EE-559 – Deep learning

1.6. Tensor internals

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A tensor is a view of [a part of] a **storage**, which is a low-level 1d vector.

```
>>> x = torch.zeros(2, 4)
>>> x.storage()
 0.0
 0.0
 0.0
 0.0
 0.0
 0.0
 0.0
 0.0
[torch.FloatStorage of size 8]
>>> q = x.storage()
>>> q[4] = 1.0
>>> x
tensor([[ 0.,  0.,  0.,  0.],
        [ 1.,  0.,  0.,  0.]])
```

Multiple tensors can share the same storage. It happens when using operations such as `view()`, `expand()` or `transpose()`.

```
>>> y = x.view(2, 2, 2)
>>> y
tensor([[[ 0.,  0.],
         [ 0.,  0.]],

        [[ 1.,  0.],
         [ 0.,  0.]]])
>>> y[1, 1, 0] = 7.0
>>> x
tensor([[ 0.,  0.,  0.,  0.],
        [ 1.,  0.,  7.,  0.]])
>>> y.narrow(0, 1, 1).fill_(3.0)
tensor([[[ 3.,  3.],
         [ 3.,  3.]]])
>>> x
tensor([[ 0.,  0.,  0.,  0.],
        [ 3.,  3.,  3.,  3.]])
```

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```
>>> q = torch.arange(0, 20).storage()
>>> x = torch.empty(0).set_(q, storage_offset = 5, size = (3, 2), stride = (4, 1))
>>> x
tensor([[  5.,   6.],
        [  9.,  10.],
        [ 13.,  14.]])
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```

q =

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

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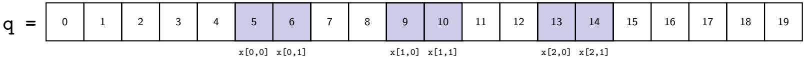
q =
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
x[0,0]
x[0,1]
x[1,0]
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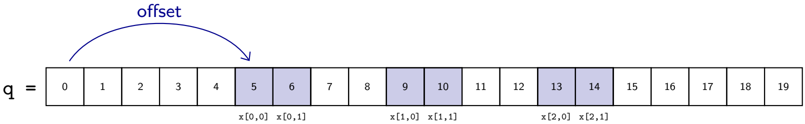
offset
q =
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
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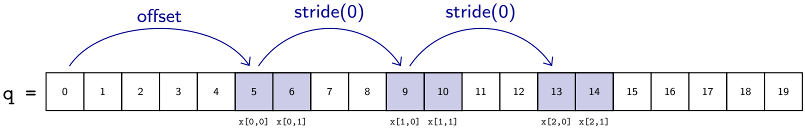
offset
stride(0)
stride(0)
q =
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3
4
5
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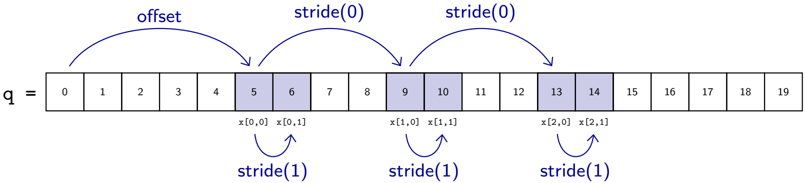
offset
stride(0)
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q =
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2
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17
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19
x[0,0]
x[0,1]
x[1,0]
x[1,1]
x[2,0]
x[2,1]
stride(1)
stride(1)
stride(1)

We can explicitly create different “views” of the same storage

```
>>> n = torch.linspace(1, 4, 4)
>>> n
tensor([ 1.,  2.,  3.,  4.])
>>> torch.tensor(0.).set_(n.storage(), 1, (3, 3), (0, 1))
tensor([[ 2.,  3.,  4.],
        [ 2.,  3.,  4.],
        [ 2.,  3.,  4.]])
>>> torch.tensor(0.).set_(n.storage(), 1, (2, 4), (1, 0))
tensor([[ 2.,  2.,  2.,  2.],
        [ 3.,  3.,  3.,  3.]])
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        [ 2.,  3.,  4.]])
>>> torch.tensor(0.).set_(n.storage(), 1, (2, 4), (1, 0))
tensor([[ 2.,  2.,  2.,  2.],
        [ 3.,  3.,  3.,  3.]])
```

This is in particular how transpositions and broadcasting are implemented.

This organization explains the following (maybe surprising) error

```
>>> x = torch.empty(100, 100)
>>> x.stride()
(100, 1)
>>> y = x.t()
>>> y.stride()
(1, 100)
>>> y.view(-1)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
RuntimeError: invalid argument 2: view size is not compatible with
input tensor’s size and stride (at least one dimension spans across
two contiguous subspaces).
```

`x.t()` shares `x`’s storage and cannot be “flattened” to 1d.

This can be fixed with `contiguous()`, which returns a contiguous version of the tensor, making a copy if needed, or with `reshape()` which combines `view()` and `contiguous()`.

The end