Optimization

```
# Example of MLE optimization using log-likelihood of Gamma distribution, found in "Optimization" Lectu
LL=function(theta,x){
    n=length(x)
    sx=sum(x)
    slogx=sum(log(x))
    r=theta[1]
    lambda=theta[2]
    loglik=n*r*log(lambda)
    loglik=loglik+(r-1)*slogx-lambda*sx
    loglik=loglik-n*log(gamma(r))
    return(-loglik)
}

r=5
lambda=2
x=rgamma(100,r,lambda)
optim(c(1,1),LL,x=x)
```

```
## $par
## [1] 5.311412 2.173240
##
## $value
## [1] 141.1846
##
## $counts
## function gradient
##       69       NA
##
## $convergence
## [1] 0
##
## $message
## NULL
```

```
library(SimDesign)

LL=function(theta,x){
    n=length(x)
    sx=sum(x)
    slogx=sum(log(x))
    r=theta[1]
    lambda=theta[2]
    loglik=n*r*log(lambda)
    loglik=loglik+(r-1)*slogx-lambda*sx
    loglik=loglik-n*log(gamma(r))
    return(-loglik)
}
```

```r
#### Step 1 --- Define your conditions under study and create design data.frame

Design <- data.frame(N = c(100, 1000, 10000))

#~~~~~~~~~~~~~~~~~~~~~~~
#### Step 2 --- Define generate, analyse, and summarise functions

# help(Generate)
Generate <- function(condition, fixed_objects = NULL){
    lambda <- 2
    r <- 5
    x <- with(condition, rgamma(N, r, lambda)) # distributed N(10, 5)
    dat <- data.frame('x'=x)
    dat
}

# help(Analyse)
Analyse <- function(condition, dat, fixed_objects = NULL){
    x <- optim(c(1,1), LL, x=dat$x) # mean of the sample data vector
    results <- data.frame('r'=mean(x$par[1]), 'lambda'=mean(x$par[2]))
    results
}

# help(Summarise)
Summarise <- function(condition, results, fixed_objects = NULL){
    ret <- c(r=mean(results$r), r_sd=sd(results$r), lambda=mean(results$lambda), lambda_sd=sd(results$r
    ret
}


#~~~~~~~~~~~~~~~~~~~~~~~
#### Step 3 --- Collect results by looping over the rows in design

# run the simulation
Final <- runSimulation(design=Design, replications=1000,
                       generate=Generate, analyse=Analyse, summarise=Summarise)
```

```
##
##
Design row: 1/3;   Started: Fri Dec 13 14:48:46 2019;   Total elapsed time: 0.00s
##
##
Design row: 2/3;   Started: Fri Dec 13 14:48:48 2019;   Total elapsed time: 1.50s
##
##
Design row: 3/3;   Started: Fri Dec 13 14:48:50 2019;   Total elapsed time: 3.71s
##
## Simulation complete. Total execution time: 18.90s
```

```r
Final
```

```
##       N        r       r_sd   lambda  lambda_sd REPLICATIONS SIM_TIME
## 1   100 5.141240 0.70667674 2.059443 0.70667674         1000    1.50s
## 2  1000 5.009739 0.21436882 2.004403 0.21436882         1000    2.20s
```

```
## 3 10000 5.001739 0.06650399 2.000612 0.06650399         1000   15.20s
##                   COMPLETED       SEED
## 1 Fri Dec 13 14:48:48 2019 1164521191
## 2 Fri Dec 13 14:48:50 2019  308209069
## 3 Fri Dec 13 14:49:05 2019  787047969
```

```
# reproduce exact simulation
Final_rep <- runSimulation(design=Design, replications=1000, seed=Final$SEED,
                       generate=Generate, analyse=Analyse, summarise=Summarise)
```

```
##
##
Design row: 1/3;   Started: Fri Dec 13 14:49:05 2019;   Total elapsed time: 0.00s
##
##
Design row: 2/3;   Started: Fri Dec 13 14:49:06 2019;   Total elapsed time: 1.10s
##
##
Design row: 3/3;   Started: Fri Dec 13 14:49:08 2019;   Total elapsed time: 3.17s
```

```
##
## Simulation complete. Total execution time: 18.65s
```

```
Final_rep
```

```
##       N        r       r_sd   lambda  lambda_sd REPLICATIONS SIM_TIME
## 1   100 5.141240 0.70667674 2.059443 0.70667674         1000    1.10s
## 2  1000 5.009739 0.21436882 2.004403 0.21436882         1000    2.06s
## 3 10000 5.001739 0.06650399 2.000612 0.06650399         1000   15.48s
##                   COMPLETED       SEED
## 1 Fri Dec 13 14:49:06 2019 1164521191
## 2 Fri Dec 13 14:49:08 2019  308209069
## 3 Fri Dec 13 14:49:24 2019  787047969
```