Analysis of Sleep and Training Load Data Using Oura and Strava Wearables from an Anonymous Subject

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Intro

Task

- Analyze and interpret sleep, recovery, and training load data

Why is this important?

- Better sleep ≈ better recover ≈ better performance

How do we measure adaptations to training?

- Heart rate variability (HRV)
  - Root Mean Square of Successive Differences between normal heartbeats (RMSSD)

https://www.bu.edu/articles/2016/treating-eating-disorders-athletes/

Objectives

Identify sleep patterns

- Are they consistent with established findings on sleep?

Examine RMSSD

- Peaks and valleys
- Trends

Is there a relationship between RMSSD and exogenous variables?

- Sleep
- Workload

https://www.hopkinsusfhp.org/class/sleep-your-way-to-better-health/black-woman-sleeping-in-bed/

Methods

Data sources
- Oura wearable ring
- Strava wearable wrist band

Data
- Oura
  - 487 observations
- Strava
  - 314 observations

Pearson correlation
- R^2 and p-value

Linear modeling
- OLS, LASSO, and Ridge Regression

https://nymag.com/strategist/2020/07/oura-ring-review-2020.html

https://www.strava.com/

Data Preparation

Oura

- Dropped days where ring was worn < 18 hours
- All times converted to hours
- Bed and wake times calculated (24hr)
- 448 entries

Strava

- Dropped workout, yoga, walk, rowing, and roller ski
- All times converted to hours
- Swim distance from m to km
- Summed daily activities, distances, and times
- 227 entries

Combined dataset

- 182 entries

Modeling dataset

- Dropped RPE
- Removed NAs
- 151 entries

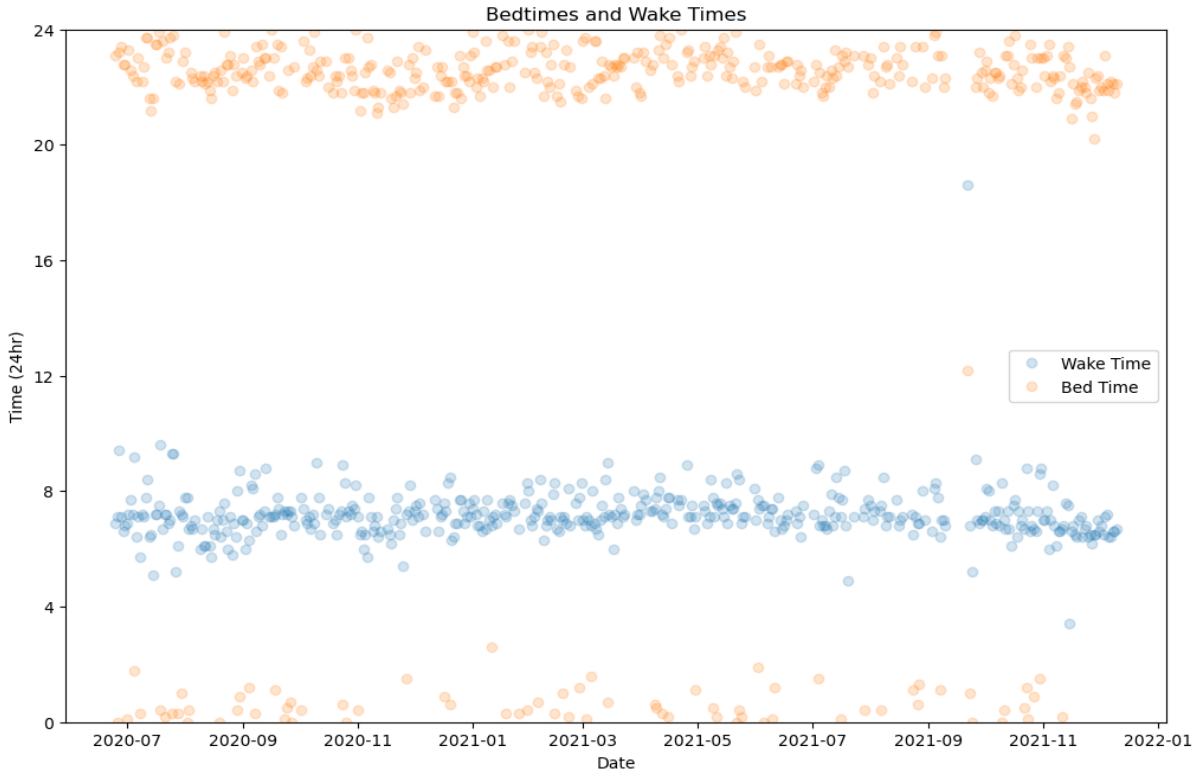
Oura Data (cleaned)

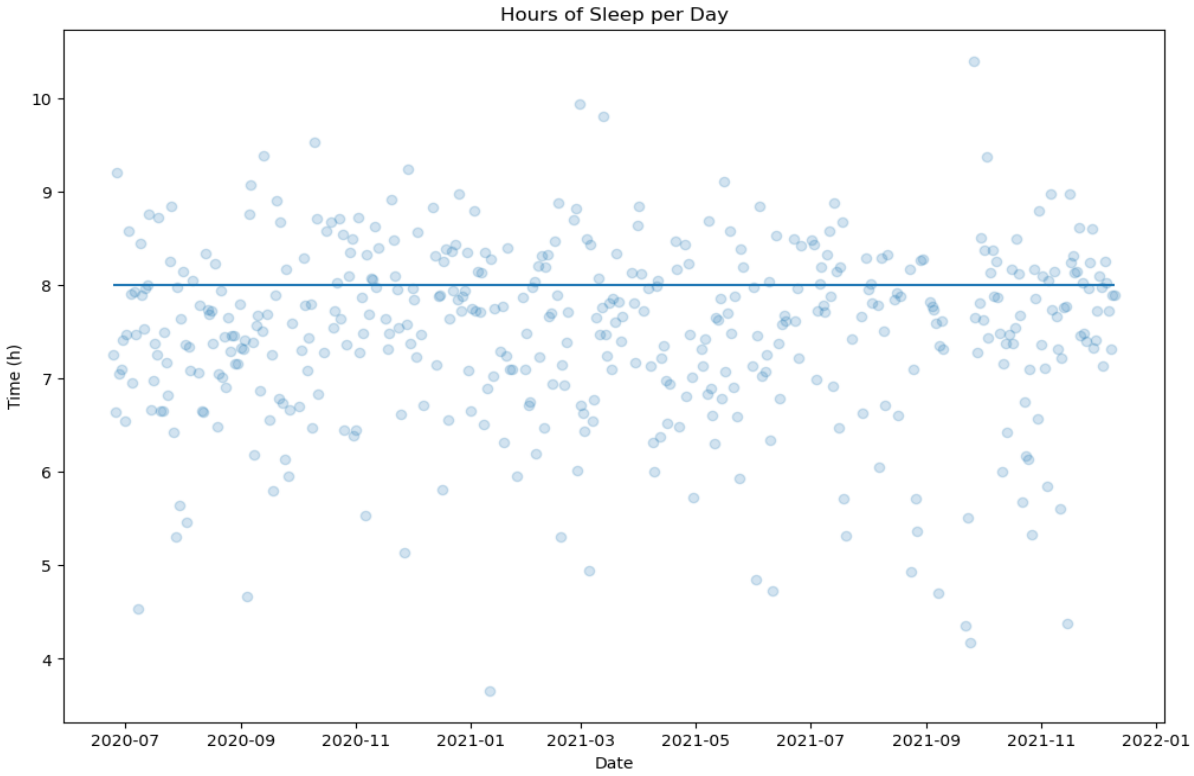
	date	awake	light	rem	deep	rmssd	bedtime	wake_time	total_sleep
0	2020-06-25	0.54	4.08	0.87	2.31	56.0	23.1	6.9	7.26
1	2020-06-26	0.46	3.55	1.25	1.84	54.0	0.0	7.1	6.64
2	2020-06-27	1.01	4.91	1.82	2.47	67.0	23.2	9.4	9.20
3	2020-06-28	0.57	3.36	1.54	2.15	57.0	23.4	7.1	7.05
4	2020-06-29	0.73	3.46	1.18	2.46	64.0	22.8	6.6	7.10

Strava Data (cleaned)

	date	max_hr	max_grade	max_speed	rpe	total_time	total_dist	hike	ride	run	swim	virtual_ride	virtual_run
0	2020-06-23	NaN	20.6	18.3	7.0	1.17	21.34	0	0	0	0	1	0
1	2020-06-24	NaN	6.5	15.8	NaN	0.75	23.31	0	0	0	0	1	0
2	2020-06-25	NaN	12.0	21.9	9.0	1.32	33.03	0	0	0	0	1	0
3	2020-06-27	NaN	15.8	20.4	9.0	2.55	47.85	0	0	0	0	2	0
4	2020-06-28	NaN	7.6	16.4	8.0	1.06	34.07	0	0	0	0	1	0

Sleep





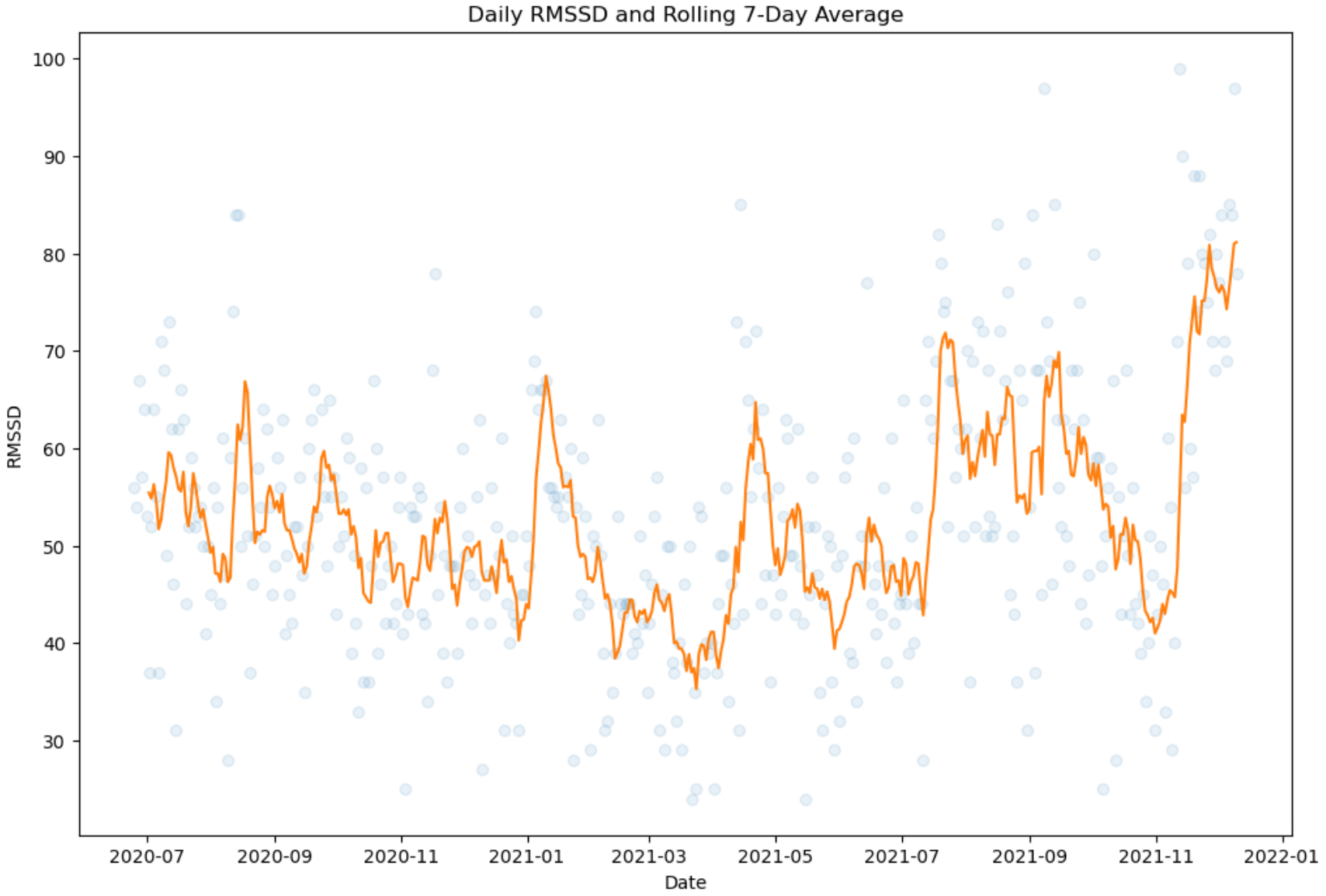
Wake time (mean ± sd)
7:10am ± 1h

Bedtime (mean ± sd)
10:58pm ± 1.4h

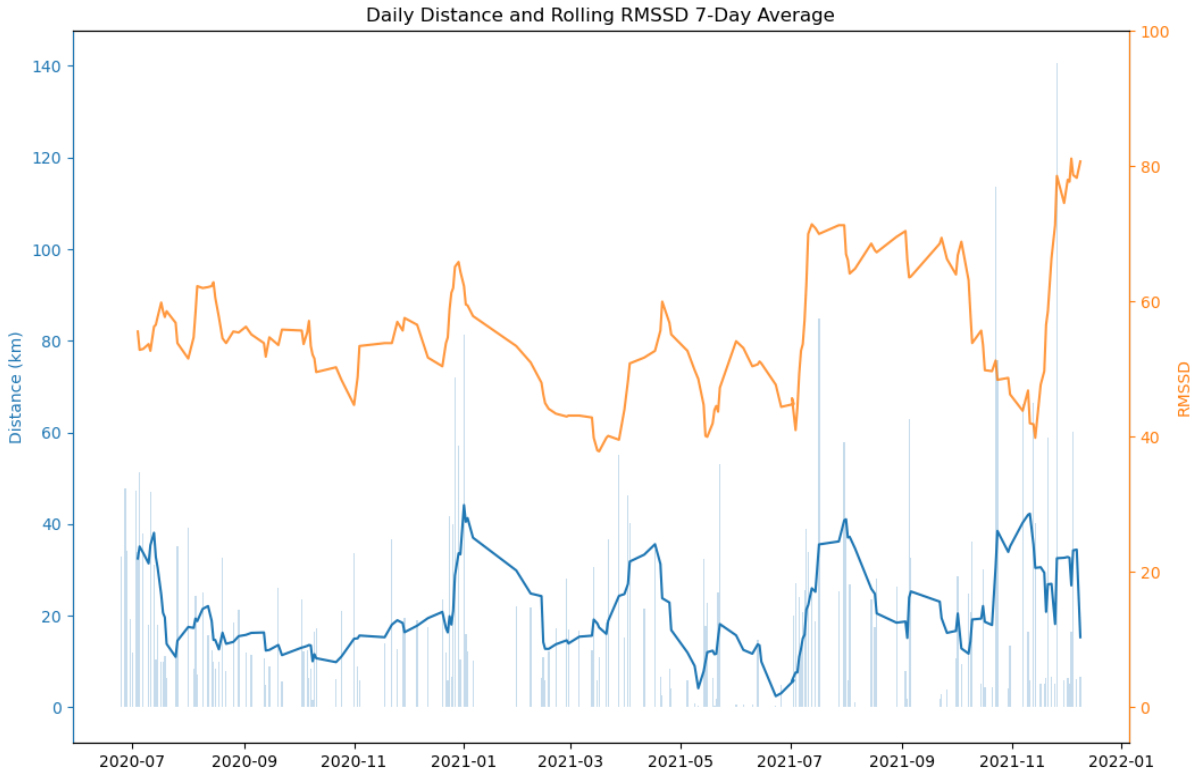
Sleep time (mean ± sd)
7.5h ± 0.95h

Less than 8 hours
70.3%

RMSSD

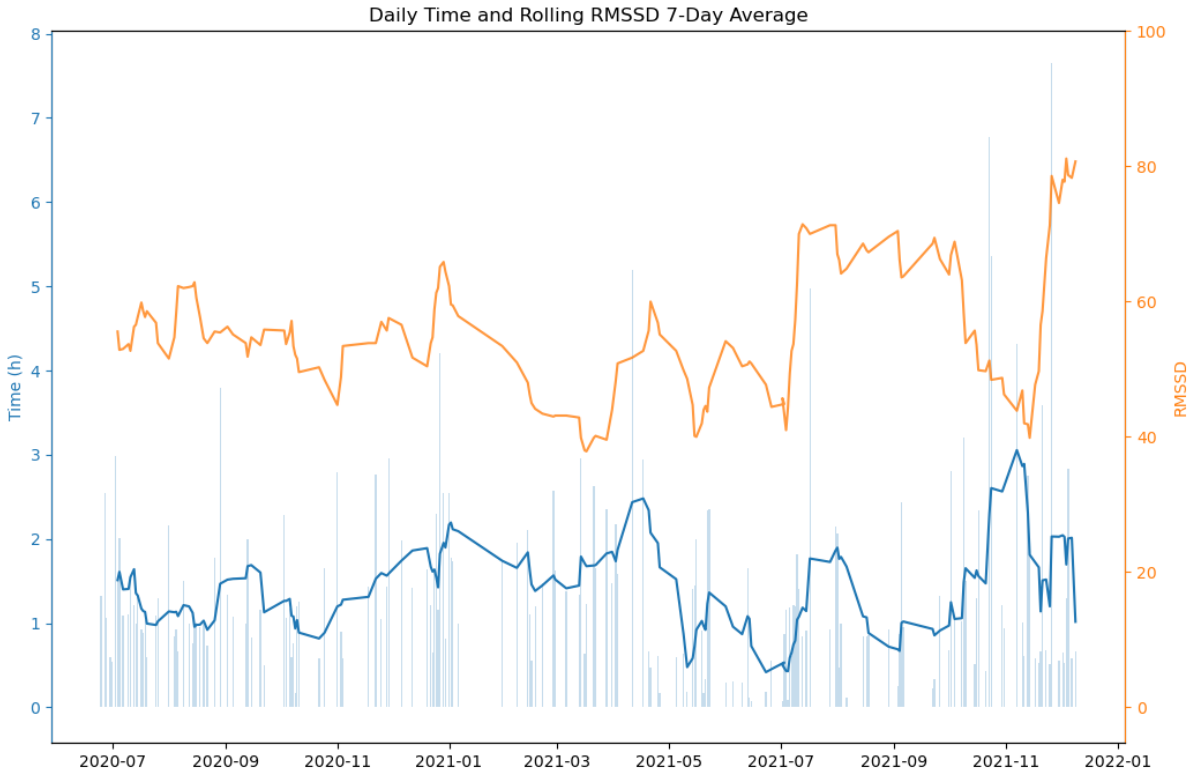

Daily RMSSD and Rolling 7-Day Average
RMSSD
100
90
80
70
60
50
40
30
2020-07
2020-09
2020-11
2021-01
2021-03
2021-05
2021-07
2021-09
2021-11
2022-01
Date

Distance and Time



Pearson correlation

$R^2 = 0.36$ P-value = 0.00001



Pearson correlation

$R^2 = 0.02$ P-value = 0.8046

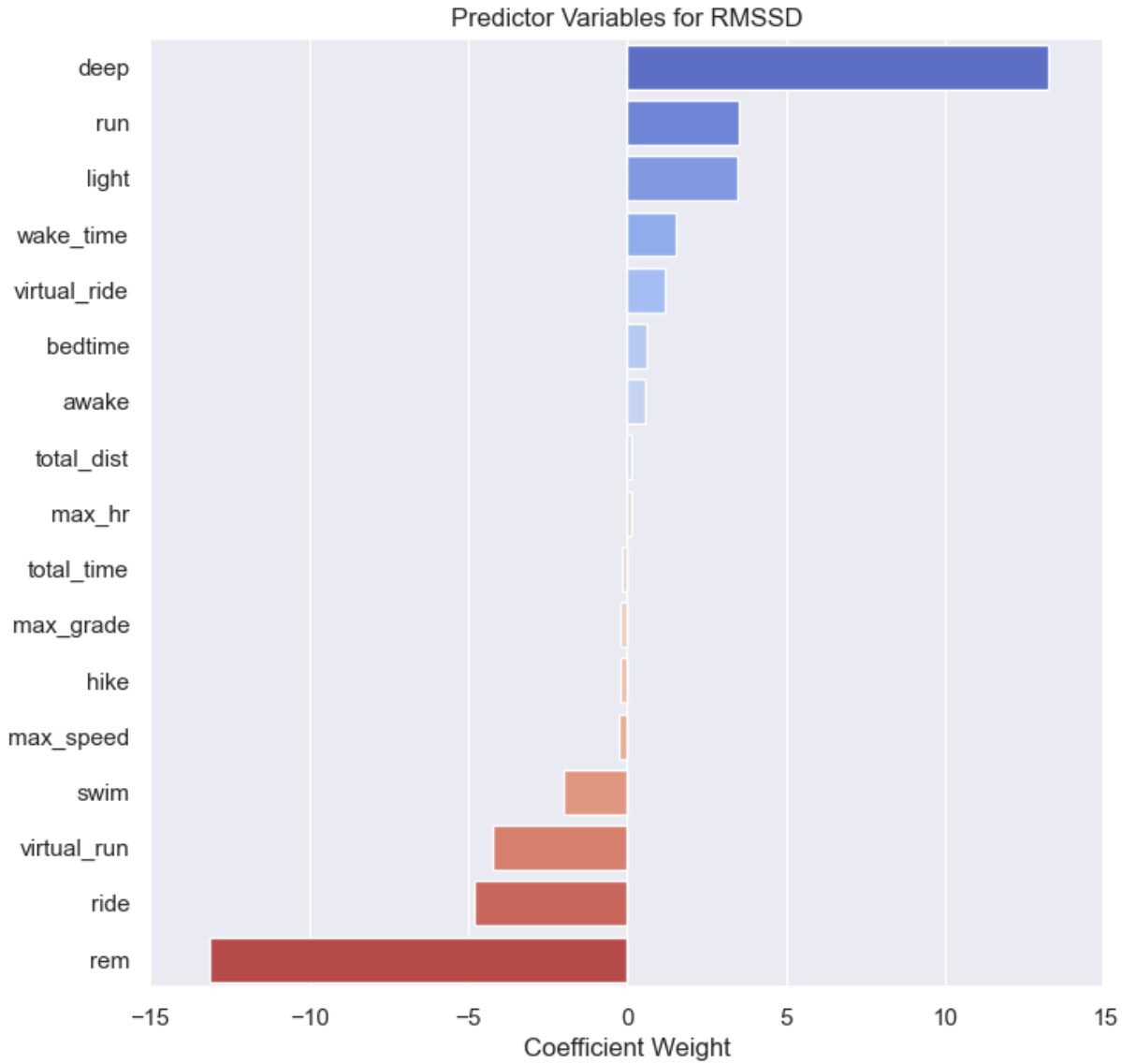
Modeling

3 linear models

- OLS, LASSO, and Ridge regression
- Similar RMSE
- OLS had highest R^2

OLS

- RMSE = 12.7
- R^2 = 0.54



Discussion

Sleep

- SD of bed and wake times > 1hr
- Less than 8 hours of sleep 70% of monitored days

RMSSD

- General decline first 8 months of monitoring
- General increase last 8 months of monitoring
- Strong correlation with total daily distance
- Almost no correlation with total daily training time

Positive influences on RMSSD

- Light and deep sleep
- Runs and virtual rides
- Later wake time

Negative influences on RMSSD

- REM sleep
- Rides, virtual runs, and swims

Conclusion

Increases in total distance showed positive adaptations to training

Prioritize runs and virtual rides

- Use rides and virtual runs sparingly

Incentivize more consistent bed and wake times

- Investigate relationship with REM sleep

Incentivize input of RPE

- Missing from ~40% of entries

https://www.trainingpeaks.com/coach-blog/how-to-coach-the-overly-busy-athlete/