# Computer Graphics

Assignment 1

## Tangram Application

**Answers**

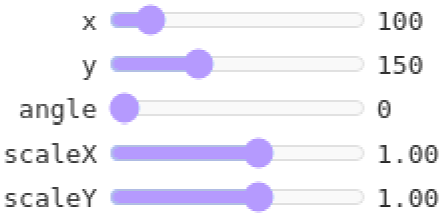
1) There are at the base level, two methodologies to implement our requirements. One is to make only one primitive as the current primitive and then switch to another primitive after completing the transformations for the previous primitive. I.e. not providing any flexibility to apply transformations to the previously selected and transformed primitive (C.2.a). And the other way is to make this flexible (C.2.b). Here apart from the functionality, the implementation also differs.
   In the case of C.2.a, since the previously worked primitive is no longer allowed to transform, therefore, we need not store its transformation data, which includes translation data, rotation data, and scaling data. We can use the same matrices for all the shapes by simply just replacing the data present inside them.
   But in the case of C.2.b, since it's flexible to even work on a primitive which was worked upon previously, we need to keep a track of its transformation data, so as to continue the transformations upon selecting that shape. Hence, here instead of maintaining one set of matrices (transformation matrix, rotation matrix, and scale matrix), we maintain different sets for different shapes with a proper mapping with its ID and its transformation matrices set.

2) **Application Programming Interfaces** (APIs) are prebuilt functions that help developers to create complex functionalities in a much easier way. They create an abstraction to replace complex code snippets, with some simple code.
   When it comes to JS, there are a couple of APIs which help in fetching events of users (specifically these kinds of APIs fall under **browser APIs**). One of such events includes detecting mouse button click. For this, **mouse events API** is generally used. The documentation for the same can be found here: https://api.jquery.com/category/events/mouse-events/

3) There are two ways using which we can minimize the number of key click events used.
   a) By click and drag: We can select a primitive to pick it. Then we can dedicate specific keys for each kind of transformation (translation, rotation, and scaling). Then to transform it, instead of using the keyboard keys, we can detect the mouse hover position and then transform the primitive accordingly. When a mode is changed (say from 1 to 2), here, we can remove the primitive selection step and can directly proceed to the second

    step, i.e. pressing the transformation dedicated key and then following the same procedure.

    b) By specifying the transformation values directly: Here, we can simply select the primitive and directly specify the destination values of that particular transformation. Example:



x 100<br>
y 150<br>
angle 0<br>
scaleX 1.00<br>
scaleY 1.00

This way is indeed even user-friendly and is preferable.
Here when the mode is changed from 1 to 2, we can omit the primitive selection (using mouse click) step.

4) There are majorly 3 transformations involved in this:
    a) Translation (Horizontal or vertical): This is absolute and is the same irrespective of the point of reference, given the axis is not rotated.
    b) Rotation (Clock-wise or Anti-Clock-wise): Here, this depends upon the point of reference as the final coordinates change depending upon the point of reference. Generally, rotations are done w.r.t origin. But if we want to rotate w.r.t its own central axis, we shift origin to that point that defines the central axis and then perform the operation. In this way, the rotation happens w.r.t its own axis. Now the best choice would be to consider centroid, as it lies at equal distance from all the vertices and hence properly define the position of a primitive with just a single point. (Though the trade-off would be that, we will lose information about its size)
    c) Scaling (Positive or Negative): Even in this case, the scaling usually happens w.r.t origin. Hence to scale it w.r.t primitive center, we consider its centroid, shift the origin to the centroid and finally scale it.

Hence, often centroid is used to define the position of a primitive (leaving its dimensions), as the transformations only depend upon the position rather than its dimensions.

**References**

1) https://webglfundamentals.org/