MTCS-102(P)-Assignment1(Report)
ADVANCED ARCHITECTURE

Nitesh Sharma

1st Sem MTech (CS)
Reg. No.: 23361

Problem Description

Given a few trace files containing information about the instructions and a simulator which reads a trace file and counts the total number of micro-operations and macro-operations.

1. Find the instruction mix(Category wise count of each Machine instruction of any three trace benchmark sets and compare the results. There are five main categories of instruction namely Arithmetic and Logic Unit(ALU), Load , Store,Conditional Branch ,Unconditional Branch, and Other instructions
2. Plot the frequency of each category of instructions in histogram.

INSTRUCTION MIX:

Sno	Instruction Category	Dataset1 1k	Dataset2 50M	Dataset3 100M
1	ALU	315	17443980	26969427
2	Loads	232	10500895	25272367
3	Stores	108	5205971	10224954
4	Unconditional Branch	36	1931438	3914559
5	Conditional Branch	157	7362160	12456836
6	Others	153	7555556	21161860
	Total	1000	50000000	100000000
	Average CPI	1.992	1.937244	1.909219

Table1: Instruction Mix(Frequencies of instruction categories) for *Intel Pentium*

Dataset1(gcc.trace-1K) Output

```
et2023@dmacs13-OptiPlex-9020:~/Nitesh$ ./a.out gcc-1K\ .trace
Processing trace...
Processed 1000 trace records.
Micro-ops: 1000
Macro-ops: 754
Loads 232
Stores 108
Unconditional branch: 36
Conditional branch: 157
ADD: 125
Subtract: 164
OR: 1
Xor: 2
AND: 9
ShiftLeft: 9
ShiftRight: 4
NOT: 1
Total Alu count: 315
Floating Point counts: 0
Other Instructions counts: 153
==========Percentage================
Percentage of Load Operations:23.199999
Percentage of Store Operations:10.800000
Percentage of Unconditional Jumps Operations:3.600000
Percentage of Conditional Jumps Operations:15.700001
Percentage of ALU Operations:31.500000
Percentage of Floating point Operations:0.000000
Percentage of Other Instruction Operations:15.299999
==========================
AverageCPI(..Assuming ClockCyles for Other Instruction to be 1.. ): 1.992000
```

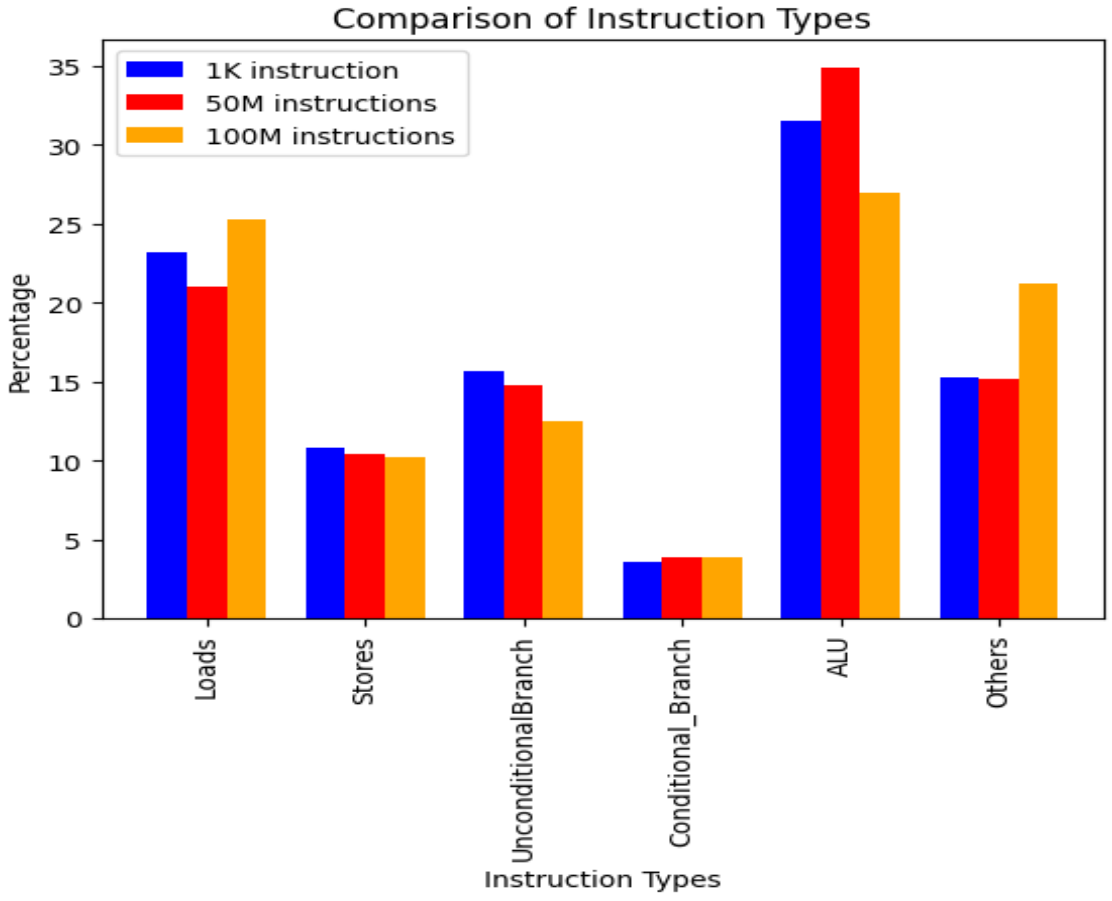
Dataset1(gcc.trace-50M) Output

```
et2023@dmacs13-OptiPlex-9020:~/Nitesh$ ./a.out gcc50M.trace
Processing trace...
Processed 49999999 trace records.
Micro-ops: 49999999
Macro-ops: 38293077
Loads 10500895
Stores 5205971
Unconditional branch: 1931438
Conditional branch: 7362160
ADD: 8223434
Subtract: 7945214
OR: 76989
Xor: 72153
AND: 287380
ShiftLeft: 637684
ShiftRight: 180178
NOT: 20948
Total Alu count: 17443980
Floating Point counts: 0
Other Instructions counts: 7555556
==========Percentage================
Percentage of Load Operations:21.001791
Percentage of Store Operations:10.411942
Percentage of Unconditional Jumps Operations:3.862876
Percentage of Conditional Jumps Operations:14.724320
Percentage of ALU Operations:34.887962
Percentage of Floating point Operations:0.000000
Percentage of Other Instruction Operations:15.111113
==========================
AverageCPI(..Assuming ClockCyles for Other Instruction to be 1.. ): 1.937244
```

Dataset1(gcc.trace-100M) Output

```
et2023@dmacs13-OptiPlex-9020:~/Nitesh$ ./a.out gcc100M.trace
Processing trace...
Processed 100000002 trace records.
Micro-ops: 100000002
Macro-ops: 75961221
Loads 25272367
Stores 10224954
Unconditional branch: 3914559
Conditional branch: 12456836
ADD: 11986853
Subtract: 14772306
OR: 165409
Xor: 2507
AND: 8890
ShiftLeft: 31518
ShiftRight: 1938
NOT: 6
Total Alu count: 26969427
Floating Point counts: 0
Other Instructions counts: 21161860
==========Percentage===============
Percentage of Load Operations:25.272369
Percentage of Store Operations:10.224954
Percentage of Unconditional Jumps Operations:3.914559
Percentage of Conditional Jumps Operations:12.456836
Percentage of ALU Operations:26.969427
Percentage of Floating point Operations:0.000000
Percentage of Other Instruction Operations:21.161860
==========================
AverageCPI(..Assuming ClockCyles for Other Instruction to be 1.. ): 1.909219
```

Histogram of given instructions:



This experiment was designed to perform an in-depth analysis of the instruction mix for three benchmark sets through trace-driven simulation. The trace files were provided to capture the sequence of executed instructions, for which simulator was configured to process these trace files and determine the total number of micro-operations and macro-operations for each benchmark set. From this trace files, various informations were extracted so that instruction mix from the simulator could be calculated

Using the categorised instructions, the experiment calculated the percentage of each instruction category relative to the overall number of micro-operations and macro-operations for each benchmark set. The comparative analysis of these percentages revealed significant variations in the instruction mix between the benchmark sets which was clearly seen from the histogram plotted.

Conclusion:

Dataset2(50M) stands out as having the highest computational workload, mainly due to its substantial number of ALU instructions. This finding highlights the potential need for optimising ALU operations for enhanced performance in applications that heavily rely on such computations.

Dataset2 exhibits a more complex control flow and branch behaviour, indicating the presence of intricate program structures.

The average CPI (Cycle Per Instruction) for the three datasets were found to be 1.992, 1.937244, and 1.909219, respectively.