Tensors 101

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PyTorch - Tensors

Introduction

- PyTorch structure to work with variables → PyTorch tensors
- Similar to numpy arrays, but more powerful
- Automatically calculates gradients
- Information about dependencies to other tensors

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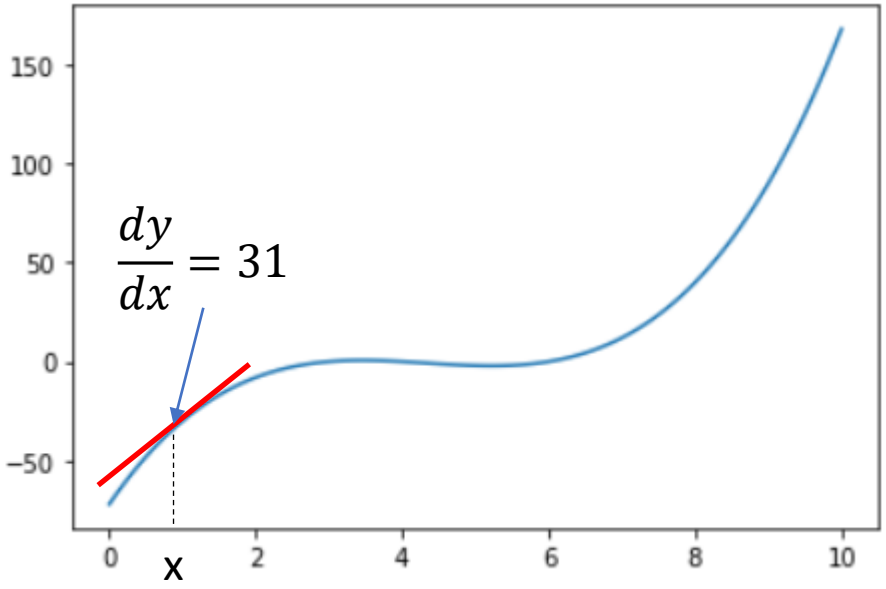
Automatic Gradients

- Gradients are calculated automatically

```
# create a tensor with gradients enabled
x = torch.tensor(1.0, requires_grad=True)
# create second tensor depending on first tensor
y = (x-3) * (x-6) * (x-4)
# calculate gradients
y.backward()
# show gradient of first tensor
print(x.grad)
```

```
tensor(31.)
```



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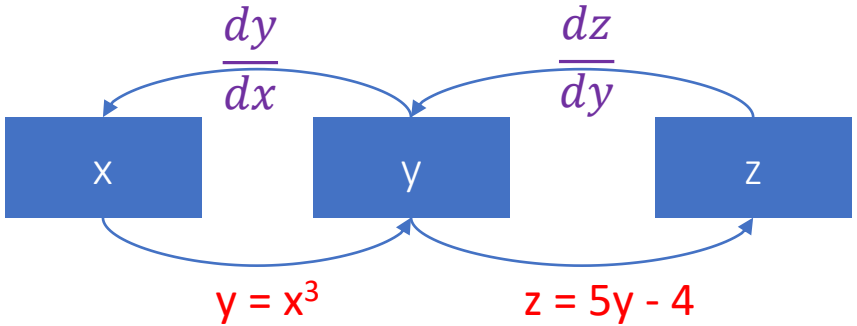
Computational Graphs

- Simple network:
  - Input *x* is used to calculate *y*, which is used to calculate *z*.



Backpropagation

Forward Pass

Change of z based on change of x: $\frac{dz}{dx} = \frac{dz}{dy}\frac{dy}{dx}$ (Chain rule)

$$\frac{dz}{dx} = 5 * 3x^2$$

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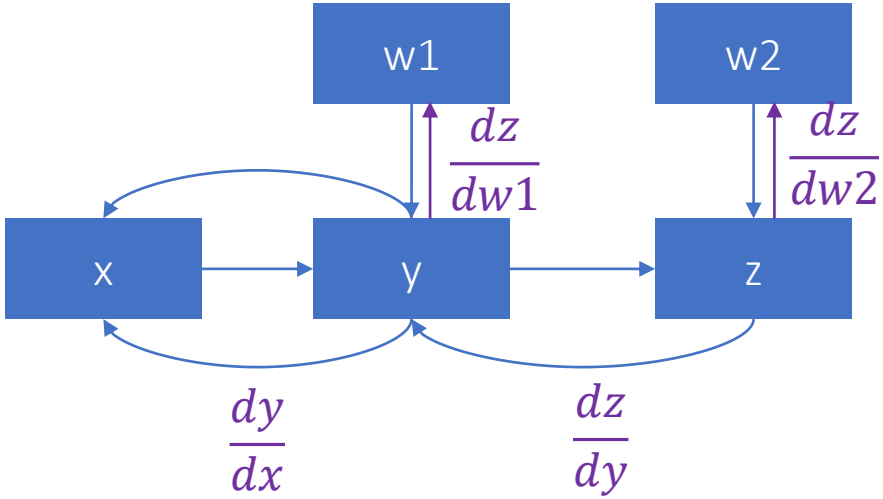
Computational Graphs

- Update of Weights
  - Calculated output z
  - True output t
  - Error E = $(z - t)^2$
  - Weights can be considered as nodes as well
  - z = f(y, w2)
  - Optimizer updates weights based on gradients



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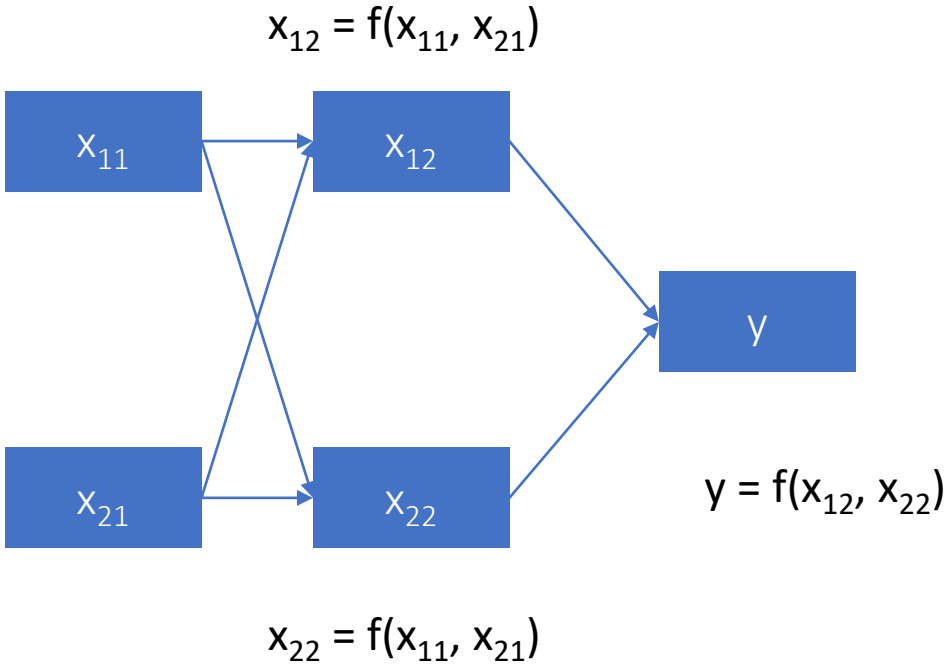
Computational Graphs: Forward Pass

- More complex network with multiple inputs



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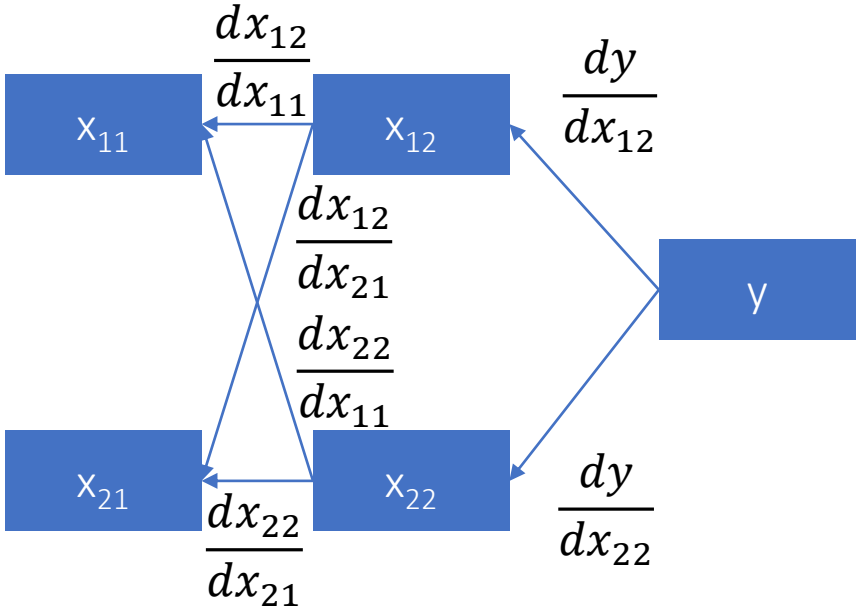
Computational Graphs: Backpropagation

- More complex network with multiple inputs



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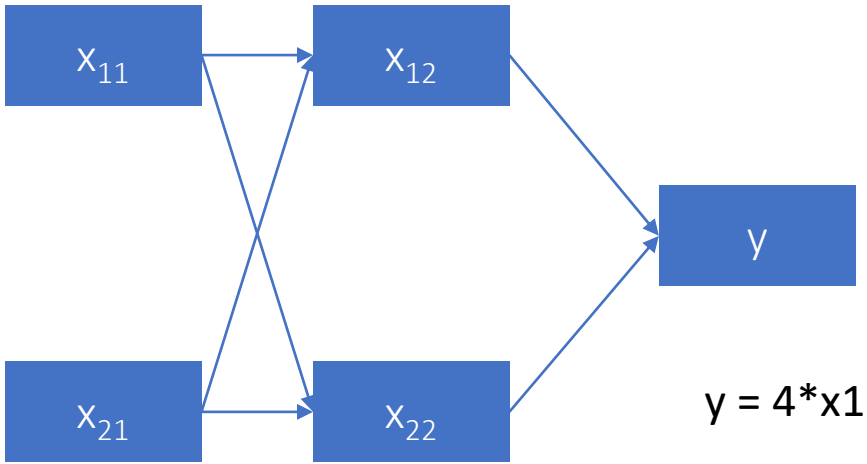
Computational Graphs: Forward Pass

- Example

$$x_{12} = 5*x_{11} - 3*x_{21}$$



$$y = 4*x12 + 3*x22$$

$$x_{22} = 2*x_{11}^{2} + 2*x_{21}$$

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Computational Graphs: Backpropagation

- More complex network with multiple inputs