Assignment 2 submitted for 3D Modelling and Animation (UCS636)

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Assignment 2: 3D Models using basic primitives

1. A) **Duplicate and Merging Techniques:** Duplicate will create a visually identical copy of the selected object(s). The copy is created at the same position as the original object, and you are automatically placed in move mode. Duplication is done by pressing Shift+D. Merge allows you to merge all selected vertices to a unique one, dissolving all others. The shortcut for merging is M. Merging vertices of course also deletes some edges and faces.

   B) **Normal:** A normal is a line that's perpendicular to a surface, a line, a curve, or even a point. Normals of faces in Blender are the average of all the vertices of the face, displayed relative to the camera in the 3D workspace. Normals are helpful in defining the inclination and the positioning of the planes in space.

   C) **Extrusion and Inset Tools:** Extrusion tools duplicate vertices, while keeping the new geometry connected with the original vertices. Vertices are turned into edges and edges will form faces. This tool is of paramount importance for creating new geometry. It allows you to create parallelepipeds from rectangles and cylinders from circles, as well as easily creating such things as tree limbs. It works by pressing E in edit mode. The axis on which vertices and edges are extruded along can be set interactively. Faces are extruded by default along their averaged normal. The extrusion can be limited to a single axis by specifying an axis. The extrude tools differentiate in how the new geometry is connected.
   Inset tool takes the currently selected faces and creates an inset of them, with adjustable thickness and depth. Think of it as like creating an edge loop, but relative to the selected edges, even in complex meshes. The tool is modal, such that when you activate it, you may adjust the thickness with your mouse position. It works by pressing I in edit mode.

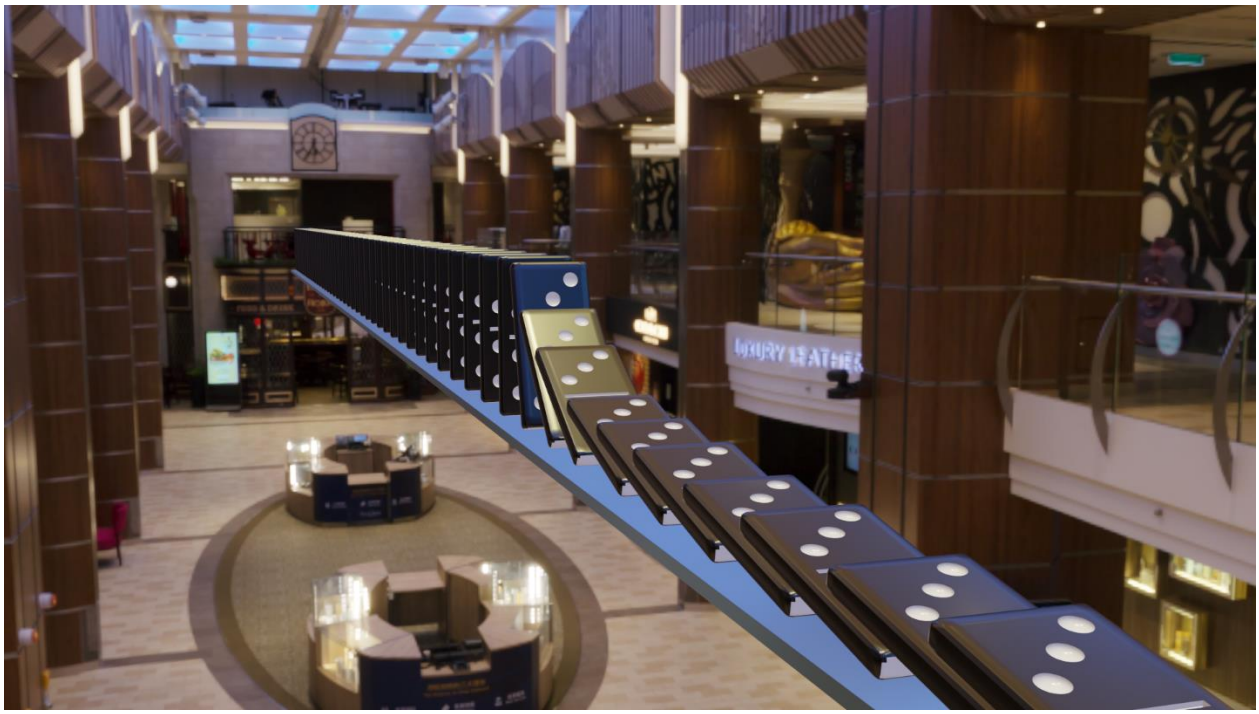
   D) **Edge Loops, Loop Cut and Slide:** An edge loop in Blender is a series of edges that connect to form a path where the first and last edges connect to each other. Edge loops can be selected by first selecting an edge (vertex or edge selection mode), and then going to Select → Edge Loop.
   Loop Cut and Slide splits a loop of faces by inserting a new edge loop intersecting the chosen edge. The shortcut to use this is Ctrl+R. It has two steps- Previsualizing the cut and then sliding the new edge loop.

   E) **Snapping Tool:** There are two types of snap operations that you can use in Blender. The first type snaps your selection or cursor to a given point while the second type is used during transformations (translate, rotate, scale) and snaps your selection to elements within the scene. The shortcut to use it is Shift+Tab. Snapping is to put an element into an exact position in relation to some other entity. The snapping tool can be accessed either by toggling the magnet icon in the header bar of the 3D viewport or by holding "CTRL". If the magnet icon is turned on, holding "CTRL" will reverse the effect and temporarily turn off snapping.

F) **Array Modifier:** The Array modifier creates an array of copies of the base object, with each copy being offset from the previous one in any of several possible ways. Vertices in adjacent copies can be merged if they are nearby, allowing smooth Subdivision Surface frameworks to be generated. This modifier can be useful when combined with tileable meshes for quickly developing large scenes. It is also useful for creating complex repetitive shapes. To separate an object, the vertices (or faces) must be selected and then separated, though there are several different ways to do this- by selecting the elements, by material and by loose parts.

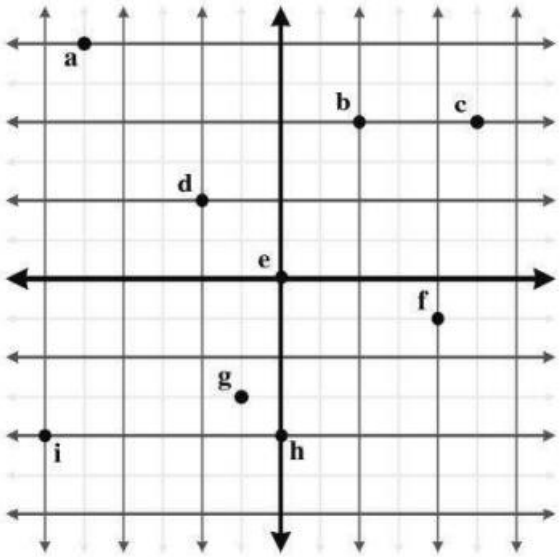
G) **Subdivision:** Subdividing splits selected edges and faces by cutting them in half or more, adding new vertices, and subdividing accordingly the faces involved. It adds resolution to the mesh by divide faces or edges into smaller units. Higher levels of subdivisions result in more vertices which means higher memory consumption (both system RAM, and video memory for display). This can cause Blender to hang or crash if not enough memory is available.

3D Model rendered image:



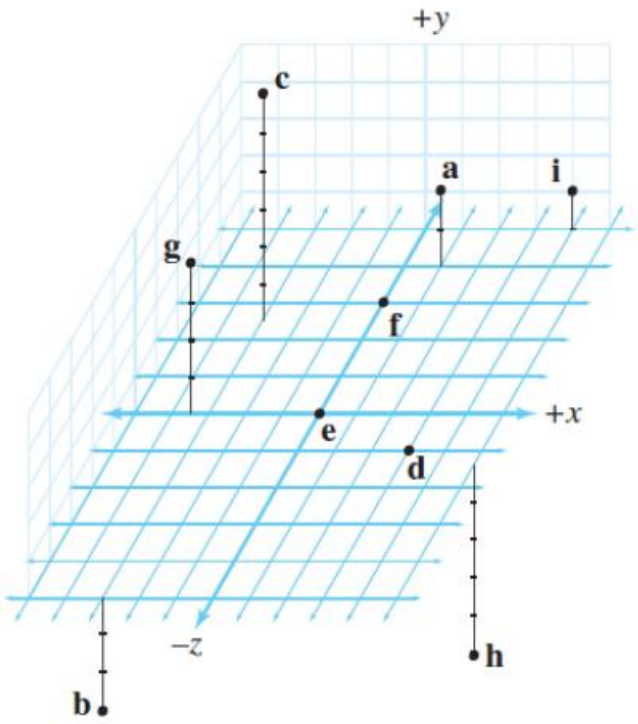
I made a domino run animation and applied all of the above tools in this object. Furthermore, I added camera walk navigation to make the animation visually appealing.

2. Coordinates of the points:



a: (-2.5, 3)
b: (1, 2)
c: (2.5, 2)
d: (-1, 1)
e: (0, 0)
g: (2, -0.5)
h: (0, -2)
i: (-3, -2)

3. Coordinates of the points:



a: (1, 2, 4)
b: (-3, -3, -5)
c: (-3, 6, 2.5)
d: (3, 0, -1)
e: (0, 0, 0)
f: (0, 0, 3)
g: (-3.5, 4, 0)
h: (5, -5, -1.5)
i: (4, 1, 5)

4. List the 48 different possible ways that the 3D axes may be assigned to the directions "north," "east," and "up." Identify which of these combinations are left-handed, and which are right-handed.

   Left-Handed:

NORTH	EAST	UP
+x	+y	+z
+x	-y	-z
-x	+y	-z
-x	-y	+z
+y	+x	-z
+y	-x	+z
-y	+x	+z
-y	-x	-z
+z	+x	+y
+z	-x	-y
-z	+x	-y
-z	-x	+y
+x	+z	-y
+x	-z	+y
-x	+z	+y
-x	-z	-y
+y	+z	+x
+y	-z	-x
-y	+z	-x
-y	-z	+x
+z	+y	-x
+z	-y	+x
-z	+y	+x
-z	-y	-x

Right-Handed:

NORTH	EAST	UP
+x	+y	-z
+x	-y	+z
-x	+y	+z
-x	-y	-z
+y	+x	+z
+y	-x	-z
-y	+x	-z
-y	-x	+z
+z	+x	-y
+z	-x	+y
-z	+x	+y
-z	-x	-y
+x	+z	+y
+x	-z	-y
-x	+z	-y
-x	-z	+y
+y	+z	-x
+y	-z	+x
-y	+z	+x
-y	-z	-x
+z	+y	+x
+z	-y	-x
-z	+y	-x
-z	-y	+x

5. In the popular modelling program such as 3DS Max and Blender, the default orientation of the axes is for +x to point right/east, +y to point forward/north, and +z to point up.
   a. Is this a left- or right-handed coordinate space?
   b. How would we convert 3D coordinates from the coordinate system used by 3DS Max into points we could use with our coordinate conventions discussed in?
   c. What about converting from our conventions to the 3DS Max conventions?

Ans. a. Right-handed coordinate space.

b. Autodesk 3ds Max uses right-handed coordinate system with Z axis pointing in the up direction. This convention is like Blender. We convert coordinate system from z-up to y-up system.

X (blender/3ds max) → X (convention)
Y (blender/3ds max) → Z (convention)
Z (blender/3ds max) → -Y (convention)

When the scene from Blender gets exported to glTF, it automatically converts all coordinates by swapping Y/Z axes. We can change the viewport from user to world viewpoint. We need to multiply the vector/matrix with the transformation matrix which converts z-up to y-up

system. Transformation matrix: [1, 0, 0] [0, 0, 1] [0, -1, 0] [0, 0, 0]

c. We can also convert our conventions to 3DS Max conventions by shifting the coordinate system from y-up system to a z-up system.

X (convention) → X (blender/3ds max)
Y (convention) → -Z (blender/3ds max)
Z (convention) → Y (blender/3ds max)

We need to multiply the vector/matrix with the transformation matrix which converts y-up to z-up system. Transformation matrix: [1, 0, 0] [0, 0, -1] [0, 1, 0] [0, 0, 0]