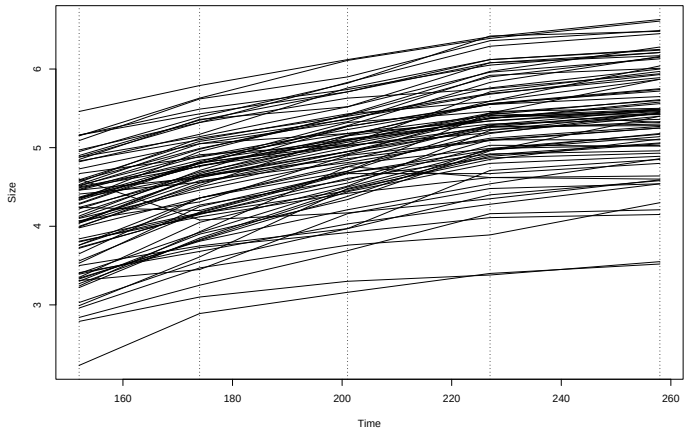
Sitka data (Sec. 10.1, V & R).

79 trees at 5 (monthly) timepoints.

Y_{ij} is 'size' of i-th tree at j-th timepoint.

Ignore control/treatment assignment.

Raw Data



Separate Analyses

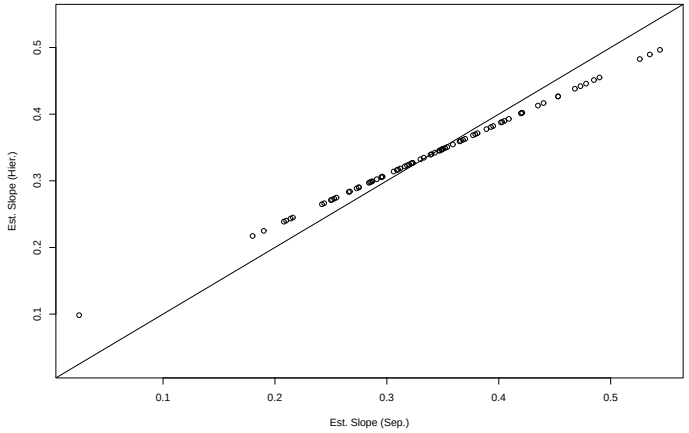
```
time.str  <- as.numeric(ordered(Time))-1 ### 0-4 coding
fit3 <- lm(size~as.factor(tree)*time.str)
slopes3 <- fit3$coef[80] + c(0,fit3$coef[81:158])

Coefficients:
                            Estimate Std. Error
(Intercept)                 4.550e+00  1.055e-01
as.factor(tree)2           -3.820e-01  1.492e-01
...
as.factor(tree)79          -1.428e+00  1.492e-01
time.str                    4.200e-01  4.307e-02
as.factor(tree)2:time.str  -2.040e-01  6.092e-02
as.factor(tree)3:time.str  -1.470e-01  6.092e-02
...
as.factor(tree)79:time.str  1.240e-01  6.092e-02
```


Hierarchical model fit

```
fit2 <- lme(size~as.factor(tree)+time.str,
            random = ~ -1+time.str| tree)

slopes2 <- fit2$coef$fixed[80]+fit2$coef$random$tree

summary(fit2)
Linear mixed-effects model fit by REML
 Data: NULL
       AIC      BIC   logLik
  49.46077 357.1717 57.26962

Random effects:
 Formula: ~-1 + time.str | tree
          time.str  Residual
StdDev: 0.07816862 0.1362102
```

```
Fixed effects: size ~ as.factor(tree) + time.str
                       Value  Std.Error
(Intercept)         4.587284 0.09708386
as.factor(tree)2   -0.477029 0.13713785
...
as.factor(tree)79 -1.370237 0.13713785
time.str           0.339962 0.01004147
```


Compare the two sets of estimated slopes:



Impact of borrowing strength!

What about standard errors for these slopes?

For slope for i-th tree, very roughly

$$\frac{1}{SE^2_{HR,i}} \approx \frac{1}{SE^2_{SEP,i}} + \frac{1}{\tau^2}$$

where τ^2 is random effect variance. WHY?

Present ex., $SE_{SEP,i} \approx 0.043$ [Same for each tree - why?]

Also τ estimated as 0.078.

Suggests $SE_{HR,i} \approx 0.038$

Impact of borrowing strength!