Predicting ASD from Daily Activity and Light Exposure Patterns

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Introduction

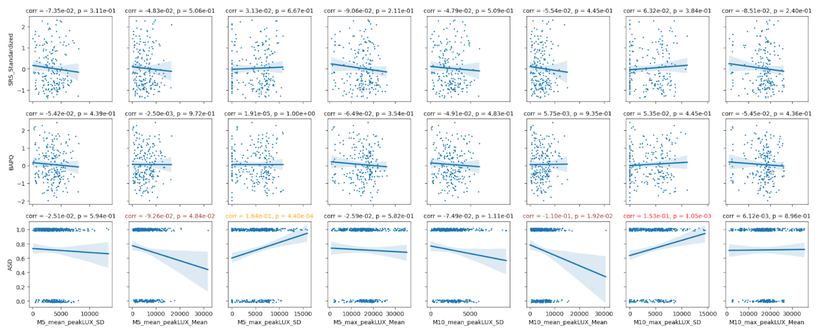
- Autism spectrum disorder (ASD) is a neurodevelopmental condition characterized by challenges in social communication and restricted or repetitive behaviors[1].
- Sleep, physical activity, and light exposure have interconnected and complex relationships with ASD. ASD is associated with sleep[2] and motor abnormalities[3].
- Actigraphy, the measurement of activity patterns with an accelerometer, has been useful in quantifying sleep disorders among subjects with autism[4].

Data Description

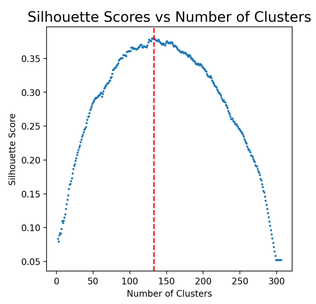
- Weissenkampen et al. recruited 145 autistic participants from the Autism Spectrum Program of Excellence (ASPE), as well as 130 non-autistic family members[6]. 180 participants from Simons Powering Autism Research (SPARK), all with autism, were also recruited.
- GENEActiv accelerometer watches were used to collect raw acceleration and light data from participants over three weeks. Participants also took the Social Responsiveness Scale (SRS) and the Broad Autism Phenotype Questionnaire (BAPQ).
- The authors then used the GGIR, Chronosapiens, and Accelerometer software programs to extract a total of 308 features from each subject's raw data.

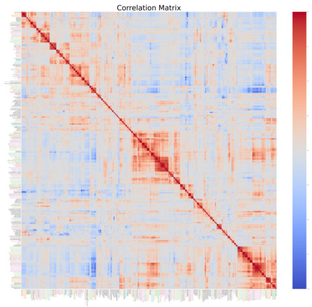
Exploratory Data Analysis

Scatterplots are used to explore the relationships between light and ASD, as well as confounding factors such as Age and Sex.



Clustering





Hierarchal clustering was performed using Euclidean distance on actimetry features after standardization, producing a dendrogram. Then the number of clusters is determined using silhouette analysis

Automated Machine Learning

The Python library Lazy Predict runs and evaluates multiple models on the same dataset, aiding in model selection.

Classification of LUX features vs ASD		
Model	Accuracy	Balanced Accuracy
GaussianNB	0.665	0.612
QuadraticDiscriminantAnalysis	0.674	0.612
BernoulliNB	0.595	0.574

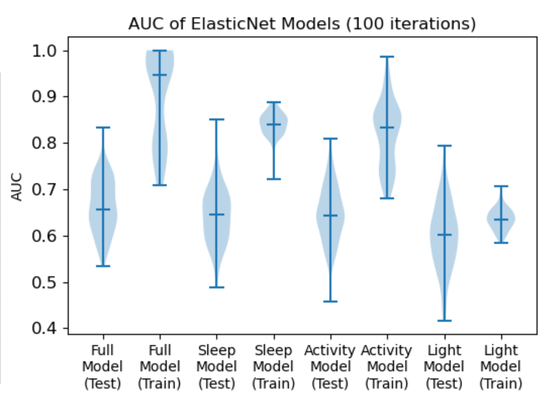
Regression of LUX features vs SRS			Regression on LUX features vs BAPQ		
Model	Adjusted R-Squared	RMSE	Model	Adjusted R-Squared	RMSE
TweedieRegressor	-0.09809	0.929	ElasticNetCV	-0.14774	0.919
BayesianRidge	-0.10045	0.930	ElasticNet	-0.14774	0.919
ElasticNet	-0.10062	0.930	DummyRegressor	-0.14774	0.919

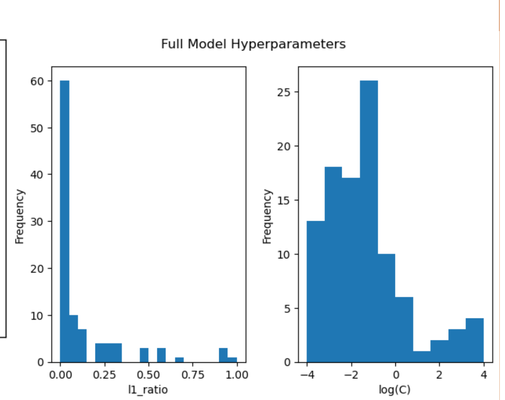
Elastic Net Logistic Regression

Repeated random sub-sampling validation method was used, along with 5-fold Cross-Validation to find the best hyperparameters for Elastic Net Logistic Regression

Random State	80% Training 20% Test Data	Fine-tune Elastic Net Logistic Regression with 5-fold CV
0	→	l1_ratio=0.35, C=0.0464
1		l1_ratio=0.00, C=0.0001
…	…	…
98		l1_ratio=0.05, C=0.0060
99		l1_ratio=0.00, C=0.0060

A model with all 308 features was evaluated, as well as 3 others with sleep, activity, and light-related features





Conclusion and Next Steps

Sleep, activity, and light are all predictors of autism, with sleep and activity being stronger predictors. Understanding this relationship can lead to motion and sleep-based interventions for treating ASD.

Next steps include

- Extracting more light features with pyActigraphy
- Causal analysis of sleep, activity, light, and ASD
- Including confounding by time of year in analysis

References

[1] *American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.).*

[2] Devnani, P. A., & Hegde, A. U. (2015). Autism and sleep disorders. Journal of pediatric neurosciences, 10(4), 304–307. https://doi.org/10.4103/1817-1745.174438

[3] Fournier, K.A., Hass, C.J., Naik, S.K. et al. Motor Coordination in Autism Spectrum Disorders: A Synthesis and Meta-Analysis. J Autism Dev Disord 40, 1227–1240 (2010). https://doi.org/10.1007/s10803-010-0981-3

[4] Wiggs L, Stores G. Sleep patterns and sleep disorders in children with autistic spectrum disorders: insights using parent report and actigraphy. *Developmental Medicine & Child Neurology*. 2004;46(6):372-380. doi:10.1017/S0012162204000611