Republic of the Philippines
POLYTECHNIC UNIVERSITY OF THE PHILIPPINES
Office of the Vice President for Academic Affairs
Department of Mathematics and Statistics

STAT 012 – Engineering Data Analysis
LAS 2.2: Hypothesis Testing
2nd Semester

Learning Objectives:
1. Define the hypothesis and hypothesis testing.
2. Differentiate and construct the null and alternative hypothesis.
3. Understand the types of errors, level of confidence, significance, t-value, and critical region.
4. Apply and utilize decision makings using hypothesis testing.

Definition. Hypothesis

It is a supposition or proposed explanation made based on limited evidence as a starting point for further investigation. It is also an educated guess as to what will happen during your experiment. We can also define this as prediction of what might occur based on a person's observations.

Examples.
1. A Coca-Cola is no longer is no longer 330 mL. I believe it is now less than 330 mL.
2. The average social media time usage of teenagers nowadays is 127 hours per week.
3. The average weight of chocolate bars from a certain company is less than 4.7 grams.
4. The academic performance of students in school A is better compared to the academic performance of students from school B.
5. The factors that affects the students to choose their desired courses in college are their family, personality, and prestige of the university.

Definition. Hypothesis Testing

It is a statistical procedure used to determine if the given hypothesis is true or not. A method where we collect samples from population, whatever conclusion we made from the sample, we will generalize this to population.

Definition. Types of Hypotheses

Null Hypothesis: A current situation or the commonly accepted fact, denoted as H_o.

Alternative Hypothesis: The opposite of null hypothesis, sometimes called research hypothesis, H_1.

Examples.

Null Hypothesis: The average height of students is 174 cm.
Alternative Hypothesis: The average height of students is not 174 cm.

Null Hypothesis: The standard deviation of the battery is 78 hours.
Alternative Hypothesis:

Null Hypothesis:
Alternative Hypothesis: The average distance from school to my home is less than or equal to 38 km.

Null Hypothesis:
Alternative Hypothesis: The average caffeine intake of teachers is not more than 4.3 mg.

Null Hypothesis: The standard deviation of the land area of farm is at most 67 square meters
Alternative Hypothesis:

Possible Outcomes

In hypothesis testing, there are only 2 possible outcomes. Reject the null hypothesis and Fail to Reject the null hypothesis.

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Types of Errors

Type I Error: Rejecting the TRUE null hypothesis.
Type II Error: Fail to reject the FALSE null hypothesis.

	H_o True	H_o False
Fail to Reject H_o.	Correct	Type II
Reject H_o.	Type I	Correct

Example. Determine the appropriate scenarios for each cell in each table.

1. H_o: May gusto sa akin si crush.

	H_o True	H_o False
Fail to Reject H_o.		**Type II**
Reject H_o.	**Type I**	

2. H_o: The suspect killed the victim.

	H_o True	H_o False
Fail to Reject H_o.		**Type II**
Reject H_o.	**Type I**	

2. H_o: I believe I will be accepted to a job interview.

	H_o True	H_o False
Fail to Reject H_o.		**Type II**
Reject H_o.	**Type I**	

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Level of Confidence: This is the probability how confident we are that the conclusion is reliable or true. This is denoted as C. Usually the values are 99%, 95%, or 90%.

Level of Significance: This is the probability that error might occur in our conclusion, denoted as α. The usual values are 1%, 5%, or 10%.

Critical Region (Rejection Region): This is the location where we reject the null hypothesis if the t-value appears here.

Non-Critical Region (Non-Rejection Region): This is the location where we fail to reject the null hypothesis if the t-value appears here.

***T*-value:** It helps us whether we will reject or fail to reject the null hypothesis. The formula is

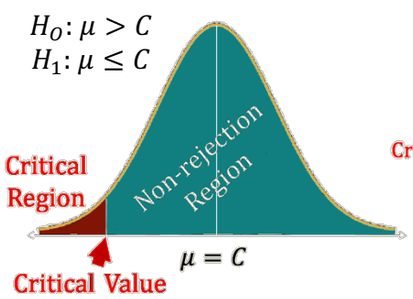
$$t = \frac{\bar{\bar{x}} - \mu}{\frac{s}{\sqrt{n}}}$$

Note:
If the T -value fell in critical region, reject the H_0.
If the T -value fell in non-rejection region, fail to reject the H_0.

One-Tailed Test

If C is any constant, then

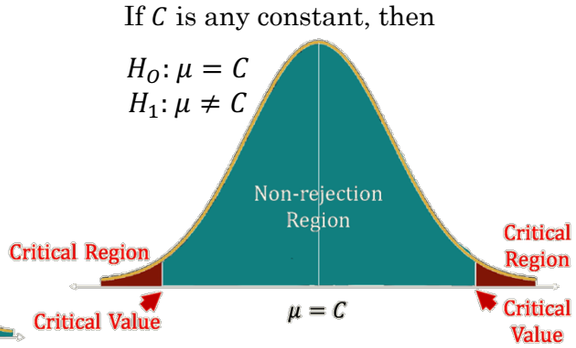
$H_O: \mu > C$
$H_1: \mu \leq C$



Two-Tailed Test

If C is any constant, then

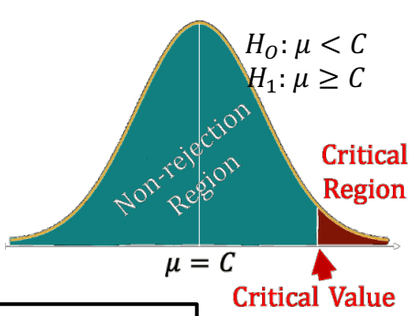
$H_O: \mu = C$
$H_1: \mu \neq C$



One-Tailed Test

If C is any constant, then

$H_O: \mu < C$
$H_1: \mu \geq C$



t Table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										

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Example 1. A machine is designed to fill jars with 16 ounces of coffee. A consumer suspects that the machine is not filling the jars completely. A sample of 8 jars has a mean of 15.6 ounces and a standard deviation of 0.3 ounces. Is there enough evidence to support the consumer's claim at α =0.01 and to conclude that the machine is not filling the jars with 16 ounces of coffee.

Example 2. The mean length of a small balance bar in a laboratory is 43 millimeters. There is a concern that the adjustments of the machine producing the bars have changed. The null hypothesis is that there has been no adjustment in the mean length(μ = 43). The other hypothesis is that there has been a change $\mu \neq 43$. Test at the 0.02 level of significance. Twelve bars were selected at random and recorded in millimeters: 42, 39, 42, 45, 43, 40, 39, 41, 40, 42, 43, and 42.

Example 3. According to a survey, the average daily usage of social media worldwide of global internet users amounts to at most 142 min/day. John conducts her own survey among her 10 friends to find out if their time spent on social media is significantly higher than the global survey. The following samples are 132, 148, 165, 157, 120, 144, 136, 160, 185, and 173.