

Dynamic structural equation model

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```
library(tinyVAST)
set.seed(101)
```

tinyVAST includes features to fit a dynamic structural equation model

```
data(isle_royale, package="dsem")

# Convert to long-form
data = expand.grid( "time"=isle_royale[,1], "var"=colnames(isle_royale[,2:3]) )
data$logn = unlist(log(isle_royale[2:3]))

# Define cross-lagged SEM
sem = "
  # Link, lag, param_name
  wolves -> wolves, 1, arW
  moose -> wolves, 1, MtoW
  wolves -> moose, 1, WtoM
  moose -> moose, 1, arM
  wolves -> moose, 0, corr
"

# fit model
mytiny = fit( sem = sem,
              data = data,
              times = isle_royale[,1],
              variables = colnames(isle_royale[,2:3]),
              estimate_delta0 = FALSE,
              formula = logn ~ 0 + var,
              quiet = TRUE )

mytiny
#> $call
#> fit(data = data, formula = logn ~ 0 + var, sem = sem, estimate_delta0 = FALSE,
#>      times = isle_royale[, 1], variables = colnames(isle_royale[,
#>      2:3]), quiet = TRUE)
#>
#> $opt
#> $opt$par
#>      alpha_j      alpha_j      beta_z      beta_z      beta_z      beta_z      beta_z      beta_z
#> 3.32526215 6.44165380 0.89304284 0.01420930 -0.11865012 0.86169491 -0.01539665 0.10648
#>
#> $opt$objective
#> [1] 5.781919
#>
#> $opt$convergence
```

```

#> [1] 0
#>
#> $opt$iterations
#> [1] 98
#>
#> $opt$evaluations
#> function gradient
#>      125      99
#>
#> $opt$message
#> [1] "relative convergence (4)"
#>
#>
#> $sdrep
#> sdreport(.) result
#>           Estimate   Std. Error
#> alpha_j      3.32526215 2.483419e-01
#> alpha_j      6.44165380 2.116017e-01
#> beta_z       0.89304284 8.420604e-02
#> beta_z       0.01420930 1.279148e-01
#> beta_z      -0.11865012 6.477637e-02
#> beta_z       0.86169491 7.080254e-02
#> beta_z      -0.01539665 6.067738e-02
#> beta_z       0.10648808 9.881848e-03
#> beta_z       0.04810383 4.460377e-03
#> log_sigma -12.52451040 1.805702e+04
#> Maximum gradient component: 1.345814e-05
#>
#> $run_time
#> Time difference of 0.261987 secs

```

We can then compare this with package `dsem`

```

library(dsem)

# Keep in wide-form
dsem_data = ts( log(isle_royale[,2:3]), start=1959)
family = c("normal","normal")

# initial first without delta0 (to improve starting values)
mydsem = dsem( sem = sem,
              tsdata = dsem_data,
              estimate_delta0 = FALSE,
              quiet = TRUE,
              getsd = FALSE,
              family = family )

mydsem
#> $par
#>      beta_z      beta_z      beta_z      beta_z      beta_z      beta_z      beta_z
#>  0.895834720  0.007358847 -0.109332511  0.875012562 -0.017355229  0.378795847 -0.172873038 -1.
#>
#> $objective
#> [1] 7.739638

```

```

#>
#> $iterations
#> [1] 79
#>
#> $evaluations
#> function gradient
#>      96      80
#>
#> $time_for_MLE
#> Time difference of 0.07351899 secs
#>
#> $max_gradient
#> [1] 7.714655e-07
#>
#> $Convergence_check
#> [1] "There is no evidence that the model is not converged"
#>
#> $number_of_coefficients
#> Total Fixed Random
#>   133      9   124
#>
#> $AIC
#> [1] 33.47928
#>
#> $diagnostics
#>      Param starting_value Lower      MLE Upper final_gradient
#> 1  beta_z      0.01  -Inf  0.895834720  Inf  4.785205e-09
#> 2  beta_z      0.01  -Inf  0.007358847  Inf -5.078683e-09
#> 3  beta_z      0.01  -Inf -0.109332511  Inf -2.031211e-08
#> 4  beta_z      0.01  -Inf  0.875012562  Inf -5.821149e-08
#> 5  beta_z      0.01  -Inf -0.017355229  Inf -5.373382e-09
#> 6  beta_z      1.00  -Inf  0.378795847  Inf  2.119351e-09
#> 7  beta_z      1.00  -Inf -0.172873038  Inf -7.714655e-07
#> 8 lnsigma_j      0.00  -Inf -15.799262455  Inf  1.628788e-12
#> 9 lnsigma_j      0.00  -Inf -11.977331517  Inf  2.141499e-09
#>
#> $time_for_run
#> Time difference of 0.07483792 secs

```