Use of Graph Algorithms in Vascular Network Analysis

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Graph algorithms have been used to analyze the complex network of the renal glomerulus by representing vessels as edges and the branch points of the network as vertices [1]. A random graph process model was used to simulate the development of a vascular network. The correlation between the invariants of this vascular network modeled as a graph and the mechanisms of the growth of the network were studied. It was shown that the relative frequencies of sprouting and splitting during the growth of a given renal glomerulus can be estimated by the primitive invariants such as root distance, radius, and diameter of the graph representing the renal glomerulus network. Here the number of paths with length \( k \) is considered to compare the similarity between two vascular networks. An algorithm is devised using the dynamic programming paradigm based on the following recurrence relation in eqn 1.

\[
npl_k(v_s, x) = \begin{cases} 
\sum_{(y,x) \in E} npl_{k-1}(v_s, y) & \text{if } k > 1 \\
1 & \text{if } k = 1 \text{ and } (v_s, x) \in E \\
0 & \text{if } k = 1 \text{ and } (v_s, x) \notin E
\end{cases}
\] (1)

The computational time complexity is \( \Theta(kn^2) \).

References