Beyond pdb

Delta Debugging in Python

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Python is not easy to debug

```
data = ["There are two kinds of people",
        "First, those who finish",
        "what they start"


SyntaxError: unexpected EOF while parsing
```

Python is not easy to debug

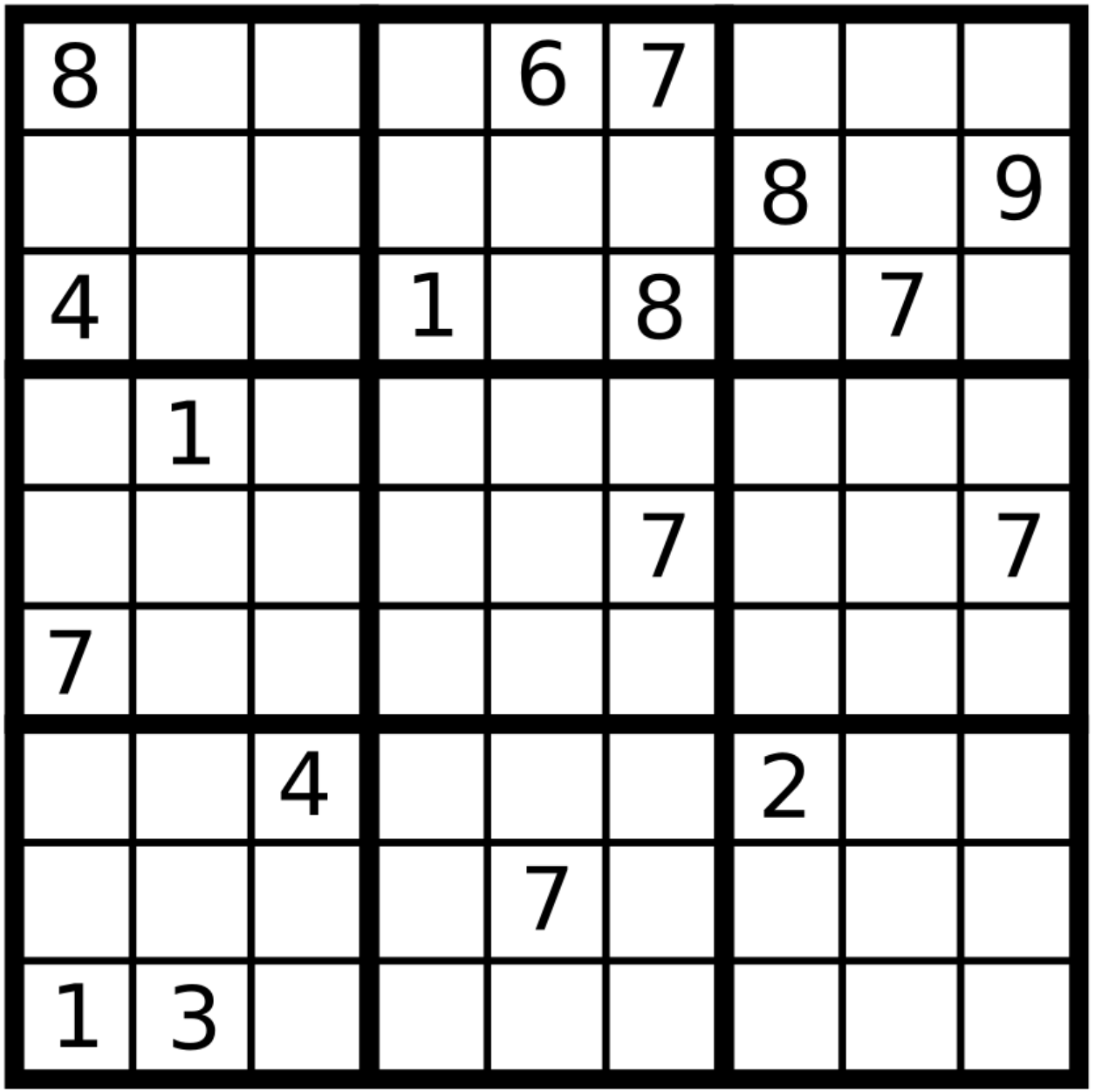
```
data = "There are 10 kinds of people",
       "those who can read binary",
       "and those who don't"]


IndentationError: unexpected indent
```

Reasons your program is failing:

- The code is buggy
- The tests are buggy
- The data is buggy
- You have no idea which of the three applies

8	4	1	3	6	7	5	2	9
5	6	7	9	2	4	8	3	1
2	9	3	1	5	8	4	7	6
3	1	8	4	9	6	7	5	2
4	5	9	2		1	6	8	3
7	2	6	8	3	5	1	9	4
9	8	4	7	1	3	2	6	5
6	7	2	5	4	9	3	1	8
1	3	5	6	8	2	9	4	7



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Sudoku Solver

- Formulated as linear equations
- `import pulp`
- 333+ constraints
- *using an LES is overkill*

8	4	1	3	6	7	5	2	9
5	6	7	9	2	4	8	3	1
2	9	3	1	5	8	4	7	6
3	1	8	4	9	6	7	5	2
4	5	9	2	7	1	6	8	3
7	2	6	8	3	5	1	9	4
9	8	4	7	1	3	2	6	5
6	7	2	5	4	9	3	1	8
1	3	5	6	8	2	9	4	7

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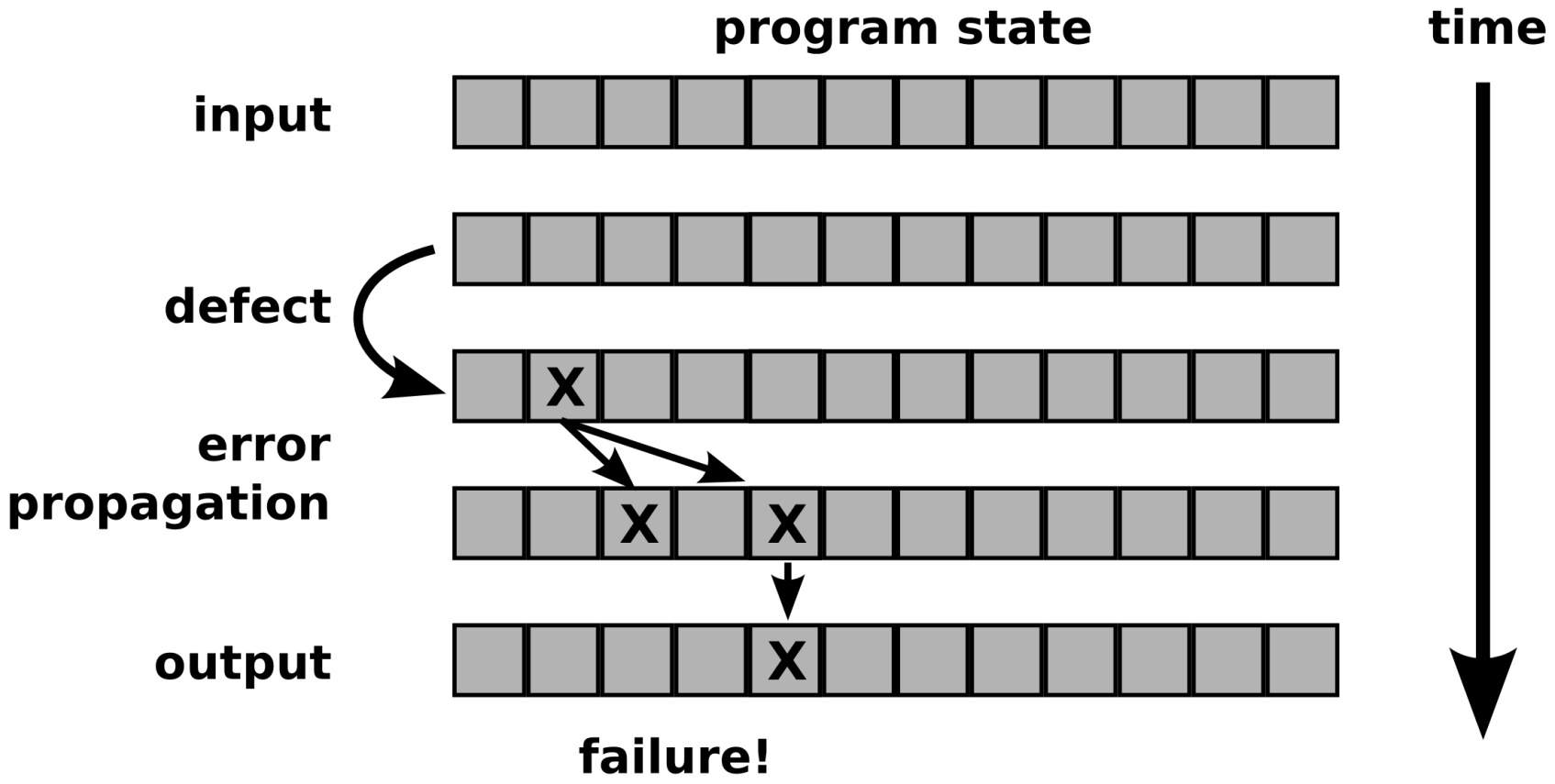
Andreas Zeller

- Udacity course: **“Software Debugging”**
- Author of the book: **“Why Programs Fail”**
- Published Delta Debugging article in 1999

Program failures and defects



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Partitioning data

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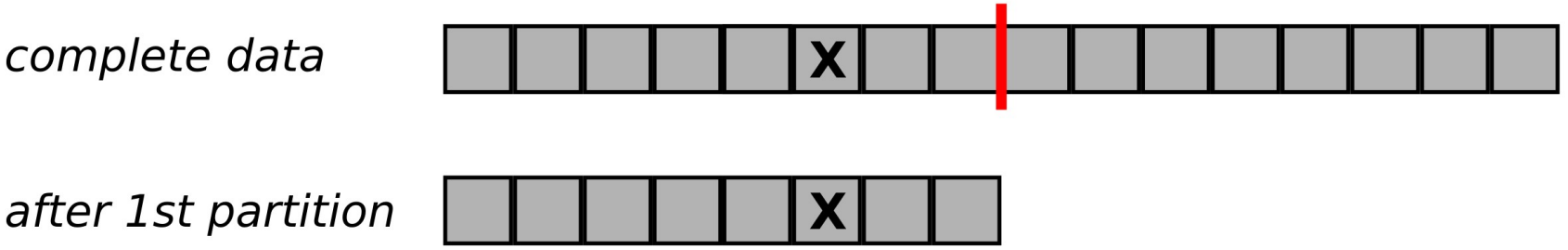
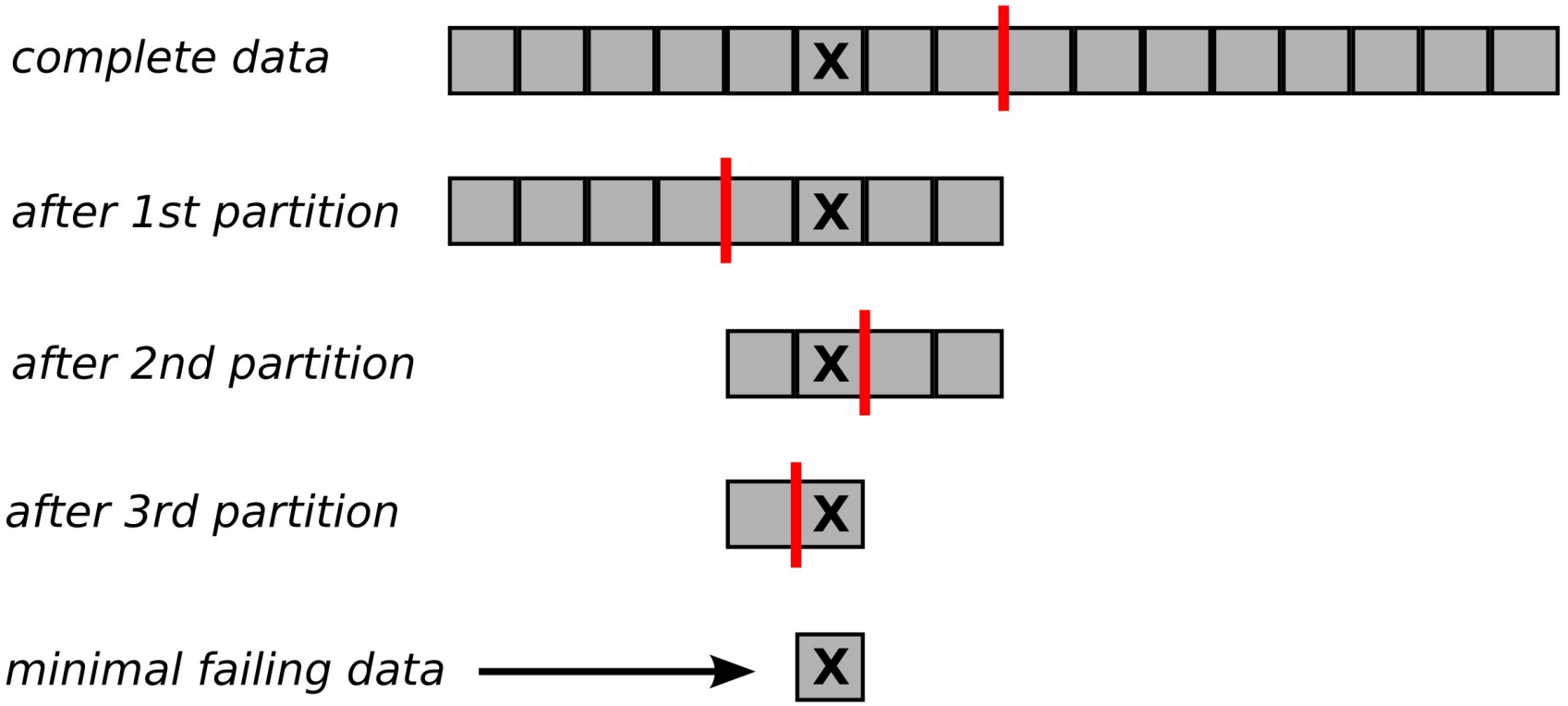
Partitioning data with binary search

complete data

Partitioning data with binary search



Partitioning data with binary search



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Partitioning data

with increasing granularity

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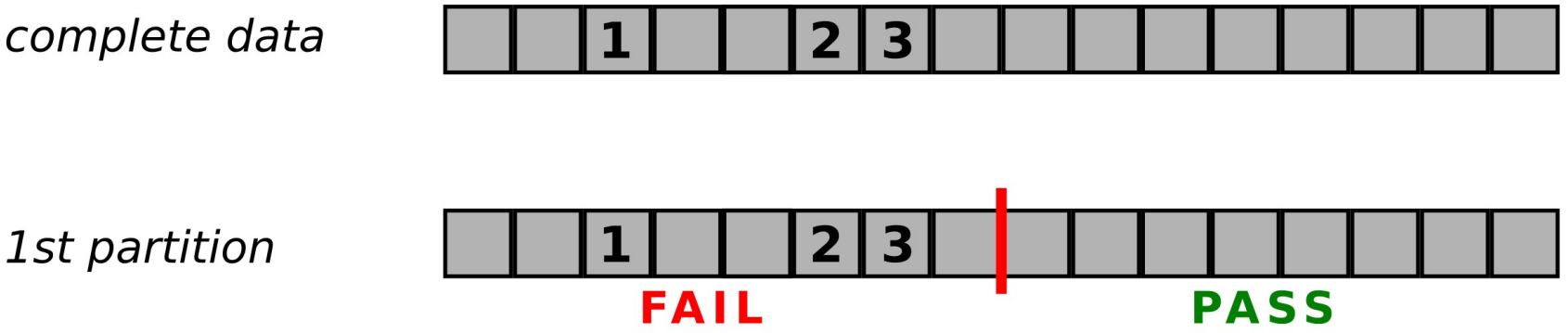
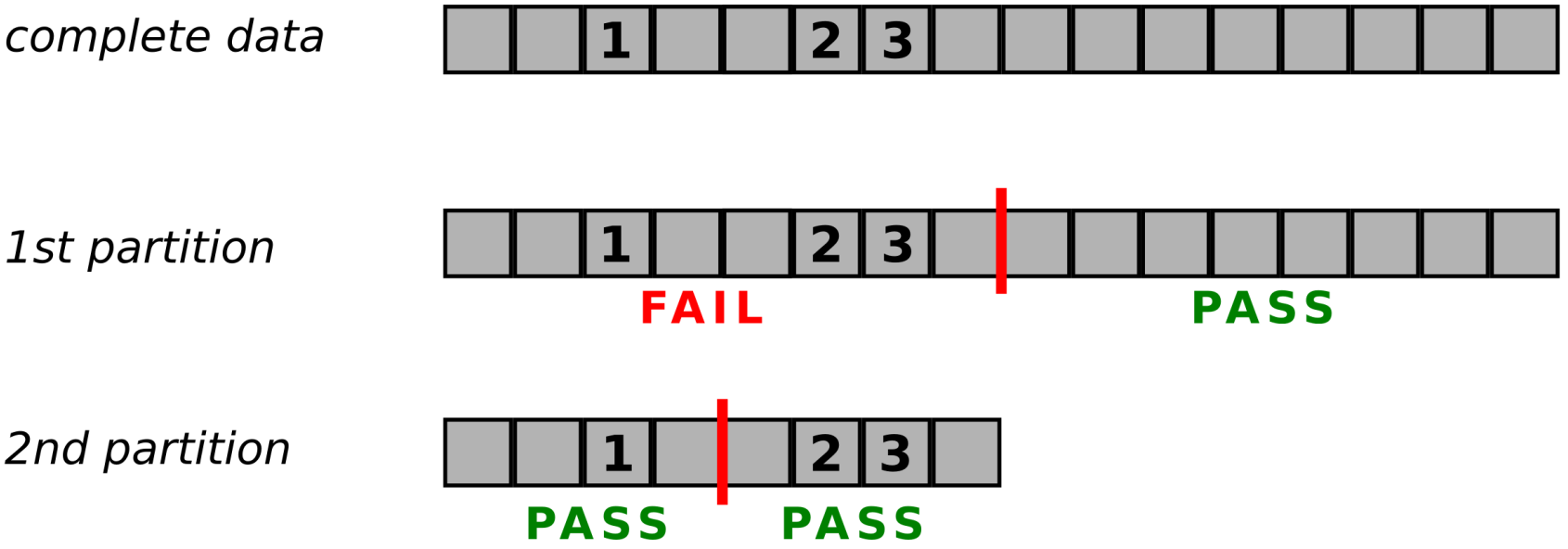
1, 2, 3 only fail together



1, 2, 3 only fail together



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1, 2, 3 only fail together

after 1st partition

re-partitioning (granularity=3)

FAIL

PASS

PASS

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1, 2, 3 only fail together

after 2nd partition

FAIL

3rd partition
(granularity=3)

PASS

PASS

PASS

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1, 2, 3 only fail together

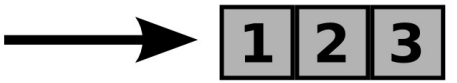
after 2nd partition

FAIL

3rd partition (granularity=4)

PASS

FAIL



PASS

PASS

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Partitioning data

with increasing granularity

is called Delta Debugging.

Delta Debugging results in a minimal failing subset

Time Complexity

Best case:

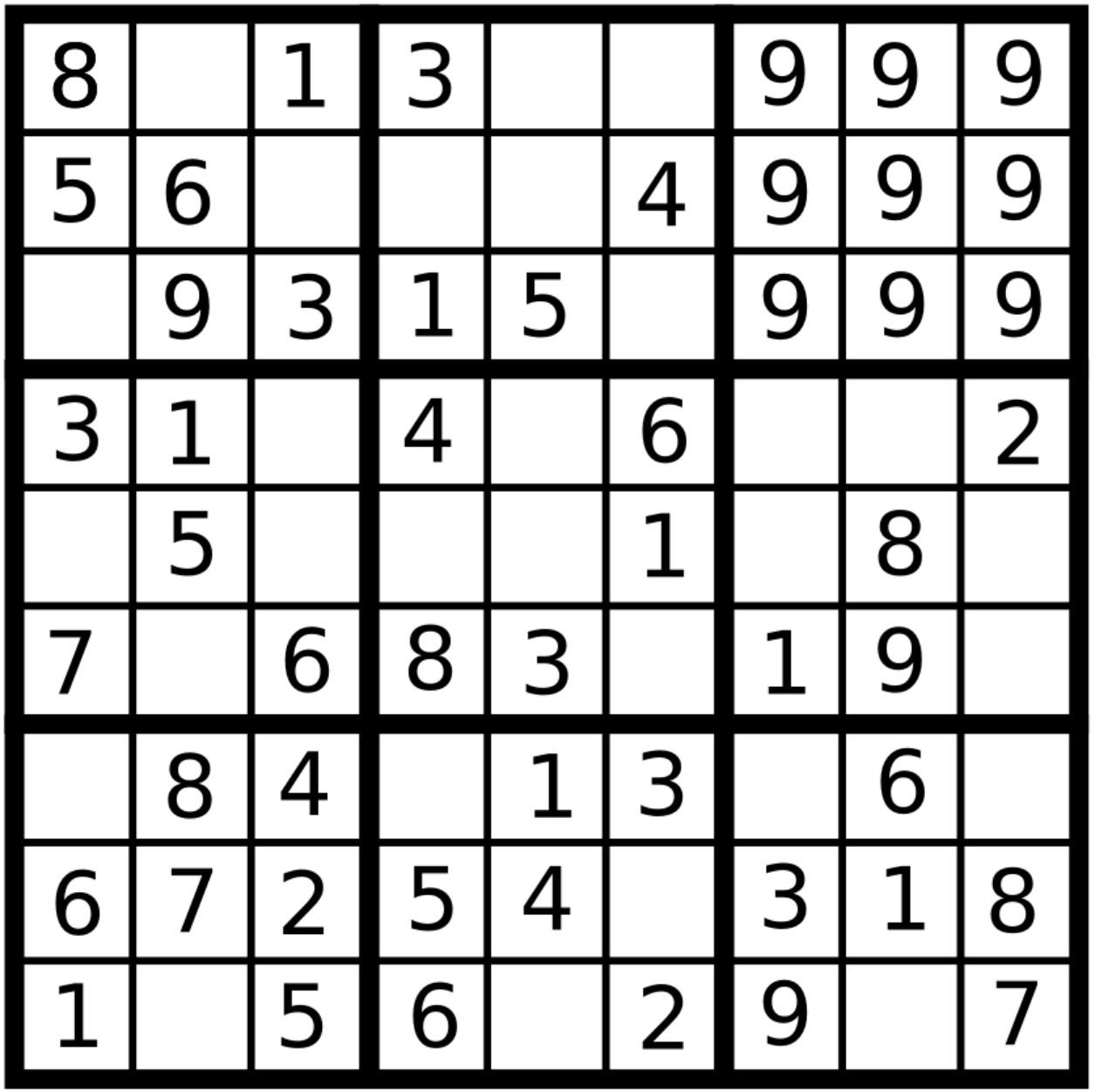
all fail

O(log n)

Worst case:

all pass

O(n)


8 1 3 9 9 9
5 6 4 9 9 9
9 3 1 5 9 9 9
3 1 4 6 2
5 8
7 6 8 3 1 9
8 4 1 3 6
6 7 2 5 4 3 1 8
1 5 6 2 9 7

Delta Debugging

Pros

- Does not require knowlede about the nature of the bug
- Works on any iterable type
- Works well with random tests
- Related approach used by `git bisect`

Cons

- You need a test first
- Partitions must not have side effects
- Few examples documented since 1999
- Does not give the **union** of failing subsets

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Partitioning data

with increasing granularity

is called Delta Debugging.

Delta Debugging results in a minimal failing subset

for any partitionable type

(HTML, key strokes, git commits, Sudoku)

Source code and references

github.com/krother/delta_debug

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Debugging Techniques

A biased and incomplete enumeration

Debug	Test	Analyze	Fail early
print	unittest	pylint	data invariants
introspection	py.test	pyflakes	contracts
pdb	doctest	mypy	assertions
deduction	Jenkins	reviews	logging
git bisect	Selenium	Z-notation	loop invariants

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