UNIVERSITÀ
DEGLI STUDI
DI PADOVA

Quantum Information and Computing

2021 - 2022

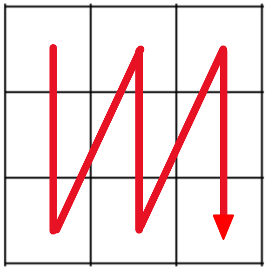
Saverio Monaco

21/11/2021

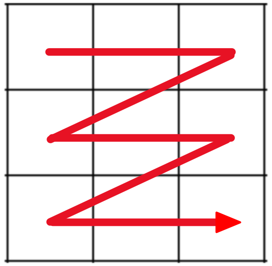
Exercise 3

Physics
of Data

Scaling of the matrix-matrix multiplication



Loop method

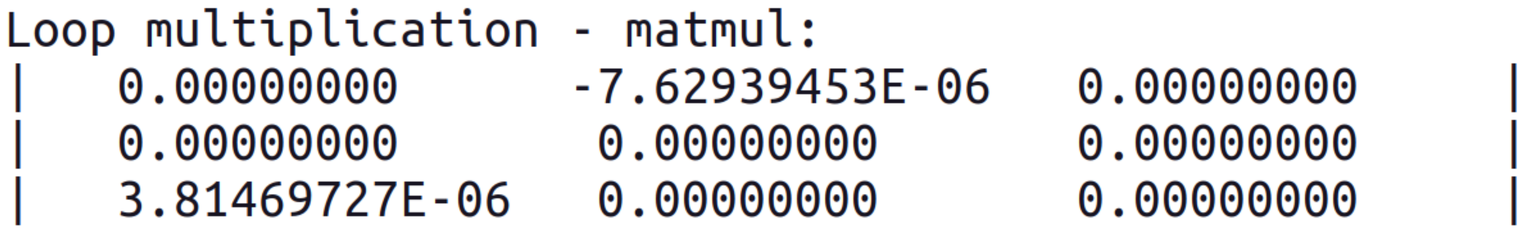


Loop2 method (not chache optimized)

Pseudocode for Loop function:

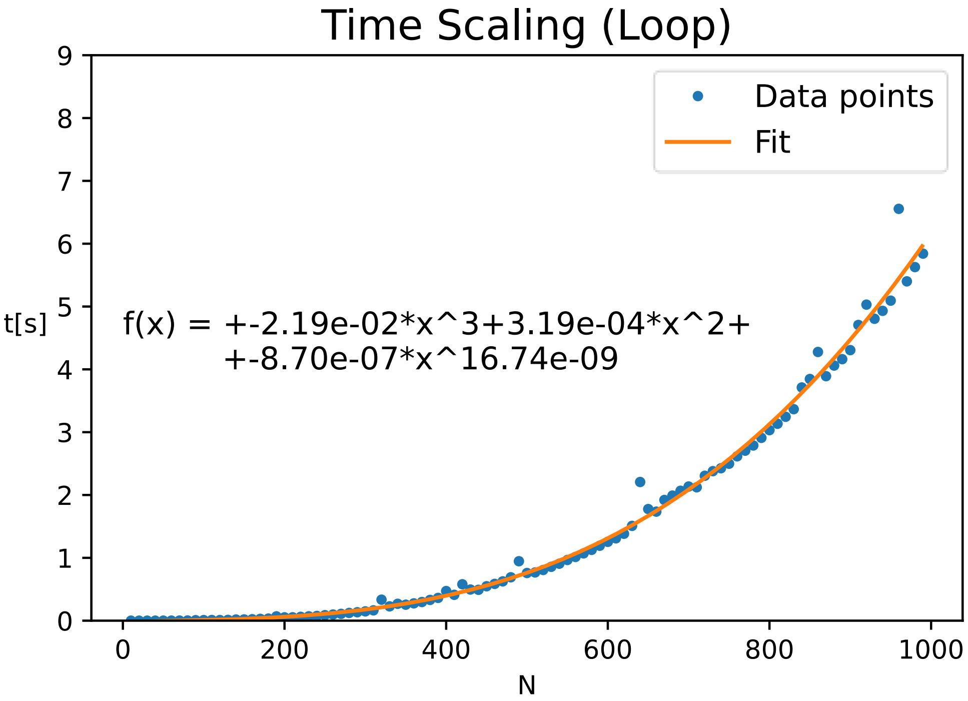
```
LOOP(A,B): # multiplies A and B
    C = matrix(A.ncols,B.nrows)
    for i from 1 to A.ncols:
        for j from 1 to B.nrows:
            sum = 0
            for k from 1 to A.nrows:
                sum = sum + $A_{ik} \times B_{kj}$
            end for
        end for
    end for
```

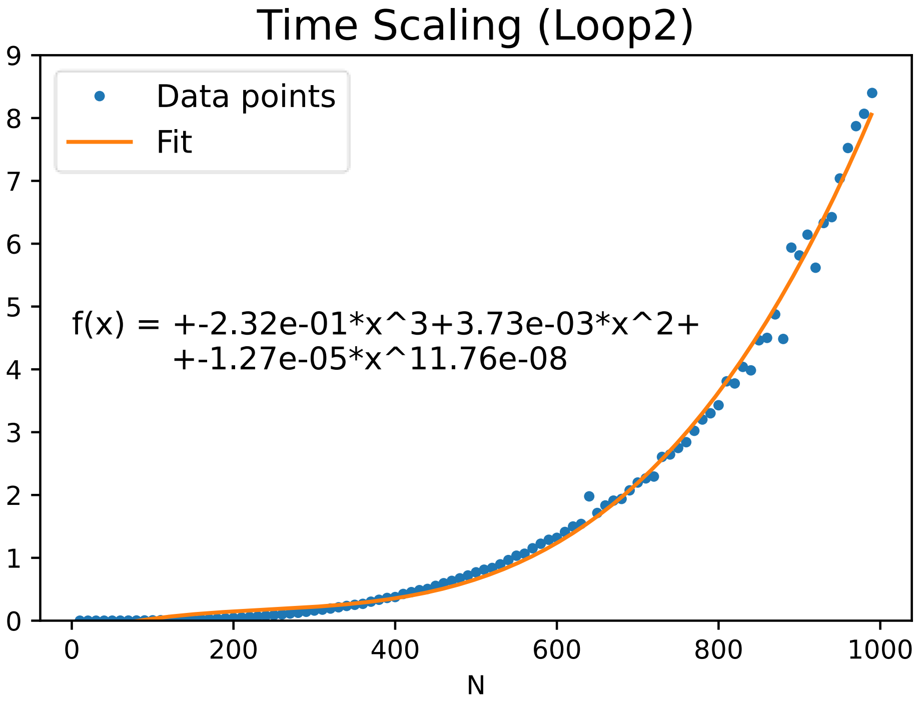
$$O(N^3)$$



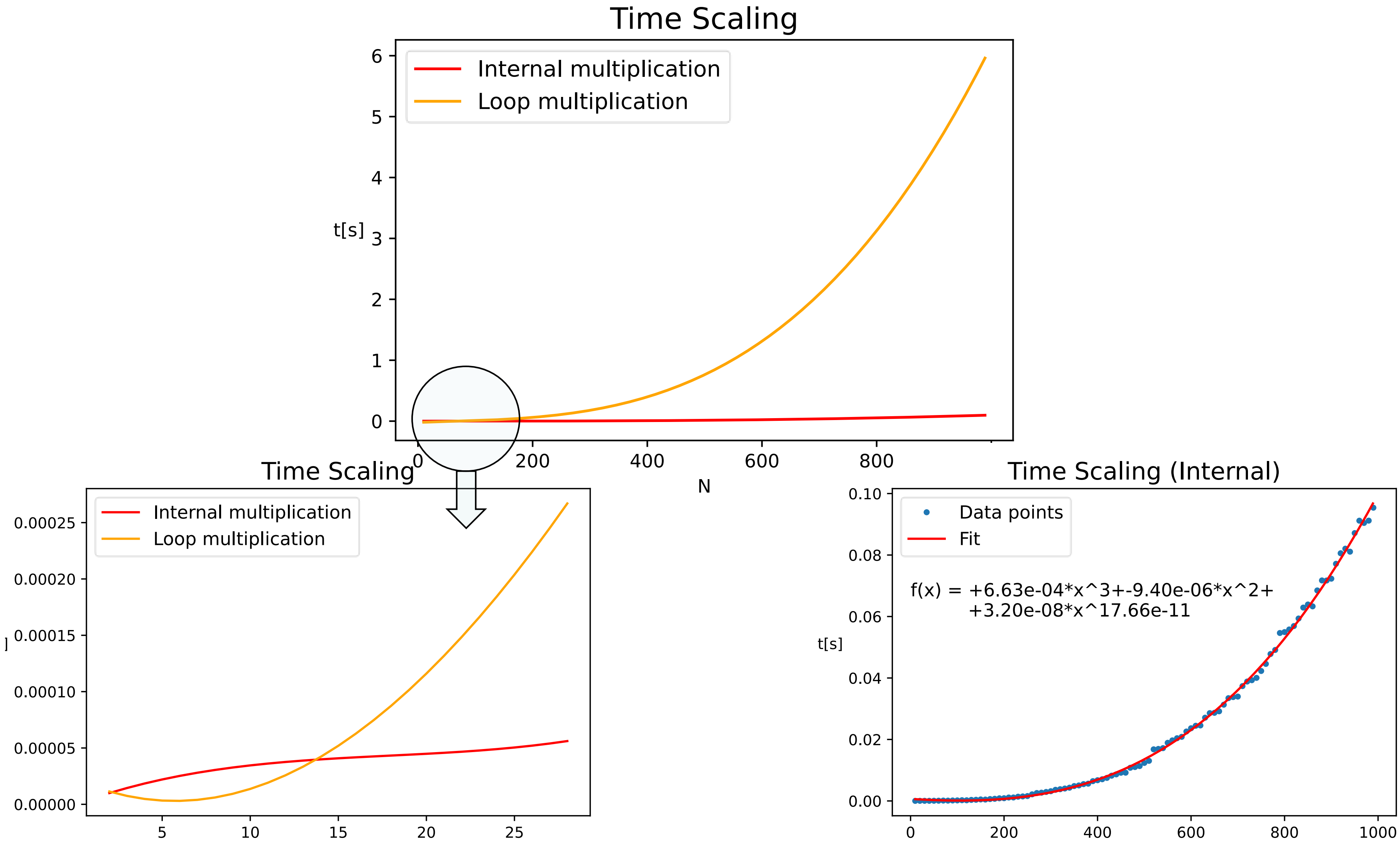
```
Loop multiplication - matmul:
|    0.00000000      -7.62939453E-06   0.00000000      |
|    0.00000000       0.00000000       0.00000000      |
|    3.81469727E-06   0.00000000       0.00000000      |
```

Scaling of the matrix-matrix multiplication





Scaling of the matrix-matrix multiplication



Random Matrix Theory

Study of the P(s) distribution, where s_i are the normalized spacings between eigenvalues:

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{13} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \longrightarrow \lambda_1,\lambda_2,\lambda_3 \quad \lambda_1 < \lambda_2 < \lambda_3 \longrightarrow \quad s_i = \Delta\lambda_i/\overline{\Delta}\lambda$$

`ZHEEV()` (Lapack)

Fit P(s) using `curve_fit` from `scipy.optimize` in Python with the function:

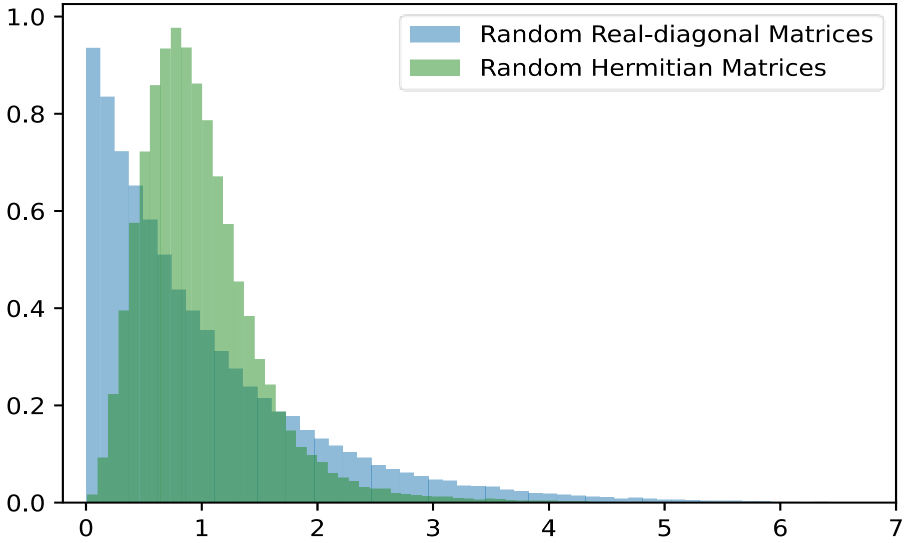
$$P(s) = a\, s^b \exp(-c\, s^d)$$

For random Hermitian matrices and random (real) diagonal matrices

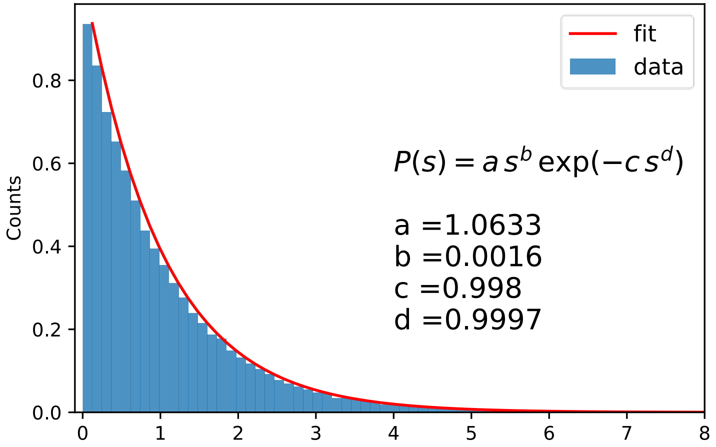
Università
degli Studi
di Padova

Random Matrix Theory

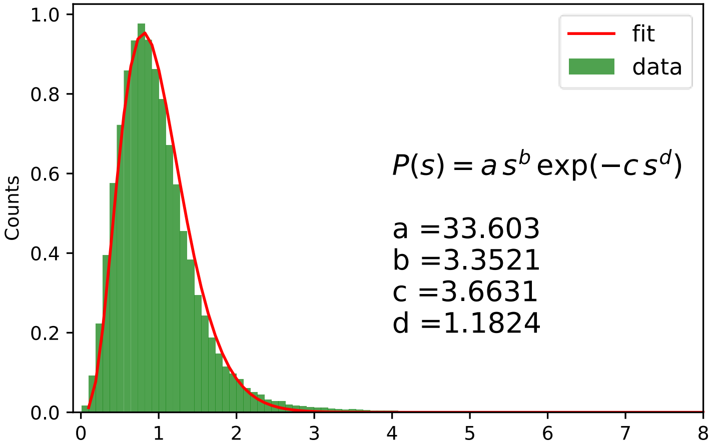
Comparison spacings generated



Normalized spacings of random diagonal matrices



Normalized spacings of random hermitian matrices



800 ANNI 1222 • 2022

UNIVERSITAS STUDII PADUANI MCCXXII

UNIVERSITÀ DEGLI STUDI DI PADOVA

Thanks for the attention