OPERATING SYSTEMS LAB REPORT

ASSIGNMENT - 2

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BCSE-III Odd Sem (Grp - A1)

QUESTION - 1

a. Design a CPU scheduler for jobs whose execution profiles will be in a file that is to be read and an appropriate scheduling algorithm to be chosen by the scheduler.

Format of the profile:

<Job id> <priority> <arrival time> <CPU burst(1) I/O burst(1) CPU burst(2) ……. >-1

(Each information is separated by blank space and each job profile ends with -1. Lesser priority the number denotes a higher priority process with priority number 1 being the process with the highest priority.)

Example: 2 3 4 100 2 200 3 25 -1 7 1 8 60 10 ….. -1 etc.

Testing:

a. Create job profiles for 30 jobs and use three different scheduling algorithms (FCFS, Priority and Round Robin (time slice: 25)).

b. Compare the average waiting time, turnaround time of each process for the different scheduling algorithms.

SOLUTION

q1.h

```
#include <stdio.h>
#include <stdlib.h>
#include <limits.h>
#define __MAX_MASK__ 127
#ifndef Q1_H
#define Q1_H
struct burststruct
{
      int time;
      struct burststruct *next;
};
typedef struct jobstruct
{
      int jobid, priority, arrival;
      struct burststruct *bursts;
} job;

struct jobnode
{
      job j;
      struct jobnode *next;
};
```

```
typedef struct jbqstr
{
     struct jobnode *head, *tail;
} job_queue;

typedef enum
{
     new_job,
     cpuend,
     ioend,
     done
} event;

struct stat
{
     int jobid, arrival, finish, wait, priority;
};
#endif

extern int time;
extern int cpu, io;
extern job_queue unarrived, jobqueue, ioqueue;
extern int currentjobs[__MAX_MASK__][4];
extern int cpubusy, iobusy;
extern job currentcpujob, currentiojob;
extern int count;
extern struct stat stats[1000];
extern job dummy;

extern void process_cpu_end();
extern void put_in_cpu();
extern void put_in_io();
extern void remove_waiting();
extern void accept_new_jobs();
extern void get_next_event(event *);

/* basic queue operations */
#pragma region queue_operations

extern void init_q(job_queue *q);

extern void push(job_queue *q, job j);

extern int empty(job_queue q);

extern job front(job_queue q);

extern void pop(job_queue *q);
```

```
#pragma endregion

/* parses jobs from a file called "jobs" */
extern int parse_jobs();

/* store stats regarding a completed job with job_id id */
extern void store_stats(int id);

/* displays results */
extern void display_results();
```

q1.c

```
#include "q1.h"
int time = 0;
int cpu = 0, io = 0;
job_queue unarrived, jobqueue, ioqueue;
int currentjobs[__MAX_MASK__][4] = {0};
int cpubusy = 0, iobusy = 0;
job currentcpujob, currentiojob;
int count = 0;
struct stat stats[1000];
job dummy = {-1, -1, -1, NULL};

int main()
{
     init_q(&unarrived);
     init_q(&ioqueue);
     init_q(&jobqueue);
     event currentevent = new_job;
     if (parse_jobs())
     {
          return 1;
     }
     if (empty(unarrived))
          goto DONE;
#define GO_TO_NEXT_EVENT           \
     get_next_event(&currentevent); \
     switch (currentevent)          \
     {                              \
     case new_job:                  \
          goto NEWJOB;               \
     case cpuend:                   \
          goto CPUEND;               \
```

```
     case ioend:                    \
          goto IOEND;                \
     case done:                     \
          goto DONE;                 \
     }
     GO_TO_NEXT_EVENT
NEWJOB:
     accept_new_jobs();
     GO_TO_NEXT_EVENT
CPUEND:
     process_cpu_end();
     GO_TO_NEXT_EVENT
IOEND:
     remove_waiting();
     GO_TO_NEXT_EVENT
DONE:
     display_results();
#undef GO_TO_NEXT_EVENT
}
```

q1-common.c

```
#include "q1.h"

/* basic queue operations */
#pragma region queue_operations

extern job dummy;
extern int count;
void init_q(job_queue *q)
{
     q->head = q->tail = NULL;
}

void push(job_queue *q, job j)
{
     if (q->head)
q->tail = q->tail->next = (struct jobnode *)malloc(sizeof(struct jobnode));
     else
          q->tail = q->head = (struct jobnode *)malloc(sizeof(struct jobnode));
     q->tail->j = j;
}

int empty(job_queue q)
```

```
{
	return !q.head;
}

job front(job_queue q)
{
	if (q.head)
		return q.head->j;
	else
		return dummy;
}

void pop(job_queue *q)
{
	if (q->head)
	{
		if (q->head == q->tail)
		{
			free(q->head);
			q->head = q->tail = NULL;
		}
		else
		{
			struct jobnode *t = q->head;
			q->head = q->head->next;
			free(t);
		}
	}
}

#pragma endregion

/* parses jobs from a file called "jobs" */
int parse_jobs()
{
	/*
	 * Assumption: job descriptions are given in primarily non-decreasing order
of
 time and secondarily non-decreasing order of priority number
	 */
	FILE *f = fopen("jobs", "r");
	if (f == NULL)
	{
		perror("Could not open file\n");
		return 1;
	}
	int l = 0;
	while (1)
	{
```

```
            l++;
            int id, pr, atime;
            if (fscanf(f, "%d", &id) == EOF)
                  break;
            fscanf(f, "%d", &pr);
            fscanf(f, "%d", &atime);
            id &= __MAX_MASK__;
            job j;
            j.jobid = id;
            j.priority = pr;
            j.arrival = atime;
            struct burststruct h, *cur;
            h.next = NULL;
            cur = &h;
            int fl = 1;
            while (1)
            {
                  int t;
                  fscanf(f, "%d", &t);
                  if (t == -1)
                        break;
                  cur = cur->next = (struct burststruct *)malloc(sizeof(struct
burststruct));
                  cur->time = t;
                  fl = !fl;
            }
            if (!h.next)
            {
                  printf("job at line %d ends with has no bursts. Ingoring it.\n",
l);
                  continue;
            }
            if (fl)
            {
                  printf("job at line %d ends with an IO burst. Ingoring it.\n", l);
                  continue;
            }
            j.bursts = h.next;
            push(&unarrived, j);
      }
      return 0;
}

/* store stats regarding a completed job with job_id id */
void store_stats(int id)
{
      struct stat *s = stats + count++;
      s->jobid = id;
      s->arrival = currentjobs[id][1];
      s->finish = time;
```

```
      s->wait = time - s->arrival - currentjobs[id][2];
      s->priority = currentjobs[id][3];
      currentjobs[id][0] = 0;
}

/* displays results */
void display_results()
{
      if (count == 0)
      {
            printf("No Results to display!\n");
            return;
      }
      int i;
#define REPEAT(n, ch) \
      i = n;            \
      while (i--)       \
            printf("%c", ch);
      REPEAT(1, '\t')
      REPEAT(1, '+')
      REPEAT(132, '-')
      REPEAT(1, '+')
      REPEAT(1, '\n')
      printf("\t|%5s|%10s|%10s|%20s|%20s|%20s|%20s|%20s|\n", "s.no.", "job
id","priority", "arrival time", "queue wait time", "finish time", "turnaround
time","wait time %");
      REPEAT(1, '\t')
      REPEAT(1, '|')
      REPEAT(5, '-')
      REPEAT(1, '+')
      REPEAT(10, '-')
      REPEAT(1, '+')
      REPEAT(10, '-')
      REPEAT(1, '+')
      REPEAT(20, '-')
      REPEAT(1, '+')
      REPEAT(20, '-')
      REPEAT(1, '+')
      REPEAT(20, '-')
      REPEAT(1, '+')
      REPEAT(20, '-')
      REPEAT(1, '+')
      REPEAT(20, '-')
      REPEAT(1, '|')
      REPEAT(1, '\n')
      int TTA, TWT;
      TTA = TWT = 0;
      for (i = 0; i < count; i++)
```

```
     {
          printf("\t|%5d|%10d|%10d|%20d|%20d|%20d|%20d|%18.3f %%|\n", i + 1,
 stats[i].jobid,stats[i].priority, stats[i].arrival, stats[i].wait,
stats[i].finish,
  stats[i].finish - stats[i].arrival,(100.00 *
stats[i].wait)/(stats[i].finish-stats[i].arrival));
          TWT += stats[i].wait;
          TTA += stats[i].finish - stats[i].arrival;
     }
     REPEAT(1, '\t')
     REPEAT(1, '+')
     REPEAT(132, '-')
     REPEAT(1, '+')
     REPEAT(2, '\n')
     printf("average turnaround time\t%.3f\n", ((float)TTA) / count);
     printf("average queue wait time\t%.3f\n", ((float)TWT) / count);

#undef REPEAT
}
```

FCFS.c

```
#include "q1.h"
void get_next_event(event *e)
{
     int ioexp, cpuexp, newarr;
     if (!iobusy)
          ioexp = INT_MAX;
     else
          ioexp = currentiojob.bursts->time - io;
     if (!cpubusy)
          cpuexp = INT_MAX;
     else
          cpuexp = currentcpujob.bursts->time - cpu;
     if (empty(unarrived))
          newarr = INT_MAX;
     else
          newarr = front(unarrived).arrival - time;
     if (ioexp == cpuexp && newarr == ioexp && ioexp == INT_MAX)
          *e = done;
     else if (cpuexp <= ioexp && cpuexp <= newarr)
     {
          time += cpuexp;
          if (cpubusy)
               cpu += cpuexp;
          if (iobusy)
               io += cpuexp;
```

```
            *e = cpuend;
      }
      else if (ioexp <= newarr)
      {
            time += ioexp;
            if (cpubusy)
                  cpu += ioexp;
            if (iobusy)
                  io += ioexp;
            *e = ioend;
      }
      else
      {
            time += newarr;
            if (cpubusy)
                  cpu += newarr;
            if (iobusy)
                  io += newarr;
            *e = new_job;
      }
}

void accept_new_jobs()
{
      while (!empty(unarrived))
      {
            job j = front(unarrived);
            if (j.arrival != time)
                  break;
            pop(&unarrived);
            if (currentjobs[j.jobid][0])
                  printf("job with job id (%d) arrived at %d cannot be taken as job
id
is already in use\n", j.jobid, time);
            else
            {
                  currentjobs[j.jobid][0] = 1;
                  currentjobs[j.jobid][1] = time;
                  currentjobs[j.jobid][2] = 0;
                  currentjobs[j.jobid][3] = j.priority;
                  push(&jobqueue, j);
            }
      }
      if (!cpubusy && !empty(jobqueue))
            put_in_cpu();
}

void process_cpu_end()
{
```

```
      struct burststruct *temp = currentcpujob.bursts;
      int incomp = (currentcpujob.bursts = currentcpujob.bursts->next) != NULL;
      free(temp);
      currentjobs[currentcpujob.jobid][2] += cpu;
      cpu = 0;
      if (!incomp)
            store_stats(currentcpujob.jobid);
      else
      {
            push(&ioqueue, currentcpujob);
            if (!iobusy)
                  put_in_io();
      }
      if (empty(jobqueue))
            cpubusy = 0;
      else
            put_in_cpu();
}

void remove_waiting()
{
      struct burststruct *temp = currentiojob.bursts;
      currentiojob.bursts = currentiojob.bursts->next;
      free(temp);
      currentjobs[currentiojob.jobid][2] += io;
      io = 0;
      push(&jobqueue, currentiojob);
      if (!cpubusy)
            put_in_cpu();
      if (empty(ioqueue))
            iobusy = 0;
      else
            put_in_io();
}

void put_in_cpu()
{
      currentcpujob = front(jobqueue);
      pop(&jobqueue);
      cpubusy = 1;
}
void put_in_io()
{
      currentiojob = front(ioqueue);
      pop(&ioqueue);
      iobusy = 1;
}
```

PRIOR.c

```
#include "q1.h"

void specialpush(job_queue *q, job j);
void get_next_event(event *e)
{
	int ioexp, cpuexp, newarr;
	if (!iobusy)
		ioexp = INT_MAX;
	else
		ioexp = currentiojob.bursts->time - io;
	if (!cpubusy)
		cpuexp = INT_MAX;
	else
		cpuexp = currentcpujob.bursts->time - cpu;
	if (empty(unarrived))
		newarr = INT_MAX;
	else
		newarr = front(unarrived).arrival - time;
	if (ioexp == cpuexp && newarr == ioexp && ioexp == INT_MAX)
		*e = done;
	else if (cpuexp <= ioexp && cpuexp <= newarr)
	{
		time += cpuexp;
		if (cpubusy)
			cpu += cpuexp;
		if (iobusy)
			io += cpuexp;
		*e = cpuend;
	}
	else if (ioexp <= newarr)
	{
		time += ioexp;
		if (cpubusy)
			cpu += ioexp;
		if (iobusy)
			io += ioexp;
		*e = ioend;
	}
	else
	{
		time += newarr;
		if (cpubusy)
			cpu += newarr;
		if (iobusy)
			io += newarr;
		*e = new_job;
```

```
	}
}

void accept_new_jobs()
{
	while (!empty(unarrived))
	{
		job j = front(unarrived);
		if (j.arrival != time)
			break;
		pop(&unarrived);
		if (currentjobs[j.jobid][0])
			printf("job with job id (%d) arrived at %d cannot be taken as job id is
already in use\n", j.jobid, time);
		else
		{
			currentjobs[j.jobid][0] = 1;
			currentjobs[j.jobid][1] = time;
			currentjobs[j.jobid][2] = 0;
			currentjobs[j.jobid][3] = j.priority;
			specialpush(&jobqueue, j);
		}
	}
	if (!cpubusy && !empty(jobqueue))
		put_in_cpu();
}
void specialpush(job_queue *q, job j)
{
	if (q->head == NULL)
	{
		push(q, j);
		return;
	}
	int pr = j.priority;
	if (q->tail->j.priority <= pr)
	{
		push(q, j);
		return;
	}
	if (q->head->j.priority > pr)
	{
		struct jobnode *n = (struct jobnode *)malloc(sizeof(struct jobnode));
		n->j = j;
		n->next = q->head;
		q->head = n;
		return;
	}
	struct jobnode *cur = q->head;
	while (cur->next->j.priority <= pr)
```

```
            cur = cur->next;
      struct jobnode *n = (struct jobnode *)malloc(sizeof(struct jobnode));
      n->j = j;
      n->next = cur->next;
      cur->next = n;
}
void process_cpu_end()
{
      struct burststruct *temp = currentcpujob.bursts;
      int incomp = (currentcpujob.bursts = currentcpujob.bursts->next) != NULL;
      free(temp);
      currentjobs[currentcpujob.jobid][2] += cpu;
      cpu = 0;
      if (!incomp)
            store_stats(currentcpujob.jobid);
      else
      {
            push(&ioqueue, currentcpujob);
            if (!iobusy)
                  put_in_io();
      }
      if (empty(jobqueue))
            cpubusy = 0;
      else
            put_in_cpu();
}

void remove_waiting()
{
      struct burststruct *temp = currentiojob.bursts;
      currentiojob.bursts = currentiojob.bursts->next;
      free(temp);
      currentjobs[currentiojob.jobid][2] += io;
      io = 0;
      specialpush(&jobqueue, currentiojob);
      if (!cpubusy)
            put_in_cpu();
      if (empty(ioqueue))
            iobusy = 0;
      else
            put_in_io();
}

void put_in_cpu()
{
      currentcpujob = front(jobqueue);
      pop(&jobqueue);
      cpubusy = 1;
```

```
}
void put_in_io()
{
	currentiojob = front(ioqueue);
	pop(&ioqueue);
	iobusy = 1;
}
```

RBRN.c

```
#include "q1.h"
int max_cpu_burst_length = 25; // time slice given in question
void get_next_event(event *e)
{
	int ioexp, cpuexp, newarr;
	if (!iobusy)
		ioexp = INT_MAX;
	else
		ioexp = currentiojob.bursts->time - io;
	if (!cpubusy)
		cpuexp = INT_MAX;
	else
		cpuexp = (currentcpujob.bursts->time > max_cpu_burst_length ?
max_cpu_burst_length : currentcpujob.bursts->time) - cpu;
	if (empty(unarrived))
		newarr = INT_MAX;
	else
		newarr = front(unarrived).arrival - time;
	if (ioexp == cpuexp && newarr == ioexp && ioexp == INT_MAX)
		*e = done;
	else if (cpuexp <= ioexp && cpuexp <= newarr)
	{
		time += cpuexp;
		if (cpubusy)
			cpu += cpuexp;
		if (iobusy)
			io += cpuexp;
		*e = cpuend;
	}
	else if (ioexp <= newarr)
	{
		time += ioexp;
		if (cpubusy)
			cpu += ioexp;
		if (iobusy)
			io += ioexp;
		*e = ioend;
```

```
	}
	else
	{
		time += newarr;
		if (cpubusy)
			cpu += newarr;
		if (iobusy)
			io += newarr;
		*e = new_job;
	}
}

void accept_new_jobs()
{
	while (!empty(unarrived))
	{
		job j = front(unarrived);
		if (j.arrival != time)
			break;
		pop(&unarrived);
		if (currentjobs[j.jobid][0])
			printf("job with job id (%d) arrived at %d cannot be taken as job id is
already in use\n", j.jobid, time);
		else
		{
			currentjobs[j.jobid][0] = 1;
			currentjobs[j.jobid][1] = time;
			currentjobs[j.jobid][2] = 0;
			currentjobs[j.jobid][3] = j.priority;
			push(&jobqueue, j);
		}
	}
	if (!cpubusy && !empty(jobqueue))
		put_in_cpu();
}

void process_cpu_end()
{
	struct burststruct *temp = currentcpujob.bursts;
	int current_burst_incomplete = temp->time > cpu, incomp = 1;
	currentjobs[currentcpujob.jobid][2] += cpu;
	if (current_burst_incomplete)
	{
		temp->time -= cpu;
	}
	else
	{
		incomp = (currentcpujob.bursts = currentcpujob.bursts->next) != NULL;
```

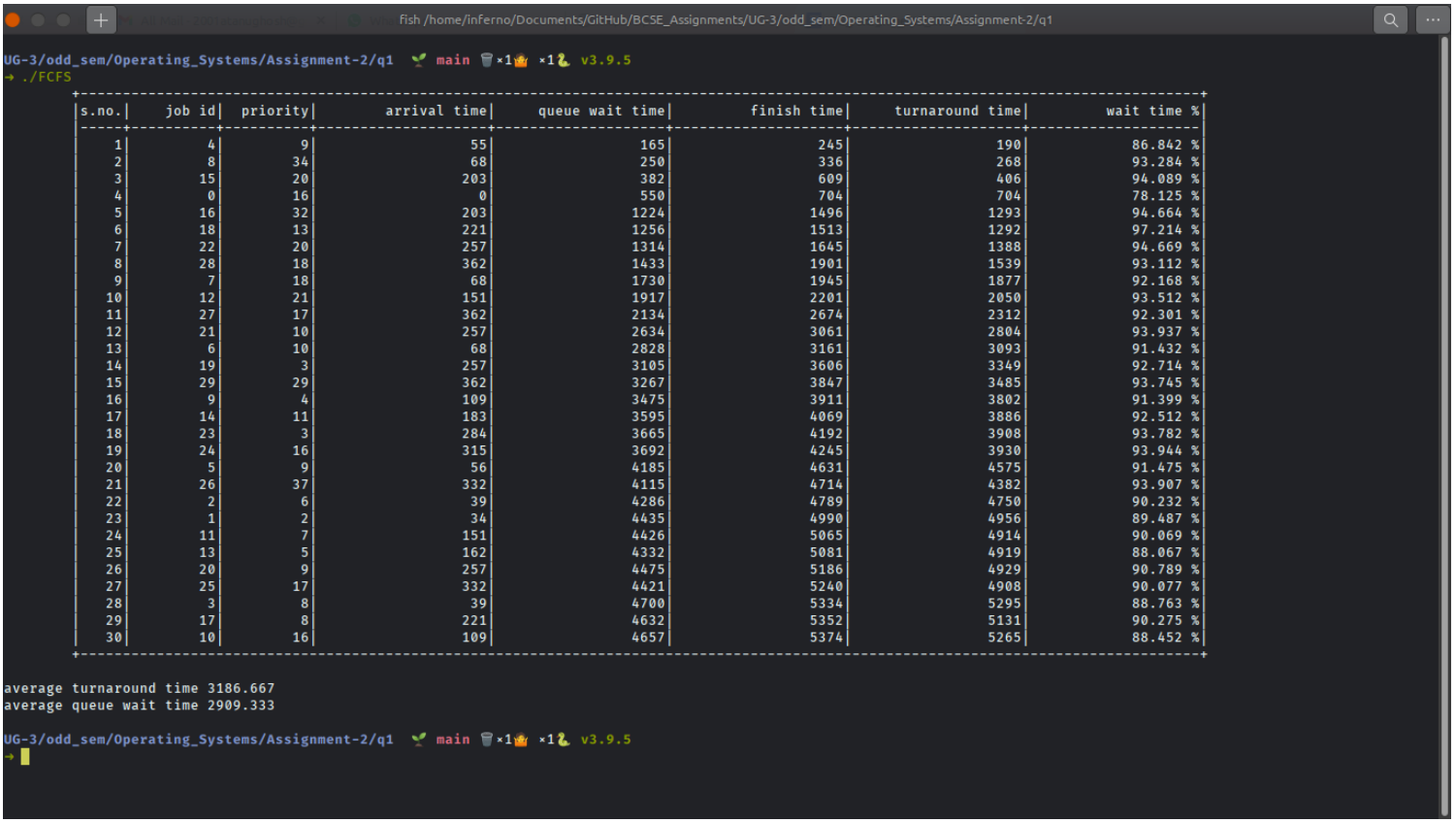
```
            free(temp);
      }
      cpu = 0;
      if (!incomp)
            store_stats(currentcpujob.jobid);
      else if (!current_burst_incomplete)
      {
            push(&ioqueue, currentcpujob);
            if (!iobusy)
                  put_in_io();
      }
      else
            push(&jobqueue, currentcpujob);
      if (empty(jobqueue))
            cpubusy = 0;
      else
            put_in_cpu();
}

void remove_waiting()
{
      struct burststruct *temp = currentiojob.bursts;
      currentiojob.bursts = currentiojob.bursts->next;
      free(temp);
      currentjobs[currentiojob.jobid][2] += io;
      io = 0;
      push(&jobqueue, currentiojob);
      if (!cpubusy)
            put_in_cpu();
      if (empty(ioqueue))
            iobusy = 0;
      else
            put_in_io();
}

void put_in_cpu()
{
      currentcpujob = front(jobqueue);
      pop(&jobqueue);
      cpubusy = 1;
}
void put_in_io()
{
      currentiojob = front(ioqueue);
      pop(&ioqueue);
      iobusy = 1;
}
```

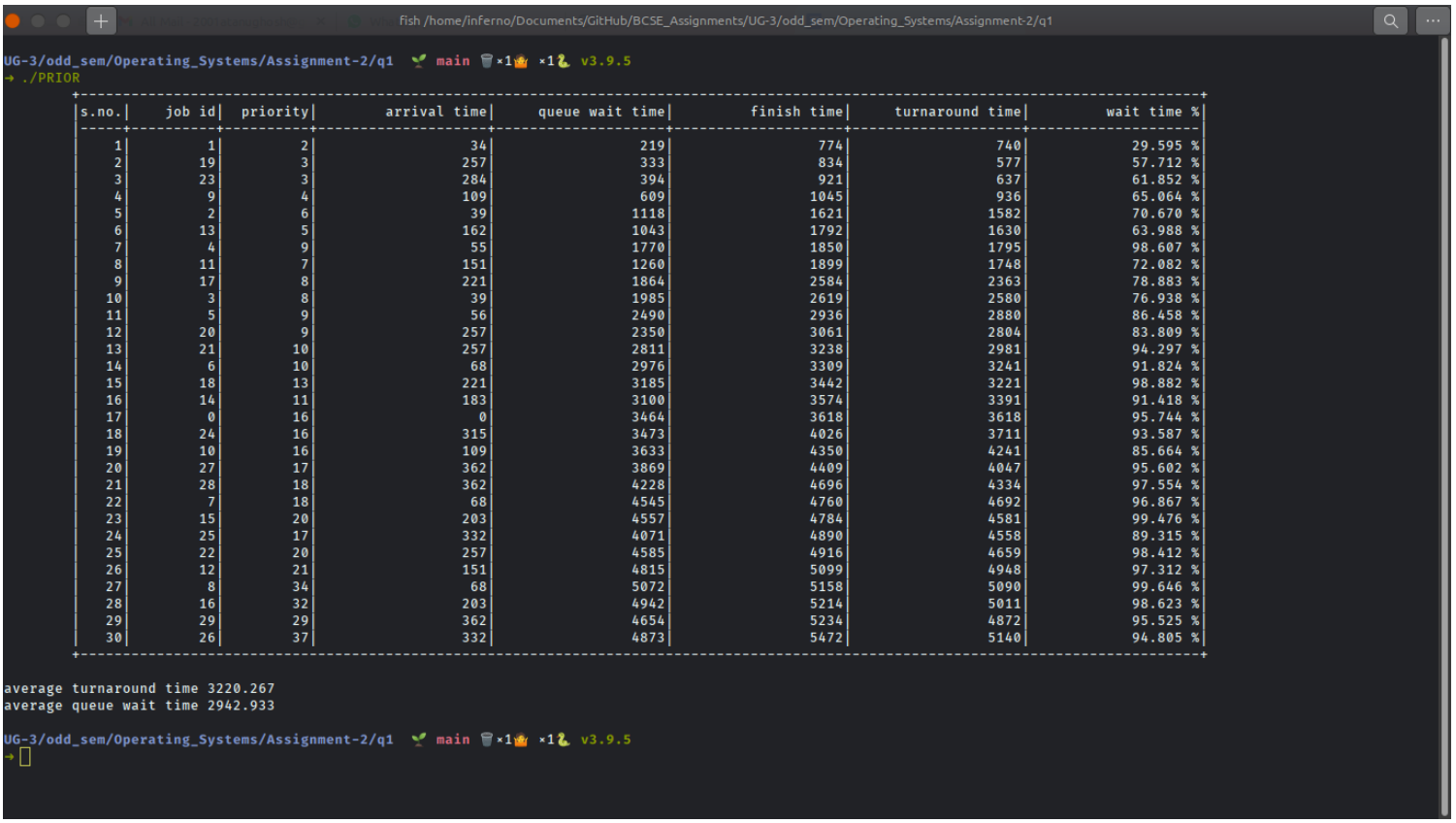
The program basically does what should be done at the current event, finds the appropriate next event and goes to the next event.

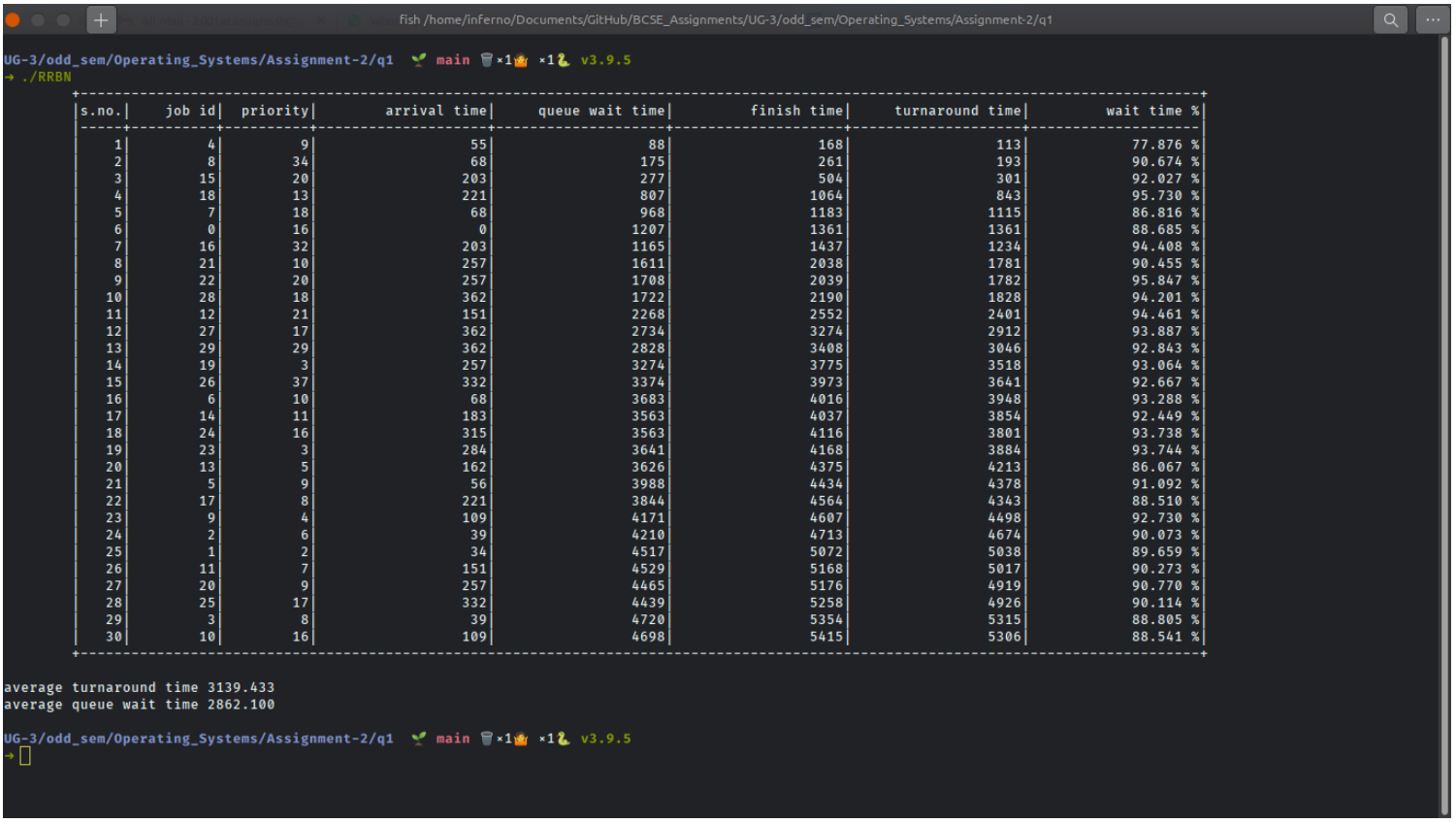
At the event `done`, it prints the statistics it has gathered and terminated.

A python script was used to generate the file `jobs` which the program takes as input.

OUTPUT




fish /home/inferno/Documents/GitHub/BCSE_Assignments/UG-3/odd_sem/Operating_Systems/Assignment-2/q1
UG-3/odd_sem/Operating_Systems/Assignment-2/q1 main ×1 ×1 v3.9.5
→ ./PRIOR
s.no.	job id	priority	arrival time	queue wait time	finish time	turnaround time	wait time %
1	1	2	34	219	774	740	29.595 %
2	19	3	257	333	834	577	57.712 %
3	23	3	284	394	921	637	61.852 %
4	9	4	109	609	1045	936	65.064 %
5	2	6	39	1118	1621	1582	70.670 %
6	13	5	162	1043	1792	1630	63.988 %
7	4	9	55	1770	1850	1795	98.607 %
8	11	7	151	1260	1899	1748	72.082 %
9	17	8	221	1864	2584	2363	78.883 %
10	3	8	39	1985	2619	2580	76.938 %
11	5	9	56	2490	2936	2880	86.458 %
12	20	9	257	2350	3061	2804	83.809 %
13	21	10	257	2811	3238	2981	94.297 %
14	6	10	68	2976	3309	3241	91.824 %
15	18	13	221	3185	3442	3221	98.882 %
16	14	11	183	3100	3574	3391	91.418 %
17	0	16	0	3464	3618	3618	95.744 %
18	24	16	315	3473	4026	3711	93.587 %
19	10	16	109	3633	4350	4241	85.664 %
20	27	17	362	3869	4409	4047	95.602 %
21	28	18	362	4228	4696	4334	97.554 %
22	7	18	68	4545	4760	4692	96.867 %
23	15	20	203	4557	4784	4581	99.476 %
24	25	17	332	4071	4890	4558	89.315 %
25	22	20	257	4585	4916	4659	98.412 %
26	12	21	151	4815	5099	4948	97.312 %
27	8	34	68	5072	5158	5090	99.646 %
28	16	32	203	4942	5214	5011	98.623 %
29	29	29	362	4654	5234	4872	95.525 %
30	26	37	332	4873	5472	5140	94.805 %
average turnaround time 3220.267
average queue wait time 2942.933
UG-3/odd_sem/Operating_Systems/Assignment-2/q1 main ×1 ×1 v3.9.5
→


fish /home/inferno/Documents/GitHub/BCSE_Assignments/UG-3/odd_sem/Operating_Systems/Assignment-2/q1
UG-3/odd_sem/Operating_Systems/Assignment-2/q1 main ×1 ×1 v3.9.5
→ ./RRBN
s.no.	job id	priority	arrival time	queue wait time	finish time	turnaround time	wait time %
1	4	9	55	88	168	113	77.876 %
2	8	34	68	175	261	193	90.674 %
3	15	20	203	277	504	301	92.027 %
4	18	13	221	807	1064	843	95.730 %
5	7	18	68	968	1183	1115	86.816 %
6	0	16	0	1207	1361	1361	88.685 %
7	16	32	203	1165	1437	1234	94.408 %
8	21	10	257	1611	2038	1781	90.455 %
9	22	20	257	1708	2039	1782	95.847 %
10	28	18	362	1722	2190	1828	94.201 %
11	12	21	151	2268	2552	2401	94.461 %
12	27	17	362	2734	3274	2912	93.887 %
13	29	29	362	2828	3408	3046	92.843 %
14	19	3	257	3274	3775	3518	93.064 %
15	26	37	332	3374	3973	3641	92.667 %
16	6	10	68	3683	4016	3948	93.288 %
17	14	11	183	3563	4037	3854	92.449 %
18	24	16	315	3563	4116	3801	93.738 %
19	23	3	284	3641	4168	3884	93.744 %
20	13	5	162	3626	4375	4213	86.067 %
21	5	9	56	3988	4434	4378	91.092 %
22	17	8	221	3844	4564	4343	88.510 %
23	9	4	109	4171	4607	4498	92.730 %
24	2	6	39	4210	4713	4674	90.073 %
25	1	2	34	4517	5072	5038	89.659 %
26	11	7	151	4529	5168	5017	90.273 %
27	20	9	257	4465	5176	4919	90.770 %
28	25	17	332	4439	5258	4926	90.114 %
29	3	8	39	4720	5354	5315	88.805 %
30	10	16	109	4698	5415	5306	88.541 %
average turnaround time 3139.433
average queue wait time 2862.100
UG-3/odd_sem/Operating_Systems/Assignment-2/q1 main ×1 ×1 v3.9.5
→

QUESTION - 2

Write a program for p-producer c-consumer problem, p, c >= 1. A shared circular buffer that can hold 50 items is to be used. Each producer process can store any number between 1 to 100 (along with the producer id) and deposit in the buffer. Each consumer process reads a number from the buffer and adds it to a shared variable TOTAL (initialized to 0). Though any consumer process can read any of the numbers in the buffer, the only constraint being that every number written by some producer should be read exactly once by exactly one of the consumers.

The program reads in the value of p and c from the user, and forks p producers and c consumers. After all the producers and consumers have finished (the consumers exit after all the data produced by all producers have been read), the parent process prints the value of TOTAL. Test the program with different values of p and c.

SOLUTION

q2.c

```
#define _DEFAULT_SOURCE
#include <stdlib.h>
#include <stdio.h>
#include <semaphore.h>
#include <unistd.h>
#include <time.h>
#include <sys/shm.h>
#include <sys/mman.h>
#include <sys/types.h>
#include <sys/wait.h>
#include <sys/signal.h>
#define BUFFER_LEN 50
#define PER_PRODUCER_MINIMUM 100
#define PER_PRODUCER_RANGE 101
struct requiredmemory
{
      sem_t f, e, m;
      int total, start, count;
      unsigned char circular_buffer[50];
};
int localtotal;
int count;
int id;
void consumerhandler(int sig)
{
      printf("Consumer %d : consumed %d items totalling to %d\n", id, count,
 localtotal);
```

```
	fflush(stdout);
	raise(SIGKILL);
};
int main(int argc, char **argv)
{
	localtotal = 0;
	if (argc != 3)
	{
		char buff[100];
		perror("Arguements mismatch\n");
		sprintf(buff, "usage: %s [producer_count] [consumer_count]\n", argv[0]);
		perror(buff);
		exit(1);
	}
	int P, C;
	P = atoi(argv[1]);
	C = atoi(argv[2]);
	struct requiredmemory *shared = mmap(NULL, sizeof(shared), PROT_READ |
PROT_WRITE, MAP_SHARED | MAP_ANONYMOUS, -1, 0);
	shared->count = 0;
	shared->start = 0;
	shared->total = 0;
	sem_t *full, *empty, *mutex;
	empty = &(shared->e);
	full = &(shared->f);
	mutex = &(shared->m);
	sem_init(empty, 1, 50);
	sem_init(full, 1, 0);
	sem_init(mutex, 1, 1);
	pid_t producers[P], consumers[C];
	int p, c;
	for (c = 0; c < C; c++)
	{
		pid_t pid = fork();
		if (pid < 0)
			goto error_forking_p;
		else if (pid)
		{
			producers[c] = pid;
		}
		else
		{
			id = c;
			goto consumer;
		}
	}
	for (p = 0; p < P; p++)
	{
```

```
            pid_t pid = fork();
            if (pid < 0)
                  goto error_forking_p;
            else if (pid)
            {
                  producers[p] = pid;
            }
            else
            {
                  id = p;
                  goto producer;
            }
      }
      while (p--)
            wait(NULL);
      while (shared->count)
            sleep(1);
      signal(SIGQUIT, SIG_IGN);
      while (c--)
      {
            kill(consumers[c], SIGQUIT);
      }
      sleep(1);
      printf("Total : %d\n", shared->total);
      exit(0);

error_forking_c:
{
      perror("Some error forking consumers\n");
      for (--c; c >= 0; c--)
            kill(consumers[c], SIGKILL);
      exit(1);
}
error_forking_p:
{
      perror("Some error forking producers\n");
      for (--c; c >= 0; c--)
            kill(consumers[c], SIGKILL);
      for (--p; p >= 0; p--)
            kill(producers[p], SIGKILL);
      exit(1);
};

producer:
{
      srand(clock());
      count = PER_PRODUCER_MINIMUM + rand() % PER_PRODUCER_RANGE;
      int cnt = count;
```

```
      while (cnt--)
      {
            unsigned char num = 1 + rand() % 100;
            sem_wait(empty);
            sem_wait(mutex);
            shared->circular_buffer[(shared->start + (shared->count)++) %
BUFFER_LEN] = num;
            sem_post(mutex);
            sem_post(full);
            localtotal += num;
      }
      printf("Producer %d : produced %d items totalling to %d\n", id, count,
localtotal);
      return 0;
}
consumer:
{
      signal(SIGQUIT, consumerhandler);
      count = 0;
      while (1)
      {
            unsigned char num = 0;
            sem_wait(full);
            sem_wait(mutex);
            num = shared->circular_buffer[shared->start];
            shared->start = (shared->start + 1) % BUFFER_LEN;
            shared->count -= 1;
            shared->total += num;
            sem_post(mutex);
            sem_post(empty);
            count++;
            localtotal += num;
      }
      return 0;
}
}
```

OUTPUT

```
odd_sem/Operating_Systems/Assignment-2/src/q2  🌱 main 🗑️×34🤷 ×3
➜ ./q2.exe 2 5
Producer 0 : produced 108 items totalling to 5546
Producer 1 : produced 186 items totalling to 9150
Consumer 4 : consumed 148 items totalling to 7594
Consumer 1 : consumed 33 items totalling to 1585
Consumer 3 : consumed 58 items totalling to 2732
Consumer 0 : consumed 2 items totalling to 99
Consumer 2 : consumed 53 items totalling to 2686
Total : 14696
```

```
odd_sem/Operating_Systems/Assignment-2/src/q2  🌱 main 🗑️×34🤷 ×3
➜ ./q2.exe 3 2
Producer 0 : produced 151 items totalling to 7341
Producer 1 : produced 190 items totalling to 9995
Producer 2 : produced 121 items totalling to 6090
Consumer 1 : consumed 232 items totalling to 12490
Consumer 0 : consumed 230 items totalling to 10936
Total : 23426
```

```
odd_sem/Operating_Systems/Assignment-2/src/q2  🌱 main 🗑️×34🤷 ×3
➜ ./q2.exe 4 4
Producer 0 : produced 151 items totalling to 7341
Producer 2 : produced 151 items totalling to 8463
Producer 1 : produced 184 items totalling to 8818
Producer 3 : produced 145 items totalling to 6660
Consumer 2 : consumed 209 items totalling to 10427
Consumer 3 : consumed 137 items totalling to 6593
Consumer 1 : consumed 191 items totalling to 9653
Consumer 0 : consumed 94 items totalling to 4609
Total : 31282
```

QUESTION - 3

Write a program for the Reader-Writer process for the following situations:

a) Multiple readers and one writer: writer gets to write whenever it is ready (reader/s wait)

b) Multiple readers and multiple writers: any writer gets to write whenever it is ready, provided no other writer is currently writing (reader/s wait)

SOLUTION

q3a.c

```
#define _DEFAULT_SOURCE
#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <semaphore.h>
#include <unistd.h>
#include <time.h>
#include <sys/shm.h>
#include <sys/mman.h>
#include <sys/types.h>
#include <sys/wait.h>
#include <sys/signal.h>
#define BUFFER_LEN 50
#define PER_WRITER_MINIMUM 100
#define PER_WRITER_RANGE 101
#define PER_READER_MINIMUM 10
#define PER_READER_RANGE 11
struct requiredmemory
{
      sem_t r, w, m;
      int readcount;
      char buffer[50];
};
int localtotal;
int count;
int id;
int main(int argc, char **argv)
{
      localtotal = 0;
      if (argc != 2)
      {
            char buff[100];
```

```
            perror("Arguements mismatch\n");
            sprintf(buff, "usage: %s [reader_count]\n", argv[0]);
            perror(buff);
            exit(1);
      }
      int R;
      R = atoi(argv[1]);
      struct requiredmemory *shared = mmap(NULL, sizeof(shared), PROT_READ |
PROT_WRITE, MAP_SHARED | MAP_ANONYMOUS, -1, 0);
      strcpy(shared->buffer, "This is the default sentence");
      shared->readcount = 0;
      sem_t *read, *wrt, *mutex;
      read = &(shared->r);
      wrt = &(shared->w);
      mutex = &(shared->m);
      sem_init(read, 1, 1);
      sem_init(wrt, 1, 1);
      sem_init(mutex, 1, 1);
      pid_t readers[R], writer;
      int r;
      for (r = 0; r < R; r++)
      {
            pid_t pid = fork();
            if (pid < 0)
                  goto error_forking_r;
            else if (pid)
            {
                  readers[r] = pid;
            }
            else
            {
                  id = r;
                  goto reader;
            }
      }
      writer = fork();
      if (writer < 0)
            goto error_forking_w;
      else if (!writer)
      {
            goto writer;
      }
      while (r--)
            wait(NULL);
      wait(NULL);
      exit(0);

error_forking_r:
```

```
{
      perror("Some error forking readers\n");
      for (--r; r >= 0; r--)
            kill(readers[r], SIGKILL);
      exit(1);
};
error_forking_w:
{
      perror("Some error forking writer\n");
      for (--r; r >= 0; r--)
            kill(readers[r], SIGKILL);
      exit(1);
};

writer:
{
      srand(clock());
      count = PER_WRITER_MINIMUM + rand() % PER_WRITER_RANGE;
      int cnt = count;
      int l = 0;
      while (cnt--)
      {
            struct timespec sltime = {0, rand() % 150 << 10};
            nanosleep(&sltime, NULL);
            l++;
            char buff[50];
            sprintf(buff, "This is line number %5d written by the writer", l);
            sem_wait(read);
            sem_wait(wrt);
            strcpy(shared->buffer, buff);
            sem_post(wrt);
            sem_post(read);
      }
      printf("Writer wrote %d lines finished at %ld\n", count,clock());
      return 0;
}
reader:
{
      srand(clock());
      int l = PER_READER_MINIMUM + rand() % PER_READER_RANGE;
      while (l--)
      {
            struct timespec sltime = {0, rand() % 150 << 10};
            nanosleep(&sltime, NULL);
            count++;
            sem_wait(read);
            sem_wait(mutex);
            if (!shared->readcount)
```

```
                sem_wait(wrt);
            sem_post(read);
            shared->readcount++;
            sem_post(mutex);
            printf("line %5d read by reader %2d: %s\n", count, id, shared->buffer);
            sem_wait(mutex);
            shared->readcount--;
            if (!shared->readcount)
                sem_post(wrt);
            sem_post(mutex);
      }
      printf("reader %d read %d lines finished at %ld\n", id, count, clock());
      return 0;
}
}
```

q3b.c

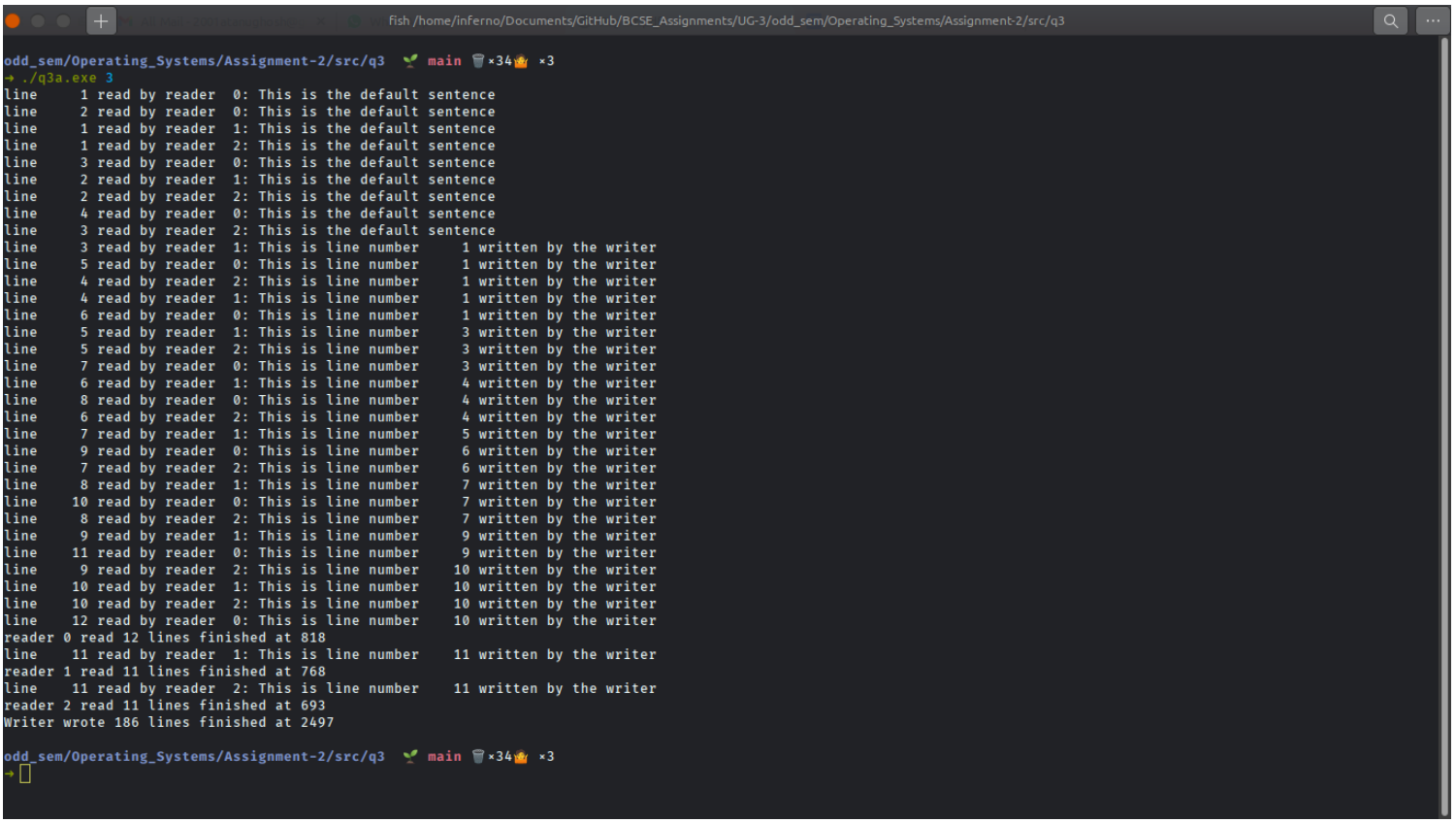
```
#define _DEFAULT_SOURCE
#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <semaphore.h>
#include <unistd.h>
#include <time.h>
#include <sys/shm.h>
#include <sys/mman.h>
#include <sys/types.h>
#include <sys/wait.h>
#include <sys/signal.h>
#define BUFFER_LEN 50
#define PER_WRITER_MINIMUM 10
#define PER_WRITER_RANGE 11
#define PER_READER_MINIMUM 10
#define PER_READER_RANGE 11
struct requiredmemory
{
      sem_t re, we, m1, m2, w;
      int readcount, writecount;
      char buffer[50];
};
int localtotal;
int count;
int id;
int main(int argc, char **argv)
```

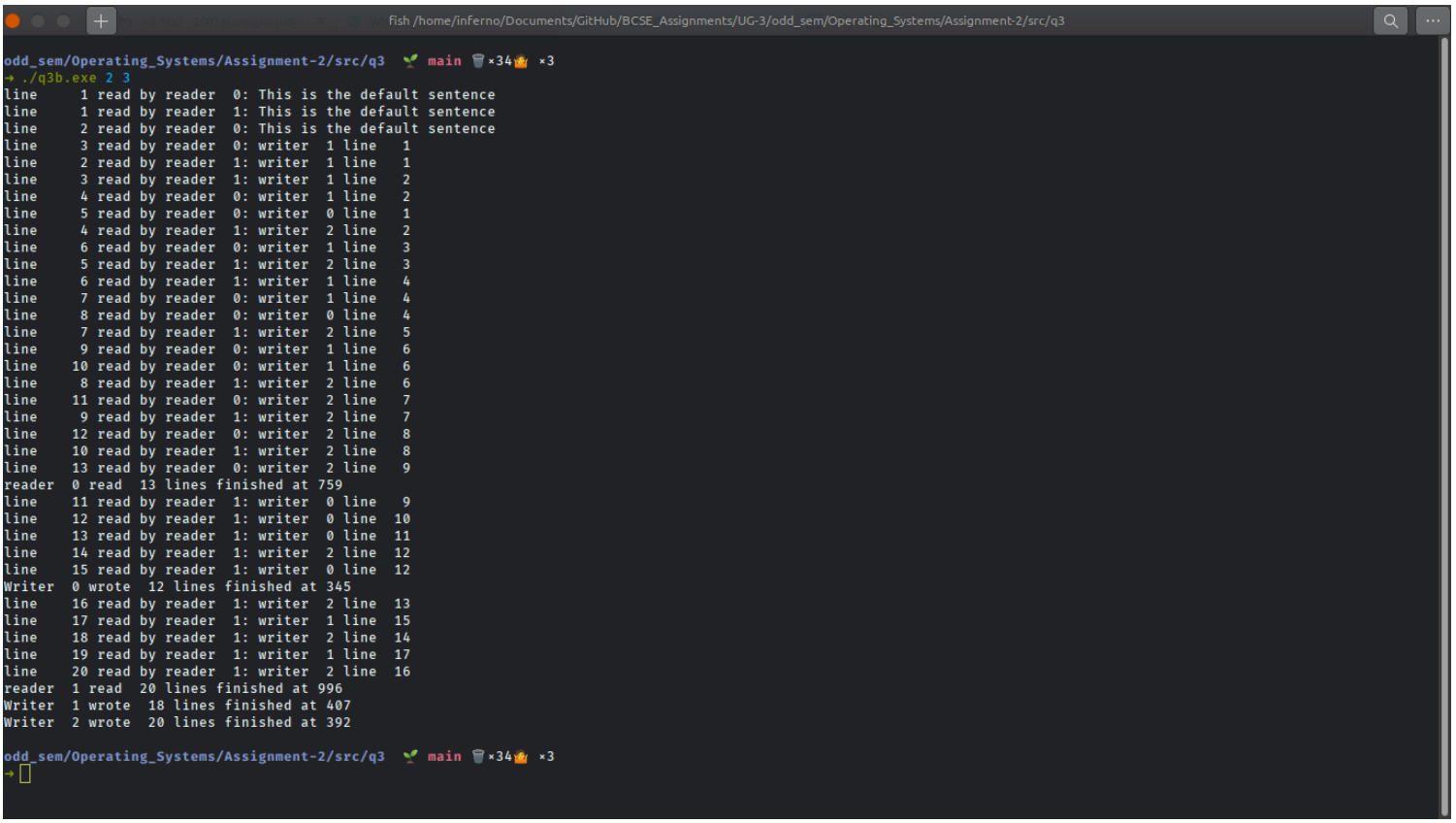
```
{
	localtotal = 0;
	if (argc != 3)
	{
		char buff[100];
		perror("Arguements mismatch\n");
		sprintf(buff, "usage: %s [reader_count] [writer_count]\n", argv[0]);
		perror(buff);
		exit(1);
	}
	int R, W;
	R = atoi(argv[1]);
	W = atoi(argv[2]);
	struct requiredmemory *shared = mmap(NULL, sizeof(shared), PROT_READ |
PROT_WRITE, MAP_SHARED | MAP_ANONYMOUS, -1, 0);
	strcpy(shared->buffer, "This is the default sentence");
	shared->readcount = 0;
	shared->writecount = 0;
	sem_t *readentry, *wrtentry, *mutex1, *mutex2, *wrt;
	readentry = &(shared->re);
	wrtentry = &(shared->we);
	wrt = &(shared->w);
	mutex1 = &(shared->m1);
	mutex2 = &(shared->m2);
	sem_init(readentry, 1, 1);
	sem_init(wrtentry, 1, 1);
	sem_init(wrt, 1, 1);
	sem_init(mutex1, 1, 1);
	sem_init(mutex2, 1, 1);
	pid_t readers[R], writers[W];
	int r, w;
	for (r = 0; r < R; r++)
	{
		pid_t pid = fork();
		if (pid < 0)
			goto error_forking_r;
		else if (pid)
		{
			readers[r] = pid;
		}
		else
		{
			id = r;
			goto reader;
		}
	}
	for (w = 0; w < W; w++)
	{
```

```
            pid_t pid = fork();
            if (pid < 0)
                  goto error_forking_w;
            else if (pid)
            {
                  writers[w] = pid;
            }
            else
            {
                  id = w;
                  goto writer;
            }
      }
      while (r--)
            wait(NULL);
      while (w--)
            wait(NULL);
      exit(0);

error_forking_r:
{
      perror("Some error forking readers\n");
      for (--r; r >= 0; r--)
            kill(readers[r], SIGKILL);
      exit(1);
};
error_forking_w:
{
      perror("Some error forking writers\n");
      for (--r; r >= 0; r--)
            kill(readers[r], SIGKILL);
      for (--w; w >= 0; w--)
            kill(writers[w], SIGKILL);
      exit(1);
};

writer:
{
      srand(clock());
      count = PER_WRITER_MINIMUM + rand() % PER_WRITER_RANGE;
      int cnt = count;
      int l = 0;
      while (cnt--)
      {
            struct timespec sltime = {0, rand() % 150 << 10};
            nanosleep(&sltime, NULL);
            l++;
            char buff[50];
```

```
            sprintf(buff, "writer %2d line %3d", id, l);
            sem_wait(mutex2);
            shared->writecount++;
            if (shared->writecount == 1)
                  sem_wait(readentry);
            sem_post(mutex2);
            sem_wait(wrt);
            strcpy(shared->buffer, buff);
            sem_post(wrt);
            sem_wait(mutex2);
            shared->writecount--;
            if (shared->writecount == 0)
                  sem_post(readentry);
            sem_post(mutex2);
      }
      printf("Writer %2d wrote %3d lines finished at %ld\n", id, count, clock());
      return 0;
}
reader:
{
      srand(clock());
      int l = PER_READER_MINIMUM + rand() % PER_READER_RANGE;
      while (l--)
      {
            struct timespec sltime = {0, rand() % 150 << 10};
            nanosleep(&sltime, NULL);
            count++;
            sem_wait(readentry);
            sem_wait(mutex1);
            if (!shared->readcount)
                  sem_wait(wrt);
            sem_post(readentry);
            shared->readcount++;
            sem_post(mutex1);
            printf("line %5d read by reader %2d: %s\n", count, id, shared->buffer);
            sem_wait(mutex1);
            shared->readcount--;
            if (!shared->readcount)
                  sem_post(wrt);
            sem_post(mutex1);
      }
      printf("reader %2d read %3d lines finished at %ld\n", id, count, clock());
      return 0;
}
}
```

OUTPUT


fish /home/inferno/Documents/GitHub/BCSE_Assignments/UG-3/odd_sem/Operating_Systems/Assignment-2/src/q3
odd_sem/Operating_Systems/Assignment-2/src/q3 main ×34 ×3
→ ./q3a.exe 3
line 1 read by reader 0: This is the default sentence
line 2 read by reader 0: This is the default sentence
line 1 read by reader 1: This is the default sentence
line 1 read by reader 2: This is the default sentence
line 3 read by reader 0: This is the default sentence
line 2 read by reader 1: This is the default sentence
line 2 read by reader 2: This is the default sentence
line 4 read by reader 0: This is the default sentence
line 3 read by reader 2: This is the default sentence
line 3 read by reader 1: This is line number 1 written by the writer
line 5 read by reader 0: This is line number 1 written by the writer
line 4 read by reader 2: This is line number 1 written by the writer
line 4 read by reader 1: This is line number 1 written by the writer
line 6 read by reader 0: This is line number 1 written by the writer
line 5 read by reader 1: This is line number 3 written by the writer
line 5 read by reader 2: This is line number 3 written by the writer
line 7 read by reader 0: This is line number 3 written by the writer
line 6 read by reader 1: This is line number 4 written by the writer
line 8 read by reader 0: This is line number 4 written by the writer
line 6 read by reader 2: This is line number 4 written by the writer
line 7 read by reader 1: This is line number 5 written by the writer
line 9 read by reader 0: This is line number 6 written by the writer
line 7 read by reader 2: This is line number 6 written by the writer
line 8 read by reader 1: This is line number 7 written by the writer
line 10 read by reader 0: This is line number 7 written by the writer
line 8 read by reader 2: This is line number 7 written by the writer
line 9 read by reader 1: This is line number 9 written by the writer
line 11 read by reader 0: This is line number 9 written by the writer
line 9 read by reader 2: This is line number 10 written by the writer
line 10 read by reader 1: This is line number 10 written by the writer
line 10 read by reader 2: This is line number 10 written by the writer
line 12 read by reader 0: This is line number 10 written by the writer
reader 0 read 12 lines finished at 818
line 11 read by reader 1: This is line number 11 written by the writer
reader 1 read 11 lines finished at 768
line 11 read by reader 2: This is line number 11 written by the writer
reader 2 read 11 lines finished at 693
Writer wrote 186 lines finished at 2497
odd_sem/Operating_Systems/Assignment-2/src/q3 main ×34 ×3
→


fish /home/inferno/Documents/GitHub/BCSE_Assignments/UG-3/odd_sem/Operating_Systems/Assignment-2/src/q3
odd_sem/Operating_Systems/Assignment-2/src/q3 main ×34 ×3
→ ./q3b.exe 2 3
line 1 read by reader 0: This is the default sentence
line 1 read by reader 1: This is the default sentence
line 2 read by reader 0: This is the default sentence
line 3 read by reader 0: writer 1 line 1
line 2 read by reader 1: writer 1 line 1
line 3 read by reader 1: writer 1 line 2
line 4 read by reader 0: writer 1 line 2
line 5 read by reader 0: writer 0 line 1
line 4 read by reader 1: writer 2 line 2
line 6 read by reader 0: writer 1 line 3
line 5 read by reader 1: writer 2 line 3
line 6 read by reader 1: writer 1 line 4
line 7 read by reader 0: writer 1 line 4
line 8 read by reader 0: writer 0 line 4
line 7 read by reader 1: writer 2 line 5
line 9 read by reader 0: writer 1 line 6
line 10 read by reader 0: writer 1 line 6
line 8 read by reader 1: writer 2 line 6
line 11 read by reader 0: writer 2 line 7
line 9 read by reader 1: writer 2 line 7
line 12 read by reader 0: writer 2 line 8
line 10 read by reader 1: writer 2 line 8
line 13 read by reader 0: writer 2 line 9
reader 0 read 13 lines finished at 759
line 11 read by reader 1: writer 0 line 9
line 12 read by reader 1: writer 0 line 10
line 13 read by reader 1: writer 0 line 11
line 14 read by reader 1: writer 2 line 12
line 15 read by reader 1: writer 0 line 12
Writer 0 wrote 12 lines finished at 345
line 16 read by reader 1: writer 2 line 13
line 17 read by reader 1: writer 1 line 15
line 18 read by reader 1: writer 2 line 14
line 19 read by reader 1: writer 1 line 17
line 20 read by reader 1: writer 2 line 16
reader 1 read 20 lines finished at 996
Writer 1 wrote 18 lines finished at 407
Writer 2 wrote 20 lines finished at 392
odd_sem/Operating_Systems/Assignment-2/src/q3 main ×34 ×3
→

QUESTION - 4

Implement the following applications using different IPC mechanisms. Your choice is restricted to Pipes, FIFOs, and Message Queues (use different mechanisms for each program)

a. Broadcasting weather information (one broadcasting process and more than one listeners)

b. Telephonic conversation (between a caller and a receiver)

c. Broadcasting information regarding pesticides for agricultural fields / prices of agricultural products for marketing with a farmer having the option of putting query (one broadcasting process and more than one listeners with option of calling back).

SOLUTION

q4a.c

```
#include <stdlib.h>
#include <stdio.h>
#include <time.h>
#include <string.h>
#include <sys/types.h>
#include <wait.h>
#include <unistd.h>
#include <signal.h>
#define READ_END 0
#define WRITE_END 1
#define BUFFER_LEN 50
int flag = 1;

void listener_handler(int sig)
{
      if (sig == SIGINT)
            return;
      if (sig == SIGTERM)
            exit(0);
}
void broadcast_signal_handler(int sig)
{
      flag = 0;
}
int main(int argc, char **argv)
{
      if (argc != 2)
      {
            perror("Number of stations not specified\n");
            return 1;
      }
      int N = atoi(argv[1]);
```

```
	pid_t stations[N];
	int fds[N][2];
	int id;
	char buffer[BUFFER_LEN];
	for (id = 0; id < N; id++)
	{
		pipe(fds[id]);
		if (stations[id] = fork())
			goto listen;
		else
			close(fds[id][READ_END]);
	}
	signal(SIGINT, broadcast_signal_handler);
	srand(time(NULL));

	while (flag)
	{
		sleep(rand() % 10);
		time_t t;
		time(&t);
		struct tm *time_val = localtime(&t);
		char *arr[] = {"windy", "clear", "snowy", "rainy", "sunny", "cloudy"};
		sprintf(buffer, "%2d:%2d:%2d The weather is %s.", (time_val->tm_hour) %
12, time_val->tm_min,time_val->tm_sec, arr[rand() % 6]);
		int l = strlen(buffer) + 1;
		for (int i = 0; i < N; i++)
			write(fds[i][WRITE_END], buffer, l);
	}
	for (int i = 0; i < N; i++)
	{kill(stations[i], SIGTERM);}
	sleep(2);
	printf("Ending");
	fflush(stdout);
	return 0;
listen:
{
	signal(SIGINT, listener_handler);
	signal(SIGTERM, listener_handler);
	for (int i = 0; i <= id; i++)
		close(fds[i][WRITE_END]);
	int fd = fds[id][READ_END];
	while (1)
	{
		read(fd, buffer, BUFFER_LEN);
		printf("stat %2d > %s\n", id, buffer);
	}
}
}
```

q4b.c

```
#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <sys/types.h>
#include <sys/signal.h>
#include <unistd.h>
#include <fcntl.h>
#include <sys/stat.h>
#define CALLER0_FIFO "/tmp/caller0"
#define CALLER1_FIFO "/tmp/caller1"
#define BUFFER_LEN 120
void makefifos()
{
     mkfifo(CALLER0_FIFO, 0666);
     mkfifo(CALLER1_FIFO, 0666);
}
int main(int argc, char **argv)
{
     if (argc != 2)
     {
          perror("Caller number not given\n");
          return 1;
     }
     char fifo_mine[13], fifo_other[13];
     char buffer[BUFFER_LEN];
     if (argv[1][0] == '0')
     {
          strcpy(fifo_mine, CALLER0_FIFO);
          strcpy(fifo_other, CALLER1_FIFO);
     }
     else if (argv[1][0] == '1')
     {
          strcpy(fifo_mine, CALLER1_FIFO);
          strcpy(fifo_other, CALLER0_FIFO);
     }
     else
     {
          perror("Caller number not valid\n");
          return 1;
     }
     makefifos();
     pid_t sender = fork();
     if (sender < 0)
     {
          perror("Error forking sender\n");
```

```
            return 2;
      }
      if (sender)
      { // receiver part
            while (1)
            {
                  int fifo = open(fifo_mine, O_RDONLY);
                  read(fifo, buffer, BUFFER_LEN);
                  close(fifo);
                  printf("%50s\n", buffer);
            }
      }
      else
      { // sender part
            while (1)
            {
                  scanf("%[^\n]%*c", buffer);
                  int fifo = open(fifo_other, O_WRONLY);
                  write(fifo, buffer, strlen(buffer) + 1);
                  close(fifo);
            }
      }
}
```

q4c-server.c

```
#define _DEFAULT_SOURCE
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <string.h>
#include <unistd.h>
#include <sys/ipc.h>
#include <sys/types.h>
#include <sys/msg.h>
#include <sys/shm.h>
#include <sys/mman.h>
#include <errno.h>
struct sharedmem
{
      int broadcastList[99], count;
      char pesticideinfo[50];
      char pricesinfo[50];
};

int main()
{
      srand(time(NULL));
```

```
    pid_t request_manager;
    struct
    {
        long message_type;
        char message[50];
    } m;
    struct sharedmem *shared = mmap(NULL, sizeof(struct sharedmem), PROT_READ |
 PROT_WRITE, MAP_SHARED | MAP_ANONYMOUS, -1, 0);
    shared->count = 0;
    strcpy(shared->pesticideinfo, "default Avalailable pesticides =  40");
    strcpy(shared->pricesinfo, "default Price =  150");
    if (request_manager = fork())
    {
        while (1)
        {
            sleep(rand() % 10);
            if (rand() % 2)
            {
                time_t t;
                time(&t);
                struct tm *time_val = localtime(&t);
                sprintf(shared->pesticideinfo, "%2d:%2d:%2d Available
persticides = %3d", time_val->tm_hour % 12, time_val->tm_min, time_val->tm_sec,
rand() % 51);
                m.message_type = 1;
                strcpy(m.message, shared->pesticideinfo);
                for (int i = 0; i < shared->count; i++)
                {
                    msgsnd(shared->broadcastList[i], &m, sizeof(m), 0);
                }
            }
            sleep(rand() % 4);
            if (rand() % 2)
            {
                time_t t;
                time(&t);
                struct tm *time_val = localtime(&t);
                sprintf(shared->pricesinfo, "%2d:%2d:%2d Price = %3d",
time_val->tm_hour % 12, time_val->tm_min, time_val->tm_sec, 100 + rand() % 101);
                m.message_type = 2;
                strcpy(m.message, shared->pricesinfo);
                for (int i = 0; i < shared->count; i++)
                {
                    msgsnd(shared->broadcastList[i], &m, sizeof(m), 0);
                }
            }
        }
    }
    else
```

```
{
      key_t k = ftok("q4c-server", 'S');
      int msqid = msgget(k, 0666 | IPC_CREAT);
      struct
      {
            long message_type;
            int messageqid;
      } m1;
      m.message[0] = 'R';
      m.message[1] = 'e';
      m.message[2] = ':';
      m.message[3] = ' ';
      while (1)
      {
            m1.message_type = 0;
            if (msgrcv(msqid, &m1, sizeof(m1), 0, 0))
            {
                  if (m1.message_type == 1)
                  { // add to broadcast list
                        printf("adding to broadcast list\n");
                        int found = 0;
                        for (int i = 0; i < shared->count; i++)
                        {
                              if (shared->broadcastList[i] == m1.messageqid)
                              {
                                    found = 1;
                                    break;
                              }
                        }
                        if (!found)
                        {
                              shared->broadcastList[shared->count] =
m1.messageqid;
                              shared->count++;
                        }
                  }
                  else if (m1.message_type == 2)
                  { // send pesticide info
                        m.message_type = 3;
                        printf("request for pesticide info\n");
                        strcpy(m.message + 4, shared->pesticideinfo);
                        msgsnd(m1.messageqid, &m, sizeof(m), 0);
                  }
                  else if (m1.message_type == 3)
                  { // send prices info
                        m.message_type = 4;
                        printf("request for price info\n");
                        strcpy(m.message + 4, shared->pricesinfo);
```

```
                        msgsnd(m1.messageqid, &m, sizeof(m), 0);
                    }
                }
            }
        }
}
```

q4c-client.c

```
#define _DEFAULT_SOURCE
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <string.h>
#include <unistd.h>
#include <sys/ipc.h>
#include <sys/types.h>
#include <sys/msg.h>
#include <sys/shm.h>
#include <sys/mman.h>
#include <errno.h>
int main(int argc, char **argv)
{
      if (argc != 2)
      {
            perror("give station name\n");
            return 1;
      }
      key_t k = ftok(argv[0], atoi(argv[1]));
      int myqid = msgget(k, IPC_CREAT | 0666);
      k = ftok("q4c-server", 'S');
      int serverqid = msgget(k, 0666);
      struct
      {
            long mtype;
            int qid;
      } m1;
      struct
      {
            long mtype;
            char message[50];
      } m;
      m1.mtype = 1;
      m1.qid = myqid;
      msgsnd(serverqid, &m1, sizeof(m1), 0);
      pid_t receiver = fork();
```

```
    if (receiver)
    {
        printf("Enter 1 to get pesticide info and 2 to get price info\n");
        while (1)
        {
            int ch = 0;
            scanf("%d", &ch);
            if (ch == 1)
            {
                m1.mtype = 2;
                msgsnd(serverqid, &m1, sizeof(m1), 0);
            }
            else if (ch == 2)
            {
                m1.mtype = 3;
                msgsnd(serverqid, &m1, sizeof(m1), 0);
            }
            else
            {
                printf("invalid choice\n");
            }
        }
    }
    else
    {
        while (1)
        {
            m.mtype = 0;
            if (msgrcv(myqid, &m, sizeof(m), 0, 0))
            {
                if (m.mtype == 1)
                    printf("%-50s (broadcast message for pesticide)\n",
 m.message);
                else if (m.mtype == 2)
                    printf("%-50s (broadcast message for price)\n",
m.message);
                else if (m.mtype == 3)
                    printf("%-50s (reply for pesticide)\n", m.message);
                else if (m.mtype == 4)
                    printf("%-50s (reply for price)\n", m.message);
            }
        }
    }
}
```

OUTPUT

```
odd_sem/Operating_Systems/Assignment-2/src/q4   main ×34 ×3
→ ./q4a.exe 5
stat   0 > 10:23:  6 The weather is clear.
stat   1 > 10:23:  6 The weather is clear.
stat   3 > 10:23:  6 The weather is clear.
stat   2 > 10:23:  6 The weather is clear.
stat   4 > 10:23:  6 The weather is clear.
stat   1 > 10:23:11 The weather is rainy.
stat   3 > 10:23:11 The weather is rainy.
stat   0 > 10:23:11 The weather is rainy.
stat   2 > 10:23:11 The weather is rainy.
stat   4 > 10:23:11 The weather is rainy.
stat   1 > 10:23:13 The weather is sunny.
stat   3 > 10:23:13 The weather is sunny.
stat   0 > 10:23:13 The weather is sunny.
stat   2 > 10:23:13 The weather is sunny.
stat   4 > 10:23:13 The weather is sunny.
^Cstat   1 > 10:23:14 The weather is snowy.
stat   1 > 10:23:14 The weather is snowy.
```

```
odd_sem/Operating_Systems/Assignment-2/src/q4   main ×34 ×3
→ ./q4b.exe 0
Hey how are you ?
                                    I'm fine.
                                How about you?
I'm great
So how's everything going?
                                Pretty smooth!
```

```
odd_sem/Operating_Systems/Assignment-2/src/q4   main ×34 ×3
→ ./q4b.exe 1
                                Hey how are you ?
I'm fine.
How about you?
                                            I'm great
                                So how's everything going?
Pretty smooth!
```