

Since differentiability implies continuity, we have that if f'' exists on an interval I , then f' must be continuous on I . The converse is not true. For example, the function f , given by

$$f(x) = \begin{cases} x^2 \sin \frac{1}{x} & \text{if } x \neq 0 \\ 0 & \text{if } x = 0, \end{cases}$$

is differentiable everywhere, but f' is not continuous at $x = 0$. Thus, certainly f' will not be differentiable on any interval containing $x = 0$.