Projekt br.8
Računarska statistika

Nina Drobac, Josipa Radnić

8.6.2022.

Sadržaj

1 Uvod

Cilj seminarskog rada je provesti Monte Carlo studiju kako bi se ispitao utjecaj distribucije podataka na snagu t-testa za testiranje dvostrane hipoteze

$$H_0 : \mu = \mu_0.$$

Dvostrani t-test za testiranje hipoteze o očekivanju distribucije kao pretpostavku ima, uz neovisnost opservacija, da podaci dolaze iz normalne distribucije. U radu sa stvarnim podacima često se događa da ta pretpostavka nije ispunjena pa je od koristi ispitati kako različite distribucije, uzimajući u obzir i duljinu uzorka i izbor μ_0, utječu na snagu t-testa.

2 Podaci

U ovoj smo studiji simulirali podatke u programskom jeziku SAS, a pri tome smo varirali:

- **duljinu uzorka** : promatrali smo uzorke duljine 10, 15, 20, 40, 100
- **distribuciju uzorka** : generirali smo podatake iz nenormalne distribucijame sa zadanim koeficijentima asimetrije (*skewness*) i spljošenosti (*kurtosis*)

Što se tiče odabira koeficijenata distribucije, promatrali smo sve kombinacije koeficijenata asimetrije γ_1 = od -2 do 2 s korakom 0.5 i koeficijenta spljoštenosti γ_2 = od -3 do 14 s korakom 3 koji zadovoljavaju uvijete:

$$\gamma_1^2 - 2 \leq \gamma_2^2$$
$$1.7022\gamma_1^2 - 1.15 < \gamma_2$$

Tako je dobiveno 46 različitih distribucija.

Za svaku duljinu uzorka i za svaku kombinaciju koeficijenata asimetrije i spljoštenosti, izvedeno je **500 replikacija**.

Također smo kod nulte hipoteze $H_0 : \mu = \mu_0$ za μ_0 uzimale vrijednosti od 15 do 45 sa korakom 5, te smo ispitivale snagu svih tako zadanih dvostranih t-testova. U obzir smo uzimale i dvije **razine značajnosti** α= 0.01 i α = 0.05.

2.1 Izvedba u SAS-u

Za generiranje podataka iz nenormalne distribucije sa zadanim koeficijentima *skewness* i *kurtosis* koristile smo *macro* funkciju **fleishman**.
Također smo uvele *macro* funkciju **misize** koja je od generiranih podataka oduzimala redom odgovarajuće vrijednosti μ_0, kako bismo mogle pozvati proceduru **proc means** i uzeti u obzir t vrijednost koju ta procedura vraća, a koja je dobivena uz nultu hipotezu $H_0 : \mu = 0$.

3 Ispitivanje jakosti testa

Jakost, odnosno snaga testa τ definira se kao funkcija $\gamma_\tau : \Theta \to [0,1]$ zadana s $\gamma_\tau(\theta) := \mathbb{E}_\theta[\tau(\mathbf{X})], \quad \theta \in \Theta$, pri čemu je Θ parametarski prostor. Interpretacija broja $\gamma_\tau(\theta)$ je vjerojatnost odbacivanja nul-hipoteze u korist alternativne ako je θ 'prava' vrijednost parametra.

Kao procjenu jakosti testa u Monte Carlo studiji uzimale smo proporciju uzoraka za koje je odbačena nulta hipoteza $H_0 : \mu = \mu_0$ i to za sve kombinacije duljine uzorka i distribucije te za obe razine značajnosti (0.01 i 0.05).
Kako bismo odredile je li na pojedinome uzorku odbačena nulta hipoteza uspoređivale smo t vrijednost iz procedure *proc means* s odgovarajućim kvantilima t razdiobe s obzirom na promatranu razinu značajnosti.

Na taj smo način dobili sljedeće tablice koje su organizirane po duljinama uzorka te razini značajnosti α. Redak u tablici predstavlja jednu od 46 distribucija (zadanih sredinom, devijacijom, koeficijentima asimetrije i spljoštenosti), a stupci idu po različitim vrijednostima μ_0 u nultoj hipotezi.

3.1 Tablice proporcija uzoraka za koje je odbačena H_0

Obs	_NAME_	MI0_15	MI0_20	MI0_25	MI0_30	MI0_35	MI0_40	MI0_45
1	mean	0.488	0.336	0.168	0.064	0.024	0.072	0.344
2	mean	0.528	0.330	0.146	0.042	0.020	0.118	0.462
3	mean	0.512	0.312	0.152	0.036	0.026	0.164	0.482
4	mean	0.460	0.272	0.122	0.048	0.036	0.096	0.340
5	mean	0.480	0.308	0.144	0.054	0.030	0.062	0.330
6	mean	0.488	0.298	0.120	0.026	0.012	0.100	0.400
7	mean	0.552	0.352	0.130	0.030	0.014	0.150	0.428
8	mean	0.532	0.324	0.132	0.022	0.036	0.186	0.544
9	mean	0.428	0.218	0.088	0.038	0.058	0.124	0.338
10	mean	0.476	0.244	0.100	0.024	0.018	0.122	0.392
11	mean	0.474	0.230	0.090	0.014	0.022	0.198	0.472
12	mean	0.508	0.296	0.114	0.016	0.034	0.184	0.492
13	mean	0.568	0.360	0.134	0.014	0.054	0.254	0.522
14	mean	0.394	0.162	0.048	0.024	0.040	0.160	0.396
15	mean	0.400	0.216	0.098	0.030	0.024	0.102	0.324
16	mean	0.446	0.244	0.054	0.014	0.042	0.150	0.440
17	mean	0.478	0.212	0.066	0.014	0.052	0.226	0.506
18	mean	0.570	0.302	0.080	0.008	0.038	0.234	0.526
19	mean	0.544	0.292	0.070	0.002	0.052	0.256	0.524
20	mean	0.576	0.310	0.094	0.008	0.060	0.308	0.570
21	mean	0.348	0.146	0.038	0.024	0.062	0.166	0.398
22	mean	0.454	0.220	0.048	0.008	0.054	0.194	0.446
23	mean	0.448	0.218	0.052	0.014	0.058	0.248	0.512
24	mean	0.532	0.272	0.060	0.016	0.068	0.280	0.536
25	mean	0.552	0.280	0.066	0.010	0.072	0.268	0.556
26	mean	0.200	0.084	0.042	0.016	0.032	0.096	0.182
27	mean	0.314	0.090	0.024	0.030	0.078	0.176	0.360
28	mean	0.444	0.158	0.052	0.016	0.096	0.258	0.478
29	mean	0.502	0.216	0.056	0.022	0.106	0.270	0.498
30	mean	0.524	0.258	0.056	0.010	0.094	0.300	0.546
31	mean	0.532	0.254	0.052	0.012	0.098	0.326	0.548
32	mean	0.578	0.314	0.070	0.022	0.116	0.358	0.586
33	mean	0.348	0.126	0.032	0.026	0.102	0.286	0.478
34	mean	0.460	0.180	0.028	0.020	0.098	0.260	0.524
35	mean	0.464	0.182	0.026	0.016	0.094	0.266	0.546
36	mean	0.512	0.216	0.036	0.022	0.136	0.312	0.516
37	mean	0.328	0.126	0.040	0.032	0.066	0.192	0.410
38	mean	0.292	0.056	0.014	0.038	0.122	0.274	0.476
39	mean	0.366	0.104	0.032	0.022	0.128	0.300	0.490
40	mean	0.460	0.150	0.026	0.034	0.160	0.344	0.582
41	mean	0.514	0.174	0.028	0.036	0.156	0.350	0.552
42	mean	0.296	0.106	0.044	0.034	0.082	0.226	0.454
43	mean	0.340	0.072	0.014	0.068	0.162	0.326	0.518
44	mean	0.416	0.126	0.018	0.062	0.196	0.390	0.556
45	mean	0.488	0.124	0.010	0.050	0.174	0.342	0.564
46	mean	0.342	0.106	0.032	0.040	0.120	0.252	0.448

Slika 1: n = 10 i $\alpha = 0.01$

Obs	_NAME_	MI0_15	MI0_20	MI0_25	MI0_30	MI0_35	MI0_40	MI0_45
1	mean	0.690	0.500	0.318	0.144	0.142	0.392	0.834
2	mean	0.718	0.550	0.314	0.126	0.142	0.472	0.846
3	mean	0.714	0.538	0.298	0.120	0.142	0.506	0.826
4	mean	0.740	0.482	0.274	0.136	0.144	0.406	0.794
5	mean	0.672	0.494	0.294	0.120	0.128	0.386	0.796
6	mean	0.714	0.512	0.284	0.104	0.114	0.432	0.796
7	mean	0.772	0.576	0.314	0.112	0.126	0.444	0.804
8	mean	0.732	0.550	0.306	0.116	0.176	0.540	0.818
9	mean	0.728	0.470	0.242	0.130	0.170	0.402	0.724
10	mean	0.724	0.504	0.232	0.096	0.154	0.428	0.744
11	mean	0.720	0.494	0.238	0.090	0.202	0.502	0.816
12	mean	0.742	0.520	0.272	0.096	0.194	0.516	0.802
13	mean	0.746	0.572	0.320	0.120	0.202	0.528	0.772
14	mean	0.734	0.440	0.176	0.086	0.198	0.452	0.754
15	mean	0.686	0.428	0.236	0.126	0.140	0.366	0.698
16	mean	0.726	0.484	0.238	0.086	0.190	0.488	0.728
17	mean	0.734	0.490	0.206	0.096	0.226	0.528	0.786
18	mean	0.760	0.582	0.258	0.080	0.184	0.546	0.774
19	mean	0.750	0.560	0.256	0.070	0.224	0.540	0.788
20	mean	0.792	0.586	0.264	0.076	0.260	0.576	0.790
21	mean	0.684	0.398	0.180	0.108	0.194	0.426	0.728
22	mean	0.768	0.484	0.226	0.088	0.180	0.480	0.740
23	mean	0.714	0.468	0.186	0.088	0.244	0.526	0.798
24	mean	0.754	0.542	0.242	0.090	0.260	0.540	0.780
25	mean	0.772	0.548	0.238	0.080	0.232	0.564	0.772
26	mean	0.482	0.274	0.140	0.100	0.140	0.264	0.470
27	mean	0.752	0.396	0.132	0.096	0.194	0.406	0.668
28	mean	0.742	0.448	0.176	0.108	0.256	0.508	0.736
29	mean	0.796	0.526	0.210	0.118	0.258	0.514	0.754
30	mean	0.786	0.540	0.218	0.088	0.262	0.558	0.768
31	mean	0.754	0.526	0.202	0.096	0.298	0.568	0.752
32	mean	0.820	0.592	0.270	0.112	0.296	0.592	0.776
33	mean	0.742	0.410	0.142	0.090	0.286	0.508	0.730
34	mean	0.768	0.498	0.186	0.102	0.244	0.548	0.730
35	mean	0.744	0.500	0.182	0.094	0.270	0.556	0.750
36	mean	0.800	0.536	0.208	0.074	0.290	0.528	0.724
37	mean	0.722	0.380	0.170	0.092	0.198	0.464	0.714
38	mean	0.804	0.348	0.096	0.122	0.266	0.508	0.730
39	mean	0.790	0.416	0.110	0.128	0.290	0.512	0.722
40	mean	0.778	0.484	0.162	0.130	0.334	0.582	0.764
41	mean	0.826	0.518	0.176	0.128	0.326	0.572	0.726
42	mean	0.734	0.364	0.138	0.112	0.248	0.506	0.770
43	mean	0.872	0.352	0.104	0.144	0.304	0.534	0.716
44	mean	0.848	0.416	0.146	0.162	0.364	0.566	0.742
45	mean	0.824	0.490	0.112	0.136	0.322	0.564	0.754
46	mean	0.840	0.392	0.144	0.114	0.252	0.486	0.724

Slika 2: n = 10 i $\alpha = 0.05$

Obs	_NAME_	MI0_15	MI0_20	MI0_25	MI0_30	MI0_35	MI0_40	MI0_45
1	mean	0.618	0.396	0.206	0.056	0.014	0.180	0.730
2	mean	0.622	0.382	0.174	0.032	0.046	0.270	0.730
3	mean	0.668	0.446	0.198	0.032	0.044	0.278	0.728
4	mean	0.660	0.376	0.124	0.032	0.040	0.226	0.700
5	mean	0.632	0.372	0.152	0.042	0.026	0.188	0.706
6	mean	0.642	0.378	0.178	0.034	0.046	0.280	0.674
7	mean	0.660	0.434	0.138	0.020	0.042	0.320	0.724
8	mean	0.672	0.392	0.160	0.020	0.070	0.348	0.740
9	mean	0.612	0.312	0.098	0.026	0.064	0.304	0.684
10	mean	0.630	0.350	0.144	0.046	0.046	0.222	0.652
11	mean	0.648	0.388	0.132	0.020	0.066	0.334	0.686
12	mean	0.684	0.406	0.122	0.022	0.056	0.340	0.728
13	mean	0.696	0.428	0.144	0.012	0.082	0.386	0.692
14	mean	0.664	0.360	0.118	0.032	0.048	0.260	0.620
15	mean	0.608	0.316	0.086	0.018	0.058	0.262	0.628
16	mean	0.646	0.336	0.094	0.016	0.074	0.314	0.674
17	mean	0.650	0.350	0.086	0.016	0.076	0.354	0.668
18	mean	0.696	0.446	0.122	0.008	0.078	0.322	0.680
19	mean	0.698	0.410	0.110	0.018	0.108	0.416	0.680
20	mean	0.714	0.492	0.170	0.010	0.088	0.430	0.744
21	mean	0.610	0.290	0.068	0.016	0.080	0.308	0.628
22	mean	0.630	0.354	0.088	0.012	0.096	0.330	0.666
23	mean	0.632	0.372	0.110	0.016	0.092	0.314	0.668
24	mean	0.650	0.346	0.064	0.010	0.090	0.384	0.678
25	mean	0.696	0.380	0.122	0.010	0.106	0.390	0.710
26	mean	0.288	0.118	0.032	0.016	0.040	0.136	0.318
27	mean	0.610	0.238	0.060	0.040	0.110	0.358	0.634
28	mean	0.696	0.336	0.068	0.022	0.102	0.322	0.670
29	mean	0.704	0.322	0.066	0.016	0.108	0.392	0.700
30	mean	0.704	0.326	0.076	0.022	0.158	0.408	0.698
31	mean	0.730	0.382	0.082	0.014	0.154	0.440	0.702
32	mean	0.728	0.396	0.076	0.008	0.148	0.488	0.738
33	mean	0.630	0.234	0.048	0.020	0.134	0.418	0.670
34	mean	0.686	0.316	0.068	0.022	0.136	0.362	0.624
35	mean	0.722	0.348	0.066	0.032	0.158	0.410	0.650
36	mean	0.724	0.386	0.074	0.016	0.146	0.446	0.684
37	mean	0.660	0.294	0.064	0.016	0.106	0.264	0.590
38	mean	0.728	0.204	0.024	0.038	0.166	0.362	0.600
39	mean	0.734	0.284	0.028	0.026	0.162	0.412	0.652
40	mean	0.660	0.262	0.024	0.028	0.152	0.416	0.662
41	mean	0.700	0.314	0.046	0.018	0.142	0.420	0.660
42	mean	0.676	0.242	0.048	0.036	0.124	0.346	0.652
43	mean	0.764	0.198	0.024	0.046	0.152	0.380	0.638
44	mean	0.710	0.180	0.028	0.048	0.188	0.430	0.654
45	mean	0.740	0.300	0.042	0.038	0.204	0.444	0.670
46	mean	0.674	0.244	0.044	0.024	0.124	0.362	0.664

Slika 3: n $= 15$ i $\alpha = 0.01$

Obs	_NAME_	MI0_15	MI0_20	MI0_25	MI0_30	MI0_35	MI0_40	MI0_45
1	mean	0.804	0.602	0.338	0.162	0.166	0.640	0.984
2	mean	0.810	0.588	0.312	0.122	0.208	0.678	0.956
3	mean	0.832	0.644	0.372	0.132	0.206	0.652	0.924
4	mean	0.842	0.640	0.314	0.108	0.210	0.604	0.970
5	mean	0.838	0.616	0.292	0.104	0.160	0.600	0.960
6	mean	0.826	0.594	0.324	0.124	0.234	0.616	0.918
7	mean	0.846	0.636	0.328	0.108	0.242	0.656	0.914
8	mean	0.832	0.630	0.310	0.094	0.256	0.688	0.924
9	mean	0.838	0.566	0.260	0.108	0.264	0.636	0.938
10	mean	0.834	0.584	0.300	0.126	0.200	0.612	0.902
11	mean	0.844	0.618	0.310	0.102	0.254	0.646	0.872
12	mean	0.856	0.654	0.322	0.086	0.236	0.668	0.912
13	mean	0.840	0.660	0.364	0.094	0.270	0.654	0.896
14	mean	0.900	0.618	0.312	0.108	0.224	0.558	0.896
15	mean	0.828	0.580	0.270	0.088	0.226	0.560	0.914
16	mean	0.844	0.600	0.272	0.102	0.250	0.630	0.908
17	mean	0.860	0.608	0.292	0.100	0.274	0.628	0.880
18	mean	0.852	0.670	0.334	0.078	0.250	0.632	0.874
19	mean	0.870	0.662	0.328	0.104	0.306	0.650	0.888
20	mean	0.876	0.694	0.392	0.104	0.284	0.700	0.876
21	mean	0.846	0.564	0.244	0.110	0.244	0.596	0.878
22	mean	0.862	0.600	0.274	0.106	0.256	0.630	0.878
23	mean	0.844	0.604	0.314	0.098	0.234	0.624	0.868
24	mean	0.878	0.636	0.250	0.062	0.298	0.656	0.868
25	mean	0.872	0.642	0.302	0.096	0.310	0.658	0.856
26	mean	0.606	0.336	0.134	0.078	0.162	0.364	0.638
27	mean	0.880	0.550	0.214	0.126	0.312	0.614	0.864
28	mean	0.900	0.638	0.272	0.102	0.260	0.614	0.836
29	mean	0.896	0.658	0.232	0.086	0.316	0.656	0.870
30	mean	0.868	0.652	0.232	0.118	0.332	0.652	0.870
31	mean	0.894	0.688	0.290	0.108	0.344	0.660	0.866
32	mean	0.874	0.700	0.290	0.078	0.378	0.696	0.882
33	mean	0.904	0.550	0.166	0.106	0.342	0.638	0.874
34	mean	0.898	0.630	0.254	0.124	0.312	0.586	0.792
35	mean	0.892	0.650	0.258	0.134	0.350	0.622	0.846
36	mean	0.904	0.662	0.264	0.094	0.362	0.646	0.860
37	mean	0.928	0.634	0.236	0.104	0.220	0.548	0.854
38	mean	0.964	0.630	0.202	0.132	0.314	0.558	0.800
39	mean	0.950	0.680	0.186	0.098	0.346	0.622	0.838
40	mean	0.904	0.630	0.184	0.090	0.334	0.632	0.838
41	mean	0.902	0.642	0.246	0.108	0.336	0.636	0.824
42	mean	0.910	0.612	0.220	0.134	0.274	0.604	0.886
43	mean	0.982	0.624	0.186	0.108	0.322	0.604	0.816
44	mean	0.954	0.648	0.132	0.136	0.366	0.626	0.806
45	mean	0.918	0.654	0.212	0.136	0.374	0.634	0.818
46	mean	0.968	0.584	0.206	0.102	0.282	0.618	0.854

Slika 4: n = 15 i $\alpha = 0.05$

Obs	_NAME_	MI0_15	MI0_20	MI0_25	MI0_30	MI0_35	MI0_40	MI0_45
1	mean	0.716	0.470	0.204	0.050	0.038	0.370	0.932
2	mean	0.740	0.496	0.208	0.032	0.058	0.410	0.886
3	mean	0.774	0.538	0.212	0.028	0.038	0.448	0.870
4	mean	0.800	0.460	0.160	0.024	0.062	0.380	0.906
5	mean	0.750	0.438	0.194	0.036	0.056	0.358	0.888
6	mean	0.746	0.478	0.152	0.022	0.076	0.404	0.890
7	mean	0.782	0.508	0.206	0.028	0.060	0.418	0.810
8	mean	0.780	0.494	0.208	0.022	0.070	0.474	0.828
9	mean	0.844	0.478	0.154	0.024	0.056	0.380	0.848
10	mean	0.742	0.436	0.152	0.010	0.062	0.410	0.848
11	mean	0.766	0.496	0.156	0.016	0.070	0.468	0.838
12	mean	0.776	0.476	0.146	0.014	0.102	0.494	0.834
13	mean	0.796	0.518	0.166	0.008	0.108	0.484	0.832
14	mean	0.810	0.452	0.128	0.020	0.098	0.384	0.824
15	mean	0.776	0.450	0.158	0.038	0.066	0.378	0.806
16	mean	0.766	0.442	0.134	0.008	0.096	0.420	0.808
17	mean	0.750	0.442	0.142	0.016	0.084	0.478	0.828
18	mean	0.742	0.482	0.140	0.008	0.112	0.444	0.802
19	mean	0.802	0.486	0.128	0.010	0.096	0.506	0.830
20	mean	0.772	0.500	0.158	0.016	0.136	0.552	0.824
21	mean	0.818	0.434	0.104	0.018	0.098	0.400	0.770
22	mean	0.812	0.404	0.122	0.022	0.132	0.472	0.798
23	mean	0.796	0.476	0.096	0.016	0.142	0.496	0.812
24	mean	0.794	0.468	0.124	0.014	0.148	0.552	0.816
25	mean	0.816	0.508	0.120	0.016	0.168	0.546	0.830
26	mean	0.452	0.178	0.058	0.022	0.058	0.190	0.434
27	mean	0.812	0.388	0.074	0.024	0.118	0.402	0.774
28	mean	0.814	0.412	0.092	0.012	0.130	0.478	0.746
29	mean	0.832	0.460	0.106	0.012	0.148	0.452	0.814
30	mean	0.786	0.460	0.092	0.006	0.142	0.484	0.782
31	mean	0.806	0.466	0.118	0.008	0.150	0.492	0.770
32	mean	0.812	0.528	0.132	0.014	0.156	0.492	0.804
33	mean	0.838	0.346	0.066	0.022	0.164	0.466	0.774
34	mean	0.840	0.454	0.074	0.022	0.176	0.472	0.768
35	mean	0.812	0.434	0.080	0.022	0.184	0.504	0.788
36	mean	0.848	0.522	0.110	0.018	0.184	0.476	0.766
37	mean	0.818	0.384	0.074	0.024	0.148	0.466	0.826
38	mean	0.900	0.360	0.042	0.032	0.196	0.486	0.752
39	mean	0.852	0.398	0.050	0.024	0.182	0.492	0.762
40	mean	0.850	0.418	0.074	0.038	0.196	0.522	0.780
41	mean	0.872	0.504	0.074	0.034	0.188	0.498	0.750
42	mean	0.854	0.364	0.074	0.026	0.156	0.472	0.804
43	mean	0.930	0.340	0.022	0.062	0.254	0.500	0.762
44	mean	0.884	0.398	0.038	0.032	0.184	0.520	0.754
45	mean	0.874	0.418	0.054	0.026	0.208	0.536	0.790
46	mean	0.898	0.376	0.068	0.026	0.168	0.476	0.782

Slika 5: n = 20 i $\alpha = 0.01$

Obs	_NAME_	MI0_15	MI0_20	MI0_25	MI0_30	MI0_35	MI0_40	MI0_45
1	mean	0.864	0.660	0.372	0.122	0.228	0.802	0.998
2	mean	0.878	0.694	0.388	0.128	0.240	0.806	0.984
3	mean	0.902	0.734	0.428	0.112	0.240	0.776	0.974
4	mean	0.924	0.730	0.340	0.110	0.230	0.748	0.986
5	mean	0.908	0.662	0.342	0.116	0.240	0.752	0.990
6	mean	0.902	0.688	0.346	0.092	0.244	0.790	0.984
7	mean	0.908	0.700	0.402	0.128	0.288	0.704	0.946
8	mean	0.902	0.734	0.400	0.110	0.272	0.766	0.960
9	mean	0.954	0.772	0.344	0.088	0.224	0.716	0.978
10	mean	0.914	0.666	0.342	0.092	0.270	0.746	0.978
11	mean	0.898	0.700	0.356	0.106	0.294	0.770	0.954
12	mean	0.894	0.704	0.346	0.094	0.334	0.774	0.956
13	mean	0.918	0.758	0.370	0.098	0.320	0.764	0.956
14	mean	0.936	0.704	0.334	0.110	0.280	0.724	0.966
15	mean	0.934	0.684	0.350	0.112	0.254	0.716	0.956
16	mean	0.922	0.704	0.324	0.098	0.294	0.736	0.968
17	mean	0.906	0.656	0.340	0.100	0.328	0.750	0.968
18	mean	0.928	0.688	0.370	0.094	0.328	0.732	0.930
19	mean	0.926	0.736	0.362	0.068	0.342	0.748	0.928
20	mean	0.896	0.712	0.380	0.078	0.408	0.774	0.938
21	mean	0.944	0.722	0.326	0.096	0.280	0.684	0.944
22	mean	0.936	0.720	0.278	0.108	0.356	0.746	0.940
23	mean	0.922	0.736	0.324	0.094	0.332	0.748	0.944
24	mean	0.918	0.734	0.310	0.100	0.392	0.752	0.928
25	mean	0.934	0.740	0.336	0.080	0.374	0.756	0.946
26	mean	0.688	0.444	0.176	0.106	0.194	0.452	0.702
27	mean	0.970	0.704	0.262	0.104	0.300	0.690	0.928
28	mean	0.962	0.722	0.292	0.110	0.346	0.694	0.896
29	mean	0.960	0.764	0.316	0.108	0.332	0.734	0.924
30	mean	0.926	0.714	0.300	0.076	0.348	0.734	0.902
31	mean	0.934	0.754	0.316	0.112	0.352	0.706	0.922
32	mean	0.930	0.766	0.386	0.096	0.348	0.716	0.924
33	mean	0.978	0.702	0.226	0.100	0.346	0.718	0.900
34	mean	0.954	0.754	0.282	0.128	0.328	0.712	0.902
35	mean	0.950	0.742	0.284	0.104	0.388	0.714	0.916
36	mean	0.950	0.786	0.350	0.082	0.346	0.692	0.902
37	mean	0.964	0.690	0.260	0.110	0.346	0.734	0.952
38	mean	0.996	0.720	0.220	0.120	0.372	0.688	0.896
39	mean	0.980	0.758	0.264	0.114	0.386	0.718	0.906
40	mean	0.968	0.754	0.246	0.128	0.388	0.726	0.906
41	mean	0.960	0.800	0.320	0.120	0.370	0.686	0.886
42	mean	0.980	0.728	0.240	0.110	0.352	0.734	0.930
43	mean	0.998	0.772	0.216	0.142	0.398	0.708	0.894
44	mean	0.988	0.792	0.240	0.100	0.390	0.710	0.872
45	mean	0.976	0.784	0.242	0.122	0.402	0.744	0.922
46	mean	0.992	0.768	0.246	0.098	0.348	0.700	0.906

Slika 6: n = 20 i $\alpha = 0.05$

Obs	_NAME_	MI0_15	MI0_20	MI0_25	MI0_30	MI0_35	MI0_40	MI0_45
1	mean	0.928	0.692	0.298	0.032	0.156	0.870	1.000
2	mean	0.962	0.738	0.328	0.044	0.148	0.854	1.000
3	mean	0.930	0.758	0.302	0.018	0.192	0.860	0.998
4	mean	0.952	0.714	0.232	0.020	0.208	0.860	1.000
5	mean	0.962	0.736	0.284	0.030	0.172	0.850	1.000
6	mean	0.958	0.712	0.284	0.020	0.192	0.860	0.992
7	mean	0.944	0.754	0.262	0.016	0.178	0.834	0.994
8	mean	0.944	0.748	0.352	0.030	0.218	0.816	0.986
9	mean	0.956	0.776	0.242	0.016	0.150	0.830	0.996
10	mean	0.966	0.718	0.256	0.004	0.214	0.816	0.996
11	mean	0.970	0.762	0.276	0.024	0.228	0.808	0.984
12	mean	0.952	0.742	0.272	0.018	0.264	0.828	0.984
13	mean	0.962	0.772	0.304	0.020	0.240	0.832	0.984
14	mean	0.978	0.786	0.250	0.014	0.186	0.824	0.996
15	mean	0.974	0.768	0.232	0.028	0.180	0.752	0.994
16	mean	0.978	0.740	0.258	0.010	0.202	0.744	0.988
17	mean	0.974	0.750	0.240	0.022	0.210	0.788	0.972
18	mean	0.960	0.796	0.258	0.012	0.222	0.792	0.972
19	mean	0.954	0.774	0.274	0.016	0.236	0.806	0.984
20	mean	0.952	0.782	0.276	0.026	0.276	0.792	0.974
21	mean	0.984	0.784	0.234	0.022	0.186	0.744	0.992
22	mean	0.972	0.756	0.212	0.018	0.250	0.764	0.982
23	mean	0.974	0.780	0.240	0.020	0.236	0.806	0.984
24	mean	0.960	0.780	0.258	0.018	0.270	0.772	0.972
25	mean	0.966	0.804	0.252	0.012	0.296	0.804	0.964
26	mean	0.740	0.412	0.100	0.004	0.090	0.382	0.702
27	mean	0.996	0.764	0.188	0.022	0.248	0.734	0.994
28	mean	0.980	0.778	0.194	0.026	0.256	0.736	0.948
29	mean	0.986	0.790	0.192	0.016	0.266	0.790	0.974
30	mean	0.986	0.786	0.194	0.026	0.278	0.768	0.956
31	mean	0.974	0.806	0.224	0.012	0.316	0.810	0.968
32	mean	0.962	0.764	0.270	0.016	0.308	0.794	0.968
33	mean	1.000	0.798	0.172	0.022	0.286	0.726	0.960
34	mean	0.996	0.784	0.176	0.032	0.304	0.760	0.952
35	mean	0.984	0.822	0.192	0.020	0.270	0.750	0.954
36	mean	0.986	0.828	0.230	0.012	0.294	0.746	0.956
37	mean	0.994	0.810	0.204	0.016	0.246	0.774	0.970
38	mean	1.000	0.852	0.144	0.018	0.246	0.718	0.948
39	mean	0.998	0.832	0.178	0.022	0.268	0.750	0.946
40	mean	0.994	0.856	0.192	0.016	0.326	0.790	0.958
41	mean	0.992	0.824	0.194	0.012	0.340	0.772	0.950
42	mean	0.998	0.842	0.186	0.016	0.230	0.818	0.974
43	mean	1.000	0.874	0.138	0.026	0.288	0.712	0.944
44	mean	1.000	0.884	0.166	0.024	0.264	0.722	0.938
45	mean	0.990	0.860	0.170	0.038	0.328	0.732	0.932
46	mean	1.000	0.830	0.164	0.032	0.304	0.768	0.938

Slika 7: n $= 40$ i $\alpha = 0.01$

Obs	_NAME_	MI0_15	MI0_20	MI0_25	MI0_30	MI0_35	MI0_40	MI0_45
1	mean	0.982	0.880	0.486	0.122	0.486	0.988	1.000
2	mean	0.996	0.902	0.516	0.108	0.466	0.972	1.000
3	mean	0.984	0.878	0.508	0.118	0.488	0.974	1.000
4	mean	0.980	0.888	0.482	0.102	0.526	0.976	1.000
5	mean	0.986	0.900	0.482	0.090	0.446	0.972	1.000
6	mean	0.988	0.894	0.492	0.110	0.504	0.968	1.000
7	mean	0.988	0.890	0.534	0.082	0.498	0.950	0.998
8	mean	0.984	0.894	0.526	0.126	0.488	0.946	0.996
9	mean	0.984	0.908	0.496	0.086	0.470	0.960	1.000
10	mean	0.998	0.902	0.464	0.090	0.482	0.950	1.000
11	mean	0.994	0.906	0.524	0.108	0.492	0.942	0.998
12	mean	0.990	0.904	0.496	0.096	0.532	0.938	0.998
13	mean	0.992	0.910	0.532	0.088	0.488	0.942	1.000
14	mean	0.998	0.932	0.514	0.092	0.446	0.946	0.996
15	mean	0.994	0.904	0.514	0.104	0.442	0.944	1.000
16	mean	0.998	0.918	0.472	0.100	0.458	0.944	0.998
17	mean	0.994	0.908	0.482	0.098	0.490	0.930	0.992
18	mean	0.996	0.924	0.508	0.088	0.478	0.926	0.992
19	mean	0.990	0.910	0.526	0.092	0.510	0.928	1.000
20	mean	0.984	0.904	0.530	0.094	0.536	0.920	0.994
21	mean	0.994	0.944	0.510	0.088	0.428	0.934	0.996
22	mean	0.996	0.900	0.448	0.100	0.512	0.928	0.998
23	mean	0.994	0.946	0.464	0.076	0.472	0.940	0.994
24	mean	0.992	0.934	0.536	0.070	0.508	0.920	0.998
25	mean	0.994	0.918	0.532	0.084	0.508	0.916	0.992
26	mean	0.856	0.638	0.320	0.076	0.298	0.628	0.866
27	mean	1.000	0.940	0.460	0.120	0.472	0.916	1.000
28	mean	1.000	0.930	0.446	0.100	0.490	0.894	0.994
29	mean	0.998	0.914	0.480	0.108	0.530	0.928	0.996
30	mean	0.998	0.920	0.488	0.098	0.540	0.894	0.988
31	mean	0.994	0.938	0.504	0.092	0.548	0.910	0.996
32	mean	0.988	0.924	0.492	0.096	0.520	0.916	0.994
33	mean	1.000	0.960	0.436	0.104	0.480	0.904	0.998
34	mean	1.000	0.958	0.480	0.112	0.514	0.902	0.988
35	mean	0.996	0.948	0.498	0.094	0.522	0.906	0.996
36	mean	0.996	0.942	0.520	0.094	0.522	0.900	0.986
37	mean	1.000	0.958	0.458	0.094	0.524	0.918	0.988
38	mean	1.000	0.976	0.434	0.088	0.460	0.868	0.992
39	mean	1.000	0.980	0.484	0.094	0.494	0.896	0.988
40	mean	1.000	0.974	0.494	0.104	0.538	0.902	0.990
41	mean	0.998	0.952	0.516	0.100	0.516	0.888	0.988
42	mean	1.000	0.964	0.482	0.088	0.506	0.924	0.990
43	mean	1.000	0.986	0.456	0.106	0.508	0.870	0.990
44	mean	1.000	0.978	0.484	0.086	0.498	0.884	0.982
45	mean	1.000	0.964	0.486	0.144	0.528	0.876	0.986
46	mean	1.000	0.964	0.462	0.116	0.504	0.900	0.984

Slika 8: n = 40 i $\alpha = 0.05$

Obs	_NAME_	MI0_15	MI0_20	MI0_25	MI0_30	MI0_35	MI0_40	MI0_45
1	mean	1.000	0.980	0.542	0.050	0.568	1.000	1.000
2	mean	1.000	0.980	0.578	0.020	0.574	1.000	1.000
3	mean	1.000	0.976	0.596	0.012	0.582	1.000	1.000
4	mean	1.000	0.976	0.584	0.012	0.536	1.000	1.000
5	mean	1.000	0.988	0.552	0.020	0.596	1.000	1.000
6	mean	1.000	0.992	0.584	0.016	0.560	1.000	1.000
7	mean	1.000	0.976	0.546	0.018	0.602	0.998	1.000
8	mean	1.000	0.978	0.616	0.016	0.570	0.998	1.000
9	mean	0.996	0.970	0.550	0.030	0.586	0.998	1.000
10	mean	1.000	0.988	0.588	0.020	0.532	1.000	1.000
11	mean	1.000	0.986	0.558	0.022	0.572	0.998	1.000
12	mean	1.000	0.982	0.568	0.028	0.582	0.996	1.000
13	mean	1.000	0.968	0.554	0.024	0.640	0.998	1.000
14	mean	0.996	0.978	0.608	0.026	0.538	0.992	1.000
15	mean	1.000	0.996	0.592	0.014	0.512	0.998	1.000
16	mean	1.000	0.992	0.596	0.022	0.544	0.998	1.000
17	mean	1.000	0.990	0.560	0.018	0.586	0.994	1.000
18	mean	1.000	0.986	0.580	0.012	0.568	0.990	1.000
19	mean	0.998	0.984	0.572	0.026	0.608	0.992	1.000
20	mean	1.000	0.986	0.592	0.024	0.562	0.982	1.000
21	mean	1.000	0.996	0.564	0.028	0.552	0.990	1.000
22	mean	1.000	0.990	0.554	0.026	0.584	0.996	1.000
23	mean	1.000	0.990	0.564	0.018	0.548	0.992	1.000
24	mean	1.000	0.994	0.578	0.026	0.568	0.988	1.000
25	mean	1.000	0.986	0.570	0.014	0.584	0.976	1.000
26	mean	0.934	0.726	0.232	0.014	0.212	0.698	0.900
27	mean	1.000	0.996	0.572	0.010	0.542	0.996	1.000
28	mean	1.000	1.000	0.558	0.016	0.618	0.990	1.000
29	mean	1.000	0.990	0.586	0.014	0.602	0.986	1.000
30	mean	1.000	0.992	0.560	0.012	0.584	0.984	1.000
31	mean	1.000	0.988	0.614	0.026	0.576	0.990	0.998
32	mean	1.000	0.996	0.608	0.018	0.554	0.968	0.998
33	mean	1.000	0.998	0.538	0.018	0.540	0.978	1.000
34	mean	1.000	0.998	0.602	0.020	0.574	0.984	1.000
35	mean	1.000	0.998	0.550	0.020	0.606	0.986	1.000
36	mean	1.000	0.998	0.612	0.014	0.574	0.984	1.000
37	mean	1.000	0.998	0.562	0.012	0.622	0.990	0.998
38	mean	1.000	1.000	0.564	0.024	0.564	0.988	1.000
39	mean	1.000	1.000	0.566	0.016	0.556	0.992	1.000
40	mean	1.000	1.000	0.560	0.018	0.562	0.986	1.000
41	mean	1.000	0.998	0.566	0.026	0.584	0.982	0.998
42	mean	1.000	0.998	0.546	0.016	0.598	0.976	1.000
43	mean	1.000	1.000	0.584	0.032	0.520	0.978	1.000
44	mean	1.000	1.000	0.562	0.010	0.582	0.980	1.000
45	mean	1.000	0.998	0.524	0.024	0.600	0.984	1.000
46	mean	1.000	1.000	0.592	0.014	0.578	0.980	0.994

Slika 9: n $=100$ i $\alpha=0.01$

Obs	_NAME_	MI0_15	MI0_20	MI0_25	MI0_30	MI0_35	MI0_40	MI0_45
1	mean	1.000	0.994	0.750	0.132	0.836	1.000	1.000
2	mean	1.000	0.996	0.780	0.118	0.832	1.000	1.000
3	mean	1.000	0.988	0.806	0.092	0.854	1.000	1.000
4	mean	1.000	0.992	0.782	0.100	0.848	1.000	1.000
5	mean	1.000	0.996	0.784	0.092	0.864	1.000	1.000
6	mean	1.000	0.998	0.804	0.098	0.846	1.000	1.000
7	mean	1.000	0.994	0.786	0.098	0.820	1.000	1.000
8	mean	1.000	0.996	0.798	0.096	0.820	1.000	1.000
9	mean	0.998	0.990	0.782	0.104	0.838	1.000	1.000
10	mean	1.000	1.000	0.792	0.106	0.806	1.000	1.000
11	mean	1.000	1.000	0.748	0.124	0.800	1.000	1.000
12	mean	1.000	1.000	0.798	0.106	0.826	1.000	1.000
13	mean	1.000	1.000	0.772	0.122	0.820	1.000	1.000
14	mean	1.000	0.994	0.808	0.114	0.810	1.000	1.000
15	mean	1.000	1.000	0.812	0.102	0.786	1.000	1.000
16	mean	1.000	1.000	0.812	0.086	0.804	1.000	1.000
17	mean	1.000	0.998	0.800	0.120	0.796	1.000	1.000
18	mean	1.000	0.998	0.802	0.086	0.804	1.000	1.000
19	mean	1.000	0.990	0.800	0.112	0.828	1.000	1.000
20	mean	1.000	0.996	0.808	0.096	0.786	1.000	1.000
21	mean	1.000	1.000	0.790	0.118	0.790	1.000	1.000
22	mean	1.000	1.000	0.770	0.104	0.828	1.000	1.000
23	mean	1.000	0.996	0.802	0.104	0.786	1.000	1.000
24	mean	1.000	1.000	0.800	0.086	0.812	1.000	1.000
25	mean	1.000	0.998	0.782	0.114	0.812	0.996	1.000
26	mean	0.982	0.864	0.476	0.086	0.456	0.846	0.962
27	mean	1.000	0.998	0.810	0.084	0.792	1.000	1.000
28	mean	1.000	1.000	0.814	0.100	0.808	1.000	1.000
29	mean	1.000	1.000	0.806	0.118	0.798	0.996	1.000
30	mean	1.000	0.998	0.802	0.094	0.816	0.998	1.000
31	mean	1.000	0.998	0.808	0.104	0.818	0.998	1.000
32	mean	1.000	1.000	0.804	0.122	0.778	0.994	1.000
33	mean	1.000	1.000	0.822	0.096	0.790	0.998	1.000
34	mean	1.000	1.000	0.834	0.116	0.780	0.998	1.000
35	mean	1.000	1.000	0.804	0.082	0.778	0.996	1.000
36	mean	1.000	1.000	0.846	0.066	0.784	0.994	1.000
37	mean	1.000	0.998	0.808	0.070	0.820	0.996	1.000
38	mean	1.000	1.000	0.856	0.110	0.754	0.998	1.000
39	mean	1.000	1.000	0.846	0.094	0.804	1.000	1.000
40	mean	1.000	1.000	0.834	0.112	0.760	0.994	1.000
41	mean	1.000	1.000	0.830	0.118	0.778	0.996	1.000
42	mean	1.000	1.000	0.818	0.092	0.808	0.996	1.000
43	mean	1.000	1.000	0.864	0.116	0.766	0.994	1.000
44	mean	1.000	1.000	0.828	0.070	0.802	0.998	1.000
45	mean	1.000	1.000	0.820	0.102	0.786	0.996	1.000
46	mean	1.000	1.000	0.860	0.070	0.818	0.988	0.998

Slika 10: n $= 100$ i $\alpha = 0.05$

3.2 Usporedba rezultata za normalnu distribuciju

U ovom potpoglavlju cilj nam je usporediti rezultate dobivene PROC POWER procedurom s rezultatima koje smo dobili Monte Carlo simulacijama za normalnu distribuciju. Promatramo procjene jakosti testa iz procedure i tablični prikaz proporcija uzoraka za koje je odbačena H_0 kod simulacija. Tablice su napravljene posebno za svaku od razina značajnosti α. Retci tablica, označeni brojevima od 1 do 7, predstavljaju 7 mogućnosti za μ_0 (od 15 do 45 sa korakom 5) u nultoj hipotezi testa $H_0 : \mu = \mu_0$, dok stupci tablica predstavljaju duljine uzoraka (10,15,20,40,100).

n=10

Computed Power		
Index	Null Mean	Power
1	15	0.245
2	20	0.092
3	25	0.025
4	30	0.010
5	35	0.032
6	40	0.112
7	45	0.281

n=15

Computed Power		
Index	Null Mean	Power
1	15	0.476
2	20	0.182
3	25	0.040
4	30	0.010
5	35	0.047
6	40	0.203
7	45	0.506

n=20

Computed Power		
Index	Null Mean	Power
1	15	0.708
2	20	0.317
3	25	0.066
4	30	0.010
5	35	0.057
6	40	0.289
7	45	0.680

n=40

Computed Power		
Index	Null Mean	Power
1	15	0.979
2	20	0.701
3	25	0.162
4	30	0.010
5	35	0.129
6	40	0.650
7	45	0.971

n=100

Computed Power		
Index	Null Mean	Power
1	15	>.999
2	20	0.991
3	25	0.456
4	30	0.010
5	35	0.454
6	40	0.991
7	45	>.999

Slika 11: Rezultati PROC POWER procedure za $\alpha = 0.01$

Obs	n10	n15	n20	n40	n100
1	0.348	0.610	0.818	0.984	1.000
2	0.146	0.290	0.434	0.784	0.996
3	0.038	0.068	0.104	0.234	0.564
4	0.024	0.016	0.018	0.022	0.028
5	0.062	0.080	0.098	0.186	0.552
6	0.166	0.308	0.400	0.744	0.990
7	0.398	0.628	0.770	0.992	1.000

Slika 12: Rezultati na temelju MC simulacija za α=0.01

n=10

Computed Power		
Index	Null Mean	Power
1	15	0.533
2	20	0.270
3	25	0.099
4	30	0.050
5	35	0.120
6	40	0.312
7	45	0.581

n=15

Computed Power		
Index	Null Mean	Power
1	15	0.755
2	20	0.420
3	25	0.138
4	30	0.050
5	35	0.156
6	40	0.451
7	45	0.779

n=20

Computed Power		
Index	Null Mean	Power
1	15	0.901
2	20	0.587
3	25	0.199
4	30	0.050
5	35	0.177
6	40	0.555
7	45	0.886

n=40

Computed Power		
Index	Null Mean	Power
1	15	0.997
2	20	0.885
3	25	0.366
4	30	0.051
5	35	0.313
6	40	0.855
7	45	0.995

n=100

Computed Power		
Index	Null Mean	Power
1	15	>.999
2	20	0.999
3	25	0.700
4	30	0.050
5	35	0.698
6	40	0.999
7	45	>.999

Slika 13: Rezultati PROC POWER procedure za $\alpha = 0.05$

Obs	n10	n15	n20	n40	n100
1	0.684	0.846	0.944	0.994	1.000
2	0.398	0.564	0.722	0.944	1.000
3	0.180	0.244	0.326	0.510	0.790
4	0.108	0.110	0.096	0.088	0.118
5	0.194	0.244	0.280	0.428	0.790
6	0.426	0.596	0.684	0.934	1.000
7	0.728	0.878	0.944	0.996	1.000

Slika 14: Rezultati na temelju MC simulacija za α=0.05

Iz gornjih tablica vidimo da su proporcije dobivene iz generiranih normalnih podataka (uz zadani skewness, kurtosis, mean i standard deviation) i PROC POWER procedurom uglavnom vrlo blizu te se razlikuju u prosjeku za 0.1. Također, ponašaju se slično tako da za svaku duljinu uzorka po različitim vrijednostima μ_0 pada prema teorijskoj vrijednosti sredine ($\mu_0 = 30$) te opet raste. Još možemo primjetiti za duljinu uzorka 100 su proporcije najveće te za razinu značajnosti 0.05 su, očekivano, vrijednosti veće nego kod razine značajnosti 0.01.

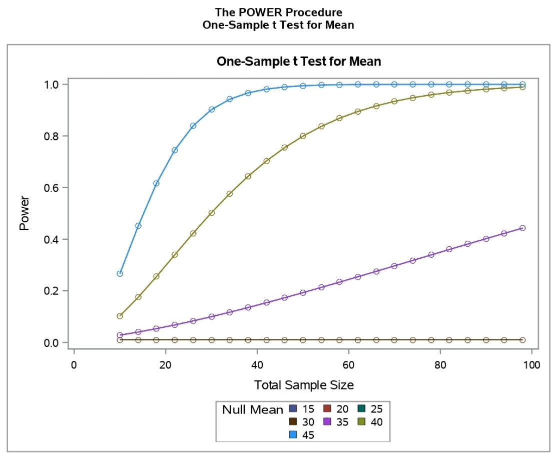
3.3 Grafovi jakosti testa

U ovom su odjeljku prikazani grafovi snage testa za nekoliko odabranih distribucija. Pri tome smo izabrali normalnu distribuciju ($skew = 0, kurt = 0$), jednu distribuciju kojoj su koeficijenti asimetrije i spljoštenosti sličniji normalnoj distribuciji ($skew = 0.5, kurt = 0$), te dvije distribucije čiji se koeficijenti asimetrije i spljoštenosti značajnije razlikuju od normalne distribucije ($skew = -2, kurt = 15$ i $skew = 2, kurt = 12$).

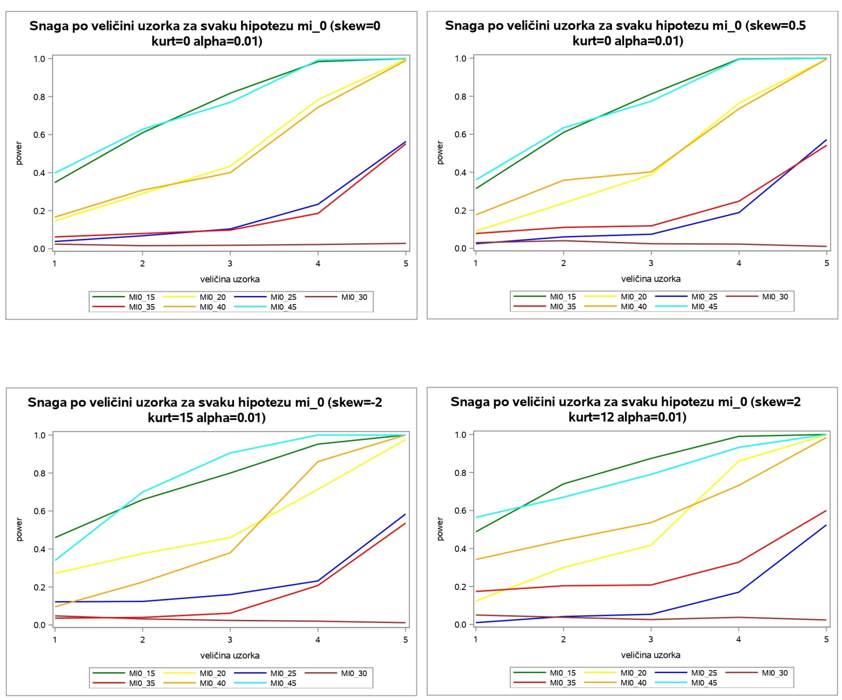
Na y osi nalazi se snaga testa, a na x osi nalazi se duljina uzorka. Pri tome 1 na x osi označava duljinu uzorka 10, sve redom do 5 što označava duljinu uzorka 100.
Grafovi su grupirani s obzirom na razinu značajnosti α.
Također je za usporedbu prikazan i graf snage testa dobiven PROC POWER procedurom.

Možemo uočiti da se jakost testa na grafovima (u odjeljcima 3.3.1 i 3.3.2) koje smo dobili Monte Carlo simulacijama ponaša slično kao jakost testa na grafu iz procedure PROC POWER. Također se uočava da grafovi jakosti testa za normalnu distribuciju i distribuciju sa *skewness=0.5* i *kurtosis=0* više nalikuju jedan drugome, a da se druga dva grafa značajnije od njih razlikuju (kod obe razine značajnosti).

3.3.1 Grafovi za $\alpha = 0.01$

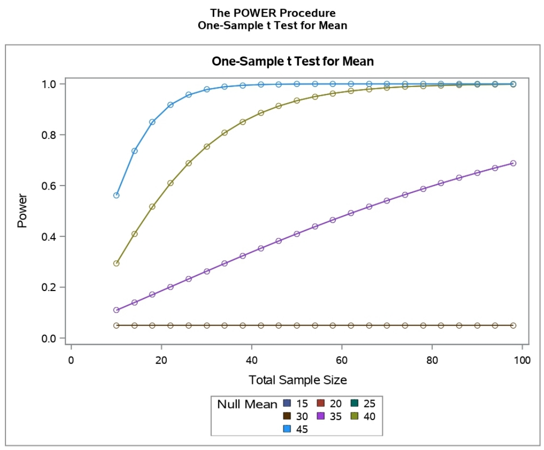


Slika 15: Graf snage testa dobiven PROC POWER procedurom

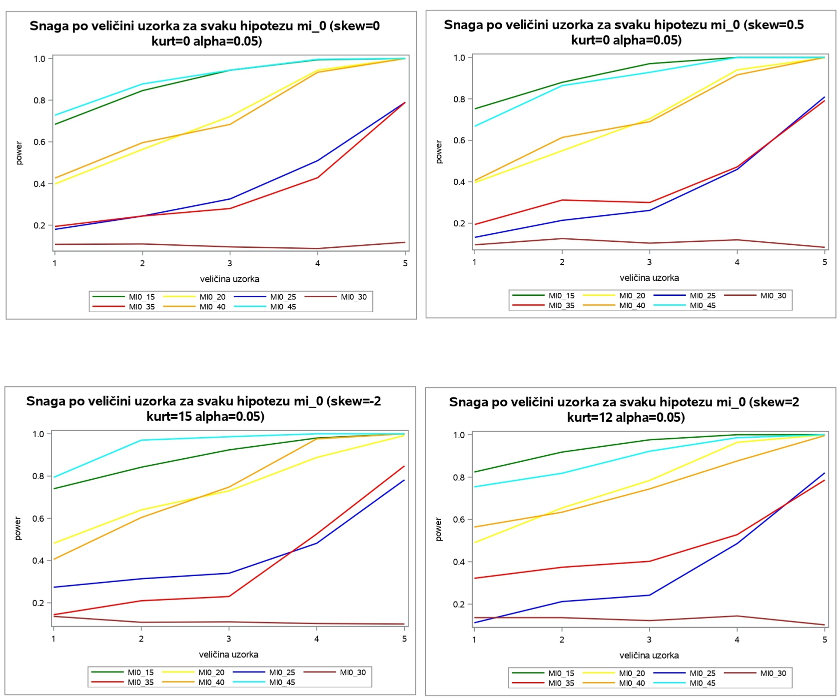


Slika 16: Graf snage za odabrane distribucije

3.3.2 Grafovi za $\alpha = 0.05$



Slika 17: Graf snage testa dobiven PROC POWER procedurom



Slika 18: Graf snage za odabrane distribucije

3.4 Uprosječeni rezultati

S obzirom da u cijeloj studiji radimo s 46 različitih distribucija, radi preglednosti i sažimanja rezultata, u ovom poglavlju iznosimo vrijednosti dobivene uprosječivanjem po svim distribucijama.

Priloženi su:

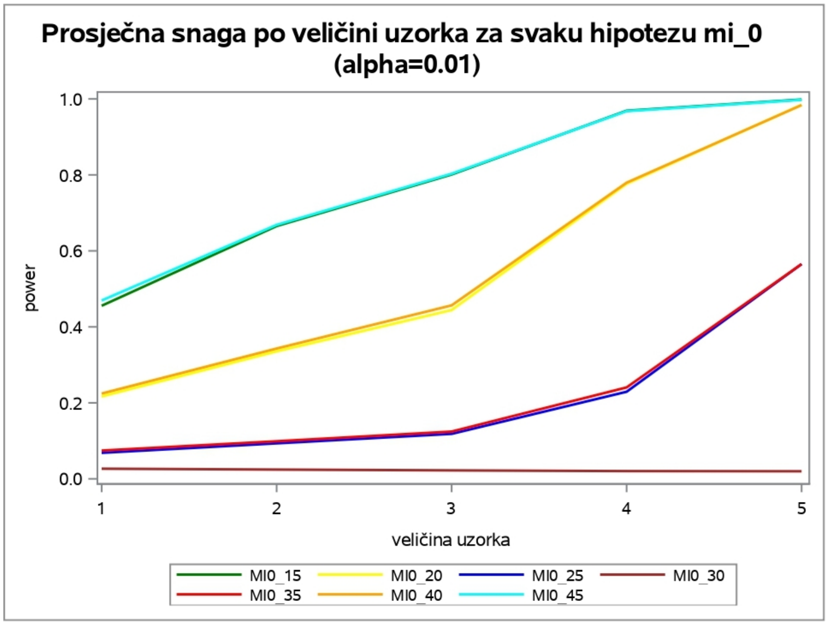
- tablice proporcija uzoraka za koje je odbačena H_0 za obe razine značajnosti $\alpha = 0.01$ i 0.05; retci predstavljaju duljine uzoraka (1 predstavlja duljinu 10, redom do 5 koji predstavlja duljinu uzoraka 100), a stupci predstavljaju μ_0 u nultoj hipotezi testa $H_0 : \mu = \mu_0$ (za svih 7 mogućnosti za μ_0)
- grafovi jakosti testa za svaku razinu značajnosti; gdje je ponovo na x-osi duljina uzorka s oznakama 1 za duljinu 10, sve do 5 za duljinu 100 te s jakosti na y osi

Obs	MI0_15	MI0_20	MI0_25	MI0_30	MI0_35	MI0_40	MI0_45
1	0.45557	0.21687	0.06839	0.026696	0.07439	0.22448	0.46939
2	0.66535	0.33557	0.09339	0.024391	0.09891	0.34296	0.66843
3	0.80109	0.44430	0.11835	0.022217	0.12439	0.45657	0.80304
4	0.96887	0.77648	0.22922	0.020391	0.24057	0.77952	0.96778
5	0.99835	0.98435	0.56530	0.019913	0.56526	0.98378	0.99752

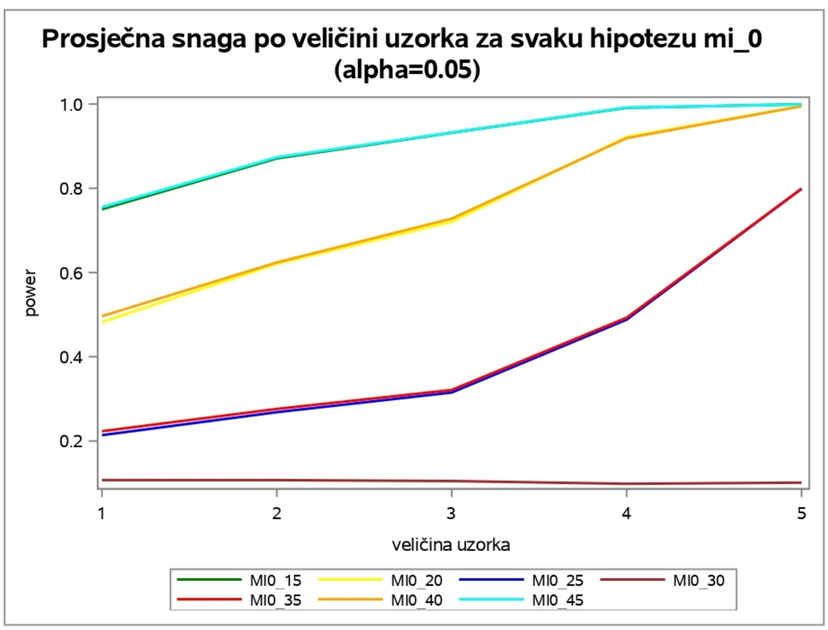
Slika 19: Tablica proporcija, uprosječena po distribucijama za $\alpha = 0.01$

Obs	MI0_15	MI0_20	MI0_25	MI0_30	MI0_35	MI0_40	MI0_45
1	0.75022	0.48213	0.21383	0.10717	0.22317	0.49630	0.75496
2	0.87109	0.62091	0.26839	0.10713	0.27609	0.62396	0.87361
3	0.93200	0.72078	0.31509	0.10487	0.32113	0.72804	0.93235
4	0.99117	0.92187	0.48813	0.09839	0.49274	0.91909	0.99174
5	0.99957	0.99500	0.79909	0.10113	0.79883	0.99500	0.99913

Slika 20: Tablica proporcija, uprosječena po distribucijama za $\alpha = 0.05$



Slika 21: Graf jakosti testa, uprosječen po distribucijama za $\alpha = 0.05$



Slika 22: Graf jakosti testa, uprosječen po distribucijama za $\alpha = 0.05$

4 Primjena izvedenih tablica

U posljednjem dijelu ovog projekta cilj nam je primjeniti tablice dobivene Monte Carlo simulacija za testiranje hipoteze $H_0 : \mu = 45$ u odnosu na $H_1 : \mu \neq 45$ za varijablu x u *dataset-u pills efron*. Radi se o 24 podatka o vremenu otapanja lijeka za 24 nasumično odabrane tablete.

Zanima nas kolika je veličina uzorka potrebna da bi se nulta hipoteza odbacila na razini statističke značajnosti α=0.01, a kolika na razini α=0.05 uz snagu testa od otprilike 0.80.

Problemu smo pristupile na sljedeći način.

1. Analizirale smo uzoračku distribuciju. Pozivom procedure PROC MEANS dobile smo aritmetičku sredinu, uzoračku devijaciju te procjene koeficijenata asimetrije i spljoštenosti za uzorak.

The MEANS Procedure

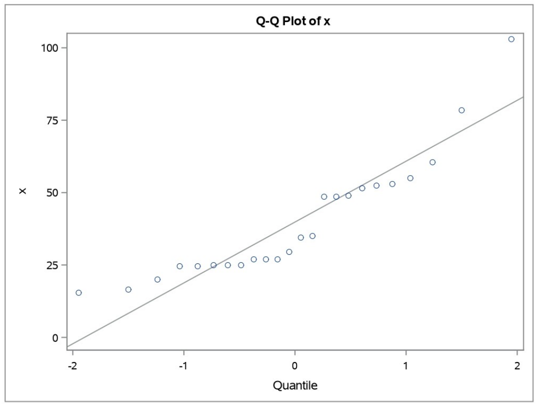
Analysis Variable : x				
Mean	Std Dev	Skewness	Kurtosis	t Value
39.8333333	21.0169014	1.3821210	2.2475124	9.29

Slika 23: Rezultati PROC MEANS procedure

Pozivom procedure PROC TTEST dobile smo i usporedbu uzoračke distribucije s normalnom, te bismo na temelju qq plota odbacile pretpostavku da uzorak dolazi iz normalne distribucije. PROC TTEST nam također vraća i vrijednost t statistike i p-vrijednost dvostranog t testa za jedan uzorak, na temelju kojih ne bismo odbacile nultu hipotezu $H_0 : \mu = 45$ niti na razini značajnost 0.05 niti na razini značajnosti 0.01.

The TTEST Procedure

Variable: x



Slika 24: QQ plot za uzorak

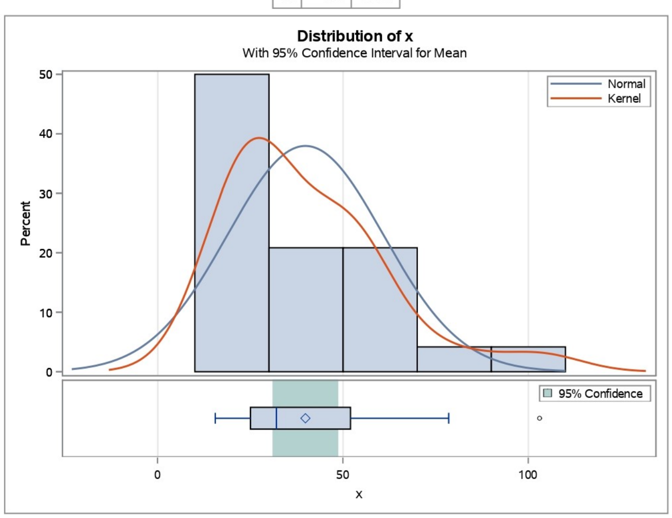
The TTEST Procedure

Variable: x

N	Mean	Std Dev	Std Err	Minimum	Maximum
24	39.8333	21.0169	4.2901	15.5000	103.0

Mean	95% CL Mean		Std Dev	95% CL Std Dev	
39.8333	30.9587	48.7080	21.0169	16.3346	29.4817

DF	t Value	Pr > |t|
23	-1.20	0.2407



Slika 25: Rezultati PROC TTEST procedure

2. Zatim smo od svih distribucija izabrale dvije zadane kombinacijom koeficijenata asimetrije i spljoštenosti koji su najsličniji uzoračkim koeficijentima asimetrije i spljoštenosti. Radi se o distribucijama za koje je *skewness = 1.5, kurtosis = 3* i *skewness = 1, kurtosis = 3.* Fokusirale smo se stoga na retke u tablicama koji odgovaraju navedenim distribucijama (retci 33 i 38).

3. Kako bismo pronašli veličinu uzorka koja za zadane razine značajnosti osigurava snagu testa otprilike 0.80, promatrale smo već spomenute retke u tablicama proporcija uzoraka za koje smo odbacili H_0 i to po veličinama uzorka, uz fiksiran $\mu_0 = 45$.

   Prvo promatramo $\alpha = 0.01$ i distribuciju sa *skewness*=1 i *kurtosis*=3.
   Proporcije za $\mu_0 = 45$ su sljedeće: za n = 10 imamo 0.478, za n = 15 imamo 0.670, za n = 20 imamo 0.774 te za n = 40 imamo 0.960. Dakle, tražena je veličina uzorka između 20 i 40, pa krećemo od 21.
   Ponovo pokrećemo kod za n = 21, 22 i 23 te promatramo redak 33 u novodobivenim tablicama proporcija.

   $$\text{n} = 21 \to 0.784$$
   $$\text{n} = 22 \to 0.772$$
   $$\text{n} = 23 \to 0.824$$

   Dakle, duljina uzorka mora biti barem 23.

   Sada promatramo $\alpha = 0.01$ i distribuciju sa *skewness*=1.5 i *kurtosis*=3.
   Proporcije za $\mu_0 = 45$ su sljedeće: za n = 10 imamo 0.476, za n = 15 imamo 0.600, za n = 20 imamo 0.752 te za n = 40 imamo 0.948. Dakle, tražena je veličina uzorka između 20 i 40, pa krećemo od 21.
   Ponovo pokrećemo kod za n = 21, 22, 23 i 24 te promatramo redak 38 u novodobivenim tablicama proporcija.

   $$\text{n} = 21 \to 0.796$$
   $$\text{n} = 22 \to 0.752$$
   $$\text{n} = 23 \to 0.770$$
   $$\text{n} = 24 \to 0.816$$

   Dakle, duljina uzorka mora biti barem 24.

Promatramo $\alpha = 0.05$ i distribuciju sa *skewness*=1 i *kurtosis*=3.
Proporcije za $\mu_0 = 45$ su sljedeće: za n = 10 imamo 0.730 te za n = 15 imamo 0.874. Dakle, tražena je veličina uzorka između 10 i 15, pa krećemo od 11.
Ponovo pokrećemo kod za n = 11, 12, 13 i 14 te promatramo redak 33 u novodobivenim tablicama proporcija.

$$\mathrm{n} = 11 \rightarrow 0.716$$
$$\mathrm{n} = 12 \rightarrow 0.788$$
$$\mathrm{n} = 13 \rightarrow 0.784$$
$$\mathrm{n} = 14 \rightarrow 0.828$$

Dakle, duljina uzorka mora biti barem 14.

Promatramo $\alpha = 0.05$ i distribuciju sa *skewness*=1.5 i *kurtosis*=3.
Proporcije za $\mu_0 = 45$ su sljedeće: za n = 10 imamo 0.730, za n = 15 imamo 0.800. Dakle, tražena je veličina uzorka između 10 i 15, pa krećemo od 11.
Ponovo pokrećemo kod za n = 11, 12, 13 i 14 te promatramo redak 38 u novodobivenim tablicama proporcija.

$$\mathrm{n} = 11 \rightarrow 0.740$$
$$\mathrm{n} = 12 \rightarrow 0.782$$
$$\mathrm{n} = 13 \rightarrow 0.792$$
$$\mathrm{n} = 14 \rightarrow 0.814$$

Dakle, duljina uzorka mora biti barem 14.

S obzirom na dobivene rezultate i da je duljina uzorka pills podataka 24 mogle bismo zaključiti da je jakost provedenog t-testa barem 0.8.