

Climb

A Generic and Dynamic Approach to Image Processing

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Introduction

- ▶ Climb: Common Lisp image processing
- ▶ Same Genericity as Olena¹
- ▶ With more Interactivity

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

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Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Erosion Definition

"All the pixels are replaced by the minimum value of the pixels around."

Erosion

Definition

Naive Version

Genericity Issues

Final Version

Morpher

Morpher Definition

Content Morpher

Combination

Demonstration

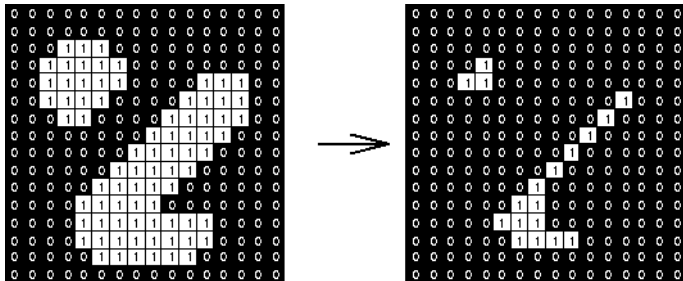
Conclusion

Conclusion

Questions

Bibliography

Erosion Example



<http://homepages.inf.ed.ac.uk/rbf/HIPR2/erode.htm>

Erosion

Definition

Naive Version

Genericity Issues

Final Version

Morpher

Morpher Definition

Content Morpher

Combination

Demonstration

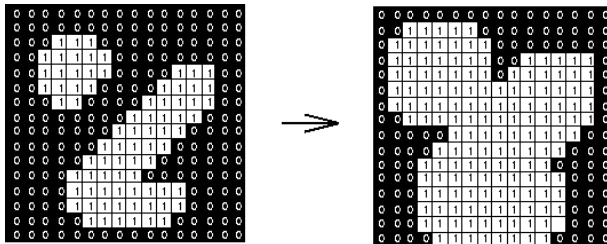
Conclusion

Conclusion

Questions

Bibliography

Dilation Example



<http://homepages.inf.ed.ac.uk/rbf/HIPR2/dilate.htm>

Erosion

Definition

Naive Version

Genericity Issues

Final Version

Morpher

Morpher Definition

Content Morpher

Combination

Demonstration

Conclusion

Conclusion

Questions

Bibliography

Naive Boolean 2D Version

```
// Loop through all the valid image pixels
for (x = 0; x < img.width; ++x)
  for (y = 0; y < img.height; ++y)

    // Initialize the output image
    new_image[x][y] = TRUE;

    // Loop through all the neighborhood pixels
neighborhood:
  for (i = -neighb_width; i <= neighb_width; ++i)
    for (j = -neighb_height; j <= neighb_height; ++j)
      if ((x + i >= 0 && x + i < img.width) &&
          (y + j >= 0 && y + j < img.height))

        /* Algorithm */
        if (old_image[x + i][y + j] == FALSE)
          new_image[x][y] = FALSE;
          break neighborhood;
```

Erosion

- Definition

- Naive Version**

- Genericity Issues

- Final Version

Morpher

- Morpher Definition

- Content Morpher

- Combination

Demonstration

Conclusion

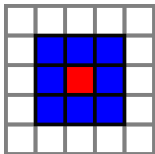
- Conclusion

- Questions

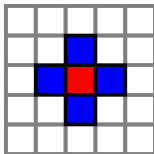
- Bibliography

Genericity Issues

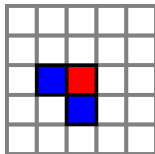
- ▶ Image Structure
- ▶ Neighborhood



8-connectivity



4-connectivity



Custom

- ▶ Algorithm
 - Difference between erosion and dilation? Min / Max
 - Accumulator
 - Black Box: Many inputs, Compute a result
- ▶ Value Type
 - Bool, Gray, RGB, ...
 - Specialize the Accumulator

Erosion

Definition

Naive Version

Genericity Issues

Final Version

Morpher

Morpher Definition

Content Morpher

Combination

Demonstration

Conclusion

Conclusion

Questions

Bibliography

Final Version

```
(defun erosion (img neighb)  
  (image-map img  
    (accu-reduce neighb  
      (min-accu))))
```

- ▶ Readable Algorithm
- ▶ Small Functions: Easily Unit Testable
- ▶ Extensible
- ▶ Write Once, Support Everything

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version**

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

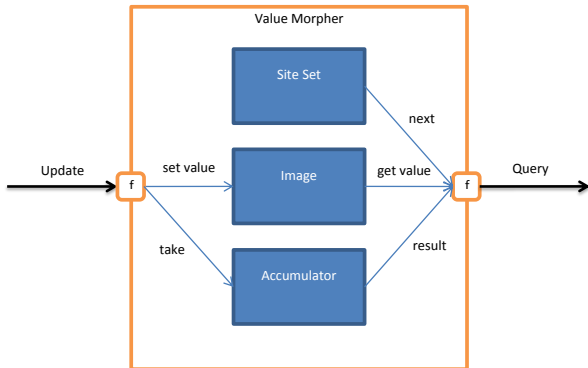
Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Definition

- ▶ Alter communication protocol
- ▶ Non intrusive, Transparent, Memory Free
- ▶ Glue between Objects



Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

RGB to Gray Implementation

```
(make-direct-value-morpher-image  
  image  
  (lambda (gray) (vector gray gray gray))  
  (lambda (rgb) (/ (reduce #'+ rgb) 3)))
```

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

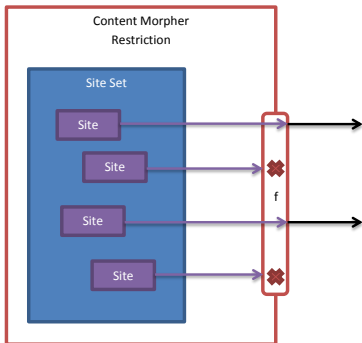
Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Content Morpher

- ▶ Work on Sets
- ▶ Restriction



- Custom-shaped Site Set
- Cropped Image
- ▶ Addition
 - Image Border
- ▶ Ordering

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

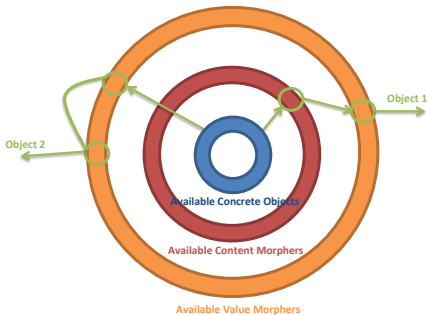
- Morpher Definition
- Content Morpher**
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Combination



- ▶ Possibilities: Combination of ...
 - Concrete Objects
 - Value Morpher
 - Content Morpher
 - Repetition

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Demonstration

```
(defparameter lena (load-image "lena.png" :magick))

(defparameter gray
  (make-direct-value-morpher-image lena
    (lambda (gray) (vector gray gray gray))
    (lambda (rgb) (/ (reduce #'+ rgb) 3))))

(defparameter c8 (make-box (make-point -1 -1) (make-point 1 1)))
(defparameter c4 (site-set-mask c8 #*010111010))

(defparameter ero (erosion gray c4))
(defparameter dil (dilation gray c4))
(defparameter diff (image-combine-values #'- dil ero))

(defparameter final (image-combine-values
  (lambda (rgb edge)
    (if (> edge 50) (vector 255 0 0) rgb))
  lena diff))

(save-image final "final.png" :png)
```



Lena



Gray



Erosion



Dilation



Diff



Final

Erosion

- Definition

- Naive Version

- Genericity Issues

- Final Version

Morpher

- Morpher Definition

- Content Morpher

- Combination

Demonstration

Conclusion

- Conclusion

- Questions

- Bibliography

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Conclusion

- ▶ Personal Additions:
 - Fusion of Olena Concepts with Functionnal and Dynamic Programming
 - Developer Friendly
- ▶ Current
 - Basic Morphological Operators
 - Morpher System
- ▶ Future
 - Genericity on Value Types
 - More Algorithms and Image Types
 - Performance

Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography

Questions

Questions ?



Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions**
- Bibliography

Bibliography

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Erosion

- Definition
- Naive Version
- Genericity Issues
- Final Version

Morpher

- Morpher Definition
- Content Morpher
- Combination

Demonstration

Conclusion

- Conclusion
- Questions
- Bibliography