

**crossdev()** — Deviation cross products

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## Description

`crossdev()` makes calculations of the form

$$(X: -x)' (X: -x)$$

$$(X: -x)' (Z: -z)$$

$$(X: -x)' \text{diag}(w) (X: -x)$$

$$(X: -x)' \text{diag}(w) (Z: -z)$$

`crossdev()` is a variation on [M-5] [cross\(\)](#). `crossdev()` mirrors `cross()` in every respect except that it has two additional arguments: `x` and `z`. `x` and `z` record the amount by which `X` and `Z` are to be deviated. `x` and `z` usually contain the (appropriately weighted) column means of `X` and `Z`.

## Syntax

*real matrix* `crossdev(X, x, Z, z)`

*real matrix* `crossdev(X, x, w, Z, z)`

*real matrix* `crossdev(X, xc, x, Z, zc, z)`

*real matrix* `crossdev(X, xc, x, w, Z, zc, z)`

where

`X`: *real matrix* `X`

`xc`: *real scalar* `xc`

`x`: *real rowvector* `x`

`w`: *real vector* `w`

`Z`: *real matrix* `Z`

`zc`: *real scalar* `zc`

`z`: *real rowvector* `z`

## Remarks and examples

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`x` usually contains the same number of rows as `X` but, if `xc`  $\neq$  0, `x` may contain an extra element on the right recording the amount from which the constant 1 should be deviated.

The same applies to `z`: it usually contains the same number of rows as `Z` but, if `zc`  $\neq$  0, `z` may contain an extra element on the right.

### ▷ Example 1: Linear regression using one view

```
: M = .
: st_view(M, ., "mpg weight foreign", 0)
:
: means = mean(M, 1)
: CP = crossdev(M, means, M, means)
: xx = CP[12, 2 \ ., .1]
: xy = CP[12, 1 \ ., 1]
: b = invsym(xx)*xy
: b = b \ means[1]-means[12\ .1]*b
```

Compare this solution with [example 3](#) in [\[M-5\]](#) `cross()`.



### ▷ Example 2: Linear regression using subviews

```
: M = X = y = .
: st_view(M, ., "mpg weight foreign", 0)
: st_subview(y, M, ., 1)
: st_subview(X, M, ., (2\..))
:
: xmean = mean(X, 1)
: ymean = mean(y, 1)
: xx = crossdev(X, xmean, X, xmean)
: xy = crossdev(X, xmean, y, ymean)
: b = invsym(xx)*xy
: b = b \ ymean-xmean*b
```

Compare this solution with [example 4](#) in [\[M-5\]](#) `cross()`.



### ▷ Example 3: Weighted linear regression

```
: M = X = y = w = .
: st_view(M, ., "w mpg weight foreign", 0)
: st_subview(w, M, ., 1)
: st_subview(y, M, ., 2)
: st_subview(X, M, ., (3\..))
:
: xmean = mean(X, w)
: ymean = mean(y, w)
: xx = crossdev(X, xmean, w, X, xmean)
: xy = crossdev(X, xmean, w, y, ymean)
: b = invsym(xx)*xy
: b = b \ ymean-xmean*b
```

Compare this solution with [example 6](#) in [\[M-5\]](#) `cross()`.



## ▷ Example 4: Variance matrix

```

: X = .
: st_view(X, ., "mpg weight displ", 0)
:
: n      = rows(X)
: means = mean(X, 1)
: xx     = crossdev(X,means , X,means)
: cov    = xx/(n-1)

```

This is exactly what `variance()` does; see [M-5] `mean()`. Compare this solution with [example 12](#) in [M-5] `cross()`.

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## ▷ Example 5: Weighted variance matrix

```

: M = w = X = .
: st_view(M, ., "w mpg weight displ", 0)
: st_subview(w, M, ., 1)
: st_subview(X, M, ., (2\..))
:
: n      = colsum(w)
: means = mean(X, w)
: cov    = crossdev(X,means, w, X,means) :/ (n-1)

```

This is exactly what `variance()` does with weighted data; see [M-5] `mean()`. Compare this solution with [example 14](#) in [M-5] `cross()`.

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**Conformability**

```

crossdev(X, xc, x, w, Z, zc, z):
  X:      n × v1  or  1 × 1,  1 × 1 treated as if n × 1
  xc:     1 × 1
           (optional)
  x:      1 × v1  or  1 × v1 + (xc ≠ 0)
  w:      n × 1   or  1 × n   or  1 × 1 (optional)
  Z:      n × v2
  zc:     1 × 1
           (optional)
  z:      1 × v2  or  1 × v2 + (zc ≠ 0)
  result: (v1 + (xc ≠ 0)) × (v2 + (zc ≠ 0))

```

**Diagnostics**

`crossdev(X, xc, x, w, Z, zc, z)` omits rows in `X` and `Z` that contain missing values.

## Also see

[M-5] `cross()` — Cross products

[M-5] `quadcross()` — Quad-precision cross products

[M-4] `utility` — Matrix utility functions

[M-4] `statistical` — Statistical functions