CS 490: Guided Design in Software Engineering

Martin Kellogg

Welcome to CS 490!

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Today’s agenda:

- What is 490 + course policies and expectations
- About the instructor (aka why you should listen to me)
- In-class activity: background survey
- Survey of the project + other assignments (syllabus day!)
- Start “Code-level design” lecture (if time permits)

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Course policies

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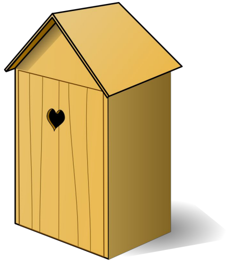
  - Let's try it now! **Suggested questions**:
    - Why would you do that?
    - Are you just bribing us to pay attention?
    - Does that actually work?
    - Do even silly questions count?

What is CS 490?

What is CS 490? An analogy



= CS 113/114

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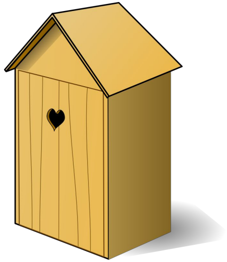

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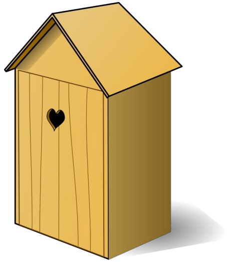

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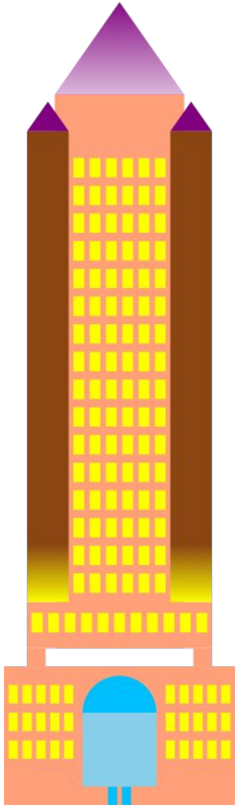

= CS 490

What is CS 490?

- Previous courses were about ***programming***
- A course about ***engineering*** software

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  - safety and reliability
  - working in a team, including with people with different skillsets
  - non-functional properties and trade-offs
  - architecture and design
  - using your mathematical skills to achieve a practical result
  - building something the right way
  - etc

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How do these principles apply to programming?

Why does software need to be engineered?

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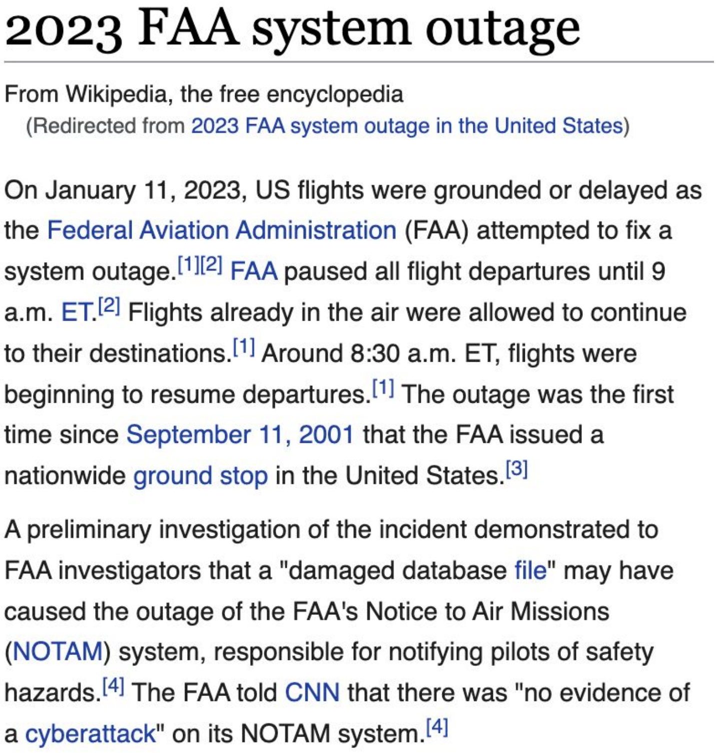


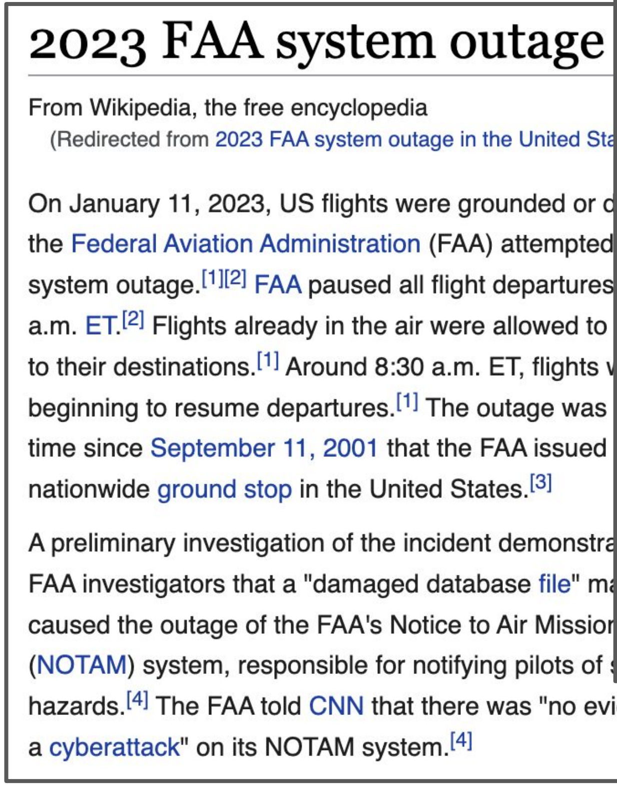
2023 FAA system outage

From Wikipedia, the free encyclopedia
(Redirected from 2023 FAA system outage in the United States)

On January 11, 2023, US flights were grounded or delayed as the Federal Aviation Administration (FAA) attempted to fix a system outage.[1][2] FAA paused all flight departures until 9 a.m. ET.[2] Flights already in the air were allowed to continue to their destinations.[1] Around 8:30 a.m. ET, flights were beginning to resume departures.[1] The outage was the first time since September 11, 2001 that the FAA issued a nationwide ground stop in the United States.[3]

A preliminary investigation of the incident demonstrated to FAA investigators that a "damaged database file" may have caused the outage of the FAA's Notice to Air Missions (NOTAM) system, responsible for notifying pilots of safety hazards.[4] The FAA told CNN that there was "no evidence of a cyberattack" on its NOTAM system.[4]

Why does software need to be engineered?



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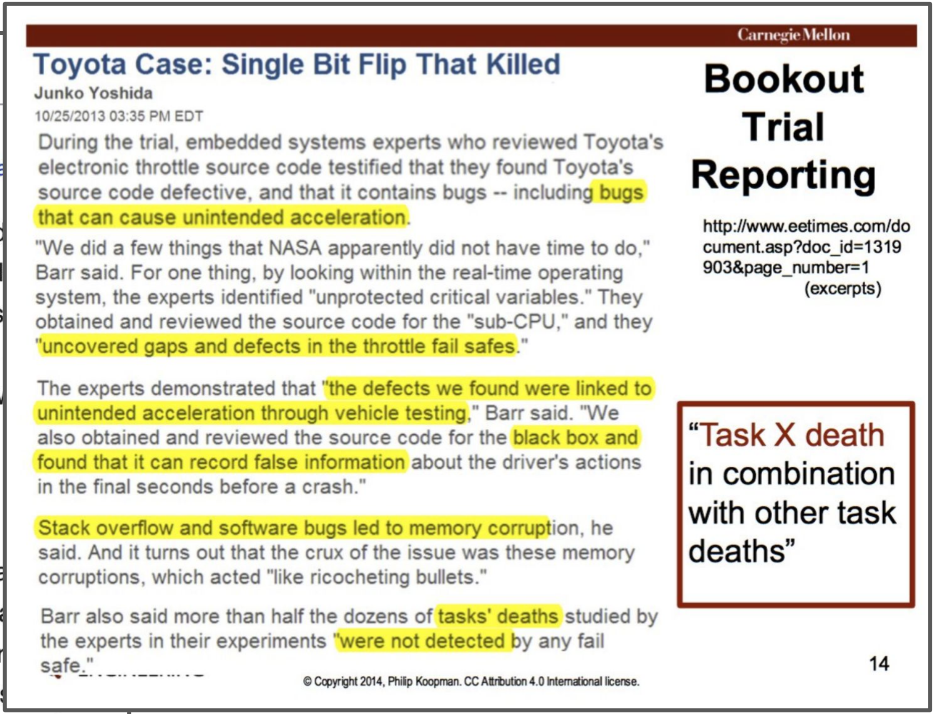


Carnegie Mellon

Toyota Case: Single Bit Flip That Killed

Junko Yoshida

10/25/2013 03:35 PM EDT

During the trial, embedded systems experts who reviewed Toyota's electronic throttle source code testified that they found Toyota's source code defective, and that it contains bugs -- including bugs that can cause unintended acceleration.

"We did a few things that NASA apparently did not have time to do," Barr said. For one thing, by looking within the real-time operating system, the experts identified "unprotected critical variables." They obtained and reviewed the source code for the "sub-CPU," and they "uncovered gaps and defects in the throttle fail safes."

The experts demonstrated that "the defects we found were linked to unintended acceleration through vehicle testing," Barr said. "We also obtained and reviewed the source code for the black box and found that it can record false information about the driver's actions in the final seconds before a crash."

Stack overflow and software bugs led to memory corruption, he said. And it turns out that the crux of the issue was these memory corruptions, which acted "like ricocheting bullets."

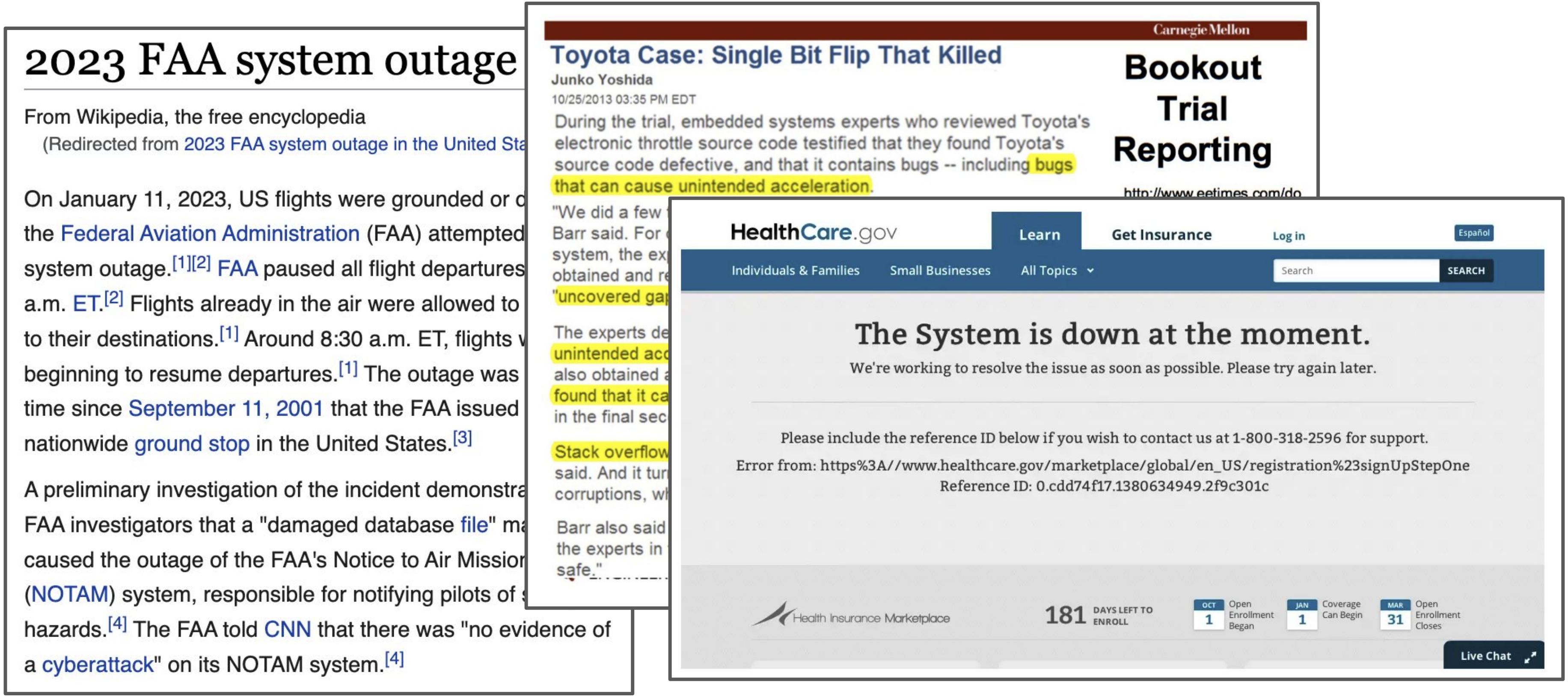
Barr also said more than half the dozens of tasks' deaths studied by the experts in their experiments "were not detected by any fail safe."

Bookout Trial Reporting

http://www.eetimes.com/document.asp?doc_id=1319903&page_number=1 (excerpts)

"Task X death in combination with other task deaths"

Why does software need to be engineered?



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We're working to resolve the issue as soon as possible. Please try again later.

Please include the reference ID below if you wish to contact us at 1-800-318-2596 for support.

Error from: https%3A//www.healthcare.gov/marketplace/global/en_US/registration%23signUpStepOne
Reference ID: 0.cdd74f17.1380634949.2f9c301c

Health Insurance Marketplace

181 DAYS LEFT TO ENROLL

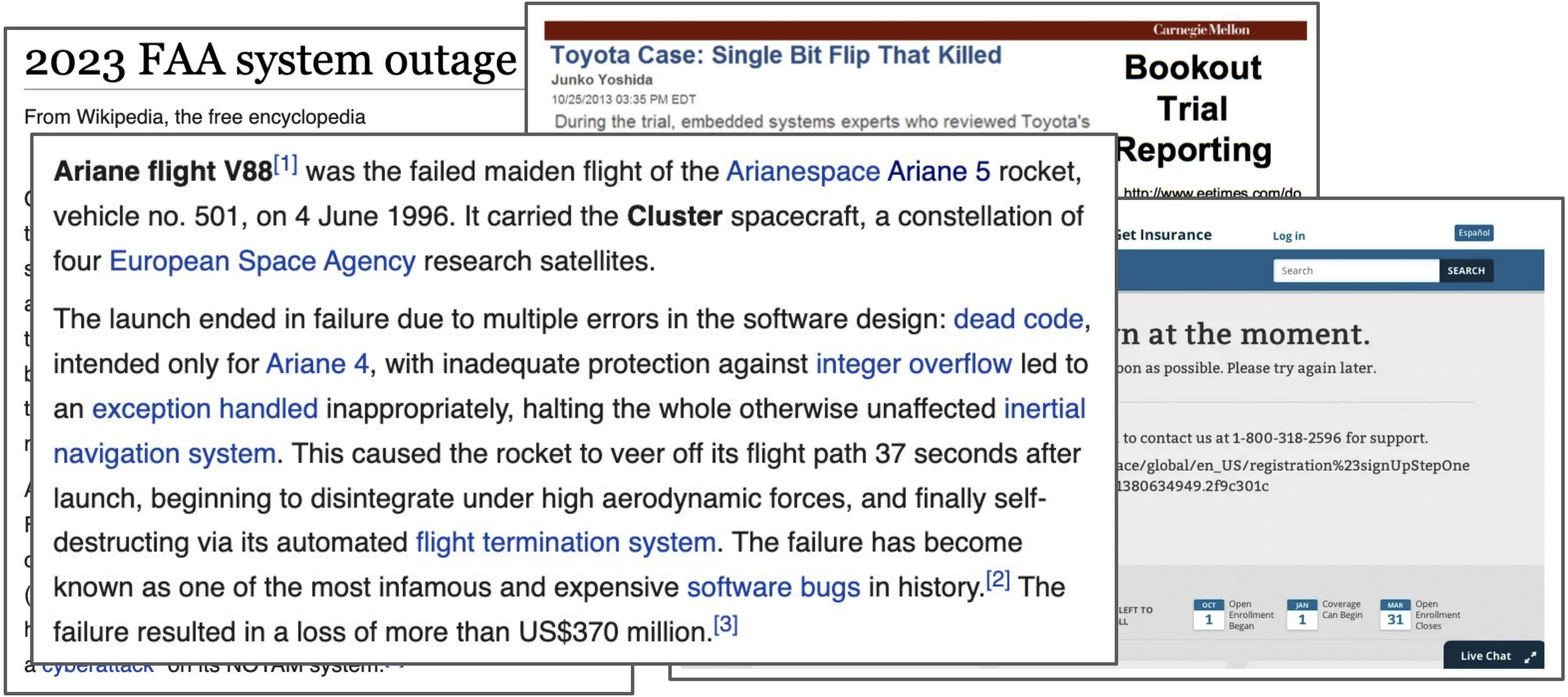
OCT 1 Open Enrollment Began

JAN 1 Coverage Can Begin

MAR 31 Open Enrollment Closes

Live Chat

Why does software need to be engineered?



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http://www.eetimes.com/do

Ariane flight V88[1] was the failed maiden flight of the Arianespace Ariane 5 rocket, vehicle no. 501, on 4 June 1996. It carried the **Cluster** spacecraft, a constellation of four European Space Agency research satellites.

The launch ended in failure due to multiple errors in the software design: dead code, intended only for Ariane 4, with inadequate protection against integer overflow led to an exception handled inappropriately, halting the whole otherwise unaffected inertial navigation system. This caused the rocket to veer off its flight path 37 seconds after launch, beginning to disintegrate under high aerodynamic forces, and finally self-destructing via its automated flight termination system. The failure has become known as one of the most infamous and expensive software bugs in history.[2] The failure resulted in a loss of more than US$370 million.[3]

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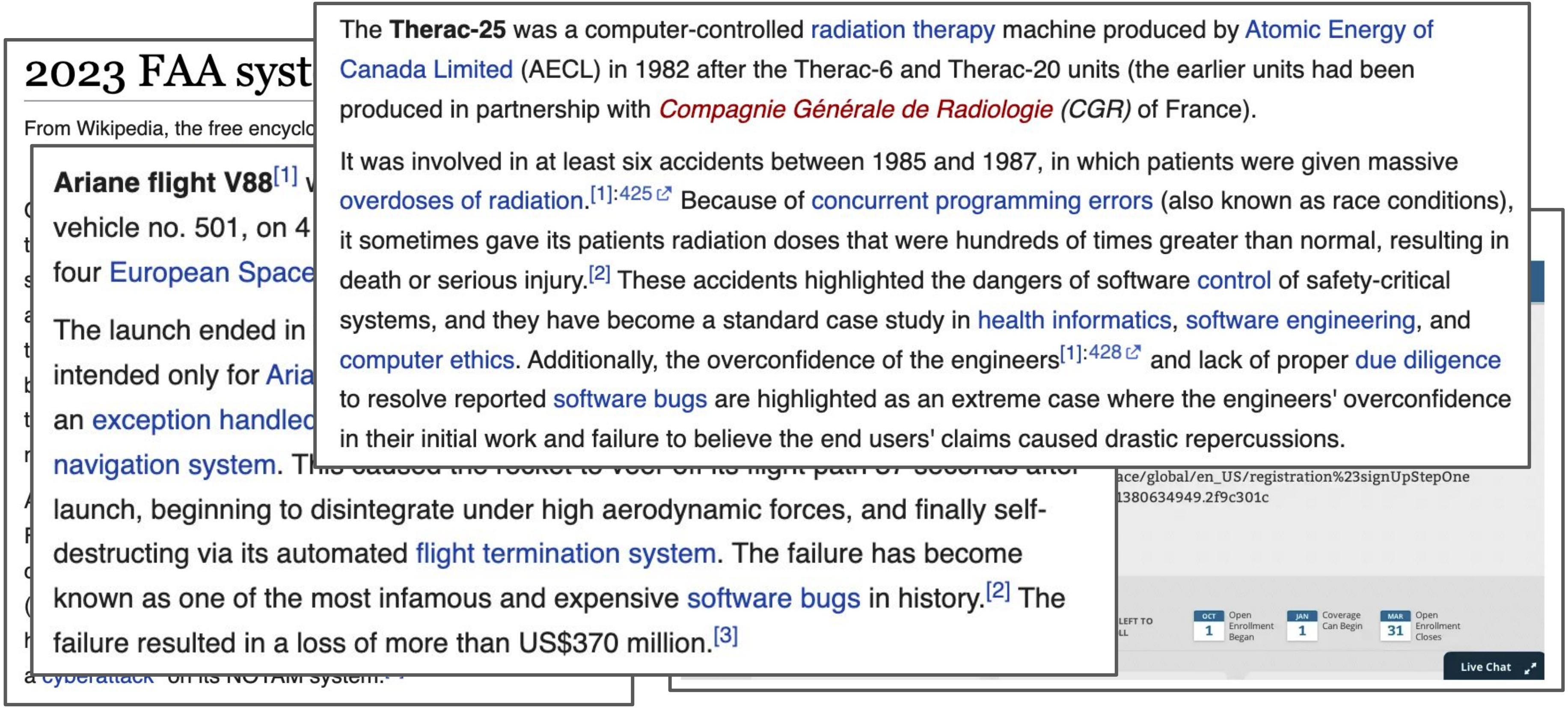

The **Therac-25** was a computer-controlled radiation therapy machine produced by Atomic Energy of Canada Limited (AECL) in 1982 after the Therac-6 and Therac-20 units (the earlier units had been produced in partnership with *Compagnie Générale de Radiologie (CGR)* of France).

It was involved in at least six accidents between 1985 and 1987, in which patients were given massive overdoses of radiation.[1]:425 Because of concurrent programming errors (also known as race conditions), it sometimes gave its patients radiation doses that were hundreds of times greater than normal, resulting in death or serious injury.[2] These accidents highlighted the dangers of software control of safety-critical systems, and they have become a standard case study in health informatics, software engineering, and computer ethics. Additionally, the overconfidence of the engineers[1]:428 and lack of proper due diligence to resolve reported software bugs are highlighted as an extreme case where the engineers' overconfidence in their initial work and failure to believe the end users' claims caused drastic repercussions.

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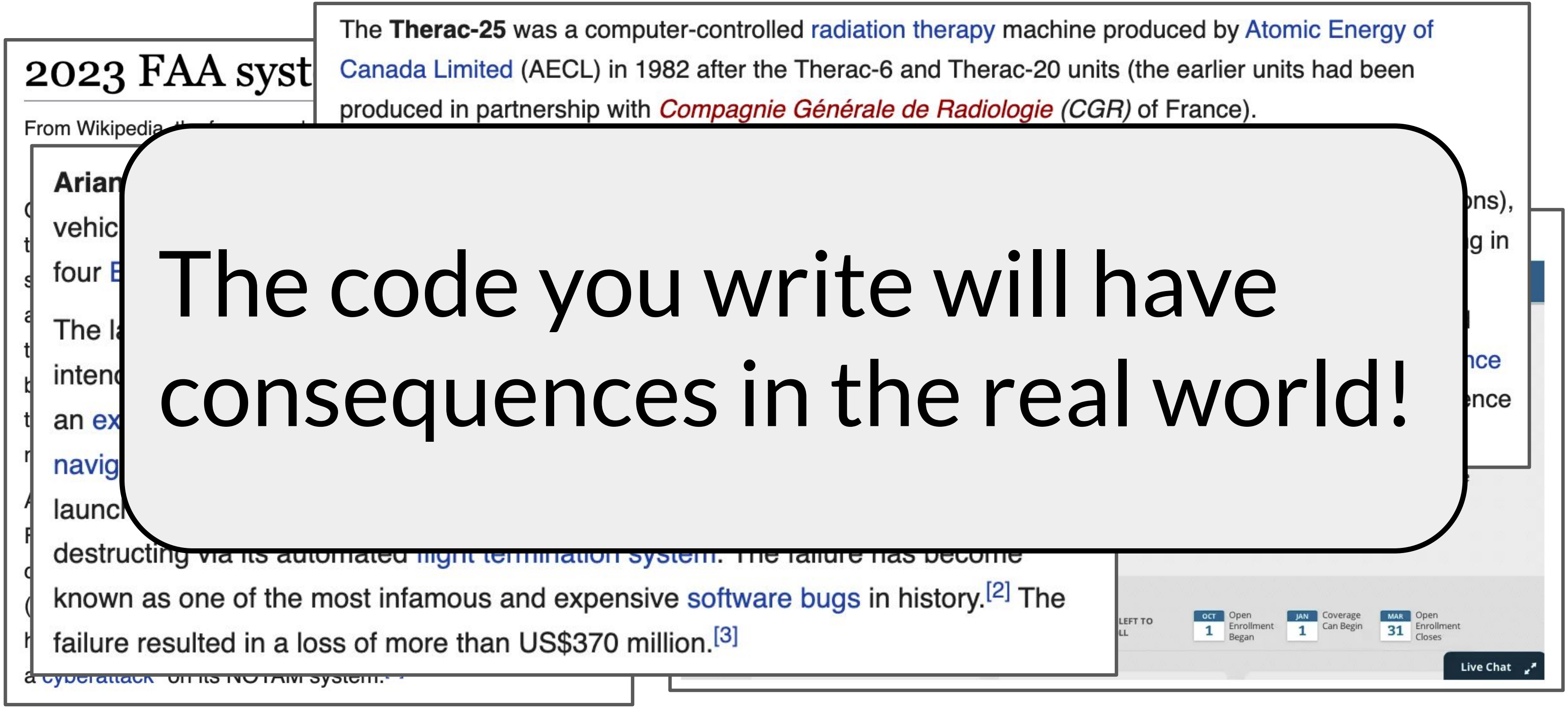

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The code you write will have consequences in the real world!

My expectations

- You know how to ***program***

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- You know how to ***program***
  - you can write code
  - you can program against an English specification
  - you can read code and figure out what it does
  - you can teach yourself a new programming language
  - you can debug code that's not behaving like you expect
  - you can install software yourself + do basic troubleshooting
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The ability to solve problems yourself with just a search engine is a ***critical*** skill for a software engineer!

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- You know how to ***program***
- Professionalism

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- You know how to ***program***
- Professionalism
- Participation

CS 490 goals

Officially the following:

- Students will be able to explain the major theories and methods applicable to professional software engineering.
- Students will be able to design, implement and evaluate a computer based system to meet desired needs.
- Students will be able to function effectively on a team to accomplish a goal.
- Students will be able to use current techniques, skills and tools necessary for computing practice.

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super vague!

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course project!

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My goals for you:

- Students will be able to assess the **quality of software engineering** being done at some future workplace
- Students will be **competent software engineers** that I wouldn't be worried about hiring

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- Previously:
  - PhD at University of Washington (Seattle) until June 2022
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I'm an academic, not a professional software engineer

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- ~25% of my PhD spent embedded at AWS
    - two co-authored publications
    - my analysis tools deployed on > 70M lines of AWS code
- My lab is one of the few in the world to take SE seriously when writing research code
    - Inherited from my PhD advisor, who employed 3 SDEs concurrently while I was a student!

Our TAs

- Tiffany and Nathan took this course with me in Au24 (and did well)
    - they know covey.town well and have experienced this course “in your shoes”

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- TA office hours are where you should go for help with covey.town
  - they know the system better than I do at this point

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- You can also ask on Discord
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- There is no YWCC tutoring for CS 490 this semester
    - it was underutilized in the past, anyway

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Break: background survey

https://forms.gle/UkTudX3Pw8xgxzv17

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A brief tour through the course website

- https://web.njit.edu/~mjk76/teaching/cs490-au25/

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- https://web.njit.edu/~mjk76/teaching/cs490-au25/
    - Mandatory readings + reading quizzes
    - “Your Choice” readings
    - Individual Project 0: due < 1 week from today
    - My grading: “tough but fair” + curve at the end
    - Collaboration policy (I expect you to use a search engine!)
    - Project structure
    - How to get help
    - Overview of topics

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Action items for next class

- Individual Project 0
- 4 (short!) mandatory readings: there will be a quiz!
  - Syllabus and IP0 specifications are also fair game
- Make sure you can access all course materials
  - Course website
  - Canvas
  - Discord