic



- 3 channels ( $\text{width} \times \text{height} \times 3$ ) to 1 channel ( $\text{width} \times \text{height}$ )

# Assignment 1: Raster Images

- Task7: Demosaic
- Inverse of the previous task => roughly get the original rgb image
- For each pixel
  - Take exact value if you have it (e.g. take R value if you are on a red pixel)
  - Approximate from the neighbours if you don't have exact value



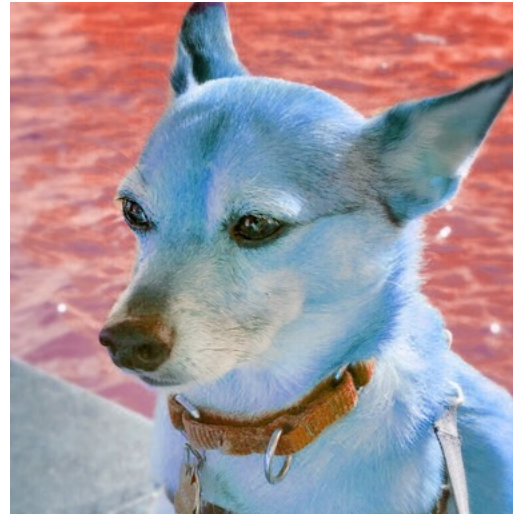
- 1 channel (width\*height) to 3 channels (width\*height\*3)

# Assignment 1: Raster Images

- Task8: helper functions for HSV color space
- RGB to HSV
  - Check with standard values online for correctness
- HSV to RGB
- Be careful with data types (i.e. inputs are of type **double**)
- Be careful with input/output ranges (e.g. 0 to 1 vs. 0 to 255)

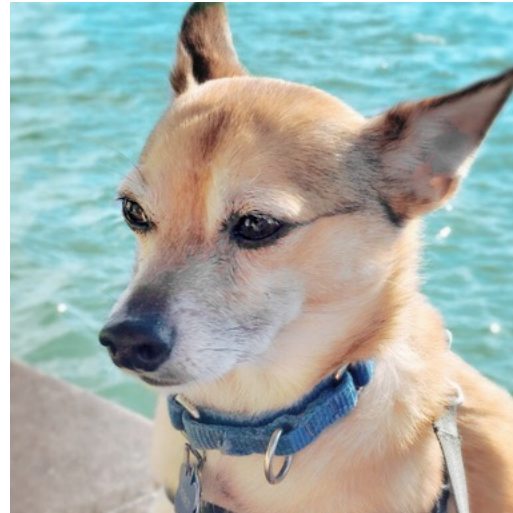
# Assignment 1: Raster Images

- Task9: hue shift
- Use the HSV helper functions implemented previously



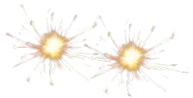
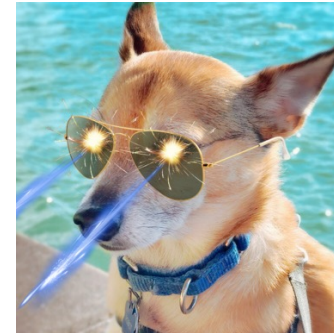
# Assignment 1: Raster Images

- Task10: desaturate
- Use the HSV helper functions implemented previously



# Assignment 1: Raster Images

- Task11: composite



# Assignment 1: Raster Images

- Submission

- Where? [Markus](#)
- What? All .cpp files in the *src* directory (also listed on Markus)

---

demosaic.cpp

---

desaturate.cpp

---

hsv\_to\_rgb.cpp

---

hue\_shift.cpp

---

over.cpp

---

reflect.cpp

---

rgb\_to\_gray.cpp

---

rgb\_to\_hsv.cpp

---

rgba\_to\_rgb.cpp

---

rotate.cpp

---

simulate\_bayer\_mosaic.cpp

---

write\_ppm.cpp

---

# Assignment 1: Raster Images

- Read assignment handout carefully:  
<https://github.com/dilevin/computer-graphics-raster-images/tree/master>
- Program entry: main.cpp
  - Input images
  - Overall flow
- Check PPM outputs online
- Experiment with different test cases



# Assignment 1: Raster Images

- Before implementing a function, check its corresponding header file for description

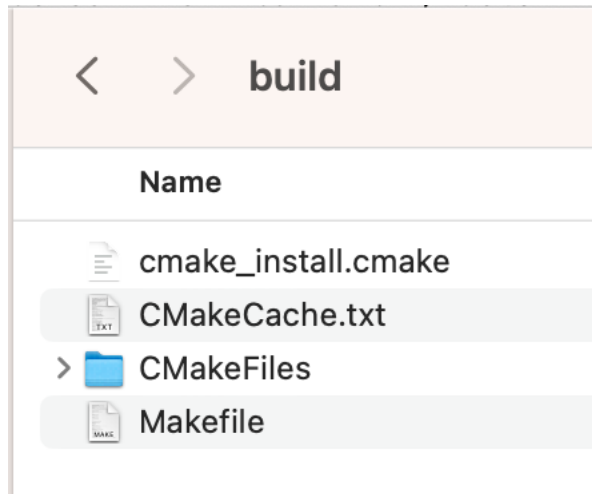
```
1  #ifndef RGBA_TO_RGB_H
2  #define RGBA_TO_RGB_H
3
4  #include <vector>
5
6  // Extract the 3-channel rgb data from a 4-channel rgba image
7  //
8  // Inputs:
9  //   rgba width*height*4 array of 4-channel rgba instensities (i.e., rgb +
10 //     alpha channel for transparency)
11 //   width image width (i.e., number of columns)
12 //   height image height (i.e., number of rows)
13 // Outputs:
14 //   rgb width*height*3 array containing rgb image color intensities
15 //
16 void rgba_to_rgb(
17     const std::vector<unsigned char> & rgba,
18     const int & width,
19     const int & height,
20     std::vector<unsigned char> & rgb);
21
22 #endif
23
```

```
#include "rgba_to_rgb.h"

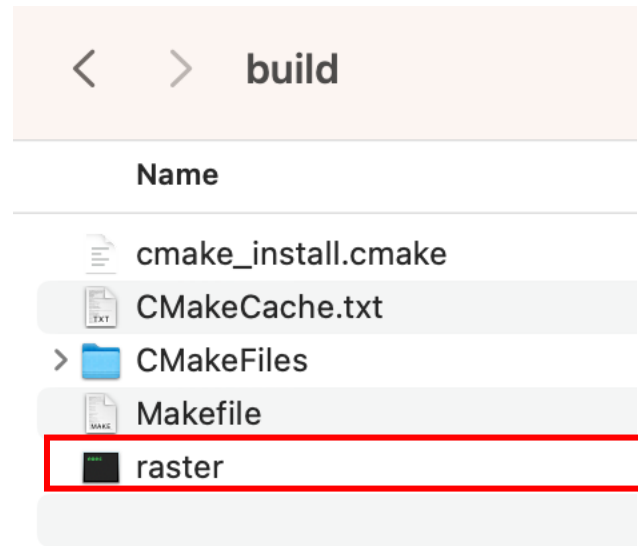
void rgba_to_rgb(
    const std::vector<unsigned char> & rgba,
    const int & width,
    const int & height,
    std::vector<unsigned char> & rgb)
{
    rgb.resize(height*width*3);
    //////////////////////////////////////
    // Add your code here
    //////////////////////////////////////
}
```

# Assignment 1: Raster Images

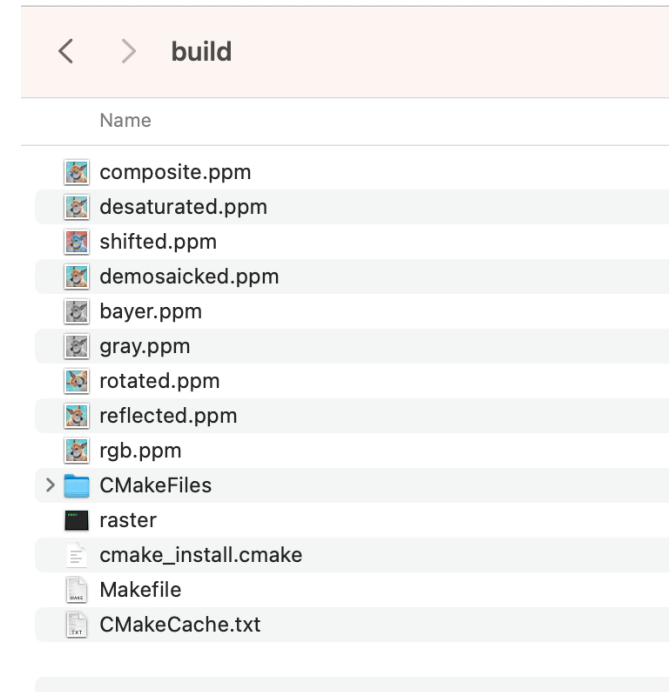
- Compilation and Running (Mac/Linux)



After “cmake ..”



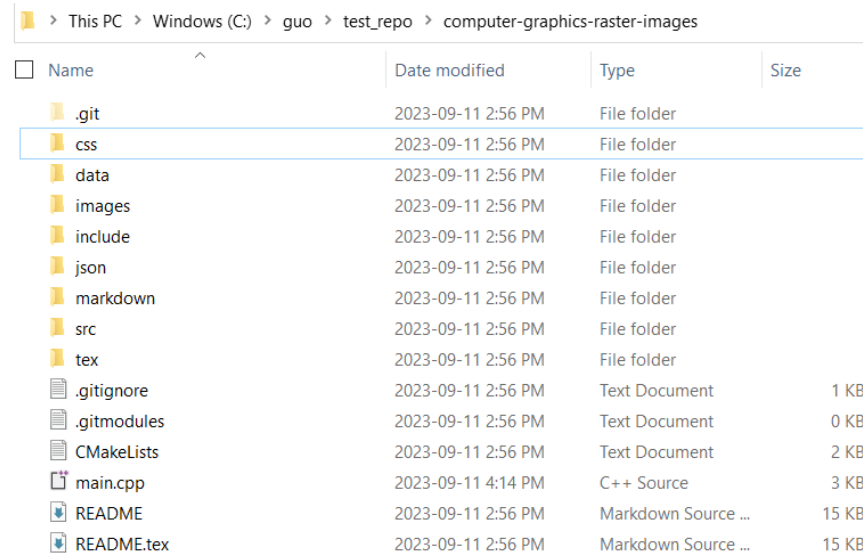
After “make”



After “./raster”

# Assignment 1: Raster Images

- Compilation and Running (Windows):

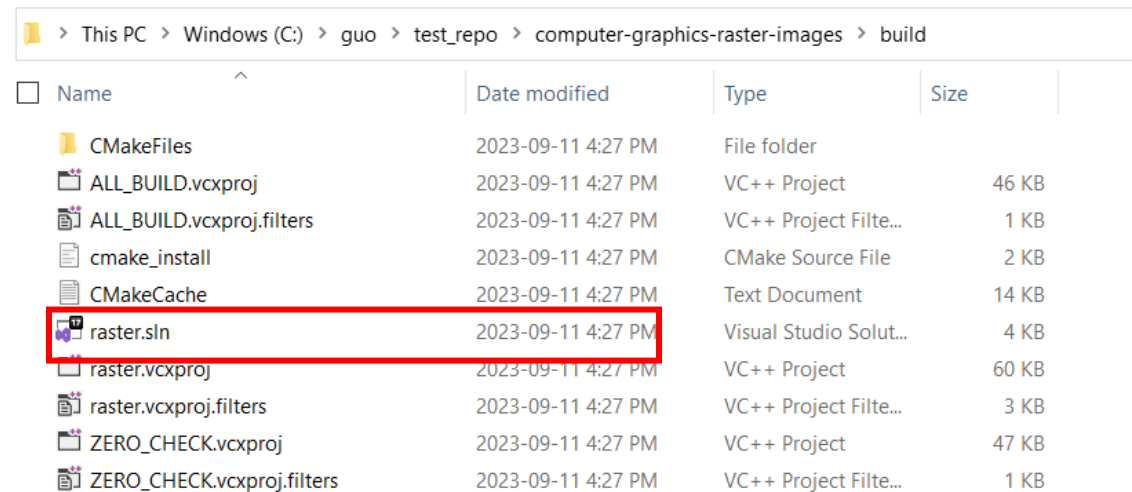


This PC > Windows (C:) > guo > test_repo > computer-graphics-raster-images				
<input type="checkbox"/>	Name	Date modified	Type	Size
<input type="checkbox"/>	.git	2023-09-11 2:56 PM	File folder	
<input type="checkbox"/>	css	2023-09-11 2:56 PM	File folder	
<input type="checkbox"/>	data	2023-09-11 2:56 PM	File folder	
<input type="checkbox"/>	images	2023-09-11 2:56 PM	File folder	
<input type="checkbox"/>	include	2023-09-11 2:56 PM	File folder	
<input type="checkbox"/>	json	2023-09-11 2:56 PM	File folder	
<input type="checkbox"/>	markdown	2023-09-11 2:56 PM	File folder	
<input type="checkbox"/>	src	2023-09-11 2:56 PM	File folder	
<input type="checkbox"/>	tex	2023-09-11 2:56 PM	File folder	
<input type="checkbox"/>	.gitignore	2023-09-11 2:56 PM	Text Document	1 KB
<input type="checkbox"/>	.gitmodules	2023-09-11 2:56 PM	Text Document	0 KB
<input type="checkbox"/>	CMakeLists	2023-09-11 2:56 PM	Text Document	2 KB
<input type="checkbox"/>	main.cpp	2023-09-11 4:14 PM	C++ Source	3 KB
<input type="checkbox"/>	README	2023-09-11 2:56 PM	Markdown Source ...	15 KB
<input type="checkbox"/>	README.tex	2023-09-11 2:56 PM	Markdown Source ...	15 KB

Fresh clone

# Assignment 1: Raster Images

- Compilation and Running (Windows):



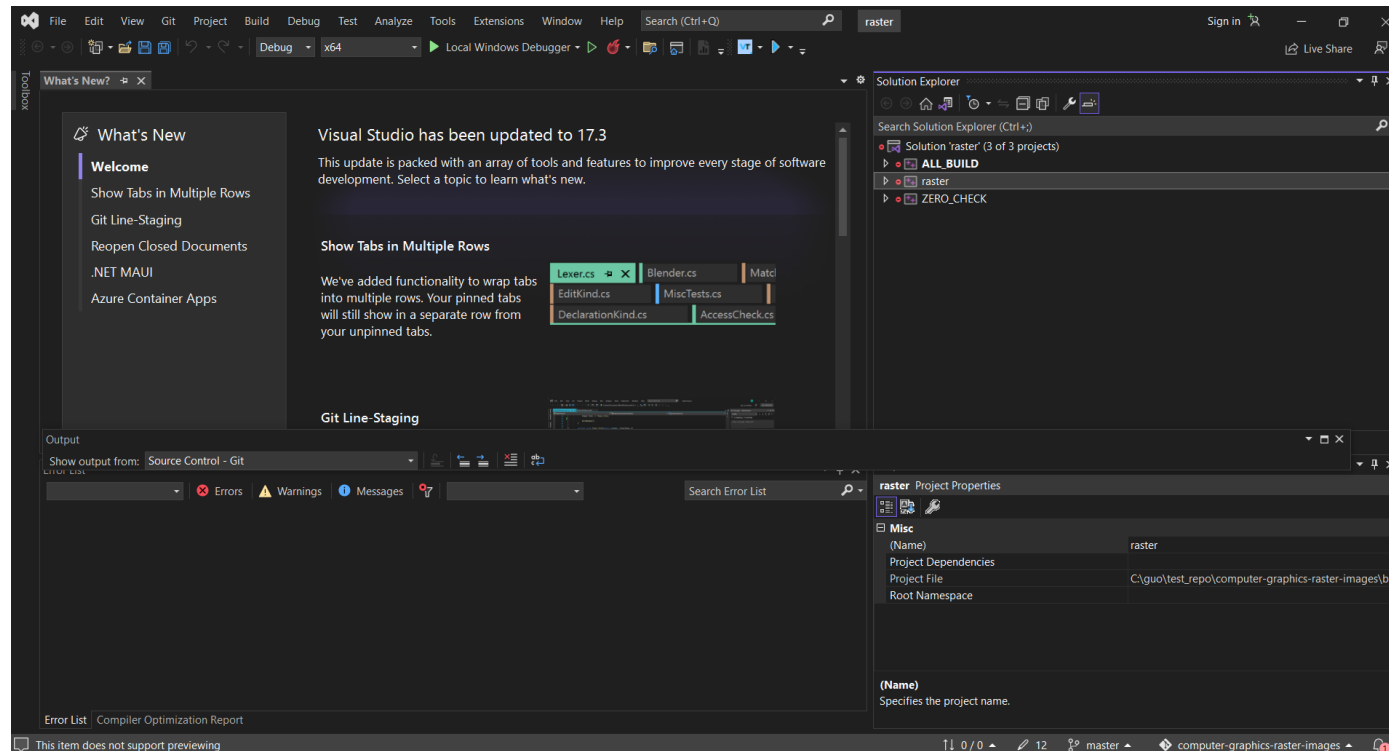
The screenshot shows a Windows File Explorer window with the address bar indicating the path: > This PC > Windows (C:) > guo > test\_repo > computer-graphics-raster-images > build. The main area displays a list of files and folders with columns for Name, Date modified, Type, and Size. The file 'raster.sln' is highlighted with a red rectangle.

Name	Date modified	Type	Size
CMakeFiles	2023-09-11 4:27 PM	File folder	
ALL_BUILD.vcxproj	2023-09-11 4:27 PM	VC++ Project	46 KB
ALL_BUILD.vcxproj.filters	2023-09-11 4:27 PM	VC++ Project Filte...	1 KB
cmake_install	2023-09-11 4:27 PM	CMake Source File	2 KB
CMakeCache	2023-09-11 4:27 PM	Text Document	14 KB
raster.sln	2023-09-11 4:27 PM	Visual Studio Solut...	4 KB
raster.vcxproj	2023-09-11 4:27 PM	VC++ Project	60 KB
raster.vcxproj.filters	2023-09-11 4:27 PM	VC++ Project Filte...	3 KB
ZERO_CHECK.vcxproj	2023-09-11 4:27 PM	VC++ Project	47 KB
ZERO_CHECK.vcxproj.filters	2023-09-11 4:27 PM	VC++ Project Filte...	1 KB

After “cmake ..”

# Assignment 1: Raster Images

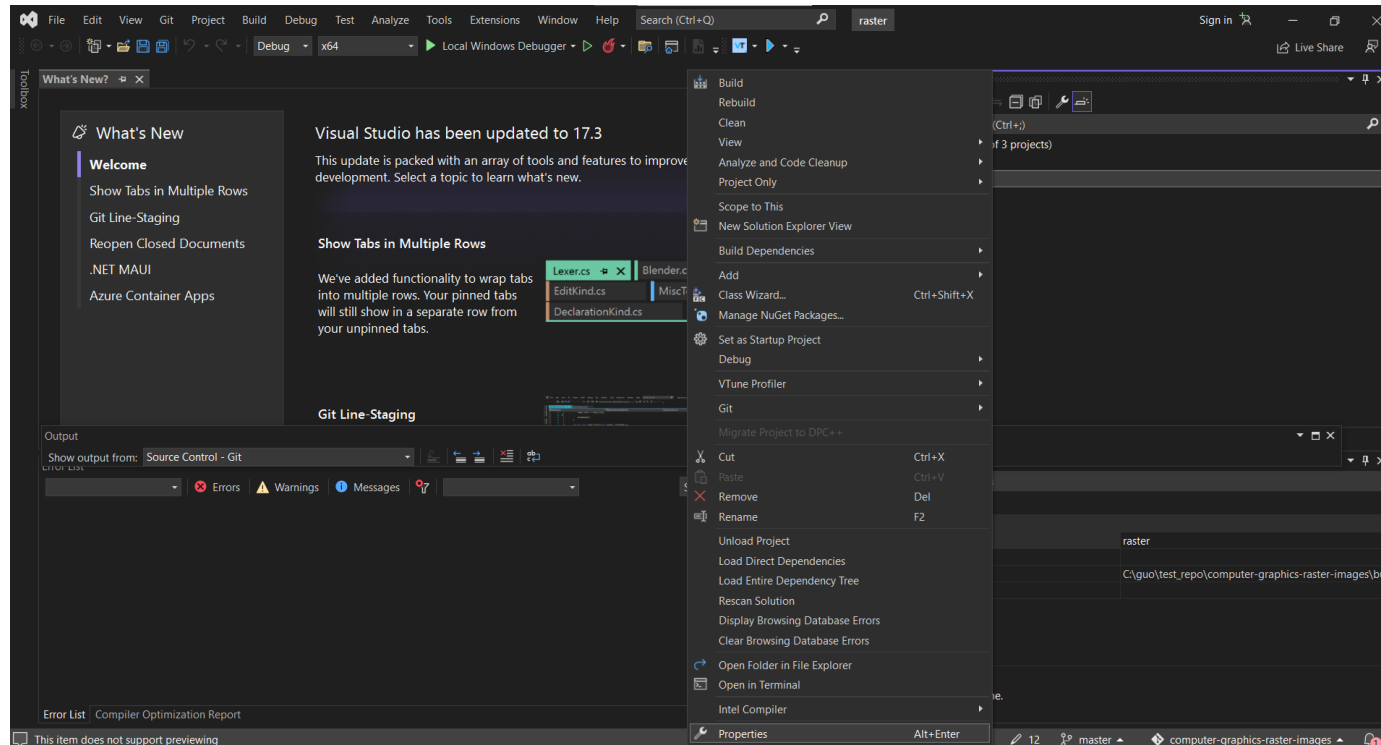
- Compilation and Running (Windows):



Visual Studio solution file

# Assignment 1: Raster Images

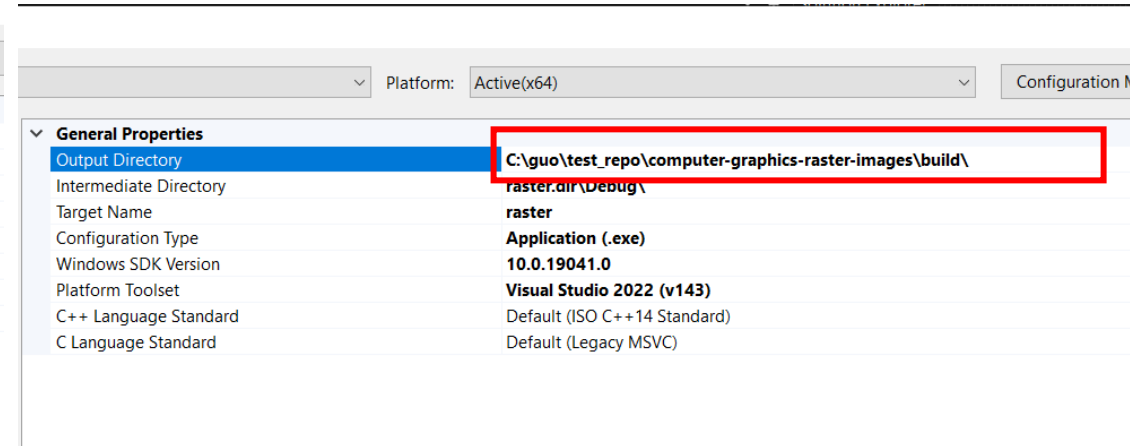
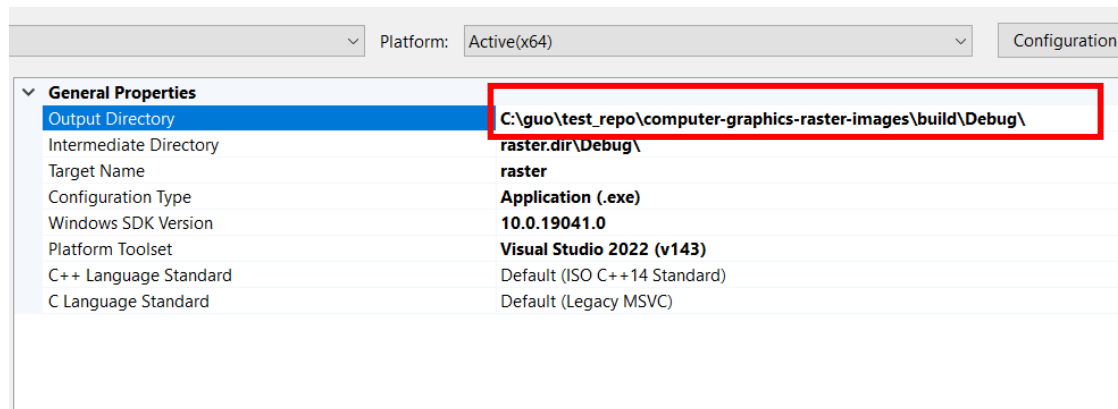
- Compilation and Running (Windows):



Change output path

# Assignment 1: Raster Images

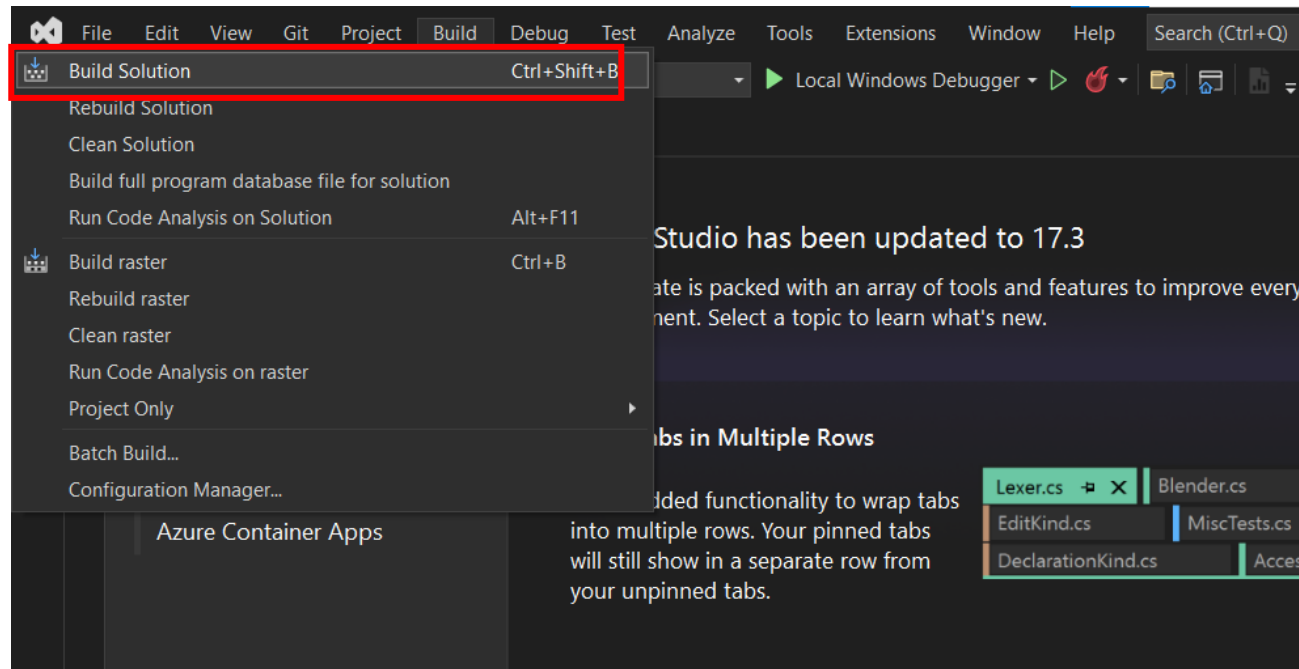
- Compilation and Running (Windows):



Change output path

# Assignment 1: Raster Images

- Compilation and Running (Windows):

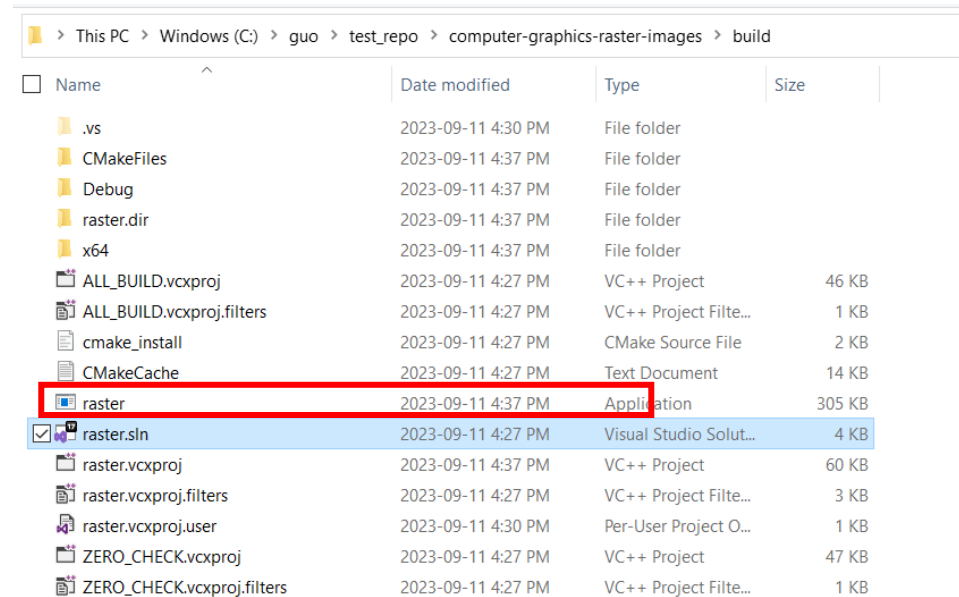


Build



# Assignment 1: Raster Images

- Compilation and Running (Windows):



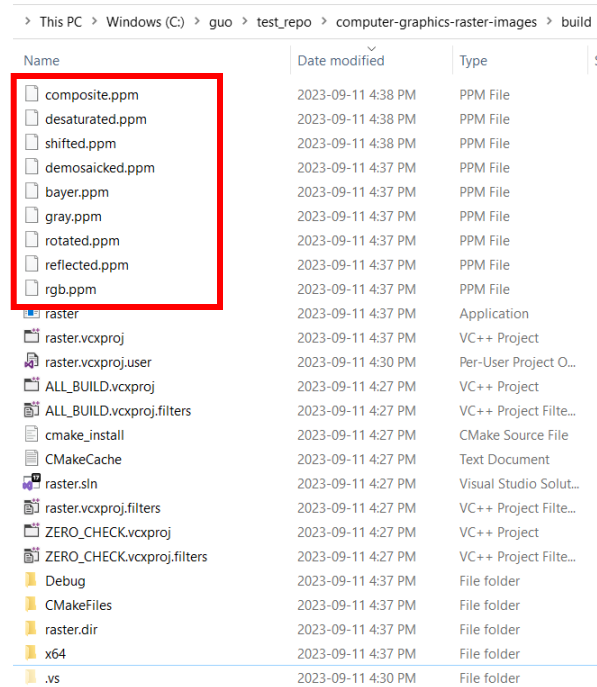
The screenshot shows a Windows File Explorer window with the address bar indicating the path: This PC > Windows (C:) > guo > test\_repo > computer-graphics-raster-images > build. The main area displays a list of files and folders with columns for Name, Date modified, Type, and Size. The file 'raster' is highlighted with a red rectangle.

Name	Date modified	Type	Size
.vs	2023-09-11 4:30 PM	File folder	
CMakeFiles	2023-09-11 4:37 PM	File folder	
Debug	2023-09-11 4:37 PM	File folder	
raster.dir	2023-09-11 4:37 PM	File folder	
x64	2023-09-11 4:37 PM	File folder	
ALL_BUILD.vcxproj	2023-09-11 4:27 PM	VC++ Project	46 KB
ALL_BUILD.vcxproj.filters	2023-09-11 4:27 PM	VC++ Project Filte...	1 KB
cmake_install	2023-09-11 4:27 PM	CMake Source File	2 KB
CMakeCache	2023-09-11 4:27 PM	Text Document	14 KB
raster	2023-09-11 4:37 PM	Application	305 KB
raster.sln	2023-09-11 4:27 PM	Visual Studio Solut...	4 KB
raster.vcxproj	2023-09-11 4:37 PM	VC++ Project	60 KB
raster.vcxproj.filters	2023-09-11 4:27 PM	VC++ Project Filte...	3 KB
raster.vcxproj.user	2023-09-11 4:30 PM	Per-User Project O...	1 KB
ZERO_CHECK.vcxproj	2023-09-11 4:27 PM	VC++ Project	47 KB
ZERO_CHECK.vcxproj.filters	2023-09-11 4:27 PM	VC++ Project Filte...	1 KB

Run executable

# Assignment 1: Raster Images

- Compilation and Running (Windows):



This screenshot shows a Windows File Explorer window with the address bar indicating the path: > This PC > Windows (C:) > guo > test\_repo > computer-graphics-raster-images > build. The file list is as follows:

Name	Date modified	Type
composite.ppm	2023-09-11 4:38 PM	PPM File
desaturated.ppm	2023-09-11 4:38 PM	PPM File
shifted.ppm	2023-09-11 4:38 PM	PPM File
demosaicked.ppm	2023-09-11 4:37 PM	PPM File
bayer.ppm	2023-09-11 4:37 PM	PPM File
gray.ppm	2023-09-11 4:37 PM	PPM File
rotated.ppm	2023-09-11 4:37 PM	PPM File
reflected.ppm	2023-09-11 4:37 PM	PPM File
rgb.ppm	2023-09-11 4:37 PM	PPM File
raster	2023-09-11 4:37 PM	Application
raster.vcxproj	2023-09-11 4:37 PM	VC++ Project
raster.vcxproj.user	2023-09-11 4:30 PM	Per-User Project O...
ALL_BUILD.vcxproj	2023-09-11 4:27 PM	VC++ Project
ALL_BUILD.vcxproj.filters	2023-09-11 4:27 PM	VC++ Project Filte...
CMake_install	2023-09-11 4:27 PM	CMake Source File
CMakeCache	2023-09-11 4:27 PM	Text Document
raster.sln	2023-09-11 4:27 PM	Visual Studio Solut...
raster.vcxproj.filters	2023-09-11 4:27 PM	VC++ Project Filte...
ZERO_CHECK.vcxproj	2023-09-11 4:27 PM	VC++ Project
ZERO_CHECK.vcxproj.filters	2023-09-11 4:27 PM	VC++ Project Filte...
Debug	2023-09-11 4:37 PM	File folder
CMakeFiles	2023-09-11 4:37 PM	File folder
raster.dir	2023-09-11 4:37 PM	File folder
x64	2023-09-11 4:37 PM	File folder
.vs	2023-09-11 4:30 PM	File folder

Check outputs