Cellular Sensory and Wave Computing Laboratory of the Computer and Automation
Research Inst., Hungarian Academy of Sciences and the
Jedlik Laboratories of the Pázmány P. Catholic University

Software Library for Cellular Wave Computing Engines

in an era of kilo-processor chips

Budapest, December 16, 2014

Version 4.0 alpha 1

Edited by K. Karacs, Gy. Cserey, Á. Zarándy, P. Szolgay, Cs. Rekeczky, L. Kék, V. Szabó, G. Pazienza, M. Marczell, G. Quintz and T. Roska
Budapest, Hungary

Contents

Introduction

We are witnessing a proliferation of cellular topographic processor arrays, such as the ones in the PlayStation 3 or the IBM Blue Gene and Roadrunner supercomputers, based on the multicore Cell technology developed by Sony, IBM and Toshiba; as well as kiloprocessor GPU and FPGA chips and the new 48-core Intel chip. We can also mention the Eye-RIS system by AnaFocus and the Xenon chip by Eutecus, developed in collaboration with MTA SZTAKI and the Pázmány University.

This new, completely revised edition of the Library abandons the error-prone process of manual compilation employed in previous editions, instead being generated automatically from a template database. This enables us to apply automatic verification, radically reducing the possibility of error. The new method also gave an opportunity to make the layout consistent and to give a polished look to the library. A further advantage is that the database can now be compiled into any other format, thus we could publish an HTML version as well available at `http://cnn-technology.itk.ppke.hu/CWCL`.

Presently only the first section of the old library is included, and only linear single-layer templates are listed, but we plan to extend it with the remaining content in upcoming editions. The style of the description still follows that of the first textbook[1].

As for the templates, they are for now classified and grouped based on their structural properties and whether the input and output images are grayscale or binary. Unless otherwise noted, the normalized first order CNN equation with linear delay-less templates is

$$\dot{x}_{ij} = -x_{ij}+z+\sum A(i,j;k,l)y_{kl}+\sum B(i,j;k,l)u_{kl}+\sum C(i,j;k,l)x_{kl}+\sum \hat{D}(i,j;k,l)(u_{kl},y_{kl},x_{kl})$$

Without the last two terms, we call it "standard" CNN dynamics.

Time is scaled in τ, the time constant of the first order CNN cell. As a default, $\tau = 1$. Observe that local template operators might have different forms (e.g. the **D** operator).

This library is the result of continuous development. It contains results published by dozens of researchers all over the world.

The library is not complete. New templates, operators and subroutines can be added. Moreover, the emergence of a new world of algorithms is foreseen. Completely new algorithms are evolving for a given task if it is implemented in a virtual cellular machine on kilo-processor chips. We encourage designers all over the world to send their templates, subroutines and programs to be included in this library, with proper reference to the original publication. You can e-mail your contributions to `zarandy@sztaki.hu`.

[1] L. O. Chua and T. Roska, Cellular Neural Networks and visual computing: Foundations and applications, Cambridge University Press, 2002 (paperback: 2005)

1 Templates / Instructions

1.1 undefined type templates

1.1.1 AVERAGE

Smoothing with binary output.
Old names: `Smoothing,avertrsh,Average,Avertrsh`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 1.0 & 2.0 & 1.0 \\ 0.0 & 1.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:	Static gray-scale image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where black (white) pixels correspond to the locations in **P** where the average of pixel intensities over the r=1 feedback convolution window is positive (negative).

Examples

Input	Output
 `madonna.png`	

1.1.2 BipolarWave

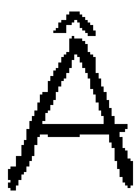
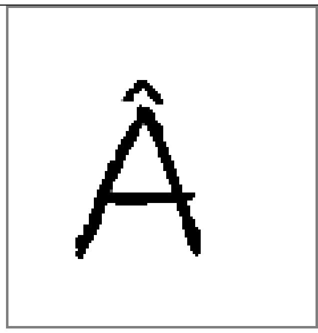
Generates black and white waves [52]
Old names: `bipolar`
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 0.3 & 0.3 & 0.3 \\ 0.3 & 0.8 & 0.3 \\ 0.3 & 0.3 & 0.3 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:	image **P** containing three gray levels: +1, 0, -1 (black, gray, white)
Input:	**P**
Initial state:	**P**
Boundary condition:	Zero-flux
Output:	Black and white areas, the boundary of which is located at positions where the waves collided.

Examples

Input	Output
 `A_LETTER.png`	

1.1.3 bprop

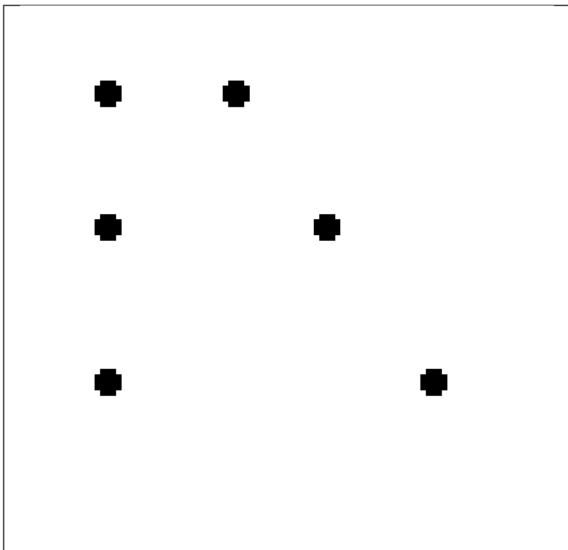
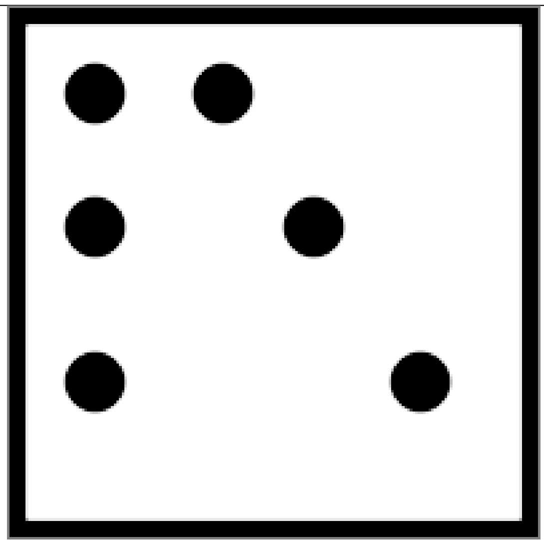
Starts omni-directional black propagation from black pixels [54]
Old names: `BlackPropagation`
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 0.25 & 0.25 & 0.25 \\ 0.25 & 3.0 & 0.25 \\ 0.25 & 0.25 & 0.25 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 3.75$$

Global task

Given:	static binary image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image showing black objects in **P** with increasing black neighborhood (white objects decreasing in size).

Examples

Input	Output
 `points.png`	

1.1.4 CCDMASKL

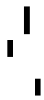
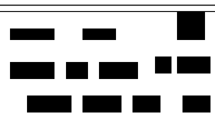
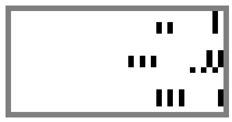
Masked connected component detector [24]
Old names: `MaskedCCD,CCDMASK`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 1.0 & 2.0 & -1.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & -3.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -3.0$$

Global task

Given:	Static binary images $\mathbf{P}_1$ (mask) and $\mathbf{P}_2$
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Fixed(0)
Output:	Binary image that is the result of CCD type shifting $\mathbf{P}_2$ from right to left. Shifting is controlled by the mask $\mathbf{P}_1$.

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 `ccdmsk1.png`	 `ccdmsk2.png`	

1.1.5 CCDMASKR

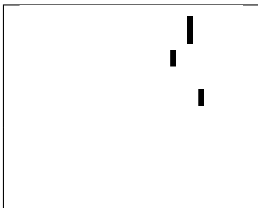
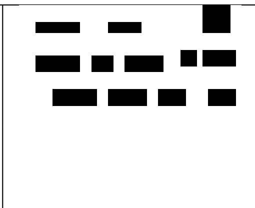
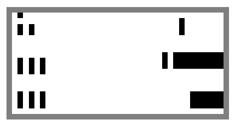
Masked (left-to-right) connected component detection.
Old names: `MaskedCCD`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ -1.0 & 2.0 & 1.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & -3.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -3.0$$

Global task

Given:	Static binary images $\mathbf{P}_1$ (mask) and $\mathbf{P}_2$
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Fixed(0)
Output:	Binary image that is the result of CCD type shifting $\mathbf{P}_2$ from left to right. Shifting is controlled by the mask $\mathbf{P}_1$.

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 `ccdmsk1.png`	 `ccdmsk2.png`	

1.1.6 CENTER

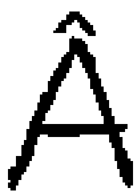
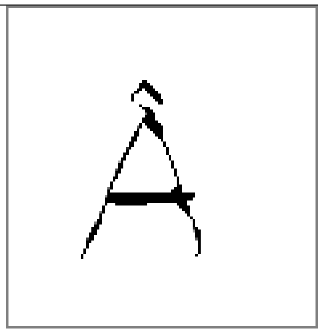
Center point detection.
Old names: `center,CenterPointDetector,Center`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 1.0 & 0.0 & 0.0 \\ 1.0 & 4.0 & -1.0 \\ 1.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	static binary image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the center point of the object in **P**

Examples

Input	Output
 `A_LETTER.png`	

1.1.7 CENTER1

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 0.0 & 0.0 \\ 1.0 & 4.0 & -1.0 \\ 1.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	-
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.8 CENTER2

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 1.0 & 1.0 \\ 1.0 & 6.0 & 0.0 \\ 1.0 & 0.0 & -1.0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	-
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.9 CENTER3

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 1.0 & 1.0 \\ 0.0 & 4.0 & 0.0 \\ 0.0 & -1.0 & 0.0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	-
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.10 CENTER4

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 1.0 & 1.0 \\ 0.0 & 6.0 & 1.0 \\ -1.0 & 0.0 & 1.0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	-
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.11 CENTER5

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 1.0 \\ -1.0 & 4.0 & 1.0 \\ 0.0 & 0.0 & 1.0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	-
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.12 CENTER6

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -1.0 & 0.0 & 1.0 \\ 0.0 & 6.0 & 1.0 \\ 1.0 & 1.0 & 1.0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	-
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.13 CENTER7

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & -1.0 & 0.0 \\ 0.0 & 4.0 & 0.0 \\ 1.0 & 1.0 & 1.0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	-
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.14 CENTER8

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 0.0 & -1.0 \\ 1.0 & 6.0 & 0.0 \\ 1.0 & 1.0 & 1.0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	-
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.15 CLDILA

Dilation (algo#).
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 1.0 & 1.0 & 0.0 \\ 1.0 & 1.0 & 0.0 \end{bmatrix} \qquad z = 3.5$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.1.16 CLERO

Erosion (algo#).
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 1.0 & 1.0 \\ 0.0 & 1.0 & 1.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -3.5$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.1.17 CNTR2

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 1.0 & 1.0 & 1.0 \\ 1.0 & 6.0 & 0.0 \\ 1.0 & 0.0 & -1.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.18 CNTR3

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 1.0 & 1.0 & 1.0 \\ 0.0 & 4.0 & 0.0 \\ 0.0 & -1.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.19 CNTR4

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 1.0 & 1.0 & 1.0 \\ 0.0 & 6.0 & 1.0 \\ -1.0 & 0.0 & 1.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.20 CNTR5

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 1.0 \\ -1.0 & 4.0 & 1.0 \\ 0.0 & 0.0 & 1.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.21 CNTR6

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} -1.0 & 0.0 & 1.0 \\ 0.0 & 6.0 & 1.0 \\ 1.0 & 1.0 & 1.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.22 CNTR7

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & -1.0 & 0.0 \\ 0.0 & 4.0 & 0.0 \\ 1.0 & 1.0 & 1.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.23 CNTR8

Center point detection.
Old names: `CenterPointDetection(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 1.0 & 0.0 & -1.0 \\ 1.0 & 6.0 & 0.0 \\ 1.0 & 1.0 & 1.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where a black pixel indicates the approximated center point of the object in **P**

1.1.24 ConcaveArcFiller

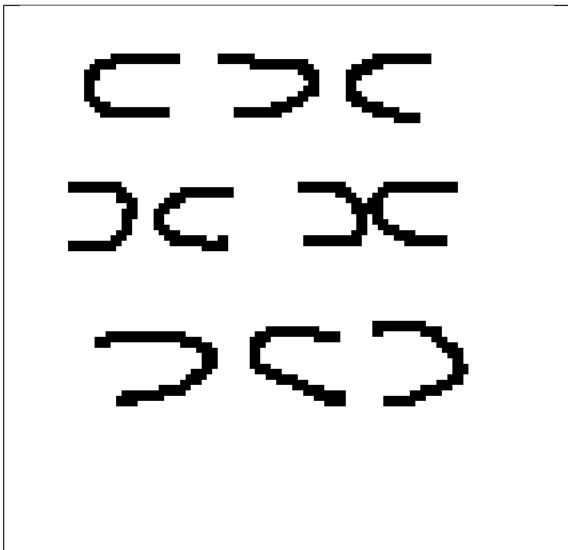
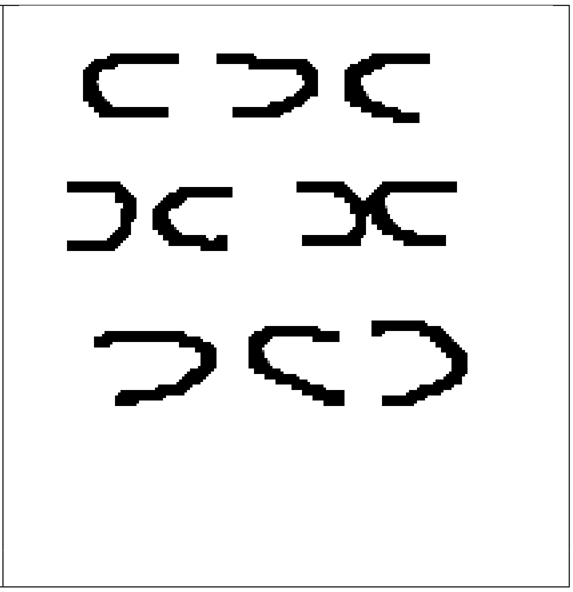
Fills the concave arcs of objects to prescribed direction
Old names: `FILL35`
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 2 & 0 \\ 1 & 1 & 0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix} \qquad z = 2$$

Global task

Given:	static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(-1)
Output:	Binary image in which those arcs of objects are filled which have a prescribed orientation.

Examples

Input	Output
 `arcs.png`	

1.1.25 CONCCONT

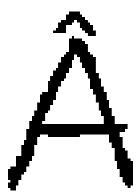
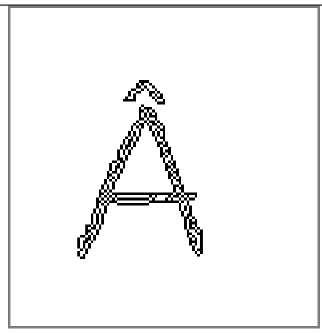
Concentric contour detection.
Old names: `ConcentricContourDetector,Conccont,concont`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & -1.0 & 0.0 \\ -1.0 & 3.5 & -1.0 \\ 0.0 & -1.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 4.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -4.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image representing the concentric black and white rings obtained from **P**

Examples

Input	Output
 `A_LETTER.png`	

1.1.26 CONCEROS

Erosion (algo#).
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 1.0 & 1.0 \\ 1.0 & 2.0 & 1.0 \\ 1.0 & 1.0 & 1.0 \end{bmatrix} \qquad z = -0.5$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.1.27 CONCHOLL

Hollow (algo#).
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.5 & 0.5 & 0.5 \\ 0.5 & 2.0 & 0.5 \\ 0.5 & 0.5 & 0.5 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 3.5$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.1.28 CONCTRES

Thresholding (algo#).
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.1.29 CONNECTI

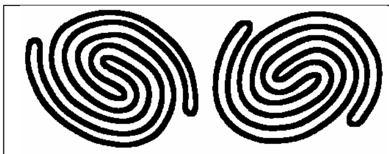
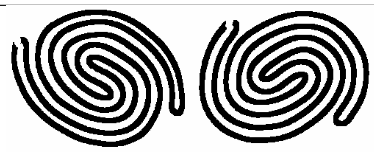
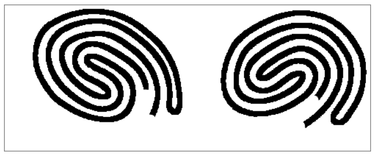
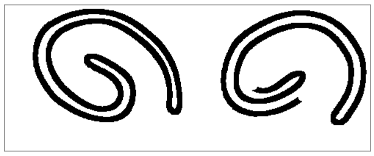
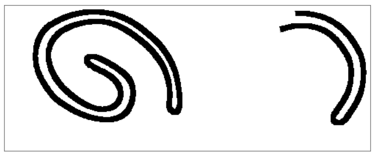
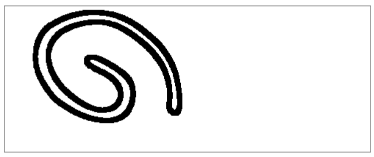
Deletes marked objects.
Old names: `Connectivity,GlobalConnectivityDetection,connecti`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.5 & 0.0 \\ 0.5 & 3.0 & 0.5 \\ 0.0 & 0.5 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & -0.5 & 0.0 \\ -0.5 & 3.0 & -0.5 \\ 0.0 & -0.5 & 0.0 \end{bmatrix} \qquad z = -4.5$$

Global task

Given:	Static binary images $\mathbf{P}_1$ (mask) and $\mathbf{P}_2$ (marker)
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Fixed(0)
Output:	Binary image containing the unmarked objects only.

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 connect1.png	 connect2.png	   

1.1.30 CORNER

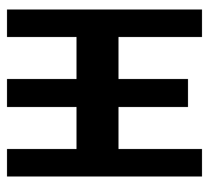
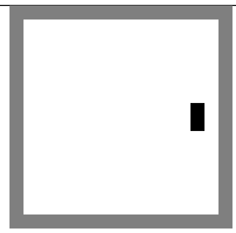
Convex corner detection.
Old names: `CornerDetection,CornerDetector`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -1.0 & -1.0 & -1.0 \\ -1.0 & 4.0 & -1.0 \\ -1.0 & -1.0 & -1.0 \end{bmatrix} \qquad z = -5.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image where black pixels represent the convex corners of objects in **P**

Examples

Input	Output
 `chineese.png`	

1.1.31 DEADENDH

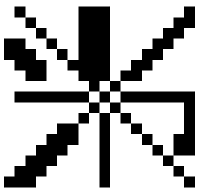
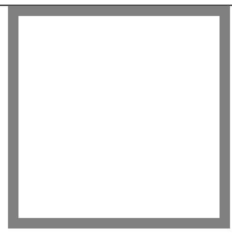
Finds the endings of horizontal (1-pixel wide) objects.
Old names: `DeadEndH`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 3.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -0.25 & -0.25 & -0.25 \\ -0.25 & 0.5 & -0.25 \\ -0.25 & -0.25 & -0.25 \end{bmatrix} \qquad z = -5.8$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image of the endings of the horizontal (1-pixel wide) objects.

Examples

Input	Output
 diag1liu.png	

1.1.32 DEADENDV

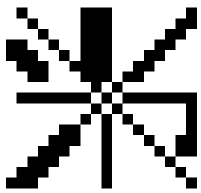
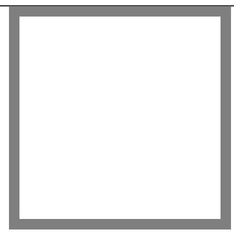
Finds the endings of vertical (1-pixel wide) objects.
Old names: `DeadEndV`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 3.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -0.25 & -0.25 & -0.25 \\ -0.25 & 0.5 & -0.25 \\ -0.25 & -0.25 & -0.25 \end{bmatrix} \qquad z = -5.8$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image of the endings of the vertical (1-pixel wide) objects.

Examples

Input	Output
 `diag1liu.png`	

1.1.33 DELDIAG1

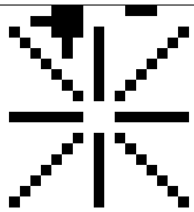
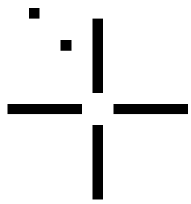
Deletes one pixel wide diagonal lines.
Old names: `DiagonalLineRemover,deldiag1`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -1.0 & 0.0 & -1.0 \\ 0.0 & 1.0 & 0.0 \\ -1.0 & 0.0 & -1.0 \end{bmatrix} \qquad z = -4.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(-1)
Output:	Binary image where black pixels have no black neighbors in diagonal directions in **P**

Examples

Input	Output
 `deldiag1.png`	

1.1.34 DELVERT1

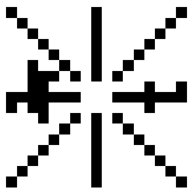
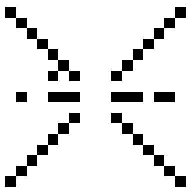
Deletes vertical lines.
Old names: `VerticalLineRemover,delvert1`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & -1.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & -1.0 & 0.0 \end{bmatrix} \qquad z = -2.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(-1)
Output:	Binary image representing **P** without vertical lines. Those parts of the objects that could be interpreted as vertical lines will also be deleted.

Examples

Input	Output
 delvert1.png	

1.1.35 DIAG

Detects approximately diagonal lines
Old names: `ApproxDiagonalLineDetector,diag`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 2.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \end{bmatrix}$$

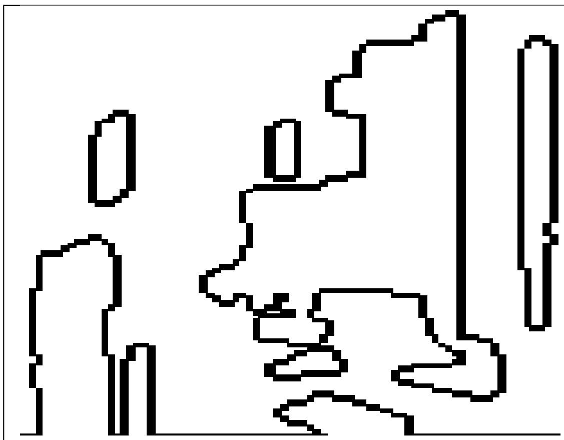
$$\mathbf{B} = \begin{bmatrix} -1.0 & -1.0 & -1.0 & 0.5 & 1.0 \\ -1.0 & -1.0 & 1.0 & 1.0 & 0.5 \\ -1.0 & 1.0 & 5.0 & 1.0 & -1.0 \\ 0.5 & 1.0 & 1.0 & -1.0 & -1.0 \\ 1.0 & 0.5 & -1.0 & -1.0 & -1.0 \end{bmatrix}$$

$$z = -13.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image representing the locations of approximately diagonal lines in **P**

Examples

Input	Output
 `diag.png`	

1.1.36 DIAG1LIU

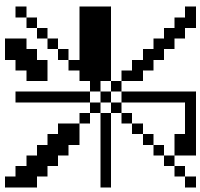
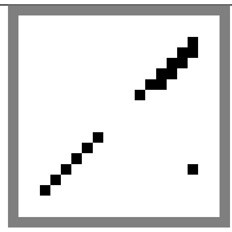
Diagonal line-detector.
Old names: `DiagonalLineDetector,diag1liu`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -1.0 & 0.0 & 1.0 \\ 0.0 & 1.0 & 0.0 \\ 1.0 & 0.0 & -1.0 \end{bmatrix} \qquad z = -4.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image representing the locations of diagonal lines in **P**

Examples

Input	Output
 `diag1liu.png`	

1.1.37 DiffM2

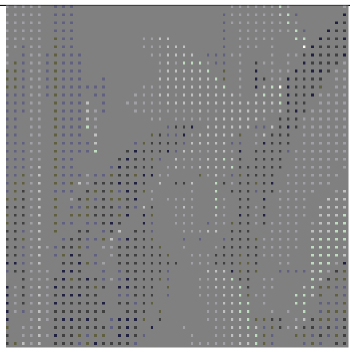
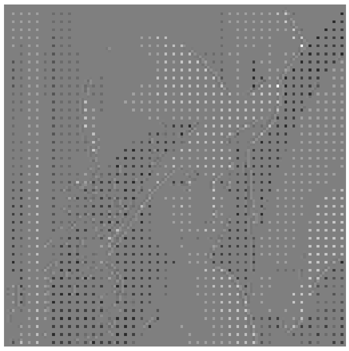
Inverse of a linear template operation using dense support of input pixels [55]
Old names: `LinearTemplateInverse`
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -0.03 & -0.1 & -0.02 \\ 0.0 & 0.5 & -0.2 \\ -0.03 & -0.1 & -0.02 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:	a linear template as well as two static gray scale images $\mathbf{P}_1$ (result of the linear template operation (see the test template above and its output) and $\mathbf{P}_2$. (masked version of the original image). $\mathbf{P}_3$ is a binary version of $\mathbf{P}_2$ providing the fixed state mask for CNN operation. $\mathbf{P}_3$ indicates the positions of supporting pixels where the interpolation is fixed.. The result of the inverse of a linear template operation is computed rapidly using masked diffusion even if the template cannot be inverted (linear template â€“ convolution kernel - have zero Eigen values).
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Fixed state mask:	$\mathbf{P}_3$
Boundary condition:	Fixed(0)
Output:	Gray scale image containing the inverse of the B template operation (B=1-A).

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 LenaSCs.png	 LenaSMask.png	

1.1.38 DIFFUSC

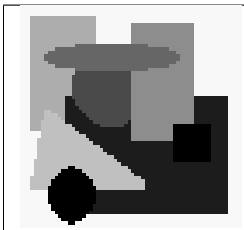
Filtering-reconstruction with constrained linear diffusion.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.05 & 0.075 & 0.05 \\ 0.075 & 0.0 & 0.075 \\ 0.05 & 0.075 & 0.05 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.05 & 0.075 & 0.05 \\ 0.075 & 0.0 & 0.075 \\ 0.05 & 0.075 & 0.05 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:	Static (noisy) gray-scale image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Zero-flux
Output:	Grayscale image.

Examples

Input	Output
 avergra2.png	

1.1.39 DILATION

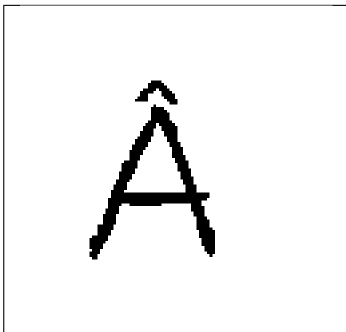
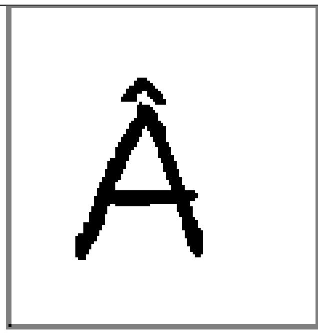
Binary dilation.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 1.0 & 1.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \end{bmatrix} \qquad z = 2.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image representing the result of the dilation operation.

Examples

Input	Output
 A_LETTER.png	

1.1.40 EDGE

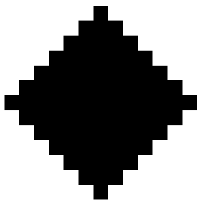
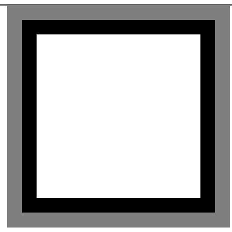
Binary edge detection.
Old names: `EdgeDetector`,`EdgeDetection`,`edge`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -1.0 & -1.0 & -1.0 \\ -1.0 & 8.0 & -1.0 \\ -1.0 & -1.0 & -1.0 \end{bmatrix} \qquad z = -1.0$$

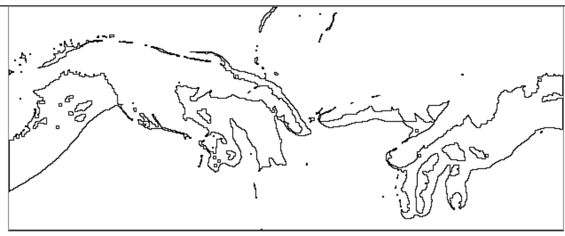
Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Binary image showing all edges of **P** in black

Examples

Input	Output
 `logic05.png`	

Examples

Input	Output
 `michelan_binary.png`	

1.1.41 EDGEA

Adaptive binary edge detection.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.5 & 0.0 & 0.0 \\ 0.0 & 0.5 & 2.0 & 0.5 & 0.0 \\ 0.0 & 0.0 & 0.5 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \end{bmatrix}$$

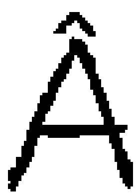
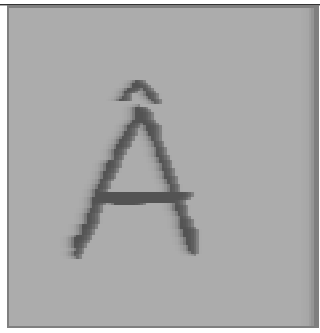
$$\mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.15 & 0.0 & 0.0 \\ 0.0 & 0.15 & 0.45 & 0.15 & 0.0 \\ 0.0 & 0.0 & 0.15 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \end{bmatrix}$$

$$z = 0.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Zero-flux
Output:	Binary image showing an edge map of **P** in black.

Examples

Input	Output
 `A_LETTER.png`	

1.1.42 EDGEGRAY

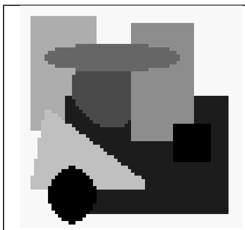
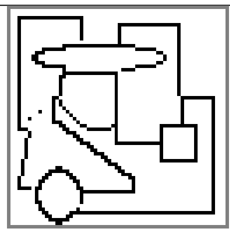
Gray-scale edge detection.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -1.0 & -1.0 & -1.0 \\ -1.0 & 8.0 & -1.0 \\ -1.0 & -1.0 & -1.0 \end{bmatrix} \qquad z = -0.5$$

Global task

Given:	Static gray-scale image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Gray-scale image showing an edge map of **P** in black.

Examples

Input	Output
 `avergra2.png`	

1.1.43 ERASMASK

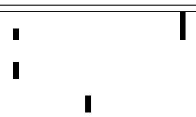
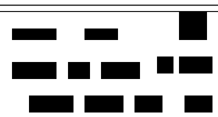
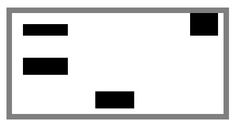
Masked erase.
Old names: `MaskedObjectExtractor,erasmask`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 1.5 & 3.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.5 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -1.5$$

Global task

Given:	Static binary image $\mathbf{P}_1$ (mask) and $\mathbf{P}_2$
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Fixed(0)
Output:	Binary image that is the result of erasing $\mathbf{P}_2$ from left to right. Erasure is stopped by the black walls on the mask ($\mathbf{P}_1$) image.

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 ccdmsk3.png	 ccdmsk2.png	

1.1.44 FIGDEL

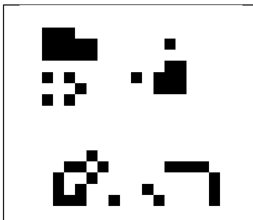
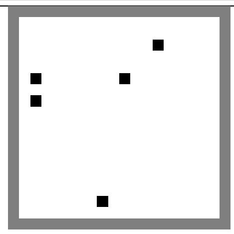
Extracts isolated black pixels
Old names: `FigureRemover`,`PointExtraction`,`figdel`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -1.0 & -1.0 & -1.0 \\ -1.0 & 1.0 & -1.0 \\ -1.0 & -1.0 & -1.0 \end{bmatrix} \qquad z = -8.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image representing all isolated black pixels in **P**

Examples

Input	Output
 `figdel.png`	

1.1.45 FIGEXTR

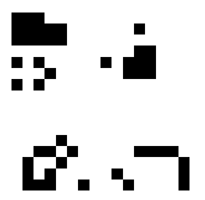
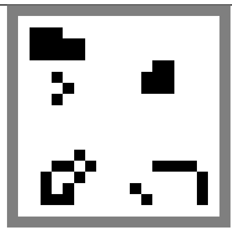
Deletes isolated black pixels
Old names: `FigureExtractor,PointRemoval,figextr`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 1.0 & 1.0 \\ 1.0 & 8.0 & 1.0 \\ 1.0 & 1.0 & 1.0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image showing all connected components in **P**

Examples

Input	Output
 `figdel.png`	

1.1.46 FIGREC

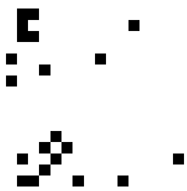
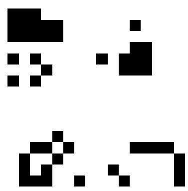
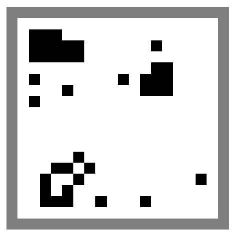
Reconstructs marked figures.
Old names: `SelectedObjectsExtraction,FigureReconstructor`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.5 & 0.5 & 0.5 \\ 0.5 & 4.0 & 0.5 \\ 0.5 & 0.5 & 0.5 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 4.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 3.0$$

Global task

Given:	Two static binary images $\mathbf{P}_1$ (mask) and $\mathbf{P}_2$ (marker). $\mathbf{P}_2$ contains just a part of $\mathbf{P}_1$.
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Fixed(0)
Output:	Binary image representing those objects of $\mathbf{P}_1$ which are marked by $\mathbf{P}_2$.

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 `figrec.png`	 `figdel.png`	

1.1.47 FILL65

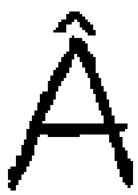
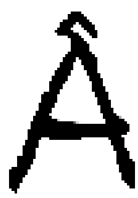
Fills the concave arcs of objects to prescribed direction
Old names: `ConcaveArcFiller`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 1 & 0 & 0 \\ 1 & 2 & 0 \\ 0 & 0 & 2 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 & 2 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \qquad z = 3$$

Global task

Given:	static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(-1)
Output:	Binary image in which those arcs of objects are filled which have a prescribed orientation.

Examples

Input	Output
 `A_LETTER.png`	

1.1.48 FINDAREA

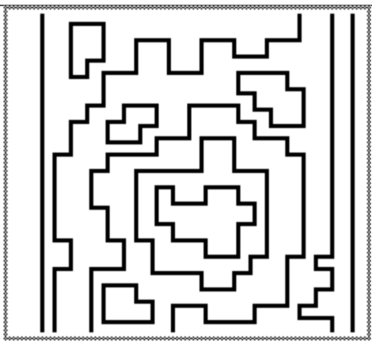
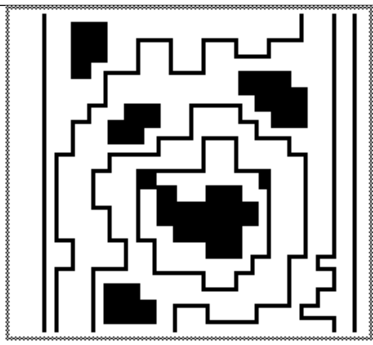
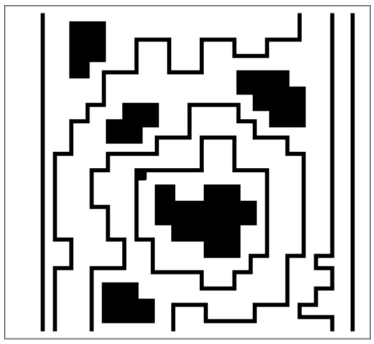
Finds solid black framed areas
Old names: `FramedAreasFinder,FilledContourExtraction,findarea`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 1.0 & 5.0 & 1.0 \\ 0.0 & 1.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -5.25$$

Global task

Given:	Two static binary images $\mathbf{P}_1$ (mask) and $\mathbf{P}_2$ (marker).
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Fixed(0)
Output:	Binary image representing those objects of $\mathbf{P}_1$ which are marked by $\mathbf{P}_2$.

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 `findare1.png`	 `findare2.png`	

1.1.49 GlobalConnectivityDetection1

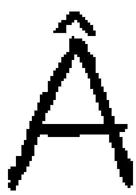
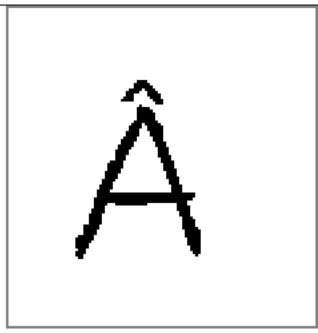
Detects the one-pixel thick closed curves and deletes the open curves from a binary image [61]
Old names:
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 6.0 & 6.0 & 6.0 \\ 6.0 & 9.0 & 6.0 \\ 6.0 & 6.0 & 6.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -3.0 & -3.0 & -3.0 \\ -3.0 & 9.0 & -3.0 \\ -3.0 & -3.0 & -3.0 \end{bmatrix} \qquad z = -4.5$$

Global task

Given:	static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image which contains all closed curves present in the initial image **P**

Examples

Input	Output
 A_LETTER.png	

1.1.50 Halfton

no description
Old names:
Available in: AladdinPro

$$\mathbf{A} = \begin{bmatrix} -0.07 & -0.1 & -0.07 \\ -0.1 & 1.03 & -0.1 \\ -0.07 & -0.1 & -0.07 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.07 & 0.1 & 0.07 \\ 0.1 & 0.32 & 0.1 \\ 0.07 & 0.1 & 0.07 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.1.51 HOLE

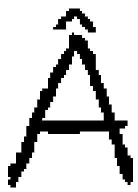
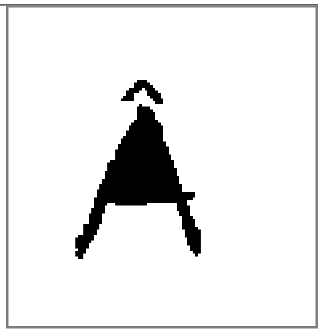
Performs hole filling.
Old names: `HoleFiller`,`Hole-Filling`,`hole`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 1.0 & 3.0 & 1.0 \\ 0.0 & 1.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 4.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	1
Boundary condition:	Fixed(0)
Output:	Binary image representing **P** with holes filled.

Examples

Input	Output
 `A_LETTER.png`	

1.1.52 HOLLOW

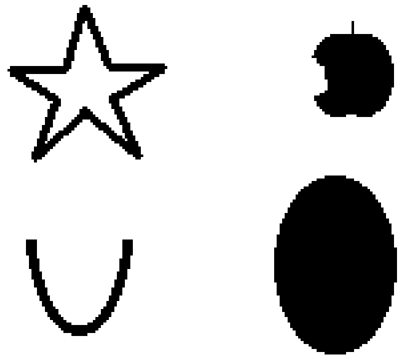
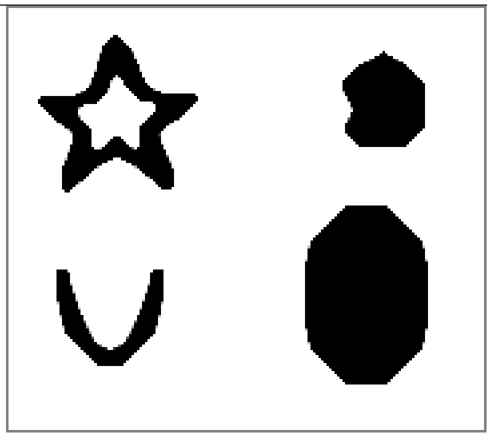
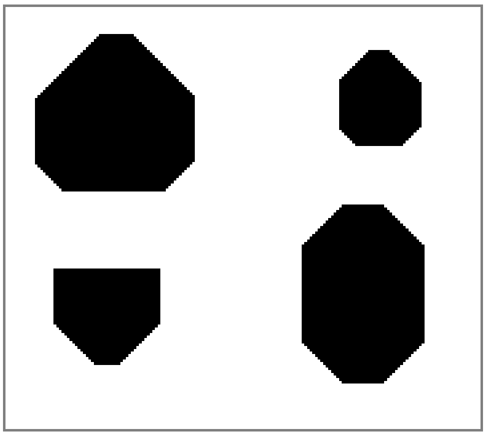
Fills the concave locations of objects
Old names: `ConcaveLocationFiller,hollow`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.5 & 0.5 & 0.5 \\ 0.5 & 2.0 & 0.5 \\ 0.5 & 0.5 & 0.5 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 3.25$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image in which the concave locations of objects are black.

Examples

Input	Output
 `hollow.png`	 

1.1.53 HORLINE

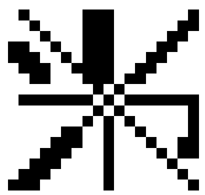
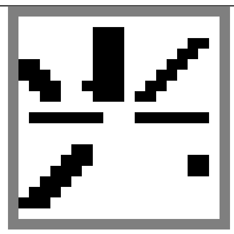
Horizontal line detector.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 1.0 & 2.0 & 1.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 1.0 & 2.0 & 1.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Zero-flux
Output:	Binary image, representing the horizontal lines in **P**

Examples

Input	Output
 diag1liu.png	

1.1.54 HORSKELL

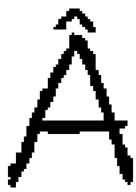
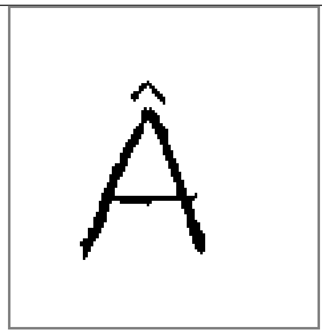
Horizontal skeleton from the left.
Old names: `HorSkelL`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 3.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.5 & 0.0 & 0.125 \\ 0.5 & 0.5 & -0.5 \\ 0.5 & 0.0 & 0.125 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image, peeling the black pixels from the left of the object.

Examples

Input	Output
 `A_LETTER.png`	

1.1.55 HORSKELR

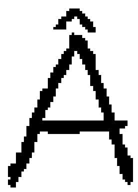
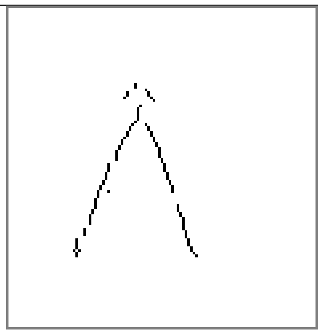
Horizontal skeleton from the right.
Old names: `HorSkelR`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 3.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.125 & 0.0 & 0.5 \\ -0.5 & 0.5 & -0.5 \\ 0.125 & 0.0 & 0.5 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image, peeling the black pixels from the right of the object.

Examples

Input	Output
 `A_LETTER.png`	

1.1.56 INCREASE

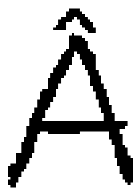
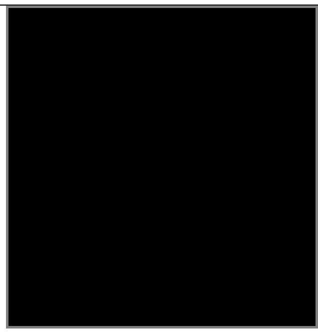
Increases the object by one pixel.
Old names: `ObjectIncreasing,increase`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.5 & 0.5 & 0.5 \\ 0.5 & 0.5 & 0.5 \\ 0.5 & 0.5 & 0.5 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = 4.0$$

Global task

Given:	Static binary image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Zero-flux
Output:	Binary image representing the objects of **P** increased by 1 pixel in all direction.

Examples

Input	Output
 A_LETTER.png	

1.1.57 INTERP

Interpolates a smooth surface through given points
Old names: `SurfaceInterpolation,INTERPOL,interp`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & -2.0 & 0.0 & 0.0 \\ 0.0 & -4.0 & 16.0 & -4.0 & 0.0 \\ -2.0 & 16.0 & -39.0 & 16.0 & -2.0 \\ 0.0 & -4.0 & 16.0 & -4.0 & 0.0 \\ 0.0 & 0.0 & -2.0 & 0.0 & 0.0 \end{bmatrix}$$

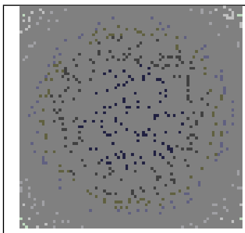
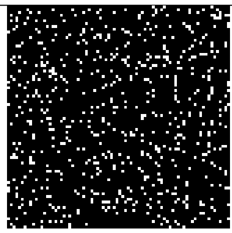
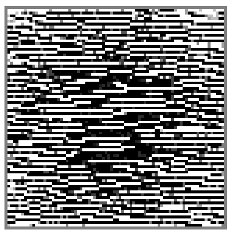
$$\mathbf{B} = \begin{bmatrix} 0 \end{bmatrix}$$

$$z = 0$$

Global task

Given:	A static grayscale image $\mathbf{P}_1$ and a static binary image $\mathbf{P}_2$
Input:	Arbitrary(0)
Initial state:	$\mathbf{P}_1$
Fixed state mask:	$\mathbf{P}_2$
Bias map:	-
Boundary condition:	Fixed(0)
Output:	Grayscale image representing an interpolated surface that fits the given points and is as smooth as possible.

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 `interp1.png`	 `interp2.png`	

1.1.58 JUNCTION

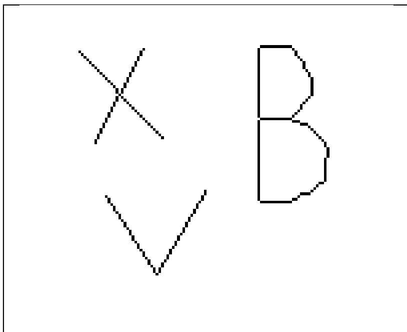
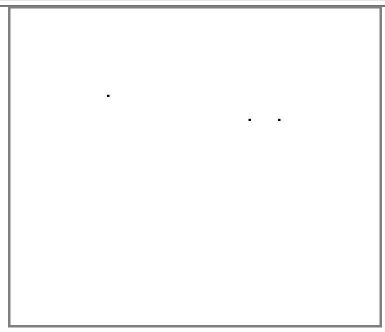
Extracts the junctions of a skeleton.
Old names: `JunctionExtractor,junction`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 1.0 & 1.0 \\ 1.0 & 6.0 & 1.0 \\ 1.0 & 1.0 & 1.0 \end{bmatrix} \qquad z = -3.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Binary image showing the junctions of a skeleton.

Examples

Input	Output
 `junction.png`	

1.1.59 JunctionExtractor1

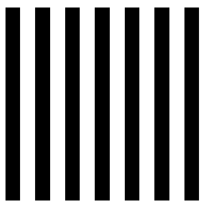
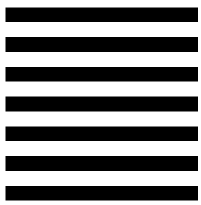
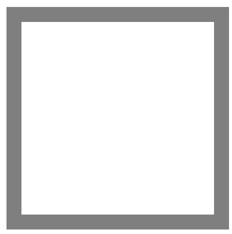
Finding the intersection points of thin (one-pixel thick) lines from two binary images
Old names:
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} -0.5 & -0.5 & -0.5 \\ -0.5 & 3.0 & -0.5 \\ -0.5 & -0.5 & -0.5 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -0.5 & -0.5 & -0.5 \\ -0.5 & 3.0 & -0.5 \\ -0.5 & -0.5 & -0.5 \end{bmatrix} \qquad z = -8.5$$

Global task

Given:	two static binary images $\mathbf{P}_1$ and $\mathbf{P}_2$ containing thin (one-pixel thick) lines or curves, among other (compact) objects
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Fixed(0)
Output:	Binary image containing all the intersection points between the thin lines contained in the binary images $\mathbf{P}_1$ and $\mathbf{P}_2$

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 logic01.png	 logic02.png	

1.1.60 LCP

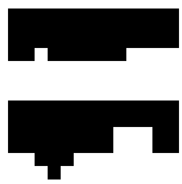
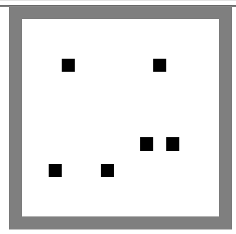
Local concave place detector.
Old names: `LocalConcavePlaceDetector,lcp`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 2.0 & 2.0 & 2.0 \\ 1.0 & -2.0 & 1.0 \end{bmatrix} \qquad z = -7.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image showing the local concave places of **P**

Examples

Input	Output
 `lcp_lse.png`	

1.1.61 LINCUT7H

Deletes horizontal lines not longer than 7 pixels.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 1.0 & 0.5 & 2.0 & 1.0 & 0.5 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \end{bmatrix}$$

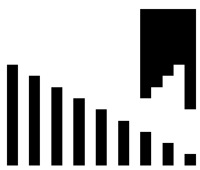
$$\mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 1.0 & 1.0 & 1.0 & 1.0 & 1.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \end{bmatrix}$$

$$z = -5.5$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(-1)
Output:	Binary image where black pixels identify the horizontal lines with a length of 8 or more pixels in **P**

Examples

Input	Output
 `lincut7v.png`	

1.1.62 LINCUT7V

Deletes vertical lines not longer than 7 pixels.
Old names: `LE7pixelVerticalLineRemover,lincut7v,CUT7V`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 1.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.5 & 0.0 & 0.0 \\ 0.0 & 0.0 & 2.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.5 & 0.0 & 0.0 \\ 0.0 & 0.0 & 1.0 & 0.0 & 0.0 \end{bmatrix}$$

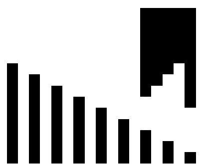
$$\mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 1.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 1.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 1.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 1.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 1.0 & 0.0 & 0.0 \end{bmatrix}$$

$$z = -5.5$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(-1)
Output:	Binary image where black pixels identify the vertical lines with a length of 8 or more pixels in **P**

Examples

Input	Output
 `lincut7v.png`	

1.1.63 LINEXTR3

Lines-not-longer-than-3-pixels detector .
Old names: `LE3pixelLineDetector,LGTHTUNE,linextr3`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.3 & 0.3 & 0.3 & 0.0 \\ 0.0 & 0.3 & 3.0 & 0.3 & 0.0 \\ 0.0 & 0.3 & 0.3 & 0.3 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \end{bmatrix}$$

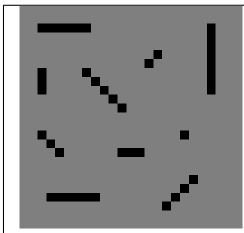
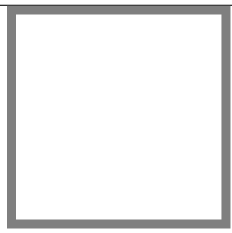
$$\mathbf{B} = \begin{bmatrix} -1.0 & 0.0 & -1.0 & 0.0 & -1.0 \\ 0.0 & -1.0 & -1.0 & -1.0 & 0.0 \\ -1.0 & -1.0 & 4.0 & -1.0 & -1.0 \\ 0.0 & -1.0 & -1.0 & -1.0 & 0.0 \\ -1.0 & 0.0 & -1.0 & 0.0 & -1.0 \end{bmatrix}$$

$$z = -2.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image representing only lines not longer than 3 pixels in **P**

Examples

Input	Output
 `linextr3.png`	

1.1.64 LOGAND

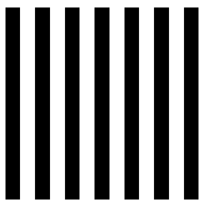
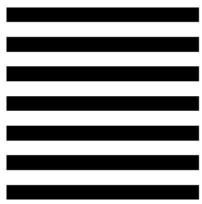
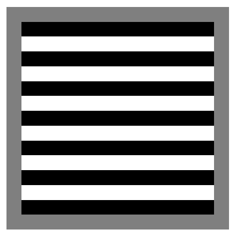
Logic AND (and Set Intersection).
Old names: `LogicAND,LogicANDOperation,AND,logand`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Two static binary images $\mathbf{P}_1$ and $\mathbf{P}_2$
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Fixed(0)
Output:	Binary output of the logic operation AND between $\mathbf{P}_1$ and $\mathbf{P}_2$ (Set Intersection).

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 `logic01.png`	 `logic02.png`	

1.1.65 LOGDIF

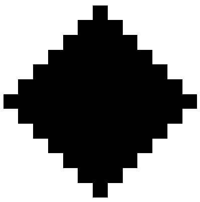
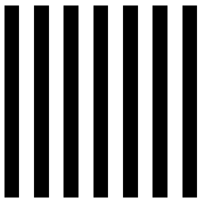
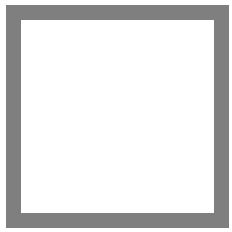
Logic Difference (alt: Relative Set Complement).
Old names: `LogicDifference1,logdif,PA-PB`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & -1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Two static binary images $\mathbf{P}_1$ and $\mathbf{P}_2$
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Fixed(0)
Output:	Binary image representing the set-theoretic, or logic complement of $\mathbf{P}_2$ relative to $\mathbf{P}_1$.

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 `logic05.png`	 `logic01.png`	

1.1.66 LOGDIFNF

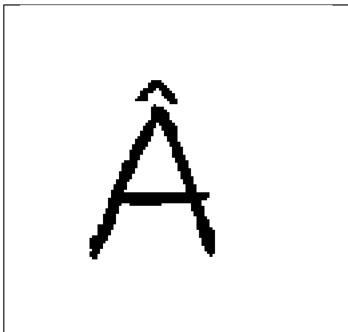
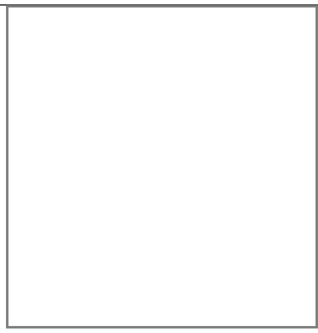
Logic difference between the initial state and the input pictures with noise filtering.
Old names: `LogicDifference2,ImageDifferenceComputation,PA-PB_F1,logdifnf`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.25 & 0.25 & 0.25 \\ 0.25 & 2.0 & 0.25 \\ 0.25 & 0.25 & 0.25 \end{bmatrix} \qquad z = -4.75$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image where black pixels identify the moving parts of **P**

Examples

Input	Output
 `A_LETTER.png`	

1.1.67 LOGNOT

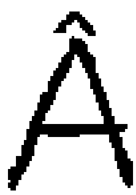
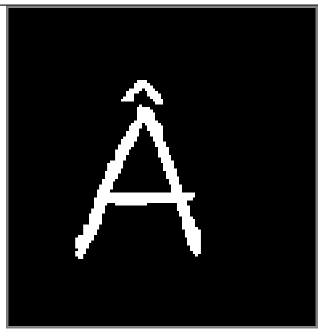
Logic NOT (alt: Set Complementation)
Old names: `LogicNOT`,`LogicNOTOperation`,`INV`,`lognot`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & -2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image where each black pixel in **P** becomes white, and vice versa.

Examples

Input	Output
 `A_LETTER.png`	

1.1.68 LOGOR

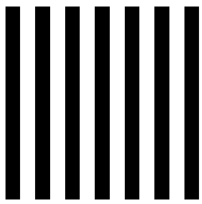
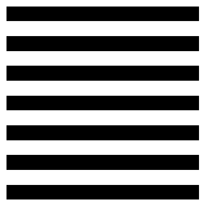
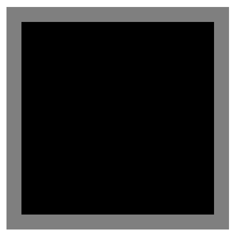
Logic OR (alt: Set Union).
Old names: `LogicOR`,`LogicOROperation`,`logor`,`OR`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 1.0$$

Global task

Given:	Two static binary images $\mathbf{P}_1$ and $\mathbf{P}_2$
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Fixed(0)
Output:	Binary output of the logic operation OR between $\mathbf{P}_1$ and $\mathbf{P}_2$ (Set Union).

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 `logic01.png`	 `logic02.png`	

1.1.69 LOGORN

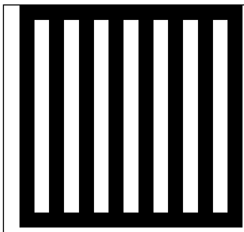
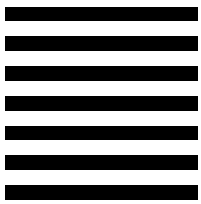
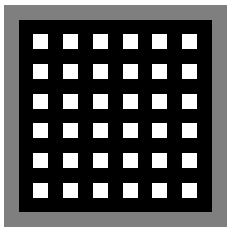
Logic OR function of the initial state and logic NOT function of the input.
Old names: `LogicORwithNOT,logorn,INV-OR`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & -1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 1.0$$

Global task

Given:	Two static binary images $\mathbf{P}_1$ and $\mathbf{P}_2$
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Fixed(0)
Output:	Binary output of the logic operation OR between NOT $\mathbf{P}_1$ and $\mathbf{P}_2$.

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 `logic06.png`	 `logic02.png`	

1.1.70 LSE

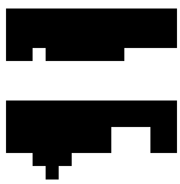
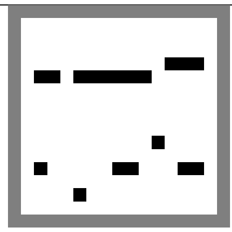
Local southern element detector.
Old names: `LocalSouthernElementDetector,lse`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ -1.0 & -1.0 & -1.0 \end{bmatrix} \qquad z = -3.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image representing local southern elements of objects in **P**

Examples

Input	Output
 lcp_lse.png	

1.1.71 MAJVOT1

Majority vote-taker.
Old names: `MajorityVoteTaker(Algorithm!)`,`MAJVOT`,`majvot1`,`MajorityVoteTaker`,`majvot2`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 1.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.05 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	

1.1.72 MAJVOT3

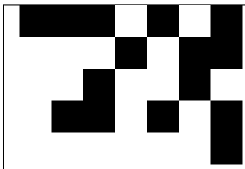
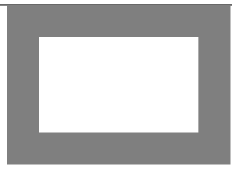
Majority vote-taker (compares the sum in a local neigborhood to the specified threshold).
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 1.0 & 1.0 \\ 1.0 & 1.0 & 1.0 \\ 1.0 & 1.0 & 1.0 \end{bmatrix} \qquad z = -6.5$$

Global task

Given:	Static gray-scale image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image - black pixels mark those locations where the sum in local neighborhood (r=1) exceeds the specified threshold.

Examples

Input	Output
 histogr.png	

1.1.73 MATCH

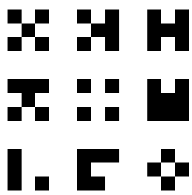
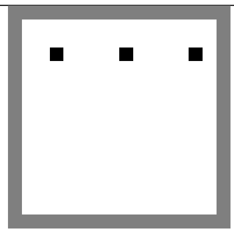
Finds matching patterns
Old names: `PatternMatchingFinder,match`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & -1.0 & 1.0 \\ 0.0 & 1.0 & 0.0 \\ 1.0 & -1.0 & 1.0 \end{bmatrix} \qquad z = -6.5$$

Global task

Given:	Static binary image **P** possessing the 3x3 pattern prescribed by the template.
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image representing the locations of the 3x3 pattern prescribed by the template. The pattern having a black/white pixel where the template value is +1/-1, respectively, is detected.

Examples

Input	Output
 `match.png`	

1.1.74 MOTDEPEN

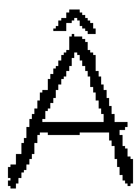
Direction and speed dependent motion detection.
Old names: `MotionDetection1`,`MOVEHOR`,`MotionDetection`,`motdepen`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} -0.1 & -0.1 & -0.1 \\ -0.1 & 0.0 & -0.1 \\ -0.1 & -0.1 & -0.1 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.5 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -2.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image representing only objects of **P** moving horizontally to the right with a speed of 1 pixel/delay-time.

Examples

Input	Output
 A_LETTER.png	

1.1.75 MOTINDEP

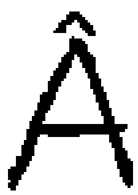
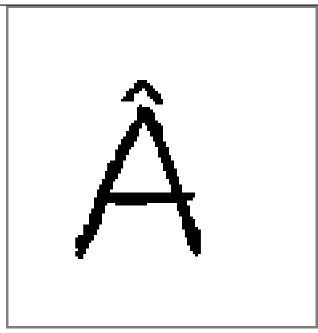
Direction independent motion detection [7]
Old names: `MotionDetection2`, `MD_CONT`, `motindep`, `SpeedDetection`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 6.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -2.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image representing only objects of **P** moving slower than 1 pixel/delay-time.

Examples

Input	Output
 `A_LETTER.png`	

1.1.76 MullerLyerIllusion

Simulates the Müller-Lyer illusion [13]
Old names: `MULLER`
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 1.3 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \end{bmatrix}$$

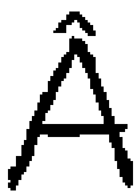
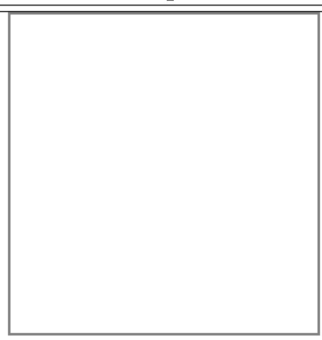
$$\mathbf{B} = \begin{bmatrix} -0.1 & -0.1 & -0.1 & -0.1 & -0.1 \\ -0.1 & -0.1 & -0.1 & -0.1 & -0.1 \\ -0.1 & -0.1 & 1.3 & -0.1 & -0.1 \\ -0.1 & -0.1 & -0.1 & -0.1 & -0.1 \\ -0.1 & -0.1 & -0.1 & -0.1 & -0.1 \end{bmatrix}$$

$$z = -2.8$$

Global task

Given:	static binary image **P** representing two horizontal lines between arrows. The arrows are dark-gray, the background is white
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image showing that the horizontal line on the top in **P** seems to be longer than the other one.

Examples

Input	Output
 A_LETTER.png	

1.1.77 PATCHMAK

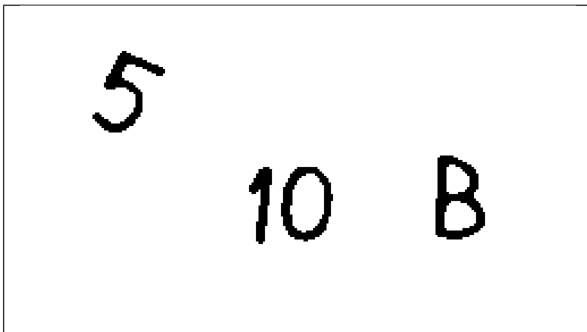
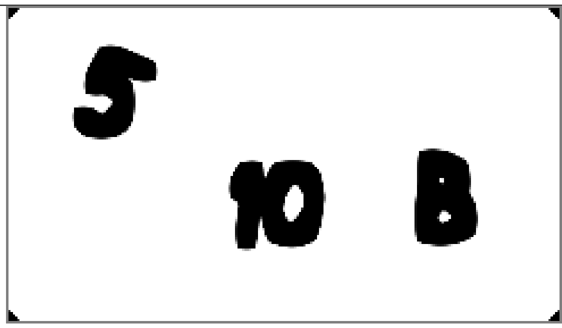
Patch maker.
Old names: `PatchMaker,patchmak`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 1.0 & 2.0 & 1.0 \\ 0.0 & 1.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 4.5$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Zero-flux
Output:	Binary image with enlarged objects of **P** obtained after a certain time.

Examples

Input	Output
 `patchmak.png`	

1.1.78 PathFinder

Finding all paths between two selected points through a labyrinth [61]
Old names:
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 0.5 & 4.0 & 0.5 \\ 4.0 & 12.0 & 4.0 \\ 0.5 & 4.0 & 0.5 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 8.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 8.0$$

Global task

Given:	static binary image **P** representing a labyrinth made of one-pixel thick white curves on a black background
Input:	
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image containing all the paths connecting the marked points (made of white curves against a black background)

1.1.79 PEEL1PIX

Peel one pixel from all directions (#).
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.4 & 0.0 \\ 0.4 & 1.4 & 0.4 \\ 0.0 & 0.4 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 4.6 & -2.8 & 4.6 \\ -2.8 & 1.0 & -2.8 \\ 4.6 & -2.8 & 4.6 \end{bmatrix} \qquad z = -7.2$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.1.80 PEELHOR

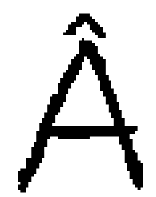
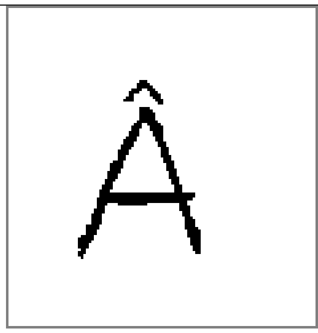
Peels one pixel from the left.
Old names: `LeftPeeler,peelhor`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 1.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -1.0$$

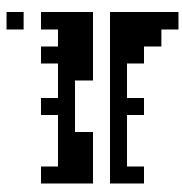
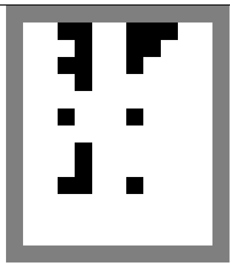
Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Zero-flux
Output:	Binary image representing the objects of **P** peeled with one pixel from the left.

Examples

Input	Output
 `a_letter.png`	

Examples

Input	Output
 `peelhor.png`	

1.1.81 PixelSearch

Pixel search in a given range [72]
Old names:
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix}$$

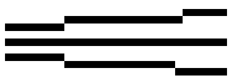
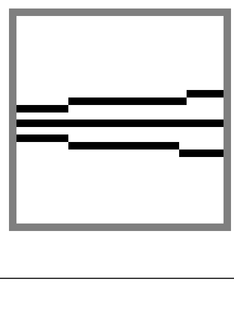
$$\mathbf{B} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \end{bmatrix}$$

$$z = -1$$

Global task

Given:	static binary image $\mathbf{P}_1$, $\mathbf{P}_2$
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Fixed(0)
Output:	Binary image representing the pixels being at the specified distance from the reference.

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 input_reference.png	 initial_available.png	

1.1.82 POISSON

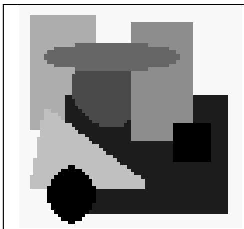
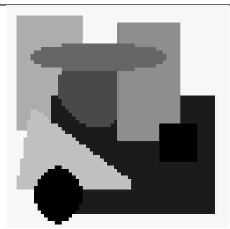
Solves the Poisson PDE (Dx = -f(x)).
Old names: `PoissonPDESolver`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 1.0 & -3.0 & 1.0 \\ 0.0 & 1.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = 0$$

Global task

Given:	Static gray-scale images $\mathbf{P}_1$ and $\mathbf{P}_2$ = -f(x)
Input:	Arbitrary(0)
Initial state:	$\mathbf{P}_1$
Bias map:	$\mathbf{P}_2$
Boundary condition:	Zero-flux
Output:	Gray-scale image - the solution of the Poisson equation.

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 `avergra2.png`	 `avergra2.png`	

1.1.83 PROP1

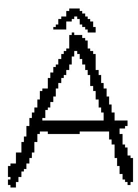
Trigger-wave generator (expands the black regions).
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.25 & 0.25 & 0.25 \\ 0.25 & 3.0 & 0.25 \\ 0.25 & 0.25 & 0.25 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = 3.75$$

Global task

Given:	Static binary image **P**
Input:	-
Initial state:	**P**
Boundary condition:	Zero-flux
Output:	Binary image with enlarged objects of **P** obtained after a certain time.

Examples

Input	Output
 A_LETTER.png	

1.1.84 PROP2

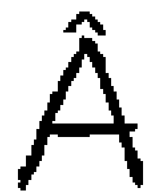
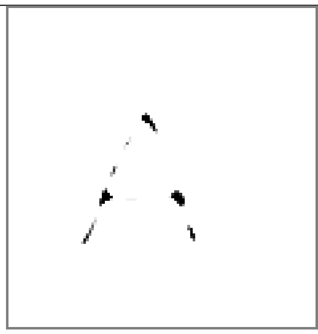
Trigger-wave generator (expands the white regions).
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.25 & 0.25 & 0.25 \\ 0.25 & 3.0 & 0.25 \\ 0.25 & 0.25 & 0.25 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = -2.75$$

Global task

Given:	Static binary image **P**
Input:	-
Initial state:	**P**
Boundary condition:	Zero-flux
Output:	Binary image with reduced objects of **P** obtained after a certain time.

Examples

Input	Output
 `A_LETTER.png`	

1.1.85 RECALL

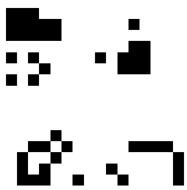
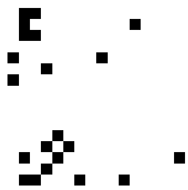
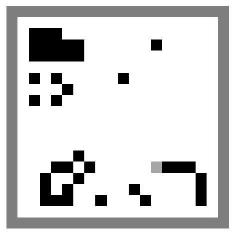
Figure reconstruction from markers.
Old names: `FigureReconstructor`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.5 & 0.5 & 0.5 \\ 0.5 & 4.0 & 0.5 \\ 0.5 & 0.5 & 0.5 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 4.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 2.5$$

Global task

Given:	Two static binary images $\mathbf{P}_1$ (mask) and $\mathbf{P}_2$ (marker)
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Zero-flux
Output:	Binary image representing those objects of $\mathbf{P}_1$ which are marked by $\mathbf{P}_2$.

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 `figdel.png`	 `figrec.png`	

1.1.86 RIGHTBC

Right (diagonal) contour detection (#).
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & -1.0 \end{bmatrix} \qquad z = -2.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.1.87 RIGHTCON

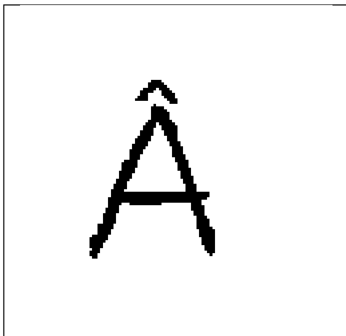
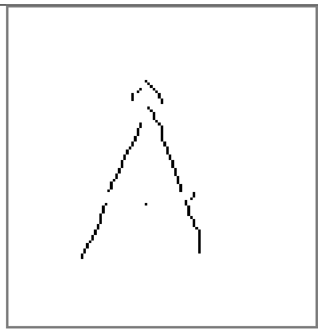
Right contour detector.
Old names: `RightContourDetector`,`RightEdgeDetection`,`rightcon`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 1.0 & 1.0 & -1.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -2.0$$

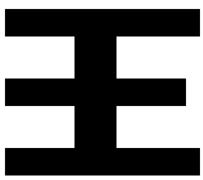
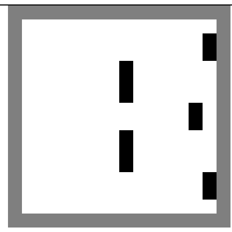
Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image representing the right edges of objects in **P**

Examples

Input	Output
 `a_letter.png`	

Examples

Input	Output
 `chineese.png`	

1.1.88 RotationDetector

Detects the rotation of compact objects in a binary image, having only horizontal and vertical edges, removes all inclined objects or objects having at least one inclined edge [61]
Old names:
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} -0.8 & 5.0 & -0.8 \\ 5.0 & 5.0 & 5.0 \\ -0.8 & 5.0 & -0.8 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -0.4 & -2.5 & -0.4 \\ -2.5 & 5.0 & -2.5 \\ -0.4 & -2.5 & -0.4 \end{bmatrix} \qquad z = -11.2$$

Global task

Given:	static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image which retains from the initial state **P** only the compact objects with horizontal or vertical edges

1.1.89 SHADMASK

Masked shadow [24]
Old names: `MaskedShadow`,`shadmask`,`MASKSHAD`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.8 & 1.5 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & -1.2 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:	Static binary images $\mathbf{P}_1$ and $\mathbf{P}_2$
Input:	$\mathbf{P}_1$
Initial state:	$\mathbf{P}_2$
Boundary condition:	Fixed(-1)
Output:	Binary image representing the result of pattern propagation of $\mathbf{P}_2$ in a particular direction. The propagation goes from the direction of the non-zero off-center feedback template entry and is halted by the mask $\mathbf{P}_1$.

Examples

$\mathbf{P}_1$	$\mathbf{P}_2$	Output
 `shdmsk1.png`	 `shdmsk2.png`	

1.1.90 SHADOW

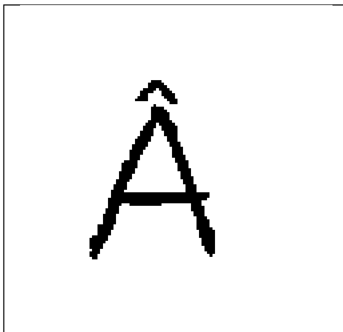
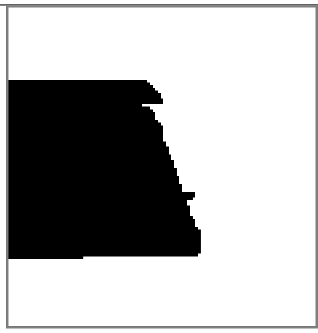
Creates the left shadow of the object.
Old names: `LeftShadow,ShadowProjection,shadow`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 2.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	1
Boundary condition:	Fixed(0)
Output:	Binary image representing the left shadow of the objects in **P**

Examples

Input	Output
 `a_letter.png`	

1.1.91 shadow0

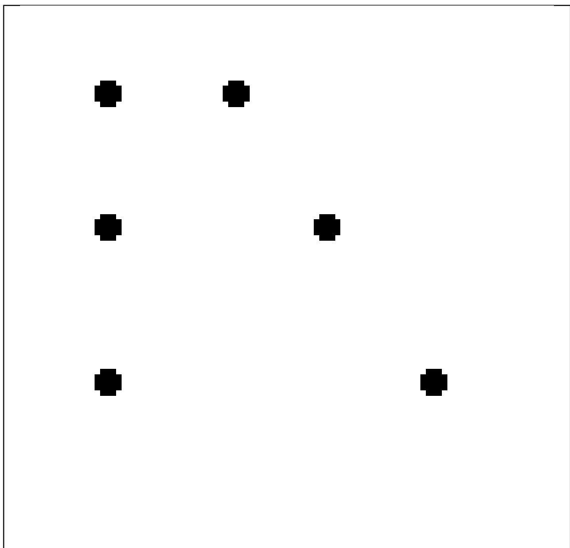
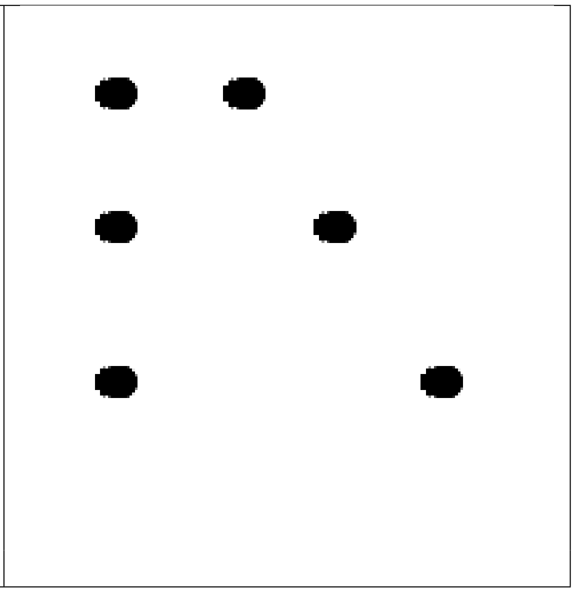
Generate growing shadows starting from black points
Old names: `DirectedGrowingShadow`
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 0.4 & 0.3 & 0.0 \\ 1.0 & 2.0 & -1.0 \\ 0.4 & 0.3 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.4 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 2.5$$

Global task

Given:	static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(-1)
Output:	Binary image in which shadows are generated starting from black pixels. During the transient shadows become wider and wider.

Examples

Input	Output
 `points.png`	

1.1.92 shadow45

Generate growing shadows starting from black points
Old names: `DirectedGrowingShadow`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0 & 0 & -1 \\ 1 & 2 & 0 \\ 1 & 1 & 0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.4 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 2.5$$

Global task

Given:	static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(-1)
Output:	Binary image in which shadows are generated starting from black pixels. During the transient shadows become wider and wider.

Examples

Input	Output
 A_LETTER.png	

1.1.93 SHADSIM

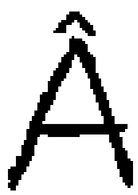
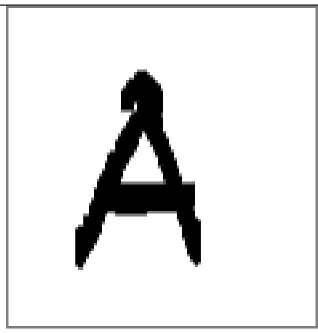
Vertical shadow template
Old names: `VerticalShadow,shadsim,SUPSHAD`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = 2.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Zero-flux
Output:	Binary image representing the vertical shadow of the objects in **P** taken upward and downward simultaneously.

Examples

Input	Output
 `A_LETTER.png`	

1.1.94 SHIFTE

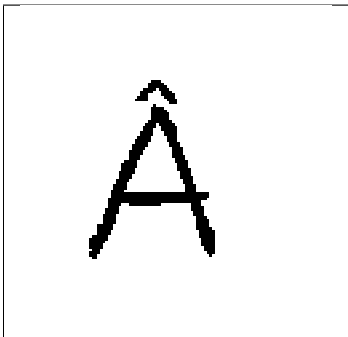
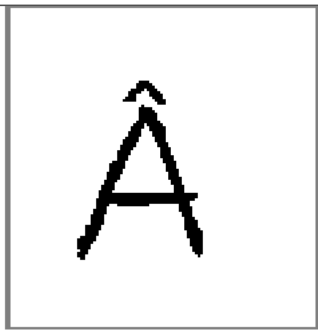
Shifts the image toward eastern direction.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 1.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	0
Boundary condition:	Zero-flux
Output:	Binary image - **P** is shifted toward the eastern direction by one pixel.

Examples

Input	Output
 A_LETTER.png	

1.1.95 SHIFTN

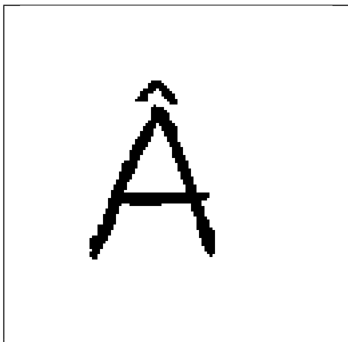
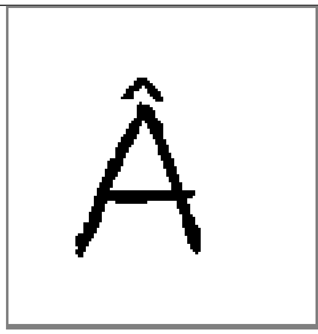
Shifts the image toward northern direction.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \end{bmatrix} \qquad z = 0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	0
Boundary condition:	Zero-flux
Output:	Binary image - **P** is shifted toward the northern direction by one pixel.

Examples

Input	Output
 `A_LETTER.png`	

1.1.96 SHIFTNE

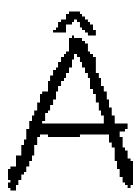
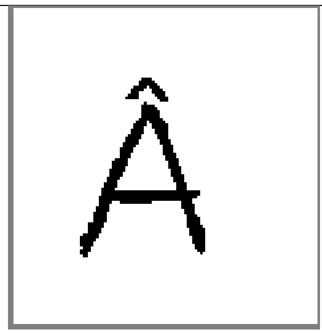
Shifts the image toward north-estern direction.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 1.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	0
Boundary condition:	Zero-flux
Output:	Binary image - **P** is shifted toward the north-estern direction by one pixel.

Examples

Input	Output
 A_LETTER.png	

1.1.97 SHIFTNW

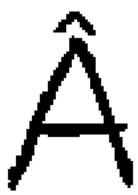
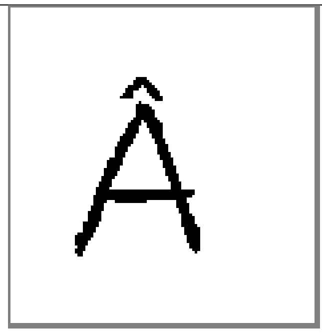
Shifts the image toward north-western direction.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 1.0 \end{bmatrix} \qquad z = 0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	0
Boundary condition:	Zero-flux
Output:	Binary image - **P** is shifted toward the north-western direction by one pixel.

Examples

Input	Output
 A_LETTER.png	

1.1.98 SHIFTS

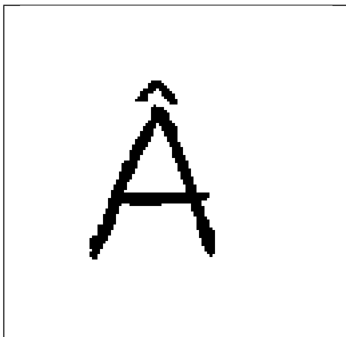
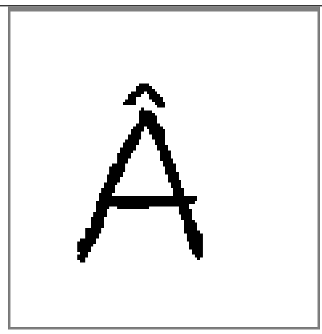
Shifts the image toward southern direction.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	0
Boundary condition:	Zero-flux
Output:	Binary image - **P** is shifted toward the southern direction by one pixel.

Examples

Input	Output
 `A_LETTER.png`	

1.1.99 SHIFTSE

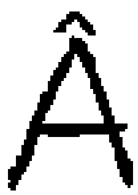
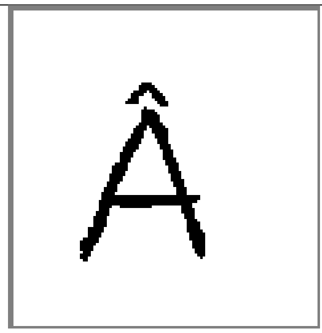
Shifts the image toward south-estern direction.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	0
Boundary condition:	Zero-flux
Output:	Binary image - **P** is shifted toward the south-estern direction by one pixel.

Examples

Input	Output
 A_LETTER.png	

1.1.100 SHIFTSW

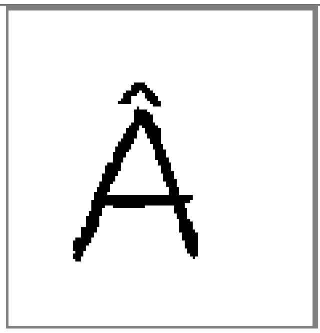
Shifts the image toward south-western direction.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 1.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	0
Boundary condition:	Zero-flux
Output:	Binary image - **P** is shifted toward the south-western direction by one pixel.

Examples

Input	Output
 A_LETTER.png	

1.1.101 SHIFTW

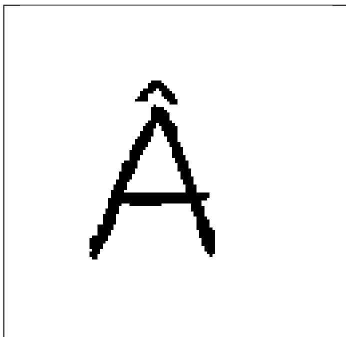
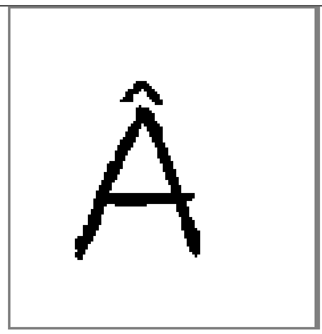
Shifts the image toward western direction.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 1.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	0
Boundary condition:	Zero-flux
Output:	Binary image - **P** is shifted toward the western direction by one pixel.

Examples

Input	Output
 A_LETTER.png	

1.1.102 SKELBW1

The algorithm finds the skeleton of a black-and-white object.
Old names: `BlackandWhiteSkeletonization(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 1.0 & 0.0 \\ 1.0 & 7.0 & -1.0 \\ 0.0 & -1.0 & 0.0 \end{bmatrix} \qquad z = -3.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Binary image (Phase 1 of the skeletonization algorithm).

1.1.103 SKELBW2

The algorithm finds the skeleton of a black-and-white object.
Old names: `BlackandWhiteSkeletonization(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 1.0 & 1.0 \\ 0.0 & 7.0 & 0.0 \\ -0.5 & -1.0 & -0.5 \end{bmatrix} \qquad z = -3.4$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Binary image (Phase 2 of the skeletonization algorithm).

1.1.104 SKELBW3

The algorithm finds the skeleton of a black-and-white object.
Old names: `BlackandWhiteSkeletonization(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 1.0 & 1.0 \\ -1.0 & 7.0 & 1.0 \\ 0.0 & -1.0 & 0.0 \end{bmatrix} \qquad z = -3.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Binary image (Phase 3 of the skeletonization algorithm).

1.1.105 SKELBW4

The algorithm finds the skeleton of a black-and-white object.
Old names: `BlackandWhiteSkeletonization(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -0.5 & 0.0 & 1.0 \\ -1.0 & 7.0 & 1.0 \\ -0.5 & 0.0 & 1.0 \end{bmatrix} \qquad z = -3.4$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Binary image (Phase 4 of the skeletonization algorithm).

1.1.106 SKELBW5

The algorithm finds the skeleton of a black-and-white object.
Old names: `BlackandWhiteSkeletonization(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & -1.0 & 0.0 \\ -1.0 & 7.0 & 1.0 \\ 0.0 & 1.0 & 1.0 \end{bmatrix} \qquad z = -3.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Binary image (Phase 5 of the skeletonization algorithm).

1.1.107 SKELBW6

The algorithm finds the skeleton of a black-and-white object.
Old names: `BlackandWhiteSkeletonization(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -0.5 & -1.0 & -0.5 \\ 0.0 & 7.0 & 0.0 \\ 1.0 & 1.0 & 1.0 \end{bmatrix} \qquad z = -3.4$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Binary image (Phase 6 of the skeletonization algorithm).

1.1.108 SKELBW7

The algorithm finds the skeleton of a black-and-white object.
Old names: `BlackandWhiteSkeletonization(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & -1.0 & 0.0 \\ 1.0 & 7.0 & -1.0 \\ 1.0 & 1.0 & 0.0 \end{bmatrix} \qquad z = -3.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Binary image (Phase 7 of the skeletonization algorithm).

1.1.109 SKELBW8

The algorithm finds the skeleton of a black-and-white object.
Old names: `BlackandWhiteSkeletonization(Algorithm!)`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 1.0 & 0.0 & -0.5 \\ 1.0 & 7.0 & -1.0 \\ 1.0 & 0.0 & -0.5 \end{bmatrix} \qquad z = -3.4$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Binary image (Phase 8 of the skeletonization algorithm).

1.1.110 SpikeGeneration1

Rhythmic burst-like spike generation using 4 ion channels, 2 of them are delayed
Old names: `SPIKE_BU`
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.1.111 SpikeGeneration2

Action potential generation in a neuromorphic way without delay using 2 ion channels
Old names: `SPIKE_N`
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.1.112 SpikeGeneration3

Action potential generation in a neuromorphic way, using 2 ion channels where one is delayed. Ion channels are modeled with voltage-controlled conductance (VCC) templates
Old names: `SPIKE_ND`
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.1.113 T1_RACC3

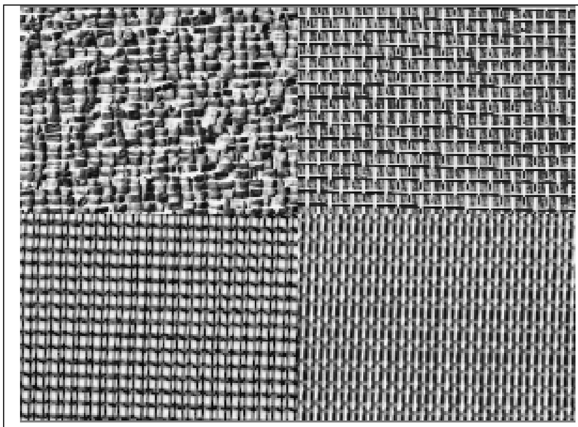
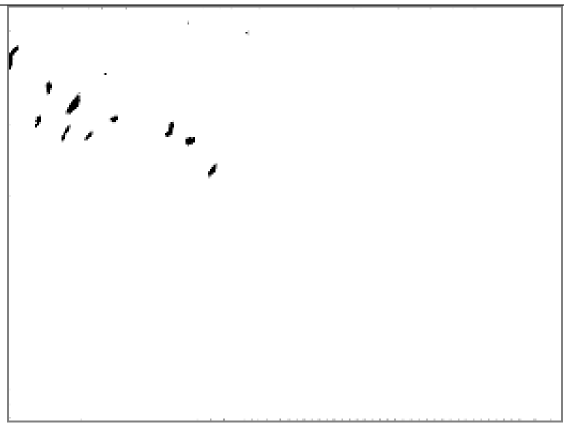
Textures detection.
Old names: `TextureDetector1`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 2.2656 & 1.7969 & 3.3594 \\ -0.7031 & -4.4531 & 1.4063 \\ 3.2031 & 3.9844 & -0.3125 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -3.9063 & 1.25 & 3.0469 \\ 0.8594 & -3.0469 & 3.3594 \\ 1.7188 & -0.625 & -4.6094 \end{bmatrix} \qquad z = -1.6406$$

Global task

Given:	Static gray-scale image **P** representing textures having the same flat grayscale histograms
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Nearly binary image where the detected texture becomes darker than the others.

Examples

Input	Output
 `tx_racc.png`	

1.1.114 T2_RACC3

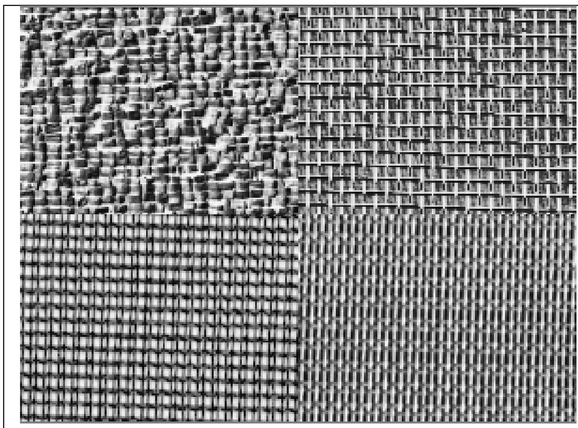
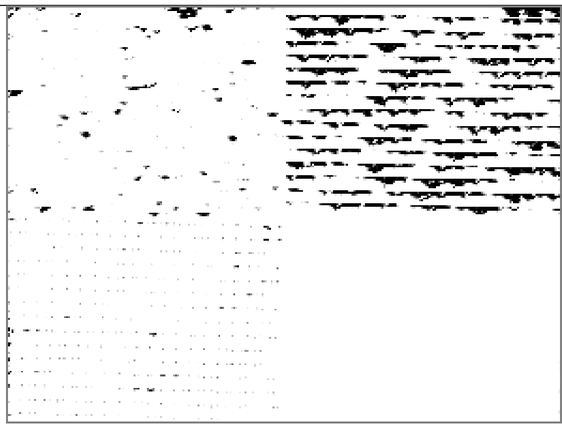
Textures detection.
Old names: `TextureDetector2`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 1.5625 & 4.375 & 2.4219 \\ 4.6875 & -3.125 & 1.4063 \\ 2.1875 & -5.0 & 0.8594 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -2.8125 & 2.4219 & -3.75 \\ -5.0 & -0.3906 & -5.0 \\ 3.6719 & 4.2188 & 3.125 \end{bmatrix} \qquad z = -3.2031$$

Global task

Given:	Static gray-scale image **P** representing textures having the same flat grayscale histograms
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Nearly binary image where the detected texture becomes darker than the others.

Examples

Input	Output
 tx_racc.png	

1.1.115 T3_RACC3

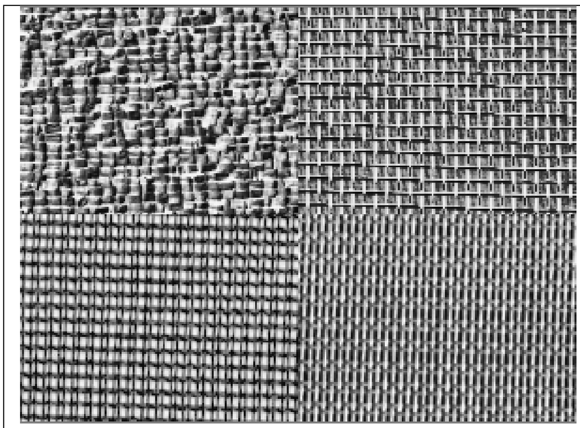
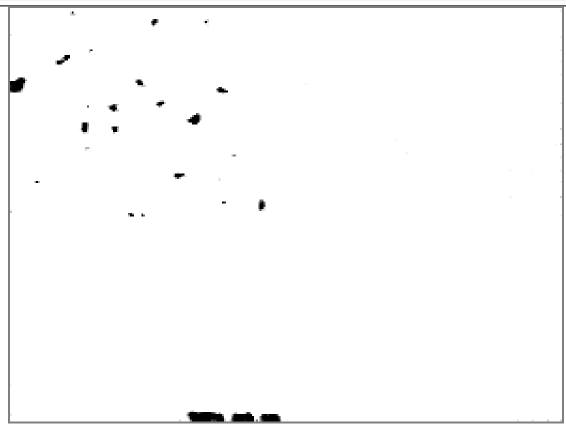
Textures detection.
Old names: `TextureDetector3`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 1.6406 & -1.0156 & 1.3281 \\ 1.875 & -4.6094 & 2.8906 \\ 3.2813 & 2.0313 & 3.75 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -3.9063 & -2.6563 & -3.125 \\ 0.9375 & 1.4844 & -3.125 \\ 1.3281 & 0.5469 & 2.3438 \end{bmatrix} \qquad z = -2.4219$$

Global task

Given:	Static gray-scale image **P** representing textures having the same flat grayscale histograms
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Nearly binary image where the detected texture becomes darker than the others.

Examples

Input	Output
 `tx_racc.png`	

1.1.116 T4_RACC3

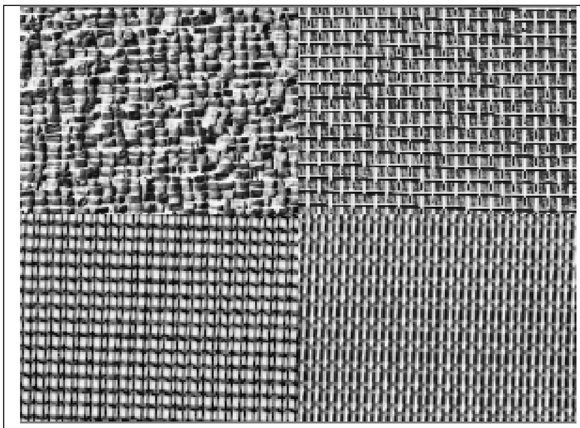
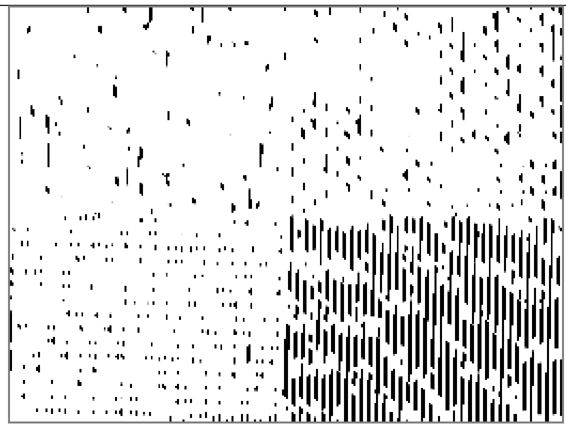
Textures detection.
Old names: `TextureDetector4`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 3.125 & 4.2969 & 2.1875 \\ -2.8125 & 3.125 & 0.1563 \\ 1.875 & 4.9219 & 4.5313 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -3.5156 & 4.375 & -5.0 \\ -0.9375 & -3.0469 & -3.6719 \\ 1.4063 & -0.625 & -4.375 \end{bmatrix} \qquad z = -2.4219$$

Global task

Given:	Static gray-scale image **P** representing textures having the same flat grayscale histograms
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Nearly binary image where the detected texture becomes darker than the others.

Examples

Input	Output
	
`tx_racc.png`	

1.1.117 ThinLineRemover

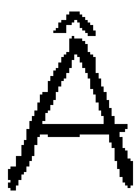
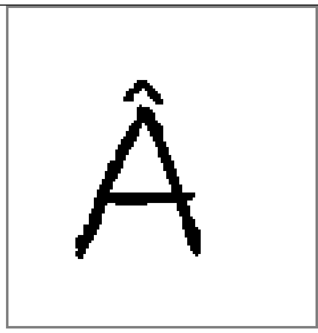
Removes thin (one-pixel thick) lines from a binary image
Old names:
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 2.0 & 2.0 & 2.0 \\ 2.0 & 8.0 & 2.0 \\ 2.0 & 2.0 & 2.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -2.0$$

Global task

Given:	static binary image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image containing compact black objects (without any thin lines) against a white background

Examples

Input	Output
 A_LETTER.png	

1.1.118 TX_HCLC

Segmentation of four textures.
Old names: `5x5TextureSegmentation1,tx_hclc`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} -3.4375 & 0.8594 & -1.6406 & -0.1563 & -1.0156 \\ -1.0938 & 0.1563 & -2.1875 & -3.2031 & 3.5156 \\ 2.5 & 1.5625 & 3.9063 & 2.6563 & 2.4219 \\ 0.5469 & 2.8906 & -0.625 & 0.4688 & 3.6719 \\ -1.7969 & -0.5469 & 2.5 & -0.2344 & 2.3438 \end{bmatrix}$$

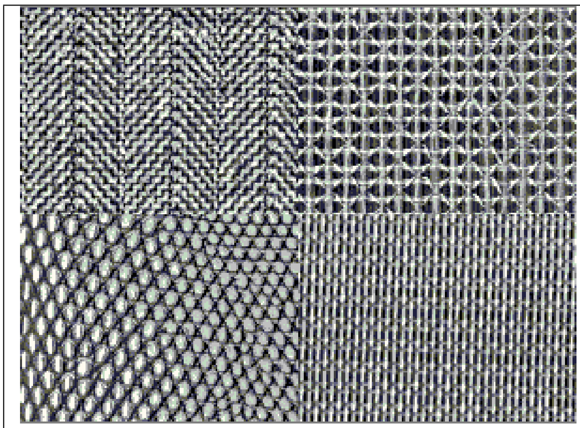
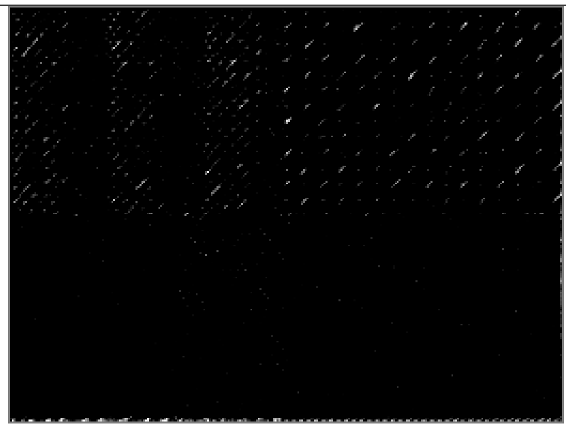
$$\mathbf{B} = \begin{bmatrix} -2.1875 & -0.2344 & 0.1563 & -0.625 & -0.7813 \\ 1.6406 & 2.2656 & -3.2031 & 1.0938 & 2.0313 \\ 0.0781 & 0.5469 & 0.8594 & 3.5156 & 0.0781 \\ 0.3906 & -3.8281 & -3.125 & -2.3438 & -2.1094 \\ 0.7813 & -2.6563 & -1.1719 & -1.4063 & 1.0156 \end{bmatrix}$$

$$z = 3.2813$$

Global task

Given:	Static gray-scale image **P** representing four textures
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Nearly binary image representing four patterns that differ in average gray-levels.

Examples

Input	Output
 `tx_hclc.png`	

1.1.119 TX_RACC3

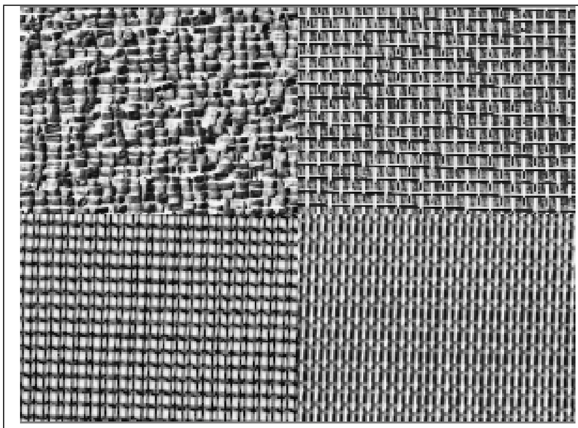
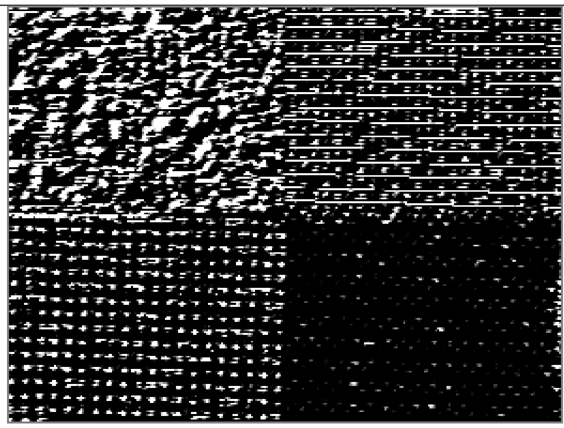
Segmentation of four textures.
Old names: `3x3TextureSegmentation`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.8594 & 0.9375 & 3.75 \\ 2.1094 & -2.8125 & 3.75 \\ -1.3281 & -2.5781 & -1.0156 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.1563 & -1.5625 & 1.25 \\ -2.8906 & 1.0938 & -3.2031 \\ 4.0625 & 4.6875 & 3.75 \end{bmatrix} \qquad z = 1.7969$$

Global task

Given:	Static gray-scale image **P** representing four textures
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Nearly binary image representing four patterns that differ in average gray-levels.

Examples

Input	Output
 `tx_racc.png`	

1.1.120 TX_RACC5

Segmentation of four textures.
Old names: `5x5TextureSegmentation2,tx_racc5`
Available in: Template Library v3.1, Candy

$$
\mathbf{A} = \begin{bmatrix} 4.2188 & -1.5625 & 1.5625 & 3.3594 & 0.625 \\ -2.8906 & 4.5313 & -0.2344 & 3.125 & -2.8906 \\ 2.6563 & 2.1875 & -4.6875 & -3.4375 & -2.8125 \\ 3.9844 & 1.5625 & -1.1719 & -3.125 & -3.2031 \\ -3.75 & -2.1875 & 3.2813 & 2.1875 & -0.625 \end{bmatrix}
$$

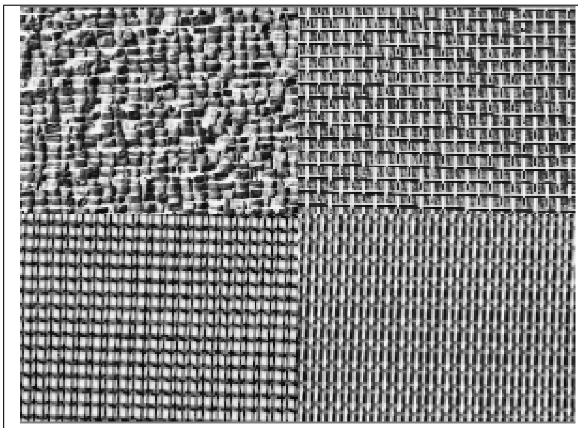
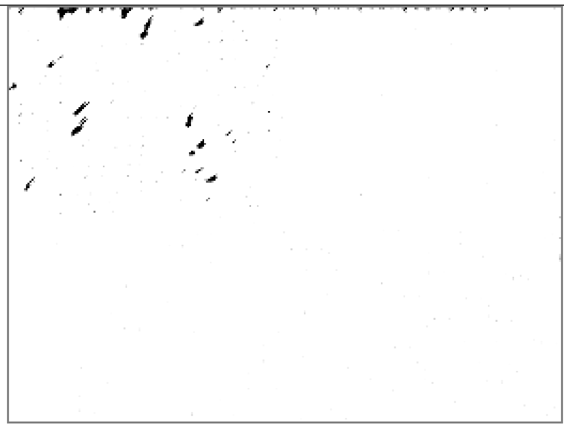
$$
\mathbf{B} = \begin{bmatrix} 4.0625 & -5.0 & 0.3906 & 2.1094 & -1.875 \\ 3.9063 & 0.3125 & -1.9531 & 4.8438 & -0.3125 \\ 0.0 & -4.0625 & 0.9375 & -0.3125 & 0.4688 \\ -0.625 & -5.0 & 2.3438 & 0.625 & -1.875 \\ 3.5938 & -0.9375 & 0.1563 & 2.8125 & -1.875 \end{bmatrix}
$$

$$
z = -5.0
$$

Global task

Given:	Static gray-scale image **P** representing four textures
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Nearly binary image representing four patterns that differ in average gray-levels.

Examples

Input	Output
 `tx_racc.png`	

1.1.121 VERSKELB

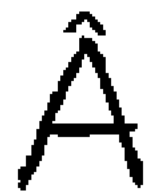
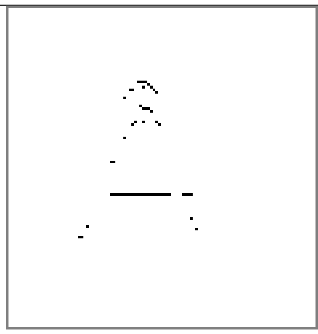
Vertical skeleton from the bottom.
Old names: `VerSkelB`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 3.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.125 & -0.5 & 0.125 \\ 0.0 & 0.5 & 0.0 \\ 0.5 & -0.5 & 0.5 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image, peeling the black pixels from the bottom of the object.

Examples

Input	Output
 A_LETTER.png	

1.1.122 VERSKELT

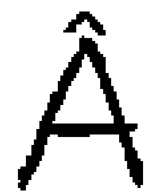
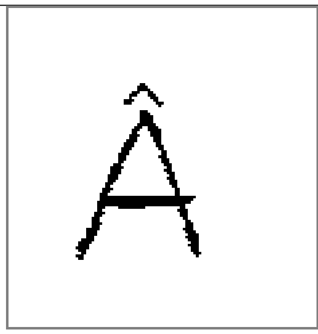
Vertical skeleton from the top.
Old names: `VerSkelT`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 3.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.5 & 0.5 & 0.5 \\ 0.0 & 0.5 & 0.0 \\ 0.125 & -0.5 & 0.125 \end{bmatrix} \qquad z = -1.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image, peeling the black pixels from the top of the object.

Examples

Input	Output
 `A_LETTER.png`	

1.1.123 WhitePropagation

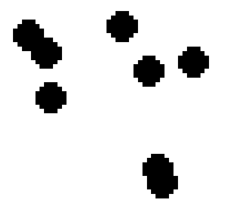
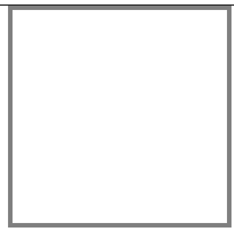
Starts omni-directional white propagation from white pixels [54]
Old names: `wprop`
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 0.25 & 0.25 & 0.25 \\ 0.25 & 3.0 & 0.25 \\ 0.25 & 0.25 & 0.25 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -3.75$$

Global task

Given:	static binary image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image showing white objects in **P** with increasing white neighborhood (black objects decreasing in size).

Examples

Input	Output
 patches.png	

1.2 Stretch type templates

Definition

$$\mathbf{A} = 0, \quad \mathbf{B} \neq 0, \quad r(\mathbf{B}) = 0$$

Input: Grayscale
Output: Grayscale

1.2.1 STRETCH

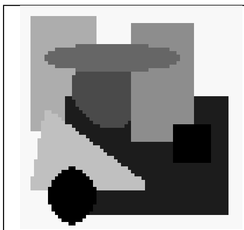
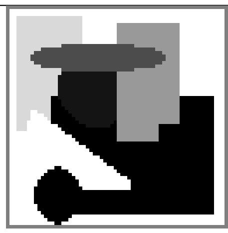
"Contrast stretching".
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:	Static (noisy) gray-scale image **P**
Input:	**P**
Initial state:	-
Boundary condition:	0
Output:	Grayscale image.

Examples

Input	Output
 avergra2.png	

1.3 Convolution type templates

Definition

$$\mathbf{A} = 0, \quad \mathbf{B} \neq 0, \quad r(\mathbf{B}) = 1$$

Input: Grayscale
Output: Grayscale

1.3.1 CONVOL

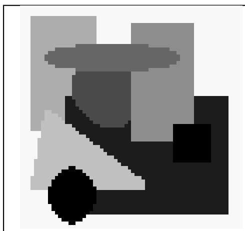
Convolution (linear averaging) in nearest neighborhood.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.11 & 0.11 & 0.11 \\ 0.11 & 0.11 & 0.11 \\ 0.11 & 0.11 & 0.11 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:	Static (noisy) gray-scale image **P**
Input:	**P**
Initial state:	-
Boundary condition:	zero-flux
Output:	Grayscale image.

Examples

Input	Output
 `avergra2.png`	

1.3.2 optimedge

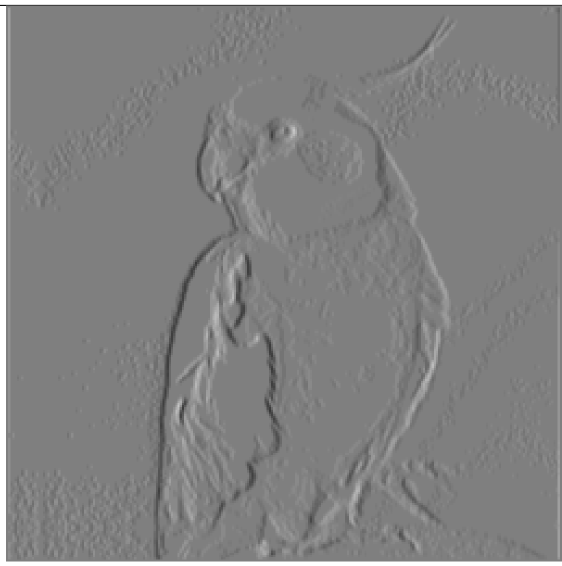
Optimal edge detector [43]
Old names: `OptimalEdgeDetector`
Available in: Template Library v3.1

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} -0.11 & 0.0 & 0.11 \\ -0.28 & 0.0 & 0.28 \\ -0.11 & 0.0 & 0.11 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:	static grayscale image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Grayscale image representing edges calculated in horizontal direction.

Examples

Input	Output
 `bird.png`	

1.4 Threshold type templates

Definition

$$\mathbf{A} \neq 0, \quad r(\mathbf{A}) = 0, \quad \mathbf{B} = 0, \quad z \neq 0$$

Input: Grayscale
Output: Binary

1.4.1 FILBLACK

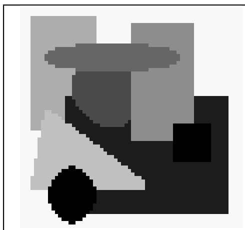
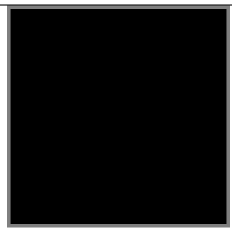
Drives the whole network into black
Old names: `BlackFiller`,`BLACK`,`filblack`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = 4.0$$

Global task

Given:	Static gray-scale image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary (black) image.

Examples

Input	Output
 `avergra2.png`	

1.4.2 FILWHITE

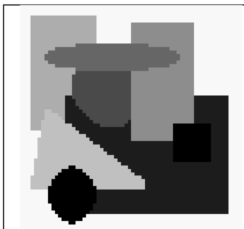
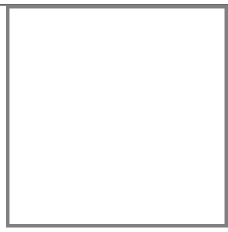
Drives the whole network into white
Old names: `WhiteFiller,WHITE,filwhite`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = -4.0$$

Global task

Given:	Static gray-scale image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary (white) image.

Examples

Input	Output
 `avergra2.png`	

1.4.3 THRES

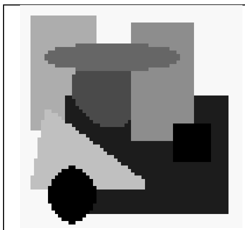
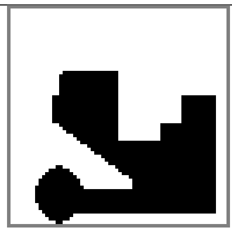
Grayscale to binary threshold template
Old names: `Threshold`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -0.4$$

Global task

Given:	Static gray-scale image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image where black pixels correspond to pixels in **P** with grayscale intensity above the given threshold.

Examples

Input	Output
 `avergra2.png`	

1.5 Erosion type templates

Definition

$$\mathbf{A} = 0, \quad \mathbf{B} \neq 0, \quad r(\mathbf{B}) = 1, \quad z \neq 0$$

Input: Binary
Output: Binary

1.5.1 EROSION

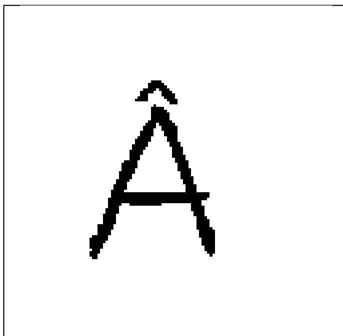
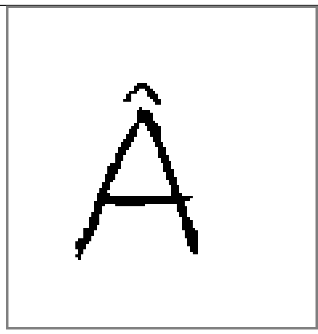
Binary erosion.
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 0.0 & 1.0 & 1.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = -2.0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Fixed(0)
Output:	Binary image representing the result of the erosion operation.

Examples

Input	Output
 `A_LETTER.png`	

1.5.2 TEXTUDIL

Dilation (algo#).
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 1.0 & 1.0 & 1.0 \\ 0.0 & 1.0 & 0.0 \end{bmatrix} \qquad z = 4.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.5.3 TEXTUERO

Erosion (algo#).
Old names:
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 1.0 & 1.0 & 1.0 \\ 0.0 & 1.0 & 0.0 \end{bmatrix} \qquad z = -4.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.6 Diffusion type templates

Definition

$$\mathbf{A} \neq 0, \quad r(\mathbf{A}) = 1, \quad \mathbf{B} = 0, \quad z = 0$$

Input: Grayscale
Output: Grayscale

1.6.1 DIFFUS

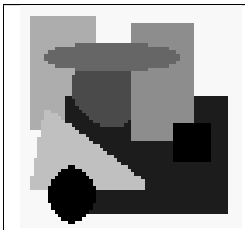
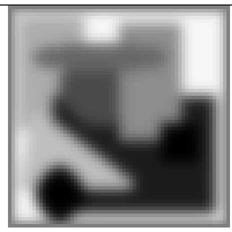
Filtering-reconstruction with heat-diffusion.
Old names: `HeatDiffusion.`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.1 & 0.15 & 0.1 \\ 0.15 & 0.0 & 0.15 \\ 0.1 & 0.15 & 0.1 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:	Static (noisy) gray-scale image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Grayscale image representing the result of the heat diffusion operation.

Examples

Input	Output
 `avergra2.png`	

1.6.2 DIFFUS2

Filtering-reconstruction with heat-diffusion.
Old names: `HeatDiffusion.`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.01 & 0.04 & 0.04 & 0.04 & 0.01 \\ 0.04 & 0.04 & 0.06 & 0.04 & 0.04 \\ 0.04 & 0.06 & 0.08 & 0.06 & 0.04 \\ 0.04 & 0.04 & 0.06 & 0.04 & 0.04 \\ 0.01 & 0.04 & 0.04 & 0.04 & 0.01 \end{bmatrix}$$

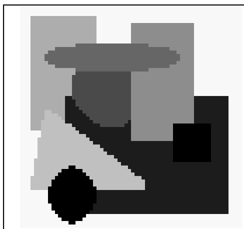
$$\mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix}$$

$$z = 0.0$$

Global task

Given:	Static (noisy) gray-scale image **P**
Input:	-
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Grayscale image representing the result of the heat diffusion operation.

Examples

Input	Output
 `avergra2.png`	

1.6.3 DIFFUS3

Filtering-reconstruction with heat-diffusion.
Old names: `HeatDiffusion.`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.01 & 0.01 & 0.01 & 0.01 & 0.01 & 0.01 & 0.01 \\ 0.01 & 0.02 & 0.02 & 0.02 & 0.02 & 0.02 & 0.01 \\ 0.01 & 0.02 & 0.04 & 0.05 & 0.04 & 0.02 & 0.01 \\ 0.01 & 0.02 & 0.05 & 0.06 & 0.05 & 0.02 & 0.01 \\ 0.01 & 0.02 & 0.04 & 0.05 & 0.04 & 0.02 & 0.01 \\ 0.01 & 0.02 & 0.02 & 0.02 & 0.02 & 0.02 & 0.01 \\ 0.01 & 0.01 & 0.01 & 0.01 & 0.01 & 0.01 & 0.01 \end{bmatrix}$$

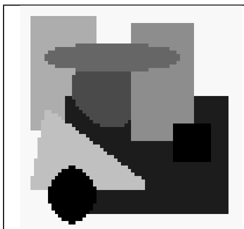
$$\mathbf{B} = \begin{bmatrix} 0 \end{bmatrix}$$

$$z = 0.0$$

Global task

Given:	Static (noisy) gray-scale image **P**
Input:	-
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Grayscale image representing the result of the heat diffusion operation.

Examples

Input	Output
 `avergra2.png`	

1.6.4 LAPLACE

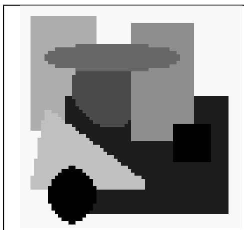
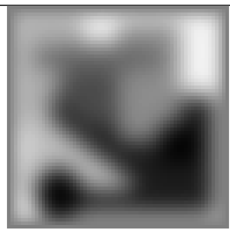
Solves the Laplace PDE (Dx = 0).
Old names: `LaplacePDESolver`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 1.0 & -3.0 & 1.0 \\ 0.0 & 1.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = 0$$

Global task

Given:	Static gray-scale image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Zero-flux
Output:	Gray-scale image - the solution of the Laplace equation.

Examples

Input	Output
 `avergra2.png`	

1.7 Constrained diffusion type templates

Definition

$$\mathbf{A} \neq 0, \quad r(\mathbf{A}) = 1, \quad \mathbf{B} \neq 0, \quad r(\mathbf{B}) = 1, \quad z = 0$$

Input: Grayscale
Output: Grayscale

1.7.1 DIFFUS4

Filtering-reconstruction with constrained heat-diffusion.
Old names: `HeatDiffusion.`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.01 & 0.02 & 0.02 & 0.02 & 0.01 \\ 0.02 & 0.02 & 0.03 & 0.02 & 0.02 \\ 0.02 & 0.03 & 0.04 & 0.03 & 0.02 \\ 0.02 & 0.02 & 0.03 & 0.02 & 0.02 \\ 0.01 & 0.02 & 0.02 & 0.02 & 0.01 \end{bmatrix}$$

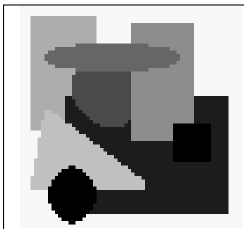
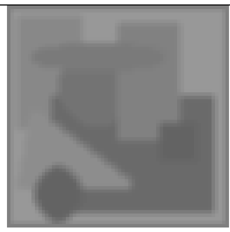
$$\mathbf{B} = \begin{bmatrix} 0.01 & 0.02 & 0.02 & 0.02 & 0.01 \\ 0.02 & 0.02 & 0.03 & 0.02 & 0.02 \\ 0.02 & 0.03 & 0.04 & 0.03 & 0.02 \\ 0.02 & 0.02 & 0.03 & 0.02 & 0.02 \\ 0.01 & 0.02 & 0.02 & 0.02 & 0.01 \end{bmatrix}$$

$$z = 0.0$$

Global task

Given:	Static (noisy) gray-scale image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Grayscale image representing the result of the heat diffusion operation.

Examples

Input	Output
 `avergra2.png`	

1.8 Halftoning type templates

Definition

$$\mathbf{A} \neq 0, \quad r(\mathbf{A}) = 1, \quad \mathbf{B} \neq 0, \quad r(\mathbf{B}) = 1, \quad z = 0$$

Input: Grayscale
Output: Binary

1.8.1 HLF3

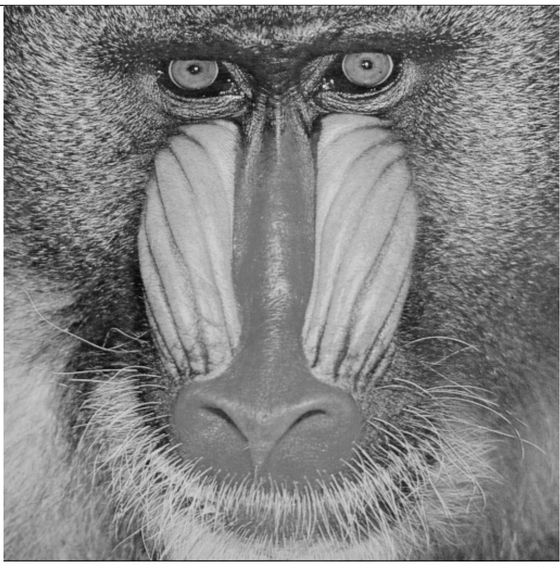
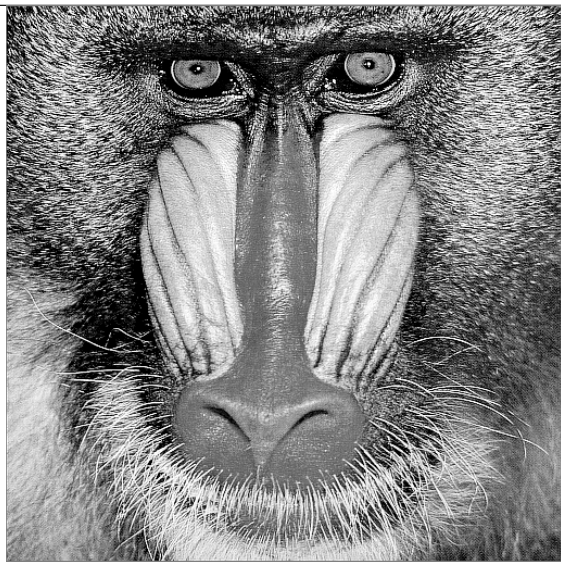
3x3 image halftoning
Old names: `3x3Halftoning,hlf3,HLF33`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} -0.07 & -0.1 & -0.07 \\ -0.1 & 1.03 & -0.1 \\ -0.07 & -0.1 & -0.07 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.07 & 0.1 & 0.07 \\ 0.1 & 0.32 & 0.1 \\ 0.07 & 0.1 & 0.07 \end{bmatrix} \qquad z = 0.0$$

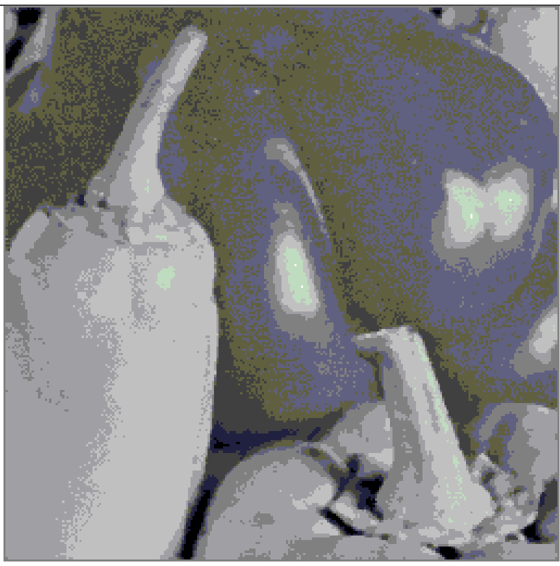
Global task

Given:	Static gray-scale image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image preserving the main features of **P**

Examples

Input	Output
 baboon.png	

Examples

Input	Output
 peppers.png	

1.8.2 HLF5

5x5 image halftoning
Old names: `5x5Halftoning2,HLF55,hlf5`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} -0.0245 & -0.07 & -0.099 & -0.07 & -0.0245 \\ -0.07 & -0.324 & -0.46 & -0.324 & -0.07 \\ -0.099 & -0.46 & 1.05 & -0.46 & -0.099 \\ -0.07 & -0.324 & -0.46 & -0.324 & -0.07 \\ -0.0245 & -0.07 & -0.099 & -0.07 & -0.0245 \end{bmatrix}$$

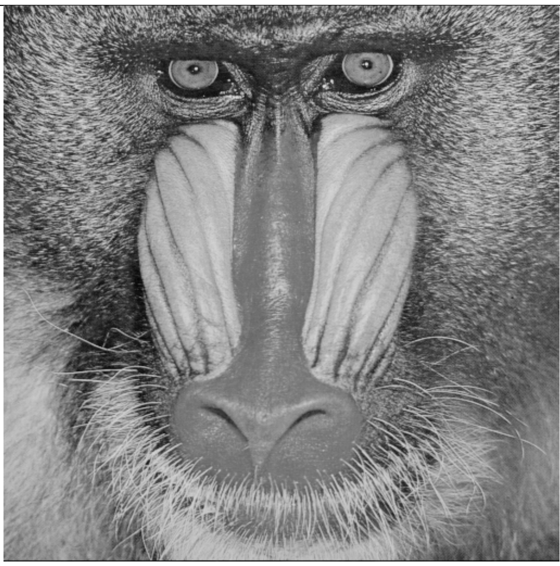
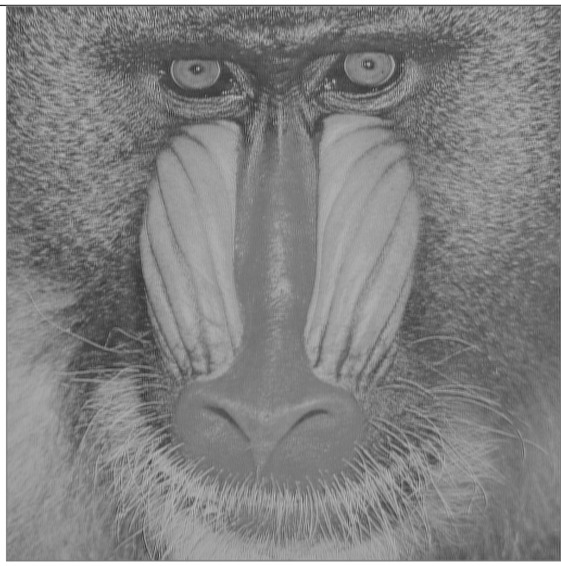
$$\mathbf{B} = \begin{bmatrix} 0.0245 & 0.07 & 0.099 & 0.07 & 0.0245 \\ 0.07 & 0.324 & 0.46 & 0.324 & 0.07 \\ 0.099 & 0.46 & 0.81 & 0.46 & 0.099 \\ 0.07 & 0.324 & 0.46 & 0.324 & 0.07 \\ 0.0245 & 0.07 & 0.099 & 0.07 & 0.0245 \end{bmatrix}$$

$$z = 0.0$$

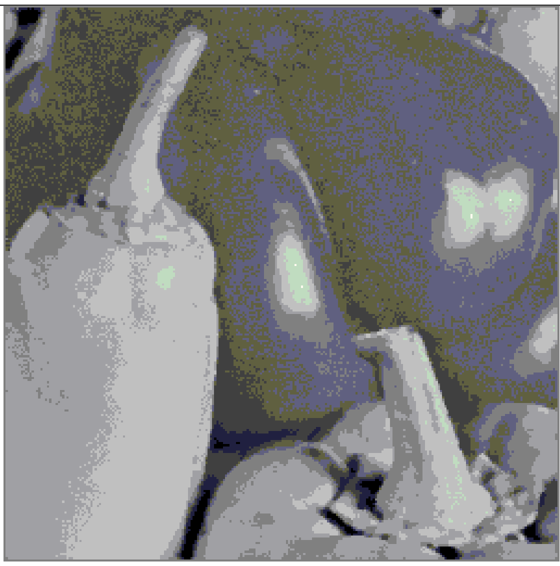
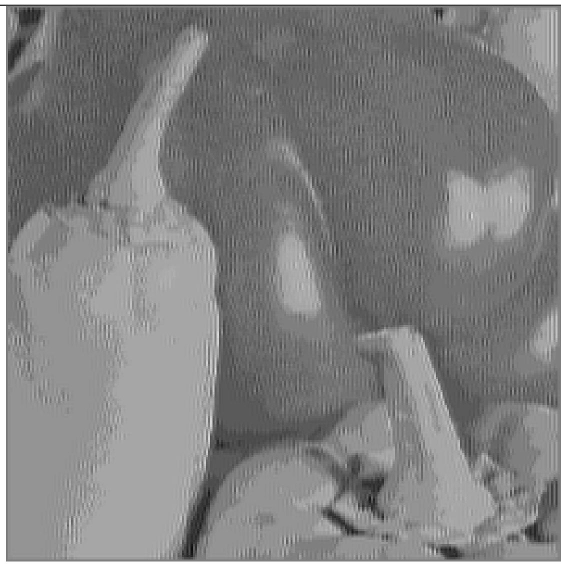
Global task

Given:	Static gray-scale image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image preserving the main features of **P**

Examples

Input	Output
 baboon.png	

Examples

Input	Output
 peppers.png	

1.8.3 HLF5KC

5x5 image halftoning.
Old names: `5x5Halftoning1,hlf5kc,HLF55_KC`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} -0.03 & -0.086 & -0.13 & -0.086 & -0.03 \\ -0.086 & -0.359 & -0.604 & -0.359 & -0.086 \\ -0.13 & -0.604 & 1.05 & -0.604 & -0.13 \\ -0.086 & -0.359 & -0.604 & -0.359 & -0.086 \\ -0.03 & -0.086 & -0.13 & -0.086 & -0.03 \end{bmatrix}$$

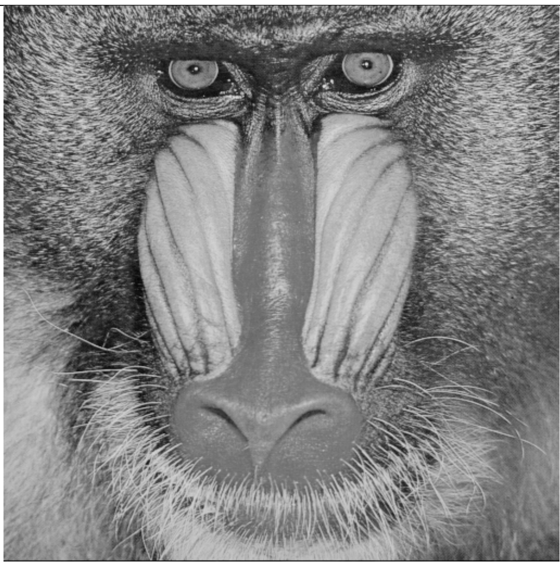
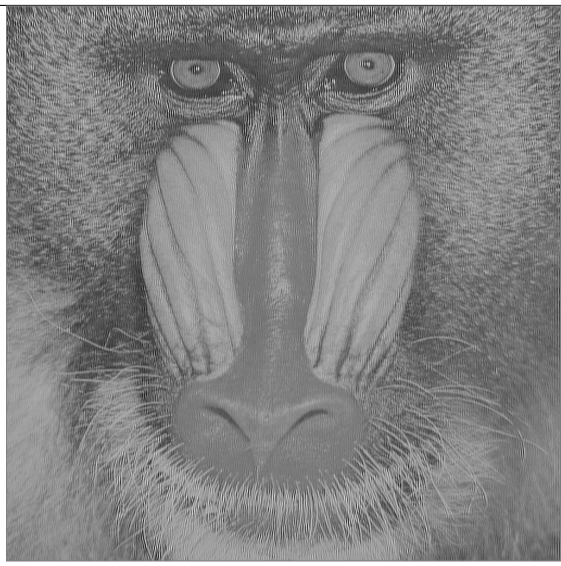
$$\mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.068 & 0.0 & 0.0 \\ 0.0 & 0.355 & 0.756 & 0.355 & 0.0 \\ 0.068 & 0.756 & 2.122 & 0.756 & 0.068 \\ 0.0 & 0.355 & 0.756 & 0.355 & 0.0 \\ 0.0 & 0.0 & 0.068 & 0.0 & 0.0 \end{bmatrix}$$

$$z = 0.0$$

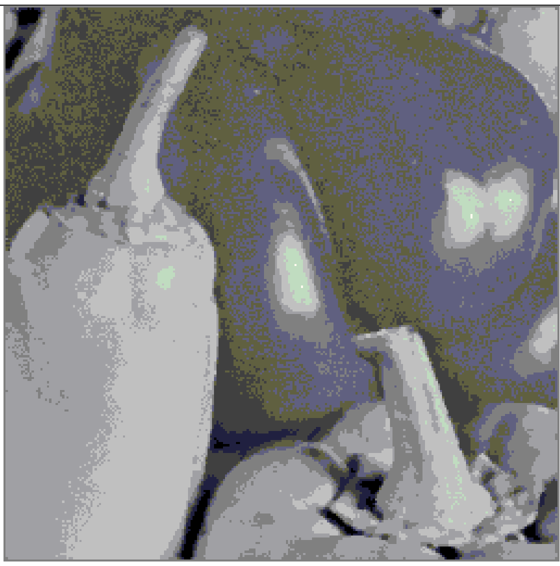
Global task

Given:	Static gray-scale image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image preserving the main features of **P**

Examples

Input	Output
 baboon.png	

Examples

Input	Output
 peppers.png	

1.9 Inverse halftoning type templates

Definition

$$\mathbf{A} = 0, \quad \mathbf{B} \neq 0, \quad r(\mathbf{B}) = 1, \quad z = 0$$

Input: Binary
Output: Grayscale

1.9.1 HERRING

Herring-grid illusion.
Old names: `HerringGridIllusion`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \end{bmatrix}$$

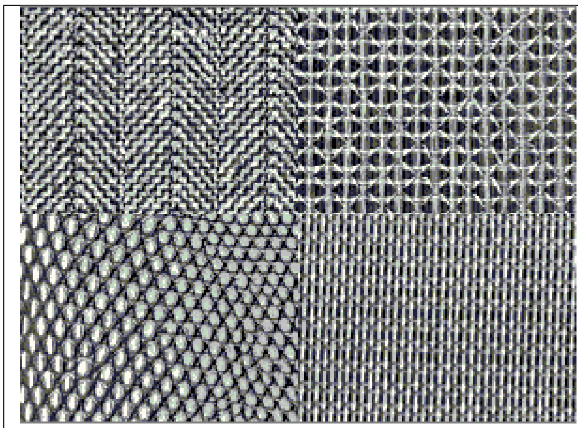
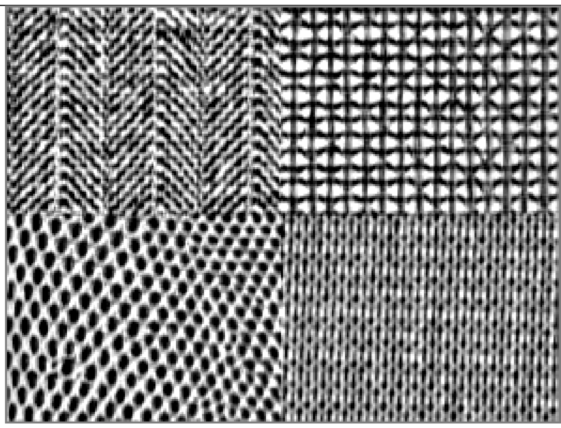
$$\mathbf{B} = \begin{bmatrix} -0.16 & -0.16 & -0.16 & -0.16 & -0.16 \\ -0.16 & -0.4 & -0.4 & -0.4 & -0.16 \\ -0.16 & -0.4 & 4.0 & -0.4 & -0.16 \\ -0.16 & -0.4 & -0.4 & -0.4 & -0.16 \\ -0.16 & -0.16 & -0.16 & -0.16 & -0.16 \end{bmatrix}$$

$$z = 0.0$$

Global task

Given:	Static binary image **P** with a grid of black squares
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Gray-scale image representing **P** with gray patches at the intersections of the grid of black squares.

Examples

Input	Output
	
tx_hclc.png	

1.9.2 INVHLF3

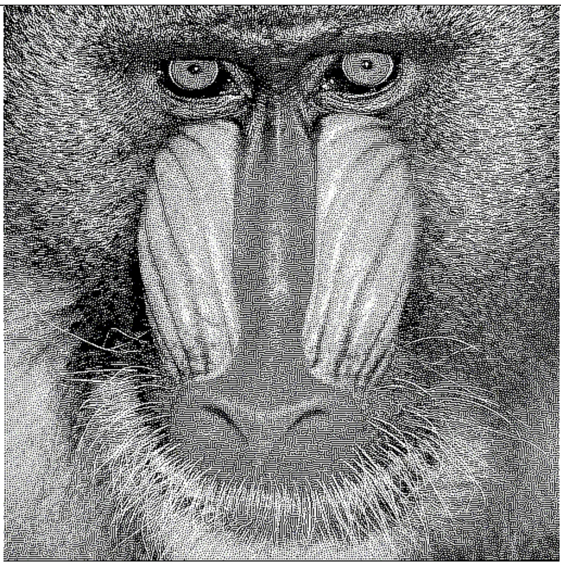
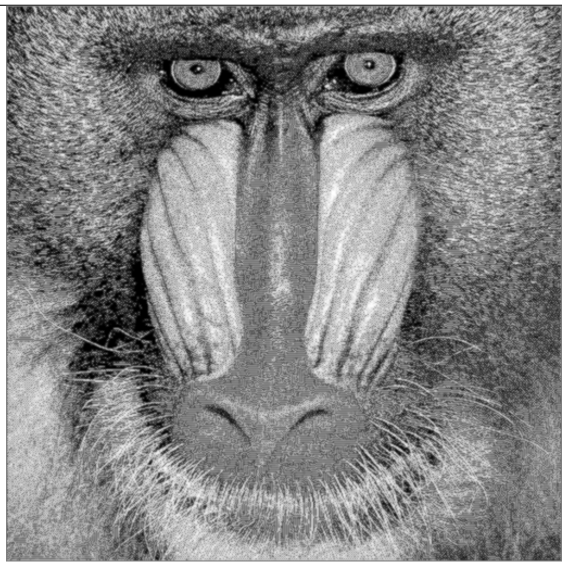
Inverts the halftoned image.
Old names: `3x3InverseHalftoning,INVHLF33,invhlf3`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.07 & 0.1 & 0.07 \\ 0.1 & 0.32 & 0.1 \\ 0.07 & 0.1 & 0.07 \end{bmatrix} \qquad z = 0.0$$

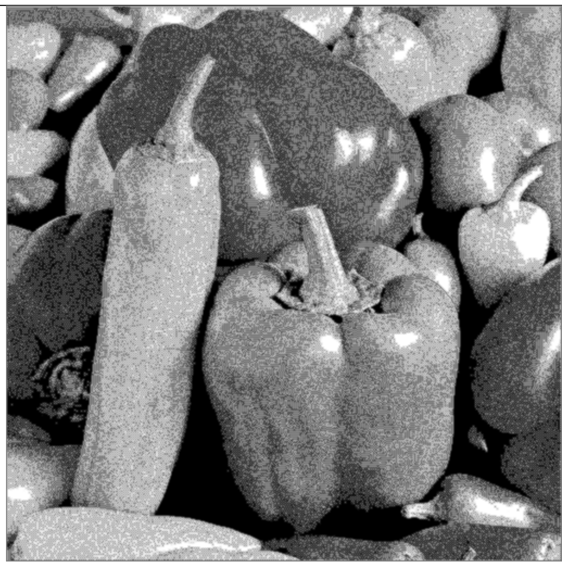
Global task

Given:	Static binary image **P** obtained by using 3x3Halftoning
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Grayscale image representing **P**

Examples

Input	Output
 `invhlf3_1.png`	

Examples

<table>
<tr><th>Input</th><th>Output</th></tr>
<tr><td>
invhlf3_2.png</td><td></td></tr>
</table>

1.9.3 INVHLF5

Inverts the halftoned image.
Old names: `5x5InverseHalftoning,INVHLF55,invhlf5`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 & 0.0 & 0.0 \end{bmatrix}$$

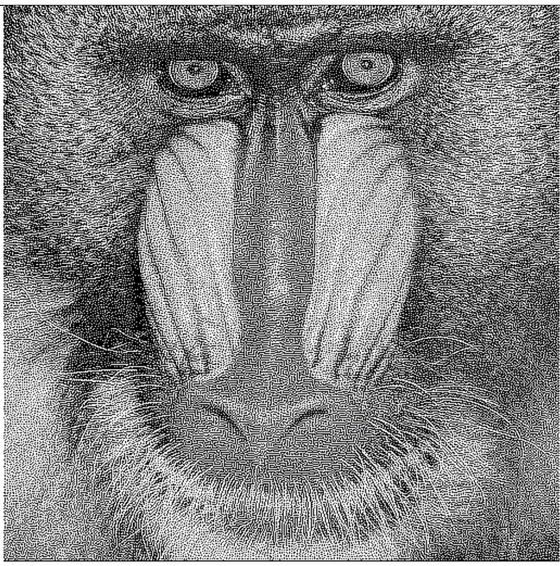
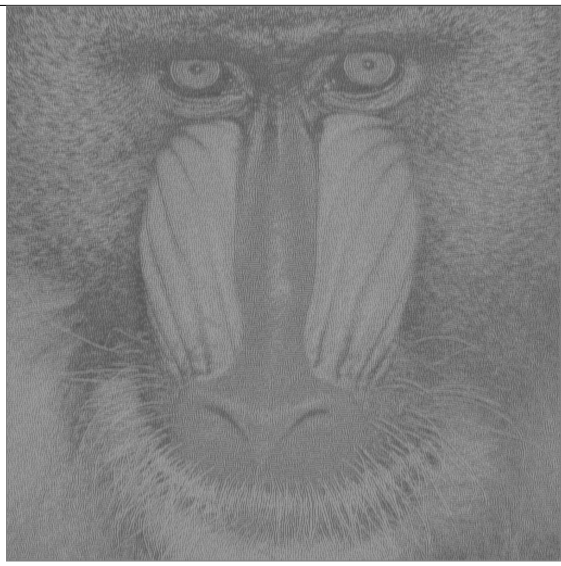
$$\mathbf{B} = \begin{bmatrix} 0.0049 & 0.014 & 0.0198 & 0.014 & 0.0049 \\ 0.014 & 0.0648 & 0.092 & 0.0648 & 0.014 \\ 0.0198 & 0.092 & 0.162 & 0.092 & 0.0198 \\ 0.014 & 0.0648 & 0.092 & 0.0648 & 0.014 \\ 0.0049 & 0.014 & 0.0198 & 0.014 & 0.0049 \end{bmatrix}$$

$$z = 0.0$$

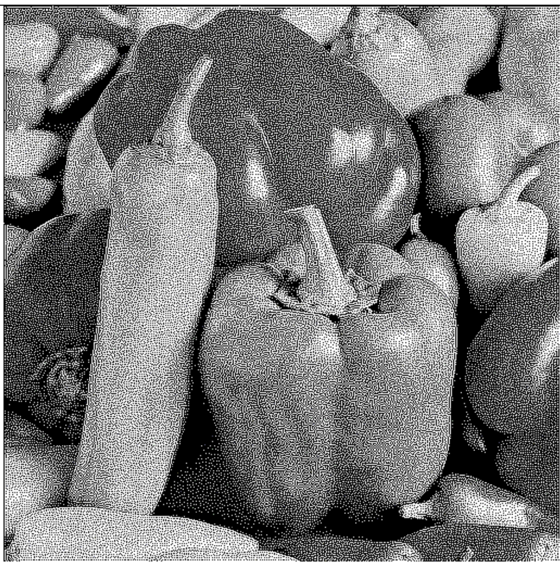
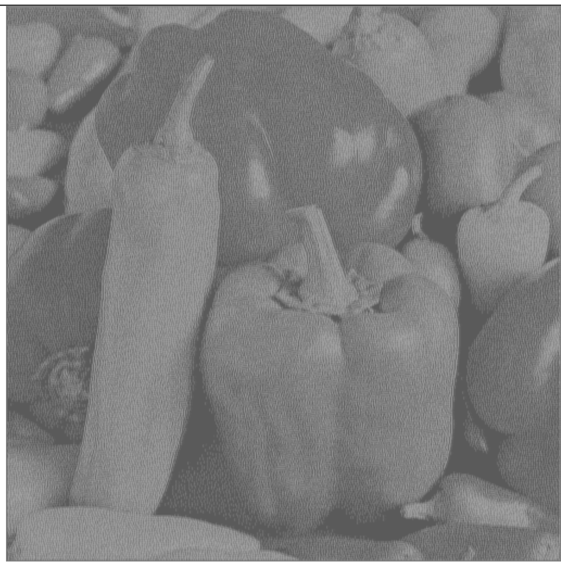
Global task

Given:	Static binary image **P** obtained by using 5x5Halftoning
Input:	**P**
Initial state:	Arbitrary(0)
Boundary condition:	Zero-flux
Output:	Grayscale image representing **P**

Examples

Input	Output
 invhlf5_1.png	

Examples

Input	Output
 invhlf5_2.png	

1.10 CCD type templates

Definition

$$\mathbf{A} \neq 0, \quad r(\mathbf{A}) = 1, \quad \mathbf{B} = 0, \quad z = 0$$

Input: Binary
Output: Binary

1.10.1 CCD_DIAG

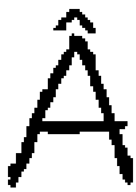
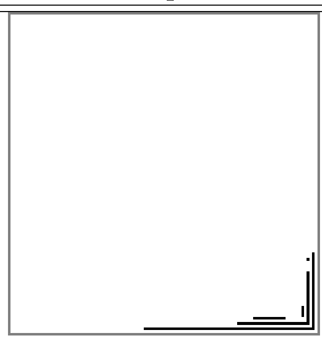
Diagonal connected component detection.
Old names: `DiagonalHoleDetection,DiagonalCCD`
Available in: Candy

$$\mathbf{A} = \begin{bmatrix} 1.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & -1.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:	Static binary image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image that shows the number of diagonally connected components in **P**

Examples

Input	Output
 `a_letter.png`	

1.10.2 CCD_HOR

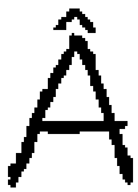
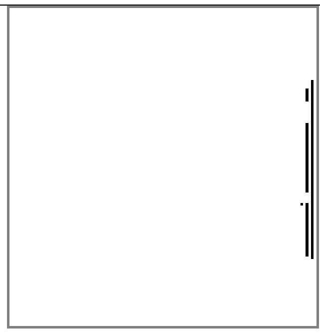
Horizontal connected component detection.
Old names: `HorizontalCCD,HorizontalHoleDetection,ccd_hor,HorizontalCCD,CCD_HOR`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 1.0 & 2.0 & -1.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = 0$$

Global task

Given:	Static binary image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image that shows the number of horizontally connected components in **P**

Examples

Input	Output
 `a_letter.png`	

1.10.3 CCD_hor_l

no description
Old names:
Available in: AladdinPro

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ -1.0 & 2.0 & 1.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.10.4 CCD_hor_r

no description
Old names:
Available in: AladdinPro

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 1.0 & 2.0 & -1.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.10.5 Ccd_NE

no description
Old names:
Available in: AladdinPro

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & -1.0 \\ 0.0 & 2.0 & 0.0 \\ 1.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.10.6 Ccd_NW

no description
Old names:
Available in: AladdinPro

$$\mathbf{A} = \begin{bmatrix} -1.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & 1.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.10.7 Ccd_SE

no description
Old names:
Available in: AladdinPro

$$\mathbf{A} = \begin{bmatrix} 1.0 & 0.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 0.0 & -1.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.10.8 Ccd_SW

no description
Old names:
Available in: AladdinPro

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.0 & 1.0 \\ 0.0 & 2.0 & 0.0 \\ -1.0 & 0.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.10.9 CCD_VERT

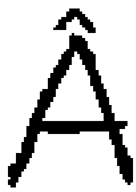
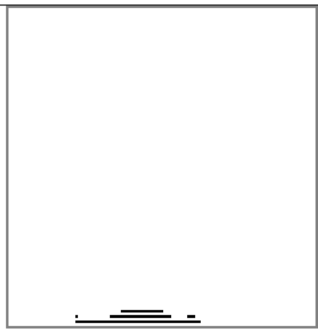
Vertical connected component detection.
Old names: `VerticalCCD`,`VerticalHoleDetection`,`ccd_vert`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & -1.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = 0$$

Global task

Given:	Static binary image **P**
Input:	Arbitrary(0)
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image that shows the number of vertically connected components in **P**

Examples

Input	Output
 `a_letter.png`	

1.10.10 Ccd_vert_down

no description
Old names:
Available in: AladdinPro

$$\mathbf{A} = \begin{bmatrix} 0.0 & 1.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & -1.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.10.11 Ccd_vert_top

no description
Old names:
Available in: AladdinPro

$$\mathbf{A} = \begin{bmatrix} 0.0 & -1.0 & 0.0 \\ 0.0 & 2.0 & 0.0 \\ 0.0 & 1.0 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

1.10.12 SMKILLER

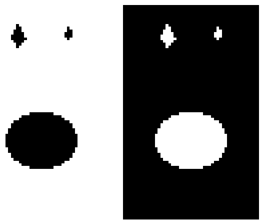
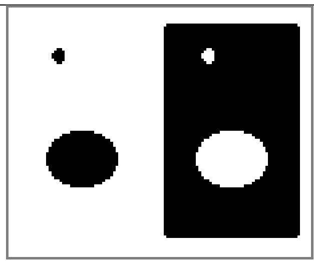
Deletes small objects.
Old names: `SmallObjectRemover,smkiller`
Available in: Template Library v3.1, Candy

$$\mathbf{A} = \begin{bmatrix} 1.0 & 1.0 & 1.0 \\ 1.0 & 2.0 & 1.0 \\ 1.0 & 1.0 & 1.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0 \end{bmatrix} \qquad z = 0$$

Global task

Given:	Static binary image **P**
Input:	**P**
Initial state:	**P**
Boundary condition:	Fixed(0)
Output:	Binary image representing **P** without small objects.

Examples

Input	Output
 `smkiller.png`	

1.10.13 WErosion

no description
Old names:
Available in: AladdinPro

$$\mathbf{A} = \begin{bmatrix} 0.0 & 0.5 & 0.0 \\ 0.5 & -1.1 & 0.5 \\ 0.0 & 0.5 & 0.0 \end{bmatrix} \qquad \mathbf{B} = \begin{bmatrix} 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \\ 0.0 & 0.0 & 0.0 \end{bmatrix} \qquad z = 0.0$$

Global task

Given:
Input:
Initial state:
Boundary condition:
Output:

Index