Estimation of statistical errors using the bootstrap method: Balanced resampling of sweeps

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Statistical errors in the best-fit parameters were estimated by balanced resampling (Efron & Tibshirani, 1993) of the experimentally recorded impulse responses. Synthetic, resampled data sets are generated by randomly selecting individual sweeps from the original, experimental data set. This *Mathematica* notebook illustrates the procedure.

```
<< "DiscreteMath`Permutations`"; SeedRandom[6328]
```

n is the number of experimental sweeps from which the average impulse response is constructed (between 36 and 351; here we use a smaller number for illustrative purposes).

```
n = 10;
```

B is the number of synthetic (bootstrap) data sets to be generated. We usually choose B = 100.

```
B = 5;
```

Each experimental sweep is indexed by a number from 1 to n. This is the index set for the original average:

```
Range[n]
```

```
{1, 2, 3, 4, 5, 6, 7, 8, 9, 10}
```

We repeat this index set B times.

```
nBList = Flatten[Table[Range[n], {B}]]
```

```
{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 1, 2, 3, 4, 5, 6,
 7, 8, 9, 10, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 1, 2, 3,
 4, 5, 6, 7, 8, 9, 10, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10}
```

After a random permutation, we have a list in which each index occurs B times, but at random positions.

```
nBList[[RandomPermutation[n B]]]
```

```
{6, 8, 5, 2, 7, 5, 1, 3, 10, 6, 4, 8, 6, 2, 10,
 1, 2, 8, 1, 9, 7, 10, 6, 4, 4, 9, 4, 9, 9, 8, 10, 5,
 7, 1, 5, 1, 3, 9, 6, 3, 7, 7, 3, 5, 10, 2, 2, 4, 8, 3}
```

We partition this list to generate B sublists of length n. These are the index sets for the bootstrap averages.

```
nBList = Partition[nBList[[RandomPermutation[n B]]], n]
```

```
{{10, 5, 1, 8, 3, 6, 5, 4, 6, 3},
 {9, 4, 3, 9, 8, 10, 7, 1, 9, 8}, {2, 6, 7, 7, 6, 7, 1, 4, 3, 1},
 {5, 9, 4, 2, 4, 5, 10, 6, 8, 10}, {1, 8, 2, 9, 3, 2, 5, 10, 7, 2}}
```

Reference

Efron, B. & Tibshirani, R. (1993). An Introduction to the Bootstrap. Chapman & Hall, New York.