Ch.3-Ex.18: Let $y$ denote am and $x$ denote hp. Then, the logistic regression model is:

$$E[Y|X] = \frac{e^{\beta_0 + \beta_1 x}}{1 + e^{\beta_0 + \beta_1 x}}$$

R code:

```r
> fit<-glm(am~hp,data=mtcars,family=binomial)
> fit
```

```
Call: glm(formula = am ~ hp, family = binomial, data = mtcars)

Coefficients:
(Intercept)      hp
       0.776614  -0.008117

Degrees of Freedom: 31 Total (i.e. Null); 30 Residual
Null Deviance: 43.23
Residual Deviance: 41.23   AIC: 45.23
```

From the output, we can see that the estimated model is

$$E[Y|X] = \frac{e^{0.7766-0.0081x}}{1 + e^{0.7766-0.0081x}}$$

I do the plot to show how the estimated model fit the observations using the following R codes:

```r
> x<-seq(50,350,length=100)
> y<-exp(0.7766-0.0081*x)/(1+exp(0.7766-0.0081*x))
> lines(x,y,lty=i)
```
Ch.3-Ex.19 I think that in an area where there are more churches, people there may not that like to go to bars, which makes the number of bars is less. Thus, in the regression equation $z_i = \beta_0 + \beta_1 y_i$, I will expect $\beta_1$ to be negative.

Ch.3-Ex.23 (a) Since $x$ is generated by $\text{rnorm}(1,2,3)$, the marginal distribution of $x$ is $N(\mu = 2, \sigma = 3)$.

(b) The marginal density of $x$ is

$$f_X(x) = \frac{1}{\sqrt{2\pi} \times 3} e^{-\frac{(x-2)^2}{18}}$$

(c) Since $y \leftarrow -2x + 1 + \text{rnorm}(0,1)$, $y = -2x + 1 + \epsilon$ and $\epsilon \sim N(\mu = 0, \sigma = 1)$. Thus, $Y|X \sim N(\mu = -2x + 1, \sigma = 1)$.

(d) The conditional density of $y$ given $x$ is

$$f_{Y|X}(y|x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{(y+2x-1)^2}{2}}$$
(e) The joint density of $(x,y)$ is

$$f_{(X,Y)}(x,y) = f_{Y|X}(y|x) \ast f_X(x) = \frac{1}{6\pi} e^{-\frac{9(y+2x-1)^2 + (x-2)^2}{18}}$$

(f) $z_1$ is estimate to $\beta_1$ where $\beta_1$ is from $y = \beta_0 + \beta_1 x$. Since $y \leftarrow -2x + 1 + \text{rnorm}(1,0,1)$, $\beta_1$ should be around -2. That’s why the code writer write $\sqrt{\text{var}(w + 2)}$ instead of $\sqrt{\text{var}(w)}$. 