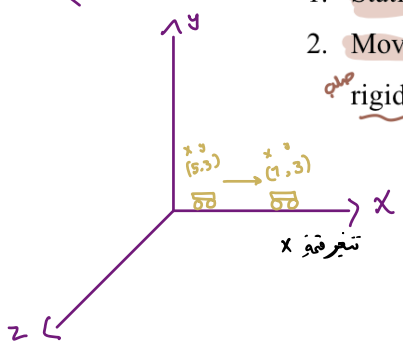
let w be 3D world

$w \subseteq R$

The world has two kind of models:

1. Stationary model described on world coordinate frame
2. Movable model have space of possible transformations, usually composed of rigid body. why ? Can be move



stationary = any thing it's stable like table , a chair

Movable = it's has possible transformation , rigid body can be move but can't minimize (cannot deformation)

Models:-

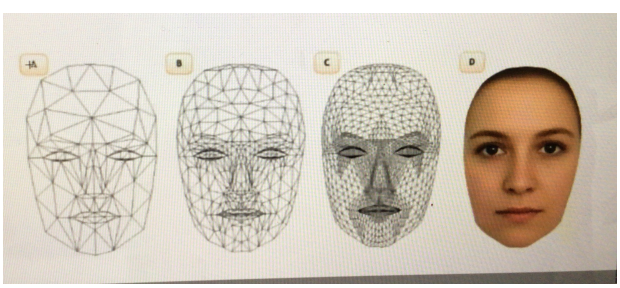
① rigid Body
② liquid
③ elastic
⑨ gas

Object modeling choices:

1. Solid representation
2. Boundary representation

When we make 3D models, what is the best to choose?

triangle as primitive , because it's a small polygonal and gives flexibility



transformation in it's not easy
1000 Tringles each trangles has (x,y,z) , when moving need to be calculated

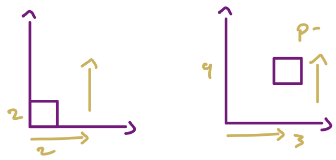
Why we do transformation?

1. Movable models
2. Perception of stationarity

kind of Transformation:

1. Translation
2. Rotation
3. Scaling
4. Shear

1. Translation +



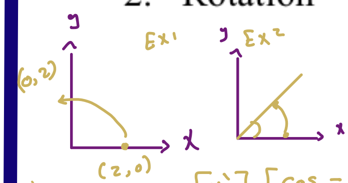
$P^- = X_{new} = X_{old} + T_x$ $P^- = Y_{new} = Y_{old} + T_y$

$P^- = Z_{new} = Z_{old} + T_z$

2D => 2 x, y moves

3D => 3 x, y, z moves

2. Rotation X



$x' = x\cos 45 - y\sin 45$

$y' = x\sin 45 + y\cos 45$

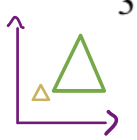
$$\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos & -\sin \\ \sin & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$$

2D => only one

3D => 3

3. Scaling

تكبير/تصغير ..



4. Shear

Combining

عشرة انواع من transformation ما يهم التفاصيل

Gives one matrix تحسب final distance final location

Homogenous

عندنا مجموعه من transformation معقده جمع ضرب جمع ضرب اعطتنا uniform matrix حسبت الموقع الاخير له بإلغاء الجمع وصار ضرب فقط

- Is matrix multiplication associative? تجميعية
  - (A.B).C $\stackrel{?}{=}$ A.(B.C)

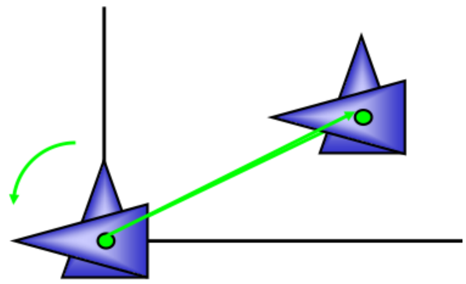
Yes

- Is matrix multiplication commutative? ابدالية
  - A . B $\stackrel{?}{=}$ B . A

No

General Pivot- Point Rotation

- **Operation :-**
  1. **Translate (pivot point is moved to origin)**
  2. **Rotate about origin**
  3. **Translate (pivot point is returned to original position)**



يروح لنقطة البداية ويعمل الدوران بعدين يرجع لمكانه

- **We often need to transform points from one coordinate system to another:**
  1. **We might model an object in non-Cartesian space (polar)**
  2. **Objects may be described in their own local system**
  3. **Other reasons: textures, display, etc**

You can Put in angwere