

README Project 3:

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Course: Operating Systems

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There are two folders:

1. One contains fcfs implementation.
2. The other folder contains Priority order implementation.

list of file changed and changes made in FCFS and Priority(Common):

test.c(user): Made few changes to run multiple process at a time.

Usys.p(user): created a new user system call which sets priority to new processes created.

User.h(user): updated header file to accommodate fork77 user system call

Makefile: updated makefile(fork77 system call)

Sysfile.c: updated sysfile.c and added sys_fork77 system call

Syscall.h: updated and added SYS_fork77

Syscall.c: updated file to add fork77 system call

Proc.c: logic of fork77() and changed scheduler function

Defs.h: updated headed file for fork77 system call

Proc.h: added new attribute to struct proc to track priority.

Logic of FCFS:

Functions created in proc.c: DEFscheduler, fcfs, numberOfProcess

numberOfProcess :returns number of runnable processes

DEFscheduler: similar to round robin(similar previous xv6 scheduler)

Fcfs: runs process which has least creation time.

Note:when there are less than 3 runnable processes the scheduler runs DEFscheduler else runs FCFS

Logic of Priority:

Functions created in proc.c: DEFscheduler, fcfs, numberOfProcess

numberOfProcess :returns number of runnable processes

DEFscheduler: similar to round robin(similar previous xv6 scheduler)

Pscheduler: runs process which has highest priority time.

By default the priority is set 0;//least priority

Note:when there are less than 3 runnable processes the scheduler runs DEFscheduler else runs Pscheduler

To test Priority Scheduler:

Created a new system call named fork77 which sets the priority of a process when created. It is similar to fork system call the only difference is the assigning priority to process.

Wait calculation:

Made changes to ps system call from project 2 to print wait ticks

Wait ticks calculation: total run ticks – total ticks in running state

Total run ticks = end ticks – start ticks

Total ticks in running state = recorded ticks with the process entered running state and process exited the running

Test Case:

Make clean ,make qemu for FCFS:

```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
(base) sudhamshreddy@newname New Folder With Items % ls
Project3_Sudhamsh_FCFS Project3_Sudhamsh_priority
(base) sudhamshreddy@newname New Folder With Items % cd Project3_Sudhamsh_F
cd: no such file or directory: Project3_Sudhamsh_F
(base) sudhamshreddy@newname New Folder With Items % cd Project3_Sudhamsh_FCFS
(base) sudhamshreddy@newname Project3_Sudhamsh_FCFS % make clean
make: *** No rule to make target `clean'. Stop.
(base) sudhamshreddy@newname Project3_Sudhamsh_FCFS % ls
Assignment 2 Screenshots Screenshots xv6-riscv
(base) sudhamshreddy@newname Project3_Sudhamsh_FCFS % cd xv6-riscv
(base) sudhamshreddy@newname xv6-riscv % make clean
rm -f *.tex *.dvi *.idx *.aux *.log *.ind *.ilg \
    /*.o /*.d /*.asm /*.sym \
    user/initcode user/initcode.out kernel/kernel fs.img \
    mkfs/mkfs .gdbinit \
    user/usys.S \
    user/_cat user/_echo user/_forktest user/_grep user/_init user/_kill user/_ln user/_ls user/_mkdir user/_rm us
er/_sh user/_stressfs user/_usertests user/_grind user/_wc user/_zombie user/_head user/_uniq user/_ps user/_test user
/_kernelHead user/_kernelUniq
(base) sudhamshreddy@newname xv6-riscv % make qemu
riscv64-unknown-elf-gcc -c -o kernel/entry.o kernel/entry.S
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o kernel/start.o kernel/start.c
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o kernel/console.o kernel/console.c
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o kernel/printk.o kernel/printk.c
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o kernel/uart.o kernel/uart.c
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o kernel/kalloc.o kernel/kalloc.c
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o kernel/spinlock.o kernel/spinlock.c
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o kernel/string.o kernel/string.c
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o kernel/vm.o kernel/vm.c
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o kernel/proc.o kernel/proc.c
riscv64-unknown-elf-gcc -c -o kernel/switch.o kernel/switch.S
riscv64-unknown-elf-gcc -c -o kernel/trampoline.o kernel/trampoline.S
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o kernel/trap.o kernel/trap.c
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o kernel/syscall.o kernel/syscall.c
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o kernel/sysproc.o kernel/sysproc.c
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
```

test uniq fileTest.txt kernelUniq fileTest.txt:

PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

```
riscv64-unknown-elf-objdump -S user/_ps > user/ps.asm
riscv64-unknown-elf-objdump -t user/_ps | sed '1,/SYMBOL TABLE/d; s/ .* / /; /^$/d' > user/ps.sym
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o user/test.o user/test.c
riscv64-unknown-elf-ld -z max-page-size=4096 -T user/user.ld -o user/_test user/test.o user/ulib.o user/usys.o user/pr
intf.o user/umalloc.o
riscv64-unknown-elf-objdump -S user/_test > user/test.asm
riscv64-unknown-elf-objdump -t user/_test | sed '1,/SYMBOL TABLE/d; s/ .* / /; /^$/d' > user/test.sym
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o user/kernelHead.o user/kernelHead.c
riscv64-unknown-elf-ld -z max-page-size=4096 -T user/user.ld -o user/_kernelHead user/kernelHead.o user/ulib.o user/us
ys.o user/printf.o user/umalloc.o
riscv64-unknown-elf-objdump -S user/_kernelHead > user/kernelHead.asm
riscv64-unknown-elf-objdump -t user/_kernelHead | sed '1,/SYMBOL TABLE/d; s/ .* / /; /^$/d' > user/kernelHead.sym
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mcmodel=medany -ffreestanding -f
no-common -nostdlib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o user/kernelUniq.o user/kernelUniq.c
riscv64-unknown-elf-ld -z max-page-size=4096 -T user/user.ld -o user/_kernelUniq user/kernelUniq.o user/ulib.o user/us
ys.o user/printf.o user/umalloc.o
riscv64-unknown-elf-objdump -S user/_kernelUniq > user/kernelUniq.asm
riscv64-unknown-elf-objdump -t user/_kernelUniq | sed '1,/SYMBOL TABLE/d; s/ .* / /; /^$/d' > user/kernelUniq.sym
mkfs/mkfs fs.img README fileTest.txt user/_cat user/_echo user/_forktest user/_grep user/_init user/_kill user/_ln use
r/_ls user/_mkdir user/_rm user/_sh user/_stressfs user/_usertests user/_grind user/_wc user/_zombie user/_head user/_
uniq user/_ps user/_test user/_kernelHead user/_kernelUniq
mmeta 46 (boot, super, log blocks 30 inode blocks 13, bitmap blocks 1) blocks 1954 total 2000
ballocc: first 977 blocks have been allocated
ballocc: write bitmap block at sector 45
qemu-system-riscv64 -machine virt -bios none -kernel kernel/kernel -m 128M -smp 3 -nographic -global virtio-mmio.force
-legacy=false -drive file=fs.img,if=none,format=raw,id=x0 -device virtio-blk-device,drive=x0,bus=virtio-mmio-bus.0

xv6 kernel is booting

hart 1 starting
hart 2 starting
init: starting sh
$ test uniq fileTest.txt kernelUniq fileTest.txt
starticks :228
  Uniq command is getting executed in user mode.
  I understand the Operating system.
  I love to work on OS.
  Thanks xv6
endticks : 229
duration : 1
starticks :229
  Uniq command is getting executed in Kernel mode.
  I understand the Operating system.
  I love to work on OS.
  Thanks xv6
endticks : 229
duration : 0
$
```

ps:

```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS zsh - xv6-riscv + v []
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mmodel=medany -ffreestanding -fno-ib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o user/kernelHead.o user/kernelHead.c
riscv64-unknown-elf-ld -z max-page-size=4096 -T user/user.ld -o user/_kernelHead user/kernelHead.o user/ulib.o user/usys.o user/umalloc.o
riscv64-unknown-elf-objdump -S user/_kernelHead > user/kernelHead.asm
riscv64-unknown-elf-objdump -t user/_kernelHead | sed '1,/SYMBOL TABLE/d; s/ .* / /; /^$/d' > user/kernelHead.sym
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mmodel=medany -ffreestanding -fno-ib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o user/kernelUniq.o user/kernelUniq.c
riscv64-unknown-elf-ld -z max-page-size=4096 -T user/user.ld -o user/_kernelUniq user/kernelUniq.o user/ulib.o user/usys.o user/umalloc.o
riscv64-unknown-elf-objdump -S user/_kernelUniq > user/kernelUniq.asm
riscv64-unknown-elf-objdump -t user/_kernelUniq | sed '1,/SYMBOL TABLE/d; s/ .* / /; /^$/d' > user/kernelUniq.sym
mkfs/mkfs fs.img README fileTest.txt user/_cat user/_echo user/_forktest user/_grep user/_init user/_kill user/_ln user/_user/_rm user/_sh user/_stressfs user/_usertests user/_grind user/_wc user/_zombie user/_head user/_uniq user/_ps user/_nelHead user/_kernelUniq
nmeta 46 (boot, super, log blocks 30 inode blocks 13, bitmap blocks 1) blocks 1954 total 2000
ballocc: first 977 blocks have been allocated
ballocc: write bitmap block at sector 45
qemu-system-riscv64 -machine virt -bios none -kernel kernel/kernel -m 128M -smp 3 -nographic -global virtio-mmio.force-legacy file=fs.img,if=none,format=raw,id=x0 -device virtio-blk-device,drive=x0,bus=virtio-mmio-bus.0

xv6 kernel is booting

hart 2 starting
hart 1 starting
init: starting sh
$ test uniq fileTest.txt kernelUniq fileTest.txt
starticks :147
Uniq command is getting executed in user mode.
I understand the Operating system.
I love to work on OS.
Thanks xv6
endticks : 147
duration : 0
starticks :147
Uniq command is getting executed in Kernel mode.
I understand the Operating system.
I love to work on OS.
Thanks xv6
endticks : 147
duration : 0
$ ps
pid    state  name      start  end    duration  waitTime
1      sleep  init      0      0      -1        -1
2      sleep  sh        2      0      -1        -1
3      dead   test     146    147    1         1
4      dead   uniq     147    147    0         0
5      dead   kernelUniq 147    147    147      0        0
6      run    ps       165    0      -1        -1
$
```

Test case for Priority:

Make clean:

```
PROBLEMS  OUTPUT  DEBUG CONSOLE  TERMINAL  PORTS  zsh - xv6-riscv + - []
⊙ (base) sudhamshreddy@newname New Folder With Items % cd Project3_Sudhamsh_P
cd: no such file or directory: Project3_Sudhamsh_P
● (base) sudhamshreddy@newname New Folder With Items % ls
Project3_Sudhamsh_FCFS      Project3_Sudhamsh_priority
● (base) sudhamshreddy@newname New Folder With Items % cd Project3_Sudhamsh_priority
● (base) sudhamshreddy@newname Project3_Sudhamsh_priority % cd xv6-riscv
● (base) sudhamshreddy@newname xv6-riscv % make clean
rm -f *.tex *.dvi *.idx *.aux *.log *.ind *.ilg \
    /*.o /*.d /*.asm /*.sym \
    user/initcode user/initcode.out kernel/kernel fs.img \
    mkfs/mkfs .gdbinit \
    user/usys.S \
    user/_cat user/_echo user/_forktest user/_grep user/_init user/_kill user/_ln user/_ls user/_mkdir user/_rm user/
ssfs user/_usertests user/_grind user/_wc user/_zombie user/_head user/_uniq user/_ps user/_fork77 user/_test user/_kerne
rnelUniq
○ (base) sudhamshreddy@newname xv6-riscv %
```

test uniq fileTest.txt 3 kernelUniq fileTest.txt 6:

```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
zsh - xv6-riscv + v

riscv64-unknown-elf-objdump -t user/_test | sed '1,/SYMBOL TABLE/d; s/ .* / /; /^$/d' > user/test.sym
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mmodel=medany -ffreestanding -fno-ib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o user/kernelHead.o user/kernelHead.c
riscv64-unknown-elf-ld -z max-page-size=4096 -T user/user.ld -o user/_kernelHead user/kernelHead.o user/ulib.o user/usys.o user/umalloc.o
riscv64-unknown-elf-objdump -S user/_kernelHead > user/kernelHead.asm
riscv64-unknown-elf-objdump -t user/_kernelHead | sed '1,/SYMBOL TABLE/d; s/ .* / /; /^$/d' > user/kernelHead.sym
riscv64-unknown-elf-gcc -Wall -Werror -O -fno-omit-frame-pointer -ggdb -gdwarf-2 -MD -mmodel=medany -ffreestanding -fno-ib -mno-relax -I. -fno-stack-protector -fno-pie -no-pie -c -o user/kernelUniq.o user/kernelUniq.c
riscv64-unknown-elf-ld -z max-page-size=4096 -T user/user.ld -o user/_kernelUniq user/kernelUniq.o user/ulib.o user/usys.o user/umalloc.o
riscv64-unknown-elf-objdump -S user/_kernelUniq > user/kernelUniq.asm
riscv64-unknown-elf-objdump -t user/_kernelUniq | sed '1,/SYMBOL TABLE/d; s/ .* / /; /^$/d' > user/kernelUniq.sym
mkfs/mkfs fs.img README fileTest.txt user/_cat user/_echo user/_forktest user/_grep user/_init user/_kill user/_ln user/_user/_rm user/_sh user/_stressfs user/_usertests user/_grind user/_wc user/_zombie user/_head user/_uniq user/_ps user/_est user/_kernelHead user/_kernelUniq
nmeta 46 (boot, super, log blocks 30 inode blocks 13, bitmap blocks 1) blocks 1954 total 2000
ballocc: first 1003 blocks have been allocated
ballocc: write bitmap block at sector 45
qemu-system-riscv64 -machine virt -bios none -kernel kernel/kernel -m 128M -smp 3 -nographic -global virtio-mmio.force-legacy file=fs.img,if=none,format=raw,id=x0 -device virtio-blk-device,drive=x0,bus=virtio-mmio-bus.0

xv6 kernel is booting

hart 2 starting
hart 1 starting
init: starting sh
$ test uniq fileTest.txt 3 kernelUniq fileTest.txt 6
sstearrttdTtairctkTsi ic:k sck 2s1 7:
Du:r2 1a2t1i77

on : 0
startTicks : 217
Uniq commaUnnidq ciosm mganed titsi ngg eextectuUniq comimand is getting executed in Kernel mode.
I tunderstand the Operating system.
negI love to work on OS.
de Thanks xv6
xien cuuteensdedrt iic kmno dsu e:.
se2r17 m
odDuer.
ation : 0
I undeIr stuanndde rthste a0ndp eratthihneg 0spyesratteimn.g
system.
I love to woI rlk oovne 0tSo .w
ork on OS.
ThankThsa nkxs vx6
v6
endticks : 218
Duration : 1
$
```

Ps:

```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS zsh - xv6-riscv + - □
riscv64-unknown-elf-ld -z max-page-size=4096 -T user/user.ld -o user/_kernelUniq user/kernelUniq.o user/ulib.o user/usys.
o user/umalloc.o
riscv64-unknown-elf-objdump -S user/_kernelUniq > user/kernelUniq.asm
riscv64-unknown-elf-objdump -t user/_kernelUniq | sed '1,/SYMBOL TABLE/d; s/ .* / /; /^$/d' > user/kernelUniq.sym
mkfs/mkfs fs.img README fileTest.txt user/_cat user/_echo user/_forktest user/_grep user/_init user/_kill user/_ln user/_
user/_rm user/_sh user/_stressfs user/_usertests user/_grind user/_wc user/_zombie user/_head user/_uniq user/_ps user/_
est user/_kernelHead user/_kernelUniq
nmeta 46 (boot, super, log blocks 30 inode blocks 13, bitmap blocks 1) blocks 1954 total 2000
balloc: first 1003 blocks have been allocated
balloc: write bitmap block at sector 45
qemu-system-riscv64 -machine virt -bios none -kernel kernel/kernel -m 128M -smp 3 -nographic -global virtio-mmio.force-le
ive file=fs.img,if=none,format=raw,id=x0 -device virtio-blk-device,drive=x0,bus=virtio-mmio-bus.0

xv6 kernel is booting

hart 2 starting
hart 1 starting
init: starting sh
$ test uniq fileTest.txt 3 kernelUniq fileTest.txt 6
sstearrttdTtairctkTsi ic:k sck 2s1 7:
Du:r2 1a2t1i77

on : 0
startTicks : 217
Uniq commaUnnidq ciosm mغانed titsi ngg eextectuUniq comimand is getting executed in Kernel mode.
I tunderstand the Operating system.
negI love to work on OS.
de Thanks xv6
xien cuuteensdedrt iic kmno dsu e:.
se2r17 m
odDuer.
ation : 0
I undeIr stuanndde rthste a0ndp erattihneg 0spyesratteimn.g
system.
I love to woI rlk oovne 0tSo .w
ork on OS.
ThankThsa nkxs vx6
v6
endticks : 218
Duration : 1
$ ps
pid state name start end duration waitTime
1 sleep init 0 0 -1 -1
2 sleep sh 2 0 -1 -1
3 dead test 217 218 1 1
4 dead uniq 217 218 1 1
5 dead kernelUniq 217 217 0 0
6 dead uniq 217 218 1 1
7 run ps 480 0 -1 -1
$
```

Note: The XV6 in mac os supports multiprocessing due to which when we create multiple processes they run parallely due to which the output is gibbershed and in most of cases the wait time is near 0 ticks.