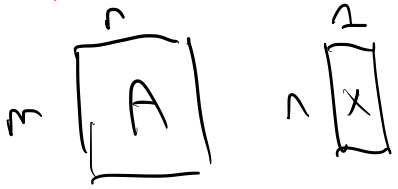
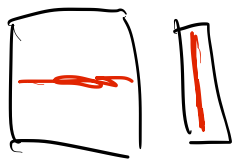
Feb 10, 2021



① vectors αx, $x+y$, $x^T y = \sum_{i=1}^{n} x_i y_i$ } $O(n)$ BLAS 1

② matrix-vector $y = Ax$ $\begin{bmatrix} a_{1,} & \cdots & a_{1n} \\ \vdots & & \end{bmatrix}$ $y_i = \sum_{j=1}^{n} a_{ij} x_j$ } $O(mn)$ $O(n^2)$ BLAS 2

$y_i = \sum_{j=1}^{n} a_{ij} x_j$

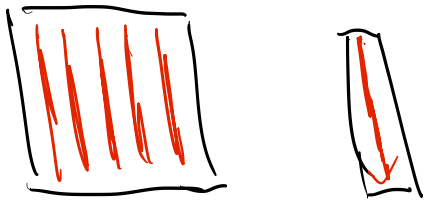


③ matrix-matrix $C = AB$ $c_{ij} = \sum_{r=1}^{k} a_{ir} b_{sj}$ } $O(mnk)$ $O(n^3)$ BLAS 3

Basic linear algebra subroutines (BLAS)

Intel MKL

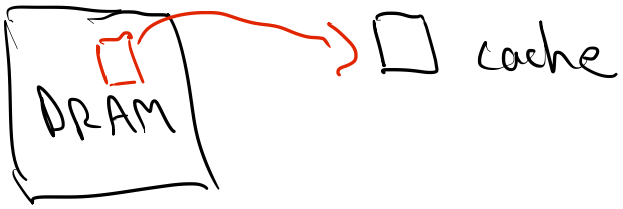
cuBLAS



store as contiguous array

column major

Two main costs
- arithmetic (flops)
- fetch data (communication)



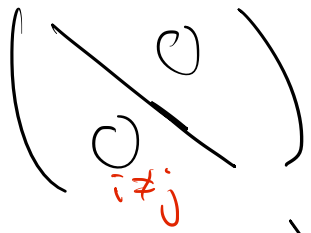
~100 cycles cost(communication) >> cost(flops) ~1 cycle

- spatial locality: faster to access sequentially
- temporal locality: reuse data in cache

Structured matrices

sparse $\Rightarrow$ many zeros $i=j$

$Ix = x$

Diagonal $=$  $i \neq j$

$I = \begin{pmatrix} 1 & & 0 \\ & \ddots & \\ 0 & & 1 \end{pmatrix}$

Tridiagonal