[FUN]ctionality of Studying Temperature and Altitude in Assessing Athlete Fatigue and Performance

Team [FUN]ction
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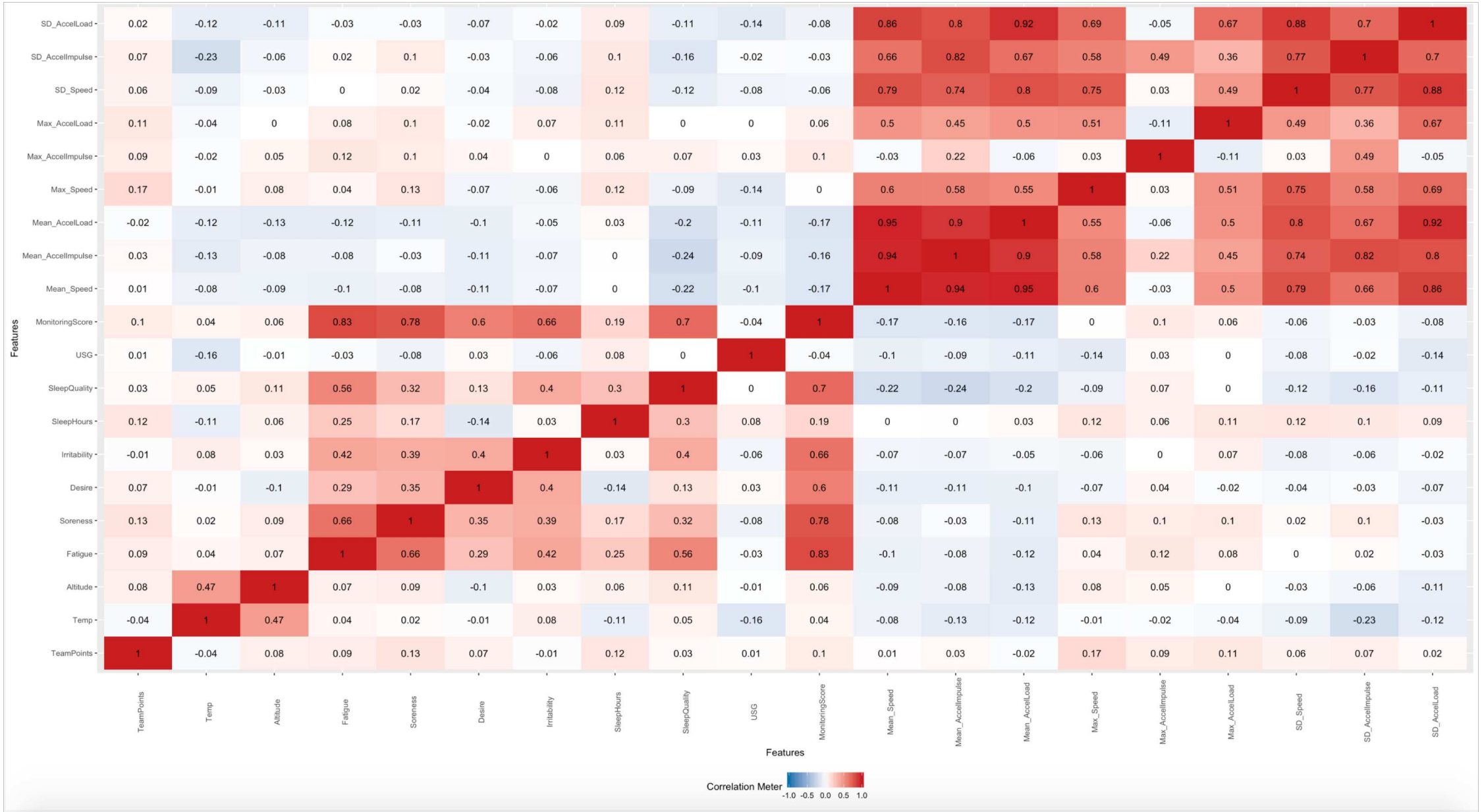
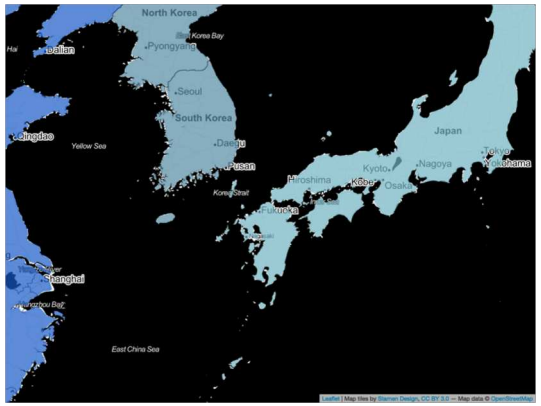
Our approach

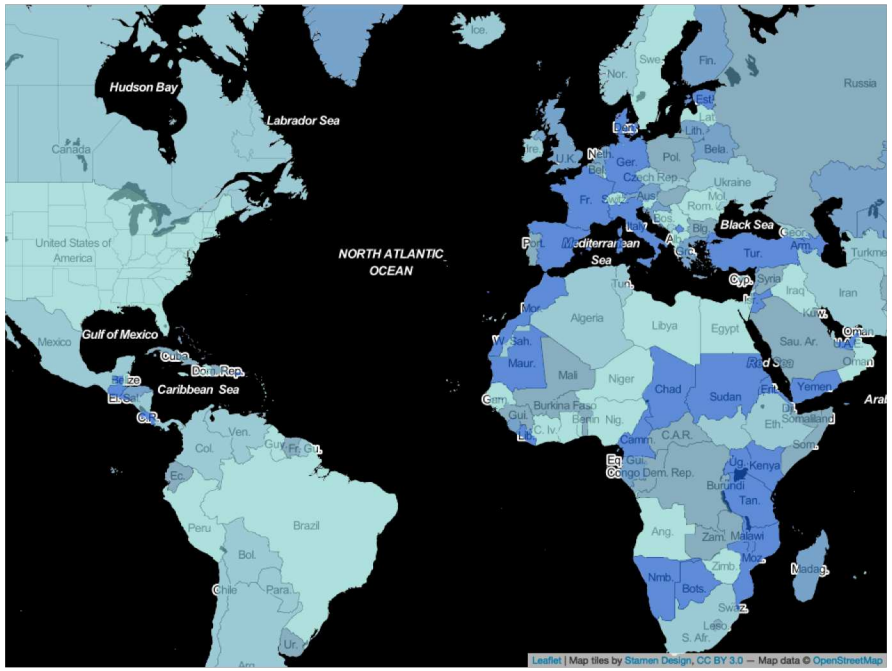
- Datafest Sources uses: Wellness, GPS, and Games Date datasets
- **Research question: Rugby7S travels very frequently games – How does it affect their acclimatization to the competition venue?**
- External data:
  - https://www.wunderground.com/ Weather archive and source of temperature information
  - https://rugby.ca/en/events/international Rugby Canada official schedule and source of game times
  - https://www.latlong.net/ geographic info website for different cities and source of elevation information

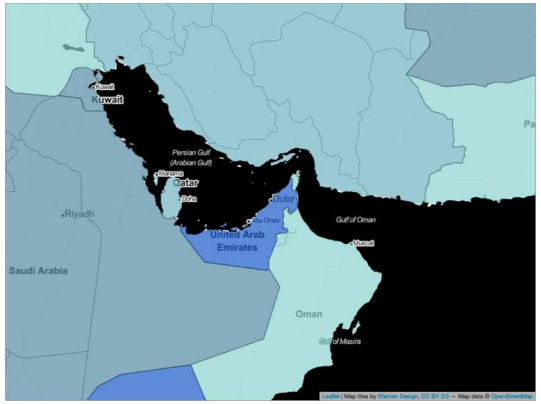
Exploratory Data Analysis

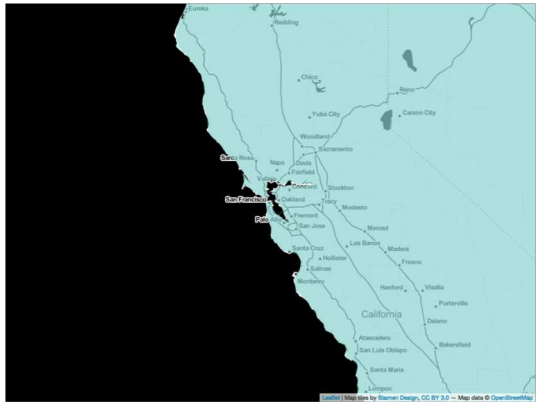


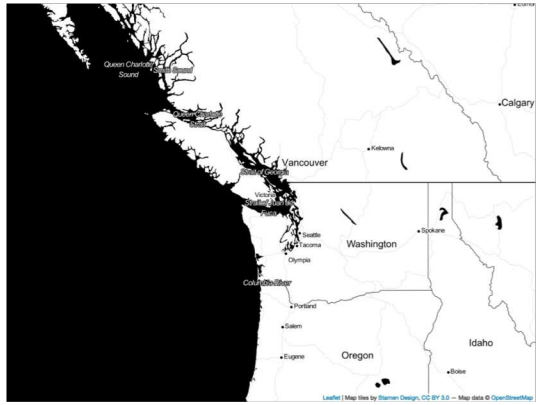
Locations where Rugby7S travelled for tournaments

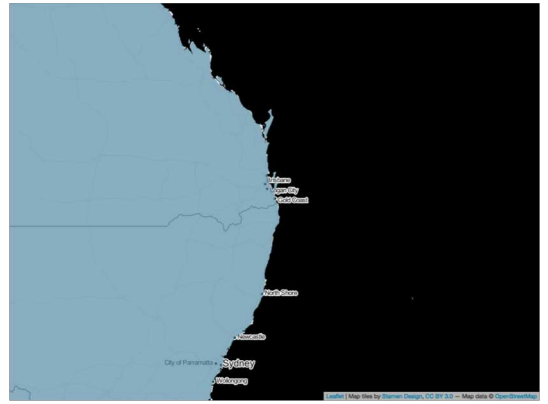




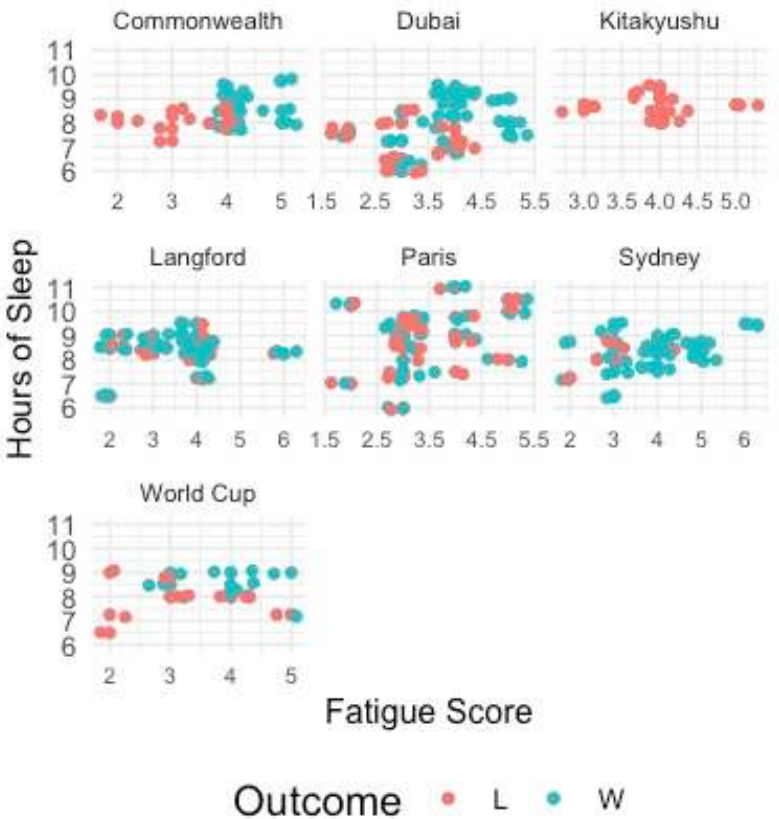


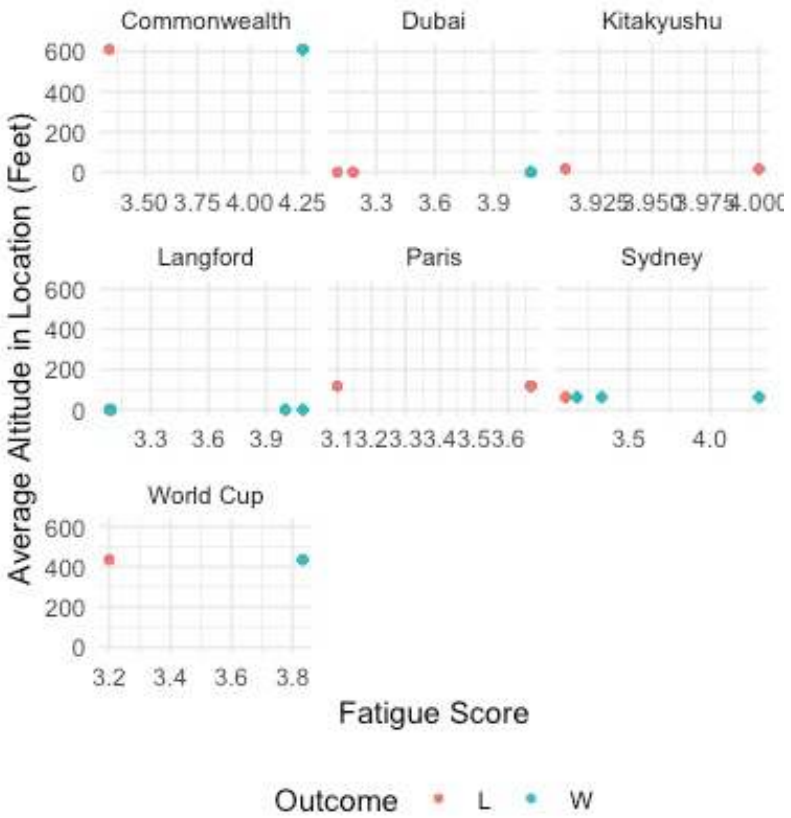


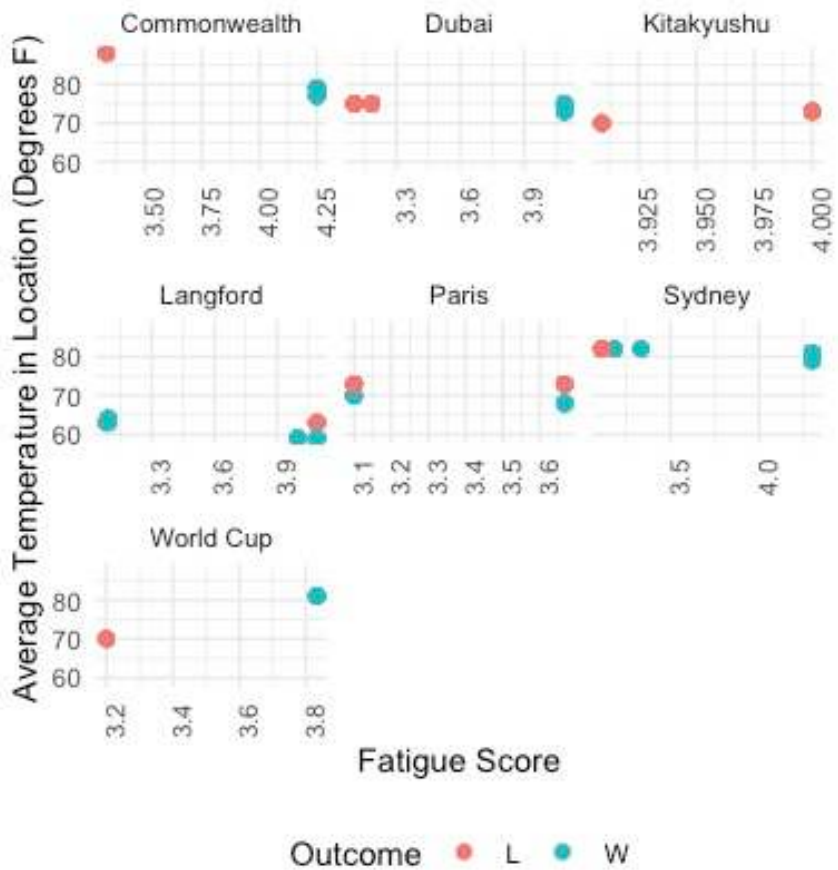




Our findings







Rethinking Performance Measures:
Performance Index

Shukry Zablah, Shu Amano, Vignesh Mahalingam, Peter Cho, Andrea Boskovic

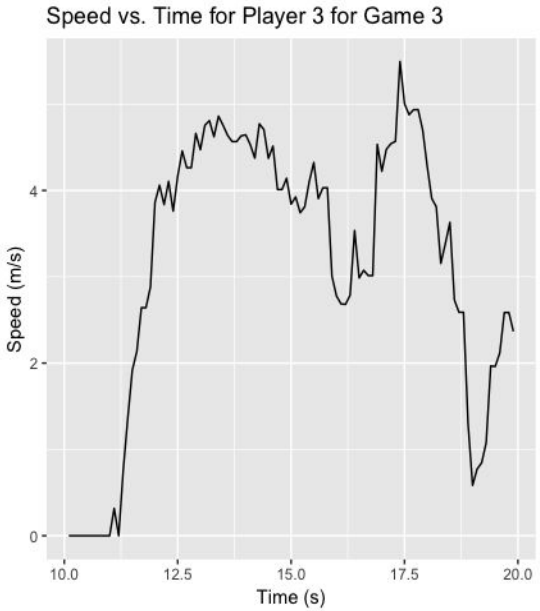
Game Play History

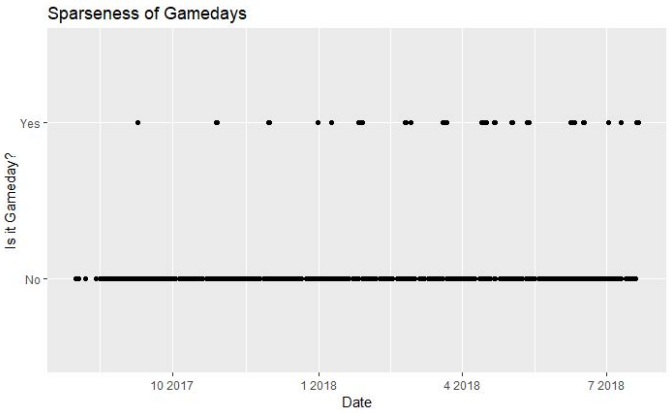
Nesting →

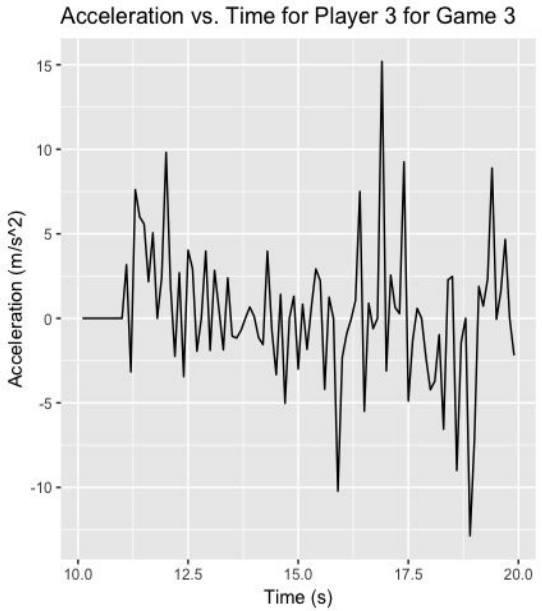
```
# A tibble: 17 x 2
   PlayerID player_specific_data
      <int> <list>
 1        1 <tibble [576 x 13]>
 2        2 <tibble [575 x 13]>
 3        3 <tibble [607 x 13]>
 4        4 <tibble [408 x 13]>
 5        5 <tibble [289 x 13]>
 6        6 <tibble [496 x 13]>
 7        7 <tibble [620 x 13]>
 8        8 <tibble [518 x 13]>
 9        9 <tibble [414 x 13]>
10       10 <tibble [544 x 13]>
11       11 <tibble [740 x 13]>
12       12 <tibble [372 x 13]>
13       13 <tibble [809 x 13]>
14       14 <tibble [415 x 13]>
15       15 <tibble [306 x 13]>
16       16 <tibble [768 x 13]>
17       17 <tibble [403 x 13]>
```

```
[[13]]
# A tibble: 17 x 9
   Date       distance max_speed  load mean_speed game_time time_running time_walking num_games
   <date>        <dbl>     <dbl> <dbl>      <dbl>     <dbl>        <dbl>        <dbl>     <int>
 1 2017-11-30    3466.      7.99  571.       1.06      3266.        583.         644.         3
 2 2017-12-01    2489.      7.91  427.       1.04      2386.        383.         582.         3
 3 2018-01-26    2643.      7.61  451.      0.856      3088.        409.         611.         3
 4 2018-01-27    2191.      7.54  363.       1.06      2071.        302.         622.         2
 5 2018-01-28     531.      6.31   98.5      0.487     1091         80.7        184.         1
 6 2018-04-13    2183.      7.10  374.       0.924     2362.        331.         510.         2
 7 2018-04-14     912.      7.74  155.       0.867     1052.        146.         247.         1
 8 2018-04-15    1305.      7.43  224.       0.617     2115.        184.         415.         2
 9 2018-04-21    2424.      7.70  413.       0.790     3068.        373.         617.         3
10 2018-04-22    2543.      7.54  411.       1.31      1936.        390          582.         2
11 2018-05-12    2702.      7.54  459.       0.894     3021.        441.         638.         3
12 2018-05-13    3796.      7.54  623.       1.27      2994.        593          867.         3
13 2018-06-08    2864.      7.88  459.       0.942     3039.        428.         702.         3
14 2018-06-09    2175.      6.81  465.       1.02      2139.        333.         569.         2
15 2018-06-10     881.      7.10  170.       0.917      961.        136          225.         1
16 2018-07-20    1592.      7.15  269.       0.761     2091.        241.         430.         2
17 2018-07-21    2133.      7.09  358.       1.03      2078.        330.         468.         2
```

Issues with GPS Data in Gauging Fatigue







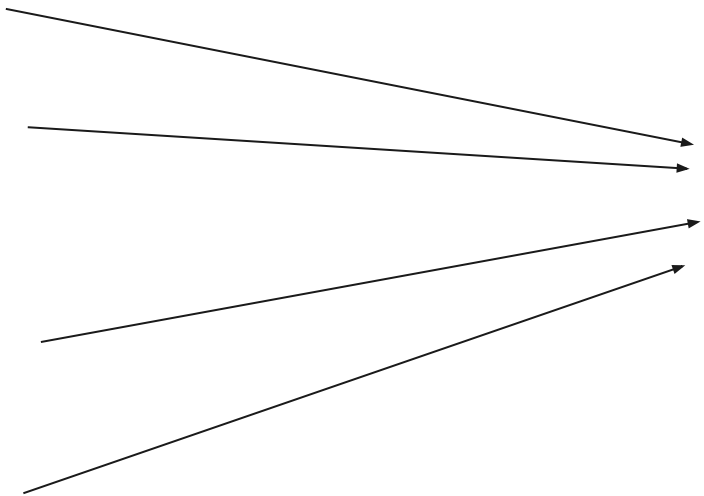
Comprehensive = Objective + Subjective

Hours of Sleep

Soreness

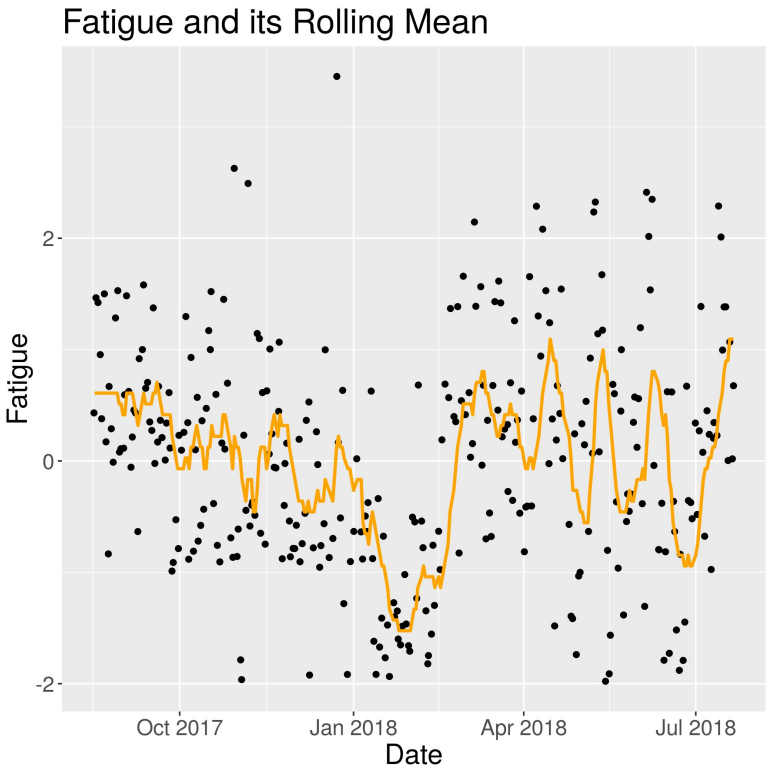
Duration of Training Session

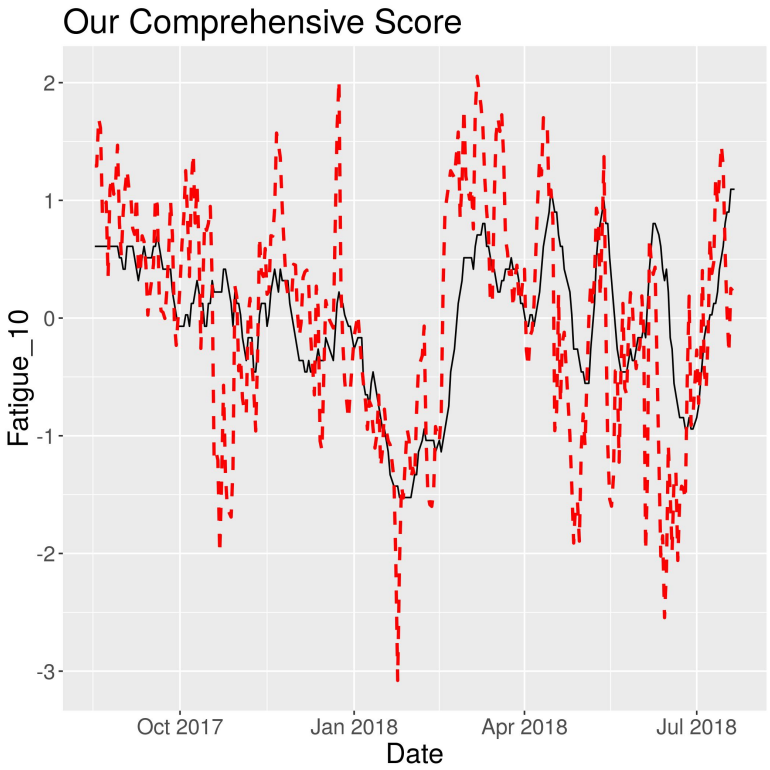
Fatigue



One comprehensive score that is a combination of the variables in the RPE and wellness datasets

Future Directions



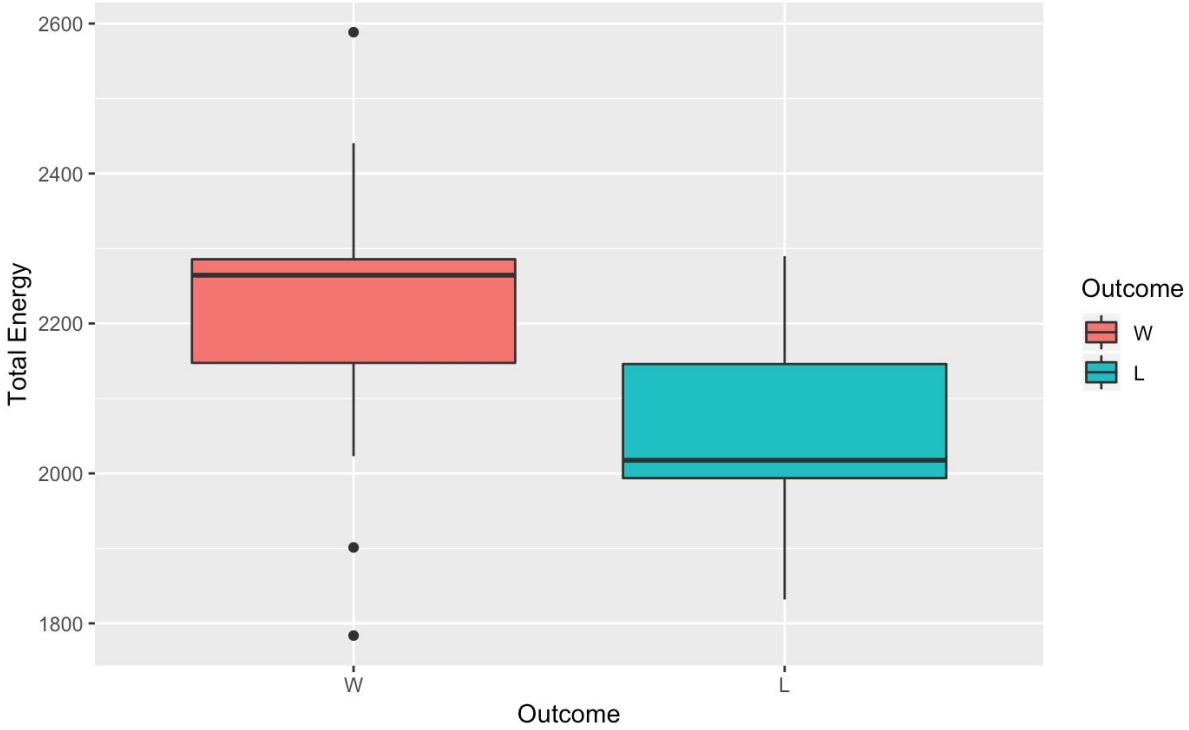


Examine Fatigue During a Game

How game results affect fatigue, How self-reports of fatigue are related

Beta Theta Data

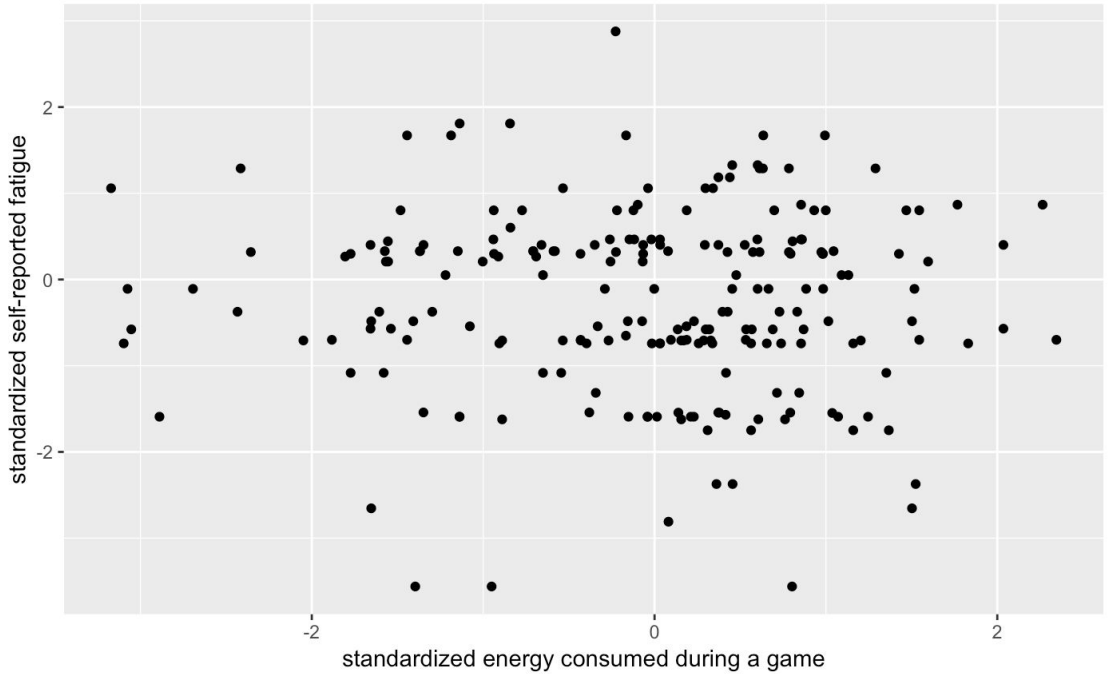
The team consume more energy in games won



Energy consumed as a proxy for fatigue. Calculated by multiplying average acceleration load and time

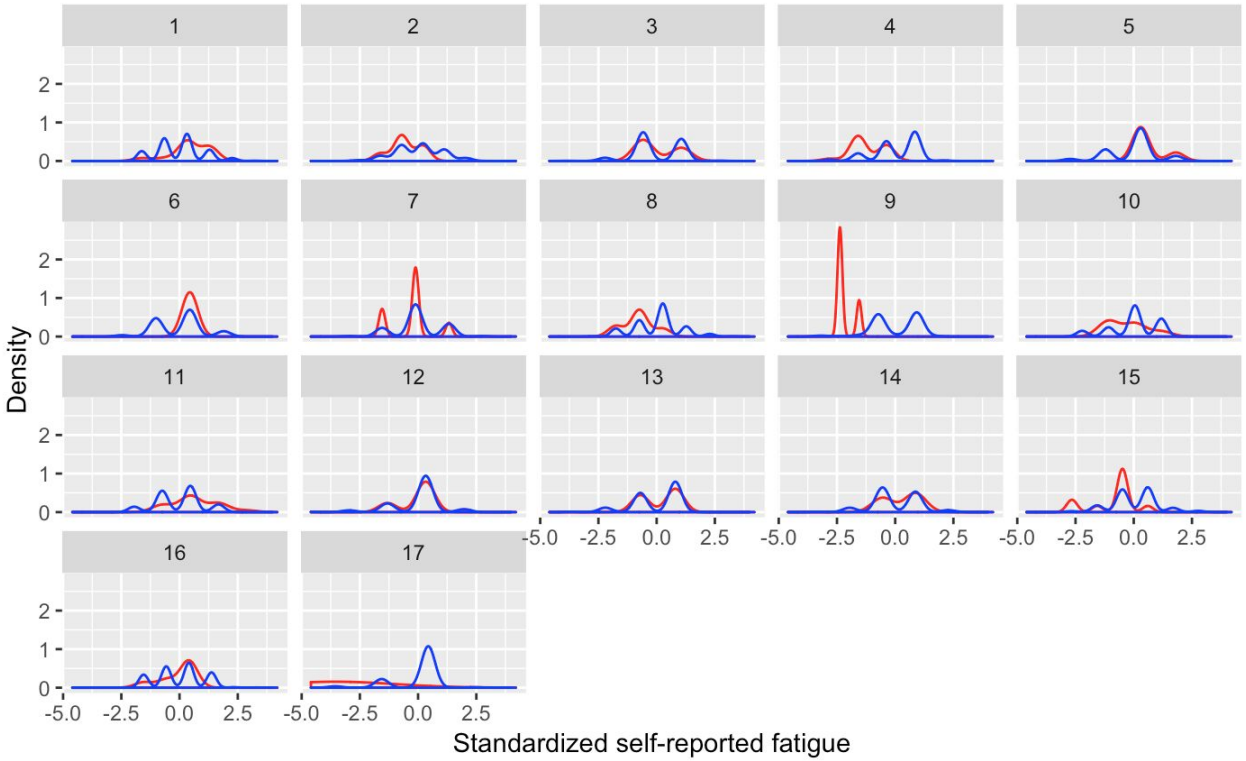
p-value from a two-sample test: 0.0111
Difference is significant at 5% level

Compare self-reported fatigue and energy consumed



No obvious relationship from scatterplot.

Comparison of fatigue by player



Density distribution of standardized self-reported fatigue.

Red: Next morning after a game

Blue: All other days

Conclusion

- Outcome of the game matters when examining fatigue during a game.
- Self-reported fatigue level is subjective, and thus difficult to determine its effect on performance.
- To more effectively control for fatigue and maximize performance, we can analyze individual players and compare self-reported fatigue levels on game-day to other days and adjust accordingly.
- Caution against the data not being reflective of players' actual condition due to habitual responses rather than post-examination.

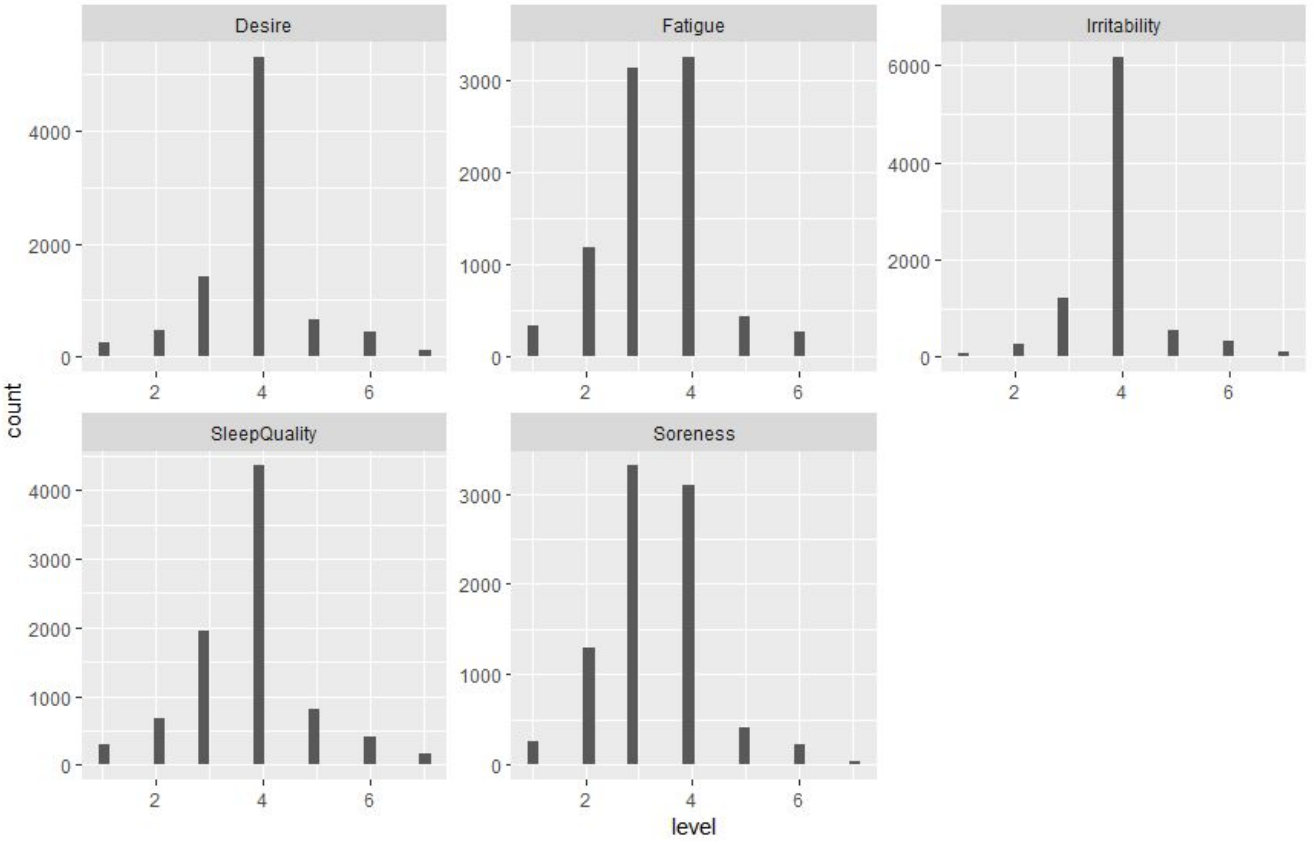
DataFest

How does player's subjective report reflect her performance on games and trainings?

Team Name: FirstFitData
Yudong Chai
Peiheng Lyu
Yexin Tian
Haoyuan Ren
Guanghao Wei

Mar 31, 2019

Frequency for personal evaluation of each category



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R^2

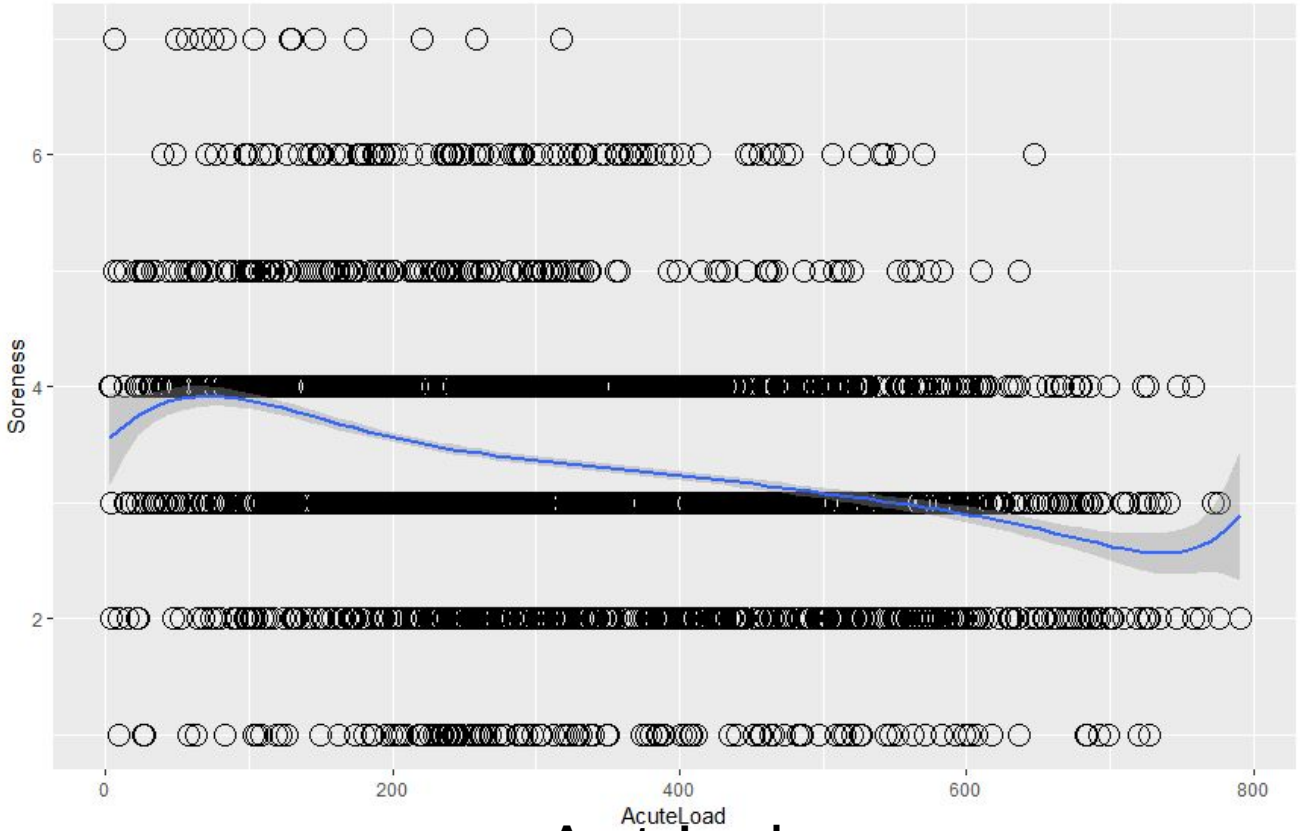
Desire: *0.013*

Fatigue: *0.02*

Irritability: *0.0073*

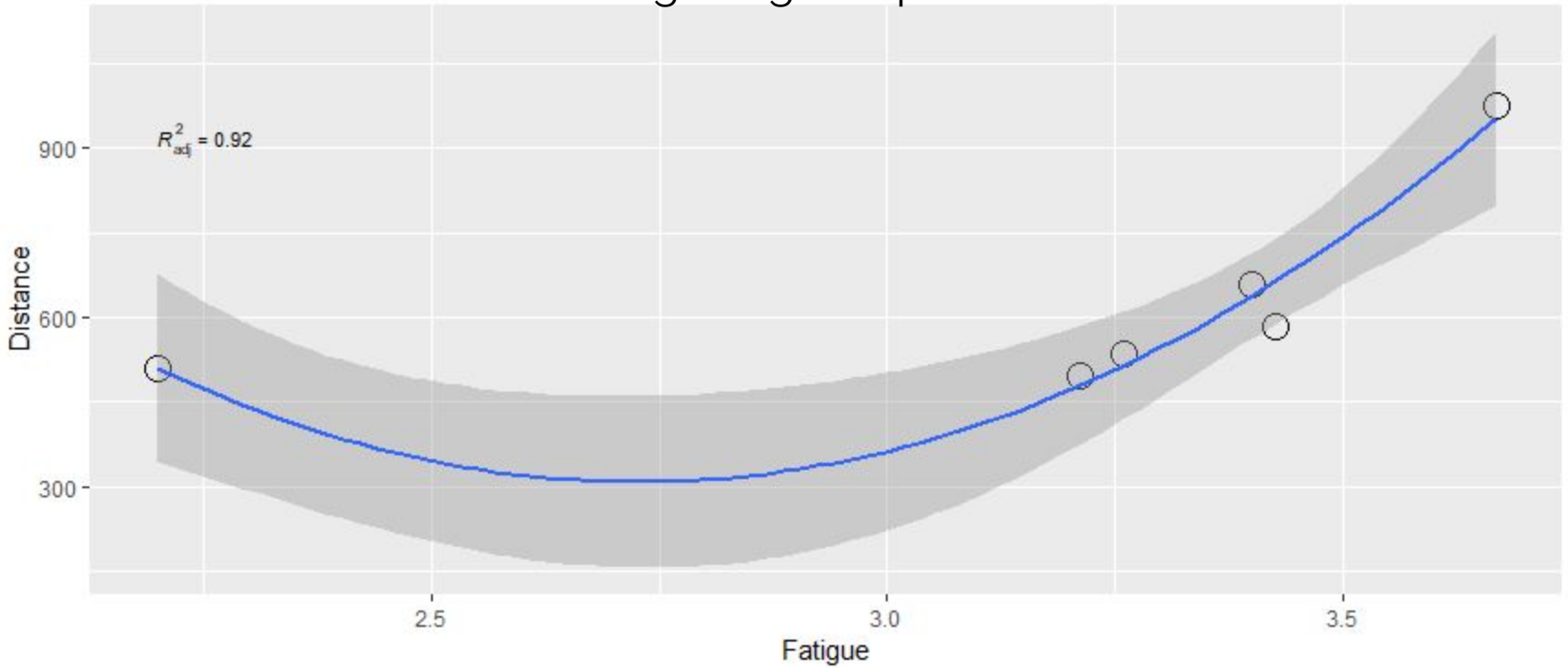
Sleep Quality: *0.000048*

Soreness: *0.078*



AcuteLoad

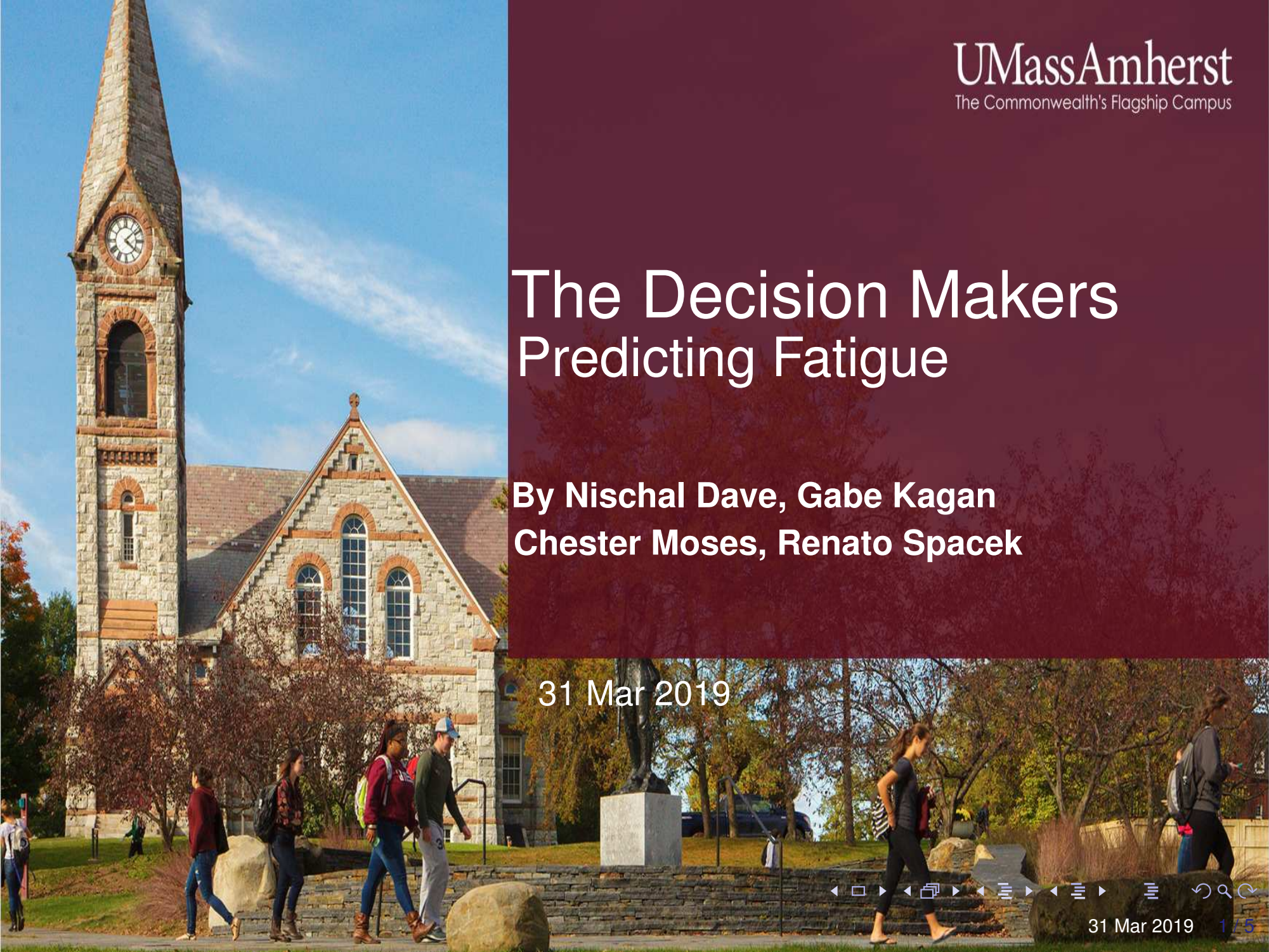
Player 13's Fatigue and Game Performance(mean of Running distance during the game period) relation



Conclusion:

- The questionnaire is lack of objectivity.
  - Most of the data are collected from self-reports. And sometimes athletes cannot give precise and objective evaluation for themselves.
  - We found that people tend to choose the average score rather than pick the number that suits them best.
  - We need to use more scientific approaches to measure these categories, such as USG.

- Fatigue affects athletes' performance.
  - If athletes give a lower score on this evaluation (they feel some pain), they may not have the best performance during the game.



UMassAmherst
The Commonwealth's Flagship Campus

The Decision Makers
Predicting Fatigue

By Nischal Dave, Gabe Kagan
Chester Moses, Renato Spacek

31 Mar 2019

Dataset

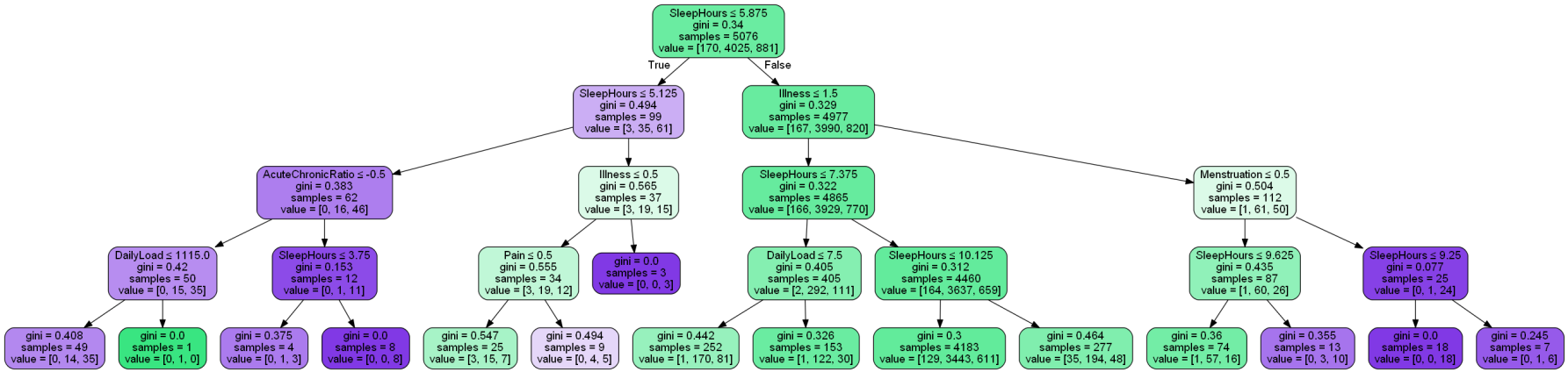
SleepHours	Pain	Illness	Menstruation	USG	DailyLoad	AcuteChronicRatio	Fatigue
8.00	1	1	1	1.015	0.0	-1.0	0
9.00	0	0	0	1.015	705.0	1.0	0
9.00	0	0	0	1.015	0.0	-1.0	0
8.50	0	0	0	1.015	0.0	-1.0	0
8.25	0	0	0	1.015	315.0	-1.0	-1

Merge(Wellness, RPE) on (Date, PlayerID)

Fatigue $\rightarrow$7:-1, 6:-1, 5:0, 4:0, 3:0, 2:1, 1:1

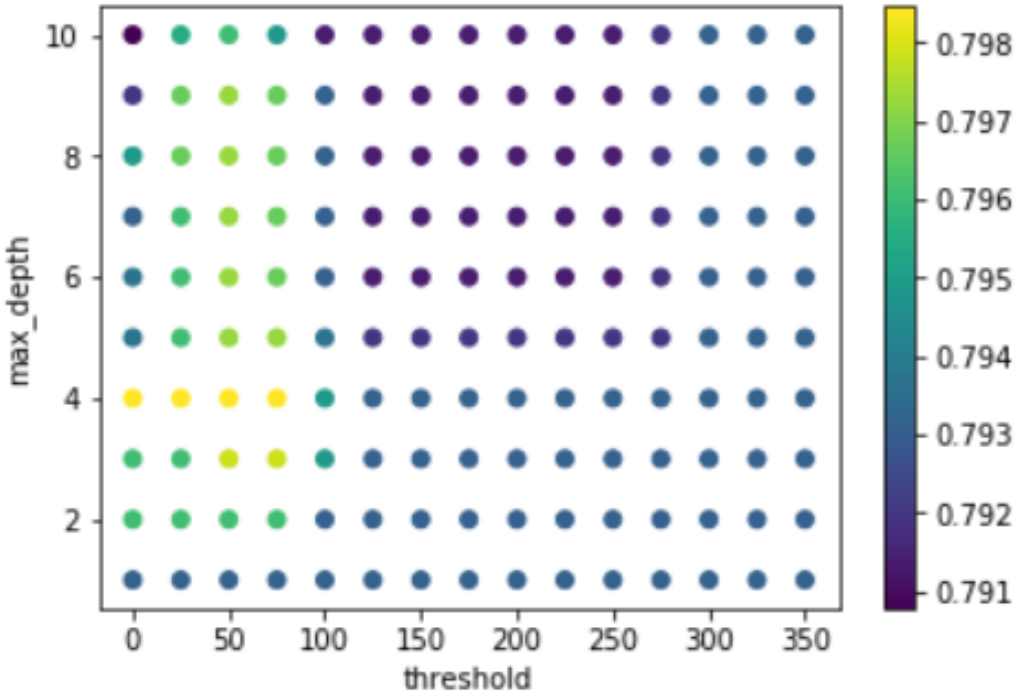
-1:‘Fit’, 0:‘Average’, 1:‘Exhausted’

Decision Tree



Analysis

Split Ratio: Train : Val : Test = 0.60 : 0.20 : 0.20



Validation accuracy

Best accuracy when threshold = 0 and max_depth = 4

Accuracy Score = 0.80 (approx.)

Predictor Variables

1. SleepHours
2. Illness
3. AcuteChronicRatio
4. DailyLoad
5. Menstruation

How To Measure Fatigue

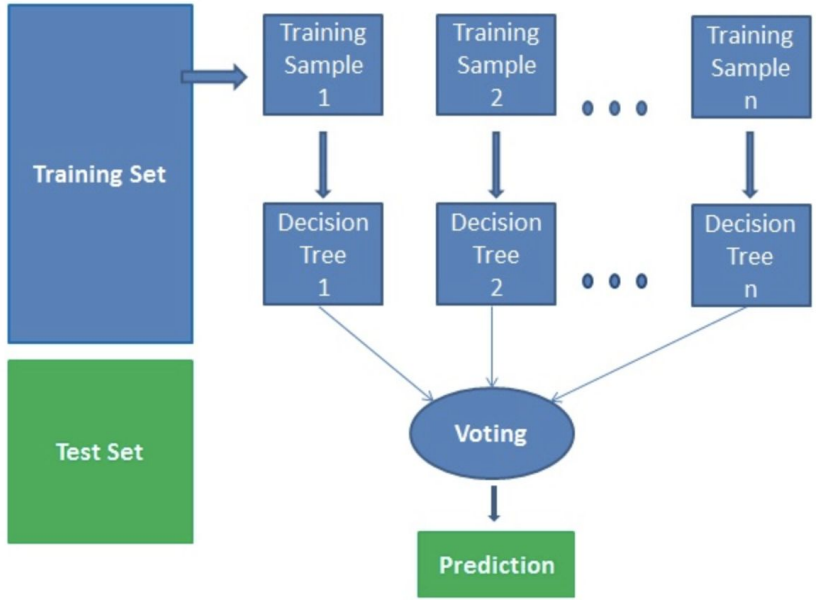
What factors contribute to fatigue more using random forest

Yuanguo Lang, Kaiwen Lu, Yongyi Peng, Yingyuan Qi, Tianyi Zhou

Big Picture

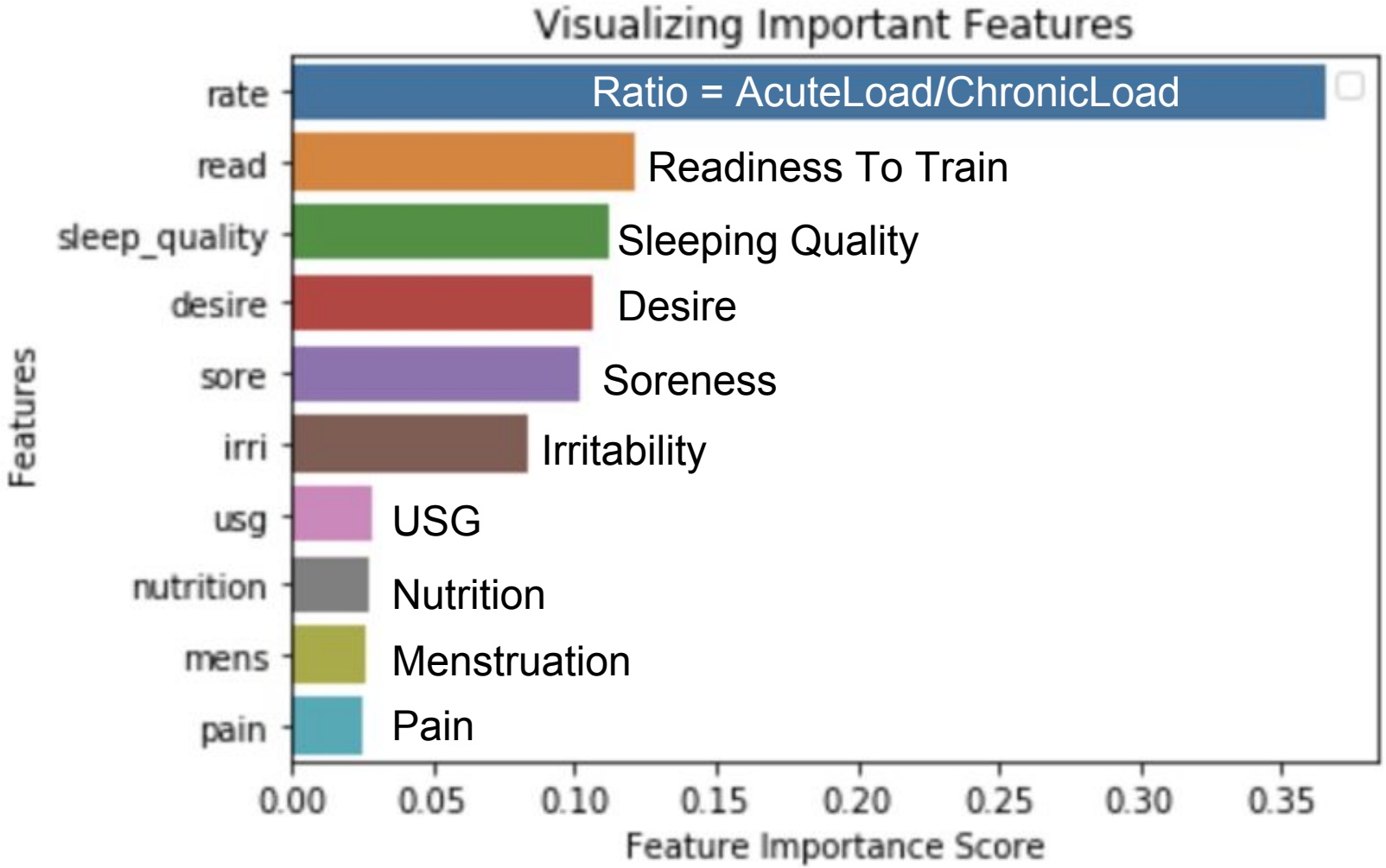
Finding important features in Sklearn

- First, we created a random forests model.
- Second, we used the feature importance variable to see feature importance scores.
- Third, we visualize these scores using the seaborn library and matplotlib.



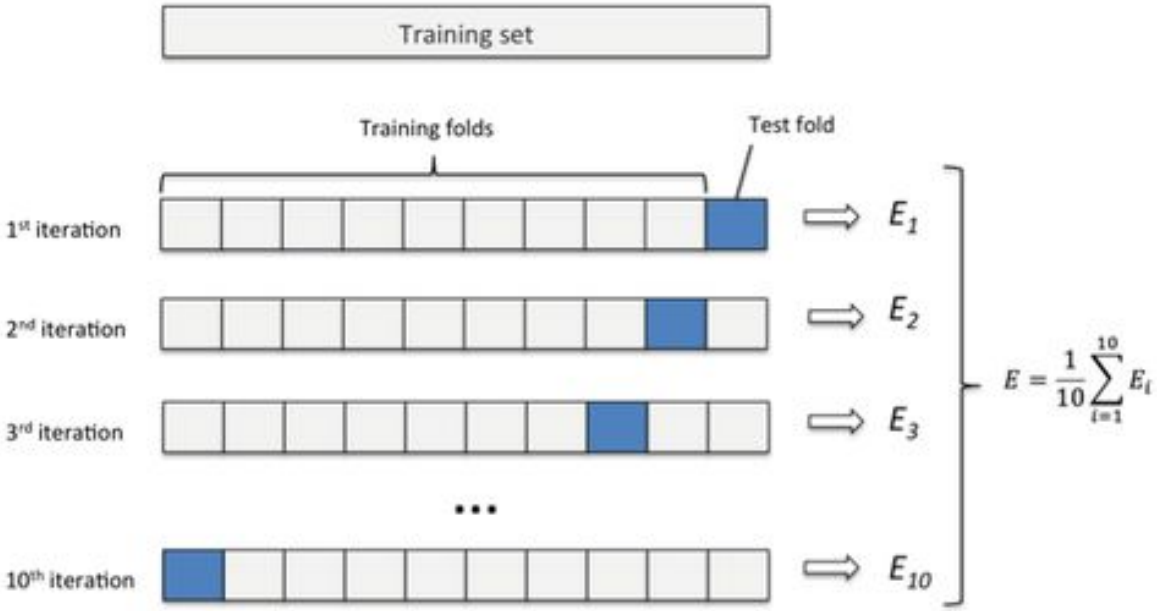
Generate a New Model on important features

- We remove the less important features and generate a new model


Visualizing Important Features
rate
read
sleep_quality
desire
sore
irri
usg
nutrition
mens
pain
Features
Ratio = AcuteLoad/ChronicLoad
Readiness To Train
Sleeping Quality
Desire
Soreness
Irritability
USG
Nutrition
Menstruation
Pain
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
Feature Importance Score

We use 10 folds cross validation to prevent overfitting.

We use selected features to train random forest model again.



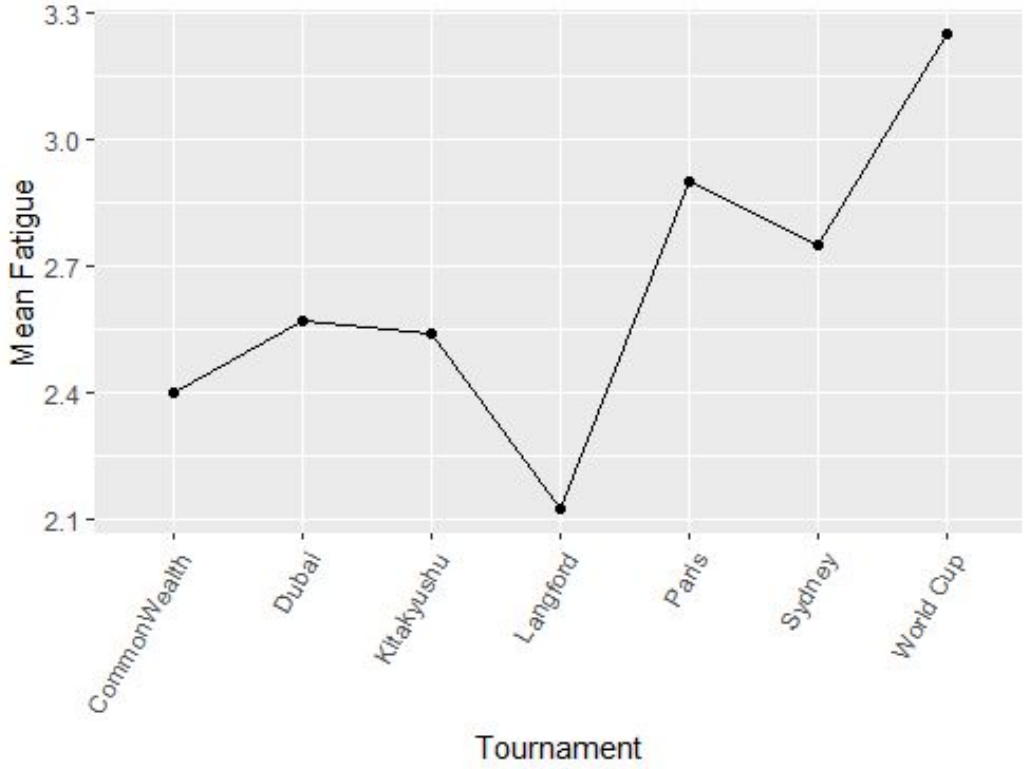

```
0
Train Accuracy: 0.9983108108108109
1
Train Accuracy: 0.9979729729729729
2
Train Accuracy: 0.9979729729729729
3
Train Accuracy: 0.9986486486486487
4
Train Accuracy: 0.9983108108108109
5
Train Accuracy: 0.9983108108108109
6
Train Accuracy: 0.9976351351351351
7
Train Accuracy: 0.9983108108108109
8
Train Accuracy: 0.9986486486486487
9
Train Accuracy: 0.9979729729729729
```

Suggestions

When coaches build the new equation to test the fatigue of athlete, they can consider the significant factors we choose (Rate (AcuteLoad/ChronicLoad), Readiness To Train, Sleeping Quality, Desire, Soreness, and Irritability). These factors have a crucial effect on the fatigue level of athletes. By considering these factors, the coach can adjust the training plan of each athlete and help them to reach their ideal condition.

Impact of Sleep and Tournament Outcome on Self-Reported Fatigue

Fatigue against Dates



Quality of Sleep vs Tournament Outcome

Higher SleepQuality avg occurs in tournaments where the team won: Dubai, Sydney:

```
> mean(dubai_sleep$SleepQuality)
[1] 3.5
> mean(syd_sleep$SleepQuality)
[1] 3.361702
```

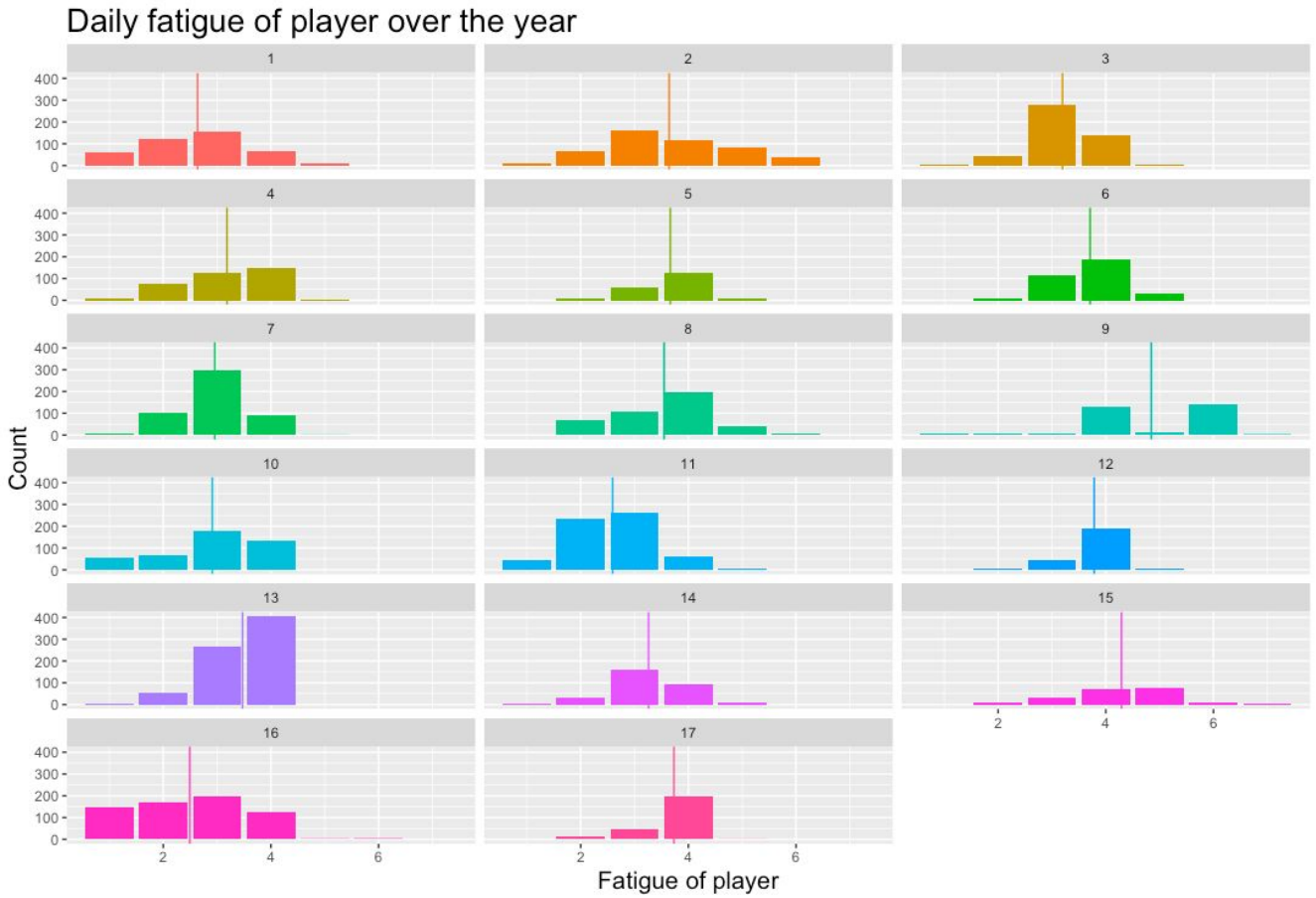
Lower averages of sleep quality predicted a tournament loss in Kitakyushu

```
> mean(kika_sleep$SleepQuality)
[1] 3.25
```

Controlling Athlete Fatigue

A tool for coaches to minimize athlete fatigue

How 17 unique people report fatigue:



Different factors influence people differently!

Player 8

(Intercept)	sleep_hours	sleep_next_day	session_load	acute_chronic_ratio	daily_load	duration
2.5845719855	-0.0517110610	0.1927143972	0.0005226021	0.3187021023	-0.0005272181	-0.0014288178

Player 9

(Intercept)	sleep_hours	sleep_next_day	session_load	acute_chronic_ratio	daily_load	duration
4.0893964237	-0.1613109317	0.2098989809	0.0004430812	0.4410132402	-0.0005215351	0.0021404360

Player 10

(Intercept)	sleep_hours	sleep_next_day	session_load	acute_chronic_ratio	daily_load	duration
1.3340425179	0.0151931528	0.2111334790	-0.0009668132	-0.0190813633	-0.0004930303	0.0052128420

Player 11

(Intercept)	sleep_hours	sleep_next_day	session_load	acute_chronic_ratio	daily_load	duration
2.3019237644	-0.0317543855	0.1138962433	0.0009250829	0.0921586701	-0.0006750606	-0.0026721846

Fatigue management

Sleep hours last night

4 6 10

4 5 6 7 8 9 10

Sleep hours tonight

4 6 10

4 5 6 7 8 9 10

Rate of perceived effort

0 6 10

0 1 2 3 4 5 6 7 8 9 10

Duration of session (minutes)

50

Daily load

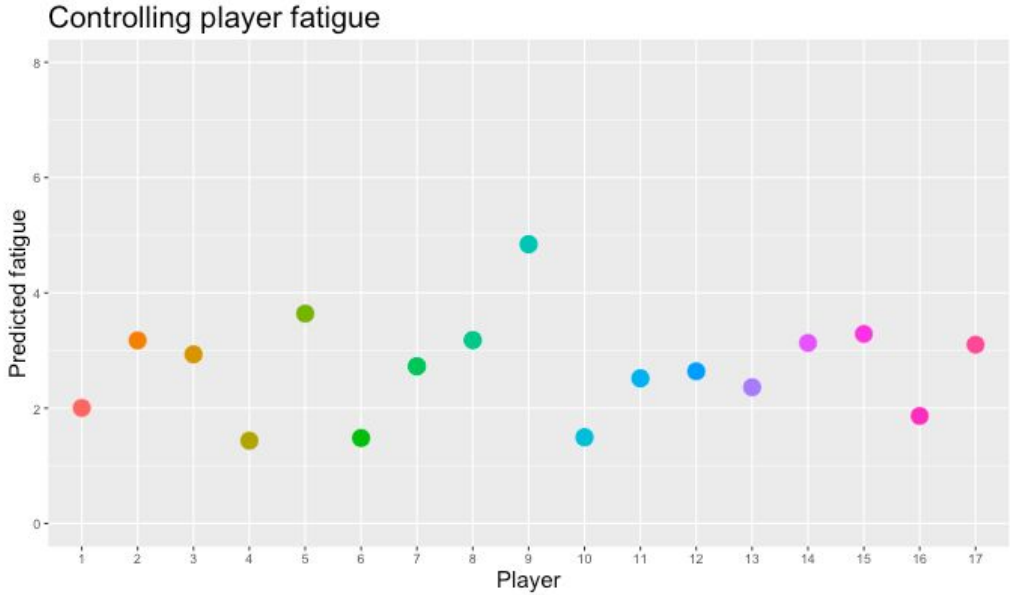
600

Average daily load over past week

400

Average daily load over past month

400



https://youtu.be/PzurTjGkxME