

Exercise: Counting operations

For all the following functions assume vectors are in \mathbb{R}^N and matrices are in $\mathbb{R}^{N \times N}$.

Calculate how many multiplications and additions are in the following functions. Write your answers in terms of N .

Note: Square operation counts as one multiplication. Don't worry about square-root operations.

	Additions	Multiplications
L2 norm of vector	$N-1$	N
Vector dot product		
Frobenius norm of matrix*	N^2	N^2
Matrix-vector multiplication		
Matrix-matrix multiplication		

*Frobenius norm of matrix is the square root of the sum of squares of all entries in a matrix.

$$\|A\|_F = \left(\sum_i \sum_j (A_{i,j})^2 \right)^{\frac{1}{2}}$$

$$C = AB$$

$$C_{ij} = \sum_{k=1}^N A_{ik} B_{kj}$$

for i

for j

for k



$\left(\begin{matrix} N \text{ mult} \\ N-1 \text{ sum} \end{matrix} \right) \cdot N \cdot N$
 $\cdot N \cdot N$

$$C[i,j] = A[i,k] * B[k,j]$$