section 25

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data<-read.csv("F://lessons//Multi Countios Variate1//pdf//TABLE 3.5 diabet.csv")  
#View(data)  
library("car")

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

## Loading required package: carData

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

#now we want to do the Exercise for chemical groups:  
chemical<-which(data[,7]=="chemical")  
Data.chemical<-tibble::as.tibble(data[chemical,2:6])

## Warning: `as.tibble()` was deprecated in tibble 2.0.0.  
## Please use `as\_tibble()` instead.  
## The signature and semantics have changed, see `?as\_tibble`.

head(Data.chemical)

## # A tibble: 6 x 5  
## relative.weight fasting.plasma.glucose glucose.intolerance insulin.response  
## <dbl> <int> <int> <int>  
## 1 0.99 98 478 151  
## 2 1.02 88 439 208  
## 3 1.19 100 429 201  
## 4 1.2 89 472 162  
## 5 1.05 91 436 148  
## 6 1.1 90 413 344  
## # ... with 1 more variable: insulin.resistance <int>

fit.chemical<-lm(cbind(relative.weight,fasting.plasma.glucose)~  
 glucose.intolerance^2+  
 insulin.resistance^2+  
 insulin.response^2+  
 glucose.intolerance:insulin.resistance+  
 glucose.intolerance:insulin.response+  
 insulin.resistance:insulin.response ,  
 data = Data.chemical)  
summary(fit.chemical)

## Response relative.weight :  
##   
## Call:  
## lm(formula = relative.weight ~ glucose.intolerance^2 + insulin.resistance^2 +   
## insulin.response^2 + glucose.intolerance:insulin.resistance +   
## glucose.intolerance:insulin.response + insulin.resistance:insulin.response,   
## data = Data.chemical)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.14616 -0.06769 0.00200 0.05885 0.12953   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.110e+00 4.715e-01 2.354 0.0256 \*  
## glucose.intolerance -6.839e-04 8.943e-04 -0.765 0.4506   
## insulin.resistance -1.686e-03 2.646e-03 -0.637 0.5290   
## insulin.response 2.688e-03 1.970e-03 1.364 0.1830   
## glucose.intolerance:insulin.resistance 6.185e-06 5.331e-06 1.160 0.2555   
## glucose.intolerance:insulin.response -4.164e-06 3.275e-06 -1.271 0.2137   
## insulin.resistance:insulin.response -2.824e-06 1.950e-06 -1.448 0.1583   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.08924 on 29 degrees of freedom  
## Multiple R-squared: 0.3536, Adjusted R-squared: 0.2198   
## F-statistic: 2.643 on 6 and 29 DF, p-value: 0.0361  
##   
##   
## Response fasting.plasma.glucose :  
##   
## Call:  
## lm(formula = fasting.plasma.glucose ~ glucose.intolerance^2 +   
## insulin.resistance^2 + insulin.response^2 + glucose.intolerance:insulin.resistance +   
## glucose.intolerance:insulin.response + insulin.resistance:insulin.response,   
## data = Data.chemical)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -18.662 -4.433 0.723 5.936 10.716   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 7.726e+01 4.309e+01 1.793 0.0834 .  
## glucose.intolerance 5.646e-02 8.174e-02 0.691 0.4952   
## insulin.resistance -2.533e-02 2.418e-01 -0.105 0.9173   
## insulin.response -1.297e-01 1.801e-01 -0.720 0.4771   
## glucose.intolerance:insulin.resistance -5.645e-06 4.873e-04 -0.012 0.9908   
## glucose.intolerance:insulin.response 2.119e-04 2.994e-04 0.708 0.4848   
## insulin.resistance:insulin.response 1.110e-04 1.782e-04 0.623 0.5383   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 8.157 on 29 degrees of freedom  
## Multiple R-squared: 0.3877, Adjusted R-squared: 0.2611   
## F-statistic: 3.061 on 6 and 29 DF, p-value: 0.01914

chemical.coef<-linearHypothesis(fit.chemical,hypothesis.matrix = c  
 ("glucose.intolerance=0",  
 "insulin.resistance=0",  
 "insulin.response=0",  
 "glucose.intolerance:insulin.resistance=0",  
 "glucose.intolerance:insulin.response=0",  
 "insulin.resistance:insulin.response=0"))  
chemical.coef

##   
## Sum of squares and products for the hypothesis:  
## relative.weight fasting.plasma.glucose  
## relative.weight 0.126316 -6.50236  
## fasting.plasma.glucose -6.502360 1221.98839  
##   
## Sum of squares and products for error:  
## relative.weight fasting.plasma.glucose  
## relative.weight 0.230959 4.148194  
## fasting.plasma.glucose 4.148194 1929.650503  
##   
## Multivariate Tests:   
## Df test stat approx F num Df den Df Pr(>F)   
## Pillai 6 0.7176278 2.704780 12 58 0.00576757 \*\*   
## Wilks 6 0.3823990 2.879883 12 56 0.00370795 \*\*   
## Hotelling-Lawley 6 1.3534927 3.045359 12 54 0.00248801 \*\*   
## Roy 6 1.1199264 5.412978 6 29 0.00074242 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

fit.chemical.y1<-lm(relative.weight~glucose.intolerance^2+  
 insulin.resistance^2+  
 insulin.response^2+  
 glucose.intolerance:insulin.resistance+  
 glucose.intolerance:insulin.response+  
 insulin.resistance:insulin.response ,  
 data = Data.chemical)  
fit.chemical.y2<-lm(fasting.plasma.glucose~glucose.intolerance^2+  
 insulin.resistance^2+  
 insulin.response^2+  
 glucose.intolerance:insulin.resistance+  
 glucose.intolerance:insulin.response+  
 insulin.resistance:insulin.response ,  
 data = Data.chemical)  
nd.chemical.coef<-data.frame(glucose.intolerance=c(413),  
 insulin.resistance=c(344),  
 insulin.response=c(270))  
  
nd.chemical.pred<-data.frame(glucose.intolerance=c(493),  
 insulin.resistance=c(288),  
 insulin.response=c(208))  
  
predict.lm(fit.chemical.y1,newdata =nd.chemical.coef,interval="confidence")

## fit lwr upr  
## 1 1.125379 0.9444473 1.30631

predict.lm(fit.chemical.y2,newdata =nd.chemical.coef,interval="confidence")

## fit lwr upr  
## 1 89.96941 73.43132 106.5075

predict.lm(fit.chemical.y1,newdata =nd.chemical.pred,interval="prediction")

## fit lwr upr  
## 1 1.128313 0.9323724 1.324254

predict.lm(fit.chemical.y2,newdata =nd.chemical.pred,interval="prediction")

## fit lwr upr  
## 1 98.38948 80.47944 116.2995

E=chemical.coef$SSPE  
H<-chemical.coef$SSPH  
lambda<-det(E)/det(E+H)  
s<-min(2,3)  
(R2<-1-lambda)

## [1] 0.617601

(A2<-1-lambda^s)

## [1] 0.853771

(R2roy<-eigen(solve(E)%\*%H)$values[1] / (1 +eigen(solve(E)%\*%H)$values[1]))

## [1] 0.5282855

Us<-sum(eigen(solve(E)%\*%H)$values)  
(Alh<-(Us/s)/(1+(Us/s)))

## [1] 0.4036069

(Apillai =sum(eigen(solve(E)%\*%H)$values/(1+eigen(solve(E)%\*%H)$values)))

## [1] 0.7176278

#now we want to do the Exercise for normal groups:  
normal<-which(data[,7]=="normal")  
Data.normal<-tibble::as.tibble(data[normal,2:6])  
head(Data.normal)

## # A tibble: 6 x 5  
## relative.weight fasting.plasma.glucose glucose.intolerance insulin.response  
## <dbl> <int> <int> <int>  
## 1 0.81 80 356 124  
## 2 0.95 97 289 117  
## 3 0.94 105 319 143  
## 4 1.04 90 356 199  
## 5 1 90 323 240  
## 6 0.76 86 381 157  
## # ... with 1 more variable: insulin.resistance <int>

fit.normal<-lm(cbind(relative.weight,fasting.plasma.glucose)~  
 glucose.intolerance^2+  
 insulin.resistance^2+  
 insulin.response^2+  
 glucose.intolerance:insulin.resistance+  
 glucose.intolerance:insulin.response+  
 insulin.resistance:insulin.response ,  
 data = Data.normal)  
summary(fit.normal)

## Response relative.weight :  
##   
## Call:  
## lm(formula = relative.weight ~ glucose.intolerance^2 + insulin.resistance^2 +   
## insulin.response^2 + glucose.intolerance:insulin.resistance +   
## glucose.intolerance:insulin.response + insulin.resistance:insulin.response,   
## data = Data.normal)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.25872 -0.09573 0.01833 0.06689 0.29283   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 6.793e-01 4.158e-01 1.634 0.107  
## glucose.intolerance 4.882e-04 1.265e-03 0.386 0.701  
## insulin.resistance 2.987e-03 2.646e-03 1.129 0.263  
## insulin.response -1.474e-03 2.590e-03 -0.569 0.571  
## glucose.intolerance:insulin.resistance -4.440e-06 7.693e-06 -0.577 0.566  
## glucose.intolerance:insulin.response 3.374e-06 7.423e-06 0.455 0.651  
## insulin.resistance:insulin.response -1.182e-06 2.994e-06 -0.395 0.694  
##   
## Residual standard error: 0.1152 on 69 degrees of freedom  
## Multiple R-squared: 0.261, Adjusted R-squared: 0.1967   
## F-statistic: 4.061 on 6 and 69 DF, p-value: 0.001523  
##   
##   
## Response fasting.plasma.glucose :  
##   
## Call:  
## lm(formula = fasting.plasma.glucose ~ glucose.intolerance^2 +   
## insulin.resistance^2 + insulin.response^2 + glucose.intolerance:insulin.resistance +   
## glucose.intolerance:insulin.response + insulin.resistance:insulin.response,   
## data = Data.normal)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -21.4046 -3.8560 -0.8551 5.4970 15.5578   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 79.5843846 29.2954682 2.717 0.00833  
## glucose.intolerance 0.0149945 0.0891641 0.168 0.86694  
## insulin.resistance -0.0359412 0.1864717 -0.193 0.84773  
## insulin.response -0.0079480 0.1825008 -0.044 0.96539  
## glucose.intolerance:insulin.resistance 0.0002583 0.0005421 0.477 0.63516  
## glucose.intolerance:insulin.response 0.0001105 0.0005230 0.211 0.83327  
## insulin.resistance:insulin.response -0.0002470 0.0002109 -1.171 0.24555  
##   
## (Intercept) \*\*  
## glucose.intolerance   
## insulin.resistance   
## insulin.response   
## glucose.intolerance:insulin.resistance   
## glucose.intolerance:insulin.response   
## insulin.resistance:insulin.response   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 8.118 on 69 degrees of freedom  
## Multiple R-squared: 0.1044, Adjusted R-squared: 0.02656   
## F-statistic: 1.341 on 6 and 69 DF, p-value: 0.251

normal.coef<-linearHypothesis(fit.normal,hypothesis.matrix = c  
 ("glucose.intolerance=0",  
 "insulin.resistance=0",  
 "insulin.response=0",  
 "glucose.intolerance:insulin.resistance=0",  
 "glucose.intolerance:insulin.response=0",  
 "insulin.resistance:insulin.response=0"))  
normal.coef

##   
## Sum of squares and products for the hypothesis:  
## relative.weight fasting.plasma.glucose  
## relative.weight 0.3234047 7.230412  
## fasting.plasma.glucose 7.2304119 530.276779  
##   
## Sum of squares and products for error:  
## relative.weight fasting.plasma.glucose  
## relative.weight 0.915915 16.39827  
## fasting.plasma.glucose 16.398272 4547.14427  
##   
## Multivariate Tests:   
## Df test stat approx F num Df den Df Pr(>F)   
## Pillai 6 0.3413802 2.366952 12 138 0.0084160 \*\*  
## Wilks 6 0.6794098 2.416320 12 136 0.0071664 \*\*  
## Hotelling-Lawley 6 0.4412655 2.463732 12 134 0.0061447 \*\*  
## Roy 6 0.3550894 4.083529 6 69 0.0014583 \*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

fit.normal.y1<-lm(relative.weight~glucose.intolerance^2+  
 insulin.resistance^2+  
 insulin.response^2+  
 glucose.intolerance:insulin.resistance+  
 glucose.intolerance:insulin.response+  
 insulin.resistance:insulin.response ,  
 data = Data.normal)  
fit.normal.y2<-lm(fasting.plasma.glucose~glucose.intolerance^2+  
 insulin.resistance^2+  
 insulin.response^2+  
 glucose.intolerance:insulin.resistance+  
 glucose.intolerance:insulin.response+  
 insulin.resistance:insulin.response ,  
 data = Data.normal)  
  
nd.normal.coef<-data.frame(glucose.intolerance=c(306),  
 insulin.resistance=c(178),  
 insulin.response=c(66))  
  
nd.normal.pred<-data.frame(glucose.intolerance=c(349),  
 insulin.resistance=c(172),  
 insulin.response=c(114))  
  
predict.lm(fit.normal.y1,newdata =nd.normal.coef,interval="confidence")

## fit lwr upr  
## 1 1.075426 0.9329289 1.217923

predict.lm(fit.normal.y2,newdata =nd.normal.coef,interval="confidence")

## fit lwr upr  
## 1 90.65141 80.61108 100.6917

predict.lm(fit.normal.y1,newdata =nd.normal.pred,interval="prediction")

## fit lwr upr  
## 1 1.039854 0.802123 1.277585

predict.lm(fit.normal.y2,newdata =nd.normal.pred,interval="prediction")

## fit lwr upr  
## 1 92.7899 76.03939 109.5404

E=normal.coef$SSPE  
H<-normal.coef$SSPH  
lambda<-det(E)/det(E+H)  
s<-min(2,3)  
(R2<-1-lambda)

## [1] 0.3205902

(A2<-1-lambda^s)

## [1] 0.5384023

(R2roy<-eigen(solve(E)%\*%H)$values[1] / (1 +eigen(solve(E)%\*%H)$values[1]))

## [1] 0.2620413

Us<-sum(eigen(solve(E)%\*%H)$values)  
(Alh<-(Us/s)/(1+(Us/s)))

## [1] 0.1807528

(Apillai =sum(eigen(solve(E)%\*%H)$values/(1+eigen(solve(E)%\*%H)$values)))

## [1] 0.3413802

#now we want to do the Exercise for overt groups:  
overt<-which(data[,7]=="overt")  
Data.overt<-tibble::as.tibble(data[overt,2:6])  
head(Data.overt)

## # A tibble: 6 x 5  
## relative.weight fasting.plasma.glucose glucose.intolerance insulin.response  
## <dbl> <int> <int> <int>  
## 1 0.92 300 1468 28  
## 2 0.86 303 1487 23  
## 3 0.85 125 714 232  
## 4 0.83 280 1470 54  
## 5 0.85 216 1113 81  
## 6 1.06 190 972 87  
## # ... with 1 more variable: insulin.resistance <int>

fit.overt<-lm(cbind(relative.weight,fasting.plasma.glucose)~  
 glucose.intolerance^2+  
 insulin.resistance^2+  
 insulin.response^2+  
 glucose.intolerance:insulin.resistance+  
 glucose.intolerance:insulin.response+  
 insulin.resistance:insulin.response ,  
 data = Data.overt)  
summary(fit.overt)

## Response relative.weight :  
##   
## Call:  
## lm(formula = relative.weight ~ glucose.intolerance^2 + insulin.resistance^2 +   
## insulin.response^2 + glucose.intolerance:insulin.resistance +   
## glucose.intolerance:insulin.response + insulin.resistance:insulin.response,   
## data = Data.overt)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.19295 -0.05312 0.01100 0.03949 0.20828   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 8.132e-01 3.333e-01 2.440 0.0218 \*  
## glucose.intolerance -1.928e-04 2.631e-04 -0.733 0.4704   
## insulin.resistance 1.829e-03 1.231e-03 1.486 0.1493   
## insulin.response 2.330e-04 1.201e-03 0.194 0.8477   
## glucose.intolerance:insulin.resistance -5.756e-07 8.900e-07 -0.647 0.5235   
## glucose.intolerance:insulin.response 5.630e-07 9.244e-07 0.609 0.5478   
## insulin.resistance:insulin.response -2.713e-06 3.825e-06 -0.709 0.4845   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 0.0929 on 26 degrees of freedom  
## Multiple R-squared: 0.5153, Adjusted R-squared: 0.4035   
## F-statistic: 4.608 on 6 and 26 DF, p-value: 0.002594  
##   
##   
## Response fasting.plasma.glucose :  
##   
## Call:  
## lm(formula = fasting.plasma.glucose ~ glucose.intolerance^2 +   
## insulin.resistance^2 + insulin.response^2 + glucose.intolerance:insulin.resistance +   
## glucose.intolerance:insulin.response + insulin.resistance:insulin.response,   
## data = Data.overt)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -46.255 -14.808 -0.584 11.664 45.909   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.091e+02 8.109e+01 1.345 0.1903   
## glucose.intolerance 1.114e-01 6.403e-02 1.739 0.0938 .  
## insulin.resistance -5.220e-01 2.995e-01 -1.743 0.0932 .  
## insulin.response -2.263e-01 2.922e-01 -0.774 0.4457   
## glucose.intolerance:insulin.resistance 4.437e-04 2.166e-04 2.049 0.0507 .  
## glucose.intolerance:insulin.response -1.118e-04 2.249e-04 -0.497 0.6232   
## insulin.resistance:insulin.response 1.204e-03 9.307e-04 1.293 0.2073   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 22.61 on 26 degrees of freedom  
## Multiple R-squared: 0.9292, Adjusted R-squared: 0.9128   
## F-statistic: 56.85 on 6 and 26 DF, p-value: 1.035e-13

overt.coef<-linearHypothesis(fit.overt,hypothesis.matrix = c  
 ("glucose.intolerance=0",  
 "insulin.resistance=0",  
 "insulin.response=0",  
 "glucose.intolerance:insulin.resistance=0",  
 "glucose.intolerance:insulin.response=0",  
 "insulin.resistance:insulin.response=0"))  
overt.coef

##   
## Sum of squares and products for the hypothesis:  
## relative.weight fasting.plasma.glucose  
## relative.weight 0.2385955 -97.89234  
## fasting.plasma.glucose -97.8923428 174295.31723  
##   
## Sum of squares and products for error:  
## relative.weight fasting.plasma.glucose  
## relative.weight 0.2243924 15.50568  
## fasting.plasma.glucose 15.5056761 13286.01610  
##   
## Multivariate Tests:   
## Df test stat approx F num Df den Df Pr(>F)   
## Pillai 6 1.365503 9.32579 12 52 2.9934e-09 \*\*\*  
## Wilks 6 0.034235 18.35261 12 50 2.5680e-14 \*\*\*  
## Hotelling-Lawley 6 16.533637 33.06727 12 48 < 2.22e-16 \*\*\*  
## Roy 6 15.794364 68.44224 6 26 1.1083e-14 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

fit.overt.y1<-lm(relative.weight~glucose.intolerance^2+  
 insulin.resistance^2+  
 insulin.response^2+  
 glucose.intolerance:insulin.resistance+  
 glucose.intolerance:insulin.response+  
 insulin.resistance:insulin.response ,  
 data = Data.overt)  
fit.overt.y2<-lm(fasting.plasma.glucose~glucose.intolerance^2+  
 insulin.resistance^2+  
 insulin.response^2+  
 glucose.intolerance:insulin.resistance+  
 glucose.intolerance:insulin.response+  
 insulin.resistance:insulin.response ,  
 data = Data.overt)  
  
nd.overt.coef<-data.frame(glucose.intolerance=c(849),  
 insulin.resistance=c(159),  
 insulin.response=c(310))  
  
nd.overt.pred<-data.frame(glucose.intolerance=c(1043),  
 insulin.resistance=c(106),  
 insulin.response=c(318))  
  
predict.lm(fit.overt.y1,newdata =nd.overt.coef,interval="confidence")

## fit lwr upr  
## 1 0.9493481 0.665944 1.232752

predict.lm(fit.overt.y2,newdata =nd.overt.coef,interval="confidence")

## fit lwr upr  
## 1 140.2494 71.28902 209.2097

predict.lm(fit.overt.y1,newdata =nd.overt.pred,interval="prediction")

## fit lwr upr  
## 1 0.9117505 0.4096567 1.413844

predict.lm(fit.overt.y2,newdata =nd.overt.pred,interval="prediction")

## fit lwr upr  
## 1 150.4541 28.28032 272.628

E=overt.coef$SSPE  
H<-overt.coef$SSPH  
lambda<-det(E)/det(E+H)  
s<-min(2,3)  
(R2<-1-lambda)

## [1] 0.9657651

(A2<-1-lambda^s)

## [1] 0.998828

(R2roy<-eigen(solve(E)%\*%H)$values[1] / (1 +eigen(solve(E)%\*%H)$values[1]))

## [1] 0.9404562

Us<-sum(eigen(solve(E)%\*%H)$values)  
(Alh<-(Us/s)/(1+(Us/s)))

## [1] 0.8920881

(Apillai =sum(eigen(solve(E)%\*%H)$values/(1+eigen(solve(E)%\*%H)$values)))

## [1] 1.365503