Insper

Computação Gráfica

Aula 13: Revisão 3

Grafo de Cena

Criando Matriz Identidade

Início

```
<Scene>
 <Transform scale="2 2 2">
  <Shape>
   <TriangleSet>
    <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
   </TriangleSet>
   <Appearance>
    <Material diffuseColor='1 0 0'/>
   </Appearance>
  </Shape>
  <Transform scale="2 1 1">
   <Transform translation="0 -1 -1">
    <Shape>
     <TriangleSet>
      <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
     </TriangleSet>
     <Appearance>
      <Material diffuseColor='0 1 0'/>
     </Appearance>
    </Shape>
   </Transform>
   <Transform translation="0 1 -2">
    <Transform rotation="0 0 1 3.14">
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       <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
      </TriangleSet>
      <Appearance>
       <Material diffuseColor='0 0 1'/>
      </Appearance>
     </Shape>
    </Transform>
   </Transform>
  </Transform>
 </Transform>
</Scene>
```

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

MATRIZ

PILHA

Insper

Empilhando e Atualizando Transformação

```
<Scene>
 <Transform scale="2 2 2">
  <Shape>
   <TriangleSet>
    <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
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   <Appearance>
    <Material diffuseColor='1 0 0'/>
   </Appearance>
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   <Transform translation="0 -1 -1">
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     </Appearance>
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   </Transform>
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      </TriangleSet>
      <Appearance>
       <Material diffuseColor='0 0 1'/>
      </Appearance>
     </Shape>
    </Transform>
   </Transform>
  </Transform>
 </Transform>
</Scene>
```

push

$$\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&1&0\\0&0&0&1\end{bmatrix} \times \begin{bmatrix}2&0&0&0\\0&2&0&0\\0&0&2&0\\0&0&0&1\end{bmatrix}$$

$$\begin{bmatrix}\mathbf{2}&\mathbf{0}&\mathbf{0}&\mathbf{0}\\\mathbf{0}&\mathbf{2}&\mathbf{0}&\mathbf{0}\\\mathbf{0}&\mathbf{0}&\mathbf{2}&\mathbf{0}\\\mathbf{0}&\mathbf{0}&\mathbf{0}&\mathbf{1}\end{bmatrix}$$

$$\begin{bmatrix}1&0&0&0\\0&1&0&0\\0&0&1&0\\0&0&0&1\end{bmatrix}$$

MATRIZ

PILHA

Insper

Desenhando Triângulo Vermelho

```
<Scene>
 <Transform scale="2 2 2">
  <Shape>
   <TriangleSet>
    <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
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   <Appearance>
    <Material diffuseColor='1 0 0'/>
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  </Shape>
  <Transform scale="2 1 1">
   <Transform translation="0 -1 -1">
    <Shape>
     <TriangleSet>
      <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
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      <Material diffuseColor='0 1 0'/>
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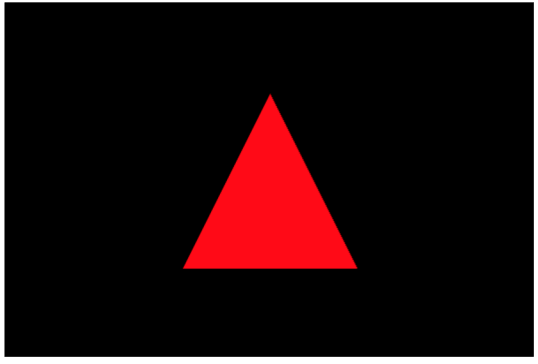
</Scene>
```

draw



$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

MATRIZ

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

PILHA

Insper

Empilhando e Atualizando Transformação

```
<Scene>
 <Transform scale="2 2 2">
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   <TriangleSet>
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  </Shape>
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     </Appearance>
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   <Transform translation="0 1 -2">
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      <Appearance>
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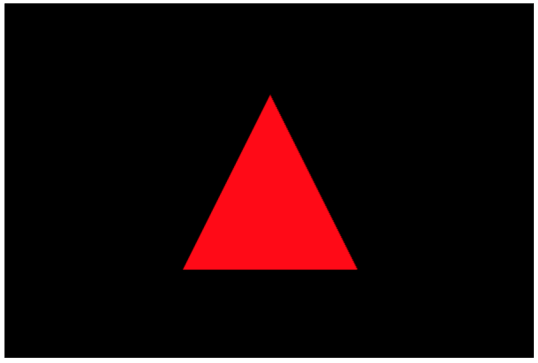
</Scene>
```

push



$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} \mathbf{4} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{2} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{2} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{1} \end{bmatrix}$$

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

MATRIZ

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

PILHA

Insper

Empilhando e Atualizando Transformação

```
<Scene>
 <Transform scale="2 2 2">
  <Shape>
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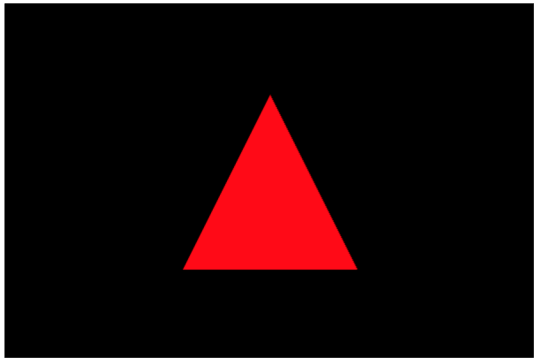
</Scene>
```

push



$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 1 & -1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} \mathbf{4} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{2} & \mathbf{0} & \mathbf{-2} \\ \mathbf{0} & \mathbf{0} & \mathbf{2} & \mathbf{-2} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{1} \end{bmatrix}$$

$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

MATRIZ

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

PILHA

Desenhando Triângulo Verde

```
<Scene>
 <Transform scale="2 2 2">
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     </Appearance>
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    <Transform rotation="0 0 1 3.14">
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    </Transform>
   </Transform>
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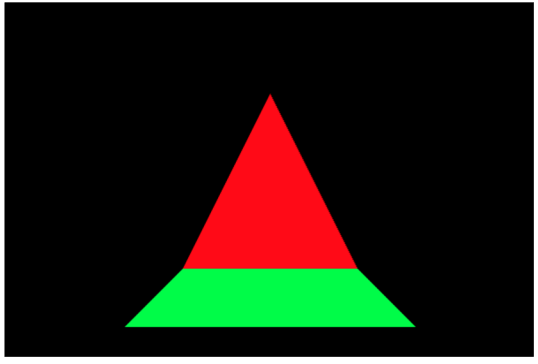
 </Transform>
</Scene>
```

draw



$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & -2 \\ 0 & 0 & 2 & -2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

MATRIZ

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

PILHA

Insper

Desempilhando e Atualizando Transformação

```
<Scene>
 <Transform scale="2 2 2">
  <Shape>
   <TriangleSet>
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   </Appearance>
  </Shape>
  <Transform scale="2 1 1">
   <Transform translation="0 -1 -1">
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     </TriangleSet>
     <Appearance>
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     </Appearance>
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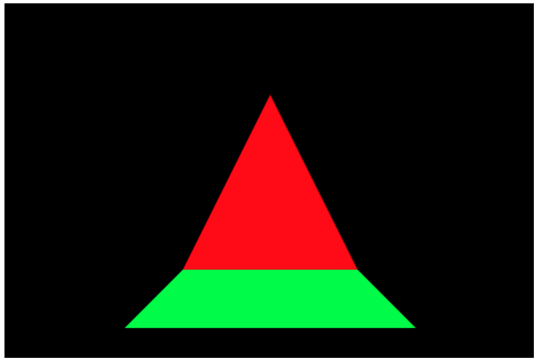
   </Transform>
   <Transform translation="0 1 -2">
    <Transform rotation="0 0 1 3.14">
     <Shape>
      <TriangleSet>
       <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
      </TriangleSet>
      <Appearance>
       <Material diffuseColor='0 0 1'/>
      </Appearance>
     </Shape>
    </Transform>
   </Transform>
  </Transform>
 </Transform>
</Scene>
```

pop



$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

PILHA

$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & -2 \\ 0 & 0 & 2 & -2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

MATRIZ

Insper

Empilhando e Atualizando Transformação

```
<Scene>
 <Transform scale="2 2 2">
  <Shape>
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   </TriangleSet>
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  </Shape>
  <Transform scale="2 1 1">
   <Transform translation="0 -1 -1">
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     <TriangleSet>
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      <Material diffuseColor='0 1 0'/>
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   <Transform translation="0 1 -2">
    <Transform rotation="0 0 1 3.14">
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  </Transform>
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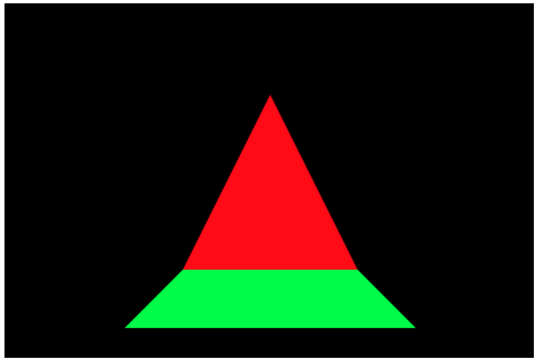
</Scene>
```



$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & -2 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

push

$$\begin{bmatrix} \mathbf{4} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{2} & \mathbf{0} & \mathbf{2} \\ \mathbf{0} & \mathbf{0} & \mathbf{2} & \mathbf{-4} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{1} \end{bmatrix}$$

$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

MATRIZ

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

PILHA

Empilhando e Atualizando Transformação

```
<Scene>
 <Transform scale="2 2 2">
  <Shape>
   <TriangleSet>
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   <Transform translation="0 -1 -1">
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     </TriangleSet>
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      <Material diffuseColor='0 1 0'/>
     </Appearance>
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   </Transform>
   <Transform translation="0 1 -2">
    <Transform rotation="0 0 1 3.14">
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      <Appearance>
       <Material diffuseColor='0 0 1'/>
      </Appearance>
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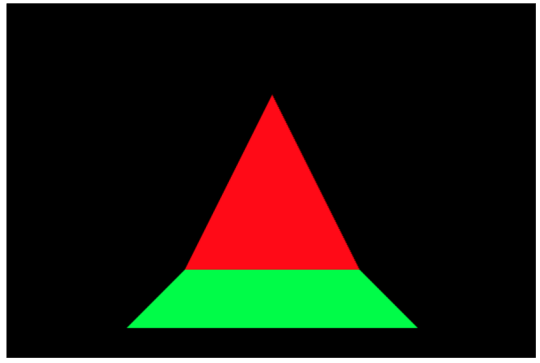
    </Transform>
   </Transform>
  </Transform>
 </Transform>
</Scene>
```



push

$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 2 \\ 0 & 0 & 2 & -4 \\ 0 & 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} \mathbf{-4} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{-2} & \mathbf{0} & \mathbf{2} \\ \mathbf{0} & \mathbf{0} & \mathbf{2} & \mathbf{-4} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{1} \end{bmatrix}$$

$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 2 \\ 0 & 0 & 2 & -4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

MATRIZ

$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

PILHA

Insper

Desenhando Triângulo Azul

```
<Scene>
 <Transform scale="2 2 2">
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  </Shape>
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   <Transform translation="0 1 -2">
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    </Transform>
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  </Transform>
 </Transform>
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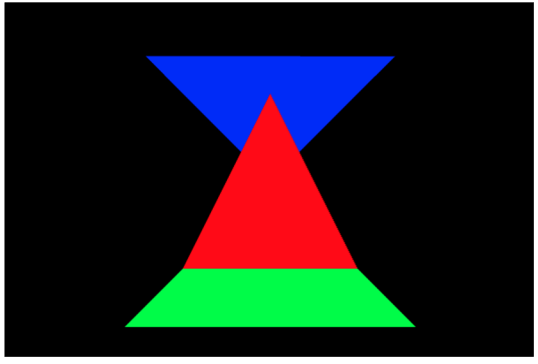
```



draw

$$\begin{bmatrix} -4 & 0 & 0 & 0 \\ 0 & -2 & 0 & 2 \\ 0 & 0 & 2 & -4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

MATRIZ

$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 2 \\ 0 & 0 & 2 & -4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

PILHA

Desempilhando e Atualizando Transformação

```
<Scene>
 <Transform scale="2 2 2">
  <Shape>
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   <Transform translation="0 1 -2">
    <Transform rotation="0 0 1 3.14">
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 </Transform>
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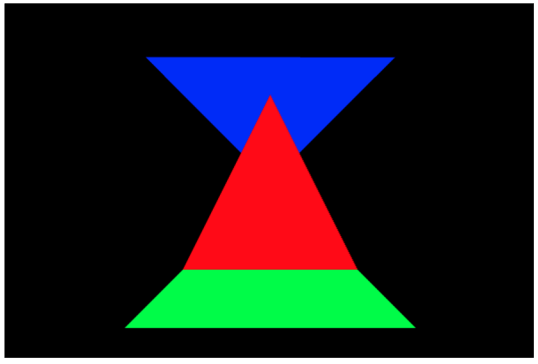
pop



$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 2 \\ 0 & 0 & 2 & -4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} -4 & 0 & 0 & 0 \\ 0 & -2 & 0 & 2 \\ 0 & 0 & 2 & -4 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

MATRIZ PILHA

Insper

Desempilhando e Atualizando Transformação

```
<Scene>
 <Transform scale="2 2 2">
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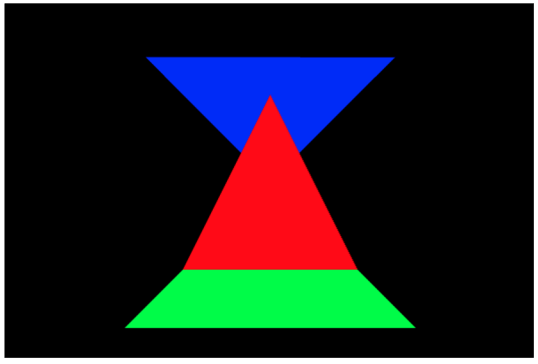
    </Transform>
   </Transform>
  </Transform>
 </Transform>
</Scene>
```

pop



$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 2 \\ 0 & 0 & 2 & -4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

MATRIZ

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

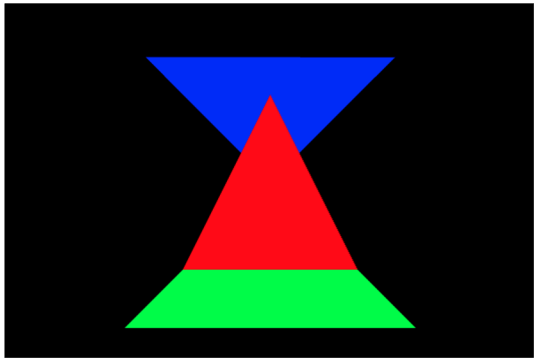
PILHA

Insper

Desempilhando e Atualizando Transformação

```
<Scene>
 <Transform scale="2 2 2">
  <Shape>
   <TriangleSet>
    <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
   </TriangleSet>
   <Appearance>
    <Material diffuseColor='1 0 0'/>
   </Appearance>
  </Shape>
  <Transform scale="2 1 1">
   <Transform translation="0 -1 -1">
    <Shape>
     <TriangleSet>
      <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
     </TriangleSet>
     <Appearance>
      <Material diffuseColor='0 1 0'/>
     </Appearance>
    </Shape>
   </Transform>
   <Transform translation="0 1 -2">
    <Transform rotation="0 0 1 3.14">
     <Shape>
      <TriangleSet>
       <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
      </TriangleSet>
      <Appearance>
       <Material diffuseColor='0 0 1'/>
      </Appearance>
     </Shape>
    </Transform>
   </Transform>
  </Transform>
 </Transform>
</Scene>
```

pop



$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} 4 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

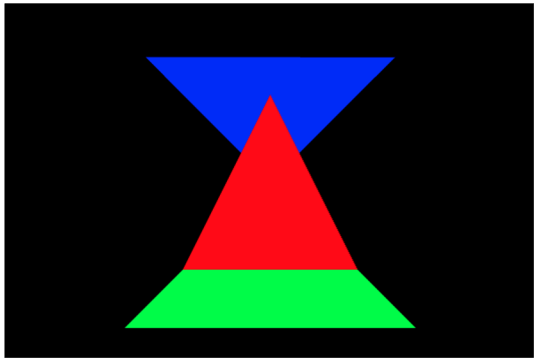
MATRIZ PILHA

Insper

Desempilhando e Atualizando Transformação

```
<Scene>
 <Transform scale="2 2 2">
  <Shape>
   <TriangleSet>
    <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
   </TriangleSet>
   <Appearance>
    <Material diffuseColor='1 0 0'/>
   </Appearance>
  </Shape>
  <Transform scale="2 1 1">
   <Transform translation="0 -1 -1">
    <Shape>
     <TriangleSet>
      <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
     </TriangleSet>
     <Appearance>
      <Material diffuseColor='0 1 0'/>
     </Appearance>
    </Shape>
   </Transform>
   <Transform translation="0 1 -2">
    <Transform rotation="0 0 1 3.14">
     <Shape>
      <TriangleSet>
       <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
      </TriangleSet>
      <Appearance>
       <Material diffuseColor='0 0 1'/>
      </Appearance>
     </Shape>
    </Transform>
   </Transform>
  </Transform>
 </Transform>
</Scene>
```

pop



$$\begin{bmatrix} 2 & 0 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

MATRIZ

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

PILHA

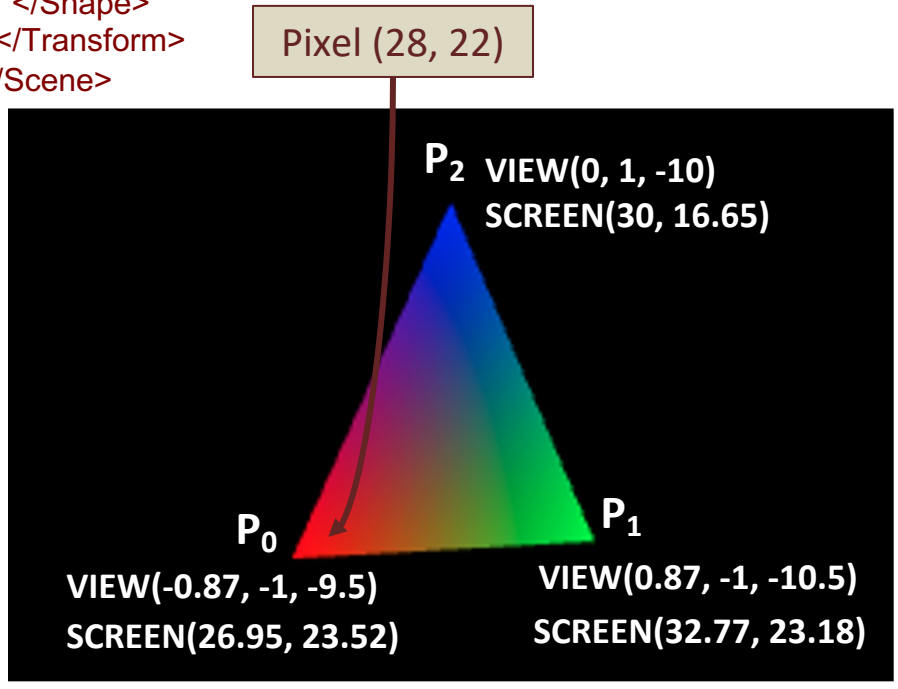
Insper

Interpolação em Triângulos

Triângulo com vértices de cores diferentes

```
<Scene>
  <Viewpoint position="0 0 10"/>
  <Transform rotation="0 1 0 0.52">
    <Shape>
      <IndexedFaceSet colorPerVertex='true' coordIndex='0 1 2 -1'>
        <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
        <Color color='1 0 0 0 1 0 0 0 1'/>
      </IndexedFaceSet>
    </Shape>
  </Transform>
</Scene>
```

30°



Distâncias do ponto(28, 22) as arestas

L(x, y) = (x – x0)(y1 – y0) – (y – y0)(x1 – x0)

L_0 = (28.5 - 32.77)(16.65 - 23.18) - (22.5 - 23.18)(30 - 32.77)
L_0 = (-4.27)(-6.53) - (-0.68)(-2.77)
L_0 = 27.8831 - 1.8836
L_0 = 25.9995

L_1 = (28.5 - 30)(23.52 - 16.65) - (22.5 – 16.65)(26.95 - 30)
L_1 = (-1.5)(6.87) - (5.85)(-3.05)
L_1 = -10.305 + 17.8425
L_1 = 7.5375

L_2 = (28.5 - 26.95)(23.18 - 23.52) - (22.5 - 23.52)(32.77 - 26.95)
L_2 = (1.55)(-0.34) - (-1.02)(5.82)
L_2 = -0.527 + 5.9364
L_2 = 5.4094

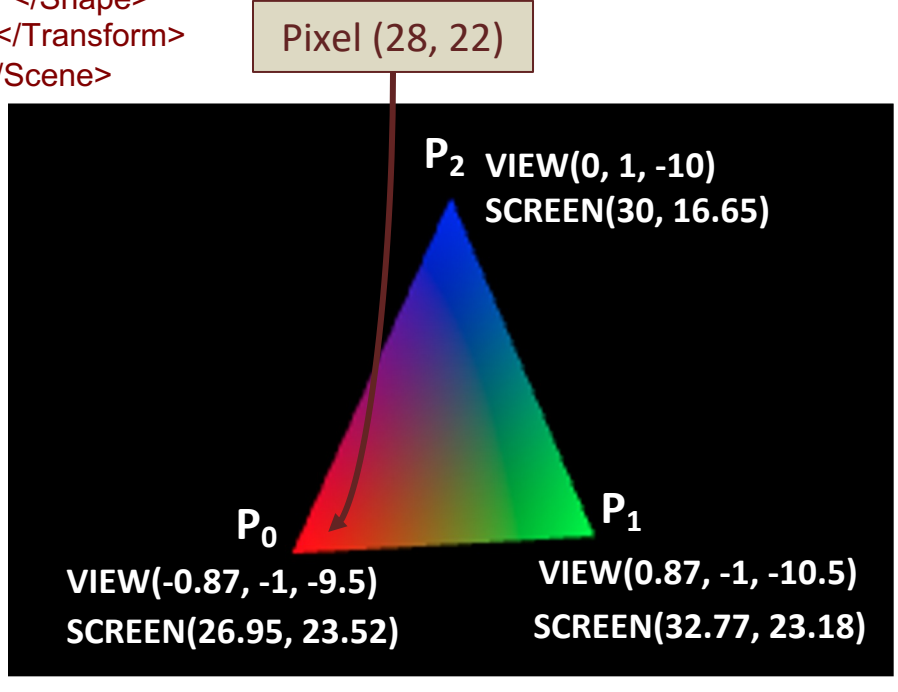
Todos positivos: Dentro !!!

Insper

Triângulo com vértices de cores diferentes

```
<Scene>
  <Viewpoint position="0 0 10"/>
  <Transform rotation="0 1 0 0.52">
    <Shape>
      <IndexedFaceSet colorPerVertex='true' coordIndex='0 1 2 -1'>
        <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
        <Color color='1 0 0 0 1 0 0 0 1'/>
      </IndexedFaceSet>
    </Shape>
  </Transform>
</Scene>
```

30°



Área dos triângulos:

Area = $|x_0(y_1–y_2) + x_1(y_2–y_0) + x_2(y_0–y_1)| / 2$

A = |26.95(23.18-16.65)+32.77(16.65-23.52)+30(23.52-23.18)|/2
A = |26.95(6.53)+32.77(-6.87)+30(0.34)|/2
A = |175.9835-225.1299+10.2|/2

A = 19.4732

A_0 = |28.5(23.18-16.65)+32.77(16.65-22.5)+30(22.5-23.18)|/2
A_0 = |28.5(6.53)+32.77(-5.85)+30(-0.68)|/2
A_0 = |186.105-191.7045-20.4|/2

A_0 = 12.99975

A_1 = |28.5(16.65-23.52)+30(23.52-22.5)+26.95(22.5-16.65)|/2
A_1 = |28.5(-6.87)+30(1.02)+26.95(5.85)|/2
A_1 = |-195.795+30.6+157.6575|/2

A_1 = 3.76875

A_2 = |28.5(23.52-23.18)+26.95(23.18-22.5)+32.77(22.5-23.52)|/2
A_2 = |28.5(0.34)+26.95(0.68)+32.77(-1.02)|/2
A_2 = |9.69+18.326-33.4254|/2

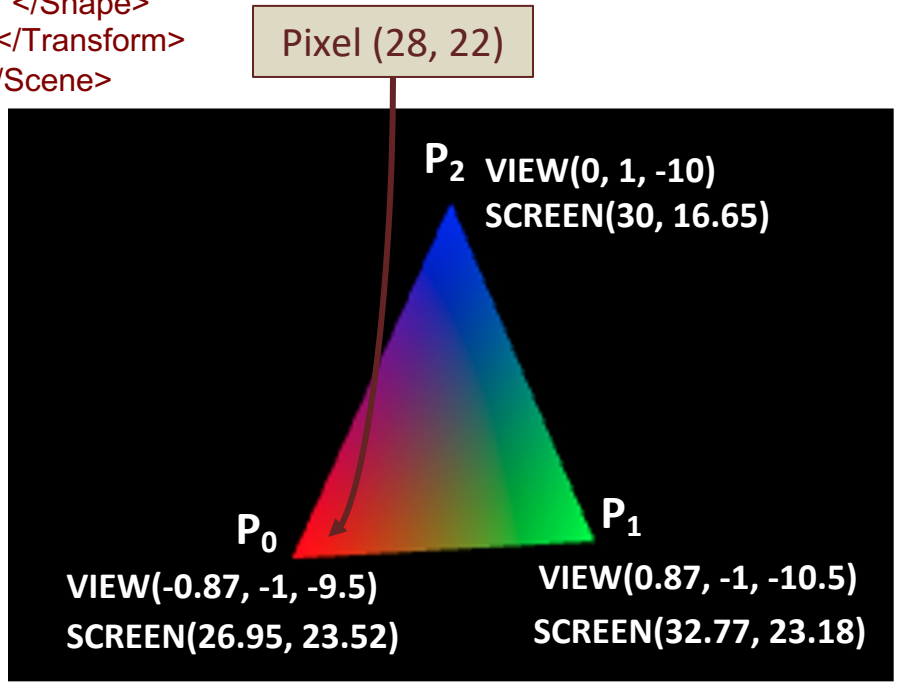
A_2 = 2.7047

Insper

Triângulo com vértices de cores diferentes

```
<Scene>
  <Viewpoint position="0 0 10"/>
  <Transform rotation="0 1 0 0.52">
    <Shape>
      <IndexedFaceSet colorPerVertex='true' coordIndex='0 1 2 -1'>
        <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
        <Color color='1 0 0 0 1 0 0 0 1'/>
      </IndexedFaceSet>
    </Shape>
  </Transform>
</Scene>
```

30°



Área dos triângulos:

A = 19.4732

A_0 = 12.99975

A_1 = 3.76875

A_2 = 2.7047

Pesos

α = 12.99975 / 19.4732 ~= 0.668

β = 3.76875 / 19. 4732 ~= 0.194

γ = 2.7047 / 19. 4732 ~= 0.139

ou

γ = 1 – α - β ~= 0.138

Cor do pixel:

$R = \alpha R_0 + \beta R_1 + \gamma R_2 = 0.668$

$G = \alpha G_0 + \beta G_1 + \gamma G_2 = 0.194$

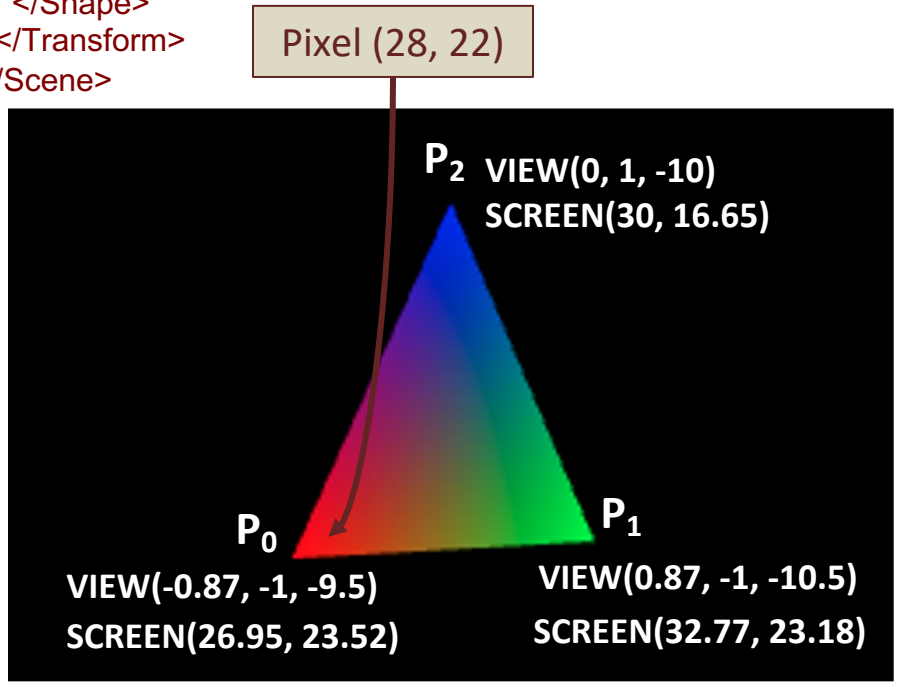
$B = \alpha B_0 + \beta B_1 + \gamma B_2 = 0.139$

C = (0.668, 0.194, 0.139)

Cores do Triângulo com Correção Perspectiva

```
<Scene>
  <Viewpoint position="0 0 10"/>
  <Transform rotation="0 1 0 0.52">
    <Shape>
      <IndexedFaceSet colorPerVertex='true' coordIndex='0 1 2 -1'>
        <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
        <Color color='1 0 0 0 1 0 0 0 1'/>
      </IndexedFaceSet>
    </Shape>
  </Transform>
</Scene>
```

30°



Pesos

$\alpha = 0.668$ $\quad Z_0 = |-9.5| = 9.5$

$\beta = 0.194$ $\quad Z_1 = |-10.5| = 10.5$

$\gamma = 0.139$ $\quad Z_2 = |-10.0| = 10$

$$Z = \frac{1}{\alpha \frac{1}{Z_0} + \beta \frac{1}{Z_1} + \gamma \frac{1}{Z_2}}$$

$$Z = \frac{1}{0.668 \frac{1}{9.5} + 0.194 \frac{1}{10.5} + 0.139 \frac{1}{10}}$$

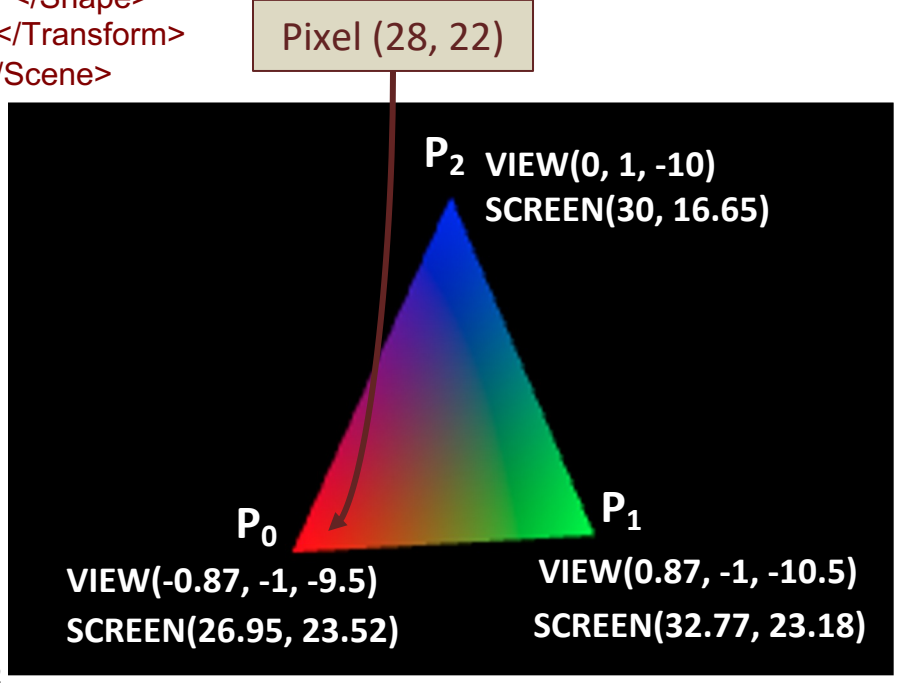
$$Z = \frac{1}{0.0703 + 0.0185 + 0.0139}$$

$$Z = 9.74$$

Cores do Triângulo com Correção Perspectiva

```
<Scene>
  <Viewpoint position="0 0 10"/>
  <Transform rotation="0 1 0 0.52">
    <Shape>
      <IndexedFaceSet colorPerVertex='true' coordIndex='0 1 2 -1'>
        <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
        <Color color='1 0 0 0 1 0 0 0 1'/>
      </IndexedFaceSet>
    </Shape>
  </Transform>
</Scene>
```

30°



Pesos
α = 0.668
β = 0.194
γ = 0.139

$Z_0 = |-9.5| = 9.5$
$Z_1 = |-10.5| = 10.5$
$Z_2 = |-10.0| = 10$

$Z = 9.74$

$$C = Z \cdot \left(\alpha \frac{C_0}{Z_0} + \beta \frac{C_1}{Z_1} + \gamma \frac{C_2}{Z_2} \right)$$

$$C_R = 9.74 \left(0.668 \frac{1}{9.5} + 0.194 \frac{0}{10.5} + 0.139 \frac{0}{10} \right) = 0.685$$

$$C_G = 9.74 \left(0.668 \frac{0}{9.5} + 0.194 \frac{1}{10.5} + 0.139 \frac{0}{10} \right) = 0.180$$

$$C_B = 9.74 \left(0.668 \frac{0}{9.5} + 0.194 \frac{0}{10.5} + 0.139 \frac{1}{10} \right) = 0.135$$

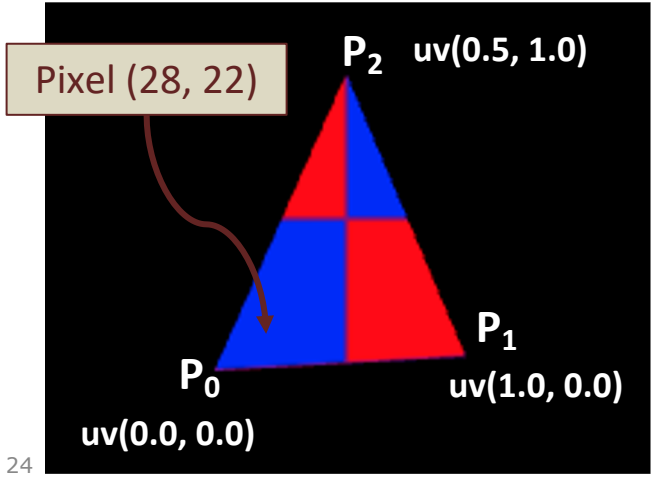
C = (0.685, 0.180, 0.135)

Insper

Aplicando Texturas

Triângulo com Texturas

```
<Scene>
  <Viewpoint position="0 0 10"/>
  <Transform rotation="0 1 0 0.52">
    <Shape>
      <IndexedFaceSet coordIndex='0 1 2 -1'>
        <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
          <TextureCoordinate point='0.0 0.0 1.0 0.0 0.5 1.0'/>
      </IndexedFaceSet>
      <Appearance>
        <ImageTexture url=' "chess.png" '/>
      </Appearance>
    </Shape>
  </Transform>
</Scene>
```



Pesos

$\alpha = 0.668$

$\beta = 0.194$

$\gamma = 0.139$

$U = \alpha U_0 + \beta U_1 + \gamma U_2$

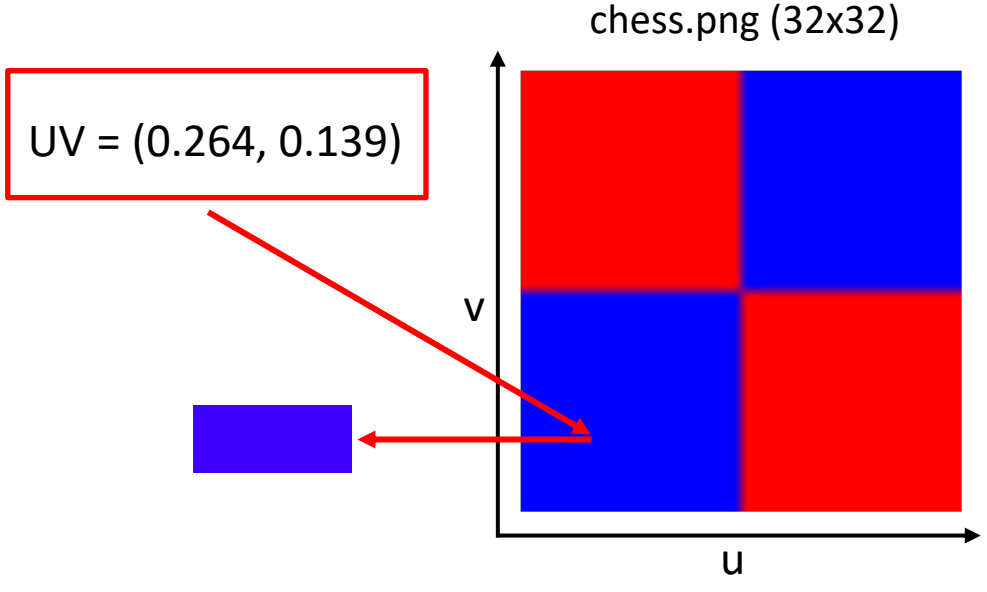
$U = 0.668*0.0 + 0.194*1.0 + 0.139*0.5$

$U = 0.2635$

$V = \alpha V_0 + \beta V_1 + \gamma V_2$

$V = 0.668*0.0 + 0.194*0.0 + 0.139*1.0$

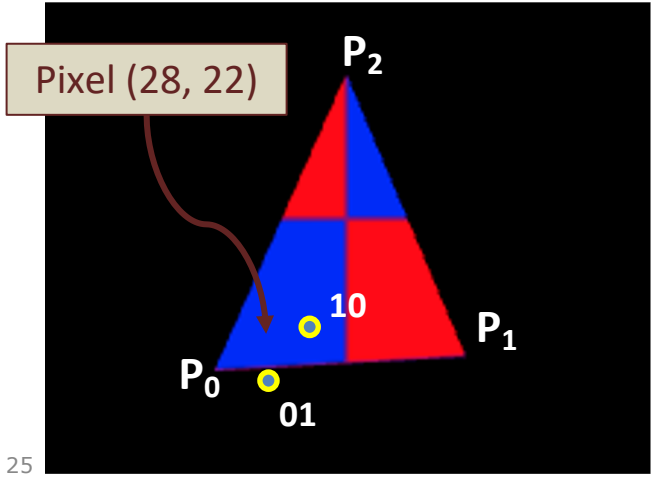
$V = 0.139$



Insper

Triângulo com Texturas MipMap

```
<Scene>
  <Viewpoint position="0 0 10"/>
  <Transform rotation="0 1 0 0.52">
    <Shape>
      <IndexedFaceSet coordIndex='0 1 2 -1'>
        <Coordinate point='-1 -1 0 1 -1 0 0 1 0'/>
          <TextureCoordinate point='0.0 0.0 1.0 0.0 0.5 1.0'/>
      </IndexedFaceSet>
      <Appearance>
        <ImageTexture url=' "chess.png" '/>
      </Appearance>
    </Shape>
  </Transform>
</Scene>
```



UV = (0.264, 0.139)

Coordenadas (u,v)

$pixel_{10}(29, 22) \Rightarrow UV(0.414, 0.129)$

$pixel_{01}(28, 23) \Rightarrow UV(0.248, -0.010)$

$$\frac{\partial u}{\partial x} = \frac{u_{10} - u_{00}}{1} \qquad \frac{\partial v}{\partial x} = \frac{v_{10} - v_{00}}{1}$$

$$\frac{\partial u}{\partial y} = \frac{u_{01} - u_{00}}{1} \qquad \frac{\partial v}{\partial y} = \frac{v_{01} - v_{00}}{1}$$

Triângulo com Texturas MipMap

U = 0.264
V = 0.139

Coordenadas (u,v)
$pixel_{10}(29, 22) \Rightarrow UV(0.414, 0.129)$
$pixel_{01}(28, 23) \Rightarrow UV(0.248, -0.010)$

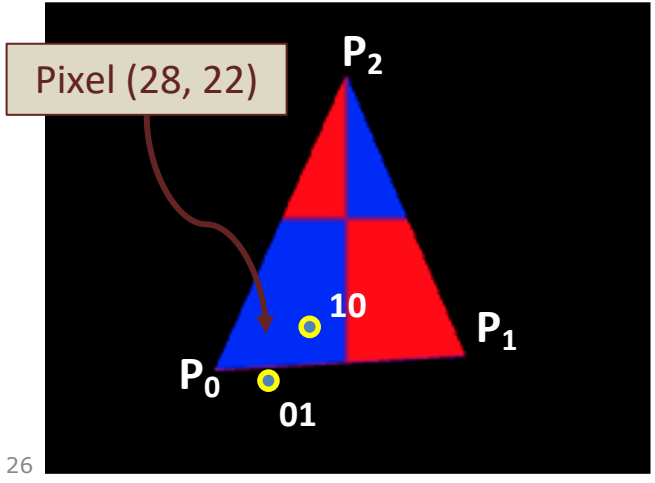
x 32

$$\frac{\partial u}{\partial x} = \frac{u_{10} - u_{00}}{1} = 32\left(\frac{0.414-0.264}{1}\right) = 4.8$$

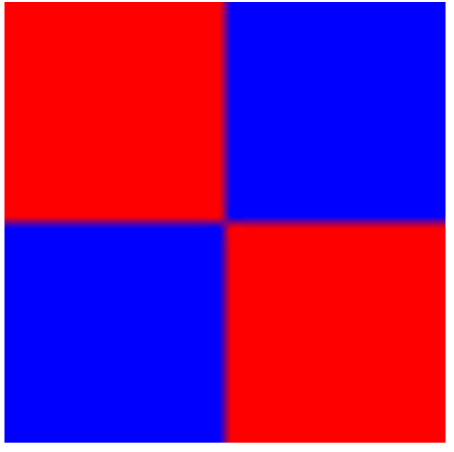
$$\frac{\partial v}{\partial x} = \frac{v_{10} - v_{00}}{1} = 32\left(\frac{0.129-0.139}{1}\right) = -0.32$$

$$\frac{\partial u}{\partial y} = \frac{u_{01} - u_{00}}{1} = 32\left(\frac{0.248-0.264}{1}\right) = -0.56$$

$$\frac{\partial v}{\partial y} = \frac{v_{01} - v_{00}}{1} = 32\left(\frac{-0.010-0.139}{1}\right) = -4.8$$



chess.png (32x32)



Insper

Triângulo com Texturas MipMap

Coordenadas (u,v)

U = 0.264

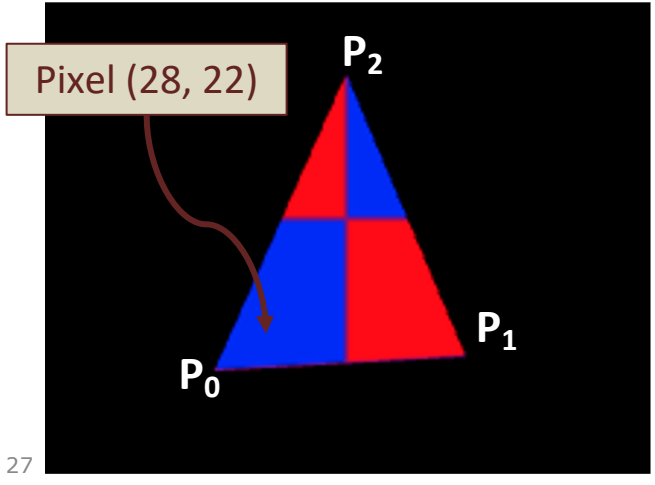
V = 0.139

$pixel_{10}(29, 22) \Rightarrow UV(0.414, 0.129)$

$pixel_{01}(28, 23) \Rightarrow UV(0.248, -0.010)$

$$\frac{du}{dx} = 4.8 \qquad \frac{dv}{dx} = -0.32$$

$$\frac{du}{dy} = -0.56 \qquad \frac{dv}{dy} = -4.8$$



$$D = \log_2 L$$

$$L = \max\left(\sqrt{\left(\frac{du}{dx}\right)^2 + \left(\frac{dv}{dx}\right)^2}, \sqrt{\left(\frac{du}{dy}\right)^2 + \left(\frac{dv}{dy}\right)^2}\right)$$

$$L = \max\left(\sqrt{(4.8)^2 + (-0.32)^2}, \sqrt{(-0.56)^2 + (-4.8)^2}\right)$$

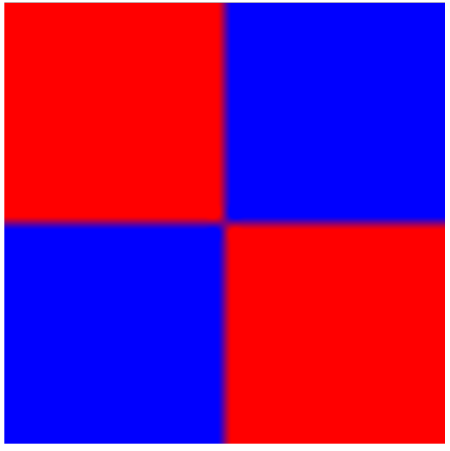
$$L = \max(4.81, 4,83)$$

L = 4.83

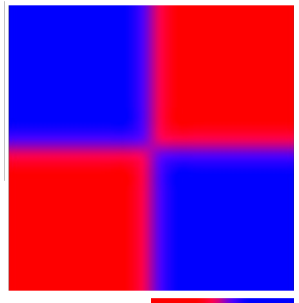
D = 2.27

D = 2

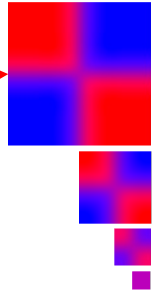
chess.png (32x32)



0



1 (16x16)



2 (8x8)

3 (4x4)

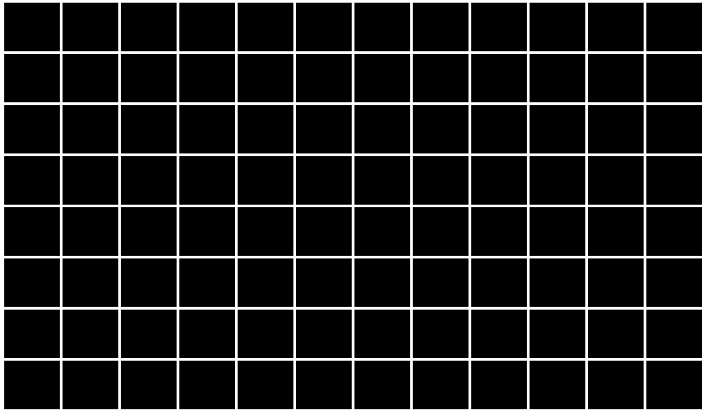
Insper

Z-Buffer

Desenhando com Z-Buffer

```
<Scene>
  <Transform translation="1 0 0">
    <Shape>
      <TriangleSet>
        <Coordinate point='-2 -2 0 2 -2 0 0 2 0'/>
      </TriangleSet>
      <Appearance>
        <Material emissiveColor='1 0 0'/>
      </Appearance>
    </Shape>
  </Transform>
  <Transform translation="-1 0 0">
    <Shape>
      <TriangleSet>
        <Coordinate point='-2 -2 -1 2 -2 -1 0 2 -1'/>
      </TriangleSet>
      <Appearance>
        <Material emissiveColor='0 0 1'/>
      </Appearance>
    </Shape>
  </Transform>
</Scene>
```

Cores



Profundidade

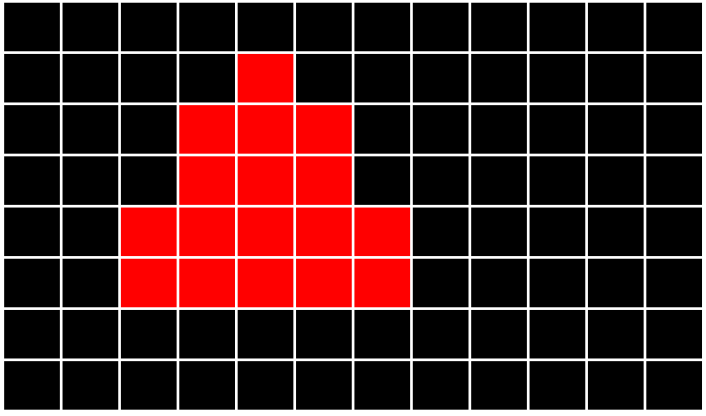
1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1

Insper

Desenhando com Z-Buffer

```
<Scene>
  <Transform translation="1 0 0">
    <Shape>
      <TriangleSet>
        <Coordinate point='-2 -2 0 2 -2 0 0 2 0'/>
      </TriangleSet>
      <Appearance>
        <Material emissiveColor='1 0 0'/>
      </Appearance>
    </Shape>
  </Transform>
  <Transform translation="-1 0 0">
    <Shape>
      <TriangleSet>
        <Coordinate point='-2 -2 -1 2 -2 -1 0 2 -1'/>
      </TriangleSet>
      <Appearance>
        <Material emissiveColor='0 0 1'/>
      </Appearance>
    </Shape>
  </Transform>
</Scene>
```

Cores



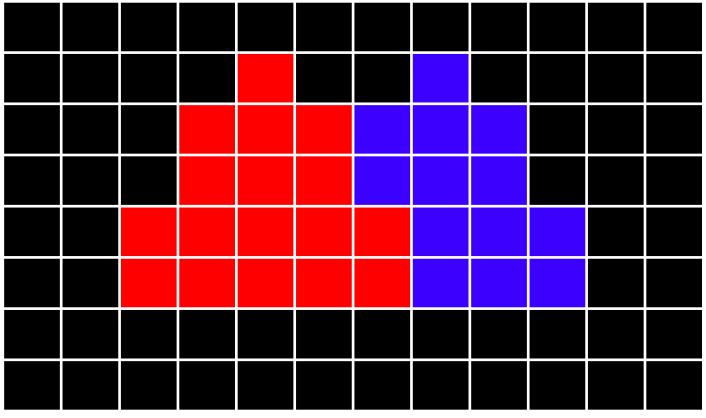
Profundidade

1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	0.8	1	1	1	1	1	1	1
1	1	1	0.8	0.8	0.8	1	1	1	1	1	1
1	1	1	0.8	0.8	0.8	1	1	1	1	1	1
1	1	0.8	0.8	0.8	0.8	0.8	1	1	1	1	1
1	1	0.8	0.8	0.8	0.8	0.8	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1

Desenhando com Z-Buffer

```
<Scene>
  <Transform translation="1 0 0">
    <Shape>
      <TriangleSet>
        <Coordinate point='-2 -2 0 2 -2 0 0 2 0'/>
      </TriangleSet>
      <Appearance>
        <Material emissiveColor='1 0 0'/>
      </Appearance>
    </Shape>
  </Transform>
  <Transform translation="-1 0 0">
    <Shape>
      <TriangleSet>
        <Coordinate point='-2 -2 -1 2 -2 -1 0 2 -1'/>
      </TriangleSet>
      <Appearance>
        <Material emissiveColor='0 0 1'/>
      </Appearance>
    </Shape>
  </Transform>
</Scene>
```

Cores



Profundidade

1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	0.8	1	1	0.9	1	1	1	1
1	1	1	0.8	0.8	0.8	0.9	0.9	0.9	1	1	1
1	1	1	0.8	0.8	0.8	0.9	0.9	0.9	1	1	1
1	1	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	1	1
1	1	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	1	1
1	1	1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1	1	1	1	1

Transparência

Transparência

```
<Scene>
 <Transform translation="-1 0 0">
  <Shape>
   <TriangleSet>
    <Coordinate point='-2 -2 -1 2 -2 -1 0 2 -1'/>
   </TriangleSet>
   <Appearance>
    <Material emissiveColor ='0 0 1'/>
   </Appearance>
  </Shape>
 </Transform>
 <Transform translation="1 0 0">
  <Shape>
   <TriangleSet>
    <Coordinate point='-2 -2 0 2 -2 0 0 2 0'/>
   </TriangleSet>
   <Appearance>
    <Material emissiveColor='1 1 0'
              transparency='0.2'/>
   </Appearance>
  </Shape>
 </Transform>
</Scene>
```

Cores

(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,1)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,0)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,0)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)

```
cor_anterior = framebuffer[x,y] * transparência
cor_nova = rbg * (1 – transparência)
framebuffer[x,y] = cor_anterior + cor_nova
```

Transparência

```
<Scene>
 <Transform translation="-1 0 0">
  <Shape>
   <TriangleSet>
    <Coordinate point='-2 -2 -1 2 -2 -1 0 2 -1'/>
   </TriangleSet>
   <Appearance>
    <Material emissiveColor ='0 0 1'/>
   </Appearance>
  </Shape>
 </Transform>
 <Transform translation="1 0 0">
  <Shape>
   <TriangleSet>
    <Coordinate point='-2 -2 0 2 -2 0 0 2 0'/>
   </TriangleSet>
   <Appearance>
    <Material emissiveColor='0 1 0'
              transparency='0.4'/>
   </Appearance>
  </Shape>
 </Transform>
</Scene>
```

Cores

(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0.6,0)	(0,0,0)	(0,0,0)	(0,0,1)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0,0)	(0,0.6,0)	(0,0.6,0)	(0,0.6,0)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,0)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0,0)	(0,0.6,0)	(0,0.6,0)	(0,0.6,0)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,0)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0.6,0)	(0,0.6,0)	(0,0.6,0)	(0,0.6,0.4)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0.6,0)	(0,0.6,0)	(0,0.6,0)	(0,0.6,0.4)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,1)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)
(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)	(0,0,0)

```
cor_anterior = framebuffer[x,y] * transparência
cor_nova = rbg * (1 – transparência)
framebuffer[x,y] = cor_anterior + cor_nova
```

Insper

Computação Gráfica

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