Chapter 3: The Basics of Regression

Modern Clinical Data Science
Chapter Guides
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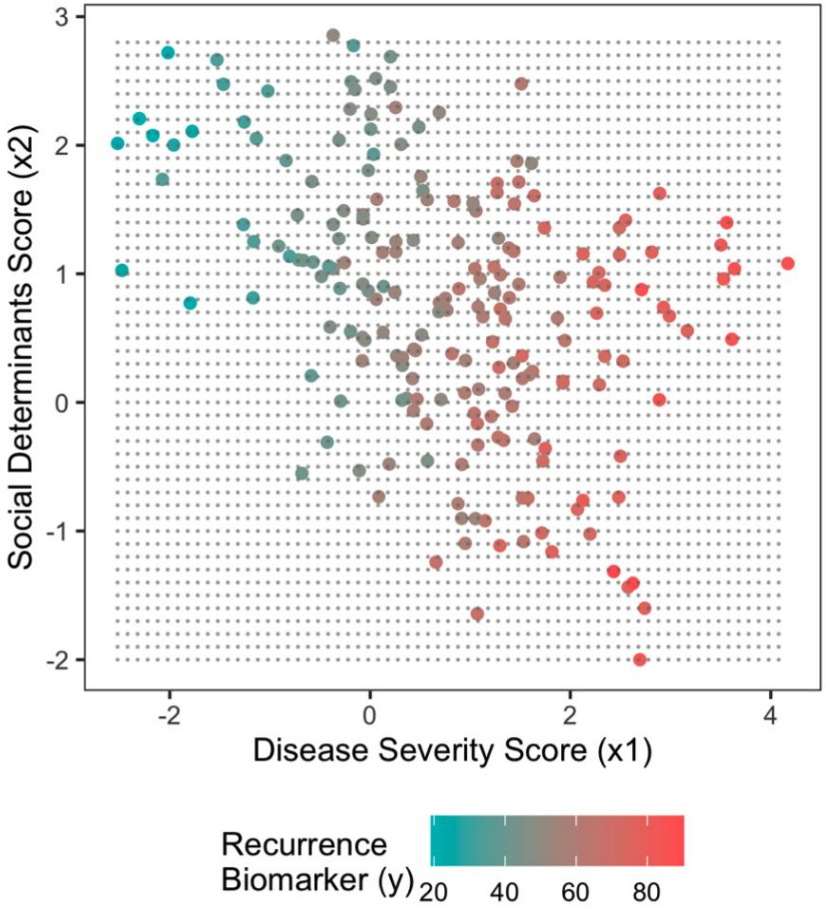
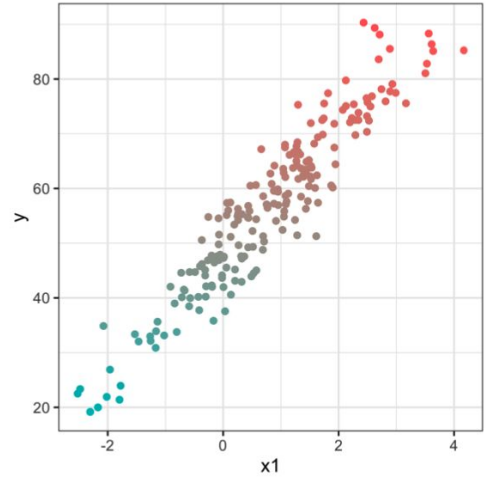
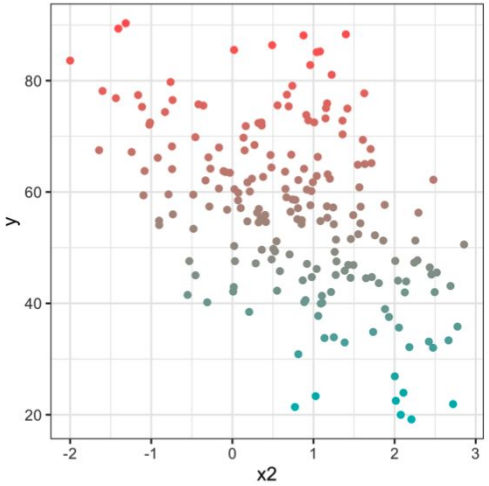
How to Use this Guide

- Read the corresponding notes chapter first
- Try to answer the discussion questions on your own
- Listen to the chapter guide (should be 15 min, max) while following along in the notes

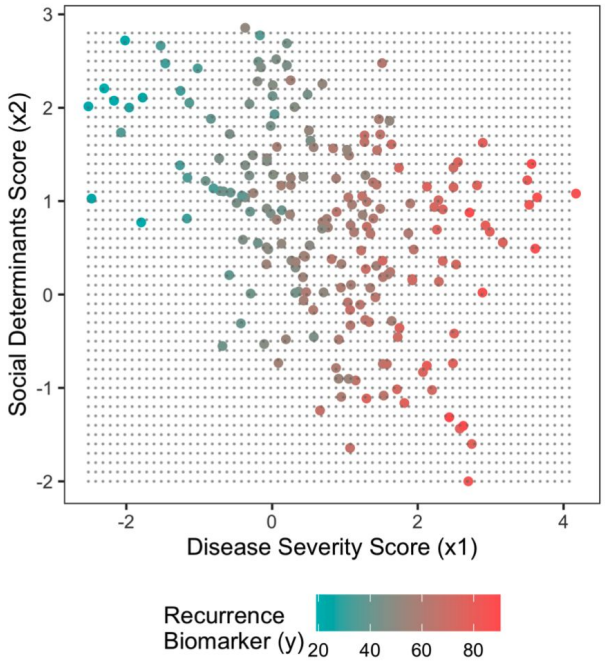

Social Determinants Score (x2)
Disease Severity Score (x1)
Recurrence Biomarker (y)
20
40
60
80
3
2
1
0
-1
-2
-2
0
2
4

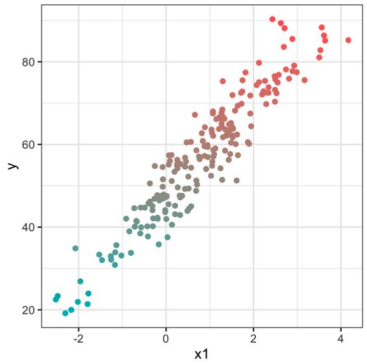

y
x1
80
60
40
20
-2
0
2
4

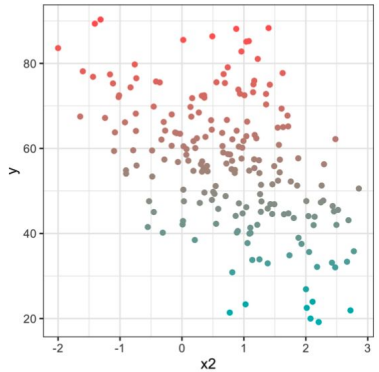

y
x2
80
60
40
20
-2
-1
0
1
2
3

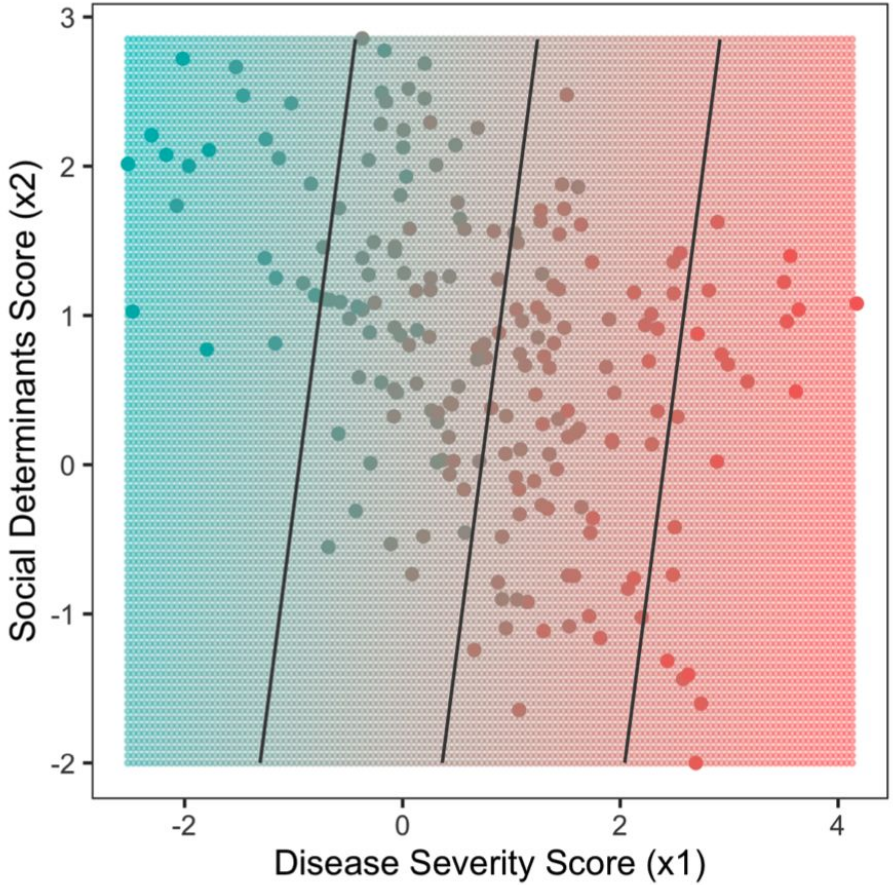
Question 3.1

Which of the two predictors, x_1 or x_2, appears to more strongly influence the value of the recurrence biomarker? Explain your reasoning using evidence from the preceding three plots.










```
Call:
lm(formula = y ~ x1 + x2, data = df)

Residuals:
     Min       1Q   Median       3Q      Max
-11.9218  -3.1032   0.2891   2.8316  12.5813

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  49.8600     0.5370  92.844  < 2e-16 ***
x1           10.4372     0.2855  36.555  < 2e-16 ***
x2           -1.8824     0.3609  -5.215 4.63e-07 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 4.769 on 197 degrees of freedom
Multiple R-squared:  0.9026,    Adjusted R-squared:  0.9016
F-statistic: 912.4 on 2 and 197 DF,  p-value: < 2.2e-16
```

$$\hat{y} = 49.8600 + 10.4372x_1 - 1.8824x_2$$

Question 3.2

Compare and contrast the output from the linear regression model with the output from the logistic regression model in Chapter 2. What looks the same? What looks different? What is being predicted in each case?

Linear Regression

```
Call:
lm(formula = y ~ x1 + x2, data = df)

Residuals:
     Min       1Q   Median       3Q      Max
-11.9218  -3.1032   0.2891   2.8316  12.5813

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  49.8600     0.5370  92.844  < 2e-16 ***
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 4.769 on 197 degrees of freedom
Multiple R-squared:  0.9026,    Adjusted R-squared:  0.9016
F-statistic: 912.4 on 2 and 197 DF,  p-value: < 2.2e-16
```
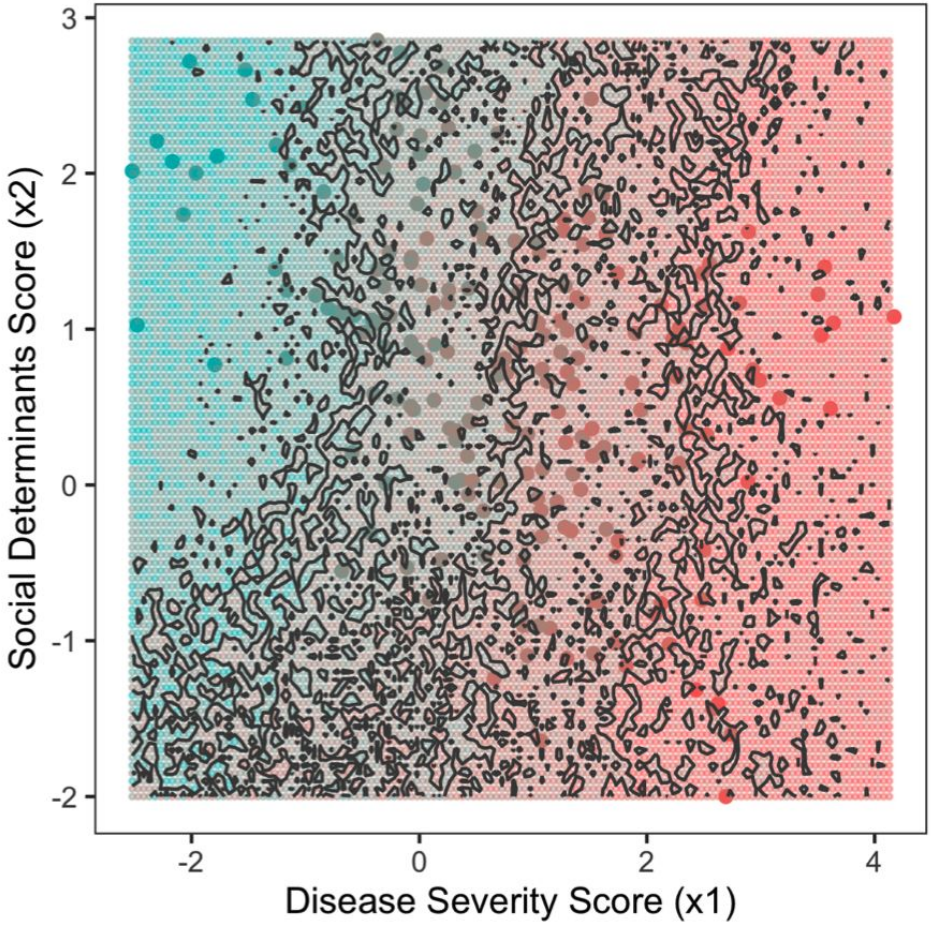
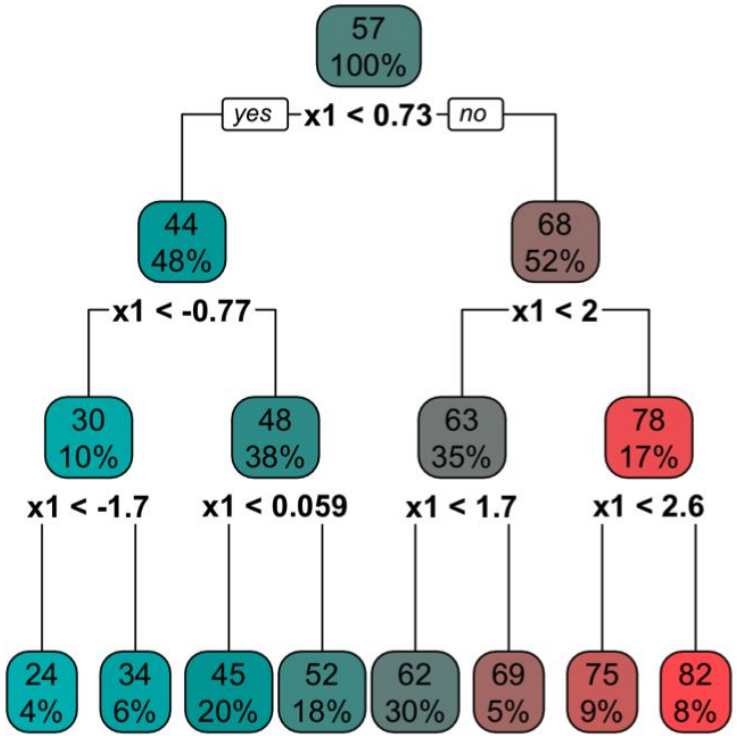
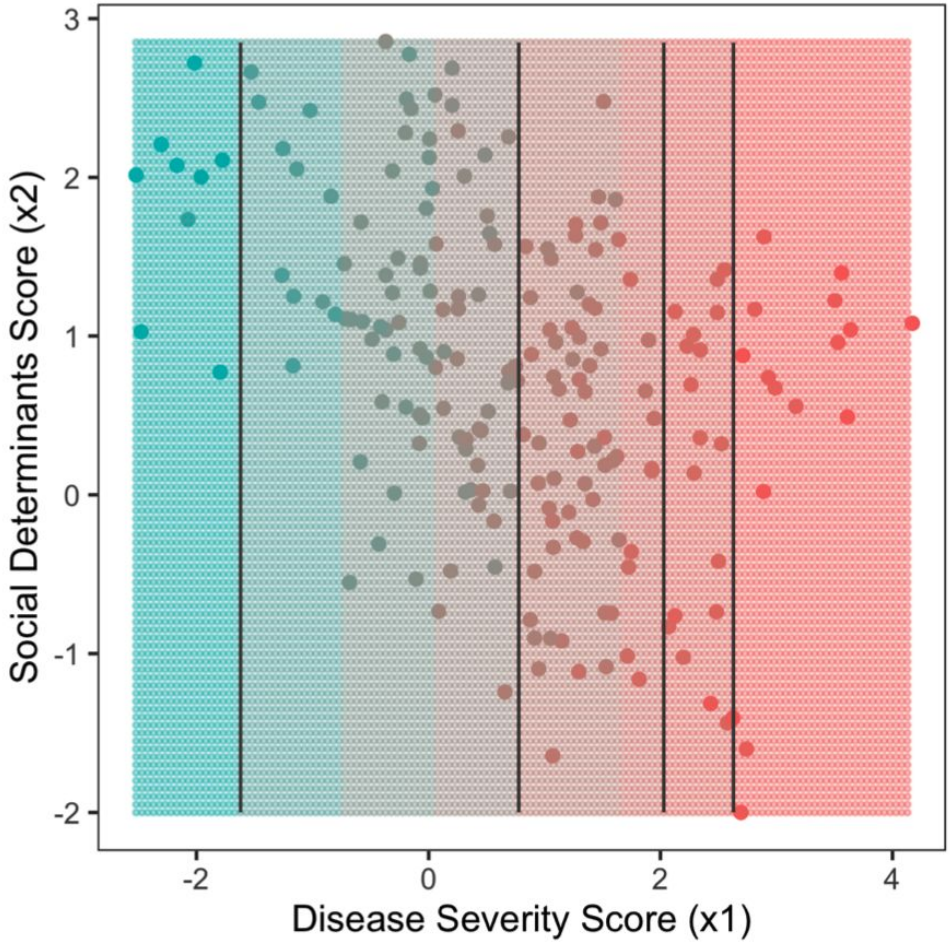

Logistic Regression

```
Call:
glm(formula = y ~ x1 + x2, family = "binomial", data = df)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-1.88232  -0.90614  -0.05965   0.86579   2.28489

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)   0.9780     0.2945   3.321 0.000897 ***
x1            0.1344     0.1372   0.980 0.327272
x2           -1.3981     0.2316  -6.035 1.59e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 277.26  on 199  degrees of freedom
Residual deviance: 209.54  on 197  degrees of freedom
AIC: 215.54

Number of Fisher Scoring iterations: 4
```

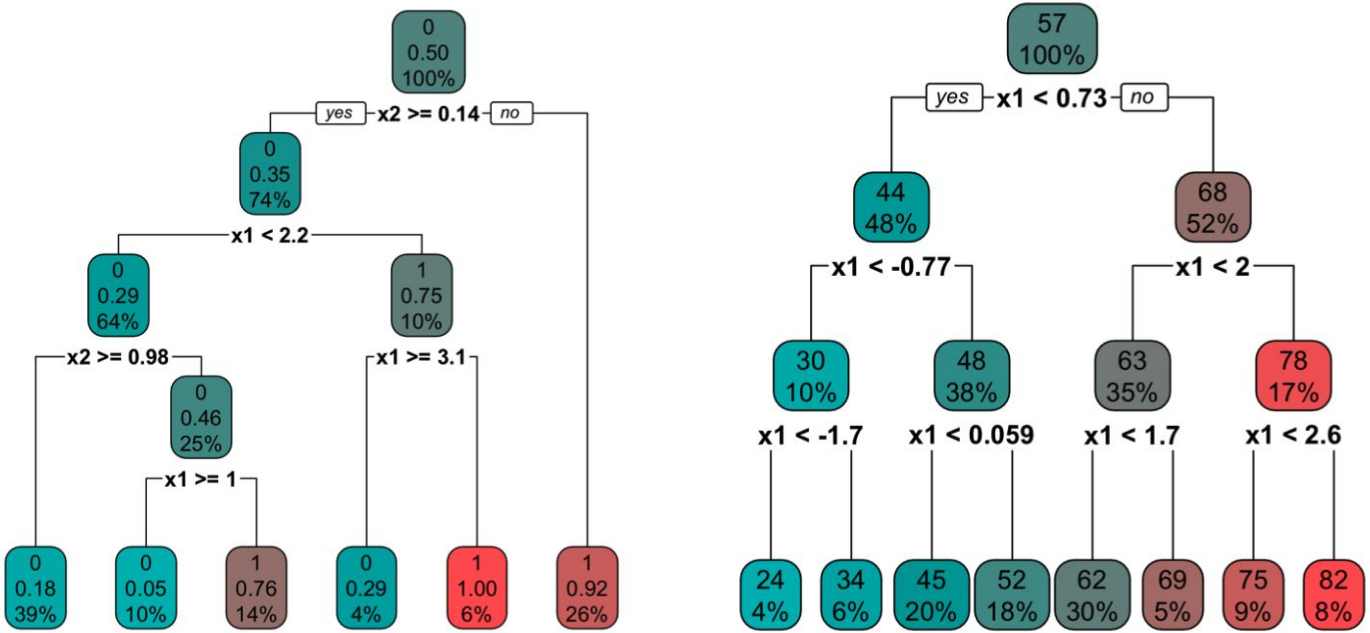

Social Determinants Score (x2)
3
2
1
0
-1
-2
-2
0
2
4
Disease Severity Score (x1)


57
100%
yes
x1 < 0.73
no
44
48%
68
52%
x1 < -0.77
x1 < 2
30
10%
48
38%
63
35%
78
17%
x1 < -1.7
x1 < 0.059
x1 < 1.7
x1 < 2.6
24
4%
34
6%
45
20%
52
18%
62
30%
69
5%
75
9%
82
8%


Social Determinants Score (x2)
Disease Severity Score (x1)
3
2
1
0
-1
-2
-2
0
2
4

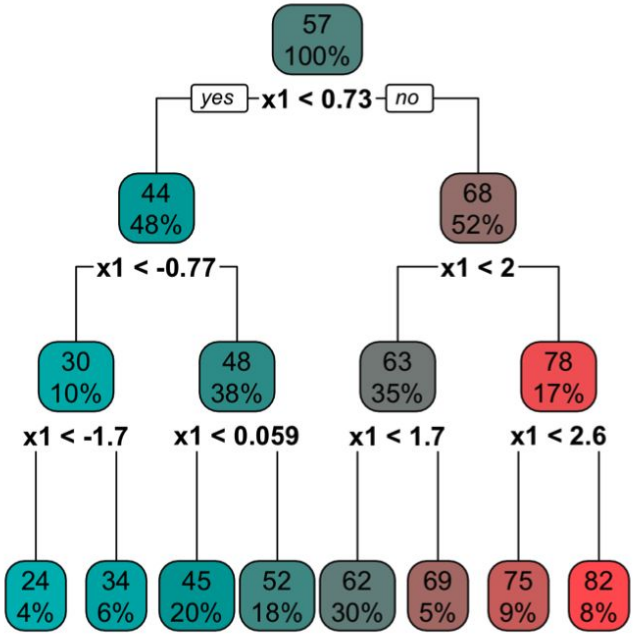
Question 3.3

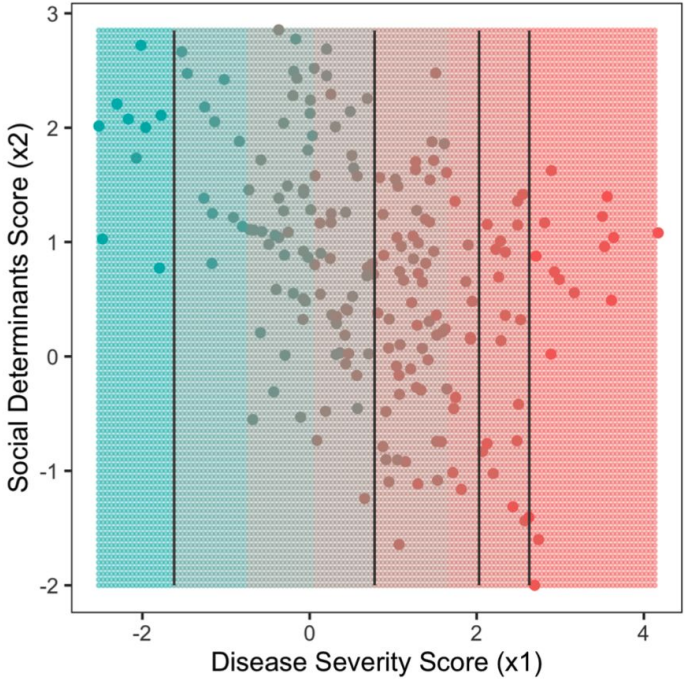
Compare this decision tree with the decision tree for the classification problem in Chapter 2. What is the same? What is different?



Question 3.4

This **regression tree** has eight leaves. What region of the feature space does each leaf correspond to?





Question 3.5

What are the advantages and disadvantages of each of these three regression algorithms (linear regression, KNN, regression tree)?