Project 0 data analysis plan

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Introduction

The data for this project is on a set of resting state functional connectivity(RSFC) and a set of measures of physical function. The investigator collect 30 resting state functional connectivity and 15 physical function of 300 participants. The objective of this report is to outline an analysis plan aimed at addressing the following research question:

- what measures of resting state functional connectivity are associate with individual physical function.

To achieve this, we employ a series of separate linear regression models, one for each measure of physical function.

Method

Data collection

The study collected data from 300 participants. For each participant, the following data were obtained:

- 30 measures of resting state functional connectivity (predictors)
- 15 measures of physical function (outcomes)

Data cleaning

There is no data cleaning procedure was done.

Data analysis

A total of 15 regression models and 450 tests was conducted. The general notation of multiple regression model can be written as following:

$$y^m = x\beta^m + \epsilon^m$$

- y^m is the vector of observations for the m-th physical function measure
- X is the design matrix containing the 30 RSFC predictors and an intercept term
- β^m is the vector of regression coefficients for the m-th model
- ϵ^m is the error term, assumed to be normally distributed: $\epsilon^m \sim N(0, \Sigma^m)$

Totally, m∗(p+1)+m = 480 parameters was estimating but investigator only interested in m∗p= 450 parameters. The estimate of coefficient and p value are reported on Appendix Table 1 and Table 2 respectively.

The hypothesis for each coefficient β_i is that :$H_0 : \beta_i = 0, H_1 : \beta_i \neq 0$. Family-wise Type I error rate is the probability of making at least one false discovery across all our tests. In order to correct multiple tests, the Bonferroni correction was applied. The adjusted significance level $\alpha_{adjusted} = \frac{\alpha}{\text{number of tests}}$. By using Bonferroni correction, the FWER is controlled to be at most 0.05. For our project, the adjusted significance level is $\frac{0.05}{450} = 0.000111$. So a P values < 0.000111 will be considered significant. After fitting the data to multiple linear regressions, a table(Appendix: table 1) of p value for each coefficients was generated.

The Bonferroni correction, while simple to implement, is often overly conservative, especially when dealing with a large number of tests. A alternative correlation approach was tried to conduct. Let $\hat{\hat{\boldsymbol{\beta}}} = \left[\hat{\boldsymbol{\beta}}^{1^t}, \ldots, \hat{\boldsymbol{\beta}}^{M^t}\right]^t$, if we know $\hat{\beta}$ is multivariate normal, then we can get a distribution of estimates for each coefficient, which we can use to construct confidence intervals. To let $\hat{\beta}$ multivariate normal, we have to make some assumptions.

Preliminary Results

According to the table, The predictor X.4, X.5, X.7, X.15, X.20, X.23, X.26, X.27, X.29 are significant in at least one model. Among the predictor that is significant in at least one model, X.5, X23 and X29 are significant in five, seven and five models respectively.

Appendix

Table 1: The p values of coefficients for 15 regression models

	Y.1	Y.2	Y.3	Y.4	Y.5	Y.6	Y.7	Y.8	Y.9	Y.10	Y.11	Y.12	Y.13	Y.14	Y.15
X.1	0.023	0.009	0.024	0.802	0.293	0.575	0.049	0.857	0.485	0.024	0.143	0.881	0.732	0.481	0.006
X.2	0.628	0.177	0.177	0.166	0.136	0.191	0.143	0.363	0.282	0.228	0.316	0.185	0.162	0.136	0.251
X.3	0.092	0.198	0.013	0.050	0.160	0.155	0.096	0.072	0.226	0.224	0.021	0.079	0.045	0.056	0.212
X.4	0.143	0.265	0.988	0.741	0.460	0.159	0.545	0.003	0.093	0.926	0.002	0.006	0.557	0.821	0.350
X.5	0.006	0.000	0.222	0.000	0.614	0.005	0.046	0.001	0.063	0.004	0.283	0.006	0.003	0.102	0.256
X.6	0.347	0.191	0.120	0.268	0.124	0.155	0.265	0.128	0.147	0.460	0.756	0.144	0.082	0.453	0.083
X.7	0.172	0.024	0.960	0.082	0.006	0.009	0.570	0.432	0.002	0.003	0.388	0.339	0.547	0.958	0.810
X.8	0.681	0.143	0.224	0.171	0.399	0.456	0.059	0.110	0.311	0.124	0.209	0.164	0.161	0.070	0.110
X.9	0.034	0.305	0.016	0.092	0.132	0.043	0.408	0.201	0.312	0.020	0.753	0.061	0.726	0.432	0.058
X.10	0.215	0.378	0.143	0.338	0.240	0.152	0.324	0.335	0.220	0.296	0.224	0.368	0.282	0.130	0.151
X.11	0.239	0.112	0.129	0.257	0.136	0.219	0.135	0.106	0.307	0.158	0.335	0.320	0.135	0.188	0.117
X.12	0.619	0.159	0.206	0.995	0.551	0.484	0.047	0.055	0.469	0.982	0.520	0.524	0.519	0.586	0.052
X.13	0.090	0.503	0.112	0.154	0.350	0.463	0.048	0.390	0.607	0.650	0.401	0.129	0.087	0.454	0.065
X.14	0.241	0.190	0.177	0.077	0.124	0.138	0.082	0.164	0.098	0.177	0.167	0.259	0.200	0.174	0.055
X.15	0.024	0.912	0.444	0.343	0.015	0.094	0.003	0.064	0.721	0.052	0.428	0.006	0.003	0.055	0.072
X.16	0.420	0.210	0.365	0.237	0.065	0.077	0.174	0.246	0.206	0.238	0.359	0.554	0.270	0.106	0.116
X.17	0.035	0.008	0.884	0.420	0.398	0.619	0.811	0.007	0.739	0.103	0.022	0.158	0.947	0.727	0.257
X.18	0.663	0.136	0.179	0.307	0.055	0.550	0.043	0.279	0.352	0.219	0.150	0.901	0.234	0.611	0.033
X.19	0.150	0.091	0.336	0.060	0.316	0.042	0.115	0.344	0.264	0.357	0.418	0.336	0.190	0.112	0.024
X.20	0.344	0.720	0.022	0.065	0.021	0.004	0.054	0.029	0.412	0.369	0.316	0.212	0.144	0.550	0.195
X.21	0.440	0.053	0.076	0.044	0.192	0.045	0.226	0.490	0.324	0.317	0.367	0.483	0.102	0.279	0.169
X.22	0.799	0.408	0.358	0.464	0.646	0.439	0.358	0.839	0.402	0.543	0.883	0.014	0.007	0.304	0.007
X.23	0.227	0.000	0.704	0.647	0.000	0.022	0.000	0.000	0.002	0.062	0.224	0.001	0.330	0.000	0.903
X.24	0.174	0.325	0.198	0.135	0.112	0.236	0.237	0.376	0.119	0.451	0.379	0.133	0.244	0.237	0.294
X.25	0.111	0.083	0.403	0.222	0.098	0.576	0.060	0.068	0.093	0.676	0.286	0.926	0.209	0.077	0.020
X.26	0.099	0.492	0.005	0.445	0.579	0.137	0.018	0.001	0.517	0.000	0.000	0.019	0.768	0.606	0.346
X.27	0.285	0.113	0.303	0.645	0.402	0.483	0.006	0.003	0.100	0.256	0.005	0.824	0.451	0.604	0.559
X.28	0.575	0.353	0.138	0.181	0.043	0.045	0.230	0.461	0.274	0.180	0.082	0.362	0.395	0.104	0.163
X.29	0.949	0.866	0.304	0.001	0.327	0.001	0.001	0.273	0.681	0.165	0.002	0.448	0.601	0.092	0.001
X.30	0.316	0.518	0.137	0.200	0.163	0.507	0.069	0.488	0.087	0.159	0.193	0.643	0.424	0.407	0.424

Table 2: The estimated coefficients for 15 regression models

	Y.1	Y.2	Y.3	Y.4	Y.5	Y.6	Y.7	Y.8	Y.9	Y.10	Y.11	Y.12	Y.13	Y.14	Y.15
X.1	-0.9	-1.0	-0.9	0.1	0.4	0.2	-0.8	-0.1	0.3	-0.9	0.6	0.1	0.1	-0.3	-1.1
X.2	1.0	2.7	2.8	2.8	3.2	2.7	3.0	1.9	2.2	2.4	2.1	2.9	3.1	3.3	2.4
X.3	1.6	1.2	2.4	1.9	1.4	1.4	1.6	1.8	1.2	1.2	2.3	1.8	2.1	2.0	1.3
X.4	0.6	-0.4	0.0	0.1	0.3	-0.6	-0.2	-1.3	-0.7	0.0	-1.3	-1.2	-0.3	-0.1	-0.4
X.5	1.3	1.8	0.6	1.8	0.3	1.4	1.0	1.7	0.9	1.4	0.5	1.4	1.6	0.9	0.6
X.6	-1.2	-1.6	-2.0	-1.4	-2.0	-1.8	-1.4	-2.0	-1.8	-0.9	-0.4	-2.0	-2.4	-1.0	-2.3
X.7	0.4	-0.7	0.0	-0.6	-0.9	-0.9	-0.2	-0.3	-1.0	-1.0	-0.3	0.3	0.2	0.0	-0.1
X.8	0.7	2.5	2.1	2.4	1.5	1.3	3.3	2.8	1.7	2.6	2.2	2.5	2.6	3.4	2.9
X.9	-1.7	-0.8	-2.0	-1.4	-1.3	-1.7	-0.7	-1.1	-0.8	-1.9	-0.3	-1.7	-0.3	-0.7	-1.7
X.10	-3.5	-2.5	-4.2	-2.7	-3.5	-4.2	-2.9	-2.8	-3.5	-3.0	-3.5	-2.7	-3.3	-4.7	-4.3
X.11	4.0	5.4	5.3	3.9	5.4	4.3	5.2	5.7	3.5	4.8	3.4	3.6	5.5	4.9	5.7
X.12	0.3	-0.8	-0.8	0.0	-0.4	-0.4	-1.2	-1.2	-0.4	0.0	0.4	0.4	0.4	-0.4	-1.2

	Y.1	Y.2	Y.3	Y.4	Y.5	Y.6	Y.7	Y.8	Y.9	Y.10	Y.11	Y.12	Y.13	Y.14	Y.15
X.13	-2.0	-0.8	-2.0	-1.7	-1.2	-0.9	-2.5	-1.1	-0.6	-0.5	-1.0	-2.0	-2.2	-1.0	-2.4
X.14	2.5	2.9	3.0	3.9	3.6	3.4	3.9	3.2	3.7	3.0	3.1	2.6	3.1	3.2	4.5
X.15	1.3	-0.1	0.4	0.5	1.5	1.0	1.8	1.1	0.2	1.1	0.5	1.7	1.8	1.2	1.1
X.16	1.4	2.2	1.6	2.1	3.4	3.2	2.4	2.1	2.2	2.1	1.6	1.1	2.1	3.0	2.9
X.17	-1.3	-1.7	-0.1	-0.5	-0.6	-0.3	-0.2	-1.8	-0.2	-1.0	-1.5	-1.0	0.0	-0.2	-0.8
X.18	-0.4	-1.5	-1.4	-1.0	-2.0	-0.6	-2.1	-1.1	-0.9	-1.2	-1.5	-0.1	-1.3	-0.6	-2.3
X.19	2.3	2.7	1.6	3.0	1.7	3.3	2.6	1.6	1.8	1.5	1.3	1.6	2.2	2.7	3.8
X.20	-0.6	-0.2	-1.6	-1.3	-1.7	-2.1	-1.4	-1.6	-0.6	-0.6	-0.7	-0.9	-1.1	-0.4	-0.9
X.21	1.0	2.6	2.4	2.7	1.8	2.8	1.7	1.0	1.3	1.3	1.2	1.0	2.4	1.6	1.9
X.22	0.1	0.4	0.5	-0.4	0.2	0.4	-0.5	0.1	-0.4	-0.3	0.1	1.3	1.4	0.5	1.4
X.23	0.2	0.9	-0.1	0.1	0.8	0.5	0.8	1.2	0.6	0.4	-0.2	0.7	0.2	1.0	0.0
X.24	-2.5	-1.8	-2.5	-2.8	-3.2	-2.3	-2.3	-1.7	-2.9	-1.4	-1.7	-3.0	-2.4	-2.4	-2.1
X.25	-1.5	-1.7	-0.8	-1.2	-1.7	-0.6	-1.9	-1.8	-1.6	-0.4	-1.0	-0.1	-1.3	-1.8	-2.4
X.26	-0.5	-0.2	0.8	-0.2	0.2	-0.4	0.7	1.0	-0.2	1.1	1.4	0.7	-0.1	-0.2	0.3
X.27	-0.7	-1.0	-0.7	-0.3	-0.6	-0.5	-1.8	-2.0	-1.0	-0.7	-1.8	-0.2	-0.5	-0.4	-0.4
X.28	0.7	1.3	2.1	1.8	2.9	2.8	1.7	1.0	1.5	1.8	2.4	1.3	1.2	2.4	2.0
X.29	0.0	-0.1	-0.5	-1.6	-0.5	-1.8	-1.7	-0.6	0.2	-0.7	-1.6	-0.4	-0.3	-0.9	-1.7
X.30	-1.2	-0.8	-1.9	-1.6	-1.8	-0.8	-2.3	-0.9	-2.1	-1.7	-1.6	-0.6	-1.1	-1.1	-1.0