Definitions

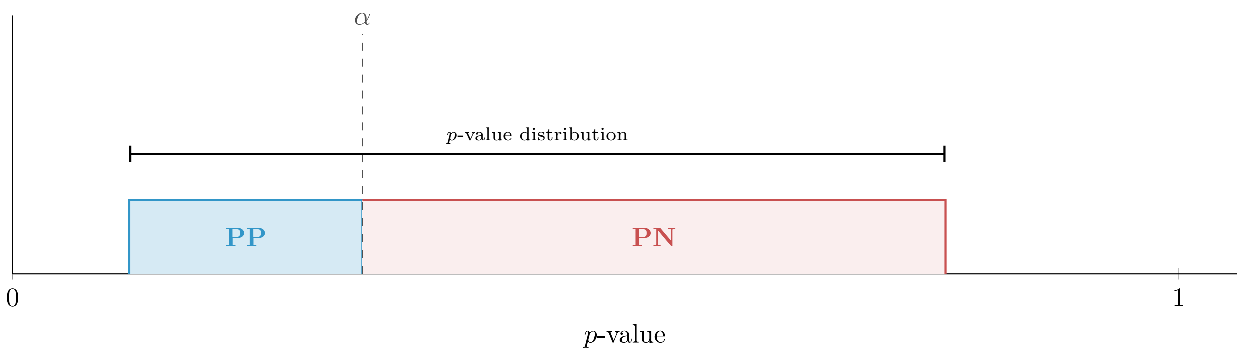
$$\text{P} = \text{Positive outcomes} = \text{FN} + \text{TP}$$
$$\text{N} = \text{Negative outcomes} = \text{FP} + \text{TN}$$
$$\text{PP} = \text{Predicted Positive outcomes} = \text{FP} + \text{TP}$$
$$\text{PN} = \text{Predicted Negative outcomes} = \text{FN} + \text{TN}$$

Positive Prediction Rate (PPR):

$$\text{PPR} = \frac{\text{PP}}{\text{PP} + \text{PN}} = \frac{\text{TP} + \text{FP}}{\text{TP} + \text{FN} + \text{FP} + \text{TN}} = \frac{\text{TP} + \text{FP}}{\text{P} + \text{N}}$$

Sampled p-value distribution

p-value distribution classified as "Predicted Positive" (PP) when below α and "Predicted Negative" (PN) otherwise. Standard deviation (σ_p) is sampled from the distribution.



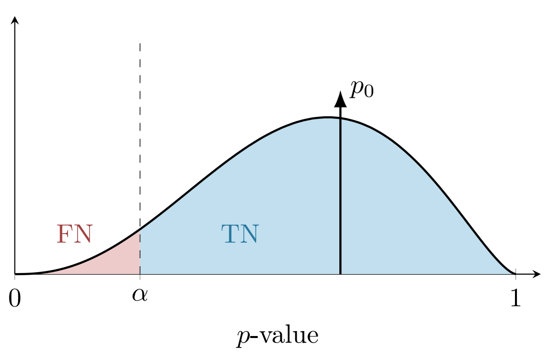
Simulated p-value using Beta distributions

Standard deviation σ_p is simulated using uncertainty formulae from Table 1. Uncertainty on p-value is modeled using Beta distributions. With $\mathbb{E}[\beta] = p_0$ and $\text{Var}[\beta] = \sigma_p^2$, we solve for parameters a, b:

$$\begin{cases} p_0 = \frac{a}{a+b} \\ \sigma_p^2 = \frac{ab}{(a+b)^2(a+b+1)} \end{cases} \implies \begin{cases} a = p_0 \left(\frac{p_0(1-p_0)}{\sigma_p^2} - 1 \right) \\ b = (1 - p_0) \left(\frac{p_0(1-p_0)}{\sigma_p^2} - 1 \right) \end{cases}$$

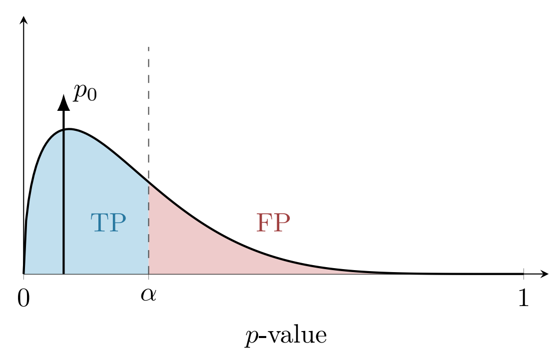
Then, we have two cases depending on p_0 significance:

Negative Case



$$\mathbb{P}[\text{FN}] = \int_0^\alpha \beta(x; a, b) dx$$
$$\mathbb{P}[\text{TN}] = 1 - \mathbb{P}[\text{FN}]$$

Positive Case



$$\mathbb{P}[\text{TP}] = \int_0^\alpha \beta(x; a, b) dx$$
$$\mathbb{P}[\text{FP}] = 1 - \mathbb{P}[\text{TP}]$$

Statistic	**Numerical standard deviation**	**Numerical p-value uncertainty**
Cohen's d	$\sigma_d \approx \nu_{\mathrm{npv}} \frac{2}{\sqrt{n}}$	-
Two-sample t	$\sigma_t \approx \nu_{\mathrm{npv}}$	$\sigma_p \approx 2 f_{t,df}(\lvert t \rvert) \nu_{\mathrm{npv}}$
Partial correlation	$\sigma_r \geq \nu_{\mathrm{npv}} \sqrt{\frac{(1-r^2)^3}{n-1}}$	$\sigma_p \geq 2 f_{t,df}(\lvert t \rvert) \sqrt{\frac{df}{n-1}} \nu_{\mathrm{npv}}$
ANCOVA	$\sigma_F \approx 2\sqrt{F} \nu_{\mathrm{npv}}$	$\sigma_p \approx 2\sqrt{F} f_{\mathcal{F}}(F; 1, df_2)\, \nu_{\mathrm{npv}}$

Table 1: First-order numerical uncertainty of common statistical tests under Monte Carlo Arithmetic perturbations. Cohen's d formula assumes large and equal group sizes. $f_{t,df}$ and $f_{\mathcal{F}}(F; 1, df_2)$ denote the probability density functions of the Student's t-distribution with df degrees of freedom and the $\mathcal{F}$-distribution with $(1, df_2)$ degrees of freedom, respectively. The p-value approximation for the partial correlation uses $t = r(df/(1-r^2))^{1/2}$.