Exercise Sheet #6

Problem 1 (*Classes and inheritence*) 10 Pts

A zoo wants to keep track of its animals and wants you to write the framework to do so. You should define each animal as a class instance, such that data about them is easily reached and manipulated.

(a) create a class `Animal` with the member variables `string name` storing the animal's nickname, `int cageNumber` storing the cage the animal occupies, `int birthYear` storing the year of birth and a function `void printAge(int year)` that receives the current year as input and prints out the animal's age in years. Set the constructor to initialize all the variables.

(b) To make sure the zoo employees don't corrupt the data, define all variables as private. The function `age` should be public, and you should write another public function `void printData` to allow anyone to see a printout of the private variables.

(c) The zoo has grown much larger and would like to keep a count of the different species it has. Write a species-specific child class, `Wolf`, which inherits from `Animal`. Add a counter to the new class `static int counter` and change the constructor and destructor such that they increase and decrease the counter by 1, respectively. Print out the updated count each time an instance is created or destroyed. Remember to initialize the counter to zero before running your code.

(d) Override the function `printAge` in `Wolf` such that it prints the age times 7 (measured in dog years). Can you access `birthYear`? Change its definition to `protected` in the base class so it becomes visible to the child class.

Problem 2 (*Truncation errors*) 10 Pts

Numerical instability can arise in calculations due to the finite nature of data types. consider the following examples:

(a) Write a loop to sum over $\sum_i^n 1/n$ with $n = 16$ and $n = 512$ using the data types `float`, `double` and `long double`. Print the output in a formatted way, considering the number of digits that are relevant for variables of the respective data type. Is there a difference in the results? Repeat this

for $n = 333$ and $100,000$. Are the results still the same? Explain why this happens (Hint: How are $\frac{1}{16}$ and $\frac{1}{512}$ represented in binary?)

(b) Show that the following expressions are equivalent

- $((a+b)(a-b))^2$
- $(a^2+b^2)^2 - 4(ab)^2$
- $(a^2-b^2)^2$

We choose $a = 10^8+2$ and $b = 10^8-1$. Write a code to calculate the above expressions, using data type `double`. You will notice the expression $(a^2+b^2)^2-4(ab)^2$ is much different than the others. Why is that? Break the calculation down and print out the intermediary steps, especially before and after applying the squares on the brackets. What happens there and why?