1. Drawing Penguin
   Drawing penguin is basically like A1, we first creating some function which can draw cube, triangle prism and trapezoidal prism. Using those functions to make different components.

   - *void drawCube*()
     Draw a unit cube
   - *void TrapPrism*()
     draw a 3d trapezoidal prism with given length, width and height
   - *void TriPrism*()
     draw triangle prism

   After done creating the shapes of all different components, let's start building the penguin. First draw the body in the middle of the window, then scale it. Then using translation takes us to local view relative to penguin's body then draw a component (i.e arm) give it some colour and scale it to a given size, then go back to world view(penguin's body)again and translation to another local view and draw another component. So every time we draw a component we always go to a local view relative penguin's body and after we done we go back to world view(penguin's body). Hence, when we moving penguin's body all other components are moving correspondingly. Especially, we need to notice that foot is also relatively to leg in the local view of leg, they are one component for world (penguin's body) but two separate parts if we go to the local view. This means when we moving leg, foot is moving correspondingly. And foot can also moving separately. Same for head, head also has subtrees, means when we moving head eye and mouth are also moving correspondingly. The structure tree below shows how does every part related to other parts and how does it move.

$$\begin{tikzcd}
 & & & Body \arrow[dlll] \arrow[dl] \arrow[d] \arrow[dr] \arrow[drr] & & \\
Head \arrow[d] \arrow[dr] & & Arm_{left} \arrow[d] & Arm_{right} \arrow[d] & Leg_{left} \arrow[d] & Leg_{right} \arrow[d] \\
Beak_{top} & Beak_{bot} & Hand_{left} & Hand_{right} & Foot_{left} & Foot_{right}
\end{tikzcd}$$

2. Render Penguin
   The penguin is rendered in a wireframe view.

- $glPolygonMode(GL\_FRONT\_AND\_BACK, GL\_LINE)$:
  draw outlines of the penguin's shape
- $glPolygonMode(GL\_FRONT\_AND\_BACK, GL\_FILL)$:
  draw a solid view of penguin

Espcieally, for $solid\ with\ outline$, we first draw the a solid view of penguin, and then call

$$glEnable(GL\_POLYGON\_OFFSET\_LINE)$$

After specifing the polygon offset, we can draw outlines on the top of solid view.
For Metallic and Matte, we needed to apply diffusion, ambience, specular and shiness

$$glMaterialfv \quad glMaterialf$$

wereused to apply these properties for both metallic and matte renders.

3. Animation
   Animation is created by keyframes of the penguin in different poses. Then using Catmull-Romm to interpolate those action to create animation.