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.

```python
>>> x = torch.zeros(2, 4)
>>> x.storage()
  0.0
  0.0
  0.0
  0.0
  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()`.

```python
>>> 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.]]))
```
The first coefficient of a tensor is the one at `storage_offset()` in `storage()`.
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Incrementing index \( k \) by 1 move by \( \text{stride}(k) \) elements in the storage.
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Incrementing index \( k \) by 1 move by `stride(k)` elements in the storage.

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

```python
>>> 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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>>> n
tensor([1., 2., 3., 4.])
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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.]])
```

This is in particular how transpositions and broadcasting are implemented.

```python
>>> x = torch.empty(100, 100)
>>> x.stride()
(100, 1)
>>> y = x.t()
>>> y.stride()
(1, 100)
```
This organization explains the following (maybe surprising) error

```python
>>> x = torch.empty(100, 100)
>>> x.t().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). Call .contiguous() before .view()
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This can be fixed with `contiguous()`, which returns a contiguous version of the tensor, **making a copy if needed**.

The function `reshape()` combines `view()` and `contiguous()`.
The end