Shallow Dive # 2

Testing

What can go wrong if software engineers don't test well?

What can go wrong ?

GAO

U.S. Government Accountability Office

Patriot Missile Defense:
Software Problem Led to System Failure at Dhahran, Saudi Arabia

IMTEC-92-26

Published: Feb 04, 1992. Publicly Released: Feb 27, 1992.

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MIM-104 Patriot

49 languages

Failure at Dhahran

On February 25, 1991, an Iraqi Al Hussein Scud missile hit the barracks in Dhahran, Saudi Arabia, killing 28 soldiers from the U.S. Army's 14th Quartermaster Detachment.[90]

A government investigation revealed that the failed intercept at Dhahran had been caused by a software error in the system's handling of timestamps.[91][92] The Patriot missile battery at Dhahran had been in operation for 100 hours, by

What can go wrong ?

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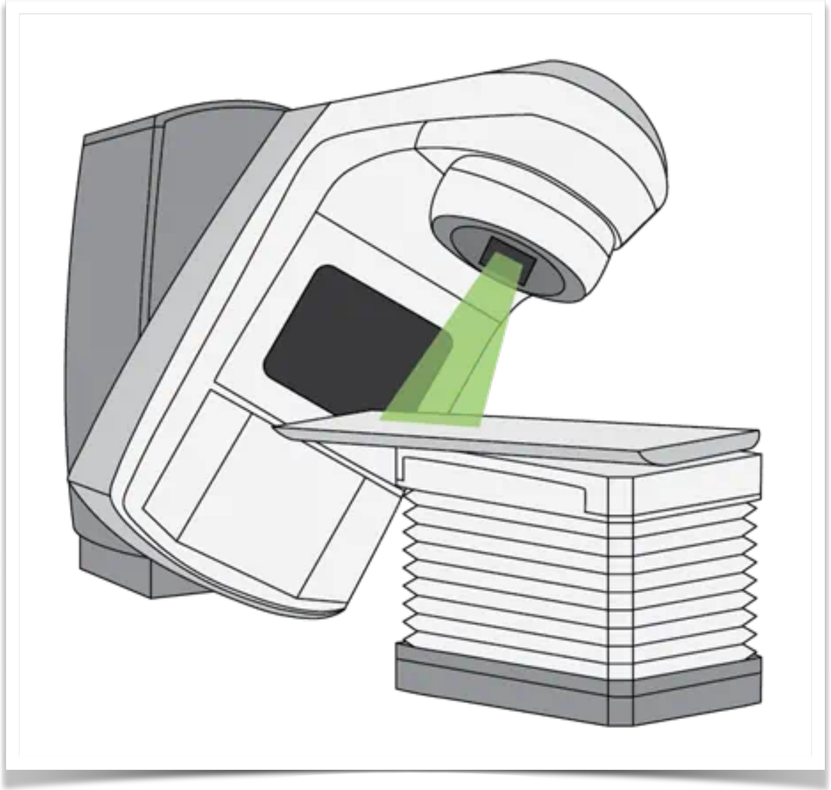
Ariane flight V88

5 languages

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]

What can go wrong ?



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Multidata Systems International

Add languages

A software product of the company was involved in an accidental overexposure of patients in Panama in 2001 when the treatment planning software RTP/2 (vers. 2.11, 1991) reportedly contributed to 28 patients receiving excessive amounts of radiation at the Instituto Oncologico Nacional in Panama City. At least eight patients died, while another 20 received overdoses likely to cause significant health problems. The physicians, who were legally required to double-check the computer's calculations by hand, were indicted for murder.[2]

A panel of experts designated by the International Atomic Energy Agency delivered a comprehensive report in August 2001, finding that the software permitted incorrect forms of data entry which in turn had led to miscalculation of treatment times.[3] Multidata began a recall

What can go wrong ?

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Northeast blackout of 2003

Add languages

The **Northeast blackout of 2003** was a widespread power outage throughout parts of the Northeastern and Midwestern United States, and most parts of the Canadian province of Ontario on Thursday, August 14, 2003, beginning just after 4:10 p.m. EDT.[1]

The blackout was due to a software bug in the alarm system at the control room of FirstEnergy, which rendered operators unaware of the need to redistribute load after overloaded transmission lines dropped in voltage. What should have been a manageable local blackout cascaded into the collapse of much of the Northeast regional electricity distribution system.

What can go wrong ?

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British Post Office scandal

Add languages

The **British Post Office scandal**, also called the **Horizon IT scandal**, involved the Post Office pursuing thousands of innocent subpostmasters for apparent financial shortfalls caused by faults in Horizon, an accounting software system developed by Fujitsu. Between 1999 and 2015, more than 900 subpostmasters were wrongfully convicted of theft, fraud and false accounting based on faulty Horizon data, with about 700 of these prosecutions carried out by the Post Office.

In 2017, 555 subpostmasters led by Bates brought a group action against the Post Office in the High Court. In 2019, the judge ruled that the subpostmasters' contracts were unfair, and that Horizon "contained bugs, errors and defects". The case was settled for £58 million, leaving the claimants with £12 million after legal costs.

What can go wrong ?

MacRumors

New iOS Bug Crashing iPhones Simply by Receiving a Text Message [Includes Fix]

Tuesday May 26, 2015 08:34 EAT by Juli Clover

A new bug has been discovered in the Messages app, allowing a string of characters sent to a person via iMessage or SMS to crash an iPhone and cause the Messages app to crash after being opened. The bug, which requires a specific string of symbols and Arabic characters to be sent, was first noticed on reddit earlier this afternoon and has been spreading around the Internet since then.

Sending the string of characters to an iPhone results in an immediate respring, causing an iPhone to crash and quickly reboot. From there, if the Messages app was opened at a list view, the Messages app crashes automatically when you try to open it. If it was opened to the conversation where you received the message, the app will open, but attempting to go to another conversation causes Messages to crash.

Shallow Dive # 2

Testing

How should we test?

Déjà vu

We need to write code that checks if our code works as intended or not!

Task

Given the *intended* behavior of a module or a function, write test cases (*without looking at the code*) that ensure the code works as intended!

Challenge

Design good test cases!

1

Not yet

TESTCASES 3 / 8 passed, 3 points

Single Row	✓	1 point
Single Column	✓	1 point
Main Diagonal	✓	1 point
Anti Diagonal	✗	1 point
Full Board	✗	1 point
Did Player Win?	✗	1 point
Ties	✗	1 point
Full Game	✗	1 point

Exercise

Which of the following test cases are enough for testing the following function?

```
def maximum(a, b, c):
    '''Returns the maximum
    between three numbers'''
    pass
```

A. (1, 2, 3)

B. (1, 2, 3) (3, 2, 1) (1, 3, 2)

C. (1, 2, 3) (3, 2, 1) (1, 3, 2)

D. (1, 2, 3) (1, 3, 2) (2, 1, 3) (2, 3, 1) (3, 1, 2) (3, 2, 1)

E. None of the above.

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E. None of the above.

Exercise

The following code passes all the previous test cases although it is incorrect when all the numbers are **negative.**

```
def maximum(a, b, c):
    max = 0

    if a > max:
        max = a
    if b > max:
        max = b
    if c > max:
        max = c

    return max
```

Exercise

Which of the following test cases are enough for testing the following function?

```
def maximum(a, b, c):
    '''Returns the maximum
    between three numbers'''
    pass
```

A. (1, 2, 3) (3, 2, 1) (1, 3, 2) (-1, -2, -3) (-3, -2, -1) (-1, -3, -2)

B. All 3-permutations of -3, -2, -1, 1, 2, 3

C. None of the above.

Exercise

Which of the following test cases are enough for testing the following function?

```
def maximum(a, b, c):
    '''Returns the maximum
    between three numbers'''
    pass
```

A. (1, 2, 3) (3, 2, 1) (1, 3, 2) (-1, -2, -3) (-3, -2, -1) (-1, -3, -2)

B. All 3-permutations of -3, -2, -1, 1, 2, 3

C. None of the above.

Exercise

The following code passes all the previous test cases although it is incorrect when some numbers are **equal.**

```
def maximum(a, b, c):
    max = 0

    if a > c and a > b:
        max = a
    if b > c and b > a:
        max = b
    if c > a and c > b:
        max = c

    return max
```

Exercise

Is it enough to test all possible **3-tuples** (permutations with repetition) of {-3, -2, -1, 1, 2, 3}?

Exercise

Is it enough to test all possible **3-tuples** (permutations with repetition) of {-3, -2, -1, 1, 2, 3}?

Not necessarily!

The following code would pass all test cases but fail with **very small numbers**!

```
def maximum(a, b, c):
    max = -9999999
    if a > max:
        max = a
    if b > max:
        max = b
    if c > max:
        max = c
    return max
```

Exercise

What about testing with millions of permutations of small and large positive and negative numbers?

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Definitely an **overkill!**

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What about testing with millions of permutations of small and large positive and negative numbers?

Definitely an **overkill!**

Think of **Equivalence Groups**:

- All *positive.*
- All *negative*.
- Mixed positive and negative.
- *Permutations*: (min, mid, max), (min, max, mid), (mid, min, max), (mid, max, min), (max, mid, min), (max, min, mid)
- With duplicates.
- With *very large* and *very small* numbers.
- Should you include *floating-point* numbers?

(1, 2, 3) Covers positive and (min, mid, max)

Testing with (5, 7, 8) might be redundant!

Equivalence Classes

Thinking about equivalence classes allows for avoiding redundancy in testing.

- All *positive.*
- All *negative*.
- Mixed positive and negative.
- *Permutations*:
  (min, mid, max), (min, max, mid),
  (mid, min, max), (mid, max, min),
  (max, mid, min), (max, min, mid)
- With duplicates.
- With *very large* and *very small* numbers.
- Should you include *floating-point* numbers?

Example. Using (1, 2, 3) as a test case covers *all positive* and (min, mid, max)

Testing with (5, 7, 8) might be redundant!
It does not fall into a different equivalence class.

Best Practices

- Include tests across the **range of possible** values.
- Include tests for **boundary** values**.**
- **Understand the problem** to come up with tests (e.g., when ordering elements, relative order and equal values matter).
- Target all **equivalence classes**.
- Add random test cases to catch issues you might not have thought about!

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