Mathematics Tutorial Series
Calculus

Video 2: Why Calculus is Important

Calculus is a mathematical tool.
Calculus is used to build mathematical models.
Calculus can give us a model that changes with time.

Models of:
       Chemical reactions
       Ecological population changes
       Photosynthesis
       Hormone levels
       Black Holes
       Underground water levels
       Crime rates
       The local economy
       The global economy
       Exotic financial instruments
       Weather
       Climate

Calculus is about **rates of change** AND **total change**.

Rates of change   =   differential calculus
Total change   =   integral calculus

Static models = invariant over time
Dynamic models = time is a variable

Without calculus all our models would be static.

Static: Todays weather predicts tomorrow's by a fixed rule.

Dynamic: Weather prediction model uses many factors that are all changing at the same time. Tomorrow's weather depends on many rates of change and total changes

Example: Rate of infection during a pandemic.
       Total number of infected people
       Impact of changing immunization rate
       Total mortality from the epidemic

Example: Atmospheric CO_2 concentration.
      Rate of change
      Long-term predictions

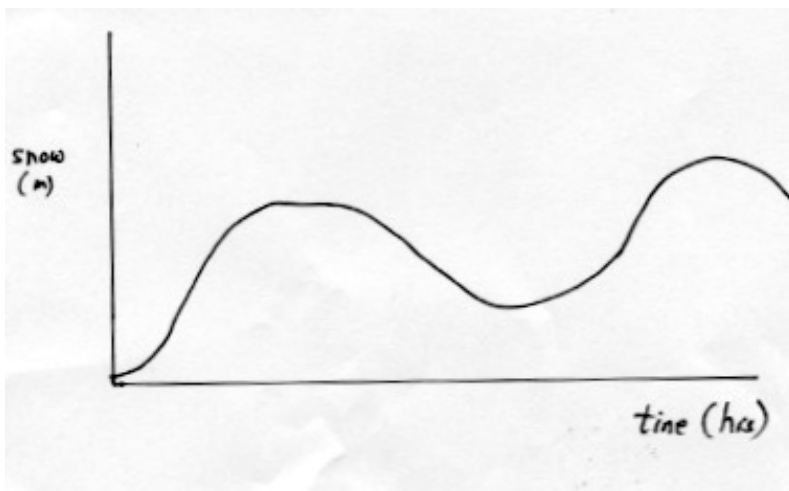## What does the derivative tell us?

Depth of snow in Ottawa

By looking at the graph we can see how fast it was snowing.
When were there flurries, a blizzard?
When did it stop snowing?

The **derivative is the rate of change** with respect to time (t)

What does it mean when this graph goes down?
What happens to the rate of increase of snow depth during this phase?

Summary

- The derivative of a function $f(t)$ with respect to t is the **rate of change** of the function $f(t)$;

- The derivative of a function is also a function;

- The derivative tells us if the function is increasing or decreasing and how fast;

- The value of the derivative **equals the slope** of the tangent to the graph of f;

- Derivatives are used in **dynamic mathematical models**

Check
1. What it **does**

2. What it **means**

3. What the **geometry** looks like

4. How the tool is **used** to solve problems

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