Algorithmics	Student information	Date	Number of session
	UO: 294067	07/02/24	1.1
	Surname: Díaz Álvarez		
	Name: Paula		

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Activity 1. Years that we can still use this way

The currentTimeMillis() method returns an integer of type long (64 bits), so we could use until all the bits has value 1 except the first one (the sign):

0111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 1111 111,

that is:

9223372036854775807 ms = 9223372036854775.807 s = 153722867280912.93 min =

= 2562047788015.22 h = 106751991167.3 days = 292471208.68 years

Activity 2. Vector 2 measurements

Time 0 means that the time difference is smaller than 1 millisecond, so it cannot be represented in a long number.

From n=10000000 we start getting reliable times (they are greater than or equal to 50 ms): SIZE=10000000 TIME=62 milliseconds SUM=144696

Activity 3. Checking complexity remains

Starting at n = 10000, ending at 10000 * k7 with T sum:

T sum (k=2)	T sum (k=3)	T sum (k=4)
0.062	0.052	0.053
0.085	0.158	0.169
0.181	0.508	0.826
0.491	1.506	3.523
0.880	4.588	22.690

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1.779	13.994	59.632
3.754	45.978	239.679
10.490	127.903	950.487

We will check

f(n_1) -> t_1 $\quad t_2 = \frac{f(n_2)}{f(n_1)} \cdot t_1 = k \cdot t_1$ as the complexity of sum is O(n): $t_2 = \frac{n_2}{n_1} \cdot t_1$

f(n_2) -> t_2?

With k=2:

$t_{2,1} = \frac{2 \cdot 10000}{10000} \cdot 0.062 = 2 \cdot 0.062 = 0.124$ The real is: 0.085

$t_{2,2} = 2 \cdot 0.085 = 0.17$ The real is: 0.181

$t_{2,3} = 2 \cdot 0.181 = 0.362$ The real is: 0.491

$t_{2,4} = 2 \cdot 0.491 = 0.982$ The real is: 0.880

$t_{2,5} = 2 \cdot 0.880 = 1.76$ The real is: 1.779

$t_{2,5} = 2 \cdot 1.779 = 3.558$ The real is: 3.754

$t_{2,6} = 2 \cdot 3.754 = 7.508$ The real is: 10.490

Witk k=3:

$t_{2,1} = \frac{3 \cdot 10000}{10000} \cdot 0.052 = 3 \cdot 0.052 = 0.156$ The real is: 0.158

$t_{2,2} = 3 \cdot 0.158 = 0.474$ The real is: 0.508

$t_{2,3} = 3 \cdot 0.508 = 1.524$ The real is: 1.506

$t_{2,4} = 3 \cdot 1.506 = 4.518$ The real is: 4.588

$t_{2,5} = 3 \cdot 4.588 = 13.764$ The real is: 13.994

$t_{2,5} = 3 \cdot 13.994 = 41.832$ The real is: 45.978

$t_{2,6} = 3 \cdot 45.978 = 137.934$ The real is: 127.903

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With k=4:

$t_{2,1} = \frac{4 \cdot 10000}{10000} \cdot 0.053 = 4 \cdot 0.053 = 0.212$ The real is: 0.169

$t_{2,2} = 4 \cdot 0.169 = 0.676$ The real is: 0.826

$t_{2,3} = 4 \cdot 0.826 = 3.304$ The real is: 3.523

$t_{2,4} = 4 \cdot 3.523 = 14.092$ The real is: 22.690

$t_{2,5} = 4 \cdot 22.690 = 90.76$ The real is: 59.632

$t_{2,5} = 4 \cdot 59.632 = 238.528$ The real is: 239.679

$t_{2,6} = 4 \cdot 239.679 = 958,716$ The real is: 950.487

We can see that when n is multiplied by k, the time is more or less also multiplied by k in the next iteration. So the complexity O(n) is preserved

TABLE1 and TABLE2 (times in milliseconds WITHOUT OPTIMIZATION):

Computer				
Processor	12th Gen Intel(R) Core(TM) i7-1255U, 1700 Mhz, 10 procesadores principales, 12 procesadores lógicos			
RAM installed	16,0 GB			
n	**Table 1**		**Table 2**	
	T sum	**T maximum**	**T matches 1**	**T matches 2**
10000	0.062	0.075	811	0.072
20000	0.085	0.129	3016	0.157
40000	0.181	0.281	13282	0.341
80000	0.491	0.643	55151	0.676

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160000	0.880	1.318	192885	1.363
320000	1.779	2.729	776953	2.635
640000	3.754	5.330	2075864	5.769
1280000	10.490	10.736	-	11.083
2560000	24.535	21.469	-	22.035
5120000	50.051	42.601	-	59.583
10240000	99.498	86.422	-	138.775
20480000	198.679	171.852	-	275.470
40960000	396.800	344.153	-	550.144
81920000	787.165	690.782	-	1099.232

- **T sum**:
  - Complexity: O(n)
  - We can see that the time doubles approximately, each time n doubles, we do it with the more representative values (the biggest times obtained):

$t_{2,1} = \frac{2 \cdot 2560000}{2560000} \cdot 24.535 = 2 \cdot 24.535 = 49.07$ The real is: 50.051

$t_{2,2} = 2 \cdot 50.051 = 100.102$ The real is: 99.498

$t_{2,3} = 2 \cdot 99.498 = 198.996$ The real is: 198.679

$t_{2,4} = 2 \cdot 198.679 = 397.358$ The real is: 396.800

$t_{2,5} = 2 \cdot 396.800 = 793.6$ The real is: 787.165

- **T maximum**:
  - Complexity: O(n)
  - We can see that the time doubles approximately, each time n doubles:

$t_{2,1} = \frac{2 \cdot 2560000}{2560000} \cdot 21.469 = 2 \cdot 21.469 = 42.938$ The theoretical is: 42.601

$t_{2,2} = 2 \cdot 42.601 = 85.202$ The real is: 86.422

$t_{2,3} = 2 \cdot 86.422 = 172.844$ The real is: 171.852

$t_{2,4} = 2 \cdot 171.852 = 343.704$ The real is: 344.153

$t_{2,5} = 2 \cdot 344.153 = 688.306$ The real is: 690.782

- **T matches 1**:
  - Complexity: $O(n^2)$
  - We can see that the time increases differently from the rest of functions, and the time is much bigger. As n doubles, time increases faster
  - As time gets huge, after n=640000 I stopped executing.

$t_{2,1} = \frac{(2 \cdot 20000)^2}{20000^2} \cdot 3016 = 4 \cdot 3016 = 12064$ The real is: 13282

$t_{2,2} = 4 \cdot 13282 = 53128$ The real is: 55151

$t_{2,3} = 4 \cdot 55151 = 220604$ The real is: 192885

$t_{2,4} = 4 \cdot 192885 = 771540$ The real is: 776953

$t_{2,5} = 4 \cdot 776953 = 3107812$ The real is: 2075864

- **T matches 2**:
  - Complexity: O(n)
  - We can see that the time doubles approximately, each time n doubles:

$t_{2,1} = \frac{2 \cdot 2560000}{2560000} \cdot 22.035 = 2 \cdot 22.035 = 44.07$ The real is: 59.583

$t_{2,2} = 2 \cdot 59.583 = 119.166$ The real is: 138.775

$t_{2,3} = 2 \cdot 138.775 = 277.55$ The real is: 275.470

$t_{2,4} = 2 \cdot 275.470 = 550.94$ The real : 550.144

$t_{2,5} = 2 \cdot 550.144 = 1100.288$ The real is: 1099.232