Processing Robot and Sensor Log File

Seeking a Circular Target

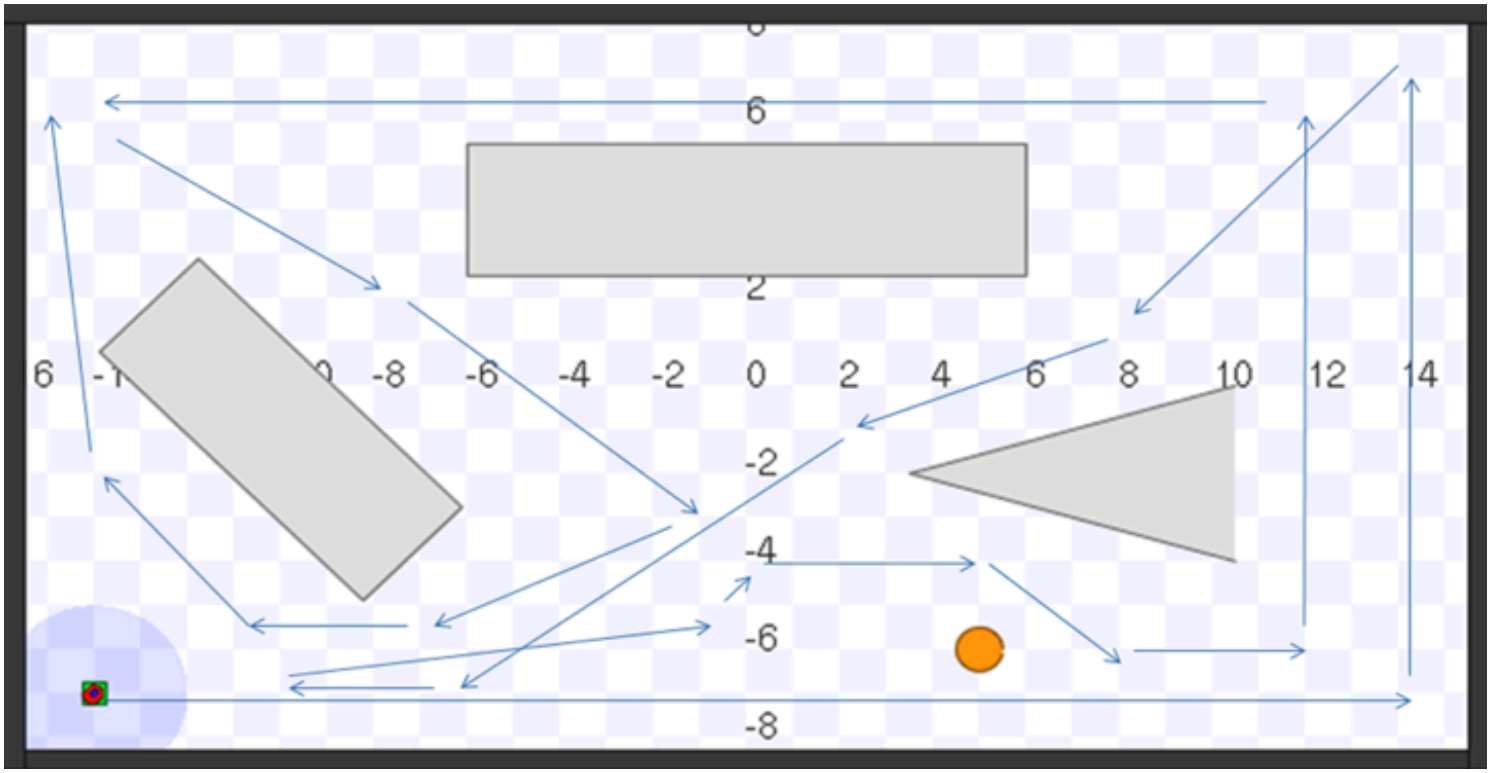


Figure 1: Robot Training Ground.

Robot Log Data

```
ff <- list.files(data.dir, full.names = T)
head(ff)
```

```
[1] "D:/Projects/Statistical-Computing/Case Studies/datasets/robot/01groundTruth.log"
[2] "D:/Projects/Statistical-Computing/Case Studies/datasets/robot/hasCircle100"
[3] "D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_31
```

```
[4] "D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_50
[5] "D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_09
[6] "D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_29
```

```
ff <- list.files(data.dir, full.names = T,
                 pattern = "JRSPdata.*\\.log")
head(ff)
```

```
[1] "D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_31
[2] "D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_50
[3] "D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_09
[4] "D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_29
[5] "D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_48
[6] "D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_39_28
```

```
info <- file.info(ff)
head(info)
```

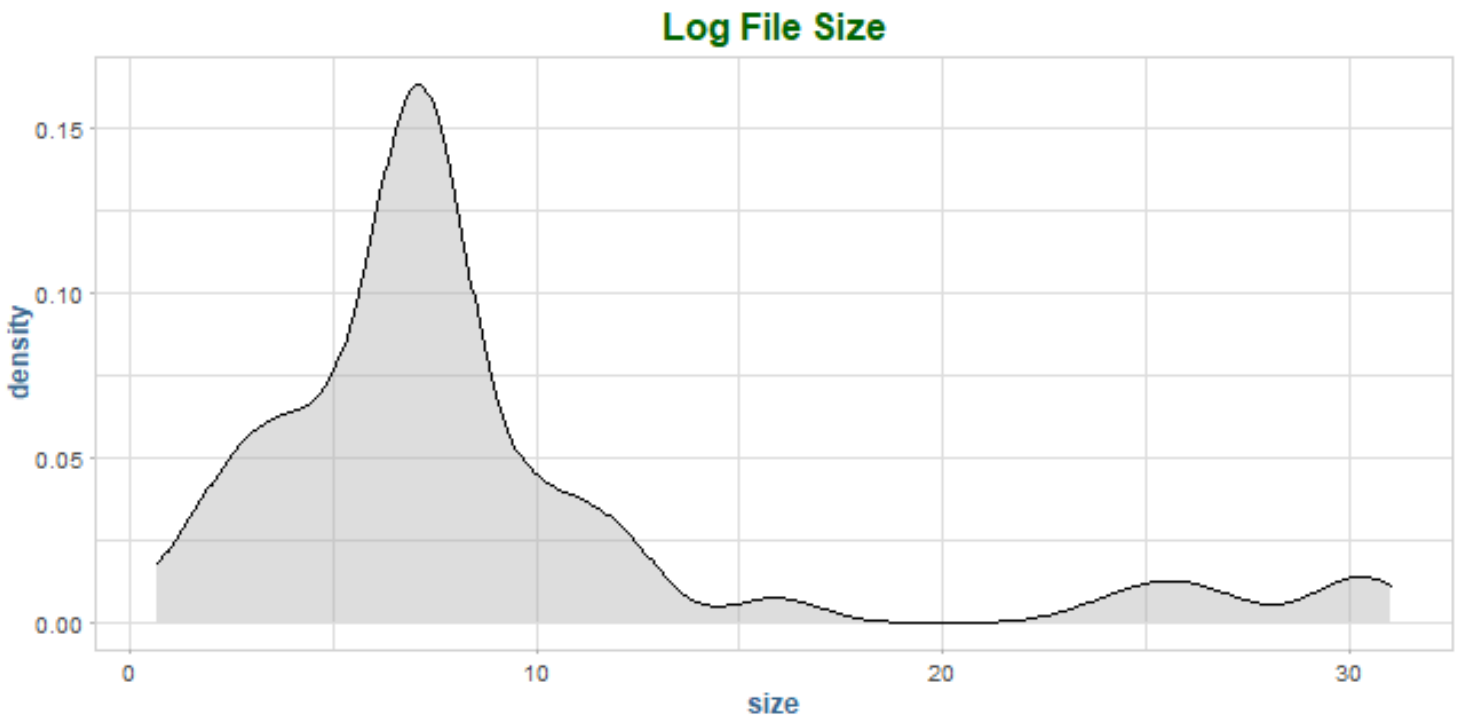
```

D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_31.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_50.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_09.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_29.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_48.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_39_28.log

D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_31.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_50.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_09.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_29.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_48.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_39_28.log

D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_31.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_50.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_09.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_29.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_48.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_39_28.log

D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_31.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_50.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_09.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_29.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_48.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_39_28.log
```

```
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_31.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_50.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_09.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_29.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_48.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_39_28.log

D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_31.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_50.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_09.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_29.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_48.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_39_28.log

D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_31.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_12_50.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_09.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_29.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_13_48.log
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_39_28.log
```

```
summary(info$size/1024^2)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
 0.6832  5.4062  7.1641  8.7556  9.3241 31.0498 
```

```
file_info <- data.frame( size = info$size/1024^2)

ggplot(file_info, aes(size)) +
   geom_density(fill = "darkgrey", alpha = .4) +
   labs(title = "Log File Size")
```




```
quantile(file_info$size, seq(.9, 1, by = 0.01))
```

```
     90%      91%      92%      93%      94%      95%      96%      97%
15.67820 16.83985 23.91586 25.18595 25.40554 26.18786 27.25159 29.87854
     98%      99%     100%
29.92587 30.47630 31.04978
```

Read Log File

```
filename <- "D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_
lines <- readLines(filename)

readLog <- function(filename,
                    lines = readLines(filename))
{
   lines <- grep("^#", lines, invert = T, value = T)
   els <- strsplit(lines, "[[:space:]]+")

   # Get the interface and type so we can subset.
   iface <- sapply(els, `[`, 4)
   type <- sapply(els, `[`, 6)

   # find the indices corresponding to a position2d
   # with a laser immediately after.
```

```
   i <- which(iface == "position2d" & type == "001")
   i = i[ iface[i+1] == "laser" & type[i+1] == "001"]

   # Get the time, x, y, and then the range of values
   # from the laser below.
   locations <- t(sapply(els[i], `[`, c(1, 8, 9)))
   ranges <- t(sapply(els[i + 1], `[`, seq(14, by = 2, length = 361) ))

   # now combine these into a data framee
   locations <- as.data.frame(lapply(1:ncol(locations),
                                     function(i)
                                        as.numeric(locations[, i])))
   ranges <- as.data.frame(lapply(1:ncol(ranges),
                                  function(i)
                                     as.numeric(ranges[, i])))

   ans <- cbind(locations, ranges)

   names(ans) <- c("time", "x", "y",
                   sprintf("range%d", 1:ncol(ranges)))

   invisible(ans)
}

log <- readLog(filename, lines)

head(log)
```

```
  time   x  y range1 range2 range3 range4 range5 range6 range7 range8 range9
1  0.2 -14 -7  1.838  1.807  1.778  1.749  1.723  1.697  1.673   1.65  1.628
2  0.4 -14 -7  1.838  1.807  1.778  1.749  1.723  1.697  1.673   1.65  1.628
3  0.6 -14 -7  1.838  1.807  1.778  1.749  1.723  1.697  1.673   1.65  1.628
4  0.8 -14 -7  1.838  1.807  1.778  1.749  1.723  1.697  1.673   1.65  1.628
5  1.0 -14 -7  1.838  1.807  1.778  1.749  1.723  1.697  1.673   1.65  1.628
6  1.1 -14 -7  1.838  1.807  1.778  1.749  1.723  1.697  1.673   1.65  1.628
  range10 range11 range12 range13 range14 range15 range16 range17 range18
1   1.607   1.587   1.568    1.55   1.533   1.517   1.501   1.486   1.472
2   1.607   1.587   1.568    1.55   1.533   1.517   1.501   1.486   1.472
3   1.607   1.587   1.568    1.55   1.533   1.517   1.501   1.486   1.472
4   1.607   1.587   1.568    1.55   1.533   1.517   1.501   1.486   1.472
5   1.607   1.587   1.568    1.55   1.533   1.517   1.501   1.486   1.472
6   1.607   1.587   1.568    1.55   1.533   1.517   1.501   1.486   1.472
  range19 range20 range21 range22 range23 range24 range25 range26 range27
1   1.459   1.446   1.434   1.423   1.412   1.402   1.392   1.383   1.375
```

2	1.459	1.446	1.434	1.423	1.412	1.402	1.392	1.383	1.375
3	1.459	1.446	1.434	1.423	1.412	1.402	1.392	1.383	1.375
4	1.459	1.446	1.434	1.423	1.412	1.402	1.392	1.383	1.375
5	1.459	1.446	1.434	1.423	1.412	1.402	1.392	1.383	1.375
6	1.459	1.446	1.434	1.423	1.412	1.402	1.392	1.383	1.375

	range28	range29	range30	range31	range32	range33	range34	range35	range36
1	1.367	1.359	1.352	1.346	1.34	1.334	1.329	1.324	1.32
2	1.367	1.359	1.352	1.346	1.34	1.334	1.329	1.324	1.32
3	1.367	1.359	1.352	1.346	1.34	1.334	1.329	1.324	1.32
4	1.367	1.359	1.352	1.346	1.34	1.334	1.329	1.324	1.32
5	1.367	1.359	1.352	1.346	1.34	1.334	1.329	1.324	1.32
6	1.367	1.359	1.352	1.346	1.34	1.334	1.329	1.324	1.32

	range37	range38	range39	range40	range41	range42	range43	range44	range45
1	1.316	1.313	1.31	1.307	1.305	1.303	1.302	1.301	1.3
2	1.316	1.313	1.31	1.307	1.305	1.303	1.302	1.301	1.3
3	1.316	1.313	1.31	1.307	1.305	1.303	1.302	1.301	1.3
4	1.316	1.313	1.31	1.307	1.305	1.303	1.302	1.301	1.3
5	1.316	1.313	1.31	1.307	1.305	1.303	1.302	1.301	1.3
6	1.316	1.313	1.31	1.307	1.305	1.303	1.302	1.301	1.3

	range46	range47	range48	range49	range50	range51	range52	range53	range54
1	1.3	1.3	1.301	1.302	1.303	1.305	1.307	1.31	1.313
2	1.3	1.3	1.301	1.302	1.303	1.305	1.307	1.31	1.313
3	1.3	1.3	1.301	1.302	1.303	1.305	1.307	1.31	1.313
4	1.3	1.3	1.301	1.302	1.303	1.305	1.307	1.31	1.313
5	1.3	1.3	1.301	1.302	1.303	1.305	1.307	1.31	1.313
6	1.3	1.3	1.301	1.302	1.303	1.305	1.307	1.31	1.313

	range55	range56	range57	range58	range59	range60	range61	range62	range63
1	1.316	1.32	1.324	1.329	1.334	1.34	1.346	1.352	1.359
2	1.316	1.32	1.324	1.329	1.334	1.34	1.346	1.352	1.359
3	1.316	1.32	1.324	1.329	1.334	1.34	1.346	1.352	1.359
4	1.316	1.32	1.324	1.329	1.334	1.34	1.346	1.352	1.359
5	1.316	1.32	1.324	1.329	1.334	1.34	1.346	1.352	1.359
6	1.316	1.32	1.324	1.329	1.334	1.34	1.346	1.352	1.359

	range64	range65	range66	range67	range68	range69	range70	range71	range72
1	1.367	1.375	1.383	1.392	1.402	1.412	1.423	1.434	1.446
2	1.367	1.375	1.383	1.392	1.402	1.412	1.423	1.434	1.446
3	1.367	1.375	1.383	1.392	1.402	1.412	1.423	1.434	1.446
4	1.367	1.375	1.383	1.392	1.402	1.412	1.423	1.434	1.446
5	1.367	1.375	1.383	1.392	1.402	1.412	1.423	1.434	1.446
6	1.367	1.375	1.383	1.392	1.402	1.412	1.423	1.434	1.446

	range73	range74	range75	range76	range77	range78	range79	range80	range81
1	1.459	1.472	1.486	1.501	1.517	1.533	1.55	1.568	1.587
2	1.459	1.472	1.486	1.501	1.517	1.533	1.55	1.568	1.587
3	1.459	1.472	1.486	1.501	1.517	1.533	1.55	1.568	1.587
4	1.459	1.472	1.486	1.501	1.517	1.533	1.55	1.568	1.587

```
5   1.459   1.472   1.486   1.501   1.517   1.533    1.55   1.568   1.587
6   1.459   1.472   1.486   1.501   1.517   1.533    1.55   1.568   1.587
  range82 range83 range84 range85 range86 range87 range88 range89 range90
1   1.607   1.628    1.65   1.673   1.697   1.723   1.749   1.778   1.807
2   1.607   1.628    1.65   1.673   1.697   1.723   1.749   1.778   1.807
3   1.607   1.628    1.65   1.673   1.697   1.723   1.749   1.778   1.807
4   1.607   1.628    1.65   1.673   1.697   1.723   1.749   1.778   1.807
5   1.607   1.628    1.65   1.673   1.697   1.723   1.749   1.778   1.807
6   1.607   1.628    1.65   1.673   1.697   1.723   1.749   1.778   1.807
  range91 range92 range93 range94 range95 range96 range97 range98 range99
1   1.838   1.843   1.905   1.941       2       2       2       2       2
2   1.838   1.843   1.905   1.941       2       2       2       2       2
3   1.838   1.843   1.905   1.941       2       2       2       2       2
4   1.838   1.843   1.905   1.941       2       2       2       2       2
5   1.838   1.843   1.905   1.941       2       2       2       2       2
6   1.838   1.843   1.905   1.941       2       2       2       2       2
  range100 range101 range102 range103 range104 range105 range106 range107
1        2        2        2        2        2        2        2        2
2        2        2        2        2        2        2        2        2
3        2        2        2        2        2        2        2        2
4        2        2        2        2        2        2        2        2
5        2        2        2        2        2        2        2        2
6        2        2        2        2        2        2        2        2
  range108 range109 range110 range111 range112 range113 range114 range115
1        2        2        2        2        2        2        2        2
2        2        2        2        2        2        2        2        2
3        2        2        2        2        2        2        2        2
4        2        2        2        2        2        2        2        2
5        2        2        2        2        2        2        2        2
6        2        2        2        2        2        2        2        2
  range116 range117 range118 range119 range120 range121 range122 range123
1        2        2        2        2        2        2        2        2
2        2        2        2        2        2        2        2        2
3        2        2        2        2        2        2        2        2
4        2        2        2        2        2        2        2        2
5        2        2        2        2        2        2        2        2
6        2        2        2        2        2        2        2        2
  range124 range125 range126 range127 range128 range129 range130 range131
1        2        2        2        2        2        2        2        2
2        2        2        2        2        2        2        2        2
3        2        2        2        2        2        2        2        2
4        2        2        2        2        2        2        2        2
5        2        2        2        2        2        2        2        2
6        2        2        2        2        2        2        2        2
  range132 range133 range134 range135 range136 range137 range138 range139
```

1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2

	range140	range141	range142	range143	range144	range145	range146	range147
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2

	range148	range149	range150	range151	range152	range153	range154	range155
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2

	range156	range157	range158	range159	range160	range161	range162	range163
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2

	range164	range165	range166	range167	range168	range169	range170	range171
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2

	range172	range173	range174	range175	range176	range177	range178	range179
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2

	range180	range181	range182	range183	range184	range185	range186	range187
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2

4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2
	range188	range189	range190	range191	range192	range193	range194	range195
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2
	range196	range197	range198	range199	range200	range201	range202	range203
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2
	range204	range205	range206	range207	range208	range209	range210	range211
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2
	range212	range213	range214	range215	range216	range217	range218	range219
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2
	range220	range221	range222	range223	range224	range225	range226	range227
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2
	range228	range229	range230	range231	range232	range233	range234	range235
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2

	range236	range237	range238	range239	range240	range241	range242	range243
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2

	range244	range245	range246	range247	range248	range249	range250	range251
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2

	range252	range253	range254	range255	range256	range257	range258	range259
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2

	range260	range261	range262	range263	range264	range265	range266	range267
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2

	range268	range269	range270	range271	range272	range273	range274	range275
1	2	2	2	2	2	2	2	2
2	2	2	2	2	2	2	2	2
3	2	2	2	2	2	2	2	2
4	2	2	2	2	2	2	2	2
5	2	2	2	2	2	2	2	2
6	2	2	2	2	2	2	2	2

	range276	range277	range278	range279	range280	range281	range282	range283
1	1.958	1.93	1.904	1.878	1.854	1.831	1.809	1.789
2	1.958	1.93	1.904	1.878	1.854	1.831	1.809	1.789
3	1.958	1.93	1.904	1.878	1.854	1.831	1.809	1.789
4	1.958	1.93	1.904	1.878	1.854	1.831	1.809	1.789
5	1.958	1.93	1.904	1.878	1.854	1.831	1.809	1.789
6	1.958	1.93	1.904	1.878	1.854	1.831	1.809	1.789

	range284	range285	range286	range287	range288	range289	range290	range291
1	1.769	1.75	1.732	1.715	1.699	1.683	1.669	1.655
2	1.769	1.75	1.732	1.715	1.699	1.683	1.669	1.655

3	1.769	1.75	1.732	1.715	1.699	1.683	1.669	1.655
4	1.769	1.75	1.732	1.715	1.699	1.683	1.669	1.655
5	1.769	1.75	1.732	1.715	1.699	1.683	1.669	1.655
6	1.769	1.75	1.732	1.715	1.699	1.683	1.669	1.655

	range292	range293	range294	range295	range296	range297	range298	range299
1	1.642	1.63	1.618	1.607	1.596	1.586	1.577	1.569
2	1.642	1.63	1.618	1.607	1.596	1.586	1.577	1.569
3	1.642	1.63	1.618	1.607	1.596	1.586	1.577	1.569
4	1.642	1.63	1.618	1.607	1.596	1.586	1.577	1.569
5	1.642	1.63	1.618	1.607	1.596	1.586	1.577	1.569
6	1.642	1.63	1.618	1.607	1.596	1.586	1.577	1.569

	range300	range301	range302	range303	range304	range305	range306	range307
1	1.56	1.553	1.546	1.539	1.534	1.528	1.523	1.519
2	1.56	1.553	1.546	1.539	1.534	1.528	1.523	1.519
3	1.56	1.553	1.546	1.539	1.534	1.528	1.523	1.519
4	1.56	1.553	1.546	1.539	1.534	1.528	1.523	1.519
5	1.56	1.553	1.546	1.539	1.534	1.528	1.523	1.519
6	1.56	1.553	1.546	1.539	1.534	1.528	1.523	1.519

	range308	range309	range310	range311	range312	range313	range314	range315
1	1.515	1.511	1.508	1.506	1.504	1.502	1.501	1.5
2	1.515	1.511	1.508	1.506	1.504	1.502	1.501	1.5
3	1.515	1.511	1.508	1.506	1.504	1.502	1.501	1.5
4	1.515	1.511	1.508	1.506	1.504	1.502	1.501	1.5
5	1.515	1.511	1.508	1.506	1.504	1.502	1.501	1.5
6	1.515	1.511	1.508	1.506	1.504	1.502	1.501	1.5

	range316	range317	range318	range319	range320	range321	range322	range323
1	1.5	1.5	1.501	1.502	1.504	1.506	1.508	1.511
2	1.5	1.5	1.501	1.502	1.504	1.506	1.508	1.511
3	1.5	1.5	1.501	1.502	1.504	1.506	1.508	1.511
4	1.5	1.5	1.501	1.502	1.504	1.506	1.508	1.511
5	1.5	1.5	1.501	1.502	1.504	1.506	1.508	1.511
6	1.5	1.5	1.501	1.502	1.504	1.506	1.508	1.511

	range324	range325	range326	range327	range328	range329	range330	range331
1	1.515	1.519	1.523	1.528	1.534	1.539	1.546	1.553
2	1.515	1.519	1.523	1.528	1.534	1.539	1.546	1.553
3	1.515	1.519	1.523	1.528	1.534	1.539	1.546	1.553
4	1.515	1.519	1.523	1.528	1.534	1.539	1.546	1.553
5	1.515	1.519	1.523	1.528	1.534	1.539	1.546	1.553
6	1.515	1.519	1.523	1.528	1.534	1.539	1.546	1.553

	range332	range333	range334	range335	range336	range337	range338	range339
1	1.56	1.569	1.577	1.586	1.596	1.607	1.618	1.63
2	1.56	1.569	1.577	1.586	1.596	1.607	1.618	1.63
3	1.56	1.569	1.577	1.586	1.596	1.607	1.618	1.63
4	1.56	1.569	1.577	1.586	1.596	1.607	1.618	1.63
5	1.56	1.569	1.577	1.586	1.596	1.607	1.618	1.63

```
6     1.56    1.569    1.577    1.586    1.596    1.607    1.618     1.63
  range340 range341 range342 range343 range344 range345 range346 range347
1    1.642    1.655    1.669    1.683    1.701    1.716    1.738    1.765
2    1.642    1.655    1.669    1.683    1.701    1.716    1.738    1.765
3    1.642    1.655    1.669    1.683    1.701    1.716    1.738    1.765
4    1.642    1.655    1.669    1.683    1.701    1.716    1.738    1.765
5    1.642    1.655    1.669    1.683    1.701    1.716    1.738    1.765
6    1.642    1.655    1.669    1.683    1.701    1.716    1.738    1.765
  range348 range349 range350 range351 range352 range353 range354 range355
1    1.774    1.811    1.817    1.852    1.864    1.885    1.921    1.941
2    1.774    1.811    1.817    1.852    1.864    1.885    1.921    1.941
3    1.774    1.811    1.817    1.852    1.864    1.885    1.921    1.941
4    1.774    1.811    1.817    1.852    1.864    1.885    1.921    1.941
5    1.774    1.811    1.817    1.852    1.864    1.885    1.921    1.941
6    1.774    1.811    1.817    1.852    1.864    1.885    1.921    1.941
  range356 range357 range358 range359 range360 range361
1    1.978        2    1.944    1.889    1.835    1.838
2    1.978        2    1.944    1.889    1.835    1.838
3    1.978        2    1.944    1.889    1.835    1.838
4    1.978        2    1.944    1.889    1.835    1.838
5    1.978        2    1.944    1.889    1.835    1.838
6    1.978        2    1.944    1.889    1.835    1.838
```

Data Exploration

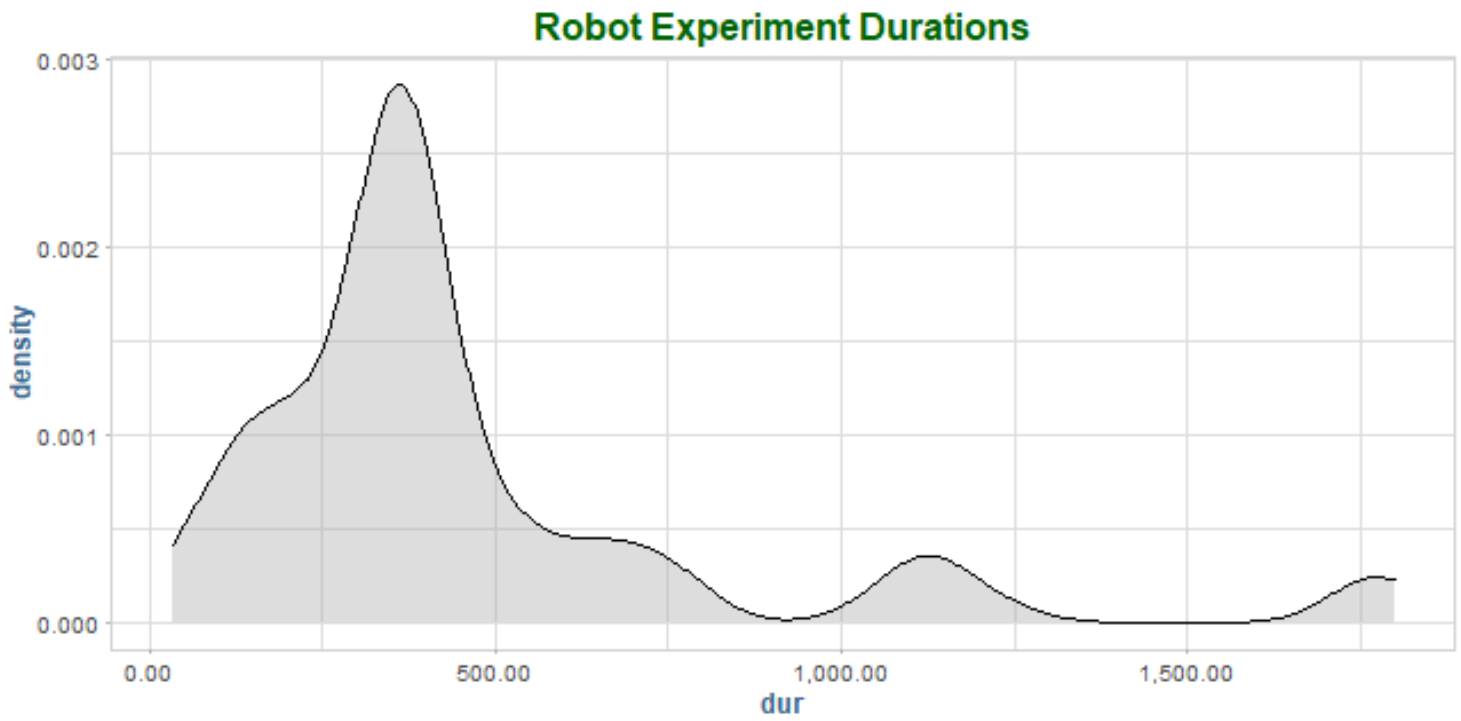
```
system.time(logs <- lapply(ff, readLog))
```

```
   user  system elapsed
 110.86    0.83  111.74
```

```
names(logs) <- ff

dur <- sapply(logs, function(x) x$time[nrow(x)] - x$time[1])

range(dur)
```

```
[1]   33.8 1799.7
```

```
ggplot(data.table(dur * 30 * 60), aes(dur)) +
   geom_density(fill = "darkgrey", alpha = .4) +
   labs(title = "Robot Experiment Durations") +
   scale_x_continuous(labels = comma)
```




```
range(sapply(logs, function(ll) range(ll$x)))
```

```
[1] -14.910  14.546
```

```
range(sapply(logs, function(ll) range(ll$y)))
```

```
[1] -7.713  7.316
```

```
table(sapply(logs, function(ll) all( diff(ll$time) > 0)))
```

```
TRUE
 100
```

```
deltas <- unlist(lapply(logs, function(ll) diff(ll$time)))
summary(deltas)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.1000  0.1000  0.2000  0.1746  0.2000  8.8000
```

```
quantile(deltas, seq(.99, 1, length = 11))
```

```
  99% 99.1% 99.2% 99.3% 99.4% 99.5% 99.6% 99.7% 99.8% 99.9%  100%
  0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   0.5   8.8
```

```
which.max(deltas)
```

```
D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_12_39_46.log2
49
```

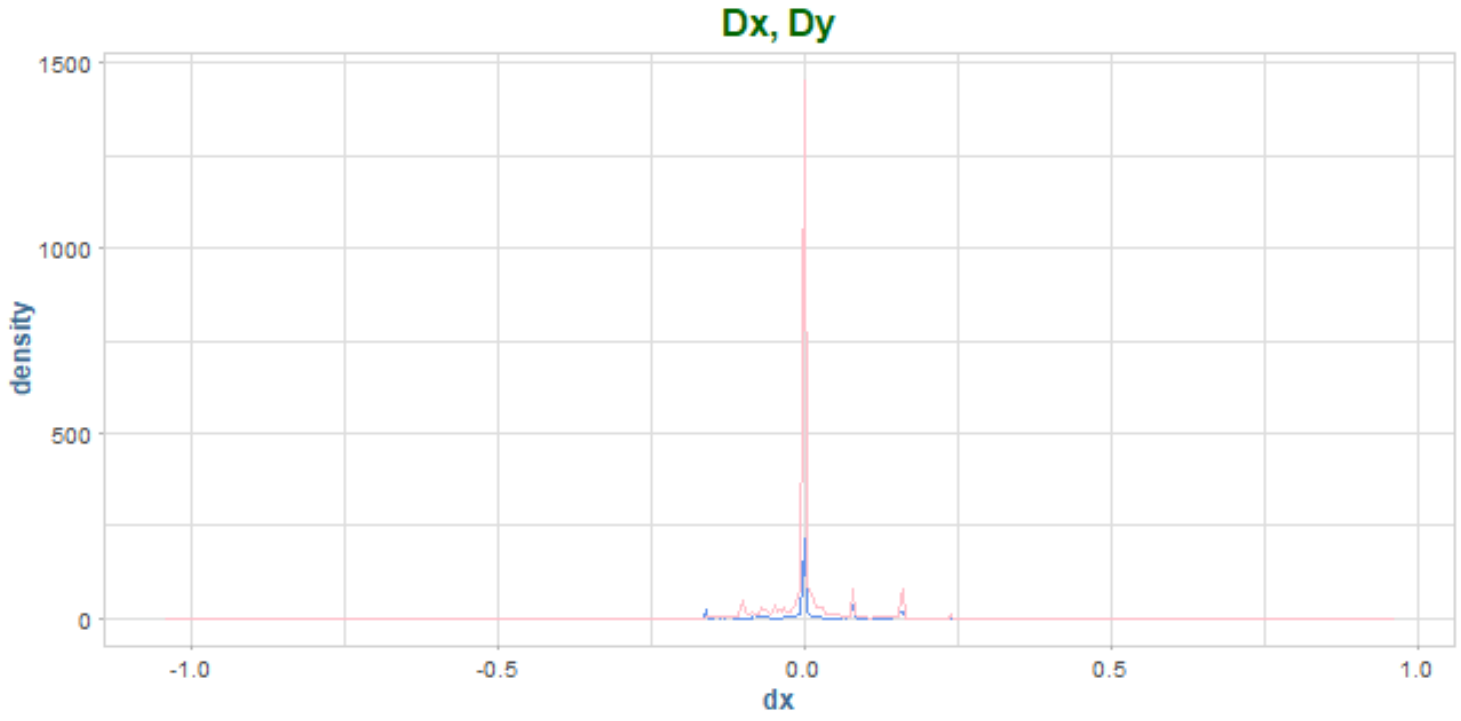
```
nrow(logs[["D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_1
```

```
[1] 2184
```

```
summary(sapply(logs, nrow))
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max. 
    208    1647    2182    2666    2840    9448 
```

```
ll <- logs[["D:/Projects/Statistical-Computing/Case Studies/datasets/robot/JRSPdata_2010_03_10_
i <- which.max(diff(ll$time))

delta.x <- unlist(lapply(logs, function(ll) diff(ll$x)))
delta.y <- unlist(lapply(logs, function(ll) diff(ll$y)))


delta_df <- data.table(dx = delta.x, dy = delta.y)

ggplot(delta_df) +
   geom_density(aes(dx), col = "cornflowerblue") +
   geom_density(aes(dy), col = "pink") +
   labs(title = "Dx, Dy", xlab = "Distance", ylab = "Density")
```




```
tail(sort(table(delta.x)))
```

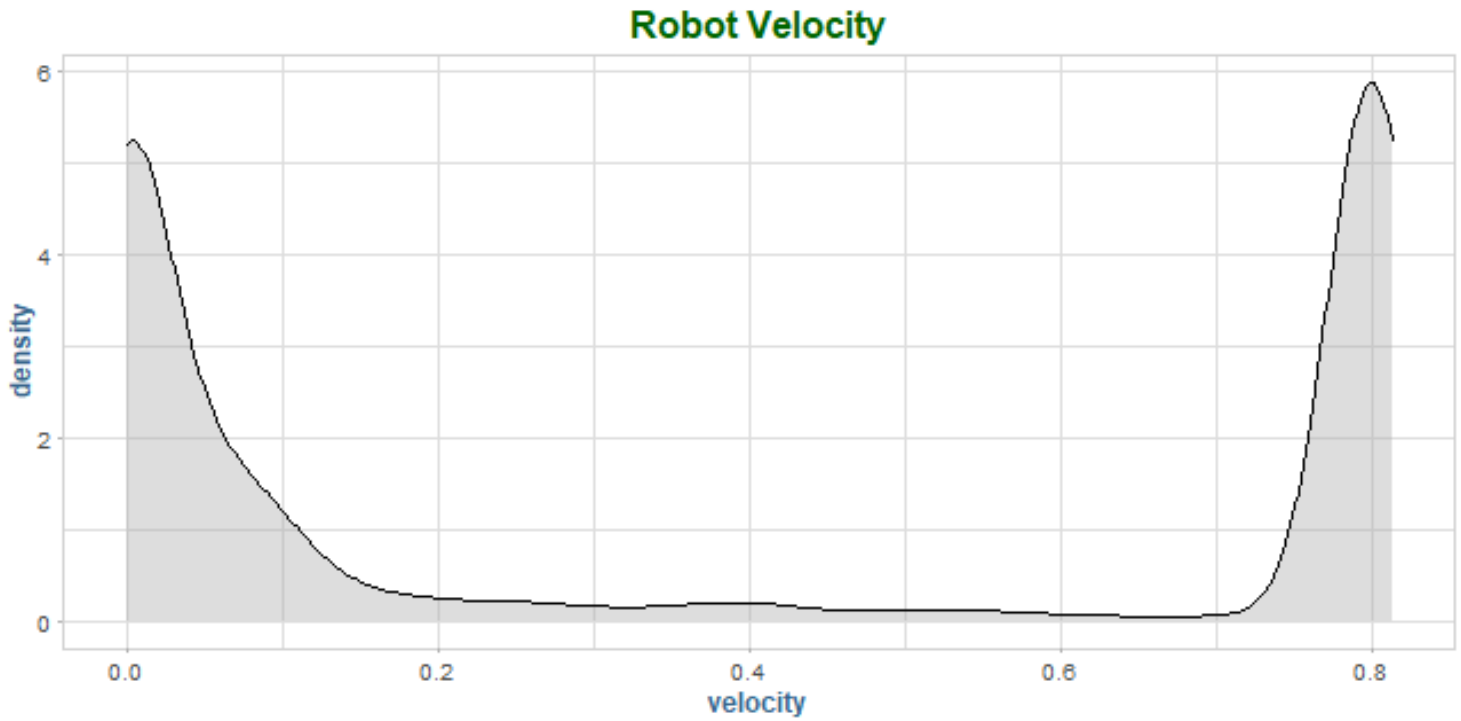
```
delta.x
```

```
 -0.0800000000000001 0.000999999999999446               -0.16
                4220                   6924                8879
                0.16   0.0800000000000001                   0
               11031                  11701              105168
```

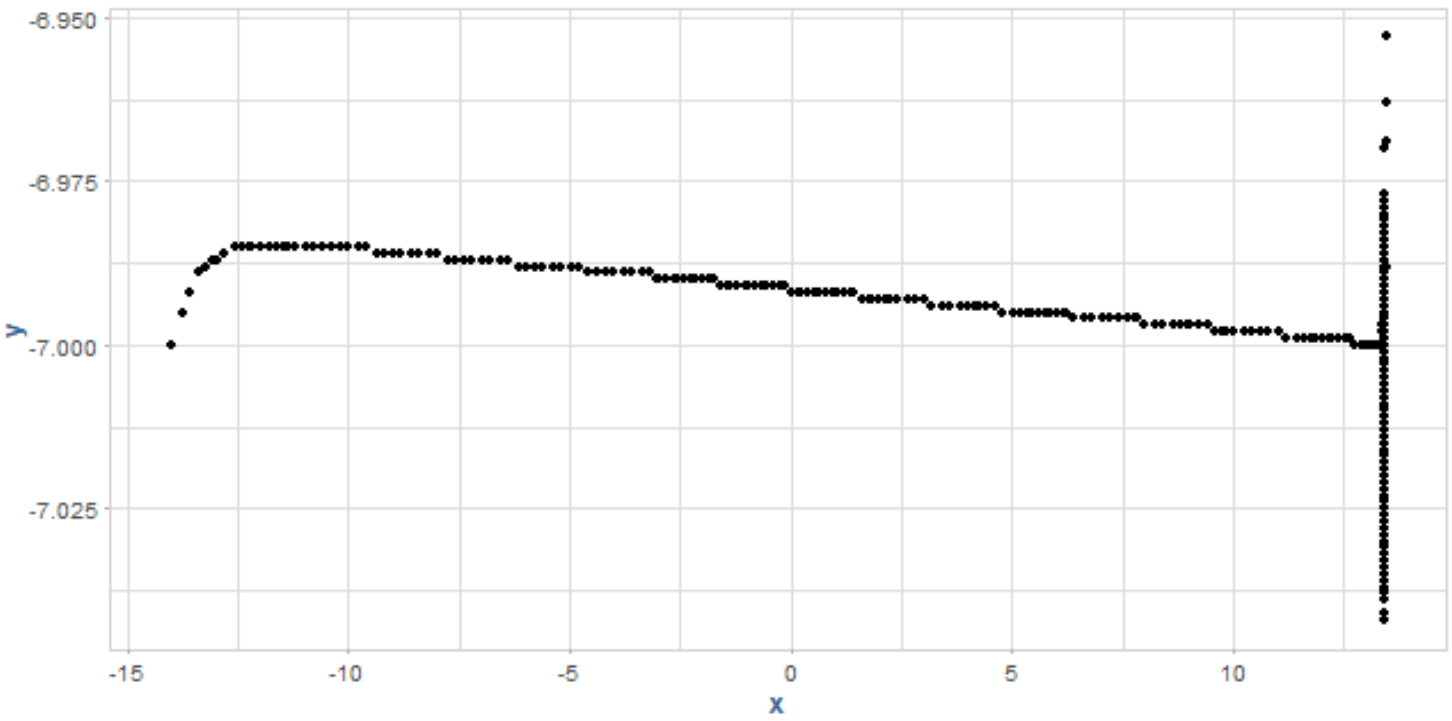
```
velocity <- lapply(logs, function(ll) sqrt( diff(ll$x)^2 + diff(ll$y)^2)/diff(ll$time))

velocity_df <- data.table( velocity = unlist(velocity))

summary(velocity_df$velocity)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.0000  0.0000  0.1350  0.3708  0.8000  0.8130
```

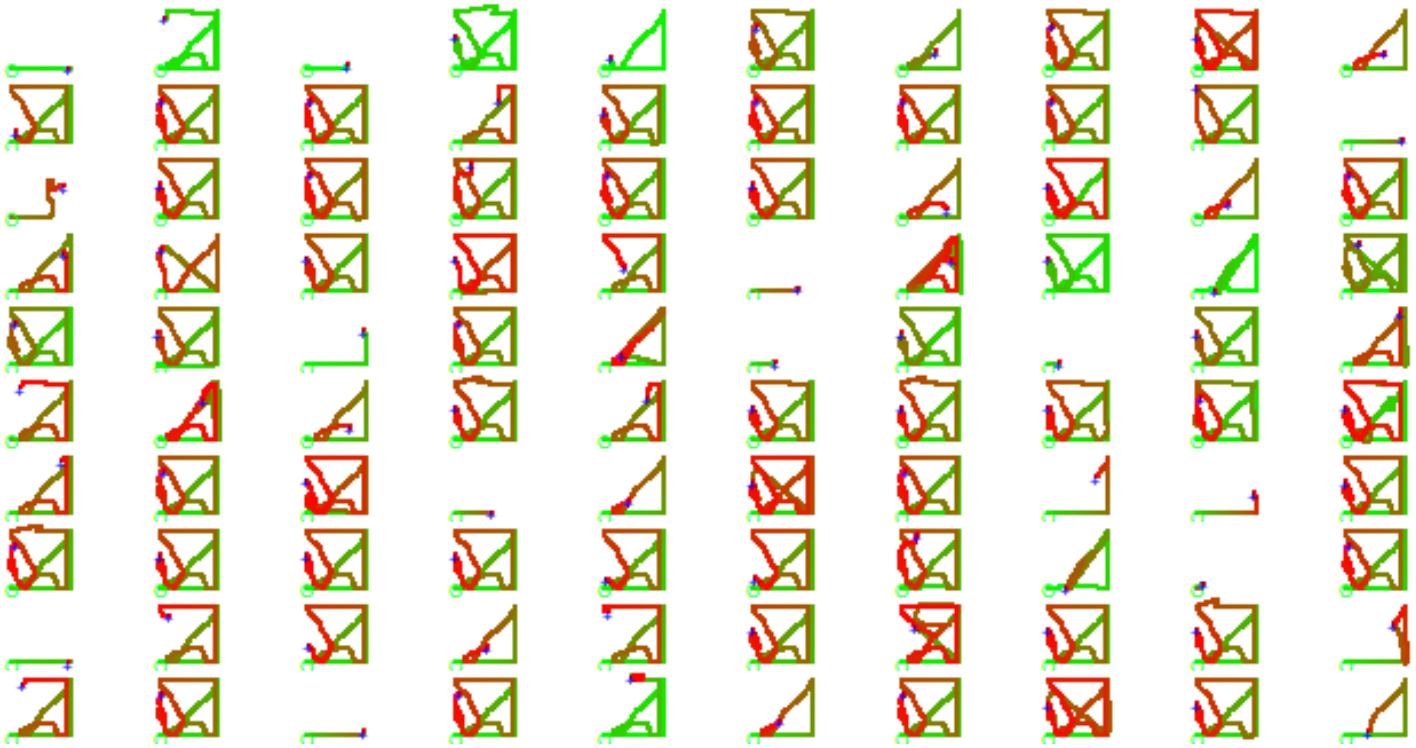
```
ggplot(velocity_df, aes(velocity)) +
   geom_density(fill = "darkgrey", alpha = .4) +
   labs(title = "Robot Velocity")
```




```
plot_path <- function(ll) {
   ggplot(ll, aes(x, y)) +
      geom_point()
}

plot_path(logs[[1]])
```




```
makeColorRamp <- function(n) {
   s <- (1:n)/n
   zero <- rep(0, n)
   rgb(s, (1-s), zero)
}

plot.RobotLog <-
function(x, y, col = makeColorRamp(nrow(x)), ...){
   plot(y ~ x, x, type = "p", pch = 20, col = col, ... )
   points(x$x[c(1, nrow(x))], x$y[c(1, nrow(x))],
          pch = c("0", "+"), col = c("green", "blue"))
}


par(mfrow = c(10, 10), mar = rep(0, 4), pty = 's')
invisible(lapply(logs, plot.RobotLog,
                 xlim = c(-16, 16), ylim = c(-8, 8),
                 axes = F))
```

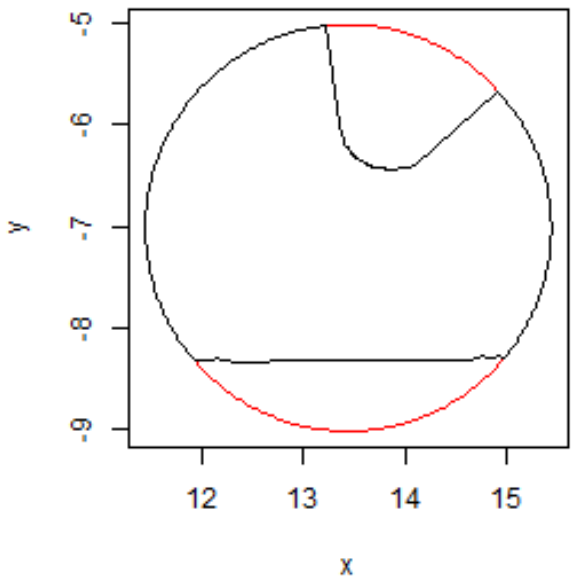


Exploring a "Look"

```
plot.Look <-
   function(row, ...) {

      x <- row[1, "x"]
      y <- row[1, "y"]

      theta <- seq(0, 2*pi, length = 360) - pi/2
      r <- as.numeric(row[1, -c(1:3, 365)])
      x1 <- x + r * cos(theta)
      y1 <- y + r * sin(theta)
      par(pty = 's')
      plot(x + 2*cos(theta), y + 2*sin(theta),
           col = "red", type = "l",
           xlab = "x", ylab = "y", ...)
      points(x1, y1, type = "l")
   }

par(mfrow = c(1,1))
plot.Look(logs[[1]][ nrow(logs[[1]]), ])
```

```
Warning in r * cos(theta): longer object length is not a multiple of shorter
object length
```

```
Warning in r * sin(theta): longer object length is not a multiple of shorter
object length
```




```
par(mfrow = c(1, 1))

index <- 2
row <- logs[[index]][ nrow(logs[[index]]), ]

x <- row[1, "x"]
y <- row[1, "y"]

theta <- seq(0, 2*pi, length = 360) - pi/2
r <- as.numeric(row[1, -c(1:3, 365)])

x1 <- x + r * cos(theta)
```

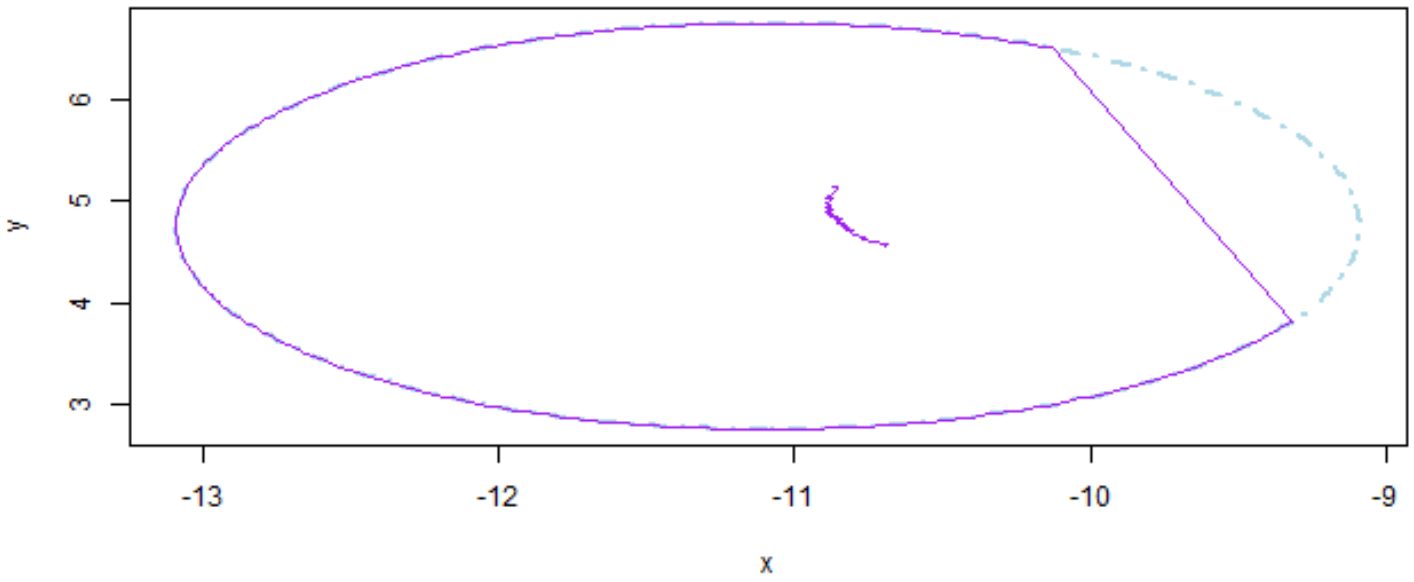
```
Warning in r * cos(theta): longer object length is not a multiple of shorter
object length
```

```
y1 <- y + r * sin(theta)
```

```
Warning in r * sin(theta): longer object length is not a multiple of shorter
object length
```

```
plot(x + 2*cos(theta), y + 2*sin(theta),
     col = "lightblue", type = "l",
     xlab = "x", ylab = "y", lwd = 2, lty=4)
```

```
eq2 <- cbind( x = x1[ which(r == 2) ], y = y1[ which(r == 2) ] )
lt2 <- cbind( x = x1[ which(r < 2) ], y = y1[ which(r < 2) ] )

points(eq2, type = "l", col="purple")
points(lt2, type ="l", col = "purple")
```




```
row <- logs[[1]][ nrow(logs[[1]]), ]

plot.Look2 <- function(row, ...) {

   x <- row[1, "x"]
   y <- row[1, "y"]

   theta <- seq(0, 2*pi, length = 360) - pi/2
   r <- as.numeric(row[1, -c(1:3, 365)])

   x1 <- x + r * cos(theta)
   y1 <- y + r * sin(theta)

   plot(x + 2*cos(theta), y + 2*sin(theta),
        col = "lightblue", type = "l",
        xlab = "x", ylab = "y", lwd = 2, lty=4)

   eq2 <- cbind( x = x1[ which(r == 2) ], y = y1[ which(r == 2) ] )
```

```r
  lt2 <- cbind( x = x1[ which(r < 2) ], y = y1[ which(r < 2) ] )

  points(eq2, type = "l", col="purple")
  points(lt2, type ="l", col = "purple")
}

par(mar = rep(0, 4), mfrow = c(10, 10), pty = 's')

invisible(lapply(logs, function(ll)
  plot.Look2(ll[ nrow(ll), ], axes = FALSE)))
```

```
Warning in r * cos(theta): longer object length is not a multiple of shorter
object length

Warning in r * sin(theta): longer object length is not a multiple of shorter
object length

Warning in r * cos(theta): longer object length is not a multiple of shorter
object length

Warning in r * sin(theta): longer object length is not a multiple of shorter
object length

Warning in r * cos(theta): longer object length is not a multiple of shorter
object length

Warning in r * sin(theta): longer object length is not a multiple of shorter
object length

Warning in r * cos(theta): longer object length is not a multiple of shorter
object length

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object length

Warning in r * cos(theta): longer object length is not a multiple of shorter
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object length

Warning in r * cos(theta): longer object length is not a multiple of shorter
object length

Warning in r * sin(theta): longer object length is not a multiple of shorter
object length

Warning in r * cos(theta): longer object length is not a multiple of shorter
object length

Warning in r * sin(theta): longer object length is not a multiple of shorter
```

```
object length

Warning in r * cos(theta): longer object length is not a multiple of shorter
object length

Warning in r * sin(theta): longer object length is not a multiple of shorter
object length

Warning in r * cos(theta): longer object length is not a multiple of shorter
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object length

Warning in r * sin(theta): longer object length is not a multiple of shorter
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Warning in r * cos(theta): longer object length is not a multiple of shorter
object length

Warning in r * sin(theta): longer object length is not a multiple of shorter
object length

Warning in r * cos(theta): longer object length is not a multiple of shorter
object length
```

```
Warning in r * sin(theta): longer object length is not a multiple of shorter
object length

Warning in r * cos(theta): longer object length is not a multiple of shorter
object length

Warning in r * sin(theta): longer object length is not a multiple of shorter
object length

Warning in r * cos(theta): longer object length is not a multiple of shorter
object length

Warning in r * sin(theta): longer object length is not a multiple of shorter
object length

Warning in r * cos(theta): longer object length is not a multiple of shorter
object length

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object length

Warning in r * cos(theta): longer object length is not a multiple of shorter
object length

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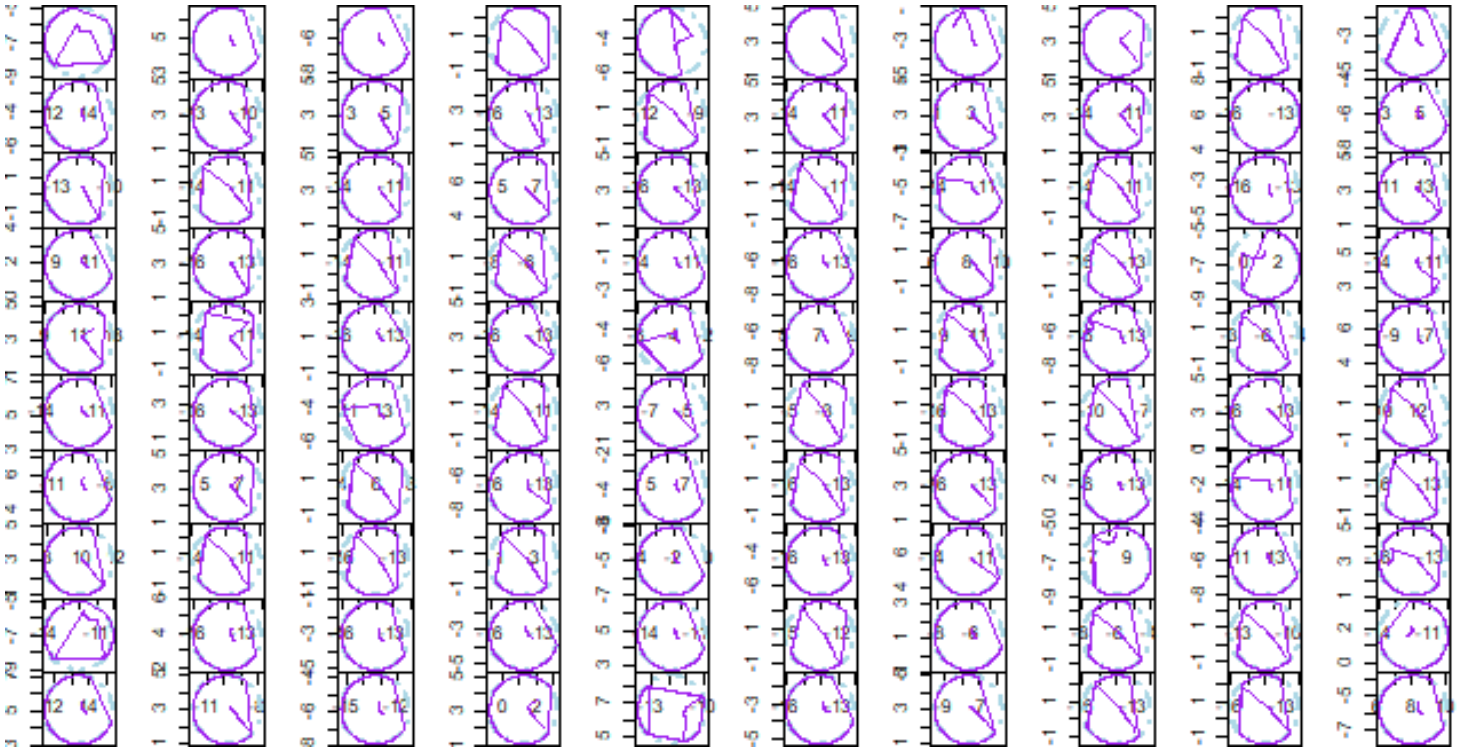

```
e <- unlist(lapply(logs, function(ll) ll$range1 - ll$range361))
summary(e)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
      0       0       0       0       0       0
```

```
class(ll)
```

```
[1] "data.frame"
```

```
getRangeErrors <- function(ll) {
   ll$pos <- sprintf("%.3f,%.3f", ll$x, ll$y)
   w <- duplicated(ll$pos)

   if(any(w)) {
      tmp <- ll[ ll$pos %in% ll$pos[w], ]
      errs <- unlist(by(tmp[, 4:364], tmp$pos, scale, scale = F,
                        simplify = F))

      errs
   }
}

rangeErrs <- unlist(lapply(logs, getRangeErrors))
```

```
finalLooks <- lapply(logs, function(ll) ll[nrow(ll), ])

length(finalLooks)
```

```
[1] 100
```

```
par(mar = rep(0, 4), mfrow = c(10, 10), pty = 's')
invisible(lapply(finalLooks, function(ll)
   plot.Look2(ll[ nrow(ll), ], axes = F)))
```

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