

Testování hypotéz





m jablka [g]	m hrušky [g]	rozdíl Δm [g]
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205	178	27
195	168	27
201	180	21
188	190	-2
197	179	18



hypotéza: $\Delta m = 27g$

hypotéza: $\Delta m = -2g$

hypotéza: $\Delta m = 18g$

Jablka váží
o 27 g víc



Takhle se
to dělat nedá!

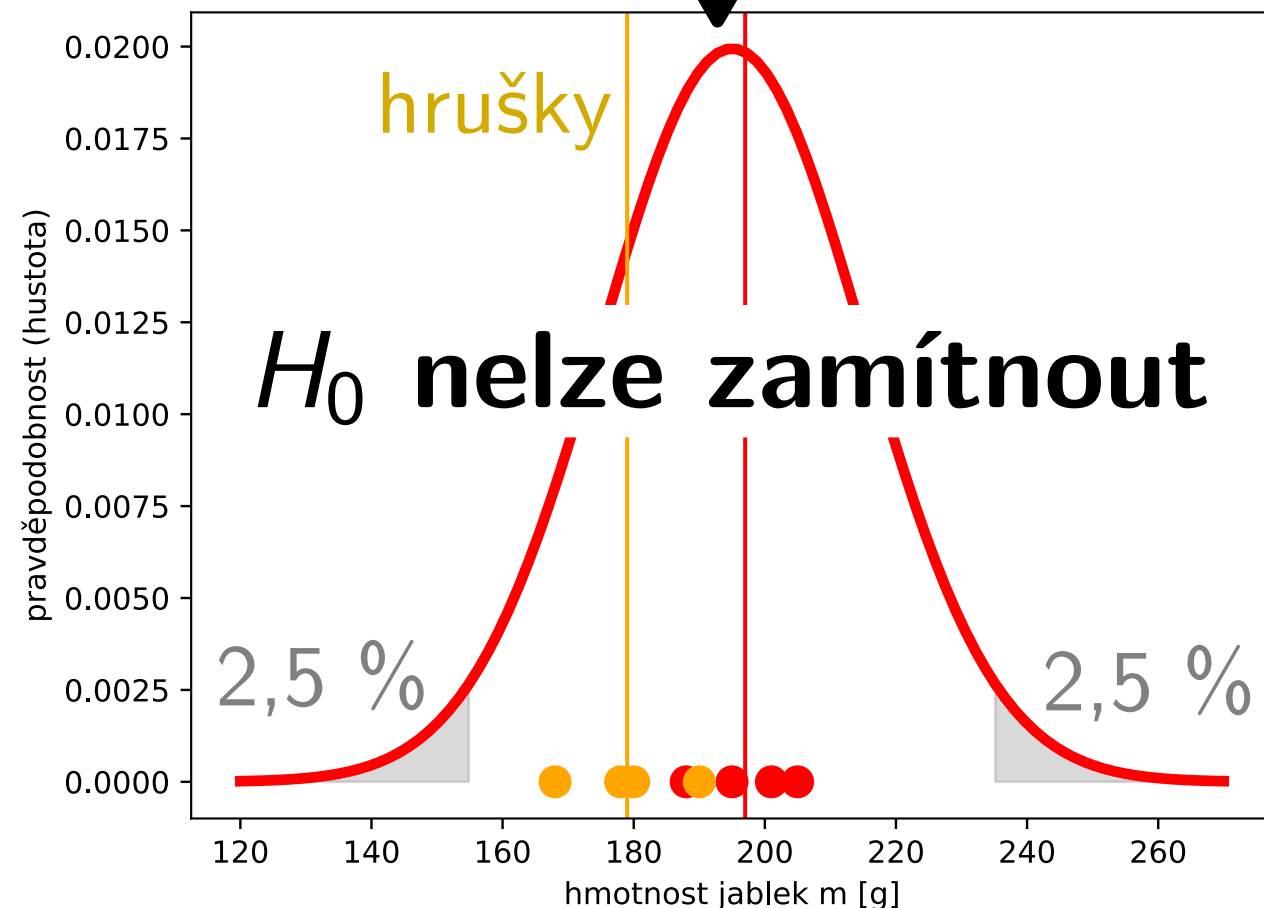


nulová hypotéza $H_0: \Delta m = 0$ jablka a hrušky
sdílí stejnou distribuci

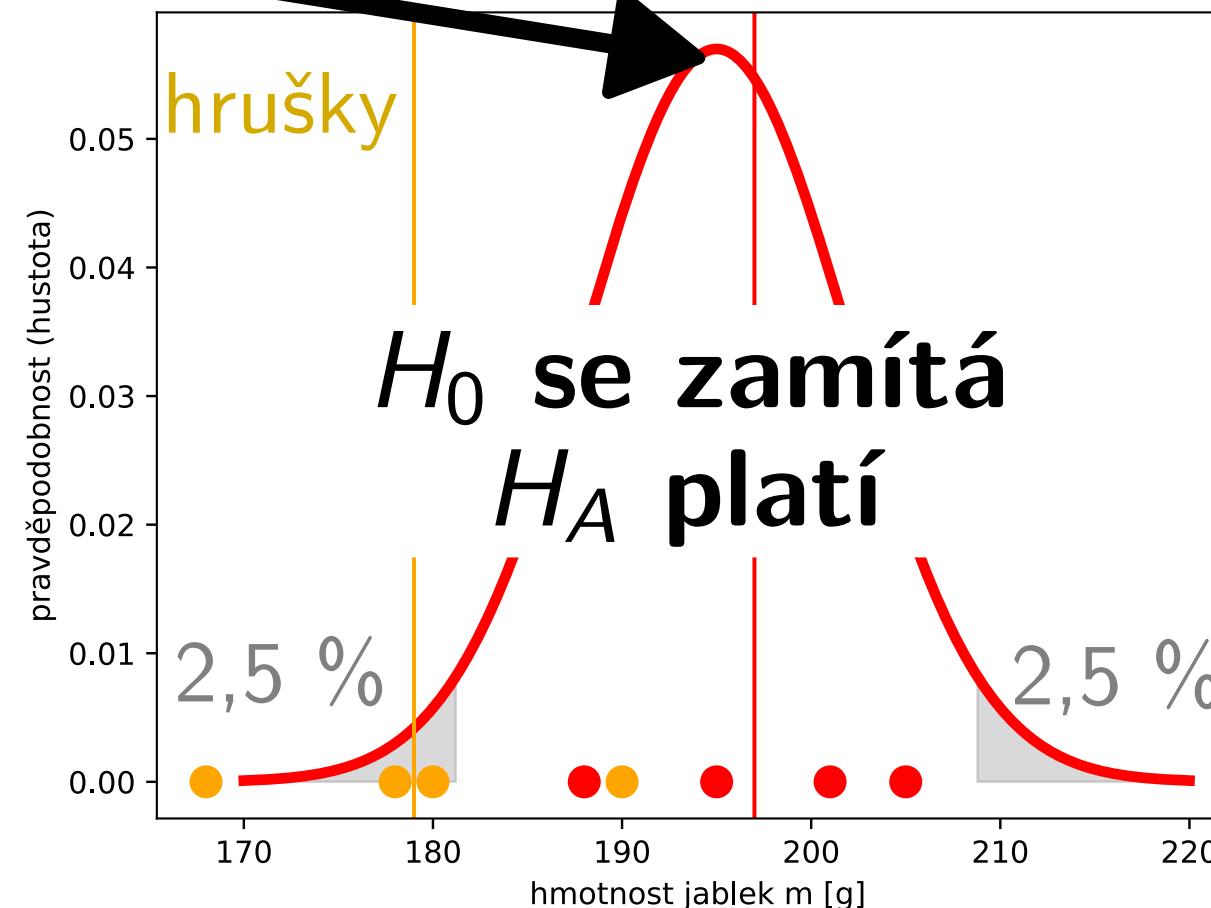
alternativní hypotéza $H_A: \Delta m \neq 0$ logická negace
nulové hypotézy

**Jak pravděpodobný je výsledek měření
nebo ještě extrémější, pokud platí hypotéza H_0 ?**

$$p(H_0) \geq \alpha = 0.05$$



$$p(H_0) < \alpha = 0.05$$



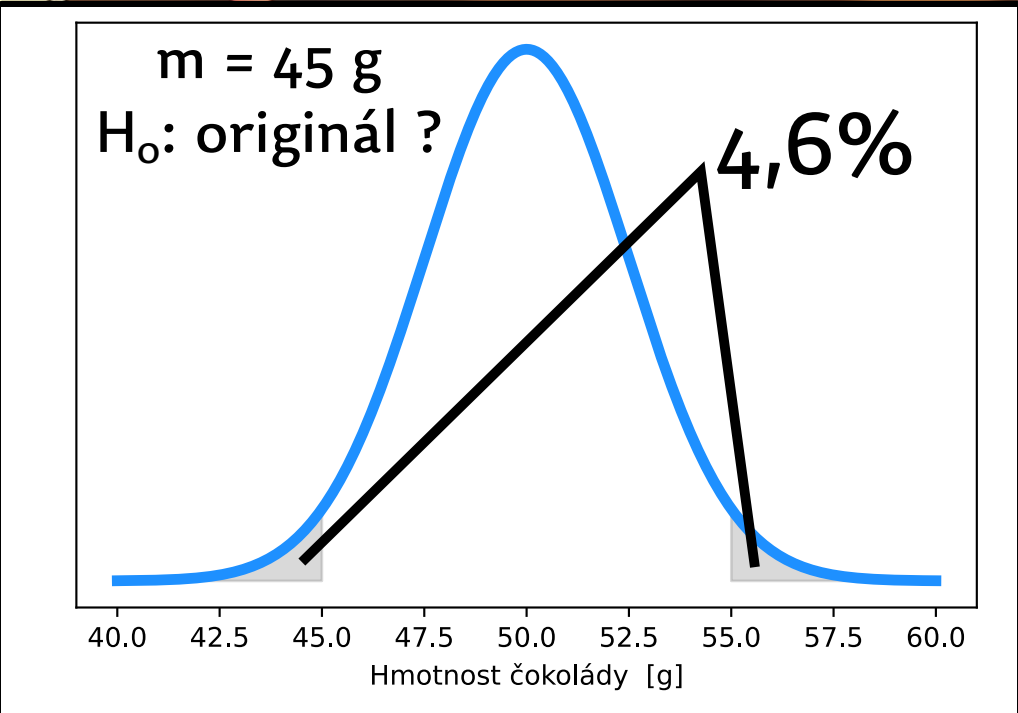
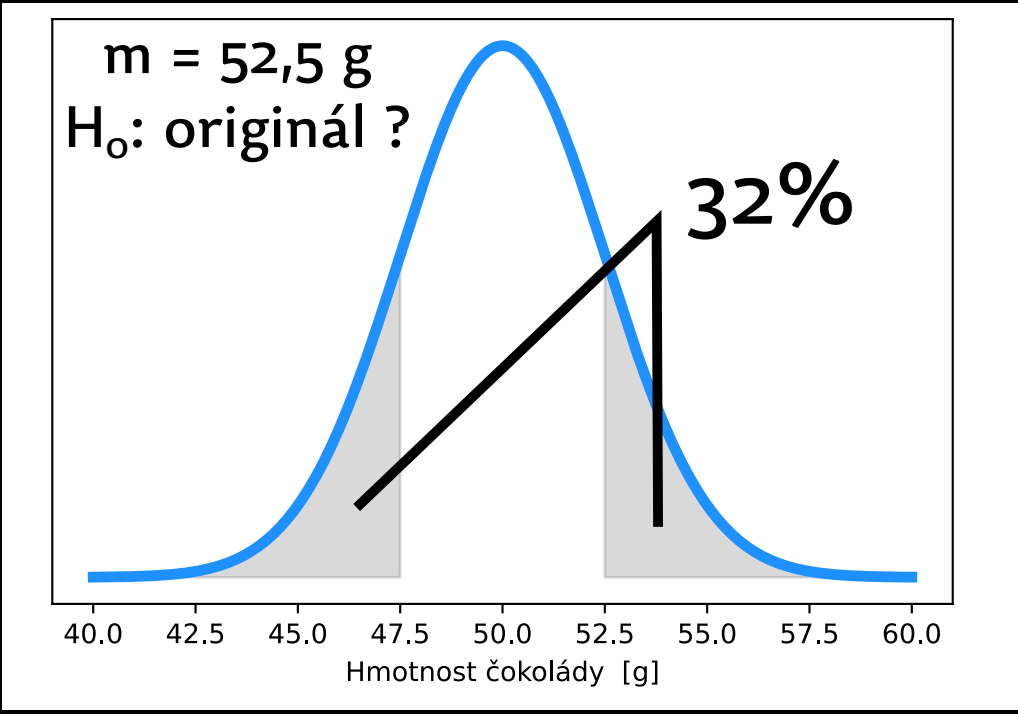
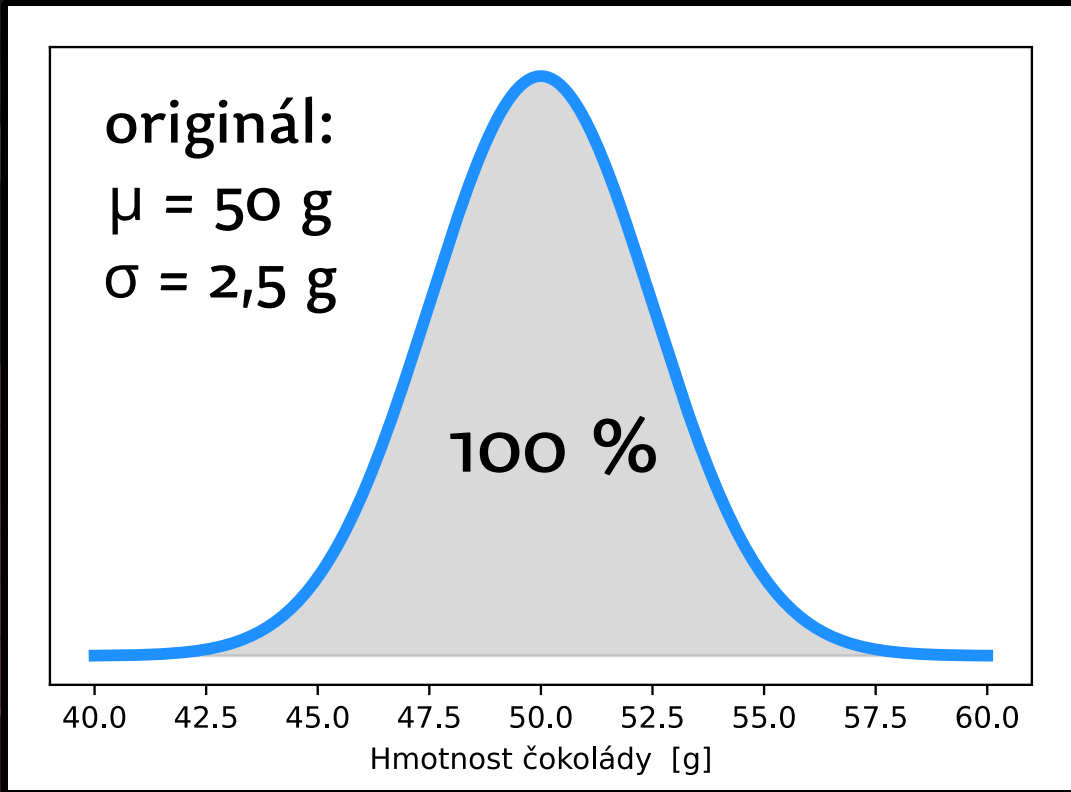
tiše předpokládáme, že známe distribuci m jablek





H_o : 50:50 ?

Chyby typu I a II



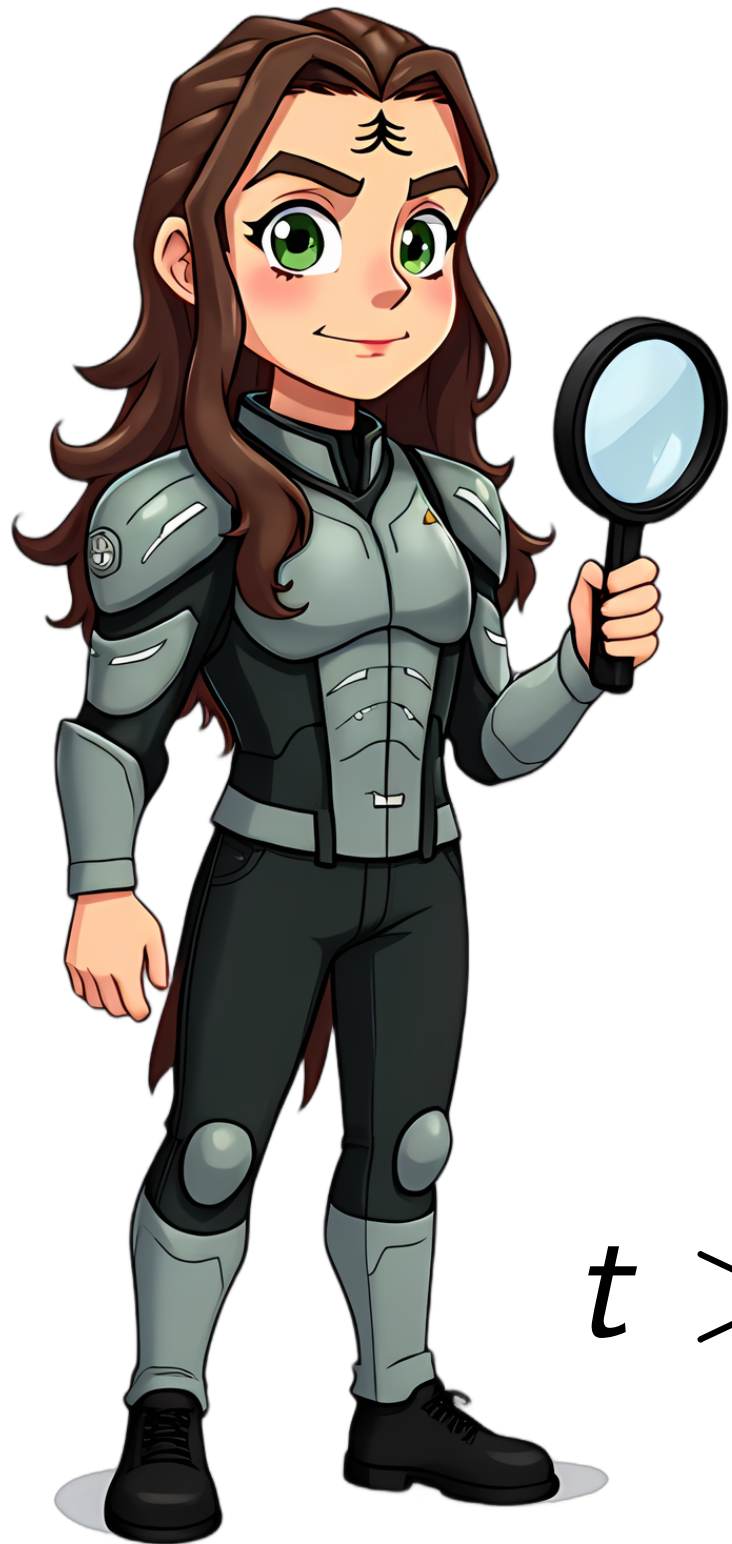
Chyba typu I (falešně pozitivní) = α
Chyba typu II (falešně negativní) $\sim 1/n$

T-test (varianta při znalosti referenční distribuce)

cíl: posoudit H_0 : střední hodnota měřené veličiny
je shodná ze střední hodnotou referenční distribuce

známe: referenční distribuci (μ, σ) **distribuce m jablek** ($\mu = 195g$, $\sigma = 20g$)

známe: střední hodnotu **vzorku** $\bar{X}$ o n prvcích **$\bar{m} = 179g$ hrušek, $n = 4$ měření**

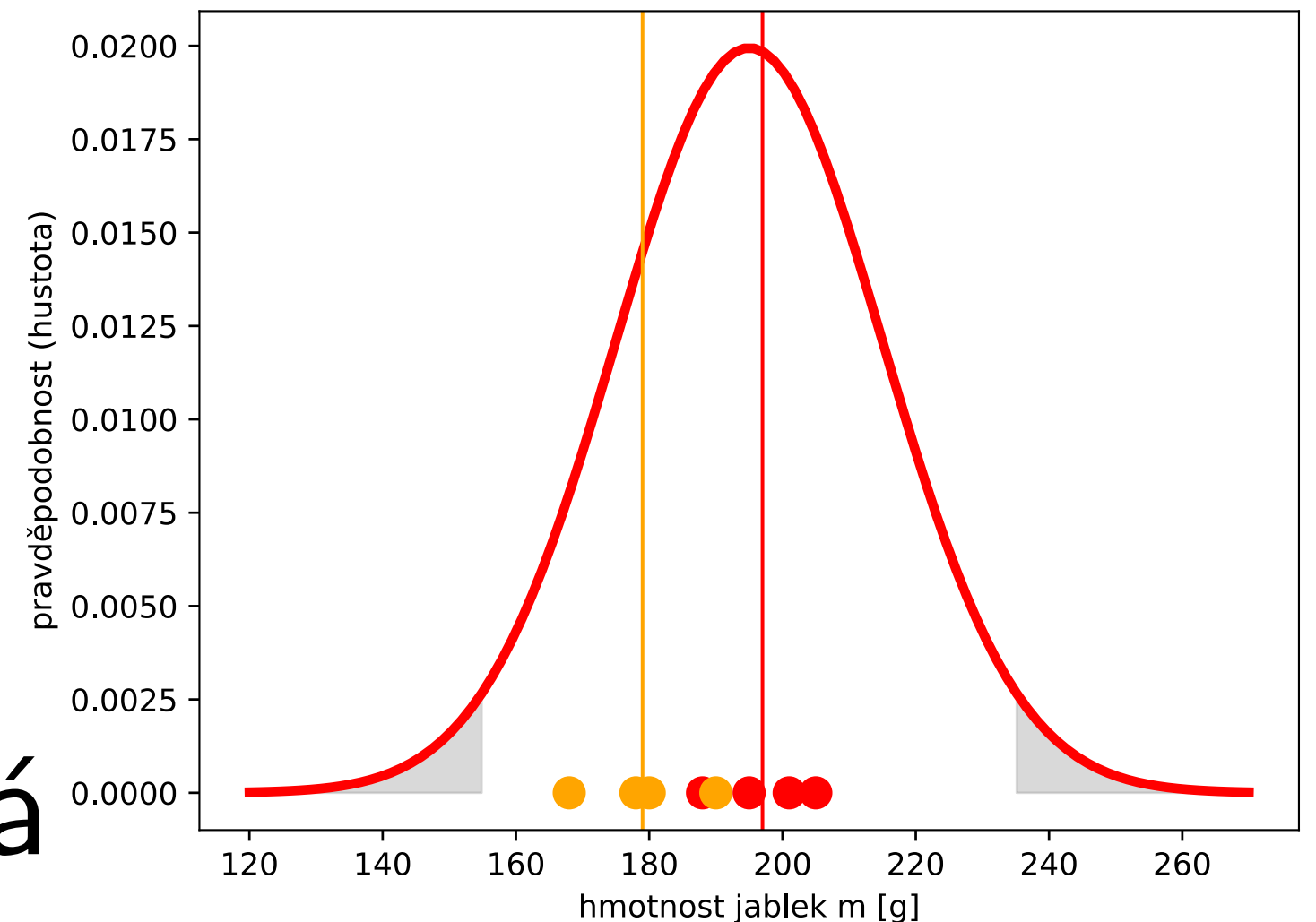


$$t = \frac{|\bar{X} - \mu|}{\sigma} \sqrt{n} = \frac{|\bar{X} - \mu|}{\sigma / \sqrt{n}}$$

$$df = n - 1$$

najdeme v tabulce

$t > t_{\text{krit.}} \rightarrow H_0$ se zamítá



Jak dopadne pro $\sigma = 6g$?

t-test 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										

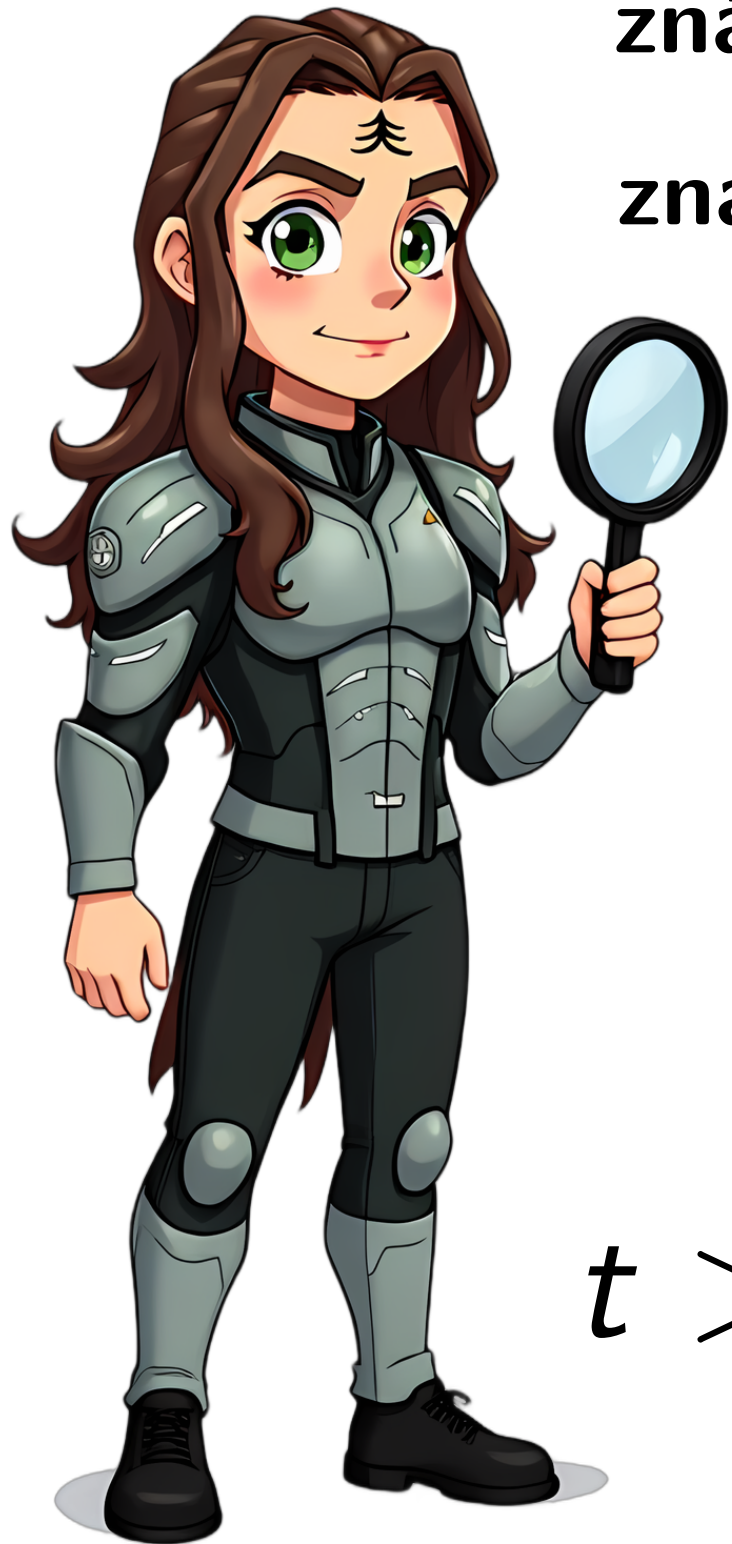
<https://byjus.com/maths/t-test-table/>

T-test (varianta bez znalosti referenční distribuce)

cíl: posoudit H_0 : střední hodnoty dvou měřených veličin jsou navzájem shodné

známe: střední hodnotu **vzorku 1** $\bar{X}_1$ o n_1 prvcích a směrodatnou odchylku s_1

známe: střední hodnotu **vzorku 2** $\bar{X}_2$ o n_2 prvcích a směrodatnou odchylku s_2



$$t = \frac{|\bar{X}_1 - \bar{X}_2|}{\sqrt{\frac{\bar{V}_1}{n_1} + \frac{\bar{V}_2}{n_2}}}$$

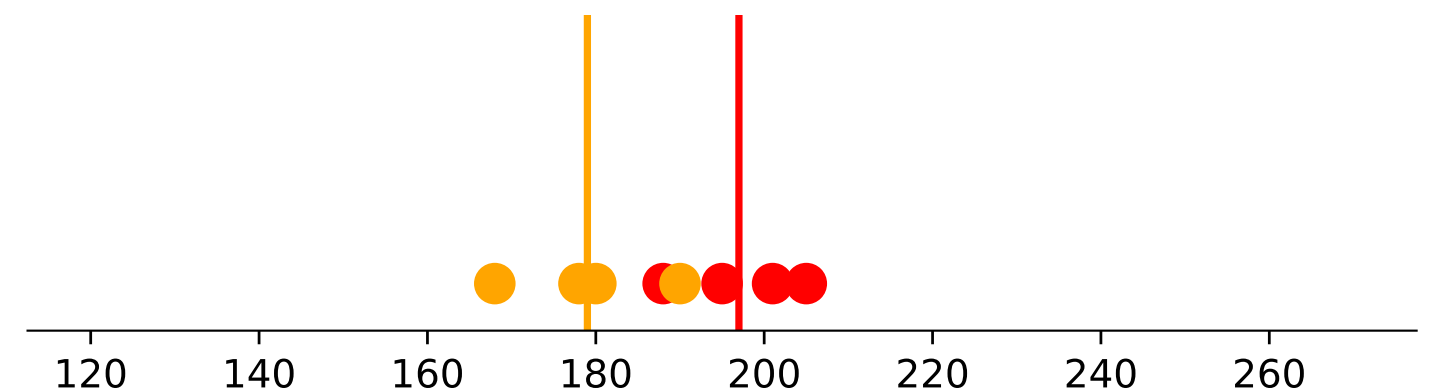
$$df = n_1 + n_2 - 2$$

najdeme v tabulce

$t > t_{\text{krit.}} \rightarrow H_0$ se zamítá

$$\bar{m}_1 = 197g, \bar{s}_1 = 7g, n_1 = 4$$

$$\bar{m}_2 = 179g, \bar{s}_2 = 9g, n_2 = 4$$





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