### Command Line Options

#### Assignment

In this assignment you will create a program to read command line arguments to configure and create an image. This program will have all of the functionality of the previous program, but no menu system or prompts to the user, once the program begins.

#### Potential Session

```plaintext
# This command will create a Julia set image, without any menus or prompts
$ ./ppm_command -T 302 -C set:300,255,255,255 -C set:301,12,99,166 -C gradient:0,2,46,80,39,2,46,80 -C gradient:130,104,228,1,299,5,63,107 -J -a 0.279047,-0.481944 -p 1000,1000 -m 300 -r 0.412096:0.797398,0.624066:1.00937 -g calculate -g apply-color -w sample-color-julia.ppm

$ ls -l *.ppm
-rw-r--r-- 1 cgl cgl 3000017 Apr 12 12:05 sample-color-julia.ppm

# This shell script has one command that generates many images
$ ./ppm_command_11.bash
$ ls -l *.ppm
-rw-r--r-- 1 cgl cgl 180015 Apr 12 12:06 sample-added-face-bright.ppm
-rw-r--r-- 1 cgl cgl 180015 Apr 12 12:06 sample-added-face.ppm
-rw-r--r-- 1 cgl cgl 180015 Apr 12 12:06 sample-added-head.ppm
-rw-r--r-- 1 cgl cgl 3000017 Apr 12 12:06 sample-color-julia.ppm
-rw-r--r-- 1 cgl cgl 750015 Apr 12 12:06 sample-color-mandelbrot.ppm
-rw-r--r-- 1 cgl cgl 180015 Apr 12 12:06 sample-face-bluegray.ppm
-rw-r--r-- 1 cgl cgl 180015 Apr 12 12:06 sample-face-greengray.ppm
-rw-r--r-- 1 cgl cgl 180015 Apr 12 12:06 sample-face-lineargray.ppm
-rw-r--r-- 1 cgl cgl 180015 Apr 12 12:06 sample-face.ppm
-rw-r--r-- 1 cgl cgl 180015 Apr 12 12:06 sample-face-redgray.ppm
-rw-r--r-- 1 cgl cgl 180015 Apr 12 12:06 sample-head.ppm
-rw-r--r-- 1 cgl cgl 3000016 Apr 12 12:06 sample-joined-julia.ppm
-rw-r--r-- 1 cgl cgl 180015 Apr 12 12:06 sample-left-eye.ppm
-rw-r--r-- 1 cgl cgl 180015 Apr 12 12:06 sample-mouth.ppm
-rw-r--r-- 1 cgl cgl 180015 Apr 12 12:06 sample-nose.ppm
-rw-r--r-- 1 cgl cgl 3000016 Apr 12 12:06 sample-rainbow-julia.ppm
-rw-r--r-- 1 cgl cgl 750014 Apr 12 12:06 sample-rainbow-mandelbrot.ppm
-rw-r--r-- 1 cgl cgl 180015 Apr 12 12:06 sample-right-eye.ppm

# This will show all of the command line arguments available.
$ ./ppm_command -h
```

Options:

<table>
<thead>
<tr>
<th>PPM options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1 filename</td>
<td>Read file into input image 1.</td>
</tr>
<tr>
<td>-2 filename</td>
<td>Read file into input image 2.</td>
</tr>
<tr>
<td>-w filename</td>
<td>Write output image to file.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PPM filter options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-f copy</td>
<td>Copy input image 1 to output image.</td>
</tr>
<tr>
<td>-f red-gray</td>
<td>Set output image from input image 1's grayscale from red.</td>
</tr>
<tr>
<td>-f green-gray</td>
<td>Set output image from input image 1's grayscale from green.</td>
</tr>
<tr>
<td>-f blue-gray</td>
<td>Set output image from input image 1's grayscale from blue.</td>
</tr>
<tr>
<td>-f linear-gray</td>
<td>Set output image from input image 1's grayscale from linear colorimetric.</td>
</tr>
<tr>
<td>-f +</td>
<td>Set output image from sum of input image 1 and input image 2.</td>
</tr>
<tr>
<td>-f +=</td>
<td>Set input image 1 by adding in input image 2.</td>
</tr>
<tr>
<td>-f -</td>
<td>Set output image from difference of input image 1 and input image 2.</td>
</tr>
<tr>
<td>-f *=number</td>
<td>Set output image from input image 1 multiplied by number.</td>
</tr>
<tr>
<td>-f %=number</td>
<td>Set input image 1 by multiplying by number.</td>
</tr>
<tr>
<td>-f /=number</td>
<td>Set output image from input image 1 divided by number.</td>
</tr>
<tr>
<td>-f /=number</td>
<td>Set input image 1 by dividing by number.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Draw options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-d size:height,width</td>
<td>Set the size of input image 1.</td>
</tr>
</tbody>
</table>
-d max:max // Set the max color value of input image 1.
-d channel:row,col,chan,value // Set a channel value in input image 1.
-d pixel:row,col,r,g,b // Set a pixel's 3 values in input image 1.
-d clear // Set all pixels to 0,0,0 in input image 1.
-d diamond:row,col,size,r,g,b // Draw a diamond shape in input image 1.
-d circle:row,col,radius,r,g,b // Draw a circle shape in input image 1.
-d box:tr,lc,br,rc,r,g,b // Draw a box shape in input image 1.

NumberGrid options:
-p height,width // Assign the grid size.
-m max // Assign grid max number.
-g set:row,column:value // Set a single value in the grid.
-g calculate // Calculate all numbers in the grid.
-g apply // Use the grid values to set colors in the output image.
-g apply-color // Use the grid values to set colors in the output image using the color table.

ComplexFractal options:
-r minx:maxx,miny:maxy // Set the dimensions of the grid in the complex plane.

Julia options:
-J // Choose a Julia image.
-a a,b // Set the parameters of the Julia Set function.

Mandelbrot options:
-M // Choose a Mandelbrot image.

ColorTable options:
-T number // Change the number of slots in the color table.
-C set:p,r,g,b // Set the RGB values for one slot in the color table.
-C random:p // Randomly set the RGB values for one slot in the color table.
-C gradient:p1,r1,g1,b1,p2,r2,g2,b2 // Smoothly set the RGB values for a range of slots in the color table.

Help options:
-h // Display this message.

Programming Requirements

Create `image_command.h` and `image_command.cpp`

These files will declare and define many functions, which will be used to complete the required actions. All of the functions use an additional type, `CommandData`, that must be created. It should be created as a `struct`, which is the same as a class, where everything is `public`. Additionally, you’ll create function pointers, using the `ActionFunctionType` type, which is declared using a `typedef`. Since `ActionFunctionType` and `CommandData` introduce a circular dependency (each needs the other to be declared), we use a forward declaration of `CommandData`.

Here’s the declaration of the `typedef` and `struct`:

```cpp
// Forward Declaration
struct CommandData;

typedef int (*ActionFunctionType)( CommandData& data );

// this structure just wraps a group of data members together
struct CommandData {
   CommandData( int n, std::istream& i, std::ostream& o );
   PPM input_image1;
   PPM input_image2;
   PPM output_image;
   NumberGrid* grid;
   ColorTable table;
   std::istream& is;
   std::ostream& os;
   std::string argument;
   std::map< std::string, ActionFunctionType > filter_actions;
   std::map< std::string, ActionFunctionType > draw_actions;
   std::map< std::string, ActionFunctionType > grid_actions;
   std::map< std::string, ActionFunctionType > color_actions;
};
```
This is the function list. Most of these functions carry out the same operation as a similar menu option in the menu program. Please refer to that documentation where appropriate. You can also see the expected argument syntax in the sample session above.

Most functions with `int` return type will return `0` if their operation went as expected, and a `1` if not as expected. For example, if the command line argument isn’t a correct command or correctly formatted, command, the function would send an error message to `data.os` and return 1.

**Input parsing**

- `void readUntilChar( std::stringstream& ss, std::string& dest, char delimiter );` This function reads characters from the input stream until the delimiter character is encountered. It stores all of the characters, except the delimiter, into the destination string.

**PPM options**

- `int readImage1( CommandData& data );` Installed in the option map.
- `int readImage2( CommandData& data );` Installed in the option map.
- `int writeImage( CommandData& data );` Installed in the option map.

**PPM filter options**

- `int filterCopy( CommandData& data );`
- `int filterRedGray( CommandData& data );`
- `int filterGreenGray( CommandData& data );`
- `int filterBlueGray( CommandData& data );`
- `int filterLinearGray( CommandData& data );`
- `int filterPlus( CommandData& data );`
- `int filterPlusEquals( CommandData& data );`
- `int filterMinus( CommandData& data );`
- `int filterMinusEquals( CommandData& data );`
- `int filterTimes( CommandData& data );`
- `int filterTimesEquals( CommandData& data );`
- `int filterDivide( CommandData& data );`
- `int filterDivideEquals( CommandData& data );`
- `int filterAction( CommandData& data );` Extracts the action word from `data.argument`, using `readUntilChar`. Uses the action word and `data.filter_actions` to call the correct action function. For example, `r = data.filter_actions[ action ]( data );`. Returns the value returned by the function. Unless the action is not in `data.filter_actions`, in which case a `1` is returned. This function itself is installed in the option map.
- `void makeFilterActionMap( std::map< std::string, ActionFunctionType >& actions );` Loads `actions` with entries for each of the commands as the key and the handler function as the value. For example, `actions[ "+=" ] = filterPlusEquals;`.

**Draw options**

- `int drawSize( CommandData& data );`
- `int drawMax( CommandData& data );`
- `int drawChannel( CommandData& data );`
- `int drawPixel( CommandData& data );`
- `int drawClear( CommandData& data );`
- `int drawDiamond( CommandData& data );`
- `int drawCircle( CommandData& data );`
- `int drawBox( CommandData& data );`
- `int drawAction( CommandData& data );` Similar to `filterAction()` above.
- `void makeDrawActionMap( std::map< std::string, ActionFunctionType >& actions );` Similar to `makeFilterActionMap()` above.

**NumberGrid functions**

- `int gridSetSize( CommandData& data );` Installed in the option map.
- `int gridSetMaxNumber( CommandData& data );` Installed in the option map.
- `int gridSetNumber( CommandData& data );`
- `int gridCalculate( CommandData& data );`
- `int gridApply( CommandData& data );`
- `int gridApplyColor( CommandData& data );`
• int gridAction(CommandData& data); Similar to filterAction() above.
• void makeGridActionMap(std::map<std::string, ActionFunctionType>& actions); Similar to makeFilterActionMap() above.

Complex Fractal functions

• int setPlaneSize(CommandData& data); Installed in the option map.

Julia functions

• int setJuliaFractal(CommandData& data); Installed in the option map.
• int setJuliaParameters(CommandData& data); Installed in the option map.

Mandelbrot functions

• int setMandelbrotFractal(CommandData& data); Installed in the option map.

Color Table functions

• int setColorTableSize(CommandData& data); Installed in the option map.
• int setColor(CommandData& data);
• int setRandomColor(CommandData& data);
• int setColorGradient(CommandData& data);
• int colorAction(CommandData& data); Similar to filterAction() above.
• void makeColorActionMap(std::map<std::string, ActionFunctionType>& actions); Similar to makeFilterActionMap() above.

meta functions

• int helpFunction(CommandData& data); Installed in the option map.
• int errorFunction(CommandData& data); Installed in the option map, under [?]. This function uses the global variable, optarg, to display an message, then calls helpFunction() and returns 1.
• void makeOptionMap(std::map<int, ActionFunctionType>& actions); Creates a map from command line option flags (such as [i], [w], [d], etc.) to the action commands.
• int imageCommand(int argc, char *argv[], std::istream& is, std::ostream& os); Creates and initializes a CommandData object, including filling in all of the action maps, using the functions above. Also builds the master option map. Loops over the command line arguments, using getopt(). Sets data.argument to the global, optarg, unless optarg is 0, in this case sets data.argument = "". For each option, if the option is in the option map, call the action function from the option map. If the action function returns anything other than 0, break from the loop, and return the value returned. If the option given is not in the option map, give a message about the unrecognized option, then call the helpFunction(), break from the loop and return 1. If all options are processed correctly, and no action returns anything but 0, return 0.

Create ppm_command.cpp

• int main(int argc, char *argv[]); Create this function, which calls imageCommand() and returns whatever is returned by imageCommand.

Update Makefile

• This file must include the rules to build the program ppm_menu and ppm_command. See the modifications in the class example for 2 target programs.

Additional Documentation

• C++ Reference
• Examples from class
• Sample Script

Sample PPM Images

Here are some of the images created by the shell script in the sample session.
Show Off Your Work

To receive credit for this assignment, you must

- (no unit tests available in CodeGrinder), so nothing there. You should test it yourself.
- use git to add, commit and push your solution to your repository for this class.

Additionally, the program must build, run and give correct output.

Extra Challenges (Not Required)

- Create additional command line options for other features of the program that you add.