

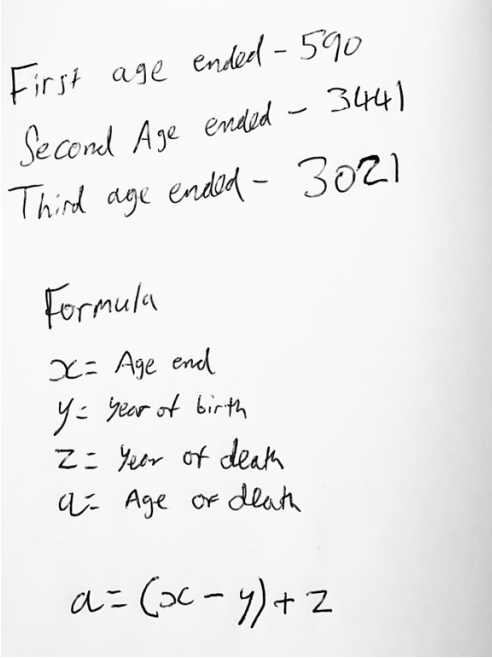
To enhance the Tolkien theme the outside of the circular arcs shows an image of the inscription from the One Ring, written in the fiery letters of Black Speech, this image was sketched in Photoshop and imported into Processing. This piece was also inspired by the iconography of the Eye of Sauron; hence the art piece appears eye shaped and similarly 'wreathed in flame' in a way.

Techniques Used

To create the Data Art piece, many methods were employed:

Data processing:

Before the data could be used, it had to be properly adapted for the processing scripts. This was done by calculating the age of death for each of the selected characters from the dataset, this had to be done since the original dataset did not have values for age of death. This was completed by subtracting the character's year of birth from their year of death, although this couldn't be done for all characters due to the changeover of the Third Age to the Fourth Age of Middle Earth, when the year would change from 3021 TA (Third Age) to 1 FO (Fourth Age), this was rectified through use of this simple formula:



First age ended - 590
Second Age ended - 3441
Third age ended - 3021

Formula

x = Age end
 y = year of birth
 z = year of death
 a = Age of death

$$a = (x - y) + z$$

Once the age of death had been determined for each character, some more data that was not included in the original dataset had to be retrieved, that being the average age of death for each race, this data was obtained through internet sources such as [LOTR Fanon - Fandom](#) and [Tolkien Gateway](#). Once all the data was collected it was organised into a separate spreadsheet:

Character	Race	Age of Death	Average Life Span	Angle		Colour (RGB)
Frodo Baggins	Hobbit	53	100	100.8	Red/Brown	200, 48, 35
Samwise Gamgee	Hobbit	102	100	277.2	Orange/Ginger	200, 111, 29
Aragorn	Men/Dúnedain	210	170	354.7	Black/Blue	0, 57, 117
Peregrin Took	Hobbit	96	100	255.6	Green/Brown	135, 154, 44
Meriadoc Brandybuck	Hobbit	104	100	284.4	Yellow/Orange	238, 206, 0
Gimli	Dwarf	262	195	393.7	Burgundy/Brown	120, 42, 29
Théoden	Men	71	80	229.5	Blonde/Red	203, 152, 0
Boromir	Men/Dúnedain	41	111	43	Red/Black	91, 16, 26
Bilbo Baggins	Hobbit	131	100	381.6	Red/White	161, 83, 81
Faramir	Men/Dúnedain	120	111	299.2	Green/Grey	92, 105, 68
Éomer	Men	93	80	328.5	Blonde/Brown	176, 139, 103
Denethor	Men/Dúnedain	89	111	198.6	Grey/Black	81, 81, 81

The angle quadrants in Processing had an offset of 90° so the positive y-axis started at -90° instead of 0°, to account for this when calculating the necessary angles for each character, the formula of $\theta^\circ = (360 * (x / y)) - 90$ was used where x is the age of death, and y is the average lifespan, the subsequent values would be ready to use within Processing.

The characters were also sorted highest to lowest based on their screen-time in the films.

A colour palette was also selected in the spreadsheet, signifying what the colours of the character circles would be, labelled with their RGB number for simple transfer to Processing.

Arcs:

The primary shapes used in the art piece were arcs, in Processing, the arc() function was used to accomplish this. The angles made in the spreadsheet were assigned to the *character_nameEnd* variables since this is the angle where the arc will stop. The colours for the arcs were carried over from the spreadsheet's RGB values and assigned to the *character_nameR*, *character_nameG*, *character_nameB* variables respectively. To arrange the arcs so that the more prominent characters appear on the outside, the individual arcs were scaled linearly.

```

20 //Frodo data input
21 float frodoStart = -64;
22 float frodoEnd = 101;
23 float frodoCurrent = frodoStart;
24 int frodoR = 200;
25 int frodoG = 48;
26 int frodoB = 35;
27 String frodo = "Frodo Baggins";
28 float frodoRad = 3160;
29
30 //Sam data input
31 float samStart = -53;
32 float samEnd = 277;
33 float samCurrent = samStart;
34 int samR = 200;
35 int samG = 111;
36 int samB = 29;
37 String sam = "Samwise Gamgee";
38 float samRad = 2960;

// Start angle for Frodo
// End angle for Frodo
// Initialise Frodo angle current value and sets to Frodo start
// Frodo arc RGB red value
// Frodo arc RGB green value
// Frodo arc RGB blue value
// String to store full character name for text display
// Radius of Frodo arc

// Repeat for all characters
//
//
//
//
//

```

```

154 void draw() { // Begin draw
155
156     background(0); // Set background to black
157
158     //Ring image
159     image(blackspeech, 1000, 1000, width * 0.8, height * 0.8); // Paste black speech image and set size and offset
160
161     //Frodo
162     if (frodoCurrent < frodoEnd) { // This will execute every draw cycle while the current Frodo arc angle is less than the end arc angle value
163         // so that it will iteratively draw the arc until it reaches the end point
164         stroke(frodoR, frodoG, frodoB); // Sets the stroke colour to the assigned colour for Frodo
165         noFill(); // Disables fill
166         arc(5000, 5000, 6400, 6400, radians(frodoStart), radians(frodoCurrent), OPEN); // Begin drawing arc at frodoStart and finish at frodoCurrent
167         frodoCurrent++; // Increments the frodoCurrent value for the next iteration
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218 //Pippin
219 if (pipCurrent < pipEnd) {
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221     stroke(pipR, pipG, pipB);
222     noFill();
223     arc(5000, 5000, 5200, 5200, radians(pipStart), radians(pipCurrent), OPEN); // Subsequent characters have a smaller arcs
224     pipCurrent++;
225
226     stroke(255, 255, 255);
227     fill(255, 255, 255);
228     ellipse(5000 + cos(radians(pipCurrent)) * (pipRad + 40), 5000 + (sin(radians(pipCurrent)) * (pipRad + 40)), 70, 70);
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230 }
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White Line:

The central white line was coded similarly to the arcs, using lineStart and lineEnd variables to define where it should begin and finish.

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13 float lineStart = 5000; // Start y point for middle line
14 float lineEnd = 1800; // End y point for middle line
15 float lineCurrent = lineStart; // Initialise middle line current position and sets to line start
16 int lineR = 255; // Middle line RGB red value
17 int lineG = 255; // Middle line RGB green value
18 int lineB = 255; // Middle line RGB blue value
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Animated Generation:

This art piece is able to generate iteratively over a span of time through the use of the draw() functionality, as well as if() statements encompassing the draw commands. The if() statement condition would be – if(*character_nameCurrent* is less than *character_nameEnd*) then the shapes, whether an arc or line, would be drawn from the *character_nameStart* position to the *character_nameCurrent*, which would begin equal to the *character_nameStart* variable, but would then increment by one after each draw, therefore, each time the draw() function is run, the shape would be become more complete, until it reaches the *character_nameEnd* value.

```

154 void draw() { // Begin draw
155
156     background(0); // Set background to black
157
158     //Ring image
159     image(blackspeech, 1000, 1000, width * 0.8, height * 0.8); // Paste black speech image and set size and offset
160
161     //Frodo
162     if (frodoCurrent < frodoEnd) { // This will execute every draw cycle while the current Frodo arc angle is less than the end arc angle value
163         // so that it will iteratively draw the arc until it reaches the end point
164         stroke(frodoR, frodoG, frodoB); // Sets the stroke colour to the assigned colour for Frodo
165         noFill(); // Disables fill
166         arc(5000, 5000, 6400, 6400, radians(frodoStart), radians(frodoCurrent), OPEN); // Begin drawing arc at frodoStart and finish at frodoCurrent
167         frodoCurrent++; // Increments the frodoCurrent value for the next iteration
168
169         stroke(255, 255, 255); // Sets stroke colour to white
170         fill(255, 255, 255); // Enables fill and sets fill colour to white
171         ellipse(5000 + cos(radians(frodoCurrent)) * (frodoRad + 40), 5000 + (sin(radians(frodoCurrent)) * (frodoRad + 40)), 70, 70); // Creates an ellipse at the end of the current position of the arc
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173     }
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439 //Line
440 if (lineCurrent > lineEnd) {
441
442     stroke(lineR, lineG, lineB);
443     line(5000, lineStart, 5000, lineCurrent);
444     lineCurrent = lineCurrent - 10;
445
446 }
447
448 if (lineCurrent == lineEnd) {
449
450     stroke(lineR, lineG, lineB);
451     line(5000, lineStart, 5000, lineEnd);
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453 }
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```

Once this would happen the entire shape would disappear due to the condition turning false, to fix this, a different if() statement was introduced with the condition of if(*character_nameCurrent* is equal to *character_nameEnd*), it would then draw the complete shape, since this condition will always be true as long as the image is complete, the image will remain.

```

175 if (frodoCurrent == frodoEnd) {
176                                     // This will execute once the frodoCurrent value has reached the frodoEnd value/when the arc has reached the desired point
177     stroke(frodoR, frodoG, frodoB);    // Sets stroke colour to the assigned colour for Frodo
178     noFill();
179     arc(5000, 5000, 6400, 6400, radians(frodoStart), radians(frodoEnd), OPEN);    // Draws the complete arc from frodoStart to frodoEnd/will remain unchanged through future iterations while frodoCurrent is equal to frodoEnd
180
181     stroke(255, 255, 255);    // Sets stroke colour to white
182     fill(255, 255, 255);    // Enables fill and sets fill colour to white
183     ellipse(5000 + cos(radians(frodoEnd)) * (frodoRad + 40), 5000 + (sin(radians(frodoEnd)) * (frodoRad + 40)), 70, 70);    // Creates an ellipse at the end of the arc.
184 }

```

To enhance the visual aesthetic, as well as to aid the viewer in distinguishing the end points for the lines, a white ellipse was added to the end of each character line, the ellipse follows the same animation as the line and remains at the end of it through the use of a mathematical function that can calculate a point on a circle, given the circle radius and current angle: $x = r(\cos(\theta^\circ))$ and $y = r(\sin(\theta^\circ))$.

```

189 stroke(255, 255, 255);    // Sets stroke colour to white
190 fill(255, 255, 255);    // Enables fill and sets fill colour to white
191 ellipse(5000 + cos(radians(frodoCurrent)) * (frodoRad + 40), 5000 + (sin(radians(frodoCurrent)) * (frodoRad + 40)), 70, 70);    // Creates an ellipse at the end of the current position of the arc.
192
193

```

To retain the image of the ellipse when the image is fully generated, the ellipse is drawn again in the new if() statement similarly to the arc:

```

181 stroke(255, 255, 255);    // Sets stroke colour to white
182 fill(255, 255, 255);    // Enables fill and sets fill colour to white
183 ellipse(5000 + cos(radians(frodoEnd)) * (frodoRad + 40), 5000 + (sin(radians(frodoEnd)) * (frodoRad + 40)), 70, 70);    // Creates an ellipse at the end of the arc

```

Curved Text:

One of the most challenging aspects of the art piece was to be able to curve the names of the characters with the arcs. To accomplish this, I found some code [online](#) and adapted it to work for each of the arcs in the art piece. The method consists of a loop that takes each letter of a given string and applies a transform to the individual letters, giving the effect that a word is curving. The letters would be transformed in reference to the radius of the arc, and the output word would appear to have the same curvature as the arc. For each character, the text position on the circumference had to be tweaked manually.

```

7  int i;    // Iterator number variable for loops
8  float arcLength;    // Variable to control rotation on letters
9  char currentChar;    // Variable storing current letter
10 float w;    // Variable for storing letter width
11 float theta;    // Variable to store angles

```

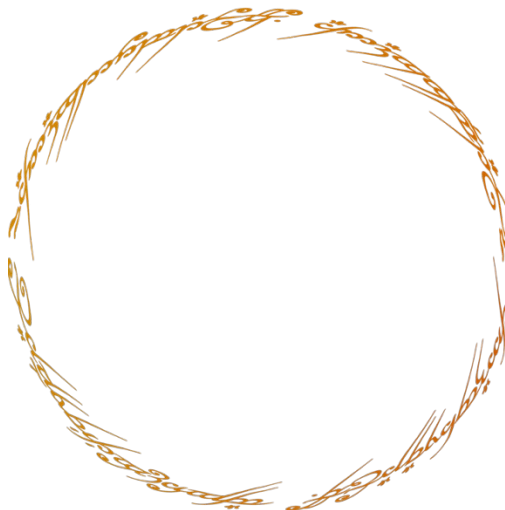
```

185 //FrodoText
186 noFill(); // Disables fill
187 stroke(frodoR, frodoG, frodoB); // Sets the stroke colour to the assigned colour for Frodo
188
189 arcLength = 0; // Resets arcLength to zero
190
191 for (i = 0; i < frodo.length(); i++) { // Loop to iterate through the length of the String text
192
193     currentChar = frodo.charAt(i); // Sets the current letter to the iterator i value
194     w = textWidth(currentChar); // Sets the letter width variable to the current letter width
195     arcLength += w/2; // Adds half the letter width to the arcLength
196
197     theta = PI * 1.02 + arcLength / frodoRad; // Sets the position of the text to the appropriate position on the circumference of the arc
198
199     pushMatrix(); // Pushes the current transformation matrix to the matrix stack
200
201     translate(frodoRad*cos(theta) + 5000, frodoRad*sin(theta) + 5000); // Places the text at the correct offset
202     rotate(theta + PI/2); // Rotates the text according to its position on the circumference
203
204     fill(frodoR, frodoG, frodoB); // Sets the text colour to the assigned colour for Frodo
205     translate(frodoRad, frodoRad); // Sets the text to the height and width of the radius to the correct position on the circumference
206     rotate(89.6); // Fine tuning rotation
207     text(currentChar, 0, 0); // Prints text
208     popMatrix(); // Pops the current transformation matrix off the matrix stack
209
210     arcLength += w/2; // Adds half the letter width to the arcLength once more
211 // Will repeat for all letters of the string
212
213 }

```

Black Speech Image:

The outer image of the Black Speech inscription that appears on the One Ring was sketched in photoshop by tracing over the official image and adding some gradient colour. The image was then curved in a ring shape so that it could surround the art piece, to give reference to the iconic One Ring, and also to the Eye of Sauron.



Critical Reflection

Overall, the Data Art piece has achieved the goal of presenting the lifespans of characters of Middle Earth. The data is clearly laid out with little clutter or overuse of colour, the colours themselves feel relevant to the theme. Once understood what is represented in the piece, the data can be clearly understood by the viewer.

Some aspects that could have been better would be the use of less monochrome colours per arc, for example, the colour could be enhanced using textures, to add more detail and intrigue to them. Another aspect to consider improving on would be the incorporation of more data, since the data presented in this piece is mostly one dimensional and does not encourage longer viewing, since the data can be read fairly quickly. A final element that could be better would be the use of more characters, since this would give more viewable data and hence make the piece more appealing.