In [1]:

```
# Sources Used :
# 1. https://www.youtube.com/watch?v=OlVepNU8GtU&t=360s ( Main  )
# 2. https://cran.r-project.org/web/packages/plspm/vignettes/plspm_introduction.pdf
# 3. https://sagaofpls.github.io/kidding.html
# 4. https://www.gastonsanchez.com/PLS_Path_Modeling_with_R.pdf (Main Reference Boo

install.packages("plspm")
library(plspm)
```

```
Updating HTML index of packages in '.Library'

Making 'packages.html' ...
 done
```

In [2]:

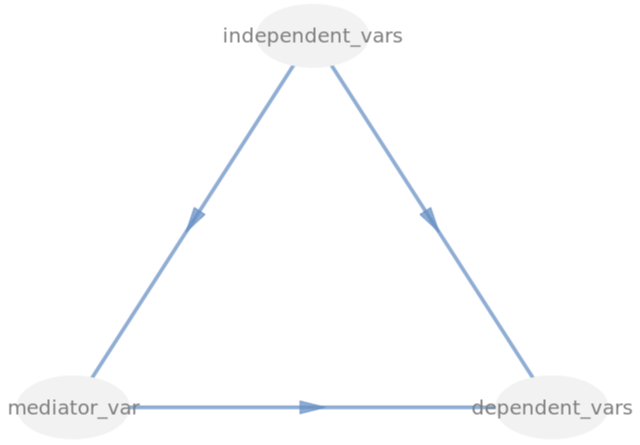
```
data <- read.csv("Pilot_modified_data_new.csv")
```

In [3]:

```
# Independent variables
independent_vars =c(0,0,0)

# Mediator variable
mediator_var =c(1,0,0)

# Dependent variables
dependent_vars =c(1,1,0)
```

In [4]:

```
x=rbind(independent_vars,mediator_var,dependent_vars)
colnames(x)=rownames(x)
innerplot(x)
```



```
In [5]: print(x)
```

```
                 independent_vars mediator_var dependent_vars
independent_vars                0            0              0
mediator_var                    1            0              0
dependent_vars                  1            1              0
```

```
In [6]: out=list(4:13, 14 ,1:3)
```

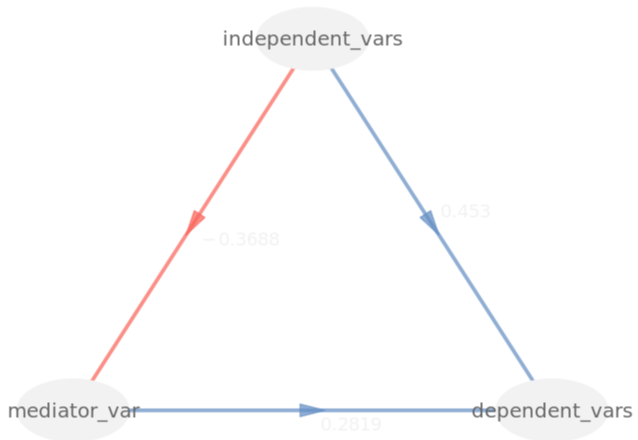
```
In [7]: mode=c("A","A","A")
```

```
In [8]: xx=plspm(data, x, out)
```

```
In [9]: summary(xx)
```

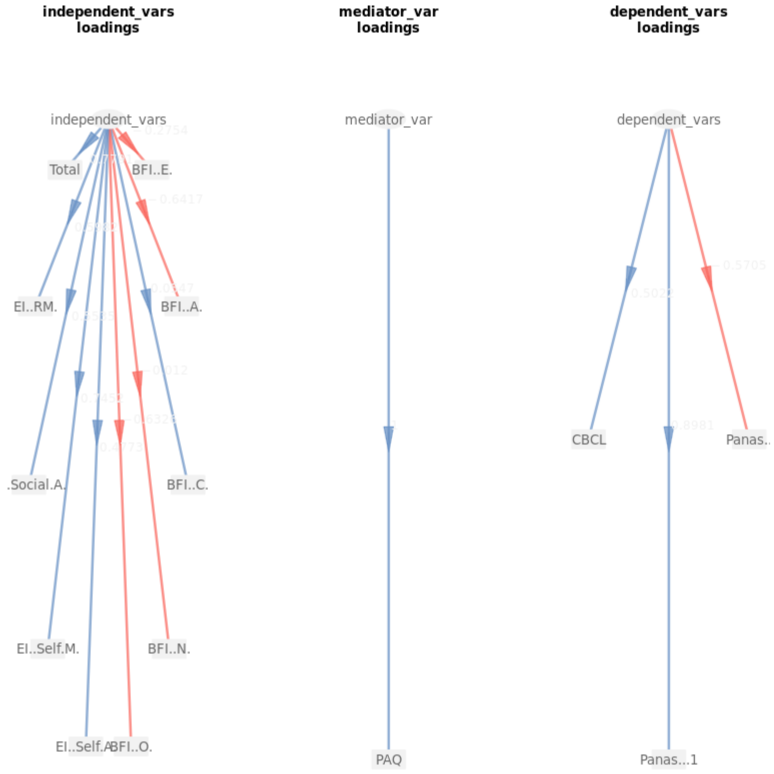
```
PARTIAL LEAST SQUARES PATH MODELING (PLS-PM)

----------------------------------------------------------
MODEL SPECIFICATION
1   Number of Cases      34
2   Latent Variables     3
3   Manifest Variables   14
4   Scale of Data        Standardized Data
5   Non-Metric PLS       FALSE
6   Weighting Scheme     centroid
7   Tolerance Crit       1e-06
8   Max Num Iters        100
9   Convergence Iters    10
10  Bootstrapping        FALSE
11  Bootstrap samples    NULL

----------------------------------------------------------
BLOCKS DEFINITION
               Block         Type   Size   Mode
1   independent_vars    Exogenous     10      A
2       mediator_var   Endogenous      1      A
3     dependent_vars   Endogenous      3      A

----------------------------------------------------------
BLOCKS UNIDIMENSIONALITY
                  Mode  MVs  C.alpha  DG.rho  eig.1st  eig.2nd
independent_vars     A   10    0.369    0.45     3.09    1.692
mediator_var         A    1    1.000    1.00     1.00    0.000
dependent_vars       A    3    0.000    0.17     1.60    0.875

----------------------------------------------------------
OUTER MODEL
                    weight  loading  communality  redundancy
independent_vars
  1 BFI..E.        -0.0976  -0.2754     0.075870       0.000
  1 BFI..A.        -0.3542  -0.6417     0.411719       0.000
  1 BFI..C.         0.0712   0.0547     0.002989       0.000
  1 BFI..N.        -0.0381  -0.0120     0.000144       0.000
  1 BFI..O.        -0.2899  -0.6326     0.400203       0.000
  1 EI..Self.A.     0.1268   0.4773     0.227775       0.000
  1 EI..Self.M.     0.2539   0.7452     0.555293       0.000
  1 EI..Social.A.   0.1417   0.5535     0.306308       0.000
  1 EI..RM.         0.1755   0.5982     0.357790       0.000
  1 Total           0.1605   0.7791     0.606956       0.000
mediator_var
  2 PAQ             1.0000   1.0000     1.000000       0.136
dependent_vars
  3 Panas..        -0.3383  -0.5705     0.325499       0.062
  3 Panas...1       0.7993   0.8981     0.806522       0.154
  3 CBCL            0.1775   0.5022     0.252191       0.048

----------------------------------------------------------
CROSSLOADINGS
                   independent_vars  mediator_var  dependent_vars
independent_vars
  1 BFI..E.                 -0.2754        0.0957       -8.73e-02
  1 BFI..A.                 -0.6417        0.5009       -1.64e-01
  1 BFI..C.                  0.0547       -0.1335        6.38e-21
  1 BFI..N.                 -0.0120        0.0592       -1.23e-02
  1 BFI..O.                 -0.6326        0.0828       -4.61e-01
  1 EI..Self.A.              0.4773       -0.1979        4.00e-02
  1 EI..Self.M.              0.7452       -0.1259        3.50e-01
  1 EI..Social.A.            0.5535       -0.1036        1.62e-01
  1 EI..RM.                  0.5982       -0.4097       -8.05e-02
  1 Total                    0.7791       -0.0164        2.85e-01
mediator_var
  2 PAQ                     -0.3688        1.0000        1.15e-01
dependent_vars
  3 Panas..                 -0.3036        0.1036       -5.71e-01
  3 Panas...1                0.2998        0.1727        8.98e-01
  3 CBCL                     0.0380        0.0669        5.02e-01

----------------------------------------------------------
INNER MODEL
$mediator_var
                    Estimate   Std. Error     t value   Pr(>|t|)
Intercept           1.49e-17        0.164    9.06e-17     1.0000
independent_vars   -3.69e-01        0.164   -2.24e+00     0.0319

$dependent_vars
                    Estimate   Std. Error     t value   Pr(>|t|)
Intercept          -1.30e-16        0.162   -8.04e-16      1.000
independent_vars    4.53e-01        0.174    2.61e+00      0.014
mediator_var        2.82e-01        0.174    1.62e+00      0.115

----------------------------------------------------------
CORRELATIONS BETWEEN LVs
                  independent_vars  mediator_var  dependent_vars
independent_vars             1.000        -0.369           0.349
mediator_var                -0.369         1.000           0.115
dependent_vars               0.349         0.115           1.000

----------------------------------------------------------
SUMMARY INNER MODEL
                        Type     R2  Block_Communality  Mean_Redundancy    AVE
independent_vars   Exogenous  0.000              0.295           0.0000  0.295
mediator_var      Endogenous  0.136              1.000           0.1360  1.000
dependent_vars    Endogenous  0.191              0.461           0.0879  0.461

----------------------------------------------------------
GOODNESS-OF-FIT
[1]  0.2332

----------------------------------------------------------
TOTAL EFFECTS
                        relationships  direct  indirect   total
1    independent_vars -> mediator_var  -0.369     0.000  -0.369
2  independent_vars -> dependent_vars   0.453    -0.104   0.349
3      mediator_var -> dependent_vars   0.282     0.000   0.282
```

```
In [10]: plot(xx)
```



```
In [11]: plot(xx, what="loadings", ar.width=0.5)
```

```
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xyouter[, 1], xyouter[, 2], col = Col, border = Col, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xyouter[, 1], xyouter[, 2], col = Col, border = Col, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xy[, 1], xy[, 2], lwd = lwd, col = box.col, border = lc
ol, :
“"ar.width" is not a graphical parameter”
Warning message in polygon(xyouter[, 1], xyouter[, 2], col = Col, border = Col, :
“"ar.width" is not a graphical parameter”
```


independent_vars
loadings
independent_vars
−0.2754
Total
0.7791
BFI..E.
−0.6417
0.5982
EI..RM.
0.0547
BFI..A.
0.5585
−0.012
0.7452
−0.6323
0.4773
.Social.A.
BFI..C.
EI..Self.M.
BFI..N.
EI..Self.A
BFI..O.
mediator_var
loadings
mediator_var
PAQ
dependent_vars
loadings
dependent_vars
−0.5705
0.5022
CBCL
0.8981
Panas..
Panas...1

In [12]:

```
?plspm
```

plspm {plspm} R Documentation

PLS-PM: Partial Least Squares Path Modeling

Description

Estimate path models with latent variables by partial least squares approach (for both metric and non-metric data)

Estimate path models with latent variables by partial least squares approach (for both metric and non-metric data)

Usage

```
plspm(Data, path_matrix, blocks, modes = NULL,
  scaling = NULL, scheme = "centroid", scaled = TRUE,
  tol = 1e-06, maxiter = 100, plscomp = NULL,
  boot.val = FALSE, br = NULL, dataset = TRUE)
```

Arguments

`Data` matrix or data frame containing the manifest variables.

`path_matrix` A square (lower triangular) boolean matrix representing the inner model (i.e. the path relationships between latent variables).

`blocks` list of vectors with column indices or column names from `Data` indicating the sets of manifest variables forming each block (i.e. which manifest variables correspond to each block).

`scaling` optional argument for runing the non-metric approach; it is a list of string vectors indicating the type of measurement scale for each manifest variable specified in `blocks`. `scaling` must be specified when working with non-metric variables. Possible values: `"num"` (linear transformation, suitable for numerical variables), `"raw"` (no transformation), `"nom"` (non-monotonic transformation, suitable for nominal variables), and `"ord"` (monotonic transformation, suitable for ordinal variables).

`modes` character vector indicating the type of measurement for each block. Possible values are: `"A", "B", "newA", "PLScore", "PLScow"`. The length of `modes` must be equal to the length of `blocks`.

`scheme` string indicating the type of inner weighting scheme. Possible values are `"centroid"`, `"factorial"`, or `"path"`.

`scaled` whether manifest variables should be standardized. Only used when `scaling = NULL`. When (`TRUE`, data is scaled to standardized values (mean=0 and variance=1). The

	variance is calculated dividing by `N` instead of `N-1`).
`tol`	decimal value indicating the tolerance criterion for the iterations (`tol=0.000001`). Can be specified between 0 and 0.001.
`maxiter`	integer indicating the maximum number of iterations (`maxiter=100` by default). The minimum value of `maxiter` is 100.
`plscomp`	optional vector indicating the number of PLS components (for each block) to be used when handling non-metric data (only used if `scaling` is provided)
`boot.val`	whether bootstrap validation should be performed. (`FALSE` by default).
`br`	number bootstrap resamples. Used only when `boot.val=TRUE` . When `boot.val=TRUE` , the default number of re-samples is 100.
`dataset`	whether the data matrix used in the computations should be retrieved (`TRUE` by default).

Details

The function `plspm` estimates a path model by partial least squares approach providing the full set of results.

The argument `path_matrix` is a matrix of zeros and ones that indicates the structural relationships between latent variables. `path_matrix` must be a lower triangular matrix; it contains a 1 when column `j` affects row `i` , 0 otherwise.

- `plspm` : Partial Least Squares Path Modeling
- `plspm.fit` : Simple version for PLS-PM
- `plspm.groups` : Two Groups Comparison in PLS-PM
- `rebus.pls` : Response Based Unit Segmentation (REBUS)

Value

An object of class `"plspm"` .

`outer_model`	Results of the outer model. Includes: outer weights, standardized loadings, communalities, and redundancies
`inner_model`	Results of the inner (structural) model. Includes: path coeffs and R-squared for each endogenous latent variable
`scores`	Matrix of latent variables used to estimate the inner model. If `scaled=FALSE` then `scores` are latent variables calculated with the original data (non-stardardized).

`path_coefs`	Matrix of path coefficients (this matrix has a similar form as `path_matrix`)
`crossloadings`	Correlations between the latent variables and the manifest variables (also called crossloadings)
`inner_summary`	Summarized results of the inner model. Includes: type of LV, type of measurement, number of indicators, R-squared, average communality, average redundancy, and average variance extracted
`effects`	Path effects of the structural relationships. Includes: direct, indirect, and total effects
`unidim`	Results for checking the unidimensionality of blocks (These results are only meaningful for reflective blocks)
`gof`	Goodness-of-Fit index
`data`	Data matrix containing the manifest variables used in the model. Only available when `dataset=TRUE`
`boot`	List of bootstrapping results; only available when argument `boot.val=TRUE`

Author(s)

Gaston Sanchez, Giorgio Russolillo

References

Tenenhaus M., Esposito Vinzi V., Chatelin Y.M., and Lauro C. (2005) PLS path modeling. *Computational Statistics & Data Analysis*, **48**, pp. 159-205.

Lohmoller J.-B. (1989) *Latent variables path modeling with partial least squares.* Heidelberg: Physica-Verlag.

Wold H. (1985) Partial Least Squares. In: Kotz, S., Johnson, N.L. (Eds.), *Encyclopedia of Statistical Sciences*, Vol. 6. Wiley, New York, pp. 581-591.

Wold H. (1982) Soft modeling: the basic design and some extensions. In: K.G. Joreskog & H. Wold (Eds.), *Systems under indirect observations: Causality, structure, prediction*, Part 2, pp. 1-54. Amsterdam: Holland.

Russolillo, G. (2012) Non-Metric Partial Least Squares. *Electronic Journal of Statistics*, **6**, pp. 1641-1669. https://projecteuclid.org/euclid.ejs/1348665231

See Also

`innerplot` , `outerplot` ,

Examples

```
## Not run:
## typical example of PLS-PM in customer satisfaction analysis
## model with six LVs and reflective indicators

# load dataset satisfaction
data(satisfaction)

# path matrix
IMAG = c(0,0,0,0,0,0)
EXPE = c(1,0,0,0,0,0)
QUAL = c(0,1,0,0,0,0)
VAL = c(0,1,1,0,0,0)
SAT = c(1,1,1,1,0,0)
LOY = c(1,0,0,0,1,0)
sat_path = rbind(IMAG, EXPE, QUAL, VAL, SAT, LOY)

# plot diagram of path matrix
innerplot(sat_path)

# blocks of outer model
sat_blocks = list(1:5, 6:10, 11:15, 16:19, 20:23, 24:27)

# vector of modes (reflective indicators)
sat_mod = rep("A", 6)

# apply plspm
satpls = plspm(satisfaction, sat_path, sat_blocks, modes = sat_mod,
   scaled = FALSE)

# plot diagram of the inner model
innerplot(satpls)

# plot loadings
outerplot(satpls, what = "loadings")

# plot outer weights
outerplot(satpls, what = "weights")

## End(Not run)
```

[Package *plspm* version 0.5.0]

```
In [ ]:
```