

ASTR 660 HOMEWORK 2

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Question 1

1. $6.1613 \times 10^7 M_\odot$
 Code uploaded as hw2-Q1_to-Q3.ipynb
2. For step = 10, $M = 1.2210 \times 10^8 M_\odot$
 For step = 100, $M = 6.2657 \times 10^7 M_\odot$
 For step = 1000, $M = 6.1624 \times 10^7 M_\odot$
 For step = 10000, $M = 6.1613 \times 10^7 M_\odot$
 Code uploaded as hw2-Q1_to-Q3.ipynb
3. We compare the two functions by calling them 10 times and getting the mean time consumption for different steps.

Mean time of 10 calls				
Steps	10	100	1000	10000
for loop	0.894 ms	7.546 ms	66.938 ms	657.504 ms
numpy array	0.131 ms	0.125 ms	0.325 ms	0.820 ms

There are several reasons why the function written in numpy is faster than that of for loop. First of all, numpy array are stored in contiguous memory, and therefore having faster accessing and writing speed. Furthermore, although not sure whether our function benefits from it, numpy contains efficient algorithm that deals with matrix and vector calculation.

Code uploaded as hw2-Q1_to-Q3.ipynb

4. Code uploaded as hw2-Q4.f90
5. The output of the program is:
The volume of a sphere of radius r = 2.000 is 0.5693-314 cubic units
 The error was caused by misspelling the return value `sphere_volume` to `sphere_voulme`. Since the function would return the last assigned value, it would be fine if `sphere_voulme` were declared, yet it was not. Also the function didn't begin with `implicit none`, and therefore the compiler didn't notice that `sphere_voulme` had no implicit type.
 However, if the format specified in `write` was `f12.4`, the output would be **0.000 cubic units**. The reason why we see 0.5693-314 is because we choose g as the format code. We may see the how g works from **FORTRAN Format Code Descriptions**.

The G format code is a compromise between these choices—it uses the F output style when reasonable and E for other values.

According to **CHATGPT**, the g choose to use scientific notation when the value is small, and 0.5693-314 means 0.5693×10^{-314} . So, the output of the function should just be an extremely small number.