

# Node.js应用中并发缺陷实证研究

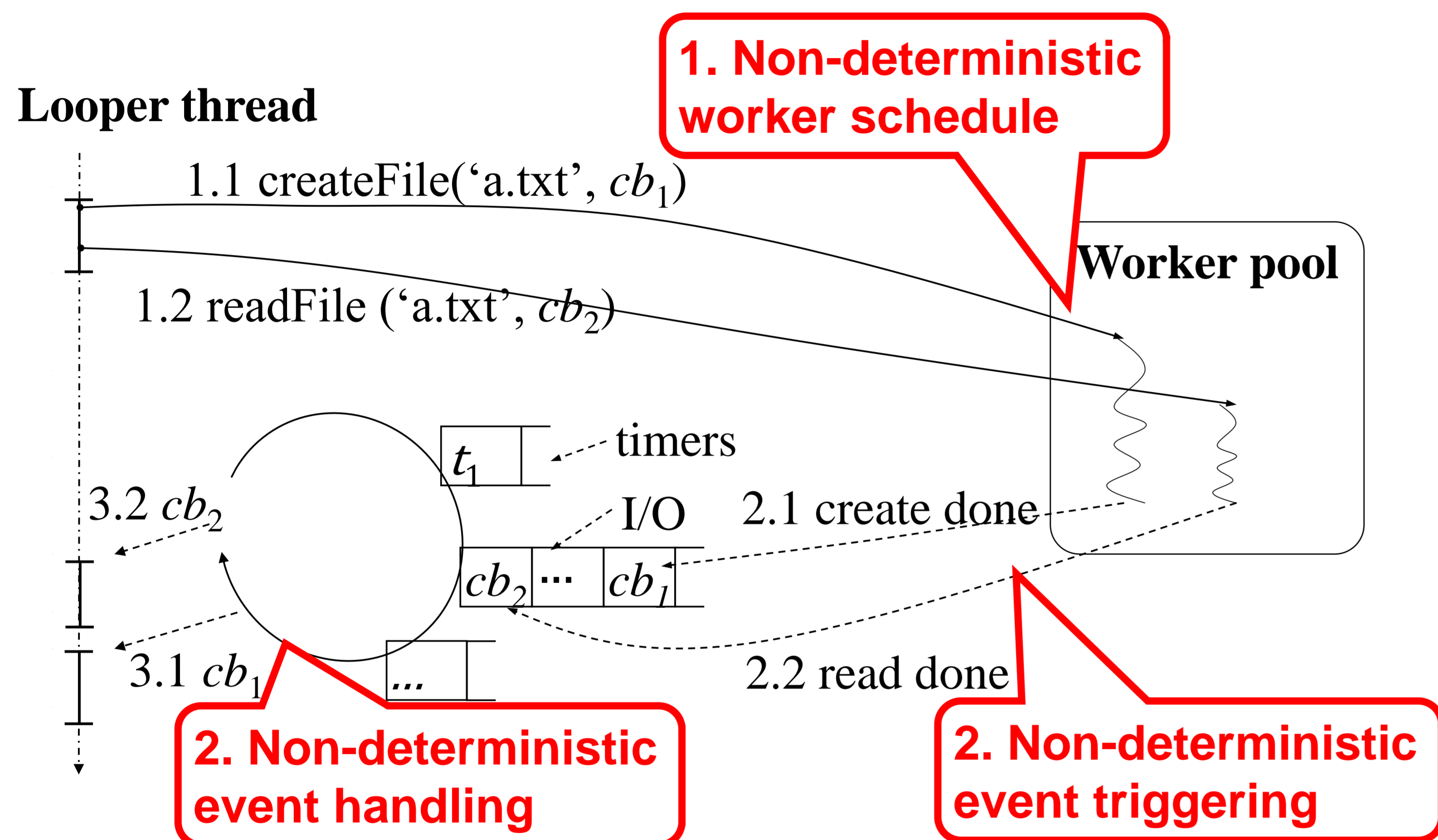
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A Comprehensive Study on Real World Concurrency Bugs in Node.js, ASE 2017

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## Concurrency Bugs in Node.js and Study Methodology

### Non-determinism in Node.js



◆ Above non-determinism can cause concurrency bugs.

### Main research questions

- ✓ RQ1. What are common bug patterns of concurrency bugs?
- ✓ RQ2. How are concurrency bugs triggered?
- ✓ RQ3. How do developers fix concurrency bugs?

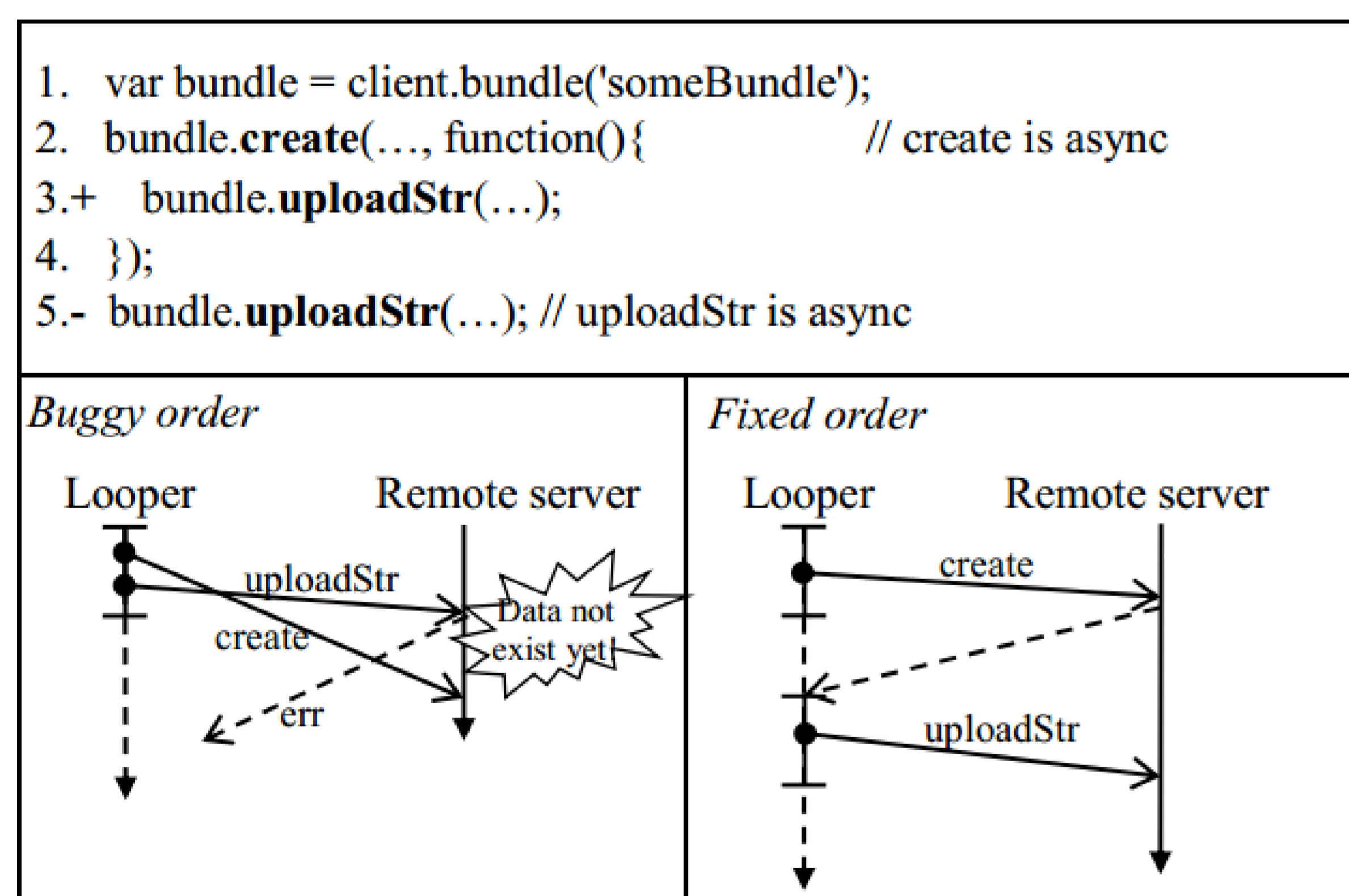
### Studied concurrency bugs

- ✓ Search bug reports from Node.js projects in GitHub
  - Keywords: concurrent, race, atomic, etc.
  - Bug state: closed
- ✓ Extract bug information from bug reports
  - Source: bug description, developer comments, patches
- ✓ Keep concurrency bugs that can answer the above research questions

◆ 57 concurrency bugs from 52 Node.js projects.

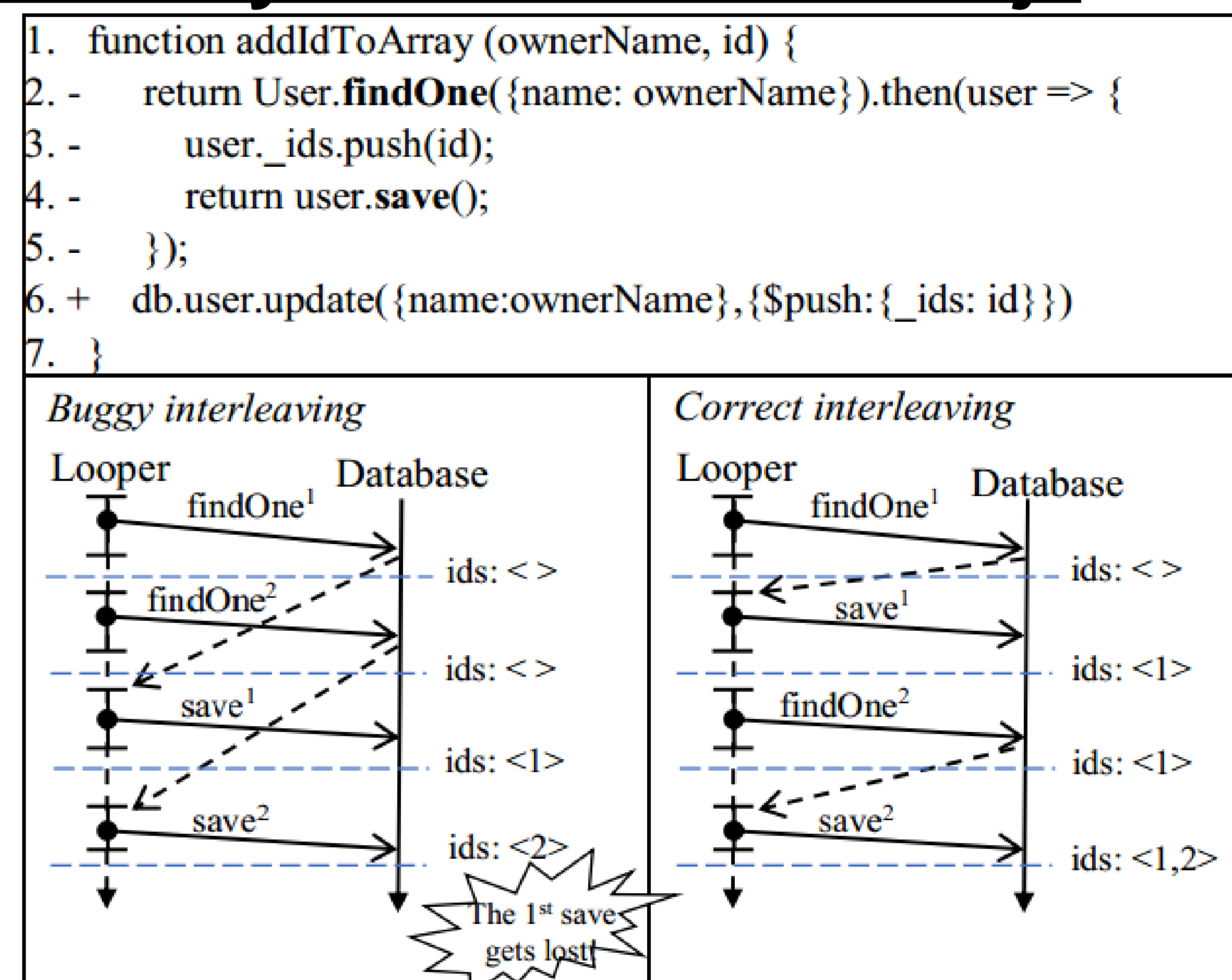
## Key Findings – Bug Patterns

### Order violation in Node.js



◆ The order intention between two events is violated.  
30% bugs are order violation.

### Atomicity violation in Node.js



◆ The atomic intention between two events is violated.  
65% bugs are atomicity violation.

## Key Findings – Bug Triggering and Fixing

### Bug triggering

Triggering scopes	Cases	#Bugs
Racing events	$\leq 4$	53
	$> 4$	4
Involved processes	1	54
	2	3
Racing resources	$\leq 1$	52
	$> 1$	5

◆ Most concurrency bugs involve no more than 4 racing events, 1 Node.js process and 1 racing resource.

### Fix patterns

Fix patterns	Order	Atomicity	Starvation	Total
Adding synchronization	7	7		14
Bypassing	5	9		14
Tolerance	1	4		5
Switching to atomic APIs		4		4
Ignoring/retrying	1	2		3
Moving code		2		2
Data privatization		2		2
Changing priority			3	3
Other	3	7		10

◆ Most concurrency bugs can be fixed by 8 fix patterns.