# Amiga JuggleR.
# OpenGL con R

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Madrid, octubre 2018

# Amiga JuggleR. OpenGL con R

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# Amiga Juggler

# Motivación

- No se usan paquetes novedosos (2004)
- Animar escenas 3D no es un punto fuerte de R
- Codificar la cinemática es ineficiente

Entonces… por qué Amiga JuggleR?

- Practicar con R
- Reto matemático
- Homenaje al Amiga

# Paquetes usados

- **`rgl`**: “3D Visualization Using OpenGL”

  Provides medium to high level functions for 3D interactive graphics, including functions modelled on base graphics (plot3d(), etc.) as well as functions for constructing representations of geometric objects (cube3d(), etc.). Output may be on screen using OpenGL, or to various standard 3D file formats including WebGL, PLY, OBJ, STL as well as 2D image formats, including PNG, Postscript, SVG, PGF.

  Dibujar objetos 3D en perspectiva cónica (esferas, cuadrados y elipses)

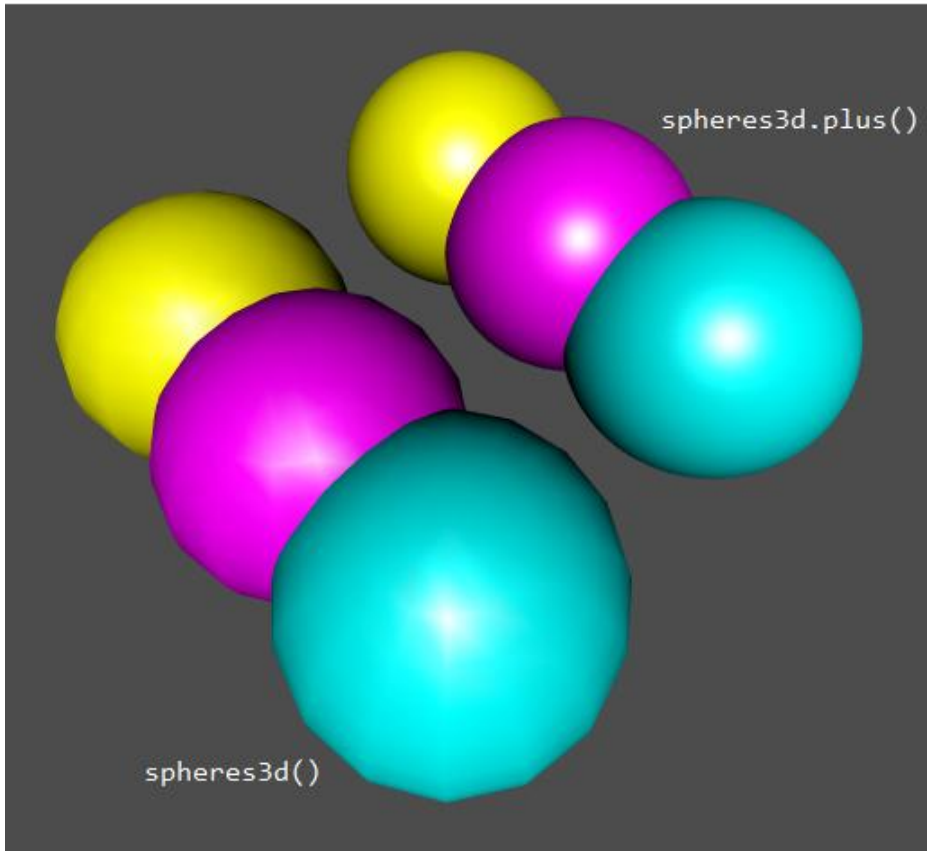
- **`tuneR`**: “Analysis of Music and Speech”

  Analyze music and speech, extract features like MFCCs, handle wave files and their representation in various ways, read mp3, read midi, perform steps of a transcription, ... Also contains functions ported from the 'rastamat' 'Matlab' package.

  Leer y guardar achivos .WAV

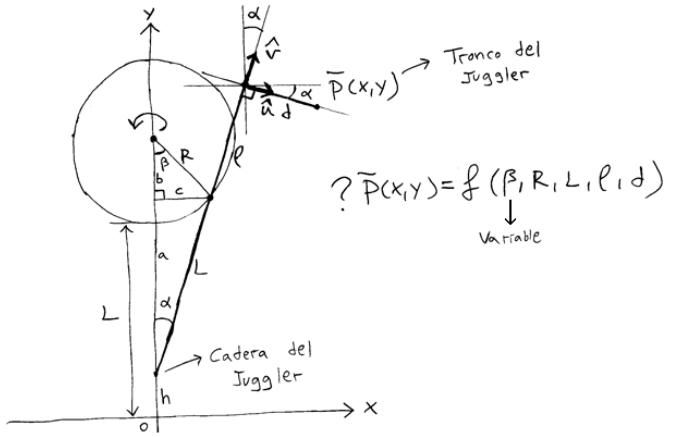
# Geometría. Esferas mejoradas

```
spheres3d.plus=function(x=0, y=0, z=0, radius=1, n=101, ...){
  f=function(s, t) cbind(radius*cos(t)*cos(s) + x,
                         radius*      sin(s) + y,
                         radius*sin(t)*cos(s) + z)
  persp3d(f, slim=c(-pi/2, pi/2), tlim=c(0, 2*pi), n=n, add=T, ...)
}
```



# Geometría. Cinemática tronco

**(1/3) TRONCO JUGGLER**




$$?\ \bar{P}(x,y) = f(\beta, R, L, \ell, d)$$

(β: variable)

$$\operatorname{sen}\beta = \frac{c}{R} \;//\; \boxed{c = R \cdot \operatorname{sen}\beta} \gtrless 0$$

$$\cos\beta = \frac{b}{R} \;//\; \boxed{b = R \cdot \cos\beta} \gtrless 0$$

$$L^2 = a^2 + c^2 \;//\; \boxed{a = \sqrt{L^2 - c^2}} \gtrless 0$$

$$\boxed{h = L + R - a - b}$$

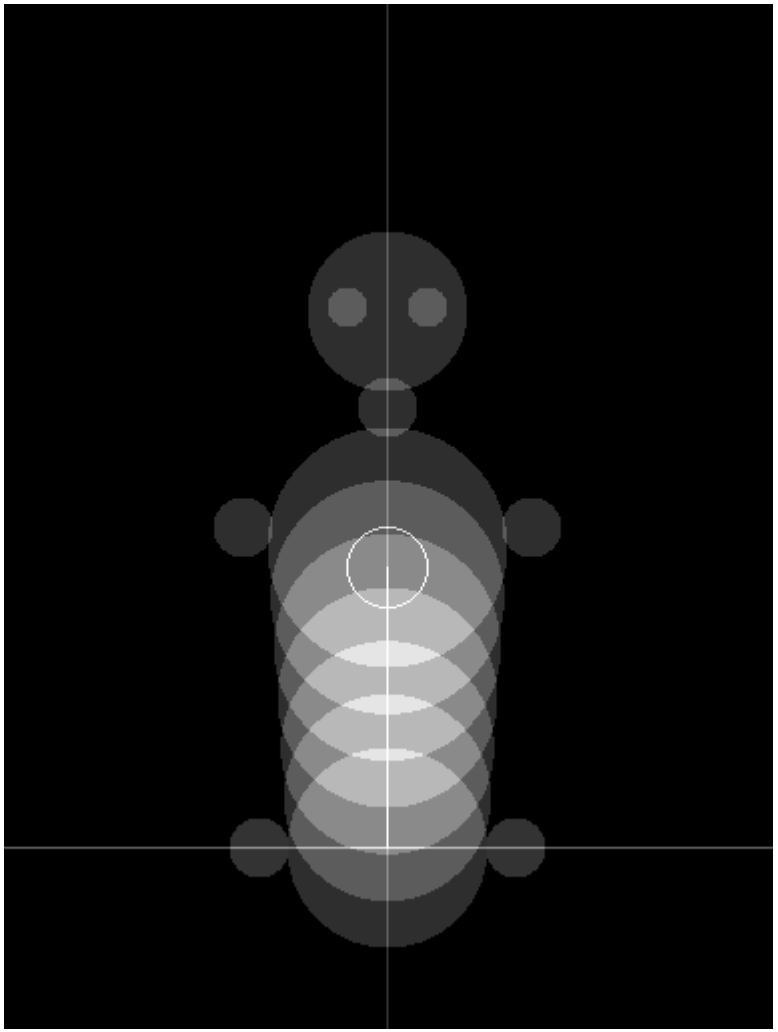
Sistema ortonormal:

$$\left.\begin{aligned} \hat{u} &= \cos\alpha \cdot \hat{x} - \operatorname{sen}\alpha \cdot \hat{y} \\ \hat{v} &= \operatorname{sen}\alpha \cdot \hat{x} + \cos\alpha \cdot \hat{y} \end{aligned}\right\} \quad \begin{aligned} \operatorname{sen}\alpha &= \frac{c}{L} \gtrless 0 \\ \cos\alpha &= \frac{a}{L} \gtrless 0 \end{aligned}$$

$$\bar{P} = h \cdot \hat{y} + (L+\ell)\cdot\hat{v} + d\cdot\hat{u} =$$
$$= h\cdot\hat{y} + (L+\ell)\cdot\operatorname{sen}\alpha\cdot\hat{x} + (L+\ell)\cdot\cos\alpha\,\hat{y} + d\cdot\cos\alpha\cdot\hat{x} - d\cdot\operatorname{sen}\alpha\cdot\hat{y}$$

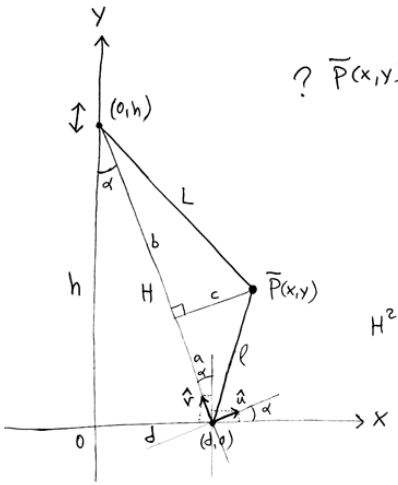
$$\boxed{x = \frac{(L+\ell)\cdot c}{L} + \frac{d\cdot a}{L} = \frac{(L+\ell)\cdot c + d\,a}{L}}$$

$$\boxed{y = h + \frac{(L+\ell)\cdot a}{L} - \frac{d\cdot c}{L} = h + \frac{(L+\ell)\,a - d\,c}{L}}$$



# Geometría. Cinemática piernas

**(2/3) PIERNAS JUGGLER**




? $\bar{P}(x,y) = f(h, d, L, \ell)$

Variable

$H^2 = h^2 + d^2$ // $\boxed{H = \sqrt{h^2+d^2}}$

$H = a + b$ // $b = H - a$

$L^2 = b^2 + c^2$

$\ell^2 = a^2 + c^2$

$L^2 - \ell^2 = b^2 - a^2$

$L^2 - \ell^2 = (H-a)^2 - a^2 = H^2 - 2Ha + \cancel{a^2} - \cancel{a^2}$ //

$2Ha = H^2 - L^2 + \ell^2$ // $\boxed{a = \dfrac{H^2 - L^2 + \ell^2}{2H}}$

Por simetría: $\boxed{b = \dfrac{H^2 - \ell^2 + L^2}{2H}}$

$\boxed{c = \sqrt{L^2 - b^2} = \sqrt{\ell^2 - a^2}}$

Sistema ortonormal:

$\hat{u} = \cos\alpha \cdot \hat{x} + \operatorname{sen}\alpha \cdot \hat{y}$

$\hat{v} = -\operatorname{sen}\alpha \cdot \hat{x} + \cos\alpha \cdot \hat{y}$

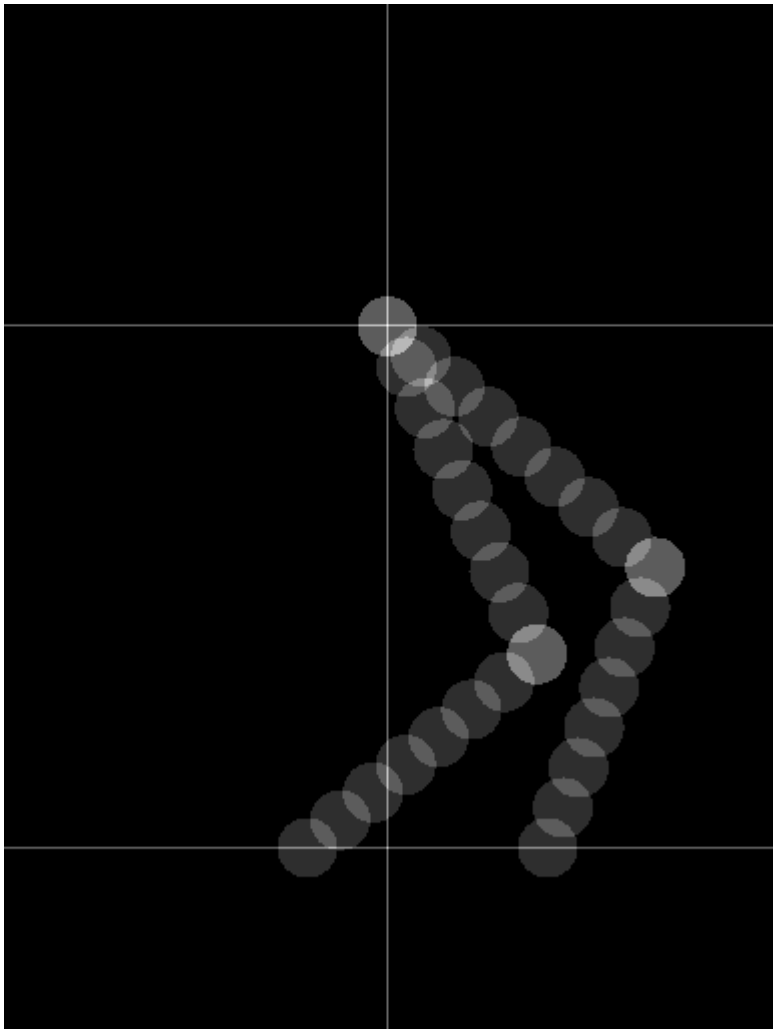
$\operatorname{sen}\alpha = \dfrac{d}{H}$

$\cos\alpha = \dfrac{h}{H}$

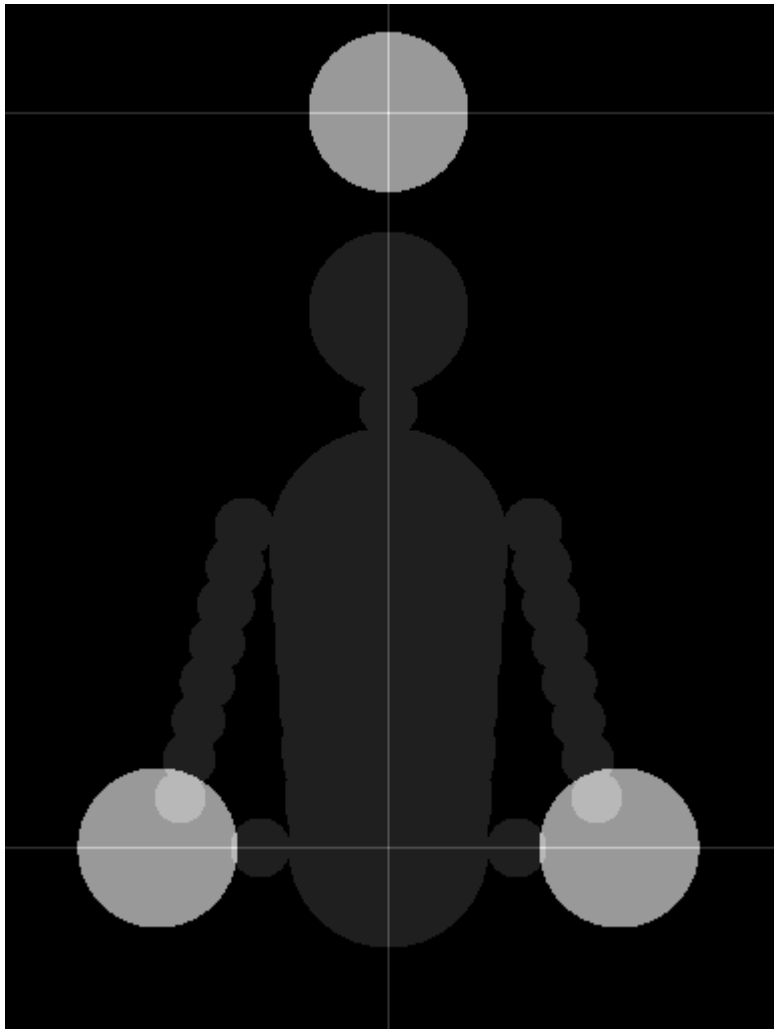
$\bar{P} = d \cdot \hat{x} + a \cdot \hat{v} + c \cdot \hat{u} = d \cdot \hat{x} - a \cdot \operatorname{sen}\alpha\, \hat{x} + a \cdot \cos\alpha \cdot \hat{y} + c \cdot \cos\alpha \cdot \hat{x} + c \cdot \operatorname{sen}\alpha \cdot \hat{y}$

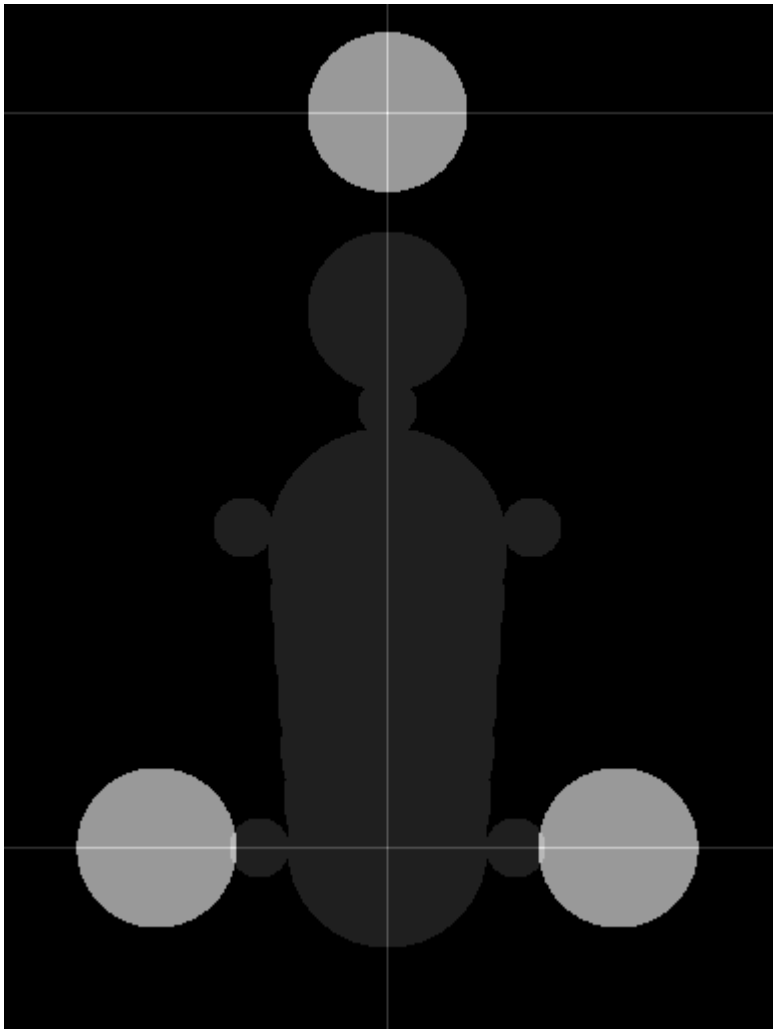
$$\boxed{x = d - a \cdot \operatorname{sen}\alpha + c \cdot \cos\alpha = d - \frac{ad}{H} + \frac{ch}{H} = d - \frac{ad - ch}{H}}$$

$$\boxed{y = a \cdot \cos\alpha + c \cdot \operatorname{sen}\alpha = \frac{ah}{H} + \frac{cd}{H} = \frac{ah + cd}{H}}$$



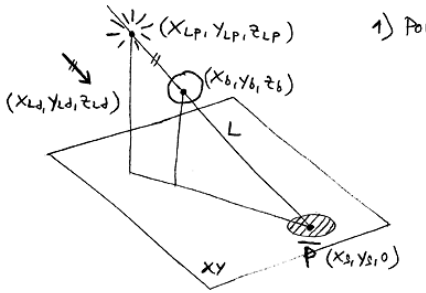
# Geometría. Cinemática malabares





# Geometría. Cálculo de sombras

**(3/3) PROYECCIÓN SOMBRAS**




1) Por posición de iluminación:

$$L \equiv (x_b, y_b, z_b) + \lambda \cdot \underbrace{(x_{LP} - x_b, y_{LP} - y_b, z_{LP} - z_b)}_{\text{vector director}}$$

$$\left.\begin{aligned} x &= x_b + \lambda \cdot (x_{LP} - x_b) \\ y &= y_b + \lambda \cdot (y_{LP} - y_b) \\ z &= z_b + \lambda \cdot (z_{LP} - z_b) \end{aligned}\right\} \text{Ec. paramétrica recta}$$

? $\overline{P}(x_s, y_s) = f(x_{LP}, y_{LP}, z_{LP}, x_b, y_b, z_b)$

$z_s = 0 \;//\; z_b + \lambda_s \cdot (z_{LP} - z_b) = 0 \;//$ $\quad \lambda_s = \dfrac{z_b}{z_b - z_{LP}}$

$$\begin{aligned} x_s &= x_b + \lambda_s \cdot (x_{LP} - x_b) \\ y_s &= y_b + \lambda_s \cdot (y_{LP} - y_b) \end{aligned}$$

2) Por dirección de iluminación (fuente de luz en el $\infty$):

$$L \equiv (x_b, y_b, z_b) + \lambda \cdot \underbrace{(x_{Ld}, y_{Ld}, z_{Ld})}_{\text{vector director}}$$

$$\left.\begin{aligned} x &= x_b + \lambda \cdot x_{Ld} \\ y &= y_b + \lambda \cdot y_{Ld} \\ z &= z_b + \lambda \cdot z_{Ld} \end{aligned}\right\} \text{Ec. paramétrica recta}$$

? $\overline{P}(x_s, y_s) = f(x_{Ld}, y_{Ld}, z_{Ld}, x_b, y_b, z_b)$

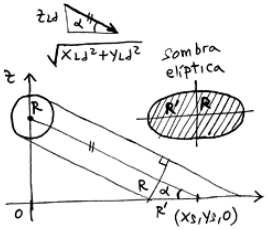
$z_s = 0 \;//\; z_b + \lambda_s z_{Ld} = 0 \;//$ $\quad \lambda_s = -\dfrac{z_b}{z_{Ld}}$

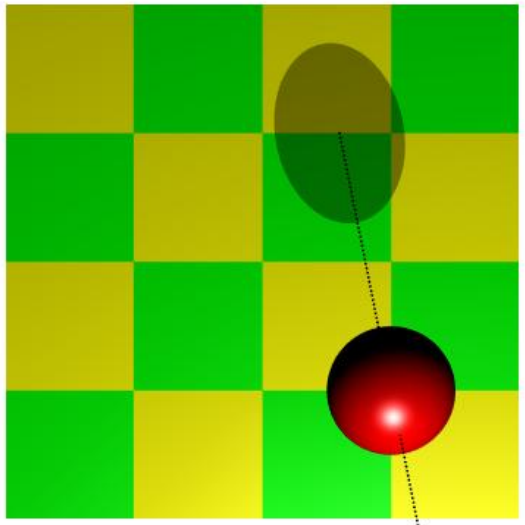
$$\begin{aligned} x_s &= x_b + \lambda_s \cdot x_{Ld} \\ y_s &= y_b + \lambda_s \cdot y_{Ld} \end{aligned}$$

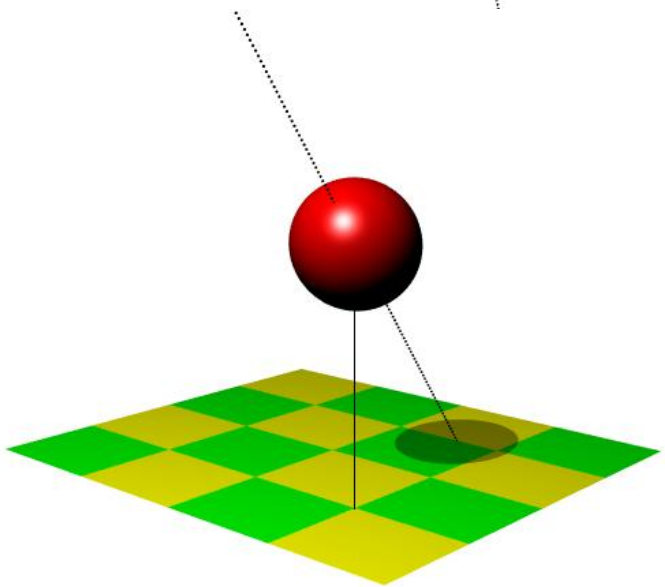
Elongación elíptica:

? $R' = f(R, x_{Ld}, y_{Ld}, z_{Ld})$

$$\text{sen}\, d = \frac{R}{R'} = \frac{z_{Ld}}{\sqrt{x_{Ld}^2 + y_{Ld}^2 + z_{Ld}^2}} \;// \quad R' = R \cdot \frac{\sqrt{x_{Ld}^2 + y_{Ld}^2 + z_{Ld}^2}}{z_{Ld}}$$





# Definición del universo

**`x, y, z`**: posición

**`radius`**: radio

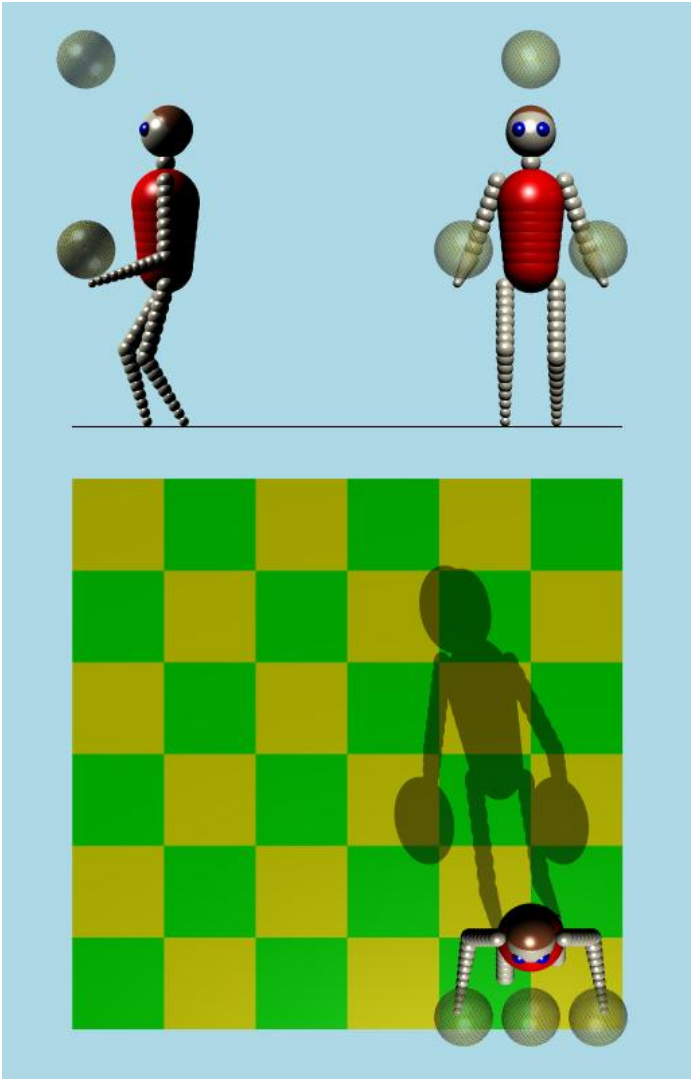
**`colour`**: color

**`alpha`**: transparencia

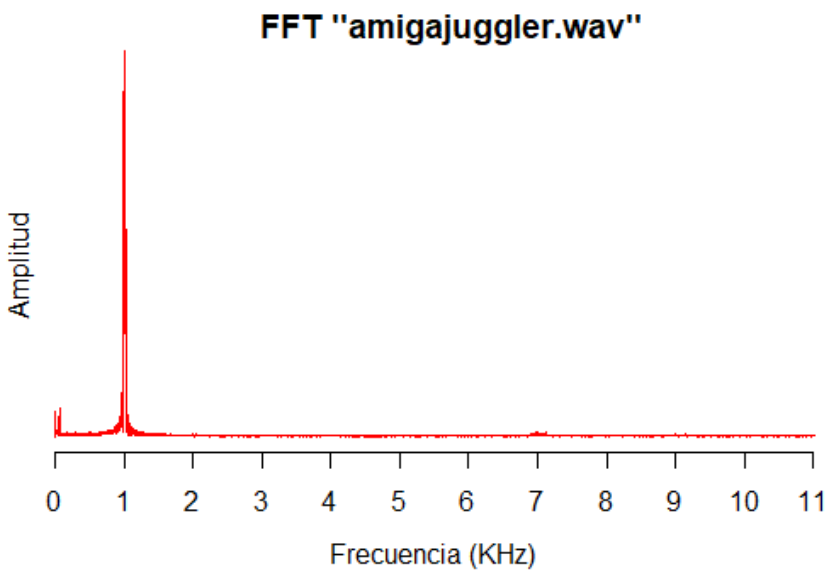
**`ninterp`**: esferas a interpolar

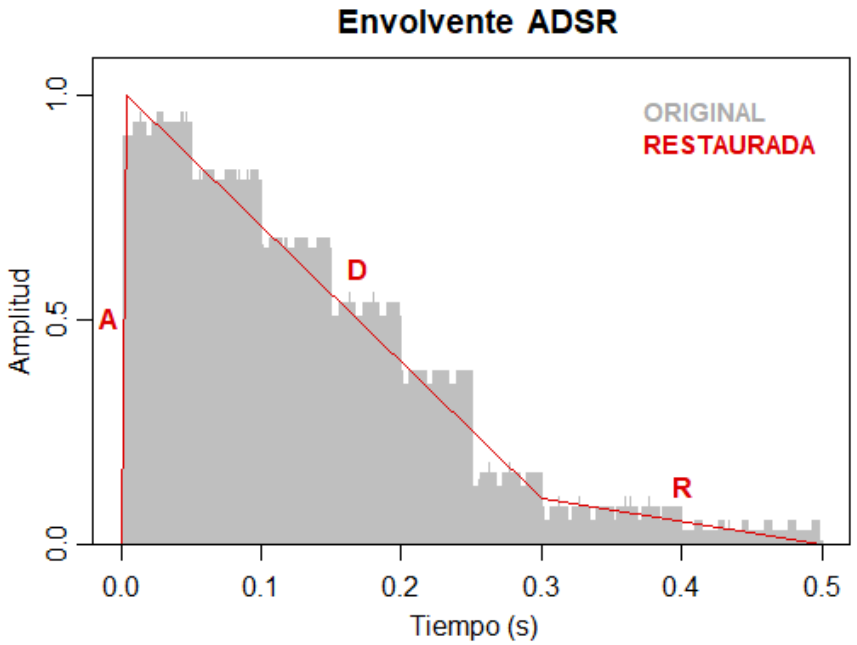
**`desc`**: descripción

```
> jug
    x    y   z radius     colour alpha ninterp         desc
1   0    0 366     56       red2   1.0       5        pecho
2   0    0 263     45       red2   1.0       0       pelvis
3   0    0 431     16  cornsilk3   1.0       0       cuello
4   0    0 480     41  cornsilk3   1.0       0       cabeza
5  -5    0 485     40    sienna4   1.0       0         kipa
6  30  -18 485     13 mediumblue   1.0       0     ojo der.
7  30   18 485     13 mediumblue   1.0       0     ojo izq.
8   0  -55 400     15  cornsilk3   1.0       6  hombro der.
9   0 -100 274     15  cornsilk3   1.0       9    codo der.
10 120 -120 234     7  cornsilk3   1.0       0    mano der.
11  0   55 400     15  cornsilk3   1.0       6  hombro izq.
12  0  100 274     15  cornsilk3   1.0       9    codo izq.
13 120  120 234     7  cornsilk3   1.0       0    mano izq.
14  0  -42 228     15  cornsilk3   1.0       6  cadera der.
15 72  -42 126     15  cornsilk3   1.0       7 rodilla der.
16 30  -42   8      8  cornsilk3   1.0       0     pie der.
17  0   42 228     15  cornsilk3   1.0       6  cadera izq.
18 42   42 110     15  cornsilk3   1.0       7 rodilla izq.
19 -30  42   8      8  cornsilk3   1.0       0     pie izq.
20 130   0 600     48       blue   0.4       0    bola sup.
21 130 -110 289    48       blue   0.4       0    bola der.
22 130  110 289    48       blue   0.4       0    bola izq.
```



# Sonido



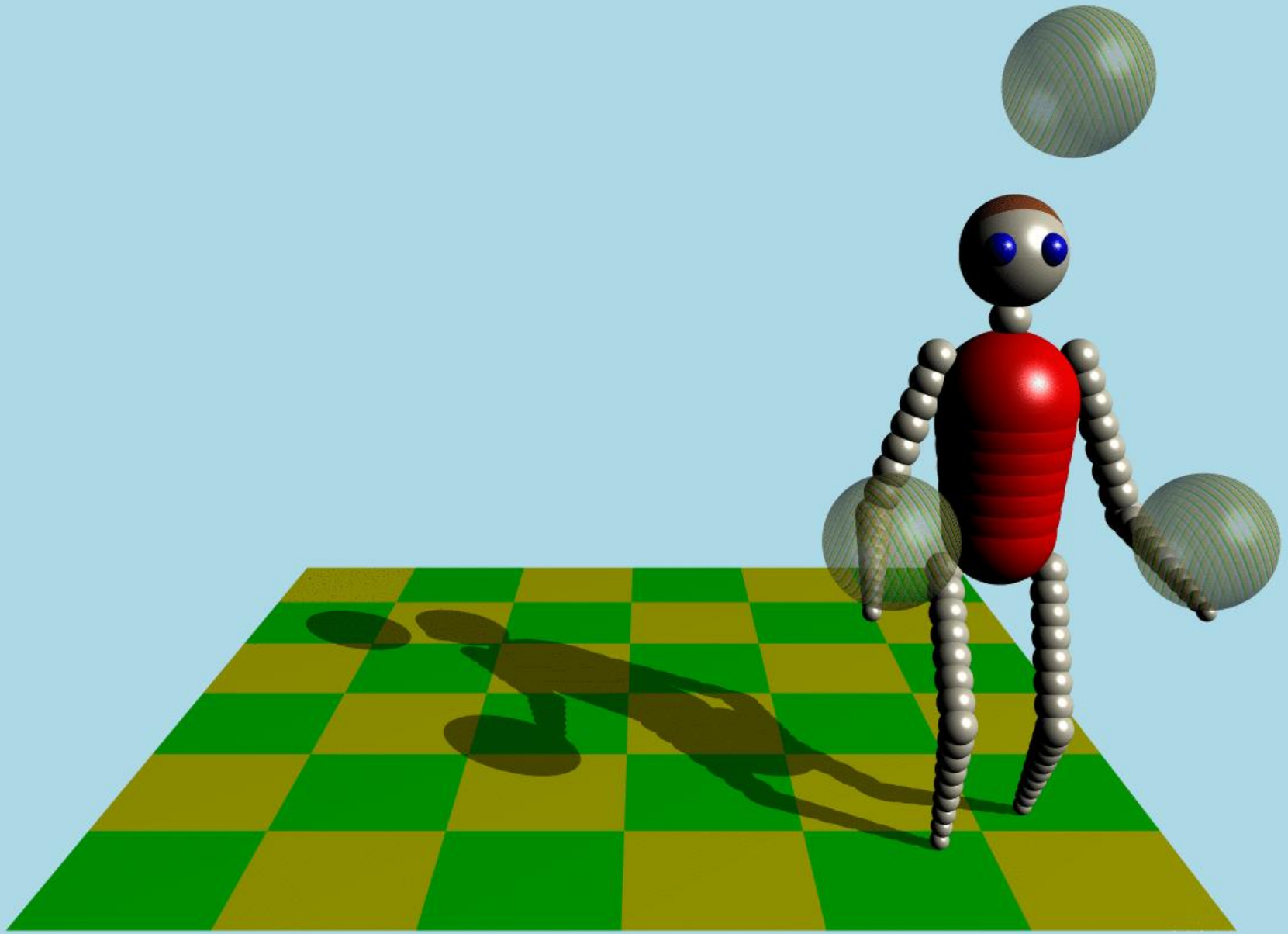




ORIGINAL RESTAURACIÓN

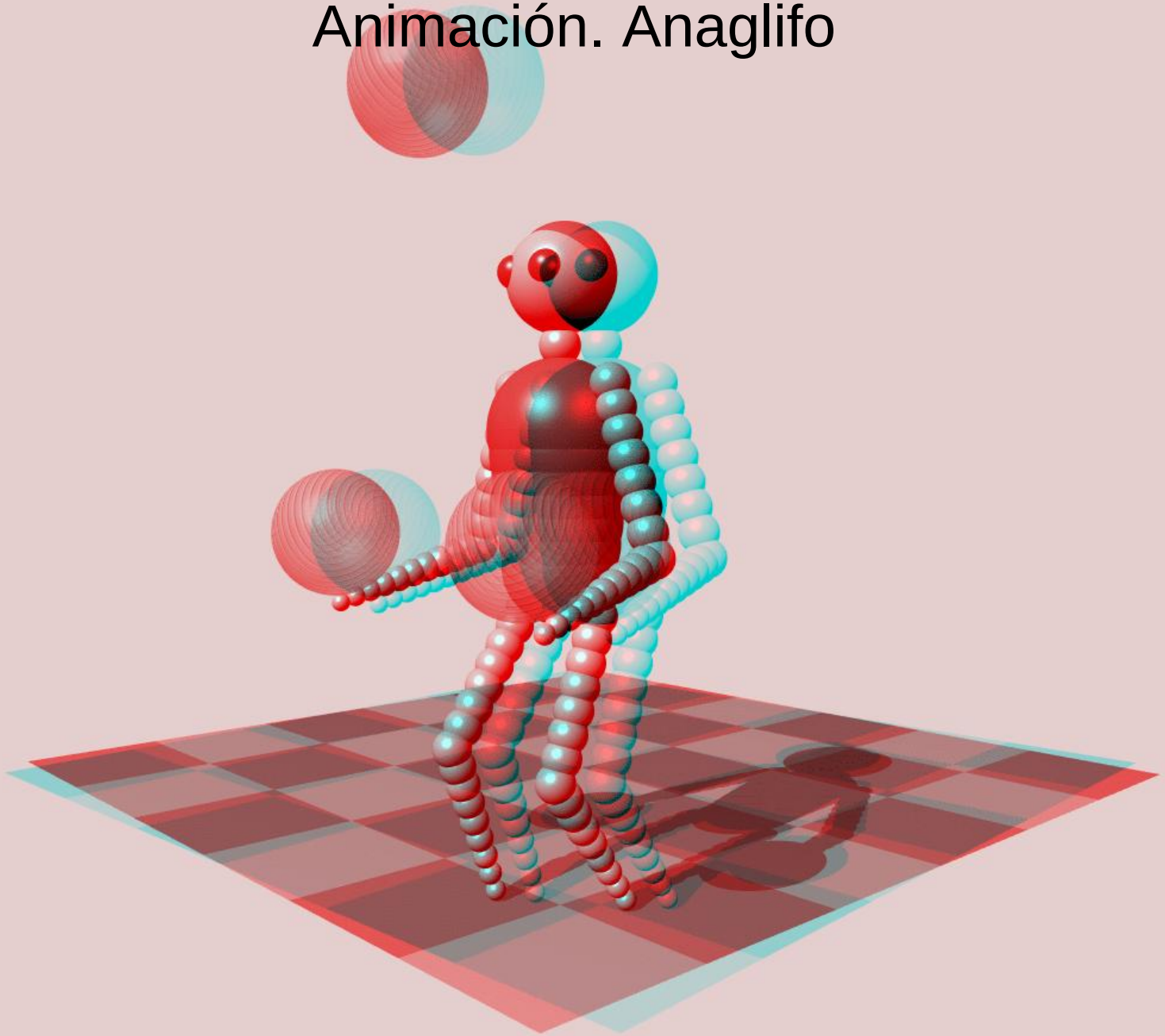
# Código

# Animación. Clásica

# Animación. Frontal



# Animación. Anaglifo



# gracias

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