Assignment #2: 2D Scalar Field Visualization
COSC 6344 Visualization
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University of Houston

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Exercise 1

1.1 Generation of blue-white-red (BWR) color scheme using HSV color space

Algorithm 1 BWR Pseudocode

Require: Set of Scalar Values S
Require: Maximum Scalar Value s_{Max}, Minimum Scalar Value s_{Min}
Require: Hue h, Saturation sat, Value v
Ensure: $[sMin, sMax] - > [0, 1]$ ▷ Normalized Scalar values

```
v ← 1
for all s ∈ S do
    if s ≤ 1/2 then
        h ← 240
        sat ← (s − s_Min) / (s_Max − s_Min)
    else if s > 1/2 then
        h ← 0
        sat ← (1 − (s − s_Min) / (s_Max − s_Min))
    end if
end for
```

1.2 Heatmap generation using RGB color space

Algorithm 2 Heatmap Pseudocode

Require: Set of Scalar Values S
Require: Maximum Scalar Value s_{Max}, Minimum Scalar Value s_{Min}
Require: Red R, Green G, Blue B
Ensure: $[sMin, sMax] -> [0, 1]$ ▷ Normalized Scalar values

```
for all s ∈ S do
    if s ≤ 1/3 then
        R ⟵ 3.0 × s
        G ⟵ 0
        B ⟵ 0
    else if s > 1/3 & s ≤ 2/3 then
        R ⟵ 1
        G ⟵ 1.5 × s
        B ⟵ 0
    else if s > 2/3 then
        R ⟵ 1
        G ⟵ 1
        B ⟵ 1 × s
    end if
end for
```

1.3 Limitations of the Rainbow color scheme

- Difficult and unintuitive to quantify colour, i.e. determine which value is higher/lower
- Dynamic range of the rainbow colour scheme has difficulty in representing all data equally
- "Transitions between some colors, green and red, for example, occur very rapidly visually, leading to false contrast." Source: Lecture 5

1.4 Pseudo-code of Marching Squares algorithm

Algorithm 3 Marching Square Algorithm

Require: Set of Scalar Values S
Require: Set of iso-values S^*
  for all $s^* \in \mathcal{S}^*$ **do**
    for all Squares $S_q \in \mathcal{S}$ **do**
      Intersection Counter $i \leftarrow 0$
      for all Edges $s_i \in \mathcal{S}_q$ **do**
        if $s_0 == s_1$ **then**
          if $s_0 == s^*$ **then**
            $Connect(Intersection(S_0, S_3), Intersection(S_2, S_3))$
          else if $s_0 \neq s^*$ **then**
            $Connect(S_0, S_1)$
          end if
        else if $s_0 > s^* \& s_1 < s^* \& s^* > s_2 \& s^* < s_3$ **then**
          $M \leftarrow \frac{s_0+s_1+s_2+s_3}{4}$
          if $s^* > M$ **then**
            $Connect(Intersection(S_0, S_1), Intersection(S_1, S_3))$
            $Connect(Intersection(S_0, S_2), Intersection(S_2, S_3))$
          else if $s^* < M$ **then**
            $Connect(Intersection(S_0, S_1), Intersection(S_0, S_2))$
            $Connect(Intersection(S_1, S_3), Intersection(S_2, S_3))$
          end if
        else if $s_0 < s^* < s_1 \| s_1 < s^* < s_0$ **then**
          $i \leftarrow i + 1$
        end if
      end for
      if $i == 2$ **then**
        $Connect(Intersection(S_0, S_1))$
      end if
    end for
  end for

Exercise 2

The assignment was done using

1. Python *3.8.3*
2. vtk *9.0.3*
3. PyQt5 *5.15.4*
4. VS Code *1.60.2*

2.1 BWR Colour Scheme

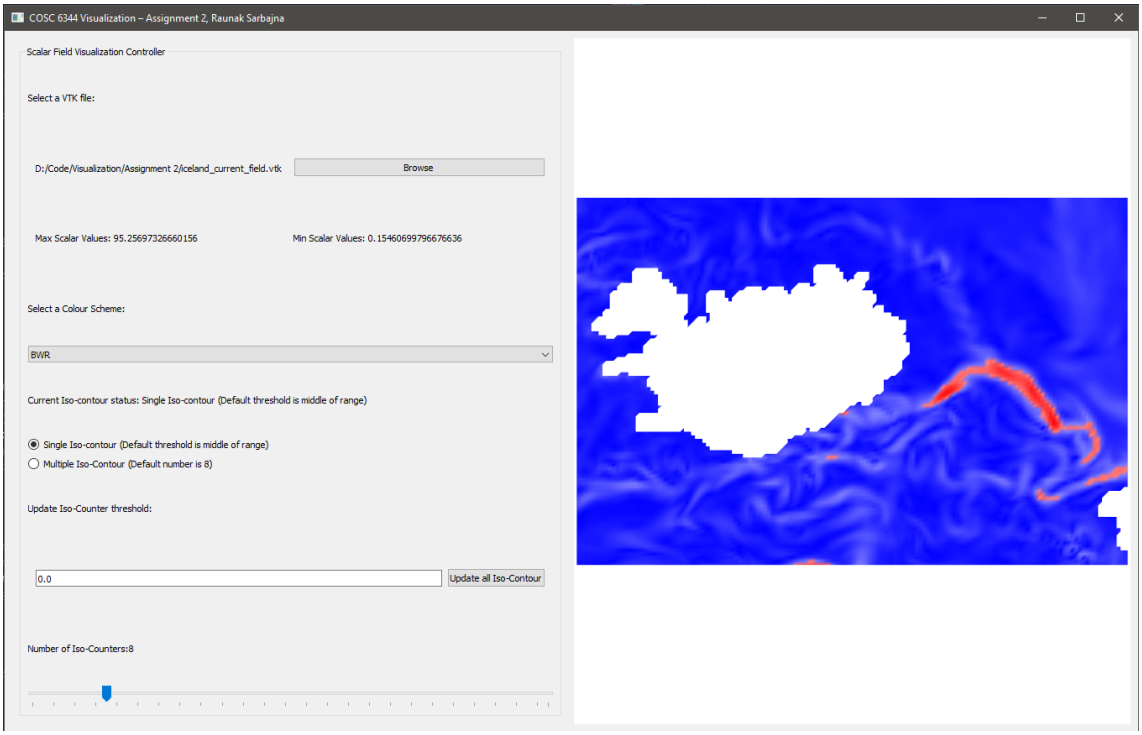

Figure 1: **Screenshot of PyQt5 application showing Black White and red colour scheme applied to the "Iceland" dataset**

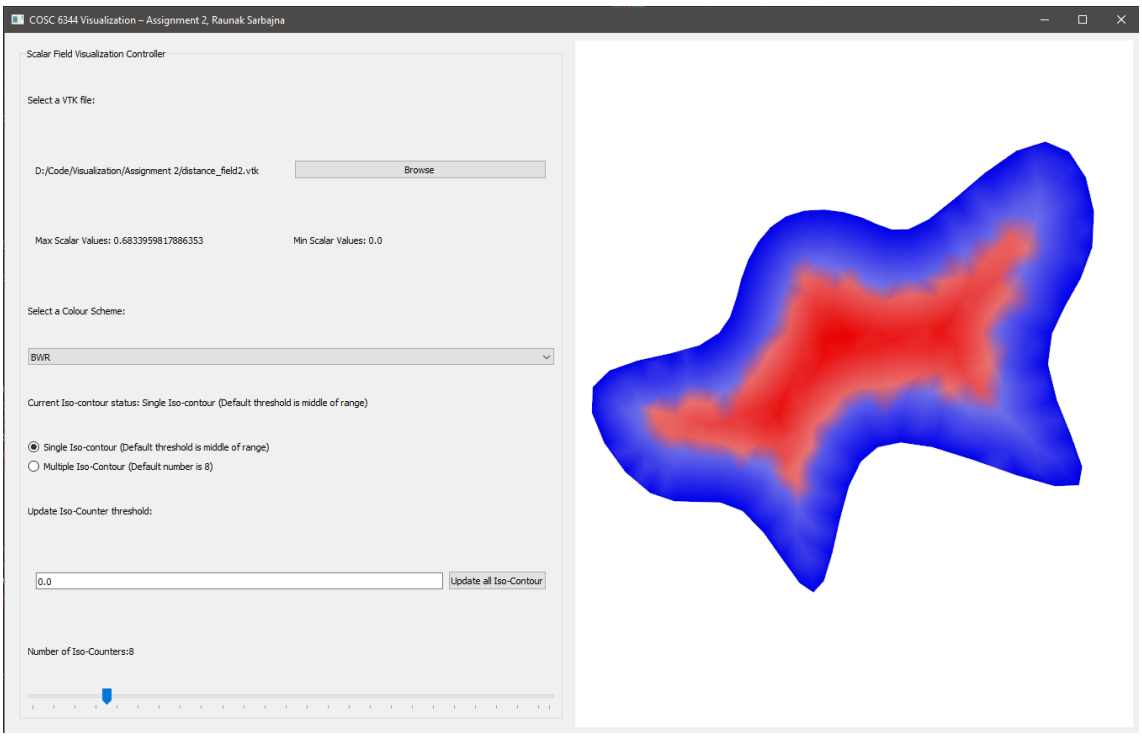

Figure 2: **Screenshot of PyQt5 application showing Black White and red colour scheme applied to the "distance field 2" dataset**

2.2 Heatmap Colour Scheme

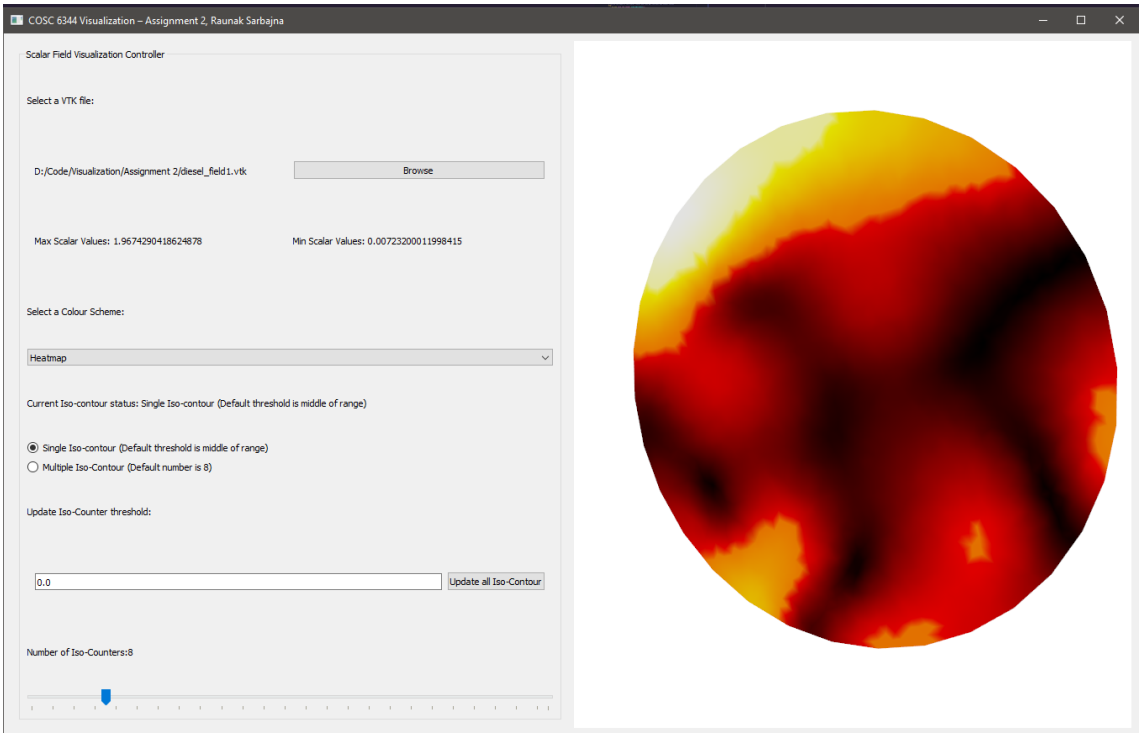

Figure 3: **Screenshot of PyQt5 application showing heatmap colour scheme applied to the "Diesel Field 1" dataset**

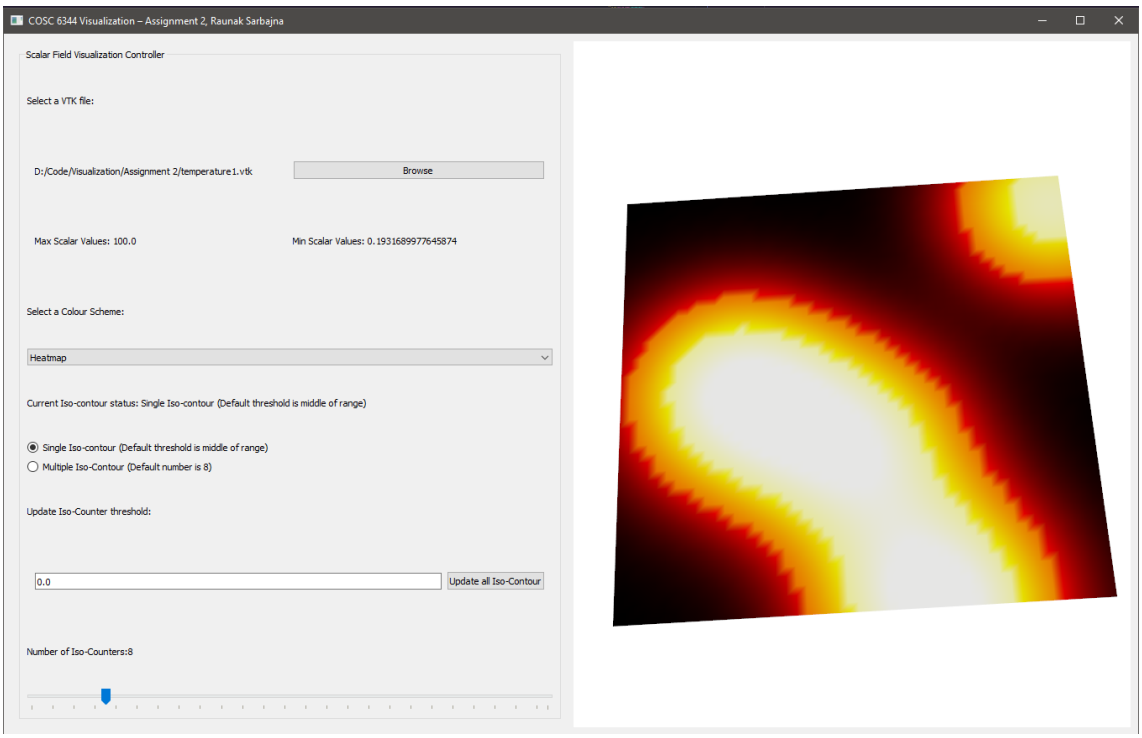

Figure 4: **Screenshot of PyQt5 application showing Black White and red colour scheme applied to the "Temperature 1" dataset**

Exercise 3

The scalar range of each dataset is visible in the UI. The iso-value and the number of contours are both changeable in the UI.

3.1 Single Iso-Contour

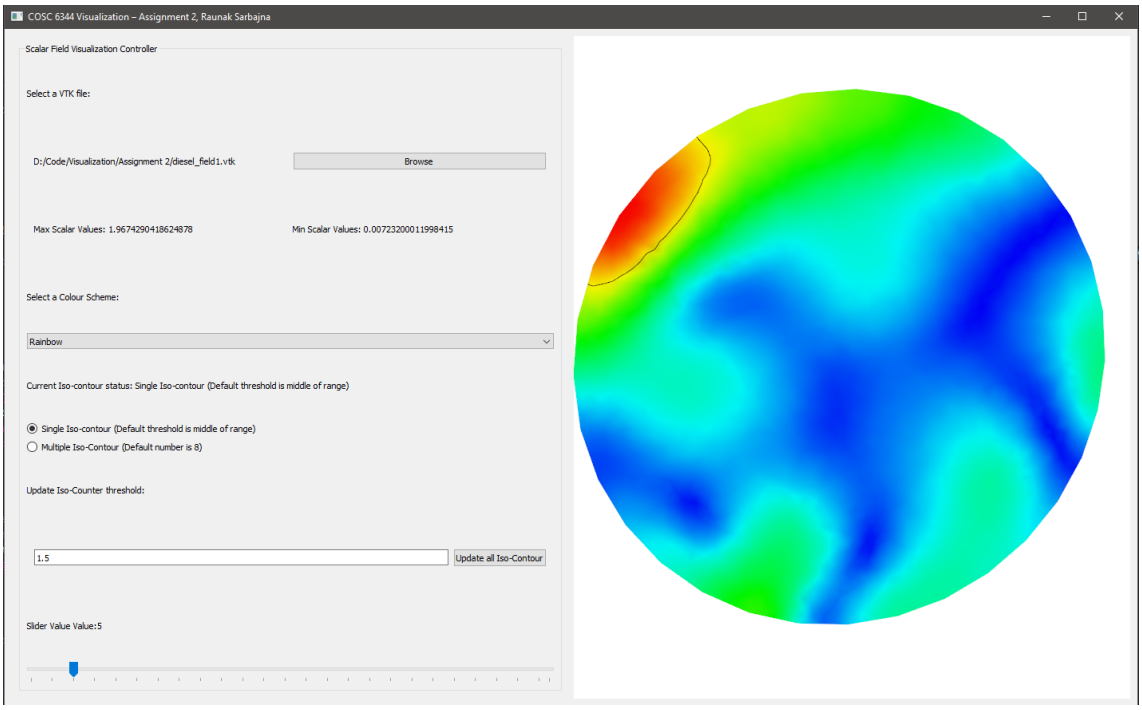

Figure 5: **Screenshot of PyQt5 application showing single iso-contour applied to the "Diesel Field 1" dataset with an iso-value of** 1.5

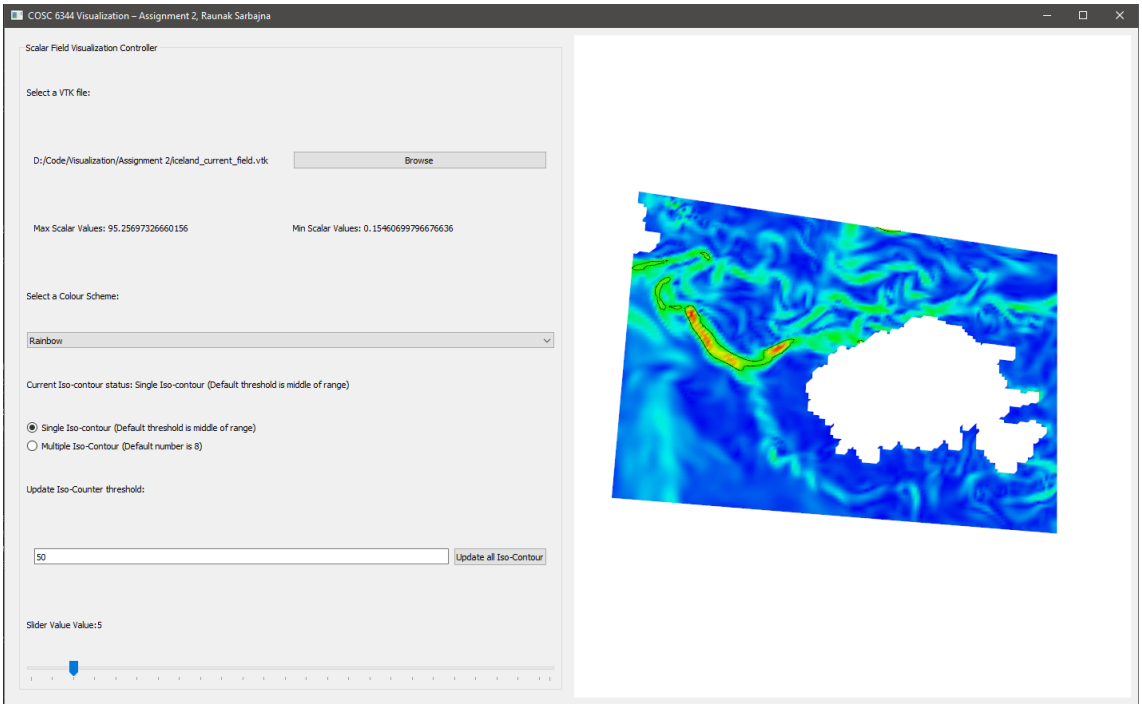

Figure 6: **Screenshot of PyQt5 application showing single iso-contour applied to the "Iceland" dataset with an iso-value of** 50

3.2 Multiple Iso-Contours

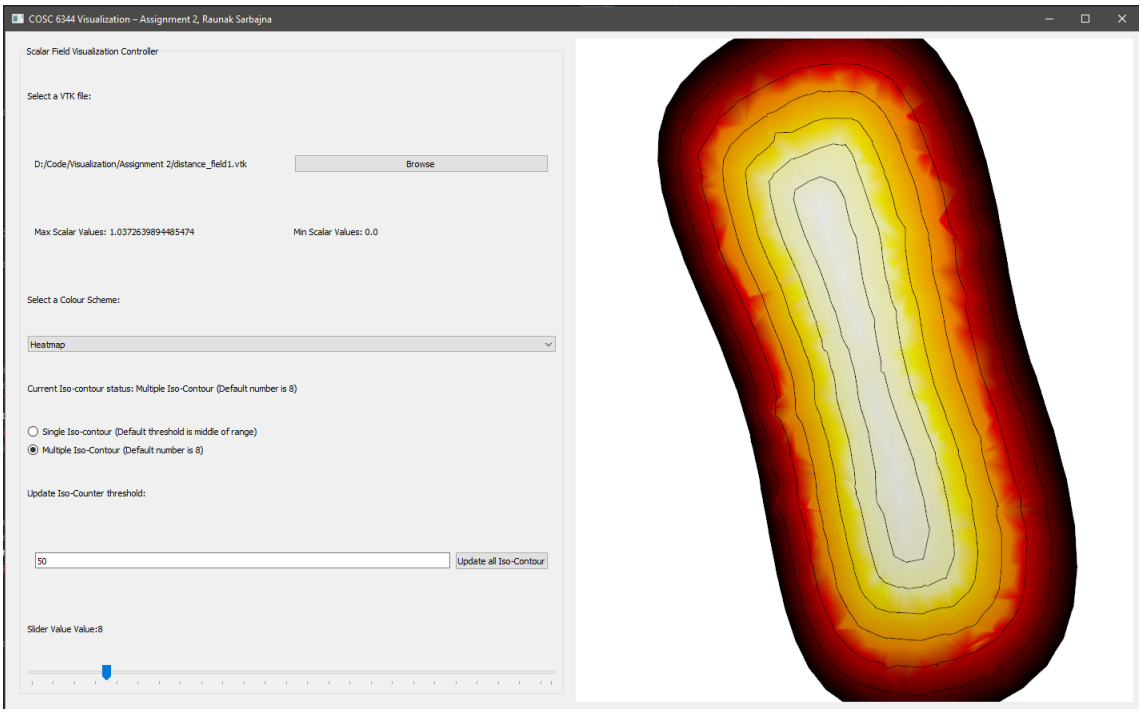

Figure 7: **Screenshot of PyQt5 application showing "Distance Field 1" dataset with** 8 **iso-contours visible**

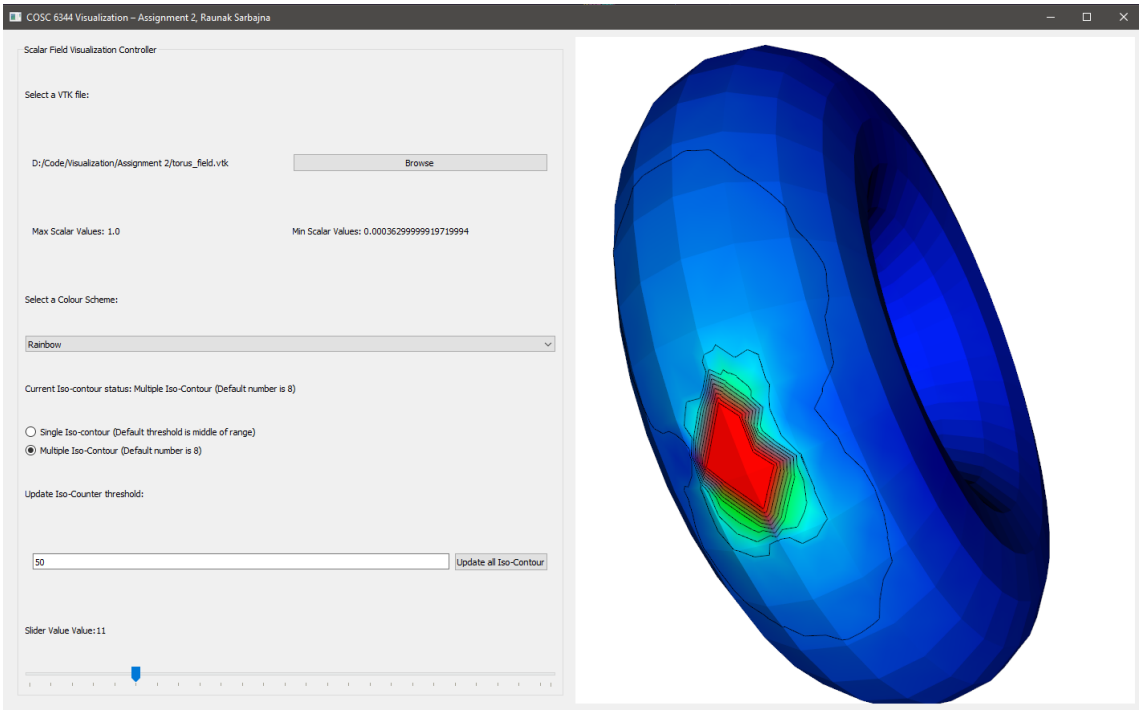

Figure 8: **Screenshot of PyQt5 application showing "Torus" dataset with 1 iso-contours visible**