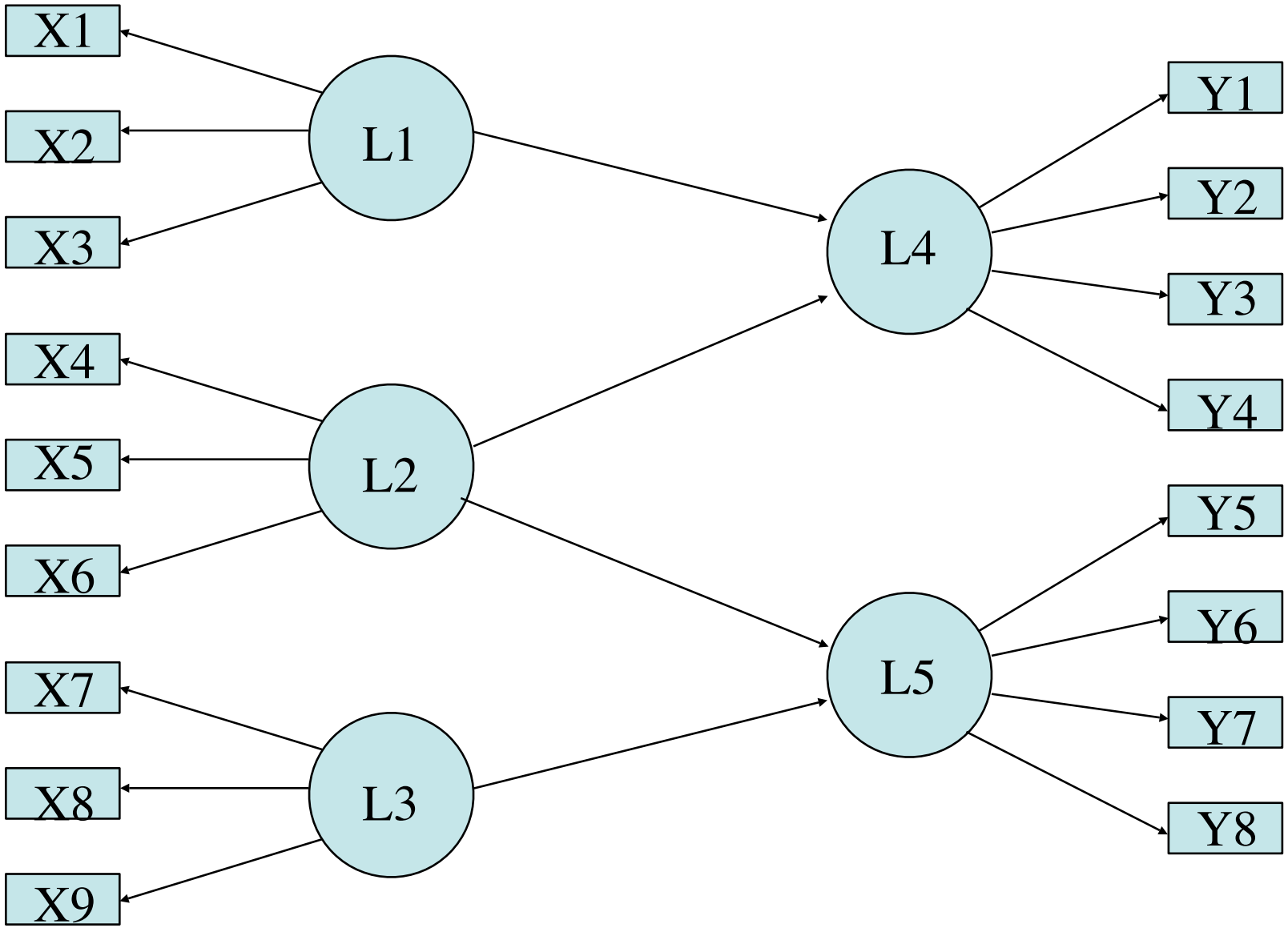
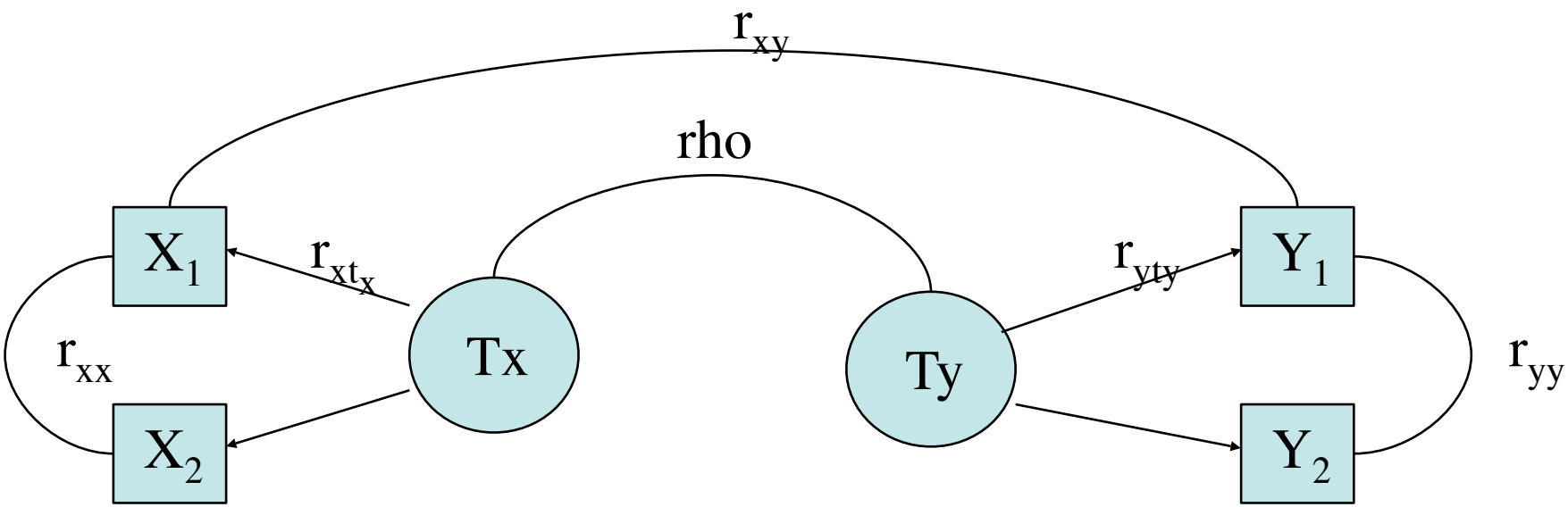
Validity

Face, Concurrent, Predictive,
Construct

Psychometric Theory: A conceptual Syllabus



Reliability- Correction for attenuation

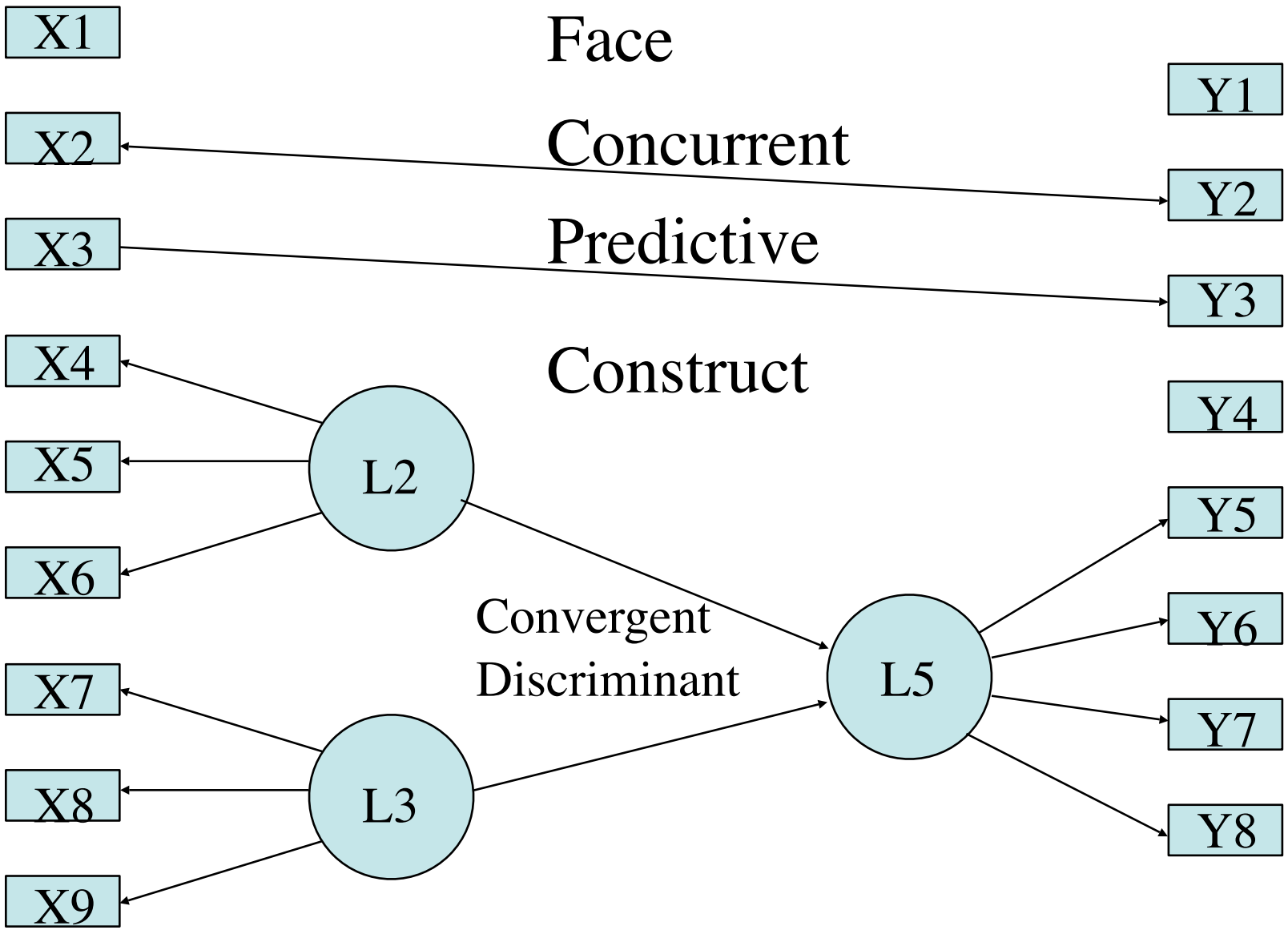


$r_{xt_x} = \text{sqrt}(r_{xx})$

$r_{yty} = \text{sqrt}(r_{yy})$

$\text{Rho} = rxy/\text{sqrt}(r_{xx} * r_{yy})$

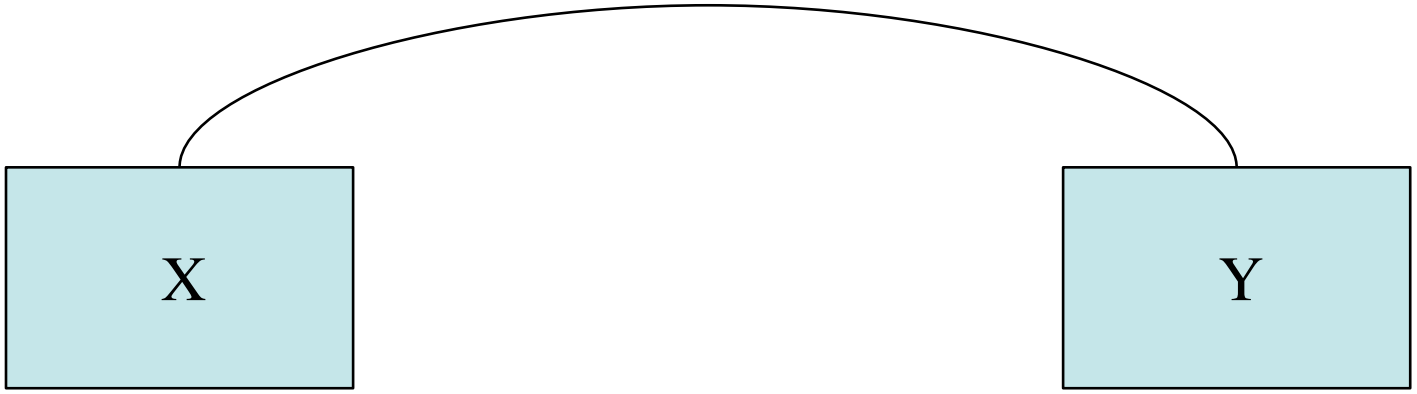
Types of Validity: What are we measuring



Face (Faith Validity)

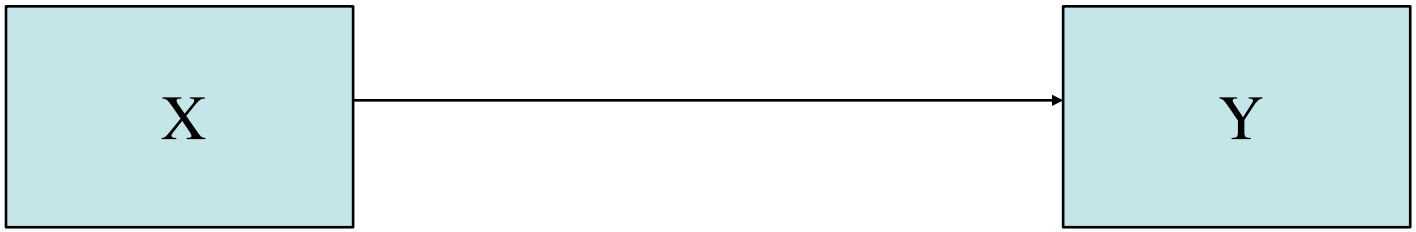
- Representative content
- Seeming relevance

Concurrent Validity



- Does a measure correlate with the criterion?
- Need to define the criterion.
- Assumes that what correlates now will have predictive value.

Predictive Validity

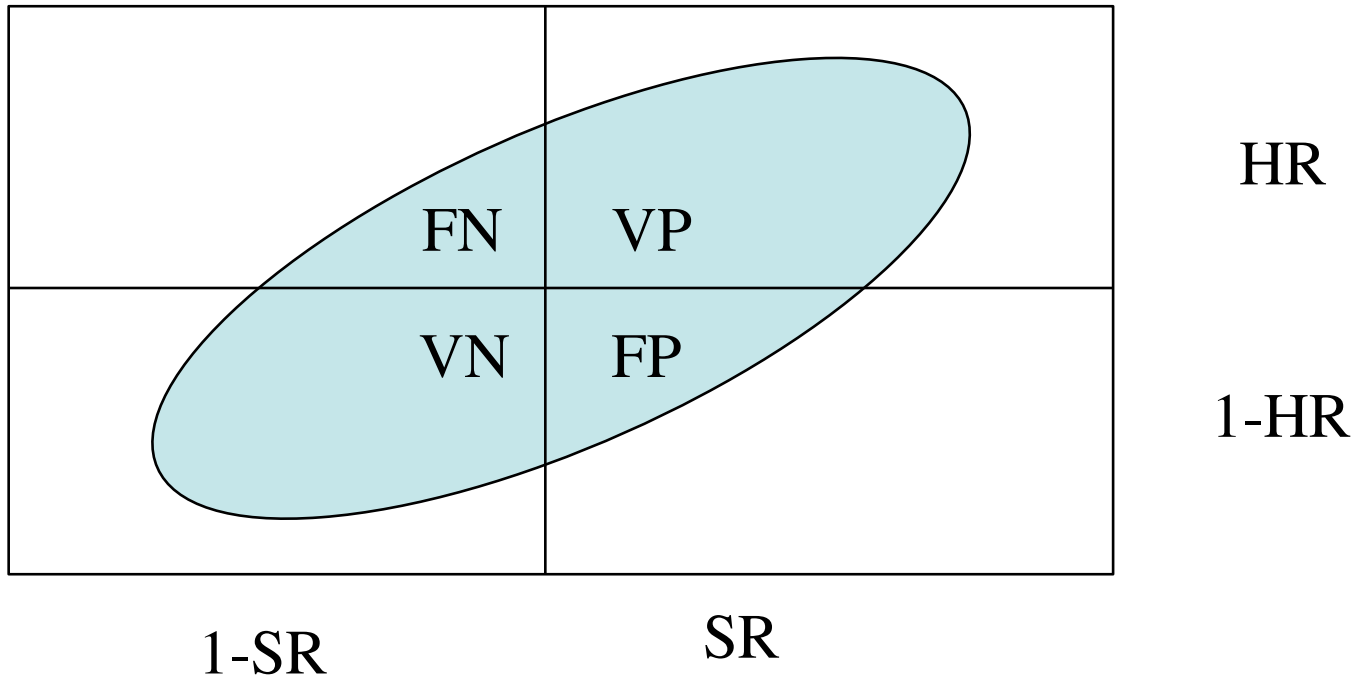


- Does a measure correlate with the criterion?
- Need to define the criterion.
- Requires waiting for time to pass.

Predictive and Concurrent Validity and Decision Making

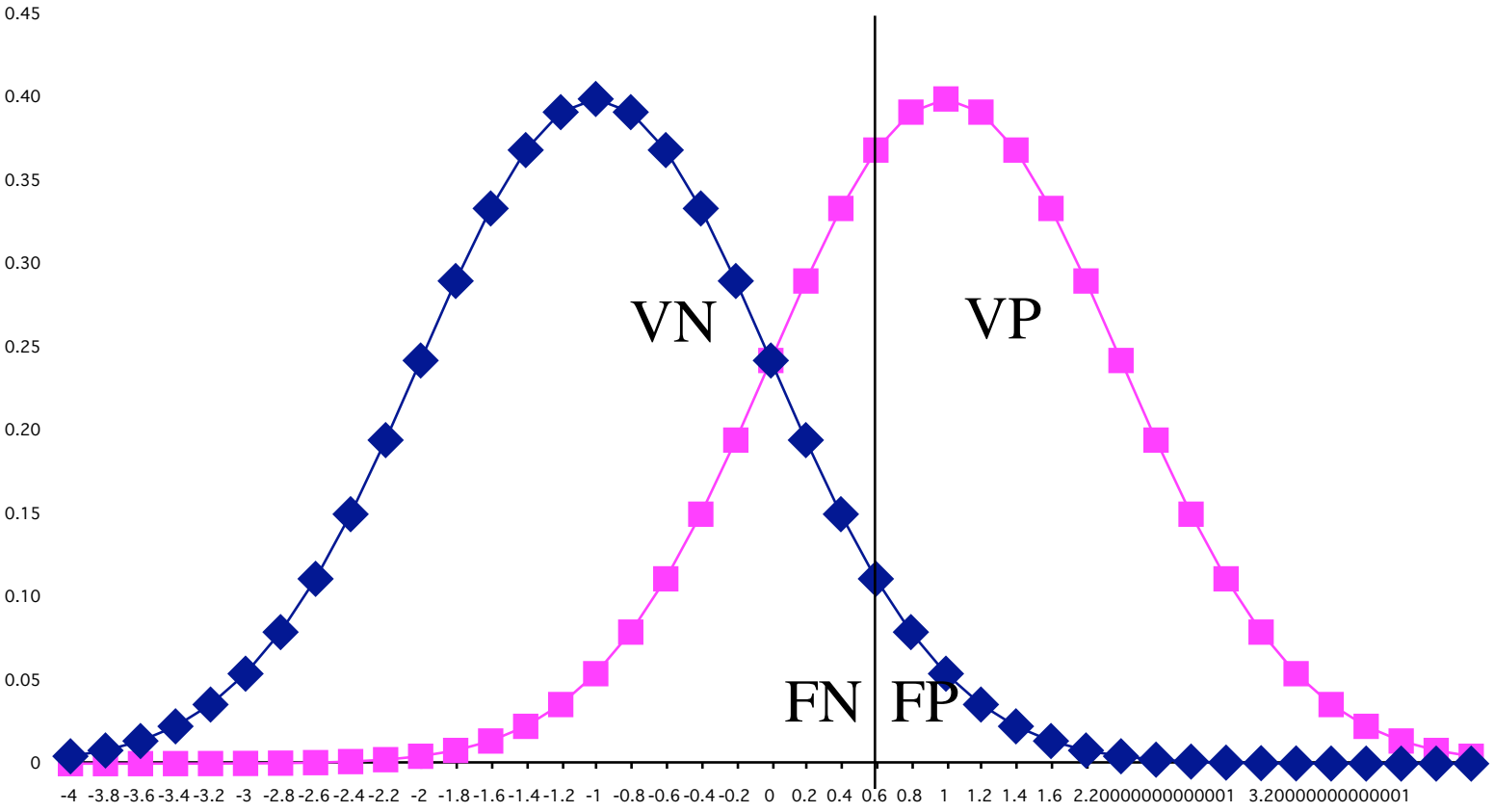
Hit Rate = Valid Positive + False Negative

Selection Ratio = Valid Positive + False Positive

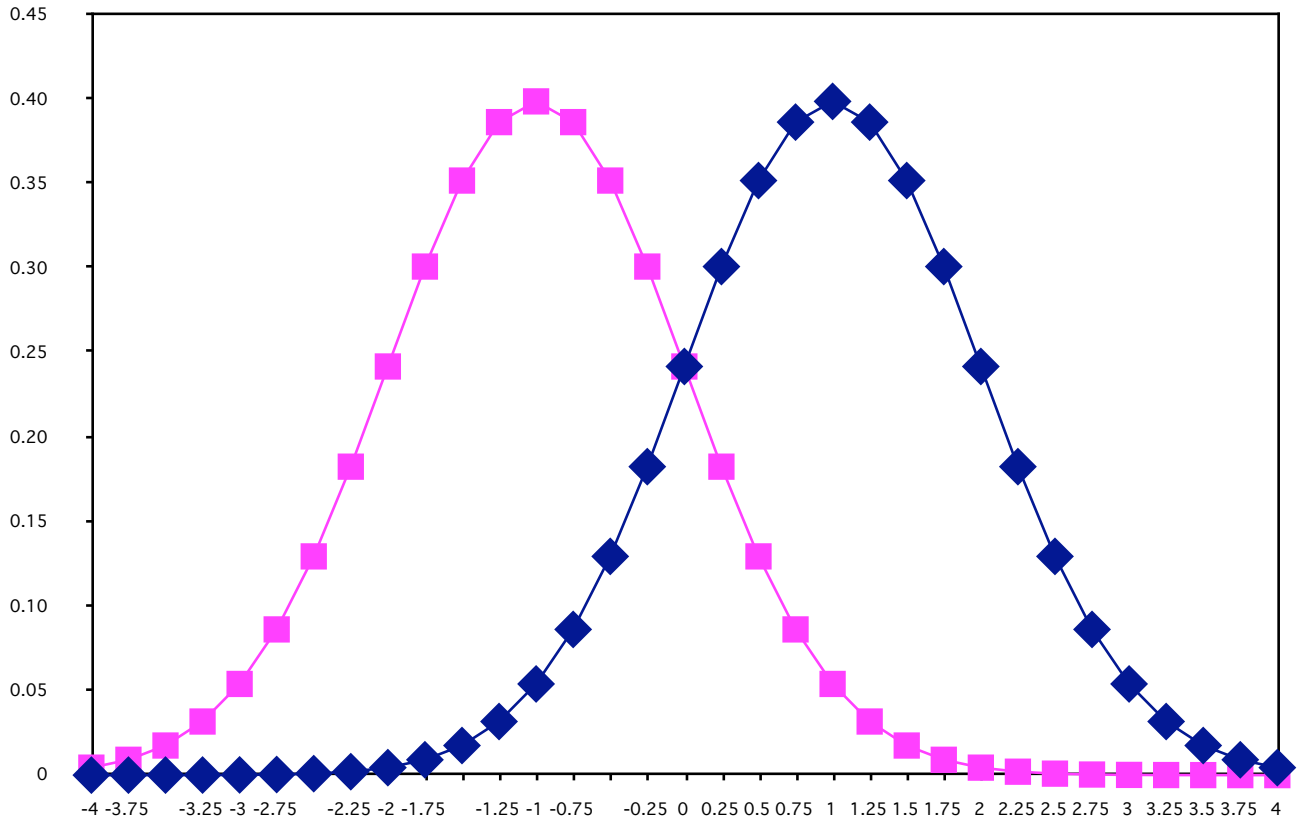


Phi =(VP - HR*SR) /sqrt(HR*(1-HR)*(SR)*(1-SR)

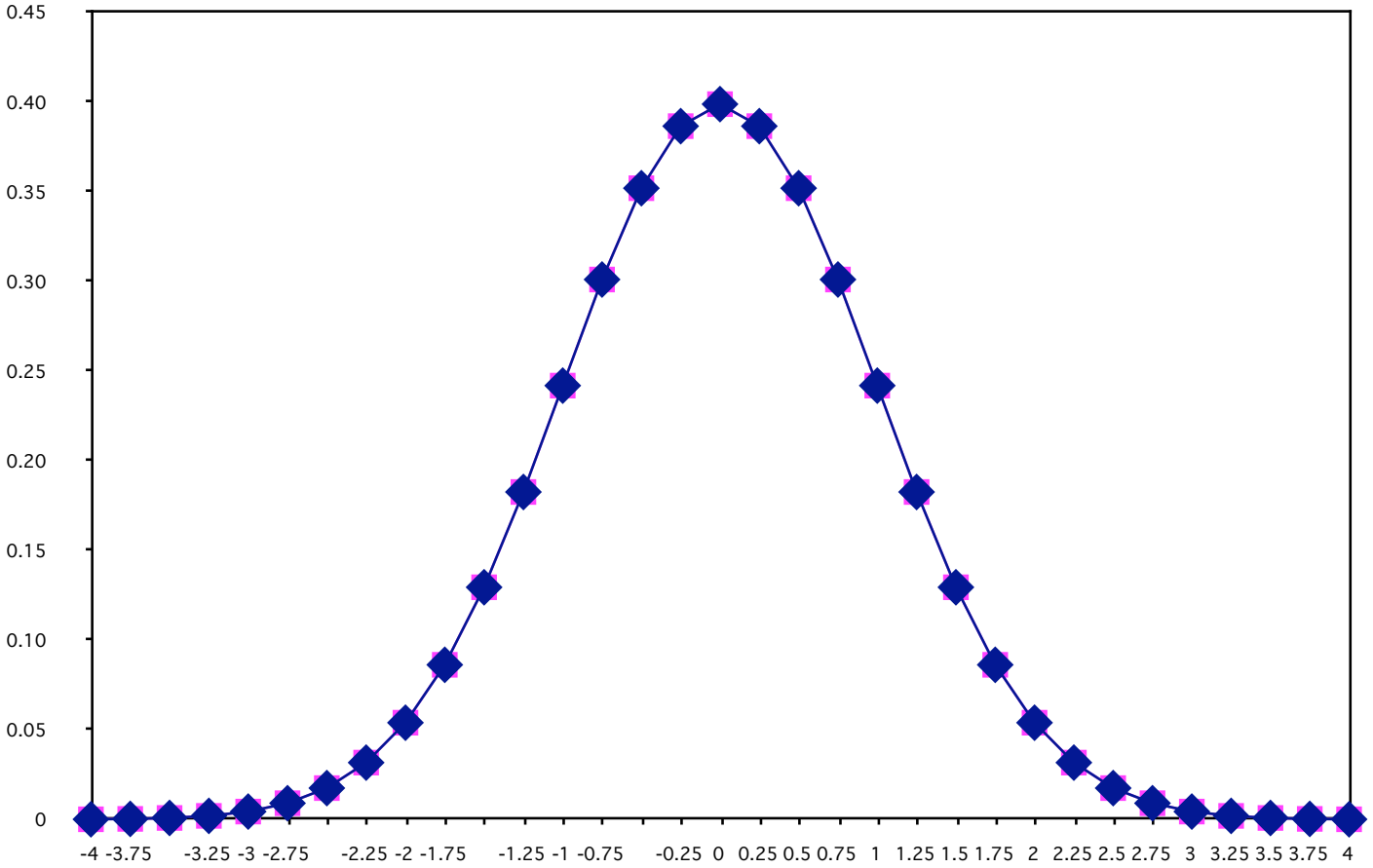
Validity as decision making



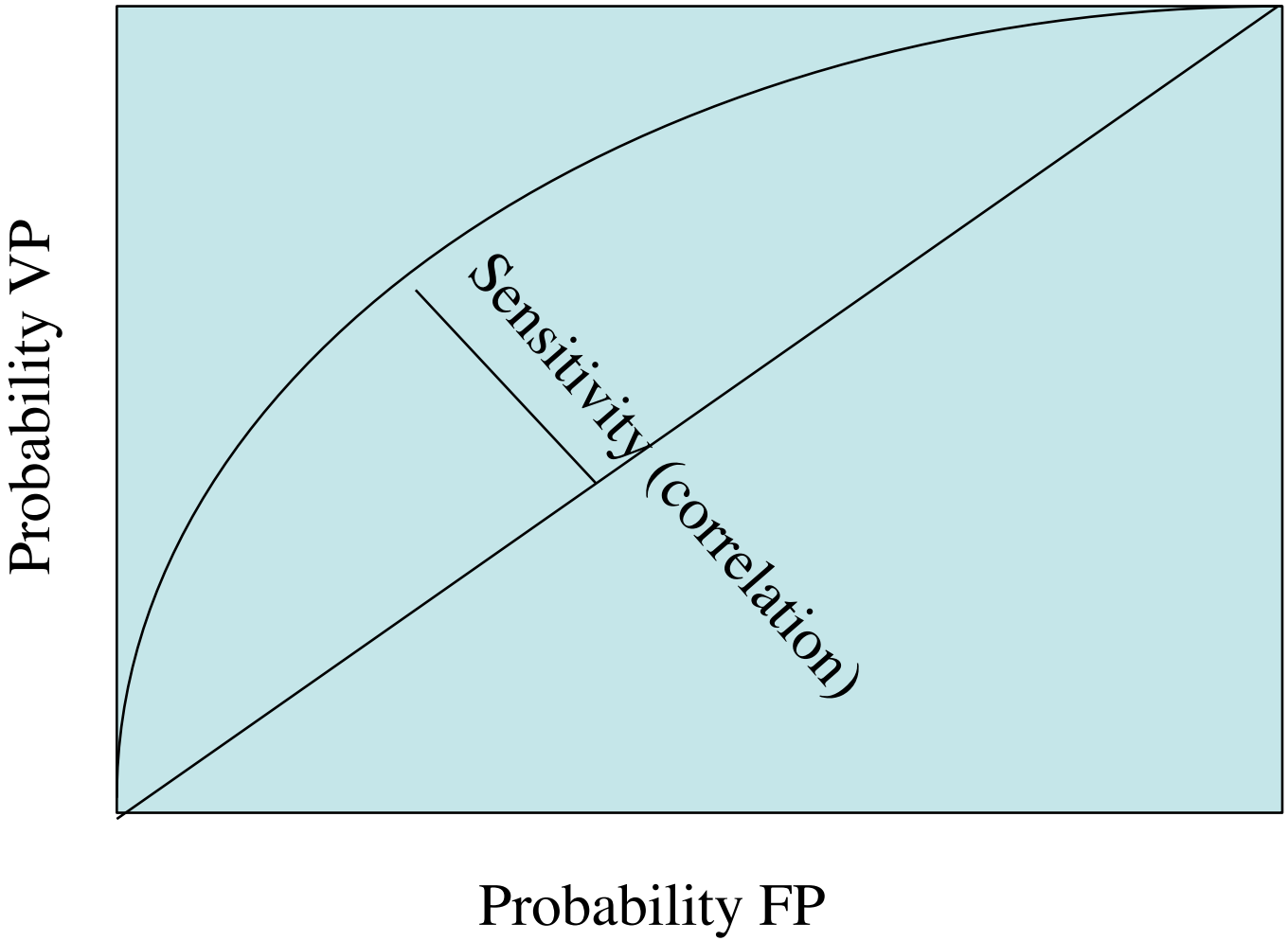
Validity as decision making



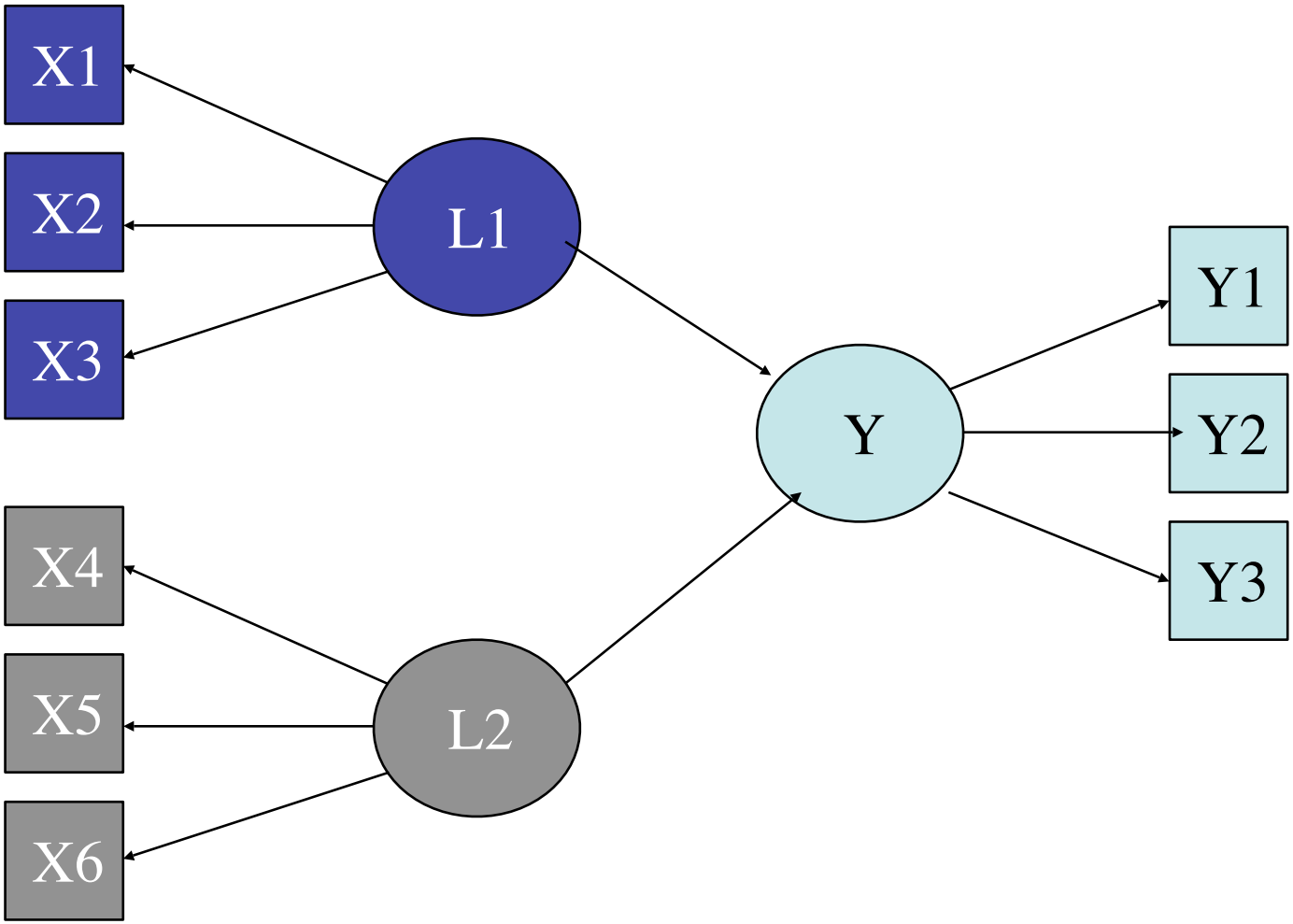
Validity as decision making



Decision Theory and Signal Detection



Construct Validity: Convergent, Discriminant, Incremental



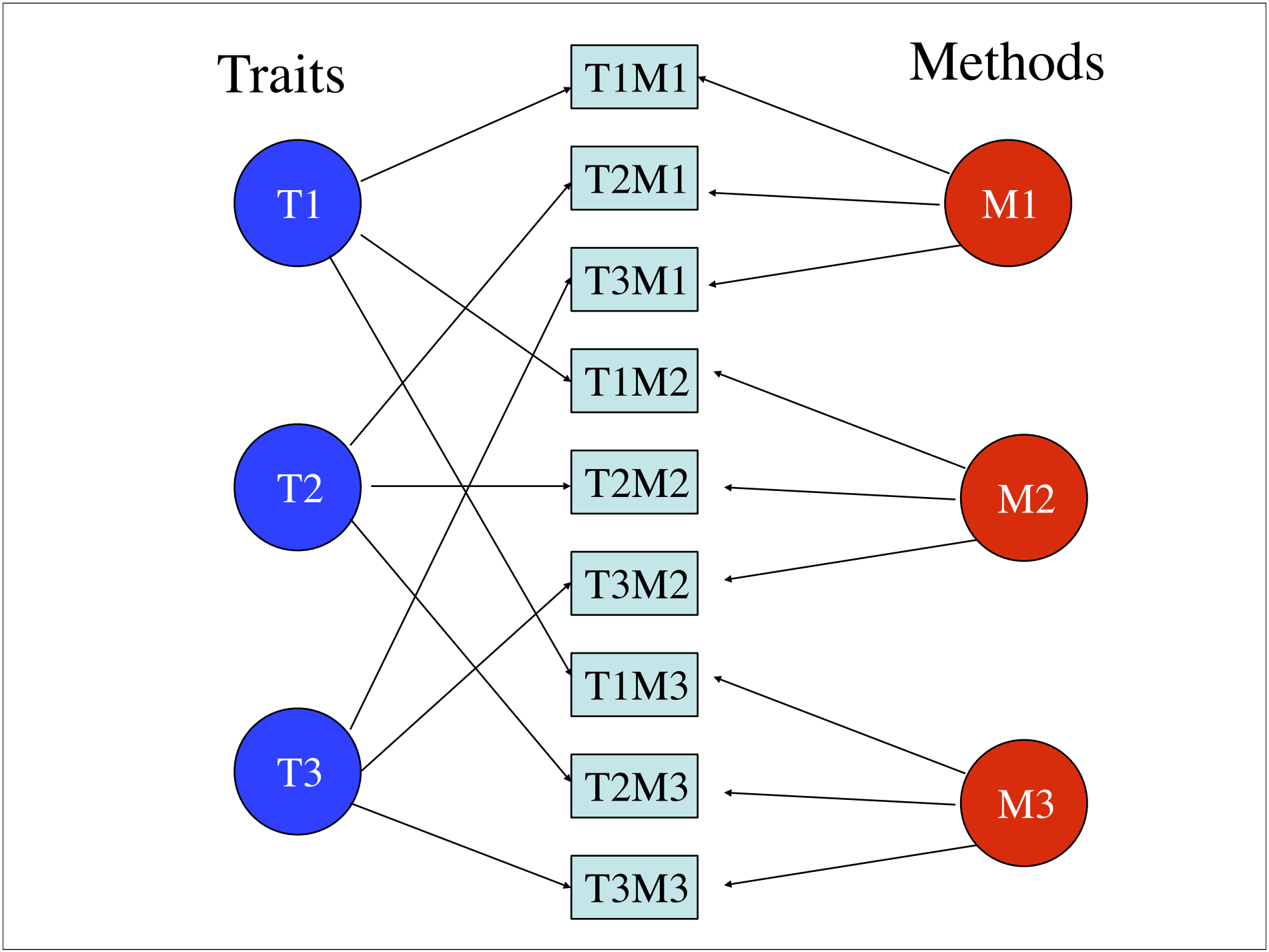
Multi-Trait, Multi-Method Matrix

	T1M1	T2M1	T3M1	T1M2	T2M2	T3M2	T1M3	T2M3	T3M3
T1M1	T1M1								
T2M1	M1	T2M1							
T3M1	M1	M1	T3M1						
T1M2	T1			T1M2					
T2M2		T2		M2	T2M2				
T3M2			T3	M2	M2	T3M2			
T1M3	T1			T1			T1M3		
T2M3		T2			T2		M3	T2M3	
T3M3			T3			T3	M3	M3	T3M3

Mono-Method, Mono trait = reliability

Hetero Method, Mono Trait = convergent validity

Hetero Method, Hetero Trait = discriminant validity


Traits
Methods
T1
T2
T3
T1M1
T2M1
T3M1
T1M2
T2M2
T3M2
T1M3
T2M3
T3M3
M1
M2
M3

Model Fitting

Structural Equation Models

Reliability + Validity

Basic concepts of iterative fit

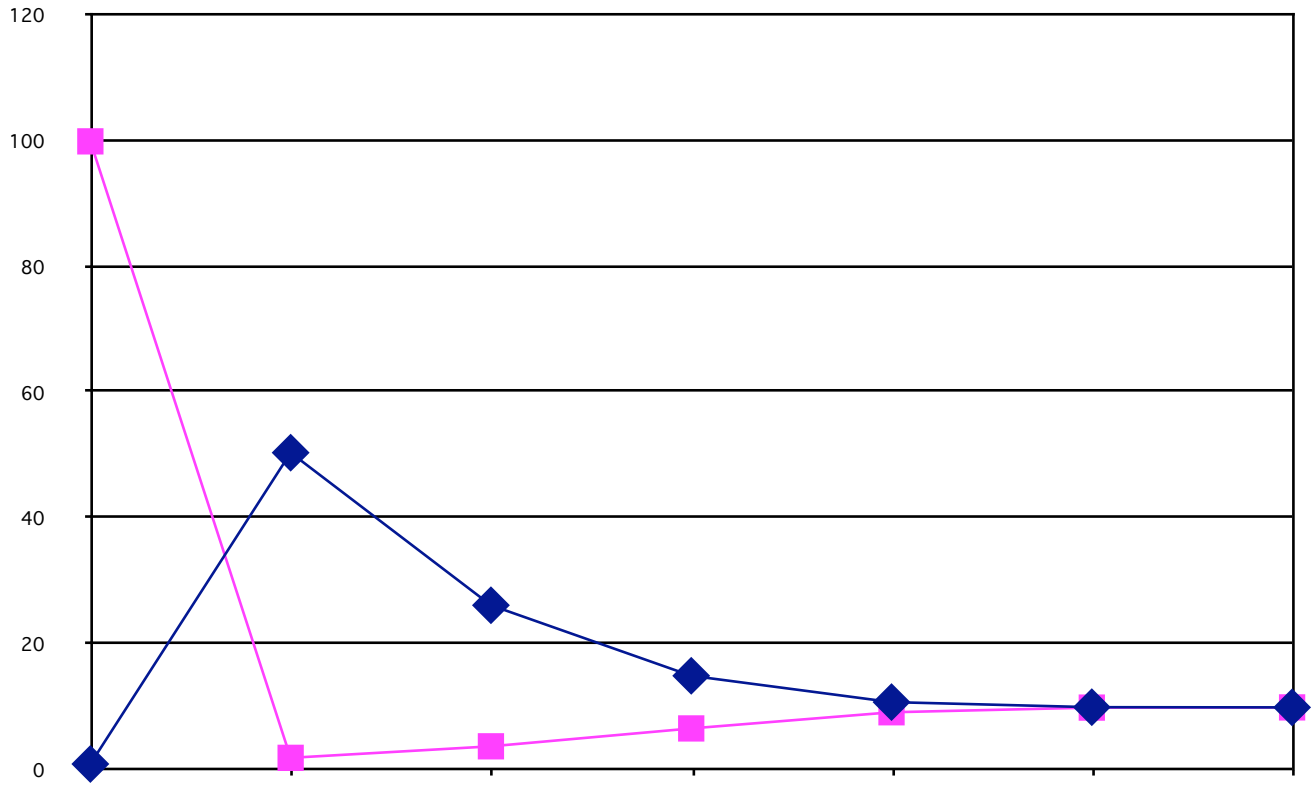
- Most classical statistics (e.g. means, variances, regression slopes) may be found by algebraic solutions of closed form expressions
- More recent statistics are the results of iteratively fitting a model until some criterion is either minimized or maximized.

Simple example: the square root

Target 100

Trial	guess	fit	diff
1	1.0	100.0	-99.0
2	50.5	2.0	48.5
3	26.2	3.8	22.4
4	15.0	6.7	8.4
5	10.8	9.2	1.6
6	10.0	10.0	0.1
7	10.0	10.0	0.0

Iteratively estimating the square root of 100



Applications: Factor Analysis

x1	1.00		
x2	0.70	1.00	
x3	0.60	0.58	1.00

Iterative Fit

x1	x2	x3	fit
1.000	1.000	1.000	0.4264000
1.000	0.800	1.000	0.2180000
1.000	0.800	0.800	0.0536000
0.800	0.800	0.800	0.0088000
0.800	0.800	0.700	0.0056000
0.800	0.800	0.750	0.0040000
0.850	0.800	0.750	0.0022000
0.850	0.800	0.700	0.0008250
0.850	0.800	0.710	0.0005625
0.851	0.823	0.705	0.0000000

Fitted model

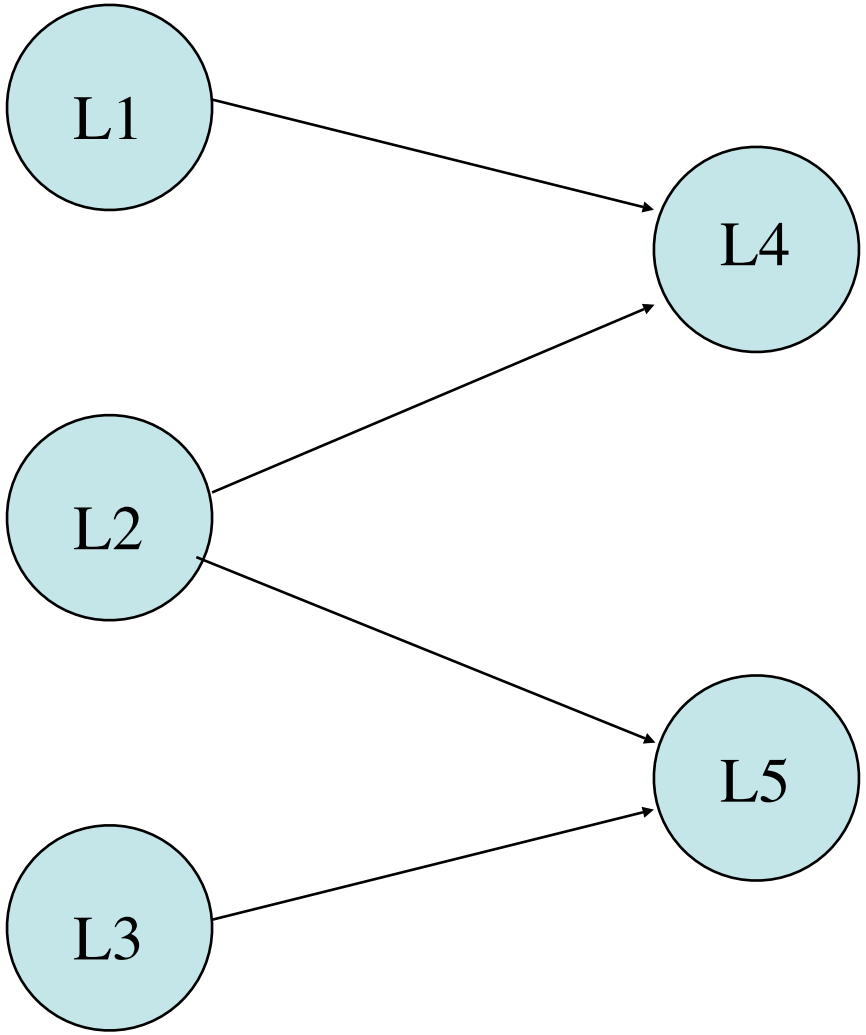
	F1
x1	0.851
x2	0.823
x3	0.705

0.72	0.70	0.60
0.70	0.68	0.58
0.60	0.58	0.50

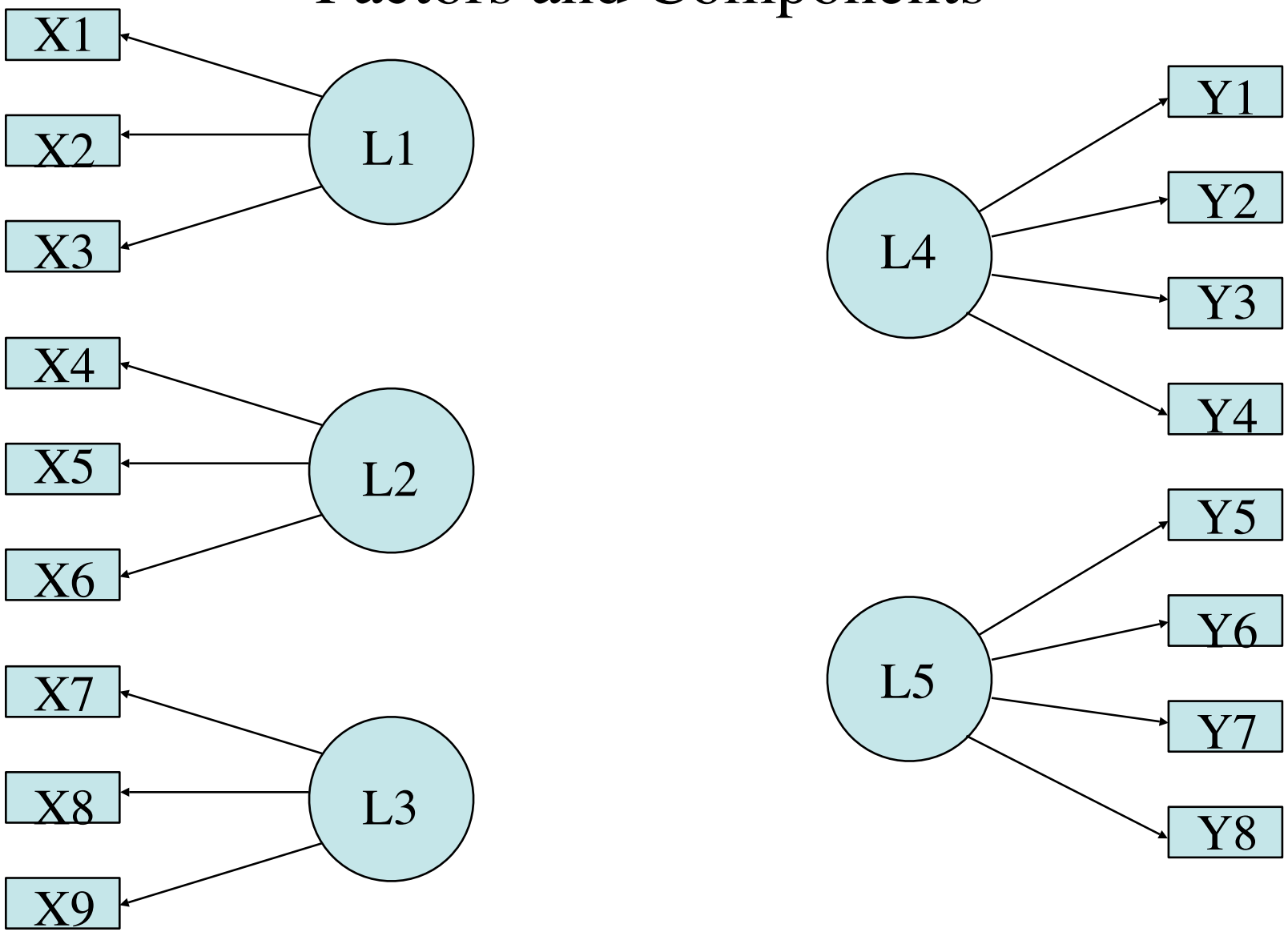
Structural Equation Models

- Basic concept is to apply a measurement model to a structure (regression) model
- Generically known as SEM, particular programs are LISREL, EQS, RAMONA, RAM-path, Mx, sem
- May be used for confirmatory factor analysis as well as sem.

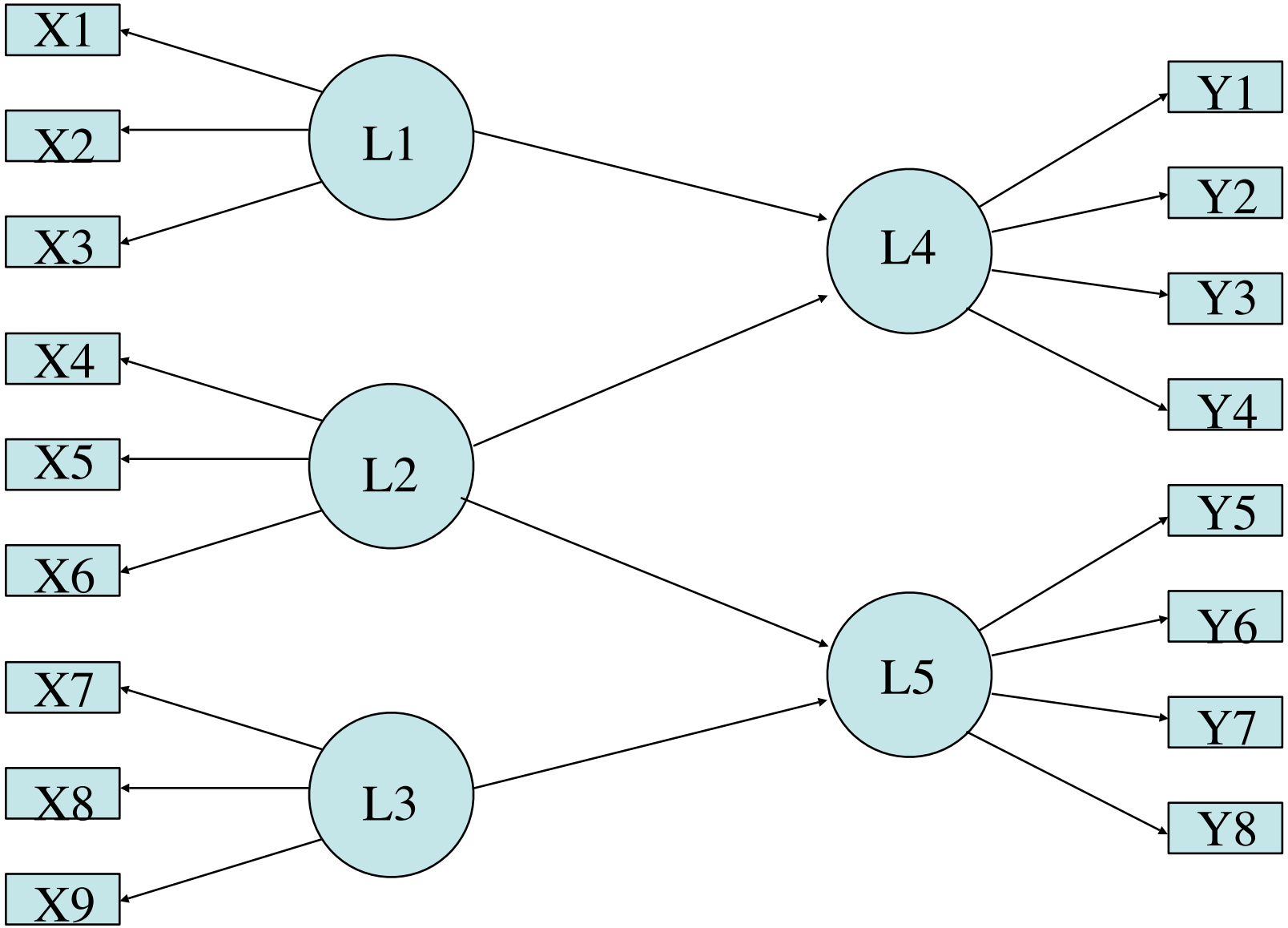
Theory as organization of constructs



Techniques of Data Reduction: Factors and Components



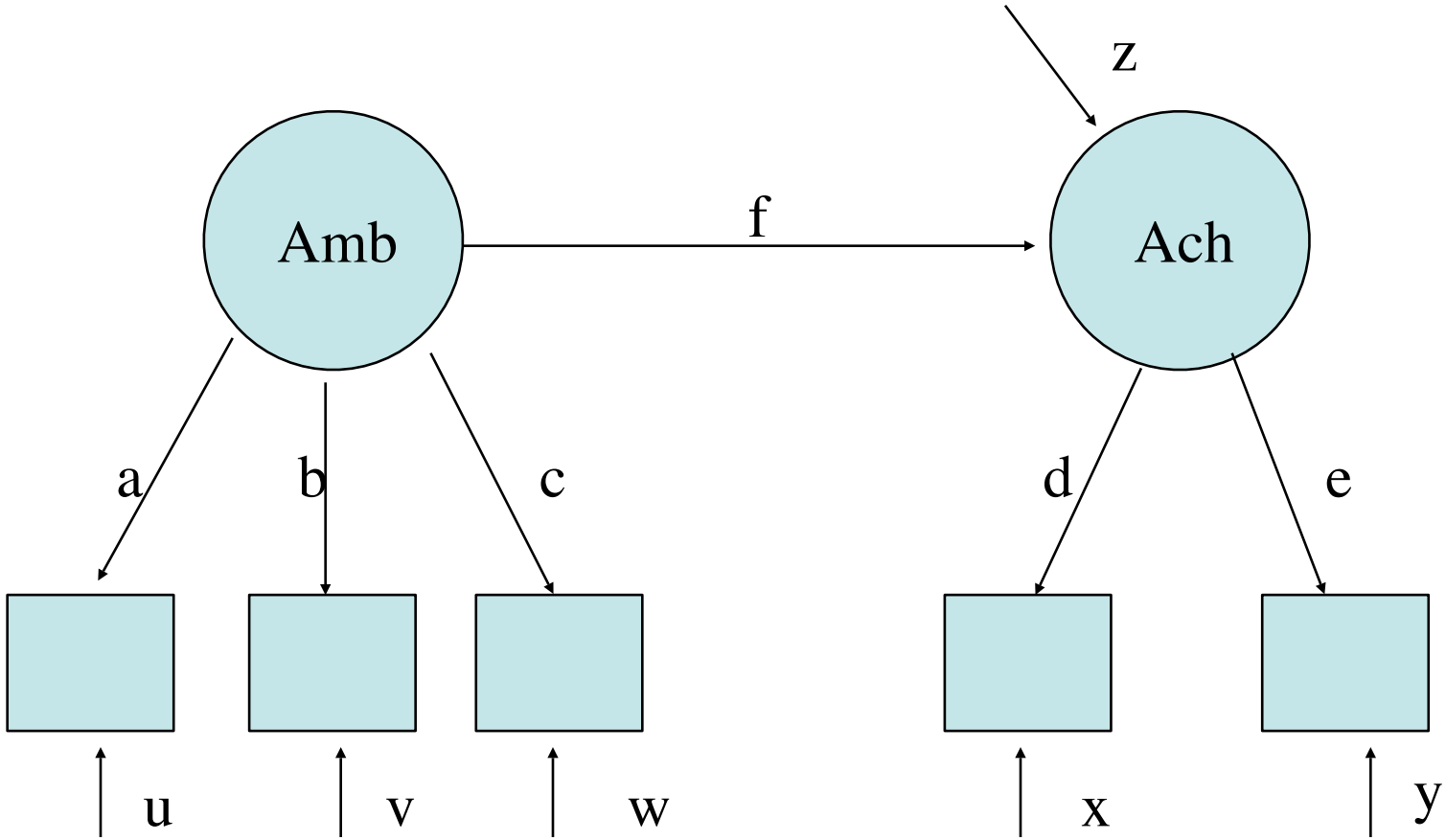
Structural Equation Modeling: Combining Measurement and Structural Models



SEM problem (Loehlin 2.5)

Ach1	Ach2	Amb1	Amb2	Amb3
1	0.6	0.3	0.2	0.2
0.6	1	0.2	0.3	0.1
0.3	0.2	1	0.7	0.6
0.2	0.3	0.7	1	0.5
0.2	0.1	0.6	0.5	1

Ambition and Achievement



R code for sem for Loehlin 2.5

First enter the correlation matrix

```
#Loehlin problem 2.5
 obs.var2.5 = c('Ach1', 'Ach2', 'Amb1', 'Amb2', 'Amb3')
 R.prob2.5 = matrix(c(
  1.00 ,  .60  , .30,  .20,   .20,
   .60,  1.00,   .20,   .30,   .10,
   .30,   .20,  1.00,   .70,   .60 ,
   .20,   .30,   .70,  1.00,   .50,
   .20,   .10,   .60,  .50,  1.00), ncol=5,byrow=TRUE)
```

R code for sem -Ram notation

```
model2.51=matrix(c(
        'Ambit ->  Amb1',      'a', NA,
        'Ambit -> Amb2' ,      'b', NA,
        'Ambit -> Amb3' ,      'c', NA,
        'Achieve -> Ach1',     'd', NA,
        'Achieve -> Ach2',     'e', NA,
        'Ambit -> Achieve',   'f', NA,
        'Amb1 <-> Amb1' ,      'u', NA,
        'Amb2 <-> Amb2' ,      'v', NA,
        'Amb3 <-> Amb3' ,      'w', NA,
        'Ach1 <-> Ach1' ,      'x', NA,
        'Ach2 <-> Ach2' ,      'y', NA,
        'Achieve <-> Achieve',  NA, 1,
        'Ambit <-> Ambit',      NA, 1),
        ncol=3, byrow=TRUE)
```

Run the R code and show results

```
sem2.5= sem(model2.5,R.prob2.5,60, obs.var2.5)
 summary(sem2.5,digits=3)
```

```
Model Chisquare =  9.74   Df =  4 Pr(>Chisq) = 0.0450
Goodness-of-fit index =  0.964
Adjusted goodness-of-fit index =  0.865
RMSEA index =  0.120   90 % CI: (0.0164, 0.219)
BIC =  -15.1

Normalized Residuals
    Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
-5.77e-01 -3.78e-02 -2.04e-06  4.85e-03  3.87e-05  1.13e+00
```

What are the parameters?

Parameter Estimates

	Estimate	Std Error	z value	Pr(>|z|)	
a	0.920	0.0924	9.966	0.00e+00	Amb1 <--- Ambit
b	0.761	0.0955	7.974	1.55e-15	Amb2 <--- Ambit
c	0.652	0.0965	6.753	1.45e-11	Amb3 <--- Ambit
d	0.879	0.1762	4.986	6.16e-07	Ach1 <--- Achieve
e	0.683	0.1509	4.525	6.03e-06	Ach2 <--- Achieve
f	0.356	0.1138	3.127	1.76e-03	Achieve <--> Ambit
u	0.153	0.0982	1.557	1.20e-01	Amb1 <--> Amb1
v	0.420	0.0898	4.679	2.88e-06	Amb2 <--> Amb2
w	0.575	0.0949	6.061	1.35e-09	Amb3 <--> Amb3
x	0.228	0.2791	0.816	4.15e-01	Ach1 <--> Ach1
y	0.534	0.1837	2.905	3.67e-03	Ach2 <--> Ach2

Iterations = 26

Problems in interpretation

- Model fit does not imply best model
- Consider alternative models
  - Reverse the arrows of causality, nothing happens
  - Range of alternative models
  - Nested models can be compared
  - Non-nested alternative models might be better

SEM points to consider

- Goodness of fit statistics
  - Statistical indices of size of residuals as compared to null model are sensitive to sample size
  - Comparisons of nested models
- Fits get better with more parameters -> development of df corrected fits
- Inspect residuals to see what is not being fit
- Avoid temptation to ‘fix’ model based upon results, or, at least be less confident in meaning of good fit

Applications of SEM techniques

- Confirmatory factor analysis
  - Does a particular structure fit the data
- Growth models (growth curve analysis)
- Multiple groups
  - Is the factor structure the same across groups
  - Is the factor structure the same across time

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