



Visualizing Parallelism with ParaMeter

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Motivation

- Single processor solutions are disappearing
- Chip Multiprocessor (CMP) solutions are becoming more prevalent
- Difficult to program. So many programmers do not.
- “Premature Optimization is the root of all evil ...” – C.A.R. Hoare

DIN vs. Ready Time

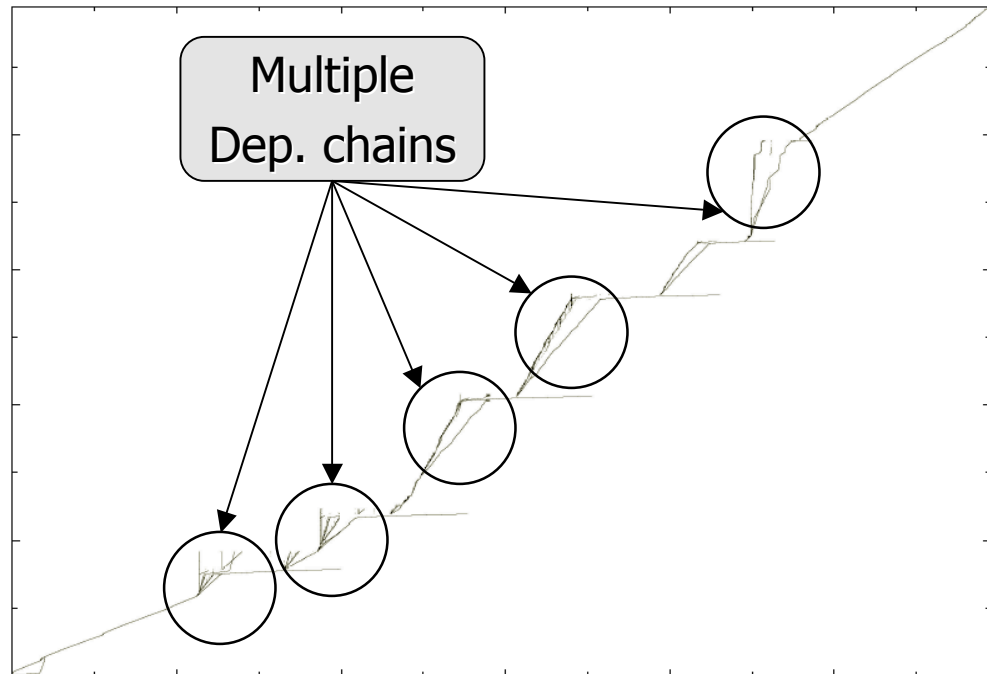
DIN	Instruction	Mem Addr
	...	
14	mov r3,r4	
13	st 0(r1),r5	0xbec4
12	add r5,r3,r4	
11	bnz r2, loop	
10	addi r1,r1,4	
9	addi r2,r2,-1	
8	mov r4,r5	
7	mov r3,r4	
6	st 0(r1),r5	0xbec0
5	add r5,r3,r4	
4	mov r3, 1	
3	mov r4, 1	
2	mov r2, 8	
1	li r1, &fibarr	

DIN	Ready Time														
14															
13															
12															
11															
10															
9															
8															
7															
6															
5															
4															
3															
2															
1															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	

Distant ILP Characteristics

DIN plot for 254.gap (IA64,gcc,inf)

- Multiple divergent lines indicate parallel “threads” of execution
- Independent chains of dependences (DDCs)
- CMP/CMT systems
 - Execute chains on separate cores

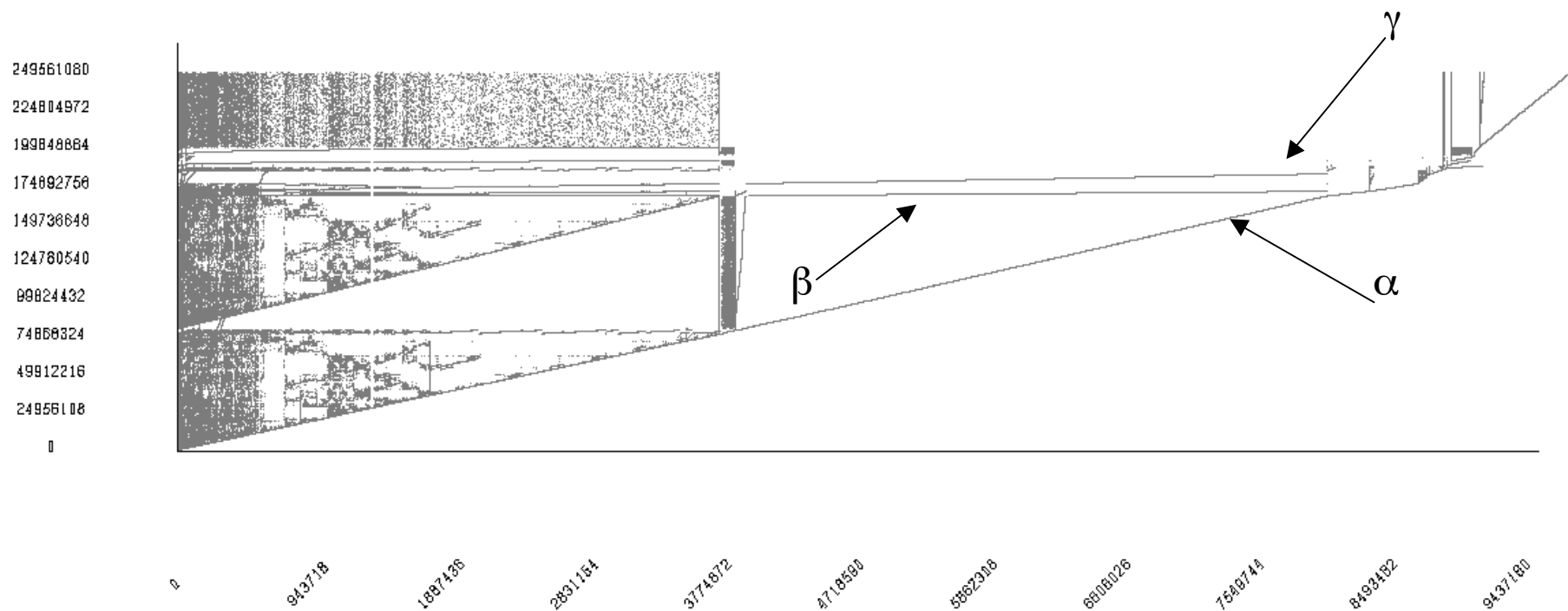




A Case Study

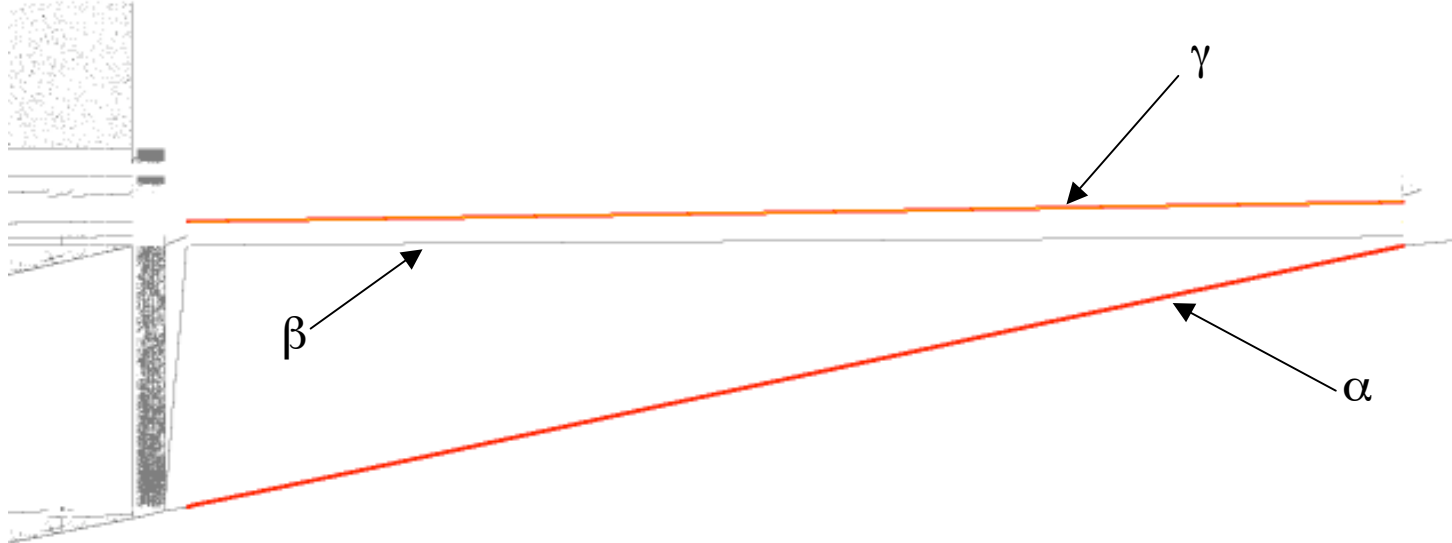
- Examine 175.vpr from SPEC INT 2000

Initial Visualization

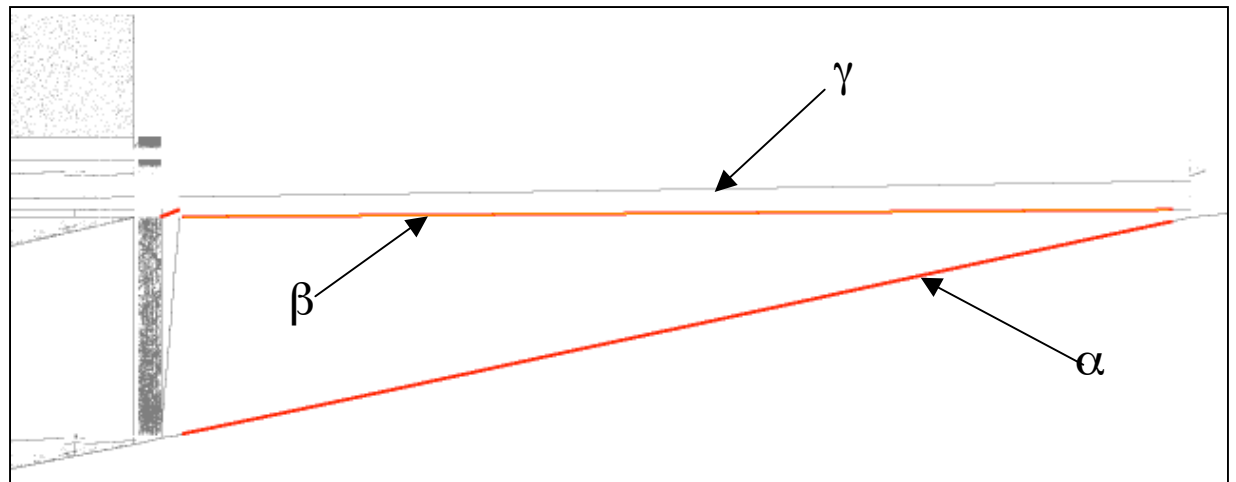
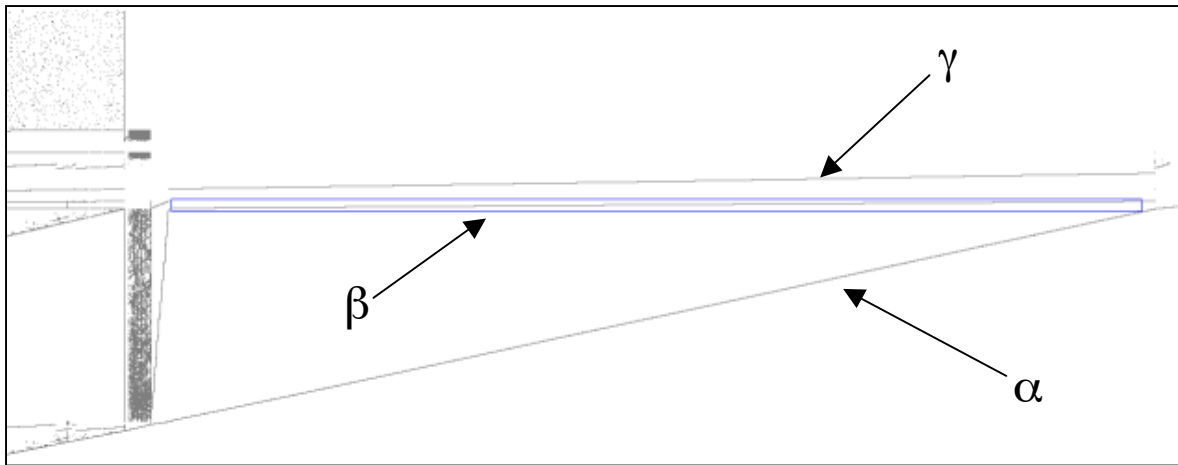


Case Study - Reverse Slice

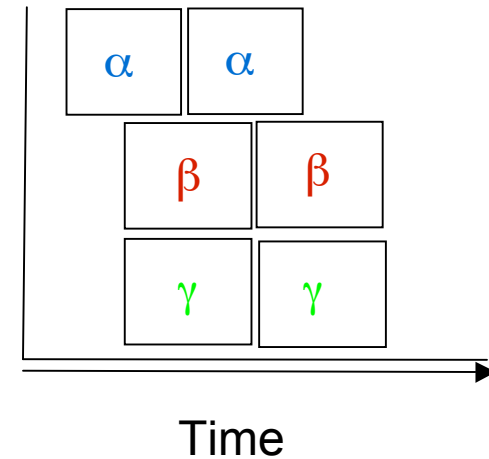
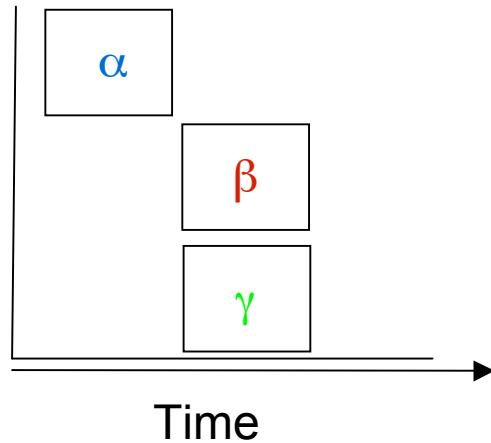
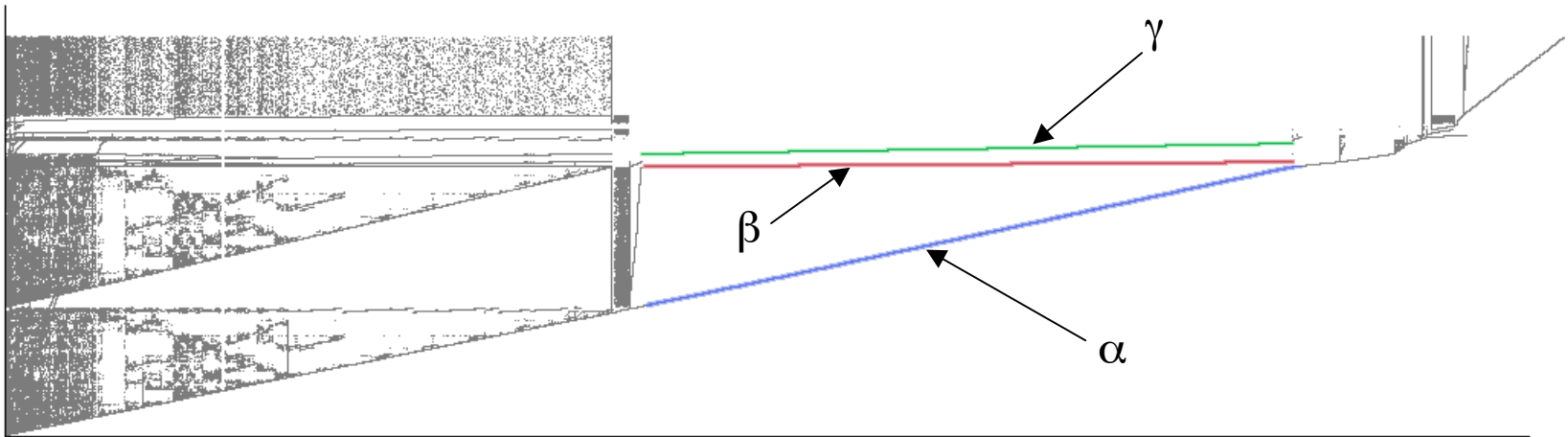
- Perform a single reverse data dependence slice on the selected region



Case Study - Select and Slice β

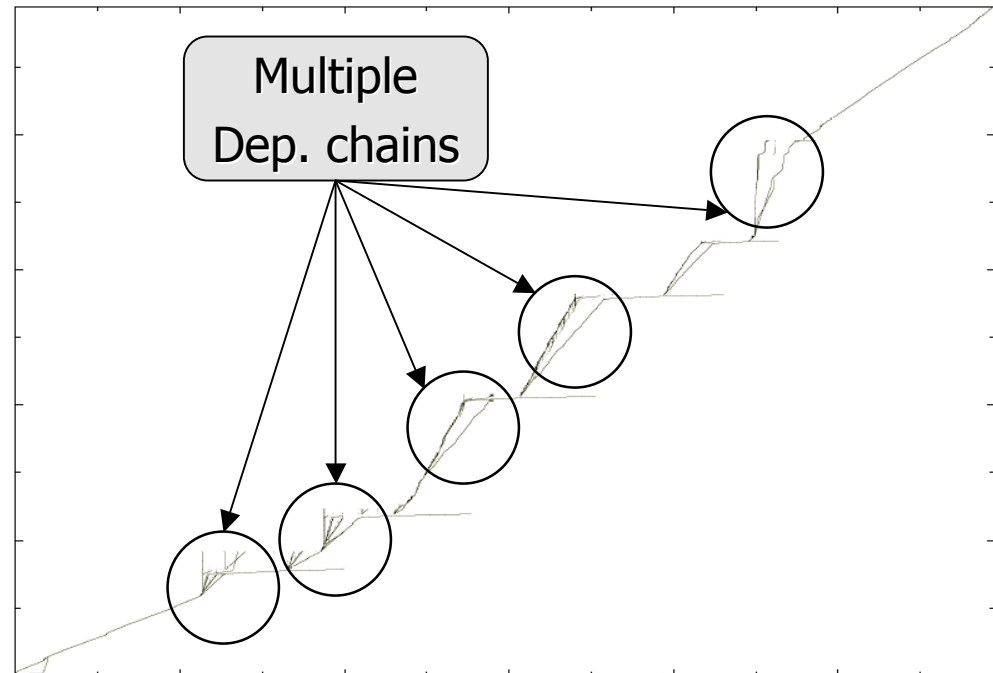


ParaMeter - Extracting TLP

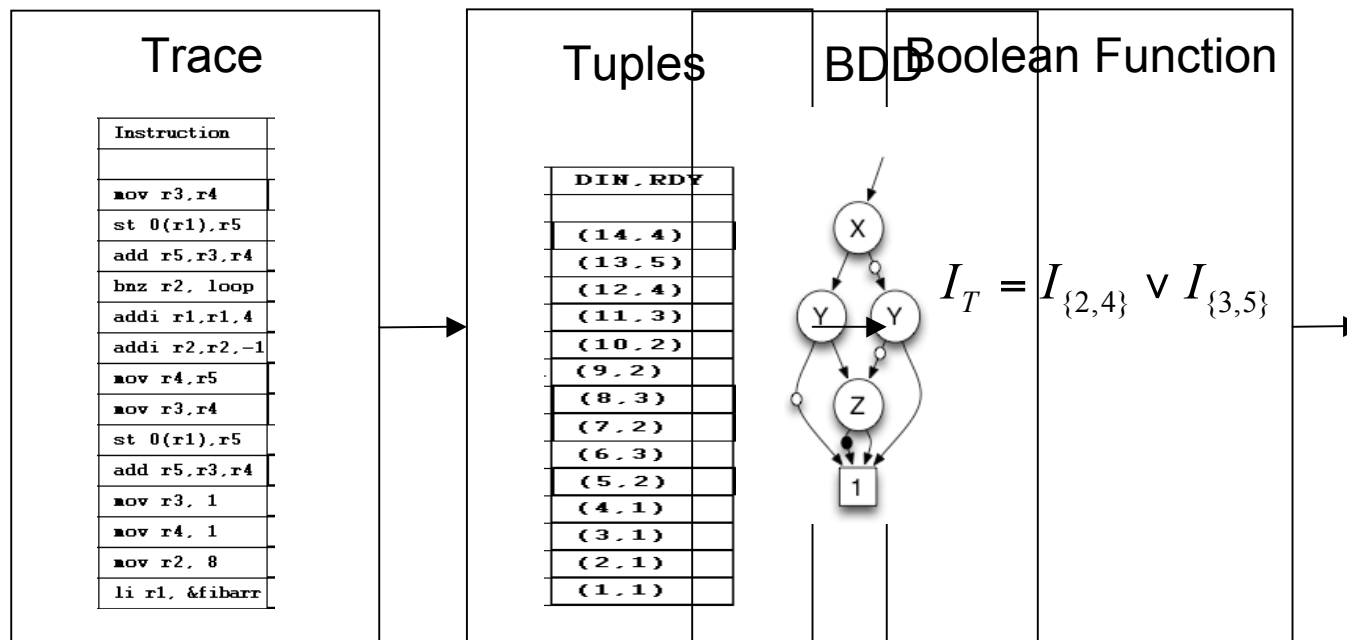


Trace Analysis Issues

- Trace Size
- With a trace of significant size global analysis is impractical
- Prior compression methods do not provide rapid global analysis

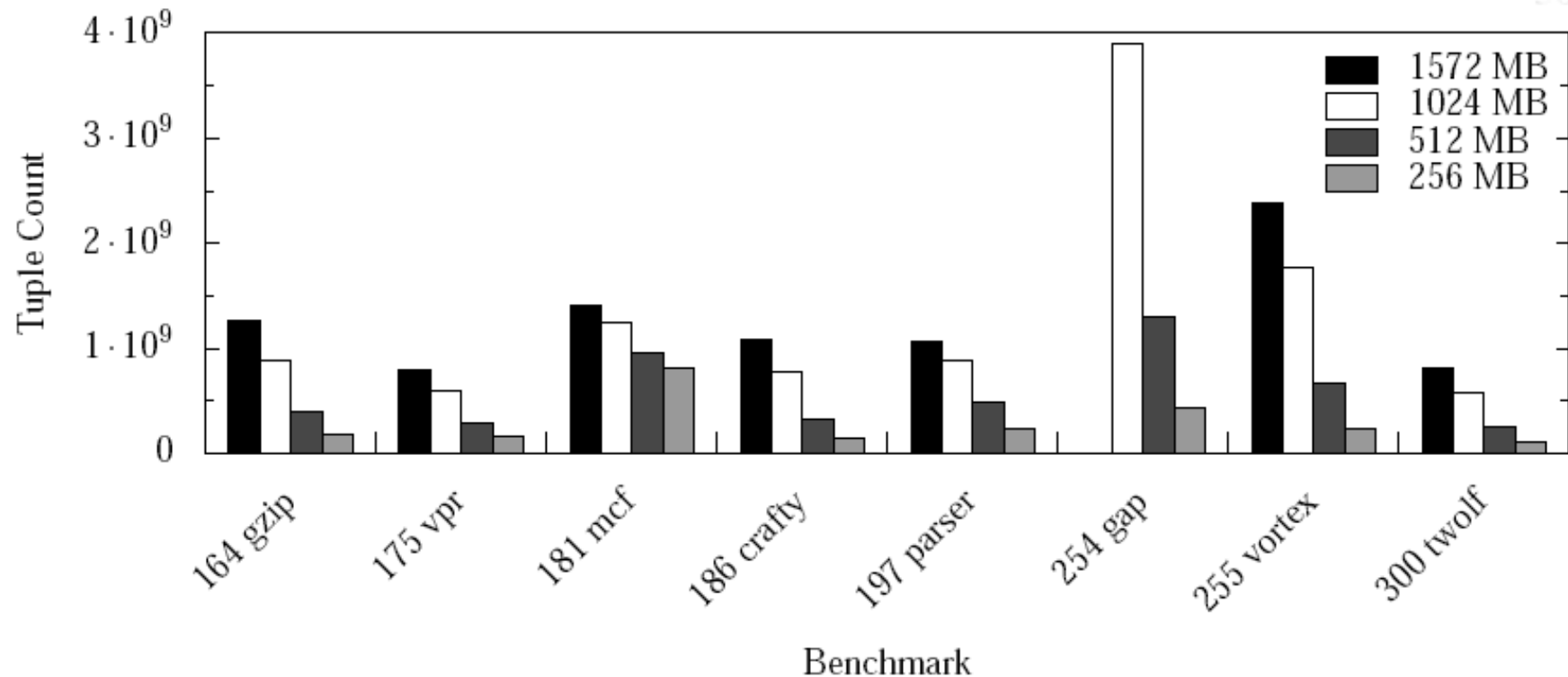


BDD Representation



- Price and Vachhajarani, “A Case for Compressing Traces with BDDs”, CAL, 2006
- Price, Giacomoni, Vachharajani, “Visualizing Potential Parallelism in Sequential Programs”, PACT 2008 [Submitted]
- “Enabling Advanced Code Analysis with BDDs”, M.S Thesis

BDD Compression Numbers



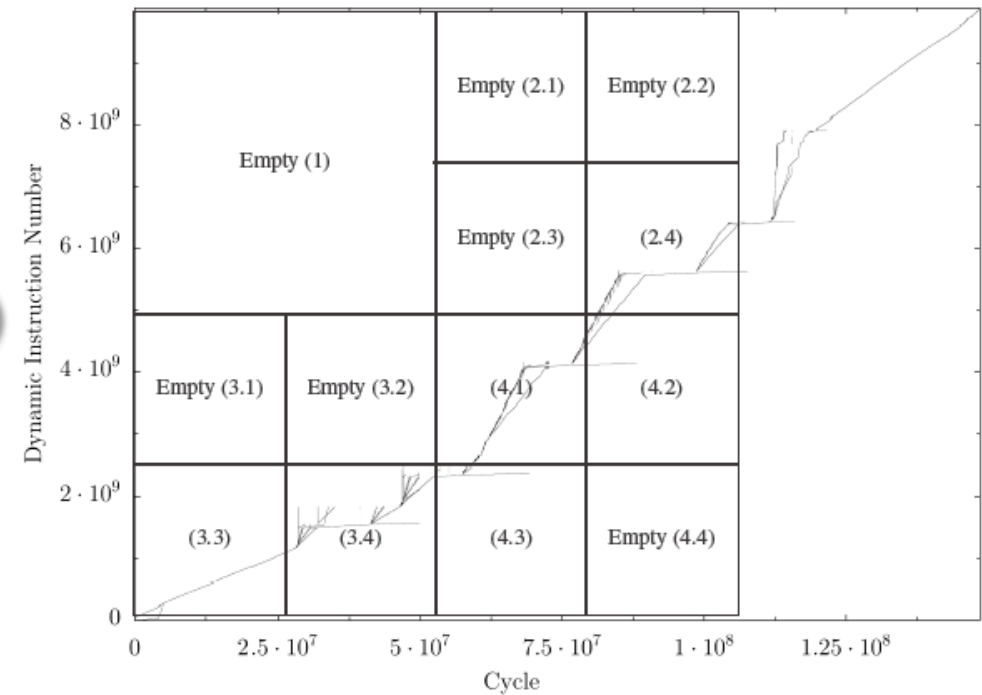
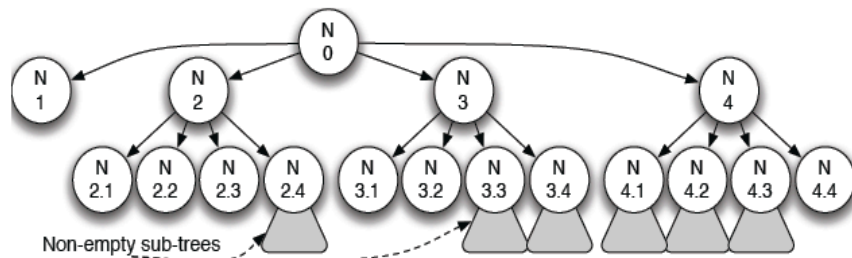
- Compression ratios range from 16 to over 60



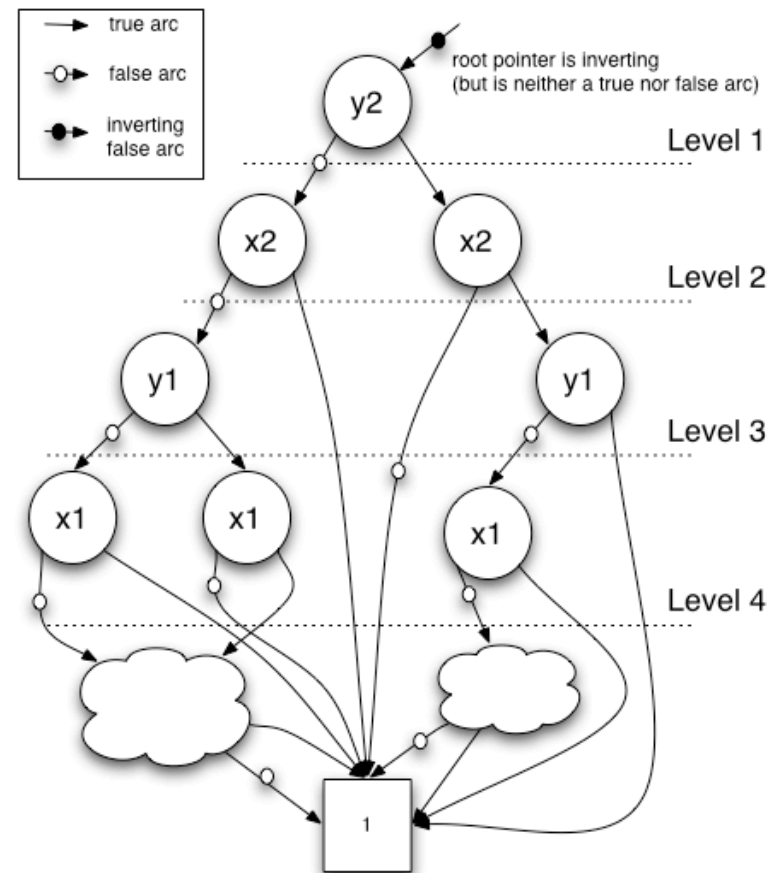
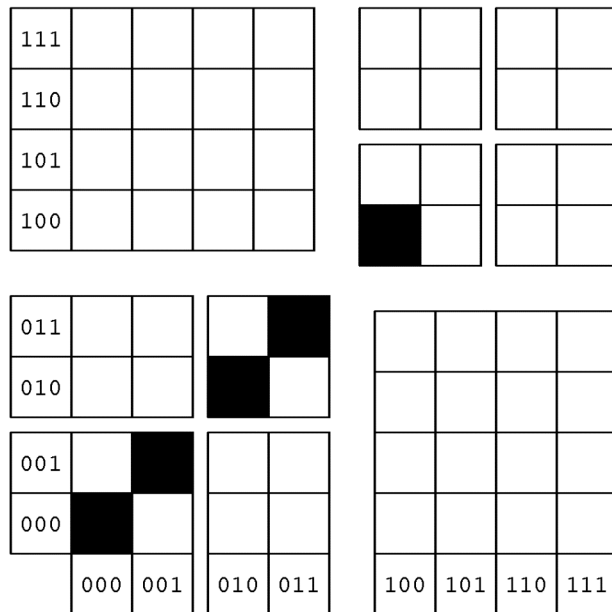
DIN x RDY Visualization

- Depth First Traversal of BDD
 - Quad - Tree Optimization
 - Depth Clipping
 - Viewport Clipping

Quad-Tree Optimization

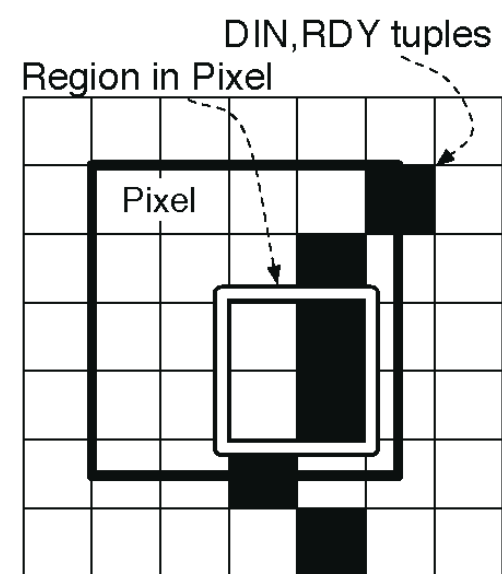
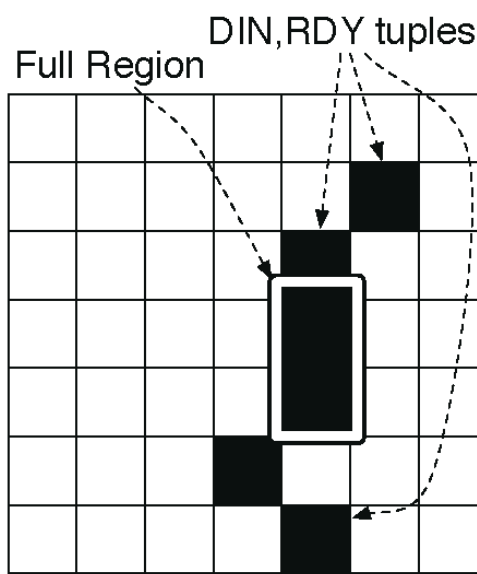
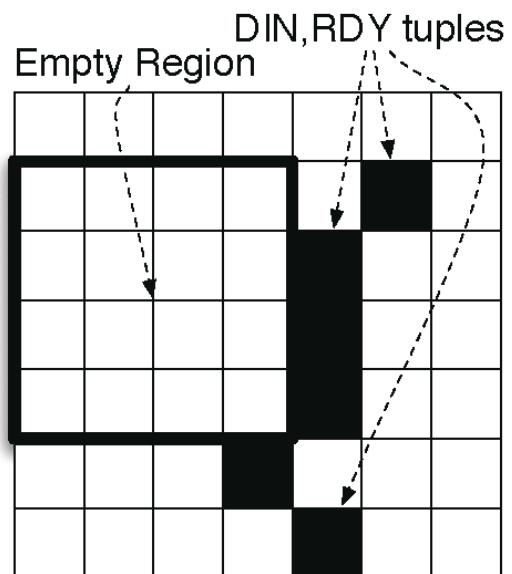


Quad-Tree Optimization





Depth Clipping





ParaMeter vs. Adamantium

- Adamantium uses Burtscher[CGO '05] bzip2 streamed compression
- DINxRDY plot data extraction

ParaMeter vs. Adamantium

Benchmark	Adamantium (s)	ParaMeter (s)	Perf. Gain
164.gzip	198.922	0.00552	36,036
175.vpr	196.484	0.01595	12,318
176.gcc	220.791	0.00676	32,661
181.mcf	208.383	0.00542	38,447
186.crafty	9.05	0.00012	75,416
197.parser	212.408	0.00357	59,498
253.perlbnk	192.637	0.01095	17,592
254.gap	161.067	0.00423	38,077
255.vortex	2.511	0.00006	41,850
256.bzip2	3.993	0.00009	44,366
300.twolf	194.133	0.00842	23,056
254.gap(500)	342.729	0.00716	47,867



Forward Slice

- BDD Based Analysis [Whaley and Lam, PLDI 2004]
- Forward slice algorithm:

```
function forward_slice( $e, I_D$ )  
   $s := I_D$   
  do  
     $s_{\text{old}} := s$   
     $e' := e \wedge s$   
     $s' := \exists d^1. e'$   
     $s := s \vee \text{rename}(d^2, d^1, s')$   
  while( $s \neq s_{\text{old}}$ )  
  return  $s$ 
```



Video



Questions?