# Problem Set 1

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GitHub repository link : [https://github.com/tedheo10/homework1_STATS506](https://github.com/tedheo10/homework1_STATS506)

## Problem 1 - Wine data

**P1-a.** import “wine.data” into a data.frame in R and give column names

```
winedata <- read.table("wine.data", sep = ",")
colnames(winedata) <- c("class", "alcohol", "acid", "ash", "alcalinity",
"magnesium", "phenols", "flavanoids", "nonflavanoid_phenols",
"proanthocyanins", "color_intensity", "hue", "protein", "proline")
```

**P1-b.** check the number of wines within each class
[class1 = 59, class2 = 71, class3 = 48]

```
wineclass <- winedata$class
count <- c(length(which(wineclass==1)), length(which(wineclass == 2)),
           length(which(wineclass == 3)))
report <- c(59, 71, 48)

if(count[1] == report[1] & count[2] == report[2] & count[3] == report[3])
  {
  print("correct as reported in wine.names")
  } else {
  print("wrong as reported in wine.names")
  }
```

```
[1] "correct as reported in wine.names"
```

**P1-c-1.** the correlation between alcohol content and color intensity
the correlation : **0.5463642**

```
alcohol <- winedata$alcohol
color <- winedata$color_intensity
cor(alcohol, color)
```

```
[1] 0.5463642
```

**P1-c-2.** the highest and the lowest correlation
the highest : **class1(0.4082913)**
the lowest : **class2(0.2697891)**

```
class <- winedata$class

alcohol1 <- winedata$alcohol[winedata$class == 1]
alcohol2 <- winedata$alcohol[winedata$class == 2]
alcohol3 <- winedata$alcohol[winedata$class == 3]

color1 <- winedata$color[winedata$class == 1]
color2 <- winedata$color[winedata$class == 2]
color3 <- winedata$color[winedata$class == 3]

gcor <- c(cor(alcohol1, color1), cor(alcohol2, color2),
          cor(alcohol3, color3))
gcor
```

```
[1] 0.4082913 0.2697891 0.3503777
```

**P1-c-3.** the alcohol content of the wine with the highest color intensity
the alcohol content with the hightest color intensity : **14.34**

```
length(which(color == max(color)))
```

```
[1] 1
```

```
alcohol_hcolor <- winedata$alcohol[winedata$color_intensity == max(color)]
alcohol_hcolor
```

```
[1] 14.34
```

**P1-c-4.** the percentage of the wines with a higher content of proanthocyanins compare to ash
the percentage : **8.426966%**

```
proanthocyanins <- winedata$proanthocyanins
proan_higher <- winedata$proanthocyanins[winedata$proanthocyanins > winedata$a
length(proan_higher) / length(proanthocyanins) * 100
```

```
[1] 8.426966
```

**P1-d.** table for the average value of each variable
the table : **average_table**

```
average_table <- matrix(0, nrow = 4, ncol = length(colnames(winedata))-1)
colnames(average_table) <- colnames(winedata[2:14])
rownames(average_table) <- c("overall", "class1", "class2", "class3")

cal_mat <- as.matrix(winedata)
n <- ncol(cal_mat)-1

ave_overall <- numeric(n)
```

```r
ave_class1 <- numeric(n)
ave_class2 <- numeric(n)
ave_class3 <- numeric(n)

for ( i in 1:n) {
  ave_overall[i] <- mean(cal_mat[,i+1])
  ave_class1[i] <- mean(cal_mat[cal_mat[,1] == 1, i+1])
  ave_class2[i] <- mean(cal_mat[cal_mat[,1] == 2, i+1])
  ave_class3[i] <- mean(cal_mat[cal_mat[,1] == 3, i+1])
}

average_table["overall",] <- ave_overall
average_table["class1",] <- ave_class1
average_table["class2",] <- ave_class2
average_table["class3",] <- ave_class3

average_table
```

```
         alcohol     acid      ash alcalinity magnesium  phenols flavanoids
overall 13.00062 2.336348 2.366517   19.49494  99.74157 2.295112  2.0292697
class1  13.74475 2.010678 2.455593   17.03729 106.33898 2.840169  2.9823729
class2  12.27873 1.932676 2.244789   20.23803  94.54930 2.258873  2.0808451
class3  13.15375 3.333750 2.437083   21.41667  99.31250 1.678750  0.7814583
        nonflavanoid_phenols proanthocyanins color_intensity       hue  protein
overall            0.3618539        1.590899        5.058090 0.9574494 2.611685
class1             0.2900000        1.899322        5.528305 1.0620339 3.157797
class2             0.3636620        1.630282        3.086620 1.0562817 2.785352
class3             0.4475000        1.153542        7.396250 0.6827083 1.683542
          proline
overall  746.8933
class1  1115.7119
class2   519.5070
class3   629.8958
```

**P1-e.** t-test to examine whether the level of phenols differs across the three classes

We can reject the hypothesis that the level of phenols is the same across the three classes because all three p-values are less than 0.01. So we can conclude that the level of phenols differs across the three classes.

t-test p-value between class1 and class2 : **$1.889e^{-11}$**
t-test p-value between class1 and class3 : **$< 2.2e^{-16}$**
t-test p-value between class2 and class3 : **$1.622e^{-10}$**

```r
phenols1 <- winedata$phenols[winedata$class == 1]
phenols2 <- winedata$phenols[winedata$class == 2]
phenols3 <- winedata$phenols[winedata$class == 3]

t.test(phenols1, phenols2)
```

```
    Welch Two Sample t-test
```

```
data:  phenols1 and phenols2
t = 7.4206, df = 119.14, p-value = 1.889e-11
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.4261870 0.7364055
sample estimates:
mean of x mean of y
 2.840169  2.258873
```

```
t.test(phenols1, phenols3)
```

```

	Welch Two Sample t-test

data:  phenols1 and phenols3
t = 17.12, df = 98.356, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 1.026801 1.296038
sample estimates:
mean of x mean of y
 2.840169  1.678750
```

```
t.test(phenols2, phenols3)
```

```

	Welch Two Sample t-test

data:  phenols2 and phenols3
t = 7.0125, df = 116.91, p-value = 1.622e-10
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.4162855 0.7439610
sample estimates:
mean of x mean of y
 2.258873  1.678750
```

## Problem 2 - AskAManager.org Data

**P2-a.** import AskAManager.csv into a data.frame

```
salary <- read.csv("AskAManager.csv")
```

**P2-b.** simplify the variable names

```
colnames(salary) <- c("number", "time", "age", "industry", "title",
                      "title_context", "salary", "bonus", "currency",
                      "currency_other", "income_context", "country",
```

```
                        "state", "city", "experience", "experience_field",
                        "education", "gender", "race")
```

**P2-c.** restrict the data to those paid in USD
the number of observations before : **28,062**
the number of oberservations after the restriction : **23,374**

```
length(salary$currency)
```

```
[1] 28062
```

```
length(salary$currency[salary$currency == "USD"])
```

```
[1] 23374
```

```
salary_res <- salary[salary$currency == "USD", ]

nrow(salary_res) == length(salary$currency[salary$currency == "USD"])
```

```
[1] TRUE
```

**P2-d.** Eliminate any rows for which their age, years of experience in their field, and years of experience total are impossible
the number of observation after the elimination : **23,116**

```
age <- salary_res$age
field <- salary_res$experience_field
total <- salary_res$experience

age[!duplicated(age)]
```

```
[1] "25-34"      "45-54"      "35-44"      "18-24"      "65 or over"
[6] "55-64"      "under 18"
```

```
field[!duplicated(field)]
```

```
[1] "5-7 years"         "2 - 4 years"       "21 - 30 years"     "11 - 20 years"
[5] "8 - 10 years"      "1 year or less"    "31 - 40 years"     "41 years or more"
```

```
total[!duplicated(total)]
```

```
[1] "5-7 years"         "2 - 4 years"       "8 - 10 years"      "21 - 30 years"
[5] "11 - 20 years"     "41 years or more" "31 - 40 years"     "1 year or less"
```

```
age_kind <- c("25-34" = 16, "45-54" = 36, "35-44" = 26, "18-24" = 6,
              "65 or over" = 56, "55-64" = 46, "under 18" = 0)

experience_kind <- c("5-7 years" = 5, "2 - 4 years" = 2,
```

```r
                              "8 - 10 years" = 8, "21 - 30 years" = 21,
                              "11 - 20 years" = 11, "41 years or more" = 41,
                              "31 - 40 years" = 31, "1 year or less" = 1 )

age_trans <- age_kind[age]
field_trans <- experience_kind[field]
total_trans <- experience_kind[total]
n_usd <- nrow(salary_res)
memo <- logical(n_usd)

for(i in 1:n_usd) {
  # if age < 18, eliminate the data
  # if age - 18 < field experience, eliminate the data
  # if age - 18 < total experience, eliminate the data
  # if total experience < field experience, eliminate the data

  if(age_trans[i] == 0) {
       memo[i] = FALSE
  }
  else if(field_trans[i]>age_trans[i]) {
       memo[i] = FALSE
  }
  else if(total_trans[i]>age_trans[i]) {
       memo[i] = FALSE
  }
  else if(field_trans[i]>total_trans[i]) {
       memo[i] = FALSE
  }
  else {
       memo[i] = TRUE
  }
}

#test whether age is under 18
salary_year <- salary_res[memo, ]
salary_year$age[!duplicated(salary_year$age)]
```

```
[1] "25-34"      "45-54"      "35-44"      "18-24"      "65 or over"
[6] "55-64"
```

```r
#test example for whether their is reasonable with total experience
experience_test <- salary_year$age[salary_year$experience
                                   == "41 years or more"]
experience_test[!duplicated(experience_test)]
```

```
[1] "65 or over" "55-64"
```

```r
#test example for whether their is reasonable with field experience
fieldexp_test <- salary_year$age[salary_year$experience_field
                                 == "41 years or more"]
fieldexp_test[!duplicated(fieldexp_test)]
```

```
[1] "65 or over" "55-64"
```

```
#test example for whether filed experience is less than total experience
exp_fieldexp_test <- salary_year$experience_field[salary_year$experience
                                                  == "8 - 10 years"]
exp_fieldexp_test[!duplicated(exp_fieldexp_test)]
```

```
[1] "5-7 years"      "2 - 4 years"    "8 - 10 years"   "1 year or less"
```

```
nrow(salary_year)
```

```
[1] 23116
```

**P2-e.** eliminate any rows with extremely low or high salaries.

The other monetary compensation is added to salalry in order to eliminate false slalrries.

The extreme high salary : **1,459,608 USD** (mean + 2*standard deviation)
-> There are values on the right side of the distribution that differ from the mean by more than twice the standard deviation.

The extreme low salary : **1,000 USD**
-> There's a very thick tail on the left side of the distribution.

The sample size : **23,044**

```
income <- salary_year$salary
bonus <- salary_year$bonus
bonus[is.na(bonus)] <- 0
monetary_reward <- income + bonus
summary(monetary_reward)
```

```
     Min.    1st Qu.     Median       Mean    3rd Qu.       Max.
        0      58000      81000     106240     120000  102000000
```

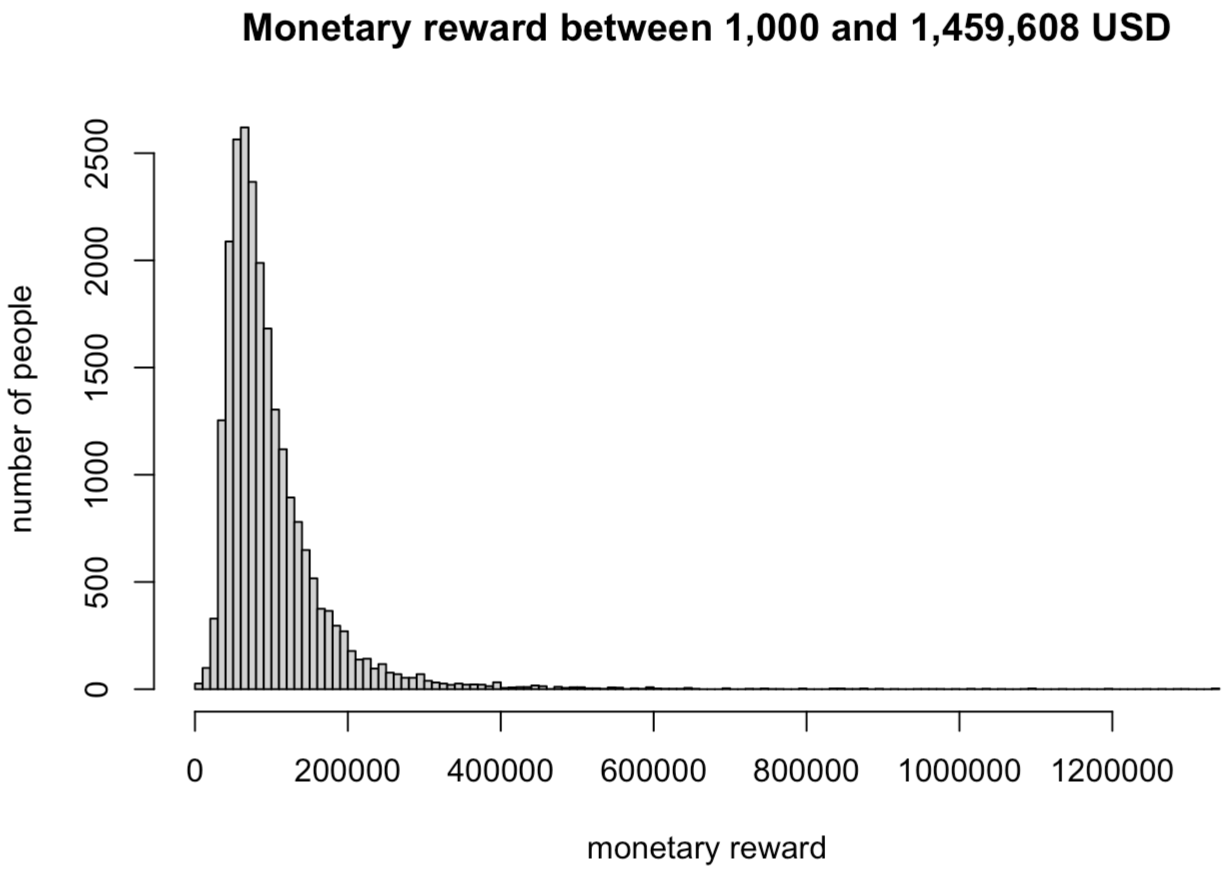
```
n_year <- length(monetary_reward)

mean_monetary <- mean(monetary_reward)
sd_monetary <- sd(monetary_reward)
mean_monetary + 2*sd_monetary
```

```
[1] 1459608
```

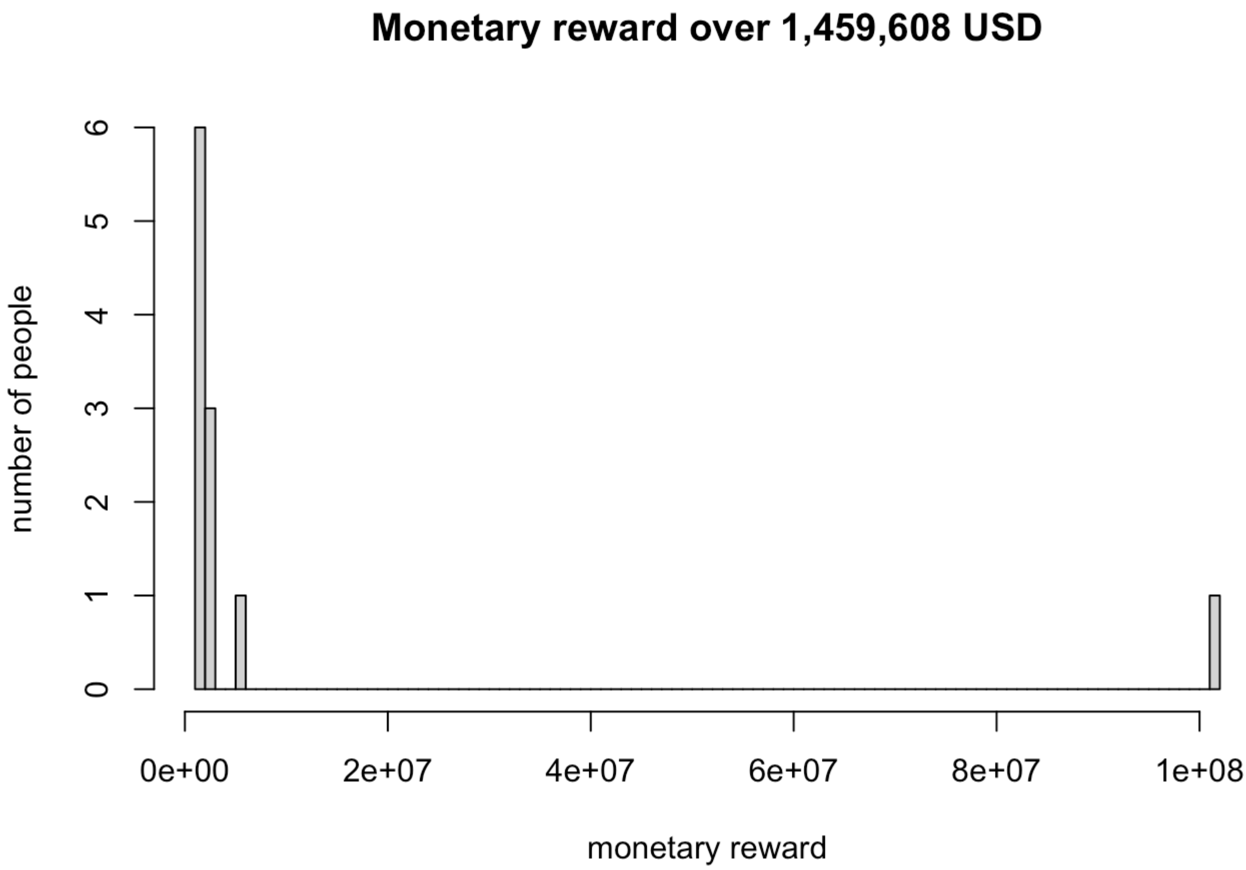
```
mean_monetary - sd_monetary
```

```
[1] -570443.5
```

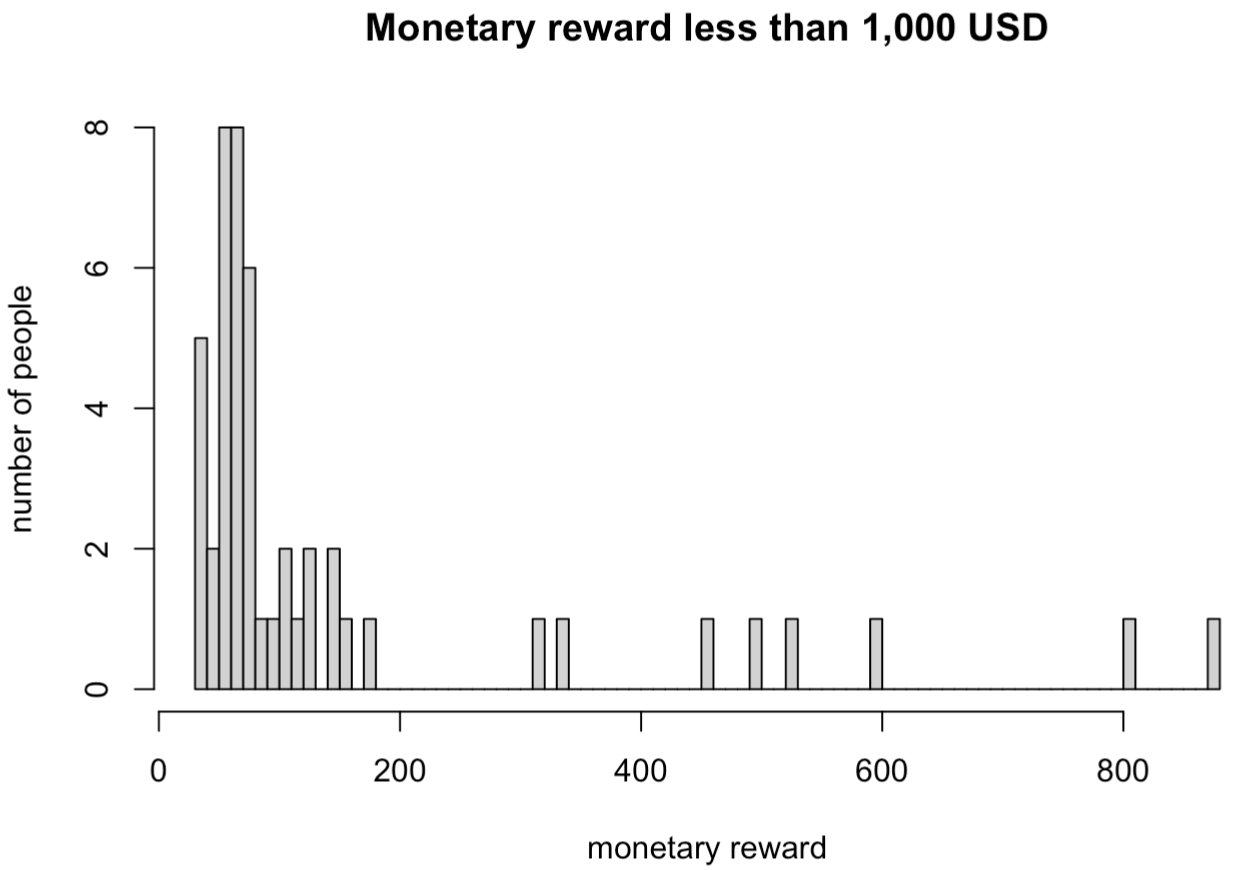
```
hist(monetary_reward[monetary_reward <= 1459608 & monetary_reward
                     >= 1000], breaks = 100, main =
       "Monetary reward between 1,000 and 1,459,608 USD",
     xlab = "monetary reward", ylab = "number of people")
```




```r
hist(monetary_reward[monetary_reward > 1459608], breaks = 100, main =
       "Monetary reward over 1,459,608 USD",
     xlab = "monetary reward", ylab = "number of people")
```




```r
hist(monetary_reward[monetary_reward < 1000 & monetary_reward > 0],
     breaks = 100, main = "Monetary reward less than 1,000 USD",
     xlab = "monetary reward", ylab = "number of people")
```




```
salary_year$monetary_reward <- monetary_reward
salary_monetary <- salary_year[monetary_reward <= 1459608 & monetary_reward >=
nrow(salary_monetary)
```

```
[1] 23044
```

## Problem 3 - Palindromic Numbers

**P3-a.** function "isPalindromic" that check if a given positive integer is a palindromic

```
#' Palindromic of Integers
#'
#' Determine whether a positive intger is palindromic or not
#'
#' This function takes a positive integer x and returns a logical value
#'  whether the integer is a palindromic number or not and return reversed #'
#'  number.
#'
#' @param x a positive integer
#' @param na.rm logical, should NA's be removed? Default is FALSE
#' @return list of a logical value and a numeric value
isPalindromic <- function(x, na.rm = FALSE) {
  if(!is.numeric(x)) {
    # this code is from STATS 506 class note
    warning("x must be a positive integer, attemting to convert")
```

```
      suppressWarnings(x <- as.numeric(x))
      if(all(is.na(x))) {
        stop(
      "x must be a positive integer or convertible to a positive integer")
      }
    }
    if(length(x) == 0) {
      # this code is from STATS 506 class note
      stop("x must have strictly positive length")
    }
    if(!is.logical(na.rm)) {
      # this code is from STATS 506 class note
      warning("na.rm must be logical")
    }
    if(x <= 0 ) {
      stop(
     "x must be a positive integer or convertible to a positive integer")
    }
    if(x != round(x)) {
      stop(
     "x must be a positive integer or convertible to a positive integer")
    }

    y <- as.character(x)
    z <- as.numeric(unlist(strsplit(y, "")))
    k <- length(z)
    check_palindromic <- logical(k)
    reverse <- numeric(k)
    for(i in 1:k) {
      if(z[i] == z[k+1-i]) {
        check_palindromic[i] <- TRUE
      } else {
        check_palindromic[i] <- FALSE
      }
      reverse[i] <- z[k+1-i]
    }
    reverse_return <- as.numeric(paste(reverse, collapse = ""))
    if(all(check_palindromic == TRUE)) {
      return(list(isPalindromic = TRUE, reversed = reverse_return))
    }
    else {
      return(list(isPalindromic = FALSE, reversed = reverse_return))
    }
  }

  isPalindromic(1100) # check the "isPalindromic()" function
```

```
$isPalindromic
[1] FALSE

$reversed
[1] 11
```

**P3-b.** create a nextPalindrome function that finds the next palindromic number strictly greater than the input

```
#' Next Palindrome
#'
#' Find the next palindromic number strictly greater than the input
#'
#' This function takes a positive integer x and check from x+1 to the next #'
#' and return the next palindromic number.
#'
#' @param x a positive integer
#' @param na.rm logical, should NA's be removed? Default is FALSE
#' @return a numeric value
nextPalindrome <- function(x, na.rm = FALSE) {
  if(!is.numeric(x)) {
    # this code is from STATS 506 class note
    warning("x must be a positive integer, attemting to convert")
    suppressWarnings(x <- as.numeric(x))
    if(all(is.na(x))) {
      stop(
     "x must be a positive integer or convertible to a positive integer")
    }
  }
  if(length(x) == 0) {
    # this code is from STATS 506 class note
    stop("x must have strictly positive length")
  }
  if(!is.logical(na.rm)) {
    # this code is from STATS 506 class note
    warning("na.rm must be logical")
  }
  if(x <= 0 ) {
    stop(
     "x must be a positive integer or convertible to a positive integer")
  }
  if(x != round(x)) {
    stop(
    "x must be a positive integer or convertible to a positive integer")
  }

  y <- as.character(x+1)
  z <- as.numeric(unlist(strsplit(y, "")))
  k <- length(z)
  check <- logical(k)
  next_palindrome <- numeric(k)
  while(!all(check == TRUE)) {
    for(i in 1:k) {
      if(z[i] == z[k+1-i]) {
        check[i] <- TRUE
      } else {
        check[i] <- FALSE
      }
```

```r
          next_palindrome[i] <- z[i]
        }
        y <- as.character(as.numeric(y)+1)
        z <- as.numeric(unlist(strsplit(y, "")))
        k <- length(z)
      }
      next_palindrome <- as.numeric(paste(next_palindrome, collapse = ""))
      return(nextPalindrome = next_palindrome)

    }

nextPalindrome(1523) # check the "nextPalindrome()" function
```

```
[1] 1551
```

**P3-c.** Use above functions to find the next palindrome for each of the following: (391, 9928, 19272719, 109, 2)

i. 391 : **393**
ii. 9928 : **9999**
iii. 19272719 : **19277291**
iv. 109 : **111**
v. 2 : **3**

```r
nextPalindrome(391)
```

```
[1] 393
```

```r
nextPalindrome(9928)
```

```
[1] 9999
```

```r
nextPalindrome(19272719)
```

```
[1] 19277291
```

```r
nextPalindrome(109)
```

```
[1] 111
```

```r
nextPalindrome(2)
```

```
[1] 3
```