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1a (10 pts). Use the definition of the derivative to find  $f'(a)$  if  $f(x) = \frac{3x - 1}{1 + x}$ .

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*Solution:*

1. (Source: 2.7.33)

$$\begin{aligned} f'(a) &= \lim_{h \rightarrow 0} \frac{\frac{3(a+h) - 1}{1 + (a+h)} - \frac{3a - 1}{1 + a}}{h} = \lim_{h \rightarrow 0} \frac{\frac{3a+3h-1}{1+a+h} - \frac{3a-1}{1+a}}{h} \cdot \frac{(1+a+h)(1+a)}{(1+a+h)(1+a)} \\ &= \lim_{h \rightarrow 0} \frac{(3a+3h-1)(1+a) - (3a-1)(1+a+h)}{h(1+a+h)(1+a)} \\ &= \lim_{h \rightarrow 0} \frac{(3a+3h-1+3a^2+3ah-a) - (3a-1+3a^2-a+3ah-h)}{h(1+a+h)(1+a)} \\ &= \lim_{h \rightarrow 0} \frac{4h}{h(1+a+h)(1+a)} = \lim_{h \rightarrow 0} \frac{4}{(1+a+h)(1+a)} = \frac{4}{(1+a)^2} \end{aligned}$$