Sample 3 MUM entrance exam solutions

Posted by: **rupaknpl** Posted date: **February 16, 2013** In: **Other** | comment : **0**

There are three questions on this exam. You have 2 hours to complete it.

1. An array is **zero-plentiful** if it contains at least one 0 and every sequence of 0s is of length at least 4.

Write a method named **isZeroPlentiful** which returns the number of zero sequences if its array argument is zero-plentiful, otherwise it returns 0.

If you are programming in Java or C#, the function signature is

int isZeroPlentiful(int[ ] a)

If you are programming in C or C++, the function signature is

int isZeroPlentiful(int a[ ], int len) where len is the number of elements in the array a.

Examples

a is	then function returns	reason
{0, 0, 0, 0, 0}1	1	because there is one sequence of 0s and its length >= 4.
{1, 2, 0, 0, 0, 0, 2, -18, 0, 0, 0, 0, 0, 12}1	2	because there are two sequences of 0s and both have lengths >= 4.
{0, 0, 0, 0, 1, 0, 0, 0, 0, 8, 0, 0, 0, 0, 0}1	3	because three are three sequences of zeros and all have length >=4
{1, 2, 3, 4}1	0	because there must be at least one 0.
{1, 0, 0, 0, 2, 0, 0, 0, 0}	0	because there is a sequence of zeros whose length is less < 4.
{0}	0	because there is a sequence of zeroes whose length is < 4.
{}	0	because there must be at lea

2. A number is called **digit-increasing** if it is equal to n + nn + nnn + … for some digit n between 1 example 24 is digit-increasing because it equals 2 + 22 (here n = 2)

Write a function called **isDigitIncreasing** that returns 1 if its argument is digit-increasing otherwise, it returns 0.

The signature of the method is

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There are three questions on this exam. You have two hours to complete it. 1. Write a function...

int isDigitIncreasing(int n)

Examples

if n is	then function returns	reason
7	1	because 7 = 7 (here n is 7)
36	1	because 36 = 3 + 33
984	1	because 984 = 8 + 88 + 888
7404	1	because 7404 = 6 + 66 + 666 + 6666

3. An integer number can be encoded as an array as follows. Each digit n of the number is represented by n zeros followed by a 1. So the digit 5 is represented by 0, 0, 0, 0, 0, 1. The encodings of each digit of a number are combined to form the encoding of the number. So the number 1234 is encoded as the array {0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 1}. The first 0, 1 is contributed by the digit 1, the next 0, 0, 1 is contributed by the digit 2, and so on.

There is one other encoding rule: if the number is negative, the first element of the encoded array must be -1, so -201 is encoded as {-1, 0, 0, 1, 1, 0, 1}. Note that the 0 digit is represented by no zeros, i.e. there are two consecutive ones!

Write a method named **decodeArray** that takes an encoded array and decodes it to return the number.

You may assume that the input array is a legal encoded array, i.e., that -1 will only appear as the first element, all elements are either 0, 1 or -1 and that the last element is 1.

If you are programming in Java or C#, the function prototype is

int decodeArray(int[ ] a)

If you are programming in C or C++, the function prototype is

int decodeArray(int a[ ], int len);

Examples

a is	then function returns	reason
{1}	0	because the digit 0 is represented by no zeros followed by a one.
{0, 1}	1	because the digit 1 is represented by one zero followed by a one.
{-1, 0, 1}	-1	because the encoding of a negative number begins with a -1 followed by the encoding of the absolute value of the number.
{0, 1, 1, 1, 1, 1, 0, 1}	100001	because the encoding of the first 1 is 0, 1, the encoding of each of the four 0s is just a 1 and the encoding of the last 1 is 0, 1.
{0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,1}	999	because each 9 digit is encoded as 0,0,0,0,0,0,0,0,0,1.

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This exam consists of three questions. You have two hours in which to complete it.

1. An **onion** array is an array that satisfies the following condition for all values of j and k:

if j>=0 and k>=0 and j+k=length of array and j!=k then a[j]+a[k] <= 10

Write a function named **isOnionArray** that returns 1 if its array argument is an onion array and returns 0 if it is not.

Your solution must not use a nested loop (i.e., a loop executed from inside another loop). Furthermore, once you determine that the array is not an onion array your function must return 0; no wasted loops cycles please!

If you are programming in Java or C#, the function signature is

int isOnionArray(int[ ] a)

If you are programming in C or C++, the function signature is

int isOnionArray(int a[ ], int len) where len is the number of elements in the array a.

Examples

a is	then function returns	reason
{1, 2, 19, 4, 5}	1	because 1+5 <= 10, 2+4 <=10
{1, 2, 3, 4, 15}	0	because 1+15 > 10
{1, 3, 9, 8}	0	because 3+9 > 10
{2}	1	because there is no j, k where a[j]+a[k] > 10 and j+k=length of array and j!=k
{}	1	because there is no j, k where a[j]+a[k] > 10 and j+k=length of array and j!=k
{-2, 5, 0, 5, 12}	1	because -2+12 <= 10 and 5+5 <= 10

2. A number n is called **prime happy** if there is at least one prime less than n and the sum of all primes less than n is evenly divisible by n.

Recall that a prime number is an integer > 1 which has only two integer factors, 1 and itself

The function prototype is int **isPrimeHappy(int n)**;

Examples:

if n is	return	because
5	1	because 2 and 3 are the primes less than 5, their sum is 5 and 5 evenly divides 5.
25	1	because 2, 3, 5, 7, 11, 13, 17, 19, 23 are the primes less than 25, their sum is 100 and 25 evenly divides 100
32	1	because 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31 are the primes less than 32, their sum is 160 and 32 evenly divides 160
8	0	because 2, 3, 5, 7 are the primes less than 8, their sum is 17 and 8 does not evenly divide 17.
2	0	because there are no primes less than 2.

3. An integer number can be encoded as an array as follows. Each digit n of the number is represented by n

zeros followed by a 1. So the digit 5 is represented by 0, 0, 0, 0, 0, 1. The encodings of each digit of a number are combined to form the encoding of the number. So the number 1234 is encoded as the array {0, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, 0, 1}. The first 0, 1 is contributed by the digit 1, the next 0, 0, 1 is contributed by the digit 2, and so on. There is one other encoding rule: if the number is negative, the first element of the encoded array must be -1, so -201 is encoded as {-1, 0, 0, 1, 1, 0, 1}. Note that the 0 digit is represented by no zeros, i.e. there are two consecutive ones!

Write a method named **encodeArray** that takes an integer as an argument and returns the encoded array.

If you are programming in Java or C#, the function prototype is

int[] encodeArray(int n)

If you are programming in C or C++, the function prototype is

int * encodeArray(int n);

Hints

Use modulo 10 arithmetic to get digits of number

Make one pass through the digits of the number to compute the size of the encoded array.

Make a second pass through the digits of the number to set elements of the encoded array to 1.

Examples

n is	then function returns	reason
0	{1}	because the digit 0 is represented by no zeros and the representation of each digit ends in one.
1	{0, 1}	because the digit 1 is represented by one zero and the representation of each digit ends in one.
-1	{-1, 0, 1}	because the encoding of a negative number begins with a -1 followed by the encoding of the absolute value of the number.
100001	{0, 1, 1, 1, 1, 1, 0, 1}	because the encoding of the first 1 is 0, 1, the encoding of each of the four 0s is just a 1 and the encoding of the last 1 is 0, 1.
999	0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0,0,0,0,1	because each 9 digit is encoded as 0,0,0,0,0,0,0,0,0,1.

1. An array is called **systematically increasing** if it consists of increasing sequences of the numbers from 1 to n.

The first six (there are over 65,000 of them) systematically increasing arrays are:

{1}

{1, 1, 2}

{1, 1, 2, 1, 2, 3}

{1, 1, 2, 1, 2, 3, 1, 2, 3, 4}

{1, 1, 2, 1, 2, 3, 1, 2, 3, 4, 1, 2, 3, 4, 5}

{1, 1, 2, 1, 2, 3, 1, 2, 3, 4, 1, 2, 3, 4, 5, 1, 2, 3, 4, 5, 6}

Write a function named **isSystematicallyIncreasing** which returns 1 if its array argument is systematically increasing. Otherwise it returns 0.

If you are programming in Java or C#, the function signature is

int isSystematicallyIncreasing(int[ ] a)

If you are programming in C or C++, the function signature is

int isSystematicallyIncreasing(int a[ ], int len) where len is the number of elements in the array a.

Examples

a is	then function returns	reason
{1}	1	because 1 is a sequence from 1 to 1 and is the only sequence.
{1, 2, 1, 2, 3}	0	because it is missing the sequence from 1 to 1.
{1, 1, 3}	0	because {1, 3} is not a sequence from 1 to n for any n.
{1, 2, 1, 2, 1, 2}	0	because it contains more than one sequence from 1 to 2.
{1, 2, 3, 1, 2, 1}	0	because it is “backwards”, i.e., the sequences from 1 to n are not ordered by increasing value of n
{1, 1, 2, 3}	0	because the sequence {1, 2} is missing (it should precede {1, 2, 3})

2. A positive, non-zero number n is a **factorial prime** if it is equal to factorial(n) + 1 for some n and it is prime. Recall that factorial(n) is equal to 1 * 2 * … * n-1 * n. If you understand recursion, the recursive definition is

factorial(1) = 1;

factorial(n) = n*factorial(n-1).

For example, factorial(5) = 1*2*3*4*5 = 120.

Recall that a prime number is a natural number which has exactly two distinct natural number divisors: 1 and itself.

Write a method named **isFactorialPrime** which returns 1 if its argument is a factorial prime number, otherwise it returns 0.

The signature of the method is

int isFactorialPrime(int n)

Examples

if n is	then	reason

	function returns	
2	1	because 2 is prime and is equal to factorial(1) + 1
3	1	because 3 is prime and is equal to factorial(2) + 1
7	1	because 7 prime and is equal to factorial(3) + 1
8	0	because 8 is not prime
11	0	because 11 does not equal factorial(n) + 1 for any n (factorial(3)=6, factorial(4)=24)
721	0	because 721 is not prime (its factors are 7 and 103)

3. Write a function named **largestDifferenceOfEvens** which returns the largest difference between even valued elements of its array argument. For example largestDifferenceOfEvens(new int[ ]{-2, 3, 4, 9}) returns 6 = (4 – (-2)). If there are fewer than 2 even numbers in the array, largestDifferenceOfEvens should return -1.

If you are programming in Java or C#, the function signature is

int largestDifferenceOfEvens(int[ ] a)

If you are programming in C or C++, the function signature is

int largestDifferenceOfEvens(int a[ ], int len) where len is the number of elements in the array a.

Examples

a is	then function returns	reason
{1, 3, 5, 9}	-1	because there are no even numbers
{1, 18, 5, 7, 33}	-1	because there is only one even number (18)
{[2, 2, 2, 2]}	0	because 2-2 == 0
{1, 2, 1, 2, 1, 4, 1, 6, 4}	4	because 6 – 2 == 4

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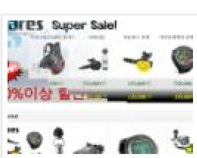

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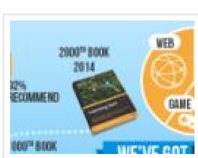

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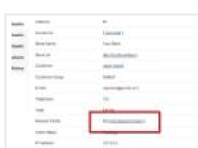

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