Basic Course on R: Object-Oriented Programming Practical Answers

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1 Part A: Object Oriented Programming

1. The ***geometric mean*** can be defined as the nth root of the product of n positive numbers $x_1, x_2, \ldots, x_n$, i.e.

$$\text{gm} = (x_1 \cdot x_2 \cdots x_n)^{\frac{1}{n}}$$

Write a function `gm()` that takes a vector argument `x` containing positive numbers and returns their geometric mean. Your function should include a `stop()` statement that returns an error message if any of the values in `x` are nonpositive. **Hint**: The function `prod()` can be used to compute the product of the values in `x`.

```
gm <- function(x) {
  if(any(x <= 0)){
    stop("All values in the vector must be positive.")
  }
  else{
    y <- prod(x)
    geom <- y^(1/length(x))
    return(geom)
  }
}
```

2. Determine the class of your output by running the following:

```
class(gm(1:4))

## [1] "numeric"
```

3. Modify your geometric mean function, using `class()`, so that the return value has the class `"geometric"`.

```
gm <- function(x){
  if(any(x <= 0)){
    stop("All values in the vector must be positive.")
  }
  else{
    geom <- prod(x)^(1/length(x))
    class(geom) <- "geometric"
    return(geom)
  }
}
```

4. Verify the new class of your output is correct by running the following:

```
class(gm(1:4))

## [1] "geometric"
```

2 Part B: Performance Enhancement: Speed

1. This problem concerns efficiency and timing code.

   Using `system.time(expression)`, explore how time changes with size of the inputs (e.g. use sizes 100, 1000, 10000, 100000, 1000000, 10000000). Plot time versus input size and see if algorithm is linear, polynomial, or exponential.

   - Move expressions within loops that are invariant to compute just once and assigned to a variable.
   - Avoid concatenating vectors by pre-allocating and assigning to the ith element. i.e.

     ```
     x <- c(); for(i in seq(along = y)) x = c(x, g(y[i]))
     ```

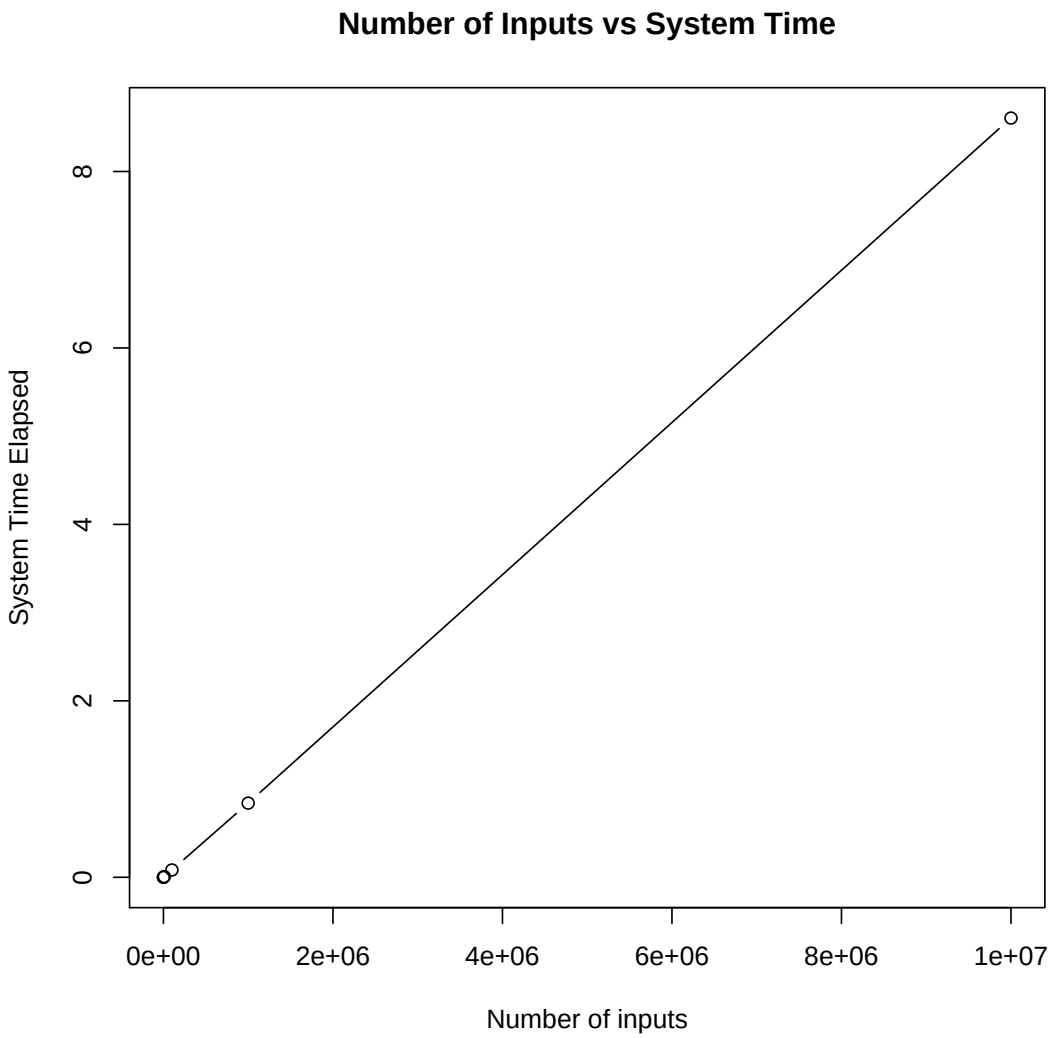
   What are your conclusions?

   Answers may vary.

```
time <- function(n){
  x <- runif(n)
  y <- sqrt(2)
  t <- system.time( for(i in 1:n) {
    x[i] <- x[i] + y
  }
  )
  return(t[["elapsed"]])
}
inputs <- c(100, 10^3, 10^4, 10^5, 10^6, 10^7)
t1 <- time(100)
t2 <- time(10^3)
t3 <- time(10^4)
t4 <- time(10^5)
t5 <- time(10^6)
```

```
t6 <- time(10^7)
timeV <- c(t1, t2, t3, t4, t5, t6)
```

```
plot(x = inputs, y = timeV, main = "Number of Inputs vs System Time",
     xlab = "Number of inputs", ylab = "System Time Elapsed",
     type = "b")
```



The scatterplot of computation time versus size of inputs is somewhat linear.