

WORKPLACE PRODUCTIVITY & STRESS OPTIMIZATION

WORKPLACE STRESS AND PARTICIPANT MODELING

Keith A. Chamberlain

Saint Mary's University of Minnesota

Schools of Graduate & Professional Programs

BIA650 Data Mining for Decision Making

Instructor: Justin Grosz



SWELL HRV DATASET

- Employers, Yerkes Dodson law and optimal stress (Wikipedia, 2019)
- Stress may leave physiological traces
- SWELL dataset (Koldijk & Colleagues, 2014)
- Version available on Kaggle (Kiriro, 2019)
- No-stress, interruption, time-pressure
 - Collapsed to No-stress vs. Stress
- Predict stress condition based on Electrocardiogram (ECG)?
- No HRV though.

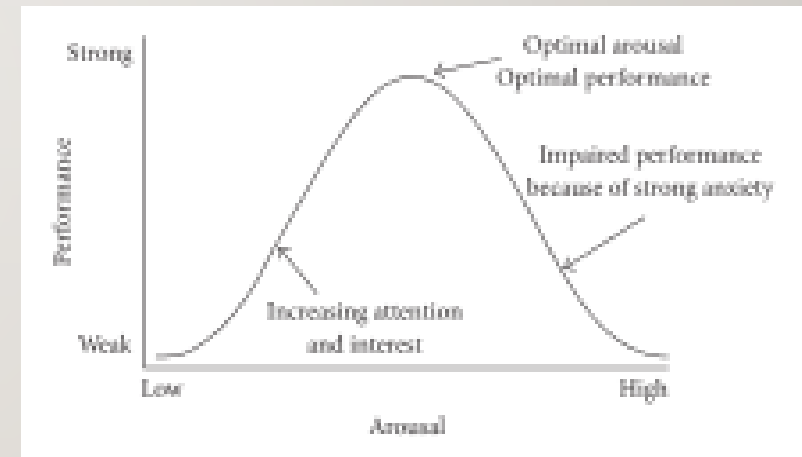
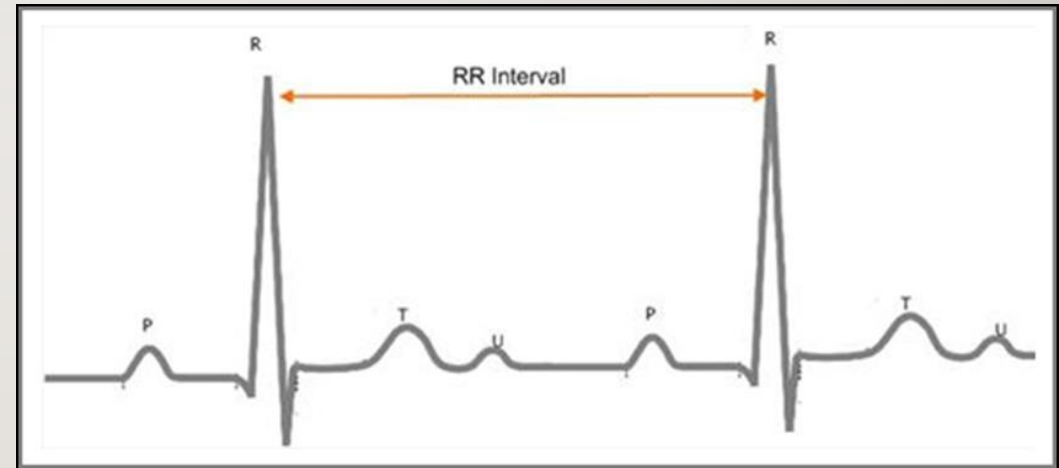


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INVESTIGATION DESIGN

- Stress (email interruption or time pressure)
- No stress (aka business as usual)
- ECG properties (very low frequency*low frequency*heart rate*high frequency)
- SWELL derived dataset (Qiriro, 2019)
- SAS University Edition
- PROC Logistic
- Train & Test: 10K random sample each
- With/Without Stepwise Selection



Retrieved from <https://www.ni.com/en-us/support/documentation/supplemental/08/archive-d--using-labview-for-heart-rate-variability-analysis.html>

METHODS & MATERIALS

SWELL derived dataset (Qiriro, 2019)

2 files

- Train.csv
>369000 Records, 35 Columns
- Test.csv
>41000 Records, 35 Columns

Statistical Properties of the ECG signal

- Frequency content
- Heart rate
- Mean, median, standard deviation, skew kurtosis of the sampling distributions of the mean and median RR intervals
- Many more

TRAINING, OPTIMIZATION & VALIDATION

Random Sample 10k
rows of training/testing

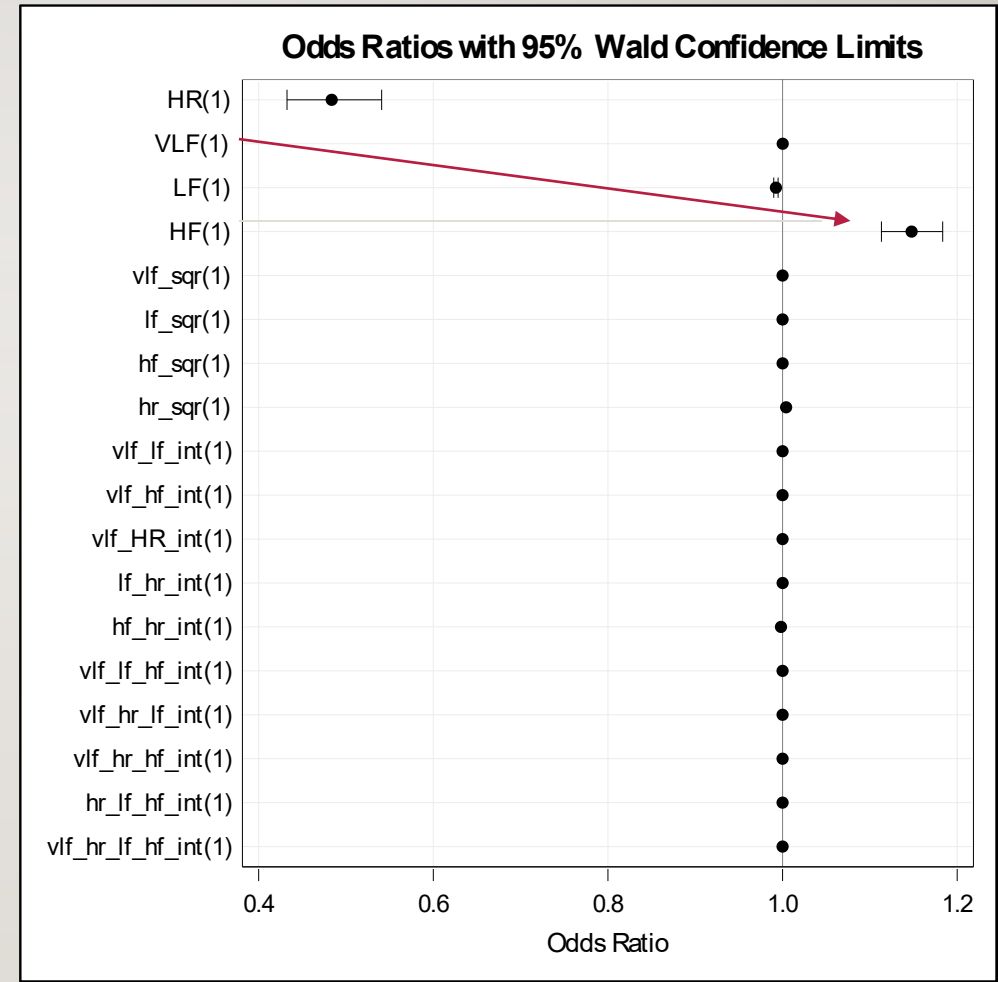
ROC, AUC/ d_a
(detectability), OR, Fit
Statistics for Training Fit

ROC, AUC/ d_a
(detectability) for
Testing Fit

RESULTS

- 68.18% of detectability by HR alone
- VLF, LF, HF 1.84% combined
- Squared terms and interactions up to 4th order = 2.71% additional in detectability
- Most effects were centered around OR 1.000 ± 0.000 (small effects)
- Stepwise selection omitted some 1st order variables (VLF) that made other important variables disappear (HF) so the full model before selection was retained.

RESULTS



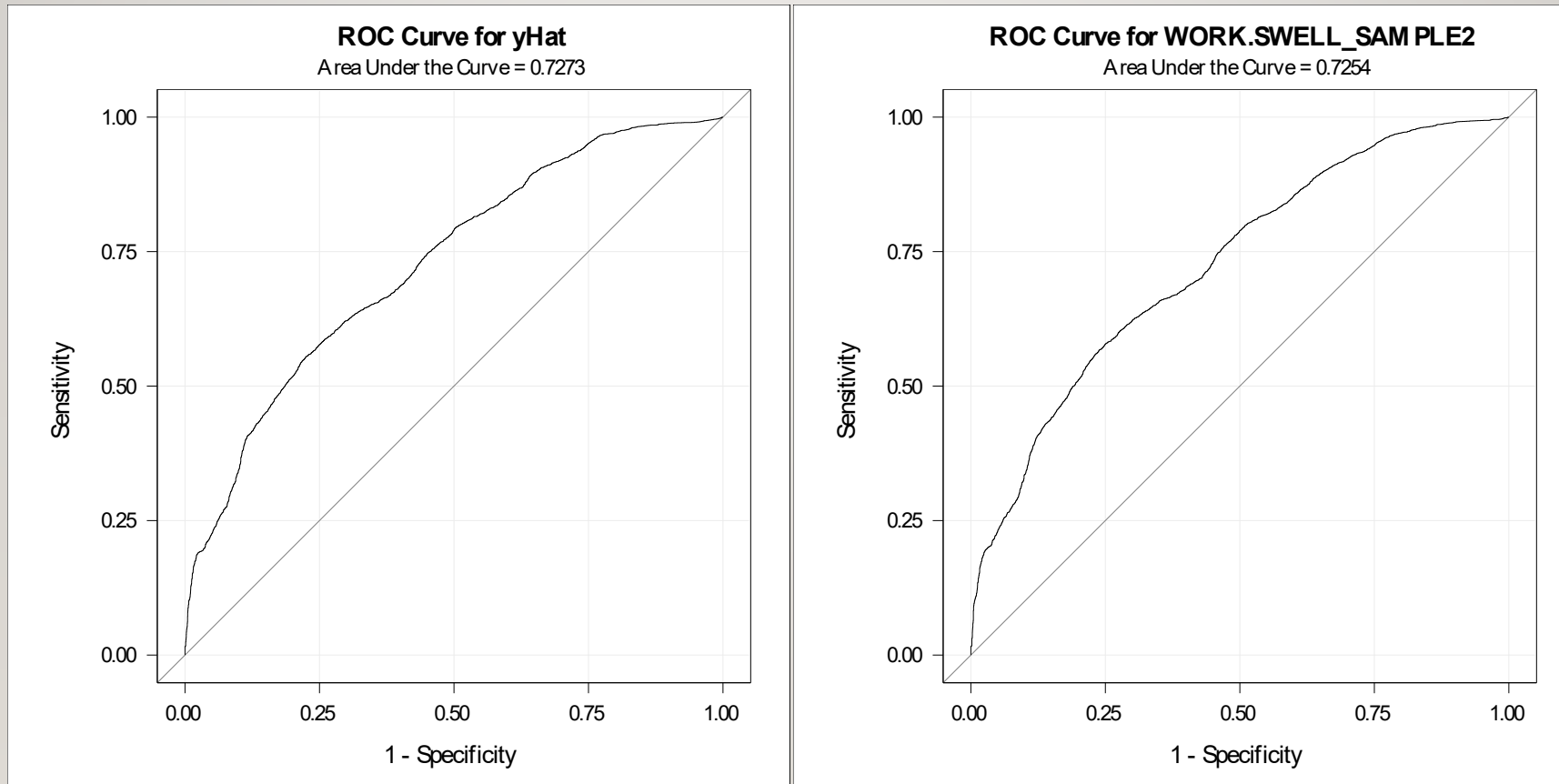
RESULTS

Wanted 75% Correct Classification Rate

Got 67.4% CCR
Sensitivity = 54.2%
Specificity = 78.3%

Conversely 63.0% CCR
Sensitivity = 77.5%
Specificity = 50.9%

RESULTS



DISCUSSION

- Will lead to real time ID of stress levels on the job.
- ECG sensors 😞
- Success only partly achieved: Either 75% sensitivity OR specificity but not both.

REFERENCES

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- Davila, M. I., Lewis, G. F., & Porges, S. W. (2017). The PhysioCam: A Novel Non-Contact Sensor to Measure Heart Rate Variability in Clinical and Field Applications. *Frontiers in Public Health*. Retrieved from <https://www.frontiersin.org/article/10.3389/fpubh.2017.00300>
 - Green, D. M., & Swets, J. A. (1966). *Signal Detection Theory and Psychophysics*. New York: Wiley.
 - Koldijk, S., Neerincx, M. A., & Kraaij, W. (2018). Detecting Work Stress in Offices by Combining Unobtrusive Sensors. *IEEE Transactions on Affective Computing*, 9(2), 227–239. <https://doi.org/10.1109/TAFFC.2016.2610975>
 - Koldijk, S., Sappelli, M., Verberne, S., Neerincx, M. A., & Kraaij, W. (2014). The SWELL Knowledge Work Dataset for Stress and User Modeling Research. In *Proceedings of the 16th International Conference on Multimodal Interaction - ICMI '14* (pp. 291–298). New York, New York, USA: ACM Press. <https://doi.org/10.1145/2663204.2663257>
 - Nkurikiyeyezu, K., Shoji, K., Yokokubo, A., & Lopez, G. (2019). Thermal comfort and stress recognition in office environment. *HEALTHINF 2019 - 12th International Conference on Health Informatics, Proceedings; Part of 12th International Joint Conference on Biomedical Engineering Systems and Technologies, BIOSTEC 2019*, 256–263. <https://doi.org/10.5220/0007368802560263>
 - Qiri. (2019). SWELL dataset: Heart Rate Variability (HRV) dataset for research on stress and user modeling. Retrieved January 10, 2020, from <https://www.kaggle.com/qiri/swell-heart-rate-variability-hrv>
 - Yerkes–Dodson law. (2019, December 31). Retrieved January 11, 2020, from https://en.wikipedia.org/wiki/Yerkes–Dodson_law