Closing the Distance Between CPU and GPU with Signed Distance Fields
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1. Some Concepts

2. Signed Distance Fields

3. Use Cases
2D Rendering: The Postscript Model

- Dominant 2D rendering model for at least 30 years.
- Essentially models a 2D plotter.
- Used by major APIs like QPainter and Canvas.
3D Rendering: The GPU

- Practically every modern computer has one.
- Massively parallel.
- Originally designed to accelerate 3D.
Programmable Shaders

- Small programs that get executed by the GPU.
- Written in GLSL or other shading language.
- Various stages exist corresponding to different parts of pipeline.

```glsl
// Vertex Shader
uniform mat4 modelViewProjection;
in vec4 vertexPosition;
void main()
{
    gl_Position = vertexPosition * modelViewProjection;
}

// Fragment Shader
out vec4 color;
void main()
{
    color = vec4(1.0, 0.0, 0.0, 1.0);
}
```
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The Problem

It would be nice if we could use the GPU to accelerate rendering complex 2D items.

But The PostScript model is inherently serial, while the GPU is massively parallel.

So We need a new rendering model for 2D shapes.
Example: Circle

\[ sdf(\vec{p}) = \|\vec{p}\| - r \]

Where:

\( \vec{p} \) is a 2D vector in range \((-1, 1)\)

\( r \) is the radius of the circle.
Turning Math to Image

\[ sdf(\vec{p}) = \|\vec{p}\| - r \]

A  \[ \vec{p} = \begin{pmatrix} 0.0 \\ 0.5 \end{pmatrix} \]  Distance = 0.0
B  \[ \vec{p} = \begin{pmatrix} 0.75 \\ 0.75 \end{pmatrix} \]  Distance = 0.56
C  \[ \vec{p} = \begin{pmatrix} -0.25 \\ -0.25 \end{pmatrix} \]  Distance = -0.15
On the GPU

```cpp
uniform float radius;
uniform vec4 color;

in vec2 uv;

out vec4 out_color;

void main()
{
    float distance = length(uv) - radius;
    out_color = vec4(distance);
}
```
uniform float radius;
uniform vec4 color;
in vec2 uv;
out vec4 out_color;

void main()
{
    float distance = length(uv) - radius;
    out_color = distance > 0.0 ? vec4(0.0) : color;
}
uniform float radius;
uniform vec4 color;
in vec2 uv;
out vec4 out_color;

void main()
{
    float distance = length(uv) - radius;
    out_color = mix(color, vec4(0.0), clamp(distance * 100.0, 0.0, 1.0));
}
Operations

- Translate
- Rotate
- Scale
- Union
- Subtract
- Intersect
- Annular
- Round
- Outline
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1. Some Concepts

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Rendering Circles

- Rendering circles is a tricky problem in 3D graphics.
- Standard geometric approach provides an approximation.
Pie Charts
Line Charts
Kirigami’s Cards

Title Alignment

The title can be aligned to all corners or centered with a combination of Qt.Alignment flags. When there are too many actions, they go in an overflow menu.

It’s possible to have custom contents overlapping...
ShadowedTexture
New Cards

Title Alignment

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Action1  Action2  Action3
Putting It Together
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https://iquilezles.org/

Links
KQuickCharts https://invent.kde.org/framework/kquickcharts/
Kirigami https://invent.kde.org/framework/kirigami/
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