Randomized Designs

Design 1 – COMPLETELY RANDOMIZED DESIGN

Assign 30 patients to treatments A, B, and C, according to a completely randomized design with equal allocation.

```
> N = 30; proportions = c(1/3, 1/3, 1/3);
> Schedule = rmultinom(N,1,proportions);
> colSums(Schedule)        # Number of treatments for each patient
 [1] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
> rowSums(Schedule)        # Number of patients receiving each treatment
[1]  9  9 12
```

Every patient is assigned to one treatment, but the sample sizes are not equal.

Prepare the treatment schedule:

```
> Treatment = numeric(N);
> K = length(proportions);              # Number of treatments
> TreatmentNames = c("TreatmentA","TreatmentB","Placebo");
> Patient = paste0("Patient",1:N);      # Patients' names or ID
> for (k in 1:K){  Treatment[Schedule[k,]==1] = TreatmentNames[k];  }

> data.frame(Patient,Treatment)
```

	Patient	Treatment
1	Patient1	TreatmentB
2	Patient2	Placebo
3	Patient3	Placebo
4	Patient4	TreatmentA
5	Patient5	TreatmentA
6	Patient6	Placebo
7	Patient7	TreatmentB
8	Patient8	TreatmentB
9	Patient9	TreatmentB
10	Patient10	TreatmentB
11	Patient11	TreatmentB
12	Patient12	TreatmentA
13	Patient13	Placebo
14	Patient14	Placebo
15	Patient15	Placebo
16	Patient16	TreatmentA
17	Patient17	Placebo
18	Patient18	TreatmentA
19	Patient19	TreatmentB
20	Patient20	Placebo
21	Patient21	Placebo
22	Patient22	TreatmentA
23	Patient23	TreatmentB
24	Patient24	TreatmentA
25	Patient25	Placebo
26	Patient26	TreatmentB
27	Patient27	TreatmentA
28	Patient28	TreatmentA
29	Patient29	Placebo
30	Patient30	Placebo

Design 2 – BLOCK RANDOMIZATION

Create a block randomization with 30 patients, 3 treatments, and equal allocation.

```
> N = 30; K = 3;
> TreatmentGroup = sample( rep(1:K, N/K) );
```

rep creates a non-random vector 1,2,3,1,2,3,... with equal group sizes
sample shuffles it randomly

```
> Treatment = TreatmentNames[TreatmentGroup];
> data.frame(Patient,Treatment)
```

```
      Patient  Treatment                Patient  Treatment
 1   Patient1 TreatmentB              16 Patient16 TreatmentA
 2   Patient2 TreatmentB              17 Patient17    Placebo
 3   Patient3    Placebo              18 Patient18    Placebo
 4   Patient4 TreatmentB              19 Patient19    Placebo
 5   Patient5 TreatmentA              20 Patient20    Placebo
 6   Patient6    Placebo              21 Patient21 TreatmentA
 7   Patient7 TreatmentA              22 Patient22    Placebo
 8   Patient8    Placebo              23 Patient23 TreatmentB
 9   Patient9 TreatmentA              24 Patient24 TreatmentA
 10 Patient10 TreatmentA              25 Patient25 TreatmentB
 11 Patient11 TreatmentB              26 Patient26    Placebo
 12 Patient12 TreatmentB              27 Patient27 TreatmentA
 13 Patient13 TreatmentB              28 Patient28 TreatmentB
 14 Patient14 TreatmentB              29 Patient29 TreatmentA
 15 Patient15    Placebo              30 Patient30 TreatmentA
```

```
 > table(Treatment)
 Treatment
    Placebo TreatmentA TreatmentB
         10         10         10
```

Equal group sizes!

Design 3 - STRATIFICATION

There are 18 female and 12 male patients.
Randomize them to 3 treatments equally within each sex group.

```
> N = 30; K = 3;
> Sex = sample( c(rep("Female",12), rep("Male",18)) );
> Data = data.frame(ID = 1:N, Patient, Sex)
> Data
```

```
    ID   Patient    Sex                    ID   Patient    Sex
 1   1  Patient1   Male               16 16 Patient16   Male
 2   2  Patient2 Female               17 17 Patient17   Male
 3   3  Patient3 Female               18 18 Patient18   Male
 4   4  Patient4 Female               19 19 Patient19   Male
 5   5  Patient5 Female               20 20 Patient20   Male
 6   6  Patient6 Female               21 21 Patient21 Female
 7   7  Patient7   Male               22 22 Patient22   Male
 8   8  Patient8   Male               23 23 Patient23   Male
 9   9  Patient9   Male               24 24 Patient24   Male
 10 10 Patient10   Male               25 25 Patient25   Male
 11 11 Patient11   Male               26 26 Patient26 Female
 12 12 Patient12 Female               27 27 Patient27 Female
 13 13 Patient13 Female               28 28 Patient28 Female
 14 14 Patient14   Male               29 29 Patient29   Male
 15 15 Patient15 Female               30 30 Patient30   Male
```

```
> table(Sex)
 Sex
 Female   Male
     12     18
> GroupNames = names(table(Sex))
> Ngroups = length(GroupNames)
```

Prepare a randomized schedule stratified by sex

```
> Schedule = data.frame()

> for (j in 1:Ngroups){
+    Group = Data[Sex==GroupNames[j],]
+    n = nrow(Group);
+    Treatment = TreatmentNames[sample( rep(1:K, n/K ) )];
+    Schedule = rbind(Schedule,
+               data.frame(Group,Treatment));
+    }
```

We can return to the original order, sorting by ID

```
> Schedule = Schedule[order(Schedule$ID),]

 > table(Schedule$Sex,Schedule$Treatment)

          Placebo TreatmentA TreatmentB
   Female       4          4          4
   Male         6          6          6
```

Equal allocation within each sex group

```
> Schedule
    ID   Patient    Sex  Treatment
 1   1  Patient1   Male TreatmentA
 2   2  Patient2 Female TreatmentA
 3   3  Patient3 Female TreatmentA
 4   4  Patient4 Female    Placebo
 5   5  Patient5 Female    Placebo
 6   6  Patient6 Female TreatmentB
 7   7  Patient7   Male    Placebo
 8   8  Patient8   Male TreatmentB
 9   9  Patient9   Male    Placebo
 10 10 Patient10   Male TreatmentA
 11 11 Patient11   Male TreatmentA
 12 12 Patient12 Female TreatmentB
 13 13 Patient13 Female TreatmentB
 14 14 Patient14   Male TreatmentB
 15 15 Patient15 Female TreatmentA
 16 16 Patient16   Male TreatmentB
 17 17 Patient17   Male    Placebo
 18 18 Patient18   Male TreatmentB
 19 19 Patient19   Male TreatmentA
 20 20 Patient20   Male    Placebo
 21 21 Patient21 Female TreatmentB
 22 22 Patient22   Male    Placebo
 23 23 Patient23   Male    Placebo
 24 24 Patient24   Male TreatmentB
 25 25 Patient25   Male TreatmentA
 26 26 Patient26 Female    Placebo
 27 27 Patient27 Female TreatmentA
 28 28 Patient28 Female    Placebo
 29 29 Patient29   Male TreatmentB
 30 30 Patient30   Male TreatmentA
```