# STAT 5474 Project I

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## READ DAILY WEATHER DATA IN 2021

```
dat <- NULL
current.month <- 9
for (i in 1:(current.month - 1)){
    i0 <- ifelse(i<10, paste("0", i, sep=""), i)
    mth <- paste("2021", i0, sep="")
    bom <- paste("IDCJDW2801.", mth, ".csv",sep="")

    dat.i <- read.csv(bom, skip=6, check.names=FALSE,
        na.strings = c("NA", "", " "),stringsAsFactors=FALSE)
        dat.i[, 1] <- toupper(month.abb[i])
    # USE month.name() TO GET FULL MONTH NAMES
    dat <- rbind(dat, dat.i)
}
month.names <- month.name[1:8]
## [1] "January"  "February" "March"    "April"    "May"      "June"     "July"     "August"
dim(dat)
```

```
## [1] 243  22
```

```
## The dimension of the data is 243 rows and 22 columns.
head(dat)
```

```
##           Date Minimum temperature (\xb0C) Maximum temperature (\xb0C)
## 1 JAN 2021-01-1                        14.4                        19.7
## 2 JAN 2021-01-2                        13.0                        22.3
## 3 JAN 2021-01-3                        15.7                        26.7
## 4 JAN 2021-01-4                        14.6                        24.8
## 5 JAN 2021-01-5                        14.1                        28.0
## 6 JAN 2021-01-6                        13.0                        24.7
##   Rainfall (mm) Evaporation (mm) Sunshine (hours)
## 1           0.0               NA               NA
## 2           0.0               NA               NA
## 3           5.8               NA               NA
## 4           7.2               NA               NA
## 5           5.4               NA               NA
## 6           0.2               NA               NA
##   Direction of maximum wind gust  Speed of maximum wind gust (km/h)
```

```
## 1                            ESE                                35
## 2                              E                                37
## 3                            NNW                                31
## 4                            WNW                                56
## 5                             NW                                39
## 6                            ESE                                46
##   Time of maximum wind gust 9am Temperature (\xb0C) 9am relative humidity (%)
## 1                     12:39                    15.9                         71
## 2                     16:02                    16.9                         59
## 3                     13:28                    17.9                         94
## 4                     13:28                    21.6                         74
## 5                     13:16                    19.2                         77
## 6                     13:23                    18.2                         68
##   9am cloud amount (oktas) 9am wind direction 9am wind speed (km/h)
## 1                        8                 SE                    17
## 2                        8                  E                     7
## 3                        8               <NA>                  Calm
## 4                        7                  W                     6
## 5                        4                  W                     9
## 6                        8                 SE                    11
##   9am MSL pressure (hPa) 3pm Temperature (\xb0C) 3pm relative humidity (%)
## 1                 1021.7                    18.5                        59
## 2                 1015.7                    20.6                        60
## 3                 1008.1                    24.1                        60
## 4                 1006.3                    16.3                        97
## 5                 1008.0                    26.6                        41
## 6                 1014.0                    19.1                        76
##   3pm cloud amount (oktas) 3pm wind direction 3pm wind speed (km/h)
## 1                        8                ESE                    17
## 2                        8                  E                    17
## 3                        8                 NW                    17
## 4                        8                SSW                    13
## 5                        2                 NW                    20
## 6                        7                ESE                    33
##   3pm MSL pressure (hPa)
## 1                 1019.1
## 2                 1011.7
## 3                 1005.8
## 4                 1007.6
## 5                 1006.2
## 6                 1013.4
```

```
## The output displays the first 6 rows of the data.
```

# 2(a)

```
apply(dat, MARGIN = 2, FUN = function(x){table(x, useNA = "ifany")})
```

```
## [[1]]
## x
## APR AUG FEB JAN JUL JUN MAR MAY
```

```
##  30  31  28  31  31  30  31  31
##
## $Date
## x
##  2021-01-1 2021-01-10 2021-01-11 2021-01-12 2021-01-13 2021-01-14 2021-01-15
##          1          1          1          1          1          1          1
## 2021-01-16 2021-01-17 2021-01-18 2021-01-19  2021-01-2 2021-01-20 2021-01-21
##          1          1          1          1          1          1          1
## 2021-01-22 2021-01-23 2021-01-24 2021-01-25 2021-01-26 2021-01-27 2021-01-28
##          1          1          1          1          1          1          1
## 2021-01-29  2021-01-3 2021-01-30 2021-01-31  2021-01-4  2021-01-5  2021-01-6
##          1          1          1          1          1          1          1
##  2021-01-7  2021-01-8  2021-01-9  2021-02-1 2021-02-10 2021-02-11 2021-02-12
##          1          1          1          1          1          1          1
## 2021-02-13 2021-02-14 2021-02-15 2021-02-16 2021-02-17 2021-02-18 2021-02-19
##          1          1          1          1          1          1          1
##  2021-02-2 2021-02-20 2021-02-21 2021-02-22 2021-02-23 2021-02-24 2021-02-25
##          1          1          1          1          1          1          1
## 2021-02-26 2021-02-27 2021-02-28  2021-02-3  2021-02-4  2021-02-5  2021-02-6
##          1          1          1          1          1          1          1
##  2021-02-7  2021-02-8  2021-02-9  2021-03-1 2021-03-10 2021-03-11 2021-03-12
##          1          1          1          1          1          1          1
## 2021-03-13 2021-03-14 2021-03-15 2021-03-16 2021-03-17 2021-03-18 2021-03-19
##          1          1          1          1          1          1          1
##  2021-03-2 2021-03-20 2021-03-21 2021-03-22 2021-03-23 2021-03-24 2021-03-25
##          1          1          1          1          1          1          1
## 2021-03-26 2021-03-27 2021-03-28 2021-03-29  2021-03-3 2021-03-30 2021-03-31
##          1          1          1          1          1          1          1
##  2021-03-4  2021-03-5  2021-03-6  2021-03-7  2021-03-8  2021-03-9  2021-04-1
##          1          1          1          1          1          1          1
## 2021-04-10 2021-04-11 2021-04-12 2021-04-13 2021-04-14 2021-04-15 2021-04-16
##          1          1          1          1          1          1          1
## 2021-04-17 2021-04-18 2021-04-19  2021-04-2 2021-04-20 2021-04-21 2021-04-22
##          1          1          1          1          1          1          1
## 2021-04-23 2021-04-24 2021-04-25 2021-04-26 2021-04-27 2021-04-28 2021-04-29
##          1          1          1          1          1          1          1
##  2021-04-3 2021-04-30  2021-04-4  2021-04-5  2021-04-6  2021-04-7  2021-04-8
##          1          1          1          1          1          1          1
##  2021-04-9  2021-05-1 2021-05-10 2021-05-11 2021-05-12 2021-05-13 2021-05-14
##          1          1          1          1          1          1          1
## 2021-05-15 2021-05-16 2021-05-17 2021-05-18 2021-05-19  2021-05-2 2021-05-20
##          1          1          1          1          1          1          1
## 2021-05-21 2021-05-22 2021-05-23 2021-05-24 2021-05-25 2021-05-26 2021-05-27
##          1          1          1          1          1          1          1
## 2021-05-28 2021-05-29  2021-05-3 2021-05-30 2021-05-31  2021-05-4  2021-05-5
##          1          1          1          1          1          1          1
##  2021-05-6  2021-05-7  2021-05-8  2021-05-9  2021-06-1 2021-06-10 2021-06-11
##          1          1          1          1          1          1          1
## 2021-06-12 2021-06-13 2021-06-14 2021-06-15 2021-06-16 2021-06-17 2021-06-18
##          1          1          1          1          1          1          1
## 2021-06-19  2021-06-2 2021-06-20 2021-06-21 2021-06-22 2021-06-23 2021-06-24
##          1          1          1          1          1          1          1
## 2021-06-25 2021-06-26 2021-06-27 2021-06-28 2021-06-29  2021-06-3 2021-06-30
##          1          1          1          1          1          1          1
```

```
##  2021-06-4  2021-06-5  2021-06-6  2021-06-7  2021-06-8  2021-06-9  2021-07-1
##          1          1          1          1          1          1          1
## 2021-07-10 2021-07-11 2021-07-12 2021-07-13 2021-07-14 2021-07-15 2021-07-16
##          1          1          1          1          1          1          1
## 2021-07-17 2021-07-18 2021-07-19  2021-07-2 2021-07-20 2021-07-21 2021-07-22
##          1          1          1          1          1          1          1
## 2021-07-23 2021-07-24 2021-07-25 2021-07-26 2021-07-27 2021-07-28 2021-07-29
##          1          1          1          1          1          1          1
##  2021-07-3 2021-07-30 2021-07-31  2021-07-4  2021-07-5  2021-07-6  2021-07-7
##          1          1          1          1          1          1          1
##  2021-07-8  2021-07-9  2021-08-1 2021-08-10 2021-08-11 2021-08-12 2021-08-13
##          1          1          1          1          1          1          1
## 2021-08-14 2021-08-15 2021-08-16 2021-08-17 2021-08-18 2021-08-19  2021-08-2
##          1          1          1          1          1          1          1
## 2021-08-20 2021-08-21 2021-08-22 2021-08-23 2021-08-24 2021-08-25 2021-08-26
##          1          1          1          1          1          1          1
## 2021-08-27 2021-08-28 2021-08-29  2021-08-3 2021-08-30 2021-08-31  2021-08-4
##          1          1          1          1          1          1          1
##  2021-08-5  2021-08-6  2021-08-7  2021-08-8  2021-08-9
##          1          1          1          1          1
##
## $`Minimum temperature (\xb0C)`
## x
##  0.0  0.2  0.3  0.5  0.6  0.7  0.9  1.0  1.1  1.4  1.8  1.9  2.1  2.3  2.4  2.5
##    2    1    1    3    3    1    2    1    1    2    2    4    2    2    3    2
##  2.6  2.8  3.2  3.3  3.4  3.5  3.6  3.7  3.8  3.9  4.0  4.1  4.2  4.3  4.4  4.7
##    1    3    3    1    4    3    3    1    3    2    2    1    1    1    3    1
##  4.8  4.9  5.0  5.4  5.5  5.6  5.7  5.8  5.9  6.0  6.1  6.2  6.4  6.6  6.7  7.0
##    3    2    2    4    1    1    2    5    2    1    3    1    1    3    2    1
##  7.1  7.2  7.3  7.4  7.6  8.0  8.1  8.2  8.3  8.4  8.7  9.0  9.2  9.7  9.8  9.9
##    1    2    1    2    1    2    1    2    2    2    1    1    1    1    1    3
## -0.1 -0.3 -0.4 -0.5 -0.6 -0.7 -0.8 -1.0 -1.1 -1.2 -1.6 -1.7 -1.8 -1.9 -2.0 -2.1
##    1    3    1    1    1    1    1    2    1    3    2    4    1    2    1    1
## -2.2 -2.5 -2.6 -2.7 -2.8 -2.9 -3.0 -3.1 -3.3 -3.4 -3.5 -3.6 -3.7 -3.8 -4.1 -4.7
##    1    1    1    1    1    1    1    1    1    3    1    1    1    1    1    1
## -4.8 -4.9 -5.0 -5.1 -5.2 -5.4 -6.0 -6.3 10.1 10.2 10.3 10.4 10.5 10.7 10.9 11.2
##    1    1    1    1    1    1    1    1    2    1    1    1    3    2    2    1
## 11.4 11.5 11.6 12.0 12.1 12.6 12.8 12.9 13.0 13.2 13.3 13.4 13.6 13.7 13.9 14.0
##    1    2    1    2    3    1    2    1    3    2    1    1    2    2    1    1
## 14.1 14.2 14.3 14.4 14.6 14.8 14.9 15.0 15.5 15.6 15.7 15.9 16.3 16.4 16.7 17.1
##    4    1    1    2    2    1    2    2    1    2    2    1    1    1    1    1
## 17.5 18.1 18.5 18.8
##    1    1    1    1
##
## $`Maximum temperature (\xb0C)`
## x
##  6.3  8.2  8.3  8.8  8.9  9.3  9.4  9.5  9.6  9.7 10.0 10.3 10.4 10.5 10.7 10.8
##    1    1    1    1    1    2    1    1    1    1    1    2    2    1    1    1
## 11.3 11.4 11.5 11.7 11.8 11.9 12.0 12.1 12.3 12.4 12.5 12.6 12.7 12.8 12.9 13.0
##    3    1    1    1    1    1    2    2    3    3    4    3    1    2    2    3
## 13.2 13.3 13.5 13.6 13.7 13.8 13.9 14.1 14.2 14.3 14.4 14.5 14.6 14.7 14.8 14.9
##    3    3    1    3    1    2    1    1    3    2    1    7    3    1    1    3
## 15.0 15.2 15.3 15.4 15.7 15.8 15.9 16.1 16.3 16.7 16.9 17.0 17.1 17.4 17.5 17.6
##    1    1    1    1    2    5    3    1    2    1    2    1    1    3    1    2
```

```
## 17.9 18.0 18.2 18.3 18.5 18.6 18.7 18.8 18.9 19.1 19.3 19.4 19.7 19.8 19.9 20.1
##    2    1    1    2    2    3    1    2    1    1    1    3    2    4    1    1
## 20.4 20.5 20.6 20.7 20.8 21.0 21.3 21.4 21.5 21.6 21.7 21.9 22.1 22.2 22.3 22.4
##    1    1    2    4    1    1    1    2    1    2    1    1    1    1    2    2
## 22.6 23.3 23.4 23.5 23.6 24.1 24.2 24.3 24.4 24.5 24.7 24.8 24.9 25.0 25.1 25.2
##    2    1    1    1    2    1    2    2    2    1    2    2    2    2    2    1
## 25.3 25.6 25.7 26.0 26.2 26.3 26.5 26.7 26.9 27.0 27.1 27.2 27.5 27.7 27.9 28.0
##    1    1    1    2    1    1    1    1    1    3    1    1    2    3    1    2
## 28.1 28.2 28.3 29.2 29.3 29.4 29.5 30.1 30.3 30.5 30.8 30.9 31.8 32.5 32.7 32.9
##    2    1    2    1    1    1    1    3    1    1    1    1    1    1    1    1
## 33.7 34.1 34.5 35.9 37.5 38.0
##    1    1    1    1    1    1
##
## $`Rainfall (mm)`
## x
##  0.0  0.2  0.4  0.6  0.8  1.0  1.2  1.4  1.8  2.0  2.2  2.4  2.6  2.8  3.0  3.2
##  153   28    2    3    2    2    1    1    2    1    1    2    1    3    1    1
##  3.6  4.0  4.2  4.8  5.0  5.4  5.8  7.2  7.6  7.8  8.0  8.2  9.0  9.4  9.8 10.2
##    1    1    1    2    3    3    2    1    1    1    1    1    1    1    1    1
## 10.4 10.8 11.0 11.2 12.4 19.2 22.2 22.8 23.8 25.4 28.4 29.4 30.6
##    1    2    1    3    1    1    1    1    1    1    1    1    2
##
## $`Evaporation (mm)`
## x
## <NA>
##  243
##
## $`Sunshine (hours)`
## x
## <NA>
##  243
##
## $`Direction of maximum wind gust `
## x
##   E ENE ESE   N  NE NNE NNW  NW   S  SE SSE SSW  SW   W WNW WSW
##  26  13  11  18   5   3  35  61   8  12   4   7   2   4  32   2
##
## $`Speed of maximum wind gust (km/h)`
## x
## 13 15 17 19 20 22 24 26 28 30 31 33 35 37 39 41 43 44 46 48 50 52 54 56 57 59
##  2  3  6  9  3  2  7  7 11 12 14 11 14 27 17  9 11 14  9 10  7  7  8  5  2  4
## 61 63 67 69 70 72
##  2  1  1  1  4  3
##
## $`Time of maximum wind gust`
## x
## 00:00 00:10 00:17 00:29 00:40 00:58 01:03 01:08 01:19 01:38 02:52 03:19 04:06
##     1     1     1     1     1     1     1     1     1     1     1     1     1
## 04:22 04:28 04:41 04:56 05:01 05:06 05:07 05:16 05:27 05:31 06:09 06:15 07:10
##     1     1     1     1     1     1     1     1     1     1     1     1     1
## 07:25 07:44 07:58 08:54 08:57 09:04 09:05 09:10 09:13 09:15 09:26 09:45 09:46
##     1     1     1     1     2     1     1     1     1     1     1     1     1
## 09:49 09:51 09:54 09:55 10:02 10:28 10:59 11:03 11:04 11:06 11:10 11:11 11:20
##     1     1     1     1     1     1     1     1     1     1     1     1     1
```

```
## 11:26 11:30 11:33 11:37 11:45 11:48 11:49 11:59 12:00 12:02 12:04 12:07 12:08
##     1     1     1     1     1     2     2     1     1     1     1     1     1
## 12:14 12:16 12:21 12:22 12:24 12:25 12:29 12:34 12:35 12:36 12:39 12:40 12:41
##     1     1     1     1     2     1     1     1     2     1     1     1     1
## 12:42 12:43 12:46 12:58 12:59 13:00 13:05 13:06 13:08 13:09 13:15 13:16 13:19
##     1     1     1     2     1     1     1     1     3     1     1     3     1
## 13:21 13:22 13:23 13:25 13:26 13:28 13:29 13:33 13:37 13:41 13:42 13:43 13:45
##     1     2     1     1     1     2     2     4     1     2     1     1     1
## 13:46 13:47 13:50 13:51 13:52 13:57 13:59 14:01 14:03 14:04 14:08 14:09 14:14
##     1     1     1     1     2     2     2     2     1     1     1     1     2
## 14:17 14:18 14:19 14:23 14:24 14:29 14:33 14:35 14:36 14:40 14:42 14:44 14:45
##     1     1     1     2     2     1     1     1     1     1     1     2     1
## 14:50 14:53 14:54 14:55 14:56 14:58 15:00 15:01 15:02 15:05 15:10 15:16 15:17
##     1     2     1     2     1     1     1     1     3     1     1     1     1
## 15:20 15:21 15:26 15:27 15:31 15:33 15:37 15:38 15:41 15:42 15:43 15:44 15:45
##     1     1     1     1     1     2     1     1     2     1     1     1     1
## 15:46 15:47 15:51 15:54 15:55 15:59 16:02 16:06 16:12 16:15 16:16 16:24 16:30
##     1     1     1     1     1     1     1     1     1     1     1     1     1
## 16:46 16:47 16:49 16:55 17:09 17:21 17:22 17:27 17:43 17:57 17:58 18:05 18:06
##     1     1     1     1     1     1     1     1     1     1     1     1     1
## 18:07 18:15 18:23 18:26 18:27 18:34 18:35 18:46 18:51 18:55 18:56 19:05 19:24
##     1     1     2     1     1     1     1     1     1     1     1     1     1
## 19:27 19:52 20:00 20:04 20:06 20:10 20:25 20:26 20:59 21:45 21:51 22:05 22:28
##     1     1     1     1     2     1     1     1     1     1     1     1     1
## 22:30 23:00
##     1     1
##
## $`9am Temperature (\xb0C)`
## x
##  0.0  0.3  0.4  0.6  0.8  0.9  1.0  1.2  1.3  1.4  1.8  2.0  2.2  2.3  2.7  2.8
##    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1    1
##  3.0  3.1  3.4  3.7  3.8  4.0  4.1  4.3  4.4  4.5  4.6  5.2  5.4  5.5  5.6  5.7
##    2    1    2    1    1    5    1    1    1    2    1    2    4    2    2    1
##  5.8  5.9  6.0  6.2  6.3  6.5  6.6  6.7  6.8  6.9  7.0  7.2  7.3  7.6  7.8  8.0
##    2    1    2    3    2    1    2    3    2    2    2    1    2    1    3    2
##  8.1  8.2  8.3  8.4  8.5  8.6  8.7  8.8  8.9  9.1  9.2  9.3  9.4  9.5  9.6  9.8
##    2    3    2    2    3    2    6    3    1    1    5    1    1    1    2    3
##  9.9 -0.8 10.2 10.3 10.4 10.5 10.6 10.7 10.8 11.0 11.1 11.2 11.3 11.4 11.5 11.8
##    3    1    3    2    1    2    2    1    1    1    1    1    1    2    1    1
## 12.0 12.2 12.3 12.4 12.7 12.9 13.0 13.2 13.3 13.4 13.8 14.2 14.4 14.5 14.7 15.0
##    1    1    4    2    1    1    2    1    1    2    3    2    2    1    1    1
## 15.1 15.2 15.3 15.4 15.5 15.6 15.8 15.9 16.0 16.3 16.4 16.5 16.6 16.7 16.8 16.9
##    3    1    2    4    1    2    1    2    1    1    3    1    4    4    2    3
## 17.0 17.1 17.2 17.3 17.5 17.8 17.9 18.0 18.1 18.2 18.3 18.4 18.8 19.0 19.1 19.2
##    1    1    1    1    2    2    1    1    1    3    2    2    1    1    3    3
## 19.5 19.7 19.9 20.3 20.5 20.8 21.1 21.2 21.5 21.6 21.7 22.1 22.4 25.0 25.4 26.3
##    1    1    3    1    1    1    1    1    1    1    1    1    1    1    1    1
##
## $`9am relative humidity (%)`
## x
##  34  37  42  45  49  50  52  53  55  56  57  58  59  60  61  62  63  64  65  66
##   1   2   1   1   2   4   1   1   1   3   3   1   4   3   7   2   8   3   6   3
##  67  68  69  70  71  72  73  74  75  76  77  78  79  80  81  82  83  84  85  86
##   2   3   4   5   1   1   6   6   5   4   7   7   6   2   4   8   3   8   4   7
```

```
##  87  88  89  90  91  92  93  94  95  96  97  98  99 100
##   6   7   5   3   5   4   1   7   6   2   2   1  25  19
##
## $`9am cloud amount (oktas)`
## x
##    1    2    3    4    5    6    7    8 <NA>
##    8    9    4    4    6    5   18   88  101
##
## $`9am wind direction`
## x
##    E  ENE  ESE    N   NE  NNE  NNW   NW    S   SE  SSE  SSW   SW    W  WNW  WSW
##   13    8   13   26    2    1   25   20   19   21   25   13    7    5    8    1
## <NA>
##   36
##
## $`9am wind speed (km/h)`
## x
##   11   13   15   17   19    2   20   22   24   26   28   30   31   33   35   37
##   13   16   12   12    7   16    8    6    4    3    3    7    2    1    1    1
##   39    4   43    6    7    9 Calm
##    2   17    2   19   33   22   36
##
## $`9am MSL pressure (hPa)`
## x
##  996.2  996.9  998.7 1001.8 1002.3 1003.2 1003.4 1005.0 1005.5 1005.7 1006.1
##      1      1      1      1      1      1      1      1      1      1      1
## 1006.3 1006.5 1006.6 1006.8 1007.0 1007.2 1008.0 1008.1 1008.2 1008.6 1009.1
##      2      1      1      2      1      2      1      1      1      1      1
## 1009.3 1009.4 1009.7 1009.8 1009.9 1010.1 1010.2 1010.3 1010.4 1010.8 1010.9
##      1      1      1      1      2      2      1      2      1      2      2
## 1011.1 1011.3 1011.5 1011.6 1011.7 1012.0 1012.2 1012.3 1012.4 1012.6 1012.7
##      1      1      1      1      1      2      1      1      2      1      1
## 1012.8 1012.9 1013.0 1013.1 1013.2 1013.3 1013.5 1013.6 1013.8 1013.9 1014.0
##      2      1      3      1      1      1      1      3      4      1      1
## 1014.1 1014.4 1014.5 1014.9 1015.2 1015.4 1015.5 1015.6 1015.7 1015.9 1016.0
##      1      1      3      4      1      2      2      2      2      1      3
## 1016.1 1016.3 1016.4 1016.6 1016.8 1017.0 1017.1 1017.2 1017.3 1017.5 1017.6
##      3      1      2      1      3      1      1      1      1      3      1
## 1017.9 1018.1 1018.2 1018.3 1018.6 1018.7 1018.8 1018.9 1019.0 1019.1 1019.2
##      1      1      1      2      3      1      1      1      1      1      1
## 1019.3 1019.4 1019.5 1019.6 1019.7 1019.8 1020.0 1020.1 1020.2 1020.3 1020.6
##      1      3      1      3      1      1      2      2      1      1      1
## 1020.8 1020.9 1021.3 1021.5 1021.6 1021.7 1021.8 1022.0 1022.1 1022.2 1022.3
##      1      1      1      2      1      1      1      2      2      2      2
## 1022.4 1022.5 1022.6 1022.7 1023.0 1023.2 1023.3 1023.4 1023.5 1023.7 1023.8
##      1      2      5      1      2      1      1      1      1      4      1
## 1024.1 1024.3 1024.5 1024.6 1024.9 1025.0 1025.1 1025.3 1025.4 1025.5 1025.6
##      2      2      2      1      1      1      1      2      3      1      2
## 1025.8 1025.9 1026.0 1026.1 1026.2 1026.3 1026.4 1026.5 1026.7 1026.8 1027.0
##      1      1      1      1      1      1      2      1      2      1      2
## 1027.1 1027.2 1027.3 1027.6 1028.1 1028.4 1029.3 1029.4 1029.5 1029.6 1029.7
##      1      3      1      1      2      1      1      1      3      1      1
## 1030.0 1030.1 1030.2 1030.7 1030.8 1030.9 1031.0 1031.5 1032.2 1032.3 1032.6
##      1      1      1      1      1      1      1      1      1      1      1
```

```
## 1033.4 1033.8 1034.3 1036.6
##      1      1      1      1
##
## $`3pm Temperature (\xb0C)`
## x
##  5.8  6.0  6.9  7.0  7.4  7.5  7.7  7.9  8.0  8.5  8.7  9.0  9.2  9.3  9.5  9.6
##    2    1    1    1    1    1    1    1    2    1    2    1    1    3    1    2
##  9.9 10.1 10.3 10.4 10.5 10.7 10.8 10.9 11.0 11.1 11.2 11.3 11.4 11.5 11.6 11.7
##    1    1    1    1    1    2    1    2    1    2    1    3    2    2    1    3
## 11.9 12.0 12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 13.0 13.1 13.2 13.3 13.4 13.6
##    2    6    1    1    3    1    3    2    2    2    3    2    1    1    5    3
## 13.8 14.0 14.2 14.3 14.4 14.5 14.6 14.7 14.8 14.9 15.0 15.1 15.3 15.4 15.7 16.0
##    3    3    1    2    1    3    2    1    2    1    2    1    2    1    1    2
## 16.1 16.3 16.6 16.8 17.0 17.1 17.2 17.3 17.6 17.7 17.8 17.9 18.0 18.1 18.2 18.3
##    3    1    1    1    2    1    2    1    1    1    1    1    5    2    1    1
## 18.4 18.5 18.6 18.7 18.9 19.0 19.1 19.2 19.4 19.5 19.8 20.0 20.1 20.3 20.6 20.7
##    2    3    1    1    1    2    3    1    1    2    2    1    1    2    1    3
## 20.8 21.0 21.1 21.4 21.5 21.6 21.9 22.3 22.5 22.6 22.7 22.8 22.9 23.1 23.2 23.4
##    2    2    1    1    3    2    2    1    1    1    4    2    2    2    1    2
## 24.0 24.1 24.4 24.6 24.7 25.0 25.1 25.2 25.4 25.6 25.9 26.0 26.1 26.3 26.4 26.5
##    1    2    2    1    1    1    2    1    1    1    1    1    2    1    1    1
## 26.6 26.7 26.8 27.0 27.2 27.4 27.6 27.8 28.1 28.3 28.4 29.0 29.4 29.7 31.3 31.5
##    4    1    1    1    1    1    1    1    2    2    2    2    1    1    2    1
## 32.0 32.8 34.6 36.1 36.2
##    1    1    1    1    1
##
## $`3pm relative humidity (%)`
## x
## 12 16 18 20 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43
##  1  2  2  1  2  2  3  1  2  1  2  1  1  2  3  7  1  8  1  2  2 10  5 11  8  7
## 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 66 67 68 69 70
##  3  8  1  5  7  6  4  8  6  6  3  5  6  3  4  3 10  2  3  3  7  7  3  3  2  1
## 71 72 73 74 75 76 77 81 82 83 84 86 90 91 92 93 94 96 97 99
##  3  2  1  2  1  1  1  1  3  2  1  1  2  1  2  3  2  1  2  4
##
## $`3pm cloud amount (oktas)`
## x
##    1    2    3    4    5    6    7    8 <NA>
##   19    7    7   11    9    5   21   71   93
##
## $`3pm wind direction`
## x
##    E  ENE  ESE    N   NE  NNE  NNW   NW    S   SE  SSE  SSW   SW    W  WNW  WSW
##   13   11   10   14    5    6   47   45    7    5    6    6    4    8   47    6
## <NA>
##    3
##
## $`3pm wind speed (km/h)`
## x
##   11   13   15   17   19   20   22   24   26   28   30   31   33   35   37   39
##   15   20   20   29   13   18   10   14   17   12   17    9    5    3    1    2
##    4   41   43    6    7    9 Calm
##    1    1    1    2    4   26    3
##
```

```
## $`3pm MSL pressure (hPa)`
## x
##  995.0  998.7  999.1  999.6 1000.6 1001.4 1001.7 1001.9 1002.8 1003.1 1003.9
##      1      1      1      1      1      1      1      1      1      1      1
## 1004.1 1004.5 1005.0 1005.2 1005.5 1005.6 1005.7 1005.8 1005.9 1006.1 1006.2
##      2      1      1      1      1      1      1      1      1      1      2
## 1006.3 1006.8 1007.0 1007.1 1007.2 1007.4 1007.5 1007.6 1007.8 1007.9 1008.0
##      1      1      1      1      1      1      1      2      1      1      1
## 1008.3 1008.5 1008.7 1008.8 1008.9 1009.0 1009.1 1009.2 1009.3 1009.4 1009.6
##      1      1      1      1      1      1      1      2      1      3      2
## 1009.7 1009.8 1009.9 1010.0 1010.1 1010.4 1010.5 1010.7 1010.8 1010.9 1011.1
##      4      2      1      1      1      1      3      1      2      1      1
## 1011.5 1011.7 1011.8 1011.9 1012.0 1012.1 1012.2 1012.3 1012.4 1012.5 1012.7
##      1      3      1      1      1      2      1      1      1      2      1
## 1013.0 1013.1 1013.2 1013.3 1013.4 1013.5 1013.7 1014.1 1014.2 1014.3 1014.4
##      1      3      4      1      1      1      1      1      4      2      2
## 1014.6 1014.7 1014.8 1015.0 1015.1 1015.2 1015.6 1015.9 1016.0 1016.1 1016.3
##      1      2      1      1      1      1      2      1      3      3      2
## 1016.4 1016.5 1016.6 1016.8 1016.9 1017.0 1017.1 1017.3 1017.4 1017.5 1017.6
##      1      1      2      2      1      1      2      2      1      3      1
## 1017.7 1017.8 1018.0 1018.1 1018.6 1018.7 1018.8 1018.9 1019.0 1019.1 1019.2
##      1      3      2      3      1      1      3      1      2      1      4
## 1019.4 1019.5 1019.6 1019.7 1019.8 1020.0 1020.3 1020.4 1020.6 1020.8 1021.0
##      1      1      1      2      2      4      1      2      1      1      1
## 1021.1 1021.3 1021.4 1021.6 1021.8 1021.9 1022.0 1022.1 1022.3 1022.4 1022.5
##      1      1      2      1      2      1      1      1      1      1      2
## 1022.6 1022.7 1022.8 1023.0 1023.1 1023.2 1023.3 1023.5 1023.7 1023.9 1024.0
##      2      1      1      1      4      1      3      1      1      1      1
## 1024.2 1024.3 1024.5 1024.8 1025.2 1025.3 1025.5 1025.7 1026.1 1026.5 1026.6
##      1      2      1      1      2      1      1      2      2      2      1
## 1026.7 1026.9 1027.0 1027.7 1027.8 1028.1 1028.3 1028.4 1028.6 1029.7 1031.7
##      2      1      4      1      1      1      1      1      1      1      1
## 1032.0 1033.2
##      1      1
```

```
## The variable "9am wind speed (km/h)" has Calm as a value and Calm has a frequency of 36.
## The variable "3pm wind speed (km/h)" has Calm as a value and Calm has a frequency of 3.
```

## 2(b)

```
dat <- dat[, -c(10)]
dim(dat)
```

```
## [1] 243  21
```

```
## The dimension is now is 243 rows and 21 columns
colnames(dat)
```

```
##  [1] ""                                  "Date"
##  [3] "Minimum temperature (\xb0C)"       "Maximum temperature (\xb0C)"
```

```
##  [5] "Rainfall (mm)"                     "Evaporation (mm)"
##  [7] "Sunshine (hours)"                  "Direction of maximum wind gust "
##  [9] "Speed of maximum wind gust (km/h)" "9am Temperature (\xb0C)"
## [11] "9am relative humidity (%)"         "9am cloud amount (oktas)"
## [13] "9am wind direction"                "9am wind speed (km/h)"
## [15] "9am MSL pressure (hPa)"            "3pm Temperature (\xb0C)"
## [17] "3pm relative humidity (%)"         "3pm cloud amount (oktas)"
## [19] "3pm wind direction"                "3pm wind speed (km/h)"
## [21] "3pm MSL pressure (hPa)"
```

```
## The output excludes the variable "Time of maximum wind gust"
```

#2(c)

```
names(dat) <- c("Month", "Date", "MinTemp", "MaxTemp", "Rainfall",
           "Evaporation", "Sunshine", "WindGustDir", "WindGustSpeed",
           "Temp9am", "Humidity9am", "Cloud9am", "WindDir9am",
           "WindSpeed9am", "Pressure9am", "Temp3pm", "Humidity3pm",
           "Cloud3pm", "WindDir3pm", "WindSpeed3pm", "Pressure3pm")
       dim(dat)
```

```
## [1] 243  21
```

```
       names(dat)
```

```
##  [1] "Month"         "Date"          "MinTemp"       "MaxTemp"
##  [5] "Rainfall"      "Evaporation"   "Sunshine"      "WindGustDir"
##  [9] "WindGustSpeed" "Temp9am"       "Humidity9am"   "Cloud9am"
## [13] "WindDir9am"    "WindSpeed9am"  "Pressure9am"   "Temp3pm"
## [17] "Humidity3pm"   "Cloud3pm"      "WindDir3pm"    "WindSpeed3pm"
## [21] "Pressure3pm"
```

```
       ## The output gives the new names
```

```
# Notice that the variables Evaporation and Sunshine have all values recorded as NA and
# may not be useful for weather forecast purpose and so let's remove from the data set
```

```
dat <- dat[,-c(6:7)]
colnames(dat)
```

```
##  [1] "Month"         "Date"          "MinTemp"       "MaxTemp"
##  [5] "Rainfall"      "WindGustDir"   "WindGustSpeed" "Temp9am"
##  [9] "Humidity9am"   "Cloud9am"      "WindDir9am"    "WindSpeed9am"
## [13] "Pressure9am"   "Temp3pm"       "Humidity3pm"   "Cloud3pm"
## [17] "WindDir3pm"    "WindSpeed3pm"  "Pressure3pm"
```

# 2(d)

```
WindSpeed9am<-as.vector(dat$"WindSpeed9am")
WindSpeed9am[WindSpeed9am=="Calm"] <-0
dat$"WindSpeed9am"<-WindSpeed9am
dat$"WindSpeed9am"<- as.numeric(dat$"WindSpeed9am")
mode(dat$"WindSpeed9am")
```

```
## [1] "numeric"
```

```
table(dat$"WindSpeed9am")
```

```
##
##  0  2  4  6  7  9 11 13 15 17 19 20 22 24 26 28 30 31 33 35 37 39 43
## 36 16 17 19 33 22 13 16 12 12  7  8  6  4  3  3  7  2  1  1  1  2  2
```

```
WindSpeed3pm<-as.vector(dat$"WindSpeed3pm")
WindSpeed3pm[WindSpeed3pm=="Calm"] <-0
dat$"WindSpeed3pm"<-WindSpeed3pm
dat$"WindSpeed3pm"<- as.numeric(dat$"WindSpeed3pm")
mode(dat$"WindSpeed3pm")
```

```
## [1] "numeric"
```

```
table(dat$"WindSpeed3pm")
```

```
##
##  0  4  6  7  9 11 13 15 17 19 20 22 24 26 28 30 31 33 35 37 39 41 43
##  3  1  2  4 26 15 20 20 29 13 18 10 14 17 12 17  9  5  3  1  2  1  1
```

```
## The output shows that the value Calm in the variable "WindSpeed9am" has been changed
## to 0 and the variable has also been changed to numeric.

## The output shows that the value Calm in the variable "WindSpeed3pm" has been changed
## to 0 and the variable has also been changed to numeric.
```

## 2(e)

```
dat$RainToday <- ifelse(dat$Rainfall >1, 1, 0)
head(dat$RainToday)
```

```
## [1] 0 0 1 1 1 0
```

```
dat$RainTomorrow <- c(dat$RainToday[2:nrow(dat)], NA)
head(dat$RainTomorrow)
```

```
## [1] 0 1 1 1 0 0
```

## 2(f)

```
save(dat, file = "Rdata")
```

# (3)

## Missing Values

```
miss.info <- function(dat, filename=NULL){
    vnames <- colnames(dat); vnames
    n <- nrow(dat)
    out <- NULL
    for (j in 1: ncol(dat)){
        vname <- colnames(dat)[j]
        x <- as.vector(dat[,j])
        n1 <- sum(is.na(x), na.rm=T)
        n2 <- sum(x=="NA", na.rm=T)
        n3 <- sum(x=="", na.rm=T)
        nmiss <- n1 + n2 + n3
        ncomplete <- n-nmiss
        out <- rbind(out, c(col.number=j, vname=vname,
          mode=mode(x), n.levels=length(unique(x)),
          ncomplete=ncomplete, miss.perc=nmiss/n))
    }
    out <- as.data.frame(out)
    row.names(out) <- NULL
    if (!is.null(filename)) write.csv(out, file = filename, row.names=F)
    return(out)
}
miss.info(dat)
```

```
##    col.number         vname      mode n.levels ncomplete           miss.perc
## 1           1         Month character        8       243                   0
## 2           2          Date character      243       243                   0
## 3           3       MinTemp   numeric      148       243                   0
## 4           4       MaxTemp   numeric      150       243                   0
## 5           5      Rainfall   numeric       45       243                   0
## 6           6   WindGustDir character       16       243                   0
## 7           7 WindGustSpeed   numeric       32       243                   0
## 8           8       Temp9am   numeric      144       243                   0
## 9           9   Humidity9am   numeric       54       243                   0
## 10         10      Cloud9am   numeric        9       142   0.415637860082305
## 11         11    WindDir9am character       17       207   0.148148148148148
## 12         12  WindSpeed9am   numeric       23       243                   0
## 13         13   Pressure9am   numeric      169       243                   0
## 14         14       Temp3pm   numeric      149       243                   0
## 15         15   Humidity3pm   numeric       72       243                   0
## 16         16      Cloud3pm   numeric        9       150   0.382716049382716
## 17         17    WindDir3pm character       17       240  0.0123456790123457
```

```
## 18         18  WindSpeed3pm   numeric       23       243                    0
## 19         19   Pressure3pm   numeric      167       243                    0
## 20         20      RainToday   numeric        2       243                    0
## 21         21  RainTomorrow   numeric        3       242 0.00411522633744856
```

```
## From the output the following are the variables with missing values and their
## corresponding missing percentage:
## Cloud9am 41.564%
## WindDir9am 14.815%
## Cloud3pm 38.272%
## WindDir3pm 1.235%
## RainTomorrow 0.412%
```

## Association between categorical variable with the binary outcome

```
tab <- table(dat$Month, dat$RainTomorrow, useNA="no"); tab
```

```
##
##        0  1
##   APR 29  1
##   AUG 24  6
##   FEB 21  7
##   JAN 24  7
##   JUL 22  9
##   JUN 20 10
##   MAR 22  9
##   MAY 27  4
```

```
chisq.test(tab)
```

```
##
##  Pearson's Chi-squared test
##
## data:  tab
## X-squared = 11.879, df = 7, p-value = 0.1046
```

```
fisher.test(tab, simulate.p.value =TRUE)
```

```
##
##  Fisher's Exact Test for Count Data with simulated p-value (based on
##  2000 replicates)
##
## data:  tab
## p-value = 0.05097
## alternative hypothesis: two.sided
```

```
## The p-value for Chi-Square test is 0.1046 > 0.05=significance level.
## Thus, we conclude that at 5% significant level, there is an association between
## RainTomorrow and WindGustDir.

## Also,the p-value for  Fisher exact test is 0.05947 > 0.05=significance level.
## Thus, we  conclude that at 5% significant level, there is an association between
## RainTomorrow and WindGustDir.
```

## Nonparameetric test-Wilcoxon rank sum test

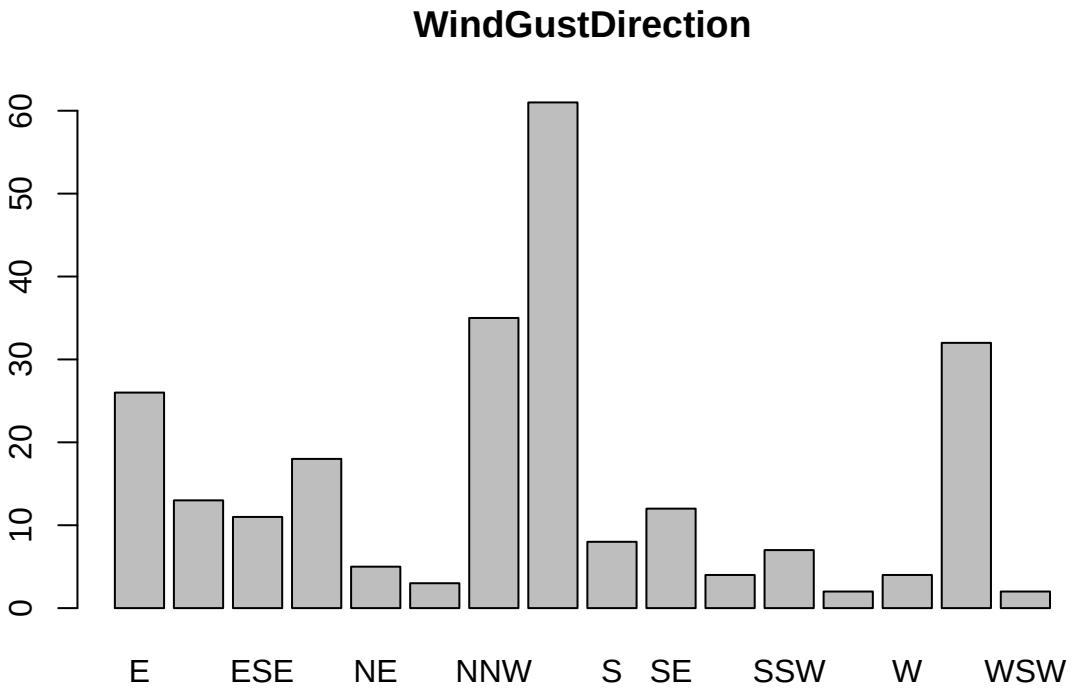
```
wilcox <- wilcox.test(Temp9am ~ RainTomorrow, data=dat)
wilcox
```

```
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  Temp9am by RainTomorrow
## W = 4408.5, p-value = 0.1831
## alternative hypothesis: true location shift is not equal to 0
```

```
## Since the p-value = 0.1831 > 0.05, we conclude that at 5% significance level,
## there is no enough evidence to say that the true location shift in not equal to 0.
```

## barplot for categorical variable(possibly grouped by the binary outcome)

```
counts <- table(dat$WindGustDir)
barplot(counts, main="WindGustDirection",
  names.arg=c( "E","ENE","ESE","N", "NE","NNE","NNW","NW","S","SE","SSE","SSW","SW","W","WNW","WSW"))
```




```
## From the graph, we see that the maximum direction of the wind occurred at NW
## and the minimum occurred at SW and WSW. Thus, we see that the direction of
## the wind tells us when there was rain and no rain.
```