

# The process of fitting structural equation models

## 1. Estimate

Specify  
Model

Check  
identification

Prepare  
data

Estimate  
model

## 2. Evaluate

Evaluate fit

Bad fit:  
Respecify model

## 3. Interpret

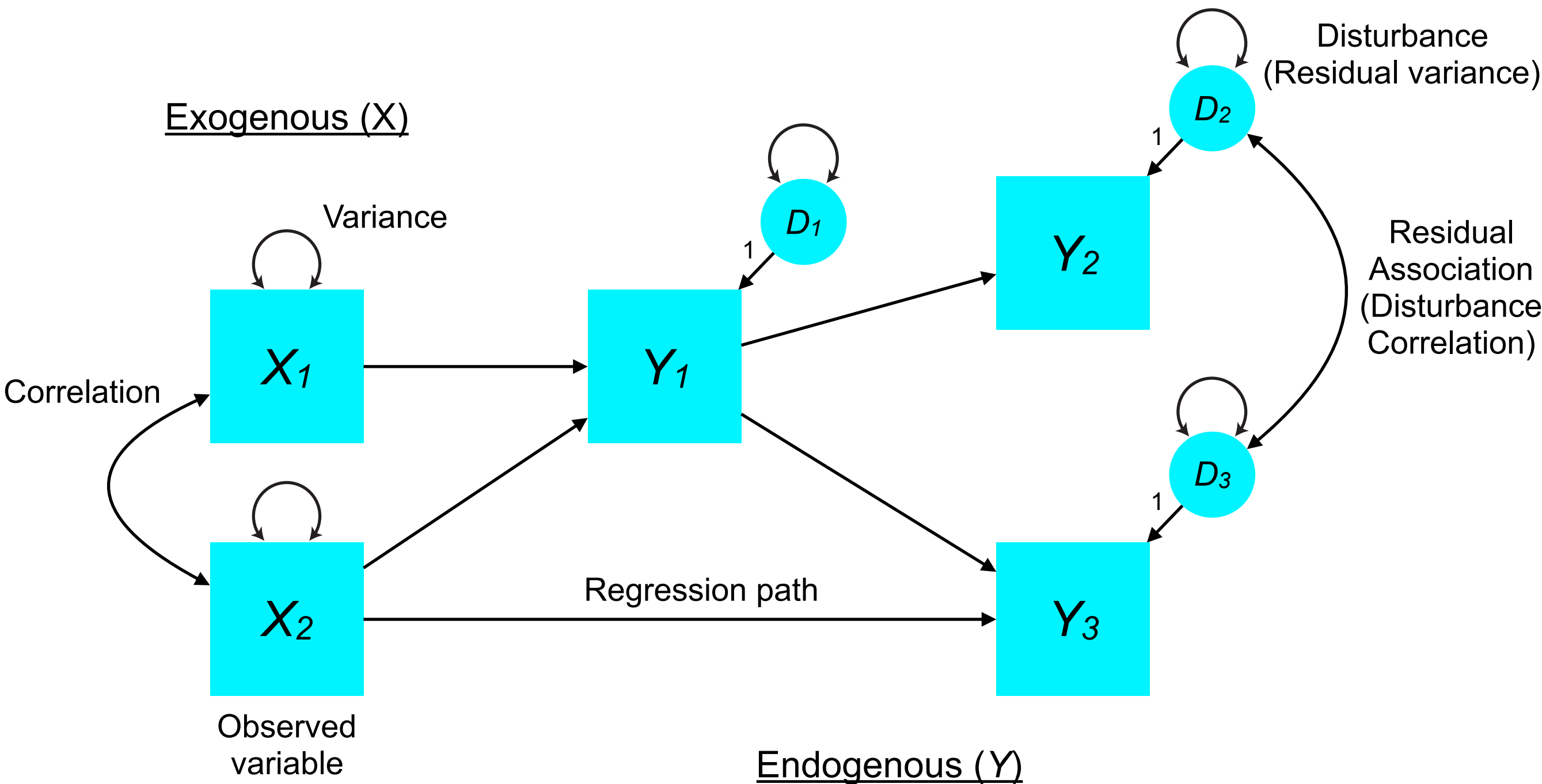
Interpret  
estimates

Consider  
other models

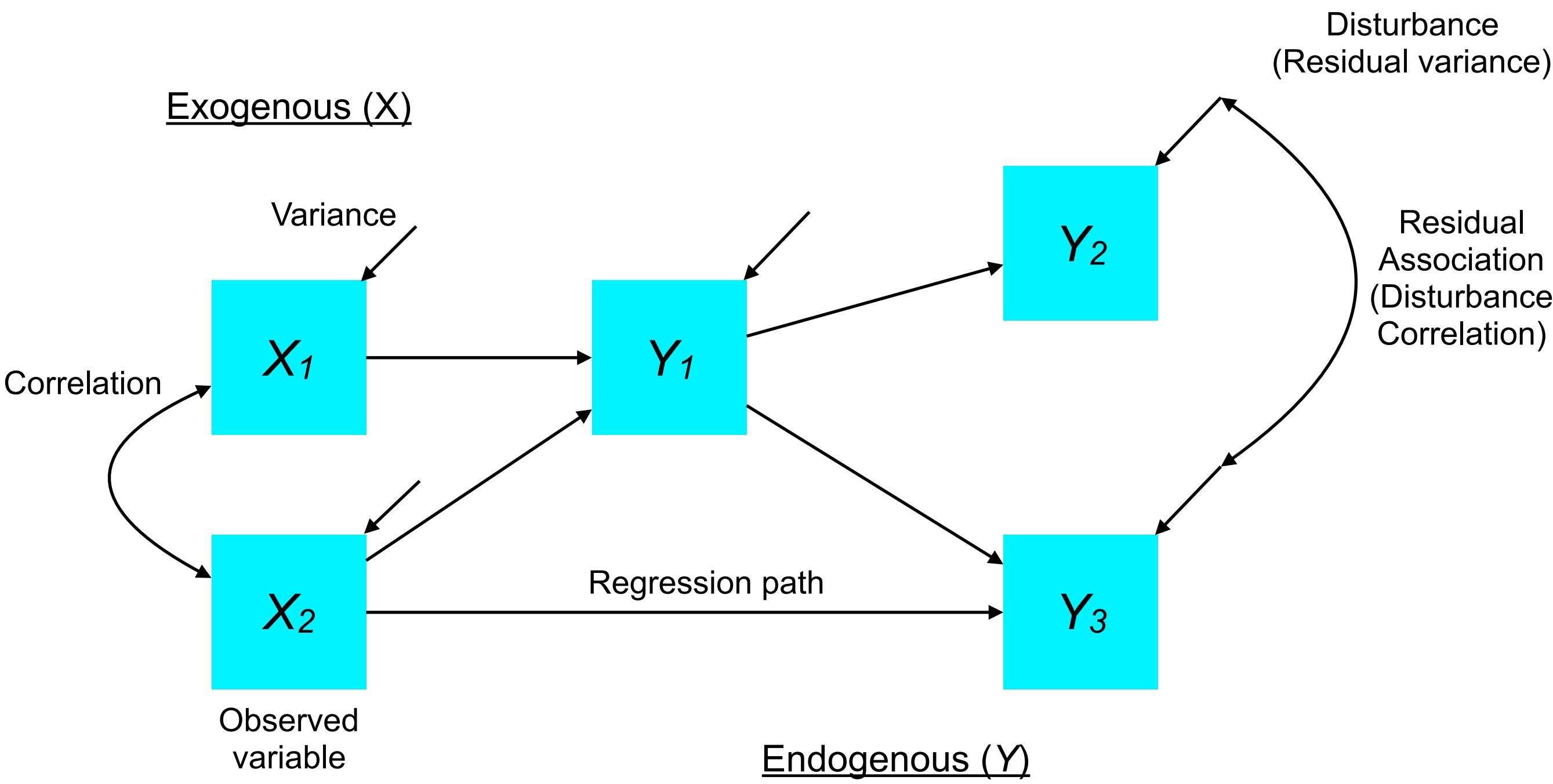
Report  
results

Good fit:  
Make inferences

# SEM notation redux (RAM notation)



# SEM notation redux (simplified RAM notation)



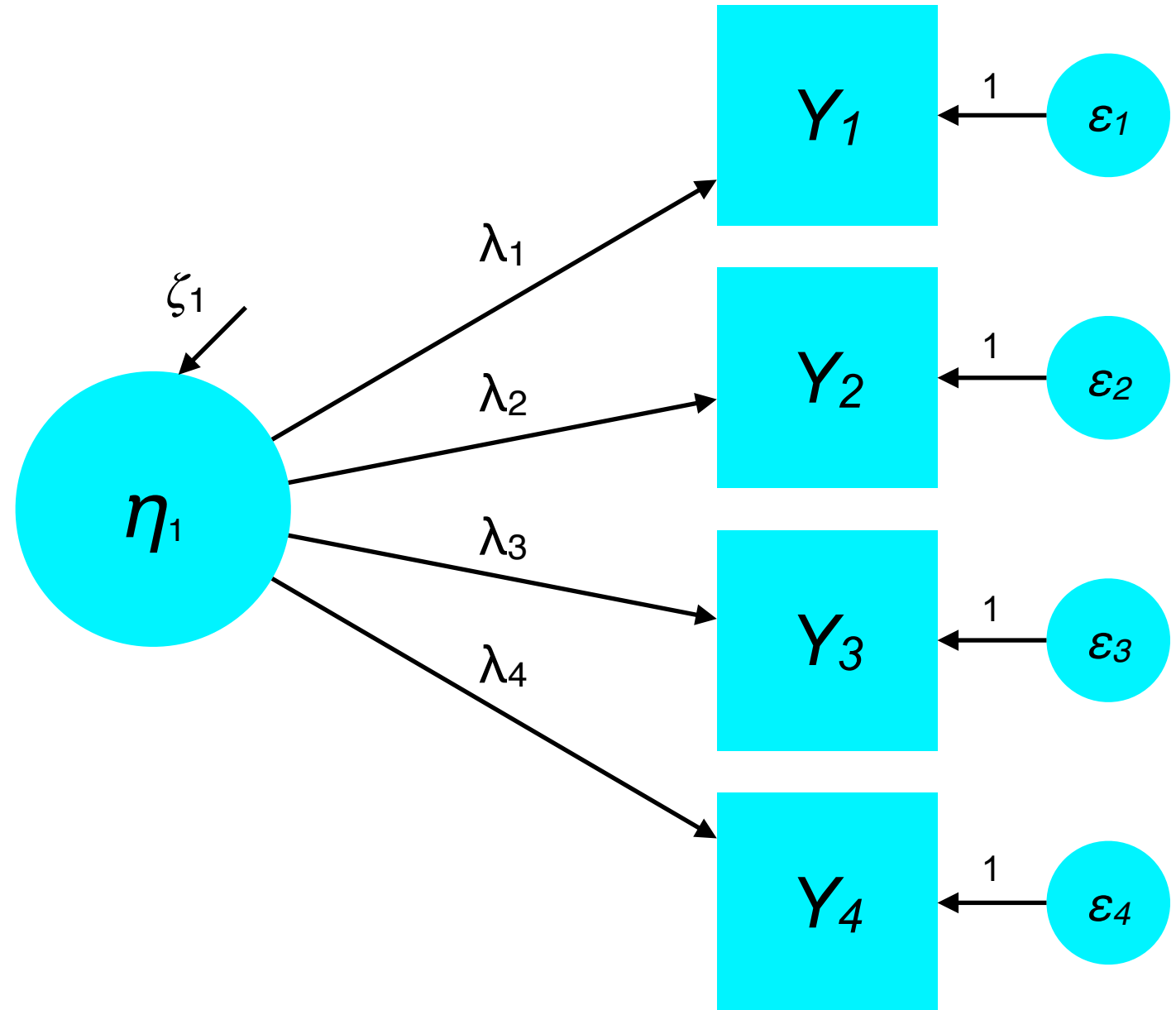
# Common Factor Model

$$y_1 = \alpha_1 + \lambda_1 \eta_1 + \varepsilon_1$$

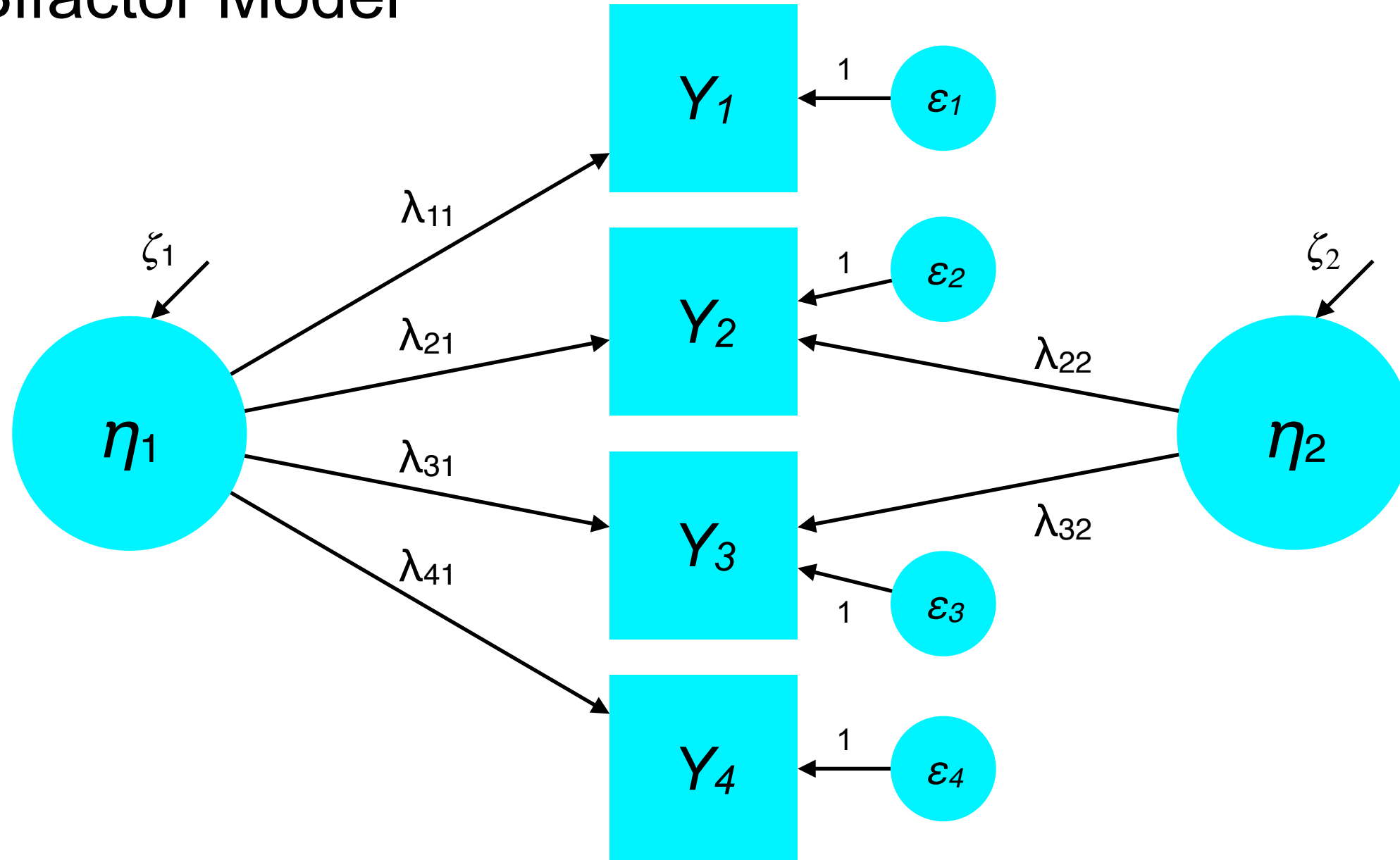
$$y_2 = \alpha_2 + \lambda_2 \eta_1 + \varepsilon_2$$

$$y_3 = \alpha_3 + \lambda_3 \eta_1 + \varepsilon_3$$

$$y_4 = \alpha_4 + \lambda_4 \eta_1 + \varepsilon_4$$



# Bifactor Model



$$y_1 = \alpha_1 + \lambda_{11}\eta_1 + \varepsilon_1$$

$$y_2 = \alpha_2 + \lambda_{21}\eta_1 + \lambda_{22}\eta_2 + \varepsilon_2$$

$$y_3 = \alpha_3 + \lambda_{31}\eta_1 + \lambda_{32}\eta_2 + \varepsilon_3$$

$$y_4 = \alpha_4 + \lambda_{41}\eta_1 + \varepsilon_4$$

# Estimating SEMs

Specify an estimable model,  
code into *lavaan* syntax

Software estimates plausible starting values  
for all parameters

Software estimates model-implied covariance  
matrix ( $\Sigma$ ) at current parameter values

Compare model-implied covariance ( $\Sigma$ ) to  
observed covariance ( $S$ ) according to sample  
log-likelihood function

$$(\mathbf{Y}_i - \boldsymbol{\mu})' \boldsymbol{\Sigma}^{-1} (\mathbf{Y}_i - \boldsymbol{\mu})$$

Update model parameters to reduce  
discrepancies (using derivative matrices)

Repeat until there is minimal  
change in log-likelihood  
(e.g.,  $10^{-5}$ ). This is called  
model convergence.