

Fisher-Freeman-Halton Exact Test

Verified Python analysis transcript

Test: Fisher-Freeman-Halton Exact Test

Design: Fixed-margin exact analysis of a 2 x 4 school-by-grade-band table.

Variables: school, G3 grade band

Null hypothesis: Rows and columns are independent conditional on the observed margins.

Primary formula: $P(\text{table} \mid \text{margins}) = \frac{[\prod \text{row!} \prod \text{column!}]}{[N! \prod \text{cell!}]}$; two-sided p sums probabilities $\leq$ observed.

Valid source rows: 649

Verified results:

observed_table_probability: 4.860376731528479e-16

monte_carlo_p_value: 1.999960000799984e-05

resamples: 50000

seed: 20260716

pearson_chi_square: 59.534045213043086

pearson_p_value: 7.392451635150176e-13

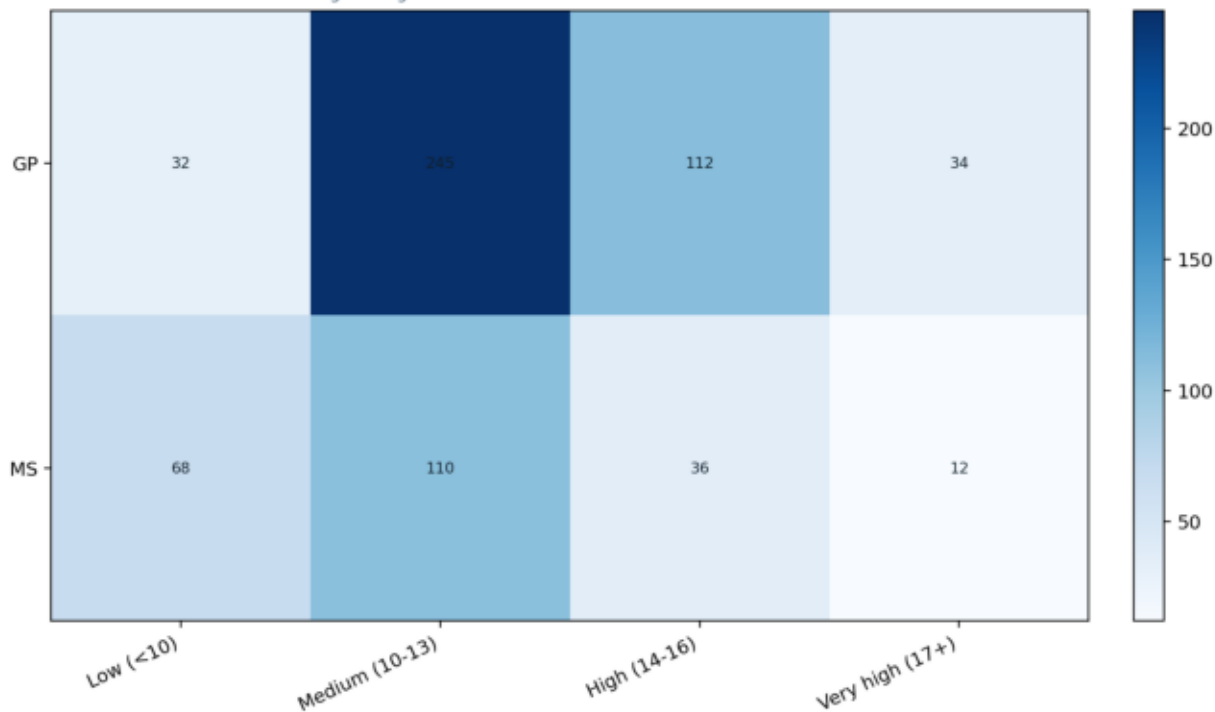
Interpretation:

Fisher-Freeman-Halton Monte Carlo p = 1.99996e-05 from 50,000 fixed-margin tables.

The convergence and Monte Carlo standard-error charts document simulation precision rather than treating a random p-value as exact to unlimited decimals.

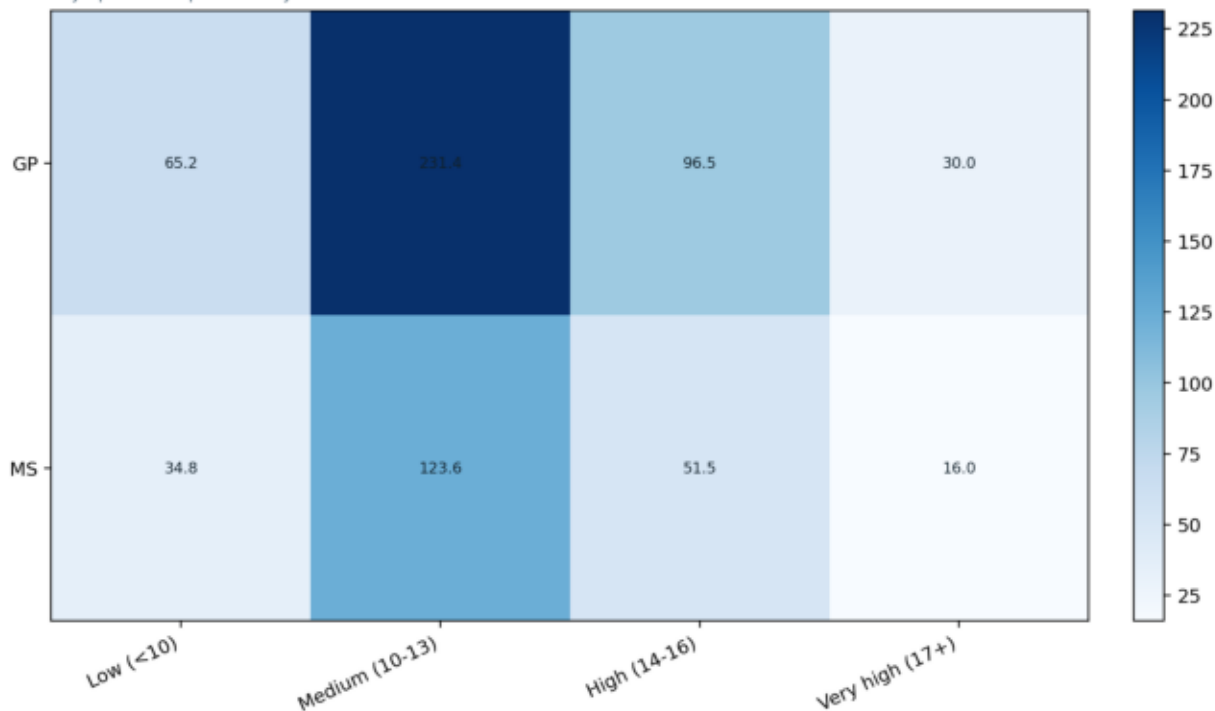
Observed 2 x 4 school-grade table

Fisher-Freeman-Halton fixed-margin design



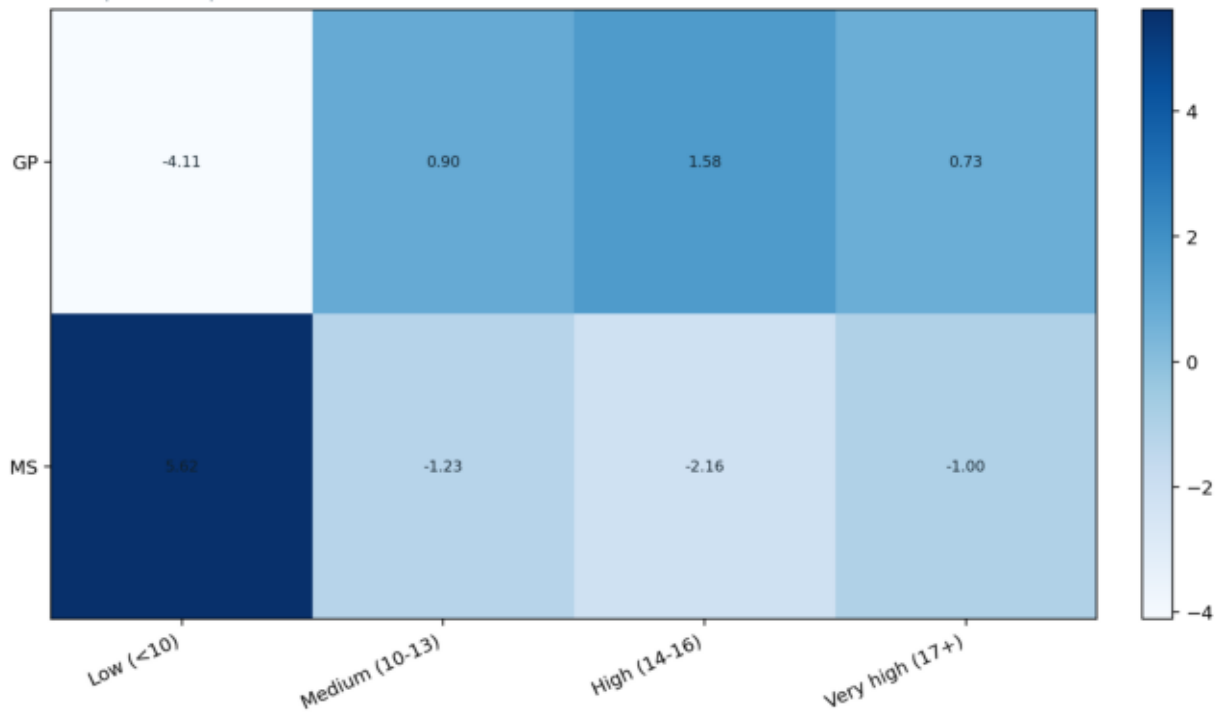
Expected counts under independence

Asymptotic comparison only



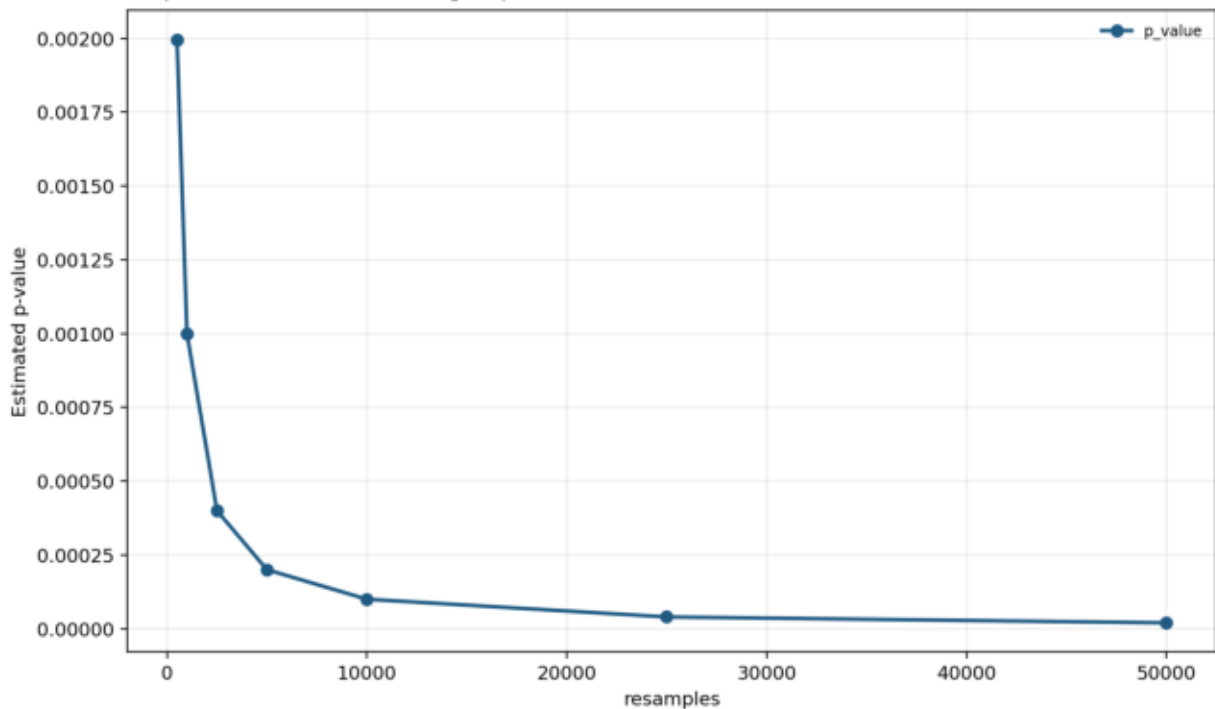
Pearson residual pattern

Descriptive cell departures

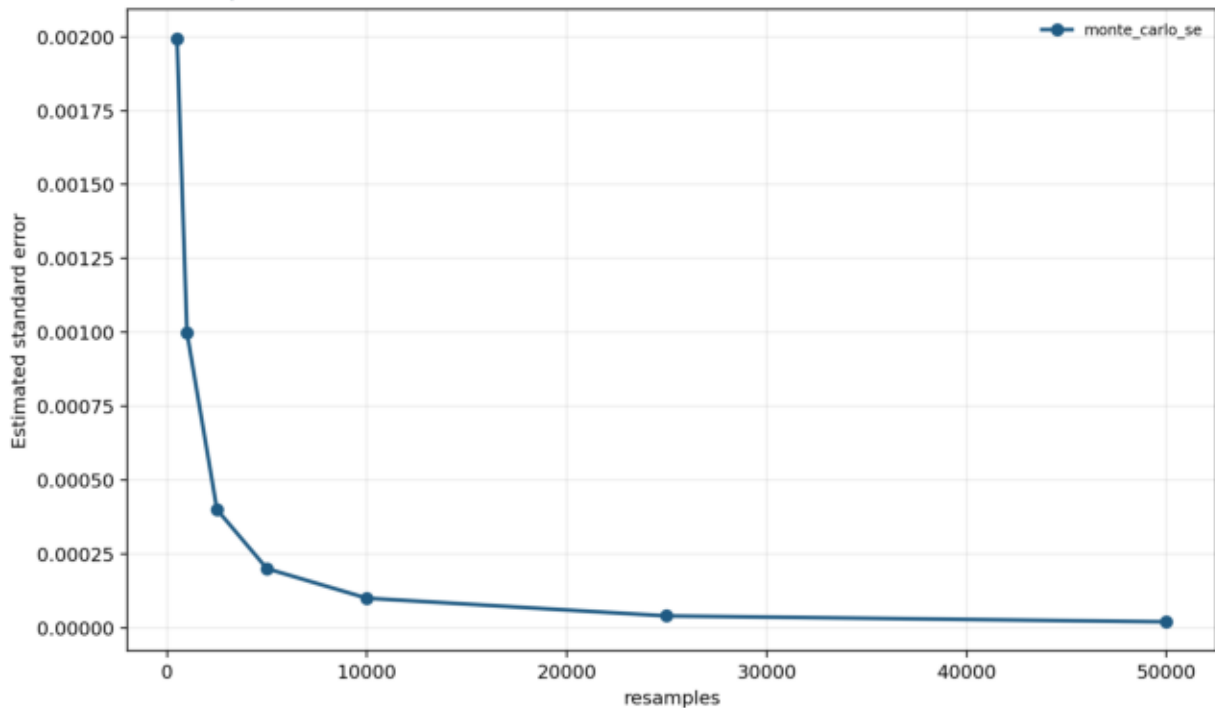


Monte Carlo exact p-value convergence

Independent seeded runs at increasing sample sizes

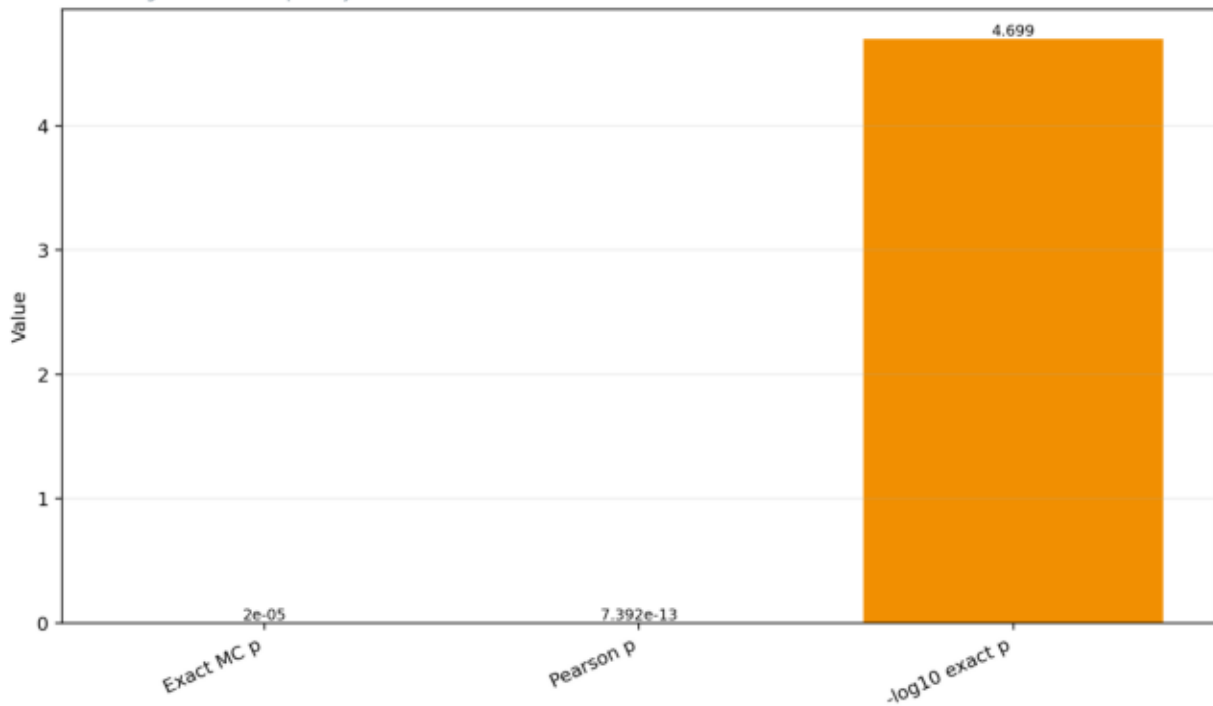


Monte Carlo standard error
Precision improves as random tables increase



Exact and asymptotic evidence

fixed-margin exact test is primary



Observed 2X4

Low (<10)	Medium (10-13)	High (14-16)	Very high (17+)
32	245	112	34
68	110	36	12

Expected Counts

Low (<10)	Medium (10-13)	High (14-16)	Very high (17+)
65.1772	231.379	96.4622	29.9815
34.8228	123.621	51.5378	16.0185

Pearson Residuals

Low (<10)	Medium (10-13)	High (14-16)	Very high (17+)
-4.10953	0.895459	1.58201	0.733899
5.62222	-1.22507	-2.16434	-1.00404

Monte Carlo Convergence

resamples	p_value	monte_carlo_se
500	0.00199601	0.00199401
1000	0.000999001	0.000998502
2500	0.00039984	0.00039976
5000	0.00019996	0.00019994
10000	9.999e-05	9.9985e-05
25000	3.99984e-05	3.99976e-05
50000	1.99996e-05	1.99994e-05