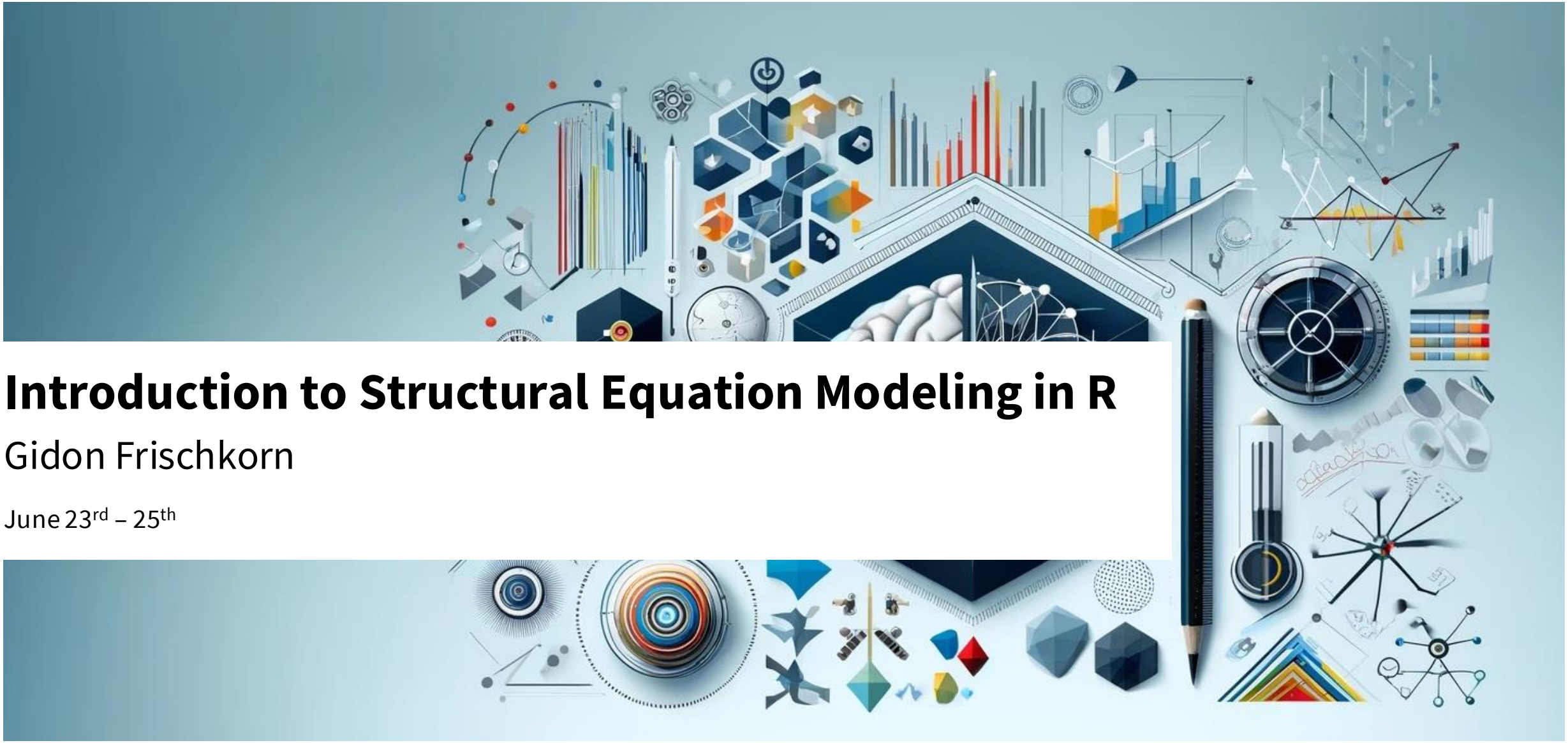
Universität Zürich[UZH]

Psychologisches Institut

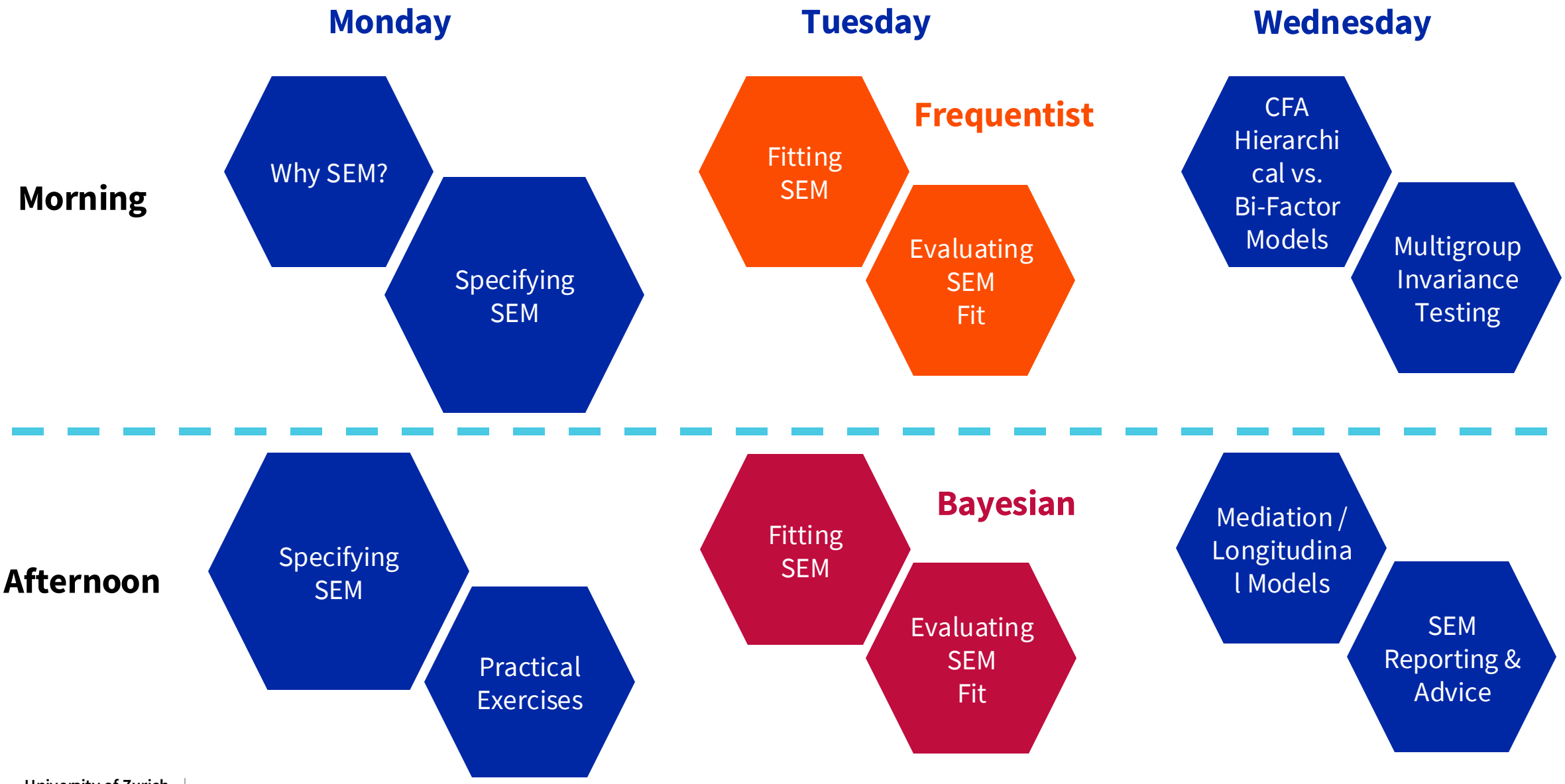


Introduction to Structural Equation Modeling in R

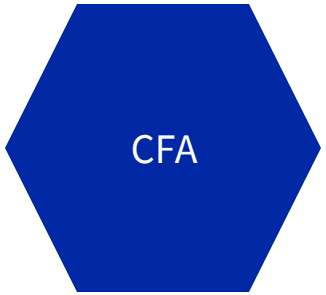
Gidon Frischkorn

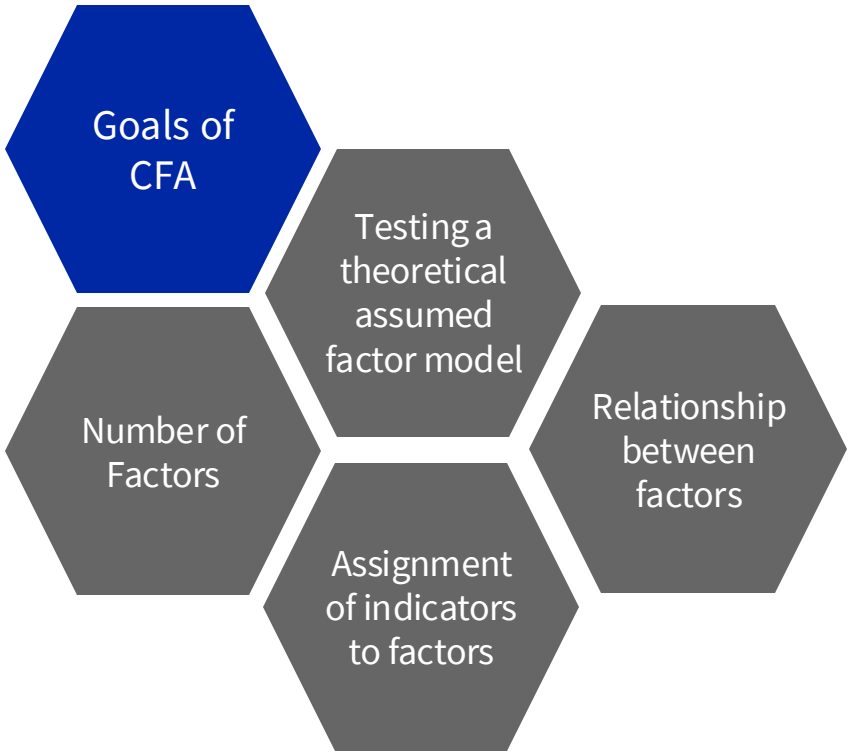
June 23rd – 25th

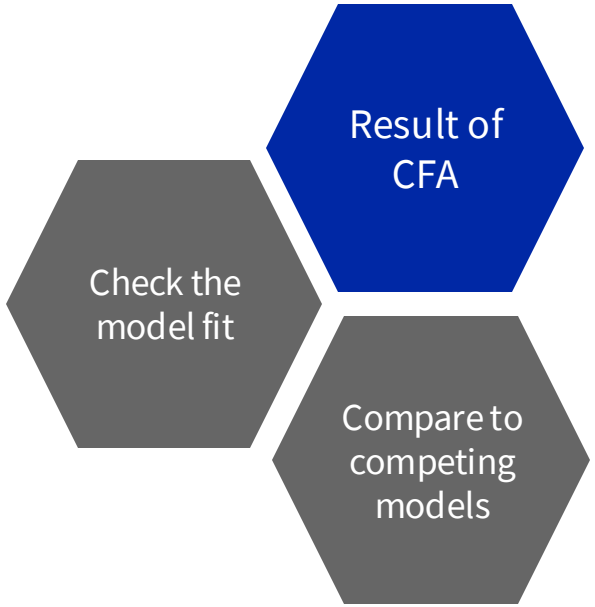
SEM Workshop: Overview



Confirmatory Factor Analysis







Confirmatory Factor Analysis

Example: HolzingerSwineford1939

CFA

Look at the help for the dataset

```
# get info for HolzingerSwineford1939
?HolzingerSwineford1939
```

Mental Ability Data

3 Task Domains: Visual / Textual / Speed

2 Schools 7th and 8th graders

Can we confirm a three-factor model for the ability tests?

1) Specify & Fit the model

What is your evaluation?

```
# measurement models
visual  =~ x1 + x2 + x3
textual =~ x4 + x5 + x6
speed   =~ x7 + x8 + x9
```

Compare it to a single factor model?

Can you think of more competing models?

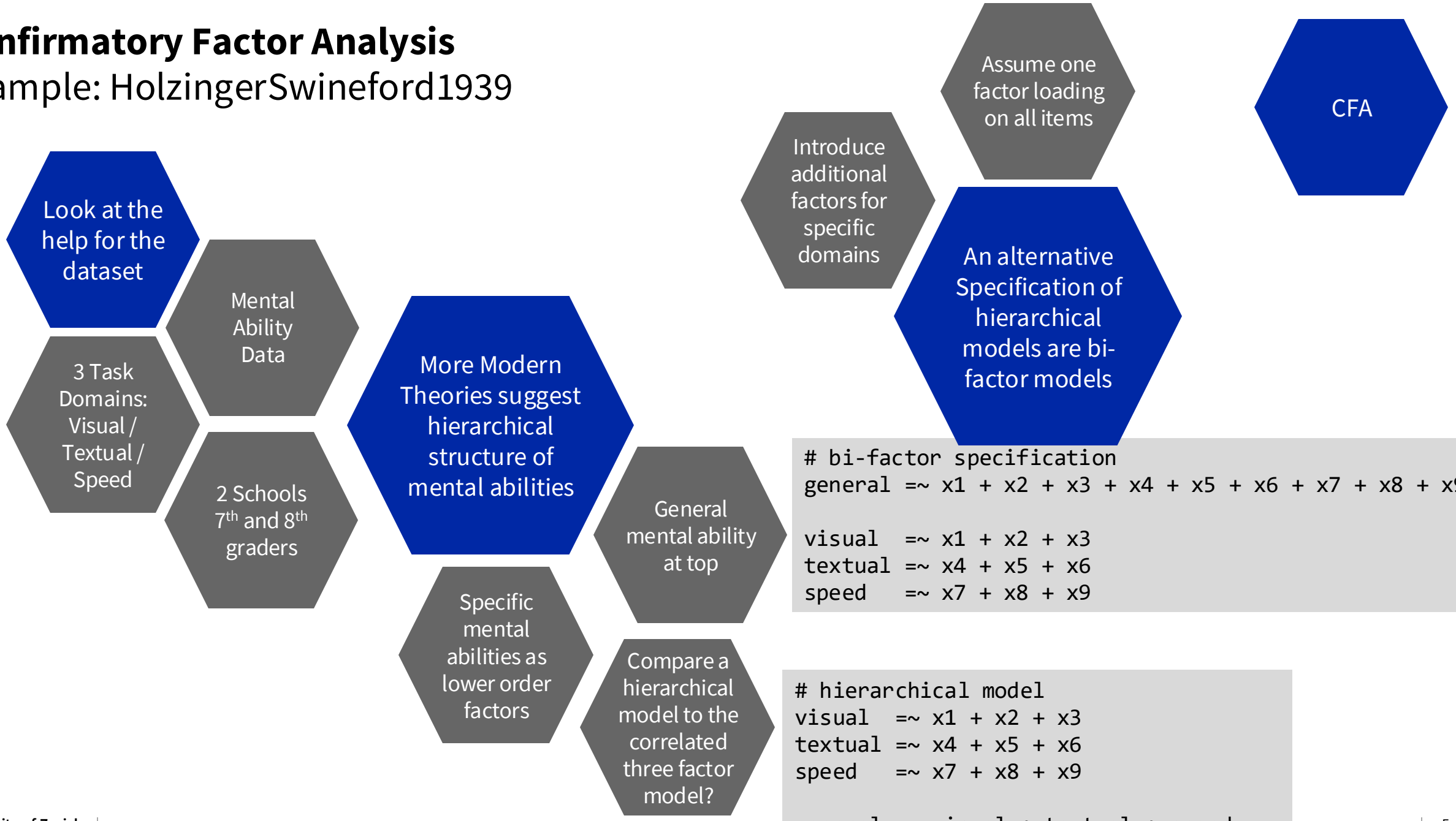
```
HS_model <- readLines("HS_model.txt")

HS_fit <- cfa(model = HS_model,
              data = HolzingerSwineford1939)

summary(HS_fit, fit.measures = TRUE)
```

Confirmatory Factor Analysis

Example: HolzingerSwineford1939




```
# bi-factor specification
general =~ x1 + x2 + x3 + x4 + x5 + x6 + x7 + x8 + x9

visual  =~ x1 + x2 + x3
textual =~ x4 + x5 + x6
speed   =~ x7 + x8 + x9
```

```
# hierarchical model
visual  =~ x1 + x2 + x3
textual =~ x4 + x5 + x6
speed   =~ x7 + x8 + x9

general =~ visual + textual + speed
```

What are your questions so far?

Multi Group SEM & Invariance Testing

Multi Group Invariance Testing

Goals of Multi Group SEM

Test the same SEM to different groups

Test if measurement & relationships are similar

```
# measurement models
visual  =~ x1 + x2 + x3
textual =~ x4 + x5 + x6
speed   =~ x7 + x8 + x9
```

Potential Coefficients that can be invariant

Intercepts = means of factors or indicators

Loadings

Variances of residuals

Variances of latent variables

```
# estimate intercepts
x1 ~ 1
x2 ~ 1
x3 ~ 1
…
```

Levels of Measurement Invariance

Configural = same factor model fits for all groups

Metric = Configural + equal loadings for all groups

Strict = Metric + residual variances for all groups

Scalar = Metric + equal indicator intercepts

```
HS_model <- readLines("HS_model.txt")

HS_fit <- cfa(model = HS_model,
              data = HolzingerSwineford1939,
              group = "school",
              group.equal = c("loadings"))

summary(HS_fit, fit.measures = TRUE)
```

Exercise: Which level of measurement invariance holds across schools / gender?

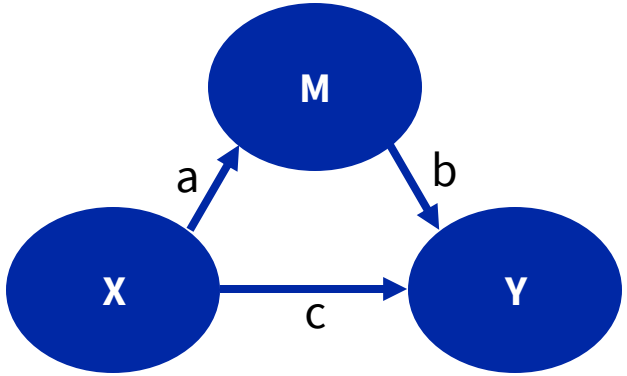
What are your questions so far?

Mediation Analyses

Mediation Analyses

Relationship between X and Y

Potentially Mediated by a third variable M



Goals of Mediation Analyses

Does X still predict Y accounting for M
c > 0

How much did X explain in Y in total?
c + (a*b)

Is the mediation significant?
a * b > 0

Specifying SEM?

lavaan allows to define these variables

label parameters used to compute variables

:=
Define a new variable from label parameters

Defined variables can still be tested for significance

```
# measurement models
X =~ ind1 + ind2 + ind3
Y =~ ind4 + ind5 + ind6
M =~ ind7 + ind8 + ind9

# regressions
Y ~ c * X + b * M
M ~ a * X

# definitions
ind := a * b
total := c + (a * b)
```

Mediation Analyses

Example: PoliticalDemocracy

CFA

Look at the help for the dataset

```
# get info for Political Democracy
?PoliticalDemocracy
```

4 Indicators of Democratic Stability in 1960 & 1965

3 Indicator of Industrial Productivity in 1960

Is effect of Industrial Productivity on Democratic Stability in 1965 mediated via Democratic Stability in 1960?

1) Specify & Fit the model

What is your evaluation?

How can we improve the absolute model fit

```
# modification indices
modindices(my_fit)
```

What are your questions so far?

Longitudinal Data with SEM

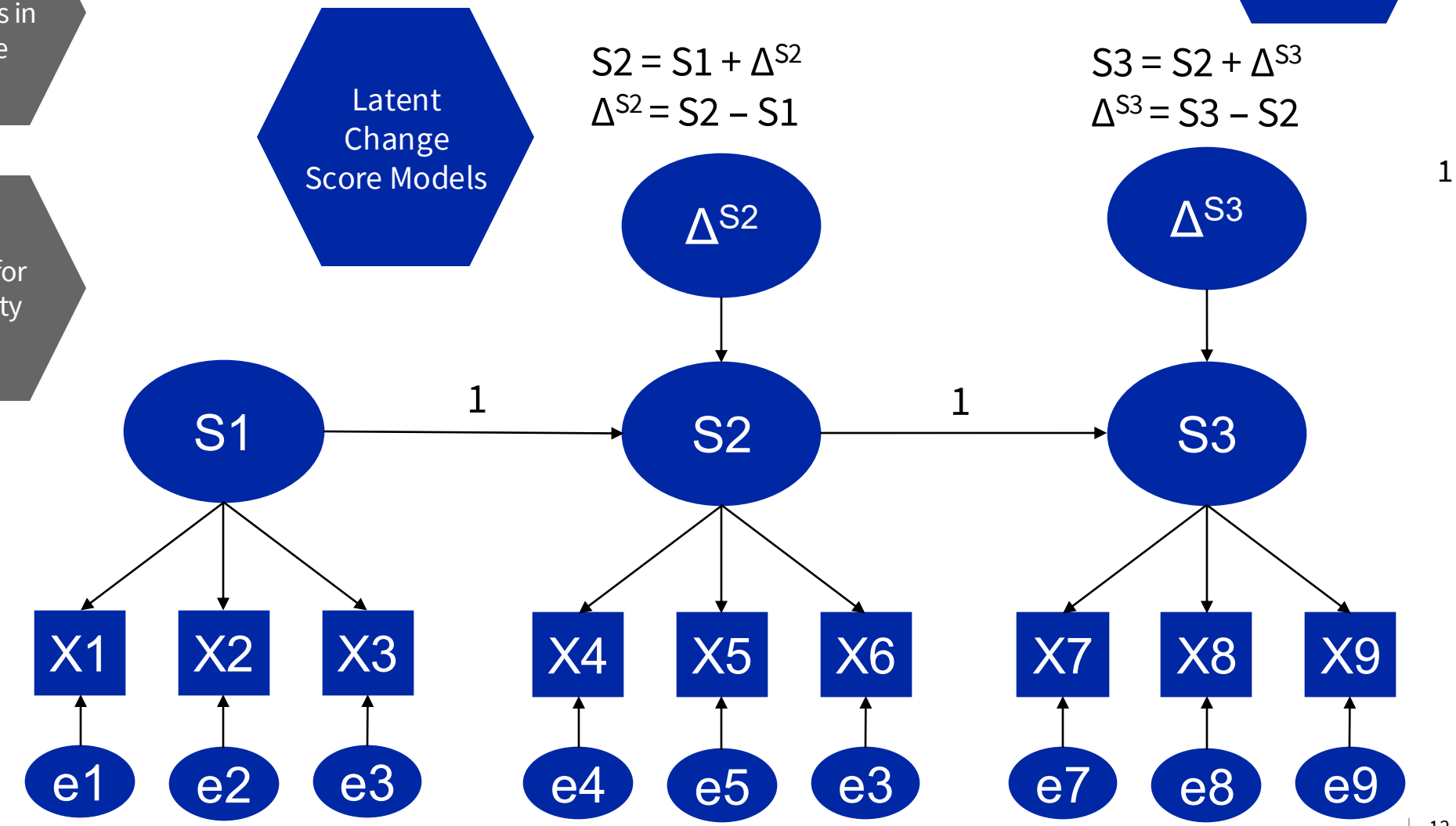
Goal of Longitudinal SEM

Capture Variations in Change

Correct for Reliability

Latent Change Score Models

Specifying SEM?



Longitudinal Data with SEM

Goal of Longitudinal SEM

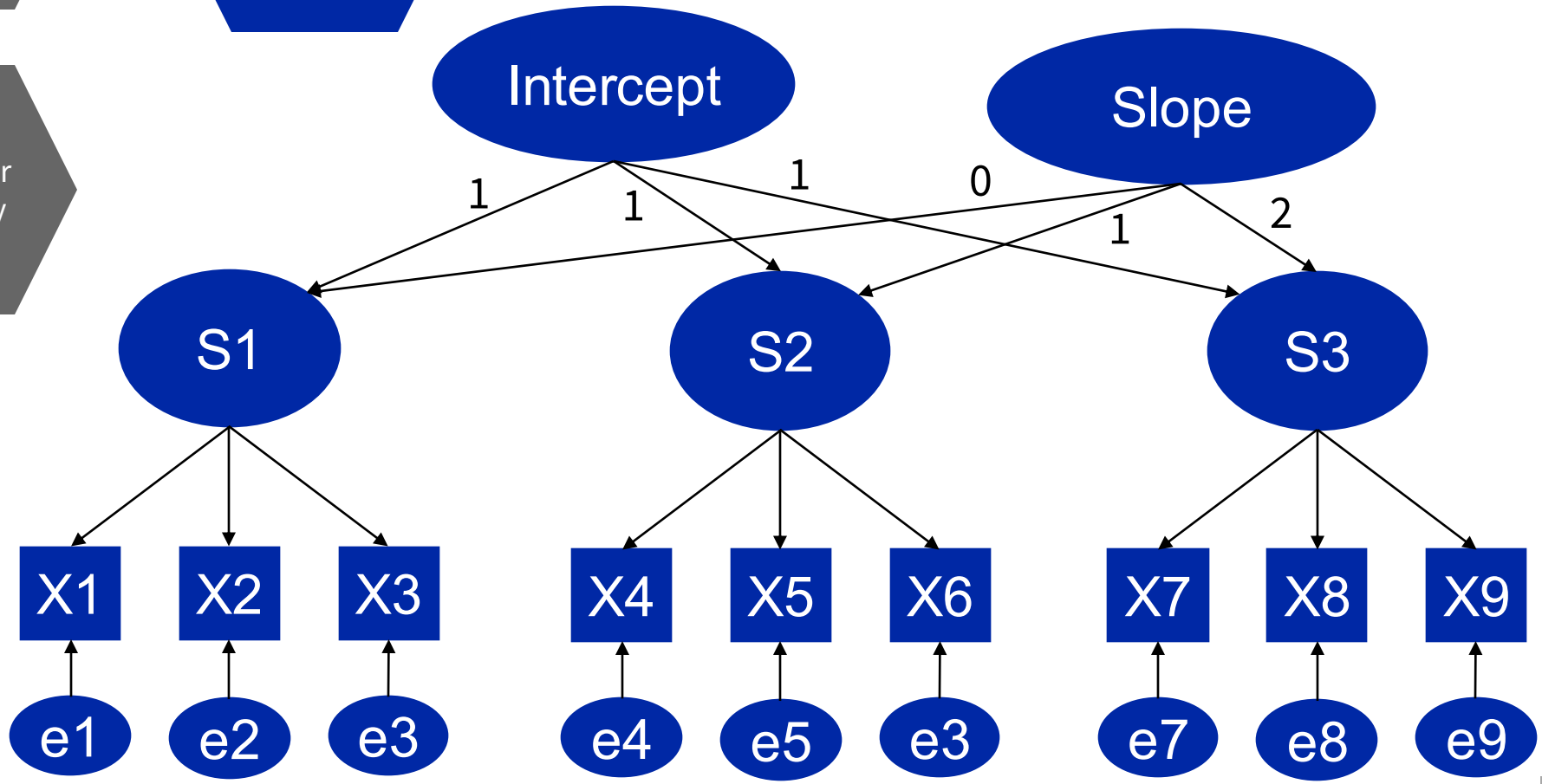
Capture Variations in Change

Correct for Reliability

Latent Growth Curve models

Specifying SEM?

S1 = Intercept + 0*Slope
S2 = Intercept + 1 * Slope
S3 = Intercept + 2 * Slope



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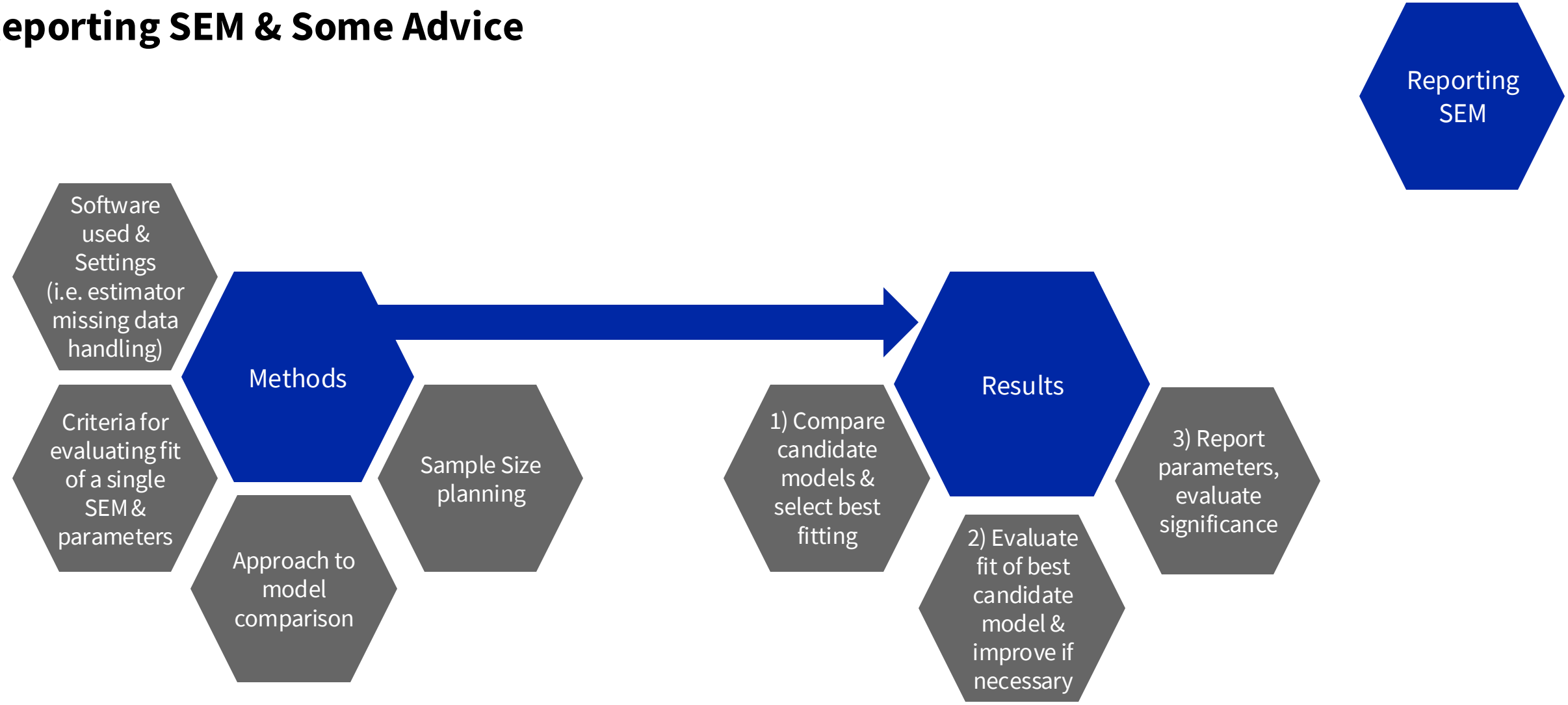
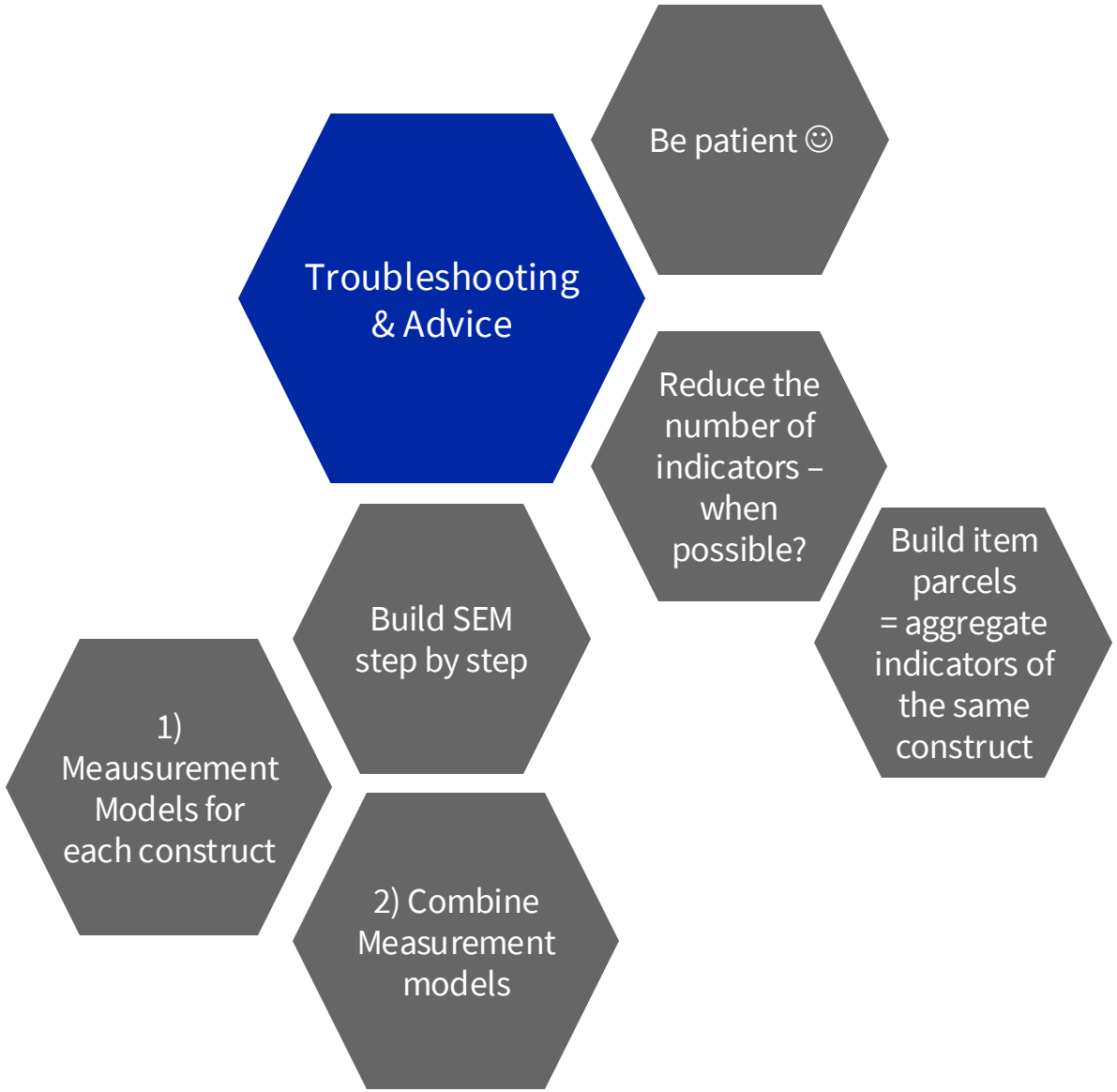
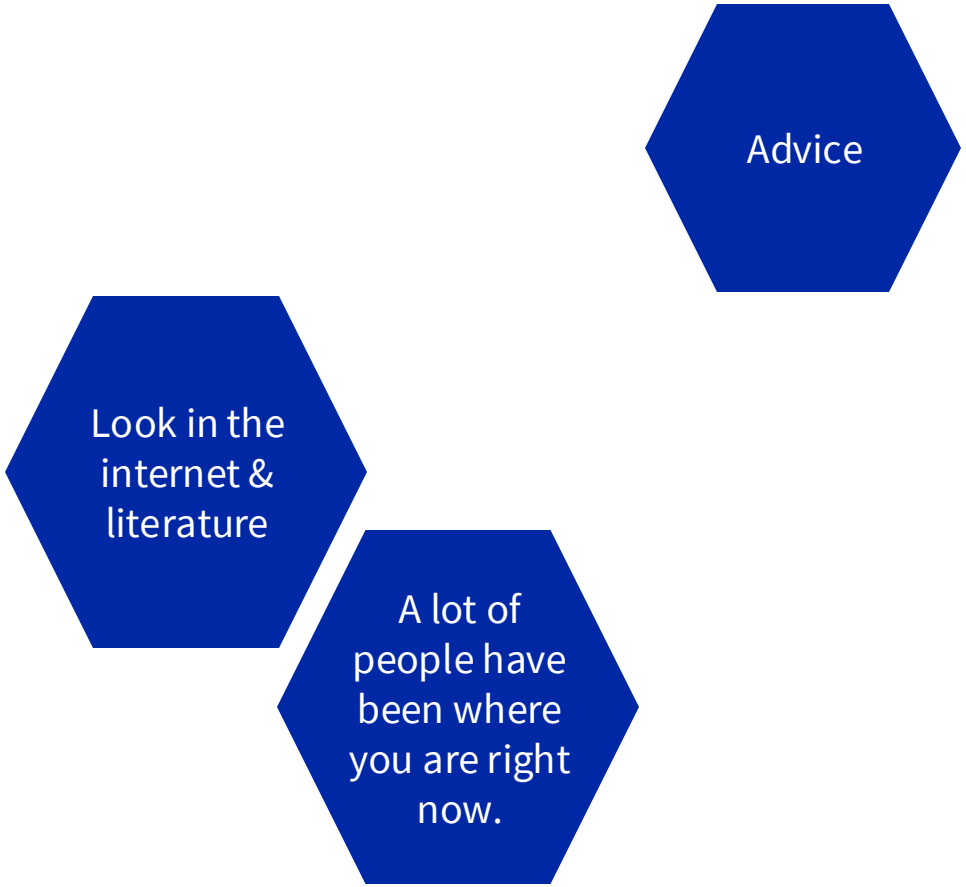
What are your questions so far?

Reporting SEM & Some Advice



Reporting SEM & Some Advice





What are your questions so far?