Vector Dot-Product (Inner-Product)

- Input: 2 vectors (dimension N)
- Output: 1 scalar

$$s = \mathbf{a} \cdot \mathbf{b} \implies s = \sum_{i=1}^{N} a_i b_i$$

```
s = 0
do i = 1,N
  s = s + a(i)*b(i)
endDo
```

More explicit, let **a** and **b** be 3-elements long. Then, their dot-product, *s*, is

$$s = \sum_{i=1}^{3} a_i b_i = a_1 b_1 + a_2 b_2 + a_3 b_3$$

Alternatively, we could let

$$s_1 = a_1 b_1 \quad ; \quad s_2 = a_2 b_2 \quad ; \quad s_3 = a_3 b_3$$

and then,

$$s = \sum_{i=1}^{3} a_i b_i = s_1 + s_2 + s_3$$

Matrix-Vector Product

- Input: 1 matrix (N x M), 1 vector (M)
- Output: 1 vector (N)

$$\mathbf{b} = \mathbf{A}\mathbf{x} \implies b_i = \sum_{j=1}^{N} A_{ij} x_j$$

```
real,dimension(N)::vecB
real,dimension(N,M)::matA
real,dimension(M)::vecX
---
vecB = 0
do i = 1,N
  do j = 1,M
    vecB(i) = vecB(i) + matA(i,j)*vecX(j)
  endDo
endDo
```

Matrix-Matrix Product

- Input: 2 matrices (one is M x N and one is N x P)
- Output: 1 matrix (M x P)

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

```
real,dimension(N,M)::matC
real,dimension(N,P)::matA
real,dimension(P,M)::matB
---
matC = 0
do i = 1,N
  do j = 1,M
    do k = 1,P
      matC(i,j) = matC(i,j) + matA(i,k)*matB(k,j)
    endDo
  endDo
endDo
```