Jeremy Kawahara†[a], Colin J. Brown†[a], Steven P. Miller[b], Brian G. Booth[a], Vann Chau[b], Ruth E. Grunau[c], Jill G. Zwicker[c], Ghassan Hamarneh[a]

†joint first authors

[a]Medical Image Analysis Lab, Simon Fraser University, Burnaby, BC, Canada
[b]Department of Paediatrics, The Hospital for Sick Children and the University of Toronto, Toronto, ON, Canada
[c]Child and Family Research Institute and the University of British Columbia, Vancouver, BC, Canada
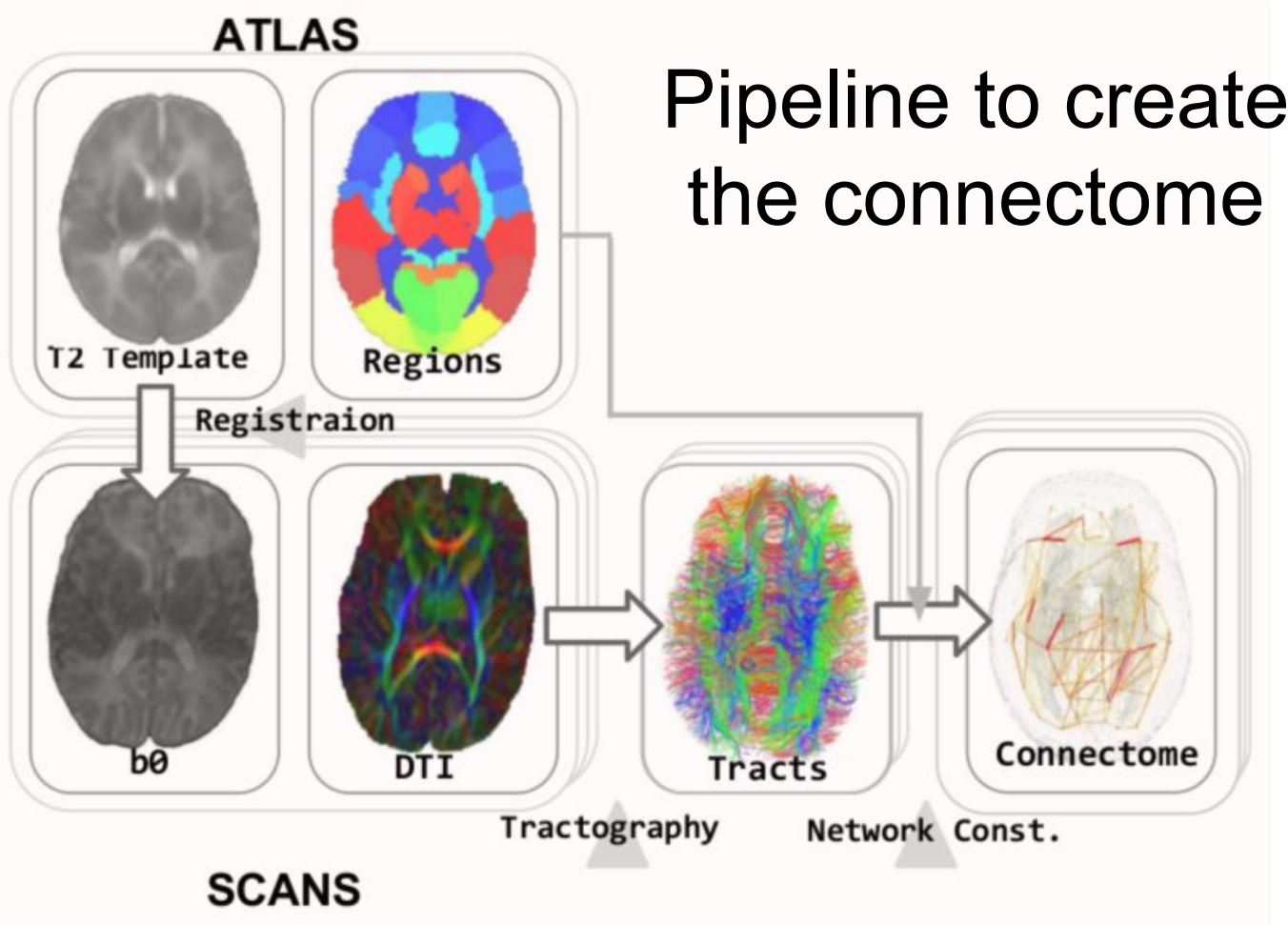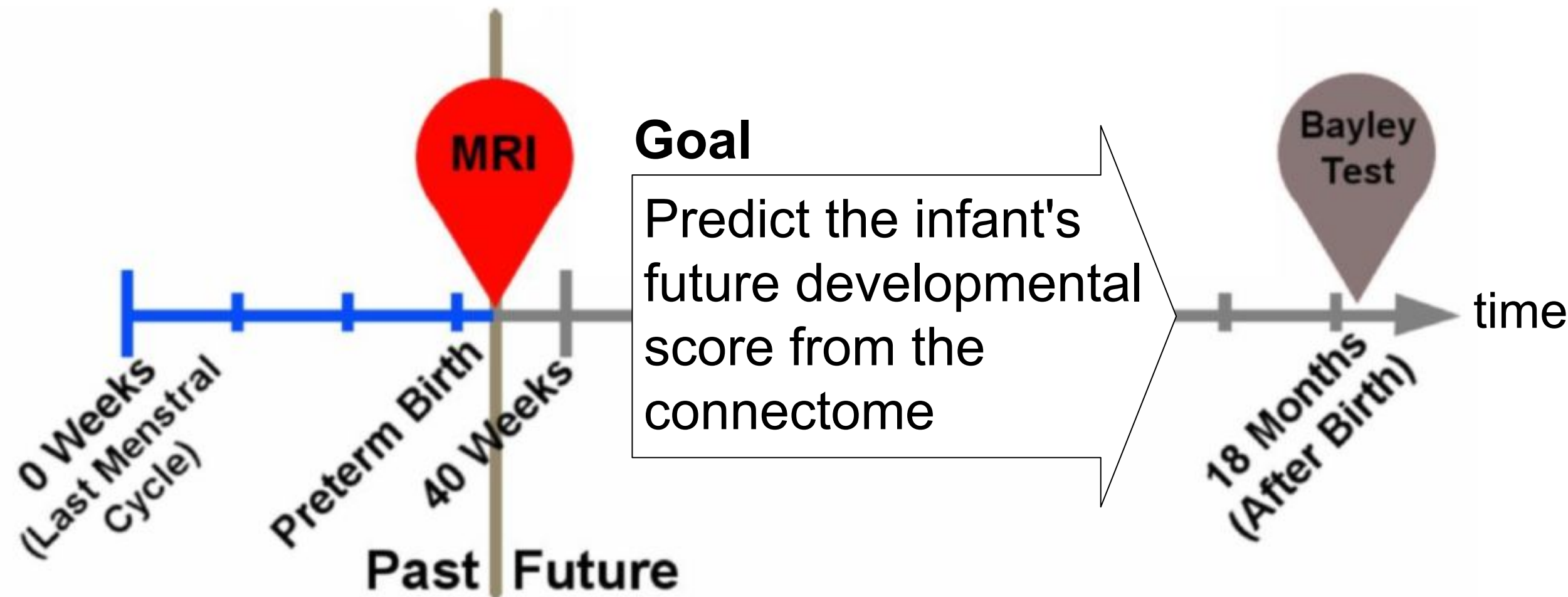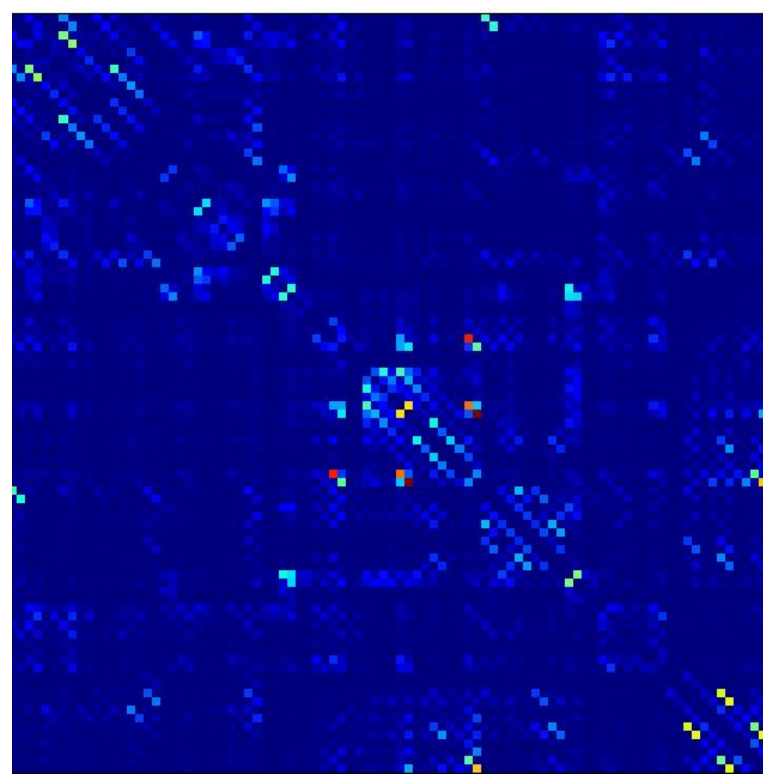
Preterm infant

Background: Deep learning via convolutional artificial neural networks has had big successes for image-based prediction tasks
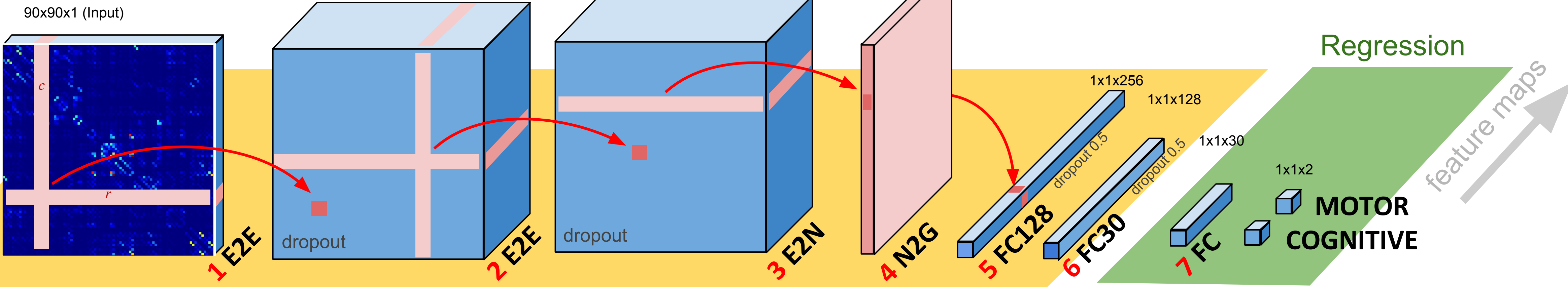
Key contributions:
- We design convolutional filters for connectomes
- Consider the topological locality in brain networks
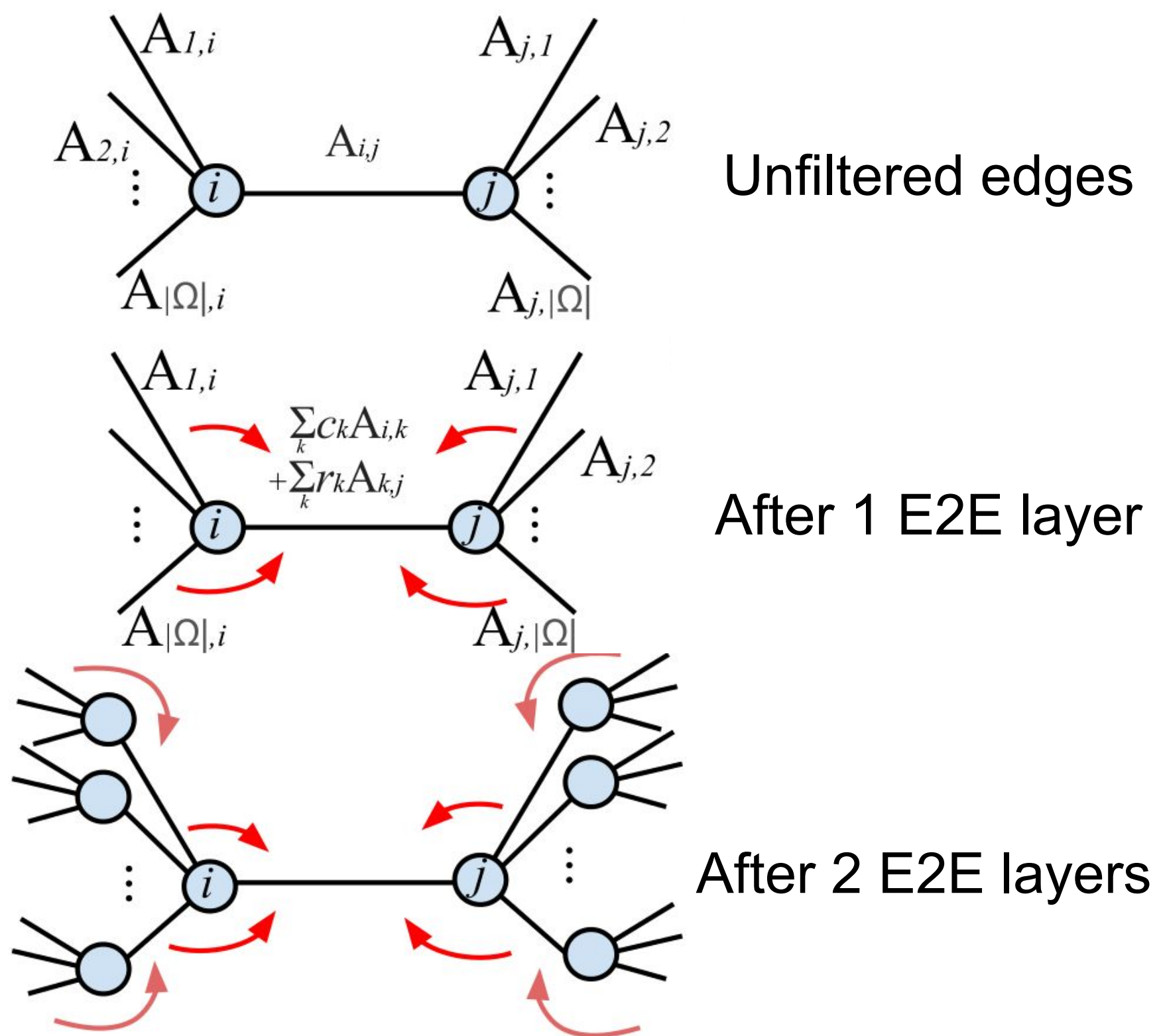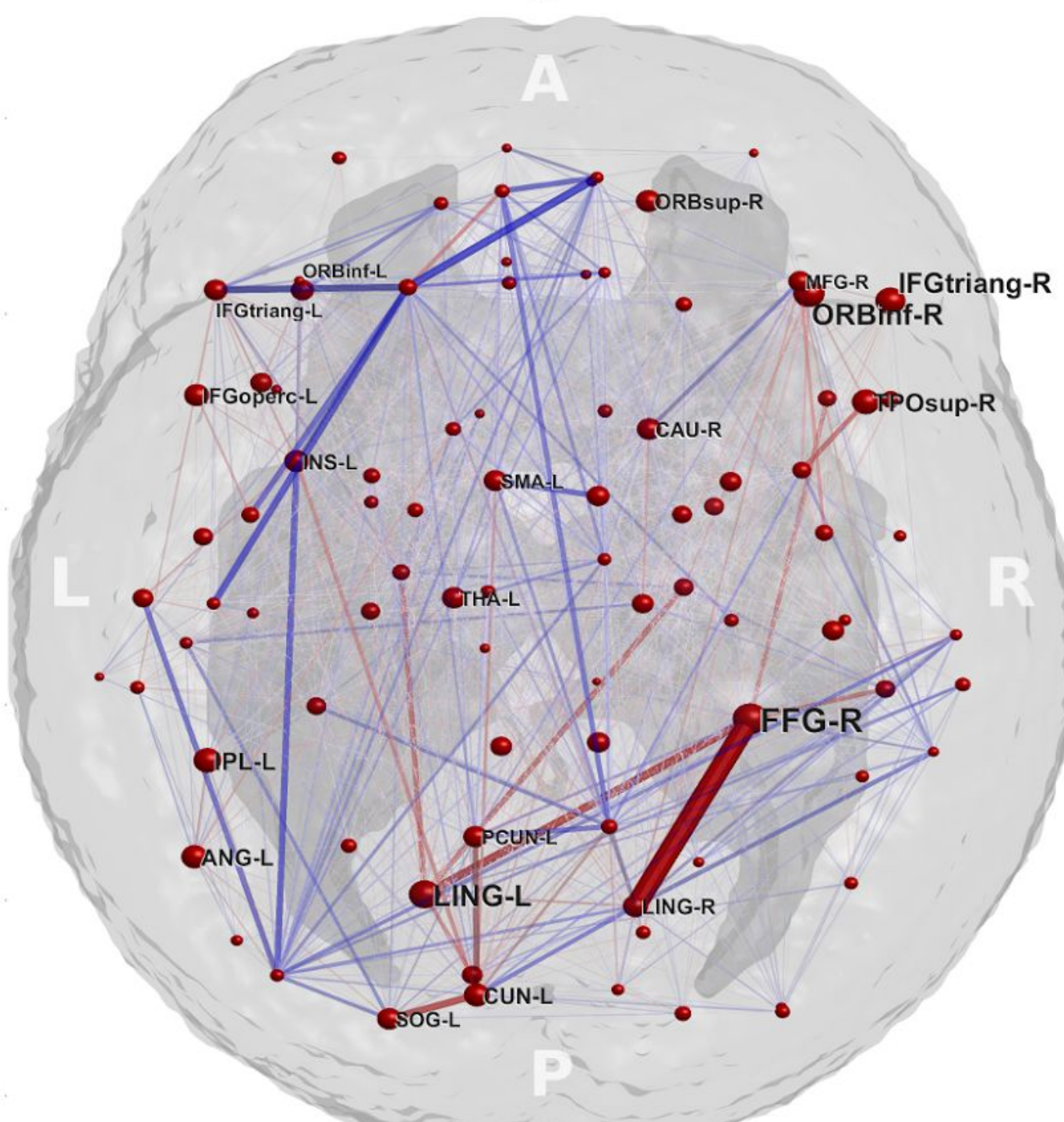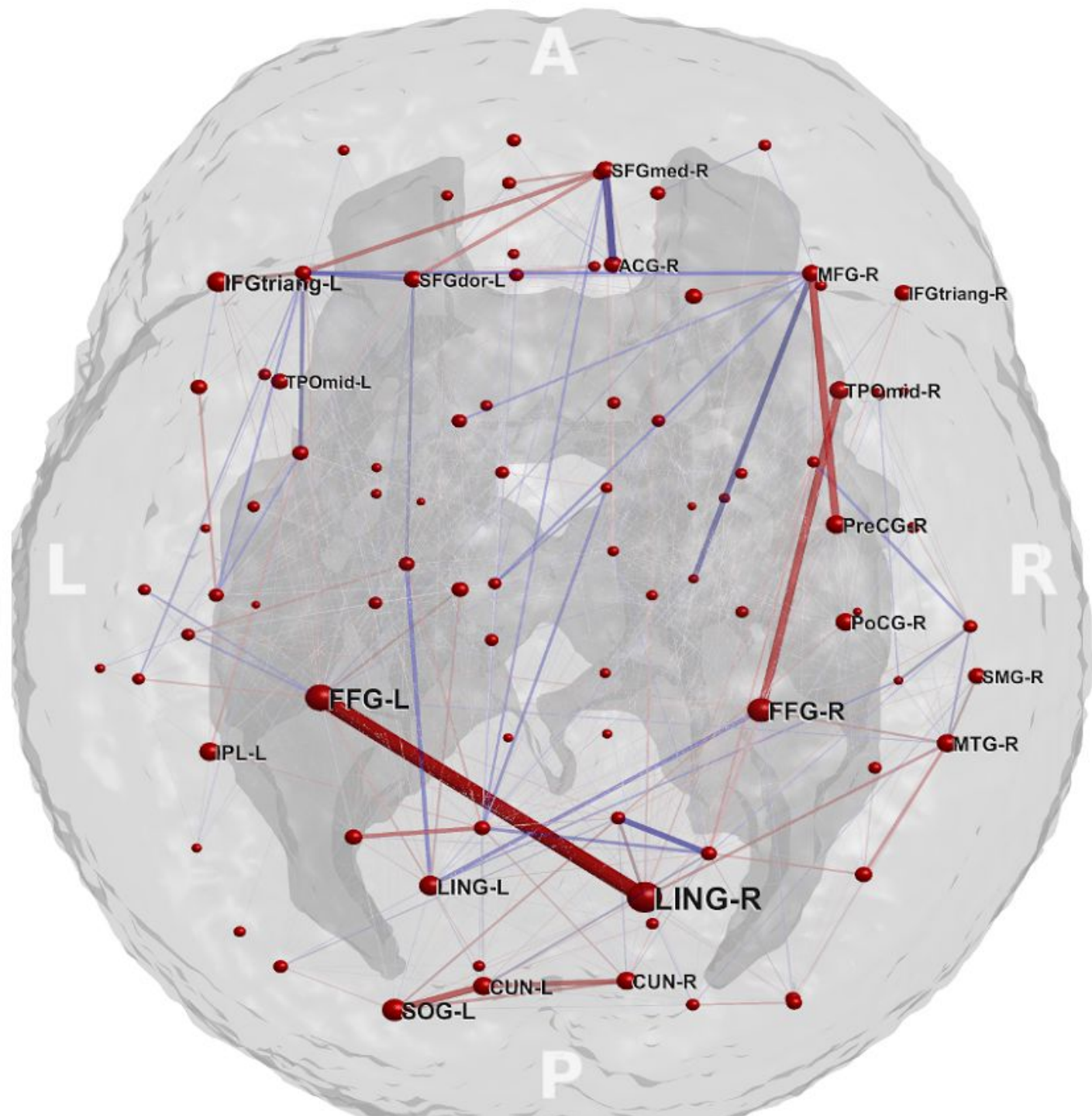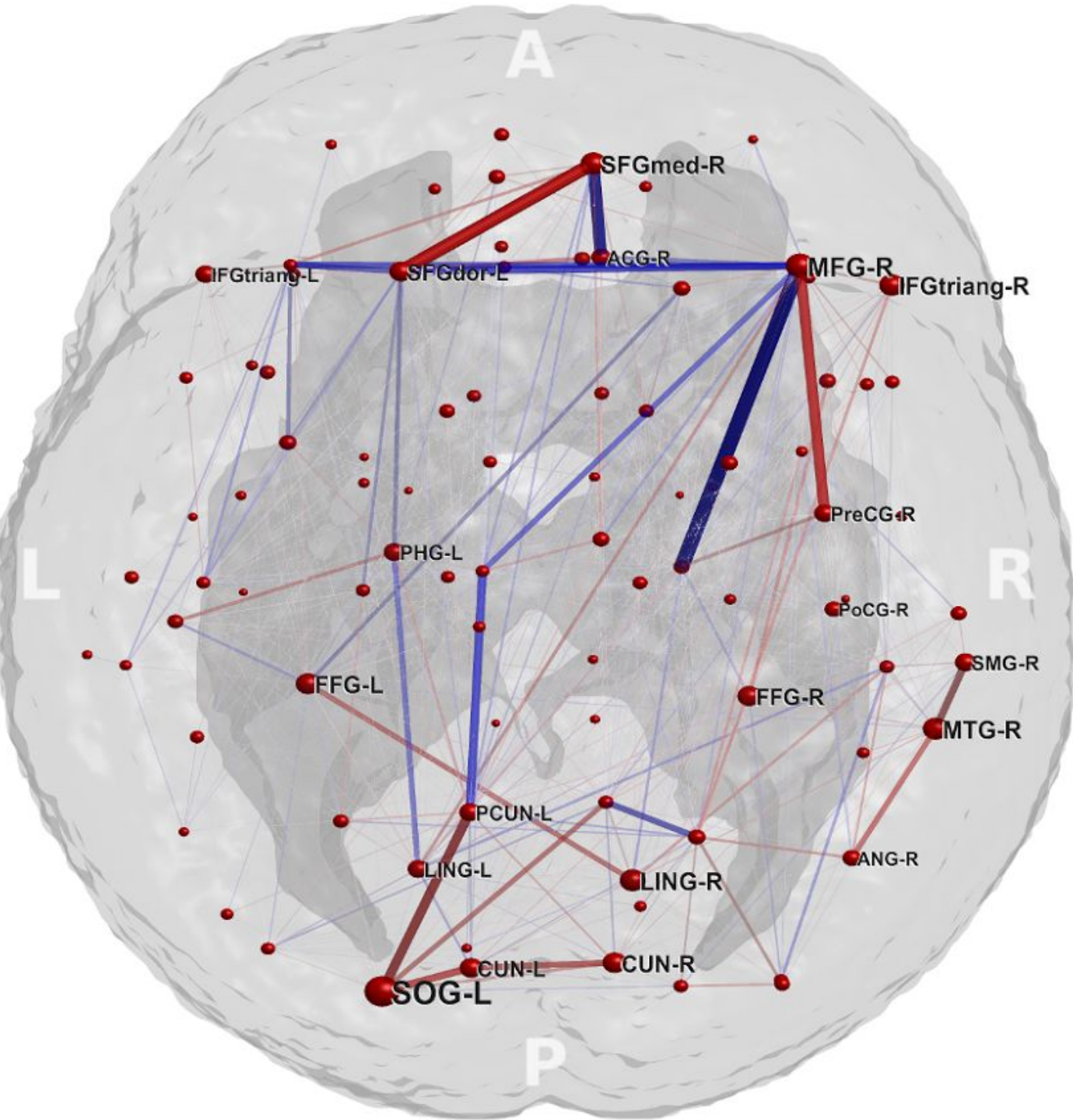- Predict clinical outcomes of pre-term babies

ATLAS

Pipeline to create the connectome

T2 Template   Regions
Registraion
b0   DTI
Tractography   Tracts   Network Const.   Connectome
SCANS

Connectome

Goal
Predict the infant's future developmental score from the connectome

MRI

0 Weeks (Last Menstral Cycle)   Preterm Birth   40 Weeks   Past | Future   time   18 Months (After Birth)   Bayley Test

Feature Extraction

90x90x1 (Input)   90x90x32   90x90x32`   90x1x64

Regression

1x1x256   1x1x128   1x1x30   1x1x2

dropout   dropout   dropout 0.5   dropout 0.5

1 E2E   2 E2E   3 E2N   4 N2G   5 FC128   6 FC30   7 FC   MOTOR   COGNITIVE

feature maps

Motor

Cognitive

Age

Unfiltered edges

$A_{1,i}$ $A_{j,1}$
$A_{2,i}$ $A_{i,j}$ $A_{j,2}$
$A_{|\Omega|,i}$ $A_{j,|\Omega|}$

After 1 E2E layer

$A_{1,i}$ $\sum_k c_k A_{i,k}$ $A_{j,1}$
$+\sum_k r_k A_{k,j}$
$A_{j,2}$
$A_{|\Omega|,i}$ $A_{j,|\Omega|}$

After 2 E2E layers

Results

Method	Motor Correlation	Cognitive Correlation
Clinical Features	0.106	0.086
Network Features	0.227	0.143
Fully Connected Neural Network	0.237	0.169
BrainNetCNN architectures	**0.310**	**0.188**