STATISTICAL COMPUTATION

WEEK 3 – HYPOTHESIS TESTING (1/2)

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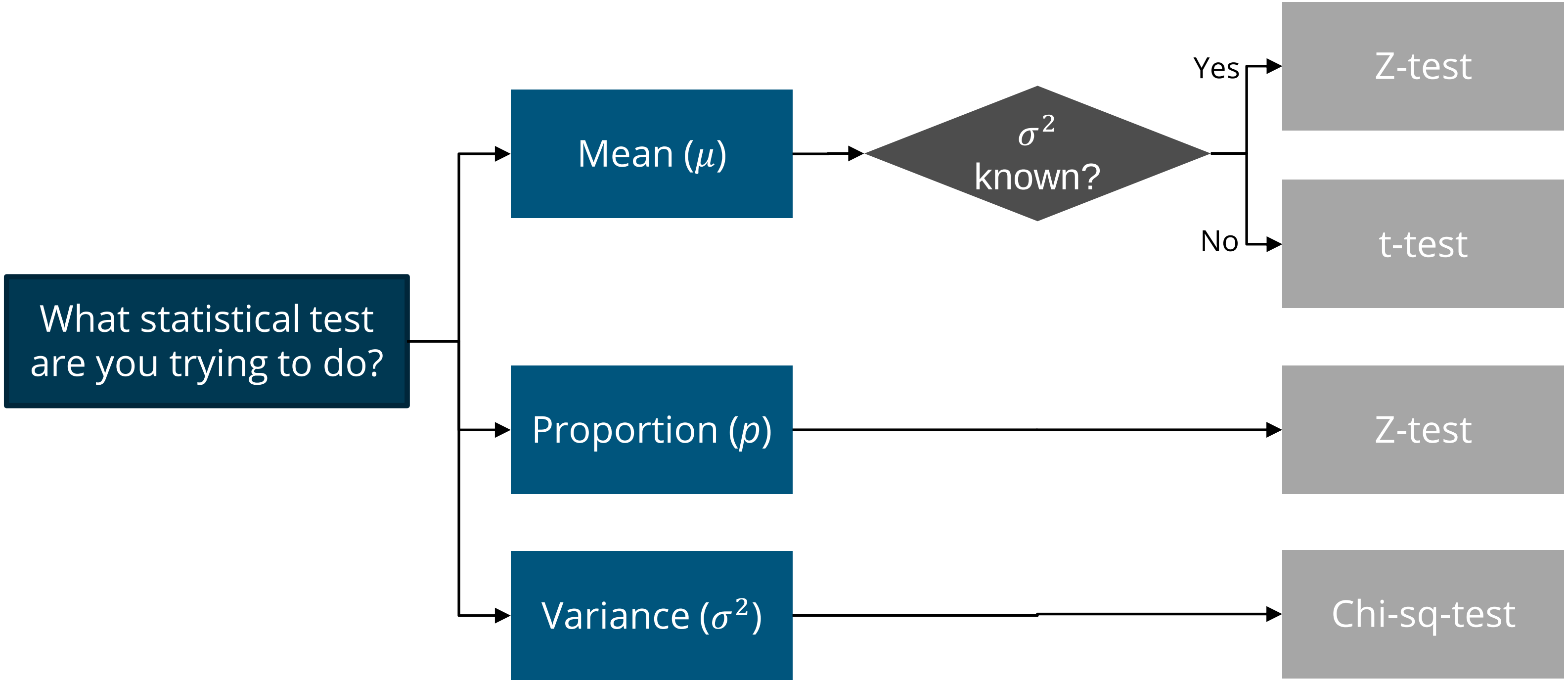
MATERIALS

- 1-Sample Test
- P-value
- Study Case

01

1-SAMPLE TEST

CHEAT SHEET (1 SAMPLE)



MEAN (σ^2 known)

	Right-side	Left-side	Two-tail
Hypothesis	$\mathrm{H}_0 : \mu = \mu_0$ $\mathrm{H}_1 : \mu > \mu_0$	$\mathrm{H}_0 : \mu = \mu_0$ $\mathrm{H}_1 : \mu < \mu_0$	$\mathrm{H}_0 : \mu = \mu_0$ $\mathrm{H}_1 : \mu \neq \mu_0$
Statistics	$Z_{hit} = \dfrac{\bar{X} - \mu_0}{\sigma/\sqrt{n}}$		
Critical Value	$Z_{hit} > Z_\alpha$	$Z_{hit} < -Z_\alpha$	$Z_{hit} < -Z_{\alpha/2}$ or $Z_{hit} > Z_{\alpha/2}$
Confidence Interval	$\bar{X} - Z_{\alpha/2}\dfrac{\sigma}{\sqrt{n}} < \mu < \bar{X} + Z_{\alpha/2}\dfrac{\sigma}{\sqrt{n}}$		

MEAN (σ^2 unknown)

	Right-side	Left-side	Two-tail
Hypothesis	$\mathrm{H}_0 : \mu = \mu_0$ $\mathrm{H}_1 : \mu > \mu_0$	$\mathrm{H}_0 : \mu = \mu_0$ $\mathrm{H}_1 : \mu < \mu_0$	$\mathrm{H}_0 : \mu = \mu_0$ $\mathrm{H}_1 : \mu \neq \mu_0$
Statistics	$T_{hit} = \dfrac{\bar{X} - \mu_0}{S/\sqrt{n}}$		
Critical Value	$T_{hit} > t_{\alpha;v}$	$T_{hit} < -t_{\alpha;\mathrm{v}}$	$T_{hit} < -t_{\alpha/2;v}$ or $T_{hit} > t_{\alpha/2;v}$
Degree of Freedom	$v = n - 1$		
Confidence Interval	$\bar{X} - t_{\alpha/2}\dfrac{S}{\sqrt{n}} < \mu < \bar{X} + t_{\alpha/2}\dfrac{S}{\sqrt{n}}$		

PROPORTION

	Right-side	Left-side	Two-tail
Hypothesis	$\mathrm{H_0}: \mathrm{p} = p_0$ $\mathrm{H_1}: \mathrm{p} > p_0$	$\mathrm{H_0}: \mathrm{p} = p_0$ $\mathrm{H_1}: \mathrm{p} < p_0$	$\mathrm{H_0}: \mathrm{p} = p_0$ $\mathrm{H_1}: p \neq p_0$
Statistics	$Z_{hit} = \dfrac{\hat{p} - p_0}{\sqrt{p_0 q_0 / n}}$		
Critical Value	$Z_{hit} > Z_\alpha$	$Z_{hit} < -Z_\alpha$	$Z_{hit} < -Z_{\alpha/2}$ or $Z_{hit} > Z_{\alpha/2}$
Confidence Interval	$\hat{p} - Z_{\alpha/2}\sqrt{\hat{p}\hat{q}/n} < \mathrm{p} < \hat{p} + Z_{\alpha/2}\sqrt{\hat{p}\hat{q}/n}$		

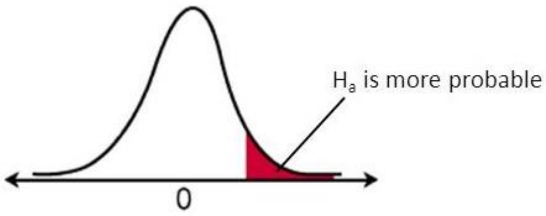
VARIANCE

	Right-side	Left-side	Two-tail
Hypothesis	$H_0 : \sigma^2 = \sigma_0^2$ $H_1 : \sigma^2 > \sigma_0^2$	$H_0 : \sigma^2 = \sigma_0^2$ $H_1 : \sigma^2 < \sigma_0^2$	$H_0 : \sigma^2 = \sigma_0^2$ $H_1 : \sigma^2 \neq \sigma_0^2$
Statistics	$\chi_{hit}^2 = (n-1)\frac{s^2}{\sigma^2}$		
Critical Value	$\chi_{hit}^2 > \chi_{\alpha;v}^2$	$\chi_{hit}^2 < \chi_{(1-\alpha);v}^2$	$\chi_{hit}^2 < \chi_{(1-\frac{\alpha}{2});v}^2$ or $\chi_{hit}^2 > \chi_{(\frac{\alpha}{2});v}^2$
Degree of Freedom	$v = n - 1$		
Confidence Interval	$(n-1)\frac{s^2}{\chi_{(\frac{\alpha}{2});v}^2} < \sigma^2 < (n-1)\frac{s^2}{\chi_{(1-\frac{\alpha}{2});v}^2}$		

02

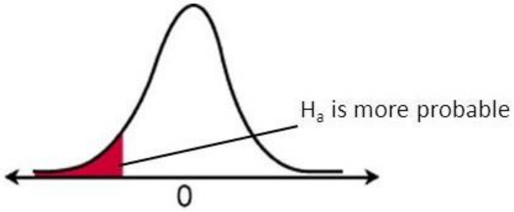
P-VALUE

TAIL OF TEST



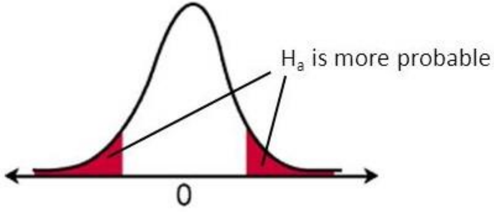
Right-tail test

H_a: $\mu >$ value



Left-tail test

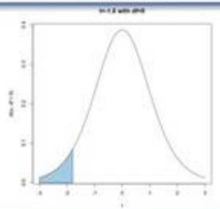
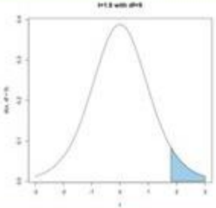
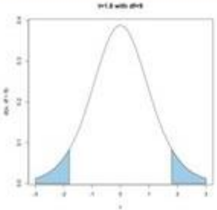
H_a: $\mu <$ value



Two-tail test

H_a: $\mu \neq$ value

Calculating P-Values Cheat Sheet

	H_a Description	Figure	Example t values	R code to get p-values
One-tailed	Population mean is below the standard		t = -1.8	pt(-1.8, df=9)
One-tailed	Population mean is above the standard		t = 1.8	1-pt(1.8, df=9) '1 - ' because otherwise you will get the probability for t less than 1.8
Two-tailed	Population mean is different from the standard		t = 1.8 t = -1.8	2*(1-pt(1.8, df=9)) 2*pt(-1.8, df=9)

MACRO MINITAB FUNCTIONS

Function	Description	Usage
PDF	Density	Find PDF
CDF	Distribution function	Find CDF (p-value)
InvCDF	Quantile function	Find inverse CDF (critical value)
Random	Random deviated	Generate random variable

03

STUDY CASE 1-SAMPLE

STUDY CASE 1

3. **Euro Coin.** Statistics students at the Akademia Podlaka conducted an experiment to test the hypothesis that the one-Euro coin is biased (i.e., not equally likely to land heads up or tails up). Belgian-minted one-Euro coins were spun on a smooth surface, and 140 out of 250 coins landed heads up. Does this result support the claim that one-Euro coins are biased? Test the hypotheses using a 10 percent level of significance.

STUDY CASE 2

A brochure inviting subscriptions for a new diet program states that the participants are expected to lose over 22 pounds in five weeks. Suppose that, from the data of the five-week weight losses of 56 participants, the sample mean and standard deviation are found to be 23.5 and 10.2 pounds, respectively. Could the statement in the brochure be substantiated on the basis of these findings? Test with $\alpha = .05$. Also calculate the P–value and interpret the result.

STUDY CASE 3

One company, actively pursuing the making of green gasoline, starts with biomass in the form of sucrose and converts it into gasoline using catalytic reactions. At one step in a pilot plant process, the output includes carbon chains of length 3. Fifteen runs with same catalyst produced the product volumes (liter)

2.79	2.88	2.09	2.32	3.51	3.31	3.17	3.62
2.79	3.94	2.34	3.62	3.22	2.80	2.70	

While mean product volume is the prime parameter, it is also important to control variation. Conduct a test with intent of showing that the population standard deviation σ is less than .8 liter. Use $\alpha = .05$.

STUDY CASE 4

The mortgage department of a large bank is interested in the nature of loans of first-time borrowers. This information will be used to tailor their marketing strategy. They believe that 50% of first-time borrowers take out smaller loans than other borrowers. They perform a hypothesis test to determine if the percentage is the **same or different from 50%.** They sample **100 first-time borrowers and find 53 of these loans are smaller than the other borrowers**. For the hypothesis test, they choose a **5% level of significance**.

STUDY CASE 5

A manufacturer of ca batteries claims that the life of the company’s batteries is approximately normally distribution with **standard deviation equal to 0.9 year**. If a **random sample of 10 of these batteries has a standard deviation of 1.2 years**, do you think that $\sigma \neq 0.9$ year? Use a 0.05 level of significance.

THANKS

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