Module 18 Activities:
Functions with Default Arguments and Anonymous Functions

1. Implement the following formula for compound interest. **The name of the variables need to be more descriptive and variables should be passed by name and not by position**.

P	principal amount (The amount that you borrow or deposit.)
r	annual rate of interest (as a decimal)
t	number of years that the amount is deposited or borrowed for.
A	amount of money accumulated after t years including interest.
n	number of times that the interest is compounded per year.

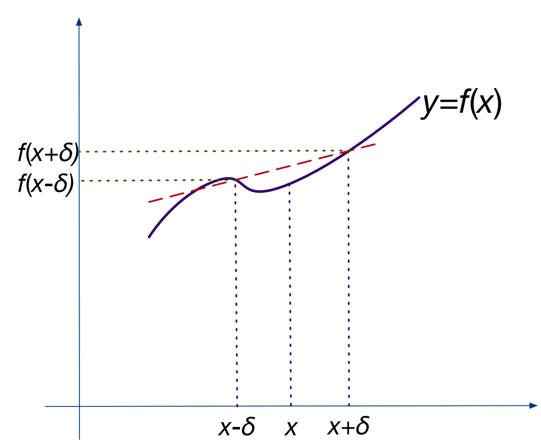
$$A = P(1 + \frac{r}{n})^{nt}$$

An amount of 150,000.- is deposited at an annual interest rate of 5.5 % (or $r = 0.055$).

Print out the amount accumulated after 20 years if the interest is compounded once, four times, twelve times, 365 times, and 1000000 times per year. Pretty-print the table:

```
Times comp   Accum sum
         1    437663.62
         4    447260.59
        12    449493.83
       365    450587.56
   1000000    450624.89
```

2. The standard "finite-difference" method of numerical differentiation uses the slope of a function through two points equally distant from the point taken. In the example on the right, the slope is obtained as the difference of the y-values over the difference of the x-values. As δ gets closer and closer to zero, the secant (the red dotted line) gets closer and closer to the tangent in the point $(x, f(x))$. We therefore set the numerical differential of a function f at x to be



$$f'(x) \approx \frac{f(x+\delta) - f(x-\delta)}{(x+\delta) - (x-\delta)} = \frac{f(x+\delta) - f(x-\delta)}{2\delta}.$$

As you can see from the figure, if δ is too large, the secant is nowhere in parallel to the tangent. However, if δ is too small, then taking the difference between two values that are almost equal for the enumerator can result in a large error.

(a) Implement the numerical differentiator with a default value for δ of 0.000001. The function takes three arguments, the function, the argument of the function, and δ. Then compare the accuracy of the differentiator using the following table:

Function *f*	**Argument x**	**Exact Derivative *f'*(*x*)**
f(x) = sin(x)cos(x)	1	-0.416147
f(x) = x2 tan(x)**	0	0
f(x) = (x2+x+1)(x**3-x+1)**	0	2
f(x)=(sin(x))0.5**	0.5	0.63372

You need to give the argument function using a lambda-expression. Now repeat this task setting $\delta = 0.01$ and $\delta = 1 \times 10^{-20}$.

(b) A more complicated formula using the "five-point stencil" is given below. Repeat the exercise with this formula in lieu of the simple one given above.

$$f'(x) \approx \frac{-f(x+2\delta) + 8f(x+\delta) - 8f(x-\delta) + f(x-2\delta)}{12\delta}$$

3. Use a loop and a test in order to solve the following puzzle: We are looking for the smallest number *n* such that (simultaneously)

$$\begin{aligned}
n &\pmod 2 = 1\\
n &\pmod 3 = 2\\
n &\pmod 4 = 3\\
n &\pmod 5 = 4\\
n &\pmod 6 = 5\\
n &\pmod 7 = 6\\
n &\pmod 8 = 7\\
n &\pmod 9 = 8\\
n &\pmod{10} = 9
\end{aligned}$$

4. Open up the file "alice.txt" (with the text of "Alice in Wonderland") from a previous exercise and print out all lines that do not contain the letter "o".