```r
rm(list = ls())
setwd("~/Dropbox/Classes/Longitudinal Data Analysis")
wgt <- read.table("weightslong.csv", sep = ",", header = TRUE)
wgtwide <- read.table("weightsbyweek.csv", sep = ",", header = TRUE)
dems <- read.table("agegender.csv", sep = ",", header = TRUE)
dems$age.c <- dems$age - 49.094
data <- merge(wgt, dems, by = "ID")
data$gender[data$gender == 1] <- 0
data$gender[data$gender == 2] <- 1
library(tidyr)
```

```
## Warning: package 'tidyr' was built under R version 3.3.2
```

```r
library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 3.3.2
##
## Attaching package: 'dplyr'
## The following objects are masked from 'package:stats':
##
##     filter, lag
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```r
library(plyr)
```

```
## ------------------------------------------------------------------------------
## You have loaded plyr after dplyr - this is likely to cause problems.
## If you need functions from both plyr and dplyr, please load plyr first, then dplyr:
## library(plyr); library(dplyr)
## ------------------------------------------------------------------------------
##
## Attaching package: 'plyr'
## The following objects are masked from 'package:dplyr':
##
##     arrange, count, desc, failwith, id, mutate, rename, summarise,
##     summarize
```

```r
library(lubridate)
```

```
##
## Attaching package: 'lubridate'
## The following object is masked from 'package:plyr':
##
##     here
## The following object is masked from 'package:base':
##
##     date
```

```r
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 3.3.2
```

```r
library(lme4)
```

```
## Loading required package:  Matrix
##
## Attaching package:  'Matrix'
## The following object is masked from 'package:tidyr':
##
##    expand
```

```
library(lavaan)
```

```
## Warning:  package 'lavaan' was built under R version 3.3.2
## This is lavaan 0.5-23.1097
## lavaan is BETA software!  Please report any bugs.
```

```
library(semPlot)
```

```
## Warning:  package 'semPlot' was built under R version 3.3.2
```

```
library(semTools)
```

```
##
## ################################################################################
## This is semTools 0.4-14
## All users of R (or SEM) are invited to submit functions or ideas for functions.
## ################################################################################
```

1 Question 1

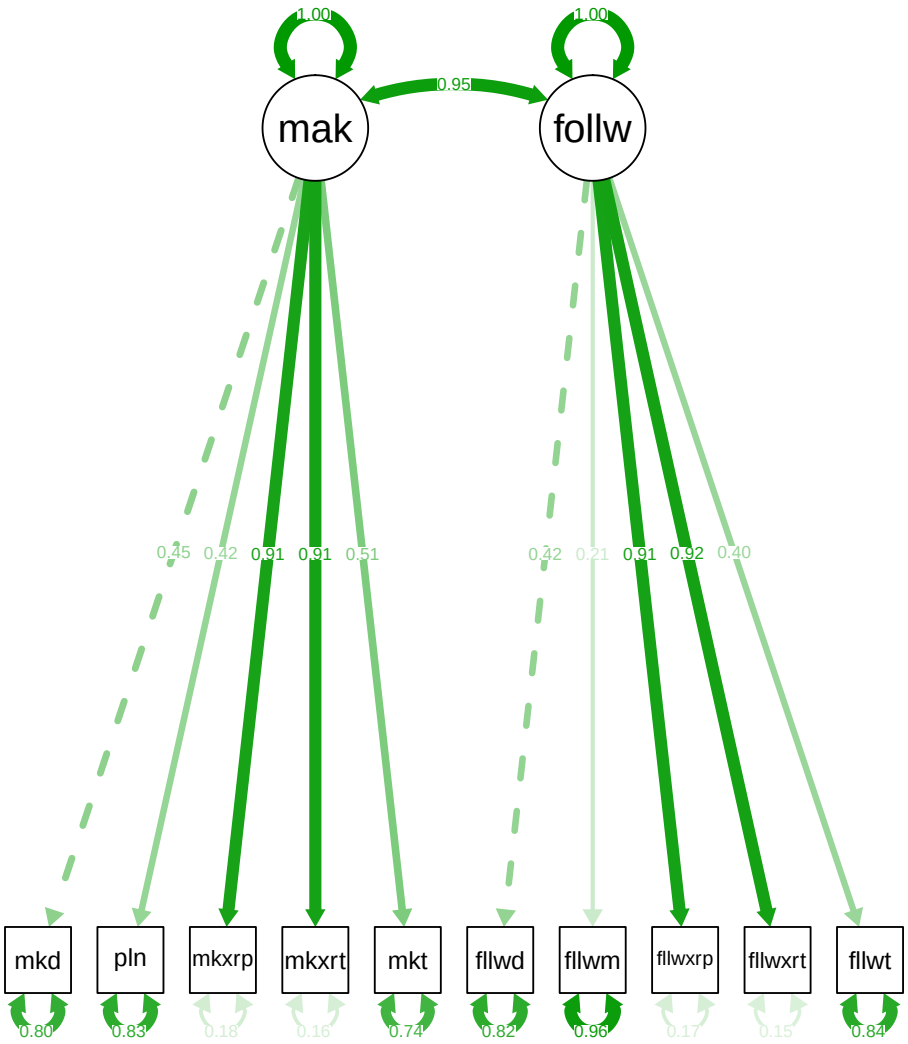
Fit a measurement model to your constructs at one time point. Try out the different types of scaling discussed in class. What changes and what stays the same?

```
plan <- read.table("planQ.csv", sep = ",", header = TRUE)
plans.model <- " make  =~ makedietplans + planmealtimes + makeexerplan +  makeexertimes + maketempplan
              follow =~ followdietplans + followmealtimes + followexerplan + followexertimes + followte
plansfit <- cfa(plans.model, data = plan)
summary(plansfit, fit.measures = TRUE, standardized = TRUE)
```

```
## lavaan (0.5-23.1097) converged normally after  53 iterations
##
##                                                   Used       Total
##   Number of observations                            486         660
##
##   Estimator                                          ML
##   Minimum Function Test Statistic              1390.612
##   Degrees of freedom                                 34
##   P-value (Chi-square)                            0.000
##
## Model test baseline model:
##
##   Minimum Function Test Statistic              3736.820
##   Degrees of freedom                                 45
##   P-value                                         0.000
```

```
##
## User model versus baseline model:
##
##   Comparative Fit Index (CFI)                    0.633
##   Tucker-Lewis Index (TLI)                       0.514
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)              -6230.771
##   Loglikelihood unrestricted model (H1)      -5535.465
##
##   Number of free parameters                         21
##   Akaike (AIC)                               12503.543
##   Bayesian (BIC)                             12591.453
##   Sample-size adjusted Bayesian (BIC)        12524.800
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.287
##   90 Percent Confidence Interval          0.274  0.300
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.179
##
## Parameter Estimates:
##
##   Information                                 Expected
##   Standard Errors                             Standard
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   make =~
##     makedietplans     1.000                               0.440    0.447
##     planmealtimes     1.032    0.143    7.206    0.000    0.454    0.416
##     makeexerplan      2.439    0.235   10.374    0.000    1.073    0.908
##     makeexertimes     2.568    0.247   10.392    0.000    1.130    0.914
##     maketempplan      1.151    0.141    8.151    0.000    0.506    0.510
##   follow =~
##     followdietplns    1.000                               0.356    0.422
##     followmealtims    1.218    0.297    4.097    0.000    0.433    0.206
##     followexerplan    2.766    0.285    9.715    0.000    0.984    0.914
##     followexertims    2.963    0.304    9.736    0.000    1.054    0.923
##     followtempplan    0.937    0.138    6.777    0.000    0.333    0.398
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   make ~~
##     follow            0.148    0.023    6.548    0.000    0.948    0.948
##
```

```
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .makedietplans     0.774    0.050   15.333    0.000    0.774    0.800
##    .planmealtimes     0.983    0.064   15.375    0.000    0.983    0.827
##    .makeexerplan      0.245    0.024   10.404    0.000    0.245    0.175
##    .makeexertimes     0.250    0.025    9.963    0.000    0.250    0.164
##    .maketempplan      0.730    0.048   15.230    0.000    0.730    0.740
##    .followdietplns    0.584    0.038   15.374    0.000    0.584    0.822
##    .followmealtims    4.240    0.273   15.545    0.000    4.240    0.958
##    .followexerplan    0.192    0.019   10.121    0.000    0.192    0.165
##    .followexertims    0.194    0.021    9.409    0.000    0.194    0.149
##    .followtempplan    0.591    0.038   15.403    0.000    0.591    0.842
##     make              0.194    0.038    5.047    0.000    1.000    1.000
##     follow            0.127    0.027    4.735    0.000    1.000    1.000

semPaths(plansfit, what = "std")
```



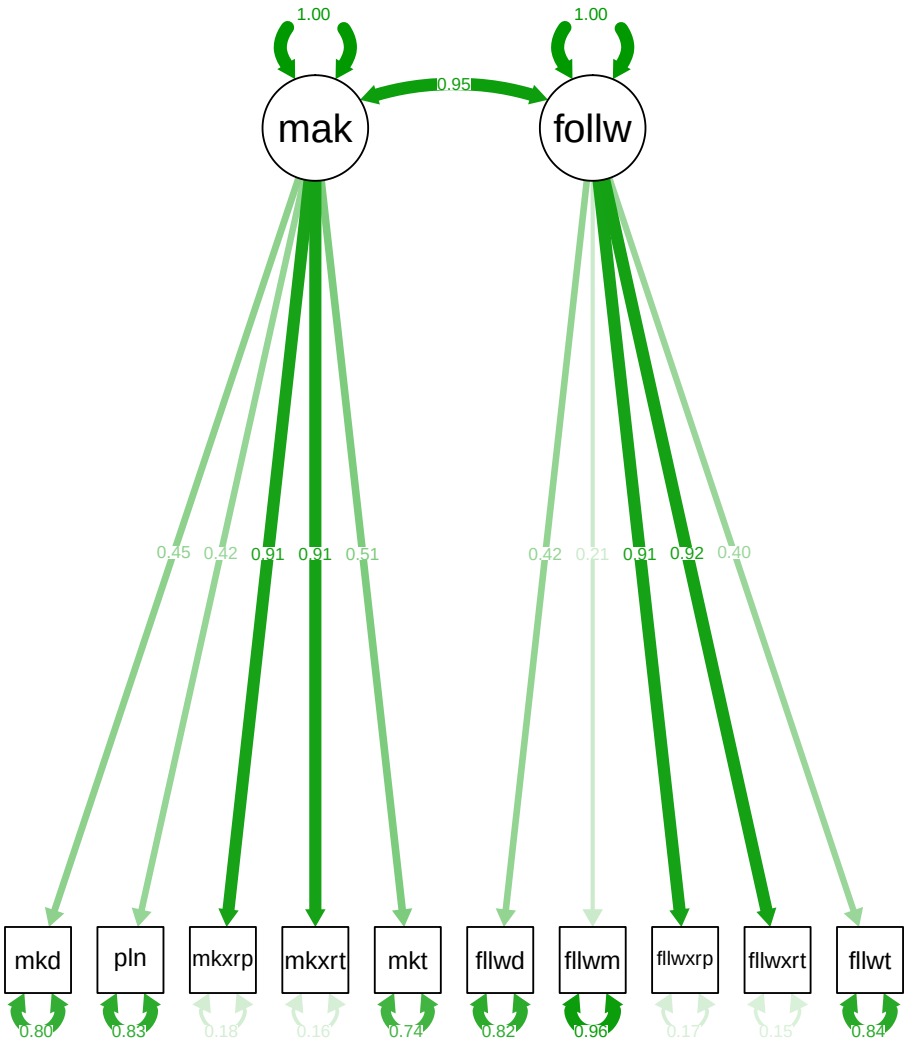

```
plansfit.2 <- cfa(plans.model, std.lv = TRUE, data = plan)
summary(plansfit.2, fit.measures = TRUE, standardized = TRUE)
```

```
## lavaan (0.5-23.1097) converged normally after  37 iterations
##
##                                                   Used       Total
##   Number of observations                            486         660
##
##   Estimator                                          ML
##   Minimum Function Test Statistic              1390.612
##   Degrees of freedom                                 34
##   P-value (Chi-square)                            0.000
```

```
##
## Model test baseline model:
##
##   Minimum Function Test Statistic             3736.820
##   Degrees of freedom                                45
##   P-value                                        0.000
##
## User model versus baseline model:
##
##   Comparative Fit Index (CFI)                    0.633
##   Tucker-Lewis Index (TLI)                       0.514
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)              -6230.771
##   Loglikelihood unrestricted model (H1)      -5535.465
##
##   Number of free parameters                         21
##   Akaike (AIC)                               12503.543
##   Bayesian (BIC)                             12591.453
##   Sample-size adjusted Bayesian (BIC)        12524.800
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.287
##   90 Percent Confidence Interval          0.274  0.300
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.179
##
## Parameter Estimates:
##
##   Information                                 Expected
##   Standard Errors                             Standard
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   make =~
##     makedietplans     0.440    0.044   10.095    0.000    0.440    0.447
##     planmealtimes     0.454    0.049    9.325    0.000    0.454    0.416
##     makeexerplan      1.073    0.042   25.619    0.000    1.073    0.908
##     makeexertimes     1.130    0.044   25.913    0.000    1.130    0.914
##     maketempplan      0.506    0.043   11.713    0.000    0.506    0.510
##   follow =~
##     followdietplns    0.356    0.038    9.471    0.000    0.356    0.422
##     followmealtims    0.433    0.097    4.450    0.000    0.433    0.206
##     followexerplan    0.984    0.038   25.896    0.000    0.984    0.914
##     followexertims    1.054    0.040   26.323    0.000    1.054    0.923
##     followtempplan    0.333    0.038    8.880    0.000    0.333    0.398
```

```
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   make ~~
##     follow            0.948    0.010   92.042    0.000    0.948    0.948
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .makedietplans     0.774    0.050   15.333    0.000    0.774    0.800
##    .planmealtimes     0.983    0.064   15.375    0.000    0.983    0.827
##    .makeexerplan      0.245    0.024   10.404    0.000    0.245    0.175
##    .makeexertimes     0.250    0.025    9.963    0.000    0.250    0.164
##    .maketempplan      0.730    0.048   15.230    0.000    0.730    0.740
##    .followdietplns    0.584    0.038   15.374    0.000    0.584    0.822
##    .followmealtims    4.240    0.273   15.545    0.000    4.240    0.958
##    .followexerplan    0.192    0.019   10.121    0.000    0.192    0.165
##    .followexertims    0.194    0.021    9.409    0.000    0.194    0.149
##    .followtempplan    0.591    0.038   15.403    0.000    0.591    0.842
##     make              1.000                              1.000    1.000
##     follow            1.000                              1.000    1.000
```

```
semPaths(plansfit.2, what = "std")
```




```
# estimates change quite a bit, although the standardized values stay the
# same Fit indices also stay the same
```

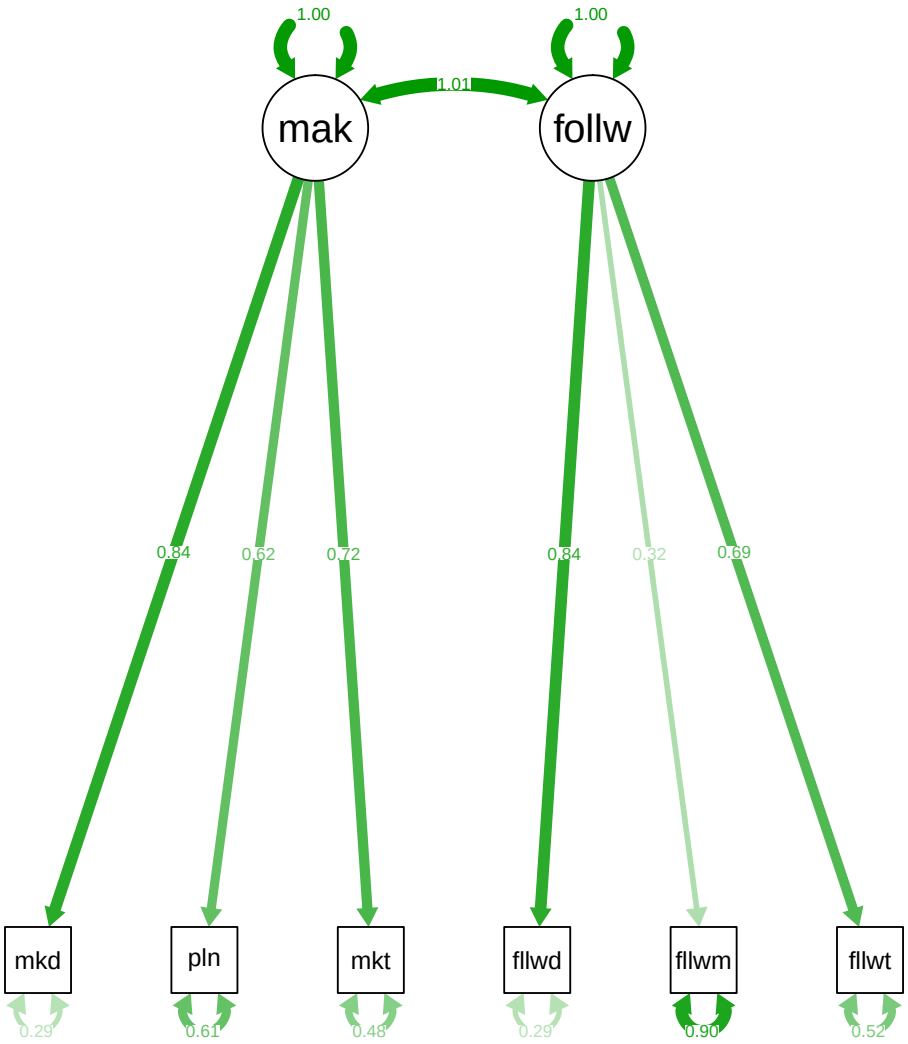
2 Question 2

What do the fit statistics say about your latent variable? Good/bad? Is your latent variable Just identified/saturdated, under identified or over identified?

```
# RMSEA and SRMR indicate poor fit CFI and TLI indicate poor fit model is
# overidentified

# split diet and exercise plans
dietplans.model <- " make  =~ makedietplans + planmealtimes + maketempplan
              follow =~ followdietplans + followmealtimes + followtempplan"
dietplansfit.fix <- cfa(dietplans.model, std.lv = TRUE, data = plan)

## Warning in lav_object_post_check(object):  lavaan WARNING: covariance matrix of latent variables
##                is not positive definite;
##                use inspect(fit,"cov.lv") to investigate.

summary(dietplansfit.fix, fit.measures = TRUE, standardized = TRUE)

## lavaan (0.5-23.1097) converged normally after  21 iterations
##
##                                                   Used       Total
##   Number of observations                            490         660
##
##   Estimator                                          ML
##   Minimum Function Test Statistic               251.145
##   Degrees of freedom                                  8
##   P-value (Chi-square)                            0.000
##
## Model test baseline model:
##
##   Minimum Function Test Statistic              1396.587
##   Degrees of freedom                                 15
##   P-value                                         0.000
##
## User model versus baseline model:
##
##   Comparative Fit Index (CFI)                     0.824
##   Tucker-Lewis Index (TLI)                        0.670
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)              -3817.581
##   Loglikelihood unrestricted model (H1)      -3692.009
##
##   Number of free parameters                          13
##   Akaike (AIC)                                7661.163
##   Bayesian (BIC)                              7715.690
##   Sample-size adjusted Bayesian (BIC)         7674.428
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.249
##   90 Percent Confidence Interval          0.223  0.276
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
```

```
##
##   SRMR                                           0.080
##
## Parameter Estimates:
##
##   Information                                 Expected
##   Standard Errors                             Standard
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   make =~
##     makedietplans     0.828    0.038   21.825    0.000    0.828    0.844
##     planmealtimes     0.679    0.047   14.575    0.000    0.679    0.623
##     maketempplan      0.716    0.041   17.652    0.000    0.716    0.722
##   follow =~
##     followdietplns    0.707    0.033   21.203    0.000    0.707    0.841
##     followmealtims    0.675    0.098    6.919    0.000    0.675    0.322
##     followtempplan    0.578    0.035   16.577    0.000    0.578    0.691
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   make ~~
##     follow            1.010    0.022   46.701    0.000    1.010    1.010
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .makedietplans     0.277    0.028    9.885    0.000    0.277    0.288
##    .planmealtimes     0.725    0.051   14.361    0.000    0.725    0.611
##    .maketempplan      0.471    0.035   13.373    0.000    0.471    0.478
##    .followdietplns    0.207    0.023    9.002    0.000    0.207    0.293
##    .followmealtims    3.938    0.255   15.426    0.000    3.938    0.896
##    .followtempplan    0.366    0.027   13.665    0.000    0.366    0.523
##     make              1.000                               1.000    1.000
##     follow            1.000                               1.000    1.000
```

```
semPaths(dietplansfit.fix, what = "std")
```

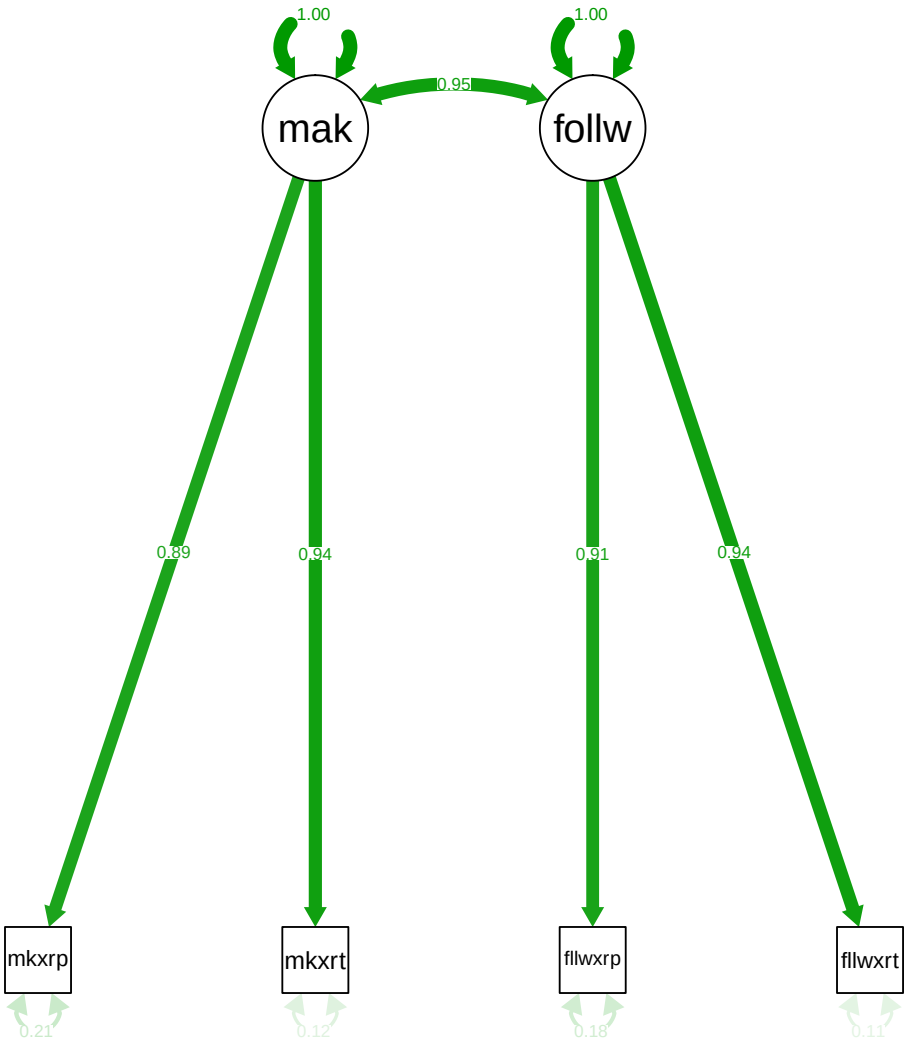



```
# does a little better SRMR indicates acceptable fit, RMSEA still way too
# high CFI and TLI still below .9 overidentified

exerplans.model <- " make  =~ makeexerplan +  makeexertimes
             follow =~ followexerplan + followexertimes"
exerplansfit.fix <- cfa(exerplans.model, std.lv = TRUE, data = plan)
summary(exerplansfit.fix, fit.measures = TRUE, standardized = TRUE)

## lavaan (0.5-23.1097) converged normally after  21 iterations
##
##                                                   Used       Total
##   Number of observations                            491         660
```

```
##
##   Estimator                                         ML
##   Minimum Function Test Statistic              221.432
##   Degrees of freedom                                 1
##   P-value (Chi-square)                           0.000
##
## Model test baseline model:
##
##   Minimum Function Test Statistic             2147.525
##   Degrees of freedom                                 6
##   P-value                                        0.000
##
## User model versus baseline model:
##
##   Comparative Fit Index (CFI)                    0.897
##   Tucker-Lewis Index (TLI)                       0.382
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)              -2116.476
##   Loglikelihood unrestricted model (H1)      -2005.760
##
##   Number of free parameters                          9
##   Akaike (AIC)                                4250.952
##   Bayesian (BIC)                              4288.720
##   Sample-size adjusted Bayesian (BIC)         4260.154
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.670
##   90 Percent Confidence Interval          0.597  0.746
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.032
##
## Parameter Estimates:
##
##   Information                                 Expected
##   Standard Errors                             Standard
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   make =~
##     makeexerplan      1.057    0.042   24.929    0.000    1.057    0.891
##     makeexertimes     1.160    0.043   27.051    0.000    1.160    0.936
##   follow =~
##     followexerplan    0.977    0.038   25.686    0.000    0.977    0.906
##     followexertims    1.079    0.039   27.487    0.000    1.079    0.943
##
```

```
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   make ~~
##     follow            0.946    0.010   90.561    0.000    0.946    0.946
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .makeexerplan       0.291    0.025   11.418    0.000    0.291    0.206
##    .makeexertimes      0.190    0.024    7.832    0.000    0.190    0.124
##    .followexerplan     0.209    0.019   10.879    0.000    0.209    0.179
##    .followexertims     0.145    0.019    7.535    0.000    0.145    0.110
##     make               1.000                              1.000    1.000
##     follow             1.000                              1.000    1.000
```

```
semPaths(exerplansfit.fix, what = "std")
```




```
# should be underidentified, but df is 6 or is it 1? which one to look at?
# RMSEA (.67) way too high, SRMR (.032) is good - sooo diferent, why? CFI
# pretty close to .9, TLI still way off
```

3 Question 3

Fit a longitudinal CFA model where you a) first correlate your latent factors across time and then b) a second model that predicts later times by a prevous time (ie auto regressive; t1 -¿ t2 -¿ t3). What are your conclusions? How does one differ from the other?

```r
#make plans wide
#create subset of data and widen
plansub <- subset(plan, select = c(ID, week, makedietplans, planmealtimes, maketempplan))
library(reshape2)

##
## Attaching package:  'reshape2'
## The following object is masked from 'package:tidyr':
##
##    smiths

plansub <- reshape(plansub, idvar = "ID", timevar = "week", direction = "wide")

longcfa <- [1126 chars quoted with ''']

fit.long.cfa <- cfa(longcfa, data=plansub, std.lv=TRUE)

## Warning in lav_model_vcov(lavmodel = lavmodel, lavsamplestats = lavsamplestats, :  lavaan
WARNING: could not compute standard errors!
##  lavaan NOTE: this may be a symptom that the model is not identified.
## Warning in lav_object_post_check(object):  lavaan WARNING: the covariance matrix of the residuals
of the observed
##                variables (theta) is not positive definite;
##                use inspect(fit,"theta") to investigate.

summary(fit.long.cfa, standardized=TRUE, fit.measures=TRUE)

## lavaan (0.5-23.1097) converged normally after  65 iterations
##
##                                                   Used       Total
##   Number of observations                             55         132
##
##   Estimator                                          ML
##   Minimum Function Test Statistic               123.986
##   Degrees of freedom                                 57
##   P-value (Chi-square)                            0.000
##
## Model test baseline model:
##
##   Minimum Function Test Statistic               422.661
##   Degrees of freedom                                105
##   P-value                                         0.000
##
## User model versus baseline model:
##
##   Comparative Fit Index (CFI)                     0.789
##   Tucker-Lewis Index (TLI)                        0.612
##
## Loglikelihood and Information Criteria:
##
##   Loglikelihood user model (H0)                -909.085
##   Loglikelihood unrestricted model (H1)        -847.092
##
```

```
##   Number of free parameters                         63
##   Akaike (AIC)                                1944.170
##   Bayesian (BIC)                              2070.632
##   Sample-size adjusted Bayesian (BIC)         1872.665
##
## Root Mean Square Error of Approximation:
##
##   RMSEA                                          0.146
##   90 Percent Confidence Interval          0.111  0.181
##   P-value RMSEA <= 0.05                          0.000
##
## Standardized Root Mean Square Residual:
##
##   SRMR                                           0.107
##
## Parameter Estimates:
##
##   Information                                 Expected
##   Standard Errors                             Standard
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   makedietplans =~
##     makedietplns.0    0.246       NA                      0.246    0.242
##     makeditplns.10    0.692       NA                      0.692    0.762
##     makeditplns.20    0.897       NA                      0.897    0.984
##     makeditplns.30    0.511       NA                      0.511    0.860
##     makeditplns.40    0.392       NA                      0.392    0.660
##   planmealtimes =~
##     planmealtims.0    0.314       NA                      0.314    0.296
##     planmealtms.10    1.062       NA                      1.062    0.883
##     planmealtms.20    0.658       NA                      0.658    0.648
##     planmealtms.30    0.691       NA                      0.691    0.712
##     planmealtms.40    0.733       NA                      0.733    0.745
##   maketempplan =~
##     maketempplan.0    0.242       NA                      0.242    0.243
##     maketemppln.10    0.638       NA                      0.638    0.779
##     maketemppln.20    0.769       NA                      0.769    0.867
##     maketemppln.30    0.670       NA                      0.670    0.885
##     maketemppln.40    0.416       NA                      0.416    0.644
##
## Covariances:
##                      Estimate  Std.Err  z-value  P(>|z|)   Std.lv
##  .makedietplans.0 ~~
##    .makeditplns.10       0.017       NA                       0.017
##    .makeditplns.20      -0.092       NA                      -0.092
##    .makeditplns.30      -0.067       NA                      -0.067
##    .makeditplns.40      -0.020       NA                      -0.020
##  .makedietplans.10 ~~
##    .makeditplns.20      -0.187       NA                      -0.187
##    .makeditplns.30      -0.181       NA                      -0.181
```

```
##    .makeditplns.40      -0.135       NA                    -0.135
##  .makedietplans.20 ~~
##    .makeditplns.30      -0.128       NA                    -0.128
##    .makeditplns.40      -0.022       NA                    -0.022
##  .makedietplans.30 ~~
##    .makeditplns.40       0.043       NA                     0.043
##  .planmealtimes.0 ~~
##    .planmealtms.10      -0.096       NA                    -0.096
##    .planmealtms.20       0.038       NA                     0.038
##    .planmealtms.30       0.139       NA                     0.139
##    .planmealtms.40      -0.172       NA                    -0.172
##  .planmealtimes.10 ~~
##    .planmealtms.20      -0.122       NA                    -0.122
##    .planmealtms.30      -0.210       NA                    -0.210
##    .planmealtms.40      -0.113       NA                    -0.113
##  .planmealtimes.20 ~~
##    .planmealtms.30       0.040       NA                     0.040
##    .planmealtms.40       0.136       NA                     0.136
##  .planmealtimes.30 ~~
##    .planmealtms.40      -0.066       NA                    -0.066
##  .maketempplan.0 ~~
##    .maketemppln.10       0.087       NA                     0.087
##    .maketemppln.20      -0.151       NA                    -0.151
##    .maketemppln.30      -0.022       NA                    -0.022
##    .maketemppln.40      -0.123       NA                    -0.123
##  .maketempplan.10 ~~
##    .maketemppln.20      -0.106       NA                    -0.106
##    .maketemppln.30      -0.109       NA                    -0.109
##    .maketemppln.40      -0.157       NA                    -0.157
##  .maketempplan.20 ~~
##    .maketemppln.30      -0.200       NA                    -0.200
##    .maketemppln.40      -0.071       NA                    -0.071
##  .maketempplan.30 ~~
##    .maketemppln.40      -0.118       NA                    -0.118
##   makedietplans ~~
##     planmealtimes        0.613       NA                     0.613
##     maketempplan         0.543       NA                     0.543
##   planmealtimes ~~
##     maketempplan         0.651       NA                     0.651
##   Std.all
##
##     0.029
##    -0.565
##    -0.224
##    -0.045
##
##    -1.935
##    -1.016
##    -0.514
##
##    -2.570
```

```
##    -0.295
##
##     0.320
##
##    -0.168
##     0.048
##     0.201
##    -0.259
##
##    -0.279
##    -0.547
##    -0.304
##
##     0.075
##     0.268
##
##    -0.148
##
##     0.175
##    -0.353
##    -0.064
##    -0.259
##
##    -0.468
##    -0.602
##    -0.620
##
##    -1.278
##    -0.324
##
##    -0.678
##
##     0.613
##     0.543
##
##     0.651
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .makedietplns.0    0.976       NA                     0.976    0.942
##    .makeditplns.10    0.345       NA                     0.345    0.419
##    .makeditplns.20    0.027       NA                     0.027    0.033
##    .makeditplns.30    0.092       NA                     0.092    0.260
##    .makeditplns.40    0.199       NA                     0.199    0.564
##    .planmealtims.0    1.030       NA                     1.030    0.913
##    .planmealtms.10    0.319       NA                     0.319    0.220
##    .planmealtms.20    0.599       NA                     0.599    0.580
##    .planmealtms.30    0.464       NA                     0.464    0.493
##    .planmealtms.40    0.430       NA                     0.430    0.445
##    .maketempplan.0    0.931       NA                     0.931    0.941
##    .maketemppln.10    0.263       NA                     0.263    0.393
```

```
##    .maketemppln.20    0.196       NA                      0.196    0.249
##    .maketemppln.30    0.124       NA                      0.124    0.217
##    .maketemppln.40    0.245       NA                      0.245    0.585
##     makedietplans     1.000                               1.000    1.000
##     planmealtimes     1.000                               1.000    1.000
##     maketempplan      1.000                               1.000    1.000

#CROSS_LAGGED - took down to two latent variables
long.cross <- [1810 chars quoted with '''']

fit.long.cross <- sem(long.cross, data=plansub, std.lv=TRUE)

## Warning in lavaan::lavaan(model = long.cross, data = plansub, std.lv = TRUE, :  lavaan WARNING:
model has NOT converged!

summary(fit.long.cross, standardized=TRUE, fit.measures=TRUE)

## ** WARNING ** lavaan (0.5-23.1097) did NOT converge after 10000 iterations
## ** WARNING ** Estimates below are most likely unreliable
##
##                                                   Used       Total
##   Number of observations                            55         132
##
##   Estimator                                         ML
##   Minimum Function Test Statistic                   NA
##   Degrees of freedom                                NA
##   P-value                                           NA

## Warning in .local(object, ...):  lavaan WARNING: fit measures not available if model did
not converge

##
## Parameter Estimates:
##
##   Information                                 Expected
##   Standard Errors                             Standard
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   makedietplans =~
##     makedietplns.0    0.856       NA                      0.856    0.838
##     makeditplns.10    9.975       NA                      9.975   10.983
##     makeditplns.20    0.958       NA                      0.958    1.052
##     makeditplns.30   -0.000       NA                     -0.000   -0.000
##     makeditplns.40    0.017       NA                      0.017    0.028
##   planmealtimes =~
##     planmealtims.0    1.347       NA                      1.347    1.260
##     planmealtms.10    7.759       NA                      7.759    6.452
##     planmealtms.20    0.530       NA                      0.530    0.521
##     planmealtms.30    5.931       NA                      5.931    6.133
##     planmealtms.40   -0.350       NA                     -0.350   -0.359
##
## Regressions:
```

```
##                      Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##   makedietplans.10 ~
##     makedietplns.0     -2.391       NA                    -2.391   -2.691
##     planmealtims.0     -4.937       NA                    -4.937   -5.808
##   planmealtimes.10 ~
##     planmealtims.0      4.342       NA                     4.342    3.858
##     makedietplns.0     -5.911       NA                    -5.911   -5.025
##   makedietplans.20 ~
##     makeditplns.10     -3.295       NA                    -3.295   -3.288
##     planmealtms.10     -0.011       NA                    -0.011   -0.015
##   planmealtimes.20 ~
##     planmealtms.10     -2.222       NA                    -2.222   -2.627
##     makeditplns.10      1.883       NA                     1.883    1.681
##   makedietplans.30 ~
##     makeditplns.20      0.368       NA                     0.368    0.565
##     planmealtms.20      0.066       NA                     0.066    0.113
##   planmealtimes.30 ~
##     planmealtms.20    -21.358       NA                   -21.358  -22.466
##     makeditplns.20     12.430       NA                    12.430   11.703
##   makedietplans.40 ~
##     makeditplns.30      1.042       NA                     1.042    1.045
##     planmealtms.30     -0.101       NA                    -0.101   -0.165
##   planmealtimes.40 ~
##     planmealtms.30      0.989       NA                     0.989    0.981
##     makeditplns.30      0.056       NA                     0.056    0.034
##
## Covariances:
##                      Estimate  Std.Err  z-value  P(>|z|)   Std.lv
##  .makedietplans.10 ~~
##    .planmealtms.10     -37.542       NA                   -37.542
##  .makedietplans.20 ~~
##    .planmealtms.20       1.135       NA                     1.135
##  .makedietplans.30 ~~
##    .planmealtms.30      -2.023       NA                    -2.023
##  .makedietplans.40 ~~
##    .planmealtms.40      -0.128       NA                    -0.128
##  .makedietplans.0 ~~
##    .makeditplns.10      -2.740       NA                    -2.740
##    .makeditplns.20      -0.070       NA                    -0.070
##    .makeditplns.30      -0.007       NA                    -0.007
##    .makeditplns.40       0.009       NA                     0.009
##  .makedietplans.10 ~~
##    .makeditplns.20      -1.123       NA                    -1.123
##    .makeditplns.30      -0.022       NA                    -0.022
##    .makeditplns.40      -0.060       NA                    -0.060
##  .makedietplans.20 ~~
##    .makeditplns.30      -0.021       NA                    -0.021
##    .makeditplns.40      -0.026       NA                    -0.026
##  .makedietplans.30 ~~
##    .makeditplns.40      -0.112       NA                    -0.112
##  .planmealtimes.0 ~~
```

```
##    .planmealtms.10     -11.432       NA                    -11.432
##    .planmealtms.20      -0.282       NA                     -0.282
##    .planmealtms.30      -3.065       NA                     -3.065
##    .planmealtms.40       0.174       NA                      0.174
##  .planmealtimes.10 ~~
##    .planmealtms.20      -1.936       NA                     -1.936
##    .planmealtms.30     -45.316       NA                    -45.316
##    .planmealtms.40       3.174       NA                      3.174
##  .planmealtimes.20 ~~
##    .planmealtms.30      24.526       NA                     24.526
##    .planmealtms.40       0.695       NA                      0.695
##  .planmealtimes.30 ~~
##    .planmealtms.40       4.704       NA                      4.704
##   makedietplans ~~
##     planmealtimes        0.546       NA                      0.546
##   Std.all
##
##    -0.952
##
##     0.126
##
##    -0.219
##
##    -0.282
##
##    -0.715
##    -0.036
##    -0.025
##     0.033
##
##    -0.048
##    -0.007
##    -0.018
##
##    -0.013
##    -0.016
##
##    -0.483
##
##    -2.429
##    -0.131
##    -0.195
##     0.224
##
##    -0.128
##    -0.411
##     0.585
##
##     0.487
##     0.280
##
```

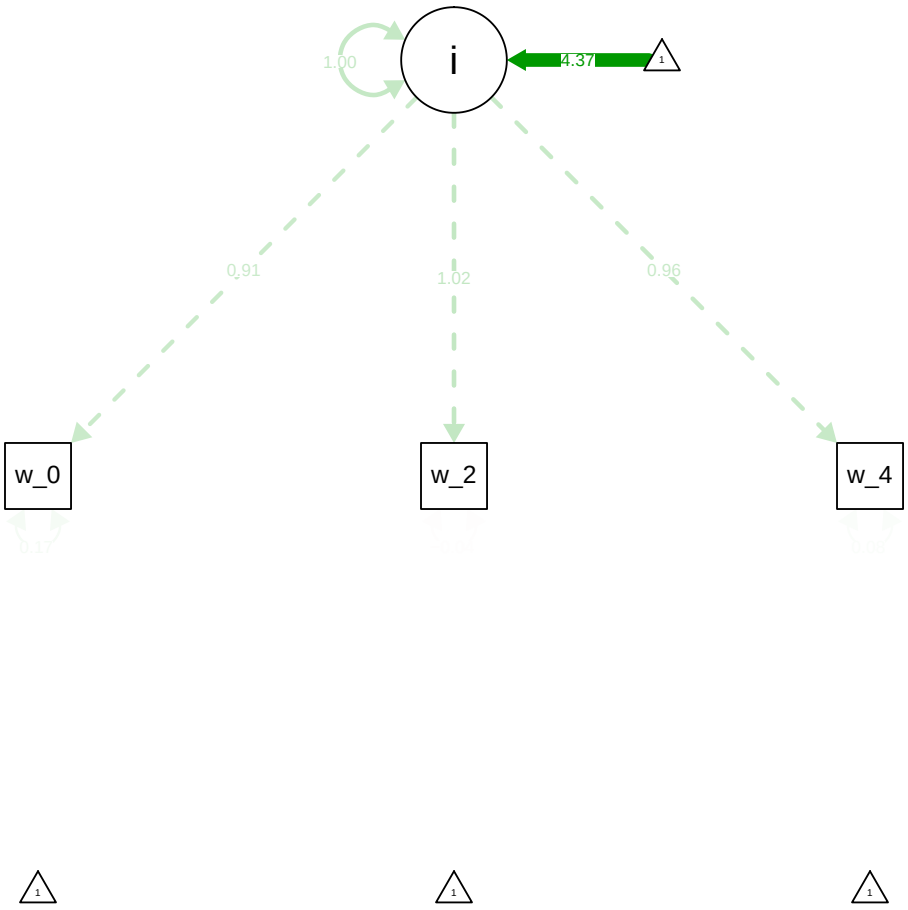
```
##     0.259
##
##     0.546
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)   Std.lv  Std.all
##    .makeditplns.10  -47.147       NA                    -47.147  -57.160
##    .makeditplns.20   11.785       NA                     11.785   14.221
##    .makeditplns.30    0.231       NA                      0.231    0.656
##    .makeditplns.40    0.231       NA                      0.231    0.660
##    .planmealtms.10  -32.993       NA                    -32.993  -22.816
##    .planmealtms.20    6.893       NA                      6.893    6.663
##    .planmealtms.30  368.537       NA                    368.537  394.156
##    .planmealtms.40    0.893       NA                      0.893    0.940
##    .makedietplns.0    0.312       NA                      0.312    0.298
##    .planmealtims.0   -0.672       NA                     -0.672   -0.588
##     makedietplans     1.000                              1.000    1.000
##     planmealtimes     1.000                              1.000    1.000

#Not getting fit indices
```

4 Question 4

Fit a longitdinal growth model in SEM and in HLM. Compare and contrast the differences.

```
# SEM intercept only model
SEMIntOnly <- " i =~ 1*w_0 + 1*w_20 + 1*w_40 "
SEMIntOnlyfit <- growth(SEMIntOnly, missing = "ML", data = wgtwide)

## Warning in lav_object_post_check(object):  lavaan WARNING: some estimated ov variances are
negative

summary(SEMIntOnlyfit)

## lavaan (0.5-23.1097) converged normally after 128 iterations
##
##   Number of observations                           139
##
##   Number of missing patterns                         4
##
##   Estimator                                         ML
##   Minimum Function Test Statistic              146.227
##   Degrees of freedom                                 4
##   P-value (Chi-square)                           0.000
##
## Parameter Estimates:
##
##   Information                                 Observed
##   Standard Errors                             Standard
##
```

```
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   i =~
##     w_0              1.000
##     w_20             1.000
##     w_40             1.000
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .w_0              0.000
##    .w_20             0.000
##    .w_40             0.000
##     i              222.130    4.363   50.918    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .w_0            543.873   67.543    8.052    0.000
##    .w_20          -103.800   20.869   -4.974    0.000
##    .w_40           236.904   36.930    6.415    0.000
##     i             2587.453  315.006    8.214    0.000

semPaths(SEMIntOnlyfit, what = "std")
```



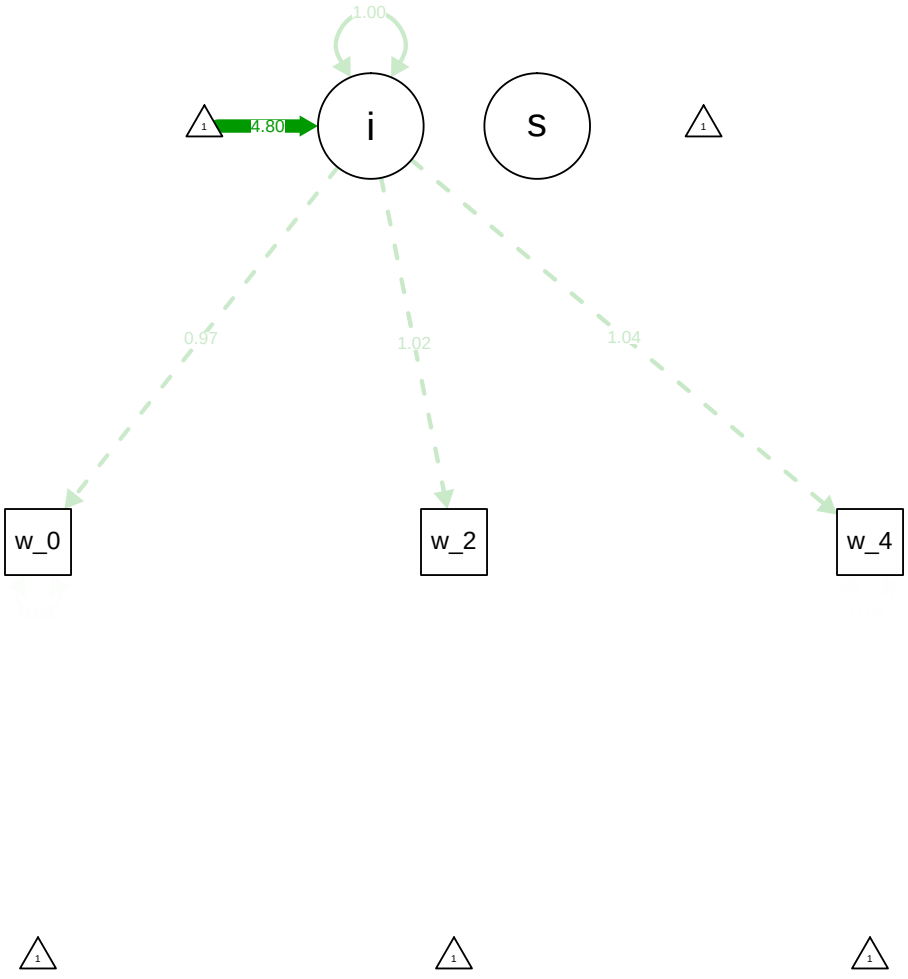

```
# intercept and fixed slope
SEMFixSlopes <- " i =~ 1*w_0 + 1*w_20 + 1*w_40
                  s =~ 0*w_0 + 20*w_20 + 40*w_40

                  s ~~ 0*s #fixed slopes, no variance"
SEMFixSlopesfit <- growth(SEMFixSlopes, missing = "ML", data = wgtwide)

## Warning in lav_object_post_check(object):  lavaan WARNING: covariance matrix of latent variables
##                 is not positive definite;
##                 use inspect(fit,"cov.lv") to investigate.

inspect(SEMFixSlopesfit, "cov.lv")
```

```
##   i        s
## i 2414.609
## s   -3.207    0.000
```

```
summary(SEMFixSlopesfit)
```

```
## lavaan (0.5-23.1097) converged normally after 211 iterations
##
##   Number of observations                           139
##
##   Number of missing patterns                         4
##
##   Estimator                                         ML
##   Minimum Function Test Statistic               32.411
##   Degrees of freedom                                 2
##   P-value (Chi-square)                           0.000
##
## Parameter Estimates:
##
##   Information                                 Observed
##   Standard Errors                             Standard
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i =~
##     w_0               1.000
##     w_20              1.000
##     w_40              1.000
##   s =~
##     w_0               0.000
##     w_20             20.000
##     w_40             40.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i ~~
##     s                -3.207    1.984   -1.616    0.106
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .w_0               0.000
##    .w_20              0.000
##    .w_40              0.000
##     i               235.630    4.320   54.550    0.000
##     s                -0.645    0.047  -13.775    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##     s                 0.000
##    .w_0             150.305   28.577    5.260    0.000
##    .w_20             24.790   17.564    1.411    0.158
##    .w_40             94.413   23.200    4.070    0.000
```

```
##     i              2414.609  302.299    7.987    0.000

semPaths(SEMFixSlopesfit, what = "std")

## Warning in qgraph(Edgelist, labels = nLab, bidirectional = Bidir, directed = Directed, :
Non-finite weights are omitted
```



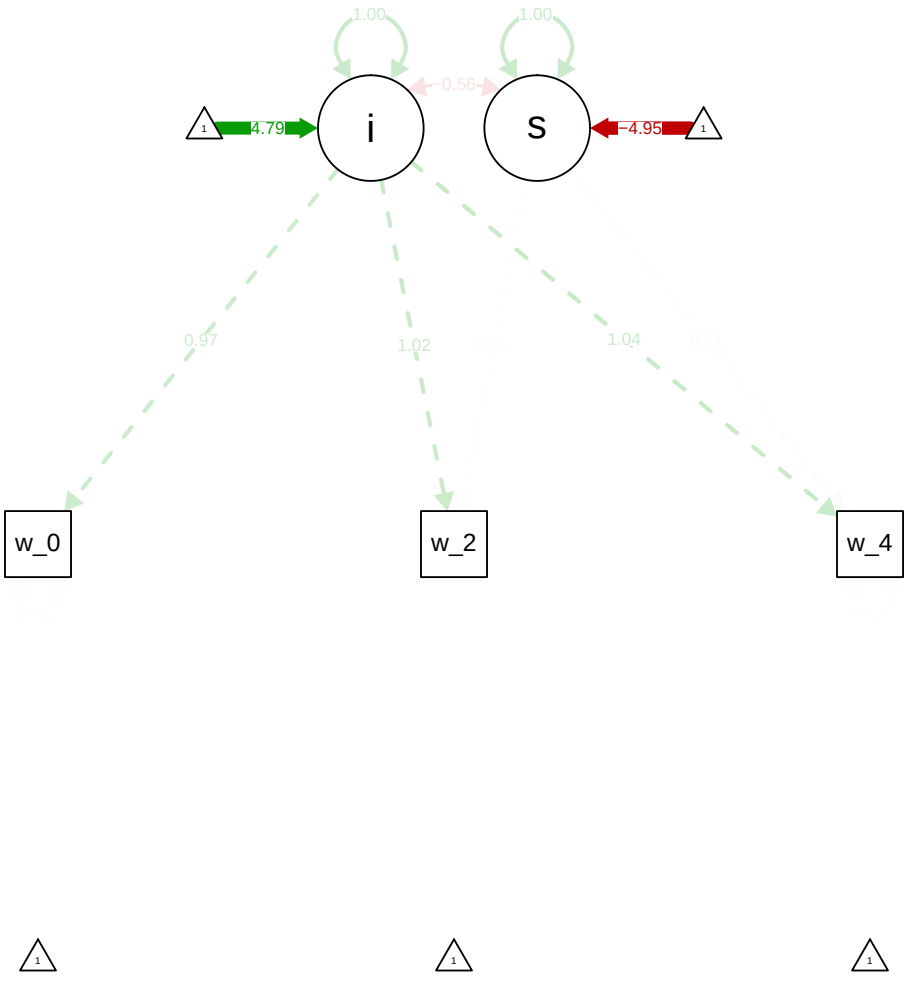

```
# improve model fit?
anova(SEMIntOnlyfit, SEMFixSlopesfit)

## Chi Square Difference Test
##
```

```
##                 Df    AIC    BIC   Chisq Chisq diff Df diff Pr(>Chisq)
## SEMFixSlopesfit  2 2819.0 2839.5  32.411
## SEMIntOnlyfit    4 2928.8 2943.4 146.227     113.82       2  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# yes

# intercept and random slope
SEMRanSlopes <- " i =~ 1*w_0 + 1*w_20 + 1*w_40
                  s =~ 0*w_0 + 20*w_20 + 40*w_40"
SEMRanSlopesfit <- growth(SEMRanSlopes, missing = "ML", data = wgtwide)
summary(SEMRanSlopesfit)
```

```
## lavaan (0.5-23.1097) converged normally after 183 iterations
##
##   Number of observations                           139
##
##   Number of missing patterns                         4
##
##   Estimator                                         ML
##   Minimum Function Test Statistic               32.395
##   Degrees of freedom                                 1
##   P-value (Chi-square)                           0.000
##
## Parameter Estimates:
##
##   Information                                 Observed
##   Standard Errors                             Standard
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i =~
##     w_0               1.000
##     w_20              1.000
##     w_40              1.000
##   s =~
##     w_0               0.000
##     w_20             20.000
##     w_40             40.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i ~~
##     s                -3.579    3.597   -0.995    0.320
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .w_0               0.000
##    .w_20              0.000
##    .w_40              0.000
##     i               235.853    4.676   50.435    0.000
```

```
##     s                -0.645    0.047  -13.693    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .w_0             136.781  112.282    1.218    0.223
##    .w_20             31.027   53.281    0.582    0.560
##    .w_40             81.713  104.498    0.782    0.434
##     i              2421.742  308.612    7.847    0.000
##     s                 0.017    0.137    0.125    0.901

semPaths(SEMRanSlopesfit, what = "std")
```



```r
# improve model fit?
anova(SEMFixSlopesfit, SEMRanSlopesfit)

## Chi Square Difference Test
##
##                 Df    AIC    BIC  Chisq Chisq diff Df diff Pr(>Chisq)
## SEMRanSlopesfit  1 2820.9 2844.4 32.395
## SEMFixSlopesfit  2 2819.0 2839.5 32.411    0.01545       1     0.9011

# nope - random slope doesn't improve fit

# MLM
MLMIntOnly <- lmer(weight ~ 1 + (1 | ID), data = wgt)
summary(MLMIntOnly)

## Linear mixed model fit by REML ['lmerMod']
## Formula: weight ~ 1 + (1 | ID)
##    Data: wgt
##
## REML criterion at convergence: 29522.2
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -3.9151 -0.5917 -0.1142  0.5112  4.8113
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ID       (Intercept) 2465.02  49.649
##  Residual               89.98   9.486
## Number of obs: 3900, groups:  ID, 139
##
## Fixed effects:
##             Estimate Std. Error t value
## (Intercept)  224.445      4.215   53.25

summary(SEMIntOnlyfit)

## lavaan (0.5-23.1097) converged normally after 128 iterations
##
##   Number of observations                           139
##
##   Number of missing patterns                         4
##
##   Estimator                                         ML
##   Minimum Function Test Statistic              146.227
##   Degrees of freedom                                 4
##   P-value (Chi-square)                           0.000
##
## Parameter Estimates:
##
##   Information                                 Observed
##   Standard Errors                             Standard
```

```
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i =~
##     w_0               1.000
##     w_20              1.000
##     w_40              1.000
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .w_0               0.000
##    .w_20              0.000
##    .w_40              0.000
##     i               222.130    4.363   50.918    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .w_0             543.873   67.543    8.052    0.000
##    .w_20           -103.800   20.869   -4.974    0.000
##    .w_40            236.904   36.930    6.415    0.000
##     i              2587.453  315.006    8.214    0.000
```

```
# Fixed effect similar 224 vs. 222 Random effect similar variance Random
# effect residuals quite different - due to full inclusion of data in MLM?
MLMFixSlope <- lmer(weight ~ 1 + wave + (1 | ID), data = wgt)
summary(MLMFixSlope)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: weight ~ 1 + wave + (1 | ID)
##    Data: wgt
##
## REML criterion at convergence: 26156.8
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.1539 -0.5597 -0.1263  0.4739  5.8045
##
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  ID       (Intercept) 2395.87  48.948
##  Residual               36.75   6.062
## Number of obs: 3900, groups:  ID, 139
##
## Fixed effects:
##               Estimate Std. Error t value
## (Intercept) 234.720596   4.155461   56.48
## wave         -0.633317   0.008576  -73.84
##
## Correlation of Fixed Effects:
##      (Intr)
## wave -0.033
```

```
summary(SEMFixSlopesfit)
```

```
## lavaan (0.5-23.1097) converged normally after 211 iterations
##
##   Number of observations                           139
##
##   Number of missing patterns                         4
##
##   Estimator                                         ML
##   Minimum Function Test Statistic               32.411
##   Degrees of freedom                                 2
##   P-value (Chi-square)                           0.000
##
## Parameter Estimates:
##
##   Information                                 Observed
##   Standard Errors                             Standard
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   i =~
##     w_0              1.000
##     w_20             1.000
##     w_40             1.000
##   s =~
##     w_0              0.000
##     w_20            20.000
##     w_40            40.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   i ~~
##     s               -3.207    1.984   -1.616    0.106
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .w_0              0.000
##    .w_20             0.000
##    .w_40             0.000
##     i              235.630    4.320   54.550    0.000
##     s               -0.645    0.047  -13.775    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##     s                0.000
##    .w_0            150.305   28.577    5.260    0.000
##    .w_20            24.790   17.564    1.411    0.158
##    .w_40            94.413   23.200    4.070    0.000
##     i             2414.609  302.299    7.987    0.000

# Fixed and random effects similar
```

5 Question 5

Constrain the residual variances to be equal. Does this change the fit of your model?

```
SEMFixSlopesres <- " i =~ 1*w_0 + 1*w_20 + 1*w_40
                  s =~ 0*w_0 + 20*w_20 + 40*w_40

                  s ~~ 0*s #fixed slopes, no variance
                  w_0 ~~ a*w_0
                  w_20 ~~ a*w_20
                  w_40 ~~ a*w_40 #residuals are equal to each other"
SEMFixSlopesfitres <- growth(SEMFixSlopesres, missing = "ML", data = wgtwide)
```

```
## Warning in lav_object_post_check(object):  lavaan WARNING: covariance matrix of latent variables
##                 is not positive definite;
##                 use inspect(fit,"cov.lv") to investigate.
```

```
summary(SEMFixSlopesfitres)
```

```
## lavaan (0.5-23.1097) converged normally after 101 iterations
##
##   Number of observations                           139
##
##   Number of missing patterns                         4
##
##   Estimator                                         ML
##   Minimum Function Test Statistic               43.451
##   Degrees of freedom                                 4
##   P-value (Chi-square)                           0.000
##
## Parameter Estimates:
##
##   Information                                 Observed
##   Standard Errors                             Standard
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i =~
##     w_0               1.000
##     w_20              1.000
##     w_40              1.000
##   s =~
##     w_0               0.000
##     w_20             20.000
##     w_40             40.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i ~~
##     s                -3.223    1.554   -2.074    0.038
##
## Intercepts:
```

```
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .w_0               0.000
##    .w_20              0.000
##    .w_40              0.000
##     i               237.214    4.230   56.080    0.000
##     s                -0.676    0.036  -18.873    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##     s                 0.000
##    .w_0        (a)   93.166   10.135    9.192    0.000
##    .w_20       (a)   93.166   10.135    9.192    0.000
##    .w_40       (a)   93.166   10.135    9.192    0.000
##     i              2402.824  292.885    8.204    0.000
```

```
SEMFixSlopesfit <- growth(SEMFixSlopes, missing = "ML", data = wgtwide)
```

```
## Warning in lav_object_post_check(object):  lavaan WARNING: covariance matrix of latent variables
##                is not positive definite;
##                use inspect(fit,"cov.lv") to investigate.
```

```
summary(SEMFixSlopesfit)
```

```
## lavaan (0.5-23.1097) converged normally after 211 iterations
##
##   Number of observations                           139
##
##   Number of missing patterns                         4
##
##   Estimator                                         ML
##   Minimum Function Test Statistic               32.411
##   Degrees of freedom                                 2
##   P-value (Chi-square)                           0.000
##
## Parameter Estimates:
##
##   Information                                 Observed
##   Standard Errors                             Standard
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i =~
##     w_0               1.000
##     w_20              1.000
##     w_40              1.000
##   s =~
##     w_0               0.000
##     w_20             20.000
##     w_40             40.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
```

```
##   i ~~
##     s                -3.207    1.984   -1.616    0.106
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .w_0               0.000
##    .w_20              0.000
##    .w_40              0.000
##     i               235.630    4.320   54.550    0.000
##     s                -0.645    0.047  -13.775    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##     s                 0.000
##    .w_0             150.305   28.577    5.260    0.000
##    .w_20             24.790   17.564    1.411    0.158
##    .w_40             94.413   23.200    4.070    0.000
##     i              2414.609  302.299    7.987    0.000
```

```
anova(SEMFixSlopesfit, SEMFixSlopesfitres)
```

```
## Chi Square Difference Test
##
##                    Df  AIC    BIC  Chisq Chisq diff Df diff Pr(>Chisq)
## SEMFixSlopesfit     2 2819 2839.5 32.411
## SEMFixSlopesfitres  4 2826 2840.7 43.451      11.04       2   0.004005 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# Fixing residuals to equal each other makes the model significantly worse
```

6 Question 6

Contrain your slope to be fixed, not random. How does this change your model?

```
# see above
anova(SEMFixSlopesfit, SEMRanSlopesfit)
```

```
## Chi Square Difference Test
##
##                 Df    AIC    BIC  Chisq Chisq diff Df diff Pr(>Chisq)
## SEMRanSlopesfit  1 2820.9 2844.4 32.395
## SEMFixSlopesfit  2 2819.0 2839.5 32.411    0.01545       1     0.9011
```

```
# Model produces similar results with fixed and random slopes
```

7 Question 7

Change the time metric in your SEM growth model. How does that change your estimates? Does it change your fit statistics?

```
SEMFixSlopestime <- " i =~ 1*w_0 + 1*w_20 + 1*w_40
                     s =~ 0*w_0 + 1*w_20 + 2*w_40

                     s ~~ 0*s #fixed slopes, no variance"
SEMFixSlopesfittime <- growth(SEMFixSlopestime, missing = "ML", data = wgtwide)

## Warning in lav_object_post_check(object):  lavaan WARNING: covariance matrix of latent variables
##                 is not positive definite;
##                 use inspect(fit,"cov.lv") to investigate.

summary(SEMFixSlopesfittime)

## lavaan (0.5-23.1097) converged normally after 181 iterations
##
##   Number of observations                           139
##
##   Number of missing patterns                         4
##
##   Estimator                                         ML
##   Minimum Function Test Statistic               32.411
##   Degrees of freedom                                 2
##   P-value (Chi-square)                           0.000
##
## Parameter Estimates:
##
##   Information                                 Observed
##   Standard Errors                             Standard
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i =~
##     w_0               1.000
##     w_20              1.000
##     w_40              1.000
##   s =~
##     w_0               0.000
##     w_20              1.000
##     w_40              2.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i ~~
##     s               -64.138   39.688   -1.616    0.106
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .w_0               0.000
##    .w_20              0.000
```

```
##    .w_40              0.000
##     i               235.630    4.320   54.550    0.000
##     s               -12.894    0.936  -13.775    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##     s                 0.000
##    .w_0             150.305   28.577    5.260    0.000
##    .w_20             24.790   17.564    1.411    0.158
##    .w_40             94.413   23.200    4.070    0.000
##     i              2414.607  302.298    7.987    0.000
```

```
summary(SEMFixSlopesfit)
```

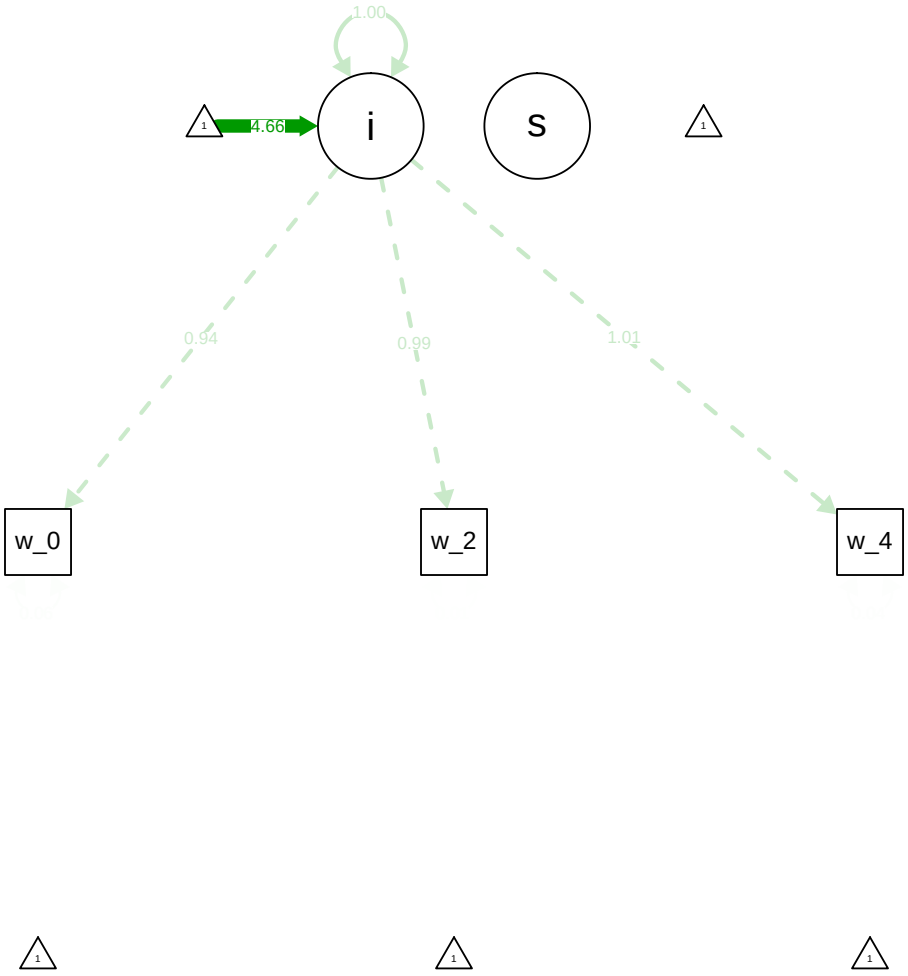
```
## lavaan (0.5-23.1097) converged normally after 211 iterations
##
##   Number of observations                           139
##
##   Number of missing patterns                         4
##
##   Estimator                                         ML
##   Minimum Function Test Statistic               32.411
##   Degrees of freedom                                 2
##   P-value (Chi-square)                           0.000
##
## Parameter Estimates:
##
##   Information                                 Observed
##   Standard Errors                             Standard
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   i =~
##     w_0               1.000
##     w_20              1.000
##     w_40              1.000
##   s =~
##     w_0               0.000
##     w_20             20.000
##     w_40             40.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   i ~~
##     s                -3.207    1.984   -1.616    0.106
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .w_0               0.000
##    .w_20              0.000
##    .w_40              0.000
##     i               235.630    4.320   54.550    0.000
```

```
##     s                -0.645    0.047  -13.775    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##     s                 0.000
##    .w_0             150.305   28.577    5.260    0.000
##    .w_20             24.790   17.564    1.411    0.158
##    .w_40             94.413   23.200    4.070    0.000
##     i              2414.609  302.299    7.987    0.000

# same - same distance between variables.

# Different intercept
SEMFixSlopesint <- " i =~ 1*w_0 + 1*w_20 + 1*w_40
                  s =~ -20*w_0 + 0*w_20 + 20*w_40

                  s ~~ 0*s #fixed slopes, no variance"
SEMFixSlopesfitint <- growth(SEMFixSlopesint, missing = "ML", data = wgtwide)

## Warning in lav_object_post_check(object):  lavaan WARNING: covariance matrix of latent variables
##                  is not positive definite;
##                  use inspect(fit,"cov.lv") to investigate.

summary(SEMFixSlopesfitint)

## lavaan (0.5-23.1097) converged normally after 187 iterations
##
##   Number of observations                           139
##
##   Number of missing patterns                         4
##
##   Estimator                                         ML
##   Minimum Function Test Statistic               32.411
##   Degrees of freedom                                 2
##   P-value (Chi-square)                           0.000
##
## Parameter Estimates:
##
##   Information                                 Observed
##   Standard Errors                             Standard
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i =~
##     w_0               1.000
##     w_20              1.000
##     w_40              1.000
##   s =~
##     w_0             -20.000
##     w_20              0.000
##     w_40             20.000
##
```

```
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i ~~
##     s                -3.207    1.984   -1.616    0.106
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .w_0               0.000
##    .w_20              0.000
##    .w_40              0.000
##     i               222.736    4.131   53.913    0.000
##     s                -0.645    0.047  -13.775    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##     s                 0.000
##    .w_0             150.305   28.577    5.260    0.000
##    .w_20             24.790   17.564    1.411    0.158
##    .w_40             94.413   23.200    4.070    0.000
##     i              2286.333  279.643    8.176    0.000
```

```
# intercept different, lower, at week 20, average weight would be lower
# random effect of intercept is lower slope and residual variance the same
semPaths(SEMFixSlopesfitint, what = "std")
```

```
## Warning in qgraph(Edgelist, labels = nLab, bidirectional = Bidir, directed = Directed, :
Non-finite weights are omitted
```



8 Question 8

Try a different type of estimation (see lavaan tutorial for details). How does that change your model?

```
SEMFixSlopesMLM <- " i =~ 1*w_0 + 1*w_20 + 1*w_40
                    s =~ 0*w_0 + 20*w_20 + 40*w_40

                    s ~~ 0*s #fixed slopes, no variance"
SEMFixSlopesfitMLM <- growth(SEMFixSlopesMLM, estimator = "MLM", data = wgtwide)
```

```
## Warning in lav_object_post_check(object):  lavaan WARNING: covariance matrix of latent variables
##                is not positive definite;
##                use inspect(fit,"cov.lv") to investigate.
```

```
summary(SEMFixSlopesfitMLM)
```

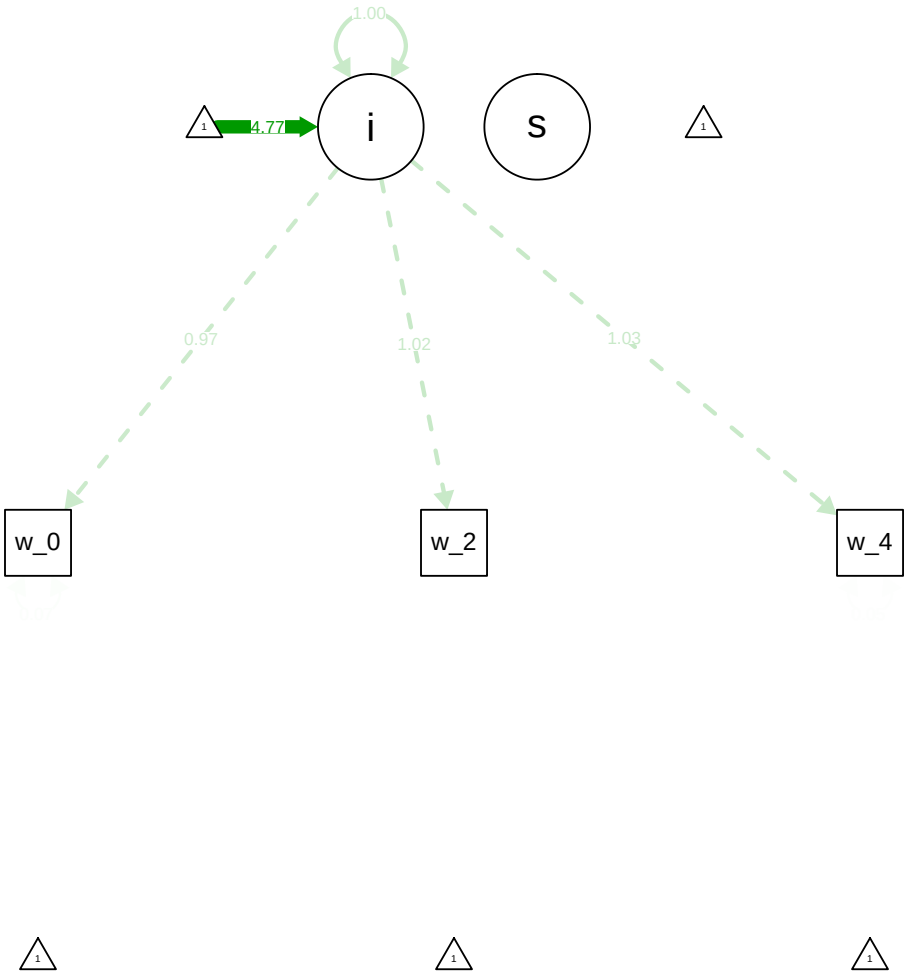
```
## lavaan (0.5-23.1097) converged normally after 205 iterations
##
##                                                   Used       Total
##   Number of observations                             62         139
##
##   Estimator                                          ML      Robust
##   Minimum Function Test Statistic                37.940      69.547
##   Degrees of freedom                                  2           2
##   P-value (Chi-square)                            0.000       0.000
##   Scaling correction factor                                   0.546
##     for the Satorra-Bentler correction
##
## Parameter Estimates:
##
##   Information                                 Expected
##   Standard Errors                           Robust.sem
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i =~
##     w_0               1.000
##     w_20              1.000
##     w_40              1.000
##   s =~
##     w_0               0.000
##     w_20             20.000
##     w_40             40.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   i ~~
##     s                -2.802    2.542   -1.103    0.270
##
## Intercepts:
##                    Estimate  Std.Err  z-value  P(>|z|)
##    .w_0               0.000
##    .w_20              0.000
##    .w_40              0.000
##     i               229.632    6.269   36.629    0.000
##     s                -0.609    0.050  -12.078    0.000
##
## Variances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##     s                 0.000
##    .w_0             162.730   31.143    5.225    0.000
##    .w_20             13.549   16.691    0.812    0.417
```

```
##    .w_40            101.618   25.733    3.949    0.000
##     i              2322.346  531.361    4.371    0.000
```

```
summary(SEMFixSlopesfit)
```

```
## lavaan (0.5-23.1097) converged normally after 211 iterations
##
##   Number of observations                           139
##
##   Number of missing patterns                         4
##
##   Estimator                                         ML
##   Minimum Function Test Statistic               32.411
##   Degrees of freedom                                 2
##   P-value (Chi-square)                           0.000
##
## Parameter Estimates:
##
##   Information                                 Observed
##   Standard Errors                             Standard
##
## Latent Variables:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   i =~
##     w_0              1.000
##     w_20             1.000
##     w_40             1.000
##   s =~
##     w_0              0.000
##     w_20            20.000
##     w_40            40.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   i ~~
##     s               -3.207    1.984   -1.616    0.106
##
## Intercepts:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .w_0              0.000
##    .w_20             0.000
##    .w_40             0.000
##     i              235.630    4.320   54.550    0.000
##     s               -0.645    0.047  -13.775    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##     s                0.000
##    .w_0            150.305   28.577    5.260    0.000
##    .w_20            24.790   17.564    1.411    0.158
##    .w_40            94.413   23.200    4.070    0.000
##     i             2414.609  302.299    7.987    0.000
```

```r
# lower intercept, slower rate of change
semPaths(SEMFixSlopesfitMLM, what = "std")

## Warning in qgraph(Edgelist, labels = nLab, bidirectional = Bidir, directed = Directed, :
Non-finite weights are omitted
```



9 Question 9

Provide semplots for each of the models

```
# Graphs provided throughout
```