15-410

"My other car is a cdr" -- Unknown

Exam #1

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Synchronization

Checkpoint schedule

- Wednesday during class time
- Meet in Wean 5207
  - If your group number *ends* with
    - 0-2 try to arrive 5 minutes early
    - 3-5 arrive at 10:42:30
    - 6-9 arrive at 10:59:27
- Preparation
  - Your kernel should be in mygroup/p3ck1
  - It should load one program, enter user space, gettid()
    - Ideally lprintf() the result of gettid()
  - We will ask you to load & run a test program we will name
  - Explain which parts are "real", which are "demo quality"

Synchronization

Book report!

- Hey, “Mid-Semester Break” is just around the corner!

Synchronization

Asking for trouble?

- If you aren't using source control, that is probably a mistake
- If your code isn't in your 410 AFS space every day, you are asking for trouble
  - GitHub sometimes goes down!
    - » S'13: on P4 hand-in day (really!)
  - Roughly 1/2 of groups have blank REPOSITORY directories...
- If your code isn't built and tested on Andrew Linux every two or three days, you are asking for trouble
  - Don't forget about CC=clang / CC=clangalyzer
- Running your code on the crash box may be useful
  - But if you aren't doing it fairly regularly, the first "release" may take a *long* time

Synchronization

Google "Summer of Code"

- http://code.google.com/soc/
- Hack on an open-source project
  - And get paid
  - And quite possibly get recruited
- Projects with CMU connections: Plan 9, OpenAFS (see me)

CMU SCS "Coding in the Summer"?

Synchronization

Debugging advice

- Once as I was buying lunch I received a fortune

Synchronization

Debugging advice

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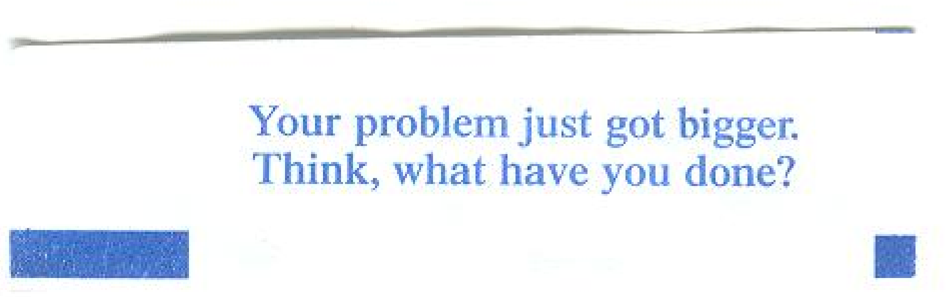

Your problem just got bigger.
Think, what have you done?

Image credit: Kartik Subramanian

A Word on the Final Exam

Disclaimer

- Past performance is not a guarantee of future results

The course will change

- Up to now: “basics” - What you need for Project 3
- Coming: advanced topics
  - Design issues
  - Things you won't experience via implementation

Examination will change to match

- More design questions
- Some things you won't have implemented (text useful!!)
- Still 3 hours, but could be more stuff (~100 points, ~7 questions)

“See Course Staff”

- If your exam says “see course staff”...
  - ...you should!
- This generally indicates a serious misconception...
  - ...which we fear will seriously harm code you are writing now...
  - ...which we believe requires personal counseling, not just a brief note, to clear up.
- ...though it might instead indicate a complex subtlety...
  - ...which we believe will benefit from personal counseling, not just a brief note, to clear up.
- “See Instructor”...
  - ...means it is probably a good idea to see an instructor...
  - ...it does not imply disaster.

"Low Exam-Score Syndrome"

What if my score is really low????

- It is frequently possible to do *dramatically* better on the final exam
- Specific suggestions later

Outline

- Question 1
- Question 2
- Question 3
- Question 4
- Question 5

Q1a – "I would like to assume..."

Basic idea: cost-benefit analysis

- What might you *gain* by assuming X?
  - Is it really a noticeable gain?
- What might you *lose* by assuming X?
  - If !X is wildly unlikely and easy to detect, then maybe the loss is "once in a long while I need to apologize and nobody will be mad"
  - If !X is plausible and would lead to disaster, then assuming X will plausibly lead to disaster

As system designers:

- You will need to "bake assumptions into your design"
- You should give real thought to which assumptions to "bake in"
- This pattern represents the most-basic "real thought"

Q1b – M:N Threading

Question goal

- Check your familiarity with what it is
- Check your design sense of when it might be useful

Common issues

- General vagueness (e.g., “More efficient”)
- Insufficient differentiation from N:1 (or from 1:1)
- Frequently missed
  - M:N allows parallelism (N:1 doesn't)

Q1 – Overall

Scores

- ~2/3 of the class scored 8/10 or better

Q2 – Critical-section protocol

What we were testing

- Find a race condition (important skill)
- Write a convincing trace (demonstrates understanding)

Good news

- ~70% scored 8/10 or better

Minor issues

- Being unclear about initial value of avail
- Omitting too many lines of trace (e.g., conditional checks)

Noticeable

- Confusing bounded waiting with progress

Alarming issues

- Misconceptions about how cvars work
- Trace can't happen

Q3 – "Dead rock"

Question goals

- Diagnose a deadlock situation, based on deadlock principles
- Show a trace
- Evaluate a solution

Q3 – “Dead rock”

Observations

- Staring at code (or a description) and tracing through random paths *may* find a deadlock, but it is often very time-consuming
- It is usually quicker to find a deadlock by focusing on parts of the code that embody deadlock ingredients
  - Hold&wait is a good thing to look for
    - If you find a couple, maybe there is a cycle
  - If you can't find hold&wait, find waits; check each for possible holding
    - Holding an object
    - Or holding a condition: “When you increment your counter, I will increment mine!”
  - Once you have the *end* of the trace it is often easy to write the beginning

Q3 – "Dead rock"

Observations

- Showing circular wait, by itself, is not enough to show a deadlock
  - Some other thread may be pre-ordained to release key resources

Q3 – “Dead rock”

Part A

- Some people missed a sequence
  - Including somebody with a username containing '0'

Part B

- Does the described protocol allow one thread to hold some X's while wanting some Y's, and also allow another thread to hold some Y's while wanting some X's?
  - If not, circular waiting might be impossible
  - If so, you might be half-way to a trace

Part C

- Imposing a total order is not likely to remove hold&wait
  - It is much more likely to remove circular waiting

Q3 – “Dead rock”

Specific issues

- Missing process/resource graphs
- Traces with long extraneous parts
- Knowing ingredients but not finding a trace

Scores

- ~40% scored 13/15 (86%) or better
- ~40% scored below 9/15 (60%) or worse
- So there was a diversity of scores

Q4 – Testing cvars

Question goal

- Atypical variant of typical “write a synchronization object” exam question
  - Make sure you can block and unblock threads without things going wrong due to race conditions
- This was a hard question
  - Eckhardt's rush-job solution scored 75% when the TAs got hold of it
  - Even with more time, breaking 90% wasn't going to happen

Hint

- If cvars are broken, there are many ways
  - cond_wait() { unlock(); lock(); return; }
  - cond_wait() { unlock(); sleep(33); lock(); return; }
  - cond_wait() { unlock(); while(1) continue; }
- There are also less-deterministic ways to be broken

Q4 – Testing cvars

Decoder ring (aka detailed hints)

- "Actual block" = tester verified that scheduler believes the threads are actually really truly blocked (this was hard)
- "Early 1st signal" = tester didn't take time to be pretty sure that both wait() have begun before first signal() starts
- "False start" = tester doesn't detect if wait() doesn't actually wait before sending the first signal()
- "Misses double wakeup" = tester doesn't detect if one signal() wakes two threads
- "Liveness" = tester doesn't check both threads run after second signal()
- "Disorder" = tester doesn't check threads ran in the right order
- "Hang" = test can hang without printing a verdict

Points may be -2 or -1

Q4 – Testing cvars

Outcome

- ~8% scored 16/20 (80%) or better
- ~20% scored 14/20 (70%) or better
- ~36% scored 10/20 (50%) or worse
  - "Severe tire damage" group is typically ~30% of class

Implications

- Being able to write this kind of code shows understanding of primitives and also hazards
- Life in P3 (and after) may involve embodying special-purpose synchronization patterns in code

Q5 – Stack Picture

Outcome

- ~40% scored 9/10 or better
- ~30% scored below 6/10

Breakdown

```
90% = 58.5    6 students (57.0 and up)
80% = 52.0    6 students
70% = 45.5   24 students (45.0 and up)
60% = 39.0   14 students
50% = 32.5   16 students (29.0 and up)
40% = 26.0    0 students
<40%          0 students
```

Comparison/calibration

- These scores are low – maybe 5% too low?
- A bit of adjustment is plausible/likely

Implications

Score below 45?

- Form a “theory of what happened”
  - Not enough textbook time?
  - Not enough reading of partner's code?
  - Lecture examples “read” but not grasped?
  - Sample exams “scanned” but not solved?
- It is important to do better on the final exam
  - Historically, an explicit plan works a lot better than “I'll try harder”
  - *Strong suggestion*:
    - » Identify causes, draft a plan, see instructor

Implications

Score below 39?

- Something went *noticeably* wrong
  - It's *important* to figure out what!
- Beware of “triple whammy”
  - Low score on *three* questions
    - » Generally Q3, Q4, Q5
- Passing the final exam could be a challenge
- *Passing the class may not be possible!*
  - To pass the class you must demonstrate proficiency on exams (not just project grades)
- Try to identify causes, draft a plan, see instructor

Action plan

Please follow steps in order:

1. **Identity causes**
2. **Draft a plan**
3. **See instructor**

Action plan

Please follow steps in order:

1. Identity causes
2. Draft a plan
3. See instructor

Please avoid:

- "I am worried about my exam, what should I do?"
  - *Each person should do something different!*
  - Thus "identify causes" and "draft a plan" steps are individual and depend on some things not known by us

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General plea

- Please check to see whether there is something we strongly recommend that you have been skipping because you never needed to do that thing before
  - This class is different