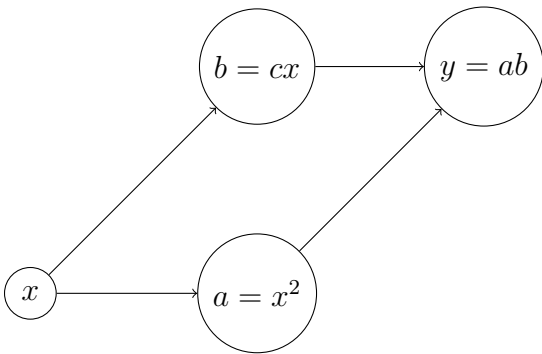# Homework 3

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Q1
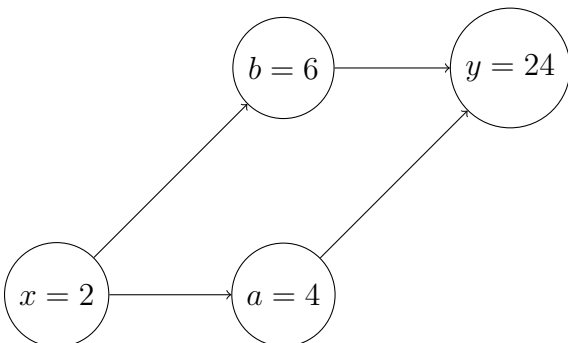
Draw a computation graph for this example:
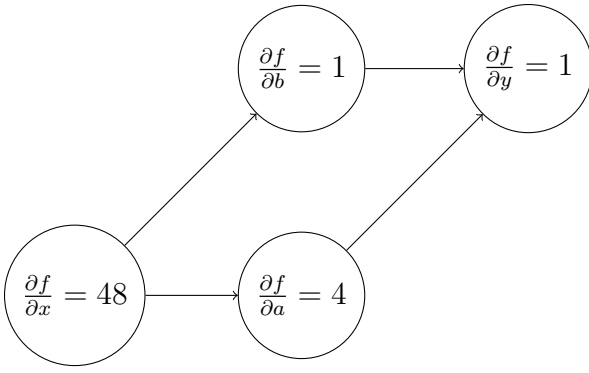

How many nodes are there (including input and output)?

4 (four) nodes

For $x = 2$ and $c = 3$, Compute the value of each node in a forward pass:

For $x = 2$ and $c = 3$, Compute $\frac{df}{dn}$ for each node n using backpropogation:

Consider the node corresponding to x^2 in the graph. For each of the following, write a symbolic expression and the numerical value (at $x = 2, c = 3$) for

If we are using Binary Cross-Entropy, and therefore our loss function is:

$$L_{BCE}(y, \hat{y}) = -(y \log(\hat{y}) + (1 - y) \log(1 - \hat{y}))$$

Then we can assume that y = 1 (for a positive result), then:

$$\frac{\partial L}{\partial \hat{y}} = -\left(\frac{1}{\hat{y}}\right)$$

If $\hat{y}$ is the output of the function, then $\hat{y} = a = 4$

$\therefore$

$$\frac{\partial L}{\partial \hat{y}} = \frac{\partial L}{\partial a} = -\left(\frac{1}{4}\right)$$

$\therefore$

- **The upstream derivative:** $\frac{\partial L}{\partial a} = -\left(\frac{1}{4}\right)$

- **The local derivative:** $\frac{\partial a}{\partial x} = 2x = 4$

- **The downstream derivative:** $\frac{\partial L}{\partial x} = \frac{\partial L}{\partial a}\left(\frac{\partial a}{\partial x}\right) = -\left(\frac{1}{4}\right)(4) = -1$

Q3

Epoch 0 average loss: 0.488037767606645
Epoch 1 average loss: 0.32633853972554966
Epoch 2 average loss: 0.28049176026340006
Epoch 3 average loss: 0.2572602522667666
Epoch 4 average loss: 0.24377345227392025
Epoch 5 average loss: 0.2353556996256047
Total training time: 1466.1704413890839