Information System Design (U08182)

Tutorial Exercise 8 Answer

1. Describe the testing that is performed within the systems development life cycle stages:

   A) Validation

   E.g. Customer acceptance

   B) Verification

   E.g. System testing, regression testing

   C) Integration

   E.g. Inspection, test harness

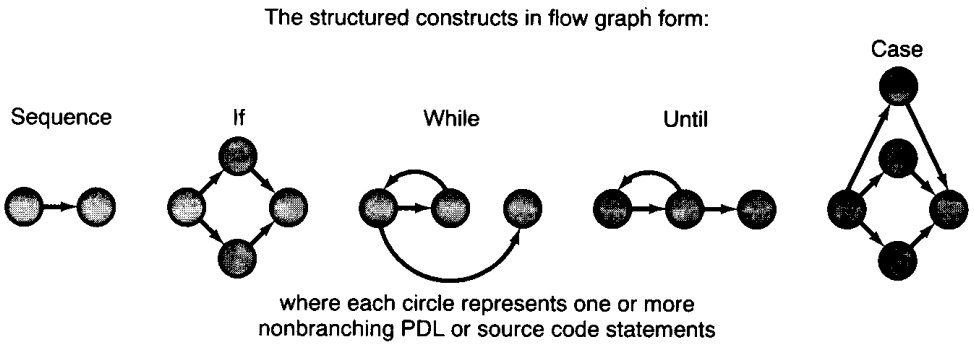
   D) Module design

   E.g. Test harness

   E) Programming.

   E.g. Trace table etc.

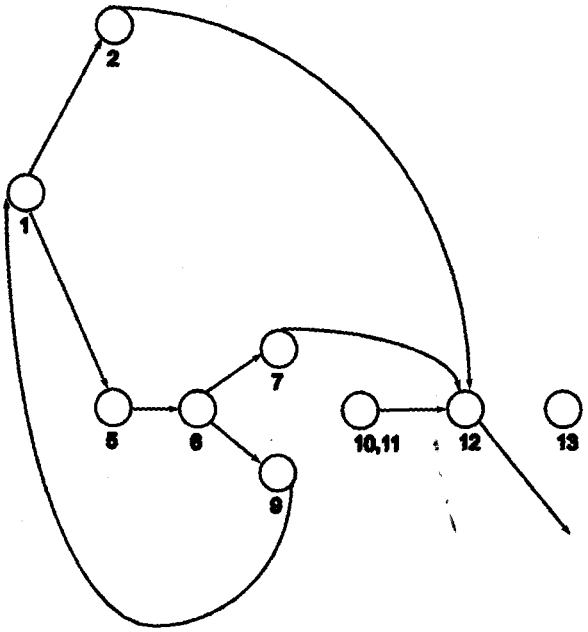
2. Using the appropriate symbols draw a directed graph of the program segment that follows:




```
LOOP:   IF P THEN
            GO TO HERE
        ELSE
            BEGIN
                INCREMENT A
                IF Q THEN
                    GO TO HERE
                ELSE
                    GO TO LOOP
                ENDIF
            END

HERE:           RETURN
        ENDIF
```

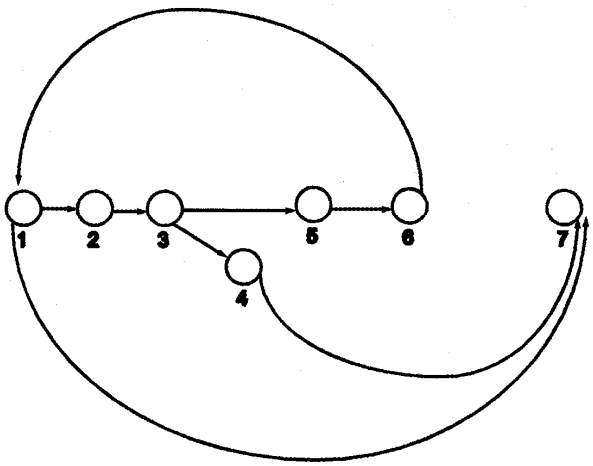
1.

```
1:      LOOP:  IF P THEN
2:                     GO TO HERE
3:             ELSE
4:                     BEGIN
5:                            INCREMENT A
6:                            IF Q THEN
7:                                   GO TO HERE
8:                            ELSE
9:                                   GO TO LOOP
10:                           ENDIF
11:                    END
12:     HERE:          RETURN
13:            ENDIF
```



Show from the directed graph why this code is not well-structured; rewrite the code, and redraw the directed graph to show how the structure can be improved

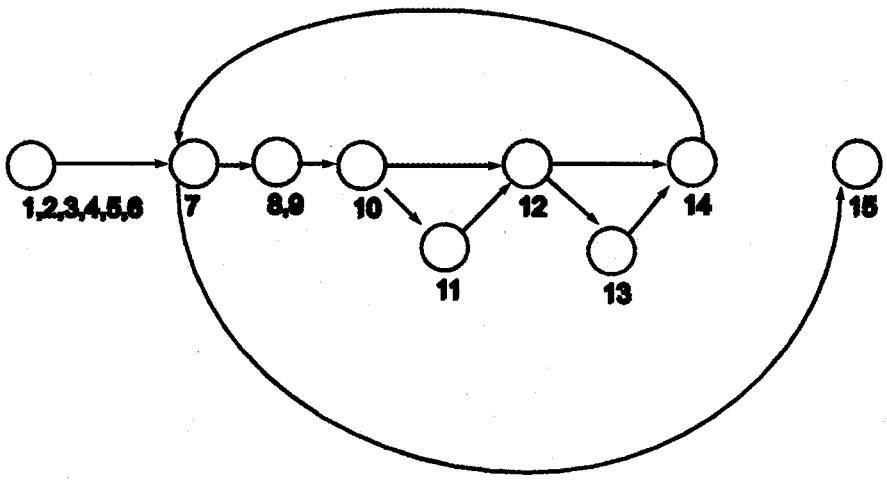
```
1:      WHILE NOT P DO
2:              INCREMENT A
3:              IF Q THEN
4:                      RETURN
5:              ENDIF
6:      ENDWHILE
7:      RETURN
```



3. Write a program using a high-level language of your choice, to input a series of numbers terminated by a sentinel value. Calculate the maximum, minimum and average values of the numbers and display the results. Use this program to answer the following questions

```
        #include <limits.h>

        void main(void)
        {
1:              int sentinel = 0;
2:              int max = INT_MIN;
3:              int min = INT_MAX;
4:              int count = 0, sum = 0;
5:              int number, average;

6:              scanf("%d", &number);
7:              while (number != sentinel)
                {
8:                      sum = sum + number;
9:                      count++;

10:                     if (number > max)
11:                     max = number;

12:                     if (number < min)
13:                     min = number;

14:                     scanf("%d", &number;
                }

15:             average = sum / count;
        }
```

A) Draw a directed graph of your program and calculate its cyclomatic complexity.



Cyclomatic complexity V = E-N+2

E = 11; N = 9

V = 4.

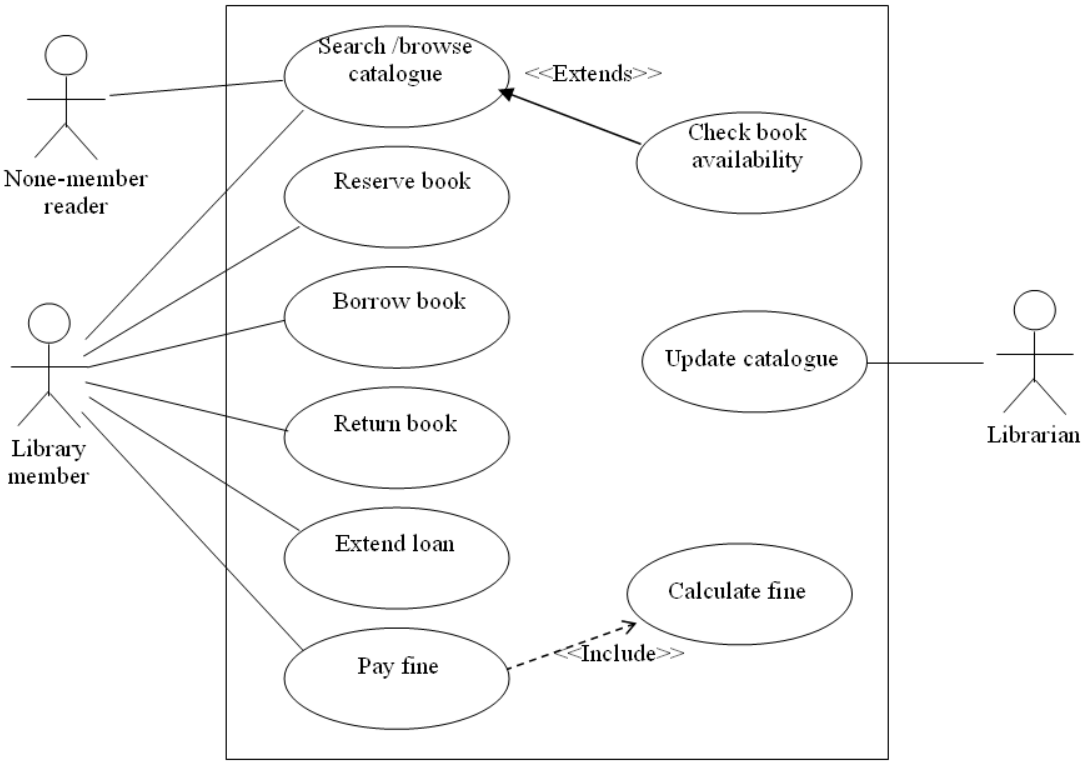
B) Use a trace table to confirm correct operation, including the use of boundary values.

The trace table may reveal errors in calculating average when first number = sentinel value, i.e. no values entered. Also division should result in floating point average (float average;). The given program can be corrected with:

```
15:   if (count>0)
        { average = (float)sum/(float)count;
          printf("min=%d, max=%d, average=%f\n", min, max, average);
        }
        else
          printf("No numbers entered\n");
```

The extra if statement (line 15) will increase the cyclomatic complexity V from 4 to 5.

4. Given the following use case diagram, develop a test plan.



There is no standard answer to this exercise. The following is a half completed table. Students should work in groups to discuss and fill the fields. Student may disagree with the fields the already filled in. In that case, reasons for different answer should be discussed.

Function	Possible errors	Consequences	Priority
Search/browse catalogue	Cannot find book that is available	Inefficiency in the use of the books	Medium
	Give search results that is not relevant	Inconvenience to the readers	Low
Check book availability	Wrong information about availability		
Reserve book	Reservation information lost or wrong		
Borrow book	Lost of record of borrowed book		
Return book	Failed to record the return of book		
Extend loan	Fail to record extension request		
Pay fine	Payment not recorded		
Calculate fine	Calculated the wrong amount		
Update catalogue	Lost of record		

5. Consider the following program.

```
Program Myth;
Begin
    Var x, y : INTEGER;
    Input(x);
    Input(y);
    x := x * y + 2;
    y := x * (x - 2);
    IF   x * x - 10 > y
    THEN    x := x - y;
    ELSE    x := x + y
    END;
    Output(x);
End Myth.
```

```
Program Myth;
Begin
    Var x, y : INTEGER;
    Input(x);              (* S1 *)
    Input(y);              (* S2 *)
    x := x*y+2;            (* S3 *)
    y := x*(x-2);          (* S4 *)
    IF x*x-10 > y THEN          (* P1 *)
       x := x-y;     (* true branch *)
    ELSE
       x := x+y            (* false branch *)
    END;
    Output(x);                  (* S3 *)
End Myth.
```

Let the symbolic input to variable x be α, variable y be 3α. Answer the following questions:

A) What is the result of a symbolic execution of the program when the TRUE branch in the IF statement is executed?

$2 - 3\alpha^2 - 9\alpha^4$

B) What is the condition on the value of α such that the TRUE branch in the IF statement can be executed?

$|\alpha| > 1$; (* This is equivalent to ($\alpha \neq 0$ and $\alpha \neq 1$ and $\alpha \neq -1$), because variable x's type is INTEGER *)

C) What is the result of α symbolic execution of the program when the FALSE branch in the IF statement is executed?

$9\alpha^4 + 9\alpha^2 + 2$;

D) What is the condition on the value of α that the FALSE branch in the IF statement can be executed?

$|\alpha| \leq 1$; (* This is equivalent to ($\alpha=0$ or $\alpha=1$ or $\alpha=-1$), because the type of x is INTEGER *)

Details of the symbolic execution are given in the following table.

Location	**X's symbolic value**	**Y's symbolic value**
S1	α	--
S2	α	3α
S3	$3\alpha^2+2$	3α
S4	$3\alpha^2+2$	$(3\alpha^2+2)(3\alpha^2+2-2) = 9\alpha^4+6\alpha^2$
P1	$(3\alpha^2+2)(3\alpha^2+2) - 10 > 9\alpha^4+6\alpha^2 \Leftrightarrow 9\alpha^4+12\alpha^2 -6> 9\alpha^4+6\alpha^2 \Leftrightarrow \alpha^2>1 \Leftrightarrow \|\alpha\| >1$	
True branch	$(3\alpha^2+2) - (9\alpha^4+6\alpha^2) = 2- 3\alpha^2 -9\alpha^4$	$9\alpha^4+6\alpha^2$
False branch	$(3\alpha^2+2) + (9\alpha^4+6\alpha^2) = 9\alpha^4 + 9\alpha^2+2$	$9\alpha^4+6\alpha^2$
S5	Output: (1) $2- 3\alpha^2 -9\alpha^4$, if $\|\alpha\| >1$ (* when the true branch is executed *) (2) $9\alpha^4 + 9\alpha^2+2$, if $\|\alpha\| \leq 1$ (* when the false branch is executed *)	

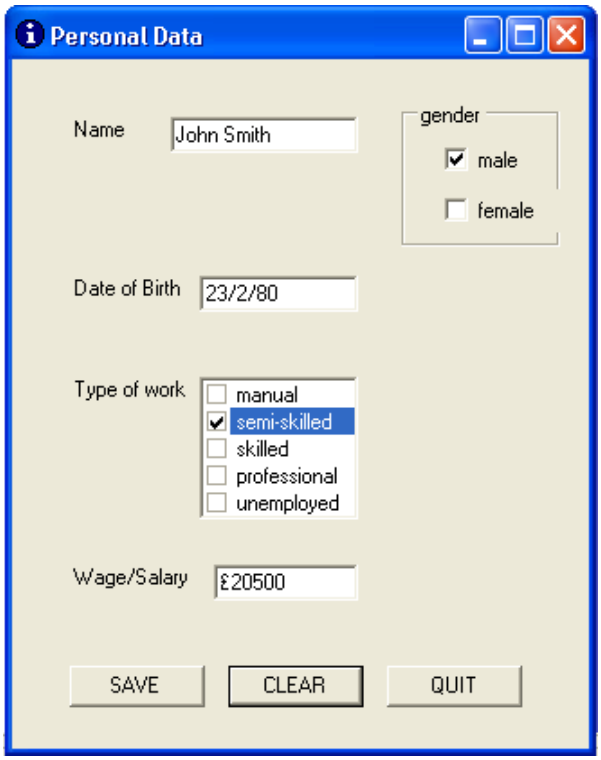
E) What is the function of the program?

$f(x, y) = 2-xy-(xy)^2$, if $(xy)^2>3$; $f(x, y) = 2+3xy + (xy)^2$, if $(xy)^2 \leq 3$;

The symbolic execution processes are given in the following table. Let x's value be α and y's value be β.

Location	X's symbolic value	Y's symbolic value
S1	α	--
S2	α	β
S3	$\alpha\beta+ 2$	β
S4	$\alpha\beta+ 2$	$(\alpha\beta+ 2)(\alpha\beta+ 2 - 2) = (\alpha\beta)^2+2\alpha\beta$
P1	$(\alpha\beta+ 2)(\alpha\beta+ 2) -10> (\alpha\beta)^2+2\alpha\beta \Leftrightarrow (\alpha\beta)^2 + 4\alpha\beta - 6 > (\alpha\beta)^2+2\alpha\beta \Leftrightarrow (\alpha\beta)^2>3$	
true branch	$(\alpha\beta+ 2) - ((\alpha\beta)^2+2\alpha\beta) = 2-\alpha\beta-(\alpha\beta)^2$	$(\alpha\beta)^2+2\alpha\beta$
false branch	$(\alpha\beta+ 2) + ((\alpha\beta)^2+2\alpha\beta) = 2+3\alpha\beta + (\alpha\beta)^2$	$(\alpha\beta)^2+2\alpha\beta$
S5	Output: (1) $2-\alpha\beta-(\alpha\beta)^2$, if $(\alpha\beta)^2>3$; (* when the true branch is executed *) (2) $2+3\alpha\beta + (\alpha\beta)^2$, if $(\alpha\beta)^2 \leq 3$; (* when the false branch is executed *)	

6. The figure illustrates a prototype for a GUI to capture personal information to be used in a survey about employment across the UK:



A) From the point of view of an inspector, devise a number of questions about the choice and appropriateness, in the context of the application, of the chosen objects for the construction of the GUI. (The author of the GUI has devised the following event/action table as a means of illustrating the dynamic properties of the interface.)

1	Input name.	none	2
2	Select gender.	Validate choice.	3, 7
3	Input date of birth	none	4
4	Input type of work	Validate choice	5, 8
5	Input wage or salary	none	6
6	Select a button	Return to main menu	0
7	Invalid choice	Display error message	0
8	Invalid choice	Display error message	0

Suggested questions

a) Why have you included a name field when this is a survey?
b) If you are going to use the name to recall information would it be better to use surname first as a possible key?
c) Is the date of birth strictly necessary? Surely such an employment survey would deal with people in specific age ranges rather than actual birth dates?
d) How does the user know the format for the date of birth is dd/mm/yy?
e) In selecting the boxes marked male or female is it possible to accidentally check both boxes?
f) Can a person in the survey be a manual, semi-skilled worker? If the answer is yes, is it possible to check more than one box for the type of work?
g) Do we need to know the precise salary of the interviewee, or will a range be sufficient for the purposes of the survey?
h) Can the various entries be made in a random order?
i) What does the SAVE button do?
j) What happens if no entries are made and the SAVE button is pressed?
k) Does the CLEAR button clear all the entries?
l) Can the CLEAR button be pressed at any time?
m) Having pressed the SAVE button, what state does it leave the entries on the screen?
n) Where does pressing the QUIT button take you?

B) As an inspector you need to review the event/action table with the author. Perform a walkthrough of the table, and list all the possible shortcomings that the table presents. If you can identify any additions or alternatives that the author might usefully consider, list these too

Shortcomings

a) If the input to the gender field is controlled by radio buttons, then why is there a need to validate the choice?
b) The date of birth field does need validation. What if the date was in the wrong format, or out of range?
c) The wage/salary field does need validation. What if the user typed a character string that could not be converted to a number?
d) Which button creates the event? Select a button is too vague.
e) Selecting any button will not just return you to the main memory. At what point in this scenario is the data saved?
f) Why is the application terminated when a user inputs wrong data?
g) There is no opportunity to correct mistakes once a user as input wrong data.

Additions or alternatives

a) To avoid the GUI being completed in random order, it might be better to constrain the order of completing the fields.
b) Since this is a questionnaire for a survey the name is not really required.
c) The survey is about employment across the UK therefore it might be useful to include a list of regions.
d) There is no need to perform validation on radio button input.
e) The date of birth is not needed. However, an indication of the age group of the candidate is required. Input age by group, and not by date of birth. This also saves the need to validate the date of birth.
f) Use radio buttons to select an age range, then there is no need for any further validation of this field.
g) You will need to perform some validation on the choice of type of work. Some combinations are viable others are not. e.g. a manual professional is not a valid combination, yet a manual, semi-skilled is viable combination.
h) After issuing a warning message that the combination is invalid, return back to the type of work field and allow the user to re-input new data.
i) Suggest the wage/salary field is changed to accommodate a range of

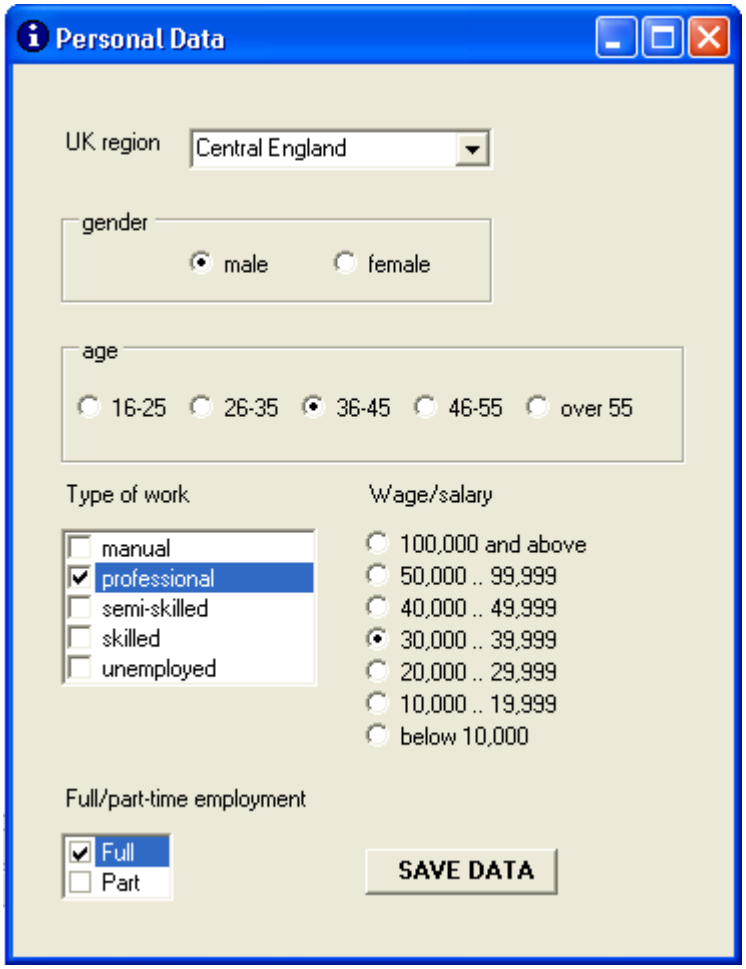
values and not a specific value. Once again if input is controlled by radio buttons there is no need to validate the field.

j) Suggest you create a new field to indicate whether employment is full or part time, since this factor might influence the findings in the survey.

k) Suggest you abandon the use of three buttons. Just use one button to save the data. The application can be closed down by just closing the window.

C) Using your findings and conclusions from your experience in the role of an inspector, switch your role back to the author and construct

1. A more meaningful prototype of the GUI for the stated application, and



2. An accurate and useful event/action table based upon your revised GUI. Note carefully the reason for each change.

Current State	Event	Action(s)	Next State
0	Select personal data from main menu	Create GUI. Disable all fields except for UK region. Disable the SAVE DATA button. Show the GUI.	1, 11
1	Select region	Enable gender group.	2, 11
2	Select gender	Enable age group.	3, 11
3	Select age	Enable type of work.	4, 11
4	Select type of work.	Validate choices. Enable wage/salary.	5, 9, 11
5	Select wage/salary	Enable full/part time.	6, 11
6	Select full/part time	Enable SAVE DATA button	7, 11
7	Press SAVE DATA	Store information in data table. Display message box informing user that data stored.	8
8	Press OK on message box	Destroy message box. Clear fields of GUI. Disable all fields except for UK region. Disable SAVE DATA button.	1
9	Illegal combination	Display message box informing of error.	10
10	Press OK on message box	Destroy message box. Disable wage/ salary.	4
11	Close window	Destroy GUI. Return to main menu.	0

Note the reasons for change are as a result of the inspector's comments and suggestions.