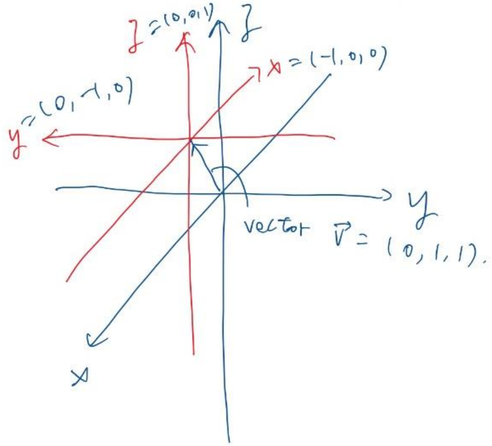
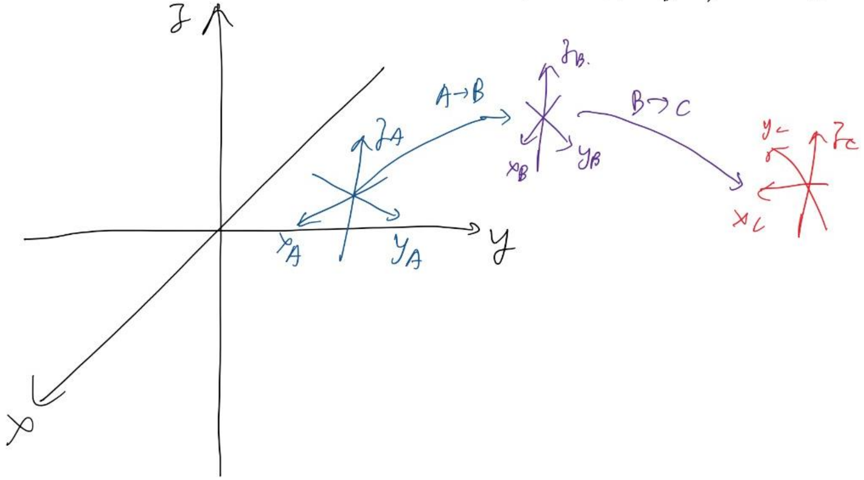
1. what is translation transformation matrix ?



$$T = \begin{array}{c} \begin{array}{cccc} x & y & z & \vec{v} \end{array} \\ \begin{bmatrix} -1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 1 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix} \end{array}$$

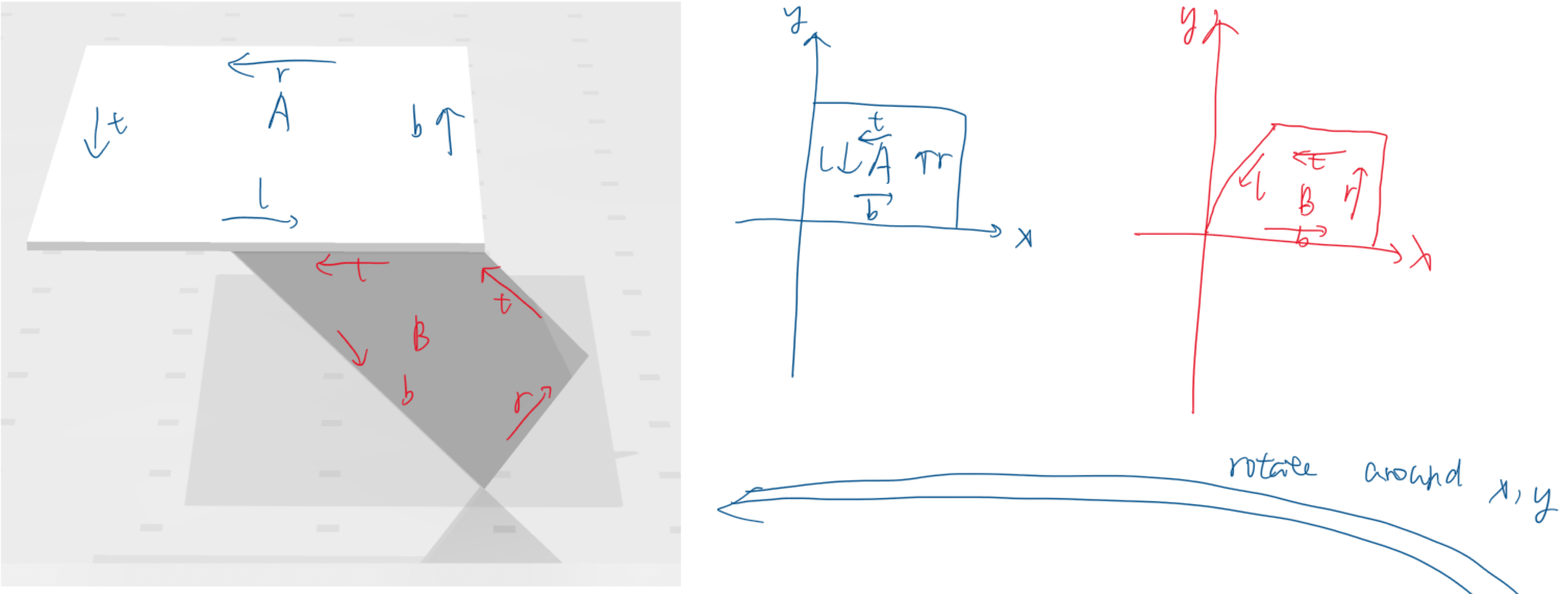
let's say we have a global reference frame $T_0 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$, and $A \in B \in C$.

Now, if we have the translation transformation matrix T_A, use the relative relation $T_{A \in B}$, we can find $T_B = T_A \cdot T_{A \in B}$, $T_C = T_B \cdot T_{B \in C}$, - - - -

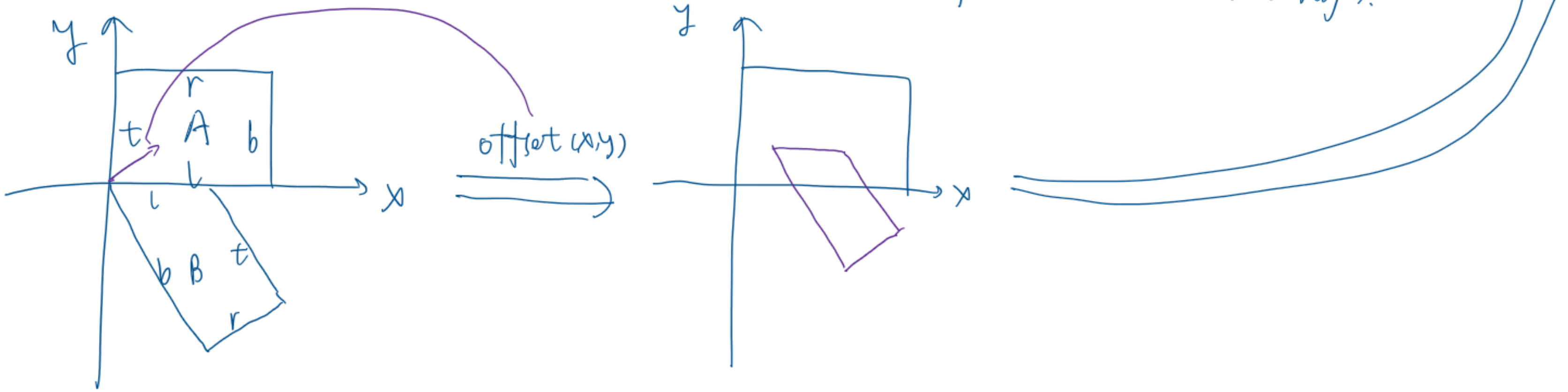


2. How do we use the relative relation between two components and the known position of one of them to find the position of another one?

```
addConnection(("B","l"),("A","l"),orientation="front-front", offset = (10,3), angle=(90, 30))
```



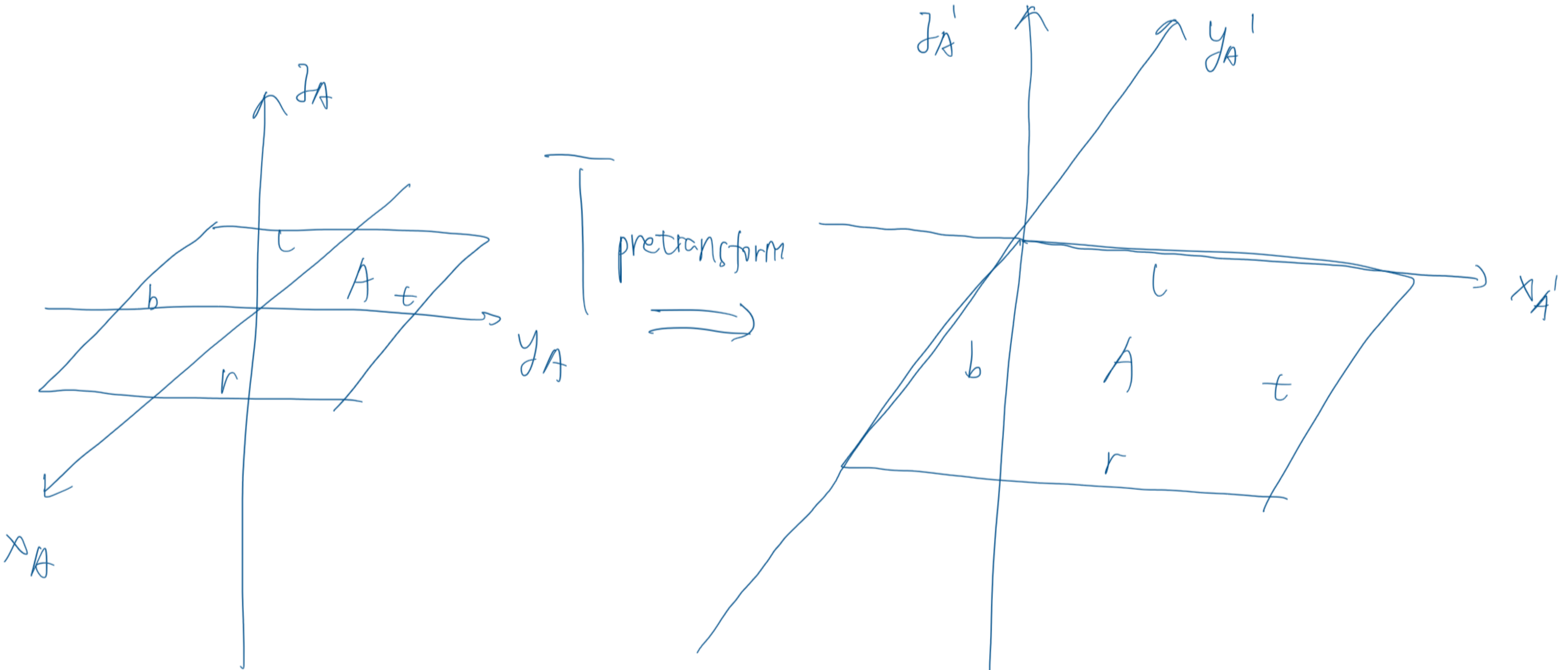
The user initial assumption should be (we define it to be this way):



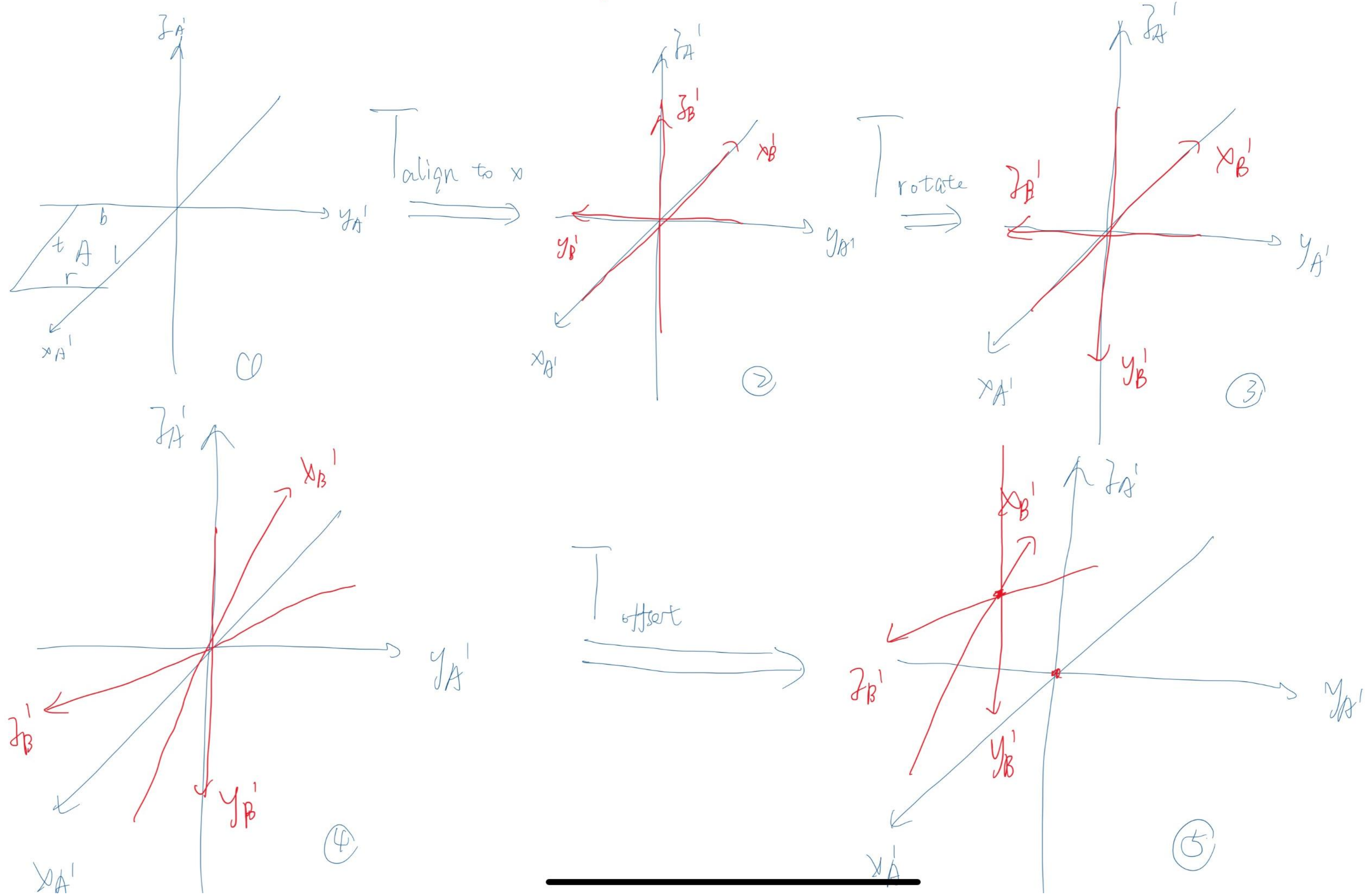
3. how is this actually processed in the recursive function that builds B from A (places)

place (T_A):

step 1: pretransform A itself : $T_A \cdot T_{pretransform} = T_A'$ — the correct global T ①



step 2: process B that is connected with A: $T_{A'} \cdot T_{offset} \cdot T_{align} \cdot T_{rotate} = T_{B}$. ②



However, user input might be from $B \to A$, but in the recursion calls, we may call A before B.

We must process $A \to B$ anyway because if the user input is $C \to A \leftarrow B$, but this is hard.

4. So we flexibly use the two equations:

A: $T_A \cdot T_{pretransform} = T_A'$ — the correct global T ①

$$T_A \cdot \underbrace{T_{offset} \cdot T_{align} \cdot T_{rotate}}_{\Downarrow} = T_B. \quad ②$$

these info are from $B \to A$, cannot be used. to find T_B

, so it may be easier if we just go to B any way.

B: $T_B \cdot T'_{pretransform} = T_{B'}$ ③

4. So we flexibly use the two equations:

A: $T_A \cdot T_{pretransform} = T_A'$ — the correct global T ①

$T_A \cdot \underbrace{T_{offset} \cdot T_{align} \cdot T_{rotate}}_{\Downarrow} = T_B$. ②

these info are from B→A, cannot be used to find T_B

, so it may be easier if we just go to B any way.

B: $T_B \cdot T'_{pretransform} = T_B'$ ③

we basically knows it.

$T_B \cdot \underbrace{T'_{offset} \cdot T'_{align} \cdot T'_{rotate}}_{T} = T_{A\,almost}$ ④

$\Downarrow$

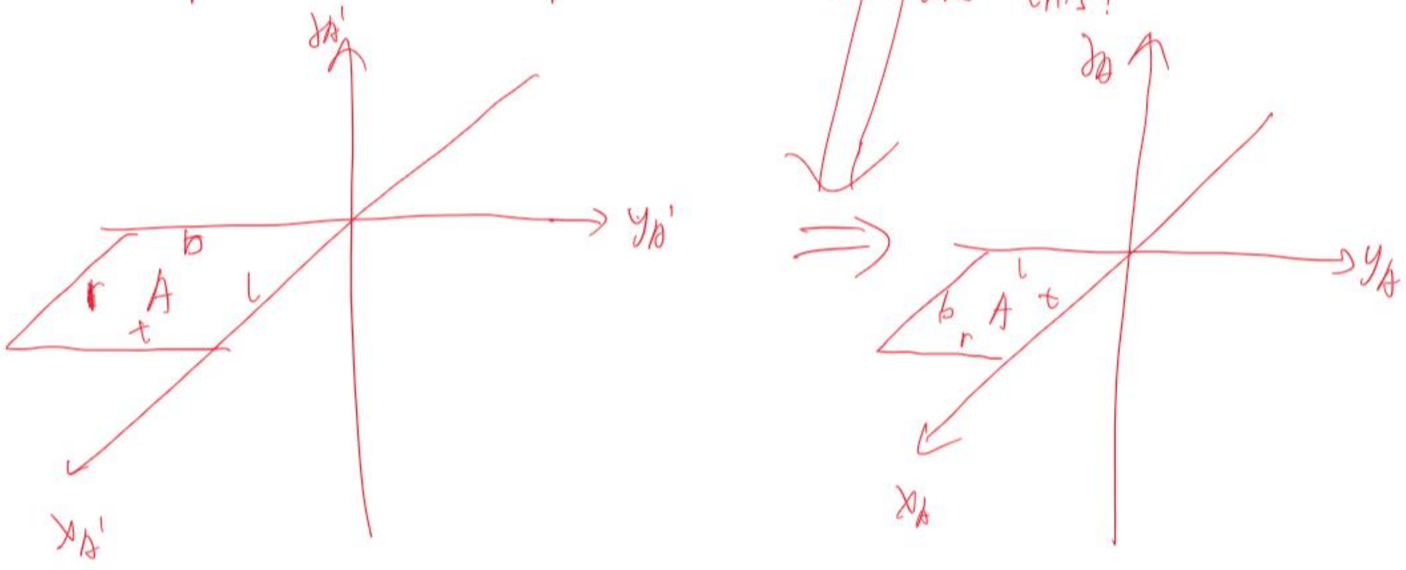
$T_{A\,almost} \cdot T^{-1} = T_B$!!!

$T \Downarrow$

$$\boxed{T_{A\,almost} \cdot T^{-1} = T_B.}\ !!!$$

$$T_{A\,almost} = T_A \cdot \underline{T''_{align} \cdot T''_{offset}}$$

when process B→A, B expects A to be like this?



$T_{A\,almost}$ $T_{A\,actual}$