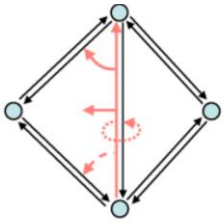
CS 418: Interactive Computer Graphics Spring 2019
In-class Worksheet

Subdivision Surfaces and Simulating Physics

1. **Implementing Subdivision Surfaces**
   The half-edge data structure is designed to be efficient for the neighborhood queries required by subdivision. It stores a ***vertex array***, ***face array***, and ***half-edge array*** holding objects of the types shown in the C style declarations below.

```
struct HE_edge{

      HE_vert*   end;        // vertex at the end of the half-edge
      HE_edge* opposite;     // oppositely oriented adjacent half-edge
      HE_face*  leftFace;    // face the half-edge borders
      HE_edge* next;         // next half-edge around the face
};

struct HE_vert{

      float x, y, z;
      HE_edge* edge;   // one of the half-edges emanating from the vertex
};

struct HE_face{

      HE_edge* edge;  // one of the half-edges bordering the face
};
```



In the average case, how many operations are required to find all the neighbors of a given vertex using a half-edge data structure? How does that compare to using an indexed face set data structure? Assume each vertex has valence 6.

How would you implement a function `HE_vert * start(HE_edge * e)` that returns the starting vertex of a half-edge?

2. Physics Engine

A particle begins at

$$\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$$

and is moving with velocity

$$\begin{bmatrix} 1 \\ -1 \\ 2 \end{bmatrix} \text{ per second,}$$

and acceleration

$$\begin{bmatrix} 0 \\ 1 \\ -1 \end{bmatrix} \text{ per second per second.}$$

a. Use the second integral of the acceleration to compute the position after 5 seconds. The update equation you should use is:

$$p' = p + \dot{p}t + \ddot{p}\frac{t^2}{2}$$

b. Calculate the position using 5 time steps of 1 second each using the update equations below.

$$p' = p + \dot{p}t \qquad \dot{p}' = \dot{p} + \ddot{p}t$$

c. What is the error? Explain why it happens.