crossdev() — Deviation cross products

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

\[
\begin{align*}
\text{real matrix} & \quad \text{crossdev}(X, x, Z, z) \\
\text{real matrix} & \quad \text{crossdev}(X, x, w, Z, z) \\
\text{real matrix} & \quad \text{crossdev}(X, xc, x, Z, zc, z) \\
\text{real matrix} & \quad \text{crossdev}(X, xc, x, w, Z, zc, z)
\end{align*}
\]

where

\[
\begin{align*}
X: & \quad \text{real matrix} X \\
xc: & \quad \text{real scalar} \ xc \\
x: & \quad \text{real rowvector} \ x \\
w: & \quad \text{real vector} \ w \\
Z: & \quad \text{real matrix} \ Z \\
zc: & \quad \text{real scalar} \ zc \\
z: & \quad \text{real rowvector} \ z
\end{align*}
\]

Remarks and examples

\(x\) 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

```plaintext
M = .
st_view(M, ., "mpg weight foreign", 0)
means = mean(M, 1)
CP = crossdev(M, means, M, means)
XX = CP[[2,2 \ .,|]
Xy = CP[[2,1 \ .,1]
b = invsym(XX)*Xy
b = b \ means[1] - means[2\.|]*b
```

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

Example 2: Linear regression using subviews

```plaintext
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

```plaintext
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

```plaintext
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()`.

Example 5: Weighted variance matrix

```plaintext
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()`.

Conformability

`crossdev(X, xc, x, w, Z, zc, z)`: 

- **X**: $n \times v_1$ or $1 \times 1$, $1 \times 1$ treated as if $n \times 1$
- **xc**: $1 \times 1$ (optional)
- **x**: $1 \times v_1$ or $1 \times v_1 + (xc \neq 0)$
- **w**: $n \times 1$ or $1 \times n$ or $1 \times 1$ (optional)
- **Z**: $n \times v_2$
- **zc**: $1 \times 1$ (optional)
- **z**: $1 \times v_2$ or $1 \times v_2 + (zc \neq 0)$
- **result**: $(v_1 + (xc \neq 0)) \times (v_2 + (zc \neq 0))$

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