



Lecture 12

Calculus in Python



Workshop 4 Review

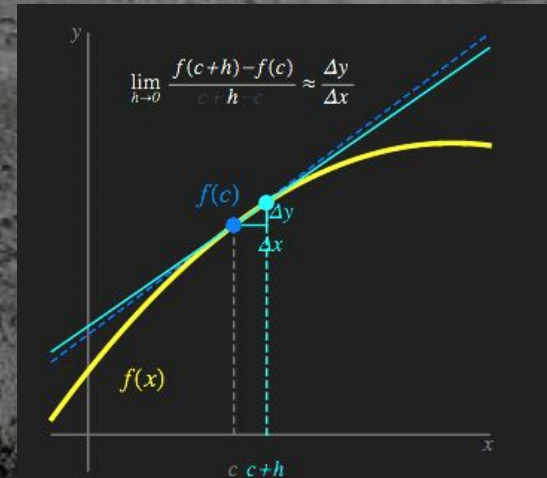
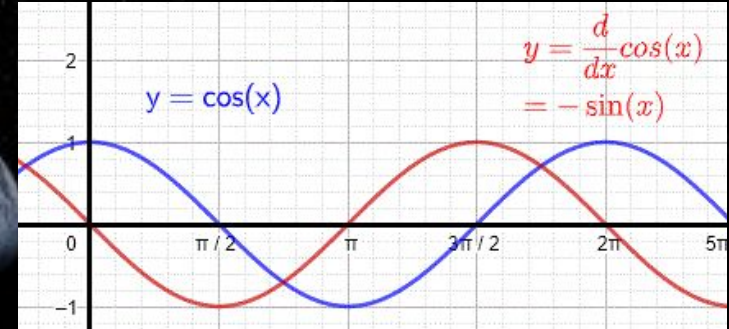
Calculus

- How many of you have already taken Calc 1A/B or some form of calculus in high school?
- Calculus invented by Sir Isaac Newton ----->
- An important aspect of physics that we can use python to approximate



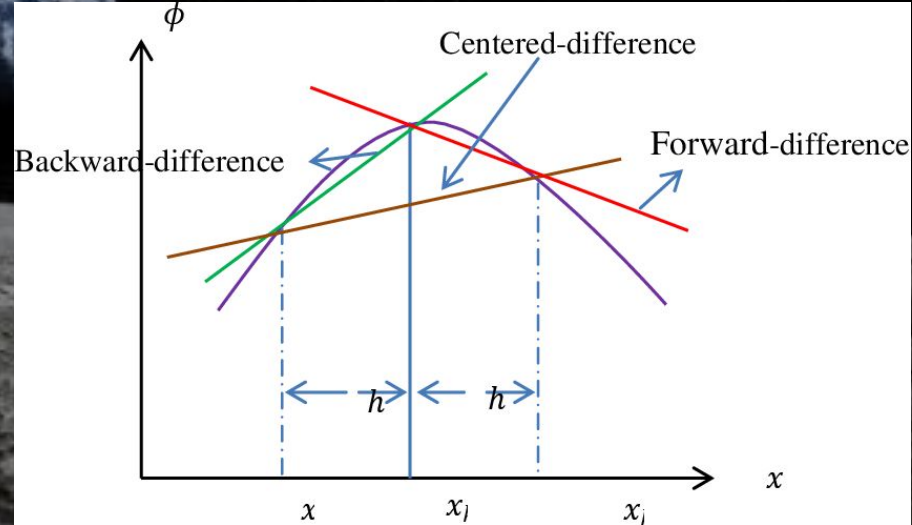
Differentiation

- Used to analyse the rate of change of any function
- The derivative describes the instantaneous slope of a function (slope of a single point instead of between two points)



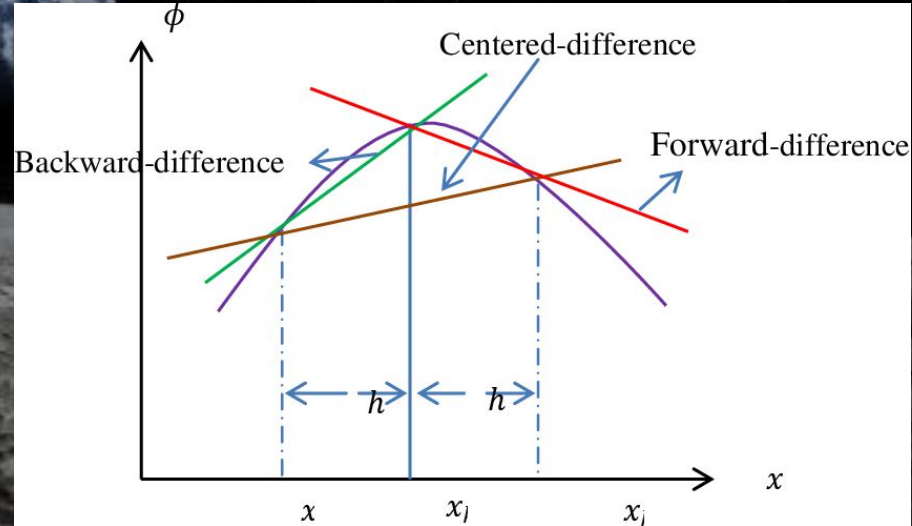
Types of Differentiation: Forward Difference

- Many of our differentiation methods we can code will be approximations
- Also known as two point difference
- Finds the approximation by calculating the slope between a single point and the next one “forward”
- $I'(t_0) = (I_1 - I_0) / (t_1 - t_0)$



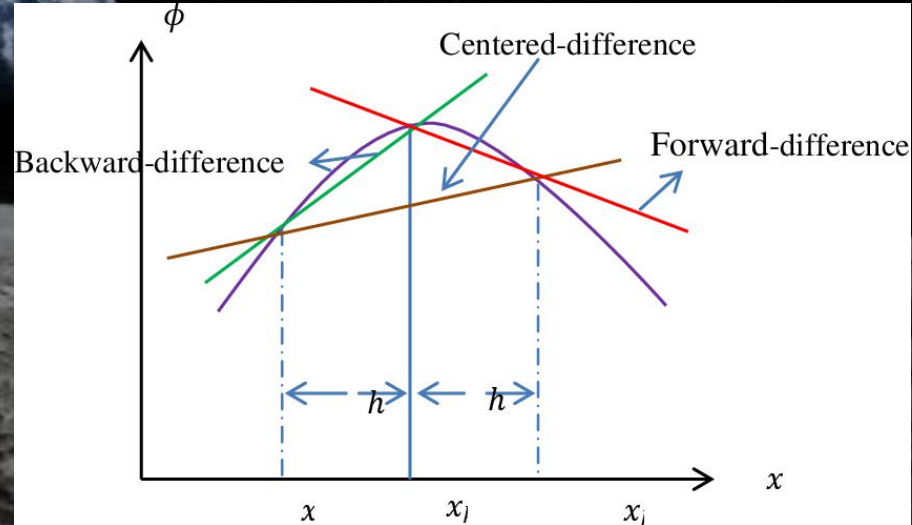
Types of Differentiation: Backward Difference

- Very similar to forward differentiation, just going in the other direction
- Finds the approximation by calculating the slope between a single point and the previous one, hence “backwards”
- $I'(t_0) = (I_0 - I_{-1}) / (t_0 - t_{-1})$



Types of Differentiation: Central Difference

- Also known as three point difference
- An average of both forward and backward differentiation
- Much more accurate approximation than the other two
- $I'(t_0) = (I_1 - I_{-1}) / (t_1 - t_{-1})$



Scipy Differentiation...

- Again, we use some packages

```
from scipy.misc import derivative
```

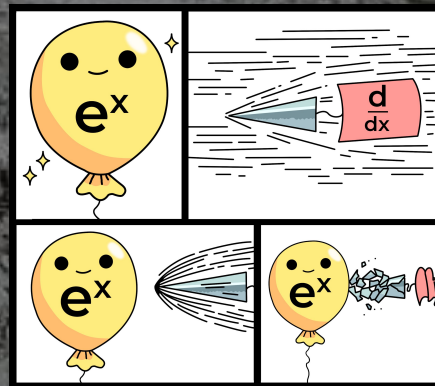
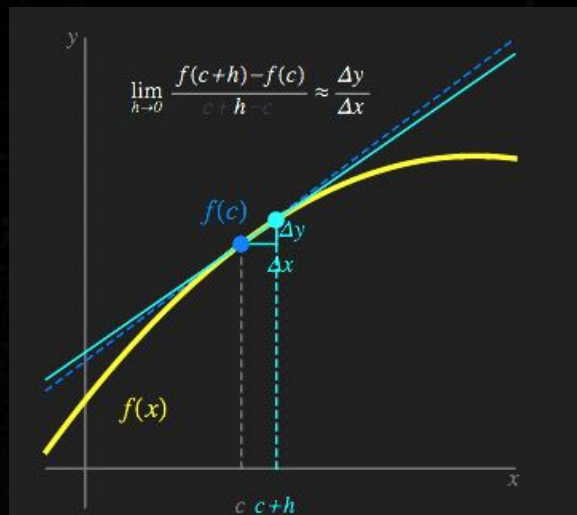
```
derivative(func, x0, dx, n)
```

You have to define
the function that
you want to
differentiate

The point
where you
want to
evaluate the
derivative

spacing

Order of
differentiation



Two ways to define the function

- The normal way:

```
def func(x):  
    return x**2 + x
```

- Lambda

```
derivative(lambda x: x**2+x, x0=17, dx=1e-6, n=1)
```

Writing a short function of variable x

A composite image featuring the Earth as seen from the Moon. The Earth is a bright blue and white sphere in the upper center of the frame. Below it, the dark, cratered horizon of the Moon is visible. In the foreground, the lunar surface is covered in grey dust and rocks, with several sets of boot prints leading from the bottom right towards the center. The background is a deep black space filled with numerous small white stars.

Ready for some calculus in python?

Demo Time