Assignment 5: Priority Queue

Topic(s):	Priority Queues, Code Reusability, More Advanced Makefiles, Debugging, Testing
Date assigned:	Wednesday, October 17, 2018
Date due:	Wednesday, October 31, 2018, 9:15 am. **BOO!**
Points:	40 pts

For this assignment, you are to implement a Generic Dynamic Priority Queue (GDPQ) ADT in a file called pqueue.c using the header file pqueue.h. You can find this header file on zeus in **/home/CS300Public/2018/05Files**. All of the data structures and function prototypes are defined in the header file. Further, each function prototype has been described to the point that you should be able to implement each function. The error codes that can be produced are listed for each function. Higher precedence error codes are listed first.

The GDPQ must be implemented using the Generic Dynamic List (GDL) from the previous assignment as the base data structure. We will be reusing this GDPQ later on, so make sure you have completely tested and debugged each operation.

In addition to implementing the GDPQ data structure, you must provide a Makefile and test driver (pqueuedriver.c that produces an executable named **pqueuedriver**) that thoroughly tests your GDPQ. The driver must display to the screen a series of SUCCESS or FAILURE messages, with enough description that a user can quickly spot broken functionality.

You may add any helper functions as needed to pqueue.c. These helper functions must be marked **static** so they are not available outside the module. You may not alter pqueue.h in any way.

1. Your code is to be written in C using Eclipse. Programs written in other environments will not be graded. Create an Eclipse project named **GenericDynamicPriorityQ**. This project must contain the directories: **src**, **include**, and **bin** with a **Makefile** at the same level as these directories.
2. The Makefile must contain the necessary targets to build the pqueuedriver as well as a **clean**, **valgrind**, and **tarball** targets. Typing **make** on the command line must build pqueuedriver.
3. Submit a file called cs300_5_PUNetID.tar.gz using the submit script by 9:15am on the day in which the assignment is due. This file must include your GenericDynamicPriorityQ **AND** your updated (if necessary) GenericDynamicList projects.
4. Submit a color, double sided, stapled packet of code by the same deadline in 3. The packet must be in the following order:
   Priority Queue Driver (.h then .c if you have both, otherwise just .c)
   pqueue.c (do not print pqueue.h)
   Any extra .h/.c pairs you have. (do not include any code from the List project)
   Makefile
5. Test one function at a time. This will lessen your level of frustration greatly.
6. You are to use the coding guidelines from V6.3 of the coding standards.

7. The only changes to GDL you can make are to fix bugs in the .c files.
8. You must insert GenericDynamicPriorityQ into your Subversion repository; GenericDynamicList must already be in Subversion and any bug fixes must be committed to Subversion.
9. **IMPORTANT:** When implementing your GDPQ ADT, you are to use the functions from the GDL module and **not access any GDL data directly**. As an example, you must use the function lstSize to determine the size of the list. Failure to access information correctly will result in losing major design points.

Goals for this assignment:

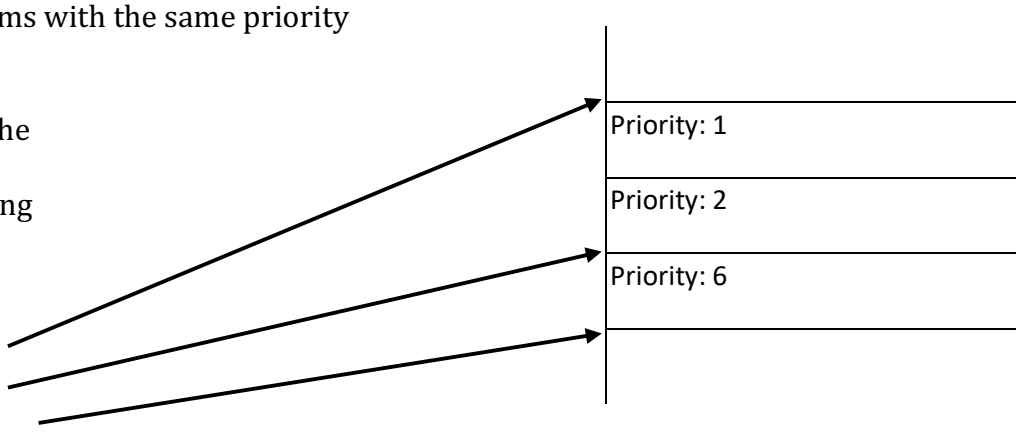
1. Reuse your GDL code.
2. Code and test your program one function at a time.
3. Write efficient/clean code
4. Use the debugger to effectively develop a correct solution
5. Thoroughly test your code.
6. Write code with no Valgrind errors.

Priority in the Queue.

You must implement priority in your queue by inserting items into the queue using the priority value provided by the user. A priority of **zero** is the **highest priority**. A newly inserted item must be inserted:

1) ahead of all items with a lower priority
2) behind all items with the same priority

For example:
The Priority Queue on the right already contains some data. The following inserts will add data at the marked points.



insert Priority 0
insert Priority 2
insert Priority 10

♦ The function **pqueueChangePriority** accepts an integer (positive or negative) and adds that integer to the priority of *every* item in the queue.

♦ **There is only one deadline**. I expect you to start this project soon. Your priority queue implementation will likely be smaller than your pqueuedriver.

Using Eclipse, Makefiles, and Multiple Projects.

Since your GDPQ relies on your GDL, which is in another Eclipse project, your **Makefile** may contain lines like the following.

```
bin/pqueue.o: src/pqueue.c include/pqueue.h ../GenericDynamicList/include/list.h
      ${CC} ${CFLAGS} -c src/pqueue.c -o bin/pqueue.o
```

In this example line, pqueue.o relies on pqueue.c and pqueue.h from the current GDPQ project as well as the header file list.h from the GDL project, which exists up a directory (to your workspace root) and then down in the GDL project's include directory. Your driver will also need to depend on the list.o file in the GDL project.

If you want to rebuild list.o via your GDPQ Makefile you may need a line like this in your GDPQ Makefile.[1]

```
../GenericDynamicList/bin/list.o:   ../GenericDynamicList/include/list.h  \
                                    ../GenericDynamicList/src/list.c
      cd ../GenericDynamicList; make bin/list.o
```

This moves to the GDL directory and invokes make. The Makefile in GDL is read and list.o is rebuilt if necessary. Note that make executes *each line* of your file with a new shell so if you **cd** on one line and run a command on the next line, the command is run as if the **cd** had not been run.

You are most likely going to run into Eclipse problems with this project. Namely, Eclipse may not see an update to the GDL data structure while you are coding in the GDPQ data structure and may produce errors *even if the Makefile succeeds in building your .o and executable files.*

If you right click a project, choose Properties, and select Project References you can mark which other projects this project relies on. (GenericDynamicPriorityQ relies on GenericDynamicList, for example). This helps Eclipse determine where to look for data type definitions and header files. Eclipse is not perfect. Sometimes projects get out of sync and you need to: clean and build each project, right click a project, choose Index, and Rebuild.

Another way to set the references is: **Right click on Project > Properties > C/C++ General > Paths & Symbols > References**[2]

If you have Makefile problems, see me early.

I expect you to start this project early. **This code will be reused in subsequent assignments.** Further, you are reusing code from GDL!

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1 http://crawlicious.com/wp/2009/06/11/make-change-dir/ (no longer valid, check the Wayback Machine).

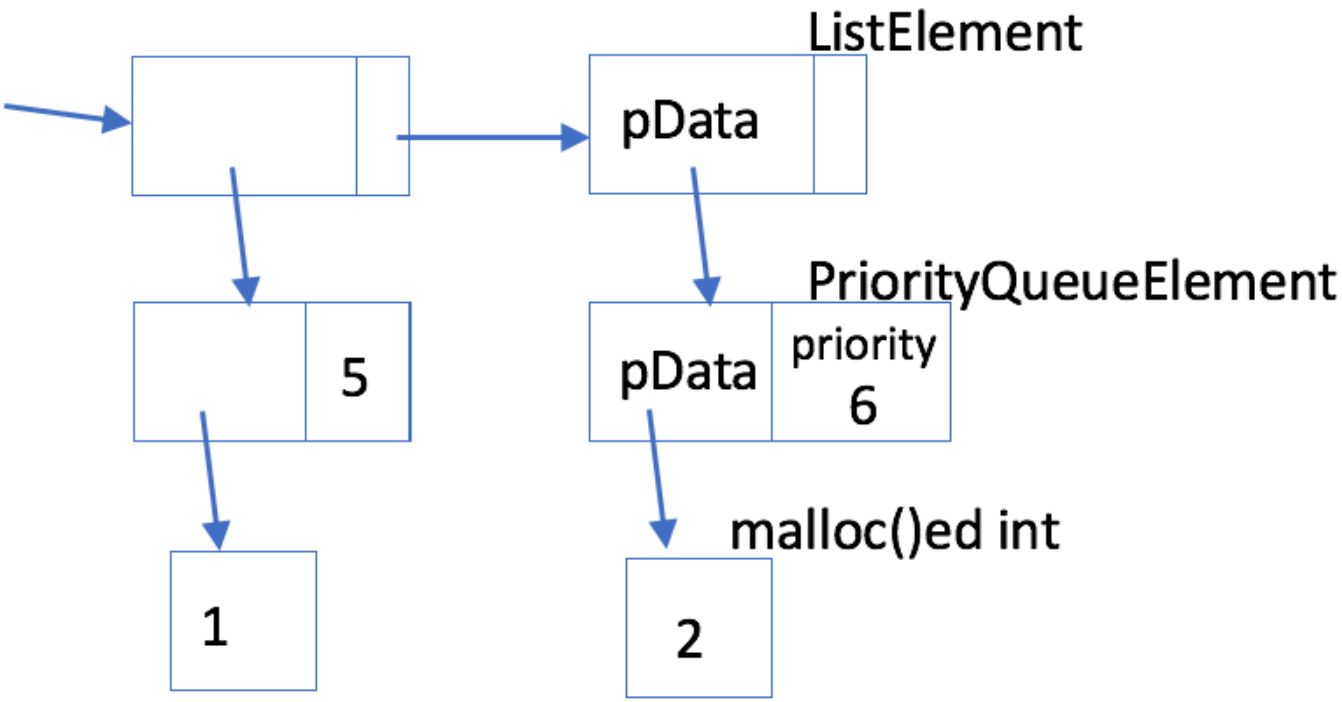
2 http://stackoverflow.com/questions/1270799/eclipse-cdt-make-a-project-rebuild-when-a-library-built-in-another-project-was-r

Some ~~helpful~~ necessary information.

Here is information that will help you successfully implement your Priority Queue.

For a priority queue given:

```
int value = 1;
pqueueEnqueue (psQueue, &value, sizeof (int), 5);
++value;
pqueueEnqueue (psQueue, &value, sizeof (int), 6);
```



The 5,1 and 6,2 are each stored as a PriorityQueueElement. Your PriorityQueue MUST insert a PriorityQueueElement into the GenericDynamicList. The user of your PriorityQueue never sees or uses PriorityQueueElement. The data the user gives your priority queue (void*) goes into the void* in the PriorityQueueElement (malloc(size) then memcpy!). You just pass the address of the PriorityQueueElement and the size of the PriorityQueueElement to the GenericDynamicList.

DANGER!

Since the data you put into the GenericDynamicList contains a pointer, lstTerminate() cannot free all the dynamic memory! pqueueTerminate() MUST walk the list, delete each element (lstDeleteCurrent()), and then free() the pointer inside PriorityQueueElement (returned by lstDeleteCurrent()). Once the list is empty, call lstTerminate().

Read this page again at least twice.