Operating Systems Laboratory

Assignment 3 - Report for Task 1(b)

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We are multiplying a matrix of size $r_1 \times c_1$ with another matrix of size $r_2 \times c_2$. So the resultant product matrix will be of size $r_1 \times c_2$, and we create $r_1 * c_2$ processes, with each computing one element of the matrix. We need to find the maximum size of matrix that we can multiply (in terms of $r_1 * c_2$)

Experimentally, we see that the limit is reached because the `fork()` system call fails, and we get an error number of 11 (`EAGAIN`). The man page for `fork()` states that `EAGAIN` can be encountered due to a number of system-imposed limits:

- The `RLIMIT_NPROC` soft resource limit (set via `setrlimit`), which limits the number of processes and threads for a real user ID, may be reached. This value can be found using `ulimit -u` and it was equal to 46977 in our case.
- The kernel's system-wide limit on the number of processes and threads, `/proc/sys/kernel/threads-max`, may have been reached. This value was 93954 for us.
- The maximum number of PIDs, `/proc/sys/kernel/pid_max`, was reached. This was 4194304 in our case.
- The PID limit (`pids.max`) imposed by the cgroup "process number" (PIDs) controller may be reached. This can be found out by looking at the value of `/sys/fs/cgroup/pids/user.slice/user-1000.slice/pids.max`. This was 31004 for us.

We observed the maximum number of processes ($r_1 * c_2$) that were being created to be around 29929 ($= 173 * 173$) (here the `pids.max` imposed by the cgroup PIDs controller was the limiting factor). Hence, we can say that the number of processes that we can create will be bounded by the minimum of all of these four values. However, the actual observed maximum number of processes is a bit lower because of other processes running in the system. Also, note that these four attributes can be changed by the user.

Hence, we can write:
$r_1 * c_2 \leq$ `min(RLIMIT_NPROC, threads-max, pid_max, pids.max for cgroup controller)`