RenR 480/711

Experimental design

Blocking, ANCOVA & Mixed models

Experimental design

<u>Some new (and old) terms:</u>

Treatment

→ predictor variable, e.g. Variety, fertilization, irrigation

Treatment level

→ levels/groups within treatments, e.g. A,B,C, Control, N1,N2,N3

Blocking

→ arrangement of experimental units in homogenous groups/blocks

Nuisance factor

→ factors that influence your response variable, but are not of primary interest, e.g. soil moisture of plots, time of day, person who took the data

Experimental Blocking

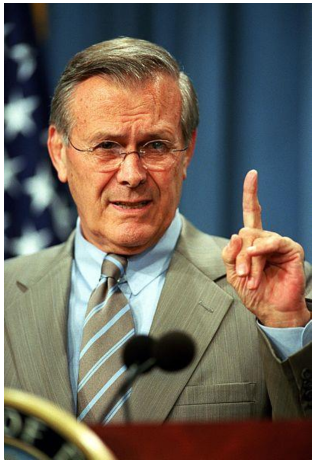
<u>The idea behind blocking</u>

- Holding nuisance factors constant within blocks *while*
- Response variable of interest varies within blocks
- Reducing experimental error caused by nuisance factors by including a blocking factor in the model

```
anova(lm(YIELD~VARIETY+BLOCK, data=lentils))
```

Experimental Blocking

Blocking can remove the effects of the most important nuisance factors

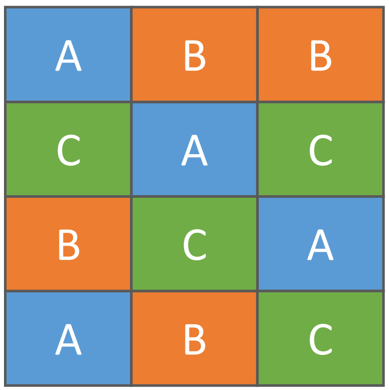


	Known	**Unknowns**
known	known Knowns	known Unknowns
unknown	unknown Knowns	unknown Unknowns

Randomization and replication reduces the effects of known unknowns, unknown knowns & and unknown unknowns

Experimental designs

Completely Randomized Design

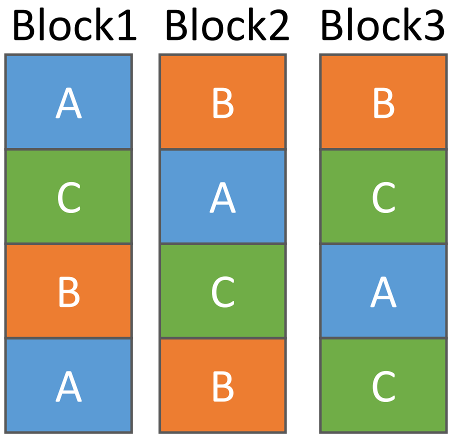


-Experimental units are randomly assigned to plots
-Equal representation of treatment levels

Original Lentil-dataset: Varieties are randomly planted in plots within farms

Experimental designs

Randomized Block Design

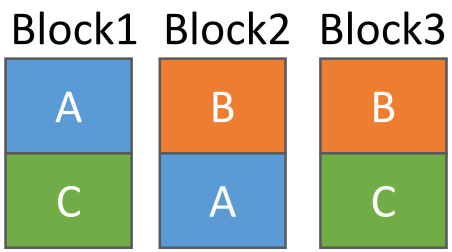


-Experimental units are randomly assigned to plots within blocks

-Representation of treatment levels can be equal or unequal

Experimental designs

Incomplete Randomized Block Design



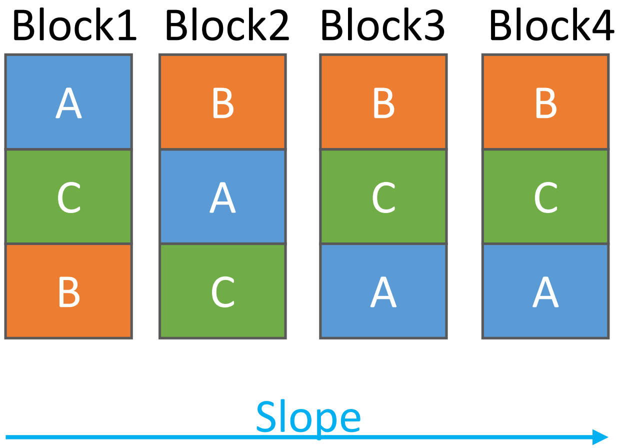
-Experimental units are randomly assigned to plots within blocks

-By definition: Representation of treatment levels is unequal

Used when we cannot assign all treatment levels to each block

Experimental designs

Complete Randomized Block Design



-Experimental units are randomly assigned to plots within blocks

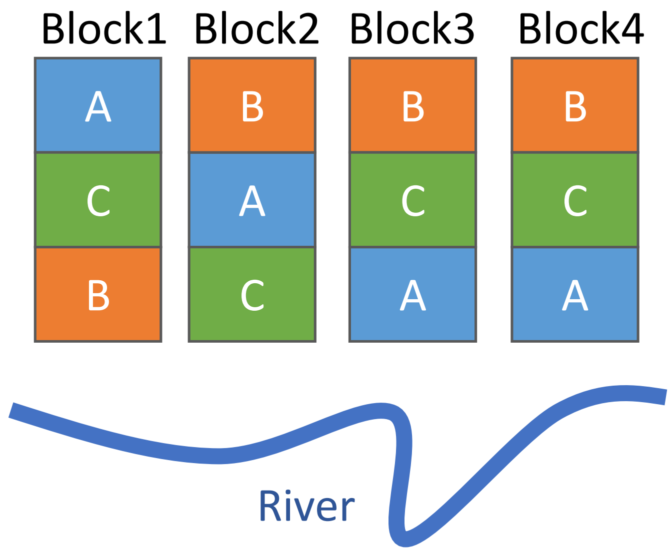
-Equal representation of treatment levels

Accounts for the nuisance factor of slope

Experimental designs

Complete Randomized Block Design

The general idea of blocking is to keep variation within block low



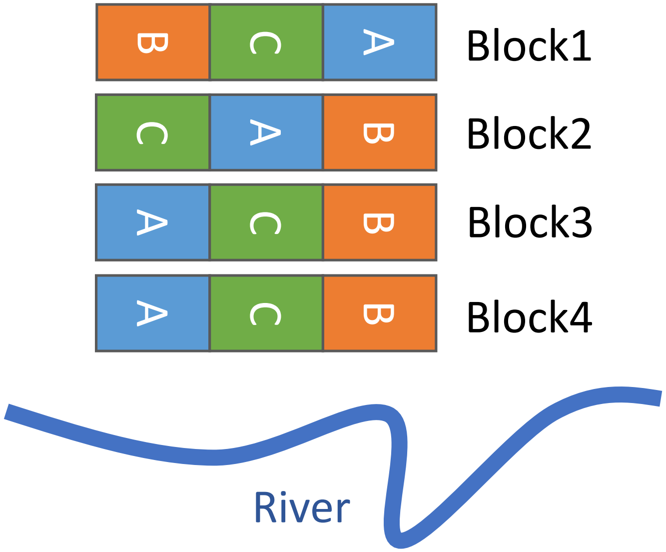
Conditions vary within blocks, therefore not a good layout

Treatment levels A and B are biased

Experimental designs

Complete Randomized Block Design

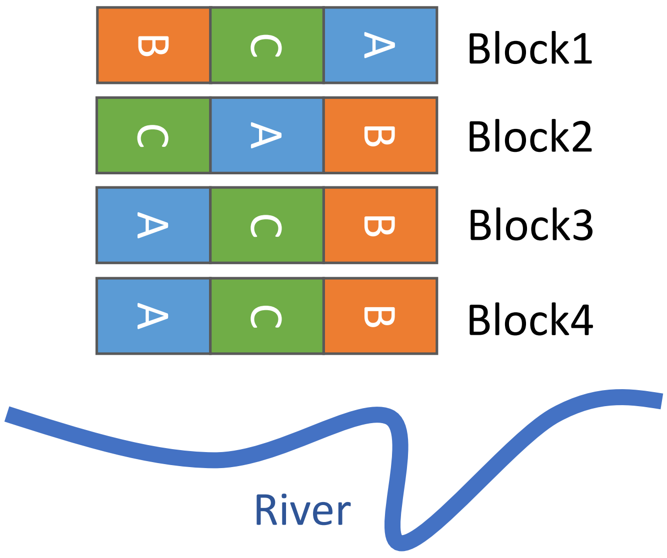
The general idea of blocking is to keep variation within block low



Experimental designs

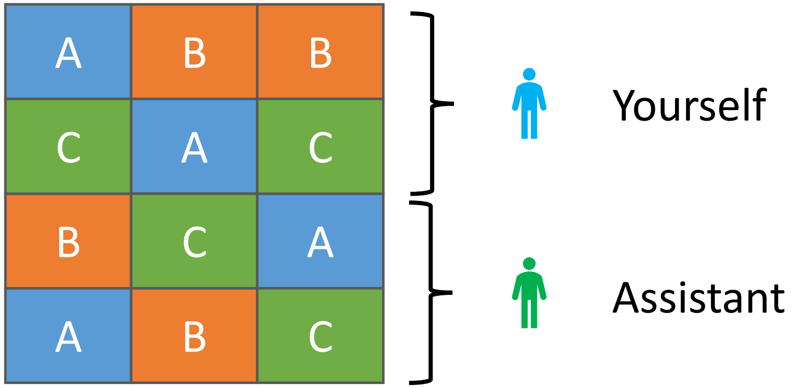
Complete Randomized Block Design

The general idea of blocking is to keep variation within block low

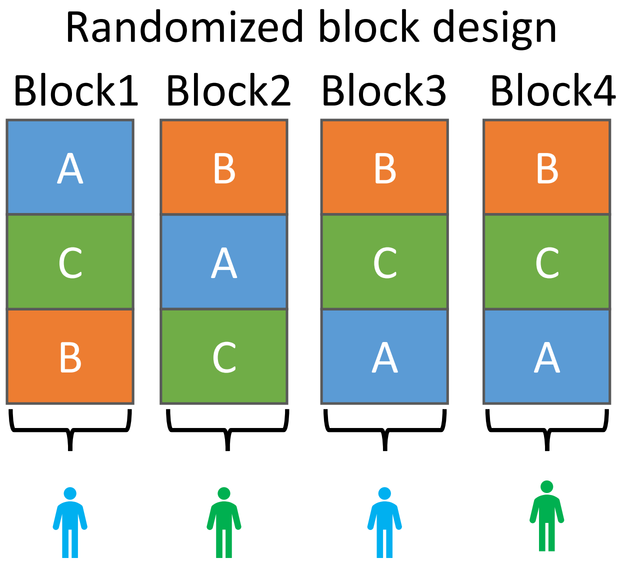


Does account for the nuisance factor of distance to river
Better!

Blocking by observer

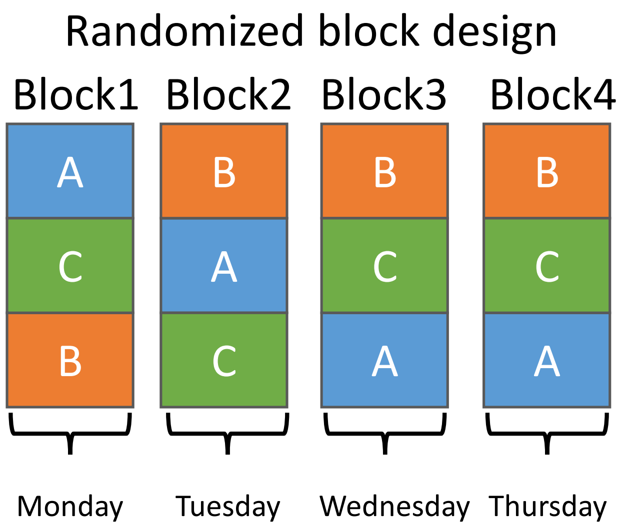


Blocking by observer



Use existing blocks!

Blocking by time



Use existing blocks!

Analysis of covariance

<u>Covariates:</u>

Factors we are not interested in and cannot control (but can measure)

Inclusion in the model reduced error and increases power

Soil nitrogen

A 0.8	B 1.2	B 1.6
C 1.1	A 0.2	C 0.4
B 5.1	C 5.6	A 1.1
A 3.1	B 2.5	C 1.5

anova(lm(YIELD~Variety+Nitrogen))

Note: The covariate needs to be a continuous numeric variable

Mixed models

<u>Fixed effects</u> – Treatments we are interested in – e.g. lentil variety

<u>Random effects</u>- Effects we are not interested in, but can be used to account for noise – e.g. block

In R:

Fixed effect

```
library(lmerTest)
out1 = lmer(YIELD~VARIETY+(1|BLOCK),data=dat1)
summary(out1)
anova(out1)
```

Random effect

For more in depth theoretical background about mixed models, consider taking RENR580