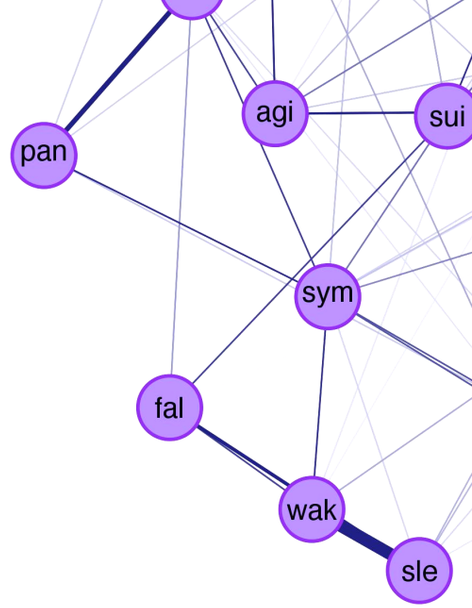
BEHIND THE SCENES



Coming to grips with the complexity of psychopathology

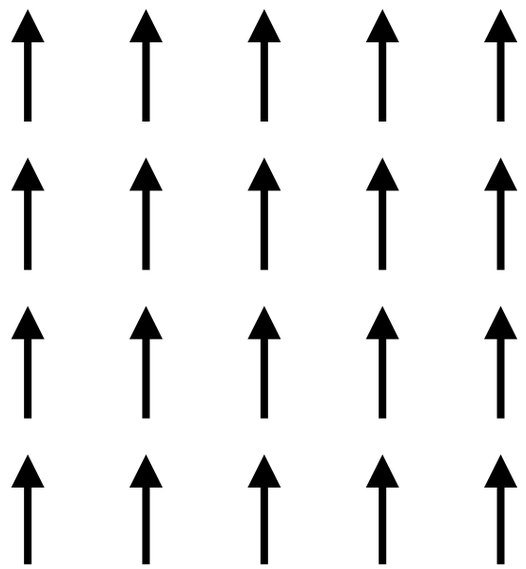
Claudia van Borkulo
University Medical Center Groningen - University of Amsterdam
Promotors: R.A. Schoevers, D. Borsboom

BEHIND THE SCENES

BEHIND the SCENES

?

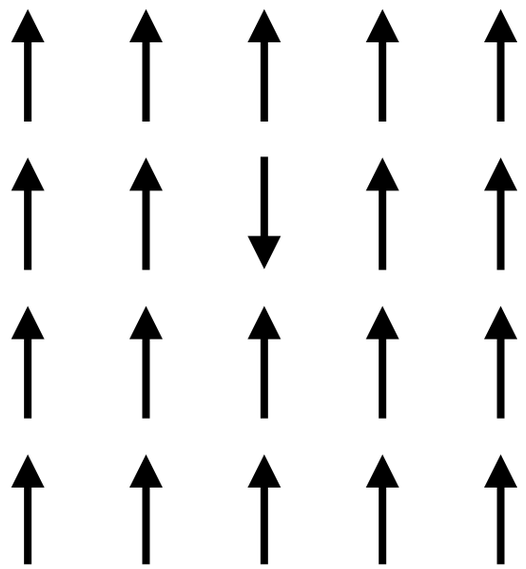
Ising model



Dipoles

- elements of ferromagnetic material
- can be spin-up or spin-down

Ising model



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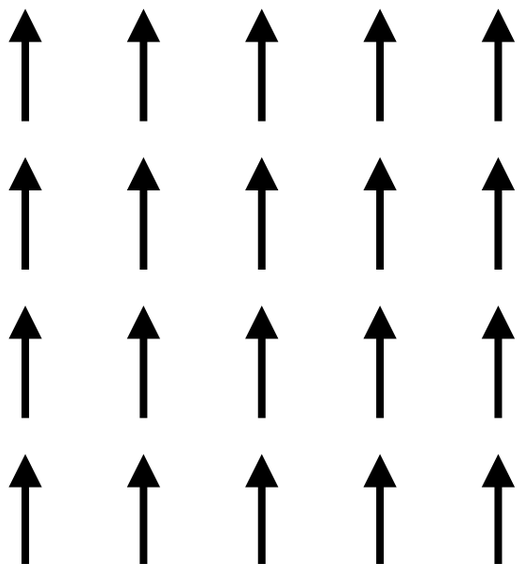
Different interpretations of the Ising model



Orientation of dipoles in ferromagnetic material

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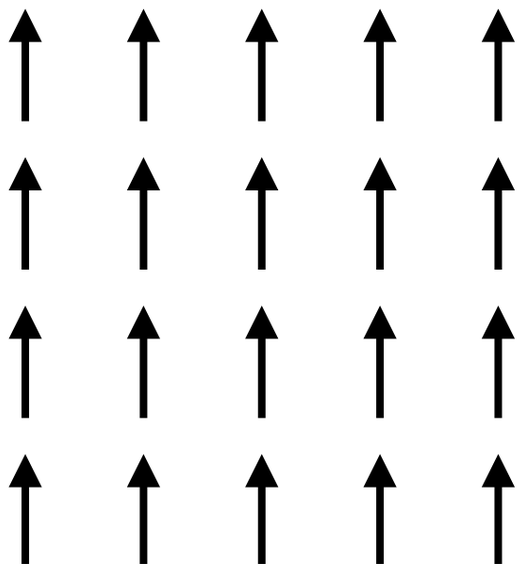

Orientation of dipoles in ferromagnetic material

Behavior of voters in an election

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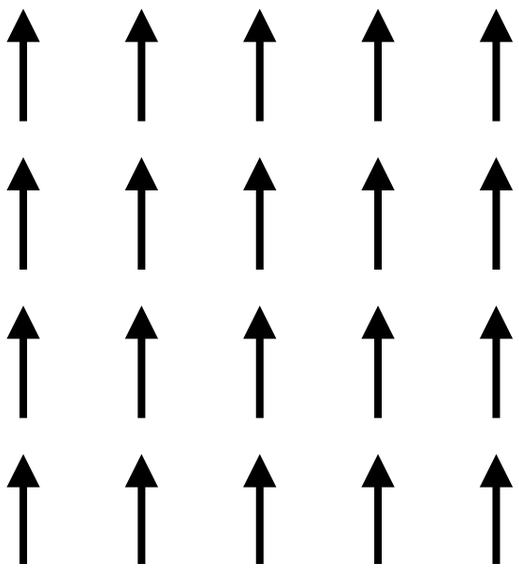

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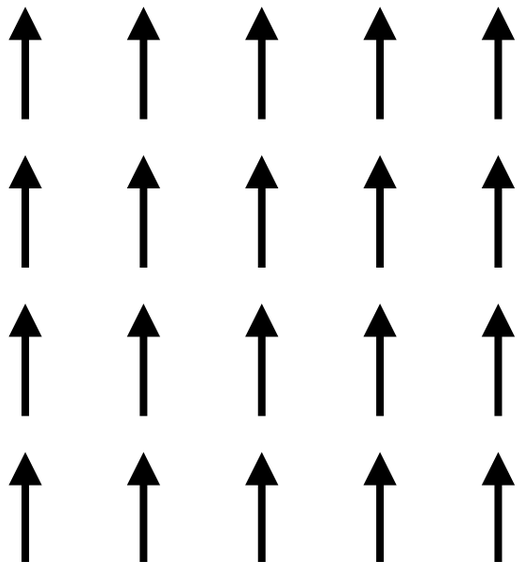

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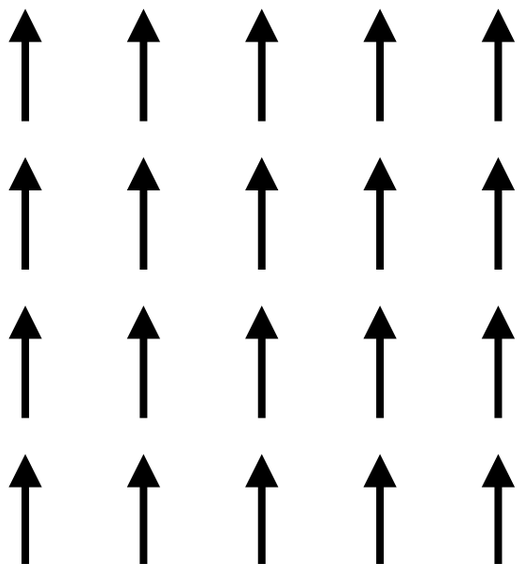

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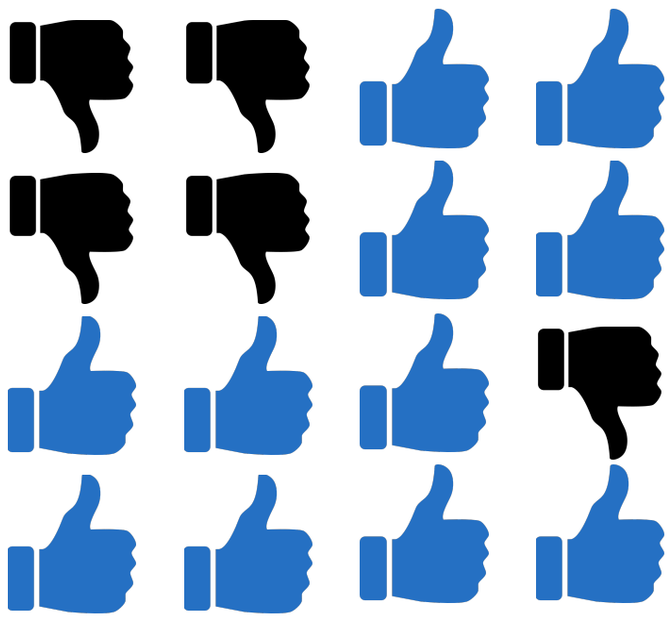

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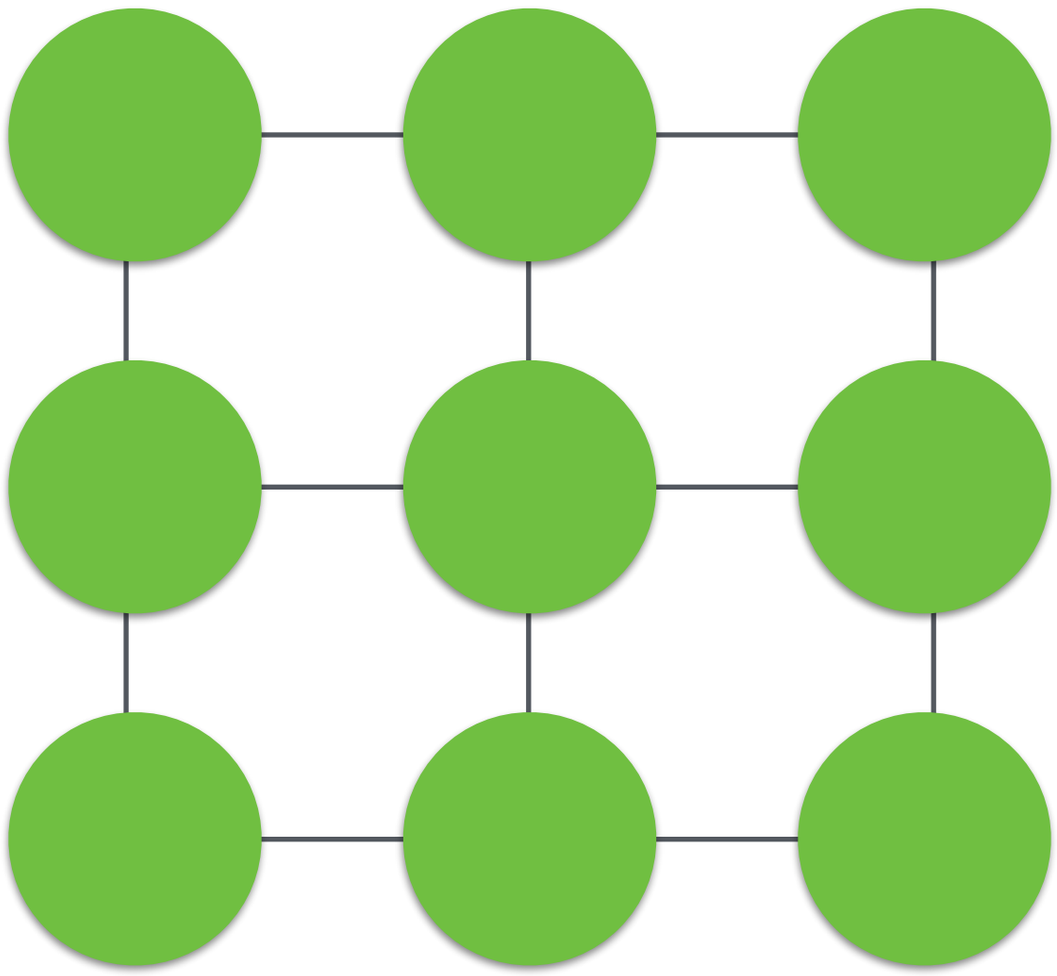

Psychopathology as an Ising model

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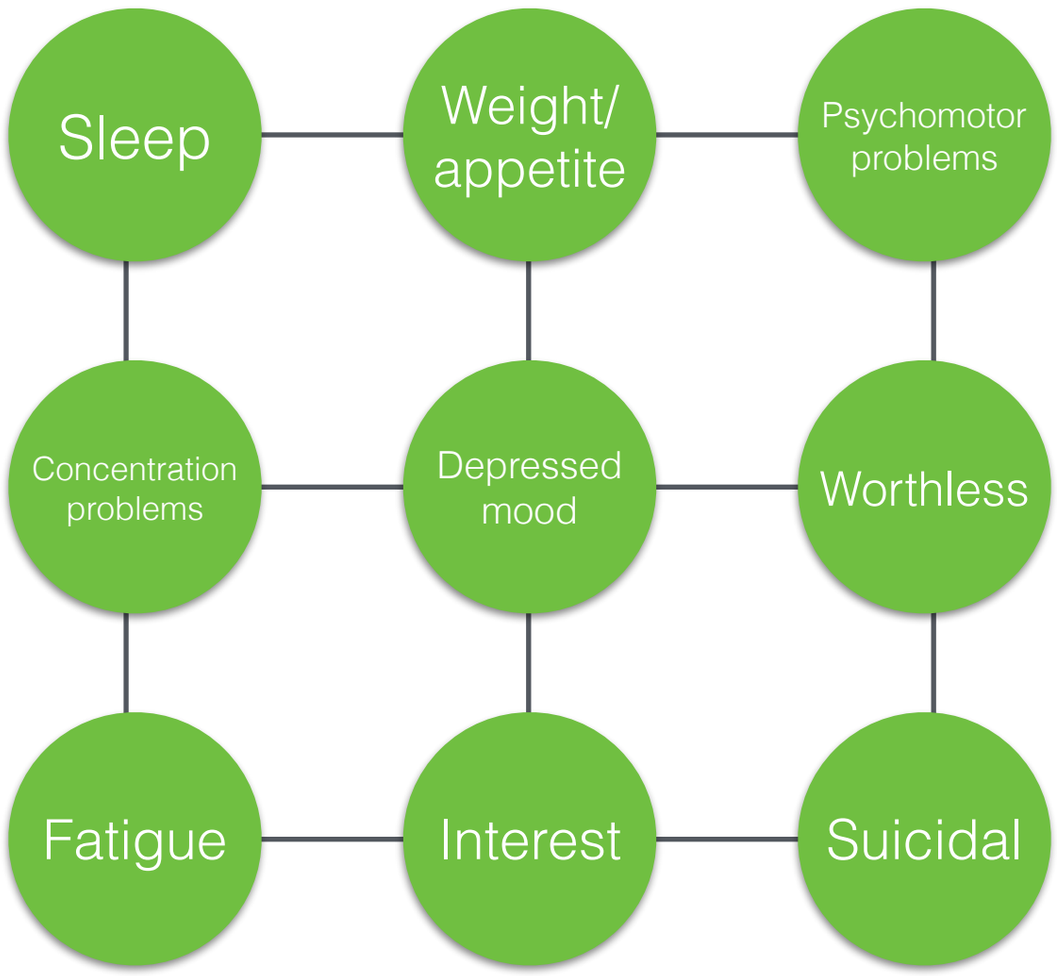

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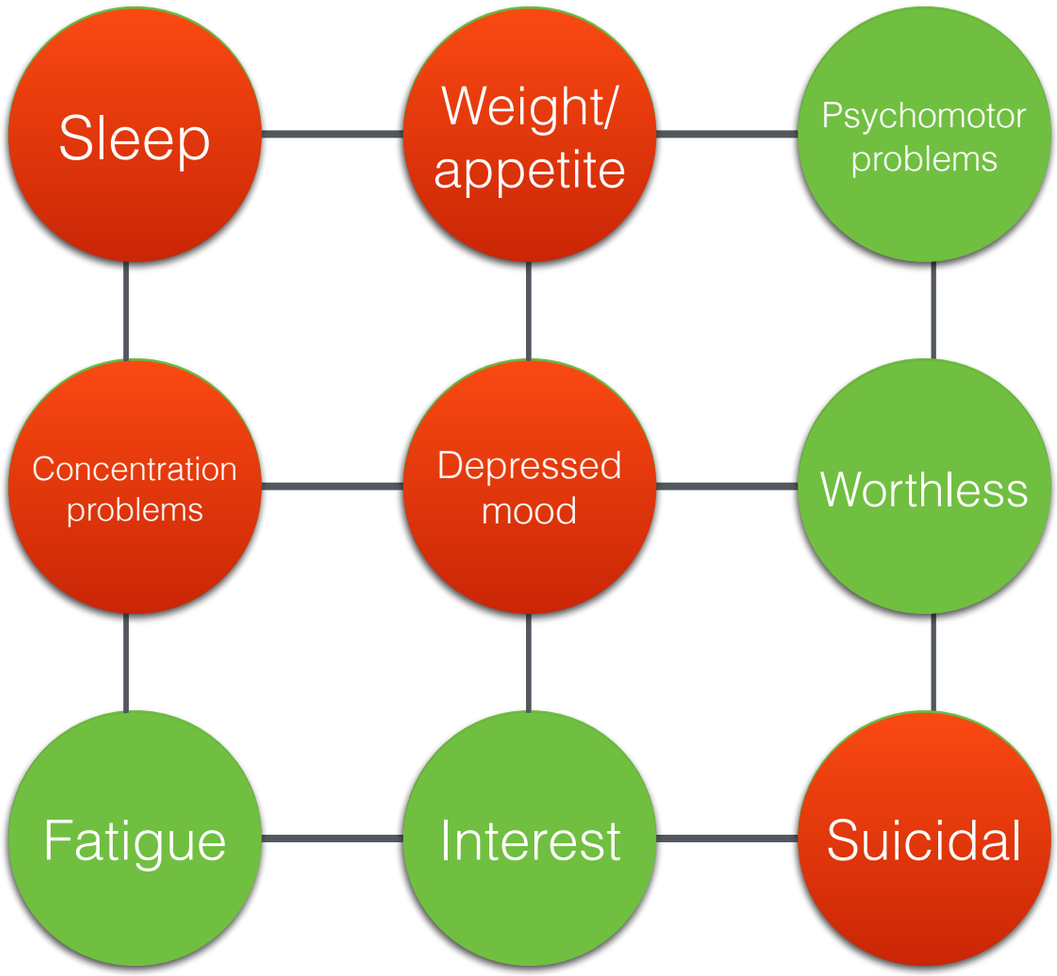

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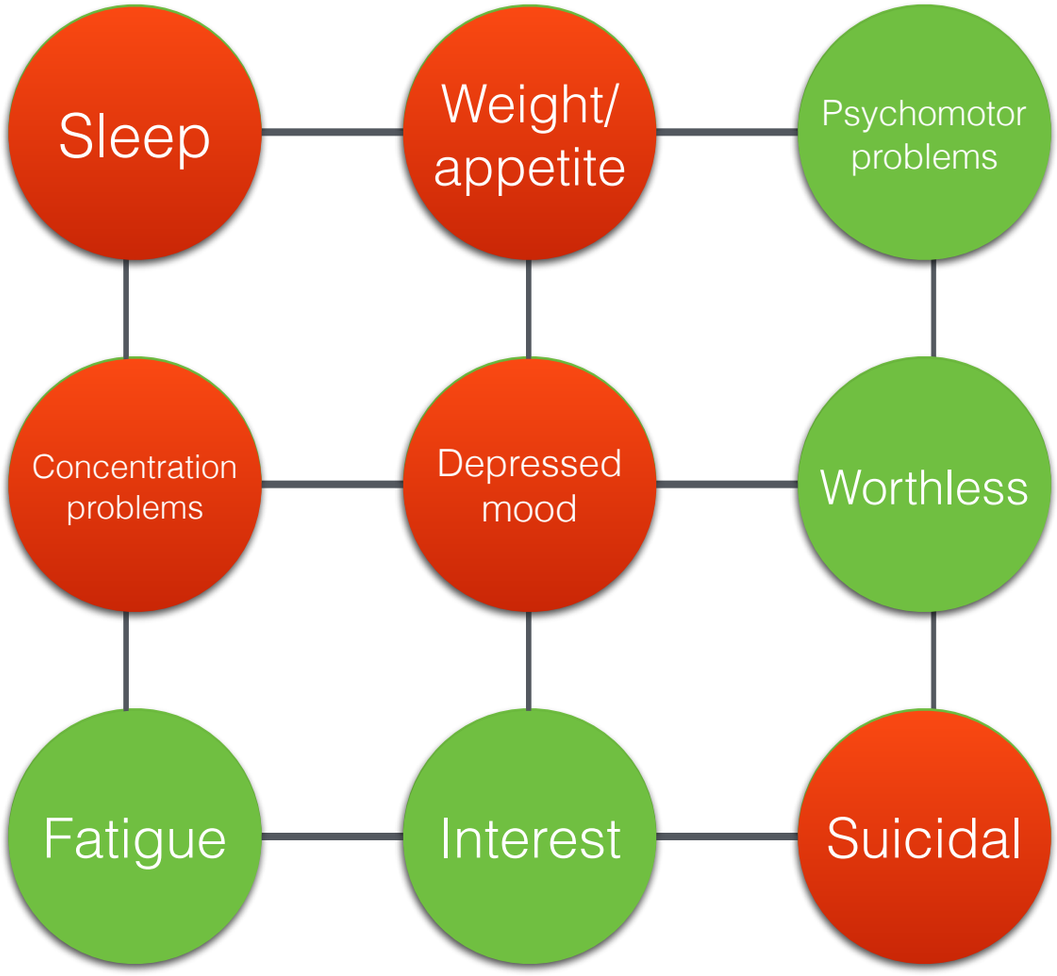
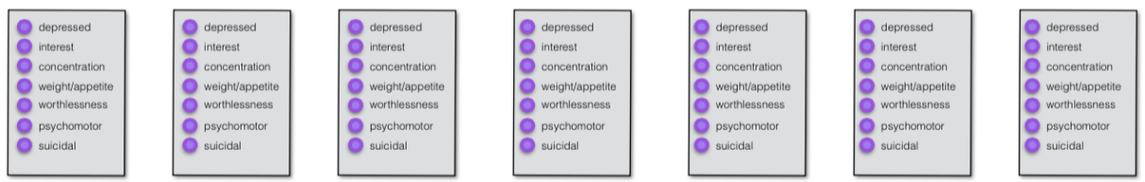


Psychopathology as an Ising model

What is the network structure of depression?



From data to network

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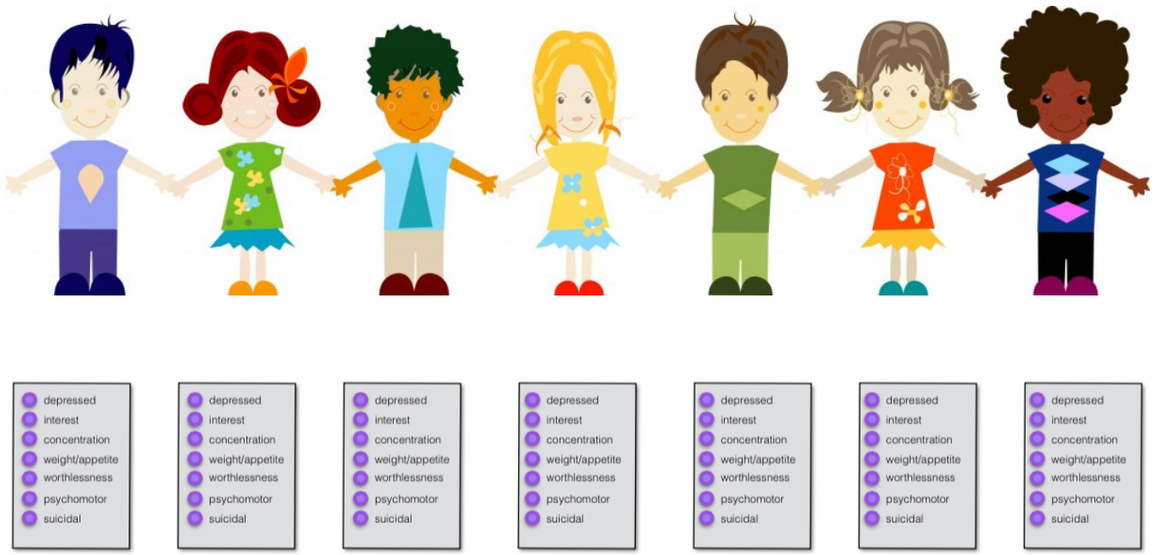

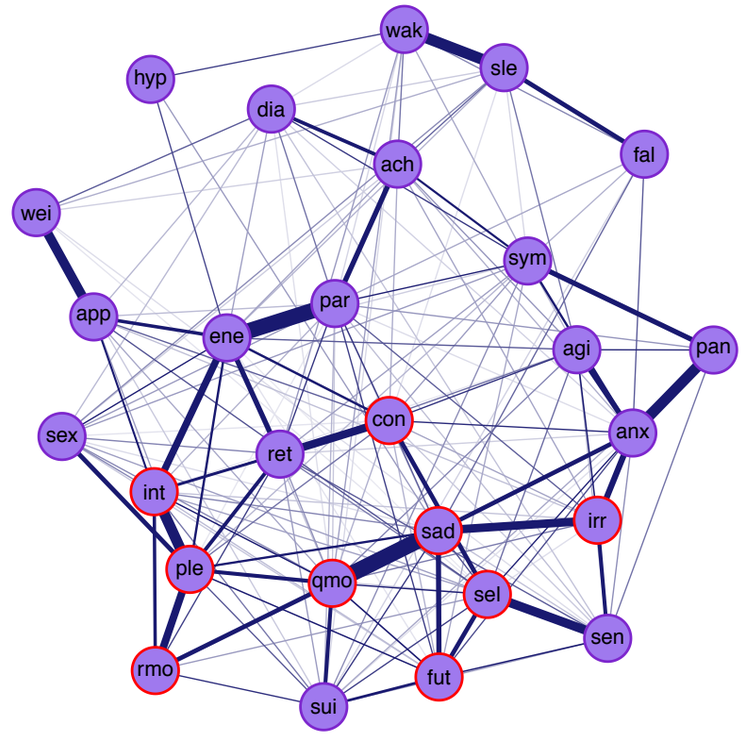

From data to network

Ising model

$$\mathbb{P}_{\Theta}\left(x_j \middle| x_{\setminus j}\right) = \frac{\exp\left[\tau_j x_j + x_j \sum_{k \in V_{\setminus j}} \beta_{jk} x_k\right]}{1 + \exp\left[\tau_j + \sum_{k \in V_{\setminus j}} \beta_{jk} x_k\right]}$$

Use the Ising model to infer network structure

Ising model

Conditional probability

$$\mathbb{P}_{\Theta}\left(x_j \middle| x_{\setminus j}\right) = \frac{\exp\left[\tau_j x_j + x_j \sum_{k \in V_{\setminus j}} \beta_{jk} x_k\right]}{1 + \exp\left[\tau_j + \sum_{k \in V_{\setminus j}} \beta_{jk} x_k\right]}$$

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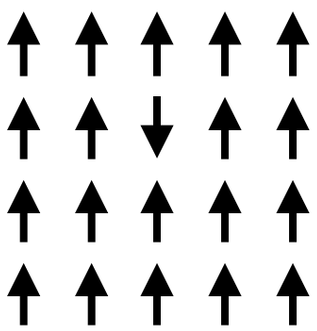

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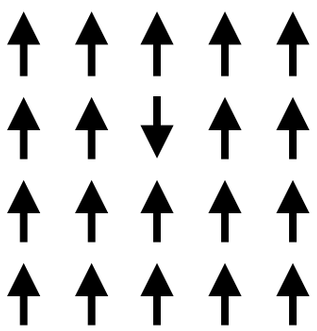

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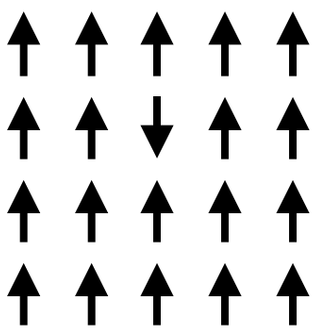


$\tau_1 + \beta_{12}X_2 + \beta_{13}X_3 + \ldots$

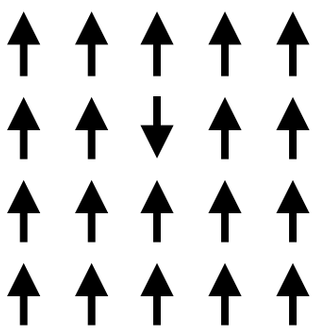
Use the Ising model to infer network structure

Ising model

Autonomous disposition x_j

Conditional probability

$$\mathbb{P}_\Theta\left(x_j \middle| x_{\setminus j}\right) = \frac{\exp\left[\tau_j x_j + x_j \sum_{k \in V_{\setminus j}} \beta_{jk} x_k\right]}{1 + \exp\left[\tau_j + \sum_{k \in V_{\setminus j}} \beta_{jk} x_k\right]}$$



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Use the Ising model to infer network structure

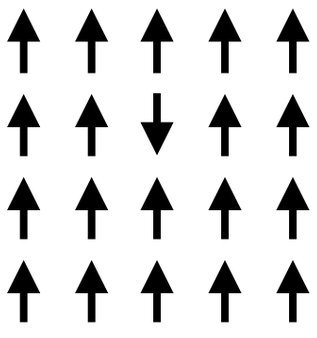
Ising model

Interaction strength between x_j and x_k

Autonomous disposition x_j

Conditional probability

$$\mathbb{P}_\Theta\left(x_j \middle| x_{\setminus j}\right) = \frac{\exp\left[\tau_j x_j + x_j \sum_{k \in V_{\setminus j}} \beta_{jk} x_k\right]}{1 + \exp\left[\tau_j + \sum_{k \in V_{\setminus j}} \beta_{jk} x_k\right]}$$



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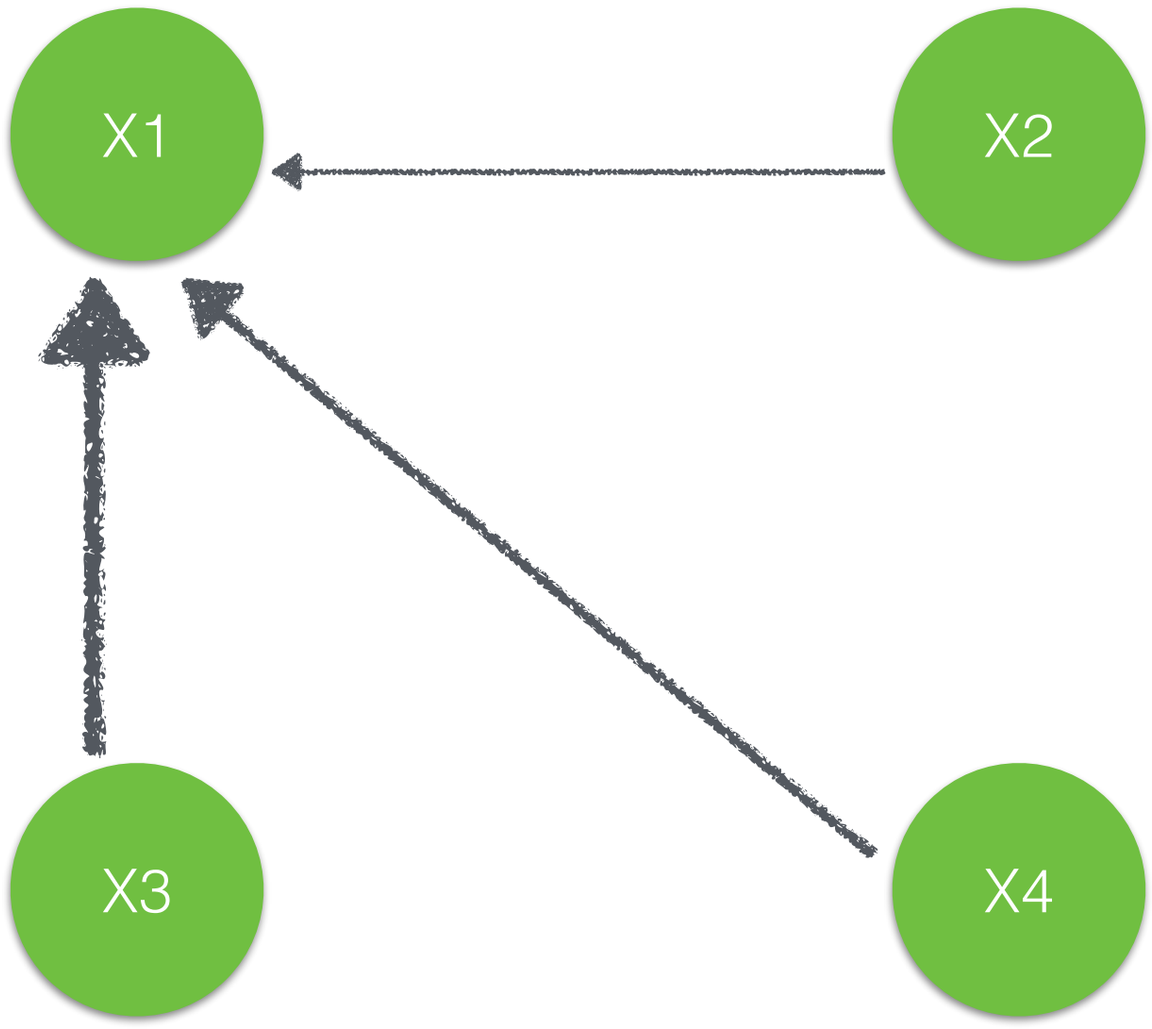
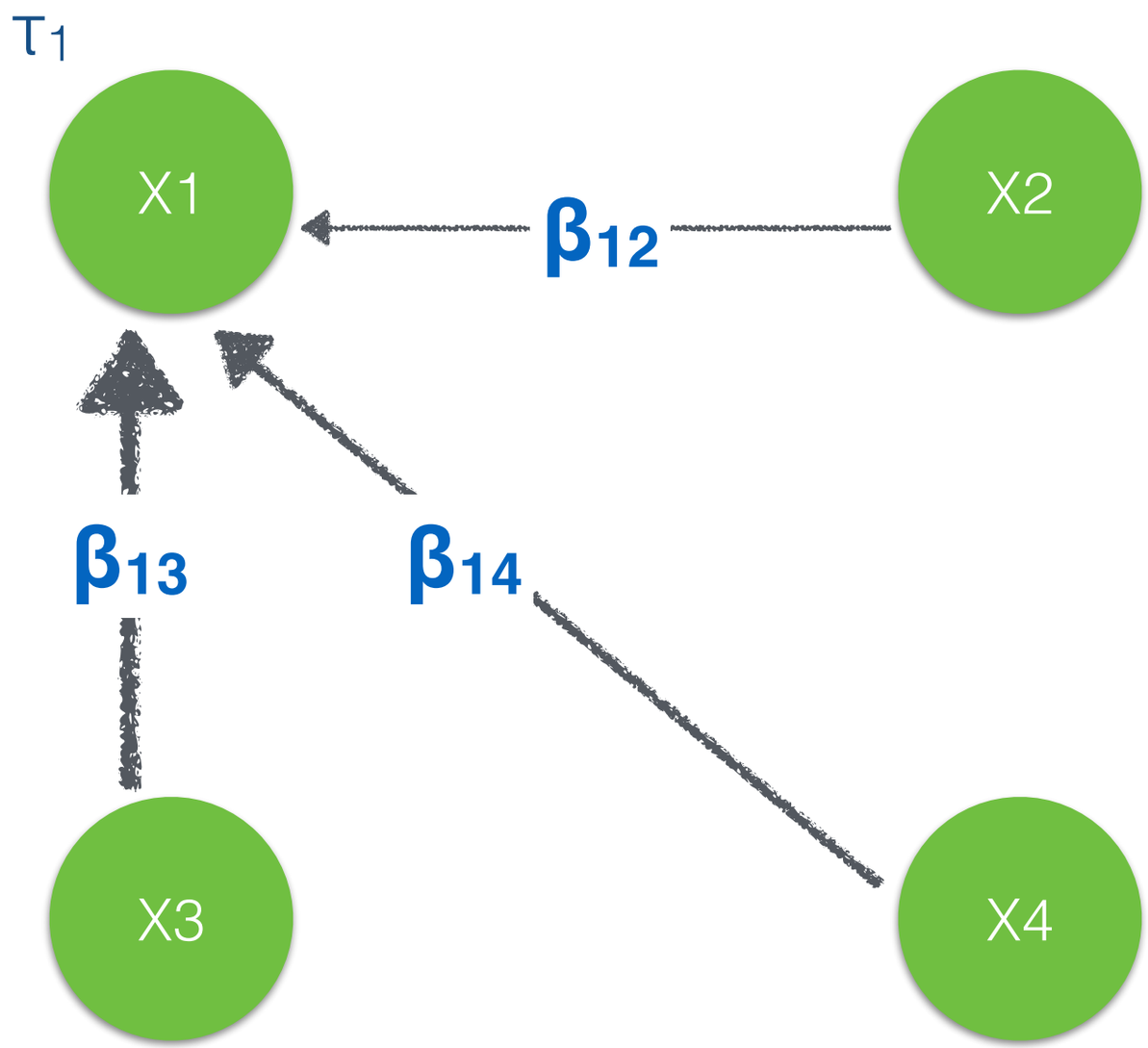
Use the Ising model to infer network structure

Basic idea



Perform regression of X_1 on all other variables

Basic idea



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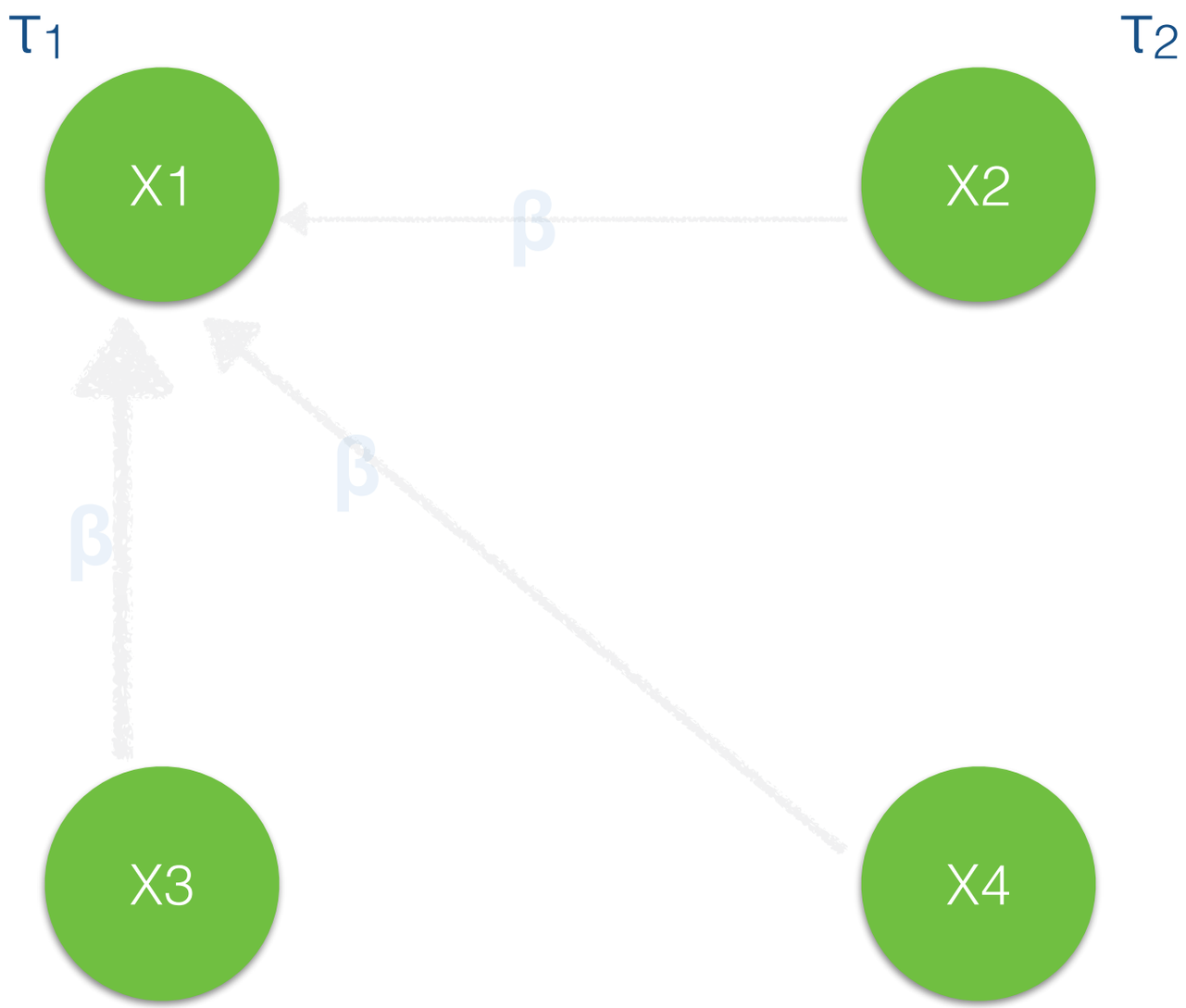
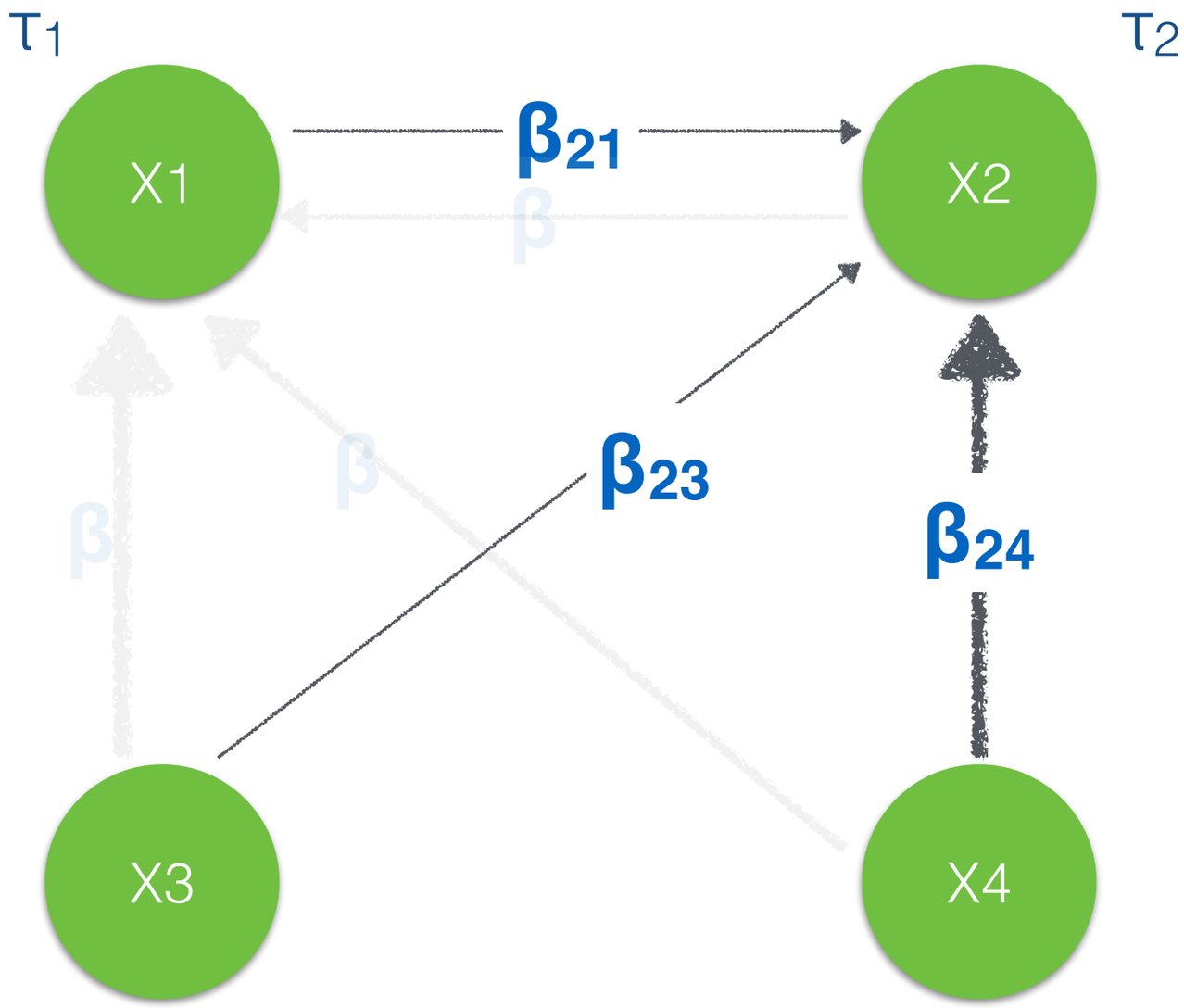


Repeat this for every variable

Basic idea



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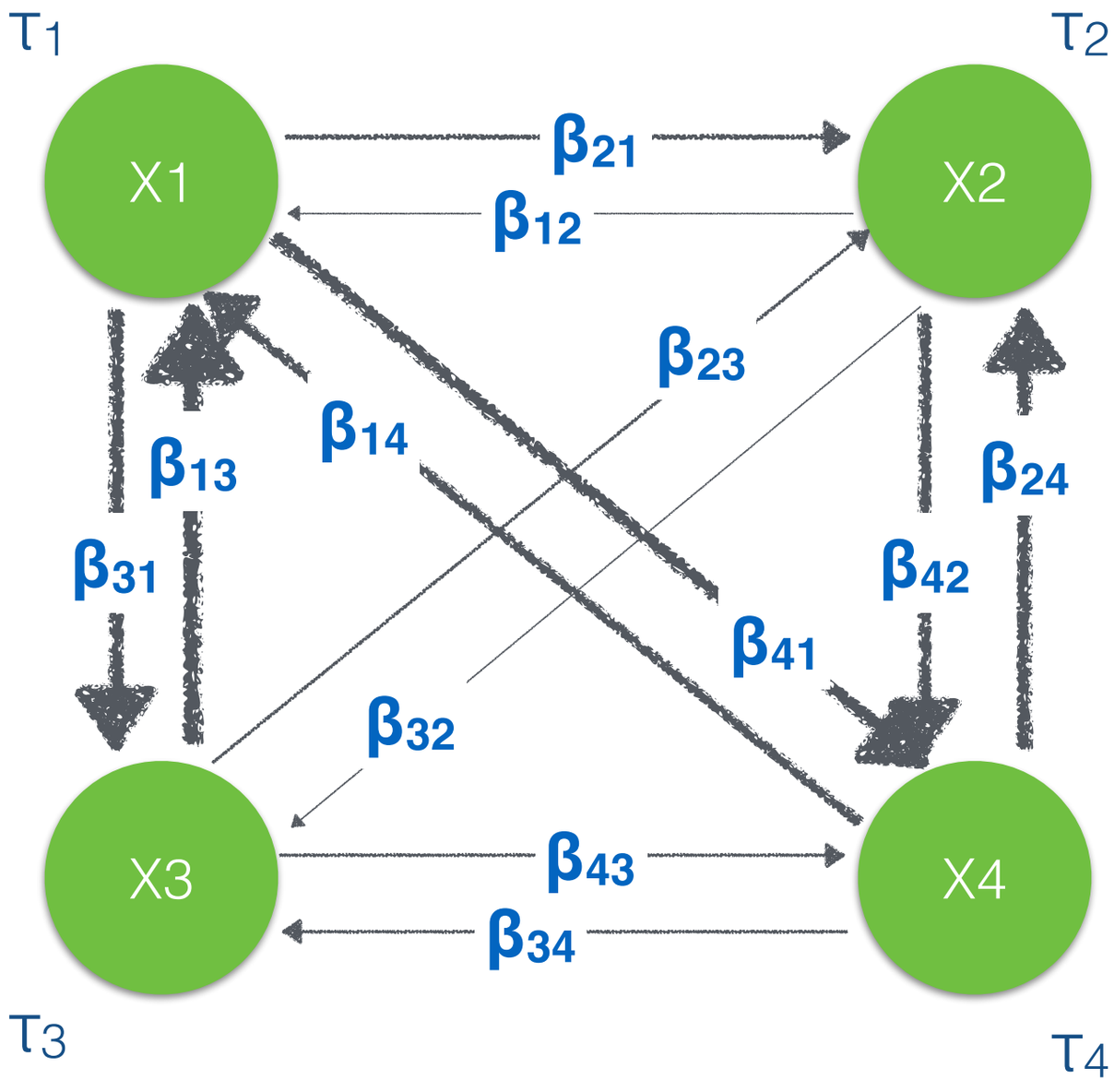
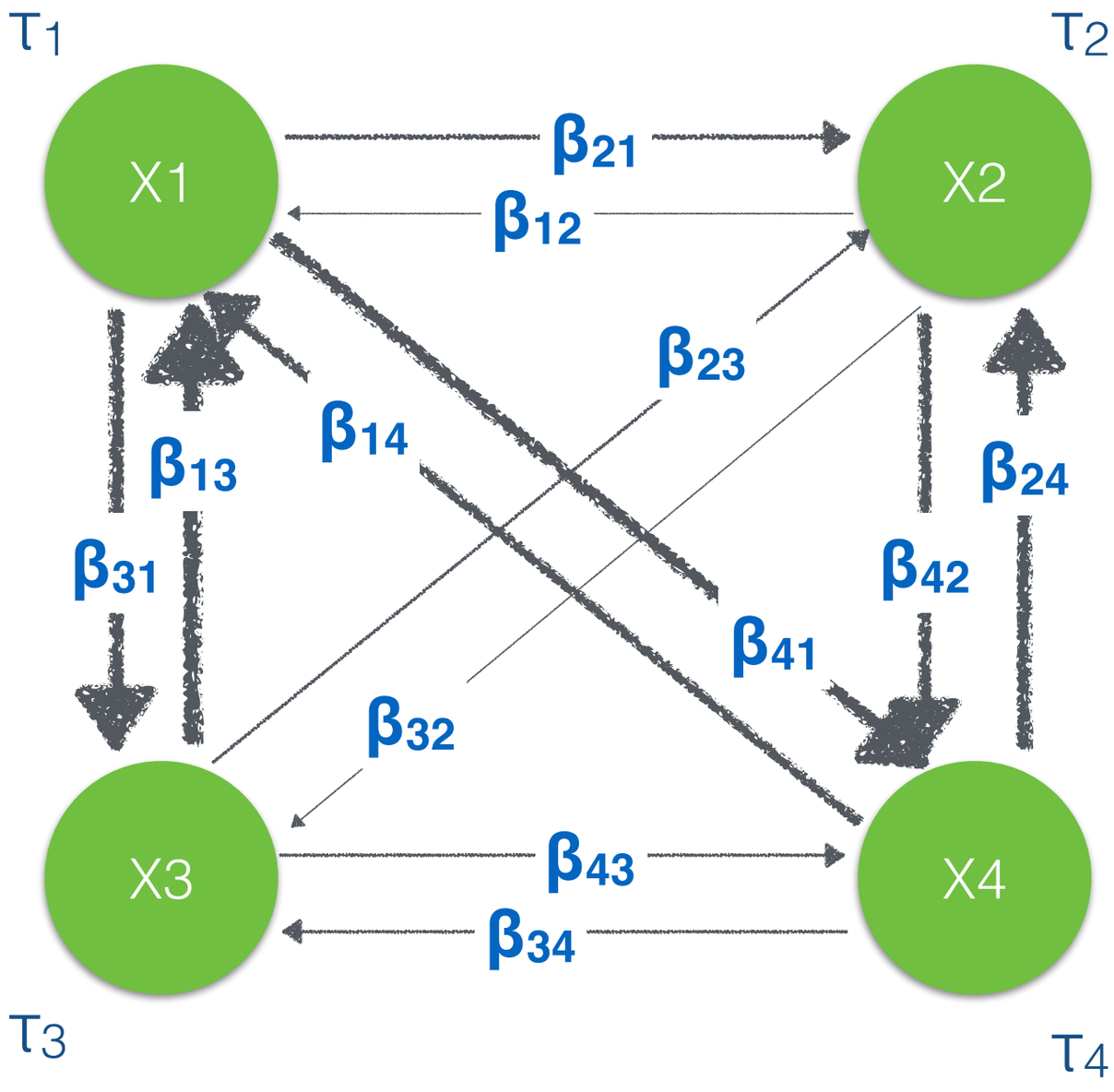

τ1
τ2
X1
X2
β21
β12
β23
β14
β13
β24
β31
β42
β41
β32
X3
X4
β43
β34
τ3
τ4

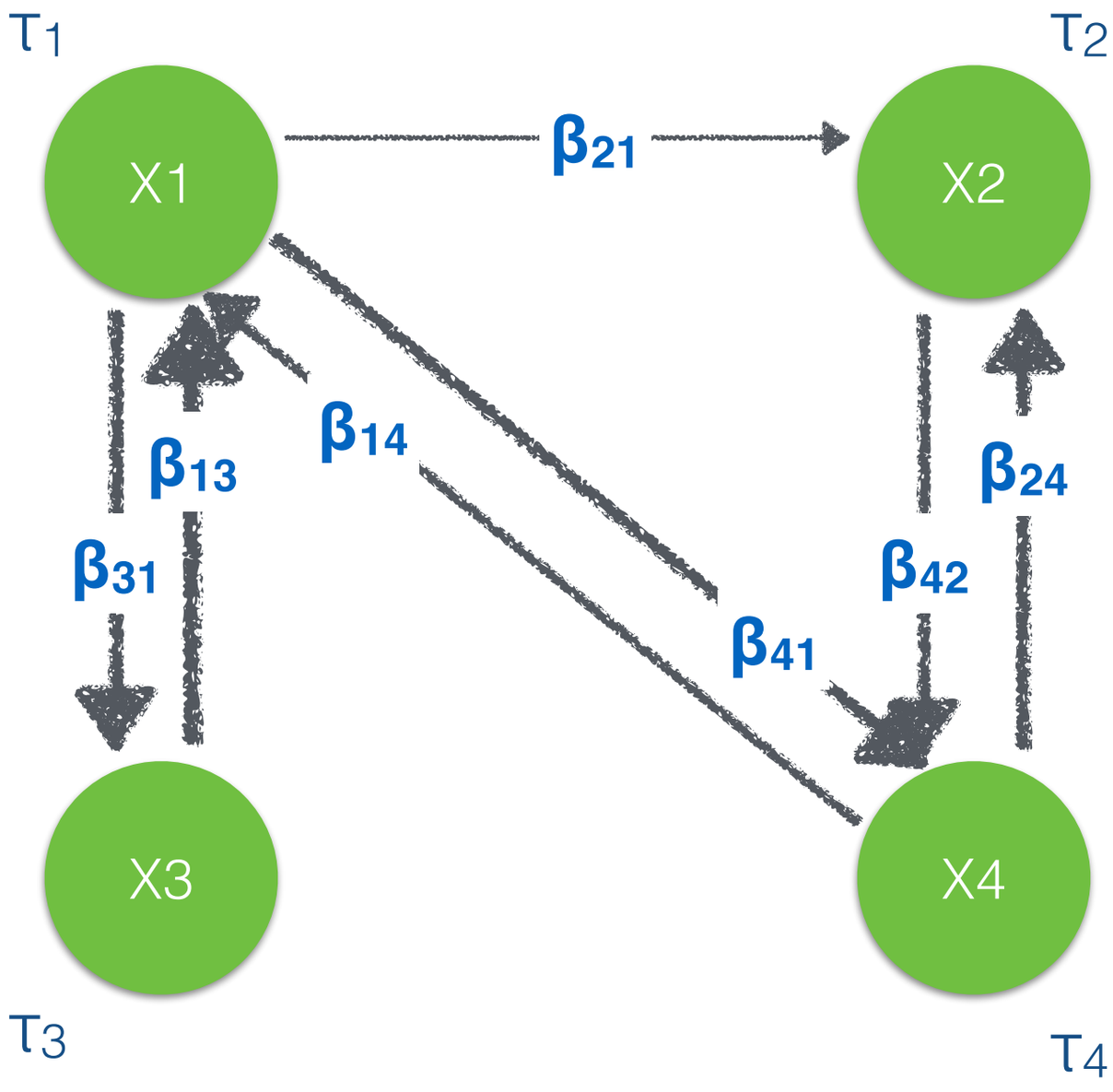
Basic idea



Control model complexity and prevent overfitting:

L_1**-regularized** logistic regression

Basic idea



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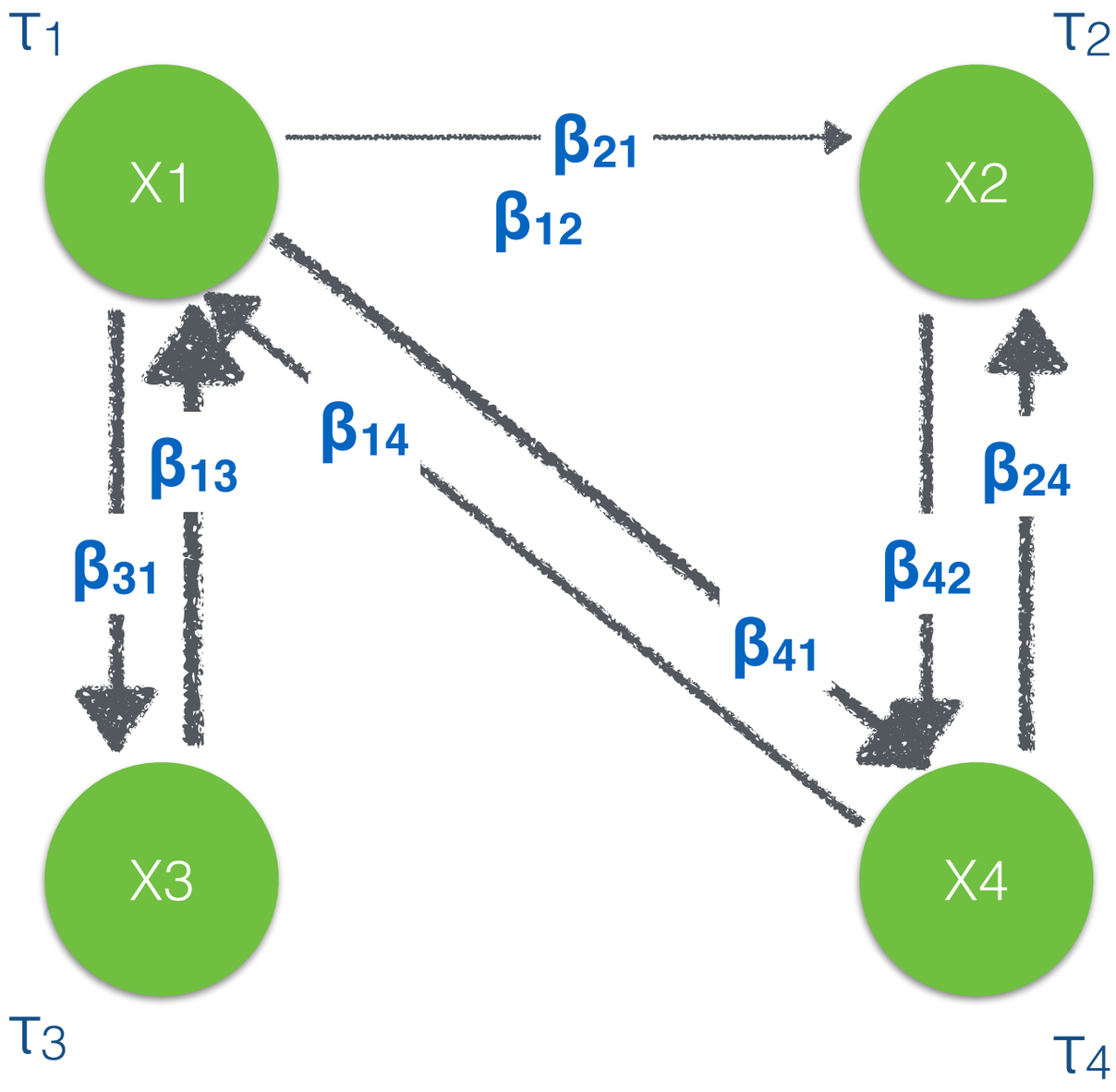
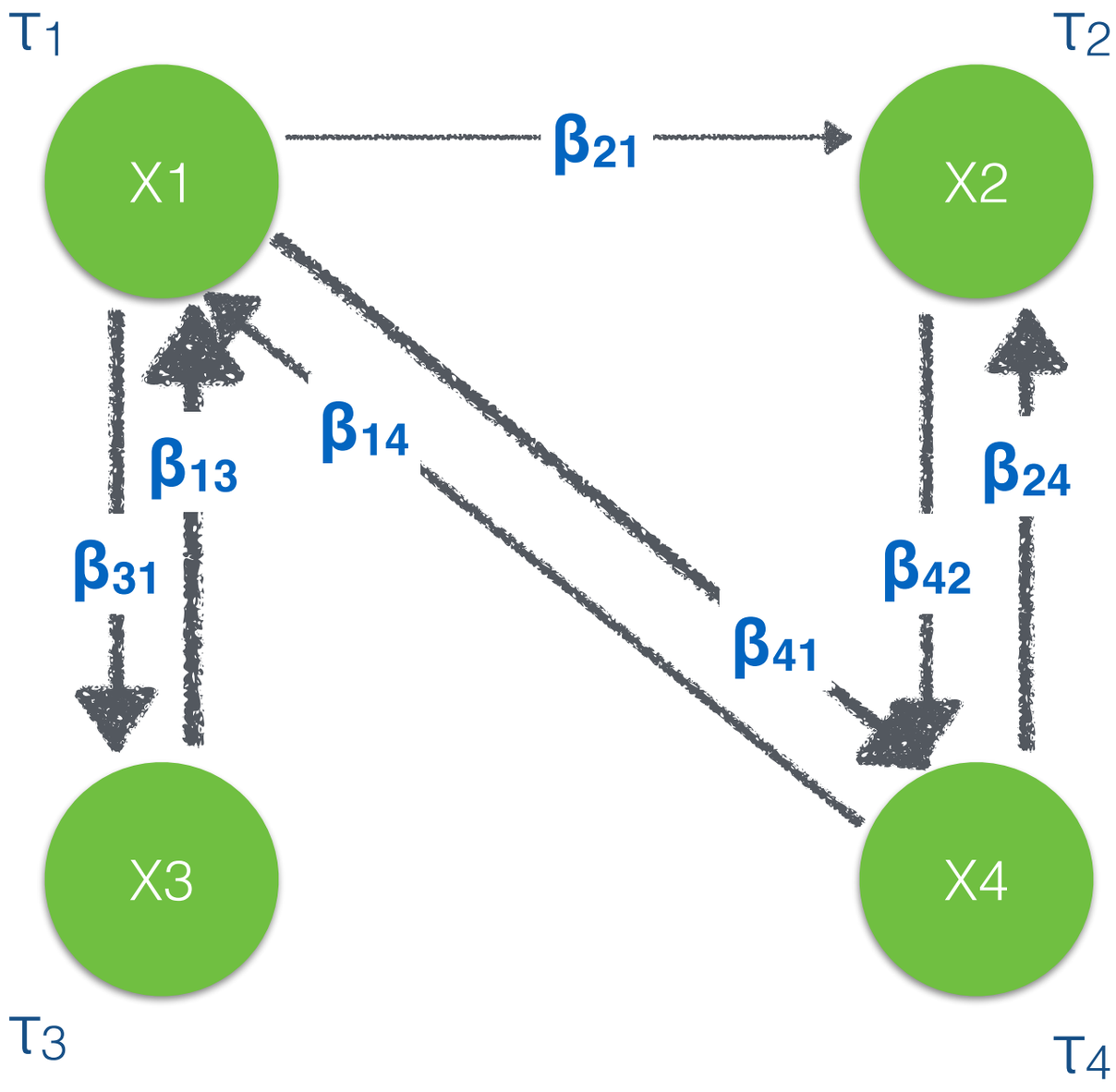


- collect regularized parameters
- apply AND/OR rule



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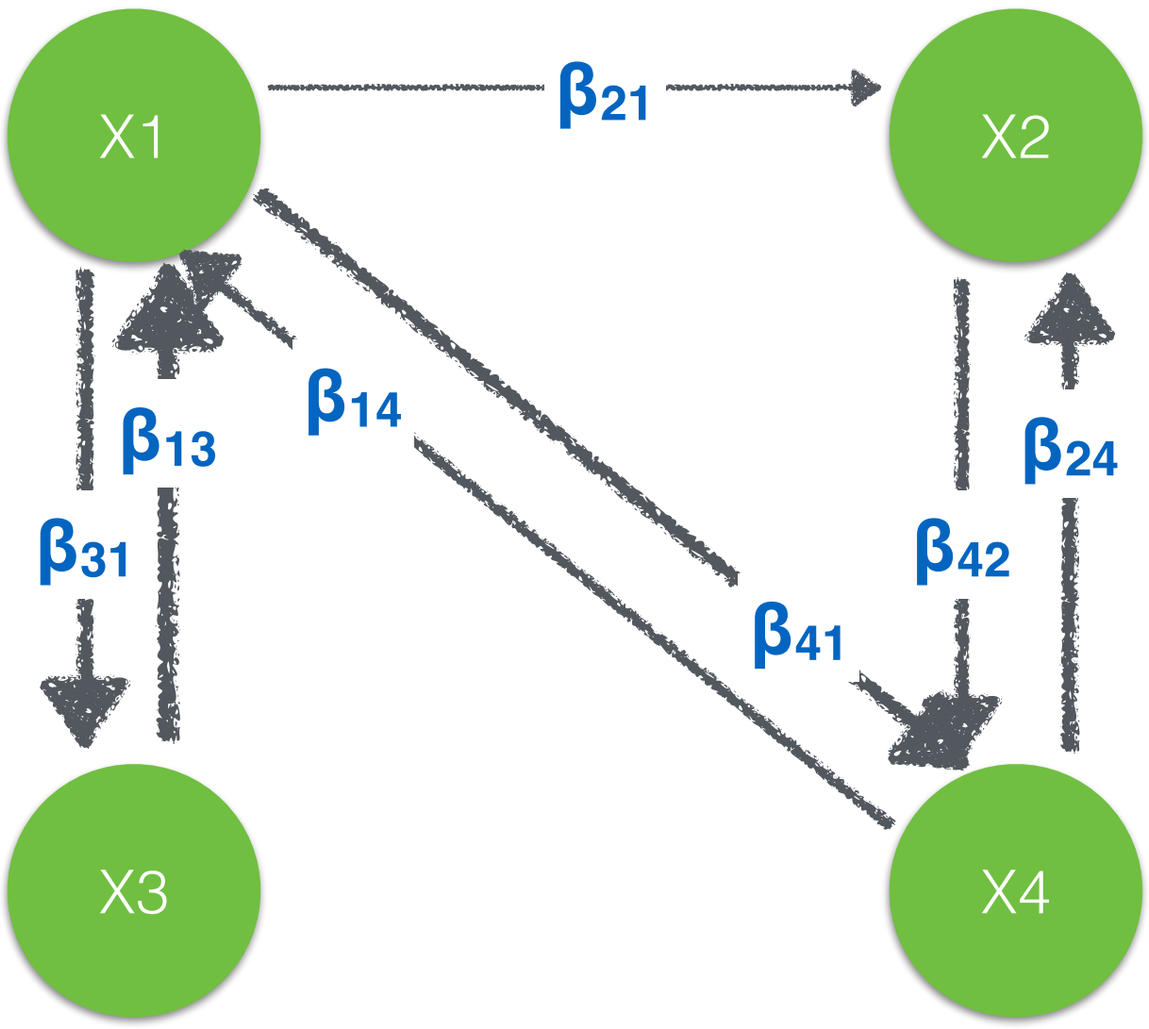
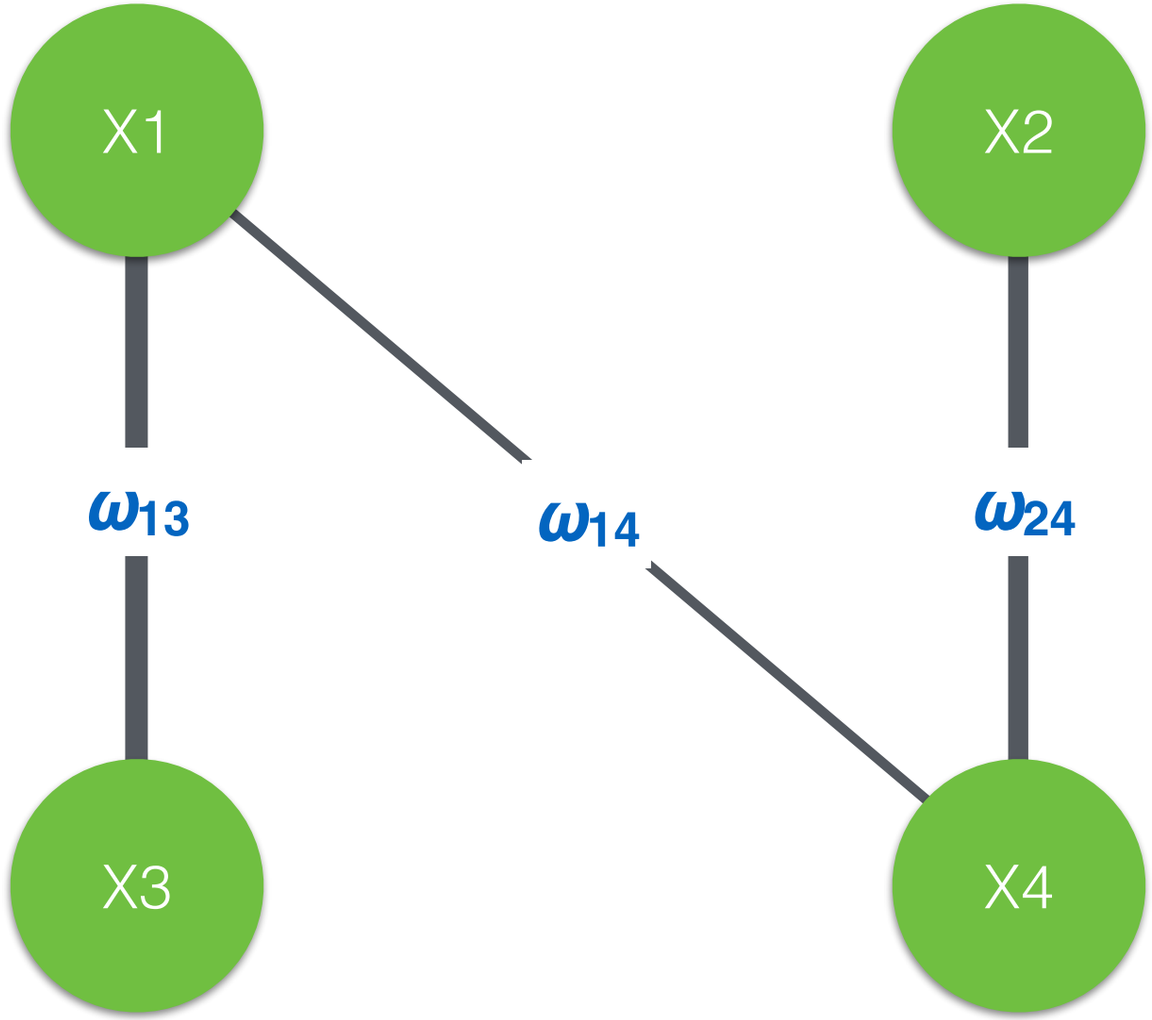


AND-rule:

if $\beta_{ij} \neq 0$ AND $\beta_{ji} \neq 0$

then $\omega_{ij} = (\beta_{ij} + \beta_{ji})/2$

else $\omega_{ij} = 0$



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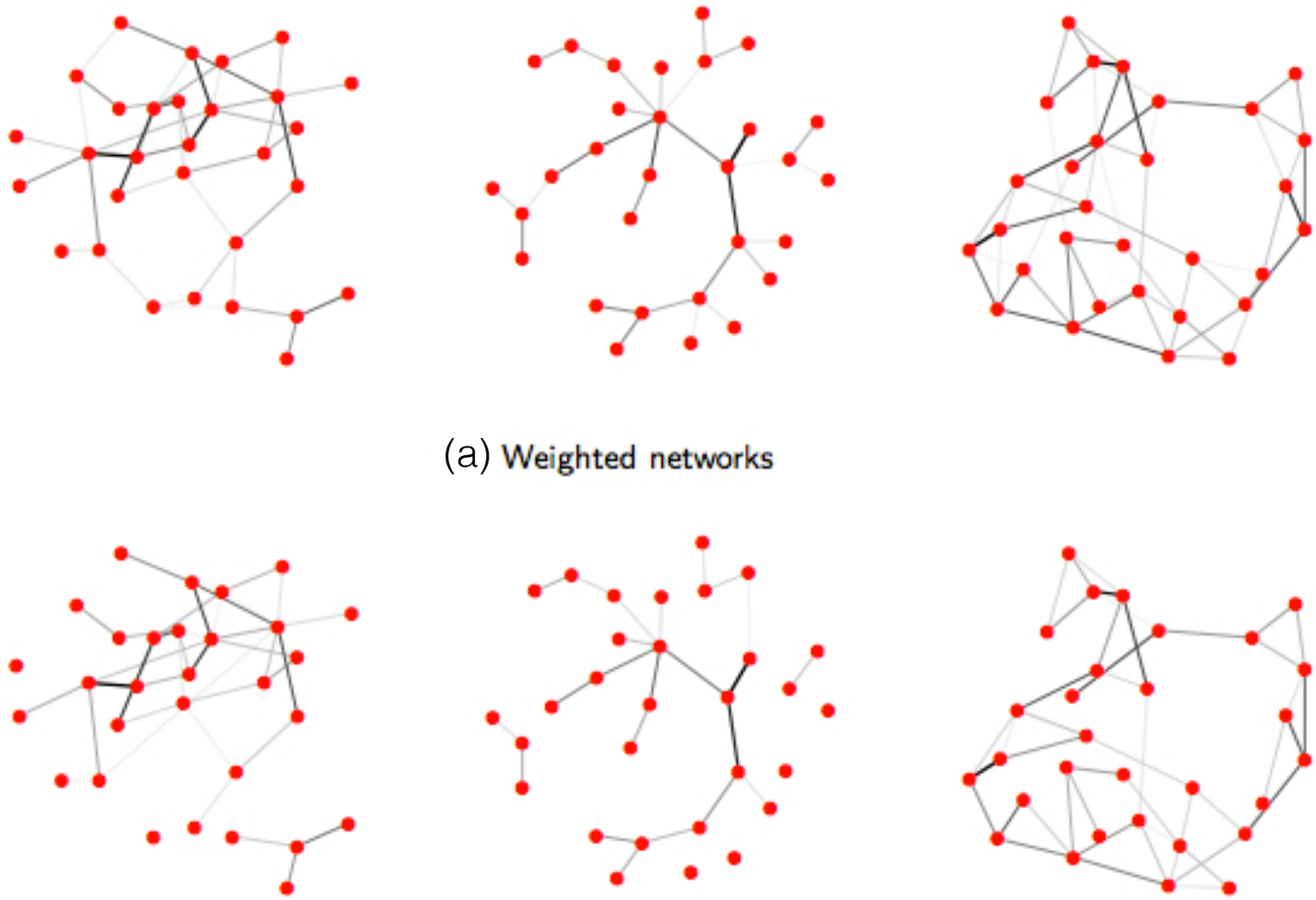
eLasso (`R` package `IsingFit`)



(a) Weighted networks

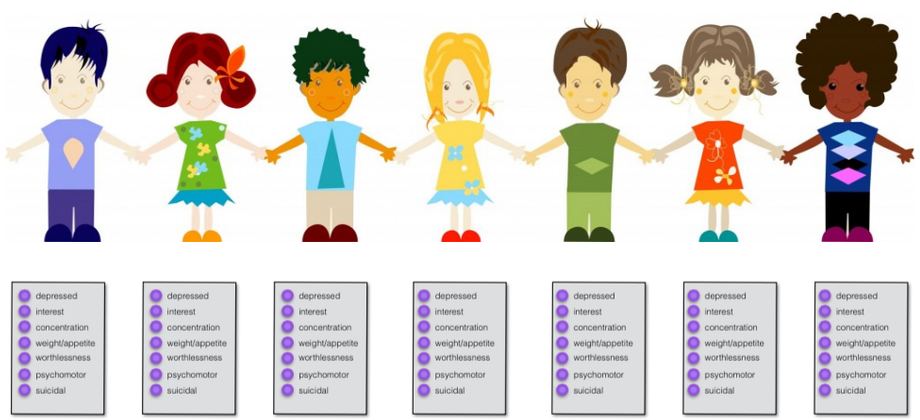
(b) Estimated networks

Borkulo, C. D. van, Borsboom, D., Epskamp, S., Blanken, T. F., Boschloo, L., Schoevers, R. A., & Waldorp, L. J. (2014). A new method for constructing networks from binary data. Scientific Reports, 4(5918), 1–10. doi:10.1038/srep05918

Example

- NESDA (Netherlands Study for Depression and Anxiety)
  - n=2981
  - Participants with and without symptoms

- IDS (Inventory of Depressive Symptomatology)
  - 28 depression and anxiety items



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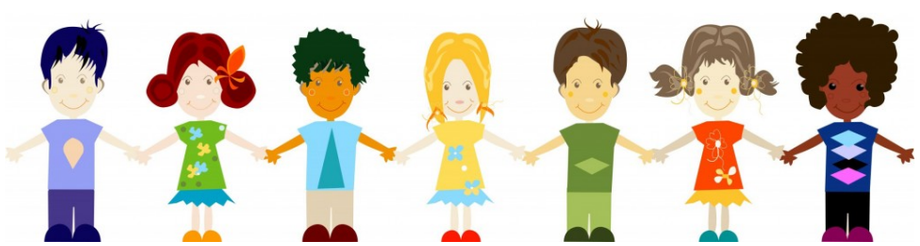

Code

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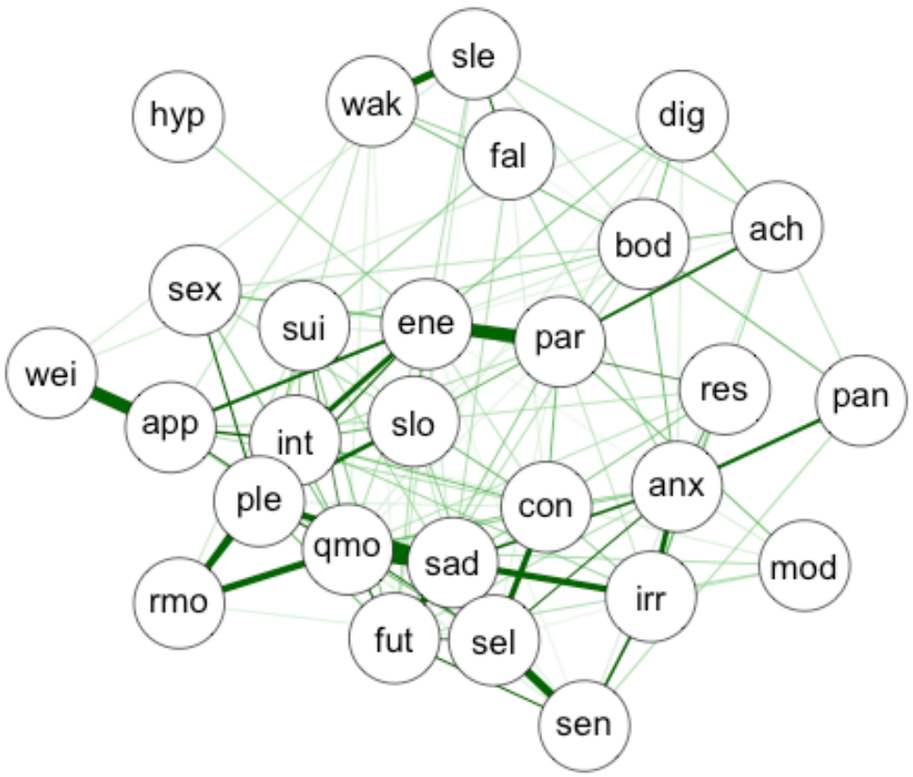
install.packages(qgraph)
install.packages(IsingFit)

## load required packages
library(IsingFit)
library(qgraph)

## data
yourdata = as.matrix(read.csv('yourdata.csv'))

## network estimation
res = IsingFit(yourdata, AND=TRUE)

##make prettier picture
adj = res$weiadj
round(adj,2)
qgraph(adj,
       layout = 'spring',
       edge.color = 'darkblue',
       vsize = 4
)
```



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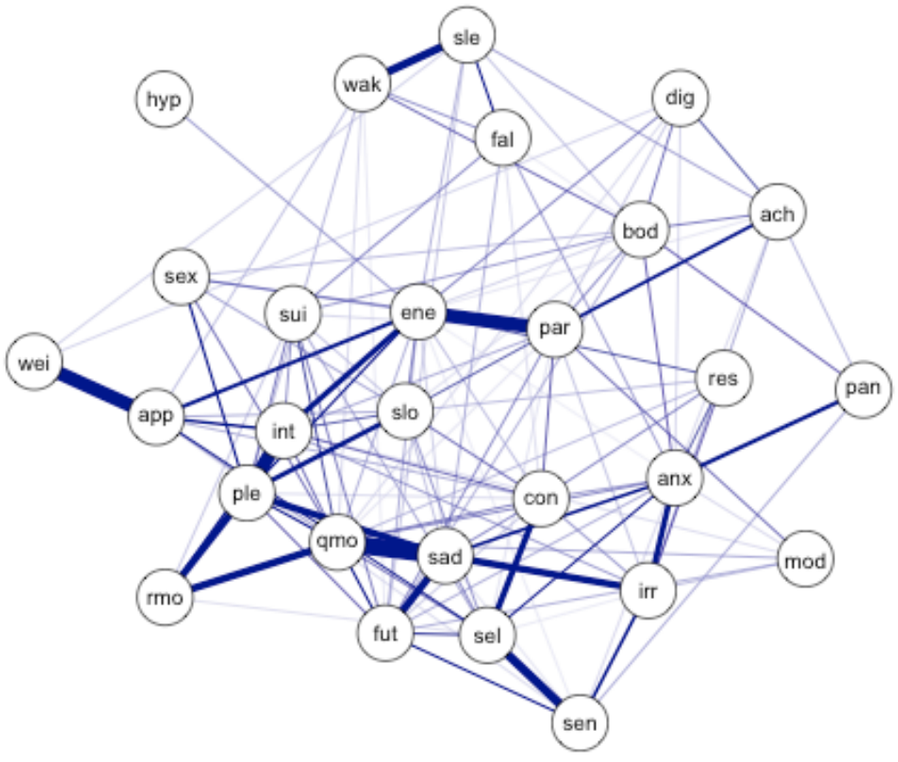
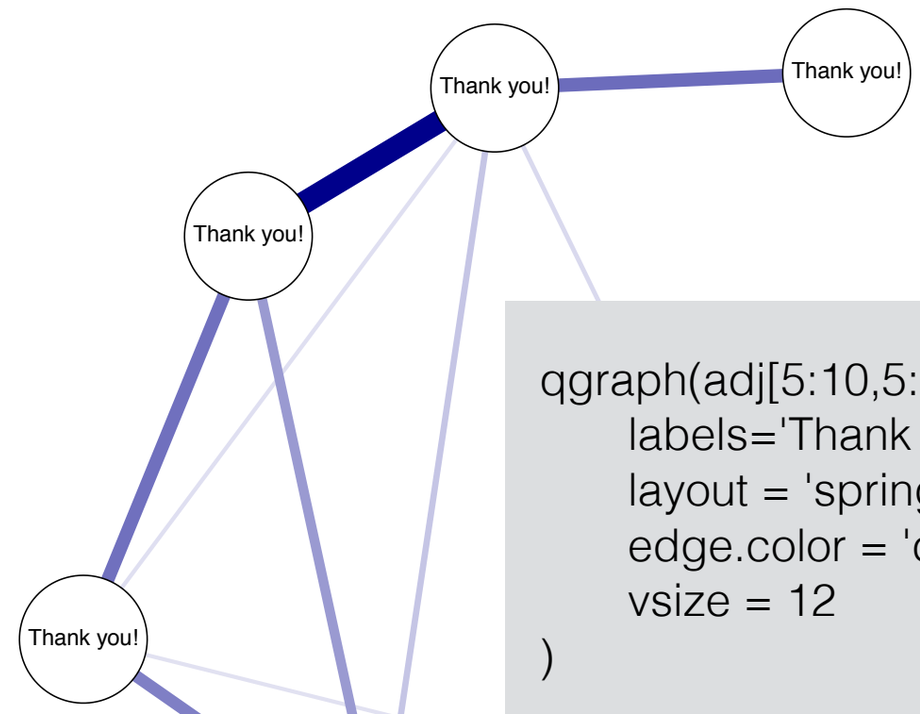


BEHIND the SCENES

Thanks for your attention!

Claudia van Borkulo
http://cvborkulo.com
cvborkulo@gmail.com




```
qgraph(adj[5:10,5:10],
       labels='Thank you!',
       layout = 'spring',
       edge.color = 'darkblue',
       vsize = 12
)
```