Leafs

Kaisa Roggeveen, Scott Graham March 22nd 2018

Introduction

Data

Measurement Process

Data Creation

Cherry 11.5 5.9 Cherry 16.7 9.1 Cherry 10.4 4.9 Cherry 18.1 8.4 Cherry 19.3 6.5 Cherry 10.3 5.3 Cherry 10.3 5.3 Cherry 9.9 4.5 Cherry 9.6 6.8 Cherry 19.2 10.4 Cherry 12.8 6.2 Cherry 12.1 8.3 Cherry 12.5 6.2 Cherry 12.5 6.2 Cherry 8.3 4.3 Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 9.2 8.9 Pear 8.5 7.5 Pear 8.2 4.1 Pear 5.8 5.1 Pear 16.8 9.3 Pear 8.9			
Cherry 16.7 9.1 Cherry 10.4 4.9 Cherry 18.1 8.4 Cherry 19.3 6.5 Cherry 10.3 5.3 Cherry 9.9 4.5 Cherry 9.6 6.8 Cherry 19.2 10.4 Cherry 12.8 6.2 Cherry 12.1 8.3 Cherry 12.5 6.2 Cherry 8.3 4.5 Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 8.5 7.5 Pear 8.5 7.5 Pear 8.5 7.5 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 6.4 4.4	Type	Length	Width
Cherry 10.4 4.9 Cherry 18.1 8.4 Cherry 19.3 6.5 Cherry 10.3 5.3 Cherry 10.3 5.3 Cherry 9.9 4.5 Cherry 9.6 6.8 Cherry 19.2 10.4 Cherry 12.8 6.2 Cherry 12.1 8.3 Cherry 12.5 6.2 Cherry 8.3 4.3 Cherry 6.9 4.5 Cherry 6.9 4.5 Cherry 9.2 5.3 Pear 6.9 6.2 Pear 9.2 8.9 Pear 8.5 7.5 Pear 8.2 4.1 Pear 5.8 5.1 Pear 16.8 9.3 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Cherry	11.5	5.9
Cherry 18.1 8.4 Cherry 19.3 6.5 Cherry 10.3 5.3 Cherry 9.9 4.5 Cherry 9.6 6.8 Cherry 19.2 10.4 Cherry 12.8 6.2 Cherry 12.1 8.3 Cherry 12.5 6.2 Cherry 8.3 4.5 Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 8.5 7.5 Pear 8.5 7.5 Pear 8.5 7.5 Pear 5.8 5.1 Pear 6.1 8.9 Pear 6.4 4.4	Cherry	16.7	9.1
Cherry 19.3 6.8 Cherry 12.2 8.0 Cherry 10.3 5.3 Cherry 9.9 4.3 Cherry 9.6 6.8 Cherry 19.2 10.4 Cherry 12.8 6.2 Cherry 12.1 8.3 Cherry 12.5 6.2 Cherry 6.9 4.5 Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 6.9 6.2 Pear 9.2 8.5 Pear 8.5 7.5 Pear 8.5 7.5 Pear 5.7 4.0 Pear 5.8 5.1 Pear 6.1 5.9 Pear 6.1 5.9 Pear 6.4 4.4	Cherry	10.4	4.9
Cherry 12.2 8.0 Cherry 10.3 5.3 Cherry 9.9 4.3 Cherry 9.6 6.8 Cherry 19.2 10.4 Cherry 12.8 6.2 Cherry 12.1 8.3 Cherry 12.5 6.2 Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 9.2 8.5 Pear 8.5 7.5 Pear 8.5 7.5 Pear 5.7 4.0 Pear 5.8 5.1 Pear 6.1 5.9 Pear 6.4 4.4	Cherry	18.1	8.4
Cherry 10.3 5.3 Cherry 9.9 4.3 Cherry 9.6 6.8 Cherry 19.2 10.4 Cherry 12.8 6.2 Cherry 12.1 8.3 Cherry 12.5 6.2 Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 9.2 8.5 Pear 8.5 7.5 Pear 8.5 7.5 Pear 8.5 7.5 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 6.4 4.4	Cherry	19.3	6.5
Cherry 9.9 4.3 Cherry 9.6 6.8 Cherry 19.2 10.4 Cherry 12.8 6.2 Cherry 12.1 8.3 Cherry 12.5 6.2 Cherry 8.3 4.3 Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 9.2 8.5 Pear 8.5 7.5 Pear 8.5 7.5 Pear 5.7 4.0 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Cherry	12.2	8.0
Cherry 9.6 6.8 Cherry 19.2 10.4 Cherry 12.8 6.2 Cherry 12.1 8.3 Cherry 12.5 6.2 Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 9.2 8.9 Pear 8.5 7.5 Pear 8.5 7.5 Pear 5.7 4.0 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Cherry	10.3	5.3
Cherry 19.2 10.4 Cherry 12.8 6.2 Cherry 12.1 8.3 Cherry 12.5 6.2 Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 9.2 8.5 Pear 8.5 7.5 Pear 8.2 4.1 Pear 5.7 4.0 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Cherry	9.9	4.3
Cherry 19.2 10.4 Cherry 12.8 6.2 Cherry 12.1 8.3 Cherry 12.5 6.2 Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 9.2 8.5 Pear 8.5 7.5 Pear 8.2 4.1 Pear 5.7 4.0 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Cherry	9.6	6.8
Cherry 12.8 6.2 Cherry 12.1 8.3 Cherry 12.5 6.2 Cherry 8.3 4.3 Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 9.2 8.5 Pear 8.5 7.5 Pear 8.2 4.1 Pear 5.7 4.0 Pear 5.8 5.1 Pear 16.8 9.5 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4		19.2	10.4
Cherry 12.1 8.3 Cherry 12.5 6.2 Cherry 8.3 4.3 Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 9.2 8.5 Pear 8.5 7.5 Pear 8.2 4.1 Pear 5.7 4.0 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4		12.8	6.2
Cherry 8.3 4.5 Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 9.2 8.5 Pear 8.5 7.5 Pear 8.2 4.1 Pear 5.7 4.0 Pear 5.8 5.1 Pear 16.8 9.5 Pear 6.1 5.5 Pear 8.9 4.1 Pear 6.4 4.4		12.1	8.3
Cherry 6.9 4.5 Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 9.2 8.5 Pear 8.5 7.5 Pear 8.2 4.1 Pear 5.7 4.0 Pear 5.8 5.1 Pear 16.8 9.6 Pear 6.1 5.6 Pear 8.9 4.1 Pear 6.4 4.4	Cherry	12.5	6.2
Cherry 9.2 5.5 Pear 5.3 3.1 Pear 6.9 6.2 Pear 9.2 8.5 Pear 8.5 7.5 Pear 8.2 4.1 Pear 5.7 4.0 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Cherry	8.3	4.3
Pear 5.3 3.1 Pear 6.9 6.2 Pear 9.2 8.5 Pear 8.5 7.5 Pear 8.2 4.1 Pear 5.7 4.6 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Cherry	6.9	4.5
Pear 6.9 6.2 Pear 9.2 8.5 Pear 8.5 7.5 Pear 8.2 4.1 Pear 5.7 4.0 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Cherry	9.2	5.5
Pear 9.2 8.8 Pear 8.5 7.5 Pear 8.2 4.1 Pear 5.7 4.0 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.8 Pear 8.9 4.1 Pear 6.4 4.4	Pear	5.3	3.1
Pear 8.5 7.5 Pear 8.2 4.1 Pear 5.7 4.0 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Pear	6.9	6.2
Pear 8.2 4.1 Pear 5.7 4.6 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Pear	9.2	8.9
Pear 5.7 4.0 Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Pear	8.5	7.5
Pear 5.8 5.1 Pear 16.8 9.9 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Pear	8.2	4.1
Pear 16.8 9.9 Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Pear	5.7	4.0
Pear 6.1 5.9 Pear 8.9 4.1 Pear 6.4 4.4	Pear	5.8	5.1
Pear 8.9 4.1 Pear 6.4 4.4	Pear	16.8	9.9
Pear 6.4 4.4	Pear	6.1	5.9
	Pear	8.9	4.1
Pear 18.8 15.2	Pear	6.4	4.4
	Pear	18.8	15.2

Type	Length	Width
Cherry:16	Min.: 5.300	Min.: 3.100
Pear:12	1st Qu.: 7.875	1st Qu.: 4.475
NA	Median: 9.750	Median: 6.050

Type	Length	Width
NA	Mean $:10.914$	Mean: 6.536
NA	3rd Qu.:12.575	3rd Qu.: 8.075
NA	Max. $:19.300$	Max. $:15.200$

Classification Procedure

Training Data

New Data

Observation Space

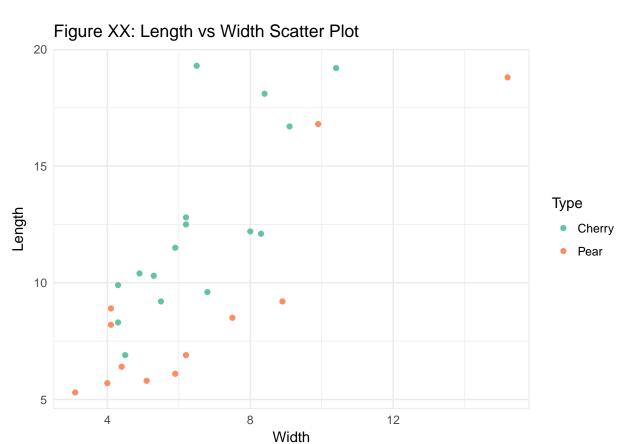


Figure XX: Length vs Width Scatter Plot

Overlayed with the Contour Plot

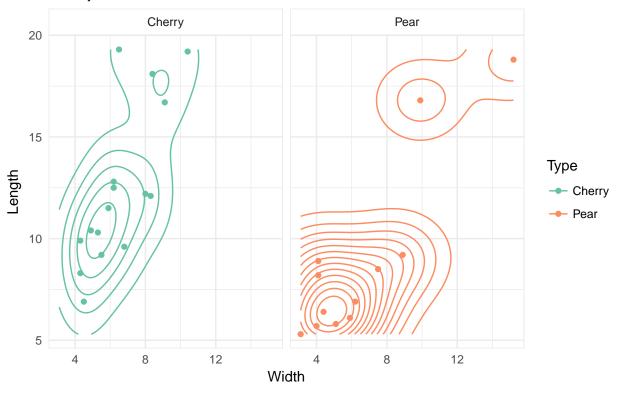


Figure XX: Length vs Width Scatter Plot

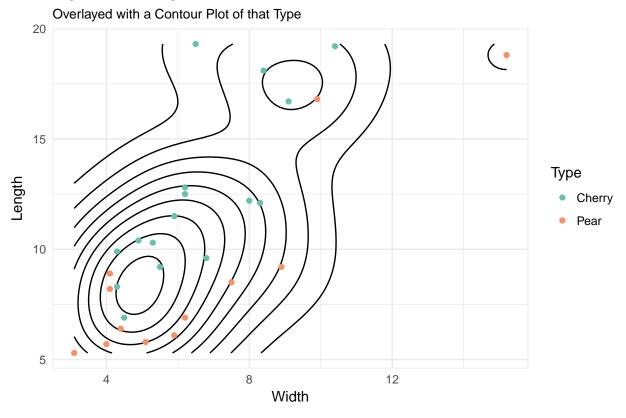


Figure XX: Length vs Width Scatter Plot

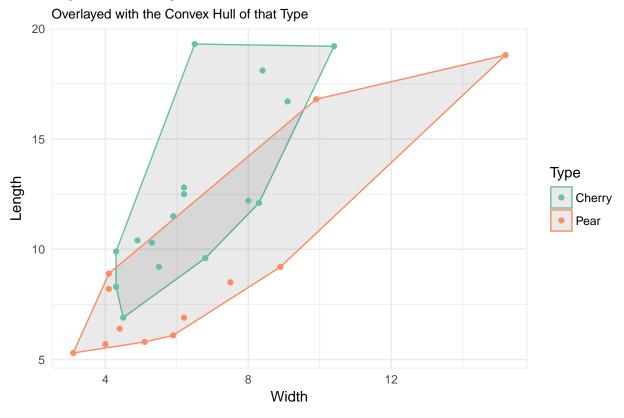
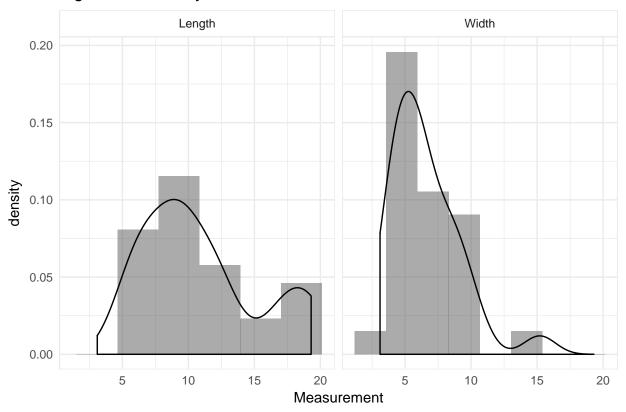


Figure XX: Density Plot



Cherry Pear 0.20 0.15 0.10 0.05 Type density 0.00 0.20 Cherry Pear 0.15 Width 0.10 0.05 0.00 5 10 15 20 5 10 15 20 Measurement

Figure XX: Density Plot by Type

Covariance Matrix

Table 3: Shared Covariance Matrix

	Length	Width
Length	19.422011	8.476508
Width	8.476508	6.685344

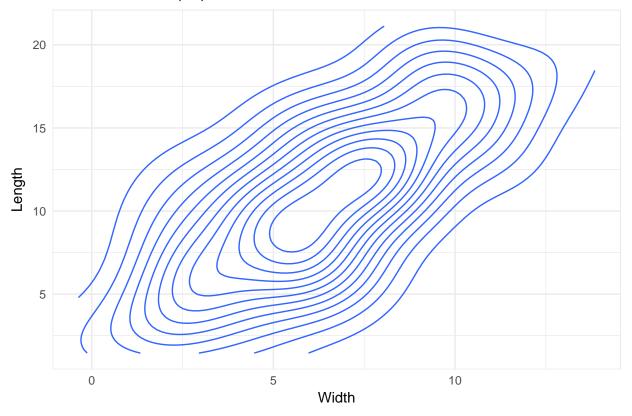
Table 4: Cherry Covariance Matrix

	Length	Width
Length	15.047833	5.443833
Width	5.443833	3.357167

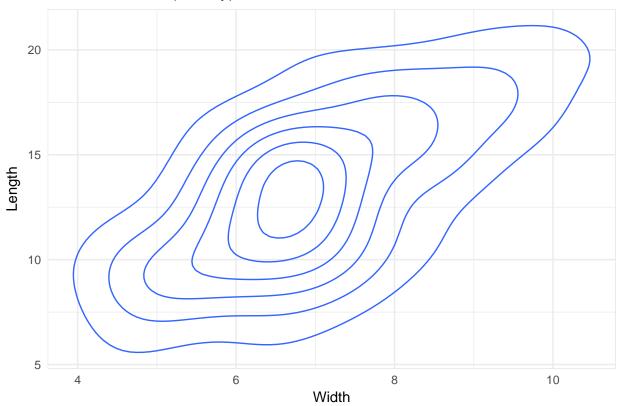
Table 5: Pear Covariance Matrix

	T /1	XX7: 1, 1
	Length	Width
Length	19.27788	13.37333
Width	13.37333	11.83152

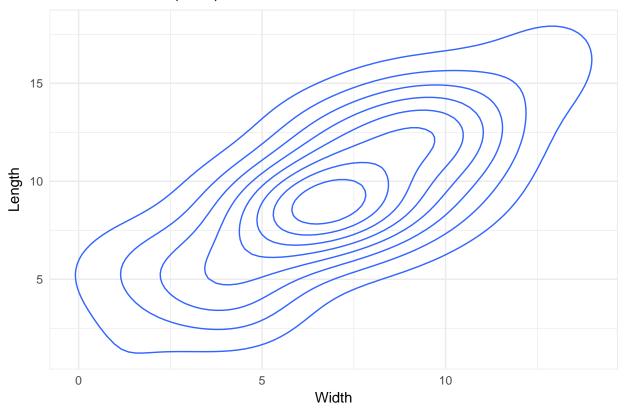
Simulated Data (All)



Simulated Data (Cherry)



Simulated Data (Pear)



```
## $Length
## [1] 5.300000 7.633333 9.966667 12.300000 14.633333 16.966667 19.300000
##
## $Width
## [1] 3.100000 5.116667 7.133333 9.150000 11.166667 13.183333 15.200000
##
## $Density
##
                             3.1 5.11666666666667 7.13333333333333
## 5.3
                    8.447458e-03
                                      0.012017959
                                                        0.005149716
## 7.6333333333333 1.124607e-02
                                      0.018558765
                                                        0.010136059
## 9.9666666666666 8.369715e-03
                                      0.017477410
                                                        0.012579266
                    3.111530e-03
                                      0.010275365
                                                        0.010725536
## 14.63333333333 5.401377e-04
                                      0.003131359
                                                        0.004983311
## 16.966666666666 9.644419e-05
                                                        0.003687849
                                      0.001089739
## 19.3
                    1.168969e-04
                                      0.001447540
                                                        0.003669233
##
                           9.15 11.1666666666667 13.1833333333333
## 5.3
                    0.000930451
                                    9.637295e-05
                                                      2.737286e-06
## 7.6333333333333 0.003445585
                                    5.207249e-04
                                                     1.580038e-05
## 9.966666666666666666 0.005470224
                                    8.414374e-04
                                                      2.383664e-05
## 12.3
                    0.005113882
                                    7.579625e-04
                                                      2.683754e-05
                                                     1.826390e-04
## 14.63333333333 0.004375421
                                    1.510035e-03
## 16.96666666666666667 0.006526390
                                    3.339904e-03
                                                      8.045625e-04
                                    2.998742e-03
## 19.3
                    0.004909057
                                                     1.108098e-03
##
                            15.2
## 5.3
                    1.190966e-08
## 7.6333333333333 6.917012e-08
```

Conclusion