常用代码及公式

$\frac{1}{\sigma^2}\sum(X_i-\mu)\sim\chi^2_n$

$\frac{1}{\sigma^2}\sum(X_i-\overline{X})\sim\chi^2_{n-1}$

$\frac{\overline{X}-\mu}{S/\sqrt{n}}\sim t_{n-1}$ ($n\geq 30$ 当 $\mathcal{N}$)

$\mathbb{P}(X>z_\alpha)=\alpha$

`dnorm` is PDF, `pnorm` is CDF, `qnorm`: quantile, $z_{1-\alpha}$, and `rnorm` 生成数据.

Hypothesis Testing

1. rejecting the null hypothesis in favor of the alternative hypothesis
2. there is not enough evidence to support the alternative hypothesis

Type I error α: reject a true H_0, FP

Type II error β: don't reject a false H_0, FN

$1-\beta$: power

Scales of Measurement

1. nominal: 没有 order 的 categories
2. ordinal: 有 order
3. interval: 数值按照等长区间分类
4. ratio: 单点的数值

数据的分类

1. Categorical / Qualitative: Nominal / Ordinal
2. Numerical / Quantitative: Discrete / Continuous

Basic Quantities

`quantile(arr, 0.25)`: Q_1

$Q_{1,2,3}$: 25%, 50%, 75% percentile

$\text{IQR}=Q_3-Q_1$

Skewness: 看尾巴在哪边

1. Left-Skewed: Negative Skewness
2. Right-Skewed: Positive Skewness

Why trimmed mean?

1. May have a lower SE when data is not normal
2. Balance between median and mean, protect against outliers

画图

1. Stem and leaf plot: 左边是数字第一位，右边是后面的，中间用 | 隔开（`stem(x)`）
2. Histogram: `hist(x)`

transformation

log 把中心往右，exp 把中心往左

Log-normal distribution: $\log X\sim\mathcal{N}(\mu,\sigma^2)$

$f(x)=\frac{1}{x\sigma\sqrt{2\pi}}e^{-\frac{(\log x-\mu)}{2\sigma^2}}$

$\mu=e^{\mu+\frac{\sigma^2}{2}}$, $\sigma^2=[\exp(\sigma^2)-1]\exp(2\mu+\sigma^2)$

Coefficient of Variation (CV): $\frac{\sigma}{\mu}$

Geomean $=\sqrt[n]{\prod X_i}$

Imposing a Normal PDF on the Histogram

```
hist(x)
xpt <- seq(from, to, by=by)
n_den <- dnorm(xpt, mean(return), sd(return))
ypt <- n_den * length(x) * 10
# We notice that each data point in the return
  dataset represents an area of 1 * 10, so the
  total area of the histogram would be * 10.
lines(xpt, ypt, col="blue")
```

QQplot: $\left(\Phi^{-1}(q_i),\hat{F}_x^{-1}(q_i)\right)$

1. 左侧越低表示 longer left tail
2. 右侧越高表示 longer right tail

left skew 是两侧都高，right skew 是两侧都低

t 两个尾巴都长，是左低右高

Shapiro-Wilk Test: `shapiro.test(x)`

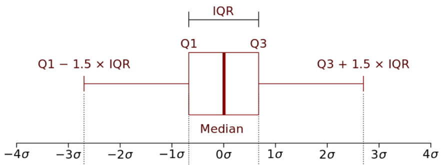
$W=\frac{\left(\sum_{i=1}^n a_ix_i\right)^2}{\sum_{i=1}^n(x_i-\overline{x})^2}$，$a_i$ 是这个系统自带的常数

p 越小越 normal

Limitations:

1. Adversely affected when there are tied data
2. Has a bias by sample size. Statistically significant result, large sample.

box-plot: `boxplot(x~group, data=x)`



Outliers

classic tech: $|x_i-\overline{x}|>2\cdot\text{sd}$

boxplot rule: $x_i<Q_1-1.5\cdot\text{IQR}$ or $x_i>Q_3+1.5\cdot\text{IQR}$

Sampling Distribution: 那个 stat 的分布

Confidence Interval (CI): $\mathbb{P}(L\leq\theta\leq U)=1-\alpha$

$1-\alpha$: confidence coefficient / degree of confidence

$X\sim\mathcal{N}(\mu,\sigma):\overline{X}-z_{\alpha/2}\cdot\frac{\sigma}{\sqrt{n}}<\mu<\overline{X}+z_{\alpha/2}\cdot\frac{\sigma}{\sqrt{n}}$

$X\sim\mathcal{N}(\mu,*):\overline{X}-t_{\alpha/2,n-1}\cdot\frac{S}{\sqrt{n}}<\mu<\overline{X}+t_{\alpha/2,n-1}\cdot\frac{S}{\sqrt{n}}$

t-test: `t.test(x, conf.level=0.95, mu=0)`

`alt="less"` 就是如果真实 μ 比较大不会拒

`alt="greater"` 就是如果真实 μ 比较小不会拒

会给 conf interval，不管 `alt` 和 `mu` 给的都是一样的

Proportion Test:

有可能会不合理: $\hat{p}-z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}<p<\hat{p}+z_{\frac{\alpha}{2}}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$

`prop.test(x, n, p=.5, conf.level=.95, alt)`