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.]]], dtype=float32)>

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.]]], dtype=float32)>
```

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.]]], dtype=float32)>
```

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] → [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)>
```

$$out = relu(X@W + b)$$

```
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.