

Problem 1

The R program *dpareto.R* is as follows.

```
dpareto <- function(x, alpha, beta, log = FALSE) {

  # Calculate the maximum length of inputs
  L <- max(length(x), length(alpha), length(beta))

  # Align all the inputs
  x <- rep(x, length.out = L)
  alpha <- rep(alpha, length.out = L)
  beta <- rep(beta, length.out = L)

  logdens <- ifelse(alpha <= 0 | beta <= 0,
                    NaN,
                    ifelse(x <= alpha,
                          log(0),
                          log(beta) + beta * log(alpha) - (beta + 1) * log(x)))

  # Check whether NaNs exist
  if (sum(is.nan(logdens)))
    warning("NaNs produced")

  if (log) logdens else exp(logdens)
}
```

I used the following code to test it.

```
dpareto(3, 2, 1)
dpareto(1, 2, 3)
dpareto(3, -2, 1)
dpareto(3, 2, -1)
dpareto(3 : 5, 2, 1)
dpareto(1 : 5, 2, 1)
dpareto(6, 2 : 4, 1)
dpareto(3, 2, 1, log = TRUE)
```

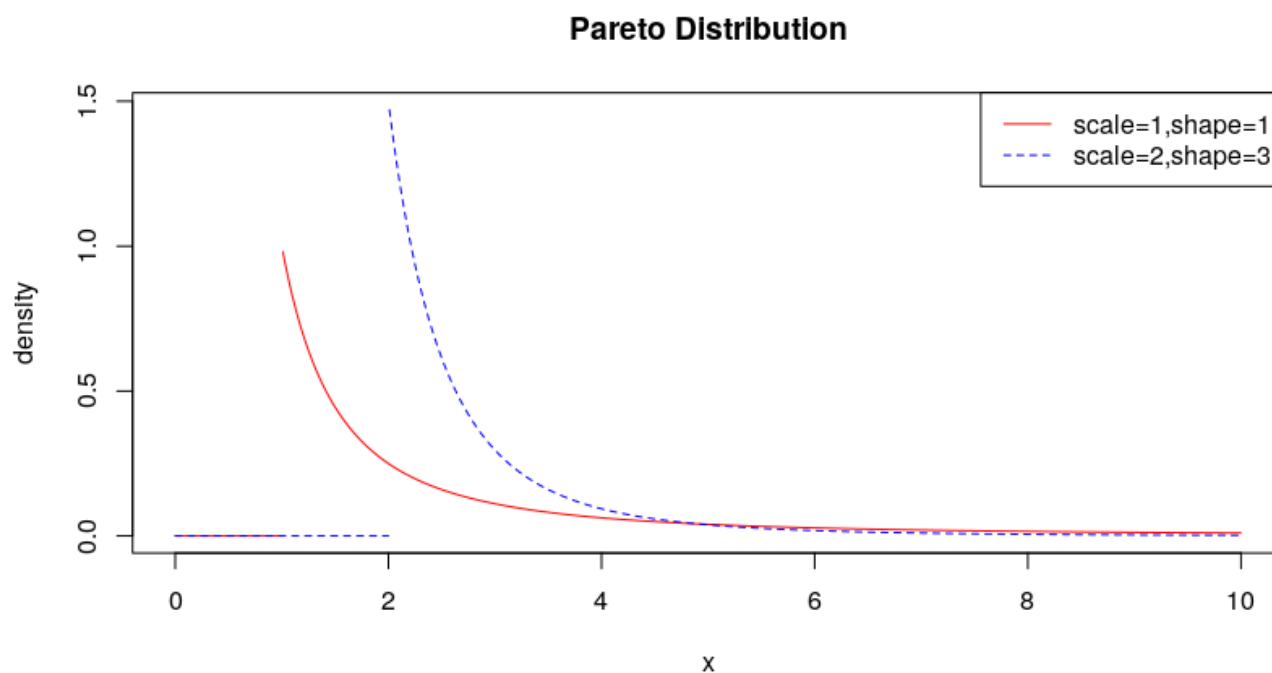
The results are as follows.

```
> dpareto(3, 2, 1)
[1] 0.2222222
> dpareto(1, 2, 3)
[1] 0
> dpareto(3, -2, 1)
[1] NaN
```

Warning message:

```
In dpareto(3, -2, 1) : NaNs produced
> dpareto(3, 2, -1)
[1] NaN
Warning message:
In dpareto(3, 2, -1) : NaNs produced
> dpareto(3 : 5, 2, 1)
[1] 0.2222222 0.1250000 0.0800000
> dpareto(1 : 5, 2, 1)
[1] 0.0000000 0.0000000 0.2222222 0.1250000 0.0800000
> dpareto(6, 2 : 4, 1)
[1] 0.05555556 0.08333333 0.11111111
> dpareto(3, 2, 1, log = TRUE)
[1] -1.504077
```

Then I used this function to plot the densities of tow sets of parameters in R.



Problem 2

The C program *paretodensDotC.c* and R program *paretodensDotC.R* are attached in Appendix. I used the following code to compile *paretodensDotC.c* and create shared objects for loading into R.

```
R CMD SHLIB paretodensDotC.c -Wall -pedantic
```

In Rstudio, I used `dyn.load("paretodensDotC.so")` to load the shared object file I just created. Then I can use the R function `paretodensDotC` I defined in *paretodensDotC.R* with `.C` interface to call my C function. I used the following code to test it.

```
paretodensDotC(3, 2, 1)
paretodensDotC(1, 2, 3)
paretodensDotC(3, -2, 1)
paretodensDotC(3, 2, -1)
paretodensDotC(3 : 5, 2, 1)
paretodensDotC(1 : 5, 2, 1)
paretodensDotC(6, 2 : 4, 1)
paretodensDotC(3, 2, 1, log = TRUE)
```

The results are as follows.

```
> paretodensDotC(3, 2, 1)
[1] 0.2222222
> paretodensDotC(1, 2, 3)
[1] 0
> paretodensDotC(3, -2, 1)
[1] NaN
Warning message:
In paretodensDotC(3, -2, 1) : NaNs produced
> paretodensDotC(3, 2, -1)
[1] NaN
Warning message:
In paretodensDotC(3, 2, -1) : NaNs produced
> paretodensDotC(3 : 5, 2, 1)
[1] 0.2222222 0.1250000 0.0800000
> paretodensDotC(1 : 5, 2, 1)
[1] 0.0000000 0.0000000 0.2222222 0.1250000 0.0800000
> paretodensDotC(6, 2 : 4, 1)
[1] 0.05555556 0.08333333 0.11111111
> paretodensDotC(3, 2, 1, log = TRUE)
[1] -1.504077
```

Appendix

paretodensDotC.c

```
#include <math.h>
#include <R.h>
#ifndef max
#define max( a, b ) ( ((a) > (b)) ? (a) : (b) )
#endif

/*Define parto density function*/
void paretodensDotC(double *x, int *nx, double *alpha, int *nalpha,
                    double *beta, int *nbeta, double *dens, int *lg)
{
    /*Calculate the maximum input length */
    int i, n = max(max(nx[0], nalpha[0]), nbeta[0]), flag = 0, ind[3];
    double ldens[n];

    for (i = 0; i < n; i++) {
        ind[0] = i % nx[0];
        ind[1] = i % nalpha[0];
        ind[2] = i % nbeta[0];

        /*Calculate whether alpha and beta are meaningful */
        if (alpha[ind[1]] <= 0 || beta[ind[2]] <= 0) {
            ldens[i] = NAN;
            flag++;
        }
        /*Check whether x is greater than alpha */
        else if (x[ind[0]] <= alpha[ind[1]]) {
            ldens[i] = log(0);
        }
        else {
            ldens[i] =
                log(beta[ind[2]]) + beta[ind[2]] * log(alpha[ind[1]]) -
                (beta[ind[2]] + 1) * log(x[ind[0]]);
        }

        if (lg[0] == 0) {
            dens[i] = exp(ldens[i]);
        }
        else {
            dens[i] = ldens[i];
        }
    }
}
```

```
    }  
    /*Check whether NaNs exist */  
    if (flag > 0) {  
        warning("NaNs produced");  
    }  
}
```

paretodensDotC.R

```
paretodensDotC <- function(x, alpha, beta, log = FALSE) {  
    nx <- length(x)  
    nalpha <- length(alpha)  
    nbeta <- length(beta)  
    n <- max(nx, nalpha, nbeta)  
  
    result <- .C("paretodensDotC",  
                as.double(x), as.integer(nx),  
                as.double(alpha), as.integer(nalpha),  
                as.double(beta), as.integer(nbeta),  
                dens = double(n), as.integer(log))  
    result$dens  
}
```