6.20. The tail lengths in millimeters (x_1) and wing lengths in millimeters (x_2) for 45 *male* hook-billed kites are given in Table 6.11 on page 346. Similar measurements for female hook-billed kites were given in Table 5.12.

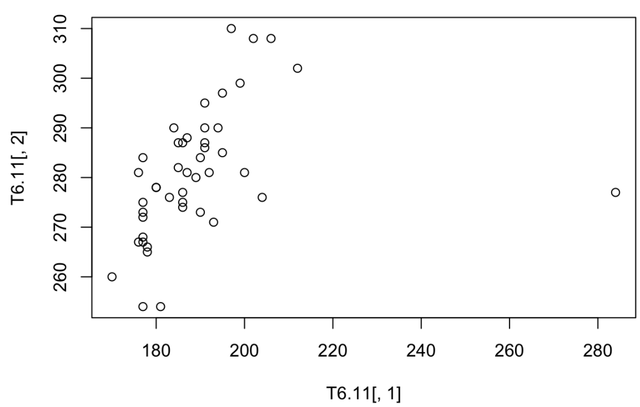
(a) Plot the male hook-billed kite data as a scatter diagram, and (visually) check for outliers. (Note, in particular, observation 31 with $x_1 = 284$.)

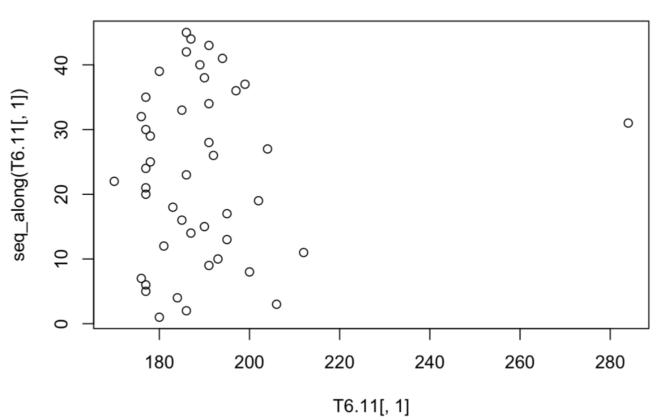
(b) Test for equality of mean vectors for the populations of male and female hook-billed kites. Set $\alpha = .05$. If H_0: $\boldsymbol{\mu}_1 - \boldsymbol{\mu}_2 = \mathbf{0}$ is rejected, find the linear combination most responsible for the rejection of H_0. (You may want to eliminate any outliers found in Part a for the male hook-billed kite data before conducting this test. Alternatively, you may want to interpret $x_1 = 284$ for observation 31 as a misprint and conduct the test with $x_1 = 184$ for this observation. Does it make any difference in this case how observation 31 for the male hook-billed kite data is treated?)

(c) Determine the 95% confidence region for $\boldsymbol{\mu}_1 - \boldsymbol{\mu}_2$ and 95% simultaneous confidence intervals for the components of $\boldsymbol{\mu}_1 - \boldsymbol{\mu}_2$.

(d) Are male or female birds generally larger?

a)





Observation 31 is the outlier

b)

```
> T6.11new<-T6.11
> T6.11new[T6.11new == 284] <- 184
> T6.11new$Gender<-("Male")
> T5.12$Gender<-("Female")
> comb<-rbind(T6.11new,T5.12)
> Hotellings.twosample.perm.test(comb,3,0)

$H
        [,1]
[1,] 10.71647

$H1
        [,1]
[1,] 5.332813

$P
            [,1]
[1,] 0.005507356

$mu
[1] -6.533333 -3.355556

$df
[1]   2.0000 209.7734

$permP
[1] 0.0049
```

c)

```
> Bootstrap.twosample.simconf(comb,3,diag(2),0,10000,.05)
$bootconf
          [,1]      [,2]      [,3]
[1,] -11.68889 -6.533333 -1.400000
[2,] -13.28889 -3.355556  6.711111

$Hotelling
          [,1]      [,2]      [,3]
[1,] -11.77776 -6.533333 -1.288909
[2,] -13.55282 -3.355556  6.841704
```

Linear combination responsible for rejection: (1,0)

d) Females are usually larger since the intervals are negative. And the CI for difference in wing span include 0 therefore indicating no significant difference.

6.33. Refer to Exercise 6.32. The data in Table 6.18 are measurements on the variables

X_1 = percent spectral reflectance at wavelength 560 nm (green)

X_2 = percent spectral reflectance at wavelength 720 nm (near infrared)

for three species (sitka spruce [SS], Japanese larch [JL], and lodgepole pine [LP]) of 1-year-old seedlings taken at three different times (Julian day 150 [1], Julian day 235 [2], and Julian day 320 [3]) during the growing season. The seedlings were all grown with the optimal level of nutrient.

(a) Perform a two-factor MANOVA using the data in Table 6.18. Test for a species effect, a time effect and species–time interaction. Use $\alpha = .05$.

a)
gui.multiway.manova.test.portmanteau()
[1] "T6.18" "c(3:4)" "10000"

$p
[1] 0 0 0

$cp
[1] 0 0 0

There is some effect of species, time, and species -time interaction.

(c) Foresters are particularly interested in the interaction of species and time. Does i teraction show up for one variable but not for the other? Check by running a ur variate two-factor ANOVA for each of the two responses.

(d) Can you think of another method of analyzing these data (or a different experime tal design) that would allow for a potential time trend in the spectral reflectan numbers?

c) Two way anova
560 NM

Source	DF	SS	MS	F	P
species	2	965.18	482.591	169.97	0.000
time	2	1275.25	637.624	224.58	0.000
Interaction	4	795.81	198.952	70.07	0.000
Error	27	76.66	2.839		
Total	35	3112.90			

S = 1.685   R-Sq = 97.54%   R-Sq(adj) = 96.81%

720 NM

Source	DF	SS	MS	F	P
species	2	2026.86	1013.43	15.46	0.000
time	2	5573.81	2786.90	42.52	0.000
Interaction	4	193.55	48.39	0.74	0.574
Error	27	1769.64	65.54		
Total	35	9563.85			

S = 8.096   R-Sq = 81.50%   R-Sq(adj) = 76.01%

i) 720 NM
ii) There is some effect of interaction.

d) The other possible method is growth curve seen in section 6.9 of the text book.