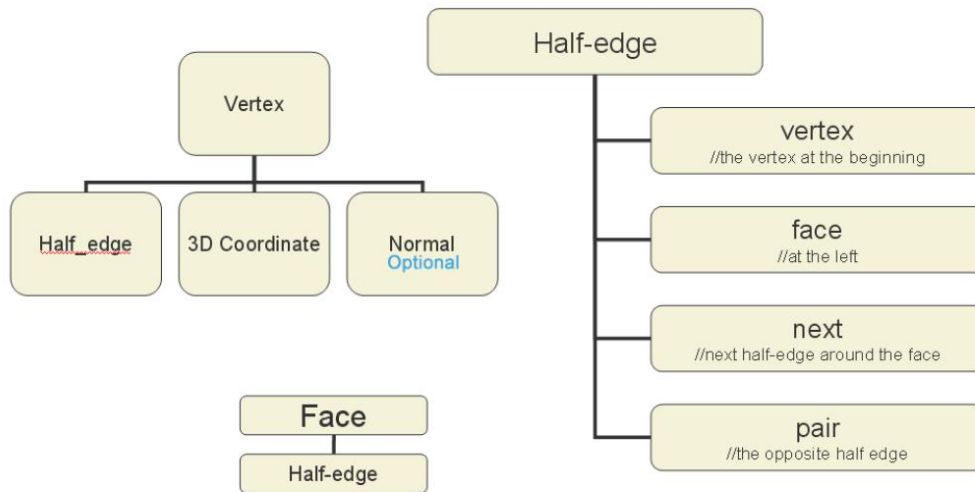


1. A simple mesh with no boundary vertex is saved in a Half-edge data structure. Write an $O(1)$ (constant time respect to the number of vertices) algorithm that replaces a given vertex with the average of all its adjacent vertices. **(5 marks)** *(This topic has not been covered in this semester yet).*



2. (a) Find a transformation matrix for a reflection about $y=2x$ line. **(4 marks)**
 (b) Find the inverse matrix of this transformation from geometric reasoning and show that the resulting matrix has the necessary property of inverse matrices. **(3 marks)**
3. Answer the following questions briefly:
- Show that $u^2 P + 2u(1-u) Q + (1-u)^2 R$ is a point for arbitrary u . **(1 marks)**
 - Show that $(4P - Q - 3R)$ is a vector. **(1 marks)**
 - Find the inverse transformation of $M=R(\theta)T(V)$ where $R(\theta)$ is a general 3D rotation and $T(V)$ is a general 3D translation. **(2 marks)**
 - Let $\{V_0, V_1, \dots, V_n\}$ be a set of given control points. We wish to apply the closed Chaikin subdivision on it. How many control points do we have after j levels of subdivision? **(2 marks)**
 - A grid of 3D points is given as control mesh of a tensor product surface. If this control mesh is flat (planar). Is the resulting cubic B-spline surface flat? Why? **(2 marks)**