## binary operators

arg2 → ; arg1 ↓

### arg2: $\mathbb{R}$ reals

| arg1 | output type | description | conventional math notation | Diderot notation |
|---|---|---|---|---|
| $\mathbb{R}$ | Bool | comparisons | < <= > >= | |
| $\mathbb{R}$ | $\mathbb{R}$ | scalar arithmetic | + - * / | |
| | | clamping | min max | |
| | | exponentiation | superscript, e.g. $x^y$ | ^ |
| | | atan2 | $\arctan(\frac{y}{x})$ (kind of) | atan2(y,x) |
| $W$ | $W$ | scalar multiplication $p_i = x_i y$ | (nothing; adjacency) | * |
| | | scalar division | / | |
| $W \otimes W$ | $W \otimes W$ | scalar multiplication $p_{ij} = x_{ij} y$ | (nothing; adjacency) | * |
| | | scalar division | / | |

### arg2: $W$ vectors = 1st-order tensors

| arg1 | output type | description | conventional math notation | Diderot notation |
|---|---|---|---|---|
| $\mathbb{R}$ | $W$ | scalar multiplication $p_i = x y_i$ | (nothing; adjacency) | * |
| $W$ | $\mathbb{R}$ | dot product $p = x_i y_i$ | • | |
| | $W$ | add, sub | + - | |
| | | cross product | × | |
| | | compnt-wise multiply $p_i = x_i y_i$ (without ESN) | no standard notation | want * |
| | $W \otimes W$ | outer/tensor product $P_{ij} = x_i y_j$ | ⊗ | |
| $W \otimes W$ | $\mathbb{R}$ | contraction (homogeneous form evaluation) $p = X_{ij} y_i y_j$ | no standard notation | maybe? :: |
| | $W$ | matrix-vector multiply (2nd index) $p_i = X_{ij} y_j$ | (nothing; adjacency) | • |
| | | | | |
| | $W \otimes W \otimes W$ | tensor product $P_{ijk} = X_{ij} y_k$ | ⊗ | want ⊗ |

### arg2: $W \otimes W$ 2nd-order tensors

| arg1 | output type | description | conventional math notation | Diderot notation |
|---|---|---|---|---|
| $\mathbb{R}$ | $W \otimes W$ | scalar multiplication $P_{ij} = x Y_{ij}$ | (nothing; adjacency) | * |
| $W$ | $\mathbb{R}$ | contraction (homogeneous form evaluation) $p = x_i x_j Y_{ij}$ | no standard notation | maybe? :: |
| | $W$ | vector-matrix multiply (1st index) $p_j = x_i Y_{ij}$ | (nothing; adjacency) | • |
| | | | | |
| | $W \otimes W \otimes W$ | tensor product $P_{ijk} = x_i Y_{jk}$ | ⊗ | want ⊗ |
| $W \otimes W$ | $\mathbb{R}$ | tensor dot, double dot product $p = X_{ij} Y_{ij}$ | : | want : |
| | | | | |
| | $W \otimes W$ | matrix-matrix multiply $P_{ij} = X_{ik} Y_{kj}$ | (nothing; adjacency) | • |
| | | | | |
| | $W \otimes W \otimes W \otimes W$ | tensor product $P_{ijkl} = X_{ij} Y_{kl}$ | ⊗ | want ⊗ |