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# 3<sup>o</sup> CONFERENCE ON STATISTICS AND DATA SCIENCE (CSDS 2021)



## Causal inference applied to neuroscience: an R-Shiny toolbox

AUTHORS:

Marcos J. Henriques;

Diego C. do Nascimento;

Alexandre C. B. Delbem;

Oilson A. Gonzatto Junior;

Lilia C. C. da Costa;

Francisco Louzada Neto.

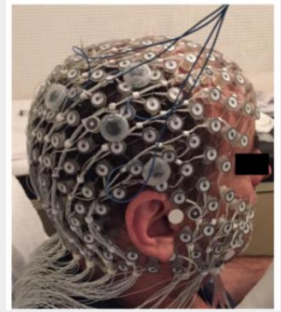


# MOTIVATION

## NEUROSCIENCE FIELD

- HIGH-DIMENSIONAL DATA
- COMPLEX DEPENDENCE
- NOISY BIOSIGNALS
- LARGE VOLUME OF RAW DATA

Electroencephalogram (EEG)

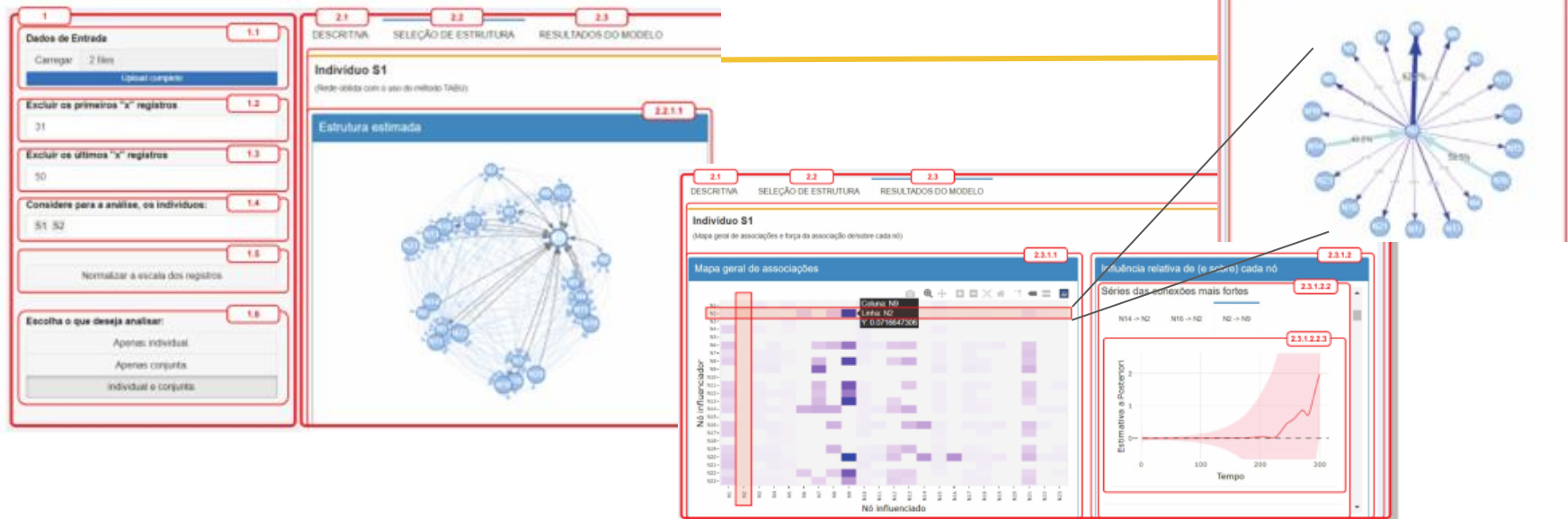


fNIRS

functional Magnetic  
Resonance Imaging  
(fMRI)



FONTE: Imagine Lab Pte. Ltd ("123RF")



DATA

Neighborhood Search  
Procedures

Maximum Search  
Markov Equivalence



TABU SEARCH  
ALGORITHM



PARTIAL  
CONDITIONAL  
DAG



MDM-IPA

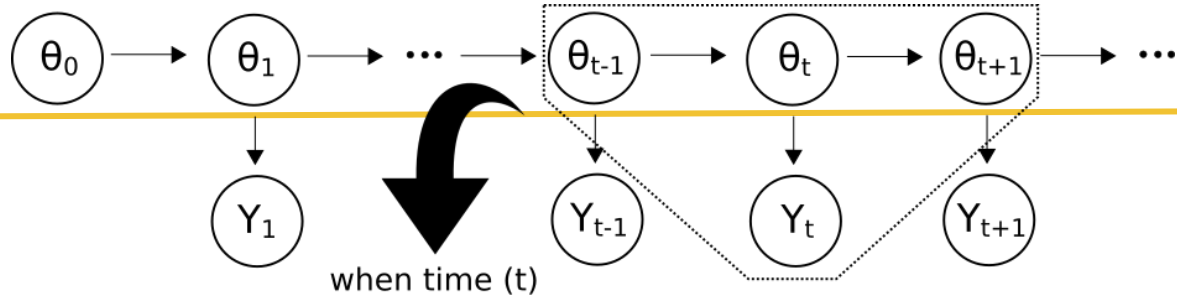


DYNAMIC ANALYSIS  
&  
CONCLUSIONS



$Y_t(i)$  independent  $Y_t^i | \text{Parent}(Y_t(i))$

Estimation as a Kalman Filter



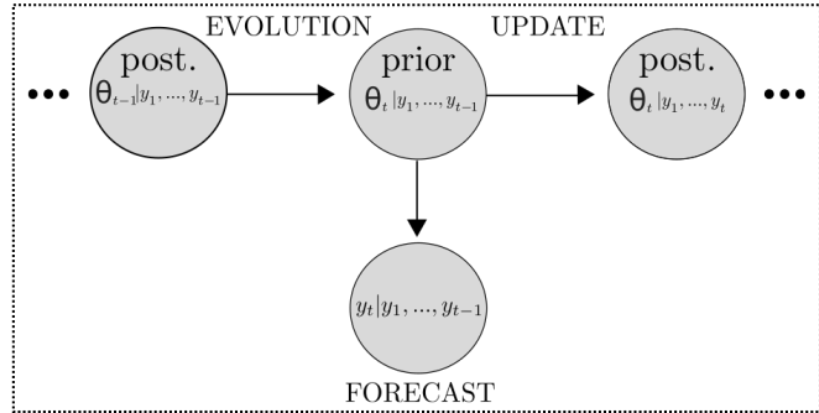
At time  $t = 0$ ,

$$\theta_0 \sim N(\theta_0, \sigma_0^2)$$

after the time  $t \geq 1$  then,

$$\underbrace{Y_t = F_t \theta_t + v_t}_{\text{observation equation}}, \quad v_t \sim N(0, V_t),$$

$$\underbrace{\theta_t = G_t \theta_{t-1} + \omega_t}_{\text{state equation}}, \quad \omega_t \sim N(0, W_t)$$



GRAPHICAL  
MODEL  
THEORY



DYNAMIC  
MODELING  
APPROACH



DYNAMIC  
GRAPHICAL MODELS  
(Queen and Smith, 1992,  
Prado and West, 2010)

