



TensorFlow

数学运算

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Outline

- $+ - * /$
 - $**$, pow, square
 - sqrt
 - $//$, $\%$
 - exp, log
 - @, matmul
 - linear layer
-

Operation type

- element-wise
 - $+ - * /$
 - matrix-wise
 - $@$, matmul
 - dim-wise
 - reduce_mean/max/min/sum
-

+ - * / % //

```
In [134]: b=tf.fill([2,2],2.)
```

```
In [135]: a=tf.ones([2,2])
```

```
In [136]: a+b,a-b,a*b,a/b
```

```
(<tf.Tensor: id=462, shape=(2, 2), dtype=float32, numpy=
array([[3., 3.],
       [3., 3.]], dtype=float32)>,
```

```
<tf.Tensor: id=463, shape=(2, 2), dtype=float32, numpy=
array([[ -1., -1.],
       [-1., -1.]], dtype=float32)>,
```

```
<tf.Tensor: id=464, shape=(2, 2), dtype=float32, numpy=
array([[2., 2.],
       [2., 2.]], dtype=float32)>,
```

```
<tf.Tensor: id=465, shape=(2, 2), dtype=float32, numpy=
array([[0.5, 0.5],
       [0.5, 0.5]], dtype=float32)>>
```

```
In [137]: b//a,b%a
```

```
(<tf.Tensor: id=470, shape=(2, 2), dtype=float32, numpy=
array([[2., 2.],
       [2., 2.]], dtype=float32)>,
```

```
<tf.Tensor: id=471, shape=(2, 2), dtype=float32, numpy=
array([[0., 0.],
       [0., 0.]], dtype=float32)>>
```

tf.math.log tf.exp

```
● ● ●  
In [138]: a  
<tf.Tensor: id=461, shape=(2, 2), dtype=float32, numpy=  
array([[1., 1.],  
       [1., 1.]], dtype=float32)>  
  
In [140]: tf.math.log(a)  
<tf.Tensor: id=475, shape=(2, 2), dtype=float32, numpy=  
array([[0., 0.],  
       [0., 0.]], dtype=float32)>  
  
In [141]: tf.exp(a)  
<tf.Tensor: id=477, shape=(2, 2), dtype=float32, numpy=  
array([[2.7182817, 2.7182817],  
       [2.7182817, 2.7182817]], dtype=float32)>
```

log2, log10?



```
In [22]: tf.math.log(8.)/tf.math.log(2.)
```

```
Out[22]: <tf.Tensor: id=54, shape=(), dtype=float32,  
numpy=3.0>
```

```
In [23]: tf.math.log(100.)/tf.math.log(10.)
```

```
Out[23]: <tf.Tensor: id=60, shape=(), dtype=float32,  
numpy=2.0>
```

pow, sqrt

```
In [142]: b  
<tf.Tensor: id=458, shape=(2, 2), dtype=float32, numpy=  
array([[2., 2.],  
       [2., 2.]], dtype=float32)>
```

```
In [143]: tf.pow(b, 3)  
<tf.Tensor: id=481, shape=(2, 2), dtype=float32, numpy=  
array([[8., 8.],  
       [8., 8.]], dtype=float32)>
```

```
In [144]: b**3  
<tf.Tensor: id=484, shape=(2, 2), dtype=float32, numpy=  
array([[8., 8.],  
       [8., 8.]], dtype=float32)>
```

```
In [145]: tf.sqrt(b)  
<tf.Tensor: id=486, shape=(2, 2), dtype=float32, numpy=  
array([[1.4142135, 1.4142135],  
       [1.4142135, 1.4142135]]], dtype=float32)>
```

@ matmul

```
● ● ●  
In [146]: a,b  
(<tf.Tensor: id=461, shape=(2, 2), dtype=float32, numpy=  
  array([[1., 1.],  
         [1., 1.]], dtype=float32)>,  
 <tf.Tensor: id=458, shape=(2, 2), dtype=float32, numpy=  
  array([[2., 2.],  
         [2., 2.]], dtype=float32)>)  
  
In [147]: a@b  
<tf.Tensor: id=490, shape=(2, 2), dtype=float32, numpy=  
  array([[4., 4.],  
         [4., 4.]], dtype=float32)>  
  
In [148]: tf.matmul(a,b)  
<tf.Tensor: id=492, shape=(2, 2), dtype=float32, numpy=  
  array([[4., 4.],  
         [4., 4.]], dtype=float32)>
```


@ matmul

```
● ● ●  
In [150]: a=tf.ones([4,2,3])  
In [151]: b=tf.fill([4,3,5], 2.)  
  
In [152]: a@b  
<tf.Tensor: id=503, shape=(4, 2, 5), dtype=float32, numpy=  
array([[6., 6., 6., 6., 6.],  
      ...  
      [6., 6., 6., 6., 6.]])>  
  
In [153]: tf.matmul(a,b)  
<tf.Tensor: id=505, shape=(4, 2, 5), dtype=float32, numpy=  
array([[6., 6., 6., 6., 6.],  
      ...  
      [6., 6., 6., 6., 6.]])>
```

With broadcasting



```
In [164]: a.shape # TensorShape([4, 2, 3])
```

```
In [165]: b.shape # TensorShape([3, 5])
```

```
In [166]: bb=tf.broadcast_to(b, [4,3,5])
```

```
In [167]: a@bb
```

```
<tf.Tensor: id=516, shape=(4, 2, 5), dtype=float32, numpy=
array([[6., 6., 6., 6., 6.],
       [6., 6., 6., 6., 6.]], ...
```

```
      [[6., 6., 6., 6., 6.],
       [6., 6., 6., 6., 6.]])>
```

Recap

- $y = w * x + b$

- $Y = X@W + b$

- $\begin{bmatrix} x_0^0 & x_0^1 \\ x_1^0 & x_1^1 \end{bmatrix} \begin{bmatrix} w_{00} & w_{01} & w_{02} \\ w_{10} & w_{11} & w_{12} \end{bmatrix} + [b_0, b_1, b_2] \rightarrow \begin{bmatrix} y_0^0 & y_0^1 & y_0^2 \\ y_1^0 & y_1^1 & y_1^2 \end{bmatrix}$

- $[b, 2] \rightarrow [b, 3]$

$$Y = X@W + b$$



```
In [168]: x=tf.ones([4,2])
```

```
In [169]: W=tf.ones([2,1])
```

```
In [170]: b=tf.constant(0.1)
```

```
In [171]: x@W+b
```

```
<tf.Tensor: id=526, shape=(4, 1), dtype=float32, numpy=
array([[2.1],
       [2.1],
       [2.1],
       [2.1]], dtype=float32)>
```

$$\mathit{out} = \mathit{relu}(X@W + b)$$

```
● ● ●  
In [171]: x@W+b  
<tf.Tensor: id=526, shape=(4, 1), dtype=float32, numpy=  
array([[2.1],  
       [2.1],  
       [2.1],  
       [2.1]]), dtype=float32)>
```

```
In [172]: out=x@W+b  
In [173]: out=tf.nn.relu(out)  
<tf.Tensor: id=530, shape=(4, 1), dtype=float32, numpy=  
array([[2.1],  
       [2.1],  
       [2.1],  
       [2.1]]), dtype=float32)>
```

下一课时

前向传播（张量）
实战

Thank You.
