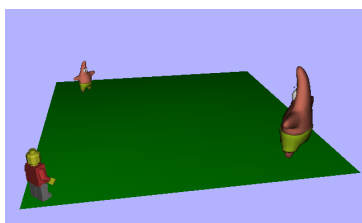
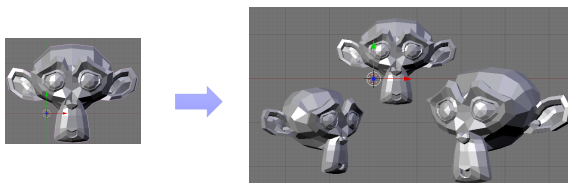


## MOTIVACIÓ: càlcul de la TG a aplicar a models

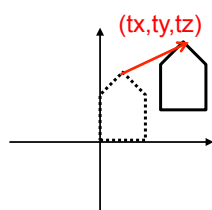


3

Transformació  
geomètrica



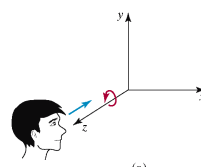
Matriu 4x4  
TG



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

$T(tx, ty, tz)$

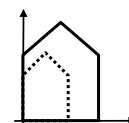
$$T(tx, ty, tz) = \begin{bmatrix} 1 & 0 & 0 & tx \\ 0 & 1 & 0 & ty \\ 0 & 0 & 1 & tz \\ 0 & 0 & 0 & 1 \end{bmatrix}$$



(a)

$G_z(\text{angle})$

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

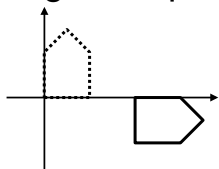


$S = (sx, sy, sz)$

$$S(s_x, s_y, s_z) = \begin{bmatrix} s_x & 0 & 0 & 0 \\ 0 & s_y & 0 & 0 \\ 0 & 0 & s_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

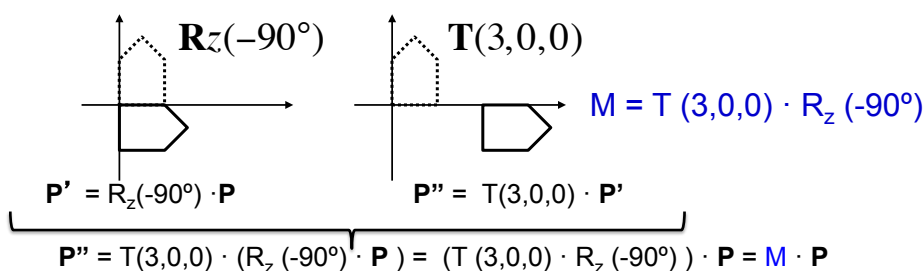
## Composició de Transformacions

- Imaginem que volem



No es pot fer amb cap de les matrius anteriors

- Cal compondre/efectuar dues transformacions

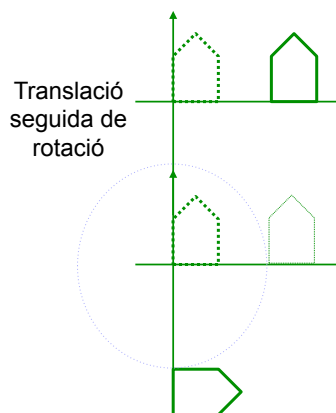
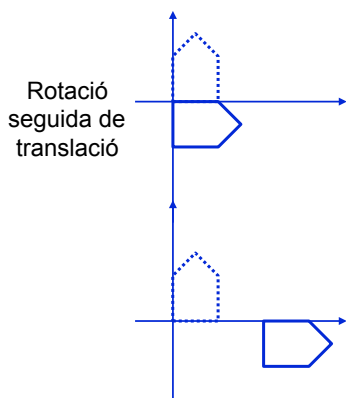


5

## Composició de Transformacions

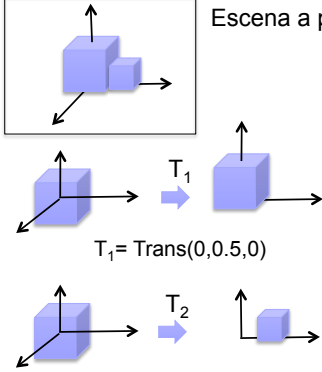
$$\underset{2}{T(3,0)} \cdot \underset{1}{R(-90^\circ)} \neq \underset{2}{R(-90^\circ)} \cdot \underset{1}{T(3,0)}$$

- Multiplicació de matrius no és commutativa



6

## Exemple simple de TG (1)



Escena a pintar utilitzant `pinta_cub()`

*Pseudo-codi*

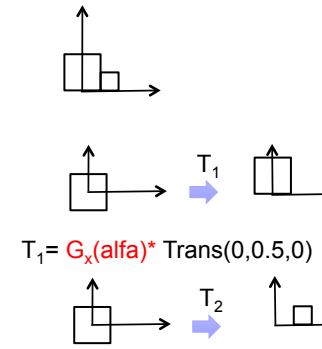
```
TG= Translate(0,0.5,0);
modelMatrix(TG);
pinta_cub ();
TG= Translate(0.75,0.25,0);
TG= TG*Scale(0.5,0.5,0.5);
modelMatrix (TG);
pinta_cub();
```

```
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 faríeu per a girar els dos cubs respecte l'eix x?**

## Exemple simple (2)

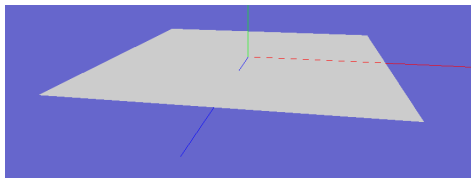


$T_1 = G_x(\text{alfa}) * \text{Trans}(0,0.5,0)$

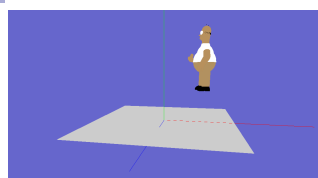
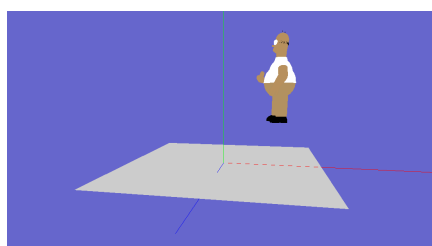
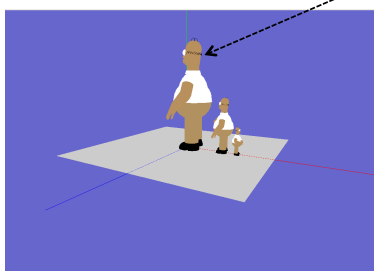
$T_2 = G_x(\text{alfa}) * \text{Trans}(0.75,0.25,0) * S(0.5,0.5,0.5)$

```
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();
```

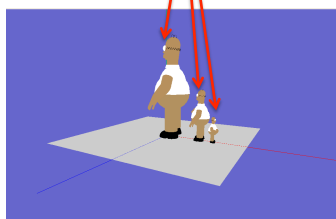
## Exercici 1



*Mateixa grandària*



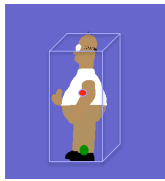
Nomes càlcul de TG



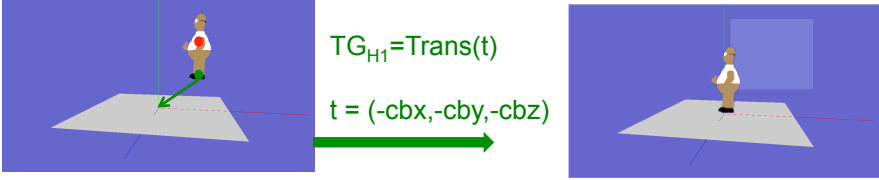
Transformació  
geomètrica



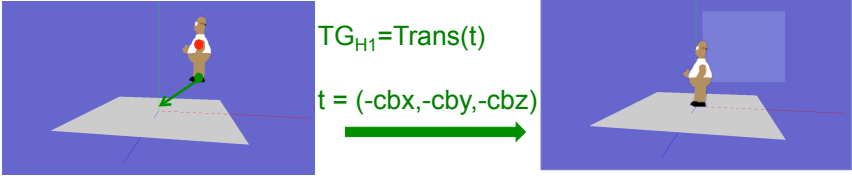
Matriu 4x4  
TG



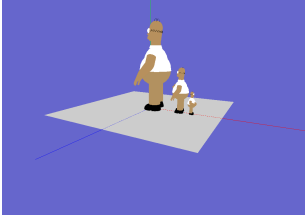
$CapsaMinCont = (xmin, ymin, zmin, xmax, ymax, zmax)$   
 Mides  $\Rightarrow a = (xmax - xmin)$ ,  $h = (ymax - ymin)$ ,  $f = (zmax - zmin)$   
 $CentBaseCapsa = (cbx, cby, cbz) = (xmin + xmax)/2, ymin, (zmin + zmax)/2$   
 Els podem afegir com atributs al model geomètric



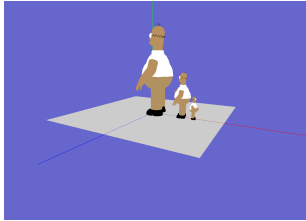
$TG_{H1} = Trans(t)$   
 $t = (-cbx, -cby, -cbz)$



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

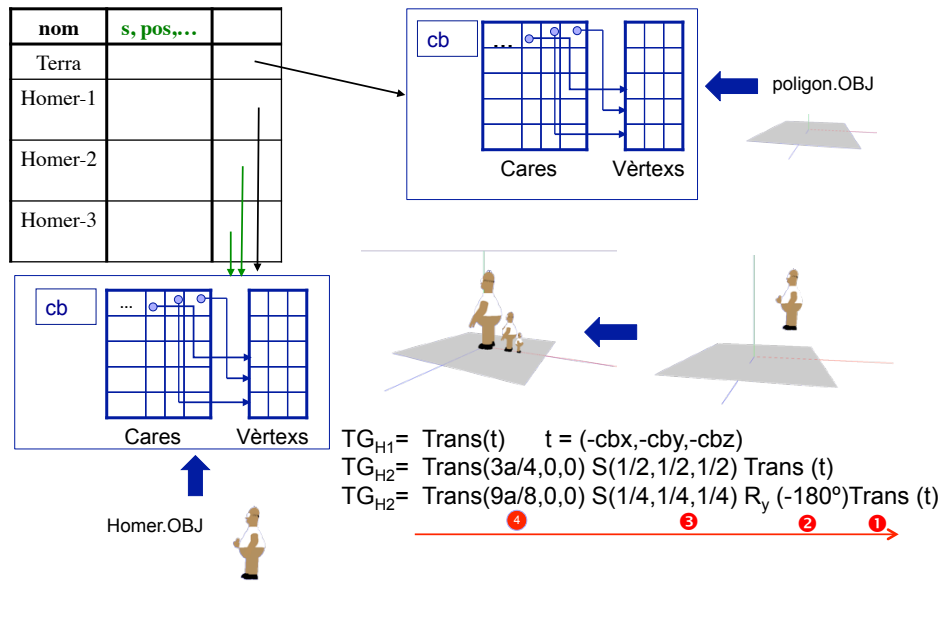


$TG_{H2} = Trans(3a/4, 0, 0) S(1/2, 1/2, 1/2) Trans(t)$



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

## Visualització OpenGL: models en SCM i paràmetres



## Visualització OpenGL: models en SCM

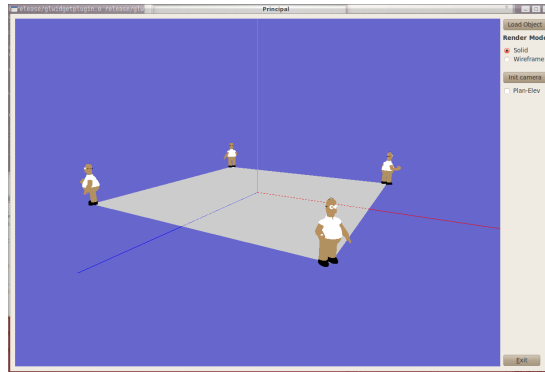
per cada objecte,  
 // Càlcul  $TG_i$  i enviar a OpenGL  
`modelTransformi()`  
`pinta_modeli()`;  
 fper

$TG_{H3} = \text{Trans}(7a/8, 0, 0) S(1/4, 1/4, 1/4) R_y(-180^\circ) \text{Trans}(t)$

```

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.