Tutorial 5 – Structures
Q1 (computeCircle)

A structure called circle is defined below. The structure consists of the radius of the circle and the (x,y) coordinates of its centre. A structure called circle is defined below. The structure consists of the radius of the circle and the (x,y) coordinates of its centre.

```
struct circle {
    double radius;
    double x;
    double y;
};
```

(a) Implement the function **intersect()** that returns 1 if two circles intersect, and 0 otherwise. Two circles intersect when the distance between their centres is less than or equal to the sum of their radii. The function prototype is given below:

```
int intersect(struct circle c1, struct circle c2);
```

(b) Implement the function **contain()** that returns 1 if *c1* contains *c2*, i.e. circle *c2* is found inside circle *c1*. Otherwise, the function returns 0. Circle *c1* contains circle *c2* when the radius of *c1* is larger than or equal to the sum of the radius of *c2* and the distance between the centres of *c1* and *c2*. The function prototype of contain() is given below:

```
int contain(struct circle *c1, struct circle *c2)
```

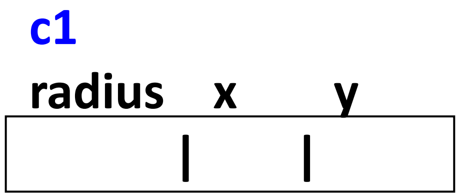
Write a program to test the functions.

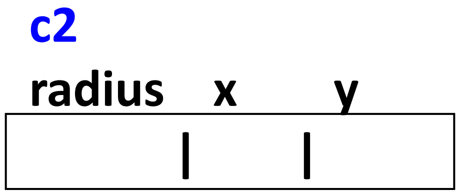
Sample input and output sessions:

```
(1)  Test Case 1
Enter circle 1 (radius x y):
10 5 5
Enter circle 2 (radius x y):
5 1 1
Circle intersection: 1
Circle contain: 0

(2) Test Case 2
Enter circle 1 (radius x y):
10 5 5
Enter circle 2 (radius x y):
1 1 1
Circle intersection: 1
Circle contain: 1
```

Q1 – Suggested Answer





```
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
#define INIT_VALUE -1000
struct circle {
   double radius;
   double x;
   double y;
};
int intersect(struct circle, struct circle);
int contain(struct circle *, struct circle *);
int main()
{
   struct circle c1, c2;
   int choice, result = INIT_VALUE;

   printf("Select one of the following options: \n");
   printf("1: intersect()\n");
   printf("2: contain()\n");
   printf("3: exit()\n");
   do {
      result=-1;
      printf("Enter your choice: \n");
      scanf("%d", &choice);
      switch (choice) {
```

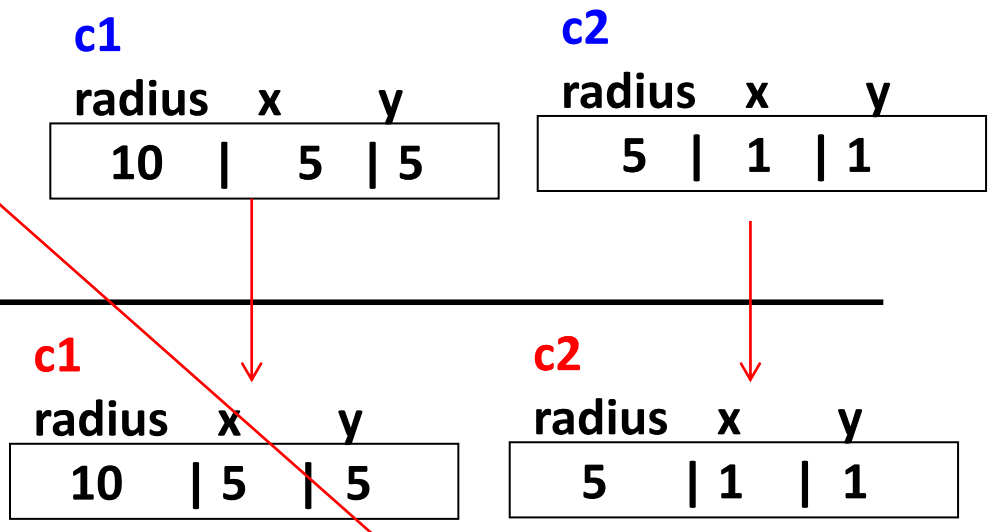
```
    case 1:
      printf("Enter circle 1 (radius x y): \n");
      scanf("%lf %lf %lf", &c1.radius, &c1.x, &c1.y);
      printf("Enter circle 2 (radius x y): \n");
      scanf("%lf %lf %lf", &c2.radius, &c2.x, &c2.y);
      result = intersect(c1, c2);
      if (result == 1)
         printf("intersect(): intersect\n");
      else if (result == 0)
         printf("intersect(): not intersect\n");
      else
         printf("intersect(): error\n");
      break;
    case 2:
      printf("Enter circle 1 (radius x y): \n");
      scanf("%lf %lf %lf", &c1.radius, &c1.x, &c1.y);
      printf("Enter circle 2 (radius x y): \n");
      scanf("%lf %lf %lf", &c2.radius, &c2.x, &c2.y);
      result = contain(&c1, &c2);
      if (result == 1)
         printf("contain(): contain\n");
      else if (result == 0)
         printf("contain(): not contain\n");
      else
         printf("contain(): error\n");
      break;
   }
  } while (choice < 3);
  return 0;
}
```

Use dot notation when accessing members of the structure.

```
int main()
{
  result = intersect(c1, c2);

}
```

Call by value



c1

radius x y

10 | 5 | 5

c2

radius x y

5 | 1 | 1

c1

radius x y

10 | 5 | 5

c2

radius x y

5 | 1 | 1

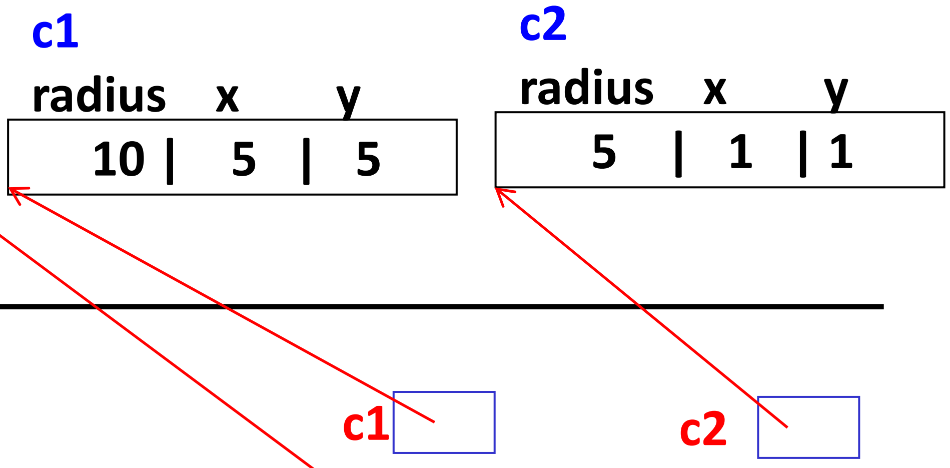
```
int intersect(struct circle c1, struct circle c2)
{
   double a, b;

   a = c1.x - c2.x;
   b = c1.y - c2.y;
   return (sqrt(a*a + b*b) <= (c1.radius + c2.radius));
}
```

Use dot notation when accessing members of the structure in this function.

```
int main()
{
  result = contain(&c1, &c2);


}
```



c1

radius x y

10 | 5 | 5

c2

radius x y

5 | 1 | 1

Call by reference

```
int contain(struct circle *c1, struct circle *c2)
{
  double a, b;

  a = c1->x - c2->x;
  b = c1->y - c2->y;
  return (c1->radius >=(c2->radius+sqrt(a*a+b*b)));
}
```

Use -> notation when accessing members of the structure in this function.

Q2 (computeExp)

(**computeExp**) A structure is defined to represent an arithmetic expression:

```
typedef struct {
    float operand1, operand2;
    char op;         /* operator ‘+’,‘-’,‘*’ or ‘/’  */
} bexpression;
```

(a) Write a C function that computes the value of an expression and returns the result. For example, the function will return the value of 4/2 if in the structure passed to it, operand1 is 4, operator is ‘/’ and operand2 is 2. The function prototype is given as:

```
float compute1(bexpression expr);
```

(b) Write another C function that performs the same computation with the following function prototype:

```
float compute2(bexpression *expr);
```

Write a C program to test the functions.

Sample input and output sessions:

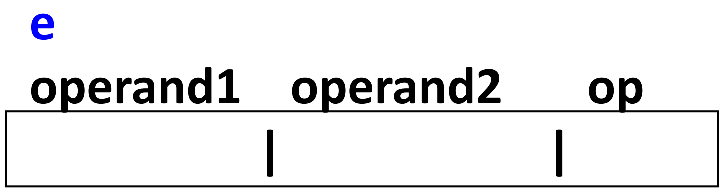
```
(1) Test Case 1
Enter expression (op1 op2 op) :
4 8 +
compute1 = 12.00
compute2 = 12.00

(2) Test Case 2
Enter expression (op1 op2 op) :
8 4 /
compute1 = 2.00
compute2 = 2.00

(3) Test Case 3
Enter expression (op1 op2 op) :
4 8 *
compute1 = 32.00
compute2 = 32.00
```

Q2 – Suggested Answer

```c
#include <stdio.h>
typedef struct {
   float operand1, operand2;
   char op;
} bexpression;
float compute1(bexpression expr);
float compute2(bexpression *expr);
int main()
{
   bexpression e;
   int choice;
   printf("Select one of the following options: \n");
   printf("1: compute1()\n");
   printf("2: compute2()\n");
   printf("3: exit()\n");
   do {
      printf("Enter your choice: \n");
      scanf("%d", &choice);
      switch (choice) {
         case 1:
            printf("Enter expression (op1 op2 op): \n");
            scanf("%f %f %c", &e.operand1, &e.operand2, &e.op);
            printf("compute1(): %.2f\n", compute1(e));
            break;
         case 2:
            printf("Enter expression (op1 op2 op): \n");
            scanf("%f %f %c", &e.operand1, &e.operand2, &e.op);
            printf("compute2(): %.2f\n", compute2(&e));
            break;
      }
   } while (choice < 3);
   return 0; }
```



```
int main()
{
  printf("compute1(): %.2f\n", compute1(e));


}
```

e

operand1	operand2	op
4	8	+

Call by value

---

expr

operand1	operand2	op
4	8	+

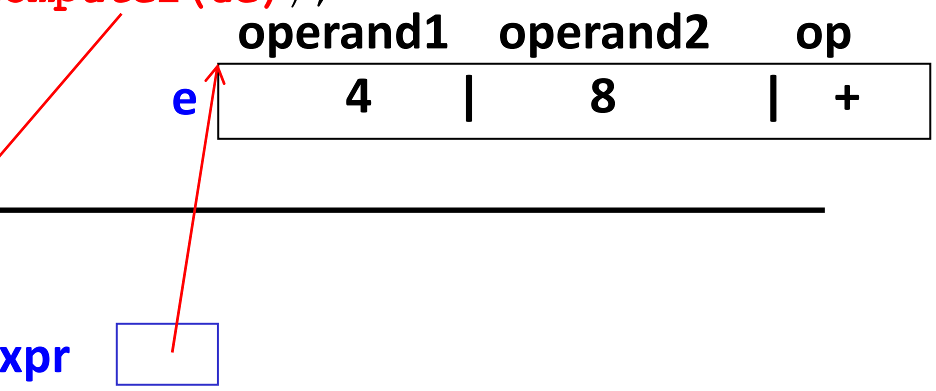
```
float compute1(bexpression expr){
   float result;
   switch (expr.op) {
      case '+': result = expr.operand1 + expr.operand2;
         break;
      case '-': result = expr.operand1 - expr.operand2;
         break;
      case '*': result = expr.operand1 * expr.operand2;
         break;
      case '/': result = expr.operand1 / expr.operand2;
         break;
   }
   return result;
}
```

Use dot notation when accessing members of the structure in this function.

```
int main()
{
      printf("compute2(): %.2f\n", compute2(&e));

}
```

Call by reference



e

operand1	operand2	op
4	8	+

expr

```
float compute2(bexpression *expr)
{
   float result;
   switch (expr->op) {
      case '+': result = expr->operand1 + expr->operand2;
         break;
      case '-': result = expr->operand1 - expr->operand2;
         break;
      case '*': result = expr->operand1 * expr->operand2;
         break;
      case '/': result = expr->operand1 / expr->operand2;
         break;
   }
   return result;
}
```

Use -> notation when accessing members of the structure in this function.

Q3 (mayTakeLeave)

Given the following information:

```
typedef struct {
    int id;   /* staff identifier */
    int totalLeave; /* the total number of days of leave allowed */
    int leaveTaken; /* the number of days of leave taken so far */
} leaveRecord;
```

write the code for the following functions:

(a) void getInput(leaveRecord list[], int *n);

Each line of the input has three integers representing one staff identifier, his/her total number of days of leave allowed and his/her number of days of leave taken so far respectively. The function will read the data into the array *list* until end of input and returns the number of records read through *n* .

(b) int mayTakeLeave(leaveRecord list[], int id, int leave, int n);

It returns 1 if a leave application for *leave* days is approved. Staff member with identifier *id* is applying for *leave* days of leave. *n* is the number of staff in *list*. Approval will be given if the leave taken so far plus the number of days applied for is less than or equal to his total number of leave days allowed. If approval is not given, it returns 0. It will return -1 if no one in *list* has identifier *id*.

(c) void printList(leaveRecord list[], int n);

It prints the list of leave records of each staff. *n* is the number of staff in *list*.

Write a program to test the functions.

Sample input and output sessions:

(1) Test Case 1

```
Enter the number of staff records:
2
Enter id, totalleave, leavetaken:
11 28 25
Enter id, totalleave, leavetaken:
12 28 6
The staff list:
id = 11, totalleave = 28, leave taken = 25
id = 12, totalleave = 28, leave taken = 6
Please input id, leave to be taken:
11 6
The staff 11 cannot take leave
```

(2) Test Case 2

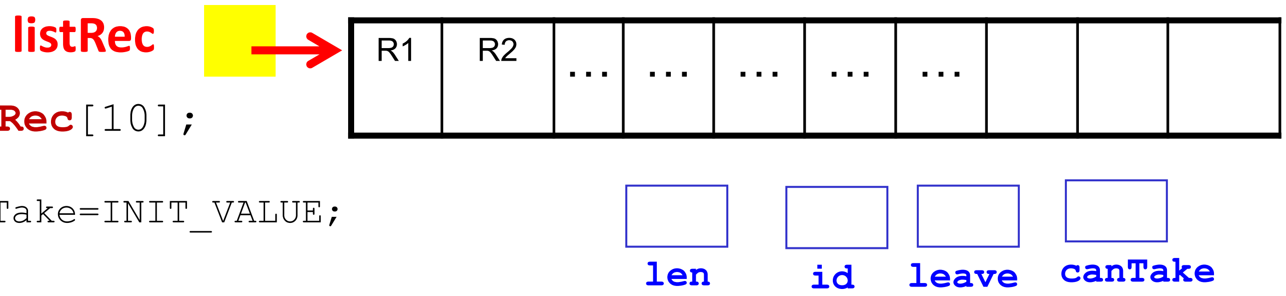
```
Enter the number of staff records:
2
Enter id, totalleave, leavetaken:
11 28 25
Enter id, totalleave, leavetaken:
12 28 6
The staff list:
id = 11, totalleave = 28, leave taken = 25
id = 12, totalleave = 28, leave taken = 6
Please input id, leave to be taken:
12 6
The staff 12 can take leave
```

Q3 – Suggested Answer

```
#include <stdio.h>
#define INIT_VALUE 1000
typedef struct {
   int id;           /* staff identifier */
   int totalLeave;   /* the total number of days of leave allowed */
   int leaveTaken;   /* the number of days of leave taken so far */
} leaveRecord;
int mayTakeLeave(leaveRecord list[], int id, int leave, int n);
void getInput(leaveRecord list[], int *n);
void printList(leaveRecord list[], int n);

int main()
{
   leaveRecord listRec[10];
   int len;
   int id, leave, canTake=INIT_VALUE;
   int choice;

   printf("Select one of the following options: \n");
   printf("1: getInput()\n");
   printf("2: printList()\n");
   printf("3: mayTakeLeave()\n");
   printf("4: exit()\n");
   do {
      printf("Enter your choice: \n");
      scanf("%d", &choice);
      switch (choice) {
```

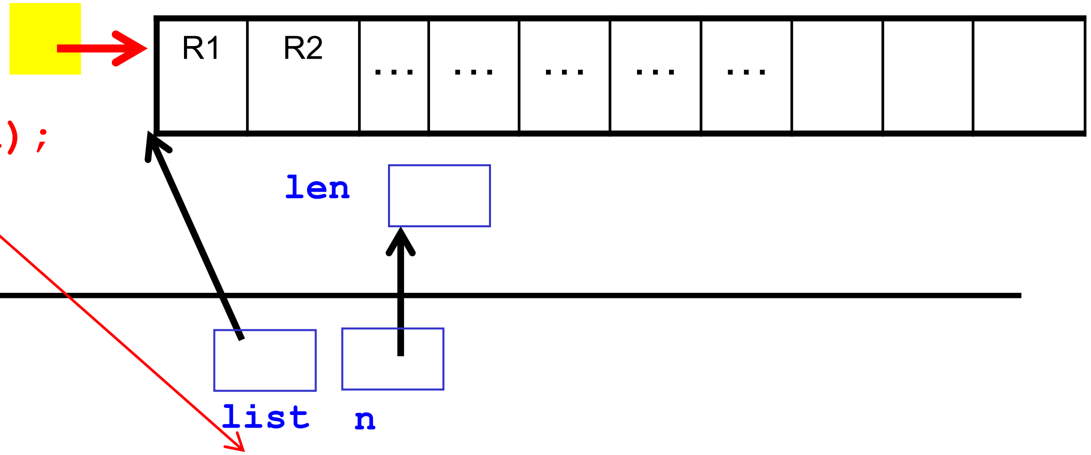


```
         case 1:
            getInput(listRec, &len);
            printList(listRec, len);
            break;
         case 2:
            printList(listRec, len);
            break;
         case 3:
            printf("Please input id, leave to be taken: \n");
            scanf("%d %d", &id, &leave);
            canTake = mayTakeLeave(listRec, id, leave, len);
            if (canTake == 1)
               printf("The staff %d can take leave\n", id);
            else if (canTake == 0)
               printf("The staff %d cannot take leave\n", id);
            else if (canTake == -1)
               printf("The staff %d is not in the list\n", id);
            else
               printf("Error!");
            break;
      }
   } while (choice < 4);
   return 0;
}
```

```
int main()
{

      getInput(listRec, &len);


}
```



Call by reference

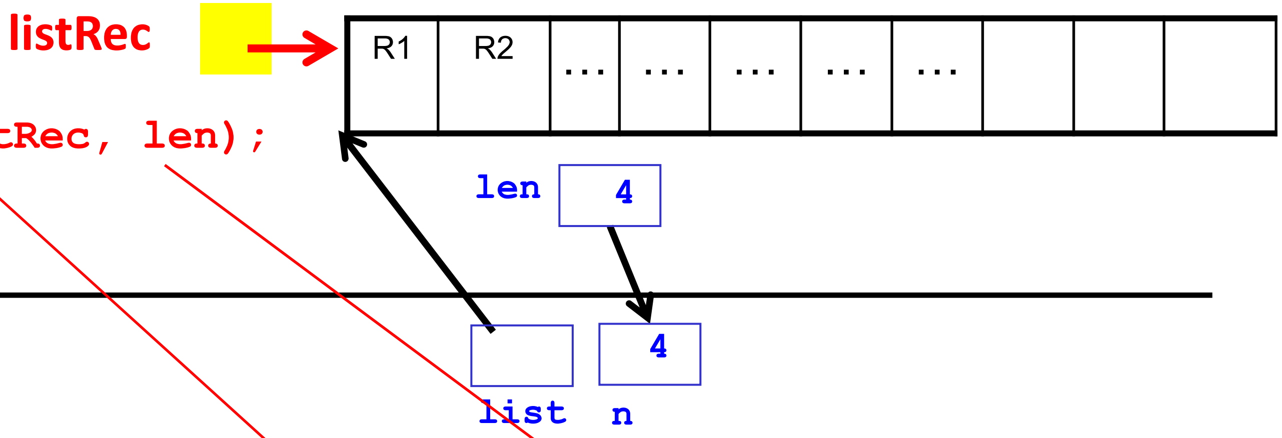
```
void getInput(leaveRecord list[], int *n)  // n – using call by
reference
{
   int total;

   *n = 0;
   printf("Enter the number of staff records: \n");
   scanf("%d", &total);
   while ((*n) != total) {
      printf("Enter id, totalleave, leavetaken: \n");
      scanf("%d %d %d", &list[*n].id, &list[*n].totalLeave,
                          &list[*n].leaveTaken);
      (*n)++;
   }
}
```

```
int main()
{

      printList(listRec, len);


}
```

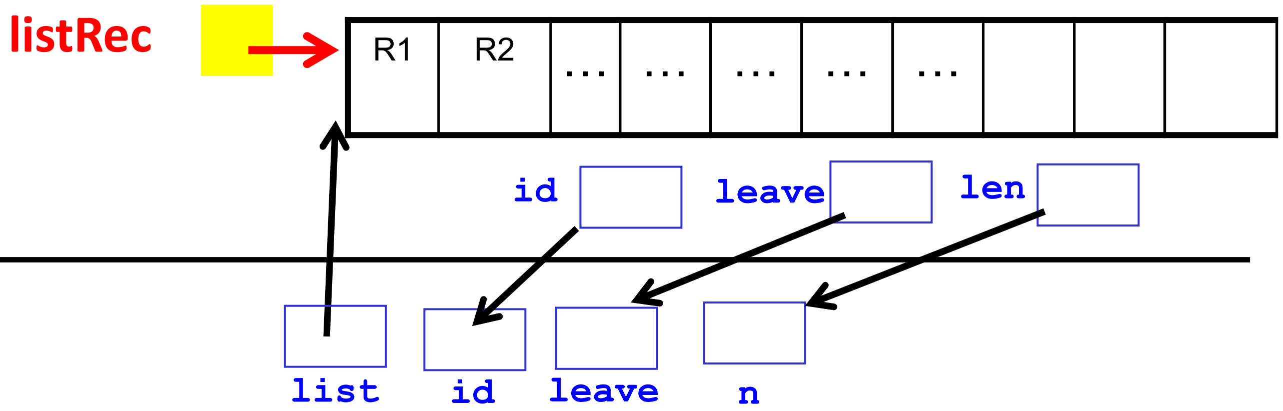


```
void printList(leaveRecord list[], int n)
{
   int p;

   printf("The staff list:\n");
   for (p = 0; p < n; p++)
      printf ("id = %d, totalleave = %d, leave taken =
%d\n",
         list[p].id, list[p].totalLeave,
list[p].leaveTaken);
}
```

```
int main()
{
 canTake = mayTakeLeave(listRec, id, leave, len);

}
```



```
int mayTakeLeave(leaveRecord list[], int id, int leave, int n)
{
   int p;

   for (p = 0; p < n; p++)
      if (list[p].id == id)
         return (list[p].totalLeave >= (list[p].leaveTaken + leave));

   return -1;
}
```