

QuadTree - Image Compression

A brief explanation of how it works

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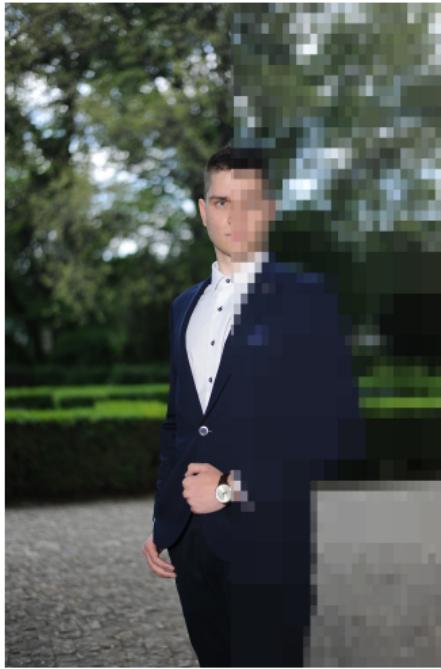
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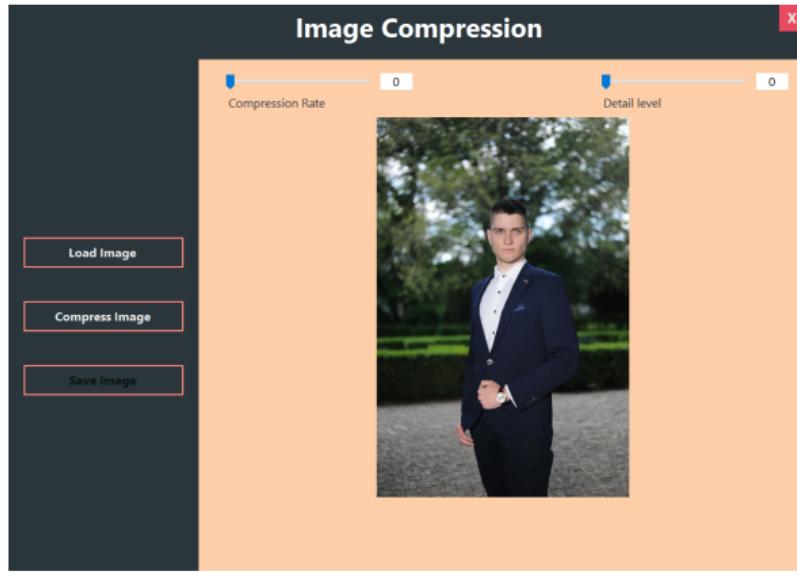
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General presentation

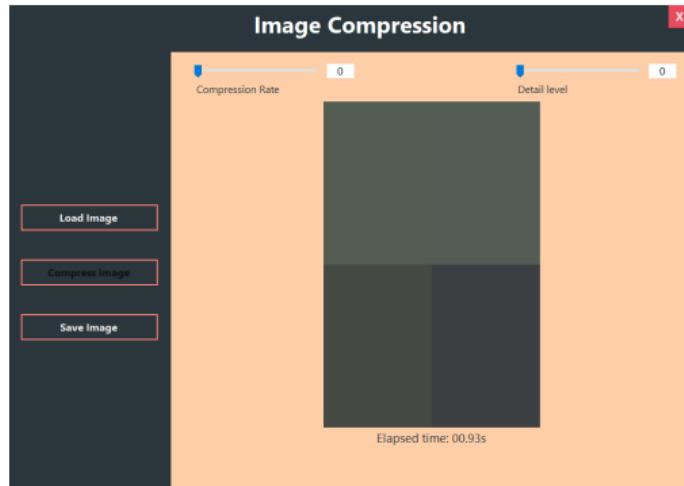


General presentation

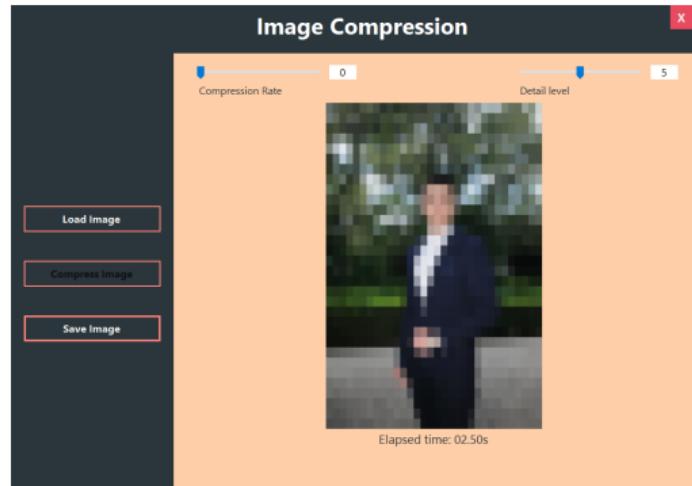
The app features a fully working GUI developed using windows forms, from which the user can choose different actions using the menu. From here, the user can load, compress, or save an image.



General presentation



Detail level - 0



Detail level - 5

What are quadtrees?

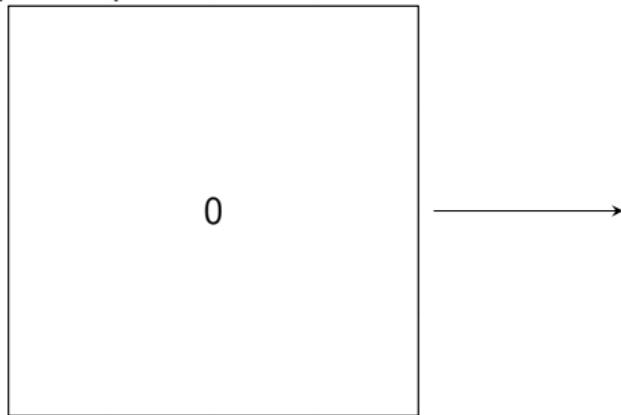


What are quadtrees?

A **quad tree** is a complete tree data structure, having the property that each internal node has exactly four children. The reason they are categorized as a spatial data structure is because of their use to represent 2-dimensional space, performing different type of operations on it.

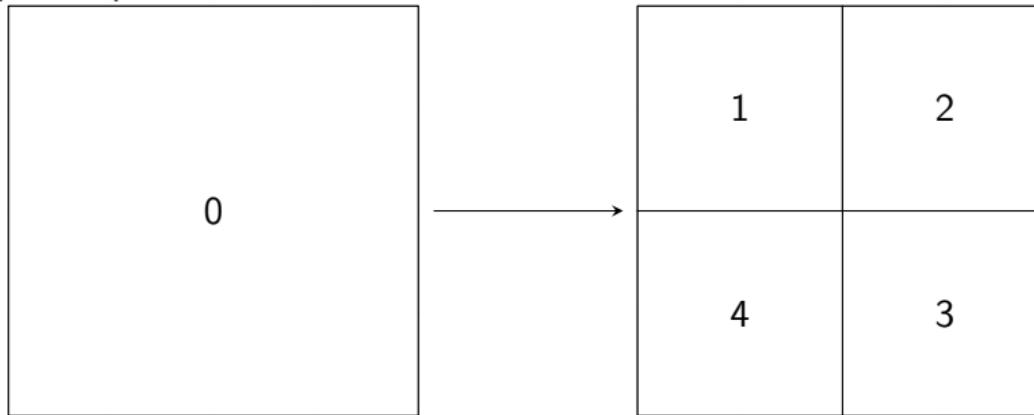
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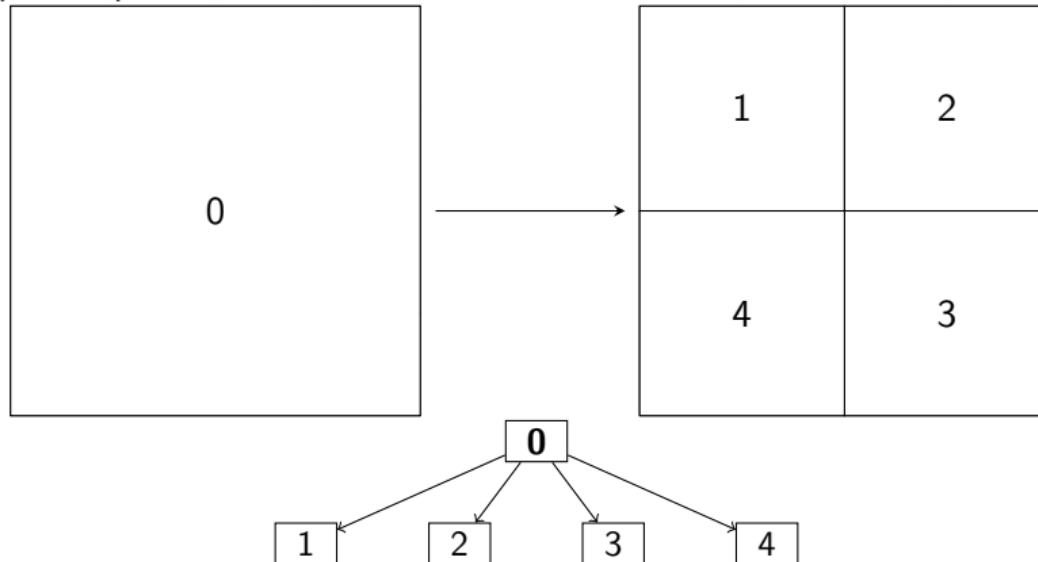
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- ③ Analyze the resulting squares

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Steps:

- ① Analyse given image
- ② If necessary divide the current square (at start the image) into 4 equal squares
- ③ Analyze the resulting squares
- ④ If we can't obtain the necessary information we check to see if we can continue splitting and
 - repeat from step 2
 - stop if we can't divide any further

Photo by Jazmin Quaynor on Unsplash



Original image



Image after quadtree decomposition

Photo by Jazmin Quaynor on Unsplash

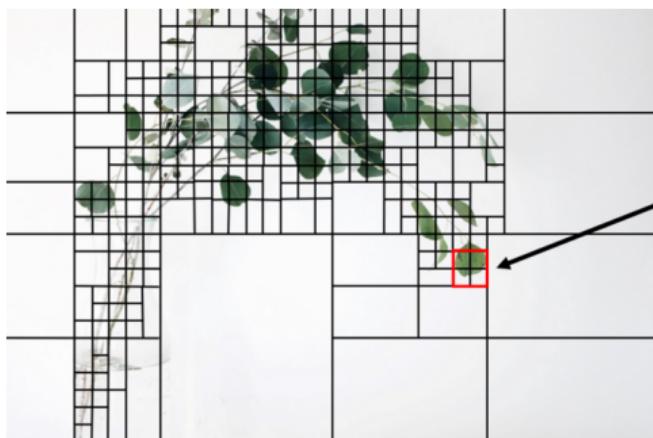
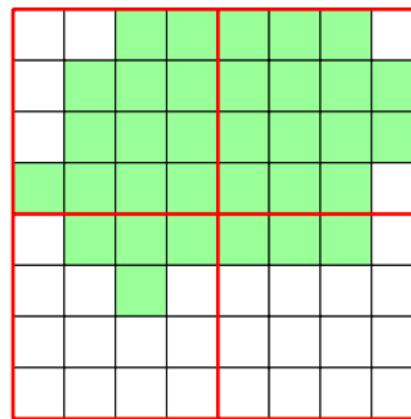
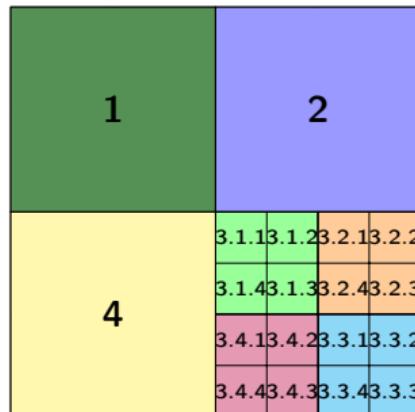


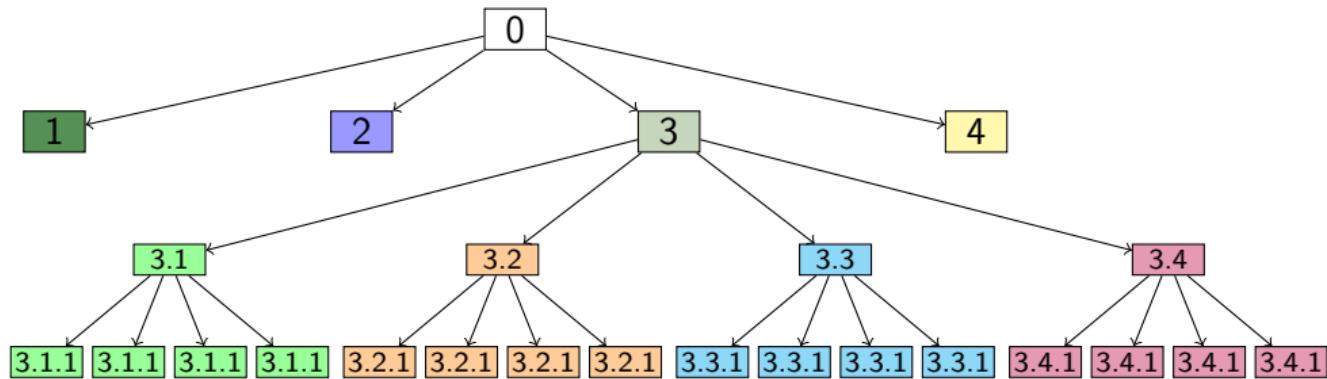
Image after quadtree decomposition



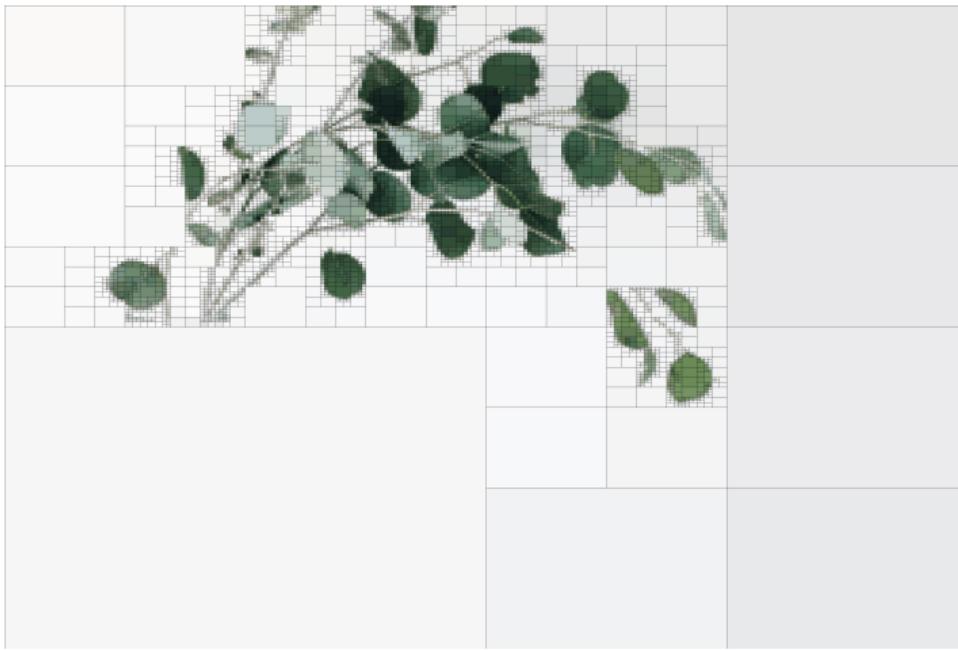
Zoom area

Region quadtrees are a very useful representation of a partition of space, in our case a 2D space, being able to split it into four equal quadrants, sub-quadrants and so on until a stopping criterion is met. They are used to achieve the quadtree decomposition phenomenon.





What is detail threshold?



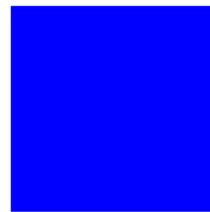
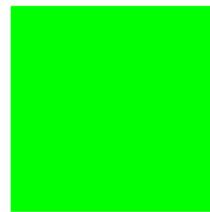
What is detail threshold?

The role of the **detail threshold** is to know when we have extracted enough information from a certain zone. The amount of details that can be extracted is dictated by the "error" value which indicates how much we can "destroy" (split) the image, or remove detail out of it, thus reducing memory size, any quadrant which isn't detailed enough being divided after.

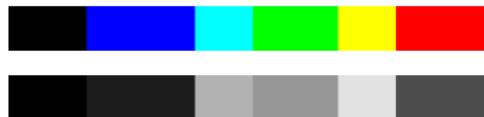
$$\text{error} = 0.2989 * \text{R} + 0.5870 * \text{G} + 0.1140 * \text{B}$$

What is detail threshold?

The "**error**" value or **color luminescence** indicates how the average human eye perceives brightness. This percentages come from the way the eye sees color. Because we do not perceive colors in a linear way, a "greener" object will appear brighter to us than a blue one.



What is detail threshold?



We can see from the above image, that the intensity of the color green, becomes even more noticeable when it is mixed with other colors, as in our case, red, resulting yellow (**yellow → R:255, G:255, B:0**)

```
private static readonly double RedPercentage = 0.2989;
private static readonly double GreenPercentage = 0.5870;
private static readonly double BluePercentage = 0.1140;

var greenFrequency = FindColorFrequencies(results.Item2, Colors.Green);
node.NodeError = GreenPercentage * FindWeightedAverage(greenFrequency,
    total);

if (node.NodeError <= detailThreshold) {
    var redFrequency = FindColorFrequencies(results.Item2, Colors.Red);
    node.NodeError += RedPercentage * FindWeightedAverage(redFrequency,
        total);
}

if (node.NodeError <= detailThreshold) {
    var blueFrequency = FindColorFrequencies(results.Item2, Colors.Blue);
    node.NodeError += BluePercentage * FindWeightedAverage(blueFrequency,
        total);
}
```

What is detail level?

Detail represents how much information our eyes can perceive. In code, the detail level translates to the maximum depth of the quadtree, forcing the division to stop if we were to go deeper than allowed. The deeper we go into a quadtree, the more detail we find about a certain image. As a consequence, altering the depth of the quadtree will impact the quality of the final output.

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Photo by Omid Armin on Unsplash



What is detail level?

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Low detail (detail level = 6)



High detail (detail level = 8)

What are threads?

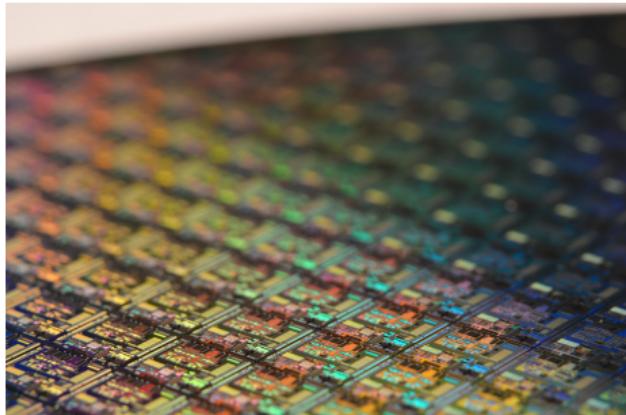


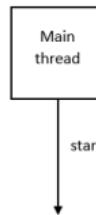
Photo by Laura Ockel on Unsplash

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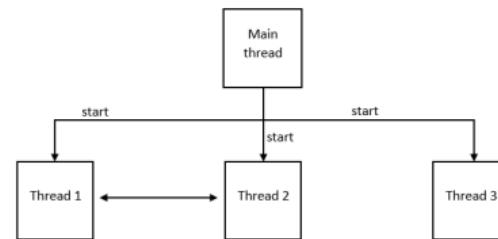
In the field of computer science, a **thread** is a "small set of instructions designed to be scheduled and executed by the CPU". These instructions are executed independently, without being affected by the parent process. Today, most processors are **multi-threaded**, meaning they can work with multiple threads simultaneously.

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Single thread application



Multi-thread application