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[1.] Orthogonal Transformation: An orthogonal transformation is a way to change the position or orientation of objects in space without distorting their shape or size.

Imagine you have a square on a piece of paper. If you rotate the paper or flip it over, the square looks different but it's still the same size and shape. That's what an orthogonal transformation does: it moves things around without stretching or squishing them.

In math, it's like using a special kind of matrix (called an orthogonal matrix) to change a set of numbers or coordinates in a way that keeps the same distances and angles between them. This is useful in many areas, like graphics and data analysis, because it helps to keep things accurate and consistent.

Example: orthogonal transformation like rotating or flipping a picture frame on your wall.

1. **Rotation**: When you rotate the picture frame 90 degrees, the picture looks different because it's oriented differently, but the image itself hasn't changed. It's still the same size and the same picture.
2. **Flipping**: If you flip the picture frame upside down or turn it around, the picture might be upside down or mirrored, but again, the image itself remains unchanged in terms of size and content.

In both cases, the transformation (rotation or flipping) changes the position and orientation of the picture but not its actual shape or size. Similarly, an orthogonal transformation in math changes the position and orientation of points in space while keeping the distances and angles between them the same.

[2.] <u>Euclidean transformation:</u> A Euclidean transformation is a way to move objects around in space without changing their shape or size.

Imagine you have a toy car on a table:

1. **<u>Translation</u>**: You can slide the toy car to a different spot on the table. It’s still the same car, just in a different position.
2. **<u>Rotation</u>**: You can rotate the toy car, turning it to face a different direction. The car itself doesn't change; only the direction it faces changes.
3. **<u>Reflection</u>**: You can flip the toy car over. The car is still the same, just mirrored.

A Euclidean transformation combines these movements—sliding, rotating, and flipping—without altering the toy car's shape or size. In math, this means moving points in space while keeping the distances and angles between them the same, ensuring that the object's size and shape are preserved.

[3.] <u>Affine transformation:</u> An affine transformation is a way to move, rotate, resize, or skew objects in space. It’s like a combination of simple movements and changes that can reshape objects while still keeping straight lines straight and parallel lines parallel.

Imagine you have a rectangle drawn on a piece of rubber:

1. **<u>Translation</u>**: You can move the entire rectangle to a different spot on the rubber. The shape remains the same, just in a different position.
2. **<u>Rotation</u>**: You can rotate the rectangle around a point. The rectangle’s orientation changes, but the shape stays the same.
3. **<u>Scaling</u>**: You can stretch or shrink the rectangle, making it bigger or smaller while keeping its proportions the same.
4. **<u>Shearing</u>**: You can push the top of the rectangle to one side while keeping the bottom fixed, turning the rectangle into a parallelogram.

In math, an affine transformation uses a special kind of matrix to apply these changes to points in space. This transformation can move, rotate, resize, and skew shapes, but it always keeps straight lines straight and parallel lines parallel.

[4.] <u>Projective transformation:</u> A projective transformation is a way to change the appearance of objects in space as if you were looking at them from a different angle or perspective. It can make straight lines appear curved and parallel lines converge, like how things look in a photograph.

Think of a projective transformation like taking a photograph of a building:

1. **<u>Perspective Change</u>**: When you take a picture of a tall building from the ground, the top of the building looks narrower than the bottom, even though the building is actually straight. The lines of the building seem to converge at a point in the distance.
2. **<u>Depth Effect</u>**: Objects closer to the camera appear larger, and objects farther away appear smaller. For example, if there are people standing at different distances from the camera, the person closer will look bigger than the person farther away.

So, a projective transformation in math works like this photo effect. It changes the way shapes look by simulating different angles and perspectives, making straight lines appear curved and parallel lines seem to meet at a point, just like how our eyes or a camera lens captures the world in 3D on a 2D surface.