Assignment\_6

Nivedita

4/7/2020

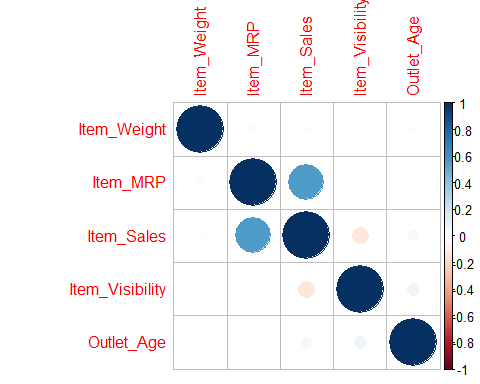
rm(list = ls())  
setwd("C:/Users/18132/Desktop/My Docs/SDM/Ass\_6")  
library(readxl)  
mart<- read\_excel("BigMartSales.xlsx")

**Data Cleaning**

mart$Outlet\_Size[is.na(mart$Outlet\_Size)]<-'Small'  
#As all the grocery store are small size and all the supermarket type 1 and city type tier 2 are small size and in the size also we have these two types, as blank we converted blank as small   
d<-na.omit(mart)  
mart<-transform(mart,Item\_Weight=d$Item\_Weight[match(Item\_ID,d$Item\_ID)])  
#Convert weight with blank cell with same item ID and weight value in other row  
mart<-na.omit(mart)  
#Generating number of years the store has been established  
mart$Outlet\_Age<-2013-(mart$Outlet\_Year)  
mart$Item\_Type<-as.factor(mart$Item\_Type)  
mart$Item\_Fat\_Content<-as.factor(mart$Item\_Fat\_Content)  
mart$Outlet\_Size<-as.factor(mart$Outlet\_Size)  
mart$City\_Type<-as.factor(mart$City\_Type)  
mart$Outlet\_Type<-as.factor(mart$Outlet\_Type)  
#To maintain the scaling of the dataset  
mart$Item\_MRP<-(mart$Item\_MRP-mean(mart$Item\_MRP))/sd(mart$Item\_MRP)

**#Corrplot**  
attach(mart)  
df<-subset(mart,select=c(Item\_Weight,Item\_MRP,Item\_Sales,Item\_Visibility,Outlet\_Age))  
m<-cor(df)  
library(corrplot)

corrplot(m,method='circle')

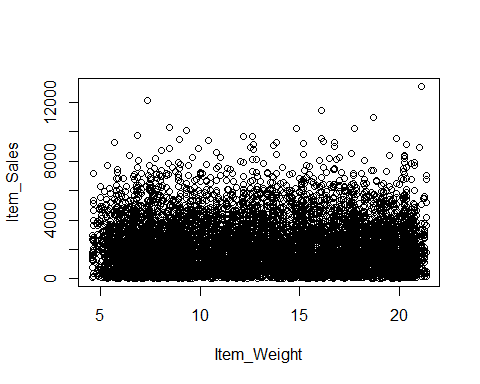


cor(Item\_Sales,Item\_MRP)

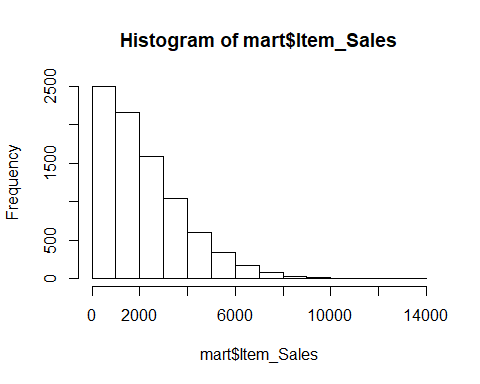
## [1] 0.5678031

As we can see there the Item\_Weight has no correlation with other features, so we are not considering it in the model.Also,the item\_weight does not affect on the sales as we consider number of item more than item weight.

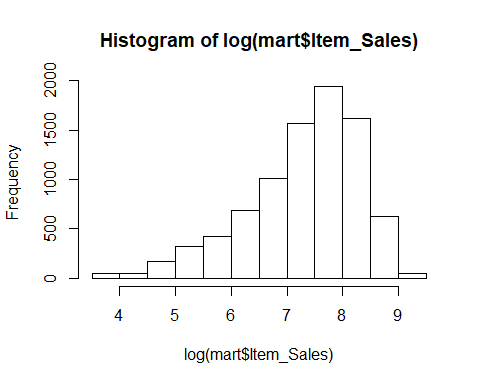
plot(Item\_Weight,Item\_Sales)



hist(mart$Item\_Sales)

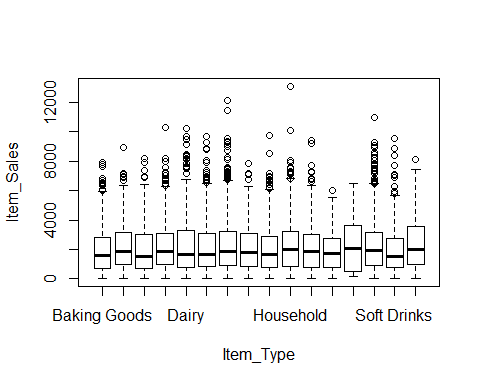


hist(log(mart$Item\_Sales))

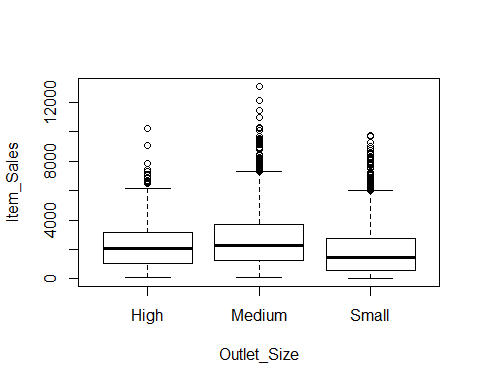


The Item sales is not normally distributed, even after the transformation.

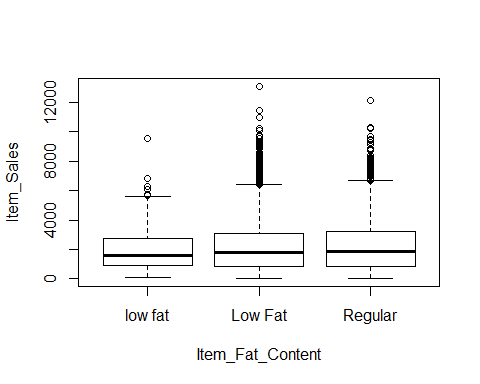
boxplot(Item\_Sales~Item\_Type,data=mart)



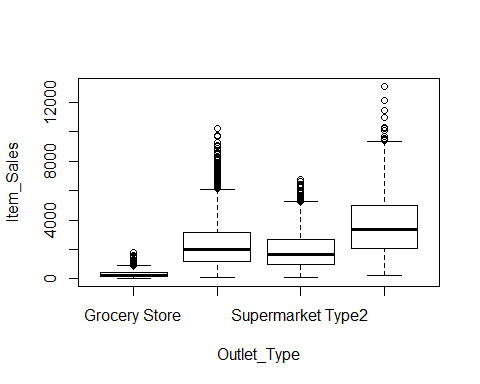
boxplot(Item\_Sales~Outlet\_Size,data=mart)



boxplot(Item\_Sales~Item\_Fat\_Content,data=mart)



boxplot(Item\_Sales~Outlet\_Type,data=mart)



**Choice of Predictors:**

As we can see in above box plots, the item sales is varying for all different category in different features, but for Item\_fat\_content, the median of item sales is mostly same for all three category, so we are not considering item fat content in our model.

**Item\_Type**: Taken into consideration, as some products like dairy, households sold more, but some like Hard Drinks, is not considered by all.

**Item\_MRP**: Taken into consideration, as If the same item, we can get in cheaper price, will consider that.

**Item Weight**: is not considered, as it depends on the necessity , sometimes can buy more, sometimes less.

**Outlet\_Age**: As the older, the store, it can be more famous, and people might prefer it. **Outlet\_Size**: The bigger, the store, we can have more options, so can be considered. **Outlet\_Type**: Considered, as supermarkets might have more sales compared to small grocery stores.

**OutletID/Item\_ID**: Not been Considered, as it has the collborated factors of multiple columns.

As the histogram of item sales shows that it is not normal, even after tranformation, there is no point of making the **OLS model**.

We are making it as **mixed effect model**, as we have different levels in the data, like outlet size, outlet type, item type and the lower level is not time.

**1.Appropriate models (with explanation and summarized output) of Outlet Type Models**

The **first model** is Varying intercept and varying slope model, in this fixed effect is only Item\_visibility, as it always affects item sales, but taken alone, to check how it affects. The random affect is outlet age and outlet size cannot have independent fixed or random affect on sales but can have random affect in collaboration with outlet type.

library(lme4)

mix1 <- lmer(Item\_Sales ~ Item\_Visibility+(Outlet\_Age+Outlet\_Size|Outlet\_Type),data=mart)

coef(mix1)

## $Outlet\_Type  
## Outlet\_Age Outlet\_SizeMedium Outlet\_SizeSmall  
## Grocery Store 0.85954823 -6.8053603 -434.952434  
## Supermarket Type1 -3.60863468 -15.4311377 -52.925386  
## Supermarket Type2 0.05873528 -0.3471625 9.464345  
## Supermarket Type3 -0.87952884 9.6160876 -213.683749  
## (Intercept) Item\_Visibility  
## Grocery Store 785.8041 -261.3576  
## Supermarket Type1 2419.2476 -261.3576  
## Supermarket Type2 2011.6580 -261.3576  
## Supermarket Type3 3723.8647 -261.3576

## attr(,"class")  
## [1] "coef.mer"

As we can see above the affect of outlet type is changing based on age and size on the sales, some might have increasing sale some might have decreasing sales, and also with the item visibilty the sales of all the outlet type is decreasing and if dont considered any factors, then every outlet type , will have some sales.

The **second model** is Varying intercept, varying slope model, but with interaction between visibility and item type. Fixed effect: MRP will always have impact on item sales, and applied interaction between type and visibility, to see how the each item sales is changing with visibility, as visibility alone affect is not so defined for item sales,also it was decreasing sales, which is reverse in real world scenario. The random affect is outlet age and outlet size cannot have independent fixed or random affect on sales but can have random affect in collaboration with outlet type.

mix2<- lmer(Item\_Sales ~Item\_MRP+Item\_Visibility\*Item\_Type+(Outlet\_Age+ Outlet\_Size|Outlet\_Type),data=mart)

coef(mix2)

## $Outlet\_Type  
## Outlet\_Age Outlet\_SizeMedium Outlet\_SizeSmall  
## Grocery Store 4.767142 -131.78605 27.45829  
## Supermarket Type1 -8.140774 -27.46186 -110.12639  
## Supermarket Type2 -3.974379 85.31491 -28.53576  
## Supermarket Type3 -14.091752 321.32299 -96.44850  
## (Intercept) Item\_MRP Item\_Visibility Item\_TypeBreads  
## Grocery Store 169.1269 970.9146 1088.795 133.7697  
## Supermarket Type1 2437.5286 970.9146 1088.795 133.7697  
## Supermarket Type2 1849.3865 970.9146 1088.795 133.7697  
## Supermarket Type3 3716.6982 970.9146 1088.795 133.7697  
## Item\_TypeBreakfast Item\_TypeCanned Item\_TypeDairy  
## Grocery Store -142.2844 165.0776 93.49603  
## Supermarket Type1 -142.2844 165.0776 93.49603  
## Supermarket Type2 -142.2844 165.0776 93.49603  
## Supermarket Type3 -142.2844 165.0776 93.49603  
## Item\_TypeFrozen Foods Item\_TypeFruits and Vegetables  
## Grocery Store 71.54166 128.0457  
## Supermarket Type1 71.54166 128.0457  
## Supermarket Type2 71.54166 128.0457  
## Supermarket Type3 71.54166 128.0457  
## Item\_TypeHard Drinks Item\_TypeHealth and Hygiene  
## Grocery Store 15.05735 76.0704  
## Supermarket Type1 15.05735 76.0704  
## Supermarket Type2 15.05735 76.0704  
## Supermarket Type3 15.05735 76.0704  
## Item\_TypeHousehold Item\_TypeMeat Item\_TypeOthers  
## Grocery Store 77.75345 -32.52443 17.74184  
## Supermarket Type1 77.75345 -32.52443 17.74184  
## Supermarket Type2 77.75345 -32.52443 17.74184  
## Supermarket Type3 77.75345 -32.52443 17.74184  
## Item\_TypeSeafood Item\_TypeSnack Foods  
## Grocery Store 450.9199 83.01106  
## Supermarket Type1 450.9199 83.01106  
## Supermarket Type2 450.9199 83.01106  
## Supermarket Type3 450.9199 83.01106  
## Item\_TypeSoft Drinks Item\_TypeStarchy Foods  
## Grocery Store 104.1578 115.1959  
## Supermarket Type1 104.1578 115.1959  
## Supermarket Type2 104.1578 115.1959  
## Supermarket Type3 104.1578 115.1959  
## Item\_Visibility:Item\_TypeBreads  
## Grocery Store -1944.495  
## Supermarket Type1 -1944.495  
## Supermarket Type2 -1944.495  
## Supermarket Type3 -1944.495  
## Item\_Visibility:Item\_TypeBreakfast  
## Grocery Store 1539.037  
## Supermarket Type1 1539.037  
## Supermarket Type2 1539.037  
## Supermarket Type3 1539.037  
## Item\_Visibility:Item\_TypeCanned  
## Grocery Store -2036.647  
## Supermarket Type1 -2036.647  
## Supermarket Type2 -2036.647  
## Supermarket Type3 -2036.647  
## Item\_Visibility:Item\_TypeDairy  
## Grocery Store -1996.626  
## Supermarket Type1 -1996.626  
## Supermarket Type2 -1996.626  
## Supermarket Type3 -1996.626  
## Item\_Visibility:Item\_TypeFrozen Foods  
## Grocery Store -1409.598  
## Supermarket Type1 -1409.598  
## Supermarket Type2 -1409.598  
## Supermarket Type3 -1409.598  
## Item\_Visibility:Item\_TypeFruits and Vegetables  
## Grocery Store -1451.591  
## Supermarket Type1 -1451.591  
## Supermarket Type2 -1451.591  
## Supermarket Type3 -1451.591  
## Item\_Visibility:Item\_TypeHard Drinks  
## Grocery Store -488.3083  
## Supermarket Type1 -488.3083  
## Supermarket Type2 -488.3083  
## Supermarket Type3 -488.3083  
## Item\_Visibility:Item\_TypeHealth and Hygiene  
## Grocery Store -1592.476  
## Supermarket Type1 -1592.476  
## Supermarket Type2 -1592.476  
## Supermarket Type3 -1592.476  
## Item\_Visibility:Item\_TypeHousehold  
## Grocery Store -2063.222  
## Supermarket Type1 -2063.222  
## Supermarket Type2 -2063.222  
## Supermarket Type3 -2063.222  
## Item\_Visibility:Item\_TypeMeat  
## Grocery Store 755.1956  
## Supermarket Type1 755.1956  
## Supermarket Type2 755.1956  
## Supermarket Type3 755.1956  
## Item\_Visibility:Item\_TypeOthers  
## Grocery Store -850.3085  
## Supermarket Type1 -850.3085  
## Supermarket Type2 -850.3085  
## Supermarket Type3 -850.3085  
## Item\_Visibility:Item\_TypeSeafood  
## Grocery Store -3748.067  
## Supermarket Type1 -3748.067  
## Supermarket Type2 -3748.067  
## Supermarket Type3 -3748.067  
## Item\_Visibility:Item\_TypeSnack Foods  
## Grocery Store -1425.638  
## Supermarket Type1 -1425.638  
## Supermarket Type2 -1425.638  
## Supermarket Type3 -1425.638  
## Item\_Visibility:Item\_TypeSoft Drinks  
## Grocery Store -2152.374  
## Supermarket Type1 -2152.374  
## Supermarket Type2 -2152.374  
## Supermarket Type3 -2152.374  
## Item\_Visibility:Item\_TypeStarchy Foods  
## Grocery Store -1358.057  
## Supermarket Type1 -1358.057  
## Supermarket Type2 -1358.057  
## Supermarket Type3 -1358.057  
##   
## attr(,"class")  
## [1] "coef.mer"

Now, as we can see the Item\_visibility, is giving positive affect for sales in each outlet type, some item are having increasing sales and some decreasing in each outlet type and also we can see from intercation of item type and item visibility , that the item type might be affecting visibility affect on sales. If we will not consider anyother features, then also each outlet type will have some sales.

The **third model** is varying slope and varying intercept model. In this also the fixed affect is same as previos model, but in random affect, we can check the affect of item visibility with outlet type , with its fixed affect with item type

mix3<-lmer(Item\_Sales ~ Item\_Visibility\*Item\_Type + Item\_MRP + (1 + Item\_Visibility|Outlet\_Type )+(Outlet\_Age + Outlet\_Size | Outlet\_Type),data=mart)

coef(mix3)

## $Outlet\_Type  
## Outlet\_Age Outlet\_SizeMedium Outlet\_SizeSmall  
## Grocery Store 1.7353756 13.402125 25.063971  
## Supermarket Type1 -10.3402424 -72.843112 -151.246154  
## Supermarket Type2 0.2539948 1.895073 3.694766  
## Supermarket Type3 -2.6119846 -19.706879 -37.833120  
## (Intercept) Item\_Visibility Item\_TypeBreads  
## Grocery Store -161.0517 1046.152 133.7086  
## Supermarket Type1 1333.0270 1090.278 133.7086  
## Supermarket Type2 2096.0261 1112.812 133.7086  
## Supermarket Type3 4129.5277 1172.869 133.7086  
## Item\_TypeBreakfast Item\_TypeCanned Item\_TypeDairy  
## Grocery Store -144.846 164.8096 92.89247  
## Supermarket Type1 -144.846 164.8096 92.89247  
## Supermarket Type2 -144.846 164.8096 92.89247  
## Supermarket Type3 -144.846 164.8096 92.89247  
## Item\_TypeFrozen Foods Item\_TypeFruits and Vegetables  
## Grocery Store 70.99786 127.3381  
## Supermarket Type1 70.99786 127.3381  
## Supermarket Type2 70.99786 127.3381  
## Supermarket Type3 70.99786 127.3381  
## Item\_TypeHard Drinks Item\_TypeHealth and Hygiene  
## Grocery Store 15.60436 75.8941  
## Supermarket Type1 15.60436 75.8941  
## Supermarket Type2 15.60436 75.8941  
## Supermarket Type3 15.60436 75.8941  
## Item\_TypeHousehold Item\_TypeMeat Item\_TypeOthers  
## Grocery Store 76.81329 -33.17854 18.83995  
## Supermarket Type1 76.81329 -33.17854 18.83995  
## Supermarket Type2 76.81329 -33.17854 18.83995  
## Supermarket Type3 76.81329 -33.17854 18.83995  
## Item\_TypeSeafood Item\_TypeSnack Foods  
## Grocery Store 448.1859 81.79523  
## Supermarket Type1 448.1859 81.79523  
## Supermarket Type2 448.1859 81.79523  
## Supermarket Type3 448.1859 81.79523  
## Item\_TypeSoft Drinks Item\_TypeStarchy Foods Item\_MRP  
## Grocery Store 102.8651 115.5052 970.928  
## Supermarket Type1 102.8651 115.5052 970.928  
## Supermarket Type2 102.8651 115.5052 970.928  
## Supermarket Type3 102.8651 115.5052 970.928  
## Item\_Visibility:Item\_TypeBreads  
## Grocery Store -1943.248  
## Supermarket Type1 -1943.248  
## Supermarket Type2 -1943.248  
## Supermarket Type3 -1943.248  
## Item\_Visibility:Item\_TypeBreakfast  
## Grocery Store 1571.389  
## Supermarket Type1 1571.389  
## Supermarket Type2 1571.389  
## Supermarket Type3 1571.389  
## Item\_Visibility:Item\_TypeCanned  
## Grocery Store -2033.473  
## Supermarket Type1 -2033.473  
## Supermarket Type2 -2033.473  
## Supermarket Type3 -2033.473  
## Item\_Visibility:Item\_TypeDairy  
## Grocery Store -1984.934  
## Supermarket Type1 -1984.934  
## Supermarket Type2 -1984.934  
## Supermarket Type3 -1984.934  
## Item\_Visibility:Item\_TypeFrozen Foods  
## Grocery Store -1403.64  
## Supermarket Type1 -1403.64  
## Supermarket Type2 -1403.64  
## Supermarket Type3 -1403.64  
## Item\_Visibility:Item\_TypeFruits and Vegetables  
## Grocery Store -1443.676  
## Supermarket Type1 -1443.676  
## Supermarket Type2 -1443.676  
## Supermarket Type3 -1443.676  
## Item\_Visibility:Item\_TypeHard Drinks  
## Grocery Store -504.2324  
## Supermarket Type1 -504.2324  
## Supermarket Type2 -504.2324  
## Supermarket Type3 -504.2324  
## Item\_Visibility:Item\_TypeHealth and Hygiene  
## Grocery Store -1598.028  
## Supermarket Type1 -1598.028  
## Supermarket Type2 -1598.028  
## Supermarket Type3 -1598.028  
## Item\_Visibility:Item\_TypeHousehold  
## Grocery Store -2053.605  
## Supermarket Type1 -2053.605  
## Supermarket Type2 -2053.605  
## Supermarket Type3 -2053.605  
## Item\_Visibility:Item\_TypeMeat  
## Grocery Store 763.4644  
## Supermarket Type1 763.4644  
## Supermarket Type2 763.4644  
## Supermarket Type3 763.4644  
## Item\_Visibility:Item\_TypeOthers  
## Grocery Store -849.6308  
## Supermarket Type1 -849.6308  
## Supermarket Type2 -849.6308  
## Supermarket Type3 -849.6308  
## Item\_Visibility:Item\_TypeSeafood  
## Grocery Store -3700.738  
## Supermarket Type1 -3700.738  
## Supermarket Type2 -3700.738  
## Supermarket Type3 -3700.738  
## Item\_Visibility:Item\_TypeSnack Foods  
## Grocery Store -1407.492  
## Supermarket Type1 -1407.492  
## Supermarket Type2 -1407.492  
## Supermarket Type3 -1407.492  
## Item\_Visibility:Item\_TypeSoft Drinks  
## Grocery Store -2138.206  
## Supermarket Type1 -2138.206  
## Supermarket Type2 -2138.206  
## Supermarket Type3 -2138.206  
## Item\_Visibility:Item\_TypeStarchy Foods  
## Grocery Store -1377.065  
## Supermarket Type1 -1377.065  
## Supermarket Type2 -1377.065  
## Supermarket Type3 -1377.065  
##   
## attr(,"class")  
## [1] "coef.mer"

In this model, we can see how item visibility can affect the sales of each outlet type differently and with positive affect, also for each item, the sales can be different in each stores depending on the visibity and also independently. But as we can see if will not consider any other features, then item sales might be decreasing for grocery stores, according to this model, which is little unconvincing compared to real world scenario.

**Interpretation**

Stargazer:

library(stargazer)

stargazer(mix1,mix2,mix3,type="text")

##   
## ====================================================================================  
## Dependent variable:   
## -------------------------------------  
## Item\_Sales   
## (1) (2) (3)   
## ------------------------------------------------------------------------------------  
## Item\_MRP 970.915\*\*\* 970.928\*\*\*   
## (12.346) (12.344)   
##   
## Item\_Visibility -261.358 1,088.795 1,105.528   
## (326.299) (859.266) (860.174)   
##   
## Item\_TypeBreads 133.770 133.709   
## (141.276) (141.255)   
##   
## Item\_TypeBreakfast -142.284 -144.846   
## (219.045) (219.025)   
##   
## Item\_TypeCanned 165.078 164.810   
## (102.899) (102.884)   
##   
## Item\_TypeDairy 93.496 92.892   
## (104.039) (104.022)   
##   
## Item\_TypeFrozen Foods 71.542 70.998   
## (98.268) (98.254)   
##   
## Item\_TypeFruits and Vegetables 128.046 127.338   
## (90.849) (90.837)   
##   
## Item\_TypeHard Drinks 15.057 15.604   
## (146.732) (146.703)   
##   
## Item\_TypeHealth and Hygiene 76.070 75.894   
## (108.231) (108.214)   
##   
## Item\_TypeHousehold 77.753 76.813   
## (93.886) (93.873)   
##   
## Item\_TypeMeat -32.524 -33.179   
## (112.207) (112.189)   
##   
## Item\_TypeOthers 17.742 18.840   
## (155.188) (155.164)   
##   
## Item\_TypeSeafood 450.920\* 448.186\*   
## (239.052) (239.011)   
##   
## Item\_TypeSnack Foods 83.011 81.795   
## (91.443) (91.432)   
##   
## Item\_TypeSoft Drinks 104.158 102.865   
## (112.916) (112.899)   
##   
## Item\_TypeStarchy Foods 115.196 115.505   
## (166.075) (166.061)   
##   
## Item\_Visibility:Item\_TypeBreads -1,944.495 -1,943.248   
## (1,695.046) (1,694.805)  
##   
## Item\_Visibility:Item\_TypeBreakfast 1,539.037 1,571.389   
## (2,221.125) (2,221.074)  
##   
## Item\_Visibility:Item\_TypeCanned -2,036.647\* -2,033.473\*  
## (1,189.343) (1,189.175)  
##   
## Item\_Visibility:Item\_TypeDairy -1,996.626\* -1,984.934\*  
## (1,180.046) (1,179.901)  
##   
## Item\_Visibility:Item\_TypeFrozen Foods -1,409.598 -1,403.640   
## (1,166.017) (1,165.850)  
##   
## Item\_Visibility:Item\_TypeFruits and Vegetables -1,451.591 -1,443.676   
## (1,050.578) (1,050.476)  
##   
## Item\_Visibility:Item\_TypeHard Drinks -488.308 -504.232   
## (1,768.887) (1,768.615)  
##   
## Item\_Visibility:Item\_TypeHealth and Hygiene -1,592.476 -1,598.028   
## (1,406.826) (1,406.602)  
##   
## Item\_Visibility:Item\_TypeHousehold -2,063.222\* -2,053.605\*  
## (1,116.994) (1,116.820)  
##   
## Item\_Visibility:Item\_TypeMeat 755.196 763.464   
## (1,339.044) (1,338.774)  
##   
## Item\_Visibility:Item\_TypeOthers -850.308 -849.631   
## (1,944.444) (1,944.135)  
##   
## Item\_Visibility:Item\_TypeSeafood -3,748.067 -3,700.738   
## (2,525.713) (2,525.241)  
##   
## Item\_Visibility:Item\_TypeSnack Foods -1,425.638 -1,407.492   
## (1,068.416) (1,068.318)  
##   
## Item\_Visibility:Item\_TypeSoft Drinks -2,152.374 -2,138.206   
## (1,346.957) (1,346.783)  
##   
## Item\_Visibility:Item\_TypeStarchy Foods -1,358.057 -1,377.065   
## (1,919.377) (1,919.381)  
##   
## Constant 2,086.707\*\*\* 1,124.736\*\*\* 1,849.382\*\*  
## (663.349) (430.529) (832.632)   
##   
## ------------------------------------------------------------------------------------  
## Observations 8,519 8,519 8,519   
## Log Likelihood -74,325.880 -71,763.390 -71,761.790  
## Akaike Inf. Crit. 148,677.800 143,614.800 143,617.600  
## Bayesian Inf. Crit. 148,769.400 143,925.000 143,948.900  
## ====================================================================================  
## Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

As we can see from above stargazer output , for the first model sales is decreasing with visibility which is not convincing in real time scenario, but it is increasing with visibility in other two models, also in the third model as we saw if we dont consider other features, the sales for grocery stores is decreasing , which is not true in real scenarios, also the AIC of second model is the best out of all three, so will consider the second model as the best, i.e. model mix2.

**2.** **Appropriate models (with explanation and summarized output) with both City Type and Outlet Type**

This is **first model** as a varying slope, nested varying intercept model, Fixed Effect: The item visibility is considered to see the independent affect of it on item sales and also how it affects each city and its outlet type sales. Random Effect: The outlet has its levels under city and they can randomly affect the sales with different combination among them

city\_mix1<-lmer(Item\_Sales~Item\_Visibility+(1|City\_Type/Outlet\_Type),data=mart)  
coef(city\_mix1)

## $`Outlet\_Type:City\_Type`  
## (Intercept) Item\_Visibility  
## Grocery Store:Tier 1 374.2300 -266.856  
## Grocery Store:Tier 3 370.7912 -266.856  
## Supermarket Type1:Tier 1 2328.9379 -266.856  
## Supermarket Type1:Tier 2 2340.0438 -266.856  
## Supermarket Type1:Tier 3 2314.3359 -266.856  
## Supermarket Type2:Tier 3 2011.6284 -266.856  
## Supermarket Type3:Tier 3 3708.4081 -266.856  
##   
## $City\_Type  
## (Intercept) Item\_Visibility  
## Tier 1 1921.196 -266.856  
## Tier 2 1921.197 -266.856  
## Tier 3 1921.197 -266.856  
##   
## attr(,"class")  
## [1] "coef.mer"

As we can see again, with increase in item visibility , the item sales is decreasing, whether we can city wise or in the combination of outlet and city, also if we don’t consider any other factor there will be some sale in every city and the outlet of each city.

This is **second model**, also a Varying slope, nested varying intercept model. As we considered before, outlet age and outlet size doesn’t have direct effect on item sales, but depending on outlet type, will see how it affect sales depending on outlet type in each city. Also will see how the item visibility of each item and Item Mrp can affect sales of outlet types in each city

city\_mix2<-lmer(Item\_Sales~Item\_Visibility\*Item\_Type+Item\_MRP+(Outlet\_Age+Outlet\_Size|City\_Type/Outlet\_Type),data=mart)

coef(city\_mix2)

## $`Outlet\_Type:City\_Type`  
## Outlet\_Age Outlet\_SizeMedium Outlet\_SizeSmall  
## Grocery Store:Tier 1 2.1847746 52.00732 -1600.431672  
## Grocery Store:Tier 3 4.2387251 92.43076 -660.024853  
## Supermarket Type1:Tier 1 4.1367432 86.74673 420.899373  
## Supermarket Type1:Tier 2 -11.9682514 -252.78749 -502.206675  
## Supermarket Type1:Tier 3 -0.5719049 -12.17193 2.687996  
## Supermarket Type2:Tier 3 2.3914429 50.36870 3.209499  
## Supermarket Type3:Tier 3 22.7985636 485.54216 -115.819052  
## (Intercept) Item\_Visibility Item\_TypeBreads  
## Grocery Store:Tier 1 2182.265 1079.063 137.0716  
## Grocery Store:Tier 3 2127.418 1079.063 137.0716  
## Supermarket Type1:Tier 1 2130.141 1079.063 137.0716  
## Supermarket Type1:Tier 2 2560.198 1079.063 137.0716  
## Supermarket Type1:Tier 3 2255.878 1079.063 137.0716  
## Supermarket Type2:Tier 3 2176.747 1079.063 137.0716  
## Supermarket Type3:Tier 3 1631.809 1079.063 137.0716  
## Item\_TypeBreakfast Item\_TypeCanned Item\_TypeDairy  
## Grocery Store:Tier 1 -144.881 165.4213 93.48346  
## Grocery Store:Tier 3 -144.881 165.4213 93.48346  
## Supermarket Type1:Tier 1 -144.881 165.4213 93.48346  
## Supermarket Type1:Tier 2 -144.881 165.4213 93.48346  
## Supermarket Type1:Tier 3 -144.881 165.4213 93.48346  
## Supermarket Type2:Tier 3 -144.881 165.4213 93.48346  
## Supermarket Type3:Tier 3 -144.881 165.4213 93.48346  
## Item\_TypeFrozen Foods  
## Grocery Store:Tier 1 68.84873  
## Grocery Store:Tier 3 68.84873  
## Supermarket Type1:Tier 1 68.84873  
## Supermarket Type1:Tier 2 68.84873  
## Supermarket Type1:Tier 3 68.84873  
## Supermarket Type2:Tier 3 68.84873  
## Supermarket Type3:Tier 3 68.84873  
## Item\_TypeFruits and Vegetables  
## Grocery Store:Tier 1 127.9036  
## Grocery Store:Tier 3 127.9036  
## Supermarket Type1:Tier 1 127.9036  
## Supermarket Type1:Tier 2 127.9036  
## Supermarket Type1:Tier 3 127.9036  
## Supermarket Type2:Tier 3 127.9036  
## Supermarket Type3:Tier 3 127.9036  
## Item\_TypeHard Drinks Item\_TypeHealth and Hygiene  
## Grocery Store:Tier 1 19.05574 75.36824  
## Grocery Store:Tier 3 19.05574 75.36824  
## Supermarket Type1:Tier 1 19.05574 75.36824  
## Supermarket Type1:Tier 2 19.05574 75.36824  
## Supermarket Type1:Tier 3 19.05574 75.36824  
## Supermarket Type2:Tier 3 19.05574 75.36824  
## Supermarket Type3:Tier 3 19.05574 75.36824  
## Item\_TypeHousehold Item\_TypeMeat Item\_TypeOthers  
## Grocery Store:Tier 1 76.85787 -34.3143 20.25894  
## Grocery Store:Tier 3 76.85787 -34.3143 20.25894  
## Supermarket Type1:Tier 1 76.85787 -34.3143 20.25894  
## Supermarket Type1:Tier 2 76.85787 -34.3143 20.25894  
## Supermarket Type1:Tier 3 76.85787 -34.3143 20.25894  
## Supermarket Type2:Tier 3 76.85787 -34.3143 20.25894  
## Supermarket Type3:Tier 3 76.85787 -34.3143 20.25894  
## Item\_TypeSeafood Item\_TypeSnack Foods  
## Grocery Store:Tier 1 456.6476 81.5185  
## Grocery Store:Tier 3 456.6476 81.5185  
## Supermarket Type1:Tier 1 456.6476 81.5185  
## Supermarket Type1:Tier 2 456.6476 81.5185  
## Supermarket Type1:Tier 3 456.6476 81.5185  
## Supermarket Type2:Tier 3 456.6476 81.5185  
## Supermarket Type3:Tier 3 456.6476 81.5185  
## Item\_TypeSoft Drinks Item\_TypeStarchy Foods  
## Grocery Store:Tier 1 103.7383 113.7113  
## Grocery Store:Tier 3 103.7383 113.7113  
## Supermarket Type1:Tier 1 103.7383 113.7113  
## Supermarket Type1:Tier 2 103.7383 113.7113  
## Supermarket Type1:Tier 3 103.7383 113.7113  
## Supermarket Type2:Tier 3 103.7383 113.7113  
## Supermarket Type3:Tier 3 103.7383 113.7113  
## Item\_MRP Item\_Visibility:Item\_TypeBreads  
## Grocery Store:Tier 1 971.0402 -1958.413  
## Grocery Store:Tier 3 971.0402 -1958.413  
## Supermarket Type1:Tier 1 971.0402 -1958.413  
## Supermarket Type1:Tier 2 971.0402 -1958.413  
## Supermarket Type1:Tier 3 971.0402 -1958.413  
## Supermarket Type2:Tier 3 971.0402 -1958.413  
## Supermarket Type3:Tier 3 971.0402 -1958.413  
## Item\_Visibility:Item\_TypeBreakfast  
## Grocery Store:Tier 1 1565.784  
## Grocery Store:Tier 3 1565.784  
## Supermarket Type1:Tier 1 1565.784  
## Supermarket Type1:Tier 2 1565.784  
## Supermarket Type1:Tier 3 1565.784  
## Supermarket Type2:Tier 3 1565.784  
## Supermarket Type3:Tier 3 1565.784  
## Item\_Visibility:Item\_TypeCanned  
## Grocery Store:Tier 1 -2030.783  
## Grocery Store:Tier 3 -2030.783  
## Supermarket Type1:Tier 1 -2030.783  
## Supermarket Type1:Tier 2 -2030.783  
## Supermarket Type1:Tier 3 -2030.783  
## Supermarket Type2:Tier 3 -2030.783  
## Supermarket Type3:Tier 3 -2030.783  
## Item\_Visibility:Item\_TypeDairy  
## Grocery Store:Tier 1 -1995.043  
## Grocery Store:Tier 3 -1995.043  
## Supermarket Type1:Tier 1 -1995.043  
## Supermarket Type1:Tier 2 -1995.043  
## Supermarket Type1:Tier 3 -1995.043  
## Supermarket Type2:Tier 3 -1995.043  
## Supermarket Type3:Tier 3 -1995.043  
## Item\_Visibility:Item\_TypeFrozen Foods  
## Grocery Store:Tier 1 -1389.662  
## Grocery Store:Tier 3 -1389.662  
## Supermarket Type1:Tier 1 -1389.662  
## Supermarket Type1:Tier 2 -1389.662  
## Supermarket Type1:Tier 3 -1389.662  
## Supermarket Type2:Tier 3 -1389.662  
## Supermarket Type3:Tier 3 -1389.662  
## Item\_Visibility:Item\_TypeFruits and Vegetables  
## Grocery Store:Tier 1 -1437.97  
## Grocery Store:Tier 3 -1437.97  
## Supermarket Type1:Tier 1 -1437.97  
## Supermarket Type1:Tier 2 -1437.97  
## Supermarket Type1:Tier 3 -1437.97  
## Supermarket Type2:Tier 3 -1437.97  
## Supermarket Type3:Tier 3 -1437.97  
## Item\_Visibility:Item\_TypeHard Drinks  
## Grocery Store:Tier 1 -535.1132  
## Grocery Store:Tier 3 -535.1132  
## Supermarket Type1:Tier 1 -535.1132  
## Supermarket Type1:Tier 2 -535.1132  
## Supermarket Type1:Tier 3 -535.1132  
## Supermarket Type2:Tier 3 -535.1132  
## Supermarket Type3:Tier 3 -535.1132  
## Item\_Visibility:Item\_TypeHealth and Hygiene  
## Grocery Store:Tier 1 -1595.143  
## Grocery Store:Tier 3 -1595.143  
## Supermarket Type1:Tier 1 -1595.143  
## Supermarket Type1:Tier 2 -1595.143  
## Supermarket Type1:Tier 3 -1595.143  
## Supermarket Type2:Tier 3 -1595.143  
## Supermarket Type3:Tier 3 -1595.143  
## Item\_Visibility:Item\_TypeHousehold  
## Grocery Store:Tier 1 -2047.17  
## Grocery Store:Tier 3 -2047.17  
## Supermarket Type1:Tier 1 -2047.17  
## Supermarket Type1:Tier 2 -2047.17  
## Supermarket Type1:Tier 3 -2047.17  
## Supermarket Type2:Tier 3 -2047.17  
## Supermarket Type3:Tier 3 -2047.17  
## Item\_Visibility:Item\_TypeMeat  
## Grocery Store:Tier 1 775.1852  
## Grocery Store:Tier 3 775.1852  
## Supermarket Type1:Tier 1 775.1852  
## Supermarket Type1:Tier 2 775.1852  
## Supermarket Type1:Tier 3 775.1852  
## Supermarket Type2:Tier 3 775.1852  
## Supermarket Type3:Tier 3 775.1852  
## Item\_Visibility:Item\_TypeOthers  
## Grocery Store:Tier 1 -858.4226  
## Grocery Store:Tier 3 -858.4226  
## Supermarket Type1:Tier 1 -858.4226  
## Supermarket Type1:Tier 2 -858.4226  
## Supermarket Type1:Tier 3 -858.4226  
## Supermarket Type2:Tier 3 -858.4226  
## Supermarket Type3:Tier 3 -858.4226  
## Item\_Visibility:Item\_TypeSeafood  
## Grocery Store:Tier 1 -3768.045  
## Grocery Store:Tier 3 -3768.045  
## Supermarket Type1:Tier 1 -3768.045  
## Supermarket Type1:Tier 2 -3768.045  
## Supermarket Type1:Tier 3 -3768.045  
## Supermarket Type2:Tier 3 -3768.045  
## Supermarket Type3:Tier 3 -3768.045  
## Item\_Visibility:Item\_TypeSnack Foods  
## Grocery Store:Tier 1 -1394.277  
## Grocery Store:Tier 3 -1394.277  
## Supermarket Type1:Tier 1 -1394.277  
## Supermarket Type1:Tier 2 -1394.277  
## Supermarket Type1:Tier 3 -1394.277  
## Supermarket Type2:Tier 3 -1394.277  
## Supermarket Type3:Tier 3 -1394.277  
## Item\_Visibility:Item\_TypeSoft Drinks  
## Grocery Store:Tier 1 -2148.858  
## Grocery Store:Tier 3 -2148.858  
## Supermarket Type1:Tier 1 -2148.858  
## Supermarket Type1:Tier 2 -2148.858  
## Supermarket Type1:Tier 3 -2148.858  
## Supermarket Type2:Tier 3 -2148.858  
## Supermarket Type3:Tier 3 -2148.858  
## Item\_Visibility:Item\_TypeStarchy Foods  
## Grocery Store:Tier 1 -1351.405  
## Grocery Store:Tier 3 -1351.405  
## Supermarket Type1:Tier 1 -1351.405  
## Supermarket Type1:Tier 2 -1351.405  
## Supermarket Type1:Tier 3 -1351.405  
## Supermarket Type2:Tier 3 -1351.405  
## Supermarket Type3:Tier 3 -1351.405  
##   
## $City\_Type  
## Outlet\_Age Outlet\_SizeMedium Outlet\_SizeSmall (Intercept)  
## Tier 1 7.083062 104.7099 -345.23420 2054.367  
## Tier 2 -16.205923 -267.6251 16.95799 2666.719  
## Tier 3 50.027390 802.2464 -677.34254 925.203  
## Item\_Visibility Item\_TypeBreads Item\_TypeBreakfast Item\_TypeCanned  
## Tier 1 1079.063 137.0716 -144.881 165.4213  
## Tier 2 1079.063 137.0716 -144.881 165.4213  
## Tier 3 1079.063 137.0716 -144.881 165.4213  
## Item\_TypeDairy Item\_TypeFrozen Foods Item\_TypeFruits and Vegetables  
## Tier 1 93.48346 68.84873 127.9036  
## Tier 2 93.48346 68.84873 127.9036  
## Tier 3 93.48346 68.84873 127.9036  
## Item\_TypeHard Drinks Item\_TypeHealth and Hygiene Item\_TypeHousehold  
## Tier 1 19.05574 75.36824 76.85787  
## Tier 2 19.05574 75.36824 76.85787  
## Tier 3 19.05574 75.36824 76.85787  
## Item\_TypeMeat Item\_TypeOthers Item\_TypeSeafood Item\_TypeSnack Foods  
## Tier 1 -34.3143 20.25894 456.6476 81.5185  
## Tier 2 -34.3143 20.25894 456.6476 81.5185  
## Tier 3 -34.3143 20.25894 456.6476 81.5185  
## Item\_TypeSoft Drinks Item\_TypeStarchy Foods Item\_MRP  
## Tier 1 103.7383 113.7113 971.0402  
## Tier 2 103.7383 113.7113 971.0402  
## Tier 3 103.7383 113.7113 971.0402  
## Item\_Visibility:Item\_TypeBreads Item\_Visibility:Item\_TypeBreakfast  
## Tier 1 -1958.413 1565.784  
## Tier 2 -1958.413 1565.784  
## Tier 3 -1958.413 1565.784  
## Item\_Visibility:Item\_TypeCanned Item\_Visibility:Item\_TypeDairy  
## Tier 1 -2030.783 -1995.043  
## Tier 2 -2030.783 -1995.043  
## Tier 3 -2030.783 -1995.043  
## Item\_Visibility:Item\_TypeFrozen Foods  
## Tier 1 -1389.662  
## Tier 2 -1389.662  
## Tier 3 -1389.662  
## Item\_Visibility:Item\_TypeFruits and Vegetables  
## Tier 1 -1437.97  
## Tier 2 -1437.97  
## Tier 3 -1437.97  
## Item\_Visibility:Item\_TypeHard Drinks  
## Tier 1 -535.1132  
## Tier 2 -535.1132  
## Tier 3 -535.1132  
## Item\_Visibility:Item\_TypeHealth and Hygiene  
## Tier 1 -1595.143  
## Tier 2 -1595.143  
## Tier 3 -1595.143  
## Item\_Visibility:Item\_TypeHousehold Item\_Visibility:Item\_TypeMeat  
## Tier 1 -2047.17 775.1852  
## Tier 2 -2047.17 775.1852  
## Tier 3 -2047.17 775.1852  
## Item\_Visibility:Item\_TypeOthers Item\_Visibility:Item\_TypeSeafood  
## Tier 1 -858.4226 -3768.045  
## Tier 2 -858.4226 -3768.045  
## Tier 3 -858.4226 -3768.045  
## Item\_Visibility:Item\_TypeSnack Foods  
## Tier 1 -1394.277  
## Tier 2 -1394.277  
## Tier 3 -1394.277  
## Item\_Visibility:Item\_TypeSoft Drinks  
## Tier 1 -2148.858  
## Tier 2 -2148.858  
## Tier 3 -2148.858  
## Item\_Visibility:Item\_TypeStarchy Foods  
## Tier 1 -1351.405  
## Tier 2 -1351.405  
## Tier 3 -1351.405  
##   
## attr(,"class")  
## [1] "coef.mer"

As we can see the visibility of item in each grocery store city wise and also independent cities is having positive effect on sales now, even some sales will be there in each grocery store of different cities and independently in each city, even if dont consider other factors. Also the sales of item is changing based on visibility of each item in each city and the outlet in it. Also the for some outlets the sales is increasing with the age, but for some it is decreasing , same is the case with city.

This is **third model**, also a varying slope, nested varying intercept model. In this model we can see how Item visibility, is affecting each city and its outlet , item sales.

city\_mix3<- lmer(Item\_Sales ~ Item\_Visibility\*Item\_Type +Item\_MRP + (1 + Item\_Visibility|City\_Type/Outlet\_Type )+(Outlet\_Age + Outlet\_Size|City\_Type/Outlet\_Type))

coef(city\_mix3)

## $`Outlet\_Type:City\_Type`  
## Outlet\_Age Outlet\_SizeMedium Outlet\_SizeSmall  
## Grocery Store:Tier 1 -7.00027717 -1107.004421 -977.197040  
## Grocery Store:Tier 3 0.99833629 -1662.725548 -1473.312678  
## Supermarket Type1:Tier 1 0.01008809 545.088102 482.818801  
## Supermarket Type1:Tier 2 -6.02218904 281.988983 252.691395  
## Supermarket Type1:Tier 3 -0.83303636 -1.734278 -1.220404  
## Supermarket Type2:Tier 3 -2.71450805 492.888734 437.907024  
## Supermarket Type3:Tier 3 7.76971804 1190.551420 1050.828961  
## (Intercept) Item\_Visibility Item\_TypeBreads  
## Grocery Store:Tier 1 2121.066 1045.623 136.2541  
## Grocery Store:Tier 3 1672.905 1046.229 136.2541  
## Supermarket Type1:Tier 1 1763.684 1045.874 136.2541  
## Supermarket Type1:Tier 2 2090.289 1045.097 136.2541  
## Supermarket Type1:Tier 3 1802.138 1045.457 136.2541  
## Supermarket Type2:Tier 3 1912.238 1046.212 136.2541  
## Supermarket Type3:Tier 3 1348.336 1045.429 136.2541  
## Item\_TypeBreakfast Item\_TypeCanned Item\_TypeDairy  
## Grocery Store:Tier 1 -146.768 164.3171 92.9341  
## Grocery Store:Tier 3 -146.768 164.3171 92.9341  
## Supermarket Type1:Tier 1 -146.768 164.3171 92.9341  
## Supermarket Type1:Tier 2 -146.768 164.3171 92.9341  
## Supermarket Type1:Tier 3 -146.768 164.3171 92.9341  
## Supermarket Type2:Tier 3 -146.768 164.3171 92.9341  
## Supermarket Type3:Tier 3 -146.768 164.3171 92.9341  
## Item\_TypeFrozen Foods  
## Grocery Store:Tier 1 67.93623  
## Grocery Store:Tier 3 67.93623  
## Supermarket Type1:Tier 1 67.93623  
## Supermarket Type1:Tier 2 67.93623  
## Supermarket Type1:Tier 3 67.93623  
## Supermarket Type2:Tier 3 67.93623  
## Supermarket Type3:Tier 3 67.93623  
## Item\_TypeFruits and Vegetables  
## Grocery Store:Tier 1 127.7563  
## Grocery Store:Tier 3 127.7563  
## Supermarket Type1:Tier 1 127.7563  
## Supermarket Type1:Tier 2 127.7563  
## Supermarket Type1:Tier 3 127.7563  
## Supermarket Type2:Tier 3 127.7563  
## Supermarket Type3:Tier 3 127.7563  
## Item\_TypeHard Drinks Item\_TypeHealth and Hygiene  
## Grocery Store:Tier 1 18.48748 75.84259  
## Grocery Store:Tier 3 18.48748 75.84259  
## Supermarket Type1:Tier 1 18.48748 75.84259  
## Supermarket Type1:Tier 2 18.48748 75.84259  
## Supermarket Type1:Tier 3 18.48748 75.84259  
## Supermarket Type2:Tier 3 18.48748 75.84259  
## Supermarket Type3:Tier 3 18.48748 75.84259  
## Item\_TypeHousehold Item\_TypeMeat Item\_TypeOthers  
## Grocery Store:Tier 1 76.31449 -35.145 19.32312  
## Grocery Store:Tier 3 76.31449 -35.145 19.32312  
## Supermarket Type1:Tier 1 76.31449 -35.145 19.32312  
## Supermarket Type1:Tier 2 76.31449 -35.145 19.32312  
## Supermarket Type1:Tier 3 76.31449 -35.145 19.32312  
## Supermarket Type2:Tier 3 76.31449 -35.145 19.32312  
## Supermarket Type3:Tier 3 76.31449 -35.145 19.32312  
## Item\_TypeSeafood Item\_TypeSnack Foods  
## Grocery Store:Tier 1 455.736 80.84625  
## Grocery Store:Tier 3 455.736 80.84625  
## Supermarket Type1:Tier 1 455.736 80.84625  
## Supermarket Type1:Tier 2 455.736 80.84625  
## Supermarket Type1:Tier 3 455.736 80.84625  
## Supermarket Type2:Tier 3 455.736 80.84625  
## Supermarket Type3:Tier 3 455.736 80.84625  
## Item\_TypeSoft Drinks Item\_TypeStarchy Foods  
## Grocery Store:Tier 1 102.5755 114.0055  
## Grocery Store:Tier 3 102.5755 114.0055  
## Supermarket Type1:Tier 1 102.5755 114.0055  
## Supermarket Type1:Tier 2 102.5755 114.0055  
## Supermarket Type1:Tier 3 102.5755 114.0055  
## Supermarket Type2:Tier 3 102.5755 114.0055  
## Supermarket Type3:Tier 3 102.5755 114.0055  
## Item\_MRP Item\_Visibility:Item\_TypeBreads  
## Grocery Store:Tier 1 971.0756 -1937.897  
## Grocery Store:Tier 3 971.0756 -1937.897  
## Supermarket Type1:Tier 1 971.0756 -1937.897  
## Supermarket Type1:Tier 2 971.0756 -1937.897  
## Supermarket Type1:Tier 3 971.0756 -1937.897  
## Supermarket Type2:Tier 3 971.0756 -1937.897  
## Supermarket Type3:Tier 3 971.0756 -1937.897  
## Item\_Visibility:Item\_TypeBreakfast  
## Grocery Store:Tier 1 1602.789  
## Grocery Store:Tier 3 1602.789  
## Supermarket Type1:Tier 1 1602.789  
## Supermarket Type1:Tier 2 1602.789  
## Supermarket Type1:Tier 3 1602.789  
## Supermarket Type2:Tier 3 1602.789  
## Supermarket Type3:Tier 3 1602.789  
## Item\_Visibility:Item\_TypeCanned  
## Grocery Store:Tier 1 -2006.79  
## Grocery Store:Tier 3 -2006.79  
## Supermarket Type1:Tier 1 -2006.79  
## Supermarket Type1:Tier 2 -2006.79  
## Supermarket Type1:Tier 3 -2006.79  
## Supermarket Type2:Tier 3 -2006.79  
## Supermarket Type3:Tier 3 -2006.79  
## Item\_Visibility:Item\_TypeDairy  
## Grocery Store:Tier 1 -1985.063  
## Grocery Store:Tier 3 -1985.063  
## Supermarket Type1:Tier 1 -1985.063  
## Supermarket Type1:Tier 2 -1985.063  
## Supermarket Type1:Tier 3 -1985.063  
## Supermarket Type2:Tier 3 -1985.063  
## Supermarket Type3:Tier 3 -1985.063  
## Item\_Visibility:Item\_TypeFrozen Foods  
## Grocery Store:Tier 1 -1376.63  
## Grocery Store:Tier 3 -1376.63  
## Supermarket Type1:Tier 1 -1376.63  
## Supermarket Type1:Tier 2 -1376.63  
## Supermarket Type1:Tier 3 -1376.63  
## Supermarket Type2:Tier 3 -1376.63  
## Supermarket Type3:Tier 3 -1376.63  
## Item\_Visibility:Item\_TypeFruits and Vegetables  
## Grocery Store:Tier 1 -1426.778  
## Grocery Store:Tier 3 -1426.778  
## Supermarket Type1:Tier 1 -1426.778  
## Supermarket Type1:Tier 2 -1426.778  
## Supermarket Type1:Tier 3 -1426.778  
## Supermarket Type2:Tier 3 -1426.778  
## Supermarket Type3:Tier 3 -1426.778  
## Item\_Visibility:Item\_TypeHard Drinks  
## Grocery Store:Tier 1 -515.8331  
## Grocery Store:Tier 3 -515.8331  
## Supermarket Type1:Tier 1 -515.8331  
## Supermarket Type1:Tier 2 -515.8331  
## Supermarket Type1:Tier 3 -515.8331  
## Supermarket Type2:Tier 3 -515.8331  
## Supermarket Type3:Tier 3 -515.8331  
## Item\_Visibility:Item\_TypeHealth and Hygiene  
## Grocery Store:Tier 1 -1603.044  
## Grocery Store:Tier 3 -1603.044  
## Supermarket Type1:Tier 1 -1603.044  
## Supermarket Type1:Tier 2 -1603.044  
## Supermarket Type1:Tier 3 -1603.044  
## Supermarket Type2:Tier 3 -1603.044  
## Supermarket Type3:Tier 3 -1603.044  
## Item\_Visibility:Item\_TypeHousehold  
## Grocery Store:Tier 1 -2036.077  
## Grocery Store:Tier 3 -2036.077  
## Supermarket Type1:Tier 1 -2036.077  
## Supermarket Type1:Tier 2 -2036.077  
## Supermarket Type1:Tier 3 -2036.077  
## Supermarket Type2:Tier 3 -2036.077  
## Supermarket Type3:Tier 3 -2036.077  
## Item\_Visibility:Item\_TypeMeat  
## Grocery Store:Tier 1 782.5733  
## Grocery Store:Tier 3 782.5733  
## Supermarket Type1:Tier 1 782.5733  
## Supermarket Type1:Tier 2 782.5733  
## Supermarket Type1:Tier 3 782.5733  
## Supermarket Type2:Tier 3 782.5733  
## Supermarket Type3:Tier 3 782.5733  
## Item\_Visibility:Item\_TypeOthers  
## Grocery Store:Tier 1 -846.7587  
## Grocery Store:Tier 3 -846.7587  
## Supermarket Type1:Tier 1 -846.7587  
## Supermarket Type1:Tier 2 -846.7587  
## Supermarket Type1:Tier 3 -846.7587  
## Supermarket Type2:Tier 3 -846.7587  
## Supermarket Type3:Tier 3 -846.7587  
## Item\_Visibility:Item\_TypeSeafood  
## Grocery Store:Tier 1 -3747.363  
## Grocery Store:Tier 3 -3747.363  
## Supermarket Type1:Tier 1 -3747.363  
## Supermarket Type1:Tier 2 -3747.363  
## Supermarket Type1:Tier 3 -3747.363  
## Supermarket Type2:Tier 3 -3747.363  
## Supermarket Type3:Tier 3 -3747.363  
## Item\_Visibility:Item\_TypeSnack Foods  
## Grocery Store:Tier 1 -1374.671  
## Grocery Store:Tier 3 -1374.671  
## Supermarket Type1:Tier 1 -1374.671  
## Supermarket Type1:Tier 2 -1374.671  
## Supermarket Type1:Tier 3 -1374.671  
## Supermarket Type2:Tier 3 -1374.671  
## Supermarket Type3:Tier 3 -1374.671  
## Item\_Visibility:Item\_TypeSoft Drinks  
## Grocery Store:Tier 1 -2126.384  
## Grocery Store:Tier 3 -2126.384  
## Supermarket Type1:Tier 1 -2126.384  
## Supermarket Type1:Tier 2 -2126.384  
## Supermarket Type1:Tier 3 -2126.384  
## Supermarket Type2:Tier 3 -2126.384  
## Supermarket Type3:Tier 3 -2126.384  
## Item\_Visibility:Item\_TypeStarchy Foods  
## Grocery Store:Tier 1 -1357.82  
## Grocery Store:Tier 3 -1357.82  
## Supermarket Type1:Tier 1 -1357.82  
## Supermarket Type1:Tier 2 -1357.82  
## Supermarket Type1:Tier 3 -1357.82  
## Supermarket Type2:Tier 3 -1357.82  
## Supermarket Type3:Tier 3 -1357.82  
##   
## $City\_Type  
## Outlet\_Age Outlet\_SizeMedium Outlet\_SizeSmall (Intercept)  
## Tier 1 -34.70520 -98.12182 -45.05202 2957.0782  
## Tier 2 -24.48159 -67.22913 -29.92760 2602.9990  
## Tier 3 45.04634 124.85111 56.13744 195.0045  
## Item\_Visibility Item\_TypeBreads Item\_TypeBreakfast Item\_TypeCanned  
## Tier 1 977.6380 136.2541 -146.768 164.3171  
## Tier 2 949.4425 136.2541 -146.768 164.3171  
## Tier 3 1210.0285 136.2541 -146.768 164.3171  
## Item\_TypeDairy Item\_TypeFrozen Foods Item\_TypeFruits and Vegetables  
## Tier 1 92.9341 67.93623 127.7563  
## Tier 2 92.9341 67.93623 127.7563  
## Tier 3 92.9341 67.93623 127.7563  
## Item\_TypeHard Drinks Item\_TypeHealth and Hygiene Item\_TypeHousehold  
## Tier 1 18.48748 75.84259 76.31449  
## Tier 2 18.48748 75.84259 76.31449  
## Tier 3 18.48748 75.84259 76.31449  
## Item\_TypeMeat Item\_TypeOthers Item\_TypeSeafood Item\_TypeSnack Foods  
## Tier 1 -35.145 19.32312 455.736 80.84625  
## Tier 2 -35.145 19.32312 455.736 80.84625  
## Tier 3 -35.145 19.32312 455.736 80.84625  
## Item\_TypeSoft Drinks Item\_TypeStarchy Foods Item\_MRP  
## Tier 1 102.5755 114.0055 971.0756  
## Tier 2 102.5755 114.0055 971.0756  
## Tier 3 102.5755 114.0055 971.0756  
## Item\_Visibility:Item\_TypeBreads Item\_Visibility:Item\_TypeBreakfast  
## Tier 1 -1937.897 1602.789  
## Tier 2 -1937.897 1602.789  
## Tier 3 -1937.897 1602.789  
## Item\_Visibility:Item\_TypeCanned Item\_Visibility:Item\_TypeDairy  
## Tier 1 -2006.79 -1985.063  
## Tier 2 -2006.79 -1985.063  
## Tier 3 -2006.79 -1985.063  
## Item\_Visibility:Item\_TypeFrozen Foods  
## Tier 1 -1376.63  
## Tier 2 -1376.63  
## Tier 3 -1376.63  
## Item\_Visibility:Item\_TypeFruits and Vegetables  
## Tier 1 -1426.778  
## Tier 2 -1426.778  
## Tier 3 -1426.778  
## Item\_Visibility:Item\_TypeHard Drinks  
## Tier 1 -515.8331  
## Tier 2 -515.8331  
## Tier 3 -515.8331  
## Item\_Visibility:Item\_TypeHealth and Hygiene  
## Tier 1 -1603.044  
## Tier 2 -1603.044  
## Tier 3 -1603.044  
## Item\_Visibility:Item\_TypeHousehold Item\_Visibility:Item\_TypeMeat  
## Tier 1 -2036.077 782.5733  
## Tier 2 -2036.077 782.5733  
## Tier 3 -2036.077 782.5733  
## Item\_Visibility:Item\_TypeOthers Item\_Visibility:Item\_TypeSeafood  
## Tier 1 -846.7587 -3747.363  
## Tier 2 -846.7587 -3747.363  
## Tier 3 -846.7587 -3747.363  
## Item\_Visibility:Item\_TypeSnack Foods  
## Tier 1 -1374.671  
## Tier 2 -1374.671  
## Tier 3 -1374.671  
## Item\_Visibility:Item\_TypeSoft Drinks  
## Tier 1 -2126.384  
## Tier 2 -2126.384  
## Tier 3 -2126.384  
## Item\_Visibility:Item\_TypeStarchy Foods  
## Tier 1 -1357.82  
## Tier 2 -1357.82  
## Tier 3 -1357.82  
##   
## attr(,"class")  
## [1] "coef.mer"

The Visibility of item is increasing the sales for all the outlets in all the cities, also if dont consider other features, then also there wil be some sales in each city and its outlets, but with age increasing the sales decreasing for most of the outlets now, which can be little unconvincing , as older stores, may have more sales. Also, we can see how for each item and its visibility, the sales keep on changing for each city and its outlet types.

**Interpretation**

Stargazer:

stargazer(city\_mix1,city\_mix2,city\_mix3,type="text")

##   
## =====================================================================================  
## Dependent variable:   
## --------------------------------------  
## Item\_Sales   
## (1) (2) (3)   
## -------------------------------------------------------------------------------------  
## Item\_Visibility -266.856 1,079.063 1,045.703   
## (326.435) (859.134) (872.948)   
##   
## Item\_TypeBreads 137.072 136.254   
## (141.271) (141.275)   
##   
## Item\_TypeBreakfast -144.881 -146.768   
## (219.032) (219.050)   
##   
## Item\_TypeCanned 165.421 164.317   
## (102.884) (102.888)   
##   
## Item\_TypeDairy 93.483 92.934   
## (104.025) (104.024)   
##   
## Item\_TypeFrozen Foods 68.849 67.936   
## (98.260) (98.259)   
##   
## Item\_TypeFruits and Vegetables 127.904 127.756   
## (90.843) (90.838)   
##   
## Item\_TypeHard Drinks 19.056 18.487   
## (146.720) (146.719)   
##   
## Item\_TypeHealth and Hygiene 75.368 75.843   
## (108.211) (108.209)   
##   
## Item\_TypeHousehold 76.858 76.314   
## (93.875) (93.875)   
##   
## Item\_TypeMeat -34.314 -35.145   
## (112.192) (112.188)   
##   
## Item\_TypeOthers 20.259 19.323   
## (155.163) (155.165)   
##   
## Item\_TypeSeafood 456.648\* 455.736\*   
## (239.082) (239.081)   
##   
## Item\_TypeSnack Foods 81.518 80.846   
## (91.437) (91.435)   
##   
## Item\_TypeSoft Drinks 103.738 102.576   
## (112.904) (112.909)   
##   
## Item\_TypeStarchy Foods 113.711 114.005   
## (166.065) (166.059)   
##   
## Item\_MRP 971.040\*\*\* 971.076\*\*\*   
## (12.344) (12.344)   
##   
## Item\_Visibility:Item\_TypeBreads -1,958.413 -1,937.897   
## (1,694.860) (1,694.987)   
##   
## Item\_Visibility:Item\_TypeBreakfast 1,565.784 1,602.789   
## (2,221.190) (2,221.592)   
##   
## Item\_Visibility:Item\_TypeCanned -2,030.783\* -2,006.790\*   
## (1,189.155) (1,189.369)   
##   
## Item\_Visibility:Item\_TypeDairy -1,995.043\* -1,985.063\*   
## (1,180.008) (1,180.089)   
##   
## Item\_Visibility:Item\_TypeFrozen Foods -1,389.662 -1,376.630   
## (1,165.891) (1,165.901)   
##   
## Item\_Visibility:Item\_TypeFruits and Vegetables -1,437.970 -1,426.778   
## (1,050.521) (1,050.537)   
##   
## Item\_Visibility:Item\_TypeHard Drinks -535.113 -515.833   
## (1,768.649) (1,768.732)   
##   
## Item\_Visibility:Item\_TypeHealth and Hygiene -1,595.143 -1,603.044   
## (1,406.551) (1,406.557)   
##   
## Item\_Visibility:Item\_TypeHousehold -2,047.170\* -2,036.077\*   
## (1,116.843) (1,116.852)   
##   
## Item\_Visibility:Item\_TypeMeat 775.185 782.573   
## (1,338.912) (1,338.861)   
##   
## Item\_Visibility:Item\_TypeOthers -858.423 -846.759   
## (1,944.089) (1,944.134)   
##   
## Item\_Visibility:Item\_TypeSeafood -3,768.045 -3,747.363   
## (2,525.960) (2,526.146)   
##   
## Item\_Visibility:Item\_TypeSnack Foods -1,394.277 -1,374.671   
## (1,068.431) (1,068.534)   
##   
## Item\_Visibility:Item\_TypeSoft Drinks -2,148.858 -2,126.384   
## (1,346.835) (1,346.987)   
##   
## Item\_Visibility:Item\_TypeStarchy Foods -1,351.405 -1,357.820   
## (1,919.585) (1,919.550)   
##   
## Constant 1,921.196\*\*\* 2,240.606\*\*\* 1,755.116\*\*\*  
## (451.179) (82.452) (257.316)   
##   
## -------------------------------------------------------------------------------------  
## Observations 8,519 8,519 8,519   
## Log Likelihood -74,333.360 -71,769.070 -71,769.620   
## Akaike Inf. Crit. 148,676.700 143,646.100 143,659.200   
## Bayesian Inf. Crit. 148,712.000 144,026.800 144,082.200   
## =====================================================================================  
## Note: \*p<0.1; \*\*p<0.05; \*\*\*p<0.01

As we saw the sales is increasing beacause of visibility in second and third model, and also the increase in age will increase the sales of most of the outlets in second model, we can consider it as the best model as, also the AIC for this model is the least among all three. The best model is city\_mix2.