4.5 Determining the Number of Blocks

The F-test for treatment or dose effect in the last example was highly significant ($P < .0001$). If the experiment were to be repeated in a situation where the variability of the response (lever press rate within a rat) and differences in treatment means were to remain approximately the same, fewer blocks or rats would be required to detect significant differences in treatments. The noncentrality parameter for the F-test of treatment effects in the randomized complete block design is $\lambda = (b/\sigma^2)\sum_j \tau_j^2$, and the degrees of freedom are $\nu_1 = t-1$, and $\nu_2 = (b-1)(t-1)$. Therefore, in order to calculate the number of blocks that will result in a power between 0.8 and 0.9 for detecting a difference in treatment means, the R code in Section 3.5.2 can be modified by changing the formula for the denominator degrees of freedom and the noncentrality factor.

The R code below can be used for calculating the power for a randomized block design as a function of the number of blocks. Using the results from the last experiment, the estimate of $\sigma^2_{rcb} = 0.00834867$ and $css = \sum_j \tau_j^2$ can be estimated to be

$$(.764 - .9142)^2 + \ldots + (0.850 - .9142)^2 = 0.460208.$$

Using these as inputs to a more general F-power function that takes the degrees of freedom, and the noncentrality parameter as arguments, the results are created that are shown below the code. There it can be seen that a power greater than 0.90 can be achieved with only $b = 5$ blocks or rats in the experiment.

```
> library(daewr)
> bmin <- 4
> bmax <- 5
> alpha <- .05
> sigma2 <- 0.0083487
> css <- 0.0460208
> nu1 <- 5-1
> blocks <- c(bmin:bmax)
> nu2 <- (blocks - 1) * nu1
> nc <- (blocks * css) / sigma2
> Power <- Fpower( alpha, nu1, nu2, nc )
> data.frame(blocks, nu1, nu2, nc, Power)
  blocks nu1 nu2       nc     Power
1      4   4  12 22.04933 0.8877817
2      5   4  16 27.56166 0.9671099
```

If an estimate σ^2_{crd} were available from previous experiments or pilot studies, Hinkelmann and Kempthorne (1994) have shown the relative efficiency (RE) σ^2_{crd} can also be used to get a rough estimate of the number of blocks required