Econ_7201 Assignment 1

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3203014

2(a)

$$E(Y) = y_1 p_1 + \cdots + y_k p_k = \sum_{i=1}^{k} y_i \, p_i$$

2(b)

$$\sigma_Y = \mathrm{Var}(Y) = E[(Y - \mu_Y)^2] = \sum_{i=1}^{k} (y_i - \mu_Y)^2 \, p_i$$

2(c)

$$\hat{\beta} = \frac{\sum_{i=1}^{n} (y - y_i)\,(x - x_i)}{\sum_{i=1}^{n} (x - x_i)^2}$$

2(d)

$$P(a \le Y \le b) = \int_a^b f_Y(y)\, dy$$

2(e)

$$g(\hat{x}) = \frac{\frac{1}{nh} \sum_{i=1}^{n} y_i \, K\left(\frac{x_i - x}{h}\right)}{\frac{1}{nh} \sum_{i=1}^{n} K\left(\frac{x_i - x}{h}\right)}$$

```
# clearing the environment
rm(list = ls())

# 3.1(a) set the sample size
n <- 1000

#3.1(b) generate two uniform random variables for u(0,1) with 500 observation
s each
u1 <- runif(500,0,1)
u2 <- runif(500,0,1)
print(u1)

  [1] 0.427843706 0.455792722 0.215142413 0.714890984 0.279272290 0.842485347
  [7] 0.932092136 0.378484985 0.179067851 0.243142662 0.080673882 0.704922589
```

```
 [13] 0.424397774 0.096075156 0.444739474 0.066023642 0.795475762 0.437422400
 [19] 0.522323507 0.401342625 0.342439445 0.445504366 0.959981937 0.358814530
 [25] 0.906755666 0.886007632 0.356477687 0.518133211 0.064601734 0.675294705
 [31] 0.537318469 0.119206372 0.436383111 0.384138786 0.685010450 0.031853831
 [37] 0.621319631 0.791589837 0.518097761 0.240552634 0.408943374 0.022792956
 [43] 0.754948256 0.533778862 0.130900257 0.946073197 0.408147490 0.238800409
 [49] 0.863899485 0.199903850 0.864678575 0.723407853 0.671292059 0.121415363
 [55] 0.578504119 0.604957657 0.079055745 0.919464385 0.245188532 0.080081874
 [61] 0.476489940 0.674695330 0.347285416 0.274067748 0.487923197 0.215453426
 [67] 0.444883427 0.442904773 0.822940956 0.768420947 0.629808041 0.030959990
 [73] 0.335972991 0.768151500 0.391213573 0.731211963 0.831056998 0.176001330
 [79] 0.318983046 0.218828114 0.900561881 0.763560342 0.926766208 0.706555158
 [85] 0.925895097 0.313350688 0.109838210 0.491564878 0.667613656 0.984295916
 [91] 0.560430423 0.096492225 0.505470008 0.416494538 0.254639128 0.671184504
 [97] 0.753799400 0.857676684 0.291454221 0.570731741 0.078980771 0.527257619
[103] 0.677982215 0.383979982 0.572738756 0.868395417 0.387226515 0.729045214
[109] 0.814214533 0.172087722 0.329116311 0.067973998 0.741646371 0.321094253
[115] 0.124438013 0.804888556 0.252487884 0.503302259 0.864627014 0.244686273
[121] 0.135769910 0.914049986 0.646342359 0.366076728 0.122704738 0.668564334
[127] 0.175096310 0.664520005 0.046084516 0.216756148 0.259782834 0.430858969
[133] 0.444792531 0.006206130 0.011191475 0.810073135 0.023841398 0.611703268
[139] 0.313675701 0.308673850 0.826270512 0.127330760 0.306355949 0.877615675
[145] 0.997398631 0.030259022 0.176999853 0.261462914 0.733094424 0.236573769
[151] 0.896047957 0.444317484 0.220175794 0.662030520 0.746362729 0.774395301
[157] 0.685355904 0.255456396 0.958959292 0.337470997 0.446259036 0.090178658
[163] 0.587125387 0.458807614 0.700213555 0.551414374 0.139565407 0.143448586
[169] 0.140880656 0.637018737 0.105230609 0.114729257 0.614594418 0.054342974
[175] 0.911188254 0.410247233 0.831196412 0.969650806 0.257320620 0.945225738
[181] 0.571600076 0.485365053 0.939396654 0.978731545 0.723556009 0.067614695
[187] 0.662465915 0.799168710 0.796177759 0.575511815 0.901774060 0.122284361
[193] 0.227112132 0.443804485 0.183472990 0.237065345 0.426247271 0.358322942
[199] 0.691579112 0.275567170 0.792610676 0.167000023 0.802210820 0.608618889
[205] 0.543776718 0.426482823 0.648256963 0.597134696 0.182273620 0.260445775
[211] 0.704571689 0.577122549 0.936489565 0.750890399 0.302189033 0.445440261
[217] 0.215028263 0.303218207 0.047531110 0.508723434 0.592237135 0.587663327
[223] 0.286393514 0.830288369 0.732098793 0.307394682 0.377214972 0.710442389
[229] 0.083083673 0.054434554 0.011641366 0.059465915 0.217237937 0.257509155
[235] 0.991321541 0.155937369 0.317508564 0.284073773 0.285167721 0.130717834
[241] 0.958246388 0.716997573 0.793682816 0.414626735 0.927336528 0.641743881
[247] 0.705546536 0.598835964 0.181649696 0.696377465 0.800850761 0.645667233
[253] 0.976692273 0.400109585 0.882430079 0.538888567 0.996609289 0.903709669
[259] 0.520269168 0.654763972 0.533114748 0.692681981 0.888273852 0.256695197
[265] 0.461511606 0.180645799 0.296800302 0.286167708 0.314353662 0.706479830
[271] 0.036427197 0.989884151 0.842162799 0.724720805 0.884379780 0.679840634
[277] 0.731813500 0.010640631 0.146386321 0.777854044 0.071576176 0.316898509
[283] 0.729590671 0.458025611 0.931160237 0.056776104 0.083553041 0.473239946
[289] 0.027350862 0.006177071 0.949486049 0.003768993 0.461393210 0.076967342
[295] 0.454039582 0.246890639 0.022055052 0.638168726 0.590669122 0.241202294
[301] 0.966827304 0.382610655 0.832590510 0.127512766 0.475999141 0.580637220
[307] 0.818979654 0.886904725 0.790239942 0.587305151 0.038951384 0.954571674
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[313] 0.199583770 0.468637155 0.987784181 0.363103506 0.245657910 0.756505459
[319] 0.643901517 0.754846006 0.869236968 0.411942960 0.899416287 0.726862165
[325] 0.719841713 0.038392338 0.644743813 0.472560593 0.703796883 0.930800428
[331] 0.853228719 0.042580273 0.118078640 0.336245930 0.231041736 0.873931304
[337] 0.596928010 0.803798271 0.218718314 0.305891020 0.350646114 0.234206392
[343] 0.671280122 0.319281253 0.904311746 0.047232564 0.525835089 0.393005573
[349] 0.352978667 0.833493867 0.255424426 0.101568369 0.331162232 0.409455374
[355] 0.189586750 0.938794203 0.906735409 0.618491160 0.974226216 0.028976208
[361] 0.259505437 0.485035681 0.955045999 0.365982238 0.748828589 0.820344472
[367] 0.402372317 0.162806388 0.483635285 0.064082189 0.413303504 0.018800854
[373] 0.432562843 0.015506374 0.647520547 0.124335864 0.896483826 0.779362943
[379] 0.057606759 0.920090426 0.367356613 0.321707050 0.677420356 0.803162847
[385] 0.878781756 0.315983365 0.105679076 0.554897707 0.018280722 0.290326227
[391] 0.048192082 0.260356312 0.081321270 0.246280120 0.447308757 0.448268725
[397] 0.801078886 0.002649974 0.334205327 0.351053704 0.253552160 0.417715704
[403] 0.443115170 0.561304725 0.979142951 0.976119484 0.721496385 0.226674935
[409] 0.817122150 0.973316310 0.367749679 0.754290898 0.671638654 0.997525681
[415] 0.709516283 0.222205975 0.482951623 0.205208368 0.688243223 0.928211669
[421] 0.014852629 0.670586424 0.742315081 0.643140385 0.369997906 0.205089214
[427] 0.662568181 0.880102582 0.138981507 0.983685313 0.947061406 0.676975857
[433] 0.090017338 0.511216715 0.371343137 0.346940153 0.393489628 0.630733343
[439] 0.811624747 0.229525101 0.737382595 0.249944067 0.938171838 0.485605909
[445] 0.270887866 0.220319366 0.346770396 0.408358583 0.117462558 0.295197861
[451] 0.875651285 0.729056350 0.699556289 0.633943421 0.605632723 0.075552951
[457] 0.951317122 0.441318563 0.820451832 0.797193378 0.947926100 0.548691483
[463] 0.388054577 0.006432258 0.904163281 0.292199093 0.252650594 0.713667683
[469] 0.149510435 0.060324984 0.200315279 0.456950581 0.488296781 0.613361008
[475] 0.200872915 0.161273912 0.939125815 0.509264368 0.176298197 0.690980622
[481] 0.492557034 0.693064858 0.261982232 0.099470271 0.719300635 0.522713848
[487] 0.208574793 0.703266393 0.709771776 0.925003666 0.131809329 0.784249132
[493] 0.051785326 0.008397231 0.849477828 0.150381577 0.548917715 0.695387605
[499] 0.811751384 0.187813641
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print(u2)
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  [1] 0.2116825287 0.5815543416 0.8009978679 0.4172112599 0.6127873093
  [6] 0.1121274275 0.3325468504 0.4170227973 0.3574978299 0.4104299480
 [11] 0.8675582106 0.9673404123 0.9833594926 0.7691771549 0.7532291531
 [16] 0.1332065964 0.5144996752 0.5926505991 0.0735167637 0.9699993380
 [21] 0.3178353861 0.9727287800 0.4156767500 0.7812149241 0.2967795809
 [26] 0.7207122273 0.0127274129 0.1905675733 0.8821376297 0.2637085444
 [31] 0.9144755460 0.2362212746 0.9820350029 0.6857690455 0.3822279566
 [36] 0.3321944163 0.2648713985 0.1351016168 0.5036630414 0.2785029048
 [41] 0.4351974262 0.0093097610 0.7370739679 0.4088777208 0.4910370412
 [46] 0.5733804274 0.6222253700 0.8685773108 0.2729011388 0.2929480770
 [51] 0.6124741200 0.8966238853 0.4568603921 0.3606382916 0.7842415436
 [56] 0.0477390229 0.0772759740 0.6006408716 0.8809853911 0.3169357048
 [61] 0.8333973030 0.3809687109 0.2053601595 0.7083419024 0.0705838159
 [66] 0.3197380719 0.6782218700 0.2147312008 0.9049359914 0.1414371366
 [71] 0.3480890617 0.4257299944 0.9626915168 0.2439272862 0.3120597736
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 [76] 0.6139908158 0.7136730754 0.4447454200 0.0988261837 0.2787774869
 [81] 0.3764657972 0.9810838739 0.3221357488 0.8681523646 0.6321498060
 [86] 0.1896329613 0.6706916122 0.3462908391 0.0758357854 0.5669935399
 [91] 0.9265320092 0.6247532496 0.9585879482 0.1040665454 0.5859978243
 [96] 0.1736615307 0.6747336895 0.6451261013 0.0045092127 0.8982876632
[101] 0.3200728453 0.5058595759 0.9451246974 0.8256616127 0.9308746431
[106] 0.9928450501 0.2440602933 0.6387048413 0.1139634612 0.8784198498
[111] 0.6249580306 0.4968053643 0.0560834548 0.9713921607 0.2522937206
[116] 0.1318106200 0.0005956904 0.7051455157 0.3082365750 0.4919300666
[121] 0.5080770676 0.4860410863 0.7968198073 0.8215536925 0.9286263033
[126] 0.8535021835 0.9716087326 0.8783406755 0.3618845886 0.3904106980
[131] 0.4992933699 0.0491606886 0.9407667867 0.0380479242 0.6229383531
[136] 0.7156291932 0.8822136677 0.8587057944 0.1091978417 0.8717739952
[141] 0.2730567462 0.4896866733 0.6220450529 0.2262856853 0.9705689454
[146] 0.3360687902 0.0263663325 0.0259936338 0.1111249374 0.2559937313
[151] 0.0372244907 0.7373609308 0.2711703901 0.6132694550 0.9273592089
[156] 0.8007058022 0.2811595798 0.1302223674 0.4710953129 0.5319678732
[161] 0.4937035504 0.0483059320 0.2931274250 0.9799295731 0.9968848100
[166] 0.6623569874 0.5767168766 0.8154918000 0.2469831752 0.6796400652
[171] 0.5599958363 0.2770529587 0.6180461585 0.1136321046 0.8493773402
[176] 0.8862095668 0.7415669183 0.2497324613 0.0794741865 0.4313870231
[181] 0.9803305690 0.2962397854 0.6657134299 0.0419940297 0.8097360604
[186] 0.0793003663 0.2109906911 0.8859633217 0.1006068632 0.5336295434
[191] 0.8079066626 0.2629421430 0.7091011619 0.1028994322 0.5483225512
[196] 0.0263425310 0.7955990105 0.5508445739 0.5720321445 0.2387295917
[201] 0.8001812343 0.8294929126 0.3882392526 0.8273163303 0.0510495522
[206] 0.0551475850 0.8431414790 0.4573042332 0.1962969906 0.1771658603
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[221] 0.8215001356 0.0698967446 0.3543350901 0.5463530109 0.4186440955
[226] 0.8077597138 0.6424659553 0.1122144524 0.0573117663 0.5705923231
[231] 0.2735208010 0.3513930899 0.0877391007 0.7800036997 0.7484646623
[236] 0.5989180619 0.5795419163 0.8889791726 0.2602245859 0.6528254603
[241] 0.6737061103 0.9204731942 0.3262842221 0.6359547318 0.5168870443
[246] 0.1721082104 0.4933794104 0.5608592331 0.5154671567 0.8886717870
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[256] 0.5901646863 0.0441990464 0.9598106956 0.3629406791 0.1124392338
[261] 0.8056663356 0.2356533781 0.7407107393 0.2297620438 0.9573497726
[266] 0.5869808488 0.0688942866 0.9873907776 0.0186784326 0.1526601918
[271] 0.2309250836 0.0124647219 0.4492766999 0.2261051200 0.7127135186
[276] 0.7988331709 0.0281282354 0.8201183160 0.0586304744 0.1080327497
[281] 0.4779592722 0.3104375806 0.1458390406 0.7323527040 0.8192711305
[286] 0.7704828477 0.0305474503 0.2690158407 0.6430541256 0.8571464561
[291] 0.4731487124 0.8339652971 0.2282939132 0.0630681745 0.6790158821
[296] 0.1984371720 0.7673993355 0.7845057026 0.7513478626 0.5005694083
[301] 0.8170176221 0.4337660663 0.1759738356 0.0657991017 0.5871309461
[306] 0.0149578345 0.4903696170 0.7971671070 0.5803378047 0.0685183066
[311] 0.7563668047 0.8234655089 0.2965161426 0.0226517520 0.1122690018
[316] 0.6953375565 0.3761364778 0.6163599908 0.6467988787 0.9965838580
[321] 0.9883458198 0.1396890639 0.5178517168 0.8344739683 0.1543309353
```

```
[326] 0.3915987434 0.1555335708 0.7127431775 0.2174896749 0.0306129621
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[336] 0.9711498683 0.6864159482 0.2341417766 0.6616045407 0.3692980350
[341] 0.1640809861 0.6894956490 0.1642382673 0.1393900951 0.9969532343
[346] 0.9607953171 0.5061187644 0.7465738244 0.3152469762 0.6844231868
[351] 0.0635158736 0.3370740921 0.4495820238 0.0761159598 0.7542268727
[356] 0.3683039555 0.0318141168 0.3105929990 0.6827299222 0.6918387369
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[366] 0.9790203839 0.9343257986 0.4939699520 0.9533012996 0.2095087066
[371] 0.9844275359 0.8611787446 0.6968878468 0.5244743782 0.6638926347
[376] 0.5981710029 0.7844461978 0.6945017262 0.3339623201 0.7057291730
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[386] 0.1148437490 0.9224310808 0.2932214104 0.8115015316 0.2362358496
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[416] 0.4413855285 0.6524314785 0.2827801064 0.6114361573 0.5546927243
[421] 0.3484349535 0.1147602610 0.6947895896 0.2893825276 0.0162078806
[426] 0.3005300723 0.5249534682 0.6444430312 0.2388089914 0.8357978377
[431] 0.9773897701 0.6645083758 0.8093248466 0.7312194309 0.2639728840
[436] 0.4310828533 0.3968887338 0.5960198480 0.7935234068 0.1582166655
[441] 0.6655573302 0.8131659592 0.6525302227 0.9735122551 0.9117184856
[446] 0.7537039795 0.7255473624 0.6835082120 0.8718683722 0.1994333593
[451] 0.5413283049 0.3182227504 0.4445211629 0.8490313960 0.5744383552
[456] 0.6930495037 0.5745393280 0.1282191316 0.0760706926 0.5676749866
[461] 0.2398638793 0.0952432447 0.2482904538 0.0564646162 0.5486463758
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[476] 0.5862037584 0.6662857698 0.0928991074 0.6459771600 0.8836081629
[481] 0.0858883585 0.5573941930 0.3796708141 0.6826599820 0.4539178929
[486] 0.3814893938 0.9934155510 0.1928381876 0.5152706043 0.3049148896
[491] 0.3322471392 0.2113718402 0.5924007194 0.6828933740 0.9993517685
[496] 0.6237856781 0.3737784750 0.7777757316 0.0498778522 0.2085341616
```

```r
#3.1(c) generate two standard normal variables (z1 & z2)
z1 <- sqrt(-2*log(u1))*cos(2*pi*u2)
z2 <- sqrt(-2*log(u1))*sin(2*pi*u2)
print(z1)
```

```
  [1]  0.3106999650 -1.0925603248  0.5521402023 -0.7109311018 -1.2126668445
  [6]  0.4460986616 -0.1859075669 -1.2087716834 -1.1596294303 -1.4223602410
 [11]  1.5107187233  0.8187166257  1.3021126777  0.2601830349  0.0258266264
 [16]  1.5613987124 -0.6736779540 -1.0741523922  1.0202658987  1.3273156908
 [21] -0.6052709435  1.2530283215 -0.2466164365  0.2790104874 -0.1281834091
 [26] -0.0900271119  1.4317132041  0.4183434604  1.7276871632 -0.0762302929
 [31]  0.9575064613  0.1783342264  1.2796202470 -0.5432315556 -0.6423679314
 [36] -1.2964403413 -0.0910283702  0.4518008110 -1.1465104022 -0.3007041597
 [41] -1.2279662857  2.7453160656 -0.0608299773 -0.9418224235 -2.0133940578
```

```
 [46] -0.2982035476 -0.9629982449  1.1474605896 -0.0775662325 -0.4783622205
 [51] -0.4101088914  0.6408477677 -0.8602086031 -1.3153185263  0.2233619189
 [56]  0.9578279927  1.9924479517 -0.3305545712  1.2293736218 -0.9174424742
 [61]  0.6092376628 -0.6503694507  0.4025971078 -0.4163464266  1.0821008522
 [66] -0.7434179874 -0.5547416315  0.2805073545  0.5161993769  0.4575952432
 [71] -0.5558348557 -2.3544323874  1.4365779046  0.0277066228 -0.5207876328
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print(z2)
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```

```r
# 3.1(d) generate a vector z
z <- c(z1,z2)
print(z)
```

```
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 [41] -1.2279662857  2.7453160656 -0.0608299773 -0.9418224235 -2.0133940578
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```

```r
# 3.1(e) generate two variables (mu & sigma)
mu <- 5
sigma <- 2

# 3.1(f)  generate a variable x
x <- mu+sigma*z
print(x)
```

```
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2
  [37]  4.81794326  5.90360162  2.70697920  4.39859168  2.54406743 10.4906321
3
  [43]  4.87834005  3.11635515  0.97321188  4.40359290  3.07400351  7.2949211
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```

```
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```
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7
```

```
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6
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6
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3
 [997]  6.56078632  3.32111210  5.39821435  8.53421523
```

```
# 3.1(g) cal mean(x)
mean(x)
```

```
[1] 5.041537
```

```
sd(x)
```

```
[1] 2.043541
```

```r
# 3.1(h) plot a histogram of x
hist(x,
     freq = FALSE,
     ylab = "Density",
     xlab = "$x$")

curve(dnorm(x,mean=mu,sd=sigma),
      col="red", lwd=2,add=TRUE)


# 3.2 import data into R
library(readr)
```

```
Warning: package 'readr' was built under R version 4.3.2
```

```r
hlthexp <- read_csv("hlthexp.csv")
```

```
Rows: 48 Columns: 20
── Column specification ────────────────────────────────────────────────────────
Delimiter: ","
chr  (2): Non-Prescribed Drugs, COVID-19 Response Funding
dbl (18): Year, Hospitals, Other Institutions, Physicians, Other Professiona...

ℹ Use `spec()` to retrieve the full column specification for this data.
ℹ Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
View(hlthexp)

# 3.2(a) Check for missing values in the column 'Hospital'
hlthexp
```

```
# A tibble: 48 × 20
    Year Hospitals `Other Institutions` Physicians `Other Professionals: Dental…¹
   <dbl>     <dbl>                <dbl>      <dbl>                          <dbl>
 1  1975     5137.                 797.      1813.                           56.4
 2  1976     5978.                 999.      2042.                           69.8
 3  1977     6373.                1175.      2252.                           83.7
 4  1978     6862.                1368.      2528.                          104.
 5  1979     7488.                1581.      2804.                          144.
 6  1980     8585.                1821.      3236.                           19
```

```
5.
 7  1981    10127.                2147.      3775.                          27
8.
 8  1982    12002.                2531.      4353.                          27
0.
 9  1983    13175.                2794.      4973.                          26
1.
10  1984    13936.                2923.      5445.                          26
7.
# ℹ 38 more rows
# ℹ abbreviated name: ¹`Other Professionals: Dental Services`
# ℹ 15 more variables: `Other Professionals: Vision Care Services` <dbl>,
#   `Other Professionals: Other Services` <dbl>,
#   `Total Other Professionals` <dbl>, `Prescribed Drugs` <dbl>,
#   `Non-Prescribed Drugs` <chr>, `Total Drugs` <dbl>, `Public Health` <dbl>,
#   Administration <dbl>, …
```

```
missing_value_Hospitals <- sum(is.na(hlthexp$Hospitals))


# 3.2(b) create a new variable (Total Other Services) by summing these three
other given variables
Total_Other_Services <- hlthexp$`Other Professionals: Dental Services`+hlthex
p$`Other Professionals: Vision Care Services`+
hlthexp$`Other Professionals: Other Services`
print(Total_Other_Services)
```

```
 [1]  138.98  164.38  189.10  231.39  290.70  367.07  483.85  504.18  530.33
[10]  565.42  620.52  693.87  719.93  788.15  897.42  987.40 1096.33 1127.56
[19] 1097.64 1069.06 1032.88  997.06 1028.44 1038.03 1123.04 1205.34 1213.77
[28] 1182.79 1180.26 1206.22 1143.10 1218.71 1323.64 1470.61 1631.54 1718.77
[37] 1789.24 1895.42 1850.52 1857.59 2431.06 2693.18 2894.46 3093.18 3304.56
[46] 3121.92 3388.85 3623.38
```

```
hlthexp<-data.frame(hlthexp, Total_Other_Services)


# 3.2(c) question seems incomplete

# 3.2(d) adding prescription drugs to the data frame using append method
Prescription_Drugs<-hlthexp$Prescribed.Drugs
View(Prescription_Drugs)
hlthexp<-append(hlthexp, Prescription_Drugs)
View(hlthexp)

# 3.2(e) determine the expenditure on hospitals in 1983
hlthexp$Hospitals[hlthexp$Year==1983]
```

```
[1] 13174.55
```

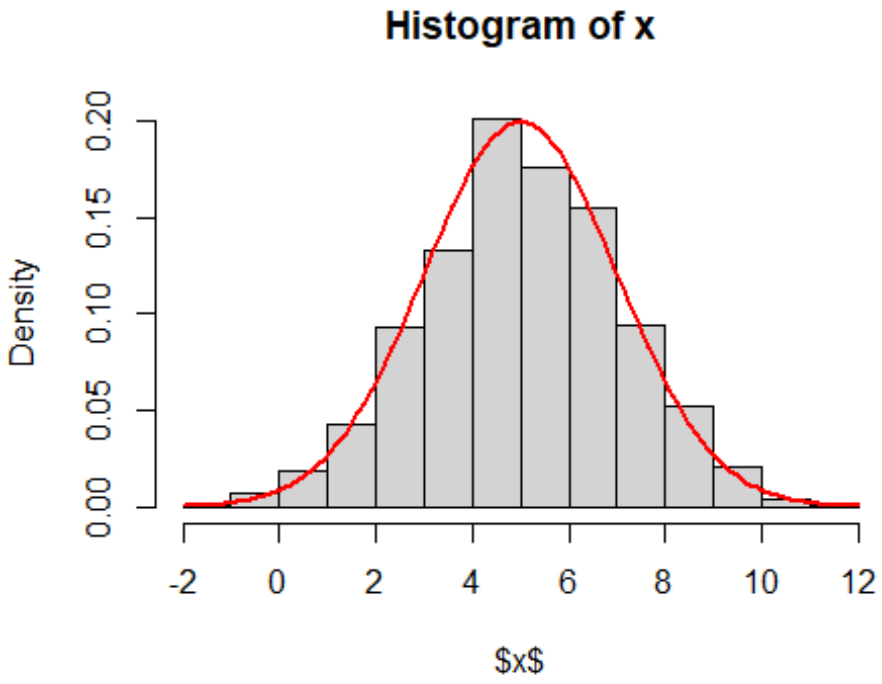
```r
# 3.2(f) listing the expenditures by year for 2012-2022
hlthexp <- read_csv("hlthexp.csv")
```

```
Rows: 48 Columns: 20
── Column specification ────────────────────────────────────────────────────────
Delimiter: ","
chr  (2): Non-Prescribed Drugs, COVID-19 Response Funding
dbl (18): Year, Hospitals, Other Institutions, Physicians, Other Professiona...

ℹ Use `spec()` to retrieve the full column specification for this data.
ℹ Specify the column types or set `show_col_types = FALSE` to quiet this mess
age.
```

```r
hlthexp[hlthexp$Year %in% 2012:2022, ]
```

```
# A tibble: 11 × 20
    Year Hospitals `Other Institutions` Physicians Other Professionals: Denta
l…¹
   <dbl>     <dbl>                <dbl>      <dbl>                        <d
bl>
 1  2012    53300.                15924.     29802.                         7
59.
 2  2013    54954.                16386.     31202.                         7
62.
 3  2014    56123.                16966.     32491.                         7
82
 4  2015    57352.                18314.     33886.                         8
21.
 5  2016    58169.                18810.     35284.                         8
76.
 6  2017    60356.                19666.     36491.                         9
19.
 7  2018    62897.                20548.     37495.                         9
61.
 8  2019    65034.                21447.     38914.                        10
18.
 9  2020    67222.                23675.     37288.                         8
97.
10  2021    69664.                25679.     41480.                         9
23.
11  2022    73778.                28096.     44195.                         9
92.
# ℹ abbreviated name: ¹`Other Professionals: Dental Services`
# ℹ 15 more variables: `Other Professionals: Vision Care Services` <dbl>,
#   `Other Professionals: Other Services` <dbl>,
#   `Total Other Professionals` <dbl>, `Prescribed Drugs` <dbl>,
#   `Non-Prescribed Drugs` <chr>, `Total Drugs` <dbl>, `Public Health` <dbl>,
#   Administration <dbl>, `Other Health Spending: Health Research (HR)` <dbl>
```

```
,
#   `Other Health Spending: Net of HR` <dbl>, …

# 3.3 (a) Installing ggplot2 before loading the mpg data set
##install.packages("ggplot2")
mpg <-ggplot2::mpg
```




```
mpg

# A tibble: 234 × 11
   manufacturer model      displ  year   cyl trans drv     cty   hwy fl    cl
ass
   <chr>        <chr>      <dbl> <int> <int> <chr> <chr> <int> <int> <chr> <c
hr>
 1 audi         a4           1.8  1999     4 auto… f        18    29 p     co
mp…
 2 audi         a4           1.8  1999     4 manu… f        21    29 p     co
mp…
 3 audi         a4           2    2008     4 manu… f        20    31 p     co
mp…
 4 audi         a4           2    2008     4 auto… f        21    30 p     co
mp…
 5 audi         a4           2.8  1999     6 auto… f        16    26 p     co
mp…
 6 audi         a4           2.8  1999     6 manu… f        18    26 p     co
mp…
 7 audi         a4           3.1  2008     6 auto… f        18    27 p     co
```

```
mp…
 8 audi         a4 quattro   1.8  1999     4 manu… 4        18    26 p     co
mp…
 9 audi         a4 quattro   1.8  1999     4 auto… 4        16    25 p     co
mp…
10 audi         a4 quattro   2    2008     4 manu… 4        20    28 p     co
mp…
# ℹ 224 more rows
```

```
?subset
```

```
starting httpd help server ... done
```

```
subset(mpg,year==2008)
```

```
# A tibble: 117 × 11
   manufacturer model      displ  year   cyl trans drv     cty   hwy fl    cl
ass
   <chr>        <chr>      <dbl> <int> <int> <chr> <chr> <int> <int> <chr> <c
hr>
 1 audi         a4           2    2008     4 manu… f        20    31 p     co
mp…
 2 audi         a4           2    2008     4 auto… f        21    30 p     co
mp…
 3 audi         a4           3.1  2008     6 auto… f        18    27 p     co
mp…
 4 audi         a4 quattro   2    2008     4 manu… 4        20    28 p     co
mp…
 5 audi         a4 quattro   2    2008     4 auto… 4        19    27 p     co
mp…
 6 audi         a4 quattro   3.1  2008     6 auto… 4        17    25 p     co
mp…
 7 audi         a4 quattro   3.1  2008     6 manu… 4        15    25 p     co
mp…
 8 audi         a6 quattro   3.1  2008     6 auto… 4        17    25 p     mi
ds…
 9 audi         a6 quattro   4.2  2008     8 auto… 4        16    23 p     mi
ds…
10 chevrolet    c1500 sub…   5.3  2008     8 auto… r        14    20 r     su
v
# ℹ 107 more rows
```

```
View(mpg)
?min
min_val<-min(mpg$cty,na.rm=TRUE)
print(min_val)
```

```
[1] 9
```

```
max_val<-max(mpg$cty,na.rm=TRUE)
print(max_val)
```

```
[1] 35

# 3.3(b) Estimating the average miles per gallon within city limits for cars
produced in 2008
# Writing the mean function as sum of all x_i's over n
n<-length(mpg$cty)
print(n)

[1] 234

average_city<-sum(mpg$cty)/n
print(average_city)

[1] 16.85897

# 3.3(c) computing mean for mpg$cty using the mean() function
mean_value<-mean(mpg$cty)
print(mean_value)

[1] 16.85897

# 3.3(d) using the ifelse argument to extract the compact vechicles
mpg_compact<-ifelse(mpg$class=="compact", 1,0)
mpg <-data.frame(mpg, mpg_compact)
print(mpg_compact)

  [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 [38] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 [75] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
[112] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0
[149] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 0 0 0 0 0 0 0 0 0
[186] 0 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1
[223] 0 0 0 0 0 0 0 0 0 0 0 0

# 3.3(e) estimating the average miles per gallon withing city limits for comp
act cars
average_city_compact<-mean(mpg$cty[mpg$class=="compact"],na.rm=TRUE)
print(average_city_compact)

[1] 20.12766

# 3.3(f) creating a scatter plot with mpg(cty) following instructions in (i),
(ii), (iii)
scatter_plot<-plot(mpg$cty, mpg$hwy, xlab ='city MPG', ylab ='Highway MPG', m
ain="City Versus Highway Fuel Efficiency (MPG)")
```

```
# cross referencing the figure "Figure 1 shows the fuel efficiency for city d
riving versus highway driving"
mtext("Figure 1 shows the fuel efficiency for
city driving versus highway driving")
```