

CS403 Parallel Programming

Mini Project 1 - Graph Search

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1 Graph Search Techniques

1.1 Breadth First Search

1.1.1 Pseudocode

Input: A starting vertex (s) and total number of vertices (n).

Output: All vertices reachable from root labeled as explored.

```
BFS(s,n)
{
    Set all nodes to "not visited";

    q.enqueue(initial node);
    vis[s]=1//set it as visited

    p=q.dequeue();
    if(p is not zero)
        print p;

    while(p is not zero)
    {
        for(i=1 to n)
            if(a[p][i] is not equal to 0 and node is not visited)
            {
                q.enqueue(i) //node i
                vis[i]=1 //set it as visited
            }
        p=q.dequeue();
        if(p is not equal to 0)
            print p;
    }

    for(i=1 to n)
        if (i is not visited)
            BFS(i,n)
}
```

1.2 Depth First search

1.2.1 Pseudocode

Input: A starting vertex (s) and total number of vertices (n).

Output: All vertices reachable from root labeled as explored.

```
DFS(s,n)
{
    push(s);
    vis[s]=1 //set it as visited

    k=pop();
    if(k not equal to 0)
        print k;

    while(k not equal to 0)
    {
        for(i=1 to n)
            if(a[k][i]not equal to 0 and node is not visited)
            {
                push(i);
                vis[i]=1;// set it as visited
            }

        k=pop();
        if(k not equal to 0)
            print k;
    }
    for(i=1 to n)
        if(node is not visited)
            dfs(i,n);
}
```

1.3 Analysis of Outputs

- Below figure shows the output of the cache miss rate.

```
==5968==  
==5968== I   refs:      278,558  
==5968== I1  misses:      964  
==5968== LLi misses:      954  
==5968== I1  miss rate:    0.34%  
==5968== LLi miss rate:    0.34%  
==5968==  
==5968== D   refs:      113,078 (72,356 rd  + 40,722 wr)  
==5968== D1  misses:      1,795 ( 1,275 rd  +   520 wr)  
==5968== L1d misses:      1,566 ( 1,086 rd  +   480 wr)  
==5968== D1  miss rate:    1.5% (  1.7%   +   1.2%  )  
==5968== L1d miss rate:    1.3% (  1.5%   +   1.1%  )  
==5968==  
==5968== LL refs:        2,759 ( 2,239 rd  +   520 wr)  
==5968== LL misses:      2,520 ( 2,040 rd  +   480 wr)  
==5968== LL miss rate:    0.6% (  0.5%   +   1.1%  )
```

Figure 1: Cache misses

- Given below is the figure showing the memory leaks analysis.

```
==5924== Memcheck, a memory error detector  
==5924== Copyright (C) 2002-2013, and GNU GPL'd, by Julian Seward et al.  
==5924== Using Valgrind-3.10.1 and LibVEX; rerun with -h for copyright info  
==5924== Command: ./serial  
==5924==  
==5924==  
==5924== HEAP SUMMARY:  
==5924==    in use at exit: 0 bytes in 0 blocks  
==5924== total heap usage: 0 allocs, 0 frees, 0 bytes allocated  
==5924==  
==5924== All heap blocks were freed -- no leaks are possible  
==5924==  
==5924== For counts of detected and suppressed errors, rerun with: -v  
==5924== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 0 from 0)
```

Figure 2: Memory leaks

- Below figure shows the contribution of each of the functions from the given code.

21.42	vfprintf	vfprin
18.89	_IO_vfscanf	vfscar
8.51	do_lookup_x	dl-loo
7.90	_IO_file_xsputn@@GLIB...	fileop
5.27	memset	rtld-m
5.26	_dl_lookup_symbol_x	dl-loo
4.96	_dl_relocate_object	dl-ma
4.15	__isoc99_scanf	isoc99
3.51	printf	printf
3.40	____strtol_l_internal	strtol
1.41	_IO_file_overflow@@G...	fileop
1.40	vfprintf	printf
1.32	check_match.9481	dl-loo
1.24	_IO_sputbackc	genop
0.78	main	(unkn
0.76	__GI_mempcpy	memc
0.72	_dl_allocate_tls_storage	dl-tls.
0.47	_IO_do_write@@GLIBC...	fileop

Figure 3: Annotated