# Notation and Math

https://colah.github.io/posts/2015-08-Backpro

The derivative of $f(g(h(x)))$ is $f'(g(h(x)))g'(h(x))h'(x)$

$$\frac{df}{dx} = \frac{df}{dg} \cdot \frac{dg}{dh} \cdot \frac{dh}{dx}$$

# Computation graphs

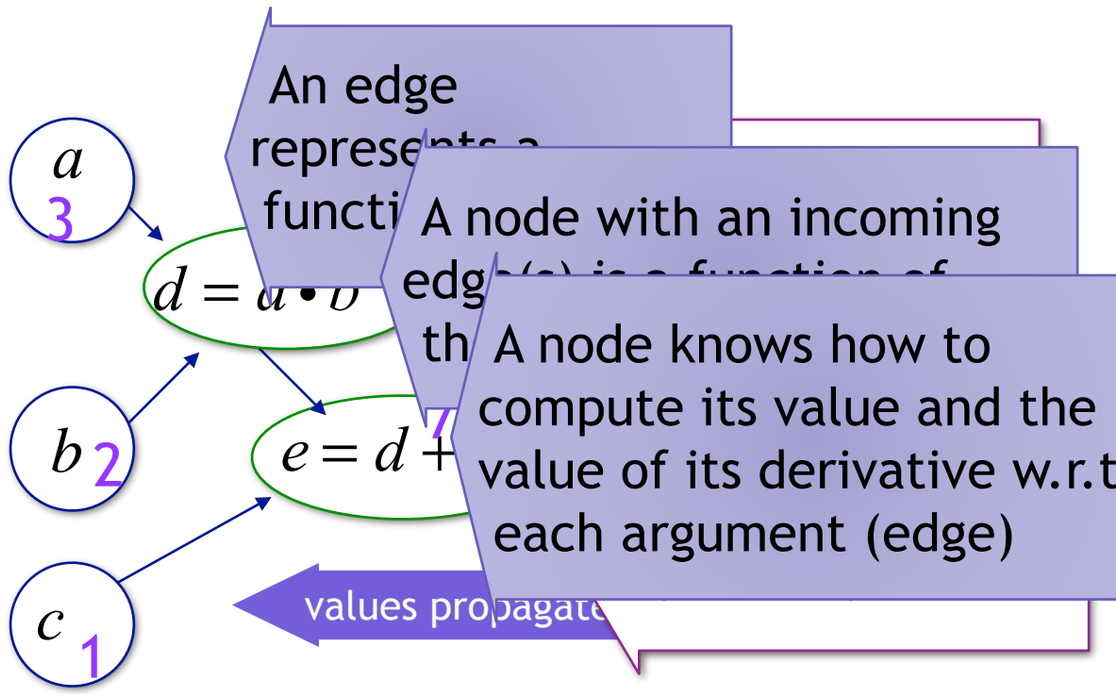
## Represents a function as a graph

- Directed acyclic graphs that show the dependency structure of the computation to be performed
- Computation graph breaks the function into steps we can compute the derivative
- Nodes
  - input values
  - functions for combining values
- Example: $(ab+c)^2$
  - input values: a,b,c
  - functions for combining values:

$$d = a \cdot b$$

$$e = d + c$$

$$z = e^2$$




$$\frac{\partial z}{\partial a} = \frac{\partial z}{\partial e} \cdot \frac{\partial e}{\partial d} \cdot \frac{\partial d}{\partial a}$$

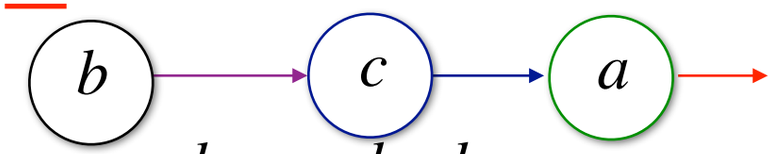
$$= 2e \cdot 1 \cdot b = 2(d + c) \cdot b$$

$$= 2(a \cdot b + c) \cdot b$$

(2*7) (1) (2)

# Basic Facts:

$$a = (3b - 1)^2$$




$$\frac{da}{db} = \frac{da}{dc}\frac{dc}{db} = 2(c - 1)\ 3$$

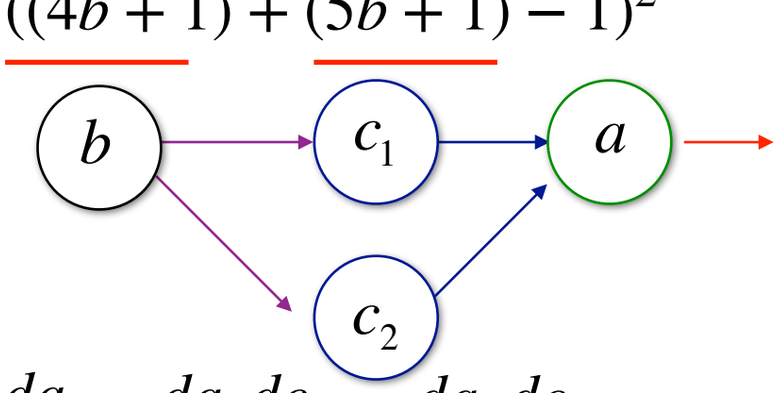
$$= 2(3b - 1)\ 3$$

$$a = (c - 1)^2$$

$$c = 3b$$

values propagate this way

$$a = ((4b + 1) + (5b + 1) - 1)^2$$




$$\frac{da}{db} = \frac{da}{dc_1}\frac{dc_1}{db} + \frac{da}{dc_2}\frac{dc_2}{db}$$

$$= 2(c_1 + c_2 - 1)4 \ + 2(c_1 + c_2 - 1)\ 5$$

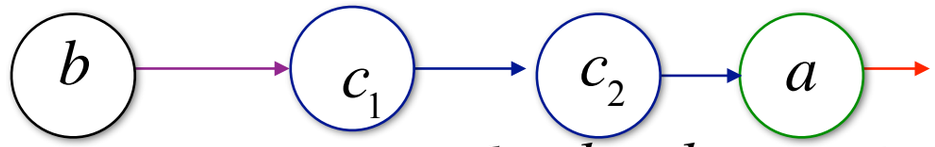
$$= 2((4b + 1) + (5b + 1) - 1)\ 4$$

$$+ 2((4b + 1) + (5b + 1) - 1)\ 5$$

$$a = (c_1 + c_2 - 1)^2$$

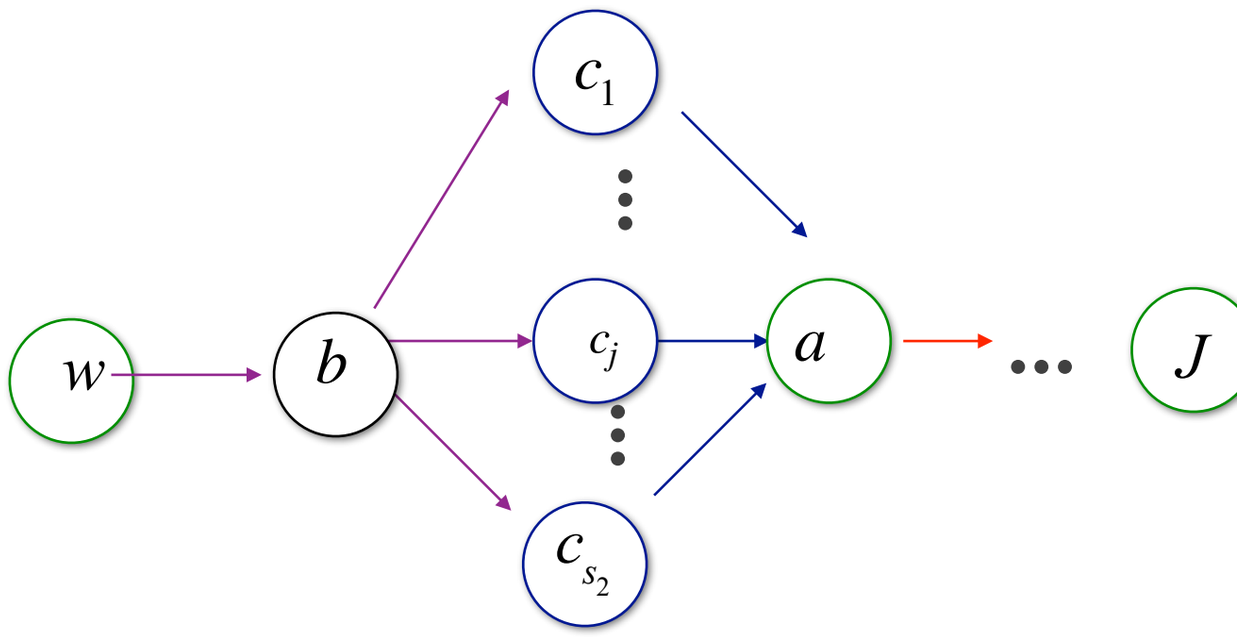
$$c_1 = (4b + 1)$$

$$c_2 = (5b + 1)$$




$$\frac{da}{db} = \frac{da}{dc_2}\frac{dc_2}{dc_1}\frac{dc_1}{db} = \frac{da}{dc_1}\frac{dc_1}{db}$$

values propagate this way




values propagate this way

$$\frac{da}{db} = \sum_{i=1}^{s_2} \frac{da}{dc_i}\frac{dc_i}{db} \qquad \frac{dJ}{db} = \sum_{i=1}^{s_2} \frac{dJ}{dc_i}\frac{dc_i}{db} \qquad \frac{dJ}{dw} = \frac{dJ}{db}\frac{db}{dw}$$