

## differentiate

<b>keys:</b>	<b>[from]</b> <number>	source picture
	<b>[to]</b> <number>	output picture
	<b>angle</b> <number>	differentiation direction in radians, anti-clockwise from the positive x axis

Use **differentiate** to calculate picture derivatives, that is the rate of change in a picture, in any direction. This command uses a three-point local operator on *Images*, with a special treatment of *Fourier* transforms.

## Examples

```
differentiate 1 to 2
```

This command differentiates along the x axis in picture 1, replacing each pixel by the difference between its right-hand neighbour and itself. It places the output in picture 2.

```
xwires line; min=-40 max=40; differentiate to display angle theta
```

This command differentiates the display in a direction marked with the cursor.

## Description

Use the **angle** key to specify the differentiation direction. The direction is measured anti-clockwise in radians from the positive x axis. The default angle is 0, if the angle is not set or if the source picture is 1-D.

On most classes of picture, **differentiate** uses a 3-point local operator of the form:

$$\cos(\text{angle}) \cdot p(x+1, y) + \sin(\text{angle}) \cdot p(x, y+1) - (\cos(\text{angle}) + \sin(\text{angle})) \cdot p(x, y)$$

The exception is a picture of type *Fourier*, in which the source is multiplied by the phase shifting factor:

$$e^{2\pi i k}$$

where  $i = \sqrt{-1}$  and with  $k$  measured in the appropriate direction. This is equivalent to differentiating the *Image* from which the *Fourier* transform was derived, but rather differently approximated.

## Notes

multi-layer pictures:	faulted
forms used internally:	fp, complex

**differentiate****Defaults and Ranges**

keys/options	defaults	range
[from]	current picture, held in the variable <i>select</i>	valid picture number
[to]	source picture	valid picture number
angle	angle 0	real number in range 0 to $2\pi$