a place of mind

Electrical and Computer Engineering

DIEBA: DIAGNOSING INTERMITTENT ERRORS BY BACKTRACING APPLICATION FAILURES

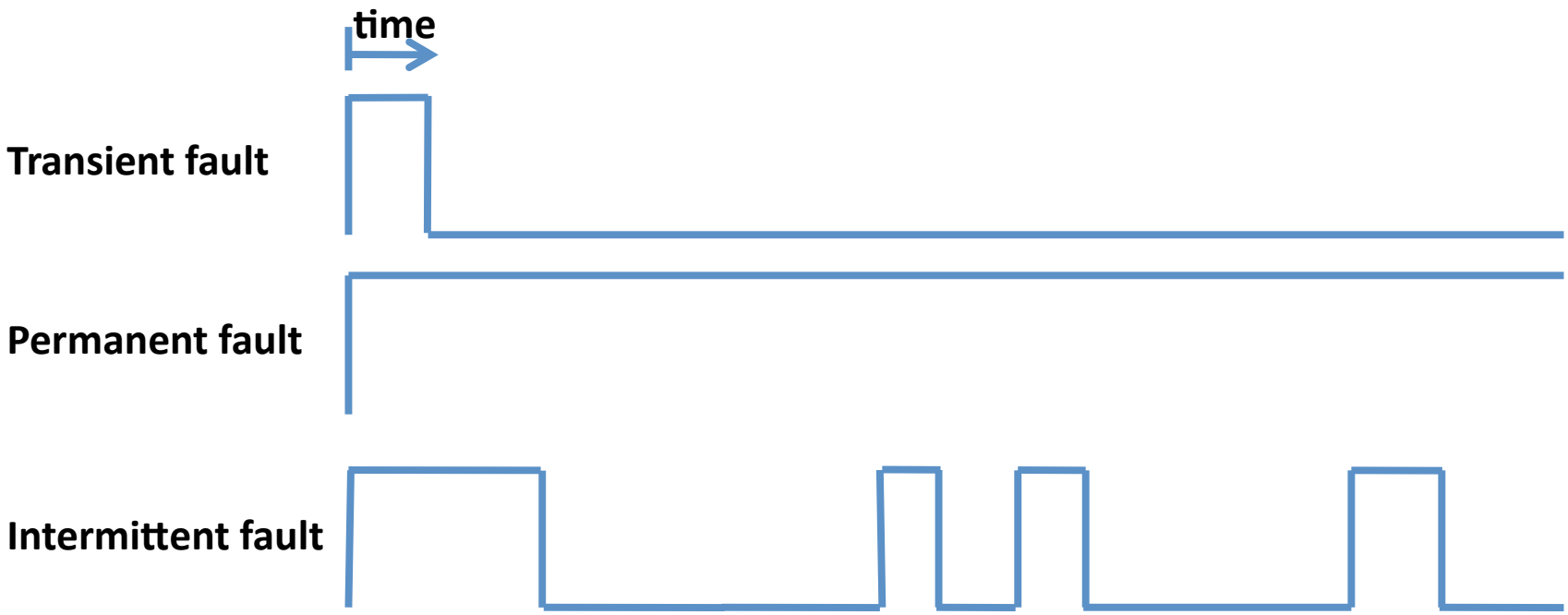
Layali Rashid, **Karthik Pattabiraman** and Sathish Gopalakrishnan

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

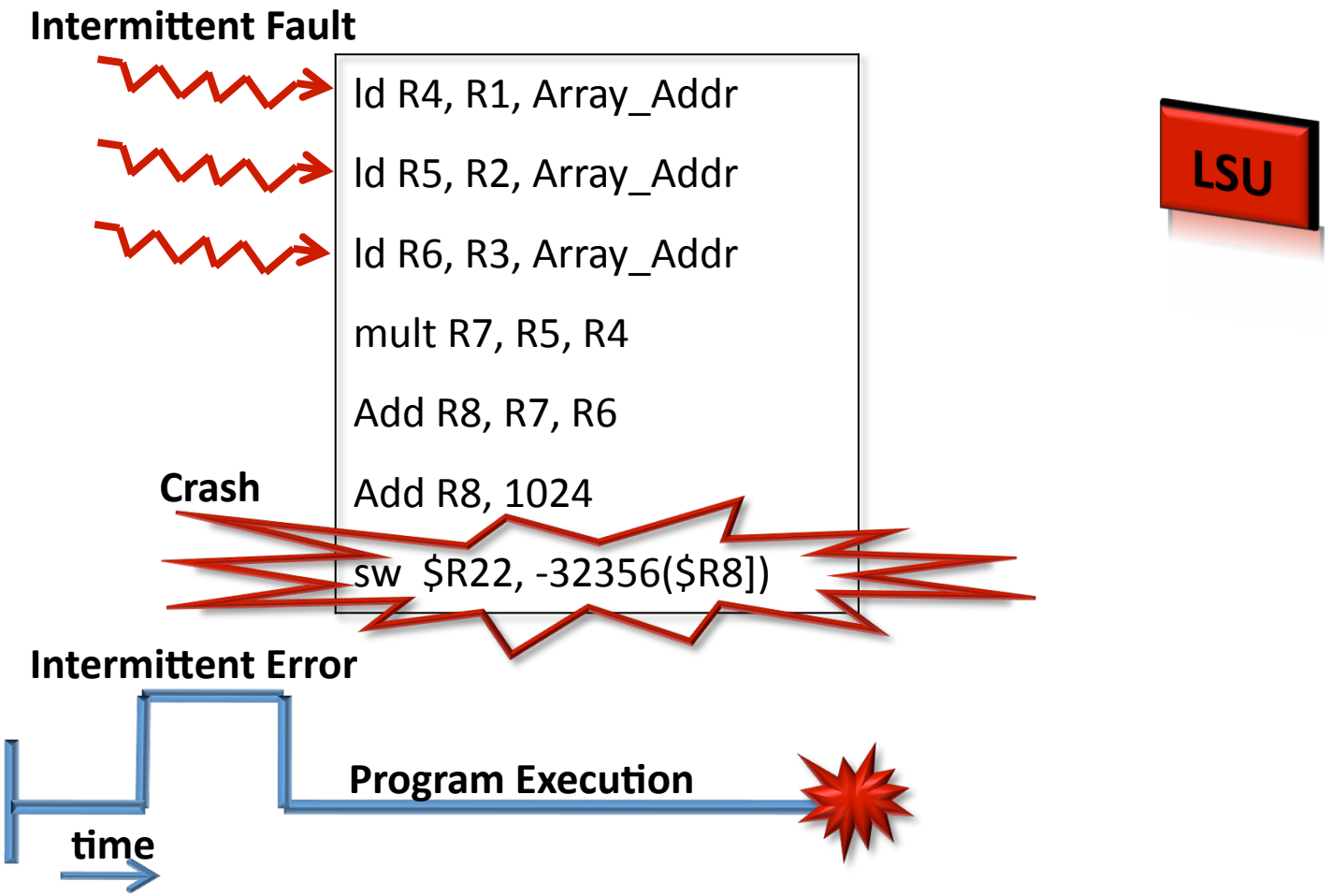
THE UNIVERSITY OF BRITISH COLUMBIA

Motivation: Why Intermittent Faults?

- 40% of the real-world failures in a processor caused by intermittent faults [Eurosys-2011]

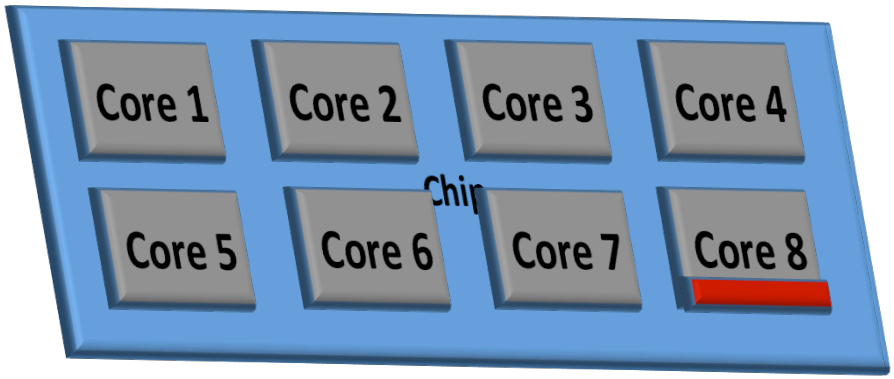


Motivation: Intermittent Errors Impact



Motivation: Why Diagnosis?

- Guide fine-grained recovery techniques
  - Higher throughput than disabling the entire core



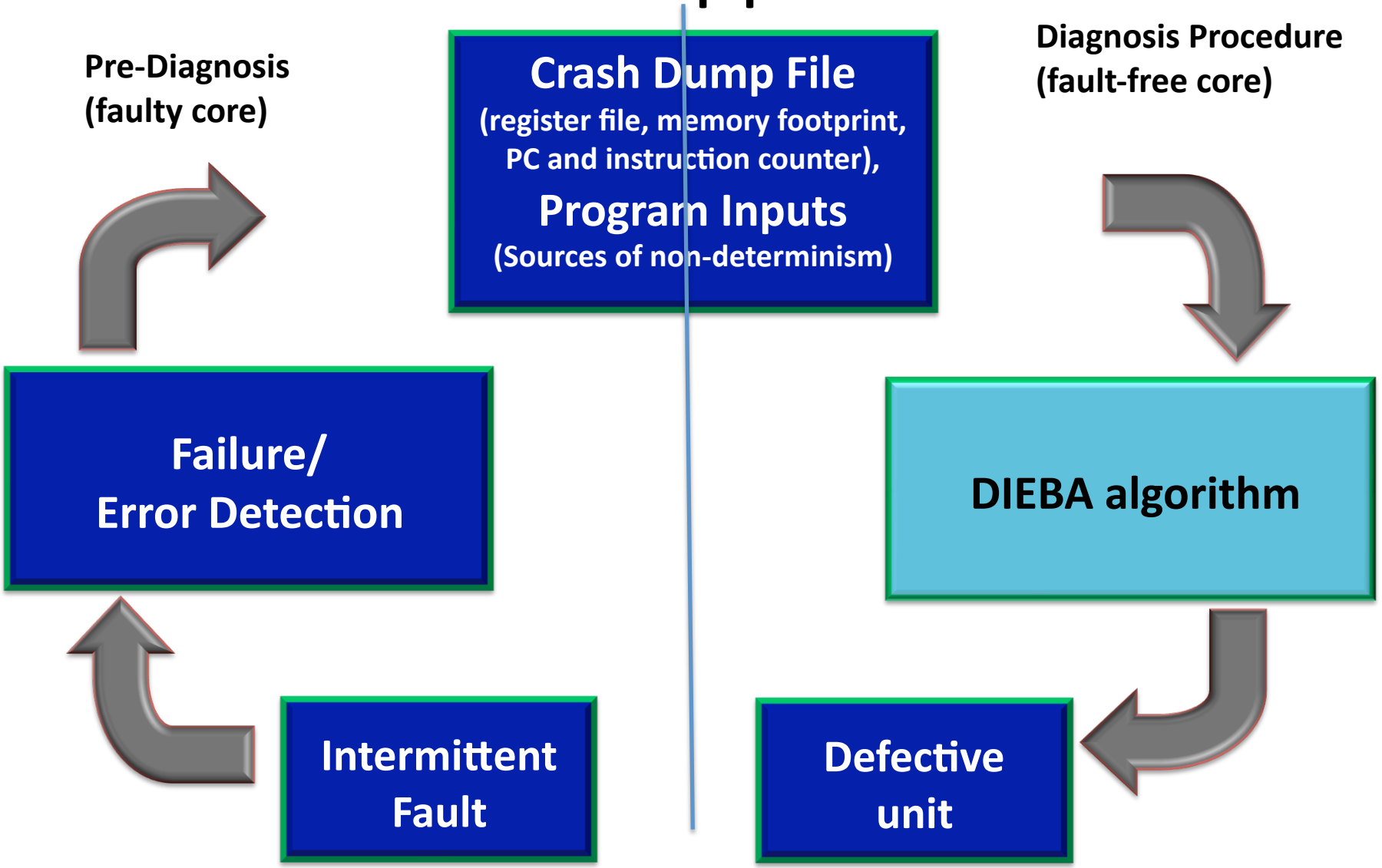
With fine-grained diagnosis if Core 8 becomes defective

Without fine-grained diagnosis if Core 8 is disabled

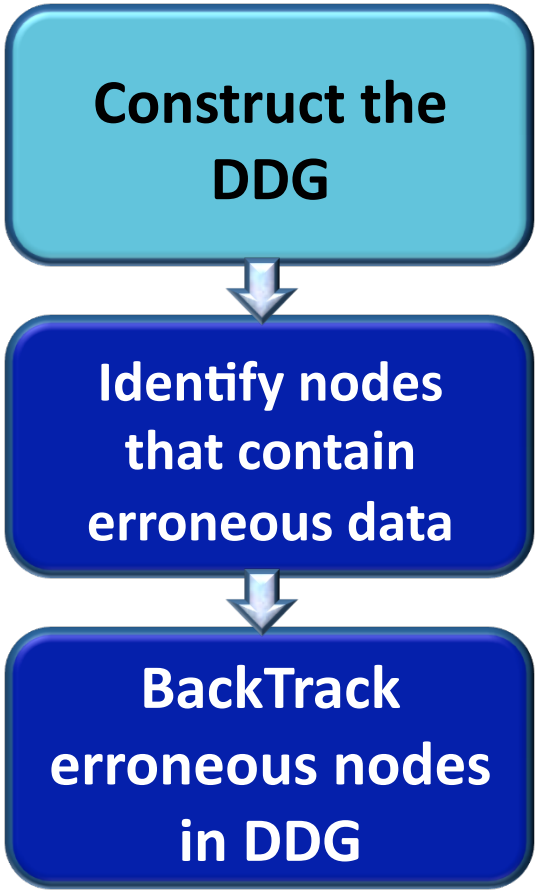
Motivation: Why Software Techniques?

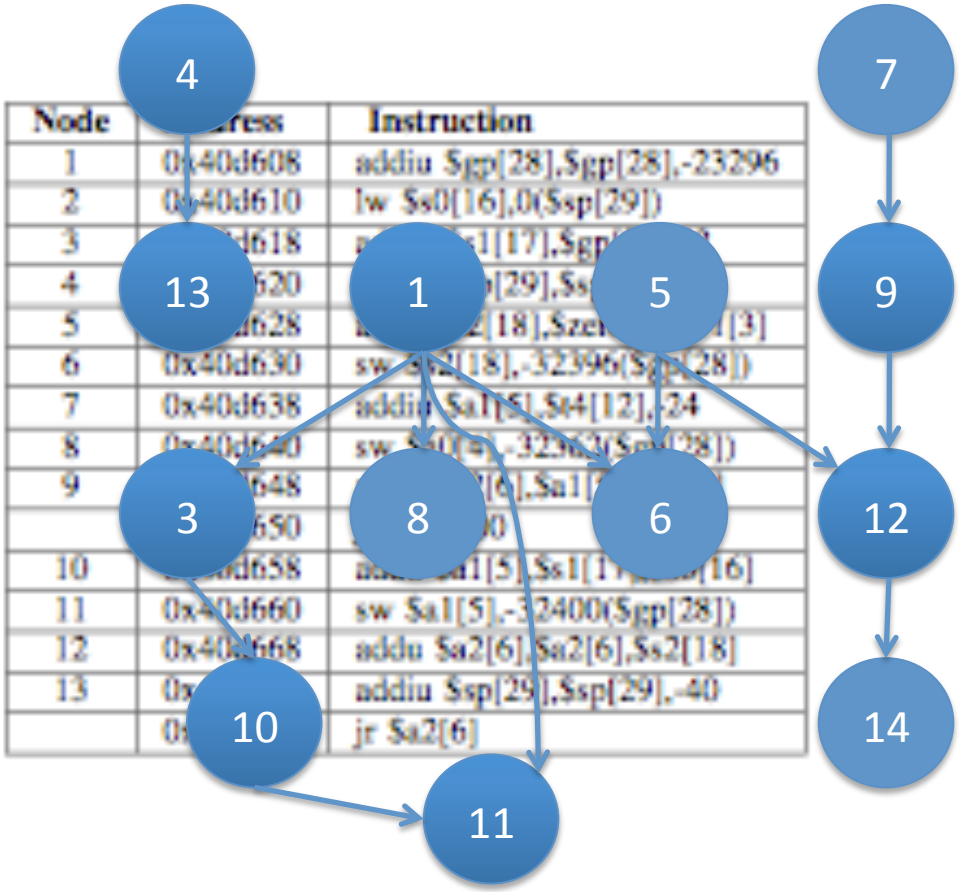
- ❑ Do not incur area overheads
- ❑ Architecturally portable
- ❑ Backward compatible
- ❑ Application-aware

DIEBA: Approach



DIEBA: Example

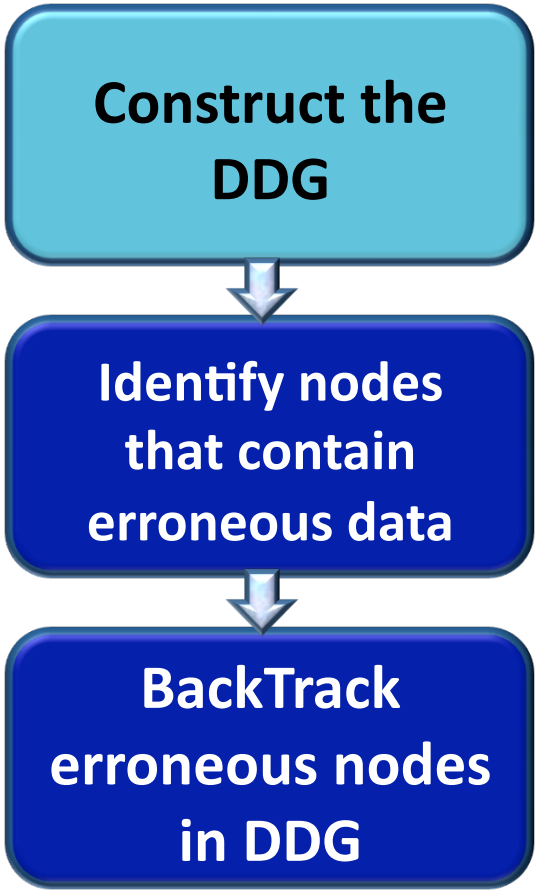


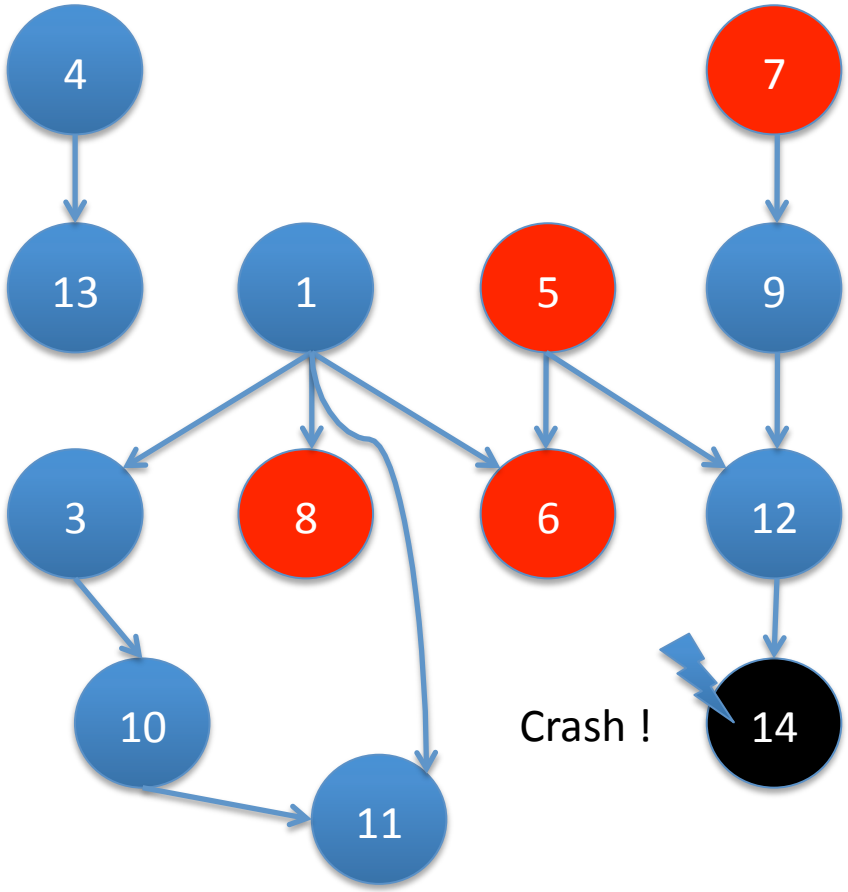


Node	ress	Instruction
1	0x40d608	addiu $gp[28],$gp[28],-23296
2	0x40d610	lw $s0[16],0($sp[29])
3	d618	
4	620	
5	d628	
6	0x40d630	
7	0x40d638	
8		
9	648	
	650	
10	d658	
11	0x40d660	sw $a1[5],-32400($gp[28])
12	0x40d668	addu $a2[6],$a2[6],$s2[18]
13	0x	addiu $sp[29],$sp[29],-40
	0x	jr $a2[6]

Nodes → Instructions. Edges → Dependencies

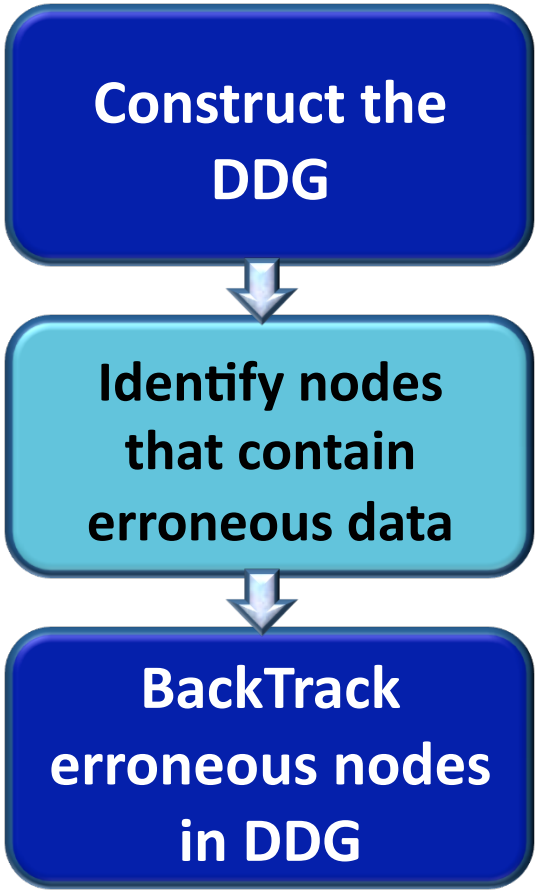
DIEBA: Example

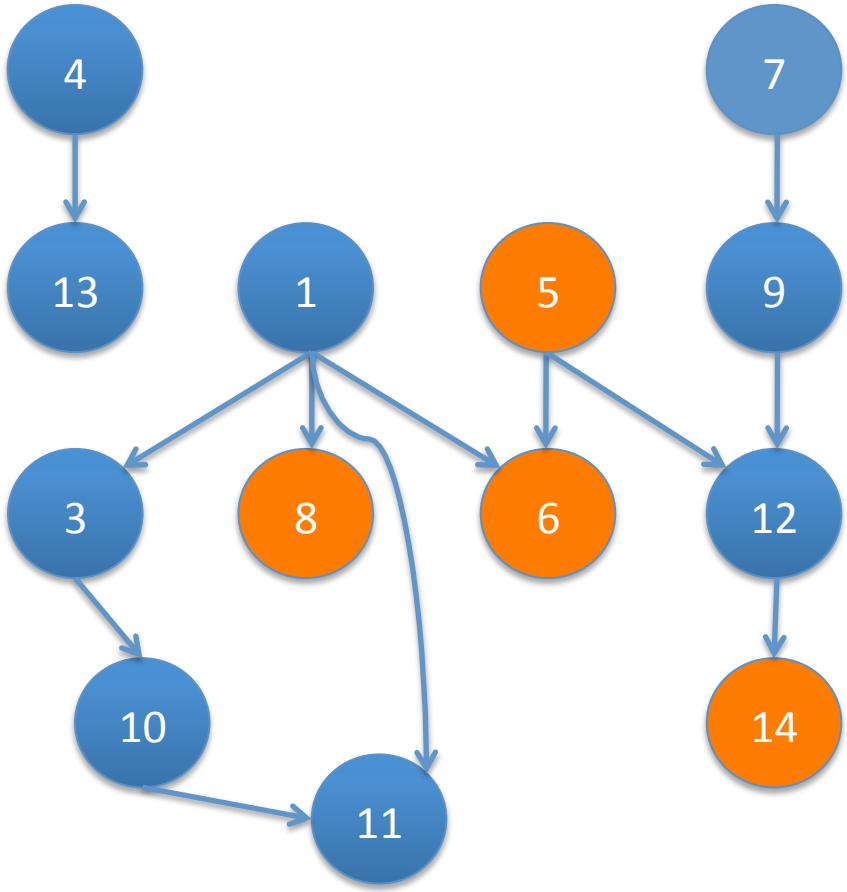




Assume intermittent fault affects nodes 5, 6, 7, 8.

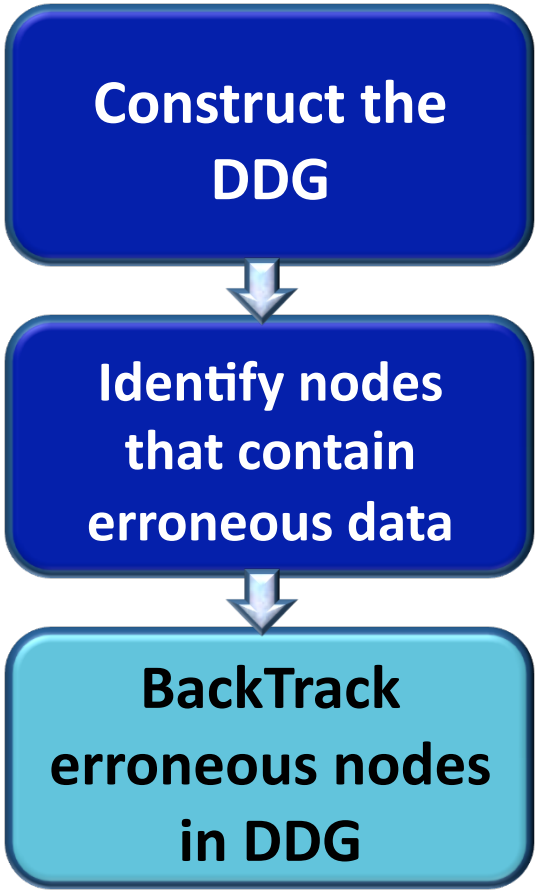
DIEBA: Example

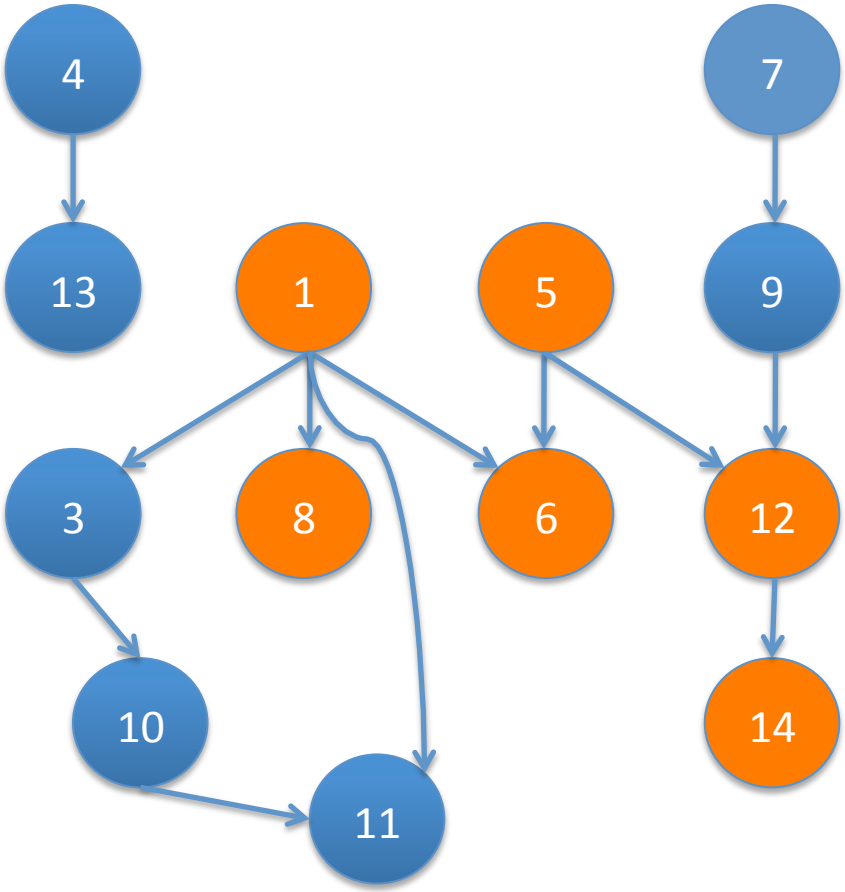




Nodes 5, 6, 8, 14 → Strong clues

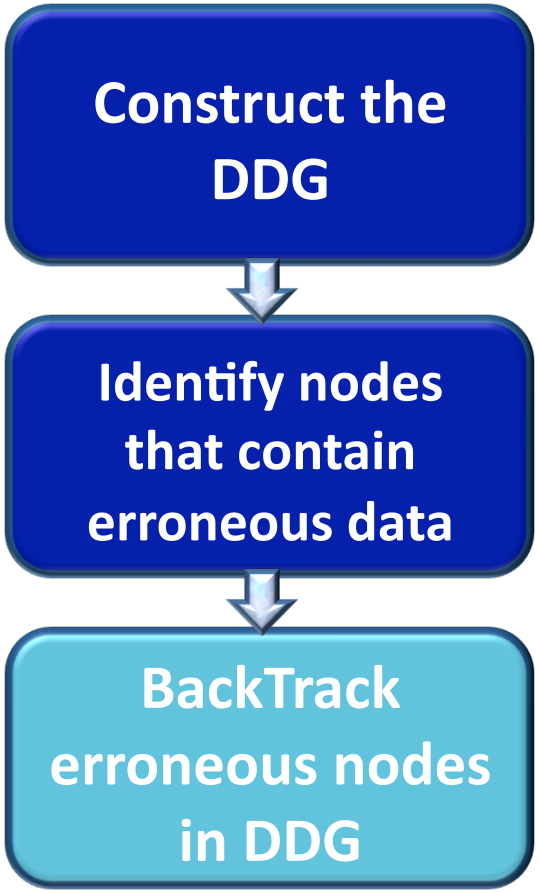
DIEBA: Example

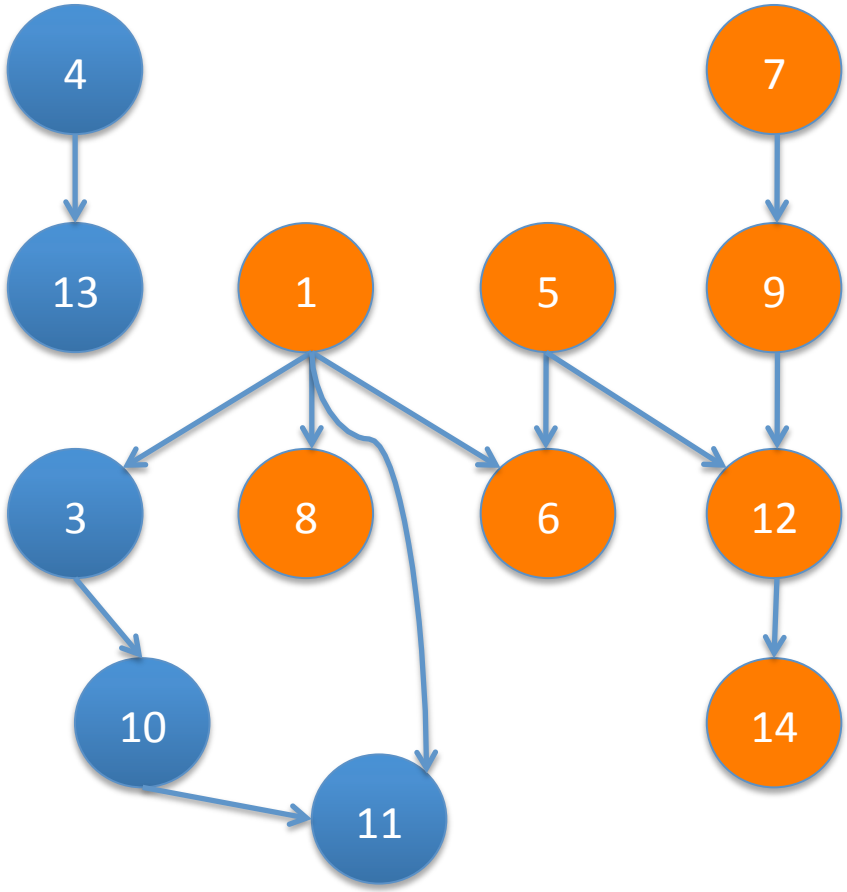




Nodes 1, 12 → Weak clues

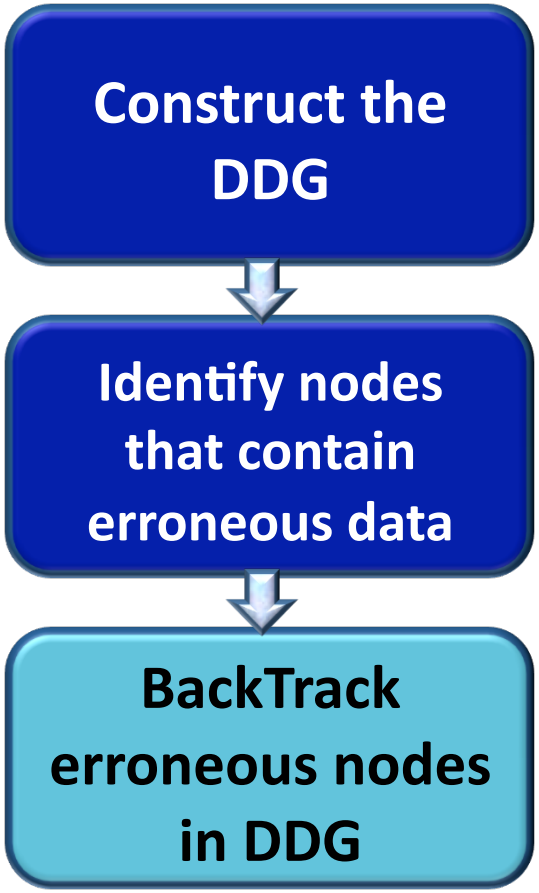
DIEBA: Example

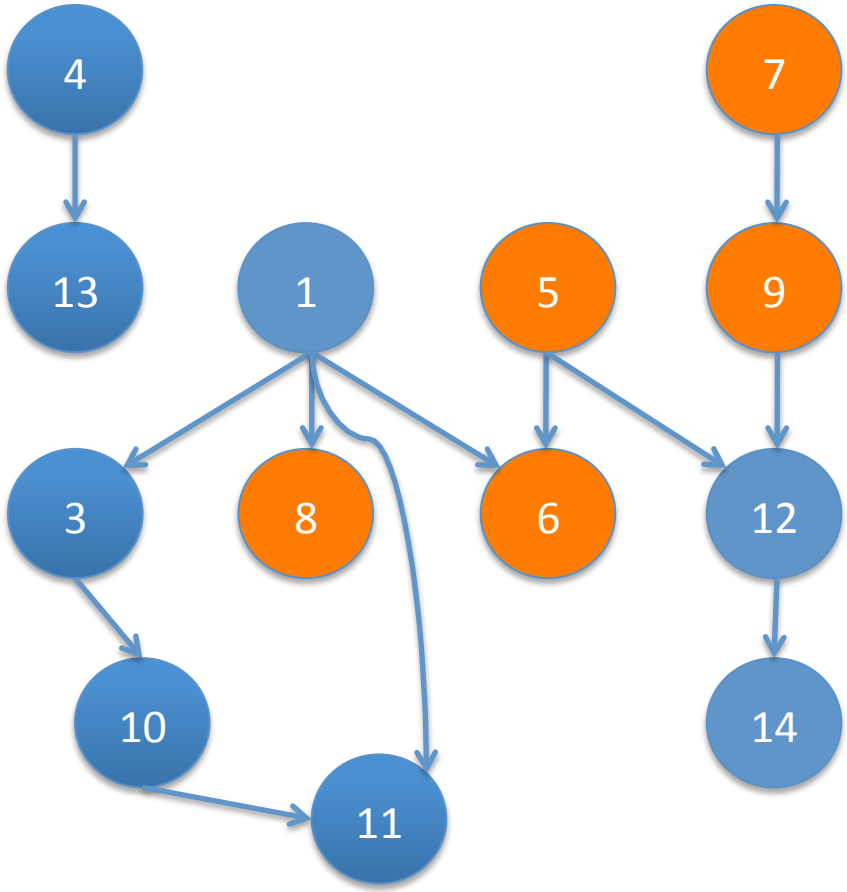




Nodes 1, 7, 9, 12 → Weak clues

DIEBA: Example

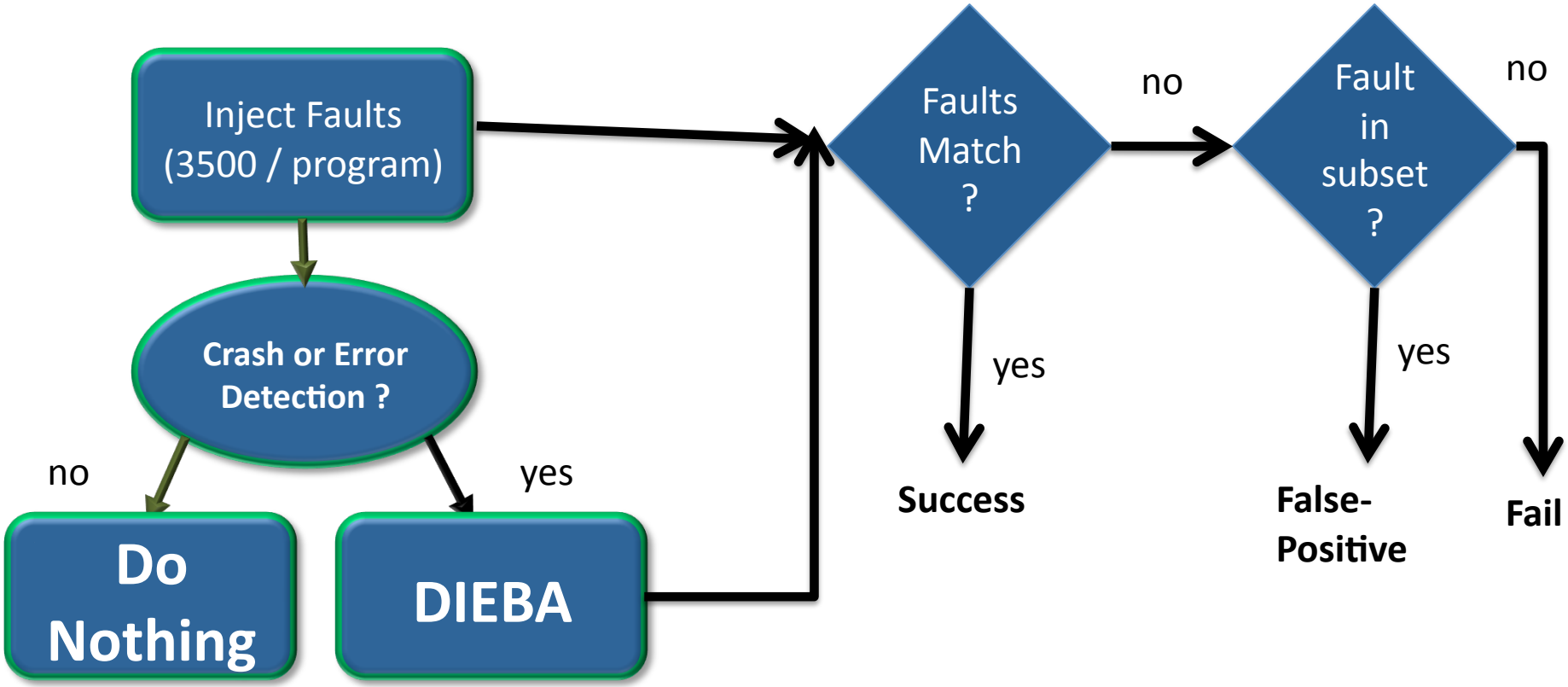




Nodes 5, 6, 7, 8, 9 → Diagnosis solution
Nodes 5, 6, 7, 8 → Original fault

Experimental Setup

- SPEC2006 benchmark suite – Chose 7 programs

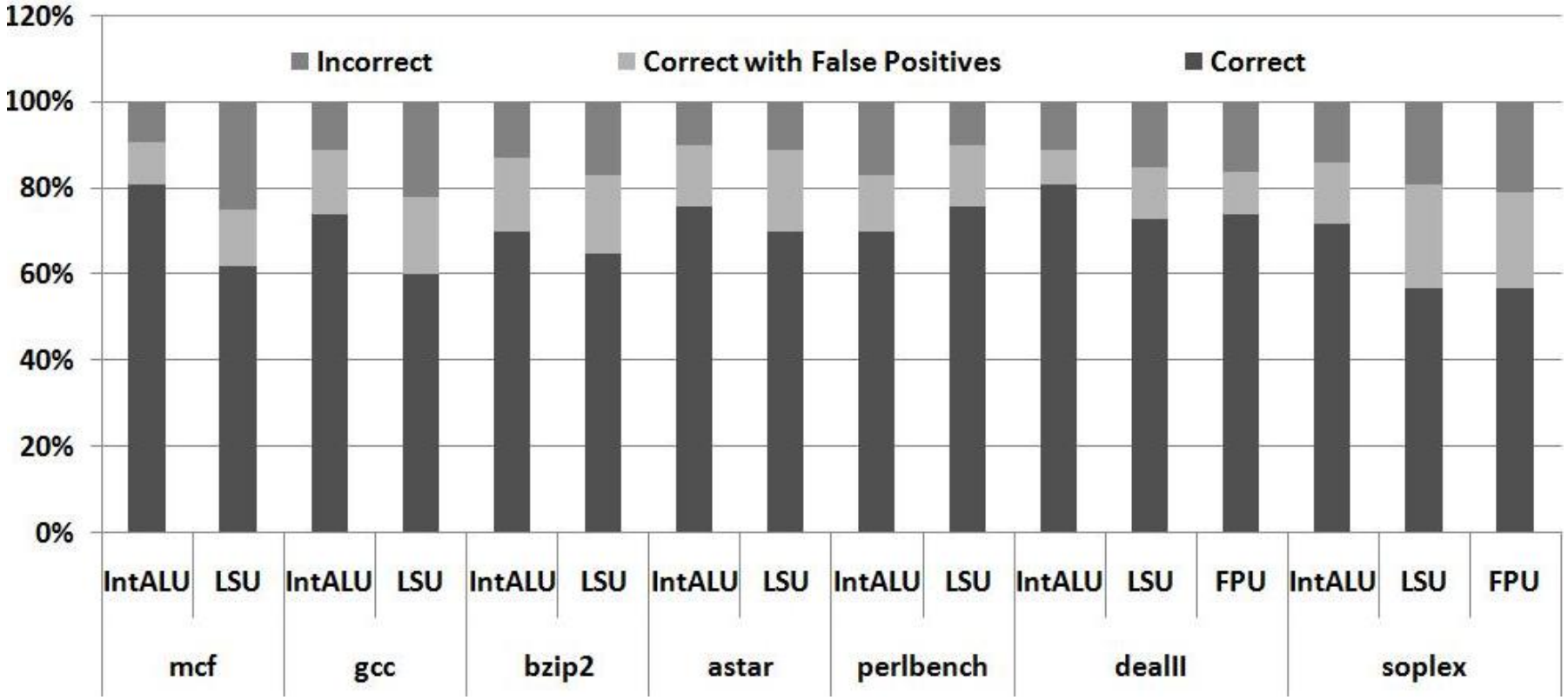


Fault Injection Parameters

- Injections into micro-architectural model
  - Simoutorder simulator with error detection

Fault Parameter	Value/Range
Location-bit	A bit chosen randomly from 0 to 63 in a microarchitectural unit.
Location-unit	Integer ALU, multiplier, divider, LSU (data, read address, write address), FPU
Start cycle	A cycle chosen randomly from 1 to 1,000,000
Duration	5, 50, 100, 500, 10,000 or 20,000 cycle
Model	Stuck-at-one/zero/last-value and Dominant-0/1

Evaluating DIEBA's Accuracy



- 70% of the cases are diagnosed successfully .
- 15% of the cases have false positives.

Conclusion

- DIEBA is a software-only technique for diagnosing intermittent errors based on application failures
- DIEBA diagnoses 70% of the crash-causing errors and error detections in functional units
- Future work: Fine grained recovery techniques