

R Notebook

```
library(readr)
Universities <- read_csv("C:/Trading detail/STUDY/01_MSBA/02 MSBA
ML/03/Universities.csv")

## Parsed with column specification:
## cols(
##   .default = col_double(),
##   `College Name` = col_character(),
##   State = col_character()
## )

## See spec(...) for full column specifications.

View(Universities)

library(tidyverse)

## -- Attaching packages ----- tidyverse 1.2.1 --

## v ggplot2 3.2.1      v purrr  0.3.2
## v tibble  2.1.3      v dplyr  0.8.3
## v tidyr   1.0.0      v stringr 1.4.0
## v ggplot2 3.2.1      v forcats 0.4.0

## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()

library(factoextra)

## Welcome! Related Books: `Practical Guide To Cluster Analysis in R` at
https://goo.gl/13EFCZ

library(ISLR)
library(caret)

## Loading required package: lattice

##
## Attaching package: 'caret'

## The following object is masked from 'package:purrr':
##
##   lift

summary(Universities)
```

```

## College Name          State          Public (1)/ Private (2)
## Length:1302          Length:1302          Min.   :1.000
## Class :character      Class :character      1st Qu.:1.000
## Mode  :character      Mode  :character      Median :2.000
##                                     Mean   :1.639
##                                     3rd Qu.:2.000
##                                     Max.   :2.000
##
## # appli. rec'd      # appl. accepted # new stud. enrolled
## Min.   : 35.0      Min.   : 35.0      Min.   : 18.0
## 1st Qu.: 695.8      1st Qu.: 554.5      1st Qu.: 236.0
## Median : 1470.0      Median : 1095.0      Median : 447.0
## Mean   : 2752.1      Mean   : 1870.7      Mean   : 778.9
## 3rd Qu.: 3314.2      3rd Qu.: 2303.0      3rd Qu.: 984.0
## Max.   :48094.0      Max.   :26330.0      Max.   :7425.0
## NA's   :10          NA's   :11          NA's   :5
## % new stud. from top 10% % new stud. from top 25% # FT undergrad
## Min.   : 1.00      Min.   : 6.00      Min.   : 59
## 1st Qu.:13.00      1st Qu.: 36.75      1st Qu.: 966
## Median :21.00      Median : 50.00      Median : 1812
## Mean   :25.67      Mean   : 52.35      Mean   : 3693
## 3rd Qu.:32.00      3rd Qu.: 66.00      3rd Qu.: 4540
## Max.   :98.00      Max.   :100.00      Max.   :31643
## NA's   :235        NA's   :202        NA's   :3
## # PT undergrad      in-state tuition out-of-state tuition      room
## Min.   : 1.0      Min.   : 480      Min.   : 1044      Min.   : 500
## 1st Qu.: 131.2      1st Qu.: 2580      1st Qu.: 6111      1st Qu.:1710
## Median : 472.0      Median : 8050      Median : 8670      Median :2200
## Mean   : 1081.5      Mean   : 7897      Mean   : 9277      Mean   :2515
## 3rd Qu.: 1313.0      3rd Qu.:11600      3rd Qu.:11659      3rd Qu.:3040
## Max.   :21836.0      Max.   :25750      Max.   :25750      Max.   :7400
## NA's   :32          NA's   :30          NA's   :20          NA's   :321
## board      add. fees      estim. book costs      estim. personal $
## Min.   : 531      Min.   : 9.0      Min.   : 90      Min.   : 75
## 1st Qu.:1619      1st Qu.: 130.0      1st Qu.: 480      1st Qu.: 900
## Median :1980      Median : 264.5      Median : 502      Median :1250
## Mean   :2061      Mean   : 392.0      Mean   : 550      Mean   :1389
## 3rd Qu.:2402      3rd Qu.: 480.0      3rd Qu.: 600      3rd Qu.:1794
## Max.   :6250      Max.   :4374.0      Max.   :2340      Max.   :6900
## NA's   :498      NA's   :274      NA's   :48      NA's   :181
## % fac. w/PHD      stud./fac. ratio      Graduation rate
## Min.   : 8.00      Min.   : 2.30      Min.   : 8.00
## 1st Qu.: 57.00      1st Qu.:11.80      1st Qu.: 47.00
## Median : 71.00      Median :14.30      Median : 60.00
## Mean   : 68.65      Mean   :14.86      Mean   : 60.41
## 3rd Qu.: 82.00      3rd Qu.:17.60      3rd Qu.: 74.00
## Max.   :105.00      Max.   :91.80      Max.   :118.00
## NA's   :32          NA's   :2          NA's   :98

```

- a. Remove all records with missing measurements from the dataset.

```
# remove na in r - remove rows - na.omit function / option

set.seed(123)
univ <- na.omit(Universities)

univ<-univ[,c(-1,-2,-3)]
summary(univ)

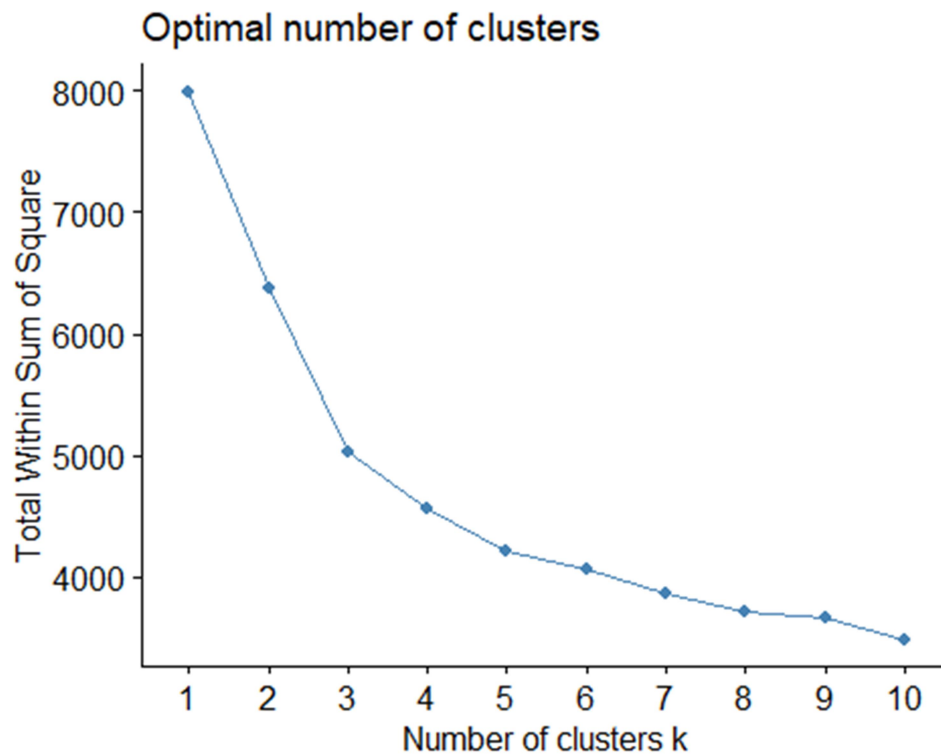
## # appli. rec'd # appl. accepted # new stud. enrolled
## Min. : 77 Min. : 61.0 Min. : 27.0
## 1st Qu.: 802 1st Qu.: 635.5 1st Qu.: 264.0
## Median : 1646 Median : 1227.0 Median : 443.0
## Mean : 3147 Mean : 2063.0 Mean : 780.7
## 3rd Qu.: 3862 3rd Qu.: 2456.0 3rd Qu.: 896.5
## Max. :48094 Max. :26330.0 Max. :6392.0
## % new stud. from top 10% % new stud. from top 25% # FT undergrad
## Min. : 1.00 Min. : 9.00 Min. : 249
## 1st Qu.:15.00 1st Qu.: 40.00 1st Qu.: 1018
## Median :23.00 Median : 54.00 Median : 1715
## Mean :28.01 Mean : 55.65 Mean : 3563
## 3rd Qu.:36.00 3rd Qu.: 69.00 3rd Qu.: 4056
## Max. :96.00 Max. :100.00 Max. :31643
## # PT undergrad in-state tuition out-of-state tuition room
## Min. : 1.0 Min. : 608 Min. : 1044 Min. : 640
## 1st Qu.: 81.5 1st Qu.: 3650 1st Qu.: 7290 1st Qu.:1740
## Median : 299.0 Median : 9858 Median :10100 Median :2090
## Mean : 797.5 Mean : 9407 Mean :10575 Mean :2221
## 3rd Qu.: 869.0 3rd Qu.:13246 3rd Qu.:13286 3rd Qu.:2663
## Max. :21836.0 Max. :20100 Max. :20100 Max. :4816
## board add. fees estim. book costs estim. personal $
## Min. : 531 Min. : 10.0 Min. : 90.0 Min. : 250
## 1st Qu.:1750 1st Qu.: 137.5 1st Qu.: 500.0 1st Qu.: 850
## Median :2082 Median : 280.0 Median : 500.0 Median :1200
## Mean :2122 Mean : 379.0 Mean : 548.8 Mean :1312
## 3rd Qu.:2420 3rd Qu.: 486.0 3rd Qu.: 600.0 3rd Qu.:1600
## Max. :4541 Max. :3247.0 Max. :2340.0 Max. :6800
## % fac. w/PHD stud./fac. ratio Graduation rate
## Min. : 8.00 Min. : 2.90 Min. : 15.00
## 1st Qu.: 63.00 1st Qu.:11.30 1st Qu.: 53.00
## Median : 76.00 Median :13.40 Median : 66.00
## Mean : 73.21 Mean :13.96 Mean : 65.56
## 3rd Qu.: 87.00 3rd Qu.:16.45 3rd Qu.: 79.00
## Max. :103.00 Max. :28.80 Max. :118.00
```

- b. For all the continuous measurements, run K-Means clustering. Make sure to normalize the measurements. How many clusters seem reasonable for describing these data? What was your optimal K?

```
##Scaling the data frame (z-score)
univ <- scale(univ)
```

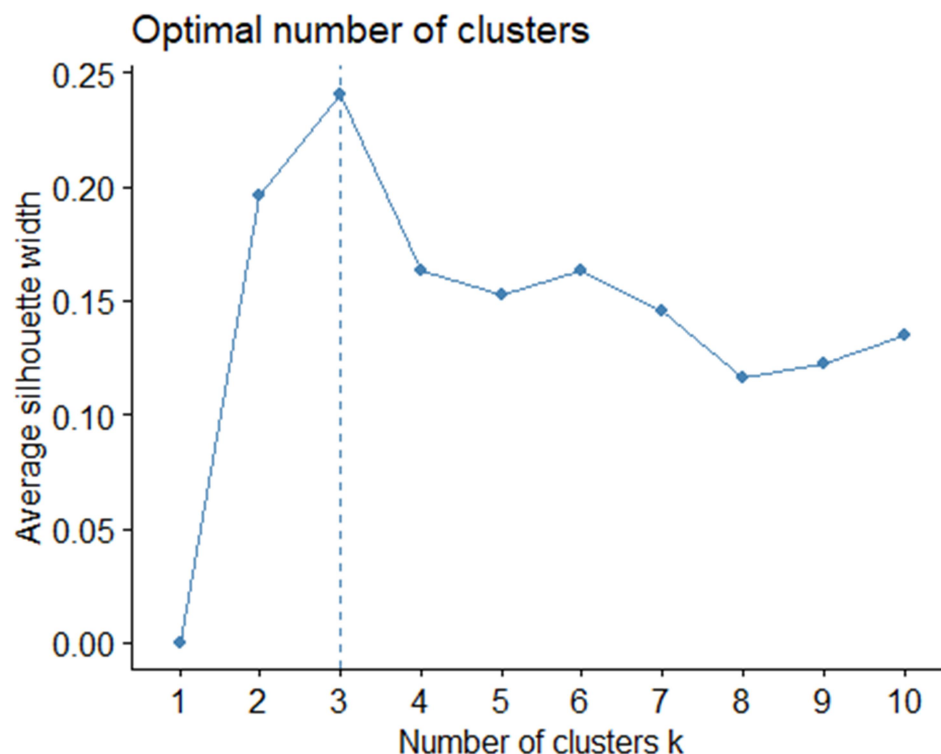
```
univ<- as.data.frame(univ)
```

```
### toFind best value of k by for total within sum of square  
fviz_nbclust(univ, kmeans, method = "wss")  ###by applying 2 method "Wss"  
The chart shows that the elbow point 3 provides the best value for k.
```



```
### toFind best value of k by average silhouette width
```

```
fviz_nbclust(univ, kmeans, method = "silhouette")  ### applying "silhouette"  
method we see that 3 is the ideal number of clusters.
```



```
fitk <- kmeans(univ,centers = 3)
```

```
fitk$size ## shows no. of observation in each cluster
```

```
## [1] 275 150 46
```

```
fitk ## summary of each cluster
```

```
## K-means clustering with 3 clusters of sizes 275, 150, 46
```

```
##
```

```
## Cluster means:
```

```
## # appli. rec'd # appl. accepted # new stud. enrolled
```

```
## 1 -0.35953828 -0.34918455 -0.3171053
```

```
## 2 0.05140256 -0.04367128 -0.1683551
```

```
## 3 1.98179657 2.22992267 2.4447222
```

```
## % new stud. from top 10% % new stud. from top 25% # FT undergrad
```

```
## 1 -0.5020886 -0.5128195 -0.2952142
```

```
## 2 0.8795798 0.8620961 -0.2324464
```

```
## 3 0.1334215 0.2545856 2.5228452
```

```
## # PT undergrad in-state tuition out-of-state tuition room
```

```
## 1 -0.1217682 -0.4036544 -0.5263964 -0.3588740
```

```
## 2 -0.3130216 1.0620416 1.1158839 0.6698444
```

```
## 3 1.7486849 -1.0500277 -0.4918168 -0.0388330
```

```
## board add. fees estim. book costs estim. personal $ % fac. w/PHD
```

```
## 1 -0.3938990 -0.05832646 -0.06621454 0.05935933 -0.5322257
```

```
## 2 0.7756859 -0.04496556 0.07122705 -0.39665857 0.7659627
```

```
## 3 -0.1745795 0.49531762 0.16358567 0.93858632 0.6840794
```

```

## stud./fac. ratio Graduation rate
## 1      0.2810858      -0.4171456
## 2      -0.7036167      0.8426062
## 3      0.6139980      -0.2538234
##
## Clustering vector:
## [1] 1 1 2 1 1 1 1 1 1 1 3 3 3 2 2 2 2 2 1 2 1 2 2 3 2 2 1 1 2 1 1 1 1 1
2
## [36] 1 2 2 2 2 2 1 3 2 2 2 2 3 1 1 2 1 1 2 2 2 3 1 2 1 2 3 1 1 1 1 1 1 2
1
## [71] 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 2 1 2 2 2 1 2 1 1 1 1 2 3 3 1 1 2 2 2
1
## [106] 1 1 1 1 1 1 2 2 2 2 1 1 1 1 1 1 1 1 2 1 1 1 2 1 1 3 2 2 2 2 2 3 1 2
2
## [141] 1 2 1 2 1 1 1 1 2 3 3 2 2 2 2 2 1 3 1 2 2 1 1 1 1 2 2 1 2 2 1 3 1 1
1
## [176] 3 1 2 1 1 2 2 2 1 1 1 1 3 1 1 1 1 1 1 1 3 2 2 1 1 1 1 1 1 1 1 1 1
1
## [211] 3 1 1 2 2 3 1 1 1 1 1 1 1 1 1 1 2 3 3 1 1 1 1 1 1 1 1 1 2 1 1 1 1 3
1
## [246] 2 1 1 3 1 1 2 1 1 1 1 1 2 1 2 1 1 3 1 1 1 2 1 1 2 2 2 2 1 2 2 2 1 2
2
## [281] 1 1 2 2 2 2 1 1 2 3 3 1 1 1 1 1 1 1 1 1 2 2 2 1 1 1 3 2 1 1 1 2 1 2
1
## [316] 2 1 1 2 3 1 3 2 1 2 1 3 1 1 1 1 3 1 1 1 2 2 2 2 2 2 2 2 2 2 2 1 2 1
1
## [351] 2 2 1 2 2 2 1 1 2 2 1 1 1 1 1 1 2 3 1 2 3 2 2 2 1 1 1 1 1 1 3 2 2 3
1
## [386] 1 1 1 1 1 2 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 2 1 1 3 2 2 1 1 1 1 1 3
1
## [421] 1 1 1 1 1 1 2 2 1 3 3 1 3 3 1 1 2 1 2 1 2 1 1 3 1 3 1 1 2 3 1 1 1 1
2
## [456] 1 2 2 2 2 1 2 2 2 1 1 1 1 1 1 1
##
## Within cluster sum of squares by cluster:
## [1] 2562.342 1424.892 1044.680
## (between_SS / total_SS = 37.0 %)
##
## Available components:
##
## [1] "cluster"      "centers"      "totss"        "withinss"
## [5] "tot.withinss" "betweenss"    "size"         "iter"
## [9] "ifault"

```

c. Compare the summary statistics for each cluster and describe each cluster in this context (e.g., "Universities with high tuition, low acceptance rate...").

```
fitk$centers ## means of each cluster
```

```

## # appli. rec'd # appl. accepted # new stud. enrolled
## 1      -0.35953828      -0.34918455      -0.3171053

```

```
## 2      0.05140256      -0.04367128      -0.1683551
## 3      1.98179657      2.22992267      2.4447222
## % new stud. from top 10% % new stud. from top 25% # FT undergrad
## 1      -0.5020886      -0.5128195      -0.2952142
## 2      0.8795798      0.8620961      -0.2324464
## 3      0.1334215      0.2545856      2.5228452
## # PT undergrad in-state tuition out-of-state tuition      room
## 1      -0.1217682      -0.4036544      -0.5263964 -0.3588740
## 2      -0.3130216      1.0620416      1.1158839 0.6698444
## 3      1.7486849      -1.0500277      -0.4918168 -0.0388330
## board add. fees estim. book costs estim. personal $ % fac. w/PHD
## 1 -0.3938990 -0.05832646      -0.06621454      0.05935933 -0.5322257
## 2 0.7756859 -0.04496556      0.07122705      -0.39665857 0.7659627
## 3 -0.1745795 0.49531762      0.16358567      0.93858632 0.6840794
## stud./fac. ratio Graduation rate
## 1      0.2810858      -0.4171456
## 2      -0.7036167      0.8426062
## 3      0.6139980      -0.2538234
```

##from means of the cluster we can conclude following information about different cluster

CLUSTER 3 : has received high no. of application received, has received high no. of application accepted, high % of student enrolling for admission, high no. of student with fulltime undergrad, high no. of student with parttime undergrad, low tution fee for in state student , high charges for additionalfees , high cost of books compared to others, high personal expense, good ratio for student to faculty,

Cluster 2

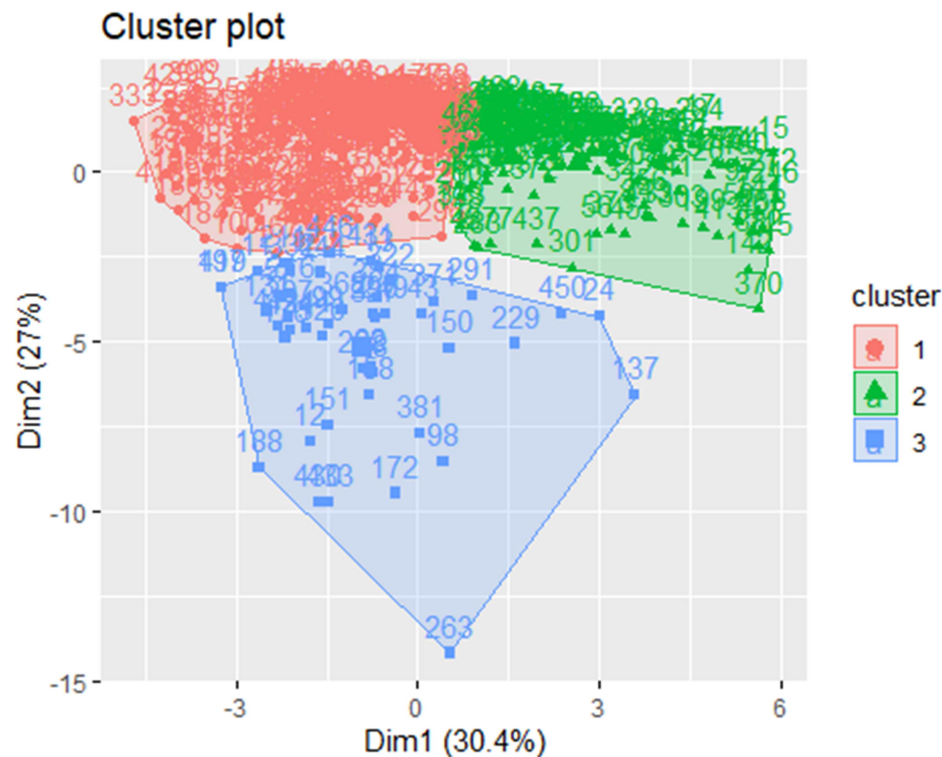
high no of new student from top 10%, high no of new student from top 25%, low no. of student enrolled in undergrad, high tution fee for in state student , high tution fee for out state student, high occupncy for rooms, high useage of board, low personal expense, high % of faculty with PHD, bad ratio for student to faculty, high graduation rate,

Cluster 1

received low application, accepted low application, low % of student enrolling for admission, low no of new student from top 10%, low no of new student from top 25%, low no. of student with fulltime undergrad, low tution fee for out state student, low occupncy for rooms, low useage of board, low charges for additionalfees, low cost of books compared to others, low % of faculty with PHD , low graduation rate,

plotting information about cluster on graph

```
fviz_cluster(fitk,data = univ)
```



- d. Use the categorical measurements that were not used in the analysis (State and Private/Public) to characterize the different clusters. Is there any relationship between the clusters and the categorical information?

adding catagorical variable into a table format

```
univ1 <- na.omit(Universities) ## using orignal dataset to omit NA values
```

```
qwe <- cbind(univ1$`College Name`,univ1$State,univ1$`Public (1)/ Private (2)`,fitk$cluster) ### combining coloumn with cluturs information and finding which university fallin which cluster
```

```
qwe <- as.data.frame(qwe) ## converting into dataframe
```

```
qwe$V3 <- factor(qwe$V3,levels = c(1,2),labels = c("public","private")) ### defining levels for private ans public
```

```
qwe$V4 <- factor(qwe$V4,levels = c(1,2,3),labels = c("below avegrage ","above Average", " average")) ## name cluster as different catagory
```

```
head(qwe)
```


		V1	V2	V3	V4
## 1	Alaska Pacific University	AK	private	below	avegrage
## 2	University of Alaska Southeast	AK	public	below	avegrage
## 3	Birmingham-Southern College	AL	private	above	Average
## 4	Huntingdon College	AL	private	below	avegrage
## 5	Talladega College	AL	private	below	avegrage
## 6	University of Alabama at Birmingham	AL	public	below	avegrage

qwe[qwe\$V4=="below avegrage ",] ### this show that good mix of private and public university

		V1	V2	V3
## 1	Alaska Pacific University	AK	private	
## 2	University of Alaska Southeast	AK	public	
## 4	Huntingdon College	AL	private	
## 5	Talladega College	AL	private	
## 6	University of Alabama at Birmingham	AL	public	
## 7	Arkansas College (Lyon College)	AR	private	
## 8	Hendrix College	AR	private	
## 9	John Brown University	AR	private	
## 10	Harding University	AR	private	
## 19	Fresno Pacific College	CA	private	
## 21	Southern California College	CA	private	
## 27	Concordia University	CA	private	
## 28	Adams State College	CO	public	
## 30	Fort Lewis College	CO	public	
## 31	Mesa State College	CO	public	
## 32	University of Southern Colorado	CO	public	
## 33	Western State College of Colorado	CO	public	
## 34	Central Connecticut State University	CT	public	
## 36	Sacred Heart University	CT	private	
## 42	Eastern Connecticut State University	CT	public	
## 49	Wesley College	DE	private	
## 50	Bethune Cookman College	FL	private	
## 52	Embry Riddle Aeronautical University	FL	private	
## 53	Florida Southern College	FL	private	
## 58	Brewton-Parker College	GA	private	
## 60	Morehouse College	GA	private	
## 63	Covenant College	GA	private	
## 64	Savannah Coll. of Art and Design	GA	private	
## 65	University of Hawaii at Manoa	HI	public	
## 66	Central College	IA	private	
## 67	Clarke College	IA	private	
## 68	Coe College	IA	private	
## 70	Dordt College	IA	private	
## 71	Graceland College	IA	private	
## 72	Grand View College	IA	private	
## 74	Morningside College	IA	private	
## 75	Mount Mercy College	IA	private	
## 76	Mount Saint Clare College	IA	private	

## 77	Simpson College	IA	private
## 78	Saint Ambrose University	IA	private
## 79	University of Northern Iowa	IA	public
## 80	University of Dubuque	IA	private
## 81	Wartburg College	IA	private
## 82	Teikyo Westmar University	IA	private
## 83	William Penn College	IA	private
## 84	Albertson College	ID	private
## 85	Northwest Nazarene College	ID	private
## 87	Eureka College	IL	private
## 91	McKendree College	IL	private
## 93	Quincy University	IL	private
## 94	Southern Illinois University at Edwardsville	IL	public
## 95	Saint Xavier University	IL	private
## 96	Trinity College	IL	private
## 100	Western Illinois University	IL	public
## 101	Anderson University	IN	private
## 105	University of Evansville	IN	private
## 106	Franklin College	IN	private
## 107	Hanover College	IN	private
## 108	University of Southern Indiana	IN	public
## 109	Manchester College	IN	private
## 110	Oakland City College	IN	private
## 111	Saint Mary-of-the-Woods College	IN	private
## 116	Baker University	KS	private
## 117	Bethany College	KS	private
## 118	Bethel College	KS	private
## 119	Kansas Wesleyan University	KS	private
## 120	McPherson College	KS	private
## 121	Tabor College	KS	private
## 122	Benedictine College	KS	private
## 123	Bellarmino College	KY	private
## 125	Georgetown College	KY	private
## 126	Kentucky Wesleyan College	KY	private
## 127	Murray State University	KY	public
## 129	Centenary College of Louisiana	LA	private
## 130	Grambling State University	LA	public
## 138	Bradford College	MA	private
## 141	Gordon College	MA	private
## 143	Lesley College	MA	private
## 145	Bridgewater State College	MA	public
## 146	North Adams State College	MA	public
## 147	Westfield State College	MA	public
## 148	Worcester State College	MA	public
## 157	Salisbury State University	MD	public
## 159	University of Maine at Presque Isle	ME	public
## 162	University of Maine at Farmington	ME	public
## 163	Thomas College	ME	private
## 164	University of Maine at Machias	ME	public
## 165	Adrian College	MI	private

## 168	Andrews University	MI	private
## 171	Madonna University	MI	private
## 173	Michigan Technological University	MI	public
## 174	Spring Arbor College	MI	private
## 175	University of Detroit Mercy	MI	private
## 177	Center for Creative Studies	MI	private
## 179	College of Saint Benedict	MN	private
## 180	College of Saint Catherine	MN	private
## 184	Saint Cloud State University	MN	public
## 185	Saint John's University	MN	private
## 186	Saint Mary's College of Minnesota	MN	private
## 187	University of Minnesota at Morris	MN	public
## 189	Central Methodist College	MO	private
## 190	Columbia College	MO	private
## 191	Drury College	MO	private
## 192	Lindenwood College	MO	private
## 193	Missouri Valley College	MO	private
## 194	Missouri Western State College	MO	public
## 195	Southeast Missouri State University	MO	public
## 196	Southwest Baptist University	MO	private
## 200	Webster University	MO	private
## 201	Westminster College	MO	private
## 202	William Jewell College	MO	private
## 203	William Woods University	MO	private
## 204	Millsaps College	MS	private
## 205	Mississippi College	MS	private
## 206	Mississippi State University	MS	public
## 207	Mississippi Valley State University	MS	public
## 208	University of Mississippi	MS	public
## 209	Montana State University-Billings	MT	public
## 210	Rocky Mountain College	MT	private
## 212	University of North Carolina at Asheville	NC	public
## 213	Bennett College	NC	private
## 217	Elon College	NC	private
## 218	Fayetteville State University	NC	public
## 219	Gardner Webb University	NC	private
## 220	Guilford College	NC	private
## 221	Lenoir-Rhyne College	NC	private
## 222	Livingstone College	NC	private
## 223	Methodist College	NC	private
## 224	North Carolina Wesleyan College	NC	private
## 225	Pembroke State University	NC	public
## 226	Queens College	NC	private
## 230	University of North Carolina at Greensboro	NC	public
## 231	Western Carolina University	NC	public
## 232	University of North Carolina at Wilmington	NC	public
## 233	Wingate College	NC	private
## 234	Dickinson State University	ND	public
## 235	University of Mary	ND	private
## 236	University of North Dakota	ND	public

## 237	Valley City State University	ND	public
## 238	North Dakota State University	ND	public
## 240	Dana College	NE	private
## 241	Doane College	NE	private
## 242	Hastings College	NE	private
## 243	Peru State College	NE	public
## 245	Wayne State College	NE	public
## 247	Franklin Pierce College	NH	private
## 248	Notre Dame College	NH	private
## 250	Keene State College	NH	public
## 251	Daniel Webster College	NH	private
## 253	Georgian Court College	NJ	private
## 254	Jersey City State College	NJ	public
## 255	Monmouth College	NJ	private
## 256	Montclair State University	NJ	public
## 257	New Jersey Institute of Technology	NJ	public
## 259	Rutgers State University at Newark	NJ	public
## 261	Saint Peter's College	NJ	private
## 262	Rutgers State University at Camden	NJ	public
## 264	Stockton College of New Jersey	NJ	public
## 265	College of Santa Fe	NM	private
## 266	College of the Southwest	NM	private
## 268	Canisius College	NY	private
## 269	Cazenovia College	NY	private
## 274	Elmira College	NY	private
## 278	Houghton College	NY	private
## 281	Marist College	NY	private
## 282	Nyack College	NY	private
## 287	St. Bonaventure University	NY	private
## 288	St. John Fisher College	NY	private
## 292	SUNY College at Brockport	NY	public
## 293	SUNY College at Buffalo	NY	public
## 294	SUNY College at Cortland	NY	public
## 295	SUNY College at Fredonia	NY	public
## 296	SUNY College at Geneseo	NY	public
## 297	SUNY College at New Paltz	NY	public
## 298	SUNY College at Oswego	NY	public
## 299	SUNY College at Plattsburgh	NY	public
## 300	SUNY College at Potsdam	NY	public
## 304	SUNY College at Purchase	NY	public
## 305	Ashland University	OH	private
## 306	Baldwin-Wallace College	OH	private
## 309	Cedarville College	OH	private
## 310	College of Mount St. Joseph	OH	private
## 311	Franciscan University of Steubenville	OH	private
## 313	Heidelberg College	OH	private
## 315	Malone College	OH	private
## 317	Mount Union College	OH	private
## 318	Muskingum College	OH	private
## 321	Tiffin University	OH	private

## 324	Ursuline College	OH	private
## 326	Xavier University	OH	private
## 328	Antioch University	OH	private
## 329	Oklahoma Baptist University	OK	private
## 330	Oklahoma Christian University	OK	private
## 331	University of Sci. and Arts of Oklahoma	OK	public
## 333	Oklahoma Panhandle State University	OK	public
## 334	Oral Roberts University	OK	private
## 335	George Fox College	OR	private
## 347	Eastern College	PA	private
## 349	Gannon University	PA	private
## 350	Geneva College	PA	private
## 353	King's College	PA	private
## 357	Lincoln University	PA	public
## 358	Marywood College	PA	private
## 361	Bloomsburg Univ. of Pennsylvania	PA	public
## 362	Millersville University of Penn.	PA	public
## 363	Shippensburg University of Penn.	PA	public
## 364	Philadelphia Coll. of Textiles and Sci.	PA	private
## 365	Seton Hill College	PA	private
## 366	Saint Vincent College	PA	private
## 369	Thiel College	PA	private
## 375	Waynesburg College	PA	private
## 376	Westminster College	PA	private
## 377	Wilkes University	PA	private
## 378	York College of Pennsylvania	PA	private
## 379	Allentown Coll. of St. Francis de Sales	PA	private
## 380	La Roche College	PA	private
## 385	Roger Williams University	RI	private
## 386	Central Wesleyan College	SC	private
## 387	The Citadel	SC	public
## 388	Claflin College	SC	private
## 389	Coker College	SC	private
## 390	Erskine College	SC	private
## 392	Lander University	SC	public
## 393	Newberry College	SC	private
## 395	Augustana College	SD	private
## 396	Huron University	SD	private
## 397	Northern State University	SD	public
## 398	South Dakota State University	SD	public
## 399	Belmont University	TN	private
## 400	Carson-Newman College	TN	private
## 401	Christian Brothers University	TN	private
## 402	Freed-Hardeman University	TN	private
## 403	King College	TN	private
## 404	Lambuth University	TN	private
## 405	Lincoln Memorial University	TN	private
## 406	Maryville College	TN	private
## 407	Milligan College	TN	private
## 409	Tennessee Wesleyan College	TN	private

## 410	Trevecca Nazarene College	TN	private
## 414	Angelo State University	TX	public
## 415	East Texas Baptist University	TX	private
## 416	Hardin-Simmons University	TX	private
## 417	Incarnate Word College	TX	private
## 418	Lamar University	TX	public
## 420	Our Lady of the Lake University	TX	private
## 421	Schreiner College	TX	private
## 422	Southwestern Adventist College	TX	private
## 423	Prairie View A. and M. University	TX	public
## 424	Texas Christian University	TX	private
## 425	Texas College	TX	private
## 426	Texas Lutheran College	TX	private
## 429	University of St. Thomas	TX	private
## 432	Texas A&M University at Galveston	TX	public
## 435	Westminster College of Salt Lake City	UT	private
## 436	Bridgewater College	VA	private
## 438	Emory & Henry College	VA	private
## 440	Hampton University	VA	private
## 442	Lynchburg College	VA	private
## 443	Randolph-Macon College	VA	private
## 445	Mary Washington College	VA	public
## 447	Virginia State University	VA	public
## 448	Virginia Wesleyan College	VA	private
## 451	Castleton State College	VT	public
## 452	Johnson State College	VT	public
## 453	Lyndon State College	VT	public
## 454	Southern Vermont College	VT	private
## 456	Trinity College	VT	private
## 461	Carroll College	WI	private
## 465	Viterbo College	WI	private
## 466	University of Wisconsin-Stout	WI	public
## 467	Univ. of Wisconsin at Eau Claire	WI	public
## 468	Wisconsin Lutheran College	WI	private
## 469	Alderson-Broadbush College	WV	private
## 470	Marshall University	WV	private
## 471	University of Wyoming	WY	public
##	V4		
## 1	below average		
## 2	below average		
## 4	below average		
## 5	below average		
## 6	below average		
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```
qwe[qwe$V4==" average",] ### this show that more no. of public university
```

##		V1	V2	V3	V4
## 11	Northern Arizona University	AZ	public	average	
## 12	University of Arizona	AZ	public	average	
## 13	California Polytechnic-San Luis	CA	public	average	
## 24	University of Southern California	CA	private	average	
## 43	University of Connecticut at Storrs	CT	public	average	
## 48	University of Delaware	DE	private	average	
## 57	University of Central Florida	FL	public	average	
## 62	University of Georgia	GA	public	average	
## 98	University of Illinois - Urbana	IL	public	average	
## 99	University of Illinois at Chicago	IL	public	average	
## 131	Louisiana State University at Baton Rouge	LA	public	average	
## 137	Boston University	MA	private	average	
## 150	Northeastern University	MA	private	average	
## 151	University of Massachusetts at Amherst	MA	public	average	
## 158	University of Maryland at College Park	MD	public	average	
## 172	Michigan State University	MI	public	average	
## 176	Western Michigan University	MI	public	average	
## 188	University of Minnesota Twin Cities	MN	public	average	
## 197	Southwest Missouri State University	MO	public	average	
## 211	Appalachian State University	NC	public	average	
## 216	East Carolina University	NC	public	average	
## 228	North Carolina State University at Raleigh	NC	public	average	
## 229	University of North Carolina at Chapel Hill	NC	public	average	
## 244	University of Nebraska at Lincoln	NE	public	average	
## 249	University of New Hampshire	NH	public	average	
## 263	Rutgers at New Brunswick	NJ	public	average	
## 290	SUNY at Albany	NY	public	average	
## 291	SUNY at Binghamton	NY	public	average	
## 307	Bowling Green State University	OH	public	average	
## 320	Ohio University	OH	public	average	
## 322	University of Cincinnati	OH	public	average	
## 327	Miami University at Oxford	OH	public	average	
## 332	Oklahoma State University	OK	public	average	

## 368	Temple University	PA	public	average
## 371	University of Pittsburgh-Main Campus	PA	public	average
## 381	Pennsylvania State Univ. Main Campus	PA	public	average
## 384	University of Rhode Island	RI	public	average
## 411	University of Tennessee at Knoxville	TN	public	average
## 419	University of North Texas	TX	public	average
## 430	University of Texas at Austin	TX	public	average
## 431	Baylor University	TX	private	average
## 433	Texas A&M Univ. at College Station	TX	public	average
## 434	University of Utah	UT	public	average
## 444	Virginia Commonwealth University	VA	public	average
## 446	George Mason University	VA	public	average
## 450	University of Virginia	VA	public	average

qwe[qwe\$V4=="above Average",] ### this show that more no. of private university

##		V1	V2	V3	V4
## 3	Birmingham-Southern College	AL	private	above	Average
## 14	Claremont McKenna College	CA	private	above	Average
## 15	Harvey Mudd College	CA	private	above	Average
## 16	Pitzer College	CA	private	above	Average
## 17	Scripps College	CA	private	above	Average
## 18	Occidental College	CA	private	above	Average
## 20	Pepperdine University	CA	private	above	Average
## 22	St. Mary's College of California	CA	private	above	Average
## 23	University of San Francisco	CA	private	above	Average
## 25	Westmont College	CA	public	above	Average
## 26	Loyola Marymount University	CA	private	above	Average
## 29	Colorado College	CO	private	above	Average
## 35	Connecticut College	CT	private	above	Average
## 37	Saint Joseph College	CT	private	above	Average
## 38	Trinity College	CT	private	above	Average
## 39	University of Bridgeport	CT	private	above	Average
## 40	University of Hartford	CT	private	above	Average
## 41	Wesleyan University	CT	private	above	Average
## 44	Catholic University of America	DC	private	above	Average
## 45	George Washington University	DC	private	above	Average
## 46	Georgetown University	DC	private	above	Average
## 47	Trinity College	DC	private	above	Average
## 51	Florida Institute of Technology	FL	private	above	Average
## 54	Rollins College	FL	private	above	Average
## 55	Stetson University	FL	private	above	Average
## 56	University of Miami	FL	private	above	Average
## 59	Emory University	GA	private	above	Average
## 61	Spelman College	GA	private	above	Average
## 69	Cornell College	IA	private	above	Average
## 73	Grinnell College	IA	private	above	Average
## 86	Augustana College	IL	private	above	Average
## 88	Illinois Wesleyan University	IL	private	above	Average

## 89	Knox College	IL	private	above	Average
## 90	Lake Forest College	IL	private	above	Average
## 92	Monmouth College	IL	private	above	Average
## 97	University of Chicago	IL	private	above	Average
## 102	Butler University	IN	private	above	Average
## 103	DePauw University	IN	private	above	Average
## 104	Earlham College	IN	private	above	Average
## 112	Saint Mary's College	IN	private	above	Average
## 113	Taylor University	IN	private	above	Average
## 114	Valparaiso University	IN	private	above	Average
## 115	Wabash College	IN	private	above	Average
## 124	Centre College	KY	private	above	Average
## 128	Transylvania University	KY	private	above	Average
## 132	Loyola University	LA	private	above	Average
## 133	Tulane University	LA	private	above	Average
## 134	Amherst College	MA	private	above	Average
## 135	Merrimack College	MA	private	above	Average
## 136	Bentley College	MA	private	above	Average
## 139	Brandeis University	MA	private	above	Average
## 140	Clark University	MA	private	above	Average
## 142	Harvard University	MA	private	above	Average
## 144	Massachusetts Institute of Technology	MA	private	above	Average
## 149	Mount Holyoke College	MA	private	above	Average
## 152	Wellesley College	MA	private	above	Average
## 153	Wheaton College	MA	private	above	Average
## 154	Williams College	MA	private	above	Average
## 155	Worcester Polytechnic Institute	MA	private	above	Average
## 156	Goucher College	MD	private	above	Average
## 160	Bowdoin College	ME	private	above	Average
## 161	Colby College	ME	private	above	Average
## 166	Albion College	MI	private	above	Average
## 167	Alma College	MI	private	above	Average
## 169	Hillsdale College	MI	private	above	Average
## 170	Hope College	MI	private	above	Average
## 178	Carleton College	MN	private	above	Average
## 181	University of St. Thomas	MN	private	above	Average
## 182	Hamline University	MN	private	above	Average
## 183	Macalester College	MN	private	above	Average
## 198	Saint Louis University	MO	private	above	Average
## 199	Washington University	MO	private	above	Average
## 214	Davidson College	NC	private	above	Average
## 215	Duke University	NC	private	above	Average
## 227	Salem College	NC	private	above	Average
## 239	Creighton University	NE	private	above	Average
## 246	Dartmouth College	NH	private	above	Average
## 252	Drew University	NJ	private	above	Average
## 258	Princeton University	NJ	private	above	Average
## 260	Seton Hall University	NJ	private	above	Average
## 267	Alfred University	NY	private	above	Average
## 270	Clarkson University	NY	private	above	Average

## 271	Colgate University	NY	private	above	Average
## 272	Columbia University	NY	private	above	Average
## 273	Barnard College	NY	private	above	Average
## 275	Hartwick College	NY	private	above	Average
## 276	Hobart and William Smith Colleges	NY	private	above	Average
## 277	Hofstra University	NY	private	above	Average
## 279	Le Moyne College	NY	private	above	Average
## 280	Manhattanville College	NY	private	above	Average
## 283	Pace University	NY	private	above	Average
## 284	Sarah Lawrence College	NY	private	above	Average
## 285	Skidmore College	NY	private	above	Average
## 286	Siena College	NY	private	above	Average
## 289	St. Lawrence University	NY	private	above	Average
## 301	Syracuse University	NY	private	above	Average
## 302	Union College	NY	private	above	Average
## 303	University of Rochester	NY	private	above	Average
## 308	Case Western Reserve University	OH	private	above	Average
## 312	Denison University	OH	private	above	Average
## 314	Kenyon College	OH	private	above	Average
## 316	Marietta College	OH	private	above	Average
## 319	Oberlin College	OH	private	above	Average
## 323	University of Dayton	OH	private	above	Average
## 325	Wittenberg University	OH	private	above	Average
## 336	Linfield College	OR	private	above	Average
## 337	Pacific University	OR	private	above	Average
## 338	Reed College	OR	private	above	Average
## 339	University of Portland	OR	private	above	Average
## 340	Albright College	PA	private	above	Average
## 341	Allegheny College	PA	private	above	Average
## 342	Bucknell University	PA	private	above	Average
## 343	Carnegie Mellon University	PA	private	above	Average
## 344	Chatham College	PA	private	above	Average
## 345	College Misericordia	PA	private	above	Average
## 346	Dickinson College	PA	private	above	Average
## 348	Elizabethtown College	PA	private	above	Average
## 351	Gettysburg College	PA	private	above	Average
## 352	Juniata College	PA	private	above	Average
## 354	Lafayette College	PA	private	above	Average
## 355	La Salle University	PA	private	above	Average
## 356	Lehigh University	PA	private	above	Average
## 359	Messiah College	PA	private	above	Average
## 360	Moravian College	PA	private	above	Average
## 367	Susquehanna University	PA	private	above	Average
## 370	University of Pennsylvania	PA	private	above	Average
## 372	University of Scranton	PA	private	above	Average
## 373	Villanova University	PA	private	above	Average
## 374	Washington and Jefferson College	PA	private	above	Average
## 382	Brown University	RI	private	above	Average
## 383	Providence College	RI	private	above	Average
## 391	Furman University	SC	private	above	Average

```
## 394          Presbyterian College SC private above Average
## 408          Rhodes College TN private above Average
## 412    University of the South TN private above Average
## 413    Vanderbilt University TN private above Average
## 427          Trinity University TX private above Average
## 428    University of Dallas TX private above Average
## 437    College of William and Mary VA public above Average
## 439    Hampden - Sydney College VA private above Average
## 441          Hollins College VA private above Average
## 449    Washington and Lee University VA private above Average
## 455    Saint Michael's College VT private above Average
## 457    University of Vermont VT public above Average
## 458    Seattle University WA private above Average
## 459    Whitman College WA private above Average
## 460    Beloit College WI private above Average
## 462    Lawrence University WI private above Average
## 463    Ripon College WI private above Average
## 464    St. Norbert College WI private above Average
```

- e. What other external information can explain the contents of some or all of these clusters?

as mention above

,

- f. Consider Tufts University, which is missing some information. Compute the Euclidean distance of this record from each of the clusters that you found above (using only the measurements that you have). Which cluster is it closest to? Impute the missing values for Tufts by taking the average of the cluster on those measurements.

```
univ2 <- Universities[ Universities$`College Name` == "Tufts University", ] ##
selecting Tufts university from original dataset
```

```
view(univ2)
univ2$`# PT undergrad` <- mean(Universities$`# PT undergrad`, na.rm=TRUE) ##
selecting means value from coloumn and applying it to NA value for PT
undergrad
```

```
univ2 <- rbind(univ1, univ2) ### combining dataset
view(univ2)
```

```
univ2_scale <- scale(univ2[, c(-1, -2, -3)]) ### applying normalization
```

```
fitk2 <- kmeans(univ2_scale, 3) ### apply kmeans to dataset
```

```
univ2 <- cbind( univ2, fitk2$cluster) ## combining cluster information col to
dataset to find which cluster does tufts fall under
```



```
univ2[472,] ### this university falls in cluster 2
```

```
##          College Name State Public (1)/ Private (2) # appli. rec'd
## 472 Tufts University    MA                2           7614
##      # appl. accepted # new stud. enrolled % new stud. from top 10%
## 472           3605           1205           60
##      % new stud. from top 25% # FT undergrad # PT undergrad
## 472           90           4598           1081.527
##      in-state tuition out-of-state tuition room board add. fees
## 472           19701           19701 3038 2930           503
##      estim. book costs estim. personal $ % fac. w/PHD stud./fac. ratio
## 472           600           928           99           10.3
##      Graduation rate fitk2$cluster
## 472           92           2
```