Stats 506, F18, Problem Set 4

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Question 1

The table of the all-time leader in hits for each birth country is shown below.

Table 1: **The all-time leader in hits for each birth country**

Player	Debut	Country of Birth	Hits
Pete Rose	1963-04-08	USA	4256
Rod Carew	1967-04-11	Panama	3053
Ichiro Suzuki	2001-04-02	Japan	3030
Rafael Palmeiro	1986-09-08	Cuba	3020
Roberto Clemente	1955-04-17	P.R.	3000
Adrian Beltre	1998-06-24	D.R.	2942
Omar Vizquel	1989-04-03	Venezuela	2877
Chili Davis	1981-04-10	Jamaica	2380
Edgar Renteria	1996-05-10	Colombia	2327
Patsy Donovan	1890-04-19	Ireland	2253
Larry Walker	1989-08-16	CAN	2160
Tom Brown	1882-07-06	United Kingdom	1951
Andruw Jones	1996-08-15	Curacao	1933
Vinny Castilla	1991-09-01	Mexico	1884
John Anderson	1894-09-08	Norway	1841
Joe Quinn	1884-04-26	Australia	1797
Elmer Valo	1940-09-22	Czech Republic	1420
Horace Clarke	1965-05-13	V.I.	1230
Shin-Soo Choo	2005-04-21	South Korea	1206
Glenn Hubbard	1978-07-14	Germany	1084
Marvin Benard	1995-09-05	Nicaragua	714
Eddie Ainsmith	1910-08-09	Russia	707
Andre Rodgers	1957-04-16	Bahamas	628
Xander Bogaerts	2013-08-20	Aruba	528
Didi Gregorius	2012-09-05	Netherlands	451
Gerald Young	1987-07-08	Honduras	446
Reno Bertoia	1953-09-22	Italy	425
Yan Gomes	2012-05-17	Brazil	367
Steve Jeltz	1983-07-17	France	367
Tony Solaita	1968-09-16	American Samoa	336
Jack Quinn	1909-04-15	Slovakia	248

Question 2

Part a

The whole output is stored as results_q4a.

The table of Monte Carlo estimates with its standard errors of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho is shown below (sigma = 1).

Table 2: **Monte Carlo estimates (standard errors) of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho**

rho	Method	FDR	FWER	Sensitivity	Specificity
-0.75	BH	0.0446 (0.0009)	0.2383 (0.0043)	0.4921 (0.0020)	0.9967 (0.0001)
-0.75	bonferroni	0.0124 (0.0007)	0.0438 (0.0020)	0.3037 (0.0015)	0.9995 (0.0000)
-0.75	BY	0.0089 (0.0005)	0.0349 (0.0018)	0.2617 (0.0018)	0.9996 (0.0000)
-0.75	holm	0.0127 (0.0007)	0.0456 (0.0021)	0.3062 (0.0015)	0.9995 (0.0000)
-0.50	BH	0.0440 (0.0009)	0.2379 (0.0043)	0.4958 (0.0020)	0.9966 (0.0001)
-0.50	bonferroni	0.0120 (0.0006)	0.0428 (0.0020)	0.3084 (0.0015)	0.9995 (0.0000)
-0.50	BY	0.0080 (0.0005)	0.0334 (0.0018)	0.2694 (0.0018)	0.9996 (0.0000)
-0.50	holm	0.0123 (0.0006)	0.0445 (0.0021)	0.3108 (0.0015)	0.9995 (0.0000)
-0.25	BH	0.0447 (0.0009)	0.2384 (0.0043)	0.5013 (0.0020)	0.9966 (0.0001)
-0.25	bonferroni	0.0134 (0.0007)	0.0460 (0.0021)	0.3117 (0.0015)	0.9995 (0.0000)
-0.25	BY	0.0098 (0.0006)	0.0370 (0.0019)	0.2747 (0.0018)	0.9996 (0.0000)
-0.25	holm	0.0136 (0.0007)	0.0477 (0.0021)	0.3143 (0.0015)	0.9995 (0.0000)
0.00	BH	0.0446 (0.0009)	0.2433 (0.0043)	0.5101 (0.0020)	0.9966 (0.0001)
0.00	bonferroni	0.0116 (0.0006)	0.0419 (0.0020)	0.3187 (0.0015)	0.9995 (0.0000)
0.00	BY	0.0084 (0.0005)	0.0354 (0.0018)	0.2814 (0.0018)	0.9996 (0.0000)
0.00	holm	0.0119 (0.0006)	0.0437 (0.0020)	0.3219 (0.0015)	0.9995 (0.0000)
0.25	BH	0.0443 (0.0009)	0.2442 (0.0043)	0.5158 (0.0020)	0.9966 (0.0001)
0.25	bonferroni	0.0113 (0.0006)	0.0430 (0.0020)	0.3237 (0.0015)	0.9995 (0.0000)
0.25	BY	0.0084 (0.0005)	0.0352 (0.0018)	0.2870 (0.0018)	0.9996 (0.0000)
0.25	holm	0.0117 (0.0006)	0.0449 (0.0021)	0.3268 (0.0015)	0.9995 (0.0000)
0.50	BH	0.0437 (0.0009)	0.2296 (0.0042)	0.4801 (0.0020)	0.9968 (0.0001)
0.50	bonferroni	0.0129 (0.0007)	0.0426 (0.0020)	0.2975 (0.0015)	0.9995 (0.0000)
0.50	BY	0.0081 (0.0005)	0.0321 (0.0018)	0.2547 (0.0018)	0.9996 (0.0000)
0.50	holm	0.0133 (0.0007)	0.0446 (0.0021)	0.3000 (0.0015)	0.9995 (0.0000)
0.75	BH	0.0472 (0.0009)	0.2633 (0.0044)	0.5310 (0.0020)	0.9963 (0.0001)
0.75	bonferroni	0.0115 (0.0006)	0.0438 (0.0020)	0.3329 (0.0015)	0.9995 (0.0000)
0.75	BY	0.0085 (0.0005)	0.0364 (0.0019)	0.2970 (0.0018)	0.9996 (0.0000)
0.75	holm	0.0116 (0.0006)	0.0451 (0.0021)	0.3356 (0.0015)	0.9995 (0.0000)

Part b

The table of Monte Carlo estimates with its standard errors of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho is shown below (sigma = 0.25).

Table 3: **Monte Carlo estimates (standard errors) of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho, when sigma is 0.25**

rho	Method	FDR	FWER	Sensitivity	Specificity
-0.75	BH	0.0121 (0.0007)	0.0435 (0.0020)	0.3177 (0.0016)	0.9995 (0.0000)
-0.75	bonferroni	0.0121 (0.0006)	0.0443 (0.0021)	0.3230 (0.0016)	0.9995 (0.0000)
-0.75	BY	0.0129 (0.0007)	0.0456 (0.0021)	0.3173 (0.0016)	0.9995 (0.0000)
-0.75	holm	0.0136 (0.0007)	0.0455 (0.0021)	0.3060 (0.0015)	0.9995 (0.0000)
-0.50	BH	0.0117 (0.0006)	0.0442 (0.0021)	0.3240 (0.0015)	0.9995 (0.0000)
-0.50	bonferroni	0.0129 (0.0007)	0.0460 (0.0021)	0.3127 (0.0015)	0.9995 (0.0000)
-0.50	BY	0.0118 (0.0006)	0.0427 (0.0020)	0.3025 (0.0015)	0.9995 (0.0000)
-0.50	holm	0.0130 (0.0007)	0.0462 (0.0021)	0.3040 (0.0015)	0.9995 (0.0000)
-0.25	BH	0.0115 (0.0006)	0.0410 (0.0020)	0.3233 (0.0015)	0.9995 (0.0000)
-0.25	bonferroni	0.0121 (0.0006)	0.0435 (0.0020)	0.3167 (0.0015)	0.9995 (0.0000)
-0.25	BY	0.0136 (0.0007)	0.0446 (0.0021)	0.2993 (0.0015)	0.9995 (0.0000)
-0.25	holm	0.0125 (0.0007)	0.0441 (0.0021)	0.3145 (0.0015)	0.9995 (0.0000)
0.00	BH	0.0129 (0.0007)	0.0442 (0.0021)	0.3017 (0.0014)	0.9995 (0.0000)
0.00	bonferroni	0.0114 (0.0006)	0.0426 (0.0020)	0.3230 (0.0015)	0.9995 (0.0000)
0.00	BY	0.0124 (0.0006)	0.0463 (0.0021)	0.3238 (0.0014)	0.9995 (0.0000)
0.00	holm	0.0117 (0.0006)	0.0415 (0.0020)	0.3000 (0.0014)	0.9995 (0.0000)
0.25	BH	0.0446 (0.0009)	0.2364 (0.0042)	0.4922 (0.0021)	0.9967 (0.0001)
0.25	bonferroni	0.0447 (0.0009)	0.2410 (0.0043)	0.4925 (0.0020)	0.9967 (0.0001)
0.25	BY	0.0461 (0.0009)	0.2435 (0.0043)	0.4936 (0.0020)	0.9966 (0.0001)
0.25	holm	0.0442 (0.0009)	0.2332 (0.0042)	0.4825 (0.0020)	0.9968 (0.0001)
0.50	BH	0.0441 (0.0009)	0.2389 (0.0043)	0.5038 (0.0020)	0.9967 (0.0001)
0.50	bonferroni	0.0459 (0.0009)	0.2452 (0.0043)	0.5004 (0.0020)	0.9966 (0.0001)
0.50	BY	0.0093 (0.0006)	0.0346 (0.0018)	0.2636 (0.0018)	0.9996 (0.0000)
0.50	holm	0.0449 (0.0009)	0.2477 (0.0043)	0.5195 (0.0019)	0.9965 (0.0001)
0.75	BH	0.0082 (0.0005)	0.0326 (0.0018)	0.2641 (0.0018)	0.9996 (0.0000)
0.75	bonferroni	0.0092 (0.0005)	0.0375 (0.0019)	0.2846 (0.0018)	0.9996 (0.0000)
0.75	BY	0.0085 (0.0005)	0.0347 (0.0018)	0.2607 (0.0018)	0.9996 (0.0000)
0.75	holm	0.0085 (0.0005)	0.0345 (0.0018)	0.2682 (0.0018)	0.9996 (0.0000)

The table of Monte Carlo estimates with its standard errors of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho is shown below (sigma = 0.5).

Table 4: **Monte Carlo estimates (standard errors) of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho, when sigma is 0.5**

rho	Method	FDR	FWER	Sensitivity	Specificity
-0.75	BH	0.0138 (0.0007)	0.0462 (0.0021)	0.3021 (0.0015)	0.9995 (0.0000)
-0.75	bonferroni	0.0117 (0.0006)	0.0423 (0.0020)	0.3261 (0.0015)	0.9995 (0.0000)
-0.75	BY	0.0126 (0.0007)	0.0448 (0.0021)	0.3087 (0.0015)	0.9995 (0.0000)
-0.75	holm	0.0123 (0.0006)	0.0448 (0.0021)	0.3197 (0.0015)	0.9995 (0.0000)
-0.50	BH	0.0126 (0.0006)	0.0476 (0.0021)	0.3267 (0.0015)	0.9995 (0.0000)
-0.50	bonferroni	0.0131 (0.0007)	0.0456 (0.0021)	0.3041 (0.0015)	0.9995 (0.0000)
-0.50	BY	0.0132 (0.0007)	0.0460 (0.0021)	0.3169 (0.0015)	0.9995 (0.0000)
-0.50	holm	0.0116 (0.0006)	0.0442 (0.0021)	0.3260 (0.0015)	0.9995 (0.0000)
-0.25	BH	0.0133 (0.0007)	0.0436 (0.0020)	0.3072 (0.0015)	0.9995 (0.0000)
-0.25	bonferroni	0.0126 (0.0007)	0.0417 (0.0020)	0.3058 (0.0015)	0.9995 (0.0000)
-0.25	BY	0.0132 (0.0007)	0.0456 (0.0021)	0.3209 (0.0015)	0.9995 (0.0000)
-0.25	holm	0.0124 (0.0007)	0.0435 (0.0020)	0.3058 (0.0015)	0.9995 (0.0000)
0.00	BH	0.0464 (0.0009)	0.2424 (0.0043)	0.4885 (0.0021)	0.9965 (0.0001)
0.00	bonferroni	0.0118 (0.0006)	0.0425 (0.0020)	0.3159 (0.0015)	0.9995 (0.0000)
0.00	BY	0.0441 (0.0009)	0.2392 (0.0043)	0.5135 (0.0020)	0.9966 (0.0001)
0.00	holm	0.0130 (0.0007)	0.0449 (0.0021)	0.3137 (0.0015)	0.9995 (0.0000)
0.25	BH	0.0447 (0.0009)	0.2376 (0.0043)	0.4851 (0.0020)	0.9967 (0.0001)
0.25	bonferroni	0.0421 (0.0009)	0.2252 (0.0042)	0.4905 (0.0021)	0.9969 (0.0001)
0.25	BY	0.0452 (0.0009)	0.2385 (0.0043)	0.4982 (0.0020)	0.9966 (0.0001)
0.25	holm	0.0447 (0.0009)	0.2432 (0.0043)	0.5127 (0.0020)	0.9966 (0.0001)
0.50	BH	0.0087 (0.0005)	0.0354 (0.0018)	0.2763 (0.0019)	0.9996 (0.0000)
0.50	bonferroni	0.0083 (0.0005)	0.0337 (0.0018)	0.2781 (0.0019)	0.9996 (0.0000)
0.50	BY	0.0081 (0.0005)	0.0339 (0.0018)	0.2789 (0.0019)	0.9996 (0.0000)
0.50	holm	0.0090 (0.0005)	0.0359 (0.0019)	0.2831 (0.0019)	0.9996 (0.0000)
0.75	BH	0.0082 (0.0005)	0.0339 (0.0018)	0.2588 (0.0018)	0.9996 (0.0000)
0.75	bonferroni	0.0082 (0.0005)	0.0344 (0.0018)	0.2832 (0.0019)	0.9996 (0.0000)
0.75	BY	0.0080 (0.0005)	0.0336 (0.0018)	0.2871 (0.0018)	0.9996 (0.0000)
0.75	holm	0.0091 (0.0005)	0.0352 (0.0018)	0.2700 (0.0018)	0.9996 (0.0000)

The table of Monte Carlo estimates with its standard errors of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho is shown below (sigma = 1).

Table 5: **Monte Carlo estimates (standard errors) of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho, when sigma is 1**

rho	Method	FDR	FWER	Sensitivity	Specificity
-0.75	BH	0.0136 (0.0007)	0.0475 (0.0021)	0.3240 (0.0015)	0.9995 (0.0000)
-0.75	bonferroni	0.0136 (0.0007)	0.0451 (0.0021)	0.3098 (0.0015)	0.9995 (0.0000)
-0.75	BY	0.0119 (0.0006)	0.0432 (0.0020)	0.3081 (0.0015)	0.9995 (0.0000)
-0.75	holm	0.0130 (0.0007)	0.0435 (0.0020)	0.3086 (0.0015)	0.9995 (0.0000)
-0.50	BH	0.0121 (0.0006)	0.0435 (0.0020)	0.3201 (0.0015)	0.9995 (0.0000)
-0.50	bonferroni	0.0132 (0.0007)	0.0439 (0.0020)	0.3034 (0.0015)	0.9995 (0.0000)
-0.50	BY	0.0118 (0.0007)	0.0417 (0.0020)	0.3151 (0.0016)	0.9995 (0.0000)
-0.50	holm	0.0119 (0.0006)	0.0435 (0.0020)	0.3191 (0.0015)	0.9995 (0.0000)
-0.25	BH	0.0126 (0.0007)	0.0440 (0.0021)	0.3096 (0.0015)	0.9995 (0.0000)
-0.25	bonferroni	0.0127 (0.0007)	0.0445 (0.0021)	0.3016 (0.0014)	0.9995 (0.0000)
-0.25	BY	0.0114 (0.0006)	0.0422 (0.0020)	0.3212 (0.0015)	0.9995 (0.0000)
-0.25	holm	0.0114 (0.0006)	0.0409 (0.0020)	0.3050 (0.0015)	0.9995 (0.0000)
0.00	BH	0.0443 (0.0009)	0.2385 (0.0043)	0.5062 (0.0020)	0.9966 (0.0001)
0.00	bonferroni	0.0441 (0.0009)	0.2403 (0.0043)	0.5082 (0.0021)	0.9967 (0.0001)
0.00	BY	0.0447 (0.0009)	0.2447 (0.0043)	0.5192 (0.0020)	0.9966 (0.0001)
0.00	holm	0.0454 (0.0009)	0.2429 (0.0043)	0.5057 (0.0021)	0.9966 (0.0001)
0.25	BH	0.0443 (0.0009)	0.2394 (0.0043)	0.5160 (0.0020)	0.9966 (0.0001)
0.25	bonferroni	0.0427 (0.0009)	0.2263 (0.0042)	0.4834 (0.0020)	0.9969 (0.0001)
0.25	BY	0.0446 (0.0009)	0.2364 (0.0042)	0.4860 (0.0020)	0.9967 (0.0001)
0.25	holm	0.0433 (0.0009)	0.2363 (0.0042)	0.5157 (0.0020)	0.9967 (0.0001)
0.50	BH	0.0091 (0.0005)	0.0356 (0.0019)	0.2668 (0.0018)	0.9996 (0.0000)
0.50	bonferroni	0.0090 (0.0005)	0.0346 (0.0018)	0.2585 (0.0018)	0.9996 (0.0000)
0.50	BY	0.0085 (0.0005)	0.0334 (0.0018)	0.2662 (0.0018)	0.9996 (0.0000)
0.50	holm	0.0079 (0.0005)	0.0331 (0.0018)	0.2861 (0.0018)	0.9996 (0.0000)
0.75	BH	0.0088 (0.0005)	0.0349 (0.0018)	0.2749 (0.0018)	0.9996 (0.0000)
0.75	bonferroni	0.0097 (0.0005)	0.0388 (0.0019)	0.2870 (0.0018)	0.9996 (0.0000)
0.75	BY	0.0091 (0.0005)	0.0363 (0.0019)	0.2792 (0.0018)	0.9996 (0.0000)
0.75	holm	0.0090 (0.0006)	0.0343 (0.0018)	0.2605 (0.0018)	0.9996 (0.0000)

The table is also stored in the file results_q4b.RData.

Part c

The tables are stored in the ps4_q2c-1.Rout, ps4_q2c-2.Rout, ps4_q2c-4.Rout, with sigma = 0.25, 0.5, 1, respectively.

The table of Monte Carlo estimates with its standard errors of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho is shown below (sigma = 0.25).

Table 6: **Monte Carlo estimates (standard errors) of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho, when sigma is 0.25**

rho	Method	FDR	FWER	Sensitivity	Specificity
-0.75	BH	0.0449 (0.0009)	0.2455 (0.0043)	0.5123 (0.0021)	0.9966 (0.0001)
-0.75	bonferroni	0.0128 (0.0007)	0.0453 (0.0021)	0.3193 (0.0015)	0.9995 (0.0000)
-0.75	BY	0.0092 (0.0005)	0.0378 (0.0019)	0.2820 (0.0019)	0.9996 (0.0000)
-0.75	holm	0.0130 (0.0007)	0.0466 (0.0021)	0.3219 (0.0016)	0.9995 (0.0000)
-0.50	BH	0.0449 (0.0009)	0.2444 (0.0043)	0.5079 (0.0020)	0.9966 (0.0001)
-0.50	bonferroni	0.0126 (0.0007)	0.0452 (0.0021)	0.3160 (0.0015)	0.9995 (0.0000)
-0.50	BY	0.0091 (0.0005)	0.0366 (0.0019)	0.2789 (0.0018)	0.9996 (0.0000)
-0.50	holm	0.0128 (0.0006)	0.0471 (0.0021)	0.3189 (0.0015)	0.9995 (0.0000)
-0.25	BH	0.0453 (0.0009)	0.2499 (0.0043)	0.5165 (0.0020)	0.9965 (0.0001)
-0.25	bonferroni	0.0115 (0.0006)	0.0414 (0.0020)	0.3232 (0.0015)	0.9995 (0.0000)
-0.25	BY	0.0082 (0.0005)	0.0346 (0.0018)	0.2857 (0.0019)	0.9996 (0.0000)
-0.25	holm	0.0118 (0.0006)	0.0429 (0.0020)	0.3260 (0.0015)	0.9995 (0.0000)
0.00	BH	0.0453 (0.0009)	0.2395 (0.0043)	0.4867 (0.0020)	0.9966 (0.0001)
0.00	bonferroni	0.0137 (0.0007)	0.0471 (0.0021)	0.3019 (0.0015)	0.9995 (0.0000)
0.00	BY	0.0096 (0.0005)	0.0378 (0.0019)	0.2598 (0.0018)	0.9996 (0.0000)
0.00	holm	0.0139 (0.0007)	0.0483 (0.0021)	0.3044 (0.0015)	0.9994 (0.0000)
0.25	BH	0.0446 (0.0009)	0.2400 (0.0043)	0.5047 (0.0020)	0.9966 (0.0001)
0.25	bonferroni	0.0114 (0.0006)	0.0404 (0.0020)	0.3133 (0.0015)	0.9995 (0.0000)
0.25	BY	0.0083 (0.0005)	0.0332 (0.0018)	0.2746 (0.0019)	0.9996 (0.0000)
0.25	holm	0.0117 (0.0006)	0.0418 (0.0020)	0.3160 (0.0015)	0.9995 (0.0000)
0.50	BH	0.0457 (0.0009)	0.2466 (0.0043)	0.5114 (0.0020)	0.9965 (0.0001)
0.50	bonferroni	0.0122 (0.0006)	0.0433 (0.0020)	0.3186 (0.0015)	0.9995 (0.0000)
0.50	BY	0.0084 (0.0005)	0.0345 (0.0018)	0.2812 (0.0018)	0.9996 (0.0000)
0.50	holm	0.0123 (0.0006)	0.0443 (0.0021)	0.3212 (0.0015)	0.9995 (0.0000)
0.75	BH	0.0455 (0.0009)	0.2480 (0.0043)	0.5044 (0.0020)	0.9965 (0.0001)
0.75	bonferroni	0.0118 (0.0006)	0.0436 (0.0020)	0.3136 (0.0015)	0.9995 (0.0000)
0.75	BY	0.0085 (0.0005)	0.0358 (0.0019)	0.2751 (0.0018)	0.9996 (0.0000)
0.75	holm	0.0120 (0.0006)	0.0447 (0.0021)	0.3169 (0.0015)	0.9995 (0.0000)

The table of Monte Carlo estimates with its standard errors of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho is shown below (sigma = 0.5).

Table 7: **Monte Carlo estimates (standard errors) of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho, when sigma is 0.5**

rho	Method	FDR	FWER	Sensitivity	Specificity
-0.75	BH	0.0443 (0.0009)	0.2417 (0.0043)	0.5060 (0.0021)	0.9967 (0.0001)
-0.75	bonferroni	0.0130 (0.0007)	0.0468 (0.0021)	0.3188 (0.0015)	0.9995 (0.0000)
-0.75	BY	0.0088 (0.0005)	0.0374 (0.0019)	0.2825 (0.0019)	0.9996 (0.0000)
-0.75	holm	0.0132 (0.0007)	0.0482 (0.0021)	0.3216 (0.0015)	0.9995 (0.0000)
-0.50	BH	0.0458 (0.0009)	0.2452 (0.0043)	0.4960 (0.0021)	0.9966 (0.0001)
-0.50	bonferroni	0.0124 (0.0007)	0.0422 (0.0020)	0.3089 (0.0015)	0.9995 (0.0000)
-0.50	BY	0.0087 (0.0006)	0.0333 (0.0018)	0.2690 (0.0019)	0.9996 (0.0000)
-0.50	holm	0.0125 (0.0007)	0.0430 (0.0020)	0.3115 (0.0015)	0.9995 (0.0000)
-0.25	BH	0.0438 (0.0009)	0.2350 (0.0042)	0.4997 (0.0020)	0.9967 (0.0001)
-0.25	bonferroni	0.0123 (0.0007)	0.0432 (0.0020)	0.3115 (0.0015)	0.9995 (0.0000)
-0.25	BY	0.0082 (0.0005)	0.0337 (0.0018)	0.2713 (0.0018)	0.9996 (0.0000)
-0.25	holm	0.0123 (0.0006)	0.0443 (0.0021)	0.3147 (0.0015)	0.9995 (0.0000)
0.00	BH	0.0444 (0.0009)	0.2353 (0.0042)	0.4892 (0.0020)	0.9967 (0.0001)
0.00	bonferroni	0.0121 (0.0007)	0.0420 (0.0020)	0.3054 (0.0015)	0.9995 (0.0000)
0.00	BY	0.0075 (0.0005)	0.0309 (0.0017)	0.2646 (0.0018)	0.9996 (0.0000)
0.00	holm	0.0122 (0.0007)	0.0430 (0.0020)	0.3082 (0.0015)	0.9995 (0.0000)
0.25	BH	0.0439 (0.0009)	0.2451 (0.0043)	0.5300 (0.0020)	0.9965 (0.0001)
0.25	bonferroni	0.0113 (0.0006)	0.0432 (0.0020)	0.3316 (0.0015)	0.9995 (0.0000)
0.25	BY	0.0085 (0.0005)	0.0368 (0.0019)	0.2967 (0.0019)	0.9996 (0.0000)
0.25	holm	0.0114 (0.0006)	0.0442 (0.0021)	0.3347 (0.0015)	0.9995 (0.0000)
0.50	BH	0.0458 (0.0009)	0.2412 (0.0043)	0.4930 (0.0020)	0.9966 (0.0001)
0.50	bonferroni	0.0127 (0.0007)	0.0434 (0.0020)	0.3069 (0.0014)	0.9995 (0.0000)
0.50	BY	0.0082 (0.0005)	0.0326 (0.0018)	0.2664 (0.0018)	0.9996 (0.0000)
0.50	holm	0.0129 (0.0007)	0.0448 (0.0021)	0.3096 (0.0015)	0.9995 (0.0000)
0.75	BH	0.0436 (0.0009)	0.2384 (0.0043)	0.5031 (0.0020)	0.9967 (0.0001)
0.75	bonferroni	0.0117 (0.0006)	0.0426 (0.0020)	0.3132 (0.0015)	0.9995 (0.0000)
0.75	BY	0.0084 (0.0005)	0.0345 (0.0018)	0.2750 (0.0018)	0.9996 (0.0000)
0.75	holm	0.0121 (0.0006)	0.0444 (0.0021)	0.3159 (0.0015)	0.9995 (0.0000)

The table of Monte Carlo estimates with its standard errors of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho is shown below (sigma = 1).

Table 8: **Monte Carlo estimates (standard errors) of FWER, FDR, Sensitivity, or Specificity with different multiple comparison method for different rho, when sigma is 1**

rho	Method	FDR	FWER	Sensitivity	Specificity
-0.75	BH	0.0449 (0.0009)	0.2455 (0.0043)	0.5123 (0.0021)	0.9966 (0.0001)
-0.75	bonferroni	0.0128 (0.0007)	0.0453 (0.0021)	0.3193 (0.0015)	0.9995 (0.0000)
-0.75	BY	0.0092 (0.0005)	0.0378 (0.0019)	0.2820 (0.0019)	0.9996 (0.0000)
-0.75	holm	0.0130 (0.0007)	0.0466 (0.0021)	0.3219 (0.0016)	0.9995 (0.0000)
-0.50	BH	0.0449 (0.0009)	0.2444 (0.0043)	0.5079 (0.0020)	0.9966 (0.0001)
-0.50	bonferroni	0.0126 (0.0007)	0.0452 (0.0021)	0.3160 (0.0015)	0.9995 (0.0000)
-0.50	BY	0.0091 (0.0005)	0.0366 (0.0019)	0.2789 (0.0018)	0.9996 (0.0000)
-0.50	holm	0.0128 (0.0006)	0.0471 (0.0021)	0.3189 (0.0015)	0.9995 (0.0000)
-0.25	BH	0.0453 (0.0009)	0.2499 (0.0043)	0.5165 (0.0020)	0.9965 (0.0001)
-0.25	bonferroni	0.0115 (0.0006)	0.0414 (0.0020)	0.3232 (0.0015)	0.9995 (0.0000)
-0.25	BY	0.0082 (0.0005)	0.0346 (0.0018)	0.2857 (0.0019)	0.9996 (0.0000)
-0.25	holm	0.0118 (0.0006)	0.0429 (0.0020)	0.3260 (0.0015)	0.9995 (0.0000)
0.00	BH	0.0453 (0.0009)	0.2395 (0.0043)	0.4867 (0.0020)	0.9966 (0.0001)
0.00	bonferroni	0.0137 (0.0007)	0.0471 (0.0021)	0.3019 (0.0015)	0.9995 (0.0000)
0.00	BY	0.0096 (0.0005)	0.0378 (0.0019)	0.2598 (0.0018)	0.9996 (0.0000)
0.00	holm	0.0139 (0.0007)	0.0483 (0.0021)	0.3044 (0.0015)	0.9994 (0.0000)
0.25	BH	0.0446 (0.0009)	0.2400 (0.0043)	0.5047 (0.0020)	0.9966 (0.0001)
0.25	bonferroni	0.0114 (0.0006)	0.0404 (0.0020)	0.3133 (0.0015)	0.9995 (0.0000)
0.25	BY	0.0083 (0.0005)	0.0332 (0.0018)	0.2746 (0.0019)	0.9996 (0.0000)
0.25	holm	0.0117 (0.0006)	0.0418 (0.0020)	0.3160 (0.0015)	0.9995 (0.0000)
0.50	BH	0.0457 (0.0009)	0.2466 (0.0043)	0.5114 (0.0020)	0.9965 (0.0001)
0.50	bonferroni	0.0122 (0.0006)	0.0433 (0.0020)	0.3186 (0.0015)	0.9995 (0.0000)
0.50	BY	0.0084 (0.0005)	0.0345 (0.0018)	0.2812 (0.0018)	0.9996 (0.0000)
0.50	holm	0.0123 (0.0006)	0.0443 (0.0021)	0.3212 (0.0015)	0.9995 (0.0000)
0.75	BH	0.0455 (0.0009)	0.2480 (0.0043)	0.5044 (0.0020)	0.9965 (0.0001)
0.75	bonferroni	0.0118 (0.0006)	0.0436 (0.0020)	0.3136 (0.0015)	0.9995 (0.0000)
0.75	BY	0.0085 (0.0005)	0.0358 (0.0019)	0.2751 (0.0018)	0.9996 (0.0000)
0.75	holm	0.0120 (0.0006)	0.0447 (0.0021)	0.3169 (0.0015)	0.9995 (0.0000)

Question 3

Part c

The result is stored in the "ps4_q3c.csv".

Table 9: **MRI procedures with the highest volume, highest total payment, and highest average payment**

MRI Procedure	Volumn	Total Payment	Average Payment
MRI scan of lower spinal canal	1430104	134223519.40	93.85575
MRI scan of one breast with contrast	161	43337.44	269.17665

Part d

The result is stored in the "ps4_q3d.csv".

Table 10: **MRI procedures with the highest volume, highest total payment, and highest average payment**

MRI Procedure	Code	Volumn	Total Payment	Average Payment
MRI scan of lower spinal canal	72148	1430104	134223519.40	93.85575
MRI scan of one breast with contrast	77058	161	43337.44	269.17665

Part e

The results of the two tables are matched. And the procedure "MRI scan of lower spinal canal" has the highest Volumn and also highest total payments. "MRI scan of one breast with contrast" has the largest average payment.