بسم الله الرحمن الرحيم

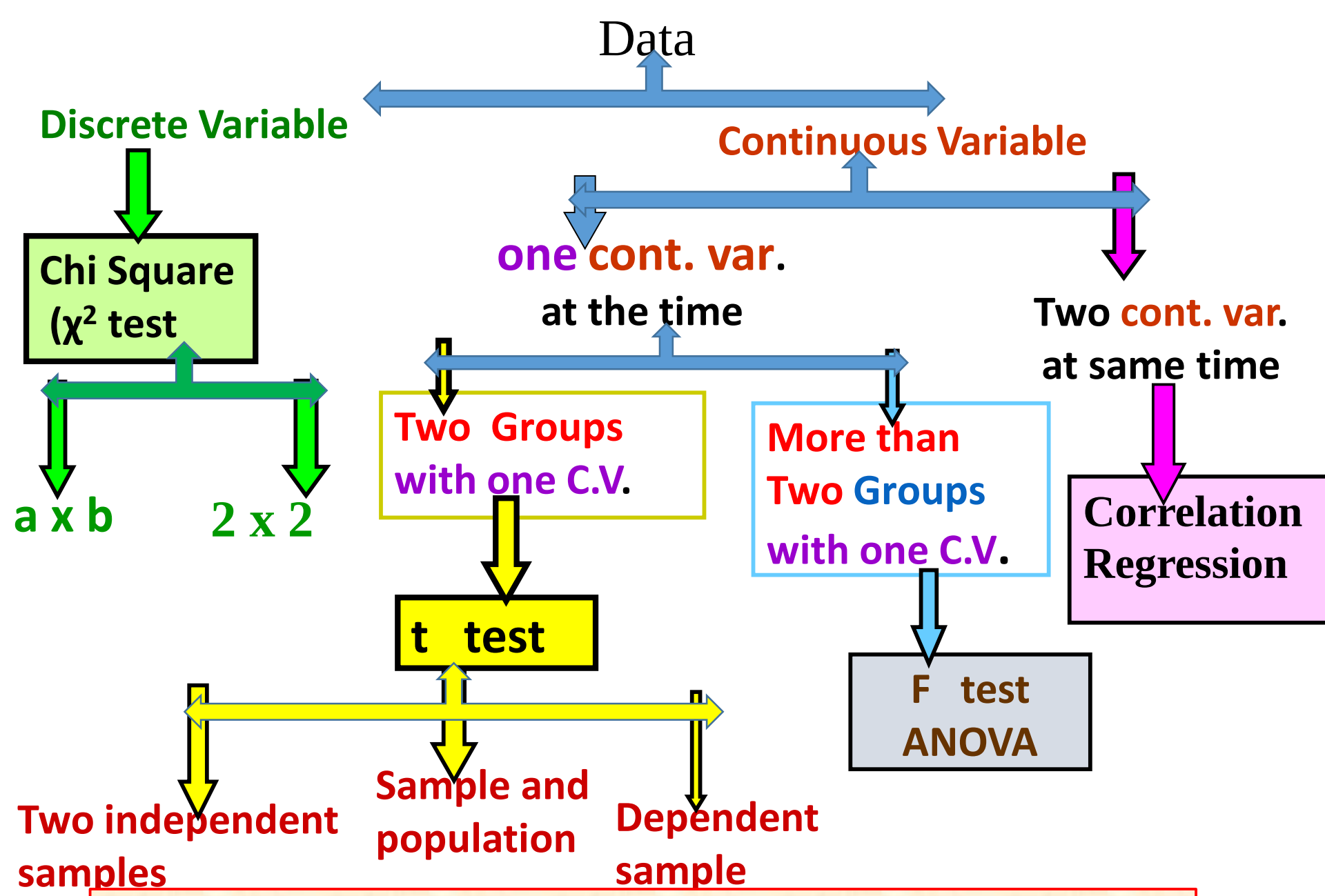
L X1V

t Test

Part 1

PROF. DR. WAQAR AL-KUBAISY

7TH AUGUST 2023



An important thing is the type of the variable concerned.

t Test

The t distributions were discovered by William S. Gosset in 1908.
who used the pseudonym “Student” when he wrote the description.
Gosset was a statistician employed by the Guinness brewing company which had covenant(agreement)عهد that he not publish under his own name.
when he published his article under the pseudonym 'student' while working for a brewery.

t-Tests

Use of t-Tests

Actually, t-tests were among the three or four most frequently used statistical tests in medical research, and they still are often found.

- The purpose of a t-test is to **compare** the **means** of a **continuous** variable in **two research samples**, such as a treatment group and a control group.

- **This is done by determining whether the difference between the two observed means exceeds the difference that would be expected by chance from the two**

When to use a t test

- ❑ **A t test can only be used when comparing the means of two groups**
- ❑ If you want to compare **more than two groups**, or if you want to do multiple pairwise comparisons,
- ✓ use an ANOVA test or a Post-hoc test.
- ❑ **The t test is a parametric test**(This is often the assumption that the population data are normally distributed) **of difference**,
- ❑ **meaning that it makes the same assumptions about your data as other parametric tests.**
- ❑ The t test **assumes** your data:
  - are independent
  - are (approximately) **normally distributed**
  - have a **similar amount of variance** within each group being compared (homogeneity of variance)

If your data do not fit these assumptions

If your data do not fit these assumptions

- If *your data do not fit these assumptions,*
- *you can try a **nonparametric alternative to the t test**,*
- *such as the Wilcoxon Signed-Rank test for data with unequal variance*

- The larger the sample size, the smaller are the errors, and the more the t distribution looks like the normal distribution.
- If the sample size were infinite, the two distributions would be identical.
- For practical purposes, when the combined **sample size of the two groups** being compared is **larger than 120**, the difference between the normal **distribution and the t distribution is negligible.**

$$t = \frac{M_1 - M_2}{SE}$$

Performing a *t* test

The *t* test estimates the true difference between two group means using the ratio of the difference in group means over the pooled standard error of both groups. You can calculate it manually using a formula, or use statistical analysis software.

t test formula

The formula for the two-sample *t* test (the Student's t-test) is shown below.

$$t = \frac{M_1 - M_2}{SE}$$

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\left(s^2\left(\frac{1}{n_1} + \frac{1}{n_2}\right)\right)}}$$

Assumptions of *t* tests

Because there are several versions of ***t* tests**, it's important to check the assumptions to figure out which is best suited for your project.

Here are our analysis checklists for unpaired *t* tests and paired *t* tests, which are the two most common.

These go into detail on the basic assumptions underlying any *t* test:

- **Exactly two groups**
- **Sample is normally distributed**
- **Independent observations**
- **Unequal or equal variance?**
- **Paired or unpaired data?**

t . test calculator

- A **t test** compares the means of two groups.

There are several types of two sample t tests

- **Therefore, selecting appropriate statistical tests is**
- **a critical step in conducting research.**

- Therefore, there are **three forms** of Student's t-test about which physicians, particularly physician-scientists, need to be aware:

(1) one-sample t-test
(2) two-sample t-test and
(3) two-sample paired t-test

What type of t test should I use?
When choosing a t test, you will need to consider two things:
1-whether the groups being compared come from a **single** population or **two** different populations,
2-and whether you want to test the difference in a **specific direction**

❑ One-sample, two-sample, or paired t test?

❖ If the groups come from a single population (e.g., measuring before and after an experimental treatment), perform a **paired t test**. This is a **within-subjects** design.

❖ If the groups come from two different populations (e.g., two different species, or people from two separate cities), perform a **two-sample t test** (independent t test). This is a **between-subjects design.**

❖ If there is one group being compared against a standard value (e.g., comparing the acidity of a liquid to a neutral pH of 7), perform a **one-sample t test**.

❑ **One-tailed or two-tailed t test?**

- ❖ If you only care whether the two populations are **different from one another,** perform a **two-tailed t test**.
- ❖ If you want to know whether **one population mean is greater** than **or less** than the other, perform a **one-tailed t test.**

❑ One-tailed or two-tailed t test?

❖ If you only care whether the two populations are **different from one another,** perform a **two-tailed t test**.

❖ If you want to know whether **one population mean is greater than or less** than the other, perform a **one-tailed t test.**

- ❖ **Student's t-test can be** one-tailed or two-tailed.
- ❖ **The calculations are the same, but the interpretation of the resulting t differs.**

Interpreting results

- The three different options **for *t* tests have** slightly different interpretations, but they all hinge on or depend on the **hypothesis testing and P values.**

You need to select a significance threshold for your **P value (often 0.05) before doing the test.**

- **P values are the most commonly used method to evaluate whether there is evidence of a difference between the sample of data collected and** the null hypothesis.

- **Once you have run the correct *t* test,** look at the **resulting P value.**

Once the **correct *t* test**

Cont. …Interpreting results

- Once you have run the **correct *t* test**, look at the **resulting P value.**

- If the **test result** is less **than your threshold**, you have **enough evidence to conclude that the data are**
- **significantly different**.

- If the **test result is larger or equal to your threshold**, **you cannot conclude that there is a difference**.

- *However, you cannot conclude that there was definitively no difference either. It's possible that a dataset with more observations would have resulted in a different conclusion*.

Common *t* test confusion

In addition to the number of *t* test options, *t* tests are often confused with completely different techniques as well.

Correlation and regression **are used to measure how much two factors move together. While *t* tests are part of regression analysis, they are focused on only one factor by comparing means in different samples.**
ANOVA **is used for comparing means across three or more total groups. In contrast**, *t* tests compare means between exactly two groups.

Finally, contingency tables compare counts of observations within groups rather than a calculated average., contingency tables use methods such as chi square instead of *t* tests.

t-distribution table

Areas in the upper tail are given along the top of the table. Critical t* values are given in the table.

df	0.1	0.05	0.025	0.02	0.01	0.005
1	3.078	6.314	12.706	15.895	31.821	63.657
2	1.886	2.920	4.303	4.849	6.965	9.925
3	1.638	2.353	3.182	3.482	4.541	5.841
4	1.533	2.132	2.776	2.999	3.747	4.604
5	1.476	2.015	2.571	2.757	3.365	4.032
6	1.440	1.943	2.447	2.612	3.143	3.707
7	1.415	1.895	2.365	2.517	2.998	3.499
8	1.397	1.860	2.306	2.449	2.896	3.355
9	1.383	1.833	2.262	2.398	2.821	3.250
10	1.372	1.812	2.228	2.359	2.764	3.169
11	1.363	1.796	2.201	2.328	2.718	3.106
12	1.356	1.782	2.179	2.303	2.681	3.055
13	1.350	1.771	2.160	2.282	2.650	3.012
14	1.345	1.761	2.145	2.264	2.624	2.977
15	1.341	1.753	2.131	2.249	2.602	2.947
16	1.337	1.746	2.120	2.235	2.583	2.921
17	1.333	1.740	2.110	2.224	2.567	2.898
18	1.330	1.734	2.101	2.214	2.552	2.878
19	1.328	1.729	2.093	2.205	2.539	2.861
20	1.325	1.725	2.086	2.197	2.528	2.845
21	1.323	1.721	2.080	2.189	2.518	2.831
22	1.321	1.717	2.074	2.183	2.508	2.819
23	1.319	1.714	2.069	2.177	2.500	2.807
24	1.318	1.711	2.064	2.172	2.492	2.797
25	1.316	1.708	2.060	2.167	2.485	2.787
26	1.315	1.706	2.056	2.162	2.479	2.779
27	1.314	1.703	2.052	2.158	2.473	2.771
28	1.313	1.701	2.048	2.154	2.467	2.763
29	1.311	1.699	2.045	2.150	2.462	2.756
30	1.310	1.697	2.042	2.147	2.457	2.750
31	1.309	1.696	2.040	2.144	2.453	2.744
32	1.309	1.694	2.037	2.141	2.449	2.738
33	1.308	1.692	2.035	2.138	2.445	2.733
34	1.307	1.691	2.032	2.136	2.441	2.728
35	1.306	1.690	2.030	2.133	2.438	2.724
36	1.306	1.688	2.028	2.131	2.434	2.719
37	1.305	1.687	2.026	2.129	2.431	2.715
38	1.304	1.686	2.024	2.127	2.429	2.712
39	1.304	1.685	2.023	2.125	2.426	2.708
40	1.303	1.684	2.021	2.123	2.423	2.704
41	1.303	1.683	2.020	2.121	2.421	2.701
42	1.302	1.682	2.018	2.120	2.418	2.698
43	1.302	1.681	2.017	2.118	2.416	2.695
44	1.301	1.680	2.015	2.116	2.414	2.692
45	1.301	1.679	2.014	2.115	2.412	2.690
46	1.300	1.679	2.013	2.114	2.410	2.687
47	1.300	1.678	2.012	2.112	2.408	2.685
48	1.299	1.677	2.011	2.111	2.407	2.682
49	1.299	1.677	2.010	2.110	2.405	2.680
50	1.299	1.676	2.009	2.109	2.403	2.678

df	0.1	0.05	0.025	0.02	0.01	0.005
51	1.298	1.675	2.008	2.108	2.402	2.676
52	1.298	1.675	2.007	2.107	2.400	2.674
53	1.298	1.674	2.006	2.106	2.399	2.672
54	1.297	1.674	2.005	2.105	2.397	2.670
55	1.297	1.673	2.004	2.104	2.396	2.668
56	1.297	1.673	2.003	2.103	2.395	2.667
57	1.297	1.672	2.002	2.102	2.394	2.665
58	1.296	1.672	2.002	2.101	2.392	2.663
59	1.296	1.671	2.001	2.100	2.391	2.662
60	1.296	1.671	2.000	2.099	2.390	2.660
61	1.296	1.670	2.000	2.099	2.389	2.659
62	1.295	1.670	1.999	2.098	2.388	2.657
63	1.295	1.669	1.998	2.097	2.387	2.656
64	1.295	1.669	1.998	2.096	2.386	2.655
65	1.295	1.669	1.997	2.096	2.385	2.654
66	1.295	1.668	1.997	2.095	2.384	2.652
67	1.294	1.668	1.996	2.095	2.383	2.651
68	1.294	1.668	1.995	2.094	2.382	2.650
69	1.294	1.667	1.995	2.093	2.382	2.649
70	1.294	1.667	1.994	2.093	2.381	2.648
71	1.294	1.667	1.994	2.092	2.380	2.647
72	1.293	1.666	1.993	2.092	2.379	2.646
73	1.293	1.666	1.993	2.091	2.379	2.645
74	1.293	1.666	1.993	2.091	2.378	2.644
75	1.293	1.665	1.992	2.090	2.377	2.643
76	1.293	1.665	1.992	2.090	2.376	2.642
77	1.293	1.665	1.991	2.089	2.376	2.641
78	1.292	1.665	1.991	2.089	2.375	2.640
79	1.292	1.664	1.990	2.088	2.374	2.640
80	1.292	1.664	1.990	2.088	2.374	2.639
81	1.292	1.664	1.990	2.087	2.373	2.638
82	1.292	1.664	1.989	2.087	2.373	2.637
83	1.292	1.663	1.989	2.087	2.372	2.636
84	1.292	1.663	1.989	2.086	2.372	2.636
85	1.292	1.663	1.988	2.086	2.371	2.635
86	1.291	1.663	1.988	2.086	2.370	2.634
87	1.291	1.663	1.988	2.085	2.370	2.634
88	1.291	1.662	1.987	2.085	2.369	2.633
89	1.291	1.662	1.987	2.084	2.369	2.632
90	1.291	1.662	1.987	2.084	2.368	2.632
91	1.291	1.662	1.986	2.084	2.368	2.631
92	1.291	1.662	1.986	2.083	2.368	2.630
93	1.291	1.661	1.986	2.083	2.367	2.630
94	1.291	1.661	1.986	2.083	2.367	2.629
95	1.291	1.661	1.985	2.082	2.366	2.629
96	1.290	1.661	1.985	2.082	2.366	2.628
97	1.290	1.661	1.985	2.082	2.365	2.627
98	1.290	1.661	1.984	2.081	2.365	2.627
99	1.290	1.660	1.984	2.081	2.365	2.626
100	1.290	1.660	1.984	2.081	2.364	2.626

T test calculator

A t test compares the means of two groups.

There are several types of two sample t tests and this calculator focuses on the three most common:

(1) one-sample t-test;
(2) two-sample t-test; and
(3) two-sample paired t-test

Choose a test from the three options:
(1) one-sample t-test;
(2) two-sample t-test; and
(3) two-sample paired t-test

Thank You