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CS 514

HW1

def factors(num):

    if(num == 1):

        return []

    if(num%2 == 0):

        return [2] + factors(int(num/2))

    # find all prime numbers that could be factors

    # Only have to search up to sqrt(num) because any number higher will not be a factor

    i = 3

    while(i\*i <= num):                           #sqrt(num)/2 times

        isprime = 0

        #check if i is prime

        # To determine if a number is prime, we only have to have to search

        # until the sqrt of the number because all other numbers will be a multiple

        # of a value already checked

        j = 3

        while (j\*j <= i):                        #sqrt(sqrt(n))/2 \* sqrt(n)/2 times

            #Check if i is a multiple of j

            if(i%j == 0):                        #sqrt(sqrt(n))/2 \* sqrt(n)/2 times

                isprime = 1

                #breaks when i is not prime

                break

            j+=2 #sqrt(sqrt(n))/2 \* sqrt(n)/2 times

        #if i is prime, check if it is a factor of num

        if(isprime == 0):

            if(num%i == 0):                      #sqrt(num)/2 times

                return [i] + factors(int(num/i))

        i+=2 #sqrt(num)/2 times

    #if num is prime, return

    return [int(num)]

2)

2. a) Derivation of the running time assuming that multiplications and additions take constant time

T(n) =

T(n) =

O(n) =

2. b) Derivation of the running time assuming multiplication and division of n-bit numbers take O(n^2) time and additions and subtractions take O(n) time

Number of bits = 2^N

T(n) = T(n/2) + O(n^2) + O(n^2) + O(n^2) + O(n^2) + O(n^2) + O(n^2) + O(n) + O(n)

T(n) = T(n/2) + 5O(n^2) + 2O(n)

T(n) =

3) Give a table T(n) vs n

|  |  |
| --- | --- |
| n | T(n) |
| 1 | 0:00:00.000002 |
| 11 | 0:00:00.000002 |
| 111 | 0:00:00.000006 |
| 1111 | 0:00:00.000004 |
| 11111 | 0:00:00.000007 |
| 111111 | 0:00:00.000005 |
| 1111111 | 0:00:00.000034 |
| 11111111 | 0:00:00.000018 |
| 111111111 | 0:00:00.000078 |
| 1111111111 | 0:00:00.000045 |
| 11111111111 | 0:00:00.009810 |
| 111111111111 | 0:00:00.000026 |
| 1111111111111 | 0:00:00.006192 |
| 11111111111111 | 0:00:00.001302 |
| 111111111111111 | 0:00:00.000342 |
| 1111111111111111 | 0:00:00.000515 |
| 11111111111111111 | 0:00:05.288088 |
| 111111111111111111 | 0:00:00.127748 |
| 1111111111111111110 | 0:00:00.165751 |
| 1111111111111111111 | Over 16 minutes before I gave up |
| 1111111111111111112 | 0:00:00.166283 |
| 22222222222222222222 | 0:00:00.000167 |

|  |  |
| --- | --- |
| n | T(n) |
| 1 | 0:00:00.000001 |
| 2 | 0:00:00.000003 |
| 1369 | 0:00:00.000004 |
| 2209 | 0:00:00.000005 |
| 2614 | 0:00:00.000006 |
| 4946 | 0:00:00.000008 |
| 9769 | 0:00:00.000009 |
| 10609 | 0:00:00.000010 |
| 10623 | 0:00:00.000012 |
| 18144 | 0:00:00.000016 |
| 19543 | 0:00:00.000017 |
| 20147 | 0:00:00.000019 |
| 36241 | 0:00:00.000020 |
| 36749 | 0:00:00.000021 |
| 37253 | 0:00:00.000022 |
| 44563 | 0:00:00.000031 |
| 77317 | 0:00:00.000032 |
| 85831 | 0:00:00.000033 |
| 85849 | 0:00:00.000034 |
| 86171 | 0:00:00.000035 |
| 86857 | 0:00:00.000036 |
| 94201 | 0:00:00.000047 |
| 94249 | 0:00:00.000049 |
| 94513 | 0:00:00.000052 |
| 97117 | 0:00:00.000053 |
| 101009 | 0:00:00.000054 |
| 102259 | 0:00:00.000055 |
| 108541 | 0:00:00.000056 |
| 109741 | 0:00:00.000057 |
| 145441 | 0:00:00.000065 |
| 146519 | 0:00:00.000066 |
| 146521 | 0:00:00.000068 |
| 166043 | 0:00:00.000071 |
| 167311 | 0:00:00.000073 |
| 184153 | 0:00:00.000076 |
| 185069 | 0:00:00.000080 |
| 202567 | 0:00:00.000082 |
| 203761 | 0:00:00.000085 |
| 214603 | 0:00:00.000086 |
| 216217 | 0:00:00.000089 |
| 232381 | 0:00:00.000095 |
| 243517 | 0:00:00.000096 |
| 250073 | 0:00:00.000097 |
| 347981 | 0:00:00.000104 |
| 348709 | 0:00:00.000119 |
| 513829 | 0:00:00.000147 |
| 513833 | 0:00:00.000151 |
| 513839 | 0:00:00.000157 |
| 624607 | 0:00:00.000160 |
| 864757 | 0:00:00.000181 |
| 864855 | 0:00:00.000219 |
| 880699 | 0:00:00.000456 |
| 881357 | 0:00:00.000504 |
| 896669 | 0:00:00.000584 |
| 1019399 | 0:00:00.000697 |
| 1188287 | 0:00:00.000721 |
| 3347768 | 0:00:00.000750 |
| 3386191 | 0:00:00.000943 |
| 3431933 | 0:00:00.000960 |
| 3632054 | 0:00:00.001019 |
| 3777601 | 0:00:00.001151 |
| 3925541 | 0:00:00.001154 |
| 7216151 | 0:00:00.001185 |
| 8160043 | 0:00:00.001319 |
| 8891093 | 0:00:00.001332 |
| 9426383 | 0:00:00.001393 |
| 9492827 | 0:00:00.001395 |
| 9859693 | 0:00:00.002396 |
| 20503429 | 0:00:00.002439 |
| 21652513 | 0:00:00.002553 |
| 23210263 | 0:00:00.002567 |