Project for Theoretical Statistics

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In today class, we have an optional project for Theoretical Statistics I.

In the lecture, Professor Zhang mentioned that the selection can be categorized into four settings.

	without replacement	with replacement
Ordered	$\frac{n!}{(n-r)!}$	n^r
Unordered	$\binom{n}{r}$	$\binom{n+r-1}{r}$

Variable Explanation

- Variable *replace*, *ordered*, are binary variables with value 0 or 1.
- Variable *ticket* is the number of lottery bought.
- Variable n is all the numbers that you can choose.
- Variable c is the number of selected for any subset.

I found out that the factorial function in base R use gamma approximation. When the value is too large the result will be biased. In this case, I created a fatorial function called *myFactorial*

The R Code starts here:

```
rm(list=ls())   ##Clear memory space

## Create Function to calculate Factorial
myFactorial <- function(x) {
    if (x == 0)
      {return(1)}
  return(x*myFactorial(x-1))
}

## Function to determine integer
check.integer <- function(x) {
    x == round(x)
}

lottery<-function(replace=0,ordered=0,ticket=1,n=53,r=6){
  stopifnot(replace==0|replace==1)  ##Stop if replace is not a binary variable
  stopifnot(ordered==0|ordered==1)  ##Stop if ordered is not a binary variable
  stopifnot(check.integer(ticket))  ##Stop if ticket is not an integer
  stopifnot(ticket>0)               ##Stop if ticket is less than 1
  stopifnot(check.integer(n))       ##Stop if n is not an integer
  stopifnot(check.integer(r))       ##Stop if r is not an integer
  stopifnot((n-r)>0)                ##Make sure n greater than r

  #Categorize them into four categories
  if (replace==0 && ordered==1){type=1}
```

```
  else if (replace==1 && ordered==1){type=2}
  else if (replace==0 && ordered==0){type=3}
  else if (replace==1 && ordered==0){type=4}

  #Calculate for type=1 which is without replacement but ordered
  if (type==1){
    event<-myFactorial(n)/myFactorial(n-r)
  }
  #Calculate for type=2 which is with replacement and ordered
  else if (type==2){
    event<-(n)^(r)
  }
  #Calculate for type=3 which is without replacement nor unordered
  else if (type==3){
    event<-(myFactorial(n))/(myFactorial(r)*myFactorial(n-r))
  }
  #Calculate for type=2 which is with replacement but unorder
  else if (type==4){
    event<-(myFactorial(n+r-1))/(myFactorial(r)*myFactorial(n-1))
  }

  ##Calculate winning rate
  winRate<-(1/event)*ticket

  return(cat(c(paste0("Your chance of winning the lottery is ",winRate),
       paste0("The number of outcomes is ",event)
       ),sep="\n"))
}
```

Example1

```
lottery(replace=0,ordered=0,ticket=1,n=54,r=7)
```

```
## Your chance of winning the lottery is 5.64650953108223e-09
## The number of outcomes is 177100560
```

Example2

```
lottery(replace=1,ordered=0,ticket=2,n=35,r=5)
```

```
## Your chance of winning the lottery is 3.473687684214e-06
## The number of outcomes is 575757
```