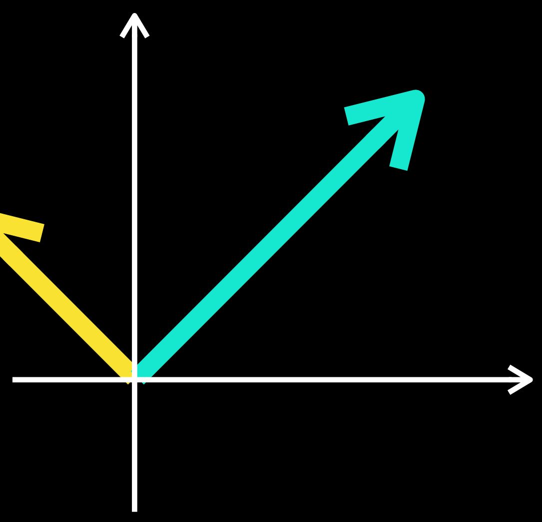
Properties of matrix multiplication

Linear Algebra Essentials



Matrix properties

Distributivity: **(A + B) C = AC + BC**

$$d_{ij} = (\overrightarrow{a}_{i\ row} + \overrightarrow{b}_{i\ row}) \cdot \overrightarrow{c}_{j\ column} =$$

$$= \underbrace{\overrightarrow{a}_{i\ row} \cdot \overrightarrow{c}_{j\ column}}_{= AC_{ij}} + \underbrace{\overrightarrow{b}_{i\ row} \cdot \overrightarrow{c}_{j\ column}}_{= BC_{ij}}$$

Matrix properties

Associativity:

(A B) C = A (BC)

(3 x 2) (2 x 2) (2 x 3)

(3 x 3)

```
A = np.array([
    [2, 1],
    [3, -1],
    [0, 1]
])
B = np.array([
    [1, -1],
    [-1, 0]
])
C = np.array([
    [1, 1, 4],
    [4, 0, 1]
])
```

Associativity

```
AB = A.dot(B)
AB
```

```
array([[ 1, -2],
       [ 4, -3],
       [-1,  0]])
```

```
AB.dot(C)
```

```
array([[-7,  1,  2],
       [-8,  4, 13],
       [-1, -1, -4]])
```

```
BC = B.dot(C)
BC
```

```
array([[-3,  1,  3],
       [-1, -1, -4]])
```

```
A.dot(BC)
```

```
array([[-7,  1,  2],
       [-8,  4, 13],
       [-1, -1, -4]])
```

$(A\ B)\ C = A\ (BC) = A\ B\ C$

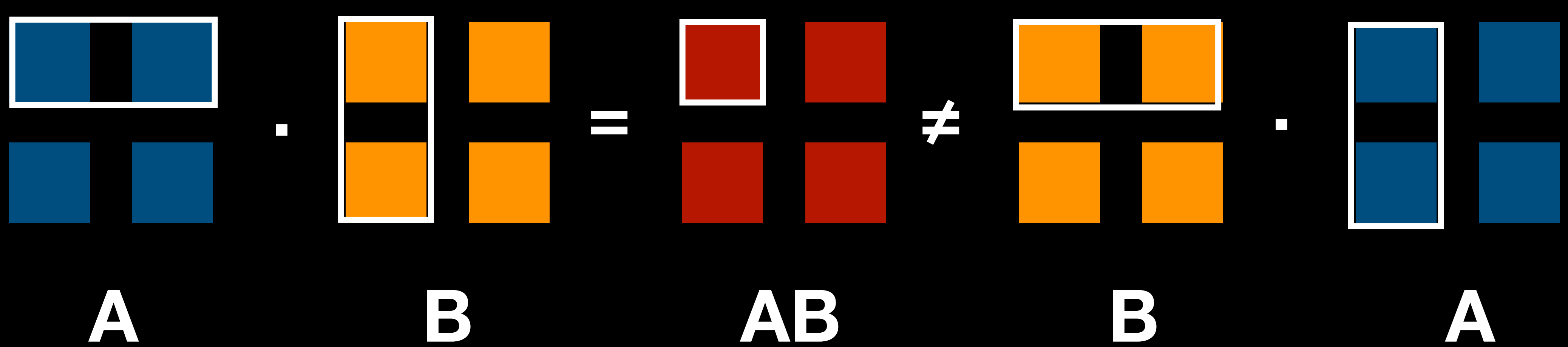
Matrix properties

Non-commutativity: **A B ≠ B A**

A B : (n x m) (m x k) = (n x k)

B A : (m x k) (n x m) -> not legit, if k ≠ n

k==n: (m x k) (n x m) -> (m x m) - ***BA*** and ***AB*** are of diff sizes



Non-commutativity

```
A = np.array([
    [2, 1],
    [3, -1]
])
B = np.array([
    [1, -1],
    [-1, 0]
])
```

```
A.dot(B)
```

```
array([[ 1, -2],
       [ 4, -3]])
```

```
B.dot(A)
```

```
array([[-1,  2],
       [-2, -1]])
```

A B ≠ B A