Thread Scheduler Efficiency Improvements for Multicore Systems

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Introduction

- *Thread scheduler* is an important system component that manages the processing programs receive in a given time
- Always running, so it must be efficient
- Most computers before 2001 were equipped with one processor containing one core
- At the end of the single-processor single-core era (early 2000s) thread scheduling was largely considered a solved problem by the Linux community

"...not very many things that have aged as well as the scheduler. Which is just another proof that scheduling is easy."

Linus, Torvals, 2001 [2]

Introduction

Hardware changed rapidly throughout the 2000s and those developments made thread scheduler implementation much more complex.

Outline

Concepts

Thread Scheduling on Linux

Bug fixes and two new schedulers

Conclusions

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Concepts

- Threads
- Synchronicity and Locks

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Using Threads

- *Threads* allow a program to run multiple independent tasks at the same time
- Useful for programs:
  - with long, mostly-independent computations
  - with a graphical interface

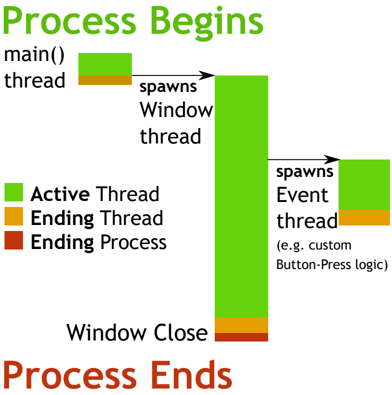


Figure: Example GUI Program. **Three** threads are created within **one** process

Using Threads

- A *multithreaded* program is a program that employs threads
- *Concurrent* computing techniques are techniques that allow many tasks to occur at the same time [W]
- *Parallel* computing techniques are techniques that allow many calculations to occur at the same time [W]
- Problems can be solved or improved using neither, either, or both of these techniques at once

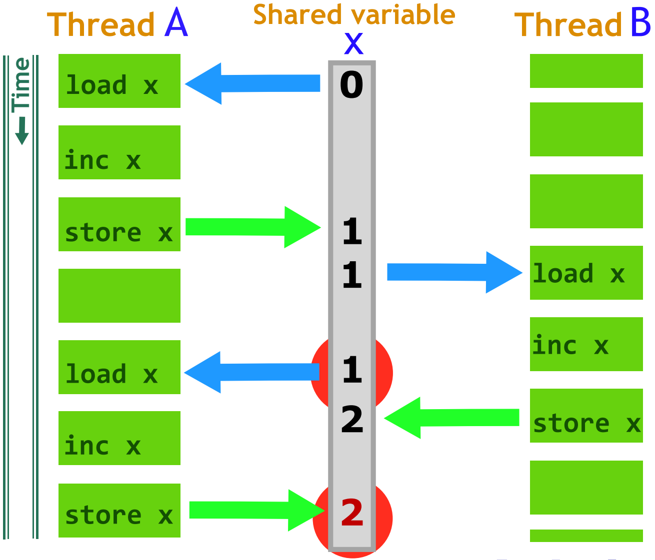
Using Threads

One problem multithreaded programs face are called *Race Conditions*.

Defined in Saltzer and Kaashoek as “A timing-dependent error in thread coordination that may result in threads computing incorrect results.”

Let’s see an example where two threads increment a shared variable.

Race Condition Example

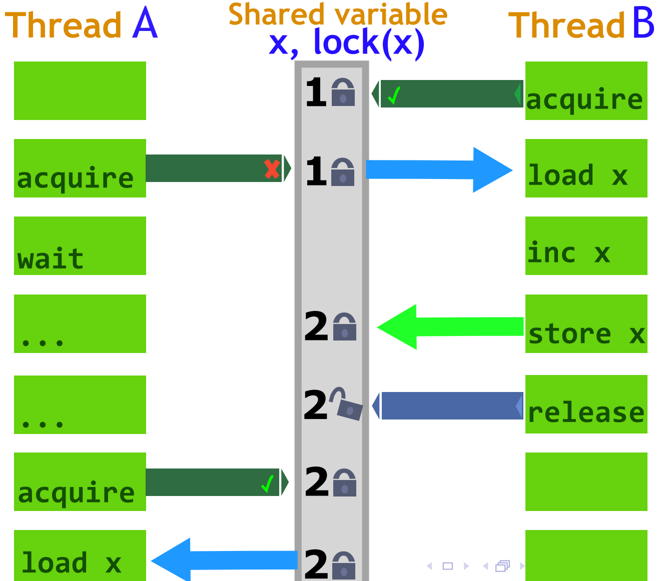


Synchronicity and Locks

- Race conditions can be fixed by controlling access to shared data.
- This control is achieved by employing locks.
- *Locks* secure objects or data shared between threads such that only one thread can read and write to it at one time.
- When a thread *locks* a lock, that thread **acquires** the lock
- When a thread *unlocks* a lock, that thread **releases** the lock

Now, let's fix the race condition in the previous example using locks

Lock Example



Outline

Concepts

Thread Scheduling on Linux
- Completely Fair Scheduler
- Cache
- Load Balancing for CFS

Bug fixes and two new schedulers

Conclusions

Completely Fair Scheduler (CFS)

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Conclusions

- Added developmental plasticity to N-gram GP using Incremental Fitness-based Development (IFD).
- IFD consistently improved N-gram GP performance on suite of test problems.
- “Knocking out” IFD shows it’s valuable in all phases, even if it wasn’t used earlier in a run.
- IFD generates more complex, less converged probability tables.
- IFD generates more modules/loops & uses more low-probability paths.
- Currently exploring applications to dynamic environments.

Thanks!

Thank you for your time and attention!

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Questions?

References

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See the GECCO '09 paper for additional references.