# rf

| keys: | [from] | <number> | source picture |
|---|---|---|---|
| | [to] | <number> | output picture |
| | a | <number> | filter width parameter |

Use **rf** to apply two point recursive filters to pictures. The effect is smoothing or sharpening as if by convolution with an infinitely wide point response.

## Examples

```
rf 1 to 2
```

This command mildly smooths picture 1 to picture 2.

```
rf to display a 0.9
```

This command displays a strongly smoothed version of the current picture.

```
rf a -0.3
```

This command replaces the current picture by a (mildly) sharpened version.

## Description

Use the **a** key to specify a filter width in the range –1 to 1. A positive value for the filter smooths the picture (retains the low frequencies only), and a negative value sharpens it (retains the high frequencies). The filter action becomes progressively stronger as it approaches 1 or –1.

**rf** is based on a simple 1-D filter recursive filter. An output pixel $f'(i)$ is calculated as a weighted average of the original value $f(i)$ and the last calculated filtered value $f'(i-1)$:

$$f'(i) = a.f'(i-1) + (1-a).f(i)$$

This has a one-sided point response (negative exponential in shape). **rf** applies it in each direction in turn along rows and columns (along the row only if 1-D) so as to achieve a symmetric point response.

The 1-D spatial frequency response is:

$$\frac{(1+a^2-2a)}{(1+a^2-2a.\cos(\frac{2\pi.i.k}{n}))}$$

for a transform pixel $k$ points from the origin and where $n$ is the picture dimension. This is unity (1) for

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zero frequency, and falls or rises to $\left(\frac{1-a}{1+a}\right)^2$ at the maximum frequency. For positive values of the weighting factor **a**, the point response has the approximate form:

$$e^{-\frac{|x|}{w}} \text{ with } w = \frac{1}{|(ln(a)|} \text{ pixels, which has a full width at half height of about } \frac{1.4}{|ln(a)|}$$

(The 2-D responses are simply the product of the 1-D responses in each direction).

## Notes

multi-layer pictures: all layers processed
forms used internally: fp

## Defaults and Ranges

| keys/options | defaults | range |
|---|---|---|
| [from] | current picture, held in the variable *select* | valid picture number |
| [to] | source picture | valid picture number |
| a | filter width .3 | real number in range –1 to 1 |