Stat 435 Lab Notes 1a

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#

Samples and summary statistics

Samples from Gaussian r.v.'s

Generate a sample from a Gaussian *random variable (r.v.)*. Basic syntax:

```
rnorm(n, mean = 0, sd = 1)
```

- `n`: sample size
- `mean` and `sd`: vector of means and vector of standard deviations

Note: `mean` and `sd` can be specified by user.

Samples from Gaussian r.v.'s

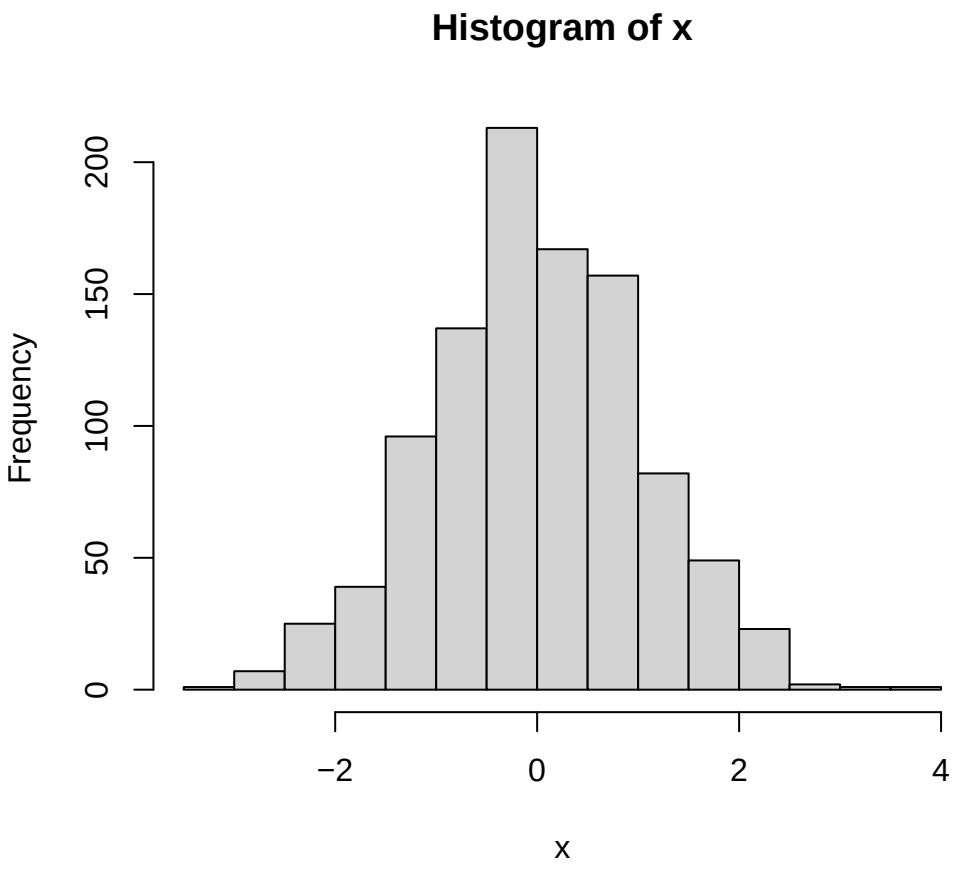
Generate a sample of size 10 from the standard Gaussian random variable:

```
> rnorm(4)
[1]  0.8508497 -0.2631238  0.4762995  0.2351962
> rnorm(4)
[1] -1.5150365  1.0657339  0.4578315 -0.6021592
> set.seed(123)
> rnorm(4)
[1] -0.56047565 -0.23017749  1.55870831  0.07050839
> set.seed(123)
> rnorm(4)
[1] -0.56047565 -0.23017749  1.55870831  0.07050839
> rnorm(4)
[1]  0.1292877  1.7150650  0.4609162 -1.2650612
```

Note the use of `set.seed`.

Samples from Gaussian r.v.'s

```
> set.seed(1)
> x = rnorm(1000,0,1)
> hist(x)
```



Summary statistics

```
> set.seed(1)
> x = rnorm(10^3,0,1)
> # sample mean
> mean(x)
[1] -0.01164814
> # sample standard deviation
> # denominator (n-1) used for sd and var
> sd(x)
[1] 1.034916
> # sample variance
> var(x)
[1] 1.071051
> # increase sample size
> y = rnorm(10^5,0,1)
> mean(y)
[1] -0.001946423
> sd(y)
[1] 1.003034
```

What do sample mean and sample variance converge to as sample size increases indefinitely?

Summary statistics

```
> set.seed(1)
> u = rnorm(10^2,0,1)
> w = rnorm(10^2,0,1)
> # sample covariance; default "pearson"
> cov(u,w)
[1] -0.0008554794
> # sample correlation; default "pearson"
> cor(u,w)
[1] -0.0009943199
> # increase sample size
> x = rnorm(10^4,0,1)
> z = rnorm(10^4,0,1)
> cov(x,z, method = "pearson")
[1] 0.006632814
> cor(x,z)
[1] 0.006609744
```

Why is the absolute value of the sample covariance close to that of the sample correlation in the above example?

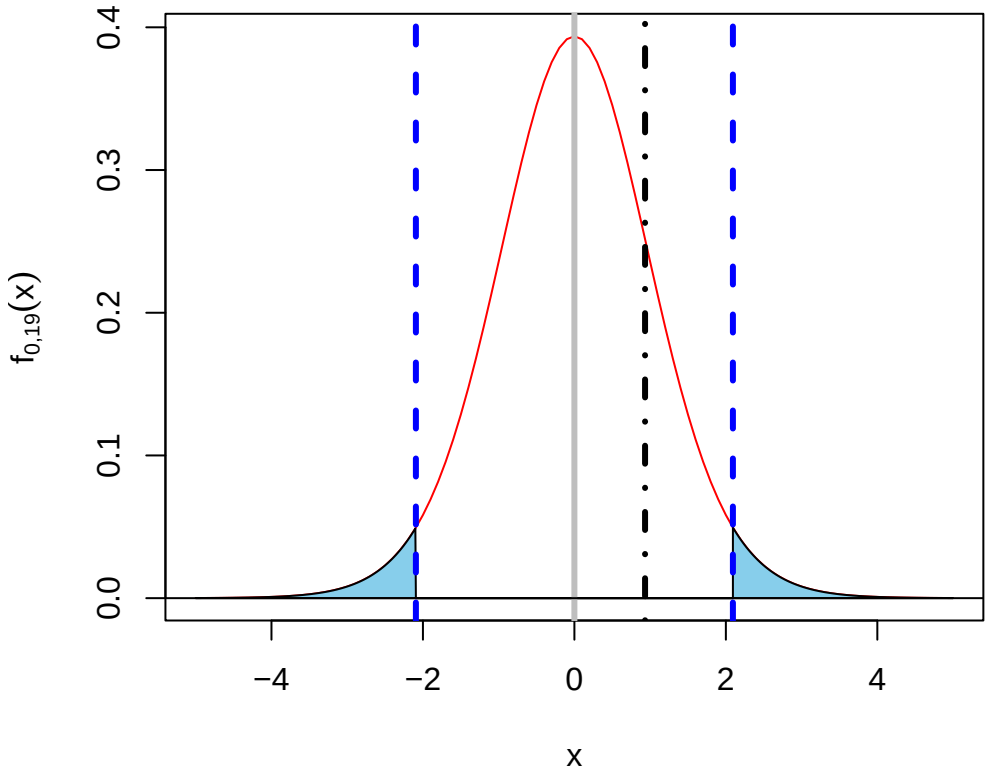
Student t test

Test if the mean μ of a Gaussian random variable is 0:

```
> set.seed(1)
> n=20
> x = rnorm(n)
> sampleMean = mean(x)
> sampleStd = sd(x)
> tTestValue = sampleMean/(sampleStd/sqrt(n))
> tTestValue
[1] 0.9329813
> # use p-value for decision
> TwoSidedPvalue = 2*pt(-abs(tTestValue),df=19,ncp=0,lower.tail=TRUE)
> TwoSidedPvalue
[1] 0.3625352
> # Type I error level
> alpha = 0.05
> # use critical value for decision
> criticalValue = qt(alpha/2,df=19,ncp=0,lower.tail=FALSE)
> criticalValue
[1] 2.093024
> abs(tTestValue) > criticalValue
[1] FALSE
```

Student t test

Student t test (mean=0, df=19), decision rule at Type I error level $\alpha = 0.05$, and two-side p-value:



The auto data set

The data set `Auto.data` contains `mpg` (miles per gallon) for cars of different numbers of `cylinders`, engine `displacement`, `horsepower`, manufactures (`name`), etc.

```
> AD1 = read.table("Auto-2.data",header = T,na.strings = "?")
> AD1a = na.omit(AD1)
> head(AD1a[,1:5])
  mpg cylinders displacement horsepower weight
1  18         8          307        130   3504
2  15         8          350        165   3693
3  18         8          318        150   3436
4  16         8          304        150   3433
5  17         8          302        140   3449
6  15         8          429        198   4341
```

The auto data set

```
> summary(AD1a)
      mpg          cylinders      displacement
 Min.   : 9.00   Min.   :3.000   Min.   : 68.0
 1st Qu.:17.00   1st Qu.:4.000   1st Qu.:105.0
 Median :22.75   Median :4.000   Median :151.0
 Mean   :23.45   Mean   :5.472   Mean   :194.4
 3rd Qu.:29.00   3rd Qu.:8.000   3rd Qu.:275.8
 Max.   :46.60   Max.   :8.000   Max.   :455.0
   horsepower       weight      acceleration
 Min.   : 46.0   Min.   :1613   Min.   : 8.00
 1st Qu.: 75.0   1st Qu.:2225   1st Qu.:13.78
 Median : 93.5   Median :2804   Median :15.50
 Mean   :104.5   Mean   :2978   Mean   :15.54
 3rd Qu.:126.0   3rd Qu.:3615   3rd Qu.:17.02
 Max.   :230.0   Max.   :5140   Max.   :24.80
      year           origin          name
 Min.   :70.00   Min.   :1.000   Length:392
 1st Qu.:73.00   1st Qu.:1.000   Class :character
 Median :76.00   Median :1.000   Mode  :character
 Mean   :75.98   Mean   :1.577
 3rd Qu.:79.00   3rd Qu.:2.000
 Max.   :82.00   Max.   :3.000
```

License and session Information

License

```
> sessionInfo()
R version 4.2.0 (2022-04-22 ucrt)
Platform: x86_64-w64-mingw32/x64 (64-bit)
Running under: Windows 10 x64 (build 19044)

Matrix products: default

locale:
[1] LC_COLLATE=English_United States.utf8
[2] LC_CTYPE=English_United States.utf8
[3] LC_MONETARY=English_United States.utf8
[4] LC_NUMERIC=C
[5] LC_TIME=English_United States.utf8

attached base packages:
[1] stats     graphics  grDevices utils     datasets  methods
[7] base

other attached packages:
[1] knitr_1.40

loaded via a namespace (and not attached):
 [1] compiler_4.2.0   magrittr_2.0.3   fastmap_1.1.0
```

```
 [4] cli_3.3.0         tools_4.2.0      htmltools_0.5.3
 [7] yaml_2.3.5        codetools_0.2-18 stringi_1.7.8
[10] rmarkdown_2.16    stringr_1.4.1    xfun_0.32
[13] digest_0.6.29     rlang_1.0.4      evaluate_0.16
```