Saffron 3.1

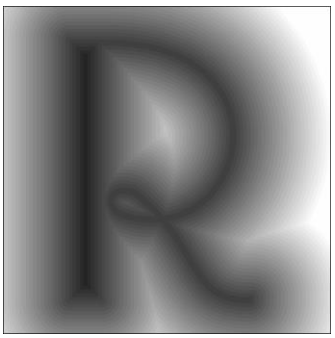
Continuous Stroke Modulation

January 26, 2007

Distance Fields

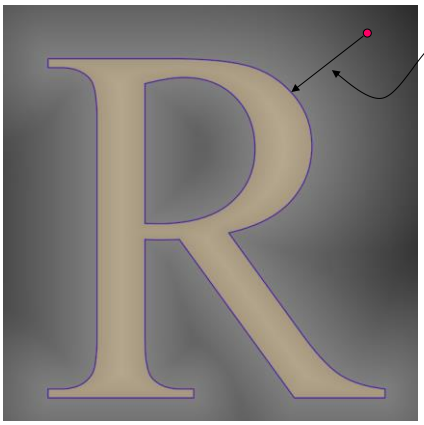
- What is a distance field?
  - The 2D distance field of a shape represents, for any point in space, the signed minimum distance from that point to the edge (i.e., outline) of the shape

Shape

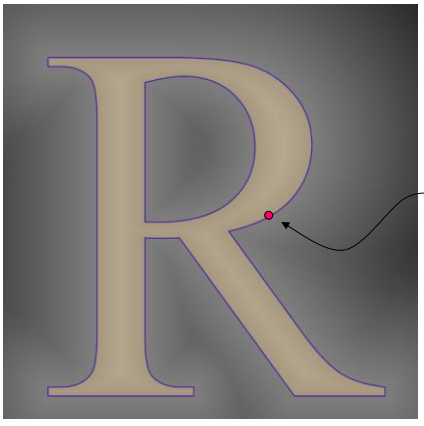


Shape's distance field

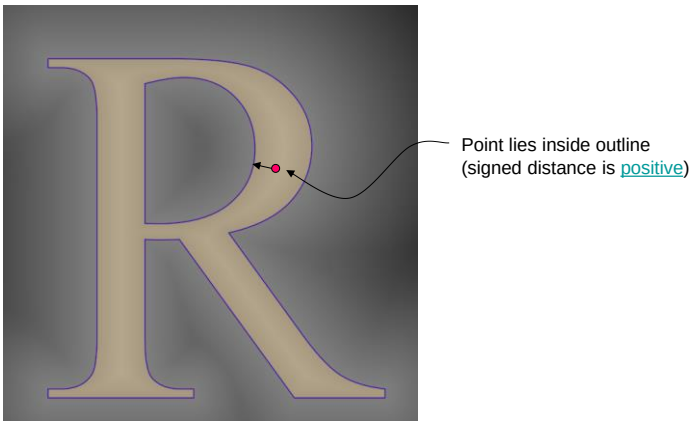
Example #1



Example #2

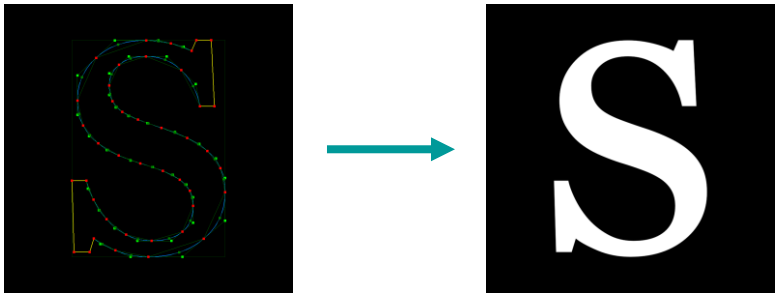


Example #3



Glyph Rendering

- Rasterize glyph outline using image samples



Outline description

Image pixels

Glyph Rendering

- For each image sample
  - Compute distance from sample to closest point on outline

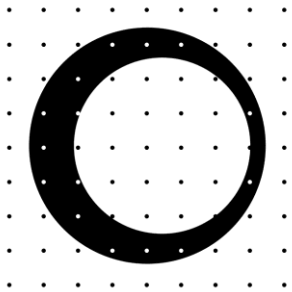
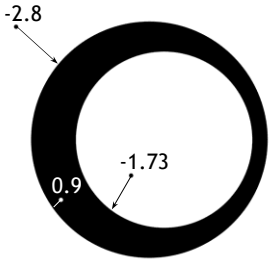


Image samples



Distances from image samples
to closest points on outline

Distances and Densities

- -2.8, -1.73, and 0.9 are signed distance values
- We want 8-bit density values in [0,255]
- How to map distance values to density values?

Continuous Stroke Modulation

- Four CSM parameters:
  - Outside cutoff
  - Inside cutoff
  - Gamma
  - Color reduction

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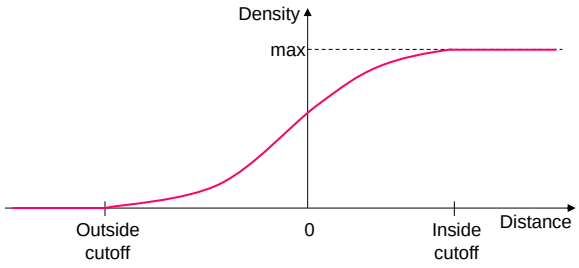
Most important

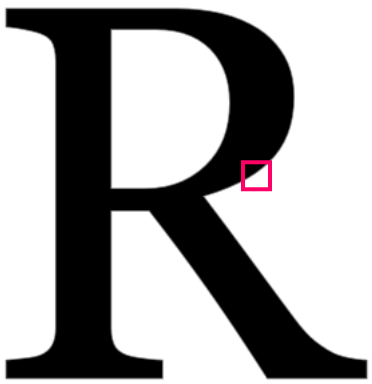
Least important (always set to 1.0)

Outside and Inside Cutoff

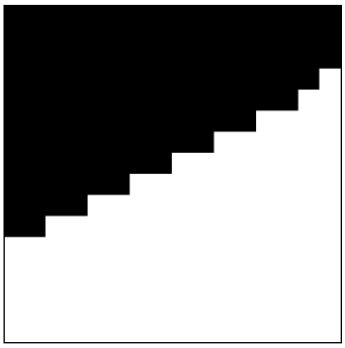
- Map distances < OC to minimum density (0)
- Map distances > IC to maximum density (255)
- Map distances in [OC,IC] to densities in [0,255]



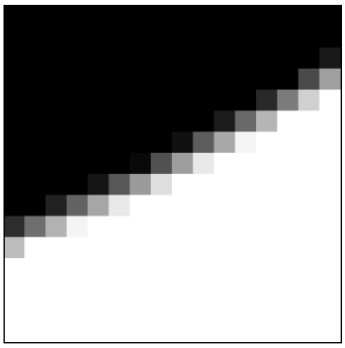
Distance-Based Antialiasing



Distance-Based Antialiasing



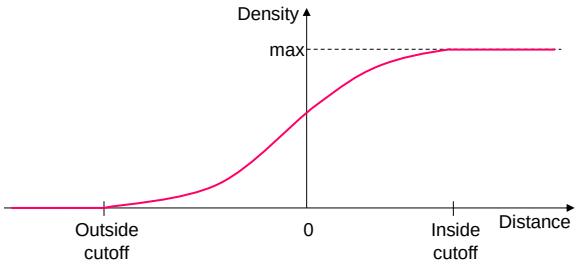
Outside cutoff equal to inside cutoff
(binary bitmap)



Outside cutoff = -0.8
Inside cutoff = +0.8
(grayscale antialiased bitmap)

Conventions

- Outside cutoff ≤ inside cutoff
- Outside cutoff ≤ 0
- Inside cutoff ≥ 0



Choosing Cutoff Values

- What are the "correct" cutoff values?
- Competing goals:
  - Maximize clarity (sharpness, edge contrast)
  - Minimize aliasing (jaggies, sampling artifacts)

Appearance Is Subjective

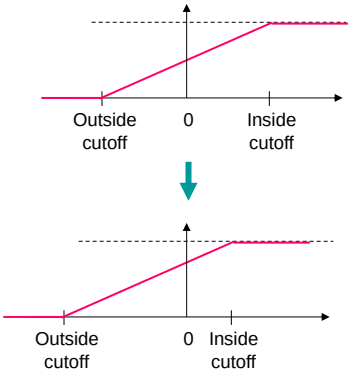
- Several factors:
  - Font design
  - Display resolution
  - Pixels per em
  - User preferences

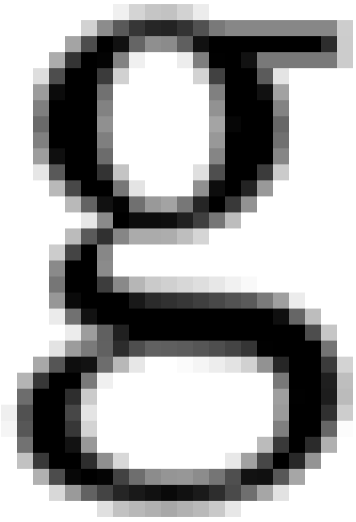
Classical Antialiasing

- Coverage-based antialiasing options:
  - Filter choice (box, tent, Gaussian, etc.)
  - Filter position
  - Filter radius
  - Isotropic vs. anisotropic (oriented) filters
- Each parameter affects appearance

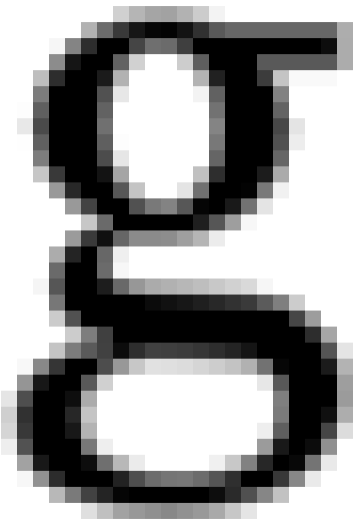
Example #1

- Decrease both outside and inside cutoff
  - Analogy: move filter position outwards
  - Makes glyph thicker





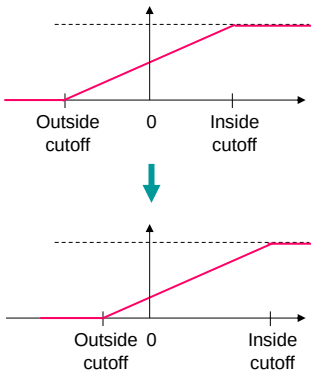
Normal

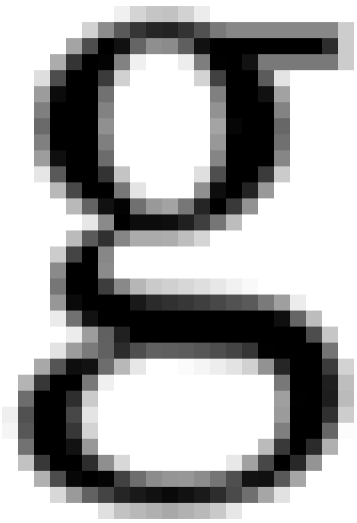


Thicker

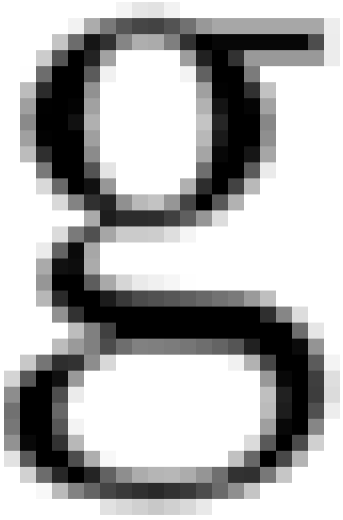
Example #2

- Increase both outside and inside cutoff
  - Analogy: move filter position inwards
  - Makes glyph thinner





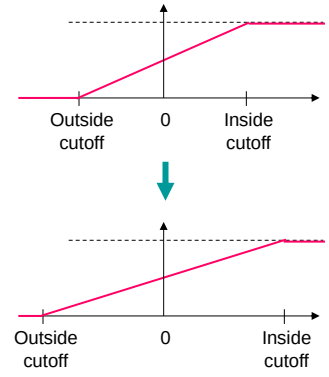
Normal

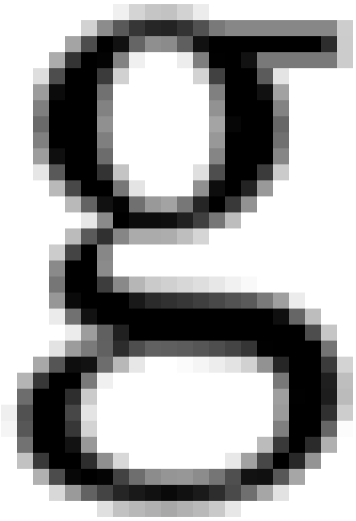


Thinner

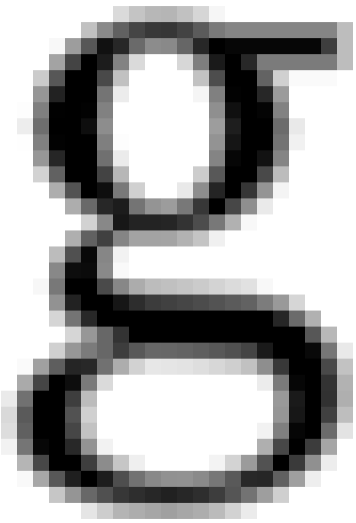
Example #3

- Decrease outside cutoff, increase inside cutoff
  - Analogy: increase filter width
  - Makes glyph edges softer





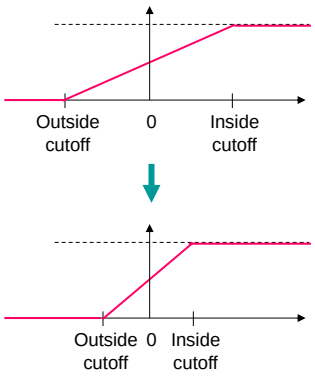
Normal

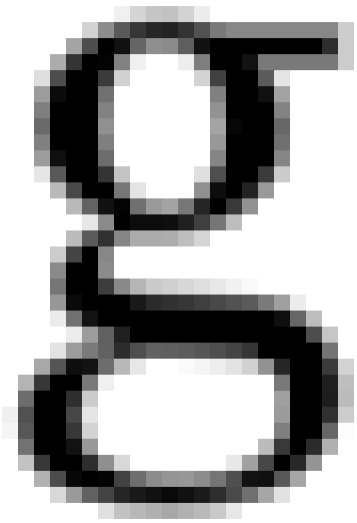


Softer

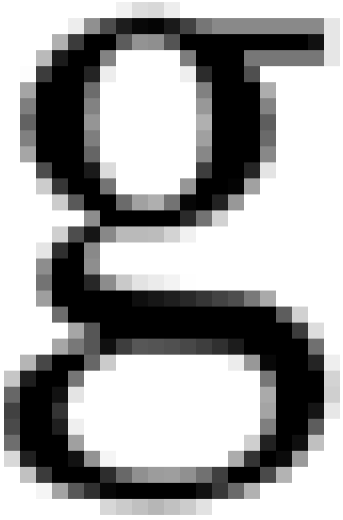
Example #4

- Increase outside cutoff, decrease inside cutoff
  - Analogy: decrease filter width
  - Makes glyph edges sharper





Normal



Sharper

Cutoff Value Summary

Outside Cutoff	Inside Cutoff	Effect
↓	↓	Thicker
↑	↑	Thinner
↓	↑	Softer
↑	↓	Sharper

Continuous Stroke Modulation

- Four CSM parameters:
  - Outside cutoff
  - Inside cutoff
  - Gamma
  - Color reduction

Gamma

- Executive summary: always set gamma to 1.0

Gamma

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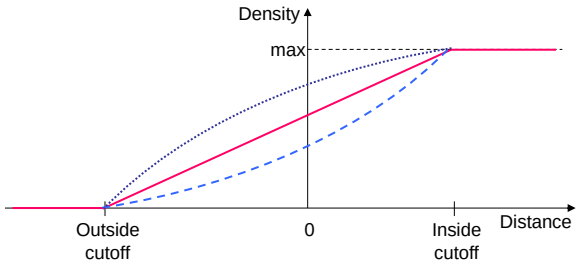
- Affects distribution curve of densities in [0,255]
- Gamma of 1.0 means linear distribution



Gamma

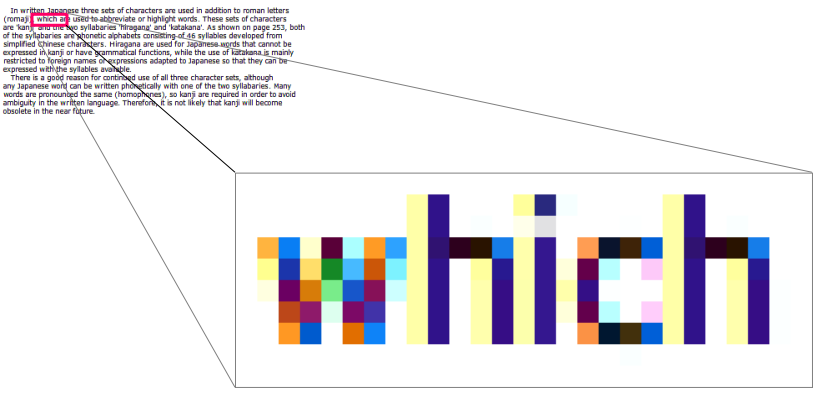
- Gamma used to help mitigate color fringing
  - Not needed for Saffron 3.0
  - Gamma ≠ 1.0 means performance penalty

Color Reduction

- Principle of LCD rendering
  - Use separate samples at red, green, blue component locations
  - Trade off color accuracy for spatial resolution

Color Reduction

- Problem: LCD rendering produces color fringes



Color Reduction

Color Reduction Benefits

- Minimizes color fringing
- Makes tuning CSM parameters much easier

Color Reduction Control

- Two controls:
  - On/Off
  - Amount (0: minimal, 1: maximum)
- Recommendations:
  - Enable color reduction
  - Set amount to 0.5

Saffron API Settings

- ADFRenderAttrs data structure:
  - ADF_F32 insideCutoff;
  - ADF_F32 outsideCutoff;
  - ADF_F32 gamma;
  - ADF_U32 useColorReduction;
  - ADF_F32 colorReductionAmt;

Saffron CSM Tuner

CSM Real-World Scenario #1

- Limitation information available
  - Don't know which typeface will be used
  - Don't know the target display resolution
- Solution: Use a table of "general" CSM values
  - Table contains CSM values for common point sizes
  - Derive CSM values for other point sizes by interpolation
- We have developed a table that we can give you
  - Early work, but results are good

CSM Real-World Scenario #2

- Memory-constrained devices
  - Examples: PDAs, cell phones
- Zero-footprint "bold" and "thin" capability
  - Simply use "thicker" and "thinner" CSM parameter variations
  - No additional memory, no performance loss

CSM Real-World Scenario #3

- The more you know, the better
  - Closed environments (e.g., consoles, PDAs, cell phones)
  - Target device (e.g., specific cell phone model and screen)
  - Typeface (e.g., core system font on a specific cell phone)
- Can tune CSM parameters for best results