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Online SAT Course

We plan to introduce an online SAT course for students. The course will have different attributes such as number of hours per week, length of the course in weeks, number of practice papers (mock exams) offered within the course, one-to-one personal interaction. The course will be offered at different price levels, depending upon the combination of the attributes. The potential customers would be students either taking the SAT for the first time or repeating SAT.

Attributes:

Number of Hours Per Week:

3 hours, 4 hours, 5 hours would be the level of this attribute. We have chosen number of hours per week as an attribute because the preference of students may vary based on their learning capabilities. Some students may prefer 3 hours per week and others may prefer 4 or 5 hours per week for the course.

Length of Course:

For the length of the course, levels are 4, 5 and 6 weeks. The length of the course is another important attribute as some students may prefer a shorter course offering learning experience within small amount of time due to some time constraint. Others may prefer a detailed learning process.

Price:

For the price, the levels are 10000 PKR, 15000 PKR, and 20000 PKR. Price is always a crucial factor when a person is making a purchase decision. The reason for including this attribute to gauge the price sensitivity of the students. It would be dependent upon the relative importance given to the SAT preparation by different students.

Number of Practice Papers:

For practice papers, the levels are 4, 5, and 6 practice papers. Practice papers are the mock exams which help students get more familiar with the actual exam. Students can choose among three

different levels of practice papers depending upon relative importance given to these by different students.

Number of Personal Meetings available per week:

For this attribute, the levels are 0, 1 and 2 personal meetings per week. Personal meetings are one-to-one interaction with a student taking the course. The students get feedback and evaluation in these meetings.

Number of Time SAT Attempted (Segments):

There is also a variable for segmentation which asks the students if they are taking the SAT for the first time, have taken SAT 2 or more times, or have not taken SAT. These three students are specified by 1, 2 and 0 respectively in the survey.

Survey Design

The objective of the survey is to gather data that will help us determine the optimal configuration of a laptop that should be launched in the market using conjoint analysis. We set up our survey of Discover sawtooth software, which uses a choice-based conjoint analysis method.
The survey design is choice-based conjoint in which we asked for 12 sets of choice questions from each respondent. For each set of choice questions, three options were provided. It also asked for ratings for the following attributes; the number of weeks for SAT course and the number of hours per week. The ratings were asked because we did not already specify the preferences.

Sample Description:

The questionnaire was issued to the group of students aged 18 to 22 who had taken and/or planned to take the upcoming SAT exam. Many participants were in their A-Levels/FSC, preparing to apply to universities whereas some of them were university students.

- 54% of the respondents had two attempts in SAT exam.
- 33% had attempted SAT once before.
- 13% of the participants had no attempts in SAT exam.

Results:

The analysis was performed using two models, m1 and m2. For both models, the dependent variable is choice and independent variables were the attributes. Model m1 incorporates the intercepts whereas model m2 is calculated without intercepts.

The log likelihood test was then used to compare the two models. Since the p value was less than 0.05, we determined that the two models are statistically distinct and we chose the more appropriate model, which in our case was m2 with all attributes and no intercepts as intercepts are not particularly important for survey data.

```
> #comparing the two models
> lrtest(m1,m2)
Likelihood ratio test

Model 1: Response ~ course_length + hours_weekly + practice_papers + meetings_weekly +
    price
Model 2: Response ~ 0 + course_length + hours_weekly + practice_papers +
    meetings_weekly + price
  #Df  LogLik Df  Chisq Pr(>Chisq)
1  11 -440.27
2   9 -445.80 -2 11.062   0.003961 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The descriptive analysis below shows how frequently an attribute of the SAT prep course was.

Course Length

The alternative with 5 weeks was chosen 164 times, which is the highest. The alternatives with 4 and 6 weeks were chosen 143 and 161 times, respectively. Since there is not a very significant difference between the top two options, we can say that customers are not strongly inclined towards a specific course length.

Number of Hours Per Week

The alternative with 5 hrs. per week was chosen 174 times, which is the highest. The alternatives with 3 and 4 hrs. per week were chosen 142 and 152 times, respectively. Most of the customers want more sessions per week for the course.

Number of Practice Papers

The alternative with 6 practice papers was chosen 164 times, which is the highest. The alternatives with 4 and 5 practice papers were chosen 154 and 150 times, respectively. Customers usually prefer greater number of practice papers.

Number of Weekly Meetings

The alternative with 2 personal meetings per week was chosen 189 times, which is the highest. The alternatives with 0 and 1 personal meetings per week were chosen 109 and 170 times, respectively. The significant difference between the top 2 alternatives suggest that customers strongly prefer more personal meetings per week.

Price

The alternative with PKR 10000 price for the course was chosen 230 times, which is the highest. The alternatives with PKR 15000 and PKR 20000 price for the course were chosen 162 and 76 times, respectively. This makes sense since customers usually want low prices for any offering.

Model Equation

In a multinomial logit model, we use a multi-attribute utility framework to describe the value of a product. We assume that we describe the value of a course offered by the number of its attributes, i.e., price, weekly hours, weekly meetings, etc.

Value:

a1(course_length5)+a2(course_length6)+a3(hours_weekly4)+a4(hours_weekly5)+a5(practise_papers5)+a6(practise_papers6)+a7(meetings_weekly1)+A8(meetings_weekly2)+A9(price)

The first levels of these attributes, course_length, hours_weekly, practise_papers, and meetings_weekly, were taken as base levels.

V1 = a(4) +b(3) + c(4) + d(0) + e(10,000) and so on we calculate V2,V3 for different courses offered with different attributes. The utility of the course is,

U1=V1+E1(Error Term)

U2=V2+E2(Error Term)

U3=V3+E3(Error Term)

The utility is random, so we estimate it using the observed choices. We also assume that people use the alternative that maximizes their utility.

Since the customer is always a utility maximizer, the Choice would be,

Choice~which.max (c(u1,u2,u3))

The probability that a customer will choose a specific alternative = scaled utility of a choice alternative, divided by the sum of scaled utilities of all available alternatives.

P1(The probability that customer will choose course V1) =e^v1/(e^v1+e^v2+e^v3….e^vn

We then estimate a multinomial logit choice model to find the value of a1,a2...a11 to maximize our data set's likelihood of observed choices.

m2<-mlogit(Choice ~ 0 + Price + course_length + hours_weekly + practise_papers + meetings_weekly, data=cbc.mlogit)

The **Dependent Variable** is the Choice (an integer variable) represented by 1 or 0, 1 means that people selected a particular profile amongst three profiles while 0 identifies that they did not.

Independent Variables are Price, course_length, hours_weekly, practise_papers, and meetings_weekly.

Price was measured as a numeric variable with values ranging from 10,000 to 15000 to 20,000.

Course_length was a factor variable taking up three values. 4 weeks was the base case, followed by 5 and 6 weeks.

Hours_weekly was a factor variable taking up three values. Three hours was the base case, followed by 4 and 5 hours. Practise_papers was a factor variable. 4 was the base case, followed by 5 and 6. Meetings_weekly was a factor variable. 0 meeting was the base, followed by 1 and 2 meetings.

```
Call:
mlogit(formula = Response ~ 0 + course_length + hours_weekly +
    practice_papers + meetings_weekly + price, data = cbc.mlogit,
    method = "nr")

Frequencies of alternatives:choice
      1       2       3
0.38034 0.36966 0.25000

nr method
4 iterations, 0h:0m:0s
g'(-H)^-1g = 2.6E-08
gradient close to zero

Coefficients :
                    Estimate  Std. Error z-value  Pr(>|z|)
course_length5     2.3154e-01  1.3464e-01  1.7197   0.08550
course_length6     1.8316e-01  1.3543e-01  1.3524   0.17625
hours_weekly4      9.9871e-02  1.3637e-01  0.7323   0.46396
hours_weekly5      3.1460e-01  1.3295e-01  2.3662   0.01797
practice_papers5 -1.5655e-03  1.3515e-01 -0.0116   0.99076
practice_papers6  1.4968e-01  1.3180e-01  1.1356   0.25612
meetings_weekly1  6.2877e-01  1.4043e-01  4.4775 7.552e-06
meetings_weekly2  7.9595e-01  1.4057e-01  5.6622 1.495e-08
price            -1.3350e-04  1.4132e-05 -9.4464 < 2.2e-16
```

Effect of each attribute:

The coefficients are on the likelihood scale. Based on the model, we can make the following statements:

Course Length:

Length of the course is not statistically significant because its p-value is greater than 0.05 but as we can see in the above table that coefficient of courses with 5- and 6-weeks length are positive with week 4 as base so, it means that people prefer courses which are 5 and 6 weeklong more than 4 week.

Hours Weekly:

The coefficient of hours_weekly 4 and 5 is positive so, people prefer courses that have 4- and 5-hours study duration than 3 hours which is a base here. Overall 4 hours is preferable than both 3 and 5, however, 4 hours is not a statistically significant characteristic. Only hours_weekly5 is significant and its coefficient is also positive so, 5 hours study duration is preferable than 3 hours.

Practice Papers:

Coefficient of practice_paper5 is negative so it suggests that people prefer 4 practice papers, which is the base case here, then 5 papers but coefficient of practice_paper6 is positive which means that 6 papers are preferable to both 4 and 5. However, the number of Practice Papers is not statistically significant.

Meetings Weekly:

Meetings weekly are statistically significant as its p-values are less than 0.05. People prefer 1 and 2 weekly meetings to 0 weekly meetings, which is the base case here, as their coefficients are positive but overall, 2 weekly meetings are most preferable.

Price:

Price is a statistically significant because of p-value being less than 0.05. attribute and people prefer low prices.

Willingness to Pay:

course_length5	course_length6	hours_weekly4
1734.37876	1371.99684	748.10174
hours_weekly5	practice_papers5	practice_papers6
2356.52176	-11.72681	1121.16595
meetings_weekly1	meetings_weekly2	price
4709.92301	5962.17167	-1.00000

Course Length:

Respondents are willing to pay PKR 1734 for 5-week course in place of 4-week course. That is, on average, customers would be indifferent between a course with a length of 4 week and a course with a length of 5-week space that costs PKR 1734 more.

Similarly, respondents are willing to pay PKR 1371 for 6-week course in place of 4-week course. That is, on average, customers would be indifferent between a course with a length of 4 week and a course with a length of 6-week space that costs PKR 1371 more.

Hours Weekly:

Respondents are willing to pay PKR 748 for 4 hours per week course in place of 3 hours per week course. That is, on average, customers would be indifferent between a course with 3 hours per week and a course with 4 hours per week duration that costs PKR 748 more**.**

Respondents are willing to pay PKR 2356 for 5 hours per week course in place of 3 hours per week course. That is, on average, customers would be indifferent between a course with 3 hours per week and a course with 5 hours per week duration that costs PKR 2356 more.

Practice Papers:

For 5 practice papers, we see that willingness to pay is negative. It means that it will take PKR 11.7 discount to make a course with 5 practice papers as attractive as 4 practice papers for certain combinations.

Respondents are willing to pay PKR 1121 for 6 practice papers in place of 4 practice papers in the course. That is, on average, customers would be indifferent between 4 practice papers in the course and a course with 6 practice papers that costs PKR 1121 more.

Meetings Weekly:

Respondents are willing to pay PKR 4709 for 1 meeting course in place of 0 meeting course. That is, on average, customers would be indifferent between 0 meeting course and a course with 1 meeting that costs PKR 4709 more**.**

Respondents are willing to pay PKR 5962 for a 2-meeting course in place of 0 meeting course. That is, on average, customers would be indifferent between 0 meeting course and a course with 2 meeting that costs PKR 5962 more

Best Configuration for Market Shares:

We use the "expand.grid" function to formulate 200 combinations possible with our given attributes and their levels. After making the combination, we predicted the market share of each combination, by using "predict.mnl", based on logit model m2. To found out the combination with highest market share we used "filter_all" function. Some of the combinations are shown below:

	share	course_length	hours_weekly	practice_papers	meetings_weekly	price
1	0.0029092485	4	3	4	0	10000
2	0.0036672204	5	3	4	0	10000
3	0.0034940310	6	3	4	0	10000
4	0.0032148035	4	4	4	0	10000
5	0.0040523842	5	4	4	0	10000
6	0.0038610049	6	4	4	0	10000
7	0.0039848112	4	5	4	0	10000

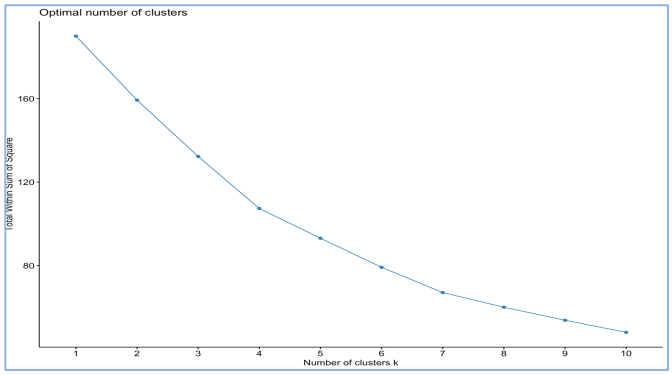
Out of 200 combination the highest market share we got is 1.2% for combination 80 whose attributes are following:

```
> ideal_con
       share course_length hours_weekly practice_papers meetings_weekly price
80 0.01293133             5            5               6               2 10000
```

Segmentation

For the Segmentation, we applied cluster analysis to our data. Firstly, from our respondent's data, we used pivot table analysis to divide our respondents into specific number of clusters. In pivot

table, we divided the data according to the respondent's id in rows, while average was taken for the attributes. By using filter option, we only chose those attributes levels in which the respondent's response was 1 i.e., their chosen combination of course among the other options. Therefore, we obtained a new data set which contained averages of the attributes with response 1. We applied cluster analysis from the new data set and chose 4 clusters in our analysis based on the **Elbow diagram** and **Dendrogram**. From the elbow diagram, we can see that after 4 clusters, there is a significant loss of information, so we decided to choose 4 clusters.



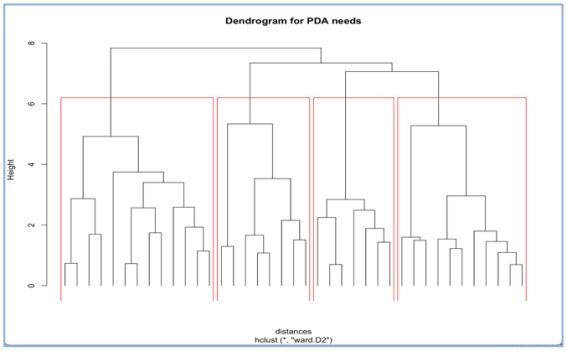
The size of each cluster group is shown as below:

Cluster groups

1 – 11, 2 – 7, 3 – 7, 4 – 8

This shows that the largest cluster group is 3rd with 13 respondents. The chosen attributes of all four cluster groups are also shown below:

	Group.1	course_length	hours_weekly	practice_papers	meetings_weekly	price
1	1	5.143939	4.128788	4.825758	1.1287879	12007.58
2	2	5.011905	4.392857	4.952381	1.2380952	15238.10
3	3	5.141026	3.903846	5.192308	1.3782051	13397.44
4	4	4.750000	3.968750	5.072917	0.8333333	13489.58

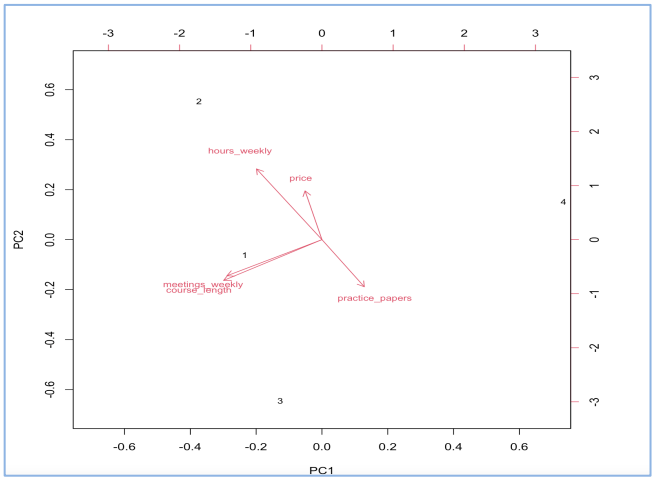


Positioning

On the chosen 4 cluster groups, we draw a perceptual map to visually represent the positioning of each attribute in the minds of different cluster groups. Positioning map is shown as below:

- From the map, we can see that weekly meetings and course length are positively correlated with each other.
- Similarly, hours weekly and price attribute are also correlated with each other.
- Furthermore, hours weekly and no. of practice papers are negatively correlated with each other.
- Lastly, price and no. of practice papers are also somewhat negatively correlated with each other.

On our chosen 4 cluster groups, from the perceptual map, we can see that segment 1 carefully considers weekly meetings and course length while choosing the course. Similarly, segment 2 gives heavy significance to weekly hours and price while making the decision. Segment 3 gives weightage to weekly meetings, no. of practise papers and course length. Lastly, segment 4 while deciding the course relies heavily on attributes such as price and no. of practice papers.



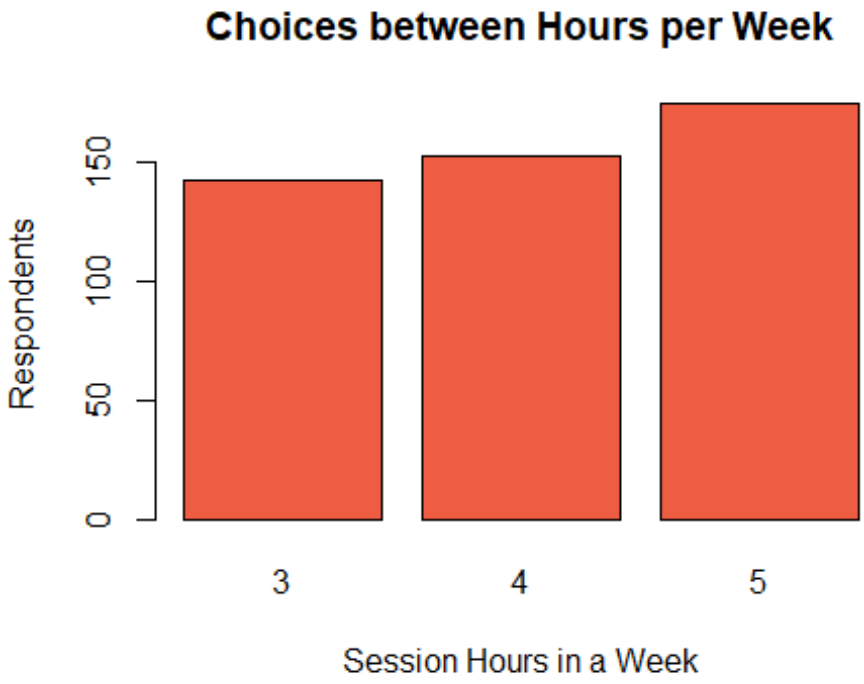
Appendix

Code File and Questionnaire:

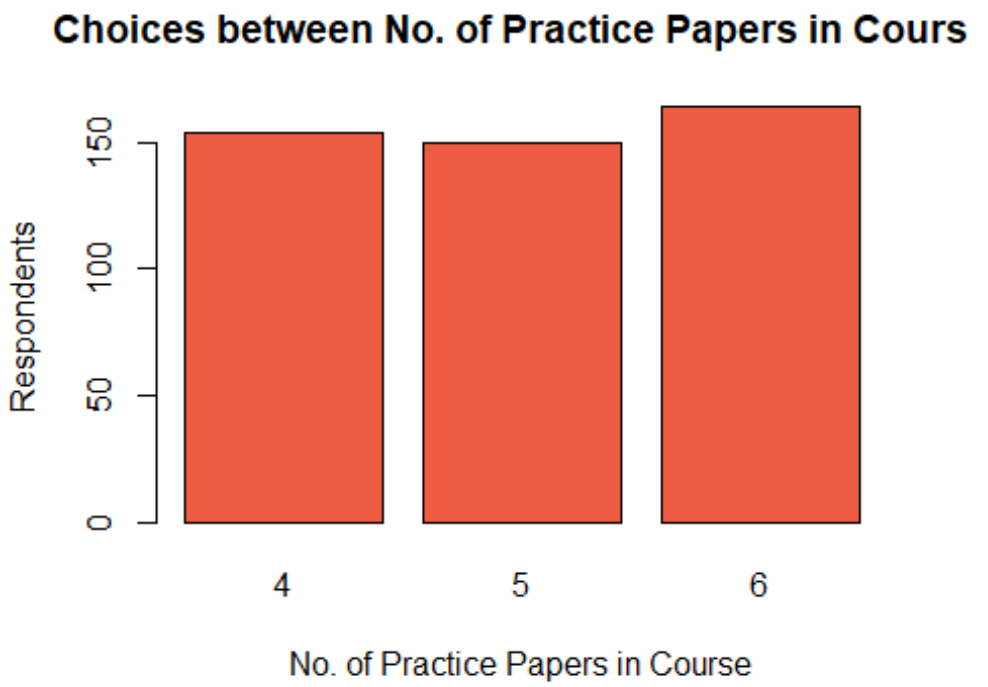
```
library(readxl)
sat<- read_excel("Sat.xlsx")

## Warning: replacing previous import 'lifecycle::last_warnings' by
## 'rlang::last_warnings' when loading 'tibble'

## Warning: replacing previous import 'lifecycle::last_warnings' by
## 'rlang::last_warnings' when loading 'pillar'

str(sat)

## tibble [1,404 x 10] (S3: tbl_df/tbl/data.frame)
##  $ Id             : num [1:1404] 5 5 5 5 5 5 5 5 5 5 ...
##  $ Task           : num [1:1404] 1 1 1 2 2 2 3 3 3 4 ...
##  $ Concept        : num [1:1404] 1 2 3 1 2 3 1 2 3 1 ...
##  $ sat_attempted  : num [1:1404] 2 2 2 2 2 2 2 2 2 2 ...
##  $ course_length  : num [1:1404] 4 6 5 5 6 4 6 5 4 5 ...
##  $ hours_weekly   : num [1:1404] 5 5 3 4 5 3 5 3 4 5 ...
##  $ practice_papers: num [1:1404] 4 5 6 4 4 4 6 5 4 4 ...
##  $ meetings_weekly: num [1:1404] 2 1 2 2 0 1 2 2 0 1 ...
##  $ price          : num [1:1404] 10000 20000 10000 20000 15000 1000
0 15000 10000 20000 15000 ...
##  $ Response       : num [1:1404] 0 1 0 0 1 0 0 1 0 0 ...

#specifying variables as integer and as factor
sat$Id<-as.integer(sat$Id)
sat$Task<-as.integer(sat$Task)
sat$Concept<-as.integer(sat$Concept)
sat$Response<-as.integer(sat$Response)
sat$sat_attempted<-as.factor(sat$sat_attempted)
sat$course_length<-as.factor(sat$course_length)
sat$hours_weekly<-as.factor(sat$hours_weekly)
sat$practice_papers<-as.factor(sat$practice_papers)
sat$meetings_weekly<-as.factor(sat$meetings_weekly)
#checking freqncy of selection of different attributes, along with plo
ts
xtabs(Response~course_length, data=sat)

## course_length
##   4   5   6
## 143 164 161
```

```
by_course_length<-xtabs(Response~course_length, data=sat)
barplot(by_course_length,main="Choices between Course length",xlab="Co
urse Length(weeks)",ylab="Respondents",col="tomato2")
```

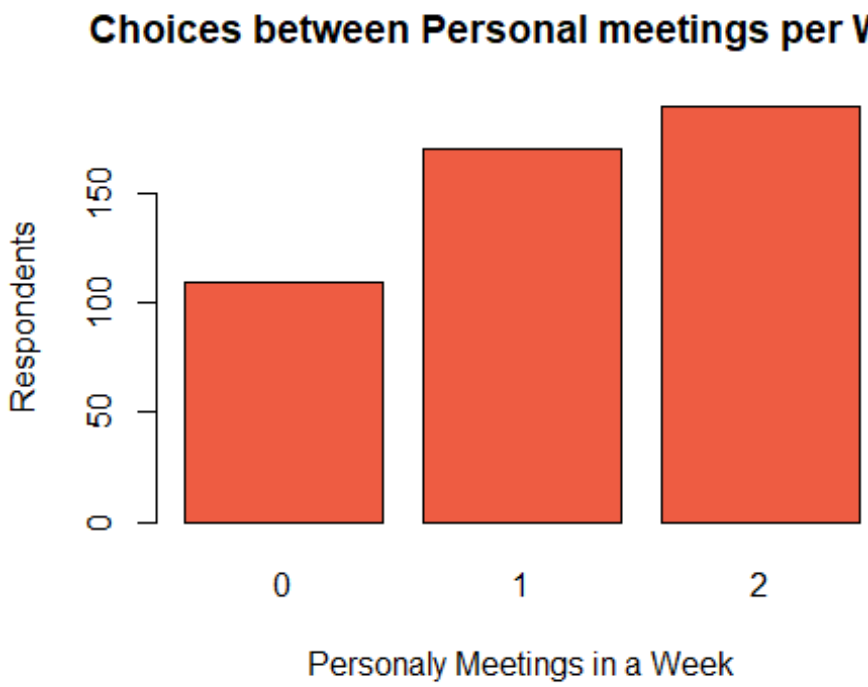

```
xtabs(Response~hours_weekly, data=sat)

## hours_weekly
##   3   4   5
## 142 152 174

by_weekly_hours<-xtabs(Response~hours_weekly, data=sat)
barplot(by_weekly_hours,main="Choices between Hours per Week",xlab="Se
ssion Hours in a Week",ylab="Respondents",col="tomato2")
```



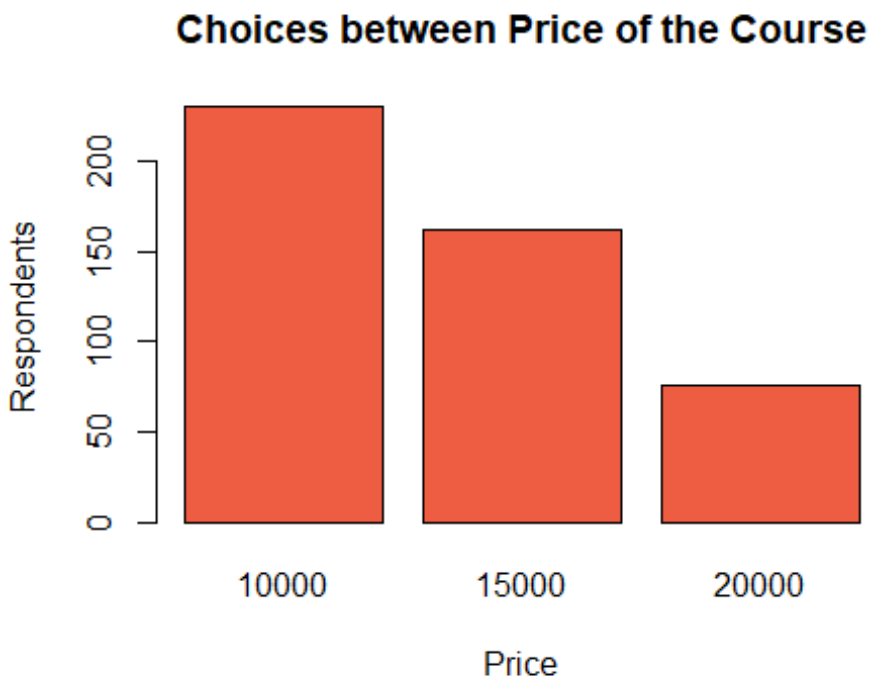

```
xtabs(Response~practice_papers, data=sat)

## practice_papers
##   4   5   6
## 154 150 164

by_practice_papers<-xtabs(Response~practice_papers, data=sat)
barplot(by_practice_papers,main="Choices between No. of Practice Paper
s in Course",xlab="No. of Practice Papers in Course",ylab="Respondents
",col="tomato2")
```




```
xtabs(Response~meetings_weekly, data=sat)

## meetings_weekly
##   0   1   2
## 109 170 189

by_weeky_meetings<-xtabs(Response~meetings_weekly, data=sat)
barplot(by_weeky_meetings,main="Choices between Personal meetings per
Week",xlab="Personaly Meetings in a Week",ylab="Respondents",col="toma
to2")
```




```
xtabs(Response~price, data=sat)

## price
## 10000 15000 20000
##   230   162    76

by_price<-xtabs(Response~price, data=sat)
barplot(by_price,main="Choices between Price of the Course",xlab="Pric
e",ylab="Respondents",col="tomato2")
#conjoint analysis
library(mlogit)

## Warning: package 'mlogit' was built under R version 4.0.5

## Loading required package: dfidx

## Warning: package 'dfidx' was built under R version 4.0.5

##
## Attaching package: 'dfidx'

## The following object is masked from 'package:stats':
##
##     filter
```




```
#before estimating the multinomial logit model, we want to set our dat
a as multinomial data object:
cbc.mlogit<-mlogit.data(sat, shape="long", choice="Response",alt.var="
Concept")
#estimating the model which includes the intercepts
m1<-mlogit(Response~course_length+hours_weekly+practice_papers+meeting
s_weekly+price, data=cbc.mlogit)
summary(m1)

##
## Call:
## mlogit(formula = Response ~ course_length + hours_weekly + practice
_papers +
##     meetings_weekly + price, data = cbc.mlogit, method = "nr")
##
## Frequencies of alternatives:choice
##       1       2       3
## 0.38034 0.36966 0.25000
##
## nr method
## 4 iterations, 0h:0m:0s
## g'(-H)^-1g = 2.3E-07
## gradient close to zero
##
## Coefficients :
```

```
##                      Estimate  Std. Error z-value  Pr(>|z|)
## (Intercept):2     3.4740e-02  1.1979e-01  0.2900  0.771808
## (Intercept):3    -3.5695e-01  1.3198e-01 -2.7046  0.006838 **
## course_length5    2.3927e-01  1.3579e-01  1.7620  0.078073 .
## course_length6    2.0342e-01  1.3696e-01  1.4853  0.137475
## hours_weekly4     9.8441e-02  1.3700e-01  0.7185  0.472427
## hours_weekly5     3.2246e-01  1.3396e-01  2.4072  0.016074 *
## practice_papers5  4.3395e-02  1.3735e-01  0.3160  0.752037
## practice_papers6  1.6518e-01  1.3265e-01  1.2453  0.213028
## meetings_weekly1  6.3901e-01  1.4201e-01  4.4997 6.803e-06 ***
## meetings_weekly2  8.1814e-01  1.4332e-01  5.7083 1.141e-08 ***
## price            -1.3168e-04  1.4479e-05 -9.0949 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -440.27
## McFadden R^2:  0.13064
## Likelihood ratio test : chisq = 132.32 (p.value = < 2.22e-16)
```

```
#in our survey, all three alternatives should be equally selectable, s
o the intercpets don't show anything significant.
#it is better to omit these intercepts
m2<-mlogit(Response~0+course_length+hours_weekly+practice_papers+meeti
ngs_weekly+price, data=cbc.mlogit)
summary(m2)
```

```
##
## Call:
## mlogit(formula = Response ~ 0 + course_length + hours_weekly +
##     practice_papers + meetings_weekly + price, data = cbc.mlogit,
##     method = "nr")
##
## Frequencies of alternatives:choice
##       1       2       3
## 0.38034 0.36966 0.25000
##
## nr method
## 4 iterations, 0h:0m:0s
## g'(-H)^-1g = 2.6E-08
## gradient close to zero
##
## Coefficients :
##                      Estimate  Std. Error z-value  Pr(>|z|)
## course_length5    2.3154e-01  1.3464e-01  1.7197   0.08550 .
## course_length6    1.8316e-01  1.3543e-01  1.3524   0.17625
## hours_weekly4     9.9871e-02  1.3637e-01  0.7323   0.46396
```

```
## hours_weekly5     3.1460e-01  1.3295e-01  2.3662   0.01797 *
## practice_papers5 -1.5655e-03  1.3515e-01 -0.0116   0.99076
## practice_papers6  1.4968e-01  1.3180e-01  1.1356   0.25612
## meetings_weekly1  6.2877e-01  1.4043e-01  4.4775 7.552e-06 ***
## meetings_weekly2  7.9595e-01  1.4057e-01  5.6622 1.495e-08 ***
## price            -1.3350e-04  1.4132e-05 -9.4464 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Log-Likelihood: -445.8

#comparing the two models
lrtest(m1,m2)

## Likelihood ratio test
##
## Model 1: Response ~ course_length + hours_weekly + practice_papers
+ meetings_weekly +
##     price
## Model 2: Response ~ 0 + course_length + hours_weekly + practice_pap
ers +
##     meetings_weekly + price
##   #Df  LogLik Df  Chisq Pr(>Chisq)
## 1  11 -440.27
## 2   9 -445.80 -2 11.062   0.003961 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

coef(m2)

##   course_length5   course_length6    hours_weekly4    hours_weekly5
##     0.2315391752     0.1831612713     0.0998714142     0.3145951269
## practice_papers5 practice_papers6 meetings_weekly1 meetings_weekly2
##    -0.0015655264     0.1496754025     0.6287736657     0.7959485816
##            price
##    -0.0001334998

#calculating willingness to pay for different attributes
(coef(m2)/-coef(m2)[9])

##   course_length5   course_length6    hours_weekly4    hours_weekly5
##       1734.37876       1371.99684        748.10174       2356.52176
## practice_papers5 practice_papers6 meetings_weekly1 meetings_weekly2
##        -11.72681       1121.16595       4709.92301       5962.17167
##            price
##         -1.00000
```

```
#writing function for simulating choice shares
predict.mnl<-function(model, data){
  data.model<-model.matrix(update(model$formula, 0~.), data=data)[,-1]
  value<-data.model%*%model$coef
  share<-exp(value)/sum(exp(value))
  cbind(share,data)
}
#storing values for all the combinations
newsat<-list(course_length=c("4","5","6"),
             hours_weekly=c("3","4","5"),
             practice_papers=c("4","5", "6"),
            meetings_weekly=c("0","1","2"),
             price=c(10000, 15000, 20000))
allcombination<-expand.grid(newsat)
allcombination
```

```
##     course_length hours_weekly practice_papers meetings_weekly pric
e
## 1               4            3               4                0 1000
0
## 2               5            3               4                0 1000
0
## 3               6            3               4                0 1000
0
## 4               4            4               4                0 1000
0
## 5               5            4               4                0 1000
0
## 6               6            4               4                0 1000
0
## 7               4            5               4                0 1000
0
## 8               5            5               4                0 1000
0
## 9               6            5               4                0 1000
0
## 10              4            3               5                0 1000
0
## 11              5            3               5                0 1000
0
## 12              6            3               5                0 1000
0
## 13              4            4               5                0 1000
0
## 14              5            4               5                0 1000
0
```

```
## 15          6          4          5          0 1000
0
## 16          4          5          5          0 1000
0
## 17          5          5          5          0 1000
0
## 18          6          5          5          0 1000
0
## 19          4          3          6          0 1000
0
## 20          5          3          6          0 1000
0
## 21          6          3          6          0 1000
0
## 22          4          4          6          0 1000
0
## 23          5          4          6          0 1000
0
## 24          6          4          6          0 1000
0
## 25          4          5          6          0 1000
0
## 26          5          5          6          0 1000
0
## 27          6          5          6          0 1000
0
## 28          4          3          4          1 1000
0
## 29          5          3          4          1 1000
0
## 30          6          3          4          1 1000
0
## 31          4          4          4          1 1000
0
## 32          5          4          4          1 1000
0
## 33          6          4          4          1 1000
0
## 34          4          5          4          1 1000
0
## 35          5          5          4          1 1000
0
## 36          6          5          4          1 1000
0
## 37          4          3          5          1 1000
0
```

```
## 38          5          3          5          1 1000
0
## 39          6          3          5          1 1000
0
## 40          4          4          5          1 1000
0
## 41          5          4          5          1 1000
0
## 42          6          4          5          1 1000
0
## 43          4          5          5          1 1000
0
## 44          5          5          5          1 1000
0
## 45          6          5          5          1 1000
0
## 46          4          3          6          1 1000
0
## 47          5          3          6          1 1000
0
## 48          6          3          6          1 1000
0
## 49          4          4          6          1 1000
0
## 50          5          4          6          1 1000
0
## 51          6          4          6          1 1000
0
## 52          4          5          6          1 1000
0
## 53          5          5          6          1 1000
0
## 54          6          5          6          1 1000
0
## 55          4          3          4          2 1000
0
## 56          5          3          4          2 1000
0
## 57          6          3          4          2 1000
0
## 58          4          4          4          2 1000
0
## 59          5          4          4          2 1000
0
## 60          6          4          4          2 1000
0
```

```
## 61          4          5          4          2 1000
0
## 62          5          5          4          2 1000
0
## 63          6          5          4          2 1000
0
## 64          4          3          5          2 1000
0
## 65          5          3          5          2 1000
0
## 66          6          3          5          2 1000
0
## 67          4          4          5          2 1000
0
## 68          5          4          5          2 1000
0
## 69          6          4          5          2 1000
0
## 70          4          5          5          2 1000
0
## 71          5          5          5          2 1000
0
## 72          6          5          5          2 1000
0
## 73          4          3          6          2 1000
0
## 74          5          3          6          2 1000
0
## 75          6          3          6          2 1000
0
## 76          4          4          6          2 1000
0
## 77          5          4          6          2 1000
0
## 78          6          4          6          2 1000
0
## 79          4          5          6          2 1000
0
## 80          5          5          6          2 1000
0
## 81          6          5          6          2 1000
0
## 82          4          3          4          0 1500
0
## 83          5          3          4          0 1500
0
```

```
## 84          6          3          4          0 1500
0
## 85          4          4          4          0 1500
0
## 86          5          4          4          0 1500
0
## 87          6          4          4          0 1500
0
## 88          4          5          4          0 1500
0
## 89          5          5          4          0 1500
0
## 90          6          5          4          0 1500
0
## 91          4          3          5          0 1500
0
## 92          5          3          5          0 1500
0
## 93          6          3          5          0 1500
0
## 94          4          4          5          0 1500
0
## 95          5          4          5          0 1500
0
## 96          6          4          5          0 1500
0
## 97          4          5          5          0 1500
0
## 98          5          5          5          0 1500
0
## 99          6          5          5          0 1500
0
## 100         4          3          6          0 1500
0
## 101         5          3          6          0 1500
0
## 102         6          3          6          0 1500
0
## 103         4          4          6          0 1500
0
## 104         5          4          6          0 1500
0
## 105         6          4          6          0 1500
0
## 106         4          5          6          0 1500
0
```

```
## 107          5          5          6          0 1500
0
## 108          6          5          6          0 1500
0
## 109          4          3          4          1 1500
0
## 110          5          3          4          1 1500
0
## 111          6          3          4          1 1500
0
## 112          4          4          4          1 1500
0
## 113          5          4          4          1 1500
0
## 114          6          4          4          1 1500
0
## 115          4          5          4          1 1500
0
## 116          5          5          4          1 1500
0
## 117          6          5          4          1 1500
0
## 118          4          3          5          1 1500
0
## 119          5          3          5          1 1500
0
## 120          6          3          5          1 1500
0
## 121          4          4          5          1 1500
0
## 122          5          4          5          1 1500
0
## 123          6          4          5          1 1500
0
## 124          4          5          5          1 1500
0
## 125          5          5          5          1 1500
0
## 126          6          5          5          1 1500
0
## 127          4          3          6          1 1500
0
## 128          5          3          6          1 1500
0
## 129          6          3          6          1 1500
0
```

```
## 130          4          4          6          1 1500
0
## 131          5          4          6          1 1500
0
## 132          6          4          6          1 1500
0
## 133          4          5          6          1 1500
0
## 134          5          5          6          1 1500
0
## 135          6          5          6          1 1500
0
## 136          4          3          4          2 1500
0
## 137          5          3          4          2 1500
0
## 138          6          3          4          2 1500
0
## 139          4          4          4          2 1500
0
## 140          5          4          4          2 1500
0
## 141          6          4          4          2 1500
0
## 142          4          5          4          2 1500
0
## 143          5          5          4          2 1500
0
## 144          6          5          4          2 1500
0
## 145          4          3          5          2 1500
0
## 146          5          3          5          2 1500
0
## 147          6          3          5          2 1500
0
## 148          4          4          5          2 1500
0
## 149          5          4          5          2 1500
0
## 150          6          4          5          2 1500
0
## 151          4          5          5          2 1500
0
## 152          5          5          5          2 1500
0
```

```
## 153          6          5          5          2 1500
0
## 154          4          3          6          2 1500
0
## 155          5          3          6          2 1500
0
## 156          6          3          6          2 1500
0
## 157          4          4          6          2 1500
0
## 158          5          4          6          2 1500
0
## 159          6          4          6          2 1500
0
## 160          4          5          6          2 1500
0
## 161          5          5          6          2 1500
0
## 162          6          5          6          2 1500
0
## 163          4          3          4          0 2000
0
## 164          5          3          4          0 2000
0
## 165          6          3          4          0 2000
0
## 166          4          4          4          0 2000
0
## 167          5          4          4          0 2000
0
## 168          6          4          4          0 2000
0
## 169          4          5          4          0 2000
0
## 170          5          5          4          0 2000
0
## 171          6          5          4          0 2000
0
## 172          4          3          5          0 2000
0
## 173          5          3          5          0 2000
0
## 174          6          3          5          0 2000
0
## 175          4          4          5          0 2000
0
```

```
## 176          5          4          5          0 2000
0
## 177          6          4          5          0 2000
0
## 178          4          5          5          0 2000
0
## 179          5          5          5          0 2000
0
## 180          6          5          5          0 2000
0
## 181          4          3          6          0 2000
0
## 182          5          3          6          0 2000
0
## 183          6          3          6          0 2000
0
## 184          4          4          6          0 2000
0
## 185          5          4          6          0 2000
0
## 186          6          4          6          0 2000
0
## 187          4          5          6          0 2000
0
## 188          5          5          6          0 2000
0
## 189          6          5          6          0 2000
0
## 190          4          3          4          1 2000
0
## 191          5          3          4          1 2000
0
## 192          6          3          4          1 2000
0
## 193          4          4          4          1 2000
0
## 194          5          4          4          1 2000
0
## 195          6          4          4          1 2000
0
## 196          4          5          4          1 2000
0
## 197          5          5          4          1 2000
0
## 198          6          5          4          1 2000
0
```

```
## 199          4          3          5          1 2000
0
## 200          5          3          5          1 2000
0
## 201          6          3          5          1 2000
0
## 202          4          4          5          1 2000
0
## 203          5          4          5          1 2000
0
## 204          6          4          5          1 2000
0
## 205          4          5          5          1 2000
0
## 206          5          5          5          1 2000
0
## 207          6          5          5          1 2000
0
## 208          4          3          6          1 2000
0
## 209          5          3          6          1 2000
0
## 210          6          3          6          1 2000
0
## 211          4          4          6          1 2000
0
## 212          5          4          6          1 2000
0
## 213          6          4          6          1 2000
0
## 214          4          5          6          1 2000
0
## 215          5          5          6          1 2000
0
## 216          6          5          6          1 2000
0
## 217          4          3          4          2 2000
0
## 218          5          3          4          2 2000
0
## 219          6          3          4          2 2000
0
## 220          4          4          4          2 2000
0
## 221          5          4          4          2 2000
0
```

```
## 222          6          4          4          2 2000
0
## 223          4          5          4          2 2000
0
## 224          5          5          4          2 2000
0
## 225          6          5          4          2 2000
0
## 226          4          3          5          2 2000
0
## 227          5          3          5          2 2000
0
## 228          6          3          5          2 2000
0
## 229          4          4          5          2 2000
0
## 230          5          4          5          2 2000
0
## 231          6          4          5          2 2000
0
## 232          4          5          5          2 2000
0
## 233          5          5          5          2 2000
0
## 234          6          5          5          2 2000
0
## 235          4          3          6          2 2000
0
## 236          5          3          6          2 2000
0
## 237          6          3          6          2 2000
0
## 238          4          4          6          2 2000
0
## 239          5          4          6          2 2000
0
## 240          6          4          6          2 2000
0
## 241          4          5          6          2 2000
0
## 242          5          5          6          2 2000
0
## 243          6          5          6          2 2000
0
```

```
#first we calculate shares for each combination
shares_for_each_combination<-predict.mnl(m2,allcombination)
shares_for_each_combination

##            share course_length hours_weekly practice_papers meeting
s_weekly
## 1   0.0029092485             4            3                4
0
## 2   0.0036672204             5            3                4
0
## 3   0.0034940310             6            3                4
0
## 4   0.0032148035             4            4                4
0
## 5   0.0040523842             5            4                4
0
## 6   0.0038610049             6            4                4
0
## 7   0.0039848112             4            5                4
0
## 8   0.0050230088             5            5                4
0
## 9   0.0047857905             6            5                4
0
## 10  0.0029046976             4            3                5
0
## 11  0.0036614837             5            3                5
0
## 12  0.0034885653             6            3                5
0
## 13  0.0032097745             4            4                5
0
## 14  0.0040460450             5            4                5
0
## 15  0.0038549652             6            4                5
0
## 16  0.0039785778             4            5                5
0
## 17  0.0050151513             5            5                5
0
## 18  0.0047783040             6            5                5
0
## 19  0.0033789676             4            3                6
0
## 20  0.0042593194             5            3                6
0
```

```
## 21  0.0040581674              6              3              6
0
## 22  0.0037338565              4              4              6
0
## 23  0.0047066707              5              4              6
0
## 24  0.0044843919              6              4              6
0
## 25  0.0046281876              4              5              6
0
## 26  0.0058340096              5              5              6
0
## 27  0.0055584907              6              5              6
0
## 28  0.0054557411              4              3              4
1
## 29  0.0068771729              5              3              4
1
## 30  0.0065523892              6              3              4
1
## 31  0.0060287512              4              4              4
1
## 32  0.0075994742              5              4              4
1
## 33  0.0072405789              6              4              4
1
## 34  0.0074727540              4              5              4
1
## 35  0.0094196956              5              5              4
1
## 36  0.0089748379              6              5              4
1
## 37  0.0054472067              4              3              5
1
## 38  0.0068664149              5              3              5
1
## 39  0.0065421393              6              3              5
1
## 40  0.0060193204              4              4              5
1
## 41  0.0075875864              5              4              5
1
## 42  0.0072292524              6              4              5
1
## 43  0.0074610643              4              5              5
1
```

```
## 44  0.0094049604           5           5           5
1
## 45  0.0089607986           6           5           5
1
## 46  0.0063366097           4           3           6
1
## 47  0.0079875418           5           3           6
1
## 48  0.0076103195           6           3           6
1
## 49  0.0070021363           4           4           6
1
## 50  0.0088264639           5           4           6
1
## 51  0.0084096223           6           4           6
1
## 52  0.0086792837           4           5           6
1
## 53  0.0109405731           5           5           6
1
## 54  0.0104238899           6           5           6
1
## 55  0.0064484732           4           3           4
2
## 56  0.0081285501           5           3           4
2
## 57  0.0077446684           6           3           4
2
## 58  0.0071257487           4           4           4
2
## 59  0.0089822821           5           4           4
2
## 60  0.0085580818           6           4           4
2
## 61  0.0088325037           4           5           4
2
## 62  0.0111337128           5           5           4
2
## 63  0.0106079083           6           5           4
2
## 64  0.0064383859           4           3           5
2
## 65  0.0081158346           5           3           5
2
## 66  0.0077325534           6           3           5
2
```

```
## 67  0.0071146019           4           4           5
2
## 68  0.0089682311           5           4           5
2
## 69  0.0085446944           6           4           5
2
## 70  0.0088186870           4           5           5
2
## 71  0.0111162963           5           5           5
2
## 72  0.0105913143           6           5           5
2
## 73  0.0074896255           4           3           6
2
## 74  0.0094409628           5           3           6
2
## 75  0.0089951007           6           3           6
2
## 76  0.0082762520           4           4           6
2
## 77  0.0104325360           5           4           6
2
## 78  0.0099398455           6           4           6
2
## 79  0.0102585748           4           5           6
2
## 80  0.0129313306           5           5           6
2
## 81  0.0123206312           6           5           6
2
## 82  0.0014924155           4           3           4
0
## 83  0.0018812475           5           3           4
0
## 84  0.0017924030           6           3           4
0
## 85  0.0016491621           4           4           4
0
## 86  0.0020788327           5           4           4
0
## 87  0.0019806570           6           4           4
0
## 88  0.0020441684           4           5           4
0
## 89  0.0025767534           5           5           4
0
```

```
## 90  0.0024550628             6             5             4
0
## 91  0.0014900809             4             3             5
0
## 92  0.0018783046             5             3             5
0
## 93  0.0017895992             6             3             5
0
## 94  0.0016465823             4             4             5
0
## 95  0.0020755807             5             4             5
0
## 96  0.0019775587             6             4             5
0
## 97  0.0020409707             4             5             5
0
## 98  0.0025727226             5             5             5
0
## 99  0.0024512223             6             5             5
0
## 100 0.0017333767             4             3             6
0
## 101 0.0021849884             5             3             6
0
## 102 0.0020817994             6             3             6
0
## 103 0.0019154312             4             4             6
0
## 104 0.0024144751             5             4             6
0
## 105 0.0023004483             6             4             6
0
## 106 0.0023742141             4             5             6
0
## 107 0.0029927887             5             5             6
0
## 108 0.0028514503             6             5             6
0
## 109 0.0027987408             4             3             4
1
## 110 0.0035279211             5             3             4
1
## 111 0.0033613103             6             3             4
1
## 112 0.0030926892             4             4             4
1
```

```
## 113 0.0038984545          5          4          4
1
## 114 0.0037143447          6          4          4
1
## 115 0.0038334482          4          5          4
1
## 116 0.0048322099          5          5          4
1
## 117 0.0046040023          6          5          4
1
## 118 0.0027943627          4          3          5
1
## 119 0.0035224024          5          3          5
1
## 120 0.0033560522          6          3          5
1
## 121 0.0030878513          4          4          5
1
## 122 0.0038923561          5          4          5
1
## 123 0.0037085344          6          4          5
1
## 124 0.0038274516          4          5          5
1
## 125 0.0048246509          5          5          5
1
## 126 0.0045968003          6          5          5
1
## 127 0.0032506176          4          3          6
1
## 128 0.0040975293          5          3          6
1
## 129 0.0039040180          6          3          6
1
## 130 0.0035920261          4          4          6
1
## 131 0.0045278879          5          4          6
1
## 132 0.0043140524          6          4          6
1
## 133 0.0044523860          4          5          6
1
## 134 0.0056124049          5          5          6
1
## 135 0.0053473515          6          5          6
1
```

```
## 136 0.0033080024              4              3              4
2
## 137 0.0041698651              5              3              4
2
## 138 0.0039729377              6              3              4
2
## 139 0.0036554380              4              4              4
2
## 140 0.0046078211              5              4              4
2
## 141 0.0043902106              6              4              4
2
## 142 0.0045309863              4              5              4
2
## 143 0.0057114836              5              5              4
2
## 144 0.0054417511              6              5              4
2
## 145 0.0033028277              4              3              5
2
## 146 0.0041633422              5              3              5
2
## 147 0.0039667228              6              3              5
2
## 148 0.0036497198              4              4              5
2
## 149 0.0046006131              5              4              5
2
## 150 0.0043833430              6              4              5
2
## 151 0.0045238985              4              5              5
2
## 152 0.0057025491              5              5              5
2
## 153 0.0054332386              6              5              5
2
## 154 0.0038421032              4              3              6
2
## 155 0.0048431198              5              3              6
2
## 156 0.0046143969              6              3              6
2
## 157 0.0042456347              4              4              6
2
## 158 0.0053517869              5              4              6
2
```

```
## 159 0.0050990416             6             4             6
2
## 160 0.0052625465             4             5             6
2
## 161 0.0066336436             5             5             6
2
## 162 0.0063203609             6             5             6
2
## 163 0.0007655943             4             3             4
0
## 164 0.0009650612             5             3             4
0
## 165 0.0009194849             6             3             4
0
## 166 0.0008460037             4             4             4
0
## 167 0.0010664204             5             4             4
0
## 168 0.0010160573             6             4             4
0
## 169 0.0010486380             4             5             4
0
## 170 0.0013218488             5             5             4
0
## 171 0.0012594227             6             5             4
0
## 172 0.0007643966             4             3             5
0
## 173 0.0009635515             5             3             5
0
## 174 0.0009180465             6             3             5
0
## 175 0.0008446803             4             4             5
0
## 176 0.0010647522             5             4             5
0
## 177 0.0010144679             6             4             5
0
## 178 0.0010469976             4             5             5
0
## 179 0.0013197810             5             5             5
0
## 180 0.0012574526             6             5             5
0
## 181 0.0008892049             4             3             6
0
```

```
## 182 0.0011208772                5                3                6
0
## 183 0.0010679423                6                3                6
0
## 184 0.0009825971                4                4                6
0
## 185 0.0012386017                5                4                6
0
## 186 0.0011801070                6                4                6
0
## 187 0.0012179481                4                5                6
0
## 188 0.0015352708                5                5                6
0
## 189 0.0014627655                6                5                6
0
## 190 0.0014357261                4                3                4
1
## 191 0.0018097883                5                3                4
1
## 192 0.0017243187                6                3                4
1
## 193 0.0015865187                4                4                4
1
## 194 0.0019998683                5                4                4
1
## 195 0.0019054218                6                4                4
1
## 196 0.0019665207                4                5                4
1
## 197 0.0024788755                5                5                4
1
## 198 0.0023618073                6                5                4
1
## 199 0.0014334802                4                3                5
1
## 200 0.0018069573                5                3                5
1
## 201 0.0017216213                6                3                5
1
## 202 0.0015840369                4                4                5
1
## 203 0.0019967399                5                4                5
1
## 204 0.0019024411                6                4                5
1
```

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## 205 0.0019634445             4             5             5
1
## 206 0.0024749978             5             5             5
1
## 207 0.0023581127             6             5             5
1
## 208 0.0016675344             4             3             6
1
## 209 0.0021019916             5             3             6
1
## 210 0.0020027223             6             3             6
1
## 211 0.0018426736             4             4             6
1
## 212 0.0023227613             5             4             6
1
## 213 0.0022130658             6             4             6
1
## 214 0.0022840296             4             5             6
1
## 215 0.0028791077             5             5             6
1
## 216 0.0027431380             6             5             6
1
## 217 0.0016969722             4             3             4
2
## 218 0.0021390992             5             3             4
2
## 219 0.0020380774             6             3             4
2
## 220 0.0018752032             4             4             4
2
## 221 0.0023637663             5             4             4
2
## 222 0.0022521342             6             4             4
2
## 223 0.0023243508             4             5             4
2
## 224 0.0029299341             5             5             4
2
## 225 0.0027915641             6             5             4
2
## 226 0.0016943177             4             3             5
2
## 227 0.0021357530             5             3             5
2
```

```
## 228 0.0020348892              6              3              5
2
## 229 0.0018722699              4              4              5
2
## 230 0.0023600686              5              4              5
2
## 231 0.0022486112              6              4              5
2
## 232 0.0023207148              4              5              5
2
## 233 0.0029253508              5              5              5
2
## 234 0.0027871972              6              5              5
2
## 235 0.0019709606              4              3              6
2
## 236 0.0024844721              5              3              6
2
## 237 0.0023671396              6              3              6
2
## 238 0.0021779683              4              4              6
2
## 239 0.0027454133              5              4              6
2
## 240 0.0026157575              6              4              6
2
## 241 0.0026996339              4              5              6
2
## 242 0.0034029930              5              5              6
2
## 243 0.0032422821              6              5              6
2
##     price
## 1   10000
## 2   10000
## 3   10000
## 4   10000
## 5   10000
## 6   10000
## 7   10000
## 8   10000
## 9   10000
## 10  10000
## 11  10000
## 12  10000
## 13  10000
```

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## 14  10000
## 15  10000
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## 80  10000
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```
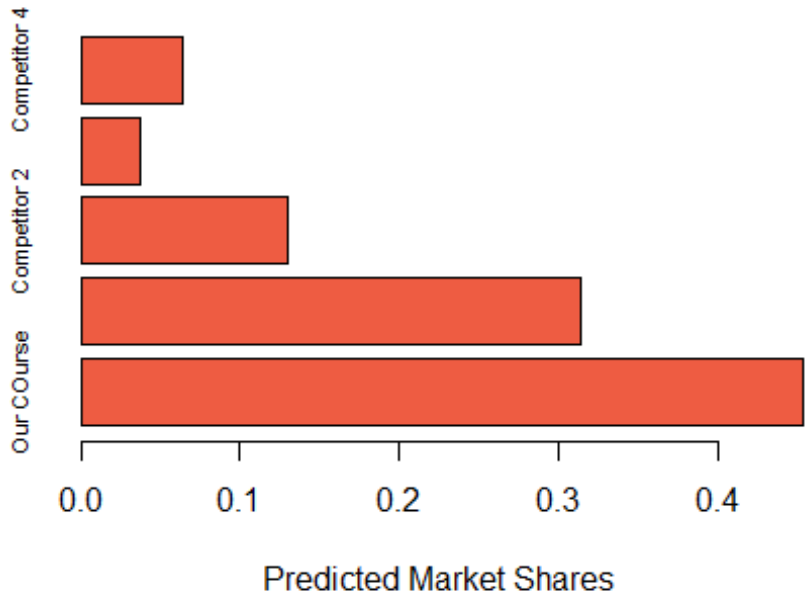

```
library(dplyr)

## Warning: package 'dplyr' was built under R version 4.0.3

##
## Attaching package: 'dplyr'

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

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

#getting the combination with the highest share
shares_for_each_combination %>% filter_all(any_vars(. %in% c(max(share
s_for_each_combination$share))))

##         share course_length hours_weekly practice_papers meetings_w
eekly price
## 80 0.01293133             5            5                6
2 10000

ideal_con<-shares_for_each_combination %>% filter_all(any_vars(. %in%
c(max(shares_for_each_combination$share))))
ideal_con

##         share course_length hours_weekly practice_papers meetings_w
eekly price
## 80 0.01293133             5            5                6
2 10000

#getting shares for 4 random combinations, 80 being the values offered
by us, which resulted
#in the overall highest shares
marketprofile<-allcombination[c(80,45,123,167,200),]
shares<-predict.mnl(m2,marketprofile)
shares

##          share course_length hours_weekly practice_papers meetings_
weekly price
## 80  0.45414455             5            5                6
2 10000
## 45  0.31470062             6            5                5
1 10000
## 123 0.13024264             6            4                5
1 15000
## 167 0.03745237             5            4                4
```

```
0 20000
## 200 0.06345981             5             3                 5
1 20000

barplot(shares$share,horiz=TRUE,col="tomato2",xlab="Predicted Market S
hares",cex.names=0.7,names.arg = c("Our COurse","Competitor 1","Compet
itor 2","Competitor 3","Competitor 4"))
```




```
#segmentation and positioning
library(readxl)
segmentation <- read_excel("segmentation.xlsx")
#View(segmentation)
seg<-segmentation[c(2:6)]
scale.seg<-scale(seg)
#View(scale.seg)
summary(scale.seg)

##  course_length      hours_weekly     practice_papers   meetings_wee
kly
##  Min.   :-3.1013   Min.   :-1.9524   Min.   :-2.1715   Min.   :-2.4
8560
##  1st Qu.:-0.4791   1st Qu.:-0.7784   1st Qu.:-0.4361   1st Qu.:-0.5
6331
##  Median : 0.1765   Median : 0.0602   Median :-0.0890   Median :-0.0
1408
```

```
##  Mean   : 0.0000   Mean   : 0.0000   Mean   : 0.0000   Mean   : 0.0
0000
##  3rd Qu.: 0.8321   3rd Qu.: 0.7311   3rd Qu.: 0.6052   3rd Qu.: 0.5
3514
##  Max.   : 1.8154   Max.   : 2.0728   Max.   : 3.0348   Max.   : 2.4
5743
##      price
##  Min.   :-1.8240
##  1st Qu.:-1.0480
##  Median : 0.2454
##  Mean   : 0.0000
##  3rd Qu.: 0.7628
##  Max.   : 2.5735
```

```
# 1. Compute a matrix of disctances between onservations in the data s
et.
distances<-dist(scale.seg)
# 2. Run hierarchical clustering using Ward's method
clusterrespondents<-hclust(distances, method="ward.D2")
# 3. Plot dendrogram and explore desired number of clusters
#install.packages("factoextra")
library(factoextra)
```

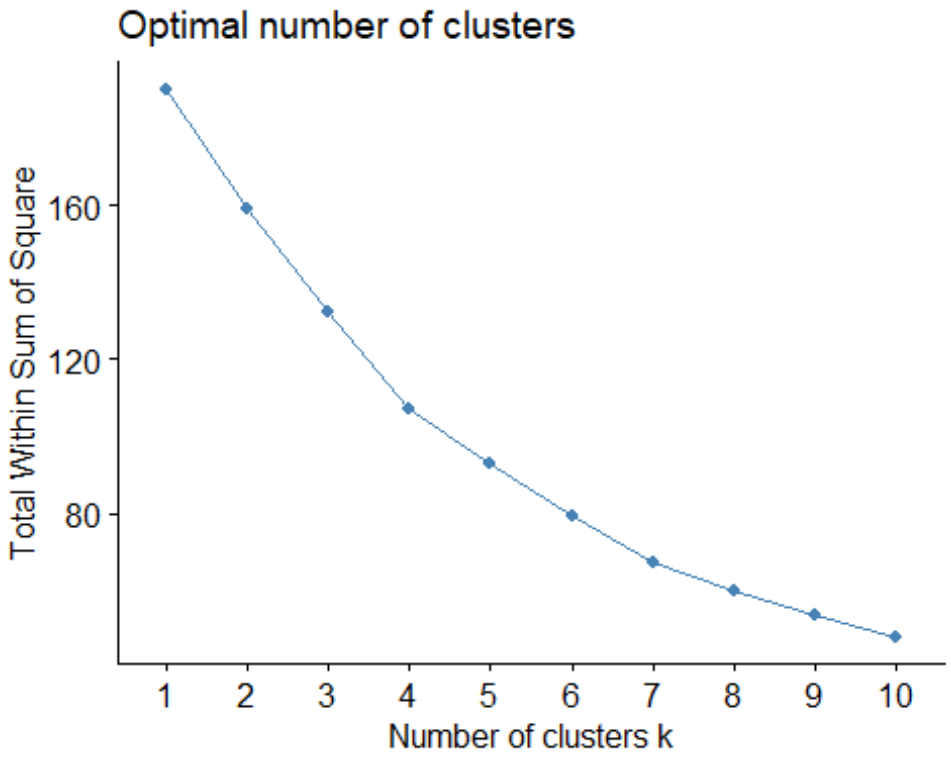
```
## Warning: package 'factoextra' was built under R version 4.0.5
```

```
## Loading required package: ggplot2
```

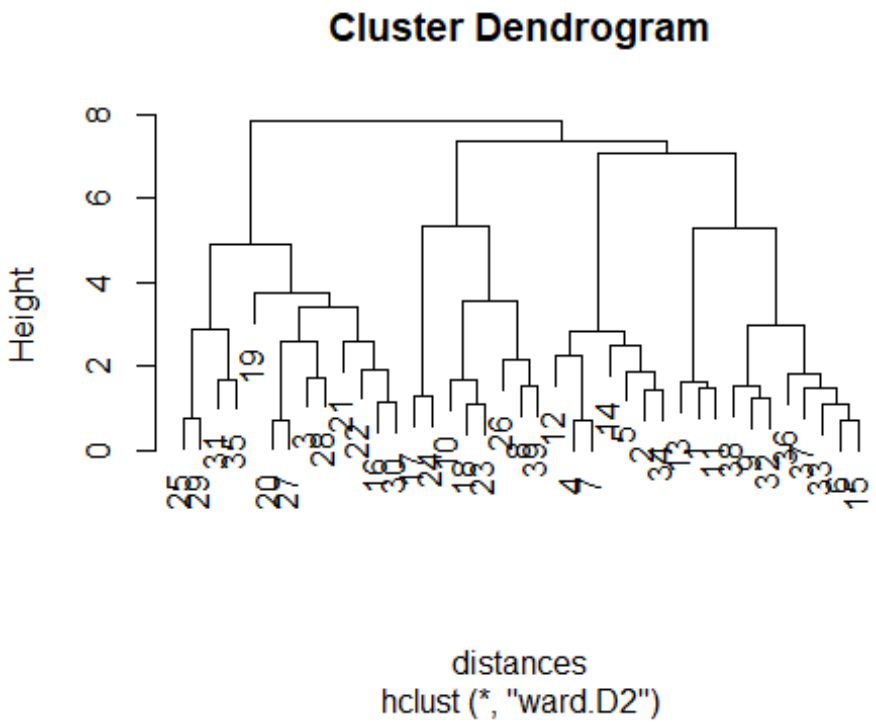
```
## Warning: package 'ggplot2' was built under R version 4.0.5
```

```
## Welcome! Want to learn more? See two factoextra-related books at ht
tps://goo.gl/ve3WBa
```

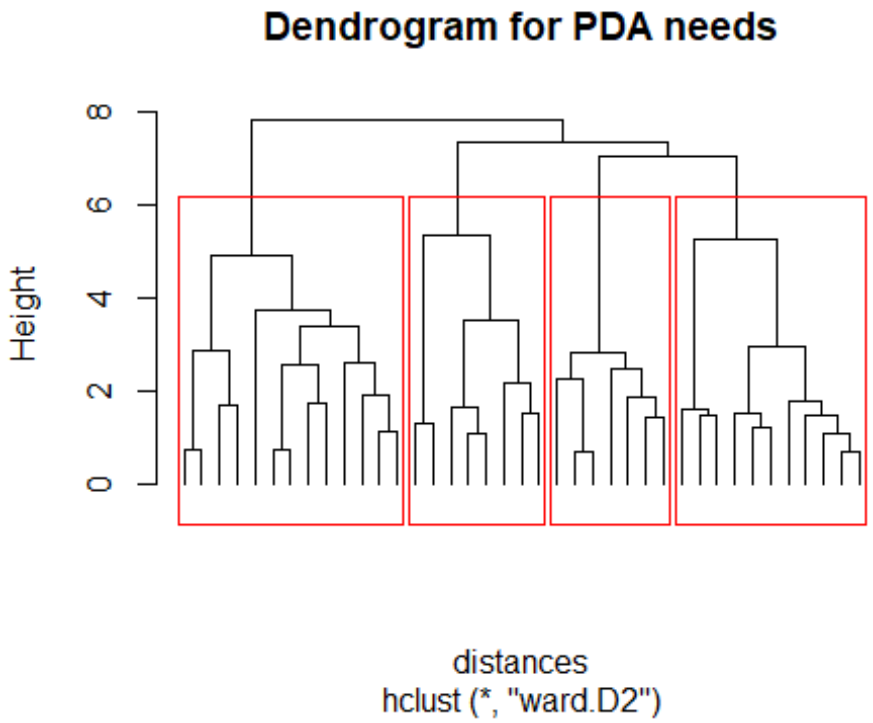
```
#making elbow diagram to decide the number of clusters, the difference
moving
#from 4 to 5 was not much, so decided 4 clusters
fviz_nbclust(scale.seg,FUN=hcut, method="wss")
```




```
plot(clusterrespondents)
```



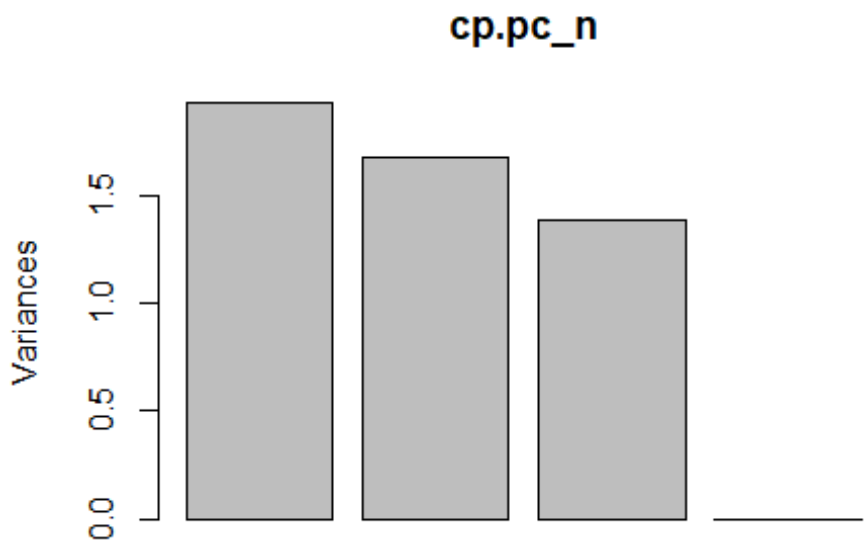
```
plot(clusterrespondents, labels=F, hang=-1, main="Dendrogram for PDA n
eeds")
rect.hclust(clusterrespondents, k=4, border="red")
```




```
# 4. Label each data point according to the cluster it belongs to
clustergroup<-cutree(clusterrespondents, k=4)
# 5. Describe each segment by its needs and descriptors
table(clustergroup)

## clustergroup
##  1  2  3  4
## 11  7 13  8

segmentation$clustergroup<-clustergroup
aggregate(segmentation[c(2:6)], list(clustergroup), mean)

##   Group.1 course_length hours_weekly practice_papers meetings_weekl
y    price
## 1       1      5.143939     4.128788        4.825758       1.128787
9 12007.58
## 2       2      5.011905     4.392857        4.952381       1.238095
2 15238.10
## 3       3      5.141026     3.903846        5.192308       1.378205
1 13397.44
```

```
## 4       4      4.750000     3.968750        5.072917       0.833333
3 13489.58
```

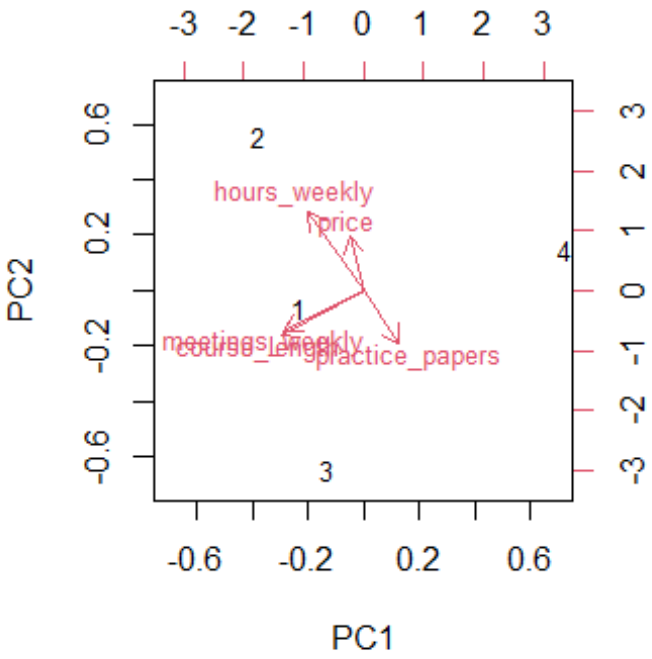
```
positioning<-data.frame(aggregate(segmentation[c(2:6)], list(clustergr
oup), mean))
#View(positioning)
positioning_n<-positioning[,-1]
cp.pc_n<-prcomp(positioning_n, scale=TRUE)
plot(cp.pc_n)
```




```
summary(cp.pc_n)
```

```
## Importance of components:
##                           PC1    PC2    PC3       PC4
## Standard deviation     1.3900 1.2967 1.1775 1.726e-15
## Proportion of Variance 0.3864 0.3363 0.2773 0.000e+00
## Cumulative Proportion  0.3864 0.7227 1.0000 1.000e+00
```

```
biplot(cp.pc_n,xlim=c(-.7,.7),ylim=c(-.7,.7),cex=0.8)
```


-3 -2 -1 0 1 2 3
0.6
0.2
-0.2
-0.6
PC2
2
hours_weekly
price
4
1
meetings_weekly
course_length
practice_papers
3
-0.6 -0.2 0.2 0.6
PC1
3 2 1 0 -1 -2 -3