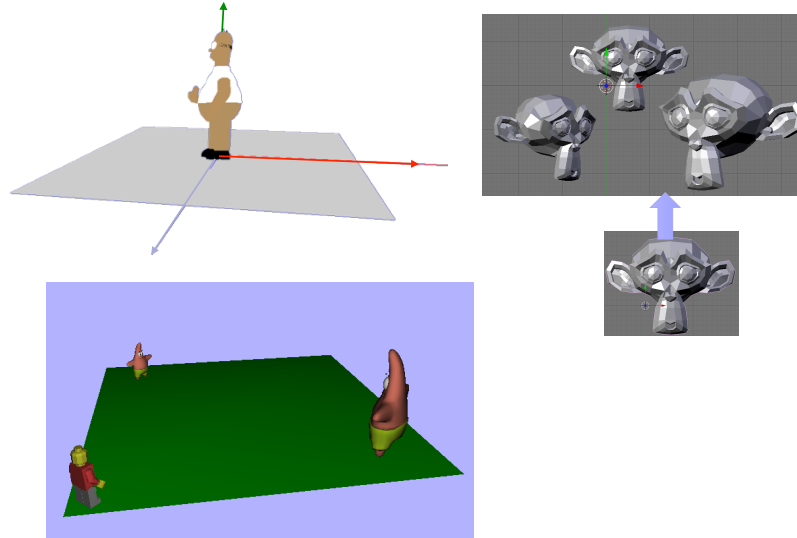


## MOTIVACIÓ: càlcul de la TG a aplicar a models

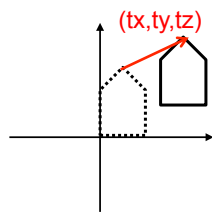


3

Transformació  
geomètrica



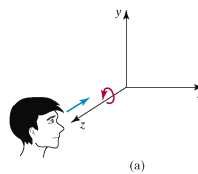
Matriu 4x4  
TG



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

$T(tx, ty, tz)$

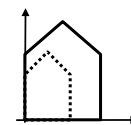
$$T(tx, ty, tz) = \begin{bmatrix} 1 & 0 & 0 & tx \\ 0 & 1 & 0 & ty \\ 0 & 0 & 1 & tz \\ 0 & 0 & 0 & 1 \end{bmatrix}$$



(a)

$R_z(\text{angle})$

$$R_z(\text{angle}) = \begin{bmatrix} \cos \alpha & -\sin \alpha & 0 & 0 \\ \sin \alpha & \cos \alpha & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

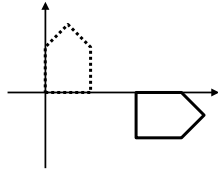


$S(sx, sy, sz)$

$$S(sx, sy, sz) = \begin{bmatrix} sx & 0 & 0 & 0 \\ 0 & sy & 0 & 0 \\ 0 & 0 & sz & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

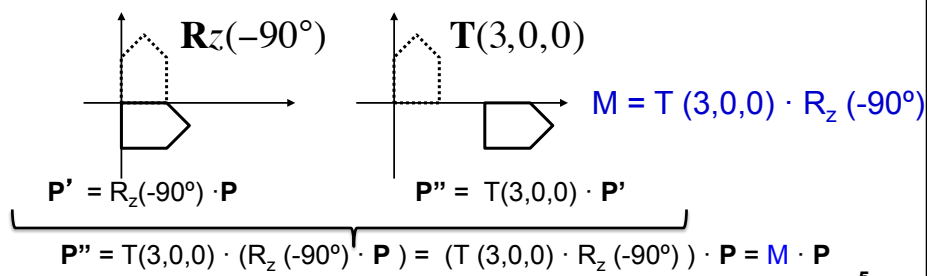
## Composició de Transformacions

- Imaginem que volem



No es pot fer amb cap de les matrius anteriors

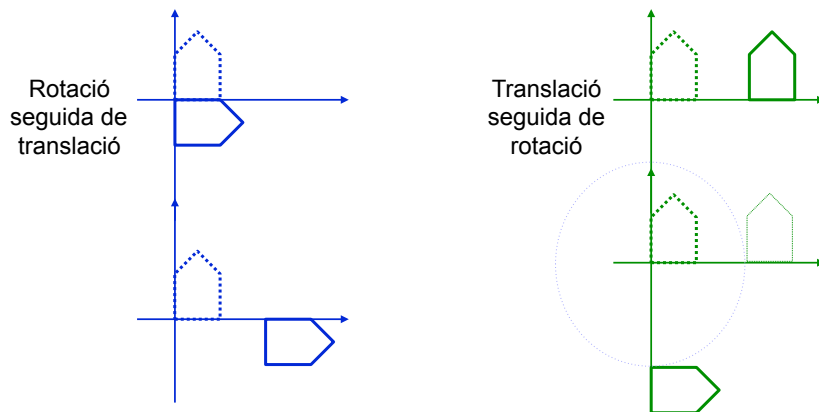
- Cal composar/efectuar dues transformacions



## Composició de Transformacions

$$\underset{2}{T(3,0)} \cdot \underset{1}{R(-90^\circ)} \neq \underset{2}{R(-90^\circ)} \cdot \underset{1}{T(3,0)}$$

- Multiplicació de matrius no és commutativa



## Exemple simple de TG (1)

Escena a pintar utilitzant `pinta_cub()`

*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();

```

```

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

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

```

**Com faréu per a girar els dos cubs respecte l'eix x?**

## Exemple simple (2)

$T_1 = R_x(\text{alfa}) * \text{Trans}(0,0.5,0)$

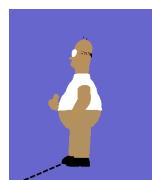
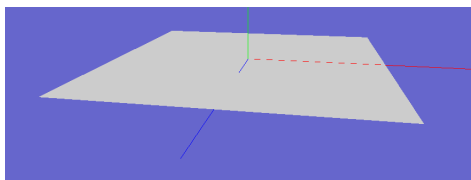
$T_2 = R_x(\text{alfa}) * \text{Trans}(0.75,0.25,0) * S(0.5,0.5,0.5)$

```

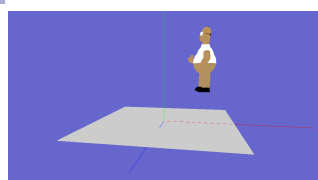
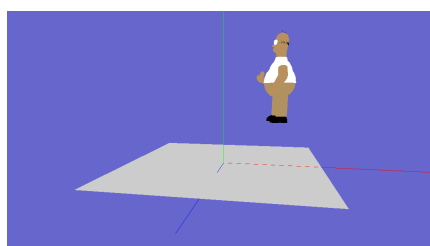
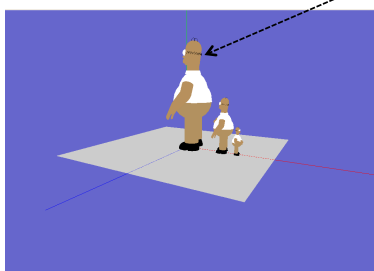
glm::mat4 TG, AUX;
AUX=glm::rotate (glm::mat4(1.f), alfa, vec3(1,0,0));
TG= glm::translate (AUX, glm::vec3(0,0.5,0));
modelMatrix (TG);
pinta_cub ();
TG= glm::translate (AUX, glm::vec3(0.75,0.25,0));
TG= glm::scale(TG, glm::vec3(0.5,0.5,0.5));
modelMatrix (TG);
pinta_cub();

```

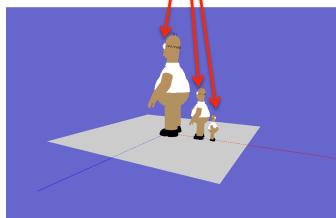
## Exercici 1



*Mateixa grandària*



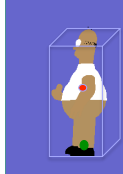
Només càlcul de TG



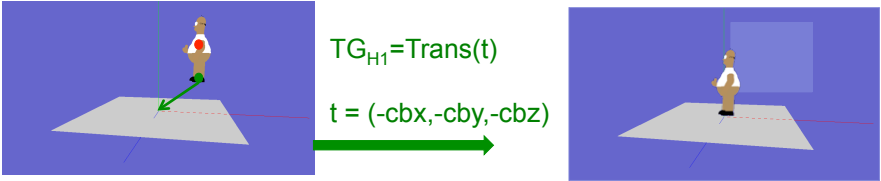
Transformació  
geomètrica



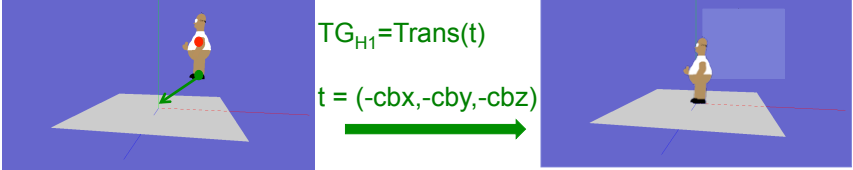
Matriu 4x4  
TG



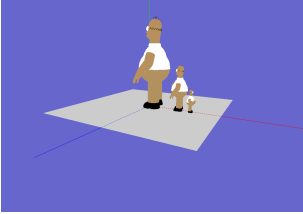
$CapsaMinCont = (xmin, ymin, zmin, xmax, ymax, zmax)$   
 Mides =>  $a = (xmax - xmin)$ ,  $h = (ymax - ymin)$ ,  $f = (zmax - zmin)$   
 $CentBaseCapsa = (cbx, cby, cbz) = (xmin + xmax)/2, ymin, (zmin + zmax)/2$   
 Els podem afegir com atributs al model geomètric



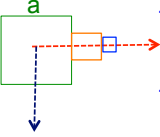
$TG_{H1} = \text{Trans}(t)$   
 $t = (-cbx, -cby, -cbz)$



$TG_{H1} = \text{Trans}(t)$   
 $t = (-cbx, -cby, -cbz)$



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



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

### Visualització OpenGL: models en SCM i paràmetres

nom	s, pos,...	
Terra		
Homer-1		
Homer-2		
Homer-3		

Diagram illustrating the transformation process for a 3D model (Homer) in a scene (Terra). The model is represented by a grid of faces (Cares) and vertices (Vèrtexs). The transformation is defined by a sequence of operations (TG) applied to the model's position (pos) and scale (s).

Transformation matrices (TG) for the model:

- $TG_{H1} = \text{Trans}(t) \quad t = (-cbx, -cby, -cbz)$
- $TG_{H2} = \text{Trans}(3a/4, 0, 0) S(1/2, 1/2, 1/2) \text{Trans}(t)$
- $TG_{H2} = \text{Trans}(9a/8, 0, 0) S(1/4, 1/4, 1/4) R_y(-180^\circ) \text{Trans}(t)$

The sequence of operations is numbered 1 to 4, corresponding to the steps in the transformation matrix.

### Visualització OpenGL: models en SCM

per cada objecte<sub>i</sub>  
 //Càlcul TG<sub>i</sub> i enviar a OpenGL  
 modelTransform<sub>i</sub>()  
 pinta\_model<sub>i</sub>();  
 fper

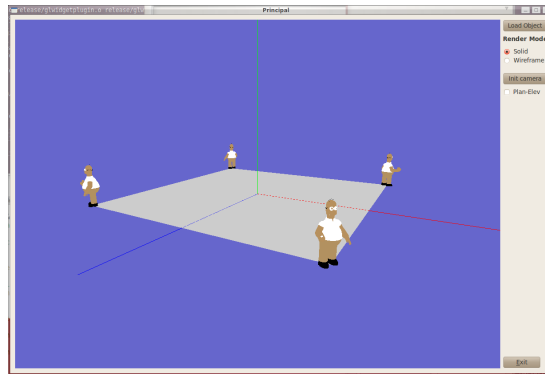
Transformation matrix (TG<sub>H3</sub>) for the model:

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

```

modelTransform()
//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 de problemes de TG.