## 4.3   How derivatives affect the shape of a graph

The first derivative helps find local extrema and it tells if the function is increasing or decreasing.

1. INCREASING/DECREASING TEST:

    - if $f' > 0$ on an interval, then f is increasing on that interval
    - if $f' < 0$ on an interval, then f is decreasing on that interval

2. FIRST DERIVATIVE TEST:

    - if f' changes form positive to negative, then f has a local maximum on that interval
    - if f' changes form negative to positive , then f has a local minimum on that interval
    - if f' does not change sign on an interval, then f has no local extrema on that interval

(a) Local maximum   (b) Local minimum   (c) No maximum or minimum   (d) No maximum or minimum
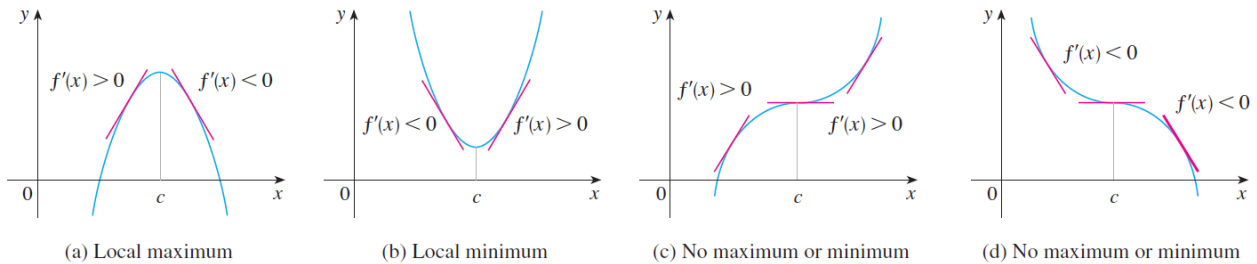
The second derivative gives the concavity of the function

1. CONCAVITY TEST:

    - if $f'' > 0$ on an interval, then f is concave up on that interval
    - if $f'' < 0$ on an interval, then f is concave down on that interval

2. an **inflection point** is a point where f changes concavities.

3. SECOND DERIVATIVE TEST:

    - if $f'(c) = 0$ and $f''(c) > 0$, then f has a local minimum at c
    - if $f'(c) = 0$ and $f''(c) < 0$, then f has a local maximum at c
    - if $f'(c) = 0$ and $f''(c) = 0$, then the test is inconclusive at c
    - if f'' changes sign, then f has an inflection point