Confounding, pseudoreplication, & split-plot designs in multi-factor global ocean change experiments

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Many confounded and **split-plot designs** are analysed as if they were **factorial designs.**

This isn't *always* wrong

(which we can use to our advantage).

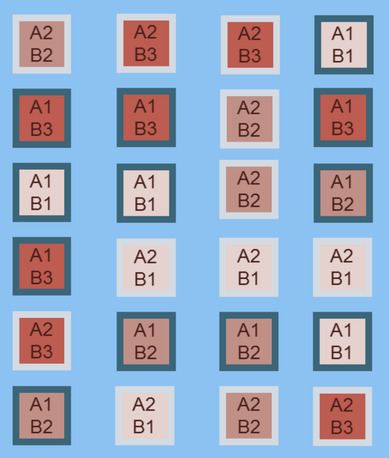
Factorial design

I**ndependently** controlled factors.

Analysed using **factorial analysis of variance.**

Highest precision, easy to analyse, easy to understand.

Can be logistically difficult or impossible to implement.



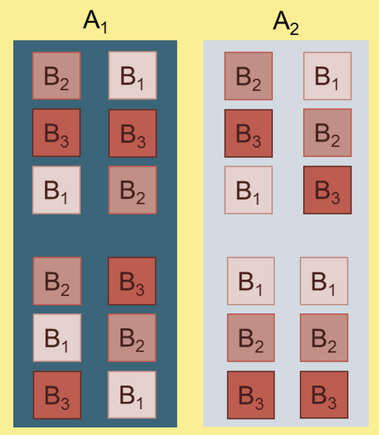
Confounded design

One or more factors controlled by unreplicated equipment, e.g. refrigerators, water baths.

Lack of replication leads to confounding or pseudoreplication. May or *may not* be important.

Best solution:

Replicate in time or space → split-plot design



Split-plot design

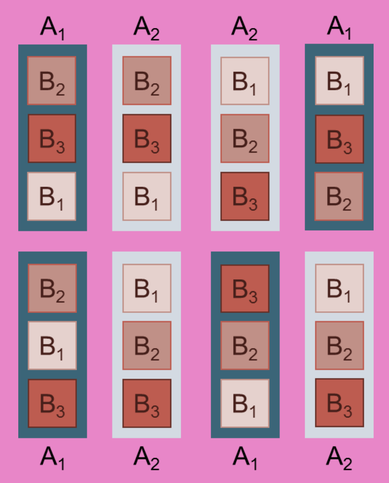
Large-scale and small-scale factors are replicated.

Split-plot analysis of variance, described by

$$Y_{ijk} = \mu + \gamma_k + \alpha_i + \delta_{ik} + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk},$$

$$\varepsilon_{ijk} \sim N(0, \sigma_e^2) \text{ and } \delta_{ik} \sim N(0, \boldsymbol{\sigma_d^2})$$

If $\sigma_d^2 \approx 0$ (plausible for physicochemical factors) then **split-plot anova reduces to factorial anova**.



Model-averaging

Split-plot experimental design, but two models:

M_1: $\sigma_d^2 \neq 0$ (split-plot) and M_2: $\sigma_d^2 = 0$ (factorial)

Weighted estimates via frequentist

or Bayesian model-averaging.

Project:

Develop model-averaging techniques for split-plot designs.

Test statistical properties via Monte Carlo simulation.

Create $\mathbb{R}$ package for community use.