

CS341: Computer Architecture Lab

Lab Assignment 4

Report

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Abstract

Summarize the objective of the lab, what experiments you have conducted, what were the results that you have obtained in a clear and concise manner. Numbers matter, not just words only, for ex. *very high, slow* etc.

Part 0: Getting Things Ready

Install Intel VTune Profiler

Installed successfully using the stand-alone app using offline installer script present in this link.

It was pretty easy to install VTune using the script.

While installing it showed that I didn't have XCB and DRM packages installed. Upon checking, I confirmed that they were already present.

Even though it failed prerequisites, there was a next option. I didn't face any issues for the rest of installation process.

From start to end, it took around 10-12 minutes to have the application installed. Followed by 3-5 minutes for tutorial.

Install Docker

Had docker setup from other projects.

Version: 20.10.9

Pull ChampSim Image

Pulled 0xd3ba/champsim-lab:latest

Part 1: Profiling with VTune

1.1 bfs.cpp

Performance Snapshot

- IPC: 1.830
- Logical Core Utilization: 8.2% (0.979 out of 12)
- Physical Core Utilization: 16.2% (0.973 out of 6)
- Memory bound: 32.0% of Pipeline slots

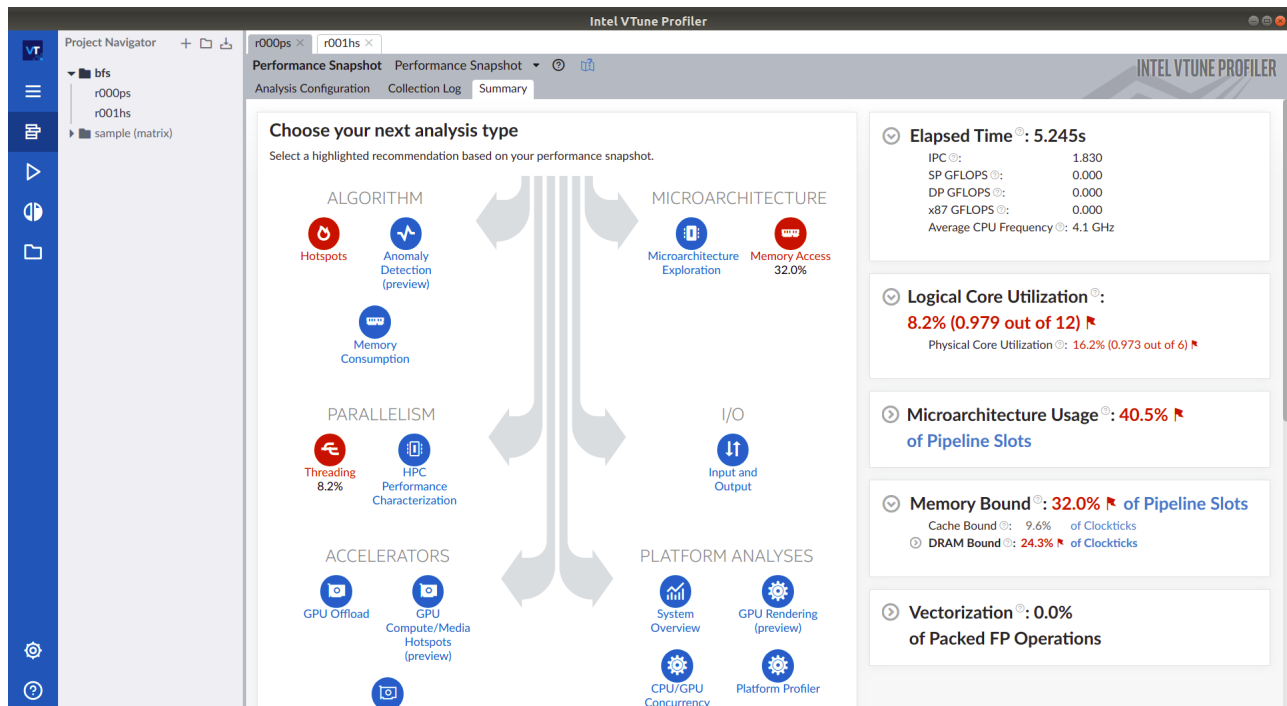


Figure 1.1: Performance Snapshot for bfs.cpp

Top 5 Functions by CPU Time

Function	Module	CPU Time
bfs	bfs.o	2.621s
main	bfs.o	1.156s
_int_free	libc-2.27.so	0.236s
_int_malloc	libc-2.27.so	0.154s
__gnu_cxx::new_allocator<Node*>::construct<Node*, Node* const&>	bfs.o	0.124s

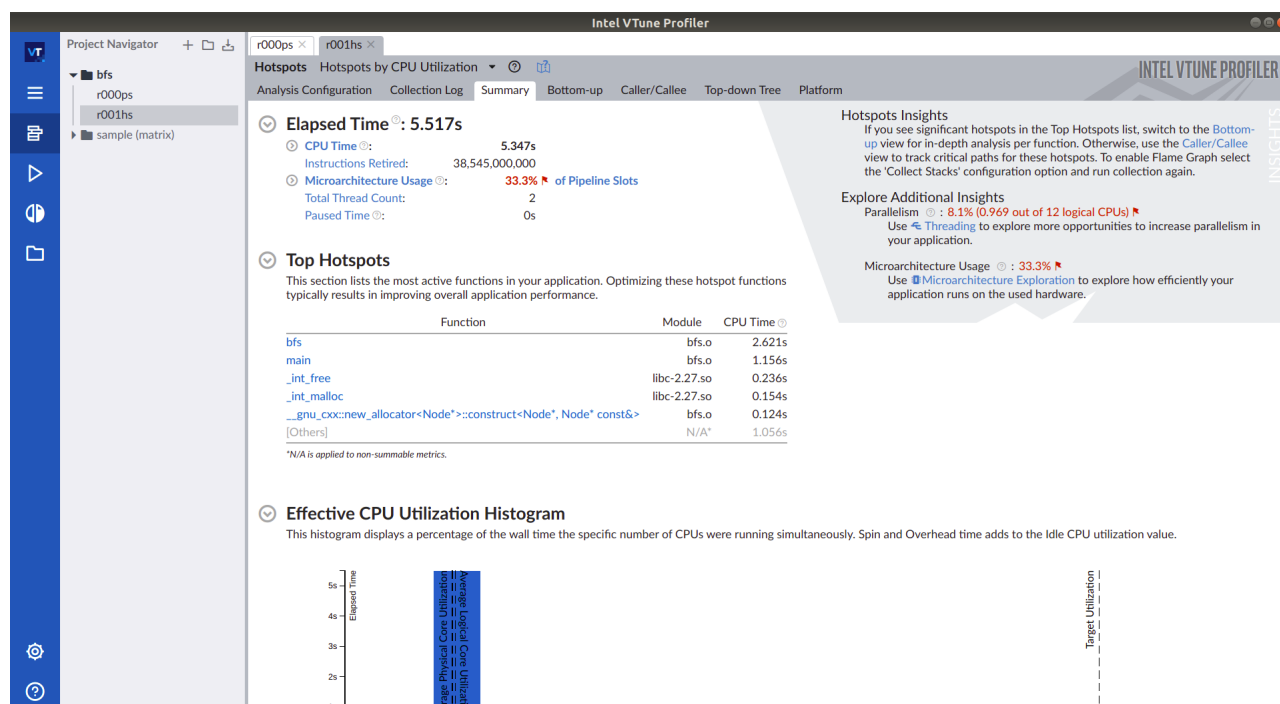


Figure 1.2: Top Functions by CPU Time for bfs.cpp

Top 5 Source lines by CPU Utilization

Source	Function	CPU Utilization
if (left_child) node_Q.push(left_child);	inline void bfs(Node *root)	22.7%
bfs(root);	int main()	21.6%
right_child = curr_node->right;	inline void bfs(Node *root)	17.2%
for (int i = 0; i < q_size; i++) {	inline void bfs(Node *root)	4.8%
left_child = curr_node->left;	inline void bfs(Node *root)	3.2%

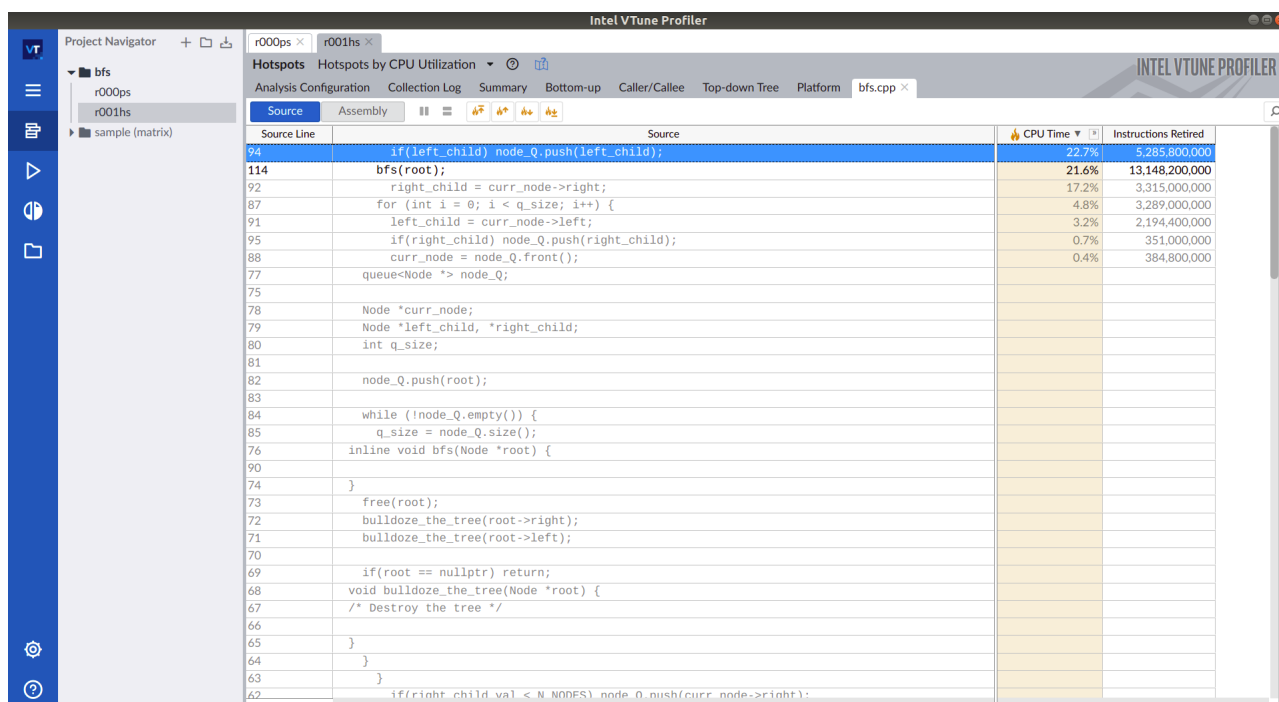


Figure 1.3: Top Source lines by CPU Utilization for bfs.cpp

1.2 matrix_multi.cpp

Performance Snapshot

- IPC: 0.874
- Logical Core Utilization: 8.2% (0.982 out of 12)
- Physical Core Utilization: 16.3% (0.976 of 6)
- Memory bound: 59.1% of Pipeline slots

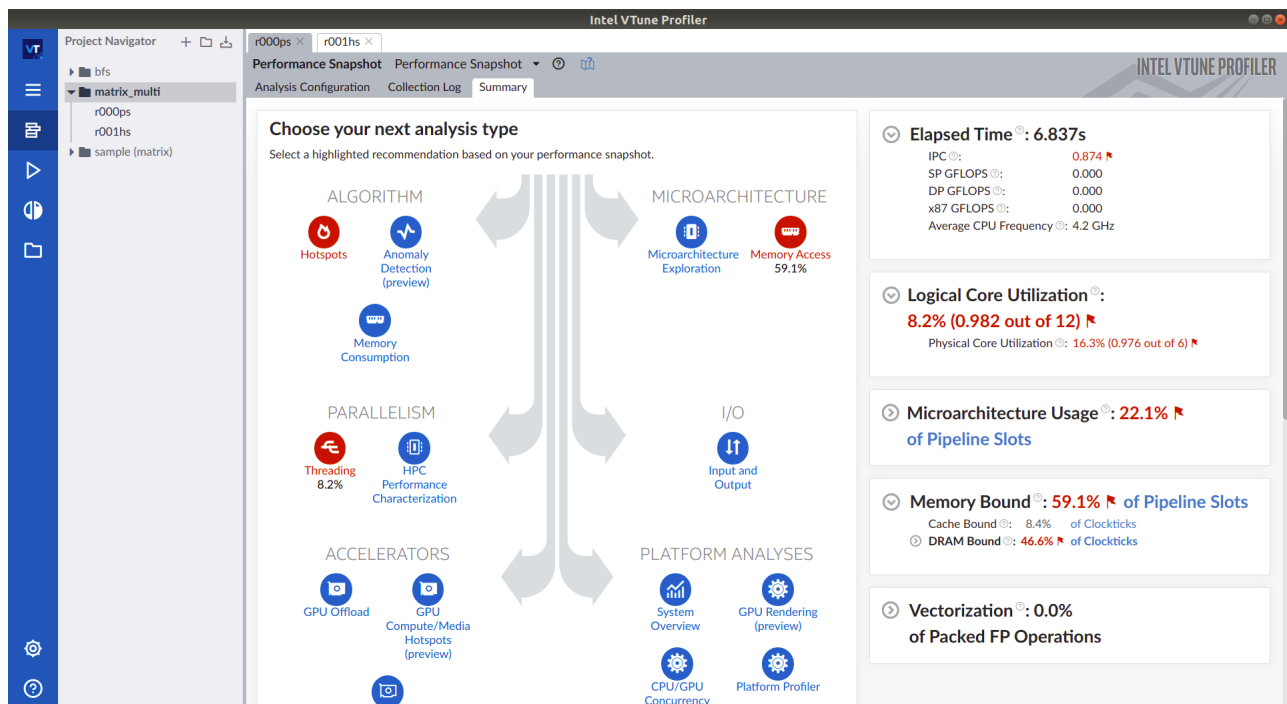


Figure 1.4: Performance Snapshot for `matrix_multi.cpp`

Top Functions by CPU Time

Function	Module	CPU Time
matrix_product	matrix_multi.o	6.597s

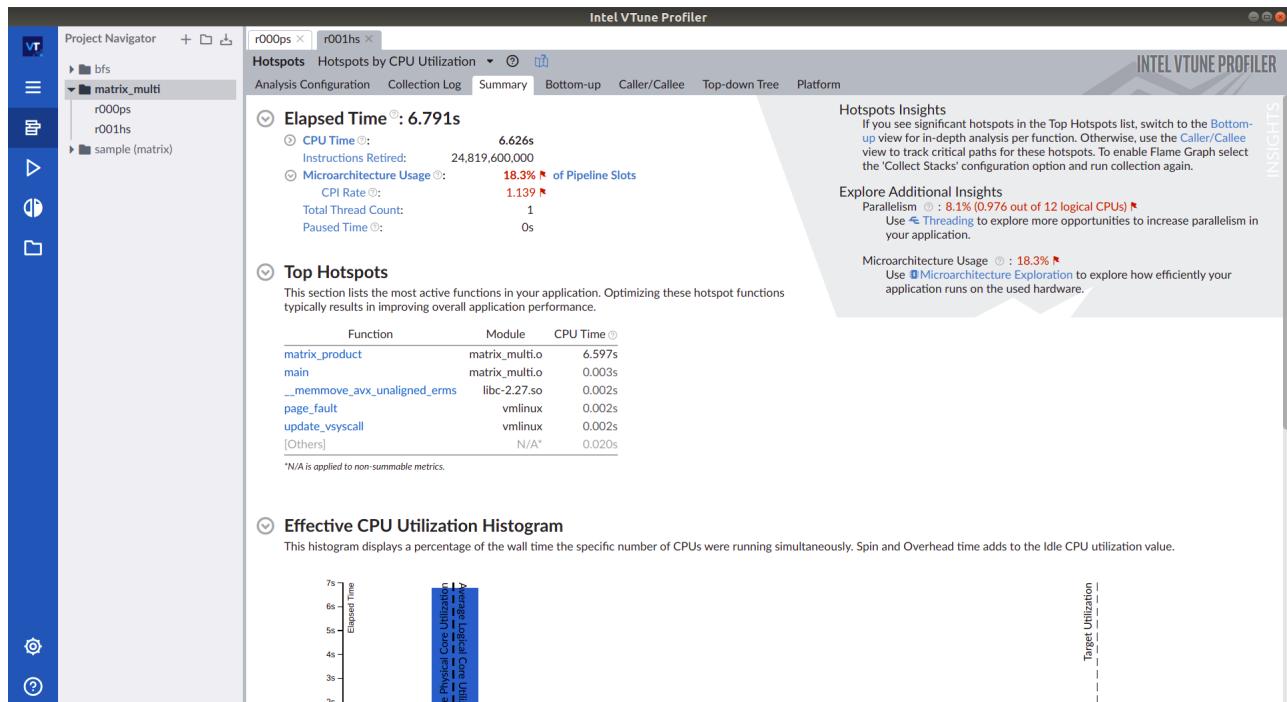


Figure 1.5: Top Functions by CPU Time for matrix_multi.cpp

Top 2 Source lines by CPU Utilization

Source	Function	CPU Utilization
C[i][j] += A[i][k] * B[k][j];	void matrix_product()	90.9%
for (int k = 0; k < N_DIMS; k++) {	void matrix_product()	8.6%

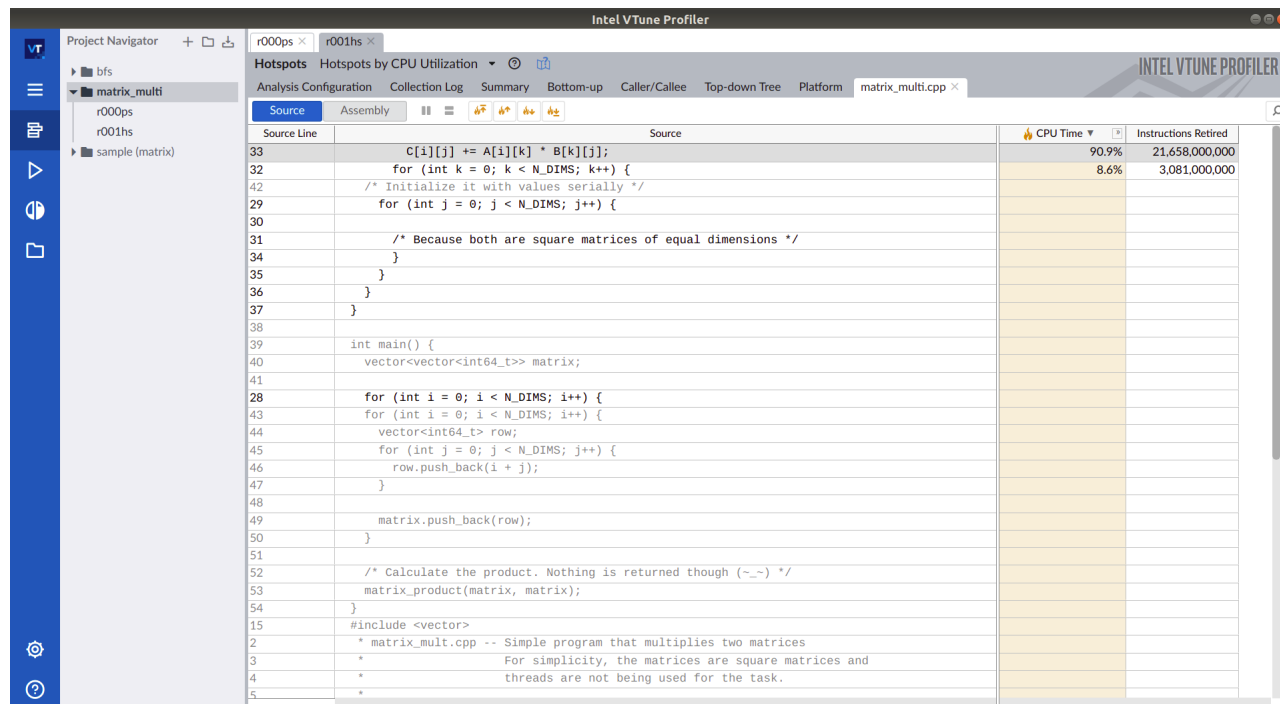


Figure 1.6: Top Source lines by CPU Utilization for `matrix_multi.cpp`

1.3 matrix_multi_2.cpp

Performance Snapshot

- IPC: 1.339
- Logical Core Utilization: 8.2% (0.981 out of 12)
- Physical Core Utilization: 16.2% (0.973 of 6)
- Memory bound: 38.0% of Pipeline slots

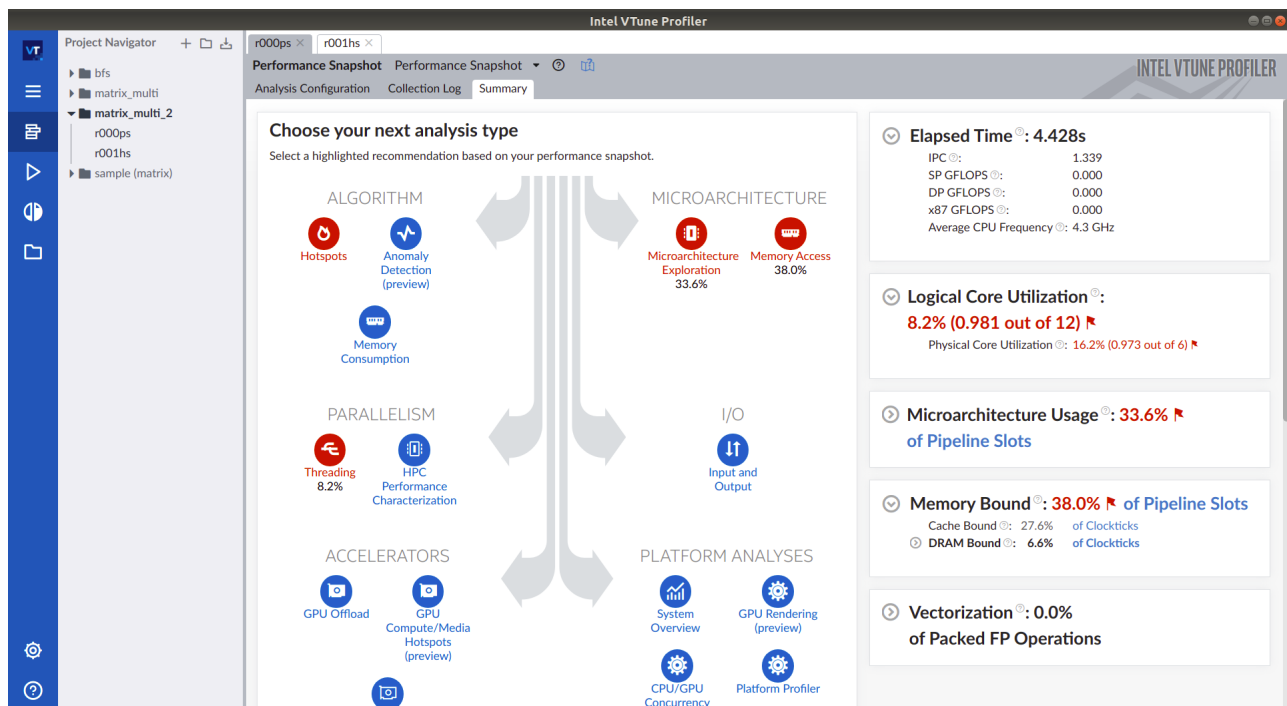


Figure 1.7: Performance Snapshot for `matrix_multi_2.cpp`

Top Functions by CPU Time

Function	Module	CPU Time
matrix_product	matrix_multi_2.o	4.492s

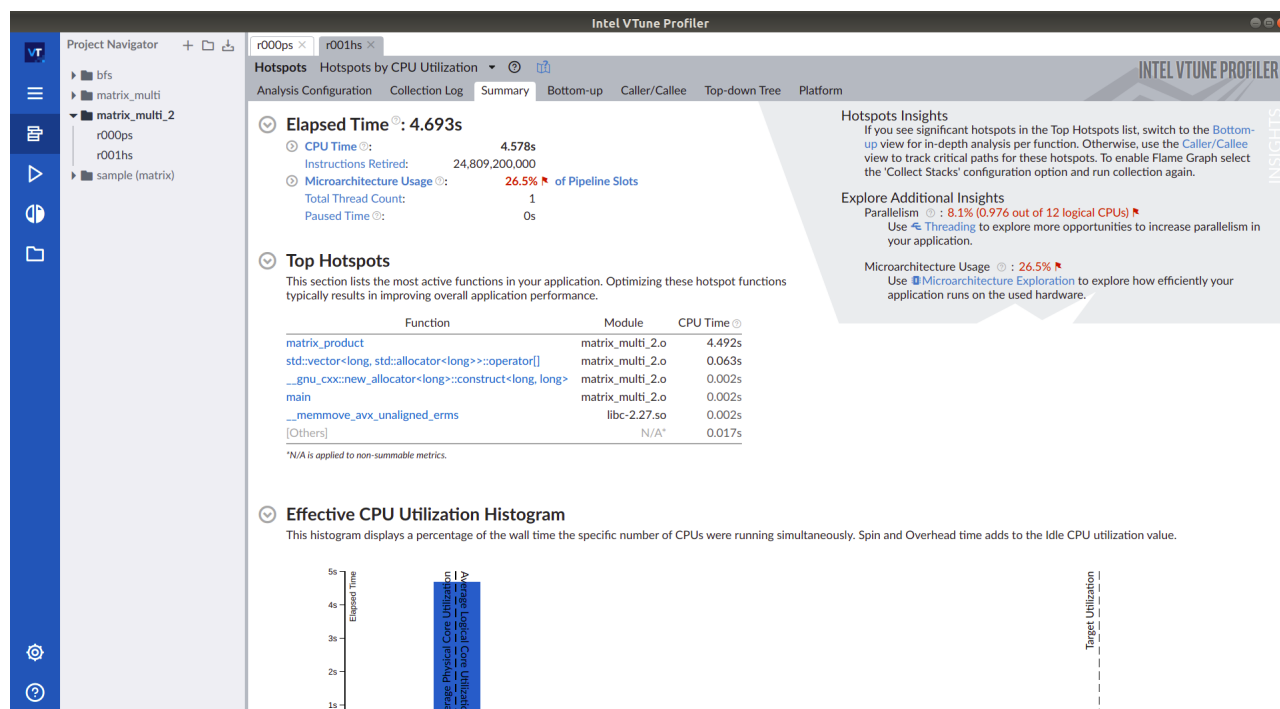


Figure 1.8: Top Functions by CPU Time for matrix_multi_2.cpp

Top 2 Source lines by CPU Utilization

Source	Function	CPU Utilization
C[i][j] += A[i][k] * B[k][j];	void matrix_product()	84.4%
for (int k = 0; k < N_DIMS; k++) {	void matrix_product()	13.7%

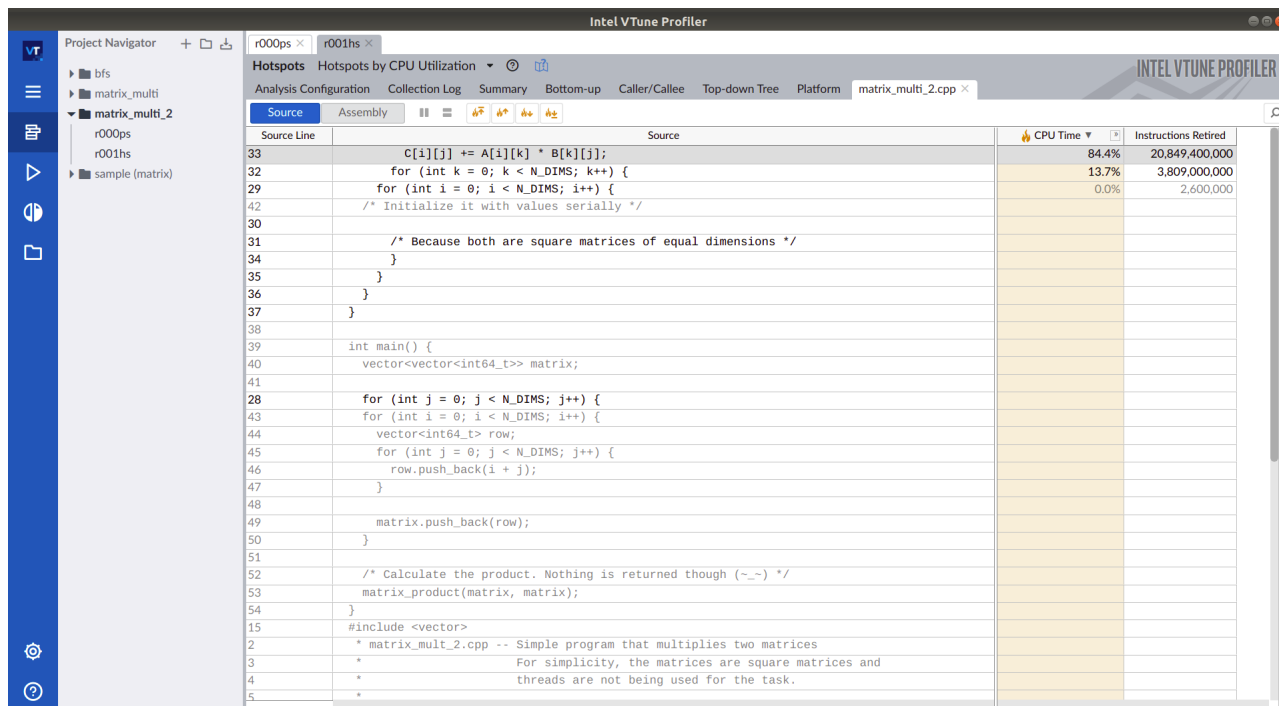


Figure 1.9: Top Source lines by CPU Utilization for matrix_multi_2.cpp

1.4 quicksort.cpp

Performance Snapshot

- IPC: 0.748
- Logical Core Utilization: 8.0% (0.966 out of 12)
- Physical Core Utilization: 15.7% (0.941 of 6)
- Memory bound: 23.0% of Pipeline slots

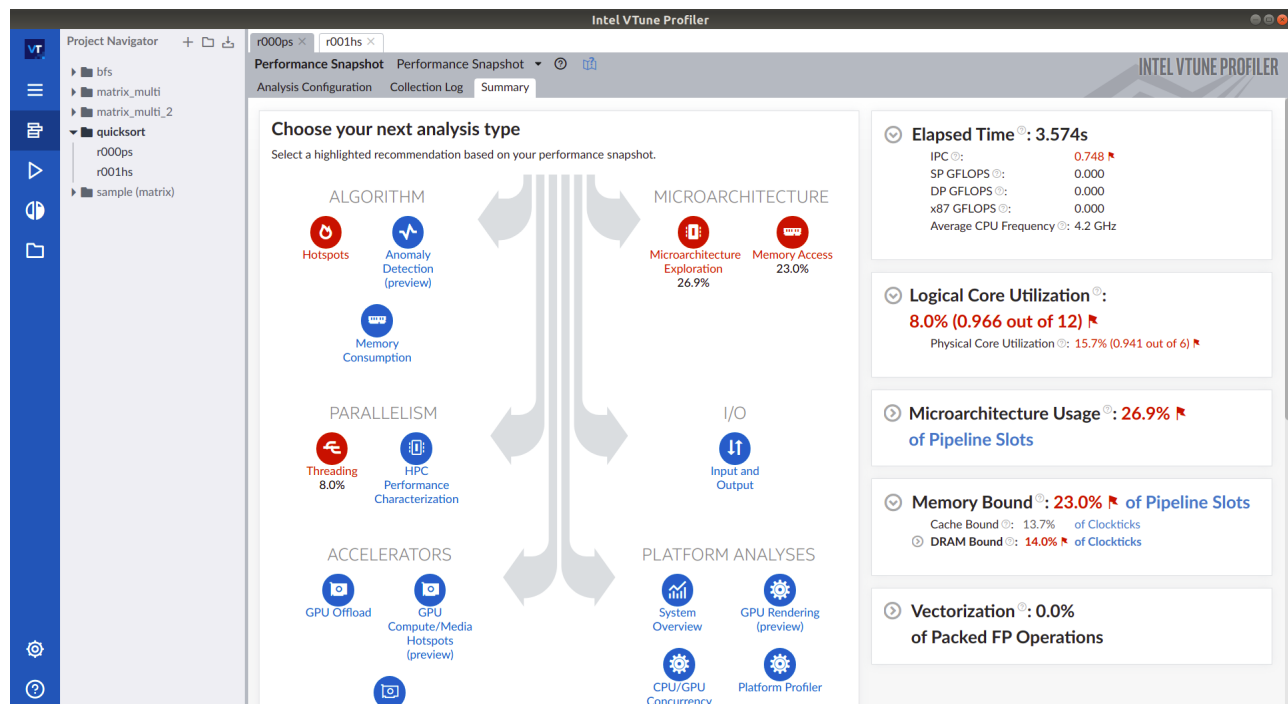


Figure 1.10: Performance Snapshot for `quicksort.cpp`

Top Functions by CPU Time

Function	Module	CPU Time
__memmove_avx_unaligned_erms	libc-2.27.so	0.875s
page_fault	vmlinux	0.511s
clear_page_erms	vmlinux	0.228s
prepare_exit_to_usermode	vmlinux	0.226s
perf_iterate_ctx	vmlinux	0.155s
Others	N/A	1.545s

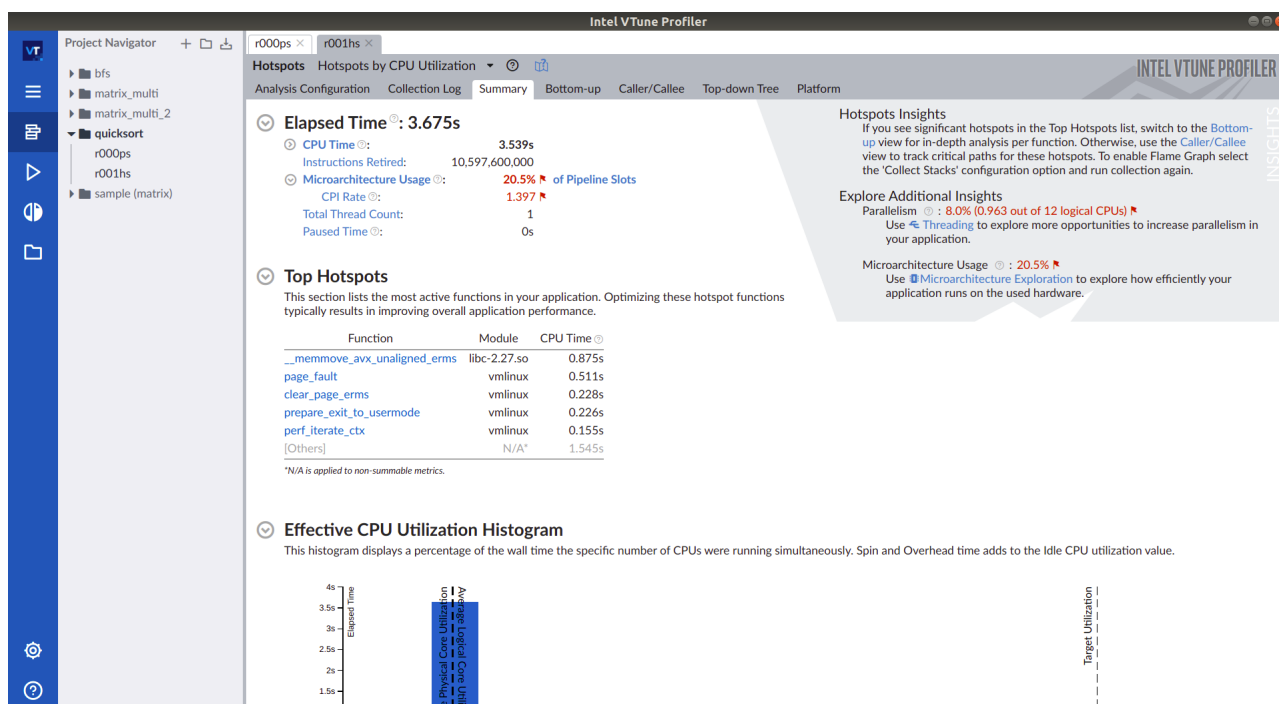


Figure 1.11: Top Functions by CPU Time for quicksort.cpp

Top 5 Source lines by CPU Utilization

Source	Function	CPU Utilization
b = c;	void swap()	2.1%
if (nums[i] < pivot) {	long partition()	1.9%
slow_ptr++;	long partition()	1.7%
for (long i = lo; i < hi; i++) {	long partition()	0.6%
a = b;	void swap()	0.2%

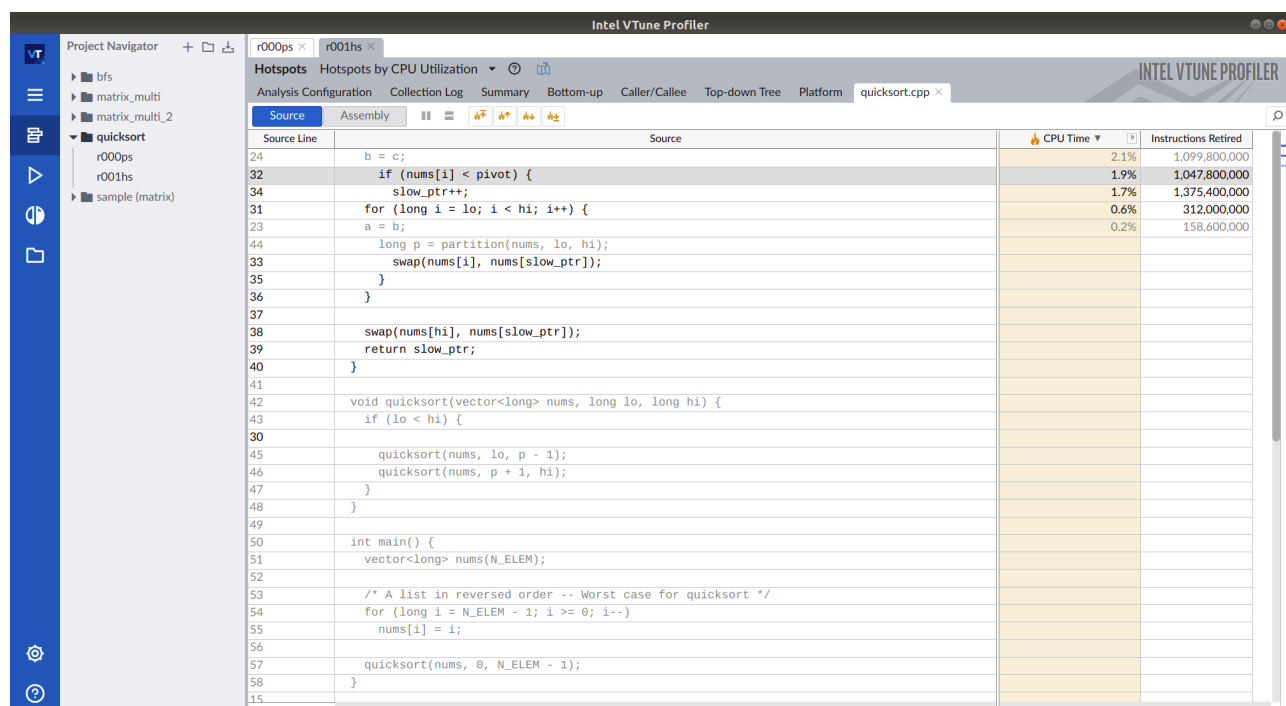


Figure 1.12: Top Source lines by CPU Utilization for quicksort.cpp

Part 2: Simulating with ChampSim

2.1 Prepare traces

Prepared traces for executables (same as ones used in Part 1).

Used pin to generate traces:

```
pin -t obj-intel64/champsim_tracer.so -o <program>.trace -t 20000000 - <executable>;
```

Used xz to compress the traces:

```
xz -vz <program>.trace -threads=0;
```

Program	Parameters	Execution time	Trace size
bfs.o	N_NODES (1«20); N_LOOPS 500	5.2 s	2368 KB
matrix_multi.o	N_DIMS 1400;	6.8 s	7264 KB
matrix_multi_2.o	N_DIMS 1400;	4.5 s	7264 KB
quicksort.o	N_ELEM (3 « 13);	4.1 s	9776 KB