EXAMPLE PROGRAM TEMPERATURE CONVERSION REPORT

1. Requirements

Design and create an Ada program that, given a temperature in Centigrade converts it to Fahrenheit and vice-versa. Output should be accurate to one decimal place. To convert from Centigrade to Fahrenheit we can use the following identity:

$$F = (9over5 \times C) + 32$$

To convert from Fahrenheit to Centigrade we will use:

$$C = (F - 32) \times \frac{5}{9}$$

2. Design

A top-down analysis of the proposed problem is given in Table 1.

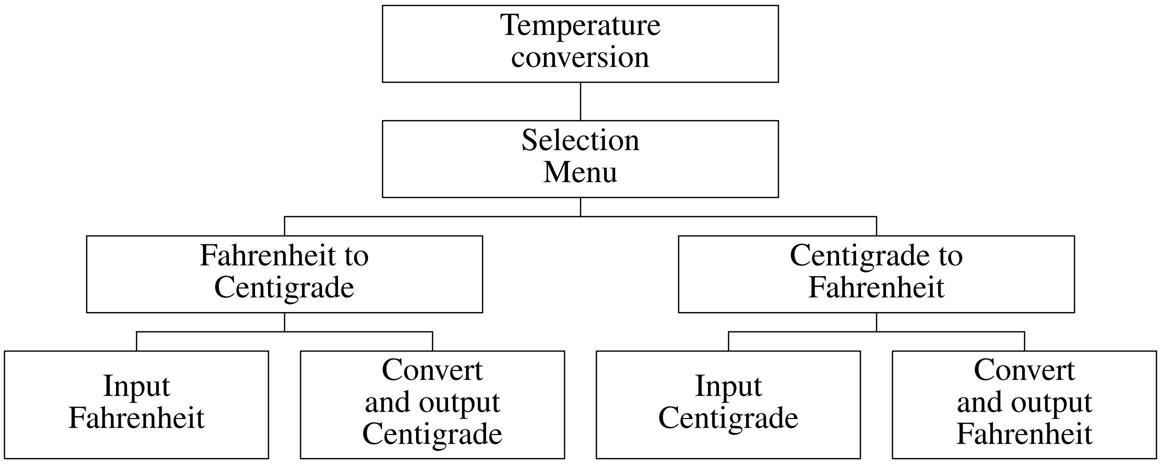

Table 1: *Top-down analysis*

With respect to the above we can identify three procedures:

1) `TEMP_CONVERT` (top level procedure): Output menu, input and check menu selection, and calls to appropriate procedure (`CENT_2_FAHR` or `FAHR_2_CENT`).

Name	Description	Type	Range
MENU_ITEM	Global input variable	CHARACTER	Default

2) `ENT_2_FAHR` (level 2 procedure): Convert from Centigrade to Fahrenheit. Include definition for subtype CENTIGRADE.

Name	Description	Type	Range
CENT_TEMP	Local input variable	CENTIGRADE	-50.0..100.0
TEMPERATURE	Local output variable	FLOAT	Default

3) `FAHR_2_CENT` (level 2 procedure): Convert from Fahrenheit to Centigrade. Include definition for subtype FAHRENHEIT.

Name	Description	Type	Range
FAHR_TEMP	Local input variable	FAHRENHEIT	-58.0..212.0
TEMPERATURE	Local output variable	FLOAT	Default

A complete Nassi-Shneiderman design for the above is given in Table 2 and a flow chart in Table 3.

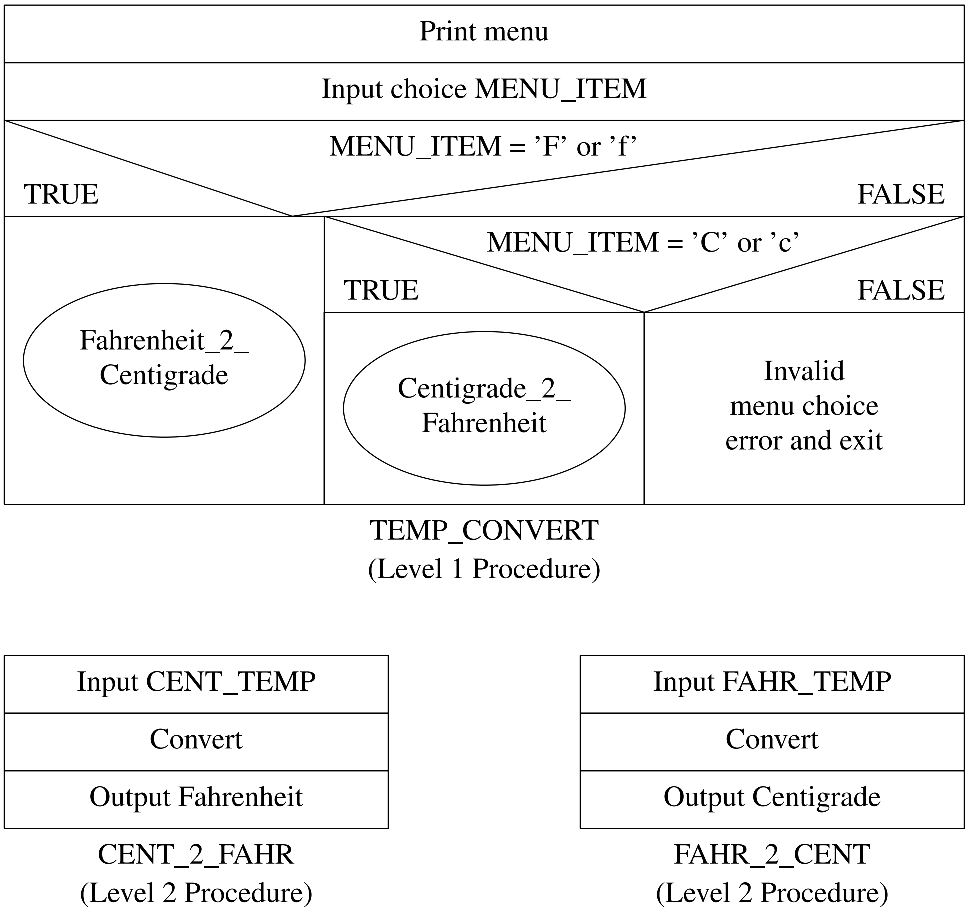

Table 2: *Nassi-Shneiderman Charts*

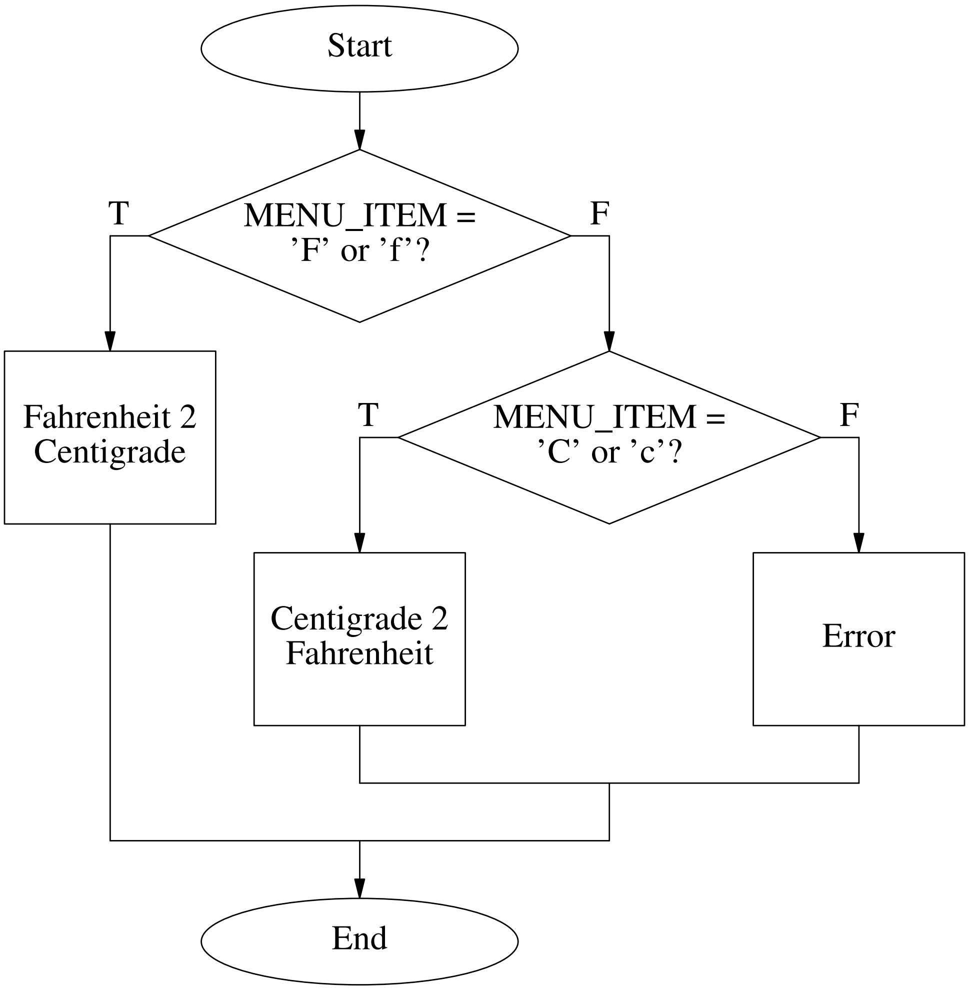

Table 3: *Flow chart*

3. Implementation

Top down implementation commencing with level 1 top level procedure and then level 2. Final implementation as shown in Table 4.

```
-- TEMPERATURE CONVERSION
-- 15 August 1997
-- Frans Coenen
-- Dept Computer Science, University of Liverpool

with TEXT_IO;
use TEXT_IO;

procedure TEMP_CONVERT is
        package FLOAT_INOUT is new FLOAT_IO(FLOAT);
        use FLOAT_INOUT;
        MENU_ITEM: CHARACTER;

        ----------------------------------------------------------------
        -- CENTIGRADE TO FAHRENHEIT CONVERSION
        procedure CENT_2_FAHR is
                subtype CENTIGRADE is FLOAT range -50.0..100.0;
                CENT_TEMP   : CENTIGRADE;
                TEMPERATURE : FLOAT;
        begin
        -- Input Centigrade value
                PUT_LINE("Input temperature in degrees Centigrade (float): ");
                GET(CENT_TEMP);
        -- Conversion
                TEMPERATURE := CENT_TEMP * (9.0/5.0) + 32.0;
        -- Output Fahrenheit value
                PUT("The equivalent in degrees Fahrenheit is: ");
                PUT(TEMPERATURE, FORE=>3, AFT=>1, EXP=>0);
                NEW_LINE;
        end CENT_2_FAHR;
        ----------------------------------------------------------------
        -- FAHRENHEIT TO CENTIGRADE CONVERSION
        procedure FAHR_2_CENT is
                subtype FAHRENHEIT is FLOAT range -58.0..212.0;
                FAHR_TEMP   : FAHRENHEIT;
                TEMPERATURE : FLOAT;

        begin
        -- Input Fahrenheit value
                PUT_LINE("Input temperature in degrees Fahrenheit (float): ");
                GET(FAHR_TEMP);
        -- Conversion
                TEMPERATURE := (FAHR_TEMP-32.0) * (5.0/9.0);
        -- Output Fahrenheit value
                PUT("The equivalent in degrees Centigrade is: ");
                PUT(TEMPERATURE, FORE=>3, AFT=>1, EXP=>0);
                NEW_LINE;
        end FAHR_2_CENT;
        ----------------------------------------------------------------
```

Table 4: *Implementation*

```
-- TOP LEVEL
begin
-- Output Menu
        PUT_LINE("MENU OPTIONS");
        PUT_LINE("C - Centigrade to Fahrenheit conversion");
        PUT_LINE("F - Fahrenheit to Centigrade conversion");
        GET(MENU_ITEM);
-- Check menu input
        if (MENU_ITEM = 'C' OR MENU_ITEM = 'c') then
                CENT_2_FAHR;
        else
                if (MENU_ITEM = 'F' OR MENU_ITEM = 'f') then
                        FAHR_2_CENT;
                else
                        PUT("Invalid menu selection: ");
                        PUT(MENU_ITEM);
                        NEW_LINE;
                end if;
        end if;
end TEMP_CONVERT;
```

Table 4 Continued

4. Testing

4.1. Black box testing

BVA testing: Do a BVA analysis for ranged values in two conversion procedures. A suitable set of BVA test cases is presented in Table 5.

TEST CASE		EXPECTED RESULT
MENU_ITEM	CENT_TEMP or FAHR_TEMP	TEMPERATURE
c	-50.1	CONSTRAINT_ERROR
C	-49.9	-57.8
c	99.9	211.8
C	100.1	CONSTRAINT_ERROR
f	-58.1	CONSTRAINT_ERROR
F	-57.9	-49.9
f	211.9	99.9
F	212.1	CONSTRAINT_ERROR

Table 5: *BVA test cases*

Limit testing: We should also derive a suitable set of test cases to exercise the limits of the input values. A suitable set of test cases for this purpose is given in Table 6.

TEST CASE		EXPECTED RESULT
MENU_ITEM	CENT_TEMP or FAHR_TEMP	TEMPERATURE
c	-50.0	-58.0
C	100.0	212.0
f	-58.0	-50.0
F	212.0	100.0

Table 6: *Limit test cases*

Arithmetic testing: Arithmetic testing requires negative, zero and positive sample values. We have already defined test cases with negative and positive values at the limits, however a "mid range" positive and negative sample value would also be appropriate (as well as zero sample values). A suitable set of test cases is given in Table 7.

TEST CASE		EXPECTED RESULT
MENU_ITEM	CENT_TEMP or FAHR_TEMP	TEMPERATURE
c	-25.0	-13.0
C	0.0	32.0
c	50.0	122.0
F	-29.0	-33.9
f	0.0	-17.8
F	106.0	41.1

Table 7: *Arithmetic test cases*

Results of black box testing are presented in Table 8.

```
kuban-300 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
c
Input temperature in degrees Centigrade (float):
-50.1

Ada-runtime: Exception CONSTRAINT_ERROR raised in
/tmp_mnt/home/staff2/ra/frans/public_html/2CS21/week6/temp_convert.ada
on line 23. Floating rangecheck error: 0 not in range 0..0.

kuban-301 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
C
Input temperature in degrees Centigrade (float):
-49.9
The equivalent in degrees Fahrenheit is: -57.8
```

Table 8: *Black box testing results*

```
kuban-302 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
c
Input temperature in degrees Centigrade (float):
99.9
The equivalent in degrees Fahrenheit is: 211.8

kuban-303 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
C
Input temperature in degrees Centigrade (float):
100.1
Ada-runtime: Exception CONSTRAINT_ERROR raised in
/tmp_mnt/home/staff2/ra/frans/public_html/2CS21/week6/temp_convert.ada
on line 23. Floating rangecheck error: 0 not in range 0..0.

kuban-304 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
f
Input temperature in degrees Fahrenheit (float):
-58.1
Ada-runtime: Exception CONSTRAINT_ERROR raised in
/tmp_mnt/home/staff2/ra/frans/public_html/2CS21/week6/temp_convert.ada
on line 42. Floating rangecheck error: 0 not in range 0..0.

kuban-305 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
F
Input temperature in degrees Fahrenheit (float):
-57.9
The equivalent in degrees Centigrade is: -49.9

kuban-306 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
f
Input temperature in degrees Fahrenheit (float):
211.9
The equivalent in degrees Centigrade is:  99.9
```

Table 8 continued

```
kuban-307 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
F
Input temperature in degrees Fahrenheit (float):
212.1
Ada-runtime: Exception CONSTRAINT_ERROR raised in
/tmp_mnt/home/staff2/ra/frans/public_html/2CS21/week6/temp_convert.ada
on line 42. Floating rangecheck error: 0 not in range 0..0.

kuban-308 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
c
Input temperature in degrees Centigrade (float):
-50.0
The equivalent in degrees Fahrenheit is: -58.0

kuban-309 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
C
Input temperature in degrees Centigrade (float):
100.0
The equivalent in degrees Fahrenheit is: 212.0

kuban-310 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
f
Input temperature in degrees Fahrenheit (float):
-58.0
The equivalent in degrees Centigrade is: -50.0

kuban-311 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
F
Input temperature in degrees Fahrenheit (float):
212.0
The equivalent in degrees Centigrade is: 100.0
```

Table 8 continued

```
kuban-312 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
c
Input temperature in degrees Centigrade (float):
-25.0
The equivalent in degrees Fahrenheit is: -13.0

kuban-313 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
C
Input temperature in degrees Centigrade (float):
0.0
The equivalent in degrees Fahrenheit is:  32.0

kuban-314 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
c
Input temperature in degrees Centigrade (float):
50.0
The equivalent in degrees Fahrenheit is: 122.0

kuban-315 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
F
Input temperature in degrees Fahrenheit (float):
-29.0
The equivalent in degrees Centigrade is: -33.9

kuban-316 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
f
Input temperature in degrees Fahrenheit (float):
0.0
The equivalent in degrees Centigrade is: -17.8

kuban-317 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
F
Input temperature in degrees Fahrenheit (float):
106.0
The equivalent in degrees Centigrade is:  41.1
```

Table 8 continued

4.2. White box testing

Path testing: We should each path through the program as indicated by the flow chart presented above. From this diagram we can identify three paths. Note that where a path is dictated by a compound condition represented by a "logical or" we should test both possible conditions associated with the "or" operator. A suitable set of test cases is presented in the Table 9. Note that the first four test cases are copies of black box cases defined earlier and thus we need only to run the last test case (Table 10).

TEST CASE		EXPECTED RESULT
MENU_ITEM	CENT_TEMP or FAHR_TEMP	TEMPERATURE
C	-25.0	-13.0
c	50.0	122.0
F	-29.0	-33.9
f	106.0	41.1
M	*	Invalid menu selection: M

Table 9: *Path test cases*

```
kuban-328 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
M
Invalid menu selection: M
```

Table 10: *White box testing results*

4.3. Data validation testing

The result of running a number of data validation test cases is given in Table 11.

```
kuban-329 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
***
Invalid menu selection: *

kuban-330 $ **
ksh: 3D.gif: cannot execute
```

Table 11: *Data validation testing results*

```
kuban-331 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
C
Input temperature in degrees Centigrade (float):
frans
Ada-runtime: Exception FLOAT_INPUT_ERROR_DIGIT_NOT_READ
propagated out of main.

kuban-332 $ rans
ksh: rans:  not found

kuban-333 $ temp_convert
MENU OPTIONS
C - Centigrade to Fahrenheit conversion
F - Fahrenheit to Centigrade conversion
F
Input temperature in degrees Fahrenheit (float):
1f5
Ada-runtime: Exception FLOAT_INPUT_ERROR_PERIOD_NOT_READ
propagated out of main.

kuban-334 $ 5
ksh: 5:  not found
```

Table 11 continued