Coming to grips with the complexity of psychopathology

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BEHIND THE SCENES

Horseshoe magnet

Unknown

Person sitting with hands on face

Arrow indicating direction
Ising model

Dipoles
- elements of ferromagnetic material
- can be spin-up or spin-down
Ising model

Dipoles
- elements of ferromagnetic material
- can be spin-up or spin-down
Different interpretations of the Ising model

Orientation of dipoles in ferromagnetic material
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Behavior of voters in an election
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Psychopathology as an Ising model
Different interpretations of the Ising model

Sleep - Weight/appetite - Psychomotor problems

Concentration problems - Depressed mood - Worthless

Fatigue - Interest - Suicidal

Psychopathology as an Ising model
Different interpretations of the Ising model

Psychopathology as an Ising model
Different interpretations of the Ising model

Psychopathology as an Ising model

But what is the structure of depression?
What is the network structure of depression?

From data to network
What is the network structure of depression?

From data to network
Use the Ising model to infer network structure

\[ P_{\Theta}(x_j | x_{\setminus j}) = \frac{\exp \left[ \tau_j x_j + x_j \sum_{k \in V_j} \beta_{jk} x_k \right]}{1 + \exp \left[ \tau_j + \sum_{k \in V_j} \beta_{jk} x_k \right]} \]
Use the Ising model to infer network structure
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Ising model

Conditional probability

\[ P_{\Theta}(x_j | x_{\setminus j}) = \frac{\exp \left[ \tau_j x_j + x_j \sum_{k \in V_j} \beta_{jk} x_k \right]}{1 + \exp \left[ \tau_j + \sum_{k \in V_j} \beta_{jk} x_k \right]} \]
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Basic idea

Perform regression of $X_1$ on all other variables
Perform regression of $X_1$ on all other variables
Basic idea

Repeat this for every variable
Basic idea

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Basic idea
Control model complexity and prevent overfitting: $\ell_1$-regularized logistic regression
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collect regularized parameters
apply AND/OR rule
- collect regularized parameters
- apply AND/OR rule
AND-rule:

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

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

else $\omega_{ij} = 0$
AND-rule:

\[
\text{if } \beta_{ij} \neq 0 \text{ AND } \beta_{ji} \neq 0 \\
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\]
**eLasso** (R package **IsingFit**)

![Weighted networks](image1)

![Estimated networks](image2)

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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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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Thanks for your attention!

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