# Comparing Four Methods for Findng Factorial

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## Contents



# Part 1

The objective is to write a function that computes the factorial of an integer greater than or equal to 0. The factorial of 0 is defined to be 1. Here are four different versions of the Factorial function:

### Factorial_loop()

```
Factorial_loop <- function(x) {
      result <- x
      if (x < 0) (return(paste('You entered a negative number: not gonna work.')))
      if (x < 1) (return(1))
      for (i in (x - 1):1) {
            result <- result * i
            }
      result
}
x = 5
Factorial_loop(x)
```

```
## [1] 120
```

### Factorial_reduce()

```
library(purrr)
```

```
## Warning: package 'purrr' was built under R version 3.5.1
```

```
Factorial_reduce <- function(x) {
      if (x < 0) (return(paste('You entered a negative number: not gonna work.')))
      if (x < 1) (return(1))
      reduce(x:1, function(x, y) {
            x * y
      })
}
```

```
x = 5
Factorial_reduce(x)
```

```
## [1] 120
```

## Factorial_func()

```
Factorial_func <- function(x) {
      if (x == 0) (1)
      else if (x < 0) {
            paste('You entered a negative number: not gonna work.')
      } else {
            return(Factorial_func(x - 1) * x)
      }
}
x = 5
Factorial_func(x)
```

```
## [1] 120
```

## Factorial_mem()

```
previous_factorials <- 1
Factorial_mem <- function(n) {
      if (x == 0) (return(1))
      else if (x < 0) return(paste('You entered a negative number: not gonna work.'))

      #grow previous_factorials if necessary
      if (length(previous_factorials) < n) previous_factorials <<- `length<-`(previous_factorials, n)

      #return pre-calculated value
      if (!is.na(previous_factorials[n])) return(previous_factorials[n])

      #calculate new values
      previous_factorials[n] <<- n * Factorial_mem(n - 1)
      previous_factorials[n]
}

x = 5
Factorial_mem(x)
```

```
## [1] 120
```

## Benchmarks

The next code chunk uses a range of inputs to time the operation of the four functions above. It also provides a visual summary of their performance.

```
library(dplyr)
library(purrr)
library(magrittr)
```

```
library(tidyr)
library(microbenchmark)
```

```
## Warning: package 'microbenchmark' was built under R version 3.5.1
```

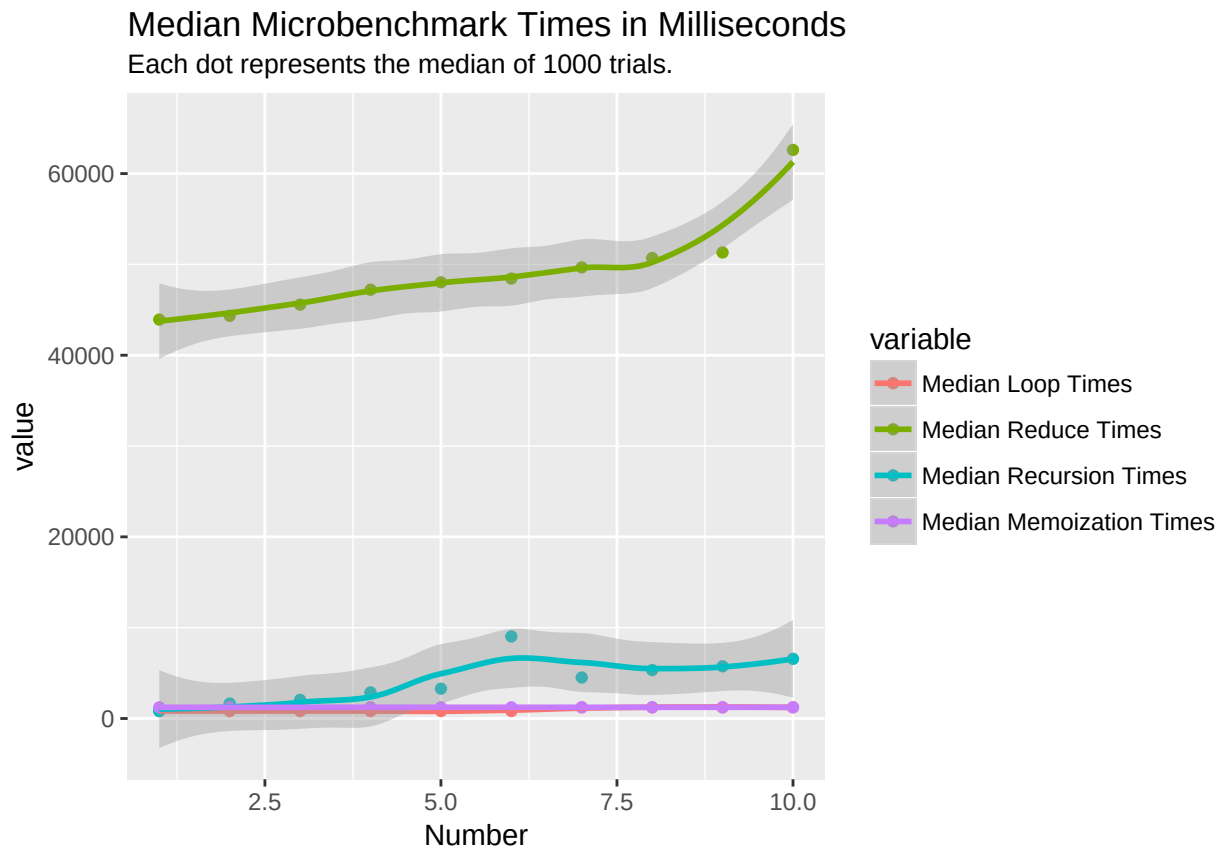
```
library(ggplot2)
```

```
#Loop Method
loop_data <- map(1:10, function(x) {microbenchmark(Factorial_loop(x),
                                                   times = 100)$time})
names(loop_data) <- paste(1:10)
loop_data <- as_tibble(loop_data)
loop_data %<>%
      gather(num, time) %>%
      group_by(num) %>%
      summarise(Median_Loop_Times = median(time))
loop_data$num <- as.numeric(loop_data$num)
loop_data <- loop_data[order(loop_data$num),]

#Reduce Method
reduce_data <- map(1:10, function(x) {microbenchmark(Factorial_reduce(x),
                                                     times = 100)$time})
names(reduce_data) <- paste(1:10)
reduce_data <- as_tibble(reduce_data)
reduce_data %<>%
      gather(num, time) %>%
      group_by(num) %>%
      summarise(Median_Reduce_Times = median(time))
reduce_data$num <- as.numeric(reduce_data$num)
reduce_data <- reduce_data[order(reduce_data$num),]

#Recursion Method
recursion_data <- map(1:10, function(x) {microbenchmark(Factorial_func(x),
                                                   times = 100)$time})
names(recursion_data) <- paste(1:10)
recursion_data <- as_tibble(recursion_data)
recursion_data %<>%
      gather(num, time) %>%
      group_by(num) %>%
      summarise(Median_Recursion_Times = median(time))
recursion_data$num <- as.numeric(recursion_data$num)
recursion_data <- recursion_data[order(recursion_data$num),]

#Memoization Method
memo_data <- map(1:10,
                 function(x) {microbenchmark(Factorial_mem(x))$time})
names(memo_data) <- paste(1:10)
memo_data <- as_tibble(memo_data)
memo_data %<>%
      gather(num, time) %>%
      group_by(num) %>%
      summarise(Median_Memoization_Times = median(time))
memo_data$num <- as.numeric(memo_data$num)
memo_data <- memo_data[order(memo_data$num),]
```

```
#Combine them in a single tibble

mbenchmarks <- as_tibble(cbind(loop_data,
                               reduce_data[,2],
                               recursion_data[,2],
                               memo_data[,2]))
colnames(mbenchmarks) <- c('Number', 'Median Loop Times', 'Median Reduce Times',
                           'Median Recursion Times', 'Median Memoization Times')
library("reshape2")
test_data_long <- melt(mbenchmarks, id = "Number")  # convert to long format
```

Next, plot the times.

```
suppressWarnings(print(
      ggplot(test_data_long, aes(Number,value,
                            col = variable)) +
            geom_point() +
            geom_smooth() +
            labs(title = "Median Microbenchmark Times in Milliseconds",
                 subtitle = "Each dot represents the median of 1000 trials.")
))
```




The loop times seem surprisingly low. They were done with a backwards loop multiplying the previous result by the index. That saved a lot of time. Recursion with memoization also performed well, as expected.