CS 419: Production Rendering Fall 2018
In-class Worksheet 5

Geometric Modeling

1. Prove the average valence of a vertex in a manifold triangle mesh is 6. *Hint: Use the Euler characteristic V-E+F=2(1-g) to write E in terms of V*

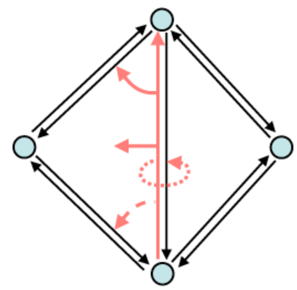
   V+F = E+2 (let's just drop the 2)
   V+(2E/3) = E
   V = (1/3)E
   3V = E

   Each edge has 2 endpoints so 6V endpoints are distributed over V vertices, with each endpoint indicating a neighbor
   So, average valence is 6

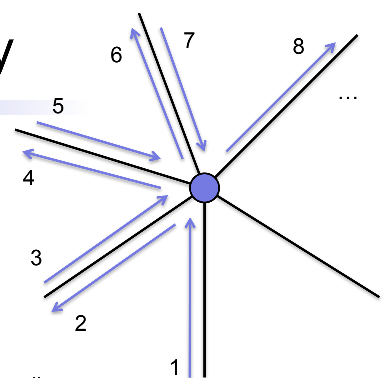
2. Write a pseudo-code function that uses the half-edge data structure below to find all neighboring vertices of a vertex ***v***.

```
class HalfEdge {
  HalfEdge   *opp;
  Vertex     *end;
  Face       *left;
  HalfEdge   *next;
};

HalfEdge e;
```



Vertex Star Query

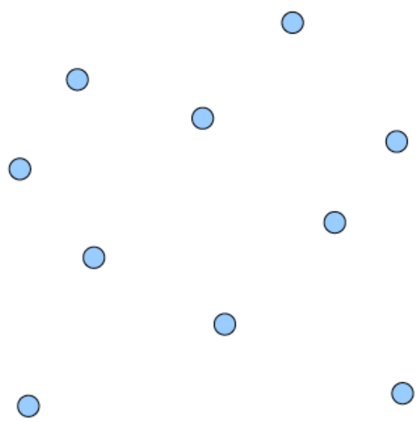


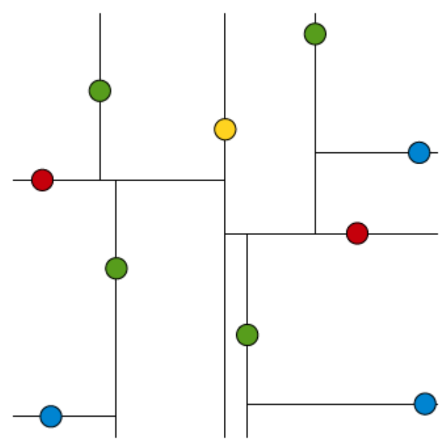
1. e
2. e->next()
3. e->next()->opp()
4. e->next()->opp()->next()
5. e->next()->opp()->next()->opp()
6. e->next()->opp()->next()->opp()->next()
7. e->next()->opp()->next()->opp()->next()->opp()
8. e->next()->opp()->next()->opp()->next()->opp()->next()

… until e(->next()->opp())^n == e

Spatial Partitions

3. Draw the 2D spatial partition that would be created by a kd-tree for the following point set. Assume you starting splitting the x-axis and split at the median point each time.





4. Suppose the overall bounding box for the tree is given by the corners (3, 5) and (8,15) and the first split is at point (7,11). What is the bounding box of the right child of the root?

   (7,5) to (8,15)

5. Compare the number of cells in a uniform grid containing n points and a kd-tree containing n points. Assume the uniform grid uses the allocation strategy discussed in lecture with a magic number m=2.

   The kd-tree will generate n+1 spatial cells while the grid will be around 8n cells