Today: The chain rule.

Homework before Wednesday’s class: watch videos 3.12, 3.13.
Compute the derivative of

1. \( f(x) = \sqrt{2x^2 + x + 1} \)

2. \( f(x) = \sqrt{x + \sqrt{x + \sqrt{x + 1}}} \)
I am inflating a spherical balloon. Below is the graph of the radius $r$ (in cm) as a function of time $t$ (in s). At what rate is the volume of the balloon increasing at time 4s?
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A different proof for the quotient rule

Assume we have already proven the product rule, the power rule, and the chain rule.

Obtain a formula for the derivative of \( h(x) = \frac{f(x)}{g(x)} \).

Hint: \( \frac{f(x)}{g(x)} = f(x) \cdot g(x)^{-1} \)
Let \( h(x) = x^2 \sin \frac{1}{x} \).

1. Calculate \( h'(x) \) for any \( x \neq 0 \).
2. Using the definition of derivative, calculate \( h'(0) \).
3. Is \( h \) continuous at 0?
4. Is \( h \) differentiable at 0?
5. Is \( h' \) continuous at 0?

*Hint:* The last two questions have different answers.
Derivatives of \((f \circ g)\)

Assume \(f\) and \(g\) are functions that have all their derivatives.

Find formulas for

1. \((f \circ g)'(x)\)
2. \((f \circ g)''(x)\)
3. \((f \circ g)'''(x)\)

in terms of the values of \(f\), \(g\) and their derivatives.

*Hint:* The first one is simply the chain rule.