In [47]:
```
library(readxl)
library(mgcv)
library(ggplot2)
library(GGally)
library(gratia)
library(Metrics)
```

```
Registered S3 method overwritten by 'GGally':
  method from
  +.gg   ggplot2
```

## Code for Prediction [remove # and run this code]

In [185…
```
data = read_excel("Real estate valuation data set.xlsx")
data = subset(data, select = -c(1) )
colnames(data) = c("TransactionDate",
                   "HouseAge_Years",
                   "DistanceToMRTStation_Metres",
                   "NumberOfConvenienceStores",
                   "Latitude",
                   "Longitude",
                   "Price")
gam_mod_final <- gam(Price ~ s(TransactionDate, bs="cr") +
                 s(HouseAge_Years, bs="cr") +
                 s(DistanceToMRTStation_Metres, bs="cr") +
                 s(NumberOfConvenienceStores, bs="cr") +
                 ti(Latitude, Longitude, bs="cr"), data=data)
```

In [ ]:
```
# test = read_excel("<Enter your file name here>.xlsx")
# unit_house_price = predict(gam_mod_final, data=test)
# data.frame(unit_house_price)
```

In [ ]:
```

```

## Read in data

In [ ]:
```

```

In [52]:
```
data = read_excel("Real estate valuation data set.xlsx")
data = subset(data, select = -c(1) )
```

In [135…
```
dim(data)
```

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In [55]:
```
colnames(data) = c("transaction_date", "age", "dist_to_mrt", "num_conv_stores", "lat", "long", "pric
```

In [56]:
```
head(data)
```

A tibble: 6 × 7

| transaction_date | age | dist_to_mrt | num_conv_stores | lat | long | price |
|---|---|---|---|---|---|---|
| <dbl> | <dbl> | <dbl> | <dbl> | <dbl> | <dbl> | <dbl> |
| 2012.917 | 32.0 | 84.87882 | 10 | 24.98298 | 121.5402 | 37.9 |

| transaction_date | age | dist_to_mrt | num_conv_stores | lat | long | price |
|---|---|---|---|---|---|---|
| <dbl> | <dbl> | <dbl> | <dbl> | <dbl> | <dbl> | <dbl> |
| 2012.917 | 19.5 | 306.59470 | 9 | 24.98034 | 121.5395 | 42.2 |
| 2013.583 | 13.3 | 561.98450 | 5 | 24.98746 | 121.5439 | 47.3 |
| 2013.500 | 13.3 | 561.98450 | 5 | 24.98746 | 121.5439 | 54.8 |
| 2012.833 | 5.0 | 390.56840 | 5 | 24.97937 | 121.5425 | 43.1 |
| 2012.667 | 7.1 | 2175.03000 | 3 | 24.96305 | 121.5125 | 32.1 |

## Exploratory Data Analysis

In [156…]
```
dim(train)
```

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In [153…]
```
sum(train$transaction_date < 2013)
```

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In [163…]
```
quantile(train$lat)
```

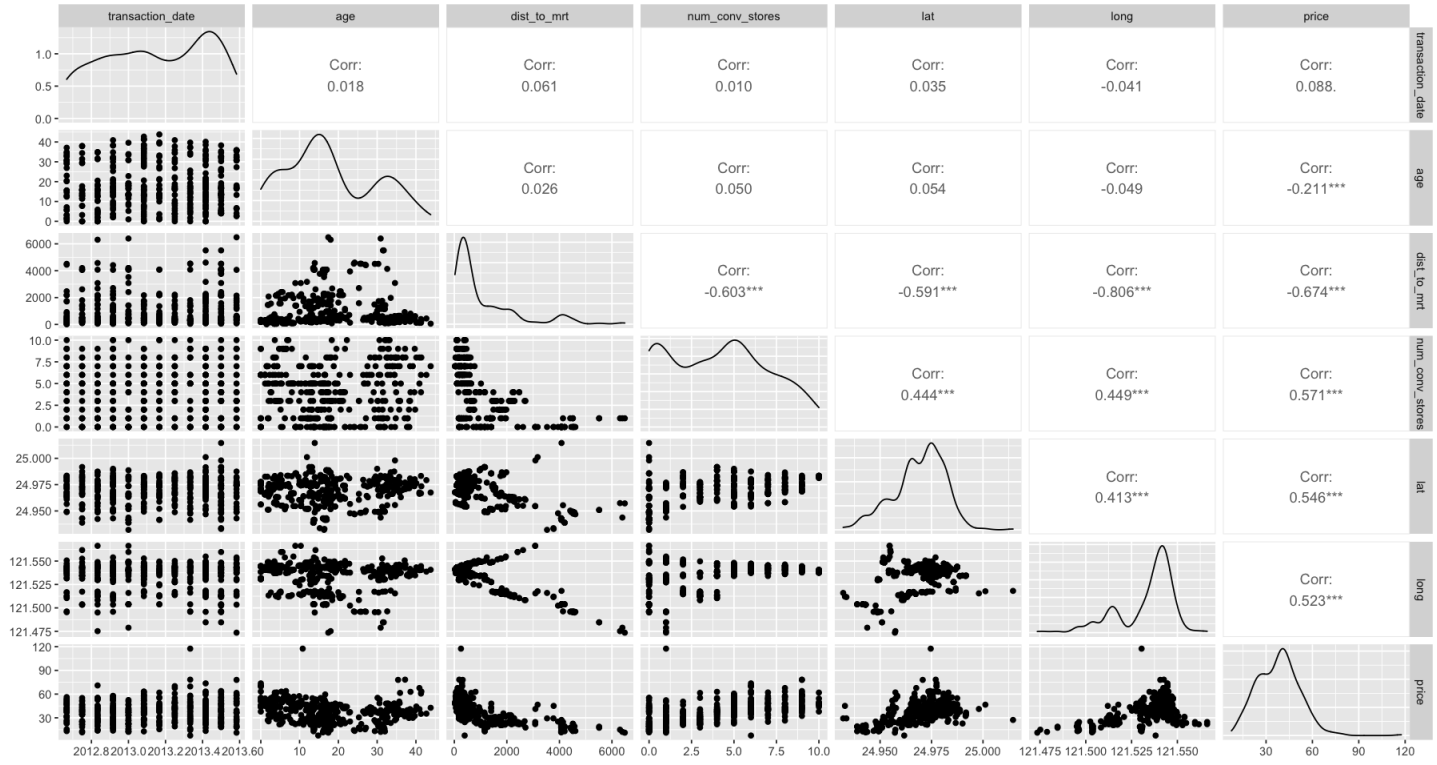
**0%:** 24.93293 **25%:** 24.96305 **50%:** 24.9711 **75%:** 24.97744 **100%:** 25.00115

In [136…]
```
summary(train)
```

```
transaction_date      age          dist_to_mrt      num_conv_stores
Min.   :2013     Min.   : 0.00   Min.   :  23.38   Min.   : 0.000
1st Qu.:2013     1st Qu.: 9.75   1st Qu.: 288.03   1st Qu.: 1.000
Median :2013     Median :16.10   Median : 492.23   Median : 4.000
Mean   :2013     Mean   :17.79   Mean   :1029.68   Mean   : 4.146
3rd Qu.:2013     3rd Qu.:28.15   3rd Qu.:1449.11   3rd Qu.: 6.000
Max.   :2014     Max.   :43.80   Max.   :6306.15   Max.   :10.000
     lat             long           price
Min.   :24.93   Min.   :121.5   Min.   :  7.60
1st Qu.:24.96   1st Qu.:121.5   1st Qu.: 28.50
Median :24.97   Median :121.5   Median : 38.40
Mean   :24.97   Mean   :121.5   Mean   : 38.00
3rd Qu.:24.98   3rd Qu.:121.5   3rd Qu.: 46.35
Max.   :25.00   Max.   :121.6   Max.   :117.50
```

In [59]:
```
options(repr.plot.width=15, repr.plot.height=8)
```

In [60]:
```
ggpairs(data)
```




## Simple Linear Model

In [130…]:

```
summary(lm(price ~ ., data=data))
```

```
Call:
lm(formula = price ~ ., data = data)

Residuals:
    Min      1Q  Median      3Q     Max
-35.667  -5.412  -0.967   4.217  75.190

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)      -1.444e+04  6.775e+03  -2.132  0.03364 *
transaction_date  5.149e+00  1.557e+00   3.307  0.00103 **
age              -2.697e-01  3.853e-02  -7.000 1.06e-11 ***
dist_to_mrt      -4.488e-03  7.180e-04  -6.250 1.04e-09 ***
num_conv_stores   1.133e+00  1.882e-01   6.023 3.83e-09 ***
lat               2.255e+02  4.457e+01   5.059 6.38e-07 ***
long             -1.243e+01  4.858e+01  -0.256  0.79820
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 8.858 on 407 degrees of freedom
Multiple R-squared:  0.5824,    Adjusted R-squared:  0.5762
F-statistic:  94.6 on 6 and 407 DF,  p-value: < 2.2e-16
```

## Train Test Split

In [94]:

```
set.seed(1029)
sample <- sample(c(TRUE, FALSE), nrow(data), replace=TRUE, prob=c(0.8,0.2))
train  <- data[sample, ]
test   <- data[!sample, ]
```

## Various Generalized Additive Models (Comparison based on AIC and RMSE)

In [96]:

```
gam_mod1 <- gam(price ~ s(transaction_date) +
                s(age) +
                s(dist_to_mrt) +
                s(num_conv_stores) +
                ti(lat, long), data=train)
```

In [97]:
```
gam_mod2 <- gam(price ~ s(transaction_date, bs="cr") +
                s(age, bs="cr") +
                s(dist_to_mrt, bs="cr") +
                s(num_conv_stores, bs="cr") +
                ti(lat, long, bs="cr"), data=train)
```

In [98]:
```
gam_mod3 <- gam(price ~ s(transaction_date, bs="cr") +
                s(dist_to_mrt, bs="cr") +
                s(num_conv_stores, bs="cr") +
                ti(lat, long, bs="cr"), data=train)
```

In [99]:
```
gam_mod4 <- gam(price ~ s(transaction_date, bs="bs") +
                s(dist_to_mrt, bs="bs") +
                s(num_conv_stores, bs="bs") +
                ti(lat, long, bs="bs"), data=train)
```

In [108…
```
gam_mod5 <- gam(price ~ transaction_date +
                s(age, bs="cr") +
                s(dist_to_mrt, bs="cr") +
                s(num_conv_stores, bs="cr") +
                ti(lat, long, bs="cr"), data=train)
```

In [109…
```
gam_mod6 <- gam(price ~ transaction_date +
                s(age, bs="bs") +
                s(dist_to_mrt, bs="bs") +
                s(num_conv_stores, bs="bs") +
                ti(lat, long, bs="bs"), data=train)
```

In [100…
```
AIC(gam_mod1)
```

2396.22825450415

In [101…
```
AIC(gam_mod2)
```

2383.87284822368

In [102…
```
AIC(gam_mod3)
```

2431.33703612261

In [103…
```
AIC(gam_mod4)
```

2448.4556477285

In [110…
```
AIC(gam_mod5)
```

2383.8728356601

In [111…
```
AIC(gam_mod6)
```

2395.98870087607

In [104…
```
rmse(test$price, predict(gam_mod1, test))
```

6.63125299168043

In [105…
```
rmse(test$price, predict(gam_mod2, test))
```

6.63351143591346

In [106…
```
rmse(test$price, predict(gam_mod3, test))
```

8.45638741256293

In [107…
```
rmse(test$price, predict(gam_mod4, test))
```

9.92676030404349

In [112…
```
rmse(test$price, predict(gam_mod5, test))
```

6.63352175171342

In [113…
```
rmse(test$price, predict(gam_mod6, test))
```

9.64911308238745

Choose `gam_mod2` as final model based on AIC and RMSE

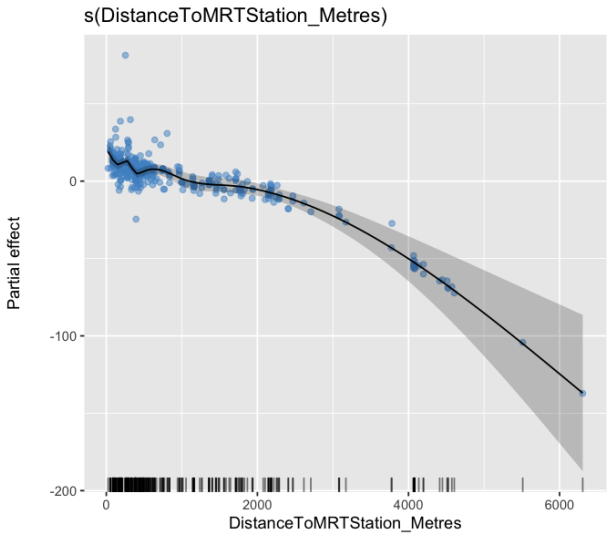
In [114…
```
summary(gam_mod2)
```

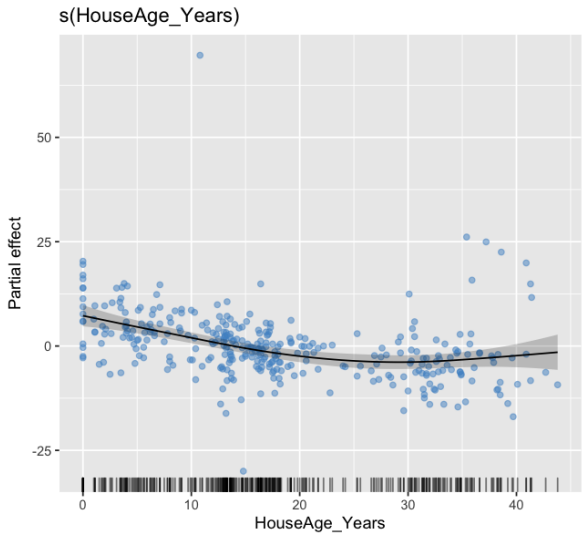
```
Family: gaussian
Link function: identity

Formula:
price ~ s(transaction_date, bs = "cr") + s(age, bs = "cr") +
    s(dist_to_mrt, bs = "cr") + s(num_conv_stores, bs = "cr") +
    ti(lat, long, bs = "cr")

Parametric coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   32.534      1.087   29.93   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Approximate significance of smooth terms:
                       edf Ref.df      F  p-value
s(transaction_date)  1.000  1.000 14.335 0.000184 ***
s(age)               2.596  3.228 16.908  < 2e-16 ***
s(dist_to_mrt)       8.756  8.968 20.035  < 2e-16 ***
s(num_conv_stores)   1.000  1.000  7.513 0.006473 **
ti(lat,long)        10.221 11.434  6.162  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

R-sq.(adj) =  0.692   Deviance explained = 71.3%
GCV = 62.308  Scale est. = 57.831    n = 342
```

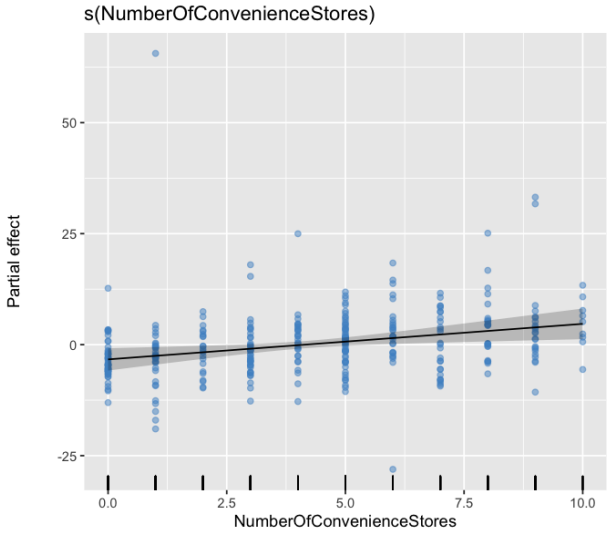
In [179…
```
options(repr.plot.width=12, repr.plot.height=15)
```

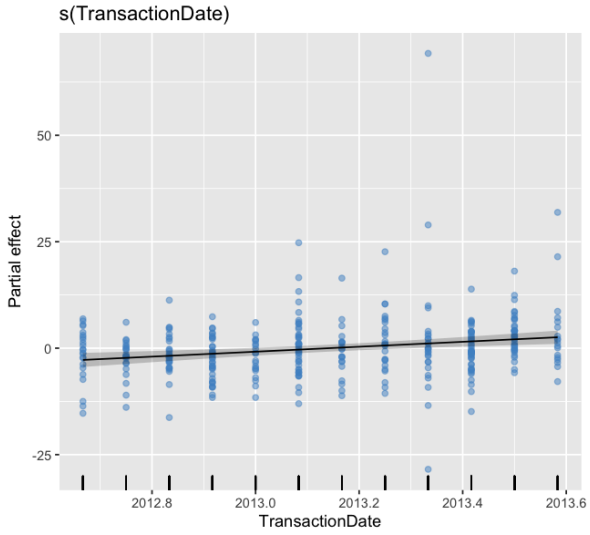
## Visualize the GAM

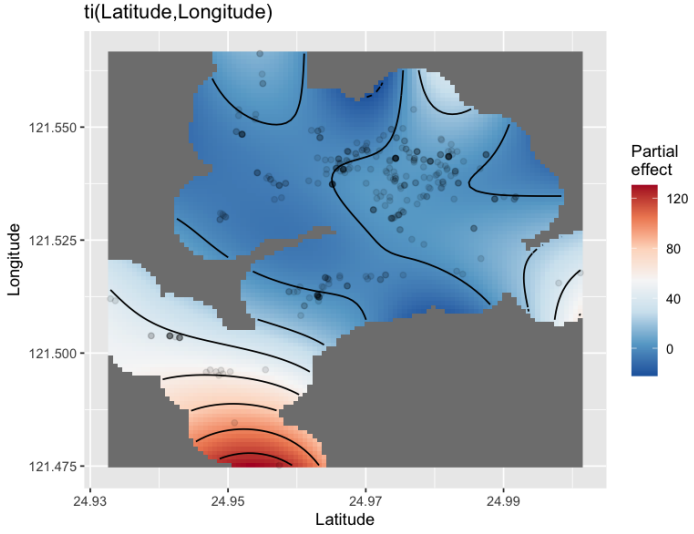
In [180…
```
gratia:::draw.gam(gam_mod_final, scales="free", residuals=TRUE, nrow=3)
```


s(DistanceToMRTStation_Metres)
Partial effect
0
-100
-200
0
2000
4000
6000
DistanceToMRTStation_Metres


s(HouseAge_Years)
Partial effect
50
25
0
-25
0
10
20
30
40
HouseAge_Years


s(NumberOfConvenienceStores)
Partial effect
50
25
0
-25
0.0
2.5
5.0
7.5
10.0
NumberOfConvenienceStores


s(TransactionDate)
Partial effect
50
25
0
-25
2012.8
2013.0
2013.2
2013.4
2013.6
TransactionDate


ti(Latitude,Longitude)
Longitude
121.550
121.525
121.500
121.475
24.93
24.95
24.97
24.99
Latitude
Partial effect
120
80
40
0