CSE 331

Computer Organizations

Homework 1

Due Date 04/11/2022 Friday 17:00

1. A compiler designer wants to improve the performance of a machine for one specific program. The program has the following properties:

	R-type ($x10^6$)	I-Type ($x10^6$)	J-Type ($x10^6$)
Program instructions	50	30	20

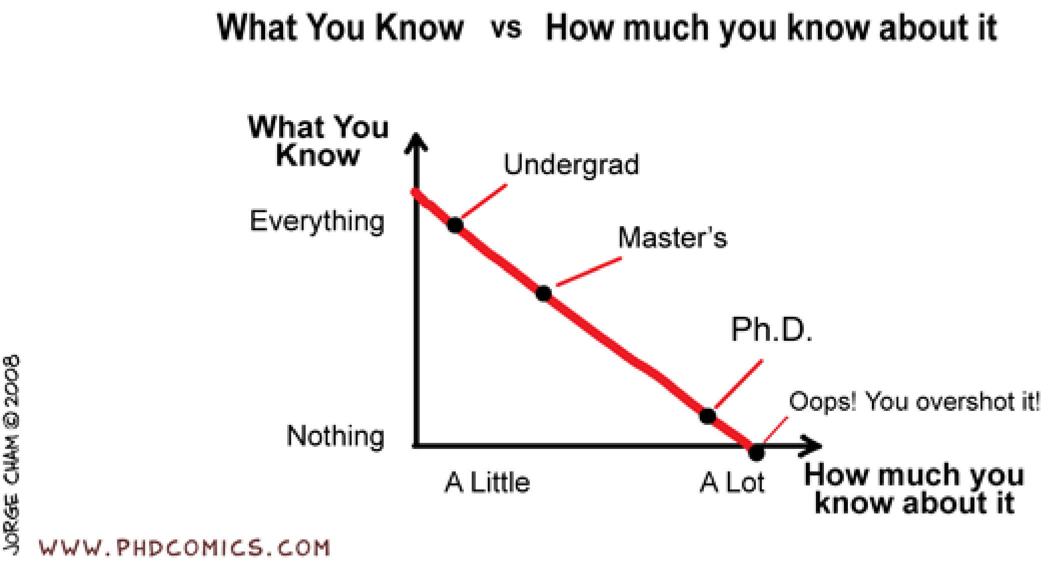
	R-type	I-Type	J-Type
Required Cycles	2	4	3

Assume you can improve only one type with 50%. Which type do you prefer for improvement and how many times can you improve the whole program in the end?

CPI: 0.5 x 2 + 0.3 x 4 + 0.2 x 3 = 1 + 1.2 + 0.6 = 2.8

Most efficient improvement is I-type with %50. Because total cycle number of I-Type more than other types.

After improvement: 1 + 0.6 + 0.6 = 2.2 --------> (2.8 - 2.2) / 2.8 = %21 faster.



2. In this part you will write an assembly program on MARS for finding and printing all divisible sum pairs as explained below:

Given an array of integers and a positive integer k, determine the number of (i, j) pairs where $i < j$ and $ar[i]$ + $ar[j]$ is divisible by k.

Example

$ar = [1, 2, 3, 4, 5, 6]$
$k = 5$

Three pairs meet the criteria: $[1, 4]$, $[2, 3]$, and $[4, 6]$.

Function Description

Complete the divisibleSumPairs function in the editor below.

divisibleSumPairs has the following parameter(s):

- int n: the length of array ar
- int ar[n]: an array of integers
- int k: the integer divisor

Returns

- int: the number of pairs

Input Format

The first line contains 2 space-separated integers, n and k.
The second line contains n space-separated integers, each a value of $arr[i]$.

Constraints

- $2 \leq n \leq 100$
- $1 \leq k \leq 100$
- $1 \leq ar[i] \leq 100$

Sample Input

```
STDIN        Function
-----        --------
6 3          n = 6, k = 3
1 3 2 6 1 2   ar = [1, 3, 2, 6, 1, 2]
```

Explanation

Here are the 5 valid pairs when $k = 3$:

- $(0, 2) \rightarrow ar[0] + ar[2] = 1 + 2 = 3$
- $(0, 5) \rightarrow ar[0] + ar[5] = 1 + 2 = 3$
- $(1, 3) \rightarrow ar[1] + ar[3] = 3 + 6 = 9$
- $(2, 4) \rightarrow ar[2] + ar[4] = 2 + 1 = 3$
- $(4, 5) \rightarrow ar[4] + ar[5] = 1 + 2 = 3$