# A GRAPH THEORY TECHNIQUE IMPLEMENTATION IN BENEFITS OF HUMAN ORGAN BLOOD CIRCULATION USING MAT LAB

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***Abstract:*** **Graph theory and its applications in human heart are discussed in this paper. Here, we have applied the techniques of graph theory and mat lab algorithm. The main concept is to get the shortest blood flow analysis in human heart with respect to oxygenated and deoxygenated blood circulation using the network graph theory. The heart organ is converted into topological structure of graph which is represented by a planar graph. This concept may help in study of blood flow system in human heart. The stereographic projection of a graph is presented with Floyd algorithm (mat lab) in order to improve the performance of the model. This work will definitely helpful to develop a tool in solving the blood flow system in human heart.**

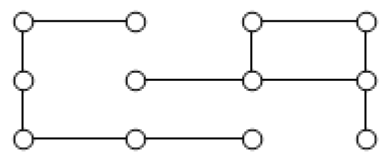
***Keywords*: Network; Graph; topological structure; Floyd algorithm; human heart; Circulation; Analysis; image processing.**

**Introduction:** Graph theory[1-4] has recently emerged as a subject in its own right as well as an important mathematical tool in such diverse areas such as health care, PERT, sociology, genetics etc. A graph $G$ is a pair $(V,E)$, where $V$ is nonempty set called vertices or nodes and $E$ is 2-element subsets of $V$ called edges or links. The number of vertices in a graph $G$ is the order of $G$, and the number of edges is the size of $G$. An edge joining a vertex to itself is called a loop. Two or more edges that join the same pair of distinct vertices are called parallel edges. Let $G = (V(G),E(G))$ be a graph; we call $H$ a subgraph of $G$ if $V(H) \subset V(G)$ and $E(H) \subset E(G)$, in which case we write $H \subset G$. The eccentricity $e(v)$ of a vertex $v$ in a connected graph $G$ is the distance between $v$ and a vertex farthest from $v$ in $G$, while the radius rad($G$) is the smallest eccentricity among the vertices of $G$. The notions of closure operator is very useful tool in several sections of mathematics, as an example, in algebra,[5,6] topology,[7,8] and computer science theory,[9] the connection between graph theory and different subjects, as in structural analysis,[10] medicine[11] and physics.[12] Topology is the science that deals with the properties of things that does not depend on the dimension, which means that it allows increases and decreases, but without cutting on things. If $X$ is a nonempty set, a collection $\tau$ of subsets of $X$ is said to be a topology on $X$, and if the following condition holds $X$ and $\phi$ belongs to $\tau$, the finite intersection of any 2 sets in $\tau$ belongs to $\tau$ and the union of any number of sets in $\tau$ belongs to $\tau$.[13] The term topology is also used to refer to a structure imposed upon a set $X$, a structure that essentially "characterizes" the set $X$ as a topological space by taking proper care of properties such as convergence, connectedness, and continuity, upon transformation. Every element in topology is called an open set, its complement is a closed set. The closure of a subset $A$ (briefly, Cl($A$)) is the smallest closed set that contains $A$ . The interior of a subset $B$ (briefly, int($B$)) is the greatest open set that is contained in $B$. The main contribution of the work is that we provide a new definition of a relation to extract a topology from any graph and study some properties. Throughout the paper, we start with the application of abstract topological graph theory. Some ideas in terms of concepts in topological graph theory, which is a branch of mathematics, and in many real-life applications will be investigated. We give an algorithm to generate some topological structural in graphs. Each topological structure on graphs is a topological space. Some properties on closure and interior operators for topological graphs will be studied. Finally, we apply both of a graph and a topology on some of the medical application such as the blood circulation in the human body and geographical application such as a street system of a community.

**Definitions**—

- If uv is an edge of G, then u and v are adjacent vertices. Two adjacent vertices are referred to as neighbors (ie, $N(v_i)$) of each other. The number of vertices in a graph G is the **order (degree) of G**, and the number of edges is the size of G. The degree of a vertex v in a graph G is the number of vertices in G that are adjacent to v, denoted by $deg_G(v)$.
- A multigraph is a nonempty set of vertices, every 2 of which are joined by a finite number of edges. Structures that permit both parallel edges and loops are called **pseudographs.** A graph is simple if it has **no loops or parallel edges**. A simple graph is called **complete graph**, if any 2 distinct vertices are joined by an edge.
- If the vertex set of a graph G can be split into 2 disjoint sets A and B, so that each edge of a graph G joins a vertex of A and a vertex of B, then graph G is **a bipartite graph**. **A complete bipartite graph** is a bipartite graph in which each vertex in A is joined to each vertex in B by just one edge.
- A **spanning subgraph** of a graph G is a subgraph obtained by edge deletions only. An induced subgraph of a graph G is a subgraph obtained by vertex deletions together with the incident edges.
- The path P is called **topological open subgraph** if the subgraph not contained its end point. The path P is called topological closed subgraph if the subgraph contained its initial and its end points.
- A graph is said to be **connected** if there exists a path from each vertex to any other vertices. All graphs shown in the above examples so far are all connected. Below we have shown the graph which is disconnected; there are two components of a graph

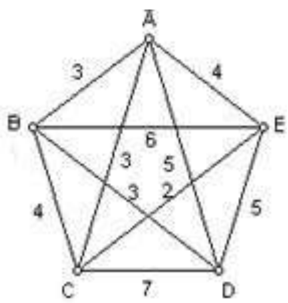
showing the disconnected graph.

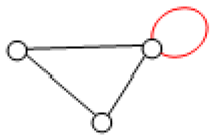


➢ Sometimes **weights** are assigned to the edges to solve some problems. The weights represent the distance between two places, the travel cost or the travel time. It is significant to notice that the distance between vertices in a graph need not corresponds to the weight of an edge of a graph.

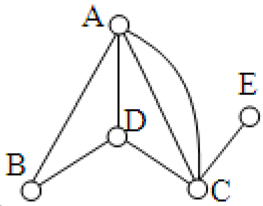
➢ If in a graph the vertex joins itself then that edge is called **a loop.**

➢ If in a graph, two or more edges join the same ordered pair of vertices $(v_i, v_j)$ then those edges are called multiple edges and the graph is called **multi-graph.**



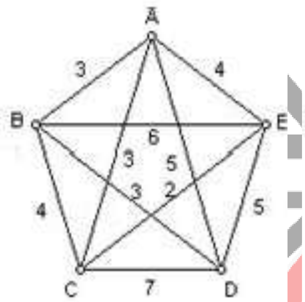



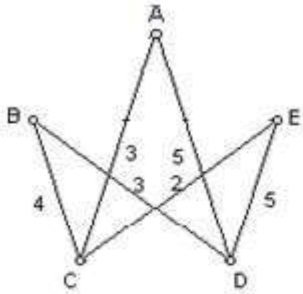
$G$




➢ It is a bipartite graph in which every pair of vertices of $V_1$ and $V_2$ is joined. A complete graph with vertices is denoted

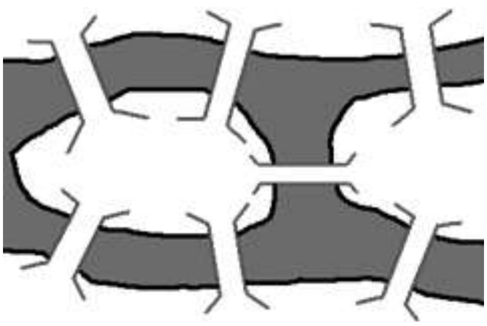
$n$ $K_n$




A Graph $G$ Its Complete bipartite graph

➢ Eulerian Graph: In a connected graph $G$ if there exists a closed trail which comprises of each edge of G then that graph is called as Eulerian graph. A non-Eulerian graph $G'$ is said to be semi-Eulerian if there exists a trail which contains every edge of $G'$. The name “Eulerian” comes up from the information that Euler was the first and main person to explain the solution for famous Konigsberg bridges problem. The problem investigates whether one can pass every seven bridges exactly once and return to the starting point without repeating the path.

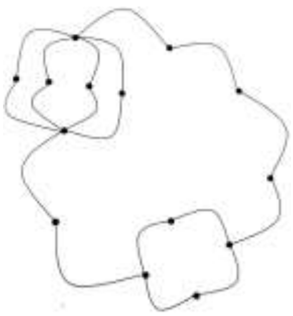


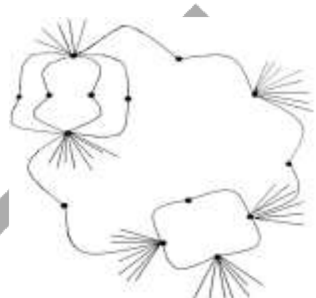
➢ Hamiltonian graph: If in a $G$ graph, there exists a cycle which passes across each vertex without repetition in , then the graph is called Hamiltonian. This cycle is called Hamiltonian cycle of $G$ . A non-Hamiltonian graph $G'$ is said to be semi- Hamiltonian if there exists a path which passes through each vertex of $G'$. This path is called Hamiltonian path of $G'$.

$G$

➢ **Proposition :** If G = (V, E) is a connected graph and (V(G), $\tau$) is a topology induced by $\beta_i$={V(G), $\phi$, {$v_i$}, {N($v_i$)}} as a basis and if $P_1$ and $P_2$ are open paths, then
1. V($P_1$) ⊆ Cl(V($P_1$)).
2. If $P_1 \subseteq P_2$, then Cl(V($P_1$)) ⊆ Cl(V($P_2$)).

**Human Heart**— the human heart is a muscular organ which is about the size of a closed palm which performs the pumping function of body's blood circulatory system. It receives deoxygenated blood inside through the veins and transports it to the lungs for oxygenation earlier than pumping it into the various arteries which provides nutrients and oxygen to tissues of the body by transferring the blood right through the body. The heart is positioned in the thoracic cavity medial in the direction of the lungs and posterior to the sternum. On its better end, the base of the heart is attached to the aorta, and veins, the vena cava and pulmonary arteries. The lower tip of the heart, known as the apex, rests just superior to the diaphragm. The bottom portion of the heart is situated at the body's midline with the peak pointing toward the left side. Since the heart exists to the left, about 2/3$^{rd}$ of the heart's mass is originated on the left side of the body and the other 1/3$^{rd}$ is on the right. The different parts of human heart are shown in Figure 1(a).


Micro Cardiac Network Graph


Thickly crowded Micro

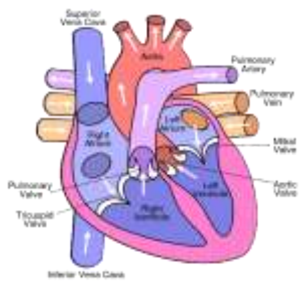

Cardiac Network System

Fig 1: Construction of Micro-Cardiac Network Graph.

**SOME APPLICATIONS:** In this section, we give Floyd algorithm which is coded in MAT Lab to evaluate the shortest pathway of blood flow in topological structure of heart system .We represent a graph by micro cardiac network graph and thickly crowded micro cardiac network system as shown above, thus by running in below MAT Lab coding, we observe the shortest blood circulation of a human body.

**The following are Mat lab codes, Floyd.m, for Floyd algorithm:**

```
d=input('Input the file name of adjacency matrix of the weighted network (e.g., adj.txt, adj.xls, etc. Adjacency matrix is d=(dij)v*v, where v is the number of nodes in the network. dij=1 for unweighted network and dij=wij for weighted network (wij is the weight for the link vi to vj), if vi and vj are adjacent, and dij=0, if vi and vj are not adjacent; i, j=1,2,…, m): ','s');
 d=load(d);
% d: weighted adjacency matrix; distances: matrix of distances between different
 % nodes; paths: string of paths and distances between any of two nodes
inf=1e+50;
v=size(d,1);
a=zeros(v);
b=zeros(1,v*(v-1)/2);
e=zeros(1,v*(v-1)/2);
h=zeros(1,v*(v-1)/2);
distances=zeros(v);
for i=1:v
for j=1:v
if ((d(i,j)==0) & (i~=j)) d(i,j)=inf; end
end; end
for i=1:v
for j=1:v
if (d(i,j)~=inf) a(i,j)=j; end
end; end
for i=1:v
for j=1:v
for k=1:v
c=d(j,i)+d(i,k);
if (c<d(j,k)) d(j,k)=c;
```

```
a(j,k)=i; end
end; end; end
paths='';
for p=1:v
for q=1:v
if (p==q) continue; end
u=a(p,q);
m=1;
b(1)=u;
while (v>0)
m=m+1;
b(m)=a(b(m-1),q);
if (q==b(m)) break; end
if (b(m)==b(m-1)) break; end
if (m>v) break; end
end
n=1;
e(1)=u;
while (v>0)
n=n+1;
e(n)=a(p,e(n-1));
if (p==e(n)) break; end
if (e(n)==e(n-1)) break; end
if (n>v) break; end
end
for i=1:m+n-1
if (i==1) h(i)=p; end
if ((i<=n) & (i>1)) h(i)=e(n-i+1); end
if ((i>n) & (i<(m+n-1))) h(i)=b(i-n+1); end
if (i==(m+n-1)) h(i)=q; end
end
paths=strcat(paths,'Shortest path from ',num2str(p),' to ',num2str(q),':\n');
for i=1:m+n-1
if ((h(i)~=0) & (d(p,q)~=inf))
if ((h(i)==h(i+1)) & (i<m+n-1)) continue; end
if (i<m+n-1) paths=strcat(paths,num2str(h(i)),'->'); end
if (i>=m+n-1) paths=strcat(paths,num2str(h(i)),'\n'); end
end; end
if (d(p,q)~=inf) paths=strcat(paths,'Distance=',num2str(d(p,q)),'\n'); distances(p,q)=d(p,q); end
if (d(p,q)==inf) paths=strcat(paths,'No path','\n'); end
end; end
disp('Distances matrix')
distances
disp('Shortest paths')
fprintf(paths)
```

## CONCLUSIONS AND DISCUSSIONS

The recent results and application techniques of network graph theory in micro cardiac system is illustrated by Graph Theory with advance era of application trends. In the present application of the Network graph theory layouts and Floyd algorithm by MAT LAB, the importance in the model of cardiac system gives effective solution in human cardiac system and stereographic network models. The objective of this investigation is to study the effort of application of network graph. To achieve the objective the investigation implemented of systemic circulation carries oxygenated blood from the ventricles, through the ateries, to the capillaries in the tissues of thr body. From this tissues capillaries, the deoxygenated blood returns through a system of veins to the right atrium of the heart.

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