## **Econometrics HW1**

Tianyu Gao 2022-09-10

1.

a)

library(knitr)

$$Pr(X = 0, Y = 0) = Pr(X = 0|Y = 0) \times Pr(Y = 0) = .75 \times .05 = .0375$$

$$Pr(X = -10, Y = 0) = Pr(Y = 0) - Pr(X = 10, Y = 0) - Pr(X = 0, Y = 0) = .75 - .4875 - .0375 = .225$$

$$Pr(X = -10) = Pr(X = -10, Y = 1) + Pr(X = -10, Y = 0) = .225 + .175 = .4$$

$$Pr(X = 10) = 1 - Pr(X = 0) - Pr(X = -10) = 1 - .4 - .05 = .55$$

$$Pr(X = 10, Y = 1) = Pr(X = 10) - Pr(X = 10, Y = 0) = .55 - .4875 = .0625$$

$$Pr(X = 0, Y = 1) = Pr(X = 0) - Pr(X = 0, Y = 0) = .05 - .0375 = .0125$$

$$Pr(Y = 1) = 1 - P(Y = 0) = .25$$

The table is filled as follows:

	Y = 0	Y = 1	Pr(Y)
X = -10	0.2250	0.1750	0.40
X = 0	0.0375	0.0125	0.05
X = 10	0.4875	0.0625	0.55
Pr(X)	0.7500	0.2500	NaN

### b)

$$E(X) = \sum_{i=1}^{3} Pr(X = x_i)x_i$$

$$= .4 \times (-10) + .05 \times 0 + .55 \times 10$$

$$= 1.5$$

$$E(Y) = \sum_{i=1}^{2} Pr(Y = y_i)y_i$$

$$= .75 \times 0 + .25 \times 1$$

$$= .25$$

$$Var(X) = \sum_{i=1}^{3} Pr(X = x_i)(x_i - E(X))^2$$

$$= .4 \times (1.5 + 10)^2 + .05 \times 1.5^2 + .55 \times 8.5^2$$

$$= 92.75$$

$$Var(Y) = \sum_{i=1}^{2} Pr(Y = y_i)(y_i - E(Y))^2 = .75 \times .25^2 + .25 \times .75^2 = .1875$$

c)

When she does not study:

$$E(X|Y=0) = \sum_{i=1}^{3} Pr(X=x_i|Y=0)x_i = \frac{4.875 - 2.25}{.75} = 3.5$$

When she studies:

$$E(X|Y = 1) = \sum_{i=1}^{3} Pr(X = x_i|Y = 0)x_i = \frac{0.625 - 1.75}{.25} = -4.5$$

2

a)

$$\sigma = 100, \mu = 500$$
 
$$P(Score > 750) = P(\frac{Score - 500}{100} > \frac{750 - 500}{100}) = 1 - \Phi(2.5) \approx .006$$

print(1 - pnorm(2.5))

$$P(Score > 600) = P(\frac{Score - 500}{100} > \frac{600 - 500}{100}) = 1 - \Phi(1) \approx 0.16$$

print(1 - pnorm(1))

## [1] 0.1586553

$$P(420 < Score < 530) = P(\frac{420 - 500}{100} < \frac{Score - 500}{100} < \frac{530 - 500}{100})$$
$$= \Phi(0.3) - \Phi(-0.8) \approx 0.41$$

pnorm(0.3) - pnorm(-0.8)

## [1] 0.406056

$$P(Score < 480) = P(\frac{Score - 500}{100} < \frac{480 - 500}{100}) = \Phi(-0.2) \approx 0.42$$

pnorm(-0.2)

## [1] 0.4207403

$$P(Score > 530) = P(\frac{Score - 500}{100} > \frac{530 - 500}{100}) = 1 - \Phi(0.3) \approx 0.38$$

1 - pnorm(0.3)

## [1] 0.3820886

### b)

$$X : Verbal score \\ Y : Math score \\ \begin{cases} X \sim N(500, 100^2) \\ Y \sim N(500, 100^2) \Rightarrow X + Y \sim N(1000, 20000) \\ X \bot Y \end{cases}$$
 
$$Var(X + Y) = 20000 \\ E(X + Y) = 1000$$

c)

$$X : Verbal score$$

$$Y : Math score$$

$$E(X + Y) = E(X) + E(Y) = 1000$$

$$Var(X + Y) =$$

$$Var(X) + Var(Y) + 2Q_{XY}\sigma_{X}\sigma_{Y} = 35000$$

d)

$$E(\bar{Y}) = E(\frac{1}{25} \sum_{i=1}^{25} Y_i) = \frac{1}{25} \sum_{i=1}^{25} E(Y_i) = 500$$

$$Var(\bar{Y}) = Var(\frac{1}{25} \sum_{i=1}^{25} Y_i)$$

$$= \frac{1}{625} \times \sum_{i=1}^{25} Var(Y_i) = 400$$

$$P(\bar{Y} > 530) = P(\frac{\bar{Y} - 500}{20} > \frac{530 - 500}{20}) = 1 - \Phi(1.5) \approx .07$$

1 - pnorm(1.5)

## [1] 0.0668072

The variance of the mean is much smaller than the mean, and this is because when we calculate the population mean, we only care about an individual in the population, however, when we talk about the sample mean, we care about some samples assumed to be identical, such a change leads to the decrease of the variance, and when the variance is smaller, the observations are more close to their center, which means fewer outliners will appear. Thus, the probability we get an extreme observation is lower.

3

a)

For two-sided confident interval, when confidence level is 0.95, the critical value is 1.96,

qnorm(0.975)

## [1] 1.959964

So the 95% confidence interval is

$$[38644.86 - 1.96 \times \frac{7541.40}{\sqrt{108}}, 38644.86 + 1.96 \times \frac{7541.40}{\sqrt{108}}] = [37222.54, 40067.18]$$

38644.86 - 1.96 \* 7541.4 / sqrt(108)

## [1] 37222.54

38644.86 + 1.96 \* 7541.4 / sqrt(108)

## [1] 40067.18

### b)

Such difference does not indicate discrimination in the job market against psychology majors, because psychology students might prefer jobs with better work-life balance but lower salary, while the employers have the same criteria about the two majors.

c)

39915.25 - 37083.33

## [1] 2831.92

sqrt(8330.21 / 59 + 6174.86 / 49)

## [1] 16.34648

$$T_0: \bar{Y}_{B+} - \bar{Y}_B = 0$$
 
$$T_A: \bar{Y}_{B+} - \bar{Y}_B \neq 0$$
 
$$p - value = \Phi(-|t^{act}|) = .07$$

pnorm(-2831.92 / 1966.62)

## [1] 0.07493462

Therefore we fail reject the null hypothesis that the two starting salaries are in the same population. The results might not hold across years because the sample size would change, which means the student t-distribution will change.

a)

$$\begin{aligned} H_0:E(D_i) &= 0 \\ H_A: \mu \neq 0 \end{aligned}$$

## b)

Wage\_before = c(8.3, 9.4, 9, 10.5, 11.4, 8.75, 10, 9.5, 10.8, 12.55, 12, 8.65, 7.75, 11.
25, 12.65)
mean(Wage\_before)

## [1] 10.16667

Wage\_after = c(9.25, 9, 9.25, 10, 12, 9.5, 10.25, 9.5, 11.5, 13.1, 11.5, 9, 7.75, 11.5,
13)
mean(Wage\_after)

## [1] 10.40667

d = Wage after - Wage before

mean(d)

## [1] 0.24

sqrt(var(d))/sqrt(15)

## [1] 0.1164147

$$p - value = 2 \times t_{14}(-\frac{.24}{.12}) = .06$$

\$\$ we fail to reject at confidence level of \$5% \$ and at confidence level of 1%

pt(-2, 14)

## [1] 0.03264398

### d)

```
qt(.975, 14)
```

## [1] 2.144787

$$t_{14}(0.975) = 2.14$$

The 95% interval is  $[.24 - .12 \times 2.14, .24 + .12 \times 2.14]$ , or equivalently, [-.02, .50]

### 5

### a)

Olympics = read.csv("/Users/kevintsukuyo/Documents/Course Files/2022F/Applied Econometri cs/HW1/Olympics\_HW.csv")

summary(Olympics\$medals)

```
## Min. 1st Qu. Median Mean 3rd Qu. Max.
## 0.000 0.000 0.000 1.751 0.000 37.000
```

summary(Olympics\$athletes)

```
## Min. 1st Qu. Median Mean 3rd Qu. Max.
## 0.00 0.00 2.00 18.17 13.00 230.00
```

summary(Olympics\$GDP)

```
## Min. 1st Qu. Median Mean 3rd Qu. Max. NA's
## 0.0110 0.1212 0.3849 1.1691 1.5127 14.5230 156
```

### b)

```
b5 = subset(Olympics, select = c('country', 'year', 'medals', 'athletes', 'GDP'))[c(0:
5), ]
b5
```

```
##
    country year medals athletes
                                     GDP
## 1 Albania 1980
                       0
                                     NA
## 2 Albania 1984
                       0
                                0 0.0641
## 3 Albania 1988
                       0
                                0 0.0637
## 4 Albania 1992
                                0 0.0206
                       0
## 5 Albania 1994
                       0
                                0 0.0587
```

### c)

```
c5 = data.frame(matrix(ncol = 2, nrow = length(unique(Olympics$year))))
colnames(c5) = c('Years', 'Numbers')
c5$Years = unique(Olympics$year)
for (i in unique(Olympics$year)){
  c5[c5$Years == i, ]$Numbers = dim(subset(Olympics, year == i))[1]
}
c5
```

```
##
     Years Numbers
## 1
      1980
               117
## 2
      1984
               117
## 3
      1988
               117
## 4
      1992
              113
## 5
      1994
               110
## 6
      1998
               110
## 7
      2002
              110
## 8
      2006
               110
## 9
      2010
               109
## 10 2014
               109
```

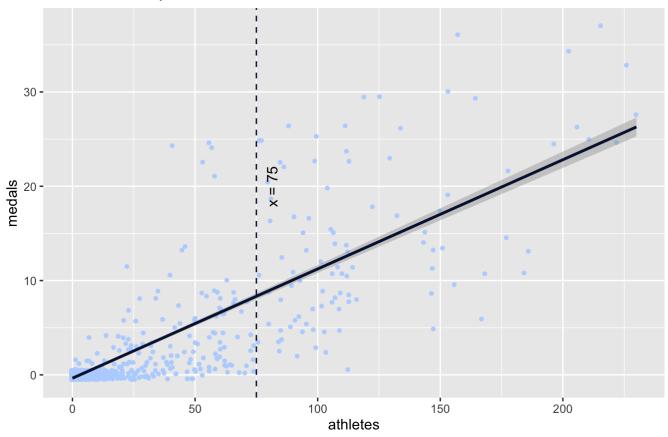
## d)

#### library(ggplot2)

```
ggplot(data = Olympics, aes(x = athletes, y = medals))+
  geom_point(size = 1, color = '#b8d5ff', position = position_jitter(height = .5))+
  labs(title = "The relationship between number of athletes and medels", caption = "Base
d on data from Olympics_HW.csv")+
  geom_smooth(method = lm, color = '#05133d')+
  geom_vline(xintercept = 75, color = '#05133d', linetype = 'dashed')+
  annotate(geom = "text", label = "x = 75", x = 75, y = 20, vjust = 2, angle = 90)
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

### The relationship between number of athletes and medels



Based on data from Olympics\_HW.csv

```
ggsave('plot.png')
```

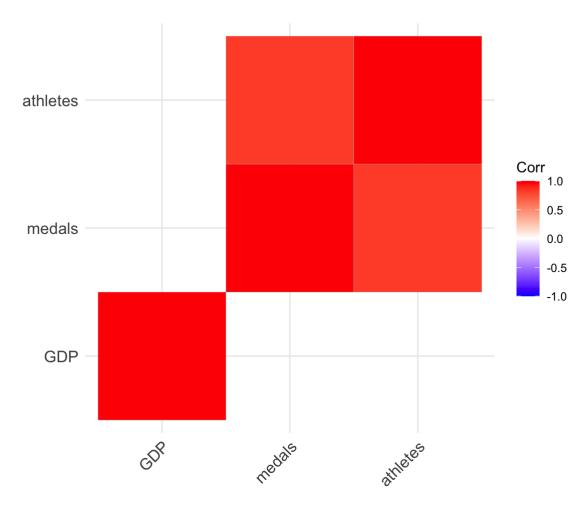
```
## Saving 7 x 5 in image
## `geom_smooth()` using formula = 'y ~ x'
```

The number of athletes and medals are positively correlated, which means there tend to be more medal winners if there are more athletes in a group. For some small athletes group with participants less than approximately 75 there are no medal winners, as the athlete group larger the medal-athlete relationship tends to be more linear.

### e)

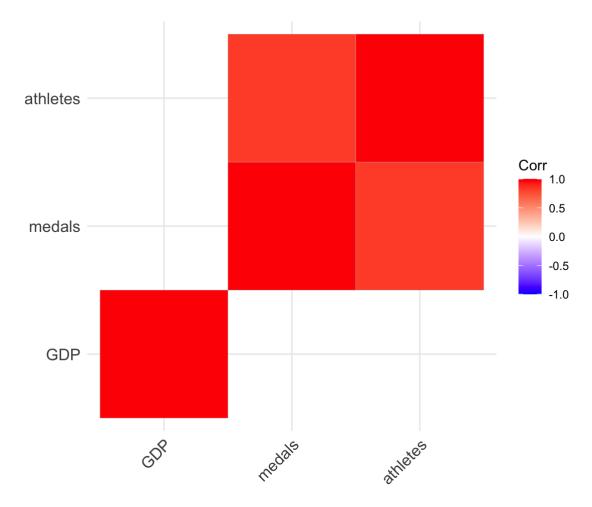
In the last session we find that medals and athletes are positively correlated. It could be explained by athletes are equally good at all events so coutries sending more athletes win more medals. However, it could be true that countries more developed tend to send more athletes and the athletes in the developed countries are trained better so they perform well.

```
library(ggcorrplot)
GDP_athletes_medals = subset(Olympics, select = c('GDP', 'medals', 'athletes'))
ggcorrplot(cor(GDP_athletes_medals))
```



It seems there is no correlation among GDP and other variables, but after observing the dataset I suspect the units are quite different among three variables. So I performed normalization on the variables.

```
GDP_athletes_medals$GDP = scale(GDP_athletes_medals$GDP)
GDP_athletes_medals$athletes = scale(GDP_athletes_medals$athletes)
GDP_athletes_medals$medals = scale(GDP_athletes_medals$medals)
ggcorrplot(cor(GDP_athletes_medals))
```



Yet, the correlation is not significant.

### f)

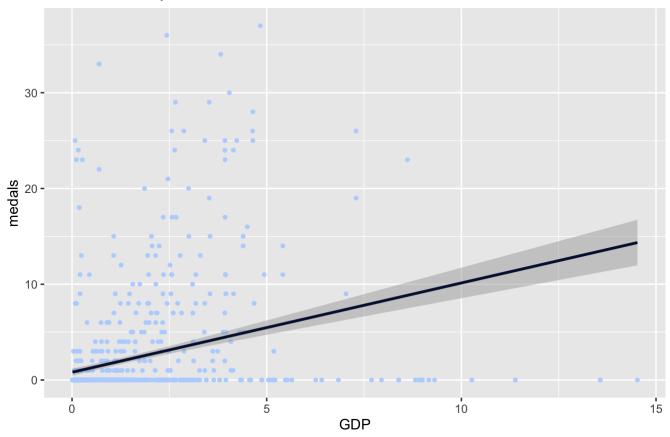
```
ggplot(data = Olympics, aes(x = GDP, y = medals), na.rm = TRUE)+
  geom_point(size = 1, color = '#b8d5ff')+
  labs(title = "The relationship between GDP and number of medels", caption = "Based on data from Olympics_HW.csv")+
  geom_smooth(method = lm, color = '#05133d')
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

```
## Warning: Removed 156 rows containing non-finite values (`stat_smooth()`).
```

```
## Warning: Removed 156 rows containing missing values (`geom_point()`).
```

### The relationship between GDP and number of medels



Based on data from Olympics\_HW.csv

There are some missing values and in the GDP data, let us explore the data.

```
GDP_missing = Olympics[is.na(Olympics$GDP), ]
GDP_missing
```

##			year	host	=	_	precipitation	
##		1	1980	0	Albania		143.0	2764
	21		1980	0	American Samoa		164.1	964
	22		1984	0	American Samoa	84.2	164.1	964
	23		1988	0	American Samoa		164.1	964
	24		1992	0	American Samoa		164.1	964
	25		1994	0	American Samoa		164.1	964
	26		1998	0	American Samoa		164.1	964
##		_	2002	0	American Samoa	84.2	164.1	964
	28		2006	0	American Samoa	84.2	164.1	964
	29		2010	0	American Samoa	_	164.1	964
##			2014	0	American Samoa		164.1	
	39		2010	0	Andorra		51.0	2946
	51		1980	0	Armenia		22.0	4090
##			1984	0	Armenia		22.0	4090
	53		1988	0	Armenia		22.0	4090
	81		1980	0	Azerbaijan		21.0	4485
##	82		1984	0	Azerbaijan		21.0	4485
##	83		1988	0	Azerbaijan		21.0	4485
##	91	10	1980	0	Belarus	28.2	45.0	346
	92	10	1984	0	Belarus	28.2	45.0	346
##	93	10	1988	0	Belarus	28.2	45.0	346
##	131		1980	0	Bosnia and Herzegovina	38.7	68.0	2386
##	132	14	1984	0	Bosnia and Herzegovina	38.7	68.0	2386
##	133	14	1988	0	Bosnia and Herzegovina	38.7	68.0	2386
##	134	14	1992	0	Bosnia and Herzegovina	38.7	68.0	2386
	160	16	2014	0	British Virgin Islands	79.0	74.2	521
##	191	20	1980	0	Cayman Islands	79.0	71.0	43
##	192	20	1984	0	Cayman Islands	79.0	71.0	43
##	193	20	1988	0	Cayman Islands	79.0	71.0	43
##	194	20	1992	0	Cayman Islands	79.0	71.0	43
##	195	20	1994	0	Cayman Islands	79.0	71.0	43
##	196	20	1998	0	Cayman Islands	79.0	71.0	43
##	197	20	2002	0	Cayman Islands	79.0	71.0	43
##	198	20	2006	0	Cayman Islands	79.0	71.0	43
##	199	20	2010	0	Cayman Islands	79.0	71.0	43
##	200	20	2014	0	Cayman Islands	79.0	71.0	43
##	230	23	2014	0	Chinese Taipei	66.4	83.2	3952
##	251	26	1980	0	Croatia	37.6	48.6	1831
##	252	26	1984	0	Croatia	37.6	48.6	1831
##	253	26	1988	0	Croatia	37.6	48.6	1831
##	271	28	1980	0	Czech Republic	32.7	23.5	1602
##	272	28	1984	0	Czech Republic	32.7	23.5	1602
##	273	28	1988	0	Czech Republic	32.7	23.5	1602
##	281	29	1980	0	Czechoslovakia	32.7	23.5	1602
##	282	29	1984	0	Czechoslovakia	32.7	23.5	1602
##	283	29	1988	0	Czechoslovakia	32.7	23.5	1602
##	318	34	1980	0	Estonia	29.8	49.0	318
##	319	34	1984	0	Estonia	29.8	49.0	318
##	320	34	1988	0	Estonia	29.8	49.0	318
##	321	34	1992	0	Estonia	29.8	49.0	318
##								

##	368	39	1980	0	Georgia	42.6	20.0	5201
##	369	39	1984	0	Georgia	42.6	20.0	5201
##	370	39	1988	0	Georgia	42.6	20.0	5201
##	418	44	1980	0	Guam	86.3	100.6	406
##	419	44	1984	0	Guam	86.3	100.6	406
##	420	44	1988	0	Guam	86.3	100.6	406
##	477	51	1992	0	Iran	43.0	63.1	5671
##	534	57	1980	0	Kazakhstan	33.3	34.0	6995
##	535	57	1984	0	Kazakhstan	33.3	34.0	6995
##	536	57	1988	0	Kazakhstan	33.3	34.0	6995
##	554	59	1980	0	Kyrgyzstan	37.8	26.0	7439
##	555	59	1984	0	Kyrgyzstan	37.8	26.0	7439
##	556	59	1988	0	Kyrgyzstan	37.8	26.0	7439
##	564	60	1980	0	Latvia	27.9	33.7	312
##	565	60	1984	0	Latvia	27.9	33.7	312
##	574	61	1980	0	Lebanon	63.0	190.9	3088
##	575	61	1984	0	Lebanon	63.0	190.9	3088
##	592	62	2010	0	Liechtenstein	39.7	41.0	2599
##	594	63	1980	0	Lithuania	25.7	38.9	294
##	595	63	1984	0	Lithuania	25.7	38.9	294
##	596	63	1988	0	Lithuania	25.7	38.9	294
##	614	65	1980	0	Macedonia	40.1	30.0	2764
##	615	65	1984	0	Macedonia	40.1	30.0	2764
##	616	65	1988	0	Macedonia	40.1	30.0	2764
##	654	69	1980	0	Moldova	33.6	36.0	430
##	655	69	1984	0	Moldova	33.6	36.0	430
##	656	69	1988	0	Moldova	33.6	36.0	430
##	674	71	1980	0	Mongolia	3.9	1.1	4374
##	684	72	1980	0	Montenegro	49.1	192.0	2522
##	685	72	1984	0	Montenegro	49.1	192.0	2522
##	686	72	1988	0	Montenegro	49.1	192.0	2522
##	687	72	1992	0	Montenegro	49.1	192.0	2522
##	688	72	1994	0	Montenegro	49.1	192.0	2522
##	689	72	1998	0	Montenegro	49.1	192.0	2522
##	738	78	1980	0	North Korea	30.6	12.2	2744
##	739	78	1984	0	North Korea	30.6	12.2	2744
##	740	78	1988	0	North Korea	30.6	12.2	2744
##	741	78	1992	0	North Korea	30.6	12.2	2744
##	742	78	1994	0	North Korea	30.6	12.2	2744
##	743	78	1998	0	North Korea	30.6	12.2	2744
##	744	78	2002	0	North Korea	30.6	12.2	2744
##	745	78	2006	0	North Korea	30.6	12.2	2744
##	746	78	2010	0	North Korea	30.6	12.2	2744
##	747	78	2014	0	North Korea	30.6	12.2	2744
##	798	84	1980	0	Poland	32.2	21.0	2499
##	799	84	1984	0	Poland	32.2	21.0	2499
##	828	87	1980	0	Romania	34.7	40.0	2544
##	829	87	1984	0	Romania	34.7	40.0	2544
##	838	88	1980	0	Russia	25.0	52.0	5633
##	839	88	1984	0	Russia	25.0	52.0	5633
##	840	88	1988	0	Russia	25.0	52.0	5633
##	848	89	1980	0	San Marino	45.5	59.0	755

##	849	89	1984	0	San Marino	45.5	59.0	755
##	850	89	1988	0	San Marino	45.5	59.0	755
##	851	89	1992	0	San Marino	45.5	59.0	755
##	852	89	1994	0	San Marino	45.5	59.0	755
##	853		1998	0	San Marino	45.5	59.0	755
##	856		2010	0	San Marino	45.5	59.0	755
	868	91	1980	0	Serbia	40.3	46.9	2169
	869		1984	0	Serbia		46.9	2169
	870		1988	0	Serbia		46.9	2169
	871		1992	0	Serbia		46.9	2169
	872		1994	0	Serbia		46.9	2169
	878		1980	0	Serbia and Montenegro	NA	NA	NA
	879		1984	0	Serbia and Montenegro	NA	NA	NA
	880		1988	0	Serbia and Montenegro	NA	NA	NA
	881		1992	0	Serbia and Montenegro	NA	NA	NA
	882		1994	0	Serbia and Montenegro	NA	NA	NA
	886		1980	0	Slovakia		39.0	2655
	896		1980	0	Slovakia		71.0	2864
	897		1984	0	Slovenia		71.0	2864
	898		1988		Slovenia			
				0 0	Soviet Union		71.0	2864
	926		1980			NA	NA	NA
	927 928		1984	0	Soviet Union	NA	NA	NA
			1988	0	Soviet Union	NA	NA	NA 7405
	969		1980	0	Tajikistan		66.3	7495
	970		1984	0	Tajikistan		66.3	7495
	971		1988	0	Tajikistan		66.3	7495
	989		1980	0	Timor-Leste		44.9	2963
	990		1984	0	Timor-Leste		44.9	2963
	991		1988	0	Timor-Leste		44.9	2963
	992		1992	0	Timor-Leste		44.9	2963
	993		1994	0	Timor-Leste		44.9	2963
	994		1998	0	Timor-Leste		44.9	2963
##	1043	109	1994	0	US Virgin Islands	86.0	48.0	474
	1044			0	US Virgin Islands		48.0	474
	1045			0	US Virgin Islands		48.0	474
	1046			0	US Virgin Islands		48.0	474
	1047			0	US Virgin Islands		48.0	474
	1048			0	US Virgin Islands		48.0	474
	1049			0	Ukraine		36.0	2061
	1050			0	Ukraine	30.4	36.0	2061
	1059			0 U	nified Team (Former Soviet)	NA	NA	NA
##	1080	114	1980	0	Uzbekistan	43.2	57.8	4301
##	1081	114	1984	0	Uzbekistan	43.2	57.8	4301
##	1082	114	1988	0	Uzbekistan	43.2	57.8	4301
##	1100	116	1980	0	West Germany	NA	NA	NA
##	1101	116	1984	0	West Germany	NA	NA	NA
##	1102	116	1988	0	West Germany	NA	NA	NA
##	1103	117	1980	0	Yugoslavia	38.7	68.0	2386
##	1104	117	1984	1	Yugoslavia	38.7	68.0	2386
##	1105	117	1988	0	Yugoslavia	38.7	68.0	2386
##	1110	117	2006	0	Yugoslavia	38.7	68.0	2386
##	1111	117	2010	0	Yugoslavia	38.7	68.0	2386

## 10 0 0 0 0.037687 NA 0 0 0 0 1 ## 22 0 0 0 0 0.037687 NA 0 0 0 0 0 1 ## 24 0 0 0 0 0.037687 NA 0 0 0 0 0 3 ## 24 0 0 0 0 0.037687 NA 0 0 0 0 0 3 ## 24 0 0 0 0 0.049597 NA 0 0 0 0 0 0 4 ## 25 0 0 0 0 0.051807 NA 1 0 0 0 0 0 6 ## 27 0 0 0 0 0.051807 NA 0 0 0 0 0 0 6 ## 27 0 0 0 0 0.051807 NA 0 0 0 0 0 0 0 ## 28 0 0 0 0 0 0.051807 NA 0 0 0 0 0 0 0 ## 28 0 0 0 0 0 0.051807 NA 0 0 0 0 0 0 0 ## 29 0 0 0 0 0.051807 NA 0 0 0 0 0 0 0 ## 29 0 0 0 0 0.051807 NA 0 0 0 0 0 0 0 ## 29 0 0 0 0 0.051807 NA 0 0 0 0 0 0 0 ## 29 0 0 0 0 0.051808 NA 0 0 0 0 0 0 0 ## 29 0 0 0 0 0.051828 NA 0 0 0 0 0 0 0 ## 30 0 0 0 0 0.05128 NA 0 0 0 0 0 0 0 ## 30 0 0 0 0 0.05128 NA 0 0 0 0 0 0 0 ## 30 0 0 0 0 0.05128 NA 0 0 0 0 0 0 0 ## 51 0 0 0 0 0 0.05128 NA 0 0 0 0 0 0 0 ## 51 0 0 0 0 0 0.05128 NA 0 0 0 0 0 0 0 0 ## 51 0 0 0 0 0 0.05128 NA 0 0 0 0 0 0 0 0 ## 51 0 0 0 0 0 0.05128 NA 0 0 0 0 0 0 0 0 ## 51 0 0 0 0 0 0.05128 NA 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	##	1112	117 2	2014	0		Υı	ugoslavia 38	. 7	68.0		2386
## 21 0 0 0 0 0.032456 NA 0 0 0 0 1	##		gold	silver	bronze	population	GDP	participate	medals	athletes	time	
## 22 0 0 0 0 0.037687 NA 0 0 0 0 2	##	1	0	0	0	2.734776	NA	0	0	0	1	
## 23	##	21	0	0	0	0.032456	NA	0	0	0	1	
## 24  0  0  0  0.049597  NA	##	22	0	0	0	0.037687	NA	0	0	0	2	
## 25  0  0  0  0.051807  NA	##	23	0	0	0	0.044049	NA	0	0	0	3	
## 26  0  0  0  0.055899  NA  0  0  0  0  6  ## 27  0  0  0  0.05879  NA  0  0  0  0  0  7  ## 28  0  0  0  0.058652  NA  0  0  0  0  0  8  ## 29  0  0  0  0.058652  NA  0  0  0  0  0  9  ## 30  0  0  0  0.055636  NA  0  0  0  0  0  0  10  10  ## 39  0  0  0  0.057970  NA  1  0  6  9  ## 37  0  0  0  0.077907  NA  1  0  6  9  ## 51  0  0  0  3.096298  NA  0  0  0  0  1  1  ## 52  0  0  0  0  3.287588  NA  0  0  0  0  0  2  2  ## 53  0  0  0  0  6.658657  NA  0  0  0  0  1  1  ## 52  0  0  0  0  3.287588  NA  0  0  0  0  0  1  1  ## 58  0  0  0  0  6.658857  NA  0  0  0  0  0  1  1  ## 82  0  0  0  0  6.658857  NA  0  0  0  0  0  1  1  ## 82  0  0  0  0  6.658857  NA  0  0  0  0  0  1  1  ## 82  0  0  0  0  6.658857  NA  0  0  0  0  0  1  1  ## 91  0  0  0  0  6.633990  NA  0  0  0  0  0  1  1  ## 92  0  0  0  0  9.910000  NA  0  0  0  0  1  1  ## 91  0  0  0  0  6.633990  NA  0  0  0  0  0  1  1  ## 91  0  0  0  0  4.263393  NA  0  0  0  0  0  1  1  40000  NA  0  0  0  0  1  1  140000  NA  0  0  0  0  0  1  1  1  10  1  10  10	##	24	0	0	0	0.049597	NA	0	0	0	4	
## 27 0 0 0 0 0.058729 NA 0 0 0 0 7	##	25	0	0	0	0.051807	NA	1	0	2	5	
## 28	##	26	0	0	0	0.055899	NA	0	0	0	6	
## 29	##	27	0	0	0	0.058729	NA	0	0	0	7	
## 30  0  0  0  0.055128 NA  0  0  0  10	##	28	0	0	0	0.058652	NA	0	0	0	8	
## 39  0  0  0  0  0.077907 NA	##	29	0	0	0	0.055636	NA	0	0	0	9	
## 51 0 0 0 3.096298 NA 0 0 0 0 1 1 ## 52 0 0 0 0 3.287588 NA 0 0 0 0 0 2 ## 53 0 0 0 3.287588 NA 0 0 0 0 0 3 ## 81 0 0 0 0 6.163990 NA 0 0 0 0 1 ## 82 0 0 0 0 6.568857 NA 0 0 0 0 2 ## 83 0 0 0 6.994139 NA 0 0 0 0 3 ## 91 0 0 0 9.643000 NA 0 0 0 0 1 ## 93 0 0 0 0 10.140000 NA 0 0 0 0 2 ## 93 0 0 0 10.140000 NA 0 0 0 0 2 ## 131 0 0 0 4.099903 NA 0 0 0 0 1 ## 132 0 0 0 4.564265 NA 0 0 0 0 1 ## 141 10 0 0 0 4.143068 NA 0 0 0 0 1 ## 191 0 0 0 0 0.016164 NA 0 0 0 0 3 ## 191 0 0 0 0 0.016164 NA 0 0 0 0 1 ## 193 0 0 0 0 0.016543 NA 0 0 0 0 1 ## 194 0 0 0 0 0.02539 NA 0 0 0 0 2 ## 193 0 0 0 0 0.027402 NA 0 0 0 0 2 ## 194 0 0 0 0 0.037742 NA 0 0 0 0 4 ## 195 0 0 0 0 0.037550 NA 0 0 0 0 6 ## 197 0 0 0 0.055509 NA 1 0 1 1 10 ## 230 0 0 0 4.588000 NA 1 0 0 0 0 1 ## 250 0 0 0 0.055509 NA 1 0 0 1 1 ## 251 0 0 0 0 4.588000 NA 0 0 0 0 1 ## 271 0 0 0 0 0.055509 NA 1 0 0 1 1 ## 272 0 0 0 0 1.330213 NA 0 0 0 0 0 2 ## 273 0 0 0 0 1.330213 NA 0 0 0 0 0 2 ## 273 0 0 0 1.330213 NA 1 1 0 1 1 ## 282 0 2 4 10.330213 NA 1 1 0 0 1 ## 283 0 1 1 2 10.355276 NA 1 1 0 0 0 0 1 ## 283 0 1 1 2 10.355276 NA 1 1 0 0 0 0 1 ## 283 0 1 1 2 10.355276 NA 1 1 1 1 1 1 1 ## 282 0 0 0 1 1.518617 NA 0 0 0 0 0 2 ## 318 0 0 0 1 1.5561900 NA 0 0 0 0 0 2 ## 318 0 0 0 0 1.5561900 NA 0 0 0 0 0 0 2 ## 330 0 0 0 1.5561900 NA 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	##	30	0	0	0	0.055128	NA	0	0	0	10	
## 52  0  0  0  3.287588 NA  0  0  0  2  ## 53  0  0  0  3.510439 NA  0  0  0  0  3  ## 81  0  0  0  6.668857 NA  0  0  0  0  2  ## 83  0  0  0  6.568857 NA  0  0  0  0  0  3  ## 81  0  0  0  6.568857 NA  0  0  0  0  0  3  ## 81  0  0  0  6.568857 NA  0  0  0  0  0  3  ## 91  0  0  0  6.994139 NA  0  0  0  0  1  ## 92  0  0  0  9.643000 NA  0  0  0  0  1  ## 93  0  0  0  10.140000 NA  0  0  0  0  3  ## 131  0  0  0  0  4.0699903 NA  0  0  0  0  1  1  ## 132  0  0  0  4.263393 NA  0  0  0  0  1  1  ## 133  0  0  0  4.263393 NA  0  0  0  0  2  ## 133  0  0  0  4.263393 NA  0  0  0  0  0  2  ## 143068 NA  0  0  0  0  0  2  ## 160  0  0  0  0  0.016164 NA  0  0  0  0  0  1  1  10  10  10  10	##	39	0	0	0	0.077907	NA	1	0	6	9	
## 53 0 0 0 0 3.510439 NA 0 0 0 0 3 ## 81 0 0 0 0 0 1 ## 82 0 0 0 0 6.163990 NA 0 0 0 0 0 1 ## 82 0 0 0 0 6.568857 NA 0 0 0 0 0 3 ## 91 0 0 0 0 9.643000 NA 0 0 0 0 0 1 ## 92 0 0 0 0 9.643000 NA 0 0 0 0 0 1 ## 93 0 0 0 10.140000 NA 0 0 0 0 3 ## 913 0 0 0 10.140000 NA 0 0 0 0 3 ## 131 0 0 0 4.099903 NA 0 0 0 0 1 1 ## 132 0 0 0 4.263393 NA 0 0 0 0 2 ## 133 0 0 0 4.564265 NA 0 0 0 0 2 ## 133 0 0 0 0 4.564265 NA 0 0 0 0 0 3 ## 141 10 1 10 ## 192 0 0 0 0 0.016164 NA 0 0 0 0 1 1 ## 192 0 0 0 0 0.016164 NA 0 0 0 0 1 1 ## 193 0 0 0 0 0.022839 NA 0 0 0 0 0 1 1 10 ## 193 0 0 0 0 0.022839 NA 0 0 0 0 0 1 1 10 ## 193 0 0 0 0 0.027402 NA 0 0 0 0 0 3 ## 194 0 0 0 0 0.030755 NA 0 0 0 0 0 5 ## 196 0 0 0 0 0.030742 NA 0 0 0 0 0 5 ## 197 0 0 0 0 0.030755 NA 0 0 0 0 0 5 ## 197 0 0 0 0 0.044742 NA 0 0 0 0 0 7 7 ## 198 0 0 0 0 0.055509 NA 1 0 0 0 0 8 ## 199 0 0 0 0 0.055509 NA 1 0 0 0 0 0 8 ## 199 0 0 0 0 0.0555509 NA 1 0 0 0 0 0 1 1 10 ## 230 0 0 0 0 0.0555509 NA 1 0 0 0 0 0 1 1 10 ## 230 0 0 0 0 0.0555509 NA 1 0 0 0 0 0 1 1 10 ## 230 0 0 0 0 0.0555509 NA 1 0 0 0 0 0 1 1 10 ## 240 0 0 0 0 0.0555509 NA 1 0 0 0 0 0 1 1 10 ## 251 0 0 0 0 0 0.555509 NA 1 1 0 1 1 10 ## 253 0 0 0 0 0 0.555509 NA 1 1 0 0 1 1 10 ## 253 0 0 0 0 0 0.555509 NA 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	##	51	0	0	0	3.096298	NA	0	0	0	1	
## 81 0 0 0 6.163990 NA 0 0 0 0 1 ## 82 0 0 0 0 6.56857 NA 0 0 0 0 2 ## 83 0 0 0 6.994139 NA 0 0 0 0 3 ## 91 0 0 0 6.994139 NA 0 0 0 0 1 ## 92 0 0 0 0 9.910000 NA 0 0 0 0 2 ## 93 0 0 0 10.140000 NA 0 0 0 0 3 ## 131 0 0 0 4.099903 NA 0 0 0 0 1 ## 132 0 0 0 4.263393 NA 0 0 0 0 2 ## 134 0 0 0 4.564265 NA 0 0 0 0 2 ## 160 0 0 0 4.143068 NA 0 0 0 0 4 ## 191 0 0 0 0 10.16164 NA 0 0 0 0 4 ## 191 0 0 0 0 0.016164 NA 0 0 0 0 1 ## 192 0 0 0 0 0.016164 NA 0 0 0 0 1 ## 193 0 0 0 0 0.02539 NA 0 0 0 0 2 ## 194 0 0 0 0 0.02539 NA 0 0 0 0 2 ## 198 0 0 0 0 0.37742 NA 0 0 0 0 4 ## 196 0 0 0 0 0.037742 NA 0 0 0 0 6 ## 197 0 0 0 0.037742 NA 0 0 0 0 6 ## 199 0 0 0 0 0.055509 NA 1 0 0 0 0 8 ## 199 0 0 0 0 0.055509 NA 1 0 0 0 0 8 ## 199 0 0 0 0 4.588000 NA 0 0 0 0 2 ## 253 0 0 0 4.68000 NA 0 0 0 0 2 ## 253 0 0 0 4.68000 NA 0 0 0 0 2 ## 253 0 0 0 0 4.55276 NA 1 0 0 0 0 2 ## 253 0 0 0 0 10.33013 NA 0 0 0 0 0 2 ## 253 0 0 0 10.33013 NA 0 0 0 0 0 2 ## 253 0 0 0 10.305576 NA 1 0 0 0 0 1 ## 252 0 0 0 0 4.588000 NA 0 0 0 0 0 2 ## 253 0 0 0 10.33013 NA 0 0 0 0 0 2 ## 253 0 0 0 10.33013 NA 0 0 0 0 0 2 ## 253 0 0 0 10.33013 NA 0 0 0 0 0 2 ## 253 0 0 0 10.33013 NA 0 0 0 0 0 2 ## 253 0 0 0 10.335576 NA 0 0 0 0 0 2 ## 253 0 0 0 10.335576 NA 0 0 0 0 0 3 ## 281 0 0 0 10.355276 NA 0 0 0 0 0 2 ## 283 0 1 2 10.355276 NA 1 1 6 50 2 ## 283 0 1 2 10.355276 NA 1 1 3 62 3 ## 281 0 0 0 1.51617 NA 0 0 0 0 0 2 ## 319 0 0 0 1.551900 NA 0 0 0 0 0 2	##	52	0	0	0	3.287588	NA	0	0	0	2	
## 82  0  0  0  6.568857  NA  0  0  0  0  2	##	53	0	0	0	3.510439	NA	0	0	0	3	
## 83  0  0  0  6.994139  NA  0  0  0  0  3	##	81	0	0	0	6.163990	NA	0	0	0	1	
## 91 0 0 0 9.643000 NA 0 0 0 0 1 ## 92 0 0 0 0 9.910000 NA 0 0 0 0 2 ## 93 0 0 0 0 10.140000 NA 0 0 0 0 3 ## 131 0 0 0 4.099903 NA 0 0 0 0 2 ## 133 0 0 0 4.564265 NA 0 0 0 2 ## 134 0 0 0 0 4.143068 NA 0 0 0 0 4 ## 191 0 0 0 0 NA NA 1 0 0 0 0 4 ## 191 0 0 0 0 0.016164 NA 0 0 0 0 1 ## 193 0 0 0 0 0.016164 NA 0 0 0 0 1 ## 193 0 0 0 0 0.018543 NA 0 0 0 0 2 ## 193 0 0 0 0 0.02539 NA 0 0 0 0 2 ## 194 0 0 0 0 0.027402 NA 0 0 0 0 3 ## 194 0 0 0 0 0.037742 NA 0 0 0 0 6 ## 197 0 0 0 0.037742 NA 0 0 0 0 6 ## 199 0 0 0 0.037742 NA 0 0 0 0 7 ## 198 0 0 0 0 0.037742 NA 0 0 0 0 7 ## 198 0 0 0 0 0.050026 NA 0 0 0 0 7 ## 198 0 0 0 0 0.055509 NA 1 0 1 0 1 9 ## 251 0 0 0 0 4.68000 NA 1 0 0 0 0 1 ## 251 0 0 0 0 4.68000 NA 1 0 0 0 0 1 ## 252 0 0 0 0 4.68000 NA 0 0 0 0 2 ## 253 0 0 0 0 4.68000 NA 0 0 0 0 2 ## 273 0 0 0 0 10.330213 NA 0 0 0 0 0 2 ## 273 0 0 0 0 10.330213 NA 1 1 1 1 1 1 ## 282 0 2 4 10.330213 NA 1 1 6 50 2 ## 283 0 1 2 10.355276 NA 0 0 0 0 0 1 ## 288 0 1 1 2 10.355276 NA 1 1 0 0 0 0 1 ## 289 0 0 0 1 1.551900 NA 0 0 0 0 0 1 ## 319 0 0 0 1 1.551900 NA 0 0 0 0 0 0 1 ## 319 0 0 0 0 1.551900 NA 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	##	82	0	0	0	6.568857	NA	0	0	0	2	
## 92  0  0  0  9.910000 NA  0  0  0  2   ## 93  0  0  0  10.140000 NA  0  0  0  0  3   ## 131  0  0  0  4.099903 NA  0  0  0  0  1   ## 133  0  0  0  4.664265 NA  0  0  0  0  3   ## 134  0  0  0  4.564265 NA  0  0  0  0  3   ## 134  0  0  0  0  4.564265 NA  0  0  0  0  3   ## 134  0  0  0  0  4.143068 NA  0  0  0  0  4   ## 160  0  0  0  NA  NA  1  0  0  0  1   ## 191  0  0  0  0  0.016164 NA  0  0  0  0  1   ## 192  0  0  0  0.018543 NA  0  0  0  0  2   ## 193  0  0  0  0.022539 NA  0  0  0  0  3   ## 194  0  0  0  0.022539 NA  0  0  0  0  3   ## 195  0  0  0  0.030755 NA  0  0  0  0  3   ## 197  0  0  0  0.037742 NA  0  0  0  0  6   ## 199  0  0  0  0.044742 NA  0  0  0  0  6   ## 199  0  0  0  0.055009 NA  1  0  0  0  8   ## 200  0  0  0  0.055009 NA  1  0  1  10   ## 230  0  0  0  0  0.055509 NA  1  0  0  0  0  8   ## 251  0  0  0  0  4.68000 NA  1  0  0  0  1   ## 252  0  0  0  0  4.68000 NA  0  0  0  0  2   ## 273  0  0  0  10.330213 NA  0  0  0  0  2   ## 273  0  0  0  10.355276 NA  1  1  1  1	##	83	0	0	0	6.994139	NA	0	0	0	3	
## 93  0  0  0  10.140000 NA  0  0  0  13	##	91	0	0	0	9.643000	NA	0	0	0	1	
## 131 0 0 0 4.099903 NA 0 0 0 0 1 ## 132 0 0 0 4.263393 NA 0 0 0 0 2 ## 133 0 0 0 4.564265 NA 0 0 0 0 3 ## 134 0 0 0 0 4.143068 NA 0 0 0 0 4 ## 160 0 0 0 NA NA 1 0 0 0 1 10 ## 191 0 0 0 0.016164 NA 0 0 0 0 2 ## 193 0 0 0 0.018543 NA 0 0 0 0 2 ## 193 0 0 0 0.022539 NA 0 0 0 0 2 ## 194 0 0 0 0 0.022539 NA 0 0 0 0 3 ## 195 0 0 0 0.033055 NA 0 0 0 0 5 ## 196 0 0 0 0.037402 NA 0 0 0 0 5 ## 197 0 0 0 0.03742 NA 0 0 0 0 5 ## 198 0 0 0 0.050026 NA 0 0 0 0 8 ## 199 0 0 0 0.055509 NA 1 0 0 0 0 8 ## 199 0 0 0 0.055559 NA 1 0 0 0 0 8 ## 200 0 0 0 0.057570 NA 1 0 1 0 1 9 ## 230 0 0 0 0 4.588000 NA 0 0 0 0 1 ## 251 0 0 0 4.588000 NA 0 0 0 0 1 ## 252 0 0 0 4.68000 NA 0 0 0 0 1 ## 253 0 0 0 0 10.330213 NA 0 0 0 0 2 ## 271 0 0 0 0 10.34193 NA 0 0 0 0 0 1 ## 272 0 0 0 10.335276 NA 0 0 0 0 0 3 ## 281 0 0 1 10.304193 NA 1 1 6 50 2 ## 282 0 2 4 10.330213 NA 1 6 50 2 ## 283 0 1 2 10.355276 NA 1 3 62 3 ## 318 0 0 0 0 1.5518617 NA 0 0 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 0 0 2 ## 318 0 0 0 0 1.518617 NA 0 0 0 0 0 0 1	##	92	0	0	0	9.910000	NA	0	0	0	2	
## 132  0  0  0  4.263393  NA  0  0  0  0  2	##	93	0	0	0	10.140000	NA	0	0	0	3	
## 133  0  0  0  4.564265  NA  0  0  0  0  4 ## 134  0  0  0  4.143068  NA  0  0  0  0  4 ## 160  0  0  0  NA  NA  1  0  0  1  10 ## 191  0  0  0  0.016164  NA  0  0  0  0  1 ## 192  0  0  0  0.018543  NA  0  0  0  0  2 ## 193  0  0  0  0.027402  NA  0  0  0  0  3 ## 194  0  0  0  0.027402  NA  0  0  0  0  5 ## 196  0  0  0  0.030055  NA  0  0  0  0  5 ## 197  0  0  0  0.037742  NA  0  0  0  0  6 ## 199  0  0  0  0.044742  NA  0  0  0  0  6 ## 199  0  0  0  0.055509  NA  1  0  0  0  8 ## 199  0  0  0  0.055509  NA  1  0  1  9 ## 230  0  0  0  0.055509  NA  1  0  1  9 ## 230  0  0  0  4.588000  NA  1  0  0  0  1 ## 252  0  0  0  4.68000  NA  0  0  0  0  1 ## 253  0  0  0  4.68000  NA  0  0  0  0  2 ## 273  0  0  0  10.330213  NA  0  0  0  0  2 ## 273  0  0  10.355276  NA  1  1  1  1  1  1 ## 272  0  0  10.355276  NA  1  1  1  1  1  1 ## 281  0  0  1  1.0355276  NA  1  1  1  1  1  1 ## 282  0  2  4  10.330213  NA  1  6  50  2 ## 283  0  1  2  10.355276  NA  1  3  62  3 ## 318  0  0  0  1.477219  NA  0  0  0  0  1 ## 319  0  0  1.477219  NA  0  0  0  0  1 ## 319  0  0  1.477219  NA  0  0  0  0  1 ## 319  0  0  1.558617  NA  0  0  0  0  0  2 ## 320  0  0  1.558617  NA  1  3  62  3 ## 318  0  0  0  1.558617  NA  0  0  0  0  0  1	##	131	0	0	0	4.099903	NA	0	0	0	1	
## 134  0  0  0  0  4.143068 NA  0  0  0  0  4  1  10	##	132	0	0	0	4.263393	NA	0	0	0	2	
## 160 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	##	133	0	0	0	4.564265	NA	0	0	0	3	
## 191 0 0 0 0 0.016164 NA 0 0 0 0 0 1 ## 192 0 0 0 0 0.018543 NA 0 0 0 0 2 ## 193 0 0 0 0.022539 NA 0 0 0 0 3 ## 194 0 0 0 0 0.027402 NA 0 0 0 0 4 ## 195 0 0 0 0 0.030055 NA 0 0 0 0 5 ## 196 0 0 0 0 0.037742 NA 0 0 0 0 0 6 ## 197 0 0 0 0 0.044742 NA 0 0 0 0 0 7 ## 198 0 0 0 0 0.055509 NA 1 0 0 0 0 8 ## 199 0 0 0 0.055509 NA 1 0 0 1 9 ## 200 0 0 0 0.057570 NA 1 0 0 1 9 ## 230 0 0 0 0 4.588000 NA 0 0 0 0 1 ## 251 0 0 0 4.688000 NA 0 0 0 0 1 ## 252 0 0 0 4.68000 NA 0 0 0 0 2 ## 253 0 0 0 0 4.757000 NA 0 0 0 0 2 ## 271 0 0 0 0 10.304193 NA 0 0 0 0 2 ## 272 0 0 0 0 10.330213 NA 0 0 0 0 2 ## 273 0 0 0 10.3355276 NA 1 1 1 41 1 ## 282 0 2 4 10.330213 NA 1 6 50 2 ## 283 0 1 2 10.355276 NA 1 1 3 62 3 ## 318 0 0 0 1.477219 NA 0 0 0 0 2 ## 319 0 0 0 1.5518617 NA 0 0 0 0 2 ## 319 0 0 0 1.561900 NA 0 0 0 0 2 ## 319 0 0 0 1.561900 NA 0 0 0 0 0 2 ## 319 0 0 0 1.561900 NA 0 0 0 0 0 2 ## 319 0 0 0 1.561900 NA 0 0 0 0 0 2	##	134	0	0	0	4.143068	NA	0	0	0	4	
## 192  0  0  0  0.018543 NA  0  0  0  0  2 ## 193  0  0  0  0.022539 NA  0  0  0  0  3 ## 194  0  0  0  0.027402 NA  0  0  0  0  4 ## 195  0  0  0  0.030055 NA  0  0  0  0  5 ## 196  0  0  0  0.037742 NA  0  0  0  0  6 ## 197  0  0  0  0.044742 NA  0  0  0  0  0  7 ## 198  0  0  0  0.055509 NA  1  0  0  0  0  8 ## 199  0  0  0  0.055509 NA  1  0  1  9 ## 200  0  0  0  0.057570 NA  1  0  1  0 ## 230  0  0  0  0.057570 NA  1  0  1  0 ## 251  0  0  0  0  4.588000 NA  0  0  0  0  1 ## 252  0  0  0  4.68000 NA  0  0  0  0  2 ## 253  0  0  0  4.757000 NA  0  0  0  0  2 ## 253  0  0  0  10.304193 NA  0  0  0  0  2 ## 271  0  0  0  10.304193 NA  0  0  0  0  2 ## 272  0  0  0  10.330213 NA  0  0  0  0  2 ## 273  0  0  0  10.3355276 NA  1  1  1  41  1 ## 282  0  2  4  10.330213 NA  1  6  50  2 ## 283  0  1  2  10.355276 NA  1  1  3  62  3 ## 318  0  0  0  1.477219 NA  0  0  0  0  1 ## 319  0  0  1.561900 NA  0  0  0  0  2 ## 319  0  0  0  1.561900 NA  0  0  0  0  2 ## 319  0  0  0  1.561900 NA  0  0  0  0  0	##	160	0	0	0	NA	NA	1	0	1	10	
## 193  0  0  0  0.022539  NA  0  0  0  0  3  ## 194  0  0  0  0  0.027402  NA  0  0  0  0  4  ## 195  0  0  0  0  0.030055  NA  0  0  0  0  5  ## 196  0  0  0  0  0.037742  NA  0  0  0  0  0  6  ## 197  0  0  0  0  0.044742  NA  0  0  0  0  0  7  ## 198  0  0  0  0  0.055509  NA  1  0  0  0  0  8  ## 199  0  0  0  0.055509  NA  1  0  1  9  ## 200  0  0  0  0.055509  NA  1  0  1  9  ## 230  0  0  0  0  0.057570  NA  1  0  0  1  10  ## 251  0  0  0  0  4.588000  NA  0  0  0  0  1  ## 252  0  0  0  4.680000  NA  0  0  0  0  1  ## 253  0  0  0  0  4.757000  NA  0  0  0  0  2  ## 253  0  0  0  10.330213  NA  0  0  0  0  1  ## 272  0  0  0  10.330213  NA  0  0  0  0  2  ## 273  0  0  0  10.330213  NA  0  0  0  0  2  ## 281  0  0  1  10.304193  NA  1  1  1  41  1  ## 282  0  2  4  10.330213  NA  1  1  6  50  2  ## 283  0  1  2  10.355276  NA  1  3  62  3  ## 318  0  0  0  1.477219  NA  0  0  0  0  0  2  ## 319  0  0  0  1.518617  NA  0  0  0  0  0  2  ## 319  0  0  0  1.518617  NA  0  0  0  0  0  3	##	191	0	0	0	0.016164	NA	0	0	0	1	
## 194  0  0  0  0.027402 NA  0  0  0  0  4  ## 195  0  0  0  0.030055 NA  0  0  0  0  5  ## 196  0  0  0  0.037742 NA  0  0  0  0  6  ## 197  0  0  0  0.044742 NA  0  0  0  0  7  ## 198  0  0  0  0.055509 NA  1  0  0  0  8  ## 199  0  0  0  0.055509 NA  1  0  1  9  ## 230  0  0  0  0.057570 NA  1  0  1  10  3  10  ## 251  0  0  0  0  4.588000 NA  0  0  0  0  1  10  4.588000 NA  0  0  0  0  2  ## 253  0  0  0  0  4.680000 NA  0  0  0  0  2  ## 271  0  0  0  10.330213 NA  0  0  0  1  10.304193 NA  0  0  0  0  1  41  11  11  11  11  11	##	192	0	0	0	0.018543	NA	0	0	0	2	
## 195 0 0 0 0 0.030055 NA 0 0 0 0 5  ## 196 0 0 0 0 0.037742 NA 0 0 0 0 6  ## 197 0 0 0 0 0.044742 NA 0 0 0 0 0 7  ## 198 0 0 0 0 0.055509 NA 1 0 0 1 9  ## 200 0 0 0 0.057570 NA 1 0 0 1 10  ## 251 0 0 0 0 4.588000 NA 0 0 0 0 1  ## 252 0 0 0 4.680000 NA 0 0 0 0 2  ## 253 0 0 0 4.757000 NA 0 0 0 0 3  ## 271 0 0 0 10.3304193 NA 0 0 0 0 2  ## 272 0 0 0 10.330213 NA 0 0 0 0 3  ## 273 0 0 0 10.3355276 NA 1 1 41 1  ## 282 0 2 4 10.330213 NA 1 6 50 2  ## 283 0 1 2 10.355276 NA 1 3 62 3  ## 318 0 0 0 1.477219 NA 0 0 0 0 1  ## 319 0 0 0 1.561900 NA 0 0 0 0 2  ## 319 0 0 0 1.561900 NA 0 0 0 0 0 2  ## 319 0 0 0 1.561900 NA 0 0 0 0 0 2  ## 319 0 0 0 1.561900 NA 0 0 0 0 0 3	##	193	0	0	0	0.022539	NA	0	0	0	3	
## 196 0 0 0 0.037742 NA 0 0 0 0 6   ## 197 0 0 0 0 0.044742 NA 0 0 0 0 7   ## 198 0 0 0 0.050026 NA 0 0 0 0 8   ## 199 0 0 0 0.055509 NA 1 0 1 0 1 9   ## 200 0 0 0 0.057570 NA 1 0 0 1 10   ## 230 0 0 0 0 0 NA NA NA 1 0 0 0 1   ## 251 0 0 0 0 4.588000 NA 0 0 0 0 1   ## 252 0 0 0 4.680000 NA 0 0 0 0 2   ## 253 0 0 0 0 4.757000 NA 0 0 0 0 3   ## 271 0 0 0 0 10.304193 NA 0 0 0 0 1   ## 272 0 0 0 0 10.330213 NA 0 0 0 0 2   ## 273 0 0 0 1 10.304193 NA 1 1 1 41 1   ## 282 0 2 4 10.330213 NA 1 6 50 2   ## 283 0 1 2 10.355276 NA 1 6 50 2   ## 283 0 1 2 10.355276 NA 1 3 62 3   ## 318 0 0 0 1.518617 NA 0 0 0 0 0 2   ## 319 0 0 0 1.518617 NA 0 0 0 0 0 2   ## 319 0 0 0 1.561900 NA 0 0 0 0 0 3	##	194	0	0	0	0.027402	NA	0	0	0	4	
## 197 0 0 0 0 0.044742 NA 0 0 0 0 7  ### 198 0 0 0 0 0.055509 NA 1 0 1 9  ## 200 0 0 0 0.057570 NA 1 0 1 10  ## 230 0 0 0 0 0.057570 NA 1 0 0 3 10  ## 251 0 0 0 0 4.588000 NA 0 0 0 0 1  ## 252 0 0 0 4.680000 NA 0 0 0 2  ## 253 0 0 0 0 4.757000 NA 0 0 0 3  ## 271 0 0 0 10.304193 NA 0 0 0 0 1  ## 272 0 0 0 10.330213 NA 0 0 0 0 2  ## 273 0 0 0 10.355276 NA 0 0 0 3  ## 281 0 0 1 10.304193 NA 1 1 41 1  ## 282 0 2 4 10.330213 NA 1 6 50 2  ## 283 0 1 2 10.355276 NA 1 3 62 3  ## 318 0 0 0 1.477219 NA 0 0 0 0 1  ## 319 0 0 0 1.561900 NA 0 0 0 0 3			0	0	0	0.030055	NA	0	0	0	5	
## 198 0 0 0 0 0.050026 NA 0 0 0 0 8   ## 199 0 0 0 0 0.055509 NA 1 0 1 9   ## 200 0 0 0 0.057570 NA 1 0 1 10   ## 230 0 0 0 0 NA NA 1 0 0 0 0 1 10   ## 251 0 0 0 4.588000 NA 0 0 0 0 1   ## 252 0 0 0 4.680000 NA 0 0 0 0 2   ## 253 0 0 0 4.757000 NA 0 0 0 0 3   ## 271 0 0 0 10.304193 NA 0 0 0 0 1   ## 272 0 0 0 10.330213 NA 0 0 0 0 2   ## 273 0 0 0 10.355276 NA 0 0 0 0 3   ## 281 0 0 1 10.304193 NA 1 1 41 1   ## 282 0 2 4 10.330213 NA 1 6 50 2   ## 283 0 1 2 10.355276 NA 1 3 62 3   ## 318 0 0 0 1.477219 NA 0 0 0 0 1   ## 319 0 0 0 1.518617 NA 0 0 0 0 0 2   ## 319 0 0 0 1.561900 NA 0 0 0 0 0 3	##	196	0	0	0	0.037742	NA	0	0	0	6	
## 199 0 0 0 0 0.055509 NA 1 0 1 9 ## 200 0 0 0 0.057570 NA 1 0 1 10 ## 230 0 0 0 0 NA NA 1 0 0 0 0 1 ## 251 0 0 0 0 4.588000 NA 0 0 0 0 1 ## 252 0 0 0 0 4.680000 NA 0 0 0 0 2 ## 273 0 0 0 10.304193 NA 0 0 0 0 3 ## 272 0 0 0 10.355276 NA 0 0 0 3 ## 281 0 0 1 10.304193 NA 1 1 1 41 1 ## 282 0 2 4 10.330213 NA 1 6 50 2 ## 283 0 1 2 10.355276 NA 1 6 50 2 ## 283 0 0 1 2 10.355276 NA 1 3 62 3 ## 318 0 0 0 1.477219 NA 0 0 0 0 2 ## 319 0 0 0 1.518617 NA 0 0 0 0 2 ## 320 0 0 0 1.561900 NA 0 0 0 0 3	##	197	0	0	0	0.044742	NA	0	0	0	7	
## 200 0 0 0 0.057570 NA 1 0 1 10 ## 230 0 0 0 0 NA NA NA 1 0 3 10 ## 251 0 0 0 4.588000 NA 0 0 0 0 1 ## 252 0 0 0 4.680000 NA 0 0 0 0 2 ## 253 0 0 0 4.757000 NA 0 0 0 0 3 ## 271 0 0 0 10.304193 NA 0 0 0 0 1 ## 272 0 0 0 10.330213 NA 0 0 0 0 2 ## 273 0 0 0 10.355276 NA 0 0 0 3 ## 281 0 0 1 10.304193 NA 1 1 1 41 1 ## 282 0 2 4 10.330213 NA 1 6 50 2 ## 283 0 1 2 10.355276 NA 1 3 62 3 ## 318 0 0 0 1.477219 NA 0 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 0 2 ## 320 0 0 0 1.561900 NA 0 0 0 0 3			0	0	0		NA	0	0	0	8	
## 230 0 0 0 0 NA NA 1 0 3 10 ## 251 0 0 0 4.588000 NA 0 0 0 0 1 ## 252 0 0 0 4.680000 NA 0 0 0 0 2 ## 253 0 0 0 4.757000 NA 0 0 0 0 3 ## 271 0 0 0 10.304193 NA 0 0 0 0 1 ## 272 0 0 0 10.330213 NA 0 0 0 0 2 ## 273 0 0 0 10.355276 NA 0 0 0 3 ## 281 0 0 1 10.304193 NA 1 1 1 41 1 ## 282 0 2 4 10.330213 NA 1 6 50 2 ## 283 0 1 2 10.355276 NA 1 3 62 3 ## 318 0 0 0 1.477219 NA 0 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 0 2 ## 320 0 0 0 1.561900 NA 0 0 0 0 3			0	0	0		NA	1		1		
## 251 0 0 0 4.588000 NA 0 0 0 0 1 ## 252 0 0 0 4.680000 NA 0 0 0 0 2 ## 253 0 0 0 4.757000 NA 0 0 0 0 3 ## 271 0 0 0 10.304193 NA 0 0 0 0 1 ## 272 0 0 0 10.330213 NA 0 0 0 0 2 ## 281 0 0 1 10.304193 NA 1 1 1 41 1 ## 282 0 2 4 10.330213 NA 1 1 6 50 2 ## 283 0 1 2 10.355276 NA 1 3 62 3 ## 318 0 0 0 1.477219 NA 0 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 0 2 ## 320 0 0 0 1.561900 NA 0 0 0 0 3												
## 252 0 0 0 4.680000 NA 0 0 0 2 ## 253 0 0 0 4.757000 NA 0 0 0 0 3 ## 271 0 0 0 10.304193 NA 0 0 0 0 1 ## 272 0 0 0 10.330213 NA 0 0 0 0 2 ## 273 0 0 0 10.355276 NA 0 0 0 0 3 ## 281 0 0 1 10.304193 NA 1 1 1 41 1 ## 282 0 2 4 10.330213 NA 1 6 50 2 ## 283 0 1 2 10.355276 NA 1 3 62 3 ## 318 0 0 0 1.477219 NA 0 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 0 2 ## 320 0 0 0 1.561900 NA 0 0 0 0 3												
## 253 0 0 0 4.757000 NA 0 0 0 0 3  ## 271 0 0 0 10.304193 NA 0 0 0 0 1  ## 272 0 0 0 10.330213 NA 0 0 0 2  ## 273 0 0 0 10.355276 NA 0 0 0 3  ## 281 0 0 1 10.304193 NA 1 1 1 41 1  ## 282 0 2 4 10.330213 NA 1 6 50 2  ## 283 0 1 2 10.355276 NA 1 3 62 3  ## 318 0 0 0 1.477219 NA 0 0 0 0 1  ## 319 0 0 0 1.518617 NA 0 0 0 0 3												
## 271 0 0 0 10.304193 NA 0 0 0 0 1 ## 272 0 0 0 10.330213 NA 0 0 0 0 2 ## 273 0 0 0 10.355276 NA 0 0 0 0 3 ## 281 0 0 1 10.304193 NA 1 1 1 41 1 ## 282 0 2 4 10.330213 NA 1 6 50 2 ## 283 0 1 2 10.355276 NA 1 3 62 3 ## 318 0 0 0 1.477219 NA 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 0 2 ## 320 0 0 0 1.561900 NA 0 0 0 0 3												
## 272 0 0 0 10.330213 NA 0 0 0 2 ## 273 0 0 0 10.355276 NA 0 0 0 0 3 ## 281 0 0 1 10.304193 NA 1 1 1 41 1 ## 282 0 2 4 10.330213 NA 1 6 50 2 ## 283 0 1 2 10.355276 NA 1 3 62 3 ## 318 0 0 0 1.477219 NA 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 2 ## 320 0 0 0 1.561900 NA 0 0 0 3												
## 273 0 0 0 10.355276 NA 0 0 0 0 3 ## 281 0 0 1 10.304193 NA 1 1 1 41 1 ## 282 0 2 4 10.330213 NA 1 6 50 2 ## 283 0 1 2 10.355276 NA 1 3 62 3 ## 318 0 0 0 1.477219 NA 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 2 ## 320 0 0 0 1.561900 NA 0 0 0 3												
## 281 0 0 1 10.304193 NA 1 1 1 41 1 ## 282 0 2 4 10.330213 NA 1 6 50 2 ## 283 0 1 2 10.355276 NA 1 3 62 3 ## 318 0 0 0 1.477219 NA 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 0 2 ## 320 0 0 0 1.561900 NA 0 0 0 0 3												
## 282 0 2 4 10.330213 NA 1 6 50 2 ## 283 0 1 2 10.355276 NA 1 3 62 3 ## 318 0 0 0 1.477219 NA 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 2 ## 320 0 0 0 1.561900 NA 0 0 0 3												
## 283 0 1 2 10.355276 NA 1 3 62 3 ## 318 0 0 0 1.477219 NA 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 2 ## 320 0 0 0 1.561900 NA 0 0 0 3												
## 318 0 0 0 1.477219 NA 0 0 0 1 ## 319 0 0 0 1.518617 NA 0 0 0 2 ## 320 0 0 0 1.561900 NA 0 0 0 3												
## 319 0 0 0 1.518617 NA 0 0 0 2 ## 320 0 0 0 1.561900 NA 0 0 3												
## 320 0 0 0 1.561900 NA 0 0 3												
## 321 0 0 0 1.533091 NA 1 0 19 4												
	##	321	0	0	0	1.533091	ΝA	1	0	19	4	

## 328	0	0	0	35.241209	NA	0	0	0	1
## 368	0	0	0	4.467700	NA	0	0	0	1
## 369	0	0	0	4.622200	NA	0	0	0	2
## 370	0	0	0	4.790700	NA	0	0	0	3
## 418	0	0	0	0.104131	NA	0	0	0	1
## 419	0	0	0	0.113961	NA	0	0	0	2
## 420	0	0	0	0.124677	NA	1	0	1	3
## 477	0	0	0	58.307457	NA	0	0	0	4
## 534	. 0	0	0	14.898332	NA	0	0	0	1
## 535	0	0	0	15.599590	NA	0	0	0	2
## 536	0	0	0	16.130832	NA	0	0	0	3
## 554	. 0	0	0	3.617400	NA	0	0	0	1
## 555	0	0	0	3.916400	NA	0	0	0	2
## 556	0	0	0	4.218400	NA	0	0	0	3
## 564	. 0	0	0	2.511701	NA	0	0	0	1
## 565	0	0	0	2.562047	NA	0	0	0	2
## 574	. 0	0	0	2.605294	NA	1	0	3	1
## 575	0	0	0	2.667229	NA	1	0	4	2
## 592	0	0	0	0.036120	NA	1	0	7	9
## 594	. 0	0	0	3.413202	NA	0	0	0	1
## 595	0	0	0	3.514205	NA	0	0	0	2
## 596	0	0	0	3.655049	NA	0	0	0	3
## 614	. 0	0	0	1.895727	NA	0	0	0	1
## 615	0	0	0	1.939913	NA	0	0	0	2
## 616	0	0	0	1.995338	NA	0	0	0	3
## 654	. 0	0	0	3.397000	NA	0	0	0	1
## 655	0	0	0	3.536000	NA	0	0	0	2
## 656	0	0	0	3.659000	NA	0	0	0	3
## 674	. 0	0	0	1.689621	NA	1	0	3	1
## 684	. 0	0	0	0.579088	NA	0	0	0	1
## 685	0	0	0	0.591105	NA	0	0	0	2
## 686	0	0	0	0.607814	NA	0	0	0	3
## 687	0	0	0	0.616630	NA	0	0	0	4
## 688	0	0	0	0.615521	NA	0	0	0	5
## 689	0	0	0	0.611947	NA	0	0	0	6
## 738	0	0	0	17.372172	NA	0	0	0	1
## 739	0	0	0	18.488002	NA	1	0	6	2
## 740	0	0	0	19.610518	NA	1	0	6	3
## 741	. 0	0	1	20.838090	NA	1	1	20	4
## 742	0	0	0	21.478552	NA	0	0	0	5
## 743	0	0	0	22.444993	NA	1	0	8	6
## 744	. 0	0	0	23.248059	NA	0	0	0	7
## 745	0	0	0	23.969917	NA	1	0	6	8
## 746	0	0	0	24.500520	NA	1	0	2	9
## 747	0	0	0	24.763188	NA	0	0	0	10
## 798		0	0	35.574150	NA	1	0	30	1
## 799		0	0	36.904134	NA	1	0	30	2
## 828	0	0	0	22.242653	NA	1	0	35	1
## 829	0	0	0	22.655940	NA	1	0	19	2
## 838		0	0	139.010000	NA	0	0	0	1
## 839	0	0	0	142.745000	NA	0	0	0	2
## 840	0	0	0	146.857000	NA	0	0	0	3

##	848	0	0	0	0.021397	NA	0	0	0	1
##	849	0	0	0	0.022514	NA	1	0	3	2
##	850	0	0	0	0.023571	NA	1	0	5	3
##	851	0	0	0	0.024766	NA	1	0	3	4
##	852	0	0	0	0.025402	NA	1	0	3	5
##	853	0	0	0	0.026321	NA	0	0	0	6
##	856	0	0	0	0.030861	NA	1	0	1	9
##	868	0	0	0	0.000000	NA	0	0	0	1
##	869	0	0	0	0.000000	NA	0	0	0	2
##	870	0	0	0	0.000000	NA	0	0	0	3
##	871	0	0	0	7.646424	NA	0	0	0	4
##	872	0	0	0	7.734639	NA	0	0	0	5
##	878	0	0	0	0.000000	NA	0	0	0	1
##	879	0	0	0	0.000000	NA	0	0	0	2
##	880	0	0	0	0.000000	NA	0	0	0	3
##	881	0	0	0	7.646424	NA	0	0	0	4
##	882	0	0	0	7.734639	NA	0	0	0	5
##	886	0	0	0	4.979815	NA	0	0	0	1
##	896	0	0	0	1.901315	NA	0	0	0	1
##	897	0	0	0	1.932154	NA	0	0	0	2
##	898	0	0	0	1.995196	NA	0	0	0	3
##	926	10	6	6	4.701961	NA	1	22	86	1
##	927	6	10	9	5.315479	NA	1	25	99	2
##	928	11	9	9	5.738763	NA	1	29	119	3
##	969	0	0	0	3.917642	NA	0	0	0	1
##	970	0	0	0	4.400743	NA	0	0	0	2
##	971	0	0	0	5.008827	NA	0	0	0	3
##	989	0	0	0	0.580730	NA	0	0	0	1
##	990	0	0	0	0.638938	NA	0	0	0	2
##	991	0	0	0	0.711794	NA	0	0	0	3
##	992	0	0	0	0.804803	NA	0	0	0	4
##	993	0	0	0	0.853716	NA	0	0	0	5
##	994	0	0	0	0.853069	NA	0	0	0	6
##	1043	0	0	0	0.107317	NA	1	0	8	5
##	1044	0	0	0	0.108535	NA	1	0	7	6
##	1045	0	0	0	0.108208	NA	1	0	8	7
##	1046	0	0	0	0.107700	NA	1	0	1	8
##	1047	0	0	0	0.106267	NA	0	0	0	9
##	1048	0	0	0	0.105275	NA	1	0	1	10
##	1049	0	0	0	49.973757	NA	0	0	0	1
##	1050	0	0	0	50.754000	NA	0	0	0	2
##	1059	9	6	8	NA	NA	1	23	129	4
##	1080	0	0	0	16.026812	NA	0	0	0	1
##	1081	0	0	0	17.778956	NA	0	0	0	2
##	1082	0	0	0	19.606739	NA	0	0	0	3
	1100	0	2	3	0.000000	NA	1	5	80	1
	1101	2	1	1	0.000000	NA	1	4	84	2
	1102	2	4	2	0.000000	NA	1	8	116	3
	1103	0	0	0	7.906977	NA	1	0	15	1
	1104	0	1	0	9.276622	NA	1	1	71	2
	1105	0	2	1	10.815614	NA	1	3	23	3
	1110	0	0	0	NA	NA	0	0	0	8
										•

```
## 1111 0 0 0 22.763008 NA 0 0 0 9 ## 1112 0 0 0 NA NA 0 0 0 10
```

```
summary(GDP_missing$medals)
```

```
## Min. 1st Qu. Median Mean 3rd Qu. Max.
## 0.0000 0.0000 0.0000 0.8397 0.0000 29.0000
```

We find that more than 75% countries with a missing GDP have no medal. Also, there are some outliers with GDP > 10 but gaining few medals, let's watch the data.

```
GDP_valid = Olympics[!is.na(Olympics$GDP), ]
GDP_outlier = GDP_valid[GDP_valid$GDP > 4 & GDP_valid$medals < 2, ]</pre>
```

```
dim(GDP_outlier)
```

```
## [1] 39 16
```

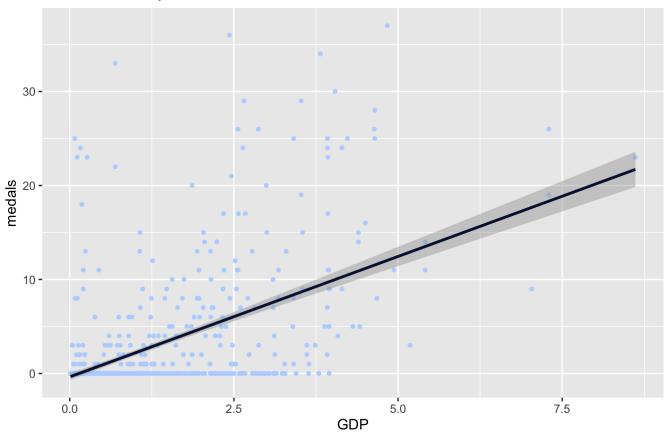
There are 39 observations out of 966 valid observations (GDP captured) being outliers, which can be droped. This is because in some small countries with pretty low or no tax, some big international firms set headquarters there to avoid high tax which leads to a ridiculous high GDP.

```
GDP_trimmed = GDP_valid[!(GDP_valid$GDP > 4 & GDP_valid$medals <2), ]</pre>
```

```
ggplot(data = GDP_trimmed, aes(x = GDP, y = medals), na.rm = TRUE)+
  geom_point(size = 1, color = '#b8d5ff')+
  labs(title = "The relationship between GDP and number of medels", caption = "Based on
data from Olympics_HW.csv")+
  geom_smooth(method = lm, color = '#05133d')
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

### The relationship between GDP and number of medels



Based on data from Olympics\_HW.csv

After trimming, our model performs better when GDP gets larger. As a result, GDP data are positively correlated to the number of medals. It infers that athletes in countries more developed are trained better and perform better in competitions.

# g)

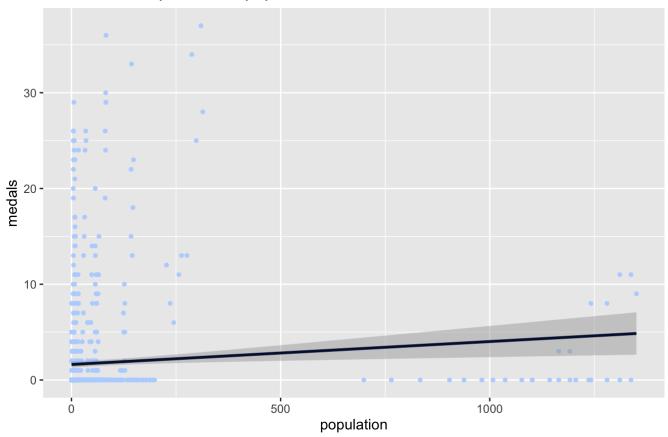
```
ggplot(data = Olympics, aes(x = population, y = medals), na.rm = TRUE)+
  geom_point(size = 1, color = '#b8d5ff')+
  labs(title = "The relationship between population and number of medels", caption = "Ba
sed on data from Olympics_HW.csv")+
  geom_smooth(method = lm, color = '#05133d')
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

```
## Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).
```

```
## Warning: Removed 9 rows containing missing values (`geom_point()`).
```

#### The relationship between population and number of medels



Based on data from Olympics\_HW.csv

Intuitively, there could be some relationship between population and number of medals because when there is a large population there might be more people perform well on sports leading to a higher number in medals. However, because the measurements between medals and population differs a lot, the relationship is not significant.

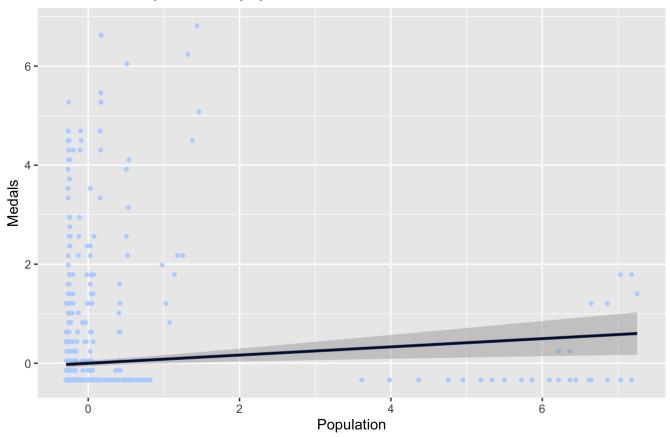
```
g5 = as.data.frame(cbind(scale(Olympics$population), scale(Olympics$medals)))
colnames(g5) = c('Population', 'Medals')
ggplot(data = g5, aes(x = Population, y = Medals), na.rm = TRUE)+
   geom_point(size = 1, color = '#b8d5ff')+
   labs(title = "The relationship between population and number of medels", caption = "Ba
sed on data from Olympics_HW.csv")+
   geom_smooth(method = lm, color = '#05133d')
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

```
## Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).
```

```
## Warning: Removed 9 rows containing missing values (`geom_point()`).
```

### The relationship between population and number of medels



Based on data from Olympics\_HW.csv

It can be found by the plot that population and methods are not linearly correlated. There are two groups mainly devided by population, for the group with lower population teams tend to earn more madels.

```
unique(Olympics[Olympics$medals >10 & Olympics$population < 500, 'country'])</pre>
                          "Canada"
                                                            "Finland"
    [1] "Austria"
                                           "East Germany"
    [5] "France"
                          "Germany"
                                           "Italy"
                                                            "Netherlands"
                          "Russia"
                                                            "Soviet Union"
    [9] "Norway"
                                           "South Korea"
## [13] "Sweden"
                          "Switzerland"
                                                            "United States"
                                           NA
```

```
## [1] "China" NA
```

unique(Olympics[Olympics\$medals >10 & Olympics\$population > 500, 'country'])

The countries earn more medals in each cohort are all countries more developed.

### h)

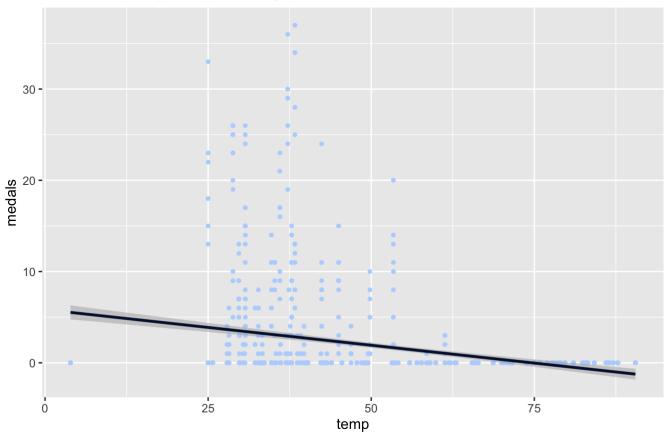
```
ggplot(data = Olympics, aes(x = temp, y = medals), na.rm = TRUE)+
  geom_point(size = 1, color = '#b8d5ff')+
  labs(title = "The relationship between temperature and number of medels", caption = "B
ased on data from Olympics_HW.csv")+
  geom_smooth(method = lm, color = '#05133d')
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

```
## Warning: Removed 22 rows containing non-finite values (`stat_smooth()`).
```

```
## Warning: Removed 22 rows containing missing values (`geom_point()`).
```

### The relationship between temperature and number of medels



Based on data from Olympics\_HW.csv

For countries with highest temperature too high or too low, it is harder for them to win medals.