Fall 2018 CSCI 402

Warmup Assignment #1

(100 points total)

Doubly-linked Circular List in C

Due 11:45PM 9/7/2018 (firm)

This spec is **private** (i.e., only for students who took or are taking CSCI 402 at USC). You do **not** have permissions to **display this spec** at a public place (such as a public bitbucket/github). You also do **not** have permissions to **display the code** you write to implementation this spec at a public place since your code was written to implement a private spec. (If a prospective employer asks you to post your code, please tell them that you do not have permissions to do so; but you can send them a **private copy**.)

Assignment

(Please check out the Warmup 1 FAQ before sending your questions to the TAs, the course producers, or the instructor.)

The main purpose of this assignment is to develop an **efficient** doubly-linked circular list from scratch in C.

Electronic submissions only.

For the first part of the assignment, you need to implement a doubly-linked circular list. You need to create `"my402list.c"` to work with `"my402list.h"`. You would also need `"cs402.h"`. You must **not** alter the files provided on this web page. For the meaning of the functions, please see function definition below. After you have successfully implemented the doubly-linked circular list, you must use it to implement the **`sort`** command specified below.

We will **not** go over the lecture slides for this assignment in class. Although it's important that youare familiar with it. Please read it over. If you have questions, please e-mail the **instructor**.

Compiling

Please use a `Makefile` so that when the grader simply enters:

```
make warmup1
```

an executable named **warmup1** is created. Please make sure that your submission conforms to other general compilation requirements and README requirements.

Commandline Syntax & Program Output

The commandline syntax (also known as "usage information") for **warmup1** is as follows:

```
warmup1 sort [tfile]
```

Square bracketed items are optional. If `tfile` is not specified, your program should read from `stdin`. Unless otherwise specified, output of your program must go to `stdout` and error messages must go to `stderr`.

The meaning of the commands are:

sort : Produce a sorted transaction history for the transaction records in **`tfile`** (or `stdin`) and compute balances. The input file should be in the **`tfile` format**.

The output for various commands are as follows.

sort : Your job is to read in a tfile one line at a time. For each line, you need to check if it has the correct format. If the line is malformed, you should print an error message and quit your program. Otherwise, you should convert the line into an internal object/data structure, and insert the object/data structure into a list, sorted by the timestamp. If there is another object/data structure with **identical** timestamp, you should print an error message and quit your program.

After all the input lines are processed, you should output all the transcations in ascending order, according to their timestamps. The output must conform to the following format (please do not print the first 3 lines below, they are only for illustration purposes):

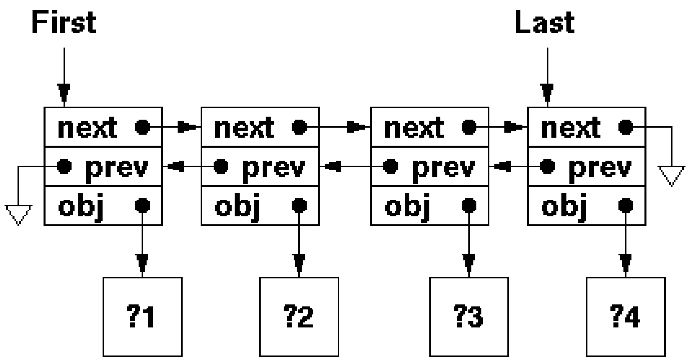
```
00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890

+-----------------+--------------------------+----------------+----------------+
|       Date      | Description              |         Amount |        Balance |
+-----------------+--------------------------+----------------+----------------+
| Thu Aug 21 2008 | ...                      |      1,723.00  |      1,723.00  |
| Wed Dec 31 2008 | ...                      | (       45.33) |      1,677.67  |
| Mon Jul 13 2009 | ...                      |     10,388.07  |     12,065.74  |
| Sun Jan 10 2010 | ...                      | (      654.32) |     11,411.42  |
+-----------------+--------------------------+----------------+----------------+
```

Each line is exactly 80 characters long (followed by a single `"\n"` character). The `Date` field spans characters 3 through 17. Please use `ctime()` to format the timestamp and remove unnecessary characters to make it look like what's in the table above. The `Description` field spans characters 21 through 44. (If a description is too long, you must truncate it.) The `Amount` field spans characters 48 through 61. It must contain a decimal point with at least one digit to the left of the decimal point and exactly two digits to the right of the decimal point. For a withdrawal, a pair of paranthesis must be used as indicated. If the amount of a transaction is more than or equal to 10 million, please print `?,???,???.??` (or `(?,???,???.??)`) in the `Amount` field. The `Balance` field spans characters 65 through 78. If a balance is negative, a pair of paranthesis must be used. If the absolute value of a balance is more than or equal to 10 million, please print `?,???,???.??` (or `(?,???,???.??)`) in the `Balance` field.

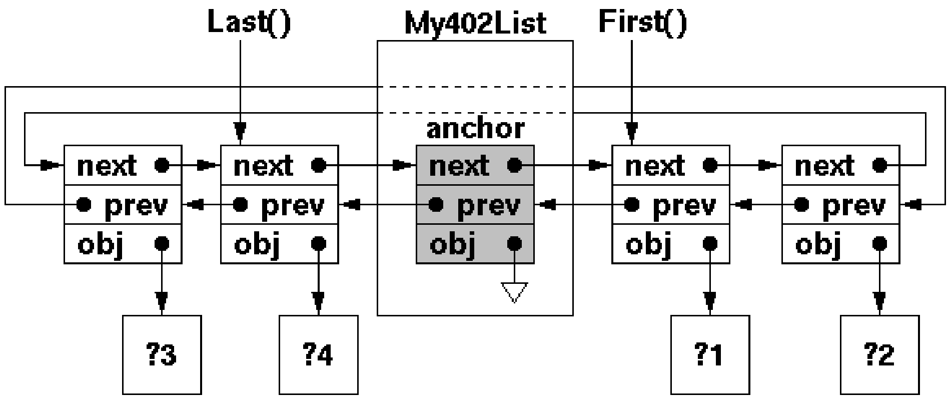
Pleaes output reasonable and useful error messages if the command is malformed or file does not exist or inaccessible.

`My402List`

A traditional doubly-linked list of length 4 looks like the following:



A corresponding `My402List` would look like the following:



The functions you need to implement has the following meaning (note that, for readability, all the functions are missing "`My402List`" before the name, and all of them are missing `(My402List*)` as the first argument as compare to what's in the actual header file, "my402list.h"):

`int Length()`
  Returns the number of elements in the list.

`int Empty()`
  Returns **TRUE** if the list is empty. Returns **FALSE** otherwise.

`int Append(void *obj)`
: If list is empty, just add **`obj`** to the list. Otherwise, add **`obj`** after **`Last()`**. This function returns **TRUE** if the operation is performed successfully and returns **FALSE** otherwise.

`int Prepend(void *obj)`
: If list is empty, just add **`obj`** to the list. Otherwise, add **`obj`** before **`First()`**. This function returns **TRUE** if the operation is performed successfully and returns **FALSE** otherwise.

`void Unlink(My402ListElem *elem)`
: Unlink and delete **`elem`** from the list. Please do not delete the object pointed to by **`elem`** and do not check if `elem` is on the list.

`void UnlinkAll()`
: Unlink and delete all elements from the list and make the list empty. Please do not delete the objects pointed to by the list elements.

`int InsertBefore(void *obj, My402ListElem *elem)`
: Insert **`obj`** between **`elem`** and **`elem->prev`**. If **`elem`** is **`NULL`**, then this is the same as **`Prepend()`**. This function returns **TRUE** if the operation is performed successfully and returns **FALSE** otherwise. Please do not check if `elem` is on the list.

`int InsertAfter(void *obj, My402ListElem *elem)`
: Insert **`obj`** between **`elem`** and **`elem->next`**. If **`elem`** is **`NULL`**, then this is the same as **`Append()`**. This function returns **TRUE** if the operation is performed successfully and returns **FALSE** otherwise. Please do not check if `elem` is on the list.

`My402ListElem *First()`
: Returns the first list element or **`NULL`** if the list is empty.

`My402ListElem *Last()`
: Returns the last list element or **`NULL`** if the list is empty.

`My402ListElem *Next(My402ListElem *elem)`
: Returns **`elem->next`** or **`NULL`** if **`elem`** is the last item on the list. Please do not check if `elem` is on the list.

`My402ListElem *Prev(My402ListElem *elem)`
: Returns **`elem->prev`** or **`NULL`** if **`elem`** is the first item on the list. Please do not check if `elem` is on the list.

`My402ListElem *Find(void *obj)`
: Returns the list element **`elem`** such that **`elem->obj`** == **`obj`**. Returns **`NULL`** if no such element can be found.

`int Init()`
: Initialize the list into an empty list. Returns **TRUE** if all is well and returns **FALSE** if there is an error initializing the list.

Assuming that you have a list of `(Foo*)` objects, a typical way to traverse the list from first to last is as follows:

```
void Traverse(My402List *list)
{
    My402ListElem *elem=NULL;

    for (elem=My402ListFirst(list);
            elem != NULL;
            elem=My402ListNext(list, elem)) {
        Foo *foo=(Foo*)(elem->obj);

        /* access foo here */
    }
}
```

Your implementation of `My420List` must allow your list to be traversed in the above way. Please use `listtest` to verify that your implementation is correct.

If you are not familiar with pointers in C, please take a look at my review on pointers.

`tfile` Format

A **`tfile`** (transaction file) is an ASCII text file. Each line in a **`tfile`** contains 4 string fields with <TAB> characters being the delimeters (i.e, each line contains exactly 3 <TAB> characters.) The fields are:

- Transcation type (single character: `"+"` for deposit or `"-"` for withdrawal).
- Transcation time (a UNIX timestamp, please see `man -s 2 time` on `nunki.usc.edu`). The value of this field must be between 0 and the timestamp that correspond to the current time. (Since the largest unsigned integer is 4,294,967,295, if the length of the string of this field is more than or equal to 11, you can safely assume that the timestamp is bad.)
- Transaction amount (a number followed by a period followed by two digits). The number to the left of the decimal point can be at most 7 digits (i.e., < 10,000,000). The transcation amount must have a positive value.
- Transcation description (textual description, cannot be empty). A description may contain leading space characters, but you must remove them before proceeding. After leading space characters have been removed, a transaction description must not be empty.

The lines are not sorted in any order. Furthermore, if a line is longer than 1,024 characters (including the '\n' at the end of a line), it is considered an error.

If you encounter an error when you process the input file, you should print an error message and quit your program. You must not process additional input lines. Please also note that a valid file must contain at least one transaction.

A sample `tfile` is provided here as test.tfile.

Testing Your Doubly-linked Circular List

To make sure that your implementation of the doubly-linked circular list is correct, we have provided a test program, `listtest.c` and a corresponding `Makefile`:

- `listtest.c`
- `Makefile`

Put these files together with your implementation of `my402list.c` and the provided `my402list.h` and `cs402.h` and type `"make"`. You should get an executable named **`listtest`**.

If you do:

```
listtest
```

no output must be produced. You can also run:

```
listtest -debug
```

to have the program output some debugging information.

Grading Guidelines

The grading guidelines has been made available. Please run the scripts in the guidelines on `nunki.usc.edu` or `aludra.usc.edu` (after the grading account is setup properly). For now, you should read the scripts to understand exactly how your assignment will be graded. It is possible that there are bugs in the guidelines. If you find bugs, please let the instructor know as soon as possible.

The grading guidelines is the **only** grading procedure we will use to grade your program. No other grading procedure will be used. To the best of our effort, we will only **change** the **testing data** for grading but not the commands. (We may make minor changes if we discover bugs in the script or things that we forgot to test.) It is strongly recommended that you run your code through the scripts in the grading guidelines.

Miscellaneous Requirements and Hints

- Please read the general programming FAQ if you need a refresher on file I/O and bit/byte manipulications in C.
- You must **NOT use any external code segments** to implement this assignment. You must implement all these functionalities from scratch.
- You must **not use any arrays** to implement list functionalities. You must dynamically allocate all elements in a list.
- For the **`sort`** command, you must use the doubly-linked circular list developed in this assignment.
- If the size of the input file is large, you **must not** read the whole file into a large memory buffer and then process the file data. You must read the file **incrementally**.
- It's important that **every byte** of your data is read and written correctly. You will **lose a lot of points** if one byte of data is generated incorrectly! The grading of this assignment will be **harsh** and you must make your code to work according to the posted grading guidelines.

- Please follow the UNIX convention that, when your output is an ASCII file (such as the output of the `sort` command), append '\n' in the last line of the output if it's not a blank line. (This way, you don't get the commandline prompt appearing at the wrong place on the screen.)

- String I/O functions such as `fgets()`, `scanf()`, and `printf()` are really meant for inputing/outputing strings. Do **not** use them to input/output binary data! Do **not** use them to input/output binary data (unless you are sure what you are doing)! Please also note that `getline()` is not available on Solaris (which is what `nunki.usc.edu` runs). Therefore, you should not use `getline()` in your code (andn use `fgets()` instead).

- The Solaris workstations in the ISD lab in SAL have the same setup as `nunki.usc.edu`. So, if you are logged on to one of these workstations, please do your development locally and not to overload `nunki` unnecessarily.

- Start working on this **early**! Please don't complain to the instructor that this assignment is too tedious or it takes too much work just to parse the commandline. Get it done early and get it done right!

Submission

All assignments are to be submitted electronically - including your `README` file. To submit your work, you must first `tar` all the files you want to submit into a **tarball** and `gzip` it to create a **gzipped tarfile** named **`warmup1.tar.gz`**. Then you upload **`warmup1.tar.gz`** to the Bistro system. On `nunki.usc.edu` or `aludra.usc.edu`, the command you can use to create a gzipped tarfile is:

```
/usr/usc/bin/gtar cvzf warmup1.tar.gz MYFILES
```

Where **`MYFILES`** is the list of file names that you are submitting (you can also use wildcard characters if you are sure that it will pick up only the right files). **DO NOT** submit your compiled code, just your source code and `README` file. **Two point will be deducted** if you submit extra binary files, such as `warmup1`, `.o`, `core`, or files that can be **generated** from the rest of your submission.

Immediately after you have created `warmup1.tar.gz` by running the command above, please also run the following command immediately (by just copying the command from the web browser and pasting it into your terminal):

```
gunzip -c warmup1.tar.gz | tar tvf -
```

This command will display the content of `warmup1.tar.gz` in the printout. Please take a look at the printout and make sure that it contains every file that you want to submit for grading.

Please note that the 2nd commandline argument of the `gtar` command above is the **output** filename of the `gtar` command. So, if you omit `warmup1.tar.gz` above, you may accidentally replace one of your files with the output of the `gtar` command. So, please make sure that the first commandline argument is **`cvzf`** and the 2nd commandline argument is **`warmup1.tar.gz`**.

A `w1-README.txt` template file is provided here. You must save it as your `w1-README.txt` file and fill it out with your documentation information (i.e., **replace all "(Comments?)"** with your evalution and **replace all standalone "?"** with information appropriate for your submission).

Here is a sample command for creating your `warmup1.tar.gz` file (your command will vary depending on what files you want to submit):

```
/usr/usc/bin/gtar cvzf warmup1.tar.gz *.c *.h Makefile w1-README.txt
```

You should read the output of the above commands carefully to make sure that `warmup1.tar.gz` is created properly. Then run the following command exactly:

```
gunzip -c warmup1.tar.gz | tar tvf -
```

If you don't understand the output of the above two commands, you need to learn how to read them! It's your responsibility to ensure that `warmup1.tar.gz` is created properly.

For this assignment, to make sure that you did not modify the provided "`my402list.h`", "`cs402.h`", and "`listtest.c`" files, if you include them in your submission, they will be discarded. We will use our copy of these files (please read the grading guidelines for details) when we grade your assignment. (If you include them and they are identical to what's in the spec, it's perfectly fine.)

You need to run **`bsubmit`** to submit warmup1.tar.gz to the submission server. Please use the following command:

```
~csci551b/bin/bsubmit upload \
  -email `whoami`@usc.edu \
  -event merlot.usc.edu_80_1372906710_192 \
  -file warmup1.tar.gz
```

Please note that the quotation marks surrounding `whoami` are **back-quote** characters and not single quotes. It's best if you just copy and paste the above command into your console and not try to type the whole command in to avoid mistakes.

If the command is executed successfully, the output should look like the sample mentioned in the submission web page (it's fine if the "Verification Successful" lines are not present). If it doesn't look like that, please fix your command and rerun it until it looks right. If there are problems, please contact the instructor.

It is extreme important that you also **verify your submission** after you have submitted `warmup1.tar.gz` electronically to make sure that everything you have submitted is everything you wanted us to grade.

Finally, please be familiar with the Electronic Submission Guidelines and information on the bsubmit web page.
