## Laboratório 5



INE5411 - Organização de Computadores I

Nome: Maykon Marcos Junior

Matrícula: 22102199

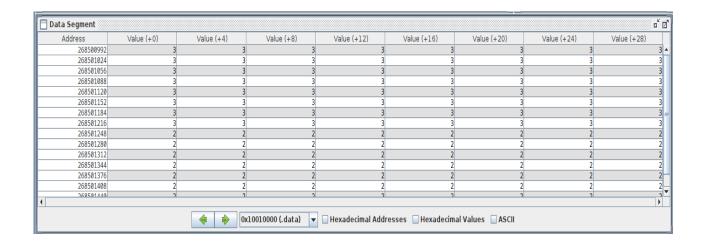
#### Exercício 1

A matriz A foi alocada com 1's e a matriz B com 2's, de forma que, para verificar o sucesso do código, os primeiros MAX² blocos devem ser 3, os próximos 2 e nenhum 1. O local de memória é reservado previamente, mas apenas como 0, sendo alocado depois

Teste com MAX = 4, primeiros 16 blocos = 3, e o resto = 2

Address	Value (+0)	Value (+4)	Value (+8)	Value (+12)	Value (+16)	Value (+20)	Value (+24)	Value (+28)
268500992	3	3	3	3	3	3	3	
268501024	3	3	3	3	3	3	3	
268501056	2	2	2	2	2	2	2	
268501088	2	2	2	2	2	2	2	
268501120	0	0	0	0	0	0	0	
268501152	0	0	0	0	0	0	0	
268501184	0	0	0	0	0	0	0	
268501216	0	0	0	0	0	0	0	
268501248	0	0	0	0	0	0	0	
268501280	0	0	0	0	0	0	0	
268501312	0	0	0	0	0	0	0	
268501344	0	0	0	0	0	0	0	
268501376	0	0	0	0	0	0	0	
268501408	0	0	0	0	0	0	0	
269501440	Ω	a	α	ρ	a	a	a	

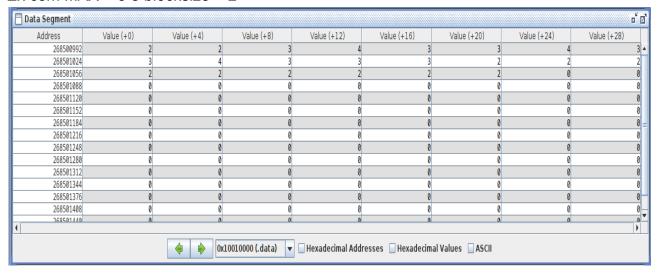
Teste com MAX = 8



#### Exercício 2

O código em linguagem de maior nível apresentado não checa se as variáveis ii e ji ultrapassam o valor MAX, além de não inicializar a matriz, então o código resultante não será equivalente ao primeiro, com várias atribuições repetidas e fora dos limites, especialmente quando MAX não é múltiplo de blocksize e, embora não seja muito comum nem faça muito sentido, se este for maior que aquele

Ex com MAX = 3 e blocksize = 2



## Exercício 3

Ao iterações fracionadas pelo block size, o programa pode usar mais vezes o mesmo conjunto de blocos, aumentando a taxa de hits e evitando buscas em memórias mais lentas. Isso deve-se sobretudo à leitura de B ser transposta (iterando as linhas antes das colunas), fazendo com que blocos distantes de memória sejam necessários em sequência. O fracionamento reduz esse problema pois, embora as linhas sejam ainda sejam iteradas primeiro, será por menos vezes antes de começar a iteração por colunas, permitindo aproveitar mais um bloco já alocado na cache.

## Código 1

Tem mais acessos (320 - 192) devido a alocação prévia de valores na matriz (usada para conferir o resultado), que são realizadas iterando colunas primeiro, tanto para A quanto para B, fazendo com que o resultado seja influenciado positivamente

Os dois exemplos apontam que ter menos blocos, porém maiores, é mais efetivo, pois serão necessárias menos buscas por um endereço antes da cache encher e, consequentemente, menos falhas.

#### matriz 8x8

Data	Cache Simulal	ion Tool, Version 1.2	_
Simulate ar	nd illustrate	data cache perform	nance
	Cache Or	ganization	
Placement Policy Direct M	apping -	Number of blocks	8 -
Block Replacement Policy	LRU ▼	Cache block size (words)	4
Set size (blocks)	1 -	Cache size (bytes)	128
	Cache Pe	rformance	
Memory Access Count	320	Cache Block Table	
Cache Hit Count	106	(block 0 at top)	
Cache Miss Count	214	= empty	
	33%	= hit	
Cache Hit Rate		= miss	
	Runti	me Log	
☐ Enabled			
'	Tool	Control	
Disconnect from MIPS	1001	Reset	Close
	nd illustrate	ion Tool, Version 1.2	–
Simulate ar	nd illustrate Cache Or	data cache perform	
	nd illustrate Cache Or	data cache perform	nance
Simulate ar	Cache Or	data cache perform ganization Number of blocks Cache block size (words)	nance
Simulate ar  Placement Policy Direct M  Block Replacement Policy	Cache Or apping LRU The LRU Th	data cache perform ganization Number of blocks Cache block size (words)	ance
Simulate ar  Placement Policy Direct M  Block Replacement Policy	Cache Or apping LRU The LRU Th	data cache perform ganization  Number of blocks  Cache block size (words)  Cache size (bytes)	ance
Placement Policy Direct M Block Replacement Policy Set size (blocks)	Cache Or  LRU  Cache Or  Cache Or  Cache Or  Cache Pe	data cache perform ganization  Number of blocks  Cache block size (words)  Cache size (bytes)  rformance  Cache Block Table (block 0 at top)	ance
Placement Policy Direct M Block Replacement Policy Set size (blocks)  Memory Access Count	Cache Or apping  LRU  Cache Pe	data cache perform ganization  Number of blocks  Cache block size (words)  Cache size (bytes)  rformance  Cache Block Table (block 0 at top)  = empty	ance
Placement Policy Direct M Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count	Cache Or apping  LRU  Cache Pe 320	data cache perform ganization  Number of blocks  Cache block size (words)  Cache size (bytes)  rformance  Cache Block Table (block 0 at top)	ance
Placement Policy Direct M Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Miss Count	Cache Or apping  LRU  Cache Pe 320 163 157	data cache perform ganization  Number of blocks  Cache block size (words)  Cache size (bytes)  erformance  Cache Block Table (block 0 at top)  = empty = hit	ance
Placement Policy Direct M Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Miss Count	Cache Or apping  LRU  Cache Pe 320 163 157	data cache perform ganization  Number of blocks  Cache block size (words)  Cache size (bytes)  rformance Cache Block Table (block 0 at top)  = empty = hit = miss	ance
Placement Policy Direct M Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Hit Rate	Cache Or apping    LRU    Cache Per 320  163  157  51 %  Runti	data cache perform ganization  Number of blocks  Cache block size (words)  Cache size (bytes)  rformance Cache Block Table (block 0 at top)  = empty = hit = miss	ance

Data	Cache Sin	nulat	ion Tool, Version 1	1.2	_ 0	×
Simulate ar			data cache perf	forman	ce	
Placement Policy Direct M		-	Number of blocks		16	-
Block Replacement Policy	LRU	-	Cache block size (wo	rds)	4	-
Set size (blocks)		1 -	Cache size (bytes)			256
	Cac	he Pe	rformance			
Memory Access Count		320	Cache Block Table			
Cache Hit Count		154	(block 0 at top)			
Cache Miss Count		166	□ = empty			
Cache Miss Count		100	= hit			
Cache Hit Rate	<b>4</b> 8%		= miss			
		Runti	me Log			
☐ Enabled						
Disconnect from MIPS		Tool (	Control Reset		Clo	ose

matriz 4x4

Data	Cache Simula	tion Tool, Version 1.	2 – – ×
Simulate a		data cache perfo	ormance
Placement Policy Direct M	1apping ¬	Number of blocks	8 🔻
Block Replacement Policy	LRU	Cache block size (word	ds) 4 ▼
Set size (blocks)	1	Cache size (bytes)	128
	Cache P	erformance	
Memory Access Count	8	Cache Block Table	
Cache Hit Count	7	(block 0 at top)	
Cache Hit Count		= empty	
Cache Miss Count		B = hit	
Cache Hit Rate	90%	= miss	
	Runt	ime Log	
□ Enabled			
	Tool	Control	
Disconnect from MIPS		Reset	Close

Data (	Cache Simulation Tool, Version 1.2	×
Simulate an	d illustrate data cache performa	ance
	Cache Organization	
Placement Policy Direct Ma	Number of blocks	4 ▼
Block Replacement Policy	LRU ▼ Cache block size (words)	4
Set size (blocks)	1 ▼ Cache size (bytes)	64
	Cache Performance	
Memory Access Count	80 Cache Block Table	
Cache Hit Count	(block 0 at top)	
Cache Miss Count	□ = empty 45 ■ = hit	
Cache Hit Rate	44% = miss	
	Runtime Log	
	Tidania Log	
☐ Enabled		
	Tool Control	
Disconnect from MIPS	Reset	Close
		·
Data (	Cache Simulation Tool, Version 1.2	_
	Cache Simulation Tool, Version 1.2	
Simulate an	d illustrate data cache performa Cache Organization	ance
	d illustrate data cache performa Cache Organization	
Simulate an	d illustrate data cache performa Cache Organization	ance
Simulate and Placement Policy Direct Ma	Cache Organization  Apping V Number of blocks	ance 4 🔻
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)	Cache Organization  Apping  Cache Organization  Apping  Cache Organization  Apping  V  Number of blocks  LRU  Cache block size (words)  1  Cache Size (bytes)  Cache Performance	ance
Placement Policy Direct Ma	Cache Organization  Apping  Cache Organization  Apping  V  Cache blocks  Cache block size (words)  Cache Performance  80  Cache Block Table	ance
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)	Cache Organization  Papping  Number of blocks  LRU  Cache block size (words)  Cache Performance  80  Cache Block Table  (block 0 at top)	ance
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)	Cache Organization Apping  Number of blocks  LRU  Cache block size (words)  Cache Performance  80  Cache Block Table  (block 0 at top)	ance
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count	Cache Organization Apping Number of blocks  LRU Cache block size (words)  Cache Performance  80 Cache Block Table (block 0 at top)  = empty	ance
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count	Cache Organization  Apping  Number of blocks  LRU  Cache block size (words)  Cache size (bytes)  Cache Performance  80  Cache Block Table  (block 0 at top)  = empty  = hit	ance
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count	Cache Organization  Apping  Number of blocks  LRU  Cache block size (words)  Cache size (bytes)  Cache Performance  80 Cache Block Table (block 0 at top)  = empty  4 = hit  95%  Bache Block Table	ance
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count	Cache Organization  Apping  Number of blocks  LRU  Cache block size (words)  Cache size (bytes)  Cache Performance  80 Cache Block Table (block 0 at top)  = empty  4 = hit  95%  Bache Block Table	ance
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Miss Count Cache Hit Rate	Cache Organization  Apping  Number of blocks  LRU  Cache block size (words)  Cache size (bytes)  Cache Performance  80 Cache Block Table (block 0 at top)  = empty  4 = hit  95%  Bache Block Table	ance
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Miss Count Cache Hit Rate	Cache Organization  Apping  Number of blocks  LRU  Cache block size (words)  Cache size (bytes)  Cache Performance  80 Cache Block Table (block 0 at top)  = empty  4 = hit  95%  Bache Block Table	ance

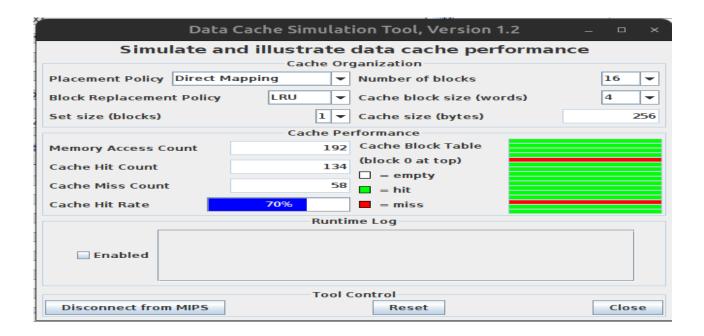
# Código 2

Tem menos acessos à memória, mas ainda sim consegue resultados melhores mesmo com matrizes e block sizes pequenos

Matriz 8X8, block size = 2

Este caso mostra a situação oposta à do exercício anterior, com mais blocos pequenos superando menos blocos grandes. Isso porque o segundo programa vai aproveitar uma parte maior de cada bloco, fazendo com que ter poucos blocos seja desvantajoso

Data	Cache Simulat	ion Tool, Version 1.2	×
		data cache perform	ance
		ganization -	
Placement Policy Direct M	apping -	Number of blocks	8 -
Block Replacement Policy	LRU ▼	Cache block size (words)	4
Set size (blocks)	1 🕶	Cache size (bytes)	128
	Cache Pe	rformance	
Memory Access Count	192	Cache Block Table	
Cache Hit Count	126	(block 0 at top)	
Cache Miss Count	66	= empty	
Cache Hit Rate	66%	= miss	
	Runtii	me Log	<u> </u>
□ Enabled			
	Tool (	Control	
Disconnect from MIPS		Reset	Close
<b>(</b> *			
	nd illustrate	tion Tool, Version 1.2	–
	nd illustrate Cache Or		
Simulate ar	nd illustrate Cache Or	data cache perform	ance
Simulate and Placement Policy Direct M	Cache Or	data cache perform ganization Number of blocks	ance 4 🔻
Simulate ar  Placement Policy Direct M  Block Replacement Policy	Cache Or apping LRU T	data cache perform ganization Number of blocks Cache block size (words)	ance
Simulate ar  Placement Policy Direct M  Block Replacement Policy	Cache Or apping LRU T	data cache perform ganization Number of blocks Cache block size (words) Cache size (bytes)	ance
Placement Policy  Block Replacement Policy  Set size (blocks)	Cache Or  LRU  Cache Or  Capping  LRU  Cache Pe	data cache perform ganization Number of blocks Cache block size (words) Cache size (bytes) erformance Cache Block Table (block 0 at top)	ance
Placement Policy Direct M Block Replacement Policy Set size (blocks)  Memory Access Count	Cache Or LRU  Cache Pe	data cache perform ganization Number of blocks Cache block size (words) Cache size (bytes) rformance Cache Block Table	ance
Placement Policy Direct M Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count	Cache Or LRU  Cache Pe  100	data cache perform ganization Number of blocks Cache block size (words) Cache size (bytes) rformance Cache Block Table (block 0 at top)  = empty	ance
Placement Policy Direct M Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Miss Count	Cache Or apping  LRU  Cache Pe 192 110 82	data cache perform ganization Number of blocks Cache block size (words) Cache size (bytes) Informance Cache Block Table (block 0 at top)  = empty = hit	ance
Placement Policy Direct M Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Miss Count	Cache Or apping  LRU  Cache Pe 192 110 82	data cache perform ganization Number of blocks Cache block size (words) Cache size (bytes) rformance Cache Block Table (block 0 at top) = empty = hit = miss	ance
Placement Policy Direct M Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Hit Rate	Cache Orlapping  LRU  Cache Pe  192  110  82  57%  Runti	data cache perform ganization Number of blocks Cache block size (words) Cache size (bytes) rformance Cache Block Table (block 0 at top) = empty = hit = miss	ance



Matriz 8X8, block size = 4

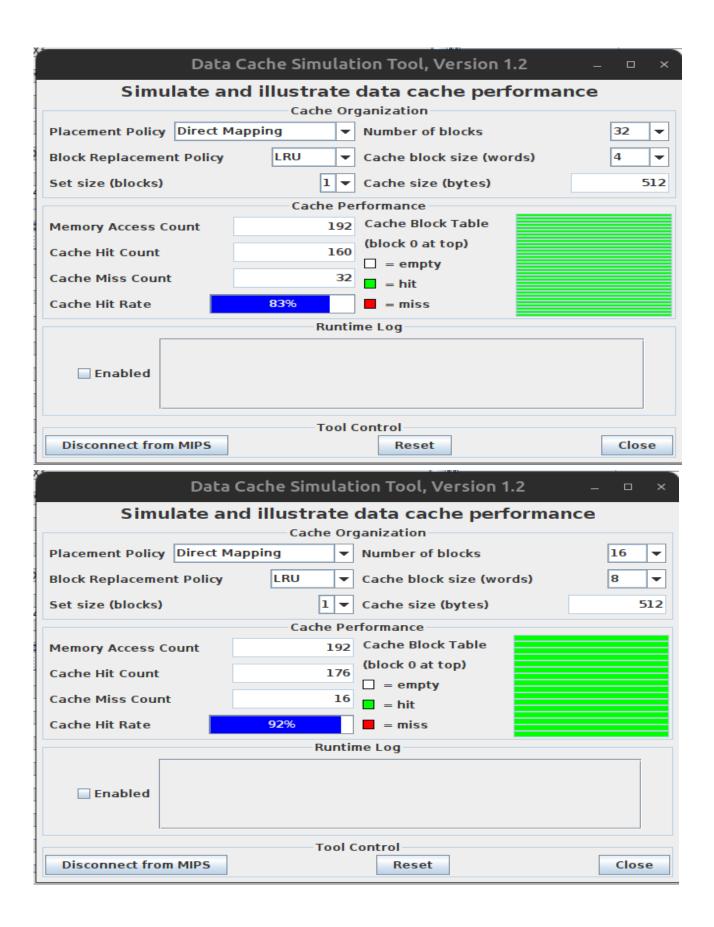
Como são aproveitadas 4 words de cada bloco, o ganho de desempenho de ir de 4 para 8 words/bloco foi nulo

Data	Cache Simulation Tool, Version 1.2	×
Simulate an	d illustrate data cache performand	e
Placement Policy Direct Management Policy  Set size (blocks)		8 v 4 v 128
Memory Access Count  Cache Hit Count  Cache Miss Count  Cache Hit Rate	192 Cache Block Table (block 0 at top)  = empty  = hit  74%  = miss	
☐ Enabled	Runtime Log	
Disconnect from MIPS	Tool Control  Reset	Close
Data	Cache Simulation Tool, Version 1.2	×
	d illustrate data cache performand	
Placement Policy Direct Ma	Cache Organization  Apping  Number of blocks  LRU  Cache block size (words)	8 <b>•</b>
Simulate an	Cache Organization  Apping  Cache Organization  Apping  Cache blocks  Cache block size (words)  Cache size (bytes)	8 <b>•</b>
Placement Policy Direct Ma	Cache Organization  Apping  Number of blocks  LRU  Cache block size (words)	8 <b>•</b>
Placement Policy Direct M. Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Miss Count	Cache Organization  Apping  Number of blocks  LRU  Cache block size (words)  Cache size (bytes)  Cache Performance  192  Cache Block Table  (block 0 at top)  143  9 = empty  9 = hit	8 <b>•</b>
Placement Policy Direct M. Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Miss Count	Cache Organization  Apping V Number of blocks  LRU V Cache block size (words)  Cache Performance  192 Cache Block Table (block 0 at top)  143 = empty 49 = hit  74%  Take Organization  Authorization  Cache Performance  192 Cache Block Table  (block 0 at top)  = miss	8 <b>•</b>

Porém, como o block size também é maior, meramente dobrar o número de blocos não é efetivo, pois não é grande o bastante para que os mesmos blocos possam permanecer após uma iteração das variáveis não-fracionadas (i, j), fazendo com que hajam mais trocas que compensam o ganho.

Data C	ache Simulation <sup>-</sup>	Tool, Version 1.2	×
Simulate and	d illustrate dat	•	mance
Direct Ma	Cache Organiz	ation iber of blocks	4
Placement Policy Direct Ma			
Block Replacement Policy	LRU ▼ Cacl	he block size (words	) 8 🔻
Set size (blocks)		he size (bytes)	128
	Cache Perform		
Memory Access Count	132	he Block Table	
Cache Hit Count	124	ck 0 at top) = empty	
Cache Miss Count	68 =	7 7	
Cache Hit Rate	65%	= miss	
	Runtime Lo	og	
☐ Enabled			
Disconnect from MIPS	Tool Contr	ol Reset	Close
	Cache Simulation		
	d illustrate dat	a cache perfo	
	d illustrate dat	a cache perfo	
Simulate an	Cache Organia	a cache perfo	rmance
Simulate and Placement Policy Direct Ma	Cache Organiz	ca cache perfo zation nber of blocks	rmance
Placement Policy Direct Ma	Cache Organiz	ca cache perfo zation nber of blocks the block size (words the size (bytes)	rmance  16 🔻 4 🔻
Placement Policy Direct Ma	Cache Organia  Pping V Num  LRU V Cac  1 V Cac  Cache Perform	ca cache perfo zation nber of blocks the block size (words the size (bytes)	rmance  16 🔻 4 🔻
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)	Cache Organiz  pping V Num  LRU V Cac  1 V Cac  Cache Perform  192 Cac  (blo	ca cache perfo zation nber of blocks the block size (words the size (bytes) nance the Block Table ock 0 at top)	rmance  16 🔻 4 🔻
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count	Cache Organiz  pping V Num  LRU Cac  1 V Cac  Cache Perform  192 Cac  (blow)	ca cache perfo	rmance  16 🔻 4 🔻
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Miss Count	Cache Organiz  pping V Num  LRU Cac  1 V Cac  Cache Perform  192 Cac  142 Cbl  50	ca cache perfo	rmance  16 🔻 4 🔻
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count	Cache Organia pping V Num  LRU Cac  1 V Cac  Cache Perform 192 Cac (blo	ca cache perfo	rmance  16 🔻 4 🔻
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Miss Count	Cache Organiz  pping V Num  LRU Cac  1 V Cac  Cache Perform  192 Cac  142 Cbl  50	ca cache perfo	rmance  16 🔻 4 🔻
Placement Policy Direct Ma Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Miss Count Cache Hit Rate	Cache Organia pping V Num  LRU Cac  1 V Cac  Cache Perform 192 Cac (blo	ca cache perfo	rmance  16 🔻 4 🔻

Entretanto, quadruplicar o tamanho da cache gera melhores resultados, especialmente quando se aumenta o tamanho de bloco (o efeito com 8 blocos e 16 words/bloco é maior ainda) pois os mesmos blocos poderão permanecer por mais tempo e ser usados mais vezes



Matriz 4x4 block size = 2

Naturalmente, o efeito é menos perceptível com um matriz menor

Data	Cache Simulation Tool, Version 1.2	×
Simulate an	nd illustrate data cache performa  Cache Organization	nce
Placement Policy  Block Replacement Policy  Set size (blocks)		8 v 4 v
Memory Access Count Cache Hit Count Cache Miss Count Cache Hit Rate	Cache Performance  48	
Disconnect from MIPS	Tool Control Reset	Close
	Cache Simulation Tool, Version 1.2	×
	Cache Simulation Tool, Version 1.2  Indicate the cache performate the cache organization	
	d illustrate data cache performa	
Simulate and Placement Policy Direct Management Policy	Cache Organization  Apping Number of blocks  LRU Cache block size (words)  Cache Performance  48 Cache Block Table (block 0 at top)  = empty 21 = hit  56%  Eache Organization  Authorization  Cache Performance  48 Cache Block Table (block 0 at top)  = empty  = hit	ance
Placement Policy Direct M. Block Replacement Policy Set size (blocks)  Memory Access Count Cache Hit Count Cache Miss Count	Cache Organization  Apping  Number of blocks  LRU  Cache block size (words)  Cache size (bytes)  Cache Performance  48  Cache Block Table  (block 0 at top)  = empty  = hit	ance