Untitled

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#load latex for rendering  
library(tinytex)

## Warning: package 'tinytex' was built under R version 4.3.3

# Load the readxl package  
library(readxl)  
  
# Define the Excel file path  
excel\_file\_path <- "C:\\Users\\Aayush\\Documents\\Golf project\\SustainableGolfSimulator.xlsx"  
  
# Get sheet names from the Excel file  
sheet\_names <- excel\_sheets(excel\_file\_path)  
  
# Initialize an empty list for data frames  
all\_data <- list()  
  
# Read each sheet into a data frame and store in the list  
for (sheet in sheet\_names) {  
 sheet\_data <- read\_excel(excel\_file\_path, sheet = sheet)  
 all\_data[[sheet]] <- sheet\_data  
}

## New names:  
## New names:  
## New names:  
## New names:  
## New names:  
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## New names:  
## • `` -> `...8`

# Access data frames using sheet names, e.g., all\_data$Sheet1

# Creating the Parameters data frame  
Parameters <- data.frame(  
 `Tee Shot Distance` = 250,  
 `SD Angle` = 8,  
 `Hole Length` = 380,  
 `Center to FW Edge` = 20,  
 `Center to Hazard Edge` = 40  
)  
  
# Print the Parameters data frame  
print(Parameters)

## Tee.Shot.Distance SD.Angle Hole.Length Center.to.FW.Edge  
## 1 250 8 380 20  
## Center.to.Hazard.Edge  
## 1 40

# Create the data frame  
Outcomes <- data.frame(  
 Approach\_Dist = 130:240,  
 F\_ES = c(2.85, 2.855, 2.86, 2.865, 2.87, 2.875, 2.88, 2.885, 2.89,   
 2.895, 2.9, rep(NA, 100)),  
 R\_ES = c(3.05, 3.055, 3.06, 3.065, 3.07, 3.075, 3.08, 3.085, 3.09,   
 3.095, rep(NA, 101)),  
 H\_ES = c(4.05, 4.055, 4.06, 4.065, 4.07, 4.075, 4.08, 4.085, 4.09,   
 4.095, rep(NA, 101))  
)  
  
# Print the data frame  
print(Outcomes)

## Approach\_Dist F\_ES R\_ES H\_ES  
## 1 130 2.850 3.050 4.050  
## 2 131 2.855 3.055 4.055  
## 3 132 2.860 3.060 4.060  
## 4 133 2.865 3.065 4.065  
## 5 134 2.870 3.070 4.070  
## 6 135 2.875 3.075 4.075  
## 7 136 2.880 3.080 4.080  
## 8 137 2.885 3.085 4.085  
## 9 138 2.890 3.090 4.090  
## 10 139 2.895 3.095 4.095  
## 11 140 2.900 NA NA  
## 12 141 NA NA NA  
## 13 142 NA NA NA  
## 14 143 NA NA NA  
## 15 144 NA NA NA  
## 16 145 NA NA NA  
## 17 146 NA NA NA  
## 18 147 NA NA NA  
## 19 148 NA NA NA  
## 20 149 NA NA NA  
## 21 150 NA NA NA  
## 22 151 NA NA NA  
## 23 152 NA NA NA  
## 24 153 NA NA NA  
## 25 154 NA NA NA  
## 26 155 NA NA NA  
## 27 156 NA NA NA  
## 28 157 NA NA NA  
## 29 158 NA NA NA  
## 30 159 NA NA NA  
## 31 160 NA NA NA  
## 32 161 NA NA NA  
## 33 162 NA NA NA  
## 34 163 NA NA NA  
## 35 164 NA NA NA  
## 36 165 NA NA NA  
## 37 166 NA NA NA  
## 38 167 NA NA NA  
## 39 168 NA NA NA  
## 40 169 NA NA NA  
## 41 170 NA NA NA  
## 42 171 NA NA NA  
## 43 172 NA NA NA  
## 44 173 NA NA NA  
## 45 174 NA NA NA  
## 46 175 NA NA NA  
## 47 176 NA NA NA  
## 48 177 NA NA NA  
## 49 178 NA NA NA  
## 50 179 NA NA NA  
## 51 180 NA NA NA  
## 52 181 NA NA NA  
## 53 182 NA NA NA  
## 54 183 NA NA NA  
## 55 184 NA NA NA  
## 56 185 NA NA NA  
## 57 186 NA NA NA  
## 58 187 NA NA NA  
## 59 188 NA NA NA  
## 60 189 NA NA NA  
## 61 190 NA NA NA  
## 62 191 NA NA NA  
## 63 192 NA NA NA  
## 64 193 NA NA NA  
## 65 194 NA NA NA  
## 66 195 NA NA NA  
## 67 196 NA NA NA  
## 68 197 NA NA NA  
## 69 198 NA NA NA  
## 70 199 NA NA NA  
## 71 200 NA NA NA  
## 72 201 NA NA NA  
## 73 202 NA NA NA  
## 74 203 NA NA NA  
## 75 204 NA NA NA  
## 76 205 NA NA NA  
## 77 206 NA NA NA  
## 78 207 NA NA NA  
## 79 208 NA NA NA  
## 80 209 NA NA NA  
## 81 210 NA NA NA  
## 82 211 NA NA NA  
## 83 212 NA NA NA  
## 84 213 NA NA NA  
## 85 214 NA NA NA  
## 86 215 NA NA NA  
## 87 216 NA NA NA  
## 88 217 NA NA NA  
## 89 218 NA NA NA  
## 90 219 NA NA NA  
## 91 220 NA NA NA  
## 92 221 NA NA NA  
## 93 222 NA NA NA  
## 94 223 NA NA NA  
## 95 224 NA NA NA  
## 96 225 NA NA NA  
## 97 226 NA NA NA  
## 98 227 NA NA NA  
## 99 228 NA NA NA  
## 100 229 NA NA NA  
## 101 230 NA NA NA  
## 102 231 NA NA NA  
## 103 232 NA NA NA  
## 104 233 NA NA NA  
## 105 234 NA NA NA  
## 106 235 NA NA NA  
## 107 236 NA NA NA  
## 108 237 NA NA NA  
## 109 238 NA NA NA  
## 110 239 NA NA NA  
## 111 240 NA NA NA

# Update row 11 based on F\_ES  
Outcomes$R\_ES[11] <- Outcomes$F\_ES[11] + 0.2  
Outcomes$H\_ES[11] <- Outcomes$R\_ES[11] + 1  
  
# Print the updated data frame  
print(Outcomes)

## Approach\_Dist F\_ES R\_ES H\_ES  
## 1 130 2.850 3.050 4.050  
## 2 131 2.855 3.055 4.055  
## 3 132 2.860 3.060 4.060  
## 4 133 2.865 3.065 4.065  
## 5 134 2.870 3.070 4.070  
## 6 135 2.875 3.075 4.075  
## 7 136 2.880 3.080 4.080  
## 8 137 2.885 3.085 4.085  
## 9 138 2.890 3.090 4.090  
## 10 139 2.895 3.095 4.095  
## 11 140 2.900 3.100 4.100  
## 12 141 NA NA NA  
## 13 142 NA NA NA  
## 14 143 NA NA NA  
## 15 144 NA NA NA  
## 16 145 NA NA NA  
## 17 146 NA NA NA  
## 18 147 NA NA NA  
## 19 148 NA NA NA  
## 20 149 NA NA NA  
## 21 150 NA NA NA  
## 22 151 NA NA NA  
## 23 152 NA NA NA  
## 24 153 NA NA NA  
## 25 154 NA NA NA  
## 26 155 NA NA NA  
## 27 156 NA NA NA  
## 28 157 NA NA NA  
## 29 158 NA NA NA  
## 30 159 NA NA NA  
## 31 160 NA NA NA  
## 32 161 NA NA NA  
## 33 162 NA NA NA  
## 34 163 NA NA NA  
## 35 164 NA NA NA  
## 36 165 NA NA NA  
## 37 166 NA NA NA  
## 38 167 NA NA NA  
## 39 168 NA NA NA  
## 40 169 NA NA NA  
## 41 170 NA NA NA  
## 42 171 NA NA NA  
## 43 172 NA NA NA  
## 44 173 NA NA NA  
## 45 174 NA NA NA  
## 46 175 NA NA NA  
## 47 176 NA NA NA  
## 48 177 NA NA NA  
## 49 178 NA NA NA  
## 50 179 NA NA NA  
## 51 180 NA NA NA  
## 52 181 NA NA NA  
## 53 182 NA NA NA  
## 54 183 NA NA NA  
## 55 184 NA NA NA  
## 56 185 NA NA NA  
## 57 186 NA NA NA  
## 58 187 NA NA NA  
## 59 188 NA NA NA  
## 60 189 NA NA NA  
## 61 190 NA NA NA  
## 62 191 NA NA NA  
## 63 192 NA NA NA  
## 64 193 NA NA NA  
## 65 194 NA NA NA  
## 66 195 NA NA NA  
## 67 196 NA NA NA  
## 68 197 NA NA NA  
## 69 198 NA NA NA  
## 70 199 NA NA NA  
## 71 200 NA NA NA  
## 72 201 NA NA NA  
## 73 202 NA NA NA  
## 74 203 NA NA NA  
## 75 204 NA NA NA  
## 76 205 NA NA NA  
## 77 206 NA NA NA  
## 78 207 NA NA NA  
## 79 208 NA NA NA  
## 80 209 NA NA NA  
## 81 210 NA NA NA  
## 82 211 NA NA NA  
## 83 212 NA NA NA  
## 84 213 NA NA NA  
## 85 214 NA NA NA  
## 86 215 NA NA NA  
## 87 216 NA NA NA  
## 88 217 NA NA NA  
## 89 218 NA NA NA  
## 90 219 NA NA NA  
## 91 220 NA NA NA  
## 92 221 NA NA NA  
## 93 222 NA NA NA  
## 94 223 NA NA NA  
## 95 224 NA NA NA  
## 96 225 NA NA NA  
## 97 226 NA NA NA  
## 98 227 NA NA NA  
## 99 228 NA NA NA  
## 100 229 NA NA NA  
## 101 230 NA NA NA  
## 102 231 NA NA NA  
## 103 232 NA NA NA  
## 104 233 NA NA NA  
## 105 234 NA NA NA  
## 106 235 NA NA NA  
## 107 236 NA NA NA  
## 108 237 NA NA NA  
## 109 238 NA NA NA  
## 110 239 NA NA NA  
## 111 240 NA NA NA

# Fill in values starting from row 12  
for (i in 12:nrow(Outcomes)) {  
 Outcomes$F\_ES[i] <- Outcomes$F\_ES[i - 1] + 0.01  
 Outcomes$R\_ES[i] <- Outcomes$F\_ES[i] + 0.2  
 Outcomes$H\_ES[i] <- Outcomes$R\_ES[i] + 1  
}  
  
# Print the final data frame  
print(Outcomes)

## Approach\_Dist F\_ES R\_ES H\_ES  
## 1 130 2.850 3.050 4.050  
## 2 131 2.855 3.055 4.055  
## 3 132 2.860 3.060 4.060  
## 4 133 2.865 3.065 4.065  
## 5 134 2.870 3.070 4.070  
## 6 135 2.875 3.075 4.075  
## 7 136 2.880 3.080 4.080  
## 8 137 2.885 3.085 4.085  
## 9 138 2.890 3.090 4.090  
## 10 139 2.895 3.095 4.095  
## 11 140 2.900 3.100 4.100  
## 12 141 2.910 3.110 4.110  
## 13 142 2.920 3.120 4.120  
## 14 143 2.930 3.130 4.130  
## 15 144 2.940 3.140 4.140  
## 16 145 2.950 3.150 4.150  
## 17 146 2.960 3.160 4.160  
## 18 147 2.970 3.170 4.170  
## 19 148 2.980 3.180 4.180  
## 20 149 2.990 3.190 4.190  
## 21 150 3.000 3.200 4.200  
## 22 151 3.010 3.210 4.210  
## 23 152 3.020 3.220 4.220  
## 24 153 3.030 3.230 4.230  
## 25 154 3.040 3.240 4.240  
## 26 155 3.050 3.250 4.250  
## 27 156 3.060 3.260 4.260  
## 28 157 3.070 3.270 4.270  
## 29 158 3.080 3.280 4.280  
## 30 159 3.090 3.290 4.290  
## 31 160 3.100 3.300 4.300  
## 32 161 3.110 3.310 4.310  
## 33 162 3.120 3.320 4.320  
## 34 163 3.130 3.330 4.330  
## 35 164 3.140 3.340 4.340  
## 36 165 3.150 3.350 4.350  
## 37 166 3.160 3.360 4.360  
## 38 167 3.170 3.370 4.370  
## 39 168 3.180 3.380 4.380  
## 40 169 3.190 3.390 4.390  
## 41 170 3.200 3.400 4.400  
## 42 171 3.210 3.410 4.410  
## 43 172 3.220 3.420 4.420  
## 44 173 3.230 3.430 4.430  
## 45 174 3.240 3.440 4.440  
## 46 175 3.250 3.450 4.450  
## 47 176 3.260 3.460 4.460  
## 48 177 3.270 3.470 4.470  
## 49 178 3.280 3.480 4.480  
## 50 179 3.290 3.490 4.490  
## 51 180 3.300 3.500 4.500  
## 52 181 3.310 3.510 4.510  
## 53 182 3.320 3.520 4.520  
## 54 183 3.330 3.530 4.530  
## 55 184 3.340 3.540 4.540  
## 56 185 3.350 3.550 4.550  
## 57 186 3.360 3.560 4.560  
## 58 187 3.370 3.570 4.570  
## 59 188 3.380 3.580 4.580  
## 60 189 3.390 3.590 4.590  
## 61 190 3.400 3.600 4.600  
## 62 191 3.410 3.610 4.610  
## 63 192 3.420 3.620 4.620  
## 64 193 3.430 3.630 4.630  
## 65 194 3.440 3.640 4.640  
## 66 195 3.450 3.650 4.650  
## 67 196 3.460 3.660 4.660  
## 68 197 3.470 3.670 4.670  
## 69 198 3.480 3.680 4.680  
## 70 199 3.490 3.690 4.690  
## 71 200 3.500 3.700 4.700  
## 72 201 3.510 3.710 4.710  
## 73 202 3.520 3.720 4.720  
## 74 203 3.530 3.730 4.730  
## 75 204 3.540 3.740 4.740  
## 76 205 3.550 3.750 4.750  
## 77 206 3.560 3.760 4.760  
## 78 207 3.570 3.770 4.770  
## 79 208 3.580 3.780 4.780  
## 80 209 3.590 3.790 4.790  
## 81 210 3.600 3.800 4.800  
## 82 211 3.610 3.810 4.810  
## 83 212 3.620 3.820 4.820  
## 84 213 3.630 3.830 4.830  
## 85 214 3.640 3.840 4.840  
## 86 215 3.650 3.850 4.850  
## 87 216 3.660 3.860 4.860  
## 88 217 3.670 3.870 4.870  
## 89 218 3.680 3.880 4.880  
## 90 219 3.690 3.890 4.890  
## 91 220 3.700 3.900 4.900  
## 92 221 3.710 3.910 4.910  
## 93 222 3.720 3.920 4.920  
## 94 223 3.730 3.930 4.930  
## 95 224 3.740 3.940 4.940  
## 96 225 3.750 3.950 4.950  
## 97 226 3.760 3.960 4.960  
## 98 227 3.770 3.970 4.970  
## 99 228 3.780 3.980 4.980  
## 100 229 3.790 3.990 4.990  
## 101 230 3.800 4.000 5.000  
## 102 231 3.810 4.010 5.010  
## 103 232 3.820 4.020 5.020  
## 104 233 3.830 4.030 5.030  
## 105 234 3.840 4.040 5.040  
## 106 235 3.850 4.050 5.050  
## 107 236 3.860 4.060 5.060  
## 108 237 3.870 4.070 5.070  
## 109 238 3.880 4.080 5.080  
## 110 239 3.890 4.090 5.090  
## 111 240 3.900 4.100 5.100

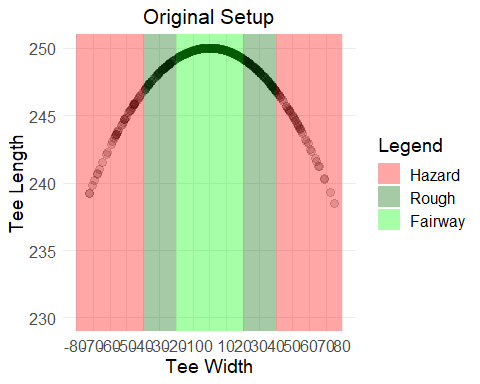
library(tidyverse)

## ── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──  
## ✔ dplyr 1.1.2 ✔ readr 2.1.4  
## ✔ forcats 1.0.0 ✔ stringr 1.5.0  
## ✔ ggplot2 3.4.2 ✔ tibble 3.2.1  
## ✔ lubridate 1.9.2 ✔ tidyr 1.3.0  
## ✔ purrr 1.0.1   
## ── Conflicts ────────────────────────────────────────── tidyverse\_conflicts() ──  
## ✖ dplyr::filter() masks stats::filter()  
## ✖ dplyr::lag() masks stats::lag()  
## ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors

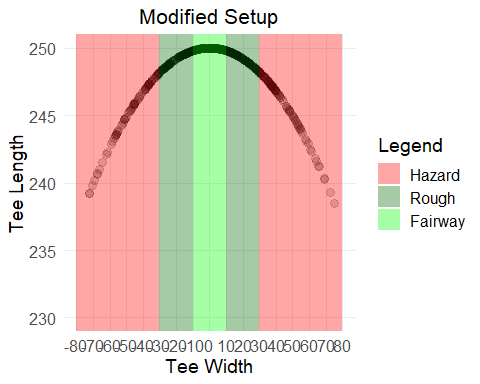
# Define the function to run the golf simulator  
runGolfSimulatorPar4 <- function(num\_trials,  
 Tee.Shot.Distance = 250,  
 SD.Angle = 8,  
 Hole.Length = 380,  
 Center.to.FW.Edge = 20,  
 Center.to.Hazard.Edge = 40) {  
 # Create the Simulator data frame  
 Simulator <- data.frame(  
 Trial = 1:num\_trials,  
 Tee\_Degrees = rep(NA, num\_trials),  
 Tee\_Length = rep(NA, num\_trials),  
 Tee\_Width = rep(NA, num\_trials),  
 Outcome = rep(NA, num\_trials),  
 Approach\_Dist = rep(NA, num\_trials),  
 Score = rep(NA, num\_trials)  
 )  
   
 # Run the simulation for each trial  
 for (i in 1:nrow(Simulator)) {  
 Simulator$Tee\_Degrees\_no\_abs[i] <- SD.Angle \*   
 (rnorm(1, mean = 0, sd = 1))  
   
 Simulator$Tee\_Width\_no\_abs[i] <- Tee.Shot.Distance \*   
 sin(Simulator$Tee\_Degrees\_no\_abs[i] \* (pi/180))  
   
 Simulator$Tee\_Degrees[i] <- SD.Angle \*   
 abs(rnorm(1, mean = 0, sd = 1))  
   
 Simulator$Tee\_Length[i] <- Tee.Shot.Distance \*   
 cos(Simulator$Tee\_Degrees[i] \* (pi/180))  
   
 Simulator$Tee\_Length\_no\_abs[i] <- Tee.Shot.Distance \*   
 cos(Simulator$Tee\_Degrees\_no\_abs[i] \* (pi/180))  
   
 Simulator$Tee\_Width[i] <- Tee.Shot.Distance \*   
 sin(Simulator$Tee\_Degrees[i] \* (pi/180))  
   
 Simulator$Outcome[i] <- ifelse(Simulator$Tee\_Width[i] <   
 Center.to.FW.Edge, "F",   
 ifelse(Simulator$Tee\_Width[i] <   
 Center.to.Hazard.Edge,   
 "R", "H"))  
   
 Simulator$Approach\_Dist[i] <- sqrt((Hole.Length -   
 Simulator$Tee\_Length[i])^2 +   
 Simulator$Tee\_Width[i]^2)  
   
 Simulator$Score[i] <- ifelse(Simulator$Outcome[i] == 'F',  
 Outcomes[which(Outcomes$Approach\_Dist ==   
 floor(Simulator$Approach\_Dist[i])),   
 "F\_ES"] + 1,  
 ifelse(Simulator$Outcome[i] == 'R',  
 Outcomes[which(Outcomes$Approach\_Dist ==   
 floor(Simulator$Approach\_Dist[i])),   
 "R\_ES"] + 1,  
 Outcomes[which(Outcomes$Approach\_Dist ==   
 floor(Simulator$Approach\_Dist[i])),   
 "H\_ES"] + 1))  
 }  
   
 # Calculate outcome distribution  
 distribution <- Simulator %>%   
 group\_by(Outcome) %>%   
 count() %>%   
 mutate(percent = n / num\_trials \* 100)  
   
 # Print the results  
 print(Simulator)  
 print(mean(Simulator$Score))  
 print(distribution)  
   
 # Plot the original setup  
 rects <- data.frame(xstart = c(-80, -40, -20, 20, 40),  
 xend = c(-40, -20, 20, 40, 80),  
 col = c("red", "darkgreen", "green",   
 "darkgreen", "red"))  
   
 custom\_labels <- c("Hazard" = "red", "Rough" = "darkgreen",   
 "Fairway" = "green")  
   
 plot\_1 <- ggplot(data = Simulator) +  
 geom\_point(aes(x = Tee\_Width\_no\_abs, y = Tee\_Length\_no\_abs),   
 alpha = 0.15, size = 3) +  
 geom\_rect(data = rects,   
 aes(xmin = xstart, xmax = xend, ymin = -Inf, ymax = Inf,   
 fill = col), alpha = 0.35) +  
 scale\_fill\_manual(values = rects$col, breaks = unique(rects$col),   
 labels = c("Hazard", "Rough", "Fairway")) +  
 guides(fill = guide\_legend(title = "Legend")) +  
 scale\_x\_continuous(breaks = seq(-80, 80, by = 10),   
 limits = c(-80, 80), minor\_breaks = NULL) +  
 scale\_y\_continuous(limits = c(230, 250), minor\_breaks = NULL) +  
 theme\_minimal() +  
 theme(  
 axis.title.x = element\_text(size = 14),  
 axis.title.y = element\_text(size = 14),  
 axis.text.x = element\_text(size = 12),  
 axis.text.y = element\_text(size = 12),  
 legend.title = element\_text(size = 14),  
 legend.text = element\_text(size = 12),  
 plot.title = element\_text(size = 16, hjust = 0.5)  
 ) +  
 labs(x = "Tee Width", y = "Tee Length", title = "Original Setup")  
   
 print(plot\_1)  
   
 ggsave("plot\_1.png", plot = plot\_1, width = 21, height = 7, dpi = 300)  
   
 # Plot the modified setup  
 rects2 <- data.frame(xstart = c(-80, -30, -10, 10, 30),  
 xend = c(-30, -10, 10, 30, 80),  
 col = c("red", "darkgreen", "green",   
 "darkgreen", "red"))  
   
 custom\_labels2 <- c("Hazard" = "red", "Rough" = "darkgreen",   
 "Fairway" = "green")  
   
 plot\_2 <- ggplot(data = Simulator) +  
 geom\_point(aes(x = Tee\_Width\_no\_abs, y = Tee\_Length\_no\_abs),   
 alpha = 0.15, size = 3) +  
 geom\_rect(data = rects2,   
 aes(xmin = xstart, xmax = xend, ymin = -Inf, ymax = Inf,   
 fill = col), alpha = 0.35) +  
 scale\_fill\_manual(values = rects2$col, breaks = unique(rects$col),   
 labels = c("Hazard", "Rough", "Fairway")) +  
 guides(fill = guide\_legend(title = "Legend")) +  
 scale\_x\_continuous(breaks = seq(-80, 80, by = 10),   
 limits = c(-80, 80), minor\_breaks = NULL) +  
 scale\_y\_continuous(limits = c(230, 250), minor\_breaks = NULL) +  
 theme\_minimal() +  
 theme(  
 axis.title.x = element\_text(size = 14),  
 axis.title.y = element\_text(size = 14),  
 axis.text.x = element\_text(size = 12),  
 axis.text.y = element\_text(size = 12),  
 legend.title = element\_text(size = 14),  
 legend.text = element\_text(size = 12),  
 plot.title = element\_text(size = 16, hjust = 0.5)  
 ) +  
 labs(x = "Tee Width", y = "Tee Length", title = "Modified Setup")  
   
 print(plot\_2)  
   
 ggsave("plot\_2.png", plot = plot\_2, width = 21, height = 7, dpi = 300)  
}  
  
# Run the golf simulator with 500 trials  
runGolfSimulatorPar4(500)

## Trial Tee\_Degrees Tee\_Length Tee\_Width Outcome Approach\_Dist Score  
## 1 1 0.534434955 249.9891 2.33187859 F 130.0318 3.850  
## 2 2 15.418591426 241.0023 66.46723368 H 154.0722 5.240  
## 3 3 13.515259776 243.0769 58.42608253 H 148.8675 5.180  
## 4 4 8.091696230 247.5110 35.18943705 R 137.0826 4.085  
## 5 5 9.557603370 246.5298 41.50977568 H 139.7761 5.095  
## 6 6 8.211059532 247.4372 35.70499571 R 137.2871 4.085  
## 7 7 10.508336009 245.8071 45.59464453 H 141.7272 5.110  
## 8 8 6.834303582 248.2236 29.74961147 R 135.0928 4.075  
## 9 9 0.610754381 249.9858 2.66486825 F 130.0415 3.850  
## 10 10 8.467178159 247.2751 36.81070749 R 137.7350 4.085  
## 11 11 3.138796917 249.6250 13.68873590 F 131.0917 3.855  
## 12 12 10.516673782 245.8005 45.63041429 H 141.7450 5.110  
## 13 13 0.707957931 249.9809 3.08897061 F 130.0558 3.850  
## 14 14 2.831822438 249.6947 12.35112637 F 130.8893 3.850  
## 15 15 3.375941877 249.5662 14.72180350 F 131.2620 3.855  
## 16 16 16.323539966 239.9225 70.26525529 H 156.7129 5.260  
## 17 17 3.489150424 249.5366 15.21488270 F 131.3476 3.855  
## 18 18 7.481760350 247.8716 32.55264178 R 136.0794 4.080  
## 19 19 15.314343805 241.1228 66.02862885 H 153.7747 5.230  
## 20 20 9.265295020 246.7384 40.25150926 H 139.2079 5.095  
## 21 21 4.757943890 249.1385 20.73659439 R 132.4943 4.060  
## 22 22 1.225841047 249.9428 5.34833254 F 130.1671 3.850  
## 23 23 8.571458623 247.2077 37.26069620 R 137.9208 4.085  
## 24 24 12.414060973 244.1549 53.74375153 H 146.0900 5.160  
## 25 25 2.924576635 249.6744 12.75533232 F 130.9483 3.850  
## 26 26 9.655146302 246.4588 41.92941882 H 139.9691 5.095  
## 27 27 14.581251438 241.9479 62.93817174 H 151.7221 5.210  
## 28 28 1.528018005 249.9111 6.66644601 F 130.2596 3.850  
## 29 29 4.151368833 249.3441 18.09791907 F 131.9034 3.855  
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## 38 38 1.333294798 249.9323 5.81707100 F 130.1977 3.850  
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## 59 59 0.895436063 249.9695 3.90691784 F 130.0892 3.850  
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## 169 169 0.092673763 249.9997 0.40436540 F 130.0010 3.850  
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## 487 -2.139530267 -9.333292470 249.8257  
## 488 -2.721913263 -11.872120316 249.7179  
## 489 3.493544473 15.234019774 249.5354  
## 490 7.990956779 34.754200320 247.5725  
## 491 -22.613876376 -96.129725559 230.7793  
## 492 8.993226215 39.079423662 246.9267  
## 493 -3.253613372 -14.188937813 249.5970  
## 494 6.701639039 29.174787078 248.2918  
## 495 -7.378225338 -32.104678259 247.9300  
## 496 11.894761962 51.528682066 244.6320  
## 497 5.635909236 24.551655951 248.7915  
## 498 -3.659643732 -15.957352671 249.4902  
## 499 -2.301598538 -10.039917449 249.7983  
## 500 2.819940263 12.299343646 249.6973  
## [1] 4.25806  
## # A tibble: 3 × 3  
## # Groups: Outcome [3]  
## Outcome n percent  
## <chr> <int> <dbl>  
## 1 F 220 44   
## 2 H 128 25.6  
## 3 R 152 30.4

## Warning: Removed 14 rows containing missing values (`geom\_point()`).  
## Removed 14 rows containing missing values (`geom\_point()`).



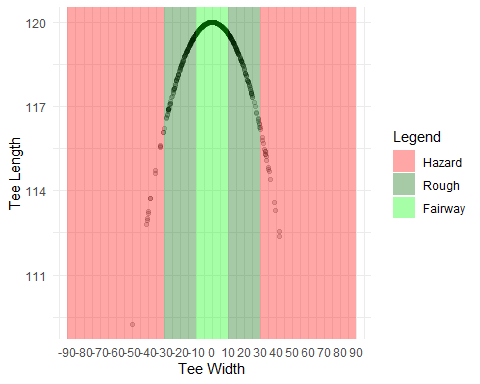
## Warning: Removed 14 rows containing missing values (`geom\_point()`).  
## Removed 14 rows containing missing values (`geom\_point()`).



library(tidyverse)  
Par3Out <- all\_data$Par3Out  
  
Par3Out <- Par3Out %>%   
 rename(Approach\_Dist = 'Approach Dist', G\_ES = 'G E(S)',   
 R\_ES = 'R E(S)', H\_ES = 'H E(S)')

runGolfSimulator2 <- function(num\_trials,  
 Tee.Shot.Distance = 120,  
 SD.Angle = 8,  
 Semicircle.Green.Radius = 25,  
 Center.to.Hazard.Edge = 30) {  
 # Create Simulator data frame  
 Simulator <- data.frame(  
 Trial = 1:num\_trials,  
 Tee\_Degrees = rep(NA, num\_trials),  
 Tee\_Length = rep(NA, num\_trials),  
 Tee\_Width = rep(NA, num\_trials),  
 Outcome = rep(NA, num\_trials),  
 Approach\_Dist = rep(NA, num\_trials),  
 Score = rep(NA, num\_trials)  
 )  
  
 for (i in 1:nrow(Simulator)) {  
 Simulator$Tee\_Degrees\_no\_abs[i] <- SD.Angle \*   
 (rnorm(1, mean = 0, sd = 1))  
   
 Simulator$Tee\_Width\_no\_abs[i] <- Tee.Shot.Distance \*   
 sin(Simulator$Tee\_Degrees\_no\_abs[i] \* (pi/180))  
   
 Simulator$Tee\_Degrees[i] <- SD.Angle \*   
 abs(rnorm(1, mean = 0, sd = 1))  
  
 Simulator$Tee\_Length[i] <- Tee.Shot.Distance \*   
 cos(Simulator$Tee\_Degrees[i] \* (pi/180))  
   
 Simulator$Tee\_Length\_no\_abs[i] <- Tee.Shot.Distance \*   
 cos(Simulator$Tee\_Degrees\_no\_abs[i] \* (pi/180))  
  
 Simulator$Tee\_Width[i] <- Tee.Shot.Distance \*   
 sin(Simulator$Tee\_Degrees[i] \* (pi/180))  
   
 Simulator$Approach\_Dist[i] <- sqrt((Tee.Shot.Distance -   
 Simulator$Tee\_Length[i])^2 + Simulator$Tee\_Width[i]^2)  
   
 Simulator$Outcome[i] <- ifelse(Simulator$Approach\_Dist[i] <   
 Semicircle.Green.Radius, "G", ifelse(Simulator$Tee\_Width[i] <   
 Center.to.Hazard.Edge, "R", "H"))  
   
 # Calculate Score based on Outcome  
 temp\_score <- ifelse(Simulator$Outcome[i] == 'G',  
 Par3Out[which(Par3Out$Approach\_Dist == floor(  
 Simulator$Approach\_Dist[i])), "G\_ES"] + 1,  
 ifelse(Simulator$Outcome[i] == 'R',  
 Par3Out[which(Par3Out$Approach\_Dist == floor(  
 Simulator$Approach\_Dist[i])), "R\_ES"] + 1,  
 Par3Out[which(Par3Out$Approach\_Dist == floor(  
 Simulator$Approach\_Dist[i])), "H\_ES"] + 1))  
  
 # Unlist to convert to numeric vector  
 temp\_score <- unlist(temp\_score)  
  
 # Assign the value to Score  
 Simulator$Score[i] <- temp\_score[1]  
 }  
   
 distribution <- Simulator %>%   
 group\_by(Outcome) %>%   
 count() %>%   
 mutate(percent = n/num\_trials \* 100)  
  
 # Print the updated Simulator data frame  
 print(Simulator)  
 cat("Average:", mean(Simulator$Score))  
 print(distribution)  
   
 # Define rectangles data  
 rects <- data.frame(xstart = c(-90, -30, -10, 10, 30),  
 xend = c(-30, -10, 10, 30, 90),  
 col = c("red", "darkgreen", "green", "darkgreen", "red"))  
  
 custom\_labels <- c("Hazard" = "red", "Rough" = "darkgreen", "Fairway" = "green")  
  
 # Create the plot  
 plot\_2 <- ggplot(data = Simulator) +  
 geom\_point(aes(x = Tee\_Width\_no\_abs, y = Tee\_Length\_no\_abs), alpha = 0.15) +  
 geom\_rect(data = rects, aes(xmin = xstart, xmax = xend, ymin = -Inf, ymax = Inf,   
 fill = col), alpha = 0.35) +  
 scale\_fill\_manual(values = rects$col, breaks = unique(rects$col),   
 labels = c("Hazard", "Rough", "Fairway")) +   
 guides(fill = guide\_legend(title = "Legend")) +  
 scale\_x\_continuous(breaks = seq(-100, 100, by = 10)) +  
 theme\_minimal() +  
 labs(x = "Tee Width", y = "Tee Length", t)  
  
 print(plot\_2)  
  
 ggsave("plot\_3.png", plot = plot\_2, width = 10, height = 8, dpi = 300)  
}  
  
# Call the function with the desired number of trials  
runGolfSimulator2(500) # You can replace 1100 with any number of trials you want

## Trial Tee\_Degrees Tee\_Length Tee\_Width Outcome Approach\_Dist Score  
## 1 1 4.323971568 119.6584 9.047511043 G 9.053955959 2.990  
## 2 2 3.171243803 119.8162 6.638446827 G 6.640989726 2.880  
## 3 3 4.845414443 119.5711 10.136120239 G 10.145188458 3.030  
## 4 4 3.409538945 119.7876 7.136707885 G 7.139868082 2.900  
## 5 5 9.374455952 118.3974 19.546332575 G 19.611922153 3.290  
## 6 6 4.572654316 119.6180 9.566781642 G 9.574403407 2.990  
## 7 7 5.699944516 119.4067 11.918254337 G 11.933013666 3.070  
## 8 8 4.194334334 119.6786 8.776749337 G 8.782631906 2.940  
## 9 9 13.038210301 116.9064 27.072096882 R 27.248282832 3.660  
## 10 10 0.521066389 119.9950 1.091303851 G 1.091315133 2.070  
## 11 11 0.811631765 119.9880 1.699820742 G 1.699863380 2.070  
## 12 12 3.240448133 119.8081 6.783161205 G 6.785874217 2.880  
## 13 13 4.162364412 119.6835 8.709969656 G 8.715718764 2.940  
## 14 14 7.630952610 118.9373 15.935022036 G 15.970419985 3.210  
## 15 15 6.454448035 119.2394 13.489590825 G 13.511017570 3.150  
## 16 16 3.181638191 119.8150 6.660183337 G 6.662751320 2.880  
## 17 17 9.108535338 118.4868 18.996619234 G 19.056789635 3.290  
## 18 18 0.300342154 119.9984 0.629032255 G 0.629034416 2.000  
## 19 19 9.319956512 118.4159 19.433704786 G 19.498158315 3.290  
## 20 20 7.137637582 119.0701 14.910397513 G 14.939368651 3.190  
## 21 21 3.710603772 119.7484 7.766039055 G 7.770112325 2.900  
## 22 22 9.316864120 118.4170 19.427313565 G 19.491703028 3.290  
## 23 23 6.540772989 119.2189 13.669228025 G 13.691525559 3.150  
## 24 24 3.385424216 119.7906 7.086290882 G 7.089384508 2.900  
## 25 25 0.035919281 120.0000 0.075229162 G 0.075229165 2.000  
## 26 26 6.604449927 119.2037 13.801716159 G 13.824670912 3.150  
## 27 27 0.253201091 119.9988 0.530301398 G 0.530302693 2.000  
## 28 28 0.001334829 120.0000 0.002795660 G 0.002795660 2.000  
## 29 29 3.156014362 119.8180 6.606598971 G 6.609105415 2.880  
## 30 30 2.383322091 119.8962 4.990178744 G 4.991258249 2.730  
## 31 31 8.911178213 118.5516 18.588375718 G 18.644722883 3.270  
## 32 32 6.636280921 119.1960 13.867938292 G 13.891226361 3.150  
## 33 33 4.545125787 119.6226 9.509308438 G 9.516793411 2.990  
## 34 34 5.724143590 119.4016 11.968685105 G 11.983633136 3.070  
## 35 35 5.969154481 119.3494 12.479164974 G 12.496114876 3.110  
## 36 36 11.038153163 117.7800 22.975514030 G 23.082519247 3.370  
## 37 37 2.113642936 119.9184 4.425799428 G 4.426552404 2.730  
## 38 38 6.531164806 119.2212 13.649235482 G 13.671434950 3.150  
## 39 39 19.517326909 113.1049 40.091029164 H 40.679645690 4.790  
## 40 40 9.764330354 118.2616 20.351519737 G 20.425627258 3.310  
## 41 41 4.566190924 119.6191 9.553287771 G 9.560877271 2.990  
## 42 42 10.443481105 118.0121 21.751861707 G 21.842509499 3.330  
## 43 43 2.716388596 119.8652 5.687059945 G 5.688658170 2.810  
## 44 44 15.497029761 115.6373 32.062610481 H 32.358059222 4.710  
## 45 45 3.014821719 119.8339 6.311314532 G 6.313499439 2.880  
## 46 46 13.813182738 116.5295 28.650827034 R 28.860251022 3.670  
## 47 47 2.165245853 119.9143 4.533800985 G 4.534610465 2.730  
## 48 48 5.908842926 119.3624 12.353526741 G 12.369968262 3.110  
## 49 49 4.455849490 119.6373 9.322905140 G 9.329957764 2.990  
## 50 50 1.114524734 119.9773 2.334107940 G 2.334218344 2.450  
## 51 51 8.473559072 118.6901 17.682357976 G 17.730811703 3.250  
## 52 52 9.500071085 118.3542 19.805859541 G 19.874118171 3.290  
## 53 53 7.535469077 118.9637 15.736790792 G 15.770877470 3.210  
## 54 54 5.160109391 119.5137 10.792704143 G 10.803655802 3.030  
## 55 55 1.480970907 119.9599 3.101392843 G 3.101651870 2.650  
## 56 56 4.506081555 119.6291 9.427789349 G 9.435083128 2.990  
## 57 57 12.413368448 117.1947 25.795584221 R 25.947680238 3.640  
## 58 58 0.053112264 119.9999 0.111238049 G 0.111238061 2.000  
## 59 59 9.215156757 118.4513 19.217077740 G 19.279383657 3.290  
## 60 60 3.565870209 119.7677 7.463520797 G 7.467135851 2.900  
## 61 61 0.041996852 120.0000 0.087957993 G 0.087957999 2.000  
## 62 62 13.600097741 116.6353 28.217252541 R 28.417155662 3.670  
## 63 63 2.259604785 119.9067 4.731278530 G 4.732198510 2.730  
## 64 64 13.791742904 116.5402 28.607220183 R 28.815672876 3.670  
## 65 65 1.016507499 119.9811 2.128856645 G 2.128940407 2.450  
## 66 66 1.757082493 119.9436 3.679448178 G 3.679880766 2.650  
## 67 67 8.454141982 118.6961 17.642133826 G 17.690255523 3.250  
## 68 68 2.465030768 119.8890 5.161155833 G 5.162350207 2.810  
## 69 69 20.186682255 112.6288 41.409605732 H 42.060553606 4.800  
## 70 70 3.879547809 119.7250 8.119098585 G 8.123753827 2.940  
## 71 71 1.713992383 119.9463 3.589241863 G 3.589643400 2.650  
## 72 72 0.194816361 119.9993 0.408021645 G 0.408022235 2.000  
## 73 73 3.969944191 119.7121 8.307980302 G 8.312968529 2.940  
## 74 74 0.617235430 119.9930 1.292709858 G 1.292728611 2.070  
## 75 75 9.042857593 118.5085 18.860786174 G 18.919665685 3.270  
## 76 76 5.930949458 119.3577 12.399579639 G 12.416206304 3.110  
## 77 77 1.294790558 119.9694 2.711572196 G 2.711745300 2.450  
## 78 78 2.437659156 119.8914 5.103881323 G 5.105036353 2.810  
## 79 79 0.273435423 119.9986 0.572679636 G 0.572681267 2.000  
## 80 80 2.620402258 119.8745 5.486244631 G 5.487679362 2.810  
## 81 81 6.080153171 119.3250 12.710356050 G 12.728268758 3.110  
## 82 82 3.415721097 119.7868 7.149632793 G 7.152810209 2.900  
## 83 83 4.665100054 119.6025 9.759770728 G 9.767864040 2.990  
## 84 84 1.148109267 119.9759 2.404433509 G 2.404554196 2.450  
## 85 85 8.876573150 118.5628 18.516770477 G 18.572464396 3.270  
## 86 86 9.067310440 118.5005 18.911361843 G 18.970719796 3.270  
## 87 87 1.307647756 119.9687 2.738493305 G 2.738671617 2.450  
## 88 88 1.513092558 119.9582 3.168645307 G 3.168921557 2.650  
## 89 89 17.608325523 114.3776 36.301007231 H 36.733832286 4.750  
## 90 90 3.456034748 119.7818 7.233913738 G 7.237204973 2.900  
## 91 91 8.129214650 118.7942 16.968722229 G 17.011510295 3.250  
## 92 92 4.875061471 119.5659 10.197989563 G 10.207225206 3.030  
## 93 93 4.623970275 119.6094 9.673911592 G 9.681792780 2.990  
## 94 94 15.398138427 115.6925 31.862975199 H 32.152820781 4.710  
## 95 95 6.557649921 119.2149 13.704344322 G 13.726814808 3.150  
## 96 96 1.156032357 119.9756 2.421024236 G 2.421147439 2.450  
## 97 97 6.121455851 119.3158 12.796370259 G 12.814650321 3.110  
## 98 98 5.728599744 119.4007 11.977971478 G 11.992954432 3.070  
## 99 99 2.403175190 119.8945 5.031722710 G 5.032829415 2.810  
## 100 100 14.284062231 116.2901 29.607534650 R 29.839055910 3.680  
## 101 101 3.811477138 119.7346 7.976852703 G 7.981267220 2.900  
## 102 102 7.913197129 118.8573 16.520722771 G 16.560192259 3.230  
## 103 103 7.615244683 118.9416 15.902414185 G 15.937594149 3.210  
## 104 104 2.203808490 119.9112 4.614507684 G 4.615361187 2.730  
## 105 105 1.308996414 119.9687 2.741317192 G 2.741496056 2.450  
## 106 106 0.791117678 119.9886 1.656860343 G 1.656899829 2.070  
## 107 107 10.249948846 118.0849 21.353120029 G 21.438827681 3.330  
## 108 108 7.960117514 118.8438 16.618051298 G 16.658226477 3.230  
## 109 109 5.006651161 119.5421 10.472566210 G 10.482569851 3.030  
## 110 110 10.193421370 118.1059 21.236608205 G 21.320907509 3.330  
## 111 111 3.875281799 119.7256 8.110184328 G 8.114824232 2.940  
## 112 112 8.822803818 118.5801 18.405496889 G 18.460185830 3.270  
## 113 113 5.579931923 119.4314 11.668117366 G 11.681964267 3.070  
## 114 114 2.706438433 119.8661 5.666243703 G 5.667824431 2.810  
## 115 115 2.147992127 119.9157 4.497690460 G 4.498480744 2.730  
## 116 116 1.698482326 119.9473 3.556772080 G 3.557162815 2.650  
## 117 117 4.681125786 119.5997 9.793223365 G 9.801400348 2.990  
## 118 118 16.135558250 115.2728 33.349304113 H 33.682670312 4.720  
## 119 119 10.721167780 117.9053 22.323555180 G 22.421616795 3.350  
## 120 120 0.885886184 119.9857 1.855321761 G 1.855377204 2.070  
## 121 121 3.427573177 119.7853 7.174411481 G 7.177622083 2.900  
## 122 122 4.138828496 119.6871 8.660805435 G 8.666457589 2.940  
## 123 123 5.165872901 119.5126 10.804726235 G 10.815714619 3.030  
## 124 124 13.168699264 116.8444 27.338276284 R 27.519793438 3.660  
## 125 125 0.198373746 119.9993 0.415472172 G 0.415472795 2.000  
## 126 126 10.286082755 118.0714 21.427586694 G 21.514202750 3.330  
## 127 127 7.722707640 118.9116 16.125470928 G 16.162160189 3.230  
## 128 128 4.590827206 119.6150 9.604721223 G 9.612434198 2.990  
## 129 129 6.227794163 119.2918 13.017792632 G 13.037041509 3.150  
## 130 130 10.260406893 118.0810 21.374673399 G 21.460643310 3.330  
## 131 131 2.324004453 119.9013 4.866048987 G 4.867049884 2.730  
## 132 132 0.984200609 119.9823 2.061203566 G 2.061279592 2.450  
## 133 133 10.214415782 118.0981 21.279883338 G 21.364703894 3.330  
## 134 134 4.449134479 119.6384 9.308883698 G 9.315904493 2.990  
## 135 135 7.393944347 119.0022 15.442894207 G 15.475097465 3.210  
## 136 136 9.059928223 118.5029 18.896093612 G 18.955306855 3.270  
## 137 137 0.384896584 119.9973 0.806119456 G 0.806124004 2.000  
## 138 138 10.469982862 118.0020 21.806445040 G 21.897783714 3.330  
## 139 139 3.158623113 119.8177 6.612054432 G 6.614567096 2.880  
## 140 140 0.720715775 119.9905 1.509423782 G 1.509453637 2.070  
## 141 141 3.025779253 119.8327 6.334232060 G 6.336440875 2.880  
## 142 142 5.705537963 119.4055 11.929911247 G 11.944714051 3.070  
## 143 143 6.119004168 119.3163 12.791264731 G 12.809522849 3.110  
## 144 144 4.648160417 119.6053 9.724409546 G 9.732415038 2.990  
## 145 145 6.845147328 119.1446 14.302362963 G 14.327918458 3.190  
## 146 146 8.277675363 118.7498 17.276475935 G 17.321649244 3.250  
## 147 147 5.981988128 119.3466 12.505897652 G 12.522957066 3.110  
## 148 148 13.922570365 116.4746 28.873249852 R 29.087676281 3.680  
## 149 149 0.364876743 119.9976 0.764190898 G 0.764194772 2.000  
## 150 150 1.666297740 119.9493 3.489393897 G 3.489762839 2.650  
## 151 151 3.972778048 119.7116 8.313901266 G 8.318900181 2.940  
## 152 152 7.440575355 118.9896 15.539740740 G 15.572556700 3.210  
## 153 153 11.046985789 117.7764 22.993670531 G 23.100932429 3.370  
## 154 154 1.361057229 119.9661 2.850323505 G 2.850524571 2.450  
## 155 155 3.771106780 119.7402 7.892486262 G 7.896762012 2.900  
## 156 156 5.991946070 119.3444 12.526639762 G 12.543784473 3.110  
## 157 157 10.334402380 118.0533 21.527152999 G 21.614993788 3.330  
## 158 158 4.168963298 119.6825 8.723753819 G 8.729530307 2.940  
## 159 159 1.994640314 119.9273 4.176721123 G 4.177353949 2.730  
## 160 160 6.182013402 119.3022 12.922471344 G 12.941299040 3.110  
## 161 161 2.179620870 119.9132 4.563886310 G 4.564712019 2.730  
## 162 162 9.562264707 118.3327 19.934319428 G 20.003925878 3.310  
## 163 163 10.924110508 117.8255 22.741037048 G 22.844764731 3.350  
## 164 164 14.506544362 116.1743 30.058870187 H 30.301349440 4.690  
## 165 165 9.569659117 118.3301 19.949590898 G 20.019358763 3.310  
## 166 166 21.015653187 112.0179 43.034758802 H 43.768760698 4.805  
## 167 167 3.488165684 119.7777 7.301085084 G 7.304468957 2.900  
## 168 168 5.592761668 119.4288 11.694860302 G 11.708802898 3.070  
## 169 169 0.085482493 119.9999 0.179034047 G 0.179034097 2.000  
## 170 170 2.306517612 119.9028 4.829454530 G 4.830433005 2.730  
## 171 171 2.275786284 119.9054 4.765142441 G 4.766082327 2.730  
## 172 172 2.565636306 119.8797 5.371660538 G 5.373007186 2.810  
## 173 173 3.846330990 119.7297 8.049687500 G 8.054224209 2.940  
## 174 174 2.081812831 119.9208 4.359179288 G 4.359898758 2.730  
## 175 175 9.500724494 118.3540 19.807209269 G 19.875481969 3.290  
## 176 176 1.765534629 119.9430 3.697141926 G 3.697580786 2.650  
## 177 177 22.481214471 110.8806 45.885660004 H 46.783088325 4.820  
## 178 178 5.499491375 119.4476 11.500429945 G 11.513686811 3.070  
## 179 179 12.061571361 117.3508 25.075525254 R 25.215075886 3.640  
## 180 180 5.602997322 119.4267 11.716195570 G 11.730214828 3.070  
## 181 181 5.232150342 119.5000 10.942966301 G 10.954382923 3.030  
## 182 182 3.367870177 119.7928 7.049589617 G 7.052635376 2.900  
## 183 183 17.747145378 114.2893 36.578021743 H 37.021123129 4.760  
## 184 184 6.301943783 119.2749 13.172163787 G 13.192108075 3.150  
## 185 185 5.862503093 119.3724 12.256984446 G 12.273042334 3.110  
## 186 186 8.845766743 118.5727 18.453019778 G 18.508136418 3.270  
## 187 187 2.505117813 119.8853 5.245034984 G 5.246288575 2.810  
## 188 188 2.275775770 119.9054 4.765120439 G 4.766060312 2.730  
## 189 189 18.037582841 114.1024 37.156892157 H 37.622013816 4.760  
## 190 190 4.173900123 119.6817 8.734066091 G 8.739863120 2.940  
## 191 191 4.020788573 119.7046 8.414209723 G 8.419392033 2.940  
## 192 192 9.508313479 118.3514 19.822885414 G 19.891321661 3.290  
## 193 193 1.636402651 119.9511 3.426807774 G 3.427157213 2.650  
## 194 194 3.230767330 119.8093 6.762918100 G 6.765606873 2.880  
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## 314 -0.47839878 -1.00194443 119.9958  
## 315 3.80145329 7.95590513 119.7360  
## 316 -0.30077145 -0.62993136 119.9983  
## 317 2.89812380 6.06722833 119.8465  
## 318 8.86924404 18.50160412 118.5651  
## 319 2.48414187 5.20114471 119.8872  
## 320 -5.40668098 -11.30692804 119.4661  
## 321 5.55333140 11.61266809 119.4368  
## 322 2.54888529 5.33661223 119.8813  
## 323 13.91401641 28.85586050 116.4789  
## 324 -5.87607064 -12.28525130 119.3695  
## 325 -7.47775589 -15.61695249 118.9795  
## 326 6.26817341 13.10186039 119.2826  
## 327 2.79710470 5.85591571 119.8570  
## 328 -3.44520529 -7.21127368 119.7831  
## 329 -5.98699830 -12.51633375 119.3455  
## 330 15.21823936 31.49956388 115.7920  
## 331 9.61963779 20.05280175 118.3127  
## 332 0.91550361 1.91734469 119.9847  
## 333 0.09906875 0.20748900 119.9998  
## 334 4.04098640 8.45640732 119.7017  
## 335 -10.64244163 -22.16152868 117.9359  
## 336 2.05735392 4.30798609 119.9226  
## 337 2.69194720 5.63592701 119.8676  
## 338 7.21569477 15.07259931 119.0496  
## 339 -8.18362943 -17.08153544 118.7780  
## 340 2.98844957 6.25615661 119.8368  
## 341 5.57363065 11.65498247 119.4327  
## 342 11.69370626 24.32156760 117.5094  
## 343 8.70567502 18.16304732 118.6175  
## 344 9.47823096 19.76074358 118.3618  
## 345 -9.48144389 -19.76738083 118.3607  
## 346 6.99286043 14.60947948 119.1074  
## 347 8.64225650 18.03174306 118.6375  
## 348 5.77033462 12.06494109 119.3919  
## 349 -11.36651683 -23.65013333 117.6464  
## 350 10.80002605 22.48581134 117.8745  
## 351 -0.03615844 -0.07573006 120.0000  
## 352 -9.14240913 -19.06666641 118.4756  
## 353 -13.02119129 -27.03737007 116.9144  
## 354 -9.15733201 -19.09752312 118.4706  
## 355 4.20194686 8.79265019 119.6774  
## 356 -2.41430783 -5.05501826 119.8935  
## 357 5.40376879 11.30085587 119.4667  
## 358 8.43706228 17.60675010 118.7013  
## 359 -5.14339299 -10.75783482 119.5168  
## 360 7.34560758 15.34249423 119.0152  
## 361 4.03953841 8.45338219 119.7019  
## 362 8.49276115 17.72213471 118.6841  
## 363 -6.13262195 -12.81962289 119.3133  
## 364 -10.45780340 -21.78136066 118.0067  
## 365 1.66034343 3.47692848 119.9496  
## 366 17.13074584 35.34638123 114.6762  
## 367 6.33739729 13.24596622 119.2667  
## 368 2.27970897 4.77335160 119.9050  
## 369 -7.62610607 -15.92496130 118.9386  
## 370 7.03494214 14.69695563 119.0966  
## 371 -4.70280440 -9.83847479 119.5960  
## 372 10.70438731 22.28902278 117.9118  
## 373 -7.10229879 -14.83695485 119.0792  
## 374 12.14768306 25.25186727 117.3130  
## 375 -3.45213147 -7.22575357 119.7823  
## 376 -5.99610521 -12.53530302 119.3435  
## 377 -10.70897241 -22.29845862 117.9100  
## 378 -6.76867965 -14.14333832 119.1636  
## 379 11.91747257 24.78030912 117.4135  
## 380 5.47274597 11.44467109 119.4530  
## 381 1.23588016 2.58822064 119.9721  
## 382 -8.76392680 -18.28363456 118.5989  
## 383 2.03901329 4.26959810 119.9240  
## 384 -6.34420033 -13.26012730 119.2651  
## 385 -12.71296687 -26.40803717 117.0582  
## 386 11.42992745 23.78032091 117.6201  
## 387 -5.23700650 -10.95309459 119.4991  
## 388 -7.61980225 -15.91187529 118.9404  
## 389 4.93803098 10.32938931 119.5546  
## 390 2.75388625 5.76550537 119.8614  
## 391 -10.04780518 -20.93637590 118.1595  
## 392 -13.66895217 -28.35739699 116.6013  
## 393 0.80019560 1.67587126 119.9883  
## 394 3.64357959 7.62595293 119.7574  
## 395 1.02581822 2.14835387 119.9808  
## 396 -3.92546467 -8.21504364 119.7185  
## 397 -10.65756025 -22.19264761 117.9300  
## 398 0.42917365 0.89885079 119.9966  
## 399 -14.69036611 -30.43143620 116.0772  
## 400 3.05937256 6.40449054 119.8290  
## 401 6.18873894 12.93647527 119.3007  
## 402 -15.53174612 -32.13267094 115.6179  
## 403 5.03106088 10.52349381 119.5377  
## 404 -2.38261879 -4.98870703 119.8963  
## 405 2.87290851 6.01448452 119.8492  
## 406 -9.06024704 -18.89675301 118.5028  
## 407 -9.68764170 -20.19321195 118.2888  
## 408 0.41420447 0.86750027 119.9969  
## 409 -1.63383633 -3.42143507 119.9512  
## 410 11.12737195 23.15888858 117.7441  
## 411 -5.01509907 -10.49019185 119.5406  
## 412 7.36119648 15.37487503 119.0110  
## 413 -10.40843803 -21.67967942 118.0254  
## 414 8.78918659 18.33591906 118.5909  
## 415 8.77869931 18.31421218 118.5942  
## 416 -1.07540871 -2.25219848 119.9789  
## 417 6.01481707 12.57427797 119.3394  
## 418 -7.60358269 -15.87820446 118.9449  
## 419 -1.45102750 -3.03870004 119.9615  
## 420 15.01157269 31.08169668 115.9048  
## 421 -4.31142431 -9.02130671 119.6604  
## 422 4.30813992 9.01444736 119.6609  
## 423 -5.47815957 -11.45595757 119.4519  
## 424 -7.19734487 -15.03447097 119.0545  
## 425 -7.43100301 -15.51986106 118.9922  
## 426 3.43857620 7.19741480 119.7840  
## 427 9.20477029 19.19560481 118.4548  
## 428 -8.78624754 -18.32983579 118.5918  
## 429 -4.19657894 -8.78143784 119.6783  
## 430 2.77546524 5.81064770 119.8592  
## 431 -5.88998995 -12.31425029 119.3665  
## 432 -6.58651022 -13.76439199 119.2080  
## 433 16.06948694 33.21635374 115.3112  
## 434 -7.58306618 -15.83561158 118.9506  
## 435 -19.95310640 -40.95011276 112.7967  
## 436 0.29673935 0.62148667 119.9984  
## 437 20.54506451 42.11327856 112.3676  
## 438 11.16798366 23.24234069 117.7276  
## 439 7.26368109 15.17230039 119.0370  
## 440 6.75514557 14.11518979 119.1669  
## 441 5.63196338 11.77657059 119.4207  
## 442 -11.68846598 -24.31082007 117.5116  
## 443 -3.57114636 -7.47454971 119.7670  
## 444 -4.84181129 -10.12860076 119.5718  
## 445 2.72848853 5.71237339 119.8640  
## 446 -8.63277284 -18.01210580 118.6405  
## 447 -19.62741665 -40.30827792 113.0276  
## 448 -6.53336296 -13.65380939 119.2207  
## 449 1.30596871 2.73497763 119.9688  
## 450 -6.12740064 -12.80874994 119.3144  
## 451 -12.15396179 -25.26472280 117.3102  
## 452 5.87100267 12.27469267 119.3706  
## 453 -3.02120647 -6.32466818 119.8332  
## 454 4.65455238 9.73775275 119.6042  
## 455 12.55329669 26.08172080 117.1313  
## 456 3.36661788 7.04697133 119.7929  
## 457 -2.56209554 -5.36425220 119.8800  
## 458 -11.40803846 -23.73538417 117.6292  
## 459 6.21423452 12.98956063 119.2949  
## 460 -2.93561854 -6.14565539 119.8425  
## 461 -3.83388587 -8.02368102 119.7315  
## 462 2.51985780 5.27587667 119.8840  
## 463 -17.24994008 -35.58486914 114.6024  
## 464 16.88377922 34.85175627 114.8275  
## 465 -9.41670012 -19.63362163 118.3829  
## 466 -7.93322585 -16.56227038 118.8516  
## 467 -1.53098262 -3.20610095 119.9572  
## 468 4.40572149 9.21823107 119.6454  
## 469 -8.27558562 -17.27214477 118.7505  
## 470 -0.76915190 -1.61085959 119.9892  
## 471 10.06109979 20.96379244 118.1546  
## 472 -8.19744842 -17.11018265 118.7739  
## 473 -12.65580147 -26.29123224 117.0845  
## 474 4.90255948 10.25537174 119.5610  
## 475 8.69164379 18.13399841 118.6219  
## 476 3.97328009 8.31495020 119.7116  
## 477 -2.59984540 -5.44323512 119.8765  
## 478 4.87896286 10.20613103 119.5652  
## 479 3.56559351 7.46294240 119.7677  
## 480 1.56291809 3.27296205 119.9554  
## 481 1.18571320 2.48317467 119.9743  
## 482 1.15615465 2.42128030 119.9756  
## 483 -4.41249177 -9.23236874 119.6443  
## 484 3.48703599 7.29872344 119.7778  
## 485 13.73585421 28.49352838 116.5681  
## 486 -0.96763144 -2.02650622 119.9829  
## 487 -3.16238953 -6.61993080 119.8173  
## 488 -1.74794291 -3.66031524 119.9442  
## 489 -3.52195888 -7.37172899 119.7734  
## 490 -1.05262343 -2.20448533 119.9797  
## 491 -7.44432933 -15.54753681 118.9885  
## 492 5.40987962 11.31359743 119.4655  
## 493 -0.27633054 -0.57874309 119.9986  
## 494 12.84716326 26.68213449 116.9960  
## 495 17.55395225 36.19244739 114.4120  
## 496 0.15807657 0.33107437 119.9995  
## 497 4.82181696 10.08687356 119.5753  
## 498 -12.00778277 -24.96534667 117.3743  
## 499 -10.08200367 -21.00689876 118.1470  
## 500 2.75785354 5.77380484 119.8610  
## Average: 3.03835# A tibble: 3 × 3  
## # Groups: Outcome [3]  
## Outcome n percent  
## <chr> <int> <dbl>  
## 1 G 446 89.2  
## 2 H 25 5   
## 3 R 29 5.8



# Function to calculate the maintenance cost of a golf course   
calculate\_maintenance\_cost <- function(length\_manicured\_land,   
 width\_manicured\_land,   
 radius\_green,   
 length\_fairway,   
 width\_fairway,   
 length\_tee\_box,   
 width\_tee\_box,   
 length\_bunker,   
 width\_bunker,   
 cost\_per\_unit\_square\_green = 25.07,   
 cost\_per\_unit\_square\_fairway = 0.36,   
 cost\_per\_unit\_square\_tee\_box = 3.03,   
 cost\_per\_unit\_square\_bunker = 20.23,   
 cost\_per\_unit\_square\_rough = 0.04) {  
   
 # Calculate the total area of the manicured land   
 area\_manicured\_land <- length\_manicured\_land \* width\_manicured\_land  
   
 # Calculate the area of the green (semicircle)   
 area\_green <- (pi \* radius\_green^2) / 2  
   
 # Calculate the area of the fairway   
 area\_fairway <- length\_fairway \* width\_fairway  
   
 # Calculate the area of the tee box   
 area\_tee\_box <- length\_tee\_box \* width\_tee\_box  
   
 # Calculate the area of the bunker   
 area\_bunker <- length\_bunker \* width\_bunker  
   
 # Calculate the area of the rough (remaining area after other features)   
 area\_rough <- area\_manicured\_land - area\_green - area\_fairway -   
 area\_tee\_box - area\_bunker  
   
 # Calculate maintenance cost for the green   
 total\_cost\_green <- area\_green \* cost\_per\_unit\_square\_green  
   
 # Calculate maintenance cost for the fairway   
 total\_cost\_fairway <- area\_fairway \* cost\_per\_unit\_square\_fairway  
   
 # Calculate maintenance cost for the tee box   
 total\_cost\_tee\_box <- area\_tee\_box \* cost\_per\_unit\_square\_tee\_box  
   
 # Calculate maintenance cost for the bunker   
 total\_cost\_bunker <- area\_bunker \* cost\_per\_unit\_square\_bunker  
   
 # Calculate maintenance cost for the rough   
 total\_cost\_rough <- area\_rough \* cost\_per\_unit\_square\_rough  
   
 # Calculate the total maintenance cost of the golf course   
 total\_cost <- total\_cost\_green + total\_cost\_fairway + total\_cost\_tee\_box +  
 total\_cost\_bunker + total\_cost\_rough  
   
 # Return the total maintenance cost   
 return(total\_cost)  
}  
  
# Example usage of the function with specified dimensions   
cost <- calculate\_maintenance\_cost(length\_manicured\_land = 100,   
 width\_manicured\_land = 80,   
 radius\_green = 20,   
 length\_fairway = 60,   
 width\_fairway = 20,   
 length\_tee\_box = 10,   
 width\_tee\_box = 10,   
 length\_bunker = 20,   
 width\_bunker = 10)  
  
# Print the calculated maintenance cost   
cat("Cost of Maintenance:", cost, "\n")

## Cost of Maintenance: 20767.81

# Par 4 Simulator and Cost Difference Analysis  
library(tidyverse)  
  
# Define the Par 4 golf simulator function  
runGolfSimulatorPar4 <- function(num\_trials,  
 Tee.Shot.Distance = 250,  
 SD.Angle = 8,  
 Hole.Length = 380,  
 Center.to.FW.Edge = 20,  
 Center.to.Hazard.Edge = 40) {  
 # Initialize the simulator data frame  
 Simulator <- data.frame(  
 Trial = 1:num\_trials,  
 Tee\_Degrees = rep(NA, num\_trials),  
 Tee\_Length = rep(NA, num\_trials),  
 Tee\_Width = rep(NA, num\_trials),  
 Outcome = rep(NA, num\_trials),  
 Approach\_Dist = rep(NA, num\_trials),  
 Score = rep(NA, num\_trials)  
 )  
  
 for (i in 1:nrow(Simulator)) {  
 # Simulate the angle and width of the tee shot without taking absolute values  
 Simulator$Tee\_Degrees\_no\_abs[i] <- SD.Angle \* (rnorm(1, mean = 0, sd = 1))  
 Simulator$Tee\_Width\_no\_abs[i] <- Tee.Shot.Distance \*   
 sin(Simulator$Tee\_Degrees\_no\_abs[i] \* (pi/180))  
  
 # Simulate the angle and width of the tee shot (absolute values)  
 Simulator$Tee\_Degrees[i] <- SD.Angle \* abs(rnorm(1, mean = 0, sd = 1))  
 Simulator$Tee\_Length[i] <- Tee.Shot.Distance \*   
 cos(Simulator$Tee\_Degrees[i] \* (pi/180))  
 Simulator$Tee\_Length\_no\_abs[i] <- Tee.Shot.Distance \*   
 cos(Simulator$Tee\_Degrees\_no\_abs[i] \* (pi/180))  
 Simulator$Tee\_Width[i] <- Tee.Shot.Distance \*   
 sin(Simulator$Tee\_Degrees[i] \* (pi/180))  
  
 # Determine outcome based on shot width  
 Simulator$Outcome[i] <- ifelse(Simulator$Tee\_Width[i] < Center.to.FW.Edge,   
 "F", ifelse(Simulator$Tee\_Width[i] <   
 Center.to.Hazard.Edge, "R", "H"))  
  
 # Calculate approach distance to the hole  
 Simulator$Approach\_Dist[i] <- sqrt((Hole.Length -   
 Simulator$Tee\_Length[i])^2 +   
 Simulator$Tee\_Width[i]^2)  
  
 # Assign score based on outcome and approach distance  
 Simulator$Score[i] <- ifelse(Simulator$Outcome[i] == 'F',  
 Outcomes[which(Outcomes$Approach\_Dist ==   
 floor(Simulator$Approach\_Dist[i])),   
 "F\_ES"] + 1, ifelse(Simulator$Outcome[i] == 'R',  
 Outcomes[which(Outcomes$Approach\_Dist ==   
 floor(Simulator$Approach\_Dist[i])),   
 "R\_ES"] + 1, Outcomes[which(Outcomes$Approach\_Dist ==   
 floor(Simulator$Approach\_Dist[i])),   
 "H\_ES"] + 1))  
 }  
  
 # Return the average score from the simulation  
 mean\_score <- mean(Simulator$Score)  
 return(mean\_score)  
}  
  
# Define the cost calculation function for golf course maintenance  
calculate\_maintenance\_cost <- function(length\_manicured\_land,   
 width\_manicured\_land,   
 radius\_green,   
 length\_fairway,   
 width\_fairway,   
 length\_tee\_box,   
 width\_tee\_box,   
 length\_bunker,   
 width\_bunker,   
 cost\_per\_unit\_square\_green = 25.07,   
 cost\_per\_unit\_square\_fairway = 0.36,   
 cost\_per\_unit\_square\_tee\_box = 3.03,   
 cost\_per\_unit\_square\_bunker = 20.23,   
 cost\_per\_unit\_square\_rough = 0.04) {  
   
 # Calculate the area of the manicured land  
 area\_manicured\_land <- length\_manicured\_land \* width\_manicured\_land  
 area\_green <- (pi \* radius\_green^2) / 2  
 area\_fairway <- length\_fairway \* width\_fairway  
 area\_tee\_box <- length\_tee\_box \* width\_tee\_box  
 area\_bunker <- length\_bunker \* width\_bunker  
 area\_rough <- area\_manicured\_land - area\_green - area\_fairway -   
 area\_tee\_box - area\_bunker  
  
 # Calculate the total maintenance cost for each area  
 total\_cost\_green <- area\_green \* cost\_per\_unit\_square\_green  
 total\_cost\_fairway <- area\_fairway \* cost\_per\_unit\_square\_fairway  
 total\_cost\_tee\_box <- area\_tee\_box \* cost\_per\_unit\_square\_tee\_box  
 total\_cost\_bunker <- area\_bunker \* cost\_per\_unit\_square\_bunker  
 total\_cost\_rough <- area\_rough \* cost\_per\_unit\_square\_rough  
  
 # Return the total maintenance cost for the golf course  
 total\_cost <- total\_cost\_green + total\_cost\_fairway +   
 total\_cost\_tee\_box + total\_cost\_bunker +   
 total\_cost\_rough  
 return(total\_cost)  
}  
  
# Set parameters for each golf course  
course1\_params <- list(  
 num\_trials = 1000,  
 Tee.Shot.Distance = 250,  
 SD.Angle = 8,  
 Hole.Length = 400,  
 Center.to.FW.Edge = 20,  
 Center.to.Hazard.Edge = 40  
)  
  
course2\_params <- list(  
 num\_trials = 1000,  
 Tee.Shot.Distance = 250,  
 SD.Angle = 8,  
 Hole.Length = 420,  
 Center.to.FW.Edge = 20,  
 Center.to.Hazard.Edge = 40  
)  
  
# Calculate stroke averages for each course  
course1\_stroke\_avg <- do.call(runGolfSimulatorPar4, course1\_params)  
course2\_stroke\_avg <- do.call(runGolfSimulatorPar4, course2\_params)  
  
# Set maintenance cost parameters for each course  
cost\_params\_course1 <- list(  
 length\_manicured\_land = 400, width\_manicured\_land = 80,  
 radius\_green = 20, length\_fairway = 400, width\_fairway = 40,  
 length\_tee\_box = 10, width\_tee\_box = 10, length\_bunker = 20,   
 width\_bunker = 10, cost\_per\_unit\_square\_green = 2,   
 cost\_per\_unit\_square\_fairway = 1.5, cost\_per\_unit\_square\_tee\_box = 1.2,   
 cost\_per\_unit\_square\_bunker = 1.8, cost\_per\_unit\_square\_rough = 1  
)  
  
cost\_params\_course2 <- list(  
 length\_manicured\_land = 420, width\_manicured\_land = 80,  
 radius\_green = 20, length\_fairway = 420, width\_fairway = 40,  
 length\_tee\_box = 10, width\_tee\_box = 10, length\_bunker = 20,   
 width\_bunker = 10, cost\_per\_unit\_square\_green = 2,   
 cost\_per\_unit\_square\_fairway = 1.5, cost\_per\_unit\_square\_tee\_box = 1.2,   
 cost\_per\_unit\_square\_bunker = 1.8, cost\_per\_unit\_square\_rough = 1  
)  
  
# Calculate maintenance costs for each course  
course1\_cost <- do.call(calculate\_maintenance\_cost, cost\_params\_course1)  
course2\_cost <- do.call(calculate\_maintenance\_cost, cost\_params\_course2)  
  
# Calculate manicured land area for each course  
length\_manicured\_land\_course1 <- course1\_params$Hole.Length  
width\_of\_manicured\_land\_course1 <- 2 \* course1\_params$Center.to.Hazard.Edge  
course1\_manicured\_land <- length\_manicured\_land\_course1 \* width\_of\_manicured\_land\_course1  
  
length\_manicured\_land\_course2 <- course2\_params$Hole.Length  
width\_of\_manicured\_land\_course2 <- 2 \* course2\_params$Center.to.Hazard.Edge  
course2\_manicured\_land <- length\_manicured\_land\_course2 \* width\_of\_manicured\_land\_course2  
  
# Compare stroke averages, maintenance costs, and manicured land areas  
stroke\_diff <- course2\_stroke\_avg - course1\_stroke\_avg  
cost\_diff <- course2\_cost - course1\_cost  
manicured\_land\_diff <- course2\_manicured\_land - course1\_manicured\_land  
  
# Calculate percentage changes  
stroke\_percent\_change <- (stroke\_diff / course1\_stroke\_avg) \* 100  
cost\_percent\_change <- (cost\_diff / course1\_cost) \* 100  
manicured\_land\_percent\_change <- (manicured\_land\_diff / course1\_manicured\_land) \* 100  
  
# Print the results of the comparison  
cat("Course 1 Stroke Average:", course1\_stroke\_avg, "\n")

## Course 1 Stroke Average: 4.42126

cat("Course 2 Stroke Average:", course2\_stroke\_avg, "\n")

## Course 2 Stroke Average: 4.61572

cat("Difference in Stroke Averages:", stroke\_diff, "\n")

## Difference in Stroke Averages: 0.19446

cat("Percentage Change in Stroke Averages:", stroke\_percent\_change, "%\n\n")

## Percentage Change in Stroke Averages: 4.398294 %

cat("Course 1 Maintenance Cost:", course1\_cost, "\n")

## Course 1 Maintenance Cost: 40808.32

cat("Course 2 Maintenance Cost:", course2\_cost, "\n")

## Course 2 Maintenance Cost: 42808.32

cat("Difference in Maintenance Costs:", cost\_diff, "\n")

## Difference in Maintenance Costs: 2000

cat("Percentage Change in Maintenance Costs:", cost\_percent\_change, "\n")

## Percentage Change in Maintenance Costs: 4.900962

#par3 simulator and cost analysis  
  
library(tidyverse)  
  
# Define the new golf simulator function  
runGolfSimulator2 <- function(num\_trials, Tee.Shot.Distance = 120, SD.Angle = 8,   
 Semicircle.Green.Radius = 25,   
 Center.to.Hazard.Edge = 30) {  
 # Create Simulator data frame  
 Simulator <- data.frame(  
 Trial = 1:num\_trials,  
 Tee\_Degrees = rep(NA, num\_trials),  
 Tee\_Length = rep(NA, num\_trials),  
 Tee\_Width = rep(NA, num\_trials),  
 Outcome = rep(NA, num\_trials),  
 Approach\_Dist = rep(NA, num\_trials),  
 Score = rep(NA, num\_trials)  
 )  
  
 for (i in 1:nrow(Simulator)) {  
 Simulator$Tee\_Degrees\_no\_abs[i] <- SD.Angle \*   
 (rnorm(1, mean = 0, sd = 1))  
 Simulator$Tee\_Width\_no\_abs[i] <- Tee.Shot.Distance \*   
 sin(Simulator$Tee\_Degrees\_no\_abs[i] \*   
 (pi/180))  
 Simulator$Tee\_Degrees[i] <- SD.Angle \* abs(rnorm(1, mean = 0, sd = 1))  
 Simulator$Tee\_Length[i] <- Tee.Shot.Distance \*   
 cos(Simulator$Tee\_Degrees[i] \* (pi/180))  
 Simulator$Tee\_Length\_no\_abs[i] <- Tee.Shot.Distance \*   
 cos(Simulator$Tee\_Degrees\_no\_abs[i] \*   
 (pi/180))  
 Simulator$Tee\_Width[i] <- Tee.Shot.Distance \*   
 sin(Simulator$Tee\_Degrees[i] \* (pi/180))  
 Simulator$Approach\_Dist[i] <- sqrt((Tee.Shot.Distance -   
 Simulator$Tee\_Length[i])^2 +   
 Simulator$Tee\_Width[i]^2)  
 Simulator$Outcome[i] <- ifelse(Simulator$Approach\_Dist[i] <   
 Semicircle.Green.Radius, "G",   
 ifelse(Simulator$Tee\_Width[i] <   
 Center.to.Hazard.Edge, "R", "H"))  
  
 temp\_score <- ifelse(Simulator$Outcome[i] == 'G',   
 Par3Out[which(Par3Out$Approach\_Dist ==   
 floor(Simulator$Approach\_Dist[i])), "G\_ES"] + 1,   
 ifelse(Simulator$Outcome[i] == 'R',   
 Par3Out[which(Par3Out$Approach\_Dist ==   
 floor(Simulator$Approach\_Dist[i])), "R\_ES"] + 1,   
 Par3Out[which(Par3Out$Approach\_Dist ==   
 floor(Simulator$Approach\_Dist[i])), "H\_ES"] + 1))  
 temp\_score <- unlist(temp\_score)  
 Simulator$Score[i] <- temp\_score[1]  
 }  
   
 mean\_score <- mean(Simulator$Score)  
 return(mean\_score)  
}  
  
# Define the cost calculation function  
calculate\_maintenance\_cost <- function(length\_manicured\_land,   
 width\_manicured\_land, radius\_green,  
 length\_fairway, width\_fairway,   
 length\_tee\_box, width\_tee\_box,  
 length\_bunker, width\_bunker,   
 cost\_per\_unit\_square\_green = 25.07,   
 cost\_per\_unit\_square\_fairway = 0.36,  
 cost\_per\_unit\_square\_tee\_box = 3.03,   
 cost\_per\_unit\_square\_bunker = 20.23,   
 cost\_per\_unit\_square\_rough = 0.04) {  
 area\_manicured\_land <- length\_manicured\_land \* width\_manicured\_land  
 area\_green <- (pi \* radius\_green^2) / 2  
 area\_fairway <- length\_fairway \* width\_fairway  
 area\_tee\_box <- length\_tee\_box \* width\_tee\_box  
 area\_bunker <- length\_bunker \* width\_bunker  
 area\_rough <- area\_manicured\_land - area\_green - area\_fairway -   
 area\_tee\_box - area\_bunker  
  
 total\_cost\_green <- area\_green \* cost\_per\_unit\_square\_green  
 total\_cost\_fairway <- area\_fairway \* cost\_per\_unit\_square\_fairway  
 total\_cost\_tee\_box <- area\_tee\_box \* cost\_per\_unit\_square\_tee\_box  
 total\_cost\_bunker <- area\_bunker \* cost\_per\_unit\_square\_bunker  
 total\_cost\_rough <- area\_rough \* cost\_per\_unit\_square\_rough  
  
 total\_cost <- total\_cost\_green + total\_cost\_fairway +  
 total\_cost\_tee\_box + total\_cost\_bunker + total\_cost\_rough  
  
 return(total\_cost)  
}  
  
# Set parameters for each golf course  
course1\_params <- list(  
 num\_trials = 1000,  
 Tee.Shot.Distance = 150,  
 SD.Angle = 8,  
 Semicircle.Green.Radius = 25,  
 Center.to.Hazard.Edge = 30  
)  
  
course2\_params <- list(  
 num\_trials = 1000,  
 Tee.Shot.Distance = 170,  
 SD.Angle = 8,  
 Semicircle.Green.Radius = 25,  
 Center.to.Hazard.Edge = 30  
)  
  
# Calculate stroke averages using the new function  
course1\_stroke\_avg <- do.call(runGolfSimulator2, course1\_params)  
course2\_stroke\_avg <- do.call(runGolfSimulator2, course2\_params)  
  
# Set maintenance cost parameters for each course  
cost\_params\_course1 <- list(  
 length\_manicured\_land = 150, width\_manicured\_land = 60,  
 radius\_green = 25, length\_fairway = 120, width\_fairway = 40,  
 length\_tee\_box = 10, width\_tee\_box = 10, length\_bunker = 20,   
 width\_bunker = 10, cost\_per\_unit\_square\_green = 2,   
 cost\_per\_unit\_square\_fairway = 1.5, cost\_per\_unit\_square\_tee\_box = 1.2,   
 cost\_per\_unit\_square\_bunker = 1.8, cost\_per\_unit\_square\_rough = 1  
)  
  
cost\_params\_course2 <- list(  
 length\_manicured\_land = 170, width\_manicured\_land = 60,  
 radius\_green = 25, length\_fairway = 120, width\_fairway = 40,  
 length\_tee\_box = 10, width\_tee\_box = 10, length\_bunker = 20,   
 width\_bunker = 10, cost\_per\_unit\_square\_green = 2,   
 cost\_per\_unit\_square\_fairway = 1.5, cost\_per\_unit\_square\_tee\_box = 1.2,   
 cost\_per\_unit\_square\_bunker = 1.8, cost\_per\_unit\_square\_rough = 1  
)  
  
# Calculate maintenance costs using the function  
course1\_cost <- do.call(calculate\_maintenance\_cost, cost\_params\_course1)  
course2\_cost <- do.call(calculate\_maintenance\_cost, cost\_params\_course2)  
  
# Extract parameters for manicured land area calculation  
length\_manicured\_land\_course1 <- course1\_params$Tee.Shot.Distance  
width\_of\_manicured\_land\_course1 <- 2 \* course1\_params$Center.to.Hazard.Edge  
course1\_manicured\_land <- length\_manicured\_land\_course1 \*   
 width\_of\_manicured\_land\_course1  
  
length\_manicured\_land\_course2 <- course2\_params$Tee.Shot.Distance  
width\_of\_manicured\_land\_course2 <- 2 \* course2\_params$Center.to.Hazard.Edge  
course2\_manicured\_land <- length\_manicured\_land\_course2 \*   
 width\_of\_manicured\_land\_course2  
  
# Compare stroke averages and costs  
stroke\_diff <- course2\_stroke\_avg - course1\_stroke\_avg  
cost\_diff <- course2\_cost - course1\_cost  
manicured\_land\_diff <- course2\_manicured\_land - course1\_manicured\_land  
  
# Calculate percentage changes  
stroke\_percent\_change <- (stroke\_diff / course1\_stroke\_avg) \* 100  
cost\_percent\_change <- (cost\_diff / course1\_cost) \* 100  
manicured\_land\_percent\_change <- (manicured\_land\_diff /   
 course1\_manicured\_land) \* 100  
  
# Print results  
cat("Course 1 Stroke Average:", course1\_stroke\_avg, "\n")

## Course 1 Stroke Average: 3.28866

cat("Course 2 Stroke Average:", course2\_stroke\_avg, "\n")

## Course 2 Stroke Average: 3.35415

cat("Difference in Stroke Averages:", stroke\_diff, "\n")

## Difference in Stroke Averages: 0.06549

cat("Percentage Change in Stroke Averages:", stroke\_percent\_change, "%\n\n")

## Percentage Change in Stroke Averages: 1.991389 %

cat("Course 1 Maintenance Cost:", course1\_cost, "\n")

## Course 1 Maintenance Cost: 12561.75

cat("Course 2 Maintenance Cost:", course2\_cost, "\n")

## Course 2 Maintenance Cost: 13761.75

cat("Difference in Maintenance Costs:", cost\_diff, "\n")

## Difference in Maintenance Costs: 1200

cat("Percentage Change in Maintenance Costs:", cost\_percent\_change, "%\n\n")

## Percentage Change in Maintenance Costs: 9.552811 %

cat("Course 1 Manicured Land Area:", course1\_manicured\_land, "\n")

## Course 1 Manicured Land Area: 9000

cat("Course 2 Manicured Land Area:", course2\_manicured\_land, "\n")

## Course 2 Manicured Land Area: 10200

cat("Difference in Manicured Land Area:", manicured\_land\_diff, "\n")

## Difference in Manicured Land Area: 1200

cat("Percentage Change in Manicured Land Area:",   
 manicured\_land\_percent\_change, "%\n")

## Percentage Change in Manicured Land Area: 13.33333 %