University of Aberdeen, Department of Computing Science

CS1028 Practical 4

Programming for Science and Engineering

7 October, 2019

1 Questions for Beginners

Everybody should be able to answer all of the questions in this section.

1.1 Questions:

1. Compose a program that creates a one-dimensional array a containing exactly 1000 integers, and then attempts to access a[1000]. What happens when you run the program?

2. Given two vectors of length n that are represented with one-dimensional arrays, compose a code fragment that computes the Euclidean distance between them (the square root of the sum of the squares of the differences between corresponding elements).

3. Compose a code fragment that reverses the order of a one-dimensional array of floats. Do not create another array to hold the result. Hint: Use the code provided earlier in this web page for exchanging two elements.

4. What is wrong with the following code fragment?

```
a = []
for i in range(10):
    a[i] = i * i
```

5. Compose a code fragment that writes the contents of a two-dimensional array of bools, using * to represent True and a space to represent False. Include row and column numbers.

6. What does the following code fragment write?

```
a = stdarray.create1D(10, 0)
for i in range(10):
   a[i] = 9 - i
for i in range(10):
   a[i] = a[a[i]]
for v in a:
   stdio.writeln(v)
```

7. What is a[] after executing the following code fragment?

```
n = 10
a = [0, 1]
for i in range(2, n):
    a += [a[i-1] + a[i-2]]
```

8. Compose a program that takes an integer command-line argument n and writes n poker hands (five cards each) from a shuffled deck, separated by blank lines.

9. Compose code fragments to create a two-dimensional array b[][] that is a copy of an existing two-dimensional array a[][], under each of the following assumptions:
   a is square.
   a is rectangular.
   a may be ragged.

10. Compose a code fragment to write the transposition (rows and columns changed) of a two-dimensional array. For the example, when given this two-dimensional array of integers:

```
99 85 98
98 57 78
92 77 76
94 32 11
99 34 22
90 46 54
76 59 88
92 66 89
97 71 24
89 29 38
```

2 Some More Advanced Questions

Once you have completed Section 1, you should now be getting more familiar with the kind of things you can do with Python.
If you feel sufficiently confident, feel free to try these harder questions.

1. Longest plateau. Given an array of integers, compose a program that finds the length and location of the longest contiguous sequence of equal values where the values of the elements just before and just after this sequence are smaller.

2. Empirical shuffle check. Run computational experiments to check that our shuffling code works as advertised. Compose a program that takes integer command-line arguments m and n, does n shuffles of an array of size m that is initialized with a[i] = i before each shuffle, and writes an m-by-m table such that row i gives the number of times i wound up in position j for all j. All entries in the array should be close to n/m.

3. Music shuffling. You set your music player to shuffle mode. It plays each of the n songs before repeating any. Compose a program to estimate the likelihood that you will not hear any sequential pair of songs (that is, song 3 does not follow song 2, song 10 does not follow song 9, and so on).

4. Minima in permutations. Compose a program that takes an integer n from the command line, generates a random permutation, writes the permutation, and writes the number of left-to-right minima in the permutation (the number of times an element is the smallest seen so far). Then compose a program that takes integers m and n from the command line, generates m random permutations of size n, and writes the average number of left-to-right minima in the permutations generated. Extra credit: Formulate a hypothesis about the number of left-to-right minima in a permutation of size n, as a function of n.

5. Rumors. Alice is throwing a party with n other guests, including Bob. Bob starts a rumor about Alice by telling it to one of the other guests. A person hearing this rumor for the first time will immediately tell it to one other guest, chosen at random from all the people at the party except Alice and the person from whom they heard it. If a person (including Bob) hears the rumor for a second time, he or she will not propagate it further. Compose a program to estimate the probability that everyone at the party (except Alice) will hear the rumor before it stops propagating. Also calculate an estimate of the expected number of people to hear the rumor.