Technical Questions and Answers in Machine Learning

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1 Problem 2

Determine the first and second derivative with respect to x of: $f(x) = \frac{1}{1+e^{-x}}$

1.1 Solution 2

First Derivative:
$f(x) = (1 + e^{-}x)^{-1}$
Using Chain Rule
$f'(x) = -1(1 + e^{-x})^{-2} \times -1e^{-x}$
$f'(x) = \frac{e^{-x}}{(1+e^{-x})^2}$

Second Derivative:
$f'(x) = \frac{e^{-x}}{(1+e^{-x})^2}$
Using Quotient Rule of Differentiation
$g(x) = e^{-x} \qquad h(x) = (1 + e^{-x})^2$
$g'(x) = -e^{x} \qquad h'(x) = -2e^{-x}(1 + e^{-x})$
$f''(x) = \frac{h \times g' - g \times h'}{g^2}$
$f''(x) = \frac{-e^{-x} \times (1+e^{-x})^2 \ + \ 2e^{-2x} \times (1+e^{-x})}{e^{-2x}}$
$f''(x) = \frac{e^{-2x} - 1}{e^{-x}}$