Improving Phenotype Prediction using Long-Range Spatio-Temporal Dynamics of Functional Connectivity

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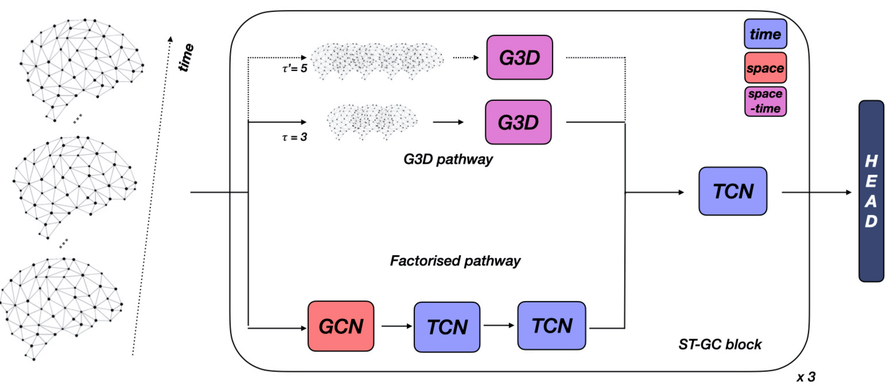
BACKGROUND

- Functional connectivity (FC) is **subject-specific** and hierarchically organised both in **space and time.**
- However, developing analysis technique accounting for FC **spatio-temporal dynamics** remains challenging.
- Several **deep learning** methods combine spatial graph convolutions followed by temporal convolution, therefore only indirectly extracting spatio-temporal features.

AIM

Explicit modelling of spatio-temporal dynamics of FC by translating a state-of-the-art methods of skeleton-based action recognition, while accounting for inter-subject cortical heterogeneity.



Brain-MS-G3D

METHODS

- Modelling functional connectivity using **dual-regressed (DR) ICA nodes** at different dimensionalities, accounting for subject-specificity.
- Translating a graph convolution model for skeleton-based action recognition, **MS-G3D.**
- Applying the method on functional graph sequences for 1003 subjects from the **HCP dataset**, predicting sex and fluid intelligence.

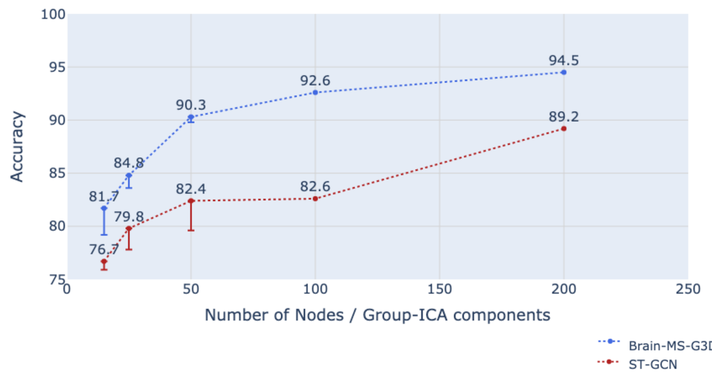
RESULTS

Methods	Data	Sex (% acc)	Fluid Intelligence (corr)
ST-GCN	22 Group ROIs	83.7	0.144
STAGIN-SERO	400 ROIs	88.20	N/A
STAGIN-GARO	400 ROIs	87.01	N/A
Brain-MS-G3D	22 Group ROIs	**84.7**	0.269
Brain-MS-G3D	ICA-15	81.5	0.286
Brain-MS-G3D	ICA-25	86.1	0.313
Brain-MS-G3D	ICA-50	90.9	**0.325**
Brain-MS-G3D	ICA-100	93.9	0.317
Brain-MS-G3D	ICA-200	**94.4**	0.324

- Consistently improving **sex classification** and **fluid intelligence** prediction results compared to methods applying spatial and temporal convolutions separately.
- Demonstrating improvement while using DR-ICA maps for sex classification, achieving **+6.2%** accuracy compared to state-of-the-art methods.

CONCLUSION & FUTURE WORK

- **Explicitly encoding spatio-temporal dynamics** via space-time convolution operations improves phenotyping prediction results.
- Accounting for **subject cortical heterogeneity** using DR-ICA nodes strengthen prediction.
- **However**, accounting for complete subject-specificity would require learning from fMRI subject-specific full resolution cortical data.
- Developing **interpretable models** would be crucial to derive functional biomarkers.



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