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Compositor System

Data

Dimensionality

Compositing nodes operate on data that is either an image or a dimensionless single value. For instance, the Levels node outputs a single value, while the Render Layers node outputs an image. Node inputs that expect a single value assume a default value if an image is given and ignore the image completely for instance, the Transform node expects single values for its inputs and will assume default values if images were given to those inputs. The default values are those that are considered identity and thus have no effect on the output, so for the Transform node, the *X*, *Y*, and *Angle* inputs will have a default valu of zero, while the *Scale* input will have a default value of one. On the other hand, if node inputs that expect an image are given a single value, the single value will be assumed to cover the whole compositing space. For instance, the Filter node expect its *Factor* input to be an image, but if a single value is given, it will be assumed to be the same for all pixels.

Type

Three types of data exist, all of which are stored in half precision formats:

Float
: A signed floating-point number. Integer data is also stored as floats because no integer type exist.

Vector
: A 4D vector. While it is 4D, it can have different interpretations depending on the node that uses it. It can be treated as a 2D vector with the last two components ignored, for instance, the *Vector* input of the Displace node is treated as a 2D vector. It can be treated as a 3D vector with the l component ignored, for instance, the *Vector* input of the Seperate XYZ node is treated as a 3D vector. It can be treated as two consecutive 2D vectors. For instance the *Velocity Pass* as expected by the Vector Blur node is assumed to have the *2D Previous Velocity* in the X and Y components of the vector and the *2D Next Velocity* in the Z and W components of the vector.

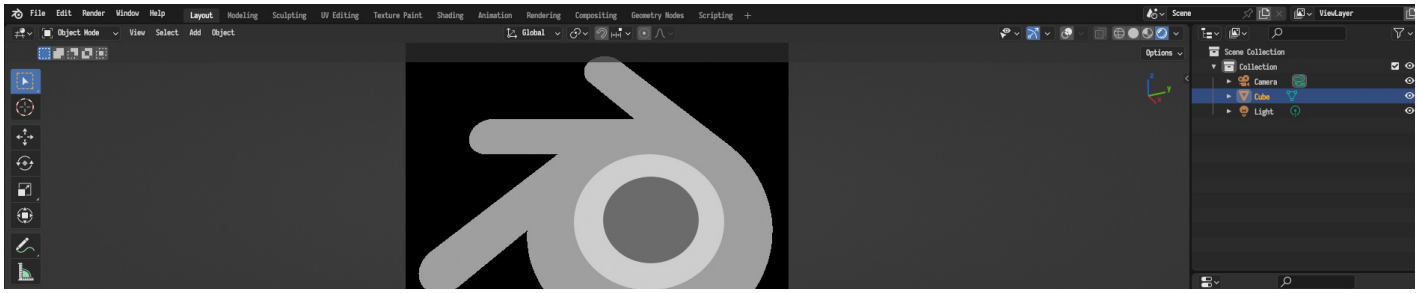
Color
: A 4D vector storing the Red, Green, Blue, and Alpha of the color. The color is free form and does not conform to a specific color space or alpha storage model, instead, appropriate nodes will have settings to control the representation of their output and nodes exist to convert between the different representations.

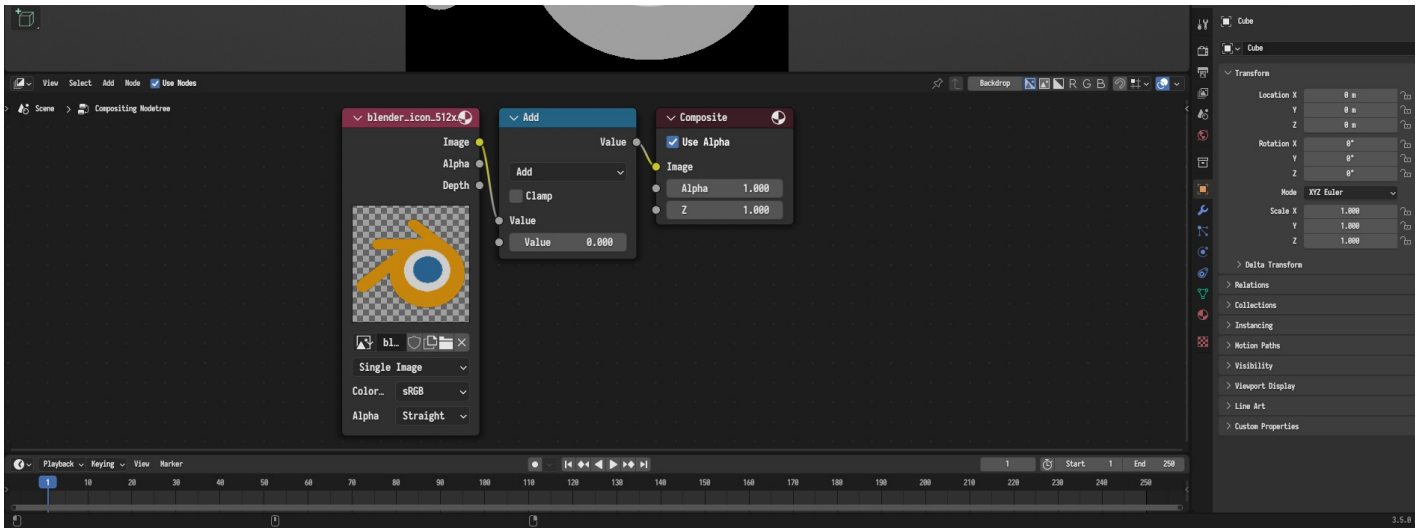
Implicit Conversion

In case a node input is given data of type other than its own type, the following implicit conversions are performed:

Source	Target	Conversion
Float	Vector	f => Vector(f, f, f, 0)
Float	Color	f => Color(f, f, f, 1)
Vector	Float	(x, y, z, w) => Average(x, y, z)
Vector	Color	(x, y, z, w) => Color(x, y, z, 1)
Color	Float	(r, g, b, a) => Luminance(r, g, b)
Color	Vector	(r, g, b, a) => Vector(r, g, b, 0)

The following example demonstrates implicit conversion between a color type and a float type, since the Math node expect float inputs.



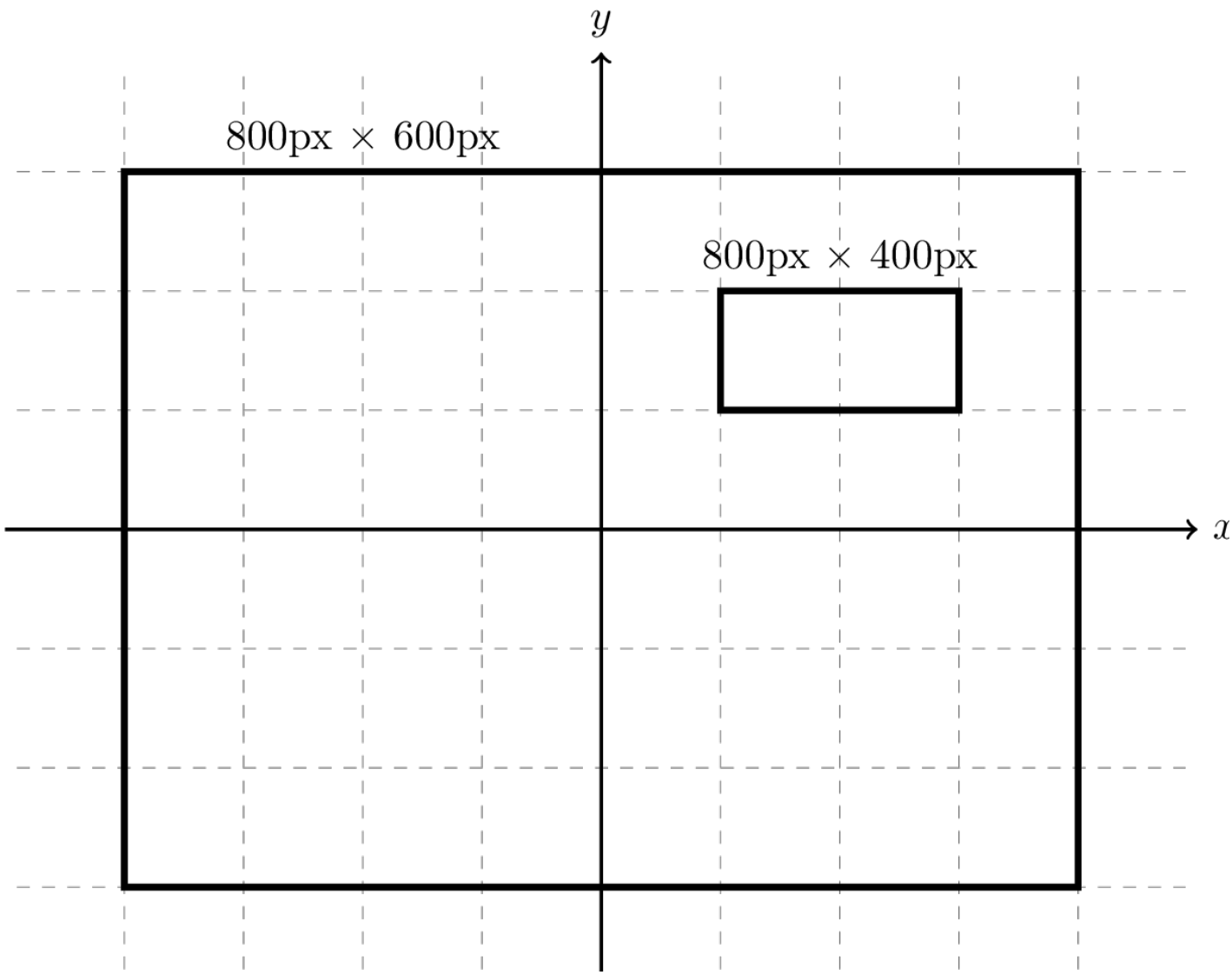


An example that demonstrates implicit conversion between a color type and a float type, since the *Math* node expects float inputs.

Compositing Space

Image Domain

The compositor is designed in such a way as to allow compositing in an infinite compositing space. Consequently, images are not only represented by the size, but also by their transformation in that space, much like 3D objects have transformations. An identity transformation represents an image that is centered in space. The rectangular area occupied by an image in that space as defined by its transformation and size is called the *Domain* of the image. The figure below demonstrates the domains of two example images.



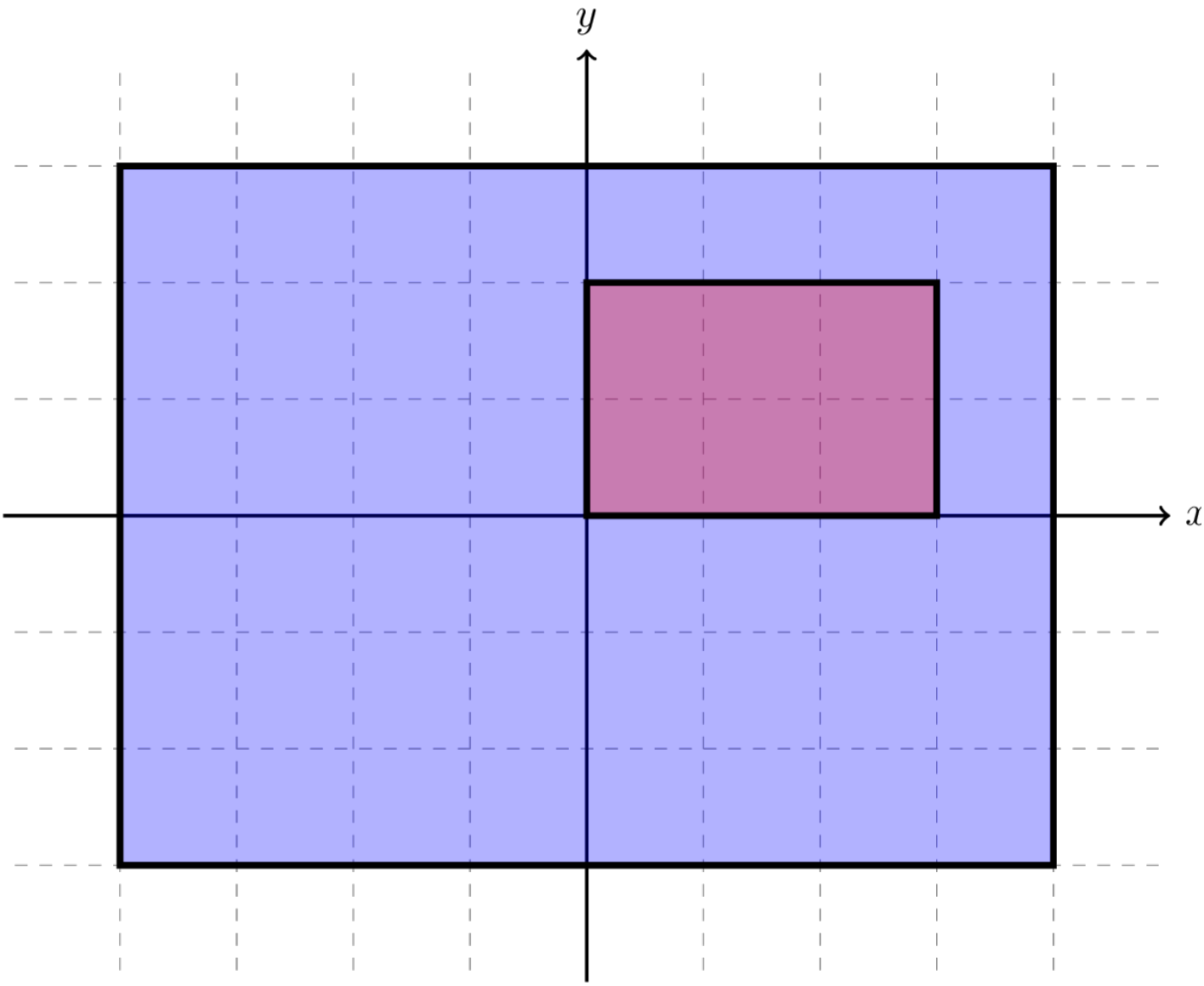
The domains of two example images are illustrated on the compositing space. One of the images is centered in space and the other is scaled down and translated such that it lies in the upper right quadrant of the space. Notice that both images have similar sizes in pixels, yet their apparent sizes are different.

Images can be transformed using nodes like the Transform, Translate, and Rotate nodes.

Operation Domain

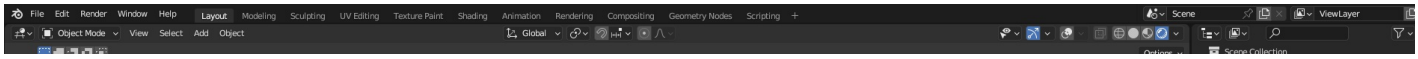
Compositor Nodes operate on a specific rectangular area of the compositing space called the *Operation Domain*. The nodes only consider the area of the input images that overlap the operation domain and ignores the rest of the images. If an input image doesn't completely overlap the operation domain the rest of the operation domain for that input will be assumed to be a zero value, a zero vector, or a transparent zero color depending on the type.

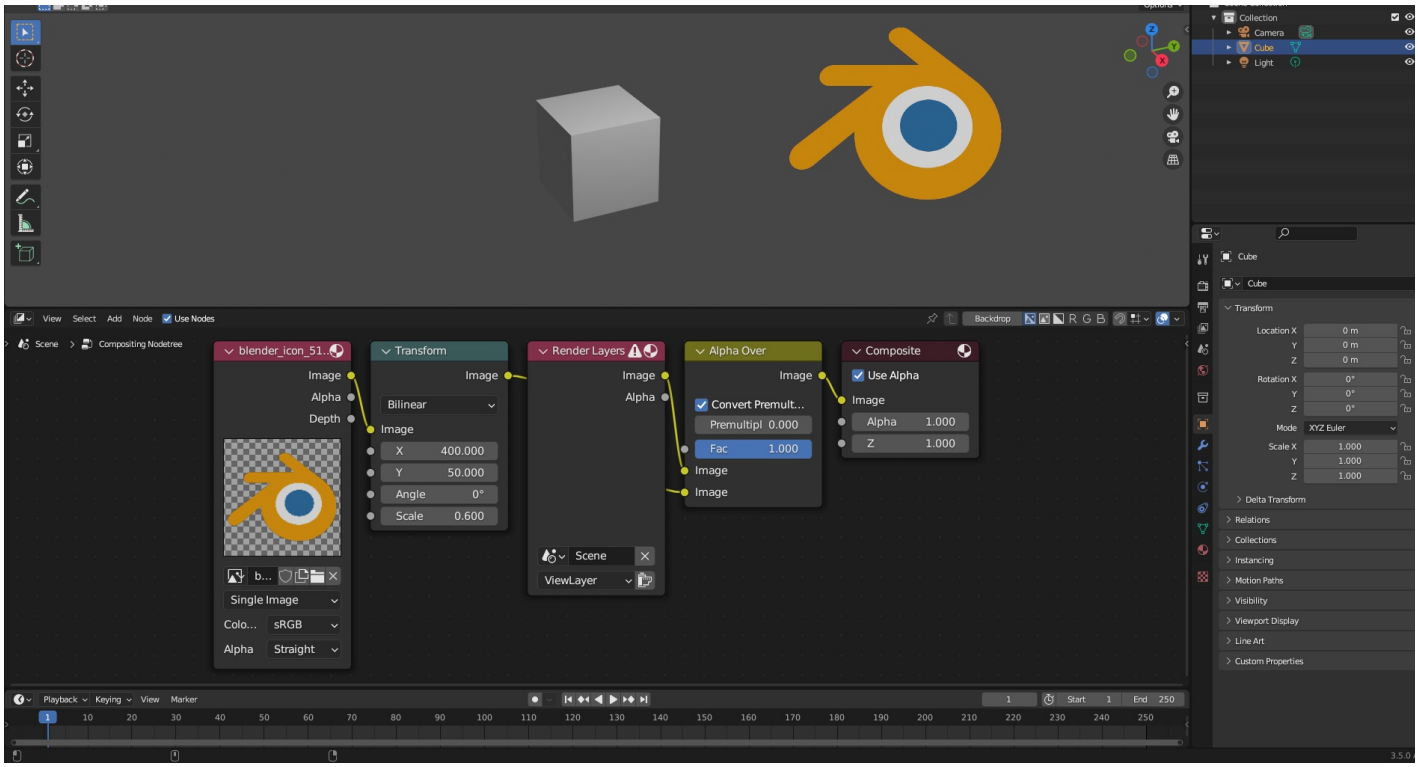
For instance, the figure below illustrates a case where the operation domain of a node is the large blue area and the domain of an input image is the small red area. In that case, the input image doesn't completely overlap the operation domain, so the rest of the blue area for that input image is assumed to be zero.



An example case where the operation domain of a node is shown in blue and the domain of an input image is shown in red. Since the input image doesn completely cover the operation domain of the node, the rest of the blue area for that input image is assumed to be zero.

The previous illustration is a representation of a real world example where one uses the Alpha Over node to overlay a small logo on an image, as shown the figure below. In that case, the operation domain covers the entirety of the viewport — as will later be demonstrated, but the logo covers only a small area of it, so the rest of the area is assumed to be a zero transparent color, which is convenient for the use case.





A real world example where the Alpha Over node is used to over a small logo on an image. The logo only covers a small area of the operation domain which is the whole viewport in this case, so the rest of the area is assumed to be a zero transparent color.

Interpolation

If an input image to a node is not perfectly aligned with the operation domain of the node or have a different size in pixels, the node would typically need do a process called Interpolation, where the input image is read at the exact positions of the pixels of the operation domain. This can be done using different interpolation methods, including Nearest-Neighbor, Bilinear, and Bicubic interpolations. Those interpolation methods are demonstrated in the following Wikipedia gallery. Transformation nodes like the Transform and Rotate nodes include an interpolation option to set how they prefer their outpu image to be read and interpolated.

Determining Operation Domain

The question remains on how nodes determine their operation domain. Different node types can have different mechanisms for determining their operatio domain. But generally, three classes of nodes exist when it comes to the mechanism of determining the operation domain, each of which is presented in o of the following sections.

Input Nodes

The operation domain of input nodes like the Image node is a domain with an identity transformation and the same size as their outputs, so for the *Image* node, the operation domain will be the domain whose size is the size of the image and whose transformation is an identity one.

Output Nodes

The operation domain of output nodes like the Viewer node is a domain with an identity transformation and the same size as the final compositor output. For viewport compositing, that size would be the viewport size, and for final render compositing, that size would be the scene render size.

Other Nodes

Unless stated otherwise in their respective documentation pages, all other nodes use the following mechanism. One of the inputs of the nodes is designate as the *Domain Input* of the node, and the operation domain of the node is identical to the domain of that designated input. For many nodes, the domain input can be intuitively identified as the main input of the node, for instance, the domain input for the Filter node is the *Image* input. But there are some caveats to note, which requires a deeper understanding of the mechanism.

Each input in the node has the so called *Domain Priority* property, the operation domain of the node is the domain of the non single value input with the highest domain priority. So for instance, the Filter node has two inputs, the domain priority of the *Image* input is higher than that of the *Factor* input, and there are four possible configurations:

- Both the *Image* and factor inputs are connected to images. In this case, the *Image* input is the domain input because it has the highest priority and is

connected to an image.

- The *Image* input is connected to an image, but the *Factor* input isn't. In this case, the *Image* input is the domain input because it it is the only input connected to an image regardless of its priority.
- The *Image* input is not connected to an image but the *Factor* input is. In this case, the *Factor* input is the domain input because it is the only input connected to an image regardless of its priority.
- Neither the *Image* nor the *Factor* inputs are connected to images, in this case, there isn't a domain input because the node is evaluated on single values.

Considerations

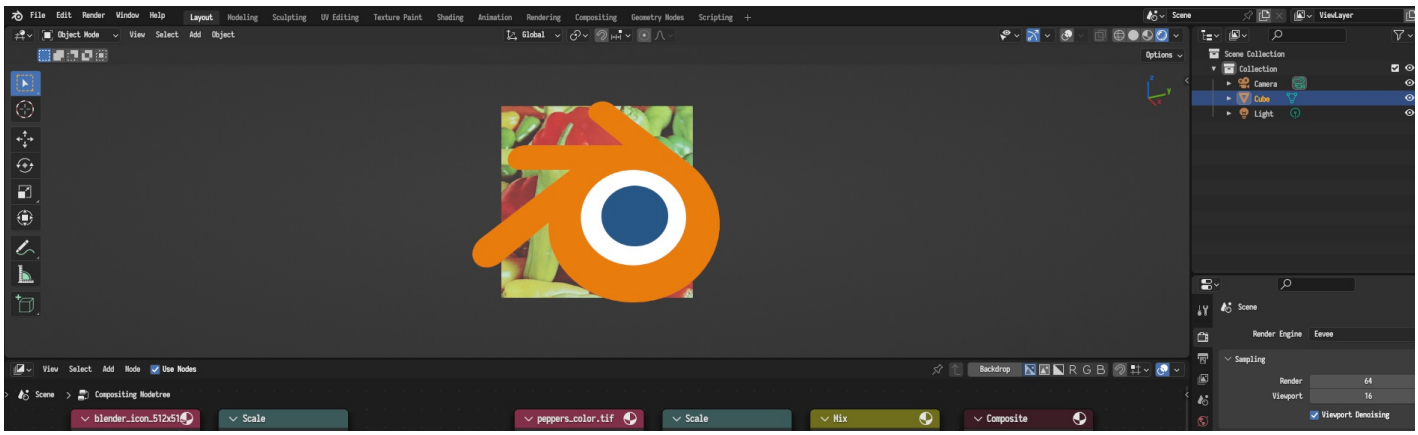
The aforementioned mechanism for determining the operation domain has a number of consequences that needs to be considered as they might be undesirable, each of which is presented in one of the following sections.

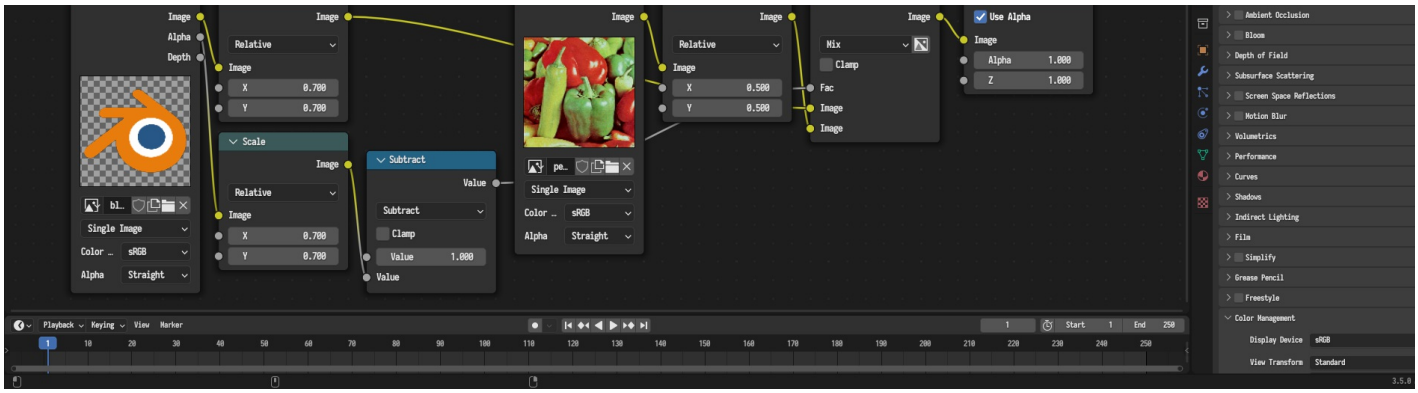
Clipping

The output of nodes will be intuitively clipped to the operation domain, or rather, the domain of the domain input. For instance, if the *Foreground* input i bigger than the *Background* input in the Alpha Over node, the output will be clipped to the *Background* input because it is the domain input, as shown i the following figure.

The *Foreground* input is bigger than the *Background* input in the *Alpha Over* node, so the output is intuitively clipped to the *Background* input becaus is the domain input.

The Alpha Over node currently does not support changing the domain priority for its inputs, so as a workaround, one can use a Mix node to achieved th desired behavior, noting that the first *Image* input in the *Mix* node has the highest domain priority, as shown in the following figure.





Working around the clipping behavior of the *Alpha Over* node using a Mix node, noting that the first *Image* input in the *Mix* node has the highest doma priority

Output

The compositor only supports a single active output target, that is, only one of the Composite nodes or Viewer nodes in the node tree will be considered active and the rest will be ignored. In particular, the compositor searches the *Active Node Tree Context* and falls back to the *Root Node Tree Contex* no active output was found in the active node tree context. The active node tree context is the node tree of an expanded node group, that is, when the us selects a node group node and edits its underlying tree, while the root node tree context is the top level node tree without any expanded node groups.

The compositor searches for the active *Composite* node, if none was found, it searches for the active *Viewer* node. If none was found, the compositor doesn't run altogether. Consequently, note that adding a *Viewer* node will have no effect on the viewport render if there is a *Composite* node, since the priority is given to *Composite* nodes.

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