Independent Project.

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Define the question

I am a data science for a blogger. The question is making conclusion on who is likely to click on the ads in the blog and derive insights. Build a model that can predict if a person will click an ad or not based on the features in the dataframe

Metric for success

In order to work on the above problem, you need to do the following:

- Define the question- the metric for success, the context,experimental design taken and the appropriateness of the available data to answer the given question.
- Find and deal with outliers, anomalies, and missing data within the dataset.
- Perform univariate and bivariate analysis.
- From your insights provide a conclusion and recommendation.
- Build a model using classification using decision trees and Support Vector Machine
- Get an accuracy => 80%

Data Understanding (the context)

A Kenyan entrepreneur has created an online cryptography course and would want to advertise it on her blog. She currently targets audiences originating from various countries. In the past, she ran ads to advertise a related course on the same blog and collected data in the process. She would now like to employ your services as a Data Science Consultant to help her identify which individuals are most likely to click on her ads.

In order to work on the above problem, you need to do the following:

- Define the question, the metric for success, the context, experimental design taken and the appropriateness of the available data to answer the given question.
- Find and deal with outliers, anomalies, and missing data within the dataset.
- Perform univariate and bivariate analysis.
- From your insights provide a conclusion and recommendation.

Experimental design

1. Import the data to R
2. Perform data exploration
3. Define metrics for success
4. Perform Univariate and Bivariate data Analysis
5. Provide conclusion

Loading Dataset

```
ad <- read.csv("http://bit.ly/IPAdvertisingData")
```

```
head(ad)
```

```
##   Daily.Time.Spent.on.Site Age Area.Income Daily.Internet.Usage
## 1                    68.95  35    61833.90               256.09
## 2                    80.23  31    68441.85               193.77
## 3                    69.47  26    59785.94               236.50
## 4                    74.15  29    54806.18               245.89
## 5                    68.37  35    73889.99               225.58
## 6                    59.99  23    59761.56               226.74
##                           Ad.Topic.Line           City Male    Country
## 1    Cloned 5thgeneration orchestration    Wrightburgh    0    Tunisia
## 2    Monitored national standardization      West Jodi    1      Nauru
## 3      Organic bottom-line service-desk       Davidton    0 San Marino
## 4 Triple-buffered reciprocal time-frame West Terrifurt    1      Italy
## 5         Robust logistical utilization   South Manuel    0    Iceland
## 6       Sharable client-driven software      Jamieberg    1     Norway
##             Timestamp Clicked.on.Ad
## 1 2016-03-27 00:53:11             0
## 2 2016-04-04 01:39:02             0
## 3 2016-03-13 20:35:42             0
## 4 2016-01-10 02:31:19             0
## 5 2016-06-03 03:36:18             0
## 6 2016-05-19 14:30:17             0
```

```
tail(ad)
```

```
##      Daily.Time.Spent.on.Site Age Area.Income Daily.Internet.Usage
## 995                     43.70  28    63126.96               173.01
## 996                     72.97  30    71384.57               208.58
## 997                     51.30  45    67782.17               134.42
## 998                     51.63  51    42415.72               120.37
## 999                     55.55  19    41920.79               187.95
## 1000                    45.01  26    29875.80               178.35
##                             Ad.Topic.Line          City Male
## 995         Front-line bifurcated ability  Nicholasland    0
## 996         Fundamental modular algorithm     Duffystad    1
## 997       Grass-roots cohesive monitoring   New Darlene    1
## 998          Expanded intangible solution South Jessica    1
```

```
## 999  Proactive bandwidth-monitored policy   West Steven    0
## 1000      Virtual 5thgeneration emulation   Ronniemouth    0
##                      Country           Timestamp Clicked.on.Ad
## 995                  Mayotte 2016-04-04 03:57:48             1
## 996                  Lebanon 2016-02-11 21:49:00             1
## 997  Bosnia and Herzegovina 2016-04-22 02:07:01             1
## 998                 Mongolia 2016-02-01 17:24:57             1
## 999                Guatemala 2016-03-24 02:35:54             0
## 1000                  Brazil 2016-06-03 21:43:21             1
```

Checking dataset.

```
# Finding the Shape of the dataset
dim(ad)
```

```
## [1] 1000   10
```

```
# Finding the datatypes of the dataset
str(ad)
```

```
## 'data.frame':    1000 obs. of  10 variables:
##  $ Daily.Time.Spent.on.Site: num  69 80.2 69.5 74.2 68.4 ...
##  $ Age                     : int  35 31 26 29 35 23 33 48 30 20 ...
##  $ Area.Income             : num  61834 68442 59786 54806 73890 ...
##  $ Daily.Internet.Usage    : num  256 194 236 246 226 ...
##  $ Ad.Topic.Line           : chr  "Cloned 5thgeneration orchestration" "Monitored national standardi
##  $ City                    : chr  "Wrightburgh" "West Jodi" "Davidton" "West Terrifurt" ...
##  $ Male                    : int  0 1 0 1 0 1 0 1 1 1 ...
##  $ Country                 : chr  "Tunisia" "Nauru" "San Marino" "Italy" ...
##  $ Timestamp               : chr  "2016-03-27 00:53:11" "2016-04-04 01:39:02" "2016-03-13 20:35:42"
##  $ Clicked.on.Ad           : int  0 0 0 0 0 0 0 1 0 0 ...
```

Data cleaning

```
# checking for missing Data
colSums(is.na(ad))
```

```
## Daily.Time.Spent.on.Site                      Age             Area.Income
##                        0                        0                        0
##     Daily.Internet.Usage            Ad.Topic.Line                     City
##                        0                        0                        0
##                     Male                  Country                Timestamp
##                        0                        0                        0
##            Clicked.on.Ad
##                        0
```

```
# Check for duplicated data in the ad
ad1 <- ad[duplicated(ad),]
ad1
```

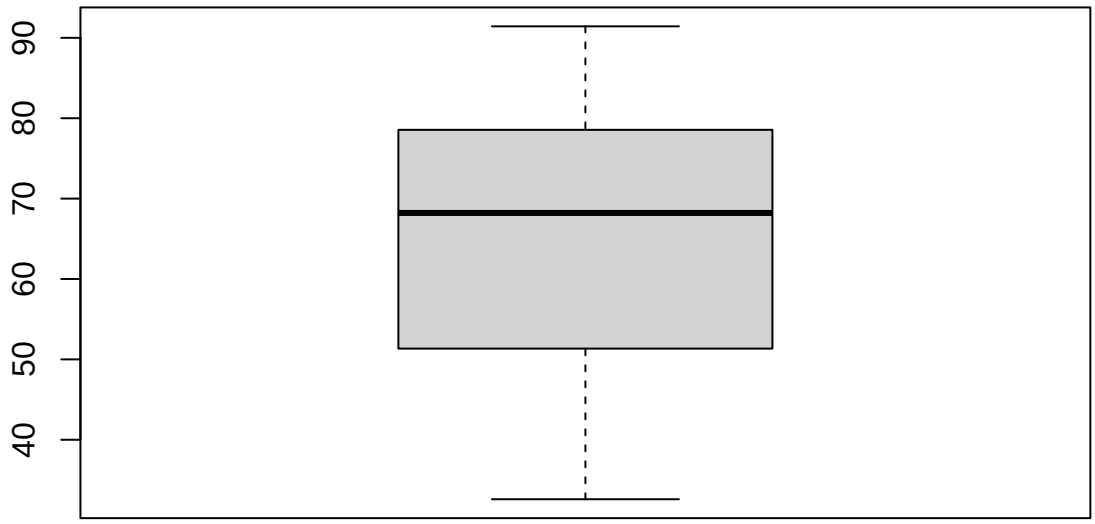
```
##  [1] Daily.Time.Spent.on.Site Age                      Area.Income
##  [4] Daily.Internet.Usage     Ad.Topic.Line            City
##  [7] Male                     Country                  Timestamp
## [10] Clicked.on.Ad
## <0 rows> (or 0-length row.names)
```

Univariate Analysis.

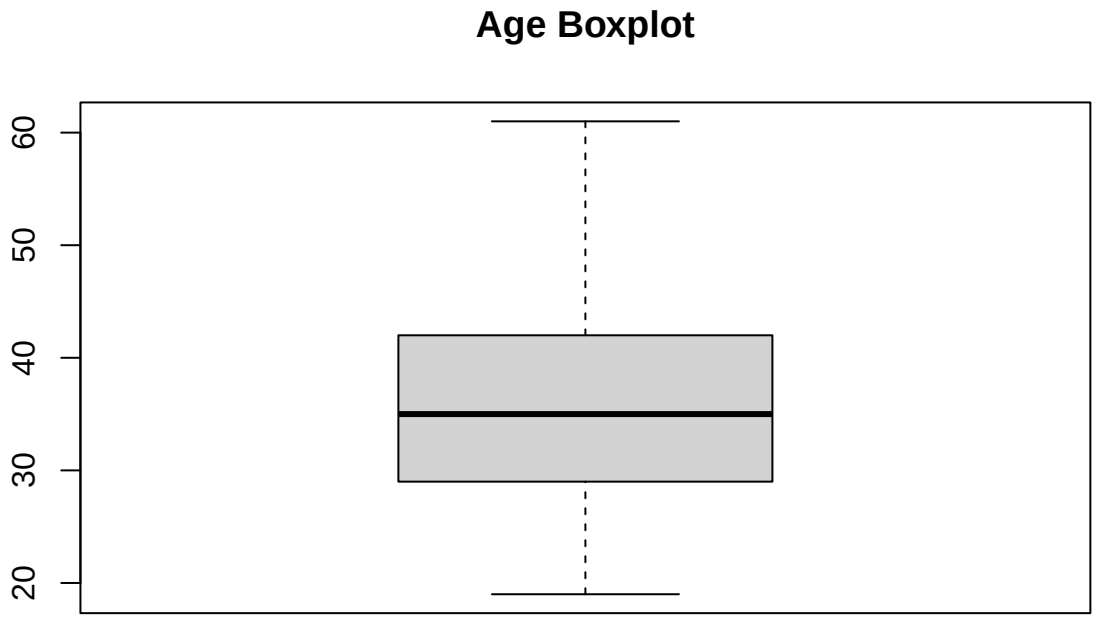
```
str(ad)
```

```
## 'data.frame':    1000 obs. of  10 variables:
##  $ Daily.Time.Spent.on.Site: num  69 80.2 69.5 74.2 68.4 ...
##  $ Age                     : int  35 31 26 29 35 23 33 48 30 20 ...
##  $ Area.Income             : num  61834 68442 59786 54806 73890 ...
##  $ Daily.Internet.Usage    : num  256 194 236 246 226 ...
##  $ Ad.Topic.Line           : chr  "Cloned 5thgeneration orchestration" "Monitored national standardi
##  $ City                    : chr  "Wrightburgh" "West Jodi" "Davidton" "West Terrifurt" ...
##  $ Male                    : int  0 1 0 1 0 1 0 1 1 1 ...
##  $ Country                 : chr  "Tunisia" "Nauru" "San Marino" "Italy" ...
##  $ Timestamp               : chr  "2016-03-27 00:53:11" "2016-04-04 01:39:02" "2016-03-13 20:35:42"
##  $ Clicked.on.Ad           : int  0 0 0 0 0 0 0 1 0 0 ...
```

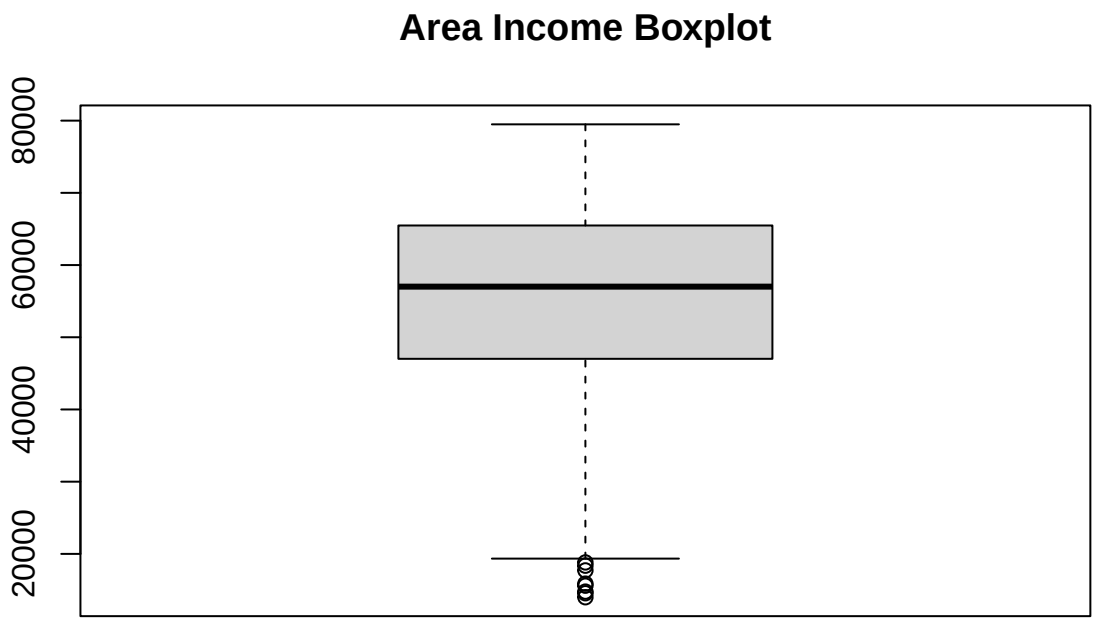
```
boxplot(ad$Daily.Time.Spent.on.Site, main = 'Daily Time Spent on-site')
```



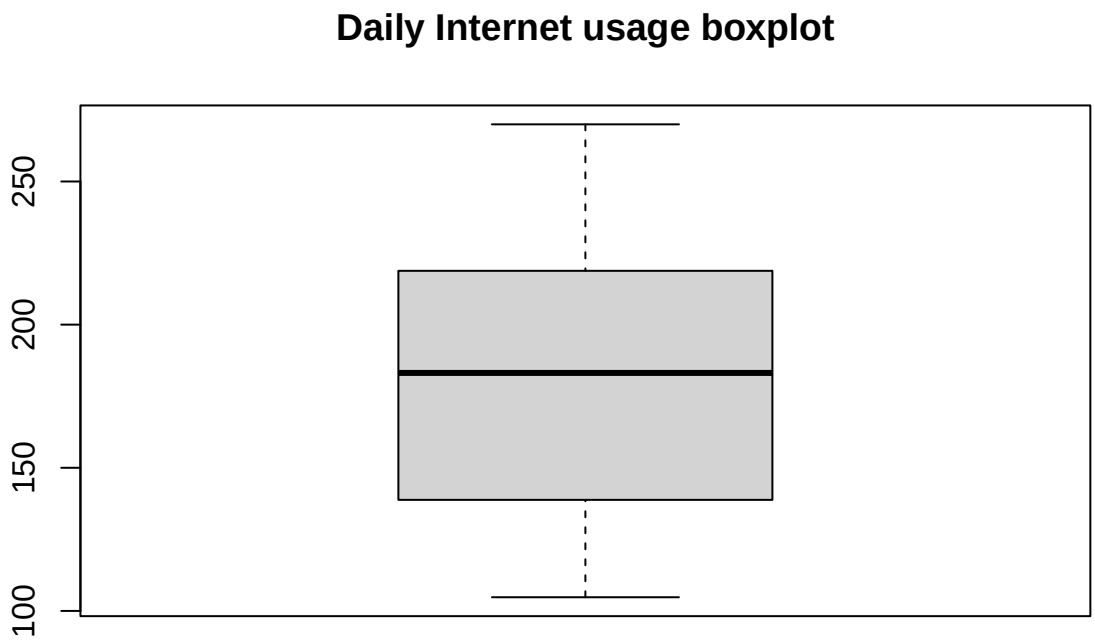

```
boxplot(ad$Age, main = 'Age Boxplot')
```




```
boxplot(ad$Area.Income, main = 'Area Income Boxplot')
```

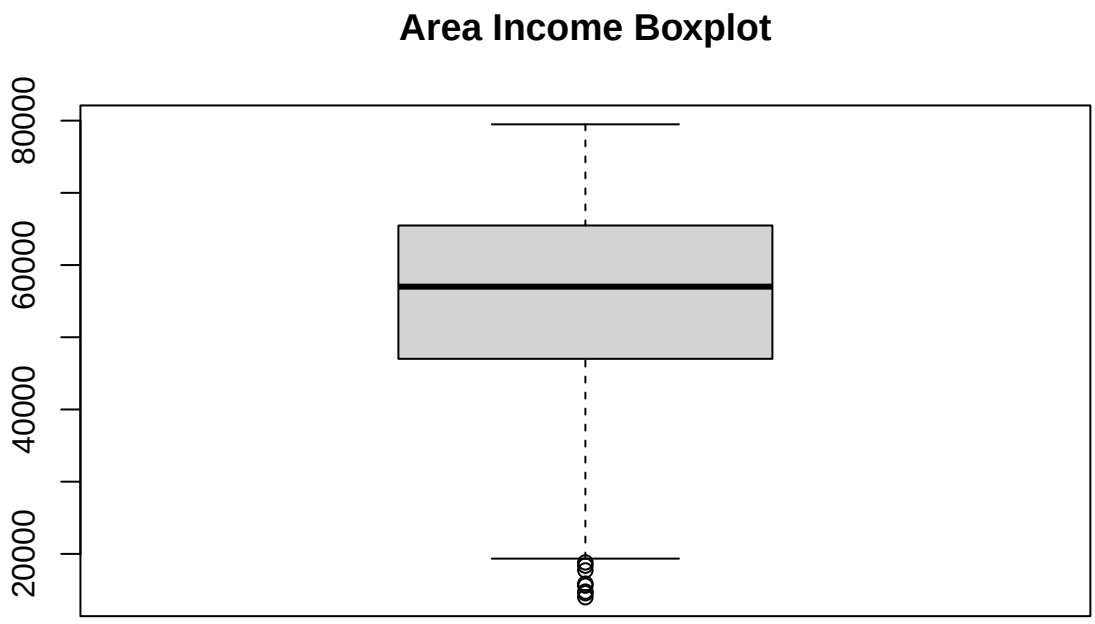



```
boxplot(ad$Daily.Internet.Usage, main = 'Daily Internet usage boxplot')
```



print out the outliers

```
boxplot(ad$Area.Income, main = 'Area Income Boxplot')$out
```




```
## [1] 17709.98 18819.34 15598.29 15879.10 14548.06 13996.50 14775.50 18368.57
```

```
ad[['Timestamp']] <- as.POSIXct(ad[['Timestamp']],
                                format = "%Y-%m-%d %H:%M:%S")
```

Numerical columns.

```
summary(ad)
```

```
##  Daily.Time.Spent.on.Site      Age          Area.Income    Daily.Internet.Usage
##  Min.   :32.60            Min.   :19.00   Min.   :13996   Min.   :104.8
##  1st Qu.:51.36            1st Qu.:29.00   1st Qu.:47032   1st Qu.:138.8
##  Median :68.22            Median :35.00   Median :57012   Median :183.1
##  Mean   :65.00            Mean   :36.01   Mean   :55000   Mean   :180.0
##  3rd Qu.:78.55            3rd Qu.:42.00   3rd Qu.:65471   3rd Qu.:218.8
##  Max.   :91.43            Max.   :61.00   Max.   :79485   Max.   :270.0
##  Ad.Topic.Line          City                Male         Country
##  Length:1000        Length:1000        Min.   :0.000   Length:1000
##  Class :character   Class :character   1st Qu.:0.000   Class :character
##  Mode  :character   Mode  :character   Median :0.000   Mode  :character
##                                        Mean   :0.481
##                                        3rd Qu.:1.000
##                                        Max.   :1.000
```

```
##    Timestamp                     Clicked.on.Ad
##  Min.   :2016-01-01 02:52:10   Min.   :0.0
##  1st Qu.:2016-02-18 02:55:42   1st Qu.:0.0
##  Median :2016-04-07 17:27:29   Median :0.5
##  Mean   :2016-04-10 10:34:06   Mean   :0.5
##  3rd Qu.:2016-05-31 03:18:14   3rd Qu.:1.0
##  Max.   :2016-07-24 00:22:16   Max.   :1.0
```

There are outliers that do not look like they are in the extreme. There are areas where poverty is prevelant in such areas the total income could be that small.

Mean.

```
mean.age <- mean(ad$Age)
mean.age
```

```
## [1] 36.009
```

Function to get the mode.

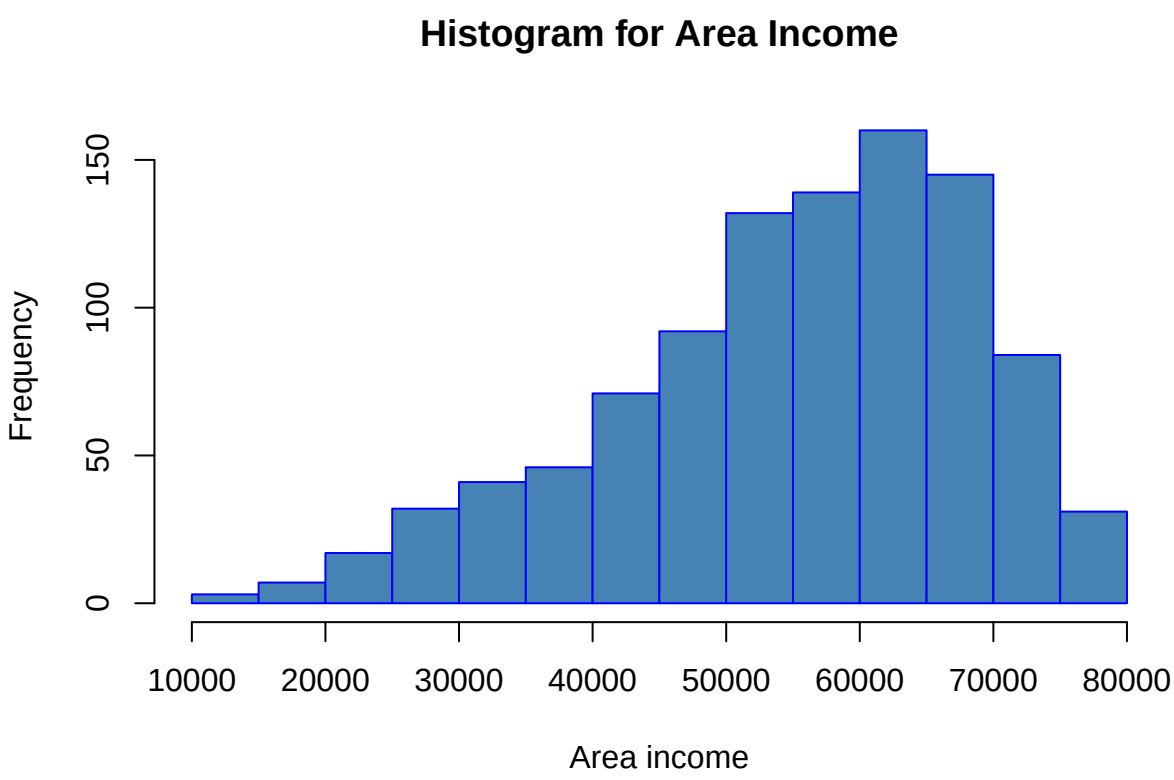
```
getmode <- function(v) {
  uniqv <- unique(v)
  uniqv[which.max(tabulate(match(v, uniqv)))]
}
```

##Area income

```
mean.areaincome <- mean(ad$Area.Income)
mean.areaincome
```

```
## [1] 55000
```

```
hist(ad$Area.Income,
     main="Histogram for Area Income",
     xlab="Area income",
     border="blue",
     col="steelblue",)
```



Daily time spent on site

```
mean.dtsos <- mean(ad$Daily.Time.Spent.on.Site)
mean.dtsos
```

```
## [1] 65.0002
```

```
uniq_clickers <- unique(ad$Clicked.on.Ad,)
length(uniq_clickers)
```

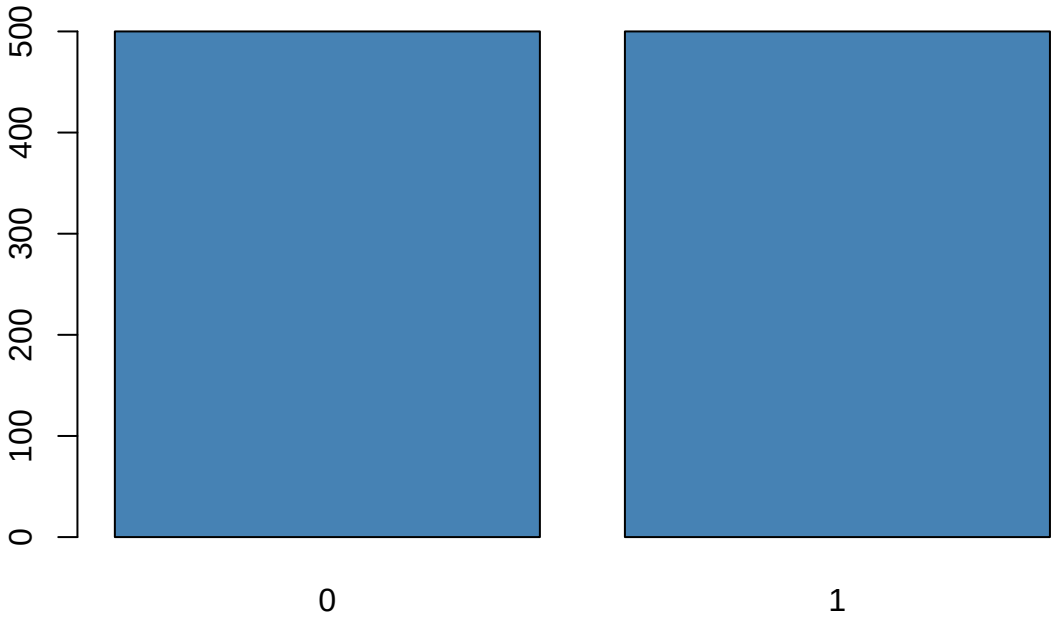
Clicked.on.Ad

```
## [1] 2
```

There are two categories of the people who clicked on ads

Let us plot the frequency of each

```
clickers <- ad$Clicked.on.Ad
clickers_frequency <- table (clickers)
barplot(clickers_frequency, col = "steelblue")
```



There are 500 people who clicked on ads and another 500 did not click on the ads.

Categorical Columns

####Ad.Topic.line

There are 1000 unique topic lines meaning it would be impossible to get a good visualization.

```
uniq_country <- unique(ad$Country)
length(uniq_country)
```

Country

```
## [1] 237
```

There are 237 unique countries.

```
library(sf)
```

```
## Linking to GEOS 3.9.1, GDAL 3.2.1, PROJ 7.2.1; sf_use_s2() is TRUE
```

```
library(raster)
```

```
## Loading required package: sp
```

```
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:raster':
##
##     intersect, select, union
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library
```

```
## function (package, help, pos = 2, lib.loc = NULL, character.only = FALSE,
##     logical.return = FALSE, warn.conflicts, quietly = FALSE,
##     verbose = getOption("verbose"), mask.ok, exclude, include.only,
##     attach.required = missing(include.only))
## {
##     conf.ctrl <- getOption("conflicts.policy")
##     if (is.character(conf.ctrl))
##         conf.ctrl <- switch(conf.ctrl, strict = list(error = TRUE,
##             warn = FALSE), depends.ok = list(error = TRUE, generics.ok = TRUE,
##             can.mask = c("base", "methods", "utils", "grDevices",
##                 "graphics", "stats"), depends.ok = TRUE), warning(gettextf("unknown conflict policy:
##             sQuote(conf.ctrl)), call. = FALSE, domain = NA))
##     if (!is.list(conf.ctrl))
##         conf.ctrl <- NULL
##     stopOnConflict <- isTRUE(conf.ctrl$error)
##     if (missing(warn.conflicts))
##         warn.conflicts <- if (isFALSE(conf.ctrl$warn))
##             FALSE
##         else TRUE
##     if ((!missing(include.only)) && (!missing(exclude)))
##         stop(gettext("only one of 'include.only' and 'exclude' can be used"),
##             call. = FALSE, domain = NA)
```

```
##     testRversion <- function(pkgInfo, pkgname, pkgpath) {
##         if (is.null(built <- pkgInfo$Built))
##             stop(gettextf("package %s has not been installed properly\n",
##                 sQuote(pkgname)), call. = FALSE, domain = NA)
##         R_version_built_under <- as.numeric_version(built$R)
##         if (R_version_built_under < "3.0.0")
##             stop(gettextf("package %s was built before R 3.0.0: please re-install it",
##                 sQuote(pkgname)), call. = FALSE, domain = NA)
##         current <- getRversion()
##         if (length(Rdeps <- pkgInfo$Rdepends2)) {
##             for (dep in Rdeps) if (length(dep) > 1L) {
##                 target <- dep$version
##                 res <- do.call(dep$op, if (is.character(target))
##                   list(as.numeric(R.version[["svn rev"]]), as.numeric(sub("^r",
##                     "", target)))
##                 else list(current, as.numeric_version(target)))
##                 if (!res)
##                   stop(gettextf("This is R %s, package %s needs %s %s",
##                     current, sQuote(pkgname), dep$op, target),
##                     call. = FALSE, domain = NA)
##             }
##         }
##         if (R_version_built_under > current)
##             warning(gettextf("package %s was built under R version %s",
##                 sQuote(pkgname), as.character(built$R)), call. = FALSE,
##                 domain = NA)
##         platform <- built$Platform
##         r_arch <- .Platform$r_arch
##         if (.Platform$OS.type == "unix") {
##         }
##         else {
##             if (nzchar(platform) && !grepl("mingw", platform))
##                 stop(gettextf("package %s was built for %s",
##                   sQuote(pkgname), platform), call. = FALSE,
##                   domain = NA)
##         }
##         if (nzchar(r_arch) && file.exists(file.path(pkgpath,
##             "libs")) && !file.exists(file.path(pkgpath, "libs",
##             r_arch)))
##             stop(gettextf("package %s is not installed for 'arch = %s'",
##                 sQuote(pkgname), r_arch), call. = FALSE, domain = NA)
##     }
##     checkNoGenerics <- function(env, pkg) {
##         nenv <- env
##         ns <- .getNamespace(as.name(pkg))
##         if (!is.null(ns))
##             nenv <- asNamespace(ns)
##         if (exists(".noGenerics", envir = nenv, inherits = FALSE))
##             TRUE
##         else {
##             !any(startsWith(names(env), ".__T"))
##         }
##     }
##     checkConflicts <- function(package, pkgname, pkgpath, nogenerics,
```

```
##         env) {
##         dont.mind <- c("last.dump", "last.warning", ".Last.value",
##             ".Random.seed", ".Last.lib", ".onDetach", ".packageName",
##             ".noGenerics", ".required", ".no_S3_generics", ".Depends",
##             ".requireCachedGenerics")
##         sp <- search()
##         lib.pos <- which(sp == pkgname)
##         ob <- names(as.environment(lib.pos))
##         if (!nogenerics) {
##             these <- ob[startsWith(ob, ".__T__")]
##             gen <- gsub(".__T__(.*):([^:]+)", "\\1", these)
##             from <- gsub(".__T__(.*):([^:]+)", "\\2", these)
##             gen <- gen[from != package]
##             ob <- ob[!(ob %in% gen)]
##         }
##         ipos <- seq_along(sp)[-c(lib.pos, match(c("Autoloads",
##             "CheckExEnv"), sp, 0L))]
##         cpos <- NULL
##         conflicts <- vector("list", 0)
##         for (i in ipos) {
##             obj.same <- match(names(as.environment(i)), ob, nomatch = 0L)
##             if (any(obj.same > 0L)) {
##                 same <- ob[obj.same]
##                 same <- same[!(same %in% dont.mind)]
##                 Classobjs <- which(startsWith(same, ".__"))
##                 if (length(Classobjs))
##                   same <- same[-Classobjs]
##                 same.isFn <- function(where) vapply(same, exists,
##                   NA, where = where, mode = "function", inherits = FALSE)
##                 same <- same[same.isFn(i) == same.isFn(lib.pos)]
##                 not.Ident <- function(ch, TRAFO = identity, ...) vapply(ch,
##                   function(.) !identical(TRAFO(get(., i)), TRAFO(get(.,
##                     lib.pos)), ...), NA)
##                 if (length(same))
##                   same <- same[not.Ident(same)]
##                 if (length(same) && identical(sp[i], "package:base"))
##                   same <- same[not.Ident(same, ignore.environment = TRUE)]
##                 if (length(same)) {
##                   conflicts[[sp[i]]] <- same
##                   cpos[sp[i]] <- i
##                 }
##             }
##         }
##         if (length(conflicts)) {
##             if (stopOnConflict) {
##                 emsg <- ""
##                 pkg <- names(conflicts)
##                 notOK <- vector("list", 0)
##                 for (i in seq_along(conflicts)) {
##                   pkgname <- sub("^package:", "", pkg[i])
##                   if (pkgname %in% canMaskEnv$canMask)
##                     next
##                   same <- conflicts[[i]]
##                   if (is.list(mask.ok))
```

```
##                     myMaskOK <- mask.ok[[pkgname]]
##                   else myMaskOK <- mask.ok
##                   if (isTRUE(myMaskOK))
##                     same <- NULL
##                   else if (is.character(myMaskOK))
##                     same <- setdiff(same, myMaskOK)
##                   if (length(same)) {
##                     notOK[[pkg[i]]] <- same
##                     msg <- .maskedMsg(sort(same), pkg = sQuote(pkg[i]),
##                       by = cpos[i] < lib.pos)
##                     emsg <- paste(emsg, msg, sep = "\n")
##                   }
##                 }
##                 if (length(notOK)) {
##                   msg <- gettextf("Conflicts attaching package %s:\n%s",
##                     sQuote(package), emsg)
##                   stop(errorCondition(msg, package = package,
##                     conflicts = conflicts, class = "packageConflictError"))
##                 }
##             }
##             if (warn.conflicts) {
##                 packageStartupMessage(gettextf("\nAttaching package: %s\n",
##                   sQuote(package)), domain = NA)
##                 pkg <- names(conflicts)
##                 for (i in seq_along(conflicts)) {
##                   msg <- .maskedMsg(sort(conflicts[[i]]), pkg = sQuote(pkg[i]),
##                     by = cpos[i] < lib.pos)
##                   packageStartupMessage(msg, domain = NA)
##                 }
##             }
##         }
##     }
##     if (verbose && quietly)
##         message("'verbose' and 'quietly' are both true; being verbose then ..")
##     if (!missing(package)) {
##         if (is.null(lib.loc))
##             lib.loc <- .libPaths()
##         lib.loc <- lib.loc[dir.exists(lib.loc)]
##         if (!character.only)
##             package <- as.character(substitute(package))
##         if (length(package) != 1L)
##             stop("'package' must be of length 1")
##         if (is.na(package) || (package == ""))
##             stop("invalid package name")
##         pkgname <- paste0("package:", package)
##         newpackage <- is.na(match(pkgname, search()))
##         if (newpackage) {
##             pkgpath <- find.package(package, lib.loc, quiet = TRUE,
##                 verbose = verbose)
##             if (length(pkgpath) == 0L) {
##                 if (length(lib.loc) && !logical.return)
##                   stop(packageNotFoundError(package, lib.loc,
##                     sys.call()))
##                 txt <- if (length(lib.loc))
```

```
##                   gettextf("there is no package called %s", sQuote(package))
##                 else gettext("no library trees found in 'lib.loc'")
##                 if (logical.return) {
##                   if (!quietly)
##                     warning(txt, domain = NA)
##                   return(FALSE)
##                 }
##                 else stop(txt, domain = NA)
##             }
##             which.lib.loc <- normalizePath(dirname(pkgpath),
##                 "/", TRUE)
##             pfile <- system.file("Meta", "package.rds", package = package,
##                 lib.loc = which.lib.loc)
##             if (!nzchar(pfile))
##                 stop(gettextf("%s is not a valid installed package",
##                   sQuote(package)), domain = NA)
##             pkgInfo <- readRDS(pfile)
##             testRversion(pkgInfo, package, pkgpath)
##             if (is.character(pos)) {
##                 npos <- match(pos, search())
##                 if (is.na(npos)) {
##                   warning(gettextf("%s not found on search path, using pos = 2",
##                     sQuote(pos)), domain = NA)
##                   pos <- 2
##                 }
##                 else pos <- npos
##             }
##             deps <- unique(names(pkgInfo$Depends))
##             depsOK <- isTRUE(conf.ctrl$depends.ok)
##             if (depsOK) {
##                 canMaskEnv <- dynGet("__library_can_mask__",
##                   NULL)
##                 if (is.null(canMaskEnv)) {
##                   canMaskEnv <- new.env()
##                   canMaskEnv$canMask <- union("base", conf.ctrl$can.mask)
##                   "__library_can_mask__" <- canMaskEnv
##                 }
##                 canMaskEnv$canMask <- unique(c(package, deps,
##                   canMaskEnv$canMask))
##             }
##             else canMaskEnv <- NULL
##             if (attach.required)
##                 .getRequiredPackages2(pkgInfo, quietly = quietly)
##             cr <- conflictRules(package)
##             if (missing(mask.ok))
##                 mask.ok <- cr$mask.ok
##             if (missing(exclude))
##                 exclude <- cr$exclude
##             if (packageHasNamespace(package, which.lib.loc)) {
##                 if (isNamespaceLoaded(package)) {
##                   newversion <- as.numeric_version(pkgInfo$DESCRIPTION["Version"])
##                   oldversion <- as.numeric_version(getNamespaceVersion(package))
##                   if (newversion != oldversion) {
##                     tryCatch(unloadNamespace(package), error = function(e) {
```

```
##                     P <- if (!is.null(cc <- conditionCall(e)))
##                       paste("Error in", deparse(cc)[1L], ": ")
##                     else "Error : "
##                     stop(gettextf("Package %s version %s cannot be unloaded:\n %s",
##                       sQuote(package), oldversion, paste0(P,
##                         conditionMessage(e), "\n")), domain = NA)
##                   })
##                 }
##               }
##               tt <- tryCatch({
##                 attr(package, "LibPath") <- which.lib.loc
##                 ns <- loadNamespace(package, lib.loc)
##                 env <- attachNamespace(ns, pos = pos, deps,
##                   exclude, include.only)
##               }, error = function(e) {
##                 P <- if (!is.null(cc <- conditionCall(e)))
##                   paste(" in", deparse(cc)[1L])
##                 else ""
##                 msg <- gettextf("package or namespace load failed for %s%s:\n %s",
##                   sQuote(package), P, conditionMessage(e))
##                 if (logical.return && !quietly)
##                   message(paste("Error:", msg), domain = NA)
##                 else stop(msg, call. = FALSE, domain = NA)
##               })
##               if (logical.return && is.null(tt))
##                 return(FALSE)
##               attr(package, "LibPath") <- NULL
##               {
##                 on.exit(detach(pos = pos))
##                 nogenerics <- !.isMethodsDispatchOn() || checkNoGenerics(env,
##                   package)
##                 if (isFALSE(conf.ctrl$generics.ok) || (stopOnConflict &&
##                   !isTRUE(conf.ctrl$generics.ok)))
##                   nogenerics <- TRUE
##                 if (stopOnConflict || (warn.conflicts && !exists(".conflicts.OK",
##                   envir = env, inherits = FALSE)))
##                   checkConflicts(package, pkgname, pkgpath,
##                     nogenerics, ns)
##                 on.exit()
##                 if (logical.return)
##                   return(TRUE)
##                 else return(invisible(.packages()))
##               }
##           }
##           else stop(gettextf("package %s does not have a namespace and should be re-installed",
##               sQuote(package)), domain = NA)
##       }
##       if (verbose && !newpackage)
##           warning(gettextf("package %s already present in search()",
##               sQuote(package)), domain = NA)
##   }
##   else if (!missing(help)) {
##       if (!character.only)
##           help <- as.character(substitute(help))
```

```
##         pkgName <- help[1L]
##         pkgPath <- find.package(pkgName, lib.loc, verbose = verbose)
##         docFiles <- c(file.path(pkgPath, "Meta", "package.rds"),
##             file.path(pkgPath, "INDEX"))
##         if (file.exists(vignetteIndexRDS <- file.path(pkgPath,
##             "Meta", "vignette.rds")))
##             docFiles <- c(docFiles, vignetteIndexRDS)
##         pkgInfo <- vector("list", 3L)
##         readDocFile <- function(f) {
##             if (basename(f) %in% "package.rds") {
##                 txt <- readRDS(f)$DESCRIPTION
##                 if ("Encoding" %in% names(txt)) {
##                   to <- if (Sys.getlocale("LC_CTYPE") == "C")
##                     "ASCII//TRANSLIT"
##                   else ""
##                   tmp <- try(iconv(txt, from = txt["Encoding"],
##                     to = to))
##                   if (!inherits(tmp, "try-error"))
##                     txt <- tmp
##                   else warning("'DESCRIPTION' has an 'Encoding' field and re-encoding is not possible
##                     call. = FALSE)
##                 }
##                 nm <- paste0(names(txt), ":")
##                 formatDL(nm, txt, indent = max(nchar(nm, "w")) +
##                   3L)
##             }
##             else if (basename(f) %in% "vignette.rds") {
##                 txt <- readRDS(f)
##                 if (is.data.frame(txt) && nrow(txt))
##                   cbind(basename(gsub("\\.[[:alpha:]]+$", "",
##                     txt$File)), paste(txt$Title, paste0(rep.int("(source",
##                     NROW(txt)), ifelse(nzchar(txt$PDF), ", pdf",
##                     ""), ")")))
##                 else NULL
##             }
##             else readLines(f)
##         }
##         for (i in which(file.exists(docFiles))) pkgInfo[[i]] <- readDocFile(docFiles[i])
##         y <- list(name = pkgName, path = pkgPath, info = pkgInfo)
##         class(y) <- "packageInfo"
##         return(y)
##     }
##     else {
##         if (is.null(lib.loc))
##             lib.loc <- .libPaths()
##         db <- matrix(character(), nrow = 0L, ncol = 3L)
##         nopkgs <- character()
##         for (lib in lib.loc) {
##             a <- .packages(all.available = TRUE, lib.loc = lib)
##             for (i in sort(a)) {
##                 file <- system.file("Meta", "package.rds", package = i,
##                   lib.loc = lib)
##                 title <- if (nzchar(file)) {
##                   txt <- readRDS(file)
```

```
##                   if (is.list(txt))
##                     txt <- txt$DESCRIPTION
##                   if ("Encoding" %in% names(txt)) {
##                     to <- if (Sys.getlocale("LC_CTYPE") == "C")
##                       "ASCII//TRANSLIT"
##                     else ""
##                     tmp <- try(iconv(txt, txt["Encoding"], to,
##                       "?"))
##                     if (!inherits(tmp, "try-error"))
##                       txt <- tmp
##                     else warning("'DESCRIPTION' has an 'Encoding' field and re-encoding is not possi
##                       call. = FALSE)
##                   }
##                   txt["Title"]
##                 }
##                 else NA
##                 if (is.na(title))
##                   title <- " ** No title available ** "
##                 db <- rbind(db, cbind(i, lib, title))
##             }
##             if (length(a) == 0L)
##                 nopkgs <- c(nopkgs, lib)
##         }
##         dimnames(db) <- list(NULL, c("Package", "LibPath", "Title"))
##         if (length(nopkgs) && !missing(lib.loc)) {
##             pkglist <- paste(sQuote(nopkgs), collapse = ", ")
##             msg <- sprintf(ngettext(length(nopkgs), "library %s contains no packages",
##                 "libraries %s contain no packages"), pkglist)
##             warning(msg, domain = NA)
##         }
##         y <- list(header = NULL, results = db, footer = NULL)
##         class(y) <- "libraryIQR"
##         return(y)
##     }
##     if (logical.return)
##         TRUE
##     else invisible(.packages())
## }
## <bytecode: 0x0000000012f25cf8>
## <environment: namespace:base>
```

```
#library(spDataLarge)
library(tmap)
library(leaflet)
library(ggplot2)
```

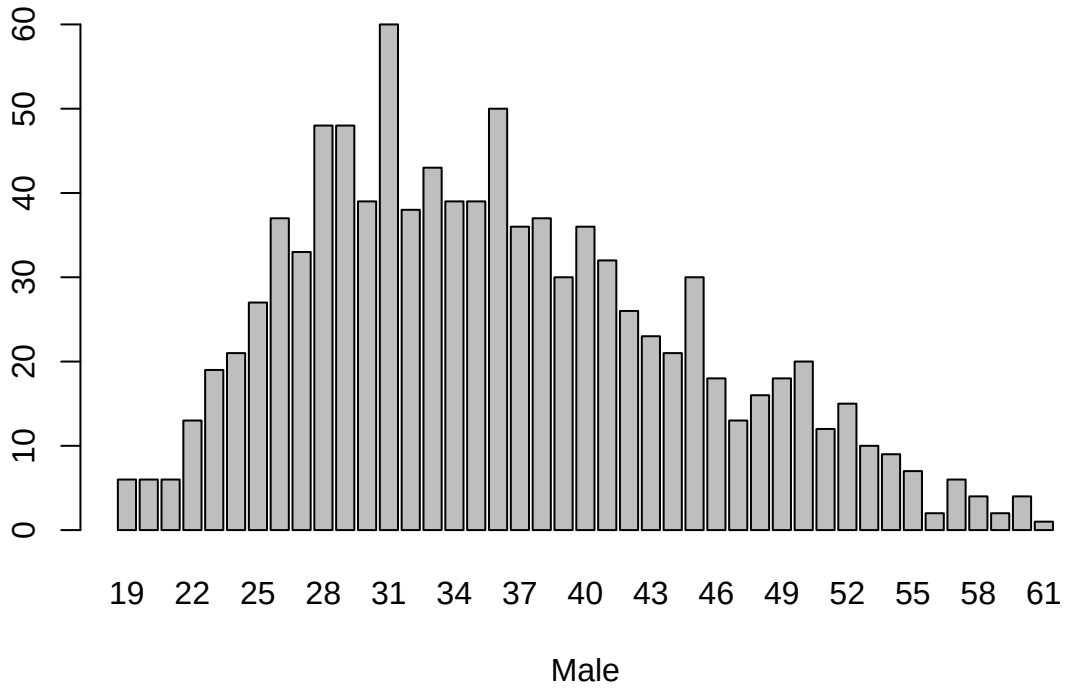
```
Country <- ad$Country
countyfreq <- table(Country)
```

```
hist(ad$`Age`, xlab = "Age")
```


```
#An even spread on time spent on site
```

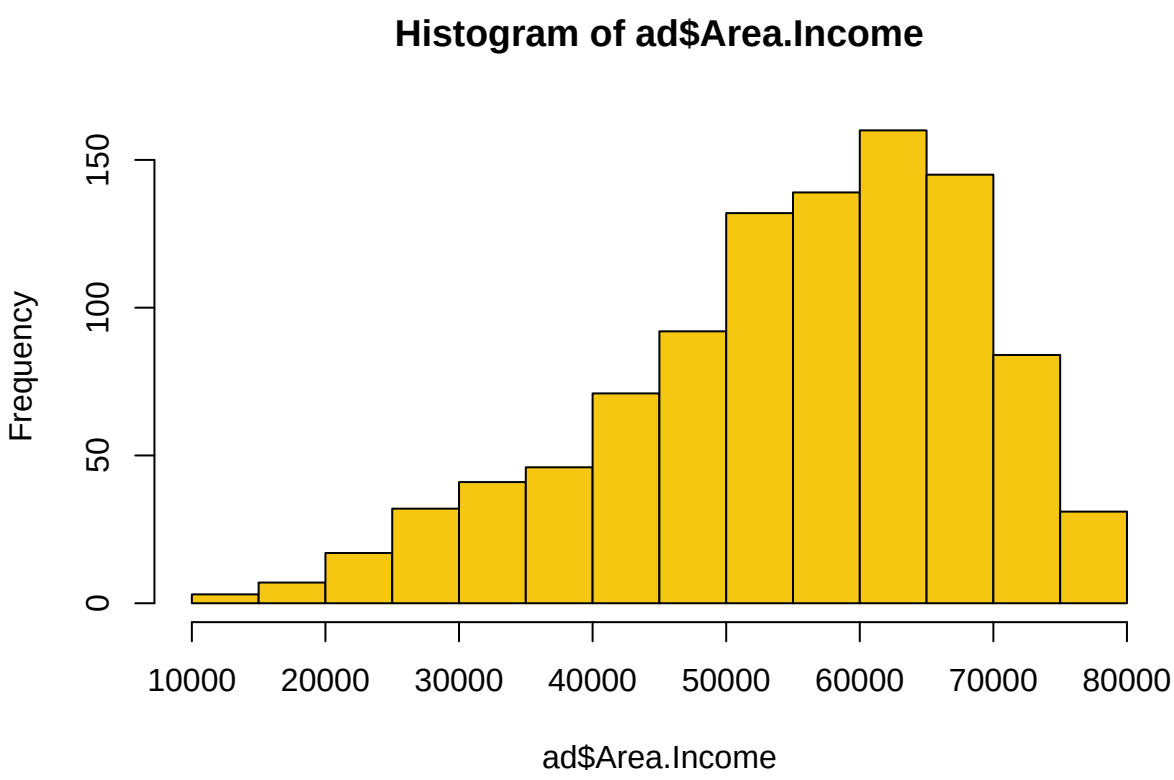
hist(ad$Male, xlab = “Male”)

```
age <- ad$Age
ages <- table(age)
barplot(ages, xlab = "Male")
```




```
#The age distribution
```

```
hist(ad$Area.Income, col = 7)
```




```
AGE  <- table(ad$Age)
AGE
```

```
##
## 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44
##  6  6  6 13 19 21 27 37 33 48 48 39 60 38 43 39 39 50 36 37 30 36 32 26 23 21
## 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61
## 30 18 13 16 18 20 12 15 10  9  7  2  6  4  2  4  1
```

```
barplot(AGE, main = "Simple bar plot", xlab = "Age ", ylab = "Frequency")
```

Bivariate Analysis

Lets find the covariance between a variety of the features

```
daily <- ad$`Daily Time Spent on Site`
age <- ad$Age
income <- ad$`Area Income`
sex <-ad$Male
use <- ad$`Daily Internet Usage`

click <- ad$`Clicked on Ad`
#cov(daily,click)
#That has a negative correlation
```

```
ad2 <- ad$Age
ad3 <- ad$Area.Income
cov(ad2, ad3)
```

```
## [1] -21520.93
```

```
cor(ad2, ad3)
```

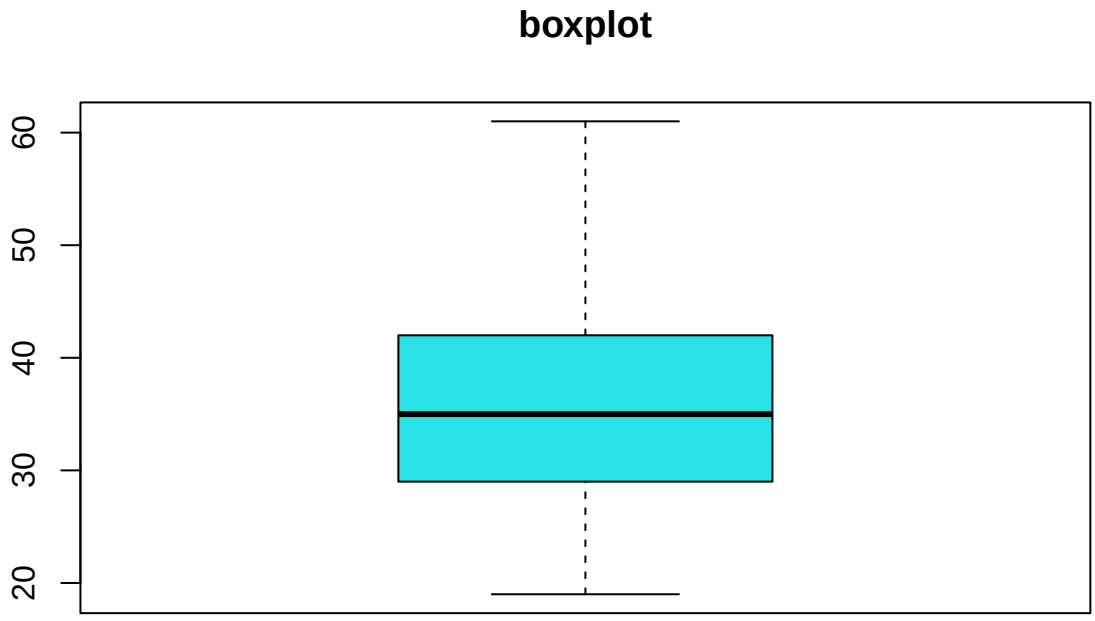
```
## [1] -0.182605
```

checking correlation matrix

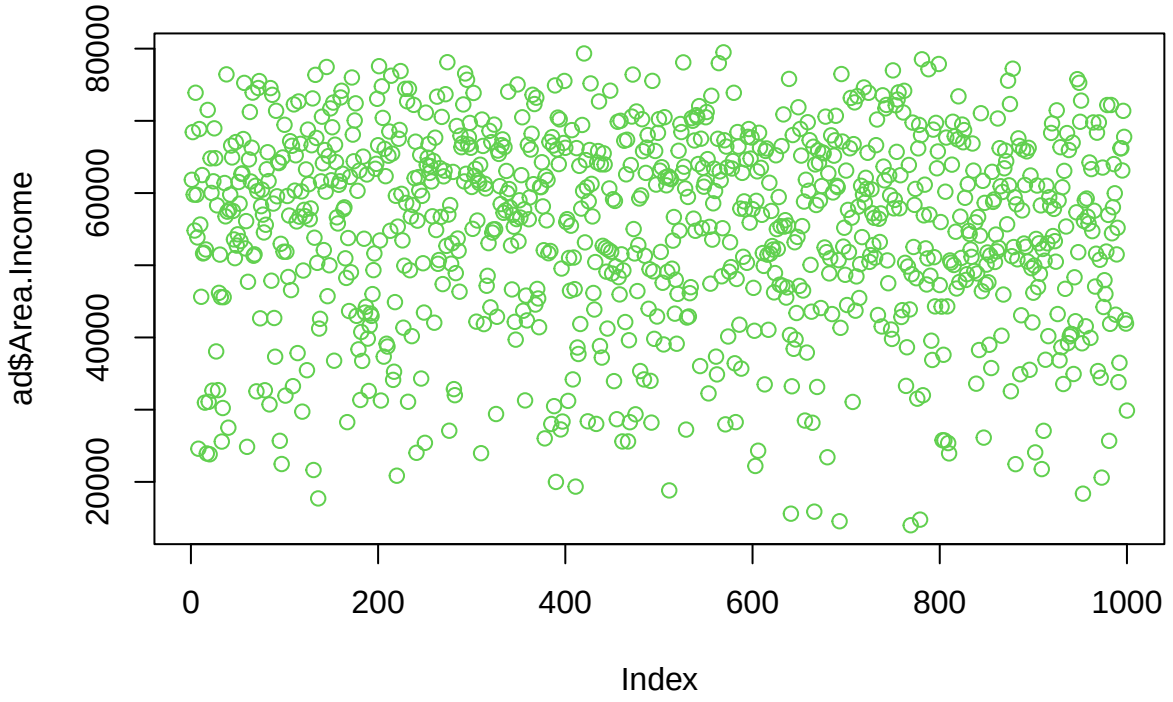
```
num_ads <- unlist(lapply(ad, is.numeric))
num_ad <- ad[ , num_ads]
cor(num_ad)
```

```
##                           Daily.Time.Spent.on.Site         Age  Area.Income
## Daily.Time.Spent.on.Site               1.00000000 -0.33151334  0.310954413
## Age                                   -0.33151334  1.00000000 -0.182604955
## Area.Income                            0.31095441 -0.18260496  1.000000000
## Daily.Internet.Usage                   0.51865848 -0.36720856  0.337495533
## Male                                  -0.01895085 -0.02104406  0.001322359
## Clicked.on.Ad                         -0.74811656  0.49253127 -0.476254628
##                           Daily.Internet.Usage         Male Clicked.on.Ad
## Daily.Time.Spent.on.Site           0.51865848 -0.018950855   -0.74811656
## Age                               -0.36720856 -0.021044064    0.49253127
## Area.Income                        0.33749553  0.001322359   -0.47625463
## Daily.Internet.Usage               1.00000000  0.028012326   -0.78653918
## Male                               0.02801233  1.000000000   -0.03802747
## Clicked.on.Ad                     -0.78653918 -0.038027466    1.00000000
```

```
boxplot(ad$Age, main='boxplot', xlab = 'area income', col = 5)
```




```
plot(ad$Area.Income, col = 3)
```



Correlation

####creating with only interger columns

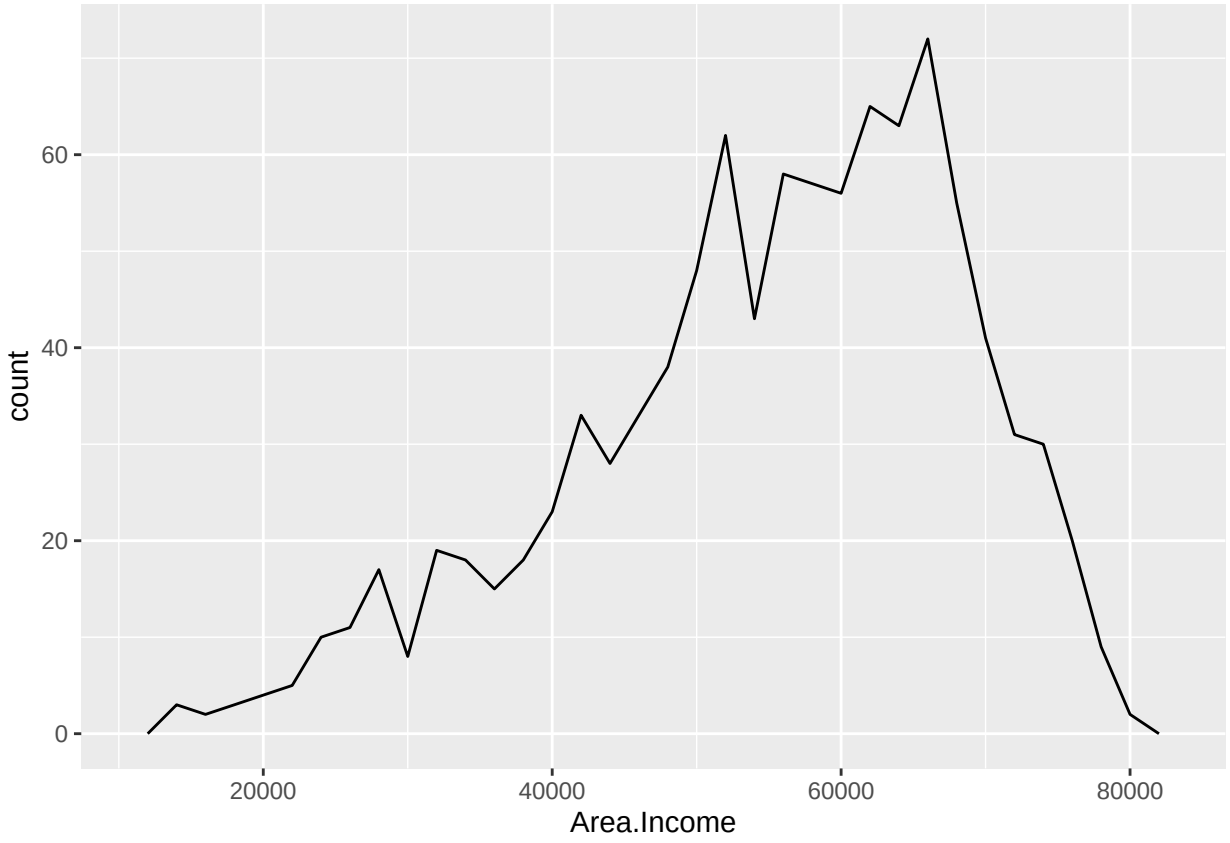
```
numerical_df = ad[c("Daily.Time.Spent.on.Site", "Age", "Area.Income","Daily.Internet.Usage" ,"Male", "C
head(numerical_df)
```

```
##   Daily.Time.Spent.on.Site Age Area.Income Daily.Internet.Usage Male
## 1                    68.95  35    61833.90               256.09    0
## 2                    80.23  31    68441.85               193.77    1
## 3                    69.47  26    59785.94               236.50    0
## 4                    74.15  29    54806.18               245.89    1
## 5                    68.37  35    73889.99               225.58    0
## 6                    59.99  23    59761.56               226.74    1
##   Clicked.on.Ad
## 1             0
## 2             0
## 3             0
## 4             0
## 5             0
## 6             0
```

```
correlation = cor(numerical_df)
correlation
```

```
##                           Daily.Time.Spent.on.Site         Age  Area.Income
## Daily.Time.Spent.on.Site               1.00000000 -0.33151334  0.310954413
## Age                                   -0.33151334  1.00000000 -0.182604955
## Area.Income                            0.31095441 -0.18260496  1.000000000
## Daily.Internet.Usage                   0.51865848 -0.36720856  0.337495533
## Male                                  -0.01895085 -0.02104406  0.001322359
## Clicked.on.Ad                         -0.74811656  0.49253127 -0.476254628
##                           Daily.Internet.Usage         Male Clicked.on.Ad
## Daily.Time.Spent.on.Site           0.51865848 -0.018950855   -0.74811656
## Age                               -0.36720856 -0.021044064    0.49253127
## Area.Income                        0.33749553  0.001322359   -0.47625463
## Daily.Internet.Usage               1.00000000  0.028012326   -0.78653918
## Male                               0.02801233  1.000000000   -0.03802747
## Clicked.on.Ad                     -0.78653918 -0.038027466    1.00000000
```

```
ggplot(data = ad, mapping = aes(x = Area.Income)) +
  geom_freqpoly(mapping = aes(colour = Clicked.on.Ad), binwidth = 2000)
```



In areas where the income lies between 60,000 and & 70,000 there is a higher number of people clicking the ads

Unsupervised learning.

```
# preview data structure
str(numerical_df)
```

```
## 'data.frame':    1000 obs. of  6 variables:
##  $ Daily.Time.Spent.on.Site: num  69 80.2 69.5 74.2 68.4 ...
##  $ Age                     : int  35 31 26 29 35 23 33 48 30 20 ...
##  $ Area.Income             : num  61834 68442 59786 54806 73890 ...
##  $ Daily.Internet.Usage    : num  256 194 236 246 226 ...
##  $ Male                    : int  0 1 0 1 0 1 0 1 1 1 ...
##  $ Clicked.on.Ad           : int  0 0 0 0 0 0 0 1 0 0 ...
```

```
head(numerical_df)
```

```
##   Daily.Time.Spent.on.Site Age Area.Income Daily.Internet.Usage Male
## 1                    68.95  35    61833.90               256.09    0
## 2                    80.23  31    68441.85               193.77    1
## 3                    69.47  26    59785.94               236.50    0
## 4                    74.15  29    54806.18               245.89    1
## 5                    68.37  35    73889.99               225.58    0
## 6                    59.99  23    59761.56               226.74    1
##   Clicked.on.Ad
## 1             0
## 2             0
## 3             0
## 4             0
## 5             0
## 6             0
```

```
#We have to first make sure all the columns are in numerical format
numerical_df[,1:6] <- sapply(numerical_df[,1:6], as.numeric)
head(numerical_df)
```

```
##   Daily.Time.Spent.on.Site Age Area.Income Daily.Internet.Usage Male
## 1                    68.95  35    61833.90               256.09    0
## 2                    80.23  31    68441.85               193.77    1
## 3                    69.47  26    59785.94               236.50    0
## 4                    74.15  29    54806.18               245.89    1
## 5                    68.37  35    73889.99               225.58    0
## 6                    59.99  23    59761.56               226.74    1
##   Clicked.on.Ad
## 1             0
## 2             0
## 3             0
## 4             0
## 5             0
## 6             0
```

```
# Normalizing the numerical variables of the data set. Normalizing the numerical values is really effec
# as it provides a measure from 0 to 1 which corresponds to min value to the max value of the data colu
# We define a normal function which will normalize the set of values according to its minimum value and
normalize <- function(x) (
  return( ((x - min(x)) /(max(x)-min(x))) )
)
```

```
# Appliying the normalization function
numerical_df$Area.Income<- normalize(numerical_df$Area.Income)
numerical_df$Daily.Internet.Usage<- normalize(numerical_df$Daily.Internet.Usage)
numerical_df$Daily.Time.Spent.on.Site<- normalize(numerical_df$Daily.Time.Spent.on.Site)
numerical_df$Male<- normalize(numerical_df$Male)
numerical_df$Age<- normalize(numerical_df$Age)
```

This is a classification problem and for the models we will build two models the Decion trees model and the SVM model Lets begin

Decision Tree

Importing the important libraries in modelling.

```
library(rpart,quietly = TRUE)
library(caret,quietly = TRUE)
library(rpart.plot,quietly = TRUE)
library(rpart.plot)
library(rattle)
```

```
## Loading required package: tibble

## Loading required package: bitops

## Rattle: A free graphical interface for data science with R.
## Version 5.5.1 Copyright (c) 2006-2021 Togaware Pty Ltd.
## Type 'rattle()' to shake, rattle, and roll your data.
```

```
library(e1071)
```

```
##
## Attaching package: 'e1071'

## The following object is masked from 'package:raster':
##
##     interpolate
```

Start with data preparation such as Splitting the data into training and testing set

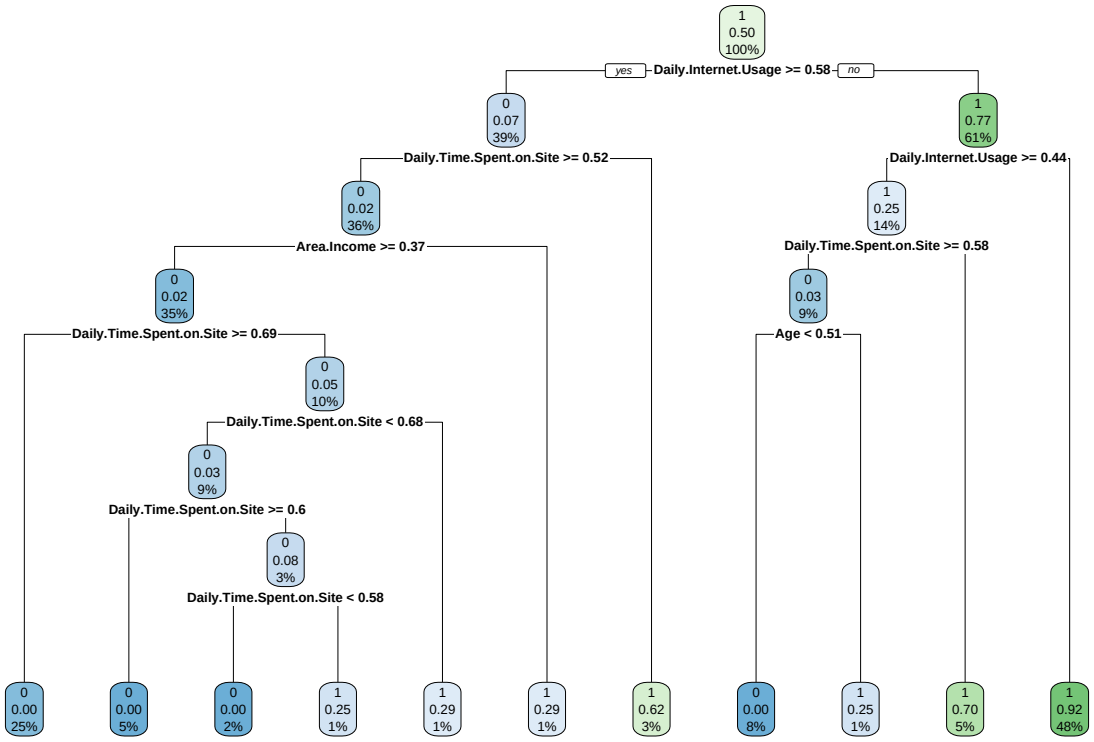
```
set.seed(42)
dttrain <- sample(1:nrow(numerical_df),size = ceiling(0.80*nrow(numerical_df)),replace = FALSE)
# training set
dt_train <- numerical_df[dttrain,]
# test set
dt_test <- numerical_df[-dttrain,]
```

we performed an 80-20 split on the data

```
# we are defining the penalty matrix for the decision tree to ensure that the model has more accurate p
# The penalty will multiply an error by 10
# Penalty matrix
penalty.matrix <- matrix(c(0, 1, 10,0), byrow = TRUE, nrow = 2)
```

```
dtree <- rpart(Clicked.on.Ad ~., data = dt_train, parms=list(loss=penalty.matrix), method = 'class')
```

```
rpart.plot(dtree)
```




```
# Calculating the metrics of the decison Tree model
# Predictions Dtree model
predt <- predict(object = dtree, dt_test[,-6], type = 'class')
#calculating accuracy
t <- table(dt_test$Clicked.on.Ad, predt)
confusionMatrix(t)
```

```
## Confusion Matrix and Statistics
##
##    predt
##       0  1
##    0 81 20
##    1  2 97
```

```
##
##                Accuracy : 0.89
##                  95% CI : (0.8382, 0.9298)
##     No Information Rate : 0.585
##     P-Value [Acc > NIR] : < 2.2e-16
##
##                   Kappa : 0.7804
##
##  Mcnemar's Test P-Value : 0.0002896
##
##             Sensitivity : 0.9759
##             Specificity : 0.8291
##          Pos Pred Value : 0.8020
##          Neg Pred Value : 0.9798
##              Prevalence : 0.4150
##          Detection Rate : 0.4050
##    Detection Prevalence : 0.5050
##       Balanced Accuracy : 0.9025
##
##        'Positive' Class : 0
##
```

The decision tree model has an accuracy of 89% That is quite acceptable as the metrics for success needed an accuracy of 80%

LinearSVM

```
library('caret')
# Performing an 80 - 20 split
svmtrain <- createDataPartition(y = numerical_df$Clicked.on.Ad, p= 0.8, list = FALSE)
training <- numerical_df[svmtrain,]
testing <- numerical_df[-svmtrain,]
```

```
# Preview the dimensions of the training and testing data
dim(training)
```

```
## [1] 800   6
```

```
dim(testing)
```

```
## [1] 200   6
```

```
# Building a LinearSVM model
# SVM model
classifierL = svm(formula = Clicked.on.Ad ~ .,
                  data = training,
                  type = 'C-classification',
                  kernel = 'linear')
```

```
# Running the metrics for the linear classification svm
y_predL = predict(classifierL, newdata = testing)
cmL = table(testing$Clicked.on.Ad, y_predL)
confusionMatrix(cmL)
```

```
## Confusion Matrix and Statistics
##
##    y_predL
##      0  1
##   0 98  2
##   1  2 98
##
##                Accuracy : 0.98
##                  95% CI : (0.9496, 0.9945)
##     No Information Rate : 0.5
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.96
##
##  Mcnemar's Test P-Value : 1
##
##             Sensitivity : 0.98
##             Specificity : 0.98
##          Pos Pred Value : 0.98
##          Neg Pred Value : 0.98
##              Prevalence : 0.50
##          Detection Rate : 0.49
##    Detection Prevalence : 0.50
##       Balanced Accuracy : 0.98
##
##        'Positive' Class : 0
##
```

The Linear SVM model has an accuracy of 97% which is quite an improvement from the Decision tree model. However, we can still challenge the model, to find a better modle that might account for overfitting.

Challenging the solution

```
# Running the clasifier with a
classifierRB = svm(formula = Clicked.on.Ad ~ .,
                 data = training,
                 type = 'C-classification',
                 kernel = 'sigmoid')
```

```
# Running the metrics for the linear classification svm
y_predRB = predict(classifierRB, newdata = testing)
cmRB = table(testing$Clicked.on.Ad, y_predRB)
confusionMatrix(cmRB)
```

```
## Confusion Matrix and Statistics
```

```
##
##    y_predRB
##      0  1
##   0 93  7
##   1  4 96
##
##                Accuracy : 0.945
##                  95% CI : (0.9037, 0.9722)
##     No Information Rate : 0.515
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.89
##
##  Mcnemar's Test P-Value : 0.5465
##
##             Sensitivity : 0.9588
##             Specificity : 0.9320
##          Pos Pred Value : 0.9300
##          Neg Pred Value : 0.9600
##              Prevalence : 0.4850
##          Detection Rate : 0.4650
##    Detection Prevalence : 0.5000
##       Balanced Accuracy : 0.9454
##
##        'Positive' Class : 0
##
```

With a sigmoid kernel on SVM technique the accuracy is (94%). This might be a better model because it would account for the overfitting.

Conclusion

- The model created using SVM performs good with an accuracy of 94%, followed by decision trees with 89%. Opted to deny Linear SVM model since it did not account overfitting data.
- We achieved our metric of success since both our models achieved an accuracy score of above 80%.

Follow up questions.

Was the data enough to answer the given questions?

The data provided was sufficient in the analysis.

Do you have any recommendation on what data should be added?

I think that the data was good, however, having more data would not be bad and training a bigger dataframe could lead to more accurate models.

The data was cleaned and used for analysis in the data frame