

Implementation Notes on Nitro

- Through extensive testing we found that 8 bit integer distances are sufficient for high quality rendering and therefore replace the previously used 32 bit floating point or fixed point distances
- No separate distance buffer is required - the target 8 bit density image is used instead
- These two changes provide big gains in performance by significantly reducing memory access
- No distances are ever computed during rendering - everything is precomputed and stored in lookup tables - thereby providing another big win in performance
- Line and corner cells are not required and therefore not constructed, thereby saving considerable setup time
- CSM cutoff values are typically limited to [-1.5, 1.5], allowing the required lookup tables (e.g., for computing distances) to be very small in size (3KB for a CSM configuration)
- When a CSM table is created for a specified CSM configuration, three LUTs are computed for (1) processing horizontal and vertical lines, (2) stamping an N x N matrix of distance values along the silhouette of the glyph, and (3) mapping intermediate distance values to their corresponding final density values
- Conceptual rendering steps include
 - Clearing the target density image to zero
 - Stamping and combining an N x N matrix of distance values along the silhouette of the glyph
 - Processing the interior of the glyph by inverting the interior distance values
 - Mapping the distance values to their corresponding final density values
- A stamp stores the distances to the silhouette of the glyph for a region (e.g., a circle) of pixels centered on the silhouette
- Stamps are computed and stored at subpixel resolution
- Combining determines the minimum distance
- If stamp distances are scaled between 0 (for a maximum distance) and 128 (for a minimum zero distance), inverting computes $255 - d$ (or $\sim d$) for a given distance d
- If the CSM configuration is symmetric, the final mapping is unnecessary
- Horizontal and vertical sections of the silhouette are not stamped and instead are anti-aliased directly using a LUT
- Sections of the silhouette with an angle in the range [45, 135] degrees or [225, 315] degrees are not stamped and instead are anti-aliased directly when processing the interior of the glyph by using corrected projected distances
- We have several variations on the rendering steps outlined above (and their corresponding data structures) which
 - Avoid the mapping step even when the CSM configuration is asymmetric
 - Minimizes the code size to as little as 37 KB
 - Minimizes RAM usage to as little as 15 KB