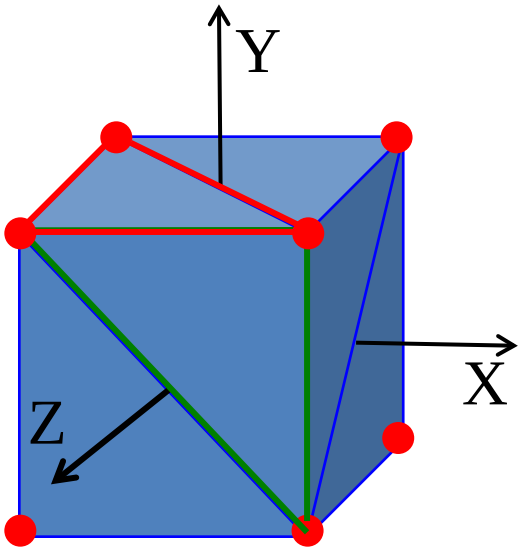
Classe 2: Contingut

- Introducció a hardware gràfic de sortida
- Introducció al procés de visualització
- **Transformacions geomètriques**
- Exercicis

Model Fronteres: conjunt de triangles



SCM

Vèrtexs

x	y	z
-1	1	-1
-1	1	1
1	1	1
-1	1	1
1	-1	1
1	1	1
.	.	.
.	.	.

Topologia implícita

Cares

normal	*Id* Vèrtexs
a_1, b_1, c_1	1,2,3
a_2, b_2, c_2	2,4,3
…	…

Vèrtexs

x	y	z
-1	1	-1
-1	1	1
1	1	1
1	-1	1
1	-1	-1
1	1	-1
-1	-1	-1
-1	-1	1

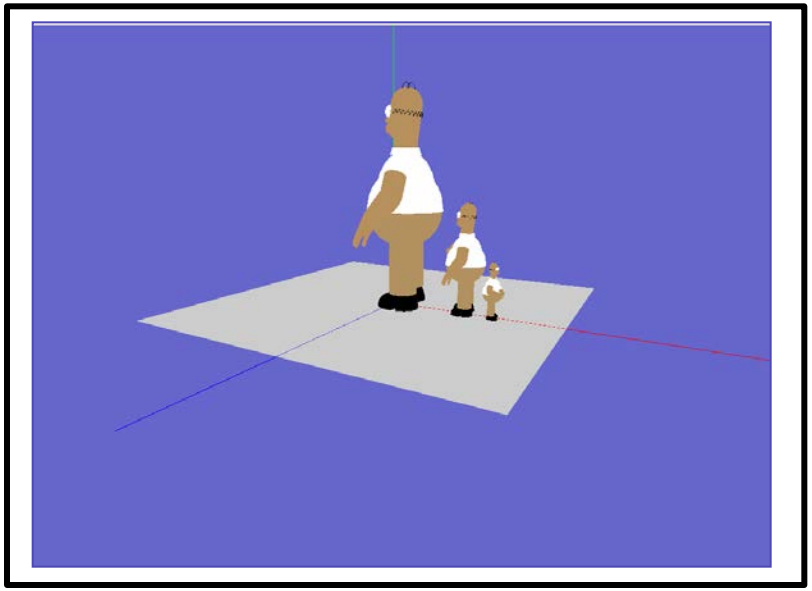
Topologia explícita

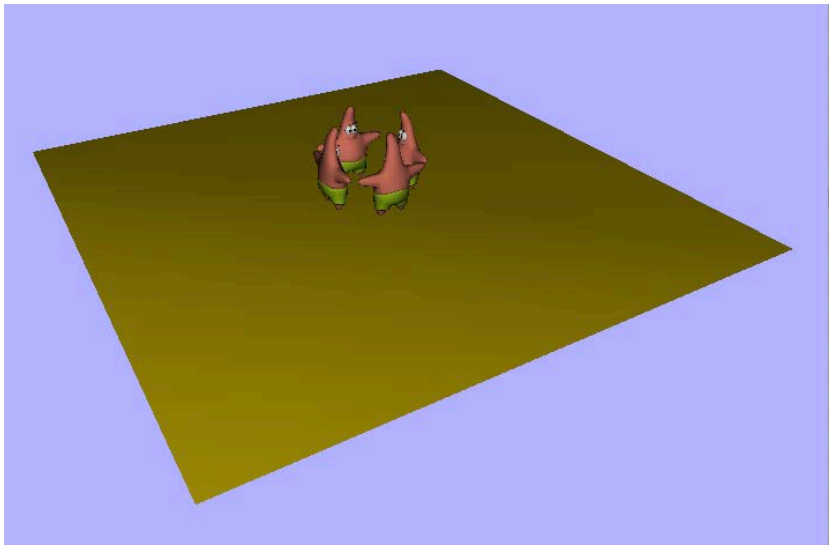
Llegim la informació de Cub.OBJ

glm::vec3 Vertices[36]

Assignem valors en el codi a estructures C++

Escenes: Conjunt d'objectes

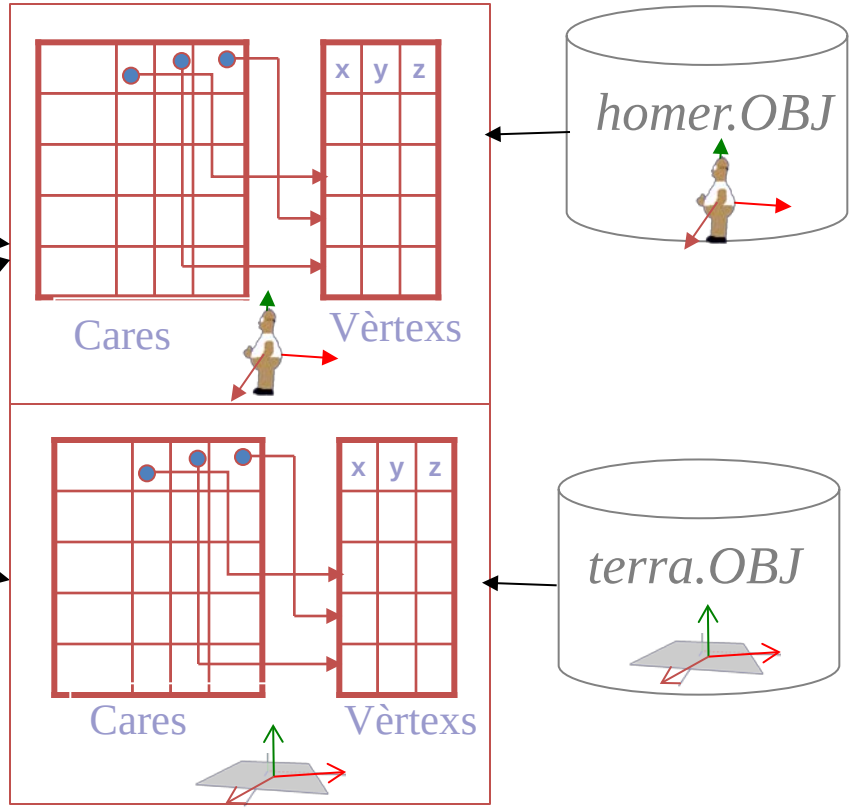




Escenes: Objectes en SCM.

Objectes

nom			model
h1			
h2			
h3			
terra			

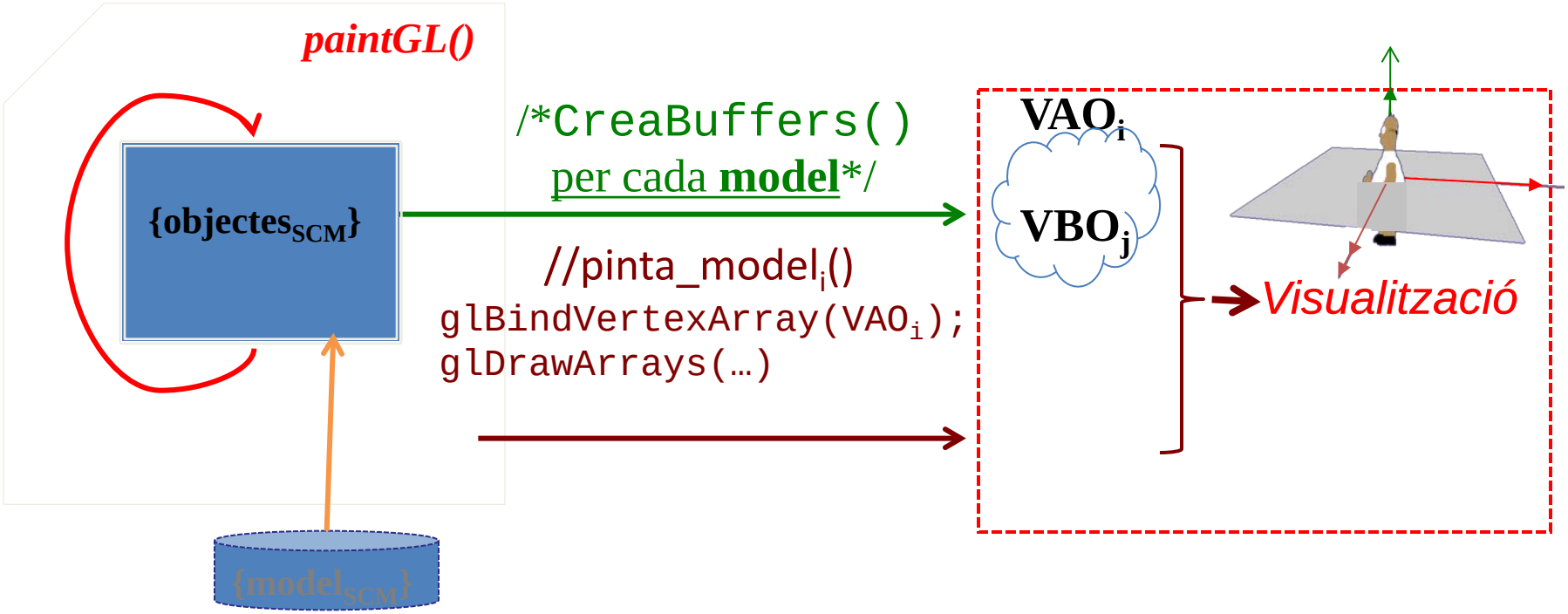


Models en SCM

Escenes: Objectes en SCM. Com fem per visualitzar? (1)

```
/*crear un únic VAO_i i VBO_j per cada model, en CreaBuffers()*/
per cada model
    llegir_Model ();
    crear i omplir VAO_i,VBO_j
fper
```

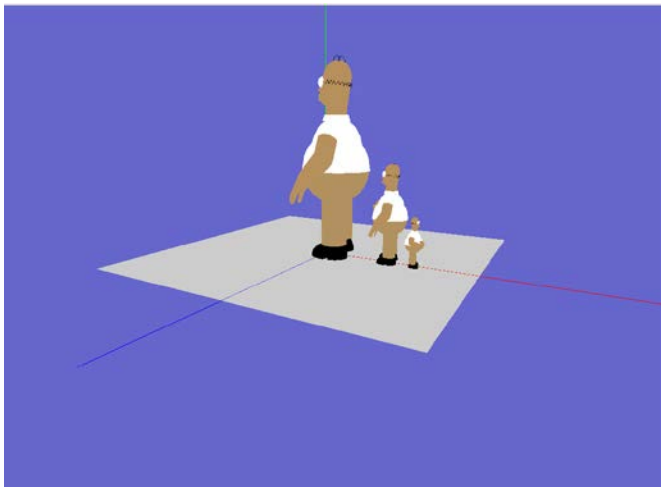
```
//paintGL ();
per cada objecte_i
    // activa VAO_i i pinta
  pinta_model_i ();
fper
```

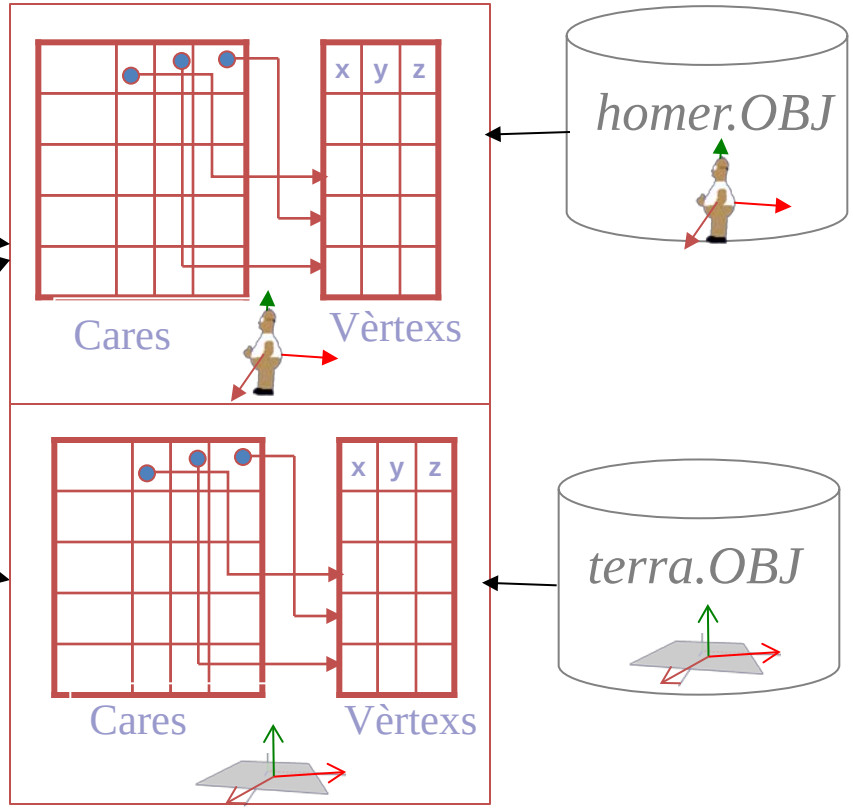


Escenes: Objectes en SCM.

Objectes

nom	…	TG	model
h1			
h2			
h3			
terra			



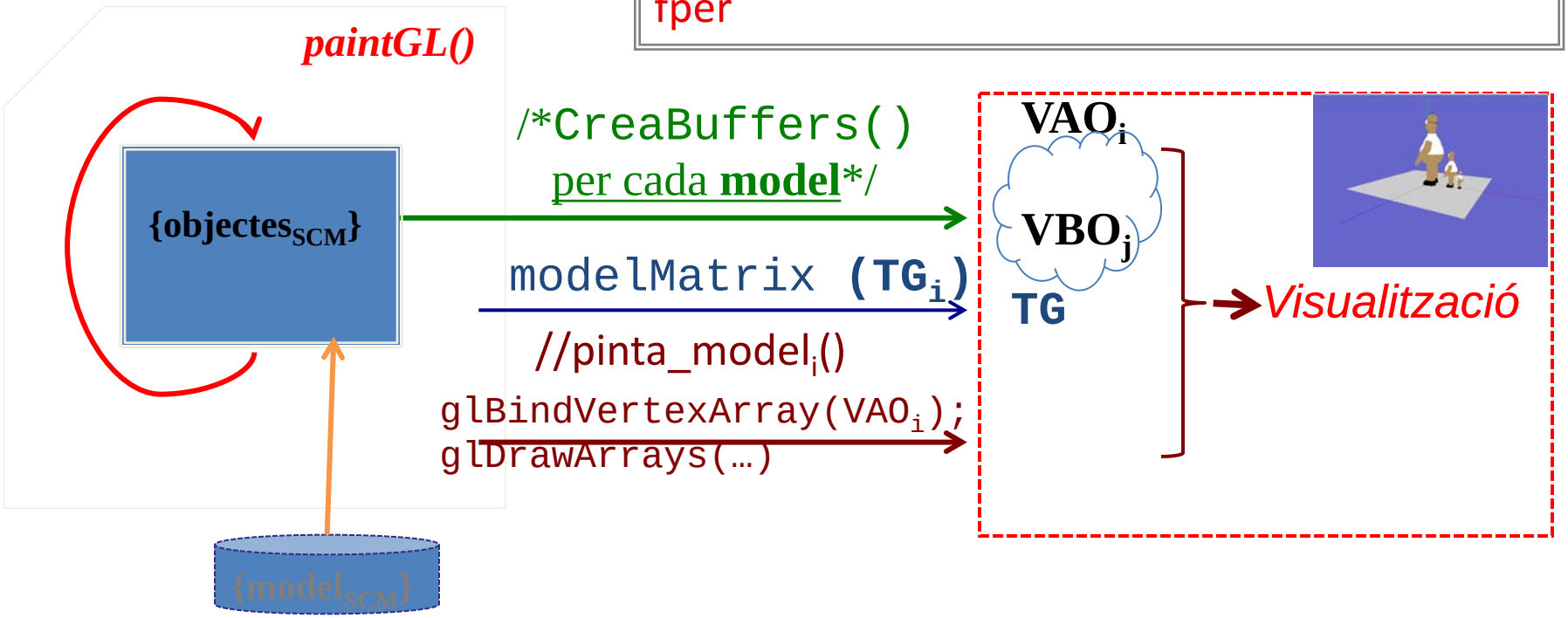


Models

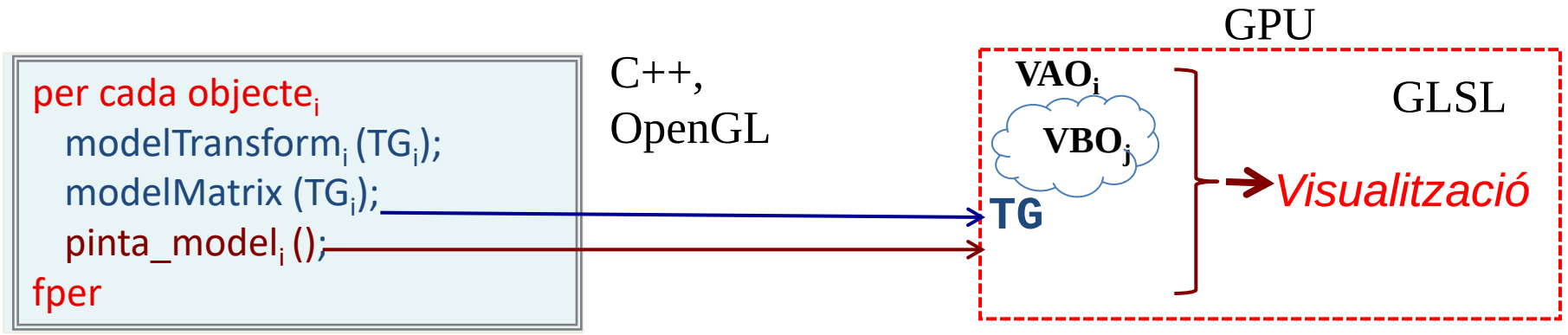
Escenes: Objectes en SCM. Com fem per visualitzar? (2)

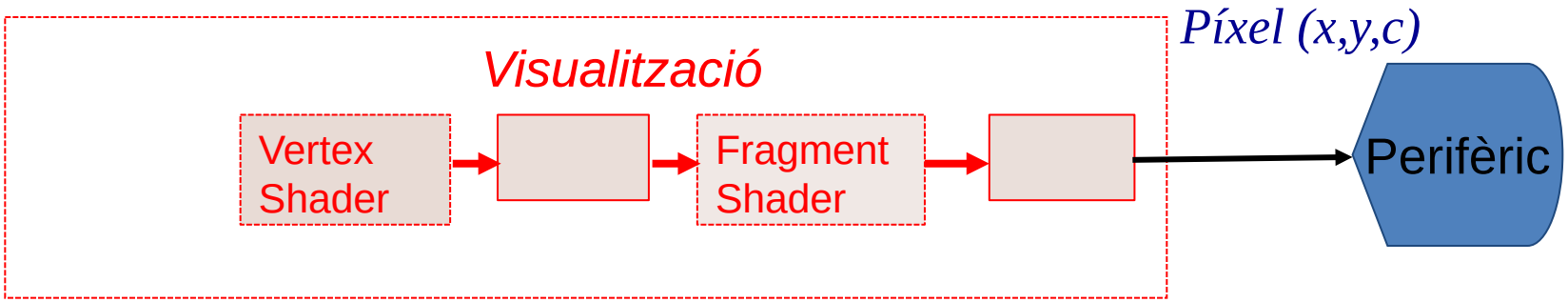
```
/*crear un únic VAO_i i VBO_j per cada model, en CreaBuffers()*/
per cada model
    llegir_Model ();
    crear i omplir VAO_i,VBO_j
fper
```

```
//paintGL ();
per cada objecte_i
    //Obtenir/calcular la TG_i a aplicar a model
    modelTransform_i (TG_i);
    //indicar a OpenGL la TG_i enviant "uniform"
    modelMatrix (TG_i);
    pinta_model_i (); //el VAO_i del seu model
fper
```



Pintar en OpenGL 3.3: "core" mode

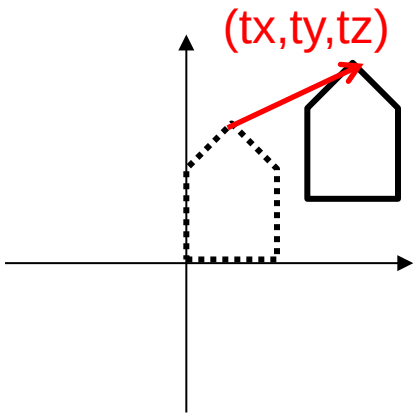




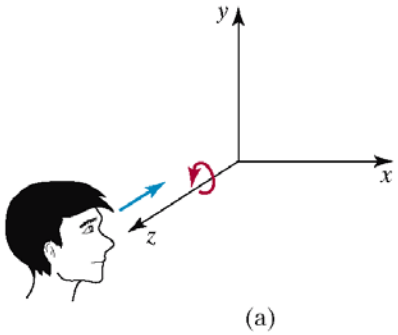

```
#version 330 core
in vec3 vertex;
uniform mat4 TG;

void main()  {
 gl_Position = TG * vec4(vertex,1.0);
}
```

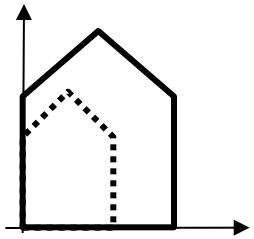
Transformacions Geomètriques

Transformació geomètrica → [ ] → Matriu 4x4 TG



x' = x+tx; y'=y+ty; z'=z+tz





T(tx,ty,tz)

$$\begin{bmatrix} 1 & 0 & 0 & tx \\ 0 & 1 & 0 & ty \\ 0 & 0 & 1 & tz \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

R_z(angle)

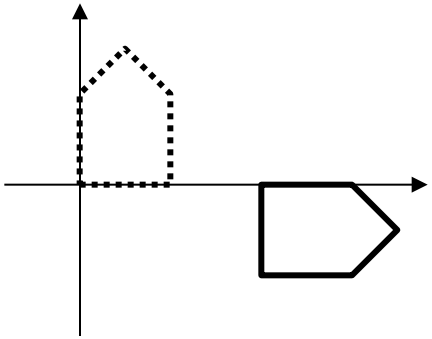
$$\begin{bmatrix} \cos\alpha & -\sin\alpha & 0 & 0 \\ \sin\alpha & \cos\alpha & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

S(sx,sy,sz)

$$\begin{bmatrix} s_x & 0 & 0 & 0 \\ 0 & s_y & 0 & 0 \\ 0 & 0 & s_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

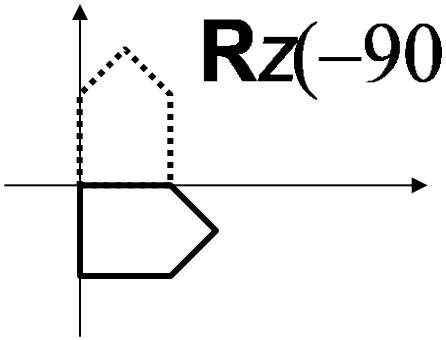
Composició de Transformacions

- Imaginem que volem

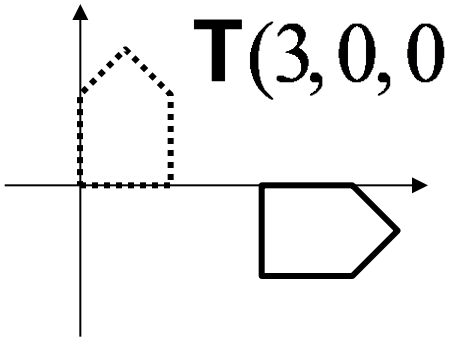


No es pot fer amb cap de les matrius anteriors

- Cal composar/efectuar dues transformacions



&



$M = T(3,0,0) \cdot R_z(-90º)$

$\mathbf{P'} = R_z(-90º) \cdot \mathbf{P}$ $\qquad$ $\mathbf{P''} = T(3,0,0) \cdot \mathbf{P'}$

$\mathbf{P''} = T(3,0,0) \cdot (R_z(-90º) \cdot \mathbf{P}) = (T(3,0,0) \cdot R_z(-90º)) \cdot \mathbf{P} = M \cdot \mathbf{P}$

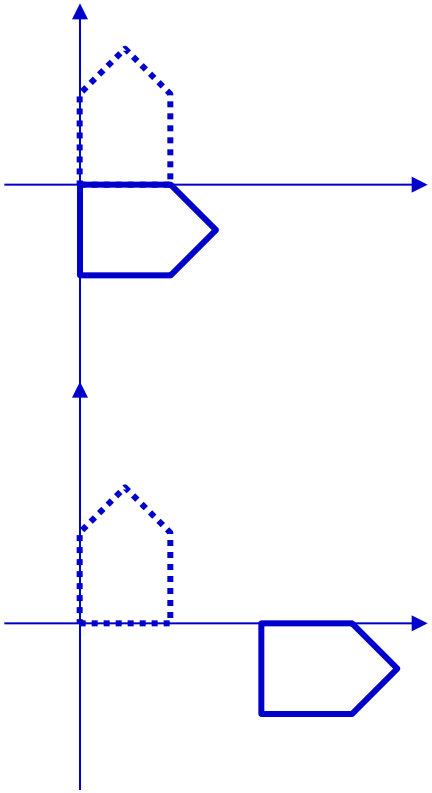
Composició de Transformacions

$$\mathbf{T}(3,0) \cdot \mathbf{R}(-90º) \neq \mathbf{R}(-90º) \cdot \mathbf{T}(3,0)$$

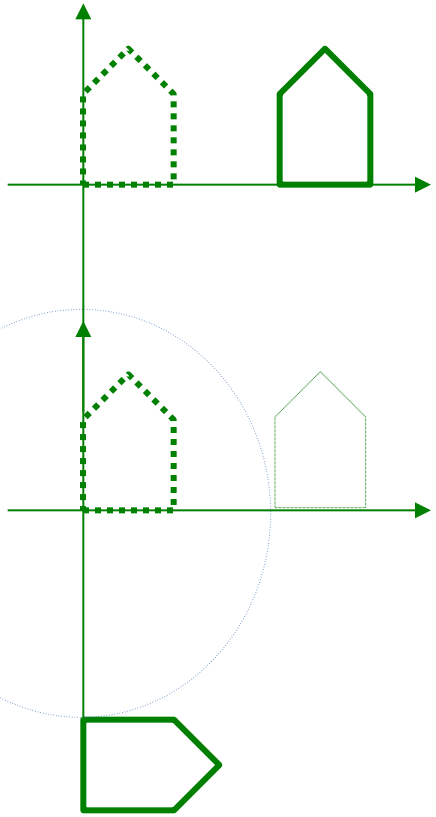
❷ ❶ ❷ ❶

- Multiplicació de matrius no és commutativa

Rotació seguida de translació



Translació seguida de rotació



Classe 2: Contingut

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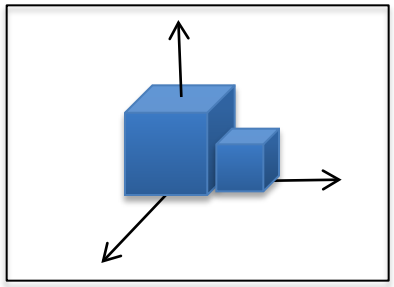
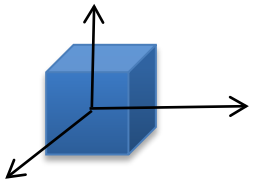
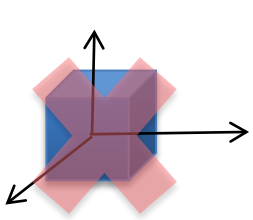
- Transformacions geomètriques
- **Exercicis**

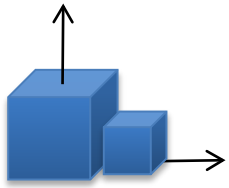
Exemple simple de TG (1)



- Visualitzar una escena com la de la figura de l'esquerra
- Utilitzant el mètode pinta_cub() que indica a OpenGL que ha de visualitzar/pintar el VAO que conté el model de triangles d'aquest cub:







```
…
CreaBuffers();
…
modelMatrix_cub1();
pinta_cub();

modelMatrix_cub2();
pinta_cub();
```

TG1

TG2

VAO

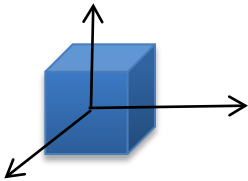
VBO

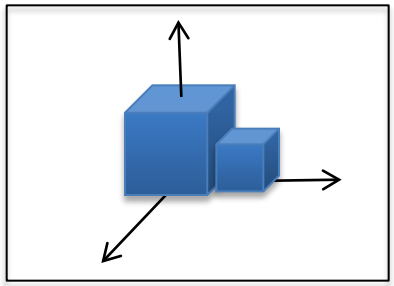
TG

OpenGL 3.3

Visualització

Exemple simple de TG (1)

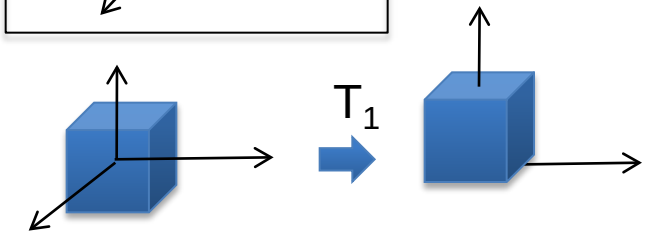




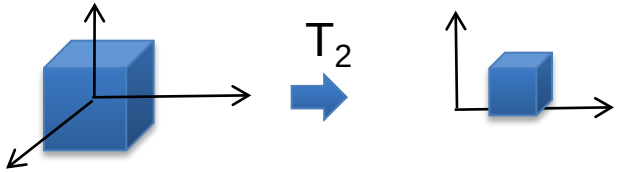
Escena a visualitzar

Pseudo-codi

```
TG= Translate (0, 0.5, 0);
modelMatrix (TG);
pinta_cub ();
TG= Translate (0.75, 0.25, 0);
TG= TG*Scale (0.5, 0.5, 0.5);
modelMatrix (TG);
pinta_cub();
```



T_1= Trans(0,0.5,0)



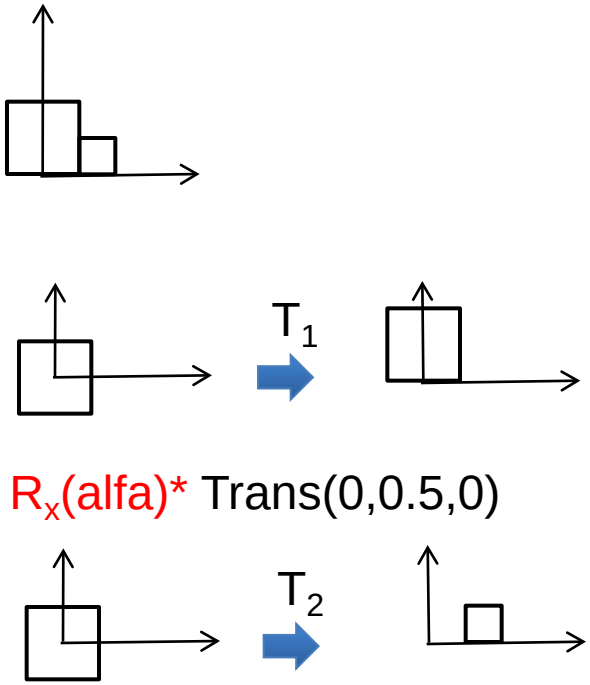
T_2= Trans(0.75,0.25,0)*S(0.5,0.5,0.5)

Exemple codi per pintar en CPU

```
glm::mat4 TG = glm::mat4(1.f);
TG= glm::translate (TG, glm::vec3(0,0.5,0));
glUniformMatrix4fv (transLoc, 1, GL_FALSE, &TG[0][0]);
pinta_cub ();

TG = glm::mat4(1.f);
TG= glm::translate (TG, glm::vec3(0.75,0.25,0));
TG= gml::scale(TG, glm::vec3(0.5,0.5,0.5));
glUniformMatrix4fv (transLoc, 1, GL_FALSE, &TG[0][0]);
pinta_cub();
```

Com faríeu per a girar tota l'escena alfa graus respecte l'eix x?

Exemple simple (2): Girar escena repecte eix X alfa graus

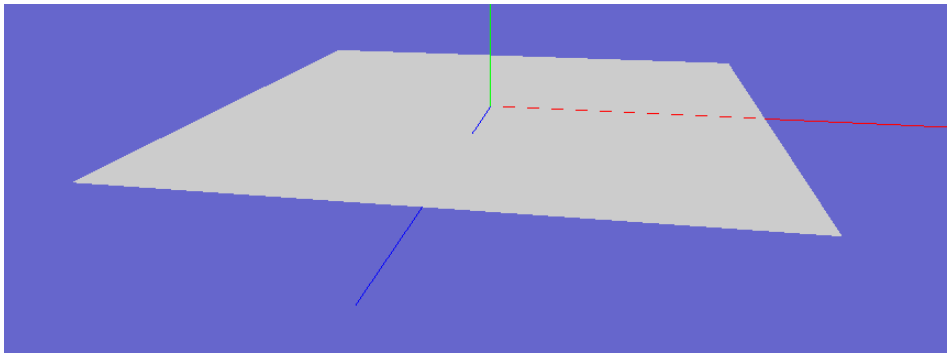


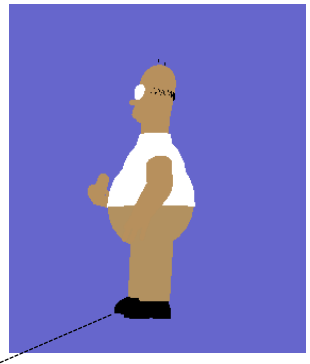
$T_1 = R_x(alfa) * Trans(0,0.5,0)$

$T_2 = R_x(alfa) * Trans(0.75,0.25,0) * S(0.5,0.5,0.5)$

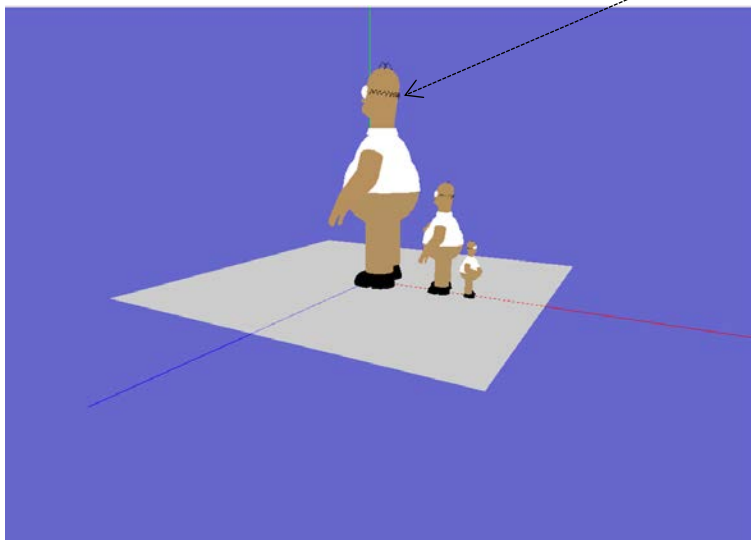
```
AUX=Rotate (alfa, (1,0,0));
TG= AUX * Translate(0, 0.5, 0);
modelMatrix (TG);
pinta_cub ();

TG= AUX * Translate(0.75, 0.25, 0);
TG= TG * Scale(0.5,0.5,0.5);
modelMatrix (TG);
pinta_cub();
```

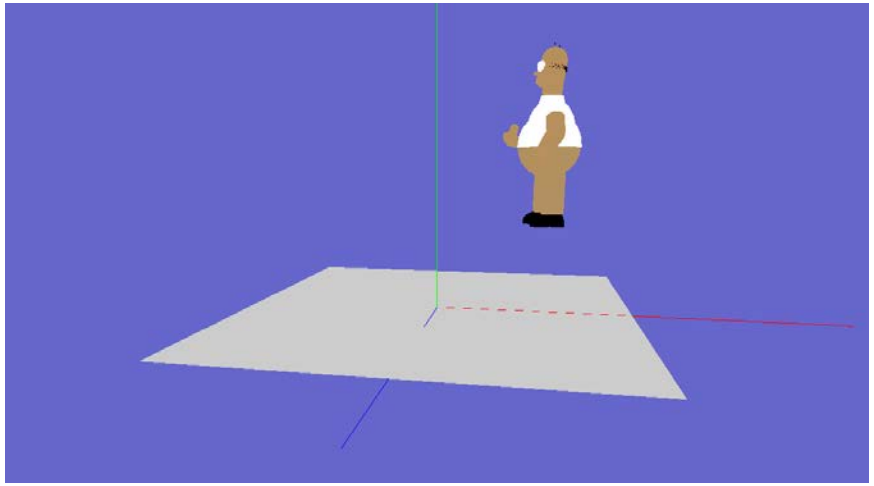
Exemple 3

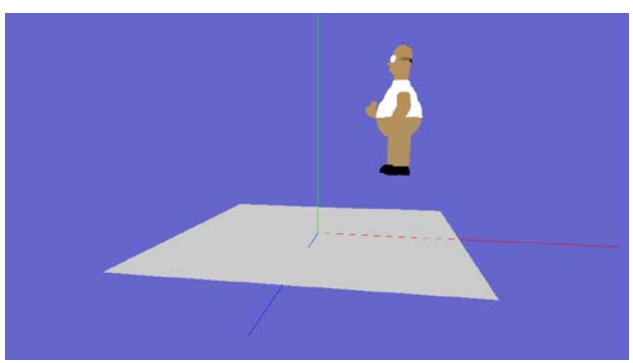


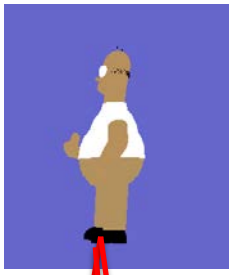


Mateixa grandària

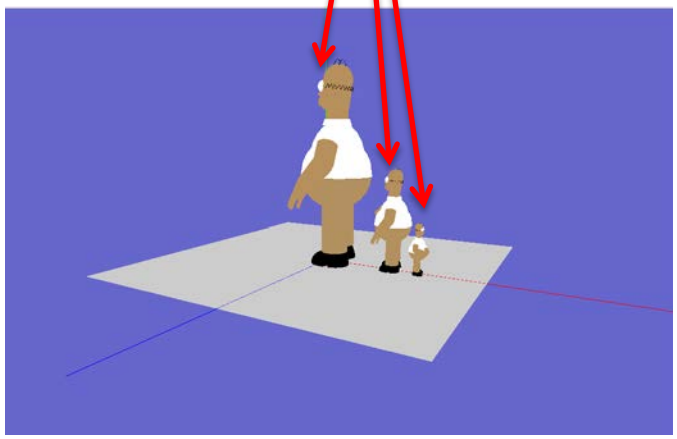






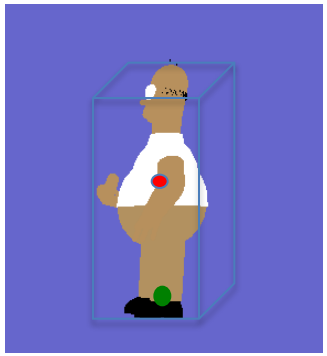


Només càlcul de TG



Transformació geomètrica

Matriu 4x4 TG

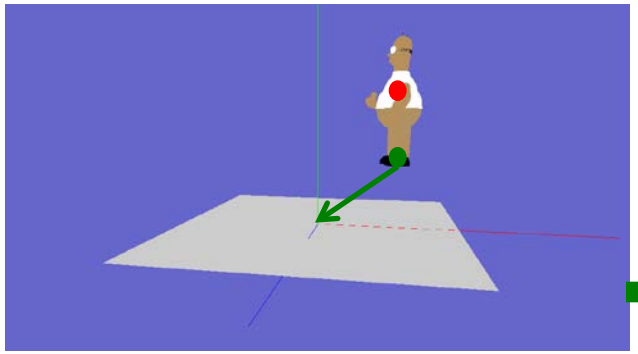


CapsaMinCont = (xmin,ymin,zmin,xmax,ymax,zmax)

Mides => a = (xmax-xmin) , h= (ymax-ymin), f = (zmax-zmin)

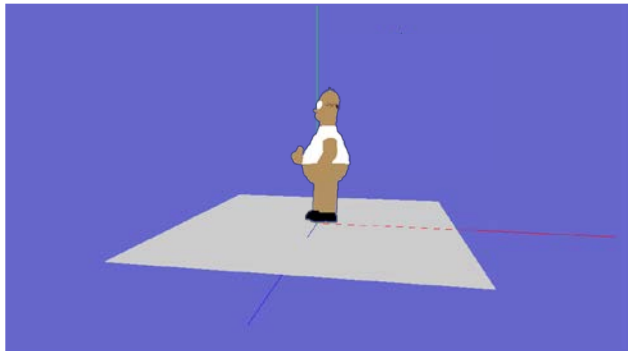
CentBaseCapsa=(cbx,cby,cbz)=(xmin+xmax)/2,ymin,(zmin+zmax)/2)

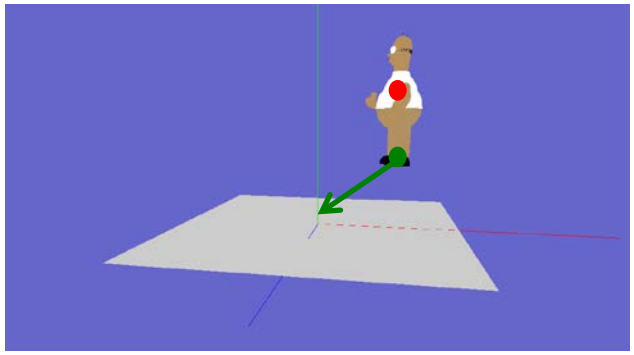
Els podem afegir com atributs al model geomètric



t = (-cbx,-cby,-cbz)

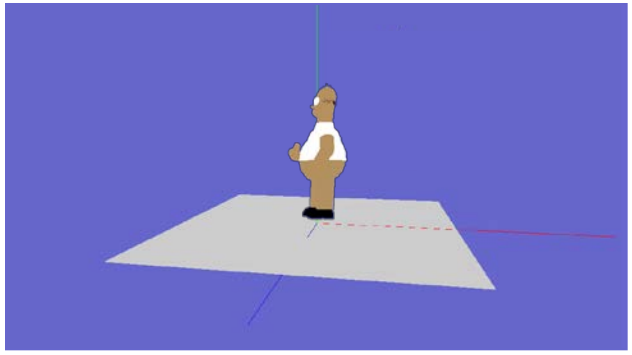
TG_{H1}=Trans(t)

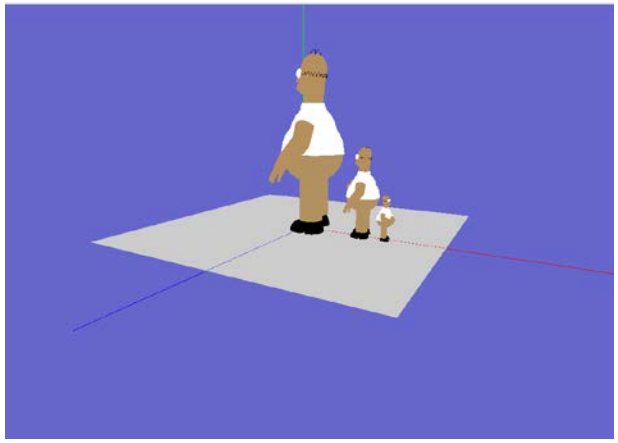




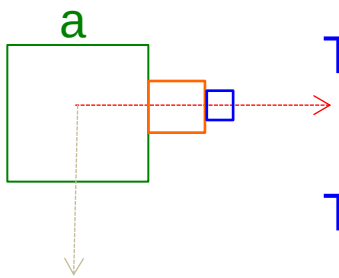
t = (-cbx,-cby,-cbz)

TG_{H1}=Trans(t)





TG_{H2}= Trans(3a/4,0,0) S(1/2,1/2,1/2) Trans (t)



TG_{H3}= Trans(9a/8,0,0) S(1/4,1/4,1/4) R_y(-180) Trans (t)

TG_{H3}= Trans(9a/8,0,0) R_y(-180) S(1/4,1/4,1/4) Trans (t)

Exemple pseudo-codi

```
per cada model
    llegir_Model ();
    crear_buffer_model ();
fper
```

```
//paintGL ();
per cada objecte_i
    modelTransform_i (TG_i);  //calcular TG
    modelMatrix (TG_i);//envia "uniform"
    pinta_model_i (); //visualitza model
fper
```

TG_{H3}= Trans(9a/8,0,0) S(1/4,1/4,1/4) R_y (-180º)Trans (t)

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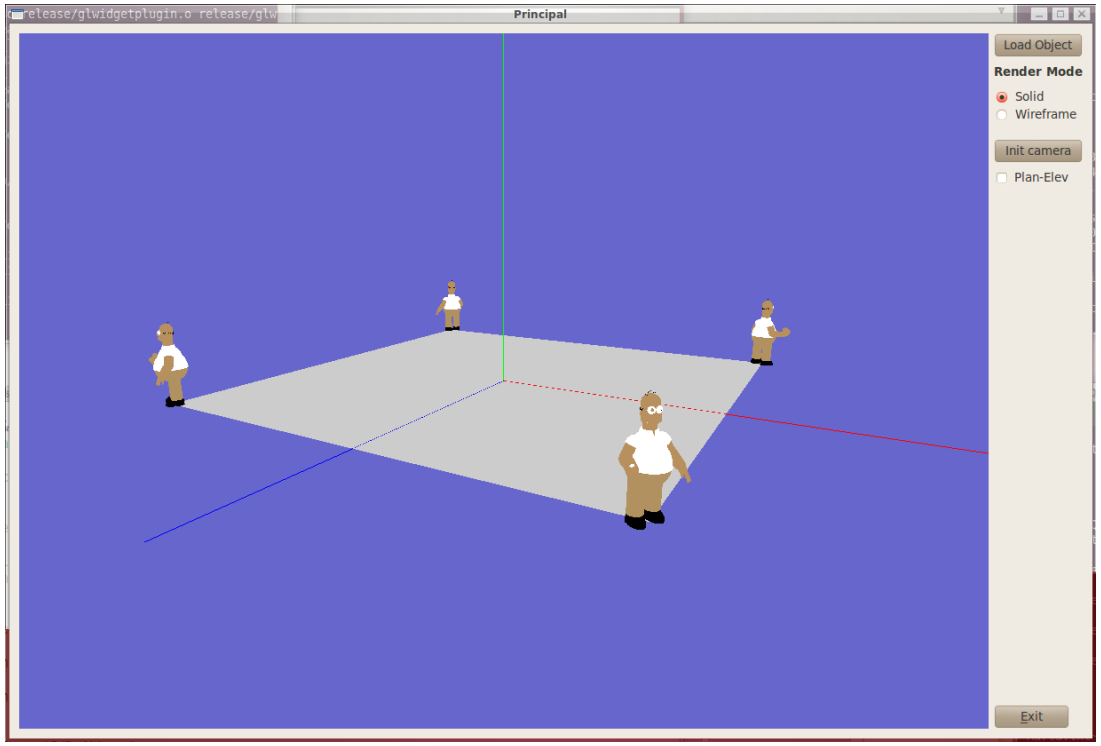
```
modelTransformHomer3()
//tercer homer
{
TG = I;
TG = TG * Translate (posx, posy, posz));
TG = TG * Scale (s, s, s);
TG = TG * Rotate (-180, (0, 1, 0));
TG = TG * Translate (-cb.x, -cb.y, -cb.z);
modelMatrix (TG); //enviar uniform
}
```

Exercicis



Mireu la col·lecció de problemes del racó.
Proposta de mínims: 16, 19, 24, 25 de la col·lecció

Classe 2: Conceptes

- Píxel, sistema de coordenades de dispositiu (SCD), resolució i finestra gràfica
- Frame buffer i Doble buffer
- Model RGB de color
- Transformacions bàsiques: entendre
- Composició transformacions: entendre i importància de l'ordre de multiplicació.
- Saber calcular TG i especificar en codi/pseudo-codi
- VAO, VBO i aplicació de TG en Vertex Shader
- Orde d'enviament de TG a la GPU