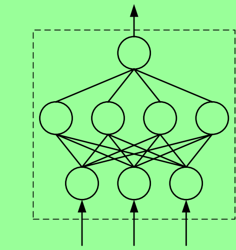
Support Vector Classification Shows Sleep Effects of Ritalin on Children with ADHD

Matthew Boardman, Sarah Ironside, Thomas Trappenberg, Penny Corkum
Dalhousie University, Halifax, Nova Scotia



Introduction

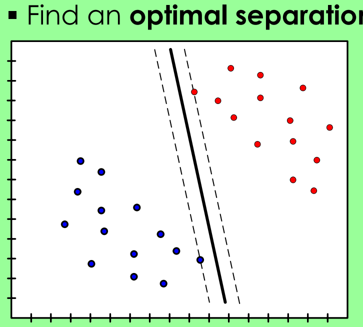
- In this work, we apply advanced machine learning techniques to statistical sleep parameters generated from actigraph measurements, taken during a blinded, randomized medication trial with low and moderate doses of Ritalin in comparison to a placebo, for children previously diagnosed with Attention Deficit Hyperactivity Disorder (ADHD). Please see Dr. Penny Corkum's presentation for more details on this clinical study.

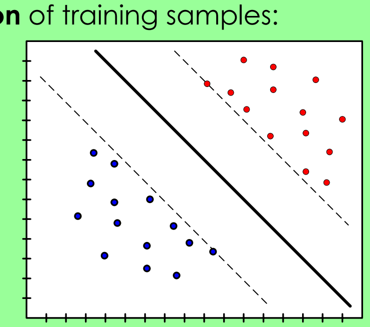
Objective:

- To discover whether a properly-tuned support vector classifier can **distinguish between ADHD subjects taking Ritalin** and those taking a placebo.
- To determine **which of the sleep parameters** contain information most relevant to the predictive power of the model, in order to enhance accuracy.

Support Vector Machines:

- Next generation of **artificial neural networks**: Fast, efficient training algorithm with a small model representation. Fewer training samples required due to excellent **generalization** capability. **Easy to apply** to practical problems since fewer free parameters.
- Find an **optimal separation** of training samples:



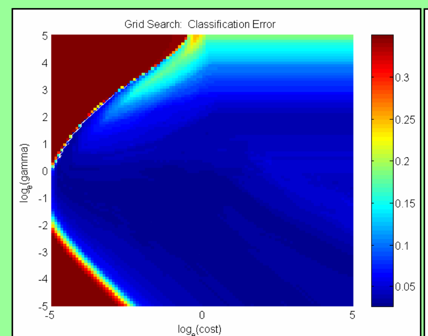


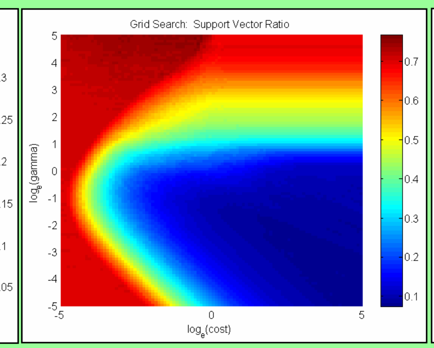
… which is better? An SVM finds a dividing line which maximizes the margin between training samples.

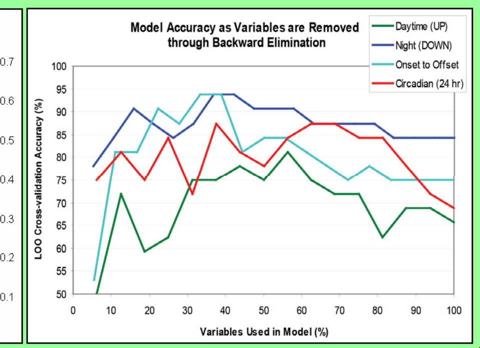
- **Intrinsic Regularization**: a cost parameter C allows a tradeoff between model complexity and misclassified samples, to enhance generalization.
- **Kernel Trick**: a non-linear transformation of the inputs can be performed using a Gaussian kernel of radius γ, providing higher feature dimensionality.

Methods

- **Extrinsic Regularization**: the best SVM model parameters (C, γ) were chosen by using a heuristic approach, to find a model which balances low **leave-one-out cross-validation error** with low **model complexity**.
- **Input Variable Saliency**: find the relevance of each input variable by measuring the **empirical effect** that each variable has on the models. Remove those inputs that have a low saliency using **backwards elimination**, then retrain the model.

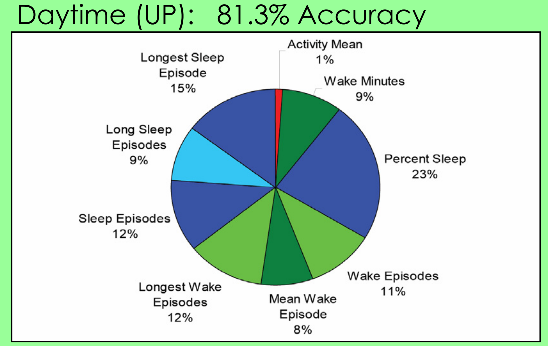




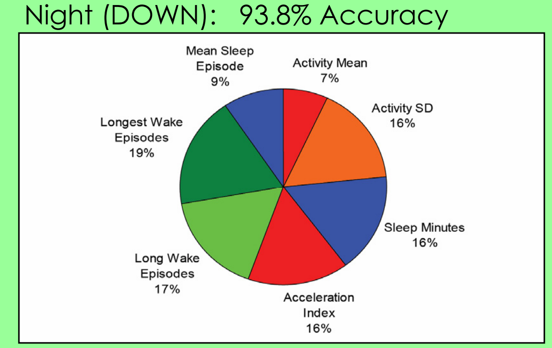


Results

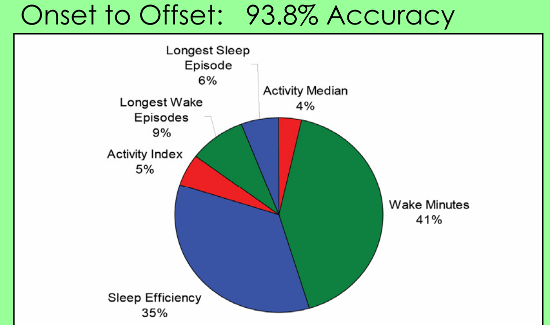
Daytime (UP): 81.3% Accuracy



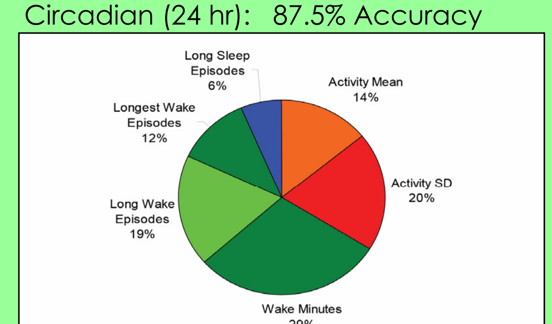
Night (DOWN): 93.8% Accuracy



Onset to Offset: 93.8% Accuracy



Circadian (24 hr): 87.5% Accuracy



For more information on Support Vector Machines, please visit http://www.cs.dal.ca/~boardman

Discussion

- With preliminary data from sixteen children in this ongoing clinical research, we find that the model can correctly distinguish between subjects taking low-dose Ritalin and those taking a placebo with **high accuracy**, up to 93.8% for the *Night (DOWN)* and *Onset-to-Offset* models.
- We find that the statistical parameters generated during sleep have the highest cross-validation accuracy, indicating that **Ritalin does have a significant, measurable effect** on wake and sleep patterns for both wake and sleep cycles. This supports conclusions made from traditional statistical methods, such as MANOVA.
- In all four cases, by removing variables with low saliency, **model complexity** is greatly reduced with some improvement in overall accuracy. We find that the statistical sleep **parameters selected** by the backward elimination algorithm **varies from model to model**, however *Longest Wake Episodes* appears in all four models, and all four models use either *Wake Minutes* or *Sleep Minutes* which are redundant variables. Interestingly, the *Activity* parameters contribute less strongly to the *Daytime* and *Onset-to-Offset* models than the others.
- **Future work**: we will continue to refine our methods as more data becomes available, in order to support further clinical psychiatric research to discover the causes of these effects.

Sponsors and supporters:

NSERC CRSNG
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