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# Basics of Neural Network Programming

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## Computation Graph

# Computation Graph

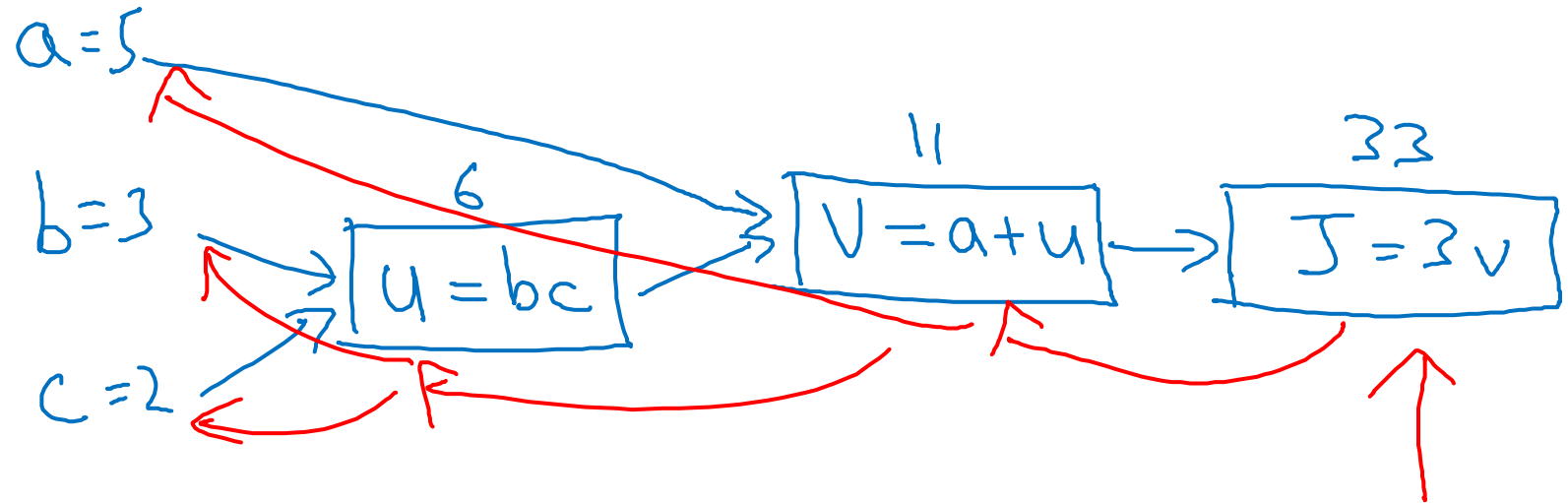
$$J(a,b,c) = 3(a + \underbrace{bc}_u) = 3(5 + 3 \times 2) = 33$$

$\underbrace{\hspace{1.5cm}}_J$

$$u = bc$$

$$V = a + u$$

$$J = 3V$$





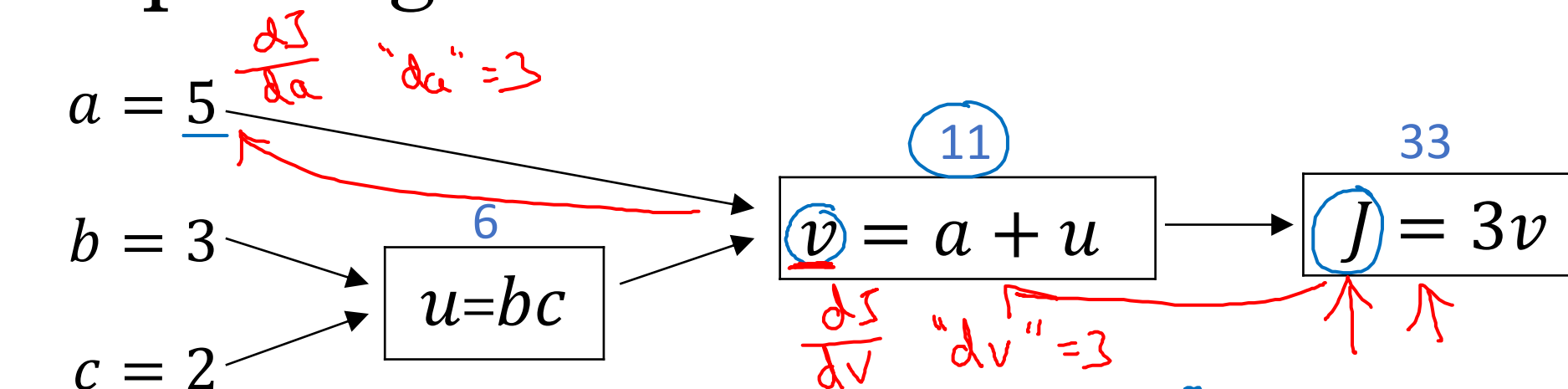
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## Derivatives with a Computation Graph

# Computing derivatives



$$\frac{dJ}{dv} = ? = 3$$

$$\frac{dJ}{da} = 3 = \frac{dJ}{dv} \frac{dv}{da}$$

$$\frac{dv}{da} = 1$$

Handwritten notes in green boxes:

- $\frac{dJ}{dv} = ? = 3$
- $\frac{dv}{da} = 1$

$$a \rightarrow v \rightarrow J$$

$$J = 3v$$

$$v = 11 \rightarrow 11.001$$

$$J = 33 \rightarrow 33.003$$

$$a = 5 \rightarrow 5.001$$

$$\rightarrow v = 11 \rightarrow 11.001$$

$$J = 33 \rightarrow 33.003$$

$$\frac{d \text{ Final Output Var}}{d \text{ var}}$$

$$\frac{dJ}{d \text{ var}}$$

Handwritten note: "dvar"

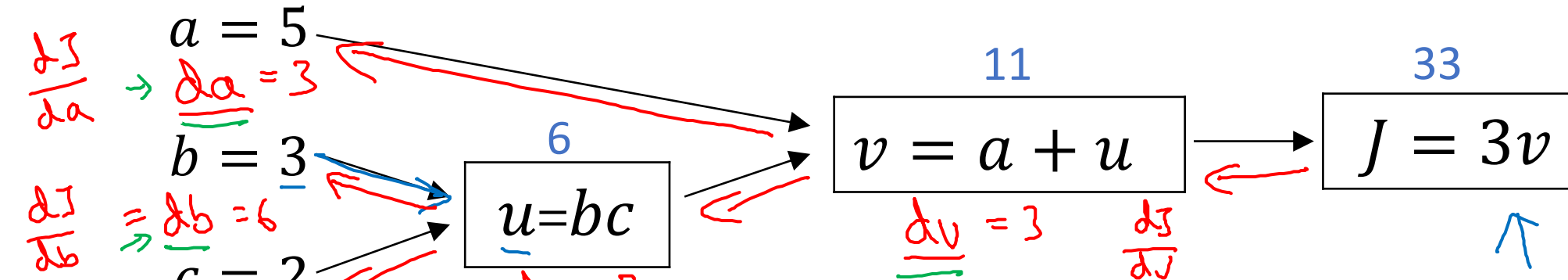
$$f(a) = 3a$$

$$\frac{df(a)}{da} = \frac{df}{da} = 3$$

$$J = 3v$$

$$\frac{dJ}{dv} = 3$$

# Computing derivatives



$$\frac{dJ}{du} = 3 = \frac{dJ}{dv} \cdot \frac{dv}{du}$$

$\underbrace{\quad}_{3} \quad \underbrace{\quad}_{1}$

$$\frac{dJ}{db} = \frac{dJ}{du} \cdot \frac{du}{db} = 6$$

$\underbrace{\quad}_{\rightarrow 3} \quad \underbrace{\quad}_{=2}$

$$\frac{dJ}{da} = \frac{dJ}{du} \cdot \frac{du}{da} = 9$$

$\underbrace{\quad}_{\rightarrow 3} \quad \underbrace{\quad}_{=3}$

$$\begin{aligned} u = 6 &\rightarrow 6.001 \\ v = 11 &\rightarrow 11.001 \\ J = 33 &\rightarrow 33.003 \end{aligned}$$

$$b = 3 \rightarrow 3.001$$

$$\begin{aligned} u = b \cdot c = 6 &\rightarrow 6.002 \\ J = 33.006 \end{aligned}$$

$$\begin{aligned} c = 2 \\ J = 33.006 \end{aligned}$$

$$\begin{aligned} v = 11.002 \\ J = 3v \end{aligned}$$