

Problem 1

```
#include <unistd.h>
#include <sys/wait.h>
#include <stdio.h>
#include <stdlib.h>

int main(int argc, char* argv[]) {
    int pipes[2];

    int idpipe;

    // loop to see if pipe works
    if (pipe(pipes) < 0) {
        printf("Pipe doesn't work\n");
        return 2;
    }

    // implementing fork within pipe
    idpipe = fork();

    if (idpipe == 0) {
        dup2(pipes[1], 1);
        close(pipes[0]);

        // executes ps ps -aux
        execlp("ps", "ps", "-aux", (char *)NULL);
    }

    else {
        int idpipe = fork();
        if(idpipe == 0) {
            close(pipes[1]);
            dup2(pipes[0], 0);

            // executes sort sort -r -n -k 5
            execlp("sort", "sort", "-r", "-n", "-k", "5", (char *)NULL);
        }
    }
}
```

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Ubuntu 22.04 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help

Activities Terminal Jun 7 6:26 PM

rchateller2022@rchateller2022-VirtualBox: ~/Development/pipes

rchateller+ 1571 0.0 0.1 680876 28708 ? Ssl 14:26 0:00 /usr/libexec/evolution-addressbook-factory
rchateller+ 1487 0.0 0.1 671536 28804 ? Ssl 14:26 0:00 /usr/libexec/xdg-desktop-portal-gnome
rchateller+ 1591 0.0 0.1 644552 2156 ? Ssl 14:26 0:00 /usr/libexec/tracker-miner-fs-1
rchateller+ 1483 0.0 0.0 632560 14468 ? Ssl 14:26 0:01 /usr/libexec/xdg-desktop-portal
rchateller+ 1606 0.0 0.1 607188 25164 ? Ssl 14:26 0:00 /usr/libexec/gsd-color
rchateller+ 1494 0.0 0.0 582968 20560 ? Ssl 14:26 0:00 /usr/libexec/gnome-shell-calendar-server
rchateller+ 1529 0.0 0.1 569680 30900 ? Ssl 14:26 0:00 /usr/libexec/goa-daemon
rchateller+ 10388 1.9 0.2 561652 51772 ? Rsl 18:24 0:00 /usr/libexec/gnome-terminal-server
rchateller+ 1226 0.0 0.2 549564 54332 ? Ssl 14:26 0:00 /usr/libexec/gnome-remote-desktop-daemon
rchateller+ 1137 0.0 0.0 545552 7300 ? Ssl 14:26 0:00 /usr/libexec/xdg-document-portal
rchateller+ 1242 0.0 0.0 527832 17680 ? Ssl 14:26 0:00 /usr/libexec/gnome-session-binary --systemd-service --session=ubuntu
rchateller+ 1910 0.0 0.2 515976 69594 ? Ssl 14:26 0:00 /usr/libexec/gsd-xsettings
rchateller+ 1626 0.0 0.0 474456 9948 ? Ssl 14:26 0:00 /usr/libexec/gsd-sharing
rchateller+ 1618 0.0 0.0 466500 6704 ? Ssl 14:26 0:00 /usr/libexec/gsd-rfkill
rchateller+ 1610 0.0 0.1 459212 25240 ? Ssl 14:26 0:00 /usr/libexec/gsd-power
rchateller+ 2326 0.0 0.1 427568 27820 ? Sl 14:27 0:00 update-notifier
rchateller+ 1629 0.0 0.0 423484 22240 ? Ssl 14:26 0:00 /usr/libexec/gsd-waconn
rchateller+ 1605 0.0 0.0 397264 11940 ? Sl 14:26 0:00 /usr/bin/ibus-daemon --panel disable
root 719 0.0 0.0 393052 13048 ? Ssl 14:25 0:00 /usr/libexec/udisks2/udisksd
rchateller+ 1608 0.0 0.0 384108 16280 ? Ssl 14:26 0:00 /usr/libexec/gsd-datetime
rchateller+ 1176 0.0 0.0 380884 5720 ? Sl 14:26 0:00 /usr/libexec/gvfsd-fuse /run/user/1000/gvfs -f
rchateller+ 1753 0.0 0.1 354668 28188 ? Ssl 14:26 0:02 /usr/libexec/ibus-extension-gtk3
rchateller+ 1840 0.0 0.1 353112 25056 ? Ssl 14:26 0:00 /usr/libexec/xdg-desktop-portal-gtk
rchateller+ 1671 0.0 0.0 351080 13732 ? Sl 14:26 0:00 /usr/libexec/gsd-printer
rchateller+ 1611 0.0 0.0 349284 21612 ? Ssl 14:26 0:00 /usr/libexec/gsd-keyboard
rchateller+ 1542 0.0 0.0 347044 14964 ? Sl 14:26 0:00 /usr/libexec/goa-identity-service
root 692 0.0 0.0 343216 19104 ? Ssl 14:25 0:00 /usr/sbin/NetworkManager --no-daemon
rchateller+ 1628 0.0 0.0 327988 9364 ? Ssl 14:26 0:00 /usr/libexec/gsd-sound
root 1883 0.0 0.0 324560 1076 ? Sl 14:26 0:00 gdm-session-worker [pam/gdm-autologin]
rchateller+ 1590 0.0 0.0 324572 9280 ? Ssl 14:26 0:00 /usr/libexec/gvfs-udisks2-volume-monitor
rchateller+ 1520 0.0 0.0 323848 8036 ? Ssl 14:26 0:00 /usr/libexec/gvfs-afc-volume-monitor
rchateller+ 1584 0.0 0.0 323508 8216 ? Sl 14:26 0:00 /usr/libexec/gvfsd-trash --spawner :1.7 /org/gtk/gvfs/exec_spaw/0
rchateller+ 1627 0.0 0.0 320944 8132 ? Ssl 14:26 0:00 /usr/libexec/gsd-smartcard
rchateller+ 1609 0.0 0.0 320744 7504 ? Ssl 14:26 0:00 /usr/libexec/gsd-housekeeping
rchateller+ 1603 0.0 0.0 319604 6724 ? Ssl 14:26 0:00 /usr/libexec/gsd-a11y-settings
rchateller+ 1272 0.0 0.0 309612 7776 ? Ssl 14:26 0:00 /usr/libexec/at-spi-bus-launcher --launch-immediately
rchateller+ 1410 0.0 0.1 308100 26684 ? Ssl 14:26 0:00 /snap/snapd-desktop-integration/14/bin/snapd-desktop-integration
root 1558 0.0 0.0 306840 20820 ? Ssl 14:26 0:00 /usr/libexec/packagekitd
rchateller+ 1607 0.0 0.0 305312 2988 ? Sl 14:26 0:01 /usr/sbin/VBoxService --pidfile /var/run/vboxadd-service.sh
rchateller+ 1617 0.0 0.0 259260 1476 ? Ssl 14:26 0:00 /usr/libexec/gsd-print-notifications
colord 1862 0.0 0.0 253936 13116 ? Ssl 14:26 0:00 /usr/libexec/colord
root 1496 0.0 0.0 250872 8468 ? Ssl 14:26 0:00 /usr/libexec/upowerd
rchateller+ 1077 0.0 0.0 249060 9032 ? Ssl 14:26 0:00 /usr/sbin/gdm3
rchateller+ 1126 0.0 0.0 249056 6884 ? Sl 14:26 0:00 /usr/bin/gnome-keyring-daemon --daemonize --login
rchateller+ 1136 0.0 0.0 249288 8184 ? Ssl 14:26 0:00 /usr/libexec/gvfsd
root 714 0.0 0.0 248740 6752 ? Ssl 14:25 0:00 /usr/libexec/power-profiles-daemon
rchateller+ 1685 0.0 0.0 248636 ? Ssl 14:25 0:00 /usr/libexec/accounts-daemon
rchateller+ 1553 0.0 0.0 246080 6836 ? Ssl 14:26 0:00 /usr/libexec/gvfs-photo2-volume-monitor
rchateller+ 1765 0.0 0.0 246036 7772 ? Sl 14:26 0:00 /usr/libexec/ibus-portal
rchateller+ 1525 0.0 0.0 245280 6352 ? Ssl 14:26 0:00 /usr/libexec/gvfs-goa-volume-monitor
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Ubuntu 22.04 [Running] - Oracle VM VirtualBox
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rchateller2022@rchateller2022-VirtualBox: ~/Development/pipes

root 713 0.0 0.0 236932 9668 ? Ssl 14:25 0:00 /usr/libexec/polkitd --no-debug
rchateller+ 1681 0.0 0.0 232260 1144 ? Ssl 14:26 0:00 /usr/libexec/gsd-disk-utility-notify
rchateller+ 1135 0.0 0.0 231688 15180 tty2 Sl+ 14:26 0:00 /usr/libexec/gnome-session-binary --session=ubuntu
rchateller+ 1792 0.1 0.0 227732 2584 ? Sl 14:26 0:19 /usr/bin/VBoxClient --draganddrop
rchateller+ 1816 0.3 0.3 224436 83336 ? S 14:26 0:56 /usr/bin/Xwayland -D -rootless -noreset -accessx -core -auth /run/user/1000/.mutter-Xwaylandauth.RBDVH1 -listen 4 -listen 5 -displayfd 6
initd fd 7
syslog 715 0.0 0.0 222400 5324 ? Ssl 14:25 0:00 /usr/sbin/rsyslogd -n -DNONE
rchateller+ 1982 0.0 0.1 202868 25384 ? Sl 14:26 0:00 /usr/libexec/ibus-x11
root 929 0.0 0.0 172612 11124 ? Ssl 14:26 0:00 /usr/sbin/cups-browsed
rchateller+ 1837 0.0 0.0 172128 7228 ? Sl 14:26 0:00 /usr/libexec/ibus-engine-simple
rchateller+ 1749 0.0 0.0 172128 7268 ? Sl 14:26 0:00 /usr/libexec/ibus-memconf
rchateller+ 1965 0.0 0.0 171656 6684 ? Ssl 14:26 0:00 /usr/libexec/gvfsd-metadata
rchateller+ 1125 0.0 0.0 171036 6240 tty2 Ssl+ 14:26 0:00 /usr/libexec/gdm-wayland-session env GNOME_SHELL_SESSION_MODE=ubuntu /usr/bin/gnome-session --session=ubuntu
rchateller+ 1088 0.0 0.0 169632 3928 ? S 14:26 0:00 (sd-pam)
root 1 0.0 0.0 166632 11748 ? Ss 14:25 0:01 /sbin/init splash
rchateller+ 1595 0.0 0.0 162676 7284 ? Sl 14:26 0:00 /usr/libexec/at-spi2-registrr --use-gnome-session
rchateller+ 1776 0.0 0.0 161700 4516 ? Sl 14:26 0:00 /usr/bin/VBoxClient --clipboard
rchateller+ 1787 0.0 0.0 161676 2576 ? Sl 14:26 0:00 /usr/bin/VBoxClient --seamless
rchateller+ 1570 0.0 0.0 156828 4556 ? Ssl 14:26 0:00 /usr/libexec/dconf-service
rtkit 1126 0.0 0.0 154080 1556 ? Ssl 14:26 0:00 /usr/libexec/rtkit-daemon
root 805 0.0 0.0 126780 23412 ? Ssl 14:25 0:00 /usr/bin/python3 /usr/share/unattended-upgrades/unattended-upgrade-shutdown --wait-for-signal
rchateller+ 1227 0.0 0.0 100556 5084 ? Ssl 14:26 0:00 /usr/libexec/gnome-session-ctl --monitor
systemd+ 681 0.0 0.0 89324 6480 ? Ssl 14:25 0:00 /lib/systemd/systemd-timesyncd
root 1796 0.0 0.0 86224 1196 ? S 14:26 0:00
root 711 0.0 0.0 85696 3812 ? Ssl 14:25 0:00 /usr/sbin/irqbalance --foreground
root 802 0.0 0.0 81652 13872 ? Ss 14:25 0:00 /usr/sbin/cupsd -l
root 712 0.0 0.0 49672 20844 ? Ss 14:25 0:00 /usr/bin/python3 /usr/bin/networkd-dispatcher --run-startup-triggers
root 285 0.0 0.0 48516 18136 ? Ss+ 14:25 0:00 /lib/systemd/systemd-journald
rchateller+ 1094 0.0 0.0 48220 6324 ? Ss+sl 14:26 0:00 /usr/bin/pipewire
rchateller+ 10416 0.0 0.0 33608 1168 pts/6 S 18:24 0:00 sort -r -n -k 5
rchateller+ 1095 0.0 0.0 32108 6324 ? Ssl 14:26 0:00 /usr/bin/pipewire-media-session
rchateller+ 1795 0.0 0.0 29440 380 ? S 14:26 0:00 /usr/bin/VBoxClient --usbfs
rchateller+ 1790 0.0 0.0 29440 384 ? S 14:26 0:00 /usr/bin/VBoxClient --draganddrop
rchateller+ 1785 0.0 0.0 29440 380 ? S 14:26 0:00 /usr/bin/VBoxClient --seamless
rchateller+ 1775 0.0 0.0 29440 384 ? S 14:26 0:00 /usr/bin/VBoxClient --clipboard
root 337 0.0 0.0 26980 7352 ? Ss 14:25 0:00 /lib/systemd/systemd-udev
systemd+ 680 0.0 0.0 25348 13760 ? Ss 14:25 0:00 /lib/systemd/systemd-resolved
root 718 0.0 0.0 23588 8120 ? Ss 14:25 0:00 /lib/systemd/systemd-logind
rchateller+ 1618 0.0 0.0 21588 3628 pts/6 R 18:24 0:00 ps -aux
rchateller+ 9109 0.0 0.0 19660 5068 pts/5 Ss+ 17:31 0:00 /usr/bin/bash
rchateller+ 7884 0.0 0.0 19660 5176 pts/4 Ss 17:17 0:00 /usr/bin/bash
rchateller+ 6606 0.0 0.0 19660 5176 pts/3 Ss 17:06 0:00 /usr/bin/bash
rchateller+ 3998 0.0 0.0 19660 5184 pts/2 Ss 14:43 0:00 /usr/bin/bash
rchateller+ 2720 0.0 0.0 19660 5196 pts/1 Ss 14:33 0:00 /usr/bin/bash
rchateller+ 2442 0.0 0.0 19660 5152 pts/0 Ss+ 14:27 0:00 /bin/bash
rchateller+ 10406 0.0 0.0 19656 5212 pts/6 Ss+ 18:24 0:00 bash
root 690 0.0 0.0 18140 2980 ? Ss 14:25 0:00 /usr/sbin/cron -f -P
rchateller+ 1087 0.0 0.0 17880 10492 ? Ss 14:26 0:00 /lib/systemd/systemd --user
root 721 0.0 0.0 16492 5756 ? Ss 14:25 0:00 /sbin/wpa_supplicant -u -s -O /run/wpa_supplicant
lp 928 0.0 0.0 16284 5272 ? S 14:26 0:00 /usr/lib/cups/notifier/dbus dbus://
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rchateller2022@rchateller2022-VirtualBox: ~/Development/pipes

lp 927 0.0 0.0 16284 5284 ? S 14:26 0:00 /usr/lib/cups/notifier/dbus dbus://
lp 926 0.0 0.0 16284 5288 ? S 14:26 0:00 /usr/lib/cups/notifier/dbus dbus://
lp 925 0.0 0.0 16284 5292 ? S 14:26 0:00 /usr/lib/cups/notifier/dbus dbus://
lp 924 0.0 0.0 16284 5144 ? S 14:26 0:00 /usr/lib/cups/notifier/dbus dbus://
lp 923 0.0 0.0 16284 5292 ? S 14:26 0:00 /usr/lib/cups/notifier/dbus dbus://
systemd+ 679 0.0 0.0 14776 5912 ? Ss 14:25 0:12 /lib/systemd/systemd-oond
kernoops 859 0.0 0.0 13080 456 ? Ss 14:25 0:00 /usr/sbin/kerneloops
kernoops 857 0.0 0.0 13080 456 ? Ss 14:25 0:00 /usr/sbin/kerneloops --test
message+ 691 0.0 0.0 10836 6188 ? Ss 14:25 0:01 dbus-daemon --system --address=systemd: --nofork --nopidfile --systemd-activation --syslog-only
rchatel+ 1130 0.0 0.0 9868 6048 ? Ss 14:26 0:02 /usr/bin/dbus-daemon --session --address=systemd: --nofork --nopidfile --systemd-activation --syslog-only
rchatel+ 1284 0.0 0.0 9420 4500 ? S 14:26 0:00 /usr/bin/dbus-daemon --config-file=/usr/share/defaults/at-spi2/accessibility.conf --nofork --print-address 11 --address=unix:path=/run/u
ser/1000/at-spi/bus
avahi 689 0.0 0.0 7628 3420 ? Ss 14:25 0:00 avahi-daemon: running [rchateller2022-VirtualBox.local]
avahi 726 0.0 0.0 7440 336 ? S 14:25 0:00 avahi-daemon: chroot helper
rchatel+ 1692 0.0 0.0 2080 1004 ? Ss 14:26 0:00 sh -c /usr/sbin/bus-daemon --panel-disable $([ "$XDG_SESSION_TYPE" = "x11" ] && echo "--x1n")
root 686 0.0 0.0 2812 1152 ? Ss 14:25 0:00 /usr/sbin/acpid
rchatel+ 1161 0.0 0.0 2792 988 ? Ss 14:26 0:00 fusermount3 -o rw,nosuid,nodev,fsname=portal,auto_omount,subtype=portal -- /run/user/1000/doc
rchatel+ 8924 0.0 0.0 2640 956 pts/4 S+ 17:25 0:00 /ple 1000 4
rchatel+ 7775 99.9 0.0 2640 960 pts/3 R+ 17:17 67:20 /ple 1000 4
rchatel+ 6434 0.0 0.0 2640 928 pts/2 S+ 17:06 0:00 /ple 1000 4
rchatel+ 3822 0.0 0.0 2640 1020 pts/1 S+ 14:42 0:00 /ple 1000 4
USER 210 KCPU MEMA VSZ RSS TTY STAT START TIME COMMAND
root 9682 0.0 0.0 0 0 ? I 18:09 0:00 [kworker/2:1-events]
root 9566 0.0 0.0 0 0 ? I 18:06 0:00 [kworker/u12:1-flush-8:0]
root 9192 0.0 0.0 0 0 ? I 17:31 0:00 [kworker/5:0]
root 8995 0.0 0.0 0 0 ? I 17:30 0:00 [kworker/u12:2-events_unbound]
root 8404 0.0 0.0 0 0 ? I 17:22 0:00 [kworker/s12-nm_percpu_wq]
root 7571 0.0 0.0 0 0 ? I 17:15 0:00 [kworker/3:0-events]
root 5789 0.0 0.0 0 0 ? I 14:25 0:00 [kworker/0:0H-events_highpri]
root 56 0.0 0.0 0 0 ? SN 14:25 0:00 [kworker/0:1-events]
root 55 0.0 0.0 0 0 ? SN 14:25 0:00 [kxugepaged]
root 53 0.0 0.0 0 0 ? I 14:25 0:00 [kcompactd0]
root 52 0.0 0.0 0 0 ? I 14:25 0:00 [writeback]
root 5142 0.0 0.0 0 0 ? S 14:25 0:00 [oom_reaper]
root 5 0.0 0.0 0 0 ? I 15:52 0:00 [kworker/1:1-nm_percpu_wq]
root 5 0.0 0.0 0 0 ? S 14:25 0:00 [khungtaskd]
root 5 0.0 0.0 0 0 ? I 14:25 0:00 [netns]
root 50 0.0 0.0 0 0 ? S 14:25 0:00 [kauditd]
root 49 0.0 0.0 0 0 ? I 14:25 0:00 [knet_frag_wq]
root 48 0.0 0.0 0 0 ? S 14:25 0:00 [kdevtmpfs]
root 47 0.0 0.0 0 0 ? I 14:25 0:00 [kworker/5:0H-events_highpri]
root 45 0.0 0.0 0 0 ? S 14:25 0:00 [ksoftirqd/5]
root 44 0.0 0.0 0 0 ? S 14:25 0:00 [migration/5]
root 43 0.0 0.0 0 0 ? S 14:25 0:00 [idle_inject/5]
root 42 0.0 0.0 0 0 ? S 14:25 0:00 [cpuhp/5]
root 41 0.0 0.0 0 0 ? I 14:25 0:00 [kworker/4:0H-events_highpri]
root 4031 0.0 0.0 0 0 ? I 14:25 0:00 [krt-wq]
root 4 0.0 0.0 0 0 ? I 14:25 0:00 [rcu_pap_gp]
root 30 0.0 0.0 0 0 ? S 14:25 0:00 [ksoftirqd/4]
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rchateller2022@rchateller2022-VirtualBox: ~/Development/pipes

root 37 0.0 0.0 0 0 ? S 14:25 0:00 [idle_inject/4]
root 3693 0.0 0.0 0 0 ? I 14:41 0:00 [kworker/4:0-events]
root 36 0.0 0.0 0 0 ? S 14:25 0:00 [cpuhp/4]
root 351 0.0 0.0 0 0 ? S 14:25 0:00 [card-crtc7]
root 35 0.0 0.0 0 0 ? I 14:25 0:00 [kworker/3:0H-kblockd]
root 350 0.0 0.0 0 0 ? S 14:25 0:00 [card-crtc6]
root 349 0.0 0.0 0 0 ? S 14:25 0:00 [card-crtc5]
root 348 0.0 0.0 0 0 ? S 14:25 0:00 [card-crtc4]
root 347 0.0 0.0 0 0 ? S 14:25 0:00 [card-crtc3]
root 346 0.0 0.0 0 0 ? S 14:25 0:00 [card-crtc2]
root 345 0.0 0.0 0 0 ? S 14:25 0:00 [card-crtc1]
root 344 0.0 0.0 0 0 ? S 14:25 0:00 [card-crtc0]
root 343 0.0 0.0 0 0 ? S 14:25 0:01 [irq/18-vmmgfx]
root 342 0.0 0.0 0 0 ? I 14:25 0:00 [ttn_swap]
root 33 0.0 0.0 0 0 ? S 14:25 0:00 [ksoftirqd/3]
root 32 0.0 0.0 0 0 ? S 14:25 0:00 [migration/3]
root 317 0.0 0.0 0 0 ? I 14:25 0:00 [ipmi-msghandler]
root 31 0.0 0.0 0 0 ? S 14:25 0:00 [idle_inject/3]
root 3 0.0 0.0 0 0 ? I 14:25 0:00 [rcu_gp]
root 30 0.0 0.0 0 0 ? S 14:25 0:00 [cpuhp/3]
root 29 0.0 0.0 0 0 ? I 14:25 0:00 [kworker/2:0H-events_highpri]
root 27 0.0 0.0 0 0 ? S 14:25 0:00 [ksoftirqd/2]
root 2602 0.0 0.0 0 0 ? I 14:32 0:00 [kworker/0:0-nm_percpu_wq]
root 26 0.0 0.0 0 0 ? S 14:25 0:00 [migration/2]
root 25 0.0 0.0 0 0 ? S 14:25 0:00 [idle_inject/2]
root 250 0.0 0.0 0 0 ? I 14:25 0:00 [kworker/2:1H-kblockd]
root 240 0.0 0.0 0 0 ? I 14:25 0:00 [ext4-rsv-conver]
root 243 0.0 0.0 0 0 ? S 14:25 0:00 [jbd2/sda3-8]
root 24 0.0 0.0 0 0 ? S 14:25 0:00 [cpuhp/2]
root 23 0.0 0.0 0 0 ? I 14:25 0:00 [kworker/1:0H-events_highpri]
root 217 0.0 0.0 0 0 ? I 14:25 0:00 [kworker/5:1H-kblockd]
root 215 0.0 0.0 0 0 ? I 14:25 0:00 [kworker/4:2-nm_percpu_wq]
root 213 0.0 0.0 0 0 ? I 14:25 0:00 [scsi_tmf_2]
root 212 0.0 0.0 0 0 ? S 14:25 0:00 [scsi_ah_2]
root 211 0.0 0.0 0 0 ? I 14:25 0:00 [kworker/1:1H-kblockd]
root 21 0.0 0.0 0 0 ? S 14:25 0:00 [ksoftirqd/1]
root 208 0.0 0.0 0 0 ? I 14:25 0:01 [kworker/3:2-events]
root 2011 0.0 0.0 0 0 ? I 14:27 0:00 [kworker/2:3-nm_percpu_wq]
root 2 0.0 0.0 0 0 ? S 14:25 0:00 [kthreadd]
root 20 0.0 0.0 0 0 ? S 14:25 0:00 [migration/1]
root 19 0.0 0.0 0 0 ? S 14:25 0:00 [idle_inject/1]
root 18 0.0 0.0 0 0 ? S 14:25 0:00 [cpuhp/1]
root 177 0.0 0.0 0 0 ? I 14:25 0:00 [kworker/4:1H-kblockd]
root 17 0.0 0.0 0 0 ? S 14:25 0:00 [cpuhp/0]
root 16 0.0 0.0 0 0 ? S 14:25 0:00 [idle_inject/0]
root 154 0.0 0.0 0 0 ? I 14:25 0:00 [charger_manager]
root 15 0.0 0.0 0 0 ? S 14:25 0:00 [migration/0]
root 149 0.0 0.0 0 0 ? I 14:25 0:00 [kworker/u13:0]
root 148 0.0 0.0 0 0 ? I 14:25 0:00 [zswap-shrink]
root 145 0.0 0.0 0 0 ? I 14:25 0:00 [kstrp]
```



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        exit(1);
    }

    // j and t checked within pipes
    for (int j = 0; j < t; j++)
    {
        // numbers assigned to pipes with index j
        int number1 = pipe(pipe1[j]);
        int number2 = pipe(pipe2[j]);

        // first pipe and checks for error in the pipe for first number
        if (number1 < 0)
        {
            printf("Pipe 1 has failed.\n");
            exit(1);
        }

        if (number2 < 0)
        {
            printf("Pipe 1 has failed.\n");
            exit(-1);
        }

        // pipe forking with its id
        pid_t idpipe = fork();

        // process for child
        if (idpipe == 0)
        {
            // n, t, and j read from the parent
            double computePartialSum(int n, int t, double j);

            int a;
            int b;
            int c;

            // pipes read and close for j
            read(pipe1[j][0], &a, sizeof(int));
            read(pipe1[j][0], &b, sizeof(int));
            read(pipe1[j][0], &c, sizeof(int));
        }
    }
}

```

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        close(pipe1[j][1]);

        double slice = computePartialSum(a, b, c);
        write(pipe2[j][1], &slice, sizeof(double));
        close(pipe2[j][1]);
        printf("\n");

        exit(0);
    }
    else {
        // writes n, t and j to the child
        close(pipe1[j][0]);
        write(pipe1[j][1], &n, sizeof(int));
        write(pipe1[j][1], &t, sizeof(int));
        write(pipe1[j][1], &j, sizeof(int));
        close(pipe1[j][1]);
    }
}

for (int j = 0; j < t; j++) {

    double b;
    // read partial sum from child
    read(pipe2[j][0], &b, sizeof(double));

    collect += b;
}

while (wait(NULL) >= 0);

// float of 1.02 with collect
printf("%.02f\n", collect);

return 0;
}

double computePartialSum(int n, int t, double j)
{
    int q = 0;
    double total = 0;

```

```

int compute1 = ((n * j) / (t)) + 1;
int compute2 = (n / t) * (j + 1);

for (int i = compute1; i <= compute2; i++)
{
    // checking for evens
    if (i % 2 == 0)
    {
        q = -1;
    }
    // checking for odds
    else
    {
        q = 1;
    }

    // Nilakantha approximation formula used to find pi
    total += q * (double)(4) / ((2 * i) * (2 * i + 1) * (2 * i + 2));
}

return total;
}

```

The screenshot shows a terminal window within an Ubuntu 22.04 virtual machine. The user has navigated to the `Development` directory and compiled a program named `pipe.c` using `gcc`. The program is then executed with the arguments `1000 4`, resulting in the output `3.14`.

```

rchateller2022@rchateller2022-VirtualBox: ~/Development/pipes
rchateller2022@rchateller2022-VirtualBox: ~/Development$ cd Development
rchateller2022@rchateller2022-VirtualBox: ~/Development$ gcc pipe.c -o pipe
rchateller2022@rchateller2022-VirtualBox: ~/Development/pipes$ ./pipe 1000 4
3.14
rchateller2022@rchateller2022-VirtualBox: ~/Development/pipes$

```