ECE Project 4:
Advanced MIPS Simulator

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Part A)

1) <u>Functionality</u>

Our program can run MC, Slow-pipe, Fast-pipe, and Cache.

For MC we are able to output the total cycle and the percent of instructions for 3, 4, and 5. We are also able to output instruction by instruction information. The cycle the instruction is currently on, pc, and what instruction is currently running

For Slow-pipe, we are able to output the cycles, the different data hazard types and how many there are and adding them to our cycles to output our total cycles taking into account of NOPS. Our instruction by instruction is able to output the current farthest instruction and what part of the pipeline it currently is in. As well as pc, if the instruction causes a type of hazard and how many NOPS are inserted.

For Fast-pipe we are able to output the total cycles, how many instructions entered the pipeline and any data or control hazards. For the instruction by instruction we outputted the instruction, where it is in the pipeline, pc, and any stalls or forwarding that is being done.

For our Cache, we are able to accurately calculate the hit and miss rates when accessing our cache. We are also able to run all 3 at the same time, there is only trouble when trying to write data back into the cache once there is a miss. We are also able to allow the user to set their own configuration.

<u>Interface</u>

The user is able to choose what file they would like to be read as well as choose if the program should go into diagnosis mode or normal mode. After which they would choose what type of MIPS CPU to be run from the 3 choices, as well as choose their own cache configuration.

2) <u>Project Experience Reflection</u>

Duy Do

My working style was running through the simplest part first then from there building up. My style of work is still consistent from the beginning. I usually hard code everything and rarely simplify. Getting a general understanding is what's most important when doing these projects because I tend to get lost.

Richard Remigoso

My general working style is 'understand the concept and purpose of the project then build and code'. This has been my working style since Project 1 and it has allowed me to perform well in the parts of which I was responsible in doing (ex. Slow-pipe, Fast-pipe for this project). Throughout the projects 2, 3, and 4, I have learned that getting a solid foundation of the project's concept is very

important. I realized that if my teammates are struggling with the concepts, I must try and help them understand, otherwise job performance will be poor. Doing so will also build team cohesion as morale will also increase. Two things that I learned as to NOT to do is leave a team member confused throughout the process of the project and also, if a team member is underperforming on purpose, then I have to talk to the professor as it is unfair to those who sacrificed their own time.

Syed Khalid

My general working style of the project is to read and understand the project as much as possible. And start breaking the project into smaller chunks. My approach has not been changed since the project one was assigned. I have learned a few debugging techniques and I have also learned not to only consider the given cases but instead make some of your own test cases also.

3) Tool Reflection
   - Python color codes their functions making it easier to see what is going on.
   - When looking at a variable or word, if highlighted, it highlights all variables allowing for easier debugging and seeing what the variable has been used for. The syntax is also nicer (no need for semicolon after every line) forcing you to indent making your code neater.
   - Advice: Look for good IDE's to use for coding such as pycharm as the python 3.7.2 IDE does not have the best format and has less tools to help you with coding. Also spend some time understanding different functions ahead of time.

Part B)

1) Main Findings

Performance comparison:

Based on the table's data, the total number of cycles of each CPU design is very different. It shows that the Fast pipeline has the best performance followed by Slow pipeline, then Multicycle.

Fast-forwarding design worthiness:

Fast-forwarding is definitely worth the expense if fast performance is desired. In the table below, Fast pipeline consistently stayed as the best performing CPU design with an average of 324 total number of cycles per test cases.

Program	Multicycle output	Slow pipeline	Fast pipeline
X with seed 24 Using SLT	Total # of cycles = 844 # of 3 cycles = 64 % of instructions are 3 cycles = 3.3684210526315788 % # of 4 cycles = 143 % of instructions are 3 cycles = 7.526315789473684 % # of 5 cycles = 16 % of instructions are 3 cycles = 0.8421052631578947 %	Total # of cycles = 607 # instr entering pipeline: 223 finishing up the last instruction: 4 control hazard delay = 189 data hazards dealy = 191	Total # of cycles = 324 # instr entering pipeline: 223 finishing up the last instruction: 4 control hazard delay= 33 data hazard delay = 64
X with seed 7 Using SLT	Total # of cycles = 836 # of 3 cycles = 64 % of instructions are 3 cycles = 3.3684210526315788 % # of 4 cycles = 141 % of instructions are 3 cycles = 7.421052631578948 % # of 5 cycles = 16 % of instructions are 3 cycles = 0.8421052631578947 %	Total # of cycles = 605 # instr entering pipeline: 221 finishing up the last instruction: 4 control hazard delay = 189 data hazards dealy = 191	Total # of cycles = 324 # instr entering pipeline: 221 finishing up the last instruction: 4 control hazard delay= 35 data hazard delay = 64
X with seed 7 Using SLTU	Total # of cycles = 852 # of 3 cycles = 64 % of instructions are 3 cycles = 3.3684210526315788 % # of 4 cycles = 145 % of instructions are 3 cycles = 7.631578947368421 % # of 5 cycles = 16 % of instructions are 3 cycles = 0.8421052631578947 %	Total # of cycles = 609 # instr entering pipeline: 225 finishing up the last instruction: 4 control hazard delay = 189 data hazards dealy = 191	Total # of cycles = 324 # instr entering pipeline: 225 finishing up the last instruction: 4 control hazard delay= 31 data hazard delay = 64

2) Simulator Showcase
   TEST CASE 0 (MC):

Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py
Please enter MIPS instruction file name: case0.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline
> 1

Choose which cache to run with the CPU
1)Direct-mapping   2)2-way Set-associative   3)Fully-associated
> 1
Enter Cache Configuration:
block size:8
way:1
set:8
cycle: 0
Running 4 cycles
addi $8, $0, 5
pc = 0

cycle: 4
Running 4 cycles
xor $9, $0, $0
pc = 4

cycle: 8
Running 5 cycles
lw $10,8196($0)
pc = 8

------------------------ cache ------------------------
target0x2004
DM cache
  blk/set to access : 0
  valid bit   : 0
  tag   : None

```
hit or not       : False
cache update data :
    block 0 :
            valid: 1
            tag  : 0
    block 1 :
            valid: 0
            tag  : None
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
    block 2 :
            valid: 0
            tag  : None
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
    block 3 :
            valid: 0
            tag  : None
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
    block 4 :
```

valid: 0

tag : None

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

block 5 :

valid: 0

tag : None

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

block 6 :

valid: 0

tag : None

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

block 7 :

valid: 0

tag : None

0x00000000

0x00000000

0x00000000

0x00000000

```
        0x00000000
        0x00000000
        0x00000000
        0x00000000
```

cycle: 13
Running 4 cycles
sw $8, 8192($0)
pc = 12

cycle: 17
Running 3 cycles
beq $0, $0, -1
pc = 16

------------------ Multi-cycle cpu ------------------
Total # of cycles = 20
# of 3 cycles = 1
% of instructions are 3 cycles = 0.25 %
# of 4 cycles = 3
% of instructions are 3 cycles = 0.75 %
# of 5 cycles = 1
% of instructions are 3 cycles = 0.25 %

>>>

TEST CASE 0 (SLOW-PIPE):
Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py
Please enter MIPS instruction file name: case0.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline
> 2

Choose which cache to run with the CPU
1)Direct-mapping   2)2-way Set-associative   3)Fully-associated

> 1
Enter Cache Configuration:
block size:8
way:1
set:8
pipeline stage: F
addi $8, $0, 5
pc = 0

pipeline stage: D
xor $9, $0, $0
pc = 4

pipeline stage: E
lw $10,8196($0)
pc = 8

------------------------- cache -------------------------
target0x2004
DM cache
  blk/set to access : 0
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
      block 0 :
            valid: 1
            tag : 0
      block 1 :
            valid: 0
            tag : None
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000
            0x00000000

```
block 2 :
       valid: 0
       tag  : None
       0x00000000
       0x00000000
       0x00000000
       0x00000000
       0x00000000
       0x00000000
       0x00000000
       0x00000000
block 3 :
       valid: 0
       tag  : None
       0x00000000
       0x00000000
       0x00000000
       0x00000000
       0x00000000
       0x00000000
       0x00000000
       0x00000000
block 4 :
       valid: 0
       tag  : None
       0x00000000
       0x00000000
       0x00000000
       0x00000000
       0x00000000
       0x00000000
       0x00000000
       0x00000000
block 5 :
       valid: 0
       tag  : None
       0x00000000
       0x00000000
       0x00000000
```

0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
        block 6 :
                valid: 0
                tag : None
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
        block 7 :
                valid: 0
                tag : None
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
No hazard
pipeline stage: M
sw $8, 8192($0)
pc = 12

Control hazard
Number of NOPs: 3
pipeline stage: W
beq $0, $0, -1
pc = 16

------------------ Slow pipeline cpu ------------------

Total # of cycles = 9
instr entering pipeline: 5
finishing up the last instruction: 4
control hazard delay = 0
data hazards dealy = 0

>>>

TEST CASE 0 (FAST-PIPE):
Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py
Please enter MIPS instruction file name: case0.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline
> 3

Choose which cache to run with the CPU
1)Direct-mapping   2)2-way Set-associative   3)Fully-associated
> 1
Enter Cache Configuration:
block size:8
way:1
set:8
pipeline stage: F
addi $8, $0, 5
pc = 0

pipeline stage: D
xor $9, $0, $0
pc = 4

pipeline stage: E
lw $10,8196($0)
pc = 8

------------------------ cache ------------------------

target0x2004

DM cache

  blk/set to access : 0

  valid bit   : 0

  tag   : None

  hit or not   : False

  cache update data :

     block 0 :

         valid: 1

         tag : 0

     block 1 :

         valid: 0

         tag : None

         0x00000000

         0x00000000

         0x00000000

         0x00000000

         0x00000000

         0x00000000

         0x00000000

         0x00000000

     block 2 :

         valid: 0

         tag : None

         0x00000000

         0x00000000

         0x00000000

         0x00000000

         0x00000000

         0x00000000

         0x00000000

         0x00000000

     block 3 :

         valid: 0

         tag : None

         0x00000000

         0x00000000

         0x00000000

```
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 4 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 5 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 6 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 7 :
```

valid: 0
                    tag : None
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
No hazard
pipeline stage: M
sw $8, 8192($0)
pc = 12

Control hazard
Stall
pipeline stage: W
beq $0, $0, -1
pc = 16

------------------ Fast pipeline cpu ------------------
Total # of cycles = 9
instr entering pipeline: 5
finishing up the last instruction: 4
control hazard delay= 0
data hazard delay = 0
>>>

TEST CASE 1 (MC):
Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py
Please enter MIPS instruction file name: case1.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline

> 1

Choose which cache to run with the CPU
1)Direct-mapping   2)2-way Set-associative   3)Fully-associated
> 1
Enter Cache Configuration:
block size:8
way:1
set:8
cycle: 0
Running 4 cycles
ori $9, $0, 0d4096
pc = 0

cycle: 4
Running 4 cycles
addu $8, $9, $9
pc = 4

cycle: 8
Running 4 cycles
sub $9, $0, $8
pc = 8

cycle: 12
Running 4 cycles
slt $10, $8, $9
pc = 12

cycle: 16
Running 4 cycles
sltu $11, $8, $9
pc = 16

cycle: 20
Running 3 cycles
beq $0, $0, -1
pc = 20

------------------ Multi-cycle cpu ------------------
Total # of cycles = 23
# of 3 cycles = 1
% of instructions are 3 cycles = 0.2 %
# of 4 cycles = 5
% of instructions are 3 cycles = 1.0 %
# of 5 cycles = 0
% of instructions are 3 cycles = 0.0 %

>>>

TEST CASE 1 (SLOW-PIPE):
Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py
Please enter MIPS instruction file name: case1.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline
> 2

Choose which cache to run with the CPU
1)Direct-mapping   2)2-way Set-associative   3)Fully-associated
> 1
Enter Cache Configuration:
block size:8
way:1
set:8
Data hazard
Number of NOPs: 2
pipeline stage: F
ori $9, $0, 0d4096
pc = 0

Data hazard
Number of NOPs: 2
pipeline stage: D

addu $8, $9, $9
pc = 4

Data hazard
Number of NOPs: 2
pipeline stage: E
sub $9, $0, $8
pc = 8

pipeline stage: M
slt $10, $8, $9
pc = 12

pipeline stage: W
sltu $11, $8, $9
pc = 16

Control hazard
Number of NOPs: 3
pipeline stage: F
beq $0, $0, -1
pc = 20

------------------ Slow pipeline cpu ------------------
Total # of cycles = 16
instr entering pipeline: 6
finishing up the last instruction: 4
control hazard delay = 0
data hazards dealy = 6

>>>

TEST CASE 1 (FAST-PIPE):
Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py
Please enter MIPS instruction file name: case1.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline
> 3

Choose which cache to run with the CPU
1)Direct-mapping   2)2-way Set-associative   3)Fully-associated
> 2
Enter Cache Configuration:
block size:8
way:2
set:8
pipeline stage: F
ori $9, $0, 0d4096
pc = 0

pipeline stage: D
addu $8, $9, $9
pc = 4

pipeline stage: E
sub $9, $0, $8
pc = 8

pipeline stage: M
slt $10, $8, $9
pc = 12

pipeline stage: W
sltu $11, $8, $9
pc = 16

Control hazard
Stall
pipeline stage: F
beq $0, $0, -1
pc = 20

------------------ Fast pipeline cpu ------------------

Total # of cycles = 10
instr entering pipeline: 6
finishing up the last instruction: 4
control hazard delay= 0
data hazard delay = 0
>>>

TEST CASE 2 (MC):
Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py
Please enter MIPS instruction file name: case2.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline
> 1

Choose which cache to run with the CPU
1)Direct-mapping   2)2-way Set-associative   3)Fully-associated
> 3
Enter Cache Configuration:
block size:8
way:4
set:1
cycle: 0
Running 4 cycles
addi $8, $0, -2
pc = 0

cycle: 4
Running 4 cycles
addi $8, $8, 1
pc = 4

cycle: 8
Running 3 cycles
bne $8, $0, -2

pc = 0

cycle: 11
Running 4 cycles
addi $8, $8, 1
pc = 4

cycle: 15
Running 3 cycles
bne $8, $0, -2
pc = 8

cycle: 18
Running 3 cycles
beq $0, $0, -1
pc = 12

------------------ Multi-cycle cpu ------------------
Total # of cycles = 21
# of 3 cycles = 3
% of instructions are 3 cycles = 1.0 %
# of 4 cycles = 3
% of instructions are 3 cycles = 1.0 %
# of 5 cycles = 0
% of instructions are 3 cycles = 0.0 %

>>>

TEST CASE 2 (SLOW-PIPE):
Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py
Please enter MIPS instruction file name: case2.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline
> 2

Choose which cache to run with the CPU

1)Direct-mapping   2)2-way Set-associative   3)Fully-associated

> 1

Enter Cache Configuration:

block size:8

way:1

set:8

Data hazard

Number of NOPs: 2

pipeline stage: F

addi $8, $0, -2

pc = 0

Data hazard

Number of NOPs: 2

pipeline stage: D

addi $8, $8, 1

pc = 4

Control hazard

Number of NOPs: 3

pipeline stage: E

bne $8, $0, -2

pc = 0

Data hazard

Number of NOPs: 2

pipeline stage: D

addi $8, $8, 1

pc = 4

Control hazard

Number of NOPs: 3

pipeline stage: E

bne $8, $0, -2

pc = 8

Control hazard

Number of NOPs: 3
pipeline stage: M
beq $0, $0, -1
pc = 12

------------------ Slow pipeline cpu ------------------
Total # of cycles = 22
instr entering pipeline: 6
finishing up the last instruction: 4
control hazard delay = 6
data hazards dealy = 6

>>>

TEST CASE 2 (FAST-PIPE):
Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py
Please enter MIPS instruction file name: case2.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline
> 3

Choose which cache to run with the CPU
1)Direct-mapping   2)2-way Set-associative   3)Fully-associated
> 1
Enter Cache Configuration:
block size:8
way:1
set:8
pipeline stage: F
addi $8, $0, -2
pc = 0

Data hazard
Stall

pipeline stage: D
addi $8, $8, 1
pc = 4

Control hazard
Stall
pipeline stage: E
bne $8, $0, -2
pc = 0

Data hazard
Stall
pipeline stage: D
addi $8, $8, 1
pc = 4

Control hazard
Flush
pipeline stage: E
bne $8, $0, -2
pc = 8

Control hazard
Stall
pipeline stage: M
beq $0, $0, -1
pc = 12

------------------ Fast pipeline cpu ------------------
Total # of cycles = 13
instr entering pipeline: 6
finishing up the last instruction: 4
control hazard delay= 1
data hazard delay = 2
>>>

TEST CASE 3 (MC):
Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.

>>>
 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py
Please enter MIPS instruction file name: case3.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline
> 1

Choose which cache to run with the CPU
1)Direct-mapping   2)2-way Set-associative   3)Fully-associated
> 1
Enter Cache Configuration:
block size:8
way:1
set:8
cycle: 0
Running 4 cycles
addi $11, $0, -1
pc = 0

cycle: 4
Running 4 cycles
ori $8, $0, 0d12
pc = 4

cycle: 8
Running 4 cycles
xor $10, $10, $10
pc = 8

cycle: 12
Running 4 cycles
addi $8, $8, -4
pc = 12

cycle: 16
Running 5 cycles
lw $9,8192($8)

pc = 16

------------------------ cache ------------------------
target0x2008
DM cache
  blk/set to access : 0
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
      block 0 :
              valid: 1
              tag : 0
      block 1 :
              valid: 0
              tag : None
              0x00000000
              0x00000000
              0x00000000
              0x00000000
              0x00000000
              0x00000000
              0x00000000
              0x00000000
      block 2 :
              valid: 0
              tag : None
              0x00000000
              0x00000000
              0x00000000
              0x00000000
              0x00000000
              0x00000000
              0x00000000
              0x00000000
      block 3 :
              valid: 0
              tag : None
              0x00000000

```
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 4 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 5 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 6 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
```

0x00000000
block 7 :
valid: 0
tag : None
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000

cycle: 21
Running 4 cycles
xor $9, $9, $11
pc = 20

cycle: 25
Running 4 cycles
sll $9, $9, 2
pc = 24

cycle: 29
Running 4 cycles
sw $9, 8208($8)
pc = 28

cycle: 33
Running 3 cycles
bne $8, $0, -6
pc = 8

cycle: 36
Running 4 cycles
addi $8, $8, -4
pc = 12

cycle: 40
Running 5 cycles

lw $9,8192($8)

pc = 16

------------------------- cache -------------------------

target0x2004

DM cache

  blk/set to access : 0

  valid bit   : 1

  tag   : 0

  hit or not   : True

  cache update data : no update

cycle: 45

Running 4 cycles

xor $9, $9, $11

pc = 20

cycle: 49

Running 4 cycles

sll $9, $9, 2

pc = 24

cycle: 53

Running 4 cycles

sw $9, 8208($8)

pc = 28

cycle: 57

Running 3 cycles

bne $8, $0, -6

pc = 8

cycle: 60

Running 4 cycles

addi $8, $8, -4

pc = 12

cycle: 64

Running 5 cycles

lw $9,8192($8)

pc = 16

------------------------ cache ------------------------
target0x2000
DM cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 69
Running 4 cycles
xor $9, $9, $11
pc = 20

cycle: 73
Running 4 cycles
sll $9, $9, 2
pc = 24

cycle: 77
Running 4 cycles
sw $9, 8208($8)
pc = 28

cycle: 81
Running 3 cycles
bne $8, $0, -6
pc = 32

cycle: 84
Running 3 cycles
beq $0, $0, -1
pc = 36

------------------ Multi-cycle cpu ------------------
Total # of cycles = 87
# of 3 cycles = 4
% of instructions are 3 cycles = 0.4444444444444444 %

# of 4 cycles = 15

% of instructions are 3 cycles = 1.6666666666666667 %

# of 5 cycles = 3

% of instructions are 3 cycles = 0.3333333333333333 %

>>>

TEST CASE 3 (SLOW-PIPE):

Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32

Type "help", "copyright", "credits" or "license()" for more information.

>>>

 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py

Please enter MIPS instruction file name: case3.txt

Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1

1)Multi-cycle   2)Slow pipeline   3)Fast pipeline

> 2

Choose which cache to run with the CPU

1)Direct-mapping   2)2-way Set-associative   3)Fully-associated

> 2

Enter Cache Configuration:

block size:4

way:2

set:4

pipeline stage: F

addi $11, $0, -1

pc = 0

Data hazard

Number of NOPs: 1

pipeline stage: D

ori $8, $0, 0d12

pc = 4

pipeline stage: E

xor $10, $10, $10

pc = 8

Data hazard
Number of NOPs: 2
pipeline stage: M
addi $8, $8, -4
pc = 12

Data hazard
Number of NOPs: 2
pipeline stage: W
lw $9,8192($8)
pc = 16

2 way SA cache
  blk/set to access : 0
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
      set 0 :
              valid: 1   valid: 0
              tag :0   tag :None

              0x00000000   0x00000000
              0x00000000   0x00000000

              0x00000000   0x00000000
              0x00000000   0x00000000

              0x00000000   0x00000000
              0x00000000   0x00000000
              0x00000000   0x00000000
              0x00000000   0x00000000

              0x00000000   0x00000000
              0x00000000   0x00000000
              0x00000000   0x00000000
              0x00000000   0x00000000

```
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000

0x00000000          0x00000000
0x00000000          0x00000000
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0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000

set 1 :
     valid:  0          valid:  0
     tag :None          tag :None
     0x00000000          0x00000000
     0x00000000          0x00000000

     0x00000000          0x00000000
     0x00000000          0x00000000
     0x00000000          0x00000000
     0x00000000          0x00000000

     0x00000000          0x00000000
     0x00000000          0x00000000
     0x00000000          0x00000000
     0x00000000          0x00000000
```

0x00000000	0x00000000
0x00000000	0x00000000
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0x00000000	0x00000000
0x00000000	0x00000000
0x00000000	0x00000000
0x00000000	0x00000000
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0x00000000	0x00000000

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0x00000000          0x00000000
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0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000

set 2 :
valid:  0           valid:  0
tag :None           tag :None
0x00000000          0x00000000
0x00000000          0x00000000

0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
```

0x00000000	0x00000000
0x00000000	0x00000000
0x00000000	0x00000000
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0x00000000	0x00000000

0x00000000   0x00000000

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0x00000000   0x00000000
0x00000000   0x00000000
0x00000000   0x00000000
0x00000000   0x00000000
0x00000000   0x00000000

set 3 :
    valid: 0   valid: 0
    tag :None   tag :None
    0x00000000   0x00000000
    0x00000000   0x00000000

```
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000
0x00000000          0x00000000

0x00000000          0x00000000
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0x00000000	0x00000000
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0x00000000	0x00000000

-------------------- end --------------------

Data hazard
Number of NOPs: 2
pipeline stage: F
xor $9, $9, $11
pc = 20

Data hazard
Number of NOPs: 2
pipeline stage: D
sll $9, $9, 2
pc = 24

No hazard
pipeline stage: E
sw $9, 8208($8)
pc = 28

Control hazard
Number of NOPs: 3
pipeline stage: M
bne $8, $0, -6
pc = 8

Data hazard
Number of NOPs: 2
pipeline stage: M
addi $8, $8, -4
pc = 12

Data hazard
Number of NOPs: 2
pipeline stage: W
lw $9,8192($8)
pc = 16

2 way SA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

------------------- end --------------------

Data hazard
Number of NOPs: 2
pipeline stage: F
xor $9, $9, $11
pc = 20

Data hazard
Number of NOPs: 2
pipeline stage: D
sll $9, $9, 2
pc = 24

No hazard
pipeline stage: E
sw $9, 8208($8)
pc = 28

Control hazard
Number of NOPs: 3
pipeline stage: M
bne $8, $0, -6
pc = 8

Data hazard
Number of NOPs: 2
pipeline stage: M
addi $8, $8, -4
pc = 12

Data hazard

Number of NOPs: 2
pipeline stage: W
lw $9,8192($8)
pc = 16

2 way SA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

-------------------- end --------------------

Data hazard
Number of NOPs: 2
pipeline stage: F
xor $9, $9, $11
pc = 20

Data hazard
Number of NOPs: 2
pipeline stage: D
sll $9, $9, 2
pc = 24

No hazard
pipeline stage: E
sw $9, 8208($8)
pc = 28

Control hazard
Number of NOPs: 3
pipeline stage: M
bne $8, $0, -6
pc = 32

Control hazard

Number of NOPs: 3
pipeline stage: W
beq $0, $0, -1
pc = 36

------------------ Slow pipeline cpu ------------------
Total # of cycles = 60
instr entering pipeline: 22
finishing up the last instruction: 4
control hazard delay = 9
data hazards dealy = 25

>>>

TEST CASE 3 (FAST-PIPE):
Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py
Please enter MIPS instruction file name: case3.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline
> 3

Choose which cache to run with the CPU
1)Direct-mapping   2)2-way Set-associative   3)Fully-associated
> 1
Enter Cache Configuration:
block size:8
way:1
set:8
pipeline stage: F
addi $11, $0, -1
pc = 0

pipeline stage: D
ori $8, $0, 0d12

pc = 4

pipeline stage: E
xor $10, $10, $10
pc = 8

pipeline stage: M
addi $8, $8, -4
pc = 12

Data hazard
Stall
pipeline stage: W
lw $9,8192($8)
pc = 16

------------------------ cache ------------------------
target0x2008
DM cache
  blk/set to access : 0
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
    block 0 :
      valid: 1
      tag : 0
    block 1 :
      valid: 0
      tag : None
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
    block 2 :

valid: 0

tag : None

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

block 3 :

valid: 0

tag : None

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

block 4 :

valid: 0

tag : None

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000

block 5 :

valid: 0

tag : None

0x00000000

0x00000000

0x00000000

0x00000000

0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
          block 6 :
                    valid: 0
                    tag : None
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
          block 7 :
                    valid: 0
                    tag : None
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
                    0x00000000
pipeline stage: F
xor $9, $9, $11
pc = 20

pipeline stage: D
sll $9, $9, 2
pc = 24

No hazard
pipeline stage: E
sw $9, 8208($8)
pc = 28

Control hazard
Stall
pipeline stage: M
bne $8, $0, -6
pc = 8

pipeline stage: M
addi $8, $8, -4
pc = 12

Data hazard
Stall
pipeline stage: W
lw $9,8192($8)
pc = 16

------------------------ cache ------------------------
target0x2004
DM cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update
pipeline stage: F
xor $9, $9, $11
pc = 20

pipeline stage: D
sll $9, $9, 2
pc = 24

No hazard
pipeline stage: E
sw $9, 8208($8)
pc = 28

Control hazard
Stall

pipeline stage: M
bne $8, $0, -6
pc = 8

pipeline stage: M
addi $8, $8, -4
pc = 12

Data hazard
Stall
pipeline stage: W
lw $9,8192($8)
pc = 16

------------------------ cache ------------------------
target0x2000
DM cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update
pipeline stage: F
xor $9, $9, $11
pc = 20

pipeline stage: D
sll $9, $9, 2
pc = 24

No hazard
pipeline stage: E
sw $9, 8208($8)
pc = 28

Control hazard
Flush
pipeline stage: M
bne $8, $0, -6

pc = 32

        Control hazard
        Stall
        pipeline stage: W
        beq $0, $0, -1
        pc = 36

        ------------------ Fast pipeline cpu ------------------
        Total # of cycles = 31
        # instr entering pipeline: 22
        finishing up the last instruction: 4
        control hazard delay= 2
        data hazard delay = 3
        >>>

Part C)
1) <u>Main Findings</u>

Performance comparison:
        Based on the table below, DM and 2-way SA cache designs had a percent average in the high 80's for its hit rate while FA averaged in the mid 90's. This shows that FA performed well in program Y.

Trade-offs:
        DM - to minimize miss rate, the number of blocks has to be increased, which would require more bits to be used.
        2-way SA - to minimize miss rate, the number of ways and/or sets can be increased, which would also require more bits to be used.
        FA - to minimize miss rate, the number of ways has to be increased, which would also require more bite to be used.

**Note: incomplete cache program*

Program	DM Cache (b=8; N=1; S=8)	2-way set-associative (b=8; N=2; S=4)	FA cache (b=16; N=4; S=1)

Y, parameter = (0x2070, 5)	blk/set to access : 3
	  valid bit : 1
	  tag : 0
	  hit or not : True
	  cache update data : no update
	Hit rate: 0.87
		blk/set to access : 3
		  valid bit : 1
		  tag : 0
		  hit or not : True
		cache update data : no update
		Hit rate: 0.87
			blk/set to access : 0
			  valid bit : 1
			  tag : 1
			  hit or not : True
			  cache update data : no update
			Hit rate: 0.93

Y, parameter = (0x2078, 3)
 	
** this is only showing latest cache at address 0x2060**
	blk/set to access : 3
	  valid bit : 0
	  tag : None
	  hit or not : False
	  cache update data :
	Hit rate: 0.88
		blk/set to access : 3
		  valid bit : 0
		  tag : None
		  hit or not : False
		  cache update data :
		      set 0
		Hit rate: 0.88
			blk/set to access : 0
			  valid bit : 1
			  tag : 1
			  hit or not : True
			  cache update data : no update
			Hit rate: 0.94

Program	N-way

Y, parameter = (0x2070, 5)	blk/set to access : 2
	  valid bit : 1
	  tag : 0
	  hit or not : True
	Cache updatedata : no update
	Hit rate: 0.87

Y, parameter = (0x2078, 3)
 	
** this is only showing latest cache at address 0x2060**
	blk/set to access : 2
	  valid bit : 1
	  tag : 1
	  hit or not : True
	cache update data : no update
	Hit rate: 0.88

2) Simulator Showcase

PRGM Y2 (DM):

Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py
Please enter MIPS instruction file name: testy2.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline
> 1

Choose which cache to run with the CPU
1)Direct-mapping   2)2-way Set-associative   3)Fully-associated
> 1
Enter Cache Configuration:
block size:8
way:1
set:8
cycle: 0
Running 4 cycles
ori $8, $0, 0d2
pc = 0

cycle: 4
Running 4 cycles
addi $9, $0, 96
pc = 4

cycle: 8
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 12
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 16

Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 19
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 23
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 27
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 31
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 34
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 38
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 42
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 45
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 49
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 53
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 57
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 60
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 64
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 68
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 71
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 75
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 79
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 83
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 86
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 90
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 94
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 97
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 101
Running 4 cycles
sub $8, $0, $8

pc = 24

cycle: 105
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 109
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 112
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 116
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 120
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 123
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 127
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 131
Running 4 cycles

addi $8, $8, -3
pc = 28

cycle: 135
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 138
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 142
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 146
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 149
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 153
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 157
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 161

Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 164
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 168
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 172
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 175
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 179
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 183
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 187
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 190
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 194
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 198
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 201
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 205
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 209
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 213
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 216
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 220
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 224
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 227
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 231
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 235
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 239
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 242
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 246
Running 4 cycles
addi $9, $9, -4

pc = 12

cycle: 250
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 253
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 257
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 261
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 265
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 268
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 272
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 276
Running 3 cycles

beq $0, $9, 4
pc = 16

cycle: 279
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 283
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 287
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 291
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 294
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 298
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 302
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 305

Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 309
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 313
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 317
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 320
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 324
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 328
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 331
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 335
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 339
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 343
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 346
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 350
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 354
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 357
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 361
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 365
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 369
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 372
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 376
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 380
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 383
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 387
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 391
Running 4 cycles
addi $8, $8, -3

pc = 28

cycle: 395
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 398
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 402
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 406
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 409
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 413
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 417
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 421
Running 3 cycles

beq $0, $0, -7
pc = 4

cycle: 424
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 428
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 432
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 435
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 439
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 443
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 447
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 450

Running 4 cycles

sw $8, 8192($9)

pc = 8

cycle: 454

Running 4 cycles

addi $9, $9, -4

pc = 12

cycle: 458

Running 3 cycles

beq $0, $9, 4

pc = 16

cycle: 461

Running 4 cycles

addu $8, $8, $8

pc = 20

cycle: 465

Running 4 cycles

sub $8, $0, $8

pc = 24

cycle: 469

Running 4 cycles

addi $8, $8, -3

pc = 28

cycle: 473

Running 3 cycles

beq $0, $0, -7

pc = 4

cycle: 476

Running 4 cycles

sw $8, 8192($9)

pc = 8

cycle: 480
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 484
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 487
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 491
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 495
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 499
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 502
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 506
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 510
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 513
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 517
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 521
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 525
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 528
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 532
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 536
Running 3 cycles
beq $0, $9, 4

pc = 16

cycle: 539
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 543
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 547
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 551
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 554
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 558
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 562
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 565
Running 4 cycles

addu $8, $8, $8
pc = 20

cycle: 569
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 573
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 577
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 580
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 584
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 588
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 591
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 595

Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 599
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 603
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 606
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 610
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 614
Running 3 cycles
beq $0, $9, 4
pc = 32

cycle: 617
Running 4 cycles
addi $8, $0, 8312
pc = 36

cycle: 621
Running 4 cycles
addi $10, $0, 8288
pc = 40

cycle: 625
Running 4 cycles
addi $9, $0, 8192
pc = 44

cycle: 629
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 633
Running 5 cycles
lw $11,0($9)
pc = 52

------------------------ cache ------------------------
target0x2000
DM cache
  blk/set to access : 0
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
    block 0 :
          valid: 1
          tag : 0
    block 1 :
          valid: 0
          tag : None
          0x00000000
          0x00000000
          0x00000000
          0x00000000
          0x00000000
          0x00000000
          0x00000000
          0x00000000
    block 2 :
          valid: 0

```
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 3 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 4 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 5 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
```

0x00000000
0x00000000
0x00000000

block 6 :
valid: 0
tag : None
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000

block 7 :
valid: 0
tag : None
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000

cycle: 638
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 642
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------- cache -------------------------
target0x2004
DM cache
  blk/set to access : 0

valid bit   : 1
        tag   : 0
        hit or not   : True
        cache update data : no update
cycle: 647
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 651
Running 3 cycles
beq $0, $13, 1
pc = 68

cycle: 654
Running 4 cycles
add $11, $0, $12
pc = 72

cycle: 658
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 662
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 665
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 669
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------

target0x2008

DM cache

   blk/set to access : 0

   valid bit   : 1

   tag   : 0

   hit or not   : True

   cache update data : no update

cycle: 674

Running 4 cycles

slt $13, $12, $11

pc = 64

cycle: 678

Running 3 cycles

beq $0, $13, 1

pc = 72

cycle: 681

Running 4 cycles

addi $14, $14, -1

pc = 76

cycle: 685

Running 3 cycles

bne $0, $14, -7

pc = 52

cycle: 688

Running 4 cycles

addi $9, $9, 4

pc = 56

cycle: 692

Running 5 cycles

lw $12,0($9)

pc = 60

------------------------ cache ------------------------

target0x200c
DM cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 697
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 701
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 704
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 708
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 711
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 715
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 719
Running 4 cycles

slt $13, $9, $10
pc = 92

cycle: 723
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 726
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 730
Running 5 cycles
lw $11,0($9)
pc = 52

------------------------ cache ------------------------
target0x200c
DM cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update
cycle: 735
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 739
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x2010
DM cache

blk/set to access : 0
    valid bit   : 1
    tag   : 0
    hit or not   : True
    cache update data : no update
cycle: 744
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 748
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 751
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 755
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 758
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 762
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------- cache -------------------------
target0x2014
DM cache
    blk/set to access : 0

valid bit   : 1
tag   : 0
hit or not   : True
cache update data : no update
cycle: 767
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 771
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 774
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 778
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 781
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 785
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x2018
DM cache
blk/set to access : 0
valid bit   : 1

tag   : 0
    hit or not   : True
    cache update data : no update
cycle: 790
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 794
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 797
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 801
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 804
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 808
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 812
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 816

Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 819
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 823
Running 5 cycles
lw $11,0($9)
pc = 52

------------------------ cache ------------------------
target0x2018
DM cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 828
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 832
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x201c
DM cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True

cache update data : no update

cycle: 837
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 841
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 844
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 848
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 851
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 855
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x2020
DM cache
  blk/set to access : 1
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :

```
block 0 :
      valid: 1
      tag  : 0
block 1 :
      valid: 1
      tag  : 0
block 2 :
      valid: 0
      tag  : None
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
block 3 :
      valid: 0
      tag  : None
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
block 4 :
      valid: 0
      tag  : None
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
      0x00000000
```

block 5 :
                valid: 0
                tag : None
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
        block 6 :
                valid: 0
                tag : None
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
        block 7 :
                valid: 0
                tag : None
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
cycle: 860
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 864

Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 867
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 871
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 874
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 878
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x2024
DM cache
   blk/set to access : 1
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update
cycle: 883
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 887
Running 3 cycles

beq $0, $13, 1
pc = 72

cycle: 890
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 894
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 897
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 901
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 905
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 909
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 912
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 916

Running 5 cycles

lw $11,0($9)

pc = 52

------------------------ cache ------------------------

target0x2024

DM cache

  blk/set to access : 1

  valid bit   : 1

  tag   : 0

  hit or not   : True

  cache update data : no update

cycle: 921

Running 4 cycles

addi $9, $9, 4

pc = 56

cycle: 925

Running 5 cycles

lw $12,0($9)

pc = 60

------------------------ cache ------------------------

target0x2028

DM cache

  blk/set to access : 1

  valid bit   : 1

  tag   : 0

  hit or not   : True

  cache update data : no update

cycle: 930

Running 4 cycles

slt $13, $12, $11

pc = 64

cycle: 934

Running 3 cycles

beq $0, $13, 1

pc = 72

cycle: 937
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 941
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 944
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 948
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x202c
DM cache
  blk/set to access : 1
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 953
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 957
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 960
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 964
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 967
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 971
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x2030
DM cache
  blk/set to access : 1
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 976
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 980
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 983

Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 987
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 990
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 994
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 998
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1002
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1005
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1009
Running 5 cycles
lw $11,0($9)
pc = 52

------------------------ cache ------------------------
target0x2030
DM cache
   blk/set to access : 1
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update
cycle: 1014
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1018
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x2034
DM cache
   blk/set to access : 1
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update
cycle: 1023
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1027
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1030
Running 4 cycles
addi $14, $14, -1

pc = 76

cycle: 1034
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1037
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1041
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x2038
DM cache
    blk/set to access : 1
    valid bit   : 1
    tag   : 0
    hit or not   : True
    cache update data : no update
cycle: 1046
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1050
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1053
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1057
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1060
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1064
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x203c
DM cache
   blk/set to access : 1
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update
cycle: 1069
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1073
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1076
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1080
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1083
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1087
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1091
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1095
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1098
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1102
Running 5 cycles
lw $11,0($9)
pc = 52

------------------------- cache -------------------------
target0x203c
DM cache
   blk/set to access : 1

valid bit   : 1
         tag   : 0
         hit or not   : True
         cache update data : no update
cycle: 1107
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1111
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x2040
DM cache
    blk/set to access : 2
    valid bit   : 0
    tag   : None
    hit or not   : False
    cache update data :
        block 0 :
               valid: 1
               tag : 0
        block 1 :
               valid: 1
               tag : 0
        block 2 :
               valid: 1
               tag : 0
        block 3 :
               valid: 0
               tag : None
               0x00000000
               0x00000000
               0x00000000
               0x00000000
               0x00000000

```
        0x00000000
        0x00000000
        0x00000000
block 4 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 5 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 6 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 7 :
        valid: 0
        tag  : None
```

0x00000000
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000
0x00000000

cycle: 1116
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1120
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1123
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1127
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1130
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1134
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------

target0x2044
DM cache
  blk/set to access : 2
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 1139
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1143
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1146
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1150
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1153
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1157
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------- cache -------------------------
target0x2048

DM cache
  blk/set to access : 2
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 1162
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1166
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1169
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1173
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1176
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1180
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1184
Running 4 cycles
slt $13, $9, $10

pc = 92

cycle: 1188
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1191
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1195
Running 5 cycles
lw $11,0($9)
pc = 52

------------------------ cache ------------------------
target0x2048
DM cache
    blk/set to access : 2
    valid bit   : 1
    tag   : 0
    hit or not   : True
    cache update data : no update
cycle: 1200
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1204
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x204c
DM cache
    blk/set to access : 2

valid bit   : 1
       tag   : 0
       hit or not   : True
       cache update data : no update
cycle: 1209
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1213
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1216
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1220
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1223
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1227
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x2050
DM cache
   blk/set to access : 2
       valid bit   : 1

```
        tag          : 0
   hit or not    : True
   cache update data : no update
cycle: 1232
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1236
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1239
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1243
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1246
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1250
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x2054
DM cache
   blk/set to access : 2
   valid bit     : 1
    tag          : 0
```

hit or not   : True
    cache update data : no update
cycle: 1255
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1259
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1262
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1266
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1269
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1273
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1277
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1281
Running 3 cycles

bne $0, $13, -13
pc = 44

cycle: 1284
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1288
Running 5 cycles
lw $11,0($9)
pc = 52

------------------------ cache ------------------------
target0x2054
DM cache
    blk/set to access : 2
    valid bit   : 1
    tag   : 0
    hit or not   : True
    cache update data : no update
cycle: 1293
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1297
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x2058
DM cache
    blk/set to access : 2
    valid bit   : 1
    tag   : 0
    hit or not   : True
    cache update data : no update

cycle: 1302
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1306
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1309
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1313
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1316
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1320
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x205c
DM cache
  blk/set to access : 2
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 1325

Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1329
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1332
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1336
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1339
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1343
Running 5 cycles
lw $12,0($9)
pc = 60

------------------------ cache ------------------------
target0x2060
DM cache
  blk/set to access : 3
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
     block 0 :
           valid: 1

```
        tag  : 0
block 1 :
        valid: 1
        tag  : 0
block 2 :
        valid: 1
        tag  : 0
block 3 :
        valid: 1
        tag  : 0
block 4 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 5 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
        0x00000000
block 6 :
        valid: 0
        tag  : None
        0x00000000
        0x00000000
        0x00000000
        0x00000000
```

0x00000000
                0x00000000
                0x00000000
                0x00000000
        block 7 :
                valid: 0
                tag : None
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
                0x00000000
cycle: 1348
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1352
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1355
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1359
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1362
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1366
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1370
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1374
Running 3 cycles
bne $0, $13, -13
pc = 96

cycle: 1377
Running 3 cycles
beq $0, $0, -1
pc = 100

For cache DM:
    Hit rate: 0.88
------------------ Multi-cycle cpu ------------------
Total # of cycles = 1380
# of 3 cycles = 104
% of instructions are 3 cycles = 4.16 %
# of 4 cycles = 227
% of instructions are 3 cycles = 9.08 %
# of 5 cycles = 32
% of instructions are 3 cycles = 1.28 %

>>>

PRGM Y2 (FA):
Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py

Please enter MIPS instruction file name: testy2.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline
> 1

Choose which cache to run with the CPU
1)Direct-mapping   2)2-way Set-associative   3)Fully-associated
> 3
Enter Cache Configuration:
block size:16
way:4
set:1
cycle: 0
Running 4 cycles
ori $8, $0, 0d2
pc = 0

cycle: 4
Running 4 cycles
addi $9, $0, 96
pc = 4

cycle: 8
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 12
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 16
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 19
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 23
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 27
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 31
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 34
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 38
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 42
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 45
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 49
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 53
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 57
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 60
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 64
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 68
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 71
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 75
Running 4 cycles
sub $8, $0, $8

pc = 24

cycle: 79
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 83
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 86
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 90
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 94
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 97
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 101
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 105
Running 4 cycles

addi $8, $8, -3
pc = 28

cycle: 109
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 112
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 116
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 120
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 123
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 127
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 131
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 135

Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 138
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 142
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 146
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 149
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 153
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 157
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 161
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 164
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 168
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 172
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 175
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 179
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 183
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 187
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 190
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 194
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 198
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 201
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 205
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 209
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 213
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 216
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 220
Running 4 cycles
addi $9, $9, -4

pc = 12

cycle: 224
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 227
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 231
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 235
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 239
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 242
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 246
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 250
Running 3 cycles

beq $0, $9, 4
pc = 16

cycle: 253
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 257
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 261
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 265
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 268
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 272
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 276
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 279

Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 283
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 287
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 291
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 294
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 298
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 302
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 305
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 309
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 313
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 317
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 320
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 324
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 328
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 331
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 335
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 339
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 343
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 346
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 350
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 354
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 357
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 361
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 365
Running 4 cycles
addi $8, $8, -3

pc = 28

cycle: 369
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 372
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 376
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 380
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 383
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 387
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 391
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 395
Running 3 cycles

beq $0, $0, -7
pc = 4

cycle: 398
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 402
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 406
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 409
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 413
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 417
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 421
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 424

Running 4 cycles

sw $8, 8192($9)

pc = 8

cycle: 428

Running 4 cycles

addi $9, $9, -4

pc = 12

cycle: 432

Running 3 cycles

beq $0, $9, 4

pc = 16

cycle: 435

Running 4 cycles

addu $8, $8, $8

pc = 20

cycle: 439

Running 4 cycles

sub $8, $0, $8

pc = 24

cycle: 443

Running 4 cycles

addi $8, $8, -3

pc = 28

cycle: 447

Running 3 cycles

beq $0, $0, -7

pc = 4

cycle: 450

Running 4 cycles

sw $8, 8192($9)

pc = 8

cycle: 454
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 458
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 461
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 465
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 469
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 473
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 476
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 480
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 484
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 487
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 491
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 495
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 499
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 502
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 506
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 510
Running 3 cycles
beq $0, $9, 4

pc = 16

cycle: 513
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 517
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 521
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 525
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 528
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 532
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 536
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 539
Running 4 cycles

addu $8, $8, $8
pc = 20

cycle: 543
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 547
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 551
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 554
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 558
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 562
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 565
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 569

Running 4 cycles

sub $8, $0, $8

pc = 24

cycle: 573

Running 4 cycles

addi $8, $8, -3

pc = 28

cycle: 577

Running 3 cycles

beq $0, $0, -7

pc = 4

cycle: 580

Running 4 cycles

sw $8, 8192($9)

pc = 8

cycle: 584

Running 4 cycles

addi $9, $9, -4

pc = 12

cycle: 588

Running 3 cycles

beq $0, $9, 4

pc = 16

cycle: 591

Running 4 cycles

addu $8, $8, $8

pc = 20

cycle: 595

Running 4 cycles

sub $8, $0, $8

pc = 24

cycle: 599
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 603
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 606
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 610
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 614
Running 3 cycles
beq $0, $9, 4
pc = 32

cycle: 617
Running 4 cycles
addi $8, $0, 8312
pc = 36

cycle: 621
Running 4 cycles
addi $10, $0, 8288
pc = 40

cycle: 625
Running 4 cycles
addi $9, $0, 8192
pc = 44

cycle: 629
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 633
Running 5 cycles
lw $11,0($9)
pc = 52

FA cache
　blk/set to access : 0
　valid bit　　　: 0
　tag　　　　　: None
　hit or not　　: False
　cache update data :
　　set 0 :
　　　　valid:　1　　　　valid:　0　　　　valid:　0　　　　valid:　0
　　　　tag :0　　　　tag :None　　　　tag :None　　　　tag :None

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cycle: 638
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 642
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 647
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 651
Running 3 cycles
beq $0, $13, 1
pc = 68

cycle: 654
Running 4 cycles
add $11, $0, $12
pc = 72

cycle: 658
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 662
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 665
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 669

Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
    blk/set to access : 0
    valid bit   : 1
    tag   : 0
    hit or not   : True
    cache update data : no update
cycle: 674
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 678
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 681
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 685
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 688
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 692
Running 5 cycles
lw $12,0($9)

pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 697
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 701
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 704
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 708
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 711
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 715
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 719
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 723
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 726
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 730
Running 5 cycles
lw $11,0($9)
pc = 52

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 735
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 739
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache

blk/set to access : 0
    valid bit   : 1
    tag   : 0
    hit or not   : True
    cache update data : no update
cycle: 744
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 748
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 751
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 755
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 758
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 762
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
    blk/set to access : 0
    valid bit   : 1

```
    tag            : 0
    hit or not     : True
    cache update data : no update
cycle: 767
Running 4 cycles
slt $13, $12, $11
pc = 64


cycle: 771
Running 3 cycles
beq $0, $13, 1
pc = 72


cycle: 774
Running 4 cycles
addi $14, $14, -1
pc = 76


cycle: 778
Running 3 cycles
bne $0, $14, -7
pc = 52


cycle: 781
Running 4 cycles
addi $9, $9, 4
pc = 56


cycle: 785
Running 5 cycles
lw $12,0($9)
pc = 60



FA cache
   blk/set to access : 0
   valid bit      : 1
   tag            : 0
   hit or not     : True
```

cache update data : no update
cycle: 790
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 794
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 797
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 801
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 804
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 808
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 812
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 816
Running 3 cycles
bne $0, $13, -13

pc = 44

cycle: 819
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 823
Running 5 cycles
lw $11,0($9)
pc = 52

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 828
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 832
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 837
Running 4 cycles
slt $13, $12, $11

pc = 64

cycle: 841
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 844
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 848
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 851
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 855
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 860
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 864
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 867
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 871
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 874
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 878
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update
cycle: 883
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 887
Running 3 cycles

beq $0, $13, 1
pc = 72

cycle: 890
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 894
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 897
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 901
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 905
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 909
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 912
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 916

Running 5 cycles
lw $11,0($9)
pc = 52

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 921
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 925
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 930
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 934
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 937

Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 941
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 944
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 948
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 953
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 957
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 960
Running 4 cycles
addi $14, $14, -1

pc = 76

cycle: 964
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 967
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 971
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update
cycle: 976
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 980
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 983
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 987
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 990
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 994
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 998
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1002
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1005
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1009
Running 5 cycles
lw $11,0($9)
pc = 52

FA cache
  blk/set to access : 0
  valid bit   : 1

tag   : 0
   hit or not   : True
   cache update data : no update
cycle: 1014
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1018
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update
cycle: 1023
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1027
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1030
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1034
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1037
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1041
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 1046
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1050
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1053
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1057
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1060

Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1064
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 1069
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1073
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1076
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1080
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1083
Running 4 cycles
sw $11, 0($8)

pc = 84

cycle: 1087
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1091
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1095
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1098
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1102
Running 5 cycles
lw $11,0($9)
pc = 52

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update
cycle: 1107
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1111
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
      set 0 :
            valid: 1   valid: 1   valid: 0   valid: 0
              tag :0   tag :1   tag :None   tag :None

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cycle: 1116
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1120
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1123
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1127
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1130
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1134
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 1
  hit or not   : True

cache update data : no update
cycle: 1139
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1143
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1146
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1150
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1153
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1157
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 1
  hit or not   : True
  cache update data : no update
cycle: 1162

Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1166
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1169
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1173
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1176
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1180
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1184
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1188
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1191
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1195
Running 5 cycles
lw $11,0($9)
pc = 52

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 1
  hit or not   : True
  cache update data : no update
cycle: 1200
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1204
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 1
  hit or not   : True
  cache update data : no update
cycle: 1209
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1213
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1216
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1220
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1223
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1227
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 1
  hit or not   : True
  cache update data : no update
cycle: 1232
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1236
Running 3 cycles

beq $0, $13, 1
pc = 72

cycle: 1239
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1243
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1246
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1250
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 1
   hit or not   : True
   cache update data : no update
cycle: 1255
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1259
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1262
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1266
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1269
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1273
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1277
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1281
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1284
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1288
Running 5 cycles
lw $11,0($9)

pc = 52

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 1
  hit or not   : True
  cache update data : no update
cycle: 1293
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1297
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 1
  hit or not   : True
  cache update data : no update
cycle: 1302
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1306
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1309
Running 4 cycles
addi $14, $14, -1

pc = 76

cycle: 1313
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1316
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1320
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
    blk/set to access : 0
    valid bit   : 1
    tag   : 1
    hit or not   : True
    cache update data : no update
cycle: 1325
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1329
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1332
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1336
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1339
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1343
Running 5 cycles
lw $12,0($9)
pc = 60

FA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 1
   hit or not   : True
   cache update data : no update
cycle: 1348
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1352
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1355
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1359
Running 3 cycles

bne $0, $14, -7
pc = 80

cycle: 1362
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1366
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1370
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1374
Running 3 cycles
bne $0, $13, -13
pc = 96

cycle: 1377
Running 3 cycles
beq $0, $0, -1
pc = 100

For cache FA:
    Hit rate: 0.94
------------------ Multi-cycle cpu ------------------
Total # of cycles = 1380
# of 3 cycles = 104
% of instructions are 3 cycles = 4.16 %
# of 4 cycles = 227
% of instructions are 3 cycles = 9.08 %
# of 5 cycles = 32
% of instructions are 3 cycles = 1.28 %

Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
 PRGM Y2 (2 WAY SA):
RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py
Please enter MIPS instruction file name: testy2.txt
Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1
1)Multi-cycle   2)Slow pipeline   3)Fast pipeline
> 1

Choose which cache to run with the CPU
1)Direct-mapping   2)2-way Set-associative   3)Fully-associated
> 2
Enter Cache Configuration:
block size:8
way:2
set:4
cycle: 0
Running 4 cycles
ori $8, $0, 0d2
pc = 0

cycle: 4
Running 4 cycles
addi $9, $0, 96
pc = 4

cycle: 8
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 12
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 16
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 19
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 23
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 27
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 31
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 34
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 38
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 42
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 45
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 49
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 53
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 57
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 60
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 64
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 68
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 71
Running 4 cycles
addu $8, $8, $8

pc = 20

cycle: 75
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 79
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 83
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 86
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 90
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 94
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 97
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 101
Running 4 cycles

sub $8, $0, $8
pc = 24

cycle: 105
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 109
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 112
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 116
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 120
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 123
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 127
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 131

Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 135
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 138
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 142
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 146
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 149
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 153
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 157
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 161
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 164
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 168
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 172
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 175
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 179
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 183
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 187
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 190
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 194
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 198
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 201
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 205
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 209
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 213
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 216
Running 4 cycles
sw $8, 8192($9)

pc = 8

cycle: 220
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 224
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 227
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 231
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 235
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 239
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 242
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 246
Running 4 cycles

addi $9, $9, -4
pc = 12

cycle: 250
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 253
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 257
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 261
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 265
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 268
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 272
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 276

Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 279
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 283
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 287
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 291
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 294
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 298
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 302
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 305
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 309
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 313
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 317
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 320
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 324
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 328
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 331
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 335
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 339
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 343
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 346
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 350
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 354
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 357
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 361
Running 4 cycles
sub $8, $0, $8

pc = 24

cycle: 365
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 369
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 372
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 376
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 380
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 383
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 387
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 391
Running 4 cycles

addi $8, $8, -3
pc = 28

cycle: 395
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 398
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 402
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 406
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 409
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 413
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 417
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 421

Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 424
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 428
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 432
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 435
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 439
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 443
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 447
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 450
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 454
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 458
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 461
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 465
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 469
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 473
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 476
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 480
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 484
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 487
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 491
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 495
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 499
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 502
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 506
Running 4 cycles
addi $9, $9, -4

pc = 12

cycle: 510
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 513
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 517
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 521
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 525
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 528
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 532
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 536
Running 3 cycles

beq $0, $9, 4
pc = 16

cycle: 539
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 543
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 547
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 551
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 554
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 558
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 562
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 565

Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 569
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 573
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 577
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 580
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 584
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 588
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 591
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 595
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 599
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 603
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 606
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 610
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 614
Running 3 cycles
beq $0, $9, 4
pc = 32

cycle: 617
Running 4 cycles
addi $8, $0, 8312
pc = 36

cycle: 621
Running 4 cycles
addi $10, $0, 8288
pc = 40

cycle: 625
Running 4 cycles
addi $9, $0, 8192
pc = 44

cycle: 629
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 633
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
  blk/set to access : 0
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
      set 0 :
              valid: 1   valid: 0
              tag :0   tag :None

              0x00000000   0x00000000
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set 1 :

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set 2 :

valid: 0	valid: 0
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set 3 :

valid: 0	valid: 0
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------------------- end --------------------

cycle: 638
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 642
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 647
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 651
Running 3 cycles
beq $0, $13, 1
pc = 68

cycle: 654
Running 4 cycles

add $11, $0, $12
pc = 72

cycle: 658
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 662
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 665
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 669
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 674
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 678

Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 681
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 685
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 688
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 692
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 697
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 701
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 704
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 708
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 711
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 715
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 719
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 723
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 726
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 730
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update

------------------ end -------------------

cycle: 735
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 739
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update

------------------ end -------------------

cycle: 744
Running 4 cycles
slt $13, $12, $11

pc = 64

cycle: 748
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 751
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 755
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 758
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 762
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 767
Running 4 cycles

slt $13, $12, $11
pc = 64

cycle: 771
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 774
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 778
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 781
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 785
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 790

Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 794
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 797
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 801
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 804
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 808
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 812
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 816
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 819
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 823
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 828
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 832
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 837
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 841
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 844
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 848
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 851
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 855
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 1
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
      set 0 :

valid: 1	valid: 0
tag :0	tag :None
0x00000000	0x00000000
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set 1 :

    valid: 1   valid: 0

    tag :0   tag :None

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          0x00000000              0x00000000
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set 2 :
          valid:  0          valid:  0
          tag :None           tag :None
          0x00000000              0x00000000
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set 3 :
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valid:  0           valid:  0
tag :None            tag :None
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------------------- end --------------------

cycle: 860
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 864
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 867
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 871
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 874
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 878
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
   blk/set to access : 1
   valid bit   : 1

tag   : 0
    hit or not   : True
    cache update data : no update

-------------------- end --------------------

cycle: 883
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 887
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 890
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 894
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 897
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 901
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 905
Running 4 cycles
slt $13, $9, $10

pc = 92

cycle: 909
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 912
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 916
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
   blk/set to access : 1
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 921
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 925
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache

blk/set to access : 1
valid bit   : 1
tag   : 0
hit or not   : True
cache update data : no update

------------------- end --------------------

cycle: 930
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 934
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 937
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 941
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 944
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 948
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 1
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 953
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 957
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 960
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 964
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 967
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 971
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 1
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 976
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 980
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 983
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 987
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 990
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 994
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 998
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1002
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1005
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1009
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
  blk/set to access : 1
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 1014
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1018
Running 5 cycles
lw $12,0($9)

pc = 60

2 way SA cache
  blk/set to access : 1
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 1023
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1027
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1030
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1034
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1037
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1041
Running 5 cycles

lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 1
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 1046
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1050
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1053
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1057
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1060
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1064

Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 1
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

-------------------- end --------------------

cycle: 1069
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1073
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1076
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1080
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1083
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1087
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1091
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1095
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1098
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1102
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
   blk/set to access : 1
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 1107
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1111
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
　blk/set to access : 2
　valid bit　　　: 0
　tag　　　　　: None
　hit or not　　　: False
　cache update data :
　　　set 0 :
　　　　　valid:　1　　　　　　valid:　0
　　　　　tag　:0　　　　　tag　:None

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set 1 :
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        tag  :0                 tag  :None

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set 2 :

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valid:  1           valid:  0
tag  :0             tag  :None


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set 3 :
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        tag :None           tag :None
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------------------- end --------------------

cycle: 1116
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1120
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1123
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1127
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1130
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1134
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 2
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 1139
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1143
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1146
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1150
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1153
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1157
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 2
  valid bit   : 1
  tag   : 0
  hit or not   : True

cache update data : no update

------------------- end --------------------

cycle: 1162
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1166
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1169
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1173
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1176
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1180
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1184
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1188
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1191
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1195
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
  blk/set to access : 2
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 1200
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1204
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 2
  valid bit   : 1

tag   : 0
    hit or not   : True
    cache update data : no update

------------------- end --------------------

cycle: 1209
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1213
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1216
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1220
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1223
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1227
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
    blk/set to access : 2

valid bit   : 1
tag   : 0
hit or not   : True
cache update data : no update

-------------------- end --------------------

cycle: 1232
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1236
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1239
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1243
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1246
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1250
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache

blk/set to access : 2
valid bit   : 1
tag   : 0
hit or not   : True
cache update data : no update

------------------- end --------------------

cycle: 1255
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1259
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1262
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1266
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1269
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1273
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1277

Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1281
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1284
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1288
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
  blk/set to access : 2
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 1293
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1297
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
   blk/set to access : 2
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 1302
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1306
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1309
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1313
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1316
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1320
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 2
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 1325
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1329
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1332
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1336
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1339
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1343
Running 5 cycles
lw $12,0($9)

pc = 60

2 way SA cache
  blk/set to access : 3
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
     set 0 :

valid: 1	valid: 0
tag :0	tag :None
0x00000000	0x00000000
0x00000000	0x00000000
0x00000000	0x00000000
0x00000000	0x00000000
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0x00000000	0x00000000
0x00000000	0x00000000
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set 1 :

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valid:  1           valid:  0
tag  :0             tag  :None

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set 2 :

```
valid:  1           valid:  0
tag :0              tag :None

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set 3 :
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        valid:  1           valid:  0
        tag  :0             tag  :None

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------------------- end --------------------

cycle: 1348
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1352
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1355
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1359
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1362
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1366
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1370
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1374
Running 3 cycles
bne $0, $13, -13
pc = 96

cycle: 1377
Running 3 cycles
beq $0, $0, -1
pc = 100

For cache SA:
    Hit rate: 0.88
------------------ Multi-cycle cpu ------------------
Total # of cycles = 1380
# of 3 cycles = 104
% of instructions are 3 cycles = 4.16 %
# of 4 cycles = 227
% of instructions are 3 cycles = 9.08 %
# of 5 cycles = 32
% of instructions are 3 cycles = 1.28 %

>>>>>>>

PRGM Y2(N - WAY SA):

Python 3.7.2 (tags/v3.7.2:9a3ffc0492, Dec 23 2018, 22:20:52) [MSC v.1916 32 bit (Intel)] on win32

Type "help", "copyright", "credits" or "license()" for more information.

>>>

 RESTART: C:\Users\Duy\AppData\Local\Programs\Python\Python37-32\proj4test.py

Please enter MIPS instruction file name: testy2.txt

Note: This program assumes that the instructions are in hex.

Press 1 for diagnose mode else 0 for normal operation: 1

1)Multi-cycle   2)Slow pipeline   3)Fast pipeline

> 1

Choose which cache to run with the CPU

1)Direct-mapping   2)2-way Set-associative   3)Fully-associated

> 2

Enter Cache Configuration:

block size:4

way:2

set:2

cycle: 0

Running 4 cycles

ori $8, $0, 0d2

pc = 0

cycle: 4

Running 4 cycles

addi $9, $0, 96

pc = 4

cycle: 8

Running 4 cycles

sw $8, 8192($9)

pc = 8

cycle: 12

Running 4 cycles

addi $9, $9, -4

pc = 12

cycle: 16
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 19
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 23
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 27
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 31
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 34
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 38
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 42
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 45
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 49
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 53
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 57
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 60
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 64
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 68
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 71
Running 4 cycles
addu $8, $8, $8

pc = 20

cycle: 75
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 79
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 83
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 86
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 90
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 94
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 97
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 101
Running 4 cycles

sub $8, $0, $8
pc = 24

cycle: 105
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 109
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 112
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 116
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 120
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 123
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 127
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 131

Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 135
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 138
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 142
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 146
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 149
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 153
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 157
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 161
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 164
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 168
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 172
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 175
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 179
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 183
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 187
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 190
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 194
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 198
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 201
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 205
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 209
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 213
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 216
Running 4 cycles
sw $8, 8192($9)

pc = 8

cycle: 220
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 224
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 227
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 231
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 235
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 239
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 242
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 246
Running 4 cycles

addi $9, $9, -4
pc = 12

cycle: 250
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 253
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 257
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 261
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 265
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 268
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 272
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 276

Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 279
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 283
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 287
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 291
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 294
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 298
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 302
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 305
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 309
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 313
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 317
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 320
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 324
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 328
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 331
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 335
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 339
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 343
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 346
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 350
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 354
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 357
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 361
Running 4 cycles
sub $8, $0, $8

pc = 24

cycle: 365
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 369
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 372
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 376
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 380
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 383
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 387
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 391
Running 4 cycles

addi $8, $8, -3
pc = 28

cycle: 395
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 398
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 402
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 406
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 409
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 413
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 417
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 421

Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 424
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 428
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 432
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 435
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 439
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 443
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 447
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 450
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 454
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 458
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 461
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 465
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 469
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 473
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 476
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 480
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 484
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 487
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 491
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 495
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 499
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 502
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 506
Running 4 cycles
addi $9, $9, -4

pc = 12

cycle: 510
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 513
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 517
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 521
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 525
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 528
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 532
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 536
Running 3 cycles

beq $0, $9, 4
pc = 16

cycle: 539
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 543
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 547
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 551
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 554
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 558
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 562
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 565

Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 569
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 573
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 577
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 580
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 584
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 588
Running 3 cycles
beq $0, $9, 4
pc = 16

cycle: 591
Running 4 cycles
addu $8, $8, $8
pc = 20

cycle: 595
Running 4 cycles
sub $8, $0, $8
pc = 24

cycle: 599
Running 4 cycles
addi $8, $8, -3
pc = 28

cycle: 603
Running 3 cycles
beq $0, $0, -7
pc = 4

cycle: 606
Running 4 cycles
sw $8, 8192($9)
pc = 8

cycle: 610
Running 4 cycles
addi $9, $9, -4
pc = 12

cycle: 614
Running 3 cycles
beq $0, $9, 4
pc = 32

cycle: 617
Running 4 cycles
addi $8, $0, 8312
pc = 36

cycle: 621
Running 4 cycles
addi $10, $0, 8288
pc = 40

cycle: 625
Running 4 cycles
addi $9, $0, 8192
pc = 44

cycle: 629
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 633
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
  blk/set to access : 0
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
     set 0 :
           valid: 1   valid: 0
           tag :0   tag :None

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set 1 :

valid: 0	valid: 0
tag :None	tag :None

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------------------- end --------------------

cycle: 638
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 642
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

-------------------- end --------------------

cycle: 647
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 651
Running 3 cycles
beq $0, $13, 1
pc = 68

cycle: 654
Running 4 cycles
add $11, $0, $12
pc = 72

cycle: 658
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 662
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 665
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 669
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : True
  cache update data : no update

-------------------- end --------------------

cycle: 674
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 678
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 681
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 685
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 688
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 692
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 697
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 701
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 704
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 708
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 711
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 715
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 719
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 723
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 726
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 730
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
    blk/set to access : 0
    valid bit   : 1
    tag   : 0
    hit or not   : True
    cache update data : no update

------------------- end --------------------

cycle: 735
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 739
Running 5 cycles
lw $12,0($9)

pc = 60

2 way SA cache
  blk/set to access : 1
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
     set 0 :
         valid: 1   valid: 0
         tag :0   tag :None

         0x00000000
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set 1 :
    valid: 1   valid: 0
    tag :0   tag :None

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------------------- end --------------------

cycle: 744
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 748
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 751
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 755
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 758
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 762
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
   blk/set to access : 1

valid bit   : 1
tag   : 0
hit or not   : True
cache update data : no update

-------------------- end --------------------

cycle: 767
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 771
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 774
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 778
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 781
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 785
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache

blk/set to access : 1
valid bit   : 1
tag   : 0
hit or not   : True
cache update data : no update

------------------- end --------------------

cycle: 790
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 794
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 797
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 801
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 804
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 808
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 812

Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 816
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 819
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 823
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
   blk/set to access : 1
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 828
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 832
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
   blk/set to access : 1
   valid bit   : 1
   tag   : 0
   hit or not   : True
   cache update data : no update

------------------ end --------------------

cycle: 837
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 841
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 844
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 848
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 851
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 855
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 0
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
      set 0 :
              valid: 1   valid: 1
              tag :0   tag :1

      set 1 :
              valid: 1   valid: 0
              tag :0   tag :None

              0x00000000
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------------------- end --------------------

cycle: 860
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 864
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 867
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 871
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 874
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 878
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 1
  hit or not   : True
  cache update data : no update

------------------ end --------------------

cycle: 883
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 887
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 890
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 894
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 897
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 901
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 905
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 909
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 912
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 916
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 1
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 921
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 925
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 1
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 930
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 934
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 937
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 941
Running 3 cycles

bne $0, $14, -7
pc = 52

cycle: 944
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 948
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 1
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 953
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 957
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 960
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 964

Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 967
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 971
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 1
  valid bit   : 0
  tag   : None
  hit or not   : False
  cache update data :
      set 0 :
            valid: 1   valid: 1
             tag :0   tag :1

      set 1 :
            valid: 1   valid: 1
             tag :0   tag :1

-------------------- end --------------------

cycle: 976
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 980
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 983
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 987
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 990
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 994
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 998
Running 4 cycles

slt $13, $9, $10
pc = 92

cycle: 1002
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1005
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1009
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
  blk/set to access : 1
  valid bit   : 1
  tag   : 1
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 1014
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1018
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
    blk/set to access : 1
    valid bit   : 1
    tag   : 1
    hit or not   : True
    cache update data : no update

------------------- end --------------------

cycle: 1023
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1027
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1030
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1034
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1037
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1041
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 1
  valid bit   : 1
  tag   : 1
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 1046
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1050
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1053
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1057
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1060
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1064
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
   blk/set to access : 1
   valid bit   : 1
   tag   : 1
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 1069
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1073
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1076
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1080
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1083
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1087
Running 4 cycles
addi $8, $8, 4

pc = 88

cycle: 1091
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1095
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1098
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1102
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
   blk/set to access : 1
   valid bit   : 1
   tag   : 1
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 1107
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1111
Running 5 cycles

lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 0
  hit or not   : False
  cache update data :
     set 0 :
        valid: 1   valid: 1
         tag :2   tag :1

     set 1 :
        valid: 1   valid: 1
         tag :0   tag :1

------------------- end --------------------

cycle: 1116
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1120
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1123
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1127
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1130
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1134
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 2
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 1139
Running 4 cycles
slt $13, $12, $11

pc = 64

cycle: 1143
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1146
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1150
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1153
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1157
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
   blk/set to access : 0
   valid bit   : 1
   tag   : 2
   hit or not   : True
   cache update data : no update

------------------- end --------------------

cycle: 1162
Running 4 cycles

slt $13, $12, $11
pc = 64

cycle: 1166
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1169
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1173
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1176
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1180
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1184
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1188
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1191

Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1195
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
    blk/set to access : 0
    valid bit   : 1
    tag   : 2
    hit or not   : True
    cache update data : no update

------------------ end --------------------

cycle: 1200
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1204
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
    blk/set to access : 0
    valid bit   : 1
    tag   : 2
    hit or not   : True
    cache update data : no update

------------------ end --------------------

cycle: 1209
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1213
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1216
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1220
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1223
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1227
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 1
  valid bit   : 1
  tag   : 0
  hit or not   : False
  cache update data :
     set 0 :
          valid: 1   valid: 1

tag :2   tag :1

          set 1 :
                    valid: 1   valid: 1
                    tag :2   tag :1

------------------- end --------------------

cycle: 1232
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1236
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1239
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1243

Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1246
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1250
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 1
  valid bit   : 1
  tag   : 2
  hit or not   : True
  cache update data : no update

------------------- end --------------------

cycle: 1255
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1259
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1262
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1266
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1269
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1273
Running 4 cycles
addi $8, $8, 4
pc = 88

cycle: 1277
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1281
Running 3 cycles
bne $0, $13, -13
pc = 44

cycle: 1284
Running 4 cycles
addi $14, $0, 3
pc = 48

cycle: 1288
Running 5 cycles
lw $11,0($9)
pc = 52

2 way SA cache
  blk/set to access : 1
   valid bit   : 1

tag   : 2
      hit or not   : True
      cache update data : no update

------------------ end --------------------

cycle: 1293
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1297
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
   blk/set to access : 1
   valid bit   : 1
   tag   : 2
   hit or not   : True
   cache update data : no update

------------------ end --------------------

cycle: 1302
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1306
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1309
Running 4 cycles
addi $14, $14, -1

pc = 76

cycle: 1313
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1316
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1320
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
    blk/set to access : 1
    valid bit   : 1
    tag   : 2
    hit or not   : True
    cache update data : no update

------------------- end --------------------

cycle: 1325
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1329
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1332
Running 4 cycles

addi $14, $14, -1
pc = 76

cycle: 1336
Running 3 cycles
bne $0, $14, -7
pc = 52

cycle: 1339
Running 4 cycles
addi $9, $9, 4
pc = 56

cycle: 1343
Running 5 cycles
lw $12,0($9)
pc = 60

2 way SA cache
  blk/set to access : 0
  valid bit   : 1
  tag   : 2
  hit or not   : False
  cache update data :
      set 0 :
            valid: 1   valid: 1
            tag :3   tag :1

      set 1 :
            valid: 1   valid: 1
            tag :2   tag :1

-------------------- end --------------------

cycle: 1348
Running 4 cycles
slt $13, $12, $11
pc = 64

cycle: 1352
Running 3 cycles
beq $0, $13, 1
pc = 72

cycle: 1355
Running 4 cycles
addi $14, $14, -1
pc = 76

cycle: 1359
Running 3 cycles
bne $0, $14, -7
pc = 80

cycle: 1362
Running 4 cycles
sw $11, 0($8)
pc = 84

cycle: 1366
Running 4 cycles
addi $8, $8, 4

pc = 88

cycle: 1370
Running 4 cycles
slt $13, $9, $10
pc = 92

cycle: 1374
Running 3 cycles
bne $0, $13, -13
pc = 96

cycle: 1377
Running 3 cycles
beq $0, $0, -1
pc = 100

For cache SA:
    Hit rate: 0.78
------------------ Multi-cycle cpu ------------------
Total # of cycles = 1380
# of 3 cycles = 104
% of instructions are 3 cycles = 4.16 %
# of 4 cycles = 227
% of instructions are 3 cycles = 9.08 %
# of 5 cycles = 32
% of instructions are 3 cycles = 1.28 %

>>>