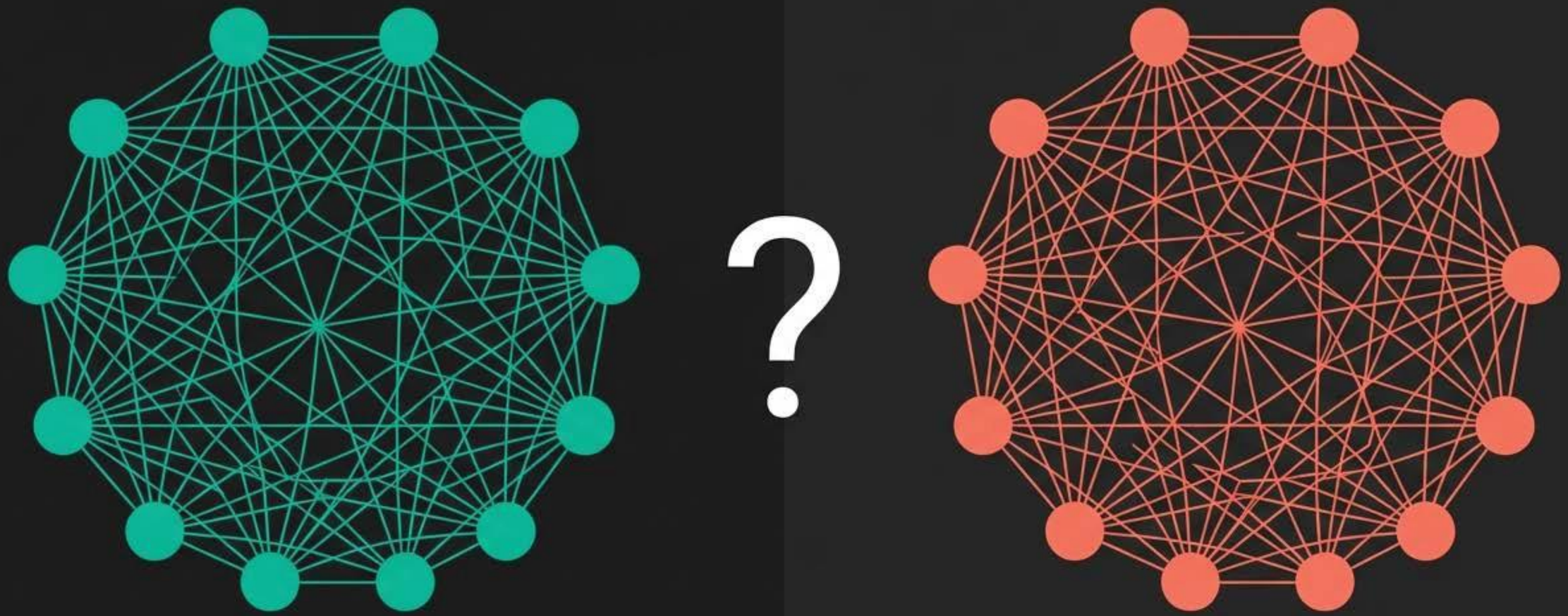
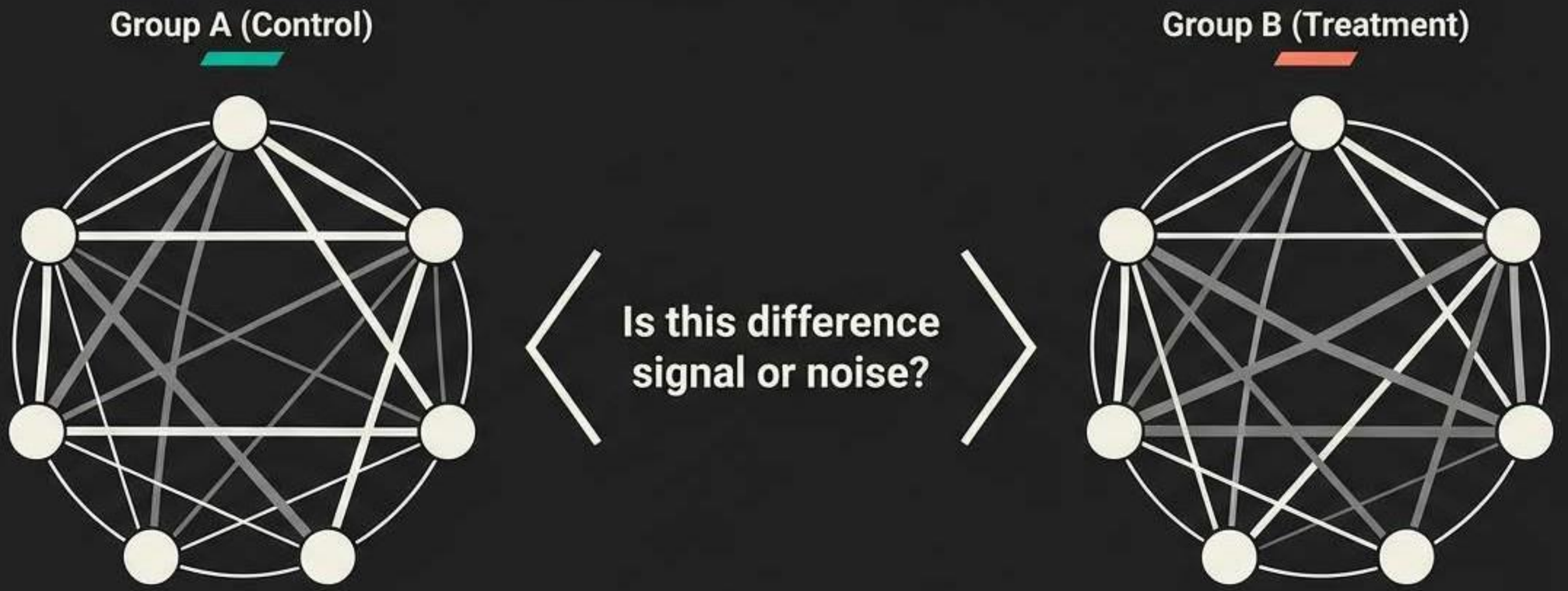


Testing for Group Differences in Multilevel **Vector Autoregressive Models**

From ‘Eyeballing’ to Inference using [redacted] mIVAR

[redacted]

The Problem with ‘Eyeballing’ Dynamics



Psychological research often asks: Is the dynamic network of Group A different from Group B?

Current State: Visual comparison is subjective.

The Gap: Without formal inference, we cannot distinguish population heterogeneity from sampling variation.

Defining the Mathematical Object

$$y_{t,s} = \mu_s + B_s(y_{t-1,s} - \mu_s) + \zeta_{t,s}$$

State of subject s at time t

Subject-specific mean

The Temporal Network (Lagged coefficients)

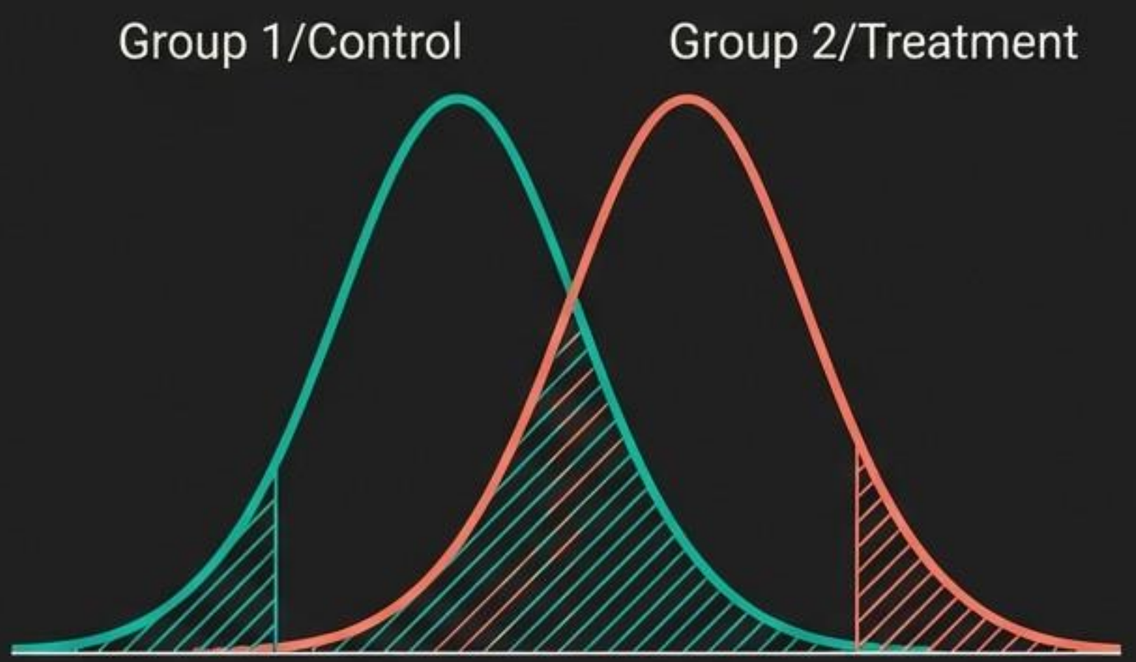
Primary target of testing

Innovation (residuals)

We test for differences in the distributions of these parameters across groups.

Path 1: The Parametric Test

- **Logic:** Uses standard errors to compute t-tests on parameters.
- **Assumption:** Sampling distribution of group differences is Gaussian (Central Limit Theorem).
- **Pros:** Fast computation.
- **Cons:** Assumes normality (often violated in psych data). Cannot test Random Effects variances in `mlVAR`.

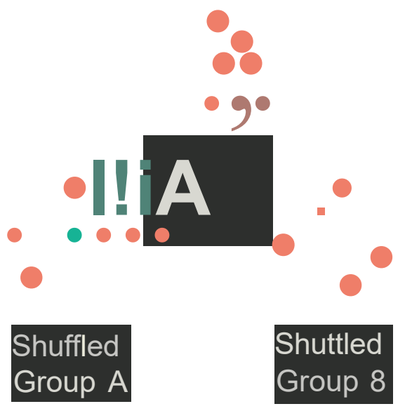


Comparing Means: β_{group1} vs β_{group2}

Path 2: The Nonparametric Permutation Test (Recommended)

Original Groups

Shuffle Labels



Build Null Distribution (1000+ perms)

Compare Observed Difference

Observed Difference

Computationally heavy, but robust to non-normal data and applicable to random effects.

mnet

Modeling Group Differences and Moderation Effects in Statistical Network Models

```
> install.packages('mnet')
> library(mnet)
```

The bridge between mlVAR estimation and hypothesis testing.

Step 1: Data Preparation

Subject Identifier

Variables of Interest

ID	Time	Happy	Group
1	1	5	0
1	2	6	0
2	1	2	1
2	2	3	1

Must be a binary indicator (e.g., 0 vs 1). Continuous moderators must be binarized.

Step 2: The Function Call

```
output <- mlVAR_GC(
  data = data,
  vars = c('Happy', 'Sad', 'Anxious'),
  idvar = 'ID',
  dayvar = 'Day',
  beepvar = 'Beep',
  groups = 'GroupVar',
  test = 'permutation',
  nP = 1000
)
```

Group Comparison Function

Critical Choice: Parametric vs Permutation

Step 3: Critical Arguments

- `test`: Choose 'permutation' (robust) or 'parametric' (fast).
- `paired`: FALSE for independent samples (Patients vs Controls). TRUE for within-subject (Pre vs Post).
- `nCores`: Crucial for performance. Use parallel processing (e.g., nCores = 12) to reduce runtime from days to minutes.
- `nP`: Number of Permutations. Recommend >= 1000 for stable p-values.

Step 4: Interpreting the Output Object

`output`

`$EmpDiffs`

Matrix of observed differences (Group 1 - Group 2)

`$ModelsEmp`

Original mlVAR objects for both groups

`$Pvals`

Matrix of significance values

`$Runtime_min`

E□ecution time in minutes

Case Study: Emotion Dynamics in Depression

Source: Koval et al. (2013)

Subjects: 95

Undergraduate students

Data: ESM

10 times/day for 7 days

Variables: 7

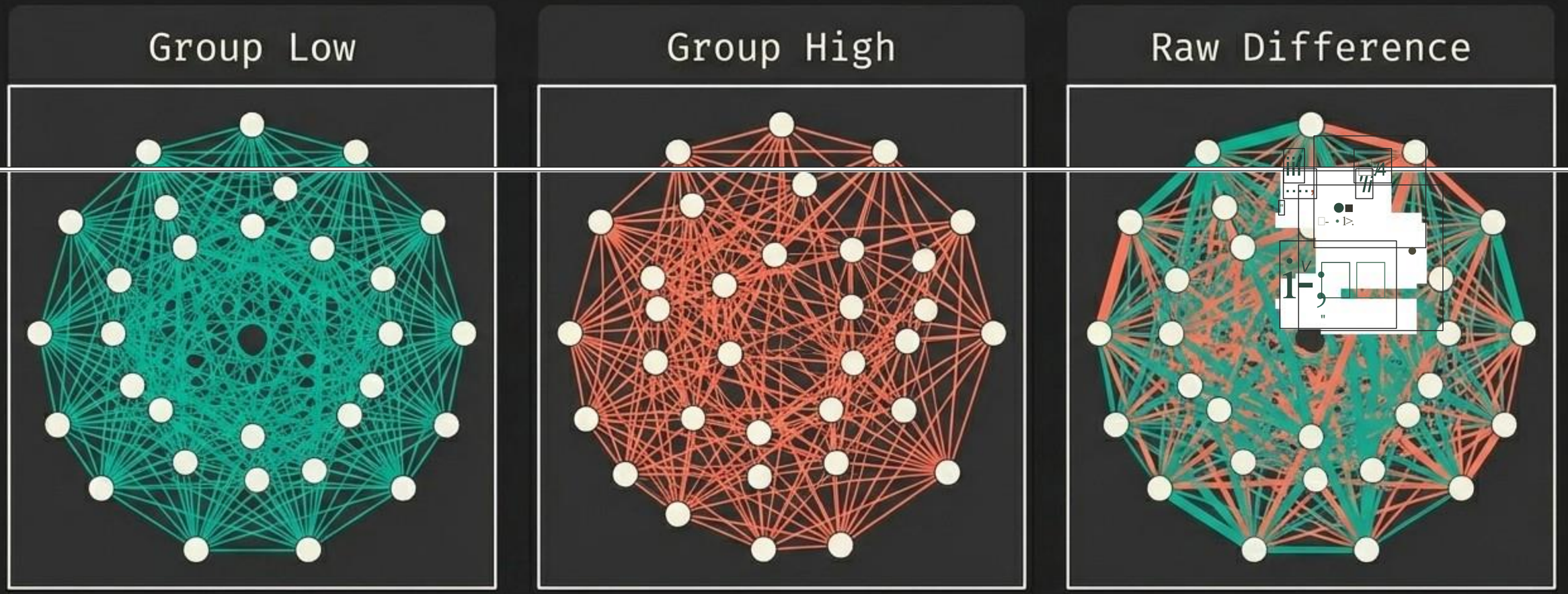
(Happy, Relaxed, Sad, Angry, Anxious, Depressed, Stressed)

Group 1
(Low Depressive)

Defined by CES-D > 16.

Group 2
(High Depressive)

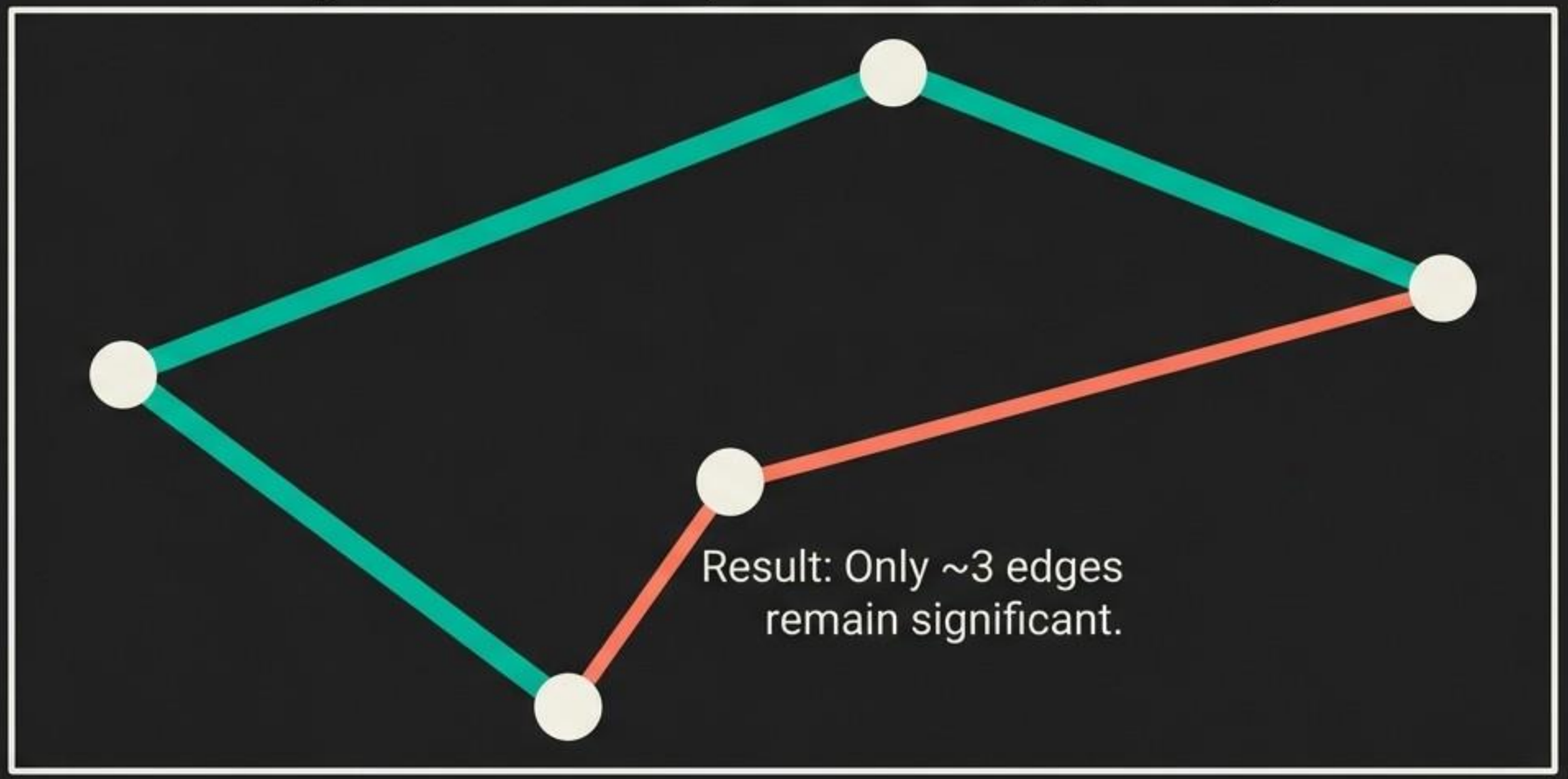
The Visual Inspection Trap



Visually, the networks appear substantially different. Is it real?

Filtering Signal from Noise

Significant Differences (Permutation Test, alpha = 0.05)



Most visual differences were due to sampling variation. Formal inference prevented false positives.

Recommendations & Limitations

✓ Best Practices

- ✓ Use Permutation tests for robustness.
- ✓ Use >= 1000 permutations.
- ✓ Avoid visual ‘eye-balling’.

⚠ Limitations

- ⚠ Computational cost is higher.
- ⚠ Caution with Between-Subject Networks (mlVAR estimation bias).

Summary

mnet provides a methodological bridge from descriptive analysis to rigorous hypothesis testing.

GitHub: `jmbh/mlVARGD`

- Paper: Haslbeck, Epskamp, & Waldorp (2023)
- Package: `install.packages('mnet')`