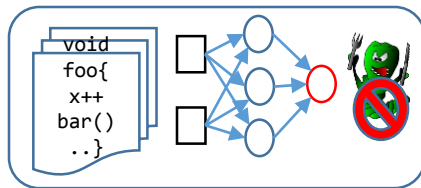


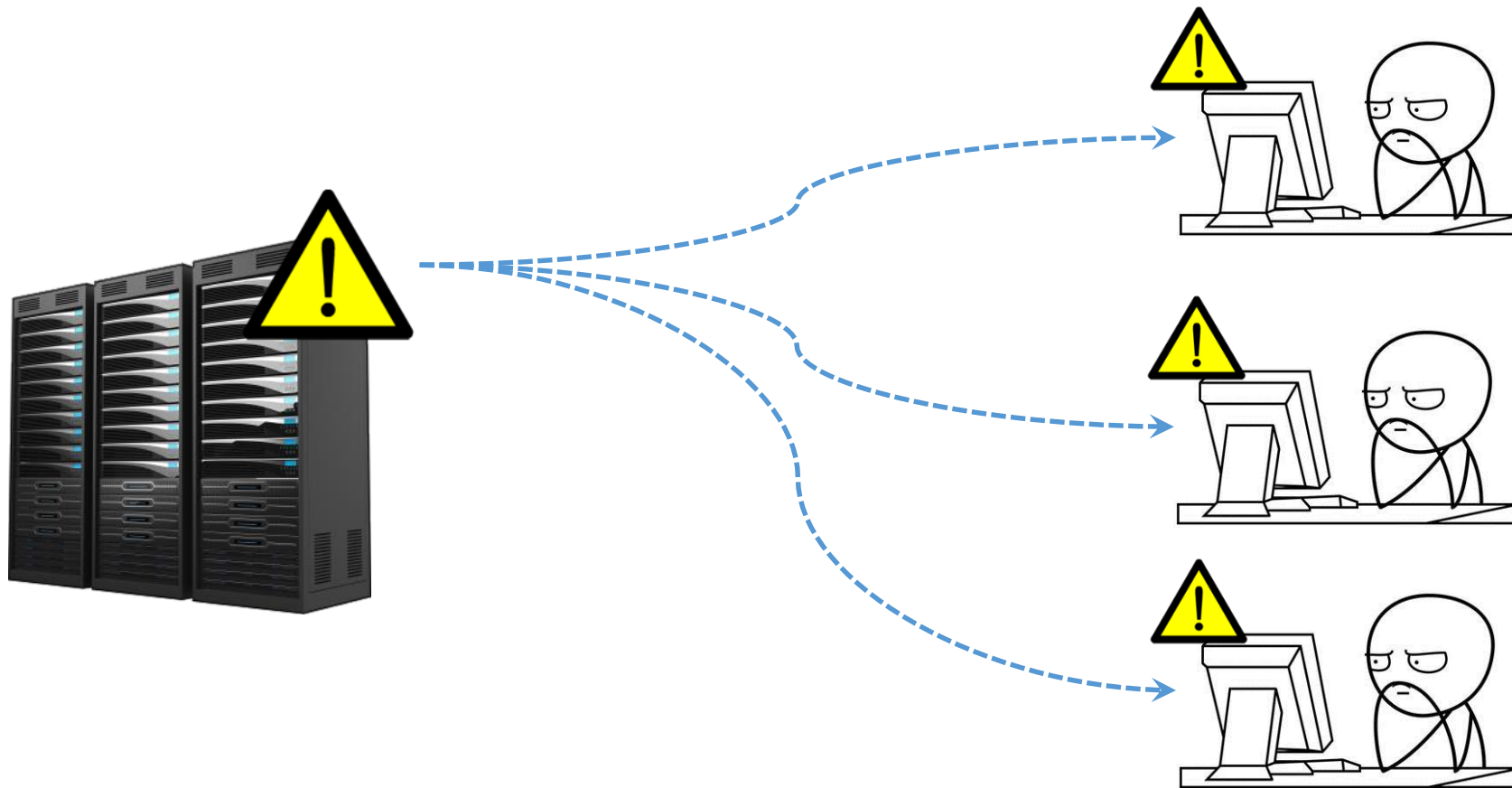
Production-Run Software Failure Diagnosis via A d a p t i v e C o m m u n i c a t i o n T r a c k i n g

Mejbah ul Alam, Abdullah Muzahid

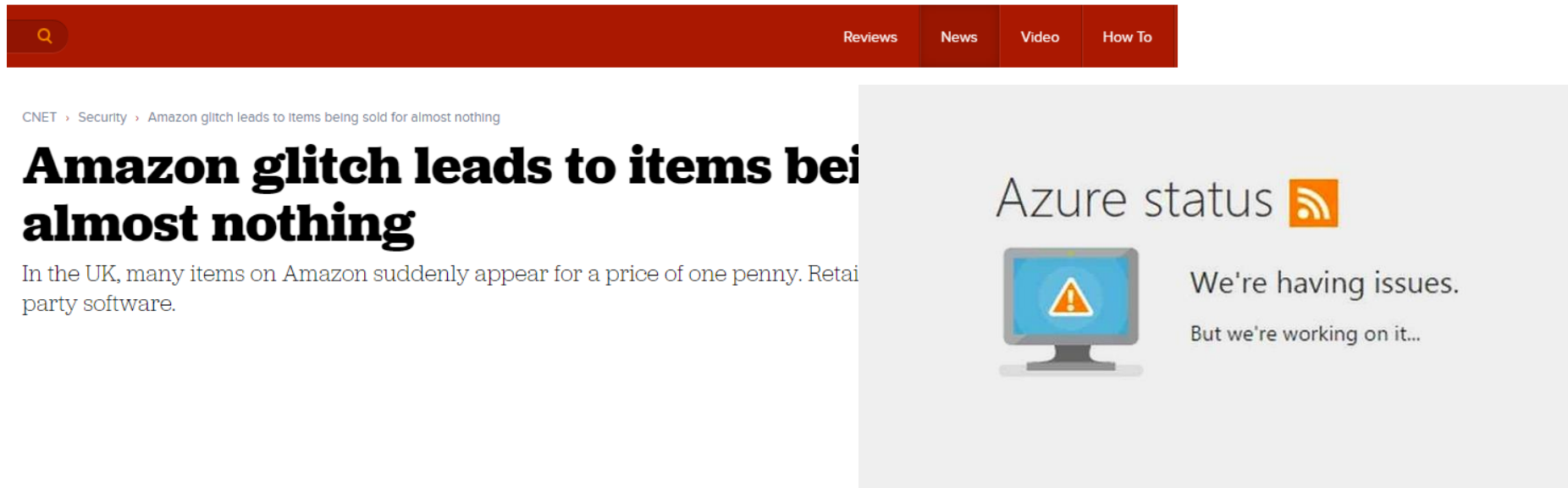
University of Texas at San Antonio



Production-run software failures are widespread and expensive



Production-run software failures are widespread and expensive




The image shows two overlapping screenshots. The top-left screenshot is a news article from CNET with the headline "Amazon glitch leads to items being sold for almost nothing". The top-right screenshot is an Azure status page with a warning icon on a monitor and the text "We're having issues. But we're working on it..".

CNET › Security › Amazon glitch leads to items being sold for almost nothing

Amazon glitch leads to items being sold for almost nothing

In the UK, many items on Amazon suddenly appear for a price of one penny. Retailer blames third-party software.

Azure status



We're having issues.
But we're working on it..

Quick failure analysis



I see no bug here!



*How to **reproduce** the bug?*

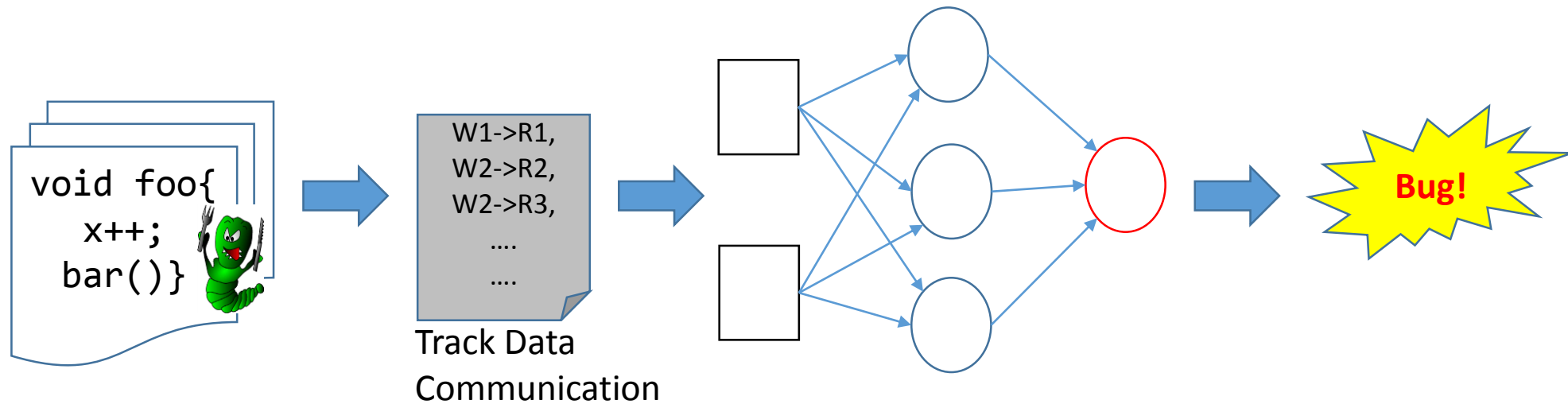


*Need to analyze the **new code***



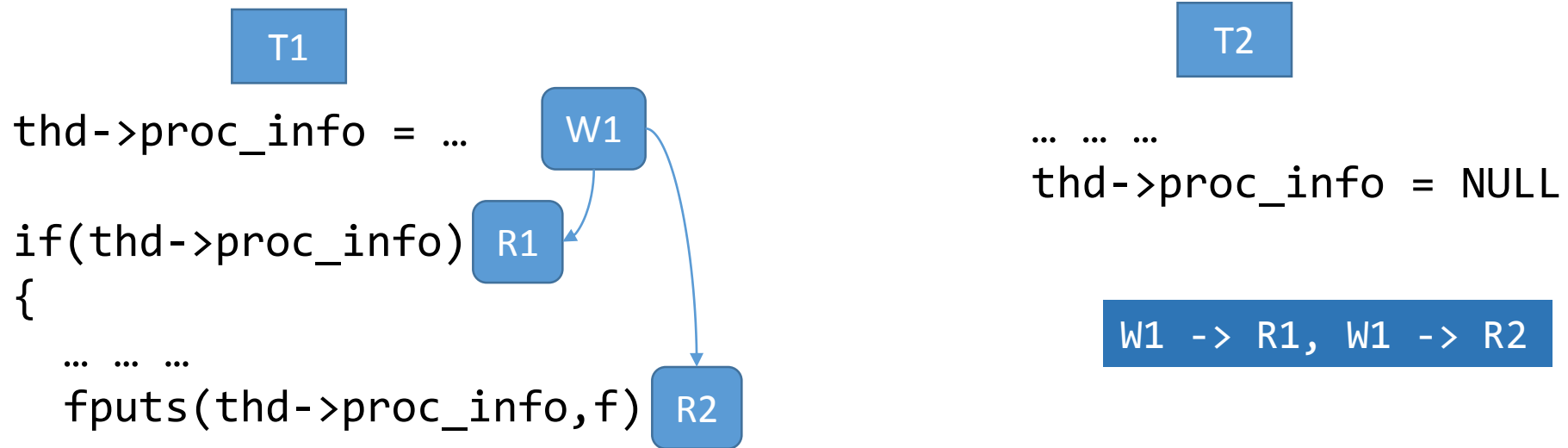
ACT

Hardware Neural Network for Failure Diagnosis



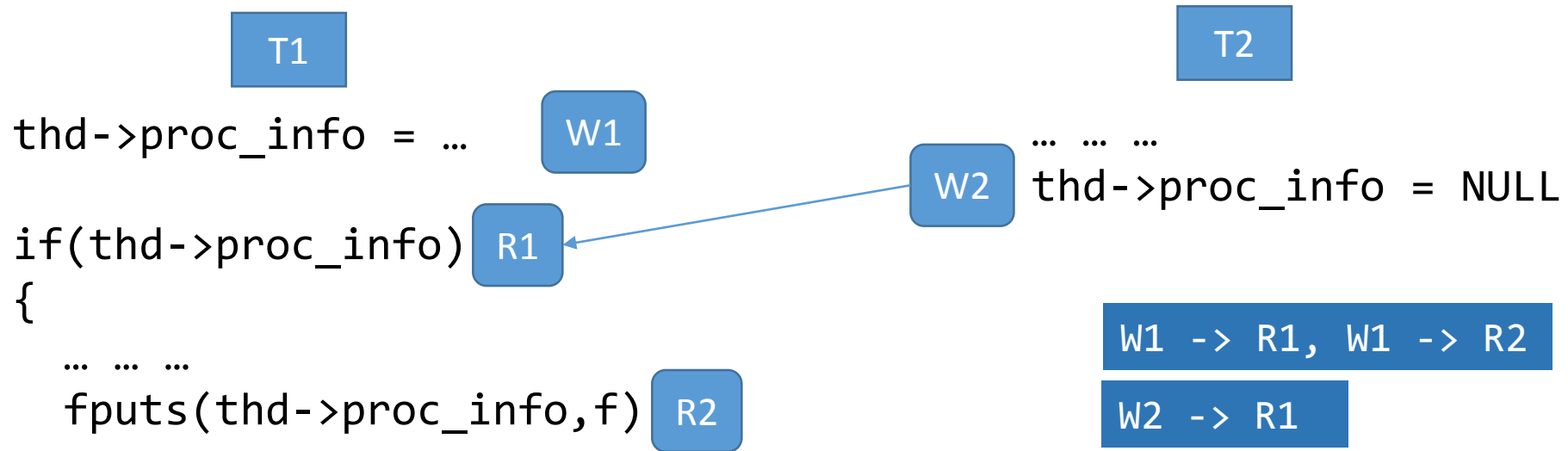
Communication Tracking for Failure Analysis

Bug in *MySQL*



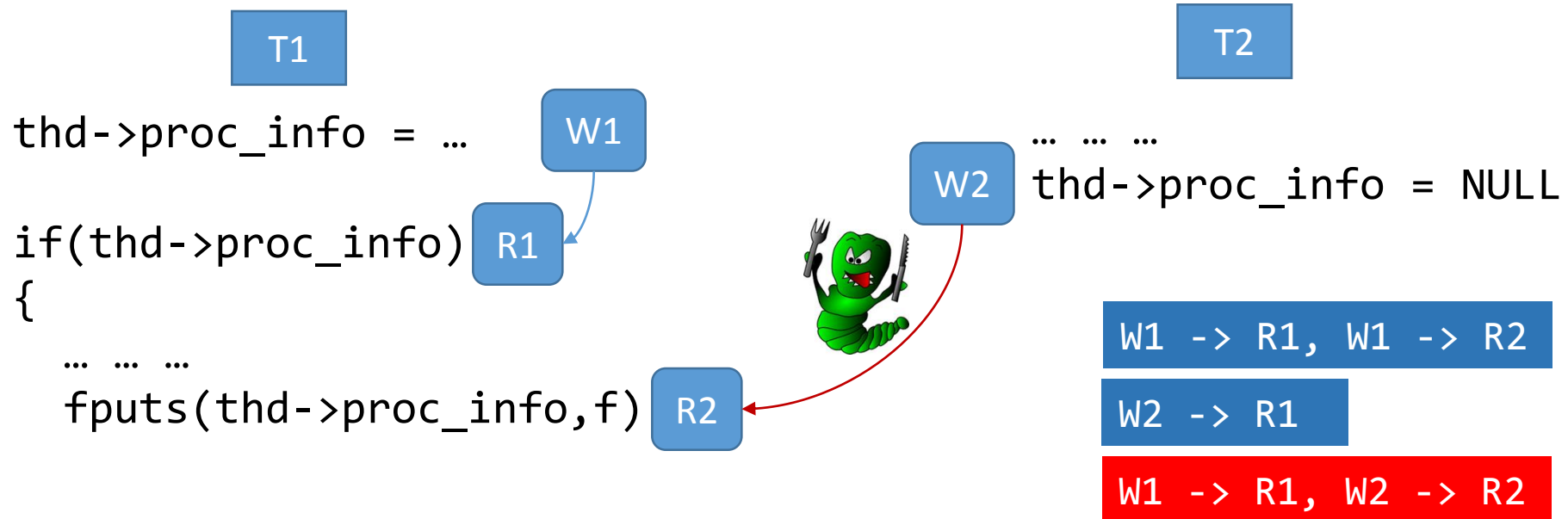
Communication Tracking for Failure Analysis

Bug in *MySQL*

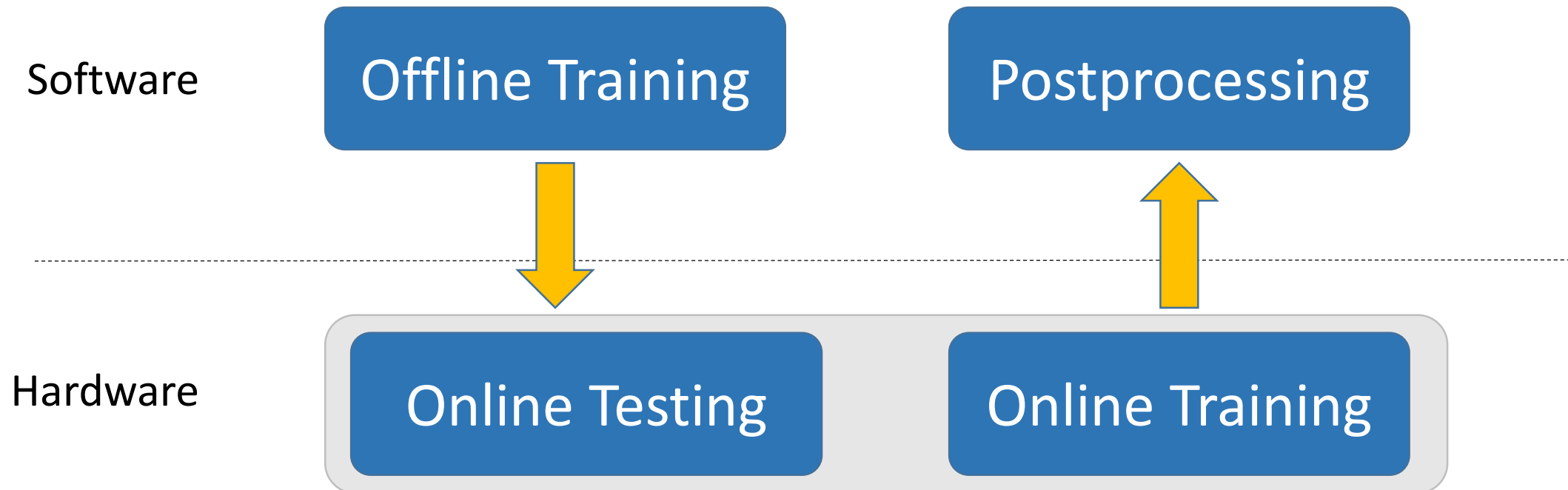


Communication Tracking for Failure Analysis

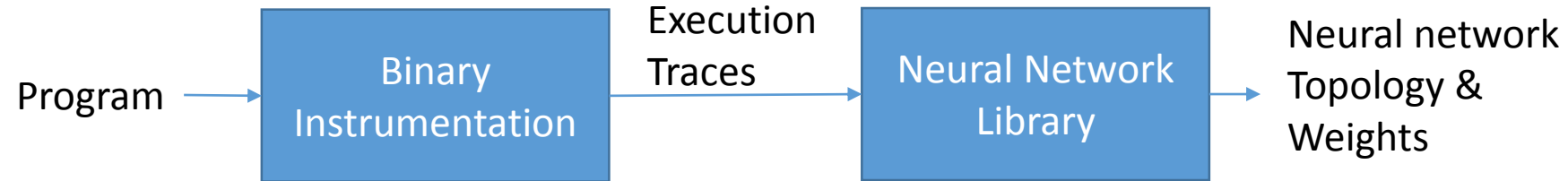
Bug in *MySQL*



How ACT Works

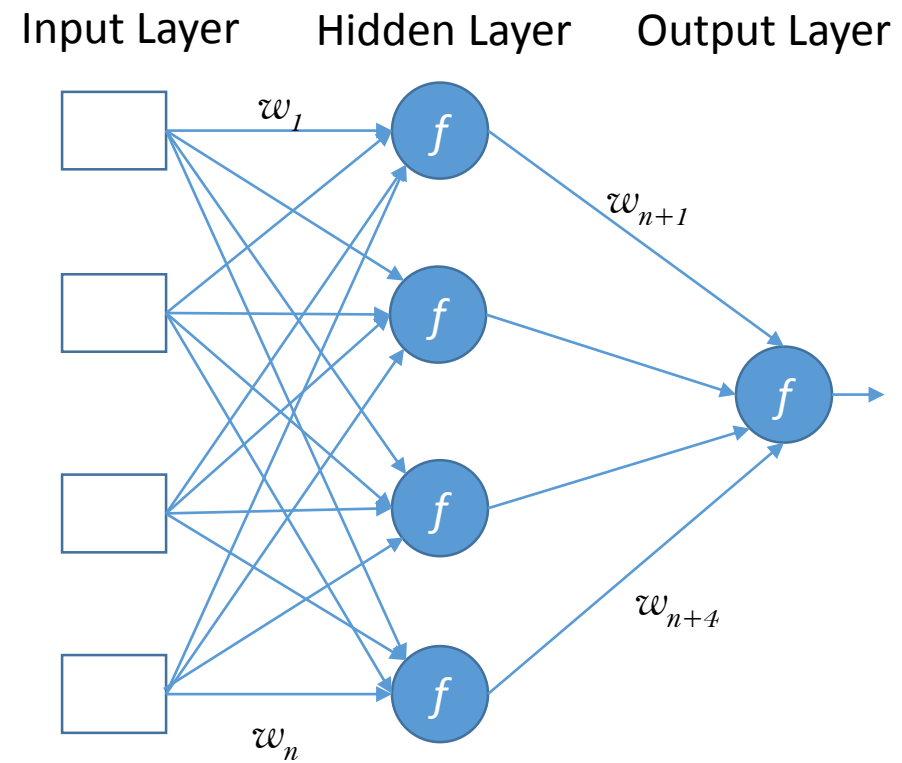


Offline Training

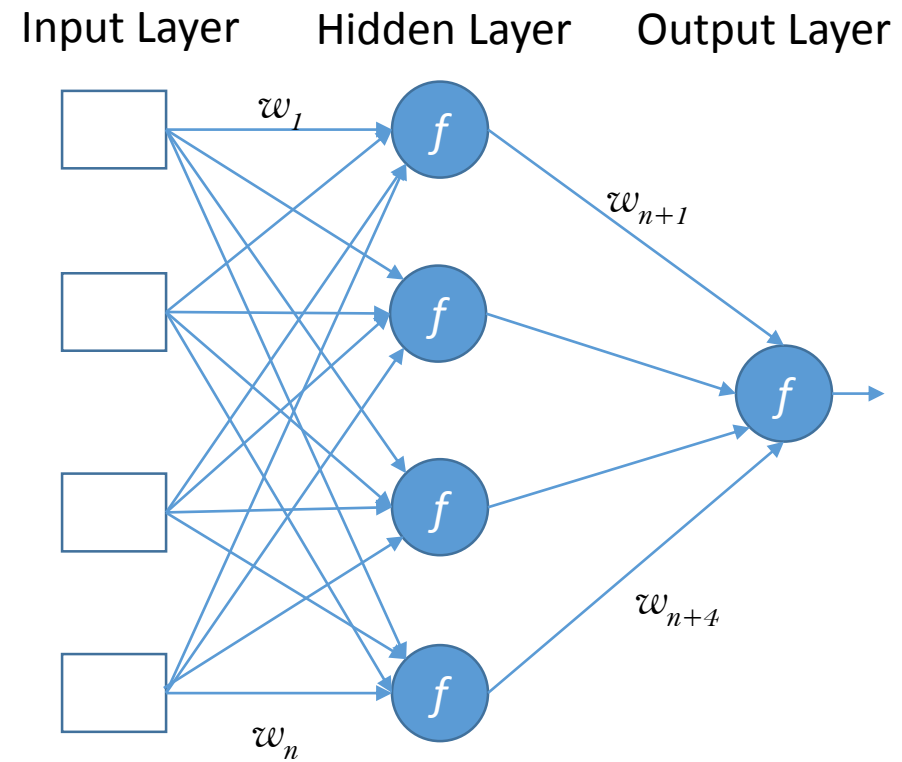
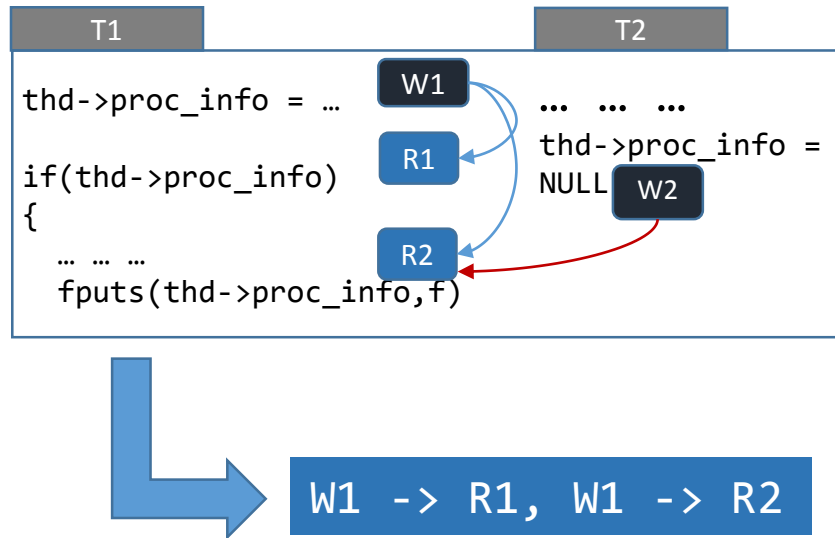


- Collection of execution traces
- Sequence of Read After Write(**RAW**) dependences
- Input vector of **N RAW** dependences
- Train different topologies

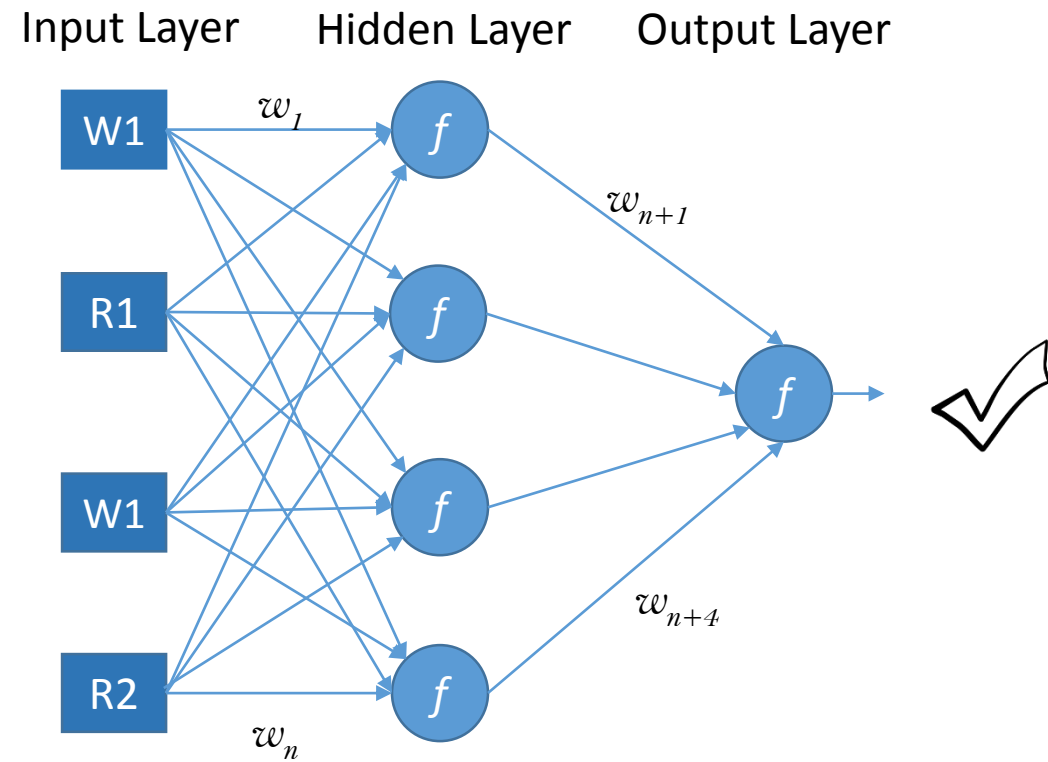
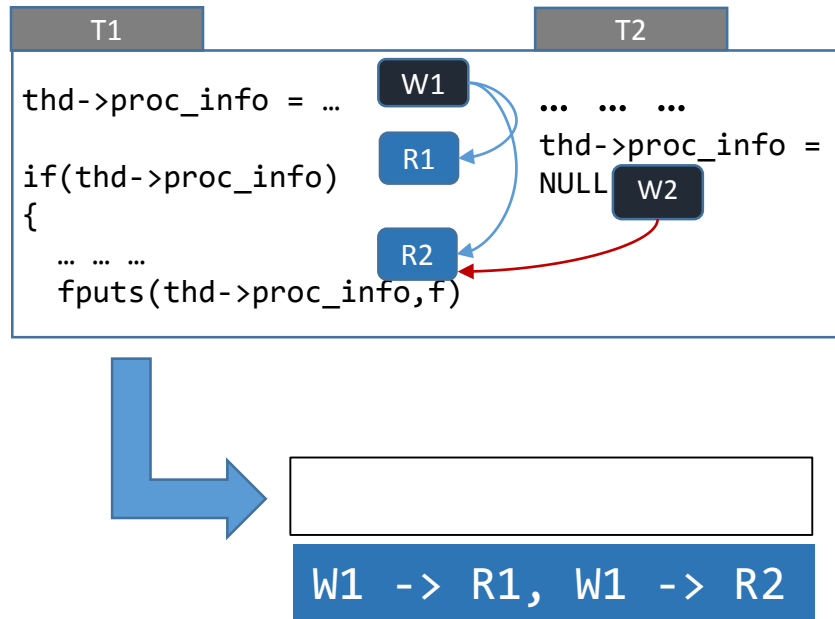
Online Testing



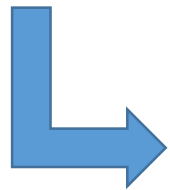
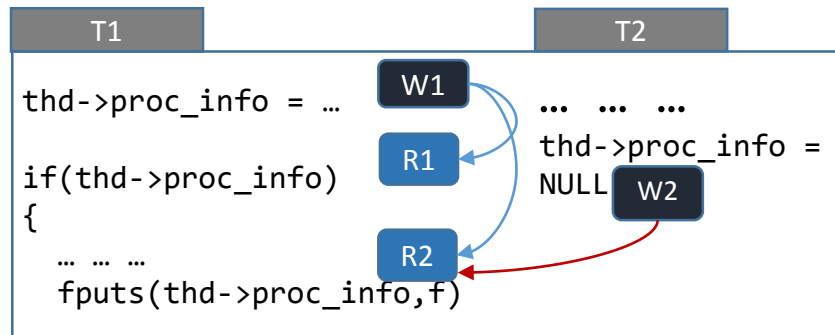
Online Testing



Online Testing



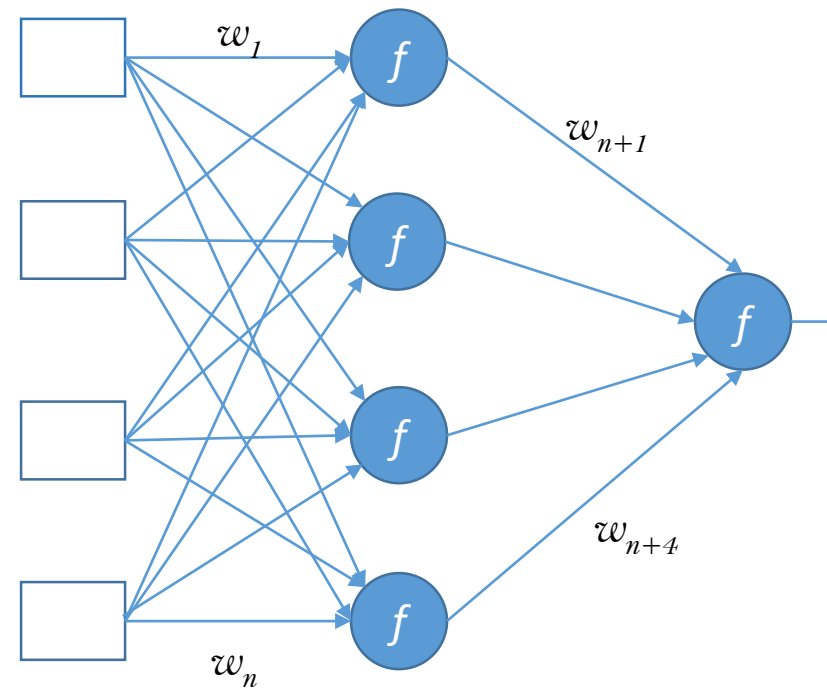
Online Testing



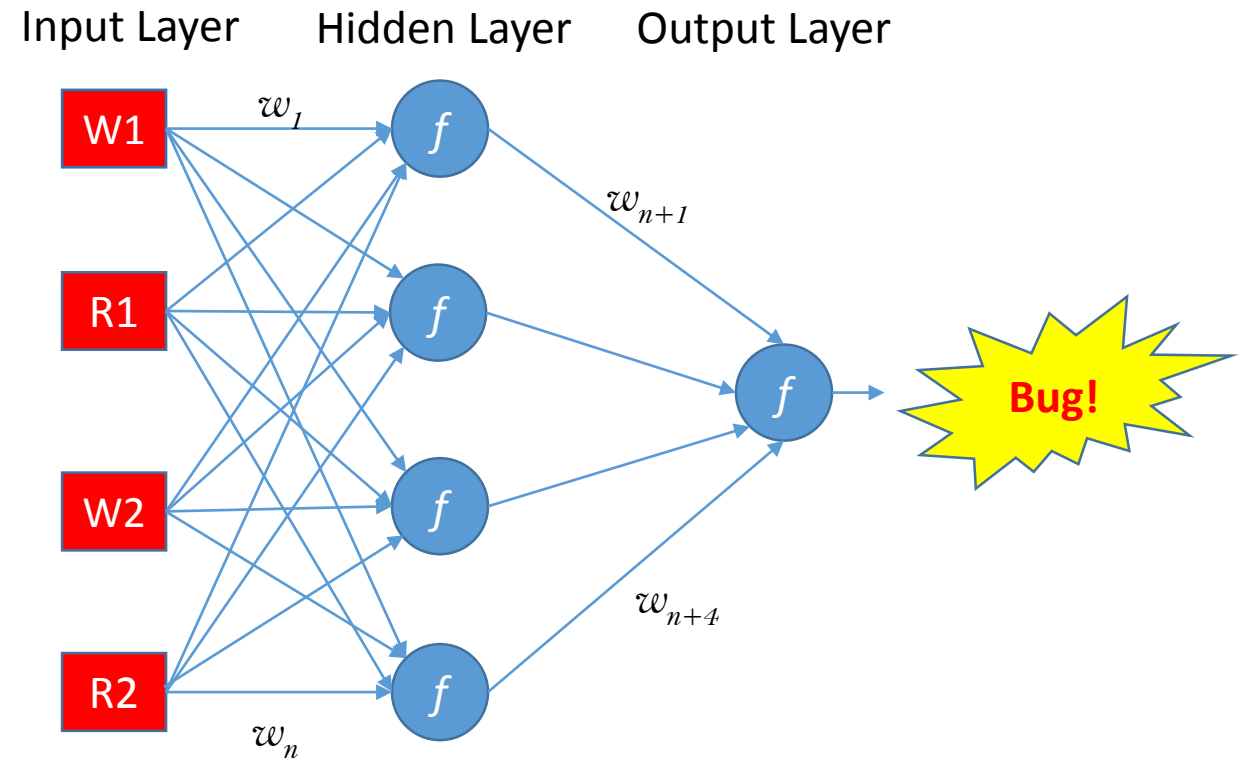
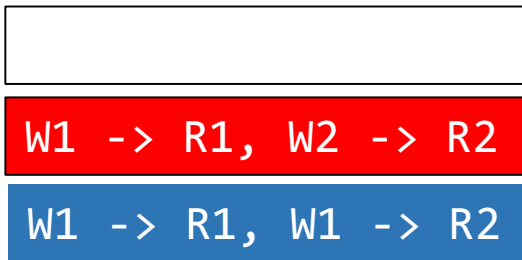
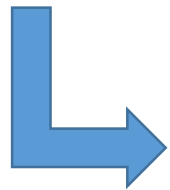
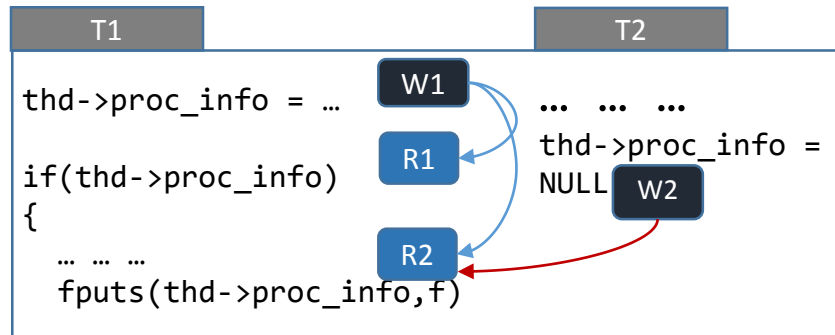
W1 -> R1, W2 -> R2

W1 -> R1, W1 -> R2

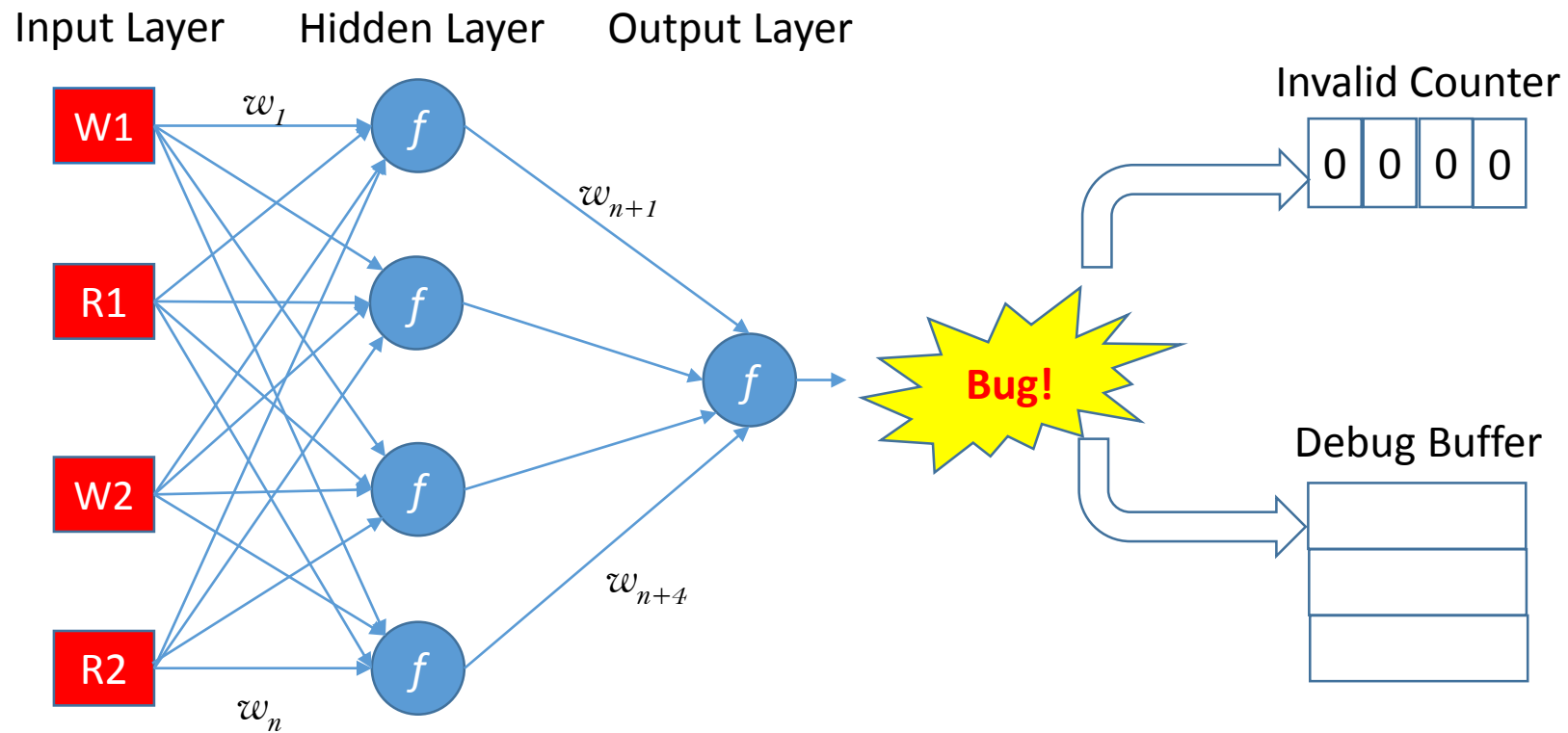
Input Layer Hidden Layer Output Layer



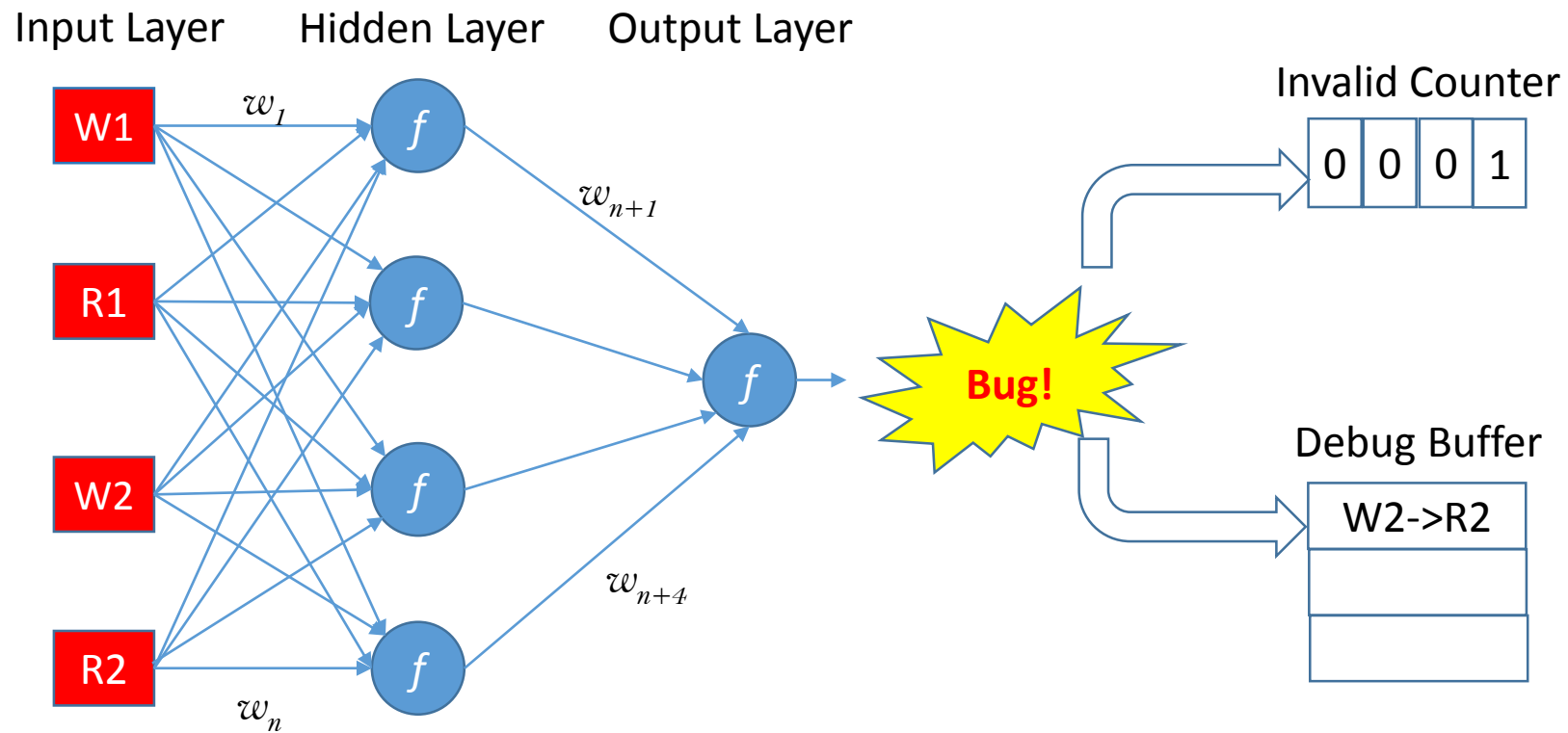
Online Testing



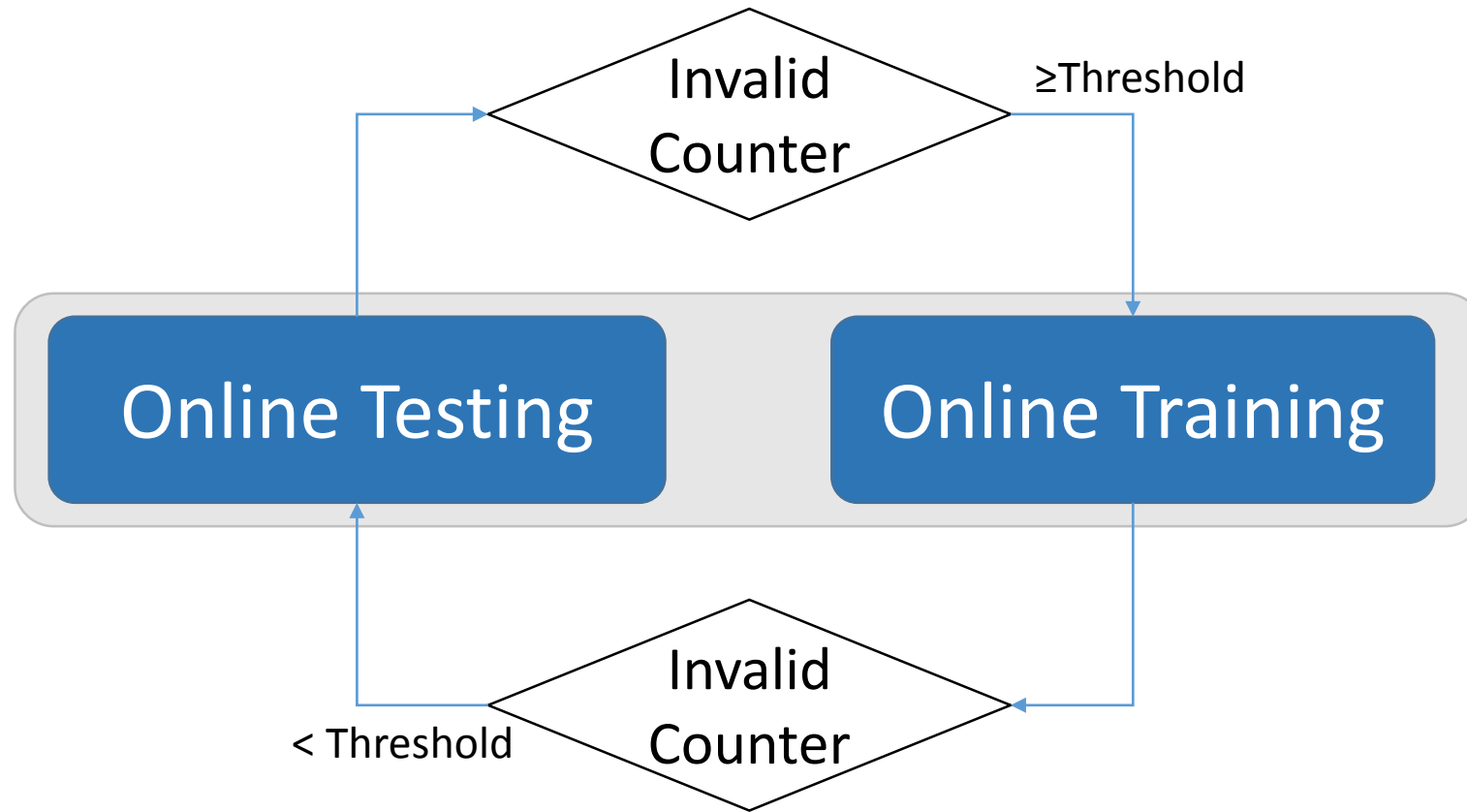
Online Testing



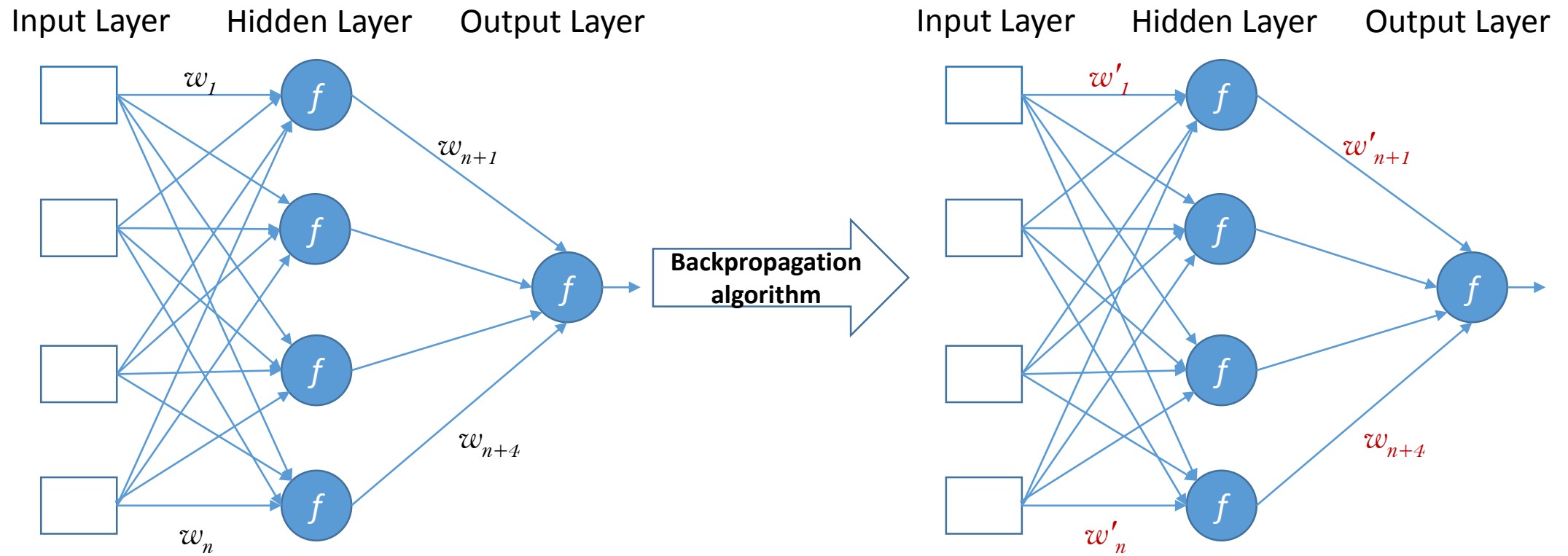
Online Testing



Adaptive to Change in Code



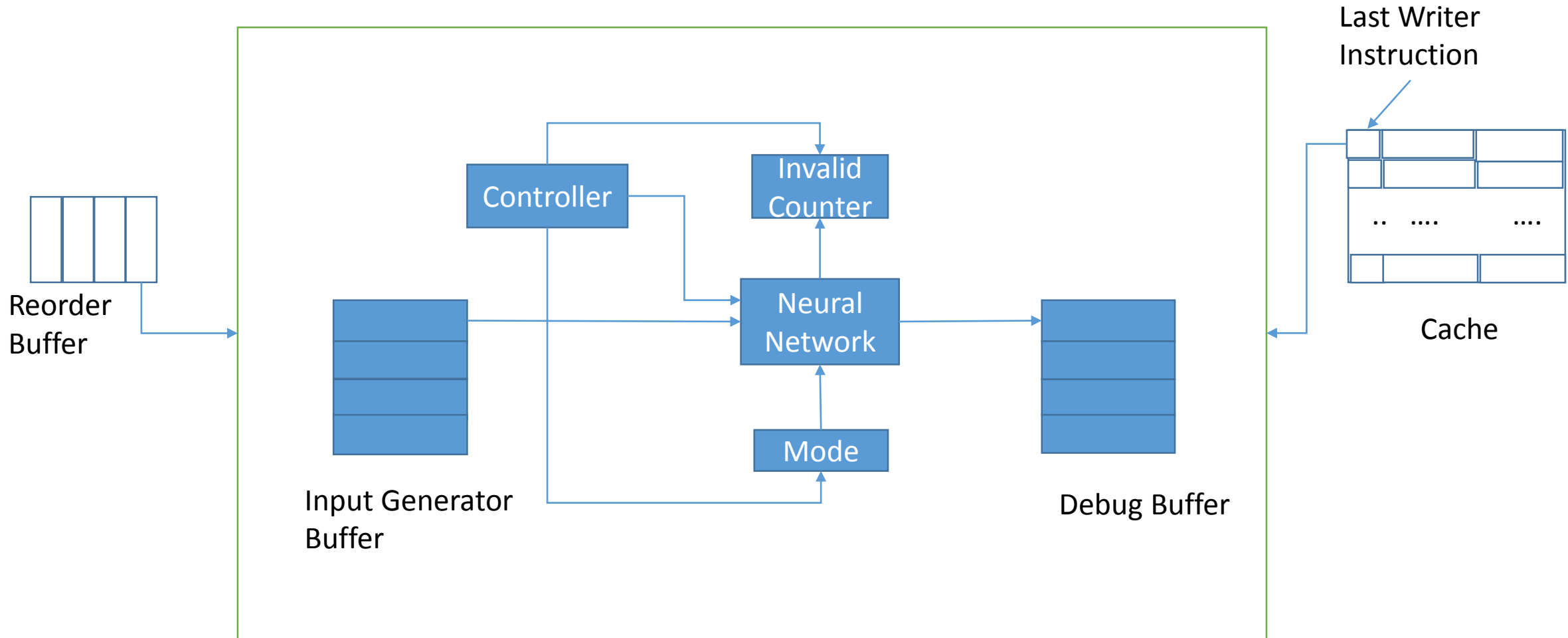
Online Training



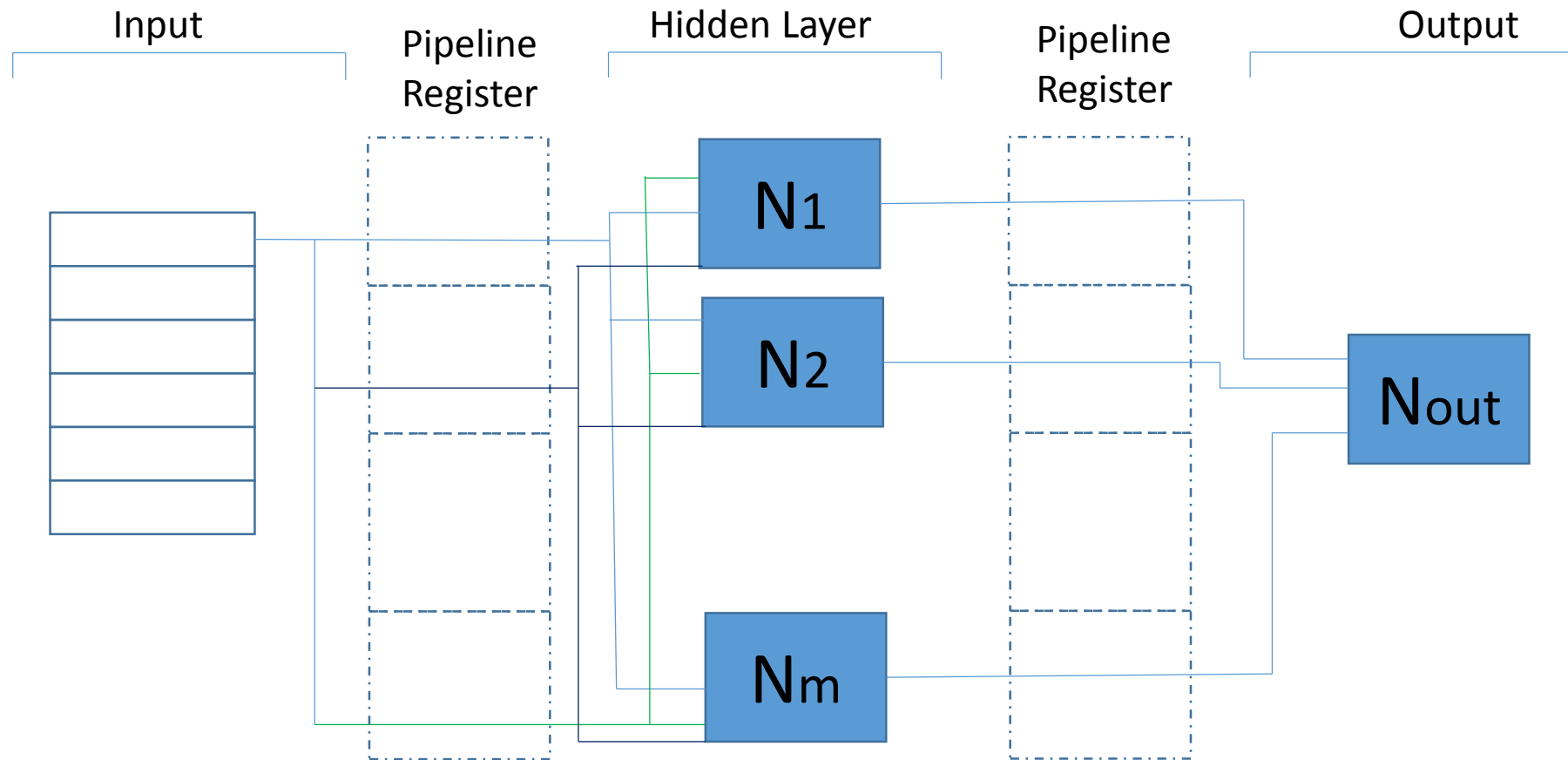
Postprocessing: Offline Pruning and Ranking

- Postprocess Invalid Communication Sequences in after a failure:
 - **Rank** recorded entries
 - Compare with a **Correct Set**
 - Number of matched RAW dependences higher → higher rank

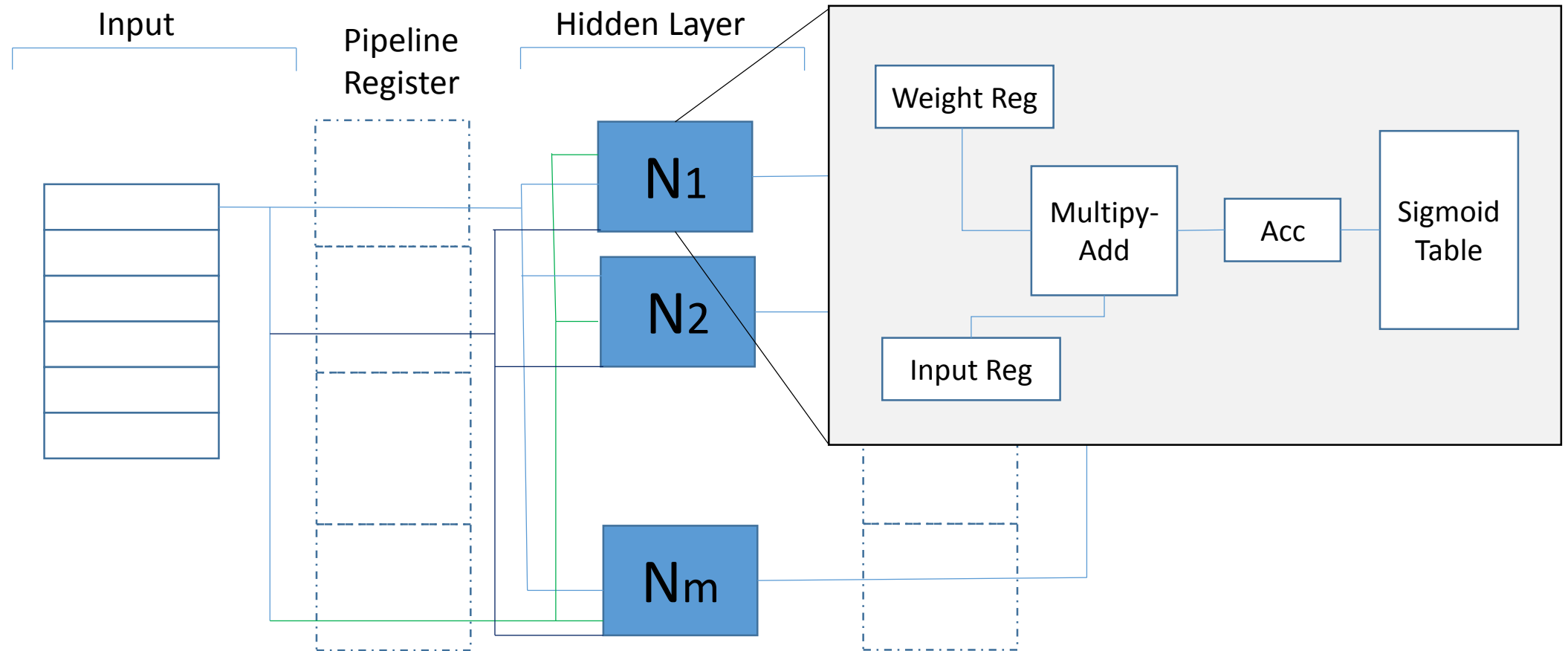
ACT Implementation



Pipelined Implementation of Neural Network



Pipelined Implementation of Neural Network



Experimental Setup

Parameters for Neuron

Max input	10
Multiply-add unit	1, 2 , 5, 10 with 1 cycle latency
Accumulator	1 cycle latency
Sigmoid unit	1 cycle latency
Input FIFO	4, 8 , 16

Parameters for ACT Module

Total neuron	11
Input generator Buffer	5 entries
Debug buffer	600 entries
Misprediction threshold	5%

Parameters for System

Architecture	Chip Multiprocessor 4,8,16 cores
Coherence	Snoopy MESI

Experimental Setup

- Applications for evaluation:
 - SPLASH2, PARSEC, SPECT INT 2006, GNU Coreutil
- Real world bugs:
 - Apache, MySQL, Memcached, Pbzip2, Aget, GNU Coreutil

Diagnosis of Existing Bugs

Bug	Bug Description	Rank
Aget	Ordering violation on <i>bwritten</i>	4
Apache	Atomicity vio. on ref. counter	7
Memcached	Atomicity vio. on item data	2
MySQL#1	Atomicity vio. loss of logged data	1
MySQL#2	Atomicity vio. thd->proc_info	1
MySQL#3	Atomicity vio. on join_init_cache	3
PBzip22	Ordering vio. Between threads	1
Gzip	Semantic bug	1
seq	Semantic bug	5
ptx	Buffer overflow	1
paste	Reads out of buffer string	8

Diagnosis of Existing Bugs

Bug	Bug Description	Rank
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MySQL#3	Atomicity vio. on join_init_cache	3
PBzip22	Ordering vio. Between threads	1
Gzip	Semantic bug	1
seq	Semantic bug	5
ptx	Buffer overflow	1
paste	Reads out of buffer string	8

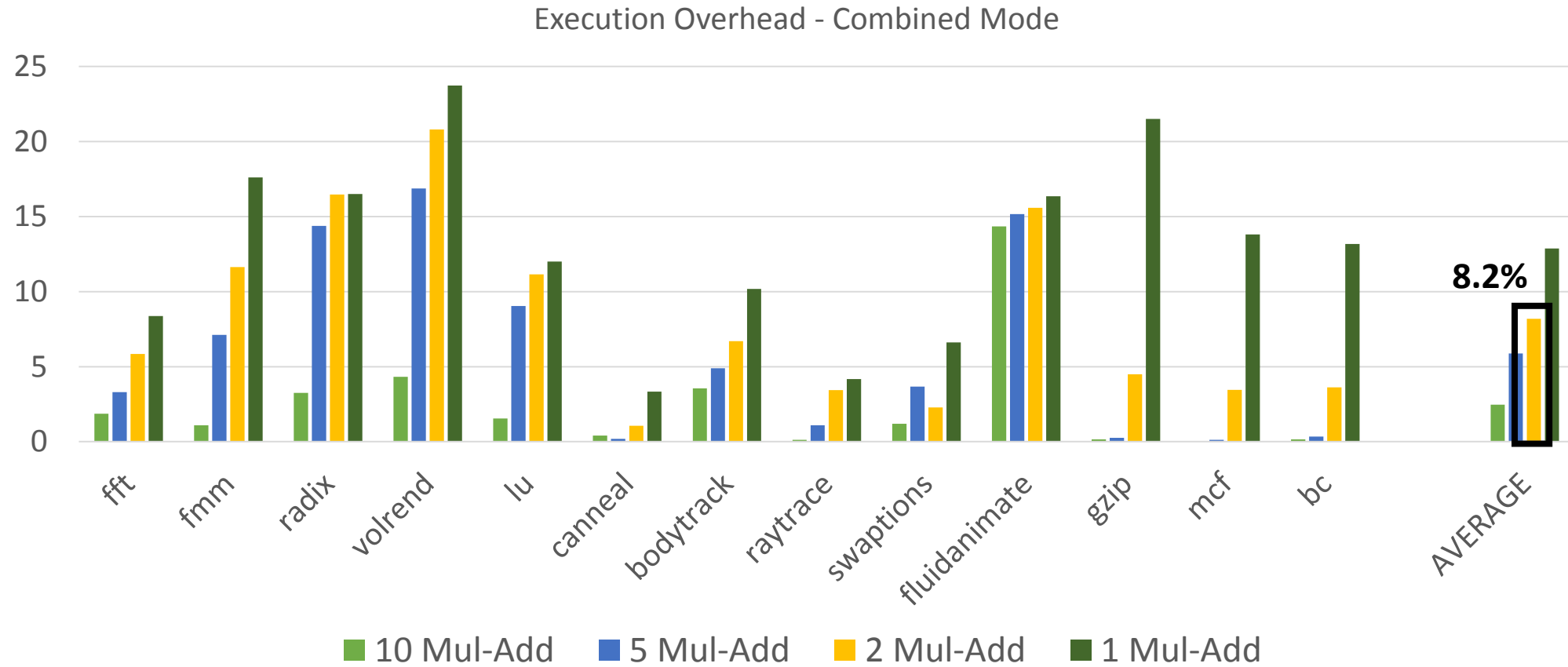
Diagnosis of Existing Bugs

Bug	Bug Description	Rank	AVISO Rank	PBI Rank
Aget	Ordering violation on <i>bwritten</i>	4	3	-
Apache	Atomicity vio. on ref. counter	7	-	136
Memcached	Atomicity vio. on item data	2	34	6
MySQL#1	Atomicity vio. loss of logged data	1	628	222
MySQL#2	Atomicity vio. thd->proc_info	1	294	153
MySQL#3	Atomicity vio. on join_init_cache	3	122	-
PBzip22	Ordering vio. Between threads	1	2	1
Gzip	Semantic bug	1	-	-
seq	Semantic bug	5	-	-
ptx	Buffer overflow	1	-	1
paste	Reads out of buffer string	8	-	4

Diagnosis of Injected Bugs in New Code

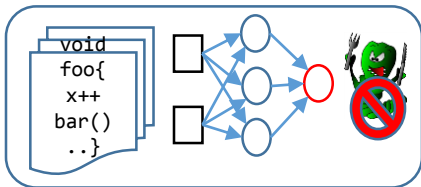
Program	Function	Rank
fft	Touch-Array	7
fmm	VListInter-action	23
fluidanimate	ComputeDensitiesMT	18
lu	TouchA	1
swaptions	Worker	6

Experiments & Results



Conclusion

- We proposed **ACT**, the **first adaptive** approach based on Hardware Neural Network
- It provides more **accurate ranking** of root causes
- It does not need to **reproduce failure**
- Average execution overhead **8.2%**



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