Return contribution

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Start with a simple case: three assets, one period. The vector w stores the beginning-of-period weights, and the vector R holds the returns for the period.

```
> w <- c( 0.1, 0.5, 0.4)
> R <- c(-0.1, 0.1, 0.2)
```

You get the return contributions of the single assets by multiplying wR element by element (as is the default in R). Summing the contributions gives the total return.

```
    A     B     C
-0.01  0.05  0.08
```

```
[1] 0.12
```

With `rc`:

```
> library("PMwR")
> rc(R, w)
```

```
$period_contributions
  timestamp     A    B    C total
1         1 -0.01 0.05 0.08  0.12

$total_contributions
    A     B     C total
-0.01  0.05  0.08  0.12

attr(,"method")
[1] "contribution"
attr(,"class")
[1] "rc"
```

Suppose the weights of some reference portfolio (a.k.a. a benchmark) are stored in `w.bm`.

```
> w.bm <- c(A = 0.2, B = 0.4, C = 0.4)
```

One way to define relative return contributions is to multiply returns by active weights, i. e. differences between portfolio and benchmark weights.

```
> (w - w.bm)*R
```

```
   A    B    C
0.01 0.01 0.00
```

Summing those relative contributions gives the total active return.

```
> sum((w - w.bm)*R)
```

```
[1] 0.02
```

```
> sum(w*R) - sum(w.bm*R)
```

```
[1] 0.02
```

If you provide benchmark weights or returns to `rc`, then this will trigger a split into allocation, selection and interaction [Brinson et al., 1986]. Since returns for the portfolio and benchmark are the same for all segments, the total effect is captured by 'allocation'.

```
> rc(R, w, weights.bm = w.bm)
```

```
$allocation
        A         B C total
[1,] 0.02 -1.39e-18 0  0.02

$selection
     A B C total
[1,] 0 0 0     0

$interaction
     A B C total
[1,] 0 0 0     0

$total
 allocation   selection interaction       total
       0.02        0.00        0.00        0.02

attr(,"method")
[1] "attribution"
attr(,"linking.method")
[1] "none"
attr(,"class")
[1] "rc"
```

But the result is not the same as above: now all relative return of 2 % is attributed to A, when before A and B both contributed 1 %. The reason is that rc, per default, computes allocation as $(w - w_{\text{bm}})(R - R_{\text{bm}})$, i. e. it subtracts the benchmark return. This setting is controlled by argument `allocation.minus.bm`.

An example from Christopherson et al. [2009], Tables 18.4–18.6.

```
> segments <- c("Large Cap", "Small Cap", "Fixed Income")
> w    <- matrix(c(60, 10, 30,
                   60, 10, 30,
                   60, 10, 30), nrow = 3, byrow = TRUE)/100
> w.bm <- matrix(c(55,  5, 40,
                   55,  5, 40,
                   55,  5, 40), nrow = 3, byrow = TRUE)/100
> R    <- matrix(c(-3.7,-3.5,-0.1,
                   +4.1,+3.7,+2.9,
                   +3.5,+1.2,+1.0), nrow = 3, byrow = TRUE)/100
> R.bm <- matrix(c(-1.9,-5.3,-0.9,
                   +2.1,+4.3,+2.4,
                   +2.1,+1.4,+0.4), nrow = 3, byrow = TRUE)/100
> rc(R = R, weights = w, R.bm = R.bm, weights.bm = w.bm,
     method = "attribution", segments = segments)
```

```
$allocation
     Large Cap Small Cap Fixed Income    total
[1,] -0.000115 -1.81e-03    -0.000770 -0.00270
[2,] -0.000115  9.85e-04    -0.000070  0.00080
[3,]  0.000357  7.50e-06     0.000985  0.00135
```

```
$selection
     Large Cap Small Cap Fixed Income   total
[1,]   -0.0099     9e-04       0.0032 -0.0058
[2,]    0.0110    -3e-04       0.0020  0.0127
[3,]    0.0077    -1e-04       0.0024  0.0100

$interaction
     Large Cap Small Cap Fixed Income     total
[1,]    -9e-04     9e-04       -8e-04 -8.00e-04
[2,]     1e-03    -3e-04       -5e-04  2.00e-04
[3,]     7e-04    -1e-04       -6e-04 -9.62e-19

$total
 allocation   selection interaction       total
   -0.00055     0.01690    -0.00060     0.01575

attr(,"method")
[1] "attribution"
attr(,"linking.method")
[1] "none"
attr(,"class")
[1] "rc"
```

References

Gary P. Brinson, L. Randolph Hood, and Gilbert L. Beebower. Determinants of portfolio performance. *Financial Analysts Journal*, 42(4):39–44, 1986.

Jon A. Christopherson, David R. Cariño, and Wayne E. Ferson. *Portfolio Performance Measurement and Benchmarking*. McGraw-Hill, 2009.