# Multivariable regression

Regression

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Consider the following simulated data

Code for the first plot, rest omitted (See the git repo for the rest of the code.)

```r
n <- 100; t <- rep(c(0, 1), c(n/2, n/2)); x <- c(runif(n/2), runif(n/2));
beta0 <- 0; beta1 <- 2; tau <- 1; sigma <- .2
y <- beta0 + x * beta1 + t * tau + rnorm(n, sd = sigma)
plot(x, y, type = "n", frame = FALSE)
abline(lm(y ~ x), lwd = 2)
abline(h = mean(y[1 : (n/2)]), lwd = 3)
abline(h = mean(y[(n/2 + 1) : n]), lwd = 3)
fit <- lm(y ~ x + t)
abline(coef(fit)[1], coef(fit)[2], lwd = 3)
abline(coef(fit)[1] + coef(fit)[3], coef(fit)[2], lwd = 3)
points(x[1 : (n/2)], y[1 : (n/2)], pch = 21, col = "black", bg = "lightblue", cex = 2)
points(x[(n/2 + 1) : n], y[(n/2 + 1) : n], pch = 21, col = "black", bg = "salmon", cex = 2)
```
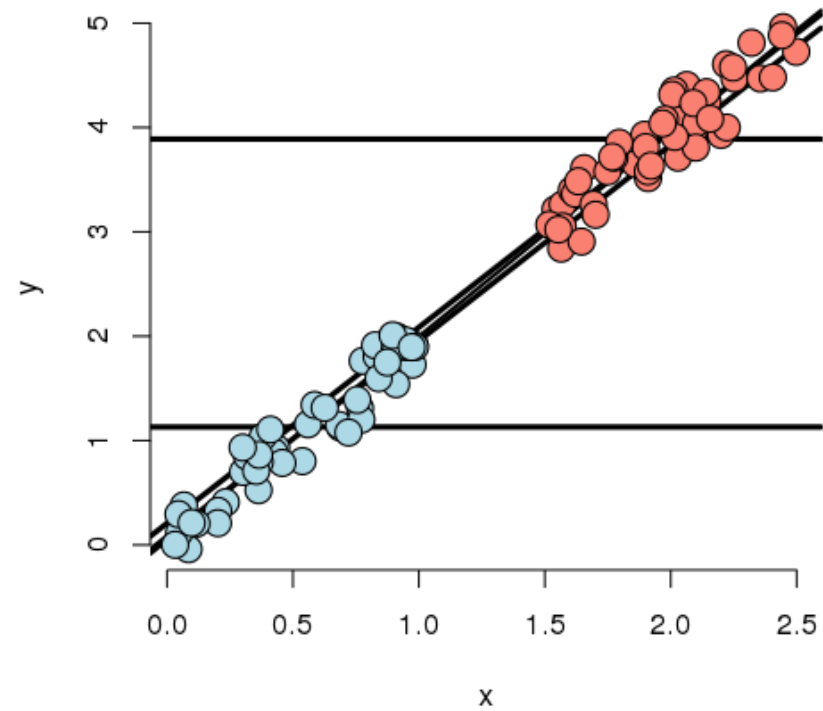
Simulation 1
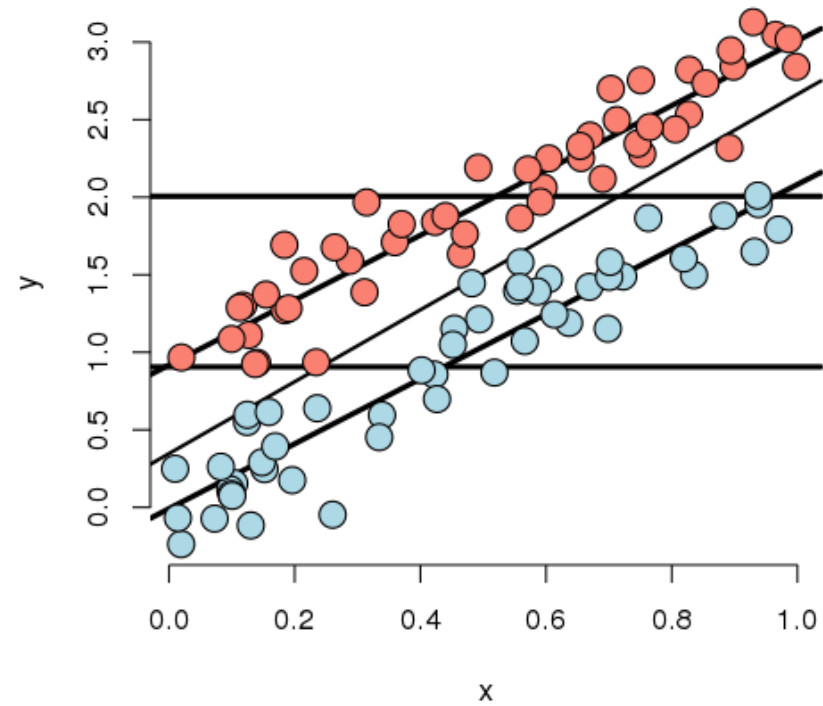
Discussion

Some things to note in this simulation

- The X variable is unrelated to group status

- The X variable is related to Y, but the intercept depends on group status.

- The group variable is related to Y.

    - The relationship between group status and Y is constant depending on X.

    - The relationship between group and Y disregarding X is about the same as holding X constant
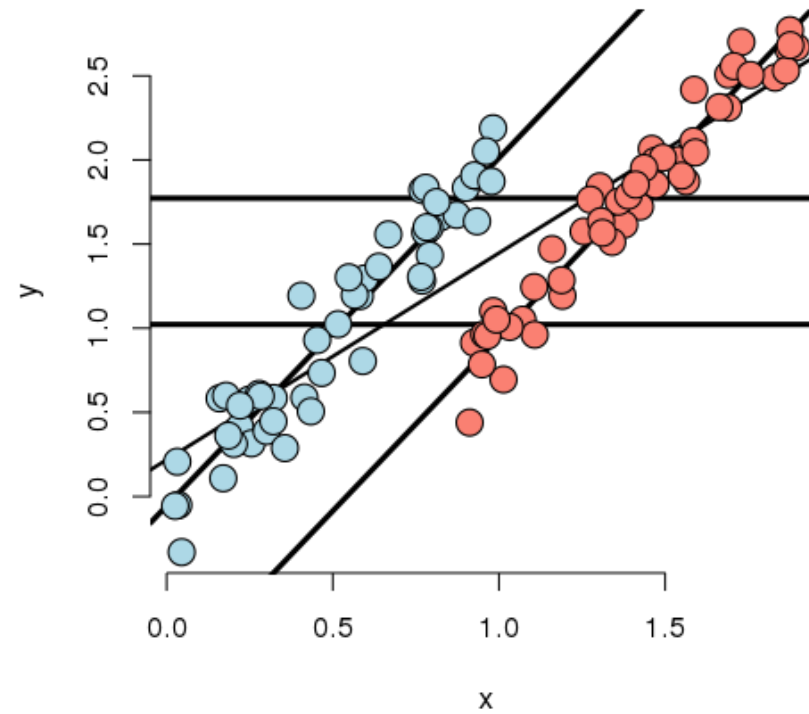
Simulation 2

Discussion

Some things to note in this simulation

· The X variable is highly related to group status

· The X variable is related to Y, the intercept doesn't depend on the group variable.

  - The X variable remains related to Y holding group status constant

· The group variable is marginally related to Y disregarding X.

· The model would estimate no adjusted effect due to group.

  - There isn't any data to inform the relationship between group and Y.

  - This conclusion is entirely based on the model.
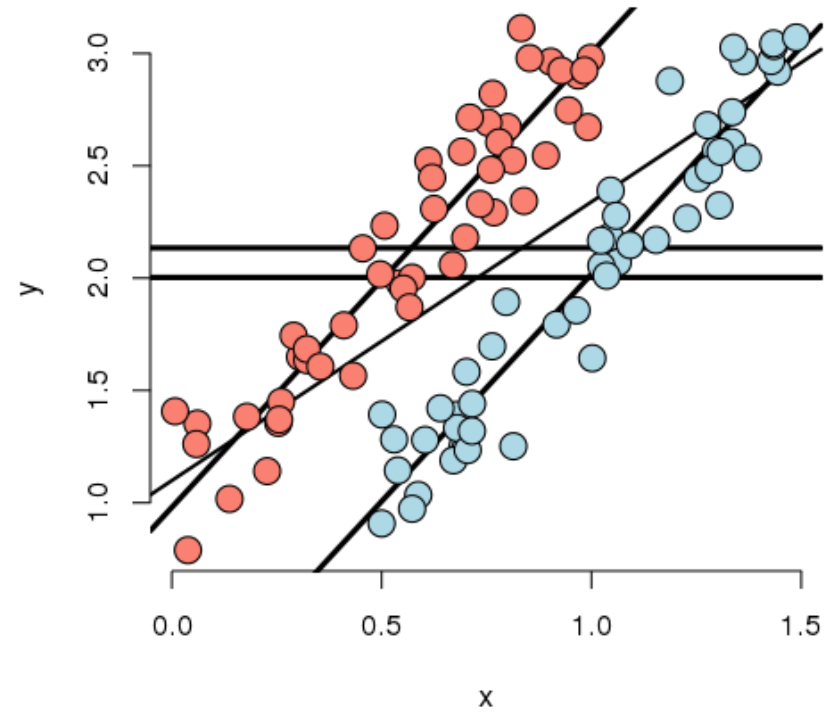
Simulation 3

Discussion

Some things to note in this simulation

· Marginal association has red group higher than blue.

· Adjusted relationship has blue group higher than red.

· Group status related to X.

· There is some direct evidence for comparing red and blue holding X fixed.
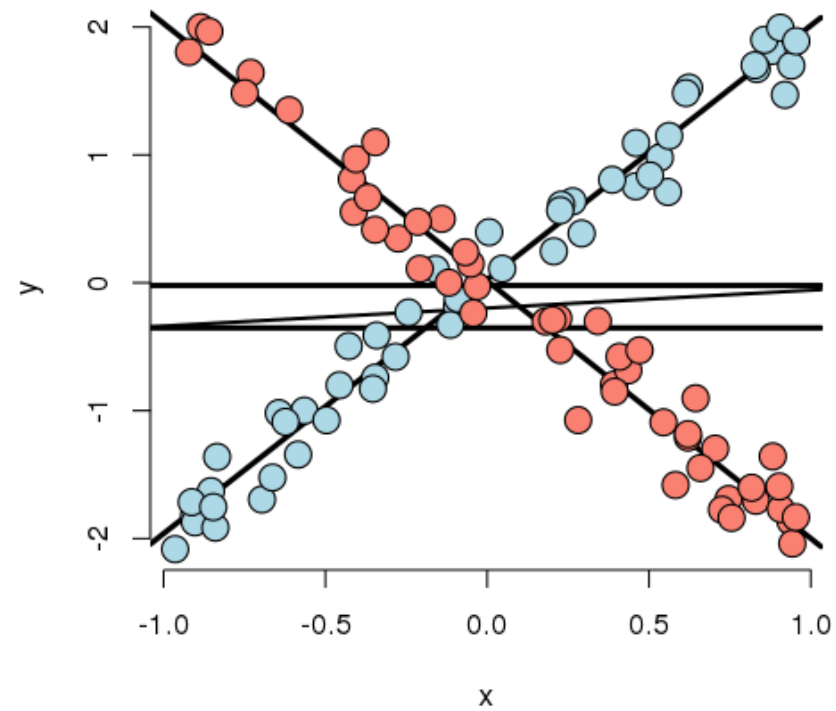
Simulation 4

Discussion

Some things to note in this simulation

- No marginal association between group status and Y.

- Strong adjusted relationship.

- Group status not related to X.

- There is lots of direct evidence for comparing red and blue holding X fixed.
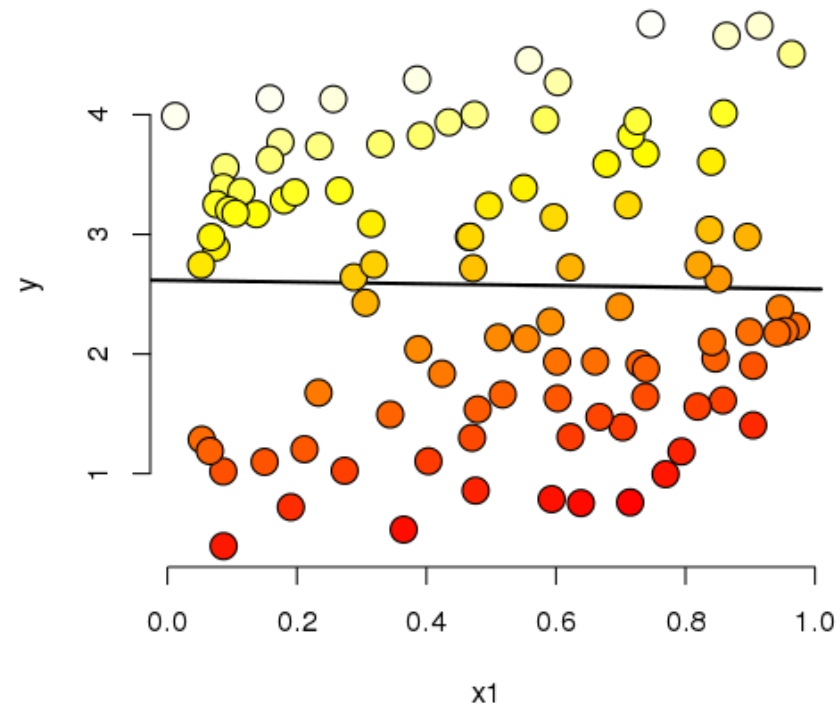
Simulation 5

Discussion

Some things to note from this simulation

- There is no such thing as a group effect here.

    - The impact of group reverses itself depending on X.

    - Both intercept and slope depends on group.

- Group status and X unrelated.

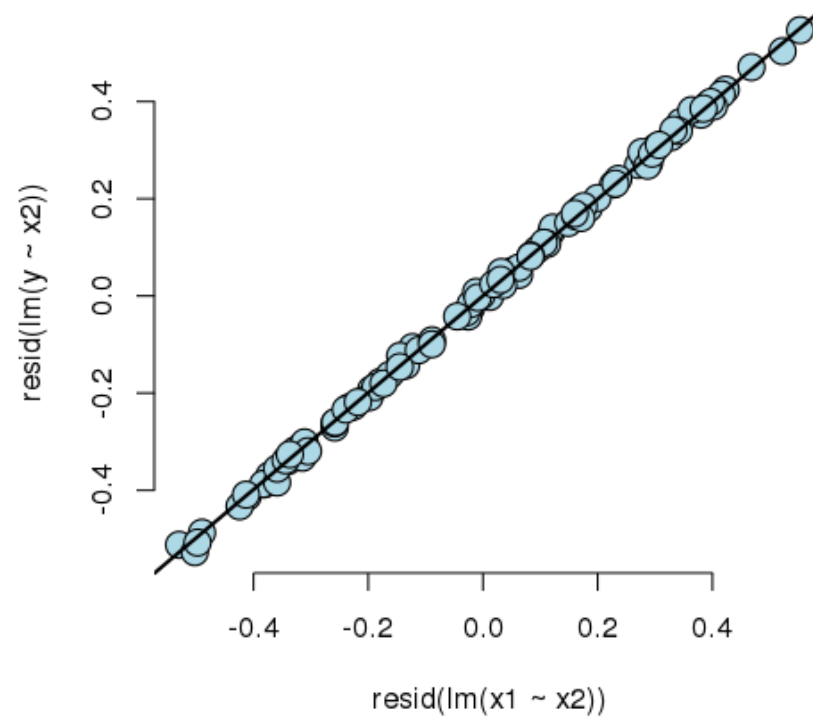   - There's lots of information about group effects holding X fixed.

Simulation 6

Do this to investigate the bivariate relationship

```r
library(rgl)
plot3d(x1, x2, y)
```

Residual relationship

Discussion

Some things to note from this simulation

- · X1 unrelated to X2

- · X2 strongly related to Y

- · Adjusted relationship between X1 and Y largely unchanged by considering X2.

    - Almost no residual variability after accounting for X2.

Some final thoughts

· Modeling multivariate relationships is difficult.

· Play around with simulations to see how the inclusion or exclustion of another variable can change analyses.

· The results of these analyses deal with the impact of variables on associations.

- Ascertaining mechanisms or cause are difficult subjects to be added on top of difficulty in understanding multivariate associations.