CS311 - FA13: Happy Primes

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November 27, 2013

1 Design

The first step I will take in this assignment will be to convert my sieve of eratosthenes to use a bitmap instead of an array. I will then refactor the main loop to be a single function which will become the thread function. I will then write functions for dealing with a bitmap, specifically set_bit, and clear_bit.

I will be reusing as much code from the first implementation of the sieve as possible, and will also try to factor out as much shared functionality as possible to a shared library (ex. compute happiness).

After each process or thread has computed the primailty of their section, they will increment a integer. Once that integer reaches the number of threads or process, the bitmap will be copied, and they will be allowed to continue onto computing happiness. This synchronization is needed due to happy numbers using the same bitmap.

1.1 Threads & Implicit Sharing

Because a bitmap backed is a single number, it would be extremely wasteful to lock the number. Instead, I will setup *MAX_INT (or MAX_LONG)/num threads* , partitions across the number. Two locked partions will be needed for working on the section of the map they represent. This includes the extra two partions at 0, and MAX_INT (or MAX_LONG). Each *num threads* section will have a condition variable to signal sections adjacent.

1.2 Processes & Shared Memory

The same approach will be used in this part, but with the exception of mutexs and condition variables being replaced by semaphors of size 2. The implicit memory, or global variable, will be replaced by the bitmap being stored in the shared memory.

1.3 Happy Numbers

Before moving onto *Happy Numbers* I will check to make sure I have all the primes with multiple numbers of threads and processes. Once I am confident with my output of primes, I will move on to checking for happy numbers. Checking for number happiness will be the same as generating primes, with the exception that if a number is not happy, it is marked as not prime. Since there is a distinct transition point between prime generation and happiness, a copy of the bitmap will be made and saved for later output.

2 Deviation

The first part of my design, converting my bitmap, was solved while looking for generic bitmap operations online. I came across not only a bitmap implementation, but also the sieve of eratosthenes using it at the same time. I have reused both pieces of code, though modified the sieve quite a bit to deal with mutexes, and to live in a thread.

Because of time constraints, I was not able to get to computing 'happy numbers'. So there was no need to have integer for signaling the completion of all prime computation threads.

2.1 Threads

Originally I planned for one mutex per (max number/threads). Though I still feel this is the correct approach, each attempt resulted in more segfaults than progress. Thus I opted for byte level locking, which though uses more memory, worked for the majority of my inputs. Having a single lock was asinine, since it enabled only one thread to work at a time. This was bad because the nature of the sieve results in only a few thread collisions.

2.2 Shared Memory

I did not have time to finish my work with shared memory.

3 Questions

What do you think the main point of this assignment is?

> The main point of this assignment is for us to gain experience with race conditions, use pthreads, shared memory, and synchronization constructs. Also to learn the trade offs between memory, speed, and locking.

How did you ensure your solution was correct? Testing details, for instance. This section should be very thorough.

> I used multiple inputs for the number of threads, and maximum integer.

What did you learn?

> Finding the right number of locks needed for absolute concurrancy, and least memory usage is extremely hard. There seems to not be a hard and fast rule besides ensuring all threads can run at once.

4 Work Log

```
commit 7a9174ad9bbd03779cceec1549eee66750f871f8
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Wed Nov 27 23:34:28 2013 -0800

    CS311: Add note on bitmap source.

commit 1bdf976b901c55dd7576e376912df5c2f1b145df
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Wed Nov 27 23:30:36 2013 -0800

    CS311: Add work for shared mem.

commit 4b2f008f351b520bed70eb411b44beb0adb6aa2c
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Wed Nov 27 22:47:47 2013 -0800

    CS311: Update references to max number.

    Add shared_main header and delaration.

commit 95086675921385b3505f784bd9d22b87fce23b29
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Wed Nov 27 22:46:09 2013 -0800

    CS311: Don’t try to compile object files.

commit f684b392669f31582b00c9d3c77aa62909ae0e8b
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Wed Nov 27 22:43:08 2013 -0800

    CS311: Fix usage string and error outputing.

commit c72ffcf0bbc9ffdbcbb2953f4d3a03c0147f6a18
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Wed Nov 27 22:36:31 2013 -0800

    CS311: Add default help for threads.

commit 96b1274b3c3044a15a6ab9a935d9bc0c38661884
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Wed Nov 27 22:34:24 2013 -0800

    CS311: Remove linking from object compilation.

commit df0111974226b9a16ce103dbecf6a58931aa25e3
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Wed Nov 27 22:33:35 2013 -0800

    CS311: Add header for threaded sieve to header.

commit 209dc4dc8c44732ef82ace6cb5abe4df8143d35a
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Wed Nov 27 22:33:12 2013 -0800

    CS311: Rename ’max_prime’ to ’max’ in main.

commit cbc87ee863986a0775869e6d31039be9fd2c49e4
```

```
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Wed Nov 27 22:28:28 2013 -0800

    CS311: Add part of deviation section.

commit 11dd480764db84201273f7c560e35aea1fbaa773
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Wed Nov 27 21:21:27 2013 -0800

    CS311: Update main to pass args to threaded.

commit 7c4a3079f72f8e8f4d760ad6596a6cef188ba7cf
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Wed Nov 27 09:23:41 2013 -0800

    CS311: Rename bitmap, update Makefile, start on main

commit b90c9f75ea1585723dacddd733f3f716f0c688f3
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Tue Nov 26 22:34:14 2013 -0800

    CS311: Don’t do extra work.

    Keeps track of sieve elements, and checks to make sure there aren’t any
    multiples already being checked.

commit 1cc6022e2b0570863d3d2a6b6a3793ecef390530
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Tue Nov 26 02:15:58 2013 -0800

    CS311: Do byte level locking.

commit 7e9a44e96f8e6bec5e3fe0b8af90bb663eacb2dd
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Tue Nov 26 01:15:32 2013 -0800

    CS311: Fix issue with integer overflow.

    Add mutex locking for whole unsigned int.

commit 5bcf63cb35c684a34507a522f9c892a66147d385
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Mon Nov 25 09:28:06 2013 -0800

    CS311: Initial threaded version.

    Currently doesn’t continue adding threads.

commit 929fb742dfbc92fb59fc2a375c508046496bd247
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Mon Nov 25 09:10:02 2013 -0800

    CS311: Add pthread and shmem examples.

commit 2b2b972c2ed7993efb35a6b519107a0b0abc41b2
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Sun Nov 24 18:08:46 2013 -0800

    CS311: Add Sieve implementation w/bitmap from c-faq.
```

```
commit e93a10d01b315be572b6cfc52fba72a376f92018
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Sun Nov 24 00:34:41 2013 -0800

    CS311: Typo in writeup.

    Should say 'Threads' not 'Signals'

commit 23b4835ba646324d96b3a24e93c4fc5b3a6df9be
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Sat Nov 23 22:56:12 2013 -0800

    CS311: Explicitly ignore object, log, and aux files.

commit 62ef527ff34d821e93971cab5a7ecb775f0513eb
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Sat Nov 23 22:55:58 2013 -0800

    CS311: Remove object files.

commit abc501fdfaca67027bb88d47bbf761b4a516753f
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Sat Nov 23 22:55:12 2013 -0800

    CS311: Add write design before starting project.

    * Included original sieve code

commit b3cfc89a4147569dab5507eee9ff27c6c04c6867
Merge: 5934c66 92055e3
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Thu Nov 21 00:04:50 2013 -0800

    Merge branch 'master' of github.com:bramwelt/homework

commit 92055e3882e664cf4b2e8ec85cb3157b32984853
Author: Trevor Bramwell <trevor@bramwell.net>
Date:   Wed Nov 20 08:40:44 2013 -0800

    CS311: Initial Commit of Assignment 4.
```