

CSC 209 Review 7 Solution

August 26, 2020

1 Exercises

1. First, I need to justify if the following declarations are legal on an individual basis:

```
struct {int x, y;} x;  
struct {int x, y;} y;
```

The first `struct {int x, y;} x;` is legal. `struct {int x, y;} x;` is equivalent to

```
1  struct {  
2      int x;  
3      int y;  
4  } x;
```

and 'x' beside struct represents variable of that type. It is used to declare struct and access members of the struct (e.g. `x.x`, `x.y`).

The same is true for `struct {int x, y;} y;`.

Second, I need to answer if both declarations of struct can appear in a program.

The answer is yes. Each structure has a separate name space for its members.

Notes

- **Declaring Structure Variables**
 - Struct can have many variables that represent the same struct

```
struct part {
    int number;
    char name[NAME_LEN+1];
    int on hand;
} part1, part2;
```

members of struct

variables that represent
this struct

• Initializing Structure Variables

- Struct can be initialized with preset values (like python class under `__init__`)

```
struct {
    int number;
    char name[NAME_LEN+1];
    int on hand;
} part1 = {528, "Disk drive", 10},
   part2 = {914, "Printer cable", 5};
```

values
that initialize
structure variables

2. a) I need to declare structure variables named `c1`, `c2` and `c3`, each having members `real` and `imaginary` of type `double`.

The solution to this problem is:

```
1  struct {
2      double real, imaginary;
3  } c1, c2, c3;
```

- b) I need to modify the declaration in part a) so that

- `c1`'s members initially have the values 0.0 and 1.0
- `c2`'s members initially have the values 1.0 and 0.0
- `c3` is not initialized

The solution to this problem is:

```

1  struct {
2      double real, imaginary;
3  } c1 = {0.0, 1.0},
4      c2 = {1.0, 0.0},
5      c3;

```

Notes

- **Designated Initializer**

- Allows specific member variable to be initialized
- Allows member variables to be initialized in any order

Example



c) I need to write statements that copy the members of `c2` to `c1`.

Copying the members of `c2` and `c1` can be done in one statement.

Below is the solution to this problem:

```

1  c2 = c1

```

d) I need to write statements that add the corresponding members of `c1` and `c2` and store the result in `c3`.

The solution to this problem is:

```

1  struct {
2      double real, imaginary;
3  } c1 = {0.0, 1.0},

```

```
4      c2 = {1.0, 0.0},
5      c3;
6
7      ...
8
9      c3 = c1 + c2;
```

Notes

- member variables of struct contains two operators & and . (e.g &part1.number and part1.number)
- & accesses memory address of the member variable, where as . accesses value
- part1 = part2 copies contents in part2 to corresponding member variable in part1

```
struct {
    int number;
    char name[NAME_LEN+1];
    int on_hand;
} part1, part2;
```

3. a) I need to declare a tag named **complex** for a structure with two members **real** and **imaginary**, of type **double**

The solution to this problem is:

```
1      struct complex {
2          double real, imaginary;
3      };
```

Notes

- **Declaring a Structure Tag**
 - allows to use struct in function calls
 - allows to use the same struct in multiple files of a program

Structure tag

```
struct part {
    int number;
    char name[NAME_LEN+1];
    int on_hand;
};
```

- b) I need to use the `complex` tag to declare variables named `c1`, `c2`, `c3`.

The solution to this problem is:

```

1  struct complex {
2      double real, imaginary;
3  } c1, c2, c3;

```

- c) I need to write a function named `make_complex` that satisfies the following:

- The function `make_complex` should have two parameters (`real`, `imaginary`) of type `double`
- The function `make_complex` should store the two arguments in `complex` struct
- The function `make_complex` should return the struct

The solution to this problem is:

```

1  struct complex {
2      double real, imaginary;
3  };
4
5  struct complex (double real, double imaginary) {
6      struct complex c1;
7
8      c1.real = real;
9      c1.imaginary = imaginary;
10
11     return c1;
12 }

```

Notes

- **Declaring Variables Cont.**

- Once the struct tag is formed, it can be used to declare variables

Example

```
struct part part1, part2
```

- Structure tag can be combined with the declaration of structure variables.
 - * it's like creating a global variable (if it's outside of `main`), or local variable (if it's created inside a function) at the instant the struct is formed

```

struct part {
    int number;
    char name[NAME_LEN+1];
    int on_hand;
} part1, part2;

```

- Declared variables can set values the moment it's declared

Example

```
struct part part1 = {528, "Disk Drive", 10}
```

d) I need to write a function named `add_complex` that satisfies the following:

- The function `add_complex` should have 2 parameters of type `struct complex`
- The function `add_complex` should add the corresponding members of its arguments
- The function `add_complex` should return the result of type `struct complex`

The solution to this problem is:

```

1  struct complex {
2      double real, imaginary;
3  };
4
5  struct complex add_complex (struct complex c1, struct complex c2)
6  {
7      struct complex c3;
8
9      c3.real = c1.real + c2.real;
10     c3.imaginary = c1.imaginary + c2.imaginary;
11
12     return c3;
13 }
```

4. I need to repeat exercise 3 but using a type named `complex`.

```

a) typedef struct {
2     double real, imaginary;
3 } Complex;
```

```

b) typedef struct {
2     double real, imaginary;
3 } Complex;
4
5     ...
6
7     Complex c1, c2, c3;
```

```

c) typedef struct {
2     double real, imaginary;
3 } Complex;
4
5     Complex make_complex(double real, double imaginary) {
6         Complex c;
7
8         c.real = real;
```

```

9         c.imaginary = imaginary;
10
11         return c;
12     }

```

d)

```

1     typedef struct {
2         double real, imaginary;
3     } Complex;
4
5     Complex add_complex(Complex c1, Complex c2) {
6         Complex c3;
7
8         c3.real = c1.real + c2.real;
9         c3.imaginary = c1.imaginary + c2.imaginary;
10
11         return c3;
12     }

```

Notes

• Structure Type

- Is an alternative to declaring a structure tag

```

typedef struct {
    int number;
    char name[NAME_LEN+1];
    int on_hand;
} Part;

```

- Allows us to define a genuine type name

Example

```
Part part1, part2;
```

- Once declared, cannot define a structure tag with the same name

5. a) I need to write the following function

```
int day_of_year (struct date d);
```

satisfying the following requirements:

- The `date` structure should contain three members: `month`, `day`, and `year` all of type `int`
- The function `day_of_year` should return the day of the year (an integer between 1 and 366) that corresponds to the date `d`

The solution to this problem is:

```

1
2     struct date {
3         int month, day, year;
4     };
5
6     int day_of_year (struct date d);
7
8     ...
9
10    int day_of_year (struct date d) {
11        bool leap_year = false;
12        int days = 0, days_in_month[] = {
13            31, 28, 31, 30,
14            31, 30, 31, 31,
15            30, 31, 30, 31};
16
17        // check if it's the leap year
18        if (((d.year % 4 == 0) &&
19            (d.year % 100 != 0)) ||
20            (d.year % 400 == 0)) {
21
22            leap_year = true;
23        }
24
25
26        // add days from months
27        for (int i = 0; i < d.month; i++) {
28            if (i == d.month-1) {
29                days += d.day;
30                continue;
31            }
32
33            days += days_in_month[i];
34        }
35
36
37        // add 1 more day if month > 2 and it's leap year
38        if (leap_year && d.month > 2) {
39            days += 1;
40        }
41
42
43        // return days
44        return days;
45    }

```

b) I need to write the following function

```
int compare_dates (struct date d1, struct date d2);
```

satisfying the following requirements:

- The function `compare_dates` should return
 - -1 if d1 is an earlier date than d2
 - +1 if d1 is a later date than d2
 - 0 if d1 and d2 are the same

The solution to this problem is:

```

1  #include <stdio.h>
2  #include <string.h>
3  #include <stdbool.h>
4
5  struct date {
6      int month, day, year;
7  };
8
9  ...
10
11 int compare_dates (struct date d1, struct date d2) {
12     char s1[9], s2[9];
13
14     sprintf(s1,"%4d%2d%2d", d1.year, d1.month, d1.day);
15     sprintf(s2,"%4d%2d%2d", d2.year, d2.month, d2.day);
16
17     // return days
18     return strcmp(s1,s2);
19 }

```

6. I need to write the following function

```
struct time split_time(long total_seconds)
```

satisfying the following requirements:

- The `time` structure has three members `hours`, `minutes`, `seconds`
- The function `split_time` should return `time` struct containing equivalent time in `hours` (0-23), `minutes` (0-59), `seconds` (0-59)

The solution to this problem is:

```

1  #include <stdio.h>
2  #include <string.h>
3  #include <stdbool.h>
4
5  struct time {
6      int hours, minutes, seconds;
7  };
8
9  struct time split_time (long total_seconds);
10

```

```

11     ...
12
13     struct time split_time (long total_seconds) {
14         struct time t;
15         int s = (int)total_seconds;
16
17         printf("%d\n", s);
18
19         t.hours = s / 3600;
20         s = s - (t.hours * 3600);
21
22         t.minutes = s / 60;
23         s = s - (t.minutes * 60);
24
25         t.seconds = s;
26
27         return t;
28     }

```

7. a) I need to write a function that satisfies the following requirements:

- The function should reduce the fraction `f` to lowest terms
- The struct `fraction` contains two members: `numerator` and `denominator`, and both are type `int`

The solution to this problem is:

```

1     struct fraction {
2         int numerator, denominator;
3     };
4
5     ...
6
7     struct fraction reduce (struct fraction f) {
8
9         int gcd;
10
11        struct fraction f2;
12
13        if (f.numerator >= f.denominator) {
14            gcd = f.denominator;
15        } else {
16            gcd = f.numerator;
17        }
18
19        while (gcd > 0) {
20            if ((f.numerator % gcd == 0) &&
21                (f.denominator % gcd == 0)) {
22                break;
23            }
24
25            gcd--;

```

```

26     }
27
28     f2.denominator = f.denominator/gcd;
29     f2.numerator = f.numerator/gcd;
30
31     return f2;
32 }

```

b) I need to write a function that adds two fractions f1 and f2.

The solution to this problem is:

```

1  struct fraction {
2      int numerator, denominator;
3  };
4
5  ...
6
7  struct fraction add (struct fraction *f1, struct fraction *f2) {
8
9      struct fraction f3;
10
11     if (f1->denominator != f2->denominator) {
12         f3.numerator = (f1->numerator * f2->denominator) + (f2->
numerator * f1->denominator);
13         f3.denominator = f1->denominator * f2->denominator;
14     } else {
15         f3.numerator = f2->numerator + f1->numerator;
16     }
17
18     f3 = reduce(f3);
19
20     return f3;
21 }

```

c) I need to create a function that subtracts two fractions f1 and f2.

The solution to this problem is:

```

1  struct fraction {
2      int numerator, denominator;
3  };
4
5  ...
6
7  struct fraction subtract (struct fraction *f1, struct fraction *
f2) {
8
9      struct fraction f3;
10
11     if (f1->denominator != f2->denominator) {
12         f3.numerator = (f2->numerator * f1->denominator) - (f1->
numerator * f2->denominator);
13         f3.denominator = f1->denominator * f2->denominator;

```

```

14     } else {
15         f3.numerator = f2->numerator - f1->denominator;
16     }
17
18     f3 = reduce(f3);
19
20     return f3;
21 }

```

d) I need to create a function that divides fractions `f1` by fraction `f2`.

The solution to this problem is:

```

1  struct fraction {
2      int numerator, denominator;
3  };
4
5  ...
6
7  struct fraction divide (struct fraction *f1, struct fraction *f2)
8  {
9
10     struct fraction f3;
11
12     f3.denominator = f1->denominator * f2->numerator;
13     f3.numerator = f1->numerator * f2->denominator;
14
15     f3 = reduce(f3);
16
17     return f3;
18 }

```

8. a) I need to write a declaration for a `const` variable named `MAGNETA` of type `struct color` that satisfies the following

- red has value 255
- green has value 0
- blue has value 255

The solution to this problem is:

```

1  struct color {
2      int red;
3      int green;
4      int blue;
5  };
6
7  const struct color MAGNETA = {255, 0, 255}

```

I need to rewrite above to use a designated initializer that doesn't specify the value of `green`.

The solution to this problem is:

```
1  struct color {  
2      int red;  
3      int green;  
4      int blue;  
5  };  
6  
7  const struct color MAGNETA = {.red = 255, .blue = 255};
```

Notes

- b) • int variable prints 0, if nothing is in it