QUEENS COLLEGE Department of Computer Science
CSCI 111 Final Exam Fall 2015 12.22.15

Solutions

08.30am – 10.30am, Tuesday, December 22, 2015

Problem 1 Write the best **title lines** for the functions that are called by the following main program. **Do not supply blocks for the functions.**

```
int main() {
   int x = 0, y = 1, z = 2;
   double b[2] = {1.1, 2.2};
   int d[2][2] = {{2,2},{3,4}};

   x = multiply(z, y);                    // (a) sets x to product 2
   copy(x, y);                            // (b) replaces x by value of y
   bigCol(d, 2, 2);                       // (c) prints biggest column: 2 4
   cout << printAll(b, 2) << endl;        // (d) prints array: 1.1 2.2
   cout << add(b[1], b[1]) << endl;       // (e) prints the sum 4.4
   return 0;
}
```

(a) Title line for **multiply**.

Answer:

```
int multiply(int z, int y)
```

(b) Title line for **copy**.

Answer:

```
void copy(int &x, int y)
```

(c) Title line for **bigCol**.

Answer:

```
void bigCol(int d[][2], int r, int c)
```

(d) Title line for **printAll**.

Answer:

```
string printAll(double b[], int cap)
```

(e) Title line for **add**.

Answer:

```
double add(double x, double y)
```

Problem 2 Consider the following C++ program.

```
#include <iostream>
using namespace std;

double down(int x[], int cap, int gap) {
  double ans = 0.0;
  for (int i = 0; i < cap; i+= gap)
     ans += x[i];
  return ans / 10;
}

int main() {
    int x[4] = {2, 1, 3, 0};
    cout << x[2] << endl;                        // line (a)
    cout << x[5/3] << endl;                      // line (b)
    cout << x[x[3]] << endl;                     // line (c)
    cout << down(x, 4, 1) << endl;               // line (d)
    cout << down(x, 4, 3) << endl;               // line (e)
}
```

(a) What is the output at line (a)?
Answer:

```
3
```

(b) What is the output at line (b)?
Answer:

```
1
```

(c) What is the output at line (c)?
Answer:

```
2
```

(d) What is the output at line (d)?
Answer:

```
0.6
```

(e) What is the output at line (e)?
Answer:

```
0.2
```

Problem 3 Write blocks of code to perform the functions used in the following main program. Your blocks must match the given title lines. Each block should be a short function of only a few lines.

```
int main() {
   int i = 2;
   int x[5] = {3, 1, 4, 1, 5};
// (a) Is i even?  Here YES is printed.
   if (isEven(i)) cout << "YES" << endl;
// (b) Return the bigger. Here 4 is printed.
   cout << bigger(i, 4) << endl;
// (c) Are all entries in the array x positive? Here YES is printed.
   if (allPositive(x, 5)) cout << "YES" << endl;
// (d) Print the array with spaces between entries. Here 3 1 4 1 5.
   printArray(x, 5);
// (e) Print the number of digits. Here 3.
   cout << numDigits(729) << endl;
   return 0;
}
```

Answer:

(a)

```
bool isEven(int x) {
    return x % 2 == 0;
}
```

(b)

```
int bigger(int x, int y) {
   if (x > y) return x;
   return y;
}
```

(c)

```
bool allPositive(int x[], int cap) {
   for (int i = 0; i < cap; i++)
      if (x[i] <= 0) return false;
   return true;
}
```

(d)

```
void printArray(int x[], int cap) {
   for (int i = 0; i < cap; i++) cout << x[i] << " ";
   cout << endl;
}
```

(e)

```
int numDigits(int x) {
   if (x < 10) return 1;
   return 1 + numDigits(x / 10);
}
```

Problem 4 Write a function called *shorten* that shortens each element of an array of strings. Every string with more than two characters is cut down to its first two characters.

For example, a program that uses the function *shorten* follows.

```
int main() {
   string x[6] = {"CSCI", "1", "11", "Queens", "College", "CUNY"};
   shorten(x, 6);
   for (int i = 0; i < 6; i++) cout << x[i] << " ";
      // Output:   CS 1 11 Qu Co CU
   cout << endl;
   return 0;
}
```

Answer:

```
void shorten(string x[], int cap) {
   for (int i = 0; i < cap; i++)
      if (x[i].length() > 2)
         x[i] = x[i].substr(0, 2);
}
```

Problem 5 Write a function called *allOdd* that reports whether all the digits in a positive integer parameter are odd.

For example, a program that uses the function *allOdd* follows.

```
int main() {
   if (allOdd(153)) cout << "All odd" << endl;        // prints: All odd
   if (!allOdd(153972)) cout << "Not" << endl;        // prints: Not
   if (!allOdd(222)) cout << "Not " << endl;          // prints: Not
   if (allOdd(5)) cout << "All odd" << endl;          // prints: All odd
   return 0;
}
```

Answer:

```
bool allOdd(int x) {
   if (x < 10) return x % 2 == 1;
   return allOdd(x / 10) && allOdd(x % 10);
}
```

Problem 6 Write a complete C++ program that does the following. (Programs that correctly carry out some of the tasks will receive partial credit.)

1. It asks the user to enter 25 quiz scores each of which is an integer between 0 and 10.
2. It reads the 25 quiz scores.
3. It prints out the most common score (or scores).

For example if the scores 6 and 8 were the two most common scores, the output would be:

6 8

Answer:

```
#include <iostream>
using namespace std;

int main() {
   int score, counts[11], maxCount = 0;
   for (int i = 0; i < 11; i++) counts[i] = 0;

   cout << "Enter 25 quiz scores: ";
   for (int i = 0; i < 25; i++) {
      cin >> score;
      counts[score] ++;
      if (counts[score] > maxCount)
         maxCount = counts[score];
   }

   for (int i = 0; i < 11; i++)
      if (counts[i] == maxCount)
         cout << i << " ";
   cout << endl;
   return 0;
}
```

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11.00am – 01.00pm, Tuesday, December 22, 2015

Problem 1 Write the best **title lines** for the functions that are called by the following main program. **Do not supply blocks for the functions.**

```
int main() {
   int x = 0, y = 1, z = 2;
   double b[2] = {1.1, 2.2};
   int d[2][2] = {{0,1},{3,4}};

   d[0][0] = sum(x, y);                      // (a) sets d[0][0] to the sum 1
   swap(x, y);                               // (b) swaps x and y
   cout << biggest(d, 2, 2);                 // (c) prints biggest entry 4
   printAll(b, 2);                           // (d) prints 1.1 2.2
   cout << summit(b[0], b[0]) << endl;       // (e) prints the sum 2.2
   return 0;
}
```

(a) Title line for **sum**.

Answer:

```
int sum(int x, int y)
```

(b) Title line for **swap**.

Answer:

```
void swap(int &x, int &y)
```

(c) Title line for **biggest**.

Answer:

```
int biggest(int d[][2], int r, int c)
```

(d) Title line for **printAll**.

Answer:

```
void printAll(double b[], int cap)
```

(e) Title line for **summit**.

Answer:

```
double summit(double x, double y)
```

Problem 2 Consider the following C++ program.

```
#include <iostream>
using namespace std;

double down(int x[], int cap, int gap) {
  double ans = 0.0;
  for (int i = 0; i < cap; i+= gap)
     ans += x[i];
  return ans / 10;
}

int main() {
    int x[4] = {3, 2, 0, 1};
    cout << x[2] << endl;                         // line (a)
    cout << x[5/3] << endl;                       // line (b)
    cout << x[x[3]] << endl;                      // line (c)
    cout << down(x, 4, 1) << endl;                // line (d)
    cout << down(x, 4, 3) << endl;                // line (e)
}
```

(a) What is the output at line (a)?

Answer:

```
0
```

(b) What is the output at line (b)?

Answer:

```
2
```

(c) What is the output at line (c)?

Answer:

```
2
```

(d) What is the output at line (d)?

Answer:

```
0.6
```

(e) What is the output at line (e)?

Answer:

```
0.4
```

Problem 3 Write blocks of code to perform the functions used in the following main program. Your blocks must match the given title lines. Each block should be a short function of only a few lines.

```
int main() {
   double i = 2.5;
   string x = "Hello";
// (a) Is i positive?  Here YES is printed.
   if (isPositive(i)) cout << "YES" << endl;
// (b) Return the bigger. Here 4 is printed.
   cout << bigger(i, 4) << endl;
// (c) Does the string x start with an upper case character? Here YES.
   if (startsUpper(x)) cout << "YES" << endl;
// (d) Add on a second copy of the string. Here HelloHello is printed.
   cout << twice(x) << endl;
// (e) Print the first digit. Here 7.
   cout << firstDigit(729) << endl;
   return 0;
}
```

Answer:

(a)

```
bool isPositive(double x) {
    return x > 0;
}
```

(b)

```
double bigger(double x, double y) {
   if (x > y) return x;
   return y;
}
```

(c)

```
bool startsUpper(string x) {
   return x[0] >= 'A' && x[0] <= 'Z';
}
```

(d)

```
string twice(string x) {
   return x + x;
}
```

(e)

```
int firstDigit(int x) {
   if (x < 10) return x;
   return firstDigit(x / 10);
}
```

Problem 4 Write a function called *lengthen* that lengthens each element of an array of strings. Every string with at least two characters has a *XXX* added after its first character.

For example, a program that uses the function *lengthen* follows.

```
int main() {
   string x[3] = {"csci", "1", "11"};
   lengthen(x, 3);
   for (int i = 0; i < 3; i++) cout << x[i] << " ";
      // Output:   cXXXsci 1 1XXX1
   cout << endl;
   return 0;
}
```

Answer:

```
void lengthen(string x[], int cap) {
   for (int i = 0; i < cap; i++)
      if (x[i].length() > 1)
         x[i] = x[i].insert(1, "XXX");
}
```

Problem 5 Write a function called *evenToNine* that returns a result obtained by turning all the even digits in a positive integer parameter to nines.

For example, a program that uses the function *evenToNine* follows.

```
int main() {
   cout << evenToNine(1234) << endl;        // prints: 1939
   cout << evenToNine(1357) << endl;        // prints: 1357
   cout << evenToNine(22) << endl;          // prints: 99
   cout << evenToNine(1) << endl;           // prints: 1
   return 0;
}
```

Answer:

```
int evenToNine(int x) {
   if (x <= 0) return 0;
   if (x % 2 == 0)
      return 10 * evenToNine(x / 10) + 9;
   return 10 * evenToNine(x/ 10) + x % 10;
}
```

Problem 6 Write a complete C++ program that does the following. (Programs that correctly carry out some of the tasks will receive partial credit.)

1. It asks the user to enter quiz scores of 25 students. Each score is an integer between 0 and 10.
2. It reads the 25 quiz scores.
3. It prints out the score obtained by the middle student. (The middle student is ranked 13^{th} in the class.)

Answer:

```
#include <iostream>
using namespace std;

int main() {
   int score, counts[11];
   for (int i = 0; i < 11; i++) counts[i] = 0;

   cout << "Enter 25 quiz scores: ";
   for (int i = 0; i < 25; i++) {
      cin >> score;
      counts[score] ++;
   }

   score = 10;
   int numberStudents = counts[score];
   while (numberStudents < 13) {
       score--;
       numberStudents += counts[score];
   }

   cout << score << endl;
   return 0;
}
```

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Solutions

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Problem 1 Write the best **title lines** for the functions that are called by the following main program. **Do not supply blocks for the functions.**

```
int main() {
   int x = 0, y = 1, z = 2;
   double b[2] = {1.1, 2.2};
   int d[2][2] = {{1,2},{3,4}};

   cout << diff(x, y) << endl;            // (a) prints difference: -1
   y = addUp(x, y);                       // (b) sets y to sum 0 + 1
   cout << lastElt(b, 2);                 // (c) prints last element: 2.2
   b[0] = average(d, 2, 2);               // (d) sets as average 2.5
   setZero(y, z);                         // (e) sets both to 0
   return 0;
}
```

(a) Title line for **diff**.

Answer:

```
int diff(int a, int b)
```

(b) Title line for **addUp**.

Answer:

```
int addUp(int x, int y)
```

(c) Title line for **lastElt**.

Answer:

```
double lastElt(double array[], int cap)
```

(d) Title line for **average**.

Answer:

```
double average(int array[][2], int r, int c)
```

(e) Title line for **setZero**.

Answer:

```
void setZero(int &x, int &y)
```

Problem 2 Consider the following C++ program.

```
#include <iostream>
using namespace std;

double down(int x[], int cap, int gap) {
  double ans = 0.0;
  for (int i = 0; i < cap; i+= gap)
     ans += x[i];
  return ans / 10;
}

int main() {
    int x[4] = {1, 1, 3, 2};
    cout << x[2] << endl;                         // line (a)
    cout << x[5/3] << endl;                       // line (b)
    cout << x[x[3]] << endl;                      // line (c)
    cout << down(x, 4, 1) << endl;                // line (d)
    cout << down(x, 4, 3) << endl;                // line (e)
}
```

(a) What is the output at line (a)?
Answer:

```
3
```

(b) What is the output at line (b)?
Answer:

```
1
```

(c) What is the output at line (c)?
Answer:

```
3
```

(d) What is the output at line (d)?
Answer:

```
0.7
```

(e) What is the output at line (e)?
Answer:

```
0.3
```

Problem 3 Write blocks of code to perform the functions used in the following main program. Your blocks must match the given title lines. Each block should be a short function of only a few lines.

```
int main() {
   int i = 2;
   string x = "Hello";
// (a) Does the number end in a 0?  Here YES is printed.
   if (endInZero(100)) cout << "YES" << endl;
// (b) Return the smaller. Here 2 is printed.
   cout << smaller(i, 4) << endl;
// (c) Return the first character of the string.  Here  H  is printed.
   cout << firstCharacter(x) << endl;
// (d) Print first two characters in reverse order. Here  eH  is printed.
   swapFirstTwo(x);  cout << endl;
// (e) Print the sum of the digits. Here 18.
   cout << sumDigits(729) << endl;
   return 0;
}
```

Answer:

(a)

```
bool endInZero(int x) {
    return x % 10 == 0;
}
```

(b)

```
int smaller(int x, int y) {
   if (x < y) return x;
   return y;
}
```

(c)

```
char firstCharacter(string x) {
   return x[0];
}
```

(d)

```
void swapFirstTwo(string x) {
   cout << x[1] << x[0];
}
```

(e)

```
int sumDigits(int x) {
   if (x < 10) return x;
   return sumDigits(x / 10) + x % 10;
}
```

Problem 4 Write a function called *setRandom* that assigns a random value between 21 and 40 to each element of a 2-dimensional array of integers (with 3 columns). (You must use a standard C++ function to generate random numbers.)

For example, a program that uses the function *setRandom* follows.

```
int main() {
   int x[2][3];
   setRandom(x, 2, 3);
   for (int c = 0; c < 3; c++) cout << x[1][c] << " ";
     // The output would be something like:  30 21 29
   cout << endl;
   return 0;
}
```

Answer:

```
#include <cstdlib>

void setRandom(int x[][3], int r, int c) {
   for (int i = 0; i < r; i++)
      for (int j = 0; j < c; j++)
         x[i][j] = rand() % 20 + 21;
}
```

Problem 5 Write a function called *startsWith* that returns a result of *even* or *odd* that describes the first digit of a positive integer parameter.

For example, a program that uses the function *startsWith* follows.

```
int main() {
   cout << startsWith(1234) << endl;        // prints: odd
   cout << startsWith(2345) << endl;        // prints: even
   cout << startsWith(22) << endl;          // prints: even
   cout << startsWith(1) << endl;           // prints: odd
   return 0;
}
```

Answer:

```
string startsWith(int x) {
   if (x > 10) return startsWith(x / 10);
   if (x % 2 == 0) return "even";
   return "odd";
}
```

Problem 6 Write a complete C++ program that does the following. (Programs that correctly carry out some of the tasks will receive partial credit.)

1. It asks the user to enter quiz scores of 24 students. Each score is an integer between 0 and 10.

2. It reads the 24 quiz scores.

3. It prints out the lowest score obtained by a student in the first quartile. (This is the score of the student ranked 6^{th} in the class.)

Answer:

```
#include <iostream>
using namespace std;

int main() {
   int score, counts[11];
   for (int i = 0; i < 11; i++) counts[i] = 0;

   cout << "Enter 24 quiz scores: ";
   for (int i = 0; i < 24; i++) {
      cin >> score;
      counts[score] ++;
   }

   score = 10;
   int numberStudents = counts[score];
   while (numberStudents < 6) {
       score--;
       numberStudents += counts[score];
   }

   cout << score << endl;
   return 0;
}
```