Results simulation study DelayedGSD

August 10, 2023

1 Rejection rate

Power by method (columns) and scenario (rows): (nominal level 80%)

scenario	n.sim	missing	binding	fixC	ar	method 1	method 2	method 3
1	10000	TRUE	TRUE	FALSE	10	81.00	80.93	80.43
3	10000	TRUE	TRUE	FALSE	5	80.53	80.53	80.14
5	10000	TRUE	TRUE	TRUE	10	80.15	80.35	80.43
7	10000	TRUE	TRUE	TRUE	5	80.08	80.20	80.14
9	10000	TRUE	FALSE	TRUE	10	79.86	80.12	80.26
11	10000	TRUE	FALSE	TRUE	5	79.93	80.04	80.06
13	10000	TRUE	FALSE	FALSE	10	80.50	80.44	80.26
15	10000	TRUE	FALSE	FALSE	5	80.37	80.36	80.06
17	10000	FALSE	TRUE	FALSE	5	80.31	80.30	79.92

Type 1 error by method (columns) and scenario (rows): (nominal level 2.5%)

scenario	n.sim	missing	binding	fixC	ar	method 1	method 2	method 3
2	10000	TRUE	TRUE	FALSE	10	2.42	2.39	2.37
4	10000	TRUE	TRUE	FALSE	5	2.40	2.40	2.35
6	10000	TRUE	TRUE	TRUE	10	2.24	2.22	2.37
8	10000	TRUE	TRUE	TRUE	5	2.32	2.31	2.35
10	10000	TRUE	FALSE	TRUE	10	2.45	2.47	2.57
12	10000	TRUE	FALSE	TRUE	5	2.63	2.64	2.66
14	10000	TRUE	FALSE	FALSE	10	2.53	2.53	2.57
16	10000	TRUE	FALSE	FALSE	5	2.68	2.68	2.66
18	10000	FALSE	TRUE	FALSE	5	2.46	2.46	2.45

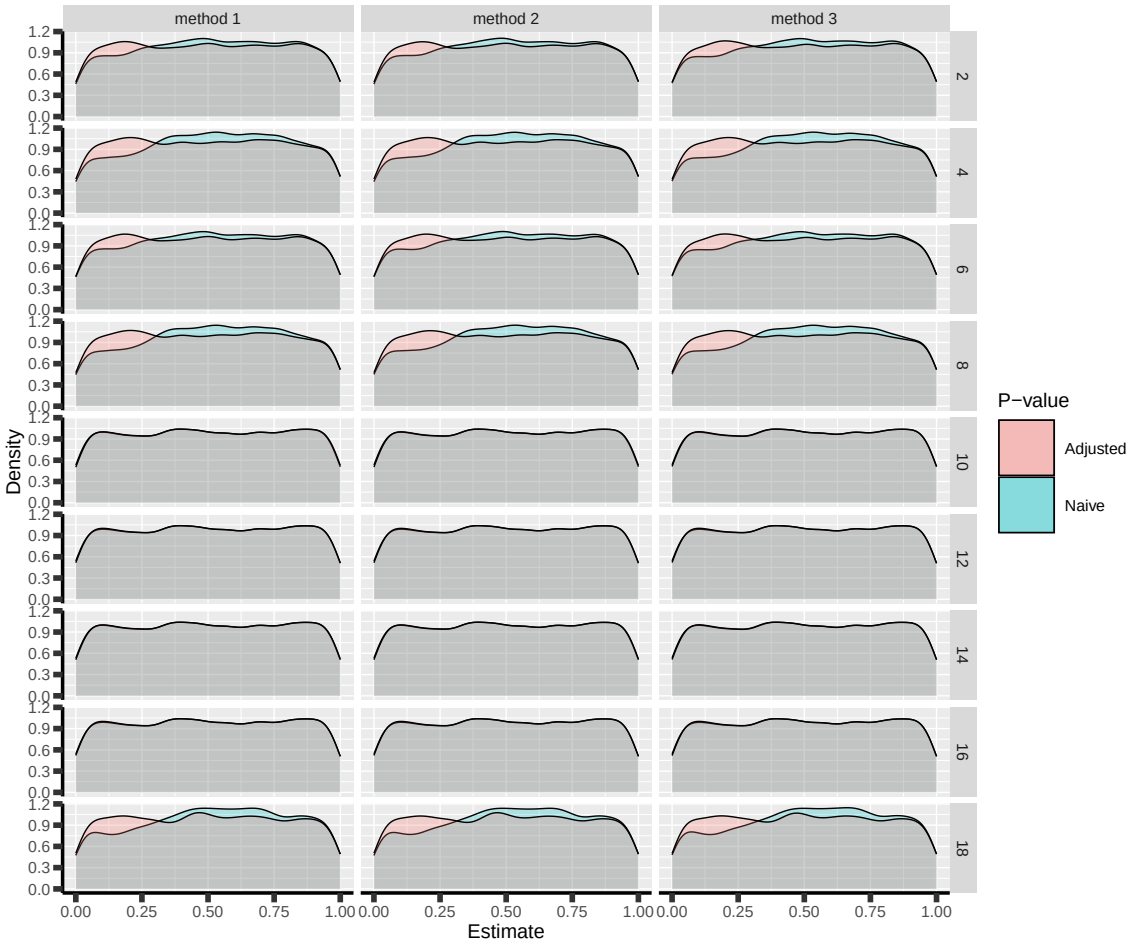

Figure 1: Naive and adjusted p-value distribution over all simulations under the null. Each row correspond to a different scenario

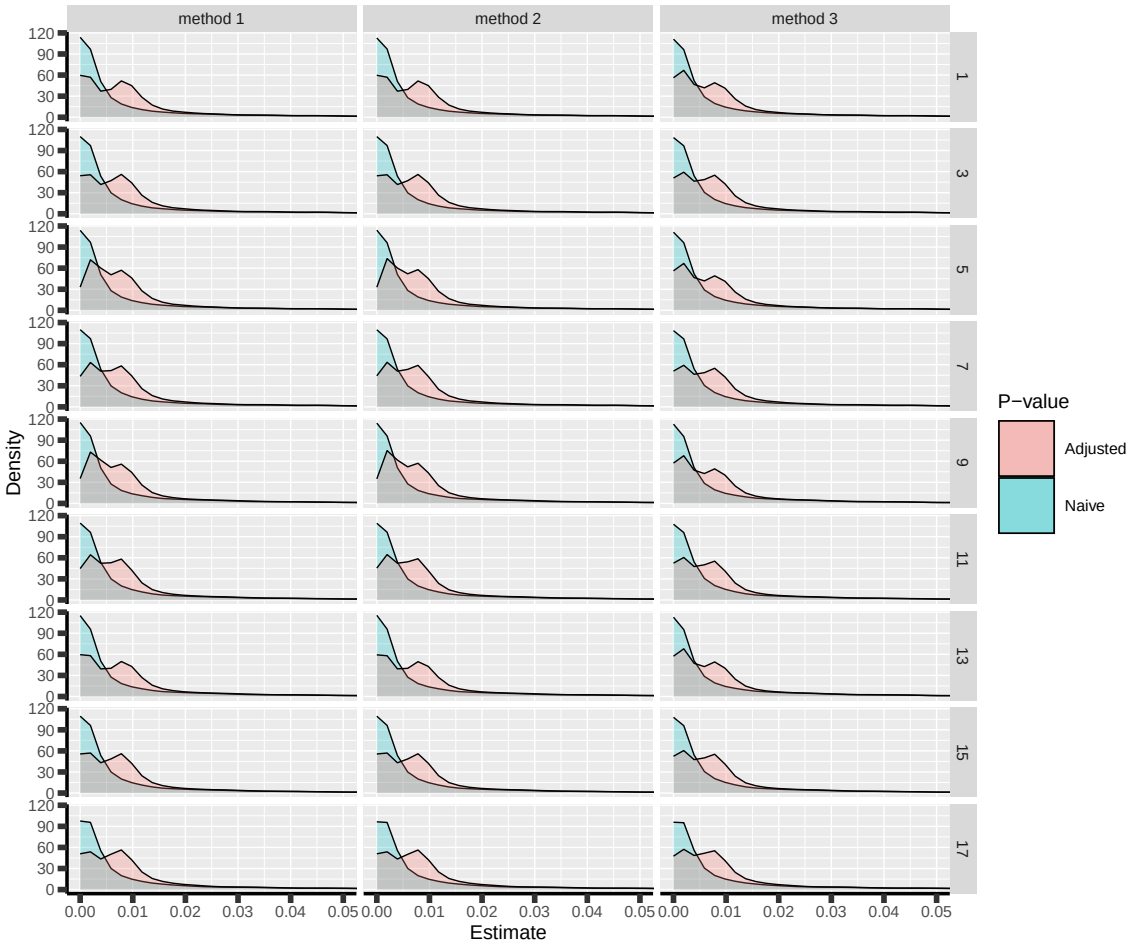

Figure 2: Naive and adjusted p-value distribution over all simulations under the alternative. Each row correspond to a different scenario

2 Conclusion of the trial

Relative frequency of stopping for efficacy/futility at decision/final

- Method 1

	N	missing	hypo	binding	fixC	ar	decision.eff	decision.fut	final.eff	final.fut
1:	10000	TRUE	power	TRUE	FALSE	10	37.79	5.93	43.21	13.1
2:	10000	TRUE	typeI	TRUE	FALSE	10	0.80	71.13	1.62	26.5
3:	10000	TRUE	power	TRUE	FALSE	5	35.74	5.98	44.79	13.5
4:	10000	TRUE	typeI	TRUE	FALSE	5	0.74	69.32	1.66	28.3
5:	10000	TRUE	power	TRUE	TRUE	10	36.94	6.78	43.21	13.1
6:	10000	TRUE	typeI	TRUE	TRUE	10	0.62	71.31	1.62	26.5
7:	10000	TRUE	power	TRUE	TRUE	5	35.29	6.43	44.79	13.5
8:	10000	TRUE	typeI	TRUE	TRUE	5	0.66	69.40	1.66	28.3
9:	10000	TRUE	power	FALSE	TRUE	10	38.05	6.57	41.81	13.6
10:	10000	TRUE	typeI	FALSE	TRUE	10	0.61	0.20	1.84	97.4
11:	10000	TRUE	power	FALSE	TRUE	5	36.35	6.15	43.58	13.9
12:	10000	TRUE	typeI	FALSE	TRUE	5	0.70	0.06	1.93	97.3
13:	10000	TRUE	power	FALSE	FALSE	10	38.69	5.93	41.81	13.6
14:	10000	TRUE	typeI	FALSE	FALSE	10	0.69	0.12	1.84	97.4
15:	10000	TRUE	power	FALSE	FALSE	5	36.79	5.71	43.58	13.9
16:	10000	TRUE	typeI	FALSE	FALSE	5	0.75	0.01	1.93	97.3
17:	10000	FALSE	power	TRUE	FALSE	5	33.98	5.33	46.33	14.4
18:	10000	FALSE	typeI	TRUE	FALSE	5	0.74	67.48	1.72	30.1

Method 2:

	N	missing	hypo	binding	fixC	ar	decision.eff	decision.fut	final.eff	final.fut
1:	10000	TRUE	power	TRUE	FALSE	10	37.85	6.19	43.08	12.9
2:	10000	TRUE	typeI	TRUE	FALSE	10	0.79	71.64	1.60	26.0
3:	10000	TRUE	power	TRUE	FALSE	5	35.77	5.99	44.76	13.5
4:	10000	TRUE	typeI	TRUE	FALSE	5	0.74	69.38	1.66	28.2
5:	10000	TRUE	power	TRUE	TRUE	10	36.69	6.24	43.66	13.4
6:	10000	TRUE	typeI	TRUE	TRUE	10	0.59	69.61	1.63	28.2
7:	10000	TRUE	power	TRUE	TRUE	5	35.02	6.05	45.18	13.8
8:	10000	TRUE	typeI	TRUE	TRUE	5	0.63	68.36	1.68	29.3
9:	10000	TRUE	power	FALSE	TRUE	10	37.85	6.04	42.27	13.8
10:	10000	TRUE	typeI	FALSE	TRUE	10	0.61	0.19	1.86	97.3
11:	10000	TRUE	power	FALSE	TRUE	5	36.18	5.84	43.86	14.1
12:	10000	TRUE	typeI	FALSE	TRUE	5	0.69	0.06	1.95	97.3
13:	10000	TRUE	power	FALSE	FALSE	10	38.70	6.09	41.74	13.5
14:	10000	TRUE	typeI	FALSE	FALSE	10	0.69	0.12	1.84	97.4
15:	10000	TRUE	power	FALSE	FALSE	5	36.82	5.75	43.54	13.9
16:	10000	TRUE	typeI	FALSE	FALSE	5	0.75	0.01	1.93	97.3
17:	10000	FALSE	power	TRUE	FALSE	5	34.03	5.36	46.27	14.3
18:	10000	FALSE	typeI	TRUE	FALSE	5	0.74	67.55	1.72	30.0

Method 3:

	N	missing	hypo	binding	fixC	ar	decision.eff	decision.fut	final.eff	final.fut
1:	10000	TRUE	power	TRUE	FALSE	10	40.58	6.53	39.85	13.0
2:	10000	TRUE	typeI	TRUE	FALSE	10	0.74	68.79	1.63	28.8
3:	10000	TRUE	power	TRUE	FALSE	5	36.54	6.30	43.60	13.6
4:	10000	TRUE	typeI	TRUE	FALSE	5	0.69	68.41	1.66	29.2
5:	10000	TRUE	power	TRUE	TRUE	10	40.58	6.53	39.85	13.0
6:	10000	TRUE	typeI	TRUE	TRUE	10	0.74	68.79	1.63	28.8
7:	10000	TRUE	power	TRUE	TRUE	5	36.54	6.30	43.60	13.6
8:	10000	TRUE	typeI	TRUE	TRUE	5	0.69	68.41	1.66	29.2
9:	10000	TRUE	power	FALSE	TRUE	10	41.34	6.20	38.92	13.5
10:	10000	TRUE	typeI	FALSE	TRUE	10	0.77	0.33	1.80	97.1
11:	10000	TRUE	power	FALSE	TRUE	5	37.71	6.03	42.35	13.9
12:	10000	TRUE	typeI	FALSE	TRUE	5	0.73	0.09	1.93	97.2
13:	10000	TRUE	power	FALSE	FALSE	10	41.34	6.20	38.92	13.5
14:	10000	TRUE	typeI	FALSE	FALSE	10	0.77	0.33	1.80	97.1
15:	10000	TRUE	power	FALSE	FALSE	5	37.71	6.03	42.35	13.9
16:	10000	TRUE	typeI	FALSE	FALSE	5	0.73	0.09	1.93	97.2
17:	10000	FALSE	power	TRUE	FALSE	5	34.65	5.59	45.27	14.5
18:	10000	FALSE	typeI	TRUE	FALSE	5	0.68	66.54	1.77	31.0

3 Bias (True effect: 0.6 under the alternative)

Bias per estimator and method[1]:

	hypo	missing	binding	fixC	ar	biasMLE1	biasMLE2	biasMLE3	biasMUE1	biasMUE2	biasMUE3
1:	power	TRUE	TRUE	FALSE	10	0.013450	0.013150	0.014680	0.005983	0.005659	0.00218
2:	typeI	TRUE	TRUE	FALSE	10	-0.017939	-0.017844	-0.018560	-0.004484	-0.004412	-0.00508
3:	power	TRUE	TRUE	FALSE	5	0.022570	0.022551	0.023584	0.010450	0.010477	0.00870
4:	typeI	TRUE	TRUE	FALSE	5	-0.030342	-0.030312	-0.030651	-0.011844	-0.011798	-0.01238
5:	power	TRUE	TRUE	TRUE	10	0.013450	0.014032	0.014680	0.001094	0.001687	0.00217
6:	typeI	TRUE	TRUE	TRUE	10	-0.017939	-0.018711	-0.018560	-0.005373	-0.006062	-0.00508
7:	power	TRUE	TRUE	TRUE	5	0.022570	0.023089	0.023584	0.007878	0.008275	0.00870
8:	typeI	TRUE	TRUE	TRUE	5	-0.030342	-0.030850	-0.030651	-0.012252	-0.012829	-0.01238
9:	power	TRUE	FALSE	TRUE	10	0.014326	0.014903	0.015285	0.037532	0.035615	0.03135
10:	typeI	TRUE	FALSE	TRUE	10	0.000186	0.000192	0.000511	0.000991	0.000981	0.00263
11:	power	TRUE	FALSE	TRUE	5	0.023657	0.024021	0.024379	0.042787	0.041614	0.04039
12:	typeI	TRUE	FALSE	TRUE	5	0.000912	0.000853	0.001008	0.001112	0.001062	0.00136
13:	power	TRUE	FALSE	FALSE	10	0.014326	0.014160	0.015285	0.036631	0.037167	0.03139
14:	typeI	TRUE	FALSE	FALSE	10	0.000186	0.000186	0.000511	0.000793	0.000783	0.00264
15:	power	TRUE	FALSE	FALSE	5	0.023657	0.023651	0.024379	0.041744	0.041949	0.04040
16:	typeI	TRUE	FALSE	FALSE	5	0.000912	0.000912	0.001008	0.000964	0.000962	0.00137
17:	power	FALSE	TRUE	FALSE	5	0.022836	0.022775	0.023807	0.011971	0.011956	0.01001
18:	typeI	FALSE	TRUE	FALSE	5	-0.029516	-0.029448	-0.029915	-0.011048	-0.011005	-0.01162

Median bias [2] per estimator and method:

	hypo	missing	binding	fixC	ar	mbiasMLE1	mbiasMLE2	mbiasMLE3	mbiasMUE1	mbiasMUE2	mbiasMUE3
1:	power	TRUE	TRUE	FALSE	10	0.0261	0.0260	0.0301	-0.0024	-0.0025	-0.0054
2:	typeI	TRUE	TRUE	FALSE	10	-0.0173	-0.0170	-0.0202	0.0011	0.0009	-0.0001
3:	power	TRUE	TRUE	FALSE	5	0.0405	0.0405	0.0432	-0.0034	-0.0033	-0.0053
4:	typeI	TRUE	TRUE	FALSE	5	-0.0330	-0.0329	-0.0345	0.0007	0.0007	0.0008
5:	power	TRUE	TRUE	TRUE	10	0.0261	0.0265	0.0301	-0.0105	-0.0101	-0.0054
6:	typeI	TRUE	TRUE	TRUE	10	-0.0173	-0.0197	-0.0202	0.0011	-0.0006	-0.0001
7:	power	TRUE	TRUE	TRUE	5	0.0405	0.0407	0.0432	-0.0077	-0.0065	-0.0053
8:	typeI	TRUE	TRUE	TRUE	5	-0.0330	-0.0346	-0.0345	0.0007	0.0009	0.0008
9:	power	TRUE	FALSE	TRUE	10	0.0326	0.0332	0.0327	0.0390	0.0345	0.0277
10:	typeI	TRUE	FALSE	TRUE	10	-0.0009	-0.0009	-0.0009	-0.0008	-0.0008	0.0014
11:	power	TRUE	FALSE	TRUE	5	0.0462	0.0459	0.0489	0.0338	0.0315	0.0294
12:	typeI	TRUE	FALSE	TRUE	5	-0.0009	-0.0010	-0.0009	-0.0008	-0.0010	0.0003
13:	power	TRUE	FALSE	FALSE	10	0.0326	0.0324	0.0327	0.0390	0.0403	0.0277
14:	typeI	TRUE	FALSE	FALSE	10	-0.0009	-0.0009	-0.0009	-0.0008	-0.0008	0.0014
15:	power	TRUE	FALSE	FALSE	5	0.0462	0.0464	0.0489	0.0337	0.0342	0.0294
16:	typeI	TRUE	FALSE	FALSE	5	-0.0009	-0.0009	-0.0009	-0.0008	-0.0008	0.0003
17:	power	FALSE	TRUE	FALSE	5	0.0383	0.0383	0.0400	-0.0026	-0.0025	-0.0047
18:	typeI	FALSE	TRUE	FALSE	5	-0.0329	-0.0327	-0.0353	0.0044	0.0044	0.0035

[1] e.g. `biasMLE1` mixed model estimator (treatment effect), method 1 (boundaries)

[2] Relative frequency at which the estimate is greater than the truth minus 0.5

4 Distribution of the estimates

Distribution of the estimates:

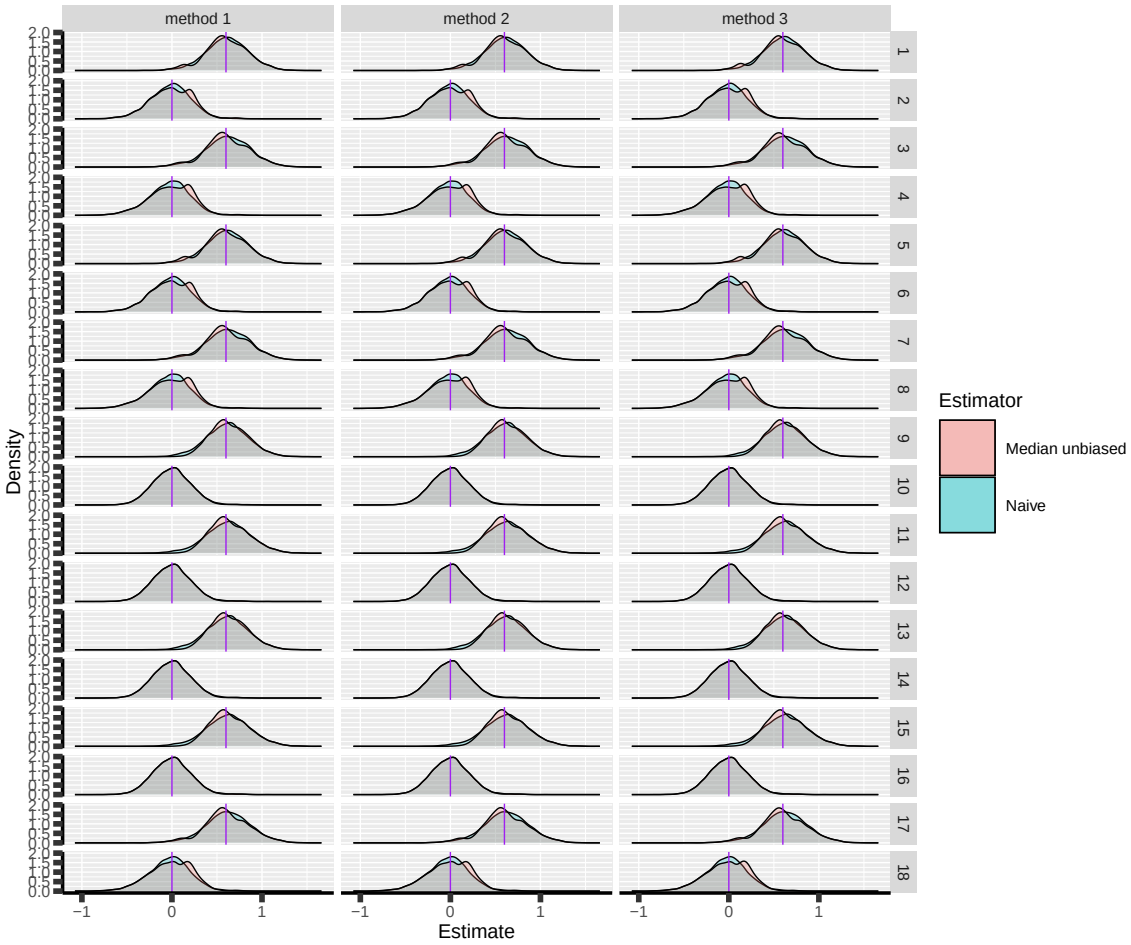

Figure 3: Naive and Median unbiased estimate distribution over all simulations. Each row correspond to a different scenario

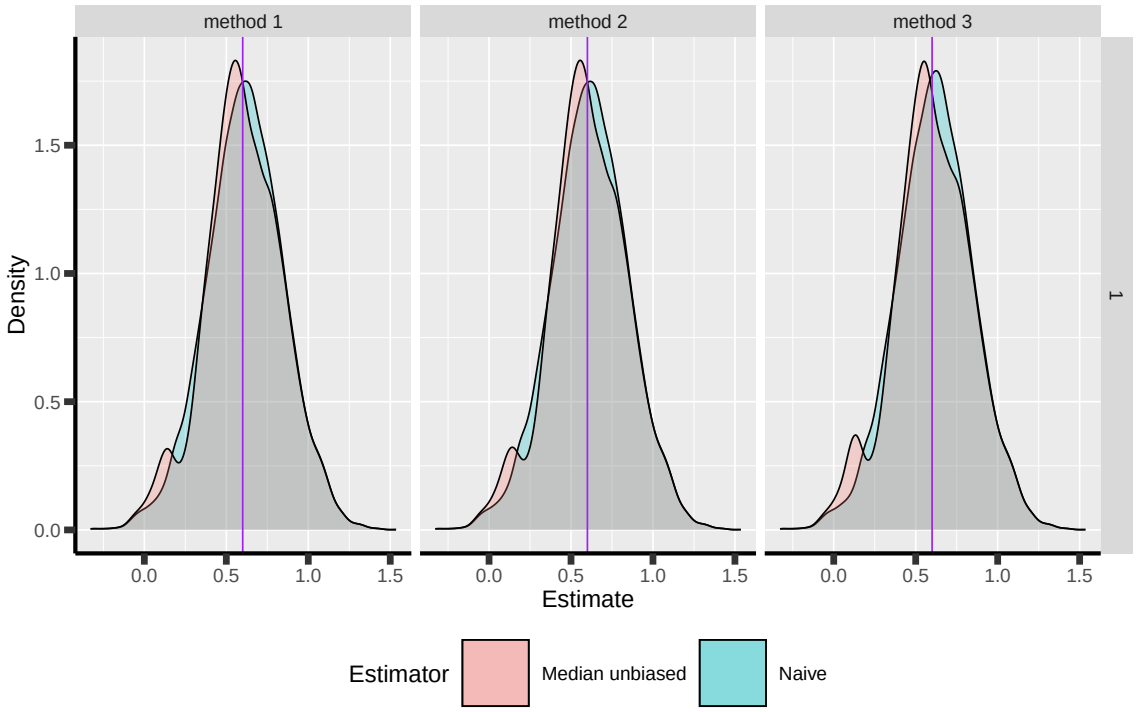

Figure 4: Same but specific to scenario 1

Distribution of the median unbiased estimate conditional to the stage:

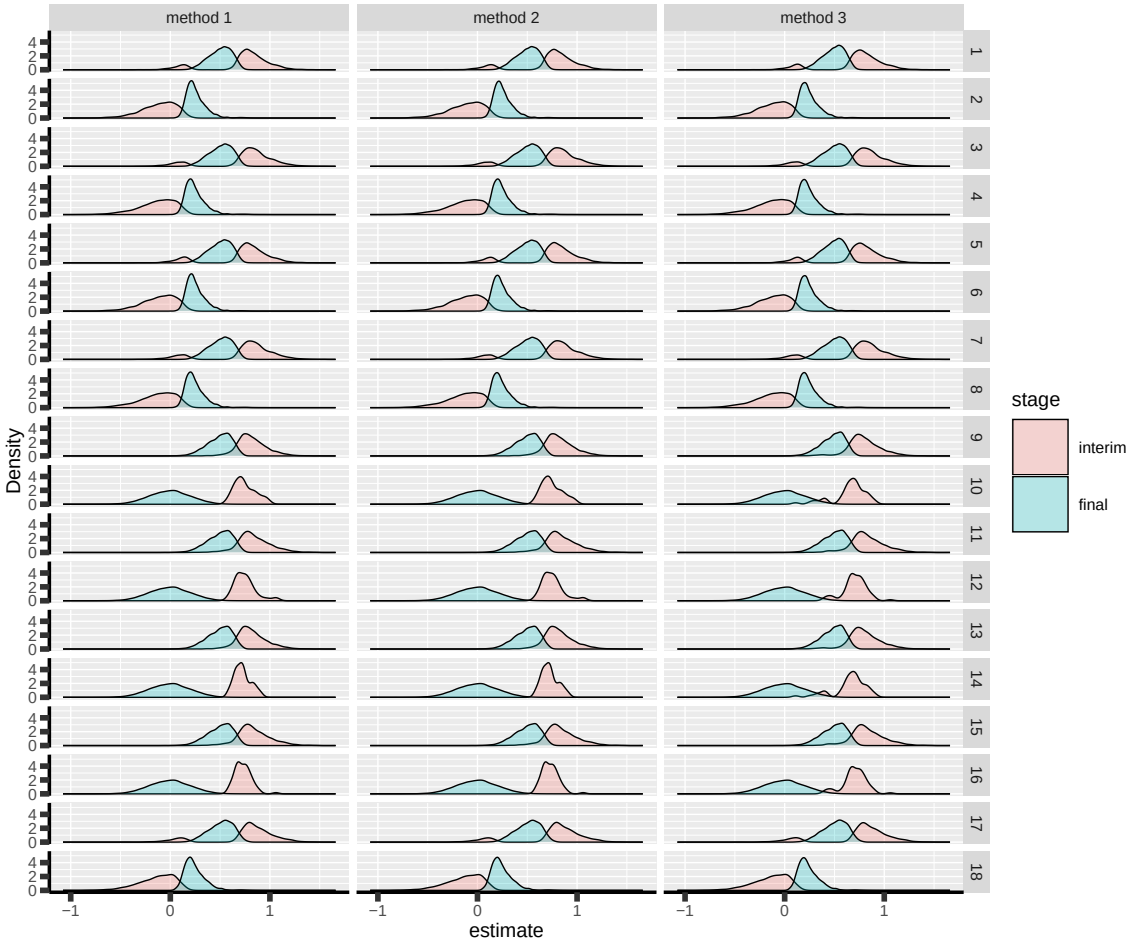

Figure 5: Median unbiased estimate distribution conditional to the stage. Each row correspond to a different scenario.

5 Special cases

Reason for stopping (efficacy, futility, Imax reached), continuing the trial (decreasing information, no boundary crossed), or concluding (stop for futility at interim):

	scenario	1	2	3	4	5	6	7	8
reason	method								
decreasing information	1	0	0	1	1	0	0	1	1
	2	0	0	1	1	0	0	1	1
	3	0	0	1	1	0	0	1	1
efficacy	1	3739	81	3573	74	3739	81	3573	74
	2	3744	81	3576	74	3718	79	3545	71
	3	4165	108	3721	82	4165	108	3721	82
futility	1	632	7111	599	6932	632	7111	599	6932
	2	659	7161	600	6938	574	6940	562	6828
	3	545	6844	563	6828	545	6844	563	6828
Imax reached	1	1	1	0	0	1	1	0	0
	2	1	1	0	0	1	1	0	0
	3	1	1	0	0	1	1	0	0
no boundary crossed	1	5628	2807	5828	2994	5628	2807	5828	2994
	2	5596	2757	5824	2988	5707	2980	5893	3101
	3	5289	3047	5716	3090	5289	3047	5716	3090
stop for futility at interim	1	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0
	3	11	1	2	0	11	1	2	0

	scenario	9	10	11	12	13	14	15	16	17
reason	method									
efficacy	1	3849	81	3680	76	3849	81	3680	76	3396
	2	3829	80	3661	75	3850	81	3683	76	3400
	3	4238	110	3831	82	4238	110	3831	82	3528
futility	1	613	7122	570	6945	613	7122	570	6945	535	6
	2	560	6975	541	6838	629	7164	574	6950	539	6
	3	516	6890	543	6842	516	6890	543	6842	496	6
no boundary crossed	1	5538	2797	5750	2979	5538	2797	5750	2979	6069	3
	2	5611	2945	5798	3087	5521	2755	5743	2974	6061	3
	3	5246	3000	5626	3076	5246	3000	5626	3076	5976	3
stop for futility at interim	1	0	0	0	0	0	0	0	0	0	
	2	0	0	0	0	0	0	0	0	0	
	3	8	0	0	0	8	0	0	0	1	

6 Reversal probability

Percentage of time we observe a reversal:

	N	hypo	missing	ar	binding	fixC	fu2eff_1	fu2eff_2	fu2eff_3	eff2fu_1	eff2fu_2	eff2fu_3
1:	10000	power	TRUE	10	TRUE	FALSE	0.57	0.61	0	0.17	0.20	1.07
2:	10000	typeI	TRUE	10	TRUE	FALSE	0.10	0.09	0	0.11	0.11	0.34
3:	10000	power	TRUE	5	TRUE	FALSE	0.08	0.08	0	0.07	0.07	0.67
4:	10000	typeI	TRUE	5	TRUE	FALSE	0.02	0.02	0	0.02	0.02	0.13
5:	10000	power	TRUE	10	TRUE	TRUE	0.22	0.16	0	0.67	0.65	1.07
6:	10000	typeI	TRUE	10	TRUE	TRUE	0.02	0.01	0	0.21	0.21	0.34
7:	10000	power	TRUE	5	TRUE	TRUE	0.02	0.02	0	0.46	0.45	0.67
8:	10000	typeI	TRUE	5	TRUE	TRUE	0.00	0.00	0	0.08	0.08	0.13
9:	10000	power	TRUE	10	FALSE	TRUE	0.14	0.11	0	0.58	0.55	1.04
10:	10000	typeI	TRUE	10	FALSE	TRUE	0.00	0.00	0	0.20	0.19	0.33
11:	10000	power	TRUE	5	FALSE	TRUE	0.01	0.01	0	0.46	0.44	0.60
12:	10000	typeI	TRUE	5	FALSE	TRUE	0.00	0.00	0	0.06	0.06	0.09
13:	10000	power	TRUE	10	FALSE	FALSE	0.41	0.42	0	0.21	0.22	1.04
14:	10000	typeI	TRUE	10	FALSE	FALSE	0.00	0.00	0	0.12	0.12	0.33
15:	10000	power	TRUE	5	FALSE	FALSE	0.03	0.03	0	0.04	0.04	0.60
16:	10000	typeI	TRUE	5	FALSE	FALSE	0.00	0.00	0	0.01	0.01	0.09
17:	10000	power	FALSE	5	TRUE	FALSE	0.06	0.07	0	0.04	0.04	0.63
18:	10000	typeI	FALSE	5	TRUE	FALSE	0.01	0.01	0	0.01	0.01	0.12

7 Logical consistency of p-values/CIs

7.1 Mismatch p-value / boundaries

When concluding for futility:

	hypo	missing	ar	binding	fixC	method 1	method 2	method 3
1:	power	TRUE	10	TRUE	FALSE	0	0	0
2:	typeI	TRUE	10	TRUE	FALSE	0	0	0
3:	power	TRUE	5	TRUE	FALSE	0	0	0
4:	typeI	TRUE	5	TRUE	FALSE	0	0	0
5:	power	TRUE	10	TRUE	TRUE	0	0	0
6:	typeI	TRUE	10	TRUE	TRUE	0	0	0
7:	power	TRUE	5	TRUE	TRUE	0	0	0
8:	typeI	TRUE	5	TRUE	TRUE	0	0	0
9:	power	TRUE	10	FALSE	TRUE	0	0	0
10:	typeI	TRUE	10	FALSE	TRUE	0	0	0
11:	power	TRUE	5	FALSE	TRUE	0	0	0
12:	typeI	TRUE	5	FALSE	TRUE	0	0	0
13:	power	TRUE	10	FALSE	FALSE	0	0	0
14:	typeI	TRUE	10	FALSE	FALSE	0	0	0
15:	power	TRUE	5	FALSE	FALSE	0	0	0
16:	typeI	TRUE	5	FALSE	FALSE	0	0	0
17:	power	FALSE	5	TRUE	FALSE	0	0	0
18:	typeI	FALSE	5	TRUE	FALSE	0	0	0

When concluding for efficacy:

	hypo	missing	ar	binding	fixC	method 1	method 2	method 3
1:	power	TRUE	10	TRUE	FALSE	0	0	0
2:	typeI	TRUE	10	TRUE	FALSE	0	0	0
3:	power	TRUE	5	TRUE	FALSE	0	0	0
4:	typeI	TRUE	5	TRUE	FALSE	0	0	0
5:	power	TRUE	10	TRUE	TRUE	0	0	0
6:	typeI	TRUE	10	TRUE	TRUE	0	0	0
7:	power	TRUE	5	TRUE	TRUE	0	0	0
8:	typeI	TRUE	5	TRUE	TRUE	0	0	0
9:	power	TRUE	10	FALSE	TRUE	0	0	0
10:	typeI	TRUE	10	FALSE	TRUE	0	0	0
11:	power	TRUE	5	FALSE	TRUE	0	0	0
12:	typeI	TRUE	5	FALSE	TRUE	0	0	0
13:	power	TRUE	10	FALSE	FALSE	0	0	0
14:	typeI	TRUE	10	FALSE	FALSE	0	0	0
15:	power	TRUE	5	FALSE	FALSE	0	0	0
16:	typeI	TRUE	5	FALSE	FALSE	0	0	0
17:	power	FALSE	5	TRUE	FALSE	0	0	0
18:	typeI	FALSE	5	TRUE	FALSE	0	0	0

7.2 Mismatch confidence intervals / boundaries

When concluding for futility:

	hypo	missing	ar	binding	fixC	method 1	method 2	method 3
1:	power	TRUE	10	TRUE	FALSE	0	0	0.0000000
2:	typeI	TRUE	10	TRUE	FALSE	0	0	0.0000000
3:	power	TRUE	5	TRUE	FALSE	0	0	0.0000000
4:	typeI	TRUE	5	TRUE	FALSE	0	0	0.0000000
5:	power	TRUE	10	TRUE	TRUE	0	0	0.0000000
6:	typeI	TRUE	10	TRUE	TRUE	0	0	0.0000000
7:	power	TRUE	5	TRUE	TRUE	0	0	0.0000000
8:	typeI	TRUE	5	TRUE	TRUE	0	0	0.0000000
9:	power	TRUE	10	FALSE	TRUE	0	0	7.8484438
10:	typeI	TRUE	10	FALSE	TRUE	0	0	0.1747533
11:	power	TRUE	5	FALSE	TRUE	0	0	4.1322314
12:	typeI	TRUE	5	FALSE	TRUE	0	0	0.0821946
13:	power	TRUE	10	FALSE	FALSE	0	0	7.8484438
14:	typeI	TRUE	10	FALSE	FALSE	0	0	0.1747533
15:	power	TRUE	5	FALSE	FALSE	0	0	4.1322314
16:	typeI	TRUE	5	FALSE	FALSE	0	0	0.0821946
17:	power	FALSE	5	TRUE	FALSE	0	0	0.0000000
18:	typeI	FALSE	5	TRUE	FALSE	0	0	0.0000000

This only occurs for non-binding futility rules and concluding futility, e.g.: #+END$_{\text{SRC}}$
When concluding for efficacy:

	hypo	missing	ar	binding	fixC	method 1	method 2	method 3
1:	power	TRUE	10	TRUE	FALSE	0	0	0
2:	typeI	TRUE	10	TRUE	FALSE	0	0	0
3:	power	TRUE	5	TRUE	FALSE	0	0	0
4:	typeI	TRUE	5	TRUE	FALSE	0	0	0
5:	power	TRUE	10	TRUE	TRUE	0	0	0
6:	typeI	TRUE	10	TRUE	TRUE	0	0	0
7:	power	TRUE	5	TRUE	TRUE	0	0	0
8:	typeI	TRUE	5	TRUE	TRUE	0	0	0
9:	power	TRUE	10	FALSE	TRUE	0	0	0
10:	typeI	TRUE	10	FALSE	TRUE	0	0	0
11:	power	TRUE	5	FALSE	TRUE	0	0	0
12:	typeI	TRUE	5	FALSE	TRUE	0	0	0
13:	power	TRUE	10	FALSE	FALSE	0	0	0
14:	typeI	TRUE	10	FALSE	FALSE	0	0	0
15:	power	TRUE	5	FALSE	FALSE	0	0	0
16:	typeI	TRUE	5	FALSE	FALSE	0	0	0
17:	power	FALSE	5	TRUE	FALSE	0	0	0
18:	typeI	FALSE	5	TRUE	FALSE	0	0	0

7.3 Range of p-values

	missing	binding	fixC	ar	hypo	method 1	method 2	method 3
1:	TRUE	TRUE	FALSE	10	power	[0;0.9147]	[0;0.9147]	[0;0.9147]
2:	TRUE	TRUE	FALSE	10	typeI	[1e-04;0.9999]	[1e-04;0.9999]	[1e-04;0.9999]
3:	TRUE	TRUE	FALSE	5	power	[0;0.9015]	[0;0.9015]	[0;0.9015]
4:	TRUE	TRUE	FALSE	5	typeI	[1e-04;0.9998]	[1e-04;0.9998]	[1e-04;0.9998]
5:	TRUE	TRUE	TRUE	10	power	[7e-04;0.9147]	[7e-04;0.9147]	[0;0.9147]
6:	TRUE	TRUE	TRUE	10	typeI	[0.0016;0.9999]	[0.0016;0.9999]	[1e-04;0.9999]
7:	TRUE	TRUE	TRUE	5	power	[1e-04;0.9015]	[1e-04;0.9015]	[0;0.9015]
8:	TRUE	TRUE	TRUE	5	typeI	[5e-04;0.9998]	[5e-04;0.9998]	[1e-04;0.9998]
9:	TRUE	FALSE	TRUE	10	power	[8e-04;1]	[8e-04;1]	[0;1]
10:	TRUE	FALSE	TRUE	10	typeI	[0.0015;1]	[0.0015;1]	[5e-04;1]
11:	TRUE	FALSE	TRUE	5	power	[1e-04;1]	[1e-04;1]	[0;1]
12:	TRUE	FALSE	TRUE	5	typeI	[6e-04;1]	[5e-04;1]	[2e-04;1]
13:	TRUE	FALSE	FALSE	10	power	[0;1]	[0;1]	[0;1]
14:	TRUE	FALSE	FALSE	10	typeI	[1e-04;1]	[1e-04;1]	[5e-04;1]
15:	TRUE	FALSE	FALSE	5	power	[0;1]	[0;1]	[0;1]
16:	TRUE	FALSE	FALSE	5	typeI	[0;1]	[0;1]	[2e-04;1]
17:	FALSE	TRUE	FALSE	5	power	[0;0.9642]	[0;0.9642]	[0;0.9642]
18:	FALSE	TRUE	FALSE	5	typeI	[0;1]	[0;1]	[3e-04;1]

8 Coverage

Average width of the confidence intervals

```
res2stage.width <- res2stage[decision %in% c("futility","efficacy"),
                             .(N = .N,
                               width.naive = mean(upper_ML-lower_ML, na.rm
    = TRUE),
                               width.MUE = mean(upper_MUE-lower_MUE, na.rm
    = TRUE)),
                             by = c("method.char","missing","binding","
   fixC","ar","hypo")]
res2stage.width[, width.ratio := width.MUE/width.naive]
dcast(res2stage.width, hypo + missing + ar + binding + fixC ~ method.char,
    value.var = "width.ratio")
```

	hypo	missing	ar	binding	fixC	method 1	method 2	method 3
1:	power	FALSE	5	TRUE	FALSE	1.0517981	1.0518066	1.053592
2:	power	TRUE	5	FALSE	FALSE	1.0355785	1.0355525	1.030753
3:	power	TRUE	5	FALSE	TRUE	1.0410966	1.0414270	1.030753
4:	power	TRUE	5	TRUE	FALSE	1.0513207	1.0513607	1.052634
5:	power	TRUE	5	TRUE	TRUE	1.0570088	1.0563598	1.052629

```
 6: power    TRUE 10   FALSE FALSE 1.0469276 1.0468858 1.039428
 7: power    TRUE 10   FALSE  TRUE 1.0634581 1.0625586 1.039438
 8: power    TRUE 10    TRUE FALSE 1.0624494 1.0626858 1.062576
 9: power    TRUE 10    TRUE  TRUE 1.0765867 1.0753692 1.062555
10: typeI   FALSE  5    TRUE FALSE 1.0431774 1.0431218 1.046821
11: typeI    TRUE  5   FALSE FALSE 0.9997886 0.9998440 1.018905
12: typeI    TRUE  5   FALSE  TRUE 0.9996979 0.9996859 1.018905
13: typeI    TRUE  5    TRUE FALSE 1.0416221 1.0415882 1.045180
14: typeI    TRUE  5    TRUE  TRUE 1.0416986 1.0423673 1.045180
15: typeI    TRUE 10   FALSE FALSE 1.0182710 1.0227130 1.049875
16: typeI    TRUE 10   FALSE  TRUE 1.0183637 1.0101640 1.049882
17: typeI    TRUE 10    TRUE FALSE 1.0459447 1.0453954 1.056218
18: typeI    TRUE 10    TRUE  TRUE 1.0461003 1.0478314 1.056215
```

9 Percentage of missing values

Here only for method 1 - values are very similar between different methods:

- `pc.all` percentage of observations with full data
- `pc.missing3` percentage of observations missing the final outcome but with intermediate outcome value and baseline.
- `pc.missing23` percentage of observations with only baseline value

```
    method missing ar  hypo  fixC binding     N   pc.all pc.missing3 pc.missing23
 1:      1    TRUE  5 power FALSE    TRUE 10000 79.52088    9.591086    10.888036
 2:      1    TRUE  5 typeI FALSE    TRUE 10000 79.52088    9.591086    10.888036
 3:      1    TRUE  5 power  TRUE    TRUE 10000 79.52088    9.591086    10.888036
 4:      1    TRUE  5 typeI  TRUE    TRUE 10000 79.52088    9.591086    10.888036
 5:      1    TRUE  5 power  TRUE   FALSE 10000 79.64470    9.441772    10.913523
 6:      1    TRUE  5 typeI  TRUE   FALSE 10000 79.64470    9.441772    10.913523
 7:      1    TRUE  5 power FALSE   FALSE 10000 79.64470    9.441772    10.913523
 8:      1    TRUE  5 typeI FALSE   FALSE 10000 79.64470    9.441772    10.913523
 9:      1   FALSE  5 power FALSE    TRUE 10000 87.78863    6.090240     6.121126
10:      1   FALSE  5 typeI FALSE    TRUE 10000 87.78863    6.090240     6.121126
11:      1    TRUE 10 power FALSE    TRUE 10000 71.59741   13.353880    15.048710
12:      1    TRUE 10 typeI FALSE    TRUE 10000 71.59741   13.353880    15.048710
13:      1    TRUE 10 power  TRUE    TRUE 10000 71.59741   13.353880    15.048710
14:      1    TRUE 10 typeI  TRUE    TRUE 10000 71.59741   13.353880    15.048710
15:      1    TRUE 10 power  TRUE   FALSE 10000 71.79650   13.161615    15.041889
16:      1    TRUE 10 typeI  TRUE   FALSE 10000 71.79650   13.161615    15.041889
17:      1    TRUE 10 power FALSE   FALSE 10000 71.79650   13.161615    15.041889
18:      1    TRUE 10 typeI FALSE   FALSE 10000 71.79650   13.161615    15.041889
```

10 Information

Percentage of information for method 1[3]:

scenario	missing	binding	fixC	ar	interim	decision	final
1	TRUE	TRUE	FALSE	10	54.63712	75.34460	102.69691
2	TRUE	TRUE	FALSE	10	54.63712	74.98217	102.36588
3	TRUE	TRUE	FALSE	5	53.26864	64.03618	102.73604
4	TRUE	TRUE	FALSE	5	53.26864	63.58436	102.37416
5	TRUE	TRUE	TRUE	10	54.63712	75.34460	102.69691
6	TRUE	TRUE	TRUE	10	54.63712	74.98217	102.36588
7	TRUE	TRUE	TRUE	5	53.26864	64.03618	102.73604
8	TRUE	TRUE	TRUE	5	53.26864	63.58436	102.37416
9	TRUE	FALSE	TRUE	10	54.50012	74.96442	102.53821
10	TRUE	FALSE	TRUE	10	54.50012	75.17490	103.12700
11	TRUE	FALSE	TRUE	5	53.15854	63.71662	102.62539
12	TRUE	FALSE	TRUE	5	53.15854	64.60960	103.12516
13	TRUE	FALSE	FALSE	10	54.50012	74.96442	102.53821
14	TRUE	FALSE	FALSE	10	54.50012	75.17490	103.12700
15	TRUE	FALSE	FALSE	5	53.15854	63.71662	102.62539
16	TRUE	FALSE	FALSE	5	53.15854	64.60960	103.12516
17	FALSE	TRUE	FALSE	5	52.06840	63.77019	99.96969
18	FALSE	TRUE	FALSE	5	52.06840	63.21929	99.62860

Similar results for other methods.

[3] average over the reached stages