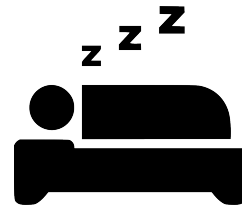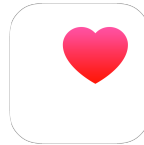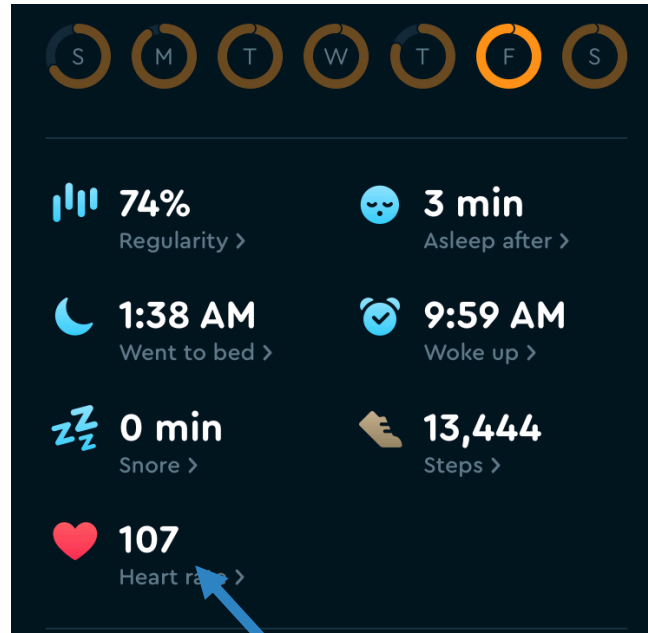# Analyzing Personal Health Data

Robert Swanson

The Question:

What factors influence sleeping heart rate?

Available Data
(Collected from my iPhone and Apple Watch)

- Sleep Analysis (minutes in bed, asleep)
- Heart Rate
- Active Calories
- Resting Calories
- Cycling Distance
- Distance
- Steps
- Flights of Stairs Climbed

Step 1: Clean Up and Manipulate

Used readr, dplyr, lubridate, matrixStats libraries

Raw Data

	Start	Finish	Heart Rate (count/min)
1	30–Nov–2018 13:13	30–Nov–2018 13:13	68.00000
2	30–Nov–2018 13:19	30–Nov–2018 13:19	75.00000
3	30–Nov–2018 13:23	30–Nov–2018 13:23	61.62732
4	30–Nov–2018 13:25	30–Nov–2018 13:25	86.00000
5	30–Nov–2018 13:29	30–Nov–2018 13:29	80.00000
6	30–Nov–2018 13:30	30–Nov–2018 13:30	78.00000
7	30–Nov–2018 13:34	30–Nov–2018 13:34	66.00000
8	30–Nov–2018 13:34	30–Nov–2018 13:34	67.00000
9	30–Nov–2018 13:34	30–Nov–2018 13:34	67.00000
10	30–Nov–2018 13:34	30–Nov–2018 13:34	68.00000

Joined to full minute table

Averaged

Grouped by datetime

	end	bpm
1	2018–11–30 13:13:00	68.00000
2	2018–11–30 13:14:00	68.00000
3	2018–11–30 13:15:00	68.00000
4	2018–11–30 13:16:00	68.00000
5	2018–11–30 13:17:00	68.00000
6	2018–11–30 13:18:00	68.00000
7	2018–11–30 13:19:00	75.00000
8	2018–11–30 13:20:00	75.00000
9	2018–11–30 13:21:00	75.00000
10	2018–11–30 13:22:00	75.00000

*Any Data Points fulfilling over 10 minutes are invalidated (NA)

Filled Down

- Mean
- Median
- Max
- Min

Grouped by date

	date	bpm
1	2018-11-30	84.06578
2	2018-12-01	70.59088
3	2018-12-02	73.34748
4	2018-12-03	77.16180
5	2018-12-04	70.84058
6	2018-12-07	76.16701
7	2018-12-08	71.77801
8	2018-12-09	63.97538
9	2018-12-10	65.06643
10	2018-12-11	62.40557

Grouped by time

	time	bpm
1	12:00 AM	58.70780
2	12:01 AM	58.78386
3	12:02 AM	58.98739
4	12:03 AM	58.66390
5	12:04 AM	58.44183
6	12:05 AM	58.51704
7	12:06 AM	58.51538
8	12:07 AM	58.64447
9	12:08 AM	58.69603
10	12:09 AM	58.82933

`pivot_wider(names_from = weekday, values_from = bpm)`

Grouped by weekday

	weekday	bpm
1	Sunday	66.47418
2	Monday	68.84909
3	Tuesday	67.73481
4	Wednesday	68.68466
5	Thursday	70.28824
6	Friday	69.09375
7	Saturday	67.74566

Grouped by weekday and time

	time	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	12:00 AM	55.49152	56.86026	60.47404	61.78257	57.75000	60.65625	57.92175
2	12:01 AM	55.13658	56.76796	60.84848	61.94130	58.26154	60.73438	57.81784
3	12:02 AM	55.60415	57.79873	61.00439	62.00000	58.30769	60.58920	57.55362
4	12:03 AM	55.34341	56.90345	61.42863	61.61290	58.15385	59.71420	57.34265
5	12:04 AM	55.76190	56.41270	61.18620	61.25806	57.46875	59.79688	57.05000

Raw Data

	In bed start	In bed Finish	Minutes in bed	Minutes asleep
1011	25-Oct-2019 00:30	25-Oct-2019 06:30	360.5173921	0.00000
1012	28-Oct-2019 00:40	28-Oct-2019 07:25	405.5136193	0.00000
1013	29-Oct-2019 03:15	29-Oct-2019 07:20	245.5044023	0.00000
1014	29-Oct-2019 22:51	30-Oct-2019 07:20	508.5393671	491.58805
1015	30-Oct-2019 23:36	31-Oct-2019 07:42	486.0953667	418.04202
1016	01-Nov-2019 02:36	01-Nov-2019 06:45	248.8458177	163.39927
1017	02-Nov-2019 00:47	02-Nov-2019 09:00	493.0725299	0.00000
1018	03-Nov-2019 01:25	03-Nov-2019 08:25	480.0013566	443.37900
1019	03-Nov-2019 23:01	04-Nov-2019 07:00	478.9337177	0.00000

End Times

	time	bed
1	2016-09-13 20:59:00	FALSE
2	2016-09-13 21:21:00	FALSE
3	2016-09-13 21:27:00	FALSE
4	2016-09-13 21:30:00	FALSE
5	2016-09-13 21:33:00	FALSE
6	2016-09-13 21:38:00	FALSE
7	2016-09-13 21:41:00	FALSE
8	2016-09-14 19:04:00	FALSE
9	2016-09-15 07:00:00	FALSE
10	2016-09-16 07:00:00	FALSE

Start Times

	time	bed
1	2016-09-13 18:48:00	TRUE
2	2016-09-13 21:04:00	TRUE
3	2016-09-13 21:23:00	TRUE
4	2016-09-13 21:29:00	TRUE
5	2016-09-13 21:32:00	TRUE
6	2016-09-13 21:35:00	TRUE
7	2016-09-13 21:39:00	TRUE
8	2016-09-14 18:15:00	TRUE
9	2016-09-14 23:20:00	TRUE
10	2016-09-15 23:30:00	TRUE

Datetime is in bed

	time	bed
129	2016-09-13 20:56:00	TRUE
130	2016-09-13 20:57:00	TRUE
131	2016-09-13 20:58:00	TRUE
132	2016-09-13 20:59:00	FALSE
133	2016-09-13 21:00:00	FALSE
134	2016-09-13 21:01:00	FALSE
135	2016-09-13 21:02:00	FALSE
136	2016-09-13 21:03:00	FALSE
137	2016-09-13 21:04:00	TRUE

Filled Down

Heart Rate Grouped by datetime

	end	bpm
1	2018-11-30 13:13:00	68.00000
2	2018-11-30 13:14:00	68.00000
3	2018-11-30 13:15:00	68.00000
4	2018-11-30 13:16:00	68.00000
5	2018-11-30 13:17:00	68.00000
6	2018-11-30 13:18:00	68.00000
7	2018-11-30 13:19:00	75.00000
8	2018-11-30 13:20:00	75.00000
9	2018-11-30 13:21:00	75.00000
10	2018-11-30 13:22:00	75.00000

Inner Join

Bed Heart Rate

|	end	bpm
458	2018-12-12 05:55:00	53.00000
459	2018-12-12 05:56:00	52.00000
460	2018-12-12 05:57:00	52.00000
461	2018-12-12 05:58:00	52.00000
462	2018-12-12 05:59:00	52.00000
463	2018-12-12 06:00:00	52.00000
464	2018-12-12 06:01:00	52.00000
465	2018-12-12 06:02:00	52.00000
466	2018-12-14 23:27:00	54.00000
467	2018-12-14 23:28:00	54.00000
468	2018-12-14 23:29:00	57.00000

Bed Heart Rate Grouped by:
- Datetime
- Date
- Weekday

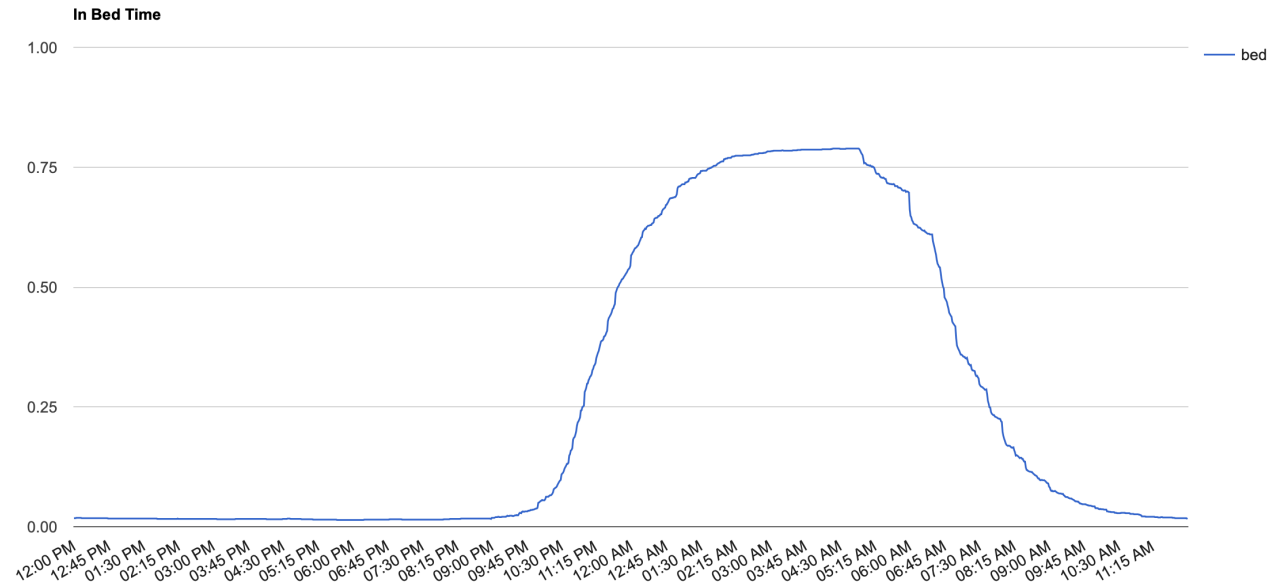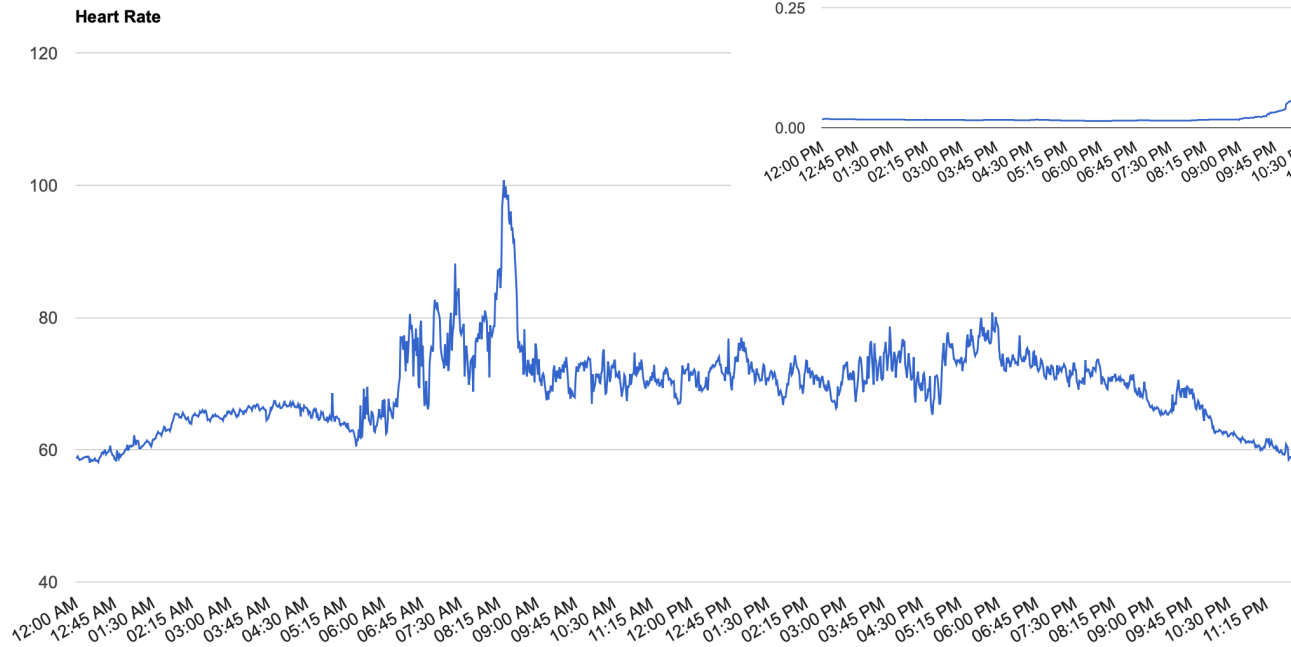# Step 2: Visualize and Understand

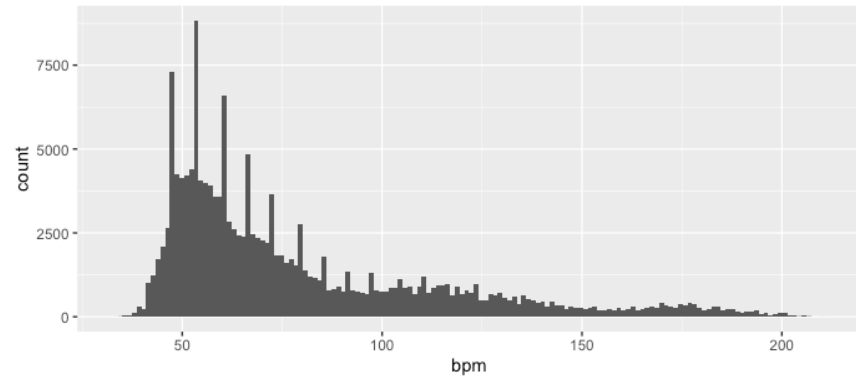Used ggplot and googleVis libraries
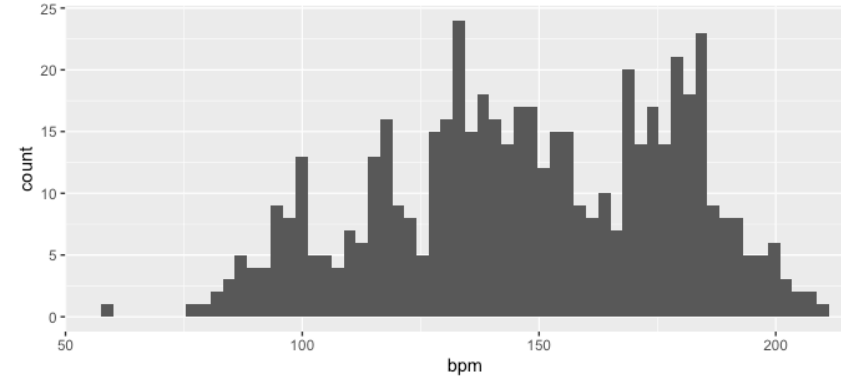
Year Plots
(googleVis)
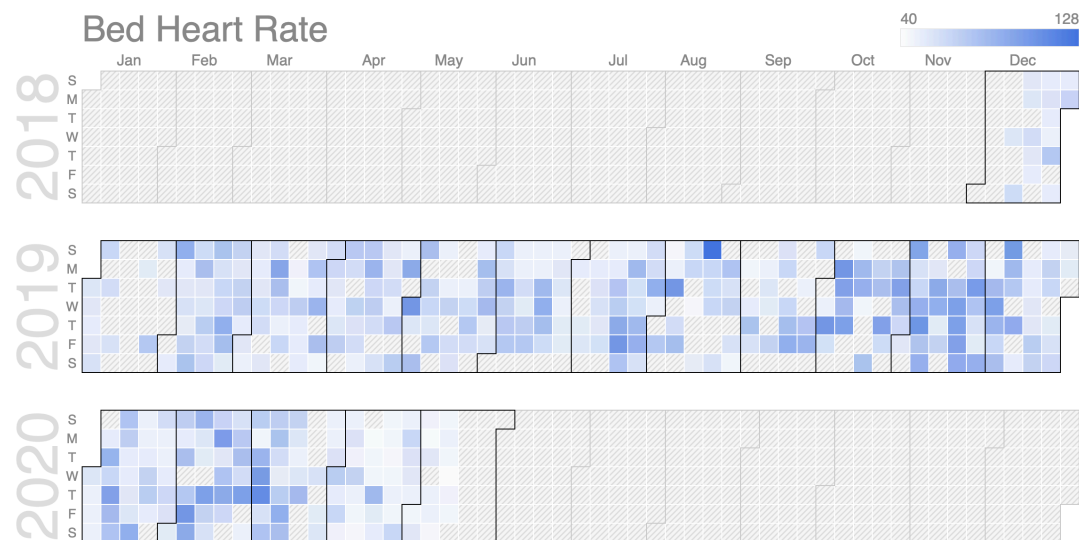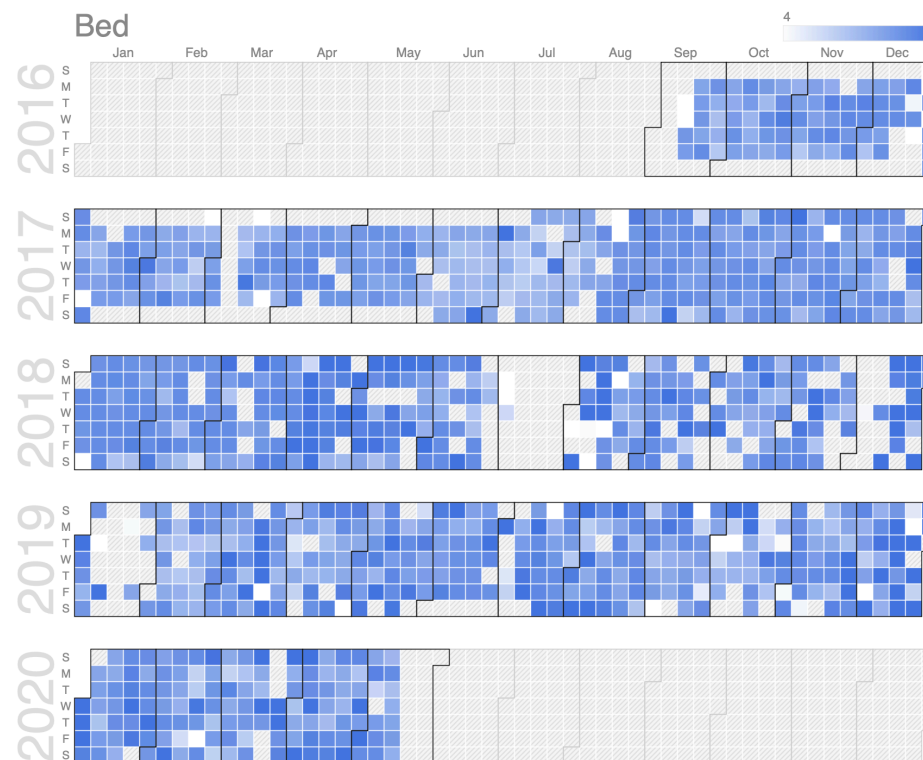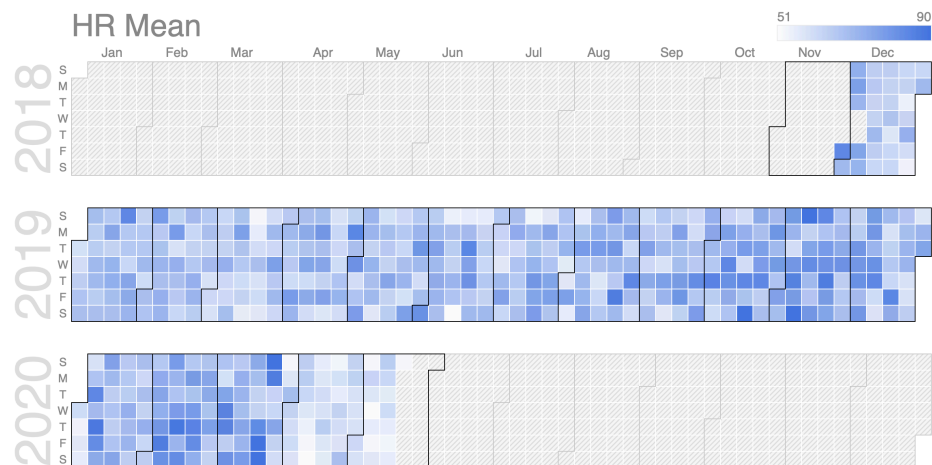
Line Plots
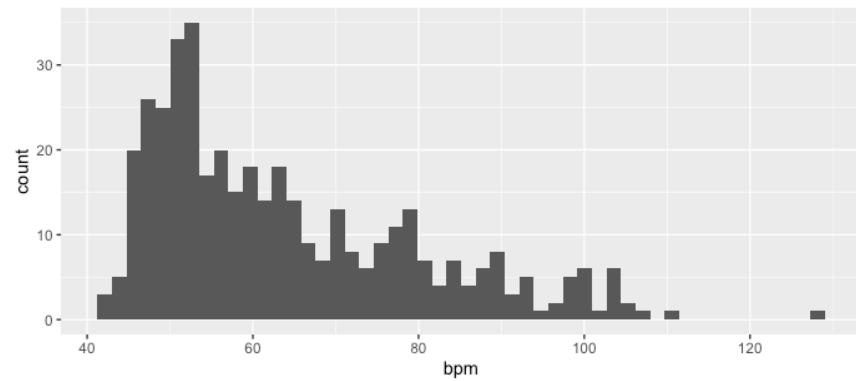
(googleVis)

Distribution Histograms
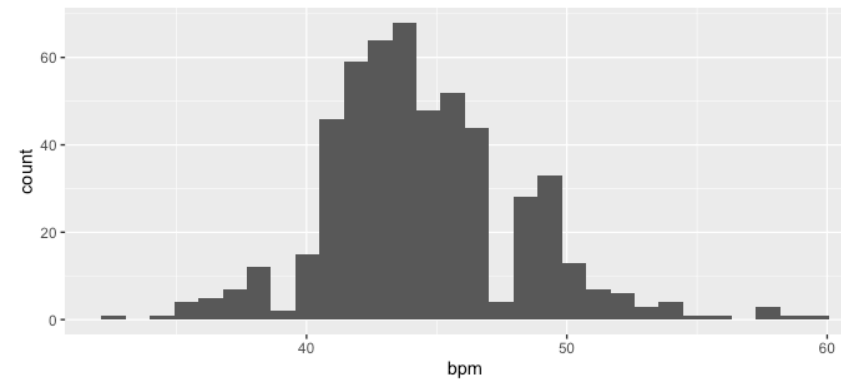
Weekday Charts
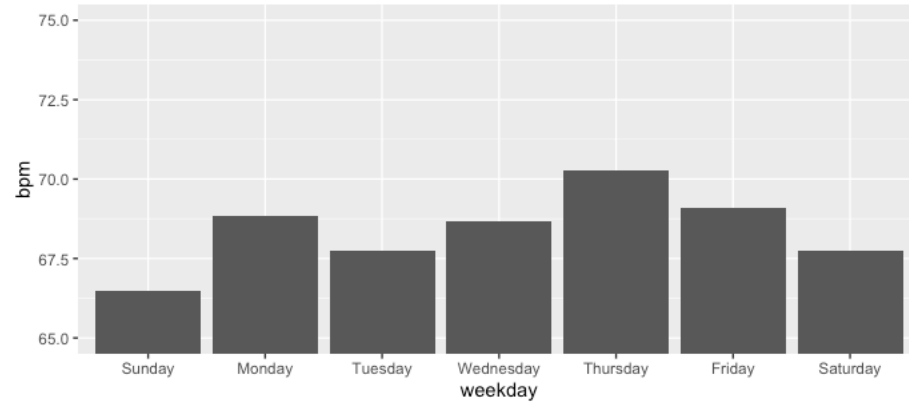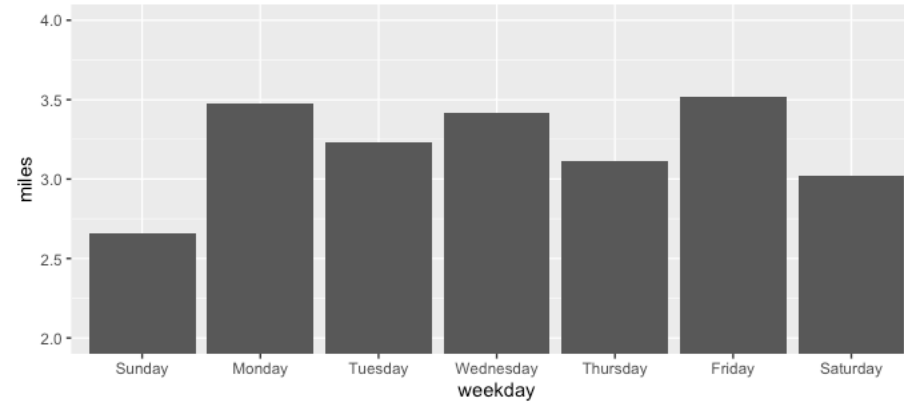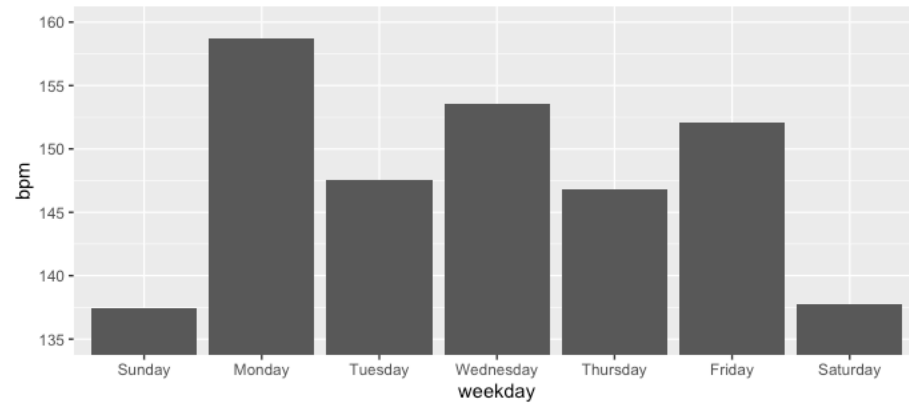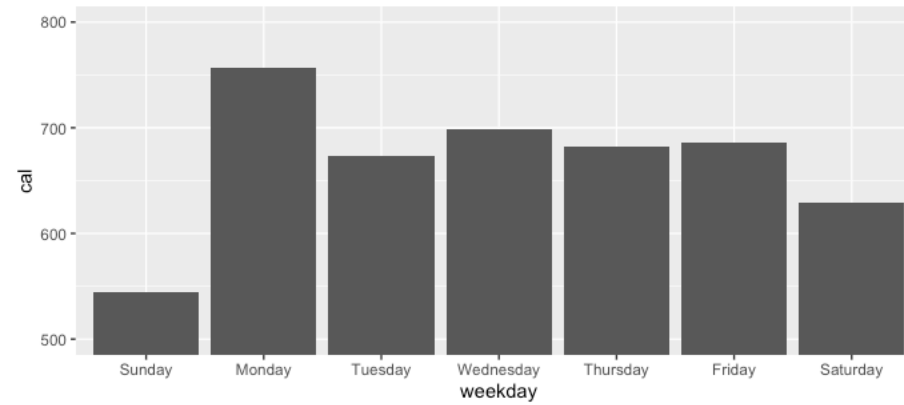
Step 3: Correlate and Analyze

Used zoo and rpart libraries

Unify into single Calendar

|	date	mean_bpm	median_bpm	max_bpm	min_bpm	bed_bpm	bed	sleep	active_cal	resting_cal	cycling_miles	miles	steps	flights	rolling_bed_4	rolling
1414	2019-11-17	83.50482	74.00000	149.0000	44.00000	NA	6.05	5.52	436.000	1702.855	NA	4.8358216	9912	23	NA	NA
1415	2019-11-18	66.57602	65.00000	147.0000	51.00000	78.25101	7.02	6.74	510.432	1677.948	NA	8.6370404	17841	35	NA	NA
1416	2019-11-19	78.26798	73.00000	150.4513	46.00000	99.76332	8.11	7.74	1008.223	1697.043	7.063051	8.6192282	17377	53	6.9225	NA
1417	2019-11-20	81.00370	74.00000	148.6101	49.00000	99.71138	8.00	7.66	893.806	1695.547	NA	8.2454858	16438	26	7.2950	NA
1418	2019-11-21	86.52842	81.92308	151.0000	47.00000	97.65913	6.19	5.99	899.731	1695.152	NA	11.1345335	22490	46	7.3300	NA
1419	2019-11-22	78.98526	74.00000	133.0000	44.00000	91.09111	8.35	8.07	677.018	1714.166	NA	11.3265267	22810	45	7.6625	NA
1420	2019-11-23	76.16838	66.00000	137.0000	46.00000	62.98199	7.69	7.17	473.207	1688.101	NA	6.2234268	12445	28	7.5575	7.240
1421	2019-11-24	67.34932	59.00000	179.0000	47.00000	62.68566	7.10	6.78	715.480	1726.373	NA	11.7749700	23728	62	7.3325	7.313
1422	2019-11-25	69.36051	66.50000	143.4664	42.00000	101.44025	6.28	6.07	929.731	1700.686	NA	9.9338595	19885	31	7.3550	7.342
1423	2019-11-26	73.96910	65.00000	136.0000	41.00000	76.43431	11.02	9.88	520.200	1717.178	NA	5.6357784	11472	30	8.0225	7.842
1424	2019-11-27	81.05539	79.00000	161.0411	45.00000	56.44060	9.13	8.43	766.837	1698.013	NA	3.7747173	6888	2	8.3825	7.970
1425	2019-11-28	64.00749	57.00000	136.0000	44.01146	52.17128	10.02	9.92	336.928	1673.564	NA	2.1514904	3812	NA	9.1125	8.222
1426	2019-11-29	65.73612	55.08333	158.0000	43.00000	88.23271	8.04	7.45	591.440	1695.791	NA	3.0621577	5629	NA	9.5525	8.453
1427	2019-11-30	68.25555	57.00000	137.0000	43.00000	NA	8.24	6.21	225.530	1632.868	NA	0.6602294	1347	4	8.8575	8.440
1428	2019-12-01	63.19715	60.00000	148.0000	46.00000	46.11420	6.70	6.12	521.754	1767.883	NA	7.0071629	14389	17	8.2500	8.316
1429	2019-12-02	64.69896	60.00000	140.0000	43.00000	81.85713	7.42	6.53	887.696	1700.595	NA	9.0384020	18316	32	7.6000	8.356
1430	2019-12-03	79.61986	78.00000	153.0000	43.00000	99.24706	5.66	5.39	628.124	1698.132	NA	9.2708713	19248	40	7.0050	8.278
1431	2019-12-04	79.93485	75.00000	159.8836	48.00000	85.14748	7.25	6.89	1063.454	1706.949	NA	9.8709562	19389	42	6.7575	7.807
1432	2019-12-05	81.65213	77.00000	140.0000	47.00000	63.43438	1.97	NA	1018.733	1723.212	NA	10.7429430	21313	35	5.5750	6.912
1433	2019-12-06	69.38030	65.72727	145.0000	47.00000	79.42747	9.79	5.41	681.911	1712.359	NA	10.1845135	20504	31	6.1675	6.883
1434	2019-12-07	79.25390	73.50000	154.3058	47.00000	103.19861	6.71	6.36	893.712	1683.194	11.324499	11.0542700	22540	39	6.4300	6.717
1435	2019-12-08	79.04778	73.00000	128.0000	48.00000	82.37521	8.01	7.72	639.757	1713.101	NA	10.5918275	21818	36	6.6200	6.688
1436	2019-12-09	79.81238	76.00000	142.0000	46.00000	72.97912	8.88	8.34	971.866	1702.176	NA	10.4730274	21036	20	8.3475	6.961
1437	2019-12-10	71.45858	66.00000	120.0000	42.00000	NA	6.75	6.48	635.161	1664.303	NA	10.5511241	21912	24	7.5875	6.877
1438	2019-12-11	81.62566	76.00000	146.6046	52.00000	90.72263	9.25	6.98	1192.684	1733.548	NA	11.8085247	23121	33	8.2225	7.326
1439	2019-12-12	84.19135	80.28571	189.0000	48.00000	NA	7.08	6.15	1015.358	1699.277	NA	11.7080434	22725	51	7.9900	7.305
1440	2019-12-13	60.39718	58.00000	103.0000	48.00000	50.68137	6.79	NA	250.954	1690.570	NA	2.3347490	4946	NA	7.4675	7.907

Heart Correlation
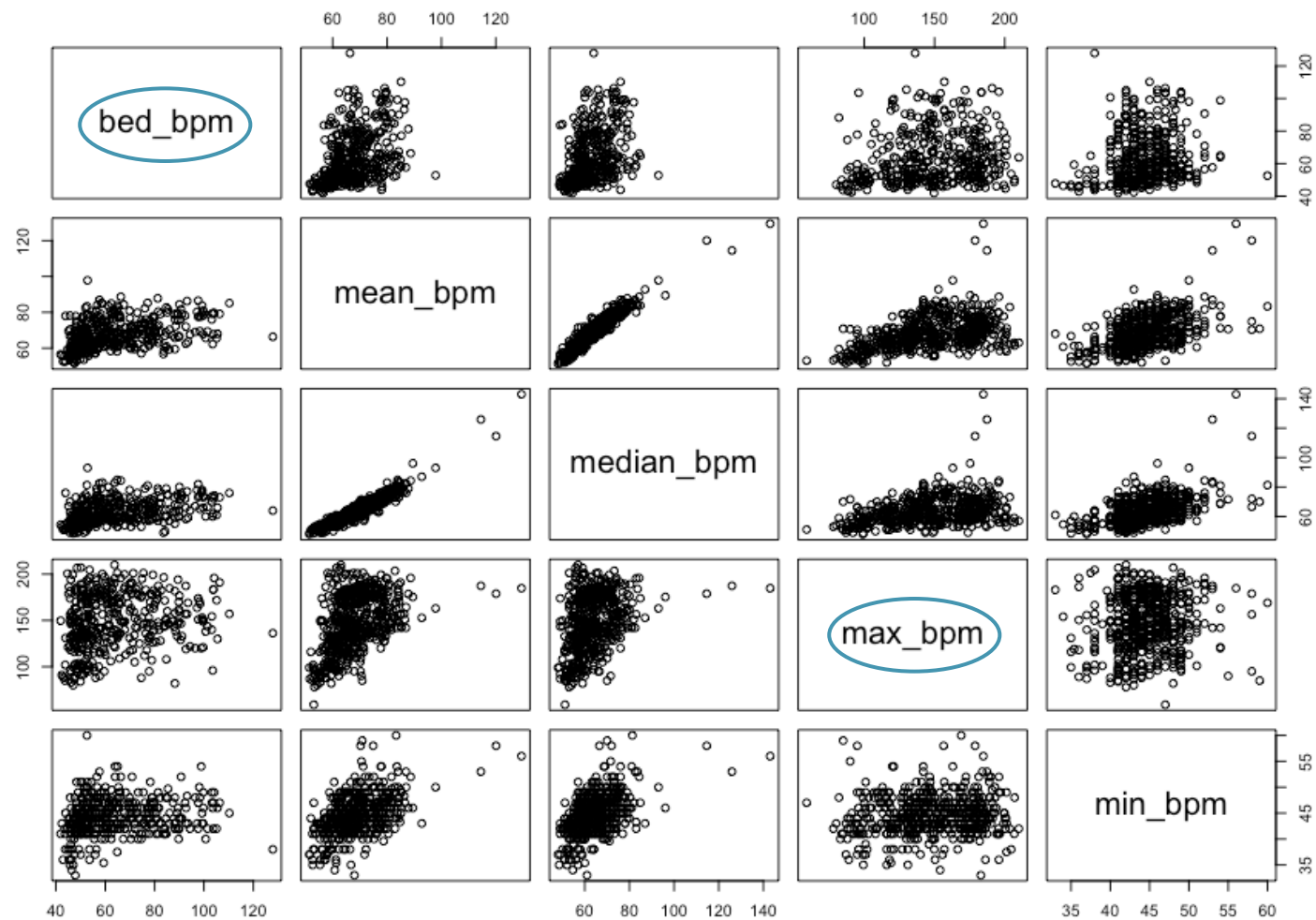
Sleep Correlation
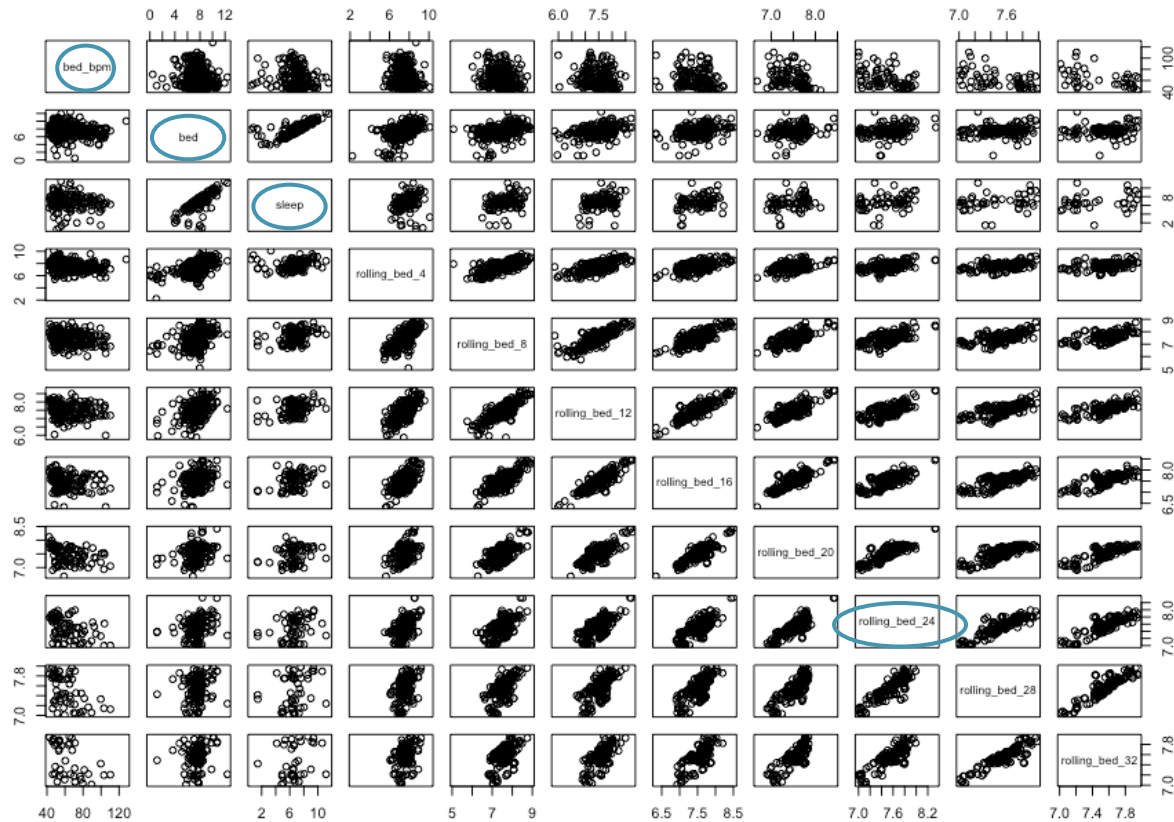

```
> coef(lm(data = calendar, bed_bpm ~ max_bpm + bed + sleep + active_cal + miles + rolling_bed_4))[7]
rolling_bed_4
    -5.5886
> coef(lm(data = calendar, bed_bpm ~ max_bpm + bed + sleep + active_cal + miles + rolling_bed_6))[7]
Error in eval(predvars, data, env) : object 'rolling_bed_6' not found
> coef(lm(data = calendar, bed_bpm ~ max_bpm + bed + sleep + active_cal + miles + rolling_bed_8))[7]
rolling_bed_8
    -4.697724
> coef(lm(data = calendar, bed_bpm ~ max_bpm + bed + sleep + active_cal + miles + rolling_bed_10))[7]
Error in eval(predvars, data, env) : object 'rolling_bed_10' not found
> coef(lm(data = calendar, bed_bpm ~ max_bpm + bed + sleep + active_cal + miles + rolling_bed_12))[7]
rolling_bed_12
    -4.543957
> coef(lm(data = calendar, bed_bpm ~ max_bpm + bed + sleep + active_cal + miles + rolling_bed_16))[7]
rolling_bed_16
    -9.688853
> coef(lm(data = calendar, bed_bpm ~ max_bpm + bed + sleep + active_cal + miles + rolling_bed_20))[7]
rolling_bed_20
    -20.91376
> coef(lm(data = calendar, bed_bpm ~ max_bpm + bed + sleep + active_cal + miles + rolling_bed_24))[7]
rolling_bed_24
    -24.47009
> coef(lm(data = calendar, bed_bpm ~ max_bpm + bed + sleep + active_cal + miles + rolling_bed_28))[7]
rolling_bed_28
    -23.65024
> coef(lm(data = calendar, bed_bpm ~ max_bpm + bed + sleep + active_cal + miles + rolling_bed_32))[7]
rolling_bed_32
    -18.20744
```

Activity Correlation
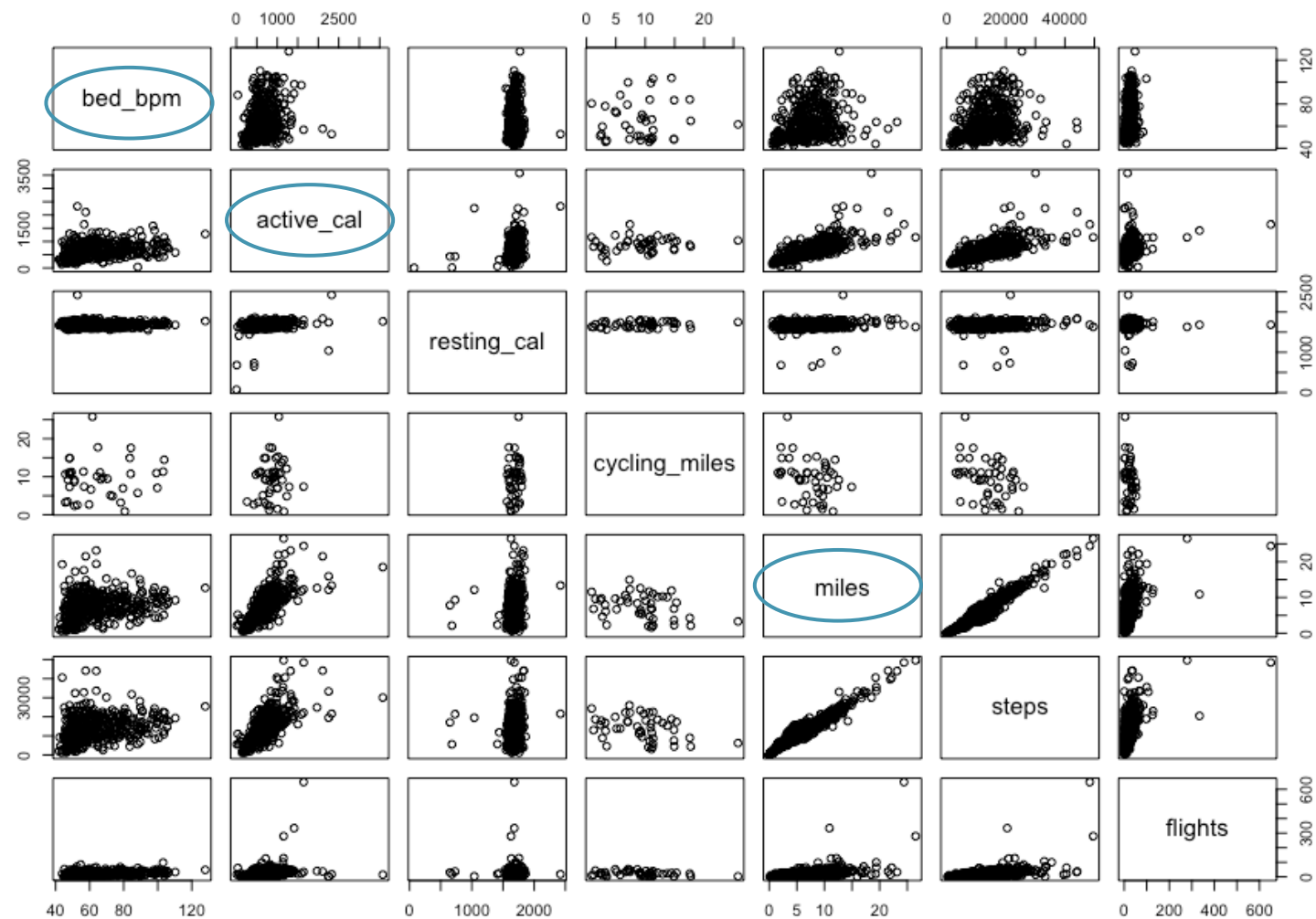
Build the models
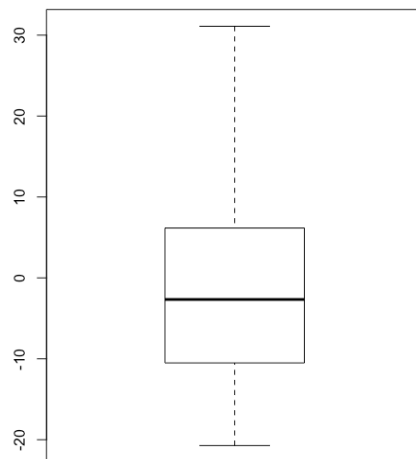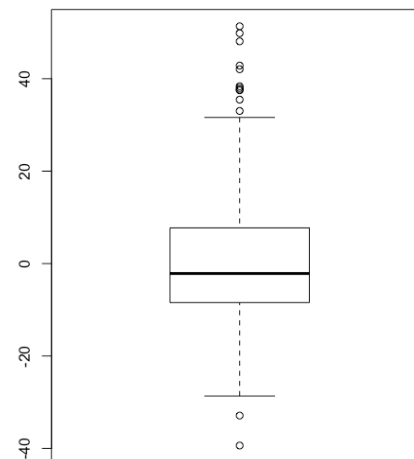
```
> formula <- bed_bpm ~ max_bpm + bed + sleep + active_cal + miles + rolling_bed_24
> lin_reg_model <- lm(data = calendar_train , formula)
> desc_tree_model <- rpart(formula, calendar_train)
> coef(lin_reg_model)
  (Intercept)        max_bpm            bed          sleep     active_cal          miles rolling_bed_24
188.671445426    0.062080412    9.705837409   -8.544298012    0.009507391    0.119297898  -20.795441859
```


Distribution of linear regression model

Distribution of decision tree model