

CSC 209 Review 5 Solution

August 21, 2020

1. a) 14
b) 34
c) 4
d) true
e) false

Notes

- **Pointer Arithmetic**

- Adding an integer to a pointer

Example



- Subtracting an integer from a pointer

Example



- Subtracting one pointer from another

Example



• Comparing pointers

- Can compare pointers using relational operators (i.e. `<`, `<=`, `>`, `>=`) and the equality operators (i.e. `==`, `!=`)
- Returns 1 if **true** and 0 if **false**

Example

```
p = &a[5];
q = &a[1];
```

`p <= q` is 0 and `p >= q` is 1

2. `low` and `high` are memory addresses.

So, `low + high` is out of bound, and it could potentially point to an undesirable or wrong value.

To fix this, we subtract the from high value to the low value:

$$\text{middle} = \frac{\text{low} + \text{high}}{2} \quad (1)$$

3. I need to write the contents of an array `a` after the execution of statements outlined in problem sheet.

After execution, the array would have contents of `[10, 9, 8, 7, 6, 5, 4, 3, 2, 1]`.

Notes

- **Combining the `*` and `++` Operators**

- `*p++` or `*p++` → Value of expression is `*p` before increment; increment `p` later
- `(*p)++` → Value of expression is `*p` before increment; increment `*p` later
- `++*p` or `*(++p)` → Increment `p` first; value of expression is `*p` after increment
- `+++p` or `++(*p)` → Increment `*p` first; value of expression is `*p` after increment

Example

`a[i++] = j`

Means assign the value `j` to `a[i]` before increment

Example 2

```
for (p = &a[0]; p < &a[N]; p++)  
    sum += *p;
```

Is the same as

```
p = &a[0];  
while (p < &a[N])  
    sum += *p++;
```

4. I need to re-write prototype `make_empty`, `is_empty` and `is_full` of the following code to use the pointer variable `top_ptr` instead of the integer variable `top`.

```
1  #include <stdbool.h>
2
3  #define STACK_SIZE 100
4
5  /*external variables*/
6  int contents[STACK_SIZE]
7  int top = 0;
8
9  void make_empty(void) {
10     top = 0;
11 }
12
13 bool is_empty(void) {
14     return top == 0;
15 }
16
17 bool is_full(void) {
18     return top == STACK_SIZE;
19 }
```

And after re-write using `top_ptr` instead of `top` have:

```
1  #include <stdbool.h>
2
3  #define STACK_SIZE 100
4
5  /*external variables*/
6  int contents[STACK_SIZE]
7  int *top_ptr = &contents[0];
8
9  void make_empty(void) {
10     top_ptr = &contents[0];
11 }
12
13 bool is_empty(void) {
14     return top_ptr == &contents[0];
15 }
16
17 bool is_full(void) {
18     return top_ptr == &contents[STACK_SIZE-1];
19 }
```

5. First, I need to identify which of the following expressions are illegal because of mismatched types.

- a) `p == a[0]`
- b) `p == &a[0]`

- c) `*p == a[0]`
 d) `p[0] == a[0]`

Here, only a) is illegal.

Second, I need to write which of the remaining expressions are true.

Here, the expressions that return true are b), c) and d).

Notes

- `*(a+i)` is equal to `a[i]`
- `*p` and `a[]` are the same given `p == a`
- **Using an Array Name as a Pointer**
 - The name of an array can be used as a pointer to the first element in the array.

Example

```
int a[10];

*a = 7; /* stores 7 in a[0] */

*(a+1) = 12; /* stores 7 in a[1] */
```

Example 2

To simplify the loop, we can replace `&a[0]` by `a` and `&a[N]` by `a + N`:

```
for (p = a; p < a + N; p++)
    sum += *p;
```

6. I need to re-write the following to use pointer arithmetic instead of array subscripting, and I need to make as few change as possible.

```
1  int sum_array(const int a[], int n) {
2      int i, sum;
3
4      sum = 0;
5
6      for (i = 0; i < n; i++)
7          sum += a[i];
8      return sum;
9  }
```

After making changes to above code to use pointer arithmetic, we have

```
1  int sum_array(const int a[], int n) {
2      int i, sum;
3
4      sum = 0;
5
6      for (i = 0; i < n; i++)
7          sum += *(a+i);
8      return sum;
9  }
```

7. I need to write the following using pointer arithmetic so it finds an element in **a** that matches to value **key**. I need to return true if there is a match.

```
bool search(const int a[], int n, int key);
```

And the solution is:

```
1  bool search(const int a[], int n, int key) {
2
3      for (int i = 0; i < n; i++) {
4          if (*(a+i) == key) {
5              return true
6          }
7      }
8
9      return false;
10 }
```

8. Here, I need to re-write the following function to use pointer arithmetic instead of array subscripting.

```
1  void store_zeros(const int a[], int n) {
2      int i;
3
4      for (i = 0; i < n; i++) {
5          a[i] = 0;
6      }
7  }
```

After re-writing above code, we have

```
1  void store_zeros(const int a[], int n) {
2      int *p;
3
4      for (p = a; p < a + n; p++) {
5          *p = 0;
6      }
7  }
```

9. Here, I need to write the function

```
double inner_product(const double *a, const double *b, int n)
```

using pointer arithmetic such that it returns $a[0] * b[0] + a[1] * b[1] + a[2] * b[2] + \dots + a[n-1] * b[n-1]$.

The solution is provided below

```
1  double inner_product(const double *a, const double *b, int n) {
2      double sum = 0, p*;
3
4      p = a;
5
6      while (p < a + n) {
7          sum += *a * *b;
8
9          a++;
10         b++;
11         p++;
12     }
13
14     return sum;
15 }
```

Correct Solution

```
1  double inner_product(const double *a, const double *b, int n) {
2      double sum = 0, *p;
3
4      p = a;
5
6      while (p++ < a + n) {
7          sum += *a++ * *b++;
8      }
9
10     return sum;
11 }
```

10. Here, I need to rewrite the function `find_middle` so that it uses pointer arithmetic - not subscripting - to visit any element.

The solution to this exercise is provided below.

```
1  int *find_middle(int a[], int n) {
2      return a + (n/2)
3  }
```

11. Here I need to modify the function `find_largest` function so that it uses pointer arithmetic - not subscripting - to visit array elements

```
1  int *find_largest(int a[], int n) {
2      int *p, *max;
3
4      max = a;
5
6      for (p = a; p < a + n; p++){
7          if (*p > *max) {
8              max = p;
9          }
10     }
11
12     return *max;
13 }
```