# sample_ACVF

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## Sample Autocovariance Function

The sample autocovariance function is a important tool in time series analysis. It measure the covariance between values of a time series across different lags. The function `sample_ACVF` is an implementation of sample autocovariance function.

The output of the sample autocovariance function is dependent on the considered time series and lag:

- If the output value is near zero then we can assume that there is weak relation between the points $X_t$ and $X_{t+h}$.
- If the output value is big and positive then we can assume that there is a strong relation between the points $X_t$ and $X_{t+h}$.
- If the output value is big and negative then we can assume that there is a strong relation between the points $X_{t+h}$ and $X_t$.

### Example 1: small example

`X` represent a time series and `h` is a integer subset of `(-n,n)`, where `n` represents the length of `X`. By calling `sample_ACVF(X,h)` the sample autocovariance function on X for h is computed.

```
X <- c(2, 4, 6, 8, 10)
h <- 2

zeitreihen::sample_ACVF(X, h)
```

```
##    2
## -0.8
```

The Output is the value `-0.8`, which is the computation of the `sample_ACVF` on `X` for `h`, and has named attribute `2`, which is the corresponding lag `h`.

What happens:

- Within the function, It is checked if `X` and `h` have the required format.
- The mean of `X`, which is $\bar{x}$, is computed.
- The length of `X`, which is $n$, is extracted from `X`.
- For each $h_i \in$ `h`: we compute $n^{-1} \sum_{t=1}^{n-|h_i|} (x_{t+|h_i|} - \bar{x}) \cdot (x_t - \bar{x})$
  - We considered the vector, which is formed by the last $n$ - `h` values from `X`, and subtract component wise the mean of `X` form it.
  - We considered the vector, which is formed by the first $n$ - `h` values from `X`, and subtract component wise the mean of `X` form it.
  - We compute the dot product of the vectors
  - Last step, we divide the dot product of the vectors by $n$
- At last, The values are returned where the *names* attribute is assigned `h`.

Required Format:

- `X` must be an atomic vector of positive length and only allows either numeric or complex values also NA, Inf or NaN aren't allowed.

- `h` must be is a numeric vector with unique values in interval `(-n,n)`, where `n` is the length of the time series `X` and NA, Inf or NaN are not allowed.

**Example 2: medium example**

```
X <- c(2 + 1i, 2 + 4i, 6, 8i, 10)
h <- c(0, 3, 1)

zeitreihen::sample_ACVF(X, h)
```

```
##            0            3            1
## 3.360-16.80i 1.656+ 1.84i 0.392+14.48i
```

Hint: `sample_ACVF` doesn't return the values sorted on `h`. It returns the values in the order of `h`.

**Example 3: big example**

```
X <- c(0:10, 20:30, 40:50, 50:58)

zeitreihen::sample_ACVF(X)
```

```
##           0           1           2           3           4           5
##  360.406463  337.432580  314.077745  290.365768  266.320457  241.965622
##           6           7           8           9          10          11
##  217.325073  192.422619  167.282070  141.927235  115.720360   89.323008
##          12          13          14          15          16          17
##   67.947765   46.643950   25.435374    4.345845  -16.600826  -37.380831
##          18          19          20          21          22          23
##  -57.970360  -78.345603  -98.482750 -112.403912 -125.825073 -131.605078
##          24          25          26          27          28          29
## -136.623178 -140.855564 -144.278426 -146.867954 -148.600340 -149.451774
##          30          31          32          33          34          35
## -149.398445 -148.416545 -140.528183 -131.449344 -121.923226 -111.182823
##          36          37          38          39          40          41
##  -99.204325  -85.963921  -71.437804  -55.602162  -38.433188  -19.907070
```

Calling the `sample_ACVF`, where `h` is omitted is allowed. Within `sample_ACVF` we use the `[0,n-1]` for `h`. Hint: The Output will get big so mind to get only the $h_i$ that are needed.

**Example 4: Incorrect Inputs**

```
X <- list(2, 4, 6, 8, 10)
h <- 2

zeitreihen::sample_ACVF(X, h)
```

```
## Error in zeitreihen::sample_ACVF(X, h): X must be an atomic vector
```

```
X <- c(2, 4, 6, NA, 10)
h <- 2

zeitreihen::sample_ACVF(X, h)
```

```
## Error in zeitreihen::sample_ACVF(X, h): X may not contain NAs
```

```r
X <- c(2, 4, 6, 8, 10)
h <- 5

zeitreihen::sample_ACVF(X, h)
```

```
## Error in zeitreihen::sample_ACVF(X, h): All values of h must be from the interval (-length(X), lengt
```