

# Comparison of *a posteriori* statistical procedures to reduce spatial variation in NDVI measured at first bloom in cotton

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## Introduction

High-throughput phenotyping (HTP) technologies are increasing the number of genotypes breeders are able to evaluate. Thus, accounting for experimental error due to spatial variation, particularly soil heterogeneity, will become increasingly important as more space is required to evaluate breeding materials.

### Objective

- Compare the effectiveness of nearest neighbor (NNA) and moving means (MVNG) covariate analyses in controlling experimental error in normalized difference vegetation index (NDVI) in cotton (*Gossypium hirsutum*) breeding trials.

## Materials & Methods

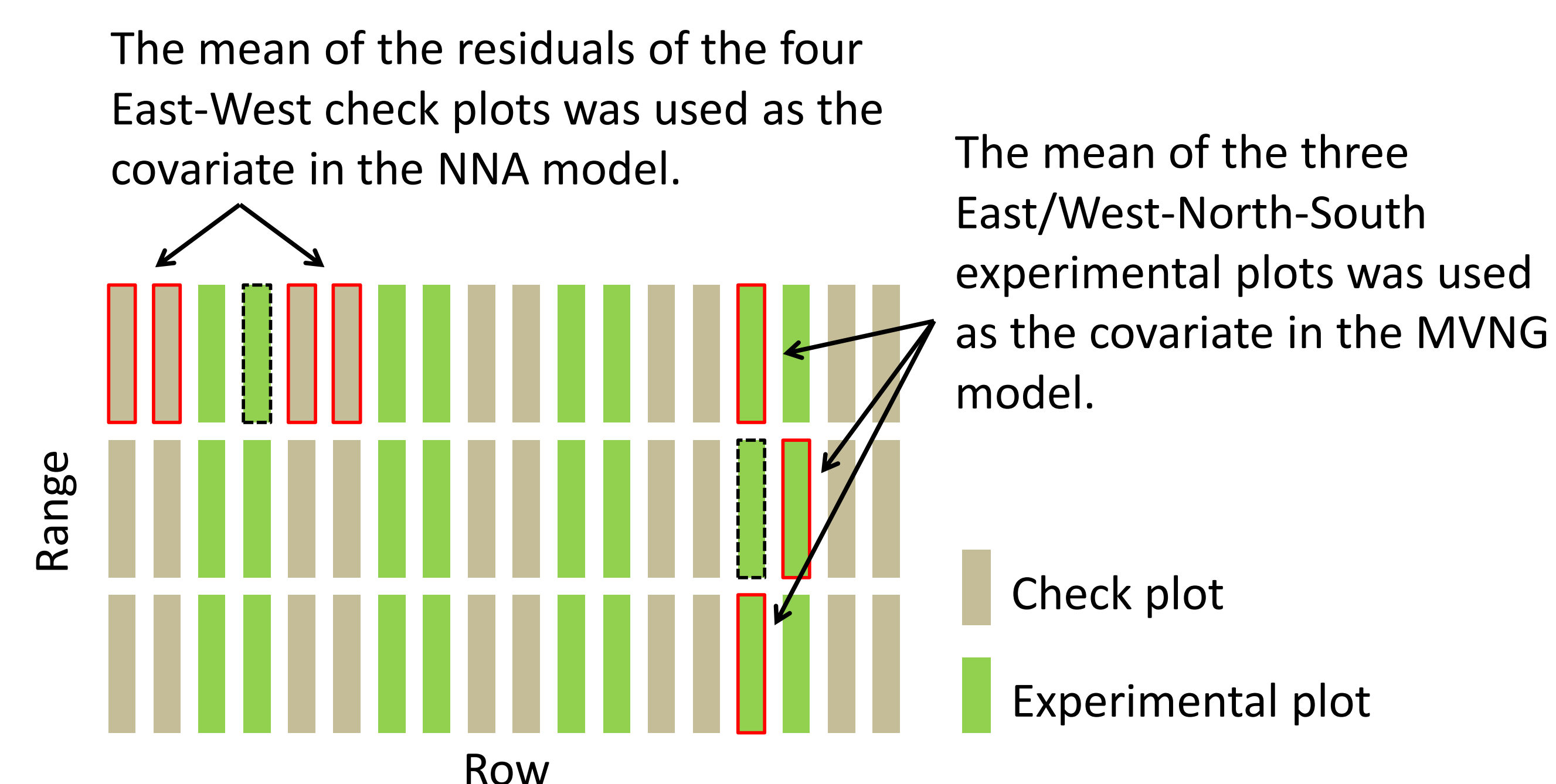
NDVI was measured at first bloom on 8 breeding trials at Florence, SC in 2014 and 2015 using a ground-based HTP platform. Five trials were planted in a randomized complete block (RCB) design, and 3 trials were planted in an alpha (0,1) lattice incomplete block (ALPHA) design. All trials were planted with alternating check rows superimposed on the RCB/ALPHA designs.

Trial	Year	# Genotypes	Design	# Reps
1	2014	66	RCBD	3
2	2015	60	RCBD	4
3	2015	60	RCBD	4
4	2015	30	RCBD	4
5	2015	30	RCBD	4
6	2014	288	ALPHA	2
7	2015	288	ALPHA	2
8	2015	288	ALPHA	2



## Statistical analysis

The mean square error from each analysis was used to estimate the relative efficiency of the different ANOVA and ANCOVA models for each trial. The RCB design was used as the baseline for all model comparisons.



## Results

Comparison of the relative efficiency and Spearman rank correlation coefficients for the nearest neighbor-adjusted (NNA), and moving means-adjusted (MVNG) models for cotton breeding trials planted as a randomized complete block (RCB) design.

Trial	Year	Significance of genotype treatment			Relative efficiency <sup>†</sup>		Rank correlation <sup>‡</sup>	
		RCB	RCB-NNA	RCB-MVNG	RCB-NNA	RCB-MVNG	RCB-NNA	RCB-MVNG
1	2014	***	***	***	1.27	1.09	0.93	0.96
2	2015	NS	NS	**	1.18	1.88	0.92	0.67
3	2015	NS	*	**	1.33	1.37	0.91	0.90
4	2015	NS	*	***	1.18	2.30	0.89	0.75
5	2015	NS	*	***	1.14	2.40	0.97	0.66

\*, \*\*, \*\*\* denotes significance at the 0.05, 0.01, and 0.001 probability levels, respectively.

<sup>†</sup>Relative efficiencies are based on comparisons to the RCB model.

<sup>‡</sup>Spearman's rank correlation coefficients are based on comparisons to the RCB model.

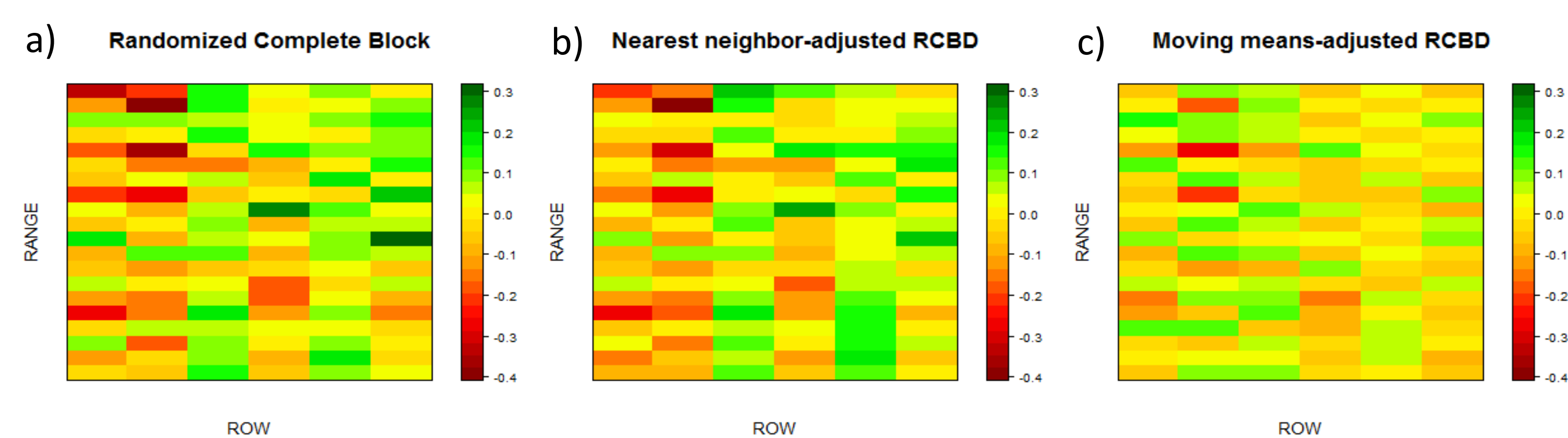


Figure 1. Residuals from the a) RCB model, b) RCB-NNA model, and c) RCB-MVNG model of NDVI measured at first bloom on trial 5 in 2015.

Comparison of the relative efficiency and Spearman rank correlation coefficients for the nearest neighbor-adjusted (NNA), and moving means-adjusted (MVNG) models for cotton breeding trials planted as an alpha (0,1) lattice (ALPHA) design.

Trial	Year	Significance of genotype treatment				Relative efficiency <sup>†</sup>			Rank correlation <sup>‡</sup>		
		RCBD	ALPHA	RCB-NNA	RCB-MVNG	ALPHA	RCB-NNA	RCB-MVNG	ALPHA	RCB-NNA	RCB-MVNG
6	2014	***	***	***	***	1.20	1.23	1.59	0.81	0.92	0.79
7	2015	NS	***	NS	***	1.88	1.01	2.87	0.60	0.99	0.59
8	2015	NS	***	NS	NS	1.49	1.01	1.01	0.59	0.99	0.99

\*, \*\*, \*\*\* denotes significance at the 0.05, 0.01, and 0.001 probability levels, respectively.

<sup>†</sup>Relative efficiencies are based on comparisons to the RCB model.

<sup>‡</sup>Spearman's rank correlation coefficients are based on comparisons to the RCB model.

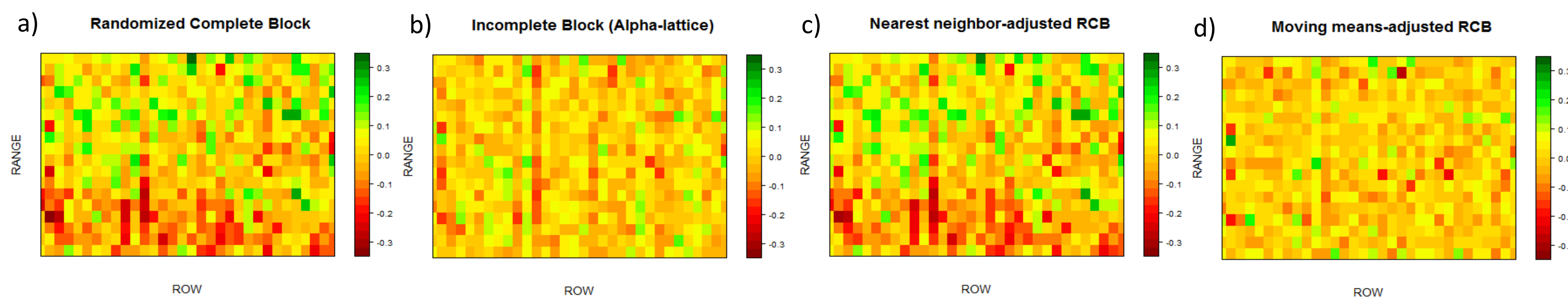


Figure 2. Residuals from the a) RCB model, b) ALPHA model, c) RCB-NNA model, and d) RCB-MVNG model of NDVI measured at first bloom on trial 7 in 2015.

## Conclusions

- Nearest neighbor covariate analysis was less efficient in controlling for experimental error in comparison to moving means covariate analysis
  - Check plot design not a cost effective strategy in these breeding trials
- Moving means covariate analysis may be used as an *a posteriori* control for spatial variability in breeding trials, particularly when blocking is ineffective
  - MVNG is not an equivalent substitute for appropriate experimental designs, such as the ALPHA design.

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