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Basics of Neural Network Programming

Computation Graph

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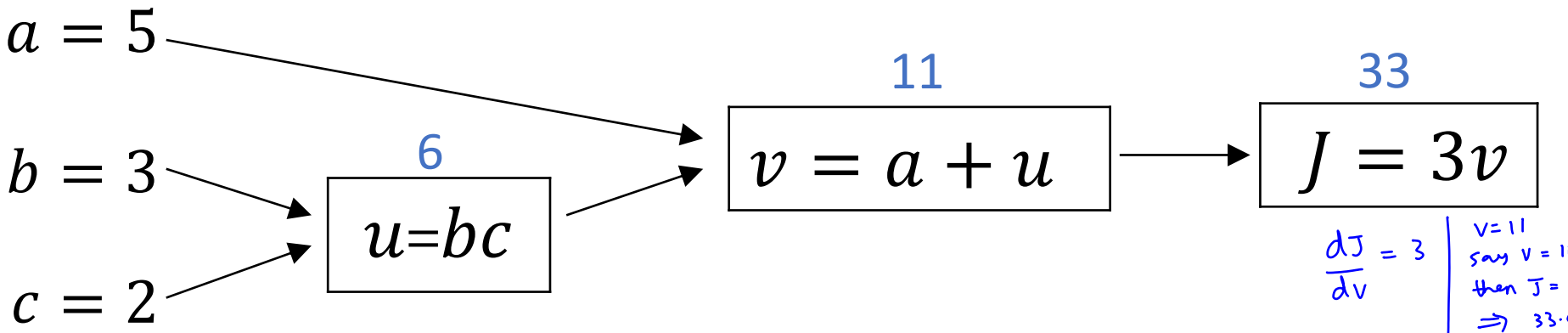
Basics of Neural Network Programming

Derivatives with a Computation Graph

Computing derivatives



$\frac{dJ}{dv} = 3$ | V = 11, say V = 11.001, then J = 33.003, $\Rightarrow \frac{33.003 - 33}{11.001 - 11} = 3$

We calculate $\frac{\partial (\text{Final output})}{\partial \text{var}}$

↳ where var can be "v" or "a" or "u" etc.

So in code, because we know we're always calculating derivative wrt Final output "J"

$\frac{\partial J}{\partial a}$ ⇒ can be written as da, $\frac{\partial J}{\partial v}$ can be dv etc

$\frac{dJ}{da} = ?$ a = 5, say a = 5.001, V = 11.001, "a" indirectly changes J via V, J = 33.003

$\Rightarrow \frac{dJ}{da} = \frac{33.003 - 33}{5.001 - 5} = 3$

Another way to look at this is chain rule

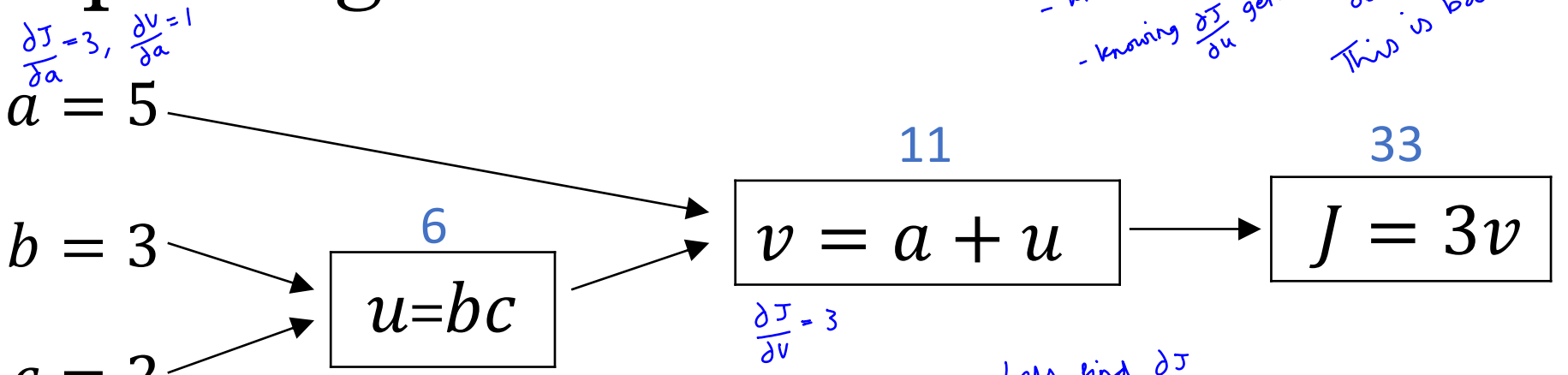
$\frac{dJ}{dv} \cdot \frac{dv}{da} = \frac{dJ}{da} = \frac{(33.003 - 33)}{(11.001 - 11)} \cdot \frac{(11.001 - 11)}{(5.001 - 5)}$

$= \frac{.003}{.001} \times \frac{.001}{.001} = 3$

↳ $\frac{dv}{da} = 1$

Andrew Ng

Computing derivatives



So we go right to left
- knowing $\frac{\partial J}{\partial v}$ gets us $\frac{\partial J}{\partial u}$
- knowing $\frac{\partial J}{\partial u}$ gets us $\frac{\partial J}{\partial b}$, $\frac{\partial J}{\partial c}$ etc

This is back prop

$\frac{\partial J}{\partial a} = 3$, $\frac{\partial v}{\partial a} = 1$

$\frac{\partial J}{\partial v} = 3$

Now lets find $\frac{\partial J}{\partial u}$ | $u = 6$, say $u = 6.001$, then $v = 11.001$

$\Rightarrow \frac{\partial v}{\partial u} = 1 = \left(\frac{11.001 - 11}{6.001 - 6}\right)$

If $v = 11.001$, $\Rightarrow J = 33.003$
& we know $\frac{\partial J}{\partial v} = 3$

$\Rightarrow \frac{\partial J}{\partial u} = \frac{\partial J}{\partial v} \cdot \frac{\partial v}{\partial u} = 3 \times 1 = 3$

Lets find $\frac{\partial J}{\partial b}$

$b = 3$, say $b = 3.001$

$u = 6.002 \Rightarrow \frac{\partial u}{\partial b} = \left(\frac{6.002 - 6}{3.001 - 3}\right) = 2$

$\frac{\partial J}{\partial b} = \frac{\partial J}{\partial u} \cdot \frac{\partial u}{\partial b} = 3 \cdot \frac{\partial u}{\partial b} = 6$

we can do further calc to complete our understanding

$b \to 3$ to 3.001
$u \to 6$ to 6.002
$v \to 11$ to 11.002
$J = 3v \to 33$ to 33.006

$\Rightarrow \frac{\partial J}{\partial b} = \frac{33.006 - 33}{3.001 - 3} = 6$