

myPLS

Partial Least Squares to relate imaging to behavior data

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Partial least squares (PLS)

- PLS finds optimal associations between 2 matrices (X and Y)

PLS variant	X	Y
Behavior PLS	Imaging measures	Behavior measures
PLS Discriminant Analysis	Imaging measures	Group labels
Task / Spatiotemporal PLS	Brain activity x Timeseries	Contrasts / Task conditions
Seed PLS	Whole brain activity	Seed activity
Multi-Block PLS	Imaging measures	Behavior + Conditions (+ ...)

Implementations

- myPLS – MATLAB code (Miplab)
 - <https://miplab.epfl.ch/index.php/software/PLS>
- PLS - MATLAB toolbox (Rotman Baycrest)
 - <https://www.rotman-baycrest.on.ca/index.php?section=84>
- PYLS - Python code (Ross Markello)
 - <https://github.com/rmarkello/ppls>

PLS

I. Cross-covariance matrix

$$Y^T \times X = R$$

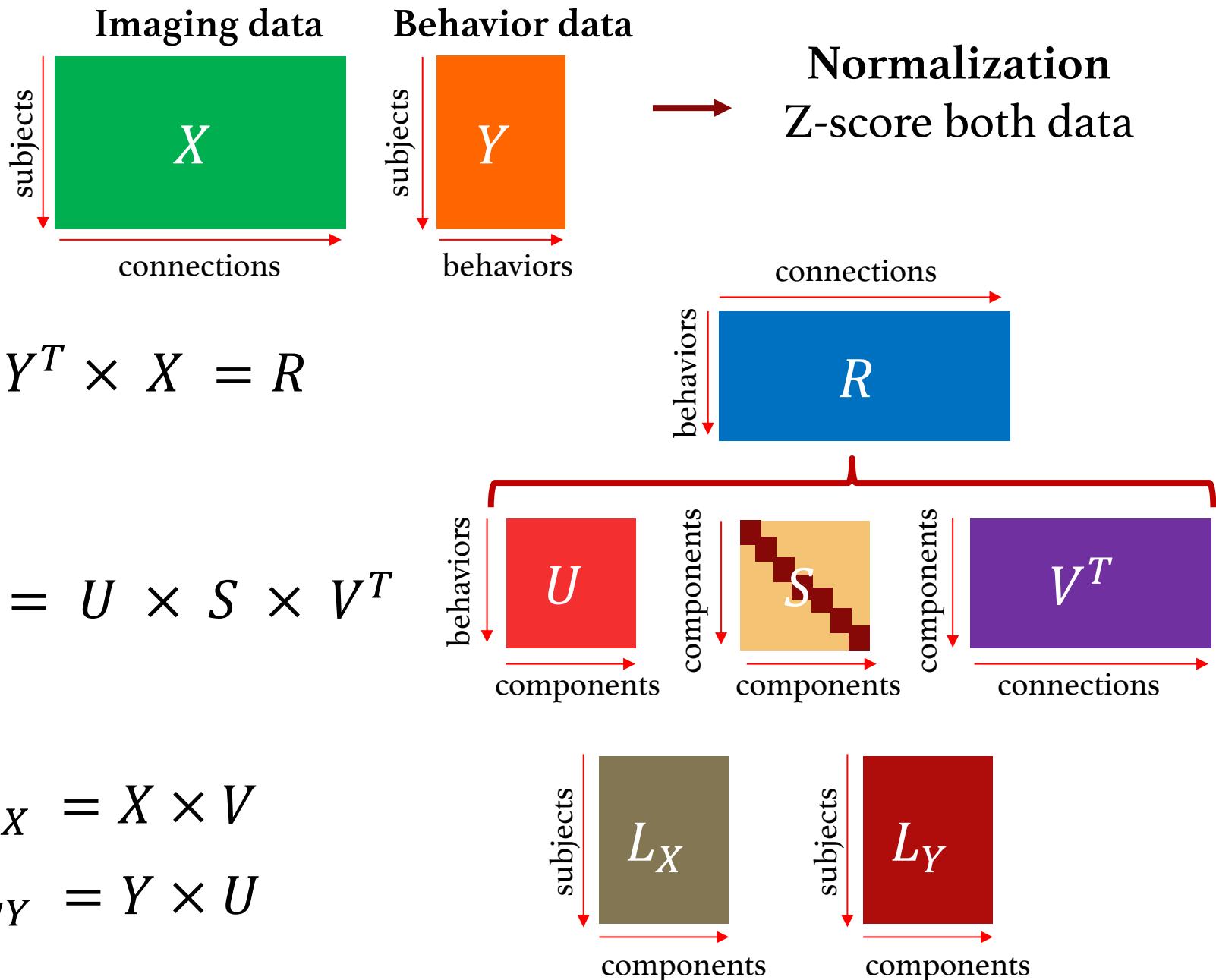
II. Singular value decomposition

$$R = U \times S \times V^T$$

III. Latent variables

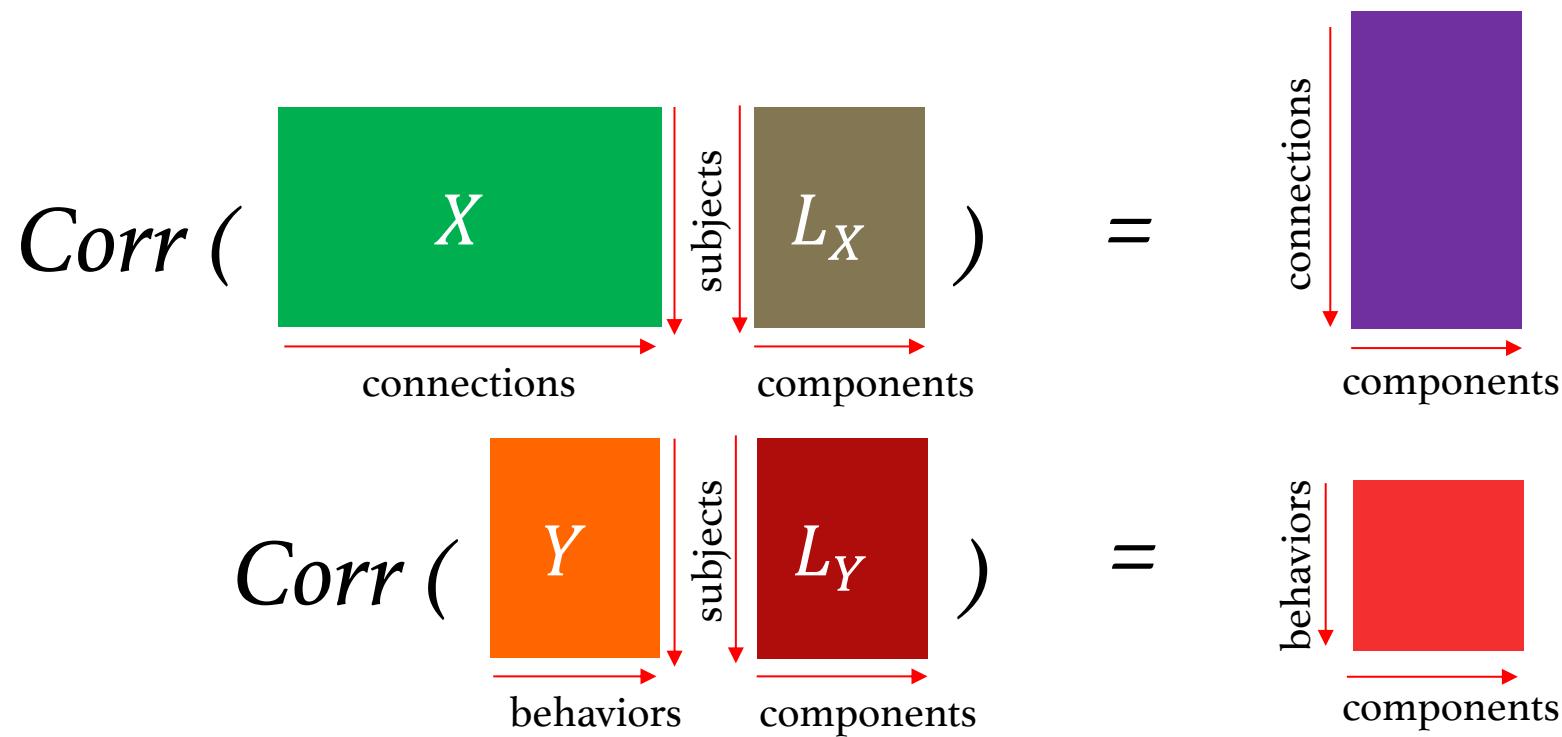
$$L_X = X \times V$$

$$L_Y = Y \times U$$



PLS

- Contribution of original variables to each component:
 - Structure coefficients : correlation between original variables and latent variables

$$\text{Corr} \left(\begin{array}{c|c} X & \\ \hline \text{connections} & \end{array} \right) = \begin{array}{c} \text{connections} \\ \downarrow \\ \text{components} \end{array}$$
$$\text{Corr} \left(\begin{array}{c|c} Y & \\ \hline \text{behaviors} & \end{array} \right) = \begin{array}{c} \text{behaviors} \\ \downarrow \\ \text{components} \end{array}$$


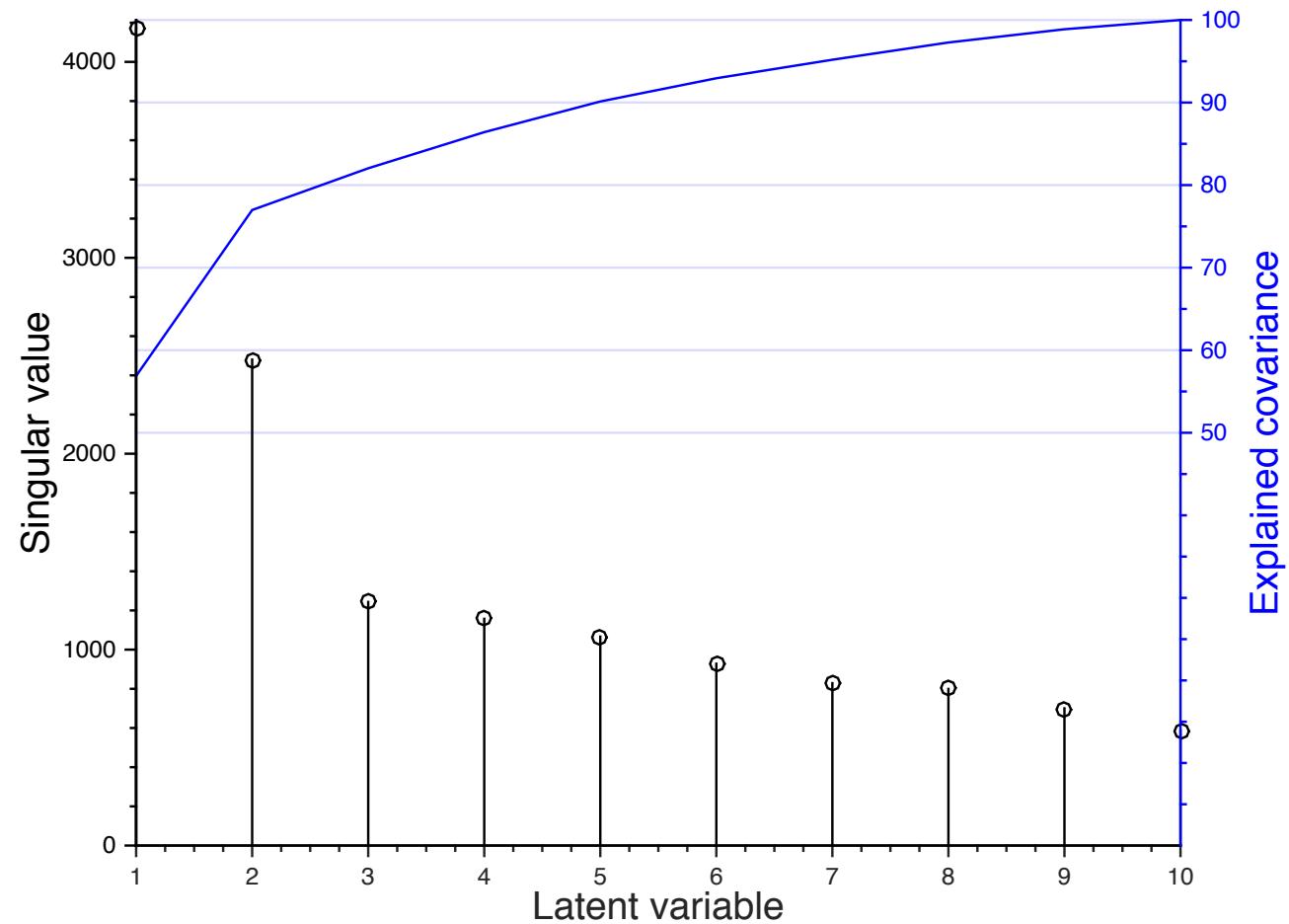
myPLS code

- Main script
 - myPLS_PR4NI
- Functions
 - myPLS_norm, myPLS_cov, ...
- Slice imaging templates
 - myobj_axial, myobj_coronal, myobj_sagittal

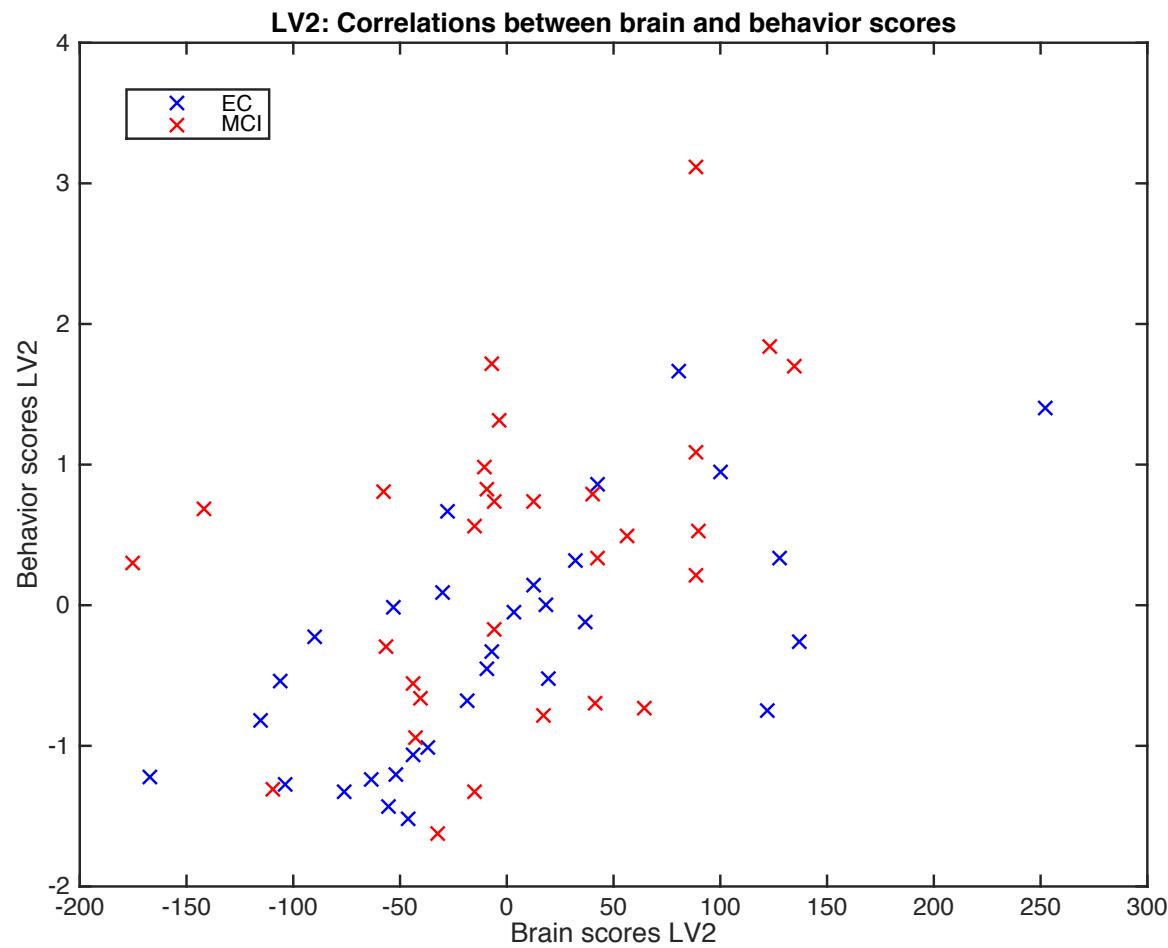
Inputs

- X : imaging data
 - Imaging space : volume / correlation matrix → common template
- Y : behavioral data
 - Names of behavioral measures
- Group information
 - name of groups
 - diagnosis grouping
- Permutations & bootstrapping

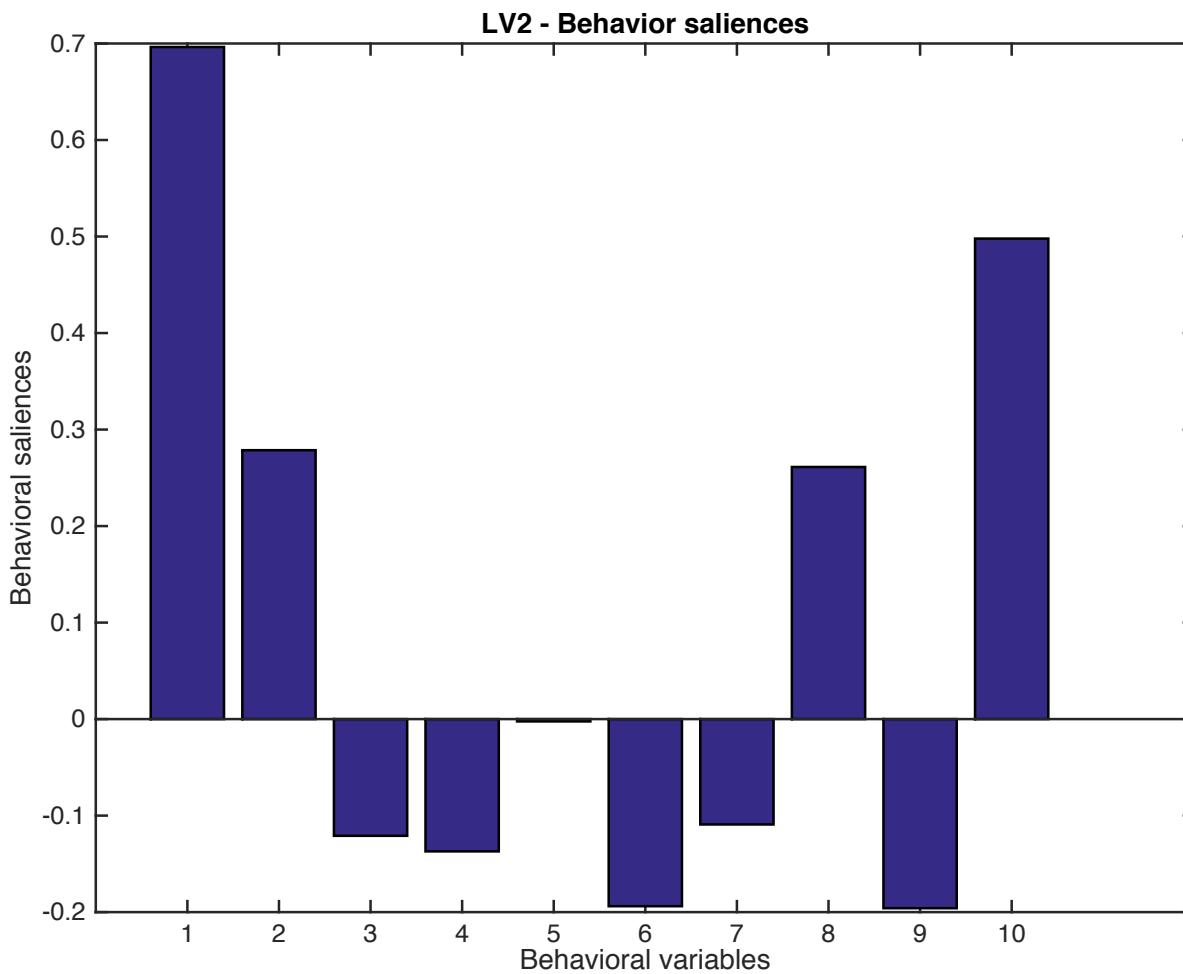
Output - Scree plot



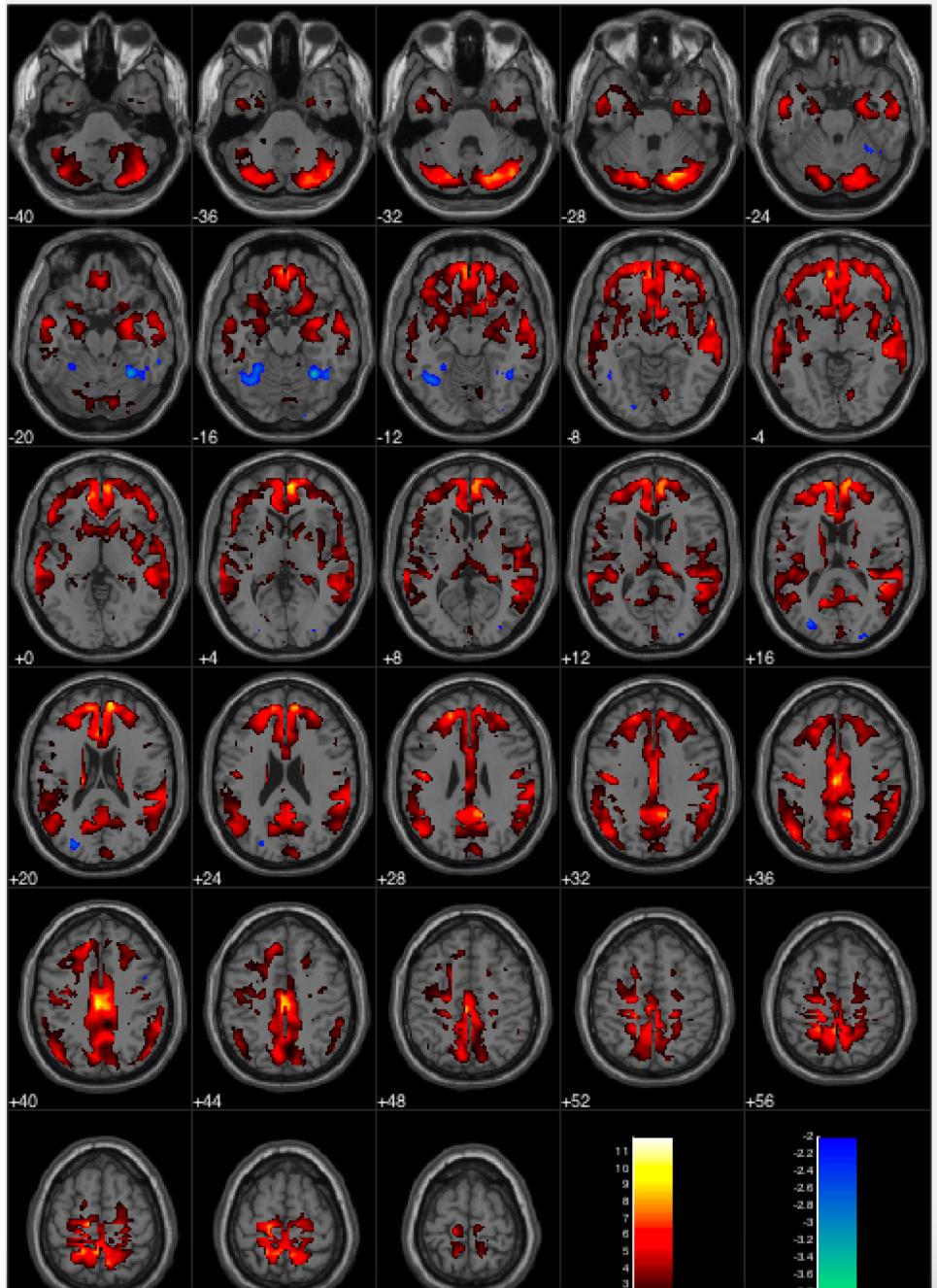
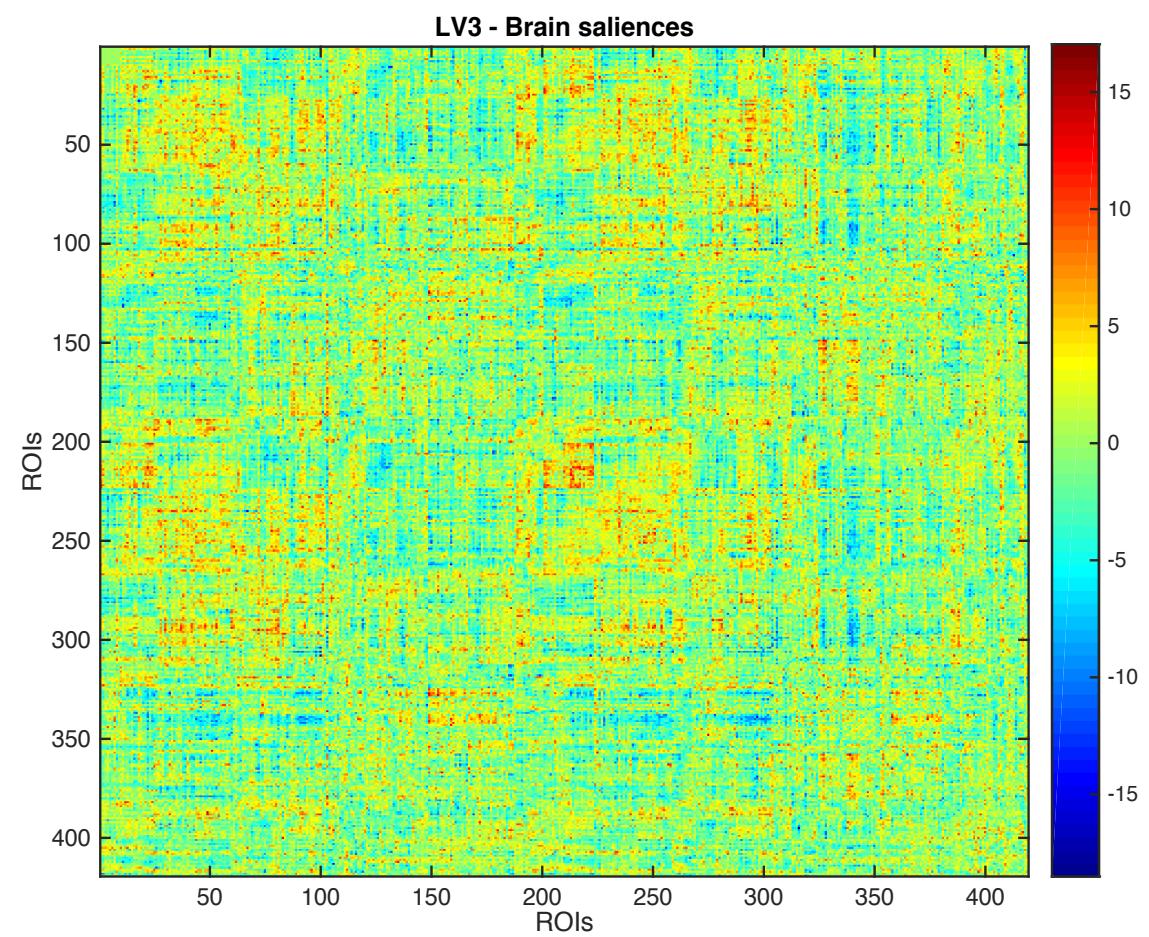
Output - Latent variables



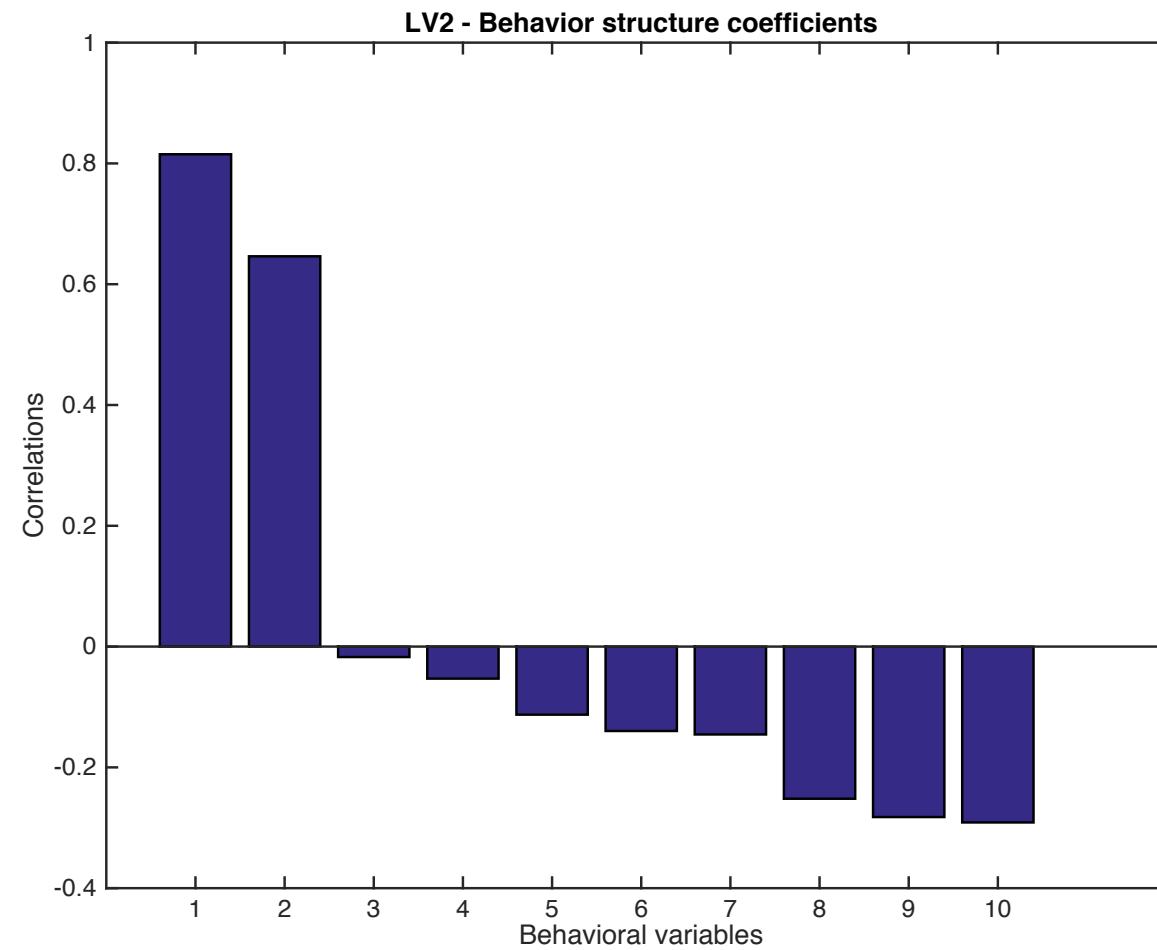
Output – Behavior saliences



Output – Brain saliences



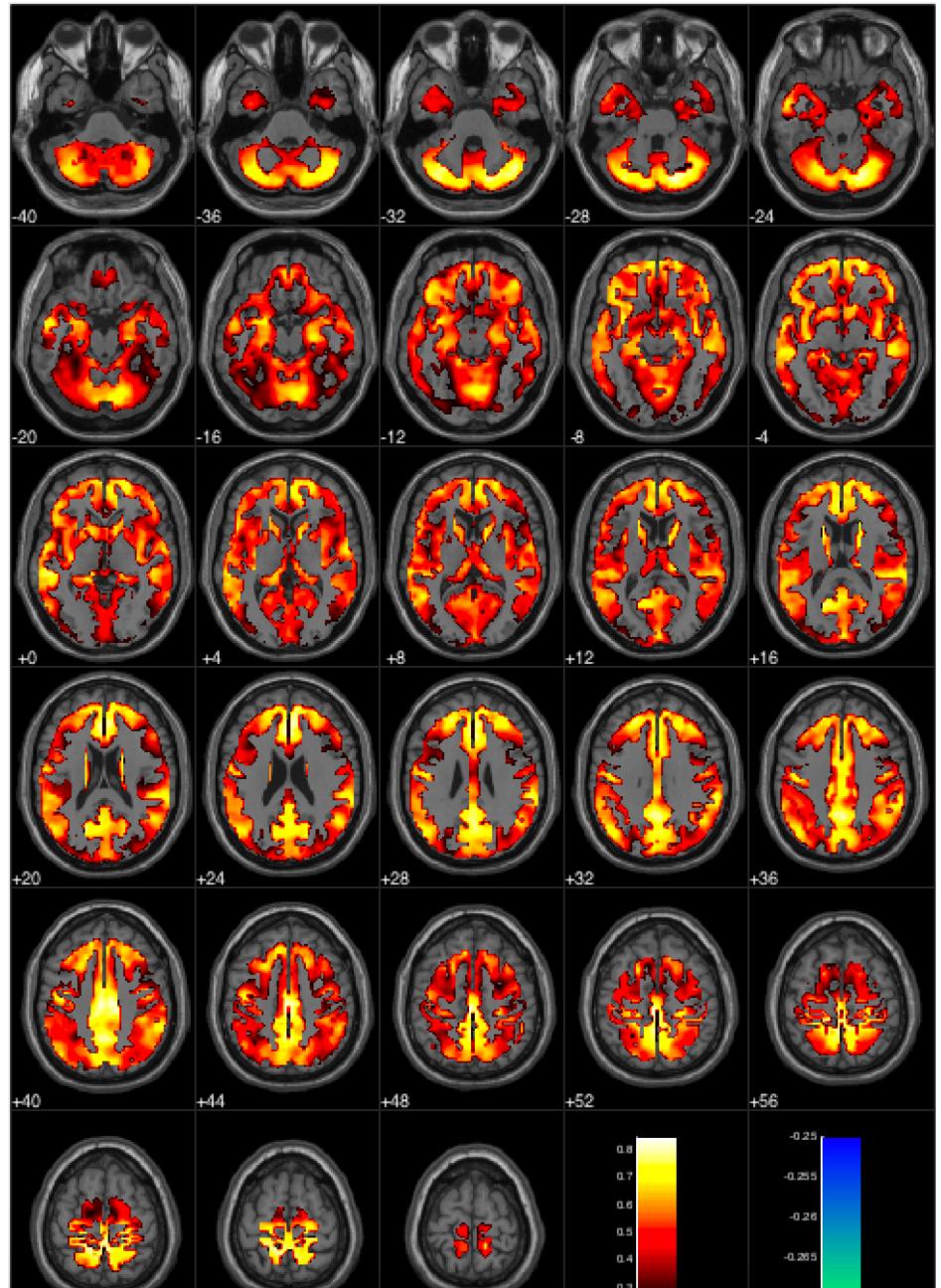
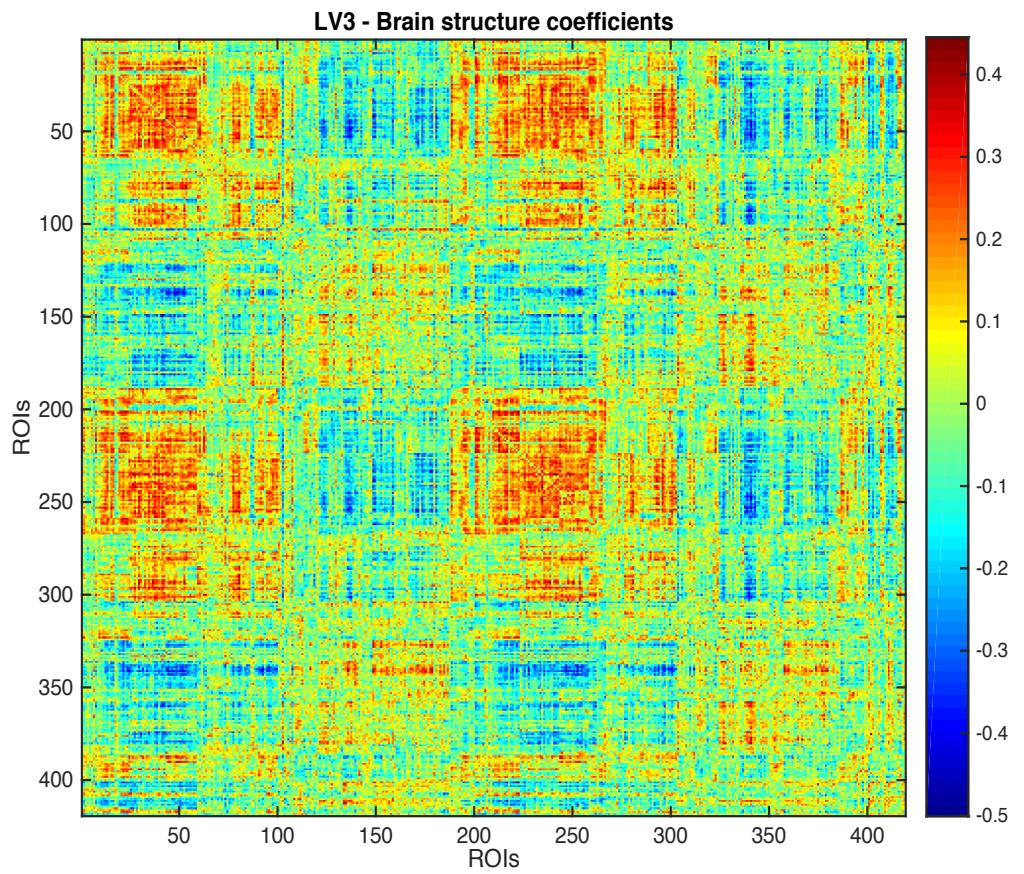
Output – Behavior structure coefficients



Top correlations for LV2 :

age - $r=0.82$
HAD-D - $r=0.65$
fluGP - $r=-0.02$
MMSE - $r=-0.05$
Boston - $r=-0.11$
HAD-A - $r=-0.14$
DRS - $r=-0.15$
Buschke_delRec - $r=-0.25$
fluCat - $r=-0.28$
Buschke_immRec - $r=-0.29$

Output – Brain structure coefficients



Acknowledgements & References

- Dimitri Van De Ville
- Daniela Zöller
- Krishnan A, Williams LJ, McIntosh AR, Abdi H (2011). Partial Least Squares (PLS) methods for neuroimaging: a tutorial and review. *Neuroimage*, 56(2), 455-75.
- McIntosh AR, Lobaugh NJ (2004). Partial least squares analysis of neuroimaging data: applications and advances. *Neuroimage*, 23(Suppl 1), S250-63.
- Any questions?
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