An-Najah National University
Faculty Of Engineering
Computer Engineering Department

Computer Architecture 2

Assignment 1: Unrolling Loop

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Input size	Normal	d4	d8	d16	d64
1024 (us)	8.371590	7.054440	9.291470	9.224460	9.020440
	8.821030	7.838910	9.233070	9.697130	9.057050
	8.887980	10.557170	10.277130	9.226020	9.241020
	9.938100	8.803970	9.839080	10.906200	10.166120
	8.918100	5.294700	7.456930	8.958100	8.443050
	8.281310	7.012121	9.224460	9.020440	8.342051
	8.511000	7.054440	9.697130	9.057050	8.543120
	8.217980	7.838452	9.226020	9.241020	9.491440
	9.818130	10.599172	10.906200	10.166120	9.134070
	8.777110	8.803970	8.958100	8.443050	10.212130
	8.211111	5.294100	9.282821	9.545421	9.130080
	9.201919	7.373194	9.432619	9.754392	7.456930
Average (us)	8.779928	8.80397	9.44619	9.3890153	8.968332
Speed up	-	0.997267	0.929502	0.935261	0.978825
1024 *1024 (ms)	4.581313	3.984671	3.833561	3.755957	4.237990
	4.621615	4.283492	4.917636	3.961270	4.016874
	4.265868	4.609614	4.028036	4.028336	5.087177
	4.214861	4.513501	4.162554	3.893518	4.060440
	4.160310	4.196313	4.073703	3.883189	3.807384
	4.208913	4.364125	4.025500	3.762780	3.869988
	4.139108	4.143209	4.020499	3.982597	3.775481
	4.704223	4.114245	4.381435	4.157444	3.782358
	4.425134	4.023349	4.059247	3.946652	4.060148
	4.288879	4.188769	4.128865	4.022755	3.711727
	4.252793	4.071652	4.086255	4.142469	4.032043
	4.162124	4.512512	3.431529	3.261153	4.233131
Average (ms)	4.318181	4.2411167	4.0799655	3.9379523	3.9875837
Speed up	-	1.018161	1.058371	1.096379	1.083050
16*1024 *1024 (ms)	0.170348	0.122682	0.144236	0.126800	0.121932
	0.135632	0.135070	0.123720	0.122620	0.123244
	0.139072	0.138250	0.125131	0.131095	0.120816
	0.187423	0.122159	0.120941	0.123632	0.120551
	0.152351	0.151254	0.123856	0.128601	0.119948
	0.137572	0.130757	0.126195	0.120163	0.122239
	0.141155	0.133756	0.126565	0.117342	0.122969
	0.144560	0.130694	0.126805	0.121291	0.118072
	0.146531	0.136101	0.122510	0.116101	0.118330
	0.137444	0.128701	0.143758	0.123614	0.119146
	0.161377	0.125862	0.115331	0.123649	0.123019
	0.138040	0.142807	0.144054	0.138783	0.151659

Average (ms)	0.146845	0.132468	0.1283535	0.1238807	0.1212194
Speed up	-	1.108382	1.144048	1.185375	1.211470

The degree of performance degradation is influenced by the cache's size, organization, and replacement policy. Specifically, when the input size or the degree of unrolling is increased beyond a certain threshold, we observe an increase in capacity misses, which in turn increases execution time. For example, in my results as we increased the degree of unrolling, the speedup improved initially but then declined once the cache's capacity was exceeded. This indicates that all loop instructions no longer fit in the cache, causing some instructions to be fetched from memory, which slows down execution.

Moreover, the data reveals that the speedup for a specific input size increases with the degree of unrolling until it reaches an optimal point. Beyond this point, further unrolling causes a decrease in speedup, highlighting that the optimal degree of unrolling has an inverse relationship with input size. Larger input sizes, which introduce more instructions, lead to more capacity misses at higher unrolling degrees.