

# Variable Selection

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```
knitr::opts_knit$set(root.dir = "..") # Reset root directory for analysis
library(lubridate) # To help handle dates
library(dplyr) # Data wrangling
library(tidyr) # Data wrangling
library(ggplot2) # Plotting
```

Read in and clean up the data:

```
train <- read.csv("data/train.csv", as.is = TRUE) # `as.is` so `datetime` comes in as
# character, not factor

test <- read.csv("data/test.csv", as.is = TRUE)

train <- mutate(train,
  datetime = ymd_hms(datetime),
  year = factor(year(datetime)),
  hour = factor(hour(datetime)),
  month = month(datetime),
  yday = yday(datetime),
  weather = factor(weather, levels = c(1, 2, 3, 4),
    labels = c("Clear", "Mist", "Light Precip",
      "Heavy Precip")),
  season = factor(season, levels = c(1, 2, 3, 4),
    labels = c("Spring", "Summer", "Fall", "Winter")),
  workingday = factor(workingday, levels = c(0, 1),
    labels = c("Holiday / weekend",
      "Working day")))

test <- mutate(test,
  datetime = ymd_hms(datetime),
  year = factor(year(datetime)),
  hour = factor(hour(datetime)),
  month = month(datetime),
  yday = yday(datetime),
  weather = factor(weather, levels = c(1, 2, 3, 4),
    labels = c("Clear", "Mist", "Light Precip",
      "Heavy Precip")),
  season = factor(season, levels = c(1, 2, 3, 4),
    labels = c("Spring", "Summer", "Fall", "Winter")),
  workingday = factor(workingday, levels = c(0, 1),
    labels = c("Holiday / weekend",
      "Working day")))
```

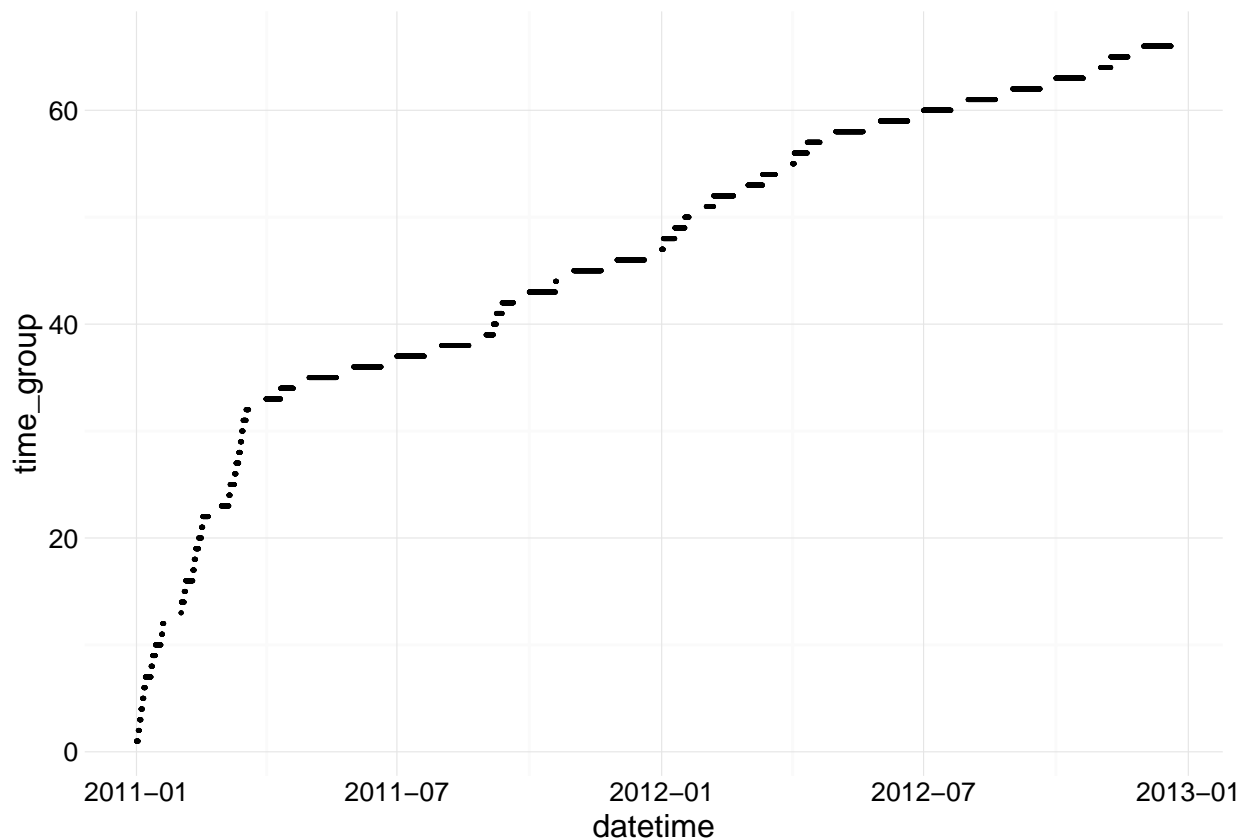
Add some derived variables related to weather and temperature, using `dplyr` for data wrangling (here's a good cheatsheet).

First, create some lagged variables for `temp` and `weather`. Because there are breaks in the time series, we need to group everything by continuous time groups before doing that lagging. Otherwise, you would end up with a case where you're saying that the temperature the last hour was really the last hour of a day several

days ago, before a gap in the time series. This code isn't terribly elegant, but it's one way to get those groups, so that every `time_group` is limited to values that are continuous by hour:

```
train <- mutate(train,
                 time_diff = difftime(datetime, lag(datetime)))
train$time_group <- NA
group_num <- 1
for(i in 1:nrow(train)){
  if(!is.na(train$time_diff[i]) & train$time_diff[i] > dhours(1)){
    group_num <- group_num + 1
  }
  train$time_group[i] <- group_num
}
```

```
ggplot(train, aes(x = datetime, y = time_group)) +
  geom_point(size = 0.2) +
  theme_minimal()
```



Then you can group by this new variable before you do lags.

```
train <- group_by(train, time_group) %>%
  mutate(temp1 = lag(temp, 1),
         temp2 = lag(temp, 2),
         temp3 = lag(temp, 3),
         temp4 = lag(temp, 4),
         temp5 = lag(temp, 5),
         weather1 = lag(weather, 1),
```

```

weather2 = lag(weather, 2),
weather3 = lag(weather, 3),
weather4 = lag(weather, 4),
weather5 = lag(weather, 5)) %>%
ungroup()

```

You can see that there are missing values for these lagged variables, because every time you get to a new time group, you won't be able to get lags that reach before the first hour in the time group:

```

rename(train,
  temp0 = temp) %>%
select(starts_with("temp")) %>%
gather("lag", "temp") %>%
mutate(lag = sub("temp", "", lag)) %>%
group_by(lag) %>%
summarize(num_missing = sum(is.na(temp)))

```

```

## Source: local data frame [6 x 2]
##
##      lag num_missing
##   (chr)         (int)
## 1     0             0
## 2     1            66
## 3     2           132
## 4     3           198
## 5     4           264
## 6     5           329

```

Here are the correlations between different lags:

```

round(cor(select(train, starts_with("temp")), use = "complete.obs"), 2)

```

```

##      temp temp1 temp2 temp3 temp4 temp5
## temp  1.00  0.99  0.98  0.96  0.94  0.92
## temp1 0.99  1.00  0.99  0.98  0.96  0.94
## temp2 0.98  0.99  1.00  0.99  0.98  0.96
## temp3 0.96  0.98  0.99  1.00  0.99  0.98
## temp4 0.94  0.96  0.98  0.99  1.00  0.99
## temp5 0.92  0.94  0.96  0.98  0.99  1.00

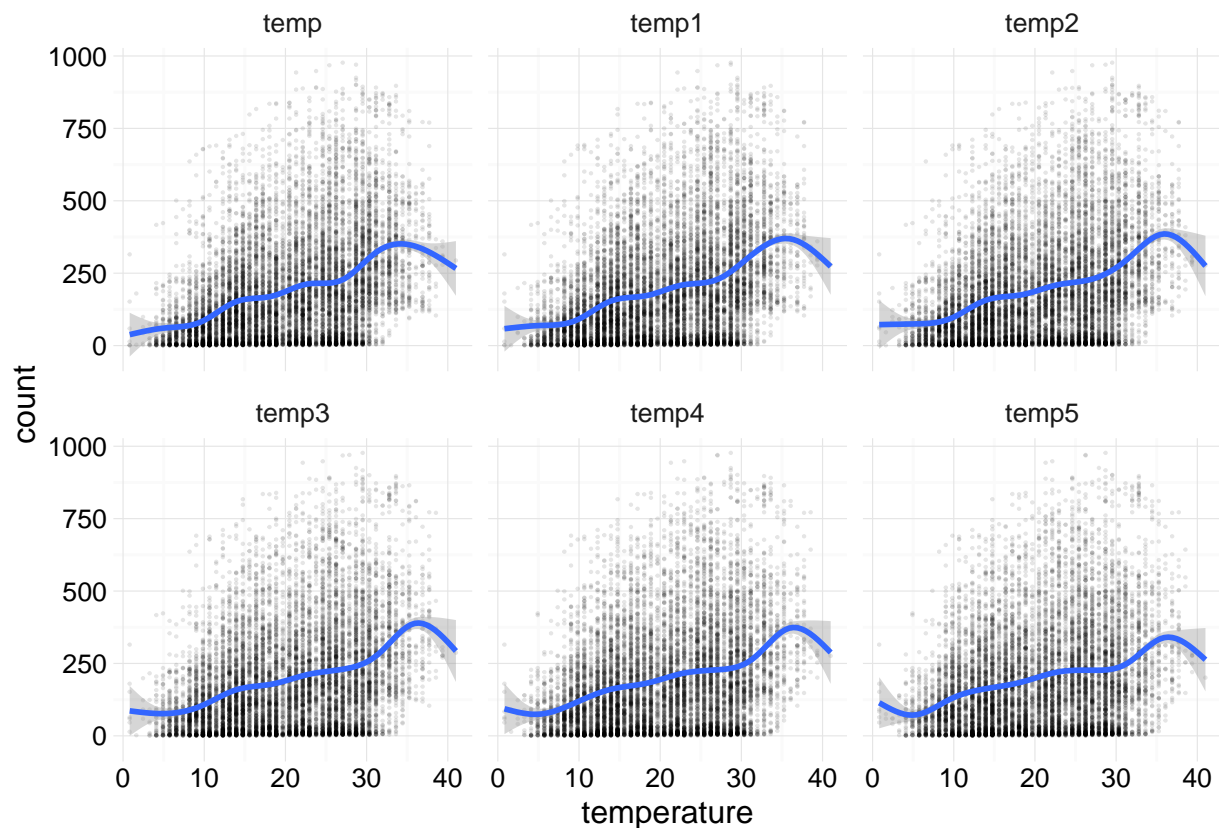
```

These are all really strongly correlated. I'm not sure if you'll gain much from the new variables, since they're all kind of saying the same thing.

```

to_plot <- select(train, count, starts_with("temp")) %>%
  gather("lag", "temperature", -count)
ggplot(to_plot, aes(x = temperature, y = count)) +
  geom_point(alpha = 0.1, size = 0.1) +
  geom_smooth() +
  facet_wrap(~ lag) +
  theme_minimal()

```

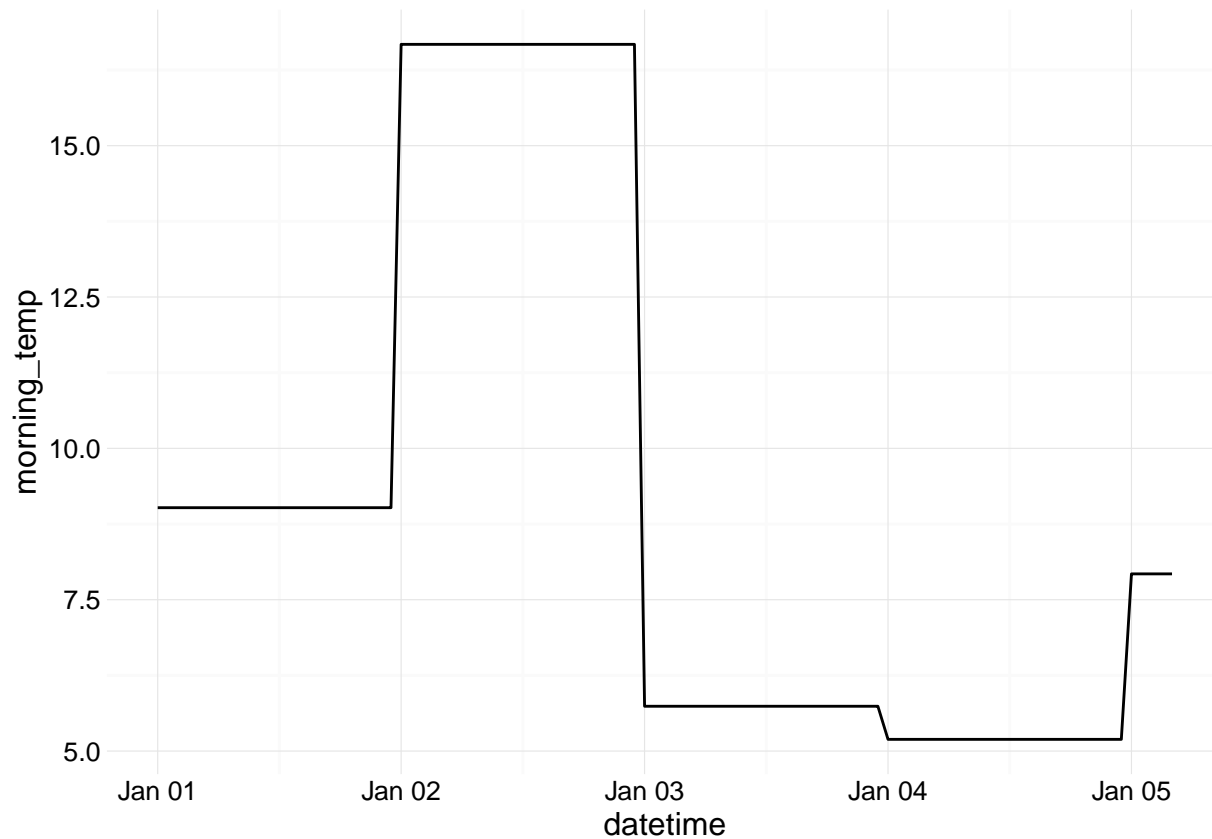


Next, create some variables by day. For example, was there one or more hours of bad weather during the day? You can get these by grouping by day (`group_by`), using `mutate` to calculate the by-day summary, and then ungrouping (`ungroup`).

```
train <- mutate(train, day = format(datetime, "%Y%m%d")) %>%
  group_by(day) %>%
  mutate(mean_daily_temp = mean(temp),
         morning = hour %in% c("6", "7", "8"),
         morning_temp = mean(temp[morning]),
         hours_bad_weather = sum(weather != "Clear"),
         any_bad_weather = ifelse(hours_bad_weather > 0, 1, 0),
         morning_bad_weather = ifelse(sum(weather[morning] != "Clear") > 0, 1, 0)) %>%
  select(-morning) %>%
  ungroup()
```

You can see that these values are constant within a day:

```
ggplot(train[1:(4*24), ], aes(x = datetime, y = morning_temp)) +
  geom_line() +
  theme_minimal()
```



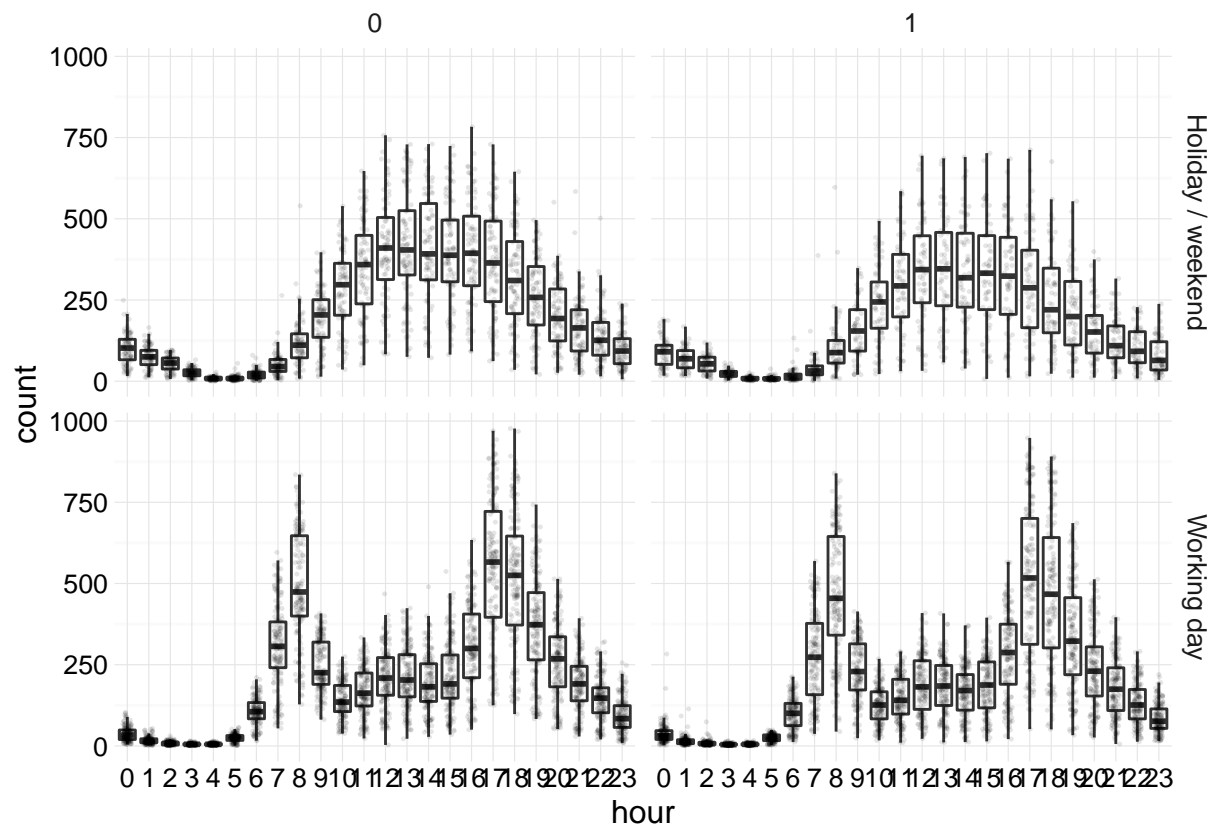
```
train$weather[1:24]
```

```
## [1] Clear      Clear      Clear      Clear      Clear
## [6] Mist       Clear      Clear      Clear      Clear
## [11] Clear      Clear      Clear      Mist       Mist
## [16] Mist       Mist       Mist       Light Precip Light Precip
## [21] Mist       Mist       Mist       Mist
## Levels: Clear Mist Light Precip Heavy Precip
```

```
train$hours_bad_weather[1:24]
```

```
## [1] 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12 12
## [24] 12
```

```
ggplot(train, aes(x = hour, y = count)) +
  geom_boxplot(outlier.shape = NA) +
  geom_jitter(width = 0.5, height = 0, alpha = 0.1, size = 0.2) +
  facet_grid(workingday ~ morning_bad_weather) +
  theme_minimal()
```



The dataframe now has 31 predictors.

## Forward stepwise selection

Since this dataset now has a lot of predictors, and a lot of these are strongly correlated, I'll try using forward (rather than backward) stepwise selection.

```
library(leaps) # For variable selection
my_train <- select(train, -casual, -registered, -time_group,
                  -time_diff, -datetime)
regfit_for <- regsubsets(count ~ ., data = my_train,
                        method = "forward")
```

```
## Warning in leaps.setup(x, y, wt = wt, nbest = nbest, nvmax = nvmax,
## force.in = force.in, : 13 linear dependencies found
```

```
## Reordering variables and trying again:
```

```
summary(regfit_for)
```

```
## Subset selection object
## Call: regsubsets.formula(count ~ ., data = my_train, method = "forward")
## 517 Variables (and intercept)
##               Forced in Forced out
## seasonSummer      FALSE      FALSE
```

## seasonFall	FALSE	FALSE
## seasonWinter	FALSE	FALSE
## holiday	FALSE	FALSE
## workingdayWorking day	FALSE	FALSE
## weatherMist	FALSE	FALSE
## weatherLight Precip	FALSE	FALSE
## weatherHeavy Precip	FALSE	FALSE
## temp	FALSE	FALSE
## atemp	FALSE	FALSE
## humidity	FALSE	FALSE
## windspeed	FALSE	FALSE
## year2012	FALSE	FALSE
## hour1	FALSE	FALSE
## hour2	FALSE	FALSE
## hour3	FALSE	FALSE
## hour4	FALSE	FALSE
## hour5	FALSE	FALSE
## hour6	FALSE	FALSE
## hour7	FALSE	FALSE
## hour8	FALSE	FALSE
## hour9	FALSE	FALSE
## hour10	FALSE	FALSE
## hour11	FALSE	FALSE
## hour12	FALSE	FALSE
## hour13	FALSE	FALSE
## hour14	FALSE	FALSE
## hour15	FALSE	FALSE
## hour16	FALSE	FALSE
## hour17	FALSE	FALSE
## hour18	FALSE	FALSE
## hour19	FALSE	FALSE
## hour20	FALSE	FALSE
## hour21	FALSE	FALSE
## hour22	FALSE	FALSE
## hour23	FALSE	FALSE
## month	FALSE	FALSE
## yday	FALSE	FALSE
## temp1	FALSE	FALSE
## temp2	FALSE	FALSE
## temp3	FALSE	FALSE
## temp4	FALSE	FALSE
## temp5	FALSE	FALSE
## weather1Mist	FALSE	FALSE
## weather1Light Precip	FALSE	FALSE
## weather1Heavy Precip	FALSE	FALSE
## weather2Mist	FALSE	FALSE
## weather2Light Precip	FALSE	FALSE
## weather2Heavy Precip	FALSE	FALSE
## weather3Mist	FALSE	FALSE
## weather3Light Precip	FALSE	FALSE
## weather3Heavy Precip	FALSE	FALSE
## weather4Mist	FALSE	FALSE
## weather4Light Precip	FALSE	FALSE
## weather4Heavy Precip	FALSE	FALSE

## weather5Mist	FALSE	FALSE
## weather5Light Precip	FALSE	FALSE
## weather5Heavy Precip	FALSE	FALSE
## day20110102	FALSE	FALSE
## day20110103	FALSE	FALSE
## day20110104	FALSE	FALSE
## day20110105	FALSE	FALSE
## day20110106	FALSE	FALSE
## day20110107	FALSE	FALSE
## day20110108	FALSE	FALSE
## day20110109	FALSE	FALSE
## day20110110	FALSE	FALSE
## day20110111	FALSE	FALSE
## day20110112	FALSE	FALSE
## day20110113	FALSE	FALSE
## day20110114	FALSE	FALSE
## day20110115	FALSE	FALSE
## day20110116	FALSE	FALSE
## day20110117	FALSE	FALSE
## day20110119	FALSE	FALSE
## day20110201	FALSE	FALSE
## day20110202	FALSE	FALSE
## day20110203	FALSE	FALSE
## day20110204	FALSE	FALSE
## day20110205	FALSE	FALSE
## day20110206	FALSE	FALSE
## day20110207	FALSE	FALSE
## day20110208	FALSE	FALSE
## day20110209	FALSE	FALSE
## day20110210	FALSE	FALSE
## day20110211	FALSE	FALSE
## day20110212	FALSE	FALSE
## day20110213	FALSE	FALSE
## day20110214	FALSE	FALSE
## day20110215	FALSE	FALSE
## day20110216	FALSE	FALSE
## day20110217	FALSE	FALSE
## day20110218	FALSE	FALSE
## day20110219	FALSE	FALSE
## day20110301	FALSE	FALSE
## day20110302	FALSE	FALSE
## day20110303	FALSE	FALSE
## day20110304	FALSE	FALSE
## day20110305	FALSE	FALSE
## day20110306	FALSE	FALSE
## day20110307	FALSE	FALSE
## day20110308	FALSE	FALSE
## day20110309	FALSE	FALSE
## day20110310	FALSE	FALSE
## day20110311	FALSE	FALSE
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## day20110316	FALSE	FALSE
## day20110317	FALSE	FALSE
## day20110318	FALSE	FALSE
## day20110319	FALSE	FALSE
## day20110401	FALSE	FALSE
## day20110402	FALSE	FALSE
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## day20110405	FALSE	FALSE
## day20110406	FALSE	FALSE
## day20110407	FALSE	FALSE
## day20110408	FALSE	FALSE
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## day20110503	FALSE	FALSE
## day20110504	FALSE	FALSE
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## day20120907	FALSE	FALSE
## day20120908	FALSE	FALSE
## day20120909	FALSE	FALSE
## day20120910	FALSE	FALSE
## day20120911	FALSE	FALSE
## day20120912	FALSE	FALSE
## day20120913	FALSE	FALSE
## day20120914	FALSE	FALSE
## day20120915	FALSE	FALSE
## day20120916	FALSE	FALSE
## day20120917	FALSE	FALSE
## day20120918	FALSE	FALSE
## day20121001	FALSE	FALSE
## day20121002	FALSE	FALSE
## day20121003	FALSE	FALSE
## day20121004	FALSE	FALSE
## day20121005	FALSE	FALSE
## day20121006	FALSE	FALSE
## day20121007	FALSE	FALSE
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## day20121011	FALSE	FALSE
## day20121012	FALSE	FALSE
## day20121013	FALSE	FALSE
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## day20121108	FALSE	FALSE
## day20121109	FALSE	FALSE
## day20121110	FALSE	FALSE
## day20121111	FALSE	FALSE
## day20121113	FALSE	FALSE
## day20121114	FALSE	FALSE
## day20121115	FALSE	FALSE
## day20121116	FALSE	FALSE
## day20121117	FALSE	FALSE

```

## day20121118          FALSE      FALSE
## day20121201          FALSE      FALSE
## day20121202          FALSE      FALSE
## day20121203          FALSE      FALSE
## day20121204          FALSE      FALSE
## day20121205          FALSE      FALSE
## day20121206          FALSE      FALSE
## day20121207          FALSE      FALSE
## day20121208          FALSE      FALSE
## day20121209          FALSE      FALSE
## day20121210          FALSE      FALSE
## day20121211          FALSE      FALSE
## day20121212          FALSE      FALSE
## day20121213          FALSE      FALSE
## day20121214          FALSE      FALSE
## day20121215          FALSE      FALSE
## day20121217          FALSE      FALSE
## day20120319          FALSE      FALSE
## day20120619          FALSE      FALSE
## day20120919          FALSE      FALSE
## day20121112          FALSE      FALSE
## day20121119          FALSE      FALSE
## day20121216          FALSE      FALSE
## day20121218          FALSE      FALSE
## day20121219          FALSE      FALSE
## mean_daily_temp      FALSE      FALSE
## morning_temp         FALSE      FALSE
## hours_bad_weather    FALSE      FALSE
## any_bad_weather      FALSE      FALSE
## morning_bad_weather  FALSE      FALSE
## 1 subsets of each size up to 9
## Selection Algorithm: forward
##          seasonSummer seasonFall seasonWinter holiday
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##          workingdayWorking day weatherMist weatherLight Precip
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##          weatherHeavy Precip temp atemp humidity windspeed year2012 hour1
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##
hour2 hour3 hour4 hour5 hour6 hour7 hour8 hour9 hour10 hour11
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hour12 hour13 hour14 hour15 hour16 hour17 hour18 hour19 hour20
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##
hour21 hour22 hour23 month yday temp1 temp2 temp3 temp4 temp5
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weather1Mist weather1Light Precip weather1Heavy Precip
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##		day20121014	day20121015	day20121016	day20121017	day20121018
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## 3	( 1 )	" "	" "	" "	" "	" "
## 4	( 1 )	" "	" "	" "	" "	" "
## 5	( 1 )	" "	" "	" "	" "	" "
## 6	( 1 )	" "	" "	" "	" "	" "
## 7	( 1 )	" "	" "	" "	" "	" "
## 8	( 1 )	" "	" "	" "	" "	" "
## 9	( 1 )	" "	" "	" "	" "	" "

##		day20121019	day20121101	day20121102	day20121103	day20121104
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## 2	( 1 )	" "	" "	" "	" "	" "
## 3	( 1 )	" "	" "	" "	" "	" "
## 4	( 1 )	" "	" "	" "	" "	" "
## 5	( 1 )	" "	" "	" "	" "	" "
## 6	( 1 )	" "	" "	" "	" "	" "
## 7	( 1 )	" "	" "	" "	" "	" "
## 8	( 1 )	" "	" "	" "	" "	" "
## 9	( 1 )	" "	" "	" "	" "	" "
##		day20121105	day20121106	day20121107	day20121108	day20121109
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## 2	( 1 )	" "	" "	" "	" "	" "
## 3	( 1 )	" "	" "	" "	" "	" "
## 4	( 1 )	" "	" "	" "	" "	" "
## 5	( 1 )	" "	" "	" "	" "	" "
## 6	( 1 )	" "	" "	" "	" "	" "
## 7	( 1 )	" "	" "	" "	" "	" "
## 8	( 1 )	" "	" "	" "	" "	" "
## 9	( 1 )	" "	" "	" "	" "	" "
##		day20121110	day20121111	day20121112	day20121113	day20121114
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## 2	( 1 )	" "	" "	" "	" "	" "
## 3	( 1 )	" "	" "	" "	" "	" "
## 4	( 1 )	" "	" "	" "	" "	" "
## 5	( 1 )	" "	" "	" "	" "	" "
## 6	( 1 )	" "	" "	" "	" "	" "
## 7	( 1 )	" "	" "	" "	" "	" "
## 8	( 1 )	" "	" "	" "	" "	" "
## 9	( 1 )	" "	" "	" "	" "	" "
##		day20121115	day20121116	day20121117	day20121118	day20121119
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## 2	( 1 )	" "	" "	" "	" "	" "
## 3	( 1 )	" "	" "	" "	" "	" "
## 4	( 1 )	" "	" "	" "	" "	" "
## 5	( 1 )	" "	" "	" "	" "	" "
## 6	( 1 )	" "	" "	" "	" "	" "
## 7	( 1 )	" "	" "	" "	" "	" "
## 8	( 1 )	" "	" "	" "	" "	" "
## 9	( 1 )	" "	" "	" "	" "	" "
##		day20121201	day20121202	day20121203	day20121204	day20121205
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## 2	( 1 )	" "	" "	" "	" "	" "
## 3	( 1 )	" "	" "	" "	" "	" "
## 4	( 1 )	" "	" "	" "	" "	" "
## 5	( 1 )	" "	" "	" "	" "	" "
## 6	( 1 )	" "	" "	" "	" "	" "
## 7	( 1 )	" "	" "	" "	" "	" "
## 8	( 1 )	" "	" "	" "	" "	" "
## 9	( 1 )	" "	" "	" "	" "	" "
##		day20121206	day20121207	day20121208	day20121209	day20121210
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## 2	( 1 )	" "	" "	" "	" "	" "
## 3	( 1 )	" "	" "	" "	" "	" "

```

## 4 ( 1 ) " " " " " " " "
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## 7 ( 1 ) " " " " " " " "
## 8 ( 1 ) " " " " " " " "
## 9 ( 1 ) " " " " " " " "
##      day20121211 day20121212 day20121213 day20121214 day20121215
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## 3 ( 1 ) " " " " " " " "
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## 5 ( 1 ) " " " " " " " "
## 6 ( 1 ) " " " " " " " "
## 7 ( 1 ) " " " " " " " "
## 8 ( 1 ) " " " " " " " "
## 9 ( 1 ) " " " " " " " "
##      day20121216 day20121217 day20121218 day20121219 mean_daily_temp
## 1 ( 1 ) " " " " " " " "
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## 3 ( 1 ) " " " " " " " "
## 4 ( 1 ) " " " " " " " "
## 5 ( 1 ) " " " " " " " "
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## 7 ( 1 ) " " " " " " " "
## 8 ( 1 ) " " " " " " " "
## 9 ( 1 ) " " " " " " " "
##      morning_temp hours_bad_weather any_bad_weather
## 1 ( 1 ) " " " " " "
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## 3 ( 1 ) "*" " " " "
## 4 ( 1 ) "*" " " " "
## 5 ( 1 ) "*" " " " "
## 6 ( 1 ) "*" " " " "
## 7 ( 1 ) "*" " " " "
## 8 ( 1 ) "*" " " " "
## 9 ( 1 ) "*" " " " "
##      morning_bad_weather
## 1 ( 1 ) " "
## 2 ( 1 ) " "
## 3 ( 1 ) " "
## 4 ( 1 ) " "
## 5 ( 1 ) " "
## 6 ( 1 ) " "
## 7 ( 1 ) " "
## 8 ( 1 ) " "
## 9 ( 1 ) " "

```