

Lab 1

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You should have RStudio installed to edit this file. You will write code in places marked “TO-DO” to complete the problems. Most of this will be a pure programming assignment but there are some questions that instead ask you to “write a few sentences”. This is a W class! The tools for the solutions to these problems can be found in the class practice lectures. I prefer you to use the methods I taught you. If you google and find esoteric code you don’t understand, this doesn’t do you too much good.

To “hand in” the homework, you should first download this file. The best way to do this is by cloning the class repository then copying this file from the folder of that clone into the folder that is your personal class repository. Then do the assignment by filling in the TO-DO’s. After you’re done, compile this file into a PDF (use the “knit to PDF” button on the submenu above). This PDF will include output of your code. Then push the PDF and this Rmd file by the deadline to your github repository in a directory called “labs”.

Basic R Skills

- Print out the numerical constant pi with ten digits after the decimal point using the internal constant pi.

```
options(digits=11)
x <- pi
x
```

```
## [1] 3.1415926536
```

- Sum up the first 103 terms of the series $1 + 1/2 + 1/4 + 1/8 + \dots$

```
sum(1/(2^(0:102)))
```

```
## [1] 2
```

- Find the product of the first 37 terms in the sequence $1/3, 1/6, 1/9 \dots$

```
prod(1/(3*(1:37)))
```

```
## [1] 1.613528728e-61
```

```
prod(1/seq(from=3, by=3, length.out=37))
```

```
## [1] 1.613528728e-61
```

- Find the product of the first 387 terms of $1 * 1/2 * 1/4 * 1/8 * \dots$

```
prod(1/(2^(0:386)))
```

```
## [1] 0
```

Is this answer *exactly* correct?

#TO-DO

- Figure out a means to express the answer more exactly. Not compute exactly, but express more exactly.

```
sum(log(1/(2^(0:386))))
```

```
## [1] -51771.856063
```

```
-log(2)*sum(0:386)
```

```
## [1] -51771.856063
```

- Create the sequence $x = [\text{Inf}, 20, 18, \dots, -20]$.

```
x <- c(Inf, seq(from=20, to=-20, by=-2))
x
```

```
## [1] Inf 20 18 16 14 12 10 8 6 4 2 0 -2 -4 -6 -8 -10 -12 -14
```

```
## [20] -16 -18 -20
```

Create the sequence $x = [\log_3(\text{Inf}), \log_3(100), \log_3(98), \dots, \log_3(-20)]$.

```
x <- c(Inf, seq(from=100, to=-20, by=-2))
x <- log(x, base=3)
```

```
## Warning: NaNs produced
```

```
log(100, 3)
```

```
## [1] 4.1918065486
```

Comment on the appropriateness of the non-numeric values.

NAN occurs because you cannot take the log of a negative number. -Inf occurs when you take the log of 0.

- Create a vector of booleans where the entry is true if $x[i]$ is positive and finite.

```
y = !is.nan(x) & is.finite(x) & x > 0
y
```

```
## [1] FALSE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE
```

```
## [13] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE
```

```
## [25] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE
```

```
## [37] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE
```

```
## [49] TRUE TRUE TRUE FALSE FALSE FALSE FALSE FALSE FALSE FALSE FALSE
```

```
## [61] FALSE FALSE
```

- Locate the indices of the non-real numbers in this vector. Hint: use the `which` function. Don't hesitate to use the documentation via `?which`.

```
?which
which(!y)
```

```
## [1] 1 52 53 54 55 56 57 58 59 60 61 62
```

```
which(y == FALSE)
```

```
## [1] 1 52 53 54 55 56 57 58 59 60 61 62
```

- Locate the indices of the infinite quantities in this vector.

```
which(is.infinite(x))
```

```
## [1] 1 52
```

- Locate the indices of the min and max in this vector. Hint: use the `which.min` and `which.max` functions.

```
which.min(x)
```

```
## [1] 52
```

```
which.max(x)
```

```
## [1] 1
```

- Count the number of unique values in `x`.

```
length(unique(x))
```

```
## [1] 53
```

- Cast `x` to a factor. Do the number of levels make sense?

```
as.factor(x)
```

```
## [1] Inf 4.19180654857877 4.1734172518943 4.15464876785729
## [5] 4.13548512895119 4.11590933734319 4.09590327428938 4.07544759935851
## [9] 4.05452163806914 4.03310325630434 4.01116871959141 3.98869253500376
## [13] 3.96564727304425 3.94200336638929 3.91772888178973 3.89278926071437
## [17] 3.86714702345081 3.84076143030548 3.81358809221559 3.78557852142874
## [21] 3.75667961082847 3.72683302786084 3.69597450568212 3.66403300987579
## [25] 3.63092975357146 3.59657702661571 3.56087679500731 3.52371901428583
## [29] 3.48497958377173 3.44451784578705 3.40217350273288 3.3577627814323
## [33] 3.31107361281783 3.26185950714291 3.20983167673402 3.15464876785729
## [37] 3.09590327428938 3.03310325630434 2.96564727304425 2.89278926071437
## [41] 2.8135880922156 2.72683302786084 2.63092975357146 2.52371901428583
## [45] 2.40217350273288 2.26185950714291 2.09590327428938 1.89278926071437
## [49] 1.63092975357146 1.26185950714291 0.630929753571457 -Inf
## [53] NaN NaN NaN NaN
## [57] NaN NaN NaN NaN
## [61] NaN NaN
## 53 Levels: -Inf 0.630929753571457 1.26185950714291 ... NaN
```

- Cast `x` to integers. What do we learn about R's infinity representation in the integer data type?

```
as.integer(x)
```

```
## Warning: NAs introduced by coercion to integer range
```

```
## [1] NA 4 4 4 4 4 4 4 4 4 4 3 3 3 3 3 3 3 3 3 3 3
## [26] 3 3 3 3 3 3 3 3 3 3 3 3 3 2 2 2 2 2 2 2 2 1 1 1
## [51] 0 NA NA NA NA NA NA NA NA NA NA NA NA
```

- Use `x` to create a new vector `y` containing only the real numbers in `x`.

```
y = x[!is.nan(x) & is.finite(x)]
```

```
y
```

```
## [1] 4.19180654858 4.17341725189 4.15464876786 4.13548512895 4.11590933734
## [6] 4.09590327429 4.07544759936 4.05452163807 4.03310325630 4.01116871959
## [11] 3.98869253500 3.96564727304 3.94200336639 3.91772888179 3.89278926071
## [16] 3.86714702345 3.84076143031 3.81358809222 3.78557852143 3.75667961083
## [21] 3.72683302786 3.69597450568 3.66403300988 3.63092975357 3.59657702662
## [26] 3.56087679501 3.52371901429 3.48497958377 3.44451784579 3.40217350273
## [31] 3.35776278143 3.31107361282 3.26185950714 3.20983167673 3.15464876786
## [36] 3.09590327429 3.03310325630 2.96564727304 2.89278926071 2.81358809222
## [41] 2.72683302786 2.63092975357 2.52371901429 2.40217350273 2.26185950714
```

```
## [46] 2.09590327429 1.89278926071 1.63092975357 1.26185950714 0.63092975357
```

- Use the left rectangle method to numerically integrate x^2 from 0 to 1 with rectangle width size $1e-6$.

```
sum(seq(from=0, to=1-(1e-6), by=1e-6)^2)*1e-6
```

```
## [1] 0.33333283333
```

- Calculate the average of 100 realizations of standard Bernoullis in one line using the `sample` function.

```
sum(sample(c(0,1), size=100, replace=TRUE))/100
```

```
## [1] 0.48
```

- Calculate the average of 500 realizations of Bernoullis with $p = 0.9$ in one line using the `sample` and `mean` functions.

```
sum(sample(c(0,1), size=500, replace=TRUE, prob=c(0.1, 0.9)))/500
```

```
## [1] 0.88
```

- Calculate the average of 1000 realizations of Bernoullis with $p = 0.9$ in one line using `rbinom`.

```
?rbinom
```

```
mean(rbinom(n=1000, size = 1, prob = 0.9))
```

```
## [1] 0.892
```

- In class we considered a variable `x_3` which measured “criminality”. We imagined $L = 4$ levels “none”, “infraction”, “misdemeanor” and “felony”. Create a variable `x_3` here with 100 random elements (equally probable). Create it as a nominal (i.e. unordered) factor.

```
x_3 = as.factor(sample(c("none", "infraction", "misdemeanor", "felony"), size=100, replace=TRUE))
x_3
```

```
## [1] misdemeanor none infraction infraction misdemeanor felony
## [7] infraction misdemeanor none none none infraction
## [13] misdemeanor none none misdemeanor misdemeanor misdemeanor
## [19] felony felony none felony felony misdemeanor
## [25] misdemeanor infraction felony felony felony infraction
## [31] misdemeanor infraction infraction misdemeanor felony infraction
## [37] infraction felony misdemeanor infraction felony infraction
## [43] none felony felony misdemeanor felony none
## [49] felony infraction infraction infraction none felony
## [55] infraction none infraction infraction none felony
## [61] infraction felony none misdemeanor infraction infraction
## [67] none infraction felony none none none
## [73] infraction misdemeanor infraction felony infraction felony
## [79] felony none felony none felony infraction
## [85] felony felony felony misdemeanor infraction felony
## [91] infraction none misdemeanor none infraction infraction
## [97] none infraction none none
## Levels: felony infraction misdemeanor none
```

- Use `x_3` to create `x_3_bin`, a binary feature where 0 is no crime and 1 is any crime.

```
x_3_bin = x_3 != "none"
x_3_bin
```

```
## [1] TRUE FALSE TRUE TRUE TRUE TRUE TRUE TRUE FALSE FALSE FALSE TRUE
## [13] TRUE FALSE FALSE TRUE TRUE TRUE TRUE TRUE FALSE TRUE TRUE TRUE
## [25] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE
```

```
## [37] TRUE TRUE TRUE TRUE TRUE TRUE FALSE TRUE TRUE TRUE TRUE FALSE
## [49] TRUE TRUE TRUE TRUE FALSE TRUE TRUE FALSE TRUE TRUE FALSE TRUE
## [61] TRUE TRUE FALSE TRUE TRUE TRUE FALSE TRUE TRUE FALSE FALSE FALSE
## [73] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE FALSE TRUE FALSE TRUE TRUE
## [85] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE FALSE TRUE FALSE TRUE TRUE
## [97] FALSE TRUE FALSE FALSE
```

- Use `x_3` to create `x_3_ord`, an ordered factor variable. Ensure the proper ordinal ordering.

```
x_3_ord = factor(x_3, levels = c("none", "infraction", "misdemeanor", "felony"), order=TRUE)
x_3_ord
```

```
## [1] misdemeanor none infraction infraction misdemeanor felony
## [7] infraction misdemeanor none none none infraction
## [13] misdemeanor none none misdemeanor misdemeanor misdemeanor
## [19] felony felony none felony felony misdemeanor
## [25] misdemeanor infraction felony felony felony infraction
## [31] misdemeanor infraction infraction misdemeanor felony infraction
## [37] infraction felony misdemeanor infraction felony infraction
## [43] none felony felony misdemeanor felony none
## [49] felony infraction infraction infraction none felony
## [55] infraction none infraction infraction none felony
## [61] infraction felony none misdemeanor infraction infraction
## [67] none infraction felony none none none
## [73] infraction misdemeanor infraction felony infraction felony
## [79] felony none felony none felony infraction
## [85] felony felony felony misdemeanor infraction felony
## [91] infraction none misdemeanor none infraction infraction
## [97] none infraction none none
## Levels: none < infraction < misdemeanor < felony
```

- Convert this variable into three binary variables without any information loss and put them into a data matrix.

```
dm = matrix(NA, nrow = 100, ncol = 3)
dm[,1] = as.numeric(x_3=="infraction")
dm[,2] = as.numeric(x_3=="felony")
dm[,3] = as.numeric(x_3=="misdemeanor")
colnames(dm) = c("infraction", "felony", "misdemeanor")
dm
```

```
##      infraction felony misdemeanor
## [1,]          0      0            1
## [2,]          0      0            0
## [3,]          1      0            0
## [4,]          1      0            0
## [5,]          0      0            1
## [6,]          0      1            0
## [7,]          1      0            0
## [8,]          0      0            1
## [9,]          0      0            0
## [10,]         0      0            0
## [11,]         0      0            0
## [12,]          1      0            0
## [13,]          0      0            1
## [14,]          0      0            0
## [15,]          0      0            0
```

##	[16,]	0	0	1
##	[17,]	0	0	1
##	[18,]	0	0	1
##	[19,]	0	1	0
##	[20,]	0	1	0
##	[21,]	0	0	0
##	[22,]	0	1	0
##	[23,]	0	1	0
##	[24,]	0	0	1
##	[25,]	0	0	1
##	[26,]	1	0	0
##	[27,]	0	1	0
##	[28,]	0	1	0
##	[29,]	0	1	0
##	[30,]	1	0	0
##	[31,]	0	0	1
##	[32,]	1	0	0
##	[33,]	1	0	0
##	[34,]	0	0	1
##	[35,]	0	1	0
##	[36,]	1	0	0
##	[37,]	1	0	0
##	[38,]	0	1	0
##	[39,]	0	0	1
##	[40,]	1	0	0
##	[41,]	0	1	0
##	[42,]	1	0	0
##	[43,]	0	0	0
##	[44,]	0	1	0
##	[45,]	0	1	0
##	[46,]	0	0	1
##	[47,]	0	1	0
##	[48,]	0	0	0
##	[49,]	0	1	0
##	[50,]	1	0	0
##	[51,]	1	0	0
##	[52,]	1	0	0
##	[53,]	0	0	0
##	[54,]	0	1	0
##	[55,]	1	0	0
##	[56,]	0	0	0
##	[57,]	1	0	0
##	[58,]	1	0	0
##	[59,]	0	0	0
##	[60,]	0	1	0
##	[61,]	1	0	0
##	[62,]	0	1	0
##	[63,]	0	0	0
##	[64,]	0	0	1
##	[65,]	1	0	0
##	[66,]	1	0	0
##	[67,]	0	0	0
##	[68,]	1	0	0
##	[69,]	0	1	0

```
## [70,]      0      0      0
## [71,]      0      0      0
## [72,]      0      0      0
## [73,]      1      0      0
## [74,]      0      0      1
## [75,]      1      0      0
## [76,]      0      1      0
## [77,]      1      0      0
## [78,]      0      1      0
## [79,]      0      1      0
## [80,]      0      0      0
## [81,]      0      1      0
## [82,]      0      0      0
## [83,]      0      1      0
## [84,]      1      0      0
## [85,]      0      1      0
## [86,]      0      1      0
## [87,]      0      1      0
## [88,]      0      0      1
## [89,]      1      0      0
## [90,]      0      1      0
## [91,]      1      0      0
## [92,]      0      0      0
## [93,]      0      0      1
## [94,]      0      0      0
## [95,]      1      0      0
## [96,]      1      0      0
## [97,]      0      0      0
## [98,]      1      0      0
## [99,]      0      0      0
## [100,]     0      0      0
```

- What should the sum of each row be (in English)?

The sum should be either 0 or 1 because there is only one place to put an object.

Verify that.

```
table(rowSums(dm))
```

```
##
##  0  1
## 24 76
```

- How should the column sum look (in English)?

The column sum should be the average of it.

Verify that.

```
colSums(dm)
```

```
##  infraction      felony misdimeanor
##         31         28         17
```

- Generate a matrix with 100 rows where the first column is realization from a normal with mean 17 and variance 38, the second column is uniform between -10 and 10, the third column is poisson with mean 6, the fourth column in exponential with lambda of 9, the fifth column is binomial with $n = 20$ and p

= 0.12 and the sixth column is a binary variable with exactly 24% 1's dispersed randomly. Name the rows the entries of the `fake_first_names` vector.

```
n = 100
dm = matrix(data = NA, nrow = 100, ncol = 6)
dm[, 1] = rnorm(n = 100, mean = 17, sd = sqrt(38))
dm[, 2] = runif(n = 100, min = -10, max = 10)
dm[, 3] = rpois(100, lambda = 6)
dm[, 4] = rexp(100, rate = 9)
dm[, 5] = rbinom(100, size = 20, prob = 0.12)
dm[, 6] = sample(c(rep(1, 100 * .24), rep(0, 100 * .76)))

fake_first_names = c(
  "Sophia", "Emma", "Olivia", "Ava", "Mia", "Isabella", "Riley",
  "Aria", "Zoe", "Charlotte", "Lily", "Layla", "Amelia", "Emily",
  "Madelyn", "Aubrey", "Adalyn", "Madison", "Chloe", "Harper",
  "Abigail", "Aaliyah", "Avery", "Evelyn", "Kaylee", "Ella", "Ellie",
  "Scarlett", "Arianna", "Hailey", "Nora", "Addison", "Brooklyn",
  "Hannah", "Mila", "Leah", "Elizabeth", "Sarah", "Eliana", "Mackenzie",
  "Peyton", "Maria", "Grace", "Adeline", "Elena", "Anna", "Victoria",
  "Camilla", "Lillian", "Natalie", "Jackson", "Aiden", "Lucas",
  "Liam", "Noah", "Ethan", "Mason", "Caden", "Oliver", "Elijah",
  "Grayson", "Jacob", "Michael", "Benjamin", "Carter", "James",
  "Jayden", "Logan", "Alexander", "Caleb", "Ryan", "Luke", "Daniel",
  "Jack", "William", "Owen", "Gabriel", "Matthew", "Connor", "Jayce",
  "Isaac", "Sebastian", "Henry", "Muhammad", "Cameron", "Wyatt",
  "Dylan", "Nathan", "Nicholas", "Julian", "Eli", "Levi", "Isaiah",
  "Landon", "David", "Christian", "Andrew", "Brayden", "John",
  "Lincoln"
)
rownames(dm) = fake_first_names
dm
```

##		[,1]	[,2]	[,3]	[,4]	[,5]	[,6]
##	Sophia	17.54928771090	5.34042522311	3	0.10271038673351	1	0
##	Emma	0.19182247492	0.61634591315	10	0.00632791096965	1	0
##	Olivia	19.84636010926	-9.91067714524	9	0.00475300475955	0	0
##	Ava	17.69433438175	6.16778148338	5	0.03831697159179	3	0
##	Mia	18.92278286266	0.62492778990	4	0.11880615053025	1	0
##	Isabella	13.78629734545	9.58562670276	4	0.00312147398169	2	0
##	Riley	18.05020407378	1.86199675314	6	0.02038148852686	0	0
##	Aria	22.79926709357	-3.61391960178	6	0.04005485742042	1	1
##	Zoe	18.85359387389	-6.23387802392	4	0.01424645803248	4	0
##	Charlotte	19.91159398002	4.41789312288	4	0.00732750057356	1	0
##	Lily	11.38417575588	4.53122995794	5	0.08275628037698	2	0
##	Layla	23.29053284931	9.61214485113	3	0.33905671477038	3	0
##	Amelia	20.42617688837	6.52854292654	6	0.21962930364636	3	0
##	Emily	18.91117764926	2.20562695526	8	0.30736309723149	2	0
##	Madelyn	24.58004626370	5.64892426599	6	0.17292336021755	3	0
##	Aubrey	18.41678769605	5.53872570395	10	0.09282622692847	2	0
##	Adalyn	21.90983750013	9.84805882443	7	0.00859323242265	2	0
##	Madison	11.33482617461	3.03066402208	6	0.22869204273549	1	0
##	Chloe	19.77157364236	-7.38537315279	4	0.15216485058629	1	1
##	Harper	24.21048758799	9.07374157105	3	0.14396959304757	5	0
##	Abigail	17.43611304045	9.96615650132	8	0.00240885678303	3	0

## Aaliyah	28.38356663317	-6.81306775194	11	0.00086431779588	2	0
## Avery	14.47053701715	5.95456657000	8	0.01442831411280	5	0
## Evelyn	34.14183548138	-5.41813993361	4	0.05131655346809	4	0
## Kaylee	26.41910948906	0.91664713342	4	0.00595314743825	4	0
## Ella	10.19741484020	-3.98787671234	6	0.09696421450986	4	1
## Ellie	29.51635026572	9.76334387902	6	0.18242056670529	2	1
## Scarlett	10.46302868994	-0.95144893974	7	0.08954510682106	3	0
## Arianna	10.59410461719	8.05679266341	5	0.01687416185935	2	0
## Hailey	13.16823017951	2.42528904695	2	0.06462184355284	2	0
## Nora	12.48543071865	-0.83103242330	4	0.18538113617484	2	0
## Addison	23.72795863308	-7.65016706195	9	0.01739838542850	2	1
## Brooklyn	13.89383826564	2.14168890379	8	0.17758841356581	3	0
## Hannah	20.00269725277	0.80532898661	12	0.13933185342646	2	0
## Mila	14.44026605604	1.42922556493	4	0.24736393899249	0	0
## Leah	22.69093802364	-7.64390768949	3	0.28597123240339	2	0
## Elizabeth	18.52207930489	-1.78274101578	5	0.46204751293014	0	0
## Sarah	19.24357712665	-9.50255497359	9	0.15381478776482	4	0
## Eliana	7.84698869921	0.61623455491	4	0.00229181282158	3	0
## Mackenzie	22.19482500721	-9.93781551253	6	0.00965389774905	4	0
## Peyton	14.68406783002	-5.52150362171	6	0.00506208676638	0	0
## Maria	12.77980391928	0.25882489979	7	0.18071823897355	4	1
## Grace	17.68470221271	-7.59666495956	2	0.07989055507660	8	0
## Adeline	20.00602444541	1.77680191118	4	0.00871432344947	4	0
## Elena	15.04631849560	6.51061561424	6	0.03062972183236	3	0
## Anna	11.64789273317	0.25021679234	3	0.03270333812560	1	0
## Victoria	17.74269837958	-2.43655897677	6	0.11336350887352	0	1
## Camilla	16.63637820332	2.95811146032	6	0.20573988121311	3	0
## Lillian	14.18448979597	9.08997670282	4	0.25190132792881	4	0
## Natalie	25.55283133471	0.42731798254	8	0.06649833369172	2	0
## Jackson	19.65885025040	7.60414412245	6	0.13920596562273	2	0
## Aiden	15.07370976299	-5.84121128079	11	0.10205640829633	2	1
## Lucas	24.42831088081	-9.99172050040	9	0.02278946754005	0	1
## Liam	17.66096122830	-9.62120617740	7	0.10512958132064	3	0
## Noah	21.71765453817	-0.36664448678	3	0.05625371029601	3	0
## Ethan	20.26534868079	-9.67012327164	4	0.11857743828321	6	0
## Mason	8.13889126601	-5.27562704403	9	0.17892560486059	5	1
## Caden	12.10102240710	4.66923533008	3	0.06143424204654	1	0
## Oliver	12.85050965909	6.80016945116	11	0.00494537921622	2	1
## Elijah	24.08151953500	0.54052844178	10	0.02048341578080	3	0
## Grayson	25.78031825099	2.11512596346	6	0.00159476061613	3	1
## Jacob	17.36769835603	-5.53313406650	6	0.14120759017713	3	1
## Michael	11.43057447220	-2.35364898574	5	0.03083834134870	0	0
## Benjamin	16.85256265255	9.93156379554	8	0.29254705926394	3	1
## Carter	8.69324487815	5.33602301963	6	0.01648281017939	2	0
## James	22.06703007316	8.21274235845	3	0.01304361803664	2	0
## Jayden	15.62571919060	1.12849625293	5	0.09613961694916	1	0
## Logan	23.91871915045	5.85906969849	3	0.27246283345180	3	0
## Alexander	27.77112558259	8.66758899763	9	0.14165856588565	0	0
## Caleb	16.89120469400	2.42806761060	7	0.11393404919826	4	0
## Ryan	14.52966917635	-6.78095351439	7	0.06853930595227	2	0
## Luke	17.65804201013	0.64911399037	7	0.04668542996256	2	0
## Daniel	10.58364610474	-7.37628079019	7	0.05465578691413	4	0
## Jack	12.22283908217	-0.49541513436	12	0.17680735450546	5	0
## William	30.40638942498	9.30853319354	8	0.10127761918171	1	1

```
## Owen      14.99089317385 -3.19846231490    7 0.01324230179855    4    0
## Gabriel   14.62539343944  9.26881806925    9 0.07182999012164    0    1
## Matthew   14.40729027384  6.73603523988    7 0.08913452188121    1    1
## Connor    11.50342219488 -3.96934771445    4 0.17424257970284    3    0
## Jayce     19.32871592810  5.46591060702    8 0.11038803297699    3    0
## Isaac     18.39900668815  5.24630306754    3 0.18324226160738    3    0
## Sebastian 15.54148163434 -5.49946785904    7 0.02019709731556    1    0
## Henry     23.04711664271 -9.13966649212    2 0.15445250996179    5    1
## Muhammad  20.94053991613  7.78502007946   12 0.28242941095853    5    1
## Cameron   23.18399917658  8.99470190518    3 0.01060529389522    1    0
## Wyatt     13.21560380821  2.50631682575    3 0.02083754016914    8    0
## Dylan      7.01077085814 -8.60474792775    7 0.20865585964481    2    1
## Nathan    15.17323397528 -3.04599201772    4 0.00769415220512    5    0
## Nicholas  22.04008365727  0.52912691142    4 0.11603032196923    3    0
## Julian    16.04449628956 -9.28625253960    4 0.00119884068974    3    1
## Eli       20.40687718531  4.09064825624    8 0.01772703266599    2    0
## Levi      14.17802052009 -1.90271978267    7 0.02126213494274    0    1
## Isaiah    21.50200985580  1.52438860387    8 0.19619715647459    5    0
## Landon    15.41290586220  5.02238866873    9 0.42654521160805    1    0
## David     18.71921774056 -3.08319239877    9 0.00467439124542    6    0
## Christian 20.13662312133 -3.05063036736    6 0.02975478693881    5    1
## Andrew    17.15979198167  0.88979264721    4 0.00442614328737    3    1
## Brayden   13.16447293303 -0.43712871615    6 0.01350349011934    3    0
## John      15.86937453076 -9.88149298821    5 0.29556849618180    1    0
## Lincoln   21.19567384734 -0.47891529277    3 0.10020453782492    2    0
```

#TO-DO

- Create a data frame of the same data as above except make the binary variable a factor “DOMESTIC” vs “FOREIGN” for 0 and 1 respectively. Use RStudio’s View function to ensure this worked as desired.

```
?data.frame
d_frame = data.frame(dm)
?factor
d_frame$ X6 = factor(d_frame$X6, levels = c(0,1), labels = c("DOMESTIC", "FOREIGN"))
?View
#View(d_frame) knit was not allowing me to use view function
```

- Print out a table of the binary variable. Then print out the proportions of “DOMESTIC” vs “FOREIGN”.

```
?print
?table
print(table(d_frame$X6))
```

```
##
## DOMESTIC FOREIGN
##      76      24
```

```
print(table(d_frame$X6)/n)
```

```
##
## DOMESTIC FOREIGN
##      0.76      0.24
```

Print out a summary of the whole dataframe.

```
?summary
(summary(d_frame))
```

```
##           X1                X2                X3
## Min.      : 0.19182247   Min.      : -9.99172050   Min.      : 2.00
## 1st Qu.:14.18287248   1st Qu.: -3.97397996   1st Qu.: 4.00
## Median :17.67283172   Median : 0.72722149   Median : 6.00
## Mean      :17.72617839   Mean      : 0.57188339   Mean      : 6.11
## 3rd Qu.:21.27225785   3rd Qu.: 5.48411438   3rd Qu.: 8.00
## Max.      :34.14183548   Max.      : 9.96615650   Max.      :12.00
##           X4                X5                X6
## Min.      :0.0008643178   Min.      :0.00   DOMESTIC:76
## 1st Qu.:0.0167763239   1st Qu.:1.00   FOREIGN :24
## Median :0.0813234177   Median :2.00
## Mean      :0.1023720233   Mean      :2.57
## 3rd Qu.:0.1590702225   3rd Qu.:3.25
## Max.      :0.4620475129   Max.      :8.00
```

- Let $n = 50$. Create a $n \times n$ matrix R of exactly 50% entries 0's, 25% 1's 25% 2's. These values should be in random locations.

```
?matrix
n=50
R = matrix(sample(c(rep(0,2500 * 0.5), rep(1,2500 * 0.25), replicate(2,2500 * 0.25))), nrow = 50, ncol = 50)

## Warning in matrix(sample(c(rep(0, 2500 * 0.5), rep(1, 2500 * 0.25),
## replicate(2, : data length [1877] is not a sub-multiple or multiple of the
## number of rows [50])
print(R)
```

```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13]
## [1,]    0    1    1    1    0    1    1    0    0    0    0    1    0
## [2,]    0    1    0    1    0    0    0    0    0    1    1    0    1
## [3,]    1    0    1    1    1    0    1    0    0    1    0    1    1
## [4,]    1    1    0    0    0    0    0    0    0    0    1    0    1
## [5,]    1    1    1    1    0    1    0    1    0    1    1    1    1
## [6,]    0    1    0    0    1    0    0    1    0    0    0    0    0
## [7,]    1    1    0    0    1    0    0    0    0    1    1    0    0
## [8,]    0    0    1    1    0    0    0    0    1    0    1    1    0
## [9,]    0    0    0    1    0    0    0    0    0    0    0    1    0
## [10,]   0    1    1    0    0    0    1    1    0    0    0    1    0
## [11,]   1    1    0    0    1    0    0    0    0    0    1    0    0
## [12,]   1    1    1    0    1    0    0    0    1    0    0    1    1
## [13,]   0    1    0    0    1    1    0    1    0    0    0    0    0
## [14,]   0    0    0    0    0    1    0    0    1    0    0    0    0
## [15,]   1    0    1    0    1    0    0    1    1    0    1    0    0
## [16,]   1    0    1    0    0    1    0    0    0    0    0    1    1
## [17,]   1    1    0    0    1    0    0    0    0    0    1    0    1
## [18,]   0    0    0    0    0    1    0    0    1    0    0    0    0
## [19,]   0    0    0    0    0    1    0    0    0    0    1    0    0
## [20,]   0    0    0    0    1    0    0    0    0    0    0    1    1
## [21,]   0    0    1    1    0    0    0    0    0    0    1    1    0
## [22,]   0    0    1    0    0    1    0    0    0    1    1    0    0
## [23,]   1    0    1    1    0    0    0    0    0    1    0    0    1
## [24,]   0    1    0    0    0    0    0    0    1    0    0    0    1
## [25,]   1    0    0    0    1    1    1    0    0    0    1    1    1
## [26,]   0    0    1    0    1    1    0    1    0    0    0    1    1
## [27,]   0    1    1    1    0    1    0    0    1    0    1    0    1
```

## [28,]	1	0	0	1	1	1	0	0	0	0	0	0	0
## [29,]	1	0	0	0	1	1	1	1	1	0	1	1	0
## [30,]	0	1	1	0	0	0	1	1	0	0	0	0	0
## [31,]	1	0	1	1	1	0	1	0	0	1	0	1	0
## [32,]	0	0	0	0	0	1	1	0	0	1	0	0	0
## [33,]	0	0	0	1	0	0	1	0	0	0	0	0	1
## [34,]	0	0	0	0	0	0	0	0	0	1	0	0	0
## [35,]	0	0	1	1	0	0	1	0	1	1	1	0	0
## [36,]	1	0	1	0	1	1	0	0	1	1	0	1	0
## [37,]	1	0	1	0	0	0	0	1	0	0	0	1	0
## [38,]	1	1	1	1	1	0	0	1	0	0	0	0	0
## [39,]	0	0	0	1	1	0	0	0	0	1	1	0	0
## [40,]	0	0	0	1	0	0	1	0	1	1	0	1	1
## [41,]	1	1	0	0	1	1	625	1	1	1	0	0	0
## [42,]	0	1	0	0	0	0	1	1	0	1	0	1	0
## [43,]	0	0	0	1	0	0	0	0	1	0	0	1	0
## [44,]	0	0	0	1	1	0	0	1	0	0	0	1	0
## [45,]	1	1	0	1	1	0	1	0	0	1	1	0	1
## [46,]	0	0	0	0	1	0	1	0	0	0	0	1	1
## [47,]	0	0	1	0	1	0	0	1	1	0	0	1	0
## [48,]	0	0	0	0	0	0	0	1	1	0	1	1	1
## [49,]	0	0	0	1	1	1	0	0	1	0	1	0	0
## [50,]	0	1	0	0	0	1	0	0	0	0	0	1	0
##	[,14]	[,15]	[,16]	[,17]	[,18]	[,19]	[,20]	[,21]	[,22]	[,23]	[,24]	[,25]	
## [1,]	1	0	0	1	0	0	0	0	0	1	0	0	
## [2,]	0	0	0	1	1	0	0	1	0	1	0	0	
## [3,]	0	0	0	0	1	0	0	0	1	0	0	1	
## [4,]	0	1	1	0	0	0	0	0	0	1	1	0	
## [5,]	0	1	1	0	0	1	1	0	0	0	0	1	
## [6,]	0	0	1	0	0	0	1	1	0	0	1	0	
## [7,]	0	1	1	1	0	0	1	0	0	0	1	0	
## [8,]	1	0	0	0	1	0	1	0	0	0	0	0	
## [9,]	0	0	0	0	0	0	1	0	0	1	0	1	
## [10,]	0	0	1	1	0	1	1	0	1	0	0	0	
## [11,]	1	1	0	0	0	0	0	0	0	1	0	0	
## [12,]	1	0	0	0	1	1	0	1	0	0	1	0	
## [13,]	1	0	0	0	0	0	0	0	0	0	0	1	
## [14,]	0	0	1	1	0	0	0	0	0	1	0	1	
## [15,]	0	1	0	0	0	0	0	0	0	1	1	0	
## [16,]	0	0	0	1	0	0	0	0	0	0	1	1	
## [17,]	0	0	0	1	0	1	0	1	0	0	0	0	
## [18,]	0	0	0	0	0	0	0	0	0	0	0	0	
## [19,]	0	0	0	1	0	0	0	0	0	0	1	0	
## [20,]	0	0	0	1	1	0	1	1	0	0	0	0	
## [21,]	1	0	1	0	0	0	0	1	1	0	1	0	
## [22,]	1	1	0	1	0	0	0	1	0	0	1	0	
## [23,]	1	0	0	1	0	0	0	1	0	0	1	0	
## [24,]	0	1	1	1	1	0	1	0	1	0	0	0	
## [25,]	1	0	0	0	0	0	1	0	0	0	0	0	
## [26,]	1	0	0	0	0	1	0	0	0	1	1	0	
## [27,]	1	1	1	0	0	0	0	0	1	0	1	0	
## [28,]	0	0	0	0	1	0	0	0	1	0	0	1	
## [29,]	0	0	1	0	0	0	0	1	0	1	1	0	
## [30,]	0	1	0	0	0	0	0	1	0	0	1	0	

## [31,]	0	1	0	0	1	0	0	0	0	0	0	0
## [32,]	1	1	0	0	0	0	1	0	0	0	0	0
## [33,]	0	0	0	0	0	0	0	0	0	1	0	1
## [34,]	1	1	0	0	0	1	1	0	1	0	0	0
## [35,]	0	1	1	1	0	0	0	0	1	0	0	0
## [36,]	0	0	1	0	0	1	0	0	0	0	0	1
## [37,]	1	0	0	1	0	0	0	1	0	0	0	0
## [38,]	0	0	0	0	1	0	1	1	0	0	1	0
## [39,]	1	0	1	0	0	0	0	0	0	0	0	1
## [40,]	1	0	1	1	1	1	1	0	1	1	0	1
## [41,]	0	0	0	1	0	0	0	0	1	0	0	0
## [42,]	0	0	0	0	0	1	0	0	1	0	0	0
## [43,]	0	1	1	0	0	0	0	1	0	0	1	0
## [44,]	0	0	0	0	0	1	0	0	1	1	0	0
## [45,]	1	0	1	0	0	0	0	1	0	0	0	0
## [46,]	0	0	0	1	0	0	0	1	0	0	0	0
## [47,]	1	0	0	0	0	0	0	1	0	0	0	0
## [48,]	0	1	0	1	1	0	0	1	0	1	0	0
## [49,]	0	0	1	1	1	0	0	1	1	1	0	0
## [50,]	1	1	1	1	0	1	0	0	0	1	0	0
##	[,26]	[,27]	[,28]	[,29]	[,30]	[,31]	[,32]	[,33]	[,34]	[,35]	[,36]	[,37]
## [1,]	0	0	0	0	0	0	0	0	0	0	0	0
## [2,]	1	0	1	0	0	0	1	0	1	0	0	1
## [3,]	0	0	0	1	0	1	0	0	1	0	0	0
## [4,]	0	0	1	0	1	0	1	0	0	0	0	0
## [5,]	0	0	0	1	0	0	0	1	0	0	0	1
## [6,]	0	0	0	0	0	1	0	0	1	0	0	0
## [7,]	1	1	0	1	1	0	1	0	0	1	0	1
## [8,]	0	0	1	1	0	0	0	0	0	0	0	0
## [9,]	0	0	1	0	0	0	0	1	0	1	1	0
## [10,]	0	1	1	1	0	0	0	0	0	0	0	0
## [11,]	0	1	1	0	1	0	1	0	0	0	0	0
## [12,]	0	0	1	0	0	0	1	0	1	1	0	1
## [13,]	1	1	1	1	1	0	1	0	0	0	1	1
## [14,]	1	1	1	0	0	0	0	0	0	1	1	0
## [15,]	1	0	0	1	1	0	1	0	1	0	1	0
## [16,]	0	0	1	1	1	1	0	0	1	0	0	0
## [17,]	0	0	1	0	1	0	1	1	0	0	0	0
## [18,]	0	0	0	0	1	0	0	0	0	1	0	1
## [19,]	0	0	0	0	1	1	0	0	0	1	0	0
## [20,]	1	1	1	0	0	1	0	0	1	0	0	0
## [21,]	0	1	0	0	1	1	1	0	1	0	0	0
## [22,]	1	0	0	0	1	0	0	0	0	0	0	1
## [23,]	0	0	1	0	0	0	1	1	0	1	0	1
## [24,]	0	0	0	1	0	1	0	0	1	0	1	0
## [25,]	0	0	0	0	0	0	1	0	0	1	0	0
## [26,]	0	0	1	1	0	1	1	0	0	0	1	0
## [27,]	1	0	0	0	0	1	0	1	0	1	0	0
## [28,]	0	0	0	0	0	1	0	0	0	0	0	0
## [29,]	0	0	0	1	1	1	1	0	0	0	0	0
## [30,]	0	1	0	0	0	1	1	0	0	0	0	0
## [31,]	0	0	0	1	0	0	0	0	0	0	1	1
## [32,]	0	0	1	0	0	0	0	1	0	0	0	0
## [33,]	1	0	0	1	1	0	0	0	0	0	0	1

## [34,]	0	0	0	0	1	1	0	0	0	1	1	1
## [35,]	0	0	0	1	0	0	1	0	1	0	0	0
## [36,]	0	0	1	0	0	0	1	1	0	1	0	1
## [37,]	0	0	1	1	1	0	0	0	0	0	0	0
## [38,]	1	0	1	0	0	0	1	0	0	1	0	0
## [39,]	0	1	0	0	1	0	0	0	0	1	0	1
## [40,]	0	0	0	1	1	0	0	0	1	0	0	0
## [41,]	1	0	0	0	0	1	0	0	0	0	0	0
## [42,]	1	0	1	0	0	1	0	0	1	0	1	1
## [43,]	1	0	0	0	0	0	1	1	0	0	0	0
## [44,]	1	0	1	0	1	625	0	1	1	1	0	1
## [45,]	1	0	0	1	1	0	0	1	0	0	0	0
## [46,]	0	0	0	0	0	0	0	1	0	0	0	1
## [47,]	0	1	0	1	0	1	0	0	0	0	0	1
## [48,]	0	1	0	0	0	1	0	1	0	0	0	0
## [49,]	1	1	1	0	1	1	1	0	0	1	0	0
## [50,]	0	1	1	0	0	1	0	0	0	0	1	0
##	[,38]	[,39]	[,40]	[,41]	[,42]	[,43]	[,44]	[,45]	[,46]	[,47]	[,48]	[,49]
## [1,]	1	0	1	0	0	0	0	0	0	1	0	0
## [2,]	0	1	0	0	0	1	1	1	0	0	0	1
## [3,]	0	0	0	1	0	1	1	0	1	0	0	0
## [4,]	0	0	1	1	1	0	1	0	0	1	0	1
## [5,]	0	1	0	0	1	1	1	0	0	0	0	0
## [6,]	0	1	0	0	0	1	1	1	1	1	0	1
## [7,]	1	0	1	1	0	0	0	1	1	0	0	0
## [8,]	0	1	0	1	1	1	0	1	0	0	1	0
## [9,]	0	0	0	0	0	0	1	1	0	0	1	0
## [10,]	0	0	0	0	1	0	0	1	0	0	0	0
## [11,]	0	0	0	0	0	0	0	0	0	0	1	0
## [12,]	1	0	0	1	1	0	0	1	0	1	1	1
## [13,]	0	1	0	1	0	1	1	0	0	1	1	0
## [14,]	0	1	0	1	0	0	0	0	1	0	0	0
## [15,]	0	1	1	1	1	1	0	0	1	0	0	0
## [16,]	1	0	0	0	1	1	0	0	0	0	1	1
## [17,]	0	0	0	0	1	0	0	1	0	1	1	0
## [18,]	0	1	1	0	0	1	1	625	1	1	1	0
## [19,]	0	0	1	0	0	0	0	1	1	0	1	0
## [20,]	0	0	0	0	1	0	0	0	0	1	0	0
## [21,]	1	0	0	0	1	1	0	0	1	0	0	0
## [22,]	0	1	1	0	1	1	0	1	0	0	1	1
## [23,]	0	0	0	0	0	1	0	1	0	0	0	0
## [24,]	1	0	0	1	0	1	0	0	1	1	0	0
## [25,]	1	0	0	0	0	0	0	0	1	1	0	1
## [26,]	0	0	0	0	1	1	1	0	0	1	0	1
## [27,]	1	0	1	0	0	0	1	0	0	0	0	0
## [28,]	0	1	1	1	0	1	1	0	0	0	0	1
## [29,]	0	1	0	1	0	0	0	0	0	1	1	0
## [30,]	1	0	1	1	1	0	1	0	0	1	0	1
## [31,]	1	1	0	0	0	0	0	0	0	0	1	0
## [32,]	1	1	1	1	0	1	0	1	0	1	1	1
## [33,]	0	1	0	0	1	0	0	1	0	0	0	0
## [34,]	1	1	0	0	1	0	0	0	0	1	1	0
## [35,]	0	0	1	1	0	0	0	0	1	0	1	1
## [36,]	0	0	0	1	0	0	0	0	0	0	0	1

## [37,]	0	1	1	0	0	0	1	1	0	0	0	1
## [38,]	1	1	0	0	1	0	0	0	0	0	1	0
## [39,]	1	1	1	0	1	0	0	0	1	0	0	1
## [40,]	0	1	0	0	1	1	0	1	0	0	0	0
## [41,]	0	0	0	0	0	1	0	0	1	0	0	0
## [42,]	1	0	1	0	1	0	0	1	1	0	1	0
## [43,]	1	0	1	0	0	1	0	0	0	0	0	1
## [44,]	1	1	0	0	1	0	0	0	0	0	1	0
## [45,]	0	0	0	0	0	1	0	0	1	0	0	0
## [46,]	0	0	0	0	0	1	0	0	0	0	1	0
## [47,]	0	0	0	0	1	0	0	0	0	0	0	1
## [48,]	0	0	1	1	0	0	0	0	0	0	1	1
## [49,]	0	0	1	0	0	1	0	0	0	1	1	0
## [50,]	1	0	1	1	0	0	0	0	0	1	0	0
##	[,50]											
## [1,]	0											
## [2,]	1											
## [3,]	1											
## [4,]	0											
## [5,]	0											
## [6,]	1											
## [7,]	0											
## [8,]	1											
## [9,]	0											
## [10,]	0											
## [11,]	0											
## [12,]	0											
## [13,]	1											
## [14,]	1											
## [15,]	0											
## [16,]	0											
## [17,]	1											
## [18,]	0											
## [19,]	1											
## [20,]	1											
## [21,]	1											
## [22,]	0											
## [23,]	1											
## [24,]	1											
## [25,]	1											
## [26,]	0											
## [27,]	1											
## [28,]	0											
## [29,]	1											
## [30,]	1											
## [31,]	1											
## [32,]	1											
## [33,]	0											
## [34,]	0											
## [35,]	0											
## [36,]	0											
## [37,]	0											
## [38,]	0											
## [39,]	1											

```
## [40,] 0
## [41,] 0
## [42,] 0
## [43,] 1
## [44,] 1
## [45,] 0
## [46,] 0
## [47,] 1
## [48,] 0
## [49,] 0
## [50,] 1
```

- Randomly punch holes (i.e. NA) values in this matrix so that an each entry is missing with probability 30%.

```
n = 100
X = matrix(rnorm(100^2), nrow = 100, ncol = 100)
for (i in 1 : n){
  for (j in 1 : n){
    if (runif(1) < 0.3){
      X[i,j] = NA
    }
  }
}
?NA
sum(is.na(X))/(100^2)
```

```
## [1] 0.3077
```

- Sort the rows in matrix R by the largest row sum to lowest. Be careful about the NA's!

```
?sort
?rowSums
?order
R = R[order(rowSums(R, na.rm=TRUE), decreasing = TRUE), ]
R
```

```
##      [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11] [,12] [,13]
## [1,] 0    0    0    1    1    0    0    1    0    0    0    1    0
## [2,] 1    1    0    0    1    1    625  1    1    1    0    0    0
## [3,] 0    0    0    0    0    1    0    0    1    0    0    0    0
## [4,] 1    1    1    0    1    0    0    0    1    0    0    1    1
## [5,] 1    1    1    1    0    1    0    1    0    1    1    1    1
## [6,] 1    1    0    0    1    0    0    0    0    1    1    0    0
## [7,] 0    0    0    1    0    0    1    0    1    1    0    1    1
## [8,] 0    0    0    1    1    1    0    0    1    0    1    0    0
## [9,] 0    1    0    0    1    1    0    1    0    0    0    0    0
## [10,] 1    0    1    0    1    0    0    1    1    0    1    0    0
## [11,] 1    0    0    0    1    1    1    1    1    0    1    1    0
## [12,] 0    1    0    1    0    0    0    0    0    1    1    0    1
## [13,] 0    0    1    0    1    1    0    1    0    0    0    1    1
## [14,] 0    1    1    1    0    1    0    0    1    0    1    0    1
## [15,] 1    0    1    1    1    0    1    0    0    1    0    1    1
## [16,] 0    0    1    1    0    0    0    0    0    0    1    1    0
## [17,] 0    0    1    0    0    1    0    0    0    1    1    0    0
## [18,] 0    1    0    0    0    0    0    0    1    0    0    0    1
## [19,] 0    1    0    0    0    0    1    1    0    1    0    1    0
```


## [20,]	1	0	1	0	0	1	0	0	0	0	0	1	1
## [21,]	0	1	1	0	0	0	1	1	0	0	0	0	0
## [22,]	0	0	0	0	0	1	1	0	0	1	0	0	0
## [23,]	0	0	1	1	0	0	1	0	1	1	1	0	0
## [24,]	1	1	1	1	1	0	0	1	0	0	0	0	0
## [25,]	0	0	0	1	1	0	0	0	0	1	1	0	0
## [26,]	0	1	0	0	0	1	0	0	0	0	0	1	0
## [27,]	1	1	0	0	0	0	0	0	0	0	1	0	1
## [28,]	0	1	0	0	1	0	0	1	0	0	0	0	0
## [29,]	0	0	1	1	0	0	0	0	1	0	1	1	0
## [30,]	1	1	0	0	1	0	0	0	0	0	1	0	1
## [31,]	1	0	1	1	0	0	0	0	0	1	0	0	1
## [32,]	1	0	1	0	1	1	0	0	1	1	0	1	0
## [33,]	1	1	0	1	1	0	1	0	0	1	1	0	1
## [34,]	0	0	0	0	0	0	0	1	1	0	1	1	1
## [35,]	1	0	0	0	1	1	1	0	0	0	1	1	1
## [36,]	1	0	1	1	1	0	1	0	0	1	0	1	0
## [37,]	0	0	0	0	0	0	0	0	0	1	0	0	0
## [38,]	0	1	1	0	0	0	1	1	0	0	0	1	0
## [39,]	0	0	0	0	0	1	0	0	1	0	0	0	0
## [40,]	0	0	0	0	1	0	0	0	0	0	0	1	1
## [41,]	1	0	1	0	0	0	0	1	0	0	0	1	0
## [42,]	0	0	0	1	0	0	0	0	1	0	0	1	0
## [43,]	1	0	0	1	1	1	0	0	0	0	0	0	0
## [44,]	0	0	1	0	1	0	0	1	1	0	0	1	0
## [45,]	0	1	1	1	0	1	1	0	0	0	0	1	0
## [46,]	0	0	0	1	0	0	0	0	0	0	0	1	0
## [47,]	1	1	0	0	1	0	0	0	0	0	1	0	0
## [48,]	0	0	0	0	0	1	0	0	0	0	1	0	0
## [49,]	0	0	0	1	0	0	1	0	0	0	0	0	1
## [50,]	0	0	0	0	1	0	1	0	0	0	0	1	1
##	[,14]	[,15]	[,16]	[,17]	[,18]	[,19]	[,20]	[,21]	[,22]	[,23]	[,24]	[,25]	
## [1,]	0	0	0	0	0	0	1	0	0	1	1	0	0
## [2,]	0	0	0	1	0	0	0	0	0	1	0	0	0
## [3,]	0	0	0	0	0	0	0	0	0	0	0	0	0
## [4,]	1	0	0	0	1	1	0	1	0	0	0	1	0
## [5,]	0	1	1	0	0	1	1	0	0	0	0	0	1
## [6,]	0	1	1	1	0	0	1	0	0	0	0	1	0
## [7,]	1	0	1	1	1	1	1	0	1	1	1	0	1
## [8,]	0	0	1	1	1	0	0	1	1	1	1	0	0
## [9,]	1	0	0	0	0	0	0	0	0	0	0	0	1
## [10,]	0	1	0	0	0	0	0	0	0	0	1	1	0
## [11,]	0	0	1	0	0	0	0	1	0	1	1	1	0
## [12,]	0	0	0	1	1	0	0	1	0	1	0	0	0
## [13,]	1	0	0	0	0	1	0	0	0	0	1	1	0
## [14,]	1	1	1	0	0	0	0	0	0	1	0	1	0
## [15,]	0	0	0	0	1	0	0	0	0	1	0	0	1
## [16,]	1	0	1	0	0	0	0	1	1	0	0	1	0
## [17,]	1	1	0	1	0	0	0	1	0	0	0	1	0
## [18,]	0	1	1	1	1	0	1	0	1	0	0	0	0
## [19,]	0	0	0	0	0	1	0	0	1	0	0	0	0
## [20,]	0	0	0	1	0	0	0	0	0	0	0	1	1
## [21,]	0	1	0	0	0	0	0	1	0	0	0	1	0
## [22,]	1	1	0	0	0	0	0	1	0	0	0	0	0

## [23,]	0	1	1	1	0	0	0	0	1	0	0	0
## [24,]	0	0	0	0	1	0	1	1	0	0	1	0
## [25,]	1	0	1	0	0	0	0	0	0	0	0	1
## [26,]	1	1	1	1	0	1	0	0	0	1	0	0
## [27,]	0	1	1	0	0	0	0	0	0	1	1	0
## [28,]	0	0	1	0	0	0	1	1	0	0	1	0
## [29,]	1	0	0	0	1	0	1	0	0	0	0	0
## [30,]	0	0	0	1	0	1	0	1	0	0	0	0
## [31,]	1	0	0	1	0	0	0	1	0	0	1	0
## [32,]	0	0	1	0	0	1	0	0	0	0	0	1
## [33,]	1	0	1	0	0	0	0	1	0	0	0	0
## [34,]	0	1	0	1	1	0	0	1	0	1	0	0
## [35,]	1	0	0	0	0	0	1	0	0	0	0	0
## [36,]	0	1	0	0	1	0	0	0	0	0	0	0
## [37,]	1	1	0	0	0	1	1	0	1	0	0	0
## [38,]	0	0	1	1	0	1	1	0	1	0	0	0
## [39,]	0	0	1	1	0	0	0	0	0	1	0	1
## [40,]	0	0	0	1	1	0	1	1	0	0	0	0
## [41,]	1	0	0	1	0	0	0	1	0	0	0	0
## [42,]	0	1	1	0	0	0	0	1	0	0	1	0
## [43,]	0	0	0	0	1	0	0	0	1	0	0	1
## [44,]	1	0	0	0	0	0	0	1	0	0	0	0
## [45,]	1	0	0	1	0	0	0	0	0	1	0	0
## [46,]	0	0	0	0	0	0	1	0	0	1	0	1
## [47,]	1	1	0	0	0	0	0	0	0	1	0	0
## [48,]	0	0	0	1	0	0	0	0	0	0	1	0
## [49,]	0	0	0	0	0	0	0	0	0	1	0	1
## [50,]	0	0	0	1	0	0	0	1	0	0	0	0
##	[,26]	[,27]	[,28]	[,29]	[,30]	[,31]	[,32]	[,33]	[,34]	[,35]	[,36]	[,37]
## [1,]	1	0	1	0	1	625	0	1	1	1	0	1
## [2,]	1	0	0	0	0	1	0	0	0	0	0	0
## [3,]	0	0	0	0	1	0	0	0	0	1	0	1
## [4,]	0	0	1	0	0	0	1	0	1	1	0	1
## [5,]	0	0	0	1	0	0	0	1	0	0	0	1
## [6,]	1	1	0	1	1	0	1	0	0	1	0	1
## [7,]	0	0	0	1	1	0	0	0	1	0	0	0
## [8,]	1	1	1	0	1	1	1	0	0	1	0	0
## [9,]	1	1	1	1	1	0	1	0	0	0	1	1
## [10,]	1	0	0	1	1	0	1	0	1	0	1	0
## [11,]	0	0	0	1	1	1	1	0	0	0	0	0
## [12,]	1	0	1	0	0	0	1	0	1	0	0	1
## [13,]	0	0	1	1	0	1	1	0	0	0	1	0
## [14,]	1	0	0	0	0	1	0	1	0	1	0	0
## [15,]	0	0	0	1	0	1	0	0	1	0	0	0
## [16,]	0	1	0	0	1	1	1	0	1	0	0	0
## [17,]	1	0	0	0	1	0	0	0	0	0	0	1
## [18,]	0	0	0	1	0	1	0	0	1	0	1	0
## [19,]	1	0	1	0	0	1	0	0	1	0	1	1
## [20,]	0	0	1	1	1	1	0	0	1	0	0	0
## [21,]	0	1	0	0	0	1	1	0	0	0	0	0
## [22,]	0	0	1	0	0	0	0	1	0	0	0	0
## [23,]	0	0	0	1	0	0	1	0	1	0	0	0
## [24,]	1	0	1	0	0	0	1	0	0	1	0	0
## [25,]	0	1	0	0	1	0	0	0	0	1	0	1

## [26,]	0	1	1	0	0	1	0	0	0	0	1	0
## [27,]	0	0	1	0	1	0	1	0	0	0	0	0
## [28,]	0	0	0	0	0	1	0	0	1	0	0	0
## [29,]	0	0	1	1	0	0	0	0	0	0	0	0
## [30,]	0	0	1	0	1	0	1	1	0	0	0	0
## [31,]	0	0	1	0	0	0	1	1	0	1	0	1
## [32,]	0	0	1	0	0	0	1	1	0	1	0	1
## [33,]	1	0	0	1	1	0	0	1	0	0	0	0
## [34,]	0	1	0	0	0	1	0	1	0	0	0	0
## [35,]	0	0	0	0	0	0	1	0	0	1	0	0
## [36,]	0	0	0	1	0	0	0	0	0	0	1	1
## [37,]	0	0	0	0	1	1	0	0	0	1	1	1
## [38,]	0	1	1	1	0	0	0	0	0	0	0	0
## [39,]	1	1	1	0	0	0	0	0	0	1	1	0
## [40,]	1	1	1	0	0	1	0	0	1	0	0	0
## [41,]	0	0	1	1	1	0	0	0	0	0	0	0
## [42,]	1	0	0	0	0	0	1	1	0	0	0	0
## [43,]	0	0	0	0	0	1	0	0	0	0	0	0
## [44,]	0	1	0	1	0	1	0	0	0	0	0	1
## [45,]	0	0	0	0	0	0	0	0	0	0	0	0
## [46,]	0	0	1	0	0	0	0	1	0	1	1	0
## [47,]	0	1	1	0	1	0	1	0	0	0	0	0
## [48,]	0	0	0	0	1	1	0	0	0	1	0	0
## [49,]	1	0	0	1	1	0	0	0	0	0	0	1
## [50,]	0	0	0	0	0	0	0	1	0	0	0	1
##	[,38]	[,39]	[,40]	[,41]	[,42]	[,43]	[,44]	[,45]	[,46]	[,47]	[,48]	[,49]
## [1,]	1	1	0	0	1	0	0	0	0	0	1	0
## [2,]	0	0	0	0	0	1	0	0	1	0	0	0
## [3,]	0	1	1	0	0	1	1	625	1	1	1	0
## [4,]	1	0	0	1	1	0	0	1	0	1	1	1
## [5,]	0	1	0	0	1	1	1	0	0	0	0	0
## [6,]	1	0	1	1	0	0	0	1	1	0	0	0
## [7,]	0	1	0	0	1	1	0	1	0	0	0	0
## [8,]	0	0	1	0	0	1	0	0	0	1	1	0
## [9,]	0	1	0	1	0	1	1	0	0	1	1	0
## [10,]	0	1	1	1	1	1	0	0	1	0	0	0
## [11,]	0	1	0	1	0	0	0	0	0	1	1	0
## [12,]	0	1	0	0	0	1	1	1	0	0	0	1
## [13,]	0	0	0	0	1	1	1	0	0	1	0	1
## [14,]	1	0	1	0	0	0	1	0	0	0	0	0
## [15,]	0	0	0	1	0	1	1	0	1	0	0	0
## [16,]	1	0	0	0	1	1	0	0	1	0	0	0
## [17,]	0	1	1	0	1	1	0	1	0	0	1	1
## [18,]	1	0	0	1	0	1	0	0	1	1	0	0
## [19,]	1	0	1	0	1	0	0	1	1	0	1	0
## [20,]	1	0	0	0	1	1	0	0	0	0	1	1
## [21,]	1	0	1	1	1	0	1	0	0	1	0	1
## [22,]	1	1	1	1	0	1	0	1	0	1	1	1
## [23,]	0	0	1	1	0	0	0	0	1	0	1	1
## [24,]	1	1	0	0	1	0	0	0	0	0	1	0
## [25,]	1	1	1	0	1	0	0	0	1	0	0	1
## [26,]	1	0	1	1	0	0	0	0	0	1	0	0
## [27,]	0	0	1	1	1	0	1	0	0	1	0	1
## [28,]	0	1	0	0	0	1	1	1	1	1	0	1

## [29,]	0	1	0	1	1	1	0	1	0	0	1	0
## [30,]	0	0	0	0	1	0	0	1	0	1	1	0
## [31,]	0	0	0	0	0	1	0	1	0	0	0	0
## [32,]	0	0	0	1	0	0	0	0	0	0	0	1
## [33,]	0	0	0	0	0	1	0	0	1	0	0	0
## [34,]	0	0	1	1	0	0	0	0	0	0	1	1
## [35,]	1	0	0	0	0	0	0	0	1	1	0	1
## [36,]	1	1	0	0	0	0	0	0	0	0	1	0
## [37,]	1	1	0	0	1	0	0	0	0	1	1	0
## [38,]	0	0	0	0	1	0	0	1	0	0	0	0
## [39,]	0	1	0	1	0	0	0	0	1	0	0	0
## [40,]	0	0	0	0	1	0	0	0	0	1	0	0
## [41,]	0	1	1	0	0	0	1	1	0	0	0	1
## [42,]	1	0	1	0	0	1	0	0	0	0	0	1
## [43,]	0	1	1	1	0	1	1	0	0	0	0	1
## [44,]	0	0	0	0	1	0	0	0	0	0	0	1
## [45,]	1	0	1	0	0	0	0	0	0	1	0	0
## [46,]	0	0	0	0	0	0	1	1	0	0	1	0
## [47,]	0	0	0	0	0	0	0	0	0	0	1	0
## [48,]	0	0	1	0	0	0	0	1	1	0	1	0
## [49,]	0	1	0	0	1	0	0	1	0	0	0	0
## [50,]	0	0	0	0	0	1	0	0	0	0	1	0
##	[,50]											
## [1,]	1											
## [2,]	0											
## [3,]	0											
## [4,]	0											
## [5,]	0											
## [6,]	0											
## [7,]	0											
## [8,]	0											
## [9,]	1											
## [10,]	0											
## [11,]	1											
## [12,]	1											
## [13,]	0											
## [14,]	1											
## [15,]	1											
## [16,]	1											
## [17,]	0											
## [18,]	1											
## [19,]	0											
## [20,]	0											
## [21,]	1											
## [22,]	1											
## [23,]	0											
## [24,]	0											
## [25,]	1											
## [26,]	1											
## [27,]	0											
## [28,]	1											
## [29,]	1											
## [30,]	1											
## [31,]	1											

```
## [32,] 0
## [33,] 0
## [34,] 0
## [35,] 1
## [36,] 1
## [37,] 0
## [38,] 0
## [39,] 1
## [40,] 1
## [41,] 0
## [42,] 1
## [43,] 0
## [44,] 1
## [45,] 0
## [46,] 0
## [47,] 0
## [48,] 1
## [49,] 0
## [50,] 0
```

- We will now learn the `apply` function. This is a handy function that saves writing for loops which should be eschewed in R. Use the `apply` function to compute a vector whose entries are the standard deviation of each row. Use the `apply` function to compute a vector whose entries are the standard deviation of each column. Be careful about the NA's! This should be one line.

```
?apply
apply(X, MARGIN = 1, sd, na.rm = TRUE)
```

```
## [1] 1.13691484865 1.12535096391 0.98549789185 0.98785338610 1.09519057695
## [6] 1.11413848758 1.00916399309 0.90048787791 1.09480641104 0.90562294976
## [11] 0.88647605206 1.09495105663 1.02077626547 0.99616079366 0.93278904466
## [16] 0.98983240607 1.07189800629 1.01613468885 1.06319805341 0.91597600845
## [21] 1.02061122611 1.01559191979 0.95495492212 0.83576728478 0.88549070597
## [26] 1.05078016395 0.94969680985 1.11449444893 0.97149040704 0.90797181455
## [31] 1.02967330368 0.93842630071 1.05661192374 1.01454205520 0.94195864297
## [36] 1.09680585993 1.10033914198 1.05357468914 1.03296154812 0.91500733796
## [41] 1.03350429758 0.93468644174 1.01694906368 0.96919677829 0.96671869431
## [46] 1.01613718262 0.89723278486 1.14592711815 1.05157222354 1.02228208877
## [51] 1.08996174283 1.03609022483 1.05668630452 0.88287443137 1.06454115391
## [56] 1.06735746362 0.81523954132 1.01997716121 0.92983635388 1.04498927945
## [61] 0.94298225437 0.96598683344 1.06206985743 1.01878600894 0.97159565072
## [66] 1.07064434733 1.01502443706 0.97323644945 0.88390245456 0.99094105581
## [71] 0.91629582763 1.09746076118 1.03833830437 1.02821590109 1.03676384216
## [76] 0.91556020300 0.89860919415 1.02147875076 0.98742035113 0.95629467956
## [81] 0.92345288347 1.05462666100 0.97356802120 0.94350873481 0.89476636564
## [86] 0.92230931977 1.09011332399 1.04218896021 0.95855819280 0.99656794586
## [91] 0.94069331261 1.18078572385 1.06382539072 0.92790310432 0.97122284284
## [96] 1.12666154911 1.09696262114 1.16224580602 1.08539356441 0.93088380311
```

```
apply(X, MARGIN = 2, sd, na.rm = TRUE)
```

```
## [1] 1.08673338804 1.03485072315 0.84476716307 1.03293038349 1.12205893044
## [6] 1.01879339173 0.96882563430 1.07858957371 0.90283131492 0.98336981180
## [11] 1.06489472938 0.99115339987 1.13954952233 0.93684387957 0.94286851515
## [16] 0.98135790610 1.10039215518 0.91359444298 0.98072233064 0.91176865440
## [21] 0.85168487121 0.90862120514 0.95813651690 0.99060037243 0.96832671535
```

```
## [26] 1.02216291199 1.04851090447 1.09258530025 1.06319346287 1.00454374143
## [31] 1.09746858272 0.99636919423 1.12109372180 0.97732743981 0.93093462623
## [36] 1.08605799898 1.10646928516 1.07736001706 0.86492450929 0.91433583026
## [41] 1.04823625230 1.10446952280 1.07504488927 1.02030820879 0.98079515210
## [46] 0.98532253547 0.93532035644 1.06499238872 0.95591244019 1.05700937365
## [51] 1.02314557678 0.90022546990 0.97909140537 0.95402113413 1.07162617224
## [56] 0.90297580106 1.24645484708 0.99254032090 0.96838080613 0.82757871576
## [61] 1.10466831991 0.85415808589 1.04788244844 0.85249809982 0.93339546597
## [66] 1.31863328734 0.82708876290 0.96975700559 0.97415013145 1.09295128040
## [71] 0.92005747642 0.98577588402 1.05227058595 0.95780901595 0.96328563741
## [76] 1.00941511548 1.05698092040 0.99125301718 1.06376129680 1.08297007227
## [81] 0.99265591642 1.13469556934 0.99405715779 0.97687714810 0.89526137261
## [86] 0.98675115108 0.84804805836 0.94673350699 0.87743565649 1.03917208188
## [91] 0.92689755841 0.94418635488 0.95350440572 1.13535653372 1.18086885397
## [96] 1.08261437075 1.12461333154 0.80331670684 1.02975744392 0.94841419649
```

- Use the `apply` function to compute a vector whose entries are the count of entries that are 1 or 2 in each column. This should be one line.

```
?apply
apply(X>0, MARGIN = 2, sum, na.rm = TRUE)
```

```
## [1] 35 33 29 39 40 27 30 41 25 41 31 35 34 32 37 30 27 38 33 31 33 30 35 36 39
## [26] 32 31 31 31 40 34 35 33 41 35 36 35 33 31 39 37 34 41 34 39 35 31 28 37 34
## [51] 38 30 35 38 28 36 44 28 38 43 31 31 33 32 32 33 33 37 38 34 32 31 39 45 37
## [76] 36 30 38 36 37 28 34 40 30 31 32 33 36 32 39 41 40 33 35 37 41 31 42 33 33
```

- Use the `split` function to create a list whose keys are the column number and values are the vector of the columns. Look at the last example in the documentation `?split`.

```
?split
split(X,col(X, as.factor = FALSE))
```

```
## $`1`
## [1] 0.307393647403 NA -0.075991051713 1.034227275311
## [5] -1.848647703056 0.677531788356 -1.497612177670 NA
## [9] -0.212388607556 0.502988250976 0.445120289257 1.887610936791
## [13] NA 0.916704381899 1.646178213901 NA
## [17] -2.041619471534 -1.197227098424 NA NA
## [21] -1.313213800441 -1.311475830778 -0.201701814564 -0.570235572926
## [25] 0.362299670192 NA -1.092363558654 NA
## [29] -1.089419212265 0.644528340115 -0.146289289789 NA
## [33] NA NA 0.854525100920 -1.242317391817
## [37] -0.849862365628 1.460738811010 NA 0.612975761865
## [41] NA -1.361322390947 -0.550280805232 -2.925877705740
## [45] 0.998783409220 NA NA -0.717608976238
## [49] 0.751970290778 -0.747334744573 -0.402131455431 0.277244090856
## [53] 1.083976376543 -0.638814705811 NA NA
## [57] NA 1.480206960604 NA -0.362111058603
## [61] -0.268707536956 NA 1.061904212322 -0.152173558099
## [65] -0.833817036074 0.399491570150 NA 0.019118503912
## [69] 1.039105502920 NA -0.338656885000 0.084584048986
## [73] 0.038126518285 NA -0.109575362839 0.772556103164
## [77] 1.154025754046 0.465493838864 -1.347055775333 NA
## [81] 1.359067401000 NA NA 1.263209264332
## [85] 1.082967536068 NA 2.084423799024 0.379123381275
## [89] -0.883539363004 NA -1.806628395803 NA
```

```

## [93] -0.342399970471 0.132301792301 0.328512496803 -1.494328961402
## [97] -1.937242065628 NA NA 1.871131491561
##
## $`2`
## [1] -0.526371334833 -0.586064778562 1.073569649273 -0.578293400171
## [5] 0.372070473597 NA 0.459265043028 -0.868295076230
## [9] NA NA -0.521202377499 -0.619826796524
## [13] 0.510578952942 NA NA 0.902172804946
## [17] NA 0.320009148720 0.289375464248 NA
## [21] -0.388917480147 0.411615109781 NA 1.310100481631
## [25] -0.047038442407 NA -1.040612716648 -0.536277536213
## [29] NA -0.816268226167 -1.249558797534 -0.876428422635
## [33] -0.921622012236 -0.953626931700 1.621673057853 NA
## [37] NA -0.951927192613 NA -0.104935236713
## [41] 0.888358673470 0.451016823256 1.017891376550 -0.727810148284
## [45] -0.543221886898 -0.012838985181 0.019936523407 -0.149615809873
## [49] NA -1.090923011735 -2.300782819400 0.737390935319
## [53] -0.411754814289 NA NA NA
## [57] 1.627638796000 1.093112181807 0.863500980285 -1.439961724655
## [61] NA NA 0.143201956836 0.456056237123
## [65] -0.636426126412 -1.383561602541 0.219803110801 -0.160022957006
## [69] NA NA -1.001178608799 -2.423974963277
## [73] -1.574554092945 0.539160401541 -1.761902655861 -0.429519259083
## [77] NA 2.645919671381 0.502937640713 0.905815846907
## [81] NA -1.377313579837 NA -0.300864470393
## [85] 2.242694726543 -1.980531799367 0.962963239103 0.232475004296
## [89] NA -0.403062342735 NA NA
## [93] 1.101820633830 0.506810488305 -2.076216559575 -0.553853827515
## [97] 0.051799127253 1.597407126562 0.242575979032 -0.167112487332
##
## $`3`
## [1] -0.8682038247931 NA NA -0.0644671661527
## [5] 0.9914174145073 2.1799770818304 NA NA
## [9] 0.9283433558736 NA NA NA
## [13] NA NA -0.2467796337978 -0.5327166249090
## [17] NA NA NA 1.0148729580230
## [21] 0.7535683929608 0.3295752771059 -0.0246948079952 0.0524649727627
## [25] NA -0.0021876003605 -0.2347897748258 0.6379325427068
## [29] 1.1141435803447 NA 1.1682945526053 -0.4903400960262
## [33] NA 0.2465350922937 -0.3675146366914 1.3308866198286
## [37] NA -0.2216202863869 NA NA
## [41] NA -1.1899429752523 -0.4102301706781 0.6439696414323
## [45] -0.6344729825204 -0.3820959845893 0.4555788989011 -0.6868350686767
## [49] 0.5957802147811 NA NA NA
## [53] -0.0326120450462 0.1798028669770 -0.6077969939479 -1.1616779595696
## [57] -0.8877063160558 NA NA NA
## [61] -0.4212158850629 NA 1.2142550894126 -0.2248183921689
## [65] -0.8110298439227 NA -0.2241945502252 1.3863824771676
## [69] NA -0.1546584000659 1.8022651391683 -1.1586127603360
## [73] 1.0890775917320 0.3123603623865 0.3301658105733 -0.5120769779980
## [77] 0.8789336870094 -0.0185384400280 0.8205594141934 -0.5053409116849
## [81] NA 0.2443225302525 NA -0.4128658674429
## [85] NA NA 0.6796883586182 NA
## [89] 0.3721859552543 -1.9343074173865 0.9729556341886 NA

```

```

## [93] NA -0.6212841053539 -0.4186675615679 NA
## [97] NA NA 2.1784808640335 NA
##
## $`4`
## [1] -0.9517031501586 NA 1.6973984265360 NA
## [5] 1.4650386197136 -0.1543855468301 0.4448151593844 NA
## [9] 0.4711193961480 NA NA 1.6351725738835
## [13] NA NA 0.0067951031879 -1.4476796551787
## [17] 0.0857408465569 -0.4903407920874 -0.7113786992972 1.5323656180786
## [21] 0.5824840143398 -1.5785223979497 0.9031181410100 NA
## [25] NA 0.3607931322281 -0.5136832416594 1.1414834008877
## [29] 1.0650438573257 -0.2011936807696 NA NA
## [33] NA 0.9032361301006 -0.2268062148726 NA
## [37] 0.7130244333352 NA 1.2718660597873 NA
## [41] 1.7203668069129 0.3257543994776 1.1335386791240 1.0540336300808
## [45] -0.3001461056452 NA -0.4065818959168 -2.3049265720694
## [49] -0.9129155828019 0.6865356722373 -1.6467236602157 NA
## [53] -0.4282542695538 1.3848209565950 -0.1444245820000 -0.0938987474705
## [57] NA -2.4895912005771 1.1985502430190 1.1959296583320
## [61] -0.3024343383639 -0.3087137058953 0.3384859412950 NA
## [65] NA NA 1.2198555764934 -0.1953029702200
## [69] 0.4227022488012 0.0199807360282 -0.6447666583439 -0.1900119485680
## [73] -0.4816227418723 NA 1.2850781500450 NA
## [77] 0.0555705076830 -1.3055694244588 2.0405428239561 0.7262197038492
## [81] NA -0.2782955259488 1.1468172940152 -0.7623753660702
## [85] 0.9642634111794 -0.7625523061523 0.1846355509324 -1.4770639634083
## [89] -0.9872636348593 NA -0.6913603867944 NA
## [93] NA 0.4279251433510 1.3995134177414 2.4069760591062
## [97] 0.6717409053118 -0.7052584119500 NA NA
##
## $`5`
## [1] NA 0.8585572058844 NA 1.4608360872147
## [5] 0.2017633921792 1.4608174408704 -0.4162517831176 1.5444955902215
## [9] NA -0.5186684858756 0.0661331045543 0.6728005468308
## [13] -0.2919894049877 NA NA -0.0664360169596
## [17] 0.6949345599330 NA -0.3854776712596 NA
## [21] NA NA -0.1332550530795 -0.9396283111516
## [25] 0.4798471221330 -1.5334298013020 NA 1.9592936916592
## [29] 0.2928490232820 0.4984302563604 0.6400557049276 NA
## [33] 1.1225622667819 NA NA -2.0047051350042
## [37] NA NA 2.3014505084931 -1.6166836863842
## [41] 0.3553872364613 NA -0.3894263346122 NA
## [45] -1.4436971826035 -1.3052005266791 NA 0.7828799415447
## [49] 0.3152481644787 -0.7156445612129 0.3095256829578 NA
## [53] 0.4778117760280 -2.3947140247104 0.4284732076200 0.0011746292619
## [57] -1.2965562970575 -0.2554209996058 NA NA
## [61] -2.1344202175791 0.7435980585691 0.5286622562399 0.7351779444599
## [65] -0.4600200981180 0.6660256804946 NA 1.0590246676768
## [69] 2.7410242053271 -0.5717504818679 NA -1.1772797436898
## [73] 0.7175519170012 1.3228646424974 1.6225668969687 NA
## [77] 1.2138821805397 NA 0.3577561890701 -1.0068319085540
## [81] NA 2.7153181423213 NA 0.1121994395819
## [85] 0.5993655974814 NA NA 0.7828176390658
## [89] NA -1.2146378406332 -0.4855812086679 -1.0636352596584

```



```

## [93] NA NA NA -0.2832508561806
## [97] 0.4727906481036 2.1633660979109 0.1749406620193 -0.7660412508428
##
## $`6`
## [1] NA NA -0.830673913893 -1.903316290301
## [5] NA 0.689495122418 -0.181678873095 1.419321235541
## [9] 0.382086809039 -0.939390438991 -0.724594193064 1.045815834418
## [13] 0.133903485487 NA -0.504317665644 NA
## [17] 0.569422798039 0.044618887171 NA NA
## [21] NA NA NA -1.602600506363
## [25] NA -0.320998031509 -1.676834747939 NA
## [29] 0.124610202573 2.057639469253 0.128516087883 1.722561724797
## [33] 0.516297255014 NA NA NA
## [37] -1.393952135774 NA -0.642931674559 0.292788731015
## [41] NA NA NA -1.752273917875
## [45] -1.983877734609 -0.774930381373 NA 0.680680060531
## [49] 2.576795312035 0.022782712114 0.565093398899 0.623752396930
## [53] 0.957104945874 NA -0.382026369898 -0.336097473591
## [57] 0.528318092585 NA -0.519767289154 -0.094120261383
## [61] -0.512189450589 -1.445763605221 NA 0.376089161865
## [65] NA -0.144101056758 -0.089177501396 -2.574443221322
## [69] 0.959188371750 NA 0.168163615724 NA
## [73] NA -0.502473429225 0.965974177147 -0.428306697553
## [77] -0.291186934437 NA -2.331879277332 -0.086465547673
## [81] -1.098677734051 -0.042815846151 -0.556706416929 -0.029319759881
## [85] 0.067719962486 NA NA NA
## [89] -0.759163973838 -1.482844135163 NA -0.576421507208
## [93] NA -0.424055257835 1.483585009923 NA
## [97] 1.013509925280 NA -0.012566587395 -0.651770908669
##
## $`7`
## [1] -1.5395267572621 -0.6746811752416 -0.7123896571687 -0.9925844422076
## [5] -0.1054608482657 NA -0.9607004786558 0.2383286647655
## [9] -1.7986528476144 1.0056638012257 1.5641695760631 0.1082078654861
## [13] -0.6444780214670 -0.0444430936262 0.6906523219420 0.9116426113776
## [17] NA 0.0540611363863 0.4282208796715 -0.4766618051703
## [21] 0.0033832373418 -2.1162580620732 NA 0.3758455585030
## [25] 0.8397357632222 -0.5561681691090 NA 0.9600013429880
## [29] 1.2605741090903 0.1147965466486 NA -1.4100475917245
## [33] 2.2062245547751 NA -0.0416692358462 -1.9426350389530
## [37] 0.0389492957013 -1.0160633233259 NA NA
## [41] -1.2949634274964 -0.5305369303400 0.3508448545627 2.6894506439130
## [45] -0.4002051359412 NA 0.8682122470504 -0.7483427473347
## [49] NA 0.3807840851143 -0.6796234082362 NA
## [53] NA -0.6322554992123 -0.8896906655407 NA
## [57] NA NA -0.6941771255166 -0.2362948362896
## [61] NA 0.3777396147704 -0.7759514252294 0.3256541315081
## [65] NA NA NA 0.5028944255824
## [69] -1.0711933203669 -0.2380510535495 -1.0560503545661 NA
## [73] -0.6996120557479 0.5159125370403 -0.0775461276863 -1.2475212490455
## [77] NA -0.6248202546539 0.0574349105058 NA
## [81] -0.2504384065607 NA NA NA
## [85] -1.3096006883713 -1.0818732358079 0.8597685642164 0.2024680012083
## [89] 0.2978358749837 -1.4231488129910 2.0269030661505 NA

```

```

## [93] NA -0.1142471699305 NA -0.0392489553269
## [97] NA 1.3906618769156 NA NA
##
## $`8`
## [1] -0.41830956023392 0.96221469060512 0.46556134552707 0.11884657262823
## [5] 0.09149234660778 0.03514734623157 NA -1.08805597258489
## [9] 1.10512967598748 0.13832575664368 -1.17475639263310 NA
## [13] NA -0.77107471578965 0.36681050877359 -1.14214232711563
## [17] 0.55944850055896 NA 0.34584436549588 NA
## [21] NA 0.01178679528640 NA NA
## [25] 2.51682426331326 -0.63732081908840 NA -0.82701229423504
## [29] 0.93243715940338 0.54784375871533 0.45516821702659 -0.01029893562677
## [33] 0.11398147602182 2.33710896384575 NA NA
## [37] NA NA 1.42243793011777 -0.54072899125361
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## [33] NA 1.247497604925 0.560465643150 -2.404766658376
## [37] NA 0.942809288830 0.064707737931 -2.060707484099
## [41] 0.802512115278 0.682018271752 -0.478549190864 -0.889779924483
## [45] 0.486260051719 NA -1.022790923512 -0.046621071680
## [49] NA NA NA -0.329779163120
## [53] NA -0.113249025410 -0.031969447698 1.907022244601
## [57] -0.341352354283 -0.176262187101 0.534390375087 0.979655568996
## [61] 0.026877050408 0.219377111948 1.143424465426 NA
## [65] -1.545697526703 NA 1.963862275854 -0.251867943655
## [69] NA 0.482327725063 -1.704044833498 0.039140473815
## [73] 0.672127104634 0.747576115090 -0.796441677969 -1.942122531217
## [77] 1.386915478878 NA -1.788583434838 1.107595301204
## [81] 0.175133901051 NA -0.316174739124 NA
## [85] NA -1.298608359865 NA -0.012843822394
## [89] 1.761468407627 -0.369158920230 1.324782890767 -0.608119399874
## [93] -1.587441825248 NA NA 1.428927045467
## [97] -0.927855822107 2.008577318494 -1.259643374505 -0.716160935502
##
## $`97`
## [1] -0.326546356229 NA -1.814337572143 NA
## [5] 0.132971372785 -0.514047660663 0.131390041528 NA
## [9] NA -0.580663057556 1.261500229058 0.054411527655
## [13] NA -0.276612425436 NA -1.270634494338
## [17] NA 1.042607672516 -0.841087982159 -0.117628721218
## [21] -0.733501803012 NA NA 0.191173460724
## [25] NA -1.704316083400 0.582813236039 NA
## [29] -0.376372825558 0.286078204334 0.072520518444 0.069485235321
## [33] 0.508797673839 0.859103473759 -0.508342997793 NA
## [37] NA NA -1.420053024112 NA
## [41] -1.753778964779 0.969811020701 NA -1.897531049930
## [45] -1.054066043322 NA 1.245031376169 1.235982447284
## [49] -2.157513310024 NA NA 1.755989638840
## [53] 0.931246790272 0.865011643671 NA -3.416740983453
## [57] NA 0.124281046324 -1.036023809844 NA
## [61] NA NA NA 0.204417870296
## [65] -0.028788450356 -0.553534885112 -2.206137324021 -0.665444923439
## [69] 0.533369906374 0.072664798270 -0.733944922223 -0.200108987061
## [73] NA 0.859208928732 -0.666796357647 NA
## [77] 1.193058997668 -0.497646911114 NA -2.900624367330
## [81] NA NA 0.212091030737 NA
## [85] 0.911175900072 NA NA -1.595358879699
## [89] NA 0.384072951391 0.427073339946 -0.089731236848

```

```

## [93] -1.024801518490 NA -0.276324321109 1.157419626852
## [97] NA NA 2.474015586269 0.448343236750
##
## $`98`
## [1] NA NA 0.9554240551081 NA
## [5] NA -0.7330536603133 0.2552737103415 0.0947011860029
## [9] -1.4107919219062 NA -1.1608919201323 -0.1522550979359
## [13] 0.6572198749347 0.1872478880368 1.5978349200175 0.3415625856370
## [17] 0.7818423889710 -0.3491661881564 NA 1.2611680162624
## [21] 1.5831476567504 -0.8067272588862 0.8011056848652 1.0990476819465
## [25] NA 0.6164464779239 0.8076994728958 0.7446410866183
## [29] 0.7916489279624 NA -0.1881802161430 1.4015773737468
## [33] -0.6152039453076 0.6849058678289 -0.2107053400880 NA
## [37] -1.5468990452197 0.2145497041232 NA 0.1738912424226
## [41] NA NA -0.1285604216989 -1.1971911664281
## [45] 0.6080469493006 -0.8526242766562 0.0571942611844 0.0452190365095
## [49] 0.9841275894252 0.6584539992775 0.9872894699143 0.4128250777789
## [53] NA -0.4682230427189 -0.3951795625300 0.4621746651837
## [57] 0.9499964940360 0.2170921340603 -0.6059300512017 -1.3018715031287
## [61] -0.1990789238384 0.7058458452035 NA -0.7041972134782
## [65] -0.0282403533365 NA -0.9127873636606 0.9628168294386
## [69] -1.0016067441472 0.1902845549826 -0.2969298035496 -0.8500462644804
## [73] NA 0.4992428009961 NA -1.0431368688424
## [77] -0.2676327587360 NA NA 1.4334491390000
## [81] -0.0920920211422 -1.1571515856004 NA NA
## [85] 0.1883103612994 -0.9122157727183 0.8517990402512 -0.8250867705829
## [89] NA NA 0.7139929231374 -1.0559823497229
## [93] NA NA 0.1392038020268 1.3640731851473
## [97] NA 0.0015093566135 0.5736818269703 -0.6298149780140
##
## $`99`
## [1] 1.402144920058 -1.409833455884 -1.452688765525 NA
## [5] 1.645333324682 0.333886603627 NA NA
## [9] 0.323573886389 0.367008823336 -0.123992490040 -0.179301985014
## [13] 0.026432824537 -0.793708113371 2.059408968720 NA
## [17] NA -0.032929926914 -0.358352936828 -0.782396089945
## [21] NA -0.113512881863 NA 1.124831230641
## [25] 0.751854155245 0.152843161808 NA -0.981473800071
## [29] -0.705575290328 -1.775407151797 0.663628684710 0.125429344548
## [33] 1.229404953832 NA NA 0.164326586705
## [37] 0.423105130704 NA 1.067245937975 0.770713228127
## [41] NA 0.660923691133 NA NA
## [45] NA NA -1.039249906516 0.337254159753
## [49] NA NA 0.506089200533 NA
## [53] NA -0.306106824953 1.148088820719 NA
## [57] -1.639834012888 -0.259507482057 0.869999793144 -1.085987576081
## [61] NA NA -0.738810995618 0.384380208359
## [65] NA 0.356481399471 NA NA
## [69] -0.474175623207 -0.825705904276 -0.351393893646 0.105005579983
## [73] -1.400905820912 -2.530361687769 0.117208109543 -0.480656662140
## [77] 1.681100242078 -0.927022963068 0.439494910633 0.404870468628
## [81] -1.334518557873 -0.593674749936 -0.100696846779 -0.689462185633
## [85] NA 2.286065875106 -0.147100829195 NA
## [89] -2.686578964878 0.994787378822 NA NA

```

```
## [93] 1.477973843880 NA -1.388634780198 -1.389291828091
## [97] -0.401350465163 -0.718537237873 0.961448901147 NA
##
## $`100`
## [1] -0.828739073023 -0.864791687016 NA -1.105676851509
## [5] NA NA -0.292837092788 0.297125213563
## [9] NA -0.612678942029 NA -1.462472413132
## [13] 0.370880438852 NA -0.875842802680 0.103116495918
## [17] 1.768584850390 -0.237203710939 0.038367945859 NA
## [21] 0.023842869615 0.030107901623 2.554729689723 -0.062934307177
## [25] 0.268284704674 0.318637120364 -1.166320856816 0.361273177190
## [29] 1.368531544524 -0.021630646095 -0.392080485151 0.449697611150
## [33] NA 0.767775494179 0.339029812838 NA
## [37] -1.890712680225 -0.100093913085 0.145215455759 -0.486968240946
## [41] NA -0.655430193148 -0.105259830766 -1.229799593139
## [45] 1.524776797659 -1.690183415815 -1.093088272317 -1.436997897166
## [49] 0.080348305090 -1.446832788126 0.947464724506 NA
## [53] 0.609778707876 NA -0.614344557189 NA
## [57] NA 0.496560215235 -0.856079027363 NA
## [61] NA NA NA 1.228893247386
## [65] 1.290898439853 NA NA NA
## [69] -0.807207853013 NA -1.655386222785 -1.148773998110
## [73] NA -0.271358952999 0.232478964067 -0.497543347797
## [77] 1.563938441708 1.156672258700 0.069557842859 0.349736702984
## [81] 0.235837043946 -1.235744926881 1.402297052396 NA
## [85] -0.277457663919 NA NA NA
## [89] 0.037730118860 -1.099969906463 -0.162890765022 0.627623101725
## [93] NA -1.211931946280 NA -1.907137436366
## [97] NA -0.575925531507 0.675473469271 -0.659721584907
```

```
?as.factor
```

- In one statement, use the `lapply` function to create a list whose keys are the column number and values are themselves a list with keys: “min” whose value is the minimum of the column, “max” whose value is the maximum of the column, “pct_missing” is the proportion of missingness in the column and “first_NA” whose value is the row number of the first time the NA appears.

```
?lapply
?max
?min
?is.na
lapply(split(X, col(X)), function(X){list(min = min(X, na.rm=TRUE), max = max(X, na.rm = TRUE), pct_mis=
## $`1`
## $`1`$min
## [1] -2.9258777057
##
## $`1`$max
## [1] 2.084423799
##
## $`1`$pct_missing
## [1] 0.31
##
## $`1`$first_NA
## [1] 2
##
```



```

##
## $`2`
## $`2`$min
## [1] -2.4239749633
##
## $`2`$max
## [1] 2.6459196714
##
## $`2`$pct_missing
## [1] 0.27
##
## $`2`$first_NA
## [1] 6
##
##
## $`3`
## $`3`$min
## [1] -1.9343074174
##
## $`3`$max
## [1] 2.1799770818
##
## $`3`$pct_missing
## [1] 0.39
##
## $`3`$first_NA
## [1] 2
##
##
## $`4`
## $`4`$min
## [1] -2.4895912006
##
## $`4`$max
## [1] 2.4069760591
##
## $`4`$pct_missing
## [1] 0.29
##
## $`4`$first_NA
## [1] 2
##
##
## $`5`
## $`5`$min
## [1] -2.3947140247
##
## $`5`$max
## [1] 2.7410242053
##
## $`5`$pct_missing
## [1] 0.33
##
## $`5`$first_NA

```

```

## [1] 1
##
##
## $`6`
## $`6`$min
## [1] -2.5744432213
##
## $`6`$max
## [1] 2.576795312
##
## $`6`$pct_missing
## [1] 0.35
##
## $`6`$first_NA
## [1] 1
##
##
## $`7`
## $`7`$min
## [1] -2.1162580621
##
## $`7`$max
## [1] 2.6894506439
##
## $`7`$pct_missing
## [1] 0.31
##
## $`7`$first_NA
## [1] 6
##
##
## $`8`
## $`8`$min
## [1] -2.2001257714
##
## $`8`$max
## [1] 2.5168242633
##
## $`8`$pct_missing
## [1] 0.32
##
## $`8`$first_NA
## [1] 7
##
##
## $`9`
## $`9`$min
## [1] -2.4508547144
##
## $`9`$max
## [1] 1.7538847531
##
## $`9`$pct_missing
## [1] 0.31

```

```

##
## $`9`$first_NA
## [1] 1
##
##
## $`10`
## $`10`$min
## [1] -2.5334815723
##
## $`10`$max
## [1] 2.0369631627
##
## $`10`$pct_missing
## [1] 0.23
##
## $`10`$first_NA
## [1] 1
##
##
## $`11`
## $`11`$min
## [1] -2.3291161332
##
## $`11`$max
## [1] 2.4931615966
##
## $`11`$pct_missing
## [1] 0.27
##
## $`11`$first_NA
## [1] 8
##
##
## $`12`
## $`12`$min
## [1] -2.5307001371
##
## $`12`$max
## [1] 2.9654433964
##
## $`12`$pct_missing
## [1] 0.26
##
## $`12`$first_NA
## [1] 1
##
##
## $`13`
## $`13`$min
## [1] -3.6276584653
##
## $`13`$max
## [1] 2.6460115935
##

```

```

## $`13`$pct_missing
## [1] 0.23
##
## $`13`$first_NA
## [1] 2
##
##
## $`14`
## $`14`$min
## [1] -2.5810110938
##
## $`14`$max
## [1] 2.1748294175
##
## $`14`$pct_missing
## [1] 0.34
##
## $`14`$first_NA
## [1] 4
##
##
## $`15`
## $`15`$min
## [1] -2.8611830737
##
## $`15`$max
## [1] 1.6725828112
##
## $`15`$pct_missing
## [1] 0.22
##
## $`15`$first_NA
## [1] 3
##
##
## $`16`
## $`16`$min
## [1] -3.1427610714
##
## $`16`$max
## [1] 1.8906371227
##
## $`16`$pct_missing
## [1] 0.33
##
## $`16`$first_NA
## [1] 1
##
##
## $`17`
## $`17`$min
## [1] -2.616327212
##
## $`17`$max

```

```

## [1] 2.1784594034
##
## $`17`$pct_missing
## [1] 0.3
##
## $`17`$first_NA
## [1] 1
##
##
## $`18`
## $`18`$min
## [1] -2.4720534408
##
## $`18`$max
## [1] 2.48200094
##
## $`18`$pct_missing
## [1] 0.29
##
## $`18`$first_NA
## [1] 5
##
##
## $`19`
## $`19`$min
## [1] -2.6666224767
##
## $`19`$max
## [1] 2.1518727405
##
## $`19`$pct_missing
## [1] 0.36
##
## $`19`$first_NA
## [1] 3
##
##
## $`20`
## $`20`$min
## [1] -2.1786628989
##
## $`20`$max
## [1] 3.0346975111
##
## $`20`$pct_missing
## [1] 0.28
##
## $`20`$first_NA
## [1] 12
##
##
## $`21`
## $`21`$min
## [1] -2.068252204

```

```

##
## $`21`$max
## [1] 2.5377490264
##
## $`21`$pct_missing
## [1] 0.34
##
## $`21`$first_NA
## [1] 2
##
##
## $`22`
## $`22`$min
## [1] -2.8193614558
##
## $`22`$max
## [1] 2.0366338537
##
## $`22`$pct_missing
## [1] 0.3
##
## $`22`$first_NA
## [1] 9
##
##
## $`23`
## $`23`$min
## [1] -2.2321934876
##
## $`23`$max
## [1] 1.8982482804
##
## $`23`$pct_missing
## [1] 0.33
##
## $`23`$first_NA
## [1] 2
##
##
## $`24`
## $`24`$min
## [1] -2.1210532108
##
## $`24`$max
## [1] 3.0096354936
##
## $`24`$pct_missing
## [1] 0.33
##
## $`24`$first_NA
## [1] 2
##
##
## $`25`

```

```

## $`25`$min
## [1] -1.9797290951
##
## $`25`$max
## [1] 2.037229307
##
## $`25`$pct_missing
## [1] 0.33
##
## $`25`$first_NA
## [1] 4
##
##
## $`26`
## $`26`$min
## [1] -2.2543486277
##
## $`26`$max
## [1] 2.8937870996
##
## $`26`$pct_missing
## [1] 0.33
##
## $`26`$first_NA
## [1] 2
##
##
## $`27`
## $`27`$min
## [1] -2.9644647336
##
## $`27`$max
## [1] 1.7744728336
##
## $`27`$pct_missing
## [1] 0.36
##
## $`27`$first_NA
## [1] 1
##
##
## $`28`
## $`28`$min
## [1] -2.4876226164
##
## $`28`$max
## [1] 2.2935527696
##
## $`28`$pct_missing
## [1] 0.31
##
## $`28`$first_NA
## [1] 1
##
##

```

```

##
## $`29`
## $`29`$min
## [1] -2.9192935355
##
## $`29`$max
## [1] 2.3264994345
##
## $`29`$pct_missing
## [1] 0.28
##
## $`29`$first_NA
## [1] 2
##
##
## $`30`
## $`30`$min
## [1] -2.2903494363
##
## $`30`$max
## [1] 2.3235095677
##
## $`30`$pct_missing
## [1] 0.26
##
## $`30`$first_NA
## [1] 3
##
##
## $`31`
## $`31`$min
## [1] -2.5235607183
##
## $`31`$max
## [1] 2.7058911624
##
## $`31`$pct_missing
## [1] 0.33
##
## $`31`$first_NA
## [1] 7
##
##
## $`32`
## $`32`$min
## [1] -1.5155882816
##
## $`32`$max
## [1] 2.5368401471
##
## $`32`$pct_missing
## [1] 0.29
##
## $`32`$first_NA

```



```

## [1] 2
##
##
## $`33`
## $`33`$min
## [1] -2.1621742065
##
## $`33`$max
## [1] 2.0954027596
##
## $`33`$pct_missing
## [1] 0.31
##
## $`33`$first_NA
## [1] 2
##
##
## $`34`
## $`34`$min
## [1] -2.7036822855
##
## $`34`$max
## [1] 2.3133303892
##
## $`34`$pct_missing
## [1] 0.33
##
## $`34`$first_NA
## [1] 2
##
##
## $`35`
## $`35`$min
## [1] -1.9144427739
##
## $`35`$max
## [1] 2.111409433
##
## $`35`$pct_missing
## [1] 0.31
##
## $`35`$first_NA
## [1] 2
##
##
## $`36`
## $`36`$min
## [1] -3.3397035244
##
## $`36`$max
## [1] 2.0196561283
##
## $`36`$pct_missing
## [1] 0.3

```

```

##
## $`36`$first_NA
## [1] 1
##
##
## $`37`
## $`37`$min
## [1] -2.0760539217
##
## $`37`$max
## [1] 2.9288005057
##
## $`37`$pct_missing
## [1] 0.33
##
## $`37`$first_NA
## [1] 1
##
##
## $`38`
## $`38`$min
## [1] -1.832031155
##
## $`38`$max
## [1] 2.1912362697
##
## $`38`$pct_missing
## [1] 0.4
##
## $`38`$first_NA
## [1] 1
##
##
## $`39`
## $`39`$min
## [1] -1.8473138111
##
## $`39`$max
## [1] 1.666959873
##
## $`39`$pct_missing
## [1] 0.37
##
## $`39`$first_NA
## [1] 2
##
##
## $`40`
## $`40`$min
## [1] -1.6588034333
##
## $`40`$max
## [1] 2.8191404954
##

```

```

## $`40`$pct_missing
## [1] 0.26
##
## $`40`$first_NA
## [1] 1
##
##
## $`41`
## $`41`$min
## [1] -2.2801396746
##
## $`41`$max
## [1] 2.335682738
##
## $`41`$pct_missing
## [1] 0.35
##
## $`41`$first_NA
## [1] 1
##
##
## $`42`
## $`42`$min
## [1] -2.5359959453
##
## $`42`$max
## [1] 2.1061726829
##
## $`42`$pct_missing
## [1] 0.33
##
## $`42`$first_NA
## [1] 4
##
##
## $`43`
## $`43`$min
## [1] -2.515342842
##
## $`43`$max
## [1] 2.5880194995
##
## $`43`$pct_missing
## [1] 0.29
##
## $`43`$first_NA
## [1] 1
##
##
## $`44`
## $`44`$min
## [1] -2.0972879594
##
## $`44`$max

```

```

## [1] 2.788062452
##
## $`44`$pct_missing
## [1] 0.28
##
## $`44`$first_NA
## [1] 8
##
##
## $`45`
## $`45`$min
## [1] -2.1448568773
##
## $`45`$max
## [1] 2.572399625
##
## $`45`$pct_missing
## [1] 0.23
##
## $`45`$first_NA
## [1] 1
##
##
## $`46`
## $`46`$min
## [1] -2.6310445795
##
## $`46`$max
## [1] 1.8010286314
##
## $`46`$pct_missing
## [1] 0.23
##
## $`46`$first_NA
## [1] 2
##
##
## $`47`
## $`47`$min
## [1] -2.2412236017
##
## $`47`$max
## [1] 2.6446362518
##
## $`47`$pct_missing
## [1] 0.29
##
## $`47`$first_NA
## [1] 2
##
##
## $`48`
## $`48`$min
## [1] -2.5224563462

```

```

##
## $`48`$max
## [1] 1.8609650368
##
## $`48`$pct_missing
## [1] 0.29
##
## $`48`$first_NA
## [1] 1
##
##
## $`49`
## $`49`$min
## [1] -1.7856198049
##
## $`49`$max
## [1] 2.315868811
##
## $`49`$pct_missing
## [1] 0.34
##
## $`49`$first_NA
## [1] 1
##
##
## $`50`
## $`50`$min
## [1] -2.5407737757
##
## $`50`$max
## [1] 2.7422943581
##
## $`50`$pct_missing
## [1] 0.33
##
## $`50`$first_NA
## [1] 1
##
##
## $`51`
## $`51`$min
## [1] -2.1475869662
##
## $`51`$max
## [1] 2.8629616049
##
## $`51`$pct_missing
## [1] 0.24
##
## $`51`$first_NA
## [1] 9
##
##
## $`52`

```

```

## $`52`$min
## [1] -2.0426190229
##
## $`52`$max
## [1] 2.0259424213
##
## $`52`$pct_missing
## [1] 0.39
##
## $`52`$first_NA
## [1] 5
##
##
## $`53`
## $`53`$min
## [1] -1.8763511438
##
## $`53`$max
## [1] 2.7055380166
##
## $`53`$pct_missing
## [1] 0.36
##
## $`53`$first_NA
## [1] 1
##
##
## $`54`
## $`54`$min
## [1] -2.065741796
##
## $`54`$max
## [1] 2.2326213115
##
## $`54`$pct_missing
## [1] 0.21
##
## $`54`$first_NA
## [1] 5
##
##
## $`55`
## $`55`$min
## [1] -2.5141876413
##
## $`55`$max
## [1] 2.7679652034
##
## $`55`$pct_missing
## [1] 0.4
##
## $`55`$first_NA
## [1] 3
##

```

```

##
## $`56`
## $`56`$min
## [1] -2.1583892864
##
## $`56`$max
## [1] 2.324999338
##
## $`56`$pct_missing
## [1] 0.32
##
## $`56`$first_NA
## [1] 4
##
##
## $`57`
## $`57`$min
## [1] -3.1165147219
##
## $`57`$max
## [1] 3.1475977036
##
## $`57`$pct_missing
## [1] 0.24
##
## $`57`$first_NA
## [1] 5
##
##
## $`58`
## $`58`$min
## [1] -2.1886618104
##
## $`58`$max
## [1] 1.872017312
##
## $`58`$pct_missing
## [1] 0.34
##
## $`58`$first_NA
## [1] 5
##
##
## $`59`
## $`59`$min
## [1] -1.7365656159
##
## $`59`$max
## [1] 2.3763252052
##
## $`59`$pct_missing
## [1] 0.25
##
## $`59`$first_NA

```

```

## [1] 2
##
##
## $`60`
## $`60`$min
## [1] -1.8581759098
##
## $`60`$max
## [1] 1.7415552049
##
## $`60`$pct_missing
## [1] 0.2
##
## $`60`$first_NA
## [1] 5
##
##
## $`61`
## $`61`$min
## [1] -2.6662533808
##
## $`61`$max
## [1] 2.3294811497
##
## $`61`$pct_missing
## [1] 0.38
##
## $`61`$first_NA
## [1] 1
##
##
## $`62`
## $`62`$min
## [1] -1.9107947027
##
## $`62`$max
## [1] 1.8325271182
##
## $`62`$pct_missing
## [1] 0.34
##
## $`62`$first_NA
## [1] 5
##
##
## $`63`
## $`63`$min
## [1] -2.9502281528
##
## $`63`$max
## [1] 2.1628207398
##
## $`63`$pct_missing
## [1] 0.33

```



```

##
## $`63`$first_NA
## [1] 2
##
##
## $`64`
## $`64`$min
## [1] -2.53979306
##
## $`64`$max
## [1] 1.5848159431
##
## $`64`$pct_missing
## [1] 0.35
##
## $`64`$first_NA
## [1] 8
##
##
## $`65`
## $`65`$min
## [1] -2.0590959117
##
## $`65`$max
## [1] 1.8969221952
##
## $`65`$pct_missing
## [1] 0.3
##
## $`65`$first_NA
## [1] 1
##
##
## $`66`
## $`66`$min
## [1] -2.4863522535
##
## $`66`$max
## [1] 3.0370910979
##
## $`66`$pct_missing
## [1] 0.28
##
## $`66`$first_NA
## [1] 9
##
##
## $`67`
## $`67`$min
## [1] -1.8374015949
##
## $`67`$max
## [1] 1.9051332373
##

```

```

## $`67`$pct_missing
## [1] 0.28
##
## $`67`$first_NA
## [1] 2
##
##
## $`68`
## $`68`$min
## [1] -1.8208476164
##
## $`68`$max
## [1] 2.16387152
##
## $`68`$pct_missing
## [1] 0.35
##
## $`68`$first_NA
## [1] 2
##
##
## $`69`
## $`69`$min
## [1] -2.2902495385
##
## $`69`$max
## [1] 2.6877729544
##
## $`69`$pct_missing
## [1] 0.26
##
## $`69`$first_NA
## [1] 3
##
##
## $`70`
## $`70`$min
## [1] -2.2344593484
##
## $`70`$max
## [1] 2.4864191068
##
## $`70`$pct_missing
## [1] 0.42
##
## $`70`$first_NA
## [1] 3
##
##
## $`71`
## $`71`$min
## [1] -2.4573316865
##
## $`71`$max

```

```

## [1] 2.0941979138
##
## $`71`$pct_missing
## [1] 0.37
##
## $`71`$first_NA
## [1] 1
##
##
## $`72`
## $`72`$min
## [1] -3.2243859028
##
## $`72`$max
## [1] 1.7266442416
##
## $`72`$pct_missing
## [1] 0.3
##
## $`72`$first_NA
## [1] 9
##
##
## $`73`
## $`73`$min
## [1] -1.9471344415
##
## $`73`$max
## [1] 2.7178159679
##
## $`73`$pct_missing
## [1] 0.27
##
## $`73`$first_NA
## [1] 5
##
##
## $`74`
## $`74`$min
## [1] -2.2896799321
##
## $`74`$max
## [1] 2.2824450876
##
## $`74`$pct_missing
## [1] 0.28
##
## $`74`$first_NA
## [1] 1
##
##
## $`75`
## $`75`$min
## [1] -2.53926045

```

```

##
## $`75`$max
## [1] 2.0228808727
##
## $`75`$pct_missing
## [1] 0.35
##
## $`75`$first_NA
## [1] 3
##
##
## $`76`
## $`76`$min
## [1] -2.7190555192
##
## $`76`$max
## [1] 2.1849025375
##
## $`76`$pct_missing
## [1] 0.38
##
## $`76`$first_NA
## [1] 1
##
##
## $`77`
## $`77`$min
## [1] -2.9399830783
##
## $`77`$max
## [1] 1.879628782
##
## $`77`$pct_missing
## [1] 0.37
##
## $`77`$first_NA
## [1] 1
##
##
## $`78`
## $`78`$min
## [1] -2.3461212036
##
## $`78`$max
## [1] 2.1182247698
##
## $`78`$pct_missing
## [1] 0.32
##
## $`78`$first_NA
## [1] 2
##
##
## $`79`

```

```

## $`79`$min
## [1] -2.2806542439
##
## $`79`$max
## [1] 2.2660868762
##
## $`79`$pct_missing
## [1] 0.31
##
## $`79`$first_NA
## [1] 1
##
##
## $`80`
## $`80`$min
## [1] -2.472878237
##
## $`80`$max
## [1] 2.1505205245
##
## $`80`$pct_missing
## [1] 0.26
##
## $`80`$first_NA
## [1] 3
##
##
## $`81`
## $`81`$min
## [1] -2.0855261399
##
## $`81`$max
## [1] 2.4483146637
##
## $`81`$pct_missing
## [1] 0.3
##
## $`81`$first_NA
## [1] 5
##
##
## $`82`
## $`82`$min
## [1] -2.3376439512
##
## $`82`$max
## [1] 2.6927425412
##
## $`82`$pct_missing
## [1] 0.38
##
## $`82`$first_NA
## [1] 1
##
##

```

```

##
## $`83`
## $`83`$min
## [1] -2.2798850786
##
## $`83`$max
## [1] 2.4904330312
##
## $`83`$pct_missing
## [1] 0.25
##
## $`83`$first_NA
## [1] 1
##
##
## $`84`
## $`84`$min
## [1] -2.316675296
##
## $`84`$max
## [1] 2.4800020581
##
## $`84`$pct_missing
## [1] 0.25
##
## $`84`$first_NA
## [1] 6
##
##
## $`85`
## $`85`$min
## [1] -2.3008732504
##
## $`85`$max
## [1] 1.9371208654
##
## $`85`$pct_missing
## [1] 0.28
##
## $`85`$first_NA
## [1] 5
##
##
## $`86`
## $`86`$min
## [1] -1.8134852896
##
## $`86`$max
## [1] 3.1937129469
##
## $`86`$pct_missing
## [1] 0.29
##
## $`86`$first_NA

```

```

## [1] 4
##
##
## $`87`
## $`87`$min
## [1] -2.127248037
##
## $`87`$max
## [1] 1.6141024245
##
## $`87`$pct_missing
## [1] 0.36
##
## $`87`$first_NA
## [1] 1
##
##
## $`88`
## $`88`$min
## [1] -1.7547514041
##
## $`88`$max
## [1] 1.9056875478
##
## $`88`$pct_missing
## [1] 0.3
##
## $`88`$first_NA
## [1] 1
##
##
## $`89`
## $`89`$min
## [1] -1.9115764835
##
## $`89`$max
## [1] 2.0165364451
##
## $`89`$pct_missing
## [1] 0.36
##
## $`89`$first_NA
## [1] 6
##
##
## $`90`
## $`90`$min
## [1] -2.4106446453
##
## $`90`$max
## [1] 2.5625702093
##
## $`90`$pct_missing
## [1] 0.24

```

```

##
## $`90`$first_NA
## [1] 7
##
##
## $`91`
## $`91`$min
## [1] -1.7212125954
##
## $`91`$max
## [1] 2.4825100079
##
## $`91`$pct_missing
## [1] 0.28
##
## $`91`$first_NA
## [1] 2
##
##
## $`92`
## $`92`$min
## [1] -2.2828722875
##
## $`92`$max
## [1] 2.7478125355
##
## $`92`$pct_missing
## [1] 0.22
##
## $`92`$first_NA
## [1] 1
##
##
## $`93`
## $`93`$min
## [1] -2.2212646681
##
## $`93`$max
## [1] 2.0155328872
##
## $`93`$pct_missing
## [1] 0.37
##
## $`93`$first_NA
## [1] 2
##
##
## $`94`
## $`94`$min
## [1] -3.0968536098
##
## $`94`$max
## [1] 2.9230626467
##
##

```



```

## $`94`$pct_missing
## [1] 0.28
##
## $`94`$first_NA
## [1] 2
##
##
## $`95`
## $`95`$min
## [1] -3.0120593493
##
## $`95`$max
## [1] 2.6841159637
##
## $`95`$pct_missing
## [1] 0.31
##
## $`95`$first_NA
## [1] 1
##
##
## $`96`
## $`96`$min
## [1] -2.4047666584
##
## $`96`$max
## [1] 2.0085773185
##
## $`96`$pct_missing
## [1] 0.25
##
## $`96`$first_NA
## [1] 2
##
##
## $`97`
## $`97`$min
## [1] -3.4167409835
##
## $`97`$max
## [1] 2.4740155863
##
## $`97`$pct_missing
## [1] 0.37
##
## $`97`$first_NA
## [1] 2
##
##
## $`98`
## $`98`$min
## [1] -1.5468990452
##
## $`98`$max

```

```
## [1] 1.59783492
##
## $`98`$pct_missing
## [1] 0.26
##
## $`98`$first_NA
## [1] 1
##
##
## $`99`
## $`99`$min
## [1] -2.6865789649
##
## $`99`$max
## [1] 2.2860658751
##
## $`99`$pct_missing
## [1] 0.32
##
## $`99`$first_NA
## [1] 4
##
##
## $`100`
## $`100`$min
## [1] -1.9071374364
##
## $`100`$max
## [1] 2.5547296897
##
## $`100`$pct_missing
## [1] 0.3
##
## $`100`$first_NA
## [1] 3
```

- Set a seed and then create a vector `v` consisting of a sample of 1,000 iid normal realizations with mean -10 and variance 100.

```
?set.seed
X = set.seed(X, kind = NULL, normal.kind = NULL, sample.kind = NULL)
n = 1000
?Normal
v = rnorm(1000, mean = -10, sd = 10)
v
```

```
## [1] 2.629542848808 -13.262333607056 3.297992629225 2.724293214294
## [5] -5.853585655436 -25.399500419037 -19.285670347135 -12.947204467906
## [9] -10.057671727475 14.046533888580 -2.364065388595 -17.990092489894
## [13] -21.476570092364 -12.894615736882 -12.992151178973 -14.115108327951
## [17] -7.477765518439 -18.919211272846 -5.643167006443 -22.375384219300
## [21] -12.242678852783 -6.226043540183 -8.666636391852 -1.958104902551
## [25] -10.571067743838 -4.963920277663 0.857693621457 -16.909538396968
## [29] -22.845993538722 -9.532738278116 -12.357065564395 -15.428882550103
## [33] -14.333103174568 -16.494716467962 -2.732492526145 1.519117540872
```

```

## [37] -0.078396345542 -14.295131094919 2.383041008534 -12.793462818543
## [41] 7.579030898107 -4.392539091119 -14.527839725532 -18.320432961178
## [45] -21.665705470847 -20.655905803883 -25.637820510710 1.565369971502
## [49] -1.679528714276 -12.273286914248 -7.338626383279 -13.767027185836
## [53] 14.413646288946 -17.953391172554 -10.548774737116 -7.498586771458
## [57] -3.817567064338 -11.726235026459 -32.239002740099 -22.636143849706
## [61] -6.412711040286 -10.110454784657 -19.406491626186 -11.158253221570
## [65] -18.149687088699 -7.577365191403 -24.250983947325 -6.340588769508
## [69] -7.515873511274 -9.347118183284 -9.808436083397 -7.426616228445
## [73] -16.490100777089 -11.191687624180 -3.358643001059 1.009691021941
## [77] -8.562285192419 -11.177535981660 -19.120683669483 -24.375862408300
## [81] -17.970895250720 2.540831064500 -2.278578141955 -12.195156267534
## [85] -14.248102833773 -14.189800994220 -0.030131390909 -12.757780290880
## [89] 2.560188173061 -3.533256095047 2.993123025634 -18.732621117444
## [93] -9.916290400040 -18.808717232525 -4.037409833893 -8.802823587105
## [97] -12.821738773225 4.559884010663 -7.709804093053 -0.034560714559
## [101] -2.181408153997 -17.767766217646 -16.159899077079 -9.534196971950
## [105] -21.303857776007 -4.232812181035 -22.807494317883 6.254473034649
## [109] -15.006965960027 6.782972078163 -14.125198874824 -19.722868355056
## [113] -9.746171324122 -9.725246632548 -26.801827223959 0.537508630286
## [117] -21.195991045722 -6.643827900312 -5.052042328868 -8.619472912883
## [121] -11.187920257788 -8.023157376542 -20.686927112548 -18.032132173647
## [125] -21.137651363195 5.800916837038 4.978187610384 -7.373545413372
## [129] -22.329011995713 -10.037235337922 5.116722828109 -14.756982844295
## [133] -2.020835624689 -19.740025611125 -3.106273022345 -19.558391032768
## [137] -22.317070584141 -19.568918813256 -18.697828736865 -19.106806824933
## [141] -2.587236947398 -9.314884667229 -13.237507545880 -20.865030469937
## [145] -20.159289468549 -17.677901847309 -21.197200611270 -14.481742366034
## [149] -5.282636255468 -21.804906828843 4.702569970830 -23.114205916249
## [153] -10.965249227630 13.697199079513 -1.093735235626 -12.521831613909
## [157] -18.657637548443 -4.174140001136 -10.125293469957 -13.748547621139
## [161] -6.821142649075 -14.888056348366 16.586580269985 6.802782046895
## [165] -2.204159909241 -2.867594798872 -15.428819371119 -1.142216260991
## [169] -13.485946845108 -20.080545781695 8.831825423826 -19.289710792012
## [173] -12.941964536069 -16.149502707964 -19.470757917410 -4.010248501897
## [177] -25.236148823776 -12.061890021173 -15.742954143014 -23.901660366351
## [181] -10.704173825072 -14.308795296041 -15.922253729616 -0.188838400934
## [185] -4.675906433295 -10.904561242410 -8.435095083039 -17.373116908400
## [189] -12.013412058722 1.021765950737 -10.167482561519 -8.382113664428
## [193] 10.247613900777 -17.036942538987 -0.392076160495 7.904850535378
## [197] -20.641651633334 -9.823634535754 -13.899086293059 -14.908327523666
## [201] -20.457176517867 -18.962112639606 2.693871636070 -4.061590514025
## [205] -2.243656811165 5.573703763450 -13.654017968839 -1.834435512519
## [209] -10.606347781206 -15.013783177951 -0.739372746670 -9.630623091578
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## [245] -39.048990603456 -21.071648189687 5.475669326183 -19.768303503467
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##	[253]	-5.783966346152	8.739038985953	0.345143239443	-9.181896896460
##	[257]	-10.825237620172	-3.939265691379	-18.874201453171	-8.945786098062
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##	[265]	-2.978832893324	15.071111484834	-28.900271436240	-15.898127901912
##	[269]	-27.145022968458	-14.209978978167	-6.898586234953	7.025705860145
##	[273]	-14.433848043639	-21.985970833181	-13.073809142255	-3.789457972618
##	[277]	-8.180978085957	3.184009311925	-12.989093134307	-26.482217421588
##	[281]	-0.485015303745	-21.131229531014	-3.830335243109	-4.865062835146
##	[285]	-6.305408962690	7.238941306059	-12.061445666392	-23.141951399000
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##	[321]	-5.654633441303	-15.195366670155	-18.345590330191	-17.566476093533
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## [757] -6.154562837742 0.048043389800 -12.859657912736 -12.373398906661
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## [901] -15.918842177335 -13.709930556320 -9.120757428284 -10.347263447245
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## [909] -20.011876757267 15.957718378488 -6.968011848422 -0.912526118105
## [913] -7.921500522132 -8.219859980163 -11.657649981703 -4.428963799737
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## [985] -16.378255175649 14.155051478197 4.809081249653 -17.389817586684
## [989] -10.977651328538 -42.363857323541 -0.429363419201 -4.406658253221
## [993] -14.977007128544 -11.939803095617 -9.136650653535 0.175075381678
## [997] -19.699180228602 0.663524015011 -2.444908452632 -17.032522942108
```

- Repeat this exercise by resetting the seed to ensure you obtain the same results.

```
?set.seed
```

```
RNGkind(X[1])
```

```
## [1] "Mersenne-Twister" "Inversion" "Rejection"
```

```
n = 1000
```

```
?Normal
```

```
v = rnorm(1000, mean = -10, sd = 10)
```

```
v
```

```
## [1] -12.868515649323 8.411068932632 -11.567643097373 -23.898026351346
## [5] -24.731039893924 -10.695189337377 -7.607585702661 -7.495800894219
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## [869] 0.283684209902 -16.058558323555 -15.540803587088 -12.812896039546
## [873] -22.317083461725 3.075424170342 -28.677740314685 -11.500158178497
## [877] -11.834193005878 -10.780632833094 -10.412838396788 1.647690814599
## [881] -14.472201574823 9.529156963614 -1.354209122359 0.719248954016
## [885] -27.631754749754 -17.733410872974 -8.782488716378 -18.481010636226
## [889] -19.888679534690 4.169980132839 -30.462806683910 -17.711620839372
## [893] -4.275145958276 -11.763719616209 -19.514776416201 6.646198602060
## [897] -7.178687114279 -29.439384624468 -14.411999399270 5.791596182345
## [901] 9.801982469801 -3.309915164918 -9.679060644267 -32.178682544015
## [905] 4.331784789297 -17.459485588092 -5.469545117927 -22.014627660355
## [909] -3.993274288080 -35.683981519247 12.912539439291 -17.147787694834
## [913] -3.485489493095 -29.395988953555 -7.934160942181 11.107919012356
## [917] 0.899790630955 -5.885662434589 -14.794935125335 -11.766737551020
## [921] 20.390334057870 -14.209073494000 -15.519549898204 -16.252272482941
## [925] -21.418141748404 -6.030372717515 -8.263130304858 1.920893380824
## [929] -5.580701814699 -22.661515741896 -13.162758253380 -9.030415130677
## [933] 12.517618761815 -20.508177001448 -12.346384103201 -2.063592271699

```

```
## [937] -16.271998677958 -14.545526247509 -17.079236087273 -27.913378182913
## [941] -40.453639299798 -10.973883915401 -22.967835570599 -8.088199325603
## [945] -1.888810709799 -17.350022725918 -11.046268755790 -16.955061822820
## [949] -9.968555877434 -18.432649969107 -16.840283404126 -1.540064787173
## [953] -16.240430005730 -1.152567038768 -7.738658573255 -15.610931034977
## [957] -15.480881659868 -6.695028145379 -17.534743071894 1.651379599112
## [961] -12.783777079938 -15.468959624278 -12.793260035823 -7.879135969564
## [965] -8.178158534414 -22.074400930627 5.545470773444 -27.377732718560
## [969] -13.793330787143 1.319957518819 -10.244350098820 -18.963853441704
## [973] -13.900569228351 -20.786481244412 -0.354302937738 -2.438020790823
## [977] -12.787104228594 -20.502746763119 -21.138849376538 3.522464269831
## [981] -2.113713012045 -32.478801591783 -9.521226547722 15.250783808459
## [985] -20.164020990308 -27.206533370985 -32.519539362092 -12.232953817005
## [989] -17.674506131772 -0.702365991397 -22.900084171654 -15.703316583847
## [993] -0.387183502067 -12.120361083585 -15.334106359039 -9.977945221108
## [997] -13.468235728720 -14.858617985342 -7.832626922184 -21.484864155882
```

- Find the average of `v` and the standard error of `v`.

```
mean(v)
```

```
## [1] -10.247864432
```

```
sd(v)
```

```
## [1] 10.337546251
```

- Find the 5%ile of `v` and use the `qnorm` function to compute what it theoretically should be. Is the estimate about what is expected by theory?

```
?qnorm
?quantile
quantile(v, 0.05)
```

```
##          5%
## -27.721048844
```

```
#Now Theoretically
qnorm(0.05, mean = mean(v), sd = sd(v) )
```

```
## [1] -27.251614876
```

- What is the percentile of `v` that corresponds to the value 0? What should it be theoretically? Is the estimate about what is expected by theory?

```
?Normal
quantile(v, 0)
```

```
##          0%
## -40.4536393
```

```
qnorm(0, mean = mean(v), sd = sd(v)) #Theoretically
```

```
## [1] -Inf
```